5RSC-2024 Study Report

Xcel Energy
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EXECUTIVE SUMMARY

The 5RSC-2024 Cluster Study was conducted to evaluate the transmission system impacts associated with fifteen (15) Generator Interconnection Requests (GIRs) submitted under the 5RSC-2024 Resource Solicitation Cluster for interconnection to the Public Service Company of Colorado (PSCo) transmission system, a subsidiary of Xcel Energy. The requests collectively seek 4,755 MW of Energy Resource Interconnection Service (ERIS), including 1,441.1 MW of grid-charging capability associated with Battery Energy Storage System (BESS) projects. For study purposes, the requests were grouped into two generation portfolios, designated as Portfolio 1 and Portfolio 2, and evaluated independently.

The study assessed thermal loading, voltage performance, and transient stability under system intact, single-contingency, and selected multiple-contingency conditions in accordance with PSCo's Business Practice Manual (BPM) and applicable WECC and NERC reliability criteria. The analysis evaluated the GIRs by study pocket based on their respective points of interconnection, including the Metro, North, East, Western Slope, and South study pockets.

The study results indicate that no thermal overloads, voltage violations, or transient stability limitations attributable to the ERIS study GIRs were identified within the Metro, North, East, Western Slope, or South study pockets after the application of appropriate redispatch of existing PSCo generation. Consequently, no mitigation measures or Network Upgrades were required to accommodate the requested ERIS capacity. As a result, the GIRs within these study pockets are able to operate at their full requested ERIS output, or up to their maximum output at the Point of Interconnection (POI), including both discharging and grid-charging operations where applicable.

In addition, the study did not identify any Affected System impacts requiring mitigation.

The breaker duty study (short-circuit analysis) performed on the PSCo transmission system, including the 5RSC-2024 Cluster additions, did not identify any circuit breakers that became over-dutied as a result of the cluster additions.

Table 1: Summary of Requested and Maximum Allowable Interconnection Service for the 5RSC-2024 Cluster

GIR #	Portfolio	Requested by Customer		Study Findings		Estimated Total Cost (million US)
		Requested ERIS (MW)	Requested Grid Charging (MW)	Maximum Allowable ERIS (MW)	Maximum Allowable Grid Charging (MW)	
5RSC-2024-01	1	200.0	NA	200.0	NA	$1.400
5RSC-2024-02	1 and 2	400.0	NA	400.0	NA	$56.374
5RSC-2024-04	1 and 2	100.0	NA	100.0	NA	$6.418
5RSC-2024-06	1 and 2	300.0	-107.5	300.0	-107.5	$13.262
5RSC-2024-09	1 and 2	200.0	-203.0	200.0	-203.0	$9.215
5RSC-2024-10	1 and 2	250.0	-252.2	250.0	-252.2	$11.161
5RSC-2024-11	1 and 2	250.0	-254.2	250.0	-254.2	$18.695
5RSC-2024-12	1 and 2	200.0	-209.3	200.0	-209.3	$7.780
5RSC-2024-13	1 and 2	199.0	-204.6	199.0	-204.6	$4.689
5RSC-2024-15	1 and 2	489.7	NA	476.8	NA	$11.698
5RSC-2024-16	1 and 2	438.0	NA	438.0	NA	$12.065
5RSC-2024-17	1 and 2	578.3	NA	578.3	NA	$10.674
5RSC-2024-21	1 and 2	400.0	NA	400.0	NA	$33.071
5RSC-2024-27	1 and 2	250.0	-210.4	250.0	-210.4	$7.653
5RSC-2024-28	1 and 2	500.0	NA	492.3	NA	$12.296

Note: The maximum allowable ERIS output for 5RSC-2024 reflects operation without network upgrades.

INTRODUCTION

PSCo received fifteen (15) GIRs in the 5RSC-2024 cluster that advanced to the study phase as part of the 5RSC-2024. Collectively, the requests represent 4,755 MW of Interconnection Service and 1,441.1 MW of requested grid-charging capacity. For study purposes, the requests were grouped into two generation portfolios, designated as Portfolio 1 and Portfolio 2, which were evaluated independently. All fifteen (15) GIRs requested Energy Resource Interconnection Service (ERIS)[1]. A summary and description of the requests is shown in Table 2.

Table 2: Summary of GIRs in 5RSC-2024 Cluster

GIR #	Portfolio	Resource Type	Service Request (MW)	Grid Charging Request (MW)	COD	POI	Location
5RSC-2024-01	1	Gas	200.0	NA	5/31/2027	Fort Lupton 115 kV	Weld
5RSC-2024-02	1 and 2	Gas	400.0	NA	5/31/2027	Fort St. Vrain 230 kV	Weld
5RSC-2024-04	1 and 2	Solar	100.0	NA	6/1/2028	Mirasol 230 kV	Pueblo
5RSC-2024-06	1 and 2	Solar + BESS	300.0	-107.5	6/1/2028	Sandstone 345 kV	Pueblo
5RSC-2024-09	1 and 2	BESS	200.0	-203.0	12/1/2027	Hartsel 230 kV	Park
5RSC-2024-10	1 and 2	BESS	250.0	-252.2	5/1/2027	Goose Creek 345 kV	Cheyenne
5RSC-2024-11	1 and 2	BESS	250.0	-254.2	6/1/2027	Pawnee 345 kV	Morgan
5RSC-2024-12	1 and 2	BESS	200.0	-209.3	5/1/2027	Comanche 345 kV	Pueblo
5RSC-2024-13	1 and 2	BESS	199.0	-204.6	1/15/2027	Spindle 230 kV	Weld
5RSC-2024-15	1 and 2	Wind	489.7	NA	5/17/2027	May Valley 345 kV	Kiowa
5RSC-2024-16	1 and 2	Wind	438.0	NA	3/16/2026	Goose Creek 345 kV	Cheyenne
5RSC-2024-17	1 and 2	Wind	578.3	NA	5/7/2026	Goose Creek 345 kV	Kit Carson
5RSC-2024-21	1 and 2	Solar	400.0	NA	4/30/2029	May Valley - Sandstone 345 kV	Crowley
5RSC-2024-27	1 and 2	Solar + BESS	250.0	-210.4	5/31/2027	Canal Crossing 345 kV	Morgan
5RSC-2024-28	1 and 2	Wind	500.0	NA	12/1/2025	Goose Creek 345 kV	Kit Carson
Total (MW)			**4,755.0**	**-1,441.1**			

[1] Energy Resource Interconnection Service (ERIS) shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an as available basis. Energy Resource Interconnection Service in and of itself does not convey transmission service.

The approximate geographical locations of the POIs within the Transmission System are shown in Figure 1.

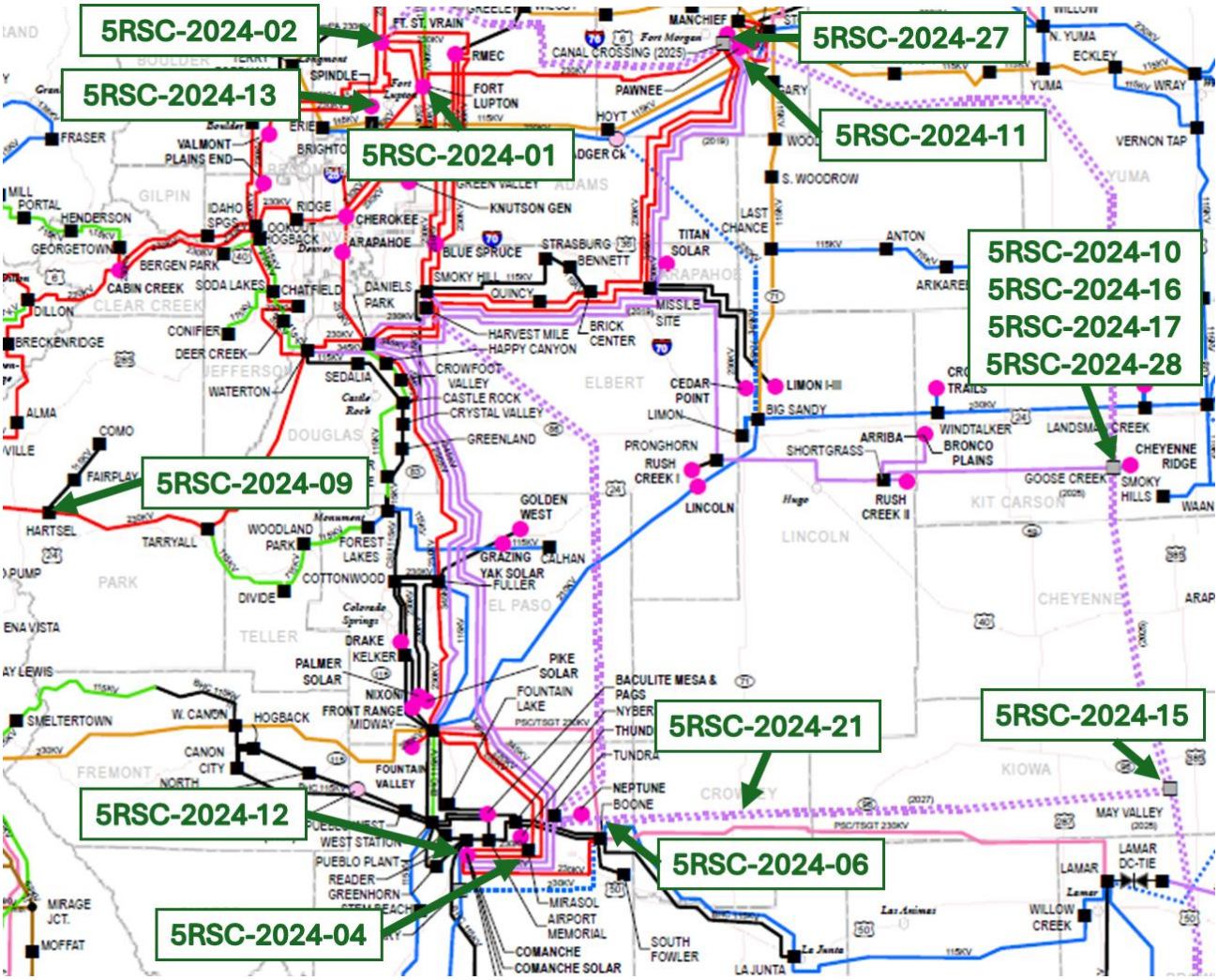

Figure 1: Approximate Locations of 5RSC-2024 Generator Interconnection POIs

STUDY SCOPE AND METHODOLOGY

The purpose of this study is to determine the system impact of interconnecting fifteen (15) GIRs under the 5RSC-2024 cluster for Interconnection Service.

The impacts on the applicable study pocket considering the applicable portfolios will be evaluated for each GIR to determine the full impact of the proposed generation. The GIRs were grouped by pocket and applicable portfolio, as defined below. Each study pocket analysis only modeled the GIRs with POI in that study pocket. The interconnection year, study pocket assignment, charging and discharging configurations as well as participation in generation portfolios associated with each GIR are presented in Table 3 below.

Table 3: 5RSC-2024 Cluster GIRs Interconnecting Dates and Study Areas

Year	Pocket	Discharging	Grid Charging	Portfolios
2027	Metro	5RSC-2024-01	NA	1
		5RSC-2024-02	NA	1 and 2
	North	5RSC-2024-01	NA	1
		5RSC-2024-02	NA	1 and 2
		5RSC-2024-13	5RSC-2024-13	1 and 2
	East	5RSC-2024-10	5RSC-2024-10	1 and 2
		5RSC-2024-11	5RSC-2024-11	1 and 2
		5RSC-2024-16	NA	1 and 2
		5RSC-2024-17	NA	1 and 2
		5RSC-2024-27	5RSC-2024-27	1 and 2
		5RSC-2024-28	NA	1 and 2
2028	Western Slope	5RSC-2024-09	5RSC-2024-09	1 and 2
2029	South	5RSC-2024-04	NA	1 and 2
		5RSC-2024-06	5RSC-2024-06	1 and 2
		5RSC-2024-12	5RSC-2024-12	1 and 2
		5RSC-2024-15	NA	1 and 2
		5RSC-2024-21	NA	1 and 2

The study pockets are described in the Xcel Energy PSCo Business Practice Manual (BPM), Section 3.11 (Study Pockets), and are defined as follows:

- Metro Study Pocket: The study area for the Metro study pocket includes the WECC base case zone 700.
- North Study Pocket: The study area for the Northern Colorado study pocket includes the WECC base case zones 700, 703 and 706. The Affected System included in the analysis is the TSGT transmission system in the study area.
- East Study Pocket: The study area for the Eastern Colorado study pocket includes the WECC base case zone 706. The Affected System included in the analysis is the TSGT transmission system in the study area.
- Western Slope Study Pocket: The study area for the Western Slope study pocket includes the WECC base case zone 708.
- South Study Pocket: The study area for the Southern Colorado study pocket includes the WECC base case zones 704, 710, 712, 751, 757, and 785. The Affected Systems included in the analysis are Tri-State Generation and Transmission Inc. (TSGT), Black Hills Energy (BHE), Colorado Spring Utilities (CSU), CORE, and Western Area Power Administration (WAPA) transmission systems in the study area.

The Study Scope includes the Power Flow (thermal and voltage), Transient Stability and Contingent Facility analyses of the clustered GIRs. These analyses are performed using the reliability criteria set forth in the TPL-001-WECC-CRT-4 under requirement WR1.

The Power Flow analysis was performed using PowerGEM TARA Version 25.03 software. The pre-contingency and post-contingency solution parameters are shown in Table 4, below.

Table 4: Solution Parameters

Parameter	Pre-Contingency	Post-Contingency
Tap Adjustments	Stepping	Disabled
Switched Shunt Adjustments	Enable All	Disabled
Area Interchange Control	Tie-lines only	Disabled
Adjust Phase Shift	Enabled	Disabled
VAR Limit	Immediately	Immediately

For PSCo and non-PSCo facilities, thermal violations attributed to the request include all new facility overloads with a thermal loading >100% and increased by 1% or more from the benchmark case overload post the GIR addition. Thermal loadings are calculated based on Normal Rating (Rate A) for System Intact and Single contingency analysis,

while thermal loadings are calculated based on Emergency Rating (Rate B) for Multiple Contingency analysis. These two ratings, Rate A and Rate B, are referenced in the tables summarizing loading violation results. Furthermore, the contingencies performed in this analysis are shown in Appendix A.

The Transient Stability criteria should be met by all generators in each study pocket analyzed. If any violations are found, the contributing GIR(s) will be identified for performance violations and mitigations will be attributed to the contributing generator(s). The stability analysis is performed by running selected single and multiple contingencies in the study pocket.

In compliance with FERC Order 2023, PSCo must evaluate potential mitigation measures, including alternative transmission technologies (ATTs), such as static synchronous compensators (STATCOMs), static VAR compensators (SVCs), advanced power flow control devices, transmission switching, synchronous condensers, voltage source converters, advanced conductors, and tower raising.

Because the 5RSC-2024 Cluster did not identify any system Network Upgrades, no ATT was required or evaluated for implementation.

VOLTAGE AND REACTIVE POWER CAPABILITY EVALUATION

Per Section 4.1.1.1 of the BPM, the following voltage regulation and reactive power capability (RPC) requirements are applicable to non-synchronous generators:

- Xcel Energy's OATT requires all non-synchronous generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the high side of the generator substation. Furthermore, Xcel Energy requires every Generating Facility to have dynamic voltage control capability to assist in maintaining the POI voltage schedule specified by the Transmission Operator.
- It is the responsibility of the Interconnection Customer to determine the type (switched shunt capacitors and/or switched shunt reactors, etc.), the size (MVAr), and the locations (on the Interconnection Customer's facility) of any additional static reactive power compensation needed within the generating plant in order to have adequate reactive capability to meet the +/- 0.95 power factor at the high side of the main step-up transformer.
- It is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under no load conditions.

Per Section 4.1.1.2 in the BPM, the following voltage regulation and reactive power capability requirements are applicable to synchronous generators:

- Xcel Energy's OATT requires all synchronous Generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the POI.
- The reactive power analysis performed in this report is an indicator of the reactive power requirements at the POI and the capability of the generator to meet those requirements. The Interconnection Customer is required to demonstrate to the satisfaction of PSCo Transmission Operations prior to the commercial in-service date of the generating plant that it can safely and reliably operate within the required power factor and the regulating voltage of the POI.

Per Section 4.4.1 in the BPM, the following steps shall be followed to perform the reactive power capability evaluation for synchronous generators:

a. The reactive power evaluation of the Synchronous generators is done by dispatching the generator at Pmax and changing the POI voltage till Qmax and Qmin are reached.
b. This step is repeated for Pmin.

c. The POI voltage and power factor for the two evaluations are noted. If the POI power factor of 0.95 is reached and the POI voltage stays under the voltage guidance values noted (1-1.04 p.u. for the 230 kV system, 1-1.05 for the 345 kV system and 1-1.03 for 115 kV system), the GIR is considered to meet reactive power requirements. If not, additional dynamic reactive support would be identified.

All proposed reactive devices in customer provided models are switched favorably to provide appropriate reactive compensation in each test, therefore identified deficiencies are in addition to any proposed reactive compensation.

All generating interconnection requests meet the reactive power capability requirements, except for 5RSC-2024-15 and 5RSC-2024-17, which do not meet the 0.95 lagging power factor requirement at Pmax. In addition, 5RSC-2024-16 and 5RSC-2024-27 meet the reactive power capability requirement; however, the terminal voltage exceeds the acceptable operating range during the Pmax lagging power factor test.

The results for each GIR are detailed at Appendix C and summarized at Table 5 below.

Table 5: Summary of Reactive Power Capability (RPC) Compliance.

GI #	Resource Type	RPC Compliance	Notes
5RSC-2024-01	Gas	✓	-
5RSC-2024-02	Gas	✓	-
5RSC-2024-04	Solar	✓	-
5RSC-2024-06	Solar + BESS	✓	-
5RSC-2024-09	BESS	✓	-
5RSC-2024-10	BESS	✓	-
5RSC-2024-11	BESS	✓	-
5RSC-2024-12	BESS	✓	-
5RSC-2024-13	BESS	✓	-
5RSC-2024-15	Wind	x	Failed (P_{MAX} & max lag 0.95 pu pf)
5RSC-2024-16	Wind	✓	Voltage out of limits for: Pmax & max lag pf (V_{TERM} = 1.08 pu)
5RSC-2024-17	Wind	x	Failed (P_{MAX} & max lag 0.95 pu pf)
5RSC-2024-21	Solar	✓	-
5RSC-2024-27	Solar + BESS	✓	Voltage out of limits for:

GI #	Resource Type	RPC Compliance	Notes
			P_{MAX} , BESS off & max lag pf (V_{TERM} = 1.06 pu)
5RSC-2024-28	Wind	✓	-

STEADY-STATE STUDY RESULTS

2027 METRO STEADY-STATE ANALYSIS RESULTS SUMMARY

For Portfolio 1, the contingency analysis was performed in the 2027 Metro Portfolio 1 Study Pocket Case. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-01:

1x combustion turbine with 200 MW net output at the POI (Fort Lupton 115 kV)

• 5RSC-2024-02:

2x combustion turbine with 400 MW net output at the POI (Fort St. Vrain 230 kV)

The results are summarized below:

- System Intact analysis: no thermal overload or voltage violations attributable to study GIRs were identified.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 6, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[2] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIRs.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 7. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIRs.

The study did not identify any voltage or thermal overload violation attributable to the ERIS study GIRs.

The maximum allowable output of the ERIS GIRs is:

- 5RSC-2024-01 is 200.0 MW
- 5RSC-2024-02 is 400.0 MW

[2] Redispatch units are shown at the Appendix D.5

For Portfolio 2, the contingency analysis was performed in the 2027 Metro Portfolio 2 Study Pocket Case. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-02:

2x combustion turbine with 400 MW net output at the POI (Fort St. Vrain 230 kV)

The results are summarized below:

- System Intact analysis: no thermal overload or voltage violations attributable to study GIRs were identified.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 8, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[3] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIRs.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 9. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIRs.

The study did not identify any voltage or thermal overload violation attributable to the ERIS study GIRs.

The maximum allowable output of the ERIS GIRs is:

- 5RSC-2024-02 is 400.0 MW

[3] Redispatch units are shown at the Appendix D.5

Table 6: 2027 Metro Portfolio 1 Single Contingency Loading for Discharging Scenario

							Study		Study with PSCo Redispatch	
Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	DENVER_TM (70149) - ELATI1 (70163) 230 kV CKT 1	70046 BUCKLEY2 230 70491 TOLLGATE 230 1 1	70	PSCo	307	97.7	101.5	3.8	97.8	0.1

Table 7: 2027 Metro Portfolio 1 Multiple Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	HENRYLAK (72024) - HENRYLAK (70605) 115/230 kV Transformer T1	P7_32	73/70	Tri-State	100	118.7	124.5	5.8
2	FT_LUPTON_1 (70191) - FT_LUPTON_2 (70090) 115 kV CKT 1	P7_77	70	PSCo	239	30.4	117.3	86.9

Table 8: 2027 Metro Portfolio 2 Single Contingency Loading for Discharging Scenario

							Study		Study with PSCo Redispatch	
Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	DENVER_TM (70149) - ELATI1 (70163) 230 kV CKT 1	70046 BUCKLEY2 230 70491 TOLLGATE 230 1 1	70	PSCo	307	97.7	101.5	3.8	97.8	0.1

Table 9: 2027 Metro Portfolio 2 Multiple Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	HENRYLAK (72024) - HENRYLAK (70605) 115/230 kV Transformer T1	P7_32	73/70	Tri-State	100	118.7	123.6	4.9

2027 NORTH STEADY-STATE ANALYSIS RESULTS SUMMARY

For Portfolio 1, the contingency analysis was performed in the 2027 North Portfolio 1 Study Pocket Case. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-01:

1x combustion turbine with 200 MW net output at the POI (Fort Lupton 115 kV)

• 5RSC-2024-02:

2x combustion turbine with 400 MW net output at the POI (Fort St. Vrain 230 kV)

• 5RSC-2024-13:

Battery Energy Storage System (BESS) with 199 MW net output (Discharging) and -204.6 MW (Grid Charging) at the POI (Spindle 230 kV)

The results for the Discharging scenario are summarized below:

- System Intact analysis: the thermal loading violations identified under this analysis are presented in Table 10, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[4] of PSCo's existing generating resources.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 11, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[4] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIRs.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 12. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIRs.

The results for the Grid Charging scenario are summarized below:

[4] Redispatch units are shown at the Appendix E.5

- System Intact analysis: no thermal overload or voltage violations attributable to the study GIR were identified.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 13, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[5] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIR.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 14. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIR.

The study did not identify any voltage or thermal overload violation attributable to the ERIS study GIRs.

The maximum allowable output of the ERIS GIRs is:

- 5RSC-2024-01 is 200.0 MW
- 5RSC-2024-02 is 400.0 MW
- 5RSC-2024-13 is 199.0 MW (Maximum output at POI in Discharging Mode) and -204.6 MW (Grid Charging)

For Portfolio 2, the contingency analysis was performed in the 2027 North Portfolio 2 Study Pocket Case. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-02:

2x combustion turbine with 400 MW net output at the POI (Fort St. Vrain 230 kV)

• 5RSC-2024-13:

Battery Energy Storage System (BESS) with 199 MW net output (Discharging) and -204.6 MW (Grid Charging) at the POI (Spindle 230 kV)

The results for the Discharging scenario are summarized below:

[5] Redispatch units are shown at the Appendix E.8

- System Intact analysis: the thermal loading violations identified under this analysis are presented in Table 15, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[6] of PSCo's existing generating resources.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 16, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[6] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIRs.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 17. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIRs.

Both Portfolio 1 and 2 have the same conditions for the Grid Charging scenario and, therefore, the results are already present in Table 13 and Table 14.

The study did not identify any voltage or thermal overload violation attributable to the ERIS study GIRs.

The maximum allowable output of the ERIS GIRs is:

- 5RSC-2024-02 is 400.0 MW
- 5RSC-2024-13 is 199.0 MW (Maximum output at POI in Discharging Mode) and -204.6 MW (Grid Charging)

[6] Redispatch units are shown at the Appendix E.5

Table 10: 2027 North Portfolio 1 System Intact Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	Base Case	70	PSCo	478	80.6	104.5	23.9	87.8	7.2

Table 11: 2027 North Portfolio 1 Single Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	DENVER_TM (70149) - ELATI1 (70163) 230 kV CKT 1	70046 BUCKLEY2 230 70491 TOLLGATE 230 1 1	70	PSCo	307	110.0	130.3	20.3	102.2	-7.8
2	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	LoTC_59 /FSVR-ISAB-230.0-1	70	PSCo	478	92.9	119.3	26.4	99.9	7.0
3	LOUISVILLE (70269) - VALMONT_1 (70444) 115 kV CKT 1	P21From: 70065 BROOMFIELD 115 70440 VALMONT_2 115 1 1	70	PSCo	191	89.8	115.6	25.8	86.0	-3.8
4	CHEROKEE_S (70108) - CHEROKEE (70107) 115/230 kV Transformer T1	P21From: 70107 CHEROKEE 230 70324 LACOMBE 230 1 1	70	PSCo	280	89.8	109.1	19.3	60.8	-29.0
5	HENRYLAK (72024) - HENRYLAK (70605) 115/230 kV Transformer T1	P21From: 70362 RIVERDALE 230 70605 HENRYLAK 230 1 1	73/70	Tri State G&T	100	95.8	108.9	13.1	98.4	2.6
6	FT_LUPTON (70192) - JLGREEN (70529) 230 kV CKT 1	P21From: 70362 RIVERDALE 230 70605 HENRYLAK 230 1 1	70	PSCo	487	89.1	108.5	19.4	87.3	-1.8
7	ELATI1 (70163) - MONROEPS (70291) 230 kV CKT 1	70046 BUCKLEY2 230 70491 TOLLGATE 230 1 1	70	PSCo	319	84.7	103.5	18.8	77.3	-7.5
8	FT_ST_VRAIN (70410) - SPINDLE (70592) 230 kV CKT 1	LoTC_74 /VALM-SPIN-230.0-1	70	PSCo	478	51.5	100.2	48.7	99.8	48.3
9	CHEROKEE_N (70110) - CONOCO (70126) 115 kV CKT 1	70108 CHEROKEE_S 115 70107 CHEROKEE 230 T1 1	70	PSCo	183	88.8	100.0	11.2	72.7	-16.1

Table 12: 2027 North Portfolio 1 Multiple Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	HENRYLAK (72024) - HENRYLAK (70605) 115/230 kV Transformer T1	P7_32	73/70	Tri State G&T	100	129.6	149.0	19.4
2	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	BF_058c	70	PSCo	478	94.6	121.0	26.4
3	FT_LUPTON_1 (70191) - FT_LUPTON_2 (70090) 115 kV CKT 1	P7_77	70	PSCo	239	30.3	116.9	86.6
4	CONOCO (70126) - SANDOWN (70377) 115 kV CKT 1	BF_033b	70	PSCo	175	93.9	114.0	20.1
5	GREEN_VLY (70048) - SPRUCE (70528) 230 kV CKT 1	P7_111	70	PSCo	717	98.8	113.7	14.9
6	GREEN_VLY (70048) - KEENESBURG (70820) 230 kV CKT 1	P7_109	70	PSCo	717	100.8	112.6	11.8
7	GREEN_VLY (70048) - KEENESBURG (70820) 230 kV CKT 2	P7_107	70	PSCo	717	100.8	112.6	11.8
8	ELDORADO (70164) - VALMONT_1 (70444) 115 kV CKT 1	P7_20	70	PSCo	120	99.9	112.3	12.4
9	CHEROKEE_N (70110) - CONOCO (70126) 115 kV CKT 1	BF_033b	70	PSCo	213	94.5	108.6	14.1
10	FT_LUPTON (70192) - JLGREEN (70529) 230 kV CKT 1	P7_47	70	PSCo	570	87.0	107.6	20.6
11	GREEN_VLY (70048) - RMEC (70590) 230 kV CKT 1	P7_106	70	PSCo	717	95.3	105.9	10.6
12	BARR_LAKE (70047) - REUNION (72026) 230 kV CKT 1	P7_149	70/73	PSCo	478	93.7	104.9	11.2
13	FT_ST_VRAIN (70410) - SPINDLE (70592) 230 kV CKT 1	BF_148a	70	PSCo	478	51.5	100.2	48.7

Table 13: 2027 North Single Contingency Loading for Grid Charging Scenario

							Study		Study with PSCo Redispatch	
Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	478	119.9	123.9	4.0	101.7	-18.2
2	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	118.4	122.4	4.0	100.4	-18.0
3	CTTNWD N (73391) - KETTLECK S (73410) 115 kV CKT 1	P21From: 73389 BRIARGATE S 115 73710 BRIARGATE N 115 1 1	73	CSU	162	114.2	119.0	4.8	109.7	-4.5
4	HARRISON_P1 (70215) - LEETSDALE_2 (70282) 115 kV CKT 1	P21From: 70148 DENVER_TM_1 115 70144 DENVER_TM_2 115 1 1	70	PSCo	141	102.8	105.7	2.9	32.8	-70.0
5	JEWELL2 (70239) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	99.6	103.6	4.0	81.6	-18.0
6	GREENWOOD_1 (70212) - GREENWOOD_2 (70189) 230 kV CKT 1	P21To: 70139 DANIEL_PK 230 70323 PRAIRIE_3 230 2 1	70	PSCo	484	98.6	103.2	4.6	81.8	-16.8
7	BHSUN_POI (78030) - CAREY_TS (78087) 230 kV CKT 1	700183 24_28_W_1 34.5 700182 24_28_W 0.69 U1 1	73/70	PRPA	305	100.6	102.7	2.1	100.5	-0.1
8	ARAPAHOE_B (70037) - ARAPAHOE (70038) 115/230 kV Transformer T5	BUS: 70149 DENVER_TM 230	70	PSCo	272	98.6	102.3	3.7	81.8	-16.8

Table 14: 2027 North Multiple Contingency Loading for Grid Charging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	EAST_1 (70162) - EAST_2 (70171) 115 kV CKT 1	P7_29	70	PSCo	119.5	137.9	142.2	4.3
2	HARRISON_P1 (70215) - LEETSDALE_2 (70282) 115 kV CKT 1	BF_033b	70	PSCo	141	124.2	127.3	3.1
3	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BF_064c	70	PSCo	478	121.6	125.4	3.8
4	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BF_064c	70	PSCo	555	104.8	108.0	3.2
5	BHSUN_POI (78030) - CAREY_TS (78087) 230 kV CKT 1	BF_151a	73/70	PRPA	359	101.3	103.9	2.6

Table 15: 2027 North Portfolio 2 System Intact Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	Base Case	70	PSCo	478	80.6	101.5	20.9	88.5	7.9

Table 16: 2027 North Portfolio 2 Single Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	DENVER_TM (70149) - ELATI1 (70163) 230 kV CKT 1	70046 BUCKLEY2 230 70491 TOLLGATE 230 1 1	70	PSCo	307	110.0	124.6	14.6	103.5	-6.5
2	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	LoTC_59 /FSVR-ISAB-230.0-1	70	PSCo	478	92.9	115.9	23.0	100.0	7.1
3	CHEROKEE_N (70110) - CONOCO (70126) 115 kV CKT 1	70108 CHEROKEE_S 115 70107 CHEROKEE 230 T1 1	70	PSCo	183	88.8	112.9	24.1	69.0	-19.8
4	CHEROKEE_S (70108) - CHEROKEE (70107) 115/230 kV Transformer T1	P21From: 70107 CHEROKEE 230 70324 LACOMBE 230 1 1	70	PSCo	280	89.8	106.5	16.7	55.4	-34.4
5	CONOCO (70126) – SANDOWN (70377) 115 kV CKT 1	70108 CHEROKEE_S 115 70107 CHEROKEE 230 T1 1	70	PSCo	159	80.5	106.5	26.0	55.6	-24.9
6	FT_LUPTON (70192) - JLGREEN (70529) 230 kV CKT 1	P21From: 70362 RIVERDALE 230 70605 HENRYLAK 230 1 1	70	PSCo	487	89.1	101.1	12.0	83.6	-5.5

Table 17: 2027 North Portfolio 2 Multiple Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	HENRYLAK (72024) - HENRYLAK (70605) 115/230 kV Transformer T1	P7_32	73/70	Tri State G&T	100	129.6	141.5	11.9
2	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	BF_058c	70	PSCo	478	94.6	117.7	23.1
3	CONOCO (70126) - SANDOWN (70377) 115 kV CKT 1	BF_033b	70	PSCo	175	93.9	123.4	29.5
4	GREEN_VLY (70048) - SPRUCE (70528) 230 kV CKT 1	P7_111	70	PSCo	717	98.8	110.7	11.9
5	GREEN_VLY (70048) - KEENESBURG (70820) 230 kV CKT 1	P7_109	70	PSCo	717	100.8	110.7	9.9
6	GREEN_VLY (70048) - KEENESBURG (70820) 230 kV CKT 2	P7_107	70	PSCo	717	100.8	110.7	9.9
7	ELDORADO (70164) - VALMONT_1 (70444) 115 kV CKT 1	P7_20	70	PSCo	120	99.9	110.3	10.4
8	CHEROKEE_N (70110) - CONOCO (70126) 115 kV CKT 1	BF_033b	70	PSCo	213	94.5	120.3	25.8
9	GREEN_VLY (70048) - RMEC (70590) 230 kV CKT 1	P7_106	70	PSCo	717	95.3	104.2	8.9
10	BARR_LAKE (70047) - REUNION (72026) 230 kV CKT 1	P7_149	70/73	PSCo	478	93.7	102.1	8.4

2027 EAST STEADY-STATE ANALYSIS RESULTS SUMMARY

For Portfolios 1 and 2, the contingency analysis was performed in the 2027 East study pocket. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-10:

Battery Energy Storage System (BESS) with 250 MW net output (Discharging) and -252.2 MW (Grid Charging) requested at the POI (Goose Creek 345 kV)

• 5RSC-2024-11:

Battery Energy Storage System (BESS) with 250 MW net output (Discharging) and -252.2 MW (Grid Charging) requested at the POI (Pawnee 345 kV)

• 5RSC-2024-16:

Wind Turbines with 438.0 MW net output requested at the POI (Goose Creek 345 kV)

• 5RSC-2024-17:

Wind Turbines with 578.3 MW net output requested at the POI (Goose Creek 345 kV)

• 5RSC-2024-27:

PV + Battery Energy Storage System (BESS) with 250 MW net output (Discharging) and -210.4 MW (Grid Charging) requested at the POI (Canal Crossing 345 kV)

• 5RSC-2024-28:

Wind Turbines with 500 MW net output requested at the POI (Goose Creek 345 kV)

The results for the Discharging scenario are summarized below:

- System Intact analysis: the thermal loading violations identified under this analysis are presented in Table 18, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[7] of PSCo's existing generating resources.

[7] Redispatch units are shown at the Appendix F.4

- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 19, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[7] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIRs.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 20. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIRs.

The results for the Grid Charging scenario are summarized below:

- System Intact analysis: no thermal overload or voltage violations attributable to the study GIRs were identified.
- Single Contingency analysis: no thermal overload or voltage violations attributable to the study GIRs were identified.
- Multiple Contingency analysis: no thermal overload or voltage violations attributable to the study GIRs were identified.

The study did not identify any voltage or thermal overload violation attributable to the ERIS study GIRs.

The maximum allowable output of the ERIS GIRs is:

- 5RSC-2024-10 is 250.0 MW (Discharging) and -252.2 MW (Grid Charging)
- 5RSC-2024-11 is 250.0 MW (Discharging) and -254.2 MW (Grid Charging)
- 5RSC-2024-16 is 438.0 MW
- 5RSC-2024-17 is 578.3 MW
- 5RSC-2024-27 is 250.0 MW (Discharging) and -210.4 MW (Grid Charging)
- 5RSC-2024-28 is 492.3 MW (Maximum output at POI)

Table 18: 2027 East System Intact Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	Base Case	70	PSCo	478	99.9	114.9	15.0	86.4	-13.5
2	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	Base Case	70	PSCo	484	98.7	113.5	14.8	85.3	-13.4
3	HARRISON_P1 (70215) - LEETSDALE_2 (70282) 115 kV CKT 1	Base Case	70	PSCo	141	72.1	109.4	37.3	35.4	-36.7

Table 19: 2027 East Single Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	478	133.3	156.3	23.0	111.6	-21.7
2	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	131.7	154.4	22.7	110.2	-21.5
3	JEWELL2 (70239) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	112.7	135.3	22.6	91.5	-21.2
4	GREENWOOD_1 (70212) - GREENWOOD_2 (70189) 230 kV CKT 1	P21To: 70139 DANIEL_PK 230 70323 PRAIRIE_3 230 2 1	70	PSCo	484	112.2	135.5	23.3	92.6	-19.6
5	ARAPAHOE_B (70037) - ARAPAHOE (70038) 115/230 kV T5	BUS: 70149 DENVER_TM 230	70	PSCo	272	107.4	127.4	20.0	90.3	-17.1
6	BEAVERCK (73020) - ADENA (73464) 115 kV CKT 1	P21To: 73020 BEAVERCK 115 73031 BRUSHTAP 115 1 1	73	PSCo	114	106.1	128.2	22.1	102.6	-3.5
7	HARRISON_P1 (70215) - LEETSDALE_2 (70282) 115 kV CKT 1	70108 CHEROKEE_S 115 70107 CHEROKEE 230 T1 1	70	PSCo	141	105.8	152.5	46.7	57.9	-47.9
8	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T4	P21From: 70396 SMOKY_HL 230 70596 HARVEST_MI 230 1 1	70	PSCo	560	104.0	134.1	30.1	100.0	-4.0
9	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T5	P21From: 70396 SMOKY_HL 230 70596 HARVEST_MI 230 1 1	70	PSCo	560	104.0	134.1	30.1	100.0	-4.0
10	DANIEL_PK (70139) - PRAIRIE_3 (70323) 230 kV CKT 2	BUS: 70212 GREENWOOD_1 230	70	PSCo	478	103.3	126.0	22.7	84.8	-18.5
11	JEWELL2 (70239) - LEETSDALE (70260) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	478	102.8	125.8	23.0	81.6	-21.2
12	DANIEL_PK (70139) - DANIEL_PK (70601) 230 kV T5	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T5 1	70	PSCo	560	99.5	115.6	16.1	93.5	-6.0
13	DANIEL_PK (70139) - DANIEL_PK (70601) 230 kV T3	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T4 1	70	PSCo	560	99.5	115.6	16.1	93.5	-6.0

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
14	DANIEL_PK (70139) - DANIEL_PK (70601) 230 kV T4	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T4 1	70	PSCo	560	99.5	115.6	16.1	93.5	-6.0
15	HAVANA2 (70217) - CHAMBERS (70538) 115 kV CKT 2	P21From: 70216 HAVANA1 115 70538 CHAMBERS 115 1 1	73	PSCo	159	92.8	102.0	9.2	69.5	-23.3
16	B.CK_TRI (73015) - B.CK_TRI (73016) 230 kV CKT 1	P21From: 70397 BEAVER_CK_S 115 73020 BEAVERCK 115 1 1	70	Tri-State G&T	224	87.9	104.8	16.9	88.1	0.2
17	BEAVERCK (73020) - BRUSHTAP (73031) 115 kV CKT 1	73020 BEAVERCK 115 73464 ADENA 115 1 1	73	WAPA	163	87.5	102.9	15.4	85.2	-2.3
18	EFMORGTP (73305) - FMWEST (73379) 115 kV CKT 1	P21From: 73020 BEAVERCK 115 73464 ADENA 115 1 1	73	WAPA	121	86.0	106.0	20.0	82.8	-3.2
19	BRUSHTAP (73031) - EFMORGTP (73305) 115 kV CKT 1	P21To: 73020 BEAVERCK 115 73464 ADENA 115 1 1	73	WAPA	163	84.9	100.3	15.4	82.6	-2.3
20	DANIEL_PK (70139) - SANTA_FE (70527) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	502	84.8	104.3	19.5	68.5	-16.3
21	FT_ST_VRAIN (70410) - FT_ST_VRAIN (70916) 230/345 kV T8	70410 FT_ST_VRAIN 230 70916 FT_ST_VRAIN 345 T7 1	70	PSCo	560	78.3	127.7	49.4	84.4	6.1
22	FT_ST_VRAIN (70410) - FT_ST_VRAIN (70916) 230/345 kV T7	70410 FT_ST_VRAIN 230 70916 FT_ST_VRAIN 345 T8 1	70	PSCo	560	78.3	127.7	49.4	84.4	6.1
23	FT_ST_VRAIN (70410) - FT_ST_VRAIN (70916) 230/345 kV T11	70410 FT_ST_VRAIN 230 70916 FT_ST_VRAIN 345 T8 1	70	PSCo	560	69.1	119.5	50.4	75.3	6.2

Table 20: 2027 East Multiple Contingency Loading for Grid Discharging

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	EAST_1 (70162) - EAST_2 (70171) 115 kV CKT 1	P7_29	70	PSCo	119.5	152.4	171.8	19.4
2	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BF_064c	70	PSCo	478	134.1	156.3	22.2
3	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BF_064c	70	PSCo	555	115.5	134.6	19.1
4	GREENWOOD_1 (70212) - GREENWOOD_2 (70189) 230 kV CKT 1	BF_045s	70	PSCo	484	105.9	129.1	23.2
5	HARRISON_P1 (70215) - LEETSDALE_2 (70282) 1115 kV CKT 1	BF_033w	70	PSCo	141	105.8	152.5	46.7
6	DANIEL_PK (70139) - PRAIRIE_3 (70323) 230 kV CKT 2	BF_064b	70	PSCo	478	104.9	127.4	22.5
7	JEWELL2 (70239) - LEETSDALE (70260) 230 kV CKT 1	BF_064c	70	PSCo	478	104.1	126.2	22.1
8	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T4	BF_129d	70	PSCo	756	102.3	134.5	32.2
9	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T5	BF_129c	70	PSCo	756	102.3	134.5	32.2
10	JEWELL2 (70239) - TOLLGATE (70491) 230 kV CKT 1	BF_064c	70	PSCo	555	99.2	118.2	19.0

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
11	DANIEL_PK (70139) - MARCY (70278) 230 1 1	P7_65	70	PSCo	478	91.8	106.0	14.2
12	DANIEL_PK (70139) - SANTA_FE (70527) 230 kV CKT 1	BF_064c	70	PSCo	553	81.6	100.6	19.0
13	BEAVERCK (73020) - ADENA (73464) 115 kV CKT 1	P7_160	70	PSCo	114	81.5	110.1	28.6
14	BEAVERCK (73020) - BRUSHTAP (73031) 115 kV CKT 1	P7_160	70	PSCo	163	81.1	101.5	20.4
15	SMOKY_HL (70599) - MISS_SITE (70624) 345 kV CKT 1	P7_61	70	PSCo	1775	81.1	109.0	27.9
16	STORY (73192) - PAWNEE (70311) 230 kV CKT 1	P7_160	70	PSCo	589	80.1	151.2	71.1
17	FT_LUPTON (70192) - PAWNEE (70311) 230 kV CKT 1	P7_160	70	PSCo	478	79.2	119.3	40.1

2028 WESTERN SLOPE (WS) STEADY-STATE ANALYSIS RESULTS SUMMARY

Fort Portfolios 1 and 2, the contingency analysis was performed in the 2028 Western Slope study pocket. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-09:

Battery Energy Storage System (BESS) with 200 MW net output (Discharging) and -203.0 MW (Grid Charging) requested at the POI (Hartsel 230 kV)

The results for the Discharging scenario are summarized below:

- System Intact analysis: the thermal loading violations identified under this analysis are presented in Table 21, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[8] of PSCo's existing generating resources.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 22, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[6] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIR.
- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 23. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIR.

The results for the Grid Charging scenario are summarized below:

- System Intact analysis: no thermal overload or voltage violations attributable to the study GIR were identified.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 24, where results for Benchmark (BM), Study

[8] Redispatch units are shown at the Appendix G.4

and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[9] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIR.

- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 25. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIR.

The study did not identify any voltage or thermal overload violation caused by the ERIS study GIRs.

The maximum allowable output of the ERIS GIRs is:

- 5RSC-2024-09 is 200.0 MW (Discharging) and -203.0 MW (Grid Charging)

[9] Redispatch units are shown at the Appendix G.7

Table 21: 2028 Western Slope (WS) System Intact Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	BHSUN_POI (78030) - CAREY_TS (78087) 230 kV CKT 1	Base Case	73/70	PRPA	305	82.5	100.1	17.6	77.1	5.4

Table 22: 2028 Western Slope (WS) Single Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	DANIEL_PK (70139) - PRAIRIE_3 (70323) 230 kV CKT 2	70139 DANIEL_PK 230 70331 PRAIRIE_1 230 1 1	70	PSCo	478	132.1	135.0	2.9	96.2	4.3
2	BHSUN_POI (78030) - CAREY_TS (78087) 230 kV CKT 1	LoTC_65 /FSVR-LGPK-230.0-1	73/70	PRPA	305	93.7	115.8	22.1	98.0	-35.9
3	DANIEL_PK (70139) - PRAIRIE_1 (70331) 230 kV CKT 1	P21To: 70139 DANIEL_PK 230 70323 PRAIRIE_3 230 2 1	70	PSCo	571	110.2	112.7	2.5	80.6	-29.6
4	GREENWOOD_2 (70189) - PRAIRIE_3 (70323) 230 kV CKT 1	70139 DANIEL_PK 230 70331 PRAIRIE_1 230 1 1	70	PSCo	572	101.9	104.4	2.5	72.1	-29.8
5	GREENWOOD_1 (70212) - PRAIRIE_1 (70331) 230 kV CKT 2	P21To: 70139 DANIEL_PK 230 70323 PRAIRIE_3 230 2 1	70	PSCo	572	97.8	100.4	2.5	68.6	-29.2

Table 23: 2028 Western Slope (WS) Multiple Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	DANIEL_PK (70139) - PRAIRIE_3 (70323) 230 kV CKT 2	BF_045t	70	PSCo	478	127.7	130.6	2.9
2	BHSUN_POI (78030) - CAREY_TS (78087) 230 kV CKT 1	BF_151a	73/70	PRPA	359	110.4	122.6	12.2
3	DANIEL_PK (70139) - PRAIRIE_1 (70331) 230 kV CKT 1	BF_045s	70	PSCo	629	97.8	100.1	2.3

Table 24: 2028 Western Slope (WS) Single Contingency Loading for Grid Charging Scenario

							Study		Study with PSCo Redispatch	
Ref. No.	**Monitored Facility**	**Contingency Name**	**Area**	**Owner**	**Rate A (MVA)**	**BM AC Loading (%)**	**AC Loading (%)**	**Loading Difference (%)**	**AC Loading (%)**	**Loading Difference (%)**
1	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	478	139.1	141.9	2.8	108.7	-30.5
2	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	137.5	140.2	2.7	107.4	-30.1
3	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV Transformer T5	P21From: 70396 SMOKY_HL 230 70596 HARVEST_MI 230 1 1	70	PSCo	560	136.2	138.9	2.7	100.7	-35.5
4	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV Transformer T4	P21From: 70396 SMOKY_HL 230 70596 HARVEST_MI 230 1 1	70	PSCo	560	136.2	138.9	2.7	100.7	-35.5
5	CTTNWD N (73391) - KETTLECK S (73410) 115 kV CKT 1	P21To: 73389 BRIARGATE S 115 73710 BRIARGATE N 115 1 1	73	CSU	162	130.6	135.4	4.8	121.0	-9.6
6	ARAPAHOE_B (70037) - ARAPAHOE (70038) 115/230 kV Transformer T5	BUS: 70149 DENVER_TM 230	70	PSCo	272	127.7	129.2	1.6	98.6	-29.1
7	JEWELL2 (70239) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	118.0	120.8	2.8	88.0	-30.0
8	DANIEL_PK (70139) - DANIEL_PK (70601) 230/345 kV Transformer T5	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T3 1	70	PSCo	560	114.7	118.2	3.5	96.0	-18.7
9	DANIEL_PK (70139) - DANIEL_PK (70601) 230/345 kV Transformer T3	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T4 1	70	PSCo	560	114.7	118.2	3.5	96.0	-18.7
10	DANIEL_PK (70139) - DANIEL_PK (70601) 230/345 kV Transformer T4	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T3 1	70	PSCo	560	114.7	118.2	3.5	96.0	-18.7
11	JEWELL2 (70239) - LEETSDALE (70260) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	478	108.0	110.9	2.9	88.0	-20.0
12	FOXRUN (73414) - FLYHORSE N2 (73738) 115 kV CKT 1	P21From: 72413 VOLLMERT 115 73481 FULLER 115 1 1	73	CSU	142	100.8	108.7	7.9	86.4	-14.4
13	FLYHORSE S (73576) - KETTLECK N (73711) 115 kV CKT 1	72413 VOLLMERT 115 73481 FULLER 115 1 1	73	CSU	162	100.2	107.3	7.1	87.4	-12.8
14	HARVEST_MI (70597) - HARVEST_MI (70596) 345/230 kV Transformer T2	LoTC_320	70	PSCo	560	98.2	100.0	1.9	72.3	-25.8
15	HARVEST_MI (70597) - HARVEST_MI (70596) 345/230 kV Transformer T1	LoTC_321	70	PSCo	560	98.2	100.0	1.9	72.3	-25.8

Table 25: 2028 Western Slope (WS) Multiple Contingency Loading for Grid Charging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BF_064c	70	PSCo	478	136.4	139.6	3.2
2	FTN_VLY (70193) - MIDWAYBR (73412) 115 kV CKT 1	BF_094d	70/73	BHE	179	121.6	127.2	5.6
3	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BF_064c	70	PSCo	555	117.5	120.3	2.8
4	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV Transformer T5	BF_129c	70	PSCo	756	109.6	114.0	4.4
5	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV Transformer T4	BF_129d	70	PSCo	756	109.6	114.0	4.4
6	DESRTCOV (70449) - W.STATON (70456) 115 kV CKT 1	BF_094d	70	BHE	221	106.7	111.2	4.6
7	JEWELL2 (70239) - LEETSDALE (70260) 230 kV CKT 1	BF_064c	70	PSCo	478	105.8	109.1	3.3
8	DANIEL_PK (70139) - MARCY (70278) 230 kV CKT 1	P7_65	70	PSCo	478	96.9	107.9	11.1
9	DANIEL_PK (70139) - PRAIRIE_3 (70323) 230 kV CKT 2	P7_66	70	PSCo	478	104.1	106.2	2.1
10	FTN_VLY (70193) - DESRTCOV (70449) 115 kV CKT 1	BF_094d	70	BHE	221	99.0	103.6	4.6
11	JEWELL2 (70239) - TOLLGATE (70491) 230 kV CKT 1	BF_064c	70	PSCo	555	100.8	103.6	2.8

2029 SOUTH STEADY-STATE ANALYSIS RESULTS SUMMARY

For Portfolios 1 and 2, the contingency analysis was performed in the 2029 South study pocket. The following ERIS GIRs were included in the analysis:

• 5RSC-2024-04:

Photovoltaic (PV) unit with 100.0 MW net output requested at the POI (Mirasol 230 kV)

• 5RSC-2024-06:

Photovoltaic plus Battery Energy Storage System (PV+BESS) with 300 MW net output (Discharging) and -107.5 MW (Grid Charging) requested at the POI (Sandstone 345 kV)

• 5RSC-2024-12:

Battery Energy Storage System (BESS) with 200 MW net output (Discharging) and -209.3 MW (Grid Charging) requested at the POI (Comanche 345 kV)

• 5RSC-2024-15:

Wind Turbines with 489.7 MW net output requested at the POI (May Valley 345 kV)

• 5RSC-2024-21:

Photovoltaic (PV) unit with 400.0 MW net output requested at the POI (May Valley to Sandstone 345 kV line)

The results for the Discharging scenario are summarized below:

- System Intact analysis: no thermal overload or voltage violations attributable to the study GIR were identified.
- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 26, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are

resolved via redispatch[10]. Therefore, none of the thermal overloads are attributable to study GIR.

- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 27. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIR.

The results for the Grid Charging scenario are summarized below:

- System Intact analysis: no thermal overload or voltage violations attributable to the study GIR were identified.

- Single Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 28, where results for Benchmark (BM), Study and Redispatch Study cases are compared. Please note that all violations are resolved via redispatch[11] of PSCo's existing generating resources. Therefore, none of the thermal overloads are attributable to study GIR.

- Multiple Contingency analysis: the thermal loading violations identified under this analysis are presented in Table 29. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (which includes GIRs under study) and/or operator actions. Therefore, none of the thermal overloads are attributable to study GIR.

The maximum allowable output of the ERIS GIRs:

- 5RSC-2024-04 is 100.0 MW without requiring Network Upgrades
- 5RSC-2024-06 is 300.0 MW (Discharging) and -107.5 MW (Grid Charging)
- 5RSC-2024-12 is 200.0 MW (Discharging) and -209.3 MW (Grid Charging)
- 5RSC-2024-15 is 476.8 MW (Maximum output at POI)
- 5RSC-2024-21 is 400.0 MW

[10] Redispatch units are shown at the Appendix H.4
[11] Redispatch units are shown at the Appendix H.7

Table 26: 2029 South Single Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	CTTNWD N (73391) - KETTLECK S (73410) 115 kV CKT 1	P21From: 73389 BRIARGATE S 115 73710 BRIARGATE N 115 1 1	73	CSU	162	145.8	157.7	11.9	137.4	-8.4
2	FOXRUN (73414) - FLYHORSE N2 (73738) 115 kV CKT 1	72413 VOLLMERT 115 73481 FULLER 115 1 1	73	CSU	142	128.0	144.9	16.9	116.2	-11.8
3	W.CANON (70550) - HOGBACK115 (71025) 115 kV CKT 1	P21From: 73413 MIDWAYBR 230 73638 HAMBONE TAP 230 1 1	70	BHE	120	112.1	138.0	25.9	100.7	-11.4
4	FLYHORSE S (73576) - KETTLECK N (73711) 115 kV CKT 1	P21To: 72413 VOLLMERT 115 73481 FULLER 115 1 1	73	CSU	162	124.3	139.3	15.0	114.0	-10.3
5	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	478	111.3	118.3	7.0	99.6	-11.7
6	DANIEL_PK (70139) - FULLER (73477) 230 kV CKT 1	P21To: 70465 MIDWAY_PS 345 70466 WATERTON 345 1 1	70/73	PSCo	478	96.4	116.1	19.7	80.1	-16.3
7	VOLLMERT (72413) - FULLER (73481) 115 kV CKT 1	73576 FLYHORSE S 115 73711 KETTLECK N 115 1 1	73	Tri-State G&T	173	96.7	106.8	10.1	89.8	-6.9
8	BUCKLEY2 (70046) - TOLLGATE (70491) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	484	110.0	116.9	6.9	98.3	-11.7
9	PUEBPLNT (70339) - READER (70352) 115 kV CKT 1	LoTC_102	70	BHE	160	92.2	113.3	21.1	82.4	-9.8
10	MIDWAY_PS (70286) - FULLER (73477) 230 kV CKT 1	P21To: 70286 MIDWAY_PS 230 73413 MIDWAYBR 230 1 1	70/73	PSCo	478	90.5	109.8	19.3	80.6	-9.9
11	VOLLMERT (72413) - BLK_SQMV (73460) 115 kV CKT 1	P21To: 73576 FLYHORSE S 115 73711 KETTLECK N 115 1 1	73	Tri-State G&T	173	91.5	101.5	10.0	89.8	-6.9
12	FTN_VLY (70193) - MIDWAYBR (73412) 115 kV CKT 1	P21To: 70286 MIDWAY_PS 230 73413 MIDWAYBR 230 1 1	70/73	BHE	179	86.2	113.1	26.9	73.5	-12.7
13	MIDWAY_PS (70286) - MIDWAYBR (73413) 230 kV CKT 1	P21From: 70286 MIDWAY_PS 230 73477 FULLER 230 1 1	70/73	WAPA	637	81.2	103.4	22.2	76.9	-4.3
14	GI_2020_10 (700139) - MIRASOL (70652) 230 kV CKT 1	LoTC_102	70	PSCo	478	95.7	117.1	21.4	82.2	-13.5
15	BRIARGATE N (73710) - KETTLECK N (73711) 115 kV CKT 1	P21To: 73391 CTTNWD N 115 73410 KETTLECK S 115 1 1	73	CSU	186	101.5	110.6	9.2	95.0	-6.5
16	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T5	P21From: 70396 SMOKY_HL 230 70596 HARVEST_MI 230 1 1	70	PSCo	560	100.7	106.9	6.2	86.6	-14.1
17	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T4	P21From: 70396 SMOKY_HL 230 70596 HARVEST_MI 230 1 1	70	PSCo	560	100.7	106.9	6.2	86.6	-14.1
18	DANIEL_PK (70139) - DANIEL_PK (70601) 230/345 kV T3	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T4 1	70	PSCo	560	91.0	100.7	9.7	87.2	-3.8
19	DANIEL_PK (70139) - DANIEL_PK (70601) 230/345 kV T4	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T5 1	70	PSCo	560	91.0	100.7	9.7	87.2	-3.8

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
21	DANIEL_PK (70139) - DANIEL_PK (70601) 230/345 kV T5	70139 DANIEL_PK 230 70601 DANIEL_PK 345 T3 1	70	PSCo	560	91.0	100.7	9.7	87.2	-3.8

Table 27: 2029 South Multiple Contingency Loading for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	FTN_VLY (70193) - MIDWAYBR (73412) 115 kV CKT 1	BF_094d	70/73	BHE	179	136.2	167.0	30.8
2	FOXRUN (73414) - FLYHORSE N2 (73738) 115 kV CKT 1	P7_129	73	CSU	157	120.4	143.0	22.6
3	DESRTCOV (70449) - W.STATON (70456) 115 kV CKT 1	BF_094d	70	BHE	221	118.5	143.6	25.1
4	MIDWAY_PS (70286) - MIDWAYBR (73413) 230 kV CKT 1	P7_130	70/73	WAPA	637	117.4	144.7	27.3
5	FLYHORSE S (73576) - KETTLECK N (73711) 115 kV CKT 1	P7_129	73	CSU	180	115.8	135.6	19.8
6	W.CANON (70550) - HOGBACK115 (71025) 115 kV CKT 1	BF_094d	70	BHE	120	111.6	140.6	29.0
7	FTN_VLY (70193) - DESRTCOV (70449) 115 kV CKT 1	BF_094d	70	BHE	221	110.9	135.9	25.0
8	PUEBPLNT (70339) - READER (70352) 115 kV CKT 1	P7_53	70	BHE	160	109.9	136.5	26.6
9	DANIEL_PK (70139) - FULLER (73477) 230 kV CKT 1	P7_51	70/73	PSCo	478	110.1	135.3	25.2
10	BUCKLEY2 (70046) - SMOKY_HL (70396) 230 kV CKT 1	BF_064c	70	PSCo	478	108.3	114.2	5.9
11	CTTNWD N (73391) - KETTLECK S (73410) 115 kV CKT 1	P7_129	73	CSU	180	105.8	119.1	13.3
12	BOONE (70061) - PI_2024_15 (700015) 230 kV CKT 1	P7_53	70	PSCo	319	97.0	122.8	25.8
13	MIDWAY_PS (70286) - PI_2024_15 (700015) 230 kV CKT 1	P7_53	70	PSCo	319	96.9	122.6	25.7
14	HYDEPARK (70236) - PUEBPLNT (70339) 115 kV CKT 1	P7_53	70	BHE	159	95.1	121.7	26.6
15	DANIEL_PK (70139) - MARCY (70278) 230 kV CKT 1	P7_65	70	PSCo	478	91.9	104.7	12.8
16	MIDWAY_PS (70286) - FULLER (73477) 230 kV CKT 1	BF_094e	70/73	PSCo	478	85.6	102.2	16.6
17	GOOSE_CK (70918) - SHORTGRASS (70630) 345 kV CKT 1	P7_159	70	PSCo	1439	75.8	101.8	26.0
18	GI_2020_10 (700139) - MIRASOL (70652) 230 kV CKT 1	P7_53	70	PSCo	559	81.8	100.1	18.3

Table 28: 2029 South Single Contingency Loading for Grid Charging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate A (MVA)	BM AC Loading (%)	Study		Study with PSCo Redispatch	
							AC Loading (%)	Loading Difference (%)	AC Loading (%)	Loading Difference (%)
1	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	LoTC_59	70	PSCo	478	118.3	121.7	3.4	100.2	-18.1
2	FT_LUPTON (70192) - FT_ST_VRAIN (70410) 230 kV CKT 1	LoTC_68	70	PSCo	478	110.9	114.2	3.3	94.7	-16.2
3	CHEROKEE (70107) - LACOMBE (70324) 230 kV CKT 1	BUS: 70189 GREENWOOD_2 230	70	PSCo	435	109.4	112.6	3.2	102.5	-6.9
4	MISS_SITE (70624) - NEW_HMIL (770597) 345 kV CKT 1	LoTC_150	70	PSCo	1449	103.2	107.5	4.3	96.5	-6.7
5	GI_2021_6 (700155) - SKYRANCH (70392) 230 kV CKT 1	LoTC_51	70	PSCo	484	97.7	101.9	4.2	76.8	-20.9
6	SKYRANCH (70392) - SPRUCE (70528) 230 kV CKT 1	LoTC_51	70	PSCo	484	96.2	100.4	4.2	75.3	-20.9

Table 29: 2029 South Multiple Contingency Loading for Grid Charging Scenario

Ref. No.	Monitored Facility	Contingency Name	Area	Owner	Rate B (MVA)	BM AC Loading (%)	Study AC Loading (%)	Loading Difference (%)
1	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T4	BF_129d	70	PSCo	560	145.1	149.0	3.9
2	SMOKY_HL (70599) - SMOKY_HL (70396) 345/230 kV T5	BF_129c	70	PSCo	560	145.1	149.0	3.9
3	VALMONT (70447) - SPINDLE (70592) 230 kV CKT 1	BF_058c	70	PSCo	478	121.3	123.1	1.8
4	CHEROKEE (70107) - LACOMBE (70324) 230 kV CKT 1	P7_152	70	PSCo	435	119.8	123.5	3.7
5	FT_LUPTON (70192) - FT_ST_VRAIN (70410) 230 kV CKT 1	P7_88	70	PSCo	478	114.3	116.4	2.1
6	MISS_SITE (70624) - NEW_HMIL (770597) 345 kV CKT 1	P7_136	70	PSCo	1449	110.9	115.6	4.7
7	GREEN_VLY (70048) - SPRUCE (70528) 230 kV CKT 1	P7_111	70	PSCo	717	101.7	107.8	6.1
8	FT_LUPTON (70192) - JLGREEN (70529) 230 kV CKT 1	P7_32	70	PSCo	487	101.2	103.3	2.1
9	GI_2021_6 (700155) - SKYRANCH (70392) 230 kV CKT 1	P7_149	70	PSCo	484	100.1	102.7	2.6
10	FT_LUPTON (70192) - FT_ST_VRAIN (70410) 230 kV CKT 2	P7_88	70	PSCo	548	99.7	101.5	1.8
11	SKYRANCH (70392) - SPRUCE (70528) 230 kV CKT 1	P7_149	70	PSCo	484	98.6	101.2	2.6
12	MISS_SITE (70624) - PRONGHORN (70628) 345 kV CKT 1	P7_163	70	PSCo	1793	97.0	103.8	6.7
13	GREEN_VLY (70048) - KEENESBURG (70820) 230 kV CKT 2	P7_107	70	PSCo	717	96.3	101.4	5.1
14	GREEN_VLY (70048) - KEENESBURG (70820) 230 kV CKT 1	P7_109	70	PSCo	717	96.3	101.4	5.1

TRANSIENT STABILITY STUDY RESULTS

This section describes the Transient Stability Study results obtained for the five different study pocket case years analyzed in the 5RSC analysis. The cases obtained in the Steady-State Analysis portion of this study were used as a starting point for the Transient Stability Analysis presented in this section.

The result for each study pocket case year is presented below in tabulated form. Transient stability plots for all scenarios are shown in Appendix L of this report.

This Transient Stability Study did not identify any Network Upgrades.

2027 METRO TRANSIENT STABILITY ANALYSIS RESULTS

Table 30 presents a summary of the contingencies studied for the 2027 Metro case year and the corresponding stability results for Portfolios 1 and 2. Please note that contingencies tested in Portfolio 1 that are not applicable to Portfolio 2 are listed in Table 30 as NA.

The following was observed for the stability analysis for both Portfolios:

- No machines lost synchronism with the system
- No transient voltage drop violations were observed
- Machine rotor angles displayed positive damping

Table 30: Transient Stability Result Summary for 2027 Metro

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Portfolio 1		Portfolio 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	-	Flatrun	P0	Flat Run	-	Stable	Stable	Stable	Stable
2	Fort Lupton 115 kV	5RSC-2024-01	P1	5RSC-2024-01 Generation	6	Stable	Stable	NA	
3	Fort St Vrain 230 kV	5RSC-2024-02	P1	5RSC-2024-02 Generation	5	Stable	Stable	Stable	Stable
4	Fort St Vrain 230 kV	LoTC_59	P1	Fort St Vrain - Isabelle 230 kV Line	5	Stable	Stable	Stable	Stable
5	Fort Lupton 230 kV	LoTC_62	P1	Fort Lupton - Fort St Vrain 230 kV Line	5	Stable	Stable	Stable	Stable
6	Fort St Vrain 230 kV	LoTC_63	P1	Fort St Vrain - Windsor 230 kV Line Windsor - Ault 230 kV Line	5	Stable	Stable	Stable	Stable
7	Fort St Vrain 230 kV	LoTC_64	P1	Fort St Vrain - Weld 230 kV Line	5	Stable	Stable	Stable	Stable
8	Fort St Vrain 230 kV	LoTC_65	P1	Fort St Vrain – Longs Peak 230 kV Line	5	Stable	Stable	Stable	Stable
9	Fort St Vrain 230 kV	LoTC_66	P1	Fort St Vrain - Fordham 230 kV Line	5	Stable	Stable	Stable	Stable
10	Fort St Vrain 230 kV	LoTC_67	P1	Fort St Vrain - Keenesburg 230 kV Line	5	Stable	Stable	Stable	Stable
11	Fort St Vrain 230 kV	LoTC_141	P1	Fort St Vrain - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable
12	Fulton 115 kV	LoTC_195	P1	Fulton - Parkway 115 kV Line Coors RCL - Fulton 115 kV Line Fort Lupton - Coors RCL 115 kV Line	6	Stable	Stable	NA	
13	Anadarko TP 115 kV	LoTC_237	P1	Anadarko - Gilcrest 115 kV Line Gilcrest - Godfrey 115 kV Line Anadarko - Vasquez 115 kV Line Vasquez - Fort Lupton 115 kV Line	6	Stable	Stable	NA	
14	Fort Lupton 230 kV	BF_057a	P4	Fort Lupton - Fort St Vrain 230 kV Line Fort Lupton 115/230 kV Transformer T3	17	Stable	Stable	Stable	Stable
15	Fort Lupton 115 kV	BF_057d	P4	Loss of Fort Lupton Bus 1 Fort Lupton Generation 5RSC-2024-01 Generation	22	Stable	Stable	NA	
16	Fort St Vrain 230 kV	BF_058a	P4	Fort St Vrain - Ault 230 kV Line Fort St Vrain - Fordham 230 kV Line	17	Stable	Stable	Stable	Stable

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Portfolio 1		Portfolio 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
17	Fort St Vrain 230 kV	BF_058c	P4	Fort St Vrain - Longs Peak 230 kV Line Fort St Vrain - Isabelle 230 kV Line	17	Stable	Stable	Stable	Stable
18	Fort St Vrain 230 kV	BF_058d	P4	Fort St Vrain - Ft Lupton 230 kV Line Fort St Vrain Generation #2	17	Stable	Stable	Stable	Stable
19	Fort St Vrain 230 kV	BF_058e	P4	Fort St Vrain - Keenesburg 230 kV Line Fort St Vrain Generation #3	17	Stable	Stable	Stable	Stable
20	Fort St Vrain 230 kV	BF_145a	P4	Fort St Vrain - Spindle 230 kV Line Spindle - Valmont 230 kV Line	17	Stable	Stable	Stable	Stable
21	Fort St Vrain 230 kV	BF_151c	P4	Fort St Vrain - Weld 230 kV Line Weld 115/230 kV Transformer T1	17	Stable	Stable	Stable	Stable
22	Fort Lupton 230 kV	P7_76	P7	Fort St Vrain - Ft Lupton 230 kV Line Circuits 1 and 2	5	Stable	Stable	Stable	Stable
23	Fort St Vrain 230 kV	P7_87	P7	Fort St Vrain - Isabelle 230 kV Line Fort St Vrain - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable
24	Fort St Vrain 230 kV	P7_88	P7	Fort St Vrain - Isabelle 230 kV Line Valmont - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable
25	Fort St Vrain 230 kV	P7_89	P7	Fort St Vrain - Isabelle 230 kV Line Niwot - Isabelle 230 kV Line	5	Stable	Stable	Stable	Stable
26	Fort St Vrain 230 kV	P7_90	P7	Fort St Vrain - Isabelle 230 kV Line Valmont - Spindle 230 kV Line Fort St Vrain Spindle 230 kV Line	5	Stable	Stable	Stable	Stable
27	Fort St Vrain 230 kV	P7_92	P7	Fort St Vrain - Keenesburg 230 kV Line Keenesburg - Green Valley 230 kV Line	5	Stable	Stable	Stable	Stable

2027 NORTH TRANSIENT STABILITY ANALYSIS RESULTS

Table 31 presents a summary of the contingencies studied for the 2027 North case year and the corresponding stability results for Portfolios 1 and 2, and the Grid Charging scenario. Please note that contingencies tested in Grid Discharging Portfolio 1 that are not applicable to Grid Discharging Portfolio 2 or to Grid Charging scenarios are listed in Table 31 as NA.

The following was observed for the stability analysis for both Portfolios in Grid Discharging and Grid Charging scenarios:

- No machines lost synchronism with the system
- No transient voltage drop violations were observed
- Machine rotor angles displayed positive damping

Table 31: Transient Stability Result Summary for 2027 North

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolio 1		Grid Discharging Portfolio 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	-	Flatrun	P0	Flat Run	-	Stable	Stable	Stable	Stable	Stable	Stable
2	Fort Lupton 115 kV	5RSC-2024-01	P1	5RSC-2024-01 Generation	6	Stable	Stable	NA		NA	
3	Fort St Vrain 230 kV	5RSC-2024-02	P1	5RSC-2024-02 Generation	5	Stable	Stable	Stable	Stable	NA	
4	Spindle 230 kV	5RSC-2024-13	P1	5RSC-2024-13 Generation	5	Stable	Stable	Stable	Stable	Stable	Stable
5	Fort St Vrain 230 kV	LoTC_59	P1	Fort St Vrain - Isabelle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
6	Fort Lupton 230 kV	LoTC_62	P1	Fort Lupton - Fort St Vrain 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
7	Fort St Vrain 230 kV	LoTC_63	P1	Fort St Vrain - Windsor 230 kV Line Windsor - Ault 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
8	Fort St Vrain 230 kV	LoTC_64	P1	Fort St Vrain - Weld 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
9	Fort St Vrain 230 kV	LoTC_65	P1	Fort St Vrain – Longs Peak 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
10	Fort St Vrain 230 kV	LoTC_66	P1	Fort St Vrain - Fordham 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
11	Fort St Vrain 230 kV	LoTC_67	P1	Fort St Vrain - Keenesburg 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
12	Valmont 230 kV	LoTC_74	P1	Valmont - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
13	Spindle 230 kV	LoTC_140	P1	Spindle Generation	5	Stable	Stable	Stable	Stable	Stable	Stable
14	Fort St Vrain 230 kV	LoTC_141	P1	Fort St Vrain - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
15	Fulton 115 kV	LoTC_195	P1	Fulton - Parkway 115 kV Line Coors RCL - Fulton 115 kV Line Fort Lupton - Coors RCL 115 kV Line	6	Stable	Stable	NA		NA	
16	Anadarko TP 115 kV	LoTC_237	P1	Anadarko - Gilcrest 115 kV Line Gilcrest - Godfrey 115 kV Line Anadarko - Vasquez 115 kV Line Vasquez - Fort Lupton 115 kV Line	6	Stable	Stable	NA		NA	
17	Fort Lupton 230 kV	BF_057a	P4	Fort Lupton 5520 Stuck Fort Lupton - Fort St Vrain 230 kV Line Fort Lupton 115/230 kV Transformer T3	17	Stable	Stable	Stable	Stable	Stable	Stable

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolio 1		Grid Discharging Portfolio 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
18	Fort Lupton 115 kV	BF_057d	P4	Loss of Fort Lupton Bus 1 Fort Lupton Generation 5RSC-2024-01 Generation	22	Stable	Stable	NA		NA	
19	Fort St Vrain 230 kV	BF_058a	P4	Fort St Vrain - Ault 230 kV Line Fort St Vrain - Fordham 230 kV Line	17	Stable	Stable	Stable	Stable	Stable	Stable
20	Fort St Vrain 230 kV	BF_058c	P4	Fort St Vrain - Longs Peak 230 kV Line Fort St Vrain - Isabelle 230 kV Line	17	Stable	Stable	Stable	Stable	Stable	Stable
21	Fort St Vrain 230 kV	BF_058d	P4	Fort St Vrain - Ft Lupton 230 kV Line Fort St Vrain Generation #2	17	Stable	Stable	Stable	Stable	Stable	Stable
22	Fort St Vrain 230 kV	BF_058e	P4	Fort St Vrain - Keenesburg 230 kV Line Fort St Vrain Generation #3	17	Stable	Stable	Stable	Stable	Stable	Stable
23	Spindle 230 kV	BF_145a	P4	Fort St Vrain - Spindle 230 kV Line Spindle - Valmont 230 kV Line	17	Stable	Stable	Stable	Stable	Stable	Stable
24	Spindle 230 kV	BF_148a	P4	Valmont - Spindle 230 kV Line Valmont 115/230 kV Transformer T4	17	Stable	Stable	Stable	Stable	Stable	Stable
25	Spindle 230 kV	BF_148d	P4	Valmont - Spindle 230 kV Line Valmont - Plains End 230 kV Line Valmont 115/230 kV Transformer T8	17	Stable	Stable	Stable	Stable	Stable	Stable
26	Fort St Vrain 230 kV	BF_151c	P4	Fort St Vrain - Weld 230 kV Line Weld 115/230 kV Transformer T1	17	Stable	Stable	Stable	Stable	Stable	Stable
27	Fort Lupton 230 kV	P7_76	P7	Fort St Vrain - Ft Lupton 230 kV Line Circuits 1 and 2	5	Stable	Stable	Stable	Stable	Stable	Stable
28	Fort St Vrain 230 kV	P7_87	P7	Fort St Vrain - Isabelle 230 kV Line Fort St Vrain - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
29	Fort St Vrain 230 kV	P7_88	P7	Fort St Vrain - Isabelle 230 kV Line Valmont - Spindle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolio 1		Grid Discharging Portfolio 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
30	Fort St Vrain 230 kV	P7_89	P7	Fort St Vrain - Isabelle 230 kV Line Niwot - Isabelle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
31	Fort St Vrain 230 kV	P7_90	P7	Fort St Vrain - Isabelle 230 kV Line Valmont - Spindle 230 kV Line Fort St Vrain Spindle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
32	Fort St Vrain 230 kV	P7_92	P7	Fort St Vrain - Keenesburg 230 kV Line Keenesburg - Green Valley 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
33	Spindle 230 kV	P7_93	P7	Fort St Vrain - Spindle 230 kV Line Spindle - Valmont 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
34	Spindle 230 kV	P7_119	P7	Spindle - Valmont 230 kV Line Niwot - Isabelle 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable
35	Spindle 230 kV	P7_138	P7	Spindle - Valmont 230 kV Line Niwot - Leggett 230 kV line Leggett - Plains End 230 kV Line	5	Stable	Stable	Stable	Stable	Stable	Stable

2027 EAST TRANSIENT STABILITY ANALYSIS RESULTS

Table 32 presents a summary of the contingencies studied for the 2027 East case year and the corresponding stability results for Discharging and Grid Charging scenarios. Note that both Portfolios provide the same result for Discharging and Grid Charging scenarios. Please note that contingencies tested in Grid Discharging that are not applicable to Grid Charging scenarios are listed in Table 32 as NA.

The following was observed for the stability analysis for both Portfolios in Discharging and Grid Charging scenarios:

- No machines lost synchronism with the system
- No transient voltage drop violations were observed
- Machine rotor angles displayed positive damping

Table 32: Transient Stability Result Summary for 2027 East

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolios 1 and 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	-	Flatrun	P0	Flat Run	-	Stable	Stable	Stable	Stable
2	Goose Creek 345 kV	5RSC-2024-10	P1	5RSC-2024-10 Generation	4	Stable	Stable	Stable	Stable
3	Pawnee 345 kV	5RSC-2024-11	P1	5RSC-2024-11 Generation	4	Stable	Stable	Stable	Stable
4	Goose Creek 345 kV	5RSC-2024-16	P1	5RSC-2024-16 Generation	4	Stable	Stable	NA	
5	Goose Creek 345 kV	5RSC-2024-17	P1	5RSC-2024-17 Generation	4	Stable	Stable	NA	
6	Canal Crossing 345 kV	5RSC-2024-27	P1	5RSC-2024-27 Generation	4	Stable	Stable	Stable	Stable
7	Goose Creek 345 kV	5RSC-2024-28	P1	5RSC-2024-28 Generation	4	Stable	Stable	NA	
8	Pawnee 230 kV	LoTC_84	P1	Pawnee - Story 230 kV Line	5	Stable	Stable	Stable	Stable
9	Pawnee 230 kV	LoTC_85	P1	Pawnee - Missile Site 230 kV Line	5	Stable	Stable	Stable	Stable
10	Pawnee 230 kV	LoTC_87	P1	Pawnee - Fort Lupton 230 kV Line	5	Stable	Stable	Stable	Stable
11	Missile Site 345 kV	LoTC_152	P1	Missile Site - Canal Crossing 345 kV Line CKT 1	4	Stable	Stable	Stable	Stable
12	Canal Crossing 345 kV	LoTC_293	P1	Canal Crossing - Goose Creek 345 kV Line CKT 1	4	Stable	Stable	Stable	Stable
13	Canal Crossing 345 kV	LoTC_294a	P1	Canal Crossing - Goose Creek 345 kV Line CKT 2 PI-2024-19 Generation	4	Stable	Stable	Stable	Stable
14	Goose Creek 345 kV	LoTC_294b	P1	Canal Crossing - Goose Creek 345 kV Line CKT 2 PI-2024-19 Generation	4	Stable	Stable	Stable	Stable
15	May Valley 345 kV	LoTC_295b	P1	May Valley - Goose Creek 345 kV Line CKT 1	4	Stable	Stable	Stable	Stable
16	Goose Creek 345 kV	LoTC_297	P1	Cheyenne Ridge West Generation	4	Stable	Stable	Stable	Stable
17	Pawnee 345 kV	LoTC_303	P1	Pawnee - Canal Crossing 345 kV Line CKT 1	4	Stable	Stable	Stable	Stable
18	Canal Crossing 345 kV	LoTC_305	P1	Canal Crossing - Fort St Vrain 345 kV Line CKT 1	4	Stable	Stable	Stable	Stable
19	Goose Creek 345 kV	BF_034	P4	Goose Creek - Cheyenne Ridge West Line Stuck Cheyenne Ridge West Generation	12	Stable	Stable	Stable	Stable
20	Canal Crossing 345 kV	BF_154a	P4	Pawnee - Canal Crossing 345 kV Line CKT 1 Canal Crossing - Fort St Vrain 345 kV CKT 1	12	Stable	Stable	Stable	Stable

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolios 1 and 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
21	Goose Creek 345 kV	BF_155a	P4	Canal Crossing - Goose Creek 345 kV Line CKT 1 May Valley - Goose Creek 345 kV Line CKT 1	12	Stable	Stable	Stable	Stable
22	Sandstone 345 kV	BF_156b	P4	Harvest Mile - Sandstone 345 kV CKT 1 Sandstone - May Valley 345 kV CKT 1	12	Stable	Stable	Stable	Stable
23	Goose Creek 345 kV	P7_159	P7	Canal Crossing - Goose Creek 345 kV Line CKT 1 Canal Crossing - Goose Creek 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable
24	Canal Crossing 345 kV	P7_160	P7	Canal Crossing - Fort St Vrain 345 kV Line CKT 1 Canal Crossing - Fort St Vrain 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable
25	Canal Crossing 345 kV	P7_161	P7	Missile Site - Canal Crossing 345 kV Line CKT 1 Missile Site - Canal Crossing 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable
26	Goose Creek 345 kV	P7_162	P7	May Valley - Goose Creek 345 kV Line CKT 1 May Valley - Goose Creek 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable

2028 WESTERN SLOPE (WS) TRANSIENT STABILITY ANALYSIS RESULTS

Before conducting the analysis, unstable results were observed when faults near Goose Creek and Canal Crossing were applied in the 2028 Western Slope Benchmark case. Two upgrades have been proposed to mitigate these issues:

- A 350 MVAr Synchronous Condenser at Waterton 345 kV
- A 350 MVAr Synchronous Condenser at Daniels Park 345 kV

PSCo is currently studying these upgrades, and the following analysis was conducted with the Synchronous Condensers in place.

Table 33 presents a summary of the contingencies studied for the 2028 Western Slope case year and the corresponding stability results for Discharging and Grid Charging scenarios. Note that both Portfolios provide the same result for Discharging and Grid Charging scenarios.

The following was observed for the stability analysis for both Portfolios in Discharging and Grid Charging scenarios:

- No machines lost synchronism with the system
- No transient voltage drop violations were observed
- Machine rotor angles displayed positive damping

Table 33: Transient Stability Result Summary for 2028 Western Slope

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolios 1 and 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	-	Flatrun	P0	Flat Run	-	Stable	Stable	Stable	Stable
2	Hartsel 230 kV	5RSC-2024-09	P1	5RSC-2024-09 Generation	5	Stable	Stable	Stable	Stable
3	Hartsel 230 kV	LoTC_29	P1	Malta - Hartsel 230 kV Line	5	Stable	Stable	Stable	Stable
4	Malta 230 kV	LoTC_30	P1	Malta - Mt Elbert 230 kV Line	5	Stable	Stable	Stable	Stable
5	Malta 230 kV	LoTC_31	P1	Malta - Basalt 230 kV Line	5	Stable	Stable	Stable	Stable
6	Malta 230 kV	LoTC_47	P1	Malta - Hagerman Tap 230 kV Line Hagerman Tap - Hopkins 230 kV Line	5	Stable	Stable	Stable	Stable
7	Malta 230 kV	LoTC_89	P1	Malta - Alma 230 kV Line Alma - Breckenridge 230 kV Line	5	Stable	Stable	Stable	Stable
8	Tarryall 230 kV	LoTC_128	P1	Tarryall - Waterton 230 kV Line	5	Stable	Stable	Stable	Stable
9	Tarryall 230 kV	LoTC_144	P1	Tarryall - Hartsel 230 kV Line	5	Stable	Stable	Stable	Stable
10	Hartsel 230 kV	BF_070b	P4	Hartsel 5990 Stuck Tarryall - Hartsel 230 kV Line Malta - Hartsel 230 kV Line	17	Stable	Stable	Stable	Stable
11	Malta 230 kV	BF_089b	P4	Malta - Hagerman Tap 230 kV Line Hagerman Tap - Hopkins 230 kV Line Malta - Hartsel 230 kV Line	17	Stable	Stable	Stable	Stable
12	Hartsel 230 kV	BF_137a	P4	Tarryall 5802 Stuck Tarryall - Waterton 230 kV Line Tarryall - Hartsel 230 kV Line	17	Stable	Stable	Stable	Stable
13	Hartsel 230 kV	P7_114	P7	Malta - Hartsel 230 kV Line Tarryall - Hartsel 230 kV Line	5	Stable	Stable	Stable	Stable

2029 SOUTH TRANSIENT STABILITY ANALYSIS RESULTS

Before conducting the analysis, unstable results were observed when faults near Goose Creek and Canal Crossing were applied in the 2029 South Benchmark case. Two upgrades have been proposed to mitigate these issues:

- A 350 MVAr Synchronous Condenser at Waterton 345 kV
- A 350 MVAr Synchronous Condenser at Daniels Park 345 kV

PSCo is currently studying these upgrades, and the following analysis was conducted with the Synchronous Condensers in place.

Table 34 presents a summary of the contingencies studied for the 2029 South case year and the corresponding stability results for Discharging and Grid Charging scenarios. Note that both Portfolios provide the same result for Discharging and Grid Charging scenarios. Please note that contingencies tested in Discharging that are not applicable to Grid Charging scenarios are listed in Table 34 as NA.

The following was observed for the stability analysis for both Portfolios in Discharging and Grid Charging scenarios:

- No machines lost synchronism with the system
- No transient voltage drop violations were observed
- Machine rotor angles displayed positive damping

Table 34: Transient Stability Result Summary for 2029 South

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolios 1 and 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	-	Flatrun	P0	Flat Run	-	Stable	Stable	Stable	Stable
2	Mirasol 230 kV	5RSC-2024-04	P1	5RSC-2024-04 Generation	5	Stable	Stable	NA	
3	Sandstone 345 kV	5RSC-2024-06	P1	5RSC-2024-06 Generation	4	Stable	Stable	Stable	Stable
4	Comanche 345 kV	5RSC-2024-12	P1	5RSC-2024-12 Generation	4	Stable	Stable	Stable	Stable
5	May Valley 345 kV	5RSC-2024-15	P1	5RSC-2024-15 Generation	4	Stable	Stable	NA	
6	Crow 345 kV	5RSC-2024-21	P1	5RSC-2024-21 Generation	4	Stable	Stable	NA	
7	Comanche 230 kV	LoTC_79	P1	Comanche - Mirasol 230 kV Line	5	Stable	Stable	Stable	Stable
8	Midway 230 kV	LoTC_102	P1	Midway - Mirasol 230 kV Line	5	Stable	Stable	Stable	Stable
9	Mirasol 230 kV	LoTC_103	P1	Thunderwolf Generation	5	Stable	Stable	Stable	Stable
10	Comanche 345 kV	LoTC_147	P1	Comanche - Tundra 345 kV Line	4	Stable	Stable	Stable	Stable
11	Kiowa 345 kV	LoTC_316b	P1	Kiowa - Sandstone 345 kV Line	4	Stable	Stable	Stable	Stable
12	Sandstone 345 kV	LoTC_317	P1	Sandstone - Tundra 345 kV Line	4	Stable	Stable	Stable	Stable
13	Crow 345 kV	LoTC_318a	P1	Crow - Sandstone 345 kV Line	4	Stable	Stable	Stable	Stable
14	Crow 345 kV	LoTC_318b	P1	May Valley - Crow 345 kV Line	4	Stable	Stable	Stable	Stable
15	Sandstone 345 kV	LoTC_324	P1	New Harvest Mile - Sandstone 345 kV Line Sandstone - Tundra 345 kV Line	4	Stable	Stable	Stable	Stable
16	Comanche 345 kV	BF_039b	P4	Comanche - Tundra 345 kV Line Comanche C3 Generation	12	Stable	Stable	Stable	Stable
17	Comanche 345 kV	BF_039e	P4	Comanche - Tundra 345 kV Line Comanche 230/345 kV Transformer T4	12	Stable	Stable	Stable	Stable
18	Midway 230 kV	BF_094c	P4	Midway - Mirasol 230 kV Line Fountain Valley Generation	17	Stable	Stable	Stable	Stable
19	Comanche 345 kV	BF_140a	P4	Comanche - Tundra 345 kV Line Neptune Generation	12	Stable	Stable	Stable	Stable
20	Tundra 345 kV	BF_140b	P4	Comanche - Tundra 345 kV Line Tundra - Daniels Park 345 kV Line	12	Stable	Stable	Stable	Stable

Ref. No.	Fault Location	Alias	Fault Category	Outage(s)	Clearing Time (Cycles)	Grid Discharging Portfolios 1 and 2		Grid Charging Portfolios 1 and 2	
						Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
21	Sandstone 345 kV	BF_156a	P4	New Harvest Mile - Sandstone 345 kV Line Sandstone - Tundra 345 kV Line	12	Stable	Stable	Stable	Stable
22	Tundra 345 kV	BF_157a	P4	Sandstone - Tundra 345 kV Line Neptune Generation	12	Stable	Stable	Stable	Stable
23	Comanche 230 kV	P7_53	P7	Comanche - Mirasol 230 kV Line Midway - Mirasol 230 kV Line	5	Stable	Stable	Stable	Stable
24	Comanche 345 kV	P7_55	P7	Comanche - Tundra 345 kV Line CKT 1 Comanche - Tundra 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable
25	Crow 345 kV	P7_163	P7	Sandstone - May Valley 345 kV Line CKT 1 Sandstone - May Valley 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable
26	Tundra 345 kV	P7_164	P7	Tundra - Sandstone 345 kV Line CKT 1 Tundra - Sandstone 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable
27	Sandstone 345 kV	P7_165	P7	New Harvest Mile - Sandstone 345 kV Line CKT 1 New Harvest Mile - Sandstone 345 kV Line CKT 2	4	Stable	Stable	Stable	Stable

FAULT AND BREAKER-DUTY ANALYSIS (SHORT-CIRCUIT STUDY)

Breaker duty studies were performed for the base case scenario and with addition of the entire 5RSC-2024 cluster. Breakers identified as overstressed will be placed into two categories.

- Overstressed breakers in the base case which are worsened by more than 3% change in breaker duty margin in the added case are considered Contingent Facilities.
- Breakers becoming overstressed when the entire cluster is added will be considered Network Upgrades.

This summary identifies only the contingent facility and network upgrades that affect the 5RSC-2024 cluster. It is not comprehensive of all overdutied breakers on the PSCo transmission system.

Table 35 lists all breakers identified as contingent facilities from the cluster study.

Table 35: List of Contingent Facilities

SUBSTATION	BASE KV	BREAKER NAME
None		

A breaker duty study on the PSCo transmission system identified all circuit breakers whose duty increased by more than 3%. These breakers were then evaluated with engineering judgement individually and deemed an acceptable risk while replacement projects are being executed.

No identified breakers are classified as contingent facilities.

Table 36 lists all breakers identified as network upgrades in the cluster study.

Table 36: List of Network Upgrades

SUBSTATION	BASE KV	BREAKER NAME
None		

A breaker duty study on the PSCo transmission system including the 5RSC-2024 cluster did not identify any circuit breakers that became overdutied because of the new interconnections.

COST ESTIMATES

There are three types of costs identified in the study:

- Transmission Provider's Interconnection Facilities (TPIF) which are directly assigned to each GIR
- Station equipment Network Upgrades, which are allocated to each GIR connecting to that station on a per-capita basis per Section 4.2.4(a) of the LGIP
- All System Network Upgrades which are allocated by the proportional impact per Section 4.2.4(b) of the LGIP

A summary of the estimated costs by GIR is provided in Table 37. Detailed cost estimates are provided in Appendix I. Preliminary one-line figures for each GIR are provided in Appendix J.

Table 37: Summary of Estimated Cost by GIR

GIR #	Transmission Provider Interconnection Facilities Estimated Cost (Million)	Station Network Upgrades Estimated Cost (million)	System Network Upgrades Estimated Cost (million)	Total Estimated Cost (million)
5RSC-2024-01	$1.069	$0.331	$0.000	$1.400
5RSC-2024-02	$4.718	$51.656	$0.000	$56.374
5RSC-2024-04	$2.996	$3.422	$0.000	$6.418
5RSC-2024-06	$3.999	$9.263	$0.000	$13.262
5RSC-2024-09	$3.616	$5.599	$0.000	$9.215
5RSC-2024-10	$4.126	$7.035	$0.000	$11.161
5RSC-2024-11	$4.762	$13.933	$0.000	$18.695
5RSC-2024-12	$4.881	$2.899	$0.000	$7.780
5RSC-2024-13	$1.955	$2.734	$0.000	$4.689
5RSC-2024-15	$3.830	$7.868	$0.000	$11.698
5RSC-2024-16	$5.030	$7.035	$0.000	$12.065
5RSC-2024-17	$3.639	$7.035	$0.000	$10.674
5RSC-2024-21	$3.348	$29.723	$0.000	$33.071
5RSC-2024-27	$3.585	$4.068	$0.000	$7.653
5RSC-2024-28	$5.261	$7.035	$0.000	$12.296

COST ESTIMATE ASSUMPTIONS

The cost estimates provided in this Study Report are based on the following assumptions:

- The cost estimates are in 2026 dollars with an escalation percentage and contingencies applied to the cost estimates.
- The cost estimates do not include an Allowance for Funds Used During Construction (AFUDC).
- The estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of the PSCo facilities to facilitate interconnection.
- The estimated costs do not include the cost for any Customer owned equipment and associated design and engineering.
- Labor is estimated at straight time only; no overtime work is included.
- No costs for retail load metering are included in these estimates.
- PSCo (or its Contractor) will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.

INTERCONNECTION CUSTOMER REQUIREMENTS

- Customer will install two (2) redundant fiber optic circuits into the Transmission Provider's substation as part of its interconnection customer interconnection facilities construction scope.
- Power Quality Metering (PQM) will be required on the Interconnection Customer's generation tie-line terminating into the POI.
- The Interconnection Customer will be required to design, procure, install, own, operate and maintain a Remote Terminal Unit (RTU) at their collector substation. PSCo will be provided with indications, readings and data from the RTU.
- The Interconnection Customer will comply with the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW, as amended from time to time, and available at: Interconnection | Transmission | Corporate | Xcel Energy.

CONTINGENT FACILITY STUDY RESULTS

The following is the list of the unbuilt Interconnection Facilities and Network Upgrades upon which the costs, timing, and study findings of the 5RSC-2024 are dependent, and if delayed or not built, could cause a need for re-studies of the Interconnection Service or a reassessment of the Interconnection Facilities and/or Network Upgrades and/or costs and timing. The individual GIR's maximum allowable output may be decreased if these Contingent Facilities are not in-service.

Each unbuilt facility was studied as a potential contingent facility independently. The unbuilt facilities in each study pocket were reverted to pre-project topology, and the resultant worst-case overloads were reported in Appendix K. The study generators' DFAX were calculated for the worst-case overloads. If reverting the unbuilt facility causes or increases an overload in more than 1% of the monitored facility rating, with more than 3% study generator DFAX, the unbuilt facility is identified as a contingent facility for that study generator.

A complete list of the unbuilt facilities tested in this analysis is presented in Appendix K, together with the list of tables exemplifying each of the results summarized in this section.

2027 METRO CONTINGENT FACILITIES

No contingent facility was identified in the 2027 Metro Case in either Portfolio 1 or Portfolio 2.

2027 NORTH CONTINGENT FACILITIES

Table 38 summarizes the contingent facilities identified for the 2027 North Case for both Portfolios 1 and 2.

Table 38: Contingent Facilities and Corresponding Study Generators for 2027 North Case

Contingent Facility	Portfolios 1 and 2 Study Generators
Uprate Valmont Transformer T7 to 448 MVA	5RSC-24-13
Uprate Valmont Transformer T8 to 448 MVA	5RSC-24-13
Addition of 100 MVAr reactor at Beaver Creek P	5RSC-24-13*
Greenwood to Monaco series reactor	5RSC-24-13*

*Contingent facilities identified under Grid Charging scenario.

2027 EAST CONTINGENT FACILITIES

Table 39 summarizes the contingent facilities identified for the 2027 East Case for both Portfolios 1 and 2.

Table 39: Contingent Facilities and Corresponding Study Generators for 2027 East Case

Contingent Facility	Portfolios 1 and 2 Study Generators
Addition of Fort Saint Vrain Transformer T1	5RSC-24-11, 5RSC-24-27
Addition of Comanche Transformer T5	5RSC-24-10, 5RSC-24-16 5RSC-24-17, 5RSC-24-28
Uprate Missile Site - Pronghorn 345 kV to 1793 MVA	5RSC-24-10, 5RSC-24-16 5RSC-24-17, 5RSC-24-28

2028 WESTERN SLOPE (WS) CONTINGENT FACILITIES

Table 40 summarizes the contingent facility identified for the 2028 Western Slope (WS) Case for both Portfolios 1 and 2.

Table 40: Contingent Facilities and Corresponding Study Generator for 2028 Western Slope (WS) Case

Contingent Facility	Portfolios 1 and 2 Study Generator
Addition of Greenwood to Monaco Series Reactor	5RSC-24-09

2029 SOUTH CONTINGENT FACILITIES

Table 41 summarizes the contingent facility identified for the 2029 South Case for both Portfolios 1 and 2.

Table 41: Contingent Facilities and Corresponding Study Generators for 2029 South Case

Contingent Facility	Portfolios 1 and 2 Study Generators
Addition of Greenwood to Monaco Series Reactor	5RSC-24-06, 5RSC-24-12 5RSC-24-15, 5RSC-24-21
Uprate Comanche - Stagecoach (GI-2020-10) 230 kV to 1195 MVA	5RSC-24-04
Uprate Midway - Mirasol 230 kV to 796 MVA	5RSC-24-04
Addition of 350 MVAr Synchronous Condenser at Waterton	5RSC-24-04
Addition of 350 MVAr Synchronous Condenser at Daniels Park	5RSC-24-04, 5RSC-24-06 5RSC-24-12, 5RSC-24-21

CONCLUSIONS

The 5RSC-2024 Cluster Study evaluated the steady-state and transient stability impacts associated with the interconnection of fifteen (15) Generator Interconnection Requests (GIRs) seeking Energy Resource Interconnection Service (ERIS) on the Public Service Company of Colorado (PSCo) transmission system. Collectively, the requests represent 4,755 MW of ERIS capacity, including 1,441.1 MW of grid-charging capability associated with Battery Energy Storage System (BESS) projects. The projects were analyzed within five study pockets and under two generation portfolios. The study was performed in accordance with PSCo's Business Practice Manual (BPM) and applicable WECC and NERC reliability criteria, considering system-intact, single-contingency, and selected multiple-contingency operating conditions.

The GIRs were evaluated based on their respective points of interconnection within the Metro, North, East, Western Slope, and South study pockets. For each study pocket, thermal loading and voltage performance were assessed to determine whether any identified violations were attributable to the study GIRs and whether such violations could be mitigated through operational measures, including generation redispatch. Because no thermal or voltage violations requiring permanent mitigation were identified, an evaluation of alternative transmission technologies (ATTs), as prescribed under FERC Order 2023 was not required.

For the Metro, North, East, Western Slope, and South study pockets, no voltage violations or thermal overloads attributable to the ERIS study GIRs were identified following the application of appropriate redispatch of existing PSCo generating resources. Consistent with NERC TPL-001-5 requirements, all identified single- and multiple-contingency thermal overloads were mitigated through generation redispatch and/or operator actions. As a result, the GIRs within these study pockets are able to operate at their full requested ERIS output, or at their maximum output at the Point of Interconnection (POI), including both discharging and grid-charging operations where applicable.

Voltage performance across all study pockets was acceptable under both system-intact and contingency conditions. No voltage violations attributable to the study GIRs were identified, and all evaluated cases demonstrated acceptable post-contingency voltage recovery.

Grid charging operation for Battery Energy Storage System (BESS) projects was evaluated as part of the steady-state analysis. The results indicate that grid charging operation does not introduce additional thermal or voltage limitations beyond those identified for generation operation, and the requested grid charging levels are acceptable for all GIRs at their maximum allowable operating levels.

Cost estimates for the Transmission Provider Interconnection Facilities, Station Network Upgrades, and System Network Upgrades required to support the requested interconnections for each GIR are provided in this study.

The breaker duty study (short-circuit analysis) performed on the PSCo transmission system, including the 5RSC-2024 Cluster additions, did not identify any circuit breakers that became over-dutied as a result of the cluster additions.

Overall, this study demonstrates that the requested ERIS interconnections can be supported by the PSCo transmission system. Furthermore, no Affected System overloads requiring mitigation were identified in this Study.

APPENDIX A – POWER FLOW CONTINGENCY FILE

Contingency List	PSCO P1,2 - tailored for OATT.con PSCO P4,7 - tailored for OATT.con

APPENDIX B – DESCRIPTION OF GENERATION INTERCONNECTION REQUESTS

5RSC-2024-01

This project is a Combustion Turbine (CT) generating facility with 200 MW net output at the POI:

- Machine model – One GE Combustion Turbine 7FA63
- Length of Gen-Tie – Not Applicable
- Number of main step-up transformers, voltage and rating – One (1) 18/115 kV, 225/300 MVA transformer
- Point of Interconnection (POI) – Ft. Lupton 115 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 31, 2027.

5RSC-2024-02

This project is a Combustion Turbine (CT) generating facility with 400 MW net output at the POI:

- Machine model – Two (2) GE Combustion Turbines 7FA63
- Length of Gen-Tie – Not Applicable
- Number of main step-up transformers, voltage and rating – Two (2) 18/230 kV, 225/300 MVA transformers
- Point of Interconnection (POI) – Ft. St. Vrain 230 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 31, 2027.

5RSC-2024-04

This project is a Solar Photovoltaic (PV) generating facility with 100 MW net output at the POI:

- Machine model – Twenty-nine (29) inverters, PE FS4105M, rated for 4.105 MVA each
- Length of Gen-Tie – 1.0 mile and it is shared with GI-2024-04 in the 2024 DISIS

- Number of main step-up transformers, voltage and rating – One (1) 230/34.5/13.8 kV, 135/180/225 MVA transformer
- Point of Interconnection (POI) – Mirasol 230 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is June 1, 2028.

5RSC-2024-06

This project is a hybrid Solar Photovoltaic (PV) generating facility with 300 MW net output at the POI plus a Battery Energy Storage System (BESS) capable of 100 MW output at the POI:

- Solar PV Machine model – Ninety-six (96) inverters, PE FS3430M, rated for 3.43 MVA each
- BESS Machine model – Thirty-three (33) inverters, PE FS3430K, rated for 3.43 MVA each, with 4-hour standalone grid-charge, using FREEMAQ PCSK 645V batteries
- Length of Gen-Tie – 3.5 miles
- Number of main step-up transformers, voltage and rating – Two (2): one (1) 34.5/13.8/345 kV, 135/180/225 MVA transformer, and one (1) 34.5/13.8/345 kV, 69/92/115 MVA transformer
- Point of Interconnection (POI) – Sandstone 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is June 1, 2028.

5RSC-2024-09

This project is a Battery Energy Storage System (BESS) generating facility with 200 MW net output at the POI:

- Machine model – One hundred twenty (120) inverters, Tesla MEGAPACK 2 XL batteries, rated for 2.40 MVA each, with 2-hour standalone grid-charge
- Length of Gen-Tie – 0.28 mile
- Number of main step-up transformers, voltage and rating – Two (2) 34.5/230 kV, 75/100/125 MVA transformers

- Point of Interconnection (POI) – Hartsel 230 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is December 1, 2027.

5RSC-2024-10

This project is a Battery Energy Storage System (BESS) generating facility with 250 MW net output at the POI:

- Machine model – Seventy-five (75) inverters, PE PCSM FP4200M, rated for 3.90 MVA each, with 4-hour standalone grid-charge
- Length of Gen-Tie – 0.1 mile
- Number of main step-up transformers, voltage and rating – Two (2) 345/34.5/13.8 kV, 102/135/170 MVA transformers
- Point of Interconnection (POI) – Goose Creek 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 1, 2027.

5RSC-2024-11

This project is a Battery Energy Storage System (BESS) generating facility with 250 MW net output at the POI:

- Machine model – Seventy-eight (78) inverters, PE FP3430K, rated for 3.43 MVA each, with 4-hour standalone grid-charge using FREEMAQ PCSK 645V batteries
- Length of Gen-Tie – 1 mile
- Number of main step-up transformers, voltage and rating – Two (2): one (1) 34.5/345/13.8 kV, 102/136/170 MVA transformer, and one (1) 34.5/345/13.8 kV, 69/92/115 MVA transformer
- Point of Interconnection (POI) – Pawnee 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is June 1, 2027.

5RSC-2024-12

This project is a Battery Energy Storage System (BESS) generating facility with 200 MW net output at the POI:

- Machine model – Forty-five (45) inverters, SG SC5000UD-MV-US, rated for 5.00 MVA each, with 2-hour standalone grid-charge using SG ST2752 UX batteries
- Length of Gen-Tie – 1.3 miles
- Number of main step-up transformers, voltage and rating – One (1) 345/34.5/13.8 kV, 132/176/220 MVA transformer
- Point of Interconnection (POI) – Comanche 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 1, 2027.

5RSC-2024-13

This project is a Battery Energy Storage System (BESS) generating facility with 199 MW net output at the POI:

- Machine model – One hundred twenty-four (124) inverters, Tesla MEGAPACK 2 XL, rated for 2.40 MVA each, with 2-hour standalone grid-charge
- Length of Gen-Tie – 0.197 mile
- Number of main step-up transformers, voltage and rating – One (1) 230/34.5/13.8 kV, 166/222/277 MVA transformer
- Point of Interconnection (POI) – Spindle 230 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is January 15, 2027.

5RSC-2024-15

This project is a Wind generating facility with 489.7 MW net output at the POI:

- Machine model – One hundred eleven (111) Vestas V163-4.5 MW wind turbine generators (WTGs), rated for 5.30 MVA each

- Length of Gen-Tie – 3.5 miles to collector substation, and 23.5 miles from collector substation to POI
- Number of main step-up transformers, voltage and rating – Four (4): two (2) 345/34.5/13.8 kV, 113/150/188 MVA transformers, and two (2) 345/34.5/13.8 kV, 94/125/156 MVA transformers
- Point of Interconnection (POI) – May Valley 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 27, 2027.

5RSC-2024-16

This project is a Wind generating facility with 438 MW net output at the POI:

- Machine model – One hundred (100) Vestas V163-4.5 MW wind turbine generators (WTGs), rated for 5.30 MVA each
- Length of Gen-Tie – 5.5 miles
- Number of main step-up transformers, voltage and rating – Three (3) 34.5/345/13.8 kV, 113/150/188 MVA transformers
- Point of Interconnection (POI) – Goose Creek 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is March 16, 2026.

5RSC-2024-17

This project is a Wind generating facility with 578.3 MW net output at the POI:

- Machine model – One hundred thirty-four (134) Vestas V163-4.5 MW wind turbine generators (WTGs), rated for 5.30 MVA each
- Length of Gen-Tie – 27.4 miles
- Number of main step-up transformers, voltage and rating – Four (4) 345/34.5/13.8 kV, 113/150/188 MVA transformers
- Point of Interconnection (POI) – Goose Creek 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 7, 2026.

5RSC-2024-21

This project is a Solar Photovoltaic (PV) generating facility with 400 MW net output at the POI:

- Machine model – Five hundred fifty-two (552) inverters, TMEIC PVU L0840URN rated for 0.81 MVA each
- Length of Gen-Tie – 0.1 mile
- Number of main step-up transformers, voltage and rating – Two (2) 345/34.5/13.8 kV, 134/178/223 MVA transformers
- Point of Interconnection (POI) – new substation tapping May Valley – Sandstone 345 kV transmission line

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is April 30, 2029.

5RSC-2024-27

This project is a hybrid Solar Photovoltaic (PV) generating facility with 250 MW net output at the POI plus a Battery Energy Storage System (BESS) capable of 200 MW output at the POI:

- Solar PV Machine model – Sixty-four (67) inverters, Sungrow SG4400UD, rated for 4.40 MVA each
- BESS Machine model – One thousand one hundred fifty-two (1152) inverters, Sungrow SC210HX-US, rated for 0.21 MVA each, with 4-hour standalone grid-charge
- Length of Gen-Tie – 0.16 mile
- Number of main step-up transformers, voltage and rating – Two (2) 34.5/345/13.8 kV, 94/125.3/156.7 MVA transformer
- Point of Interconnection (POI) – Canal Crossing 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is May 31, 2027.

5RSC-2024-28

This project is a Wind generating facility with 500 MW net output at the POI:

- Machine model – One hundred seventy-eight (178) GE 2.82-127 wind turbine generators (WTGs), rated for 3.13 MVA each
- Length of Gen-Tie – 14.5 miles
- Number of main step-up transformers, voltage and rating – Three (3): two (2) 345/34.5/13.8 kV, 135/180/225 MVA transformers, and one (1) 345/34.5/13.8 kV, 102/136/170 MVA transformer
- Point of Interconnection (POI) – Goose Creek 345 kV substation

This project has requested Energy Resource Interconnection Service (ERIS), and its proposed Commercial Operation Date (COD) is December 1, 2025.

APPENDIX C – REACTIVE POWER CAPABILITY RESULTS

All summary tables representing GIRs' Voltage and Reactive Power Capability tests adhere to the following color formatting representing the different aspects of the tests:

- Values highlighted in red indicate a failed reactive power requirement.
- For inverter-based resources (Wind, PV and BESS generators), voltages outside of 0.95 – 1.05 p.u. are highlighted in yellow to provide additional information.
- For synchronous- generators, voltages outside the following ranges are highlighted in yellow to provide additional information.
    - 1.00 – 1.03 for 115 kV system
    - 1.00 – 1.04 for 230 kV system
    - 1.00 – 1.05 for 345 kV system

5RSC-2024-01

This project's gross capacity is modeled as follows: Pmax = 208.3 MW, Pmin = 50.0 MW, Qmax = 129.1 Mvar, Qmin = -85.0 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting 0.95 lagging power factor at the POI while maintaining an adequate POI bus voltage, at either operating point.
- The GIR is capable of meeting 0.95 leading power factor at the POI while maintaining an adequate POI bus voltage, at either operating point.

The tests performed for 5RSC-2024-01 are summarized in Table 42.

Table 42: Reactive Power Capability Evaluation for 5RSC-2024-01

Test	POI			
	P (MW)	Q (Mvar)	V (p.u.)	PF
Pmax - Lagging	200.0	103.5	1.03	0.89
Pmax - Leading	199.9	-112.5	1.00	-0.87
Pmin - Lagging	43.7	118.2	1.03	0.35
Pmin - Leading	43.8	-93.9	1.00	-0.42

5RSC-2024-02

This project's gross capacity is modeled as follows: Pmax = 416.5 MW, Pmin = 100 MW, Qmax = 258.2 Mvar, Qmin = -170.0 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting 0.95 lagging power factor at the POI while maintaining an adequate POI bus voltage, at either operating point.
- The GIR is capable of meeting 0.95 leading power factor at the POI while maintaining an adequate POI bus voltage, at either operating point.

The tests performed for 5RSC-2024-02 are summarized in Table 43.

Table 43: Reactive Power Capability Evaluation for 5RSC-2024-02

Test	POI			
	P (MW)	Q (Mvar)	V (p.u.)	PF
Pmax - Lagging	400.6	207.8	1.04	0.89
Pmax - Leading	400.6	-223.0	1.02	-0.87
Pmin - Lagging	87.2	236.4	1.04	0.35
Pmin - Leading	87.4	-187.2	1.02	0.42

5RSC-2024-04

This project's gross capacity is modeled as follows: Pmax = 102.4 MW, Pmin = 0.0 MW, Qmax = 60.7 Mvar, Qmin = -60.7 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-04 are summarized in Table 44.

Table 44: Reactive Power Capability Evaluation for 5RSC-2024-04

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
102.7	33.3	60.7	-60.7	1.05	100.0	33.0	1.02	0.95	100.0	33.1	1.02	0.95
102.7	-17.8	60.7	-60.7	1.00	100.0	-33.2	1.02	-0.95	100.0	-33.1	1.02	-0.95
0.0	1.3	60.7	-60.7	1.02	-1.0	1.4	1.03	-0.58	-1.1	1.7	1.02	-0.54

5RSC-2024-06

This project's gross capacity is modeled as follows:

PV: Pmax = 304.4 MW, Pmin = 0.0 MW, Qmax = 102.4 Mvar, Qmin = -102.4 Mvar.

BESS: Pmax = 102.9 MW, Pmin = -102.9 MW, Qmax = 35.2 Mvar, Qmin = -35.2 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-06 are summarized in

Table 45.

Table 45: Reactive Power Capability Evaluation for 5RSC-2024-06

PV Generator Terminals					High Side of Main Transformer			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
228.0	62.2	102.4	-102.4	1.03	300.2	100.1	1.00	0.95
228.0	-53.7	102.4	-102.4	0.96	300.1	-100.2	0.99	-0.95

304.4	57.7	102.4	-102.4	1.03	300.0	100.1	1.00	0.95
OFFLINE					100.0	39.3	1.00	0.93
304.4	-59.5	102.4	-102.4	0.96	300.0	-100.3	0.99	0.95
OFFLINE					99.9	-36.5	0.99	-0.94
0.0	0.0	102.4	-102.4	1.01	-2.0	1.7	1.02	0.76
BESS Generator Terminals					**POI**			
Pgen (MW)	**Qgen (Mvar)**	**Qmax (Mvar)**	**Qmin (Mvar)**	**V (p.u.)**	**P (MW)**	**Q (Mvar)**	**V (p.u.)**	**PF**
76.4	0.7	35.2	-35.2	1.03	300.1	100.0	1.00	0.95
76.4	0.3	35.2	-35.2	0.96	300.0	-100.2	0.99	-0.95
OFFLINE					300.0	100.0	1.00	0.95
102.9	23.4	35.2	-35.2	1.03	99.9	39.6	1.00	0.95
OFFLINE					300.0	-100.4	0.99	-0.95
102.9	-21.7	35.2	-35.2	0.96	99.9	-36.2	0.99	-0.94
0.0	0.0	35.2	-35.2	1.01	-2.0	2.0	1.02	0.71

5RSC-2024-09

This project's gross capacity is modeled as follows: Pmax = 203.0 MW, Pmin = -197.1 MW, Qmax = 204.3 Mvar, Qmin = -204.3 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-09 are summarized in Table 46.

Table 46: Reactive Power Capability Evaluation for 5RSC-2024-09

Generator Terminals					**High Side of Main Transformer**				**POI**			
Pgen (MW)	**Qgen (Mvar)**	**Qmax (Mvar)**	**Qmin (Mvar)**	**V (p.u.)**	**P (MW)**	**Q (Mvar)**	**V (p.u.)**	**PF**	**P (MW)**	**Q (Mvar)**	**V (p.u.)**	**PF**
203.0	105.1	204.3	-204.3	1.04	200.1	67.9	1.04	0.95	200.0	67.9	1.04	0.95
203.0	-26.7	204.3	-204.3	0.96	200.1	-65.8	0.99	-0.95	200.0	-65.8	0.99	-0.95
0.0	-9.7	204.3	-204.3	1.00	0.0	-9.2	1.01	0.00	0.0	0.3	1.01	0.00

5RSC-2024-10

This project's gross capacity is modeled as follows: Pmax = 252.2 MW, Pmin = -252.2 MW, Qmax = 129.0 Mvar, Qmin = -129.0 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-10 are summarized in Table 47.

Table 47: Reactive Power Capability Evaluation for 5RSC-2024-10

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
252.2	110.3	129.0	-129.0	1.05	250.0	83.9	1.01	0.95	250.0	83.9	1.01	0.95
252.2	-60.7	129.0	-129.0	0.97	250.0	-83.7	1.00	-0.95	249.8	-83.7	1.00	-0.95
0.0	-13.3	129.0	-129.0	1.00	0.0	-13.4	1.01	0.00	0.0	-13.3	1.01	0.00

5RSC-2024-11

This project's gross capacity is modeled as follows: Pmax = 254.2 MW, Pmin = -254.2 MW, Qmax = 83.2 Mvar, Qmin = -83.2 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-11 are summarized in Table 48.

Table 48: Reactive Power Capability Evaluation for 5RSC-2024-11

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
254.2	39.5	83.2	-83.2	1.03	250.0	84.9	1.02	0.95	250.0	85.4	1.02	0.95
254.2	-34.5	83.2	-83.2	1.04	250.1	-83.6	1.02	-0.95	250.0	-83.1	1.02	-0.95
0.0	-1.3	83.2	-83.2	1.03	-1.5	-1.3	1.03	-0.76	-1.5	-0.4	1.03	-0.97

5RSC-2024-12

This project's gross capacity is modeled as follows: Pmax = 209.3 MW, Pmin = -209.3 MW, Qmax = 165.2 Mvar, Qmin = -165.2 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-12 are summarized in Table 49.

Table 49: Reactive Power Capability Evaluation for 5RSC-2024-12

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
207.3	128.1	165.2	-165.2	1.05	200.2	66.7	1.00	0.95	200.0	67.6	1.00	0.95
207.5	-19.1	165.2	-165.2	0.96	200.2	-66.8	0.99	-0.95	200.0	-65.9	0.99	-0.95
0.0	0.0	165.2	-165.2	1.00	-5.0	-0.1	1.00	-1.00	-5.0	1.0	1.00	0.98

5RSC-2024-13

This project's gross capacity is modeled as follows: Pmax = 205.2 MW, Pmin = -199 MW, Qmax = 215.5 Mvar, Qmin = -215.5 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.

- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-13 are summarized in Table **50**.

Table 50: Reactive Power Capability Evaluation for 5RSC-2024-13

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
205.2	102.7	215.5	-215.5	1.05	199.0	66.1	1.04	0.94	199.0	66.1	1.04	0.94
205.2	-32.8	215.5	-215.5	1.00	199.0	-65.7	1.03	-0.94	199.0	-65.7	1.03	-0.94
0.0	0.1	215.5	-215.5	1.03	-5.0	-8.3	1.03	-0.52	-5.0	-8.2	1.03	-0.52

5RSC-2024-15

This project's gross capacity is modeled as follows:

Wind Generator 1: Pmax = 139.5 MW, Pmin = 0 MW, Qmax = 64.4 Mvar, Qmin= -49.6 Mvar.

Wind Generator 2: Pmax = 135.0 MW, Pmin = 0 MW, Qmax = 62.3 Mvar, Qmin= -48.0 Mvar.

Wind Generator 3: Pmax = 112.5 MW, Pmin = 0 MW, Qmax = 51.9 Mvar, Qmin= -40.0 Mvar.

Wind Generator 4: Pmax = 112.5 MW, Pmin = 0 MW, Qmax = 51.9 Mvar, Qmin= -40.0 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is not capable of meeting +0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI. The shortage of Mvar is shown in red, while the high voltages are highlighted in yellow.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-15 are summarized in **Table 51**

Table 51: Reactive Power Capability Evaluation for 5RSC-2024-15

Generator 1 Terminals					Generator 2 Terminals					High Side of Main Transformer			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
139.5	64.4	64.4	-49.6	1.06	135.0	62.3	62.3	-48.0	1.06	490.6	150.9	0.97	0.96
139.5	-41.3	64.4	-49.6	0.99	135.0	-41.3	62.3	-48.0	0.98	490.9	-163.1	0.95	-0.95
0.0	-0.3	64.4	-49.6	1.02	0.0	-0.3	62.3	-48.0	1.02	-0.5	7.6	1.02	0.07
Generator 3 Terminals					**Generator 4 Terminals**					**POI**			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
112.5	51.9	51.9	-40.0	1.07	112.5	51.9	51.9	-40.0	1.07	488.5	122.0	0.95	0.96
112.5	9.3	51.9	-40.0	1.01	112.5	9.3	51.9	-40.0	1.01	488.7	-174.9	0.96	-0.94
0.0	-3.2	51.9	-40.0	1.01	0.0	-3.2	51.9	-40.0	1.01	-0.5	30.0	1.01	0.02

5RSC-2024-16

This project's gross capacity is modeled as follows:

Wind Generator 1: Pmax = 144.0 MW, Pmin = 0.0 MW, Qmax = 81.6 Mvar, Qmin= -70.4 Mvar.

Wind Generator 2: Pmax = 162.0 MW, Pmin = 0.0 MW, Qmax = 91.8 Mvar, Qmin= -79.2 Mvar.

Wind Generator 3: Pmax = 144.0 MW, Pmin = 0.0 MW, Qmax = 81.6 Mvar, Qmin= -70.4 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI. However, the generator terminal voltages are above the 1.05 limit for the lagging power factor test, as highlighted in yellow. It is noted that inverter-based resources are typically designed to operate over a wider terminal voltage range, commonly on the order of ± 8% of nominal voltage, without loss of capability or adverse performance.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-16 are summarized in Table 52.

Table 52: Reactive Power Capability Evaluation for 5RSC-2024-16

Generator 1 Terminals					High Side of Main Transformer			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
144.0	76.8	81.6	-70.4	1.08	436.9	154.9	1.03	0.94
144.0	-23.9	81.6	-70.4	0.97	437.4	-155.4	0.99	-0.94
0.0	-19.0	81.6	-70.4	0.99	-3.4	-31.0	1.03	-0.11
Generator 2 Terminals					**POI**			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
162.0	86.4	91.8	-79.2	1.08	436.5	153.8	1.02	0.94
162.0	-26.8	91.8	-79.2	0.97	436.9	-157.3	0.99	-0.94
0.0	-21.4	91.8	-79.2	0.98	-3.4	-25.9	1.03	-0.13

Generator 3 Terminals				
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)
144.0	76.8	81.6	-70.4	1.08
144.0	-23.9	81.6	-70.4	0.97
0.0	-19.0	81.6	-70.4	0.98

5RSC-2024-17

This project's gross capacity is modeled as follows:

Wind Generator 1: Pmax = 153.0 MW, Pmin = 0 MW, Qmax = 86.7 Mvar, Qmin= -54.4 Mvar

Wind Generator 2: Pmax = 162.0 MW, Pmin = 0 MW, Qmax = 91.8 Mvar, Qmin= -57.6 Mvar

Wind Generator 3: Pmax = 135.0 MW, Pmin = 0 MW, Qmax = 76.5 Mvar, Qmin= -48.0 Mvar

Wind Generator 4: Pmax = 153.0 MW, Pmin = 0 MW, Qmax = 86.7 Mvar, Qmin= -54.4 Mvar

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI. However, the generator terminal voltages are above the 1.05 limit for the lagging power factor test, as highlighted in yellow.

- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-17 are summarized in Table 53.

Table 53: Reactive Power Capability Evaluation for 5RSC-2024-17

Generator 1 Terminals					Generator 2 Terminals					High Side of Main Transformer			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
153.0	86.7	86.7	-54.4	1.10	162.0	91.8	91.8	-57.6	1.11	587.4	189.1	0.98	0.952
153.0	-11.0	86.7	-54.4	0.96	162.0	-11.0	91.8	-57.6	0.96	586.9	-195.7	0.98	-0.95
0.0	-36.5	86.7	-54.4	0.96	0.0	-36.5	91.8	-57.6	0.96	-1.2	-164.7	1.02	-0.01
Generator 3 Terminals					**Generator 4 Terminals**					**POI**			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
135.0	76.5	76.5	-48.0	1.09	153.0	86.7	86.7	-54.4	1.11	582.0	165.9	0.95	0.96
135.0	-11.0	76.5	-48.0	0.97	153.0	-11.0	86.7	-54.4	0.97	574.5	-197.8	0.98	-0.95
0.0	-48.0	76.5	-48.0	0.96	0.0	-36.5	86.7	-54.4	0.96	-1.9	-129.7	1.03	-0.02

5RSC-2024-21

This project's gross capacity is modeled as follows: Pmax = 411.3 MW, Pmin = 0.0 MW, Qmax = 175.3 Mvar, Qmin = -175.3 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-21 are summarized in Table 54.

Table 54: Reactive Power Capability Evaluation for 5RSC-2024-21

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF

411.3	175.3	175.3	-175.3	1.05	399.9	134.6	1.00	0.95	399.9	134.7	1.00	0.95
411.3	-108.1	175.3	-175.3	1.00	400.0	-138.6	0.96	-0.94	400.0	-138.5	0.96	-0.94
0.0	-5.2	175.3	-175.3	0.99	-2.5	19.8	0.98	-0.52	-2.5	19.9	0.98	-0.52

5RSC-2024-27

This project's gross capacity is modeled as follows:

PV Gen. 1: Pmax = 129.0 MW, Pmin = 0.0 MW, Qmax = 75.8 Mvar, Qmin = -75.8 Mvar.

PV Gen. 2: Pmax = 126.0 MW, Pmin = 0.0 MW, Qmax = 72.2 Mvar, Qmin = -72.2 Mvar.

BESS Gen. 1: Pmax = 105.3 MW, Pmin = -95.5 MW, Qmax = 59.5 Mvar, Qmin = -59.5 Mvar.

BESS Gen. 2: Pmax = 105.3 MW, Pmin = -95.5 MW, Qmax = 59.5 Mvar, Qmin = -59.5 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI. However, the generator terminal voltages are above the 1.05 limit for the lagging power factor test, as highlighted in yellow. It is noted that inverter-based resources are typically designed to operate over a wider terminal voltage range, commonly on the order of ±8 % of nominal voltage, without loss of capability or adverse performance.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-27 are summarized in Table 55.

Table 55: Reactive Power Capability Evaluation for 5RSC-2024-27

Generator 1 Terminals					Generator 2 Terminals					High Side of Main Transformer			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
90.0	40.4	75.8	-75.8	1.04	90.0	39.8	72.2	-72.2	1.04	250.3	86.5	0.96	0.95
90.0	-10.5	75.8	-75.8	0.99	90.0	-12.8	72.2	-72.2	0.99	250.4	-86.4	1.05	-0.95
129.0	75.8	75.8	-75.8	1.06	126.0	72.2	72.2	-72.2	1.06	242.9	82.2	0.95	0.95
OFFLINE					OFFLINE					199.9	66.1	0.95	0.95
129.0	-10.9	75.8	-75.8	1.00	126.0	-14.3	72.2	-72.2	1.00	243.5	-82.8	1.03	-0.95
OFFLINE					OFFLINE					200.3	-66.6	1.04	-0.95
0.0	0.9	75.8	-75.8	1.00	0.0	0.8	72.2	-72.2	1.00	-8.1	-3.6	1.03	0.91
Generator 3 Terminals					Generator 4 Terminals					POI			

Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF
42.2	33.5	59.5	-59.5	1.04	39.1	34.3	59.5	-59.5	1.04	250.3	86.7	0.96	0.95
42.0	-3.8	59.5	-59.5	0.99	39.0	-5.4	59.5	-59.5	0.99	250.4	-86.4	1.05	-0.95
OFFLINE					OFFLINE					242.9	82.4	0.95	0.95
105.3	59.5	59.5	-59.5	1.04	105.3	59.5	59.5	-59.5	1.04	199.9	65.6	0.95	0.95
OFFLINE					OFFLINE					243.5	-82.7	1.03	-0.95
105.3	-10.9	59.5	-59.5	1.00	105.3	-10.3	59.5	-59.5	1.00	200.3	-66.5	1.04	-0.95
0.0	0.7	59.5	-59.5	1.00	0.0	0.7	59.5	-59.5	1.00	-8.1	-3.6	1.03	0.91

5RSC-2024-28

This project's gross capacity is modeled as follows: Pmax = 502.0 MW, Pmin = 0.0 MW, Qmax = 243.0 Mvar, Qmin = -243.0 Mvar.

The summary for the voltage and reactive power capability evaluation for this GIR is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The tests performed for 5RSC-2024-28 are summarized in Table 56.

Table 56: Reactive Power Capability Evaluation for 5RSC-2024-28

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
502.0	228.5	243.0	-243.0	1.05	492.0	164.7	1.04	0.95	490.9	162.4	1.03	0.95
502.0	-92.7	243.0	-243.0	0.97	492.1	-163.2	1.02	-0.95	491.0	-166.1	1.03	-0.95
0.0	0.0	243.0	-243.0	1.03	-2.0	11.9	1.03	0.17	-2.0	20.7	1.03	0.10

APPENDIX D – 2027 METRO CASE SETUP

D.1 2027 METRO BASE CASE MODEL

The 2027 case year studies were performed using the 2029HS2 WECC Base Case released on May 8, 2023, that has been modified to represent 2027 heavy summer loading conditions. To adjust the system to properly reflect the 2027 case year, the model fixes presented in Table 57. The planned transmission projects applied to the 2027HS Base Case are listed in Table 58.

Table 57: Model Fixes Performed to Create the 2027HS Base Case

Modification Description
Replacement of Valmont 9064 and 9066 Capacitor Banks
Removal of Mirasol 2nd 230 kV circuit
Derating Buckley-Smoky Hill from 796 MVA to 478 MVA
Derating Federal Heights - Semper 115kV from 398 MVA to 159 MVA
Removal of Comanche BESS
Removal of Longhorn 345 kV Bus
Removal of Port Data Center
Removal of Deer Trail II
Removal of Cornflower
Removal of Alamosa Energy Center
Removal of Fort St Vrain BESS

Table 58: Planned Transmission Projects Included in the 2027HS Base Case

Project Description
Uprate Cherokee South - North 115 kV to 398 MVA
Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
Uprate Leetsdale Transformer T5 to 448 MVA
Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
Uprate Sargent Transformer T1 to 112 MVA
Upgrade Smoky Hill - Harvest Mile 230 kV to 1195 MVA
Addition of Fort Saint Vrain Transformer T1
Addition of Comanche Transformer T5
Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
Uprate Valmont Transformer T7 to 448 MVA
Uprate Valmont Transformer T8 to 448 MVA
Uprate Missile Site - Pronghorn to 1793 MVA
Uprate California - Cherokee S to 398 MVA

Project Description
Uprate Clark - Jordan to 1195 MVA
Uprate Denver Terminal bus-tie breaker to 398 MVA
Uprate Poncha E - Sargent to 248.9 MVA
Addition of Malta Third Transformer
Addition of 30 Mvar Capacitor Bank at San Luis Valley
Addition of 100 Mvar reactor at Beaver Creek P
Greenwood to Monaco series reactor
Addition of 45 Mvar Reactor at Cedar Point
Addition of two Synchronous Condenser at May Valley
Addition of a STATCOM at Goose Creek

D.2 2027 METRO BENCHMARK CASE MODEL

The 2027 Metro Benchmark (BM) Case was created from the 2027 Metro Base Case described above by changing the Metro Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 59. Table 60 summarizes the Native Load Priority Generation totaling 2845 MW that was dispatched in the 2027 Metro Benchmark Case.

Table 59: Study Pocket Generation Dispatch to Create the 2027 Metro Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70106	CHEROK4	G4	1	279.0
2	70145	CHEROKEE5	G5	1	155.8
3	70146	CHEROKEE6	G6	1	154.7
4	70147	CHEROKEE7	ST	1	201.6
5	70188	FT_LUPTN_12	G1	1	41.3
6	70188	FT_LUPTN_12	G2	1	40.3
7	70409	ST.VRAIN	ST	1	271.8
8	70406	ST.VR_2	G2	1	163.7
9	70407	ST.VR_3	G3	1	156.0
10	70408	ST.VR_4	G4	1	157.5
11	70950	ST.VR_5	G5	1	156.2
12	70951	ST.VR_6	G6	1	154.5
13	70553	ARAP5&6	G5	1	39.0
14	70553	ARAP5&6	G6	1	39.5
15	70554	ARAP7	G7	1	45.0
16	70448	VALMNT6	G6	1	46.6

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
17	70557	VALMNT7	G7	1	39.6
18	70558	VALMNT8	G8	1	39.6
19	700151	GI_2021_6	S1	1	169.2
20	70580	PLNENDG1_1	G0	1	5.1
21	70580	PLNENDG1_1	G1	1	5.1
22	70580	PLNENDG1_1	G2	1	5.1
23	70580	PLNENDG1_1	G3	1	5.1
24	70580	PLNENDG1_1	G4	1	5.1
25	70580	PLNENDG1_1	G5	1	5.1
26	70580	PLNENDG1_1	G6	1	5.1
27	70580	PLNENDG1_1	G7	1	5.1
28	70580	PLNENDG1_1	G8	1	5.1
29	70580	PLNENDG1_1	G9	1	5.1
30	70587	PLNENDG1_2	G0	1	5.1
31	70587	PLNENDG1_2	G1	1	5.1
32	70587	PLNENDG1_2	G2	1	5.1
33	70587	PLNENDG1_2	G3	1	5.1
34	70587	PLNENDG1_2	G4	1	5.1
35	70587	PLNENDG1_2	G5	1	5.1
36	70587	PLNENDG1_2	G6	1	5.1
37	70587	PLNENDG1_2	G7	1	5.1
38	70587	PLNENDG1_2	G8	1	5.1
39	70587	PLNENDG1_2	G9	1	5.1
40	70585	PLNENDG2_1	G1	1	7.3
41	70585	PLNENDG2_1	G2	1	7.3
42	70585	PLNENDG2_1	G3	1	7.3
43	70585	PLNENDG2_1	G4	1	7.3
44	70585	PLNENDG2_1	G5	1	7.3
45	70585	PLNENDG2_1	G6	1	7.3
46	70585	PLNENDG2_1	G7	1	7.3
47	70586	PLNENDG2_2	G1	1	7.3
48	70586	PLNENDG2_2	G2	1	7.3
49	70586	PLNENDG2_2	G3	1	7.3
50	70586	PLNENDG2_2	G4	1	7.3
51	70586	PLNENDG2_2	G5	1	7.3
52	70586	PLNENDG2_2	G6	1	7.3
53	70586	PLNENDG2_2	G7	1	7.3
Total					**2,550.0**

Table 60: NLP Generation Included in 2027 Metro Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	291.4
2	700057	24_13_W2	W2	1	128.6
3	700060	24_13_W3	W3	1	28.6
4	700063	24_13_W4	W4	1	13.8
5	700067	24_13_W1	W1	1	106.3
6	700226	24_6_S	S	1	400.0
7	700196	24_19_W1	W1	1	442.8
8	700076	24_12_W1	W1	1	144.0
9	700077	24_12_W2	W2	1	162.0
10	700078	24_12_W3	W3	1	44.0
11	700182	24_28_W	W1	1	500.0
12	700079	24_9_W1	W1	1	153.0
13	700082	24_9_W2	W2	1	130.0
14	700085	24_9_W3	W3	1	35.0
15	700088	24_9_W4	W4	1	53.0
16	700244	24_27_B1	B1	1	49.5
17	700245	24_27_B2	B2	1	47.3
18	700246	24_27_S1	S1	1	57.8
19	700247	24_27_S2	S2	1	57.8
Total					**2,844.9**

D.3 2027 METRO PORTFOLIO 1 STUDY CASE

The 2027 Metro Portfolio 1 Study Case model was created from the 2027 Metro Benchmark Case model by turning on the GIR generation shown in Table 61. The additional output from the GIRs was sunk into generation externally to the Study Pocket.

Table 61: Study GIRs Dispatch for 2027 Metro Portfolio 1 Study Case

Resource	POI	Pgen (MW)
5RSC-2024-01	Fort Lupton 115 kV	200.0
5RSC-2024-02	Fort St. Vrain 230 kV	400.0

D.4 2027 METRO PORTFOLIO 2 STUDY CASE

The 2027 Metro Portfolio 2 Study Case model was created from the 2027 Metro Benchmark Case model by turning on the GIR generation shown in Table 62. The additional output from the GIRs was sunk into generation externally to the Study Pocket.

Table 62: Study GIRs Dispatch for 2027 Metro Portfolio 2 Study Case

Resource	POI	Pgen (MW)
5RSC-2024-02	Fort St. Vrain 230 kV	400.0

D.5 RE-DISPATCHED 2027 METRO STUDY CASE

The redispatch scenario presented in Table 63 was adopted to mitigate the violations observed on facilities in the 2027 Metro Study Case for both Portfolios 1 and 2.

Table 63: Redispatch to Mitigate Facility Overloads in 2027 Metro Study Case

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70069	CABCRKA	HA	160.0	1	131.0	1
70070	CABCRKB	HB	160.0	1	131.0	1
70145	CHEROKEE5	G5	155.8	1	170.0	1
70146	CHEROKEE6	G6	154.7	1	170.0	1
70147	CHEROKEE7	G7	201.6	1	230.0	1

APPENDIX E – 2027 NORTH CASE SETUP

E.1 2027 NORTH BASE CASE MODEL

The 2027 case year studies were performed using the 2029HS2 WECC Base Case released on May 8, 2023, that has been modified to represent 2027 heavy summer loading conditions. To adjust the system to properly reflect the 2027 case year, the model fixes presented in Table 64. The planned transmission projects applied to the 2027HS Base Case are listed in Table 65.

Table 64: Model Fixes Performed to Create the 2027HS Base Case

Modification Description
Replacement of Valmont 9064 and 9066 Capacitor Banks
Removal of Mirasol 2nd 230 kV circuit
Derating Buckley-Smoky Hill from 796 MVA to 478 MVA
Derating Federal Heights - Semper 115kV from 398 MVA to 159 MVA
Removal of Comanche BESS
Removal of Longhorn 345 kV Bus
Removal of Port Data Center
Removal of Deer Trail II
Removal of Cornflower
Removal of Alamosa Energy Center
Removal of Fort St Vrain BESS

Table 65: Planned Transmission Projects Included in the 2027HS Base Case

Project Description
Uprate Cherokee South - North 115 kV to 398 MVA
Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
Uprate Leetsdale Transformer T5 to 448 MVA
Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
Uprate Sargent Transformer T1 to 112 MVA
Upgrade Smoky Hill - Harvest Mile 230 kV to 1195 MVA
Addition of Fort Saint Vrain Transformer T1
Addition of Comanche Transformer T5
Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
Uprate Valmont Transformer T7 to 448 MVA
Uprate Valmont Transformer T8 to 448 MVA
Uprate Missile Site - Pronghorn to 1793 MVA
Uprate California - Cherokee S to 398 MVA

Project Description
Uprate Clark - Jordan to 1195 MVA
Uprate Denver Terminal bus-tie breaker to 398 MVA
Uprate Poncha E - Sargent to 248.9 MVA
Addition of Malta Third Transformer
Addition of 30 Mvar Capacitor Bank at San Luis Valley
Addition of 100 Mvar reactor at Beaver Creek P
Greenwood to Monaco series reactor
Addition of 45 Mvar Reactor at Cedar Point
Addition of two Synchronous Condenser at May Valley
Addition of a STATCOM at Goose Creek

E.2 2027 NORTH BENCHMARK CASE MODEL

The 2027 North Benchmark (BM) Case was created from the 2027 North Base Case described above by changing the North Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 66. Table 67 summarizes the Native Load Priority Generation totaling 2845 MW that was dispatched in the 2027 North Benchmark Case.

Table 66: Study Pocket Generation Dispatch to Create the 2027 North Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70188	FT_LUPTN_12	G1	1	41.3
2	70188	FT_LUPTN_12	G2	1	40.3
3	70409	ST.VRAIN	ST	1	271.8
4	70406	ST.VR_2	G2	1	163.7
5	70407	ST.VR_3	G3	1	156.0
6	70408	ST.VR_4	G4	1	157.5
7	70950	ST.VR_5	G5	1	156.2
8	70951	ST.VR_6	G6	1	154.5
9	70588	RMEC1	G1	1	132.4
10	70589	RMEC2	G2	1	140.5
11	70591	RMEC3	ST	1	288.7
12	70448	VALMNT6	G6	1	46.6
13	70557	VALMNT7	G7	1	39.6
14	70558	VALMNT8	G8	1	39.6
15	70487	JMSHAFR4	G5	1	29.7
16	70487	JMSHAFR4	G4	1	31.8

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
17	70490	JMSHAFR3	G3	1	34.0
18	70490	JMSHAFR3	ST	1	40.5
19	70493	JMSHAFR2	ST	1	42.5
20	70495	JMSHAFR1	G1	1	32.7
21	70495	JMSHAFR1	G2	1	31.5
22	700151	GI_2021_6	S1	1	169.2
23	70562	SPRUCE1	G1	1	122.9
24	70563	SPRUCE2	G2	1	122.0
25	70580	PLNENDG1_1	G0	1	5.1
26	70580	PLNENDG1_1	G1	1	5.1
27	70580	PLNENDG1_1	G2	1	5.1
28	70580	PLNENDG1_1	G3	1	5.1
29	70580	PLNENDG1_1	G4	1	5.1
30	70580	PLNENDG1_1	G5	1	5.1
31	70580	PLNENDG1_1	G6	1	5.1
32	70580	PLNENDG1_1	G7	1	5.1
33	70580	PLNENDG1_1	G8	1	5.1
34	70580	PLNENDG1_1	G9	1	5.1
35	70587	PLNENDG1_2	G0	1	5.1
36	70587	PLNENDG1_2	G1	1	5.1
37	70587	PLNENDG1_2	G2	1	5.1
38	70587	PLNENDG1_2	G3	1	5.1
39	70587	PLNENDG1_2	G4	1	5.1
40	70587	PLNENDG1_2	G5	1	5.1
41	70587	PLNENDG1_2	G6	1	5.1
42	70587	PLNENDG1_2	G7	1	5.1
43	70587	PLNENDG1_2	G8	1	5.1
44	70587	PLNENDG1_2	G9	1	5.1
45	70585	PLNENDG2_1	G1	1	7.3
46	70585	PLNENDG2_1	G2	1	7.3
47	70585	PLNENDG2_1	G3	1	7.3
48	70585	PLNENDG2_1	G4	1	7.3
49	70585	PLNENDG2_1	G5	1	7.3
50	70585	PLNENDG2_1	G6	1	7.3
51	70585	PLNENDG2_1	G7	1	7.3
52	70586	PLNENDG2_2	G1	1	7.3
53	70586	PLNENDG2_2	G2	1	7.3
54	70586	PLNENDG2_2	G3	1	7.3
55	70586	PLNENDG2_2	G4	1	7.3
56	70586	PLNENDG2_2	G5	1	7.3

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
57	70586	PLNENDG2_2	G6	1	7.3
58	70586	PLNENDG2_2	G7	1	7.3
59	70593	SPNDLE1	G1	1	128.8
60	70594	SPNDLE2	G2	1	126.5
61	70823	CEDARCK_1A	W1	1	176.6
62	70824	CEDARCK_1B	W2	1	64.2
63	70825	CEDAR2_W1	W1	1	100.1
64	70826	CEDAR2_W2	W2	1	80.7
65	70827	CEDAR2_W3	W3	1	20.0
Total					**3,386.5**

Table 67: NLP Generation Included in 2027 North Benchmark Cases

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	291.4
2	700057	24_13_W2	W2	1	128.6
3	700060	24_13_W3	W3	1	28.6
4	700063	24_13_W4	W4	1	13.8
5	700067	24_13_W1	W1	1	106.3
6	700226	24_6_S	S	1	400.0
7	700196	24_19_W1	W1	1	442.8
8	700076	24_12_W1	W1	1	144.0
9	700077	24_12_W2	W2	1	162.0
10	700078	24_12_W3	W3	1	44.0
11	700182	24_28_W	W1	1	500.0
12	700079	24_9_W1	W1	1	153.0
13	700082	24_9_W2	W2	1	130.0
14	700085	24_9_W3	W3	1	35.0
15	700088	24_9_W4	W4	1	53.0
16	700244	24_27_B1	B1	1	49.5
17	700245	24_27_B2	B2	1	47.3
18	700246	24_27_S1	S1	1	57.8
19	700247	24_27_S2	S2	1	57.8
Total					**2,844.9**

E.3 2027 NORTH PORTFOLIO 1 STUDY CASE MODEL

The 2027 North Portfolio 1 Study Case model was created from the 2027 North Benchmark Case model by turning on the GIR generation shown in Table 68. The additional output from the GIR was sunk into generation externally to the study pocket.

Table 68: Study GIRs Dispatch for 2027 North Portfolio 1 Study Case

Resource	POI	Pgen (MW)
5RSC-2024-01	Fort Lupton 115 kV	200.0
5RSC-2024-02	Fort St. Vrain 230 kV	400.0
5RSC-2024-13	Spindle 230 kV	199.0

E.4 2027 NORTH PORTFOLIO 2 STUDY CASE MODEL

The 2027 North Portfolio 2 Study Case model was created from the 2027 North Benchmark Case model by turning on the GIR generation shown in Table 69. The additional output from the GIR was sunk into generation externally to the study pocket.

Table 69: Study GIRs Dispatch for 2027 North Portfolio 2 Study Case

Resource	POI	Pgen (MW)
5RSC-2024-02	Fort St. Vrain 230 kV	400.0
5RSC-2024-13	Spindle 230 kV	199.0

E.5 RE-DISPATCHED 2027 NORTH STUDY CASE

The redispatch scenario presented in Table 70 was adopted to mitigate the violations observed on facilities in the 2027 North Study Case for both Portfolios 1 and 2.

Table 70: Redispatch to Mitigate Facility Overloads in 2027 North Study Case

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70069	CABCRKA	HA	0.0	0	120.0	1
70106	CHEROK4	G4	0.0	0	308.0	1
70145	CHEROKEE5	G5	56.0	0	90.4	1
70146	CHEROKEE6	G6	56.0	0	178.0	1
70147	CHEROKEE7	ST	146.0	0	232.0	1
70310	PAWNEE	C1	489.3	1	0.0	0
70408	ST.VR_4	G4	157.5	1	140.0	1

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70409	ST.VRAIN	ST	271.8	1	239.7	1
70771	RUSHCK2_W3	W3	1.4	1	0.0	0
70775	CHEYRGE_W3	W3	22.8	1	0.0	0
70950	ST.VR_5	G5	156.2	1	0.0	0
70951	ST.VR_6	G6	154.5	1	0.0	0
700215	24_1_S1	S1	35.0	1	0.0	0
700216	24_1_S2	S2	35.0	1	0.0	0
700217	24_1_S3	S3	35.0	1	0.0	0

E.6 2027 NORTH GRID CHARGING BENCHMARK CASE MODEL

The 2027 North Grid Charging Benchmark (BM) Case was created from the 2027HS North Base Case by changing the North Study Pocket generation dispatch to reflect the stressed generation scenario. This was accomplished by adopting the generation dispatch given in Table 71. summarizes the Native Load Priority Generation totaling 2845 MW that was dispatched in the 2027 North Grid Charging Benchmark Case.

Table 71: North Study Pocket Generation Dispatch to Create the 2027 Grid Charging Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70188	FT_LUPTN_12	G1	1	41.3
2	70188	FT_LUPTN_12	G2	1	40.3
3	70409	ST.VRAIN	ST	1	271.8
4	70406	ST.VR_2	G2	1	163.7
5	70407	ST.VR_3	G3	1	156.0
6	70408	ST.VR_4	G4	1	157.5
7	70950	ST.VR_5	G5	1	156.2
8	70951	ST.VR_6	G6	1	154.5
9	70588	RMEC1	G1	1	132.4
10	70589	RMEC2	G2	1	140.5
11	70591	RMEC3	ST	1	288.7
12	70448	VALMNT6	G6	1	46.6
13	70557	VALMNT7	G7	1	39.6
14	70558	VALMNT8	G8	1	39.6
15	70487	JMSHAFR4	G5	1	29.7
16	70487	JMSHAFR4	G4	1	31.8
17	70490	JMSHAFR3	G3	1	34.0

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
18	70490	JMSHAFR3	ST	1	40.5
19	70493	JMSHAFR2	ST	1	42.5
20	70495	JMSHAFR1	G1	1	32.7
21	70495	JMSHAFR1	G2	1	31.5
22	700151	GI_2021_6	S1	1	169.2
23	70562	SPRUCE1	G1	1	122.9
24	70563	SPRUCE2	G2	1	122.0
25	70580	PLNENDG1_1	G0	1	5.1
26	70580	PLNENDG1_1	G1	1	5.1
27	70580	PLNENDG1_1	G2	1	5.1
28	70580	PLNENDG1_1	G3	1	5.1
29	70580	PLNENDG1_1	G4	1	5.1
30	70580	PLNENDG1_1	G5	1	5.1
31	70580	PLNENDG1_1	G6	1	5.1
32	70580	PLNENDG1_1	G7	1	5.1
33	70580	PLNENDG1_1	G8	1	5.1
34	70580	PLNENDG1_1	G9	1	5.1
35	70587	PLNENDG1_2	G0	1	5.1
36	70587	PLNENDG1_2	G1	1	5.1
37	70587	PLNENDG1_2	G2	1	5.1
38	70587	PLNENDG1_2	G3	1	5.1
39	70587	PLNENDG1_2	G4	1	5.1
40	70587	PLNENDG1_2	G5	1	5.1
41	70587	PLNENDG1_2	G6	1	5.1
42	70587	PLNENDG1_2	G7	1	5.1
43	70587	PLNENDG1_2	G8	1	5.1
44	70587	PLNENDG1_2	G9	1	5.1
45	70585	PLNENDG2_1	G1	1	7.3
46	70585	PLNENDG2_1	G2	1	7.3
47	70585	PLNENDG2_1	G3	1	7.3
48	70585	PLNENDG2_1	G4	1	7.3
49	70585	PLNENDG2_1	G5	1	7.3
50	70585	PLNENDG2_1	G6	1	7.3
51	70585	PLNENDG2_1	G7	1	7.3
52	70586	PLNENDG2_2	G1	1	7.3
53	70586	PLNENDG2_2	G2	1	7.3
54	70586	PLNENDG2_2	G3	1	7.3
55	70586	PLNENDG2_2	G4	1	7.3
56	70586	PLNENDG2_2	G5	1	7.3
57	70586	PLNENDG2_2	G6	1	7.3

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
58	70586	PLNENDG2_2	G7	1	7.3
59	70593	SPNDLE1	G1	1	128.8
60	70594	SPNDLE2	G2	1	126.5
61	70823	CEDARCK_1A	W1	1	46.2
62	70824	CEDARCK_1B	W2	1	16.8
63	70825	CEDAR2_W1	W1	1	26.3
64	70826	CEDAR2_W2	W2	1	21.2
65	70827	CEDAR2_W3	W3	1	5.3
Total					**3,060.6**

E.7 2027 NORTH GRID CHARGING STUDY CASE MODEL

The 2027 North Study Case model was created from the 2027 North Grid Charging Benchmark Case model by turning on the GIR generation shown in Table 72. The additional consumption from the GIR was balanced using generation externally to the study pocket.

Table 72: Study GIR Dispatch for 2027 North Grid Charging Study Case

Resource	POI	Pgen (MW)
5RSC-2024-13	Spindle 230 kV	-207.08

E.8 RE-DISPATCHED 2027 NORTH GRID CHARGING STUDY CASE

The redispatch scenario presented in Table 73 was adopted to mitigate the violations observed on facilities in the 2027 North Grid Charging Study Case.

Table 73: Redispatch to Mitigate Facility Overloads in 2027 North Grid Charging Study Case

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70106	CHEROK4	G4	198.3	1	308.0	1
70145	CHEROKEE5	G5	55.0	1	152.5	1
70146	CHEROKEE6	G6	55.1	1	178.0	1
70147	CHEROKEE7	ST	51.1	1	232.0	1
70188	FT_LUPTN_12	G1	41.3	1	45.9	1
70188	FT_LUPTN_12	G2	40.3	1	44.8	1
70310	PAWNEE	C1	301.6	1	0.0	0
70408	ST.VR_4	G4	157.5	1	173.6	1
70409	ST.VRAIN	ST	271.8	1	317.8	1

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70557	VALMNT7	G7	39.6	1	40.7	1
70558	VALMNT8	G8	39.6	1	41.8	1
70562	SPRUCE1	G1	122.9	1	136.5	1
70563	SPRUCE2	G2	122.0	1	135.5	1
70588	RMEC1	G1	132.4	1	147.1	1
70589	RMEC2	G2	140.5	1	156.1	1
70591	RMEC3	ST	288.7	1	320.8	1
70767	RUSHCK1_W1	W1	0.0	0	171.6	1
70777	COMAN_3	C3	493.0	1	0.0	0
700215	24_1_S1	S1	35.0	1	0.0	0
700216	24_1_S2	S2	35.0	1	0.0	0
700217	24_1_S3	S3	35.0	1	0.0	0

APPENDIX F – 2027 EAST CASE SETUP

F.1 2027 EAST BASE CASE MODEL

The 2027 case year studies were performed using the 2029HS2 WECC Base Case released on May 8, 2023, that has been modified to represent 2027 heavy summer loading conditions. To adjust the system to properly reflect the 2027 case year, the model fixes presented in Table 74. The planned transmission projects applied to the 2027HS Base Case are listed in Table 75.

Table 74: Model Fixes Performed to Create the 2027HS Base Case

Modification Description
Replacement of Valmont 9064 and 9066 Capacitor Banks
Removal of Mirasol 2nd 230 kV circuit
Derating Buckley-Smoky Hill from 796 MVA to 478 MVA
Derating Federal Heights - Semper 115kV from 398 MVA to 159 MVA
Removal of Comanche BESS
Removal of Longhorn 345 kV Bus
Removal of Port Data Center
Removal of Deer Trail II
Removal of Cornflower
Removal of Alamosa Energy Center
Removal of Fort St Vrain BESS

Table 75: Planned Transmission Projects Included in the 2027HS Base Case

Project Description
Uprate Cherokee South - North 115 kV to 398 MVA
Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
Uprate Leetsdale Transformer T5 to 448 MVA
Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
Uprate Sargent Transformer T1 to 112 MVA
Upgrade Smoky Hill - Harvest Mile 230 kV to 1195 MVA
Addition of Fort Saint Vrain Transformer T1
Addition of Comanche Transformer T5
Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
Uprate Valmont Transformer T7 to 448 MVA
Uprate Valmont Transformer T8 to 448 MVA
Uprate Missile Site - Pronghorn to 1793 MVA
Uprate California - Cherokee S to 398 MVA

Project Description
Uprate Clark - Jordan to 1195 MVA
Uprate Denver Terminal bus-tie breaker to 398 MVA
Uprate Poncha E - Sargent to 248.9 MVA
Addition of Malta Third Transformer
Addition of 30 Mvar Capacitor Bank at San Luis Valley
Addition of 100 Mvar reactor at Beaver Creek P
Greenwood to Monaco series reactor
Addition of 45 Mvar Reactor at Cedar Point
Addition of two Synchronous Condenser at May Valley
Addition of a STATCOM at Goose Creek

F.2 2027 EAST BENCHMARK CASE MODEL

The 2027 East Benchmark (BM) Case was created from the 2027HS Base Case described above by changing the East Study Pocket generation dispatch to reflect the heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 76. Table 77 summarizes the Native Load Priority Generation totaling 1,534 MW that was dispatched in the 2027 East Benchmark Case.

Table 76: Study Pocket Generation Dispatch to Create the 2027 East Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70310	PAWNEE	C1	1	505.0
2	70314	MANCHEF1	G1	1	131.5
3	70315	MANCHEF2	G1	1	131.0
4	70442	ARRIBA_W2	W2	1	80.1
5	70443	ARRIBA_W1	W1	1	80.1
6	70498	QF_BCP2T	G3	1	33.3
7	70498	QF_BCP2T	ST	1	35.1
8	70499	QF_B4-4T	G4	1	24.0
9	70499	QF_B4-4T	G5	1	25.0
10	70556	QF_B4D4T	ST	1	70.0
11	70616	TITAN_S1	S1	1	42.5
12	70635	LIMON1_W	W1	1	160.0
13	70636	LIMON2_W	W2	1	160.0
14	70637	LIMON3_W	W3	1	160.0
15	70670	CEDARPT_W1	W1	1	100.1
16	70671	CEDARPT_W2	W2	1	101.5

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
17	70710	PTZLOGN1	W1	1	160.8
18	70712	PTZLOGN2	W2	1	96.2
19	70713	PTZLOGN3	W3	1	63.8
20	70714	PTZLOGN4	W4	1	140.0
21	70721	SPRNGCAN1_W1	W1	1	48.0
22	70733	CHEYRGE_W1	W1	1	43.2
23	70736	CHEYRGE_W2	W2	1	88.1
24	70739	CHEYRGW_W1	W1	1	109.3
25	70742	CHEYRGW_W2	W2	1	105.7
26	70749	BRONCO_W2	W2	1	125.7
27	70753	BRONCO_W1	W1	1	114.3
28	70767	RUSHCK1_W1	W1	1	161.6
29	70770	RUSHCK1_W2	W2	1	142.4
30	70771	RUSHCK2_W3	W3	1	176.0
31	70775	CHEYRGE_W3	W3	1	52.9
32	70818	MTNBRZ_W1	W1	1	120.9
33	70817	MTNBRZ_W2	W2	1	10.9
Total					**3,599.0**

Table 77: NLP Generation Included in 2027 East Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	291.4
2	700226	24_6_S	S	1	400.0
3	700057	24_13_W2	W2	1	103.6
4	700060	24_13_W3	W3	1	103.6
5	700063	24_13_W4	W4	1	88.8
6	700067	24_13_W1	W1	1	103.6
7	700196	24_19_W1	W1	1	442.8
Total					**1,533.8**

F.3 2027 EAST STUDY CASE MODEL

The 2027 East Study Case model was created from the 2027 East Benchmark Case model by turning on the GIR generation shown in Table 78. The additional output from the GIR was sunk in generation externally to the study area.

Table 78: Generation Dispatch for 2027 East Study Case

Resource	POI	Pgen (MW)
5RSC-2024-10	Goose Creek 345 kV	250.0
5RSC-2024-11	Pawnee 345 kV	250.0
5RSC-2024-16	Goose Creek 345 kV	438.0
5RSC-2024-17	Goose Creek 345 kV	578.3
5RSC-2024-27	Canal Crossing 345 kV	250.8
5RSC-2024-28	Goose Creek 345 kV	492.3

F.4 RE-DISPATCHED 2027 EAST STUDY CASE

The redispatch scenario presented in Table 79 can be adopted to mitigate the violations observed on facilities in the Study Case.

Table 79: Redispatch to Mitigate Facility Overloads in 2027 East Study Case

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70106	CHEROK4	G4	134.0	1	308.0	1
70145	CHEROKEE5	G5	0.0	0	179.2	1
70146	CHEROKEE6	G6	0.0	0	178.0	1
70147	CHEROKEE7	ST	122.0	1	232.0	1
70188	FT_LUPTN_12	G2	0.0	0	8.5	1
70310	PAWNEE	C1	505.0	1	0.0	0
70314	MANCHEF1	G1	131.5	1	0.0	0
70315	MANCHEF2	G2	131.0	1	0.0	0
70407	ST.VR_3	G3	0.0	0	131.4	1
70408	ST.VR_4	G4	0.0	0	173.6	1
70409	ST.VRAIN	ST	0.0	0	317.8	1
70448	VALMNT6	G6	0.0	0	46.6	1
70557	VALMNT7	G7	0.0	0	40.7	1
70558	VALMNT8	G8	0.0	0	41.8	1
70562	SPRUCE1	G1	0.0	0	66.1	1
70563	SPRUCE2	G2	0.0	0	135.5	1
70591	RMEC3	ST	0.0	0	68.4	1
70733	CHEYRGE_W1	W1	43.3	1	0.0	0
70736	CHEYRGE_W2	W2	88.1	1	0.0	0
70739	CHEYRGW_W1	W1	109.3	1	0.0	0
70742	CHEYRGW_W2	W2	105.7	1	0.0	0
70767	RUSHCK1_W1	W1	161.6	1	0.0	0

Bus No.	Bus Name	ID	Original Pgen (MW)	Original Status	Modified Pgen (MW)	Modified Status
70770	RUSHCK1_W2	W2	142.4	1	0.0	0
70771	RUSHCK2_W3	W3	176	1	0.0	0
70775	CHEYRGE_W3	W3	52.9	1	0.0	0
70777	COMAN_3	C3	495.1	1	0.0	0
70950	ST.VR_5	G5	0.0	0	156.2	1
70951	ST.VR_6	G6	0.0	0	154.5	1

F.5 2027 EAST GRID CHARGING BENCHMARK CASE MODEL

The 2027 East Grid Charging Benchmark (BM) Case was created from the 2027HS Base Case described above by changing the East Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 80. Table 81 summarizes the Native Load Priority Generation totaling 1,534 MW that was dispatched in the 2027 East Benchmark Case.

Table 80: Study Pocket Generation Dispatch to Create the 2027 East Grid Charging Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70310	PAWNEE	C1	1	505.0
2	70314	MANCHEF1	G1	1	131.5
3	70315	MANCHEF2	G2	1	131.0
4	70443	ARRIBA W1	W1	1	21.0
5	70442	ARRIBA W2	W2	1	21.0
6	70498	QF_BCP2T	G3	1	33.3
7	70498	QF_BCP2T	ST	1	35.1
8	70499	QF_B4-4T	G4	1	24.0
9	70499	QF_B4-4T	G5	1	25.0
10	70556	QF_B4D4T	ST	1	70.0
11	70616	TITAN_S1	S1	1	42.5
12	70635	LIMON1_W	W1	1	42.0
13	70636	LIMON2_W	W2	1	42.0
14	70637	LIMON3_W	W3	1	42.0
15	70670	CEDARPT_W1	W1	1	26.3
16	70671	CEDARPT_W2	W2	1	26.6
17	70710	PTZLOGN1	W1	1	42.2
18	70712	PTZLOGN2	W2	1	25.3
19	70713	PTZLOGN3	W3	1	16.7

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
20	70714	PTZLOGN4	W4	1	36.8
21	70721	SPRNGCAN1_W1	W1	1	12.6
22	70733	CHEYRGE_W1	W1	1	11.3
23	70736	CHEYRGE_W2	W2	1	23.1
24	70739	CHEYRGW_W1	W1	1	28.6
25	70742	CHEYRGW_W2	W2	1	27.7
26	70749	BRONCO_W2	W2	1	33.0
27	70753	BRONCO_W1	W1	1	30.0
28	70767	RUSHCK1_W1	W1	1	42.4
29	70770	RUSHCK1_W2	W2	1	37.4
30	70771	RUSHCK2_W3	W3	1	46.2
31	70775	CHEYRGE_W3	W3	1	13.9
32	70818	MTNBRZ_W1	W1	1	33.2
33	70817	MTNBRZ_W2	W2	1	2.9
Total					**1,468.7**

Table 81: NLP Generation Included in 2027 East Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	291.4
2	700226	24_6_S	S	1	400.0
3	700057	24_13_W2	W2	1	103.6
4	700060	24_13_W3	W3	1	103.6
5	700063	24_13_W4	W4	1	88.8
6	700067	24_13_W1	W1	1	103.6
7	700196	24_19_W1	W1	1	442.8
Total					**1,533.8**

F.6 2027 EAST GRID CHARGING STUDY CASE MODEL

The 2027 East Study Case model was created from the 2027 East Benchmark Case model by turning on the GIR generation shown in Table 82. The additional output from the GIR was sunk in generation externally to the study area.

Table 82: Generation Dispatch for 2027 East Study Case

Resource	POI	Pgen (MW)
5RSC-2024-10	Goose Creek 345 kV	-253.6
5RSC-2024-11	Pawnee 345 kV	-254.2
5RSC-2024-27	Canal Crossing 345 kV	-210.6

APPENDIX G – 2028 WESTERN SLOPE (WS) CASE SETUP

G.1 2028 WESTERN SLOPE (WS) BASE CASE MODEL

The 2028 case year studies were performed using the 2029HS2 WECC Base Case released on May 8, 2023, that has been modified to represent 2028 heavy summer loading conditions. To adjust the system to properly reflect the 2028 case year, the model fixes presented in Table 83. The planned transmission projects applied to the 2028HS Base Case are listed in Table 84.

Table 83: Model Fixes Performed to Create the 2028HS Base Case

Modification Description
Replacement of Valmont 9064 and 9066 Capacitor Banks
Removal of Mirasol 2nd 230 kV circuit
Removal of Comanche BESS
Derating Cherokee - Mapleton L9546 from 318 MVA to 159 MVA
Derating Cherokee - New Substation A Line 952 from 318 MVA to 153 MVA
Derating Smoky Hill - Buckley - Tollgate - Jewell - Leetsdale lines and updated impedances
Removal of South Sub Expansion
Derating Arapahoe 115 kV bus-tie and removed 2nd 230/115 kV transformer
Derating Cherokee - Broomfield - Federal Heights - Semper lines and updated impedances
Removal of Daniels Park 4th Transformer
Removal of Smoky Hill 3rd Transformer
Removal of Smoky Hill 4th Transformer
Removal of Longhorn 345 kV Bus
Removal of Port Data Center
Removal of Deer Trail II
Removal of Cornflower
Removal of Alamosa Energy Center
Removal of Fort St Vrain BESS
Removal of double circuit from Chambers to Sandown to New Harvest Mile to Cherokee

Table 84: Planned Transmission Projects Included in the 2028HS Base Case

Project Description
Uprate Cherokee South - North 115 kV to 398 MVA
Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
Uprate Leetsdale Transformer T5 to 448 MVA
Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
Upgrade Sargent Transformer T1 to 112 MVA
Uprate Smoky Hill - Harvest Mile 230 kV to 1195 MVA

Project Description
Addition of Fort Saint Vrain Transformer T1
Addition of Comanche Transformer T5
Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
Ugrade Valmont Transformer T7 to 448 MVA
Upgrade Valmont Transformer T8 to 448 MVA
Uprate Missile Site - Pronghorn to 1793 MVA
Uprate Clark - Jordan to 1195 MVA
Uprate Denver Terminal bus-tie breaker to 398 MVA
Uprate Poncha E - Sargent to 248.9 MVA
Addition of Malta Third Transformer
Addition of 30 Mvar Capacitor Bank at San Luis Valley
Addition of 100 Mvar reactor at Beaver Creek P
Addition of Greenwood to Monaco Series Reactor
Addition of 45 Mvar Reactor at Cedar Point
Uprate Argo - Cherokee South 115 kV to 398 MVA
Uprate Leetsdale 1 - University to 398 MVA
Upgrade Denver Terminal Transformer T2 to 448 MVA
Uprate Havana - Chambers two circuits to 318 MVA
Uprate Mapleton 2 - Sub A to 398 MVA
Uprate Cherokee S - Sub A to 398 MVA
Uprate Sub A - California to 398 MVA
Addition of two Synchronous Condenser at May Valley
Addition of a STATCOM at Goose Creek
Addition of Synchronous Condenser at Waterton
Addition of Synchronous Condenser at Daniels Park

G.2 2028 WESTERN SLOPE (WS) BENCHMARK CASE MODEL (GRID DISCHARING)

The 2028 Western Slope (WS) Benchmark (BM) Case was created from the 2028HS Base Case described above by changing the East Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 85. Table 86 summarizes the Native Load Priority Generation totaling 3,522 MW that was dispatched in the 2028 Western Slope (WS) Benchmark Case.

Table 85: Western Slope (WS) Study Pocket Generation Dispatch to Create the 2028 Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	79040	HAYDEN1	1	1	200.0
2	79041	HAYDEN2	1	1	285.0
3	79015	CRAIG 1	1	1	42.0
4	79016	CRAIG 2	1	1	445.0
5	79017	CRAIG 3	1	1	462.4
6	70180	FRUITA	G1	1	18.0
7	73347	SHOSHONE	1	1	1.5
Total					**1,453.9**

Table 86: NLP Generation Included in 2028 Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	233.1
2	700057	24_13_W2	W2	1	103.6
3	700060	24_13_W3	W3	1	103.6
4	700063	24_13_W4	W4	1	88.8
5	700067	24_13_W1	W1	1	103.2
6	700226	24_6_S	S	1	340.0
7	700196	24_19_W1	W1	1	442.8
8	700076	24_12_W1	W1	1	115.2
9	700077	24_12_W2	W2	1	129.6
10	700078	24_12_W3	W3	1	115.2
11	700182	24_28_W	W1	1	400.0
12	700079	24_9_W1	W1	1	122.4
13	700082	24_9_W2	W2	1	129.6
14	700085	24_9_W3	W3	1	108.0
15	700088	24_9_W4	W4	1	122.4
16	700244	24_27_B1	B1	1	49.5
17	700245	24_27_B2	B2	1	49.5
18	700246	24_27_S1	S1	1	57.8
19	700247	24_27_S2	S2	1	57.8
20	700043	24_14_B	B1	1	225.0
21	700232	24_22_S	S	1	425.0
Total					**3,522.1**

G.3 2028 WESTERN SLOPE (WS) STUDY CASE MODEL (GRID DISCHARGING)

The 2028 Western Slope (WS) Study Case model was created from the 2028 Western Slope (WS) Benchmark Case model by turning on the GIR generation shown in Table 87. The additional output from the GIR was sunk in generation externally to the study area.

Table 87: Generation Dispatch for 2028 Western Slope (WS) Study Case

Resource	POI	Pgen (MW)
5RSC-2024-09	Hartsel 230 kV	199.0

G.4 RE-DISPATCHED 2028 WESTERN SLOPE (WS) STUDY CASE (GRID DISCHARGING)

The redispatch scenario presented in Table 88 can be adopted to mitigate the violations observed on facilities in the Study Case.

Table 88: Redispatch to Mitigate Facility Overloads in 2028 Western Slope (WS) Study Case

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70106	CHEROK4	G4	0	0.0	1	308.0
70146	CHEROKEE6	G6	1	170.0	1	177.0
70147	CHEROKEE7	ST	1	180.0	1	232.0
70180	FRUITA	G1	1	18.0	0	0.0
70188	FT_LUPTN_12	G1	0	0.0	1	45.9
70188	FT_LUPTN_12	G2	0	0.0	1	44.8
70310	PAWNEE	C1	1	513.2	0	0.0
70314	MANCHEF1	G1	1	131.5	0	0.0
70315	MANCHEF2	G2	1	131.0	0	0.0
70406	ST.VR_2	G2	0	0.0	1	163.7
70407	ST.VR_3	G3	0	0.0	1	156.0
70408	ST.VR_4	G4	0	0.0	1	173.6
70409	ST.VRAIN	ST	0	0.0	1	317.8
70448	VALMNT6	G6	0	0.0	1	46.6
70557	VALMNT7	G7	0	0.0	1	40.7
70558	VALMNT8	G8	0	0.0	1	41.8
70562	SPRUCE1	G1	0	0.0	1	43.0
70563	SPRUCE2	G2	0	0.0	1	135.5
70589	RMEC2	G2	0	0.0	1	114.6
70591	RMEC3	ST	0	0.0	1	320.8
70733	CHEYRGE_W1	W1	1	43.2	0	0.0

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70736	CHEYRGE_W2	W2	1	88.0	0	0.0
70739	CHEYRGW_W1	W1	1	109.1	0	0.0
70742	CHEYRGW_W2	W2	1	105.6	0	0.0
70767	RUSHCK1_W1	W1	1	161.6	0	0.0
70770	RUSHCK1_W2	W2	1	142.4	0	0.0
70771	RUSHCK2_W3	W3	1	176.0	0	0.0
70775	CHEYRGE_W3	W3	1	52.8	0	0.0
70777	COMAN_3	C3	1	650.0	0	0.0
70950	ST.VR_5	G5	0	0.0	1	156.2
70951	ST.VR_6	G6	0	0.0	1	154.5

G.5 2028 WESTERN SLOPE (WS) BENCHMARK CASE MODEL (GRID CHARGING)

The 2028 Western Slope (WS) Benchmark (BM) Case was created from the 2028HS Base Case described above by changing the East Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 89. Table 90 summarizes the Native Load Priority Generation totaling 3,522 MW that was dispatched in the 2028 Western Slope (WS) Benchmark Case.

Table 89: Western Slope (WS) Study Pocket Generation Dispatch to Create the 2028 Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	79040	HAYDEN1	1	1	200.0
2	79041	HAYDEN2	1	1	285.0
3	79015	CRAIG 1	1	1	42.0
4	79016	CRAIG 2	1	1	445.0
5	79017	CRAIG 3	1	1	462.4
6	70180	FRUITA	G1	1	18.0
7	73347	SHOSHONE	1	1	1.5
Total					**1,453.9**

Table 90: NLP Generation Included in 2028 Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	233.1
2	700057	24_13_W2	W2	1	103.6
3	700060	24_13_W3	W3	1	103.6

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
4	700063	24_13_W4	W4	1	88.8
5	700067	24_13_W1	W1	1	103.2
6	700226	24_6_S	S	1	340.0
7	700196	24_19_W1	W1	1	442.8
8	700076	24_12_W1	W1	1	115.2
9	700077	24_12_W2	W2	1	129.6
10	700078	24_12_W3	W3	1	115.2
11	700182	24_28_W	W1	1	400.0
12	700079	24_9_W1	W1	1	122.4
13	700082	24_9_W2	W2	1	129.6
14	700085	24_9_W3	W3	1	108.0
15	700088	24_9_W4	W4	1	122.4
16	700244	24_27_B1	B1	1	49.5
17	700245	24_27_B2	B2	1	49.5
18	700246	24_27_S1	S1	1	57.8
19	700247	24_27_S2	S2	1	57.8
20	700043	24_14_B	B1	1	225.0
21	700232	24_22_S	S	1	425.0
Total					**3,522.1**

G.6 2028 WESTERN SLOPE (WS) STUDY CASE MODEL (GRID CHARGING)

The 2028 Western Slope (WS) Study Case model was created from the 2028 Western Slope (WS) Benchmark Case model by turning on the GIR generation shown in Table 91. The additional output from the GIR was sunk in generation externally to the study area.

Table 91: Generation Dispatch for 2028 Western Slope (WS) Study Case

Resource	POI	Pgen (MW)
5RSC-2024-09	Hartsel 230 kV	-201.28

G.7 RE-DISPATCHED 2028 WESTERN SLOPE (WS) STUDY CASE (GRID CHARGING)

The redispatch scenario presented in Table 92 can be adopted to mitigate the violations observed on facilities in the Study Case.

Table 92: Redispatch to Mitigate Facility Overloads in 2028 Western Slope (WS) Study Case

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70106	CHEROK4	G4	0	0.0	1	308.0
70146	CHEROKEE6	G6	1	170.0	1	175.5
70147	CHEROKEE7	ST	1	180.0	1	232.0
70180	FRUITA	G1	1	18.0	0	0.0
70188	FT_LUPTN_12	G1	0	0.0	1	45.9
70188	FT_LUPTN_12	G2	0	0.0	1	44.8
70310	PAWNEE	C1	1	512.6	0	0.0
70314	MANCHEF1	G1	1	131.5	0	0.0
70315	MANCHEF2	G2	1	131.0	0	0.0
70406	ST.VR_2	G2	0	0.0	1	130.3
70407	ST.VR_3	G3	0	0.0	1	156.0
70408	ST.VR_4	G4	0	0.0	1	173.6
70409	ST.VRAIN	ST	0	0.0	1	317.8
70448	VALMNT6	G6	0	0.0	1	46.6
70557	VALMNT7	G7	0	0.0	1	40.7
70558	VALMNT8	G8	0	0.0	1	41.8
70563	SPRUCE2	G2	0	0.0	1	24.2
70588	RMEC1	G1	0	0.0	1	147.1
70589	RMEC2	G2	0	0.0	1	156.1
70591	RMEC3	ST	0	0.0	1	320.8
70733	CHEYRGE_W1	W1	1	43.2	0	0.0
70736	CHEYRGE_W2	W2	1	88.0	0	0.0
70739	CHEYRGW_W1	W1	1	109.1	0	0.0
70742	CHEYRGW_W2	W2	1	105.6	0	0.0
70767	RUSHCK1_W1	W1	1	161.6	0	0.0
70770	RUSHCK1_W2	W2	1	142.4	0	0.0
70771	RUSHCK2_W3	W3	1	176.0	0	0.0
70775	CHEYRGE_W3	W3	1	52.8	0	0.0
70777	COMAN_3	C3	1	650.0	0	0.0
70950	ST.VR_5	G5	0	0.0	1	156.2
70951	ST.VR_6	G6	0	0.0	1	154.5

APPENDIX H – 2029 SOUTH CASE SETUP

H.1 2029 SOUTH BASE CASE MODEL

The 2029 case year studies were performed using the 2029HS2 WECC Base Case released on May 8, 2023, that has been modified to represent 2029 heavy summer loading conditions.

To adjust the system to properly reflect the 2029 case year, the model fixes presented in Table 93. The planned transmission projects applied to the 2029HS Base Case are listed in Table 94.

Table 93: Planned Transmission Projects Included in the 2029HS Base Case

Modification Description
Replacement of Valmont 9064 and 9066 Capacitor Banks
Removal of Mirasol 2nd 230 kV circuit
Removal of Comanche BESS
Derating Cherokee - Mapleton L9546 from 318 MVA to 159 MVA
Derating Cherokee - New Substation A Line 952 from 318 MVA to 153 MVA
Derating Smoky Hill - Buckley - Tollgate - Jewell - Leetsdale lines and updated impedances
Removal of South Sub Expansion
Derating Arapahoe 115 kV bus-tie and removed 2nd 230/115 kV transformer
Derating Cherokee - Broomfield - Federal Heights - Semper lines and updated impedances
Removal of Daniels Park 4th Transformer
Removal of Smoky Hill 3rd Transformer
Removal of Smoky Hill 4th Transformer
Removal of Longhorn 345 kV Bus
Removal of Port Data Center
Removal of Deer Trail II
Removal of Cornflower
Removal of Alamosa Energy Center
Removal of Fort St Vrain BESS

Table 94: Transmission Solutions Included in the 2029HS Base Case

Project Description
Uprate Cherokee South - North 115 kV to 398 MVA
Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
Uprate Leetsdale Transformer T5 to 448 MVA
Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
Upgrade Sargent Transformer T1 to 112 MVA
Uprate Smoky Hill - Harvest Mile 230 kV to 1195 MVA
Addition of Fort Saint Vrain Transformer T1
Addition of Comanche Transformer T5
Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
Ugrade Valmont Transformer T7 to 448 MVA
Upgrade Valmont Transformer T8 to 448 MVA
Uprate Missile Site - Pronghorn to 1793 MVA

Uprate Clark - Jordan to 1195 MVA
Uprate Denver Terminal bus-tie breaker to 398 MVA
Uprate Poncha E - Sargent to 248.9 MVA
Addition of Malta Third Transformer
Addition of 30 Mvar Capacitor Bank at San Luis Valley
Addition of 100 Mvar reactor at Beaver Creek P
Addition of Greenwood to Monaco Series Reactor
Addition of 45 Mvar Reactor at Cedar Point
Uprate Argo - Cherokee South 115 kV to 398 MVA
Uprate Leetsdale 1 - University to 398 MVA
Upgrade Denver Terminal Transformer T2 to 448 MVA
Uprate Havana - Chambers two circuits to 318 MVA
Uprate Mapleton 2 - Sub A to 398 MVA
Uprate Cherokee S - Sub A to 398 MVA
Uprate Cherokee S - California to 398 MVA
Addition of 50 Mvar Capacitor Bank at Tarryall
Uprate Comanche - Stagecoach (GI-2020-10) 230 kV to 1195 MVA
Uprate Deer Creek - Soda Lakes to 398 MVA
Uprate Littleton - Waterton to 398 MVA
Uprate Midway - Mirasol 230 kV to 796 MVA
Uprate Palmer Lake - Fox Rrun to 398 MVA
Upgrade two transformers at New Sandown to 448 MVA
Addition of two Synchronous Condenser at May Valley
Addition of a STATCOM at Goose Creek
Addition of Synchronous Condenser at Waterton
Addition of Synchronous Condenser at Daniels Park

H.2 2029 SOUTH BENCHMARK CASE MODEL (GRID DISCHARING)

The 2029 South Benchmark (BM) Case was created from the 2029HS Base Case described above by changing the South Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 95. Table 96 summarizes the Native Load Priority Generation totaling 2,780 MW that was dispatched in the 2029 South Benchmark Case.

Table 95: South Study Pocket Generation Dispatch to Create the 2029 Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70577	FTNVL1&2	G1	1	36.3

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
2	70577	FTNVL1&2	G2	1	36.3
3	70578	FTNVL3&4	G3	1	36.3
4	70578	FTNVL3&4	G4	1	36.3
5	70579	FTNVL5&6	G5	1	36.3
6	70579	FTNVL5&6	G6	1	36.3
7	70777	COMAN_3	C3	1	804.9
8	70934	COMAN_S1	S1	1	102.0
9	70017	SI_GEN 0	1	1	15.1
10	70878	BIGHORN_S	S1	1	204.0
11	70756	NEPTUNE_B1	B1	1	92.1
12	70758	NEPTUNE_S1	S1	1	184.3
13	70761	THNDWLF_B1	B1	1	70.3
14	70763	THNDWLF_S1	S1	1	140.5
15	70859	SUN_MTN_S1	S1	1	170.0
16	700142	20_10_S1	S1	1	57.5
17	700144	20_10_B1	B1	1	57.5
18	700146	20_10_S2	S2	1	57.5
19	700147	20_10_B2	B2	1	57.5
20	70256	CO_GRN_W	W2	1	64.8
21	70708	CO_GRN_E	W1	1	64.8
22	70704	TBI_GEN	W1	1	60.0
23	70663	GLDNWST_W1	W1	1	200.0
24	70010	TBII_GEN	W	1	60.0
25	700119	21_1_S1	S1	1	56.4
26	700120	21_1_S2	S2	1	56.4
27	700121	21_1_S3	S3	1	56.4
28	700122	21_1_B1	B1	1	35.7
29	700123	21_1_B2	B2	1	35.7
30	700124	21_1_B3	B3	1	35.7
31	700215	24_1_S1	S1	1	94.9
32	700216	24_1_S2	S2	1	94.9
33	700217	24_1_S3	S3	1	94.9
Total					**3,241.6**

Table 96: NLP Generation Included in 2029 Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	233.1
2	700196	24_19_W1	W1	1	553.5
3	700076	24_12_W1	W1	1	144

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
4	700077	24_12_W2	W2	1	162
5	700078	24_12_W3	W3	1	144
6	700182	24_28_W	W1	1	500.0
7	700079	24_9_W1	W1	1	153.0
8	700082	24_9_W2	W2	1	102.9
9	700085	24_9_W3	W3	1	135.0
10	700088	24_9_W4	W4	1	153
11	700244	24_27_B1	B1	1	87.0
12	700245	24_27_B2	B2	1	47.3
13	700246	24_27_S1	S1	1	57.8
14	700247	24_27_S2	S2	1	57.8
15	700043	24_14_B	B1	1	250.0
Total					2,780.4

H.3 2029 SOUTH STUDY CASE MODEL (GRID DISCHARGING)

The 2029 South Study Case model was created from the 2029 South Benchmark Case model by turning on the GIR generation shown in Table 97. The additional output from the GIR was sunk in generation externally to the study area.

Table 97: Generation Dispatch for 2029 South Study Case

Resource	POI	Pgen (MW)
5RSC-2024-04	Mirasol 230 kV	100.0
5RSC-2024-06	Sandstone 345 kV	300.0
5RSC-2024-12	Comanche 345 kV	200.0
5RSC-2024-15	May Valley 345 kV	476.8
5RSC-2024-21	May Valley - Sandstone 345 kV	400.0

H.4 RE-DISPATCHED 2029 SOUTH STUDY CASE (GRID DISCHARGING)

The redispatch scenario presented in Table 98 can be adopted to mitigate the violations observed on facilities in the Study Case.

Table 98: Redispatch to Mitigate Facility Overloads in 2029 South Study Case

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70106	CHEROK4	G4	1	243.0	1	308.0

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70145	CHEROKEE5	G5	1	56.0	1	179.2
70146	CHEROKEE6	G6	1	56.0	1	178.0
70147	CHEROKEE7	G7	1	146.0	1	232.0
70180	FRUITA	G1	0	0.0	1	19.7
70188	FT_LUPTN_12	G1	0	0.0	1	45.9
70188	FT_LUPTN_12	G2	0	0.0	1	44.8
70310	PAWNEE	G2	1	499.9	0	0.0
70315	MANCHEF2	C1	1	18.0	0	0.0
70448	VALMNT6	G6	0	0.0	1	46.6
70485	ALMSACT1	G1	0	0.0	1	11.2
70557	VALMNT7	G7	0	0.0	1	40.7
70558	VALMNT8	G8	0	0.0	1	41.8
70652	SPRUCE1	G1	0	0.0	1	136.5
70653	SPRUCE2	G2	0	0.0	1	135.5
70588	RMEC1	G1	0	0.0	1	147.1
70589	RMEC2	G2	0	0.0	1	156.1
70591	RMEC3	ST	0	0.0	1	320.8
70777	COMAN_3	C3	1	804.9	0	0.0
70951	ST.VR_6	G6	0	0.0	1	97.5
700104	3RSC_23_1	S1	1	85.0	0	0.0
700107	3RSC_23_1	S2	1	85.0	0	0.0
700215	24_1_S1	S1	1	94.9	0	0.0
700216	24_1_S2	S2	1	94.9	0	0.0
700217	24_1_S3	S3	1	94.9	0	0.0

H.5 2029 SOUTH BENCHMARK CASE MODEL (GRID CHARGING)

The 2029 South Benchmark (BM) Case was created from the 2029HS Base Case described above by changing the South Study Pocket generation dispatch to reflect heavy generation scenario. This was accomplished by adopting the stressed generation dispatch given in Table 99. Table 100 summarizes the Native Load Priority Generation totaling 2,780 MW that was dispatched in the 2029 South Benchmark Case.

Table 99: South Study Pocket Generation Dispatch to Create the 2029 Benchmark Case (MW is Gross Capacity)

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	70577	FTNVL1&2	G1	1	36.3
2	70577	FTNVL1&2	G2	1	36.3

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
3	70578	FTNVL3&4	G3	1	36.3
4	70578	FTNVL3&4	G4	1	36.3
5	70579	FTNVL5&6	G5	1	36.3
6	70579	FTNVL5&6	G6	1	36.3
7	70777	COMAN_3	C3	1	804.9
8	70934	COMAN_S1	S1	1	0.0
9	70017	SI_GEN 0	1	1	0.0
10	70878	BIGHORN_S	S1	1	0.0
11	70756	NEPTUNE_B1	B1	1	-112.8
12	70758	NEPTUNE_S1	S1	1	0.0
13	70761	THNDWLF_B1	B1	1	-50.0
14	70763	THNDWLF_S1	S1	1	0.0
15	70859	SUN_MTN_S1	S1	1	0.0
16	700142	20_10_S1	S1	1	0.0
17	700144	20_10_B1	B1	1	-110.0
18	700146	20_10_S2	S2	1	0.0
19	700147	20_10_B2	B2	1	-110.0
20	70256	CO_GRN_W	W2	1	17.0
21	70708	CO_GRN_E	W1	1	17.0
22	70704	TBI_GEN	W1	1	15.8
23	70663	GLDNWST_W1	W1	1	52.4
24	70010	TBII_GEN	W	1	16.4
25	700119	21_1_S1	S1	1	0.0
26	700120	21_1_S2	S2	1	0.0
27	700121	21_1_S3	S3	1	0.0
28	700122	21_1_B1	B1	1	-75.0
29	700123	21_1_B2	B2	1	-75.0
30	700124	21_1_B3	B3	1	-75.0
31	700215	24_1_S1	S1	1	0.0
32	700216	24_1_S2	S2	1	0.0
33	700217	24_1_S3	S3	1	0.0
Total					**533.5**

Table 100: NLP Generation Included in 2029 Benchmark Case

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
1	700095	24_18_W	W	1	233.1
2	700196	24_19_W1	W1	1	553.5
3	700076	24_12_W1	W1	1	144
4	700077	24_12_W2	W2	1	162

Ref. No.	Bus No.	Bus Name	ID	Status	Pgen (MW)
5	700078	24_12_W3	W3	1	144
6	700182	24_28_W	W1	1	500.0
7	700079	24_9_W1	W1	1	153.0
8	700082	24_9_W2	W2	1	102.9
9	700085	24_9_W3	W3	1	135.0
10	700088	24_9_W4	W4	1	153
11	700244	24_27_B1	B1	1	87.0
12	700245	24_27_B2	B2	1	47.3
13	700246	24_27_S1	S1	1	57.8
14	700247	24_27_S2	S2	1	57.8
15	700043	24_14_B	B1	1	250.0
Total					**2,780.4**

H.6 2029 SOUTH STUDY CASE MODEL (GRID CHARGING)

The 2029 South Study Case model was created from the 2029 South Benchmark Case model by turning on the GIR generation shown in Table 101. The additional output from the GIR was sunk in generation externally to the study area.

Table 101: Generation Dispatch for 2029 South Study Case

Resource	POI	Pgen (MW)
5RSC-2024-06	Sandstone 345 kV	-102.9
5RSC-2024-12	Comanche 345 kV	-207.3

H.7 RE-DISPATCHED 2029 SOUTH STUDY CASE (GRID CHARGING)

The redispatch scenario presented in Table 102 can be adopted to mitigate the violations observed on facilities in the Study Case.

Table 102: Redispatch to Mitigate Facility Overloads in 2029 South Study Case

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70106	CHEROK4	G4	0	0.0	1	308.0
70145	CHEROKEE5	G5	1	56.0	1	179.2
70146	CHEROKEE6	G6	1	56.0	1	178.0
70147	CHEROKEE7	ST	1	146.0	1	232.0
70310	PAWNEE	C1	1	489.3	0	0.0
70314	MANCHEF1	G1	1	131.5	0	0.0

Bus No.	Bus Name	ID	Original Status	Original Pgen (MW)	Modified Status	Modified Pgen (MW)
70315	MANCHEF2	G2	1	131.0	0	0.0
70409	ST.VRAIN	ST	1	317.8	1	304.5
70448	VALMNT6	G6	0	0.0	1	37.5
70557	VALMNT7	G7	0	0.0	1	40.7
70558	VALMNT8	G8	0	0.0	1	41.8
70562	SPRUCE1	G1	0	0.0	1	118.8
70563	SPRUCE2	G2	0	0.0	1	135.5
70733	CHEYRGE_W1	W1	1	54.0	1	50.4
70736	CHEYRGE_W2	W2	1	110.0	1	97.9
70950	ST.VR_5	G5	1	156.2	0	0.0
70951	ST.VR_6	G6	1	154.5	0	0.0

APPENDIX I – ESTIMATED COSTS

5RSC-2024-01

The total estimated cost of the required upgrades for 5RSC-2024-01 to interconnect at the Fort Lupton 115 kV substation is $1.400 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.069 million (Table 103)**
- **The cost of Station Network Upgrades is $0.331 million (Table 104)**
- **The cost of System Network Upgrades is $0 million**

Figure 2 in Appendix J provides a conceptual one-line of the Fort Lupton 115 kV substation for the interconnection of 5RSC-2024-01.

The list of improvements required to accommodate the interconnection of 5RSC-2024-01 is presented in Table 103 and Table 104. System improvements are subject to revision as a more detailed and refined design is produced.

Table 103: 5RSC-2024-01 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Fort Lupton 115 kV substation	Interconnection of 5RSC-2024-01 at the Fort Lupton 115 kV substation. The new equipment includes: • (1) 115 kV single bay dead-end structure • (2) 115 kV disconnect switches • (1) 115 kV CCVT 3-phase metering unit • Dual fiber communication equipment • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Testing and commissioning	$1.069
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$1.069**

Table 104: 5RSC-2024-01 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Fort Lupton 115 kV substation	Install required communication in the EEE at the Ft Lupton 115 kV substation	$0.331
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$0.331**

5RSC-2024-02

The total estimated cost of the required upgrades for 5RSC-2024-02 to interconnect at the Fort Saint Vrain 230 kV substation is $56.374 million.

- **The cost of Transmission Provider's Interconnection Facilities is $4.718 million (Table 105)**
- **The cost of Station Network Upgrades is $51.656 million (Table 106)**
- **The cost of System Network Upgrades is $0 million**

Figure 3 in Appendix J provides a conceptual one-line of the Fort Saint Vrain 230 kV substation for the interconnection of 5RSC-2024-02.

The list of improvements required to accommodate the interconnection of 5RSC-2024-02 is presented in Table 105 and Table 106. System improvements are subject to revision as a more detailed and refined design is produced.

Table 105: 5RSC-2024-02 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Fort Saint Vrain 230 kV substation	Interconnection of 5RSC-2024-02 at the Fort Saint Vrain 230 kV substation. The new equipment includes: • (2) 230 kV 3-phase arresters • (2) 230 kV 3-phase metering CTs for CT#7 and CT#8 • (2) 230 kV 3-phase CVTs • (2) Line terminations for CT#7 and CT#8 • Removal of existing lines and line terminations from CT#5 and CT#6 • Removal of existing metering CTs for CT#5 and CT#6 • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Testing and commissioning	$4.718
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$4.718**

Table 106: 5RSC-2024-02 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Fort Saint Vrain 230 kV substation	Interconnection of 5RSC-2024-02 at Fort Saint Vrain 230 kV substation. The new equipment includes: • (3) 230 kV dead-end structures for line terminations • (2) Static masts • (12) 230 kV 3000A SF6 circuit breakers • (24) 230 kV 3000A disconnect switches • (2) 230 kV 3-phase metering CTs for CT#5 and CT#6 • (2) 230 kV 3-phase CVTs for CT#5 and CT#6 • (14) 230 kV 1-phase CVTs for line interconnections and main bus • (6) 230 kV 3-phase arresters • (2) 230 kV 1-phase SSVTs • (1) Temporary shoo fly for CT#6 during construction • (2) Line terminations for CT#5 and CT#6 • (1) 27'x55' EEE • Grading and gravel 6.25 acres for substation pad • 2,200 ft of 10 ft tall chain link fencing • Permitting • Associated electrical equipment, bus extensions, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Testing and commissioning	$47.593
PSCo's Fort Saint Vrain 230 kV substation	Install required communication equipment in the EEE at the Fort Saint Vrain 230 kV substation. The new COMM equipment includes: • (1) OrionLX+ RTU Panel • (4) AGC RTU OrionLXm's • (1) Communication Fiber Panel • Testing and commissioning	$1.381
PSCo's Fort Saint Vrain 230 kV substation	Install (4) 230 kV steel dead-end structures to connect the new substation to the existing Fort Saint Vrain substation. Structures consist of (1) single circuit 230 kV dead-end steel structure for circuit 55186 and (3) double circuit 230 kV dead-end steel structures for both 55186 & 55013 circuits. Includes installing the necessary insulators and hardware at the substation dead-ends.	$2.682
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$51.565**

5RSC-2024-04

The total estimated cost of the required upgrades for 5RSC-2024-04 to interconnect at the Mirasol 230 kV switching station is $6.418 million.

- **The cost of Transmission Provider's Interconnection Facilities is $2.996 million (Table 107)**
- **The cost of Station Network Upgrades is $3.422 million (Table 108)**
- **The cost of System Network Upgrades is $0 million**

Figure 4 in Appendix J provides a conceptual one-line of the Mirasol 230 kV switching station for the interconnection of 5RSC-2024-04.

The list of improvements required to accommodate the interconnection of 5RSC-2024-04 is provided in Table 107 and Table 108. System improvements are subject to revision as a more detailed and refined design is produced.

Table 107: 5RSC-2024-04 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Mirasol 230 kV switching station	Interconnection of 5RSC-2024-04 at the Mirasol 230 kV switching station. The new equipment includes: • (1) 230 kV single bay dead-end structure • (1) 230 kV 3-phase arrester • (1) 230 kV 3000 A disconnect switch • (1) 230 kV 3-phase CT for metering • (1) 230 kV 3-phase CCVT for metering • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$2.996
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$2.996**

Table 108: 5RSC-2024-04 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Mirasol 230 kV switching station	Interconnection of 5RSC-2024-04 at the Mirasol 230 kV switching station. The new equipment includes: • (1) 230 kV single bay dead-end structure • (1) 230 kV 3000 A circuit breaker • (5) 230 kV 3000 A disconnect switches • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$3.011
PSCo's Mirasol 230 kV switching station	Install required communication in the EEE at the Mirasol 230 kV switching station	$0.411
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$3.422**

5RSC-2024-06

The total estimated cost of the required upgrades for 5RSC-2024-06 to interconnect at the Sandstone 345 kV switching station is $13.262 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.999 million (Table 109)**
- **The cost of Station Network Upgrades is $9.263 million (Table 110)**
- **The cost of System Network Upgrades is $0 million**

Figure 5 in Appendix J provides a conceptual one-line of the Sandstone 345 kV switching station for the interconnection of 5RSC-2024-06.

The list of improvements required to accommodate the interconnection of 5RSC-2024-06 is provided in Table 109 and Table 110. System improvements are subject to revision as a more detailed and refined design is produced.

Table 109: 5RSC-2024-06 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Sandstone 345 kV switching station	Interconnection of 5RSC-2024-06 at the Sandstone 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and Commissioning	$3.999
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.999**

Table 110: 5RSC-2024-06 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Sandstone 345 kV switching station	Interconnection of 5RSC-2024-06 at Sandstone 345 kV switching station. The new equipment includes: • (2) 345 kV dead-end structure • (2) 345 kV 3000 A SF6 circuit breakers • (4) 345 kV 3000 A disconnect switches • Yard fence extension with gates • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$8.683
PSCo's Sandstone 345 kV switching station	Install required communication in the EEE at the Sandstone 345 kV switching station	$0.580
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$9.263**

5RSC-2024-09

The total estimated cost of the required upgrades for 5RSC-2024-09 to interconnect at the Hartsel 230 kV substation is $9.215 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.616 million (Table 111)**
- **The cost of Station Network Upgrades is $5.599 million (Table 112)**
- **The cost of System Network Upgrades is $0 million**

Figure 6 in Appendix J provides a conceptual one-line of the Hartsel 230 kV substation for the interconnection of 5RSC-2024-09.

The list of improvements required to accommodate the interconnection of 5RSC-2024-09 is provided in Table 111 and in Table 112. System improvements are subject to revision as a more detailed and refined design is produced.

Table 111: 5RSC-2024-09 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Hartsel 230 kV substation	Interconnection of 5RSC-2024-09 at the Hartsel 230 kV substation. The new equipment includes: • (1) 230 kV single bay dead-end structure • (1) 230 kV 3-phase arrester • (3) 230 kV 1-phase CTs for metering • (3) 230 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Testing and commissioning	$2.405
PSCo's Hartsel 230 kV substation	Transmission Provider's single circuit dead-end structure (5997-PCO STR) at the Point of Change of Ownership (PCO) and transmission line and OPGW from the PCO into substation from the PCO. The line will connect to (2) double circuit dead-end structures, but those costs are covered under the Station Network Upgrades. Three (3) spans, 3 conductors, OPGW, insulators, hardware and installation.	$0.709
PSCo's Hartsel 230 kV substation	Siting and Land Rights land acquisition and permitting, no land purchase costs included	$0.502
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.616**

Table 112: 5RSC-2024-09 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Hartsel 230 kV substation	Interconnection of 5RSC-2024-09 at Hartsel 230 kV substation. The new equipment includes: • (1) 230 kV 3000 A SF6 circuit breaker • (2) 230 kV 3000 A disconnect switches • (2) Gate relocations • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$2.827
PSCo's Hartsel 230 kV substation	Install required communication in the EEE at the Hartsel 230 kV substation	$0.711
PSCo's Hartsel 230 kV substation	5145 Tline - Move the 5145 circuit from the existing double circuit structure for 5995/5145 lines to a new single circuit dead-end structure (5145-1163).	$0.873
PSCo's Hartsel 230 kV substation	5995 Tline - Move the 5995 circuit from the existing double circuit structure for 5995/5145 lines to a new configuration that includes (2) double-circuit dead-end structures (5995_5997-1 and 5995_5997-2) shared with line 5997 from the generating facility. The existing double circuit structure 5415-1163 will be removed.	$1.188
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$5.599**

5RSC-2024-11

The total estimated cost of the required upgrades for 5RSC-2024-11 to interconnect at the Pawnee 345 kV substation is $18.695 million.

- **The cost of Transmission Provider's Interconnection Facilities is $4.762 million (Table 113)**
- **The cost of Station Network Upgrades is $13.933 million (Table 114)**
- **The cost of System Network Upgrades is $0 million**

Figure 7 in Appendix J provides a conceptual one-line of the Pawnee 345 kV substation for the interconnection of 5RSC-2024-11.

The list of improvements required to accommodate the interconnection of 5RSC-2024-11 is provided in Table 113 and Table 114. System improvements are subject to revision as a more detailed and refined design is produced.

Table 113: 5RSC-2024-11 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Pawnee 345 kV substation	Interconnection of 5RSC-2024-11 at the Pawnee 345 kV substation. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CT's for metering • (3) 345 kV 1-phase CCVT's • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$4.762
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$4.762**

Table 114: 5RSC-2024-11 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Pawnee 345 kV substation	Interconnection of 5RSC-2024-11 at Pawnee 345 kV substation. The new equipment includes: • (3) 345 kV dead-end structures • (5) 345 kV 3000 A SF6 circuit breakers • (11) 345 kV 3000 A disconnect switches • (2) 345 kV 3-phase CCVTs • Extension of the 345 kV North and South Bus • Yard expansion including grading, ground grid, access road relocation, surfacing and fencing • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$13.510
PSCo's Pawnee 345 kV substation	Install required communication in the EEE at the Pawnee 345 kV substation	$0.423
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$13.933**

5RSC-2024-12

The total estimated cost of the required upgrades for 5RSC-2024-12 to interconnect at the Comanche 345 kV substation is $7.780 million.

- **The cost of Transmission Provider's Interconnection Facilities is $4.881 million (Table 115)**
- **The cost of Station Network Upgrades is $2.899 million (Table 116)**
- **The cost of System Network Upgrades is $0 million**

Figure 8 in Appendix J provides a conceptual one-line of the Comanche 345 kV substation for the interconnection of 5RSC-2024-12.

The list of improvements required to accommodate the interconnection of 5RSC-2024-12 is provided in Table 115 and Table 116. System improvements are subject to revision as a more detailed and refined design is produced.

Table 115: 5RSC-2024-12 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Comanche 345 kV substation	Interconnection of 5RSC-2024-12 at the Comanche 345 kV substation. The new equipment includes: • (2) 345 kV single bay dead-end structures • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CVTs • Yard expansion including grading, ground grid, surfacing and fencing • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$4.881
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$4.881**

Table 116: 5RSC-2024-12 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Comanche 345 kV substation	Interconnection of 5RSC-2024-12 at the Comanche 345 kV substation. The new equipment includes: • (1) 345 kV 3000 A SF6 circuit breaker • (2) 345 kV 3000 A disconnect switches • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$2.535
PSCo's Comanche 345 kV substation	Install required communication in the EEE at the Comanche 345 kV substation	$0.364
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$2.899**

5RSC-2024-13

The total estimated cost of the required upgrades for 5RSC-2024-13 to interconnect at the Spindle 230 kV switching station is $4.689 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.995 million (Table 117)**
- **The cost of Station Network Upgrades is $2.734 million (Table 118)**
- **The cost of System Network Upgrades is $0 million**

Figure 9 in Appendix J provides a conceptual one-line of the Spindle 230 kV switching station for the interconnection of 5RSC-2024-13.

The list of improvements required to accommodate the interconnection of 5RSC-2024-13 is provided in Table 117 and Table 118. System improvements are subject to revision as a more detailed and refined design is produced.

Table 117: 5RSC-2024-13 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Spindle 230 kV switching station	Interconnection of 5RSC-2024-13 at the Spindle 230 kV switching station. The new equipment includes: • (1) 230 kV single bay dead-end structure • (1) 230 kV single bay dead-end extension structure • (1) 230 kV 3-phase arrester • (1) 230 kV 3000 A disconnect switch • (3) 230 kV 1-phase CTs for metering • (3) 230 kV CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying, and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$1.955
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$1.955**

Table 118: 5RSC-2024-13 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Spindle 230 kV switching station	Interconnection of 5RSC-2024-13 at the Spindle 230 kV Switching Station. The new equipment includes: • (1) 230 kV 3000 A Circuit Breaker • (2) 230 kV 3000 A Gang Switches • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$2.044
PSCo's Spindle 230 kV switching station	Install required communication in the EEE at the Spindle 230 kV Switching Station	$0.690
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$2.734**

5RSC-2024-15

The total estimated cost of the required upgrades for 5RSC-2024-15 to interconnect at the May Valley 345 kV switching station is $11.698 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.830 million (Table 119)**
- **The cost of Station Network Upgrades is $7.868 million (Table 120)**
- **The cost of System Network Upgrades is $0 million**

Figure 10 in Appendix J provides a conceptual one-line of the May Valley 345 kV switching station for the interconnection of 5RSC-2024-15.

The list of improvements required to accommodate the interconnection of 5RSC-2024-15 is provided in Table 119 and Table 120. System improvements are subject to revision as a more detailed and refined design is produced.

Table 119: 5RSC-2024-15 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's May Valley 345 kV switching station	Interconnection of 5RSC-2024-15 at the May Valley 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Dead-end structure, single span, 3 conductors, insulators, hardware, jumpers and labor. • Testing and commissioning	$3.830
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.830**

Table 120: 5RSC-2024-15 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's May Valley 345 kV switching station	Interconnection of 5RSC-2024-15 at May Valley 345 kV switching station. The new equipment includes: • (1) 345 kV dead-end structure • (2) 345 kV 3000 A SF6 circuit breakers • (4) 345 kV 3000 A disconnect switches • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$7.413
PSCo's May Valley 345 kV switching station	Install required communication in the EEE at the May Valley 345 kV switching station	$0.455
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$7.868**

5RSC-2024-21

The total estimated cost of the required upgrades for 5RSC-2024-21 to interconnect at a new 345 kV switching station on the May Valley – Sandstone 345 kV transmission line is $33.071 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.348 million (Table 121)**
- **The cost of Station Network Upgrades is $29.723 million (Table 122)**
- **The cost of System Network Upgrades is $0 million**

Figure 11 in Appendix J provides a conceptual one-line of the new 345 kV switching station on the May Valley – Sandstone 345 kV transmission line for the interconnection of 5RSC-2024-21.

The list of improvements required to accommodate the interconnection of 5RSC-2024-21 is provided in Table 121 and Table 122. System improvements are subject to revision as a more detailed and refined design is produced.

Table 121: 5RSC-2024-21 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's New 5RSC-2024-21 345 kV switching station	Interconnection of 5RSC-2024-21 at the new 345 kV switching station on the May Valley – Sandstone 345 kV transmission line. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000A disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying, and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Dead-end structure, single span, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$3.348
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.348**

Table 122: 5RSC-2024-21 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's New 5RSC-2024-21 345 kV switching station	Install new 345 kV switching station on the May Valley – Sandstone 345 kV transmission line. The new equipment includes: • (3) 345 kV dead-end structures • (3) 345 kV 3000A circuit breakers • (8) 345 kV 3000A disconnect switches • (6) 345 kV CCVTs • (2) 345 kV SSVTs • (6) 345 kV Surge Arresters • (1) Electrical Equipment Enclosure (EEE) • Site grading and fencing • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$24.191
PSCo's New 5RSC-2024-21 345 kV switching station	Install required communication in the EEE at the new 345 kV switching station	$0.872
PSCo's May Valley 345 kV switching station	Remote end upgrade at May Valley 345 kV switching station, removal of wave traps and Line tuners and update to line protection	$0.557
PSCo's Sandstone 345 kV switching station	Remote end upgrade at Sandstone 345 kV switching station, removal of wave traps and Line tuners and update to line protection	$0.555
PSCo's circuit 7273	Circuit 7273 - Removal of 1 OPGW and (3) tangent structure arms	$0.039
PSCo's circuit 7411	Circuit 741 - Removal of hardware, insulators, and conductor and adding (2) single-pole dead-end structures for conductor and OPGW into new Colt Creek 345 kV Switching Station	$1.637
PSCo's new circuit	New circuit - Work on the new circuit out of the new Colt Creek 345 kV Switching Station adding (2) single-pole dead-end structures, conductor, and OPGW	$1.615
PSCo's New 5RSC-2024-21 345 kV switching station	Siting and Land Rights land acquisition and permitting, no land purchase costs included	$0.257
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$29.723**

5RSC-2024-27

The total estimated cost of the required upgrades for 5RSC-2024-27 to interconnect at the Canal Crossing 345 kV switching station is $7.653 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.585 million (Table 123)**
- **The cost of Station Network Upgrades is $4.068 million (Table 124)**
- **The cost of System Network Upgrades is $0 million**

Figure 12 in Appendix J provides a conceptual one-line of the Canal Crossing 345 kV switching station for the interconnection of 5RSC-2024-27.

The list of improvements required to accommodate the interconnection of 5RSC-2024-27 is provided in Table 123 and Table 124. System improvements are subject to revision as a more detailed and refined design is produced.

Table 123: 5RSC-2024-27 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Canal Crossing 345 kV switching station	Interconnection of 5RSC-2024-27 at the Canal Crossing 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Dead-end structure, single span, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$3.585
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.585**

Table 124: 5RSC-2024-27 Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Canal Crossing 345 kV switching station	Interconnection of 5RSC-2024-27 at Canal Crossing 345 kV switching station. The new equipment includes: • (1) 345 kV dead-end structure • (1) 345 kV 3000 A SF6 circuit breakers • (2) 345 kV 3000 A disconnect switches • Permitting • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$3.372
PSCo's Canal Crossing 345 kV switching station	Install required communication in the EEE at the Canal Crossing 345 kV switching station	$0.696
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$4.068**

GOOSE CREEK SWITCHING STATION NETWORK UPGRADE COSTS

Four GIRs (5RSC-2024-10, 5RSC-2024-16, 5RSC-2024-17, and 5RSC-2024-28) interconnect at the Goose Creek 345 kV switching station and will share the Station Network Upgrade costs. Table 125 presents the total Station Network Upgrade costs. Table 126 presents the allocation of Station Network Upgrade costs by GIR. Station Network Upgrades are allocated to each GIR connecting to that station on a per-capita basis per Section 4.2.4(a) of the LGIP.

Figure 13 in Appendix J provides a conceptual one-line of the Goose Creek 345 kV switching station.

Table 125: Goose Creek 345 kV Switching Station Network Upgrades

Element	Description	Estimated Cost (million)
PSCo's Goose Creek 345 kV switching station	Station Network Upgrades at Goose Creek 345 kV switching station for 5RSC-2024-10, 5RSC-2024-16, 5RSC-2024-17, and 5RSC-2024-28. The new equipment includes: • (6) 345 kV dead-end structures • (6) 345 kV 3000A SF6 circuit breakers • (12) 345 kV 3000A disconnect switches • Yard expansion including grading, ground grid, surfacing and fencing • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures	**$26.131**
PSCo's Goose Creek 345 kV switching station	Install required communication in the EEE at the Goose Creek 345 kV switching station	**$2.009**
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$28.140**

Table 126: Allocation of Station Network Upgrade Costs by GIR at Goose Creek 345 kV Switching Station

GIR	% Share	Estimated Cost (million)
5RSC-2024-10	25.0%	**$7.035**
5RSC-2024-16	25.0%	**$7.035**
5RSC-2024-17	25.0%	**$7.035**
5RSC-2024-28	25.0%	**$7.035**

5RSC-2024-10

The total estimated cost of the required upgrades for 5RSC-2024-10 to interconnect at the Goose Creek 345 kV switching station is $11.161 million.

- **The cost of Transmission Provider's Interconnection Facilities is $4.126 million (Table 127)**
- **The cost of Station Network Upgrades is $7.035 million (Table 126)**
- **The cost of System Network Upgrades is $0 million**

Figure 13 in Appendix J provides a conceptual one-line of the Goose Creek 345 kV switching station for the interconnection of 5RSC-2024-10.

The list of improvements required to accommodate the interconnection of 5RSC-2024-10 is provided in Table 125 and Table 127. System improvements are subject to revision as a more detailed and refined design is produced.

Table 127: 5RSC-2024-10 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Goose Creek 345 kV switching station	Interconnection of 5RSC-2024-10 at the Goose Creek 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$4.126
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$4.126**

5RSC-2024-16

The total estimated cost of the required upgrades for 5RSC-2024-16 to interconnect at the Goose Creek 345 kV switching station is $12.065 million.

- **The cost of Transmission Provider's Interconnection Facilities is $5.030 million (Table 128)**
- **The cost of Station Network Upgrades is $7.035 million (Table 126)**
- **The cost of System Network Upgrades is $0 million**

Figure 13 in Appendix J provides a conceptual one-line of the Goose Creek 345 kV switching station for the interconnection of 5RSC-2024-16.

The list of improvements required to accommodate the interconnection of 5RSC-2024-16 is provided in Table 125 and Table 128. System improvements are subject to revision as a more detailed and refined design is produced.

Table 128: 5RSC-2024-16 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Goose Creek 345 kV switching station	Interconnection of 5RSC-2024-16 at the Goose Creek 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Dead-end structure, single span, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$5.030
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$5.030**

5RSC-2024-17

The total estimated cost of the required upgrades for 5RSC-2024-17 to interconnect at the Goose Creek 345 kV switching station is $10.674 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.639 million (Table 129)**
- **The cost of Station Network Upgrades is $7.035 million (Table 126)**
- **The cost of System Network Upgrades is $0 million**

Figure 13 in Appendix J provides a conceptual one-line of the Goose Creek 345 kV switching station for the interconnection of 5RSC-2024-17.

The list of improvements required to accommodate the interconnection of 5RSC-2024-17 is provided in Table 125 and Table 129. System improvements are subject to revision as a more detailed and refined design is produced.

Table 129: 5RSC-2024-17 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Goose Creek 345 kV switching station	Interconnection of 5RSC-2024-17 at the Goose Creek 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (3) 345 kV 1-phase CTs for metering • (3) 345 kV 1-phase CCVTs • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$3.639
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.639**

5RSC-2024-28

The total estimated cost of the required upgrades for 5RSC-2024-28 to interconnect at the Goose Creek 345 kV switching station is $12.296 million.

- **The cost of Transmission Provider's Interconnection Facilities is $5.261 million (Table 130)**
- **The cost of Station Network Upgrades is $7.035 million (Table 126)**
- **The cost of System Network Upgrades is $0 million**

Figure 13 in Appendix J provides a conceptual one-line of the Goose Creek 345 kV switching station for the interconnection of 5RSC-2024-28.

The list of improvements required to accommodate the interconnection of 5RSC-2024-28 is provided in Table 125 and Table 130. System improvements are subject to revision as a more detailed and refined design is produced.

Table 130: 5RSC-2024-28 Transmission Provider's Interconnection Facilities

Element	Description	Estimated Cost (million)
PSCo's Goose Creek 345 kV switching station	Interconnection of 5RSC-2024-28 at the Goose Creek 345 kV switching station. The new equipment includes: • (1) 345 kV single bay dead-end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000A line disconnect switch • (3) 345 kV 1-phase CT/PT for metering • Dual fiber communication equipment • Associated electrical equipment, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing • Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead-end structure, 3 conductors, insulators, hardware, jumpers and labor • Testing and commissioning	$5.261
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$5.261**

APPENDIX J – PRELIMINARY ONE-LINE DIAGRAMS

5RSC-2024-01

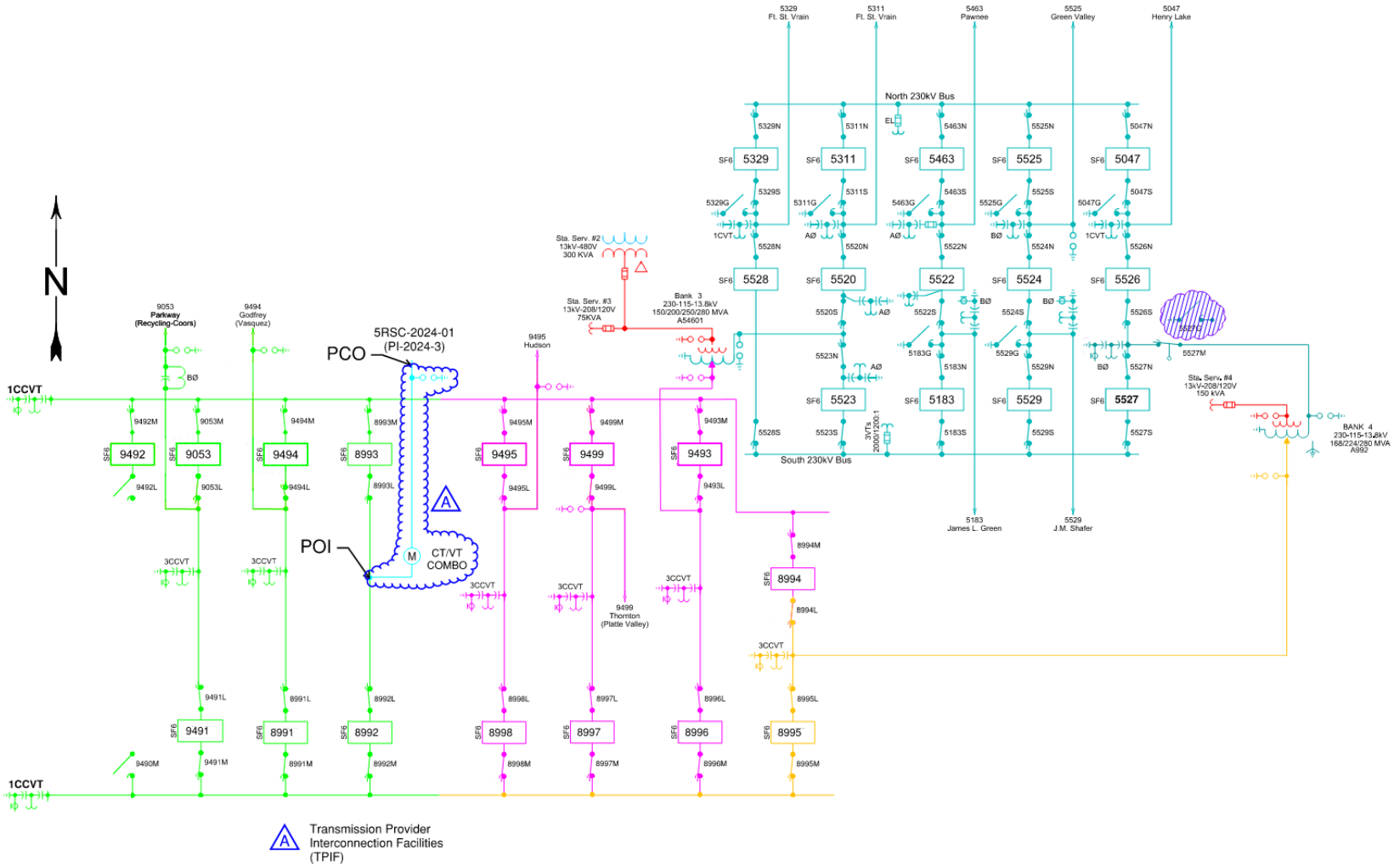

Figure 2: 5RSC-2024-01 One-Line Diagram

5RSC-2024-02

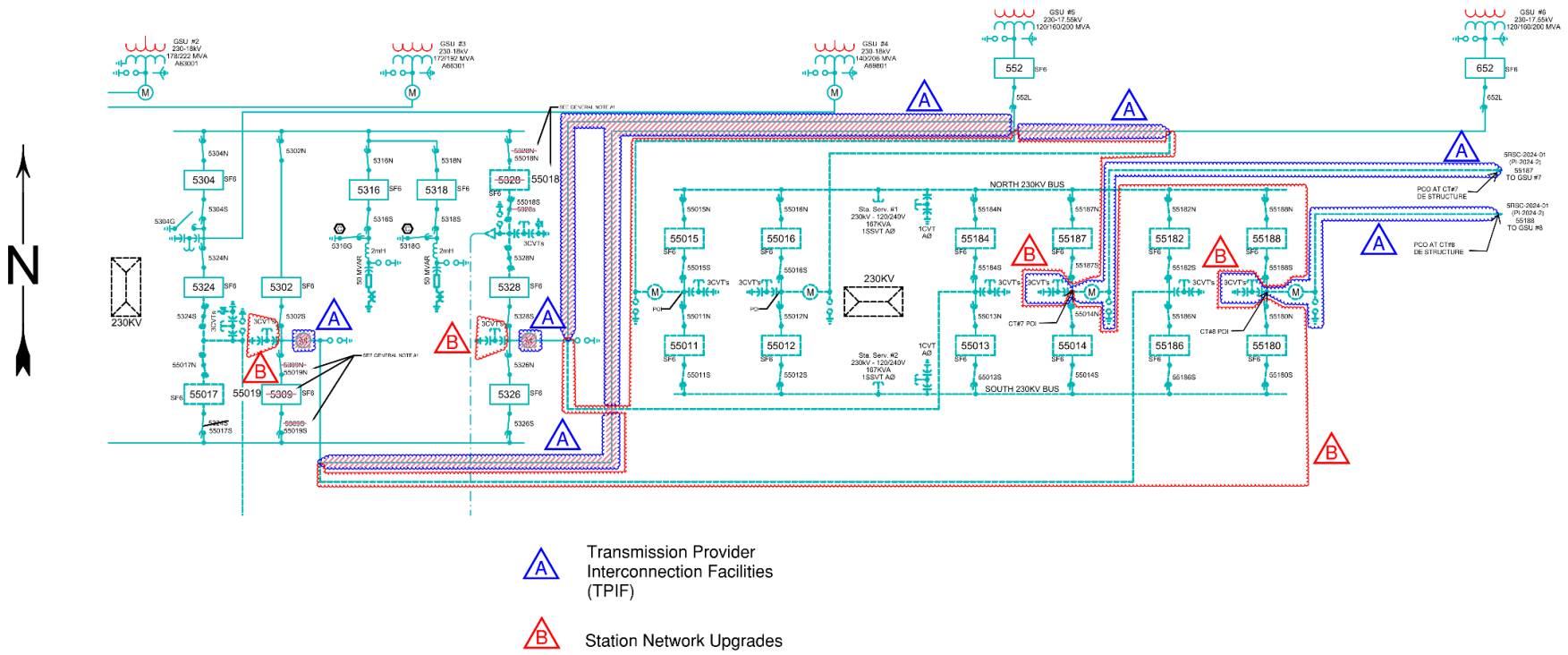

Figure 3: 5RSC-2024-02 One-Line Diagram

5RSC-2024-04

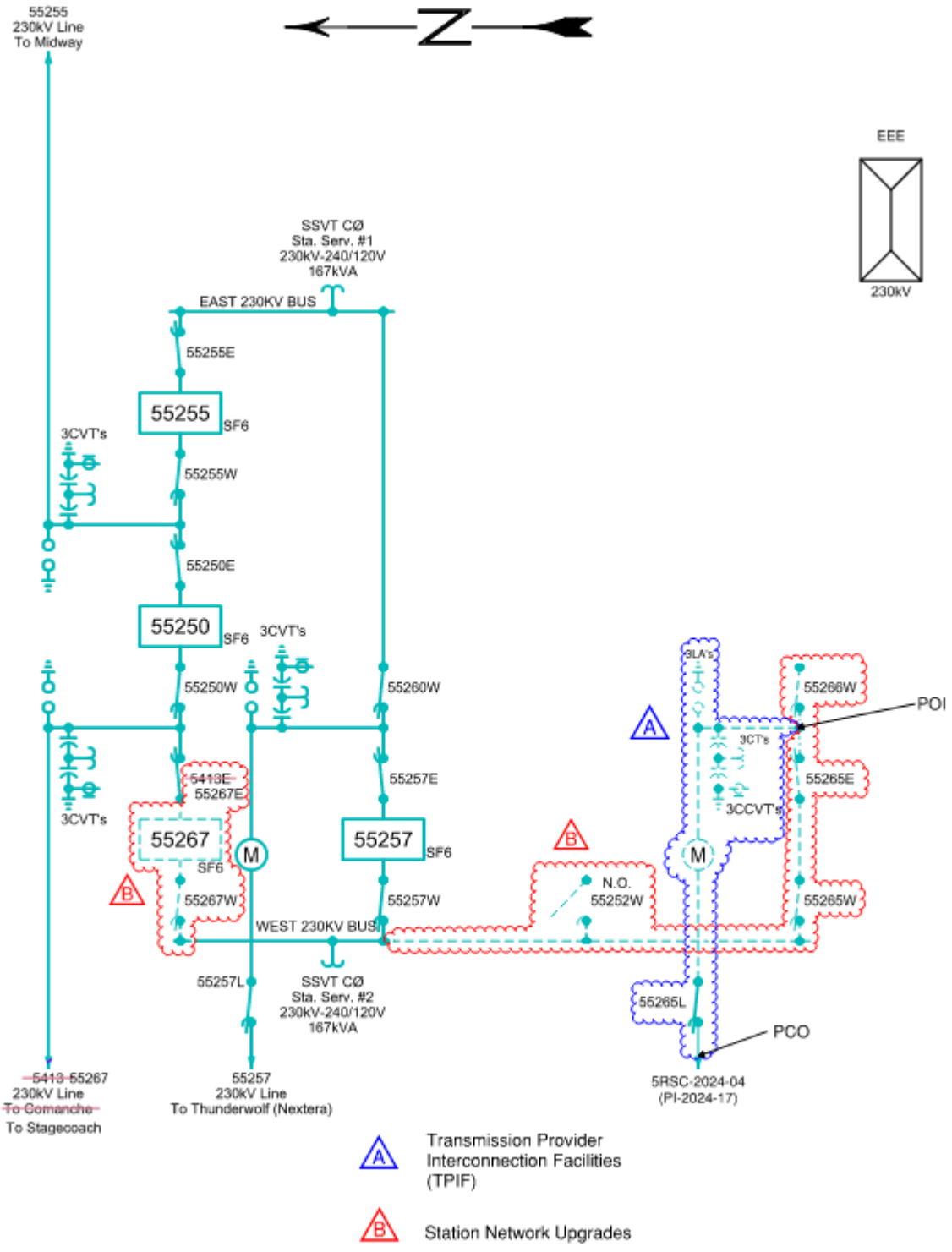

Figure 4: 5RSC-2024-04 One-Line Diagram

5RSC-2024-06

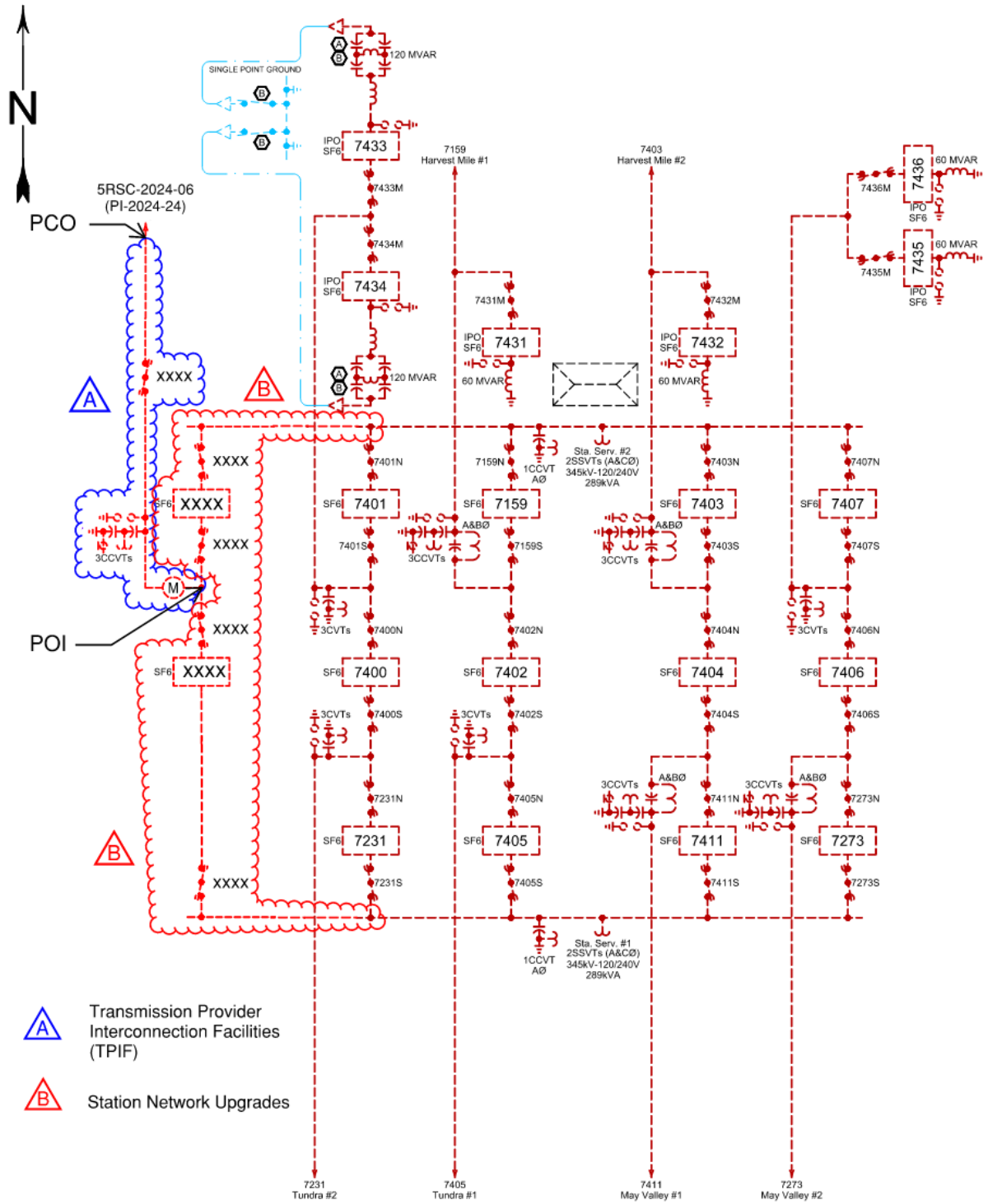

Figure 5: 5RSC-2024-06 One-Line Diagram

5RSC-2024-09

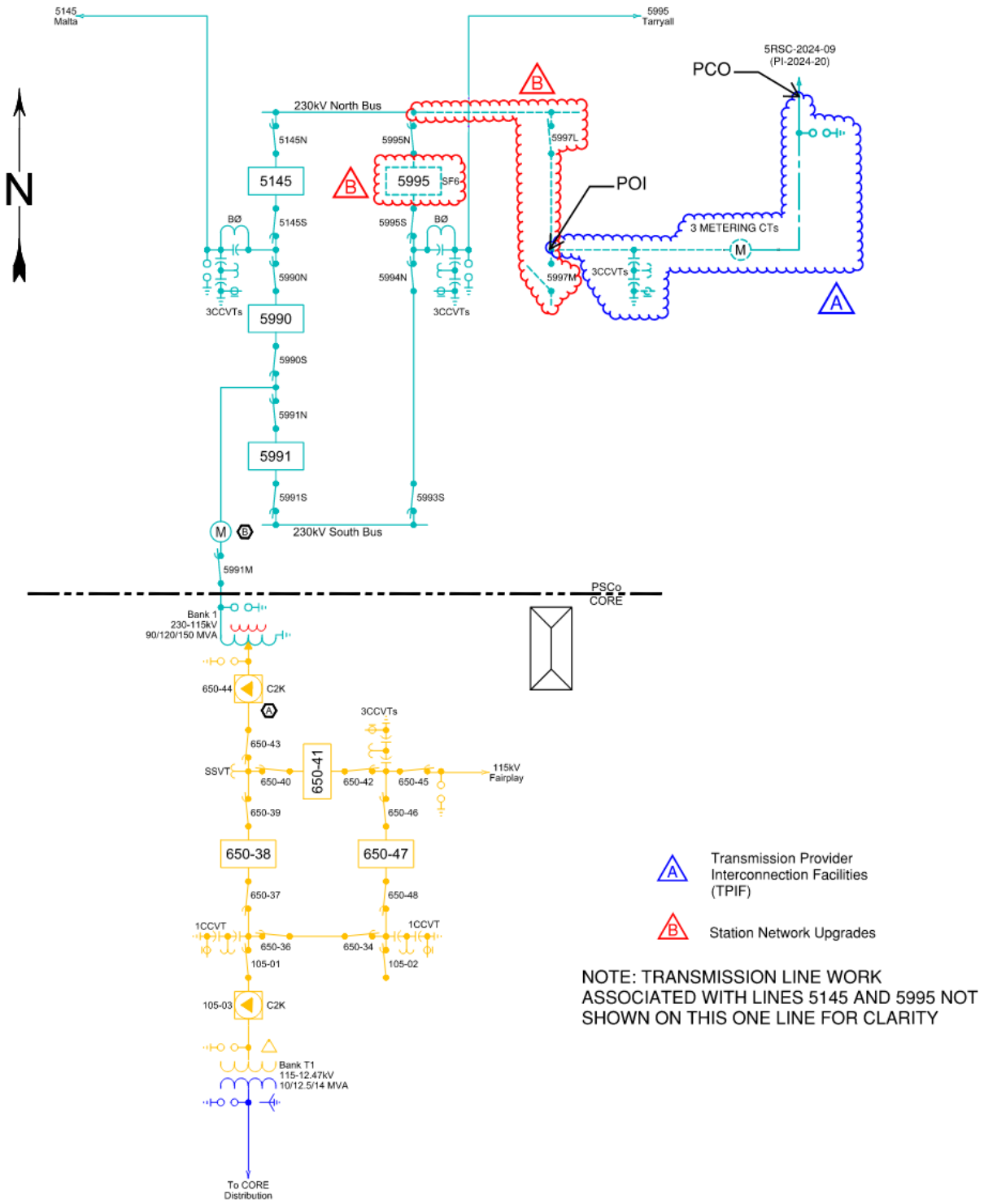

Figure 6: 5RSC-2024-09 One-Line Diagram

5RSC-2024-11

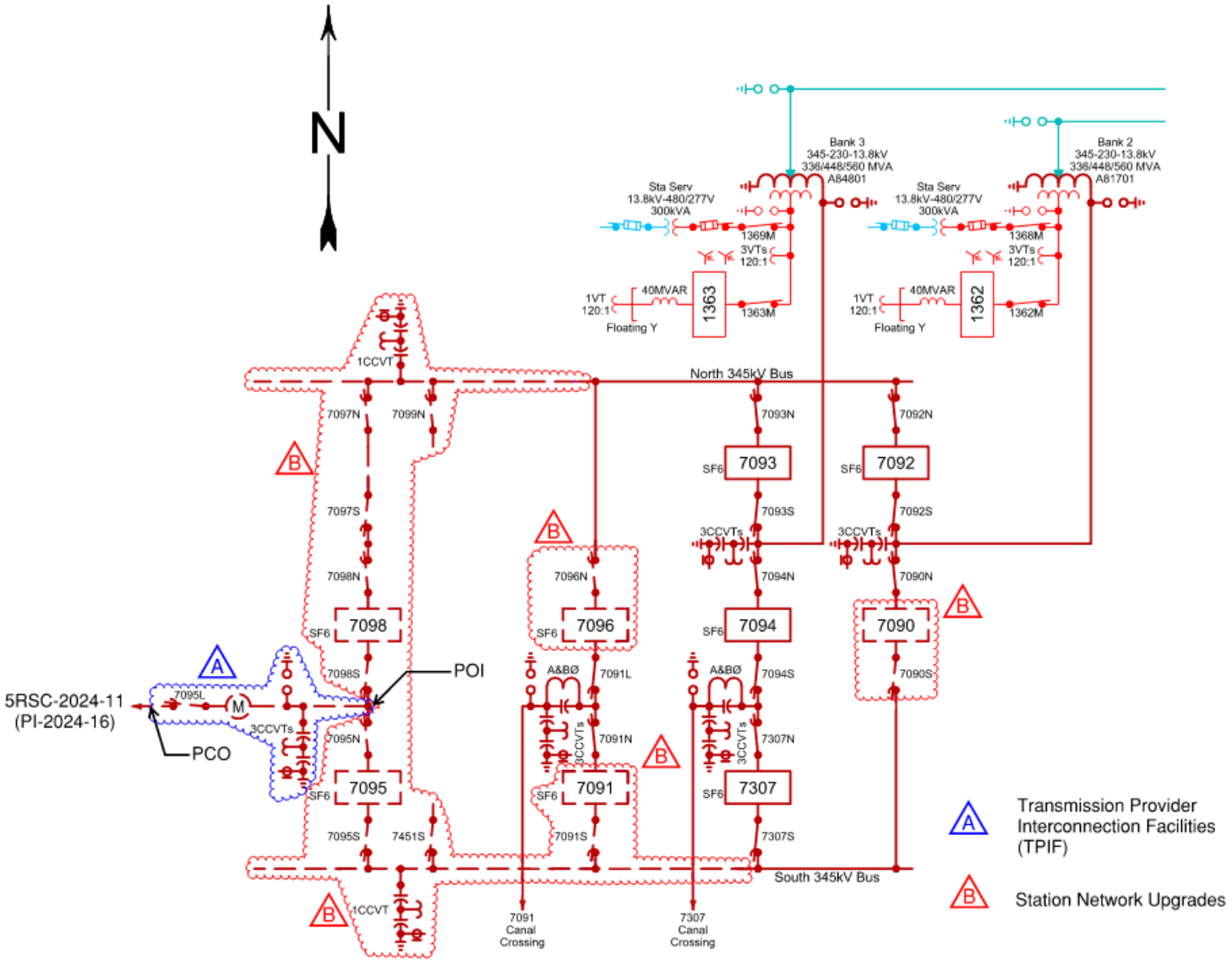

Figure 7: 5RSC-2024-11 One-Line Diagram

5RSC-2024-12

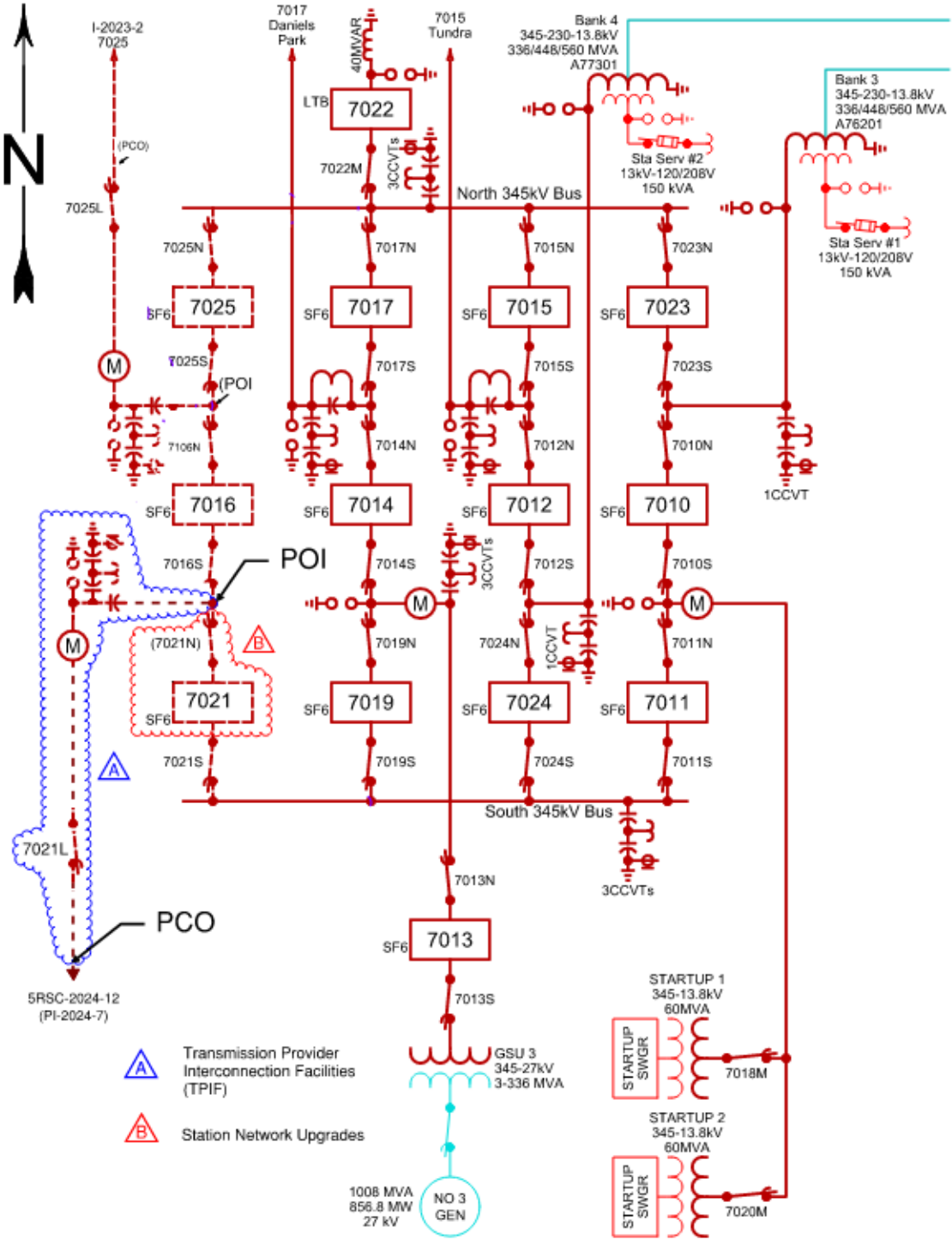

Figure 8: 5RSC-2024-12 One-Line Diagram

5RSC-2024-13

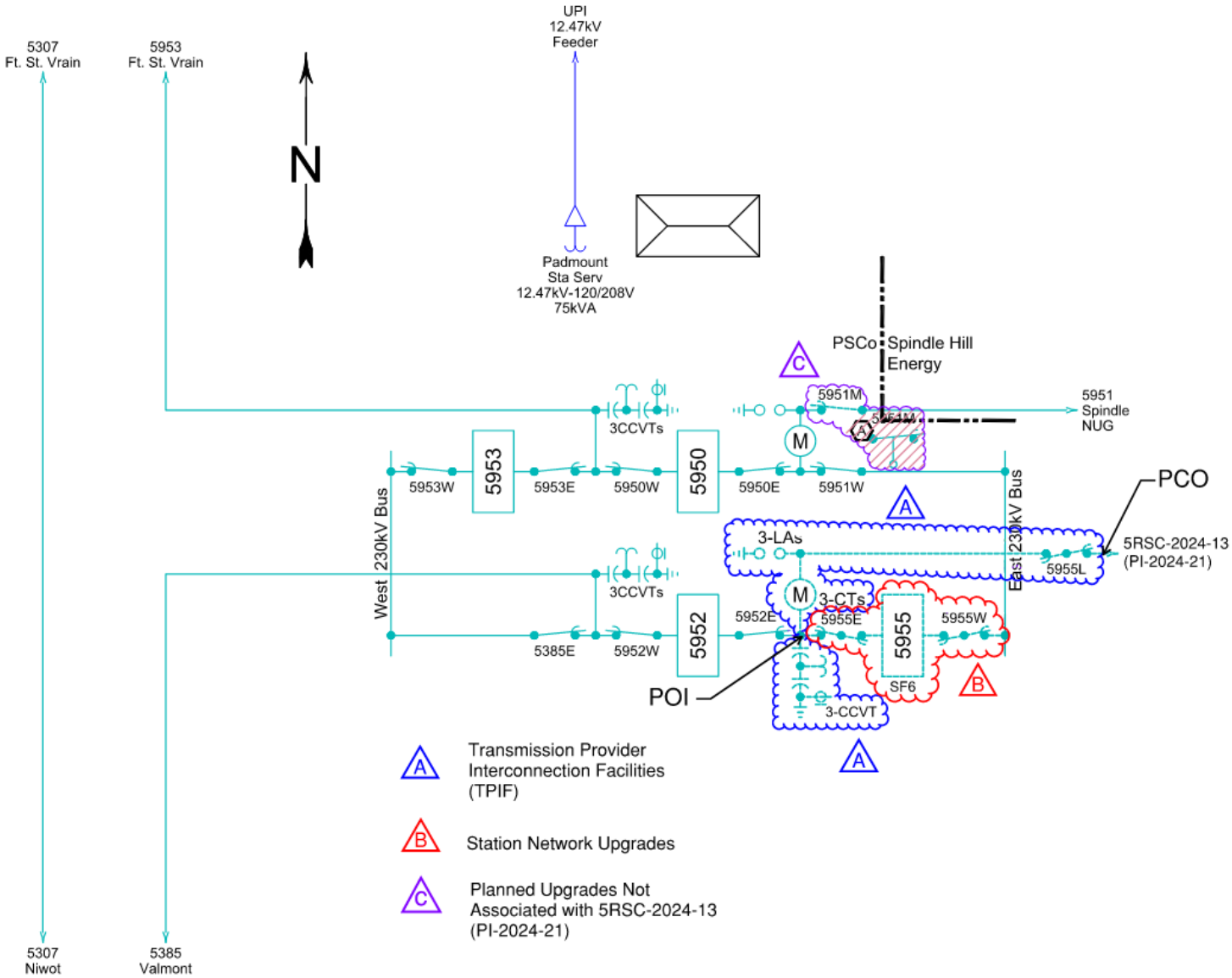

Figure 9: 5RSC-2024-13 One-Line Diagram

5RSC-2024-15

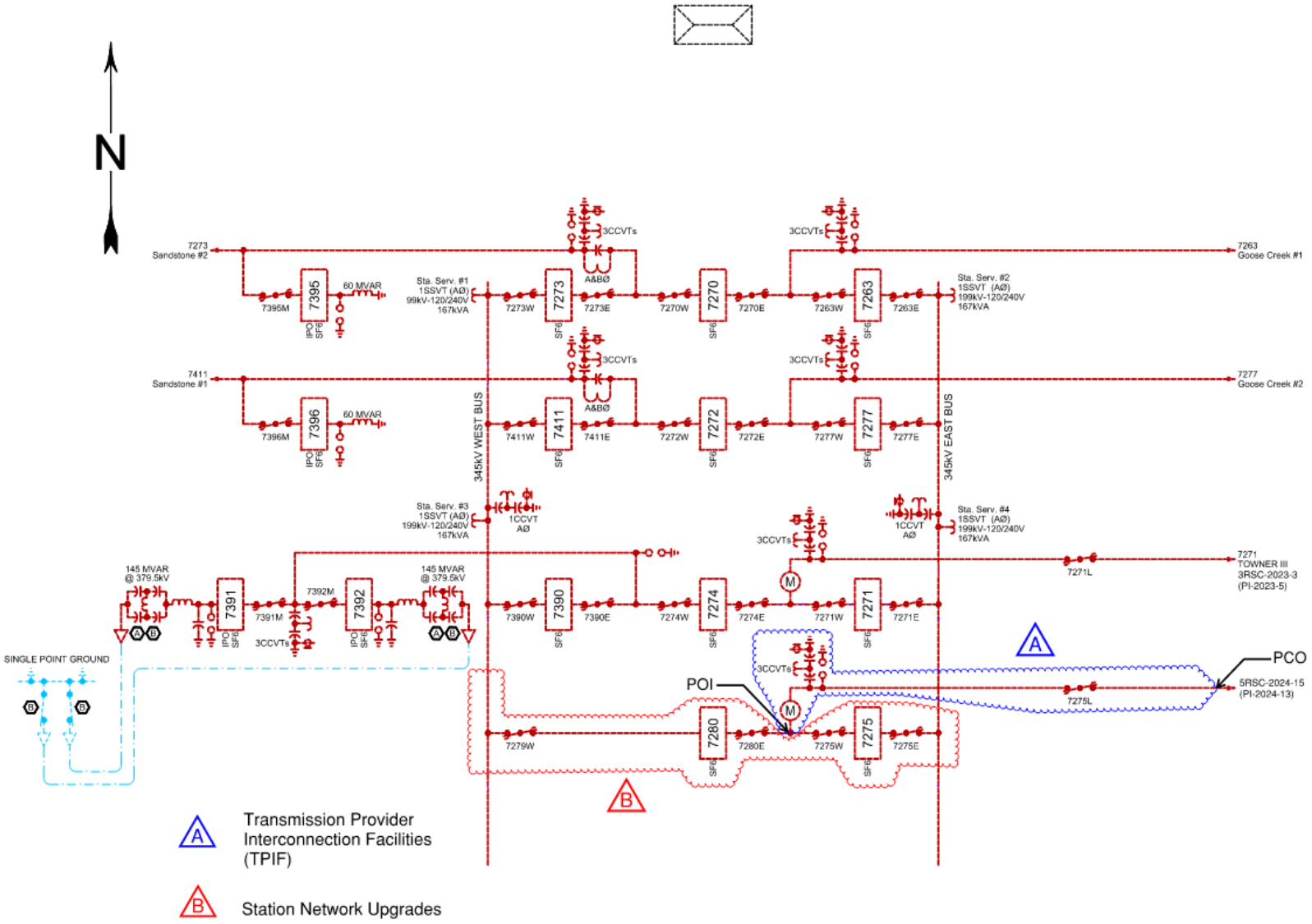

Figure 10: 5RSC-2024-15 One-Line Diagram

5RSC-2024-21

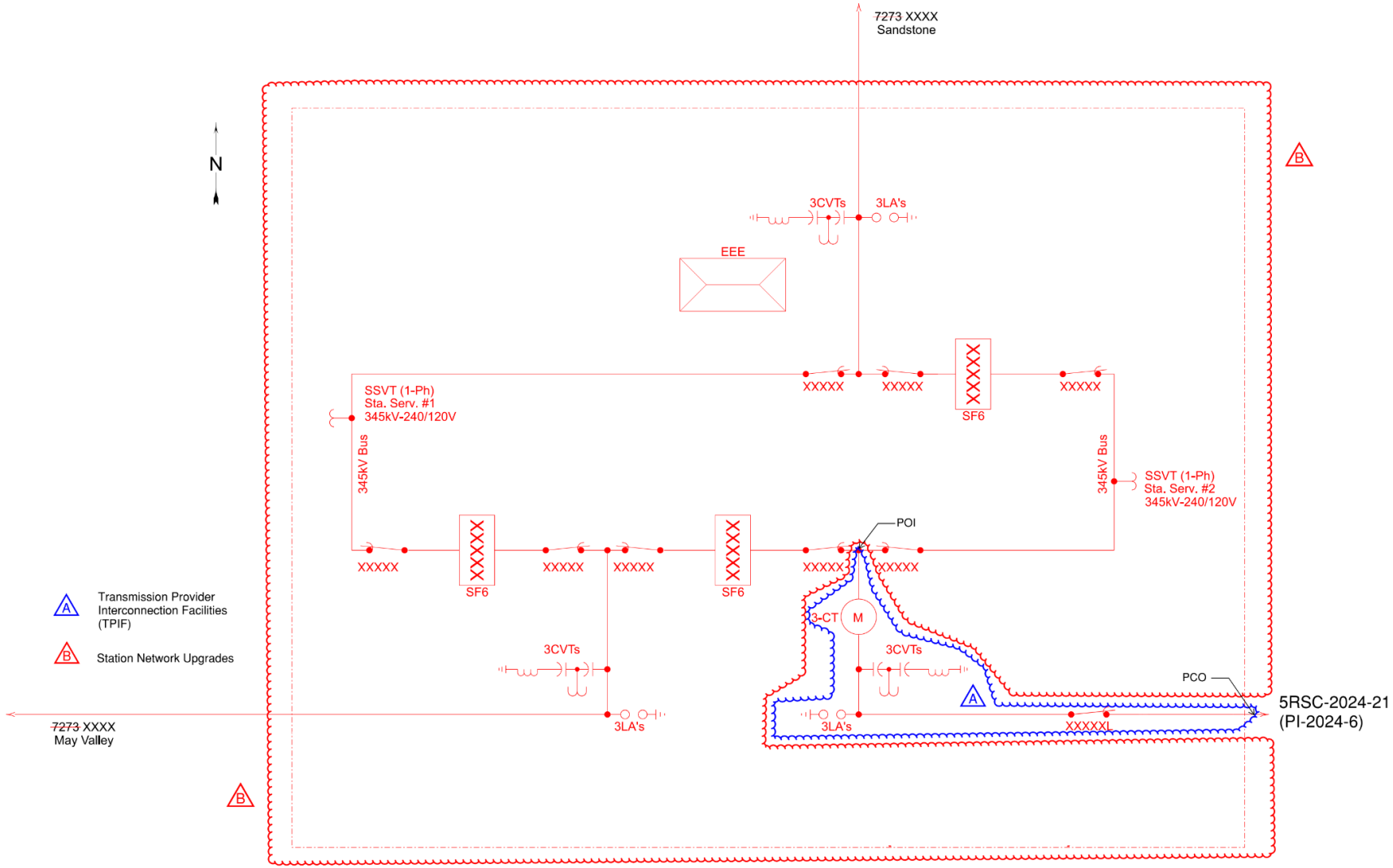

Figure 11: 5RSC-2024-21 One-Line Diagram

5RSC-2024-27

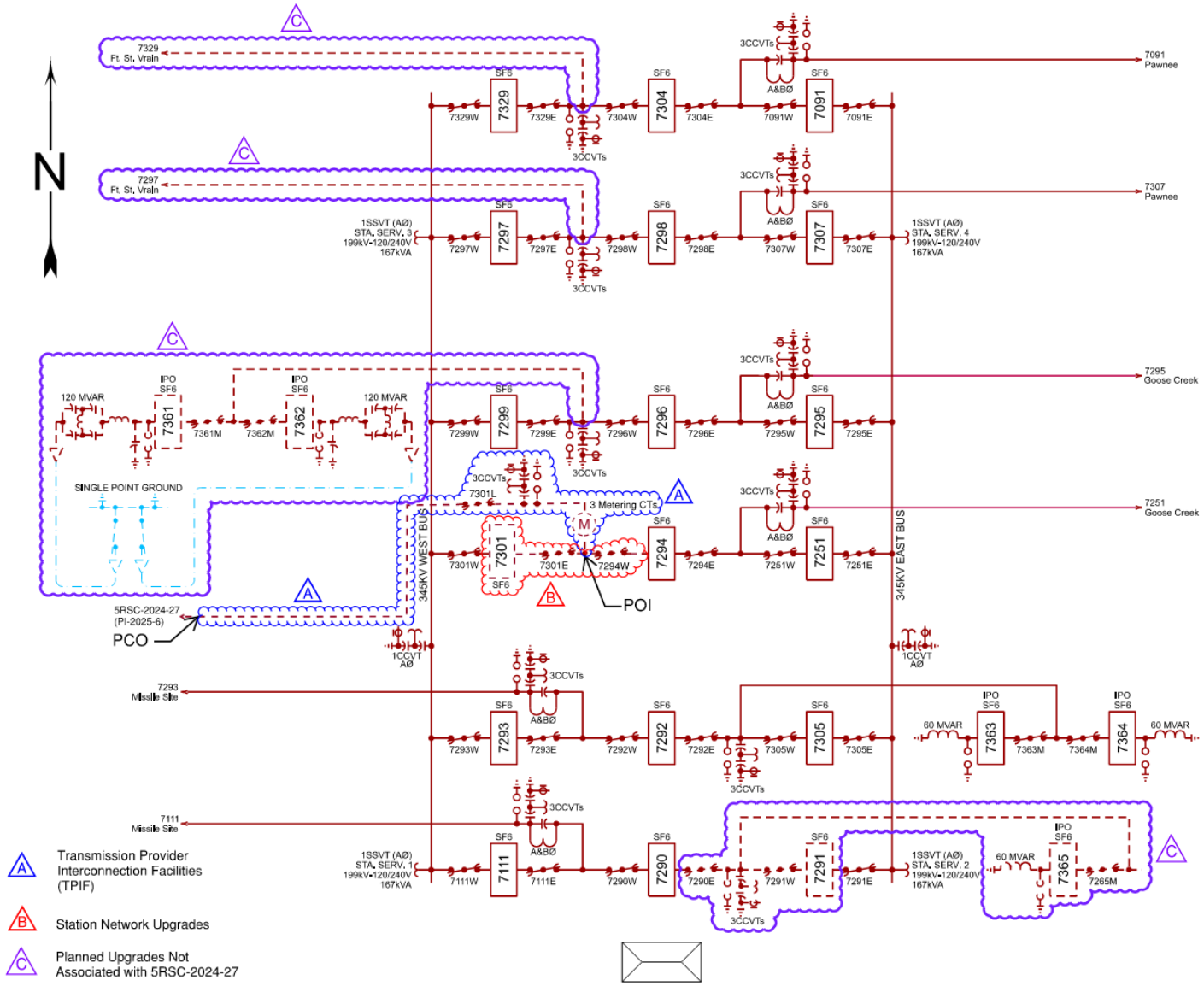

Figure 12: 5RSC-2024-27 One-Line Diagram

GOOSE CREEK INTERCONNECTIONS

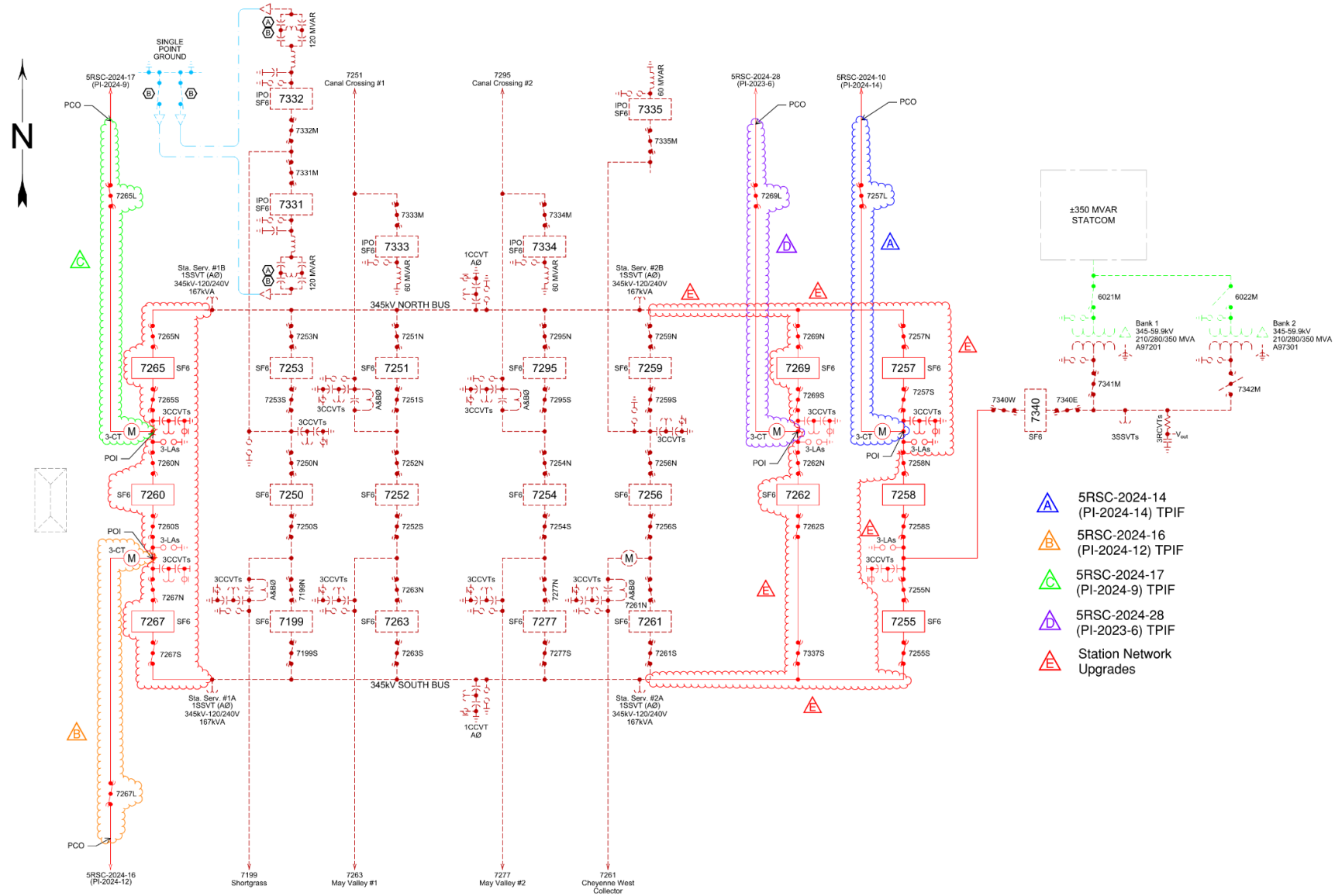

Figure 13: Goose Creek 345 kV Switching Station Preliminary One-Line Diagram

APPENDIX K – CONTINGENT FACILITY ANALYSIS

The list of facilities tested during the contingent facility analysis for the 2027 Metro, 2027 North and 2027 East Cases is presented in Table 131.

Table 131: List of Facilities Tested in 2027 HS Cases

Ref. No.	Description
1	Uprate Cherokee South - North 115 kV to 398 MVA
2	Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
3	Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
4	Uprate Leetsdale Transformer T5 to 448 MVA
5	Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
6	Uprate Sargent Transformer T1 to 112 MVA
7	Upgrade Smoky Hill - Harvest Mile 230 kV to 1195 MVA
8	Addition of Fort Saint Vrain Transformer T1
9	Addition of Comanche Transformer T5
10	Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
11	Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
12	Uprate Valmont Transformer T7 to 448 MVA
13	Uprate Valmont Transformer T8 to 448 MVA
14	Uprate Missile Site - Pronghorn to 1793 MVA
15	Uprate California - Cherokee S to 398 MVA
16	Uprate Clark - Jordan to 1195 MVA
17	Uprate Denver Terminal bus-tie breaker to 398 MVA
18	Uprate Poncha E - Sargent to 248.9 MVA
19	Addition of Malta Third Transformer
20	Addition of 30 Mvar Capacitor Bank at San Luis Valley
21	Addition of 100 Mvar reactor at Beaver Creek P
22	Greenwood to Monaco series reactor
23	Addition of 45 Mvar Reactor at Cedar Point
24	Addition of two Synchronous Condensers at May Valley
25	Addition of a STATCOM at Goose Creek

The list of facilities tested during the contingent facility analysis for the 2028 Western Slope Case is presented in Table 132.

Table 132: List of Facilities Tested in the 2028 HS Case

Ref. No.	Description
1	Uprate Cherokee South - North 115 kV to 398 MVA
2	Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
3	Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
4	Uprate Leetsdale Transformer T5 to 448 MVA
5	Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
6	Upgrade Sargent Transformer T1 to 112 MVA
7	Uprate Smoky Hill - Harvest Mile 230 kV to 1195 MVA
8	Addition of Fort Saint Vrain Transformer T1
9	Addition of Comanche Transformer T5
10	Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
11	Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
12	Upgrade Valmont Transformer T7 to 448 MVA
13	Upgrade Valmont Transformer T8 to 448 MVA
14	Uprate Missile Site - Pronghorn to 1793 MVA
15	Uprate Clark - Jordan to 1195 MVA
16	Uprate Denver Terminal bus-tie breaker to 398 MVA
17	Uprate Poncha E - Sargent to 248.9 MVA
18	Addition of Malta Third Transformer
19	Addition of 30 Mvar Capacitor Bank at San Luis Valley
20	Addition of 100 Mvar reactor at Beaver Creek P
21	Addition of Greenwood to Monaco Series Reactor
22	Addition of 45 Mvar Reactor at Cedar Point
23	Uprate Argo - Cherokee South 115 kV to 398 MVA
24	Uprate Leetsdale 1 - University to 398 MVA
25	Upgrade Denver Terminal Transformer T2 to 448 MVA
26	Uprate Havana - Chambers two circuits to 318 MVA
27	Uprate Mapleton 2 - Sub A to 398 MVA
28	Uprate Cherokee S - Sub A to 398 MVA
29	Uprate Sub A - California to 398 MVA
30	Addition of two Synchronous Condensers at May Valley
31	Addition of a STATCOM at Goose Creek
32	Addition of Synchronous Condenser at Waterton
33	Addition of Synchronous Condenser at Daniels Park

The list of facilities tested during the contingent facility analysis for the 2029 South Case is presented in Table 133.

Table 133: List of Facilities Tested in the 2029 HS Case

Ref. No.	Description
1	Uprate Cherokee South - North 115 kV to 398 MVA
2	Uprate Denver Terminal - Gray Street 115 kV to 398 MVA
3	Uprate Gray Street - Lakewood 2 115 kV to 398 MVA
4	Uprate Leetsdale Transformer T5 to 448 MVA
5	Uprate Ralston 2 - Ridge 1 115kV to 398 MVA
6	Upgrade Sargent Transformer T1 to 112 MVA
7	Uprate Smoky Hill - Harvest Mile 230 kV to 1195 MVA
8	Addition of Fort Saint Vrain Transformer T1
9	Addition of Comanche Transformer T5
10	Uprate Boulder Canyon bus-tie breaker CKT 2 to 398 MVA
11	Uprate Boulder Canyon 1 - Boulder Hydro to 398 MVA
12	Upgrade Valmont Transformer T7 to 448 MVA
13	Upgrade Valmont Transformer T8 to 448 MVA
14	Uprate Missile Site - Pronghorn to 1793 MVA
15	Uprate Clark - Jordan to 1195 MVA
16	Uprate Denver Terminal bus-tie breaker to 398 MVA
17	Uprate Poncha E - Sargent to 248.9 MVA
18	Addition of Malta Third Transformer
19	Addition of 30 Mvar Capacitor Bank at San Luis Valley
20	Addition of 100 Mvar reactor at Beaver Creek P
21	Addition of Greenwood to Monaco Series Reactor
22	Addition of 45 Mvar Reactor at Cedar Point
23	Uprate Argo - Cherokee South 115 kV to 398 MVA
24	Uprate Leetsdale 1 - University to 398 MVA
25	Upgrade Denver Terminal Transformer T2 to 448 MVA
26	Uprate Havana - Chambers two circuits to 318 MVA
27	Uprate Mapleton 2 - Sub A to 398 MVA
28	Uprate Cherokee S - Sub A to 398 MVA
29	Uprate Cherokee S - California to 398 MVA
30	Addition of 50 Mvar Capacitor Bank at Tarryall
31	Uprate Comanche - Stagecoach (GI-2020-10) 230 kV to 1195 MVA
32	Uprate Deer Creek - Soda Lakes to 398 MVA
33	Uprate Littleton - Waterton to 398 MVA
34	Uprate Midway - Mirasol 230 kV to 796 MVA
35	Uprate Palmer Lake - Fox Run to 398 MVA
36	Upgrade two transformers at New Sandown to 448 MVA

Ref. No.	Description
37	Addition of two Synchronous Condensers at May Valley
38	Addition of a STATCOM at Goose Creek
39	Addition of Synchronous Condenser at Waterton
40	Addition of Synchronous Condenser at Daniels Park

Below are the results for each study pocket summarized in tables for each of the facilities that were found to be contingent in this analysis.

2027 METRO CONTINGENT FACILITIES

The facilities listed in Table 131 were tested for the 2027 Metro Case. No contingent facility was identified during the analysis of this study pocket in either Portfolio 1 or Portfolio 2.

2027 NORTH CONTINGENT FACILITIES

The facilities listed in Table 131 were tested for the 2027 North Case. The following facilities were found to be contingent for the Discharging scenario of both Portfolios 1 and 2:

- Uprate Valmont Transformer T7 to 448 MVA was found to be a contingent facility for unit 5RSC-2024-13. Results are shown in Table 134.
- Uprate Valmont Transformer T8 to 448 MVA was found to be a contingent facility for unit 5RSC-2024-13. Results are shown in Table 135.

The following facilities were found to be contingent for the Grid Charging scenario of both Portfolios 1 and 2:

- Addition of 100 MVAr reactor at Beaver Creek P was found to be a contingent facility for unit 5RSC-2024-13. Results are shown in Table 136.
- Addition of Greenwood to Monaco series reactor was found to be a contingent facility for unit 5RSC-2024-13. Results are shown in Table 137.

Table 134: Uprating Valmont Transformer T7 to 448 MVA in the 2027 HS North Case

Overloaded Facility	Area	Upgraded Facility Rating (MVA)	Non-Upgraded Facility Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-13 DFAX
				MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Valmont (70440/70447) 115/230 kV Transformer T7	70	448	280	310.0	69.2	310.0	110.7	41.5	Valmont (70444/70447) 115/230 kV Transformer T8	0.10402

Table 135: Uprating Valmont Transformer T8 to 448 MVA in the 2027 HS North Case

Overloaded Facility	Area	Upgraded Facility Rating (MVA)	Non-Upgraded Facility Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-13 DFAX
				MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Valmont (70440/70447) 115/230 kV Transformer T8	70	448	280	310.0	69.2	310.0	110.7	41.5	Valmont (70444/70447) 115/230 kV Transformer T7	0.104

Table 136: Adding of 100 MVAr reactor at Beaver Creek P in the 2027 HS North Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-13 DFAX
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Spindle (70592) - PI-2024-10 (700052) 230 kV CKT 1	70	304.8	335.9	109.1	332.6	110.2	1.1	Broomfield (70065) - Valmont 1 (70444) 115 kV CKT 1	1.000

Table 137: Adding Greenwood to Monaco series reactor in the 2027 HS North Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-13 DFAX
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Greenwood 1 (70212) - Greenwood 2 (70189) 230 kV CKT 1	70	484	499.3	103.1	581.4	120.1	17.0	Daniel Park (70139) - Prairie 3 (70323) 230 kV CKT 1	0.091

2027 EAST CONTINGENT FACILITIES

The facilities listed in Table 131 were tested for the 2027 East Case. The following facilities were found to be contingent for the Discharging scenario of both Portfolios 1 and 2:

- Addition of Fort St Vrain Transformer T1 was found to be a contingent facility for units 5RSC-2024-11 and 5RSC-2024-27. Results are shown in Table 138.
- Addition of Comanche Transformer T5 was found to be a contingent facility for units 5RSC-2024-10, 5RSC-2024-16, 5RSC-2024-17, and 5RSC-2024-28. Results are shown in Table 139.
- Uprating Missile Site to Pronghorn line to 1793 MVA was found to be a contingent facility for units 5RSC-2024-10, 5RSC-2024-16, 5RSC-2024-17, and 5RSC-2024-28. Results are shown in Table 140.

Table 138: Adding Fort St Vrain Transformer T1 in the 2027 HS East Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24 Units DFAX	
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			11	27
Ft St Vrain (70410/70916) 230/345 kV Transformer T7	70	560	715.0	127.7	1200.7	214.4	86.7	Ft St Vrain (70410/70916) 230/345 kV Transformer T8	0.088	0.100

Table 139: Adding Comanche Transformer T5 in the 2027 HS East Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24 Units DFAX			
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			10	16	17	28
Comanche (70122/70654) 230/345 kV Transformer T4	70	560	460.2	82.2	908.8	162.3	80.1	Comanche (70122/70654) 230/345 kV Transformer T3	0.057	0.057	0.057	0.057

Table 140: Uprating Missile Site to Pronghorn line to 1793 MVA in the 2027 HS East Case

Overloaded Facility	Area	Upgraded Facility Rating (MVA)	Non-Upgraded Facility Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24 Units DFAX			
				MVA Flow	Loading (%)	MVA Flow	Loading (%)			10	16	17	28
Missile Site (70624) - Pronghorn (70628) 345 kV CKT 1	70	1793	1449	1681.3	93.2	1681.3	115.3	22.1	Canal Crossing (70915) - PI-2024-19 (700192) 345 kV CKT 2	0.130	0.130	0.130	0.130

2028 WESTERN SLOPE CONTINGENT FACILITIES

The facilities listed in Table 132 were tested for the 2028 Western Slope Case. The following facility was found to be contingent for the Discharging scenario of both Portfolios 1 and 2:

- Addition of Greenwood to Monaco series reactor was found to be a contingent facility for unit 5RSC-2024-9. Results are shown in Table 141.

Table 141: Adding Greenwood to Monaco series reactor in the 2028 HS Western Slope Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-9 DFAX
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Daniel Park (70139) - Prairie 3 (70323) 230 kV CKT 1	70	478	642.2	134.4	679.2	142.1	7.7	Daniel Park (70139) - Prairie 1 (70331) 230 kV CKT 1	0.055

2029 SOUTH CONTINGENT FACILITIES

The facilities listed in Table 133 were tested for the 2029 South Case. The following facility was found to be contingent for the Discharging scenario of both Portfolios 1 and 2:

- Addition of Greenwood to Monaco series reactor was found to be a contingent facility for units 5RSC-2024-6, 5RSC-2024-12, 5RSC-2024-15, and 5RSC-2024-21. Results are shown in Table 142.
- Uprating Comanche to Stagecoach Tap 230 kV to 1195 MVA was found to be a contingent facility for unit 5RSC-2024-4. Results are shown in Table 143.
- Uprating Midway to Mirasol 230 kV to 796 MVA was found to be a contingent facility for unit 5RSC-2024-4. Results are shown in Table 144.
- Addition of Synchronous Condenser at Waterton 345 kV was found to be a contingent facility for unit 5RSC-2024-4. Results are shown in Table 145.
- Addition of Synchronous Condenser at Daniels Park 345 kV was found to be a contingent facility for units 5RSC-2024-4, 5RSC-2024-6, 5RSC-2024-12, and 5RSC-2024-21. Results are shown in Table 146.

Table 142: Adding Greenwood to Monaco series reactor in the 2029 HS South Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24 Units DFAX			
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			6	12	15	21
Daniel Park (70139/70601) 230/345 kV T3	70	560	572.0	102.1	581.6	103.9	1.7	Daniel Park (70139/70601) 230/345 kV T4	0.064	0.049	0.041	0.052

Table 143: Uprating Comanche to Stagecoach 230 kV to 1195 MVA in the 2029 HS South Case

Overloaded Facility	Area	Upgraded Facility Rating (MVA)	Non-Upgraded Facility Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-4 DFAX
				MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Comanche (70122) - Stagecoach (700139) 230 kV CKT 1	70	1195	478	533.9	44.7	533.9	111.7	67.0	Midway PSCo (70286) - Mirasol (70652) 230 kV CKT 1	1.000

Table 144: Uprating Midway to Mirasol 230 kV to 796 MVA in the 2029 HS South Case

Overloaded Facility	Area	Upgraded Facility Rating (MVA)	Non-Upgraded Facility Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-4 DFAX
				MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Midway PSCo (70286) - Mirasol (70652) 230 kV CKT 1	70	796	505	532.9	66.9	532.9	105.5	38.6	Comanche (70122) - Stagecoach Tap (700139) 230 kV CKT 1	1.000

Table 145: Addition of Synchronous Condenser at Waterton 345 kV in the 2029 HS South Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24-4 DFAX
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			
Fox Run (73414) - Flyhorse N2 (73738) 115 kV line CKT 1	73	142	203.2	143.1	205.7	144.9	1.8	Vollmert (72413) - Fuller (73481) 115kV line CKT 1	0.033

Table 146: Addition of Synchronous Condenser at Daniels Park 345 kV in the 2029 HS South Case

Overloaded Facility	Area	Facility Normal Rating (MVA)	Facility Loading in Study Case		Facility Loading in Study Case with Unbuilt Facility Reverted		Loading Change Due to Facility Reversion (%)	Single Contingency Definition	5RSC-24 Units DFAX			
			MVA Flow	Loading (%)	MVA Flow	Loading (%)			4	6	12	21
Daniels Park (70139) - Fuller (73477) 230 kV line CKT 1	70/73	478	548.6	114.8	553.6	115.8	1.1	Midway PSCo (70465) - Waterton (70466) 345kV line CKT 1	0.150	0.056	0.107	0.043

APPENDIX L – TRANSIENT STABILITY ANALYSIS PLOTS

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2027 METRO PORTFOLIO 1 – TRANSIENT STABILITY PLOTS

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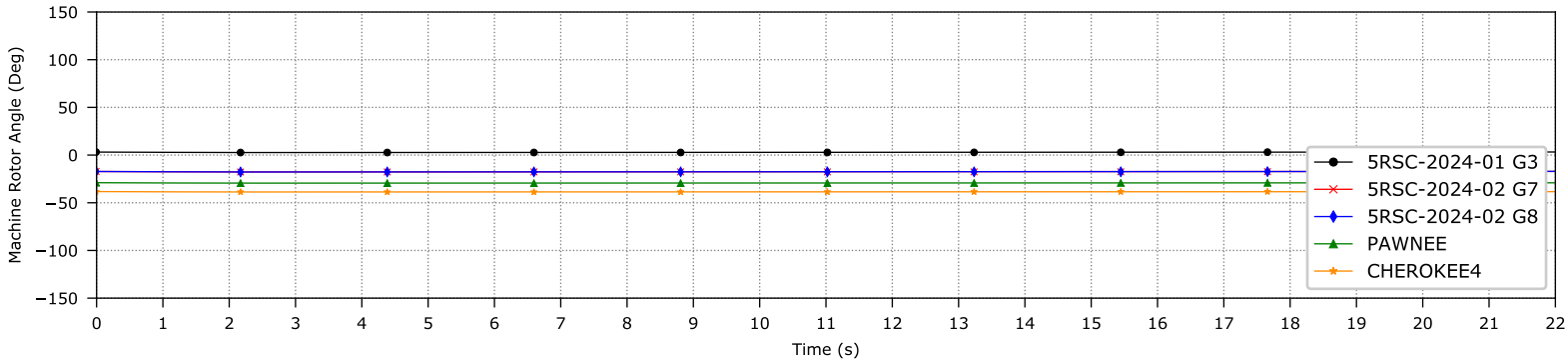

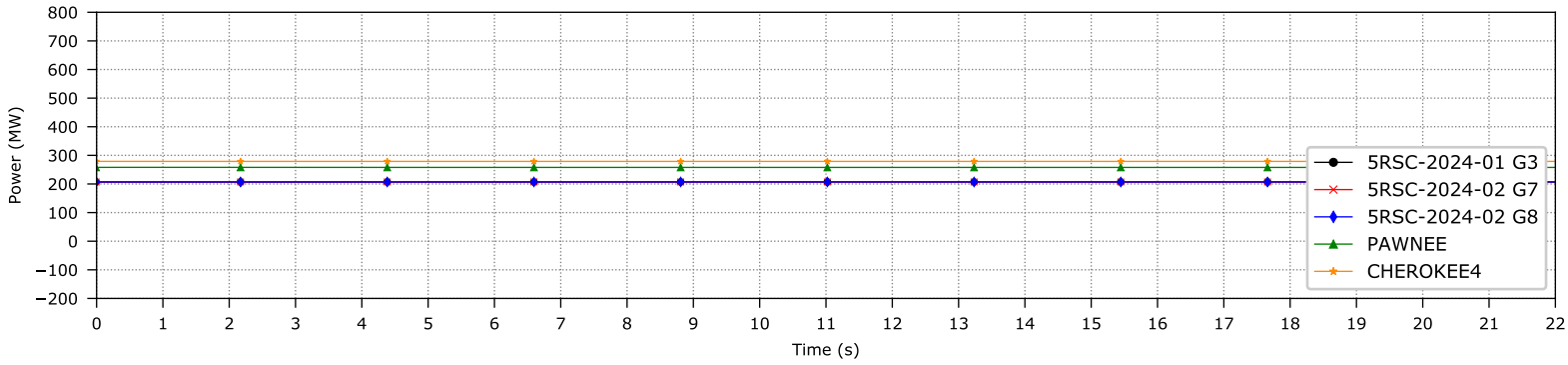

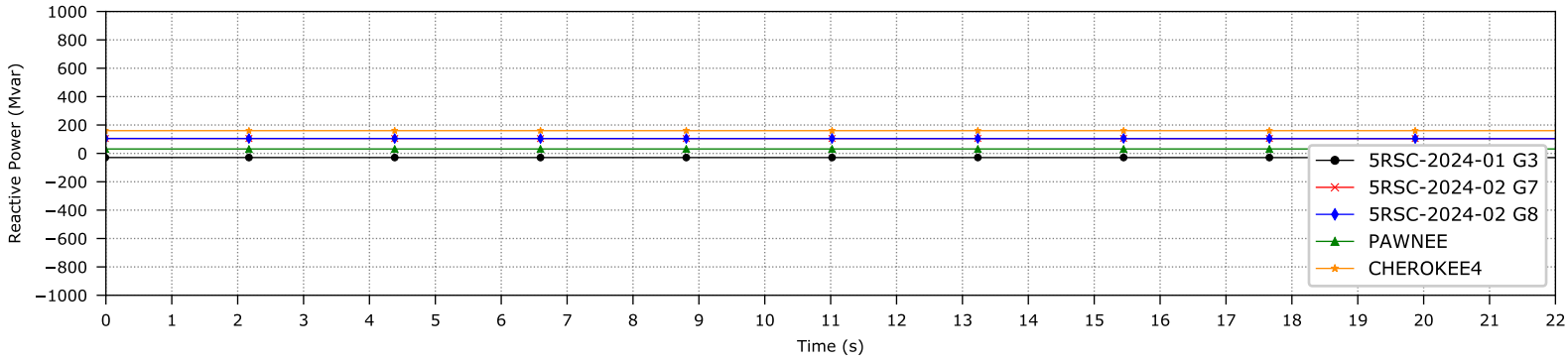

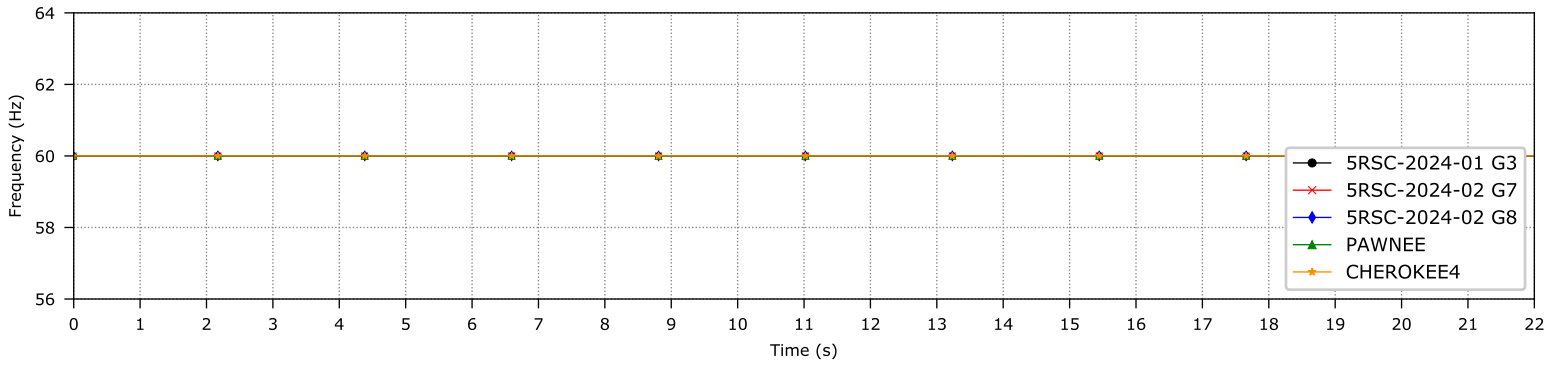

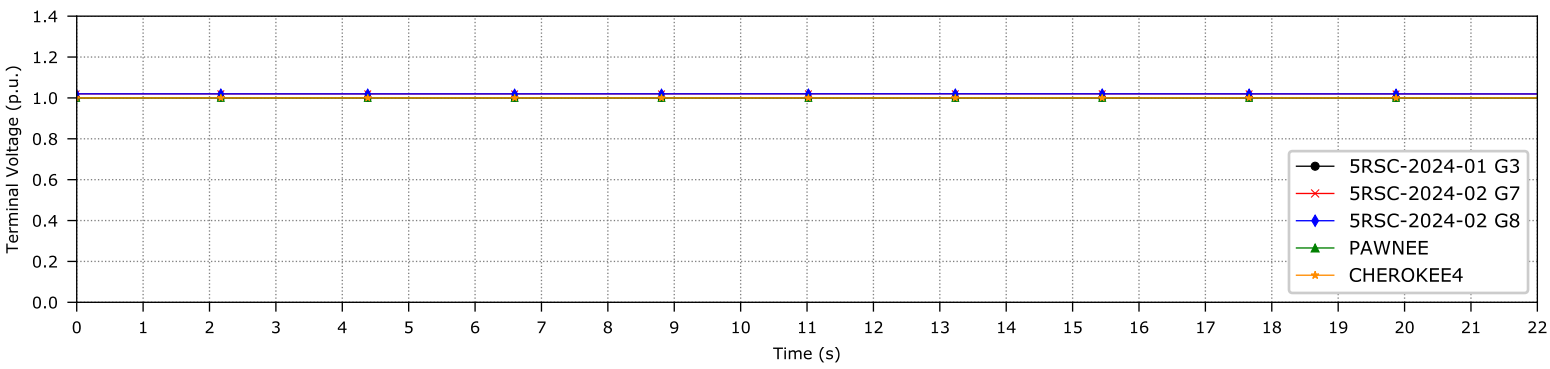

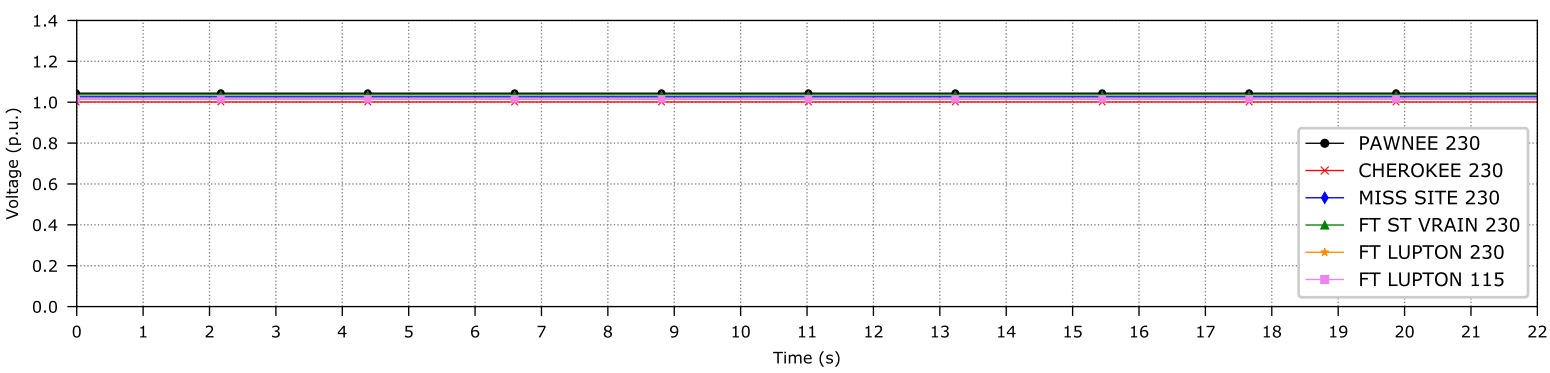

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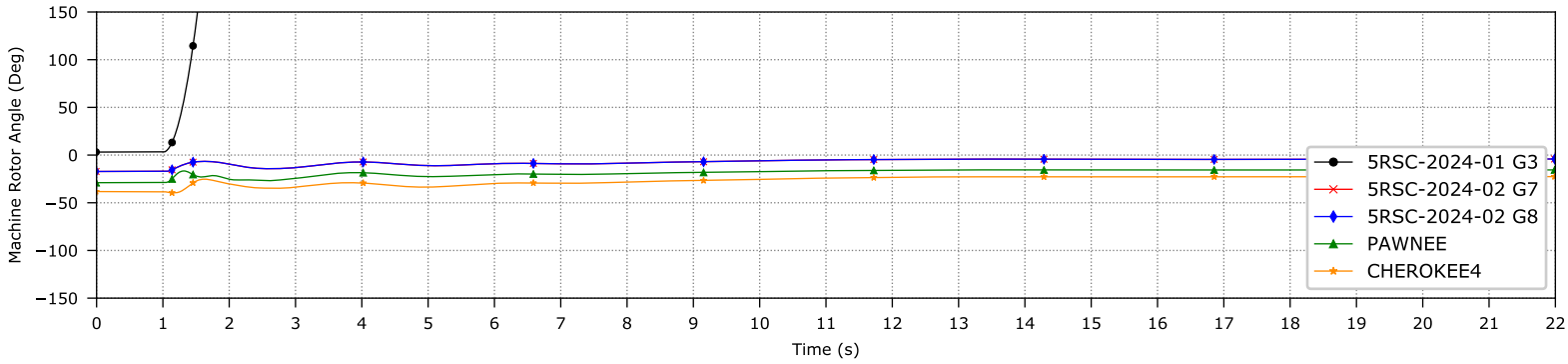

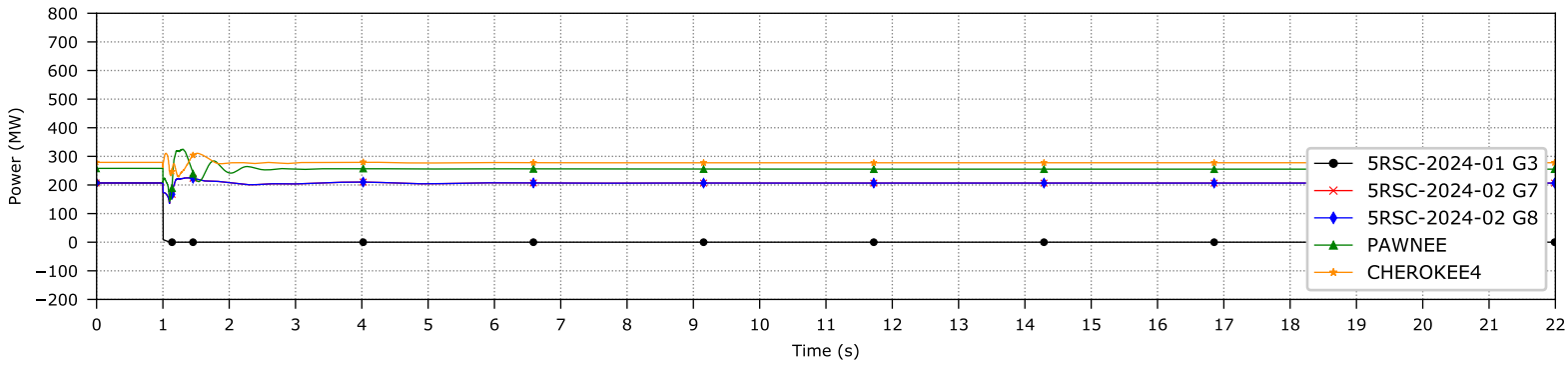

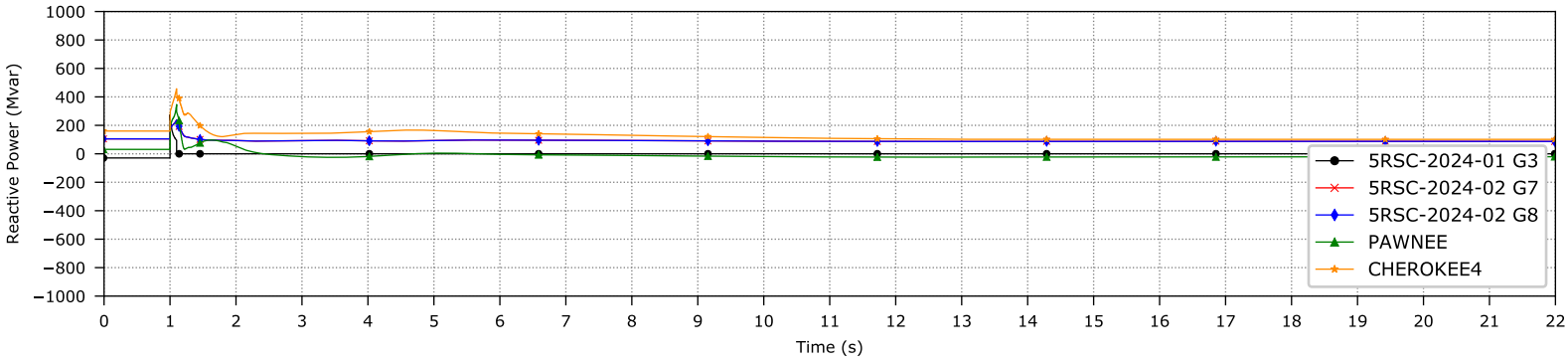

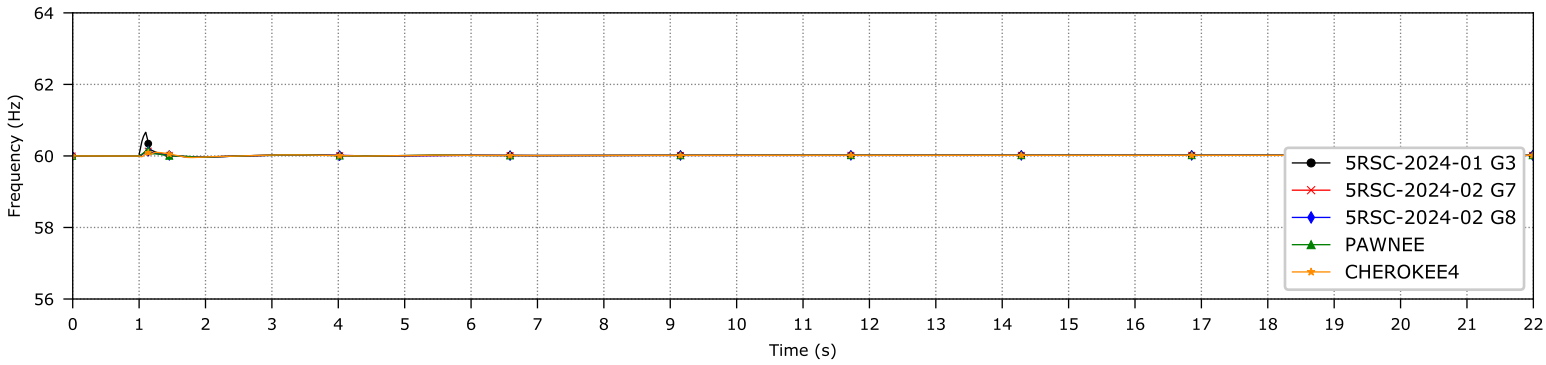

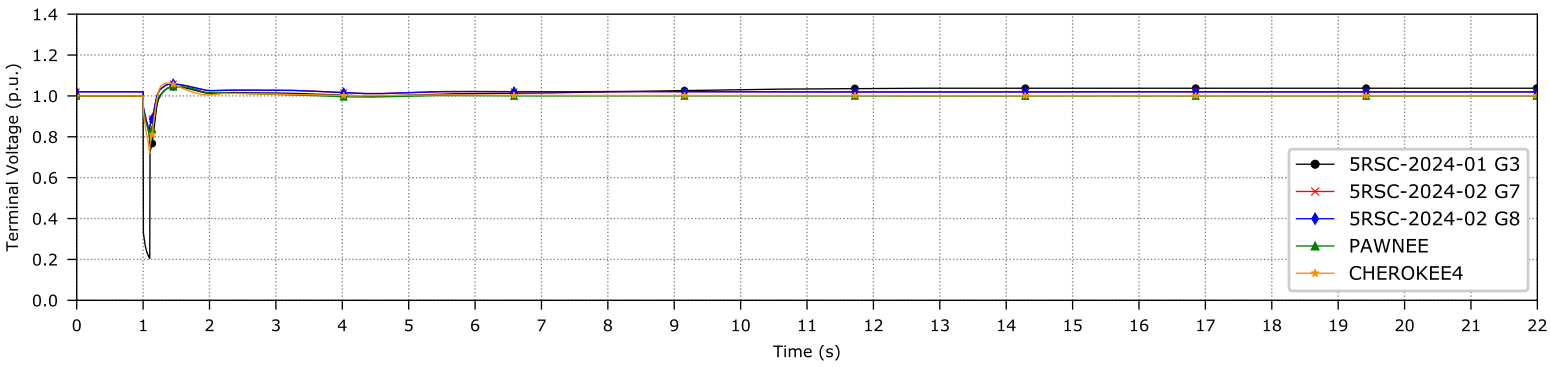

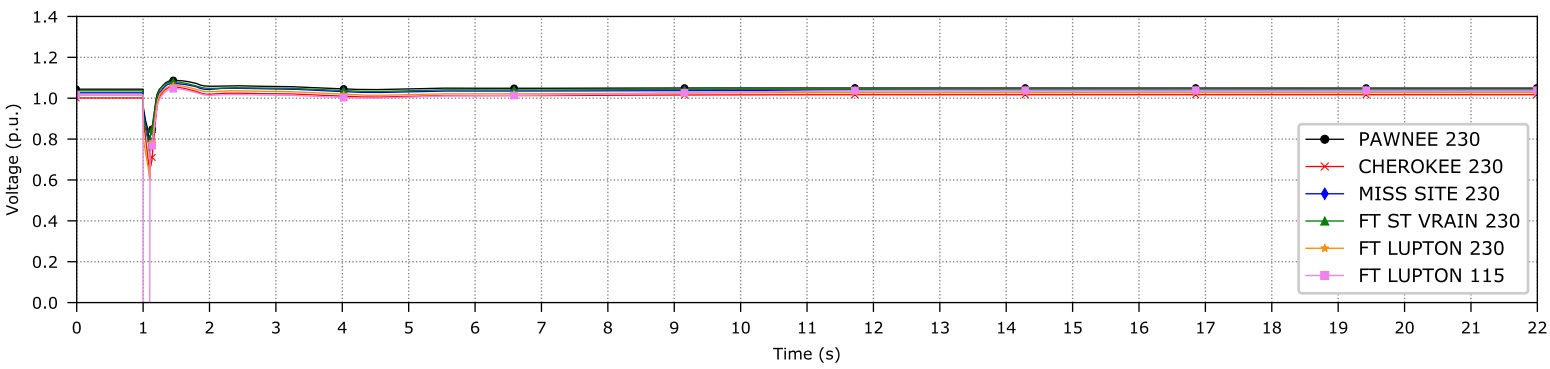

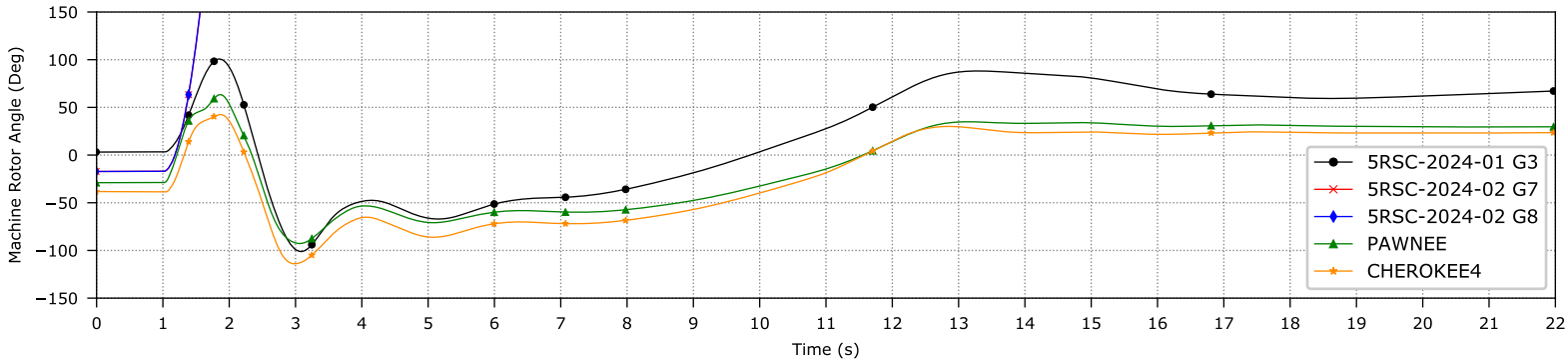
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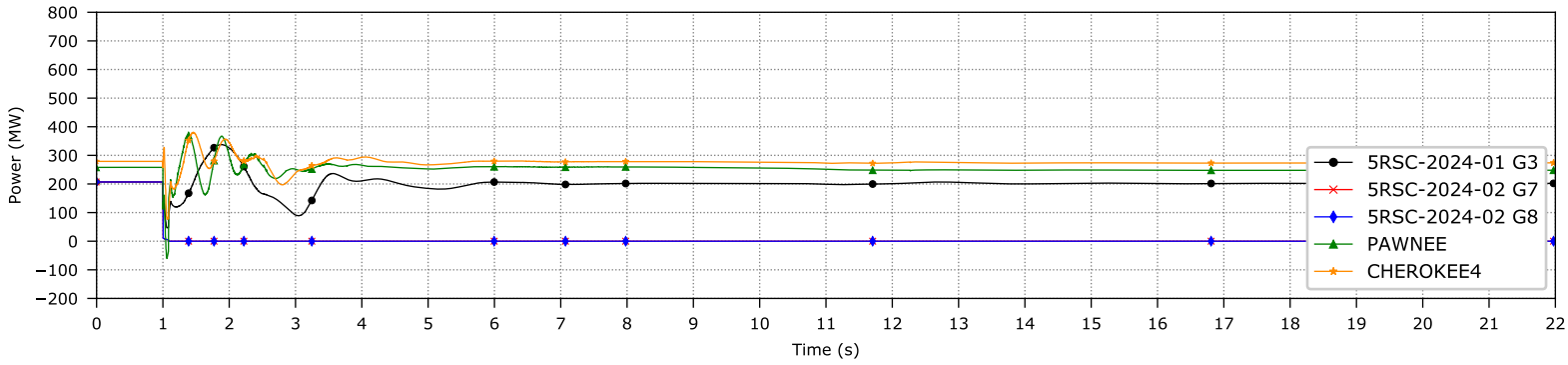
CHEROKEE4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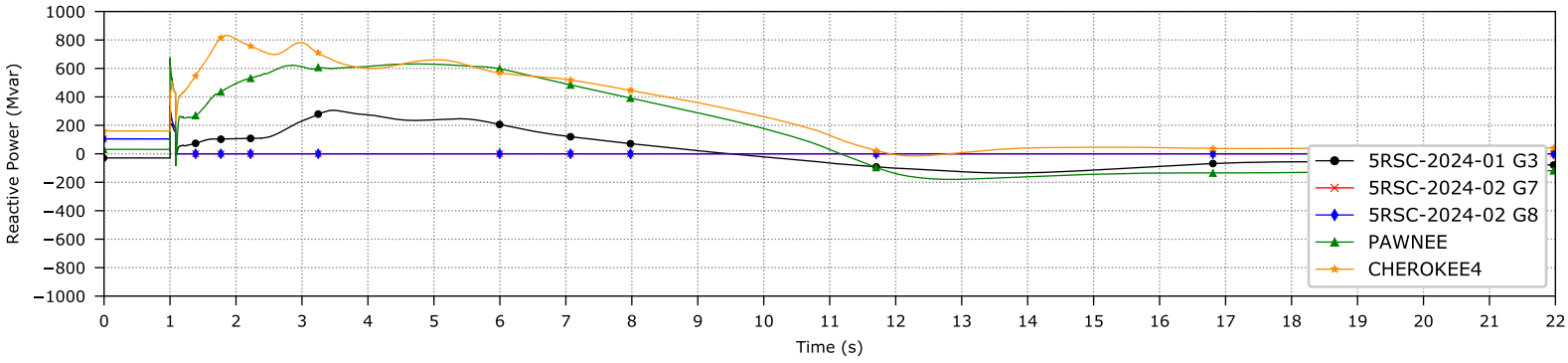
CHEROKEE4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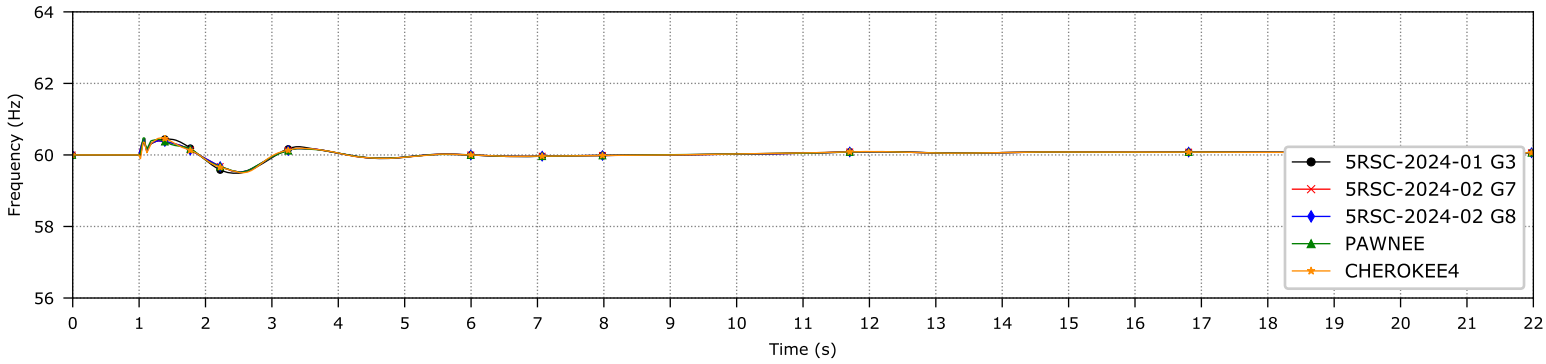
CHEROKEE4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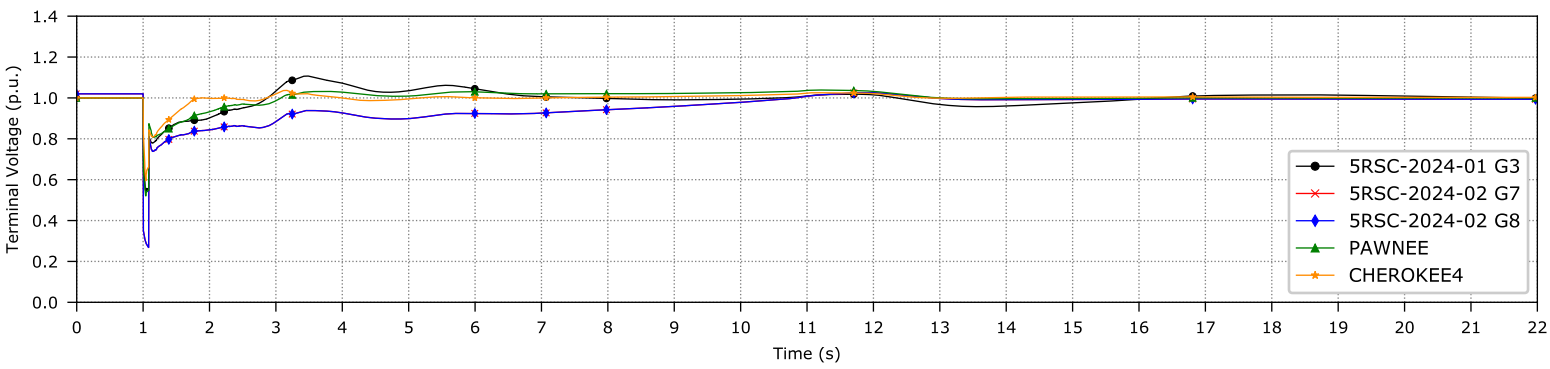
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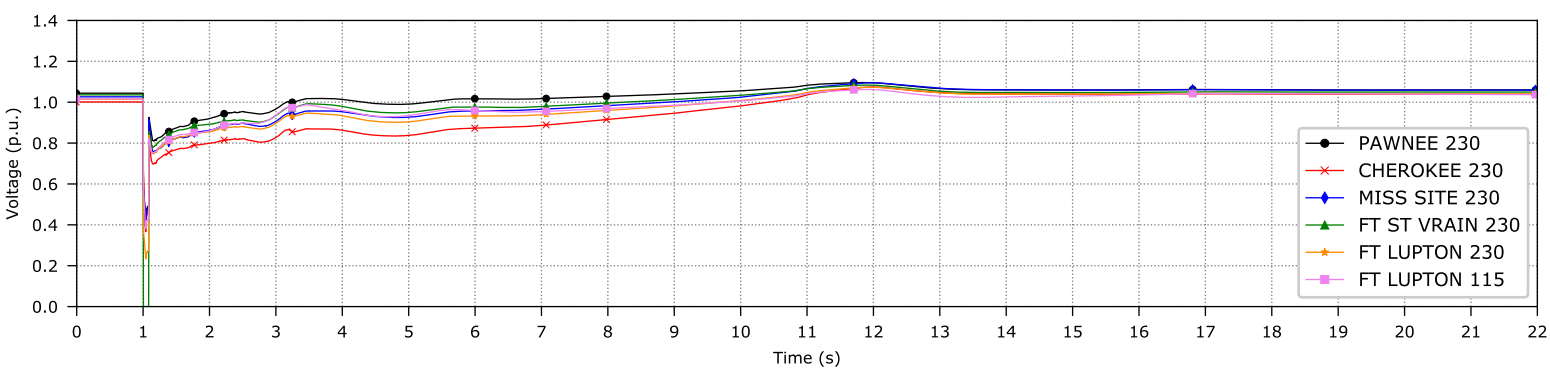
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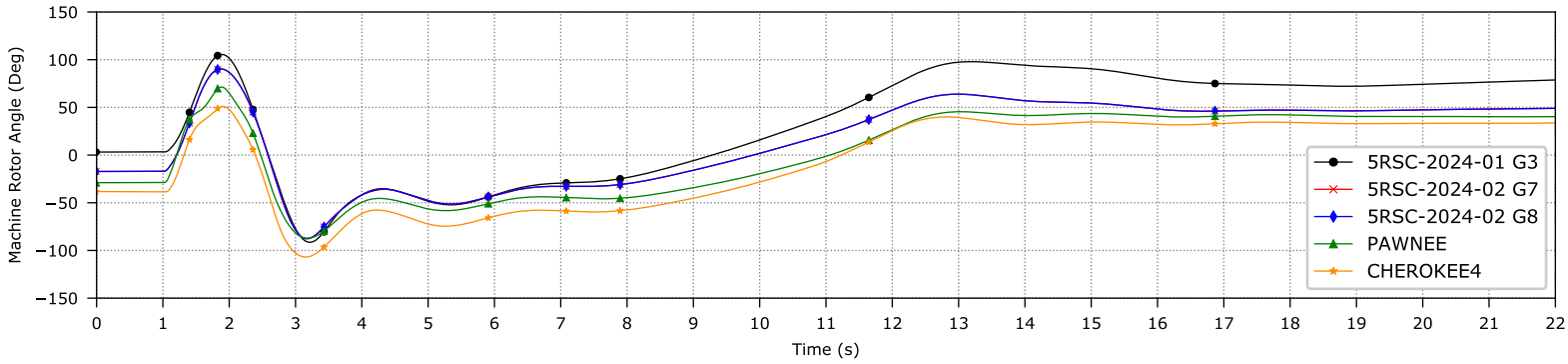
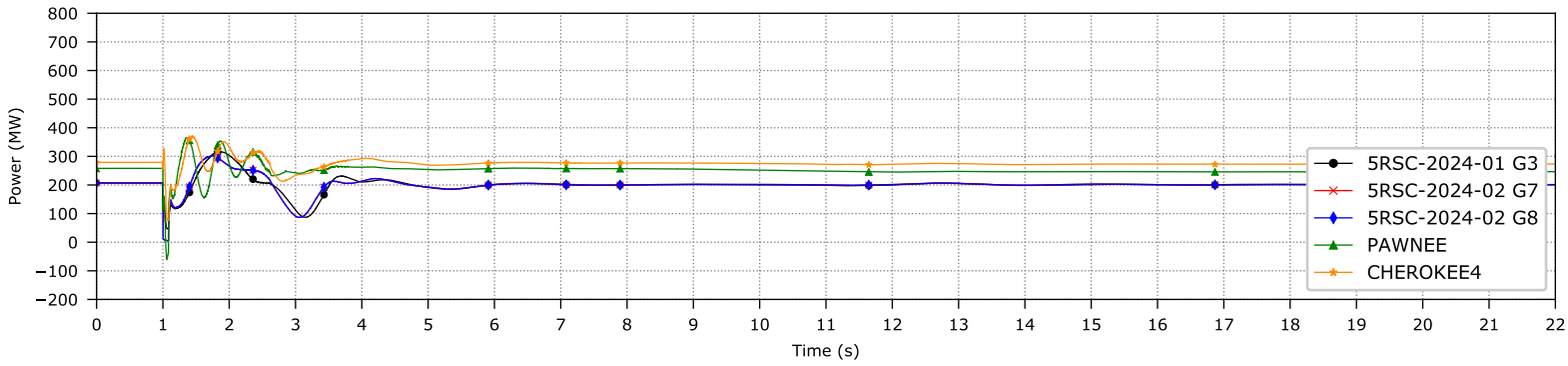
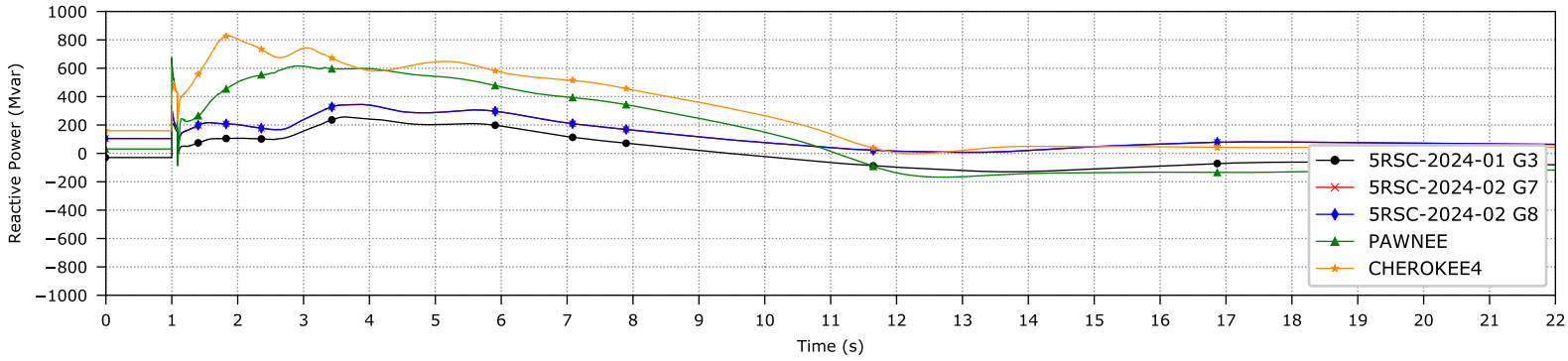
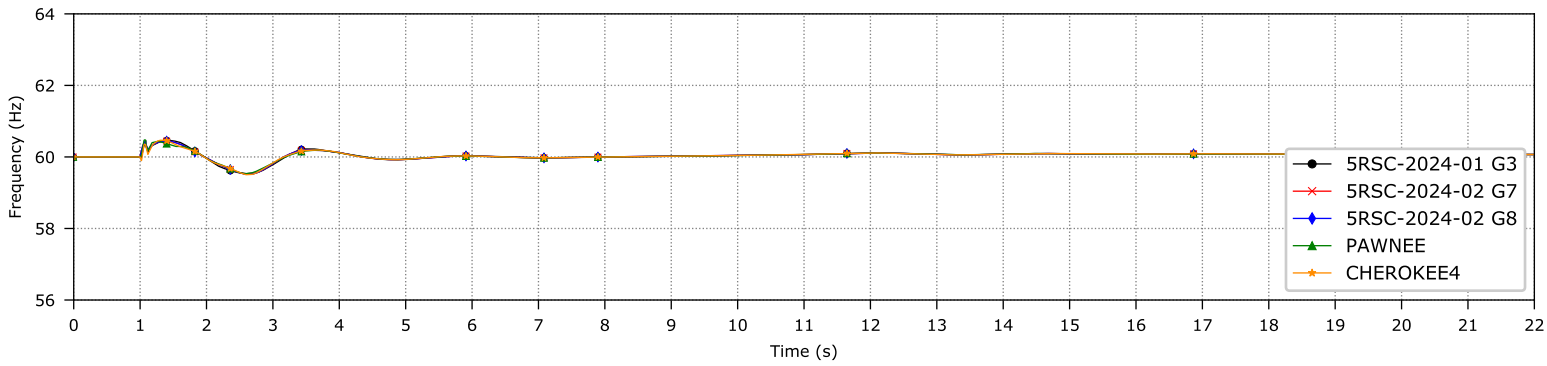
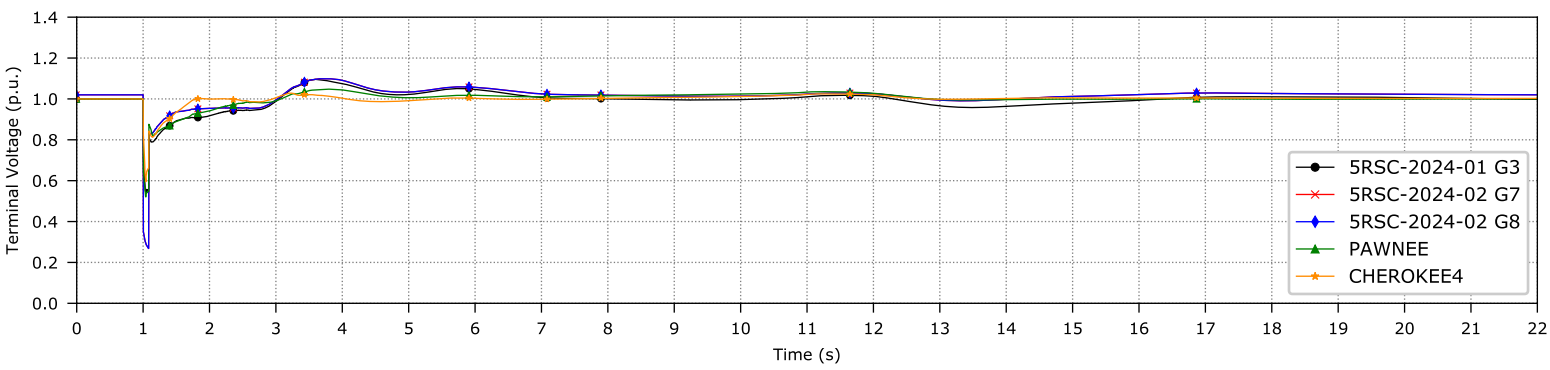
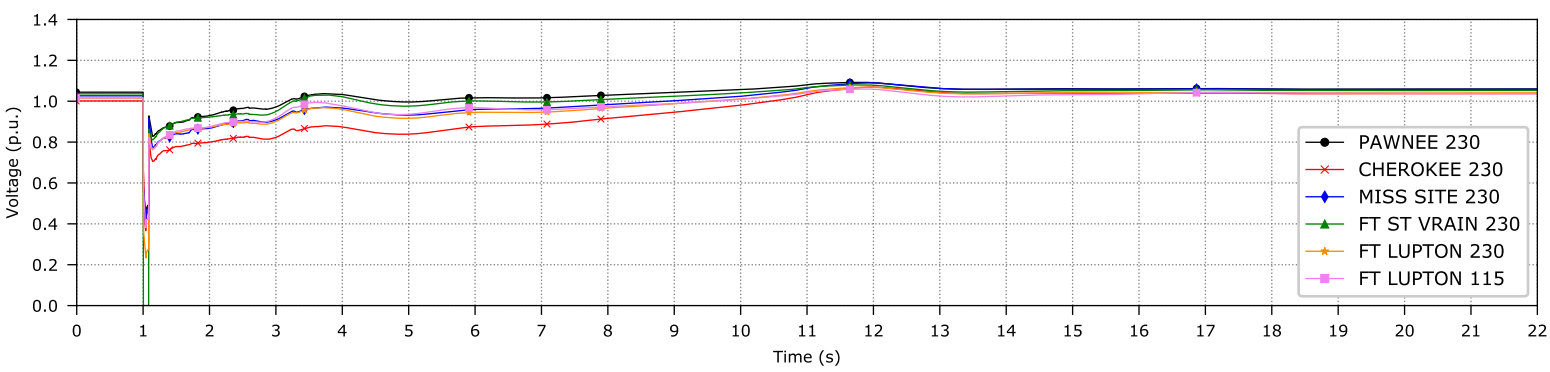


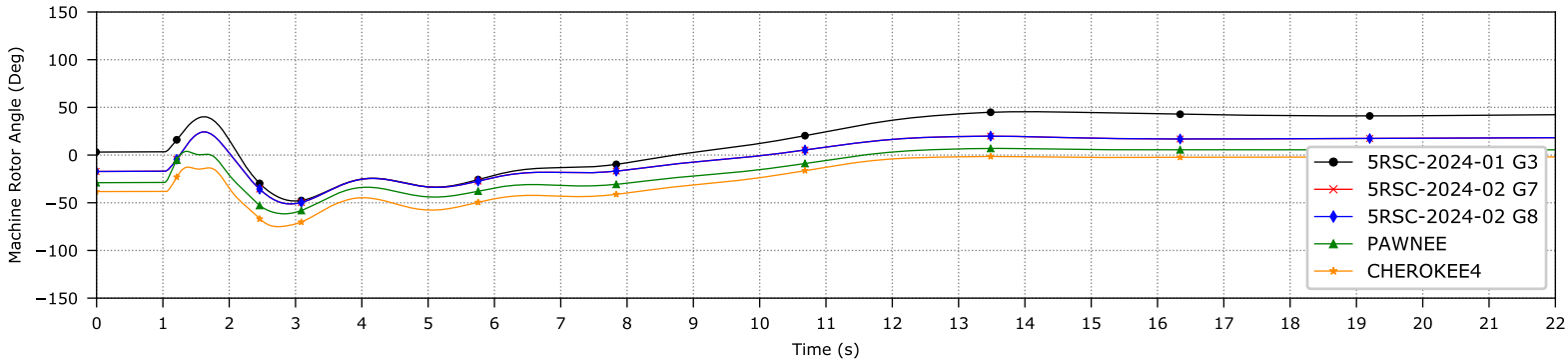


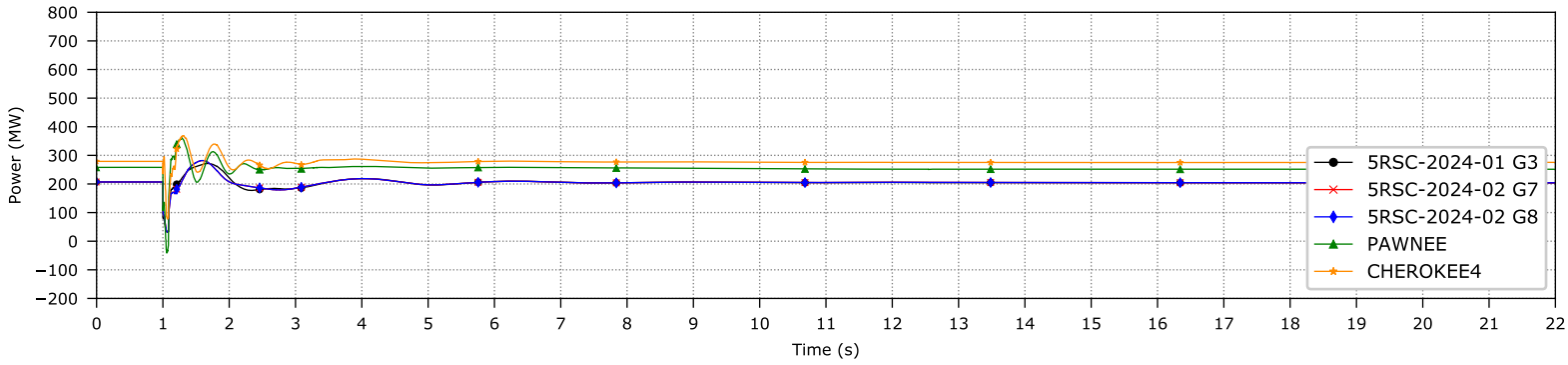


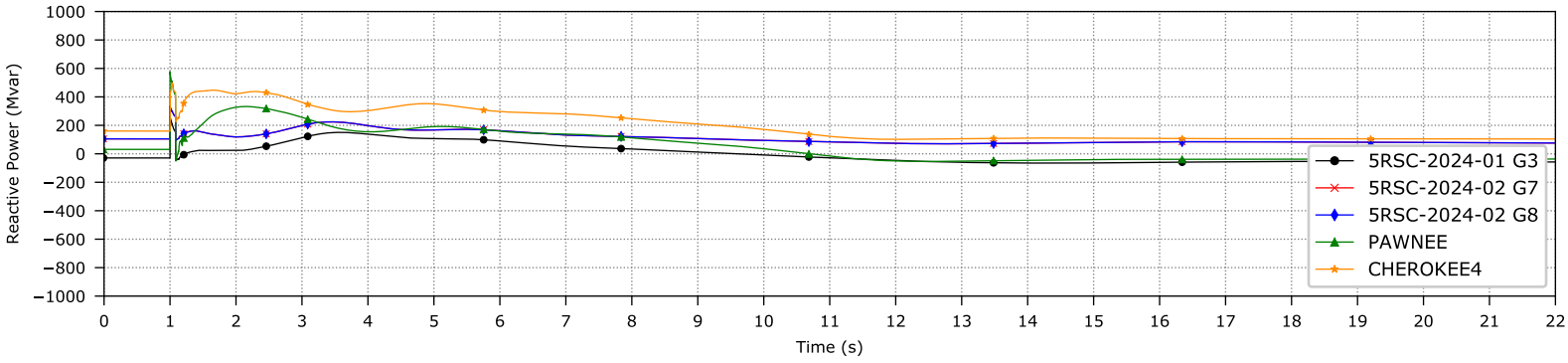


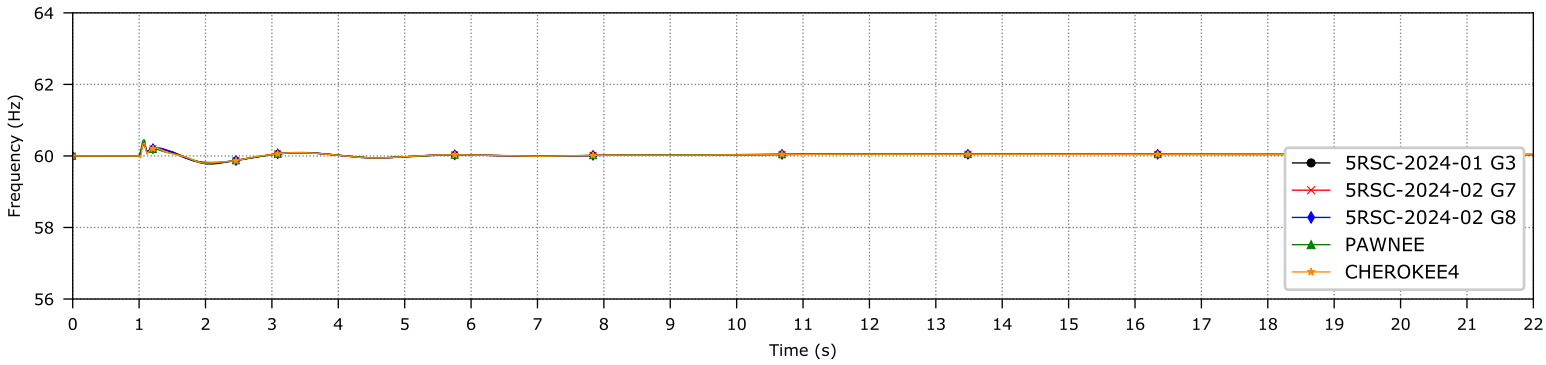


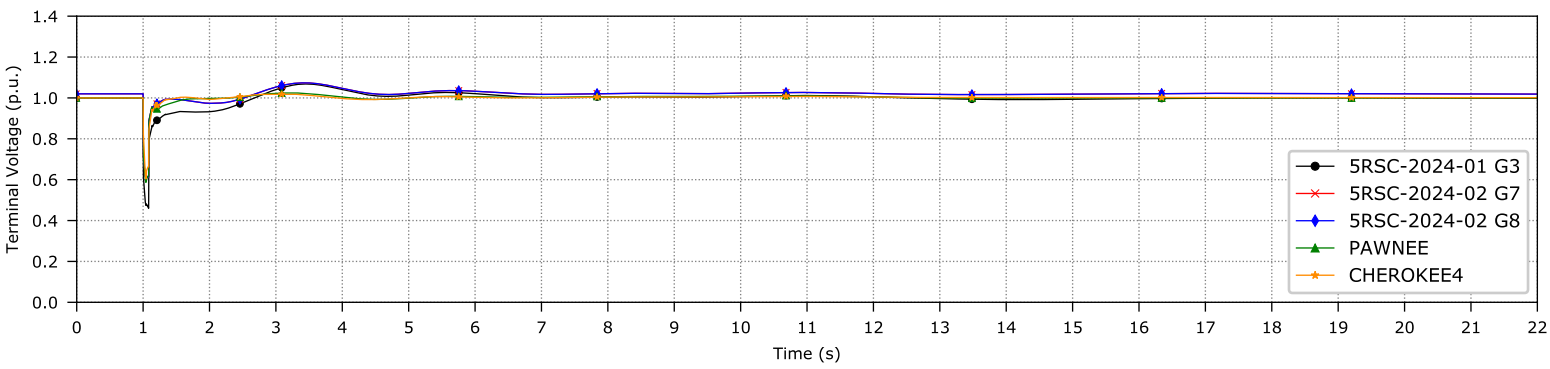


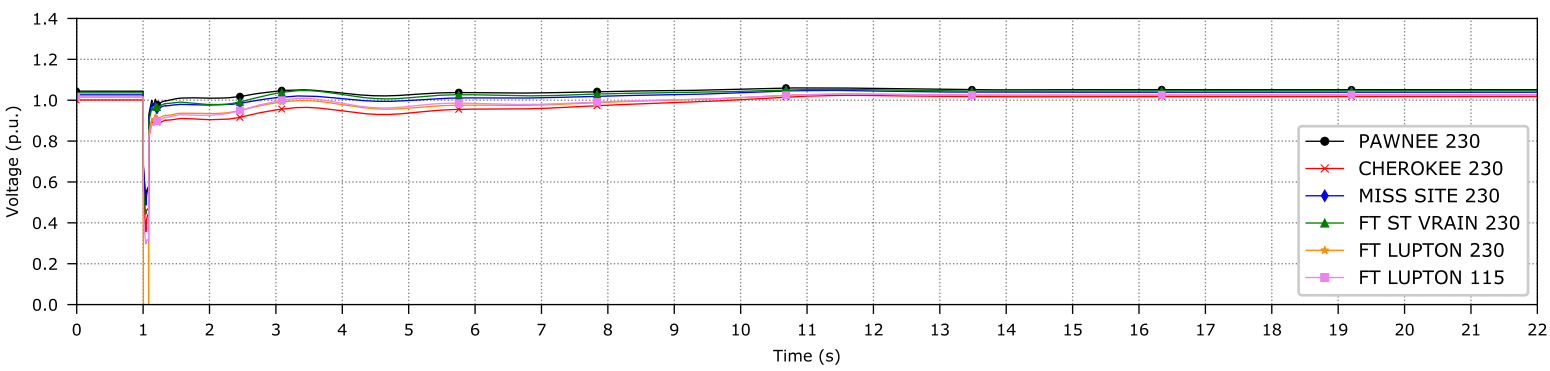

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

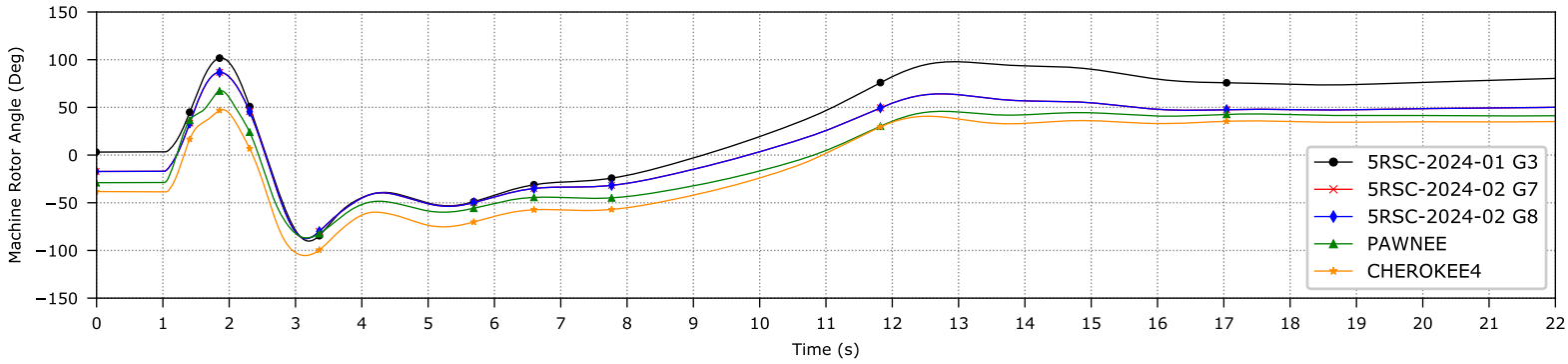

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

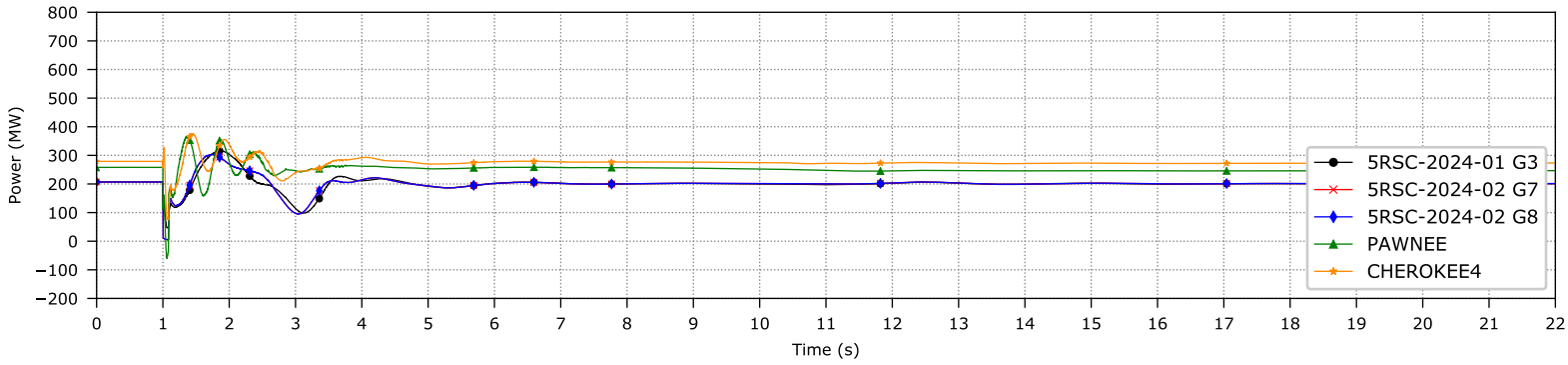

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

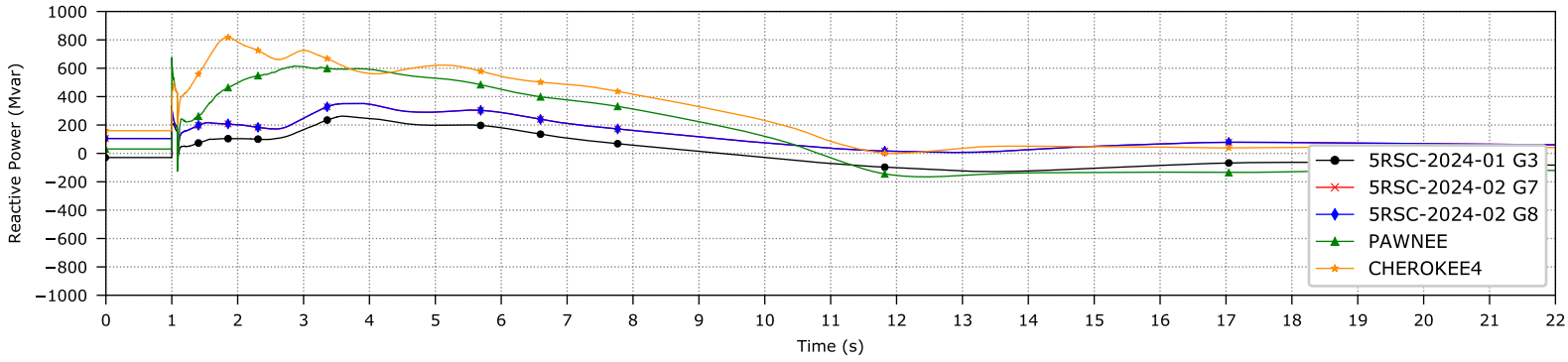

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

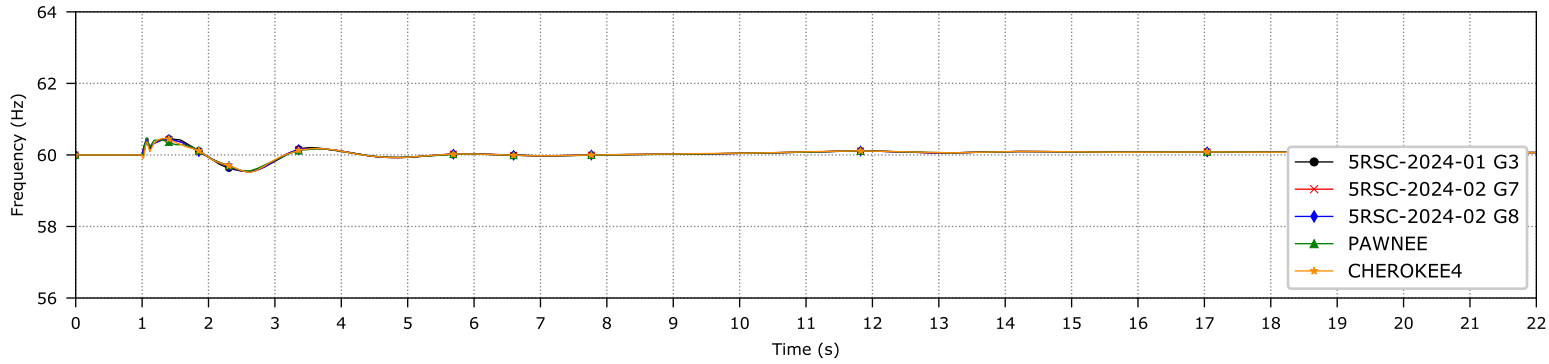

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

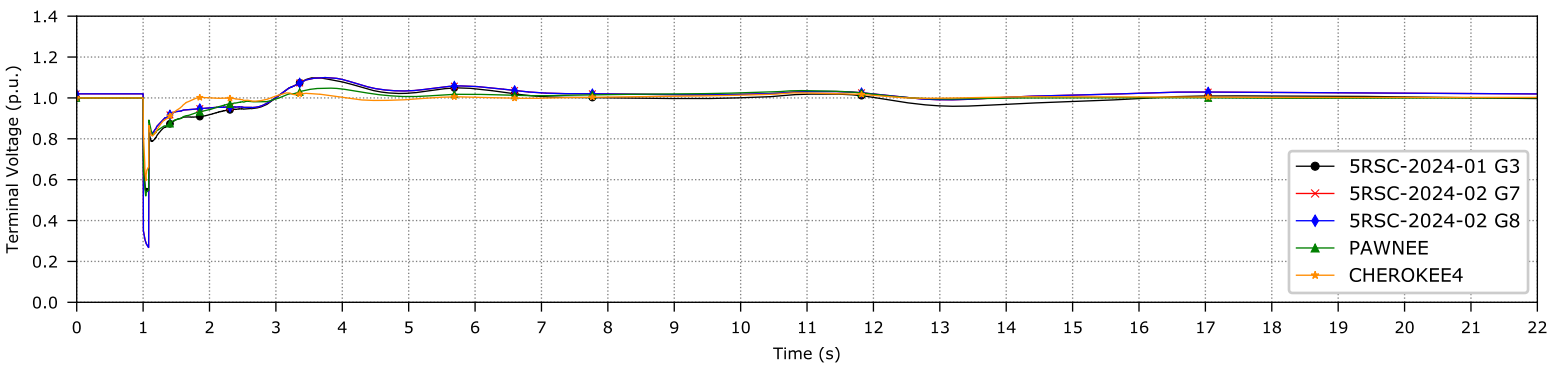
Ref. No. 06 - LoTC_63

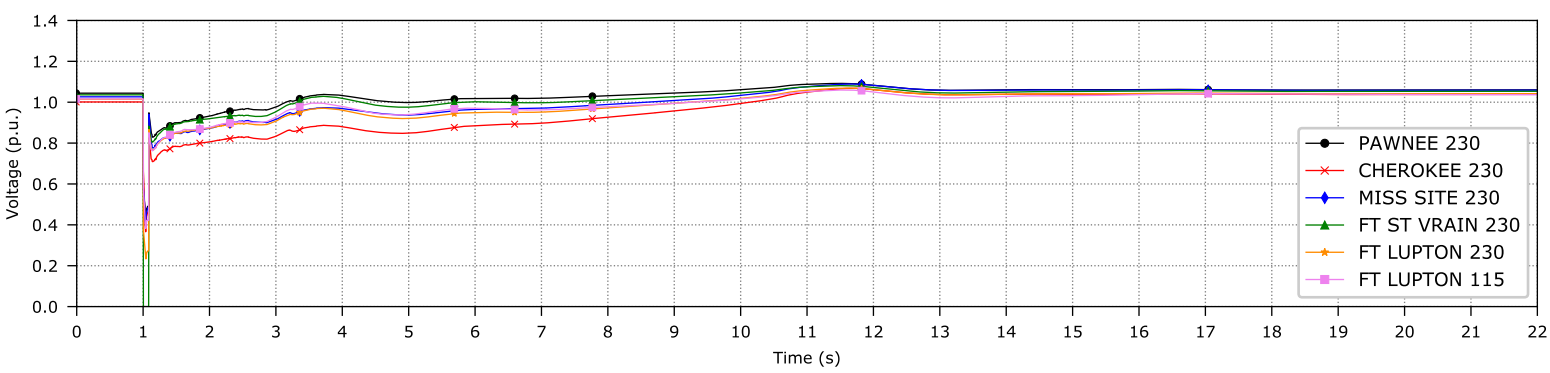




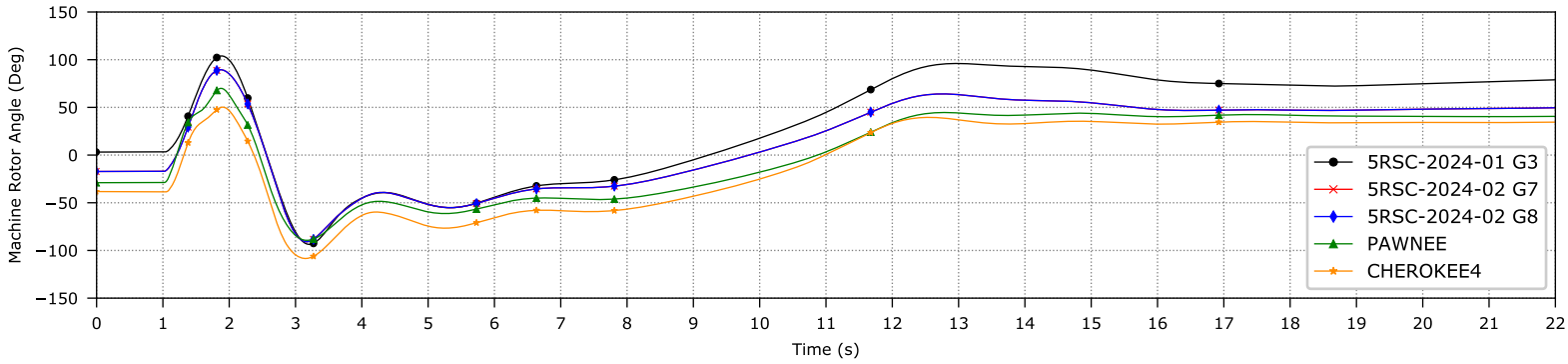


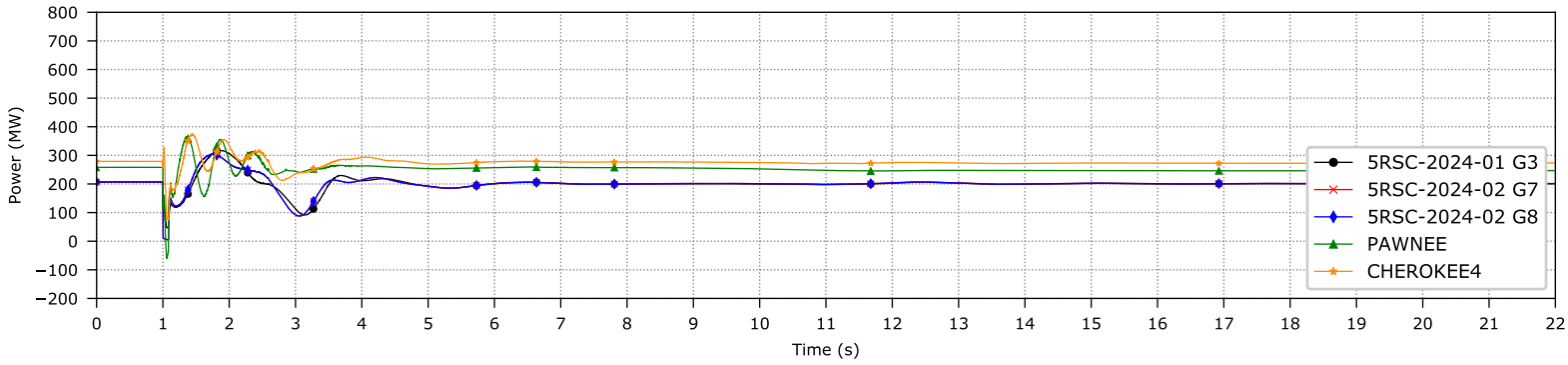


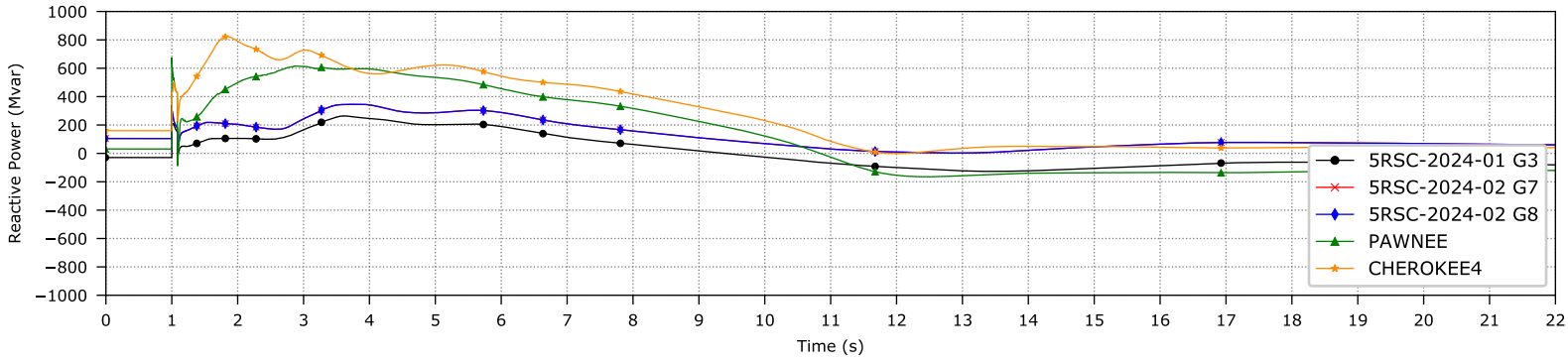


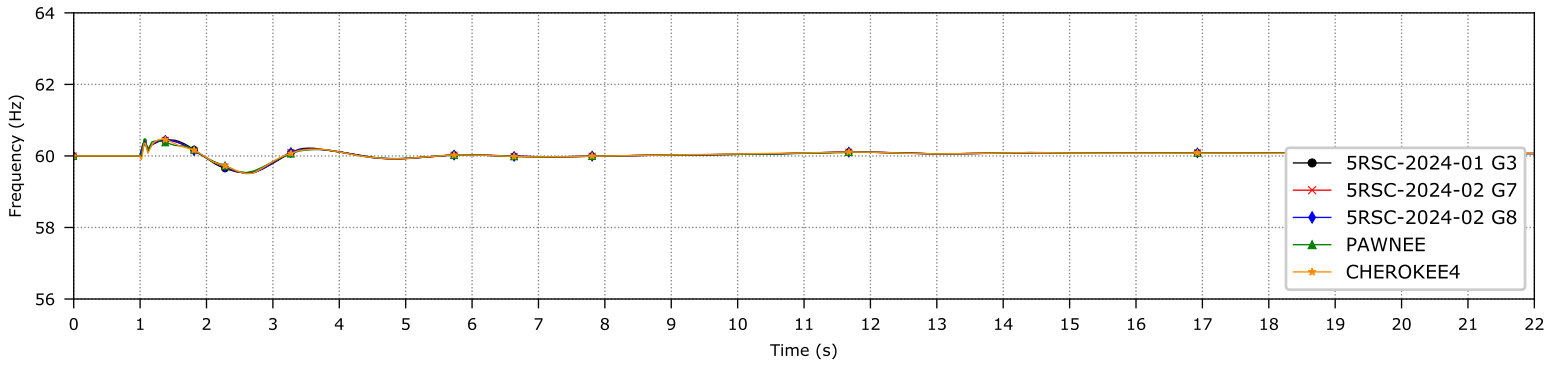


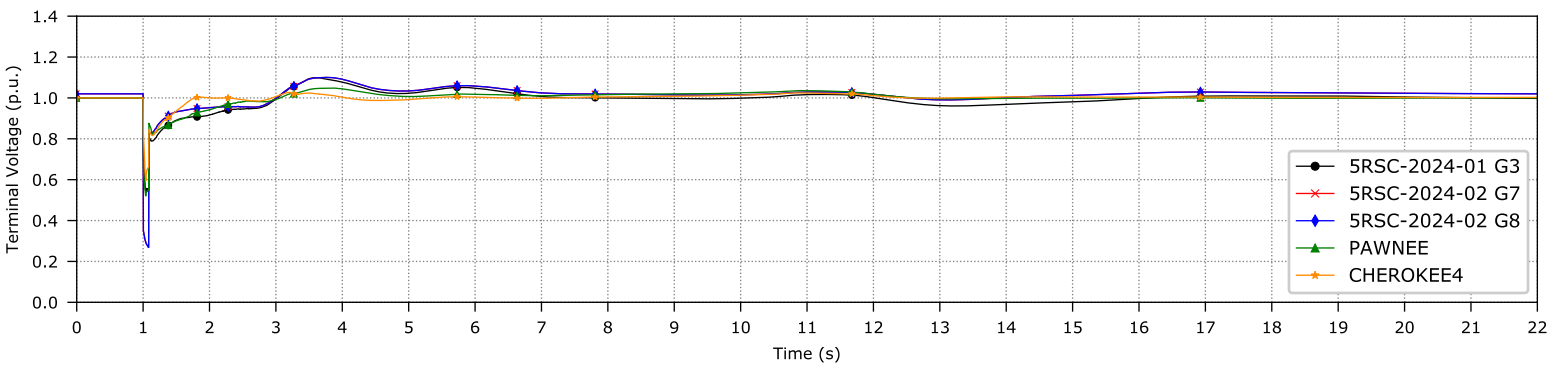
Ref. No. 07 - LoTC_64

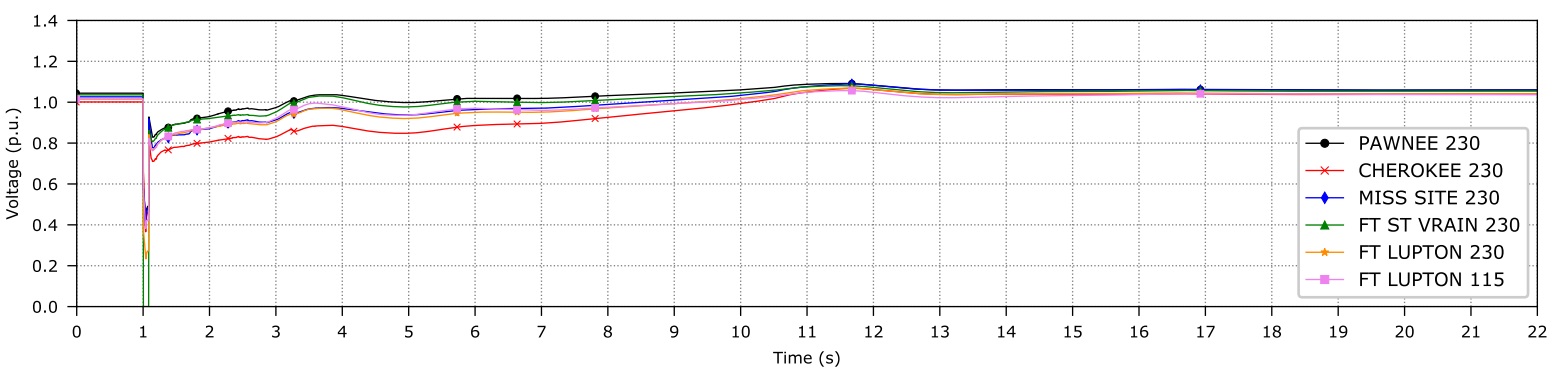




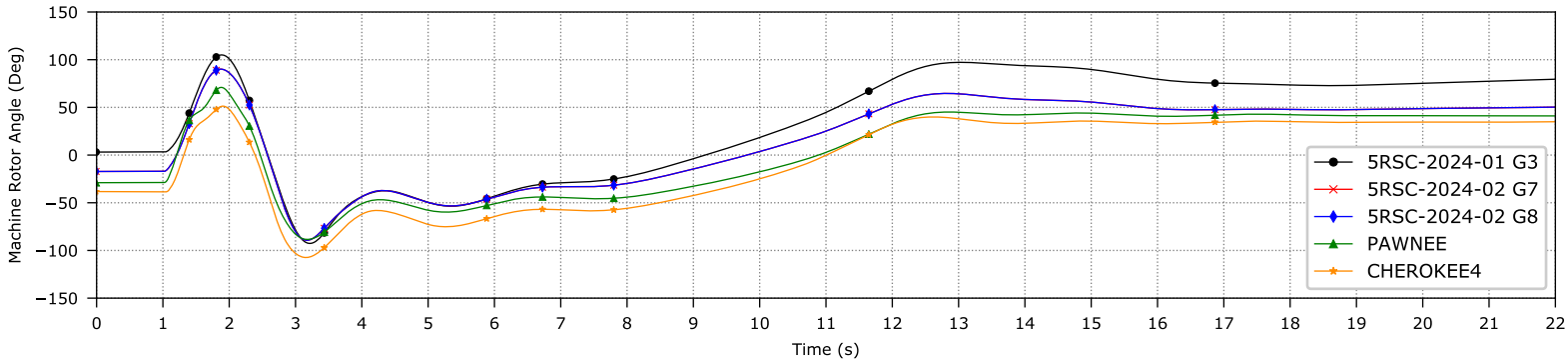


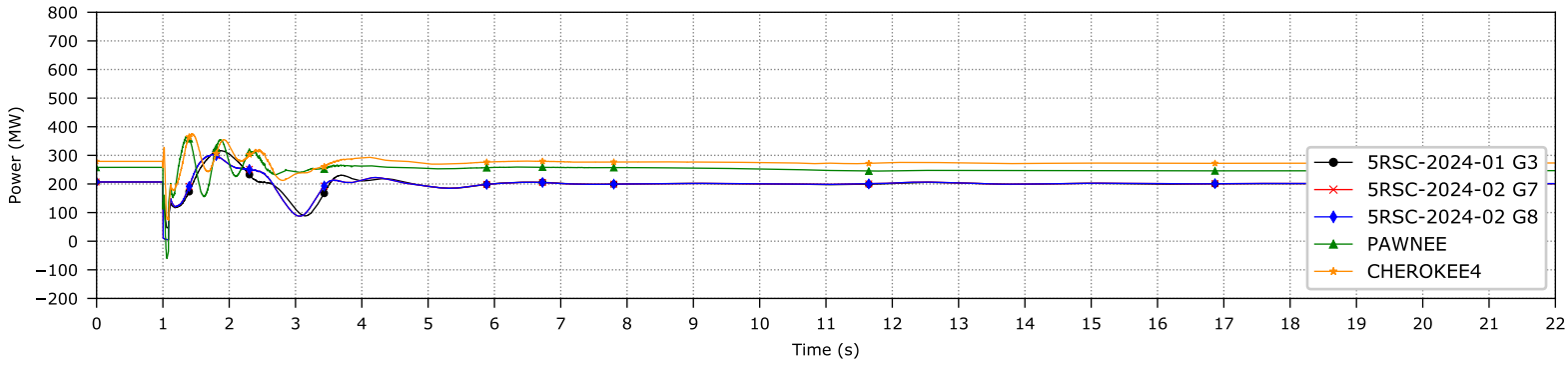


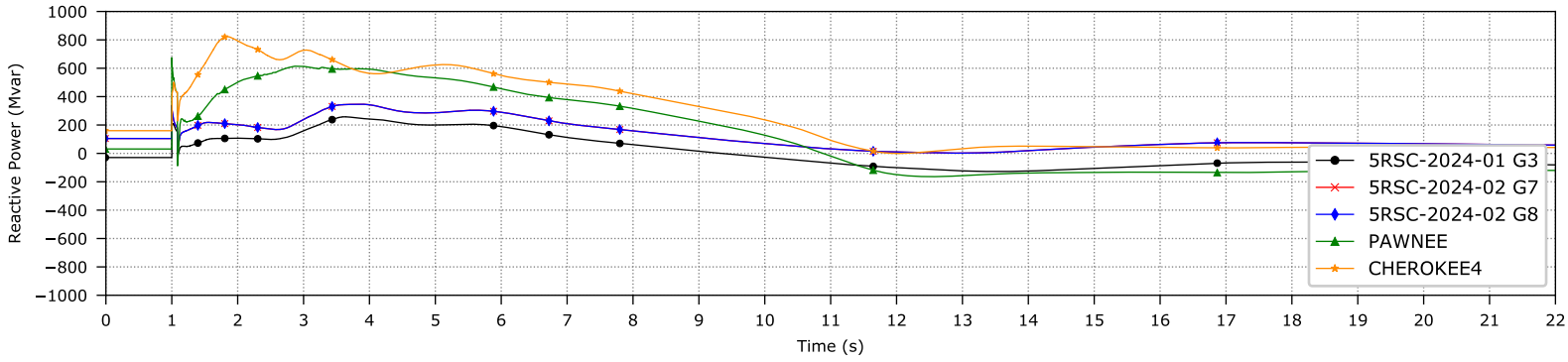


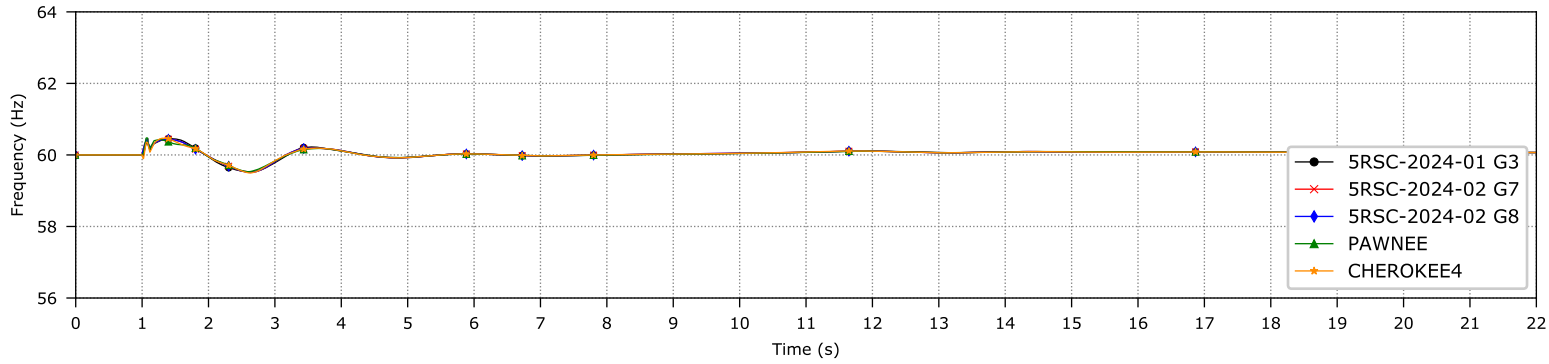


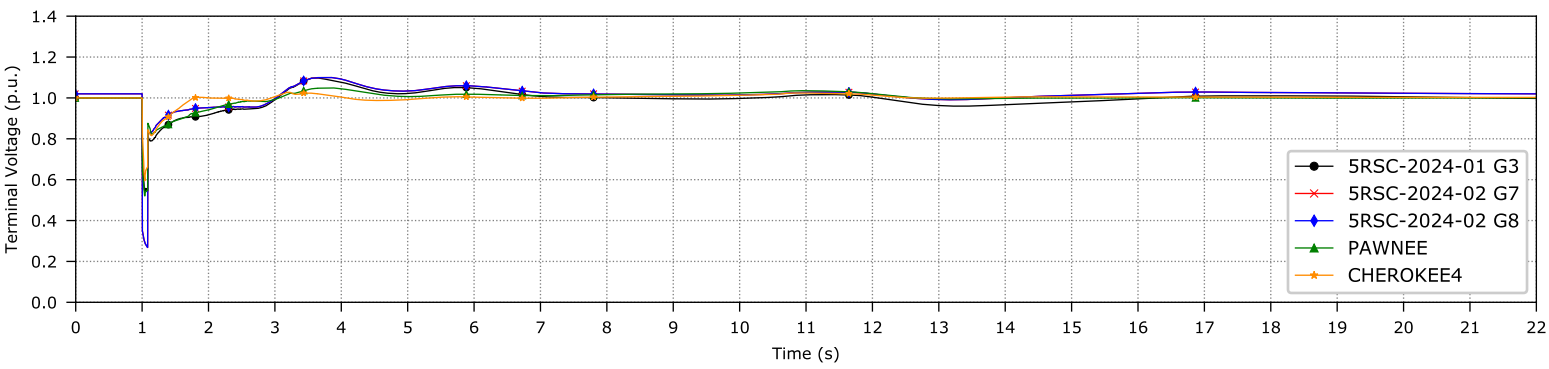
Ref. No. 08 - LoTC_65

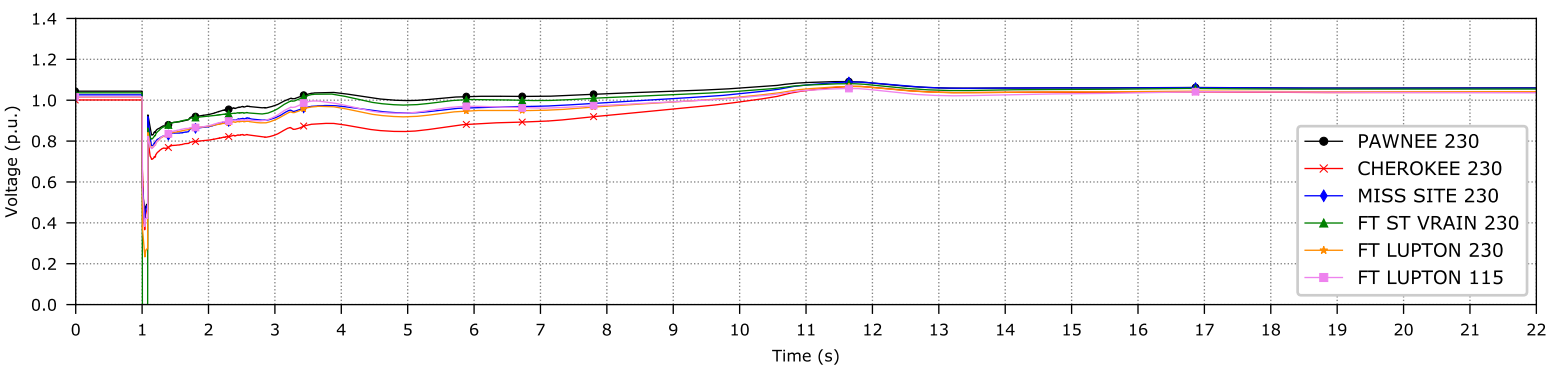




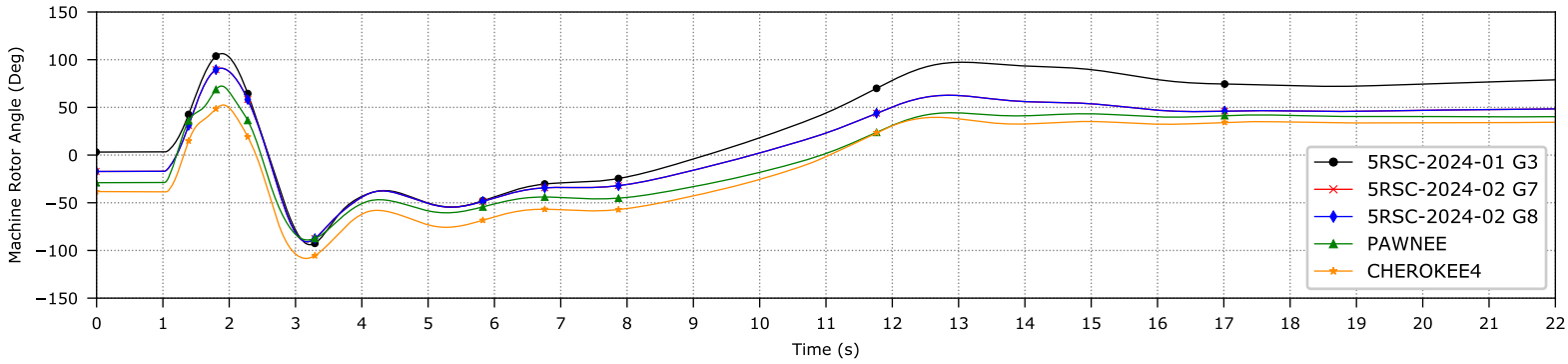


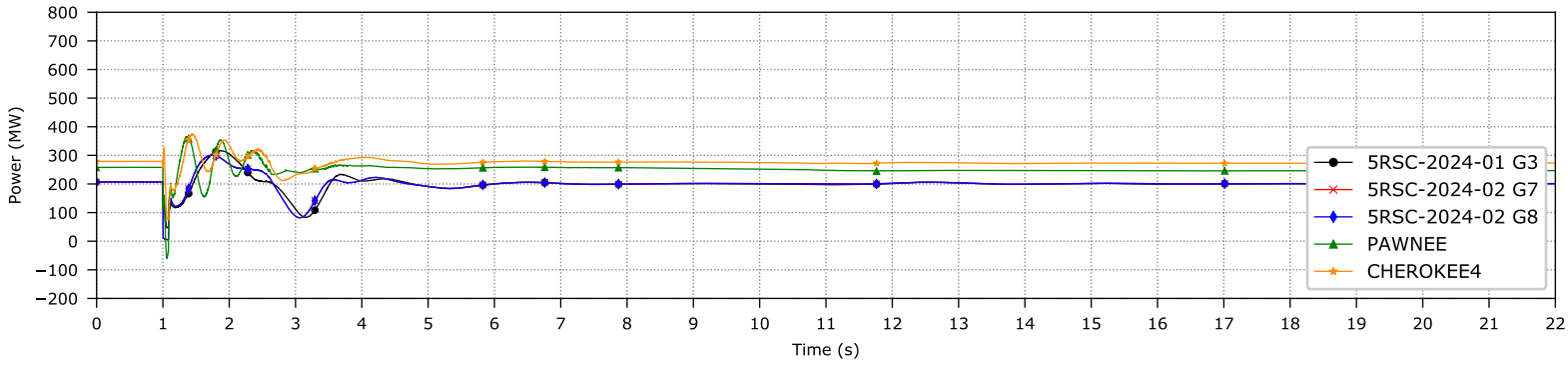


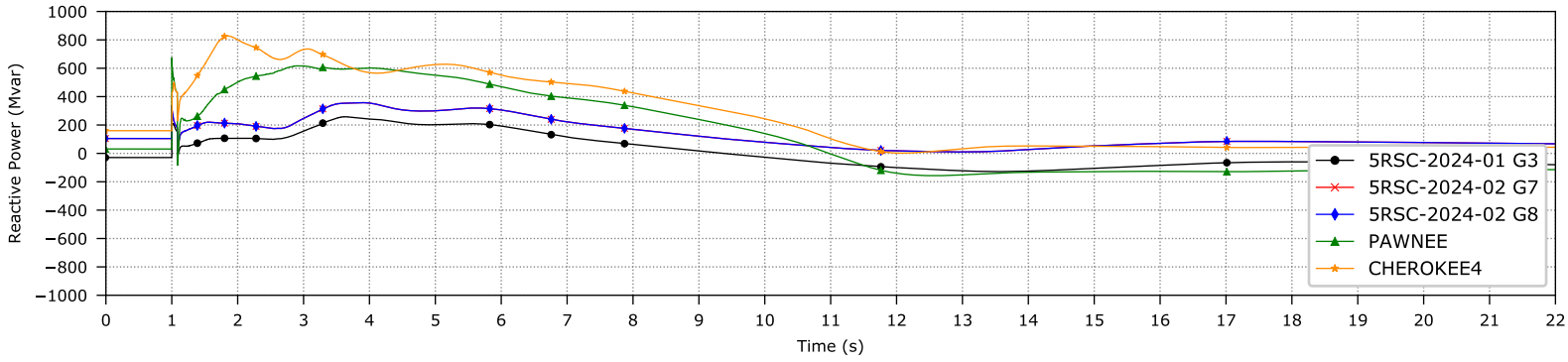


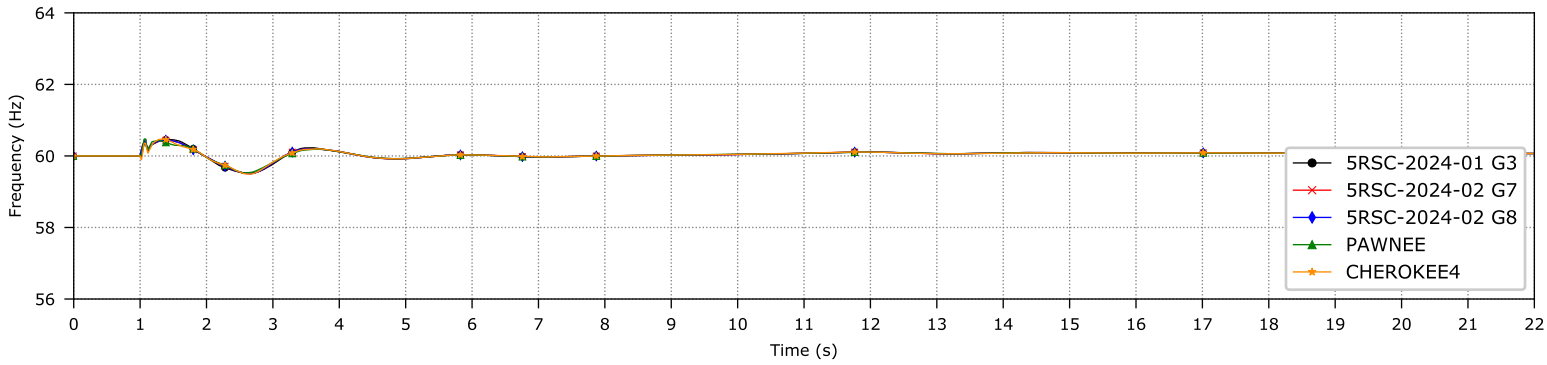


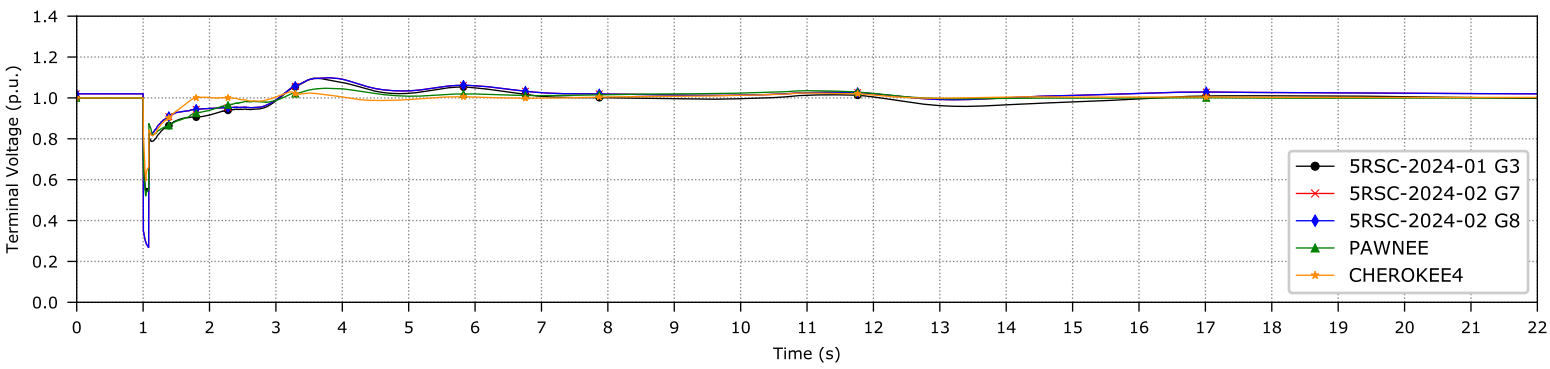
Ref. No. 09 - LoTC_66

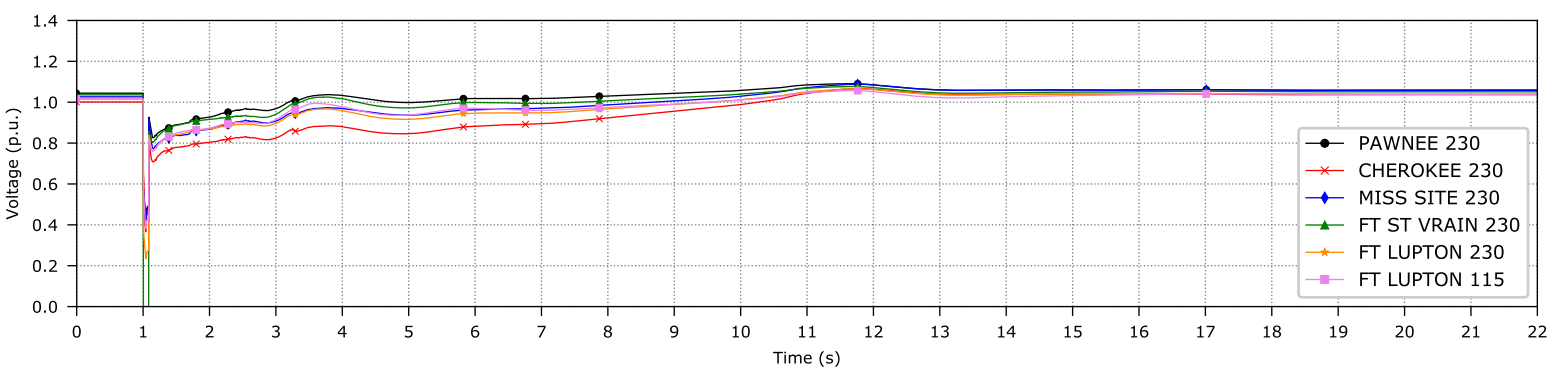




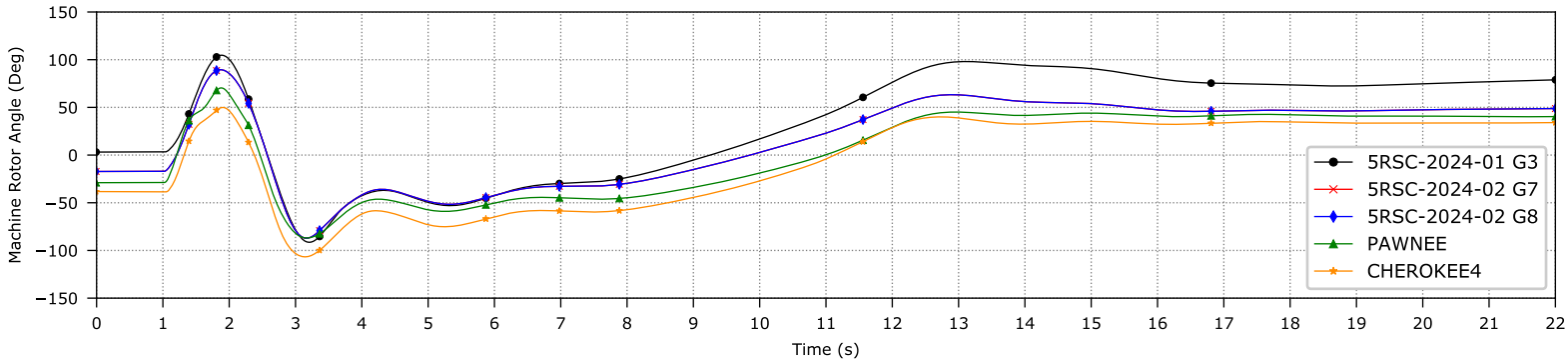


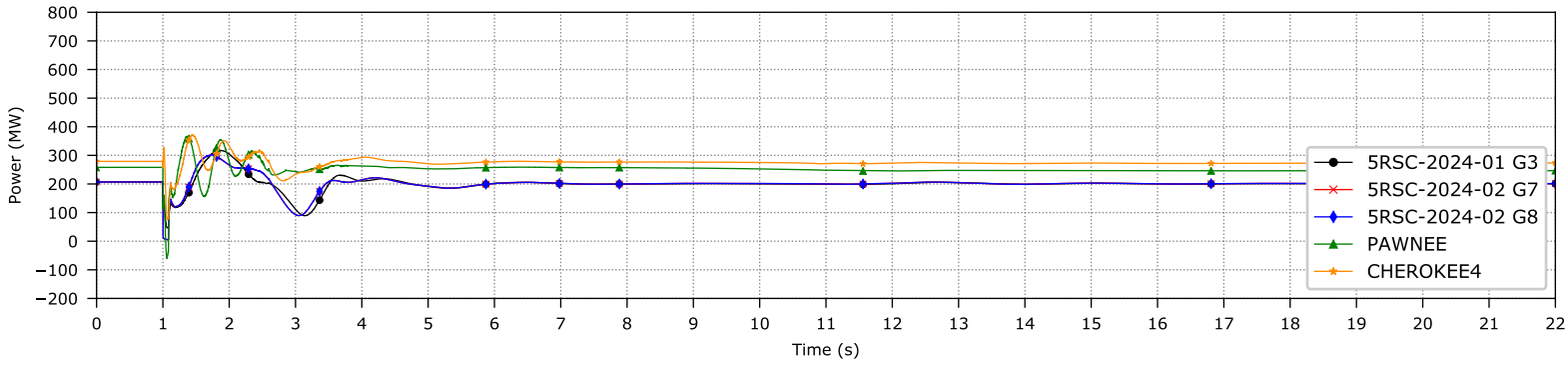


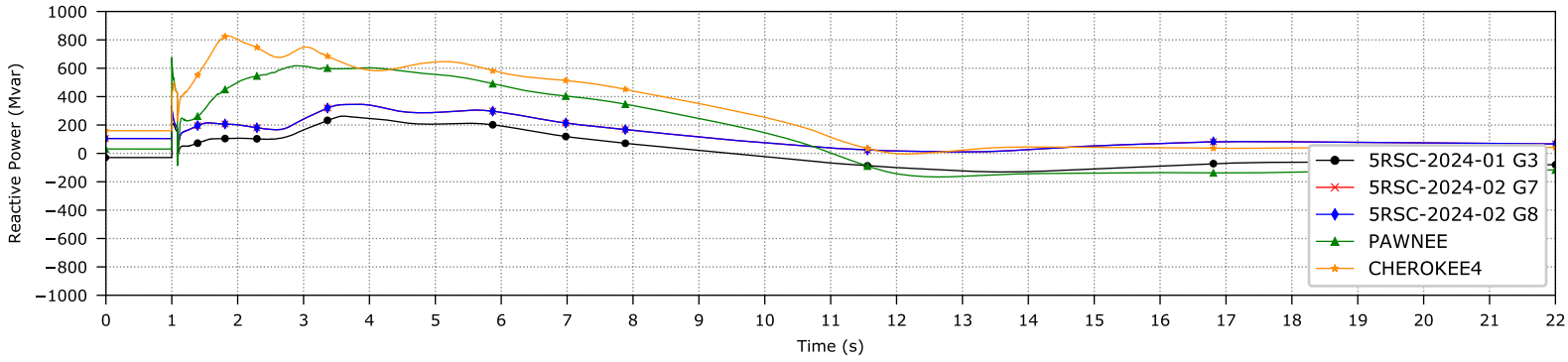


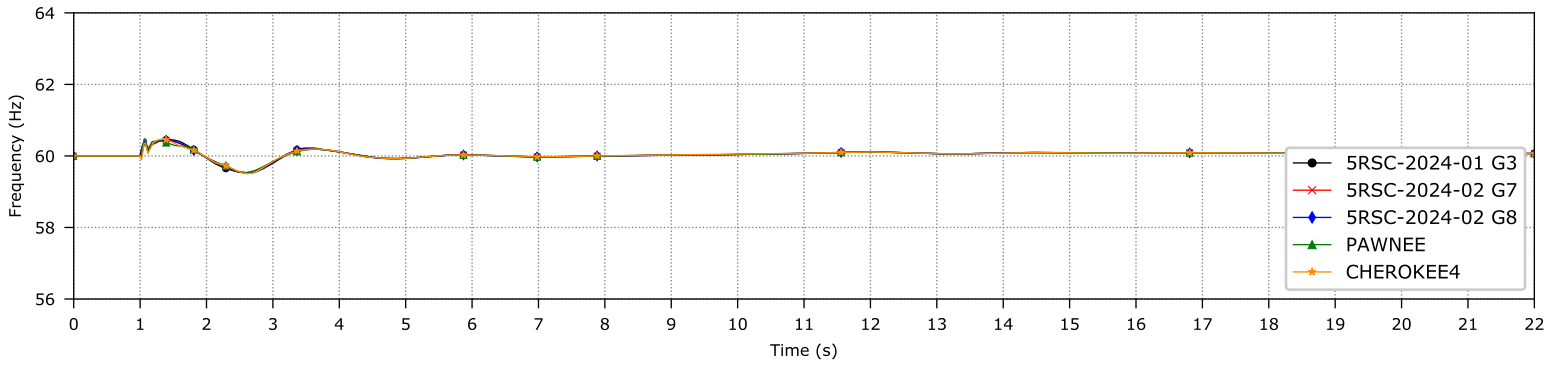


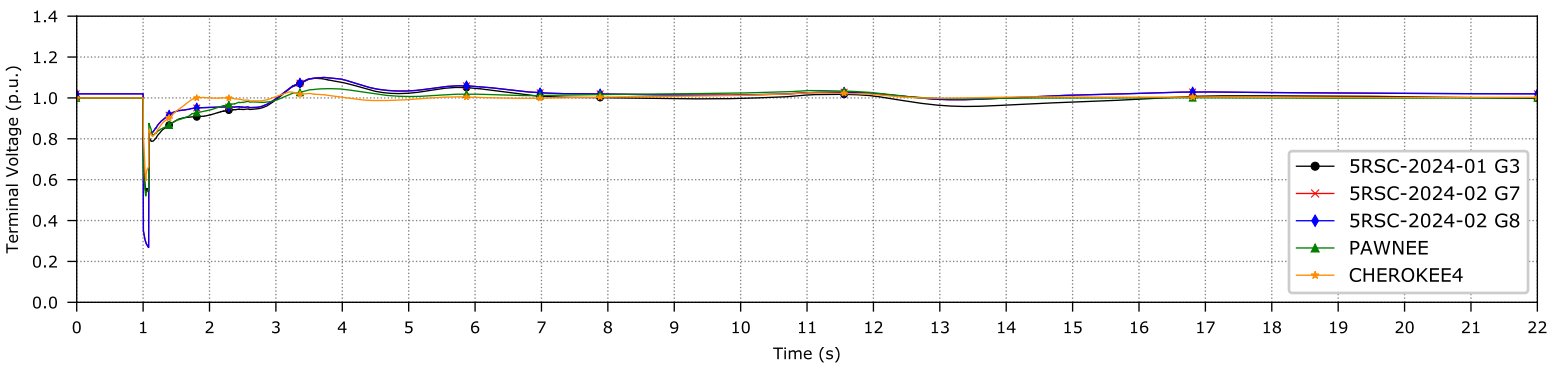
Ref. No. 10 - LoTC_67

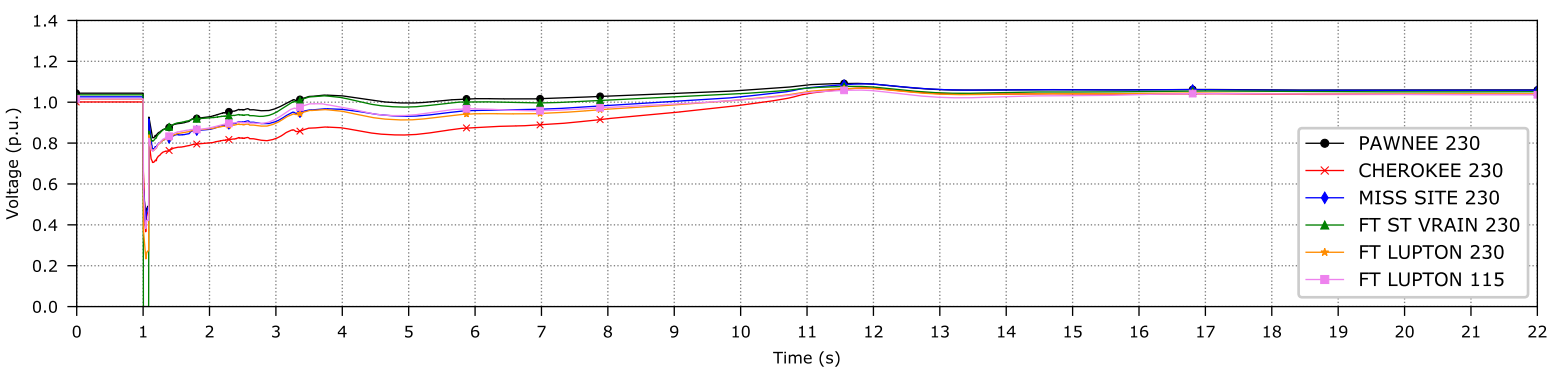


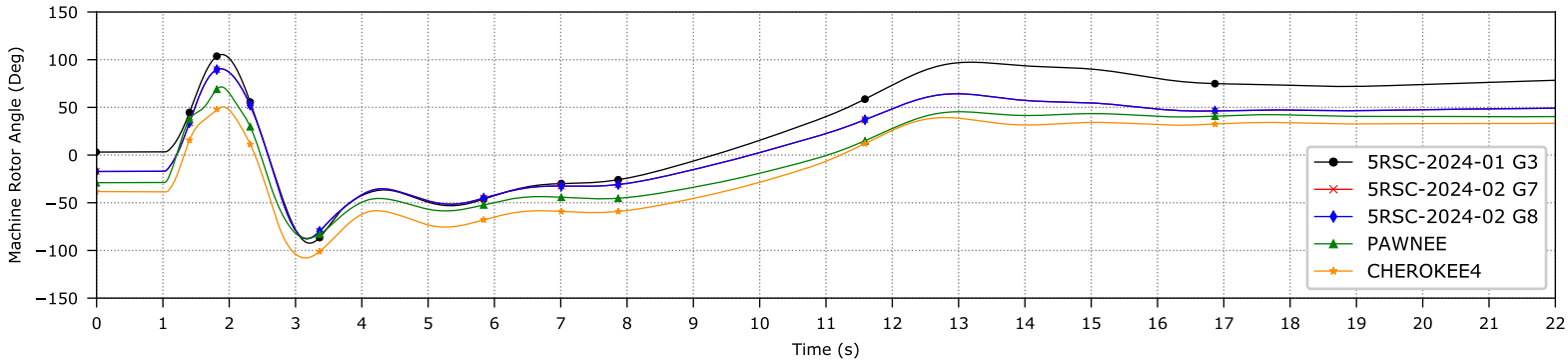


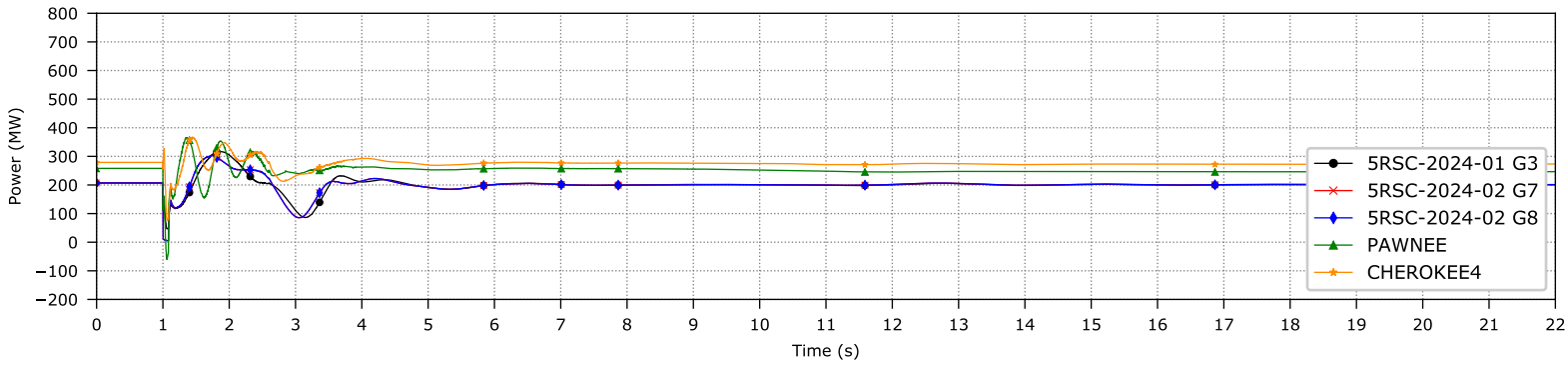


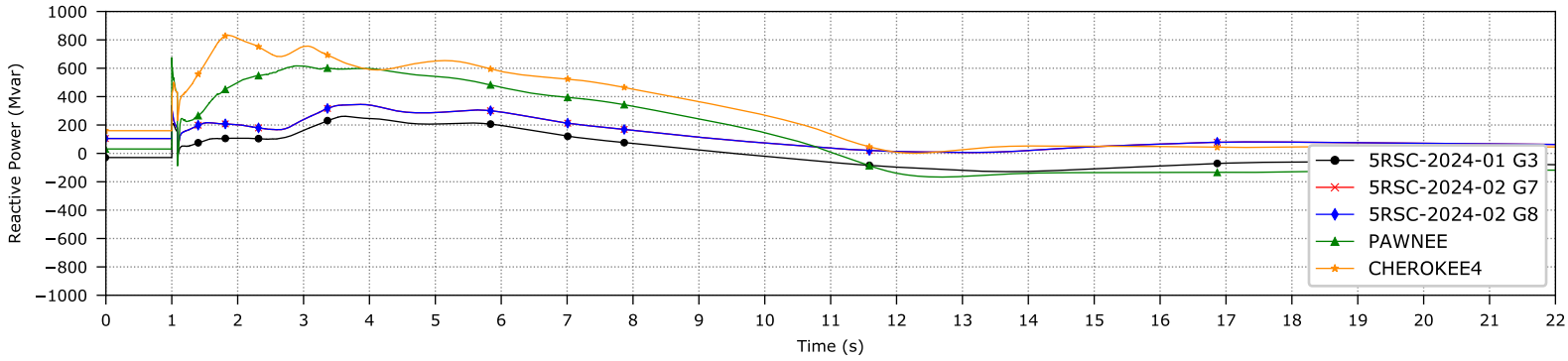


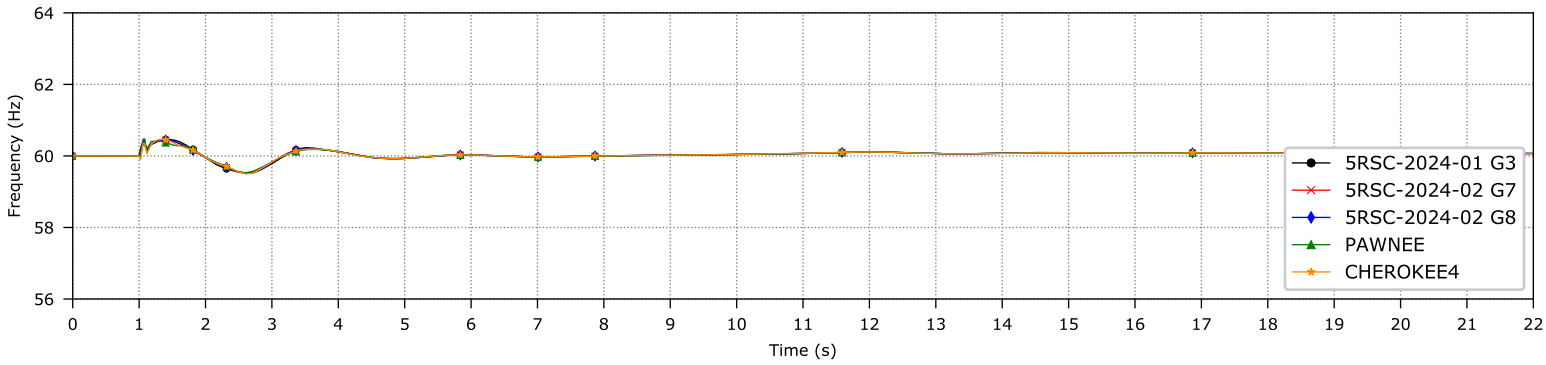


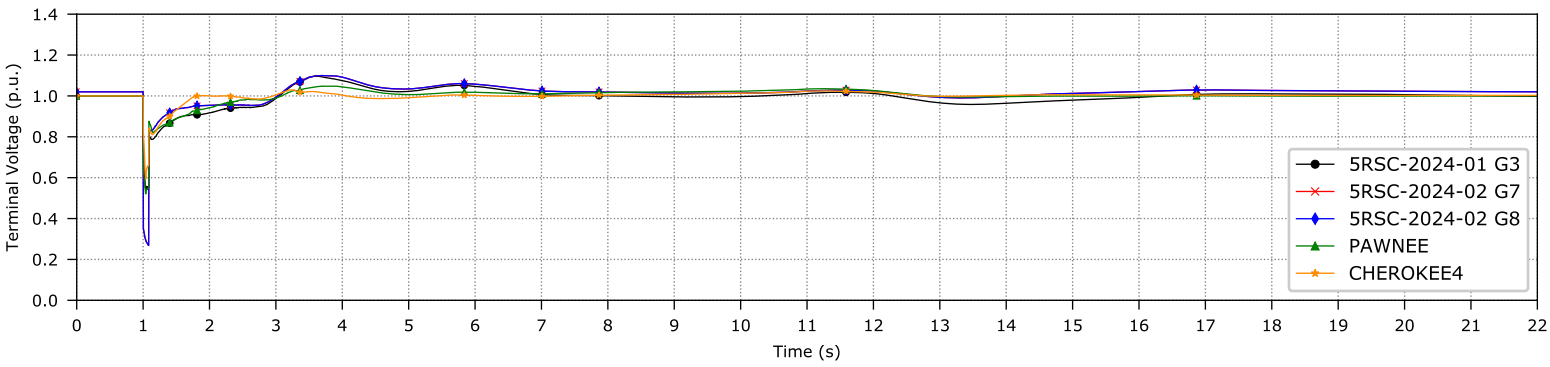


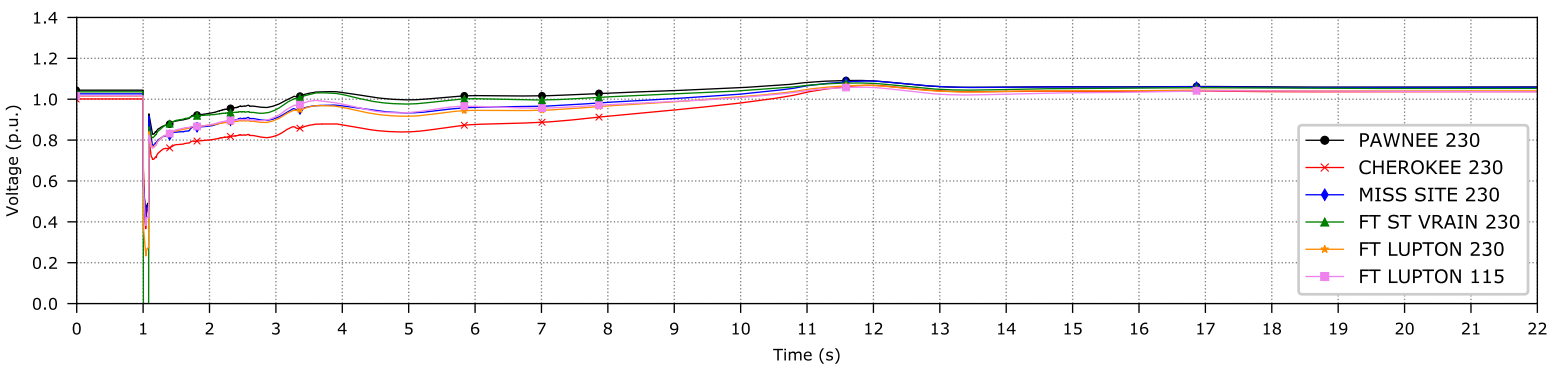

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

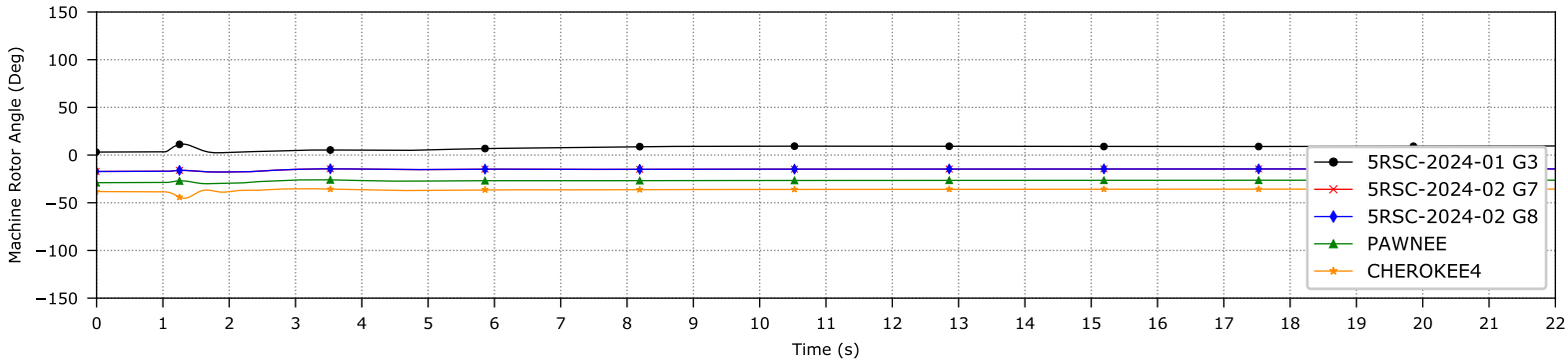

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

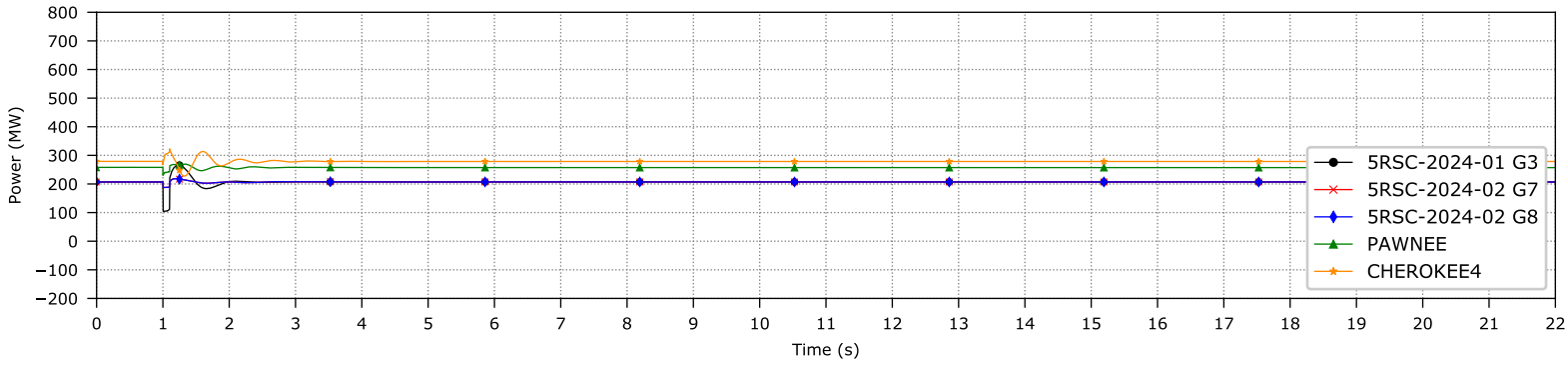

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

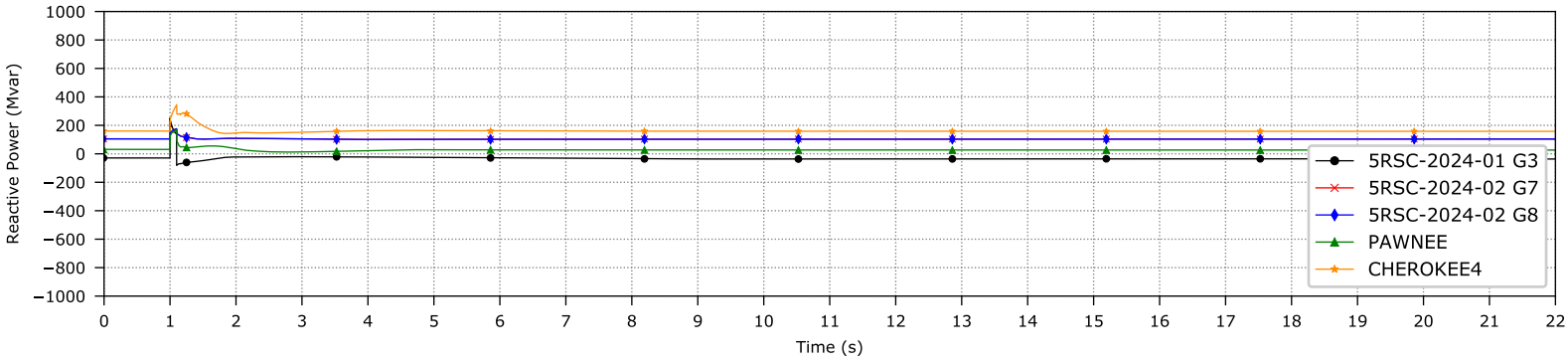

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

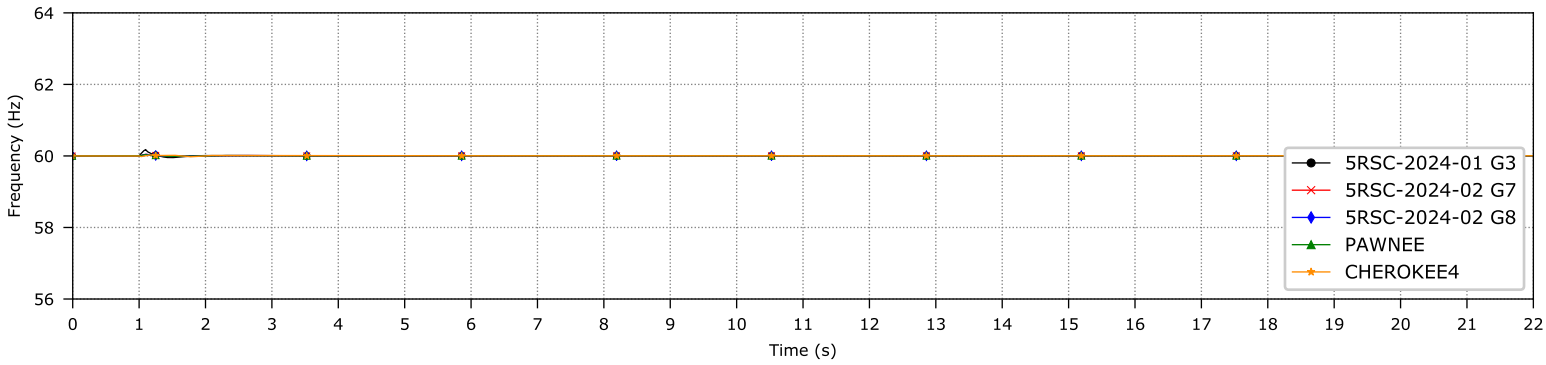

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

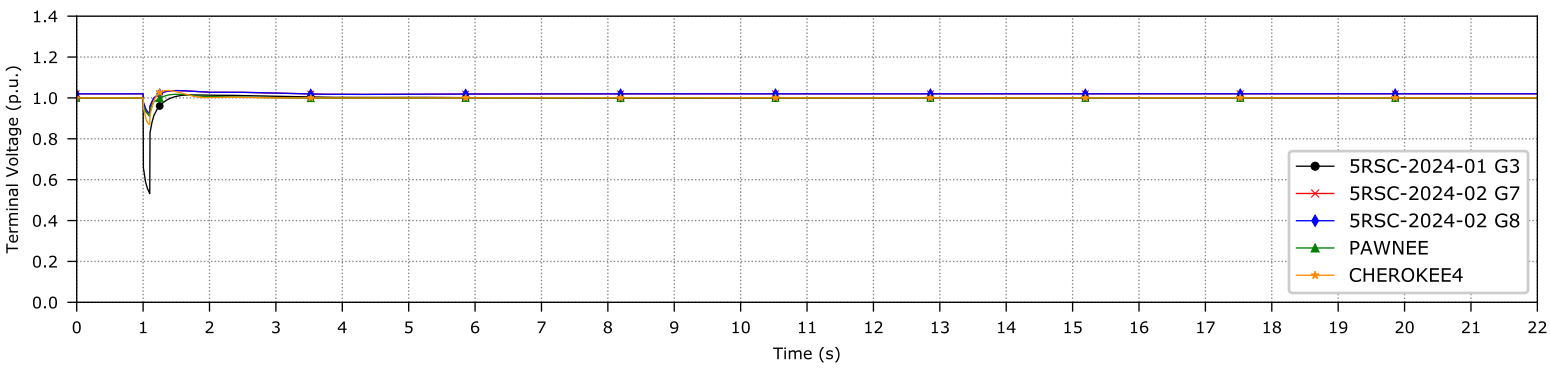
Ref. No. 12 - LoTC_195

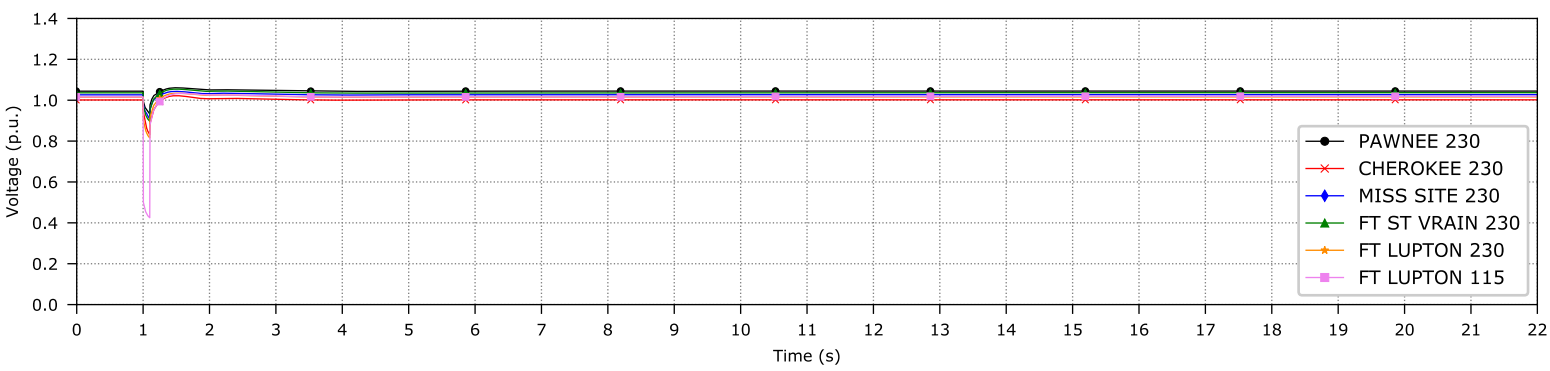




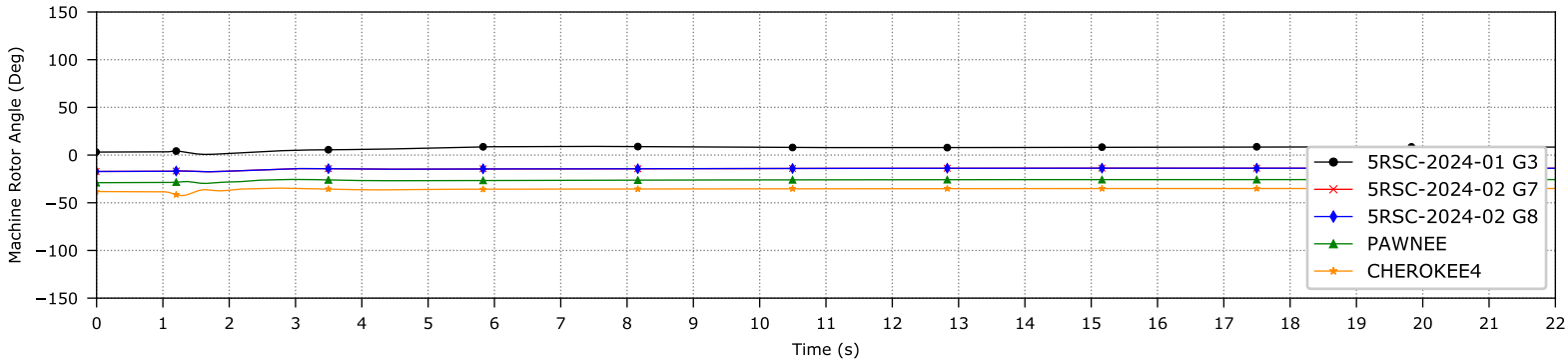


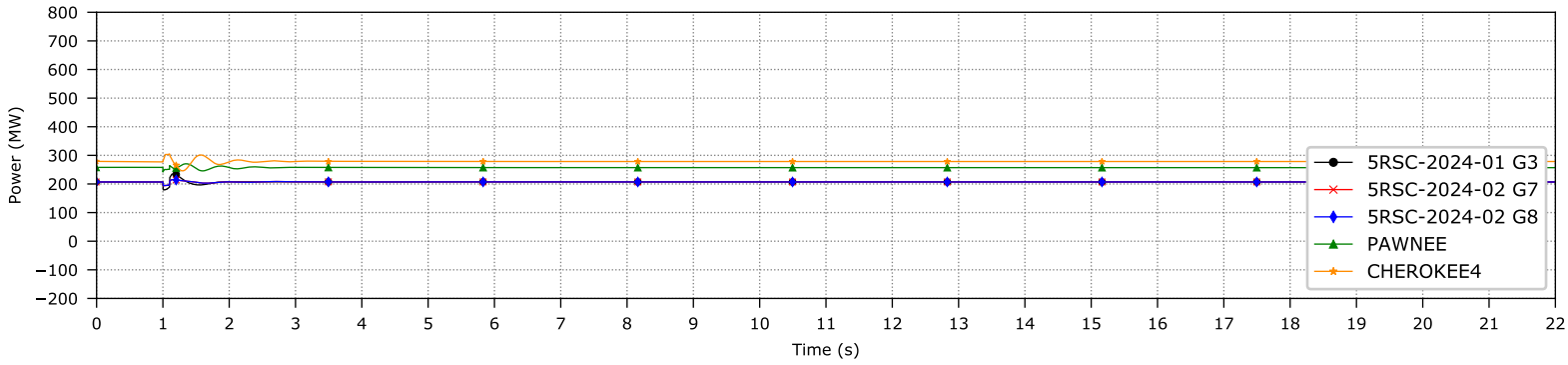


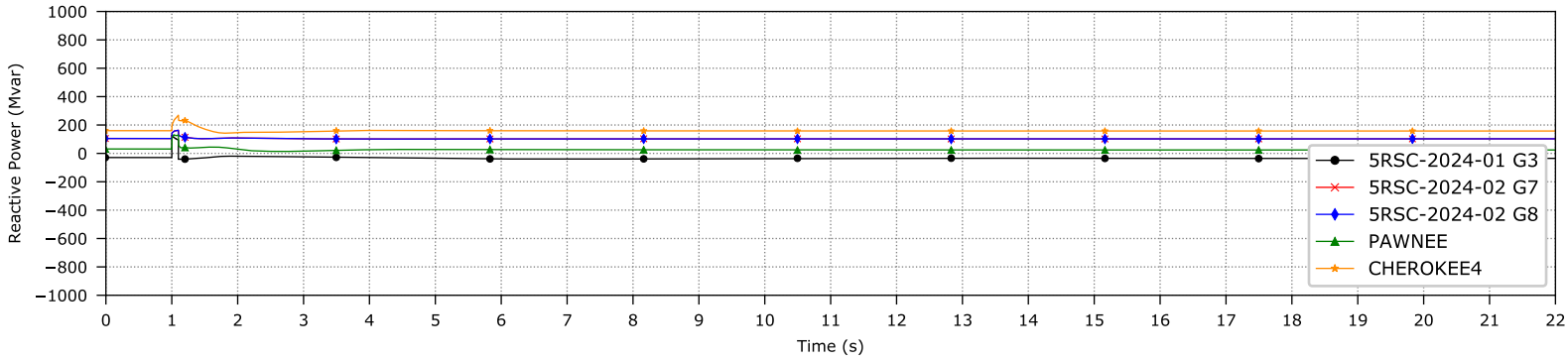


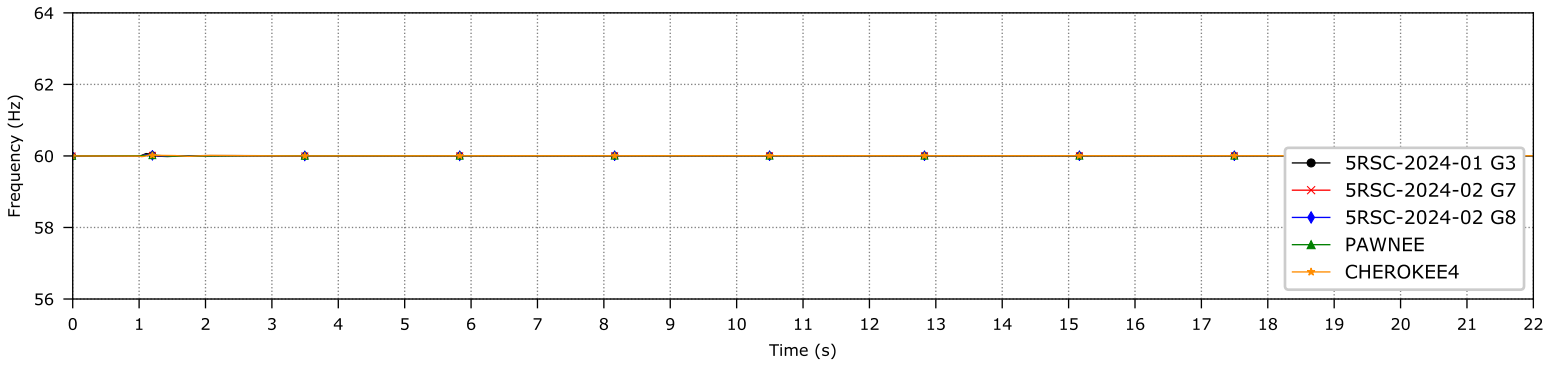


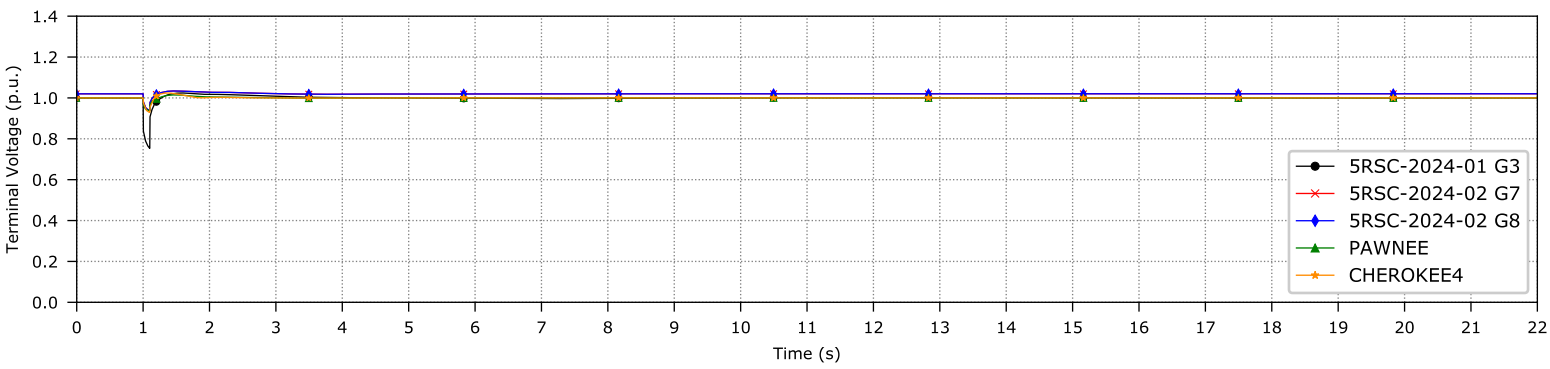
Ref. No. 13 - LoTC_237

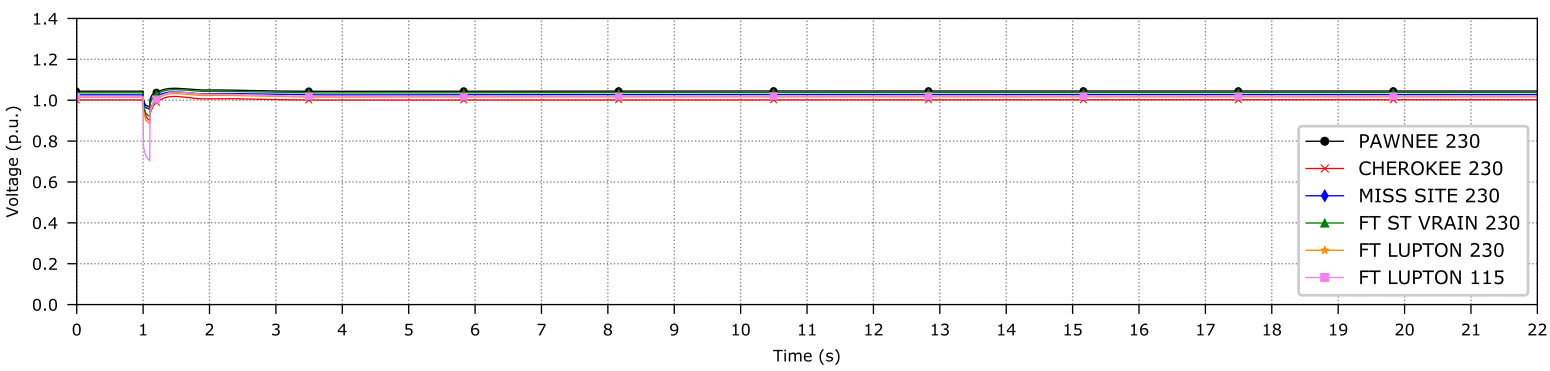


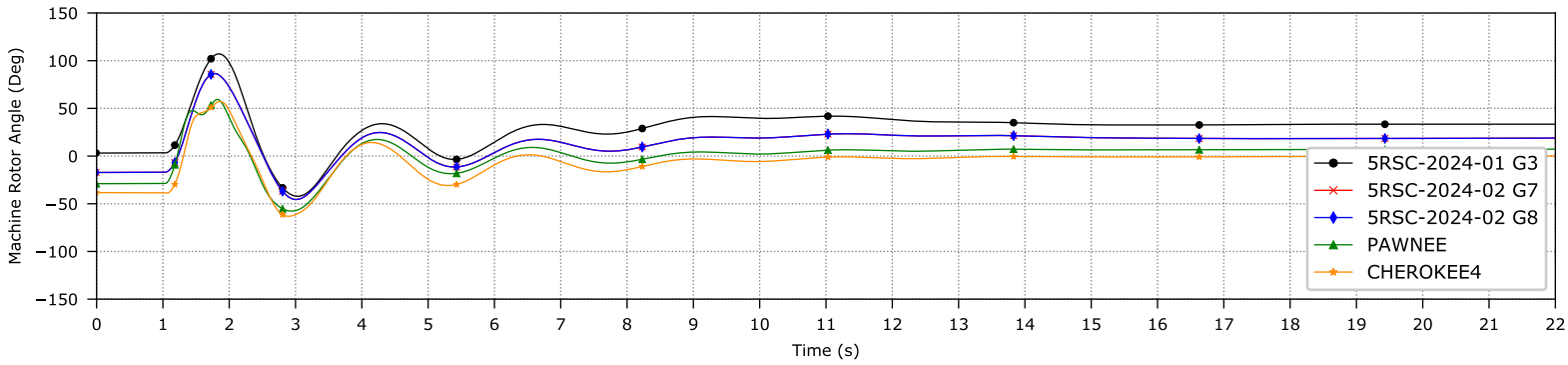


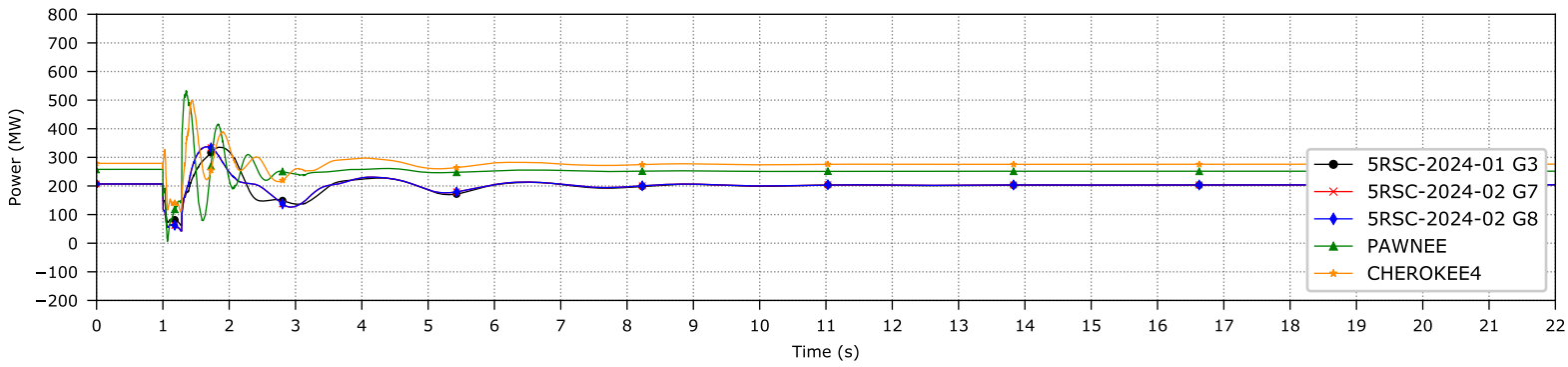


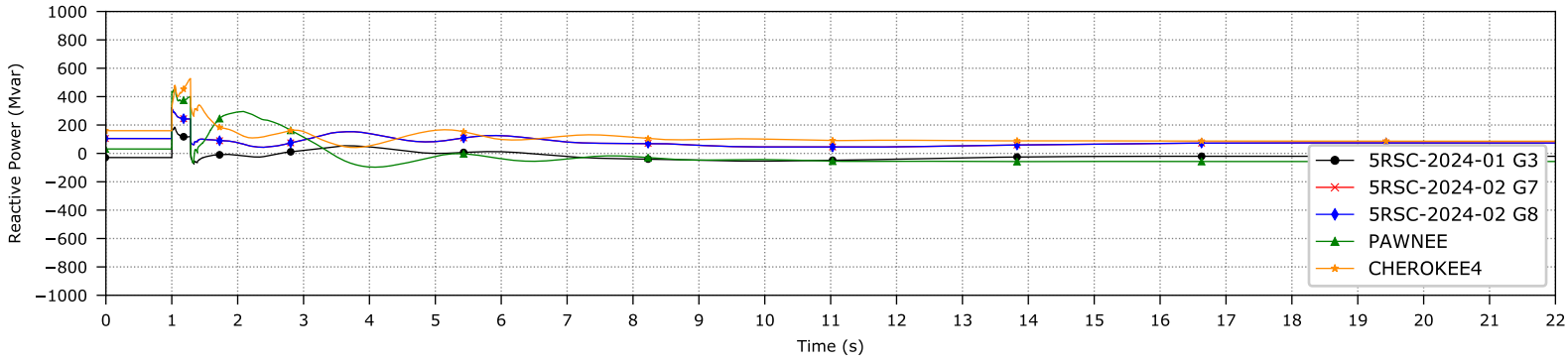


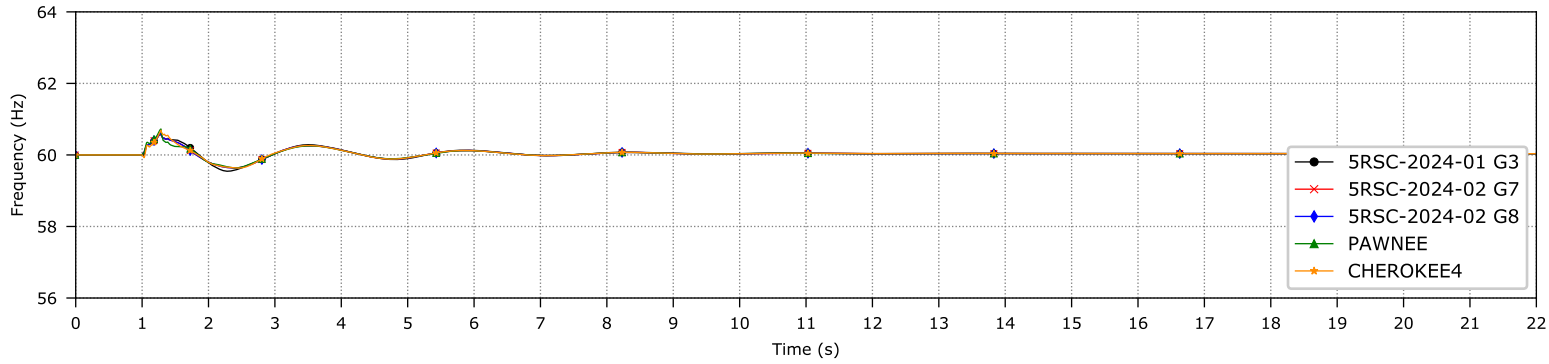


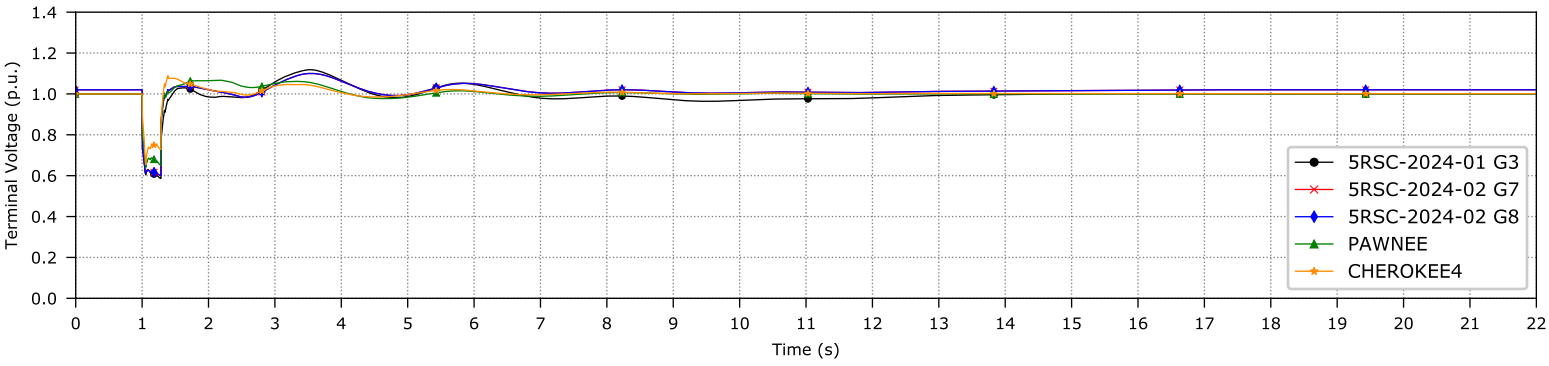


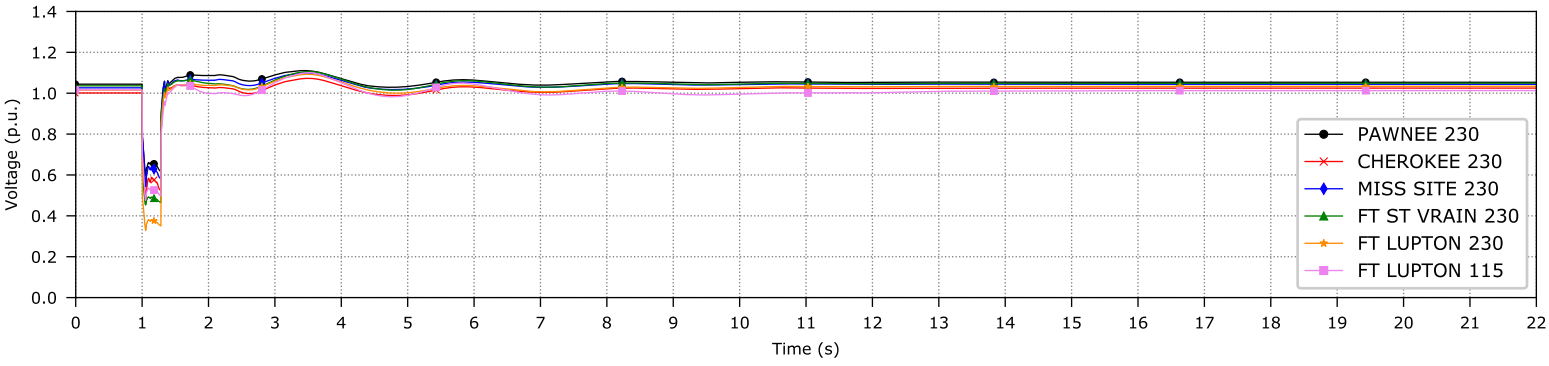

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

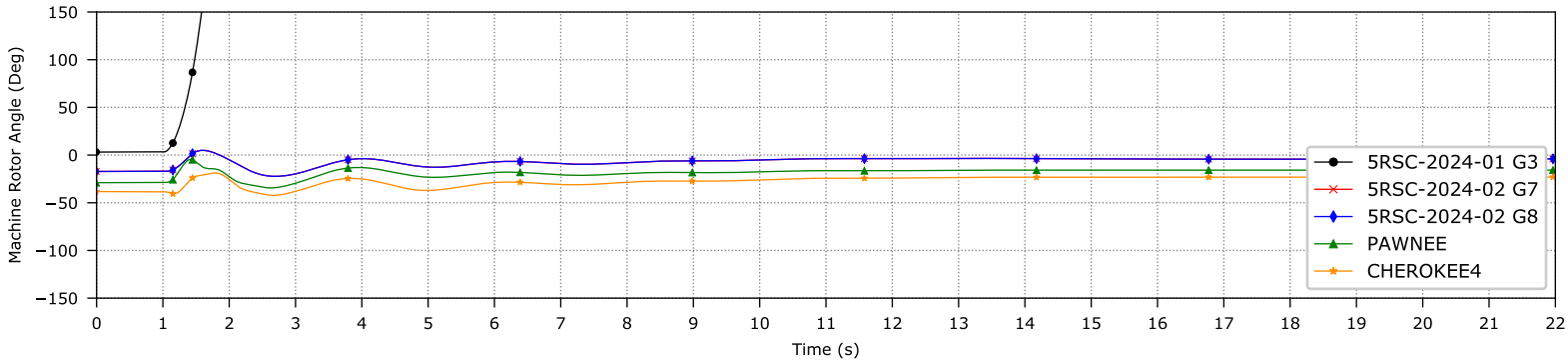

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

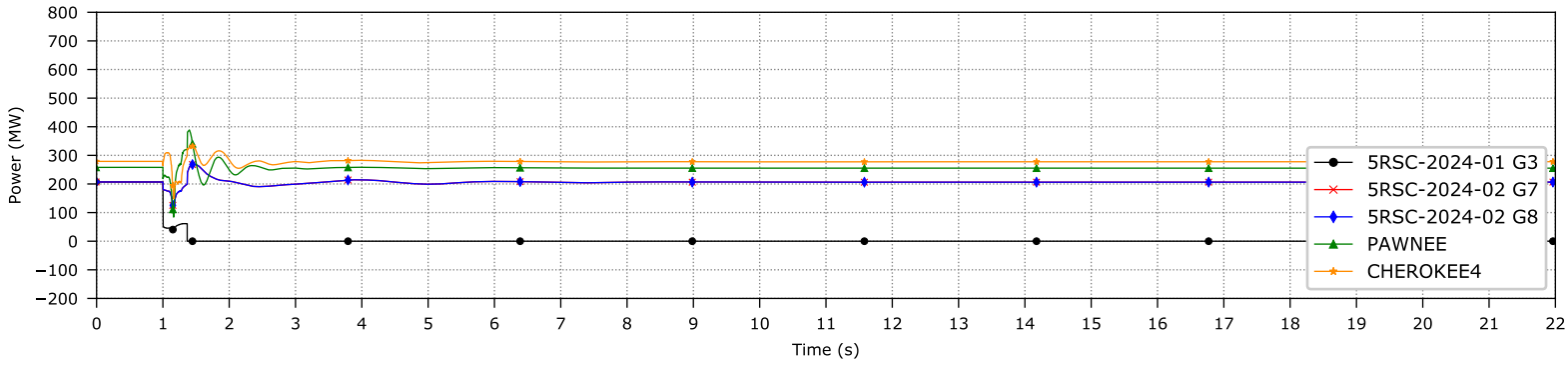

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

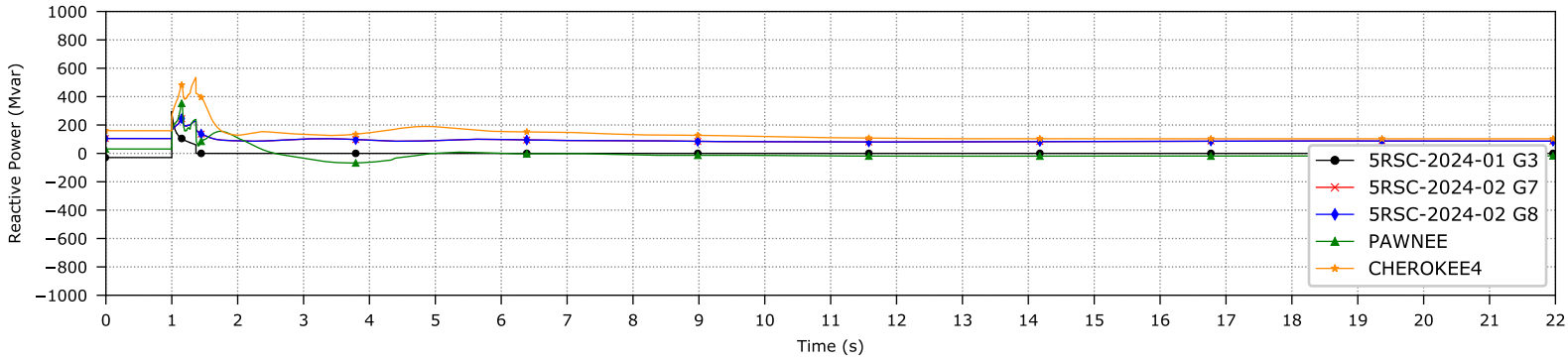

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

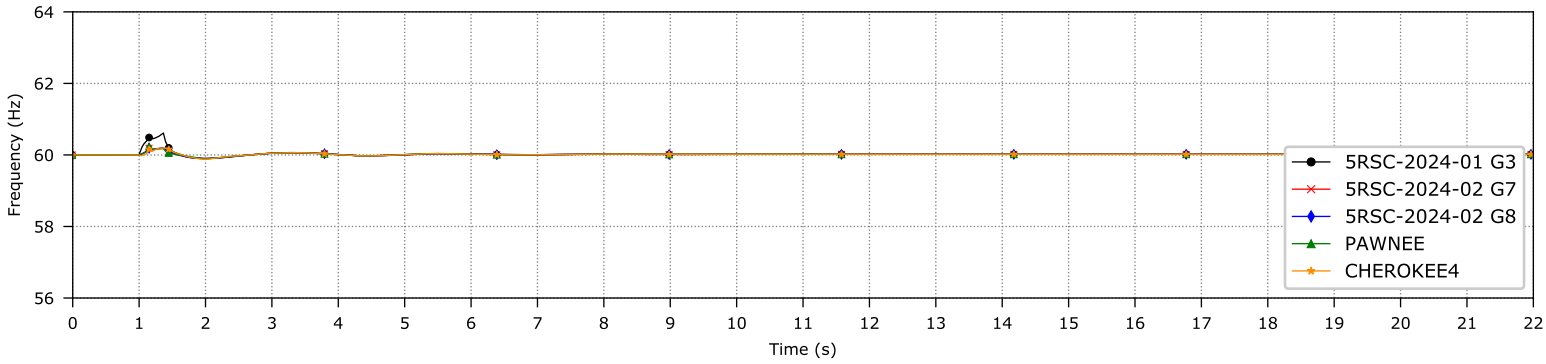

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

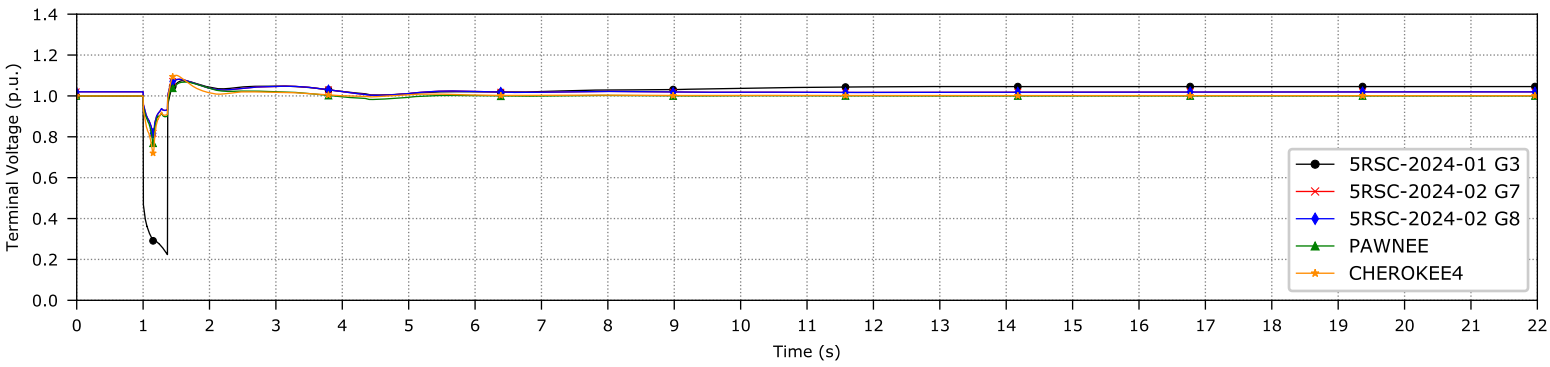
Ref. No. 15 - BF_057d

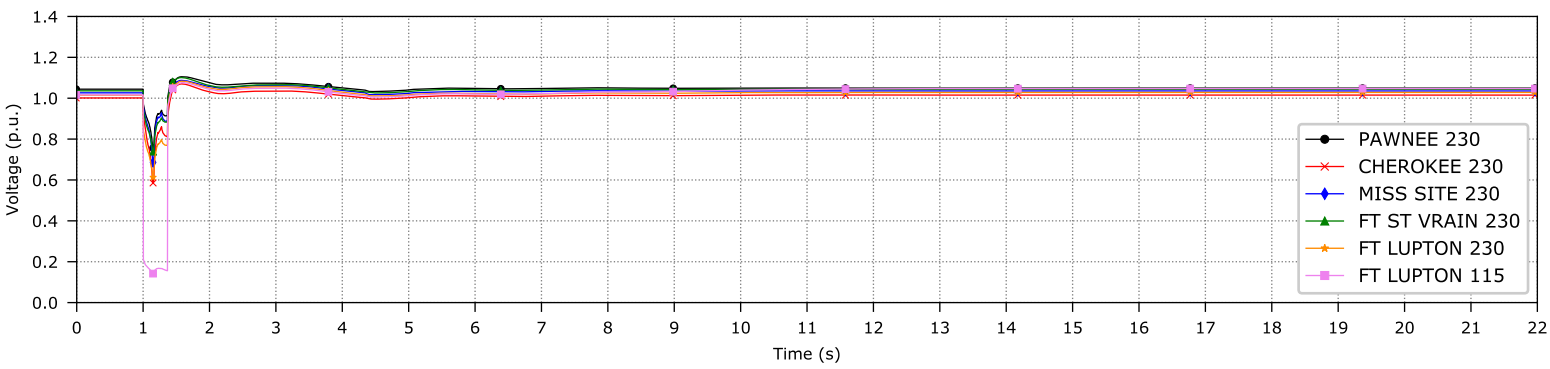












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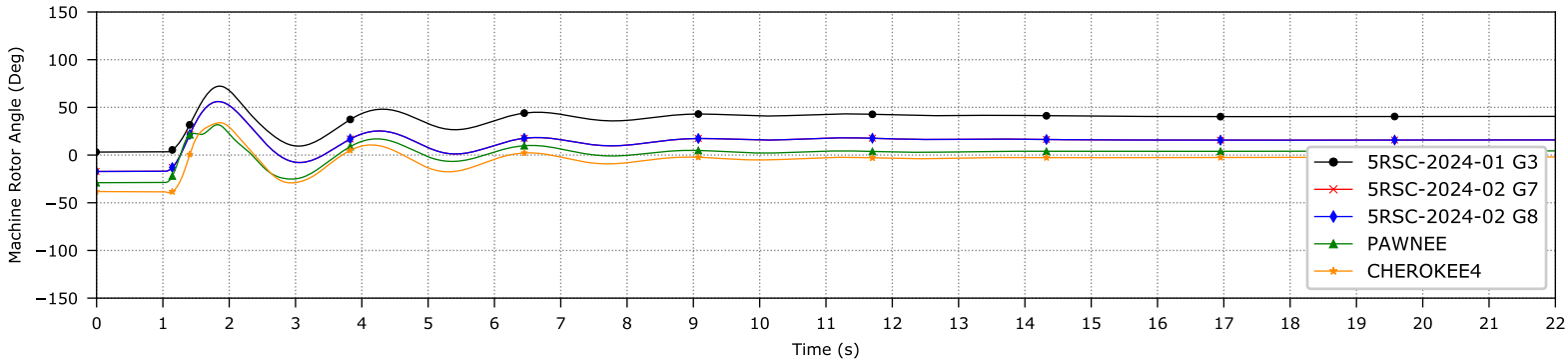

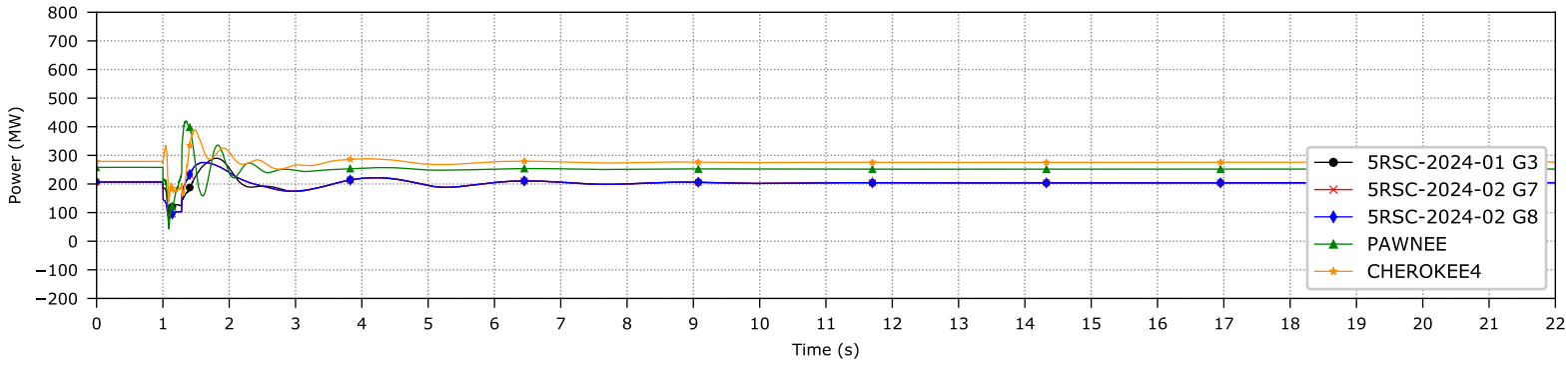

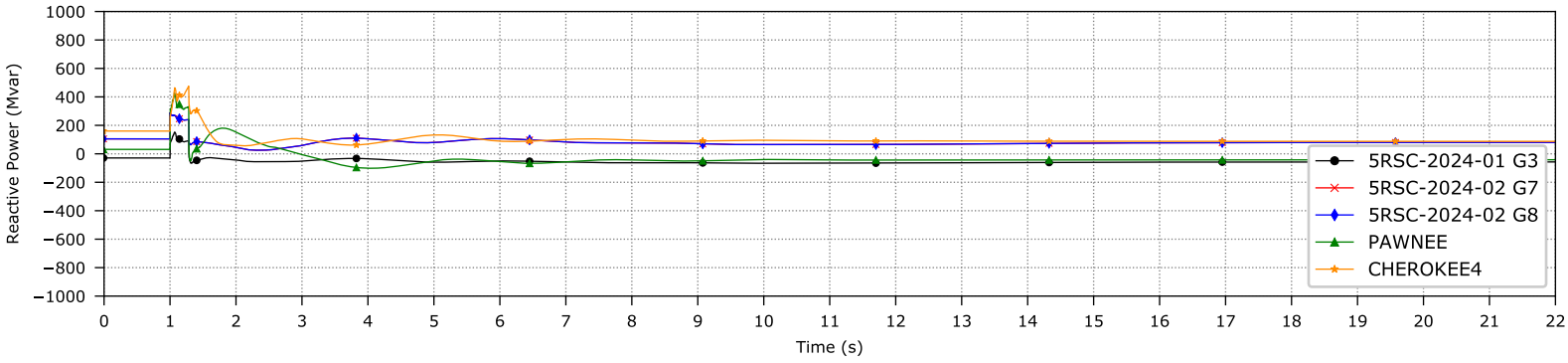

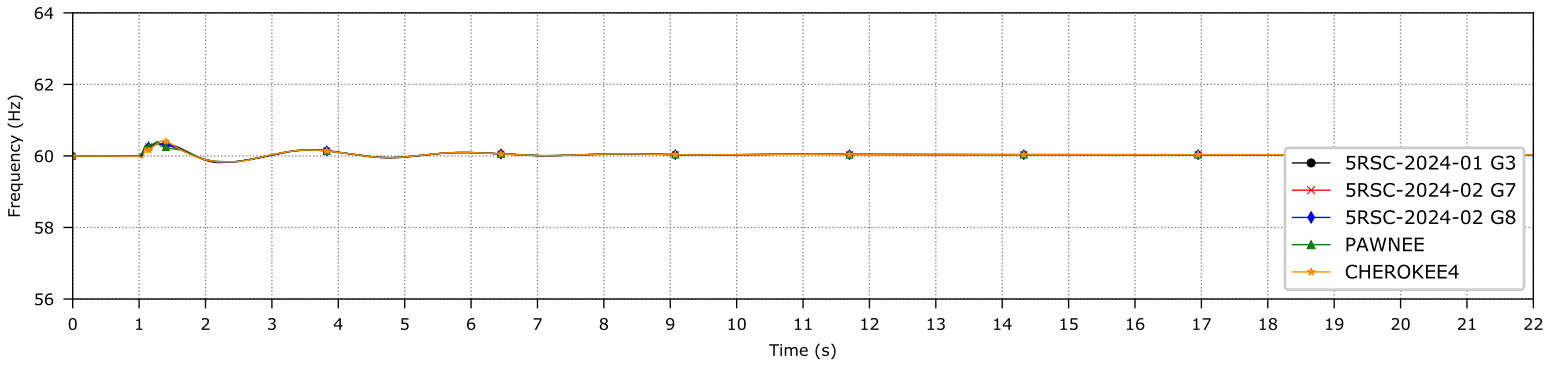

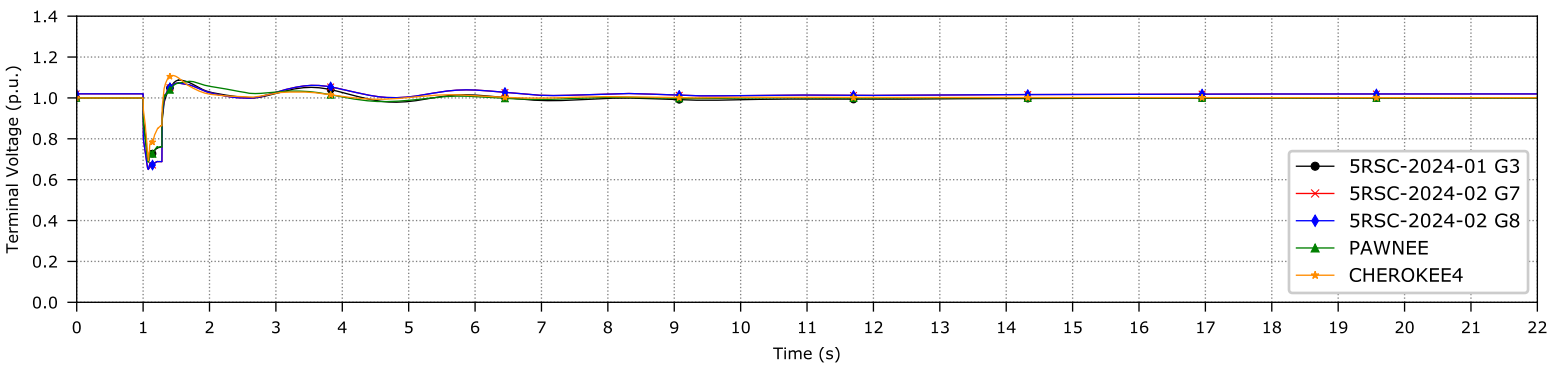

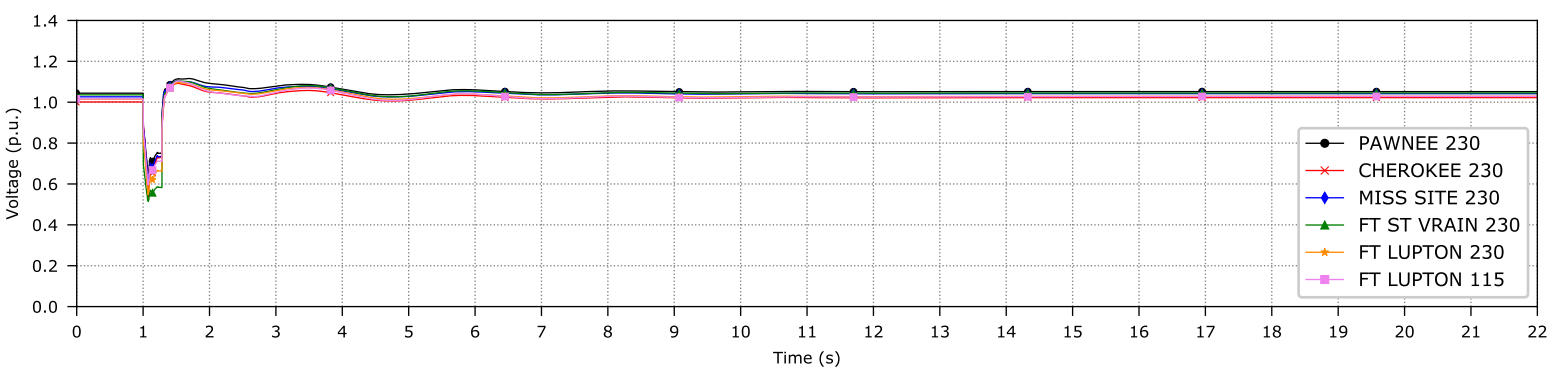

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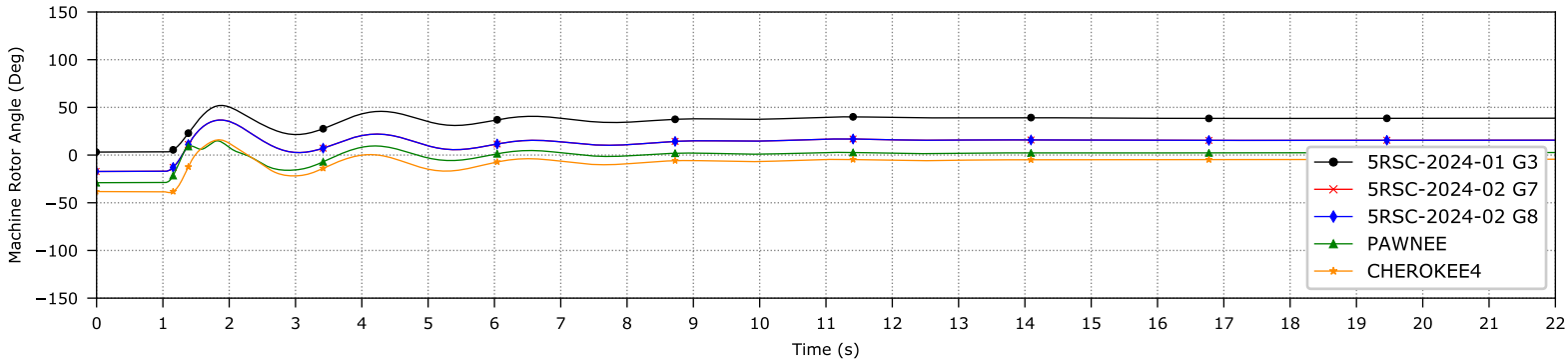
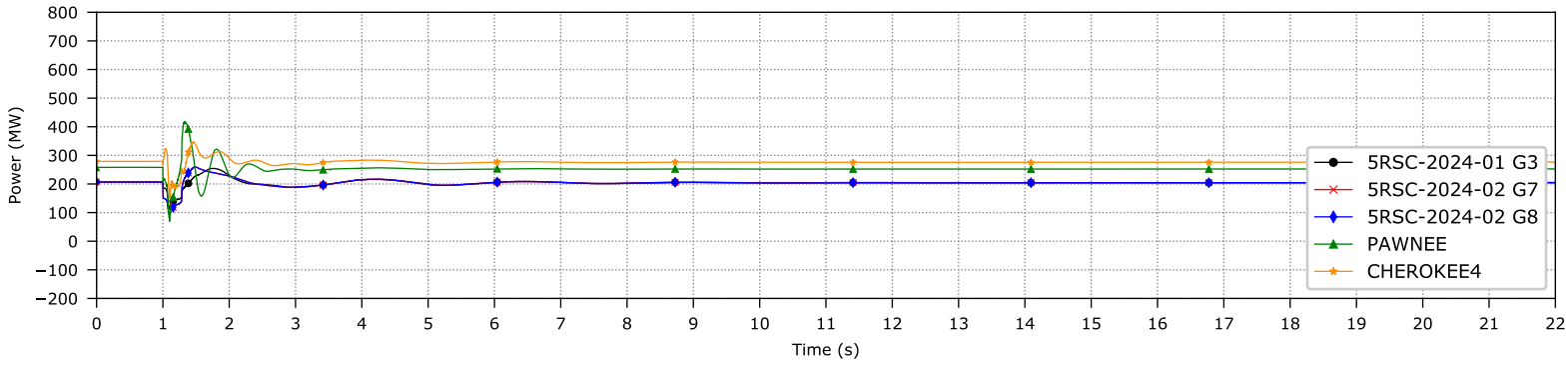
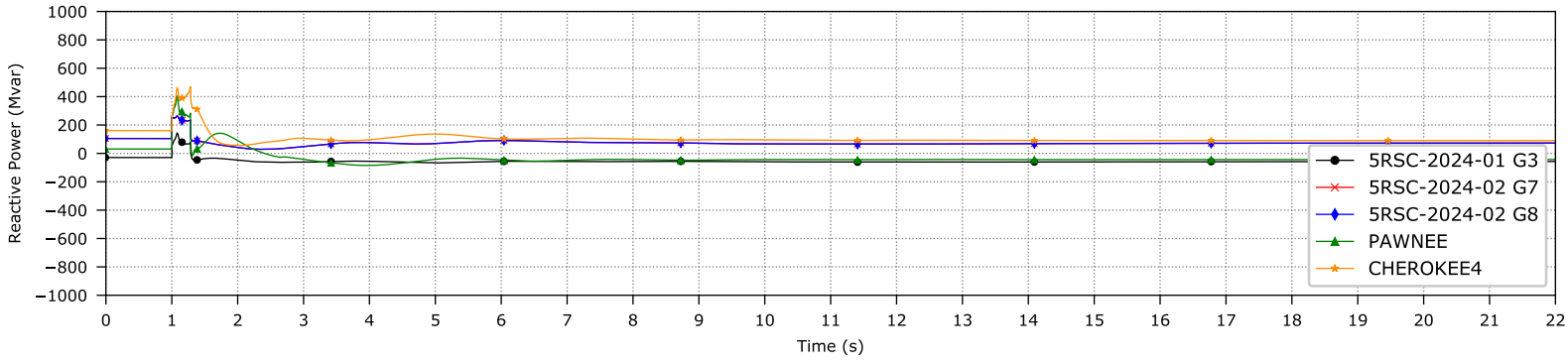
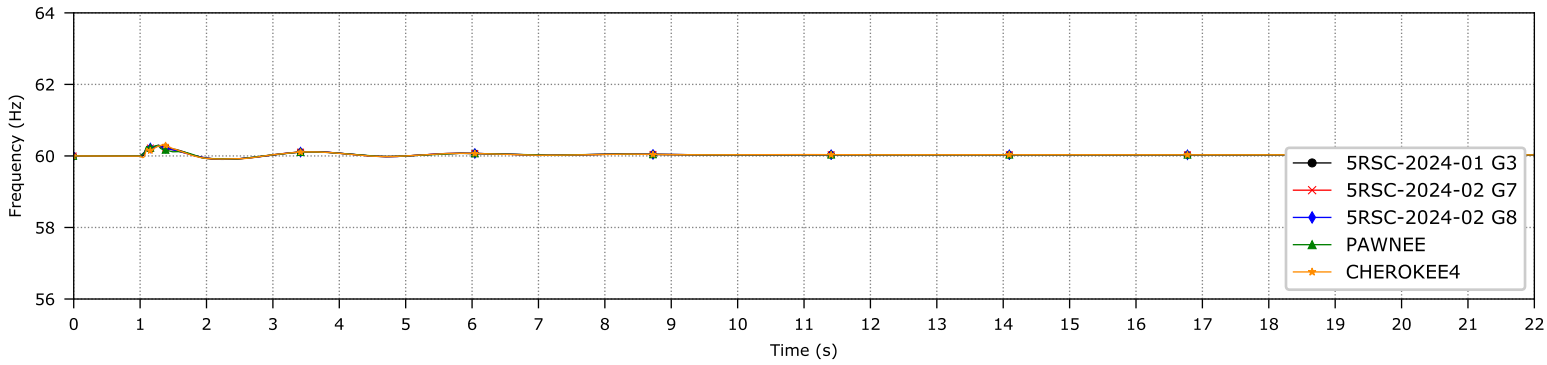
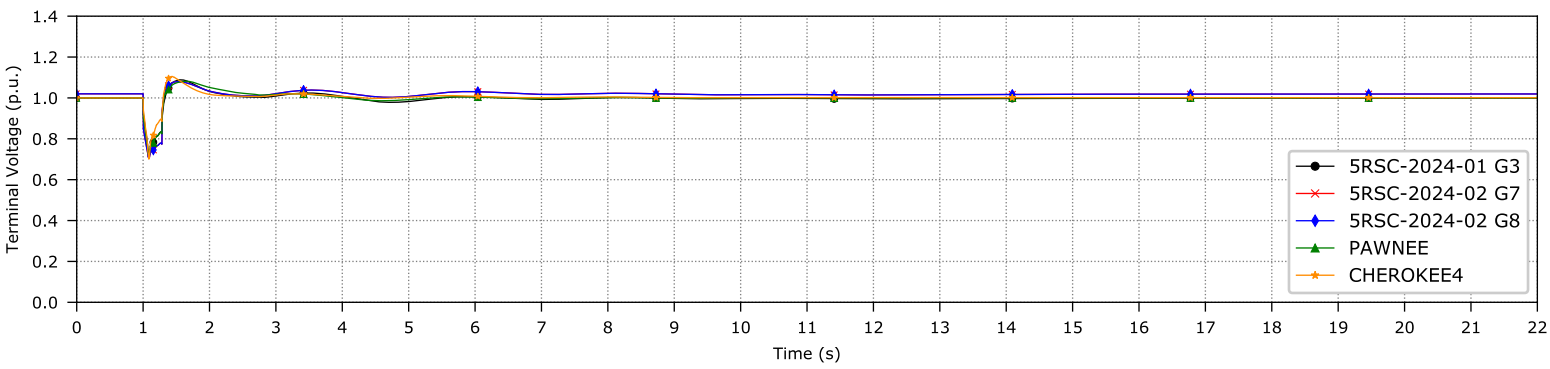
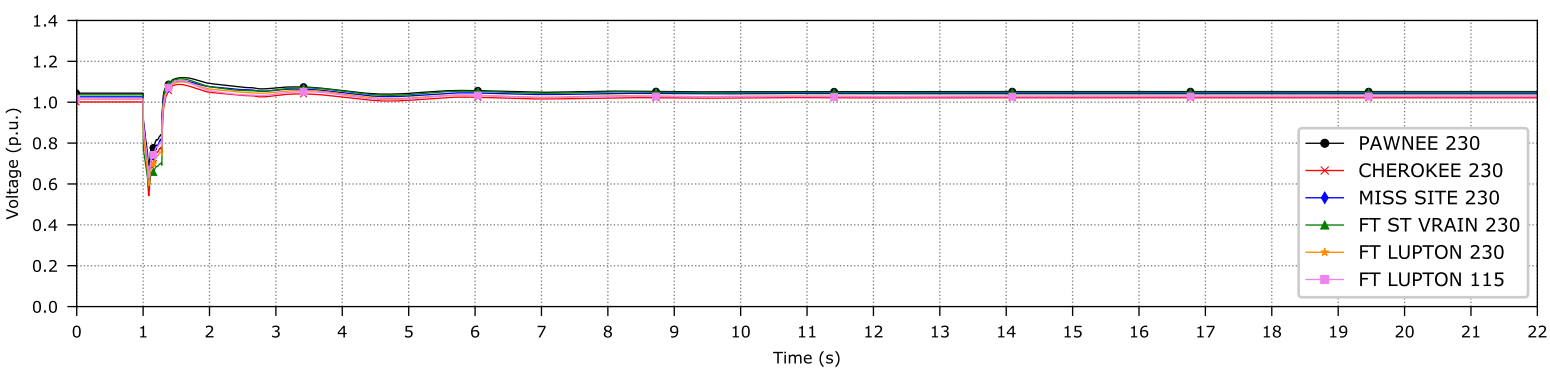




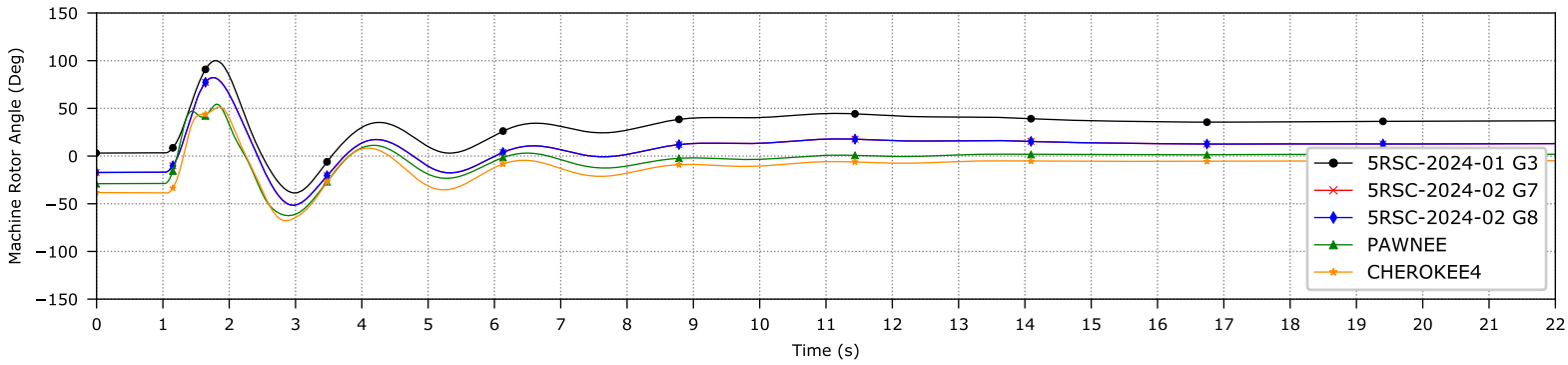


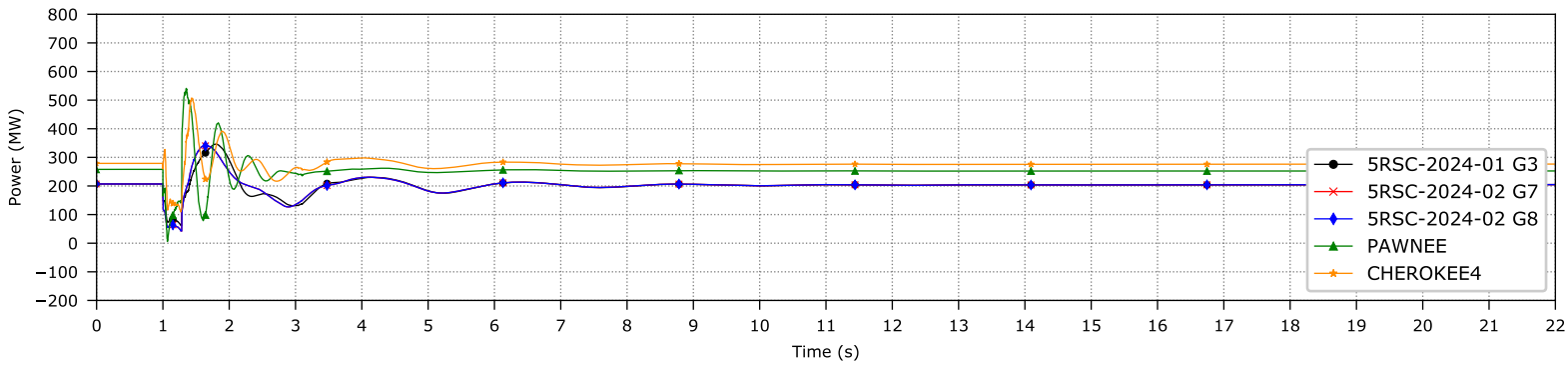


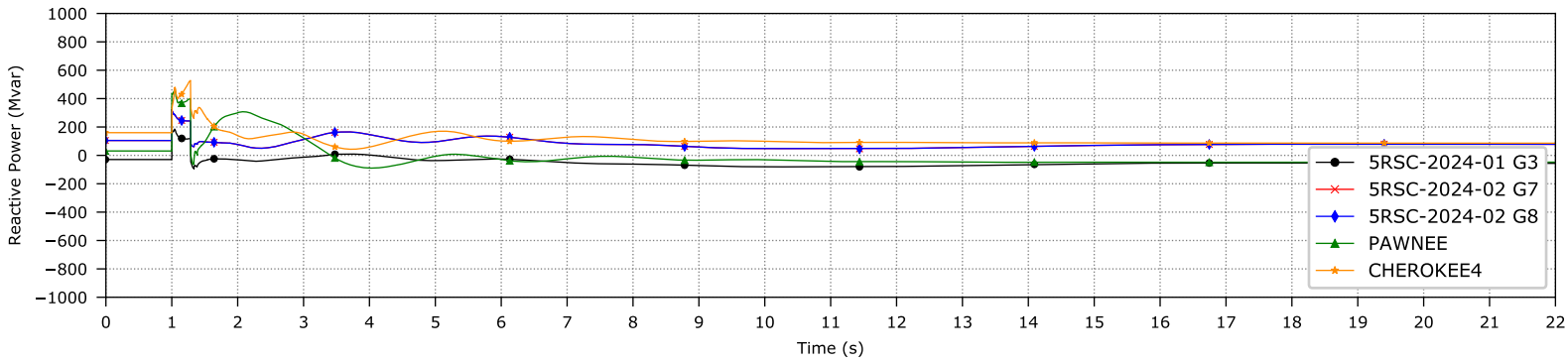


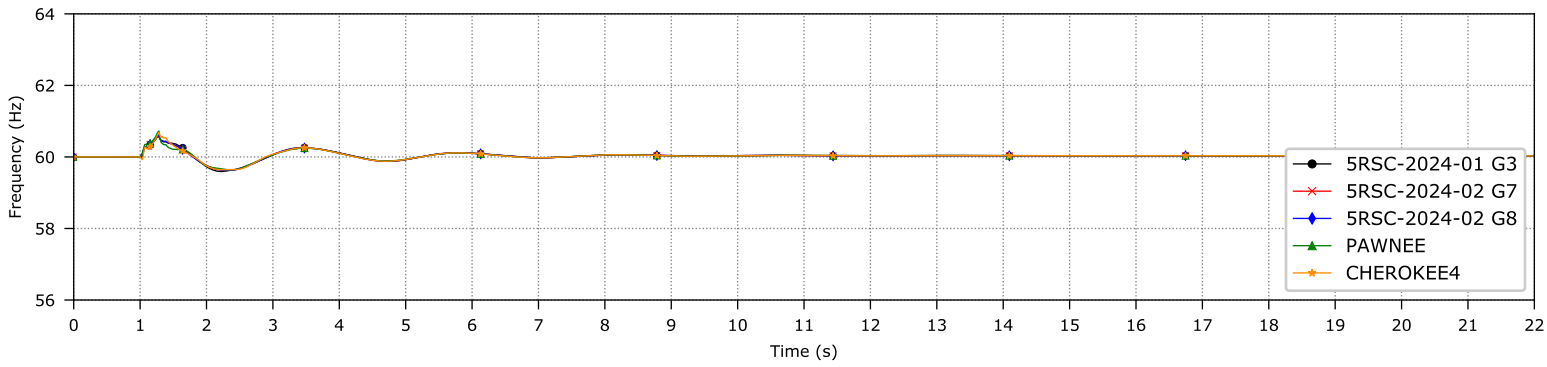


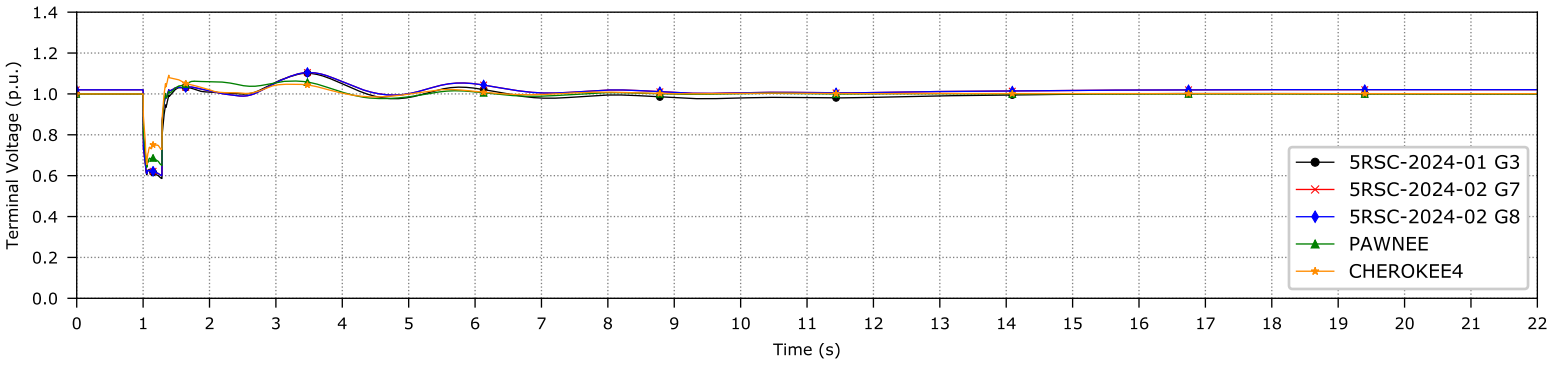
Ref. No. 18 - BF_058d

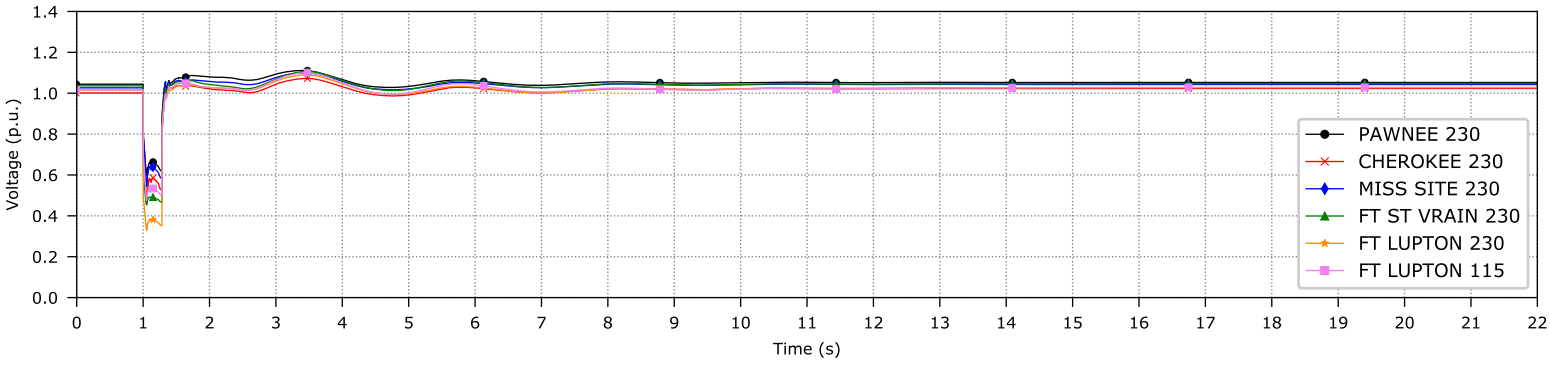


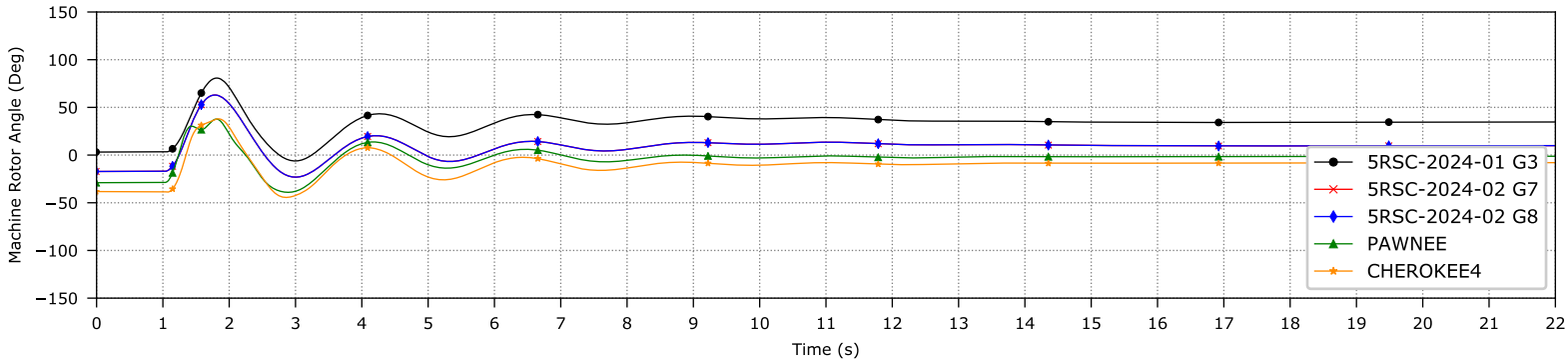


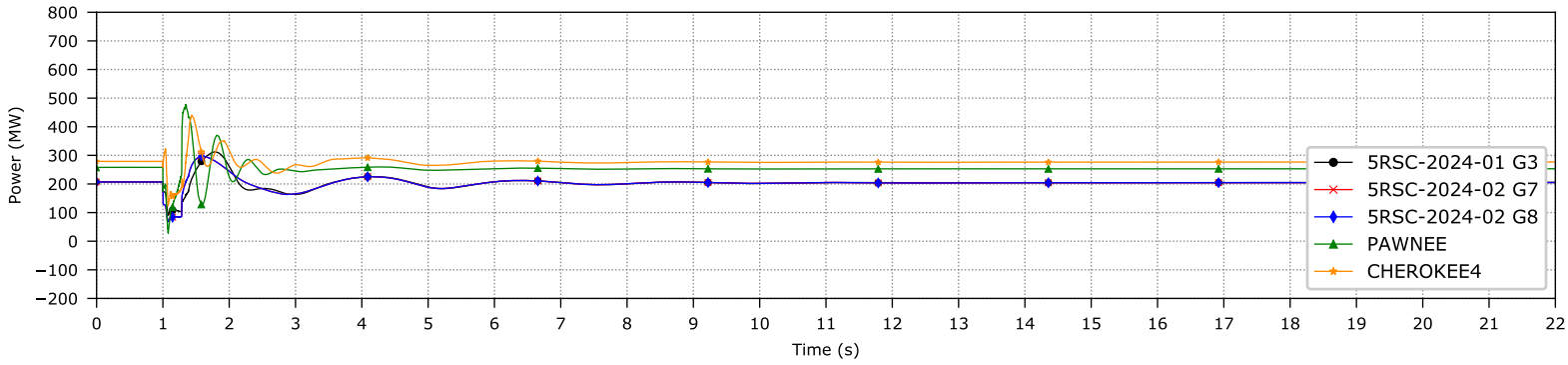


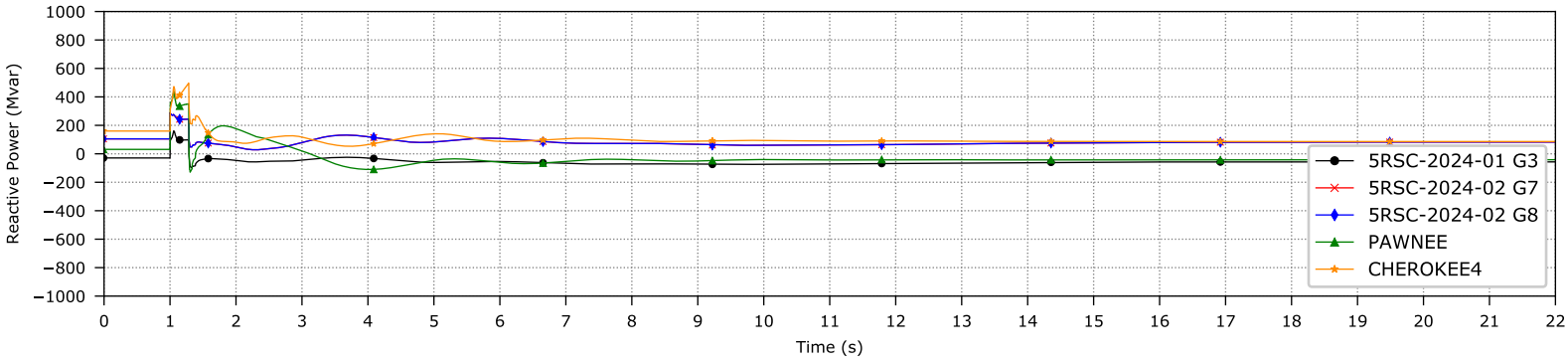


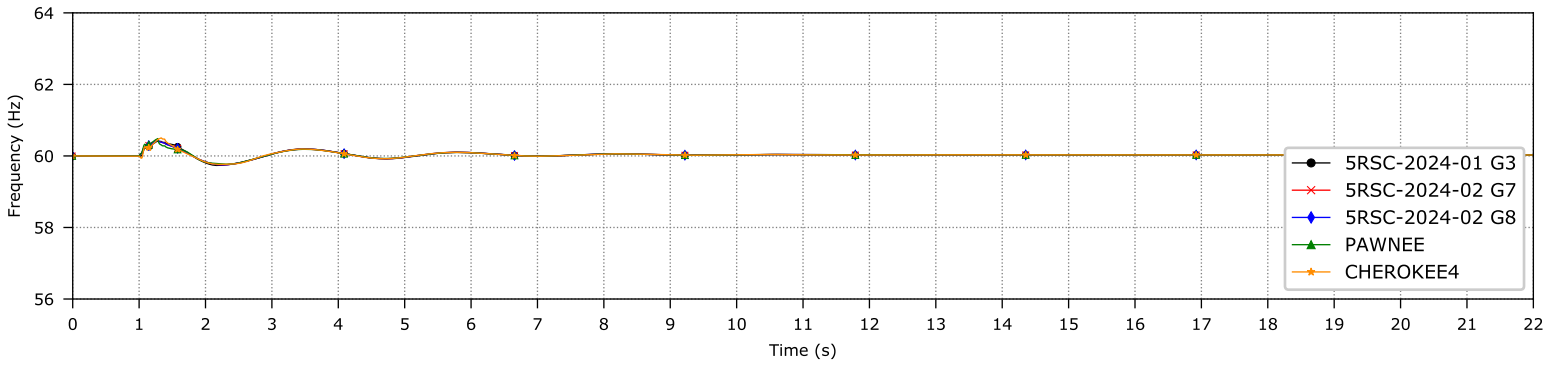


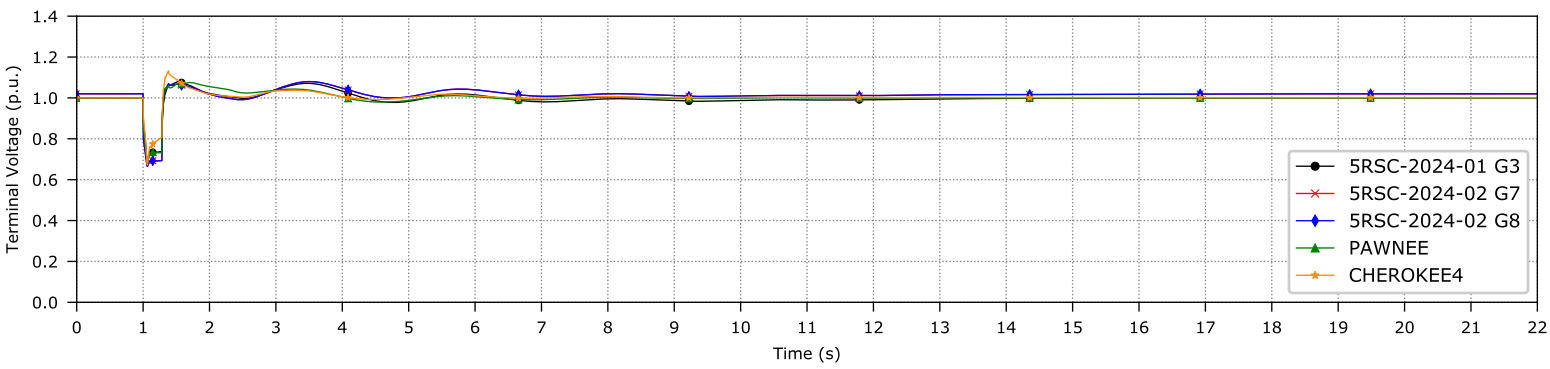


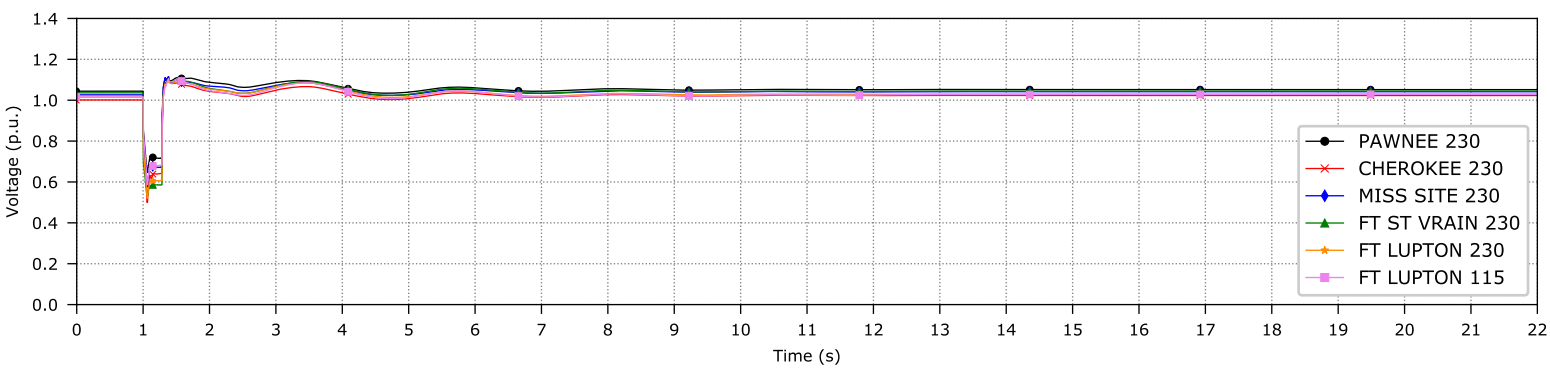

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

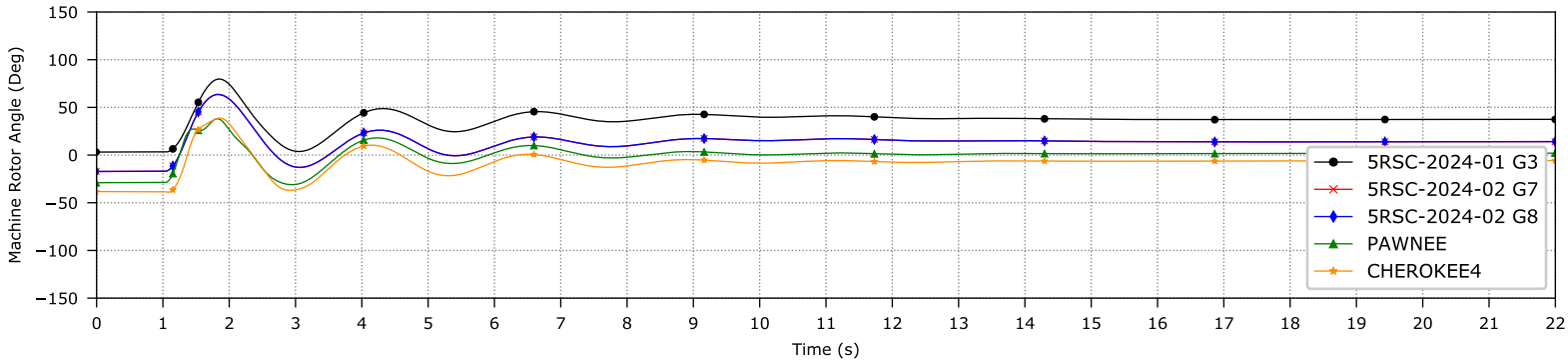

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

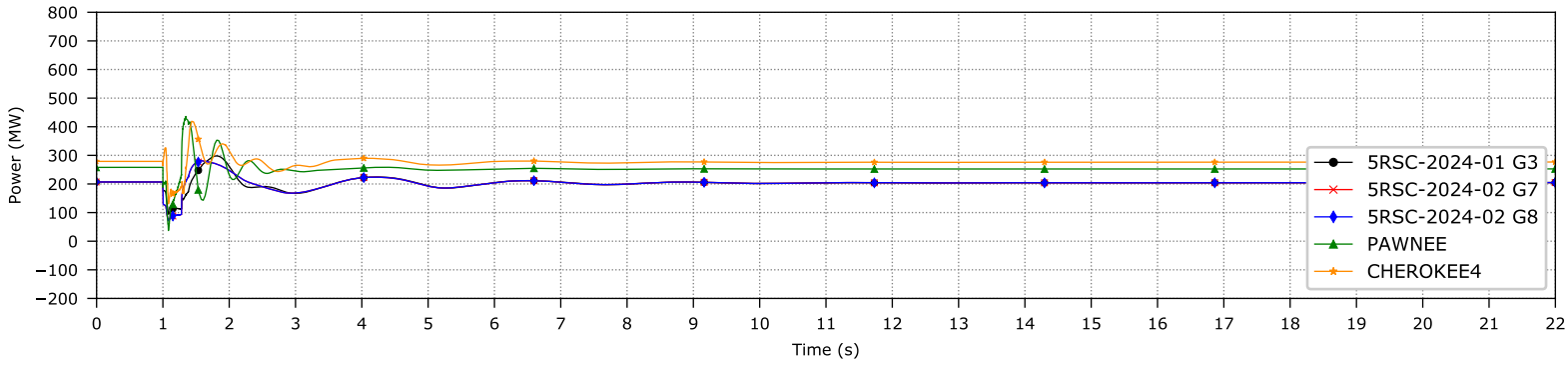

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

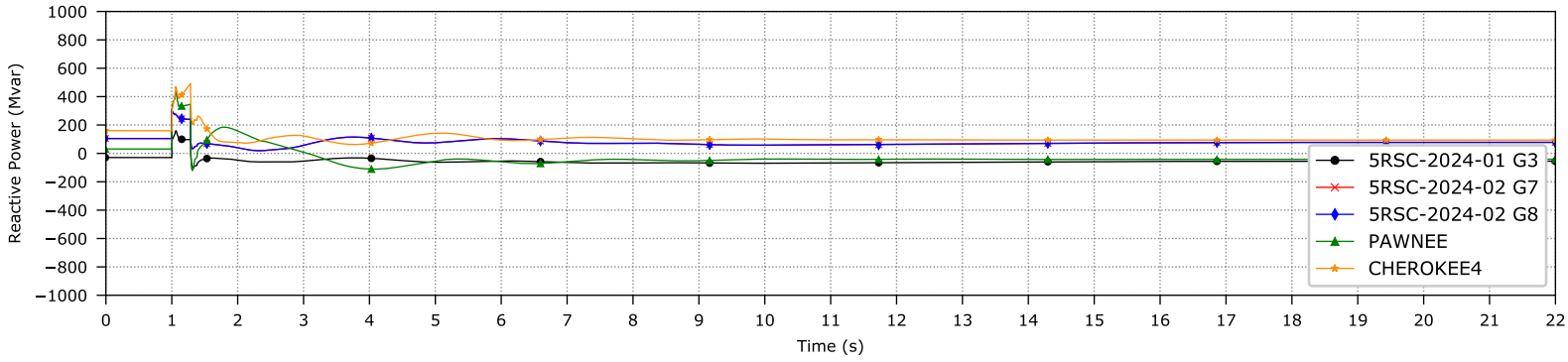

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

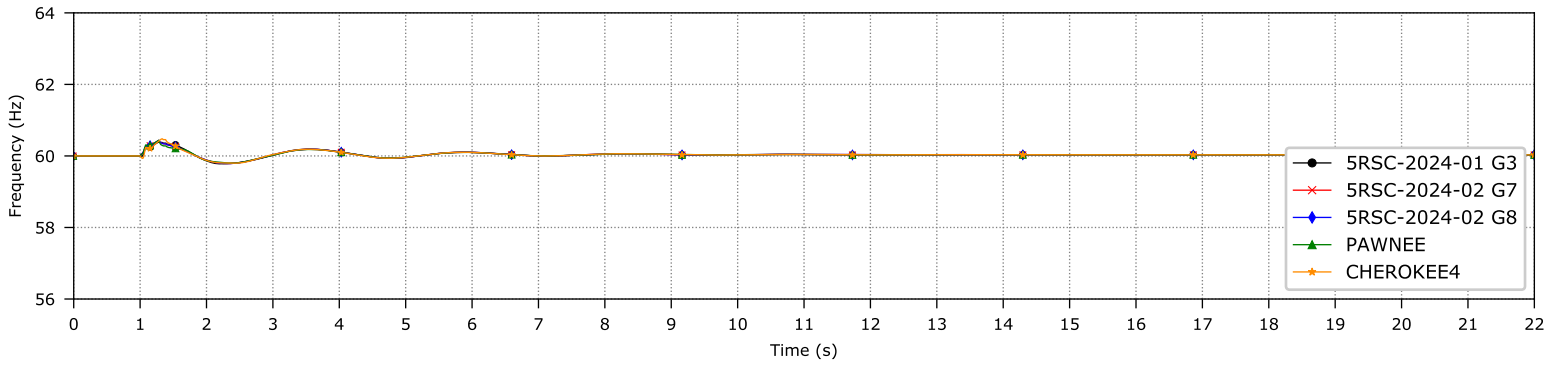

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

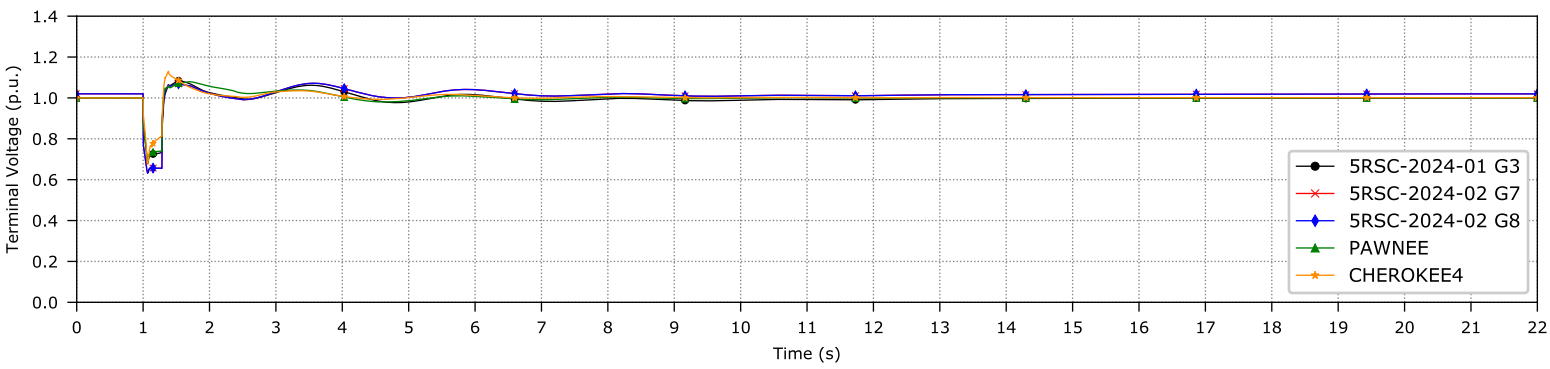
Ref. No. 20 - BF_145a

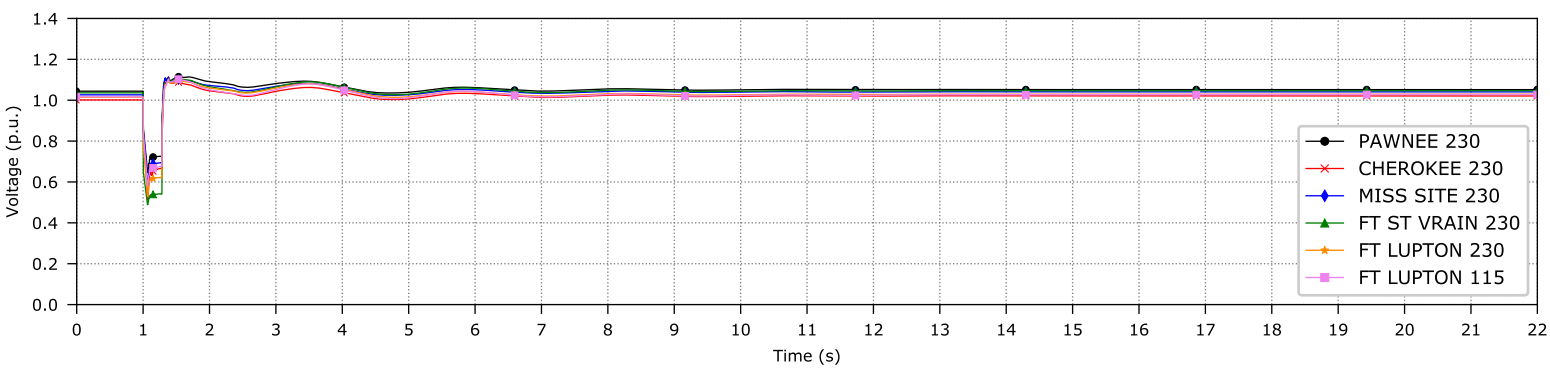




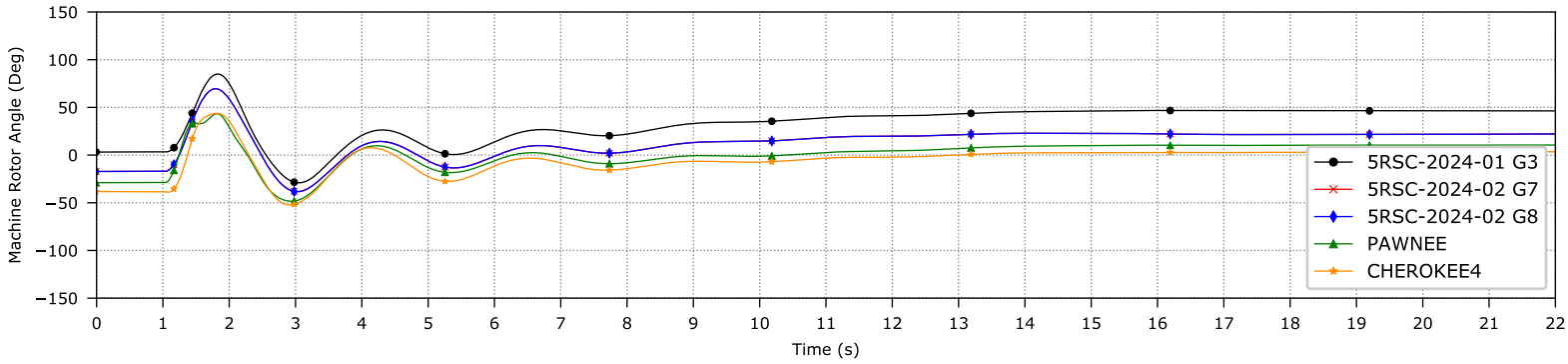


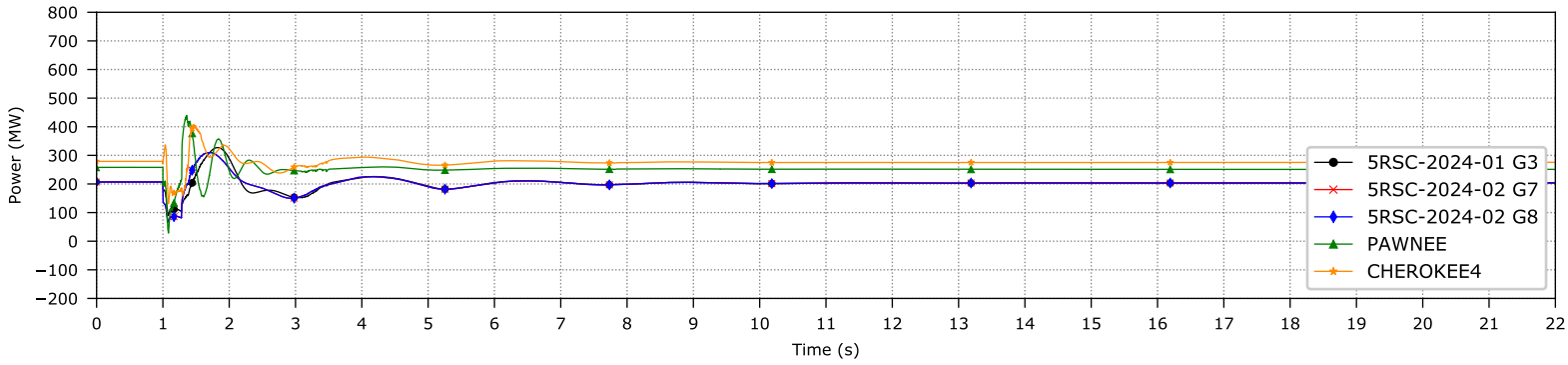


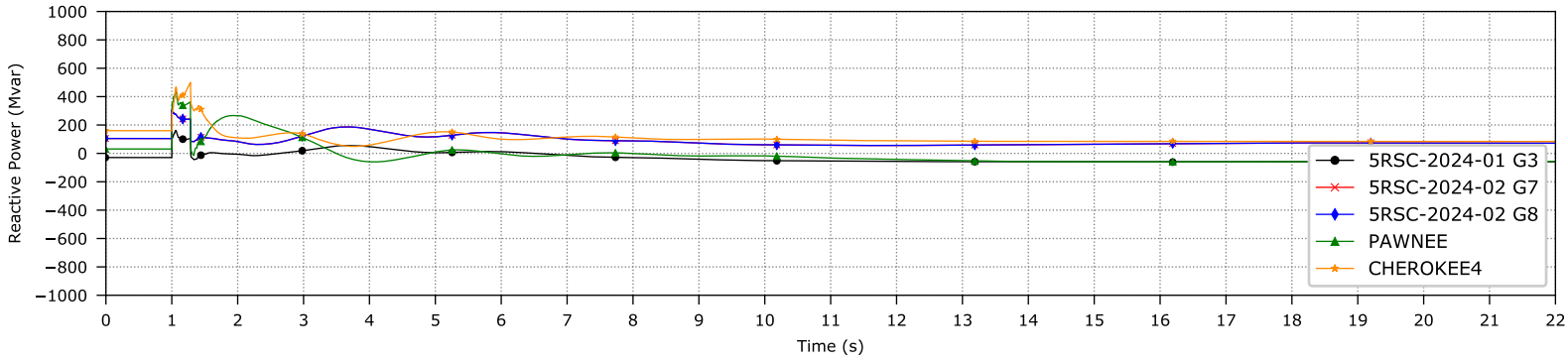


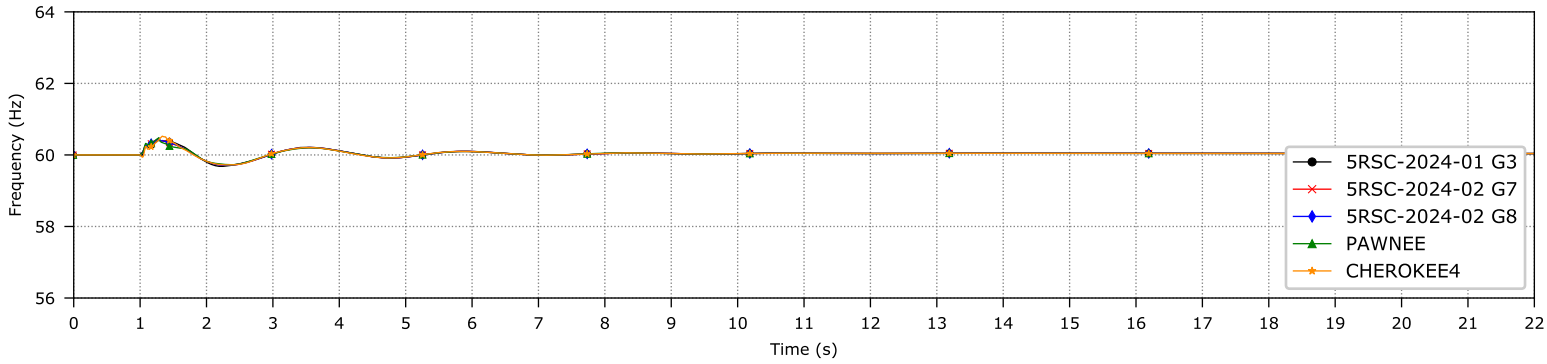


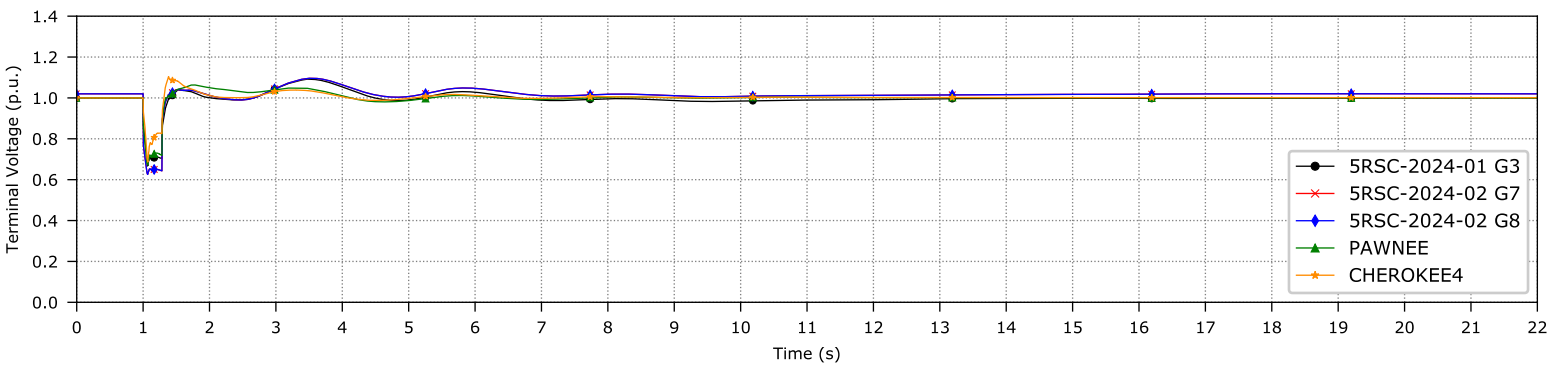
Ref. No. 21 - BF_151c

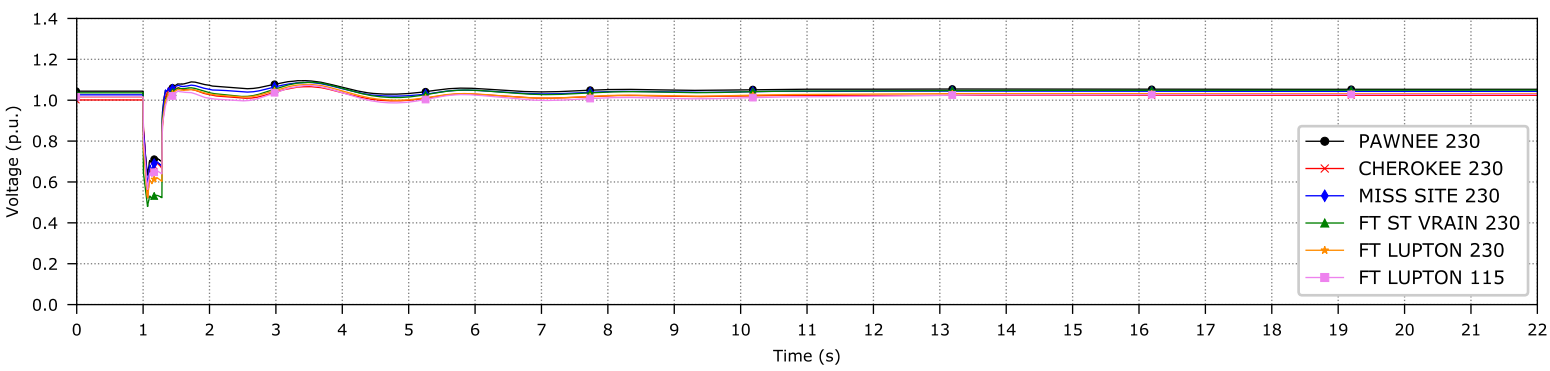


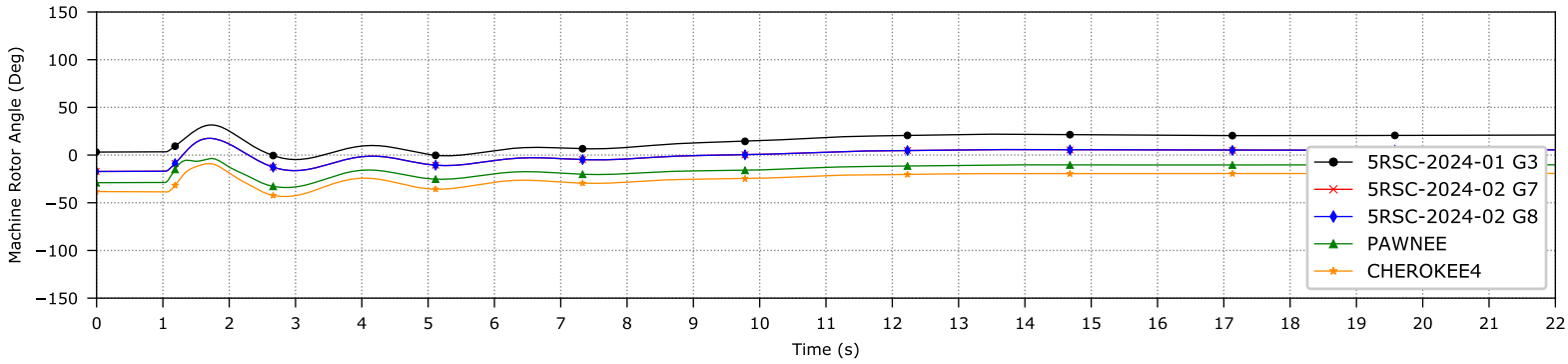


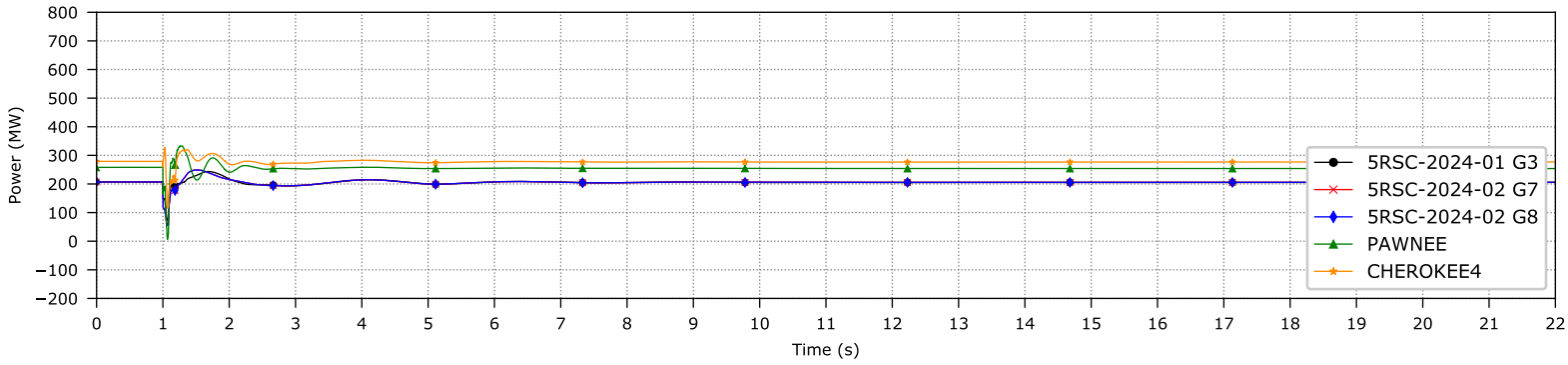


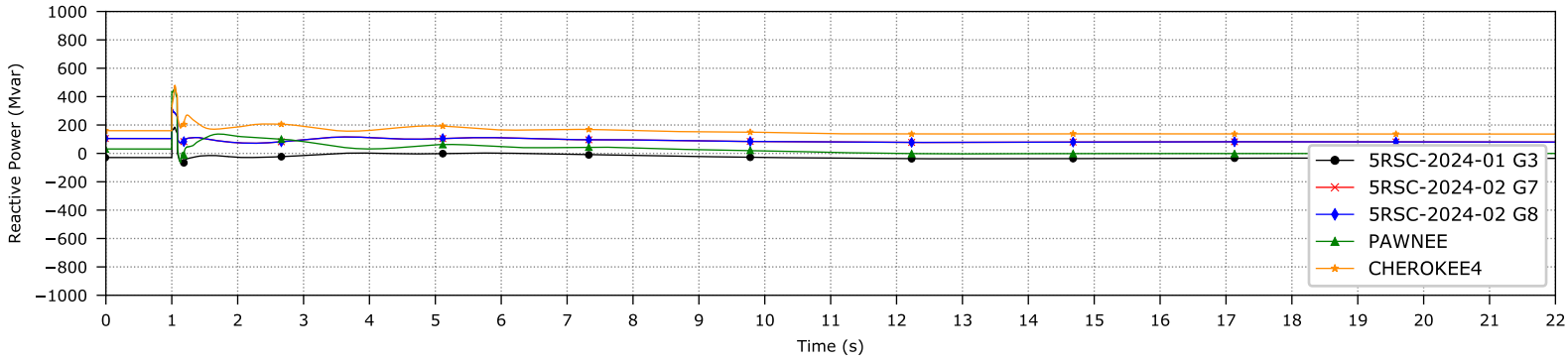


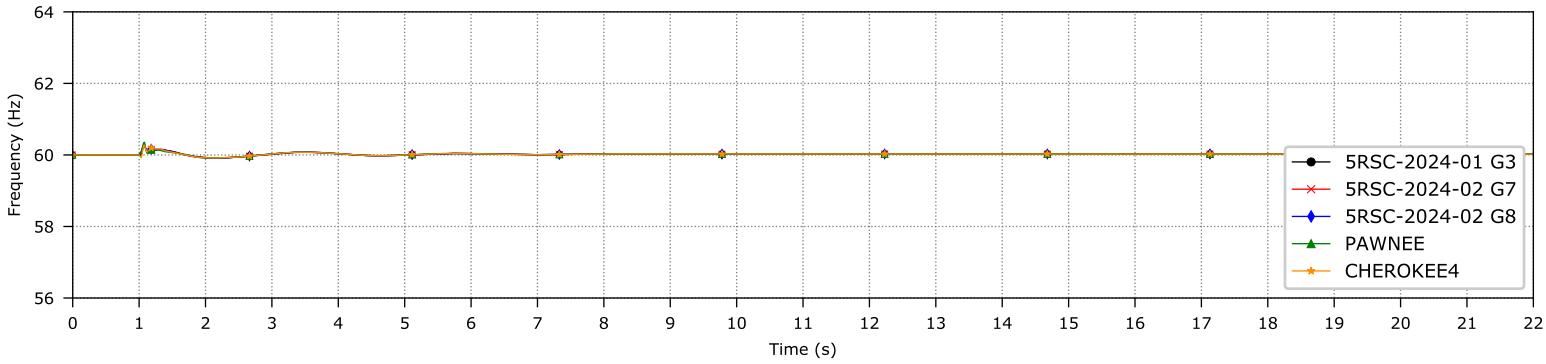


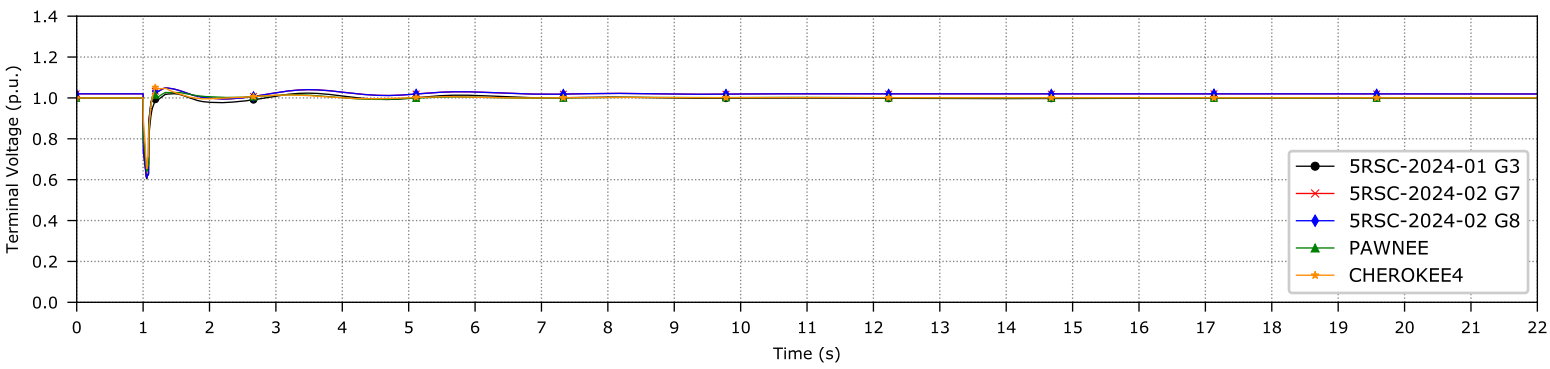


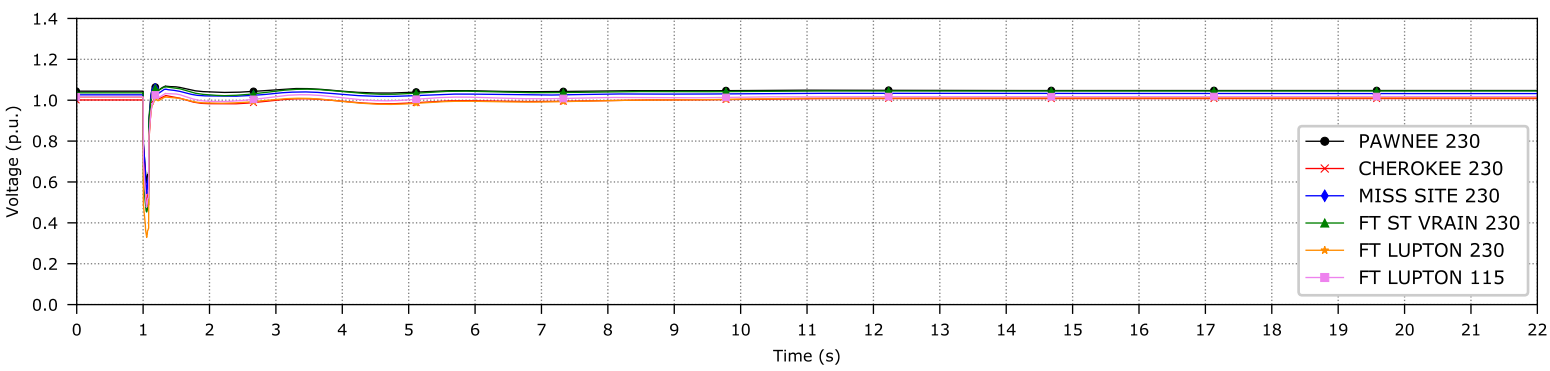

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

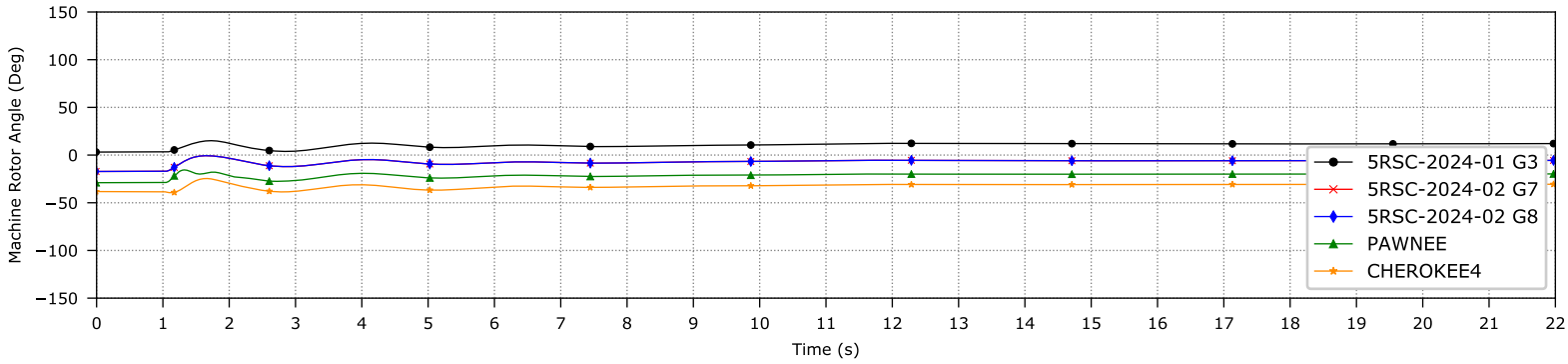

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

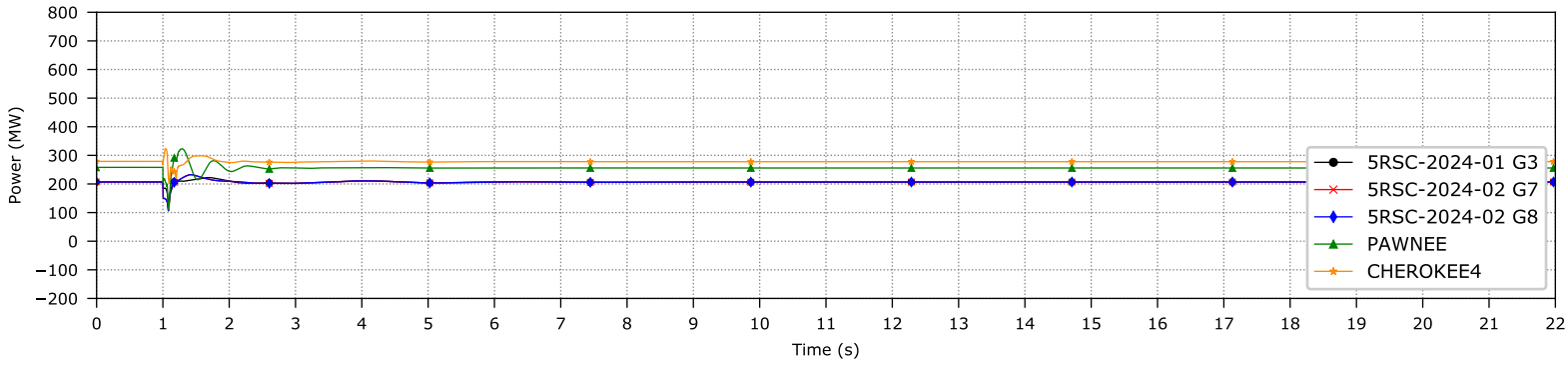

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

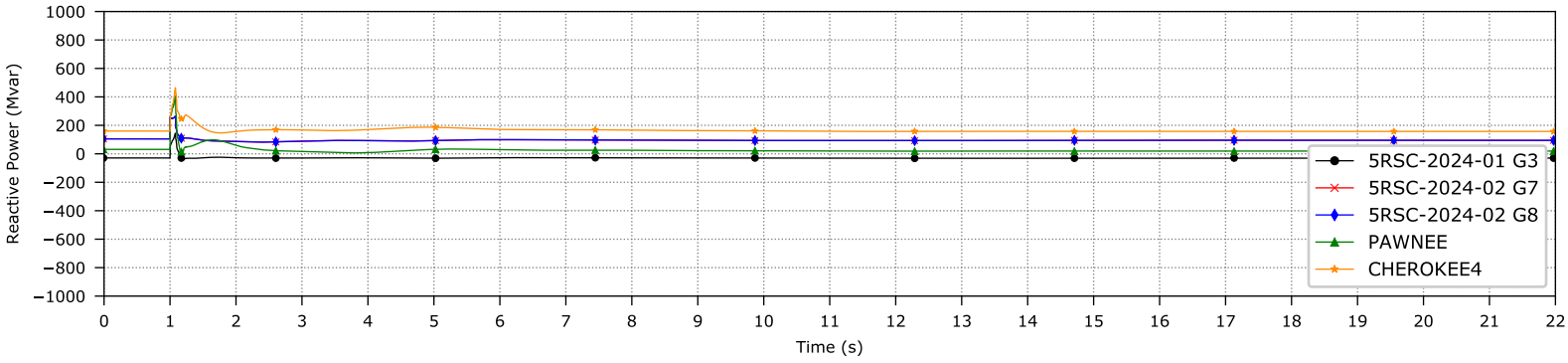

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

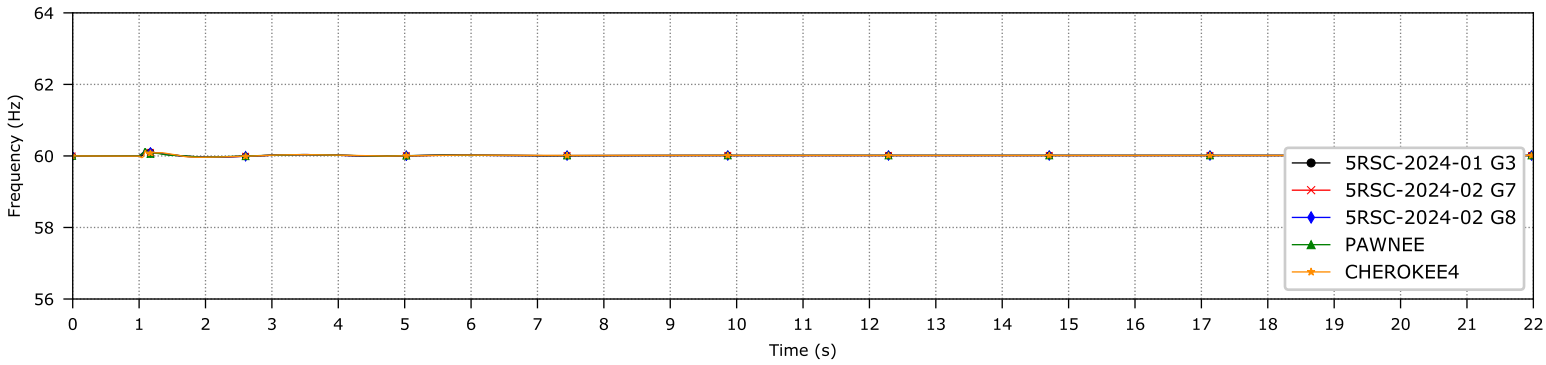

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

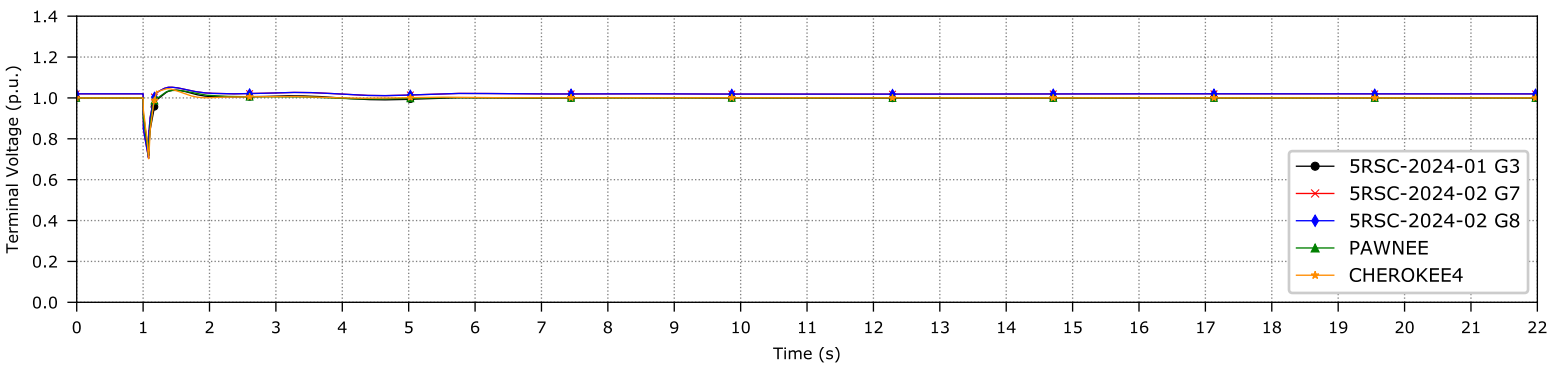
Ref. No. 23 - P7_87

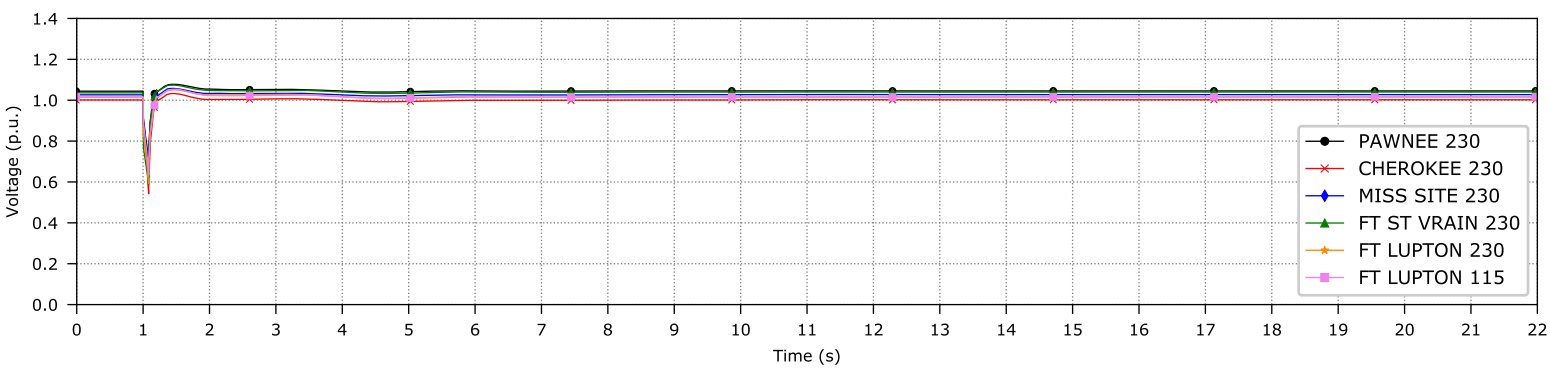


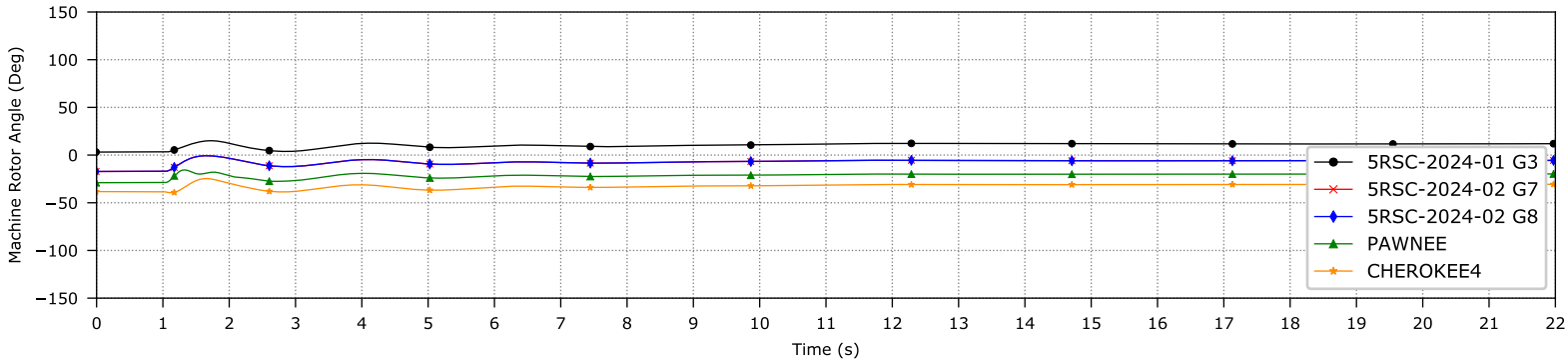


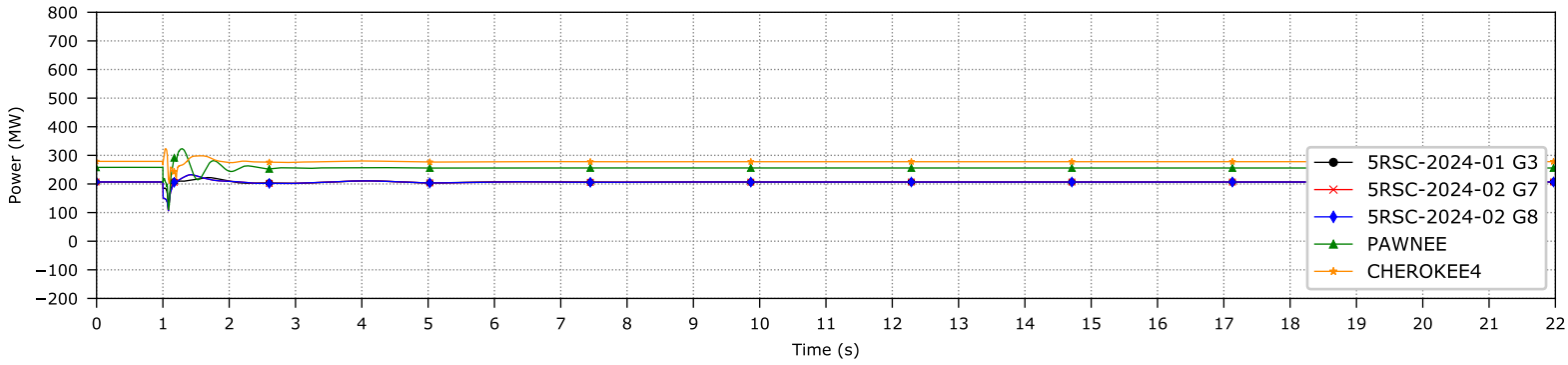


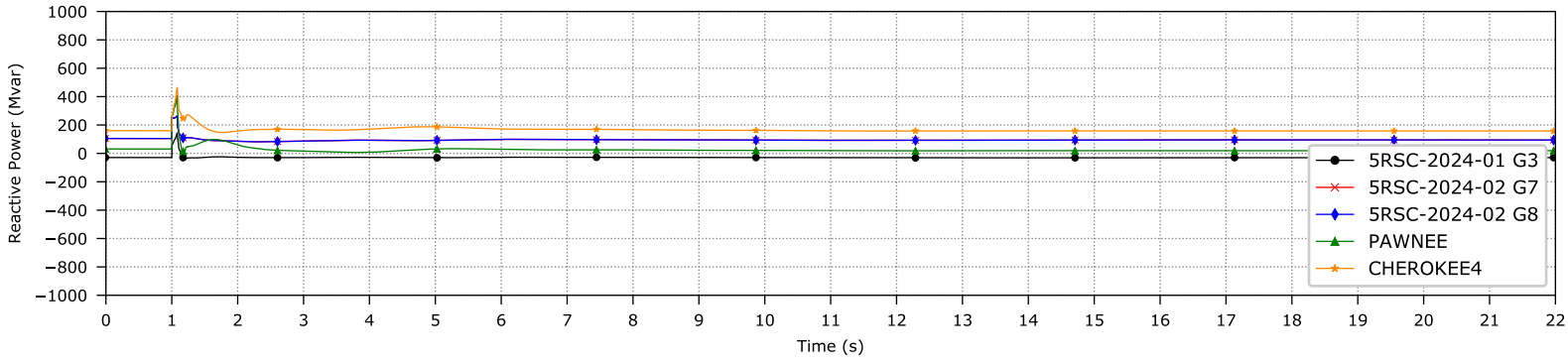


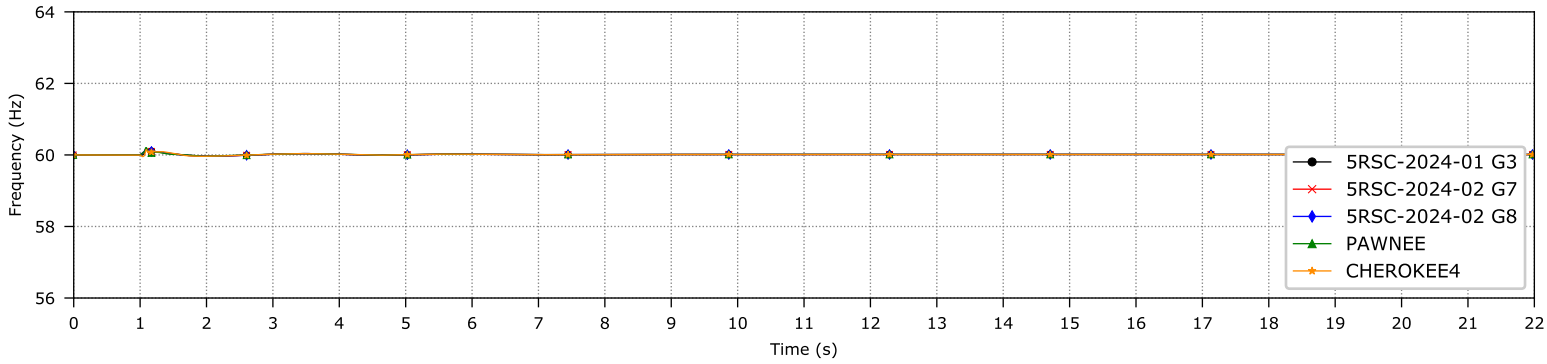


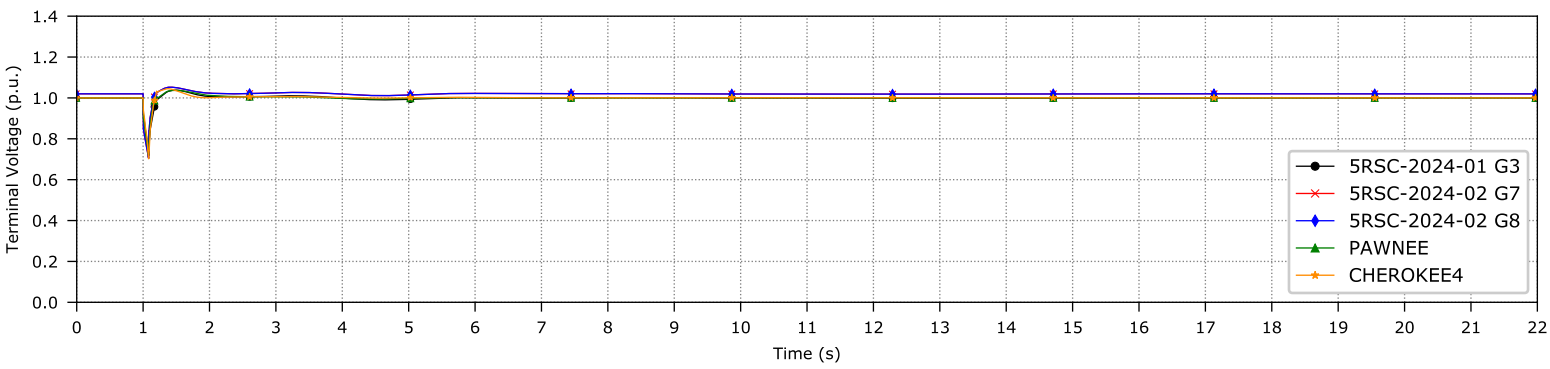


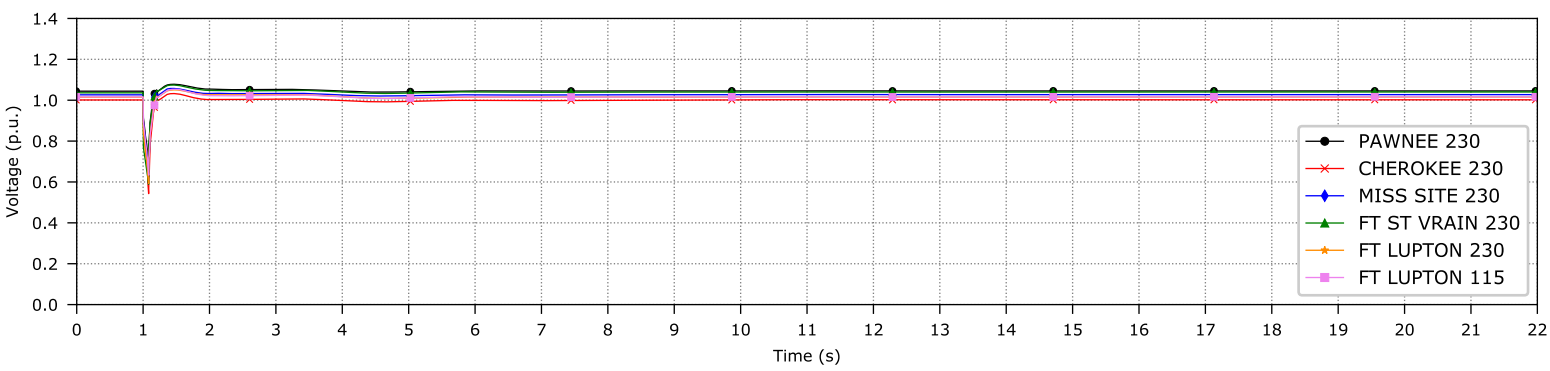

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

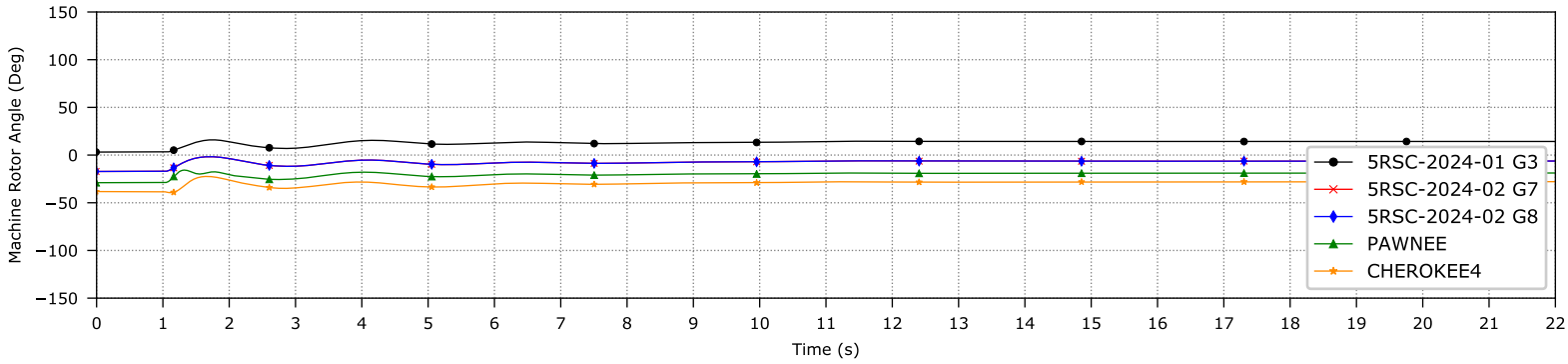

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

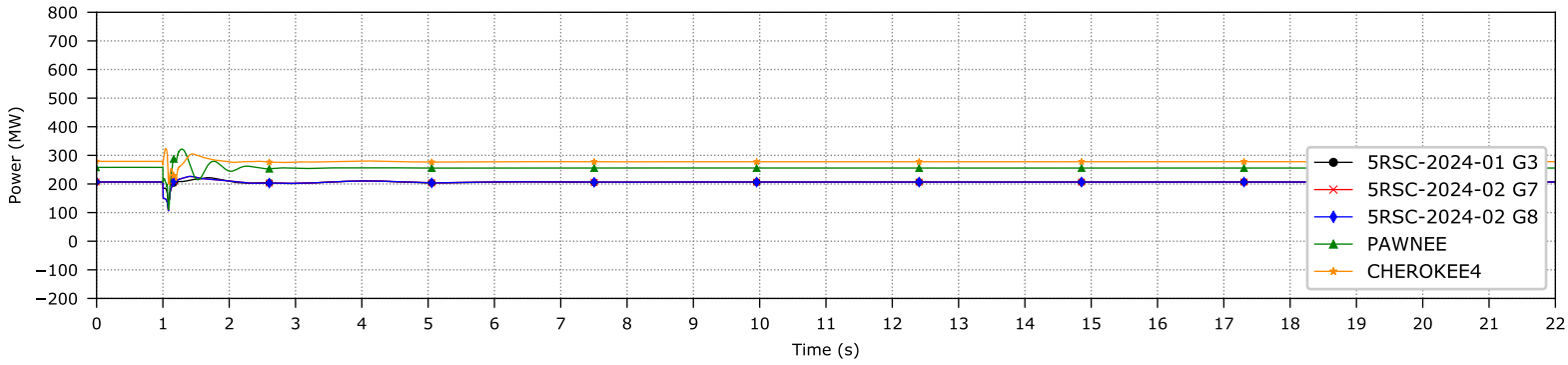

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

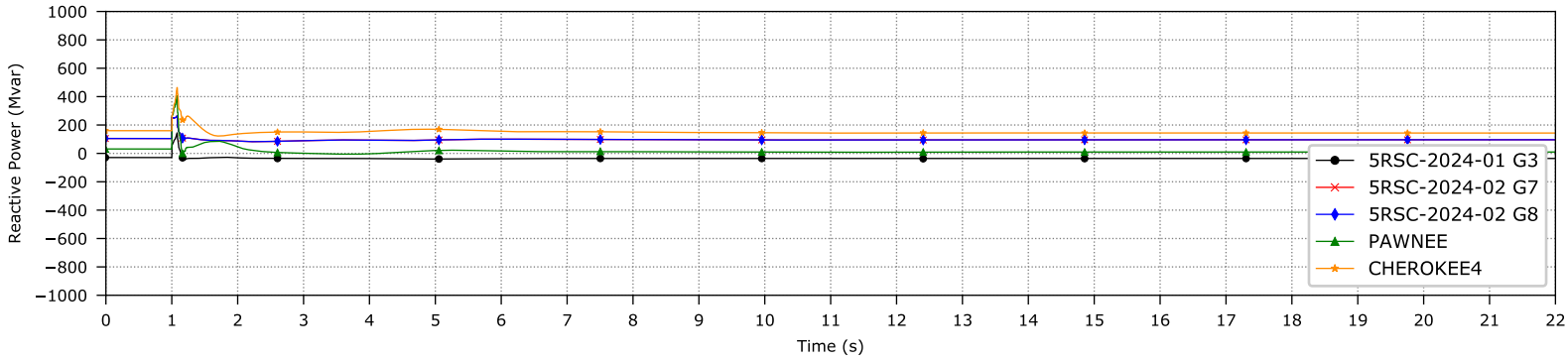

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

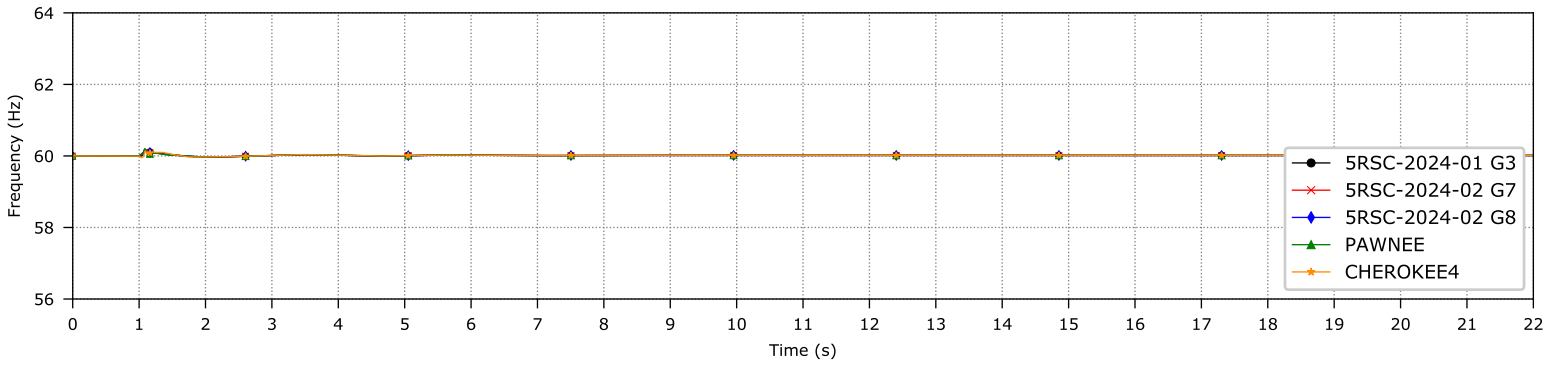

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

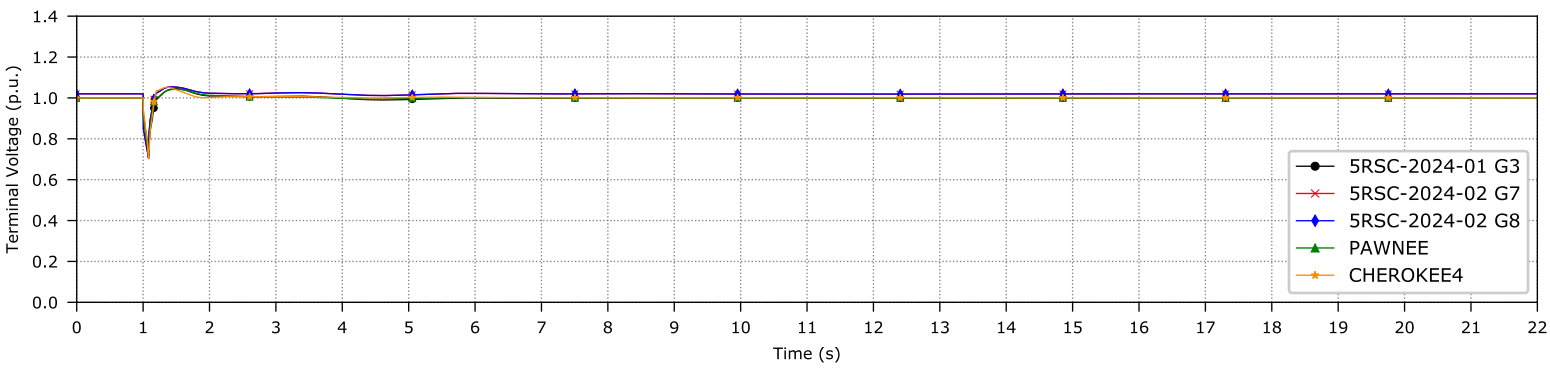
Ref. No. 25 - P7_89

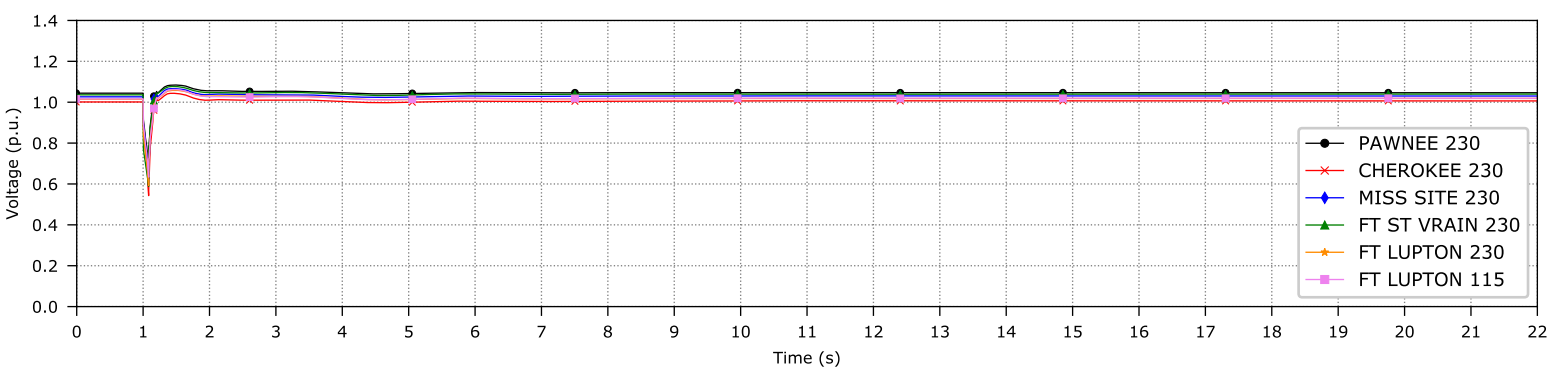


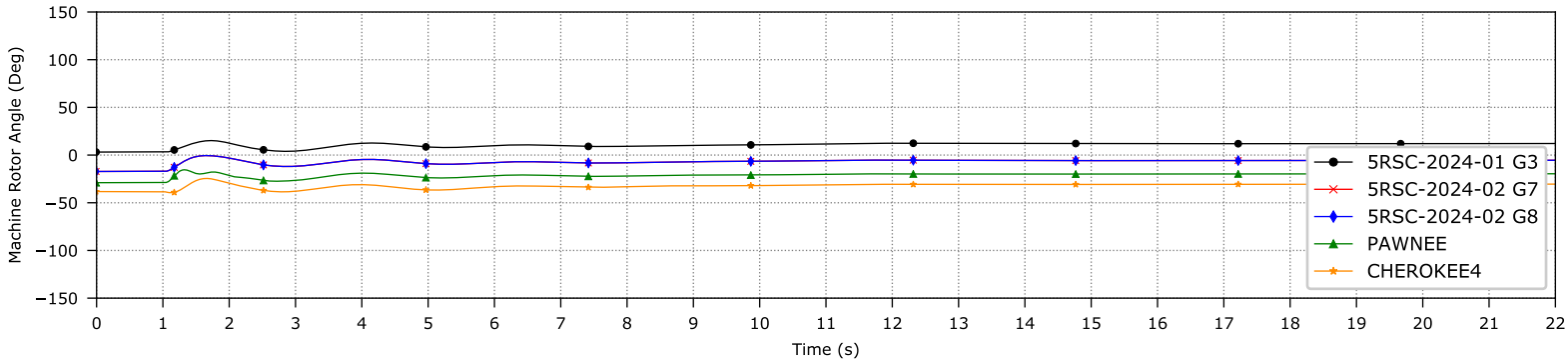


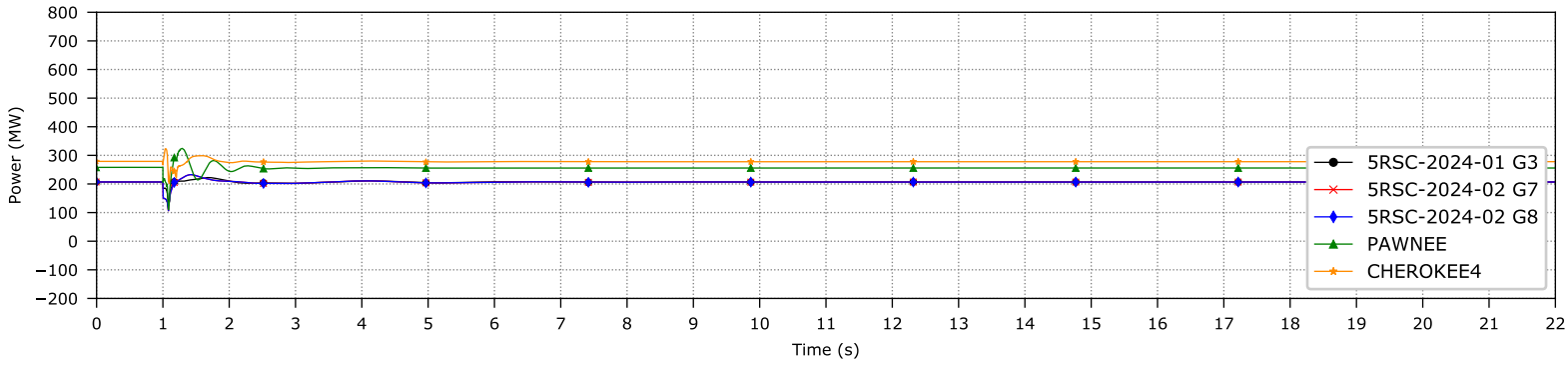


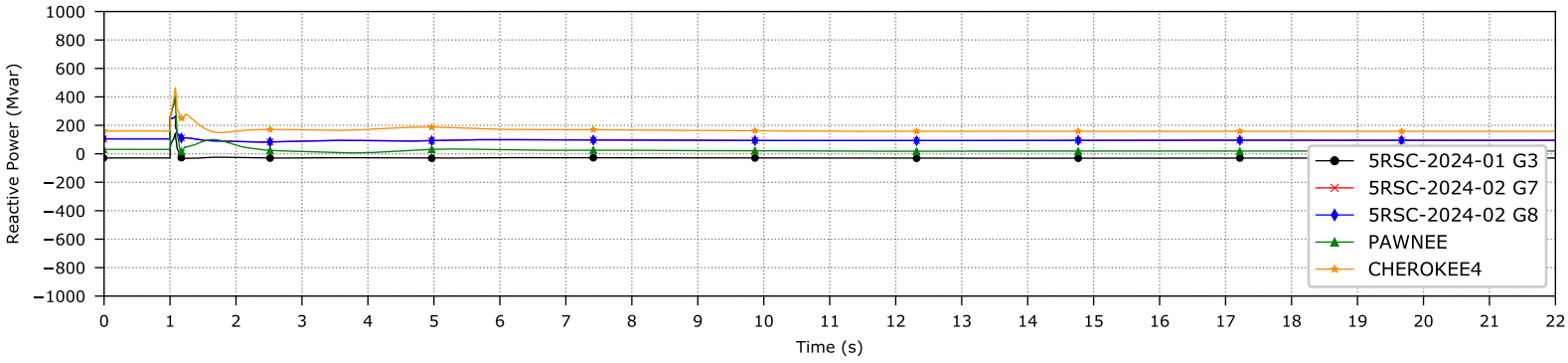


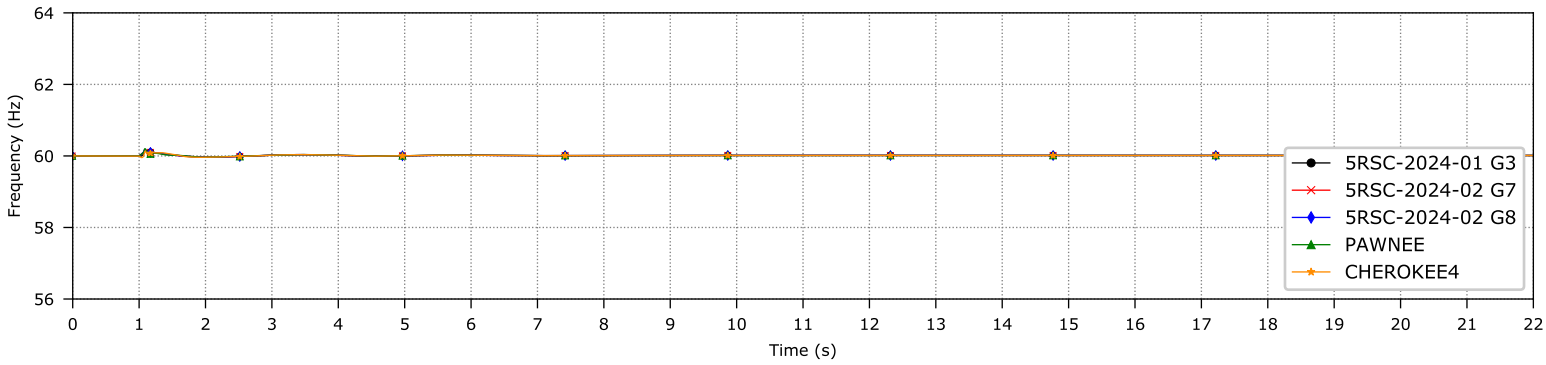


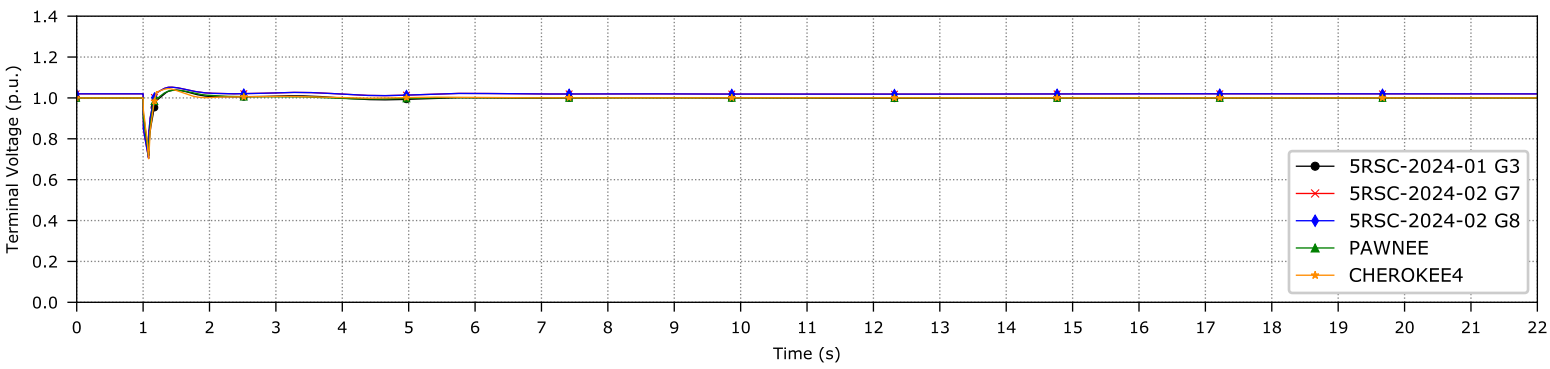


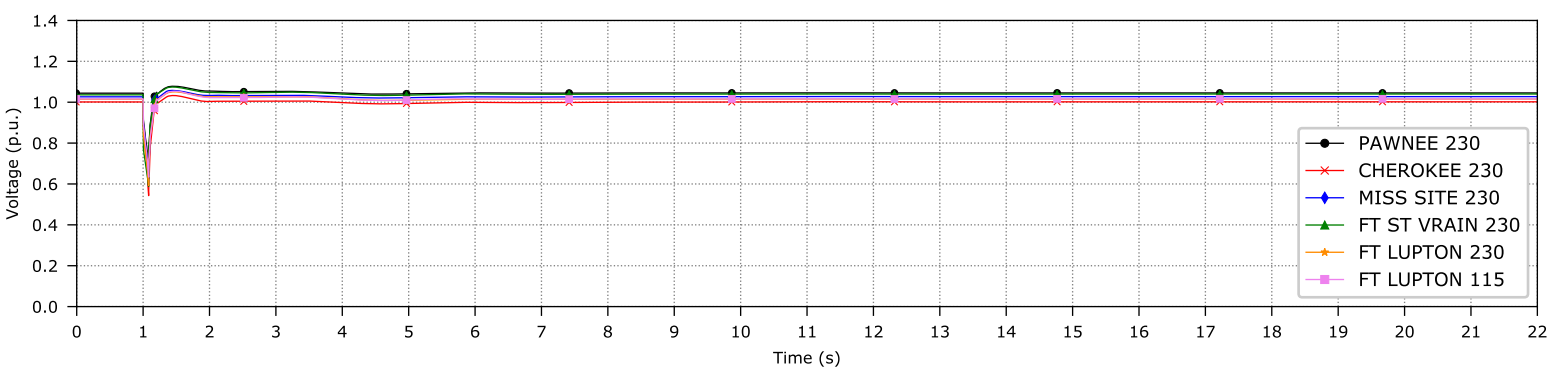

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

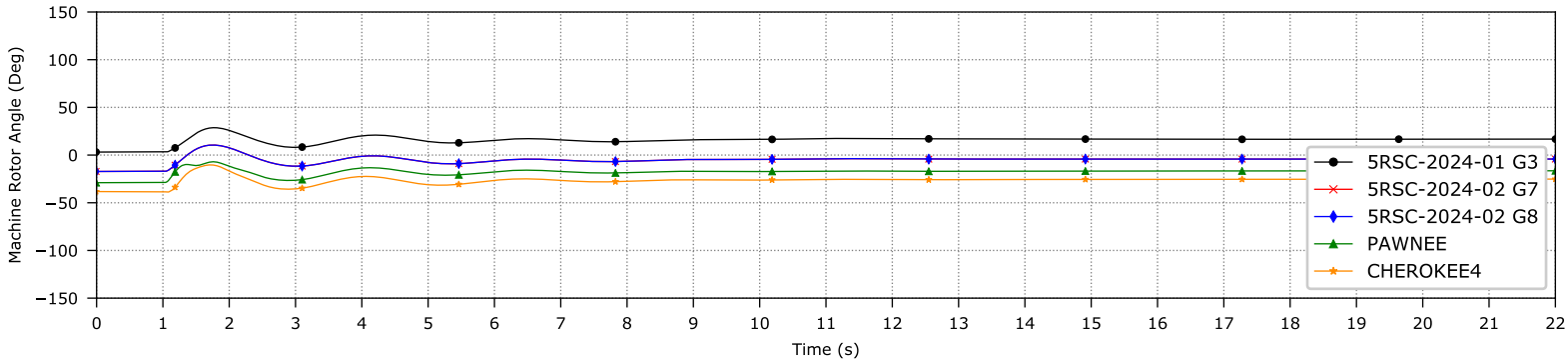

Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

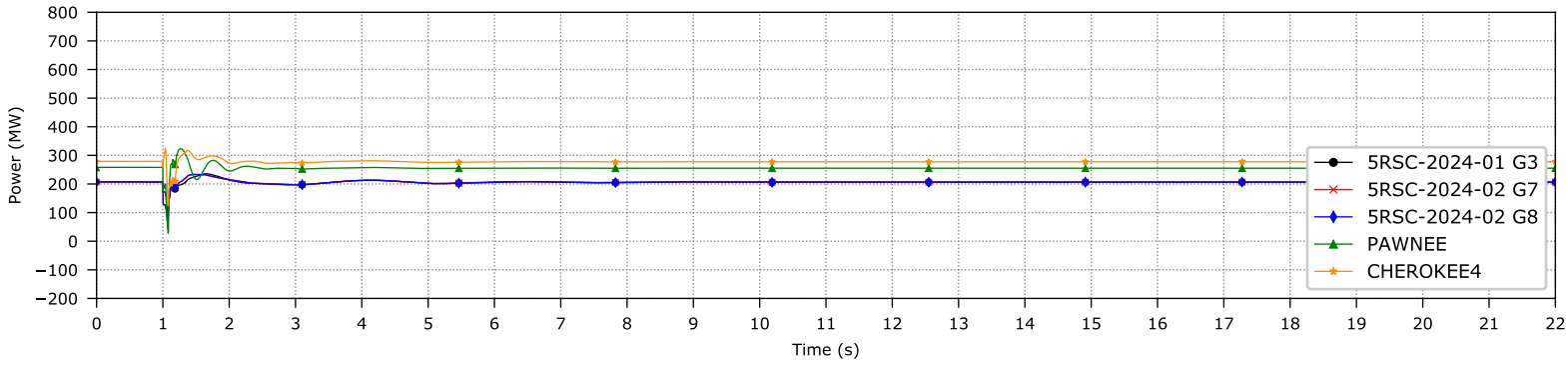

Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

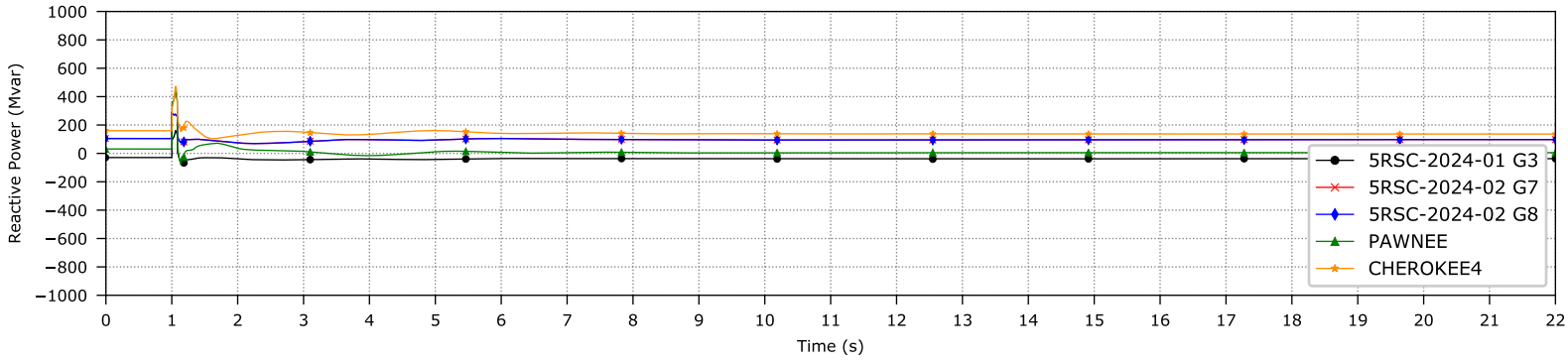

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

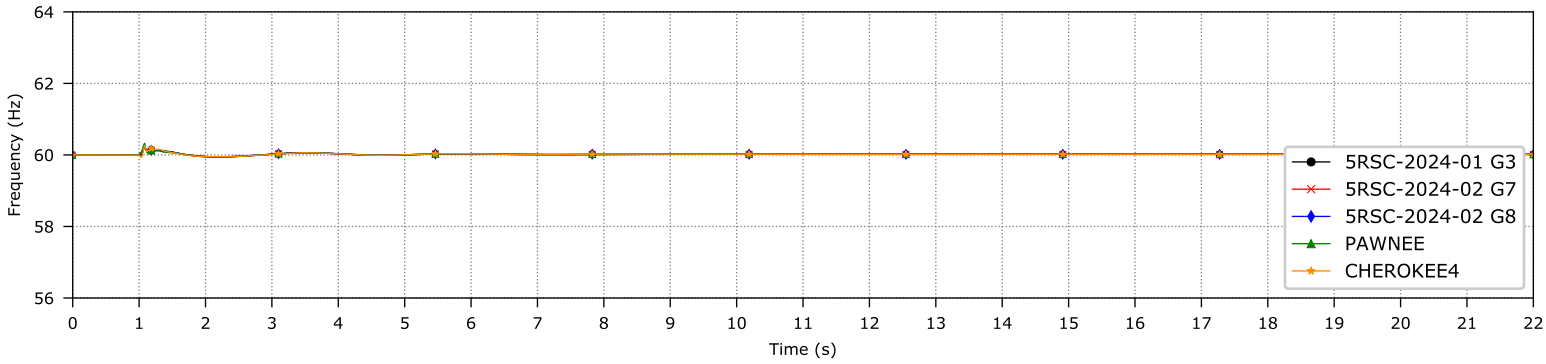

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

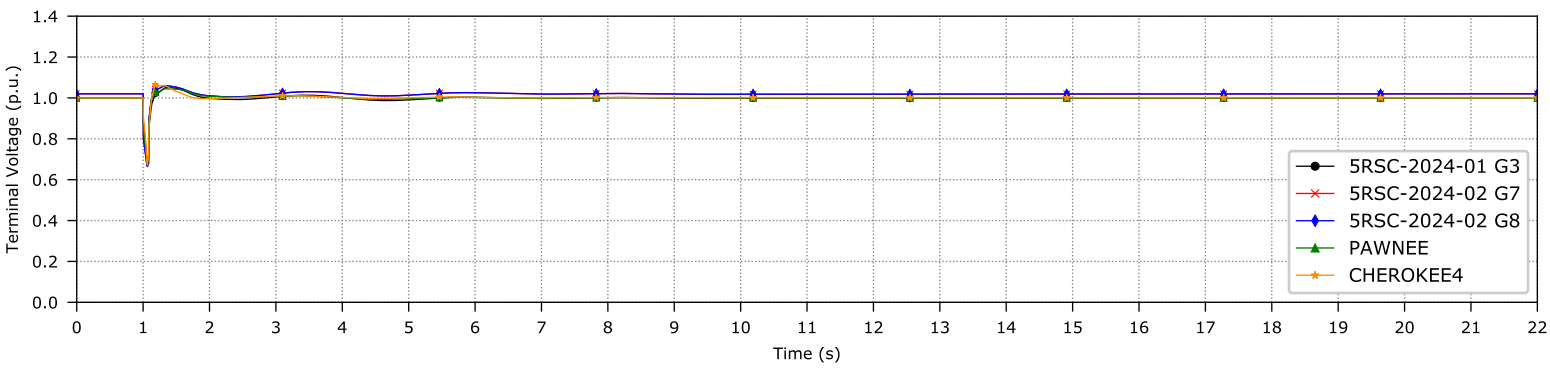

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

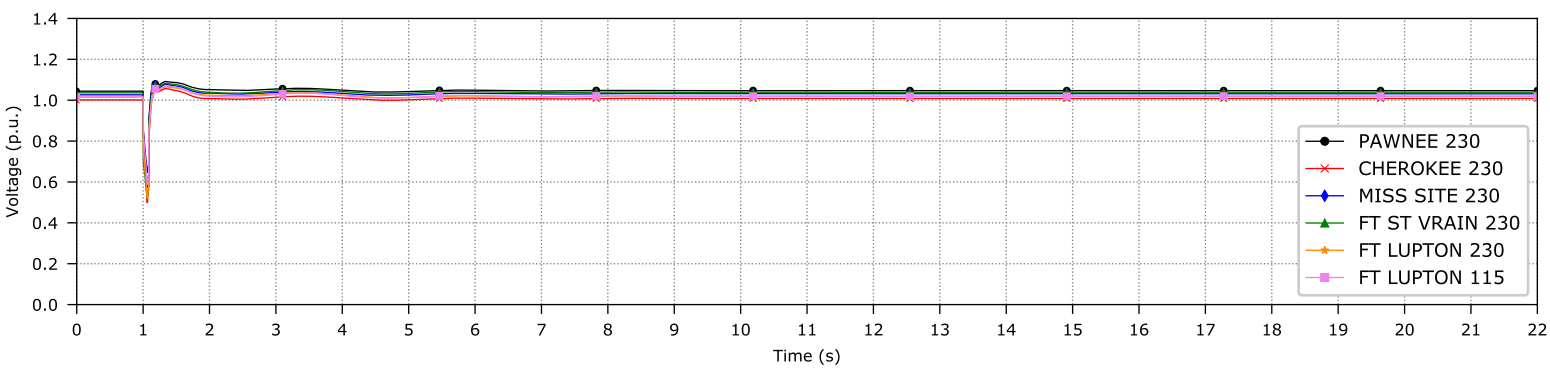

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Reactive Power (Mvar)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

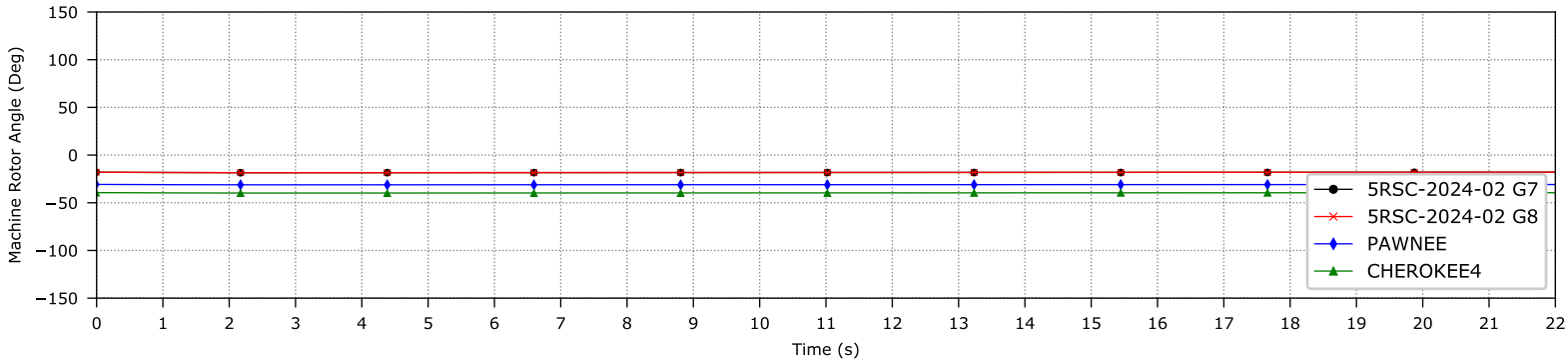

Frequency (Hz)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

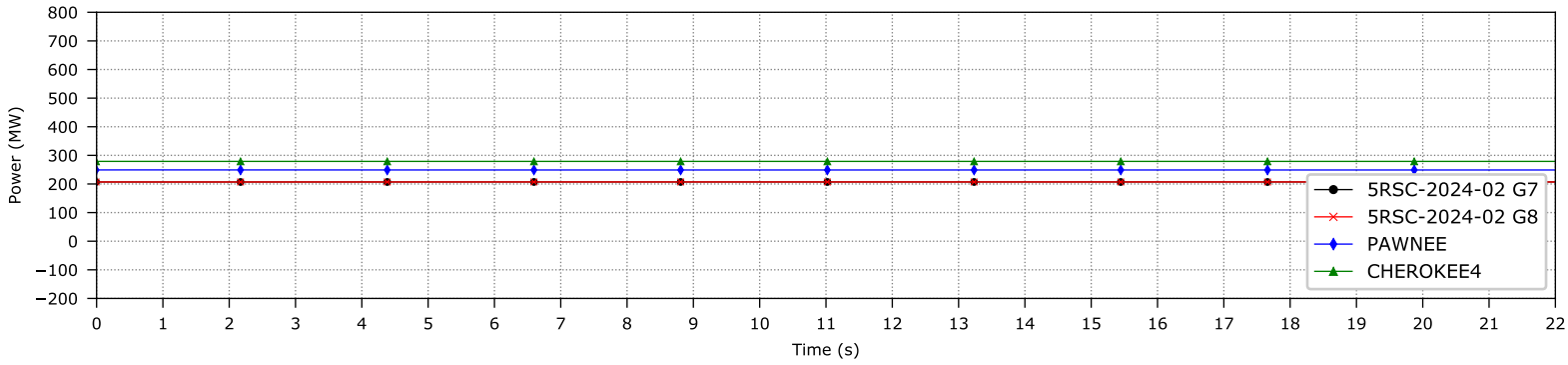

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-01 G3
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

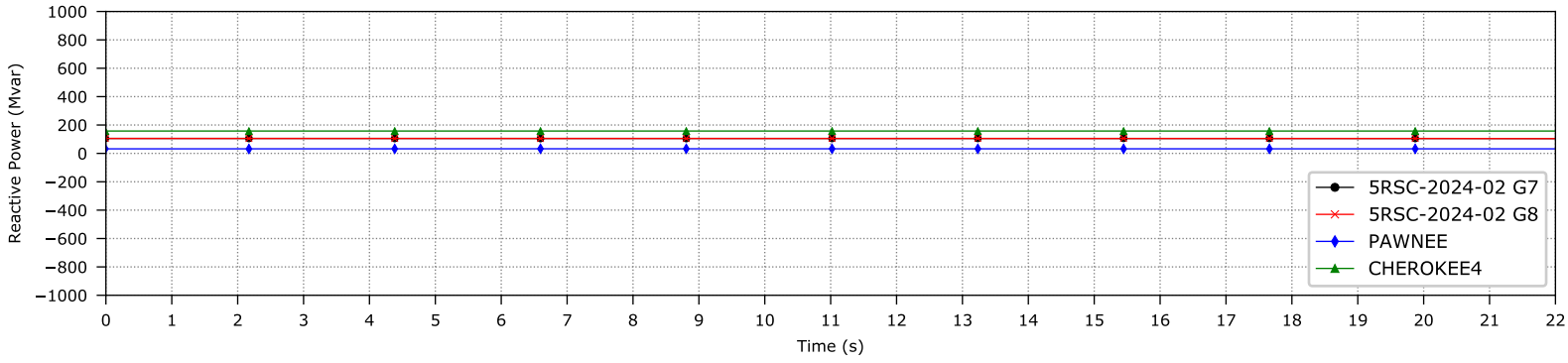

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230
FT LUPTON 115

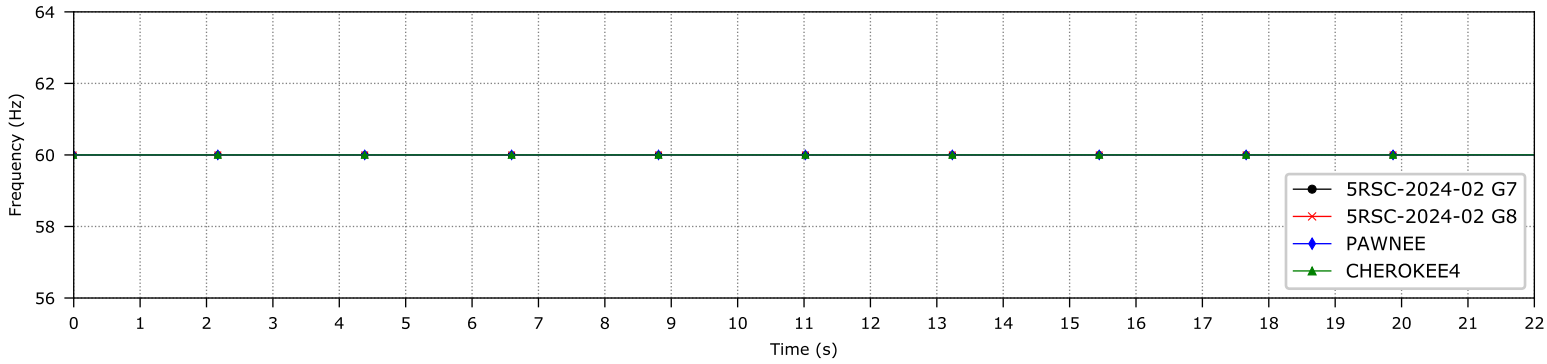
2027 METRO PORTFOLIO 2 – TRANSIENT STABILITY PLOTS

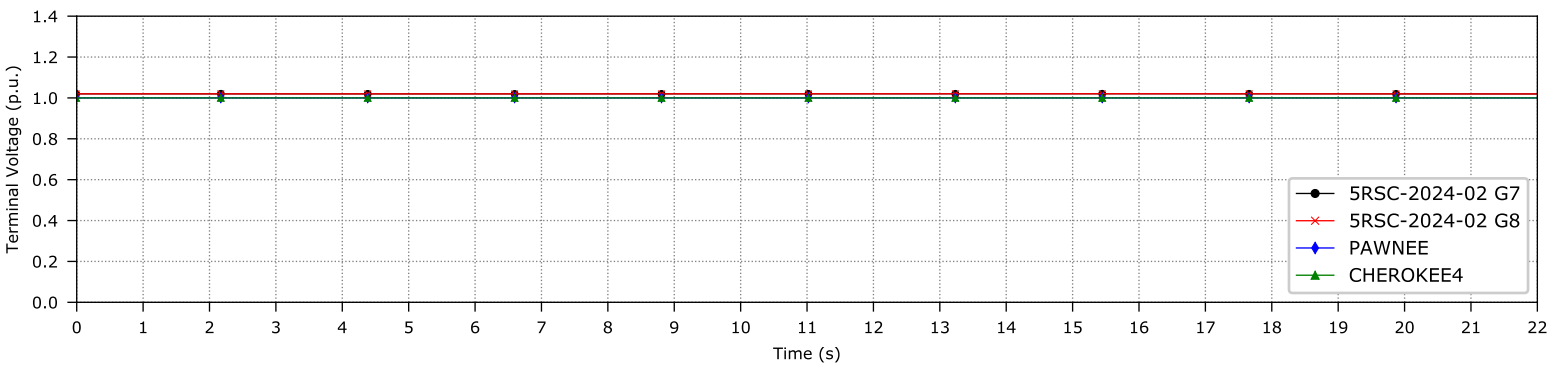
Ref. No. 01 - Flatrun

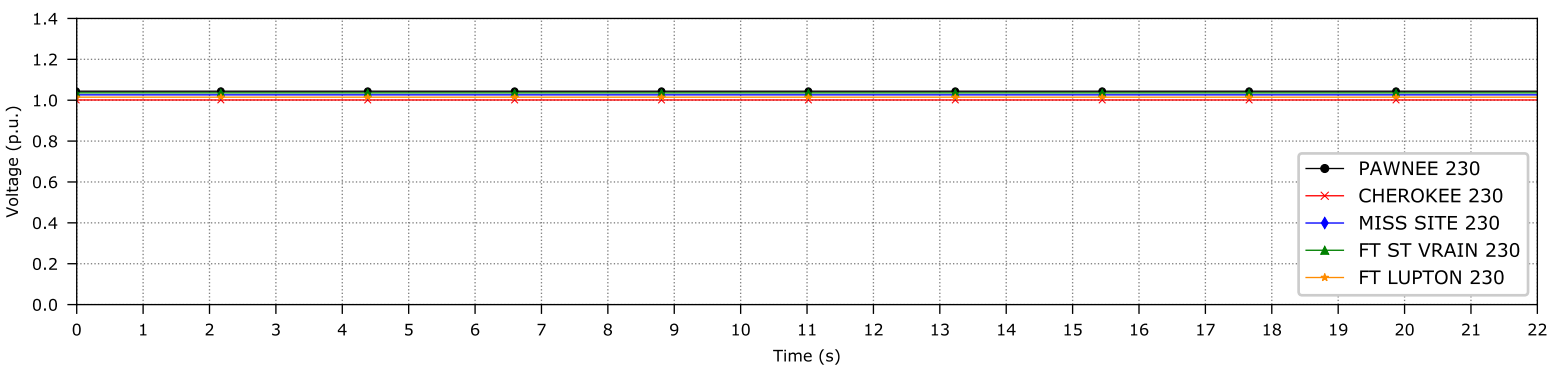




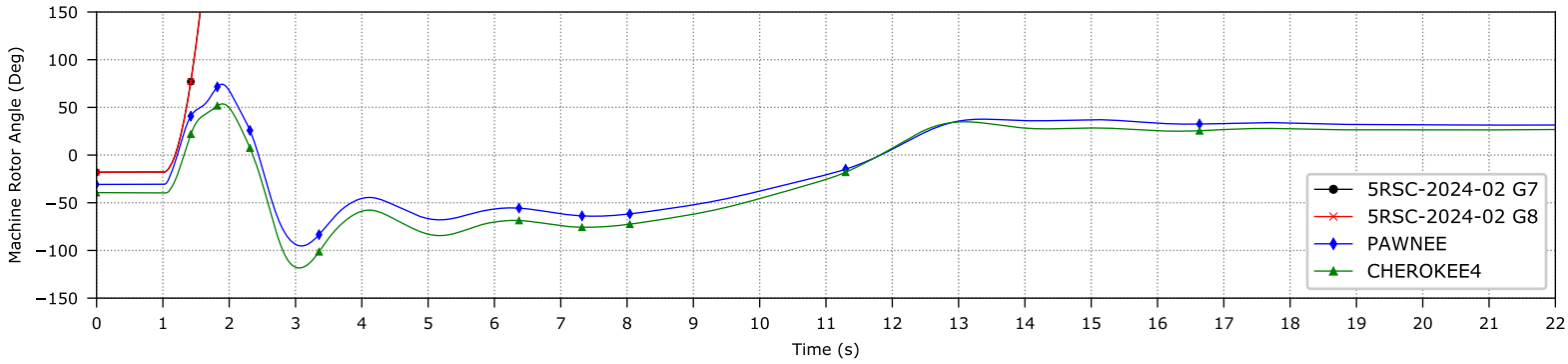


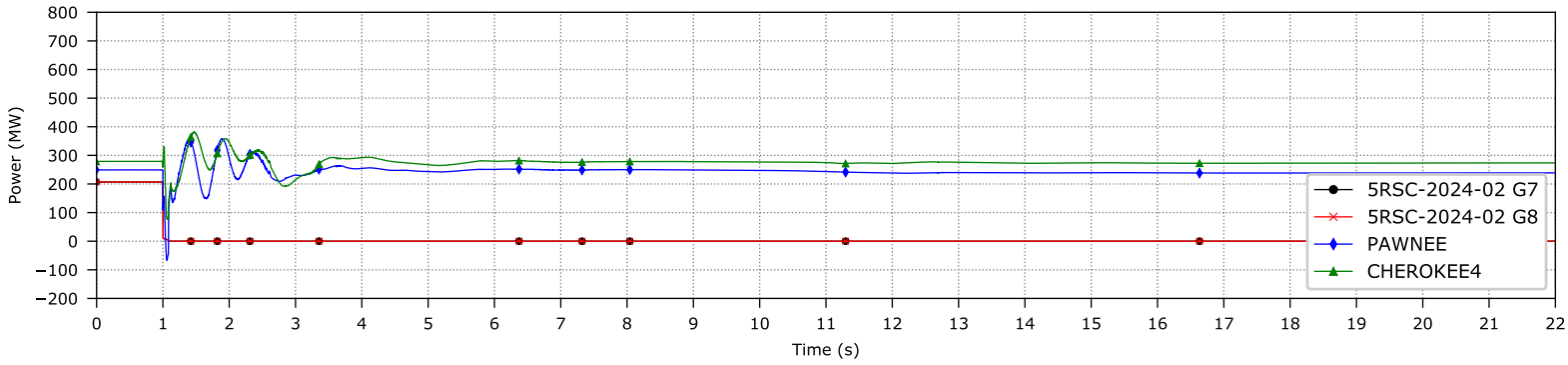


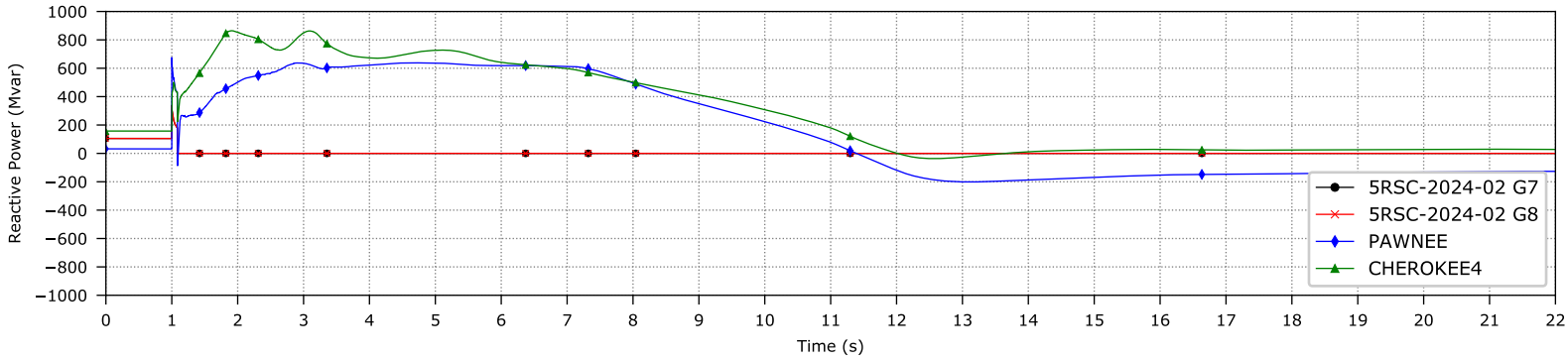


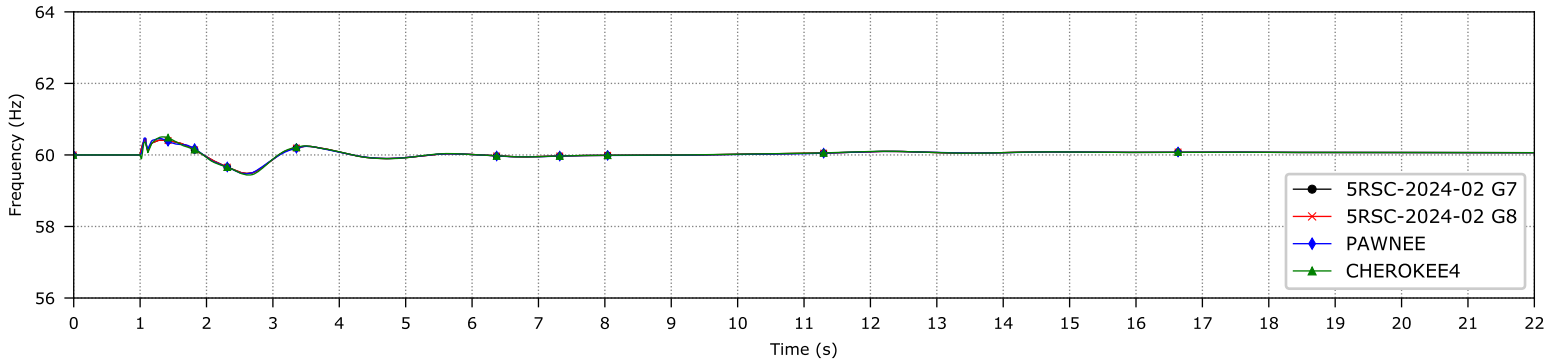


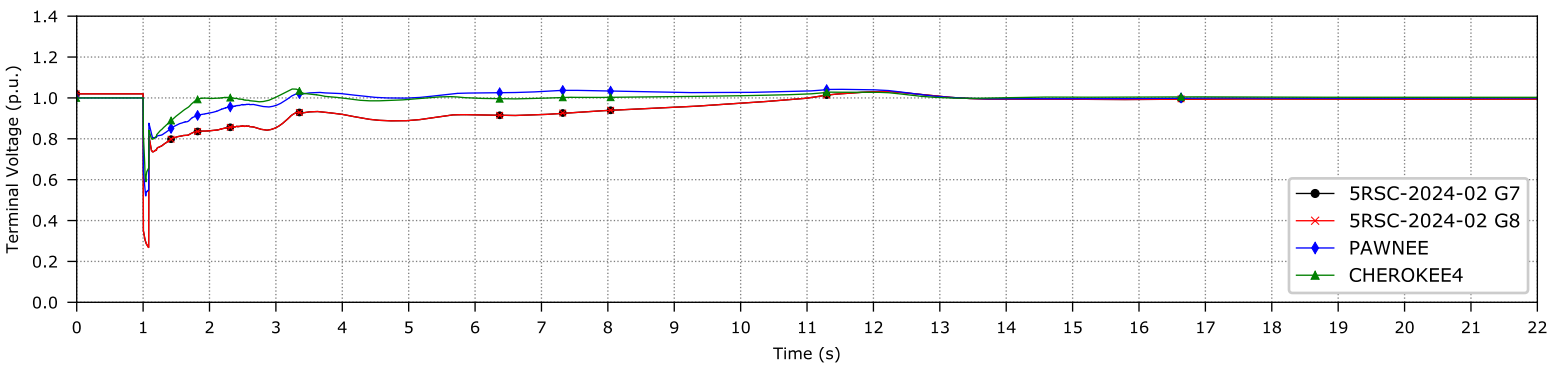
Ref. No. 03 - 5RSC-2024-02

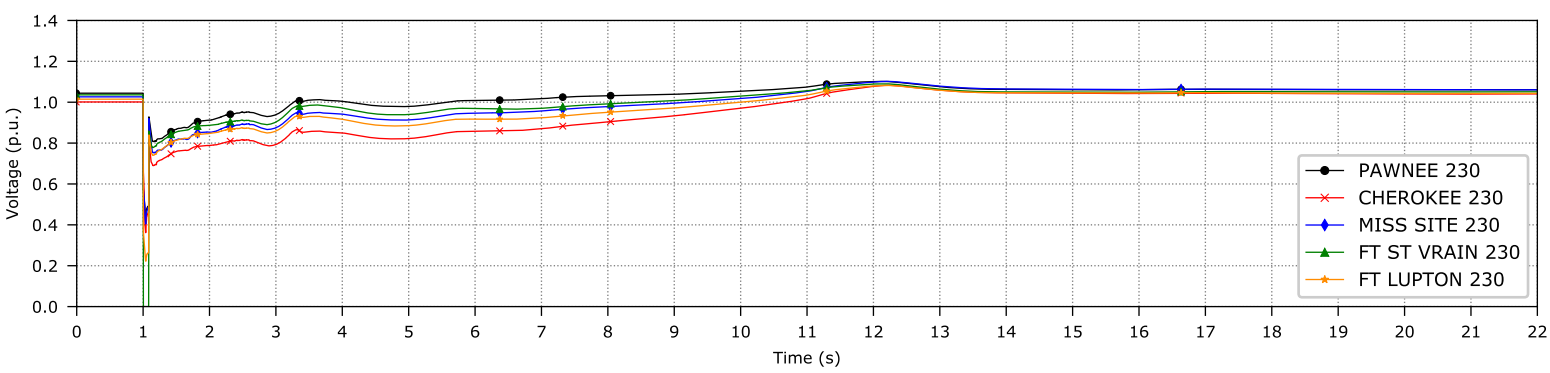




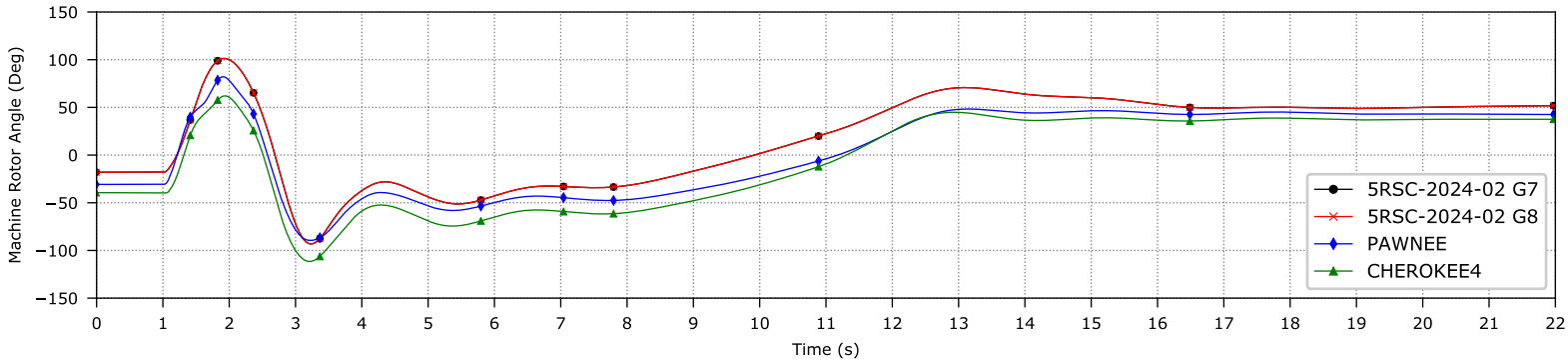


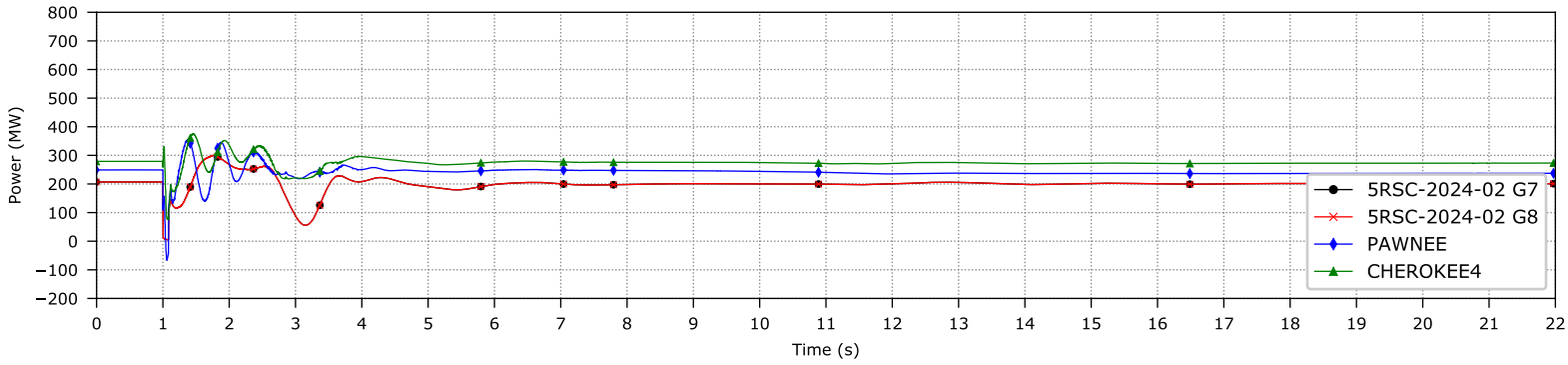


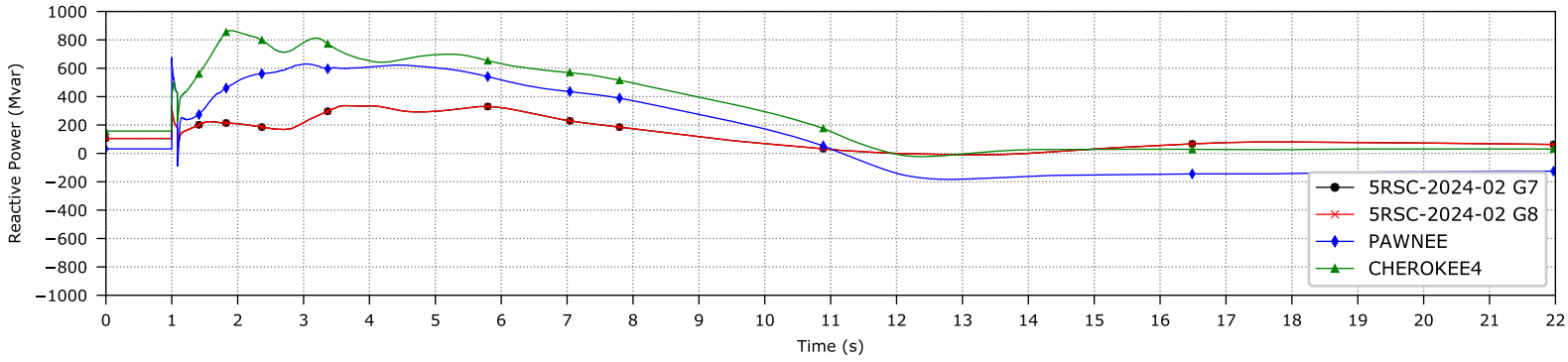


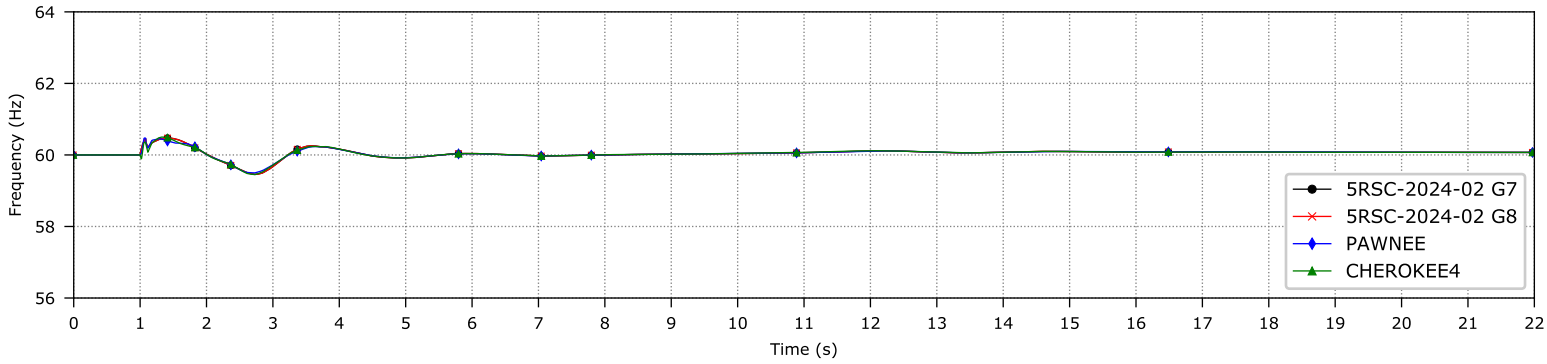


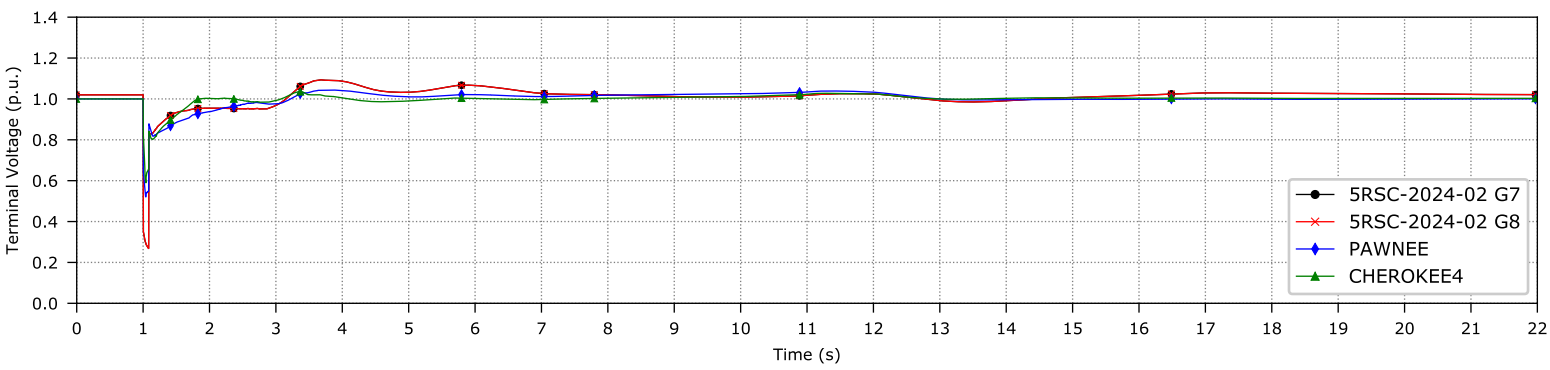
Ref. No. 04 - LoTC_59

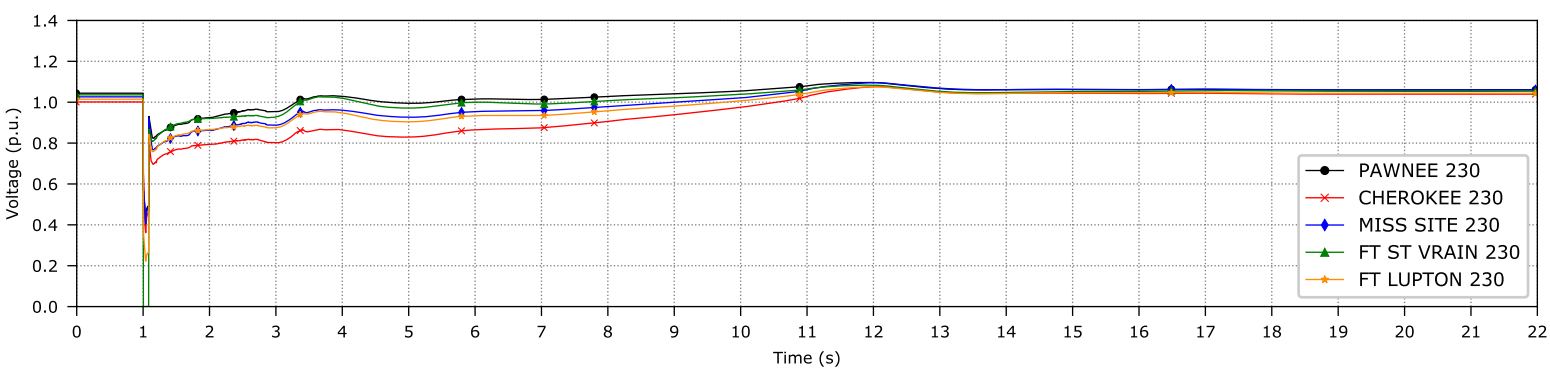




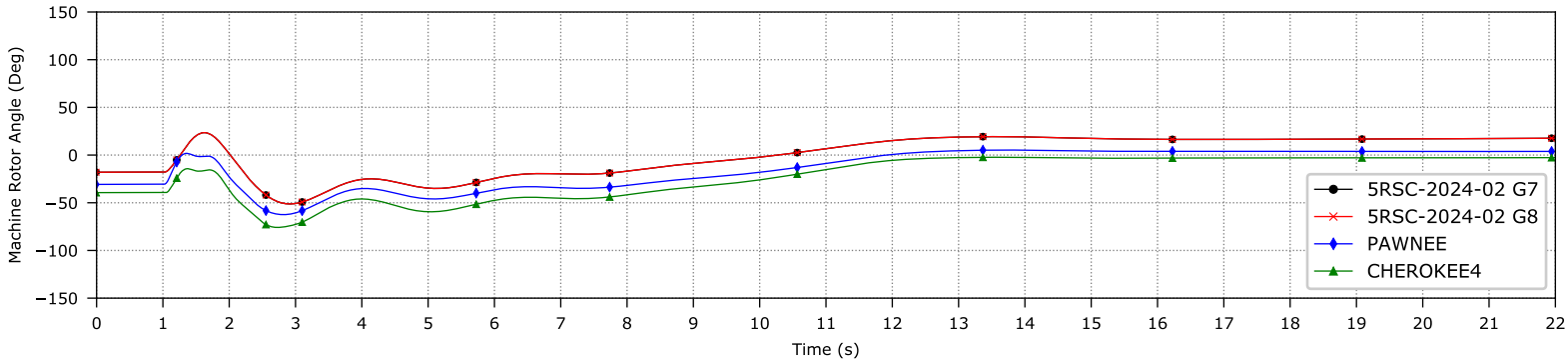


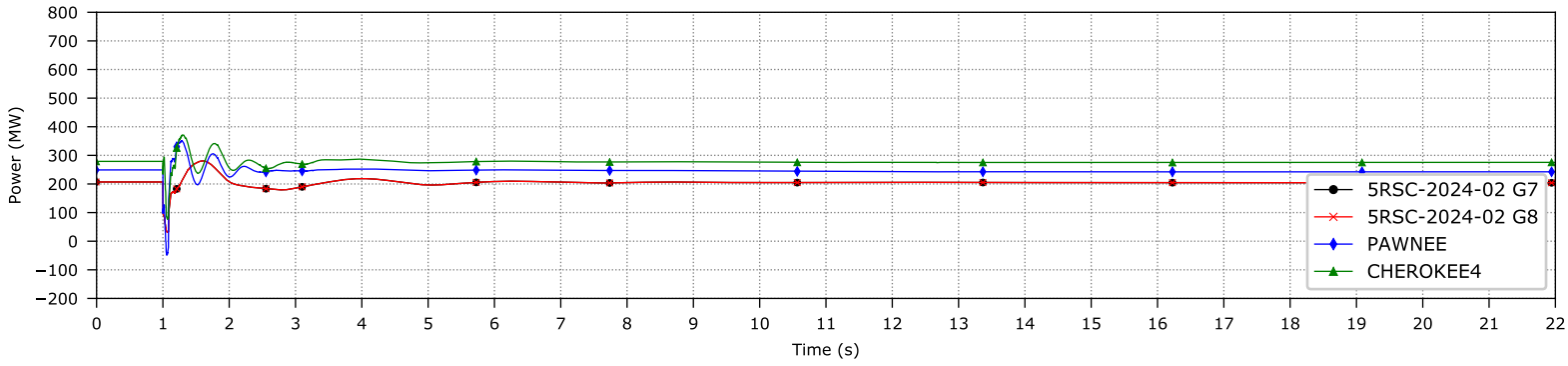


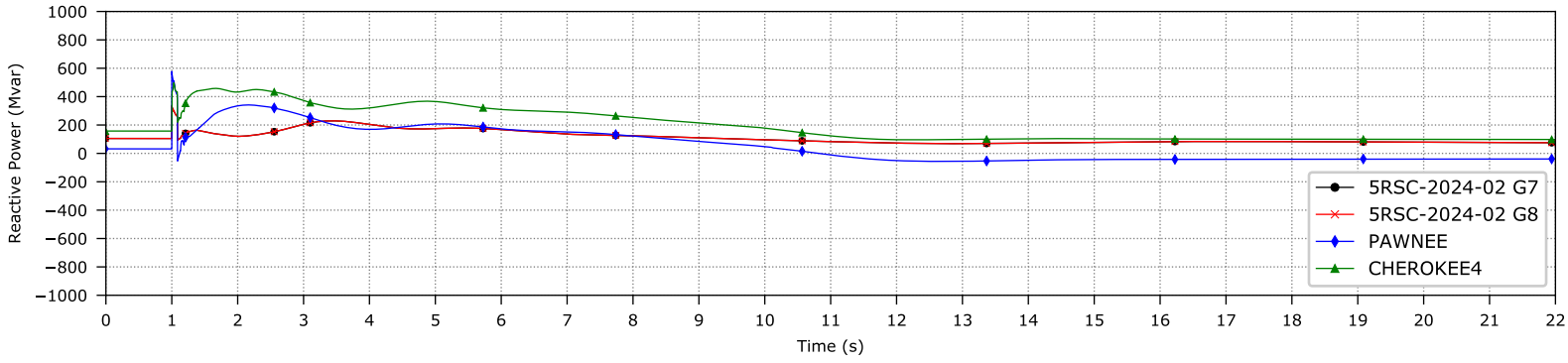


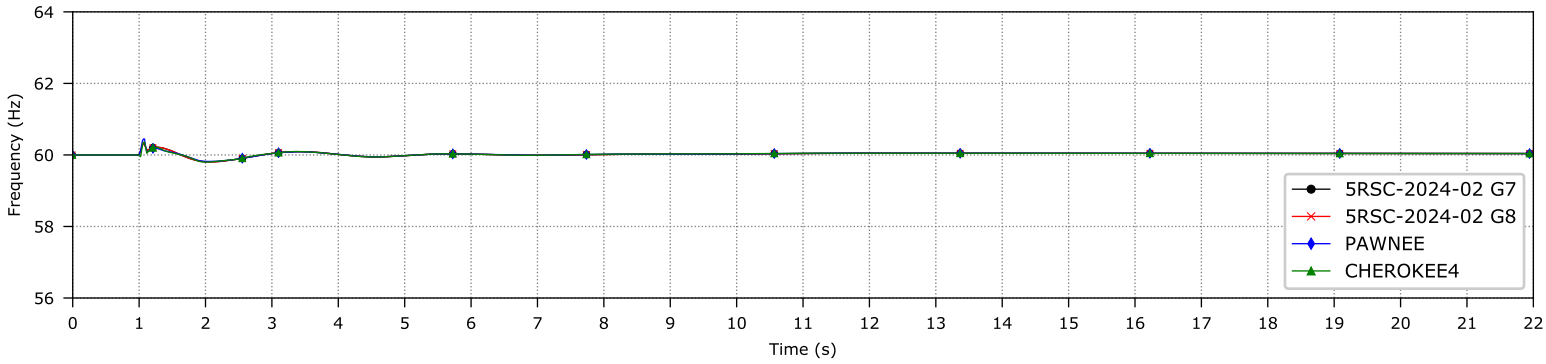


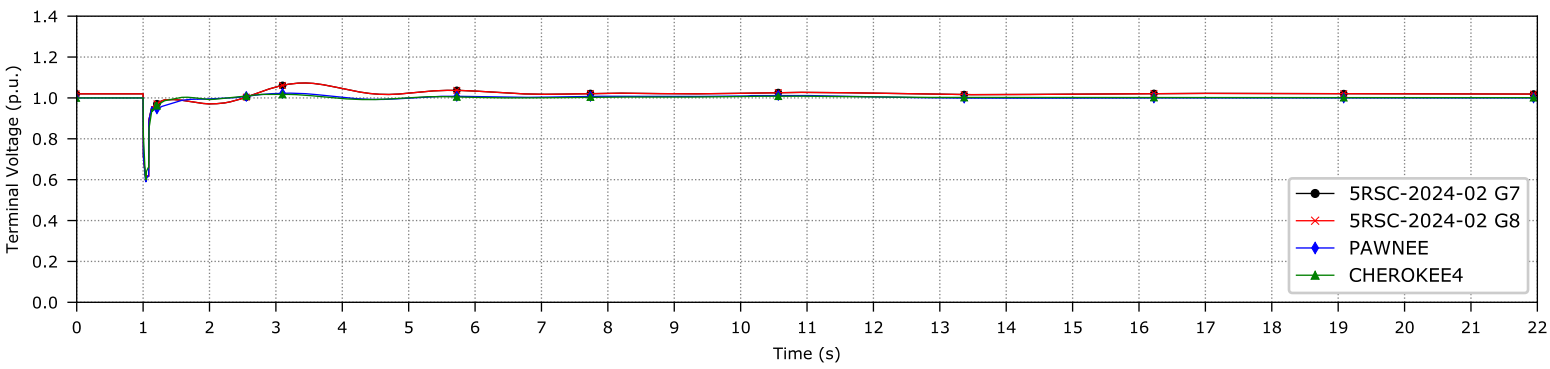
Ref. No. 05 - LoTC_62

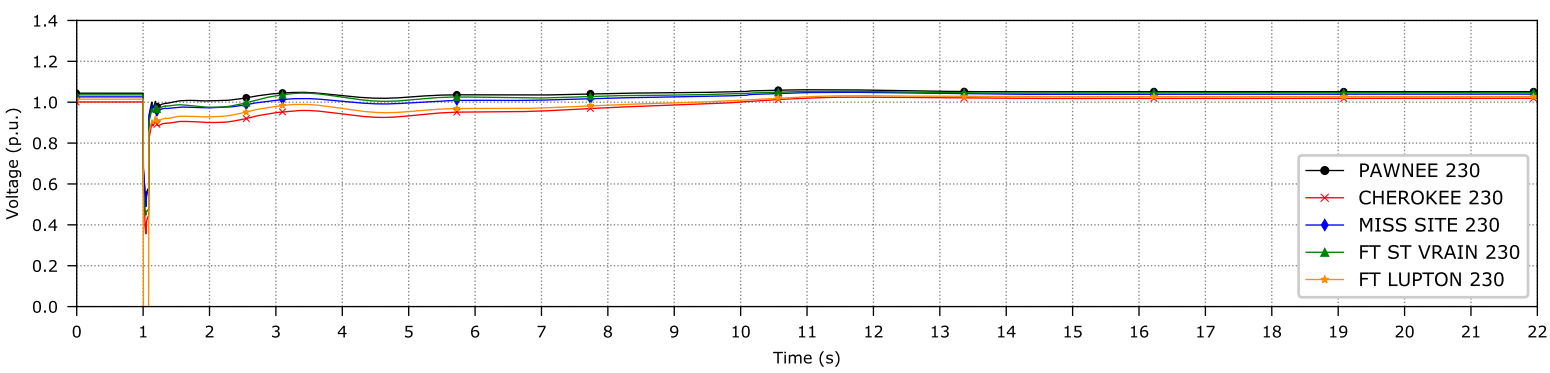




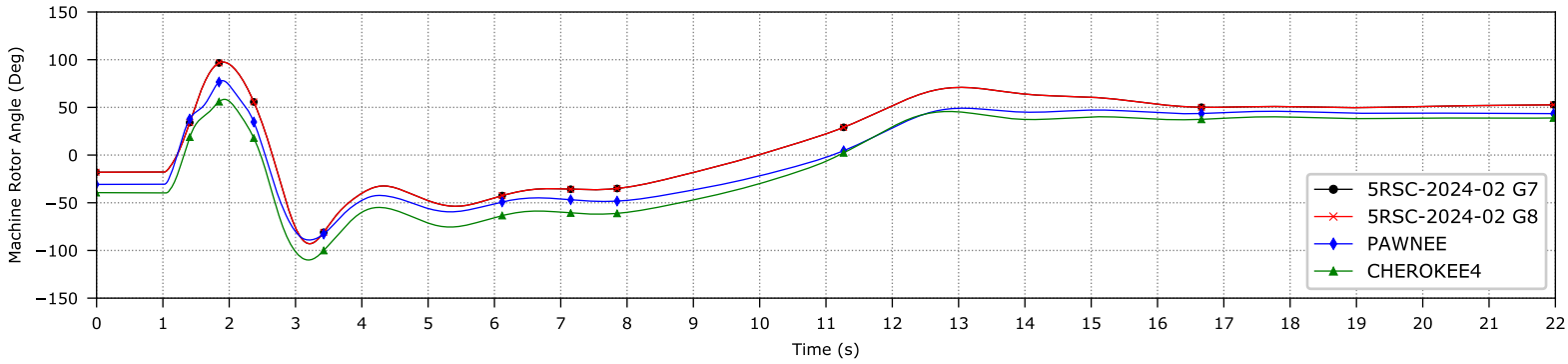


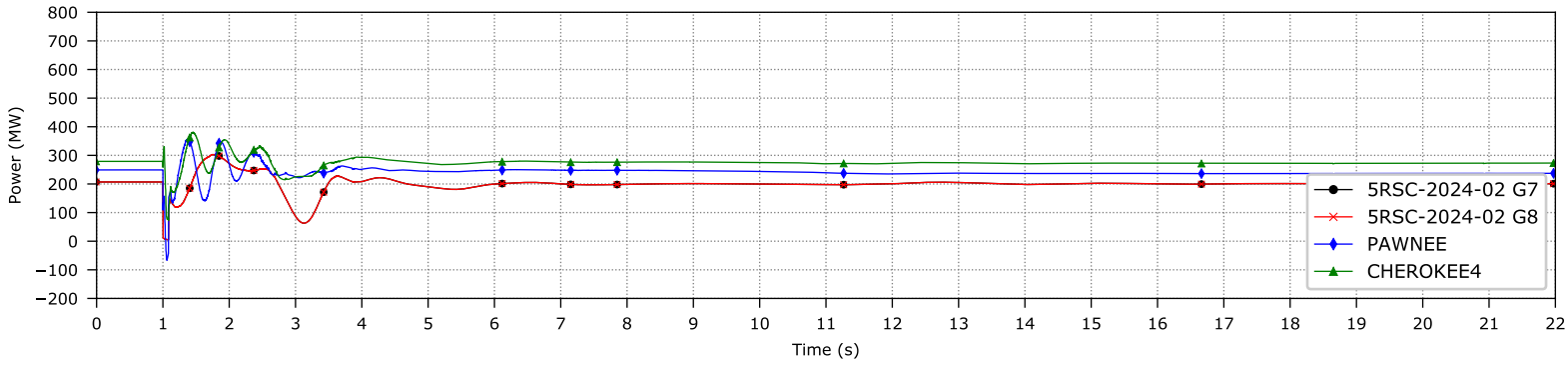


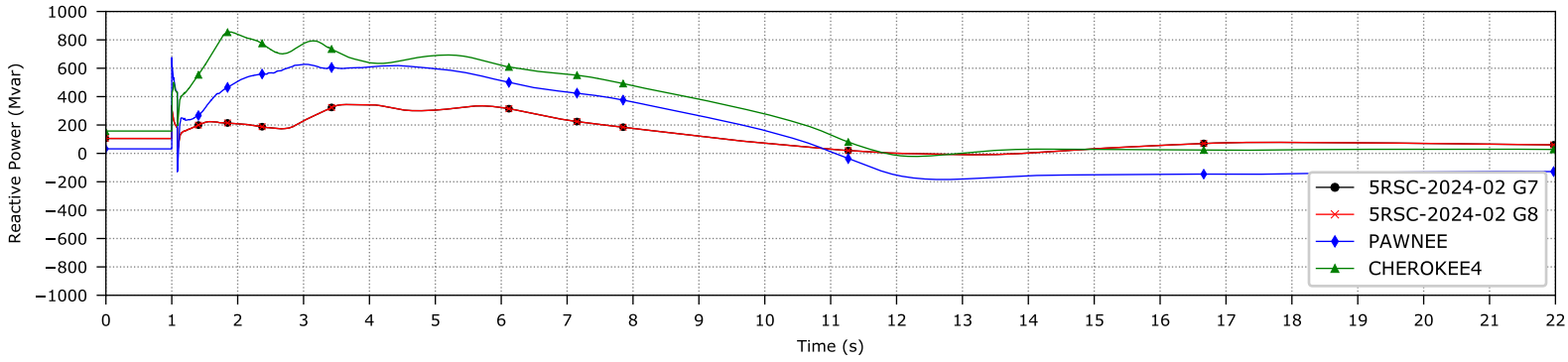


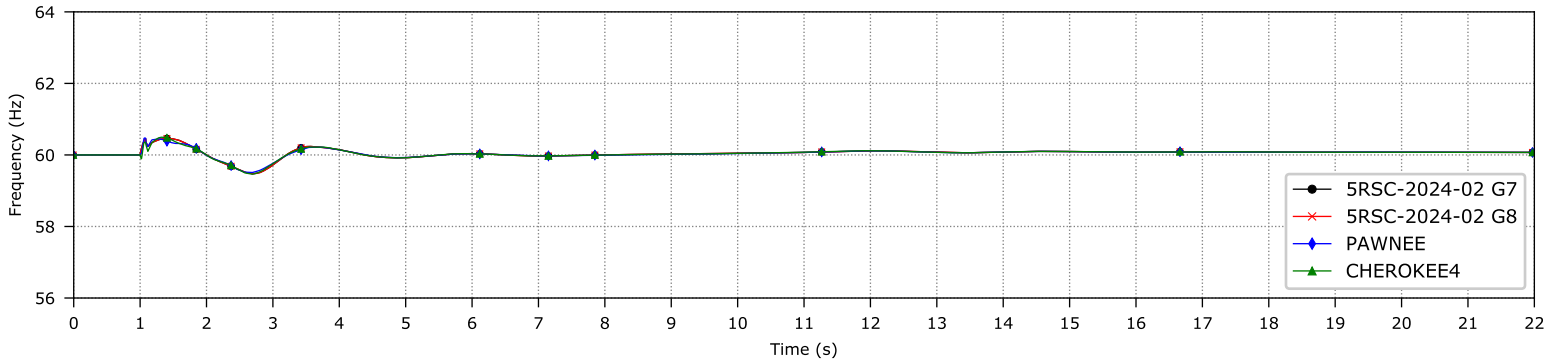


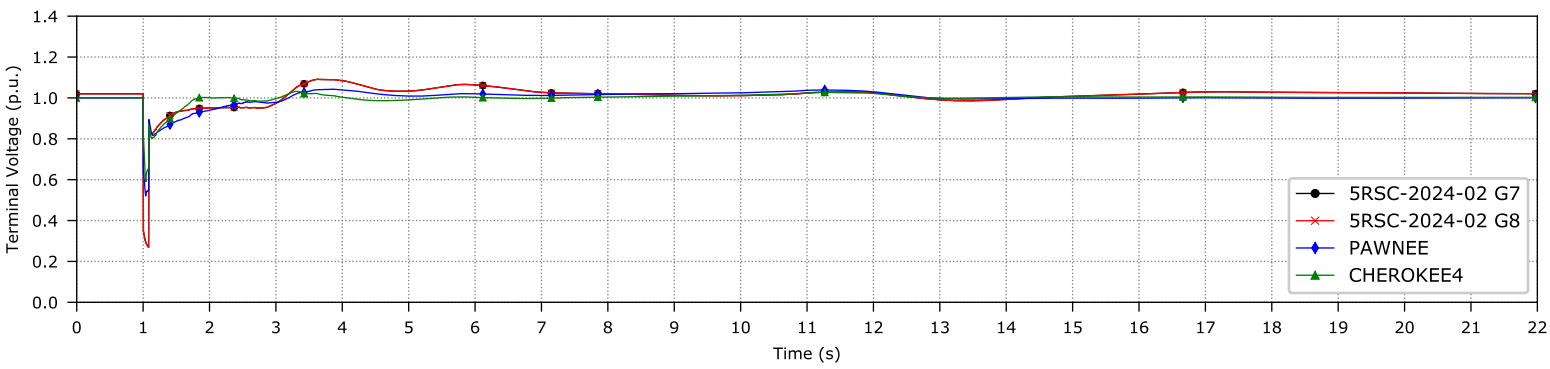
Ref. No. 06 - LoTC_63

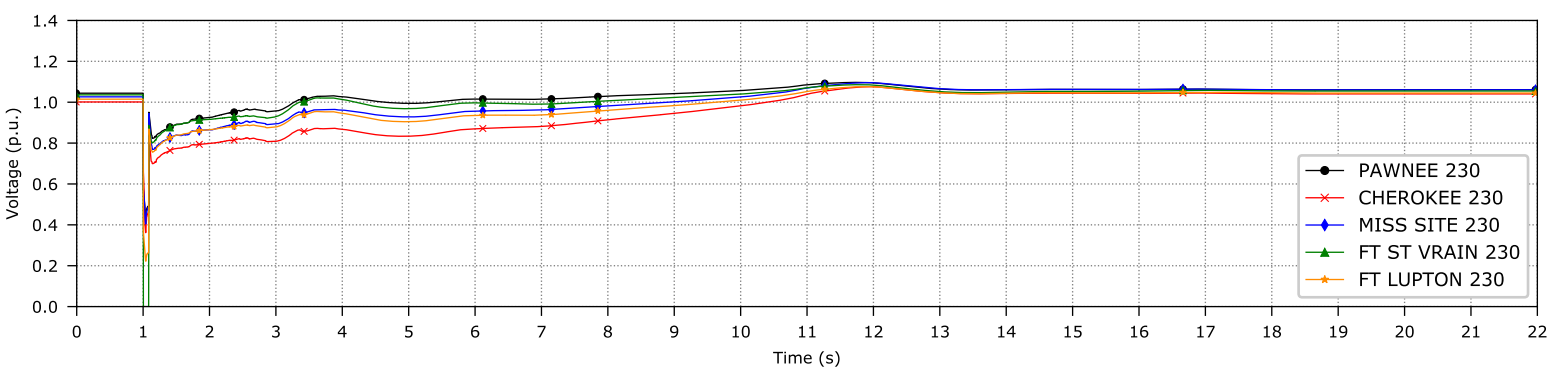




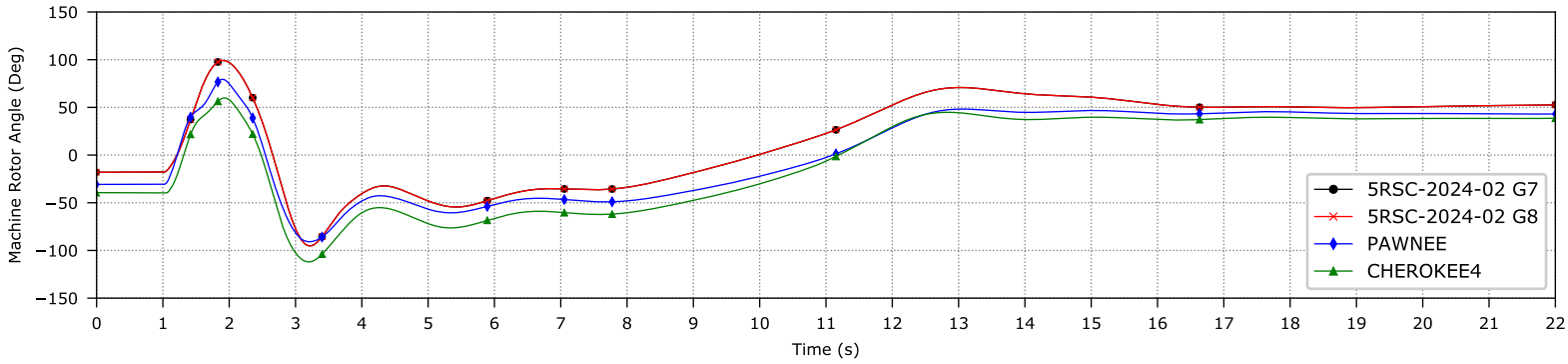


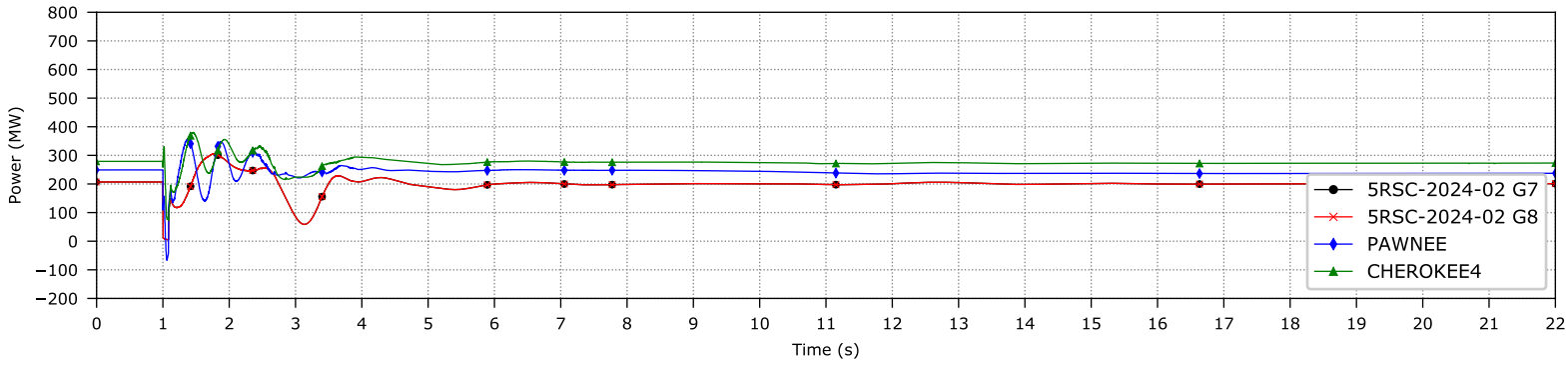


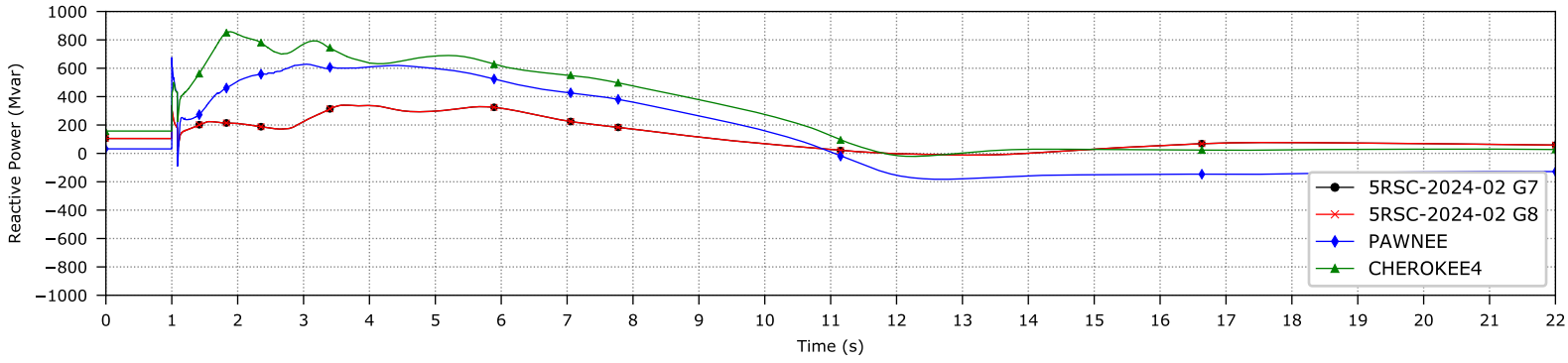


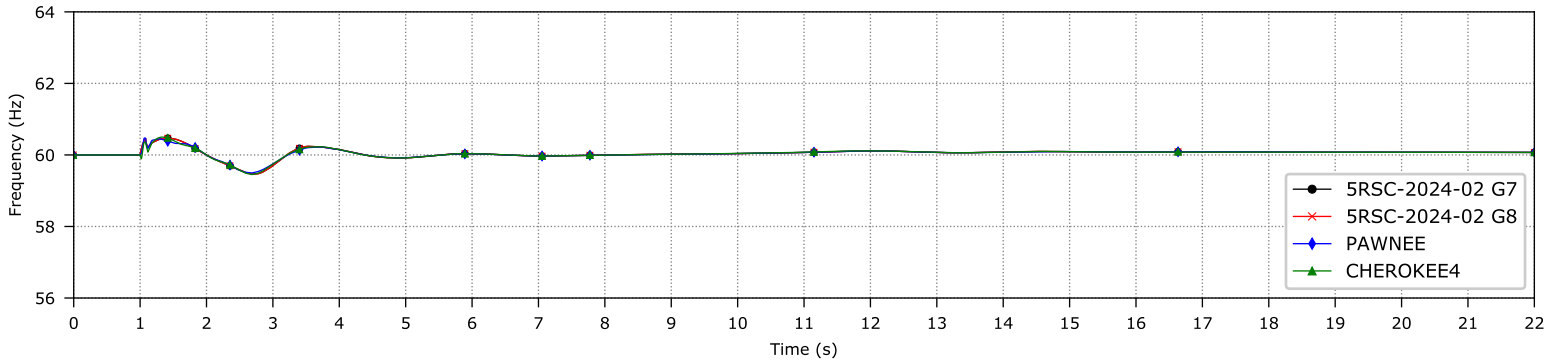


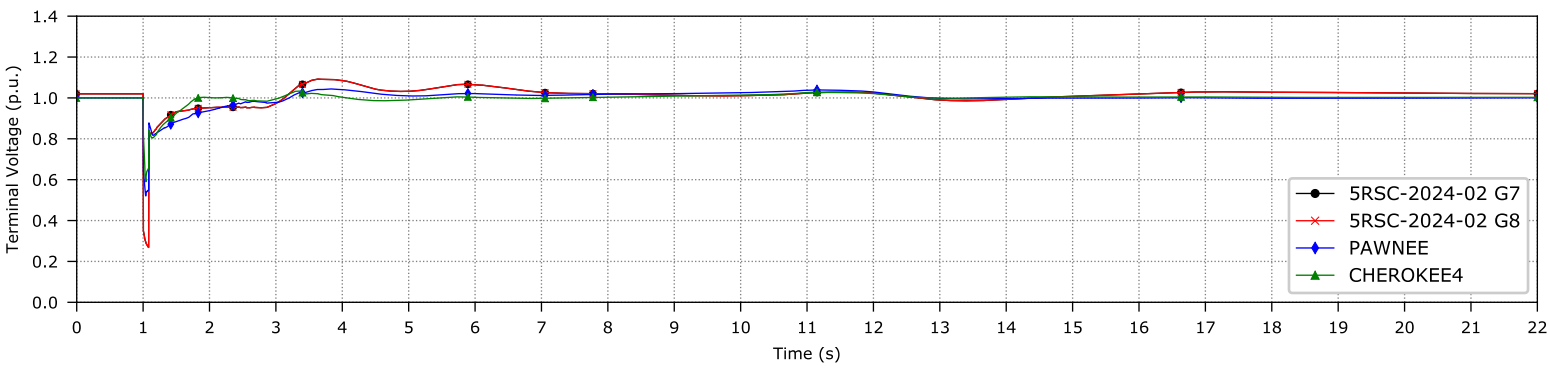
Ref. No. 07 - LoTC_64

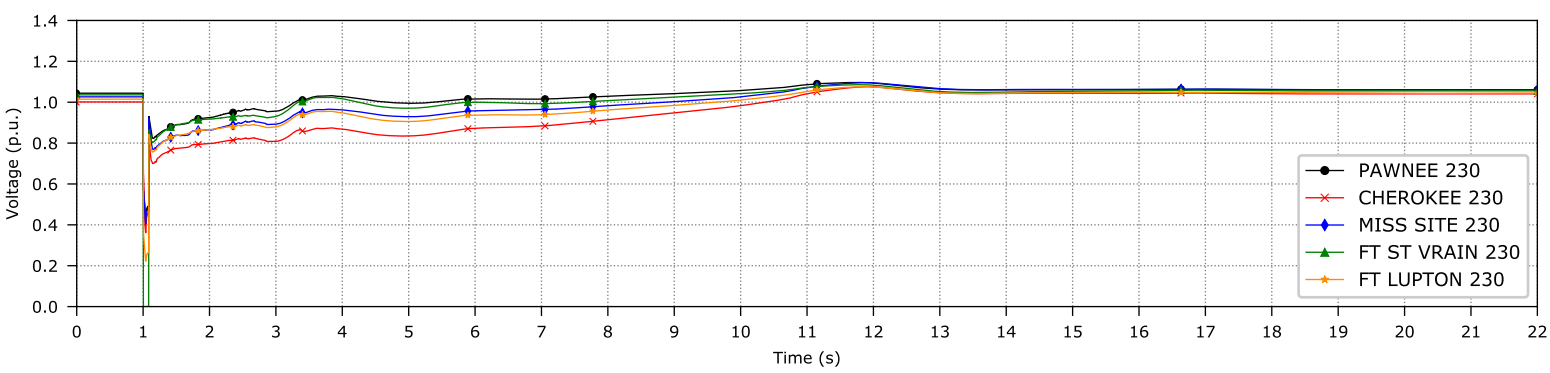




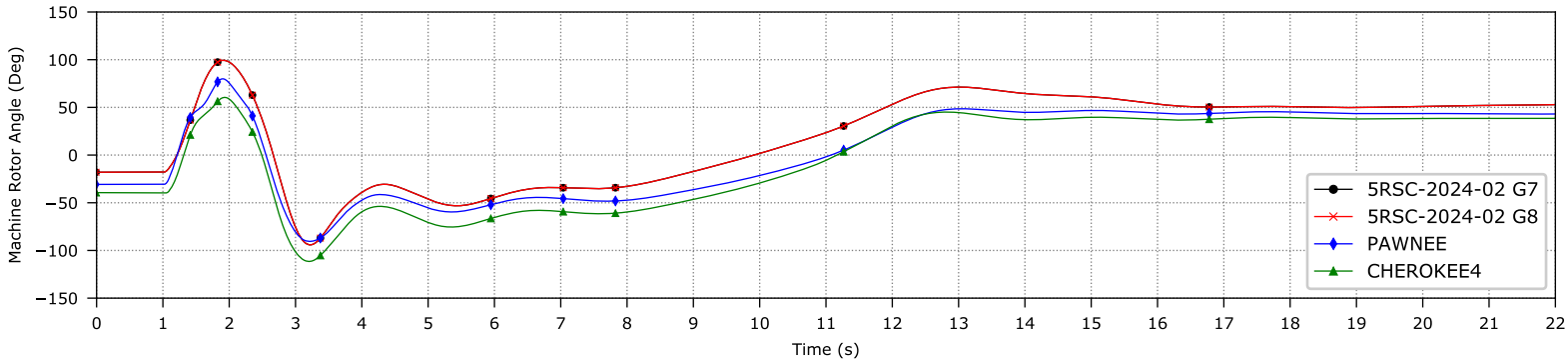


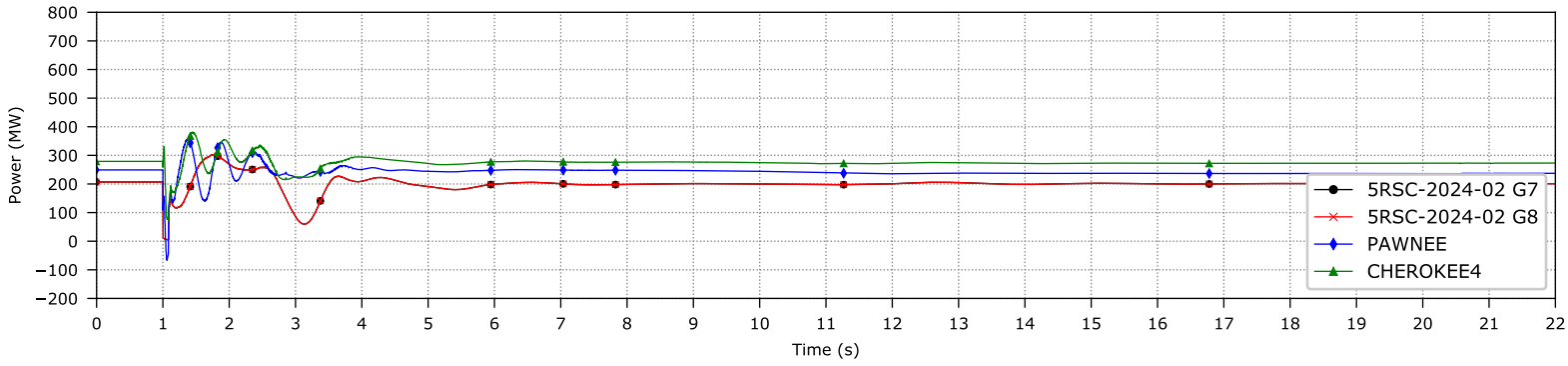


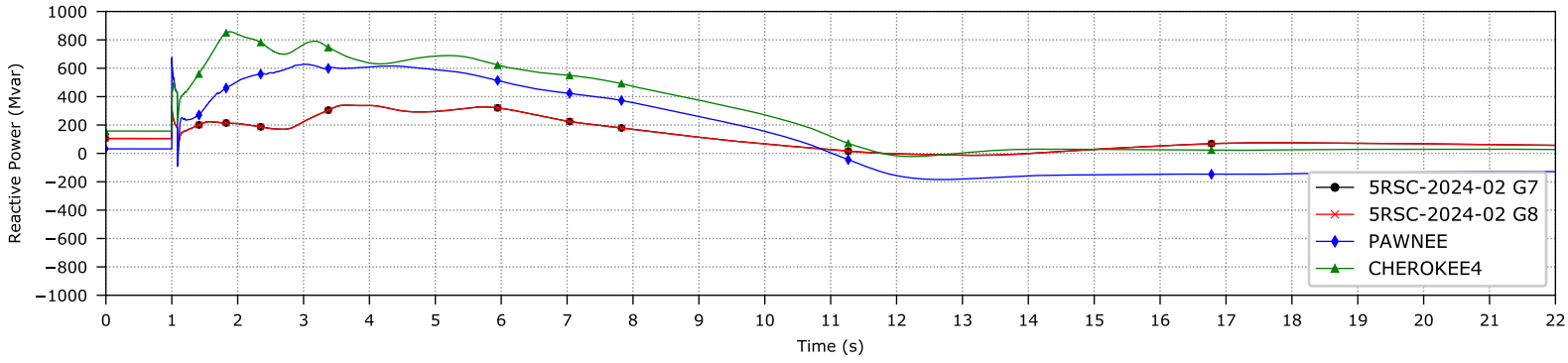


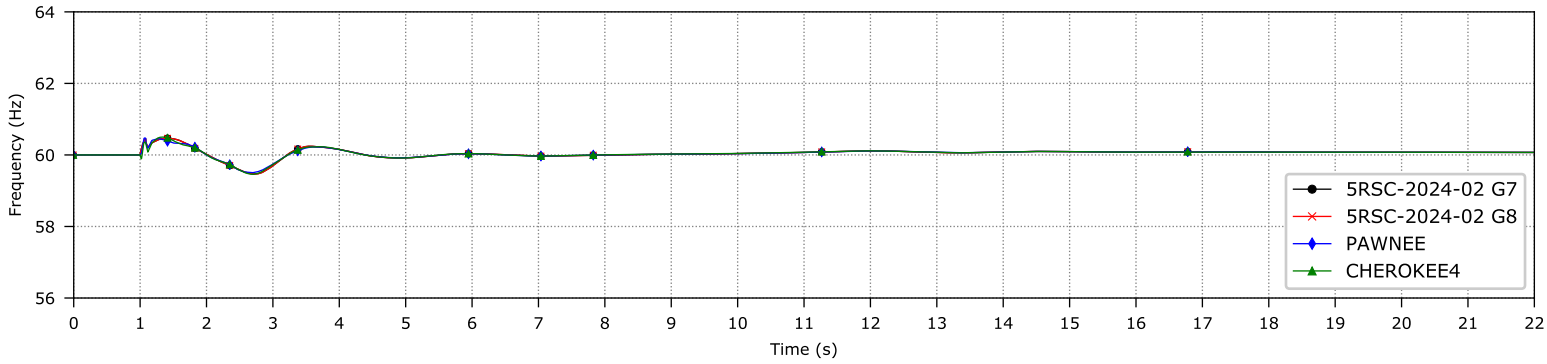


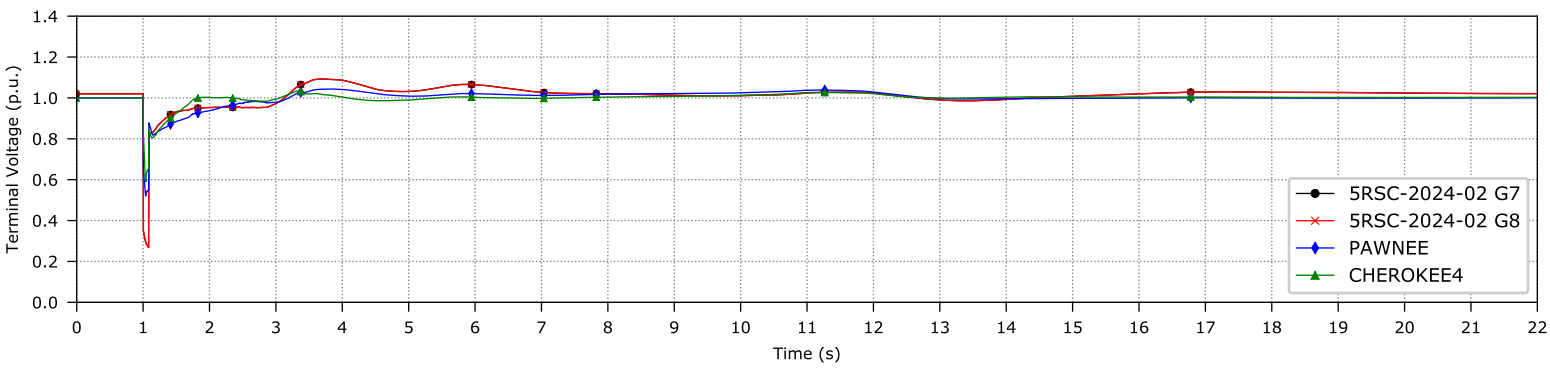
Ref. No. 08 - LoTC_65

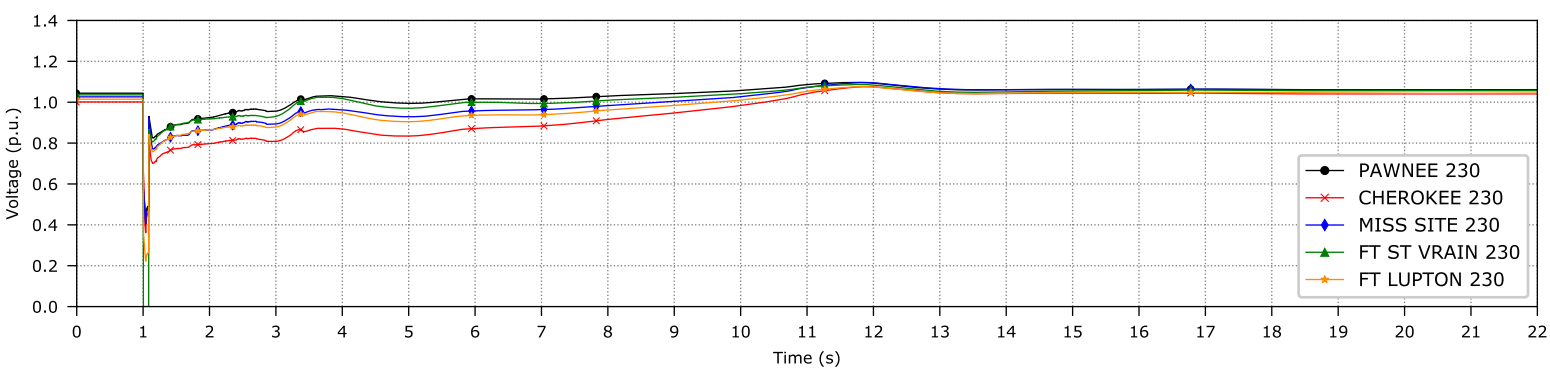


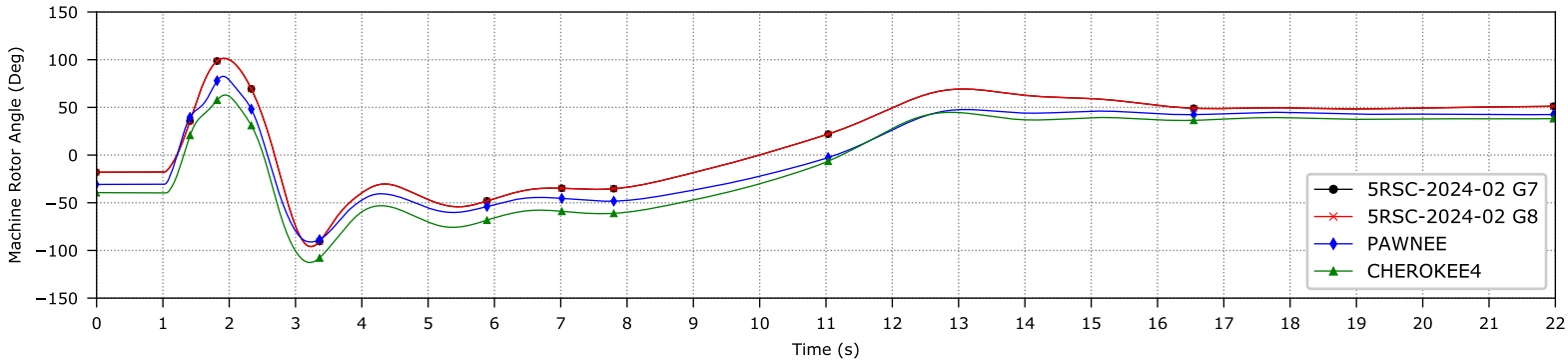


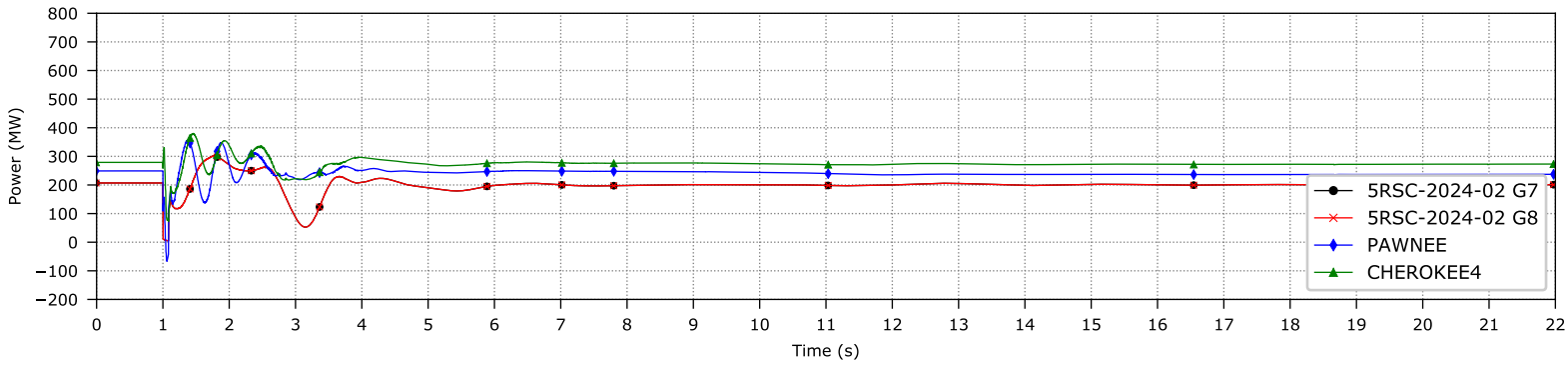


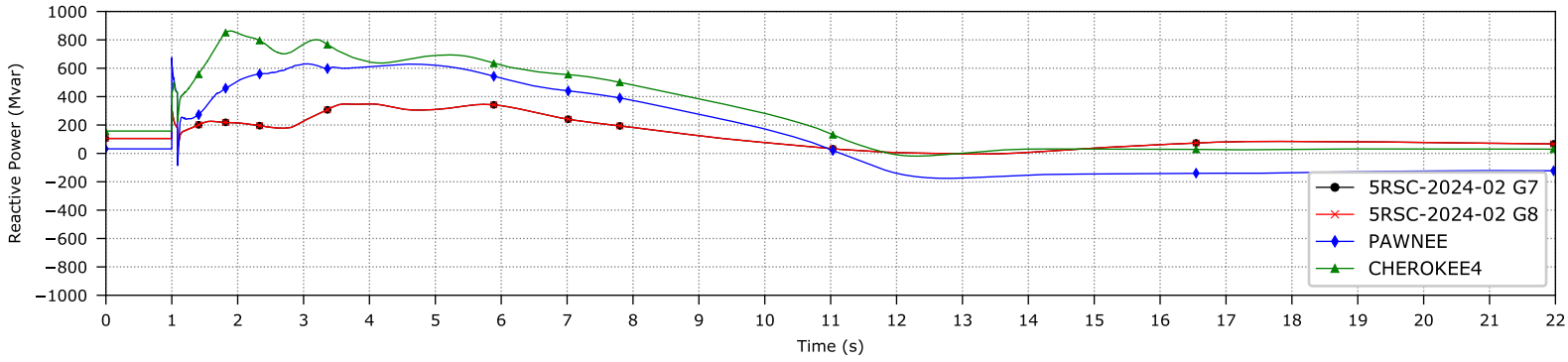


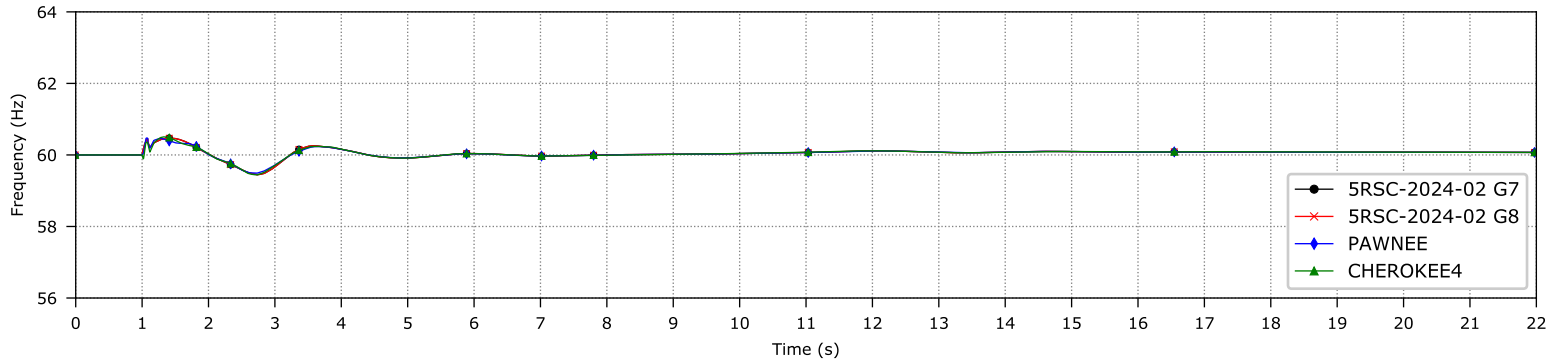


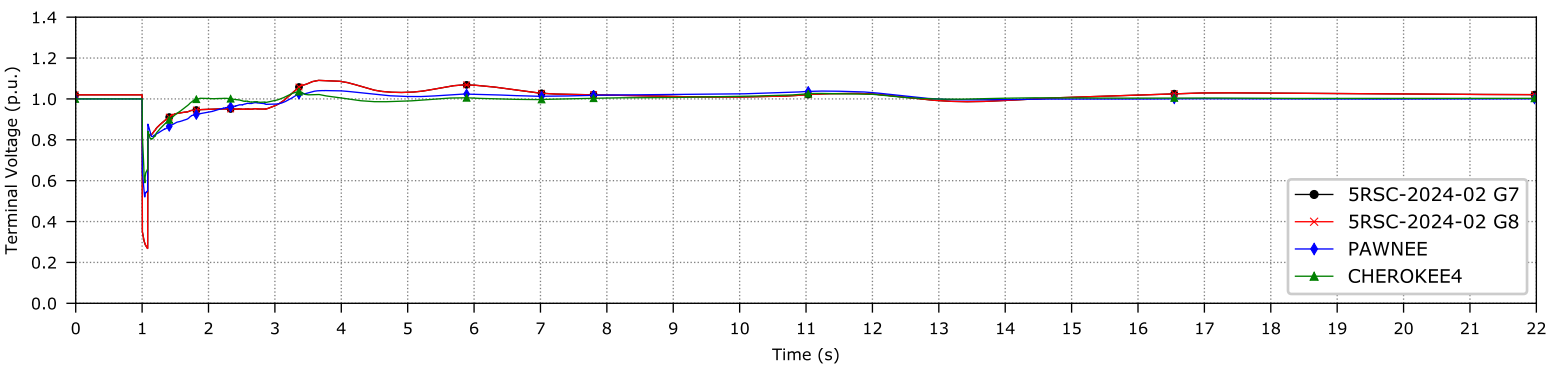


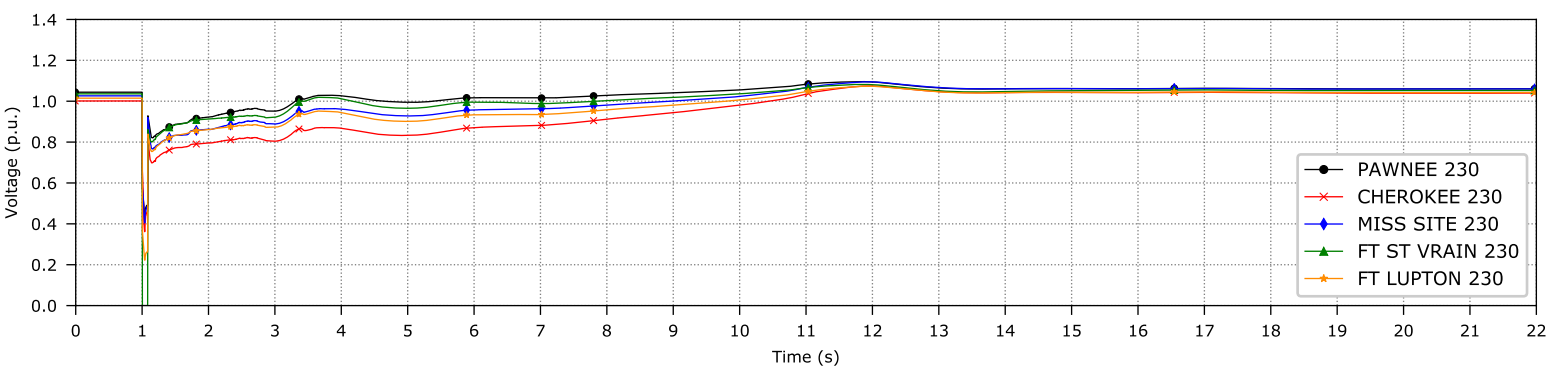

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

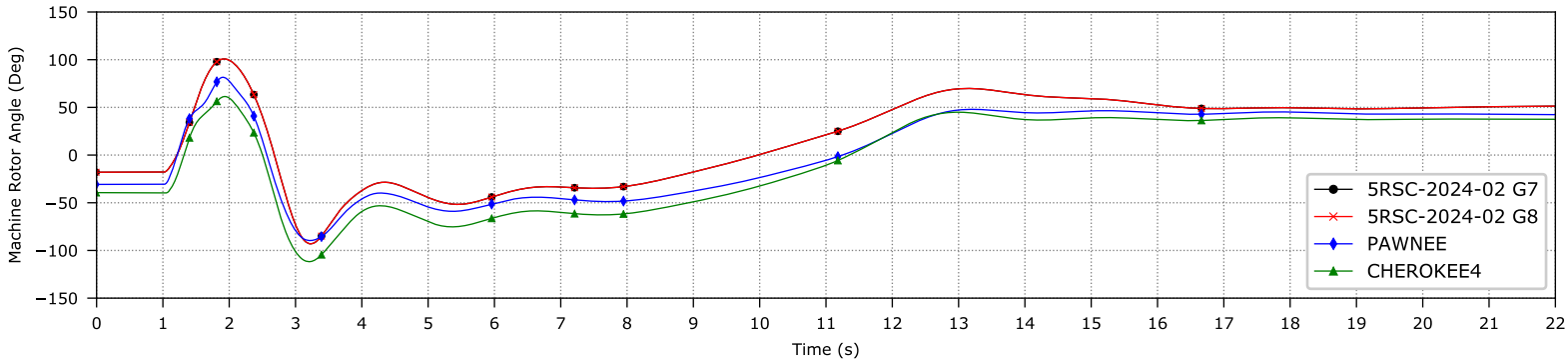

Reactive Power (Mvar)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

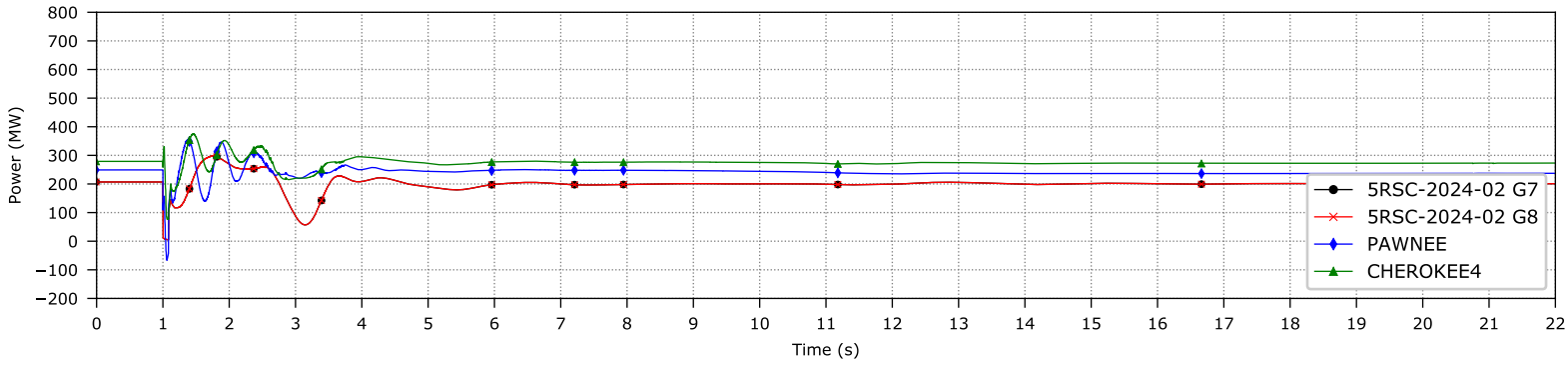

Frequency (Hz)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

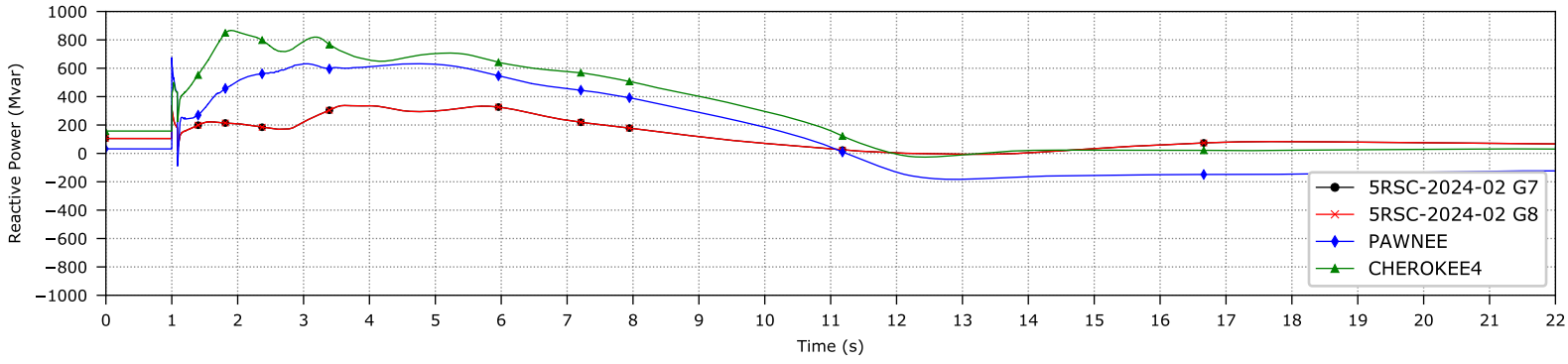

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

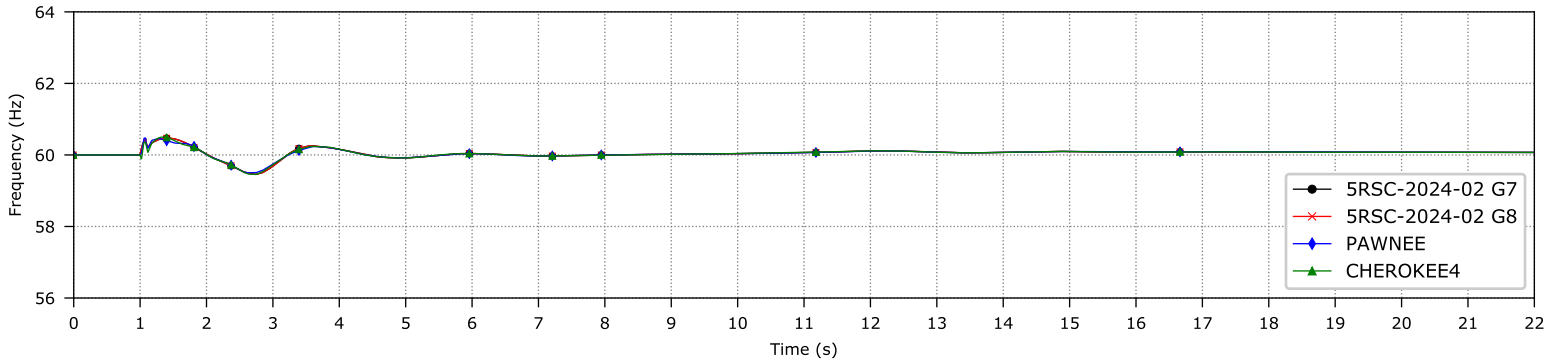

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230

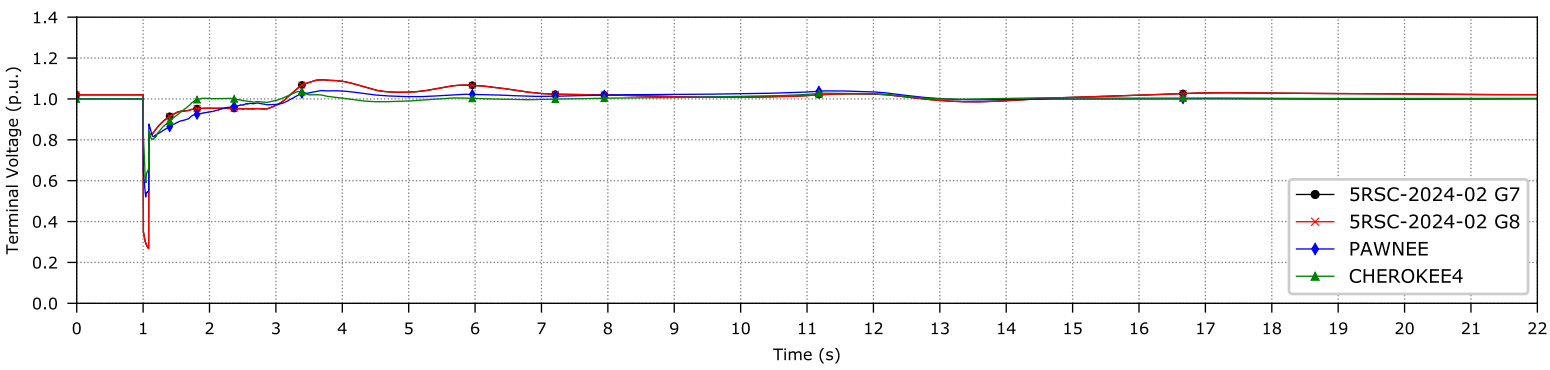
Ref. No. 10 - LoTC_67

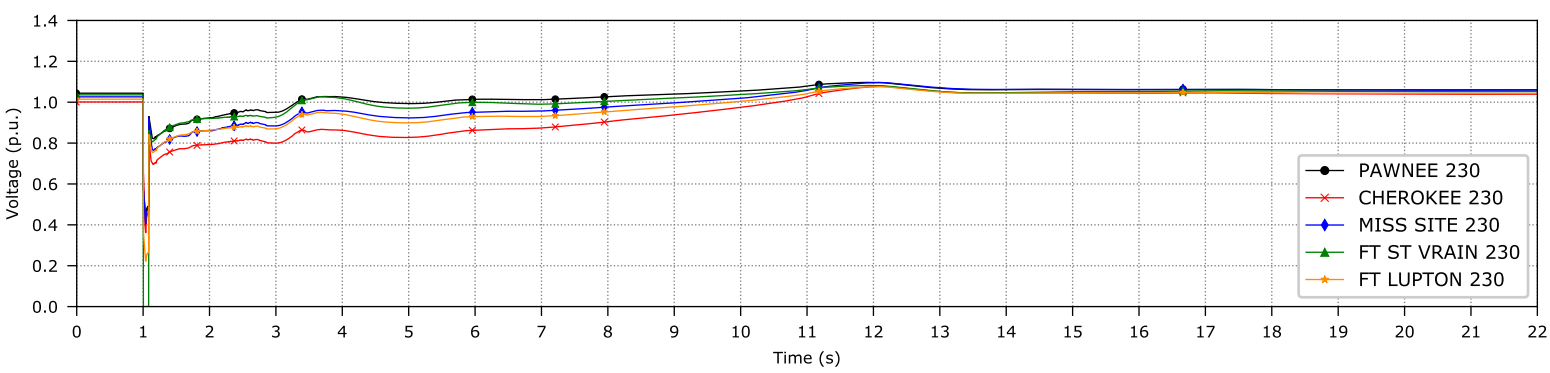




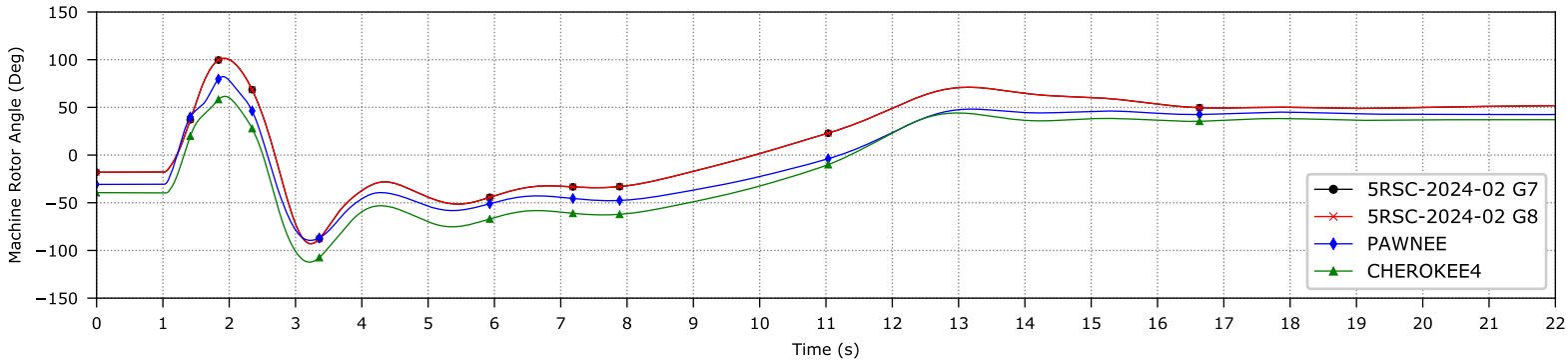


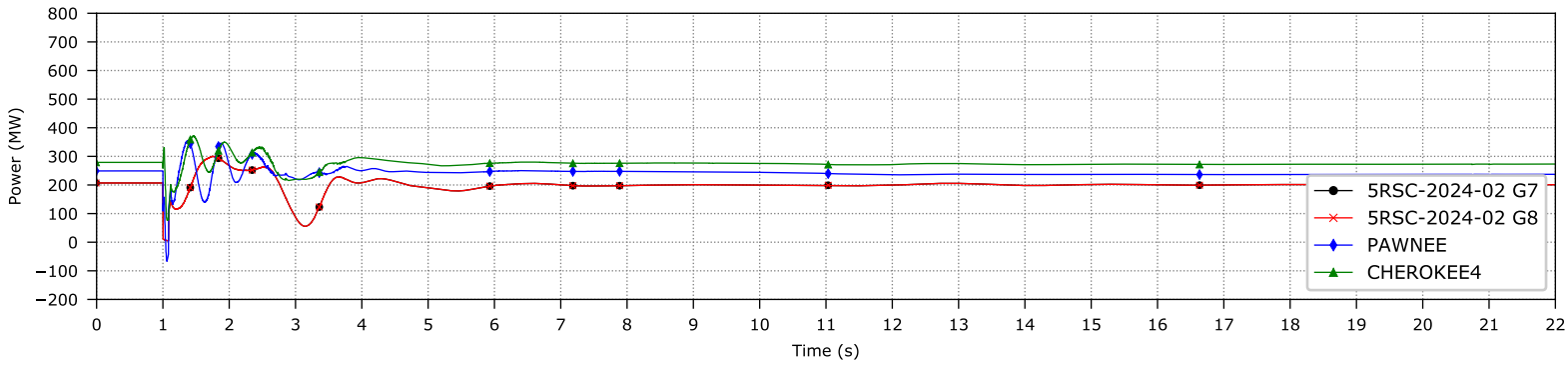


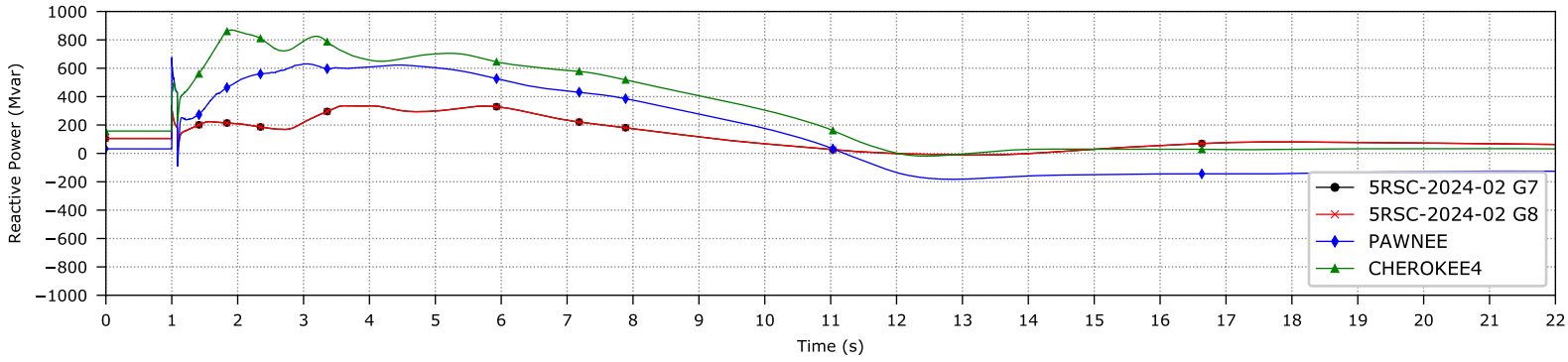


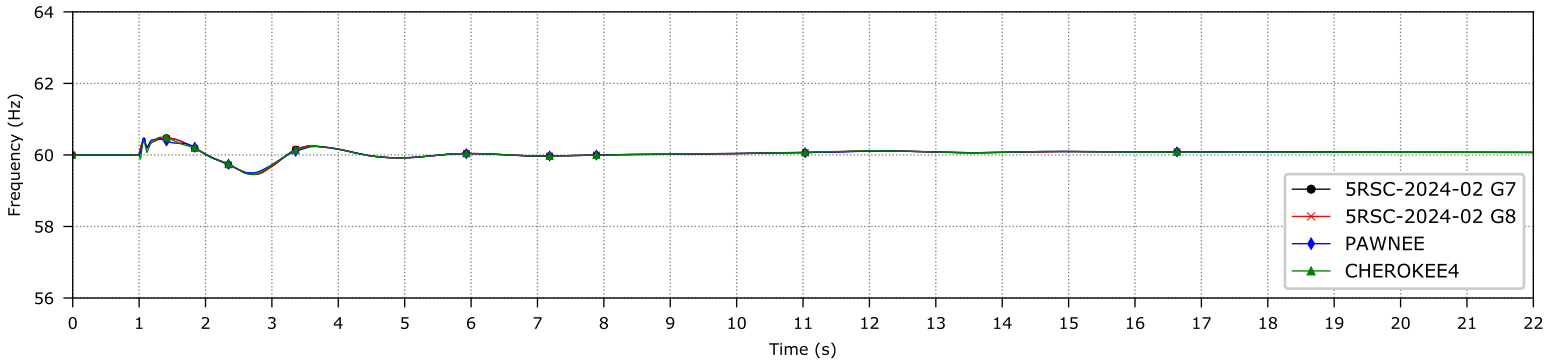


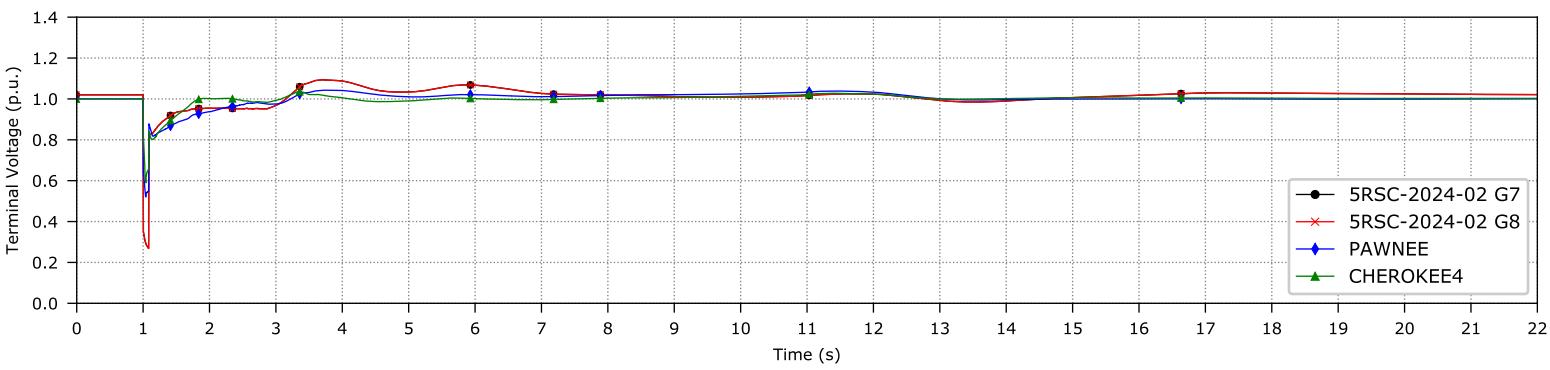
Ref. No. 11 - LoTC_141

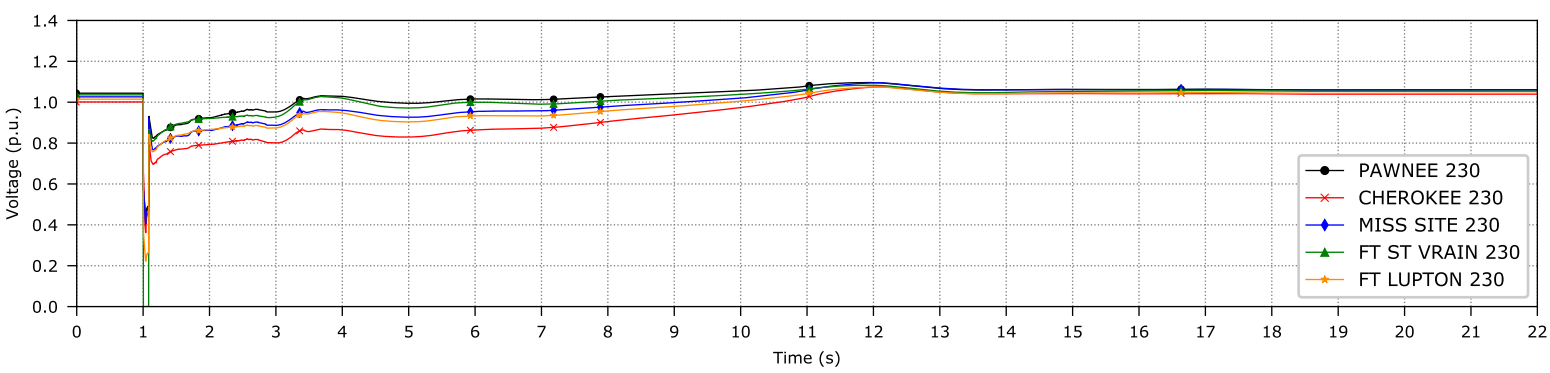




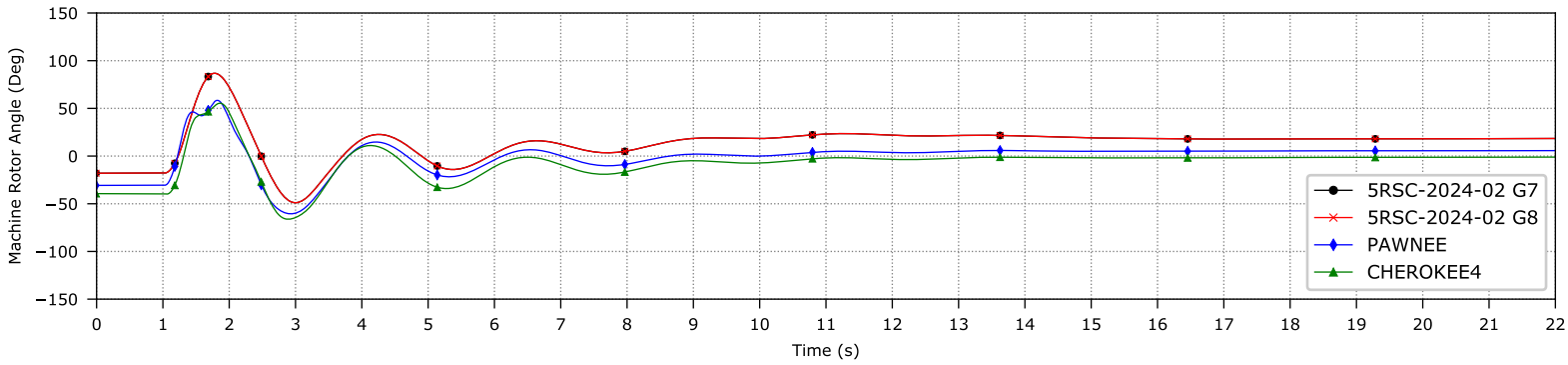


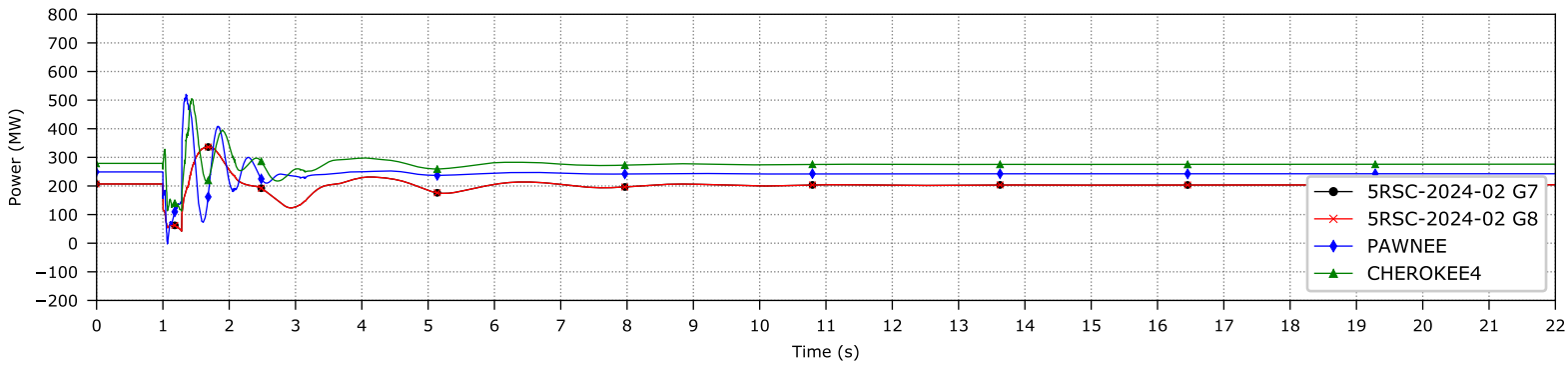


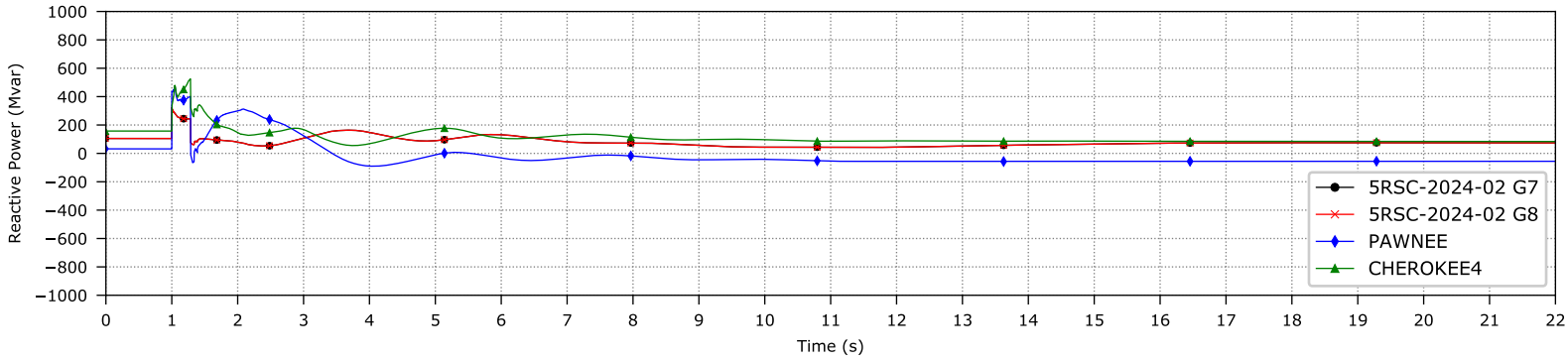


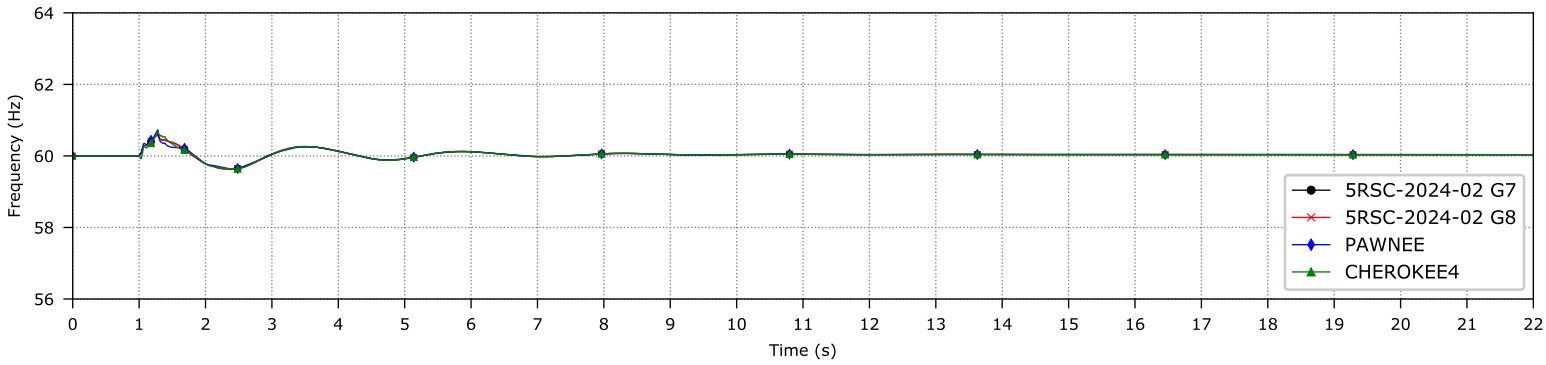


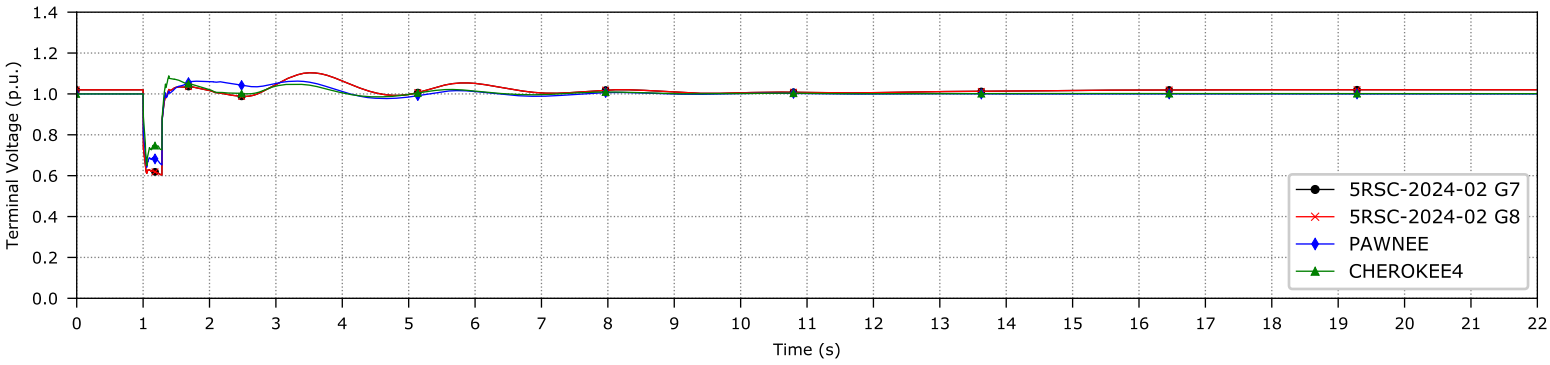
Ref. No. 14 - BF_057a

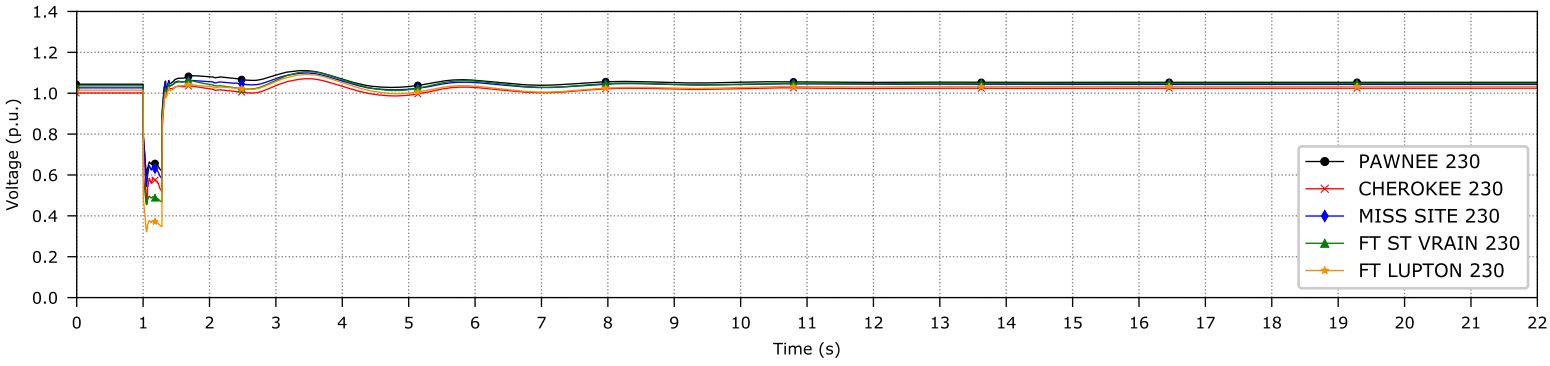












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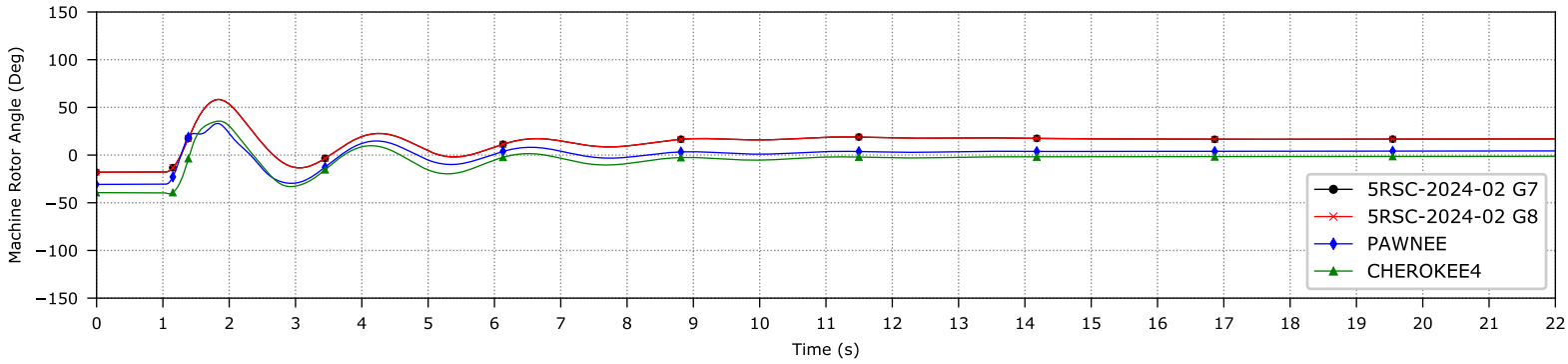

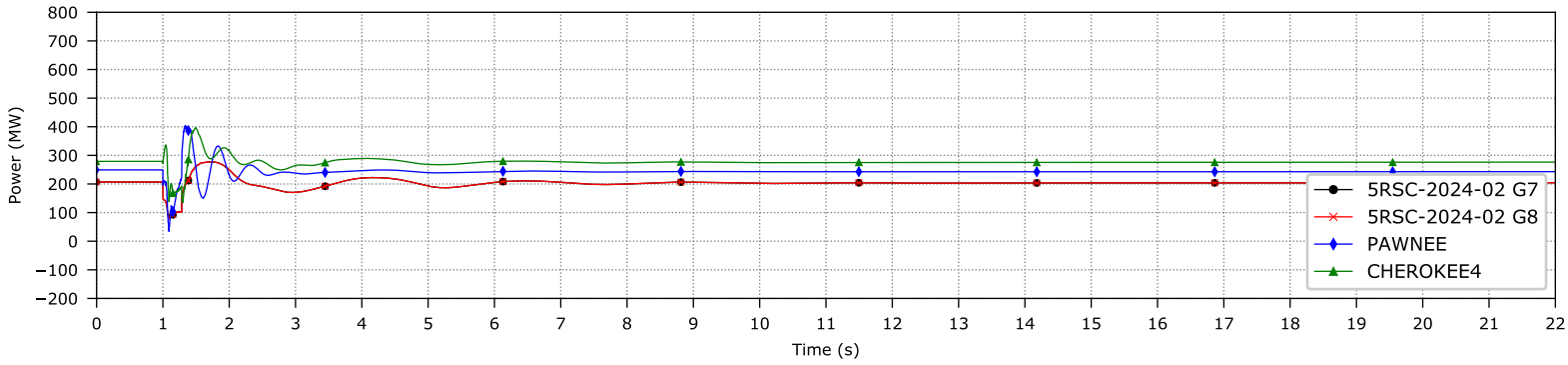

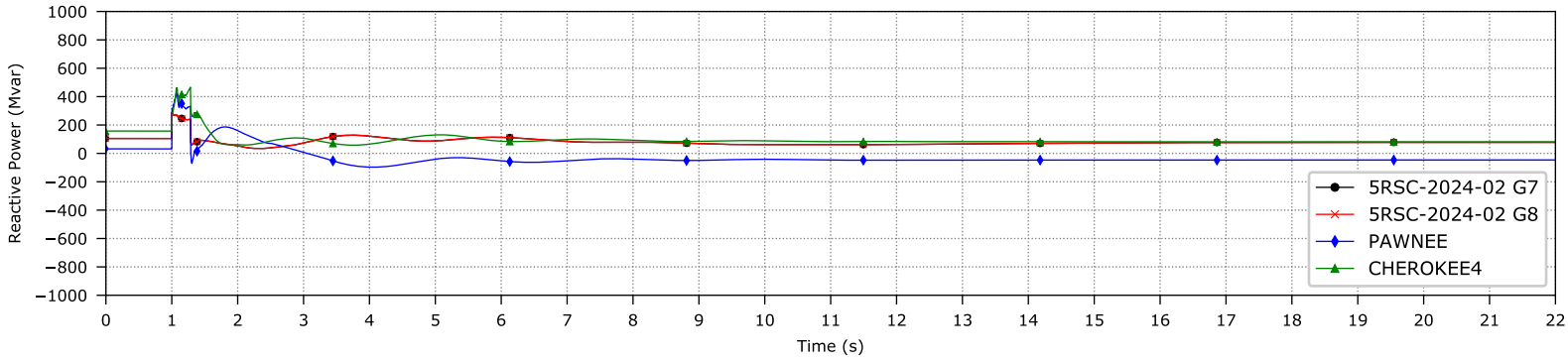

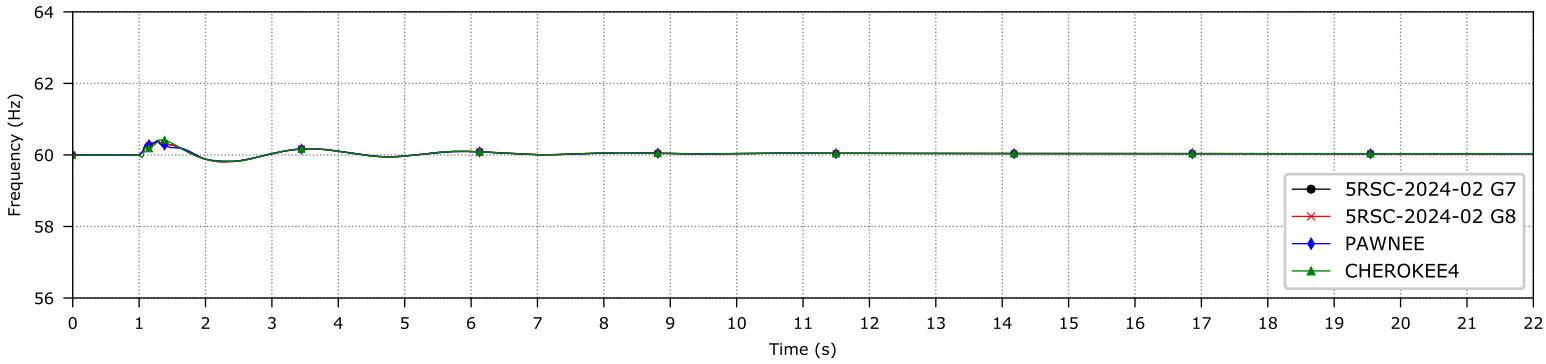

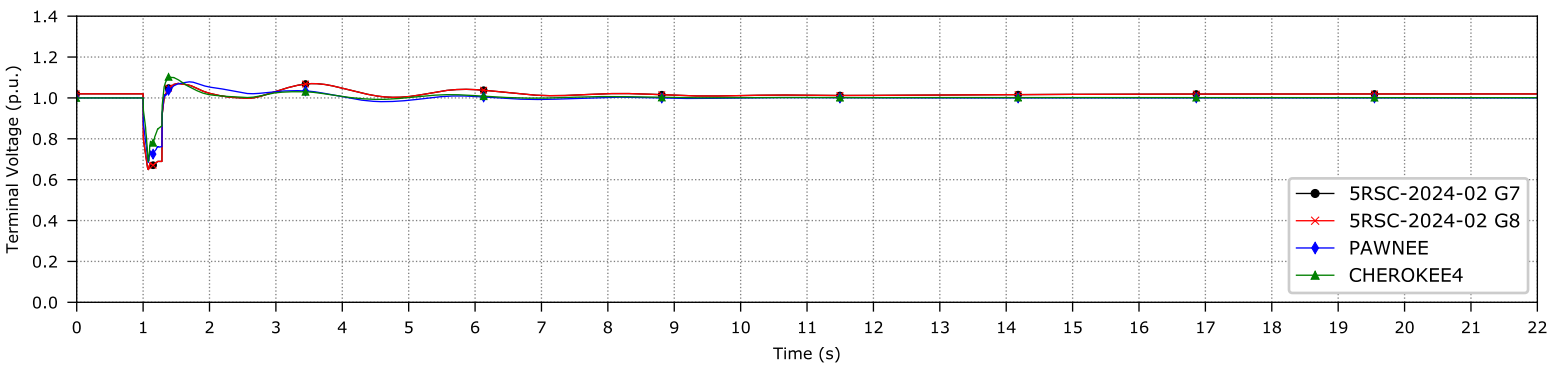

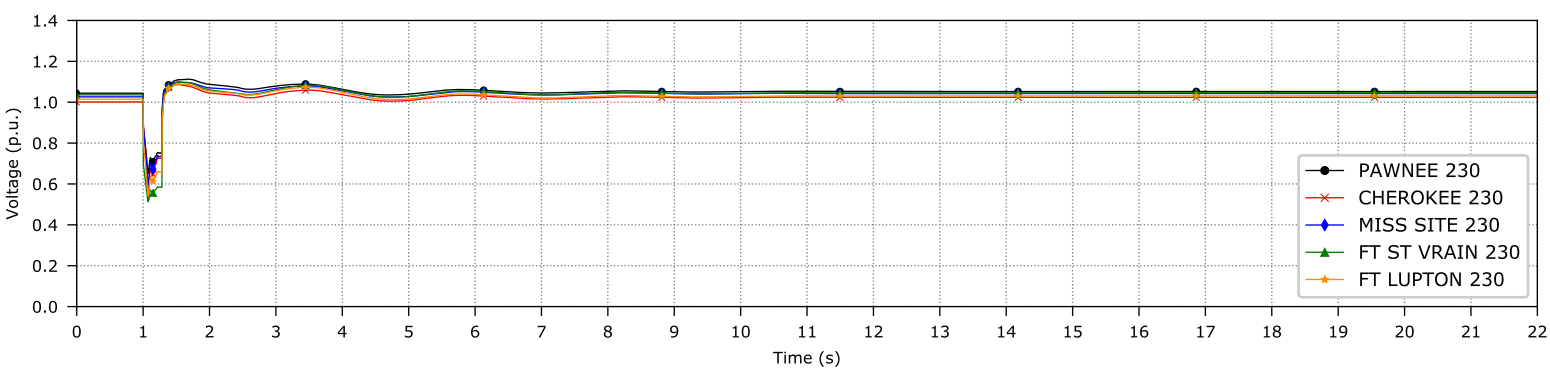

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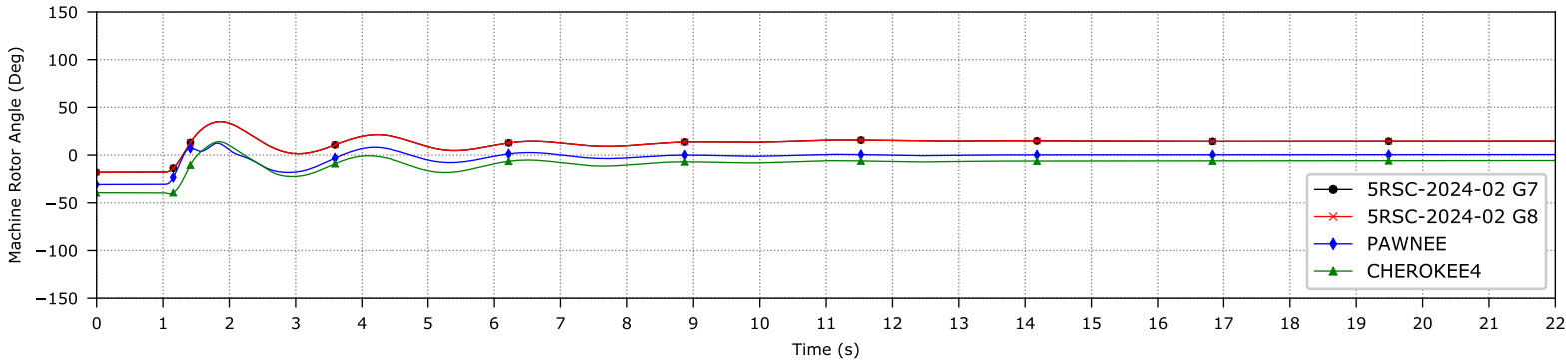

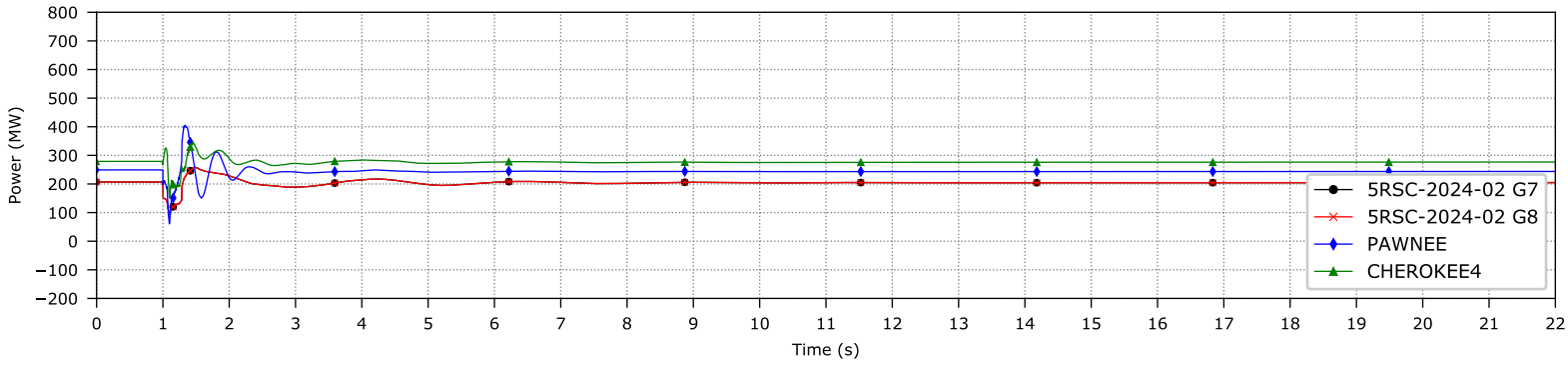

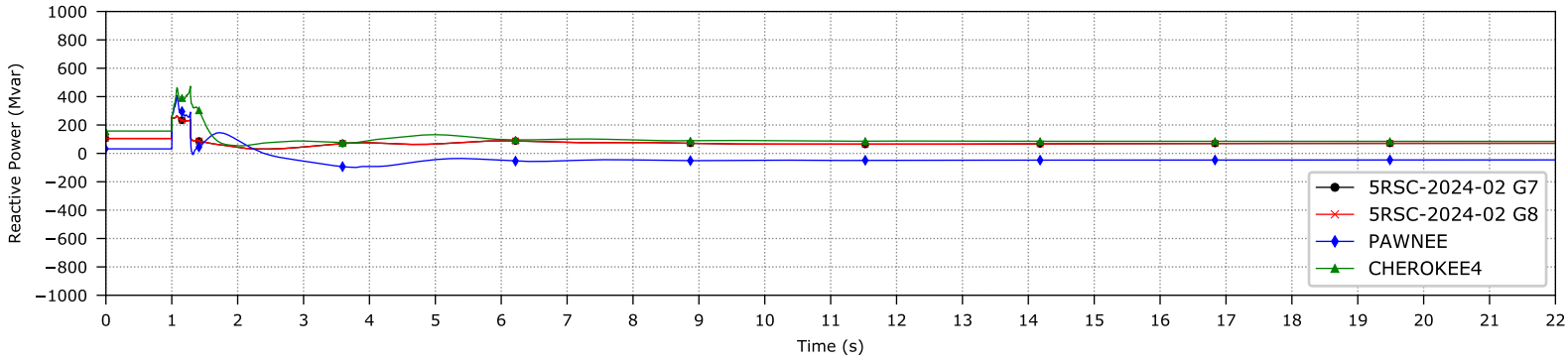

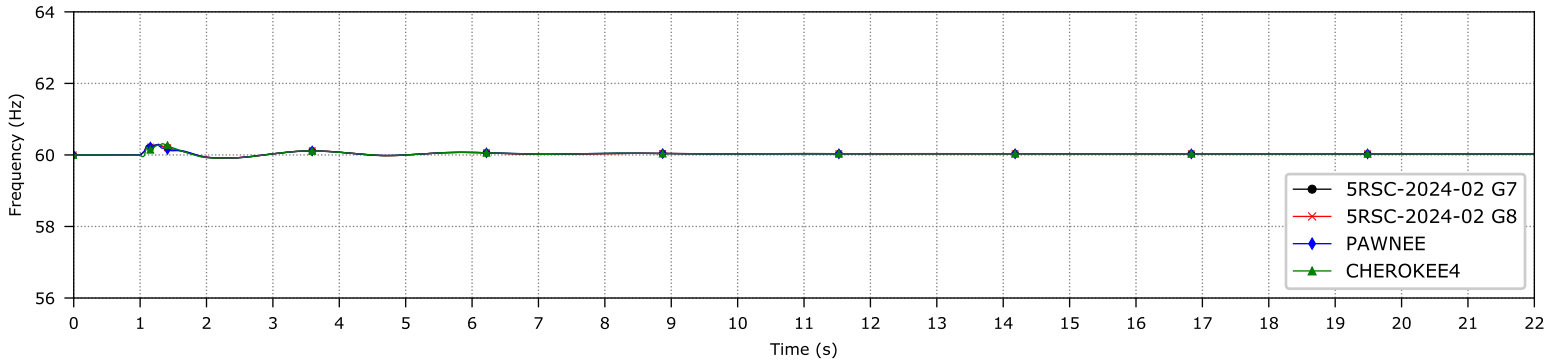

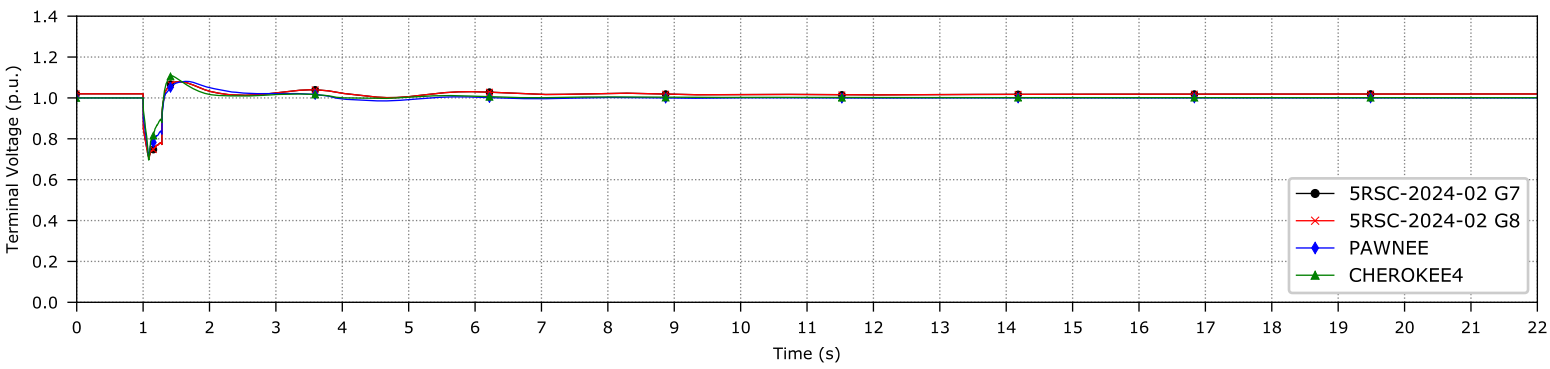

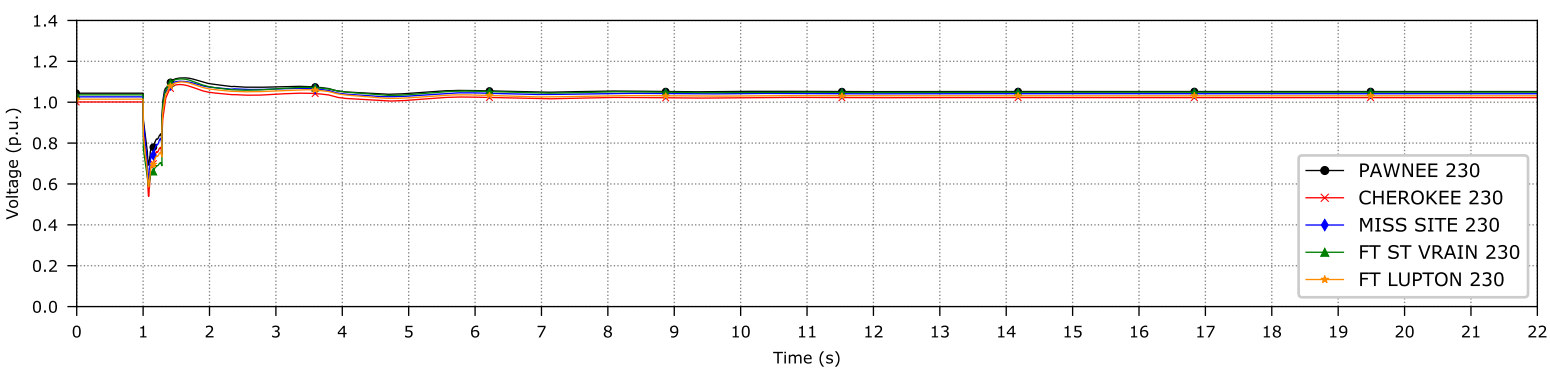

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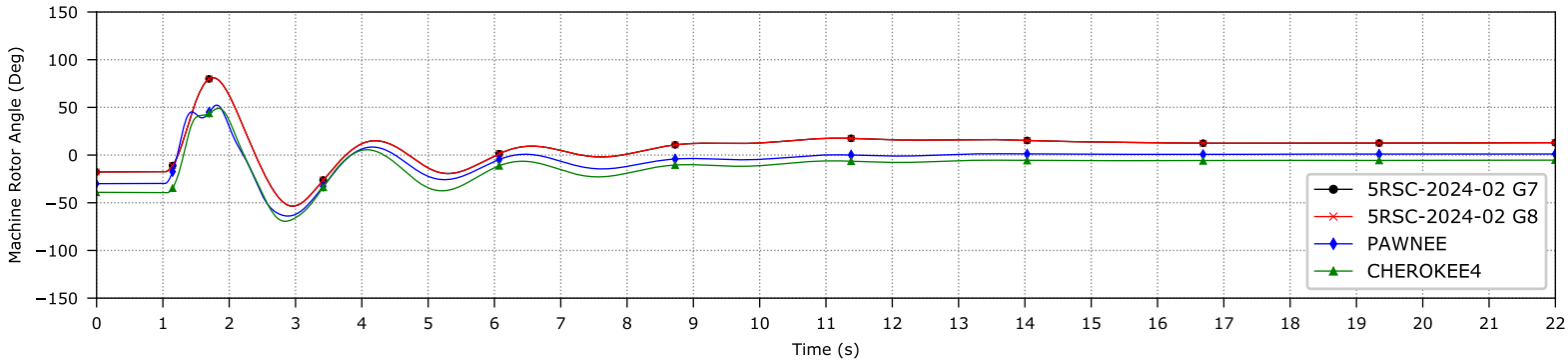
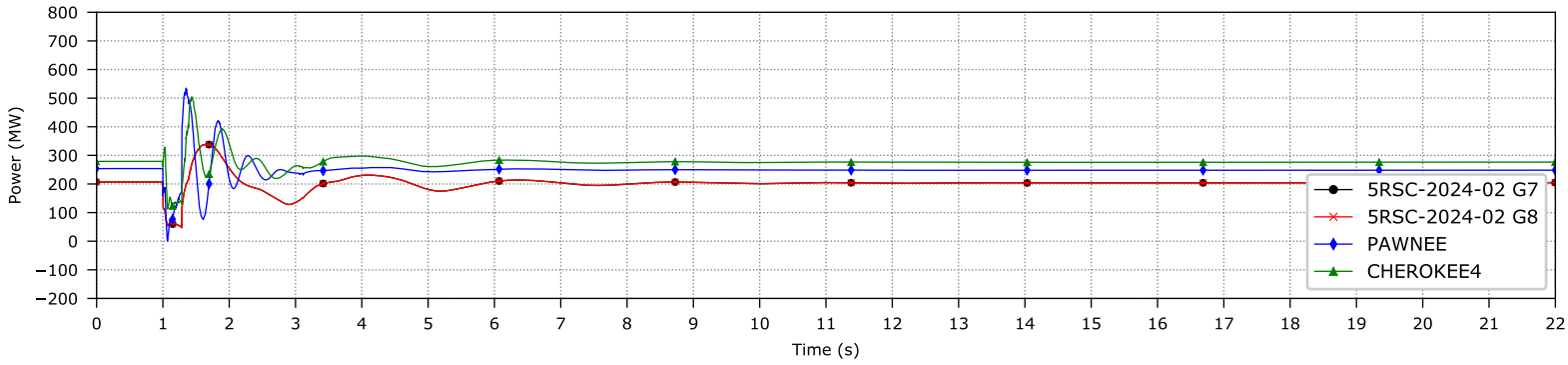
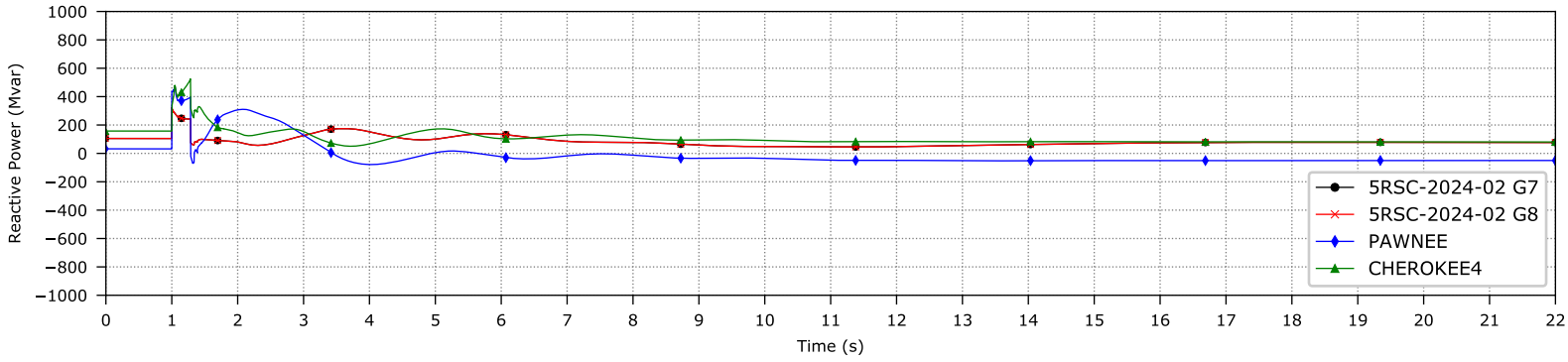
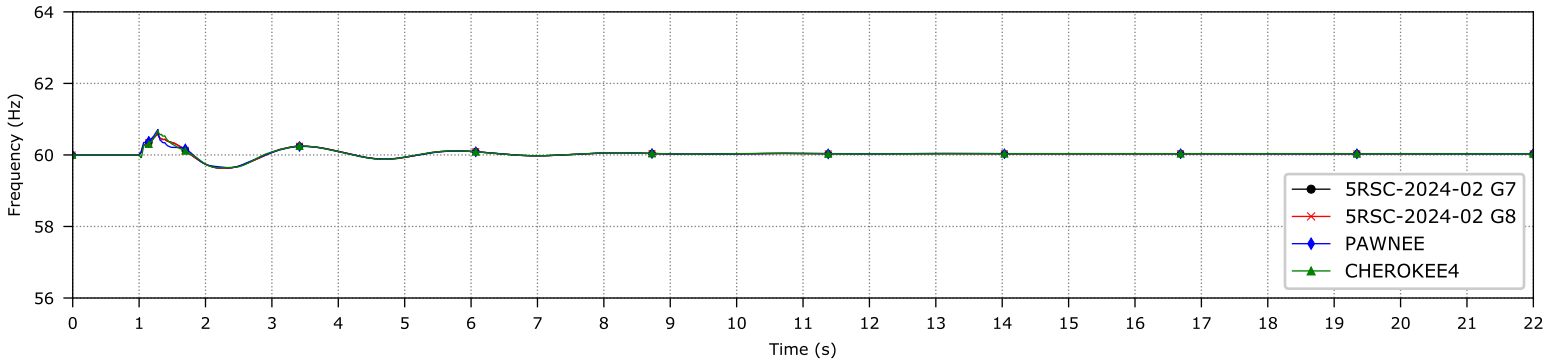
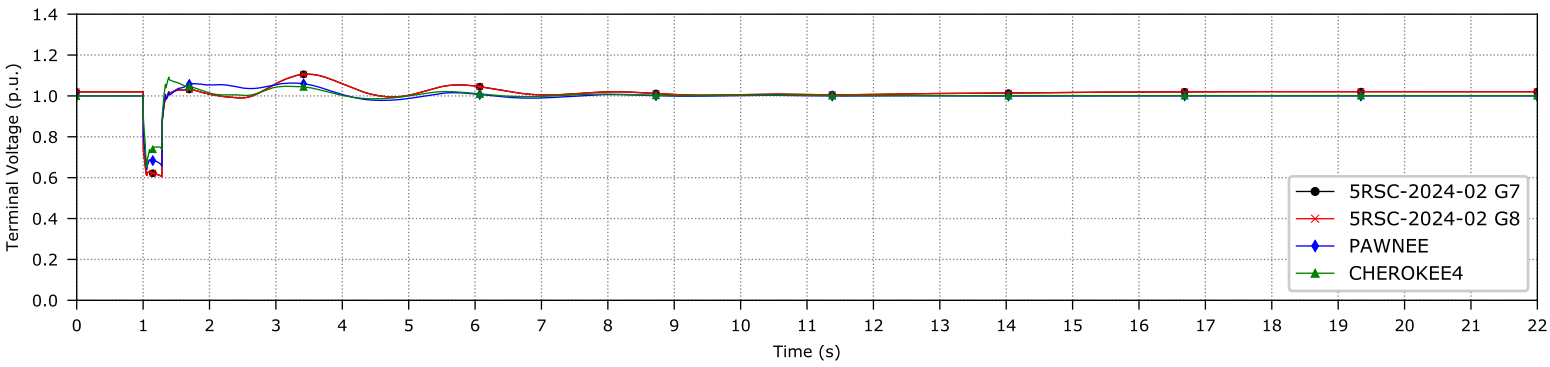
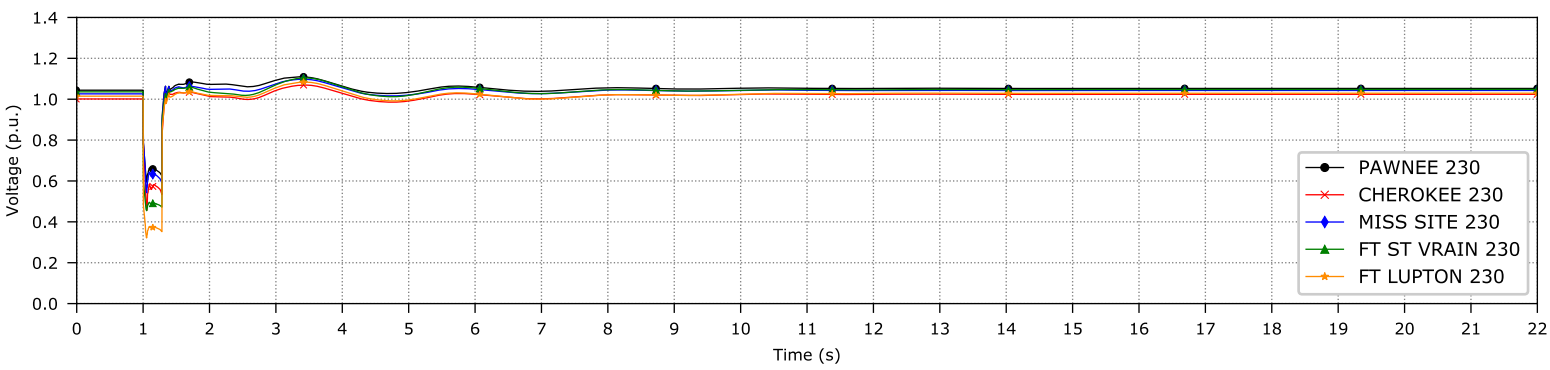


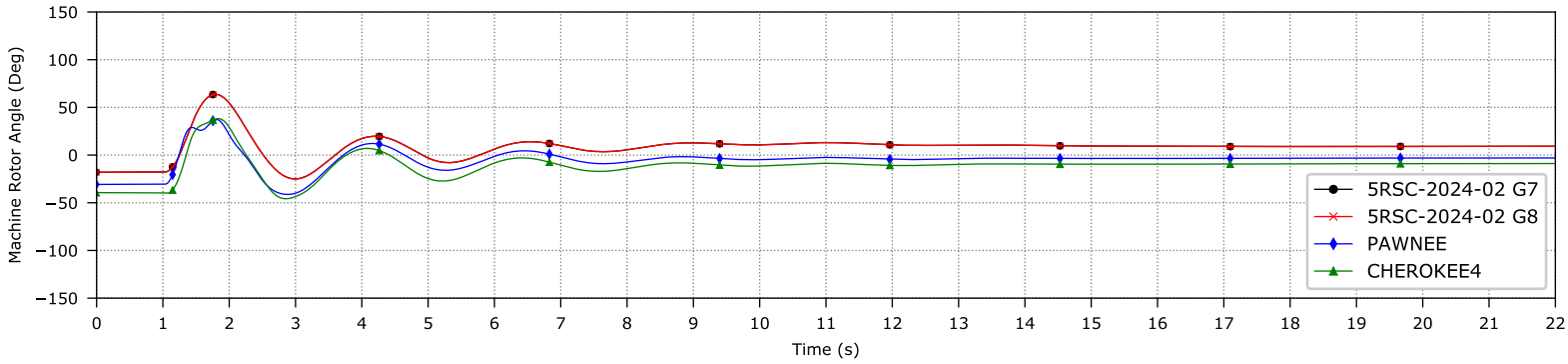


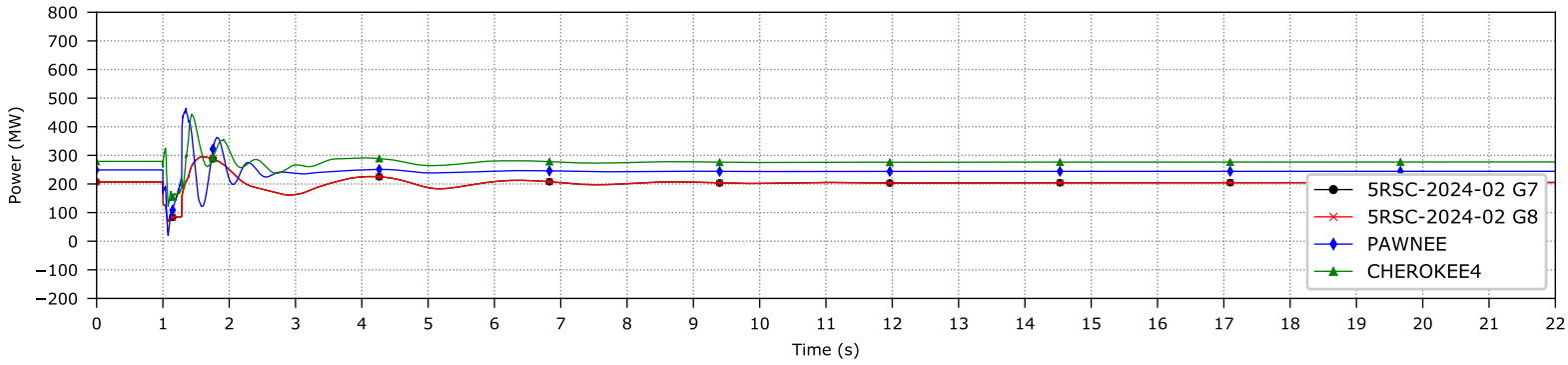


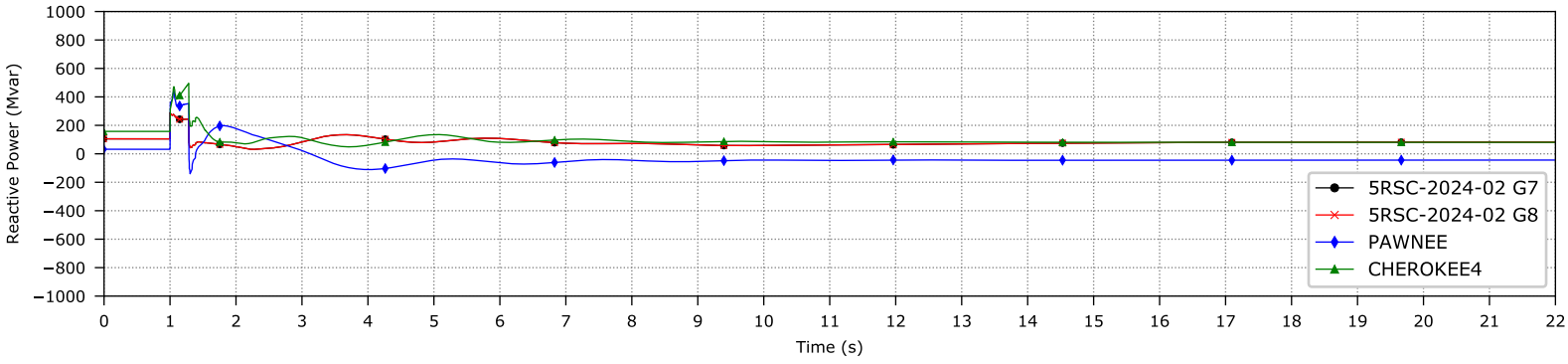


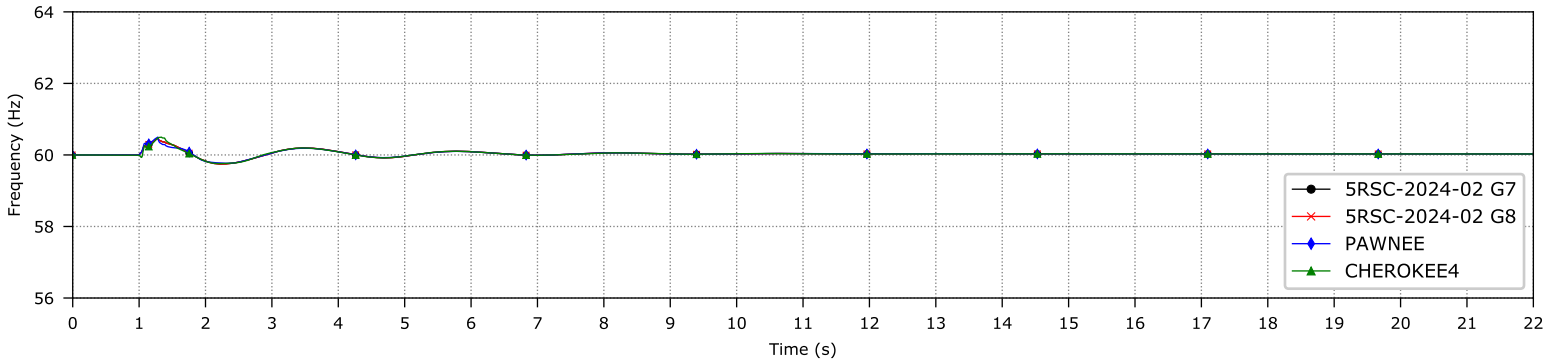


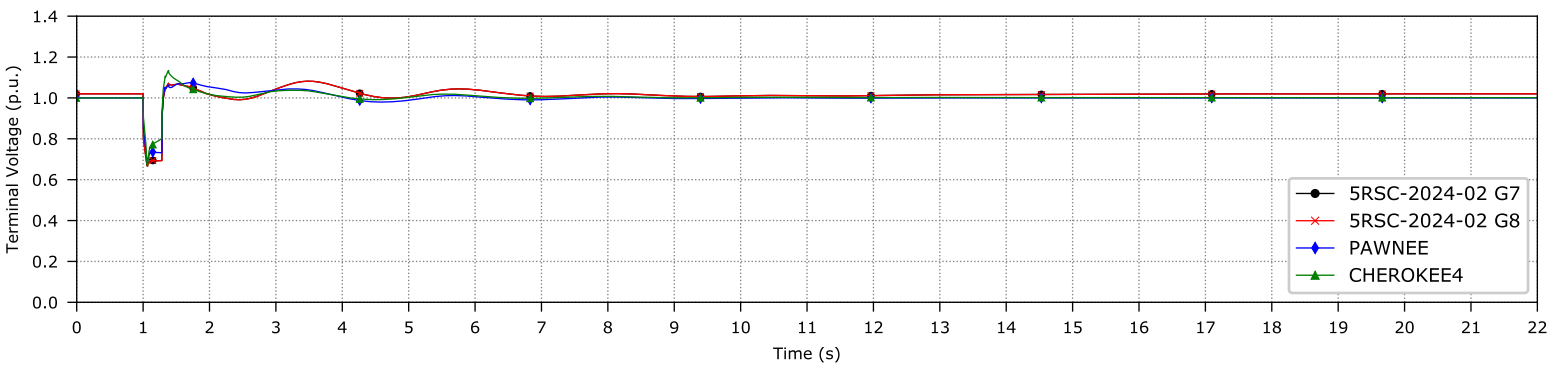


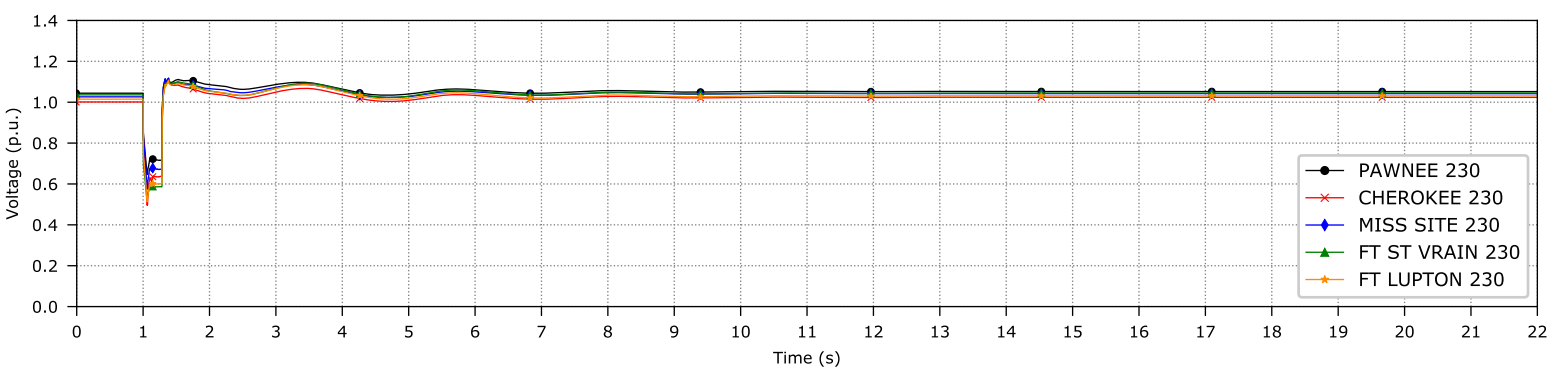

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

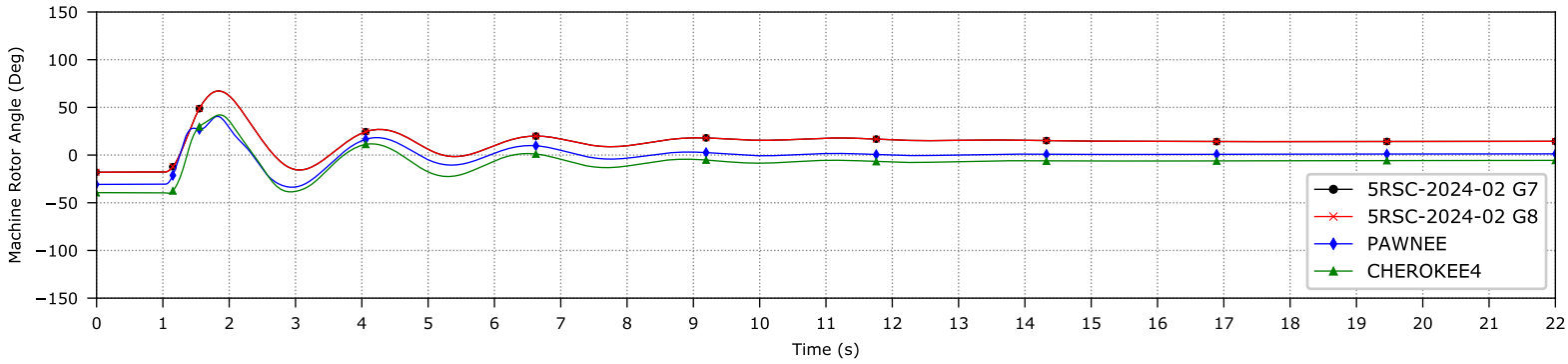

Reactive Power (Mvar)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

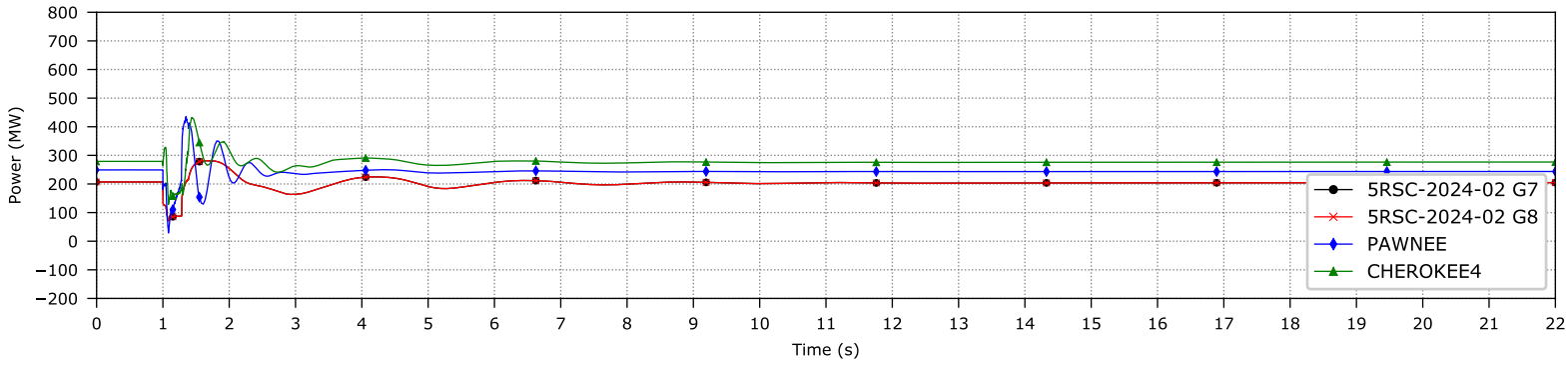

Frequency (Hz)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

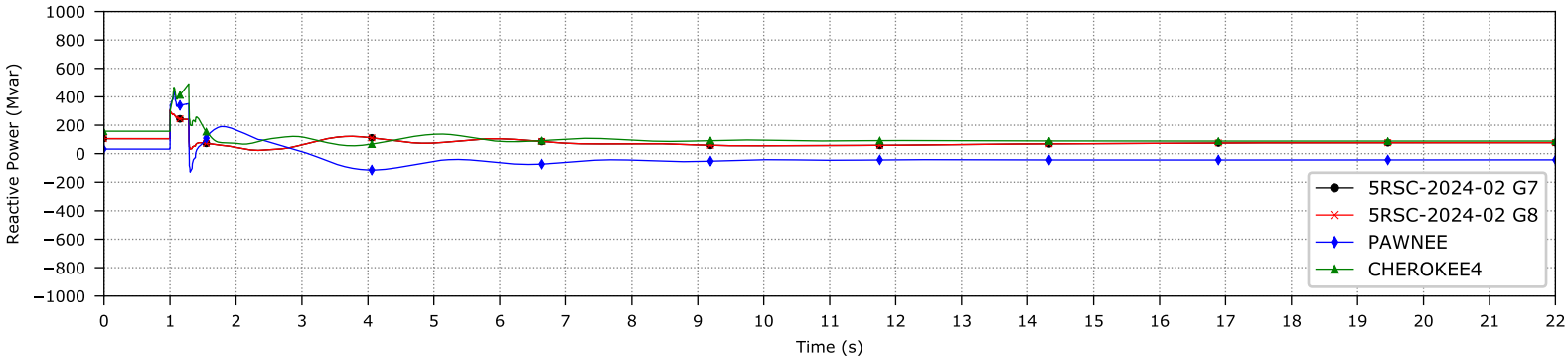

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
CHEROKEE4

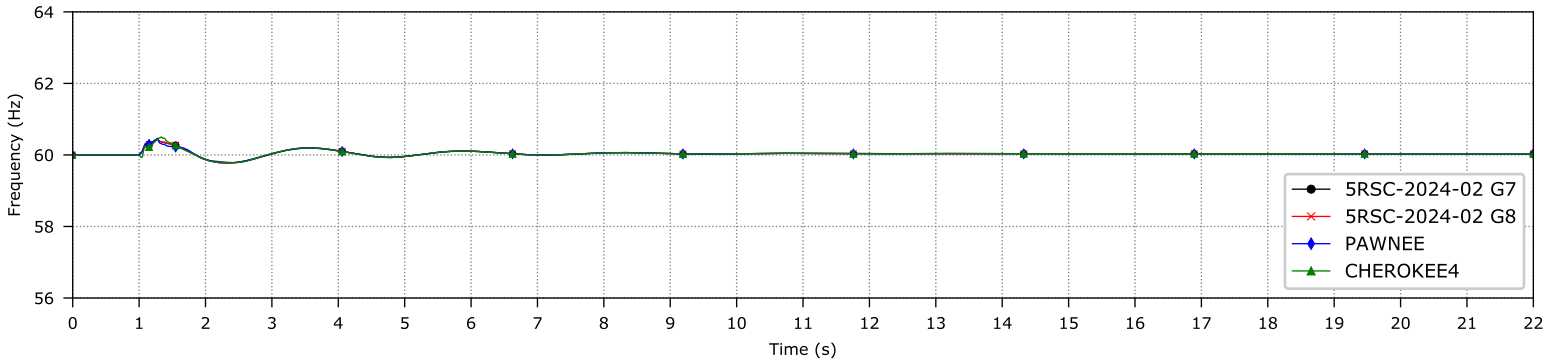

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
FT ST VRAIN 230
FT LUPTON 230

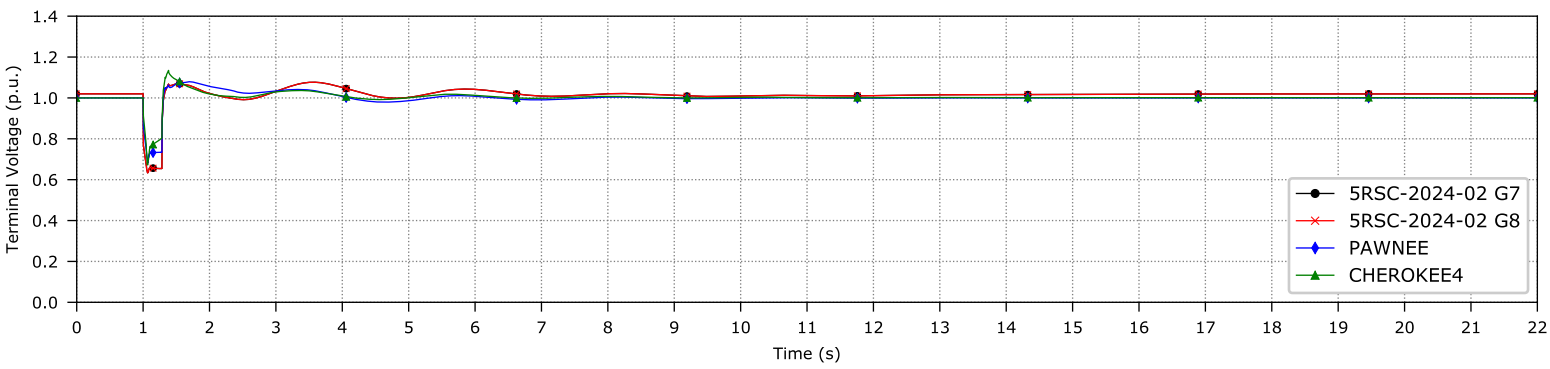
Ref. No. 20 - BF_145a

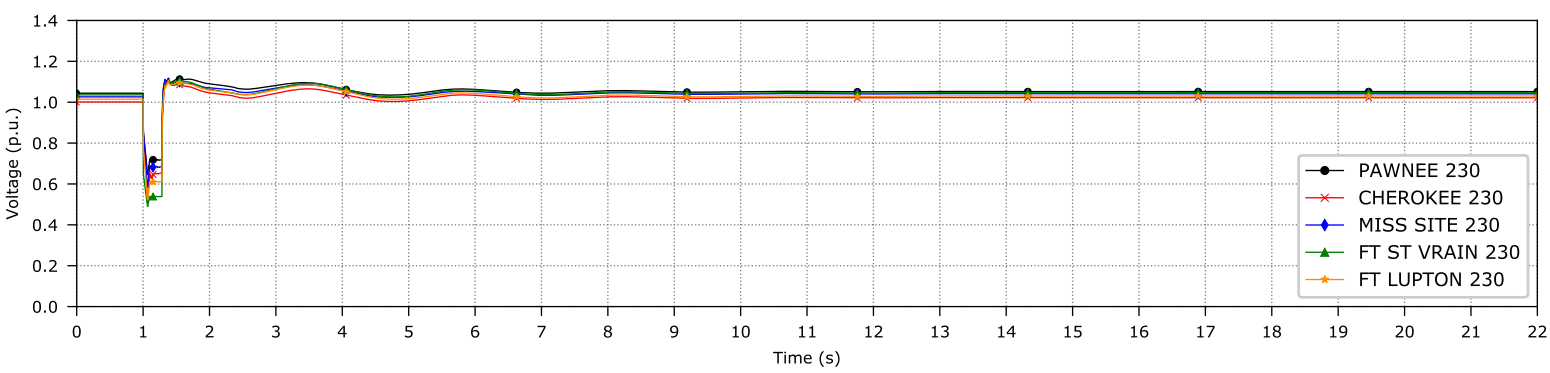




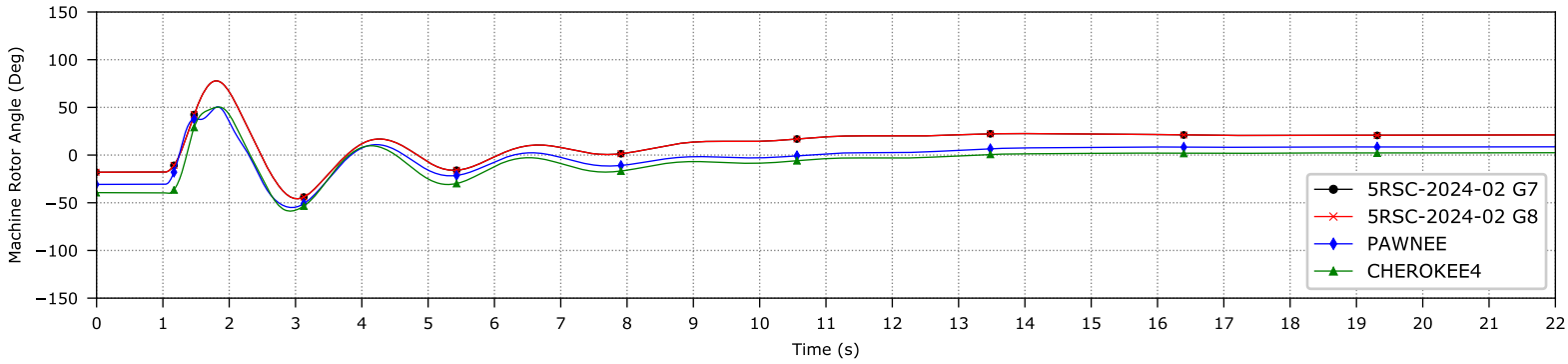


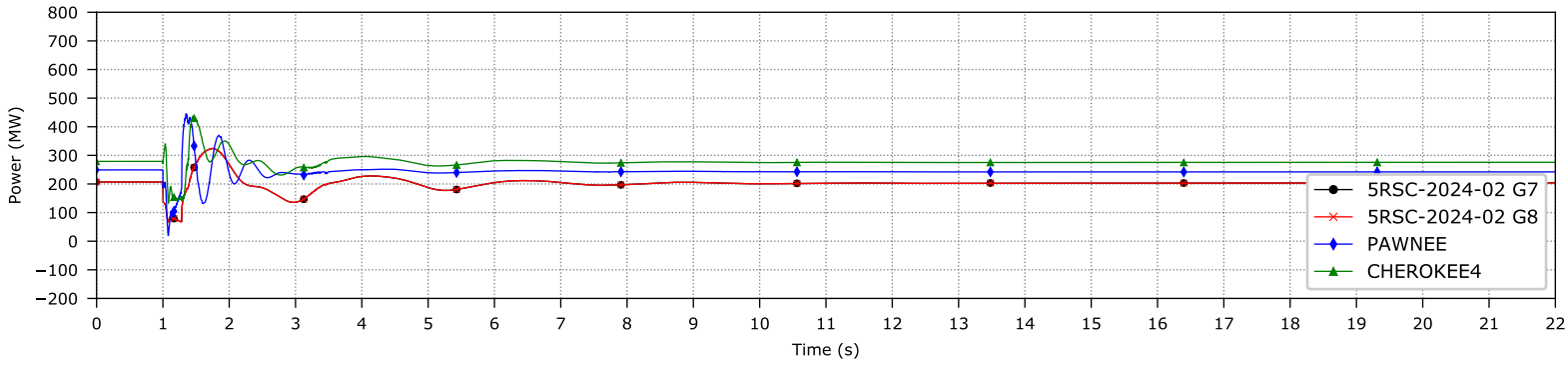


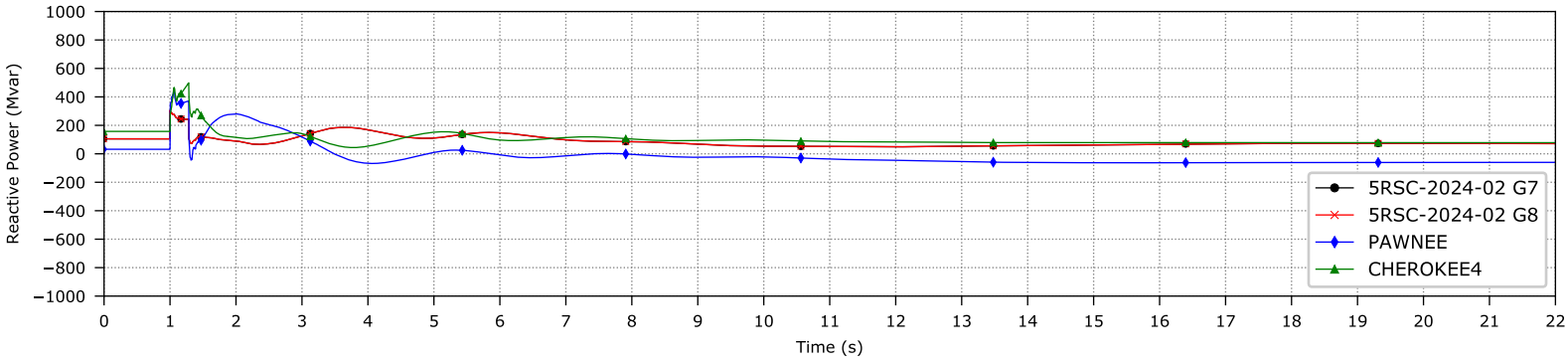


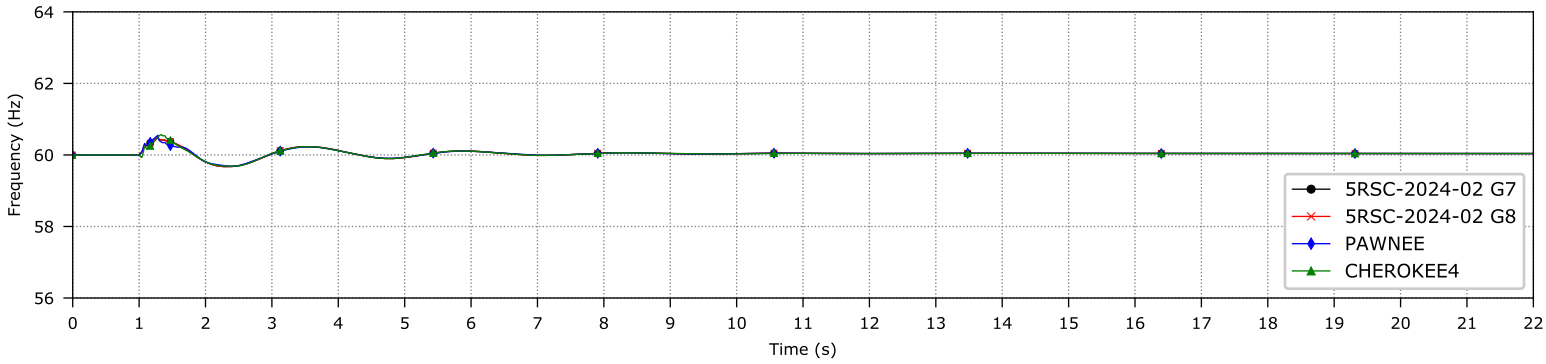


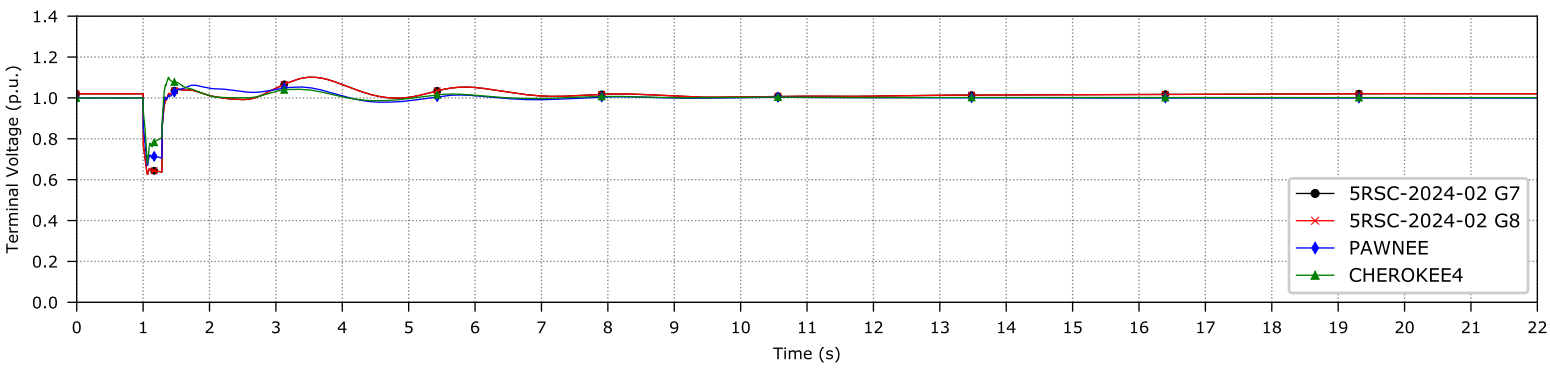
Ref. No. 21 - BF_151c

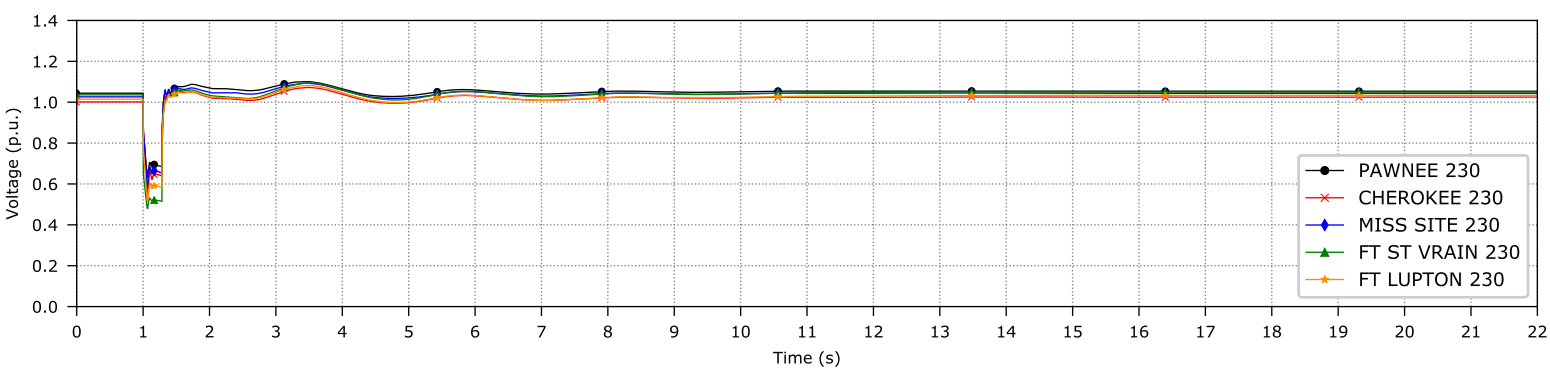




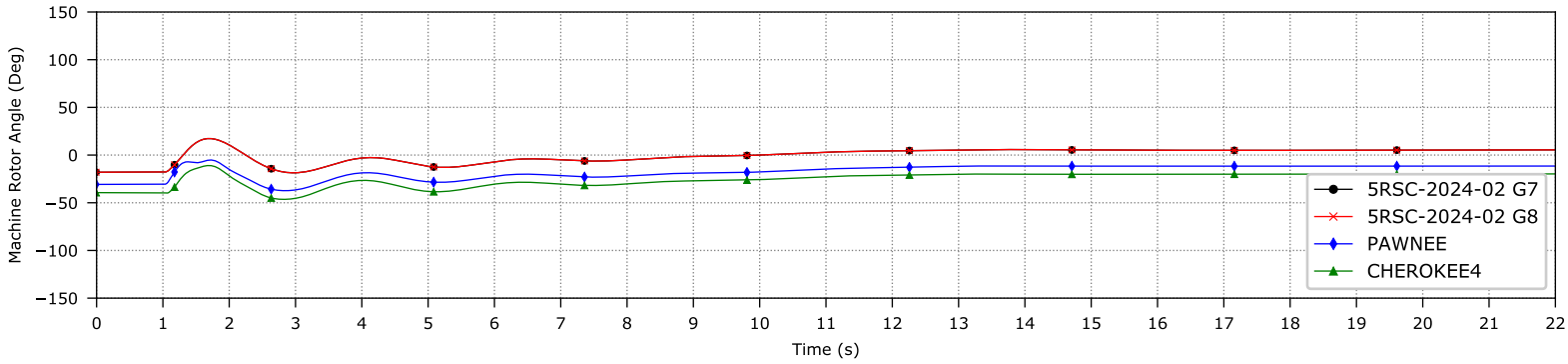


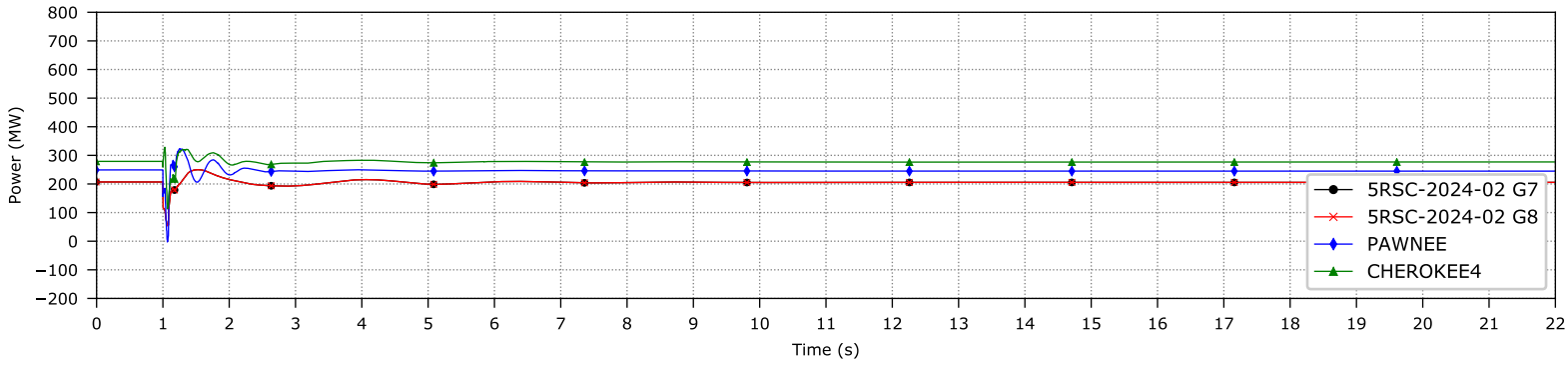


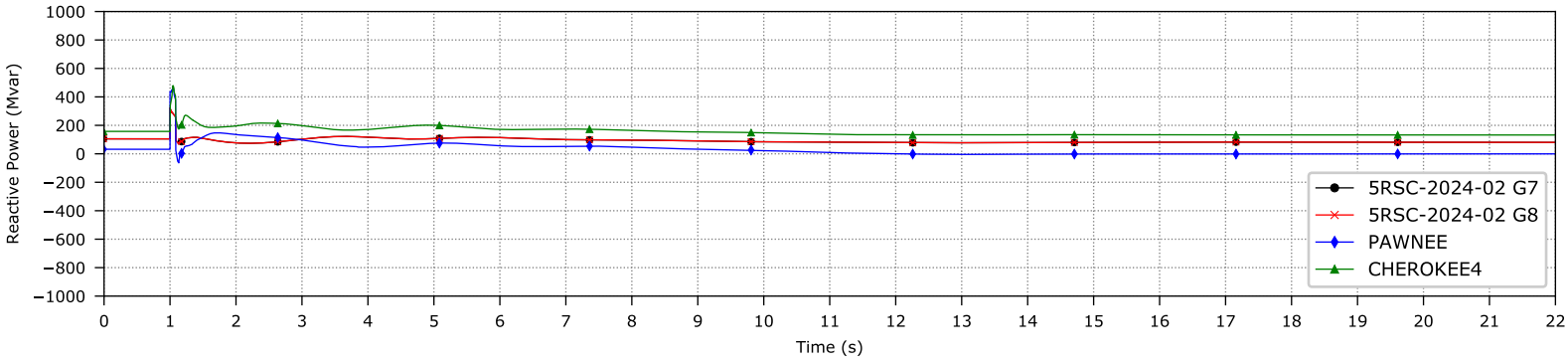


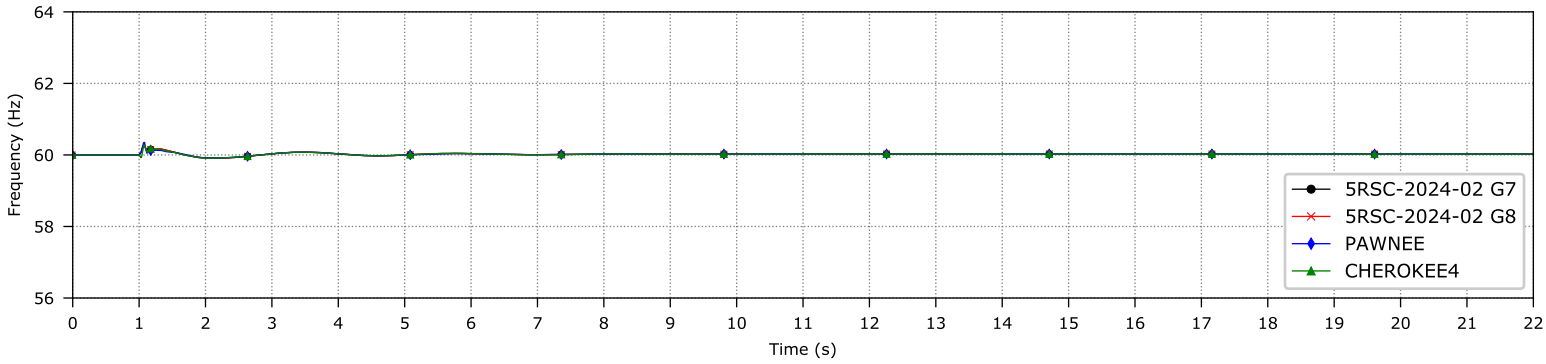


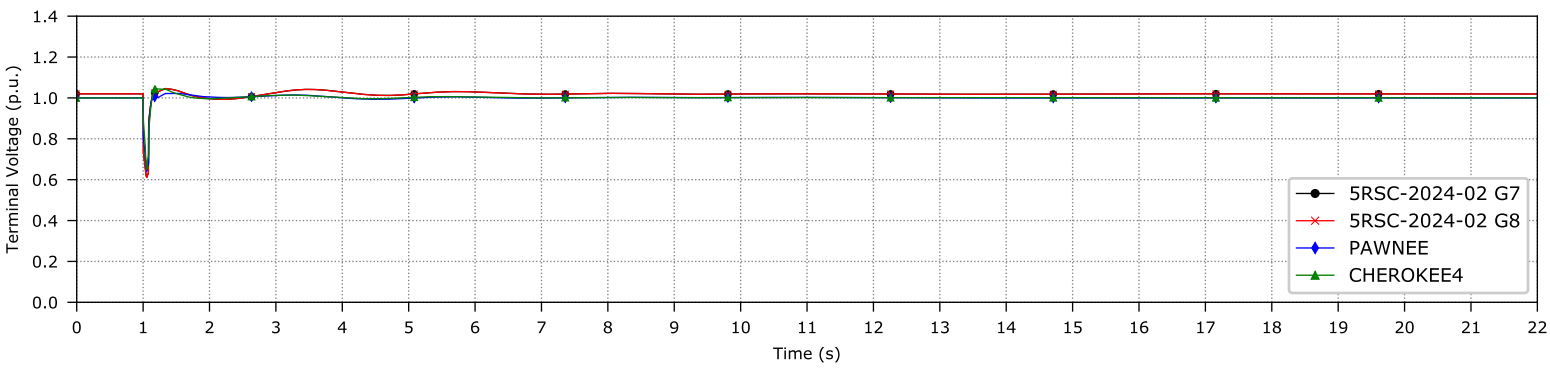
Ref. No. 22 - P7_76

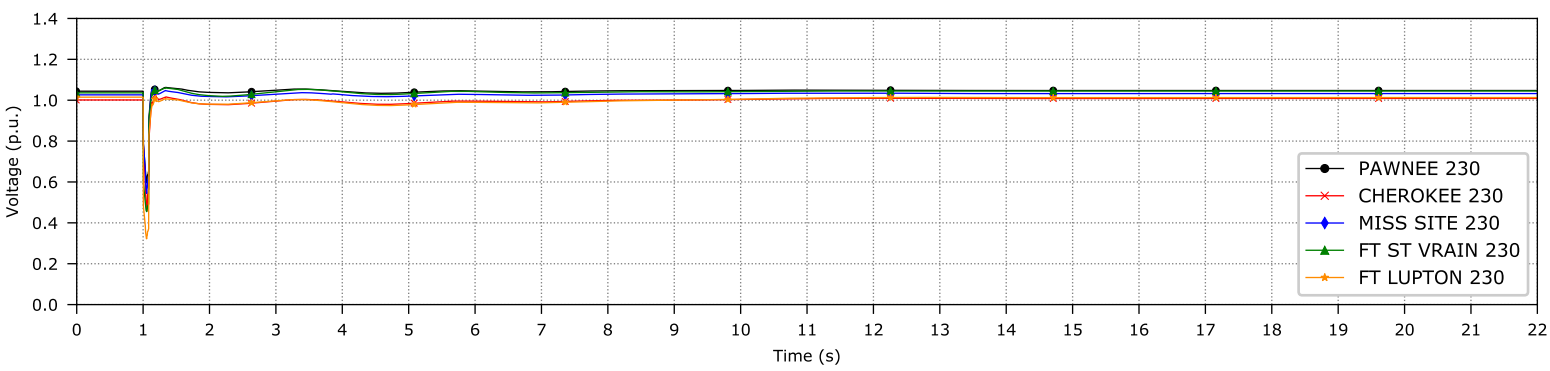












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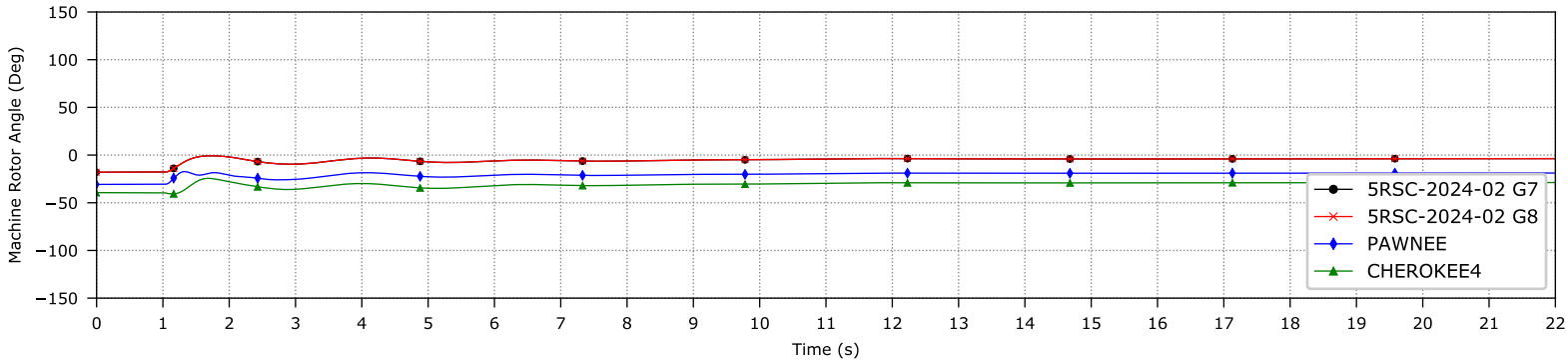
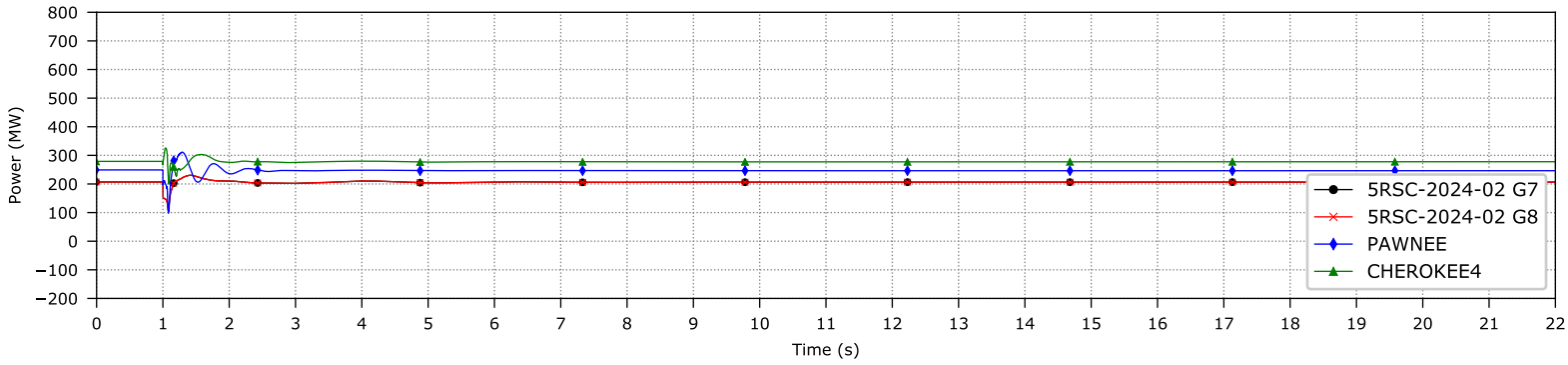
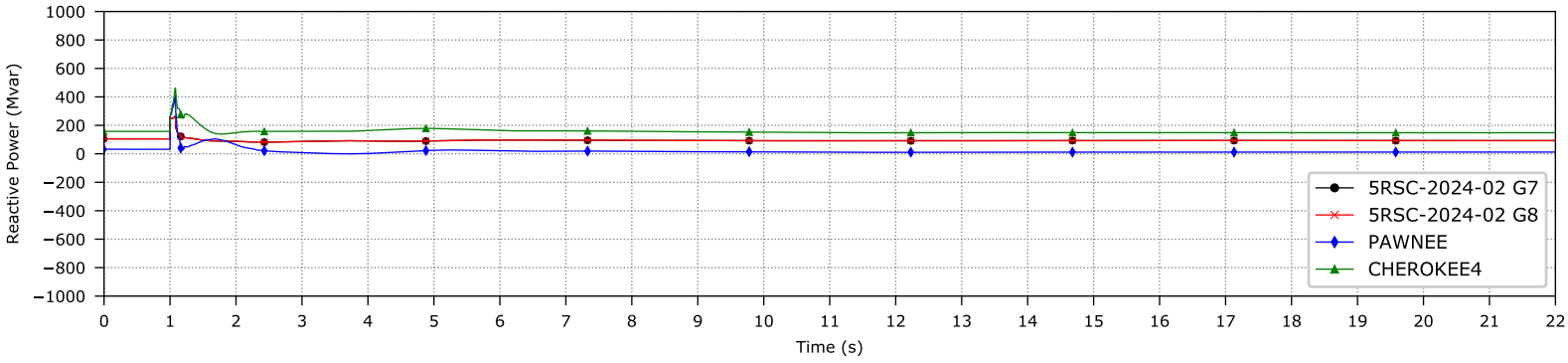
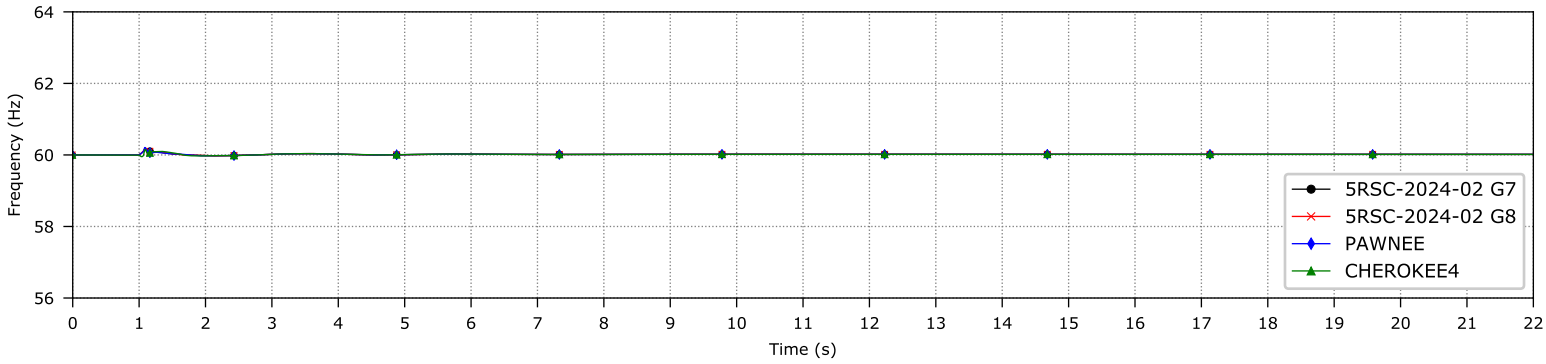
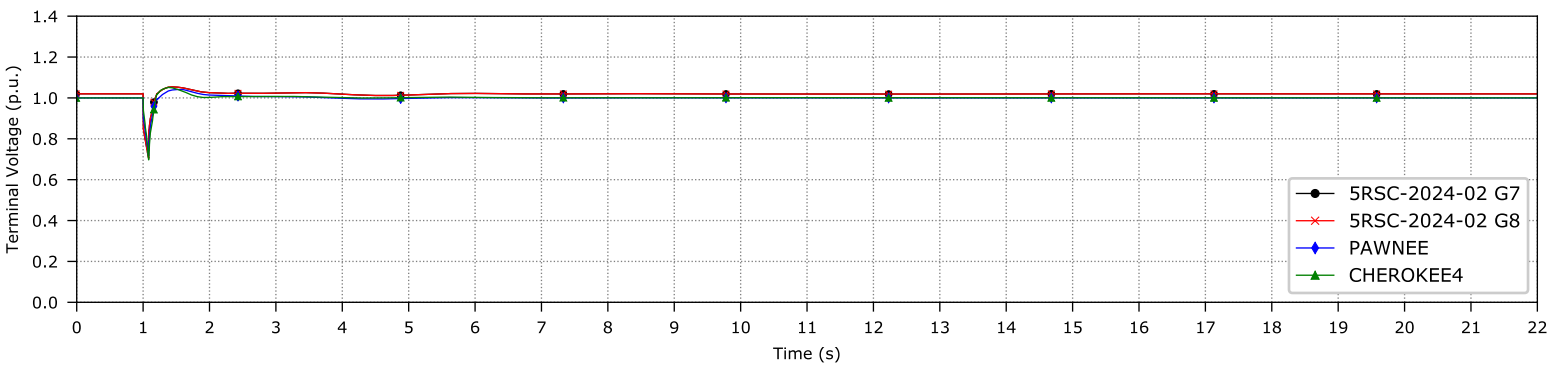
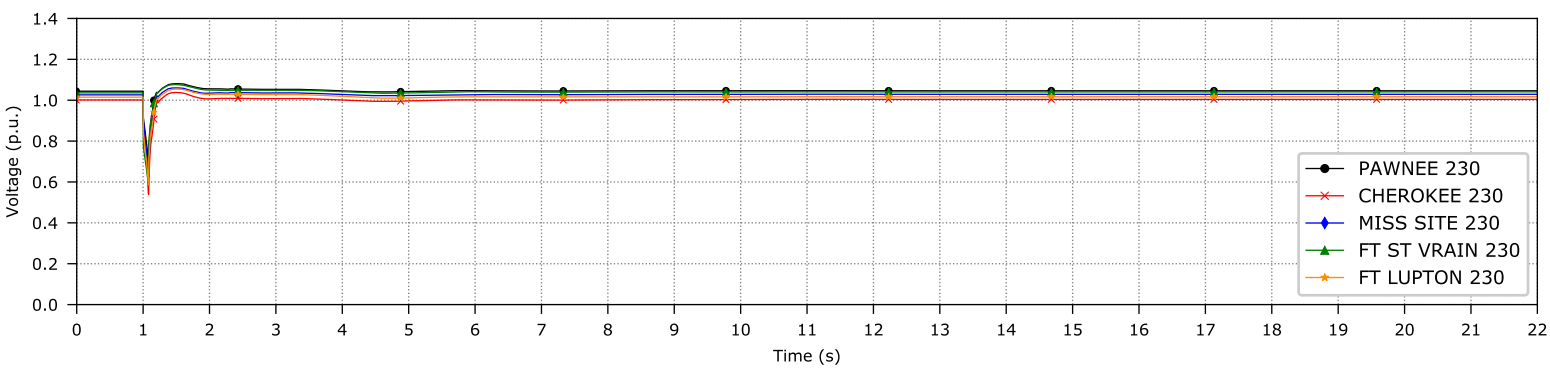




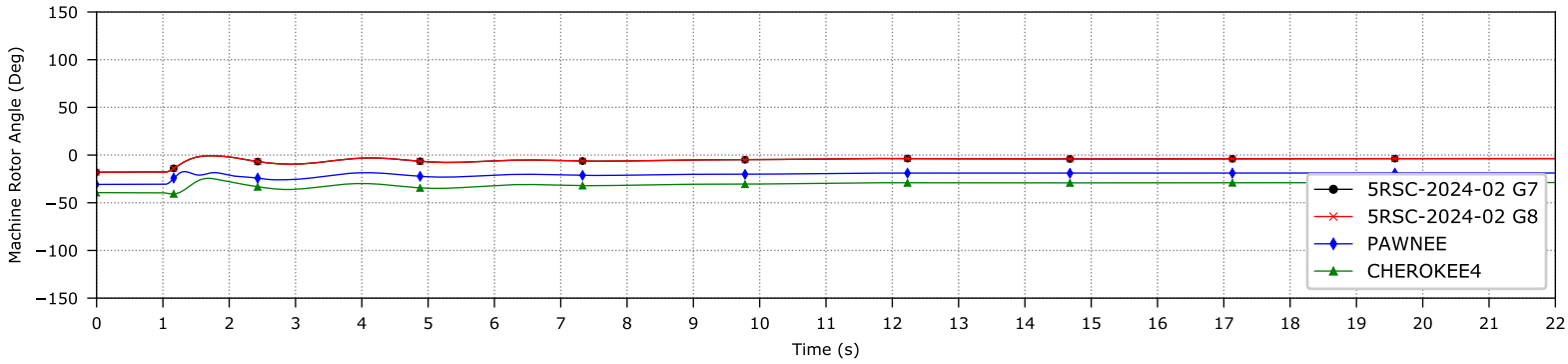


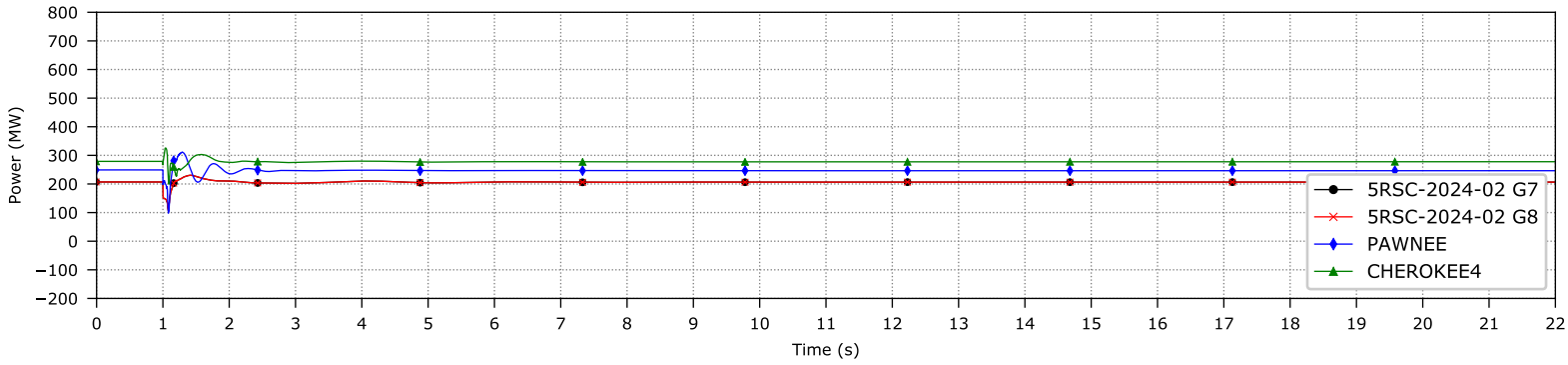


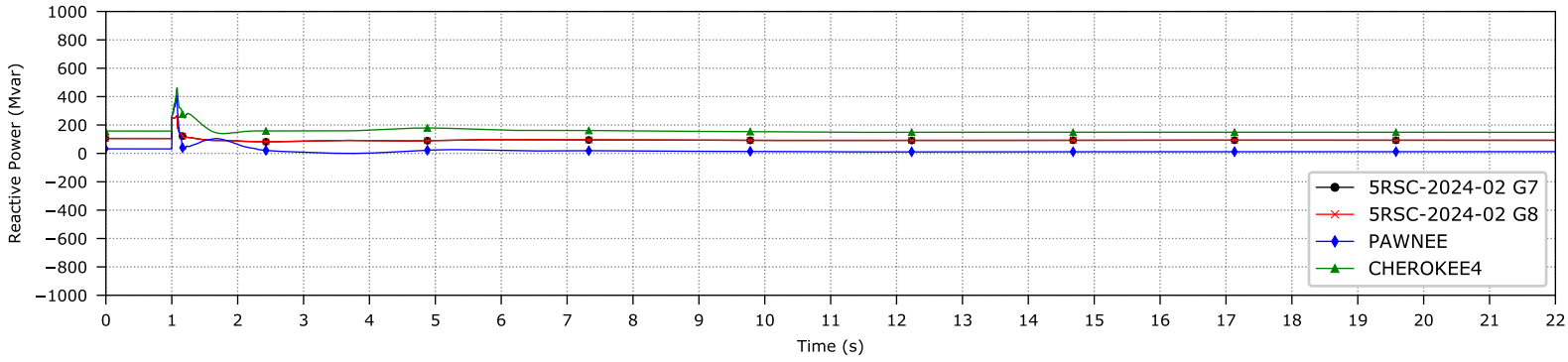


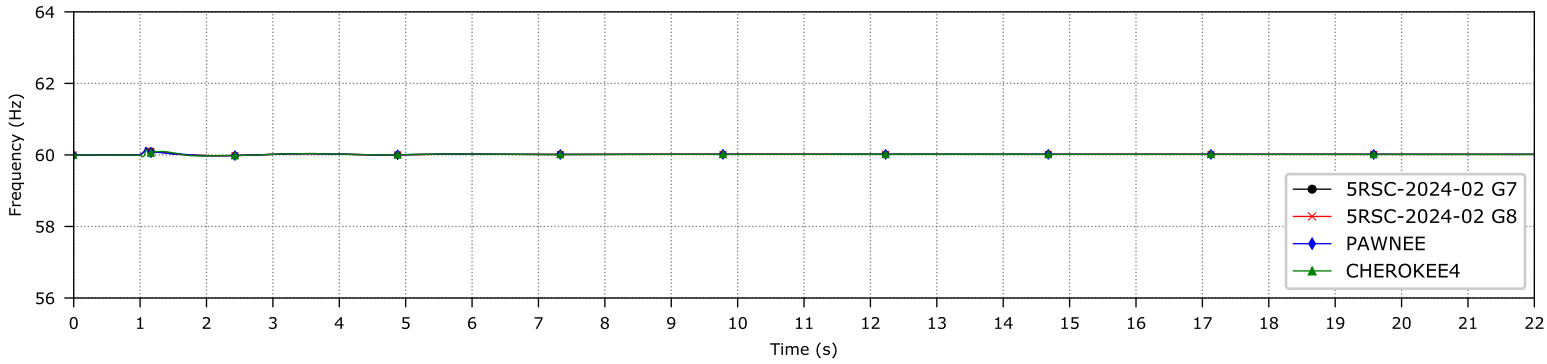


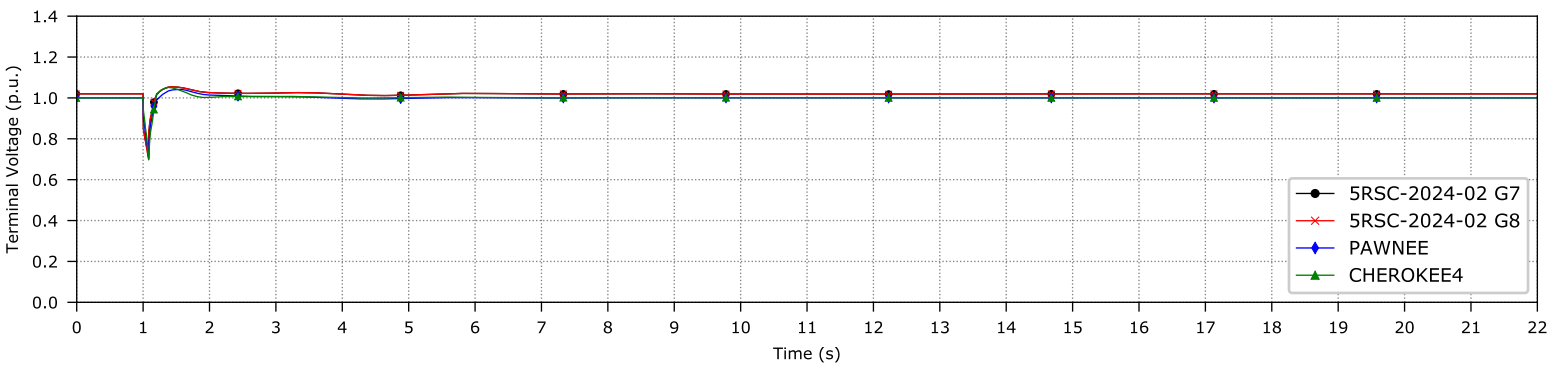
Ref. No. 24 - P7_88

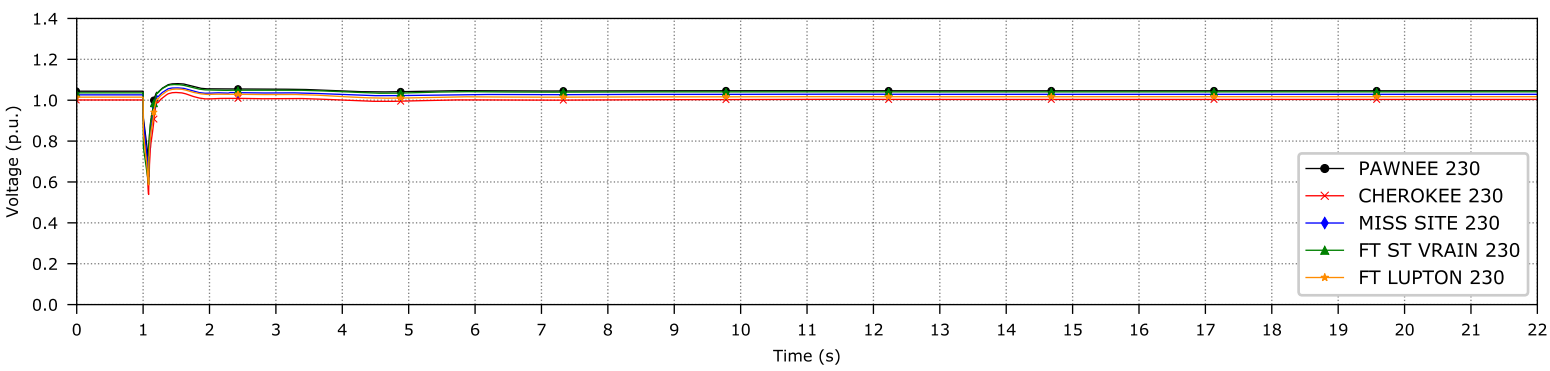




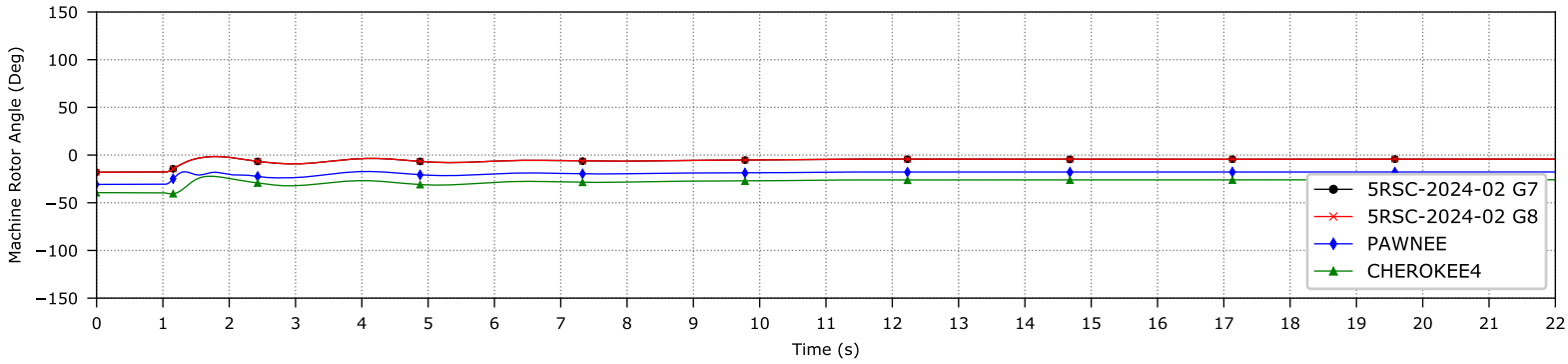


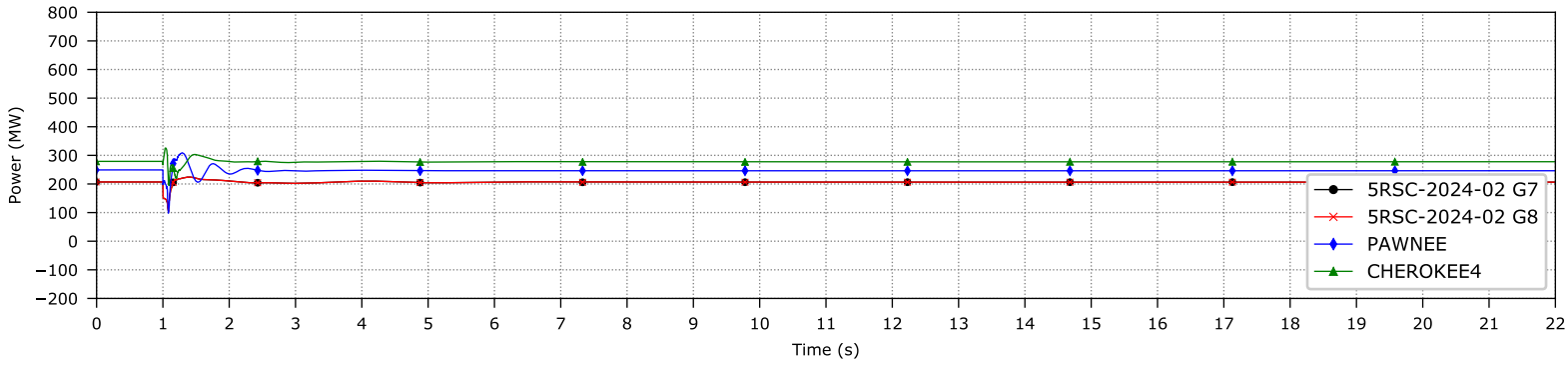


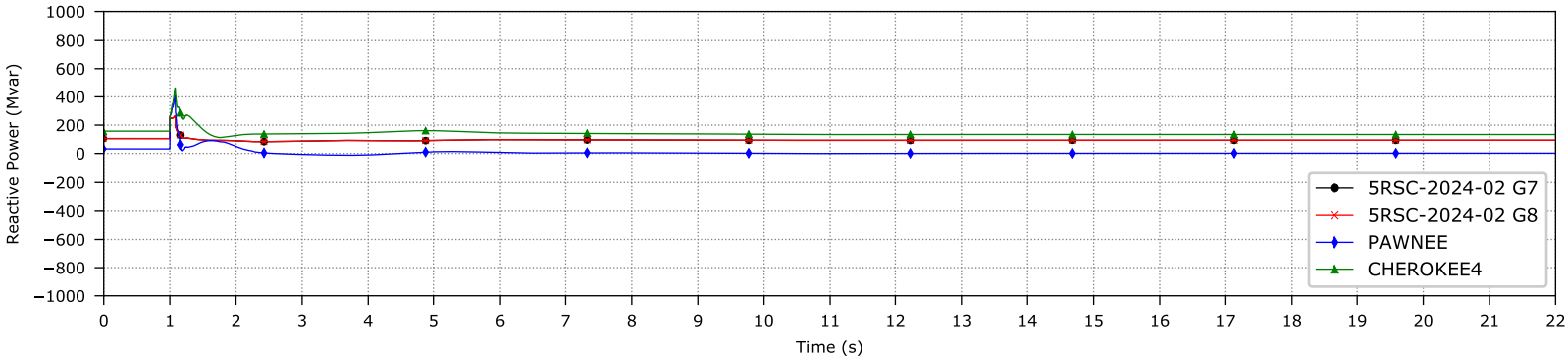


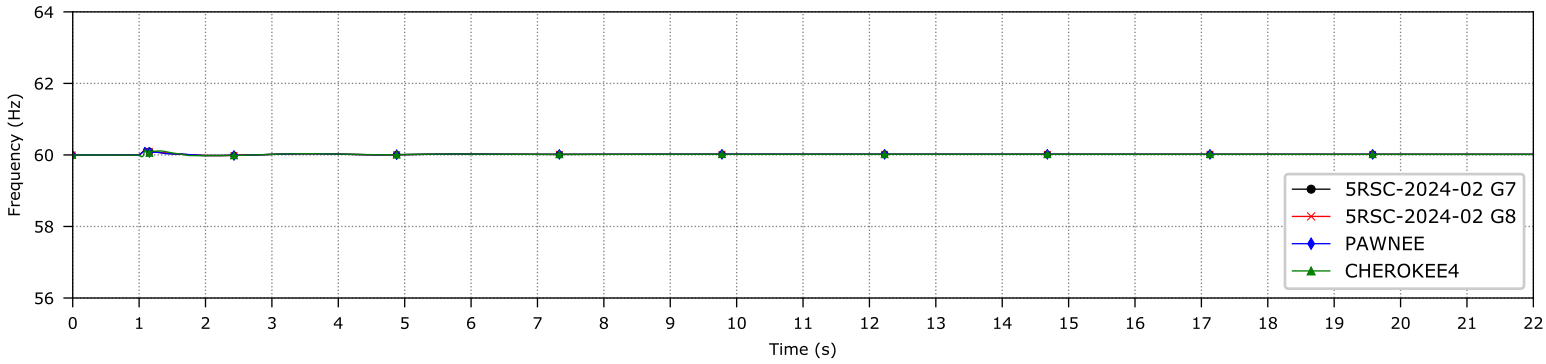


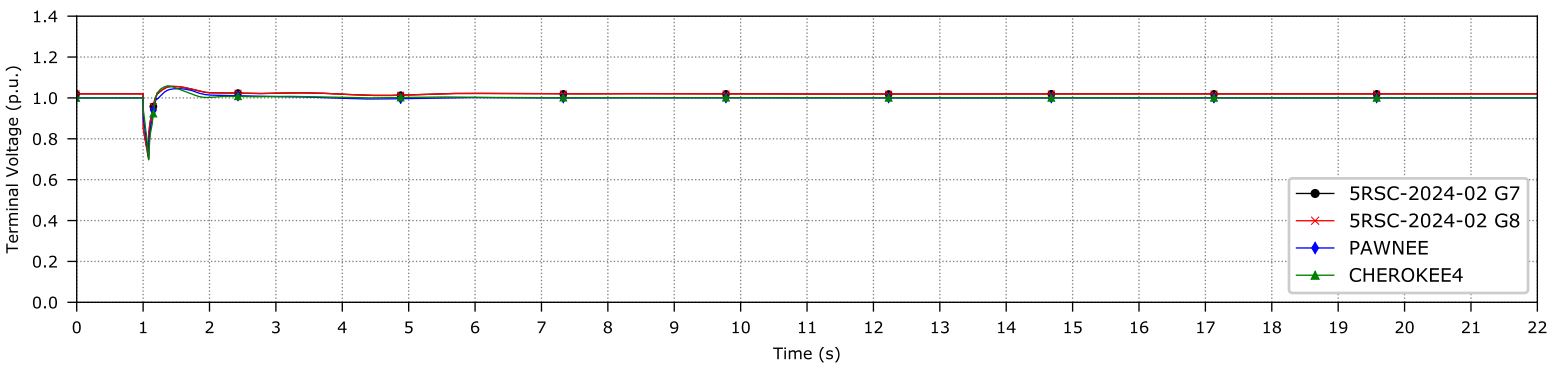
Ref. No. 25 - P7_89

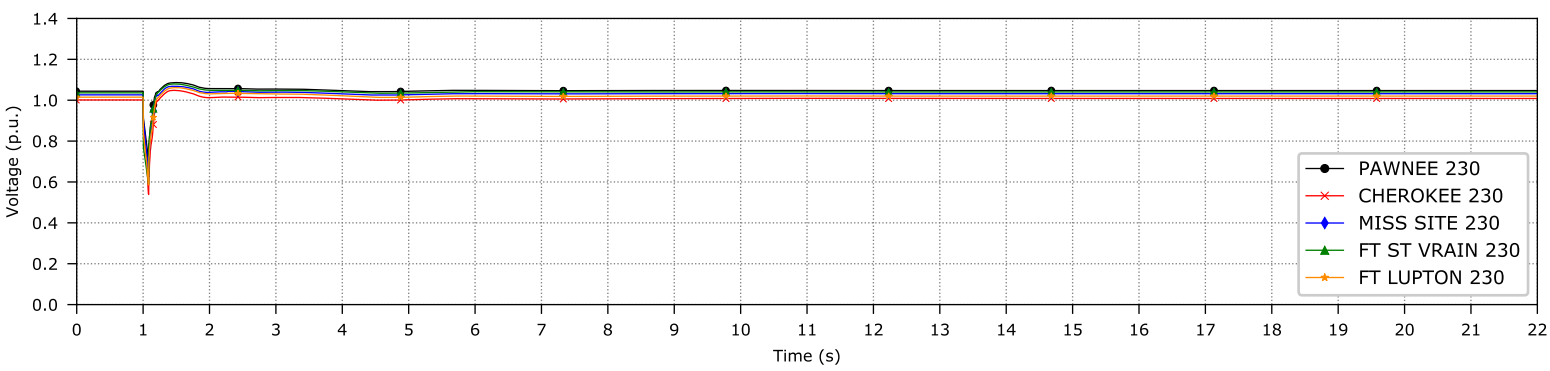




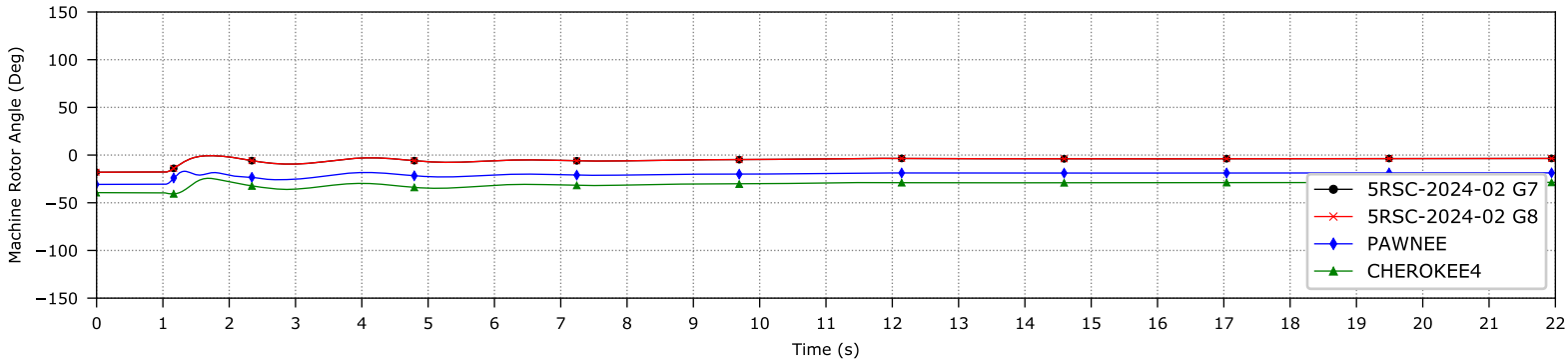


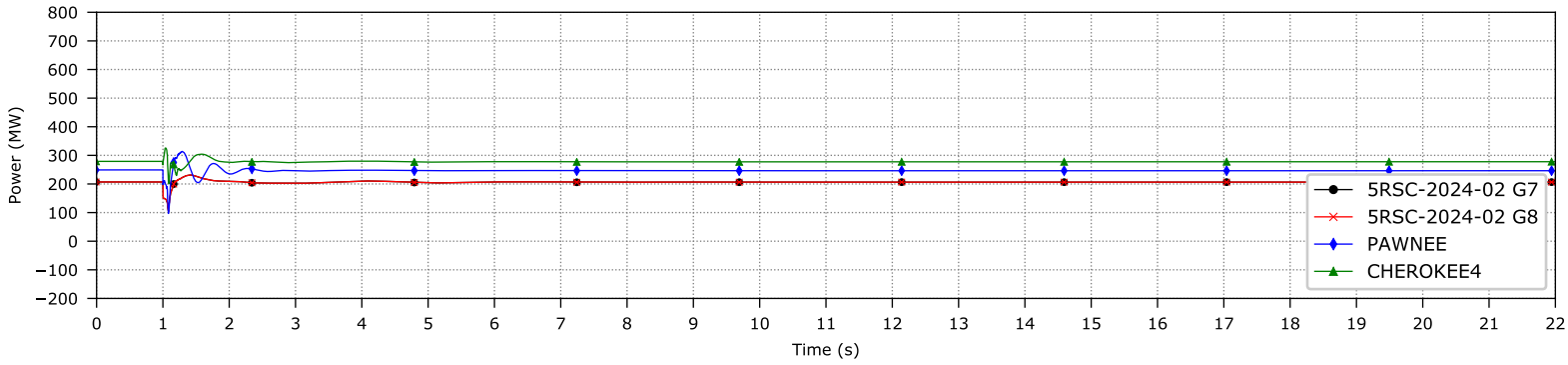


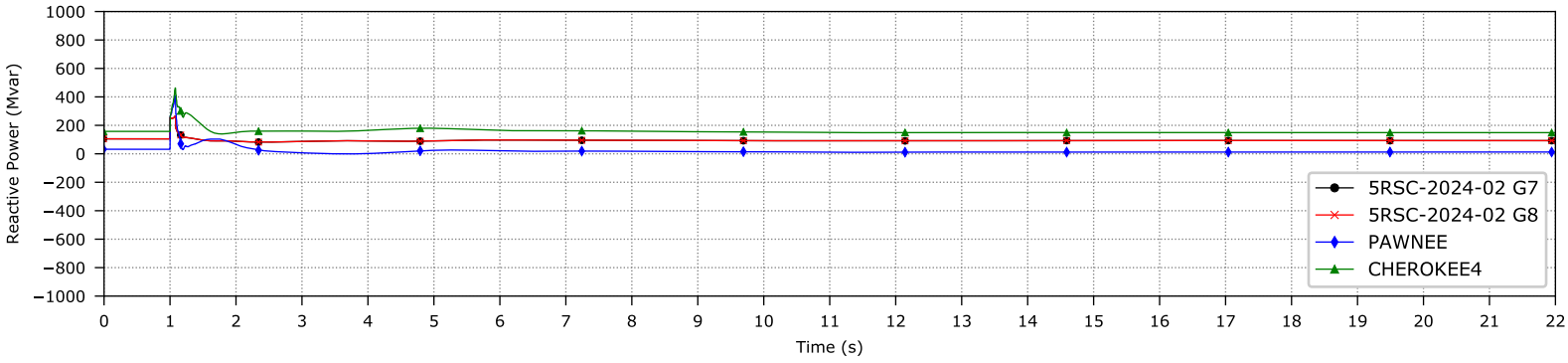


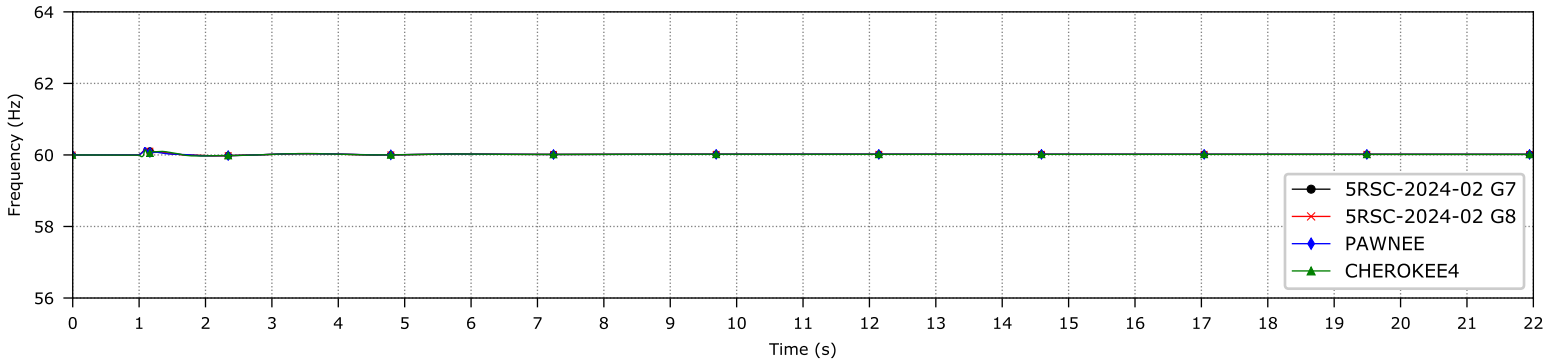


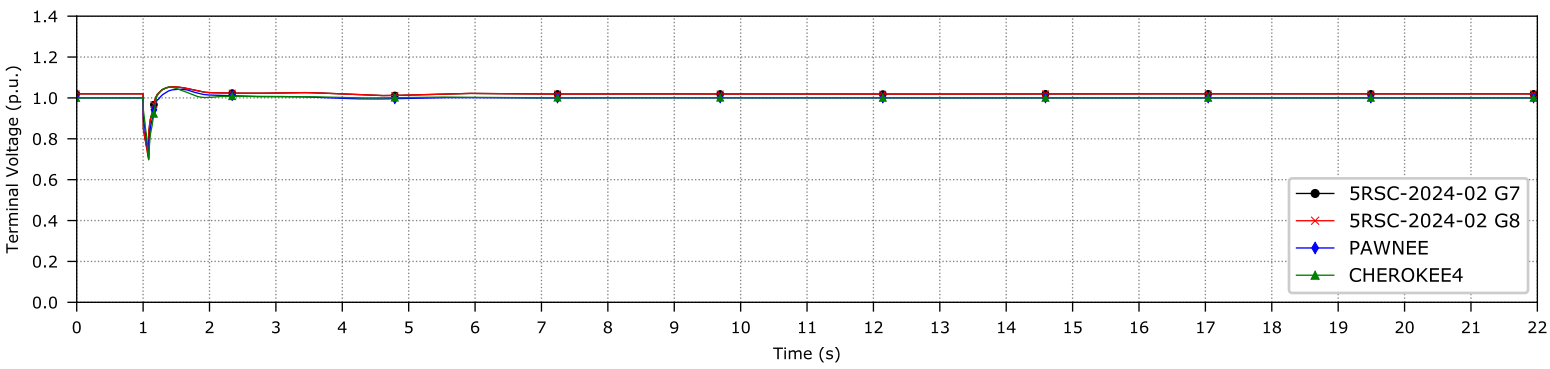
Ref. No. 26 - P7_90

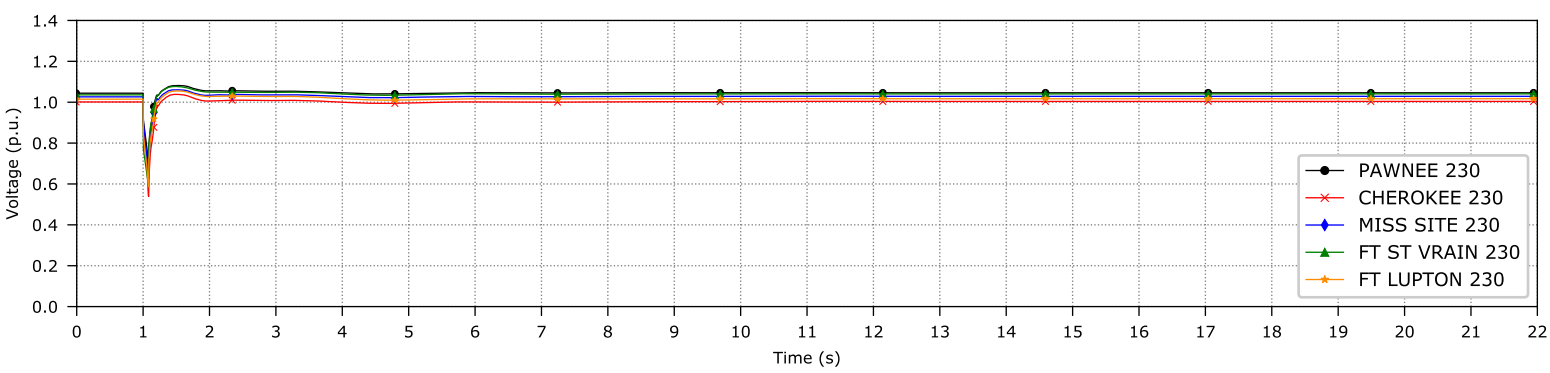




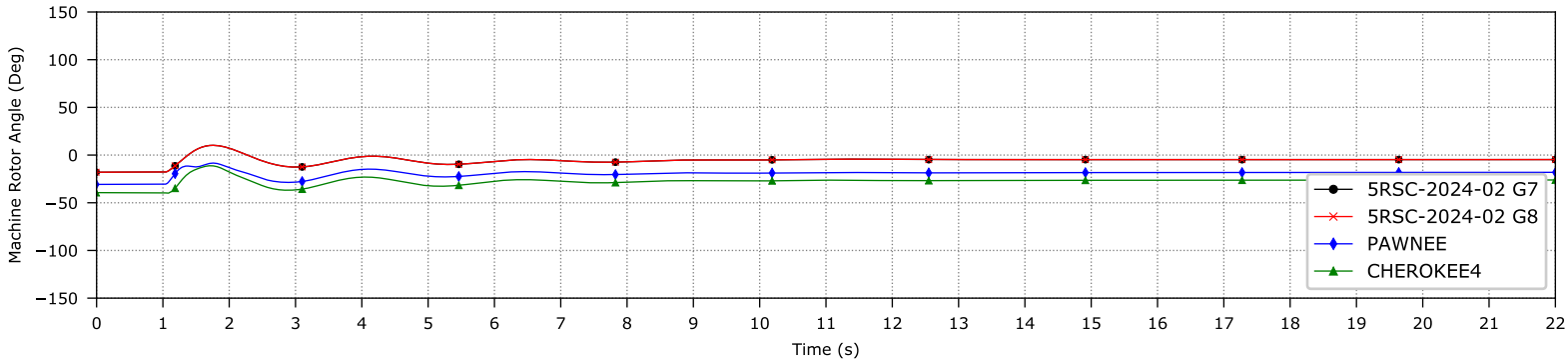


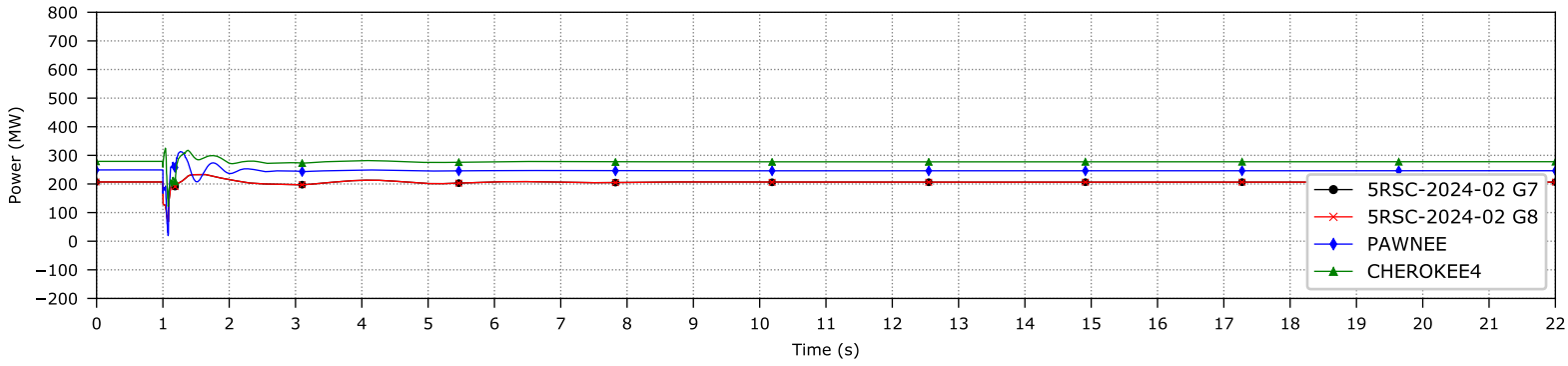


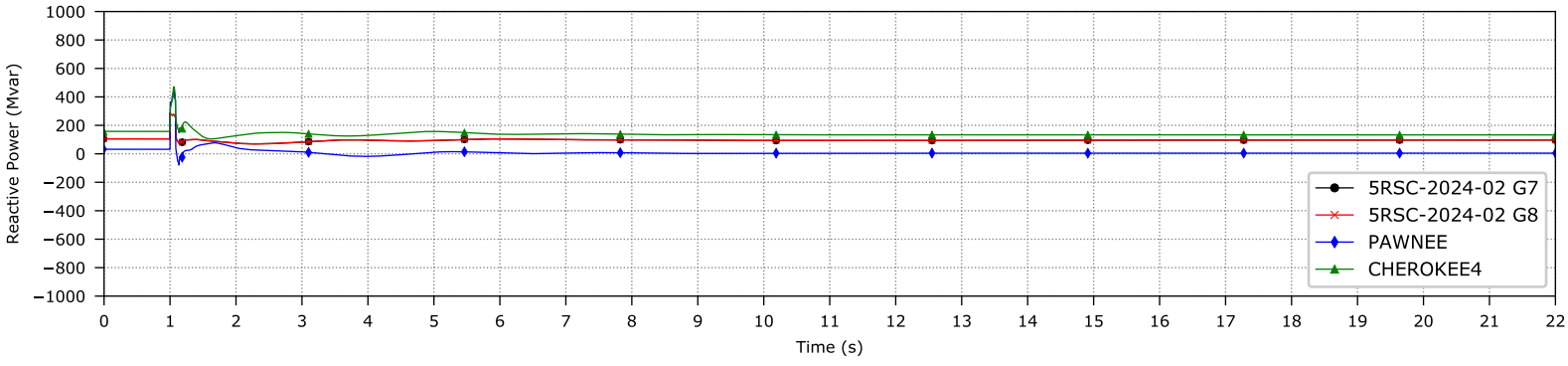


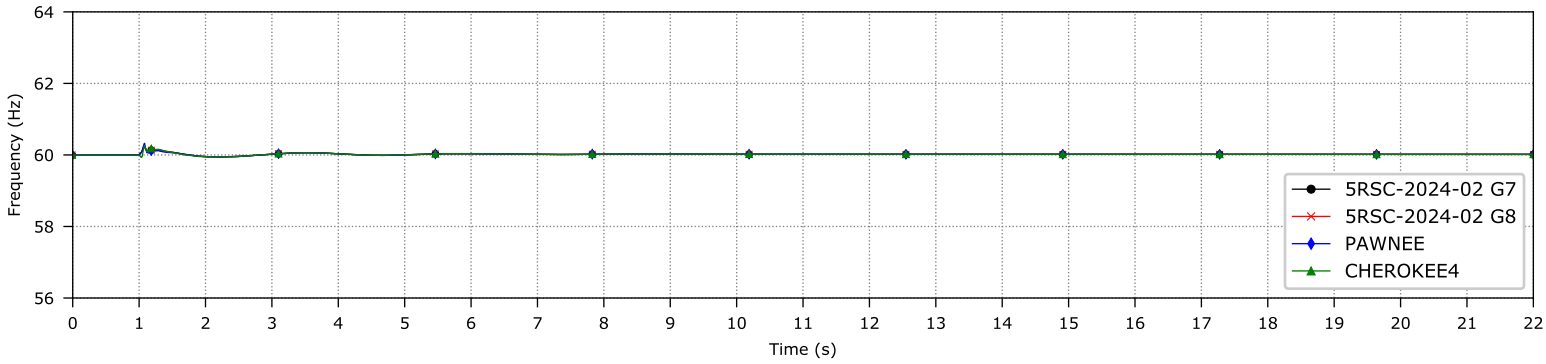


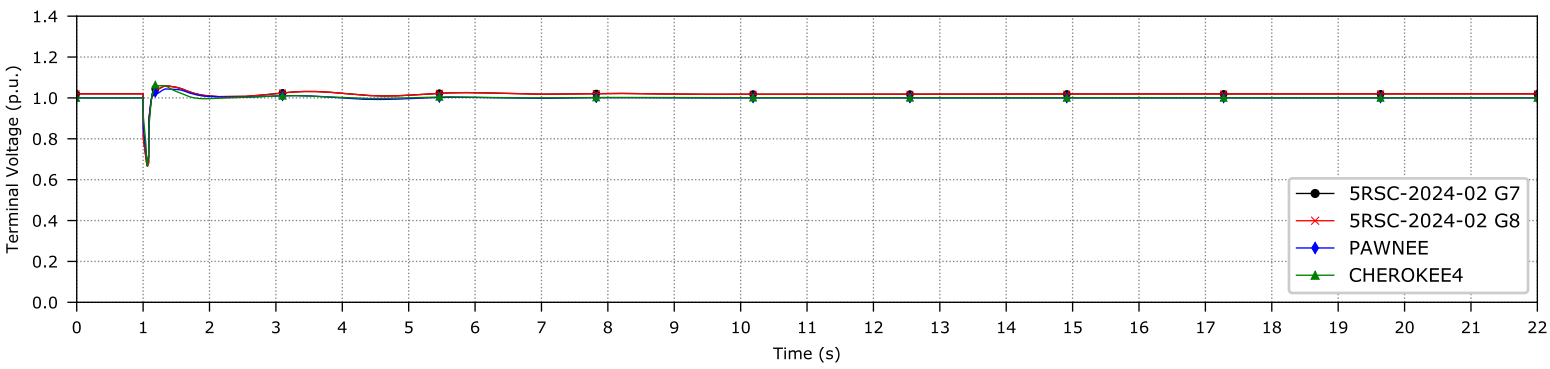
Ref. No. 27 - P7_92

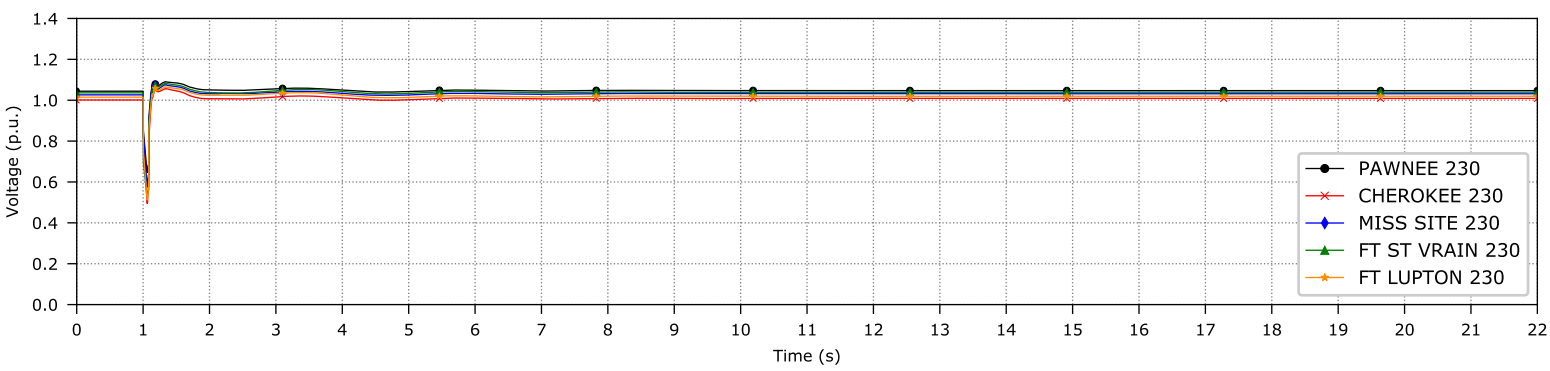






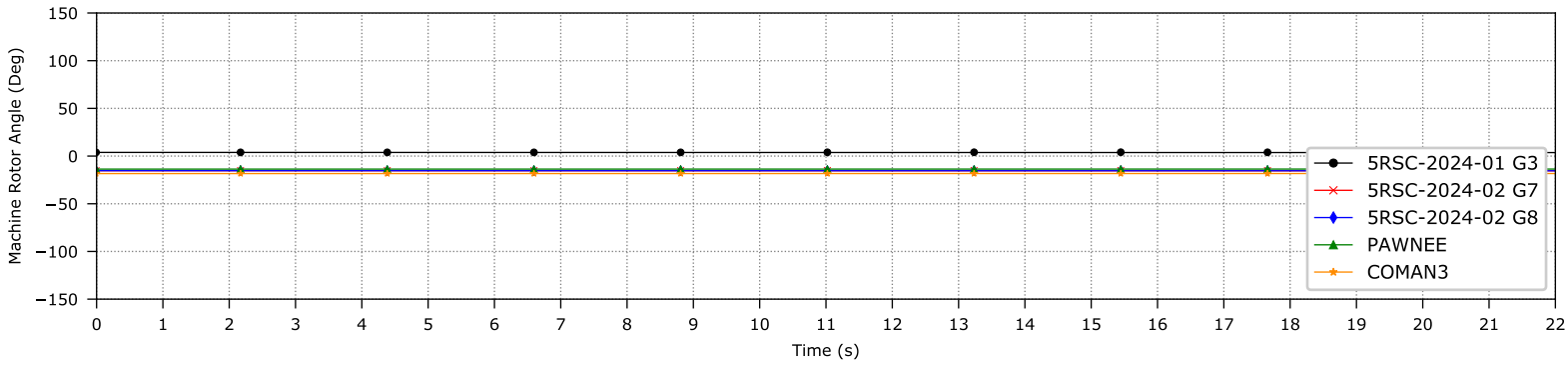


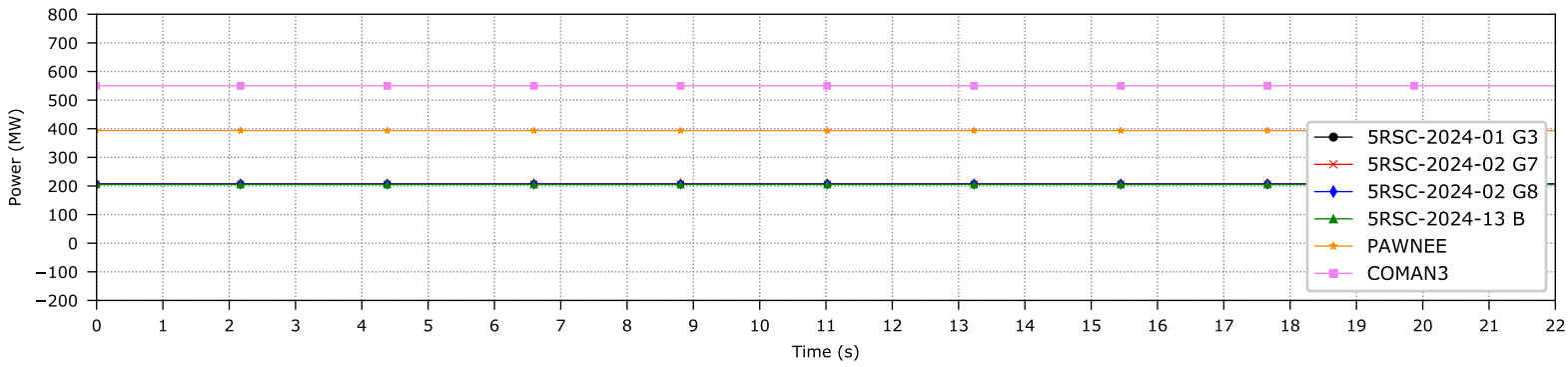


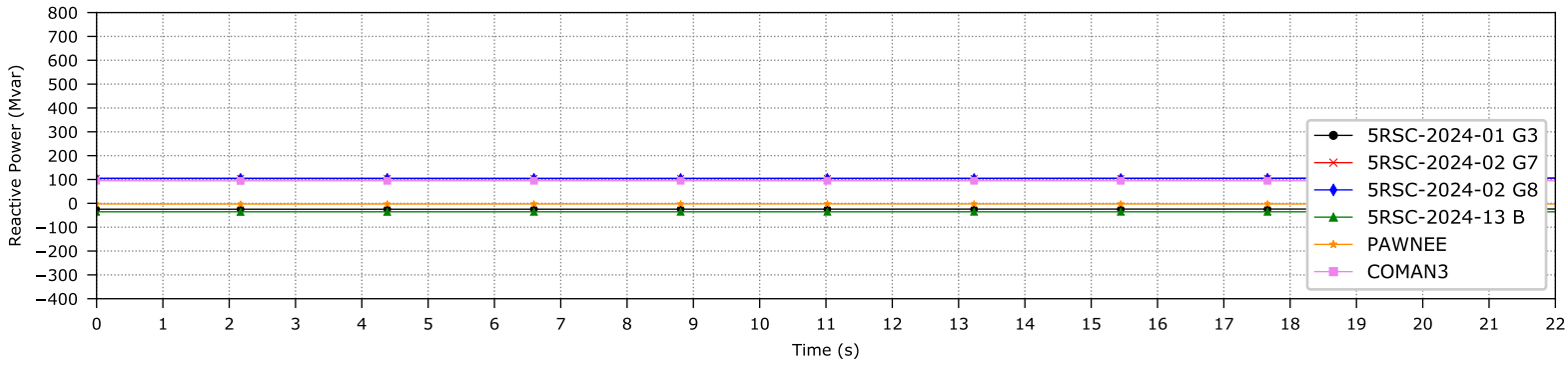


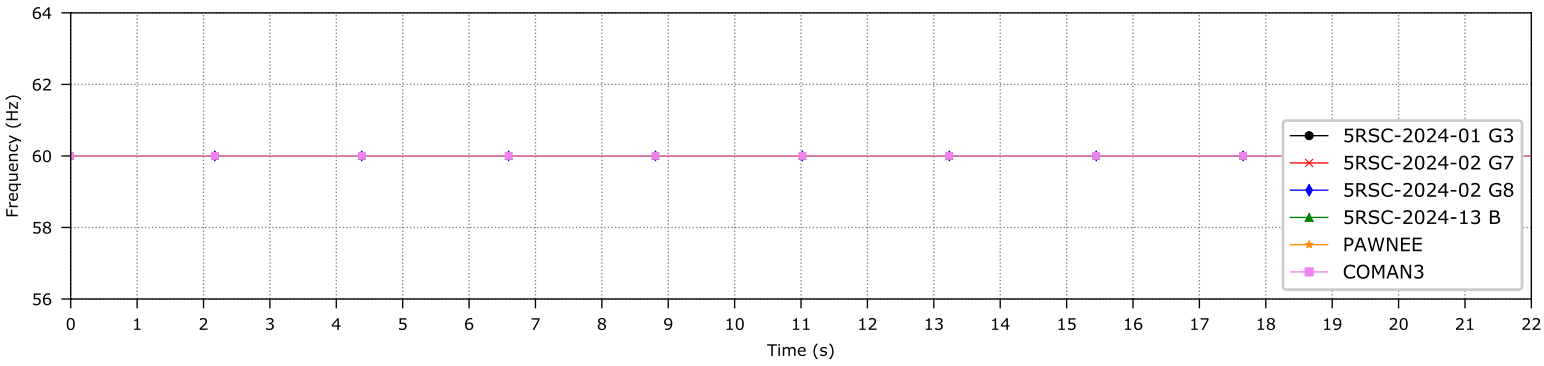
2027 NORTH PORTFOLIO 1 – TRANSIENT STABILITY PLOTS

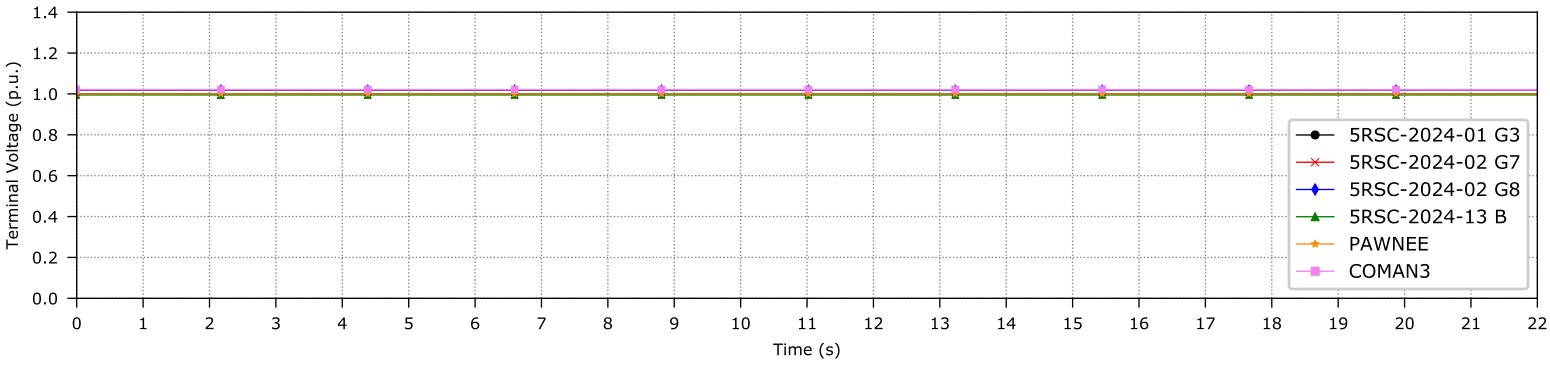
Ref. No. 01 - Flatrun

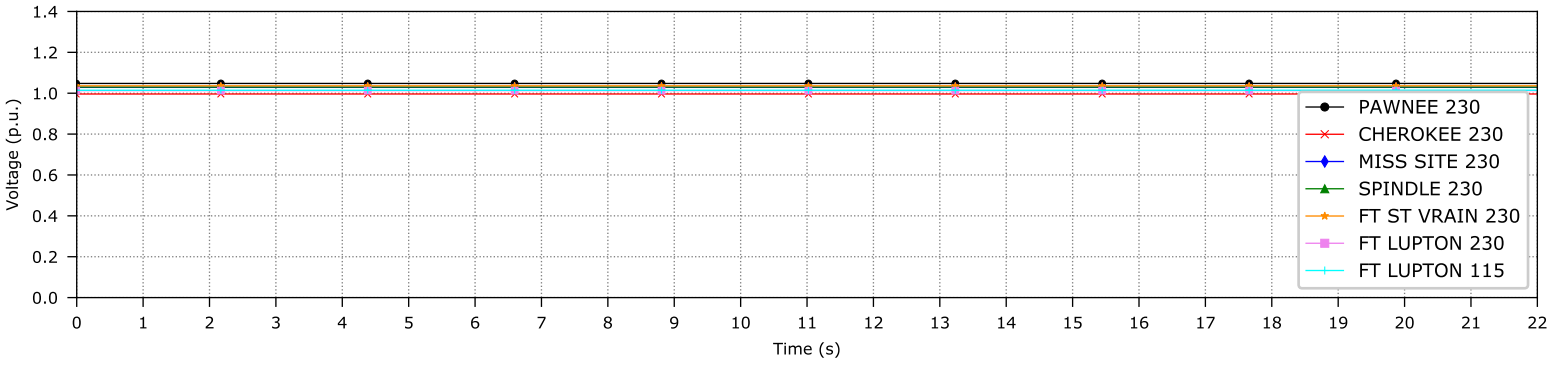




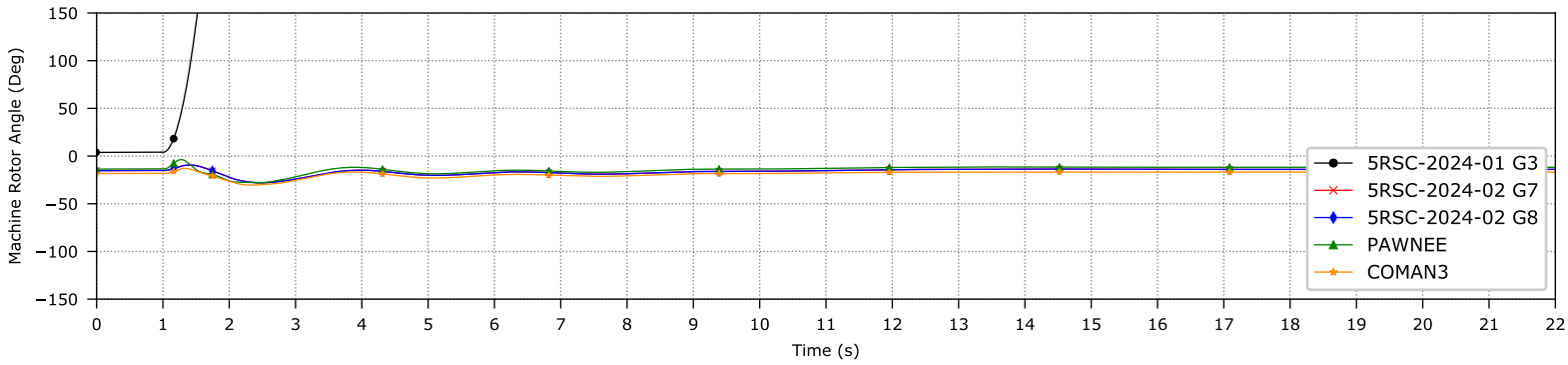


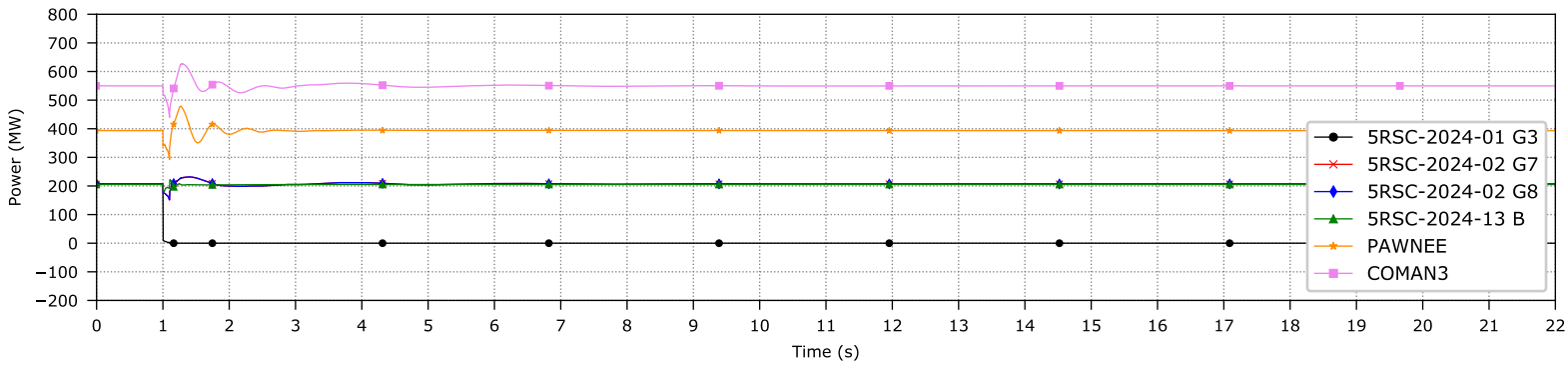


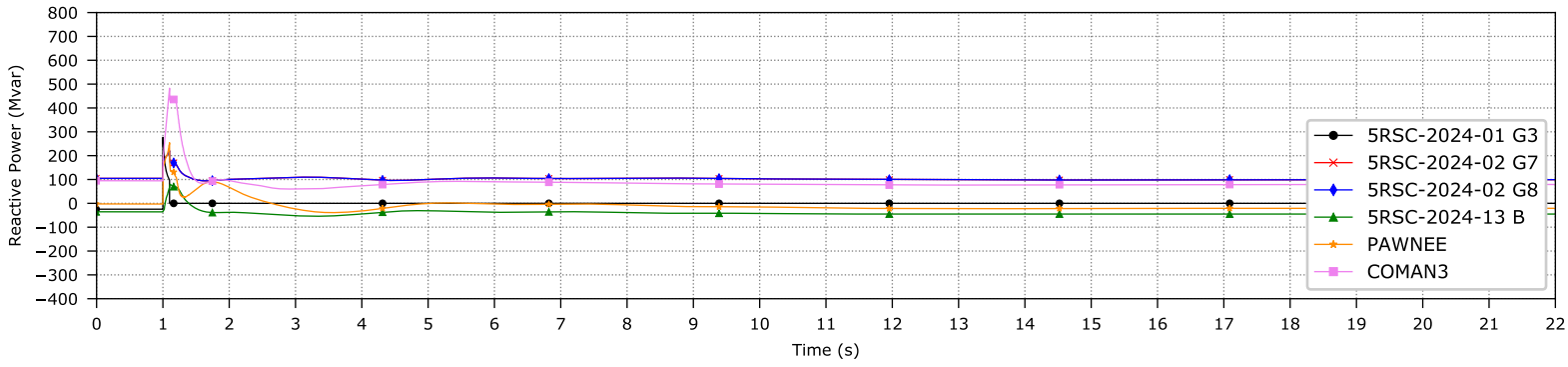


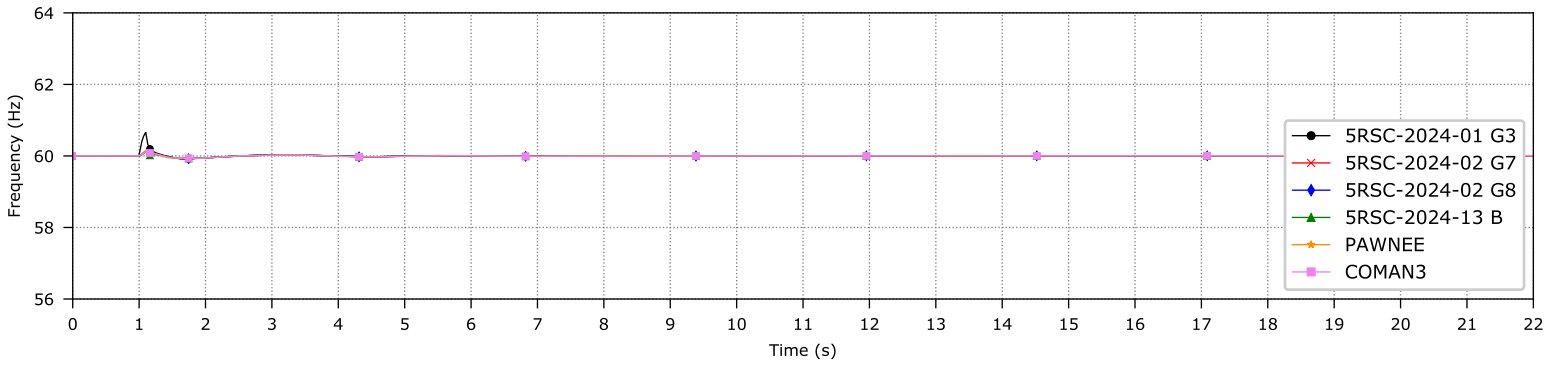


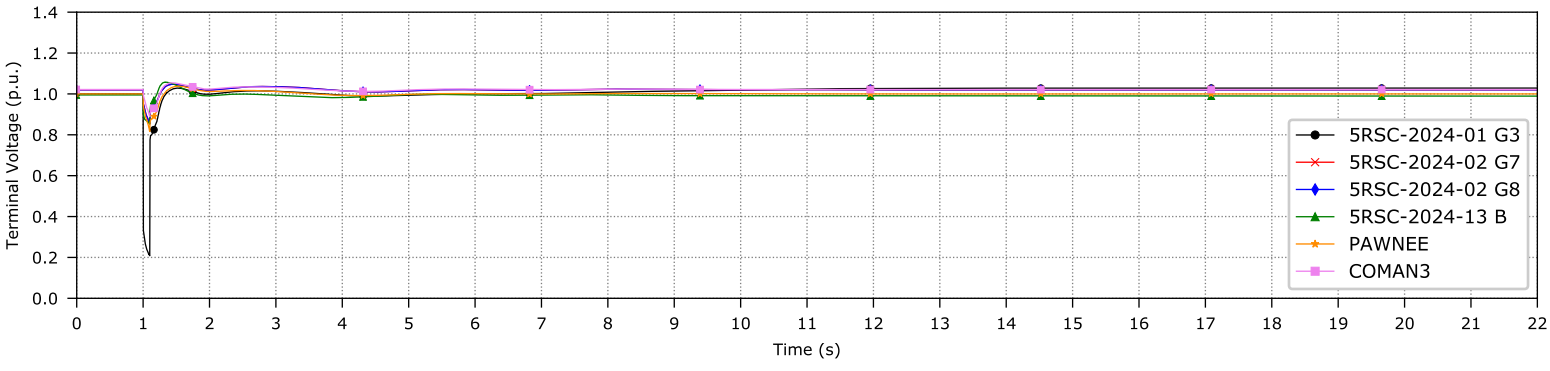
Ref. No. 02 - 5RSC-2024-01

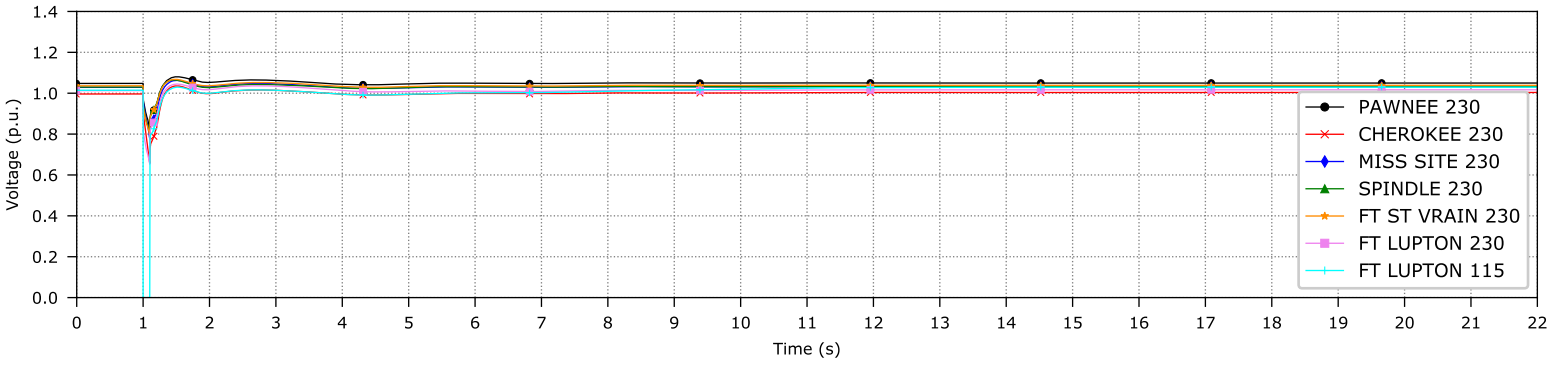




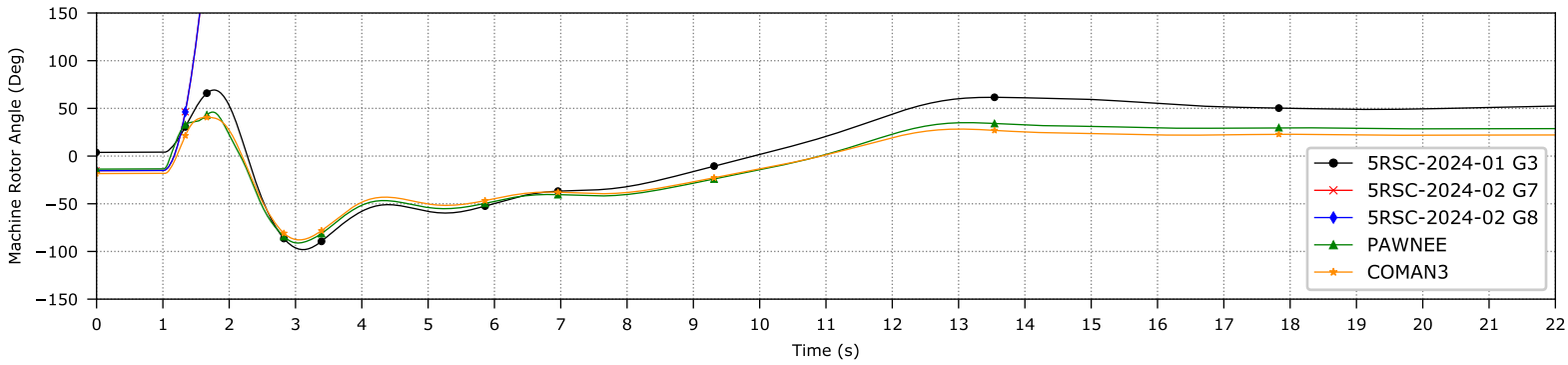


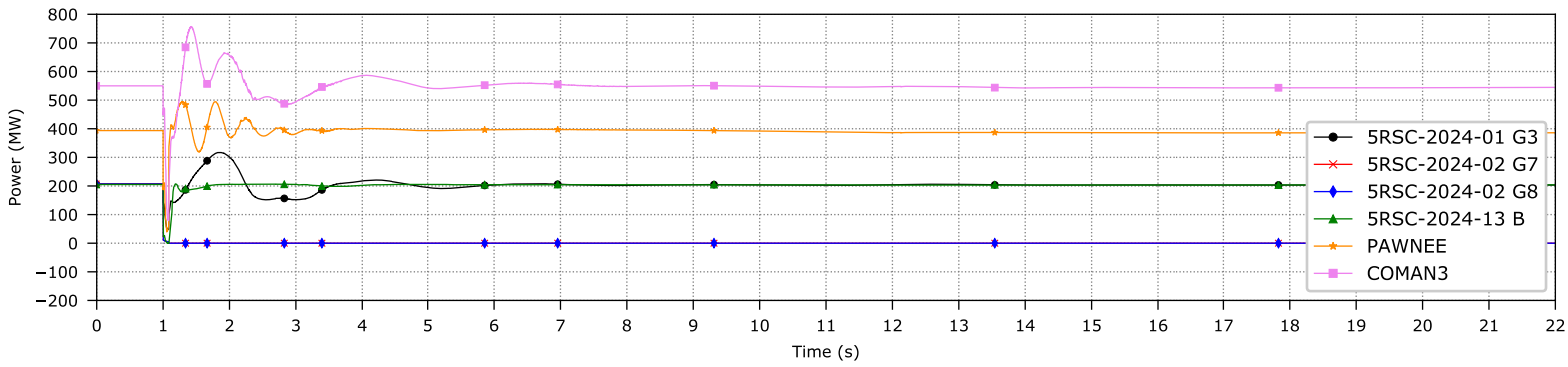


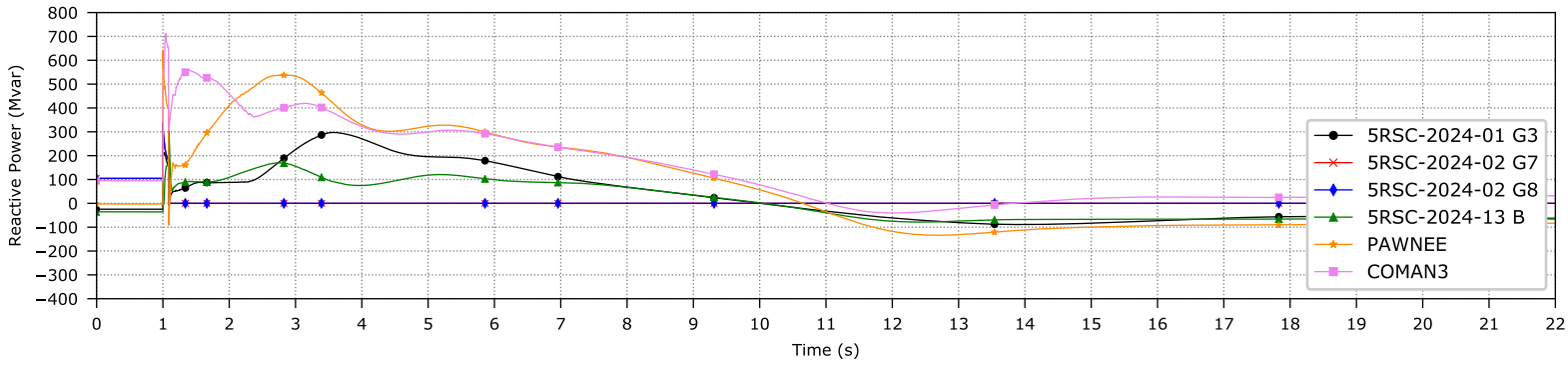


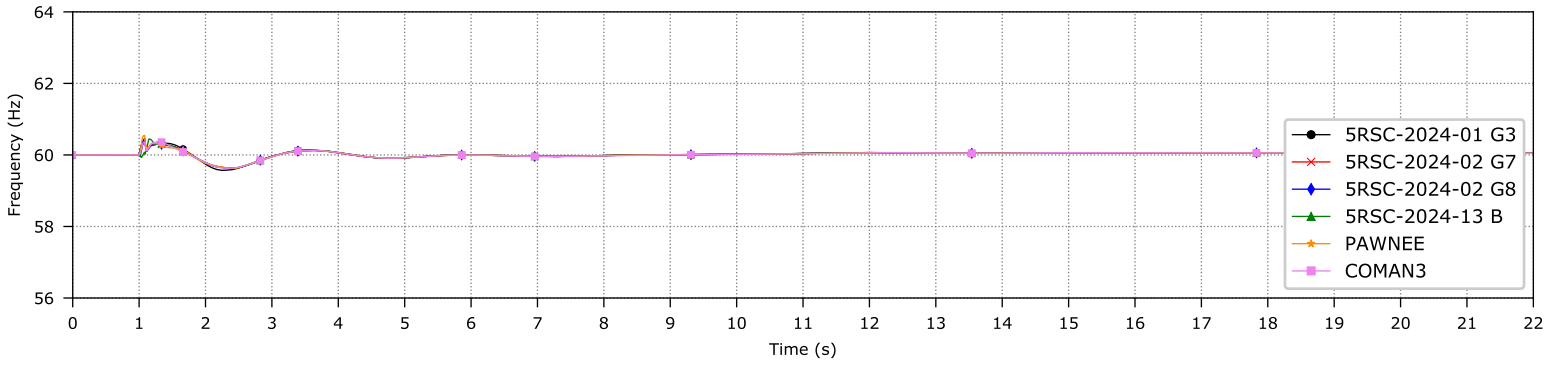


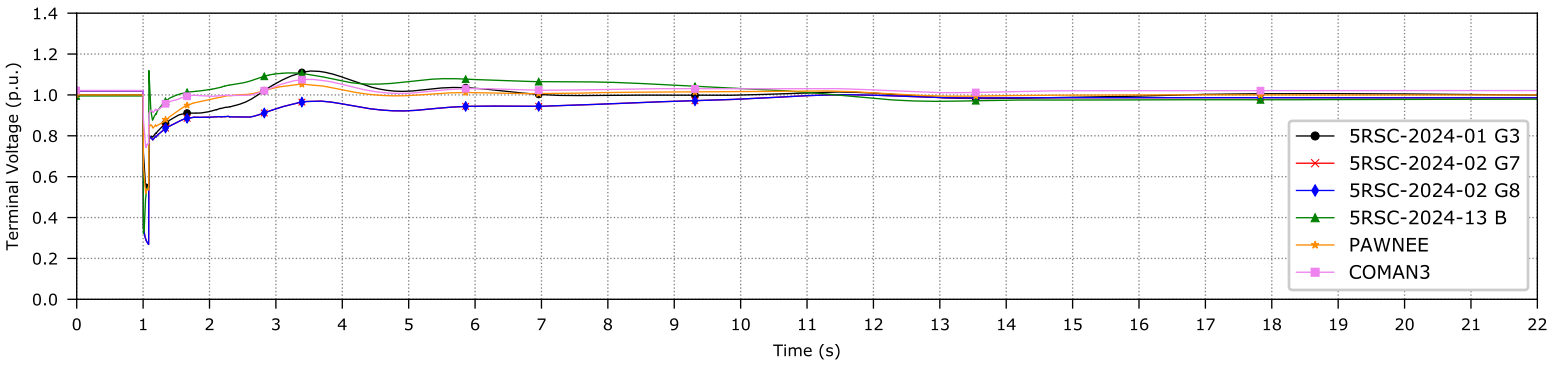
Ref. No. 03 - 5RSC-2024-02

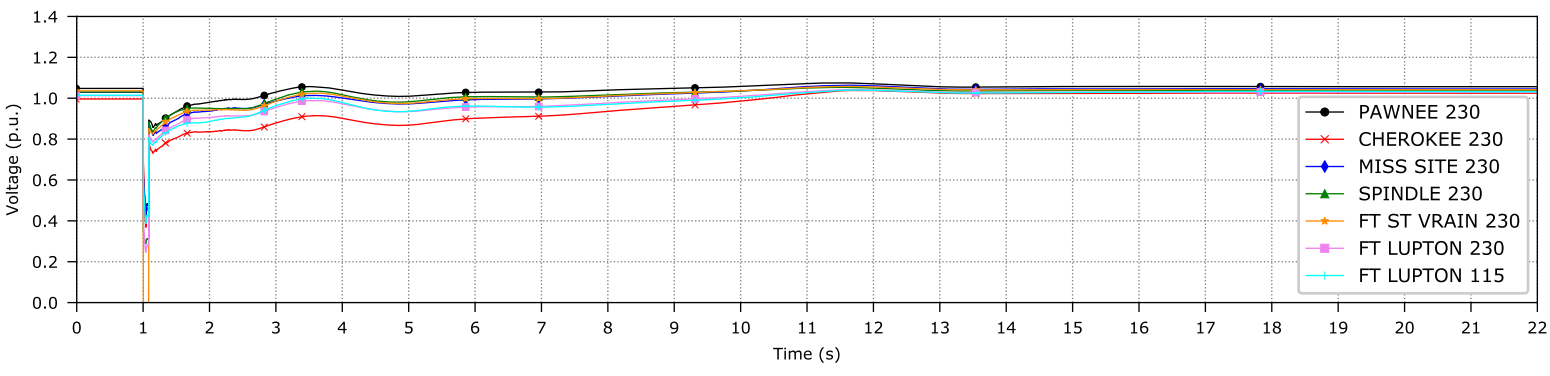




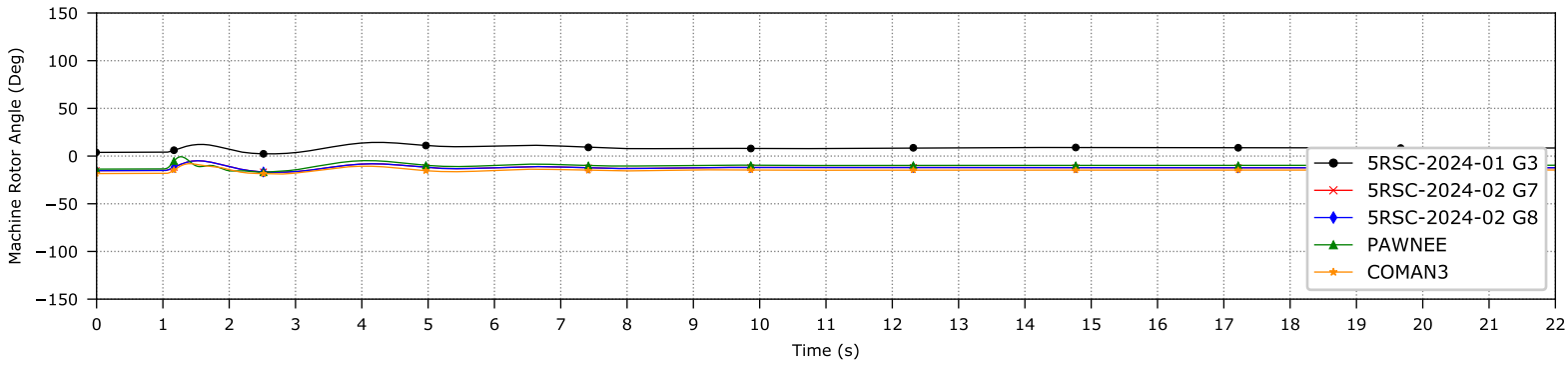


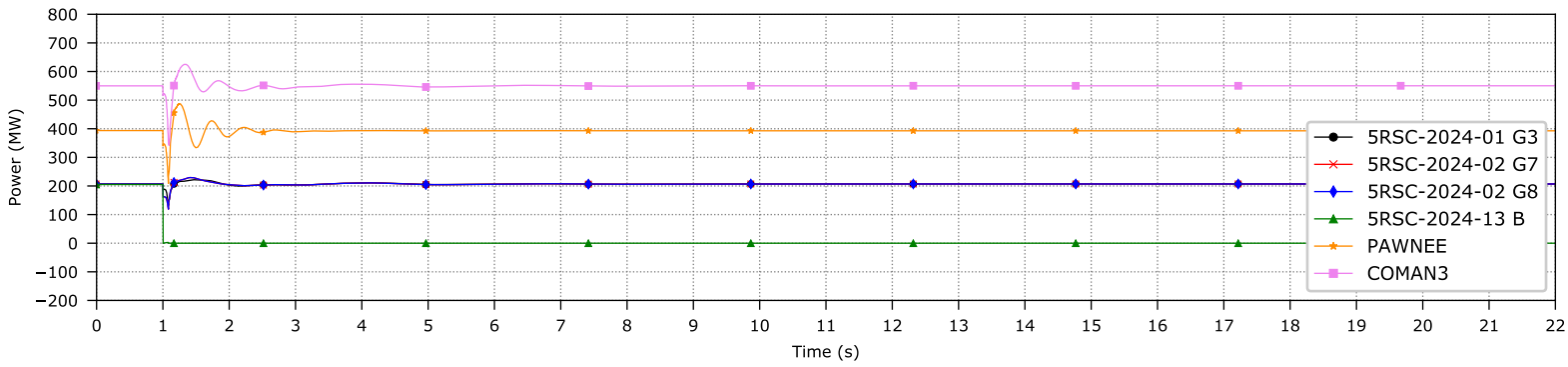


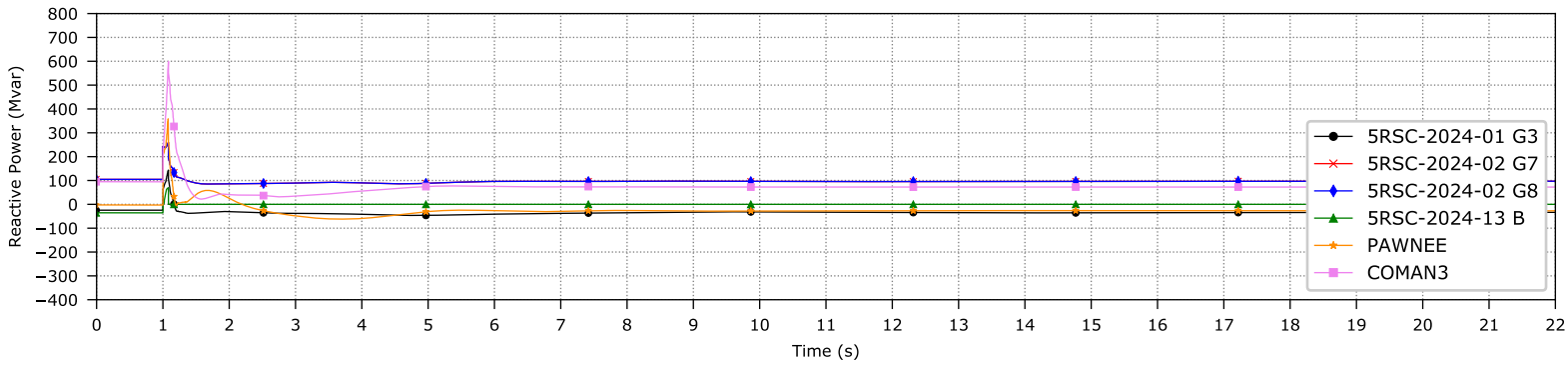


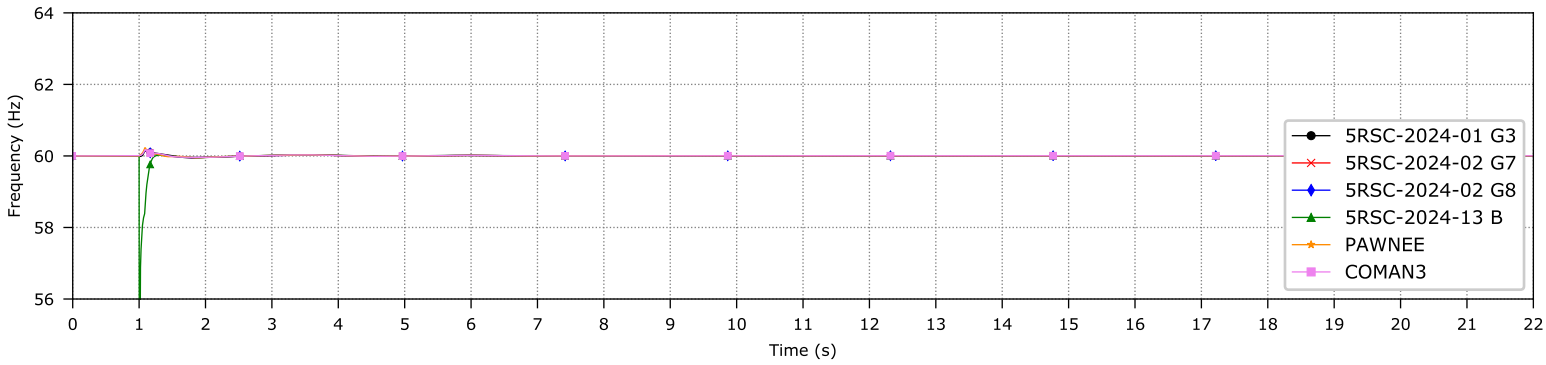


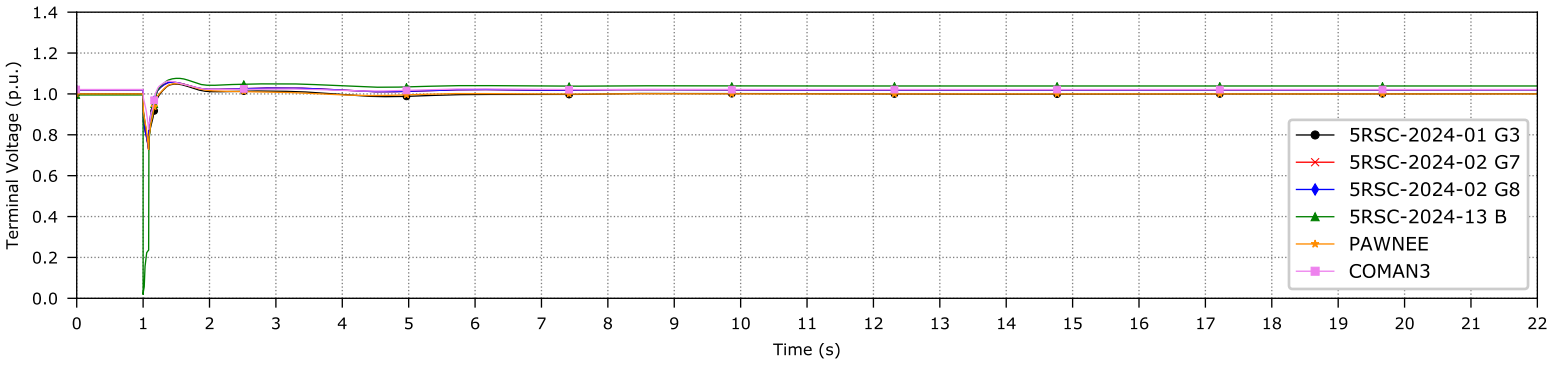
Ref. No. 04 - 5RSC-2024-13

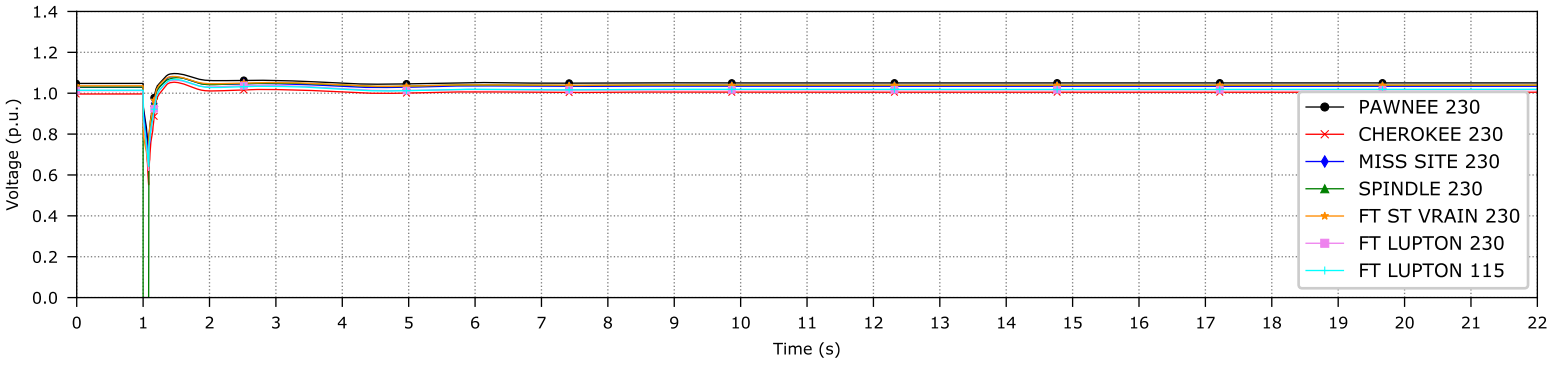




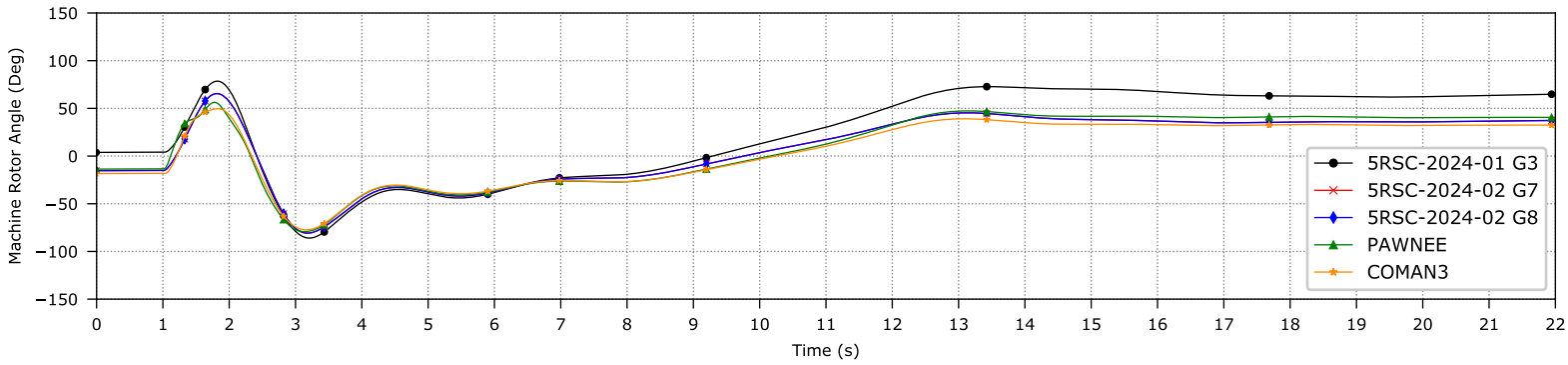


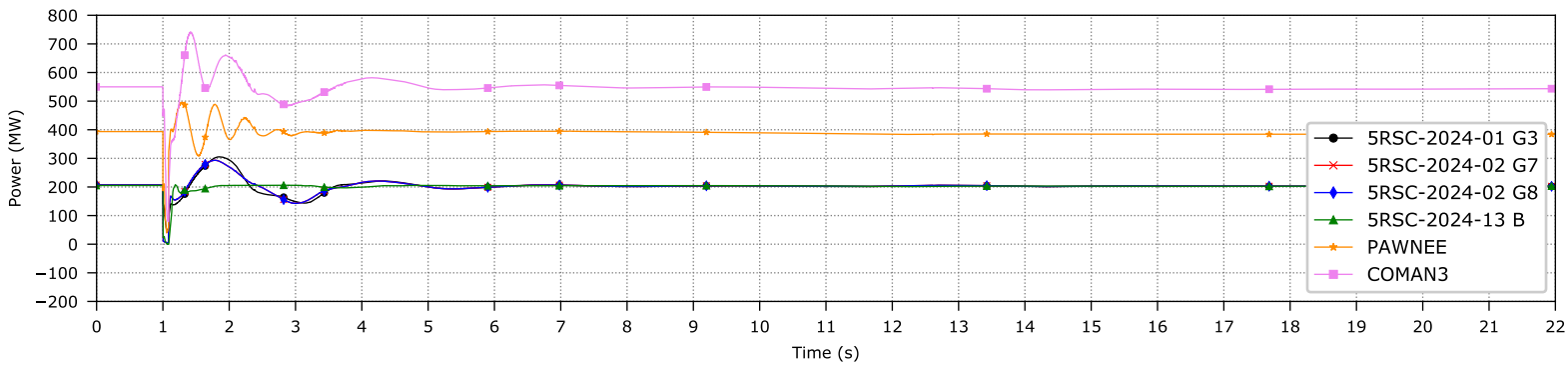


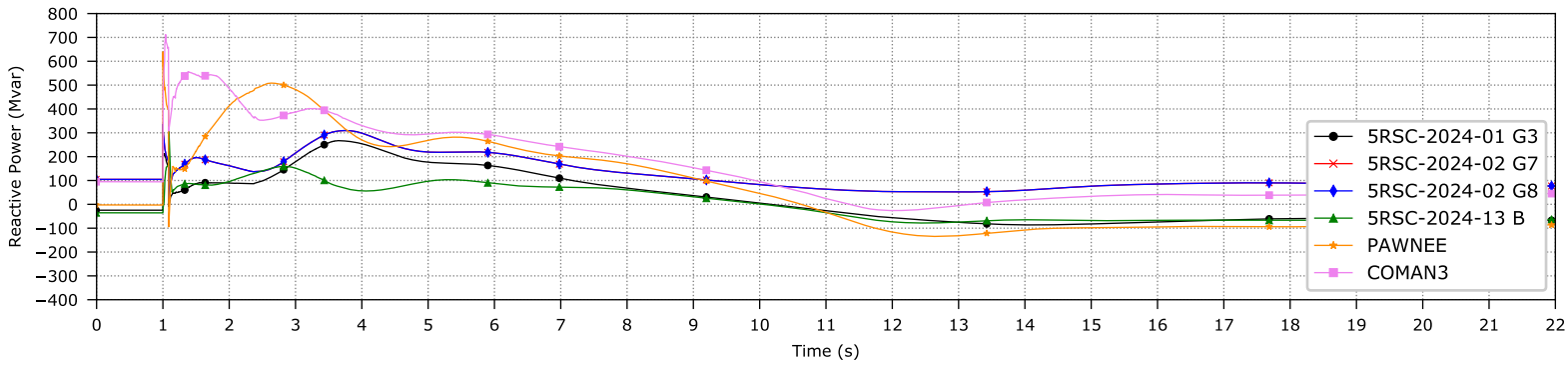


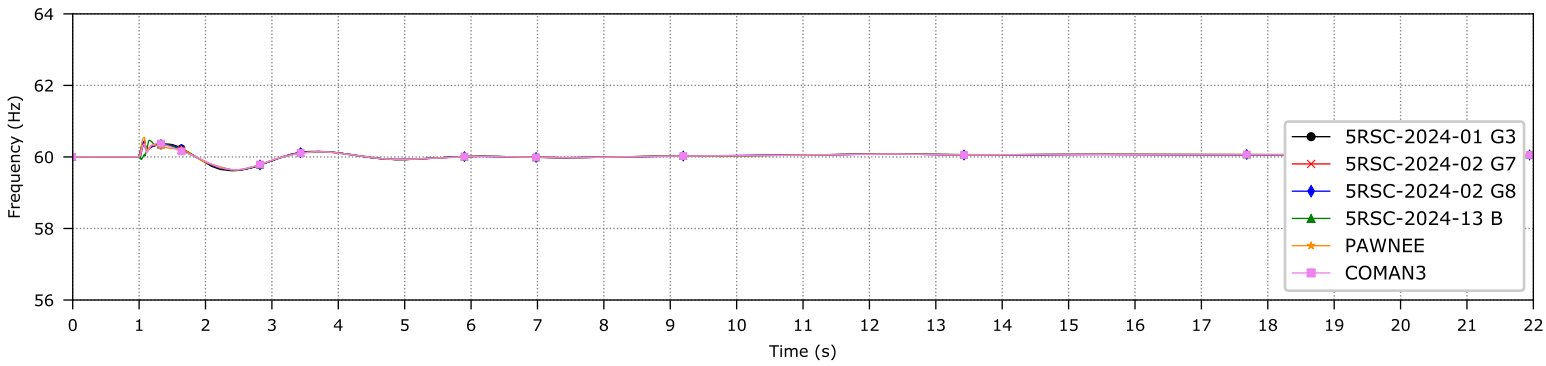


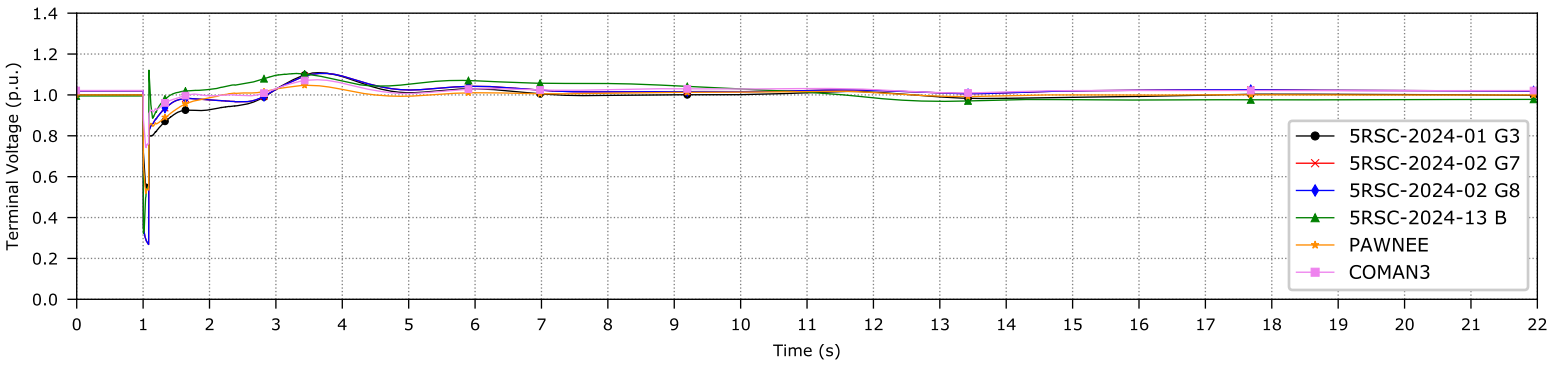
Ref. No. 05 - LoTC_59

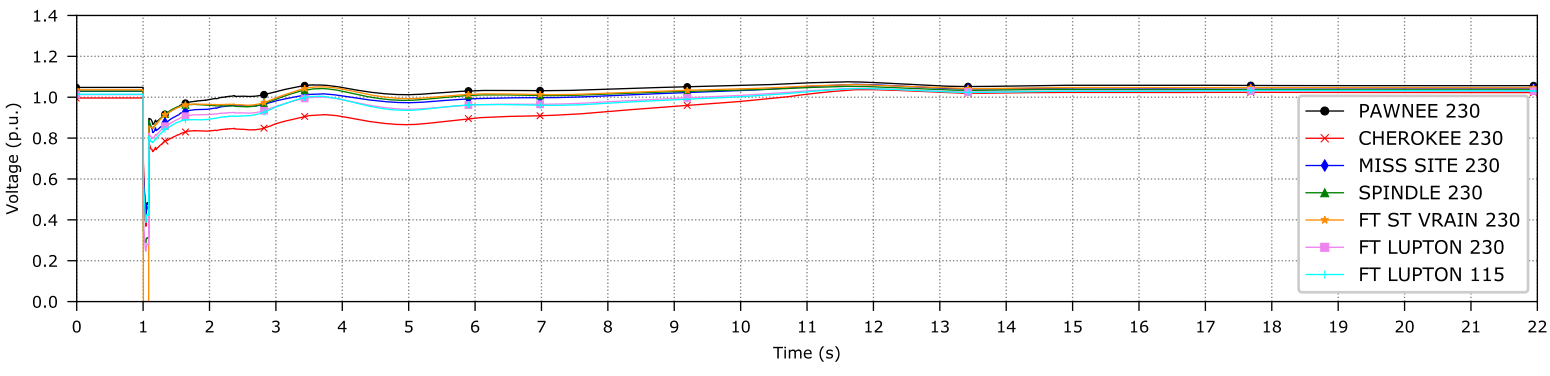




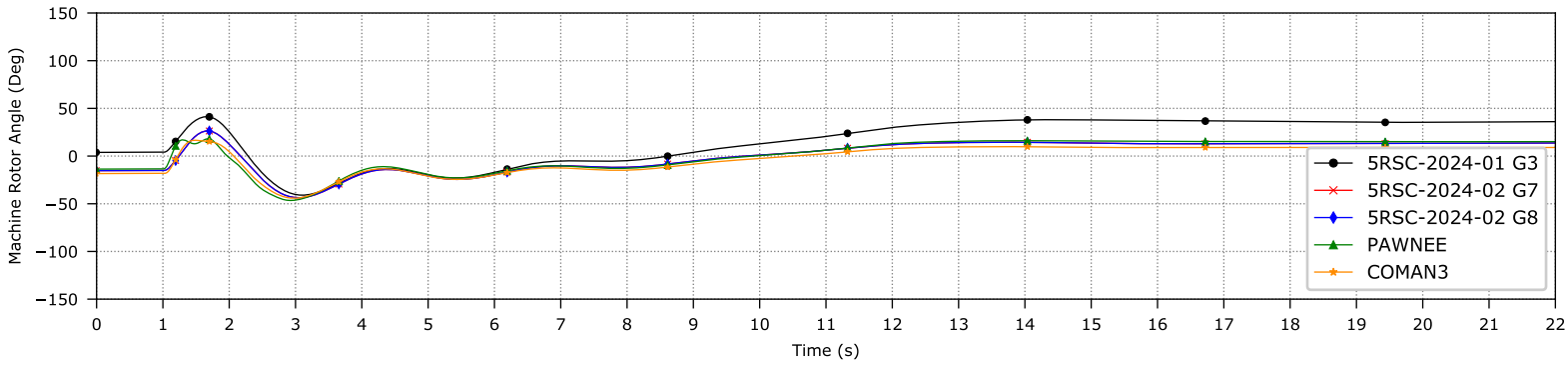


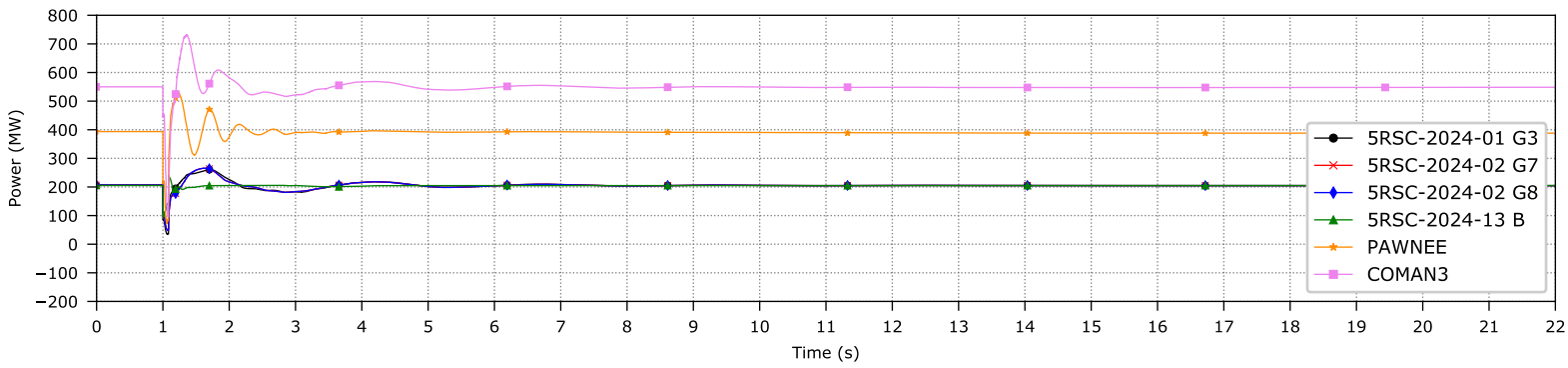


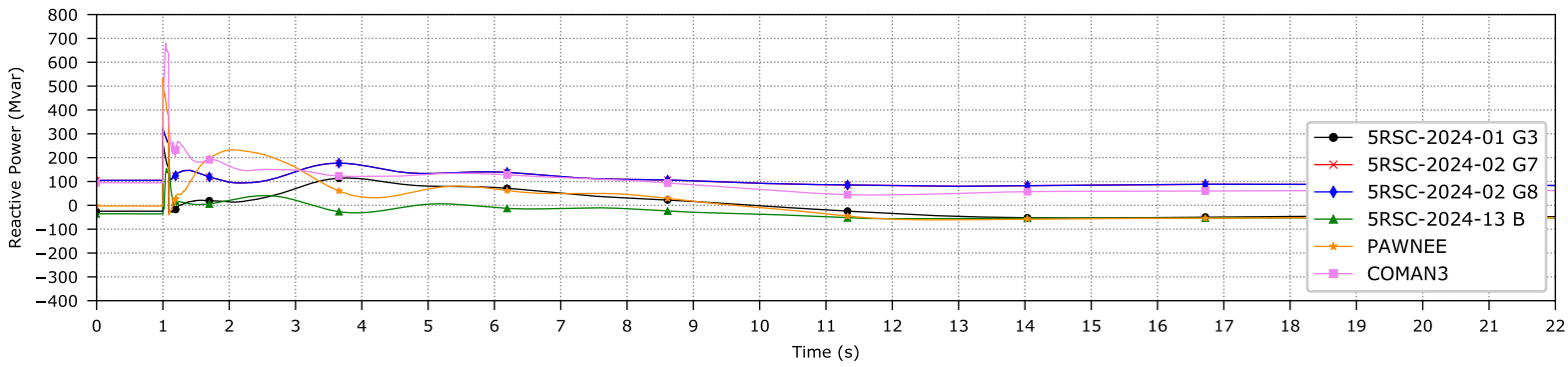


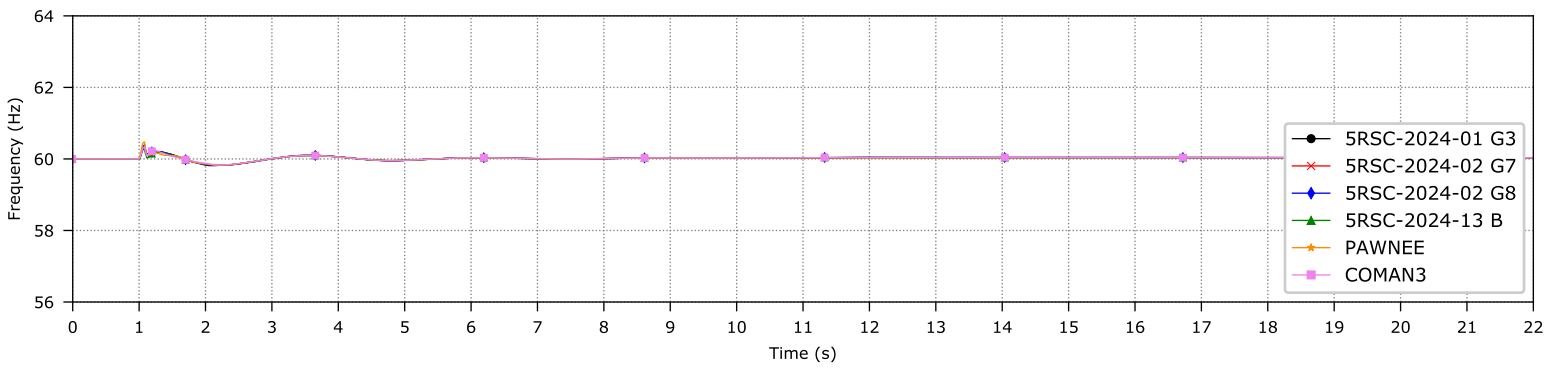


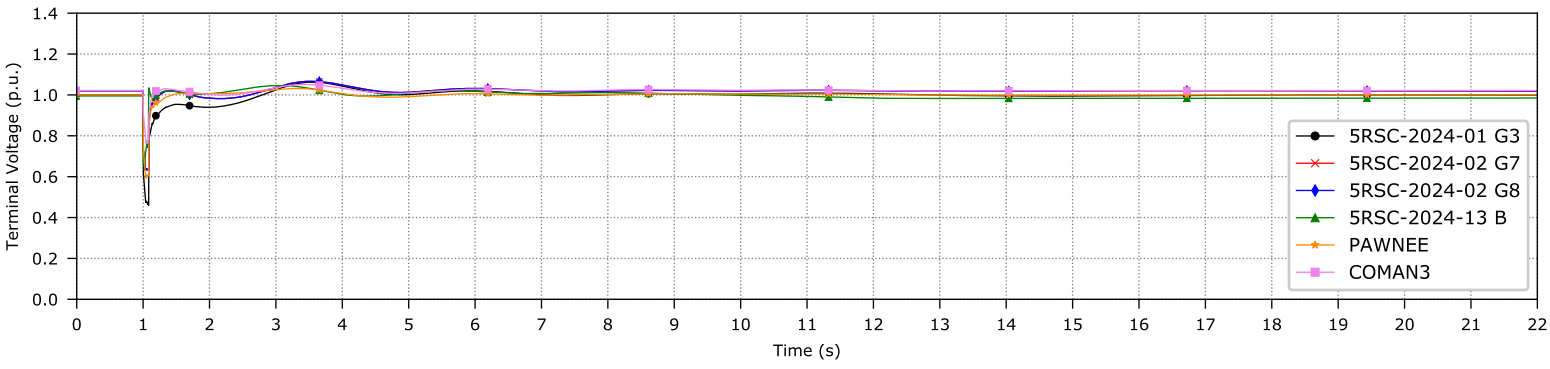
Ref. No. 06 - LoTC_62

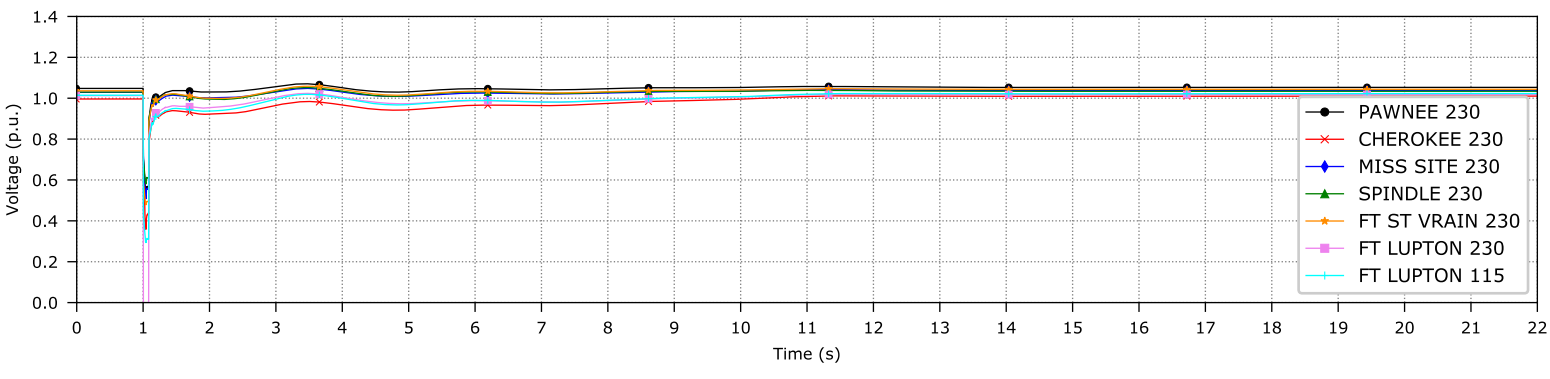




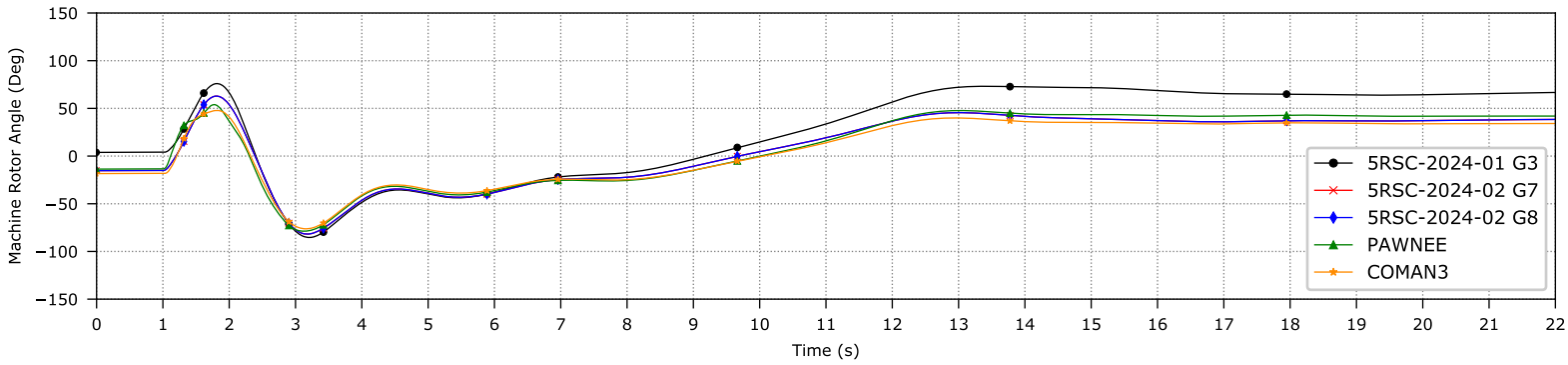


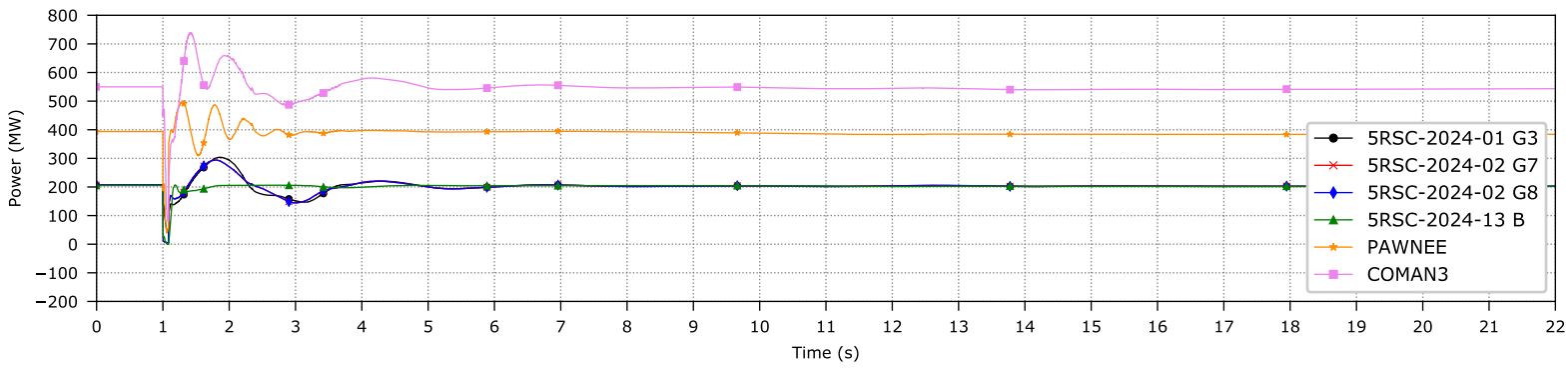


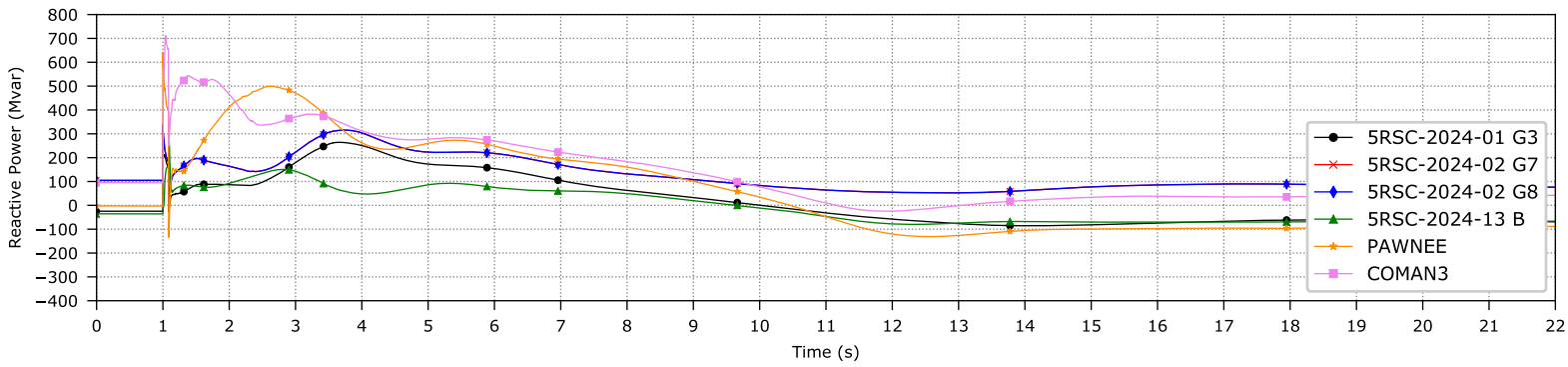


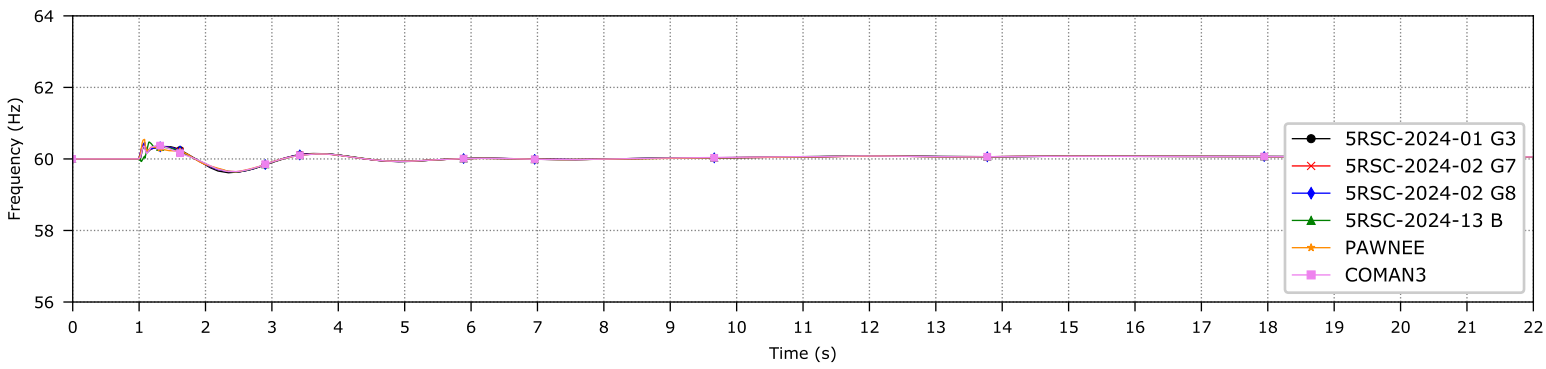


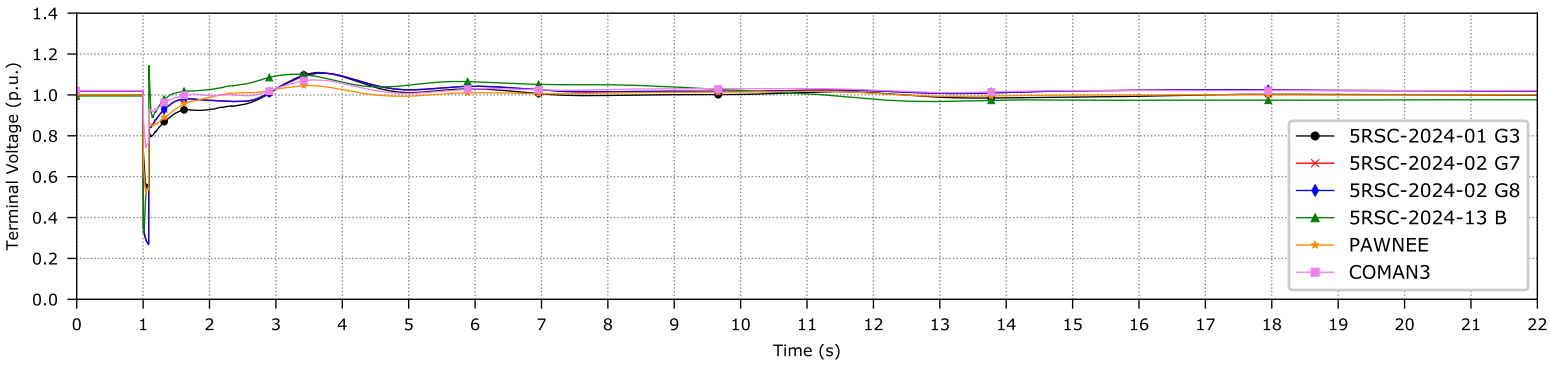
Ref. No. 07 - LoTC_63

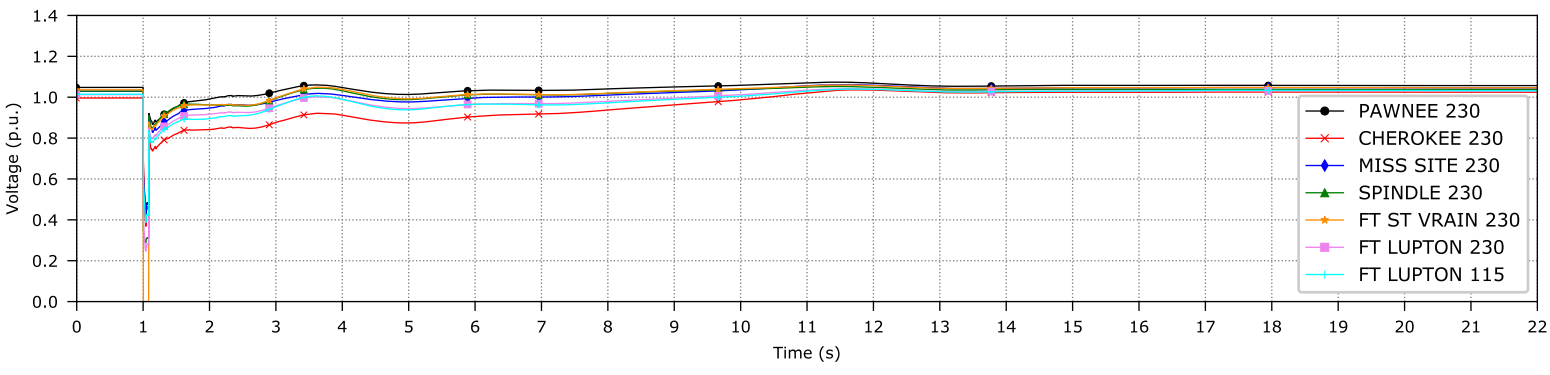




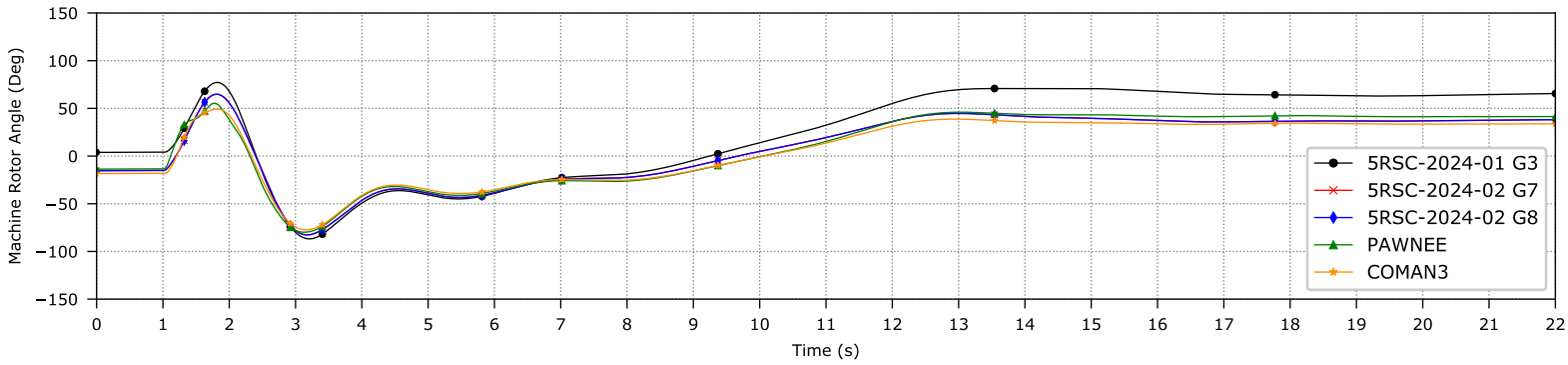


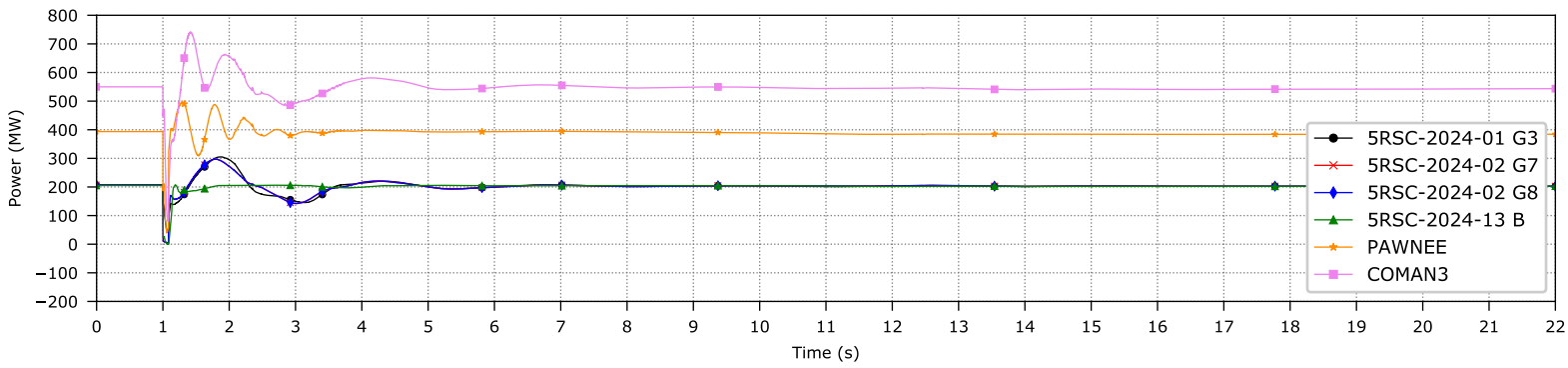


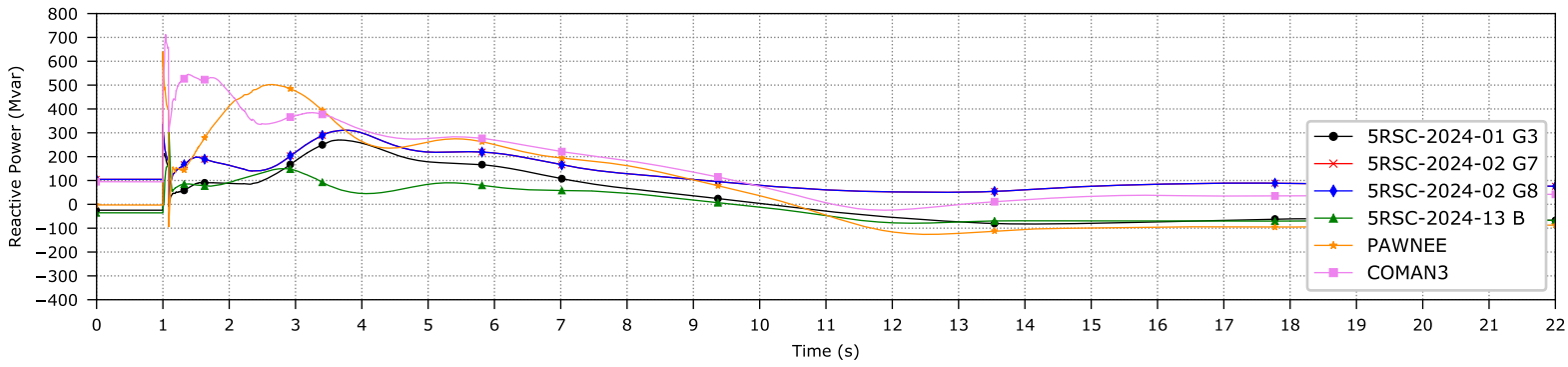


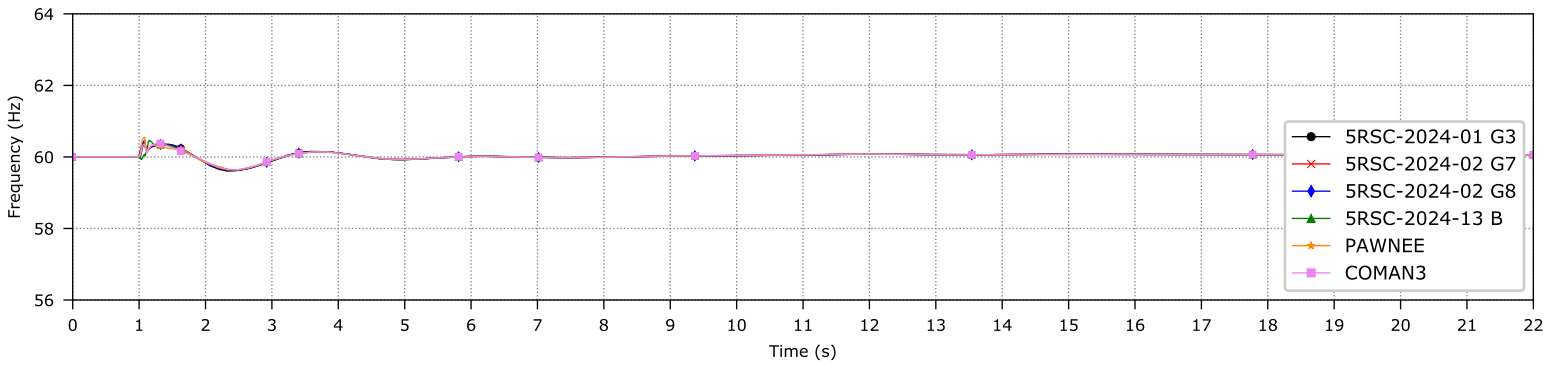


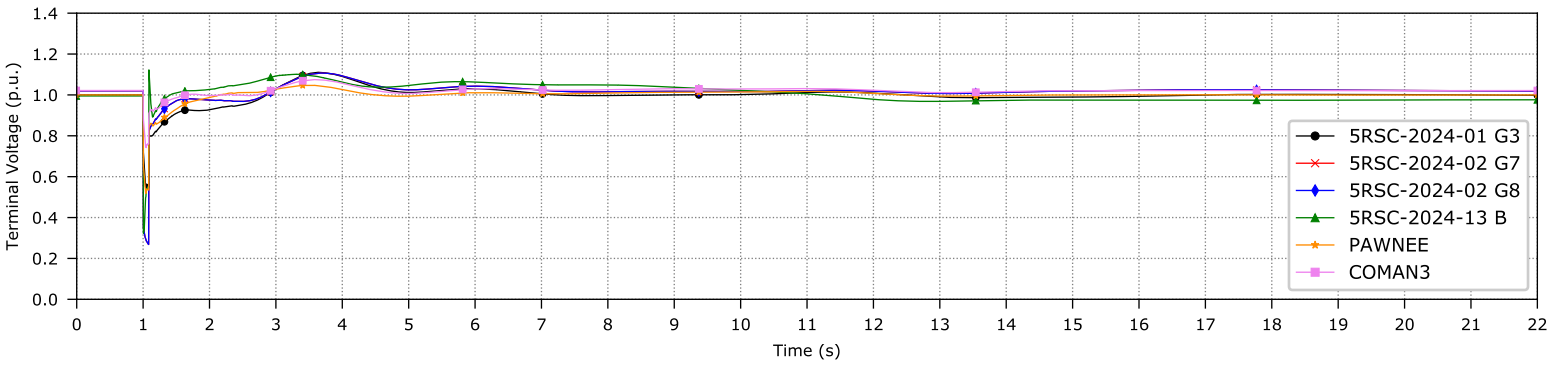
Ref. No. 08 - LoTC_64

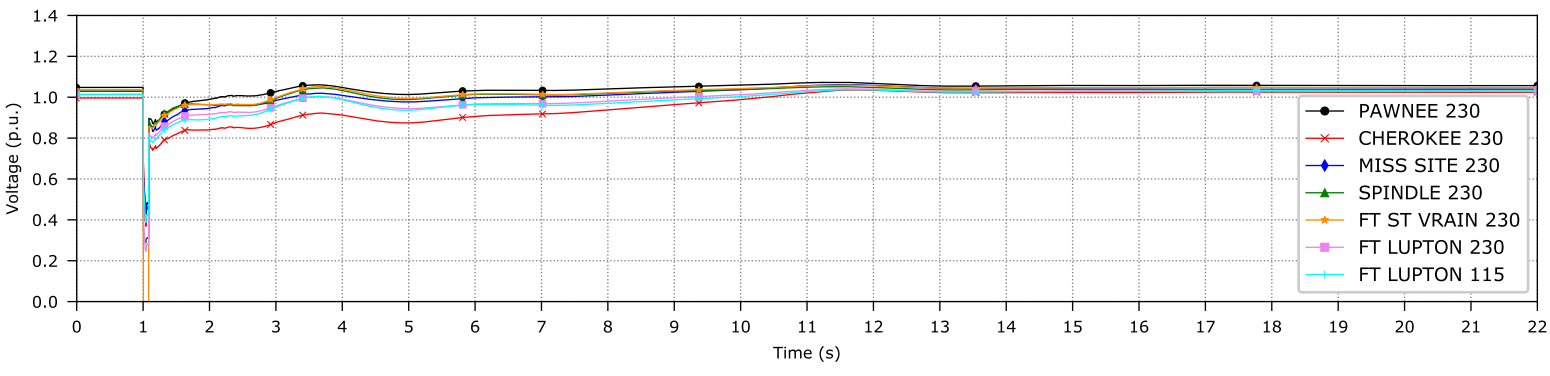




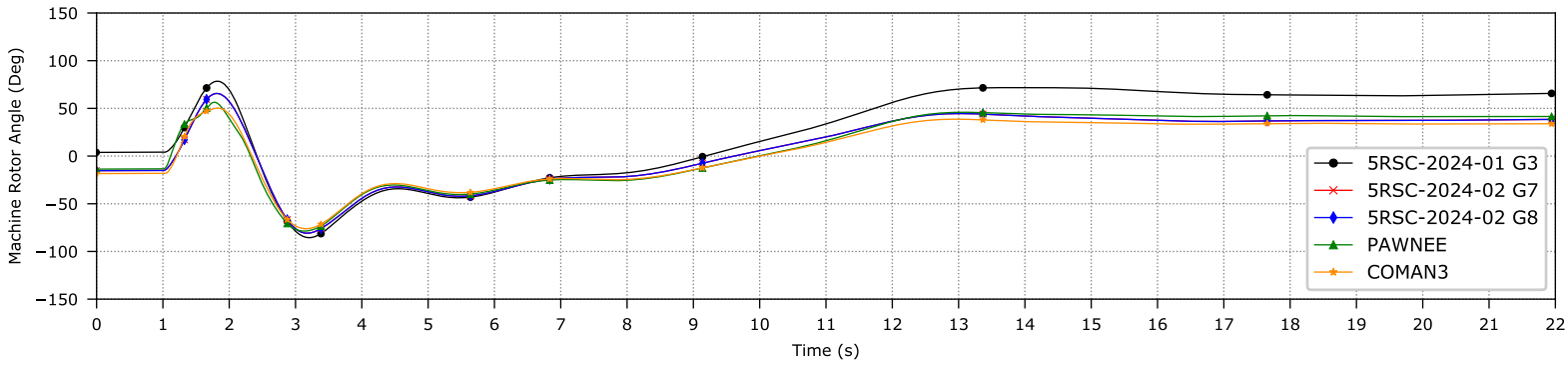


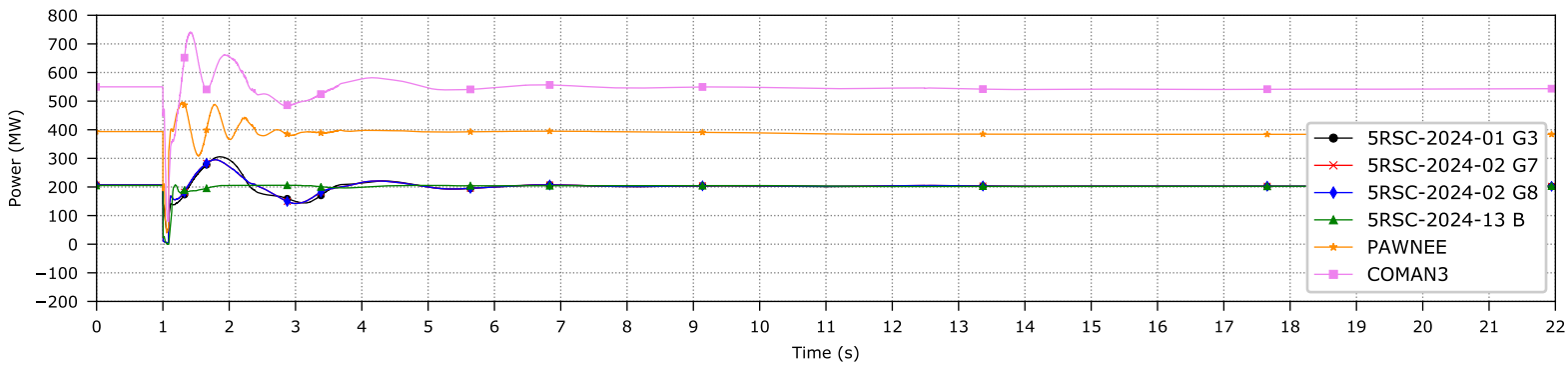


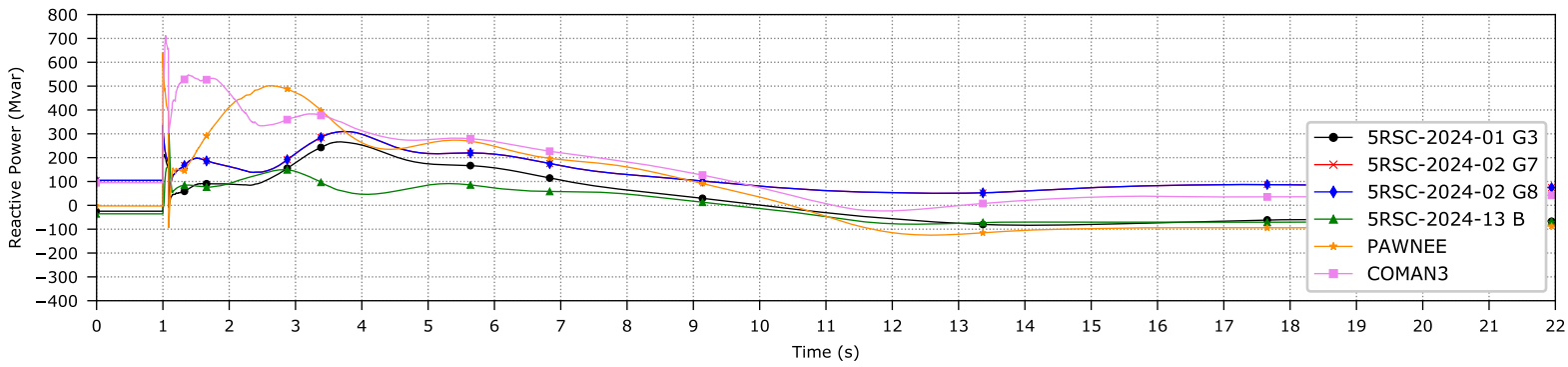


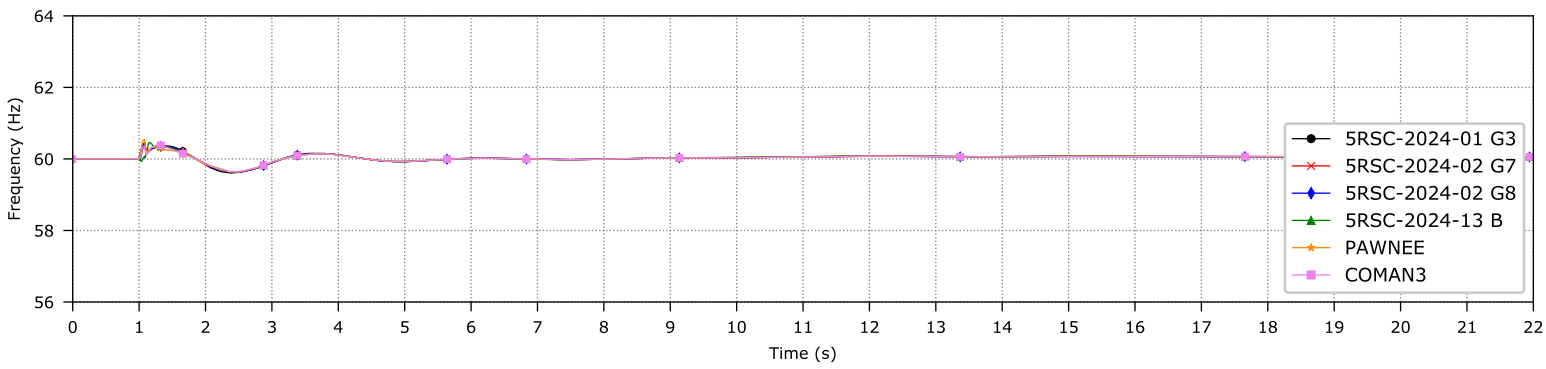


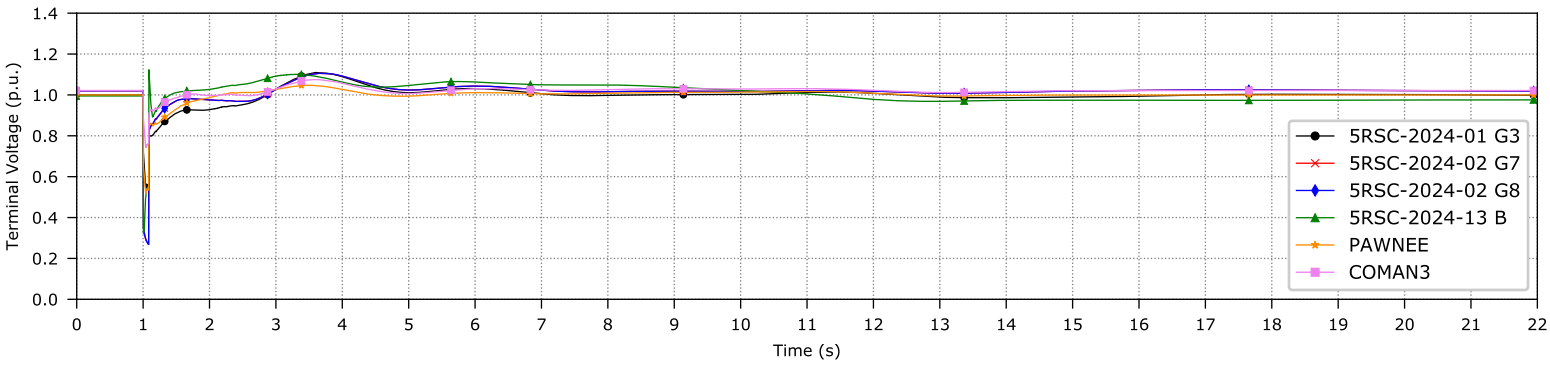
Ref. No. 09 - LoTC_65

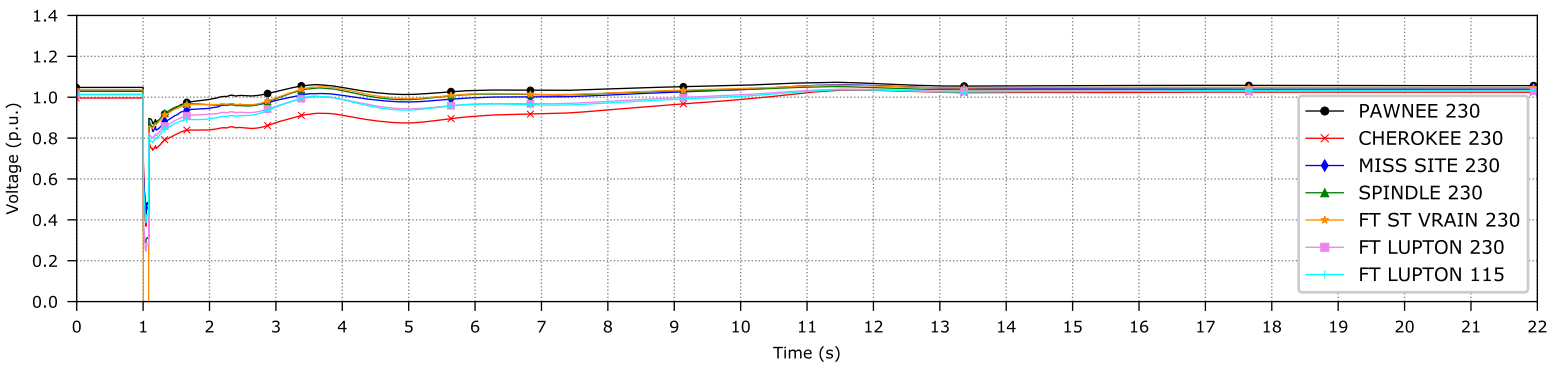




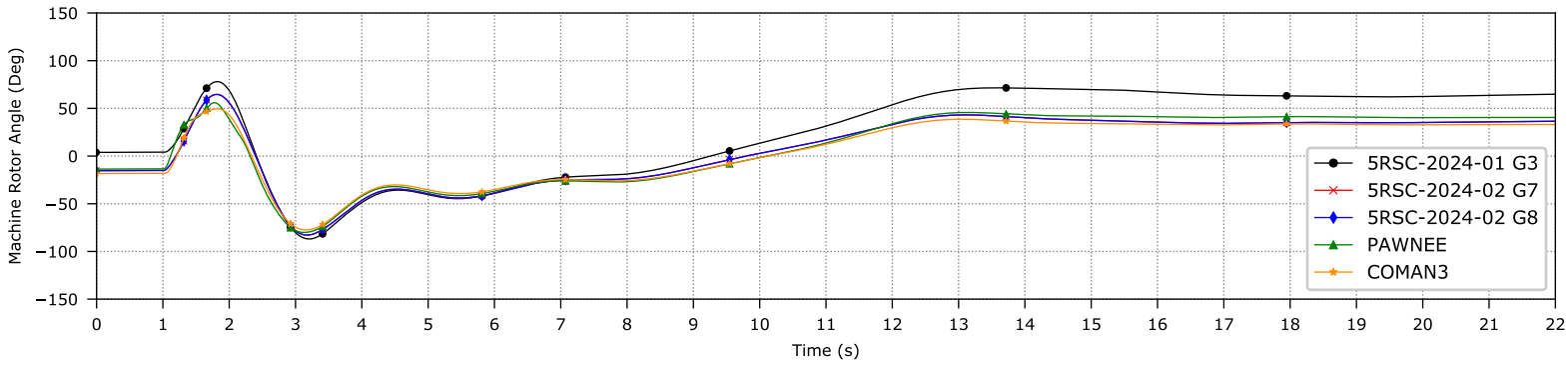


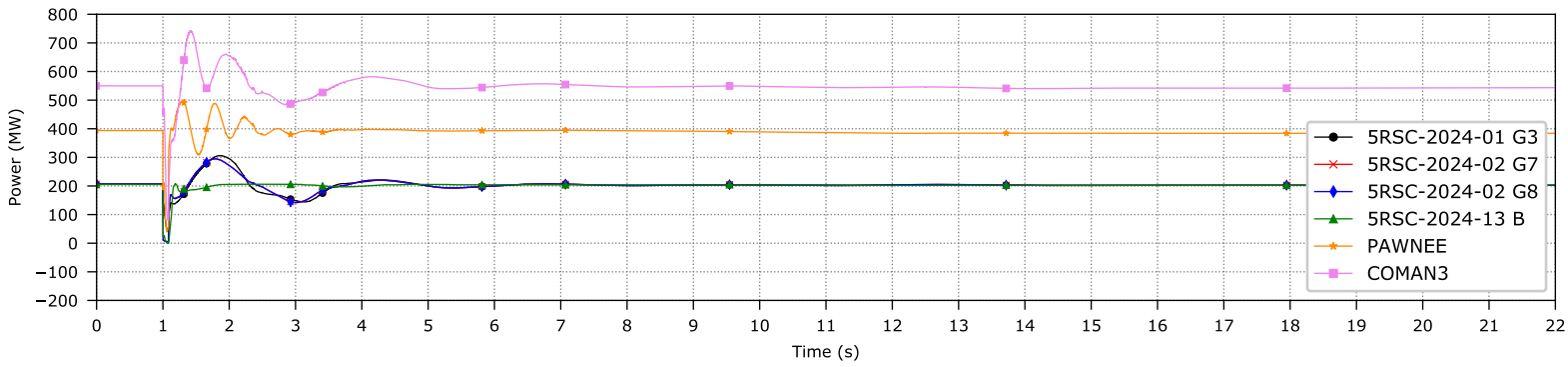


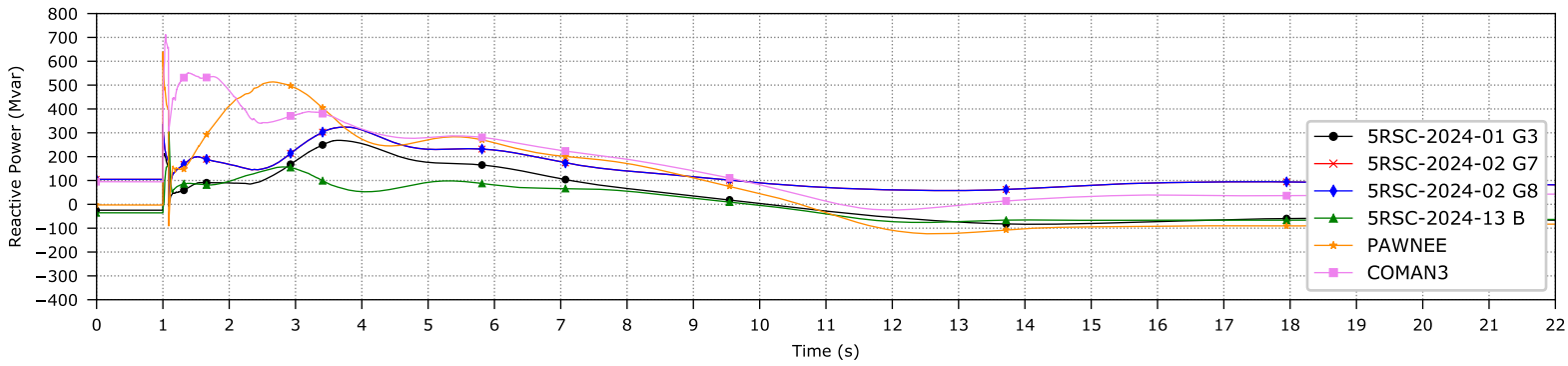


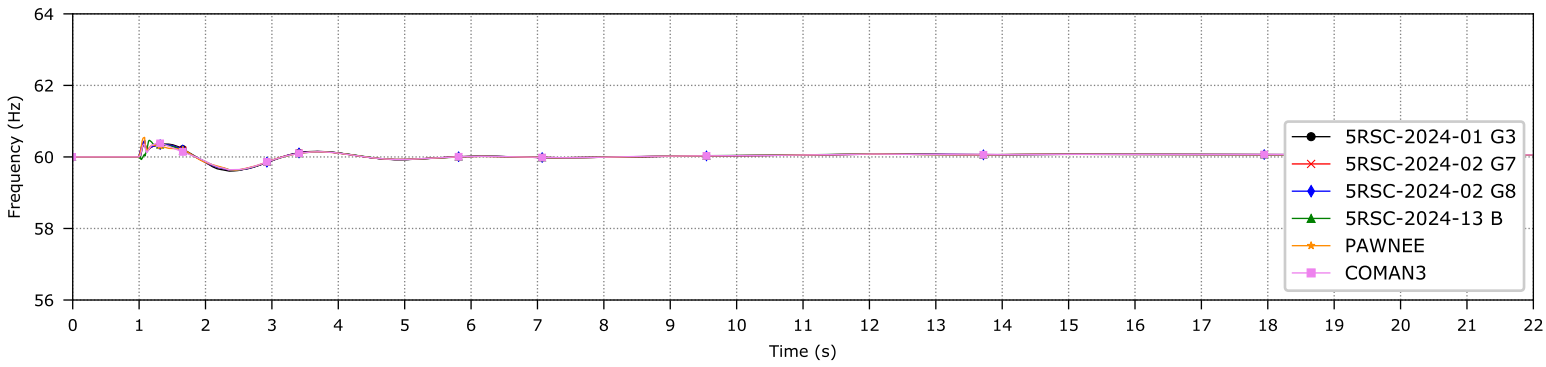


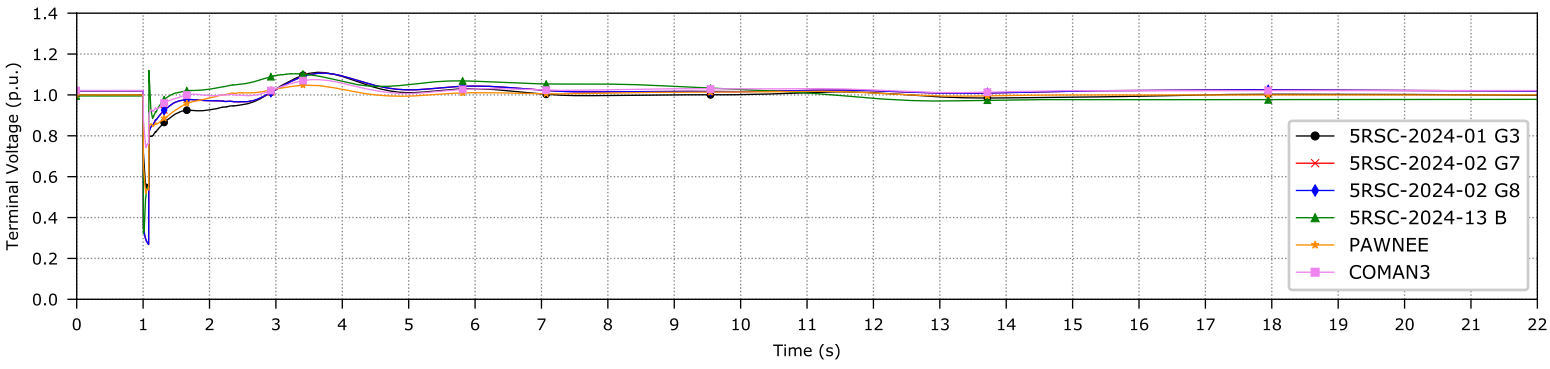
Ref. No. 10 - LoTC_66

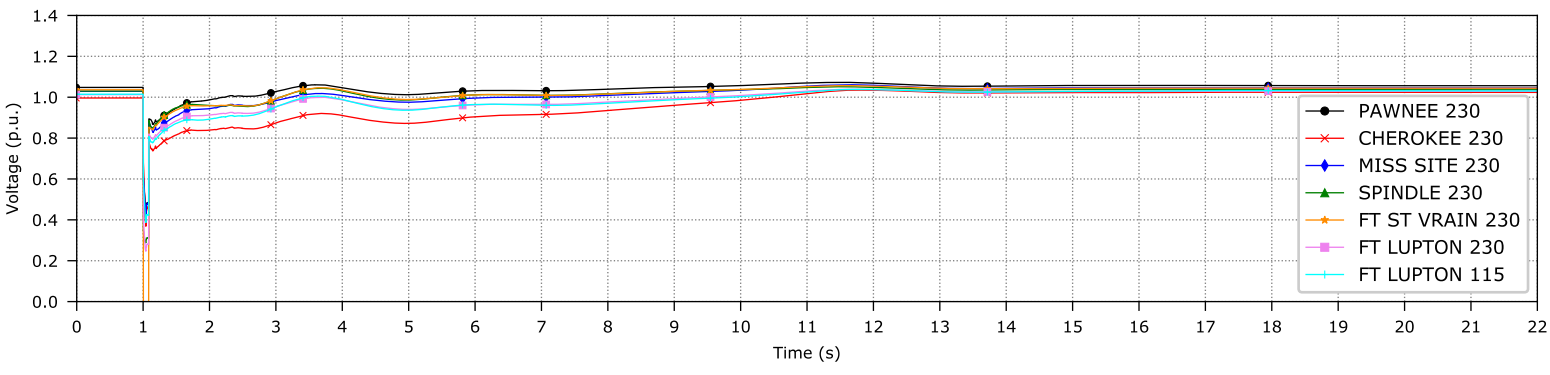




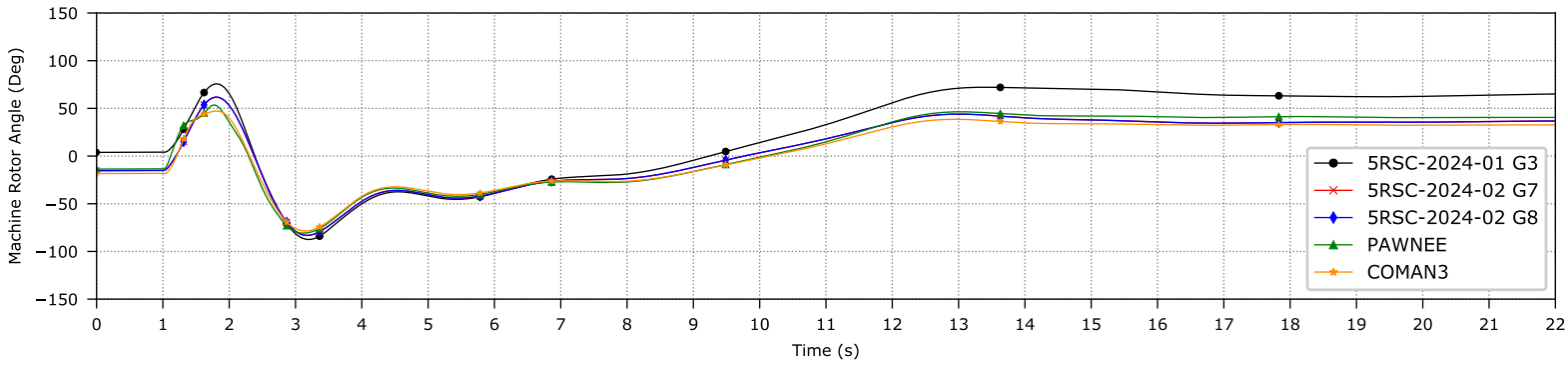


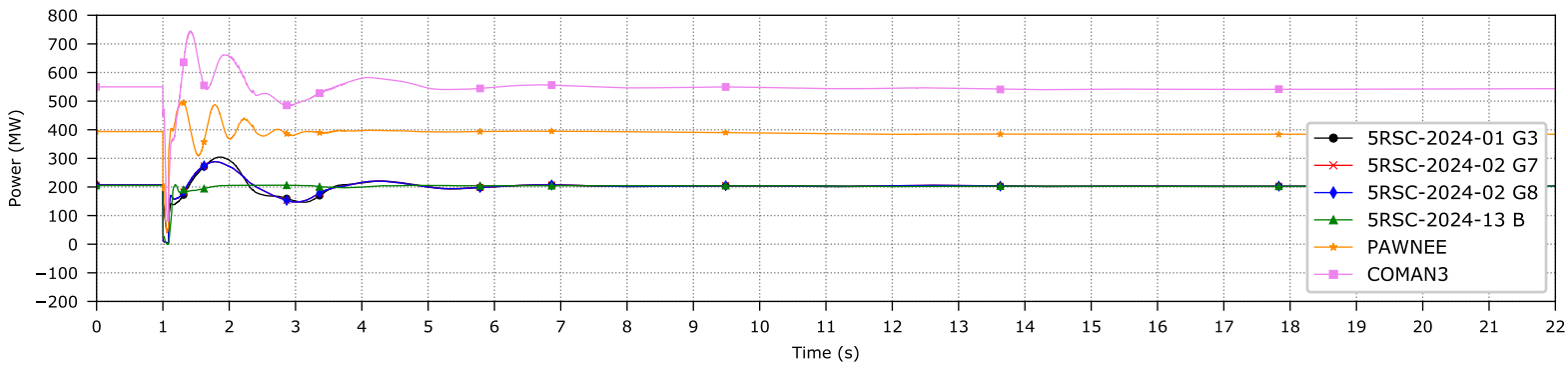


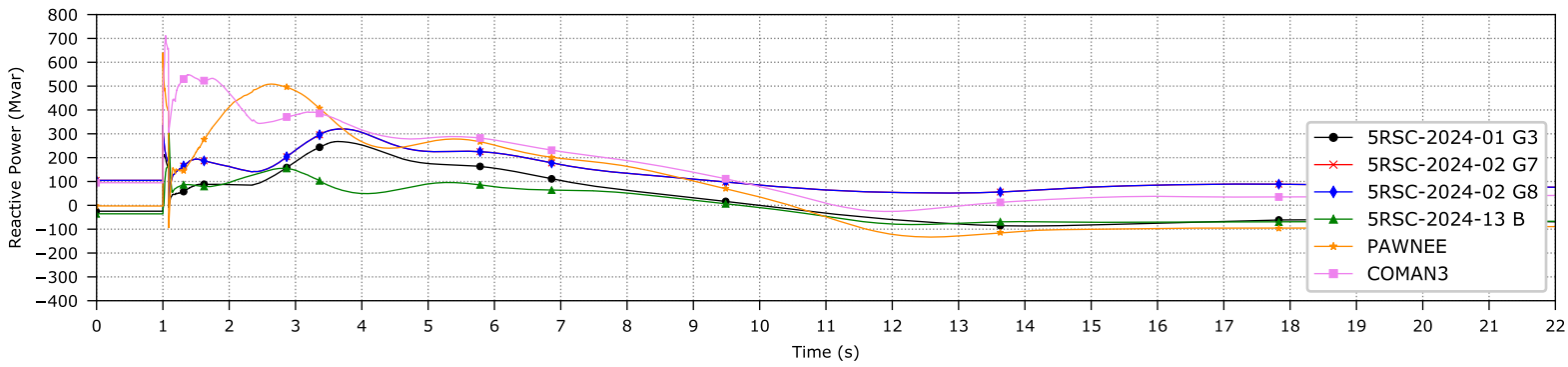


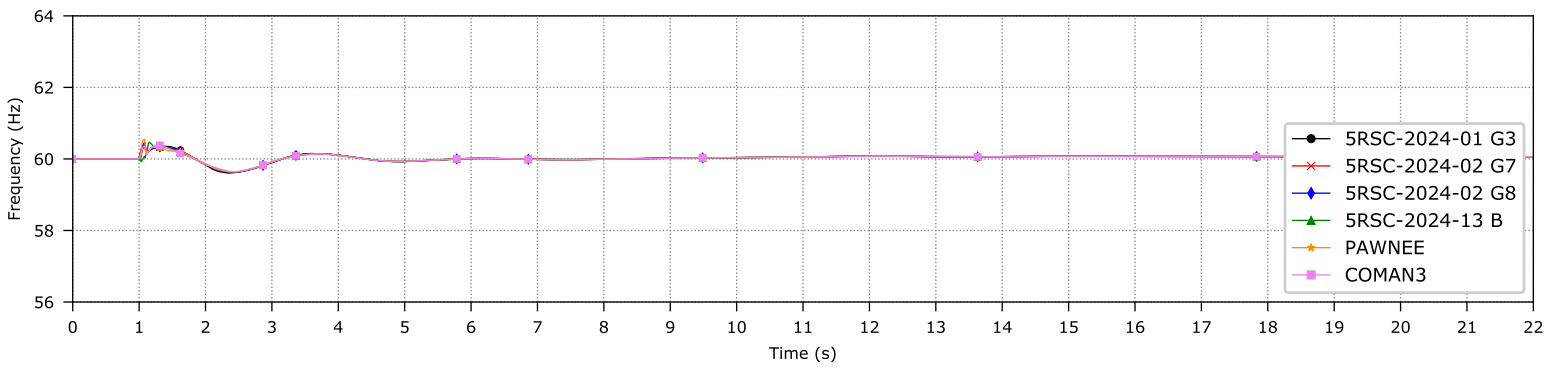


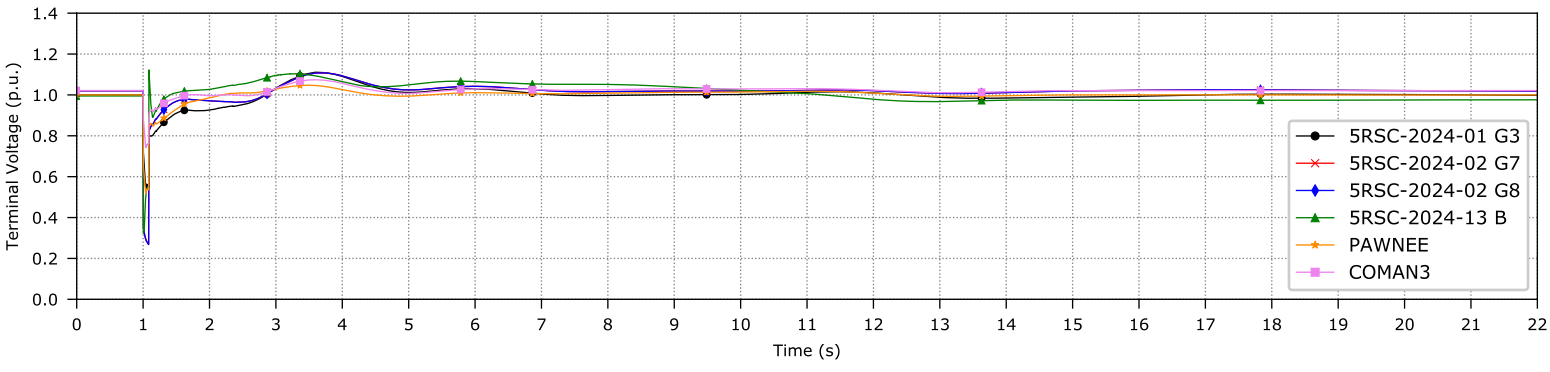
Ref. No. 11 - LoTC_67

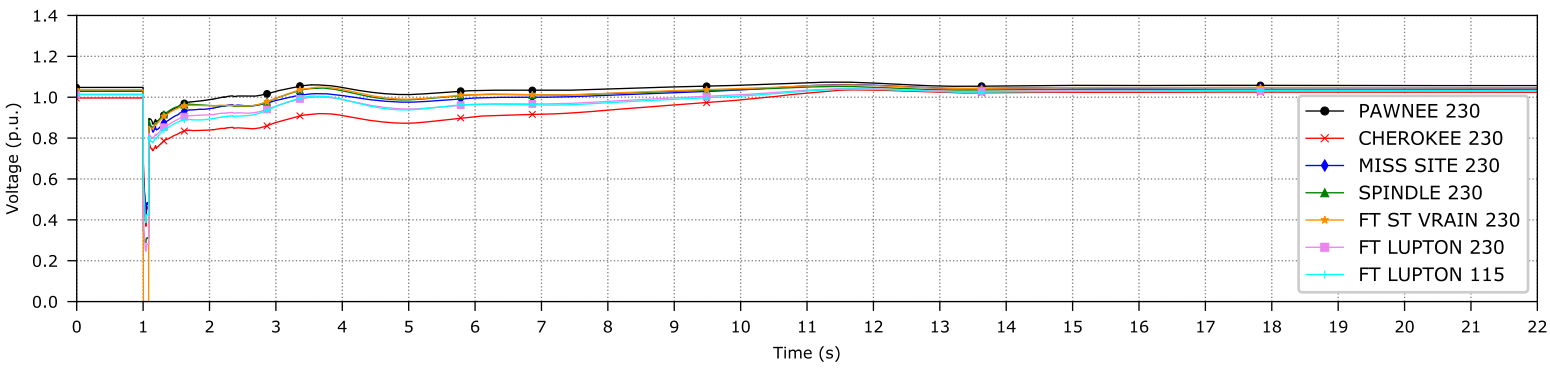




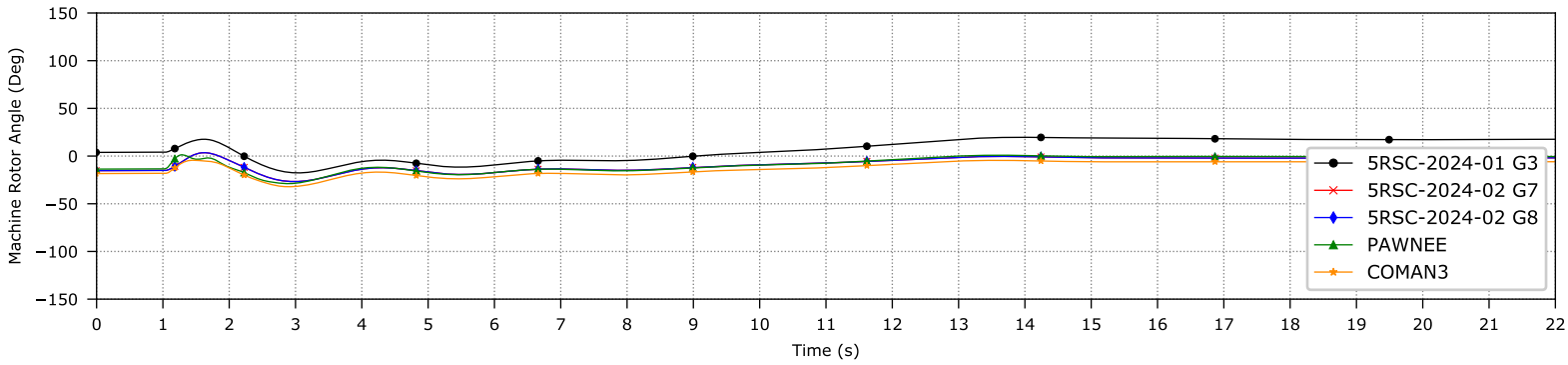


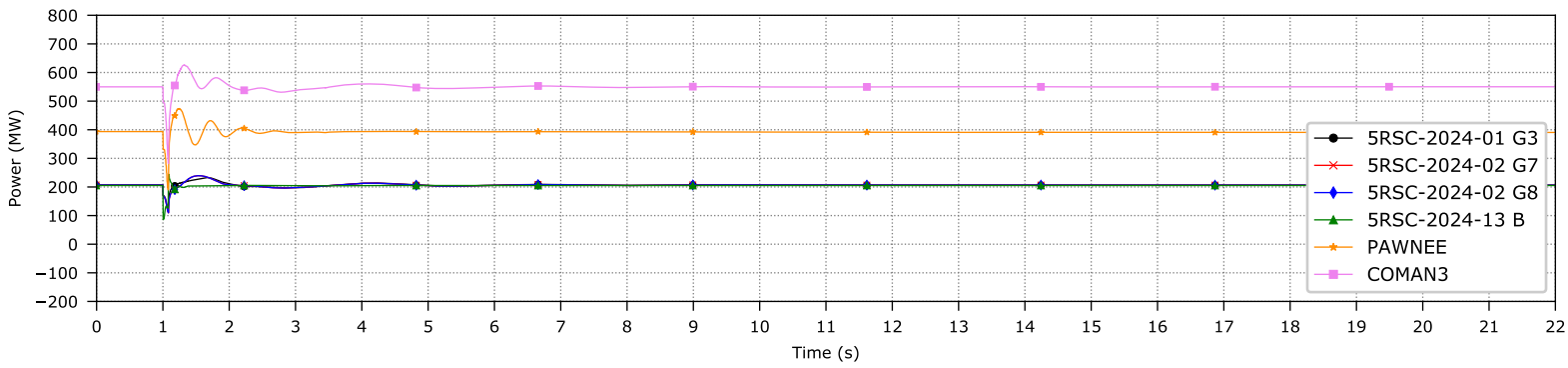


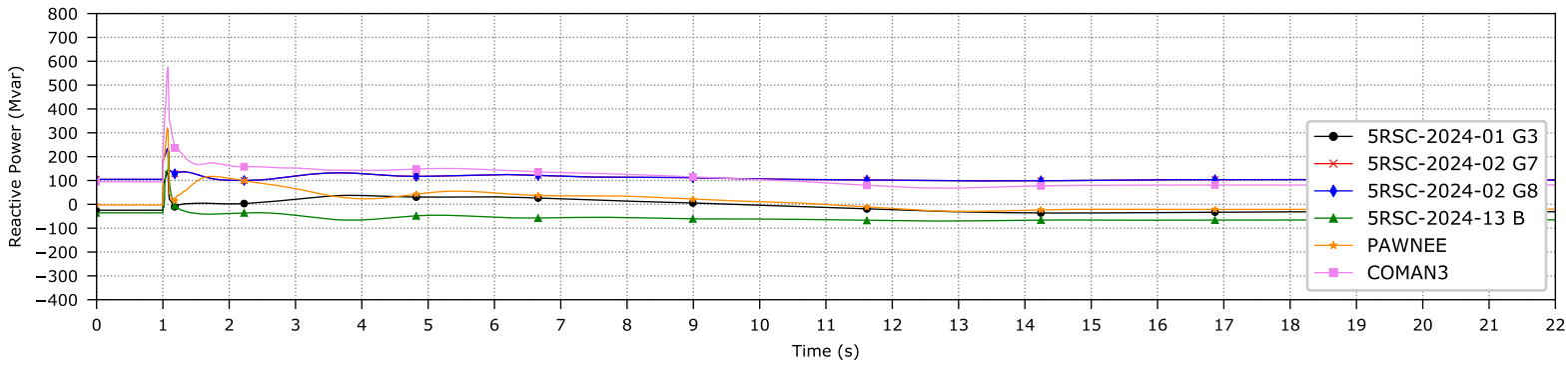


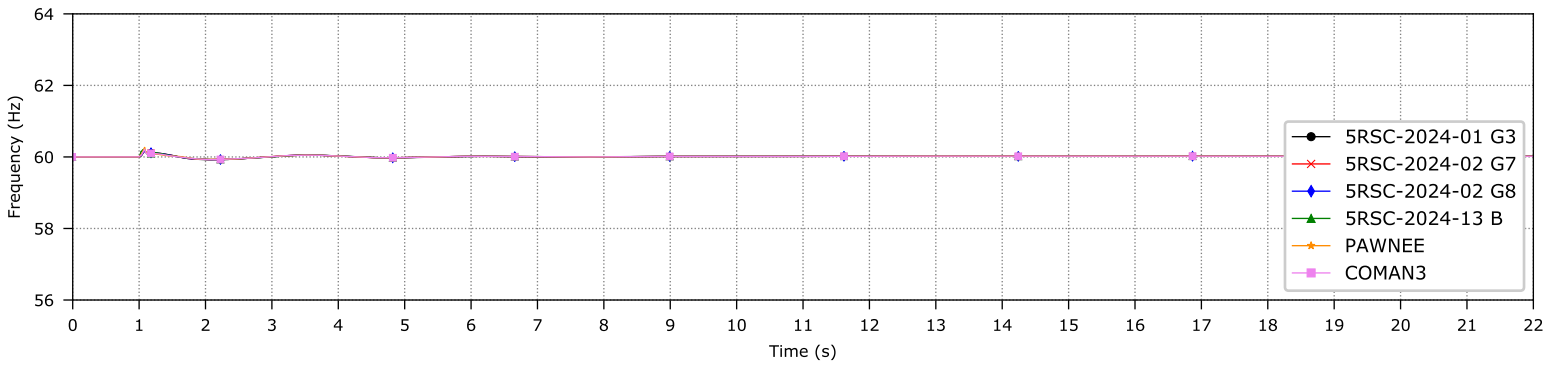


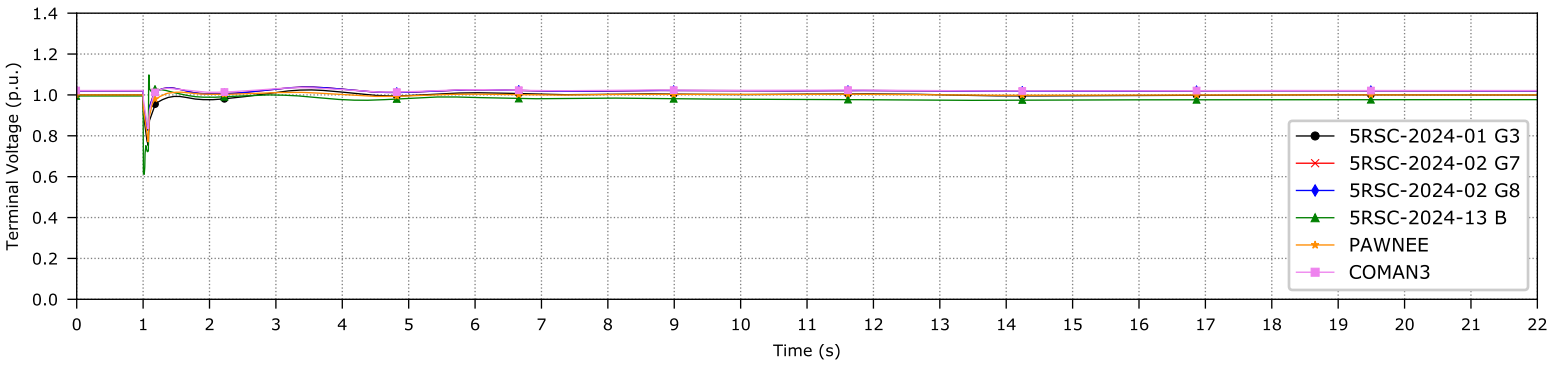
Ref. No. 12 - LoTC_74

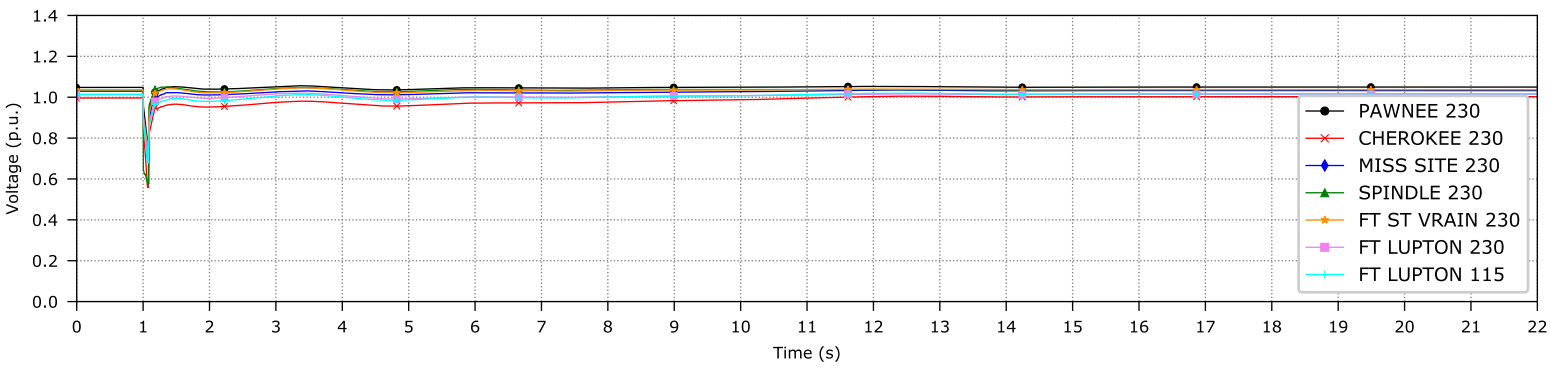




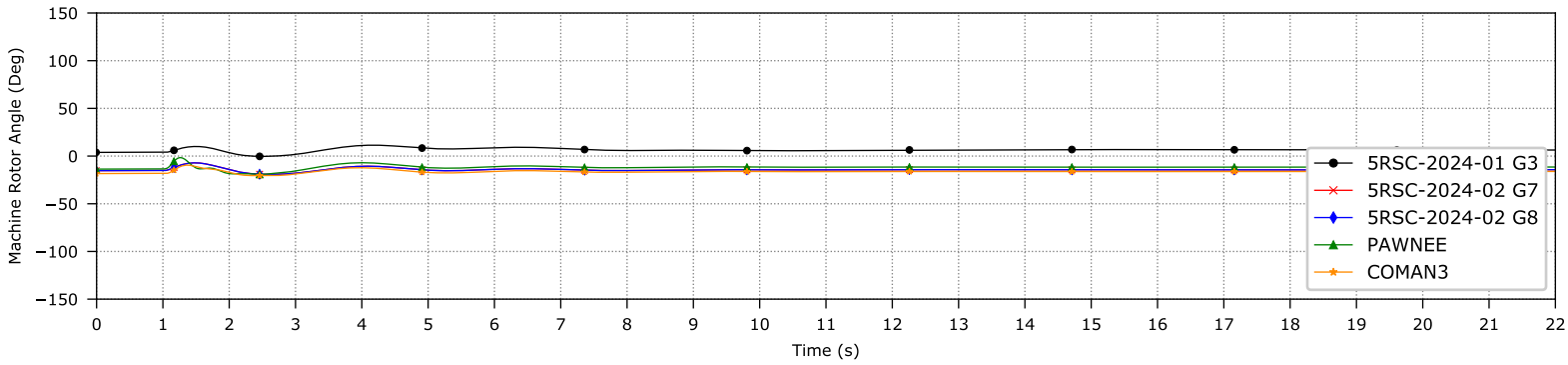


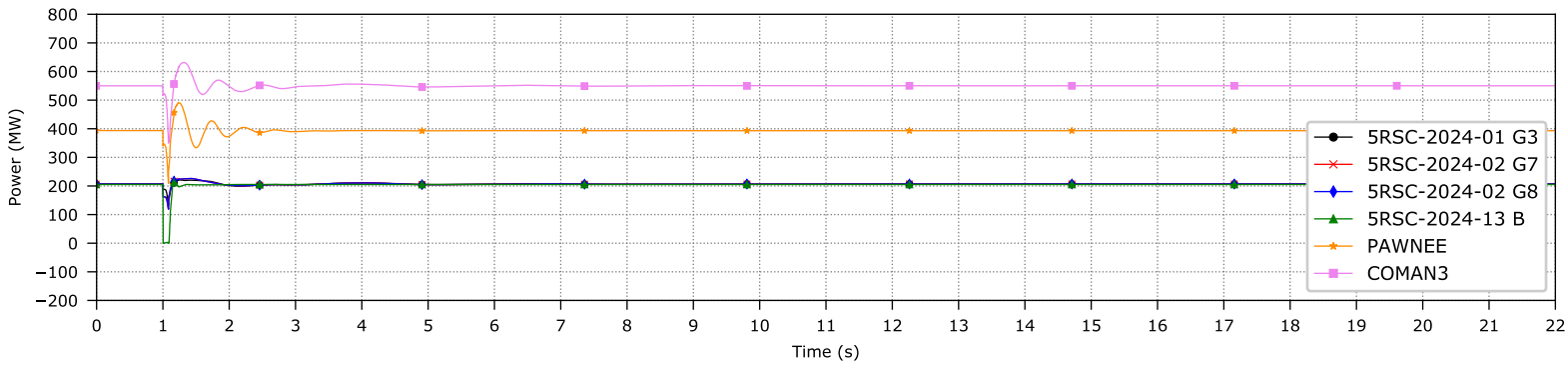


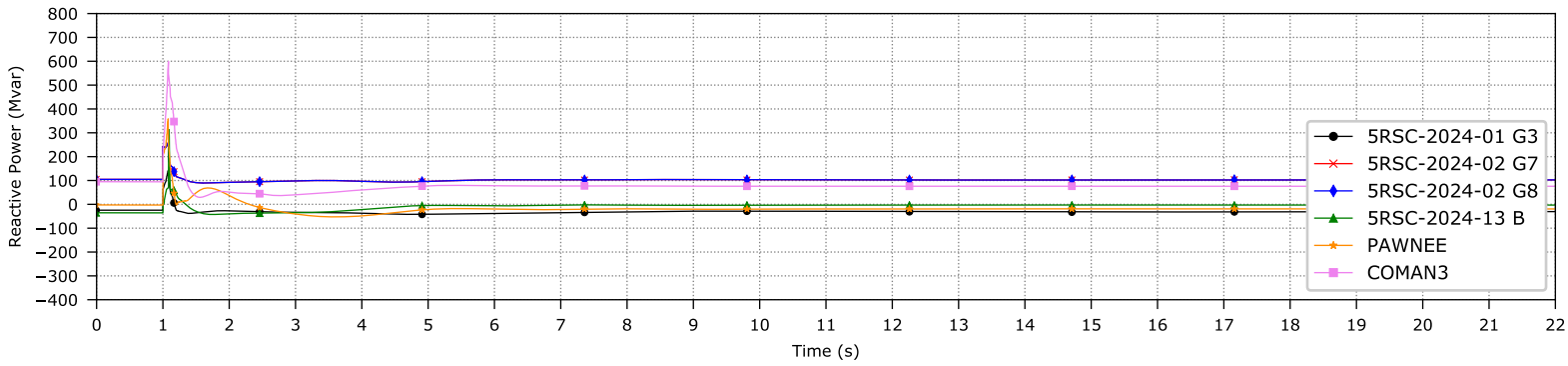


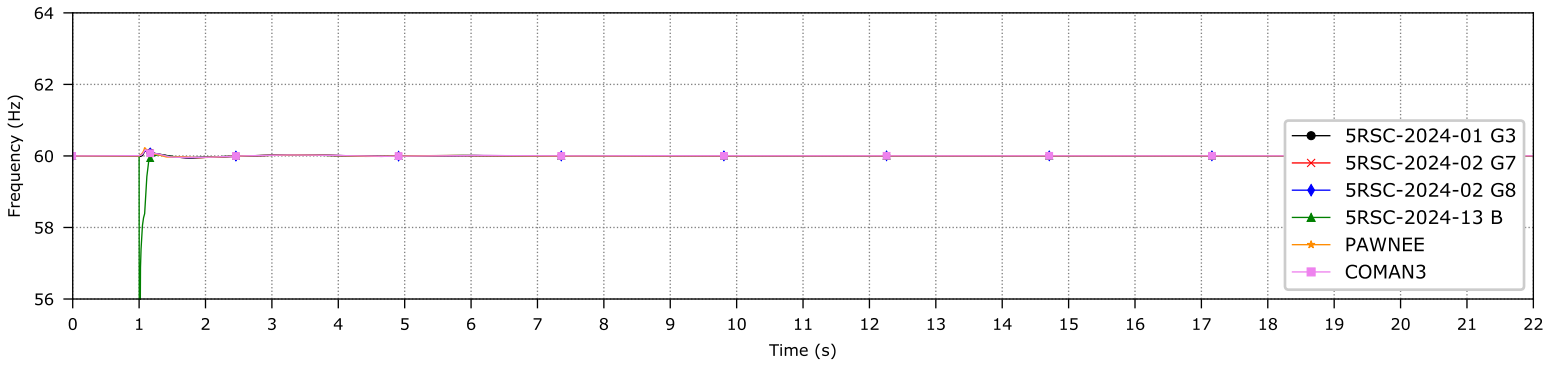


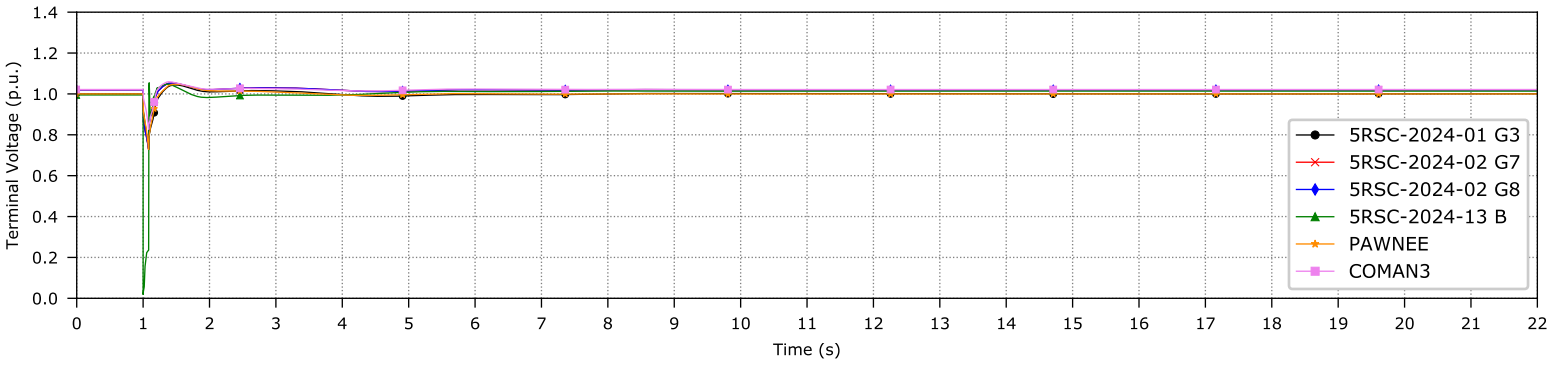
Ref. No. 13 - LoTC_140

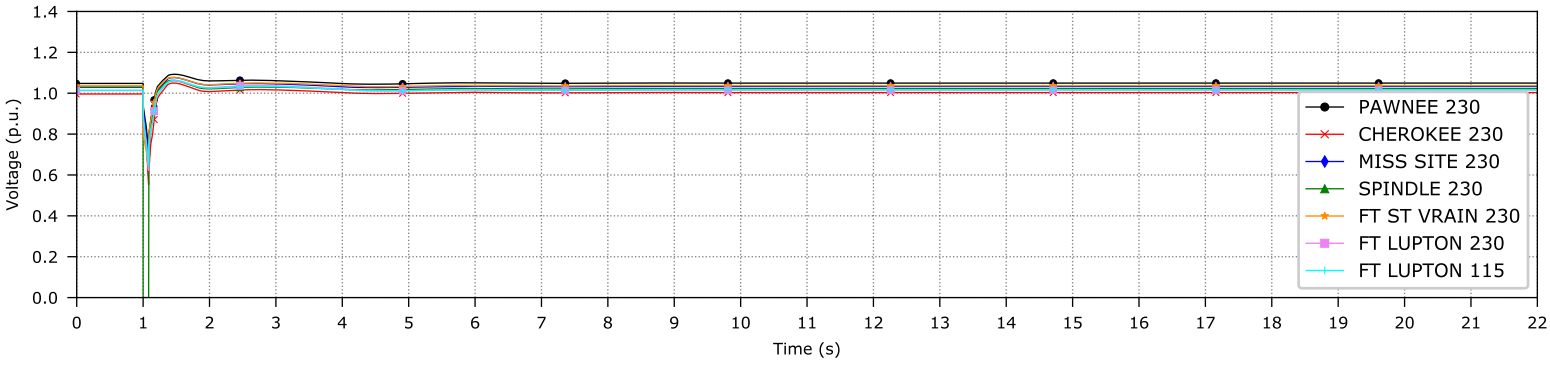




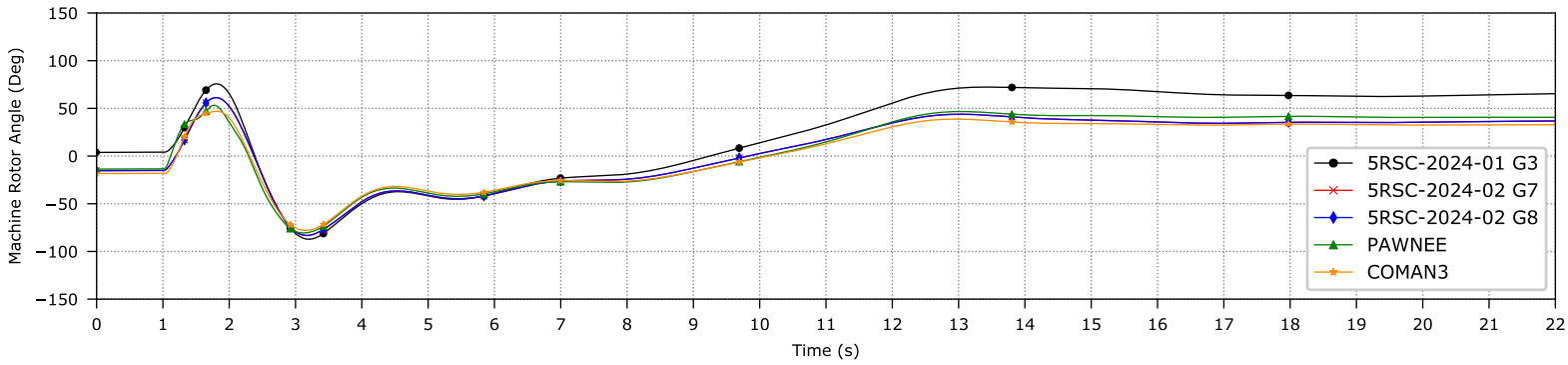


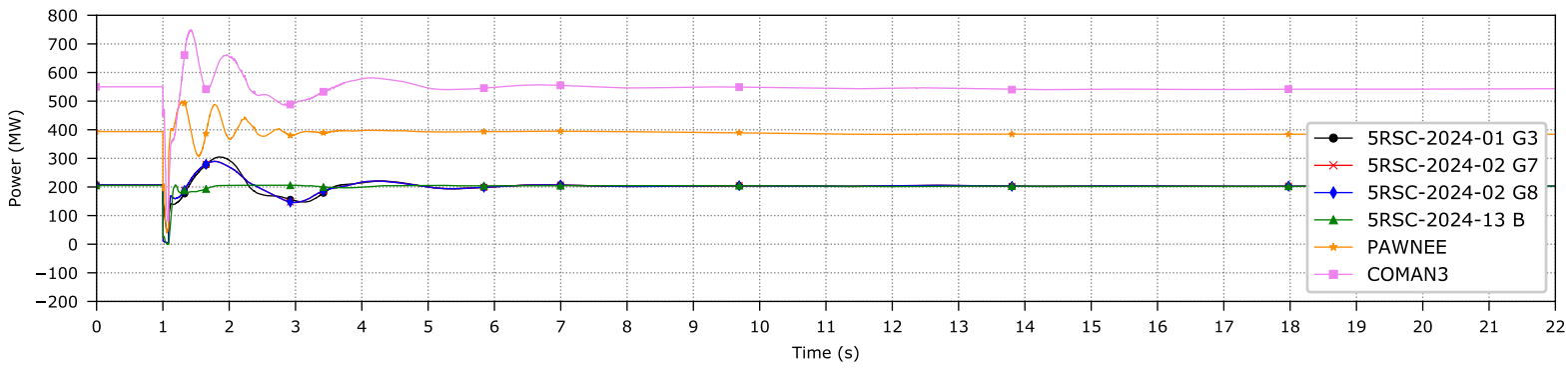


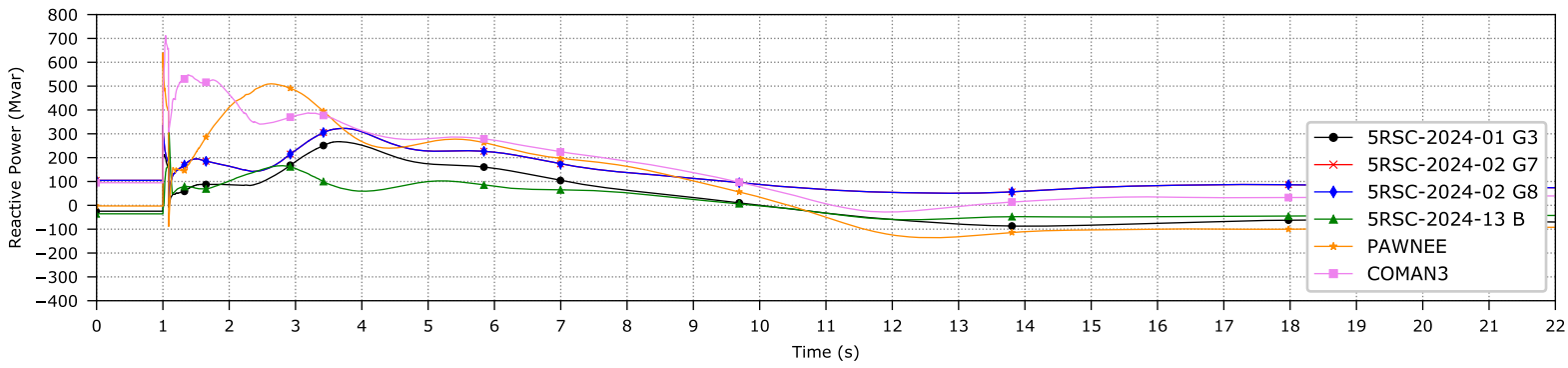


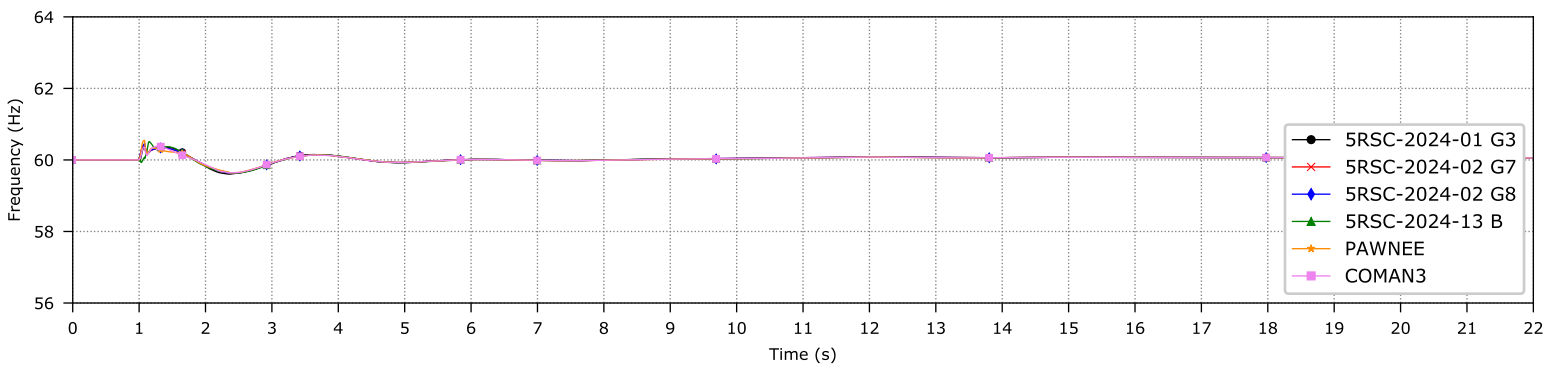


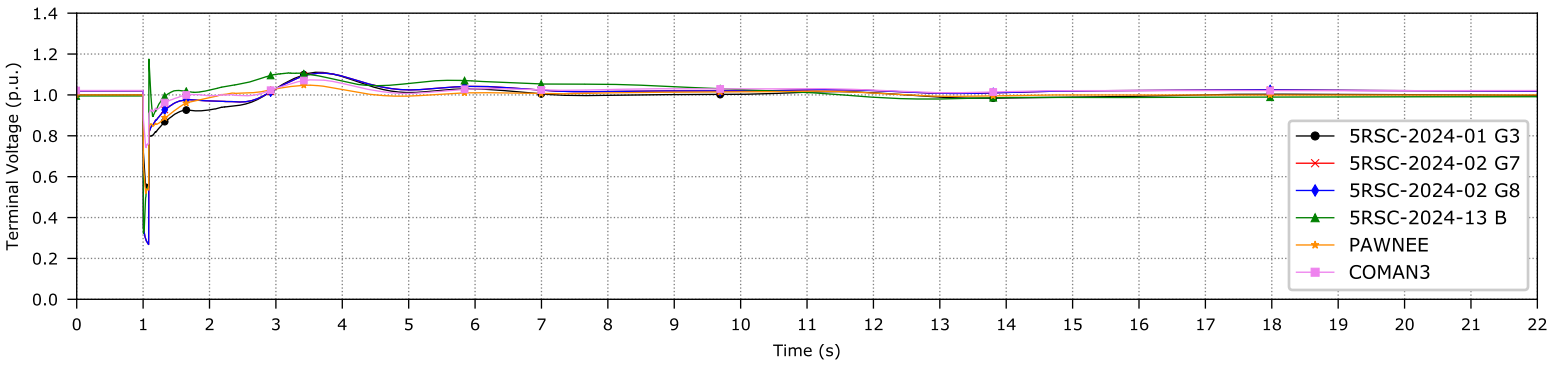
Ref. No. 14 - LoTC_141

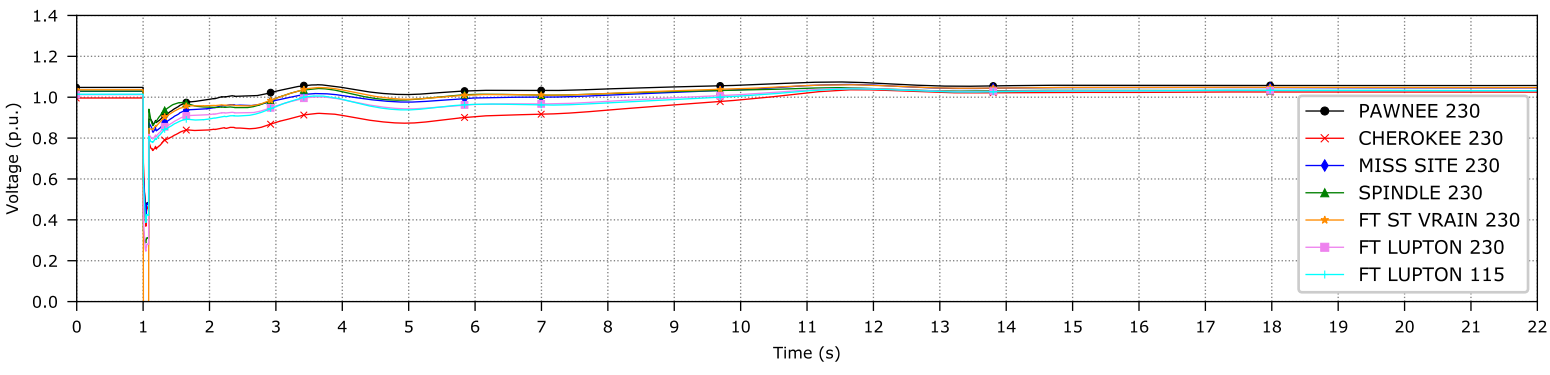




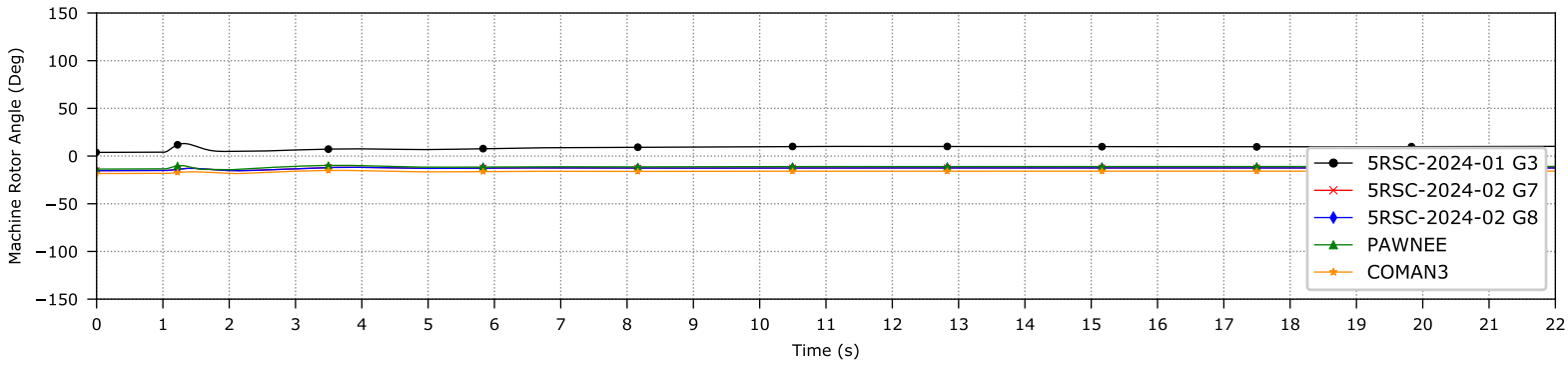


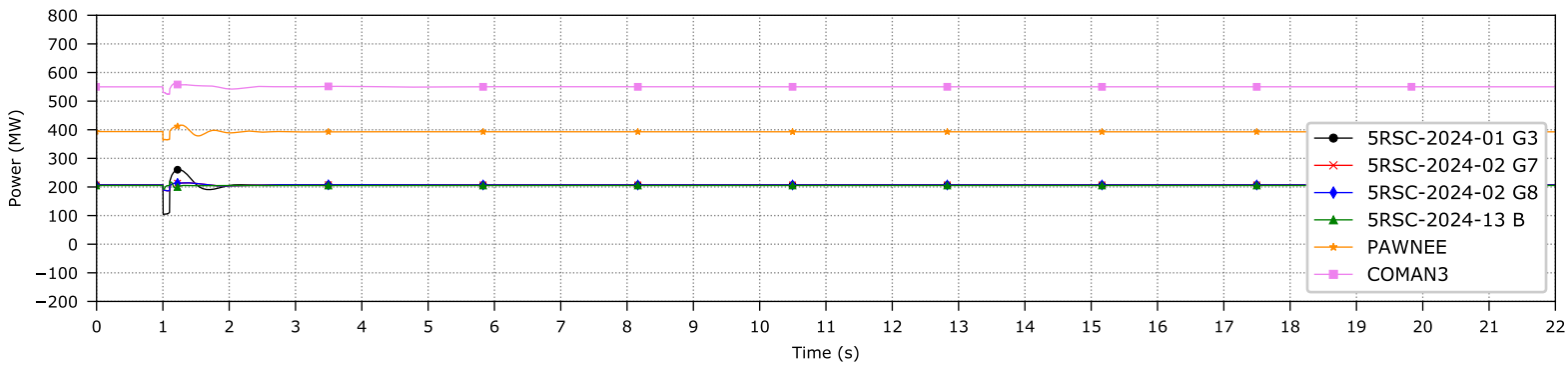


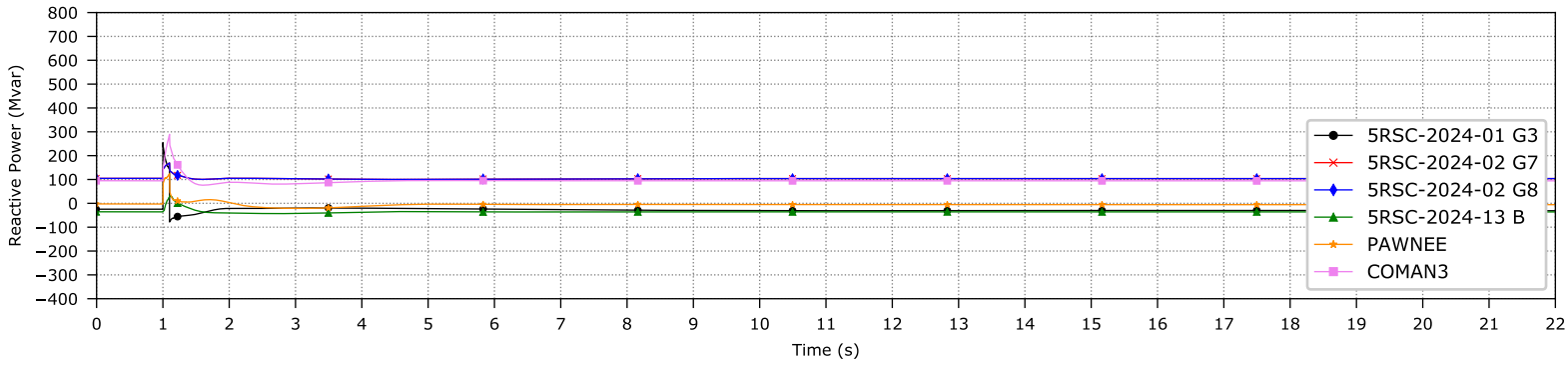


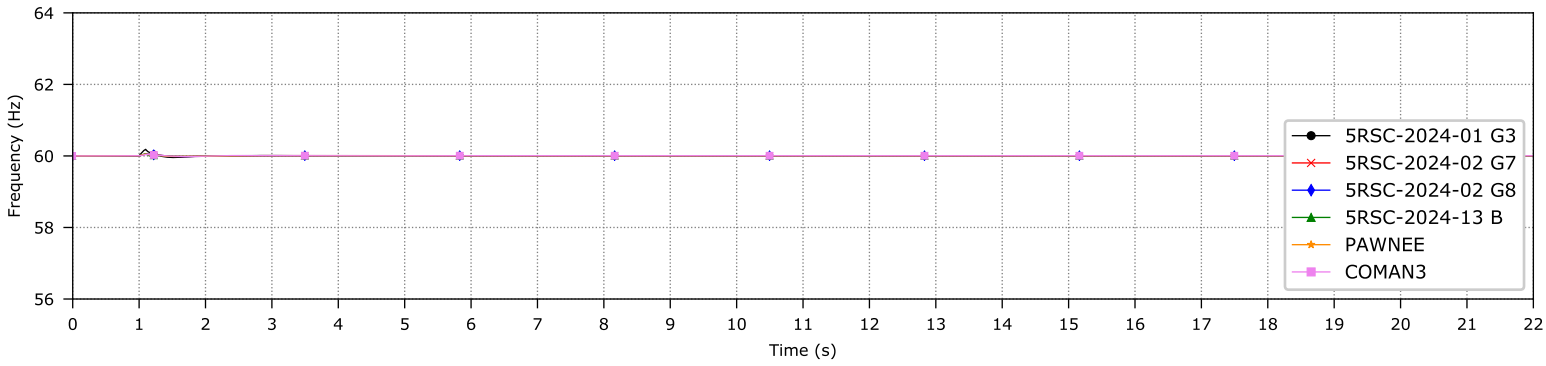


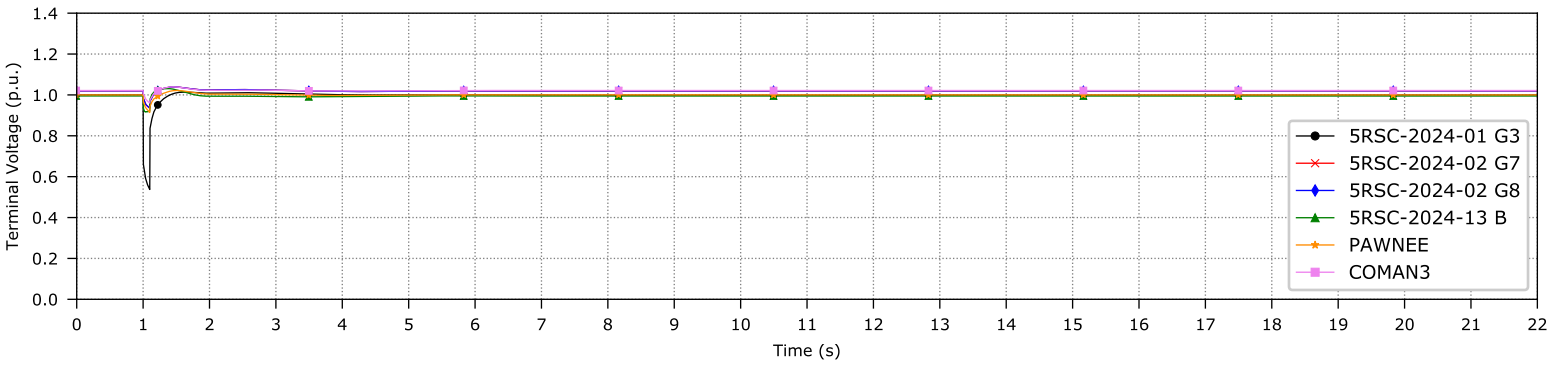
Ref. No. 15 - LoTC_195

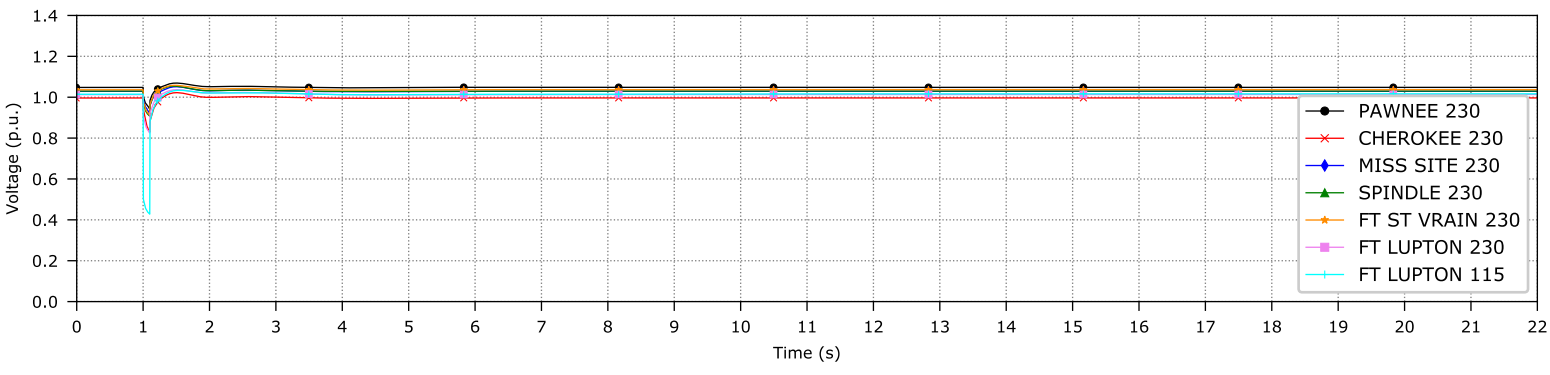




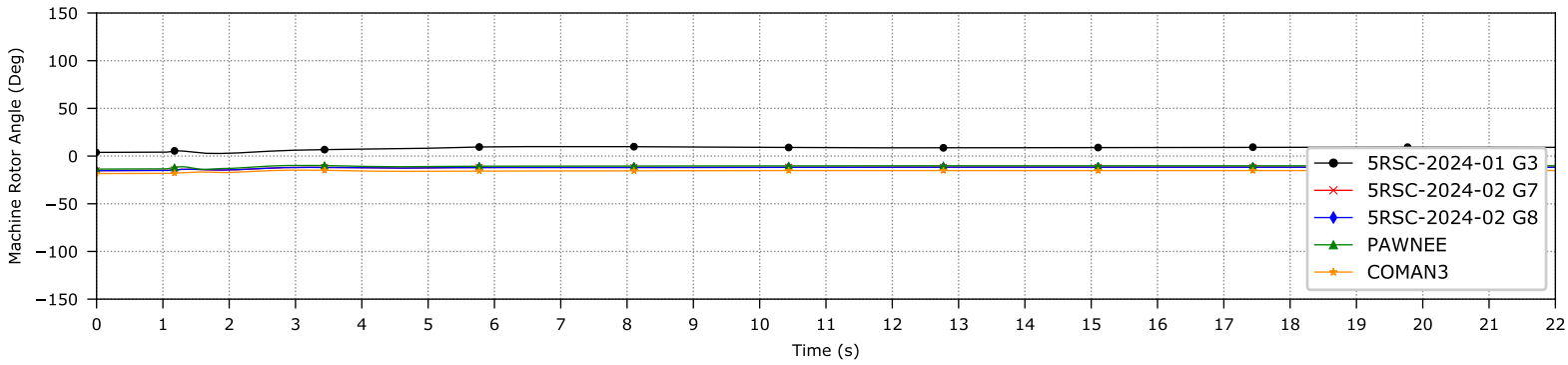


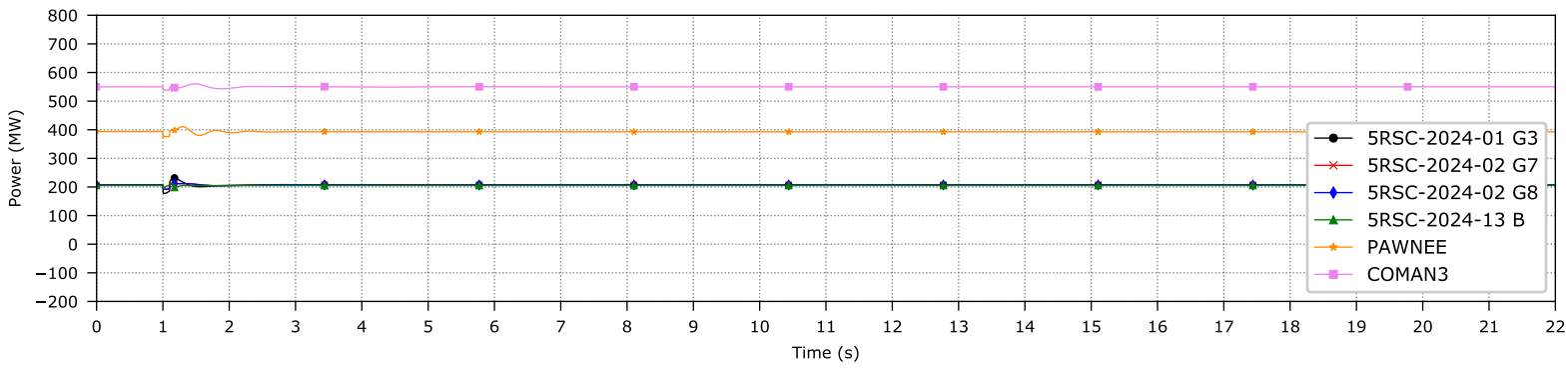


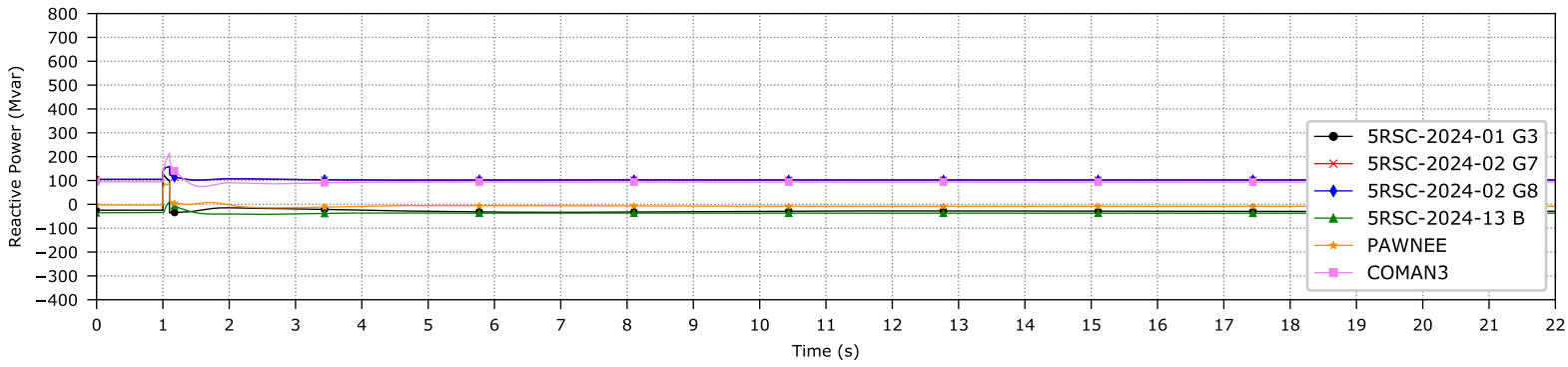


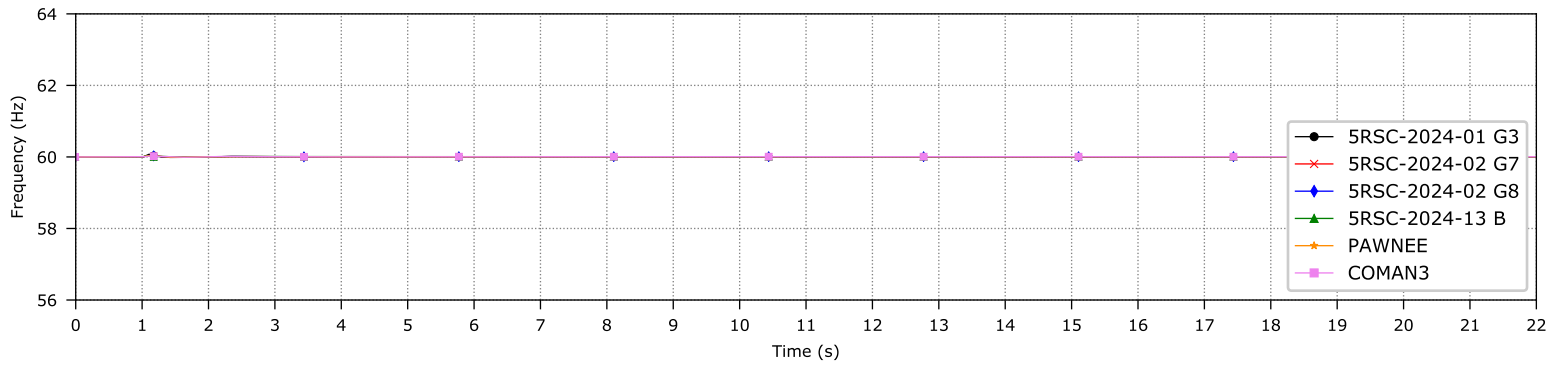


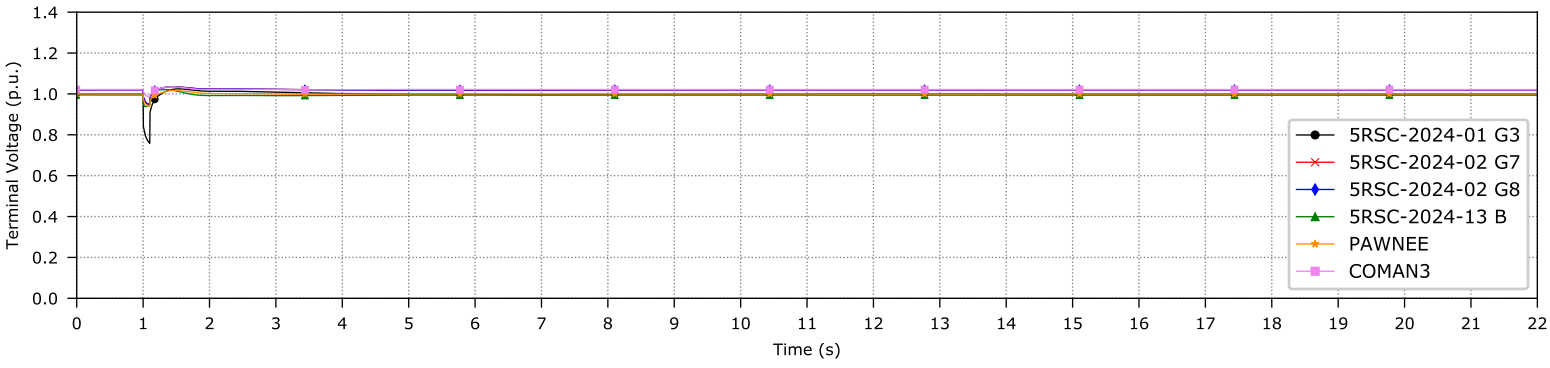
Ref. No. 16 - LoTC_237

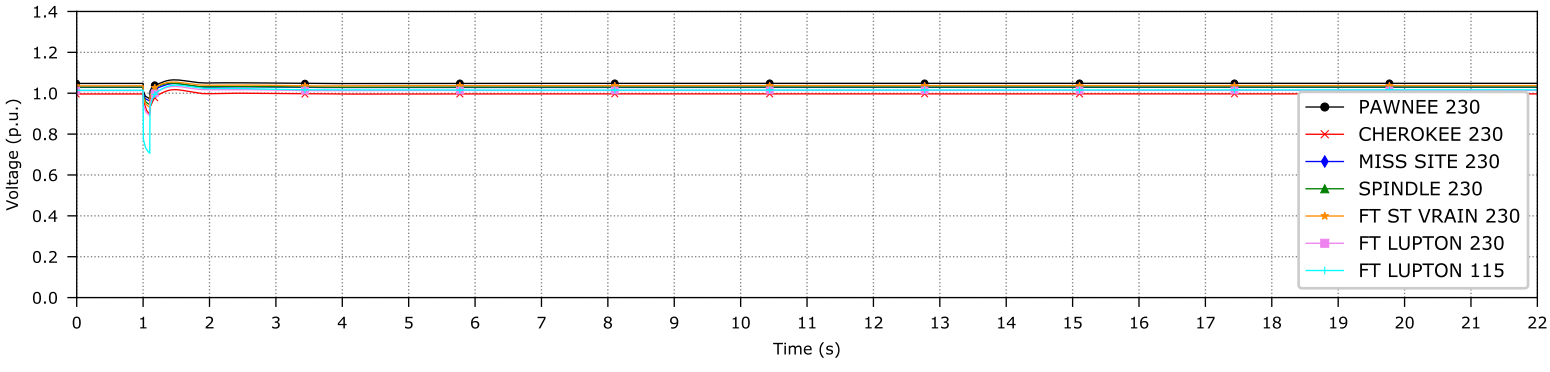




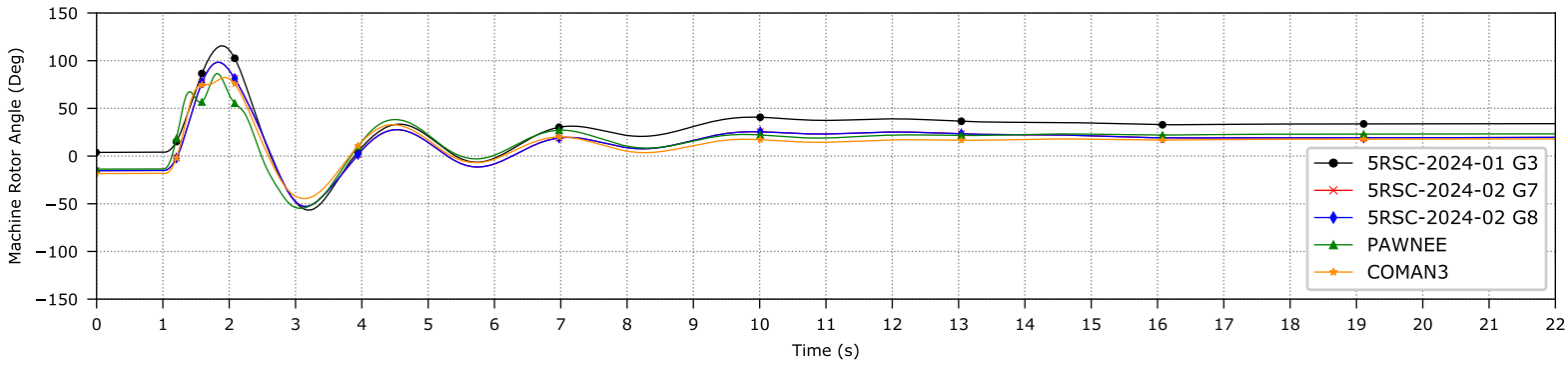


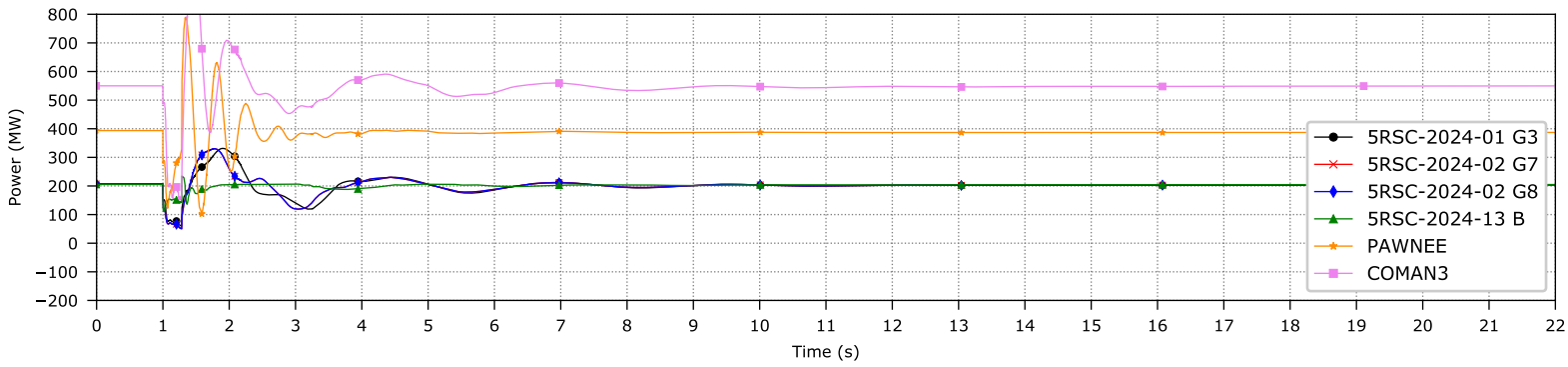


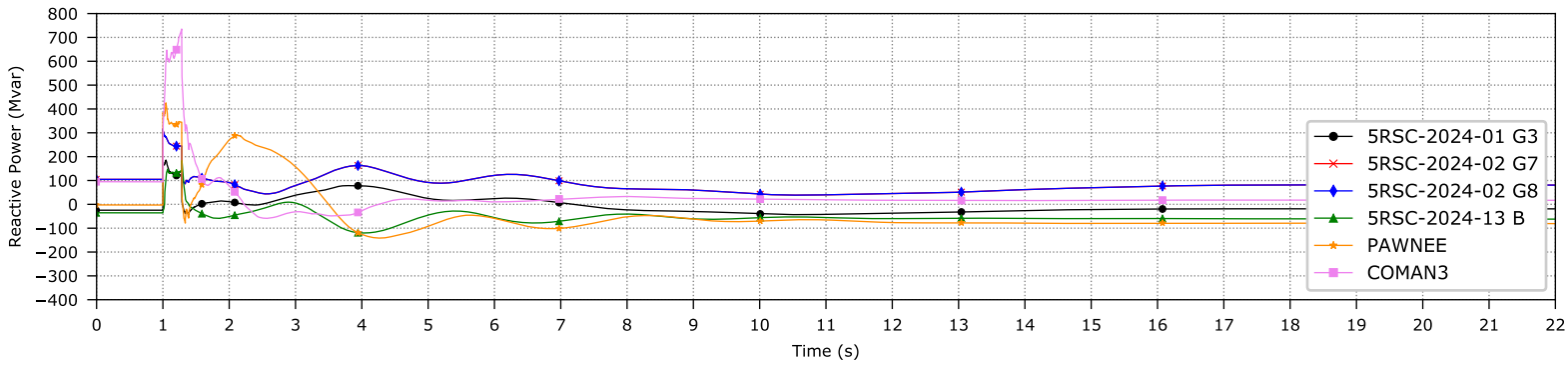


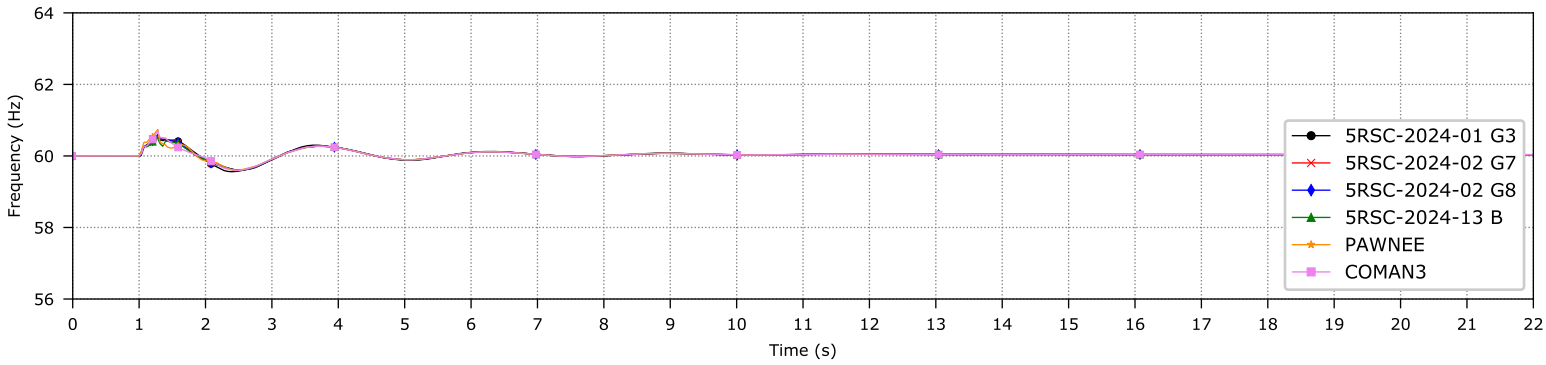


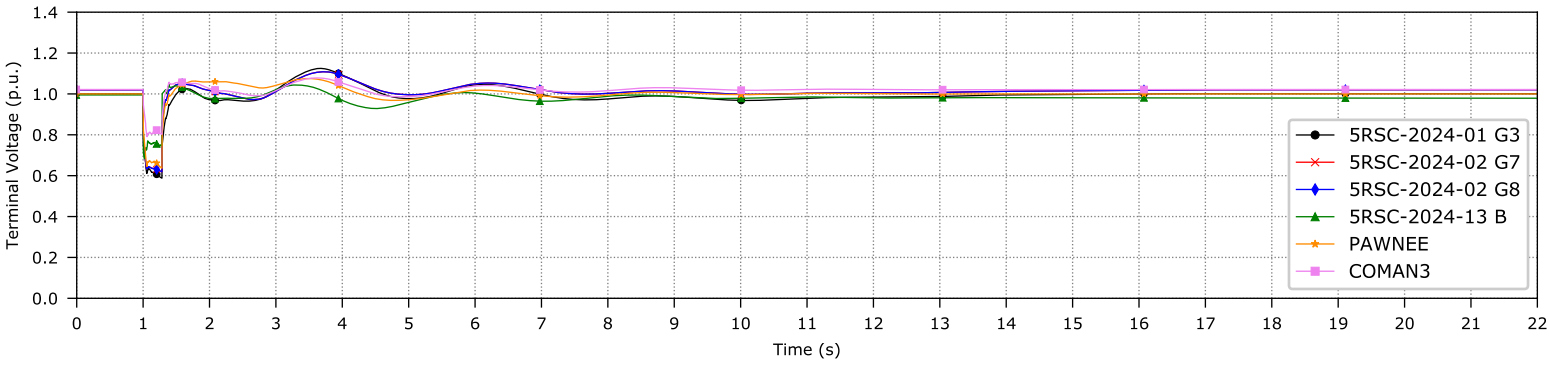
Ref. No. 17 - BF_057a

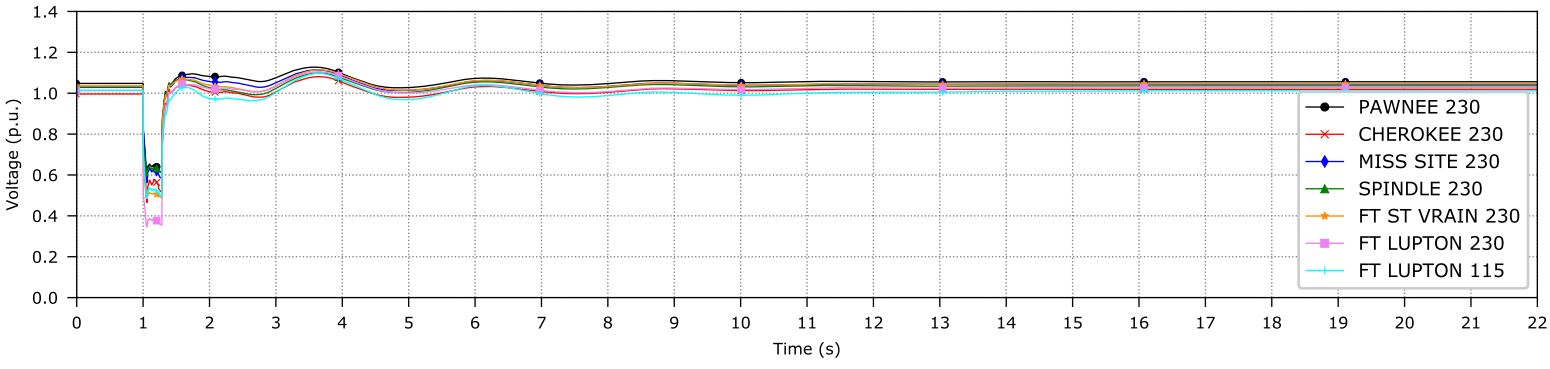




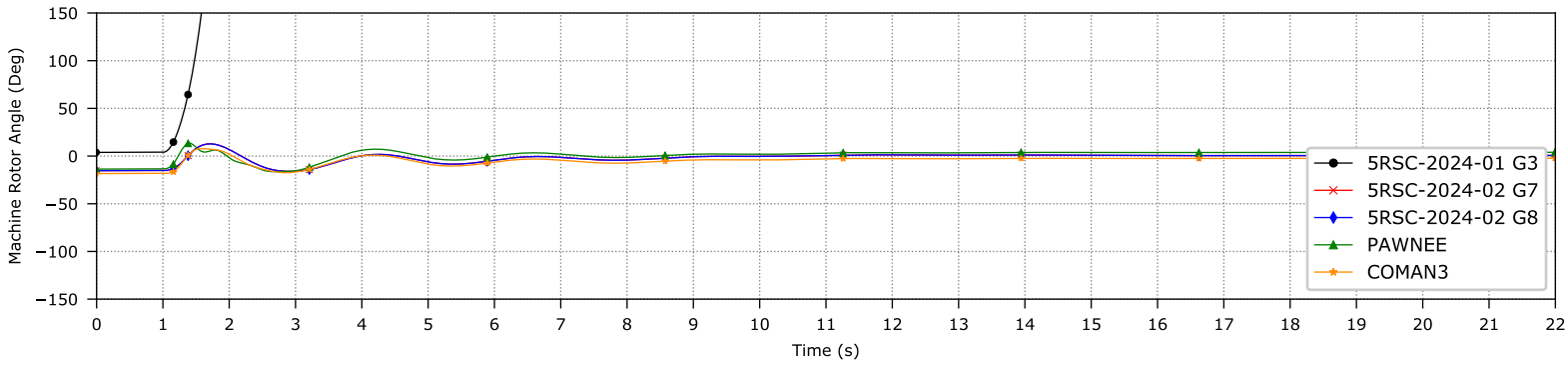


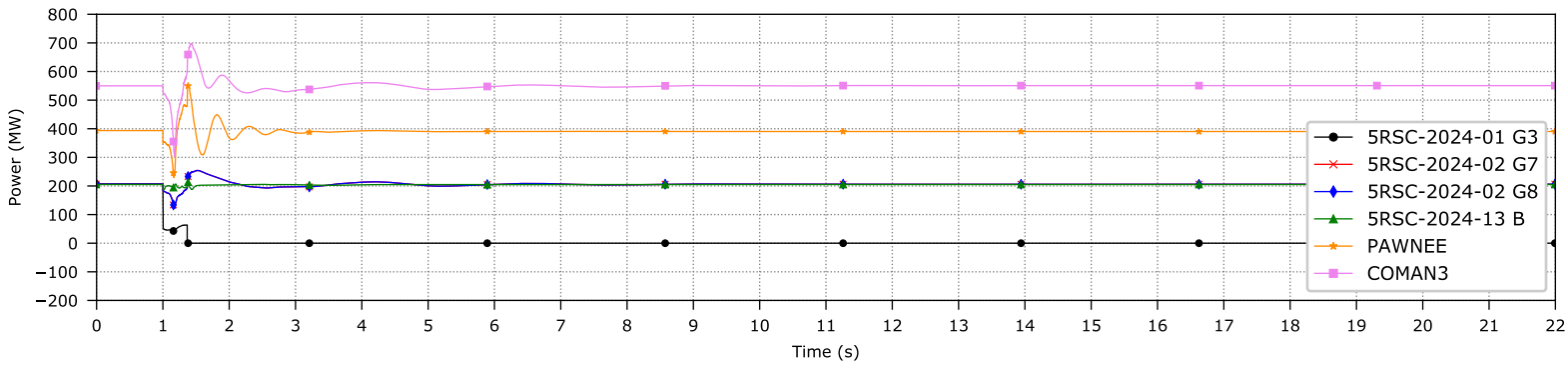


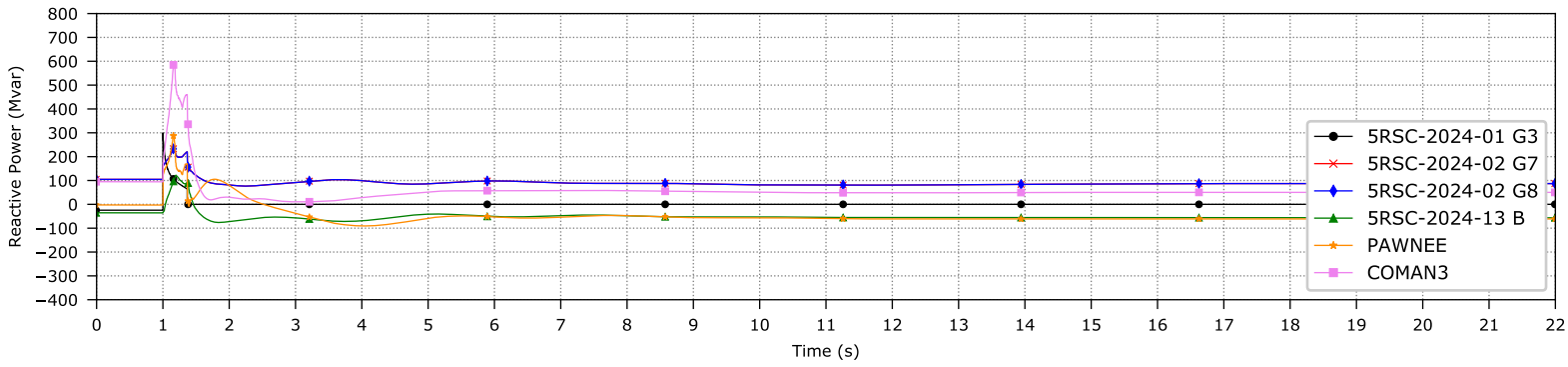


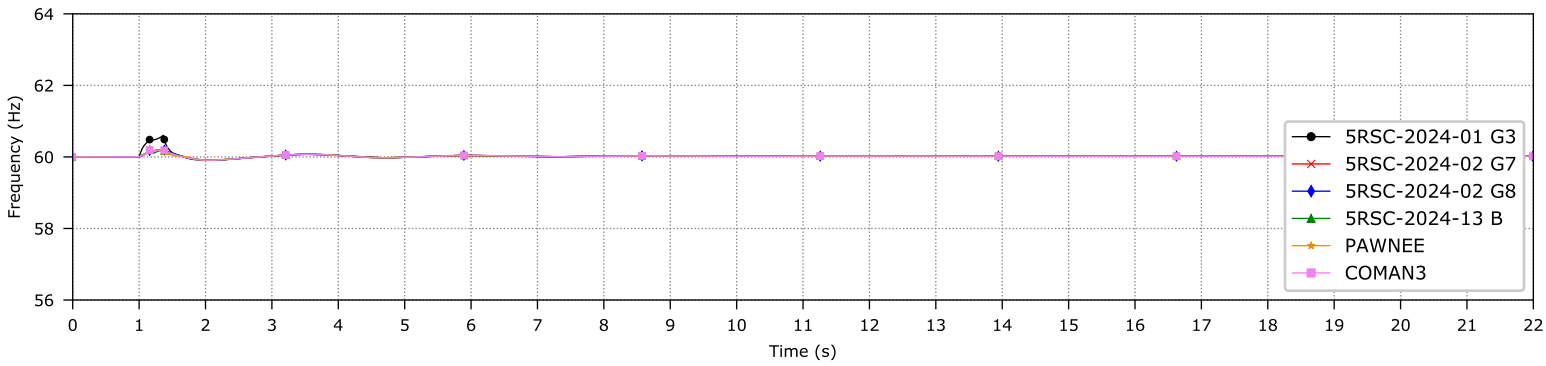


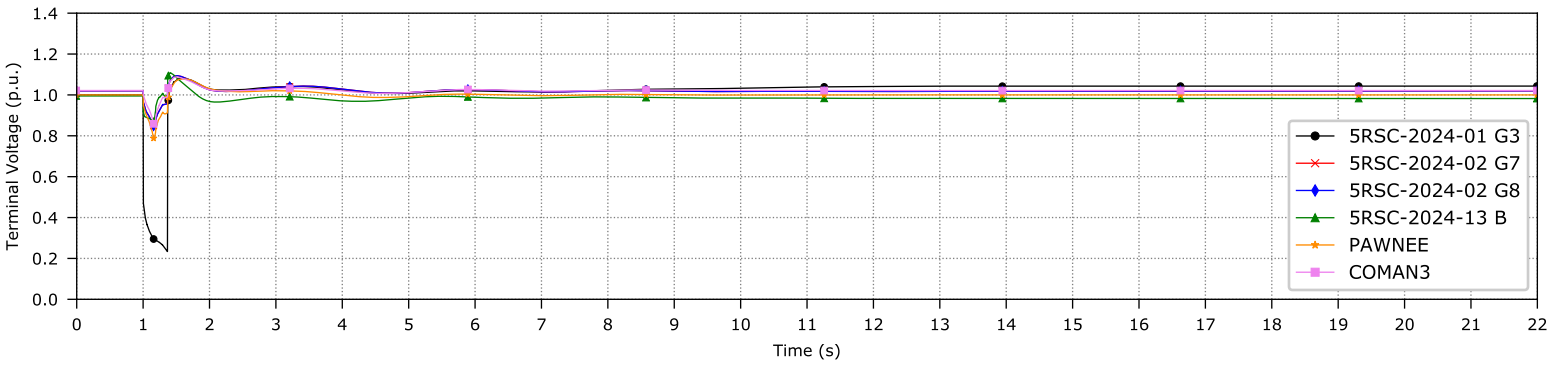
Ref. No. 18 - BF_057d

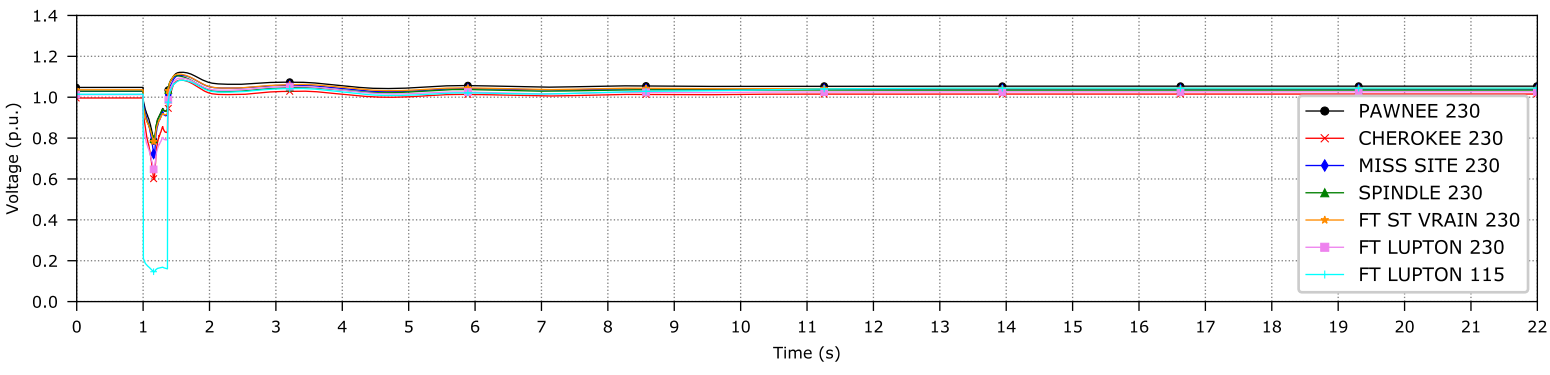












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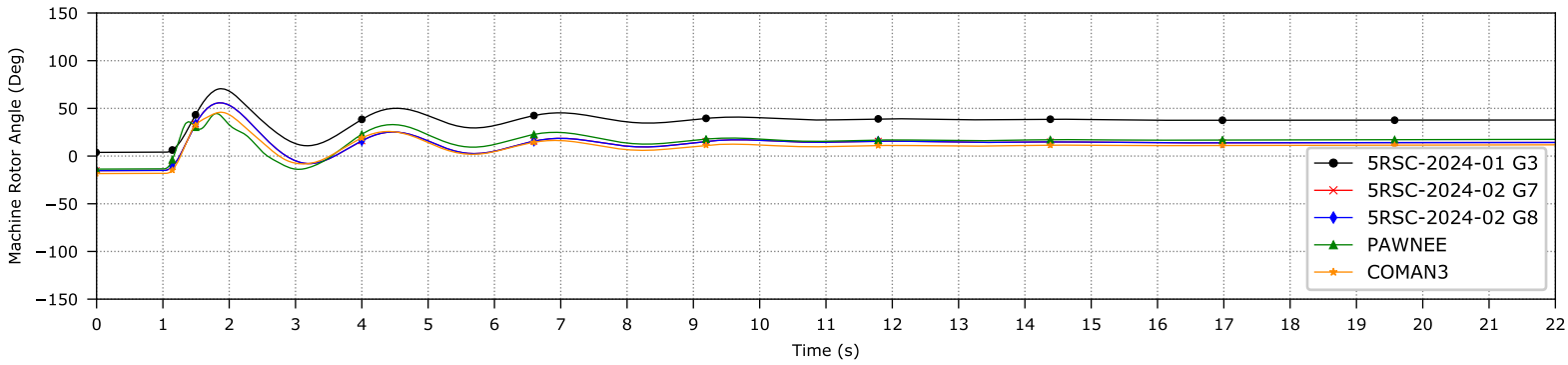
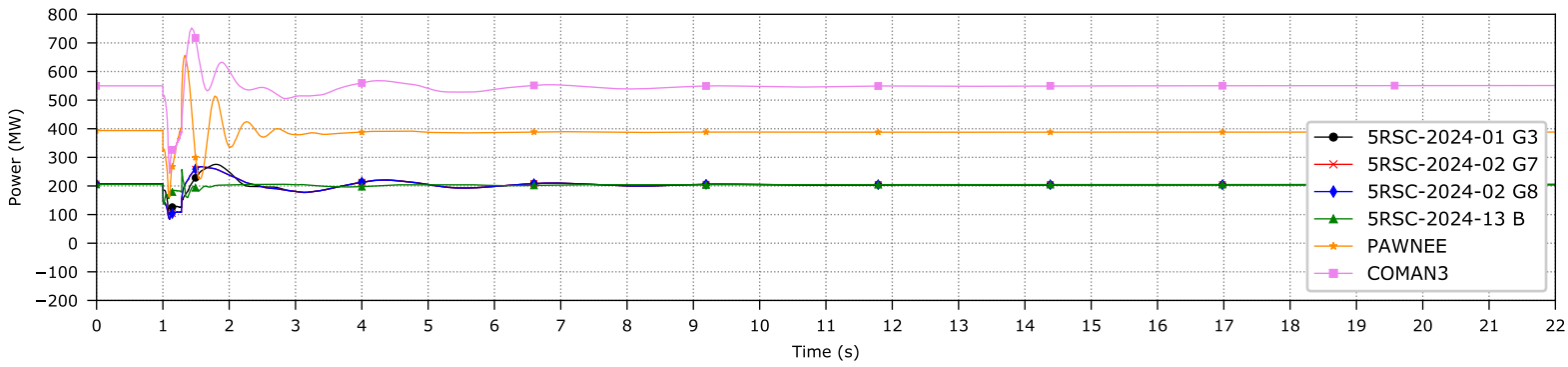
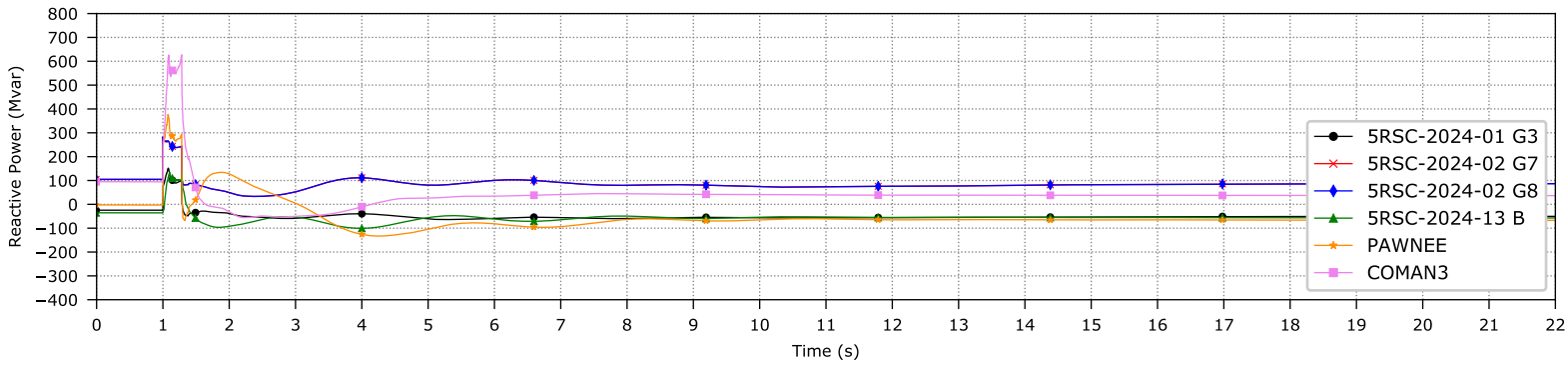
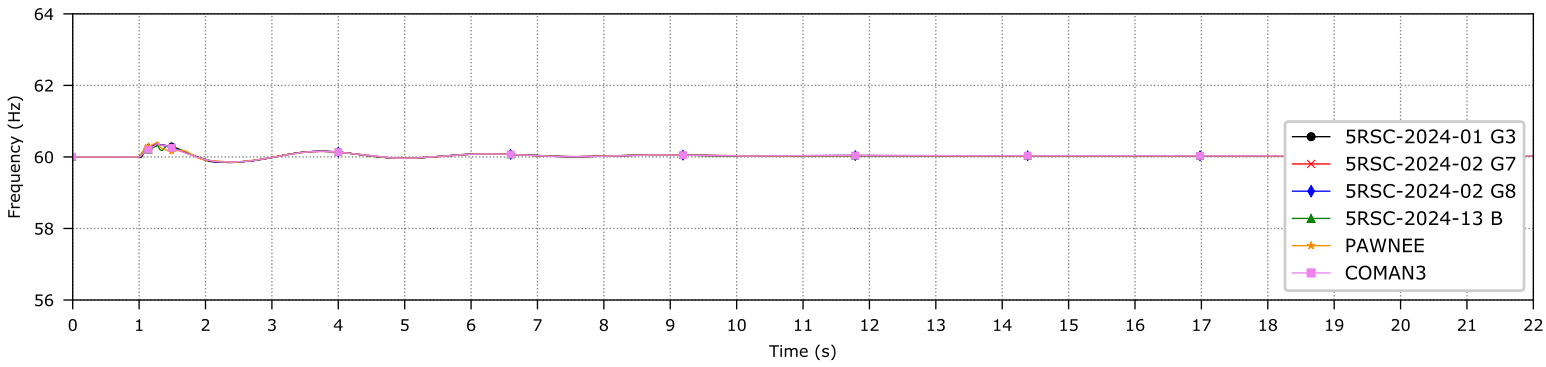
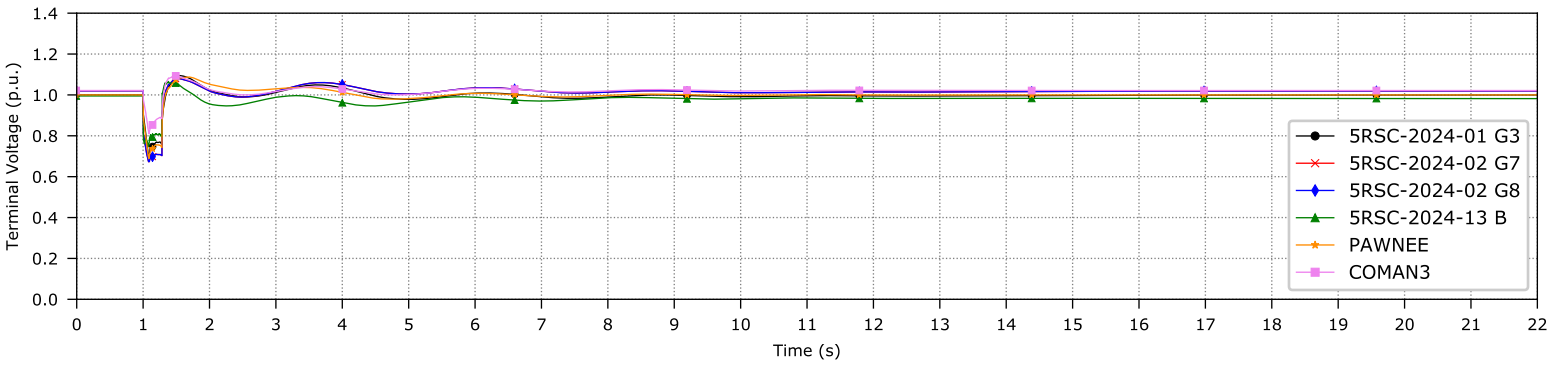
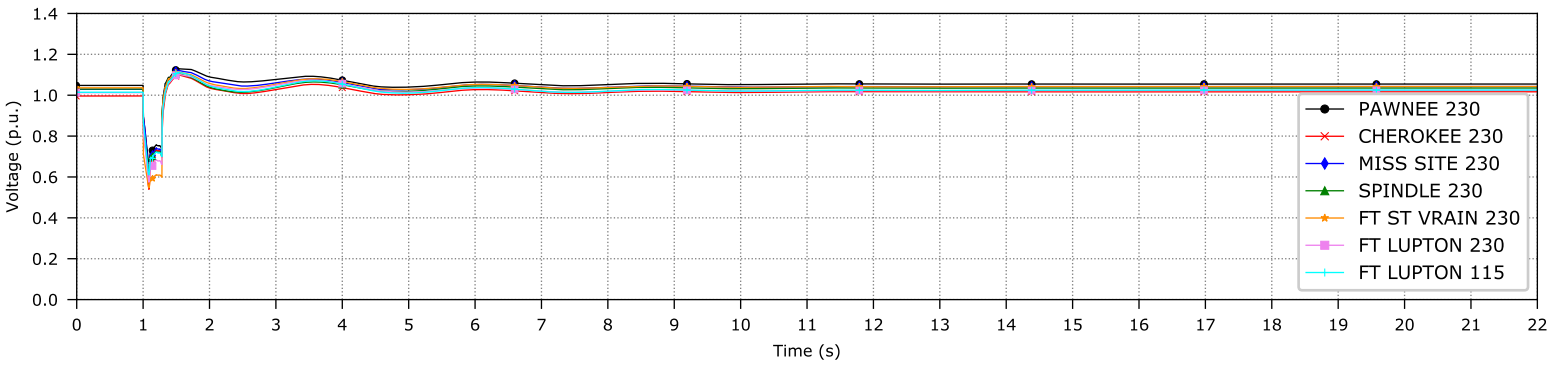




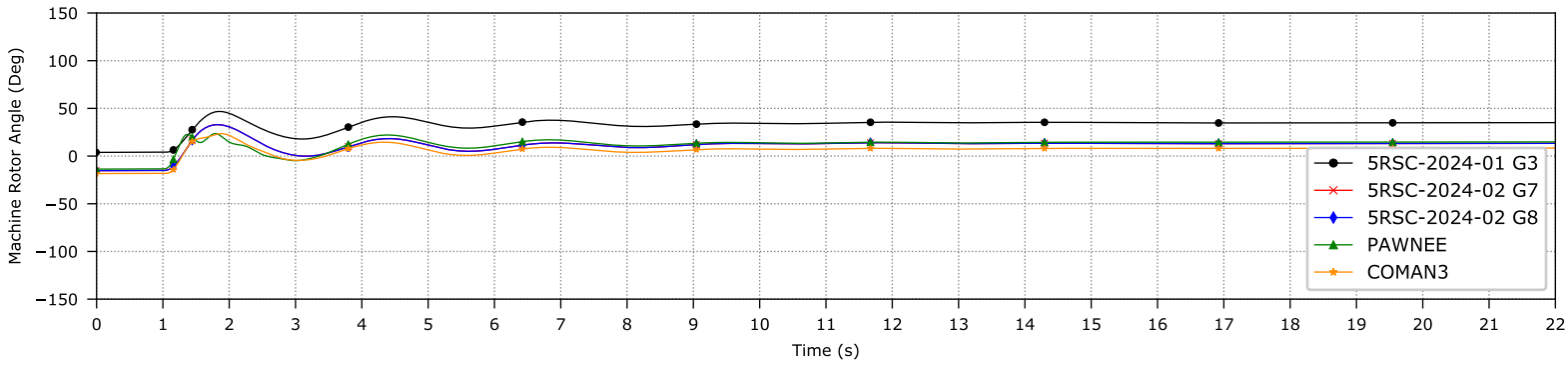


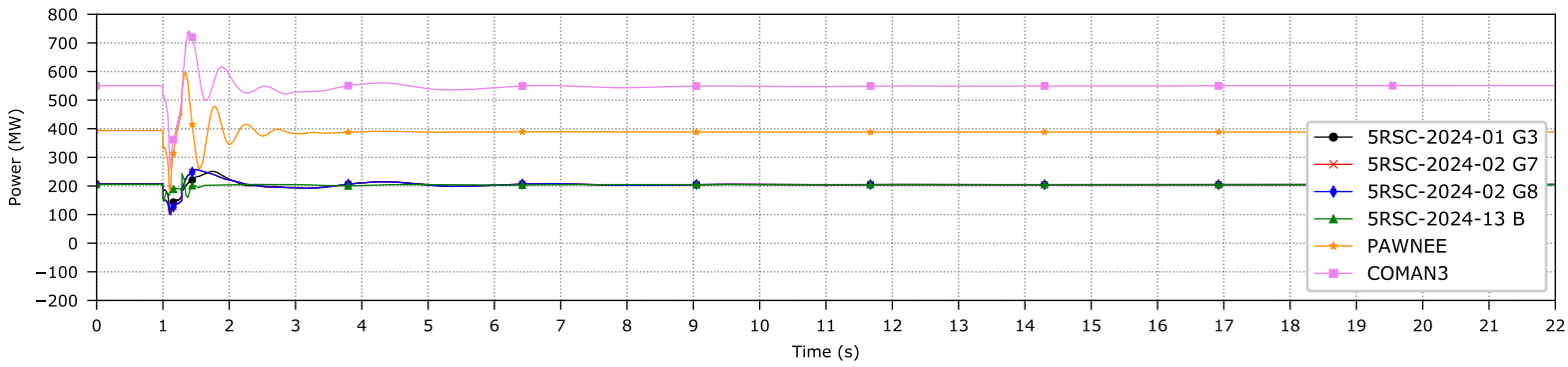


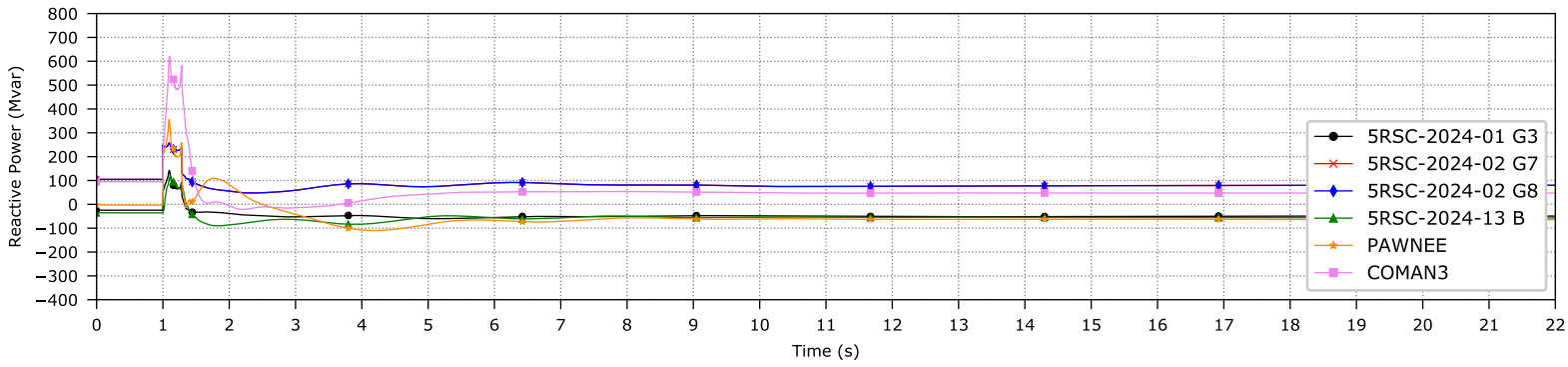


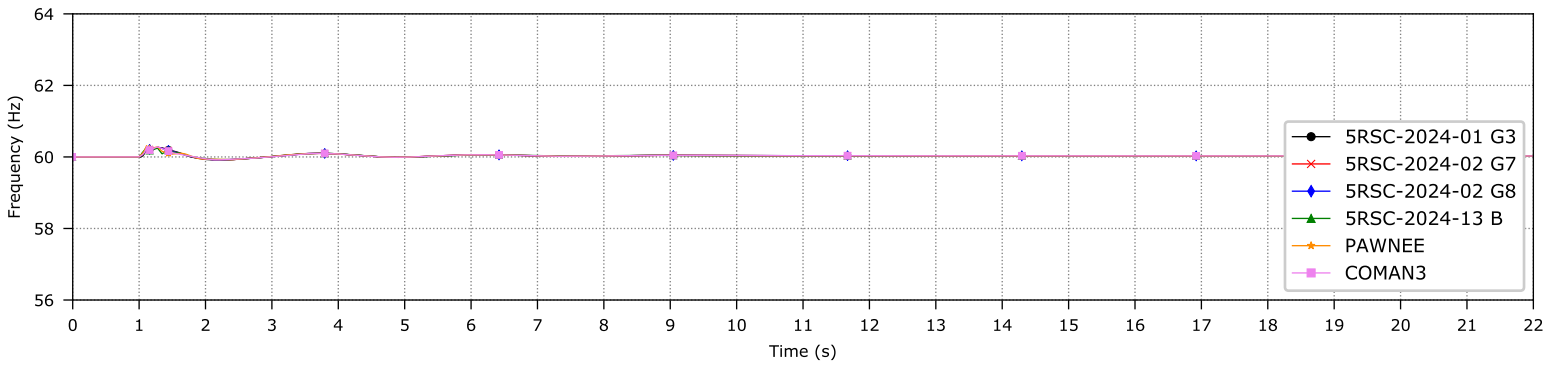


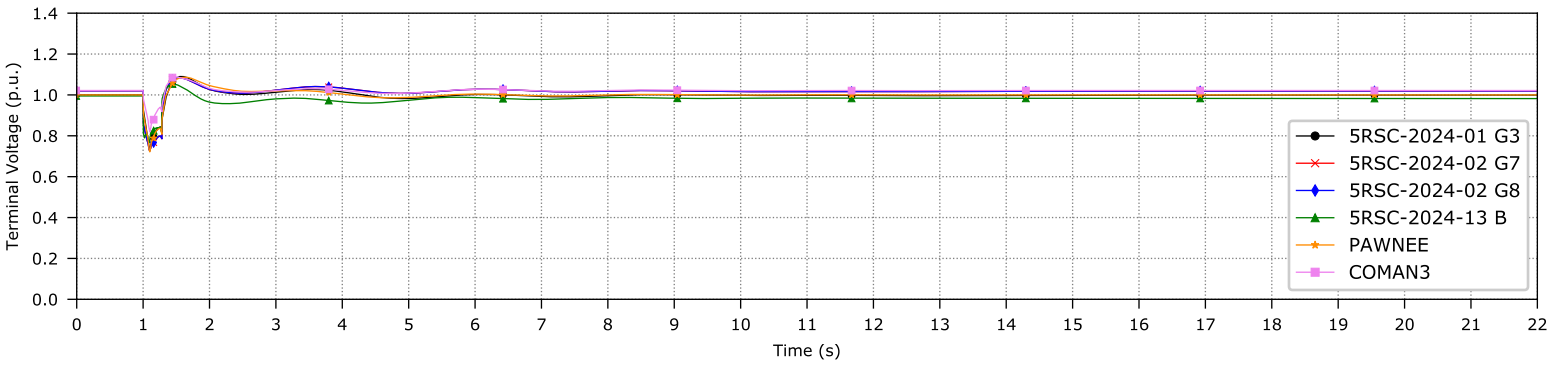
Ref. No. 20 - BF_058c

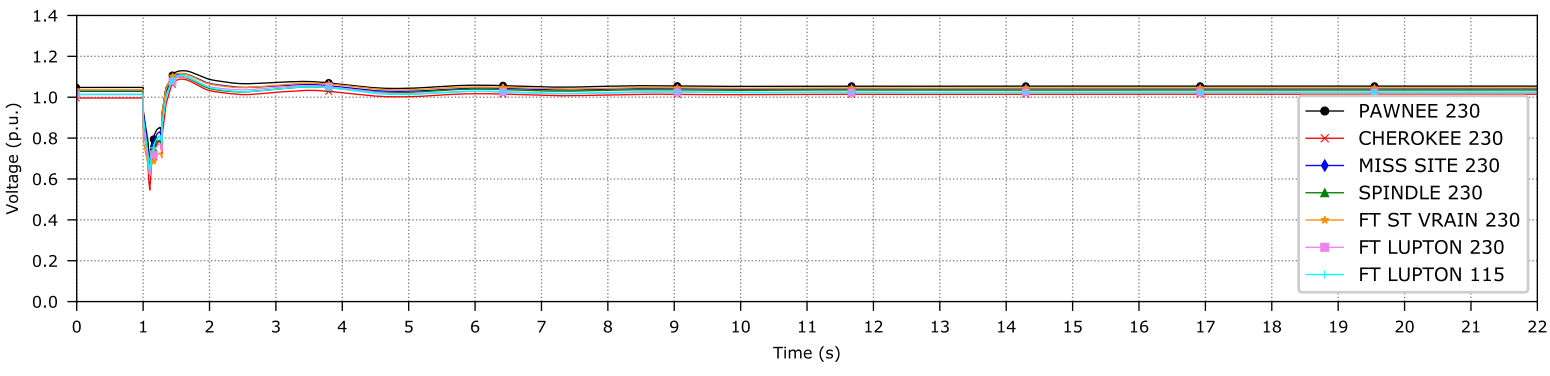




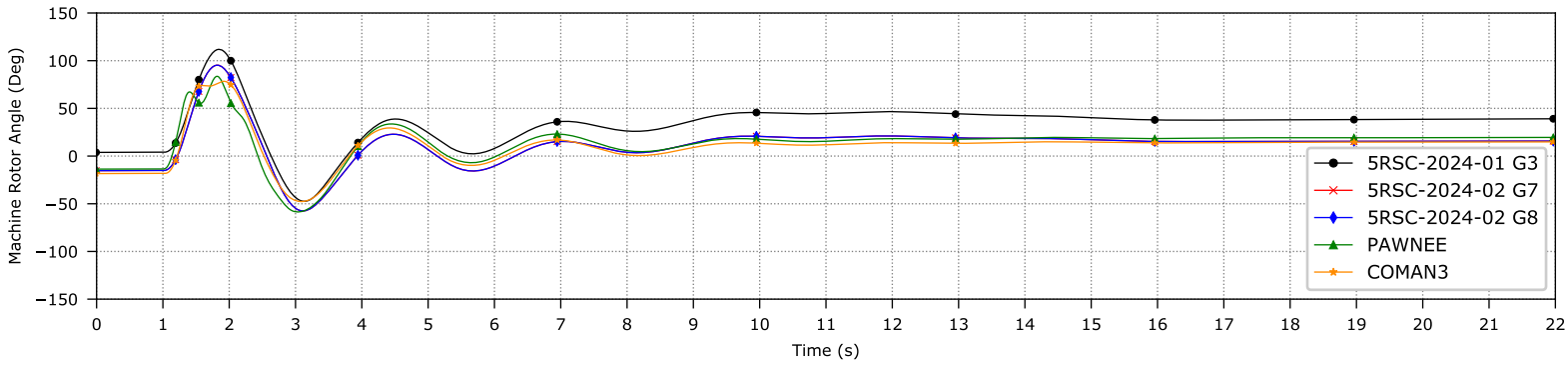


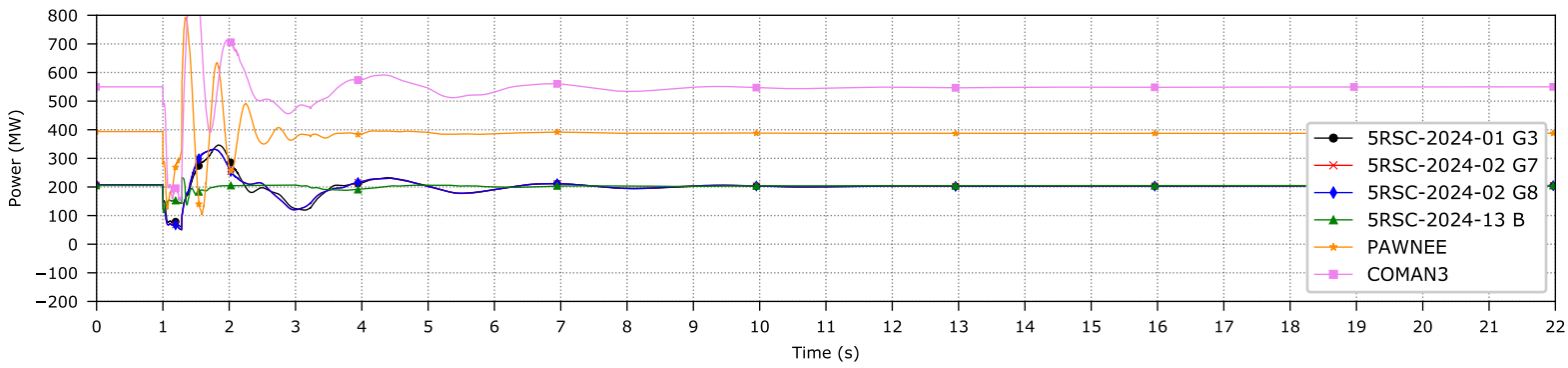


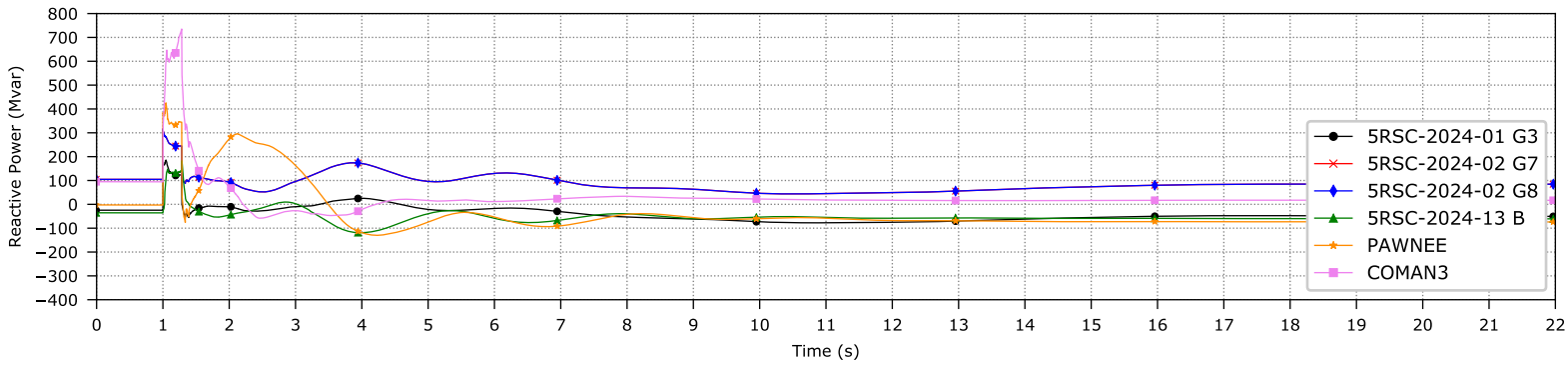


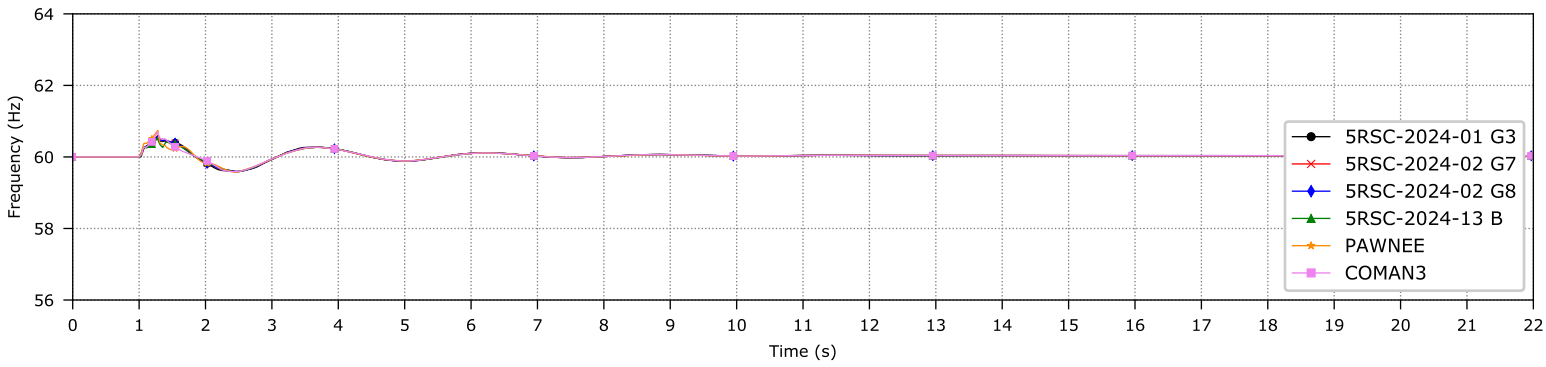


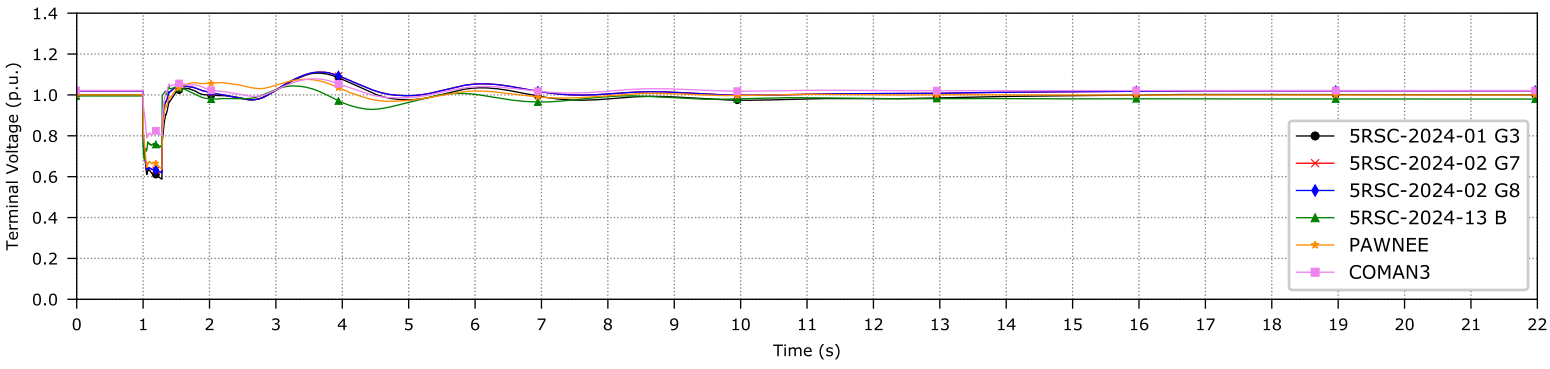
Ref. No. 21 - BF_058d

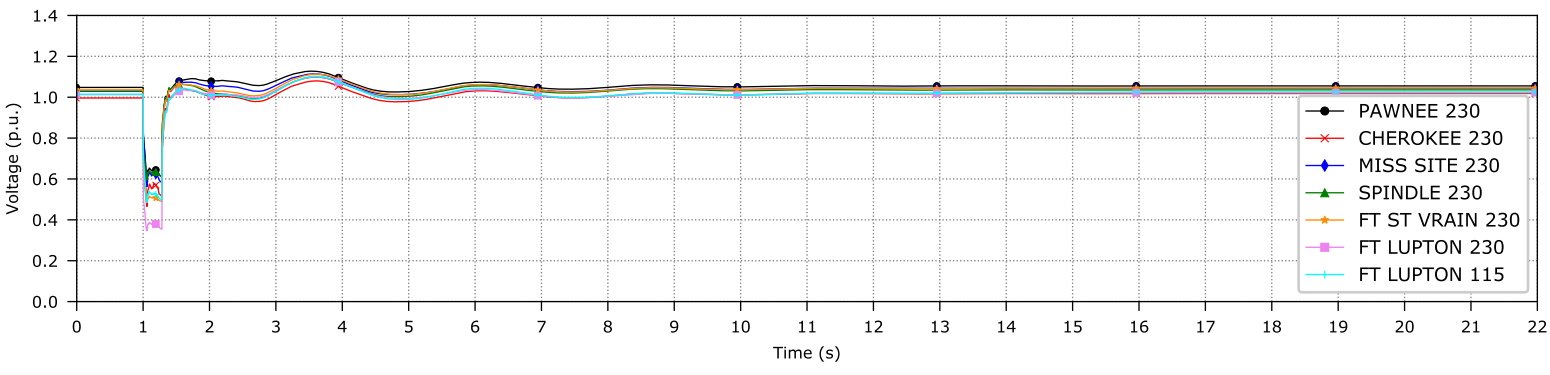




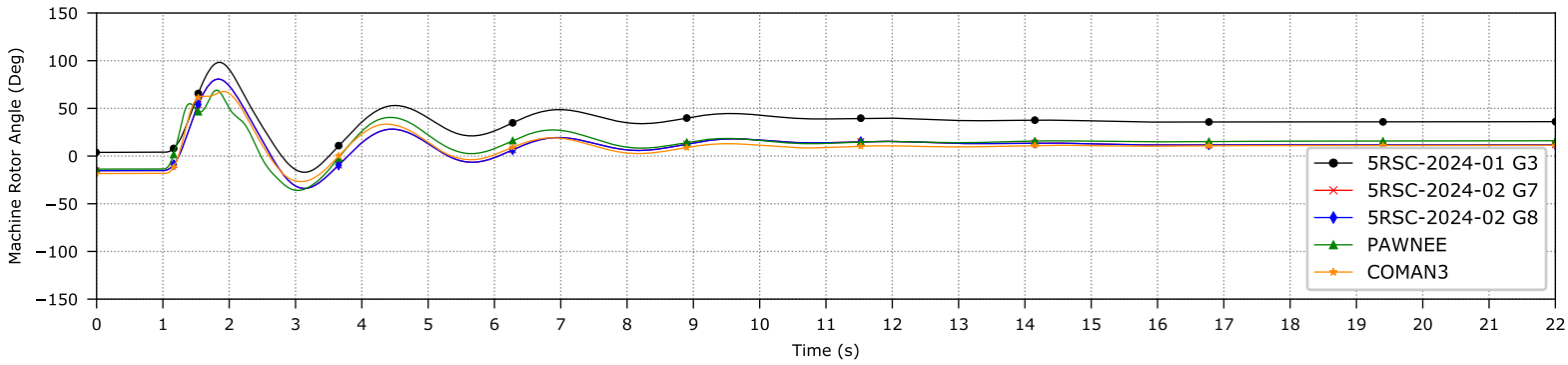


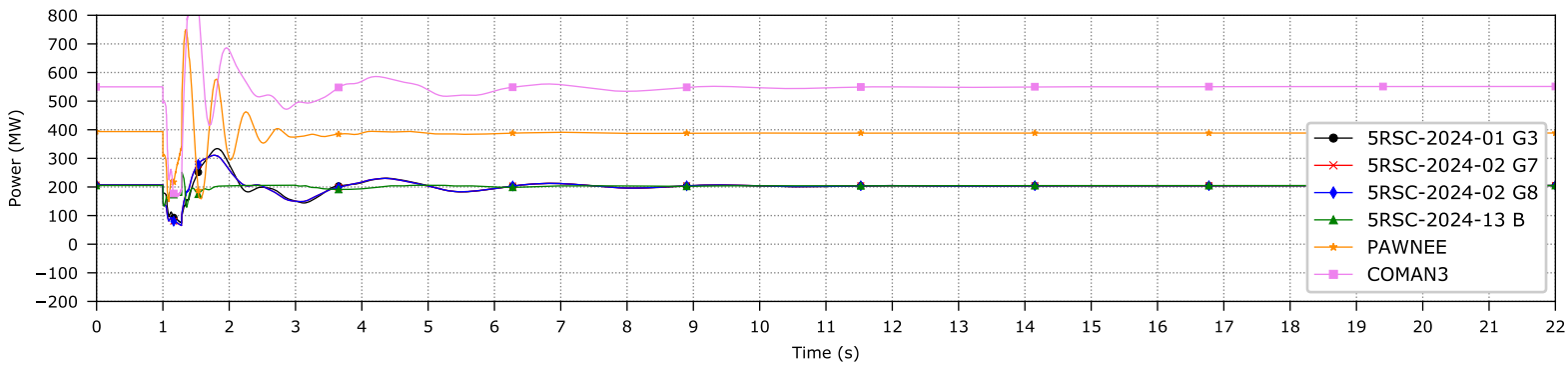


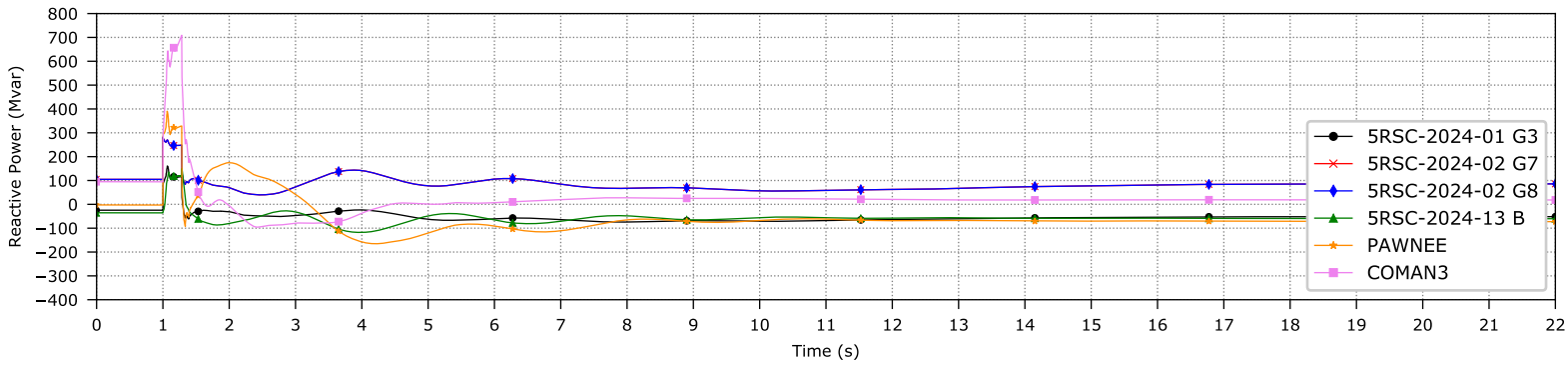


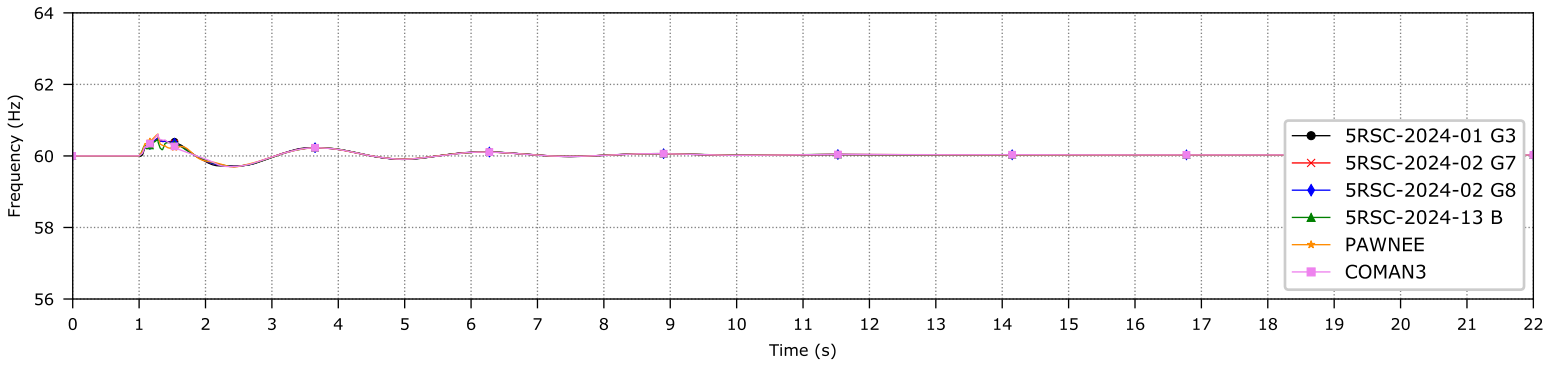


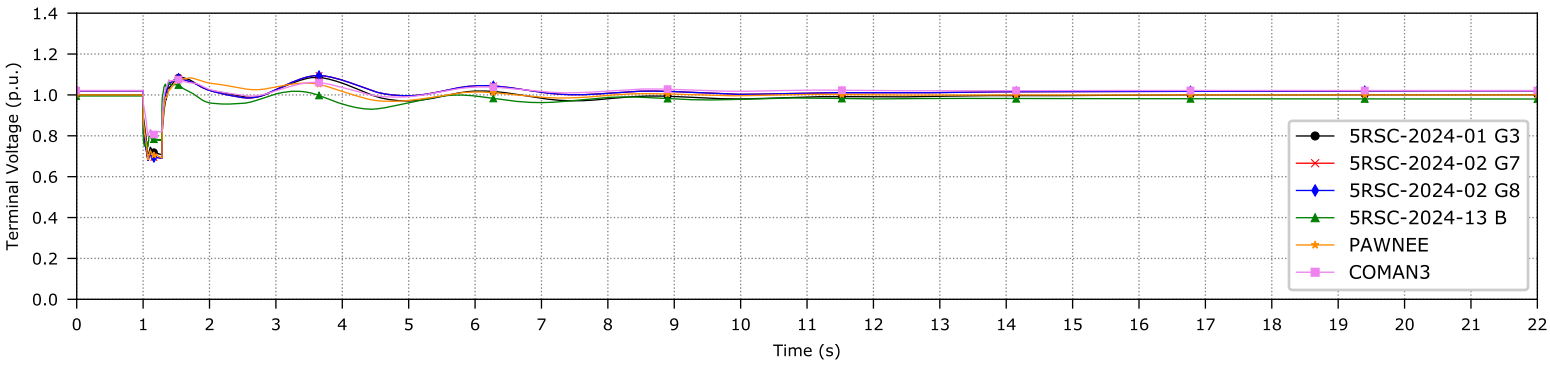
Ref. No. 22 - BF_058e

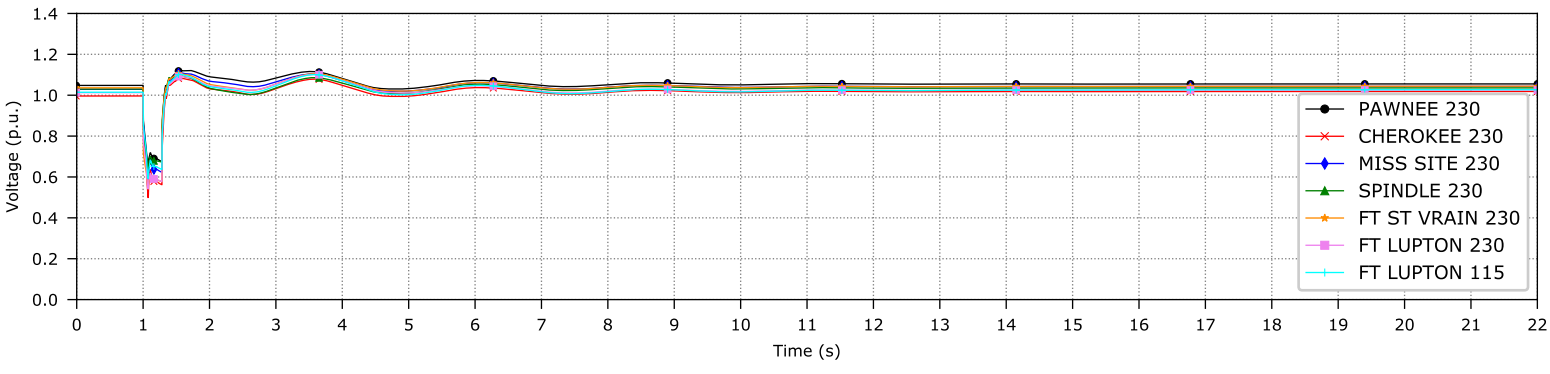




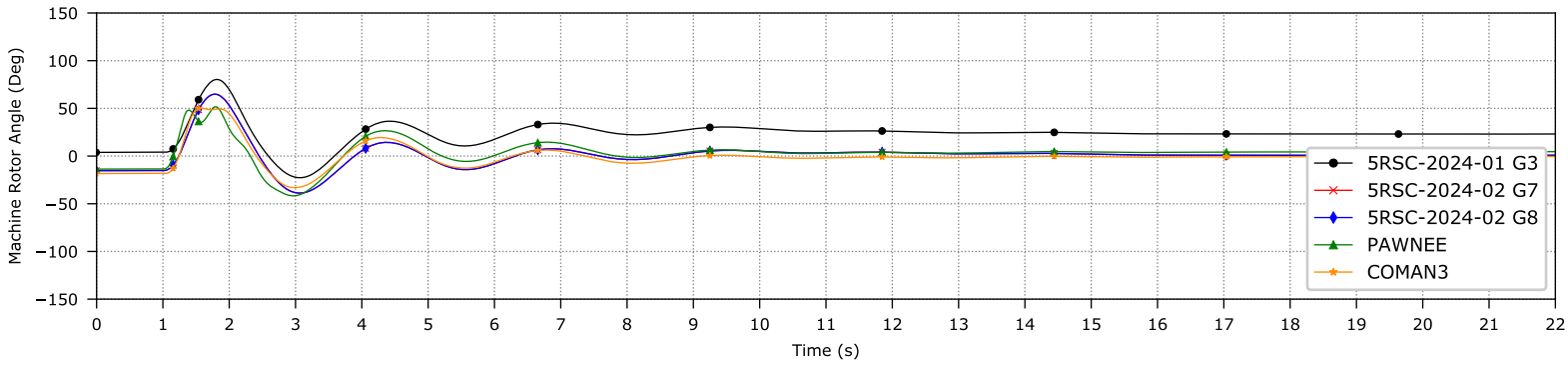


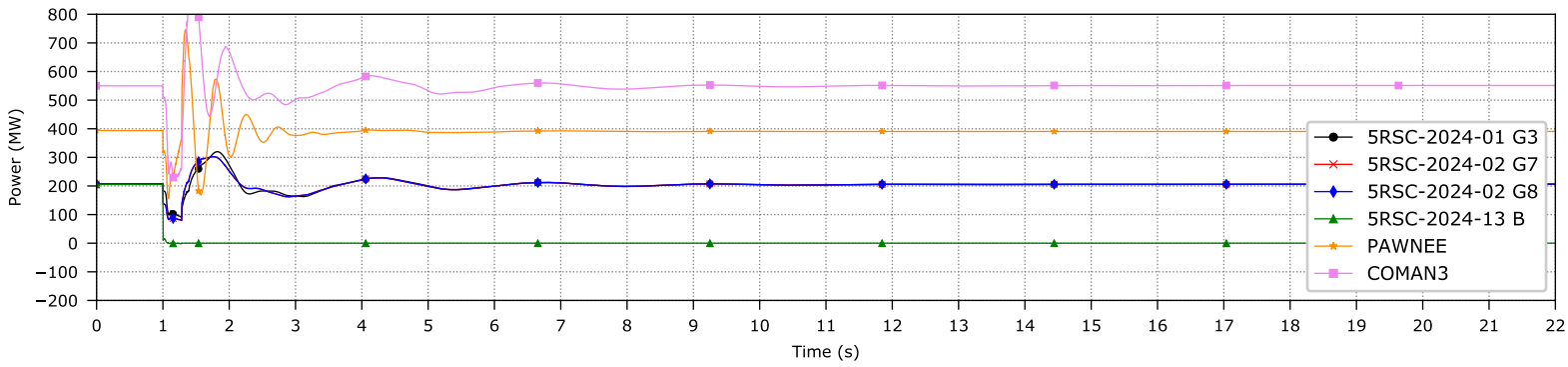


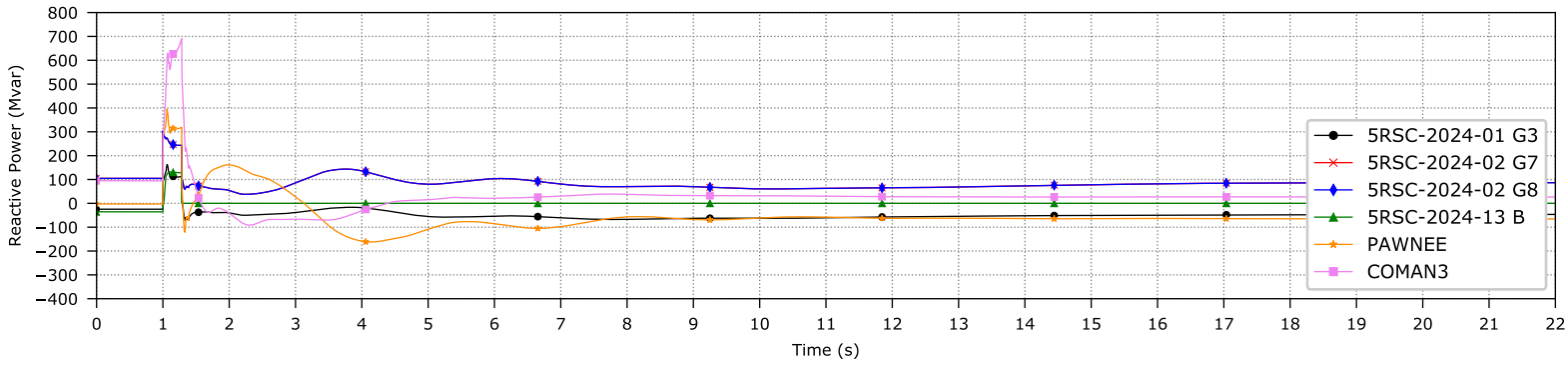


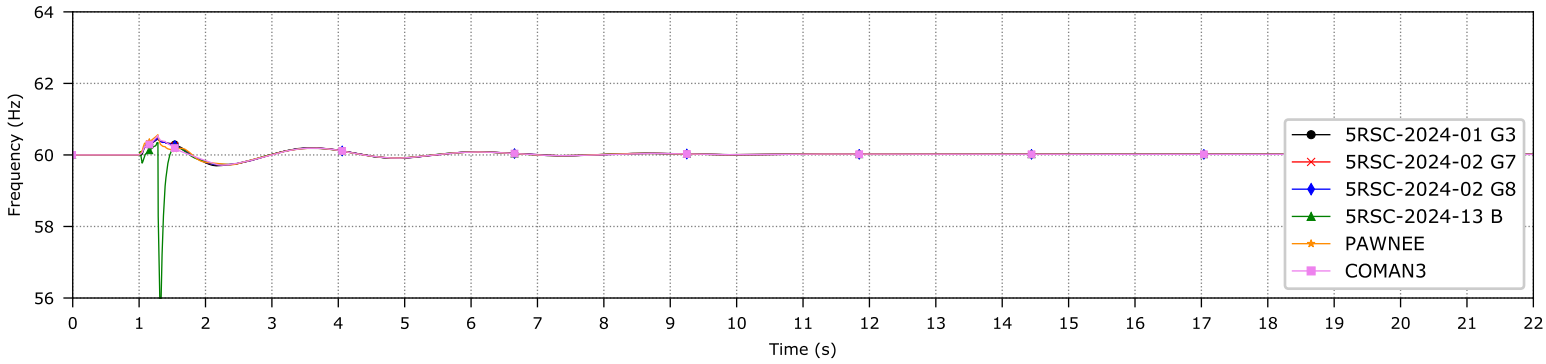


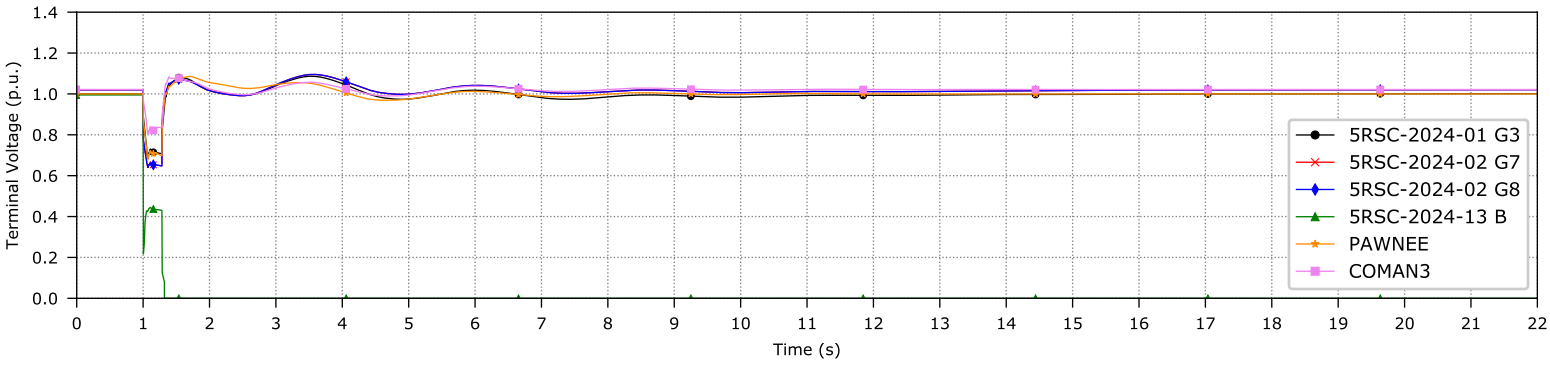
Ref. No. 23 - BF_145a

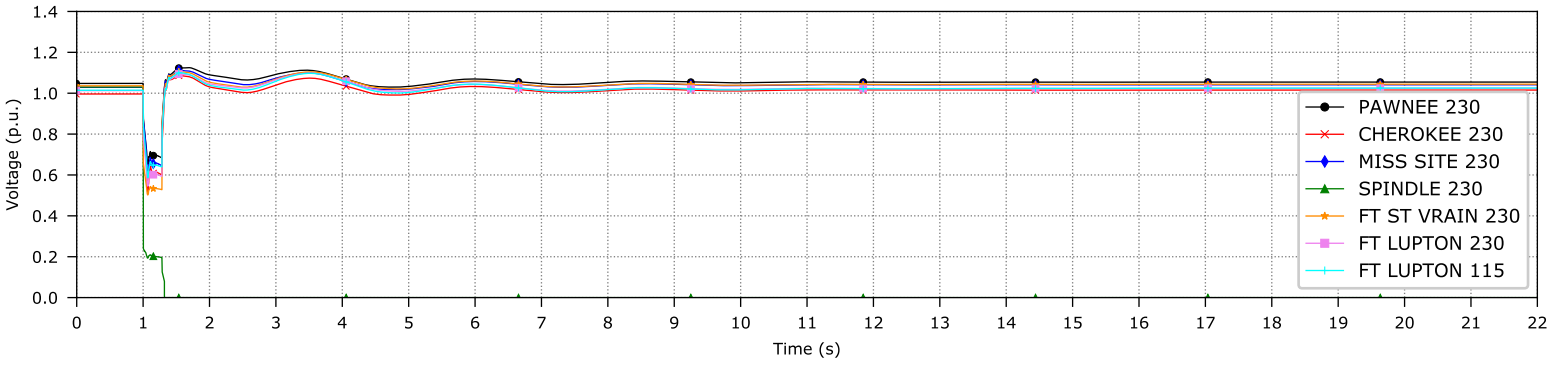












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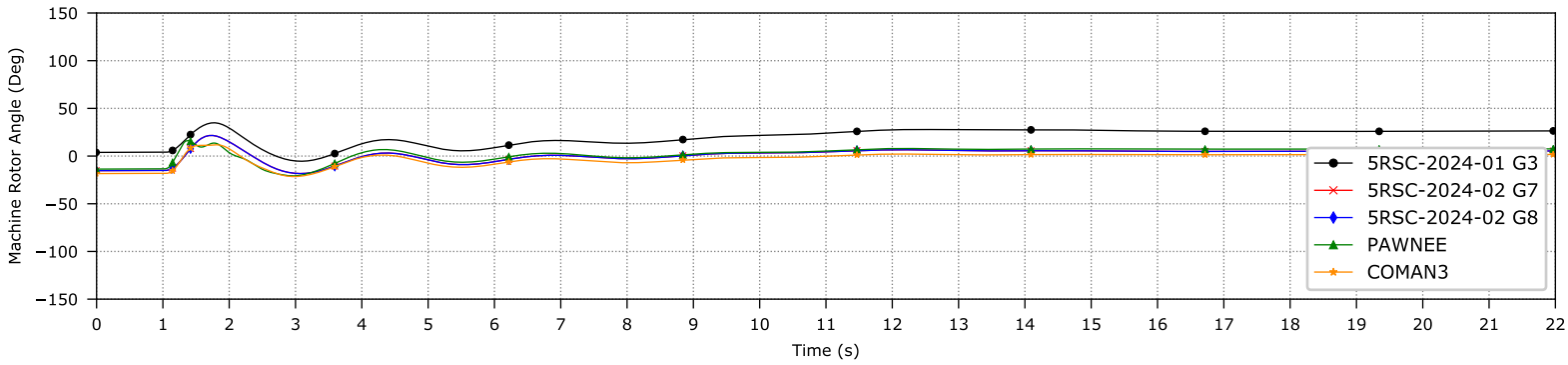
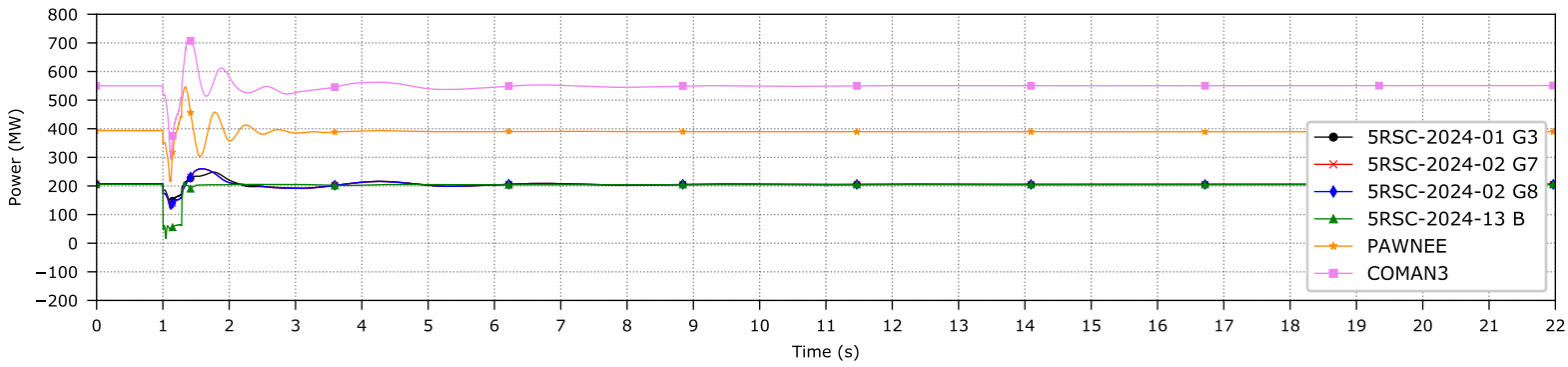
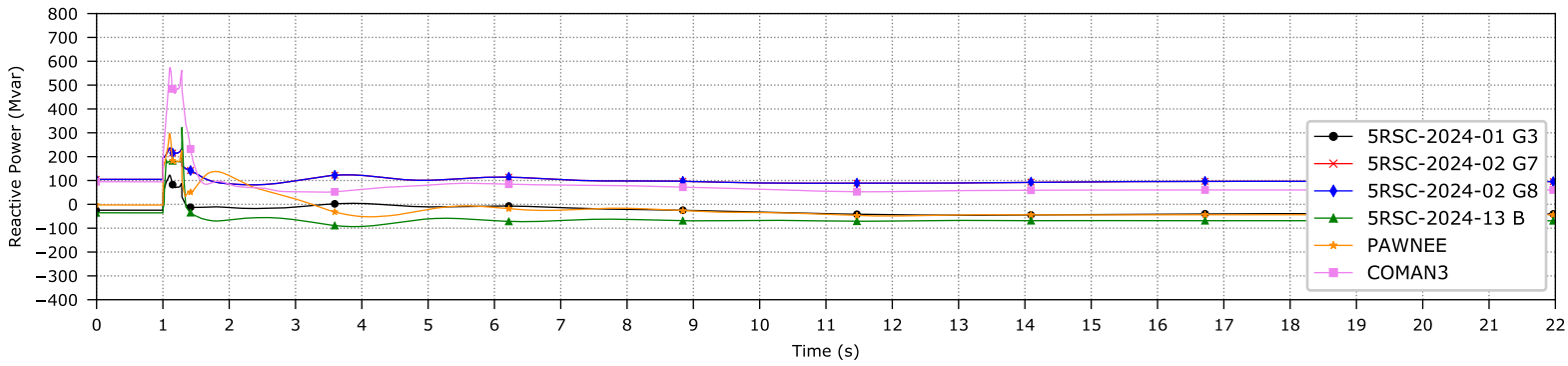
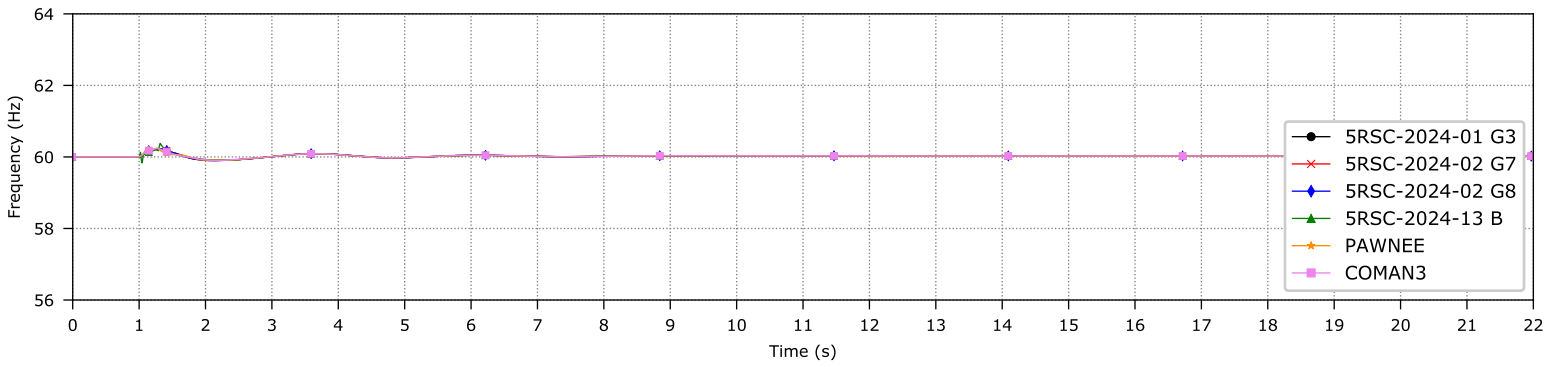
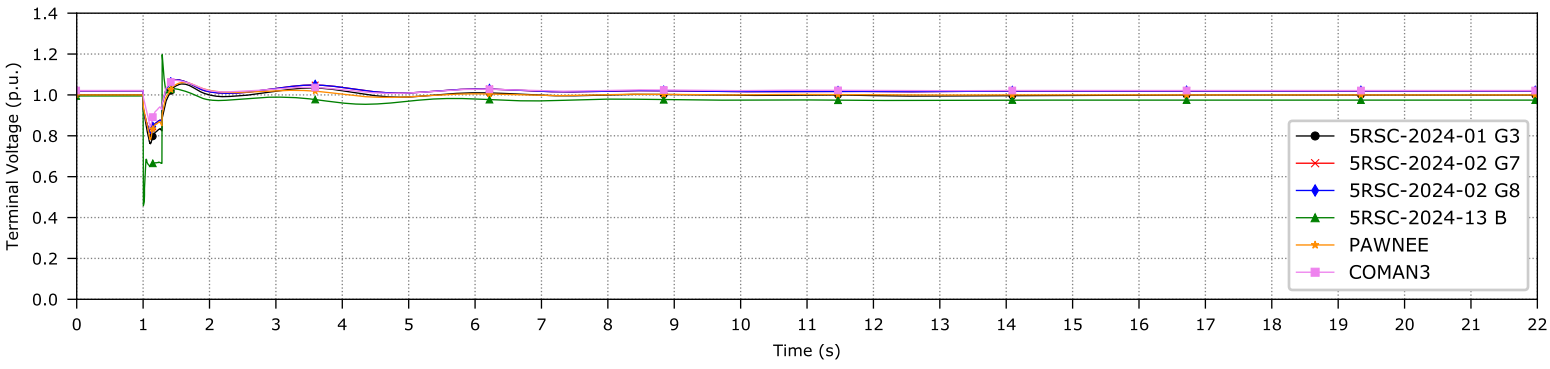
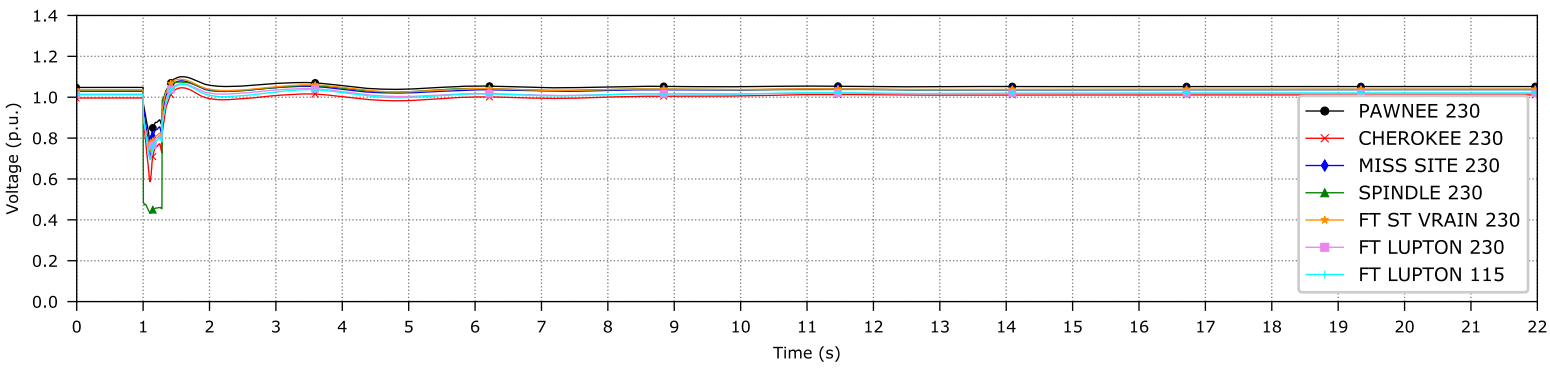




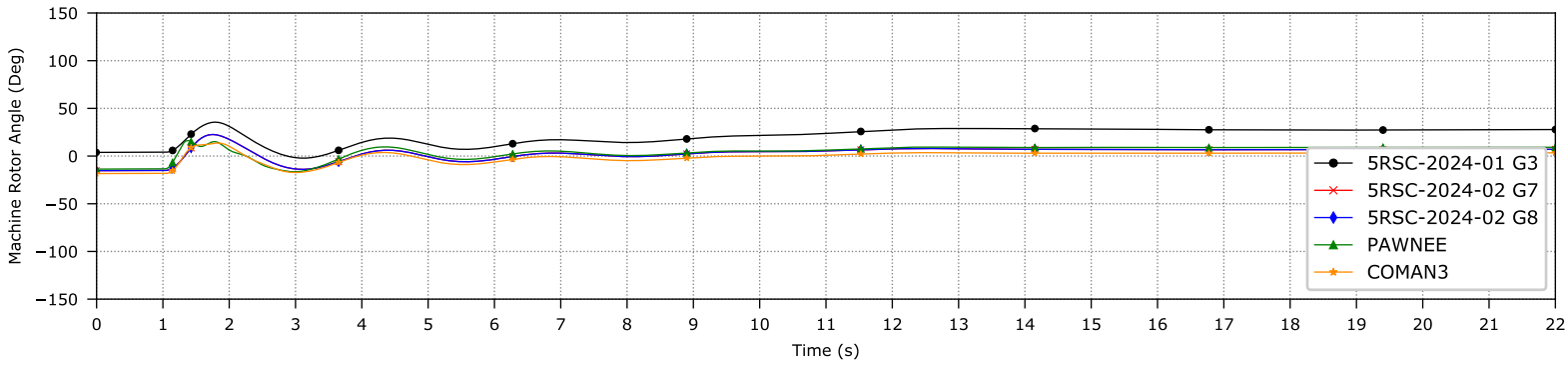


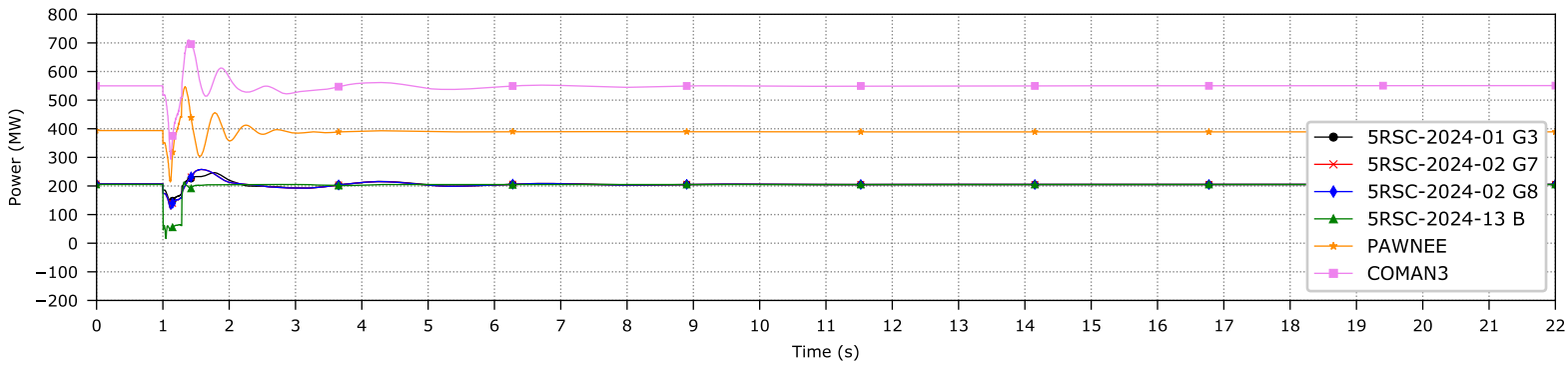


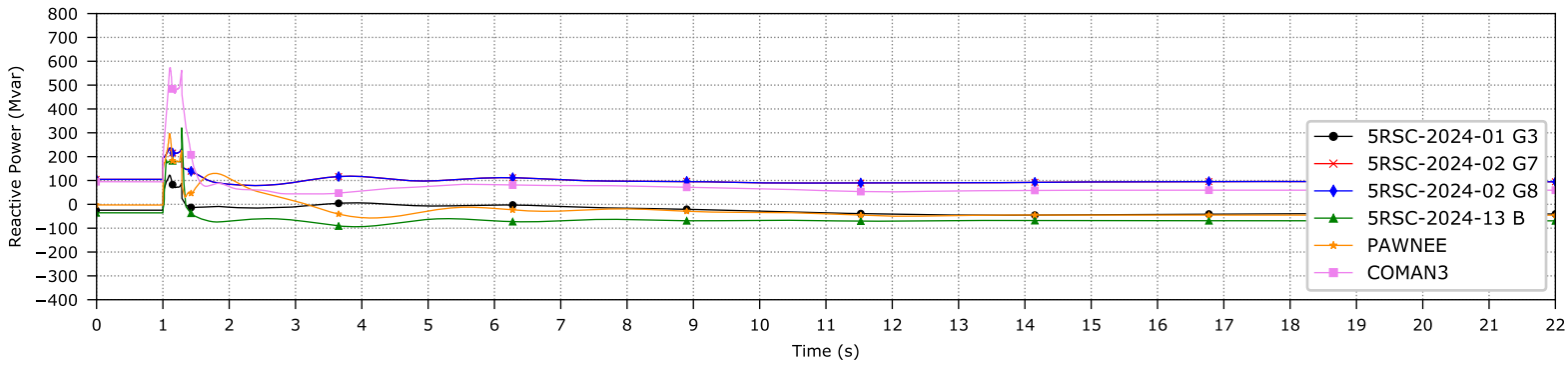


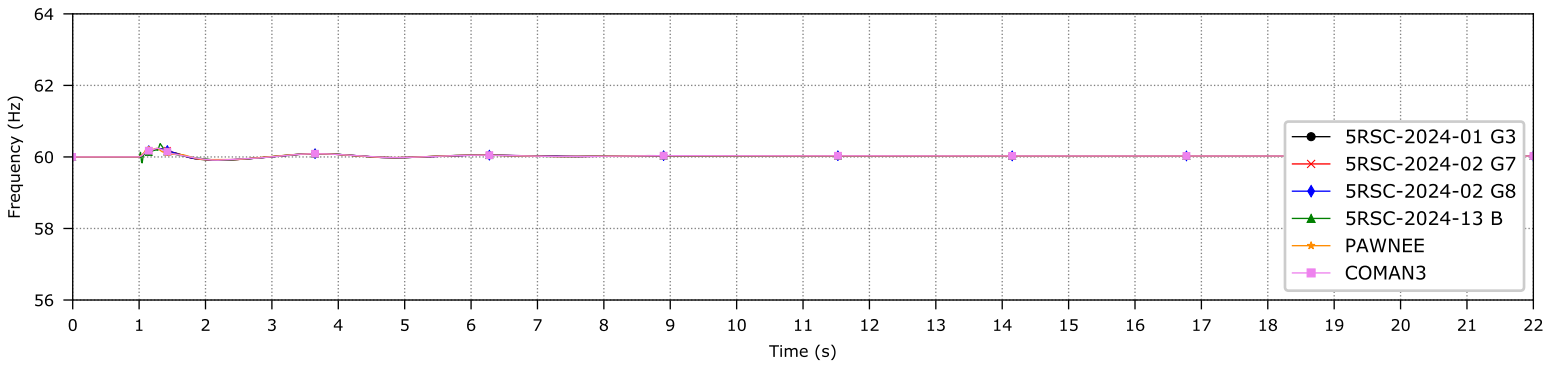


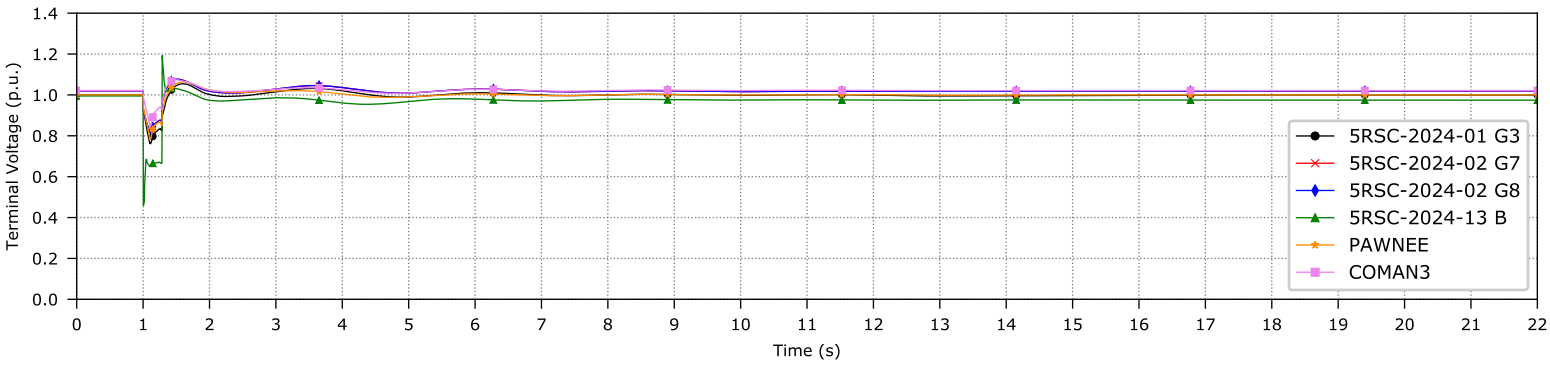
Ref. No. 25 - BF_148d

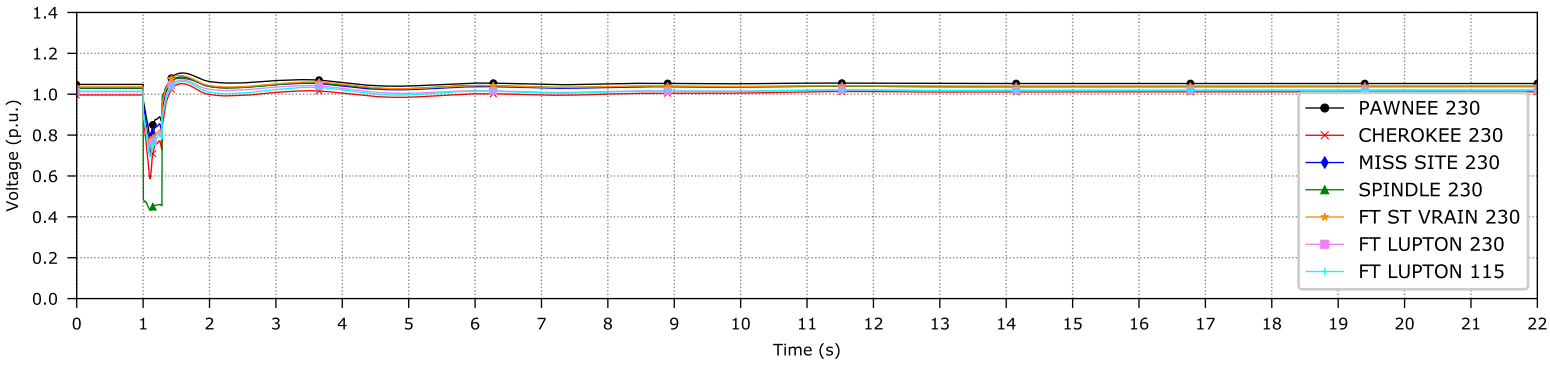




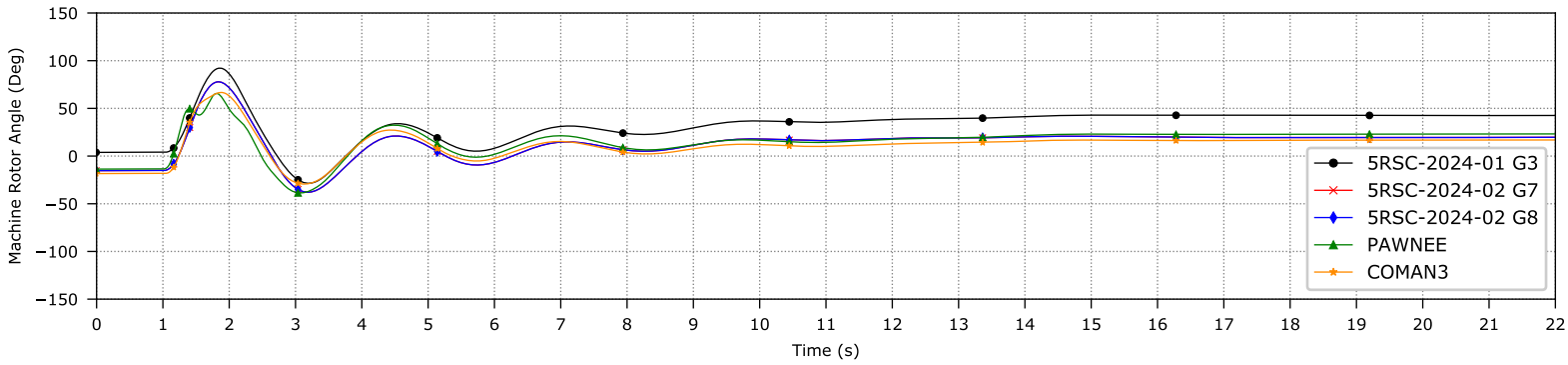


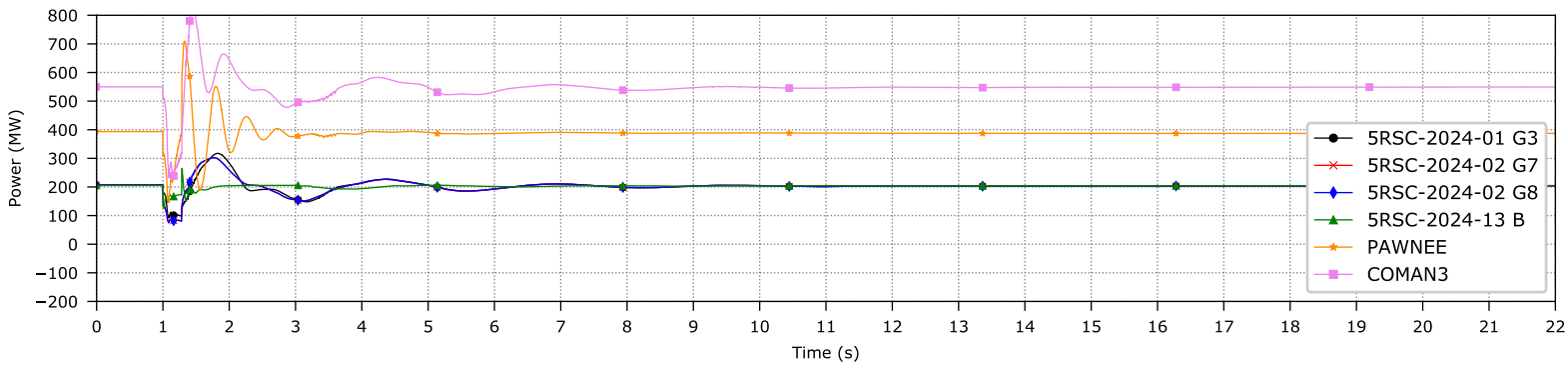


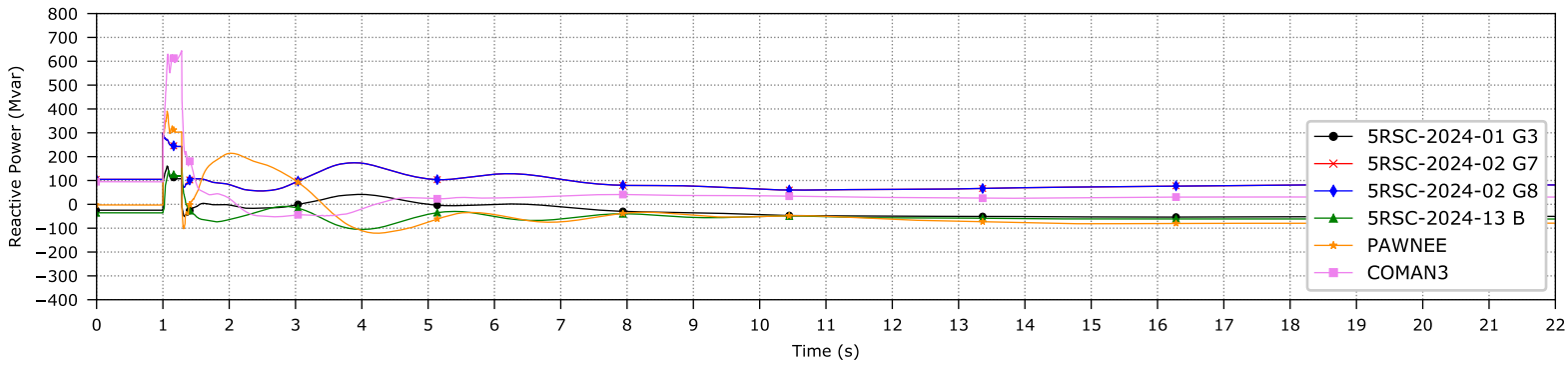


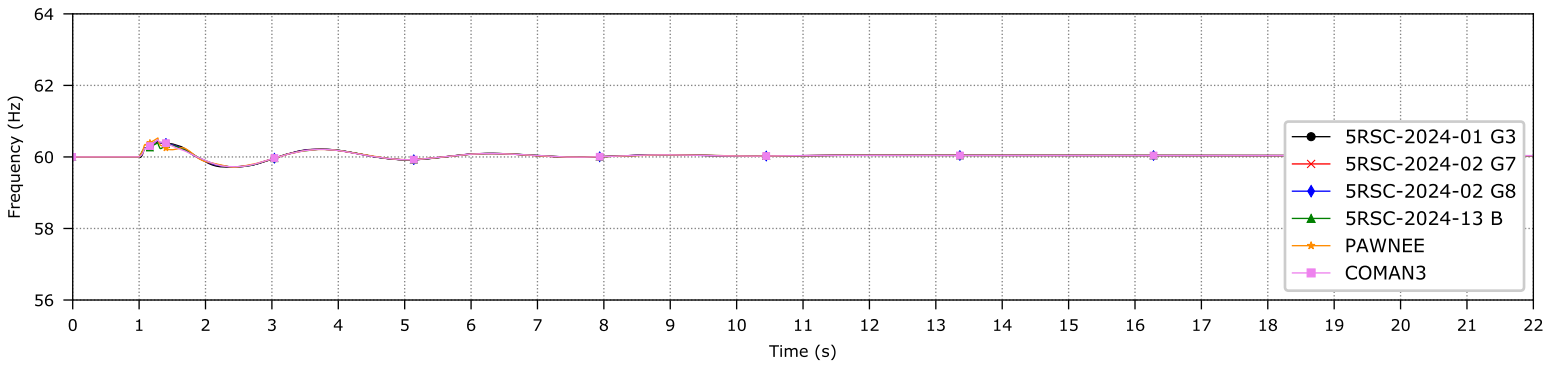


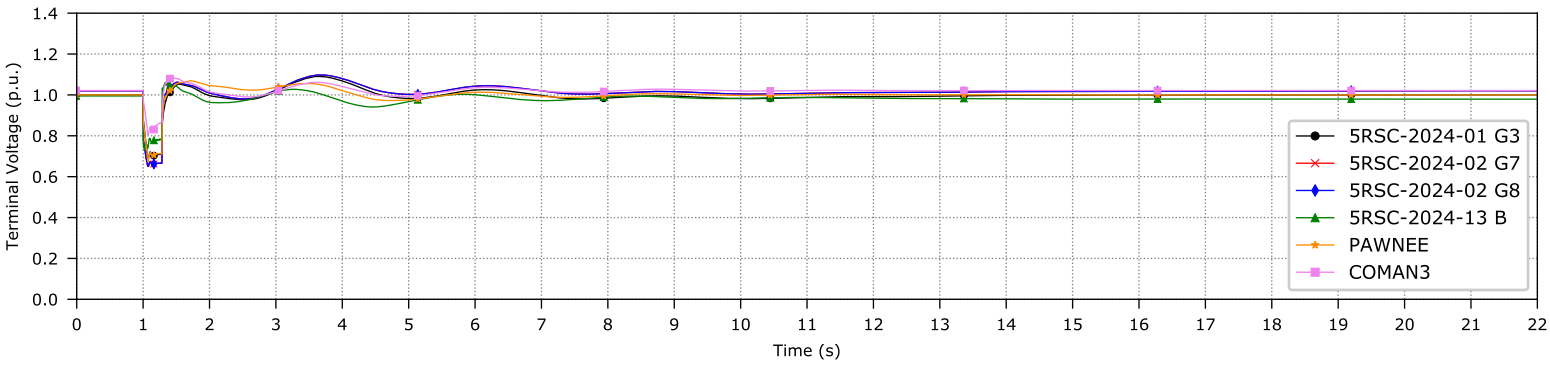
Ref. No. 26 - BF_151c

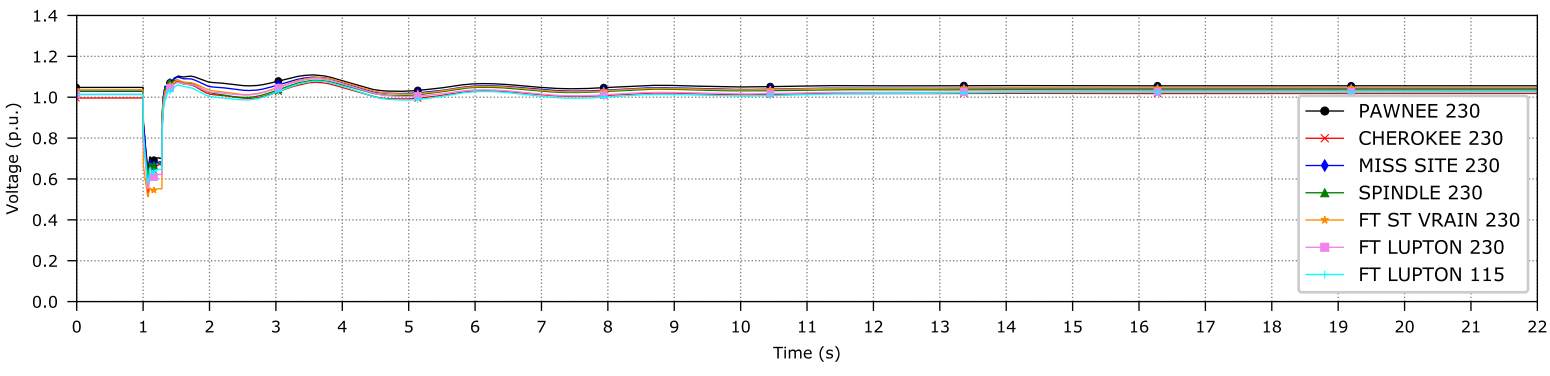




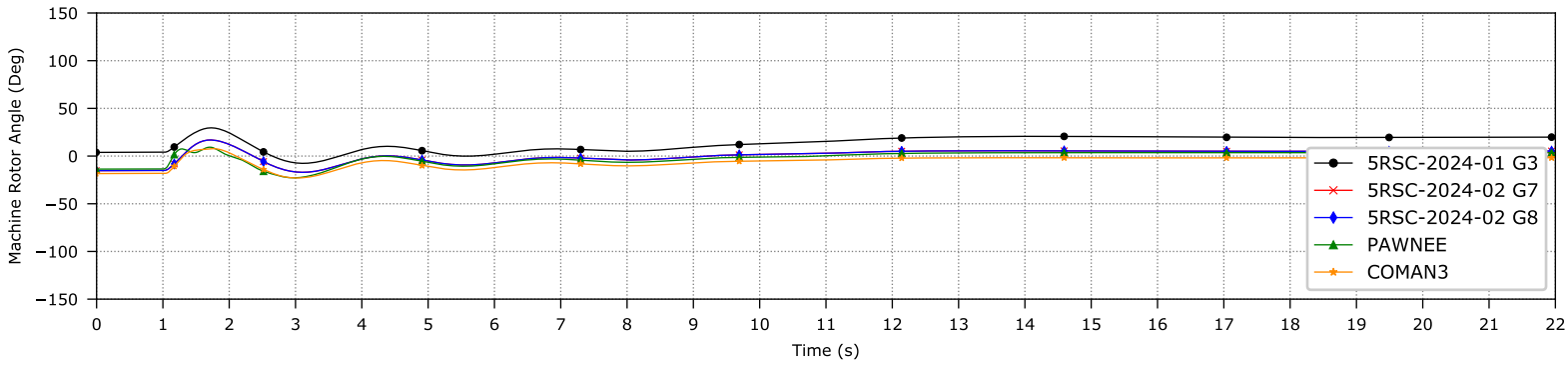


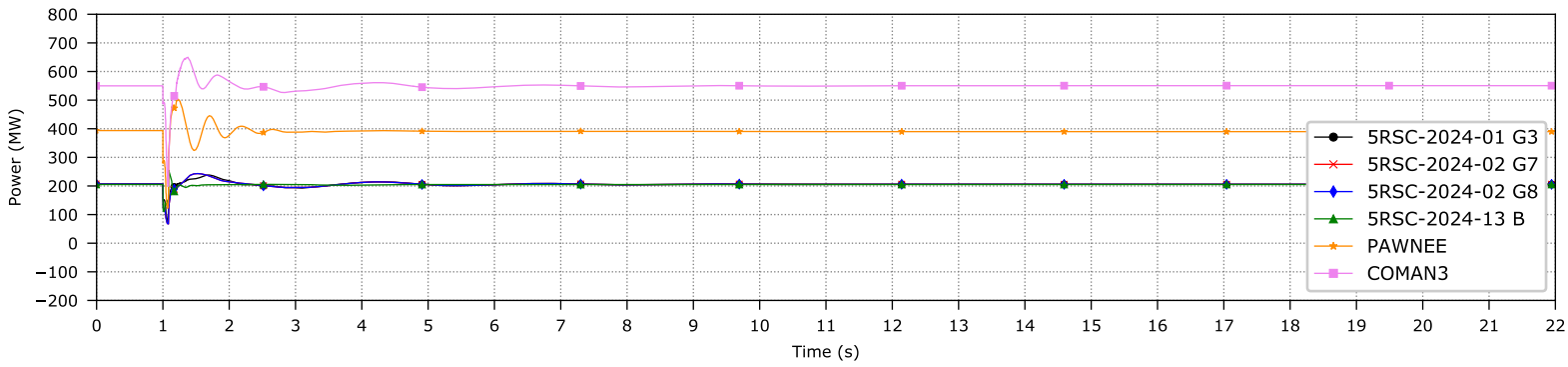


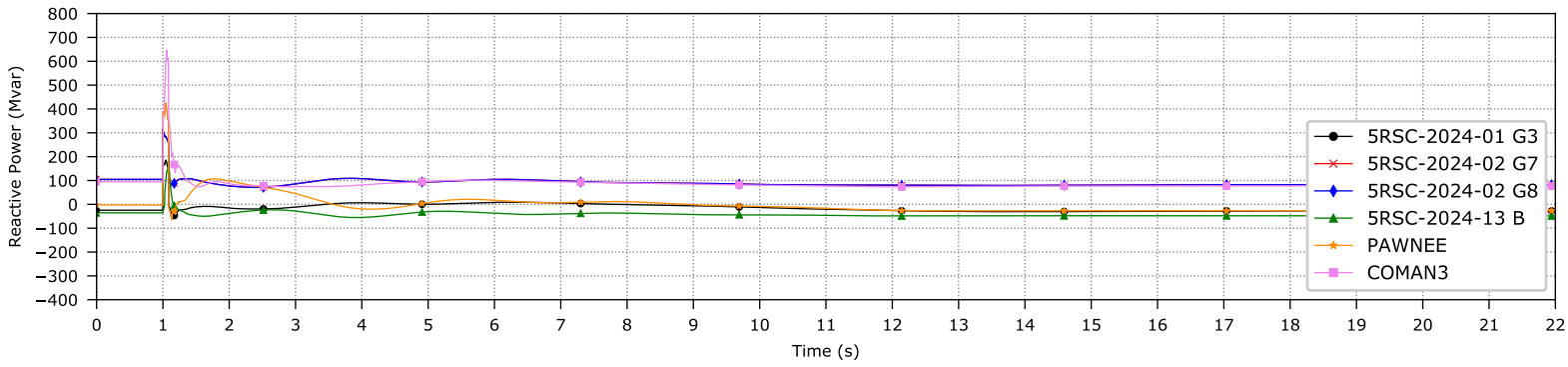


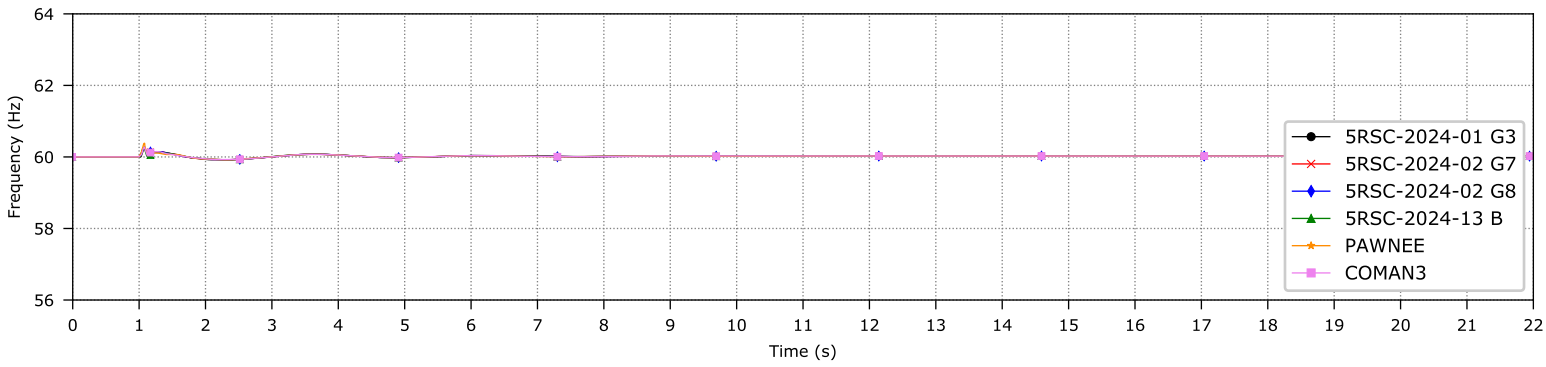


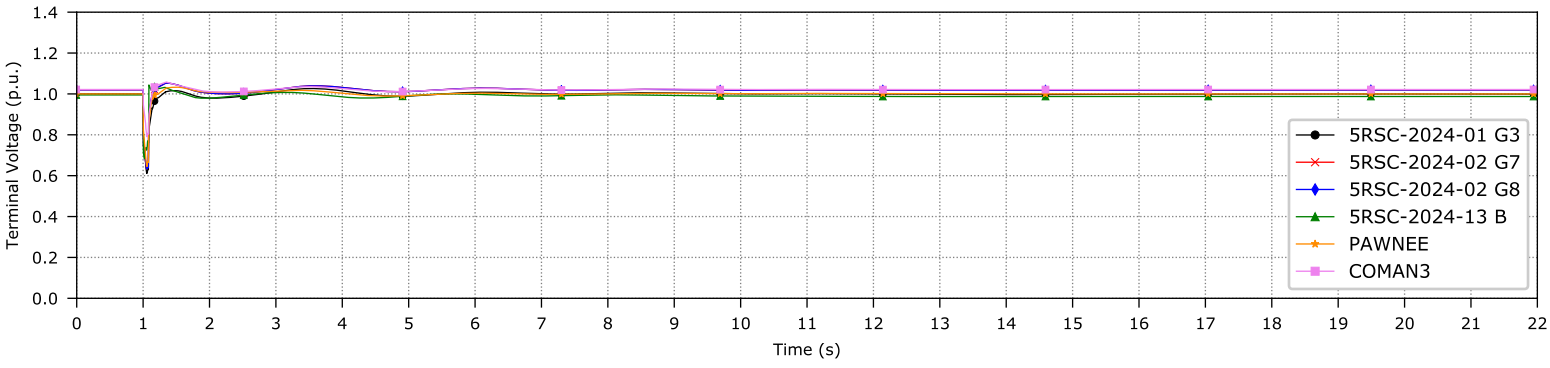
Ref. No. 27 - P7_76

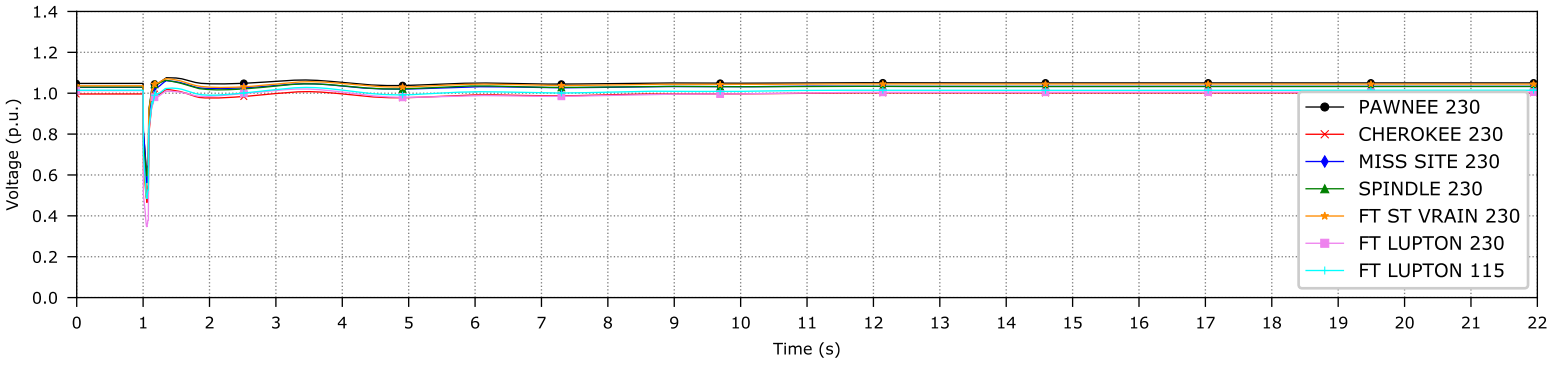




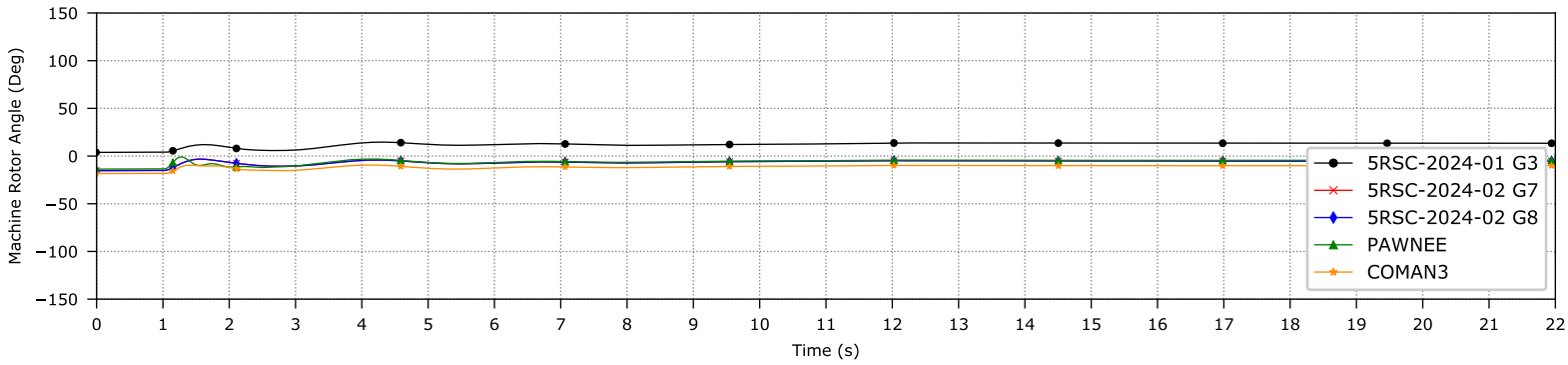


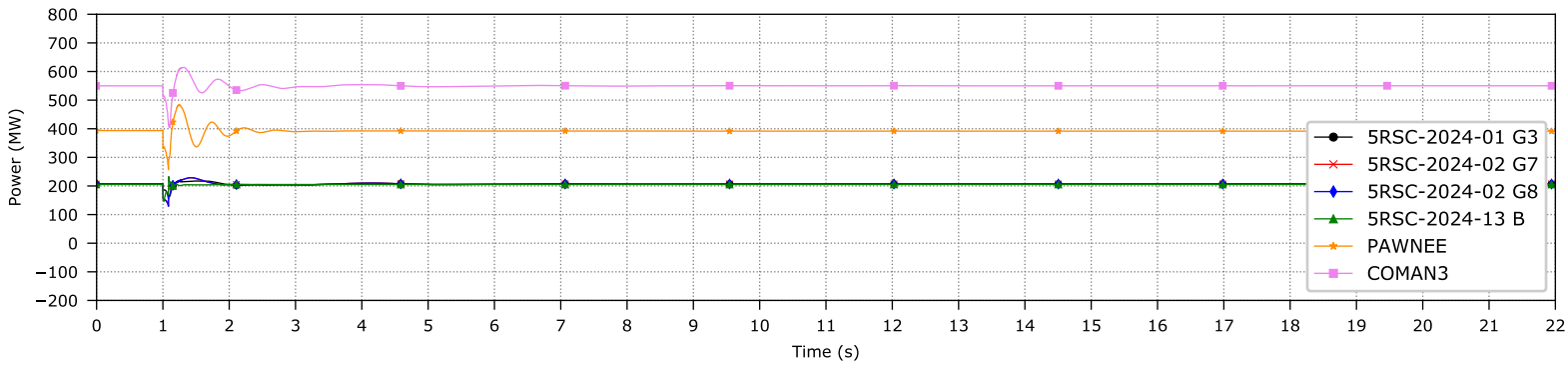


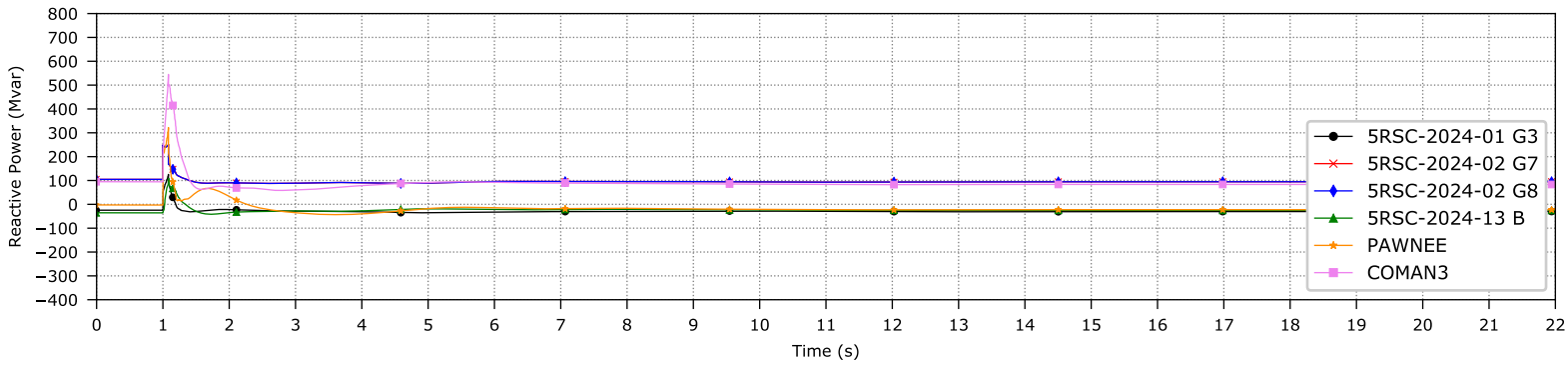


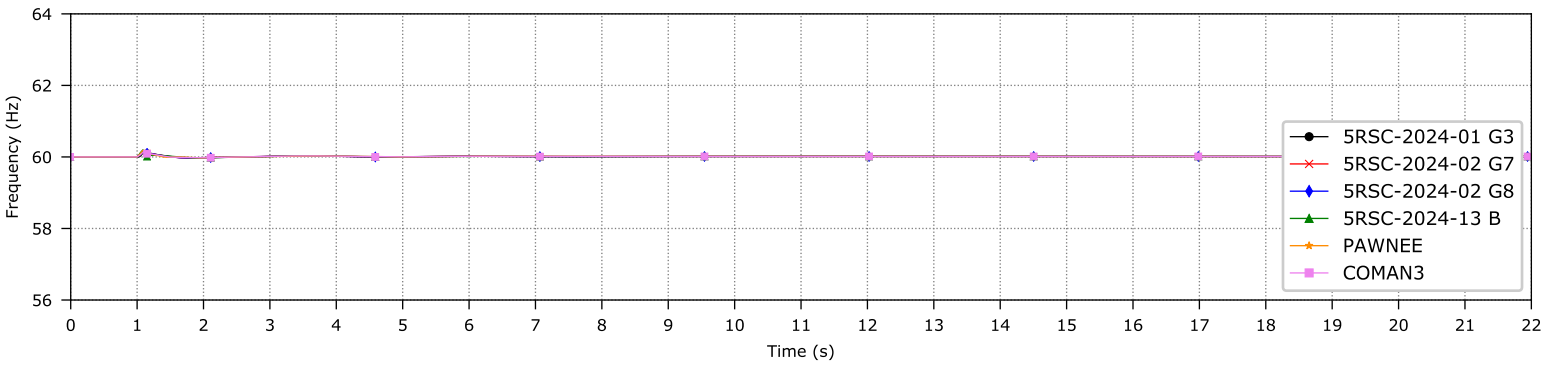


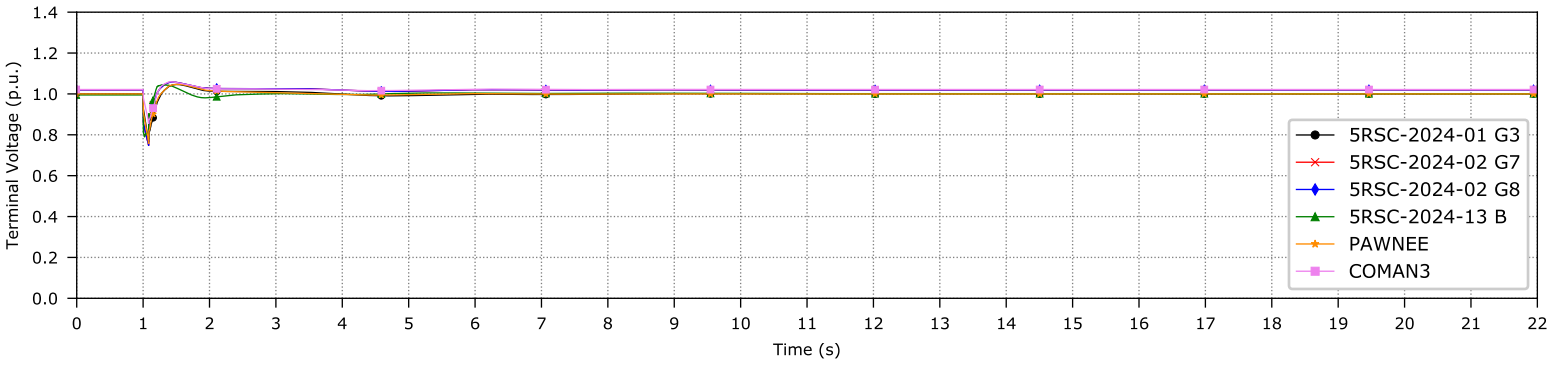
Ref. No. 28 - P7_87

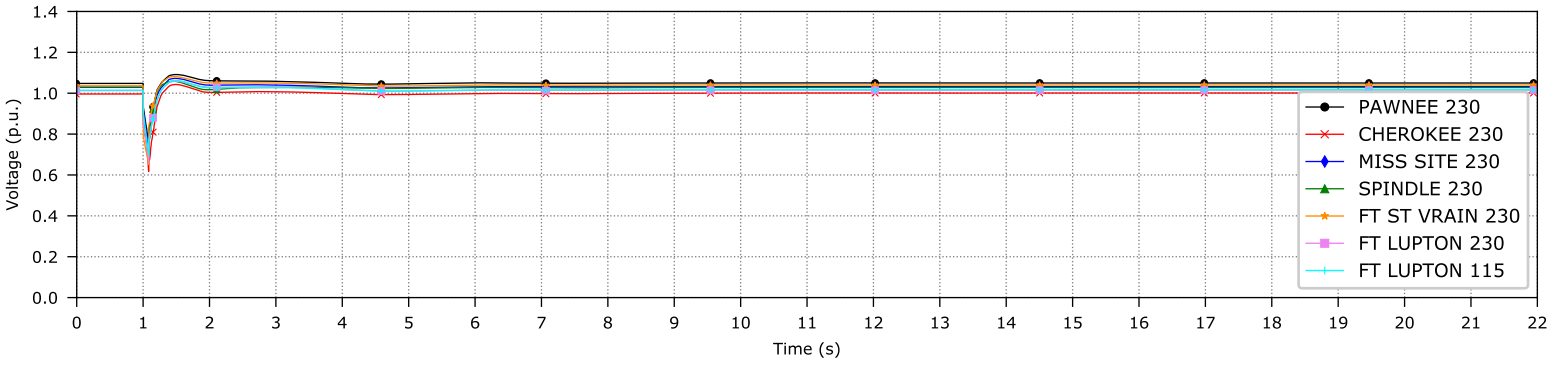




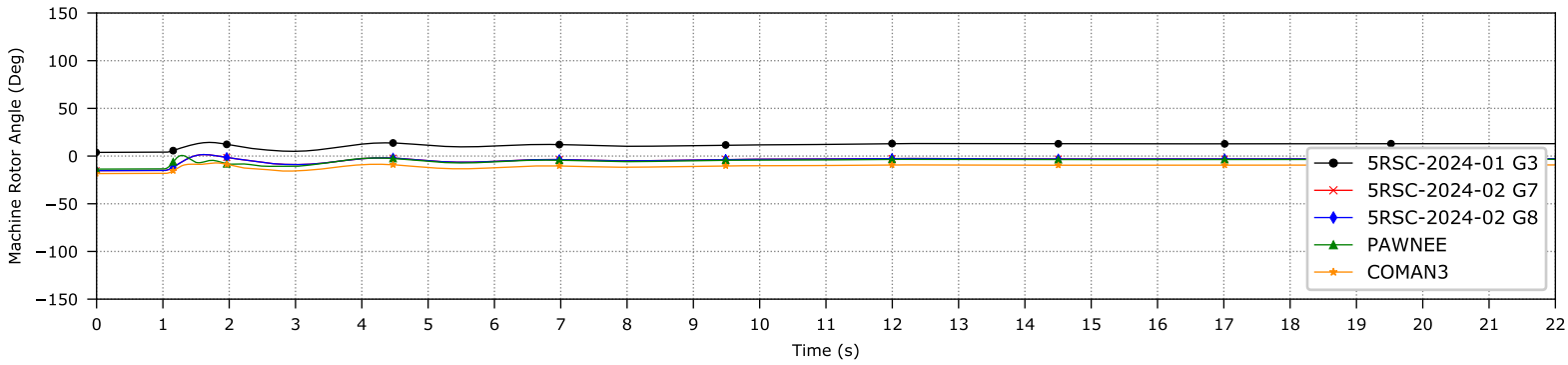


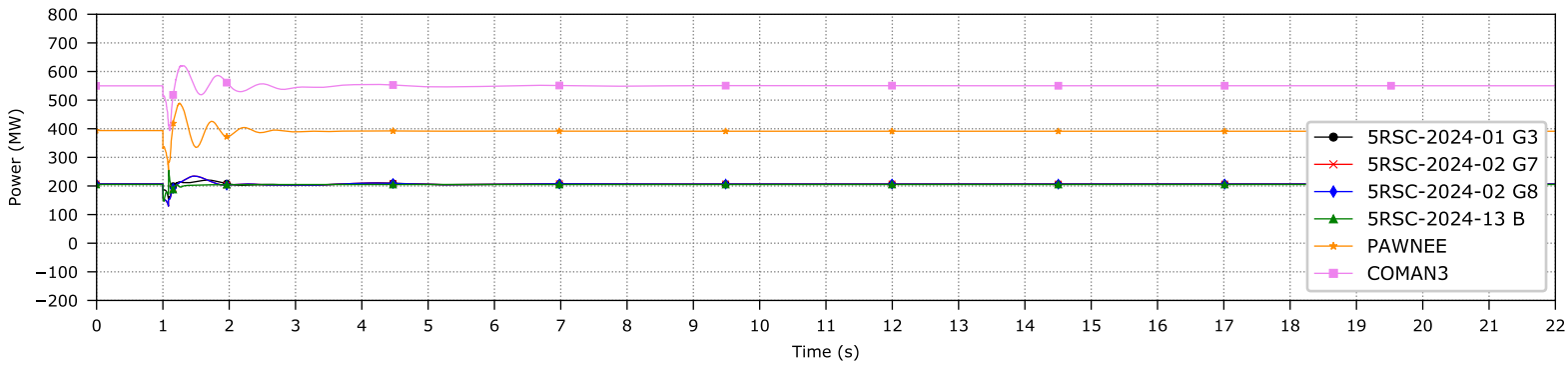


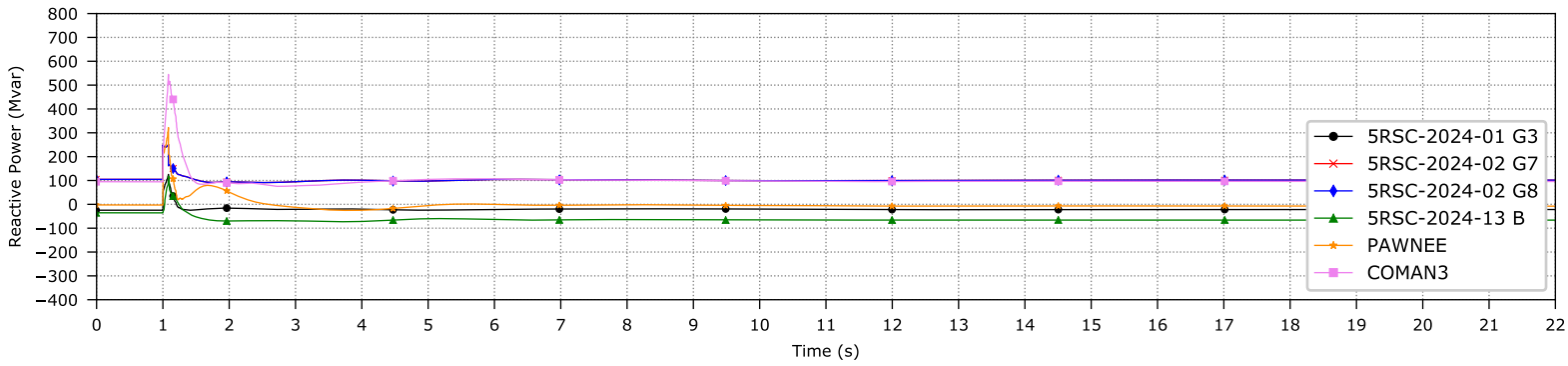


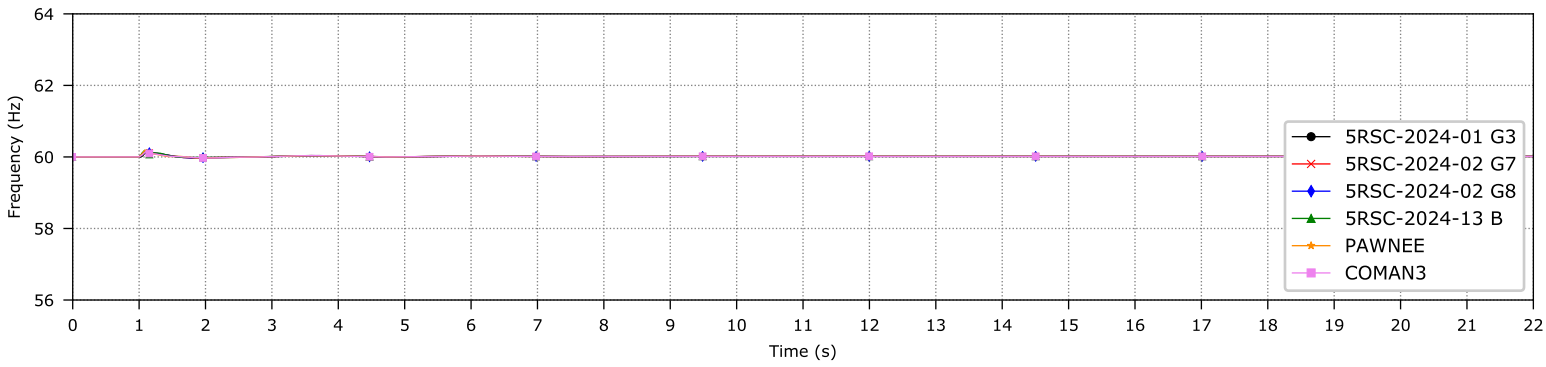


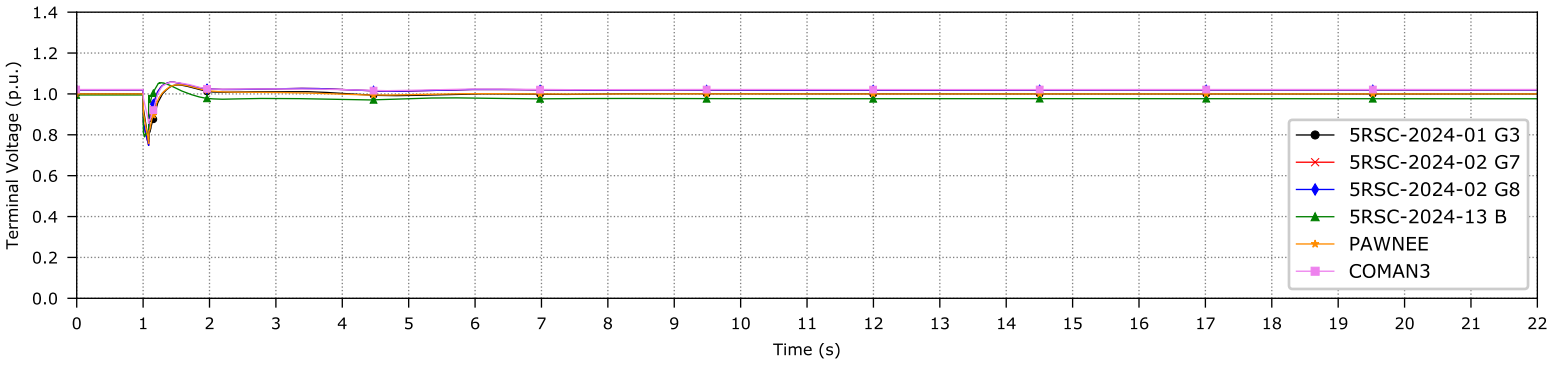
Ref. No. 29 - P7_88

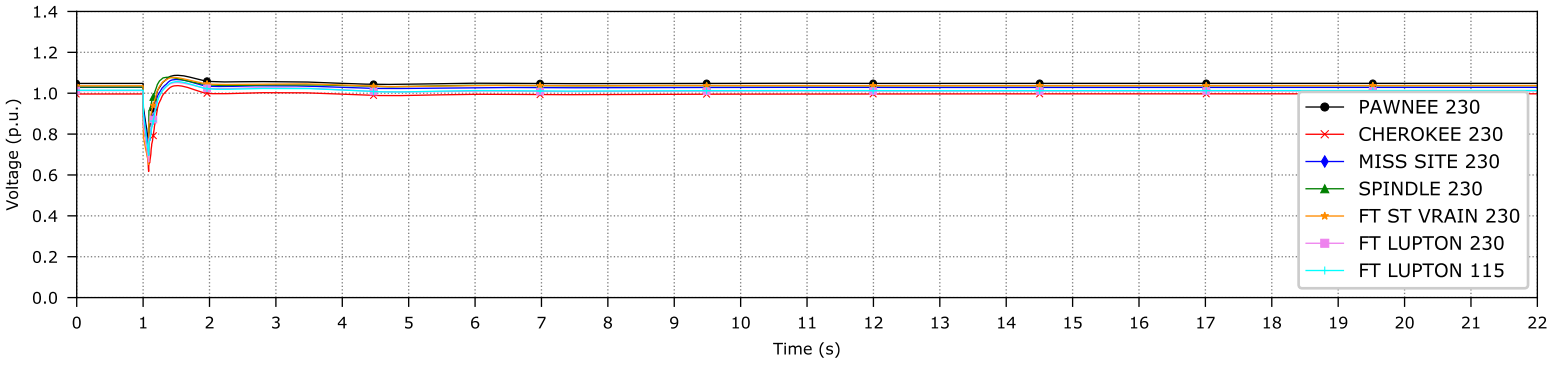




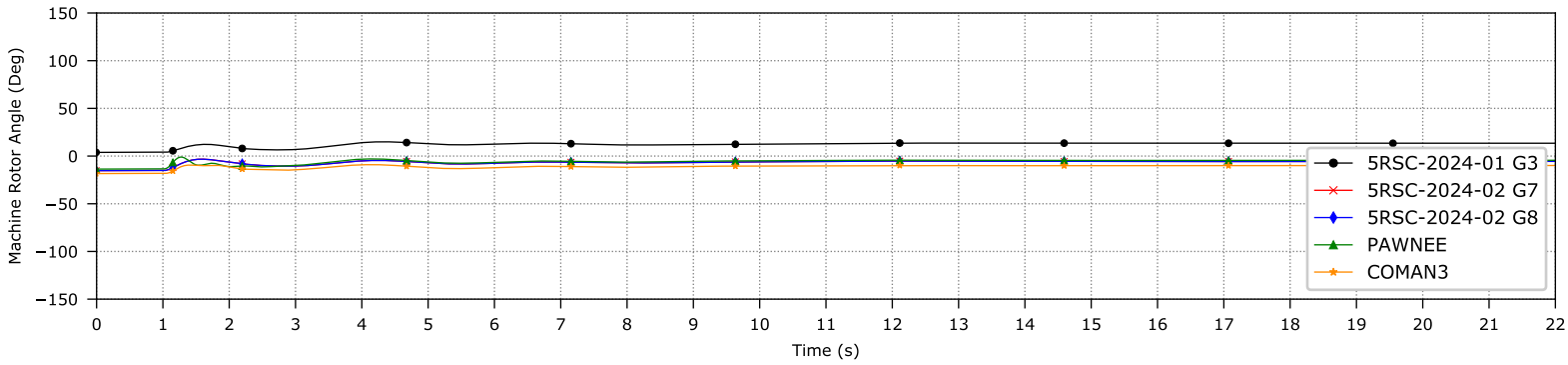


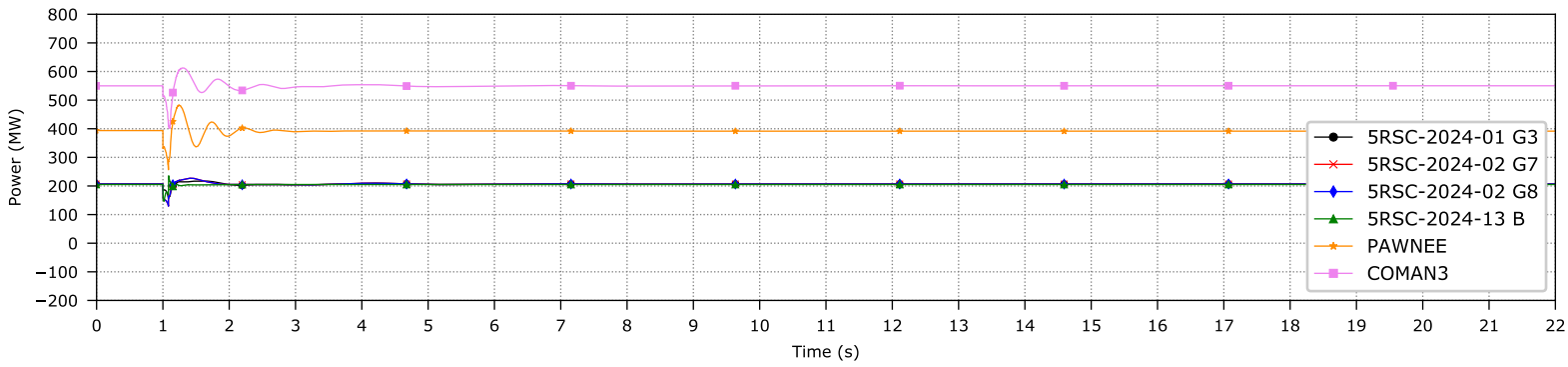


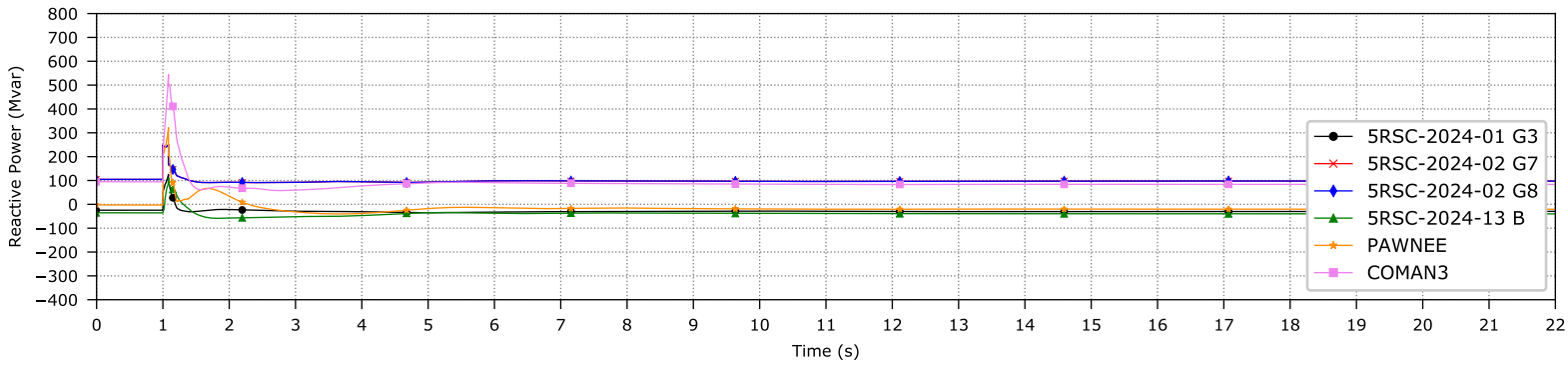


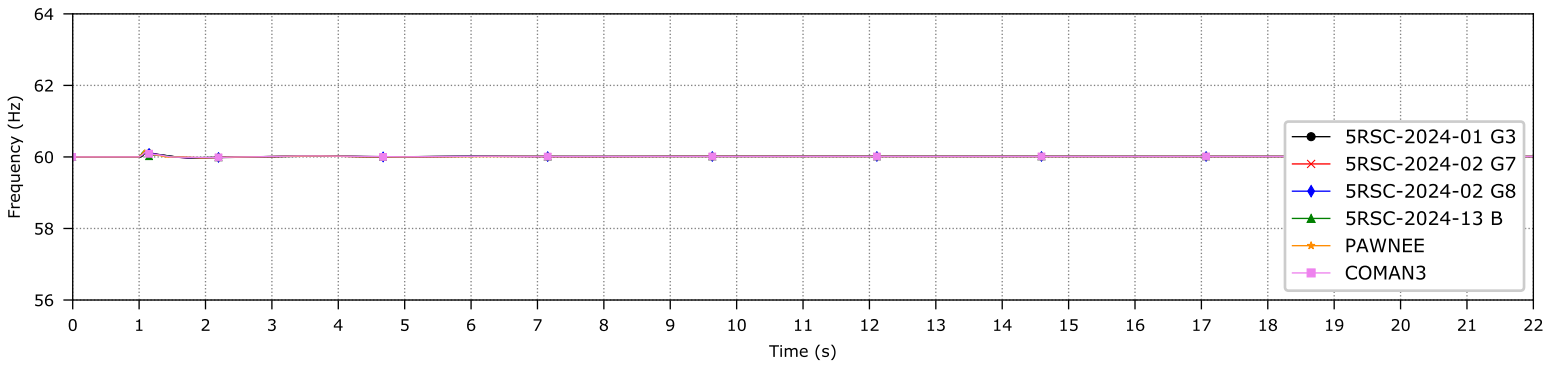


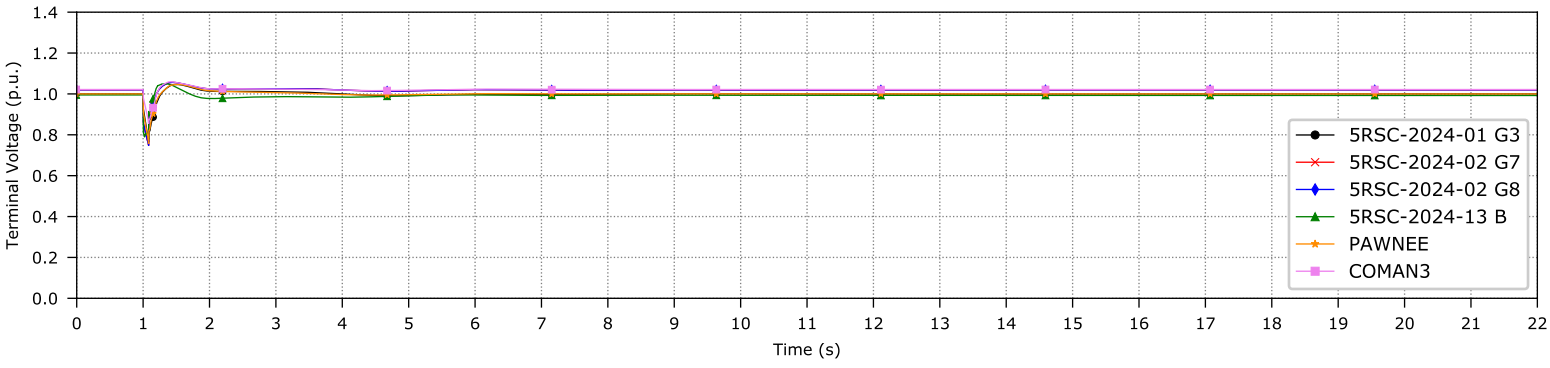
Ref. No. 30 - P7_89

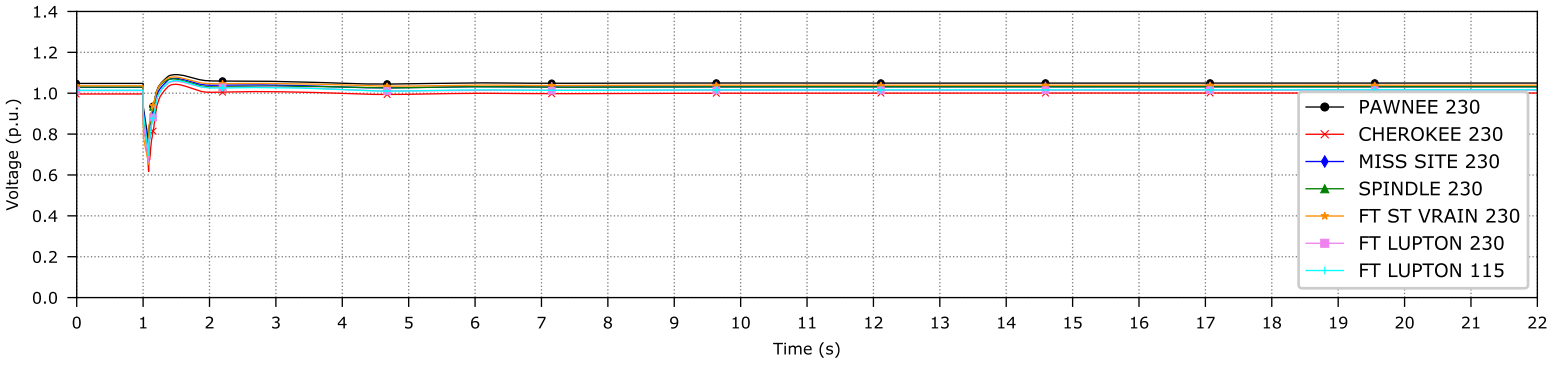




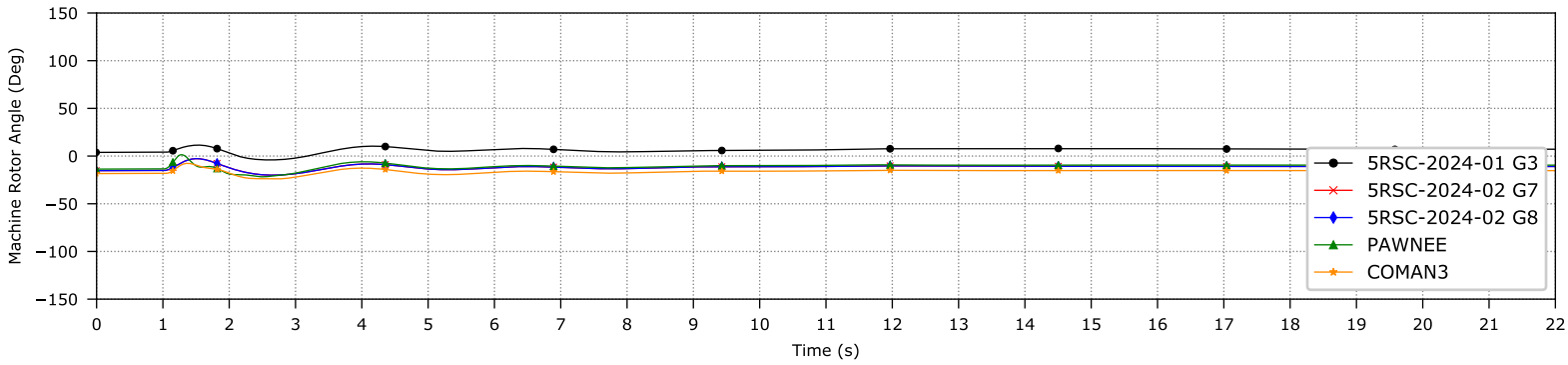


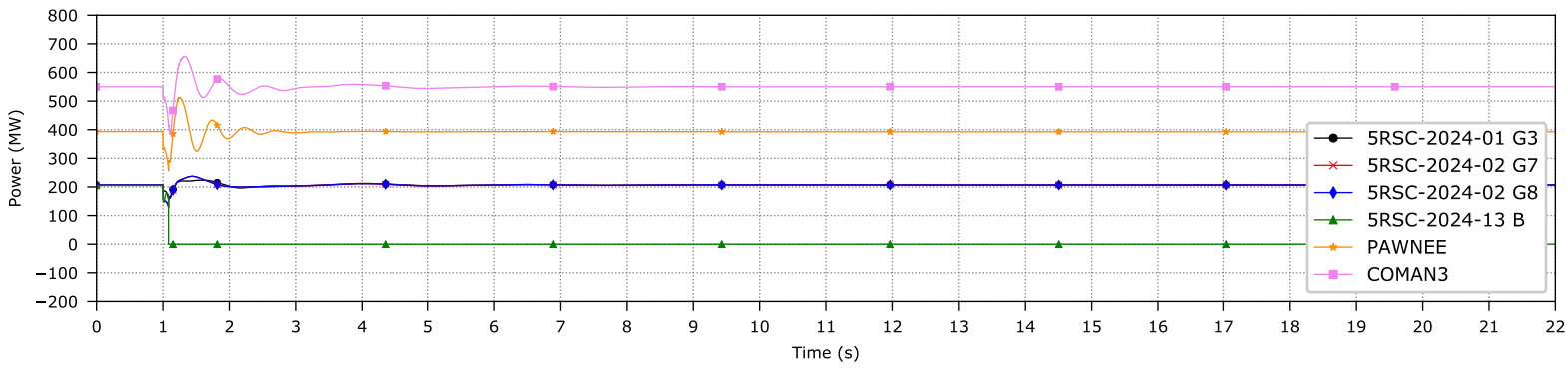


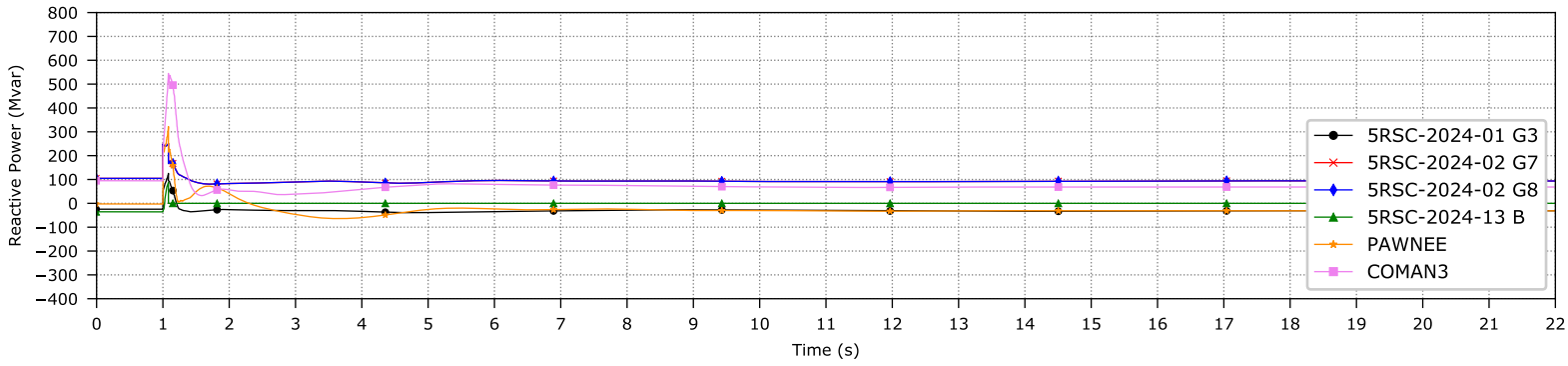


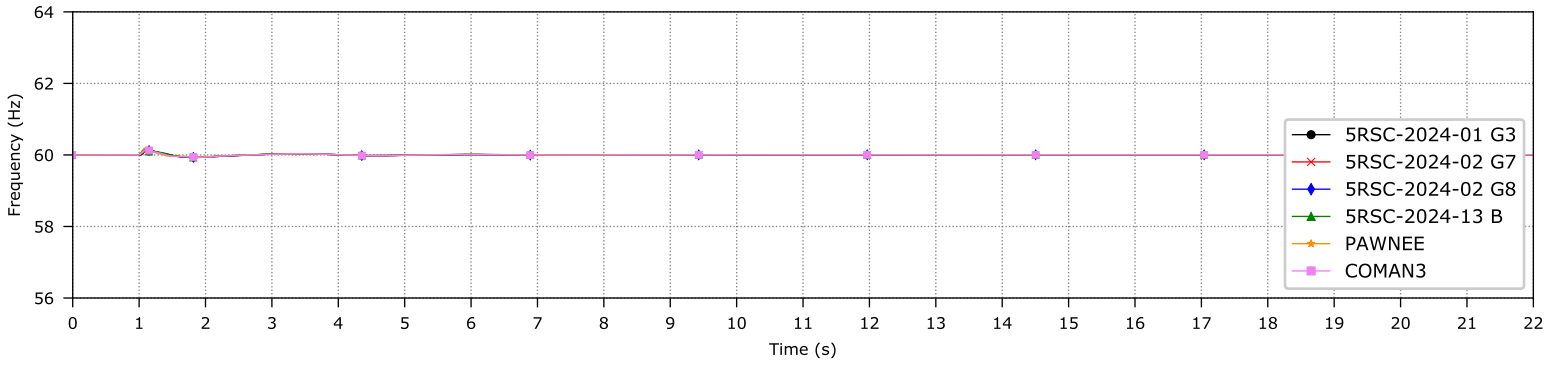


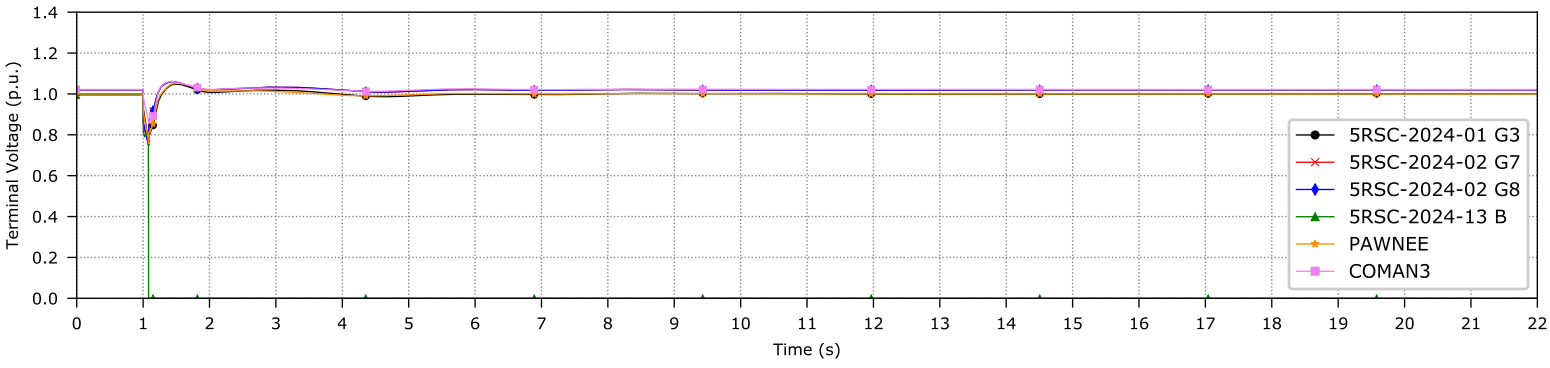
Ref. No. 31 - P7_90

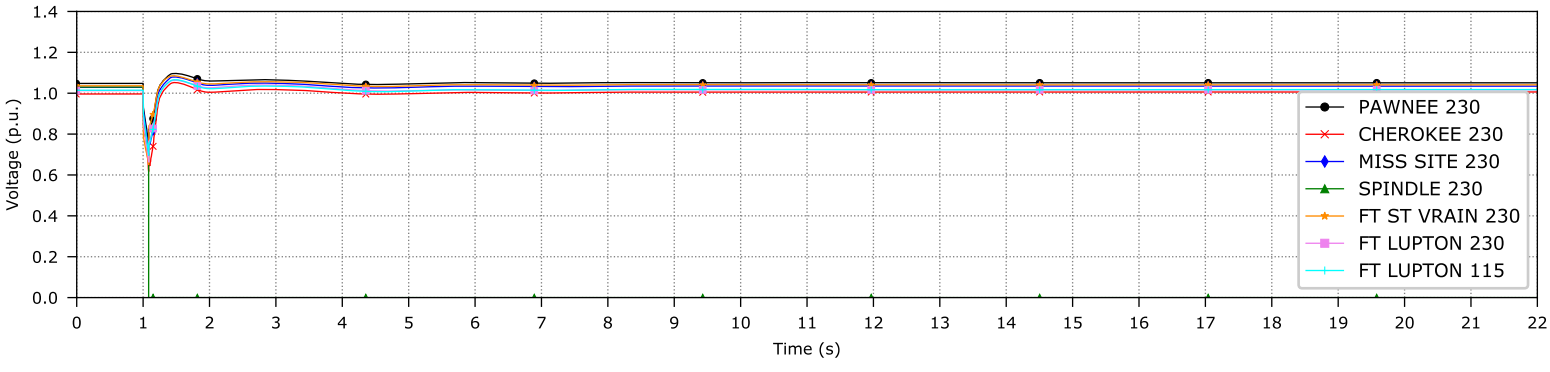




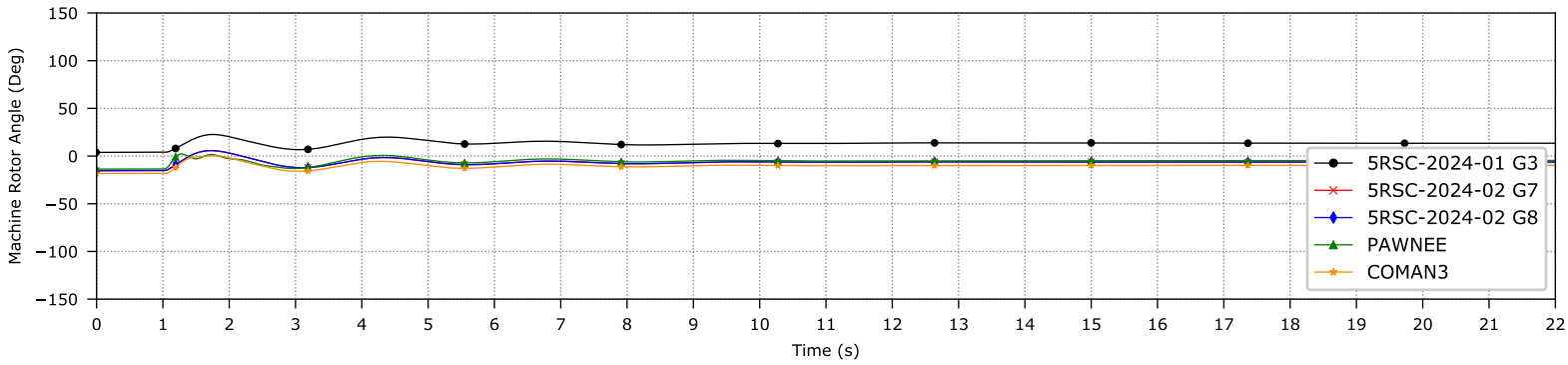


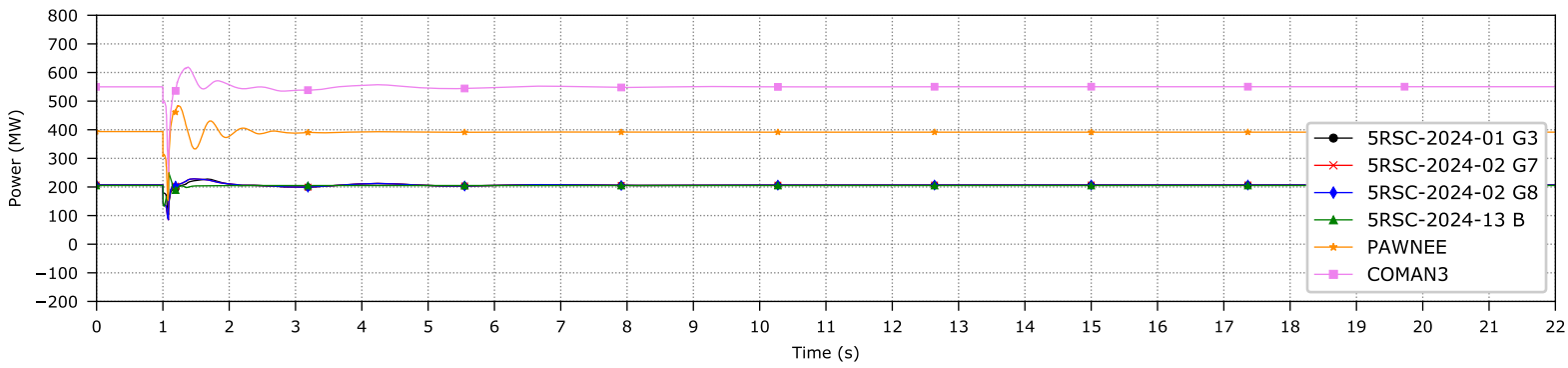


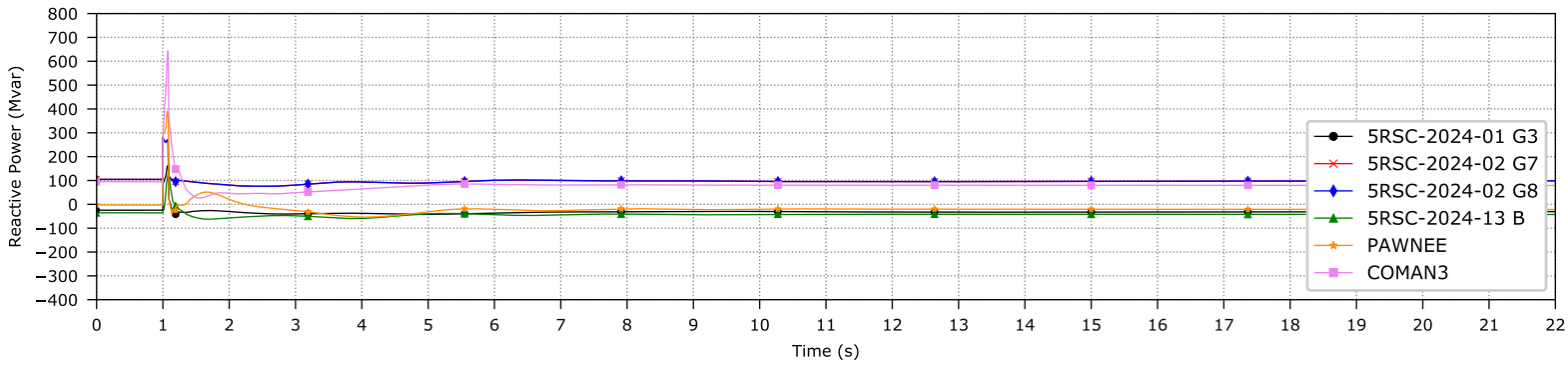


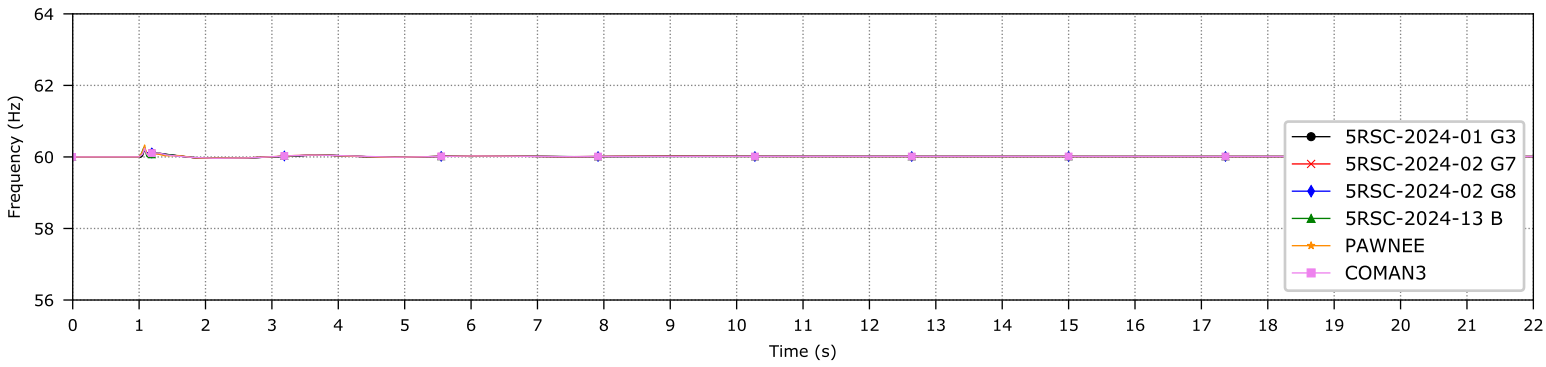


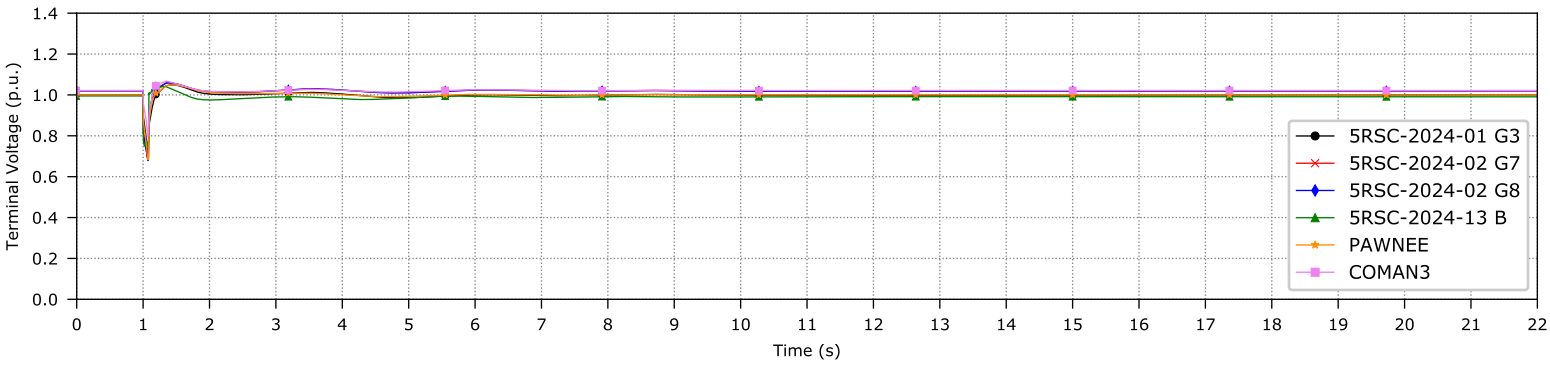
Ref. No. 32 - P7_92

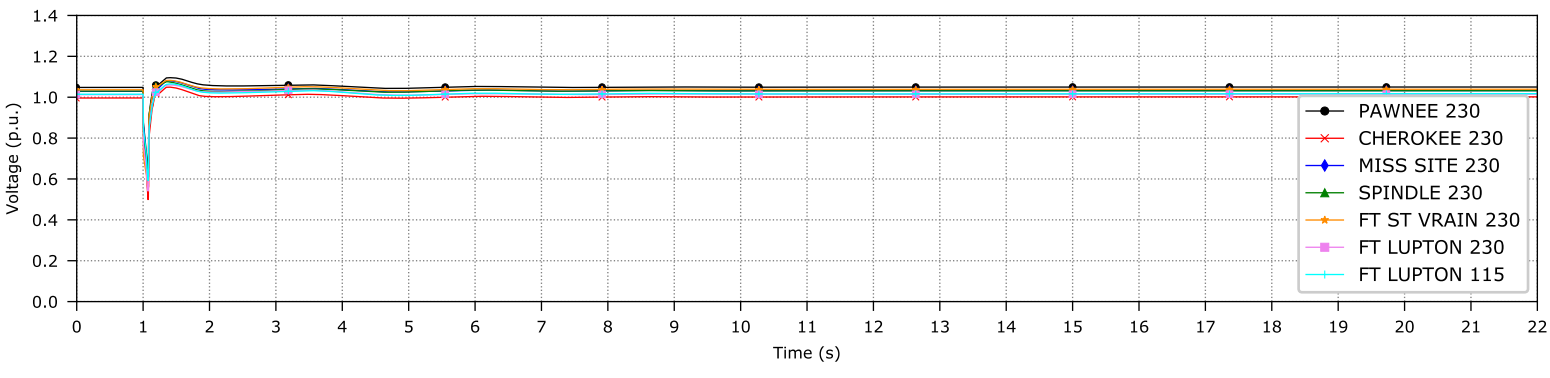




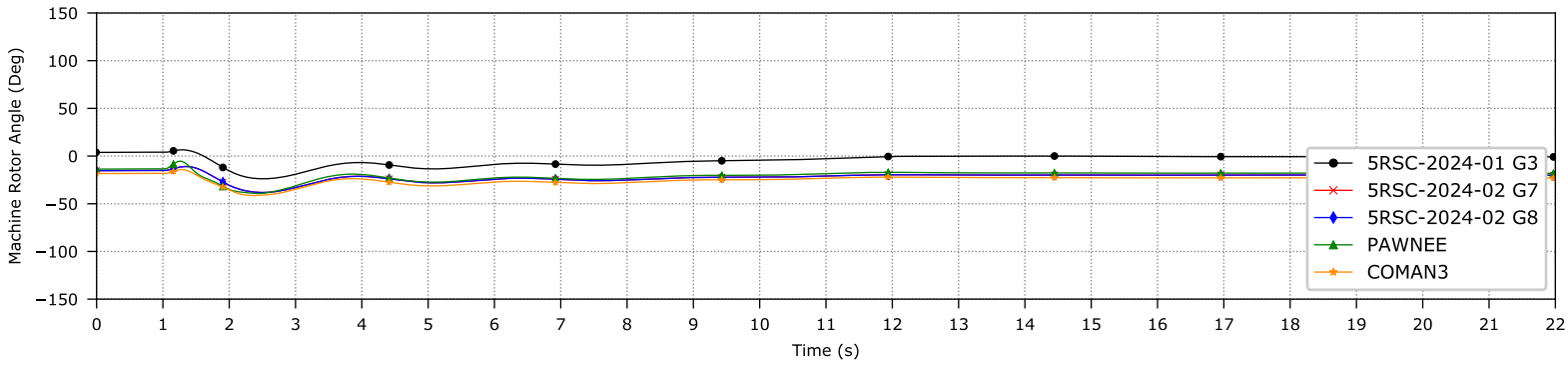


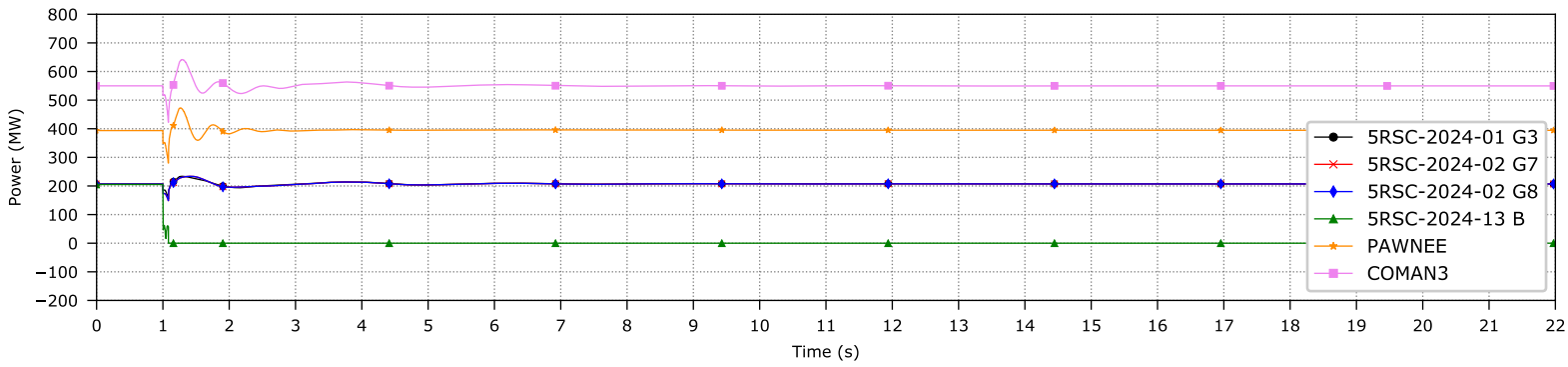


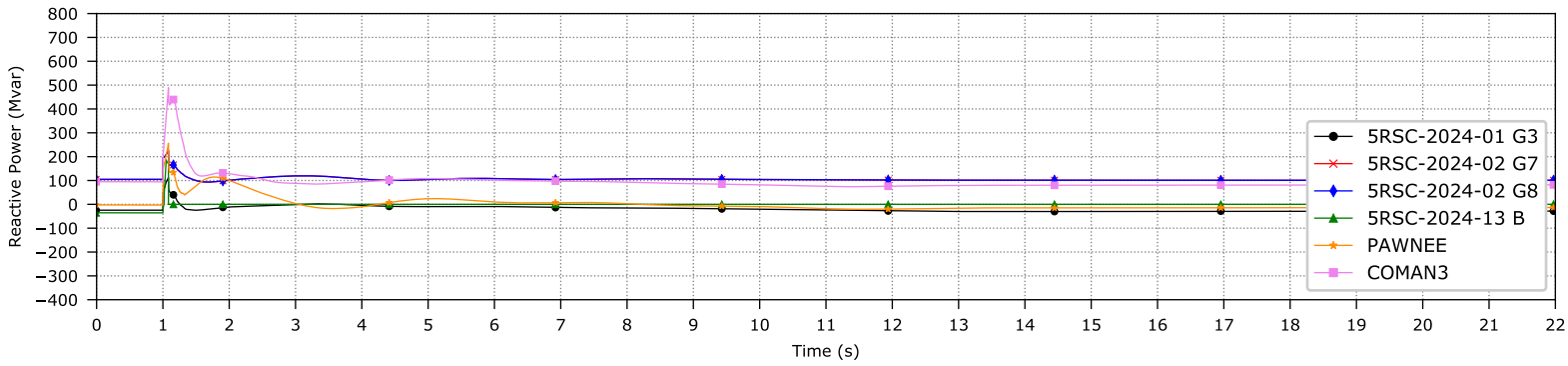


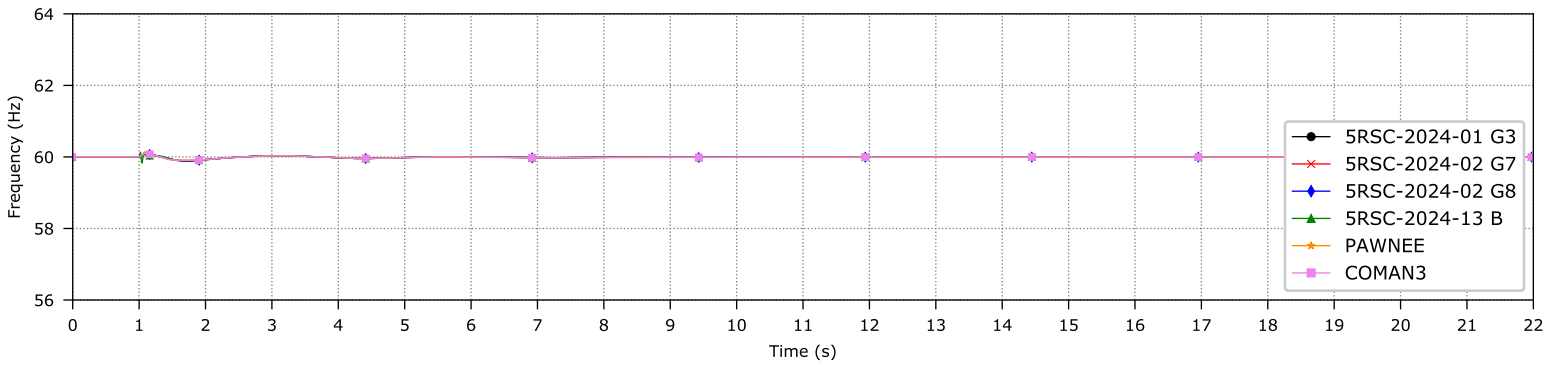


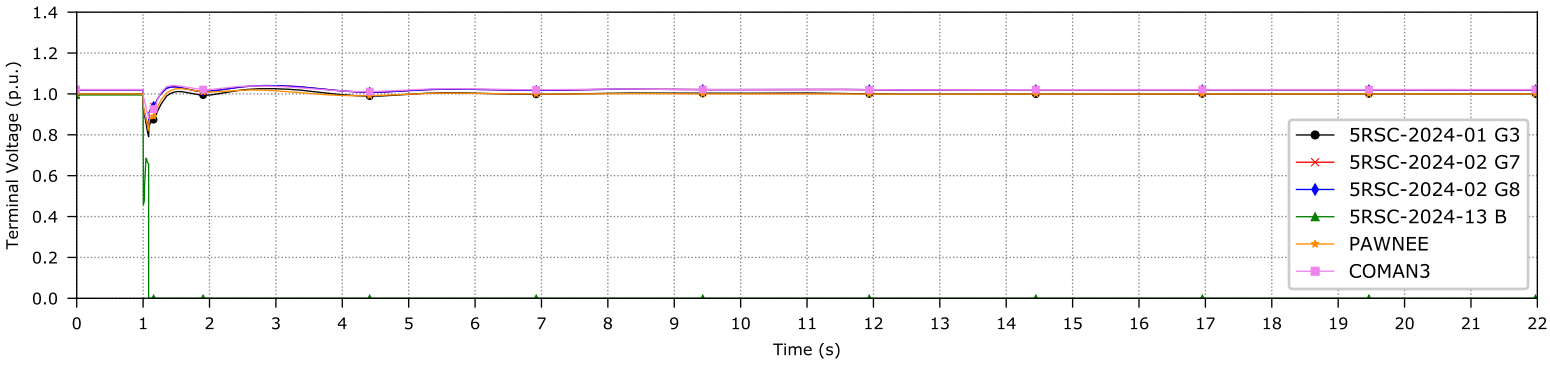
Ref. No. 33 - P7_93

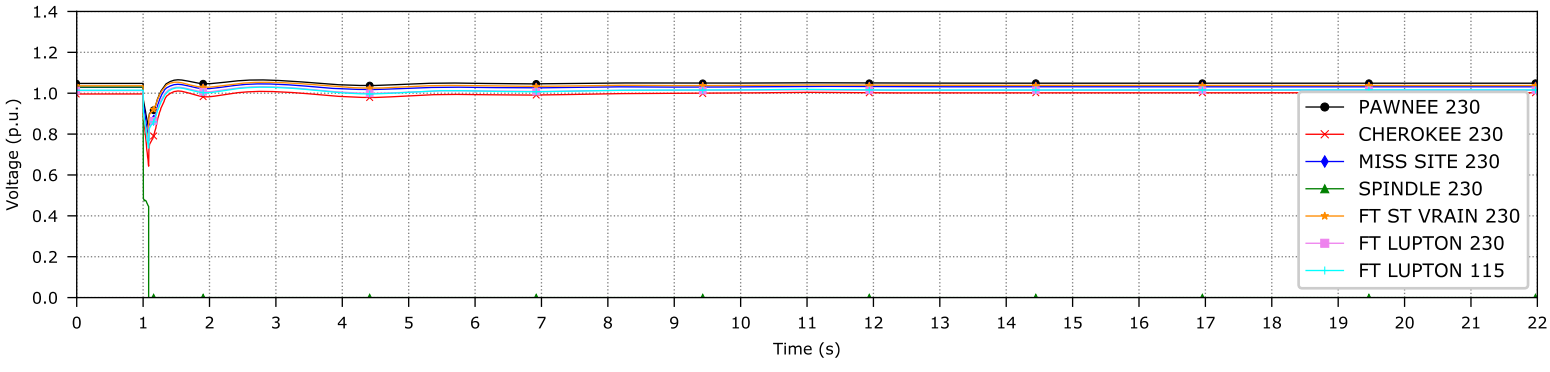




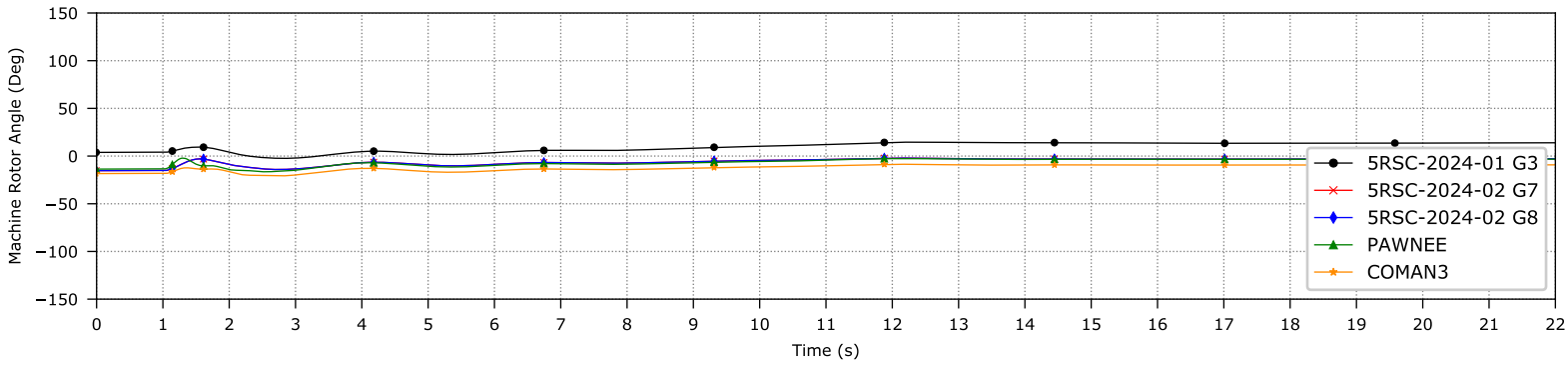


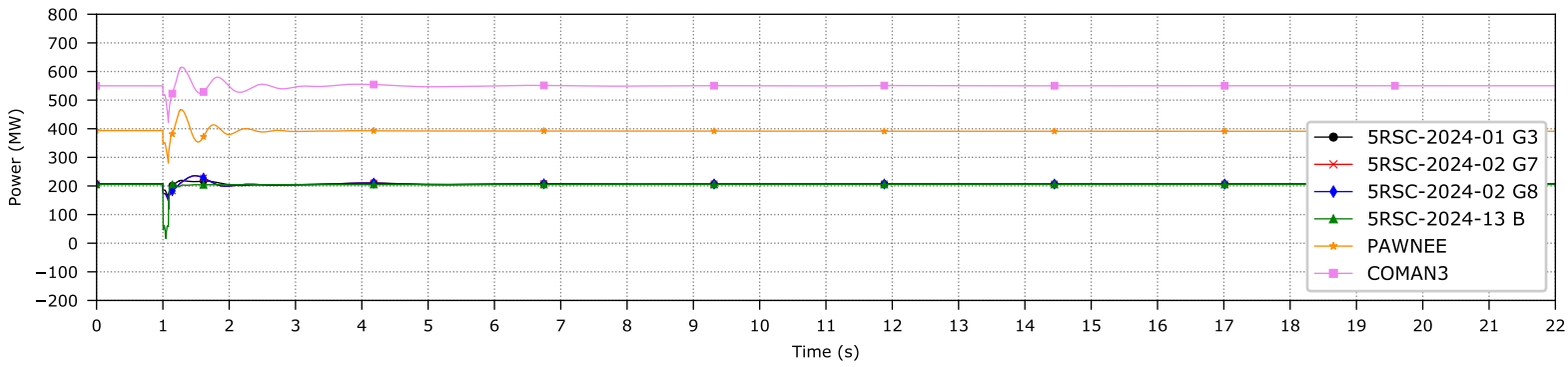


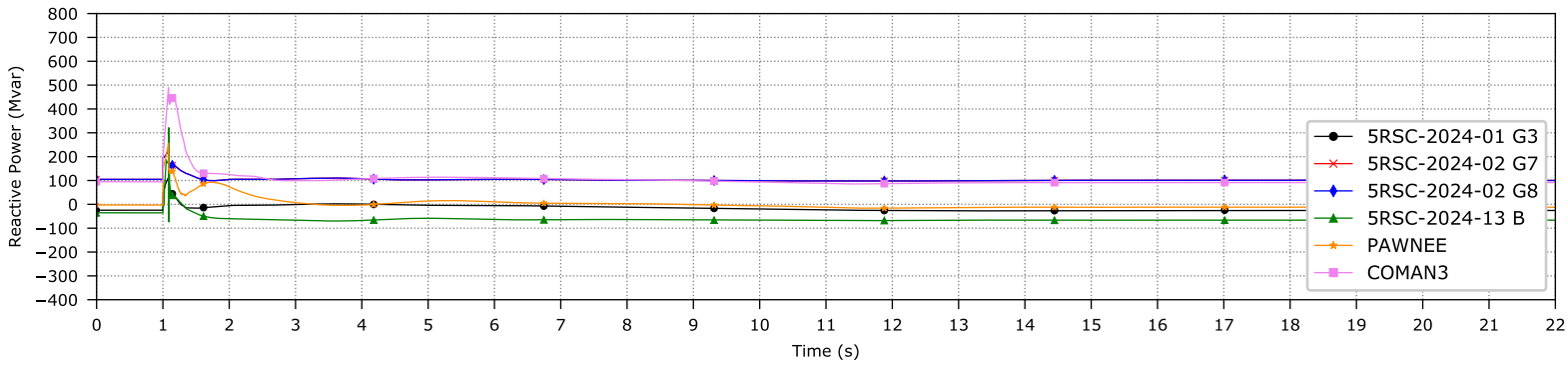


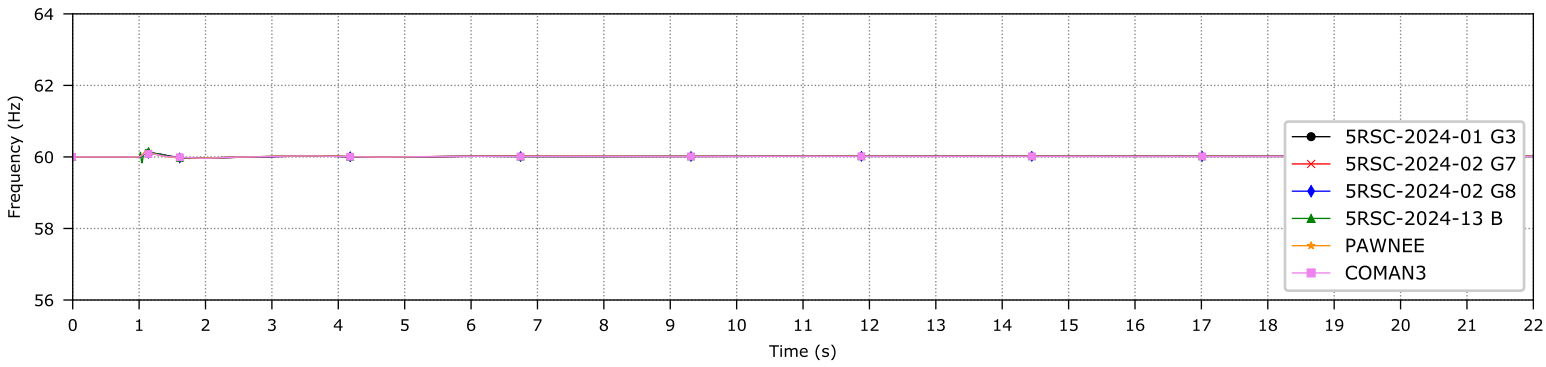


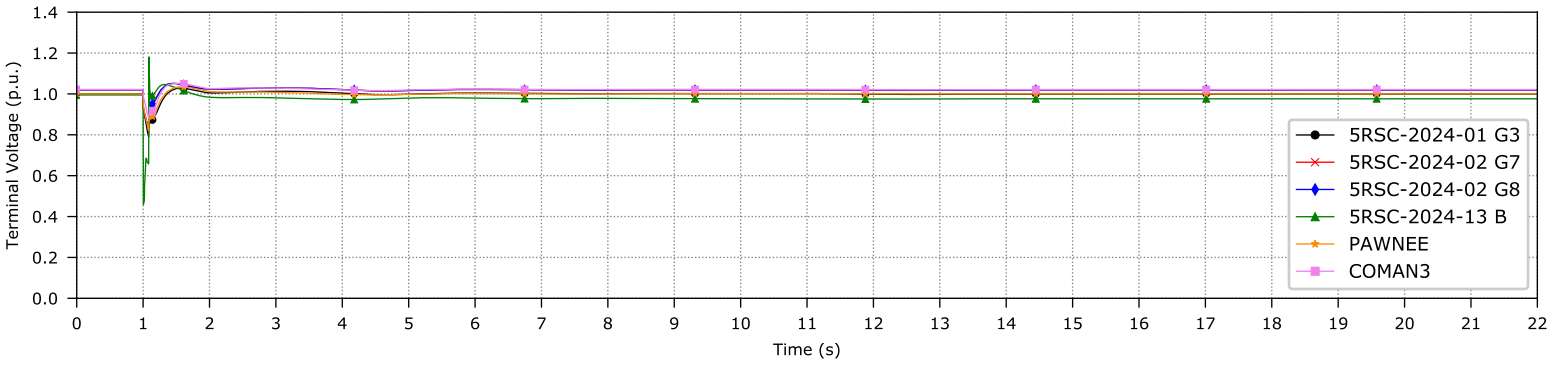
Ref. No. 34 - P7_119

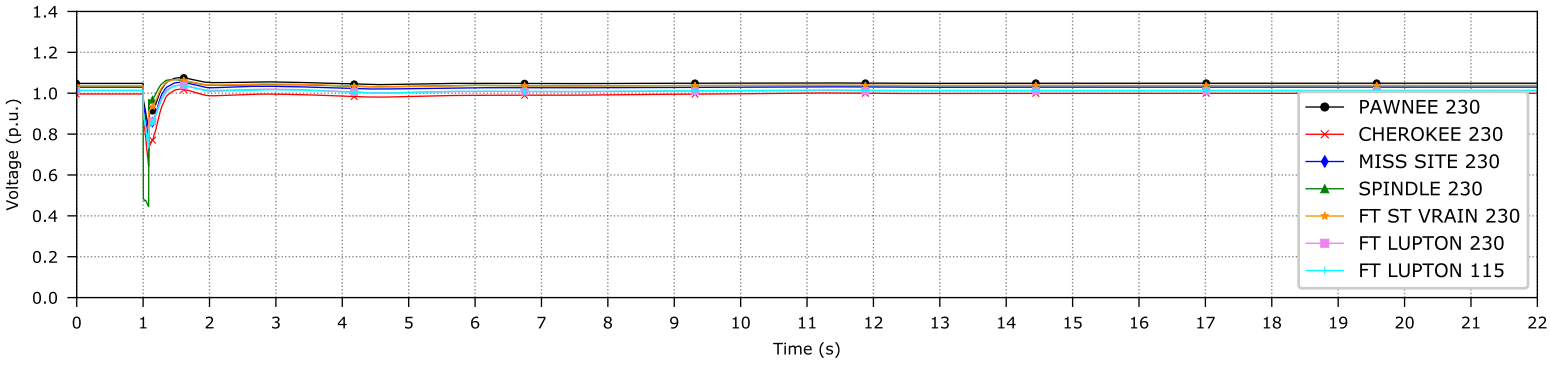




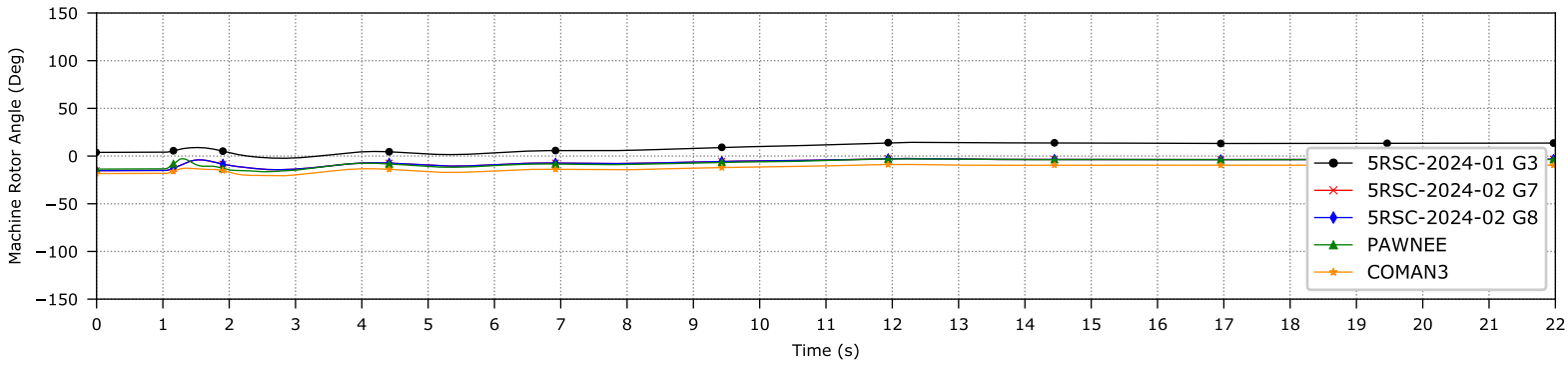


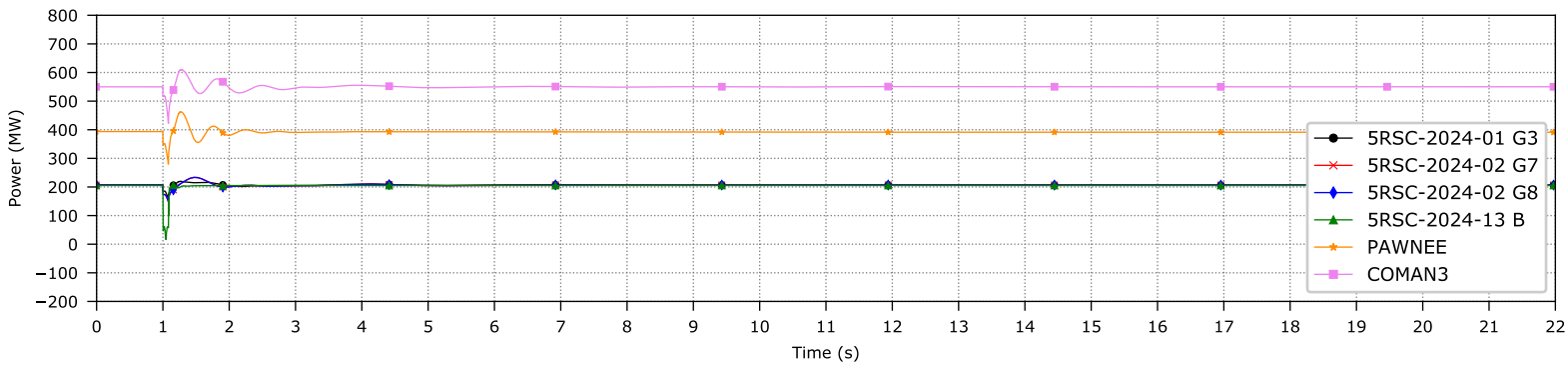


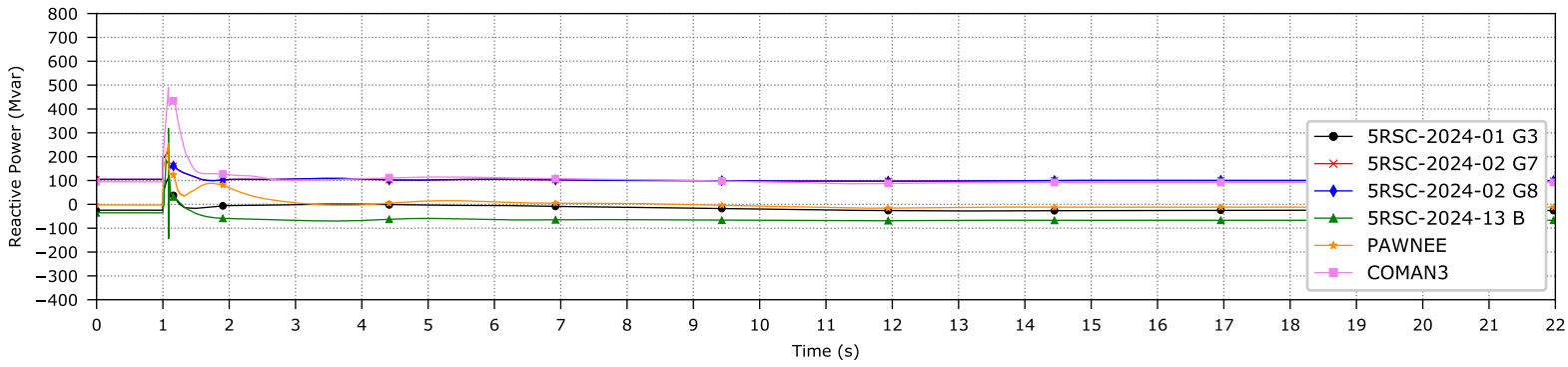


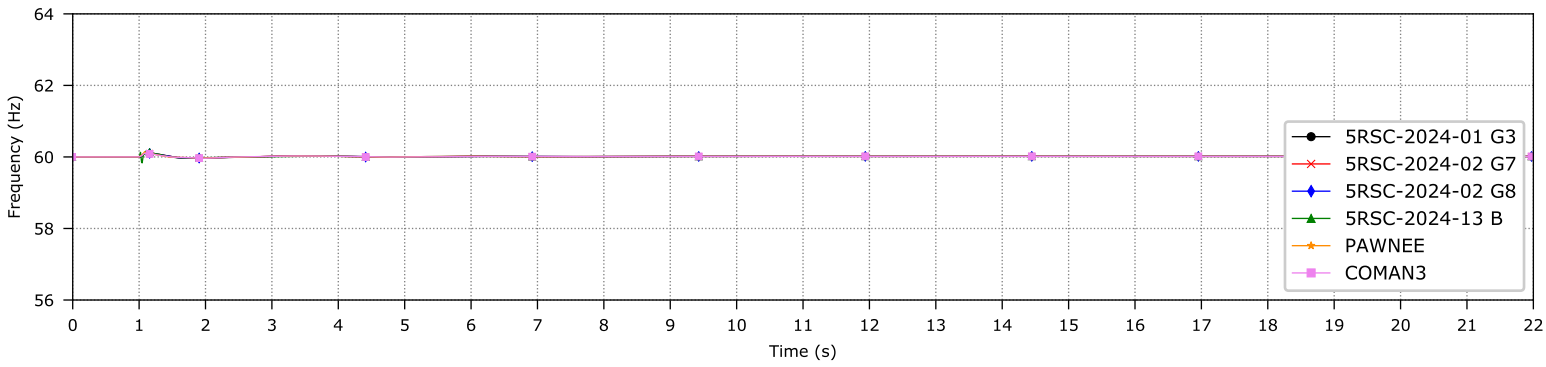


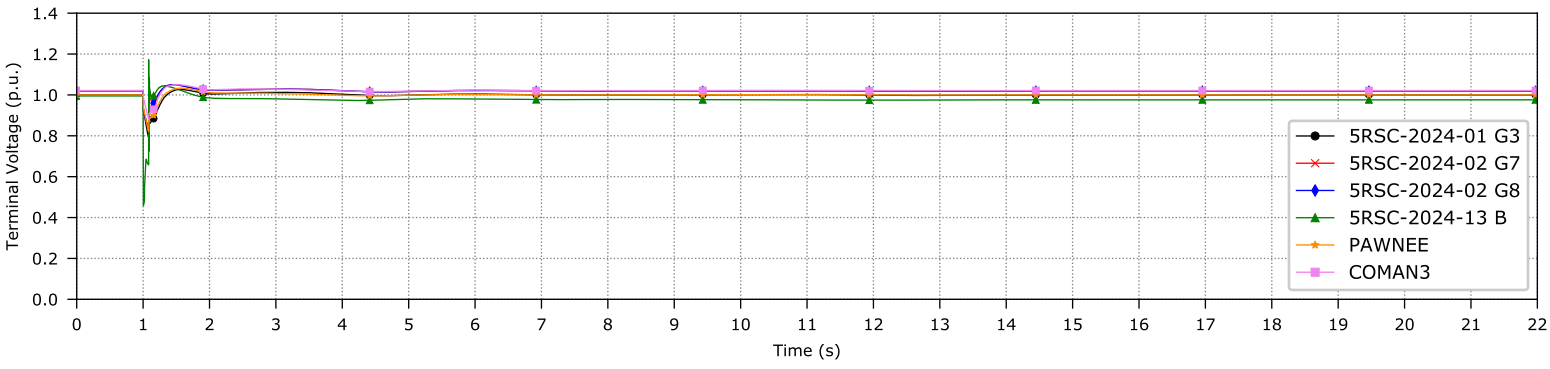
Ref. No. 35 - P7_138

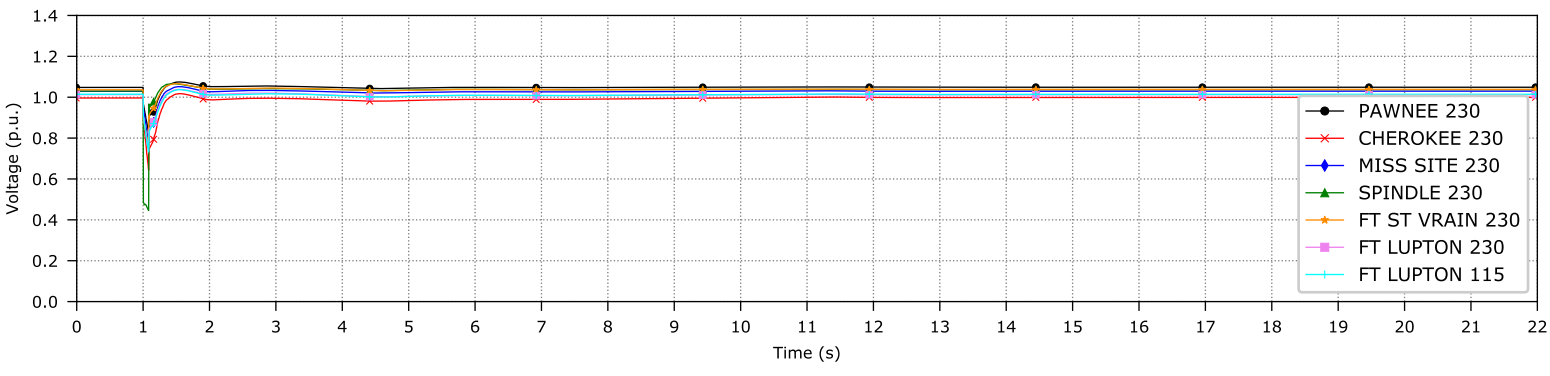






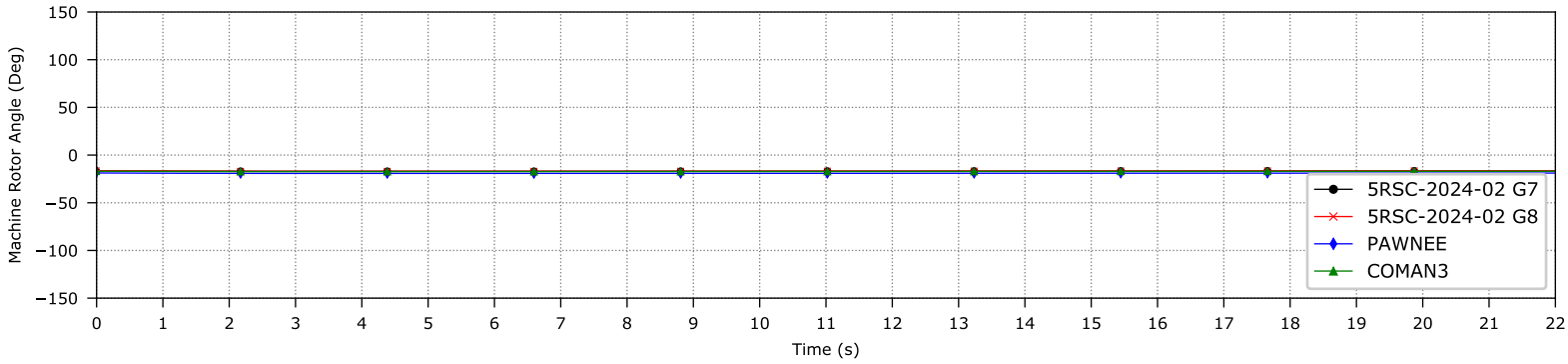


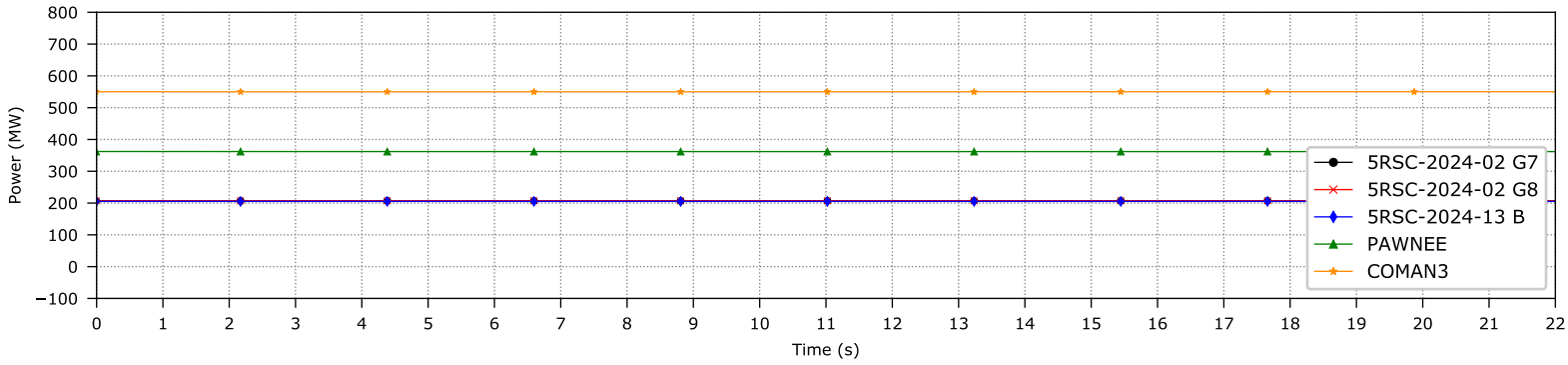


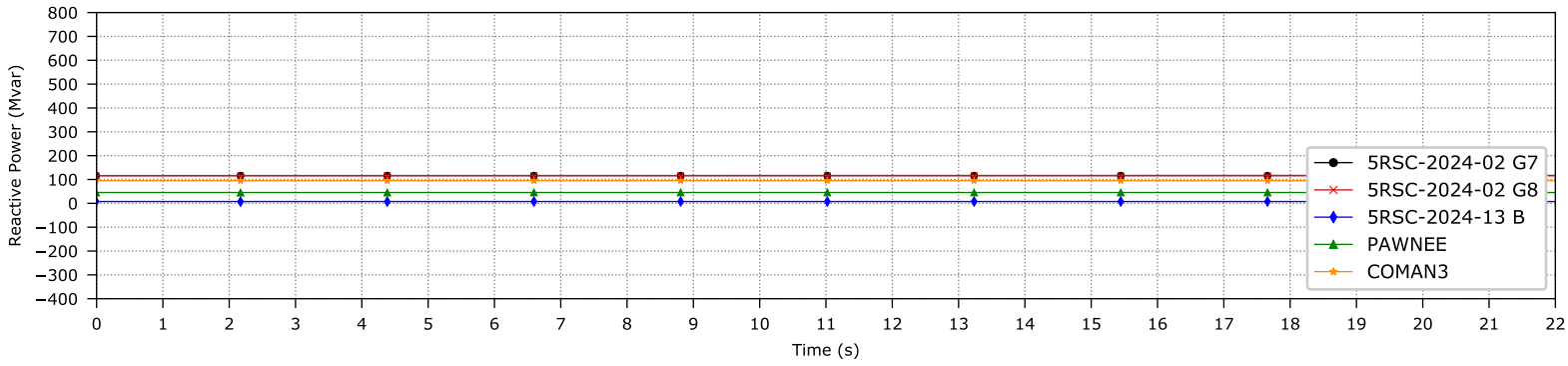


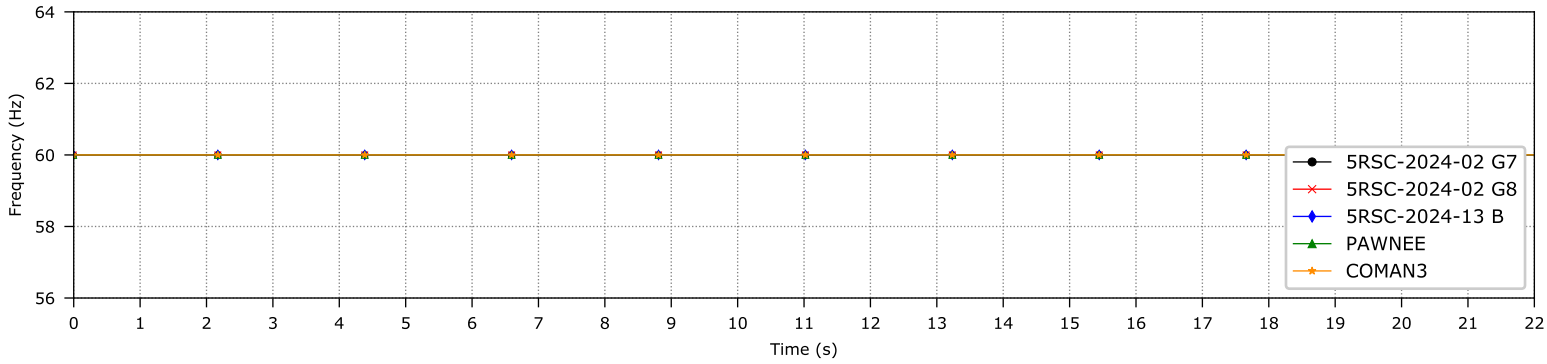
2027 NORTH PORTFOLIO 2 – TRANSIENT STABILITY PLOTS

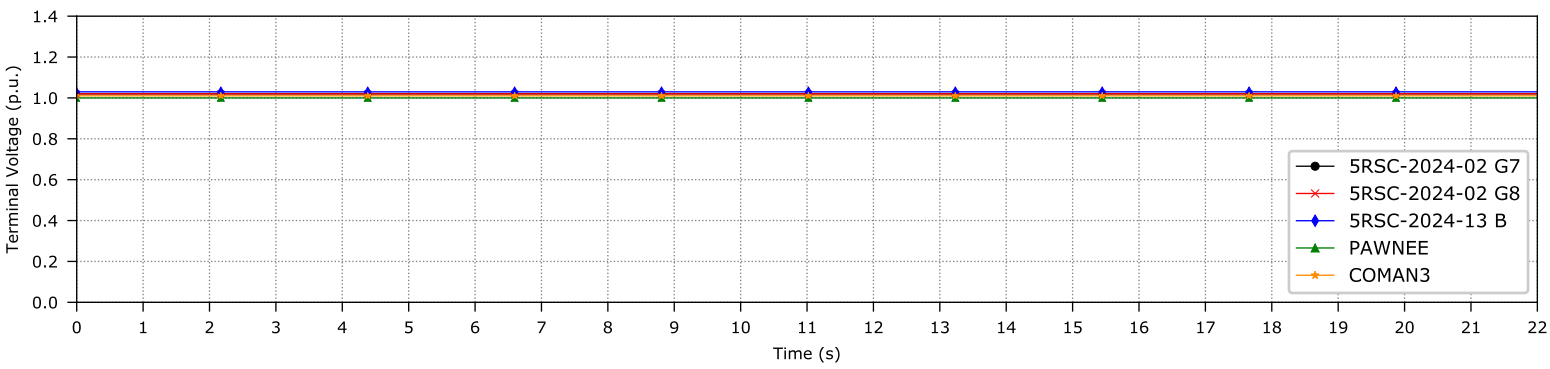
Ref. No. 01 - Flatrun

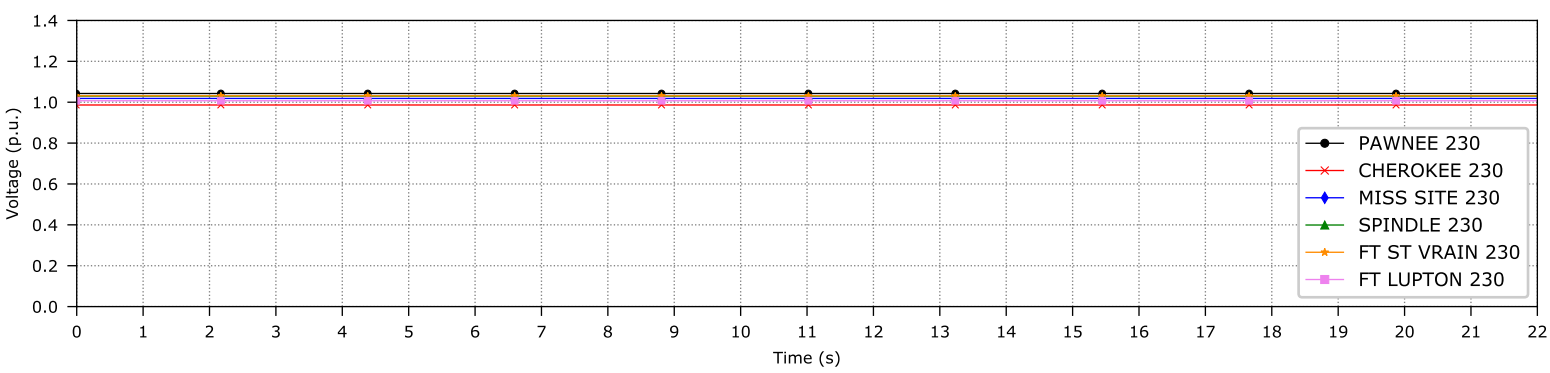




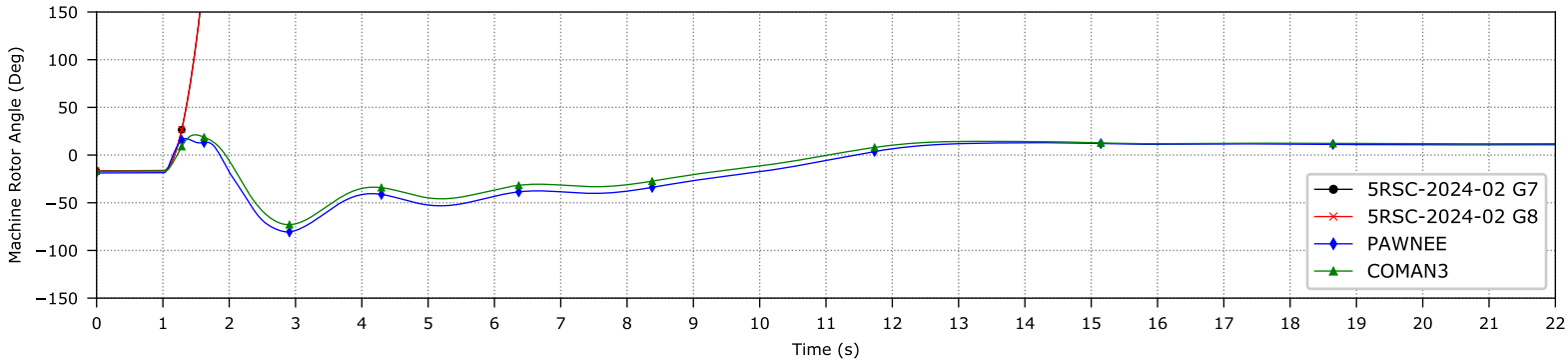


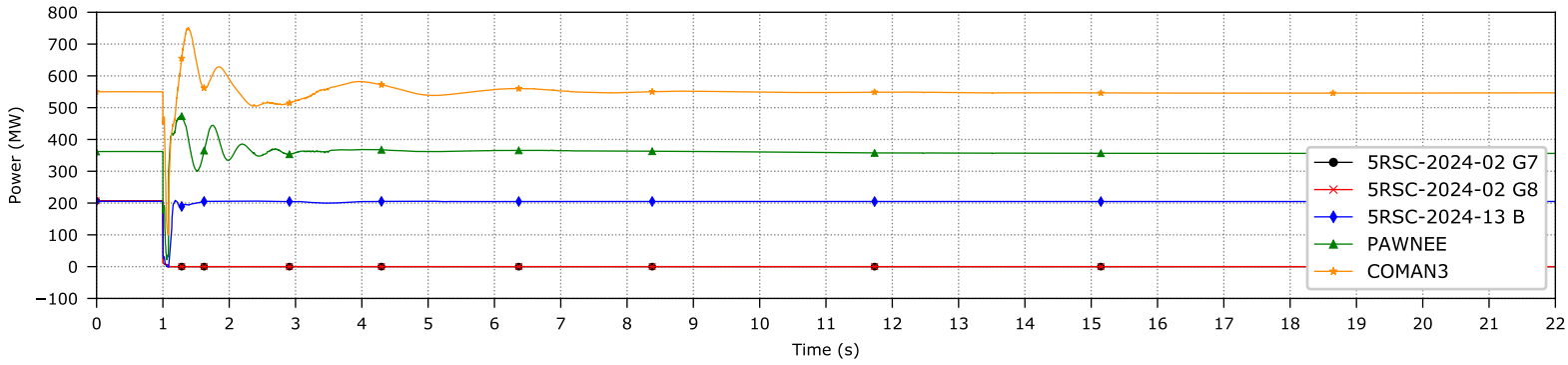


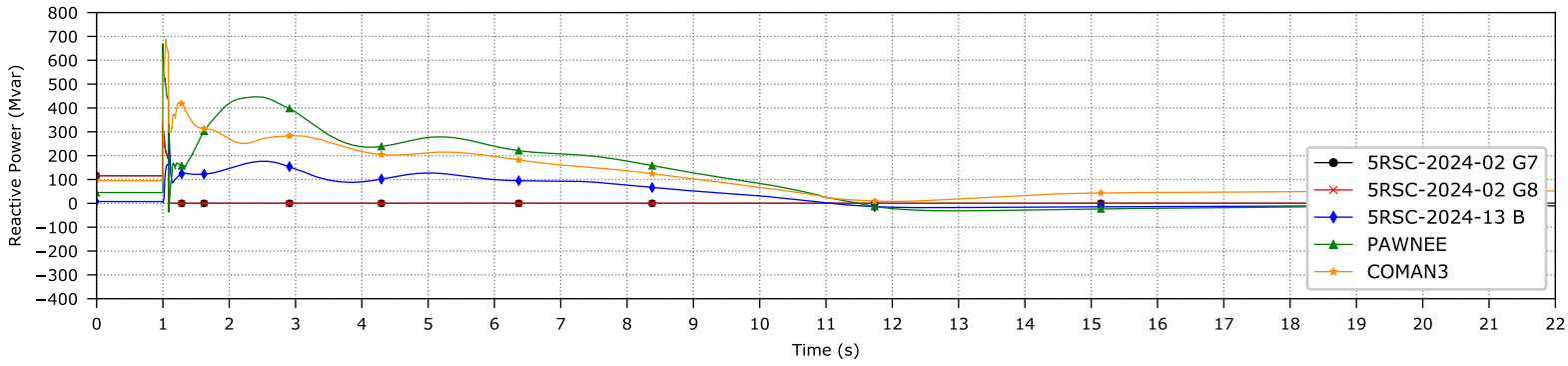


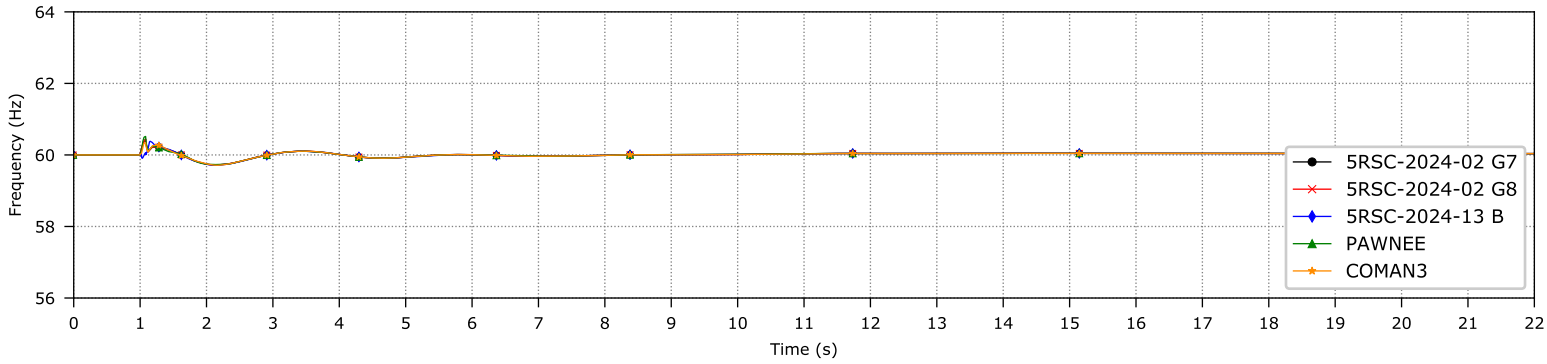


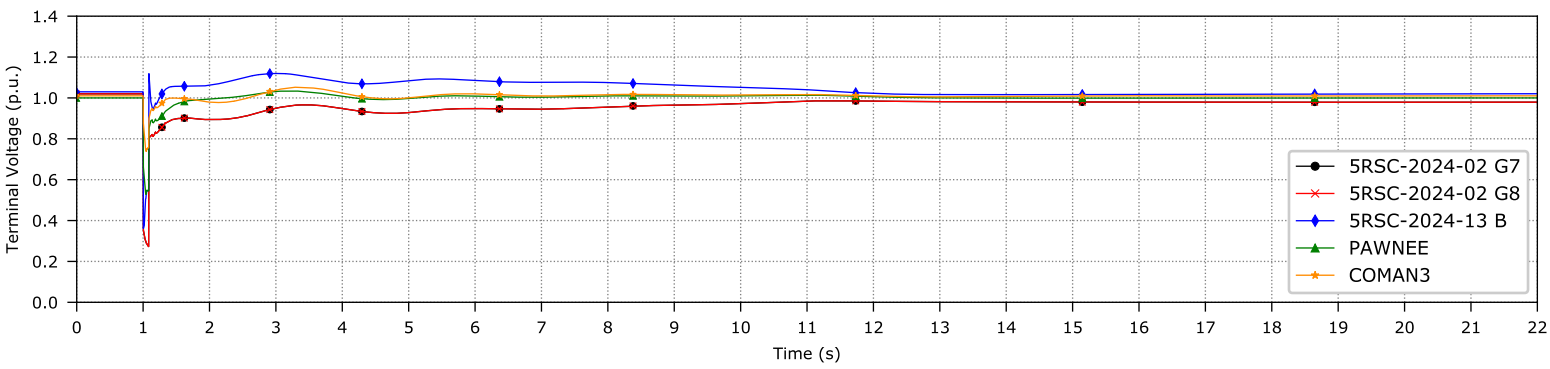
Ref. No. 03 - 5RSC-2024-02

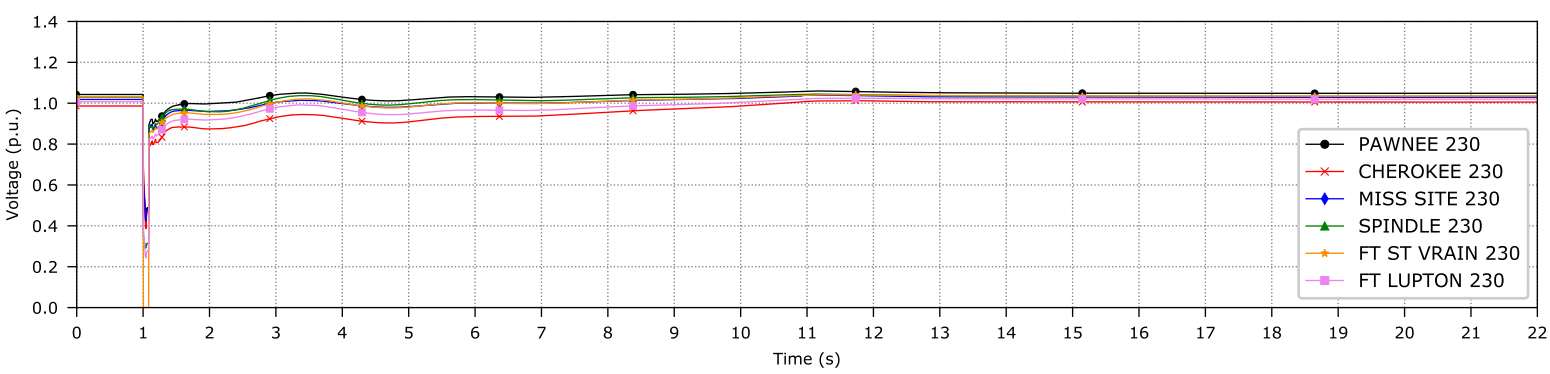




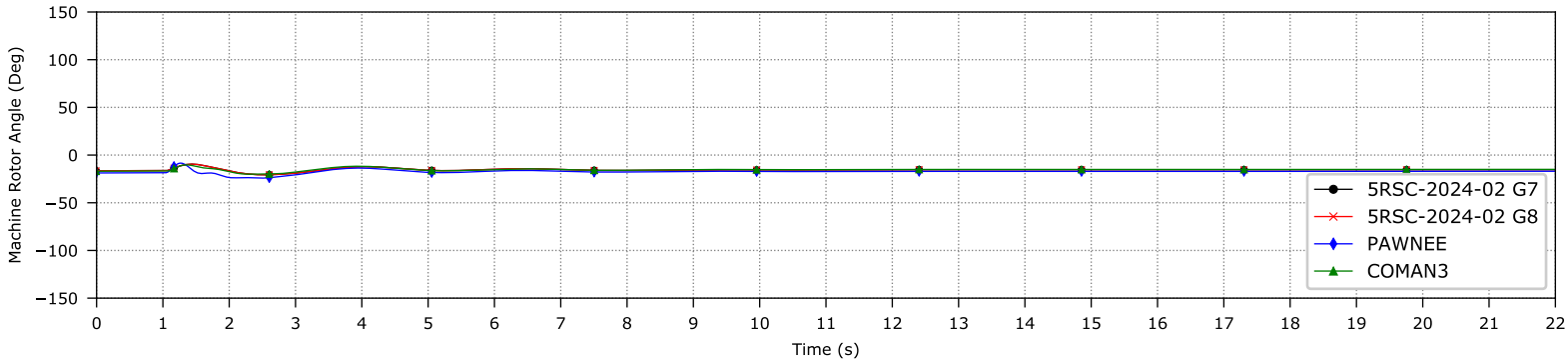


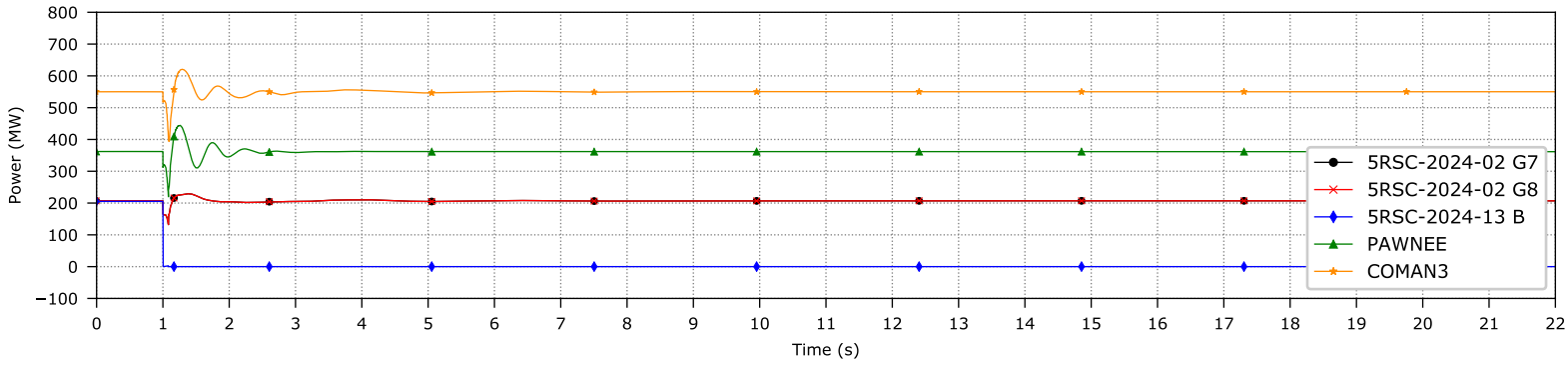


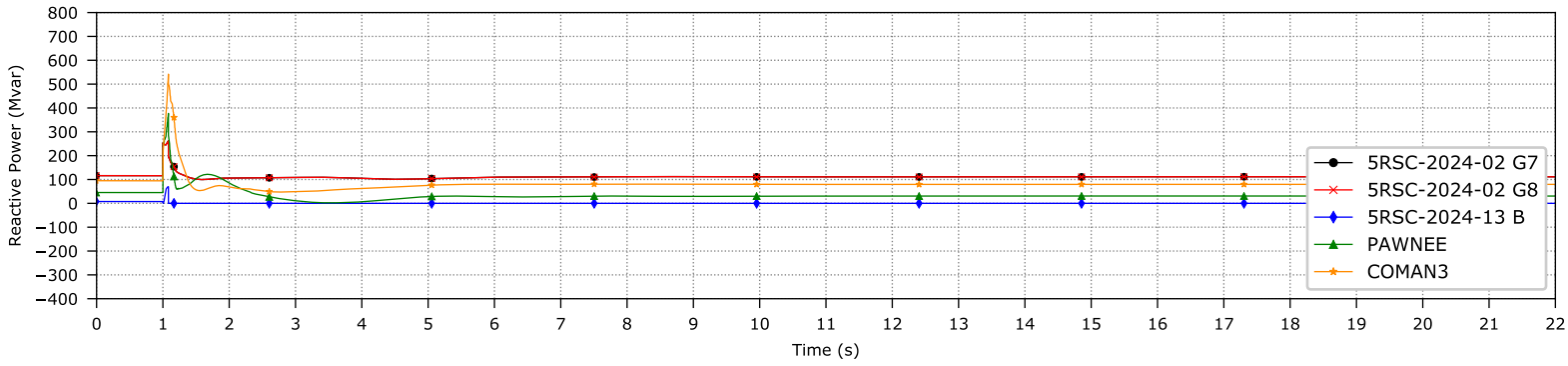


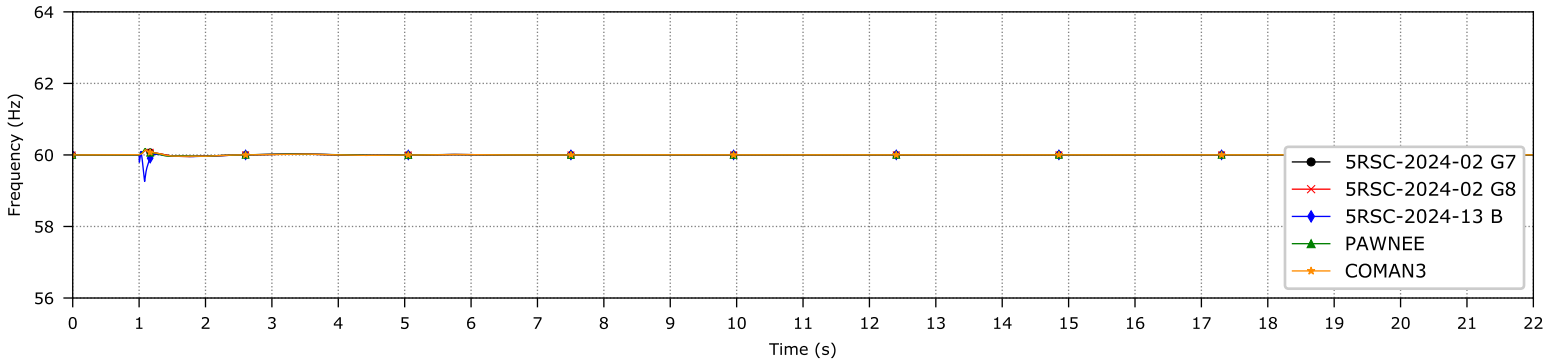


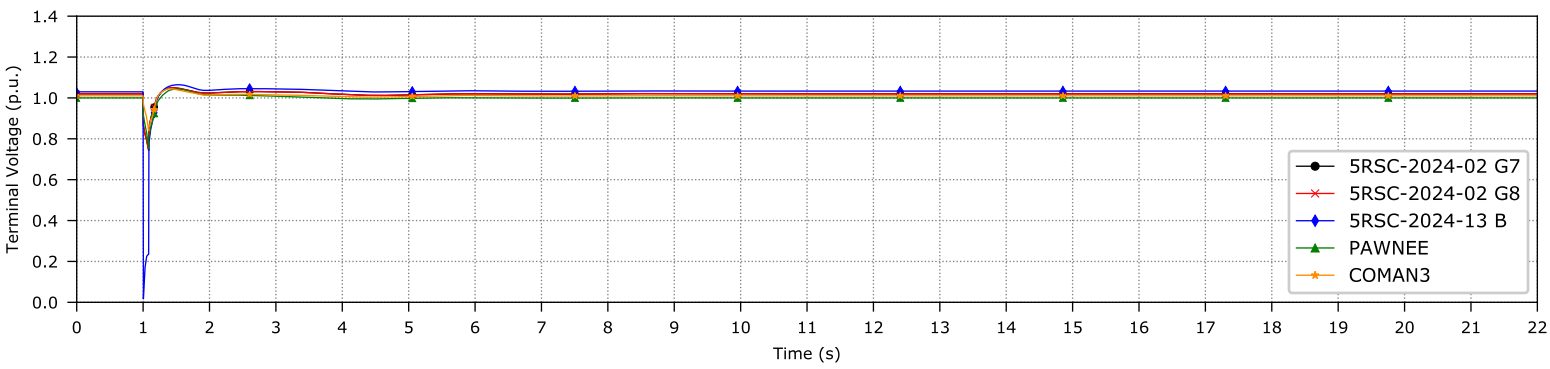
Ref. No. 04 - 5RSC-2024-13

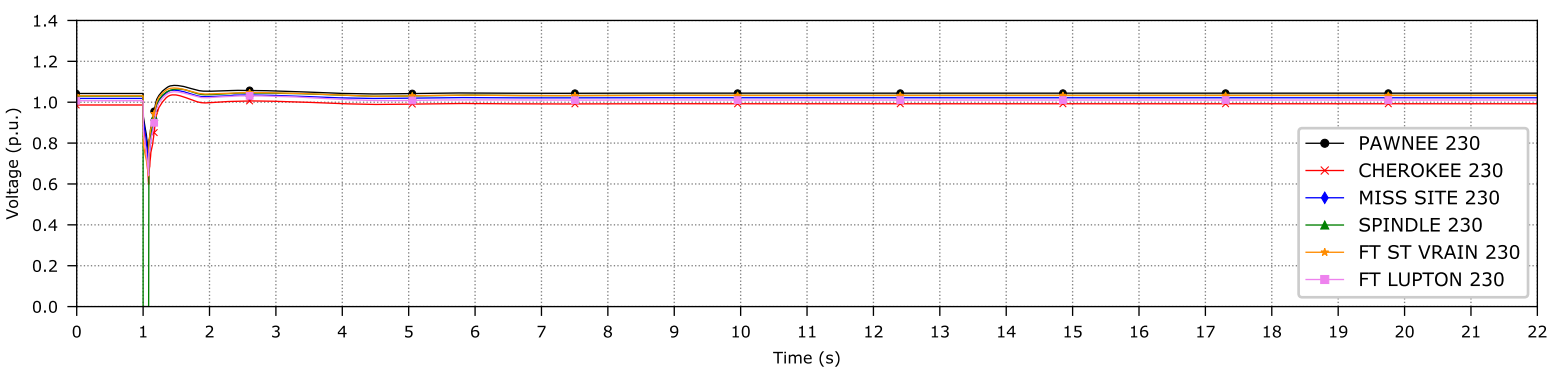




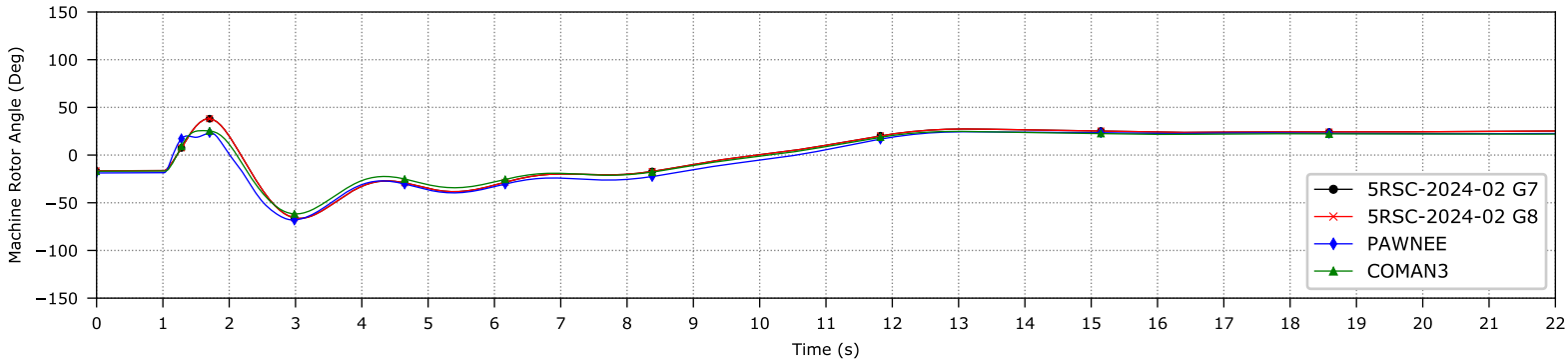


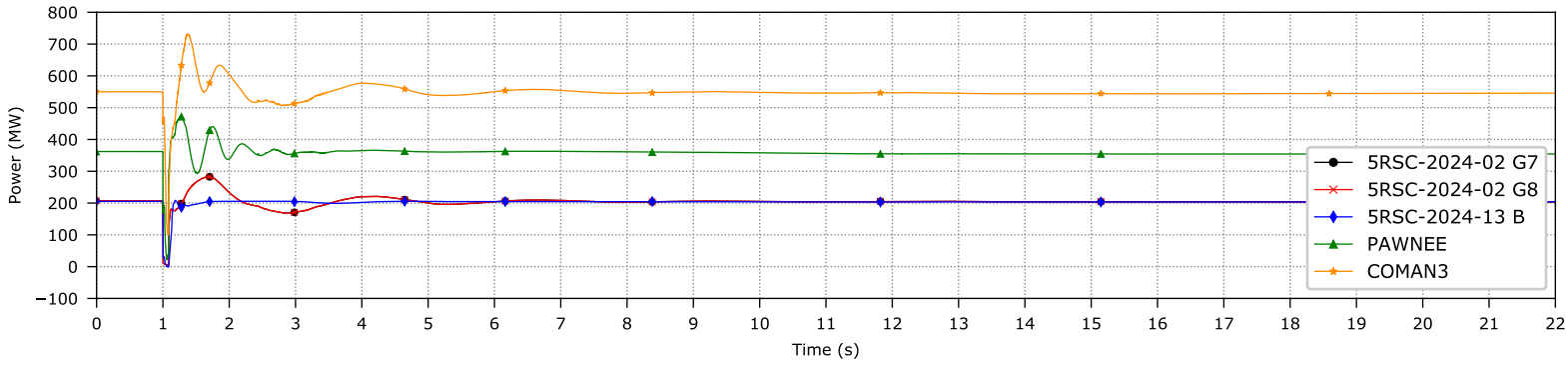


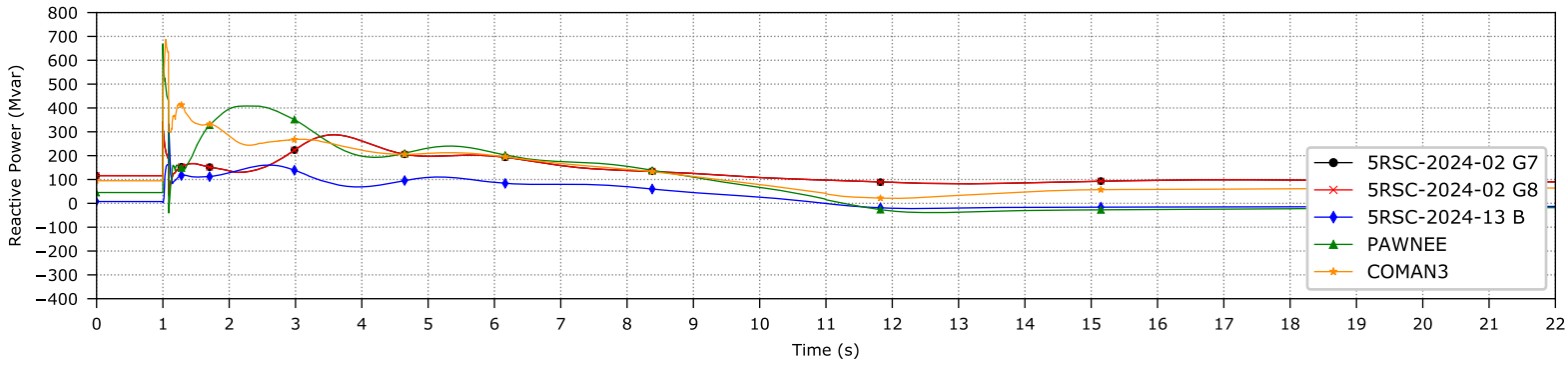


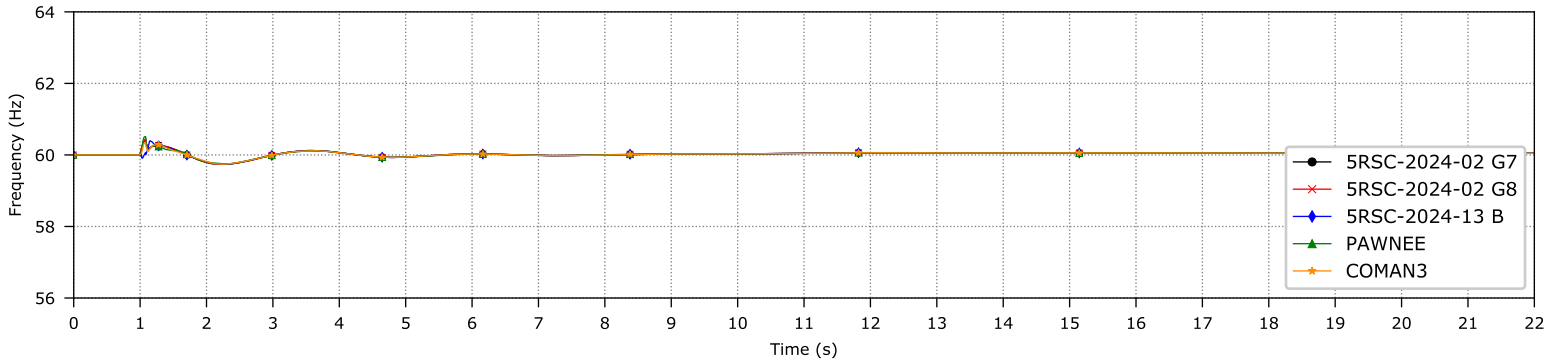


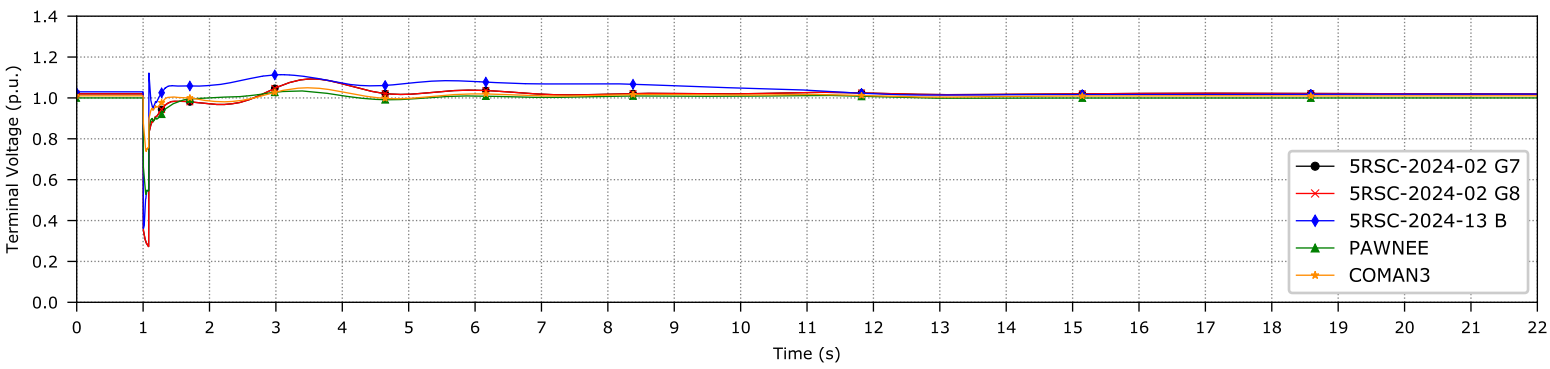
Ref. No. 05 - LoTC_59

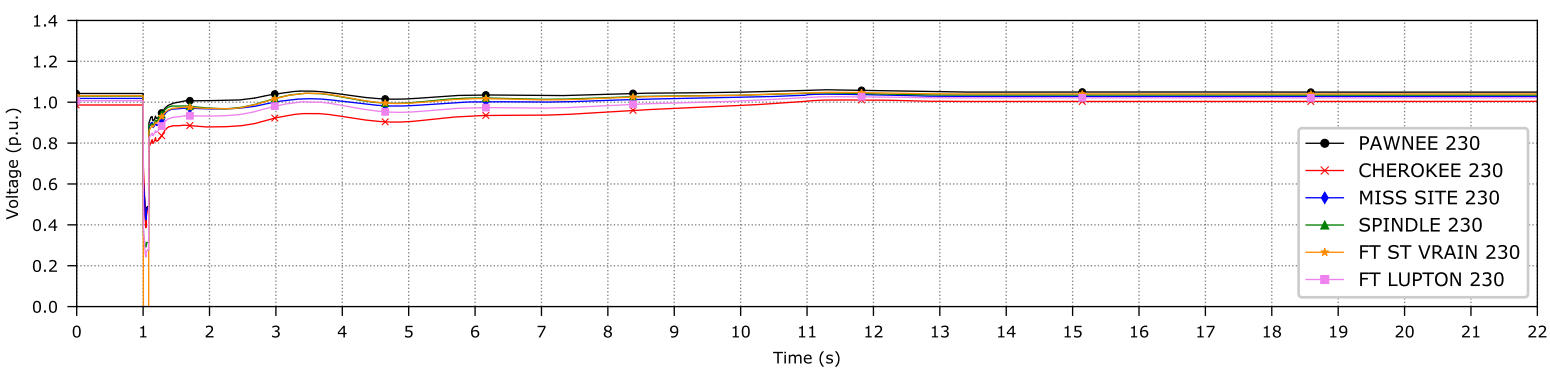




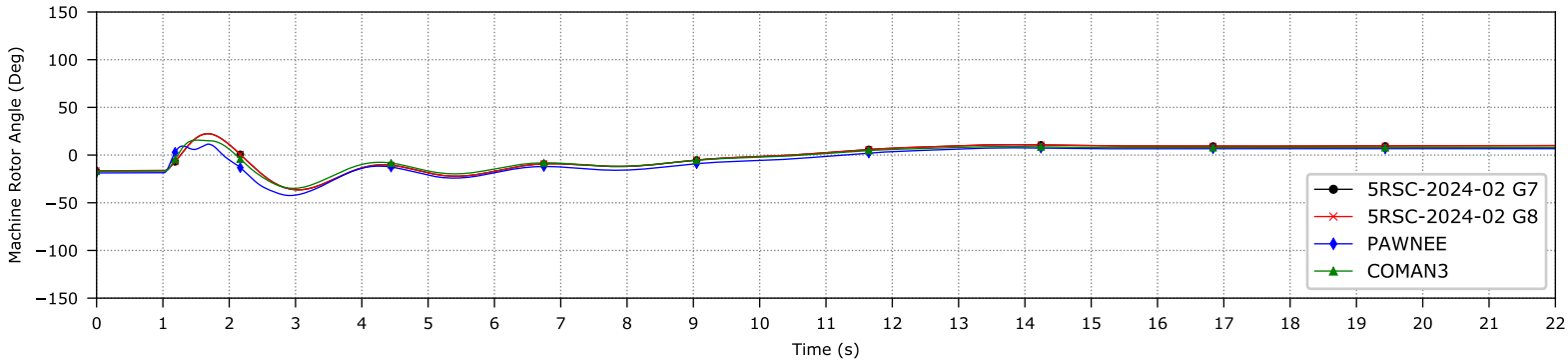


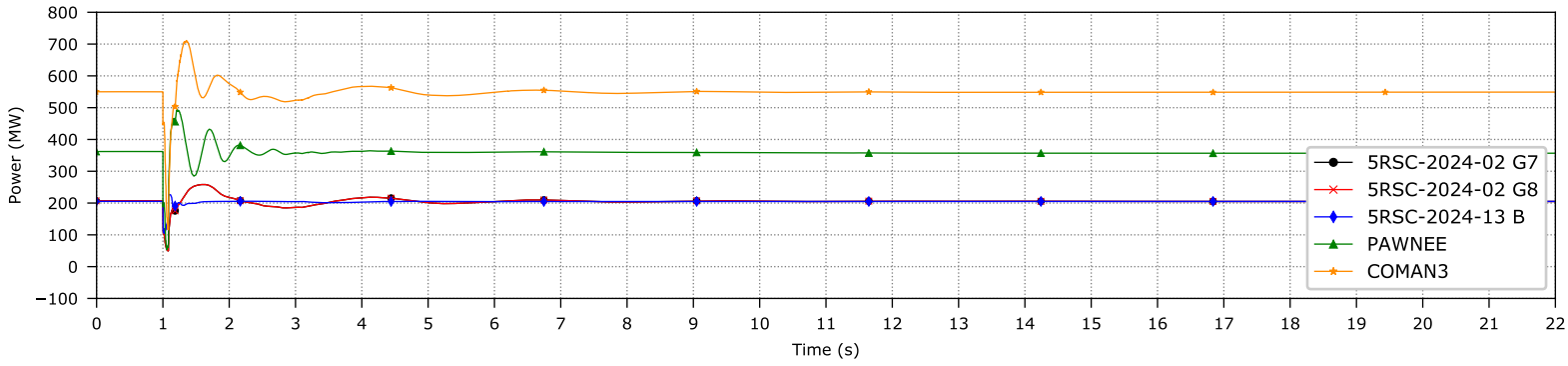


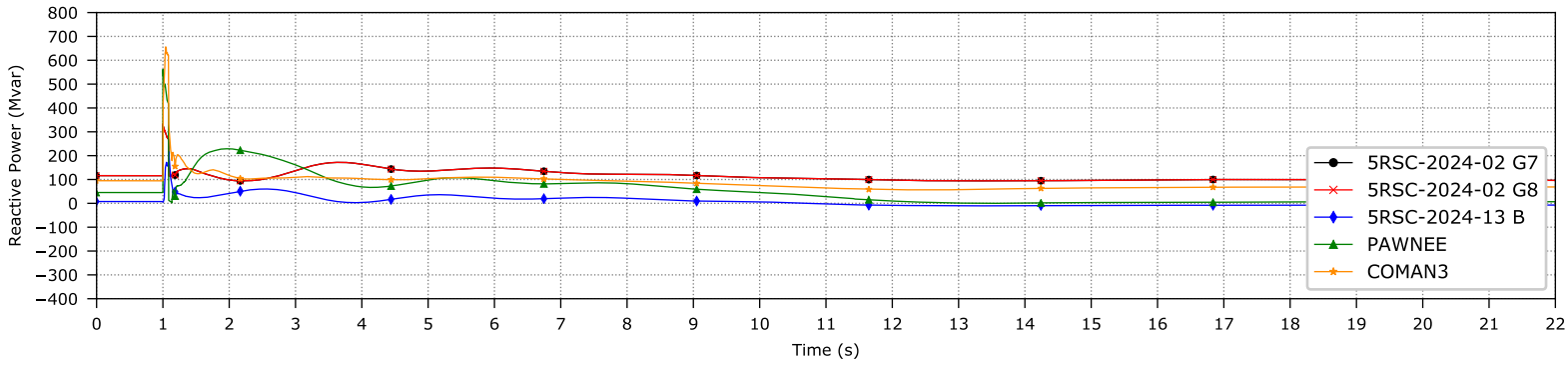


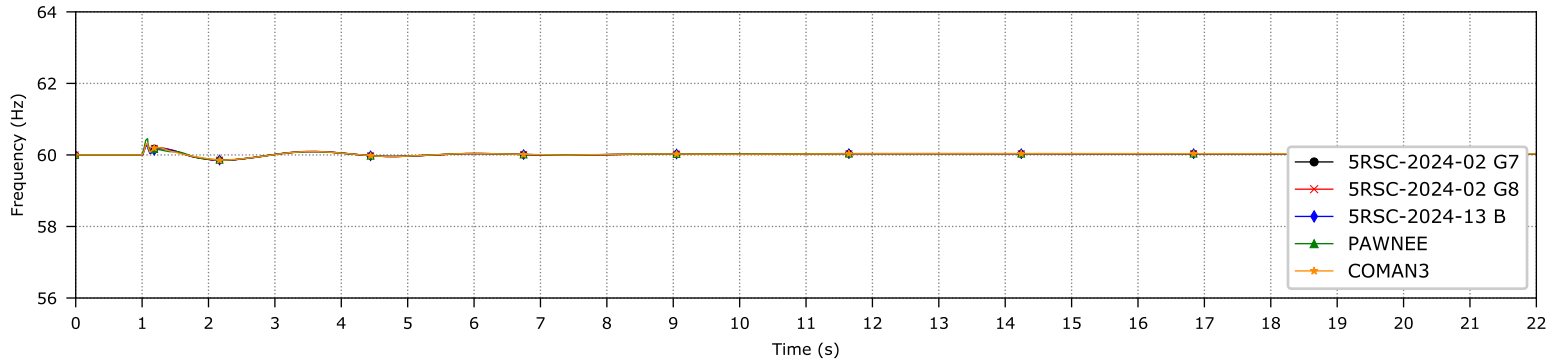


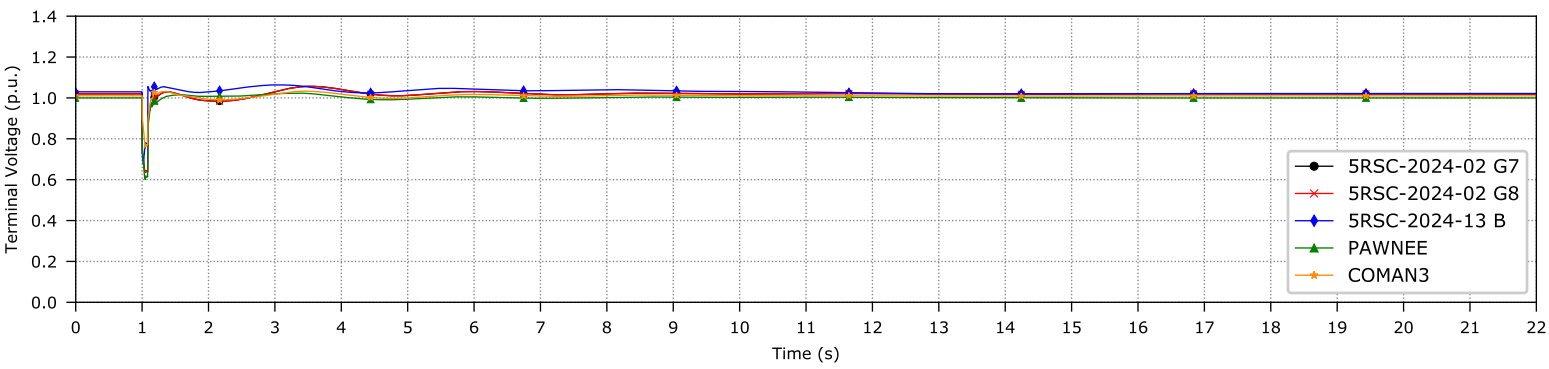
Ref. No. 06 - LoTC_62

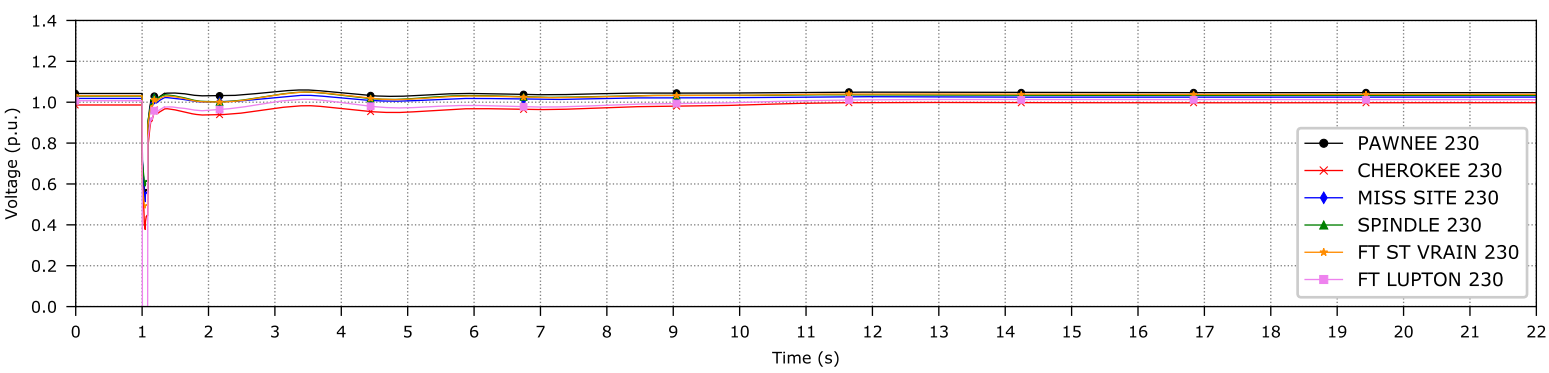




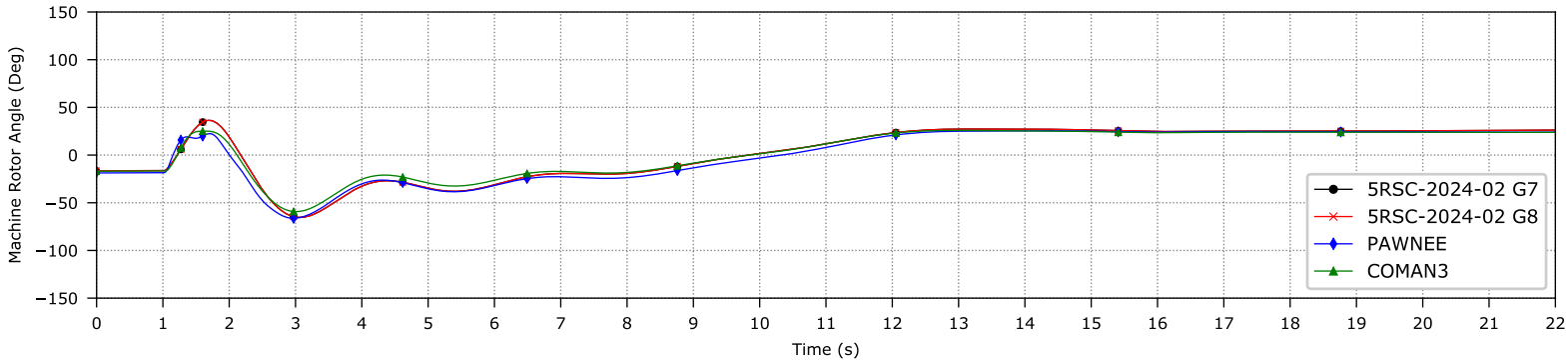


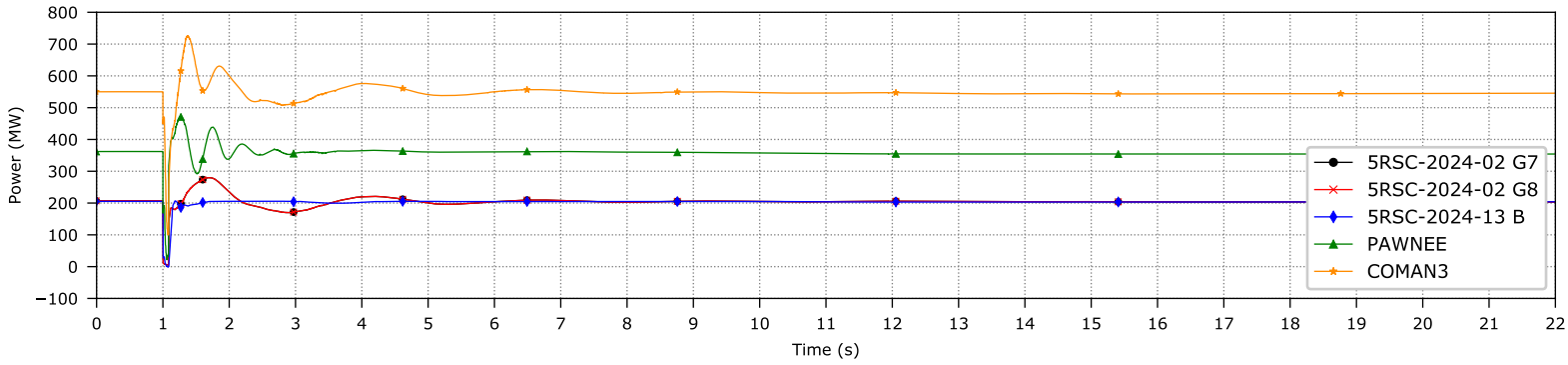


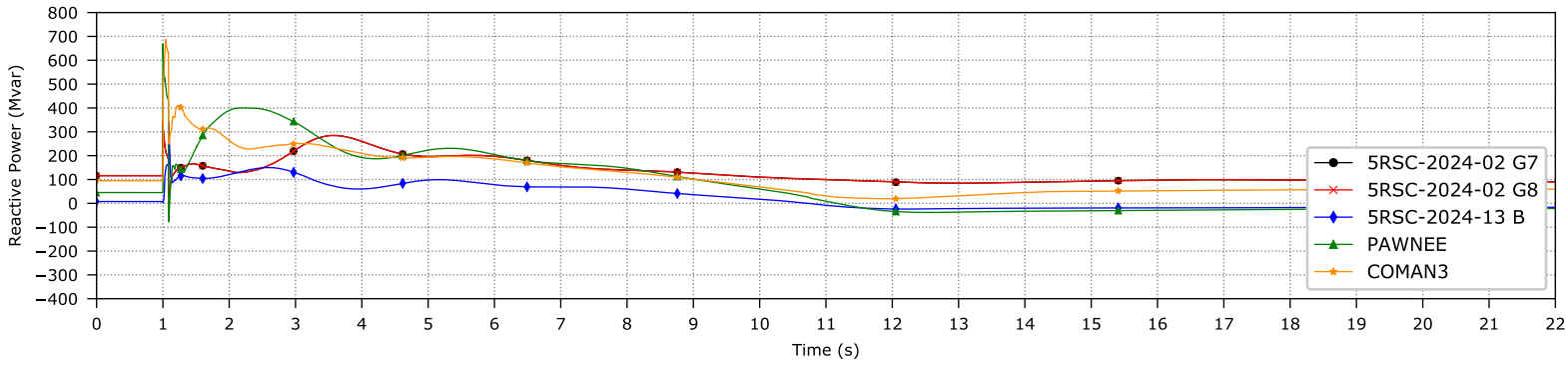


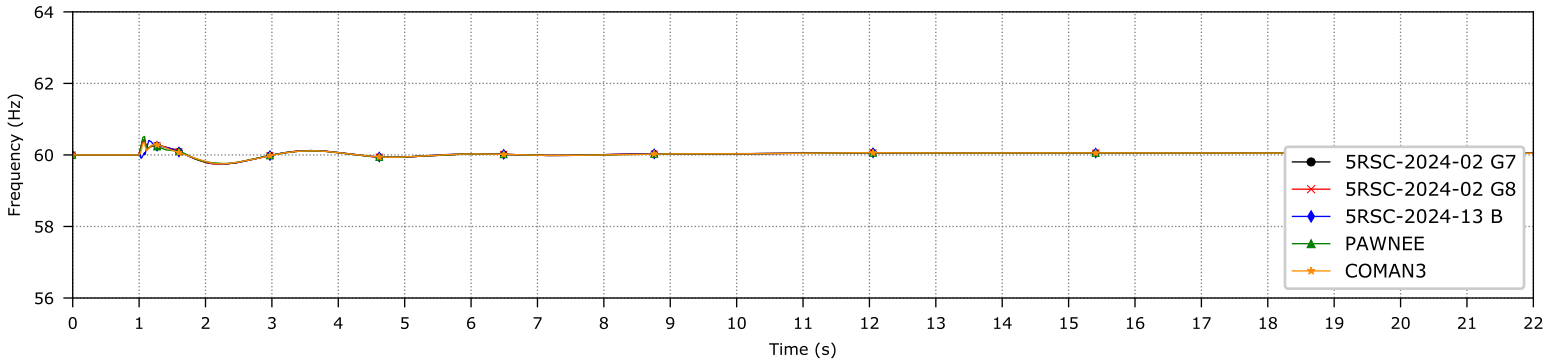


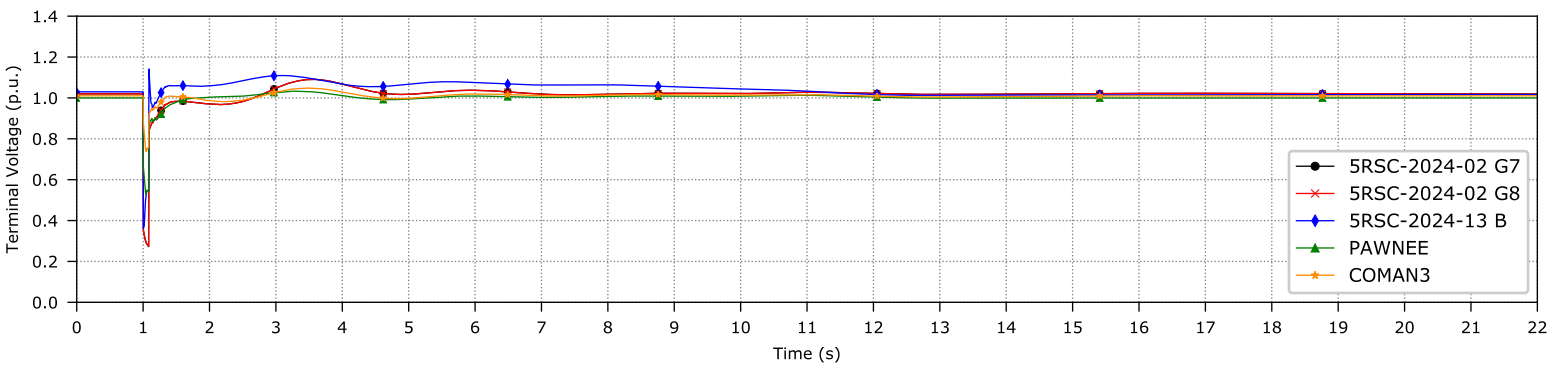
Ref. No. 07 - LoTC_63

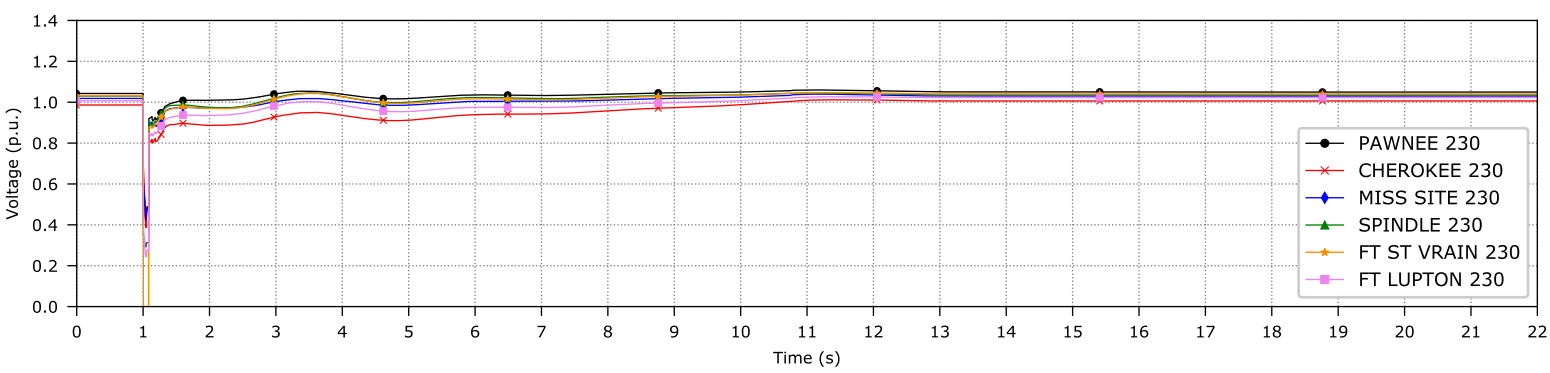


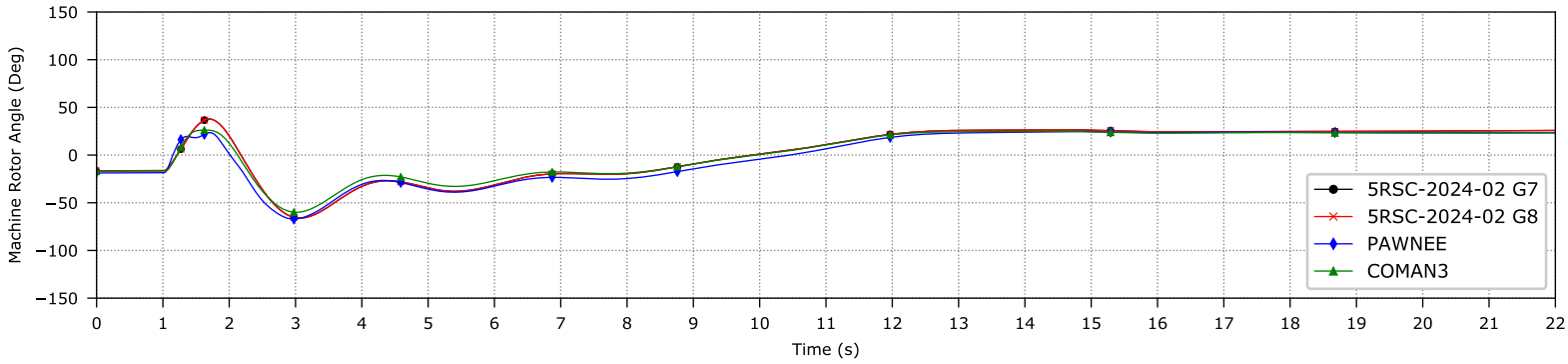


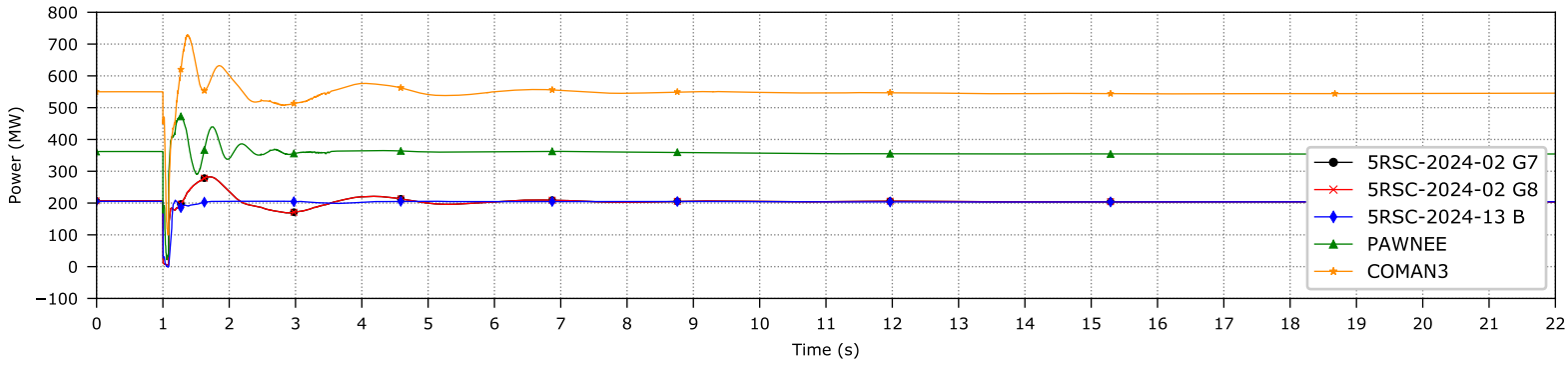


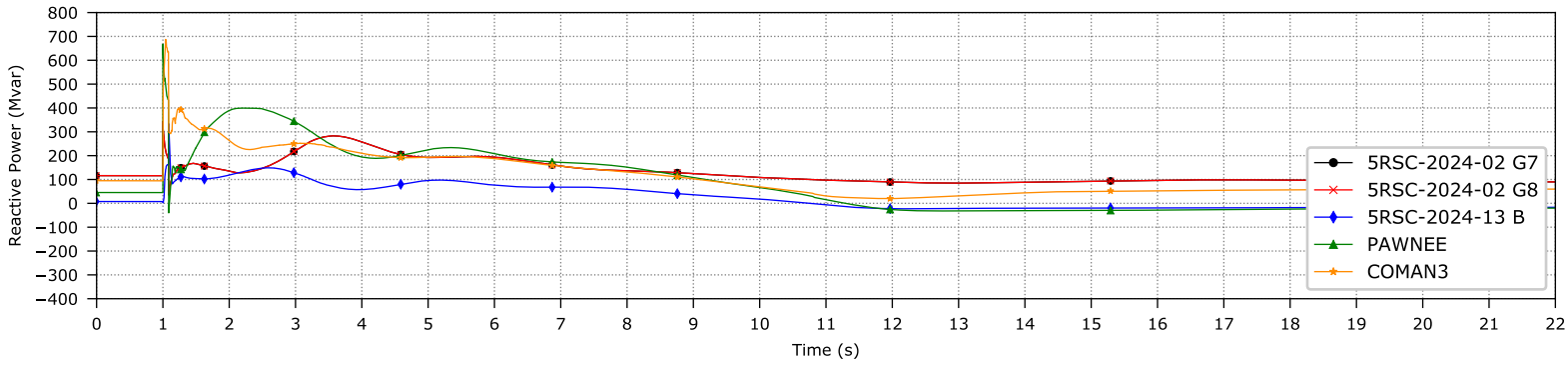


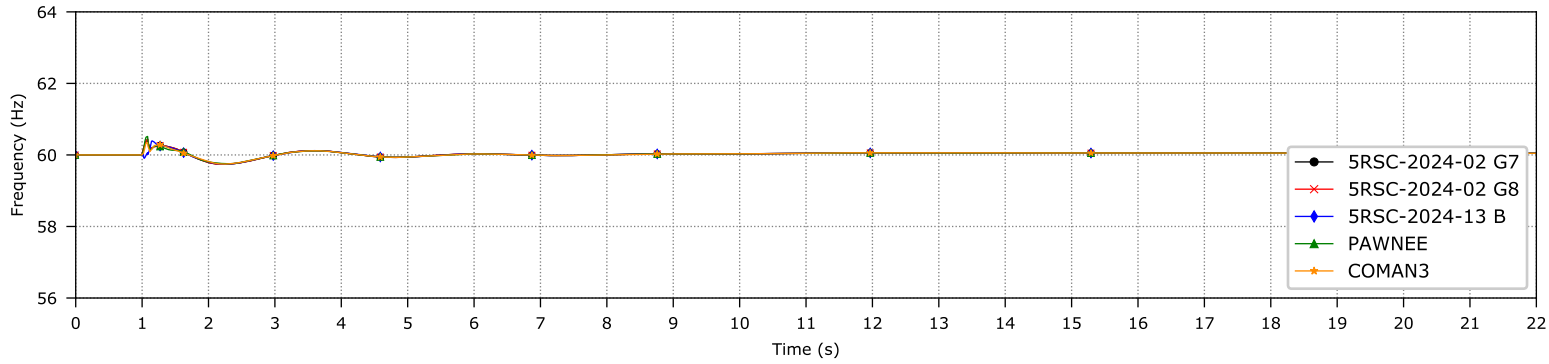


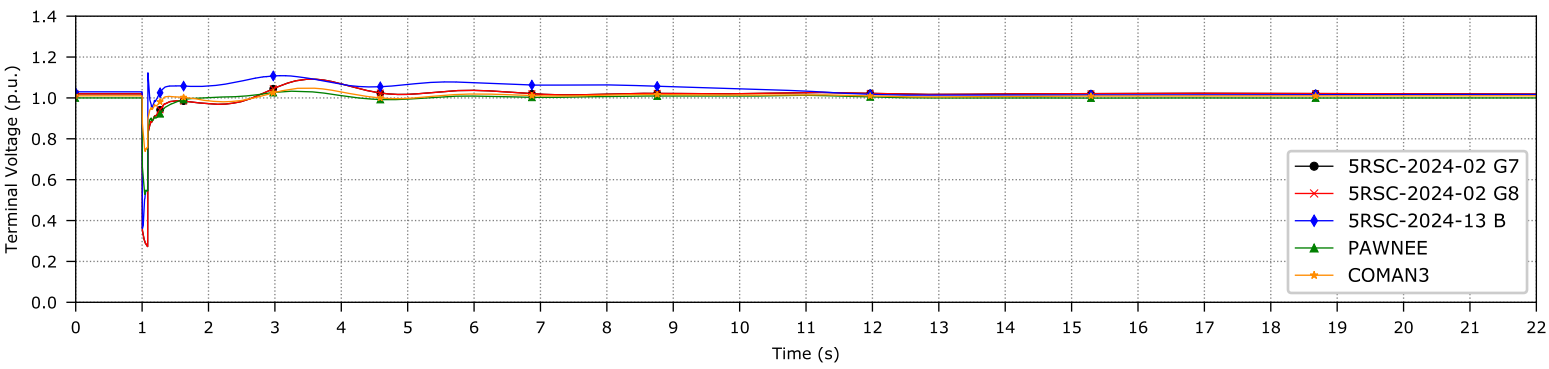


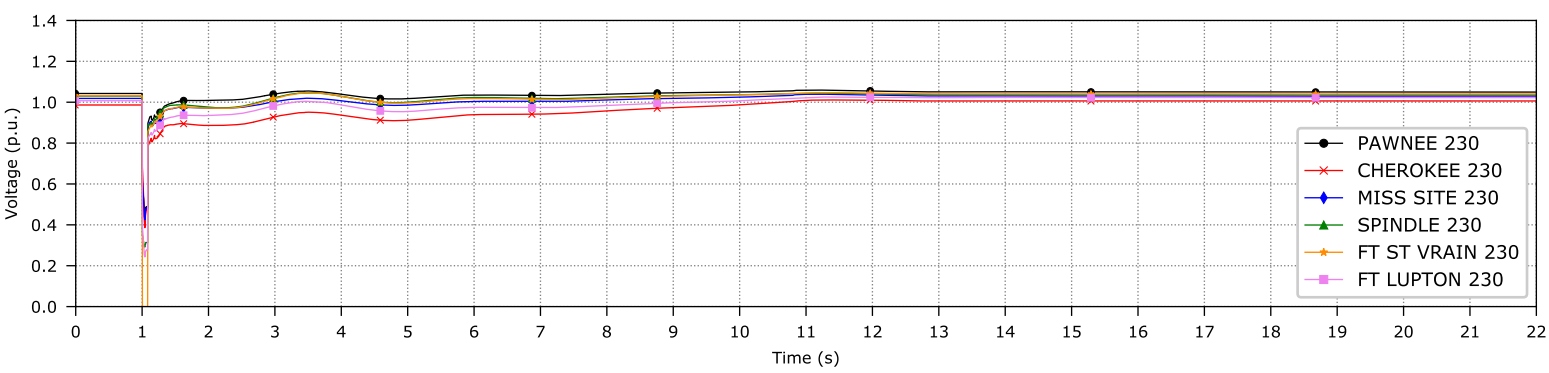

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

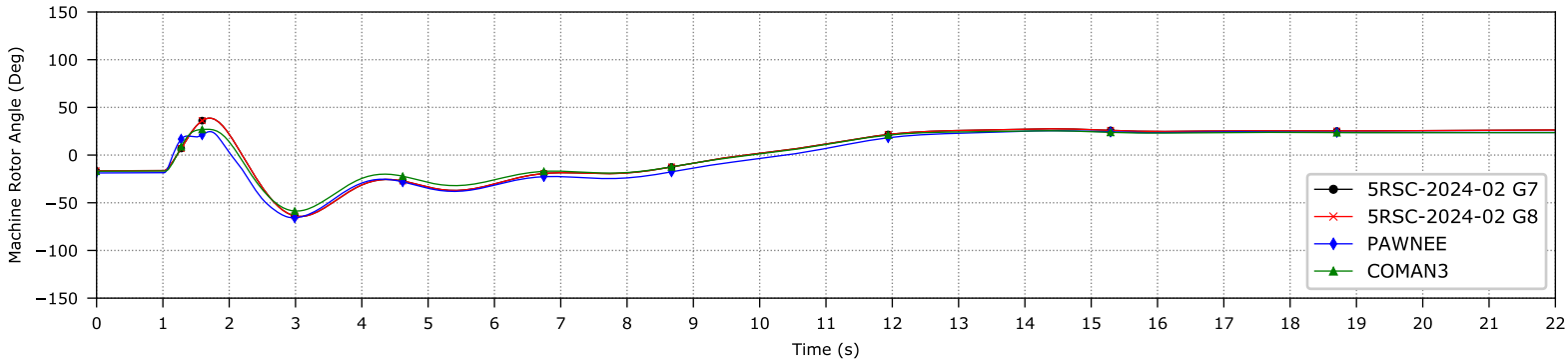

Reactive Power (Mvar)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

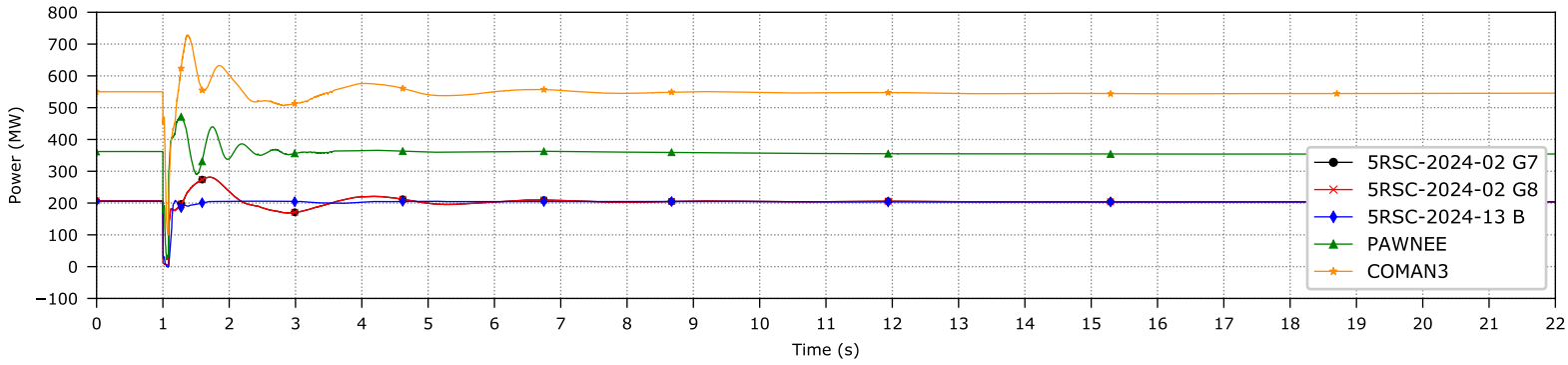

Frequency (Hz)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

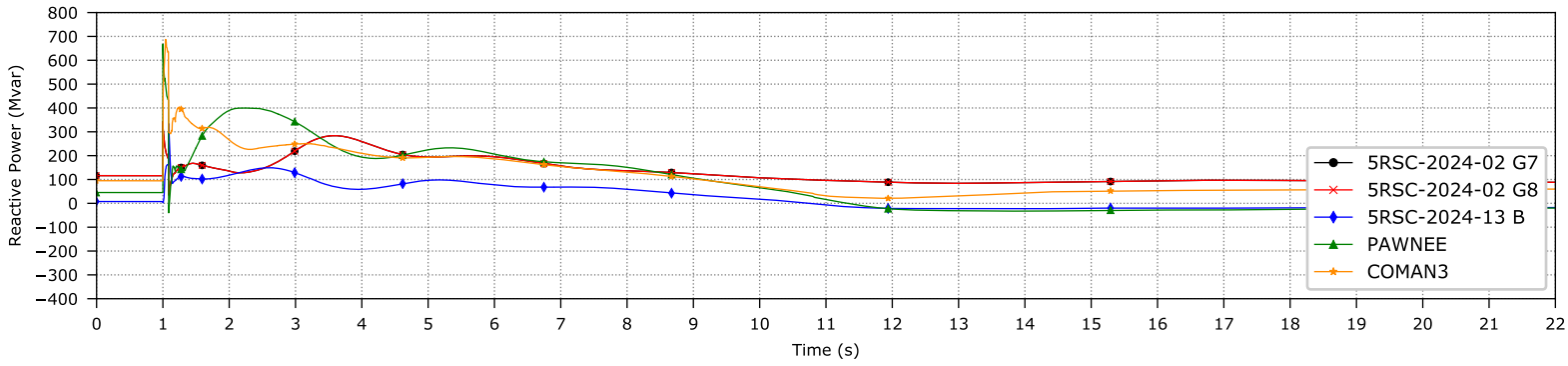

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

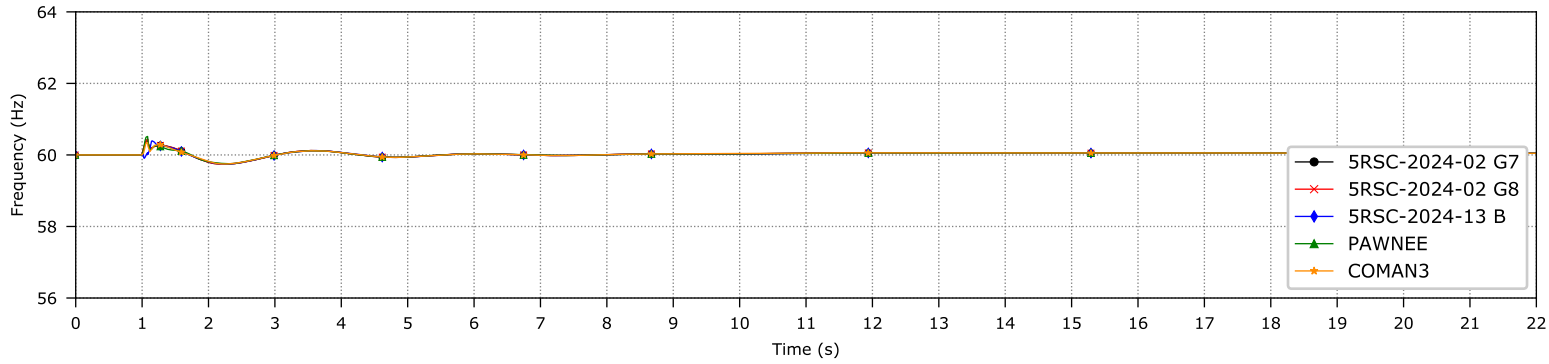

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

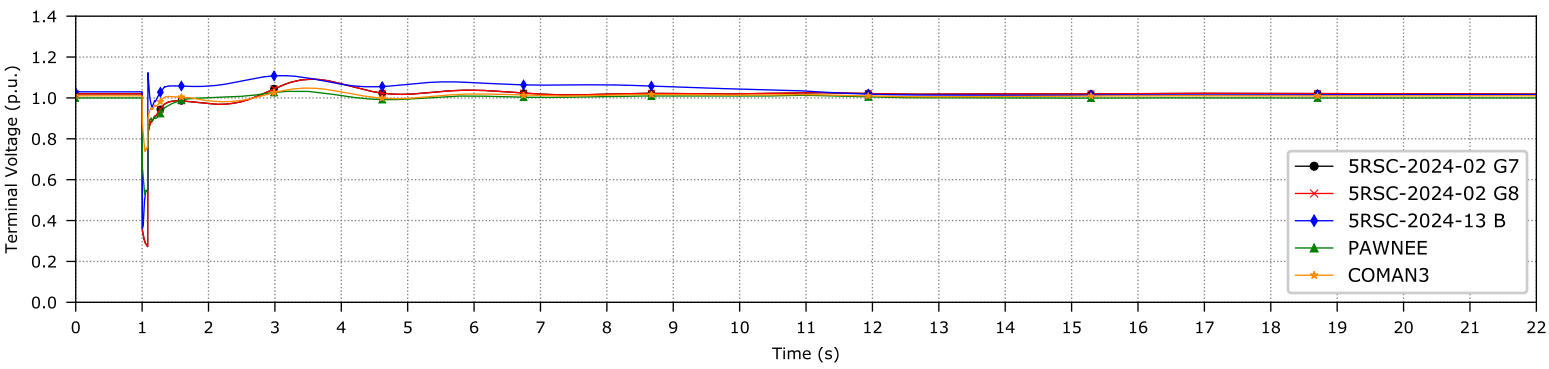
Ref. No. 09 - LoTC_65

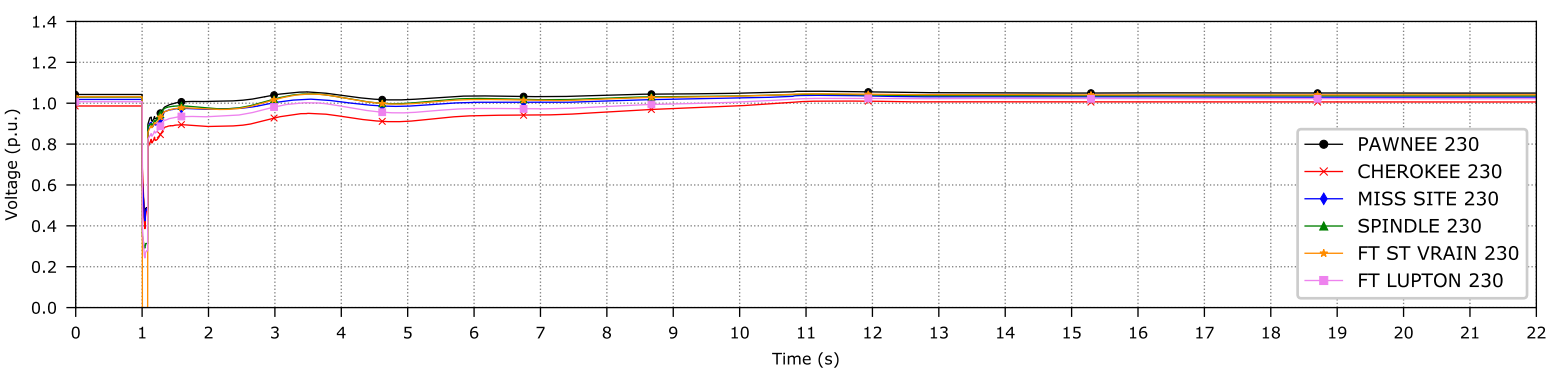




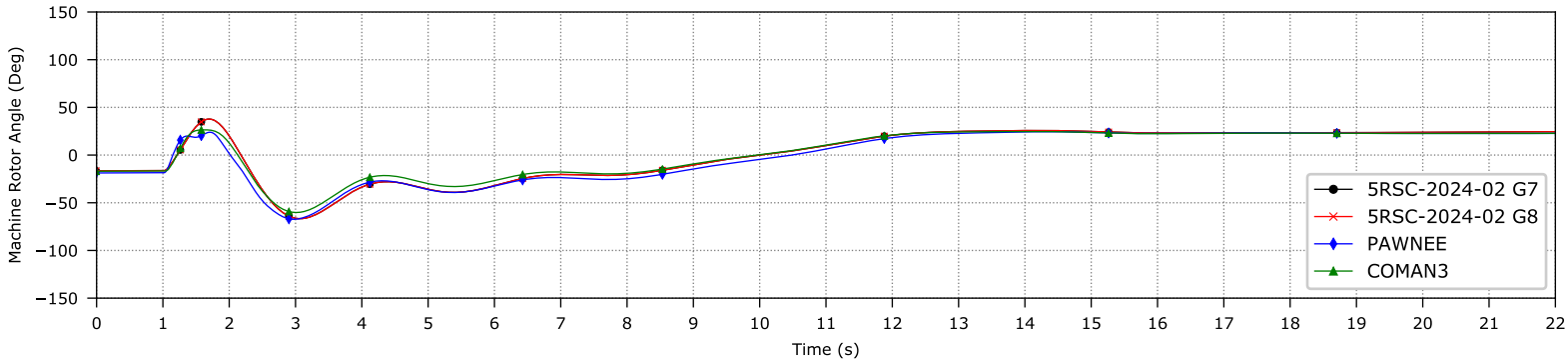


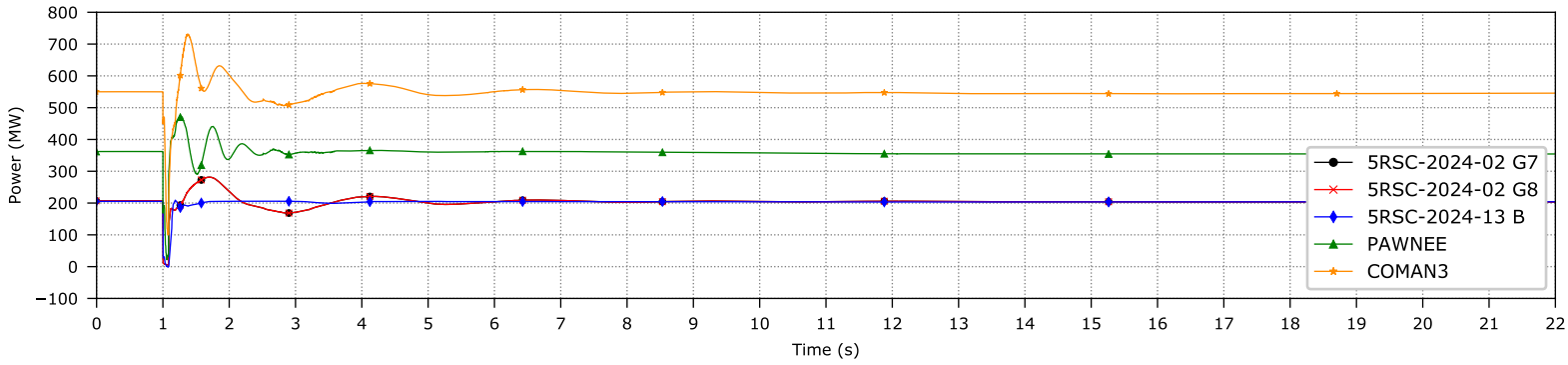


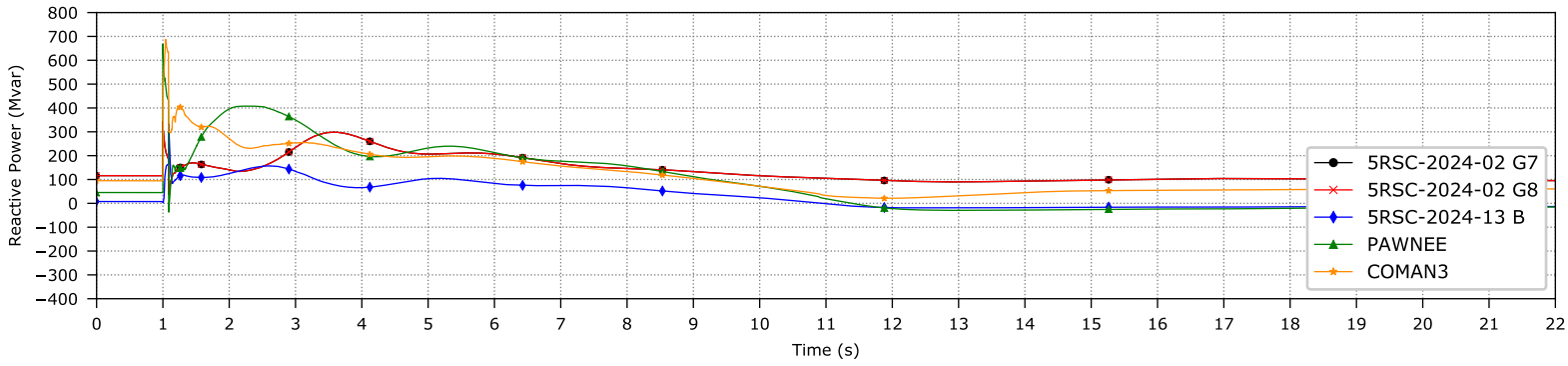


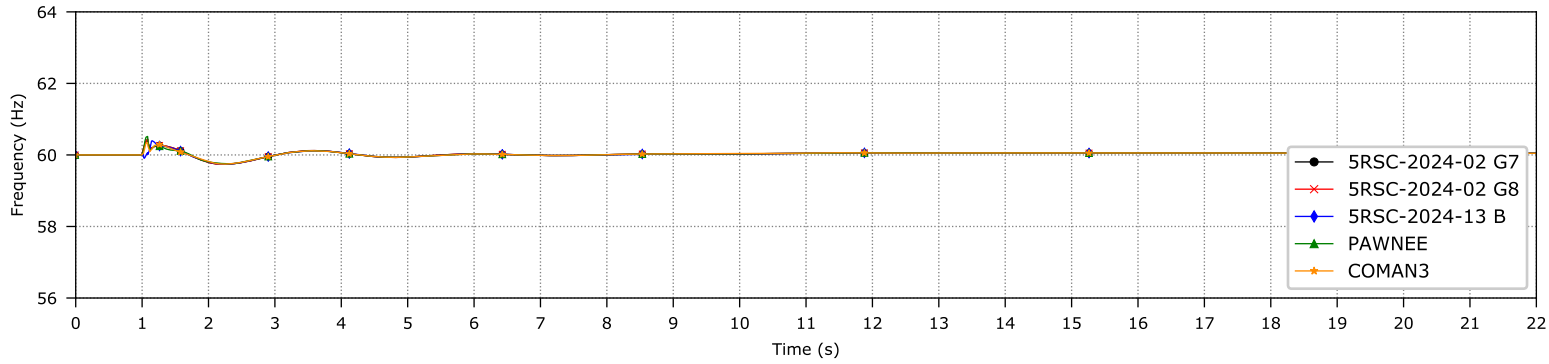


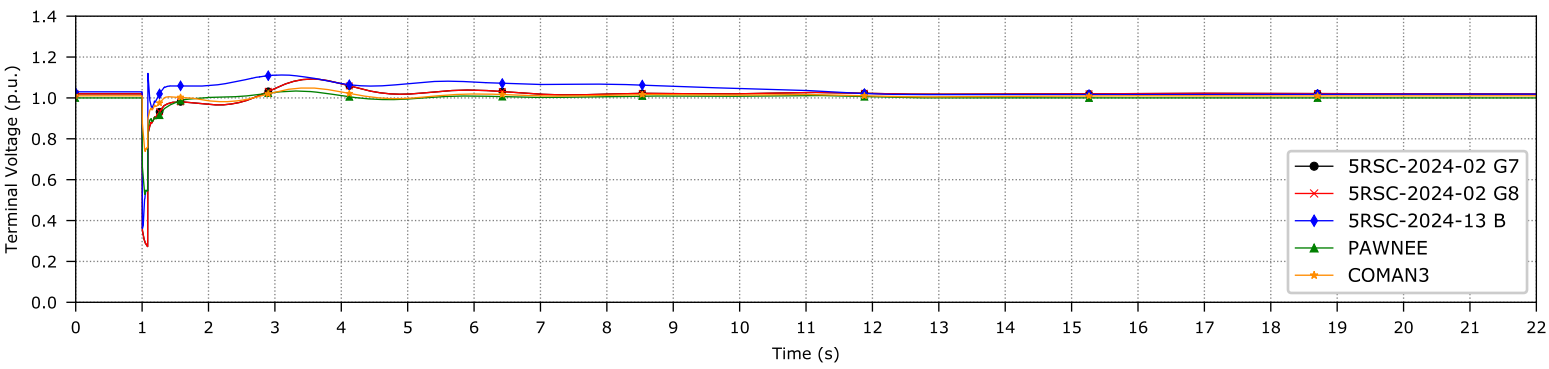
Ref. No. 10 - LoTC_66

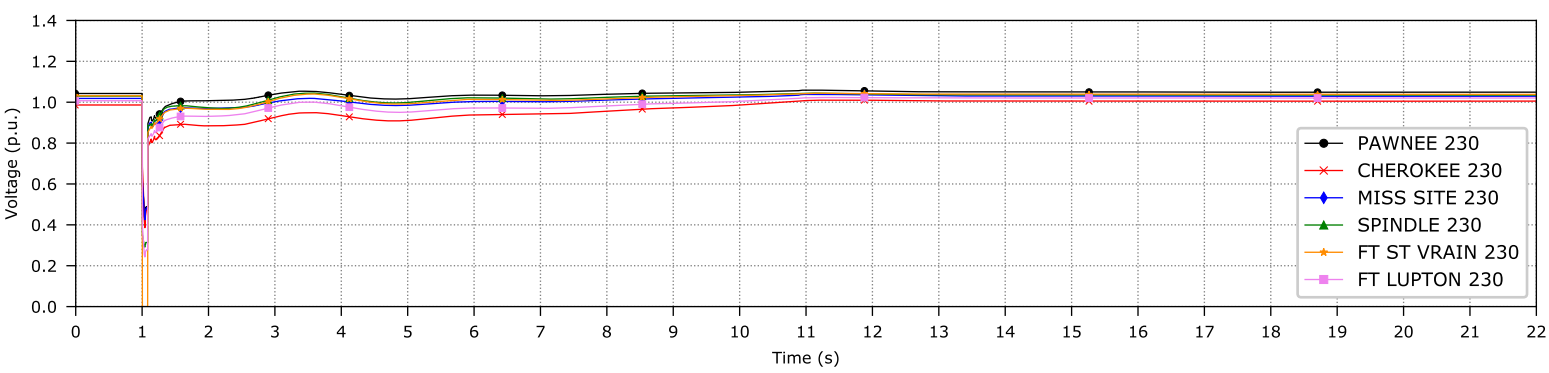




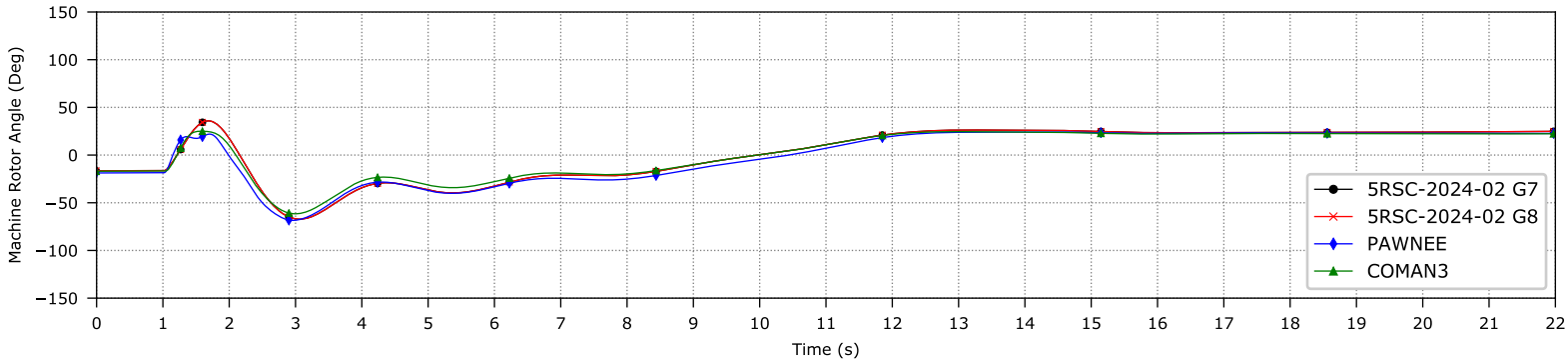


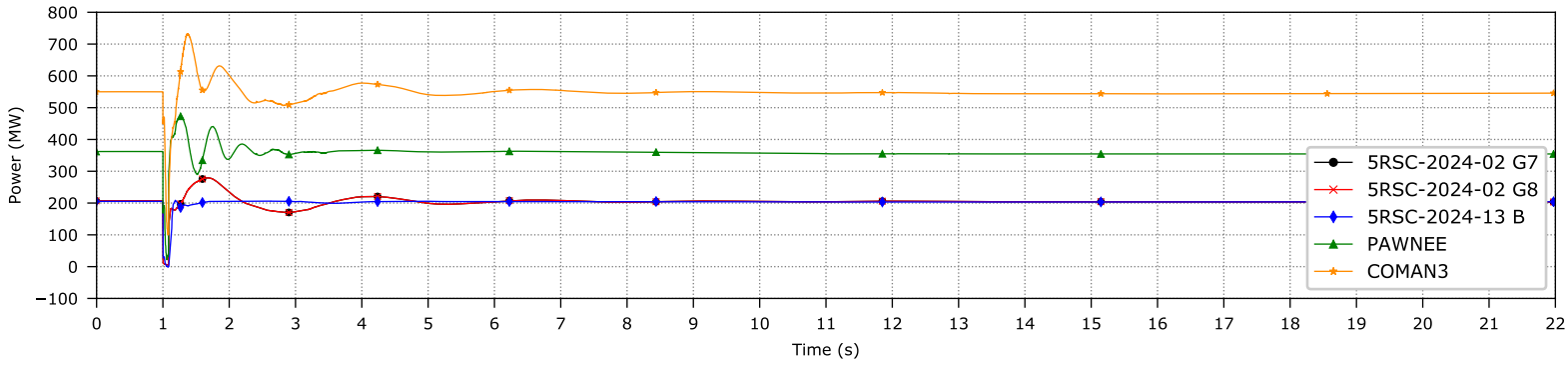


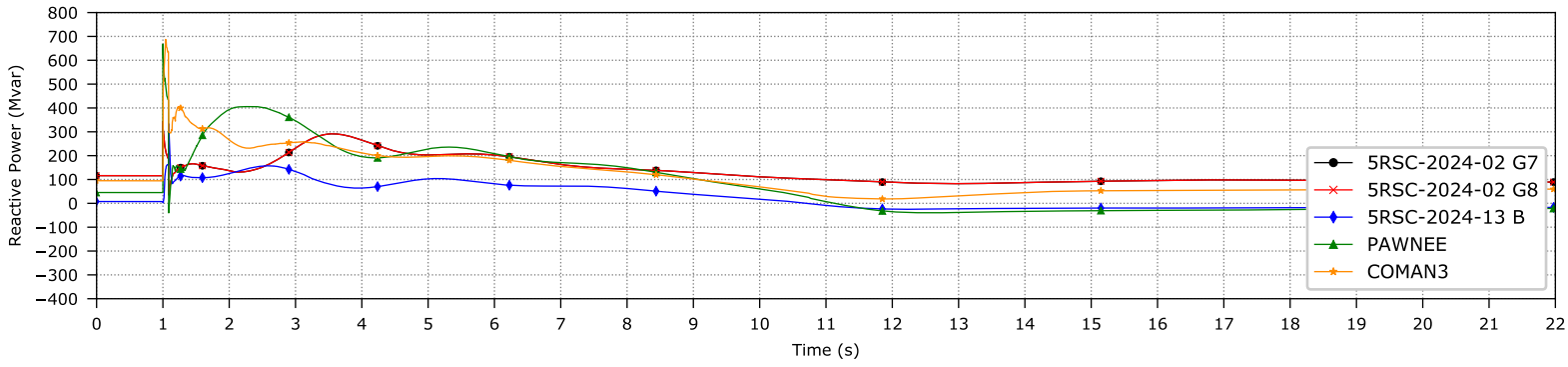


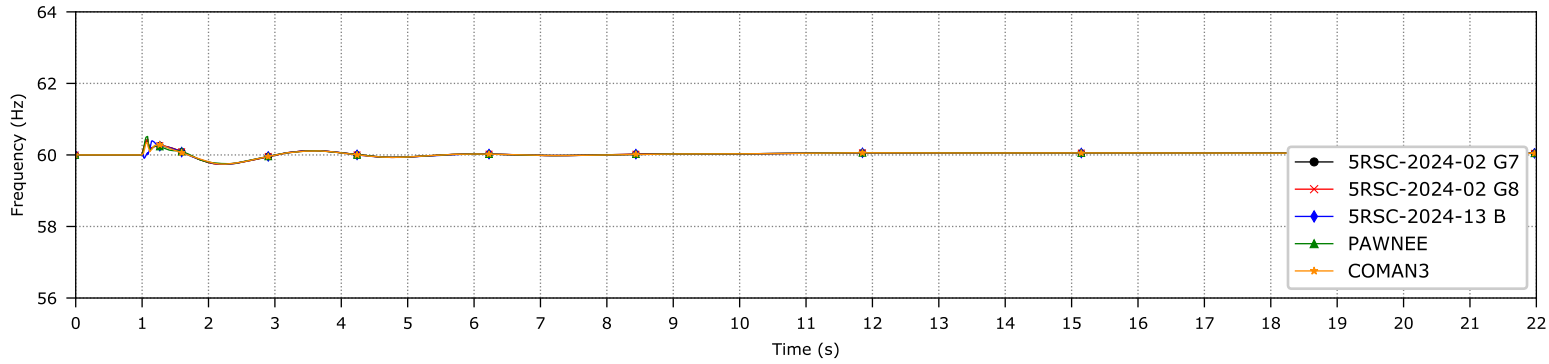


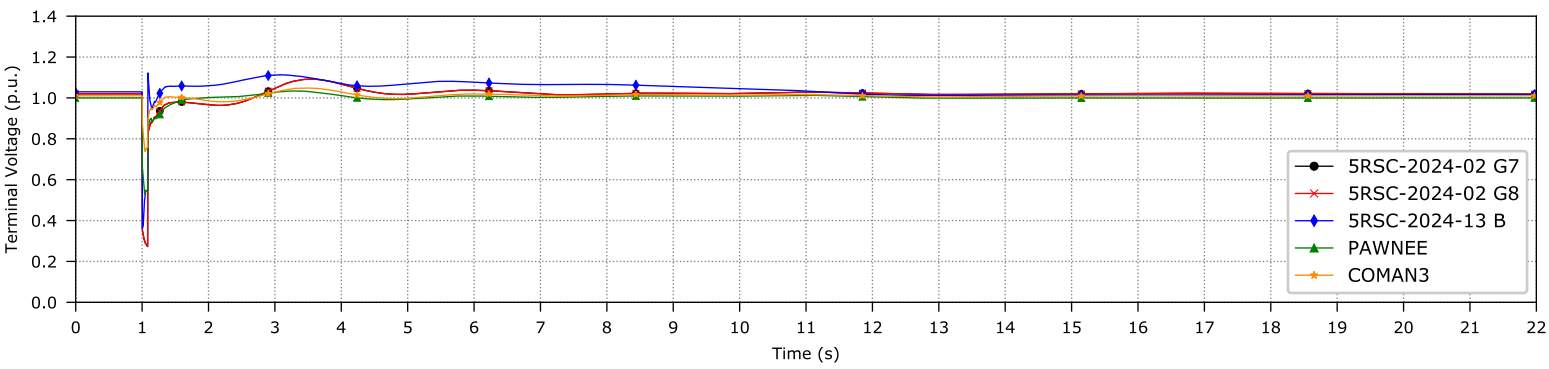
Ref. No. 11 - LoTC_67

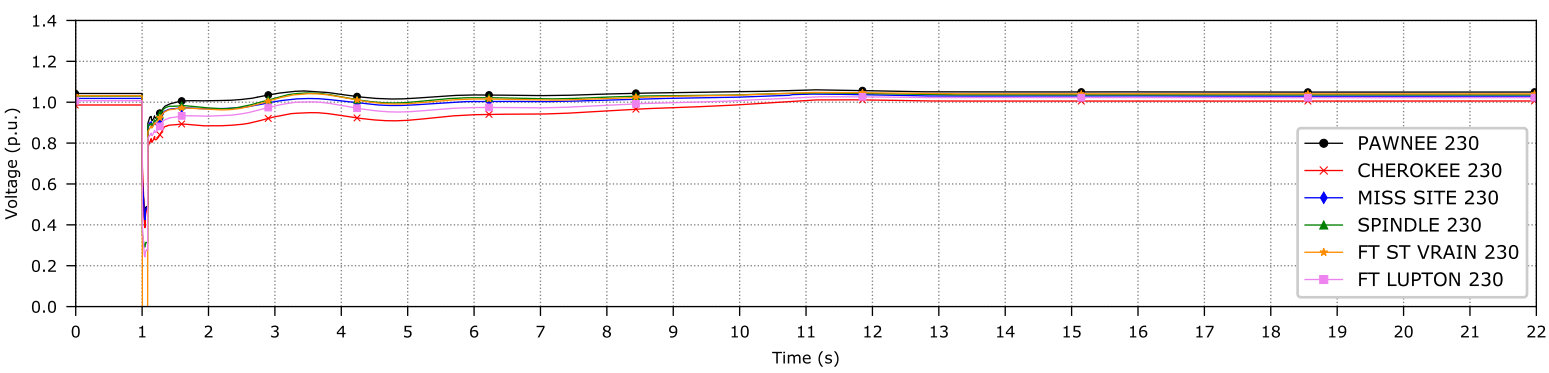




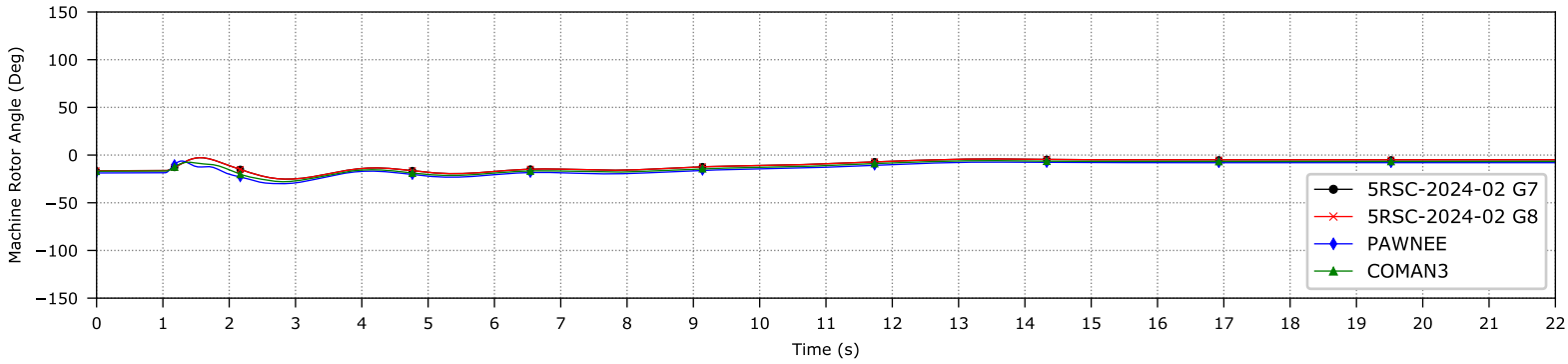


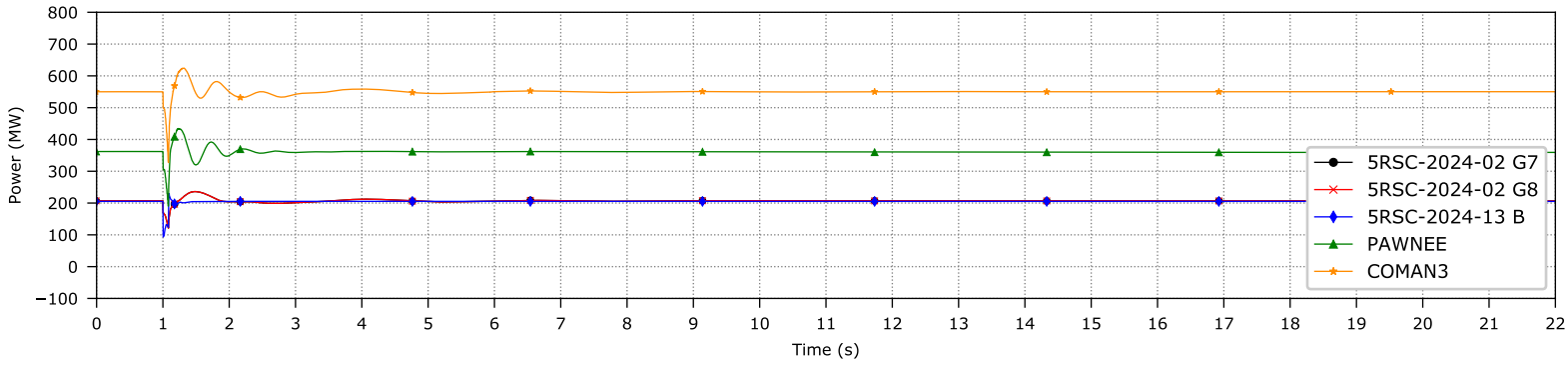


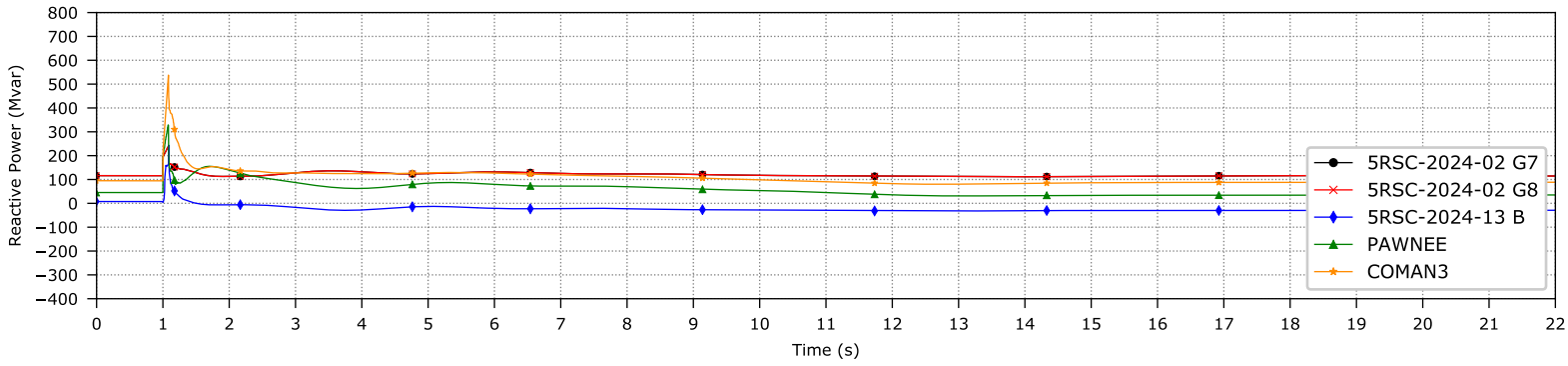


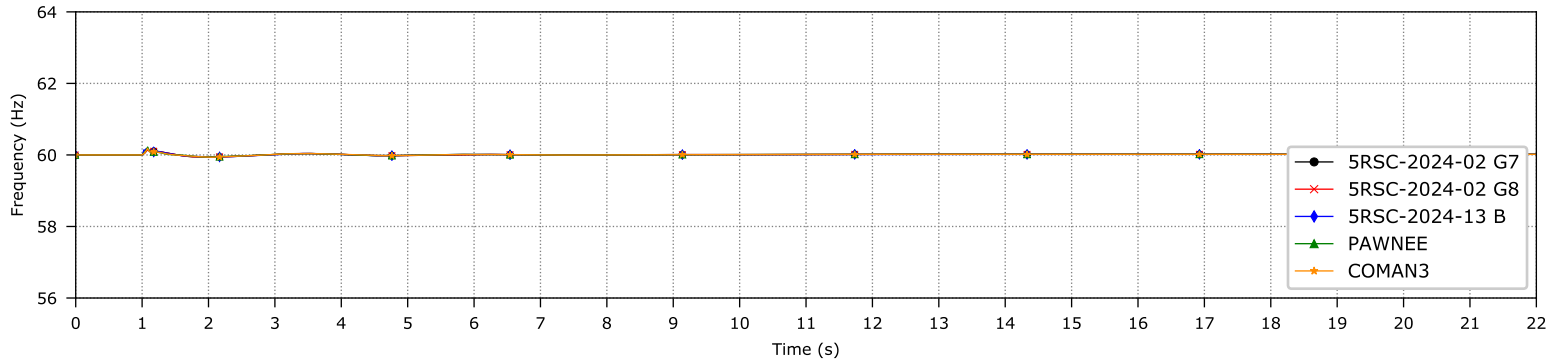


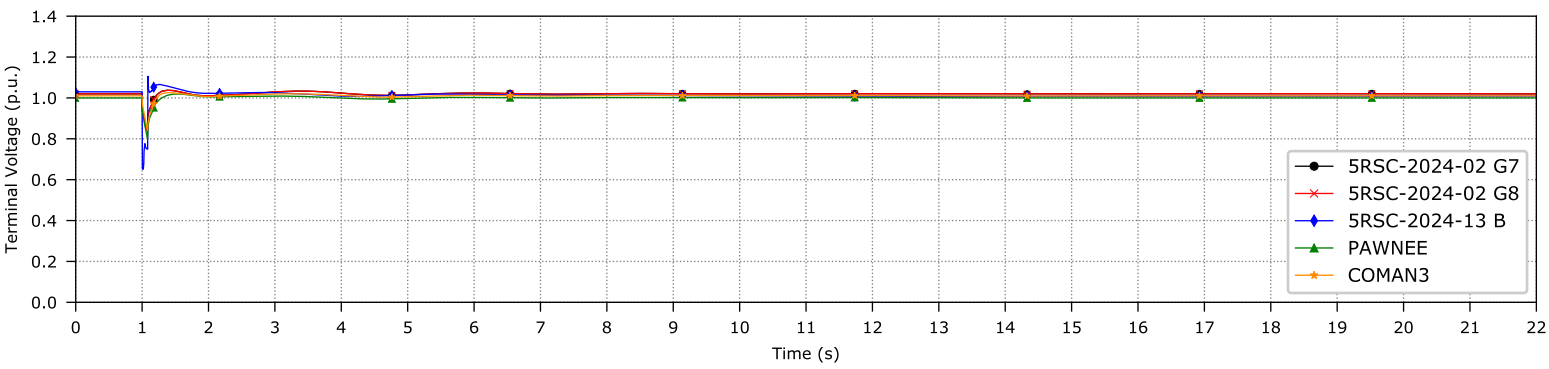
Ref. No. 12 - LoTC_74

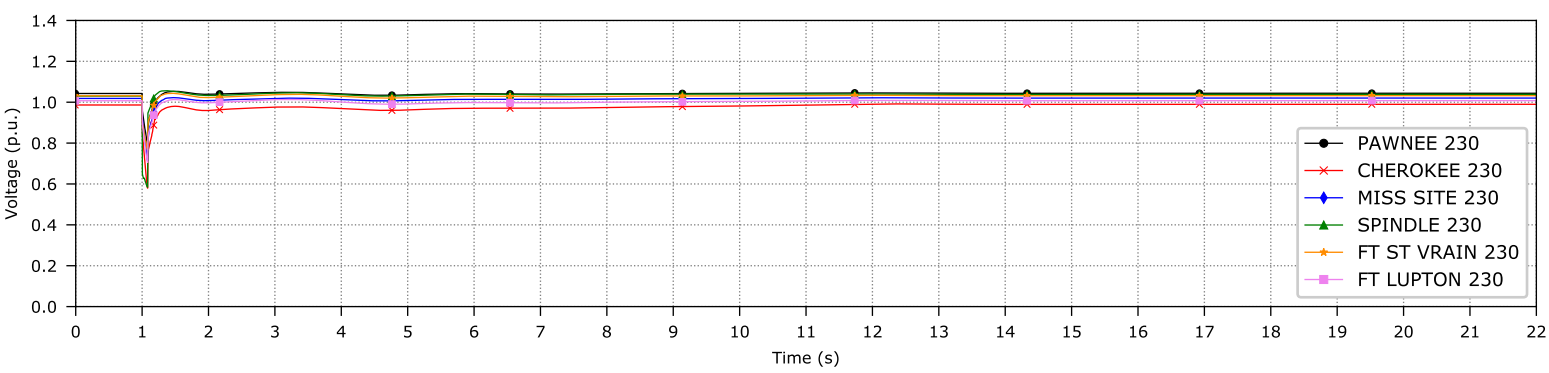




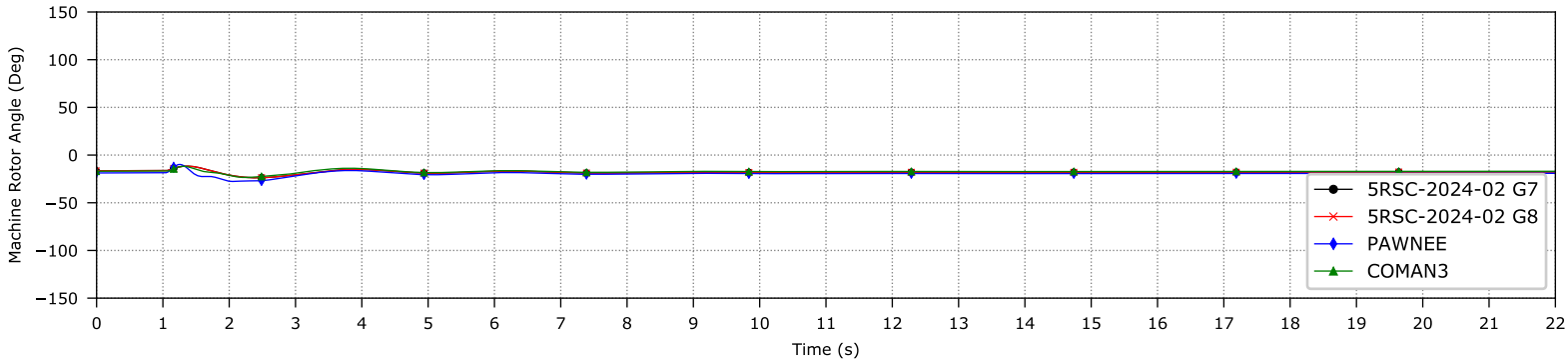


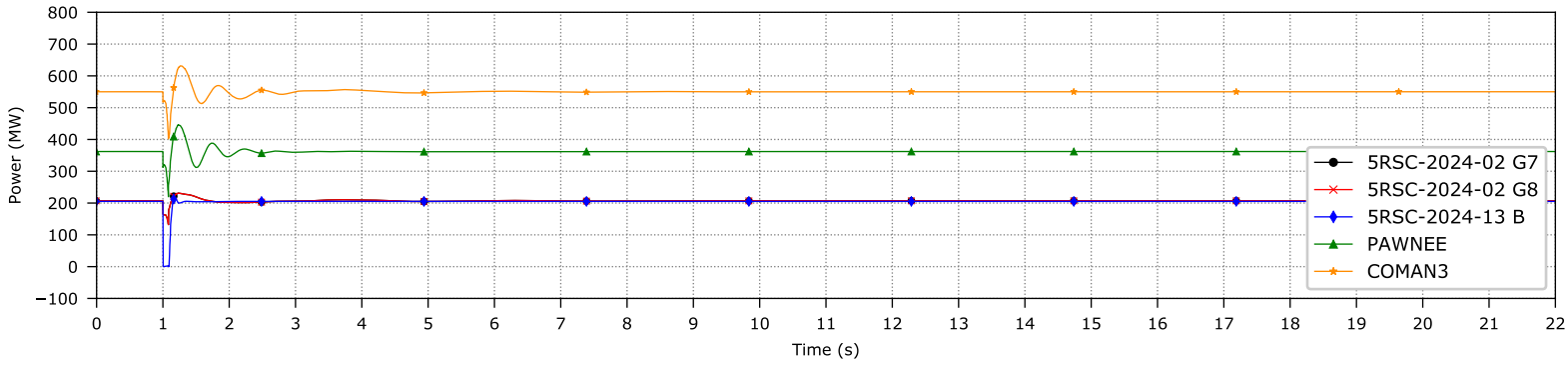


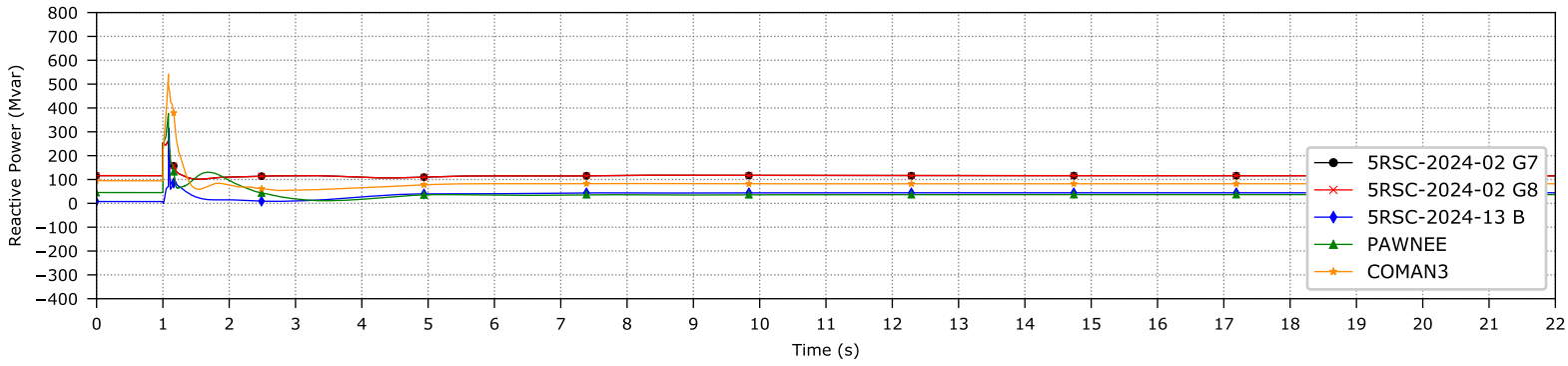


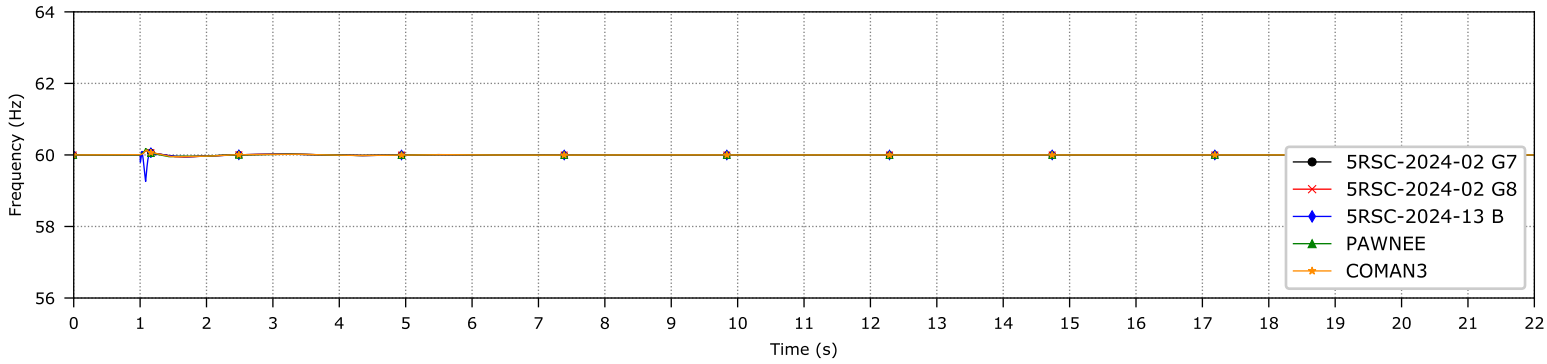


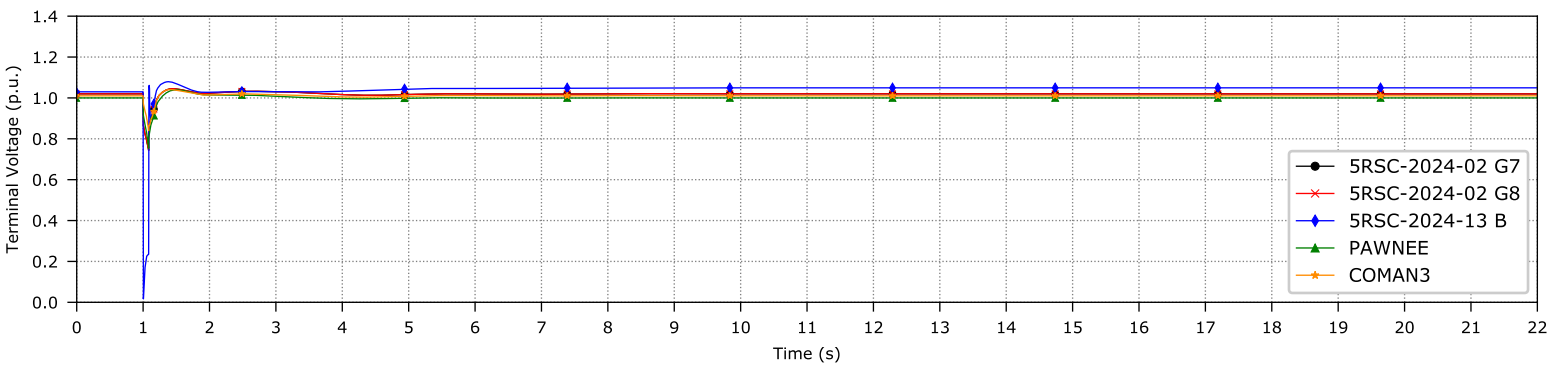
Ref. No. 13 - LoTC_140

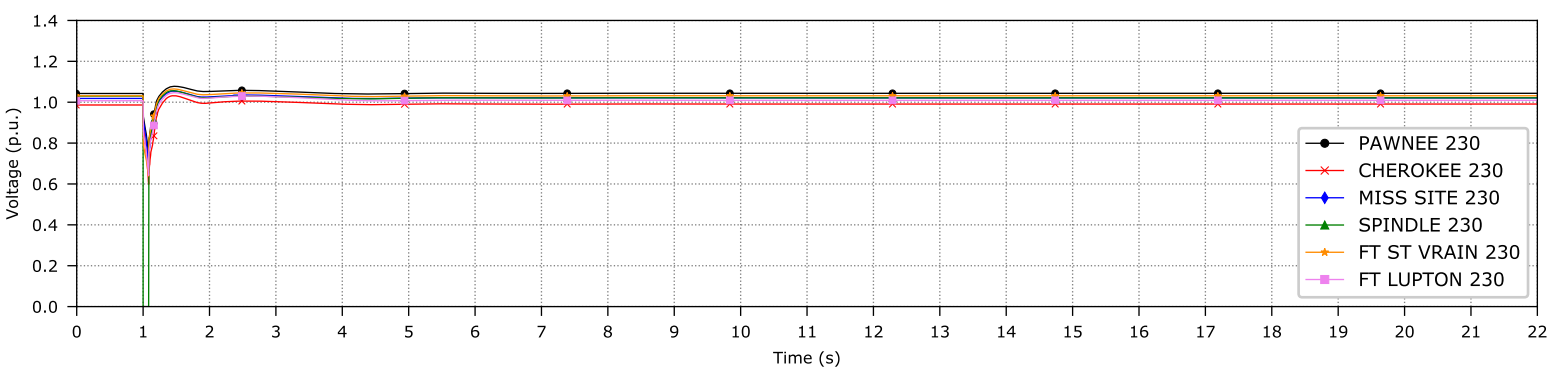




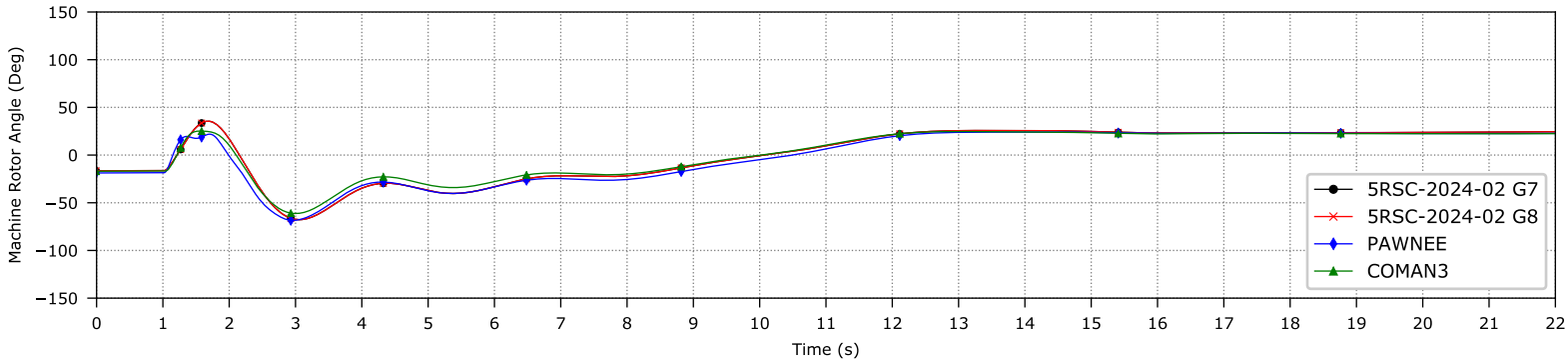


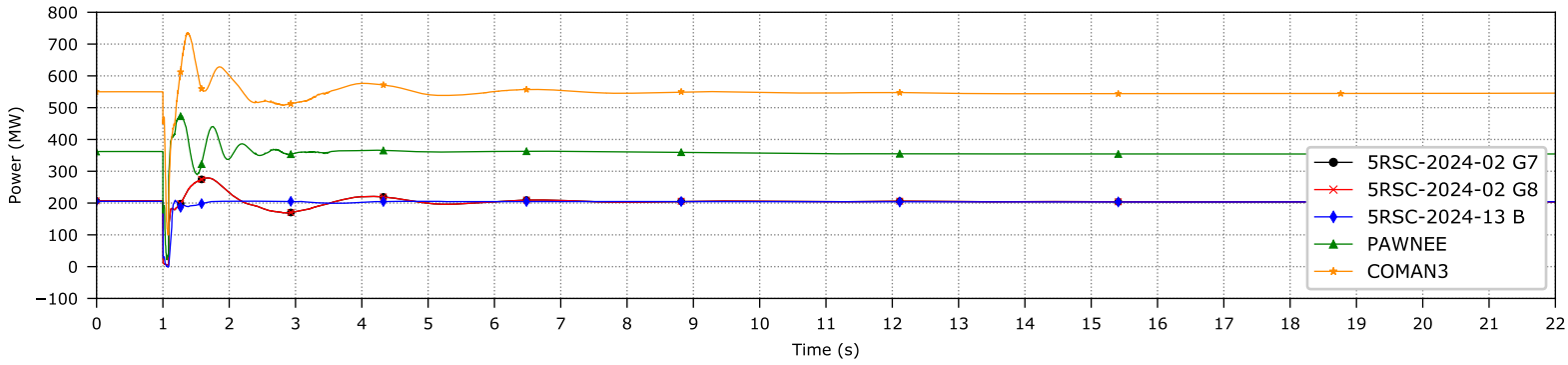


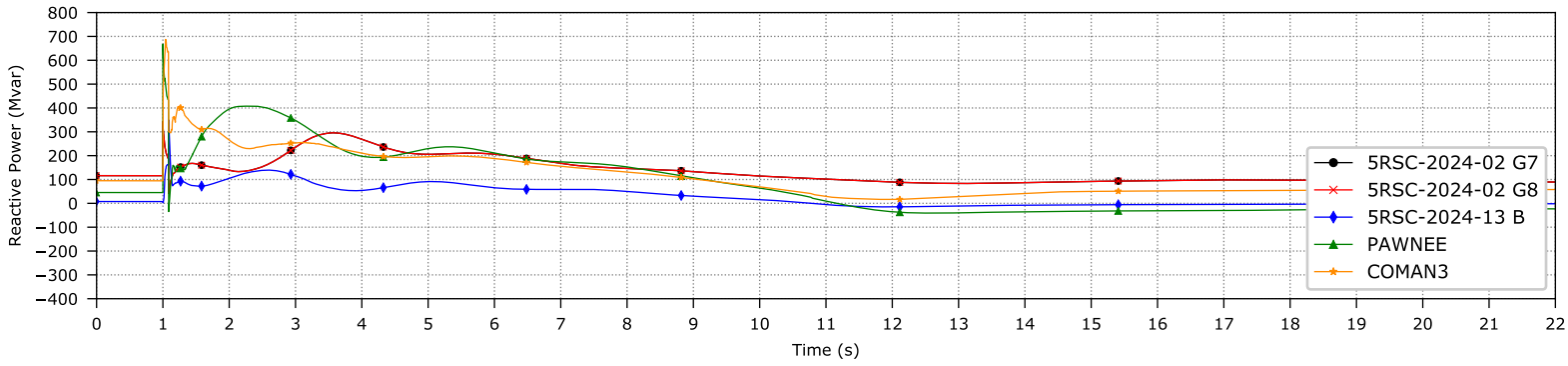


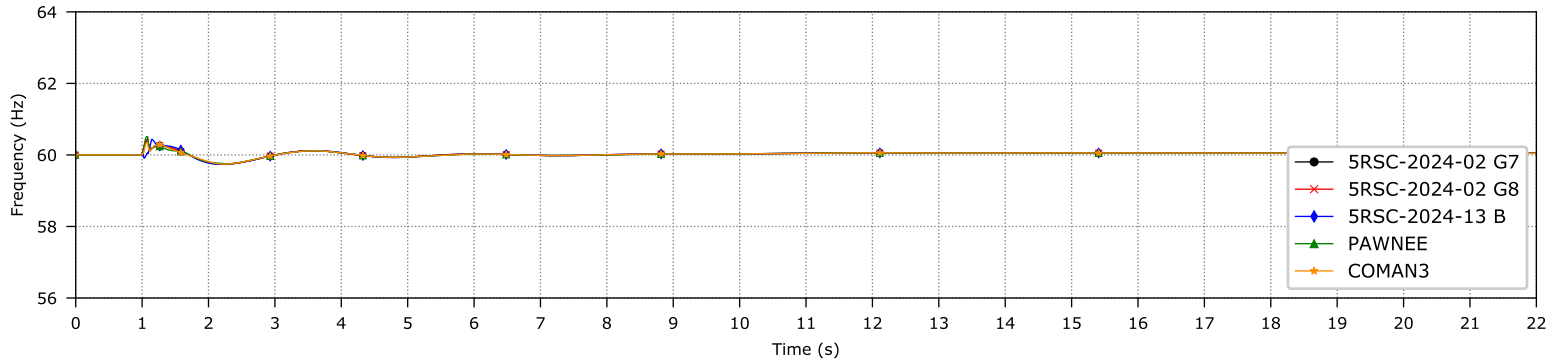


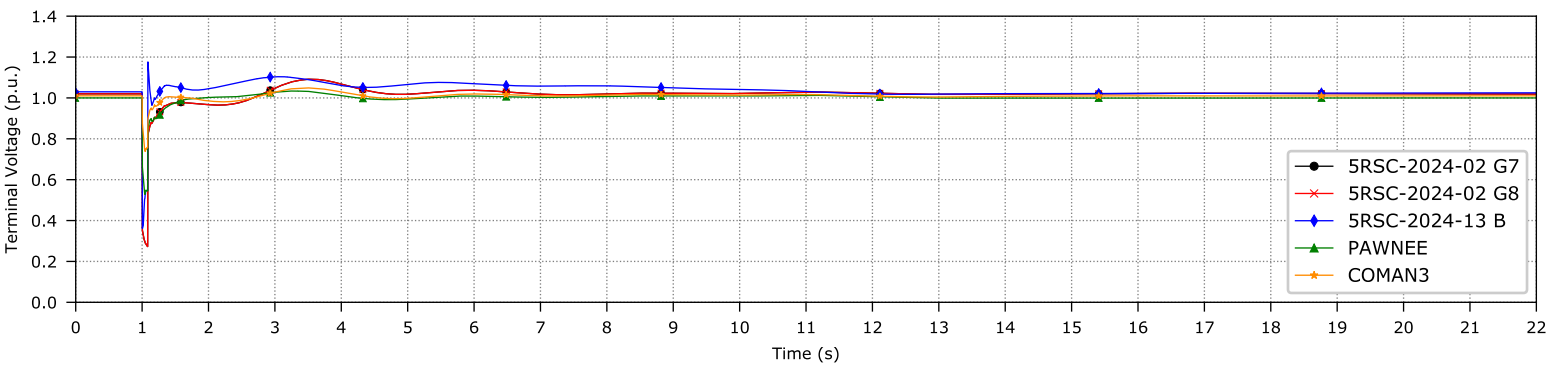
Ref. No. 14 - LoTC_141

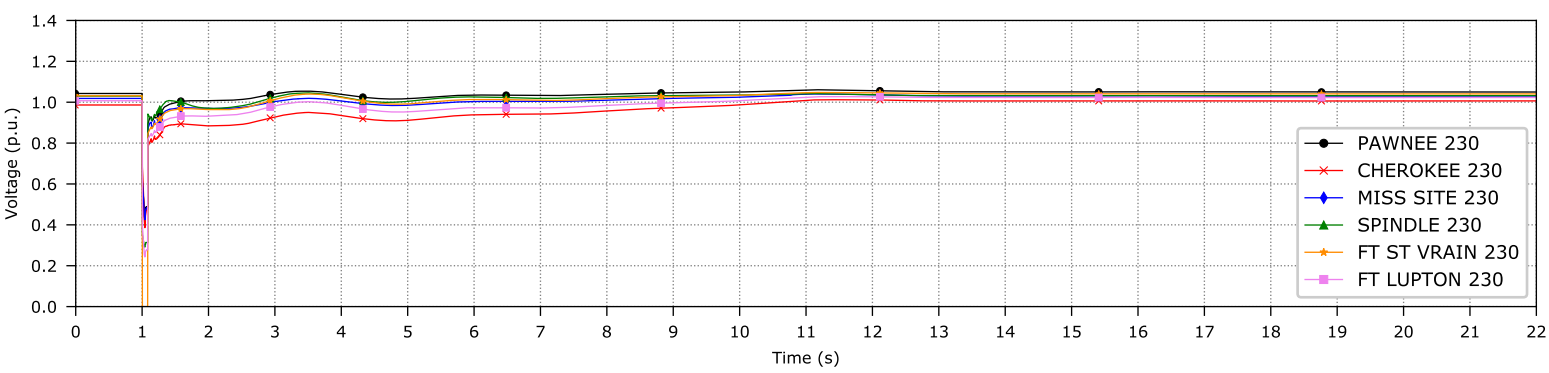




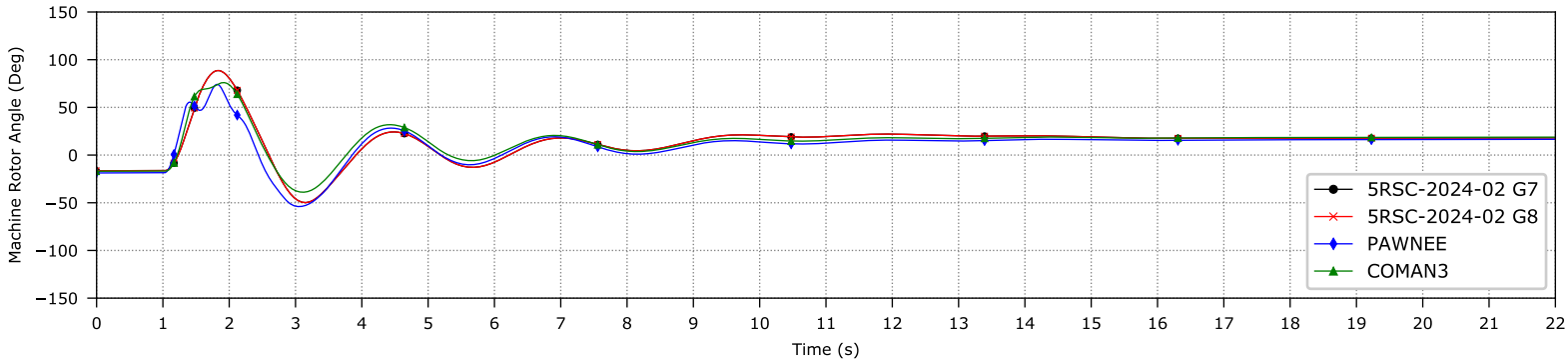


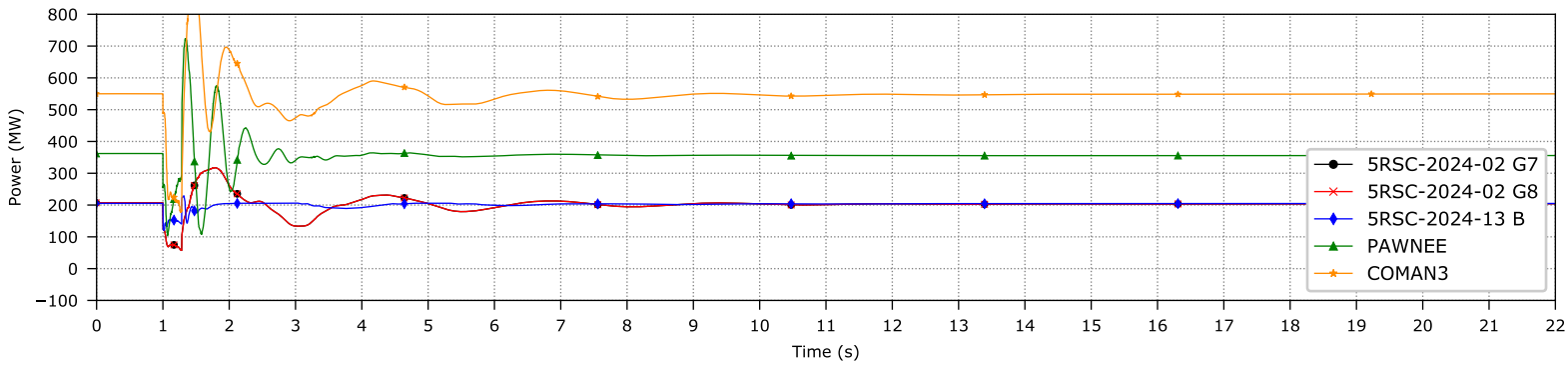


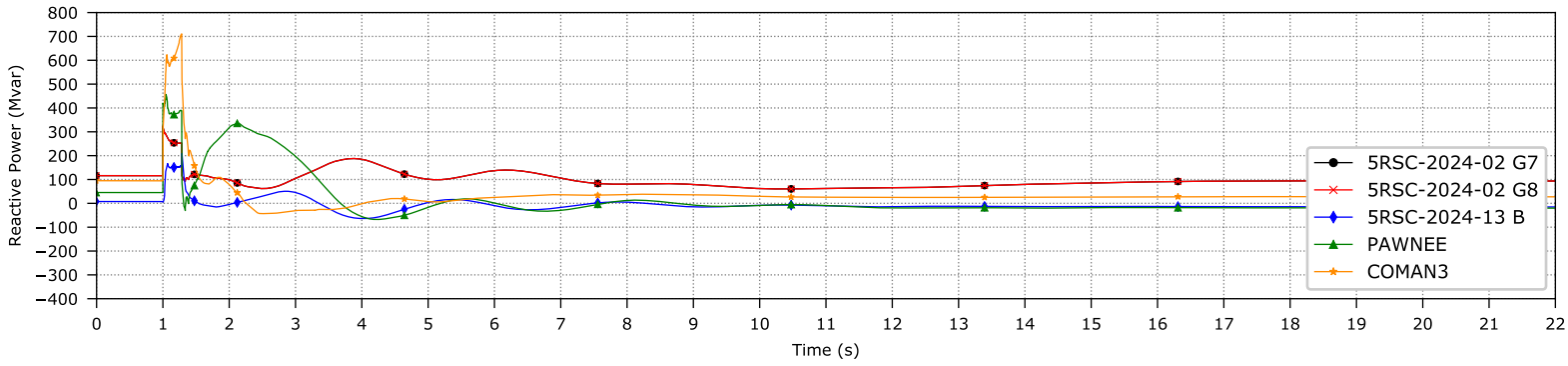


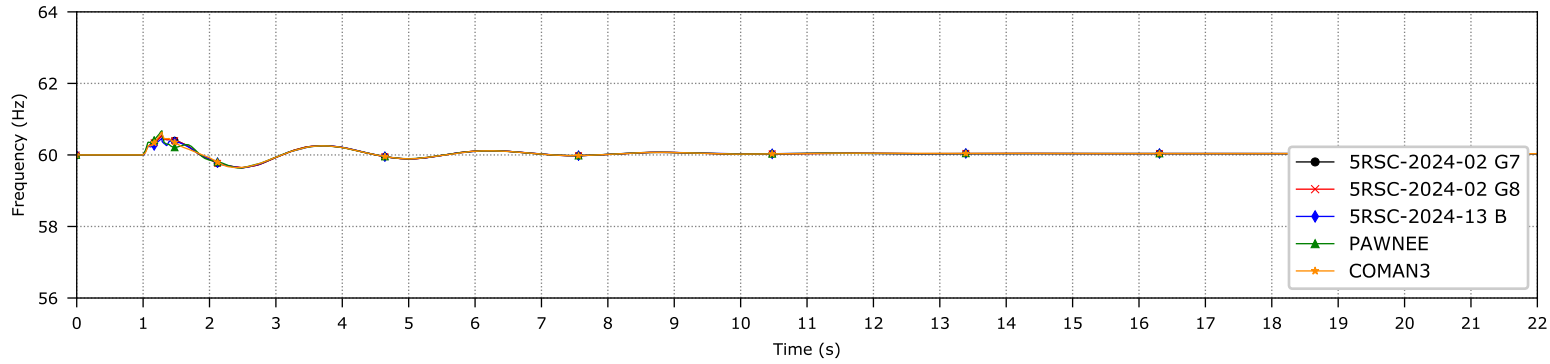


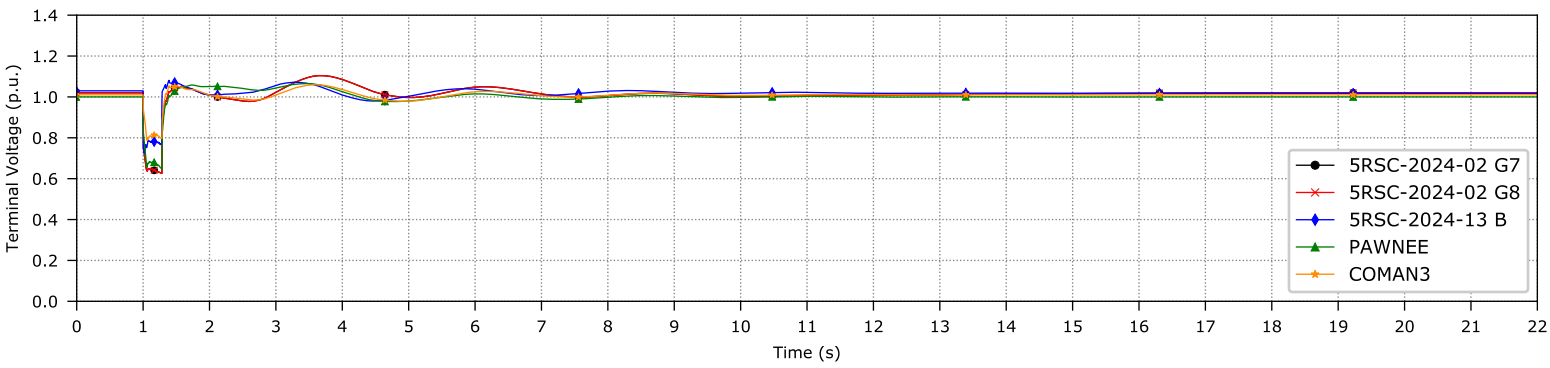
Ref. No. 17 - BF_057a

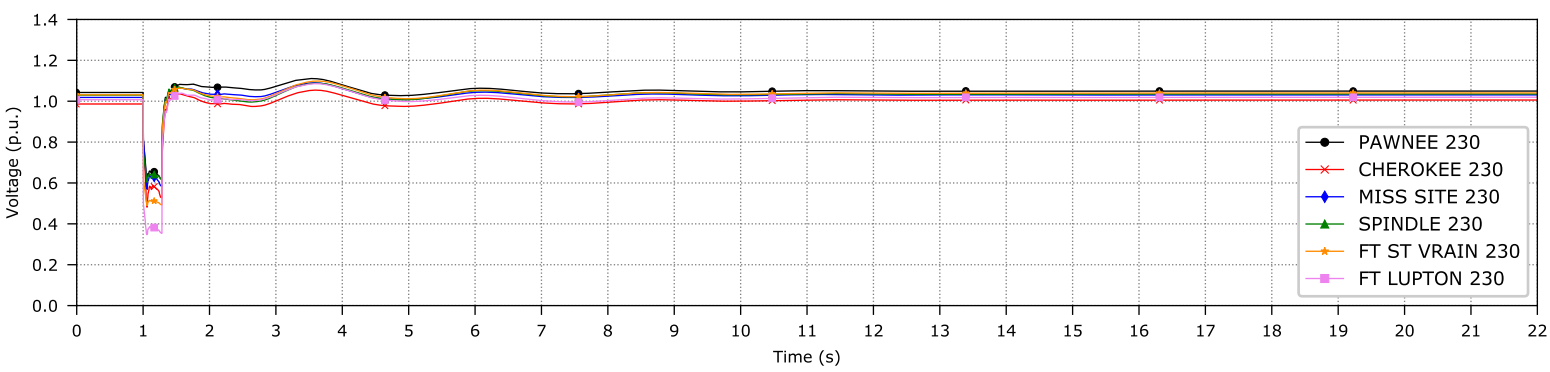












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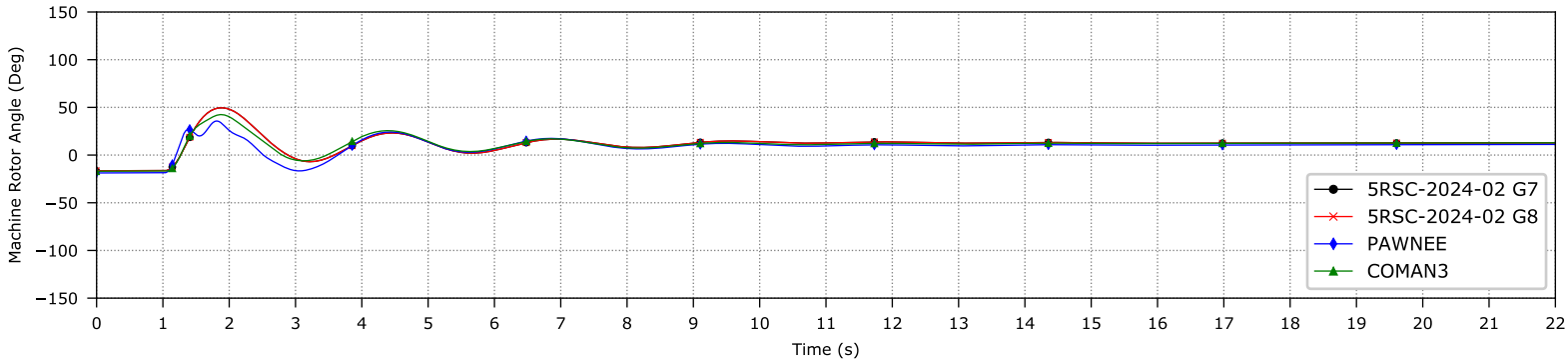

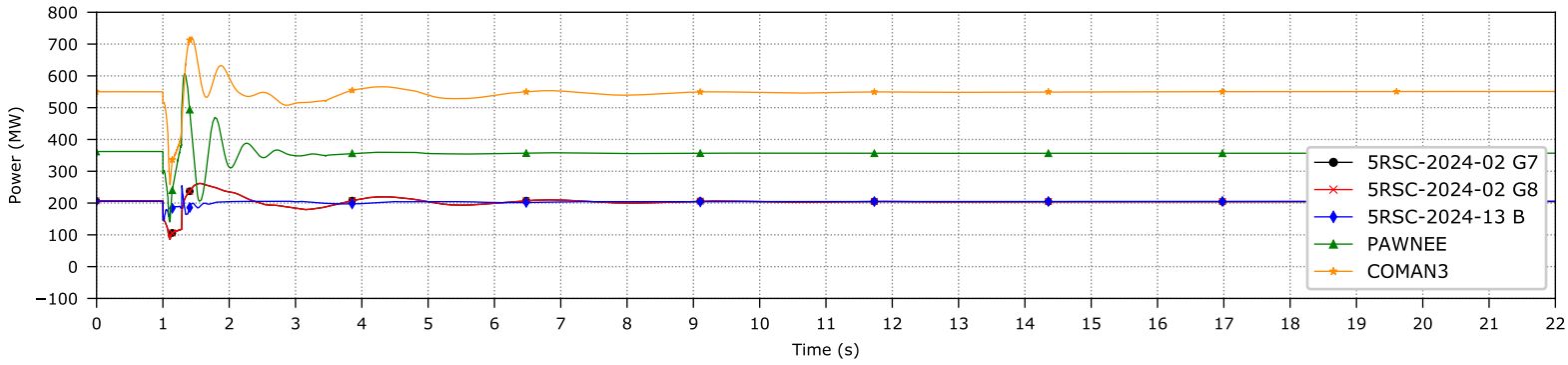

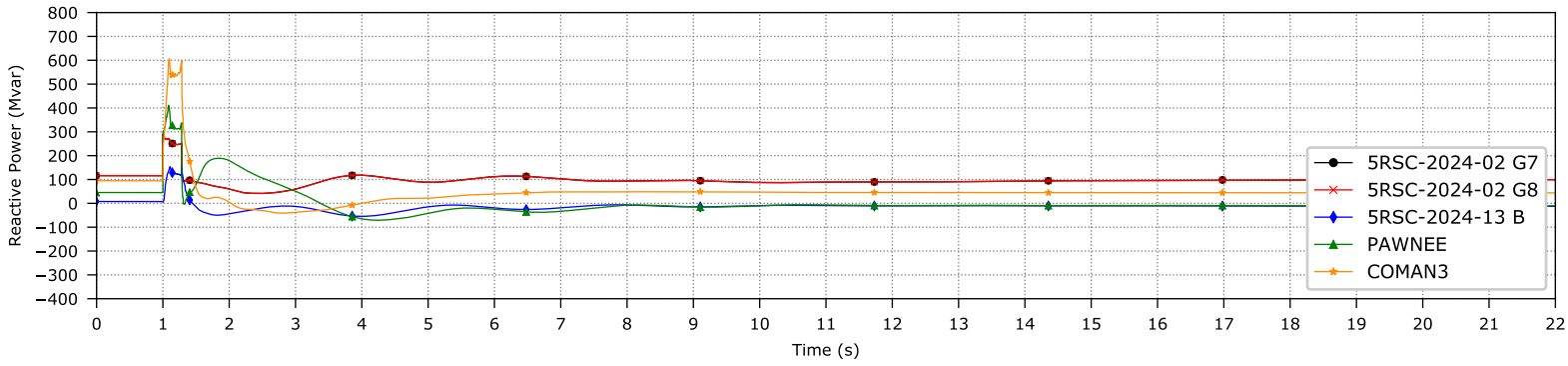

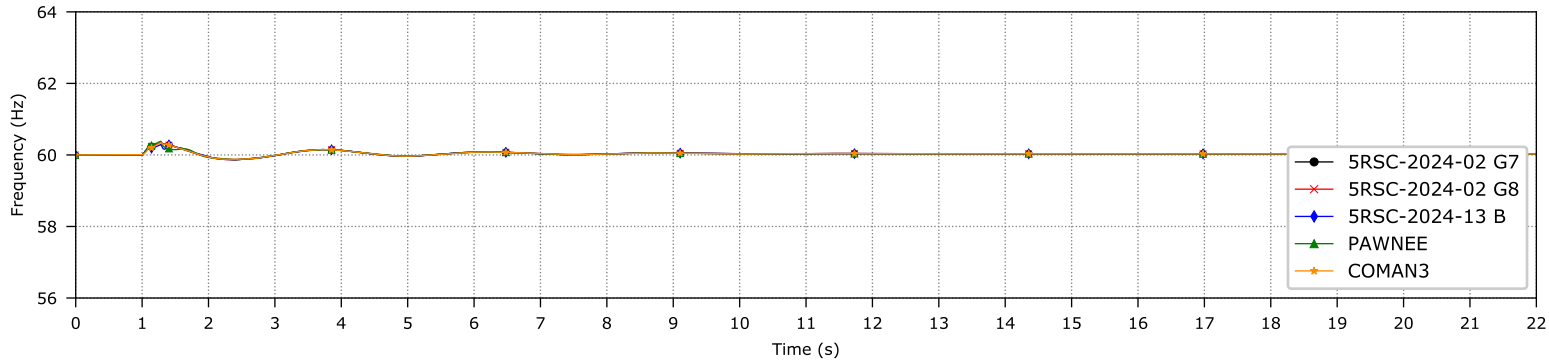

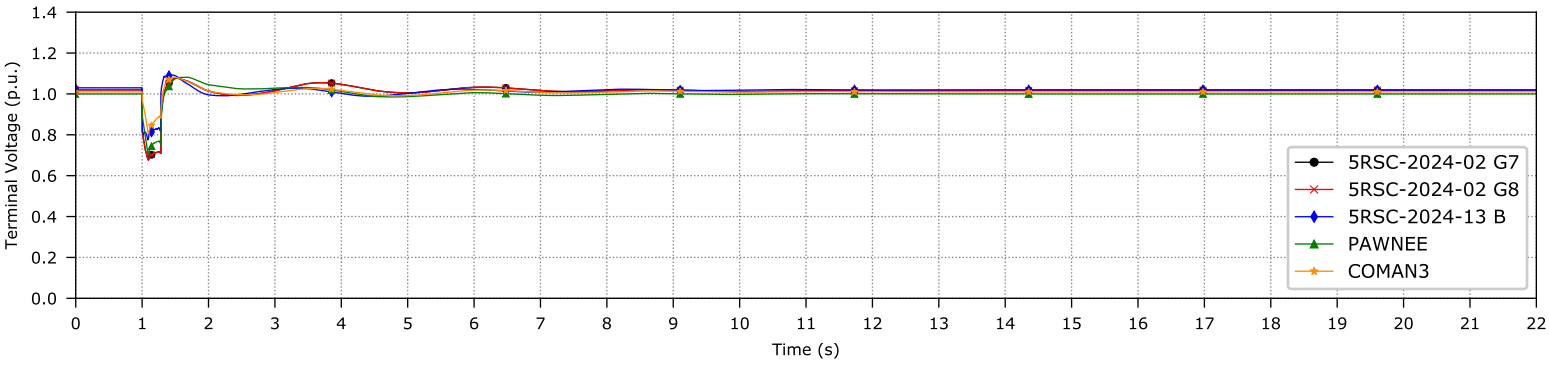

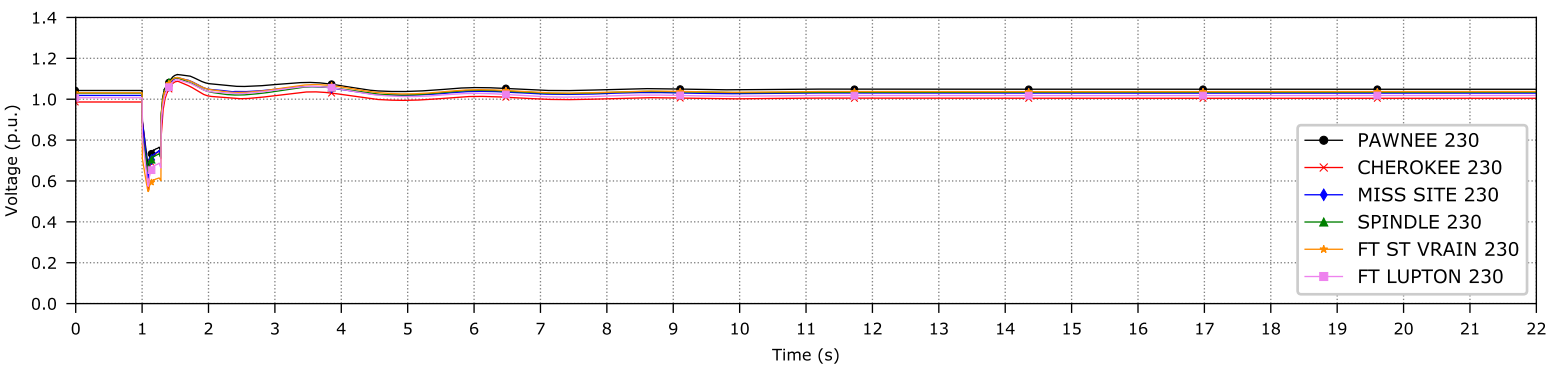

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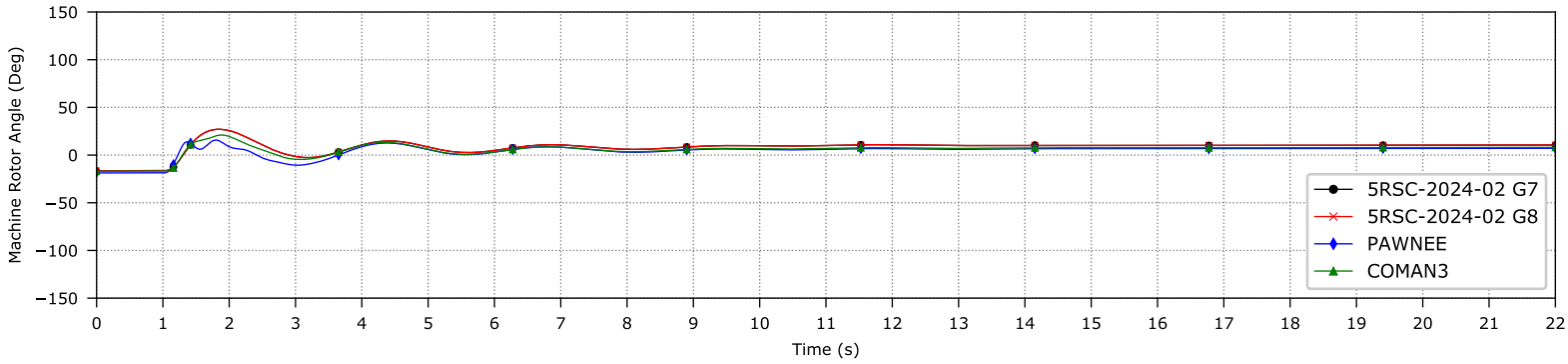

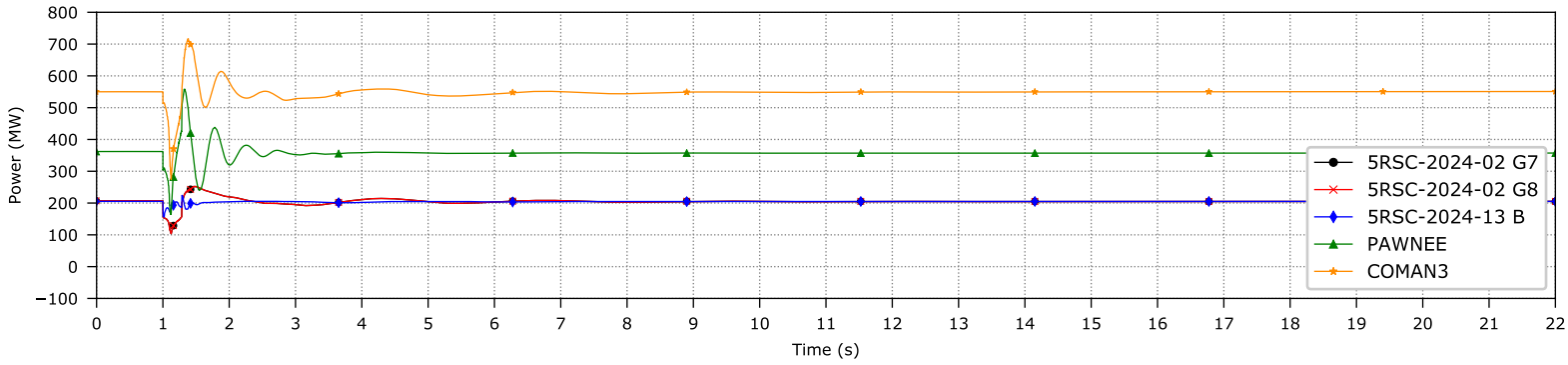

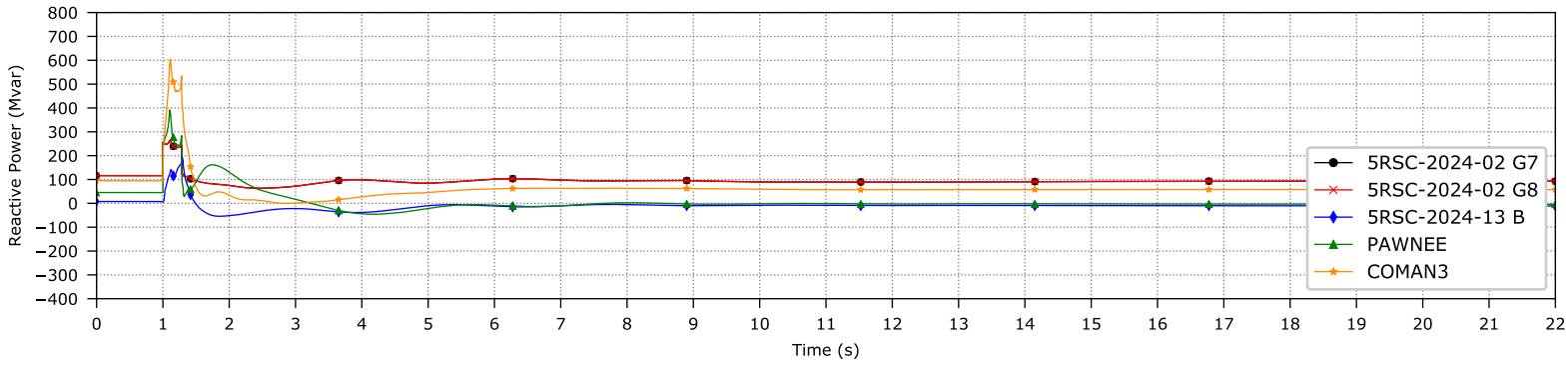

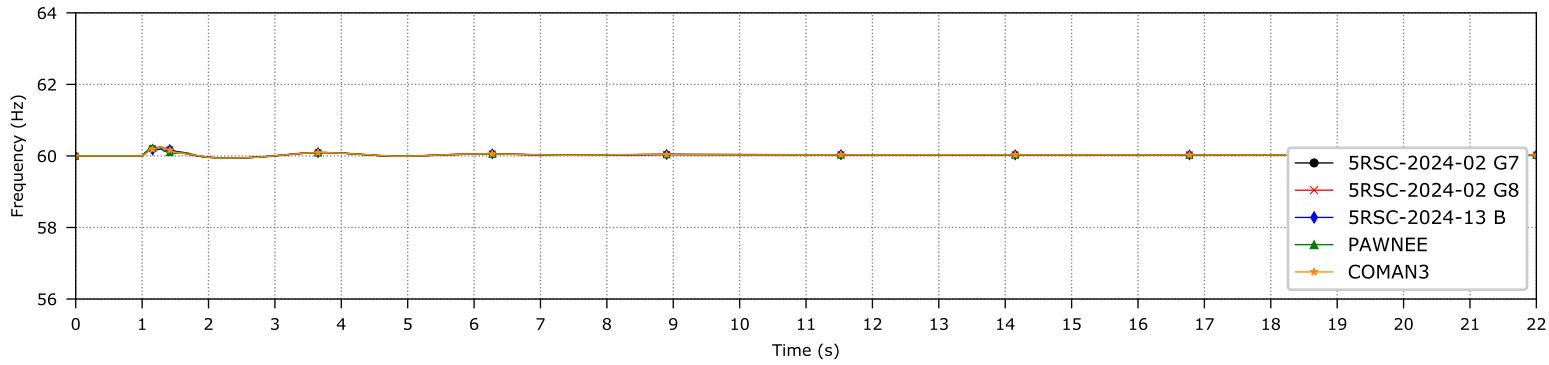

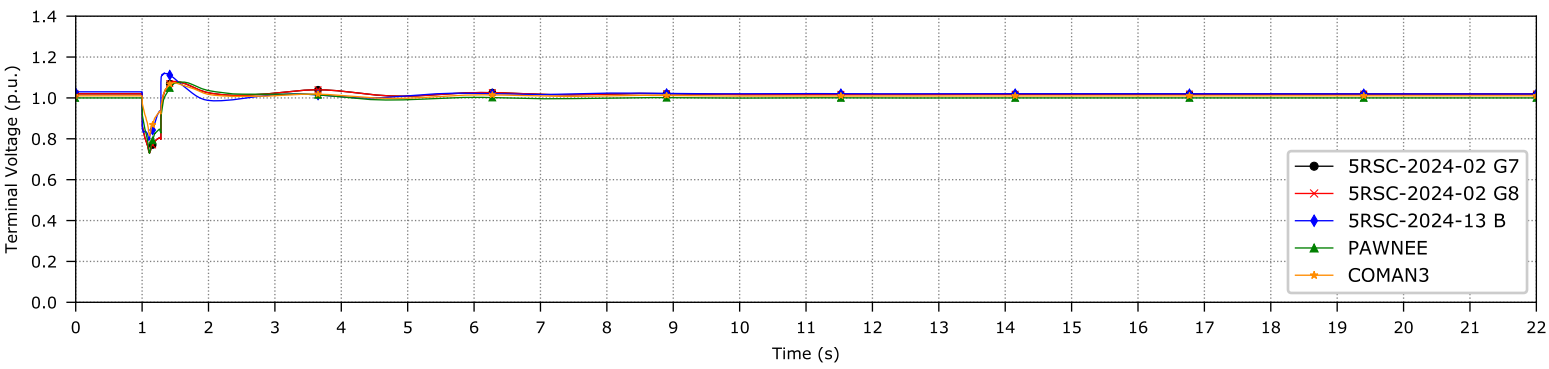

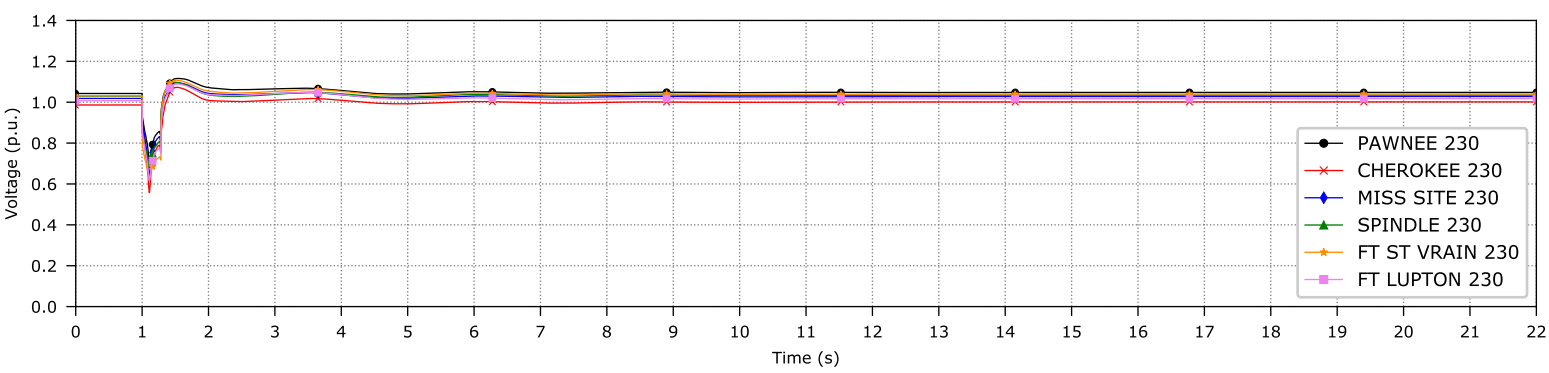

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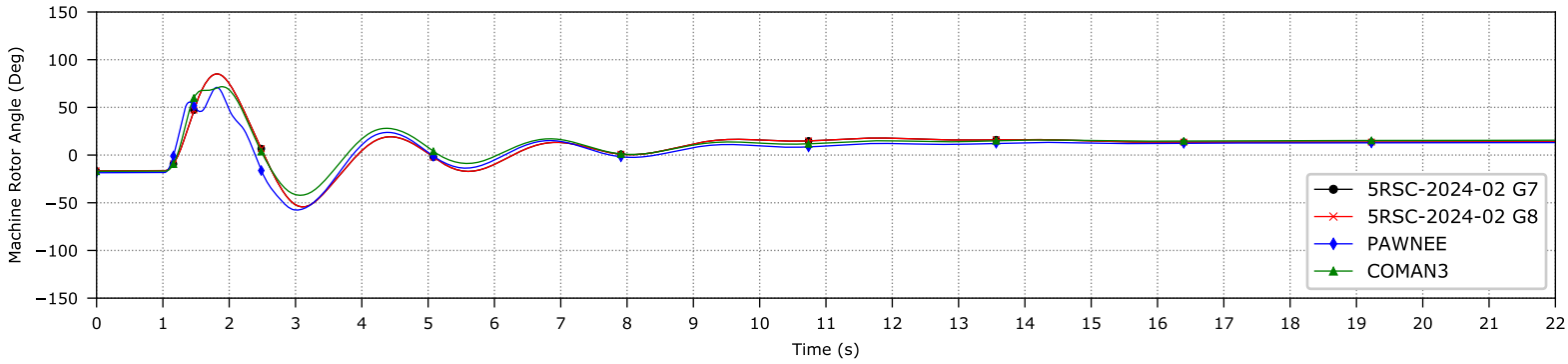

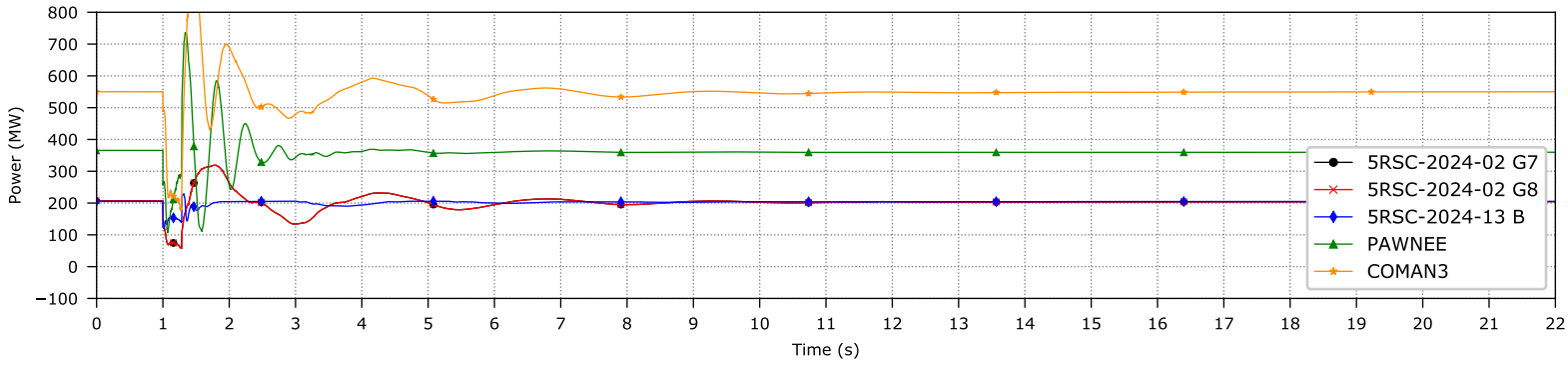

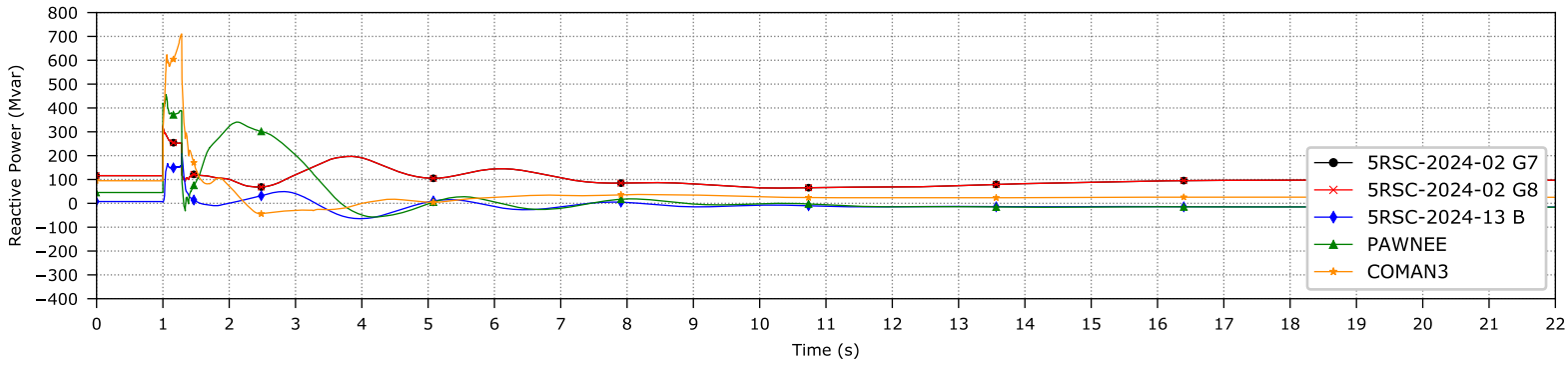

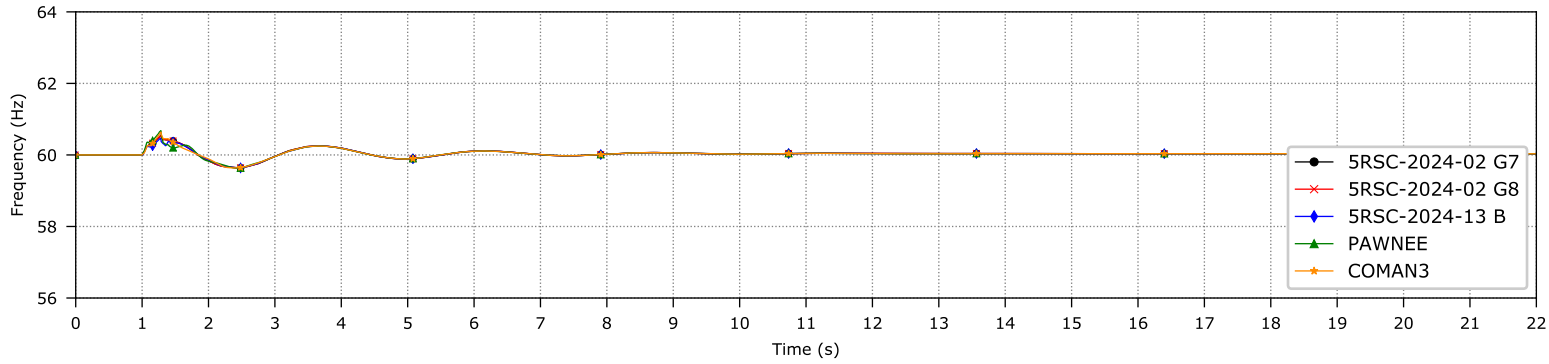

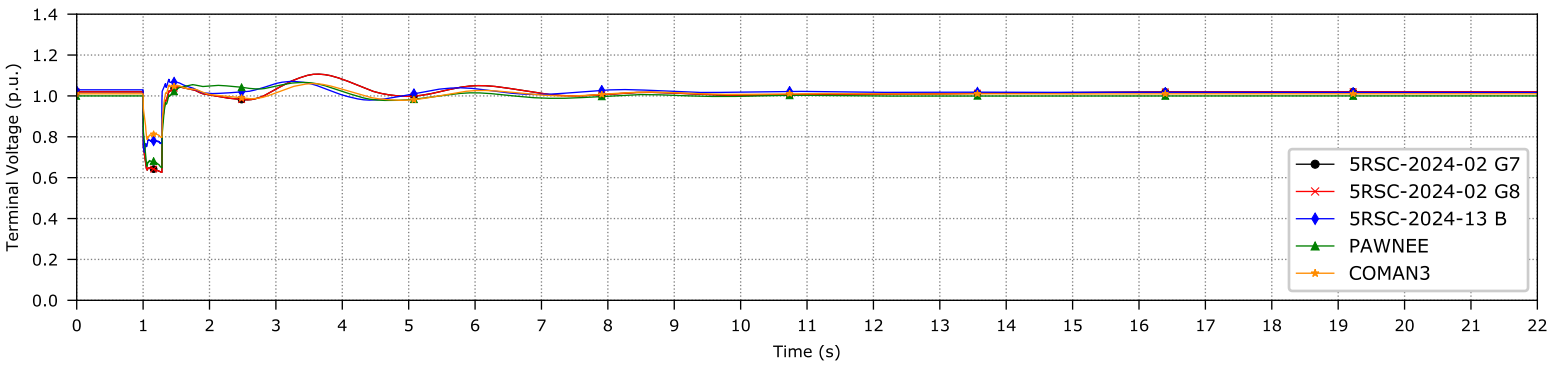

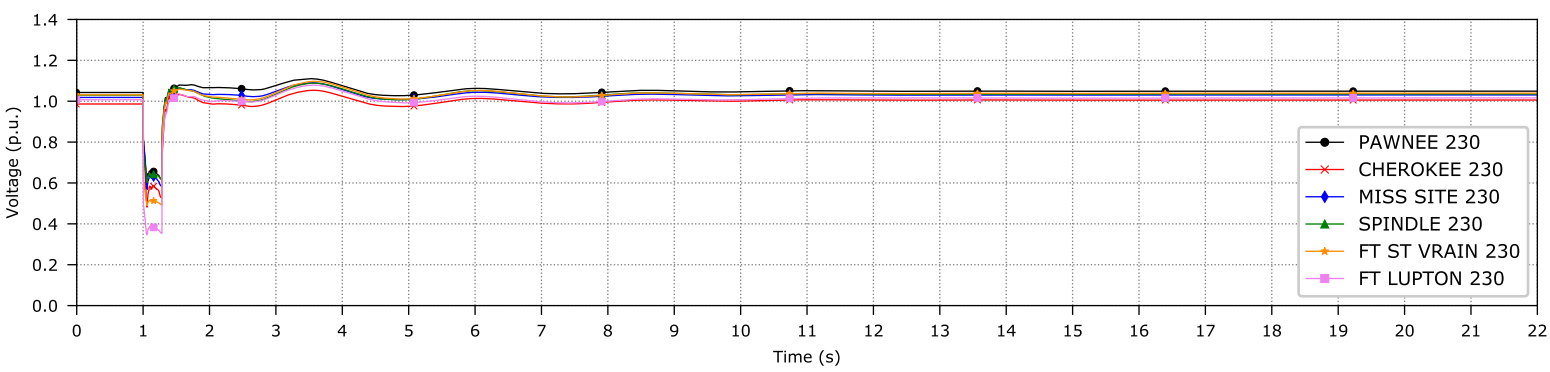

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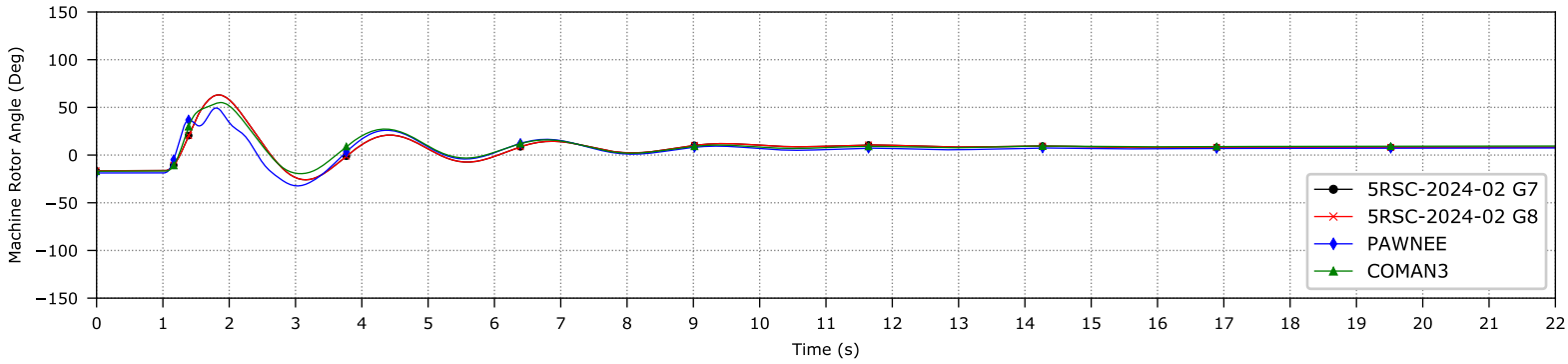

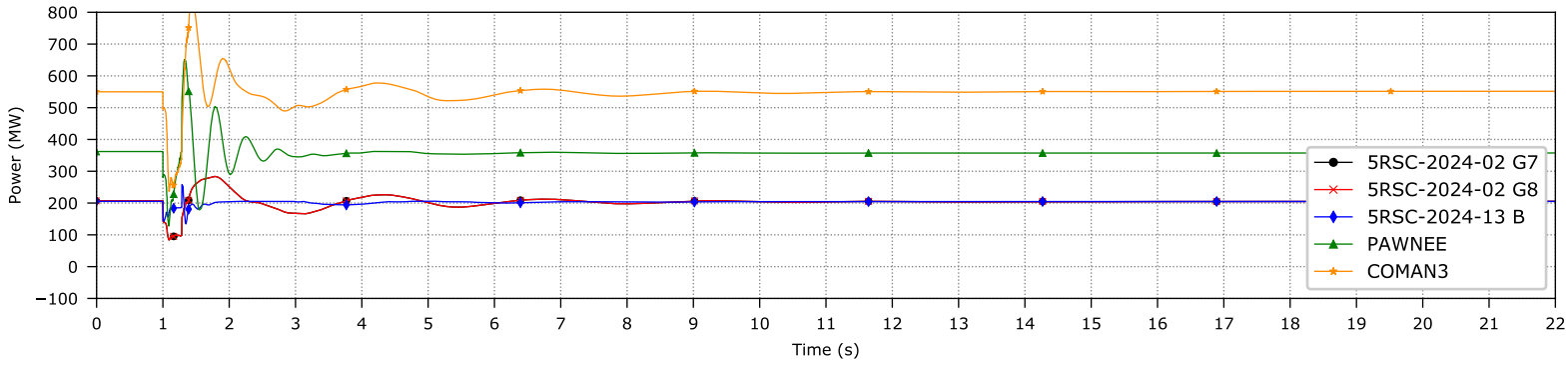

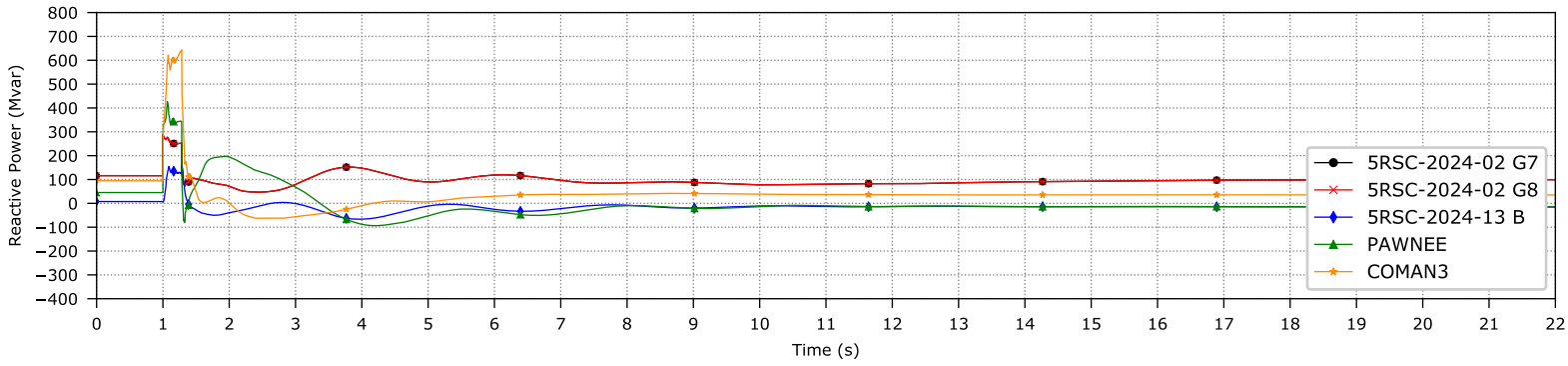

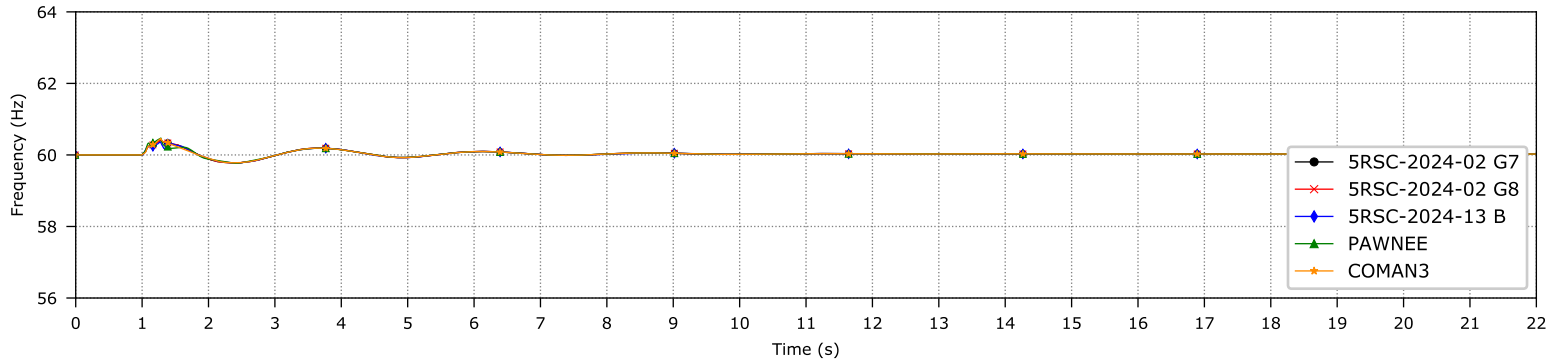

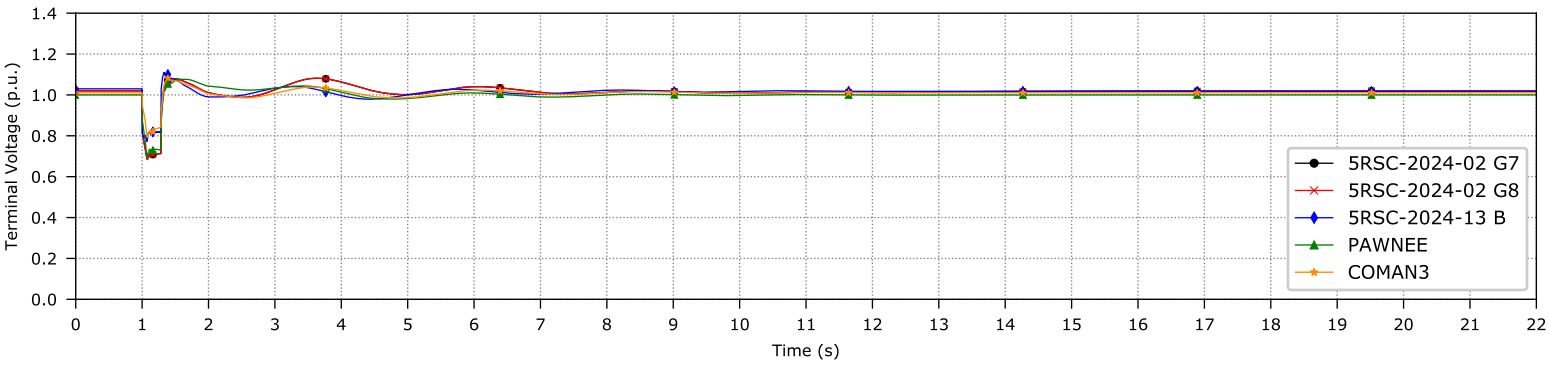

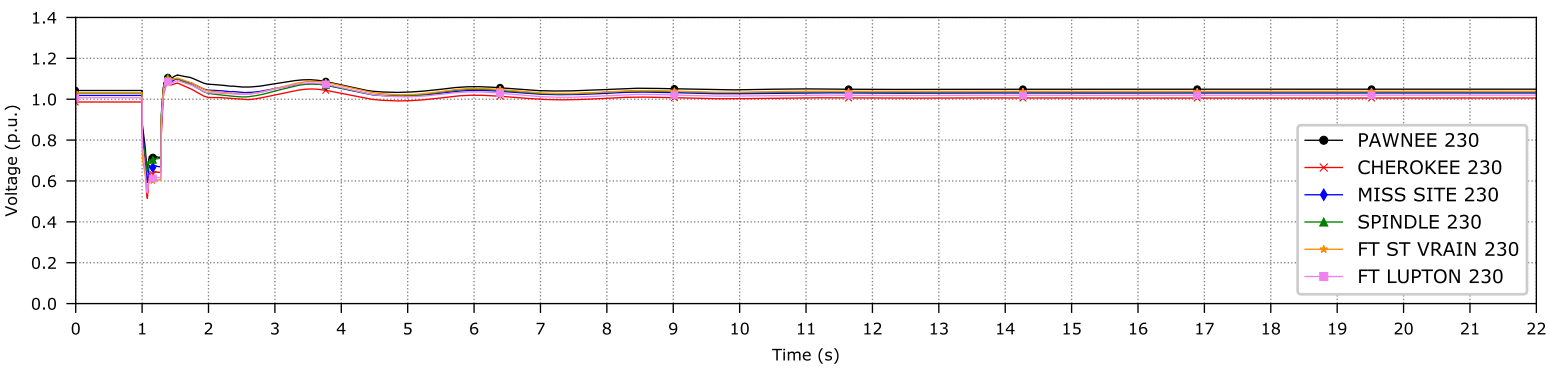

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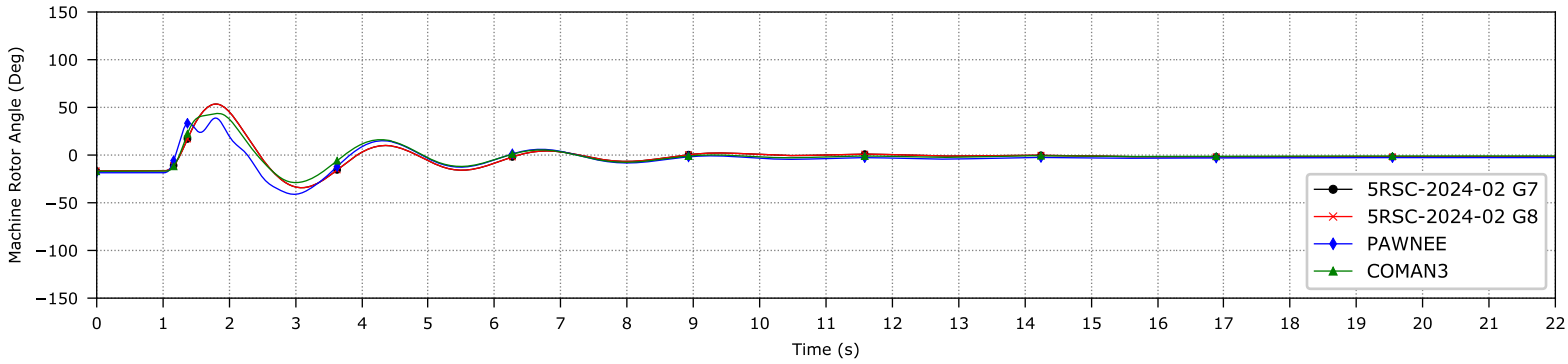

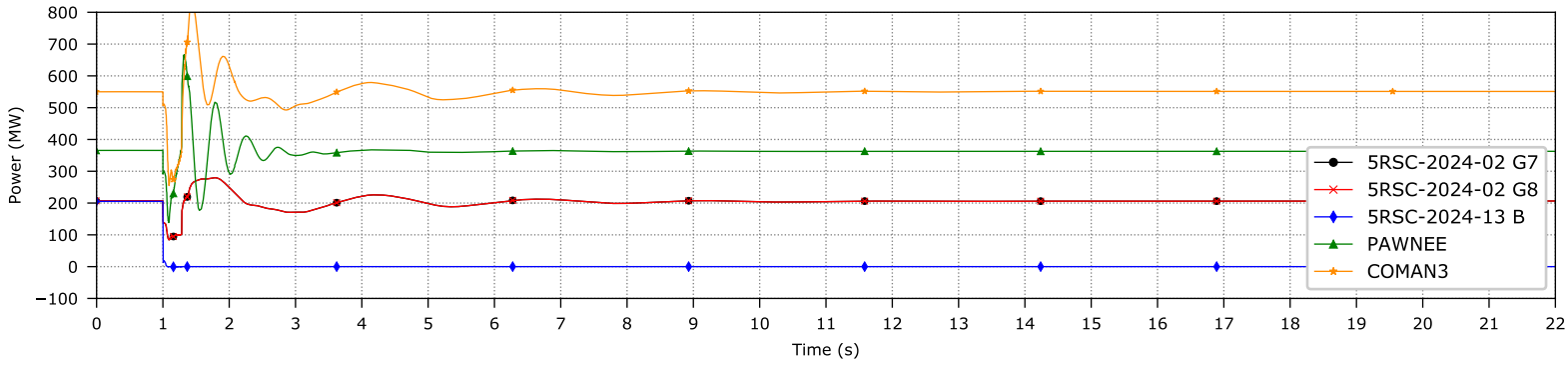

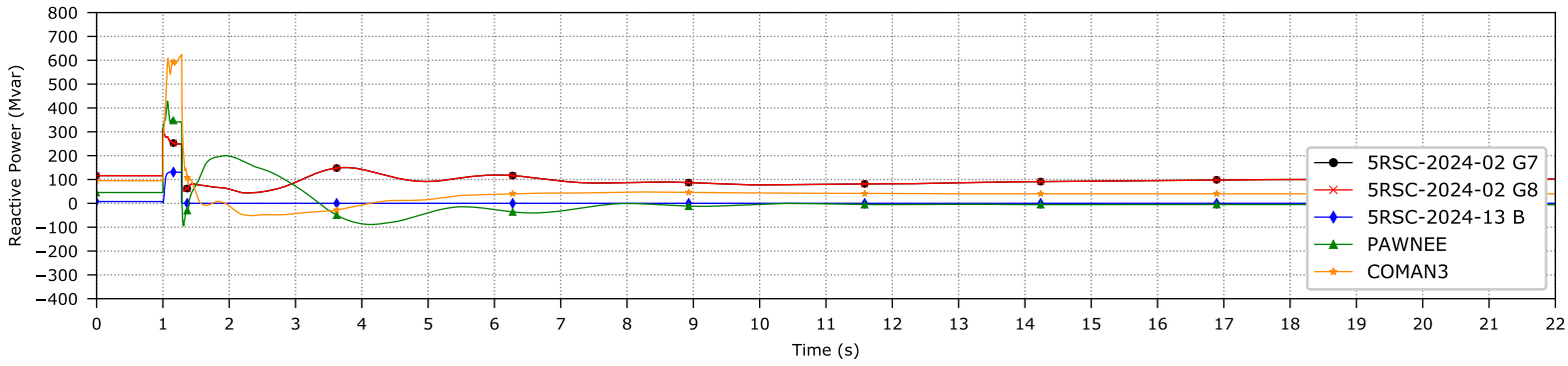

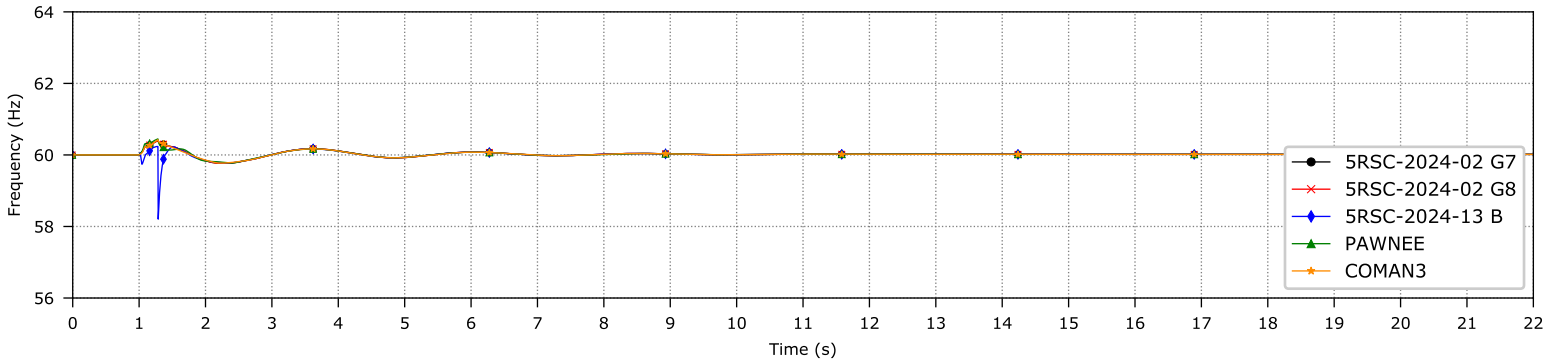

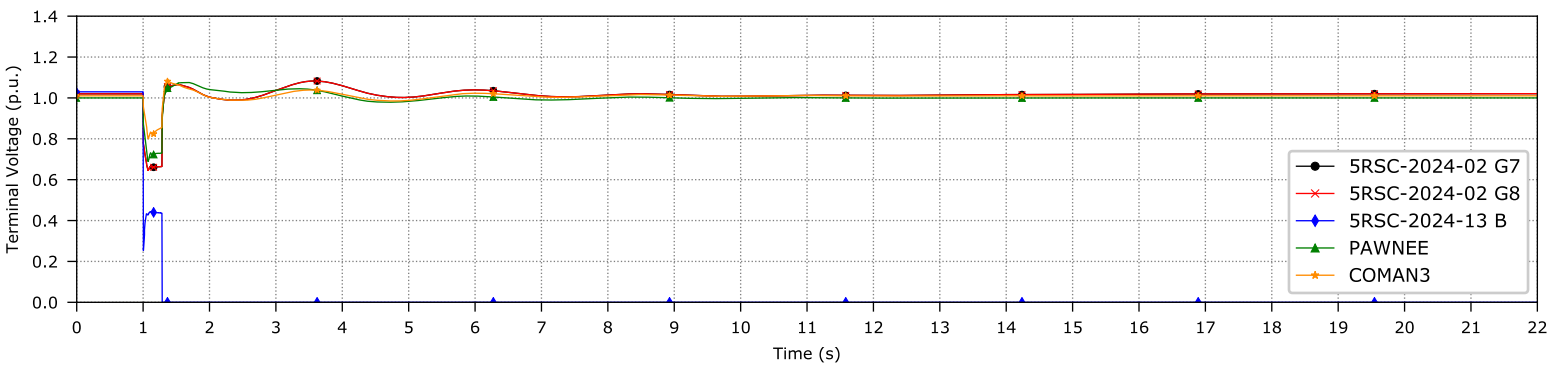

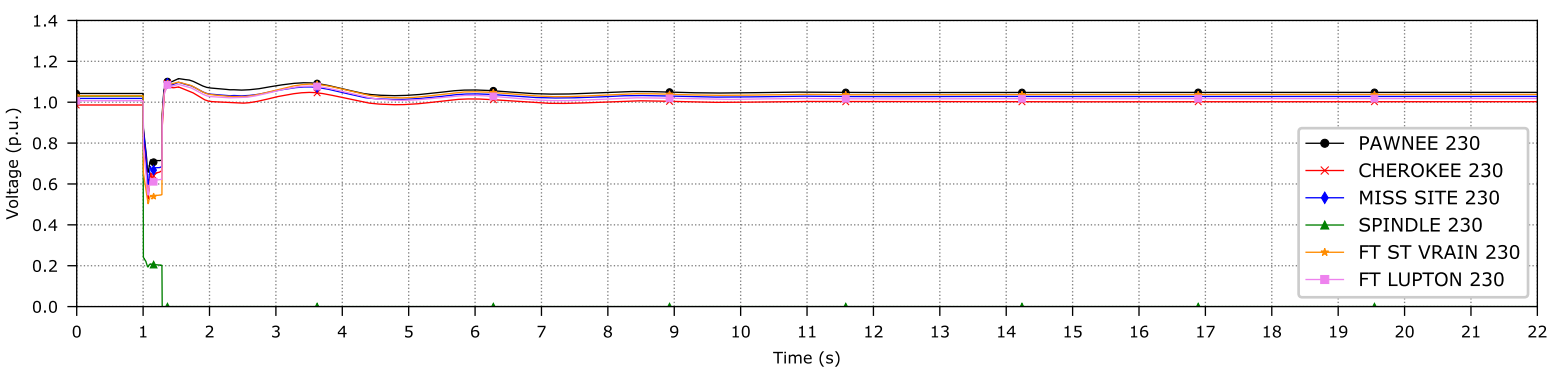

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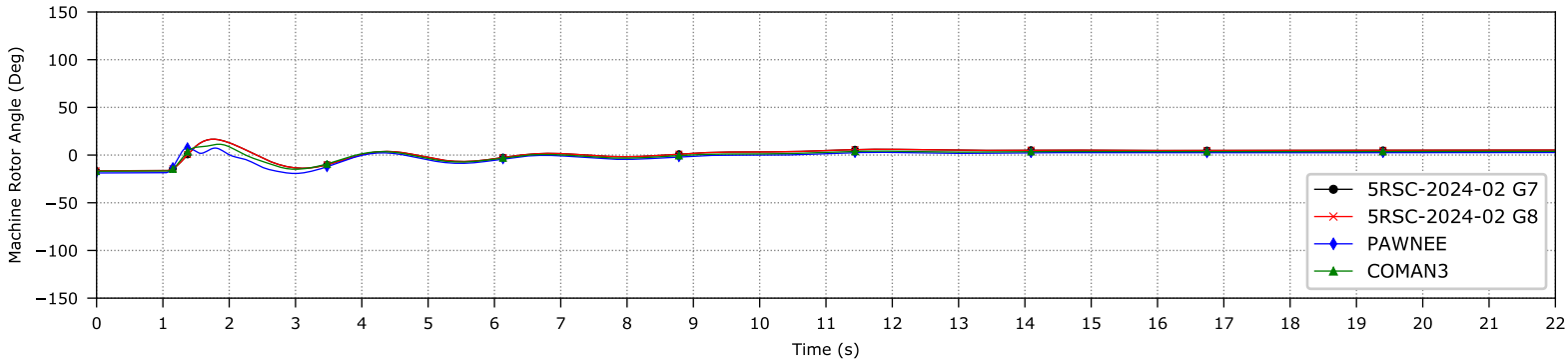

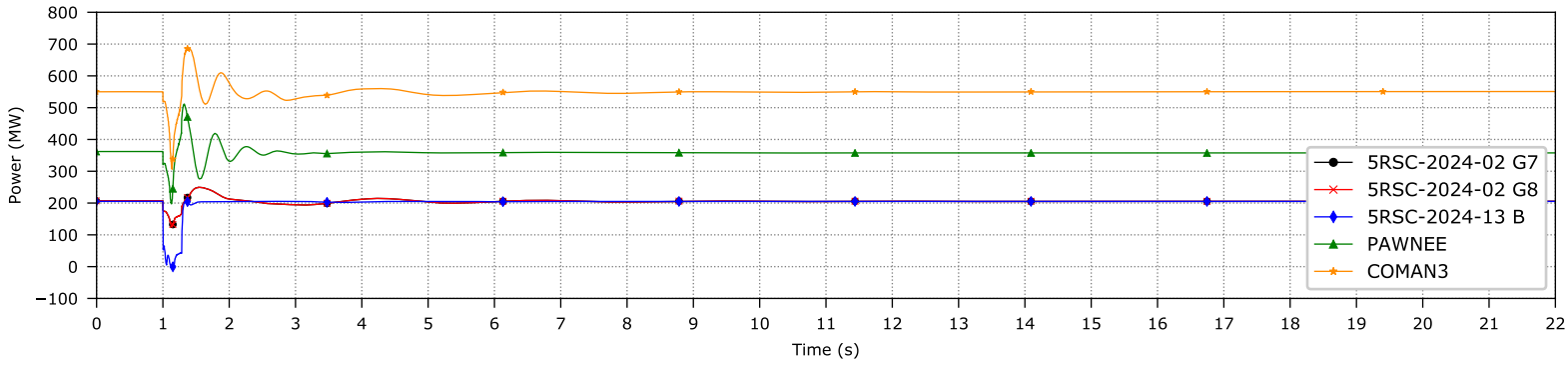

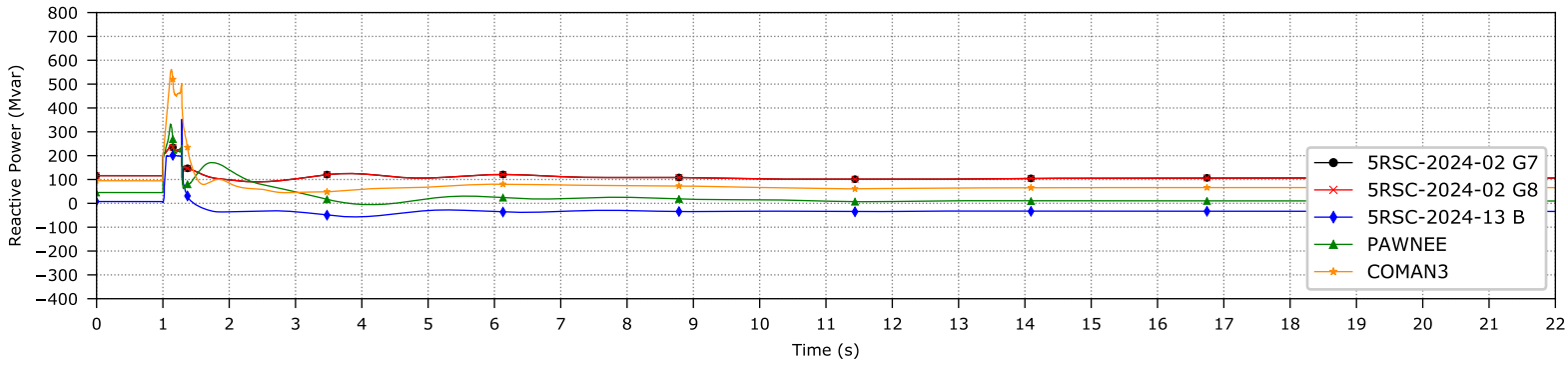

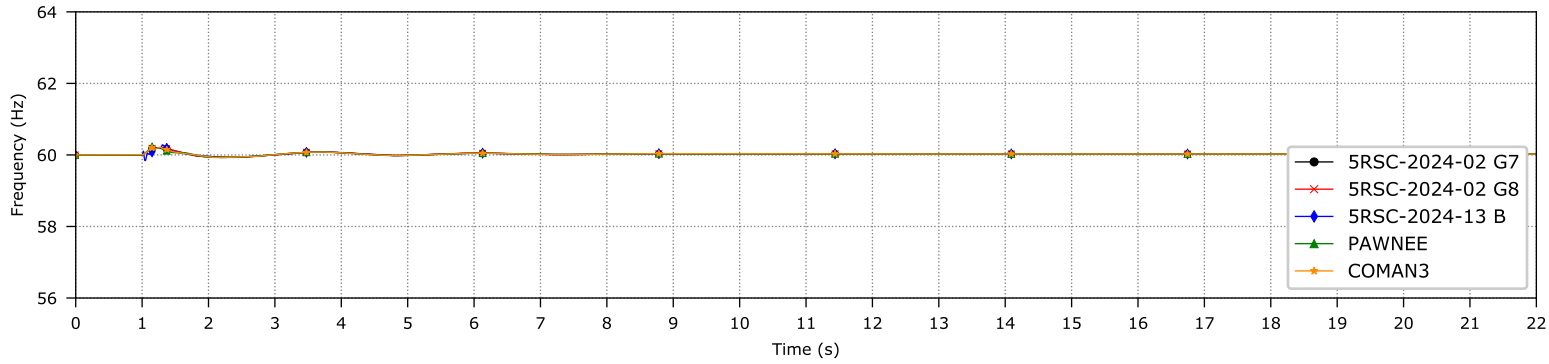

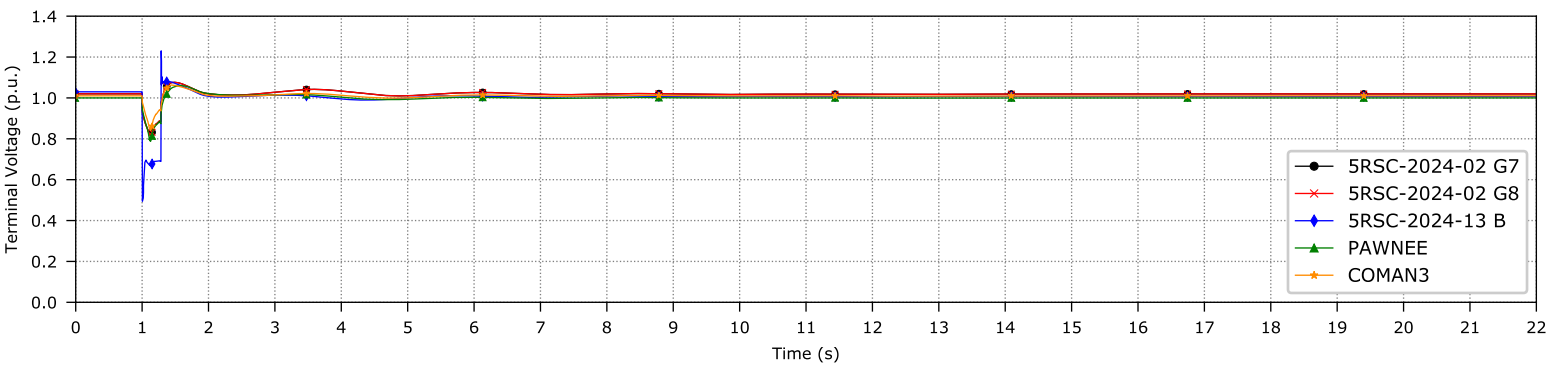

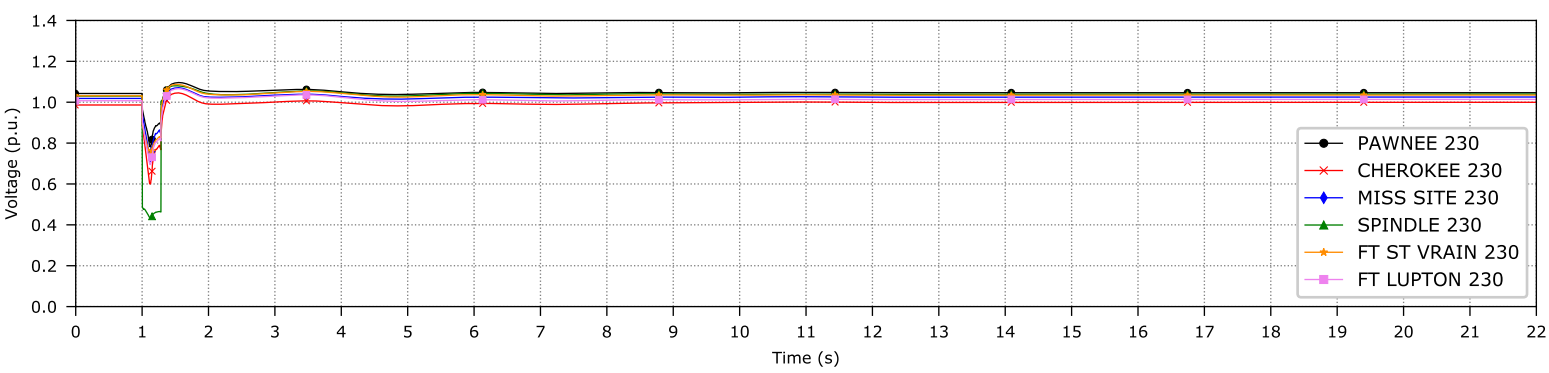

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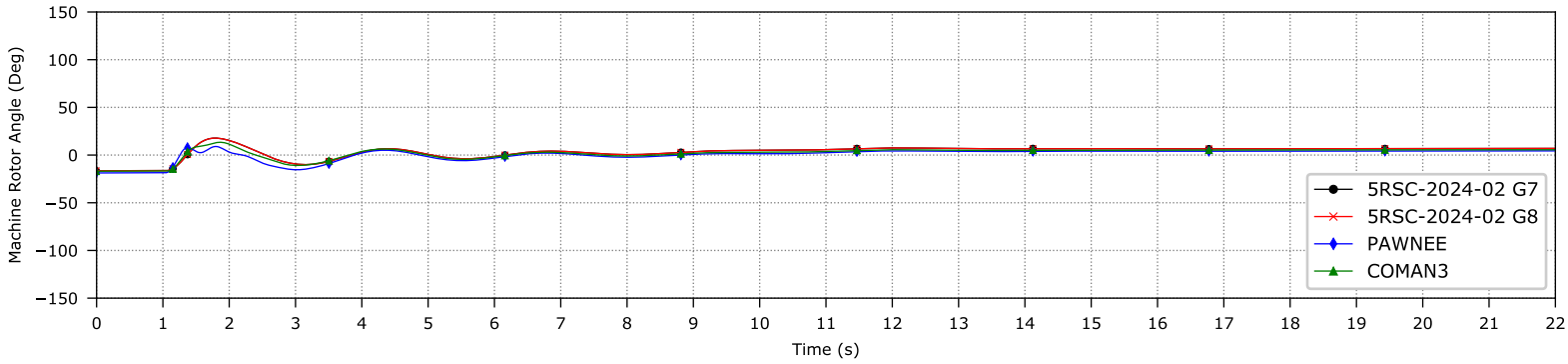

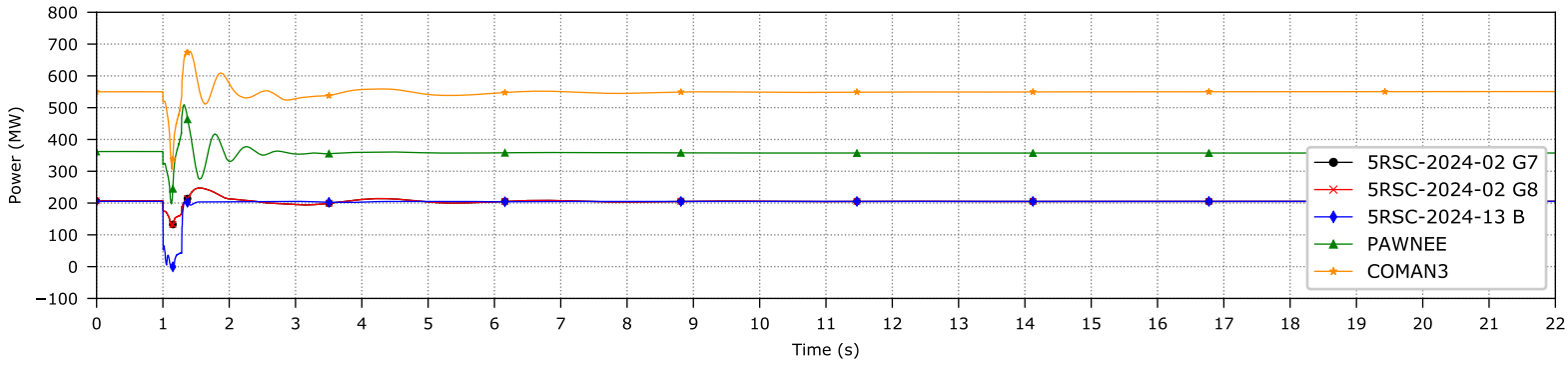

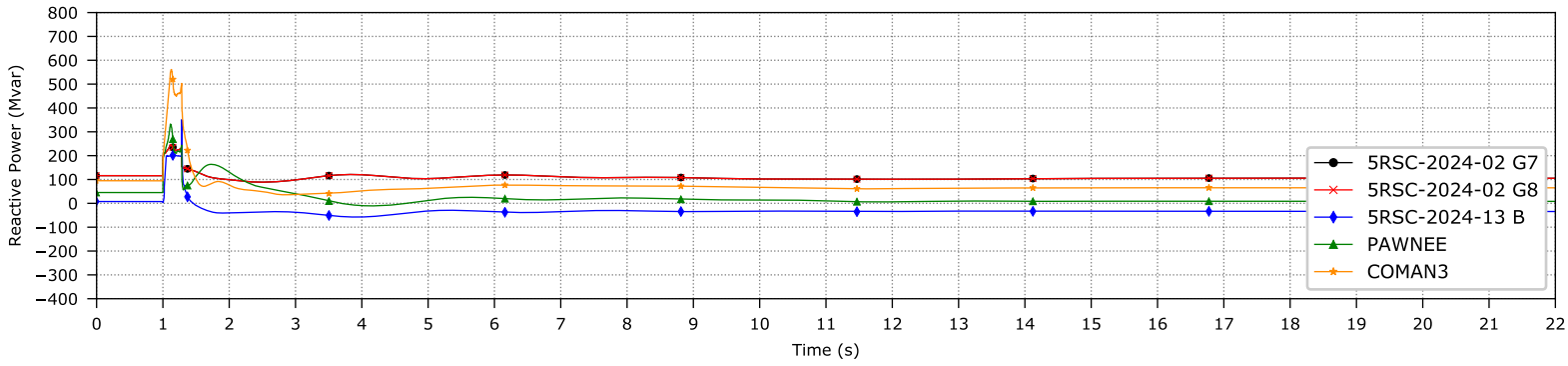

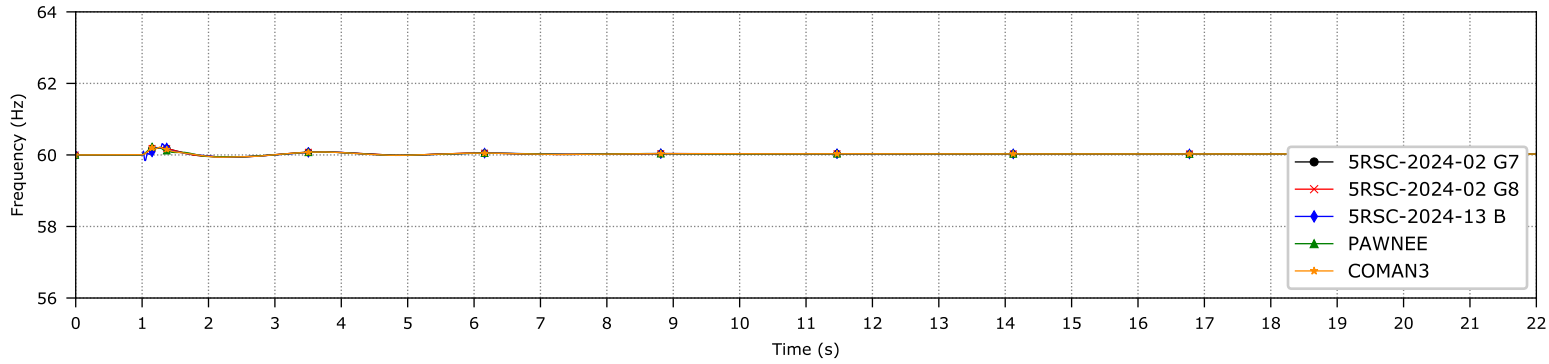

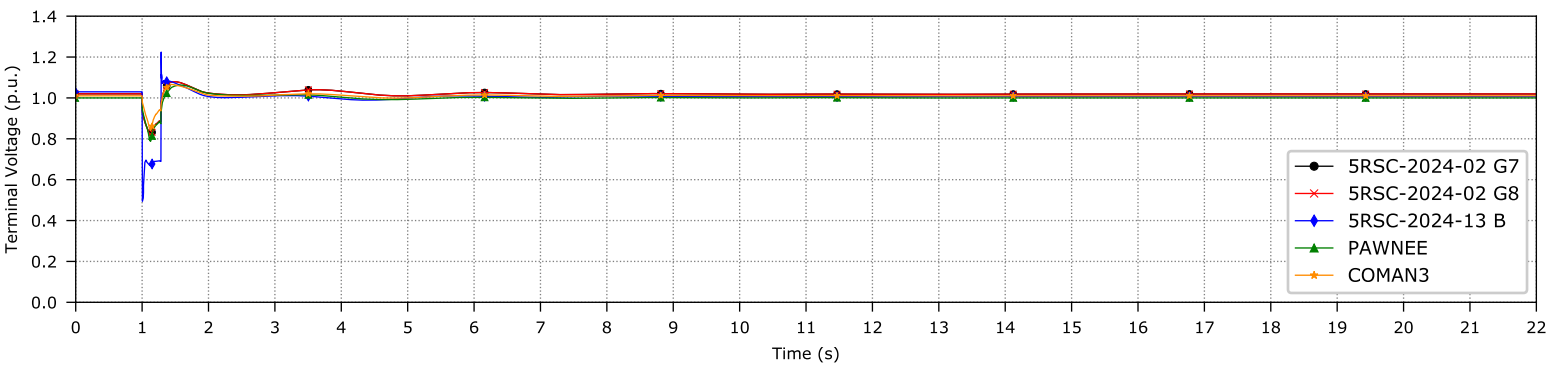

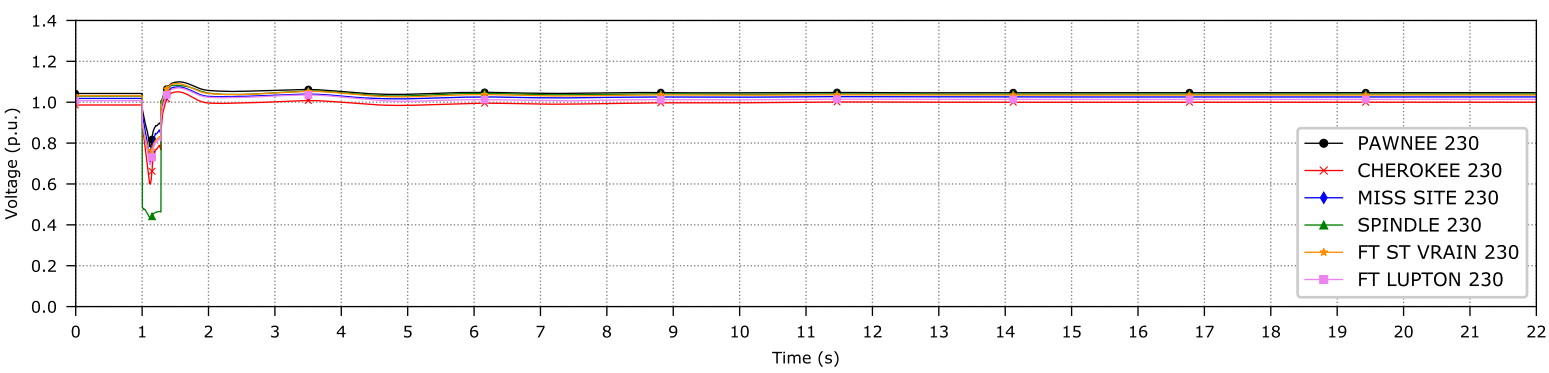

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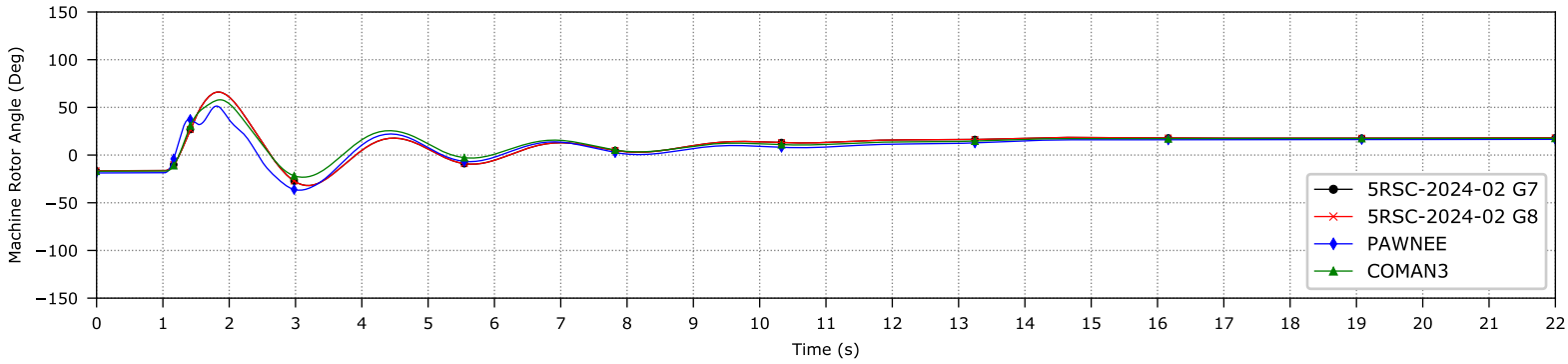
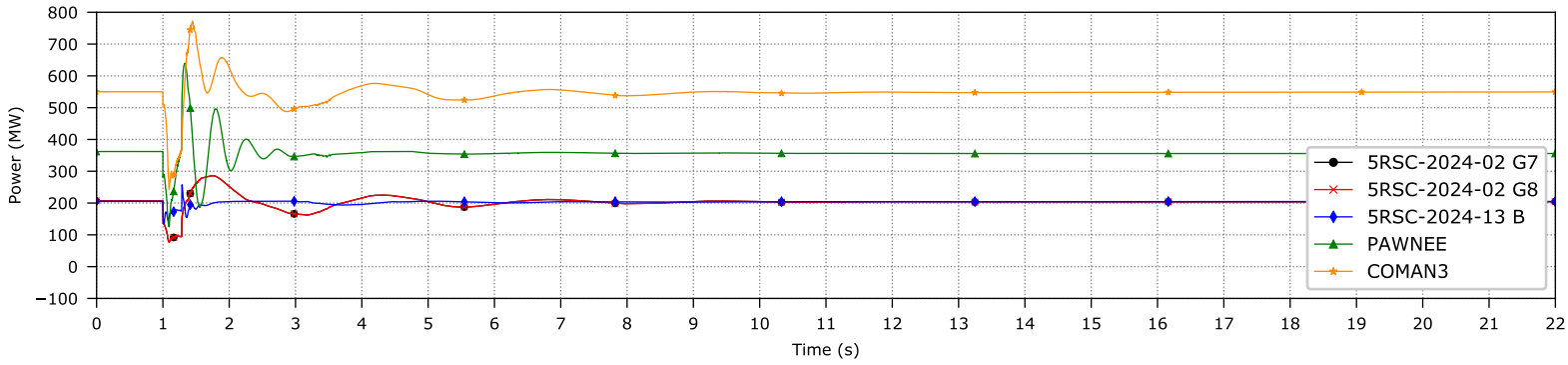
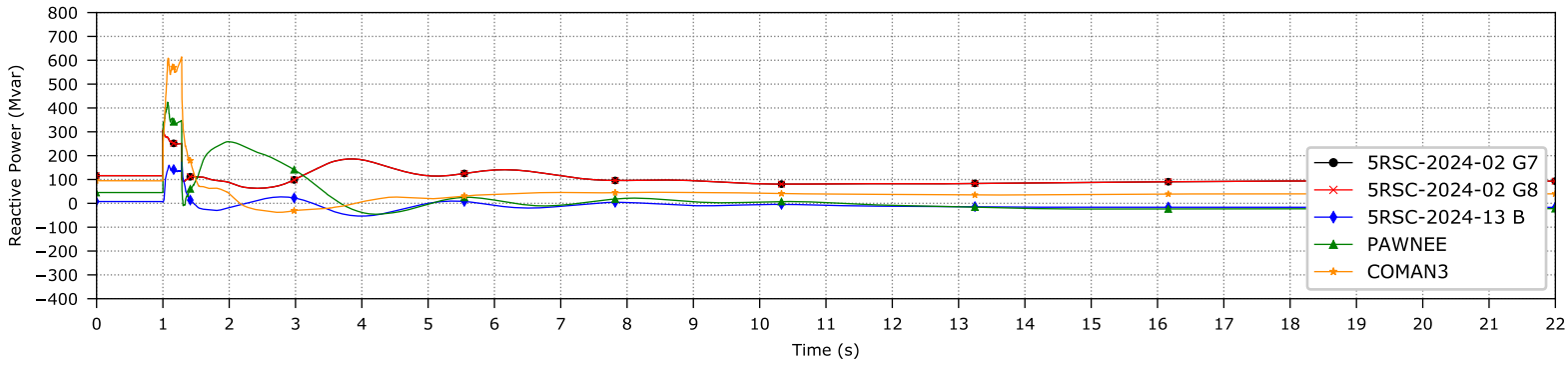
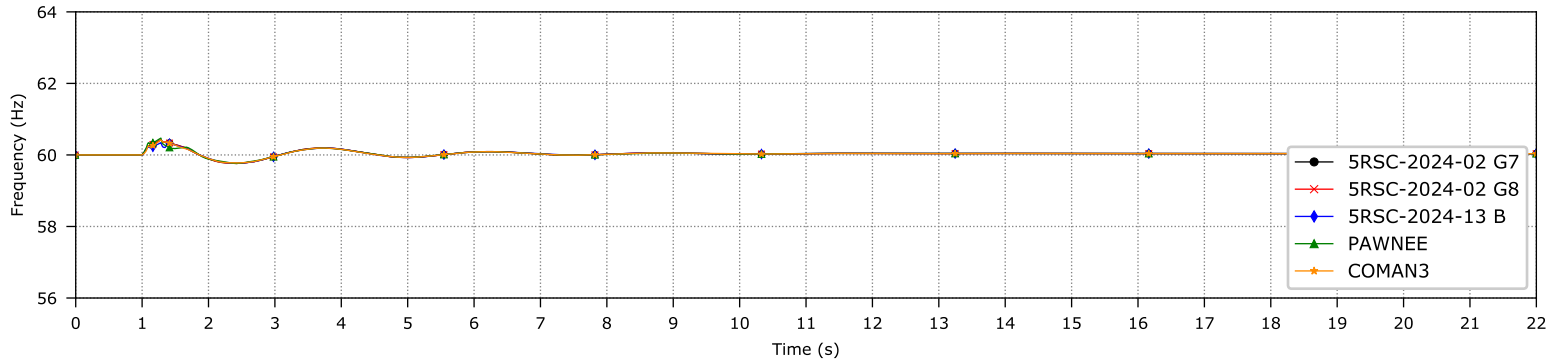
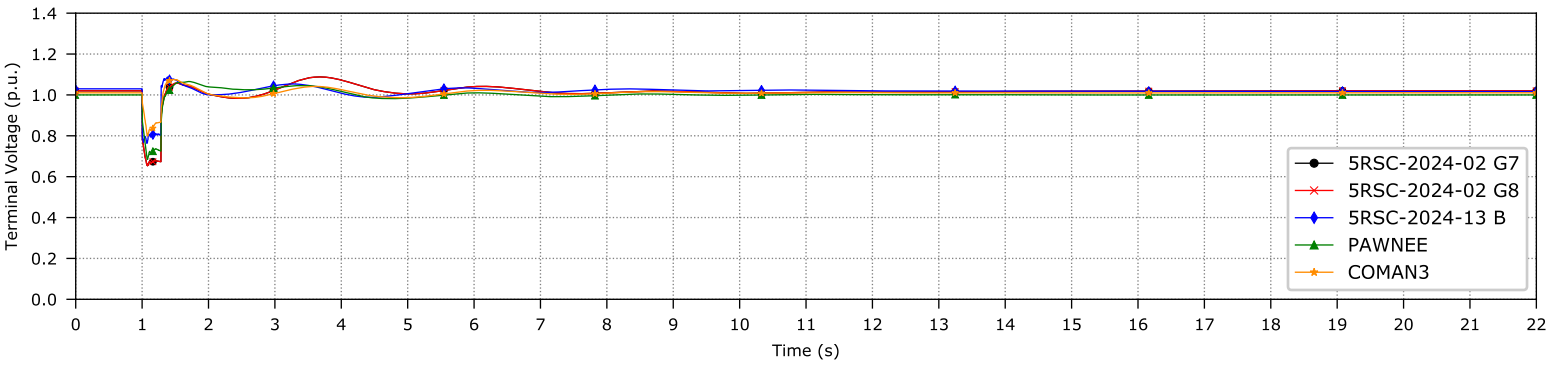
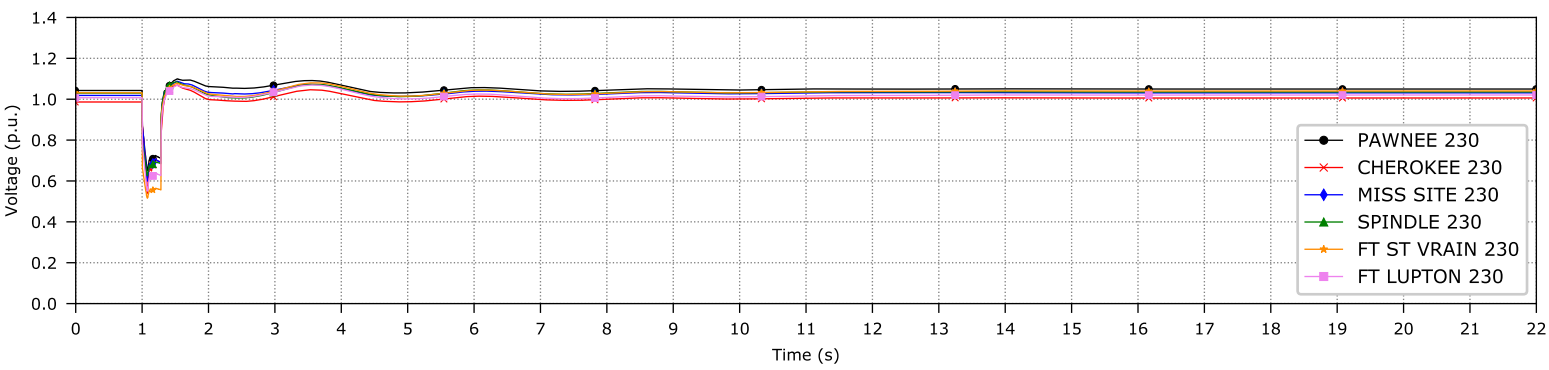


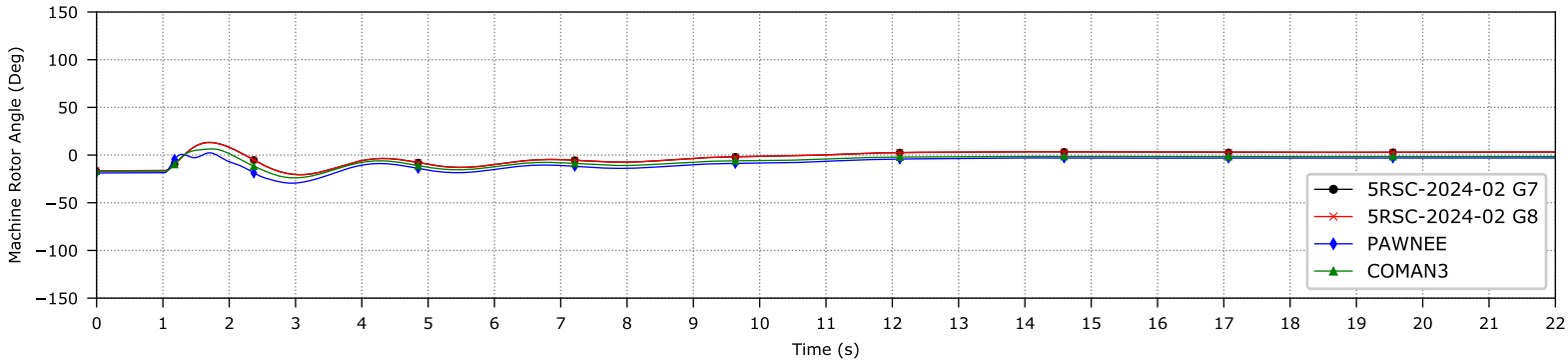


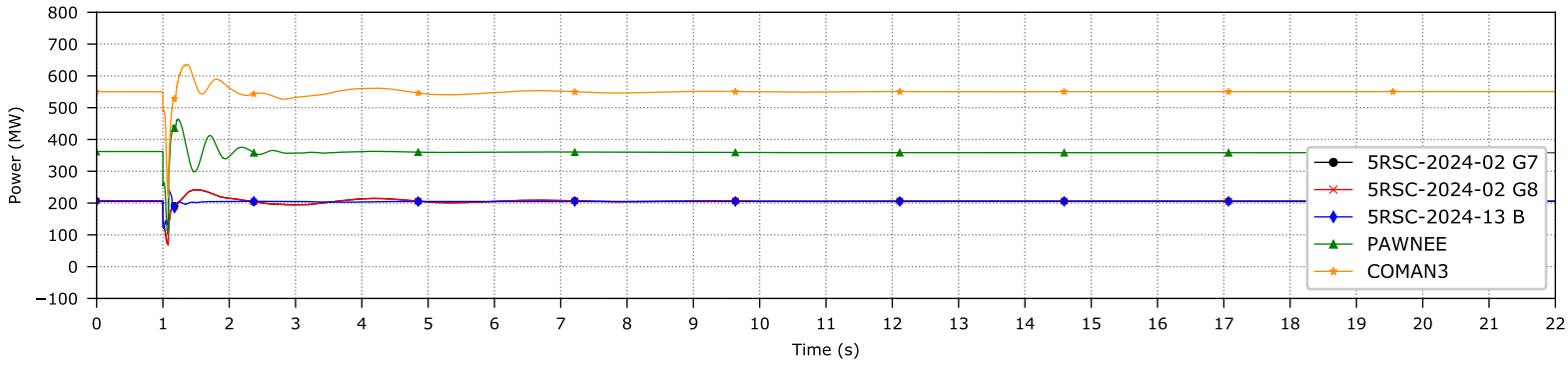


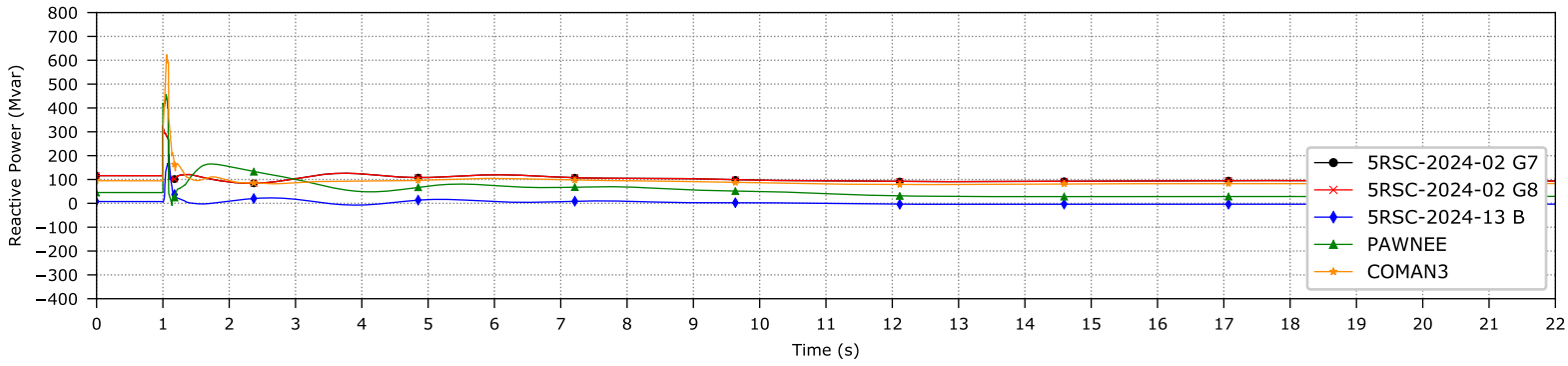


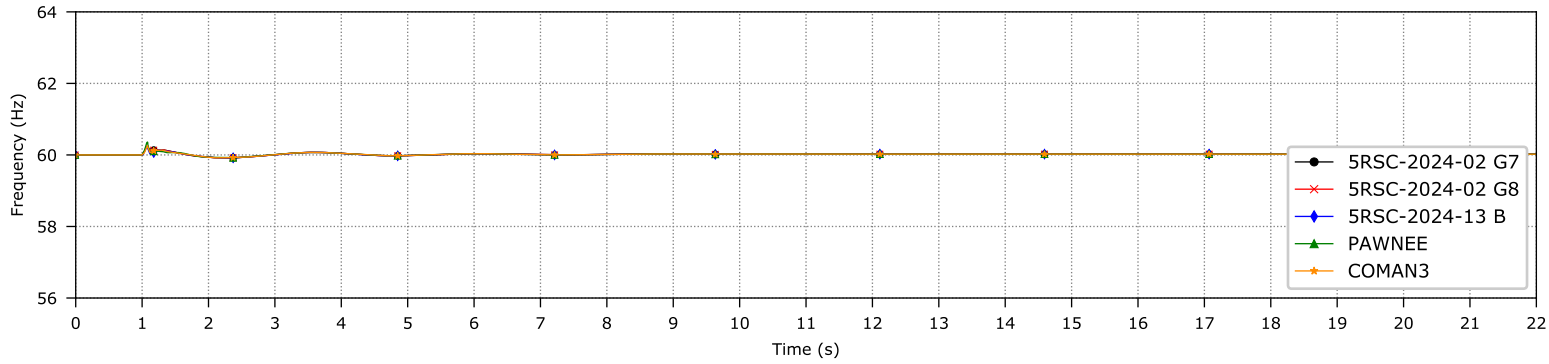


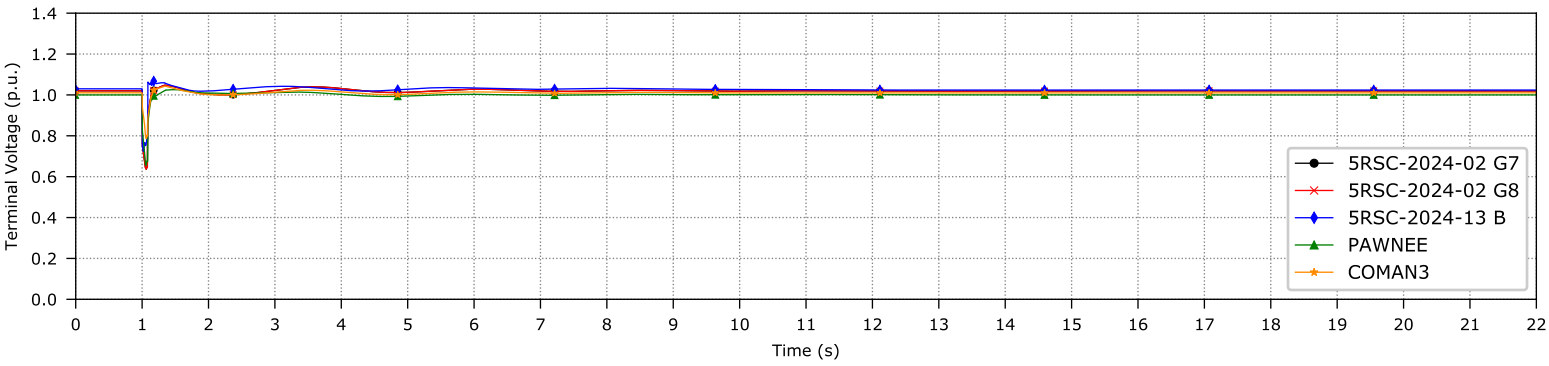


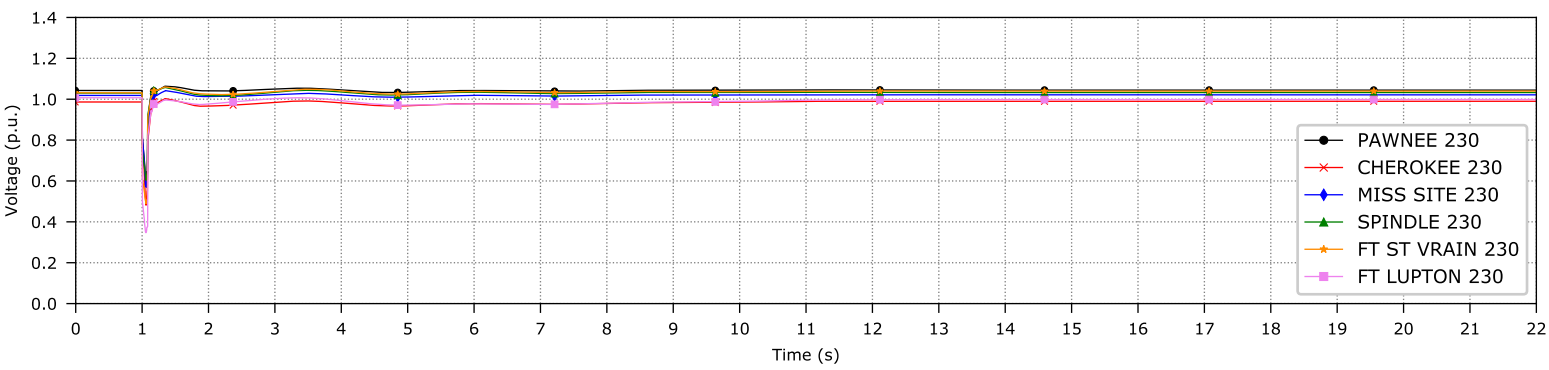

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

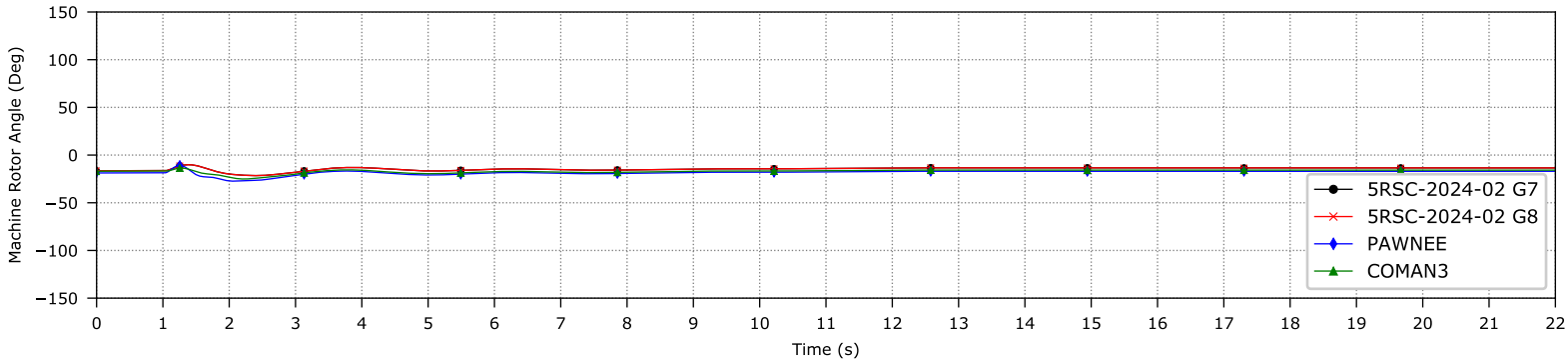

Reactive Power (Mvar)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

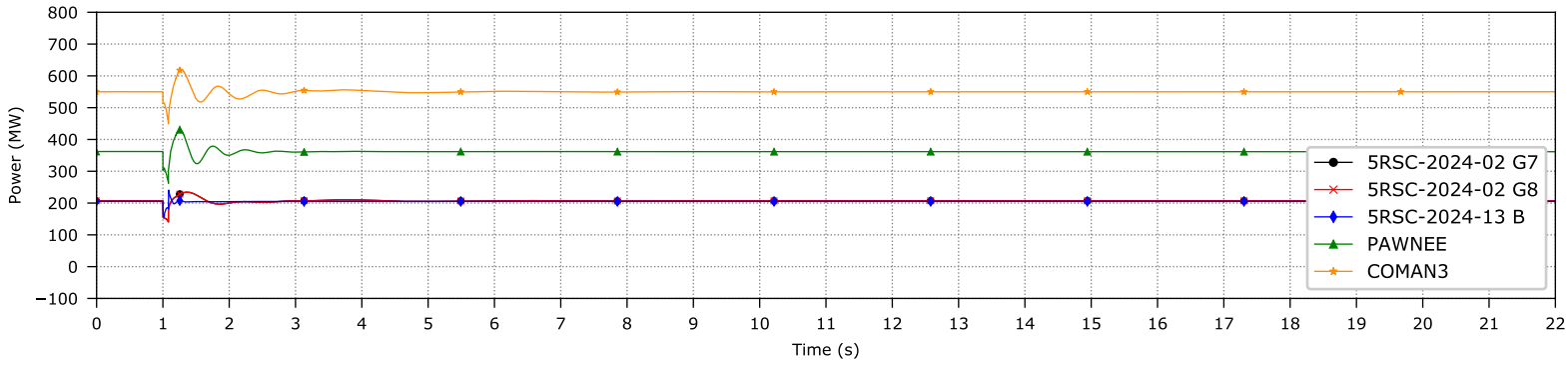

Frequency (Hz)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

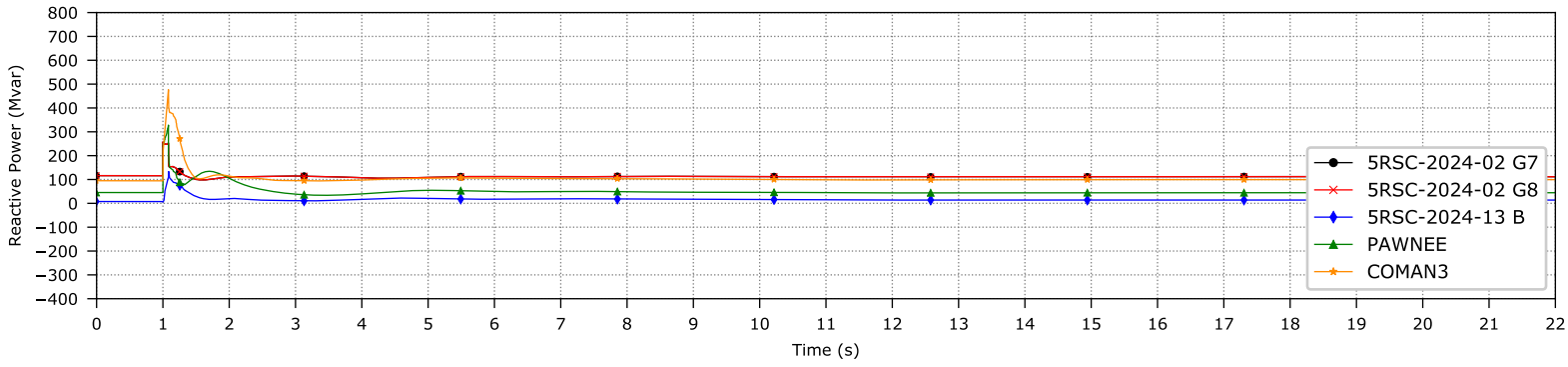

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

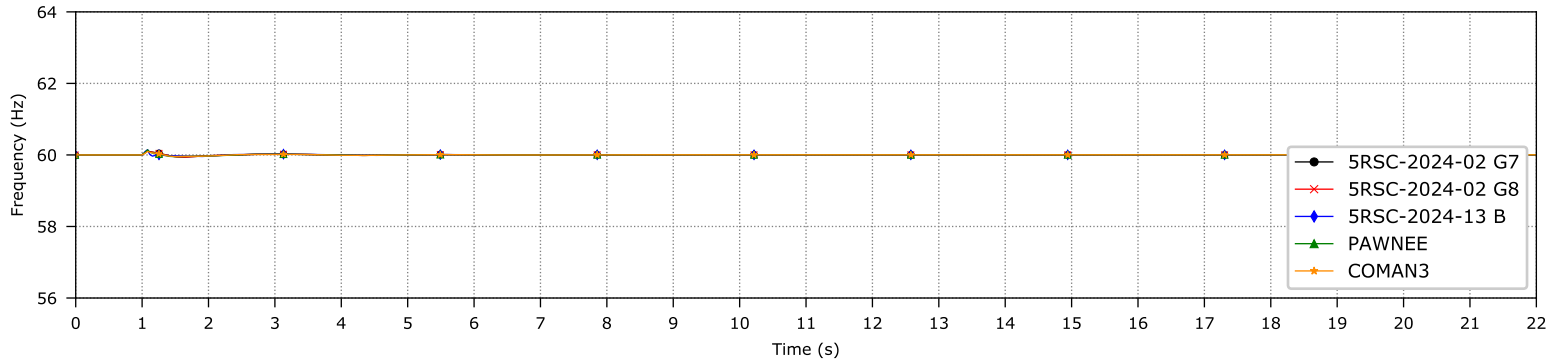

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

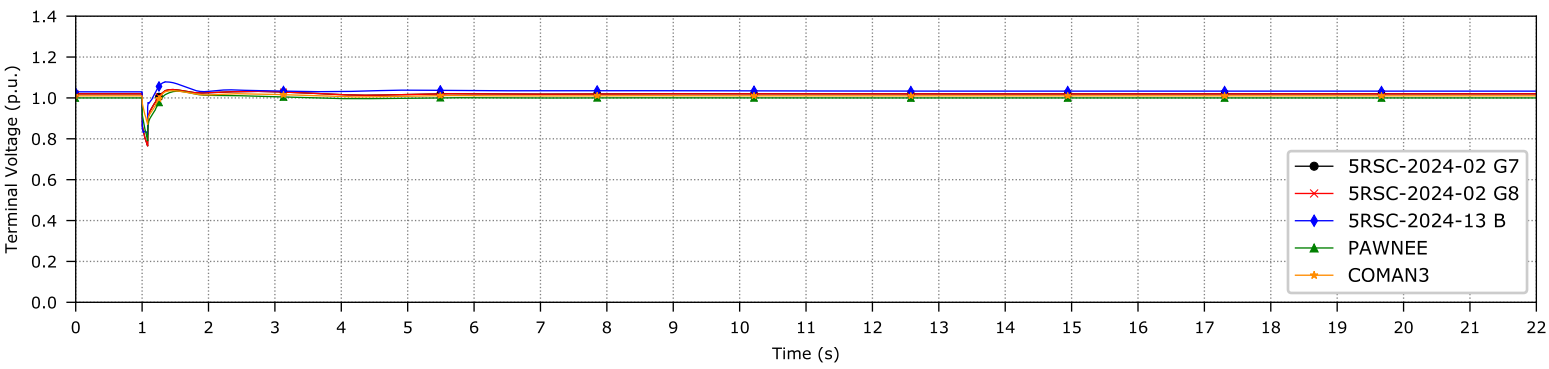
Ref. No. 28 - P7_87

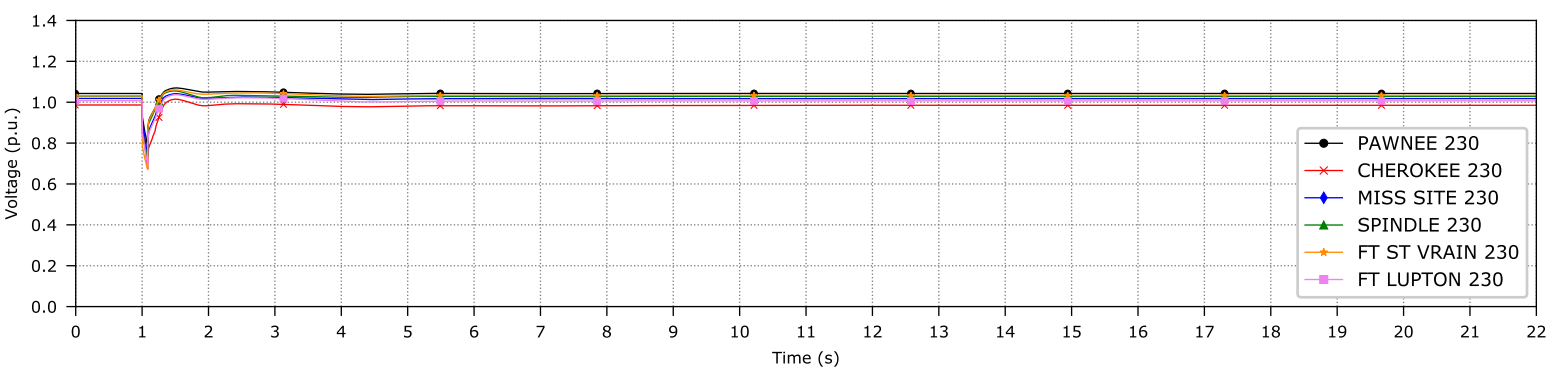




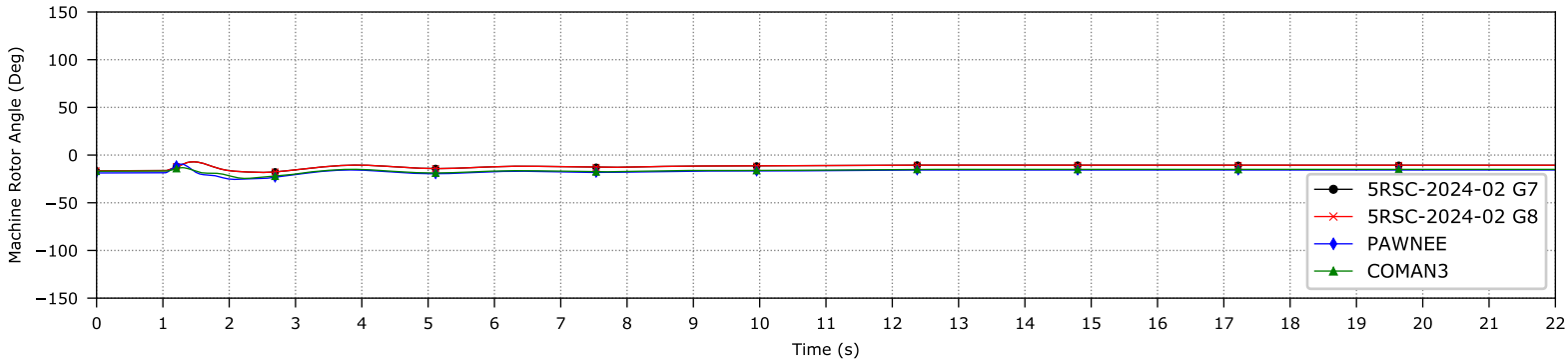


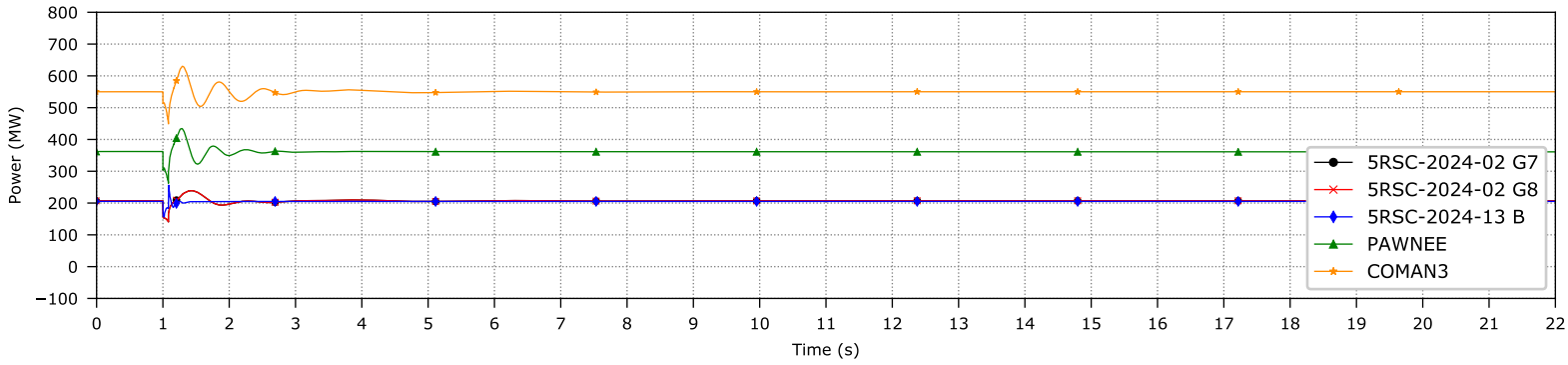


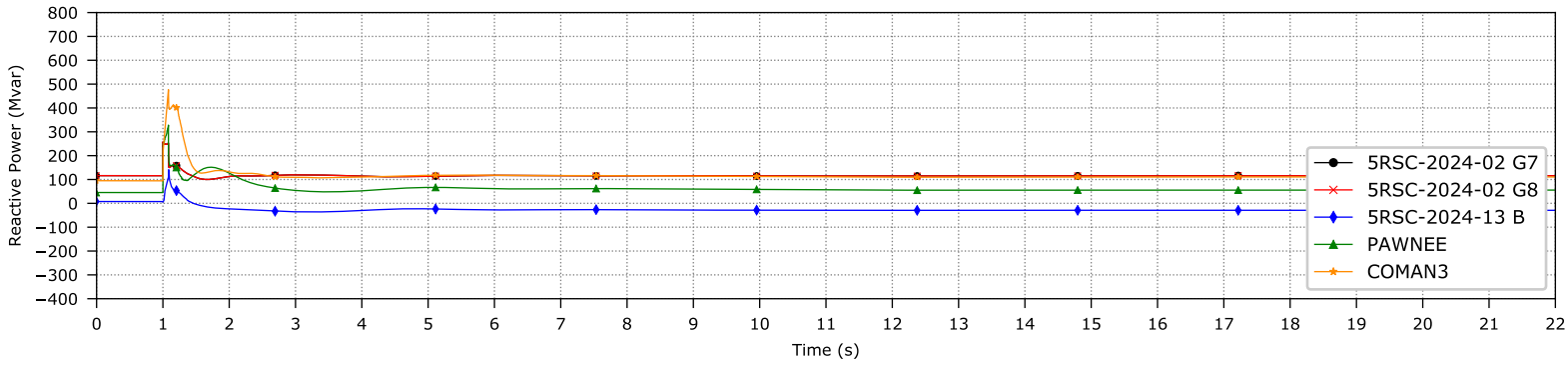


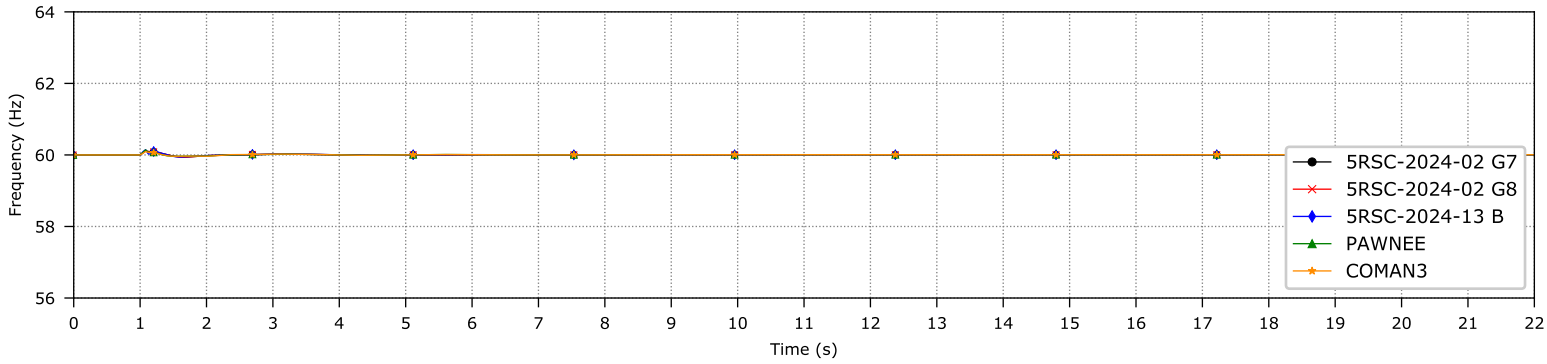


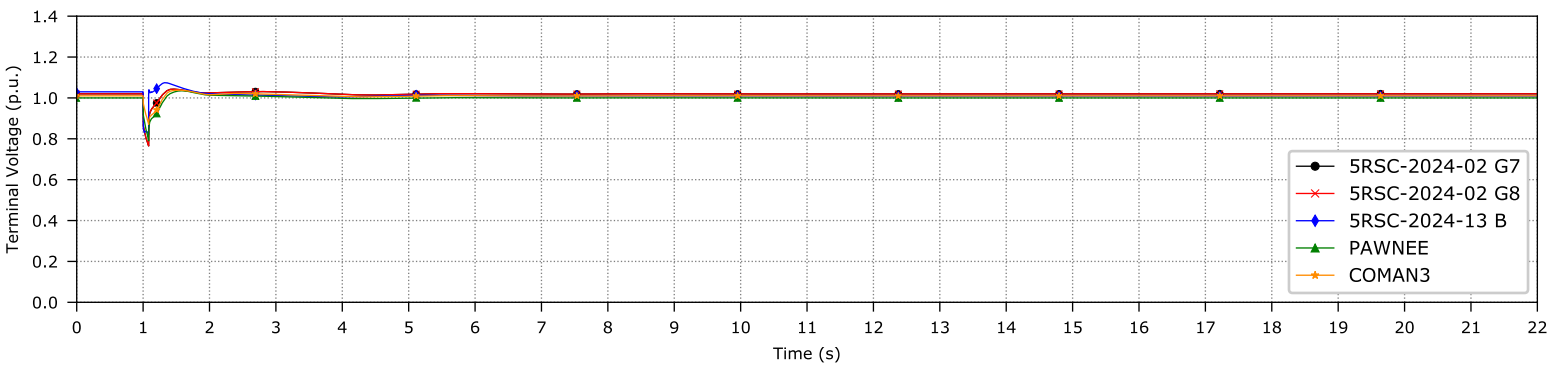
Ref. No. 29 - P7_88

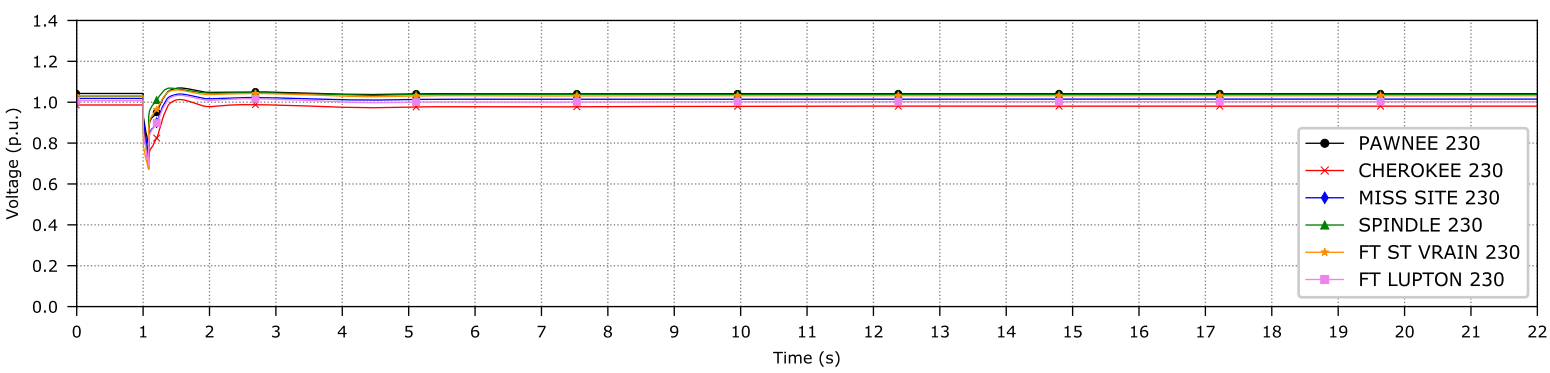




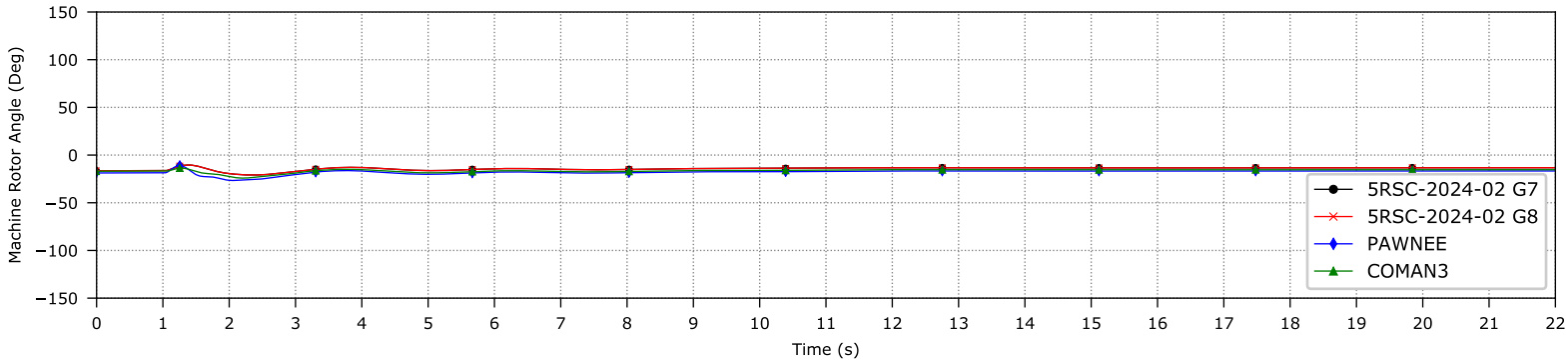


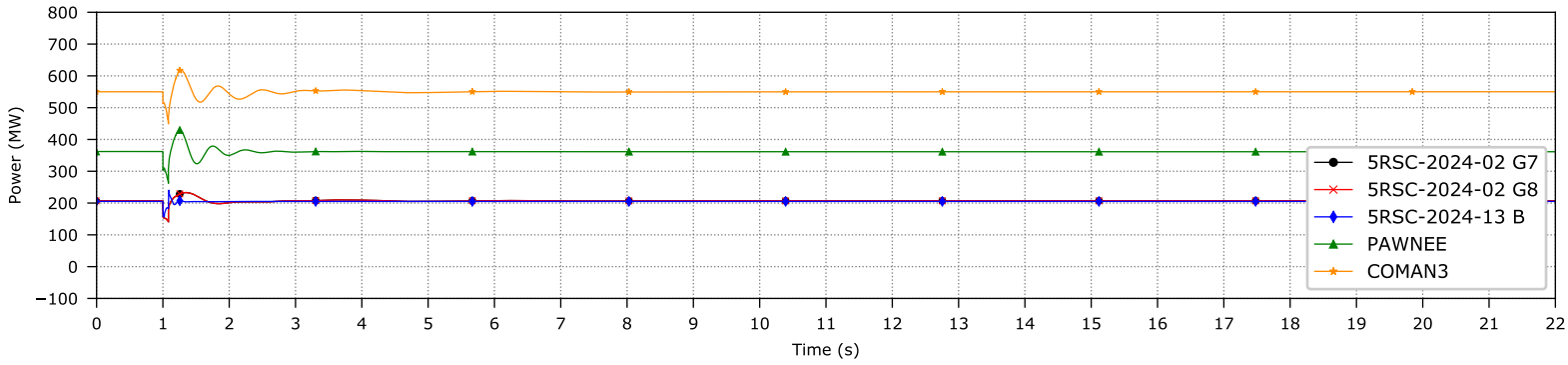


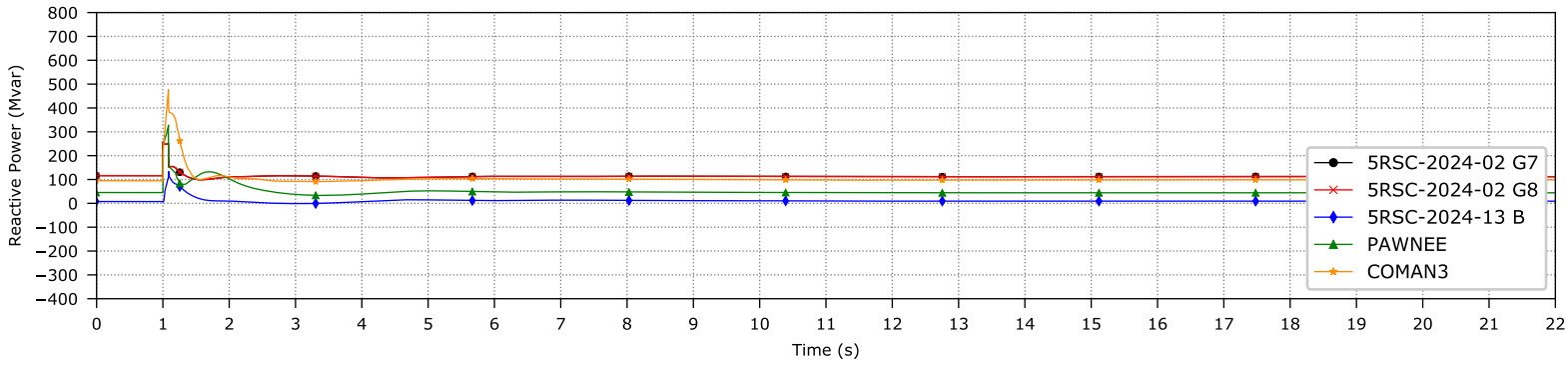


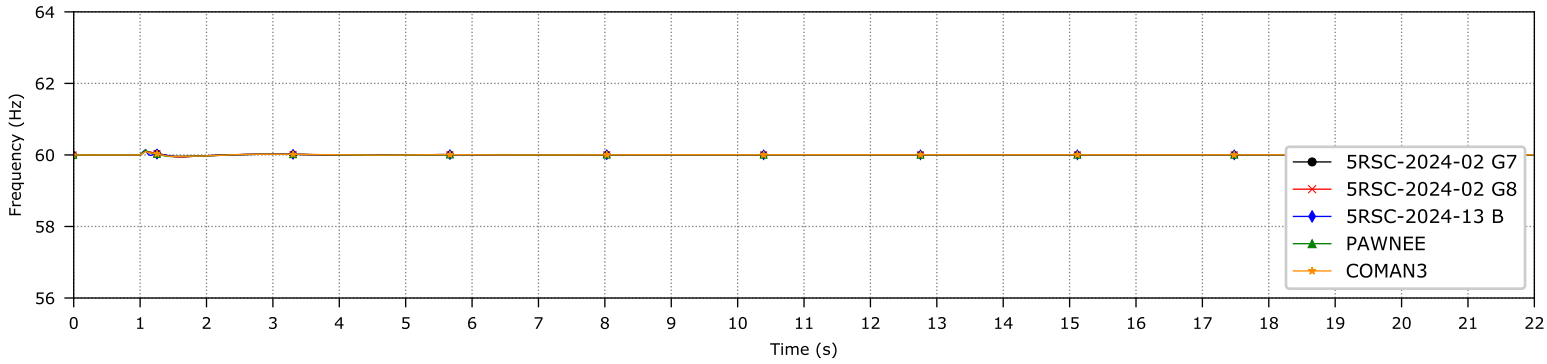


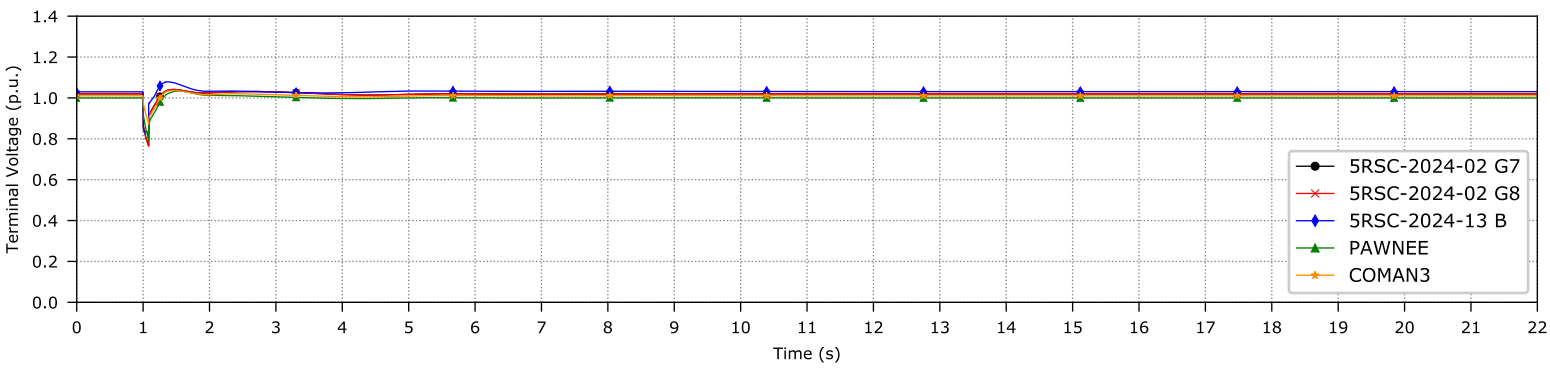
Ref. No. 30 - P7_89

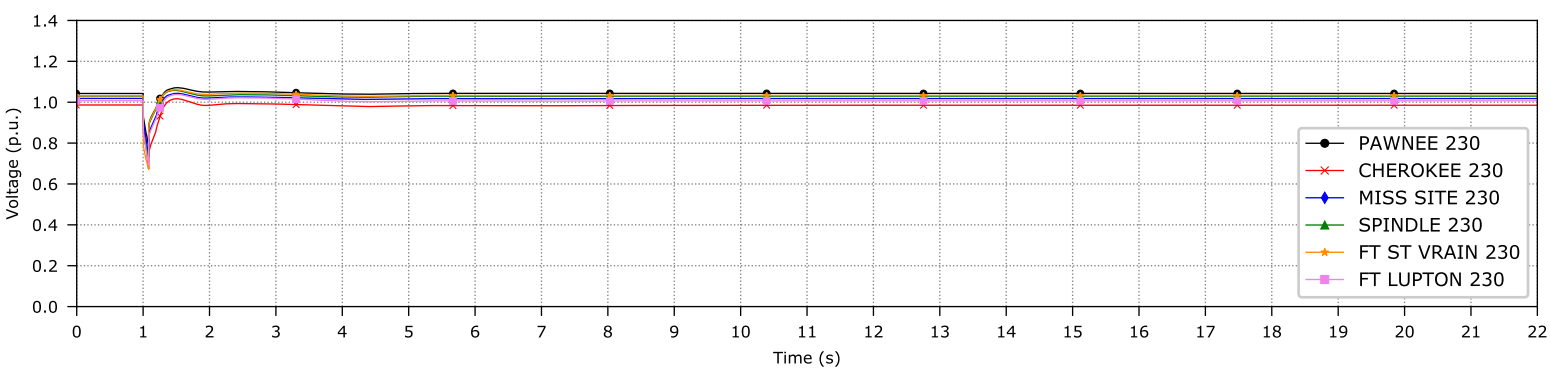




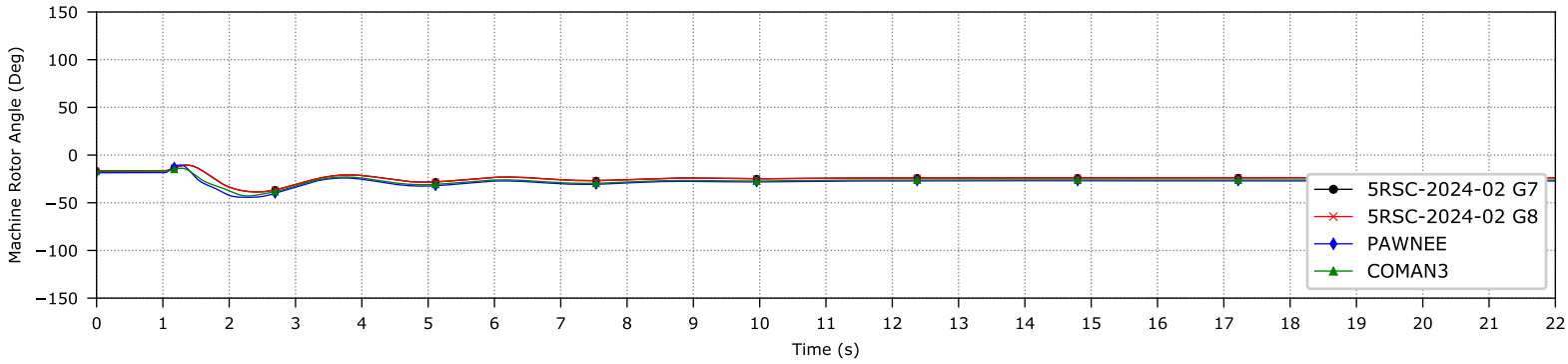


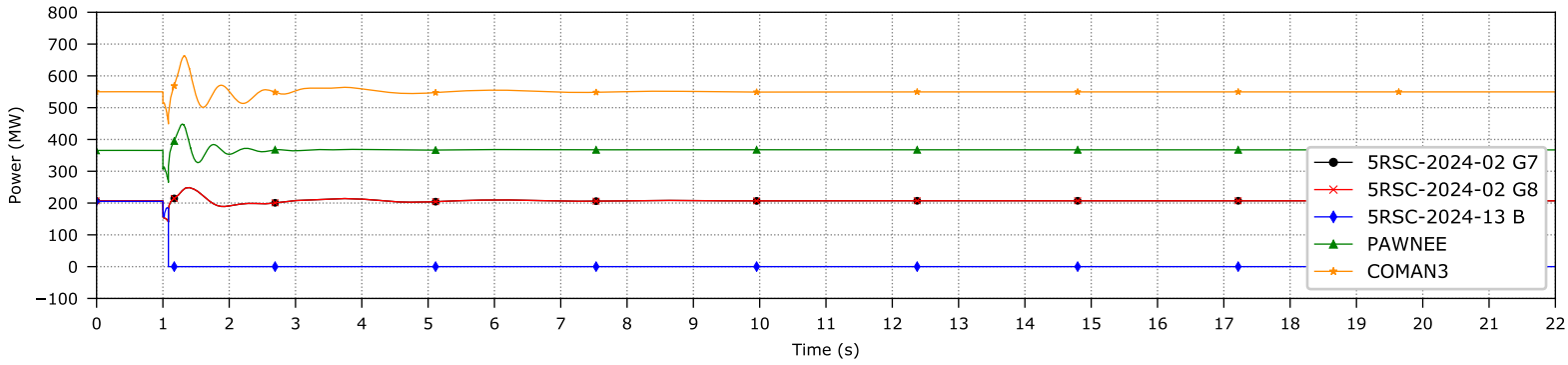


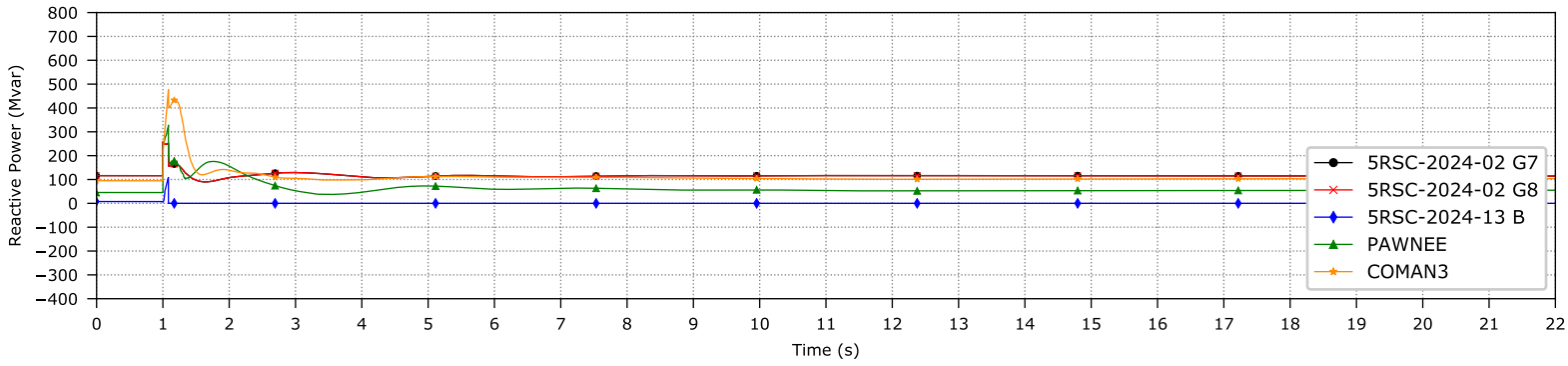


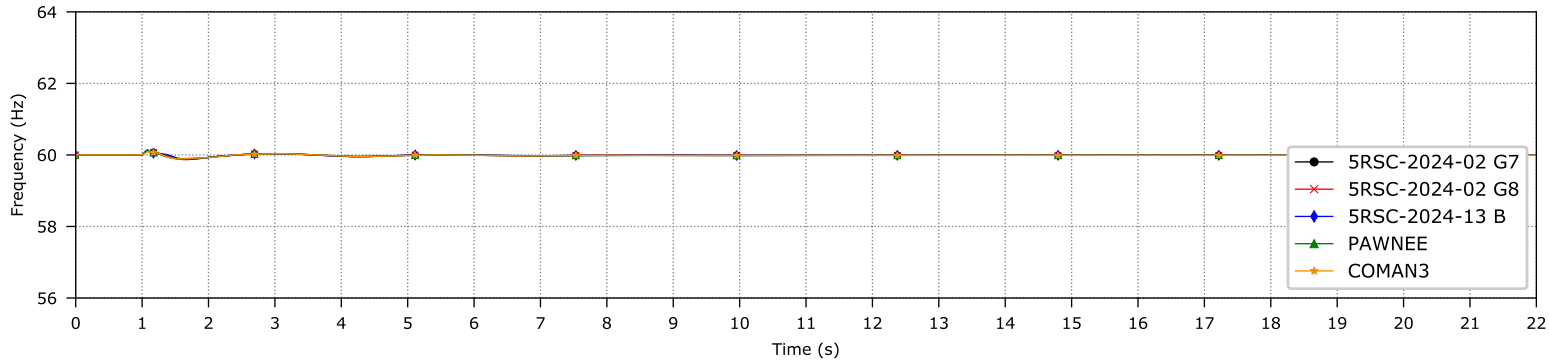


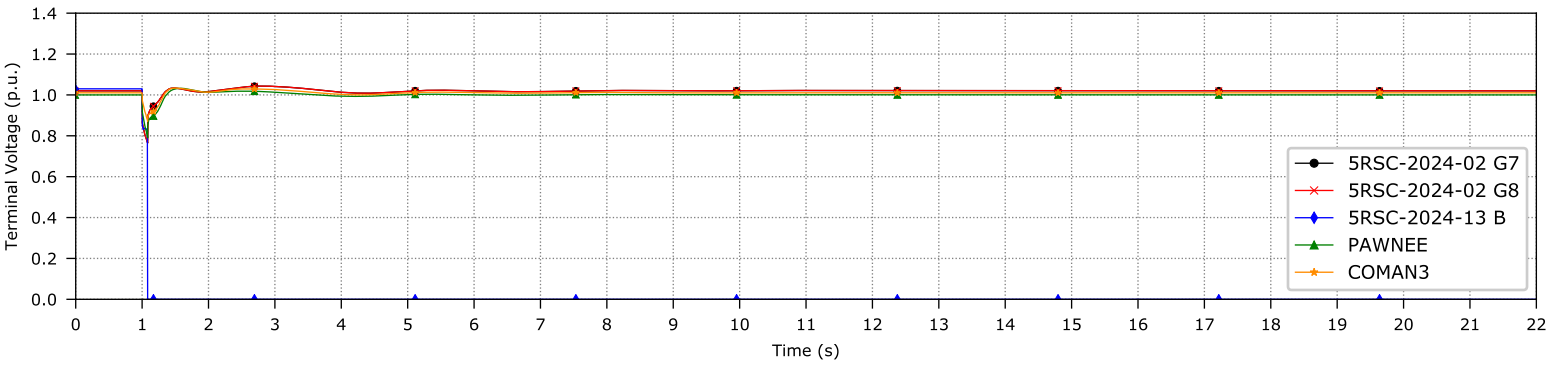
Ref. No. 31 - P7_90

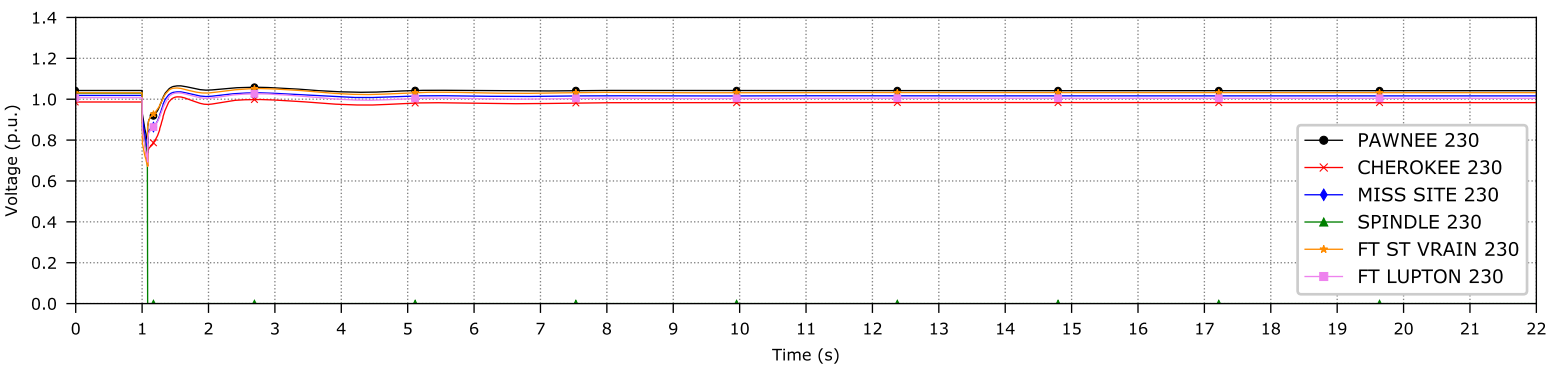




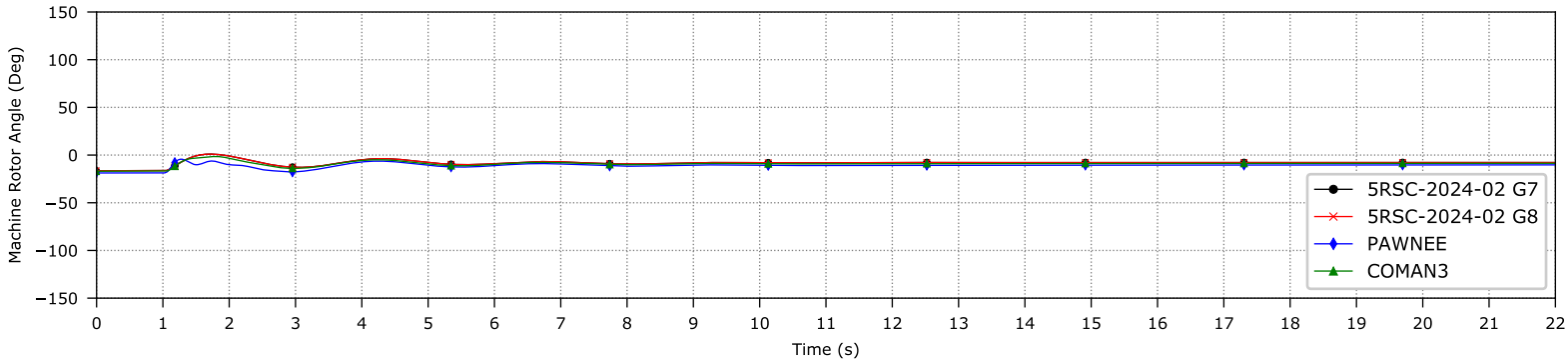


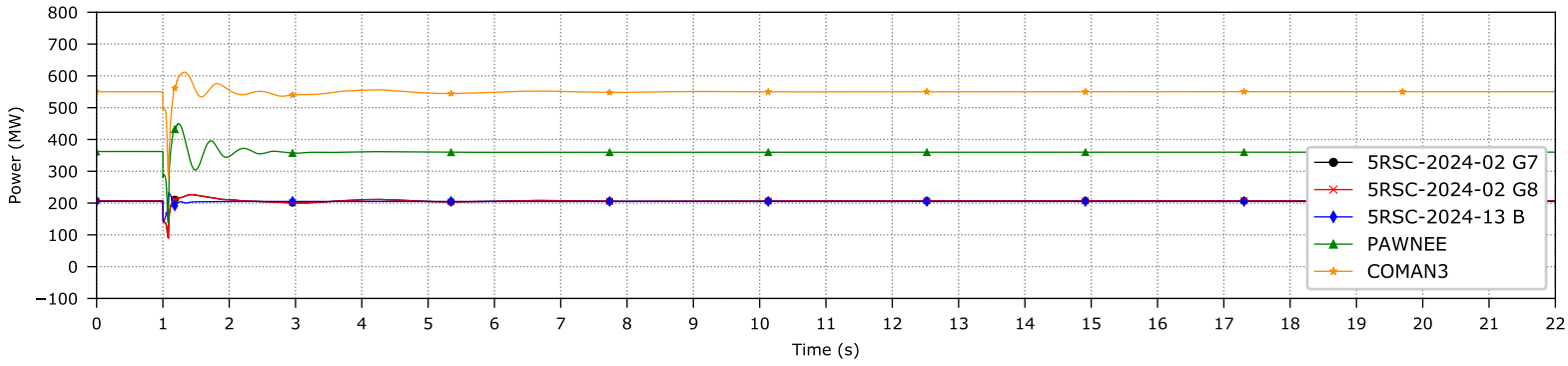


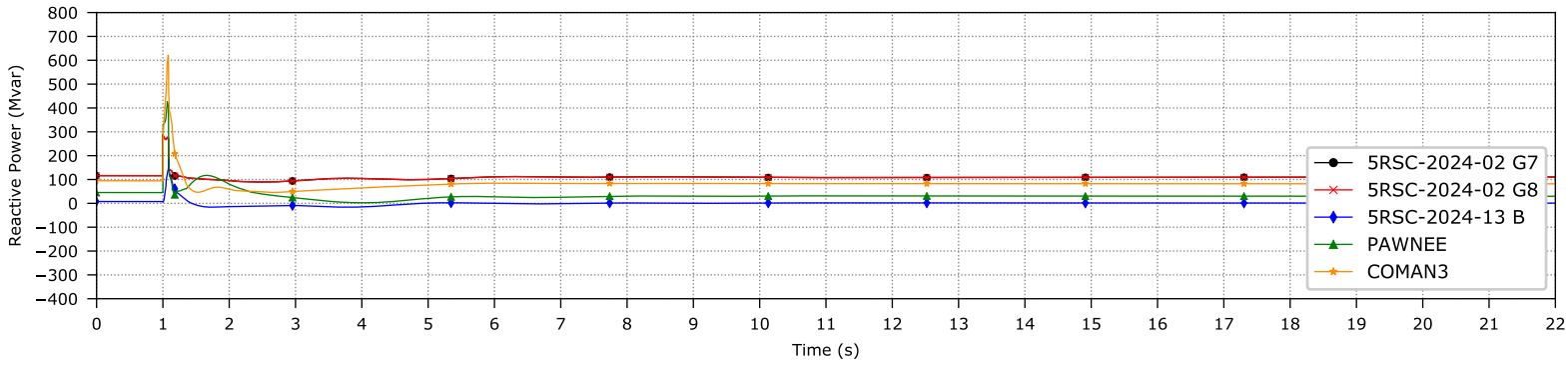


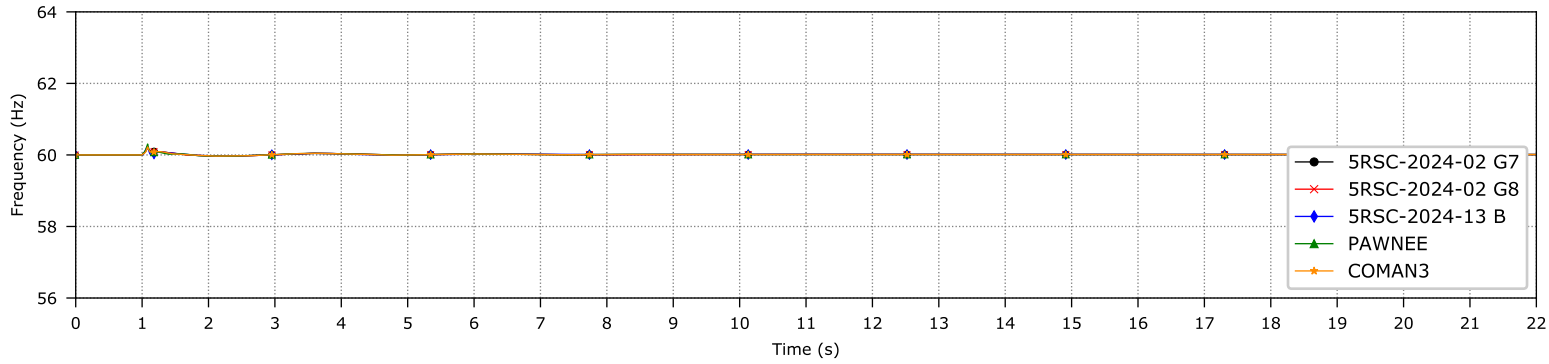


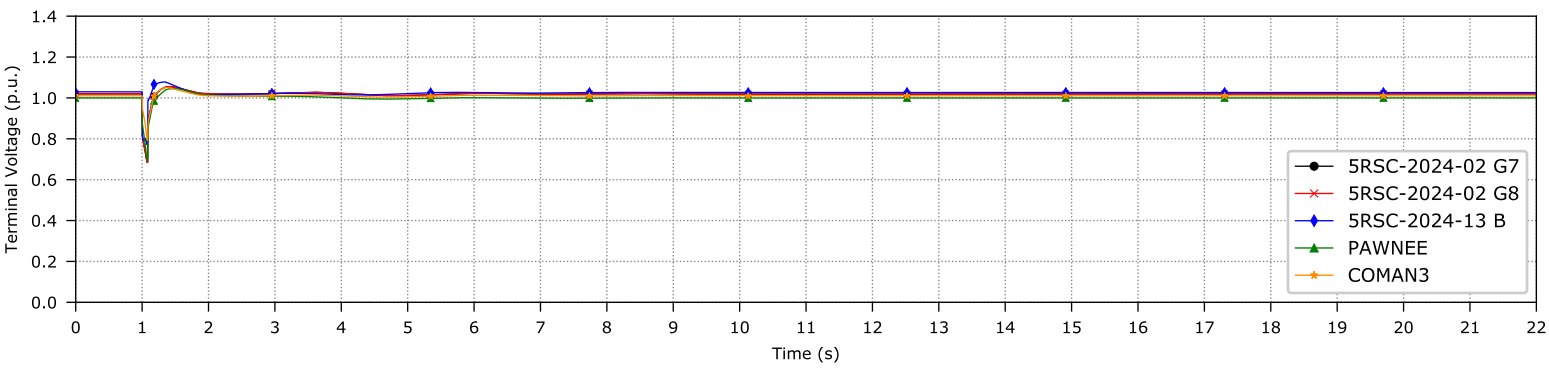
Ref. No. 32 - P7_92

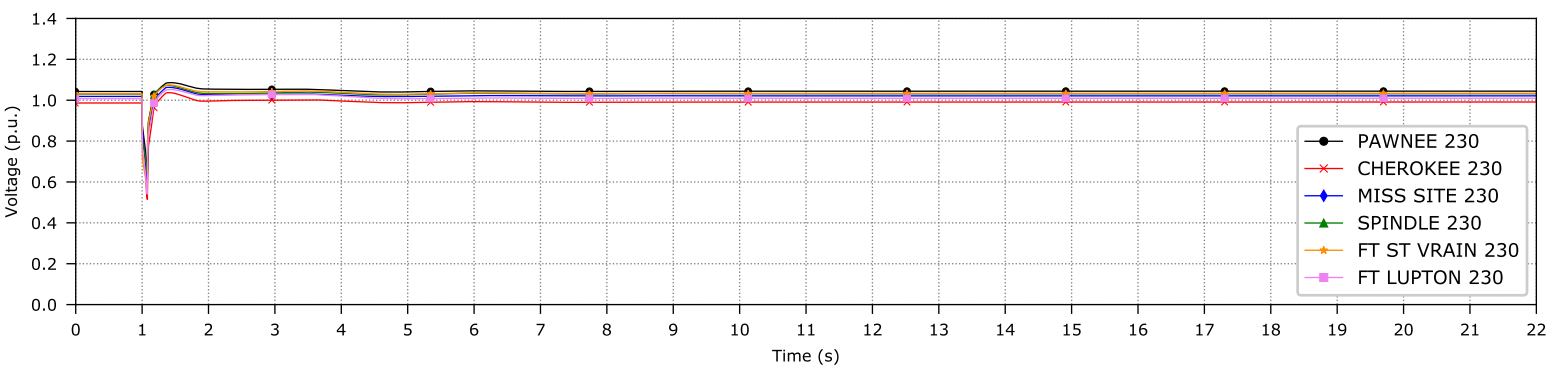




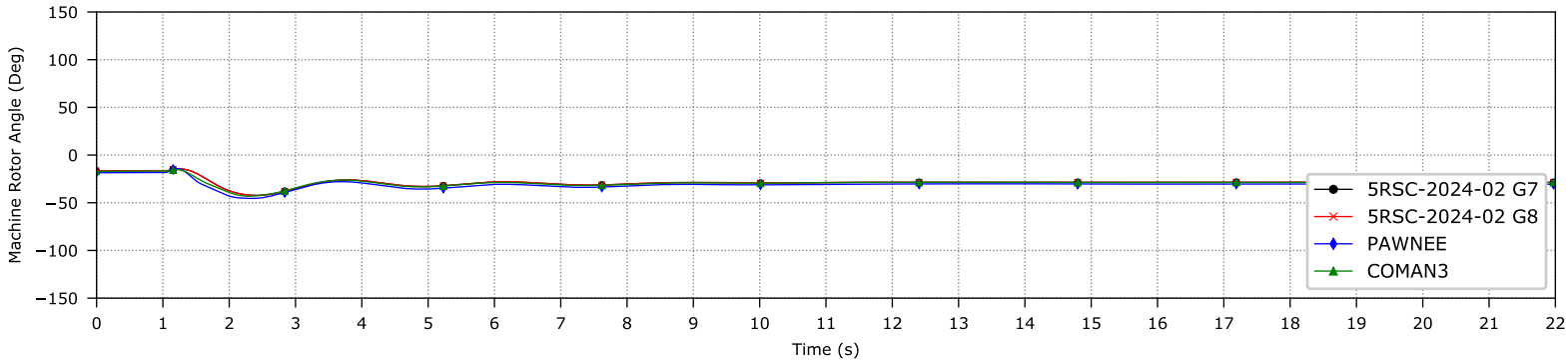


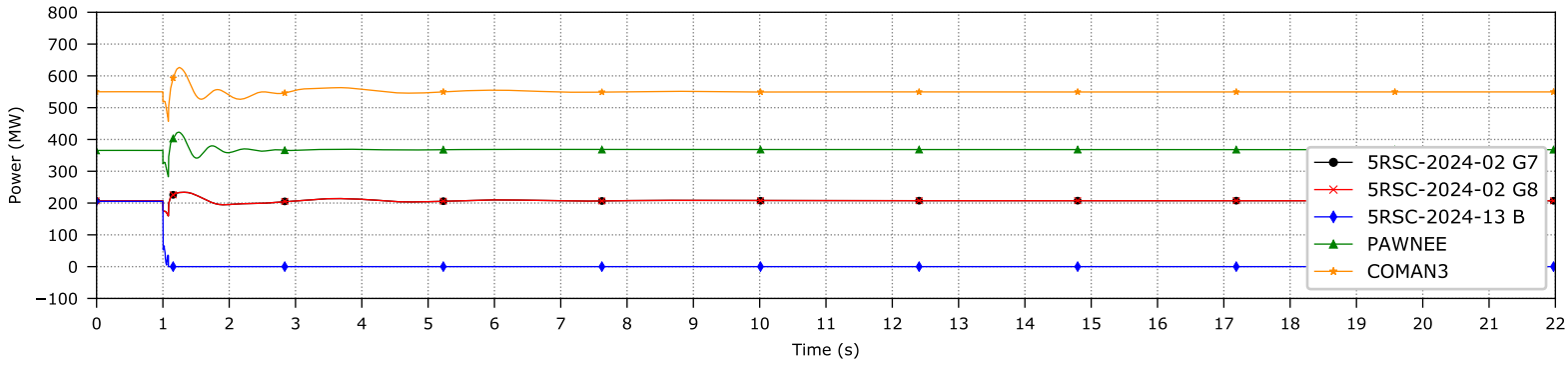


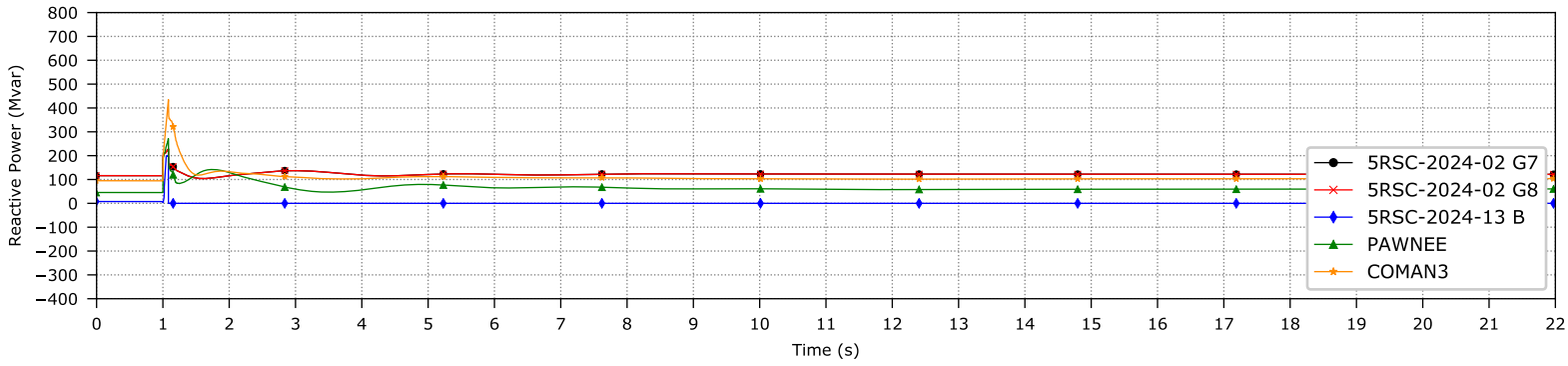


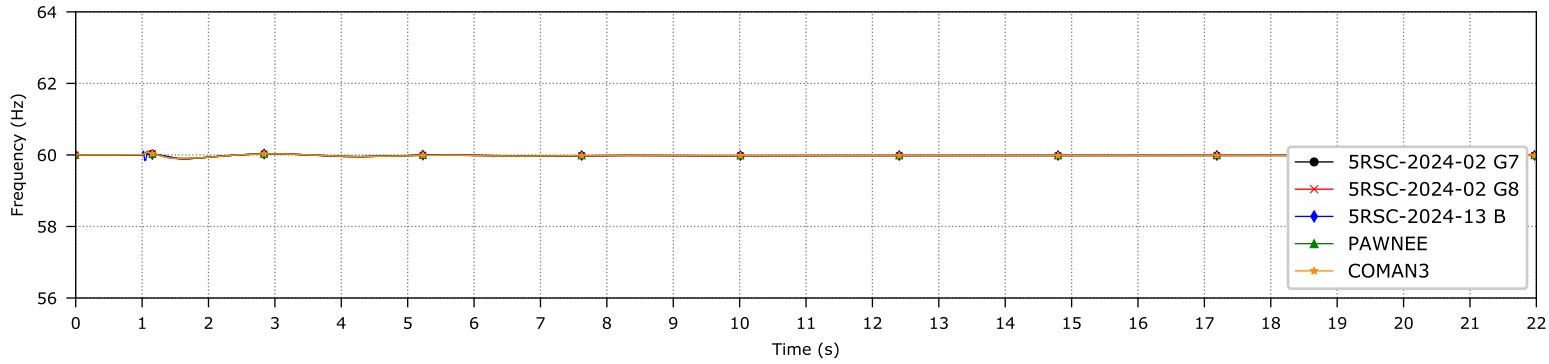


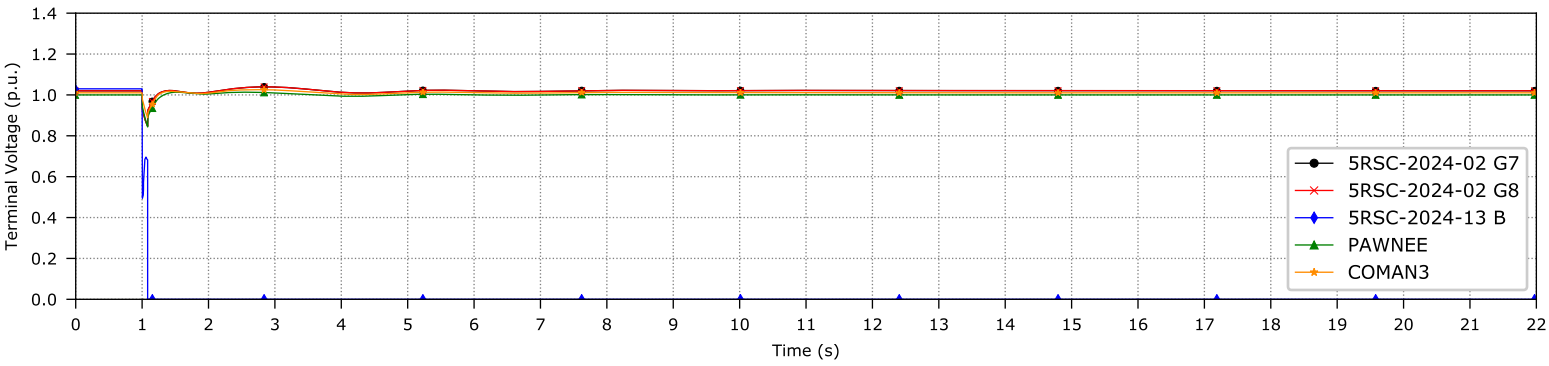
Ref. No. 33 - P7_93

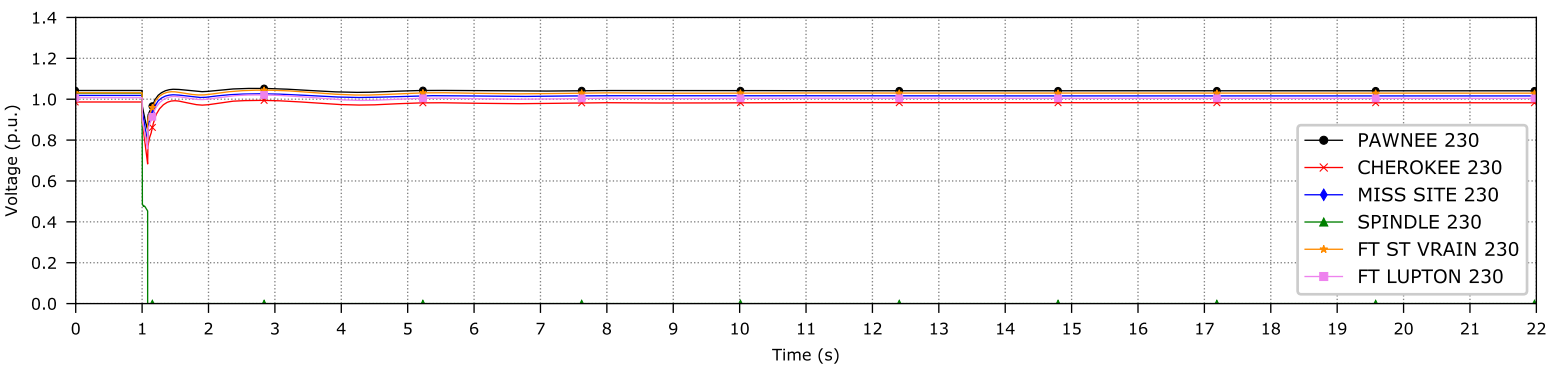


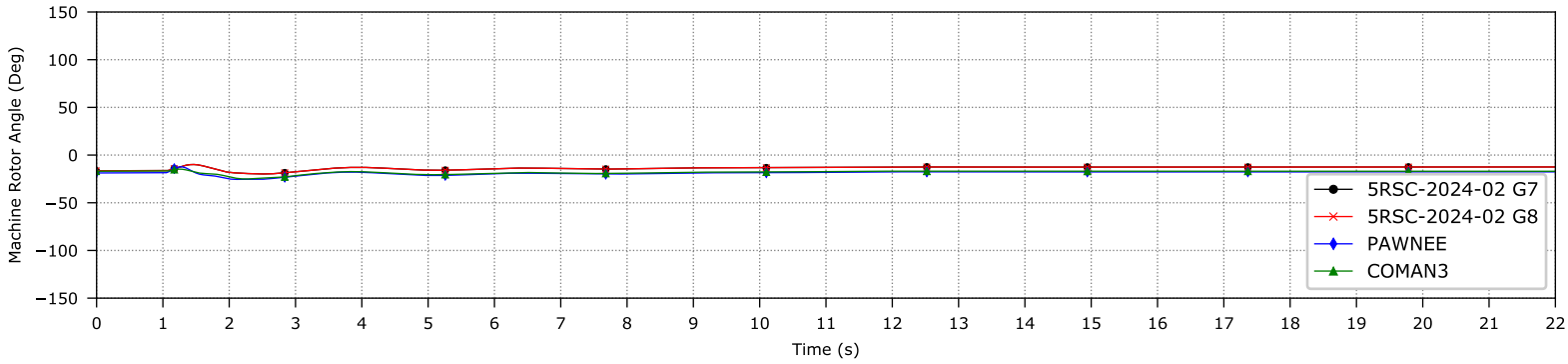


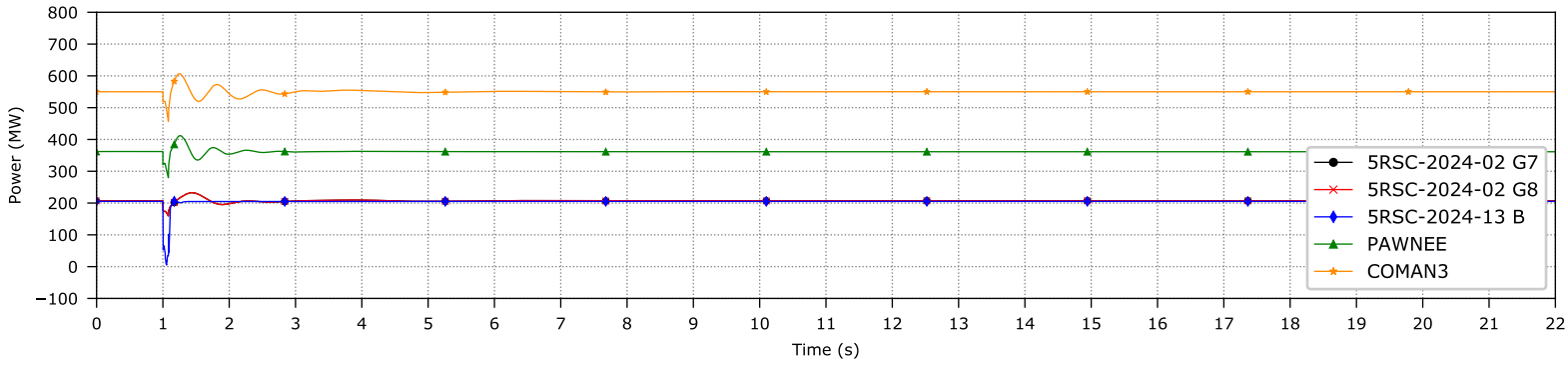


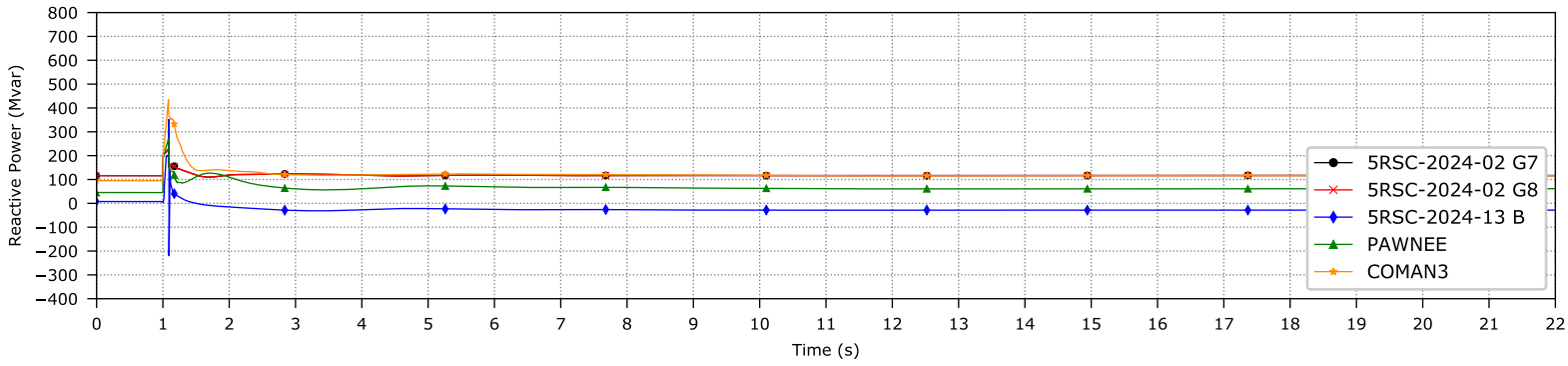


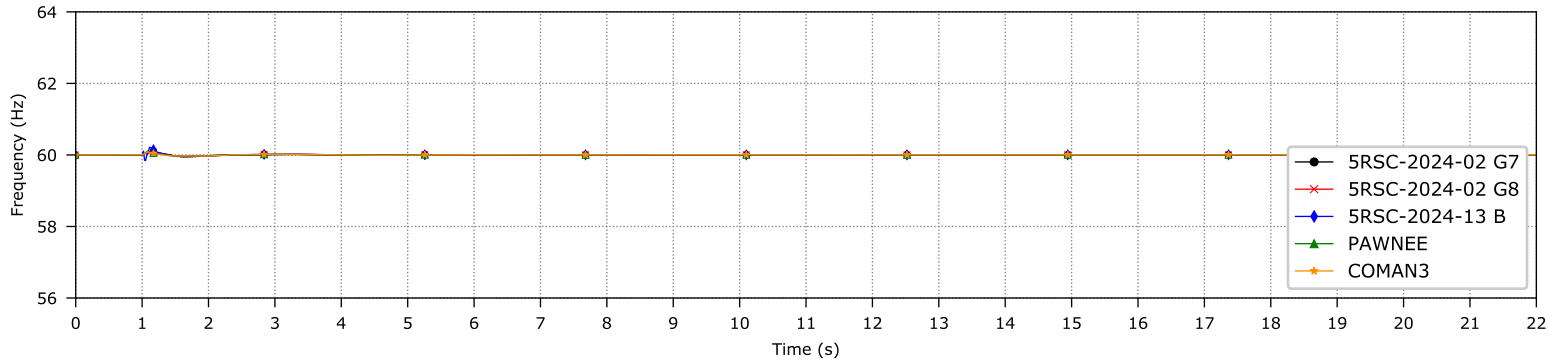


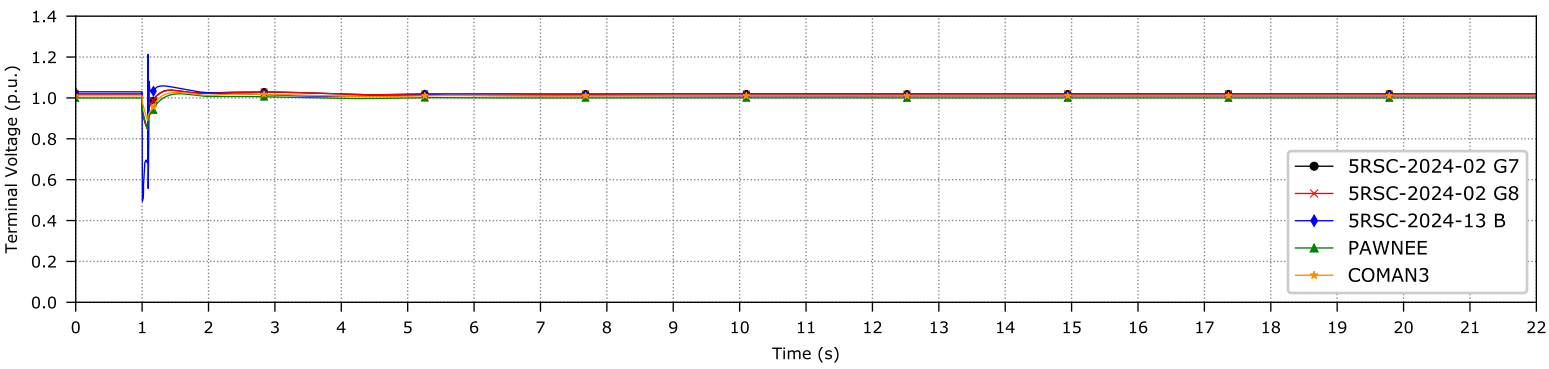


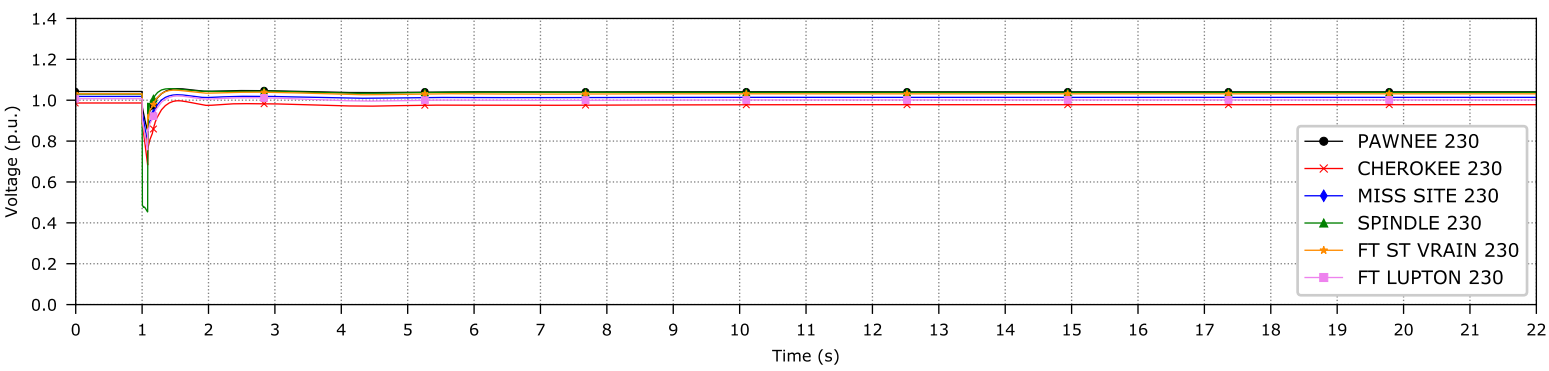

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
COMAN3

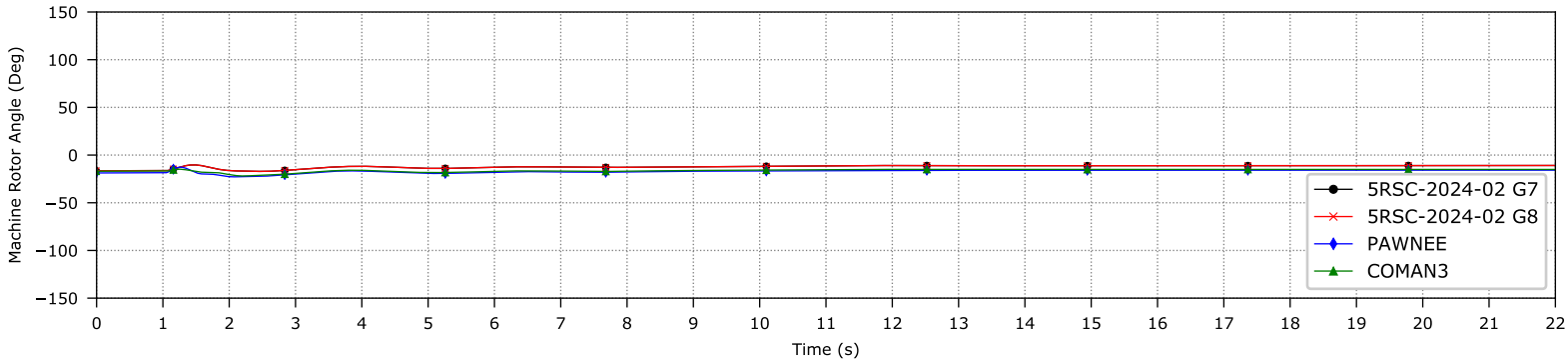

Power (MW)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

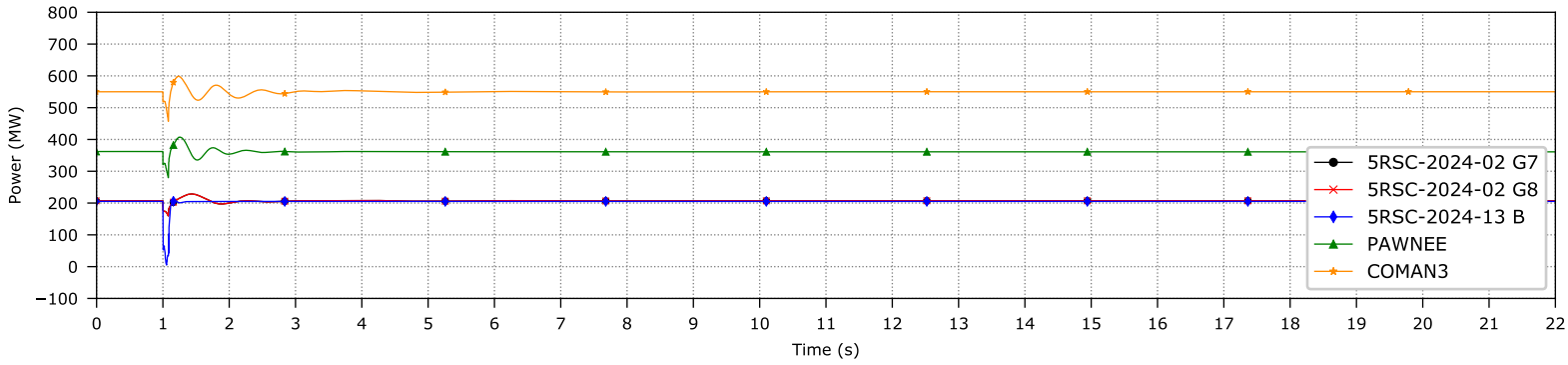

Reactive Power (Mvar)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

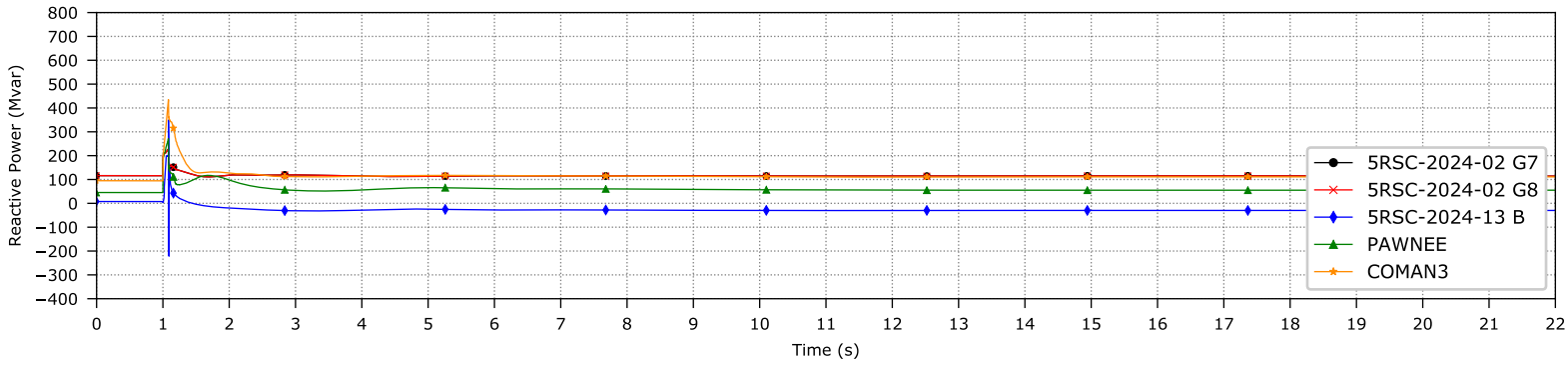

Frequency (Hz)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

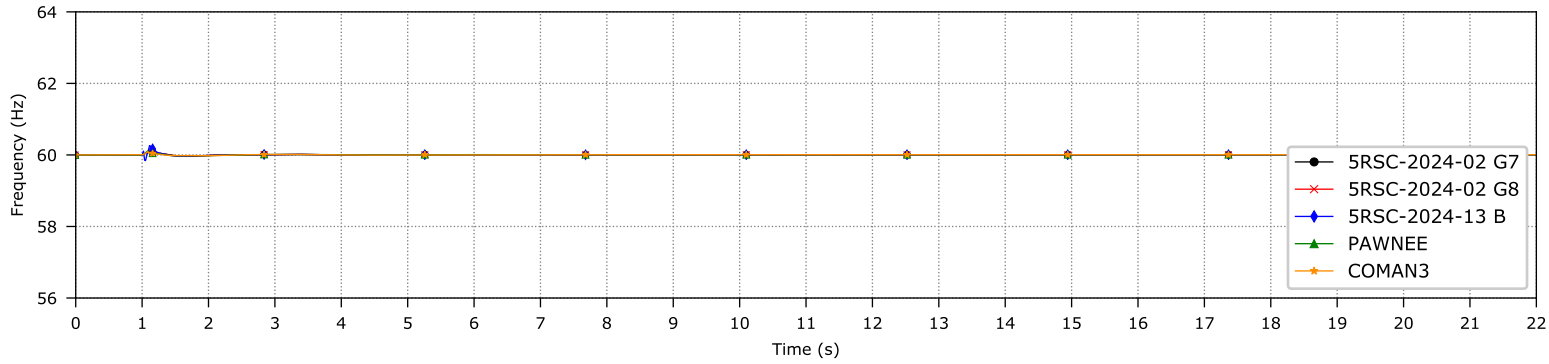

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

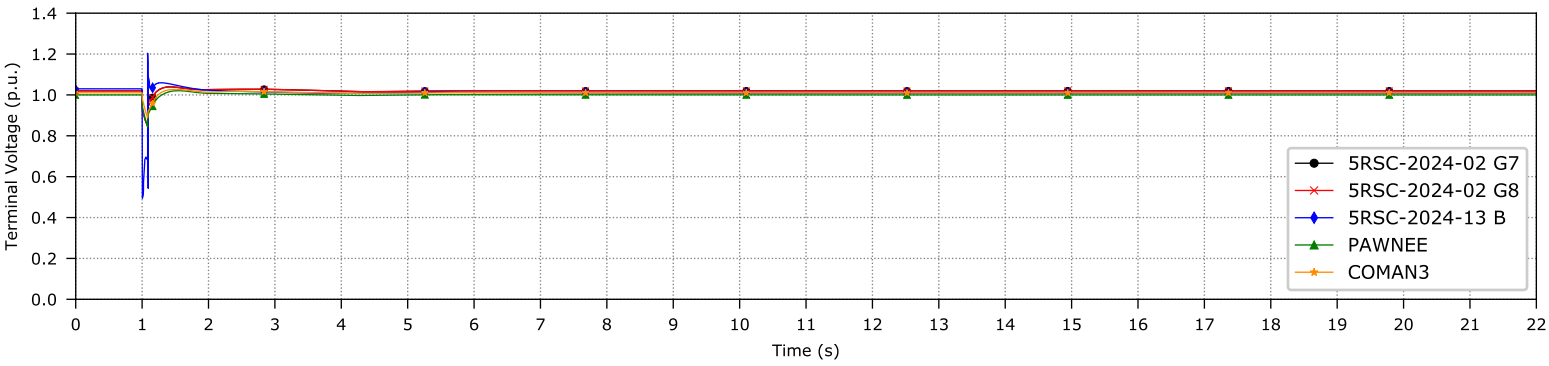

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

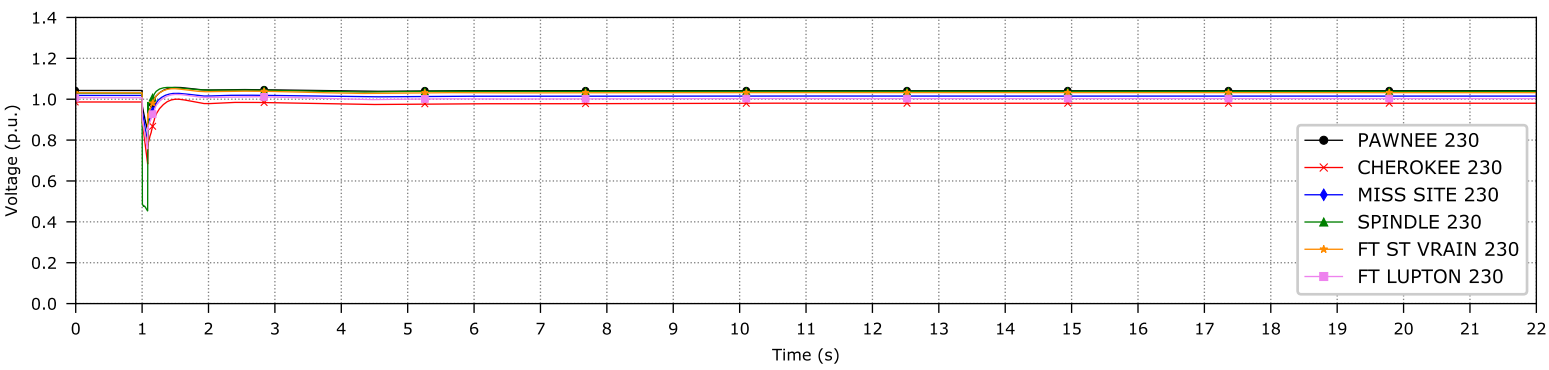

Machine Rotor Angle (Deg)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3


Reactive Power (Mvar)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

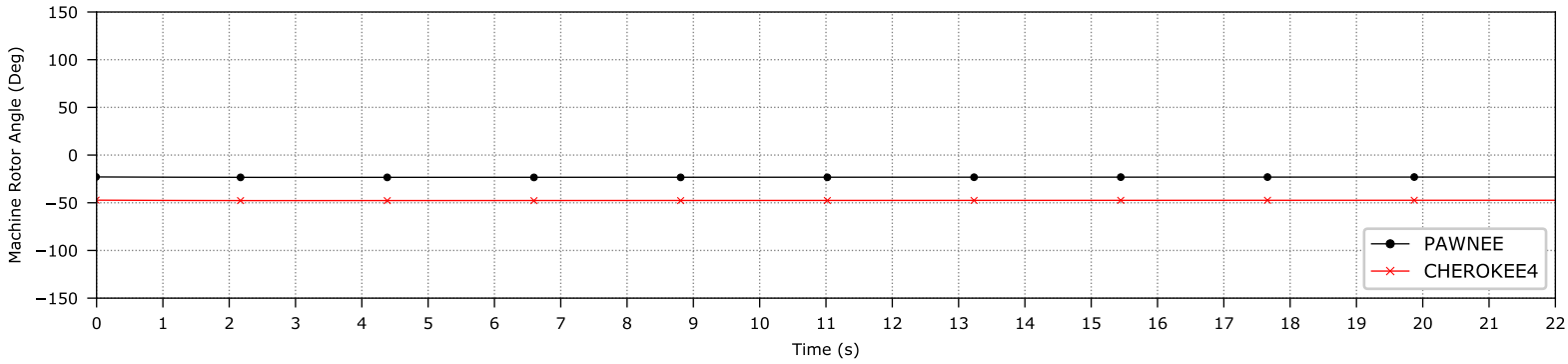

Frequency (Hz)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

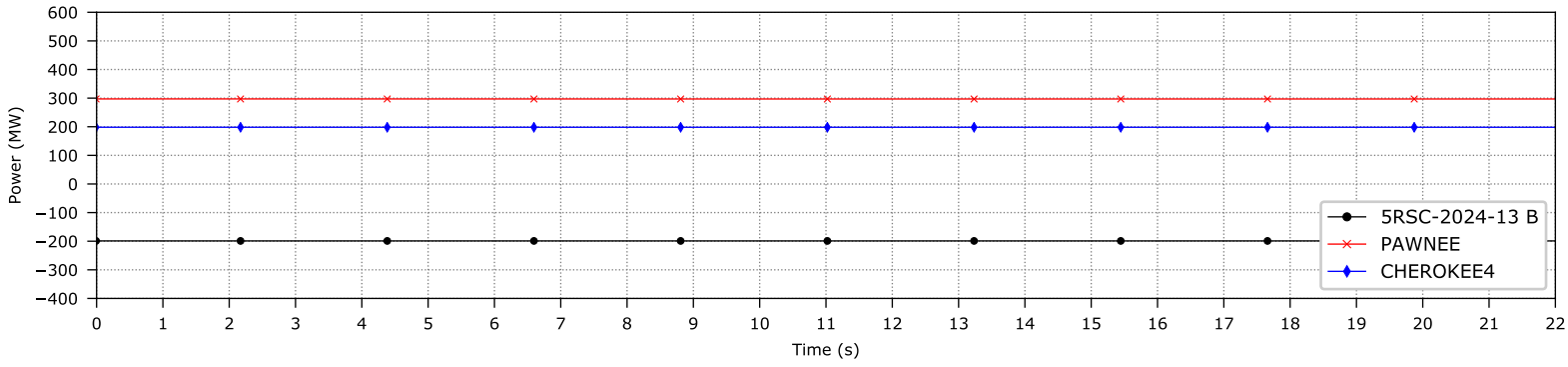

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-02 G7
5RSC-2024-02 G8
5RSC-2024-13 B
PAWNEE
COMAN3

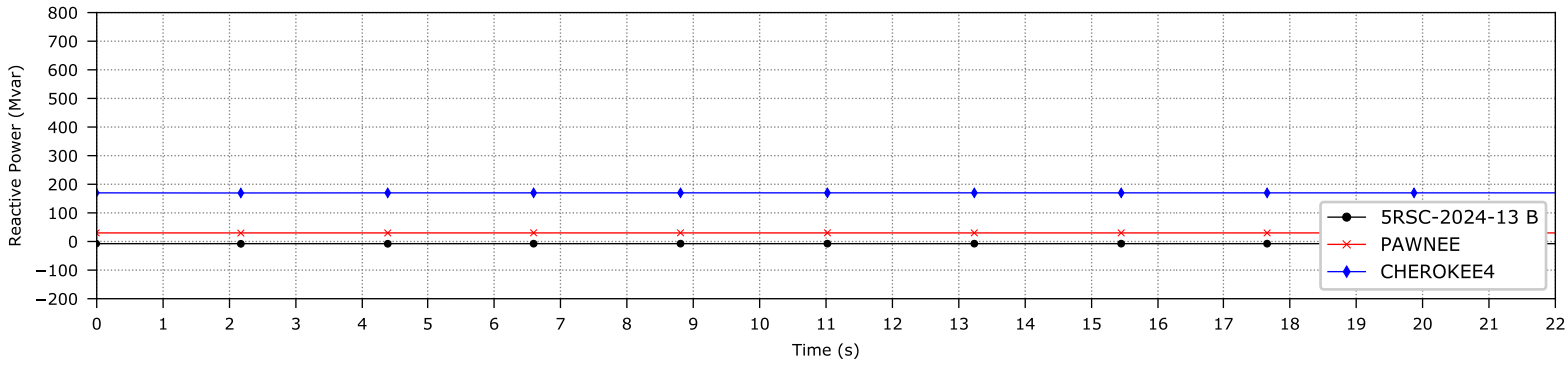

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

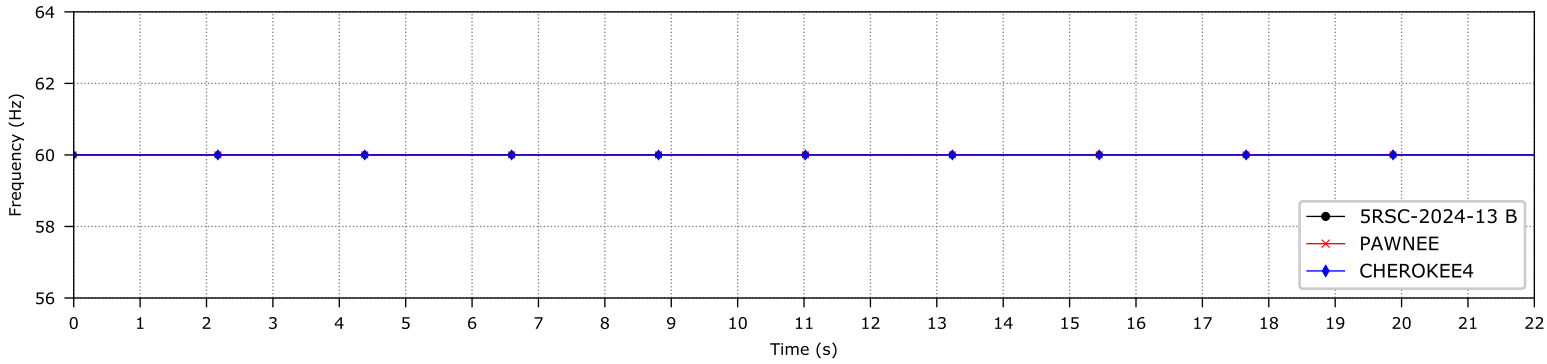
2027 NORTH GRID CHARGING – TRANSIENT STABILITY PLOTS

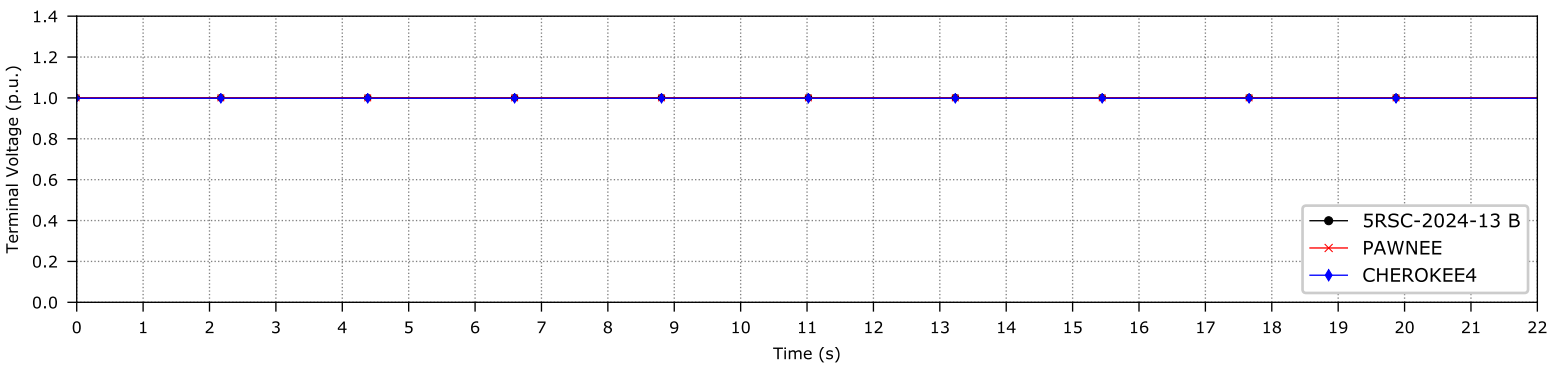
Ref. No. 01 - Flatrun

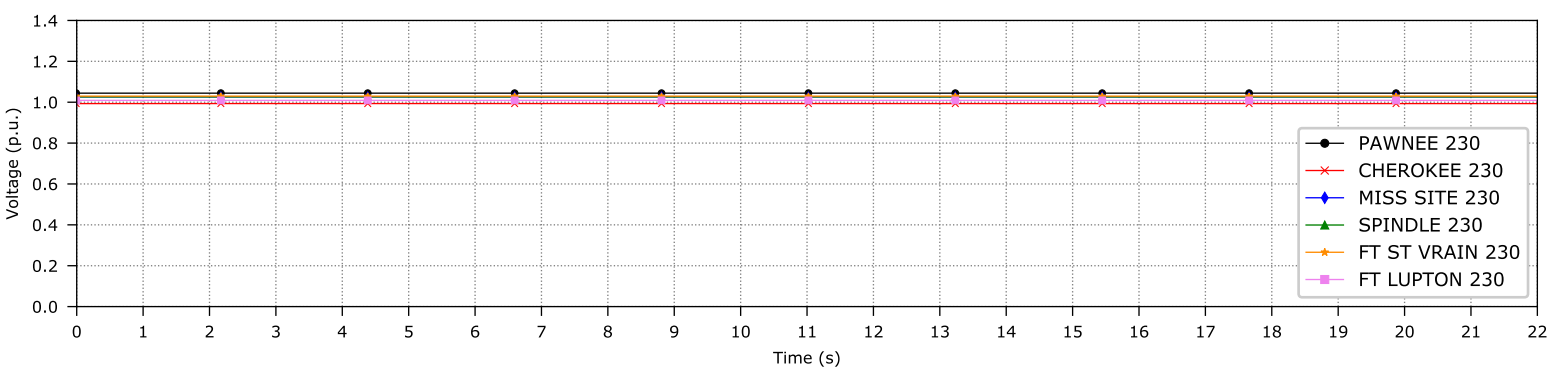


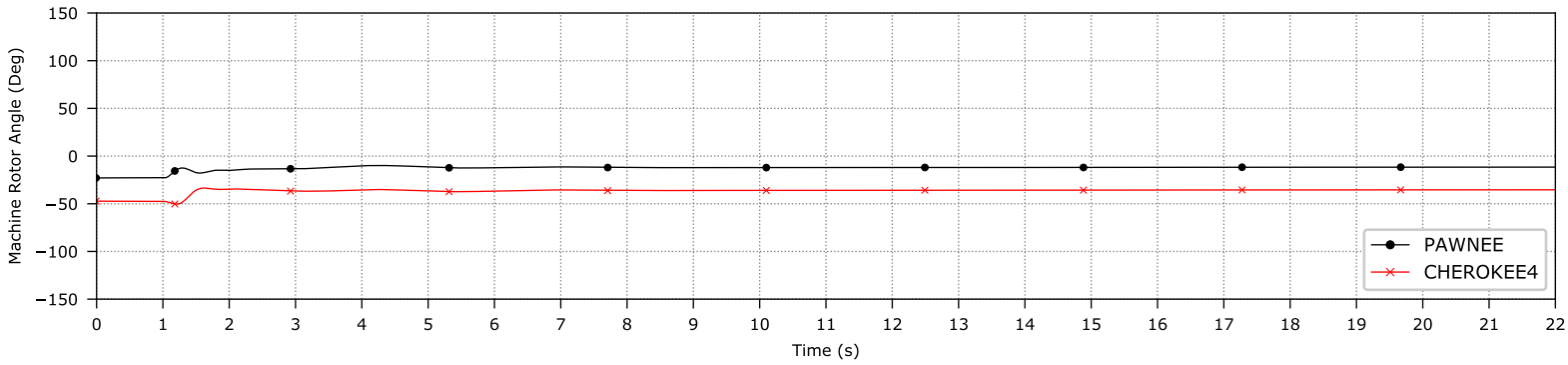


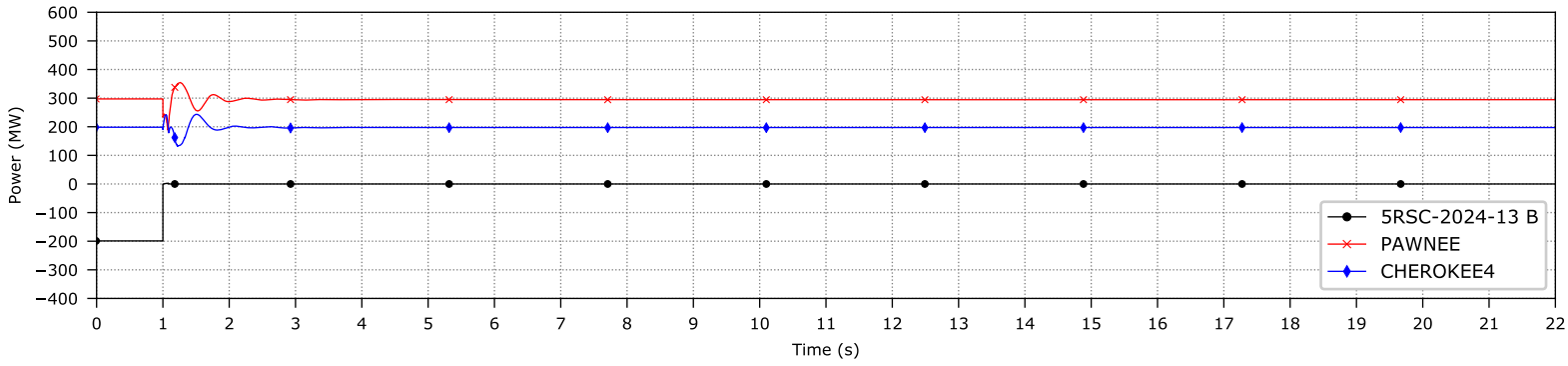


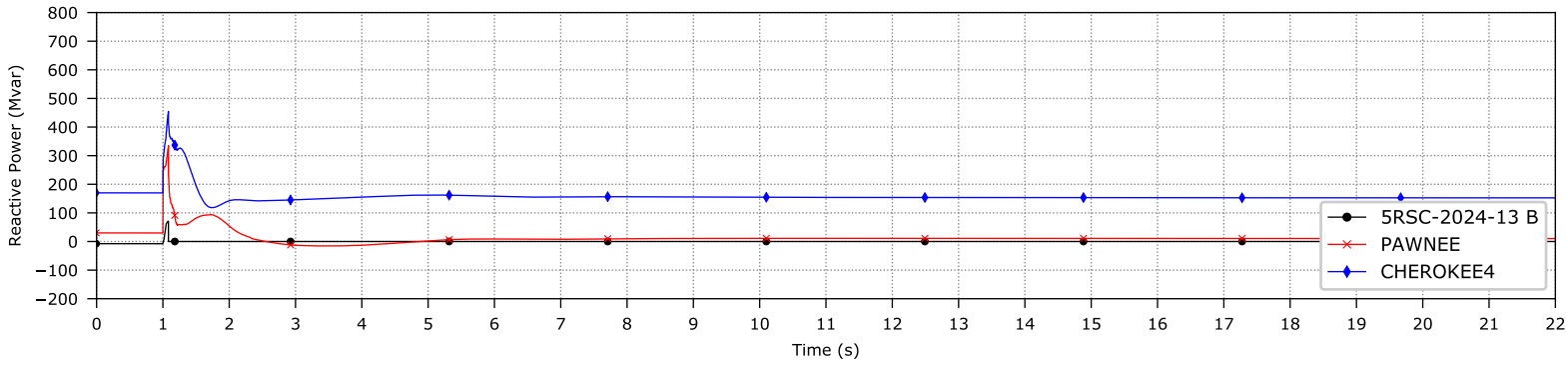


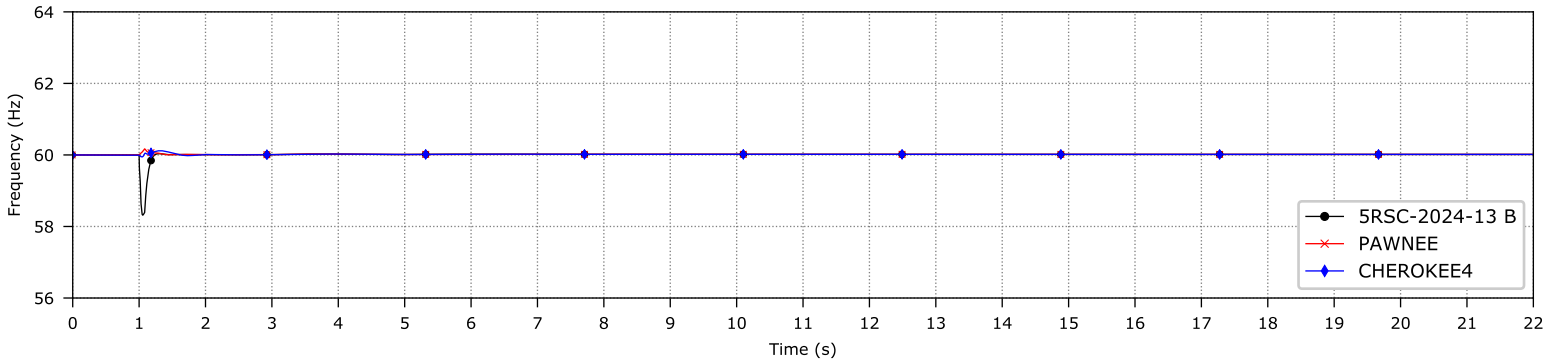


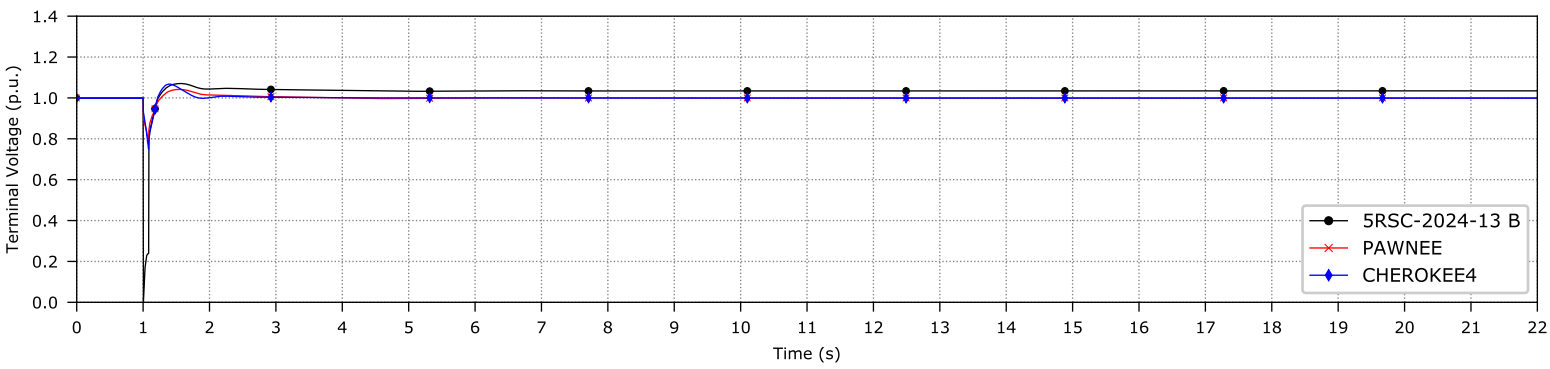


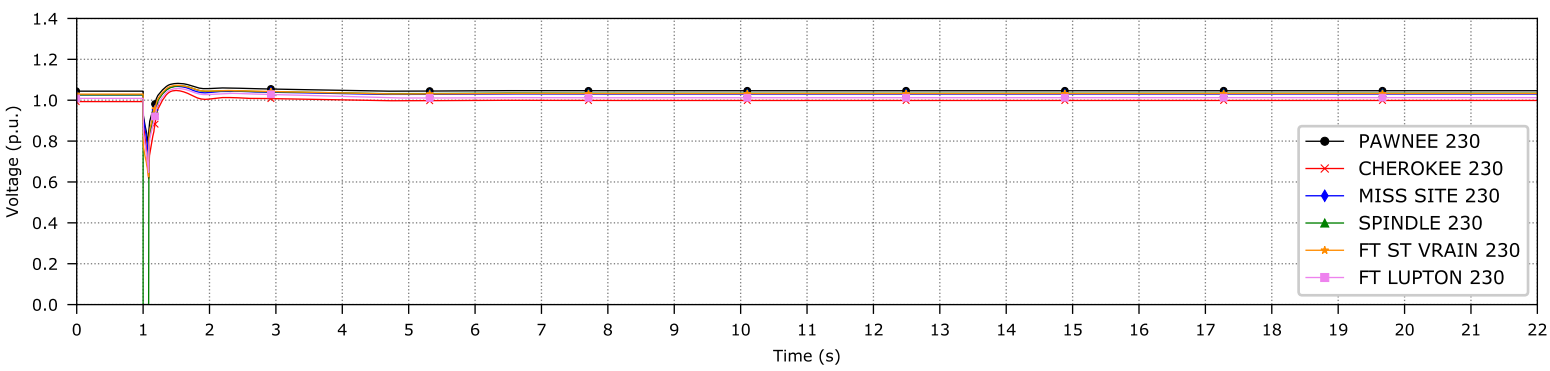

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

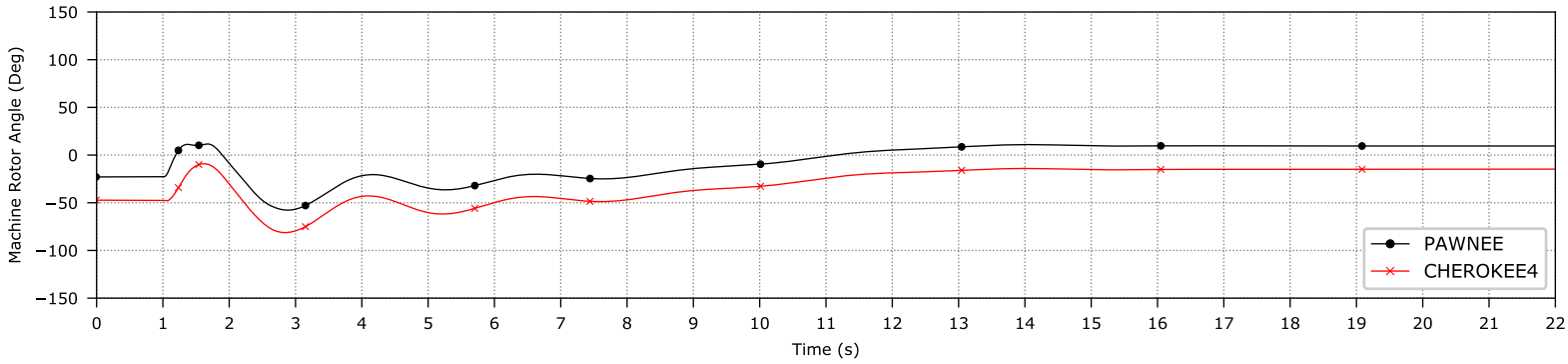

Reactive Power (Mvar)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

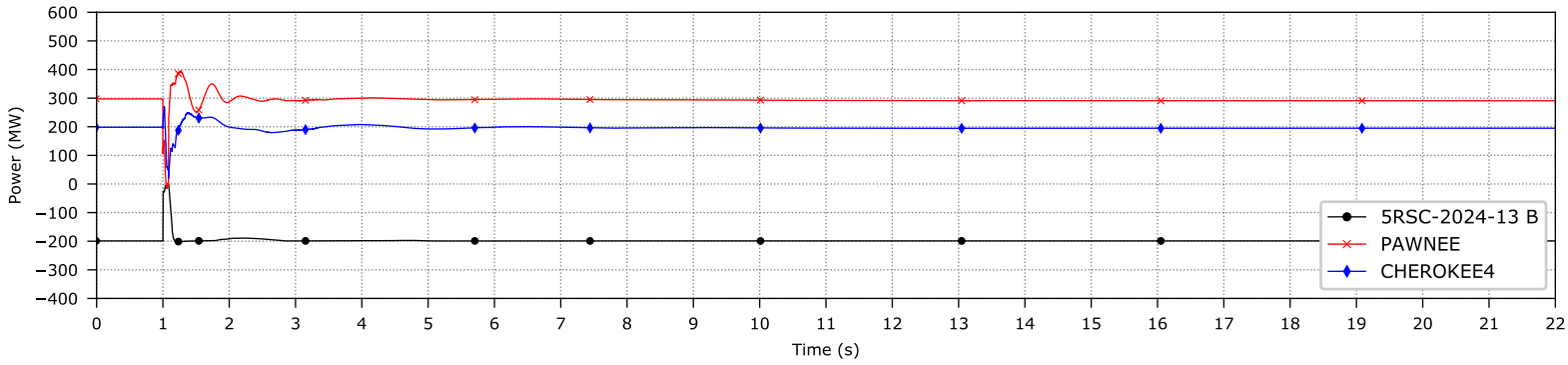

Frequency (Hz)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

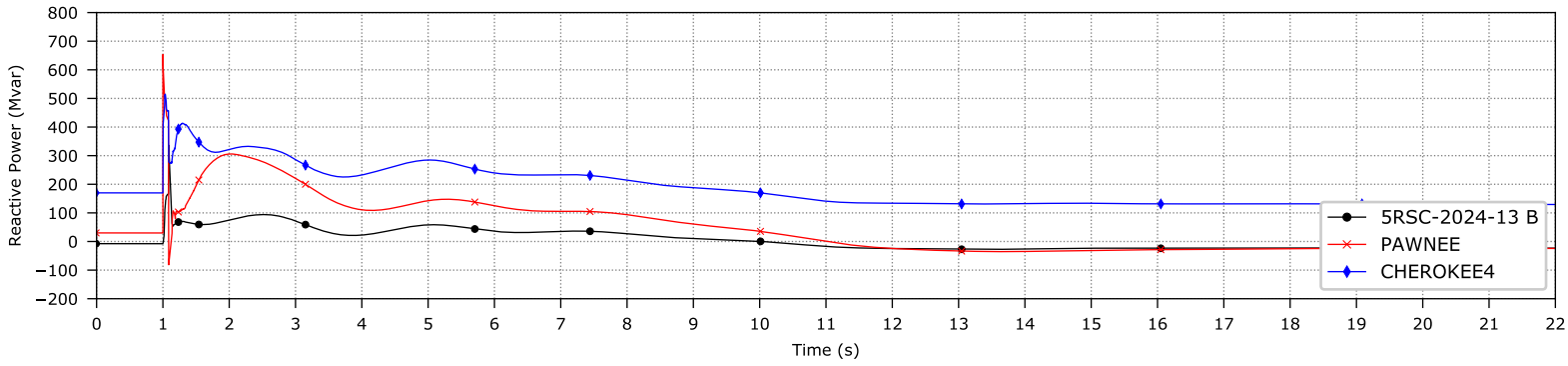

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

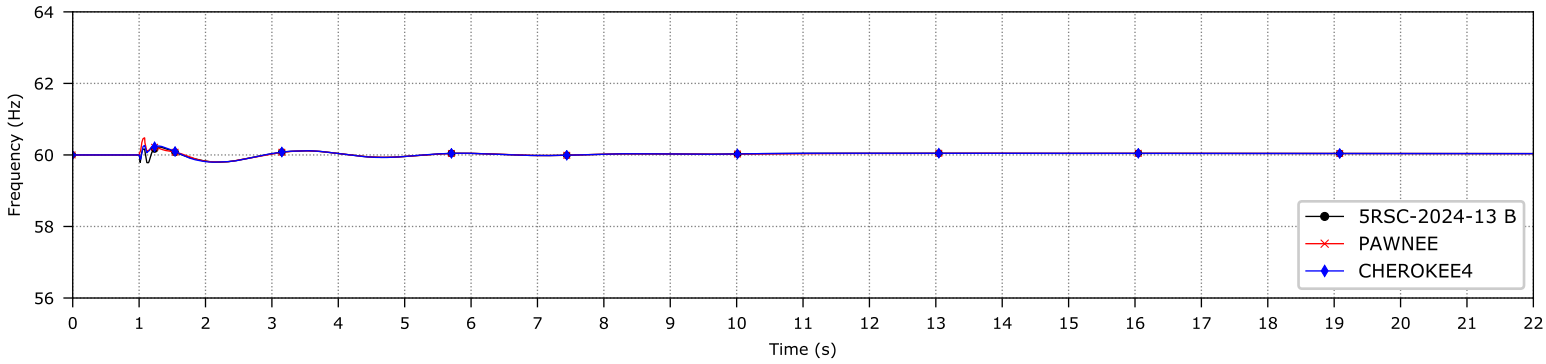

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

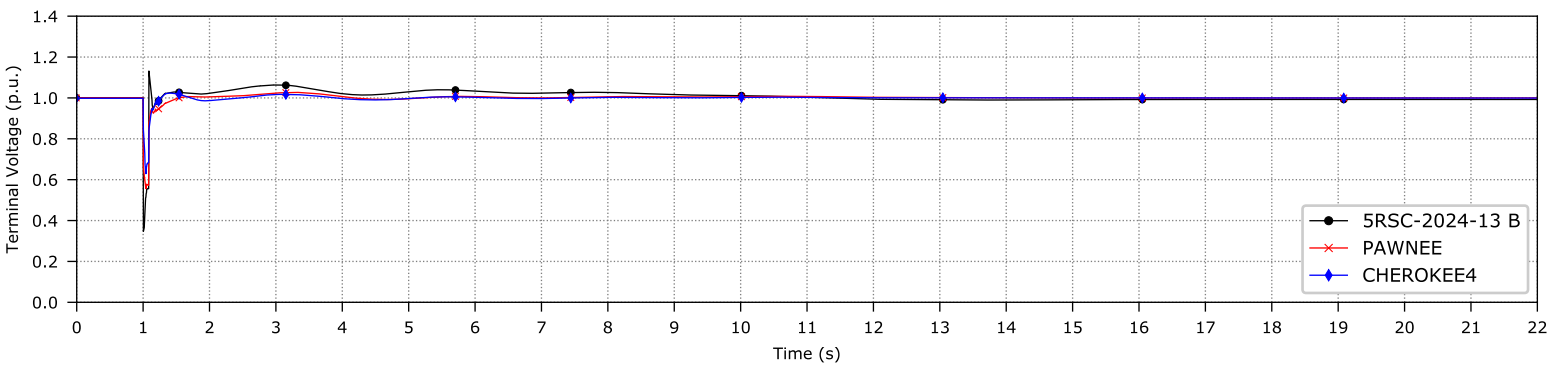
Ref. No. 05 - LoTC_59

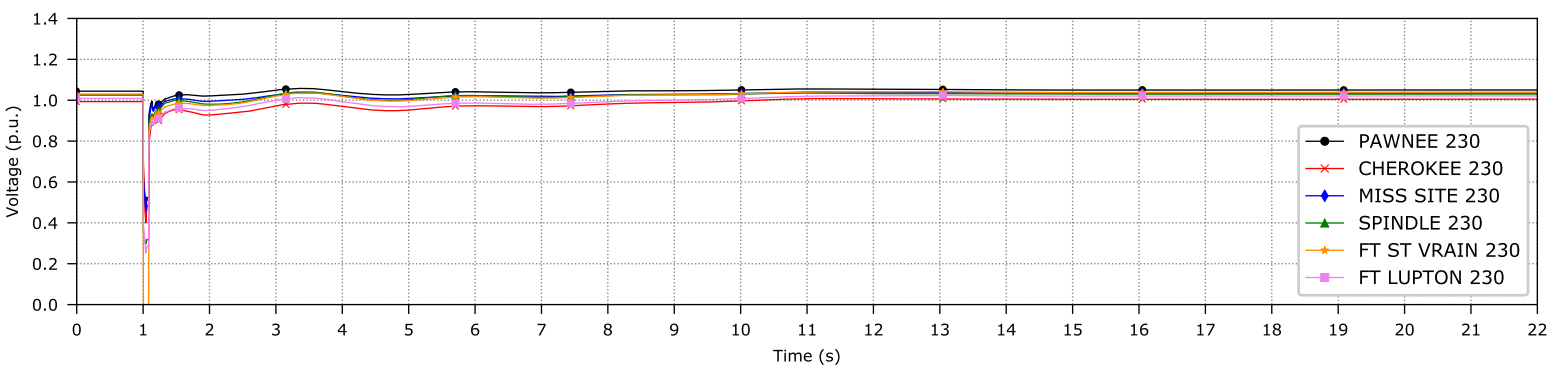




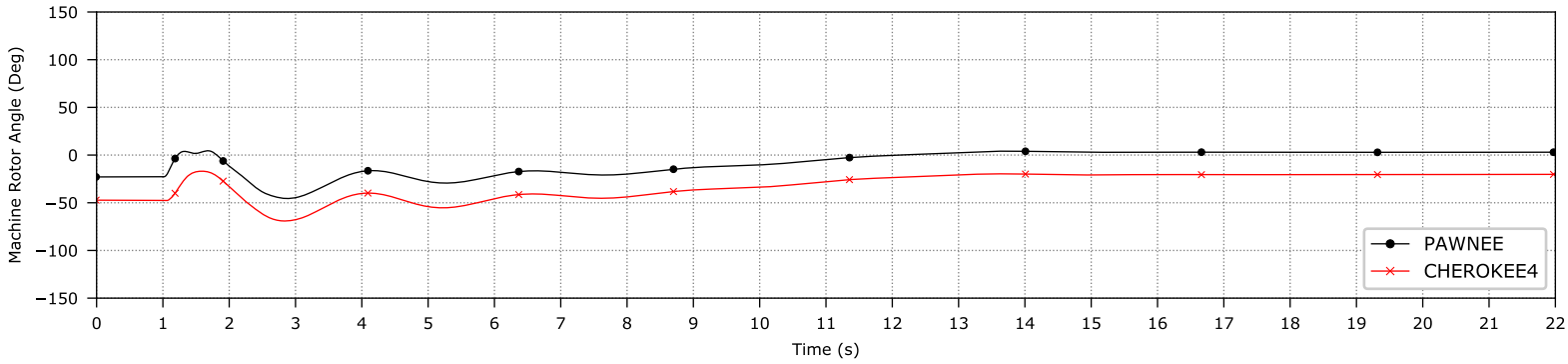


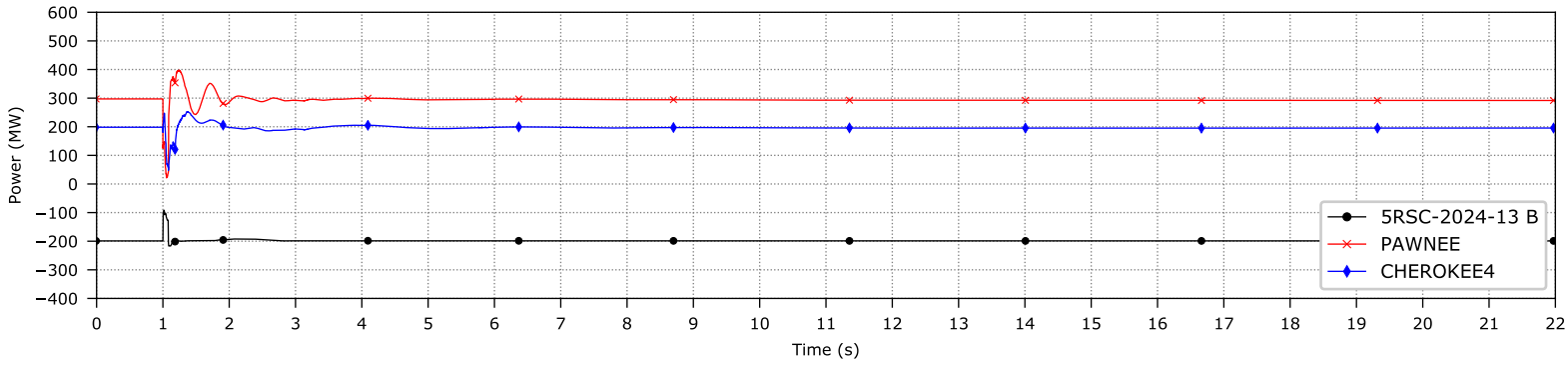


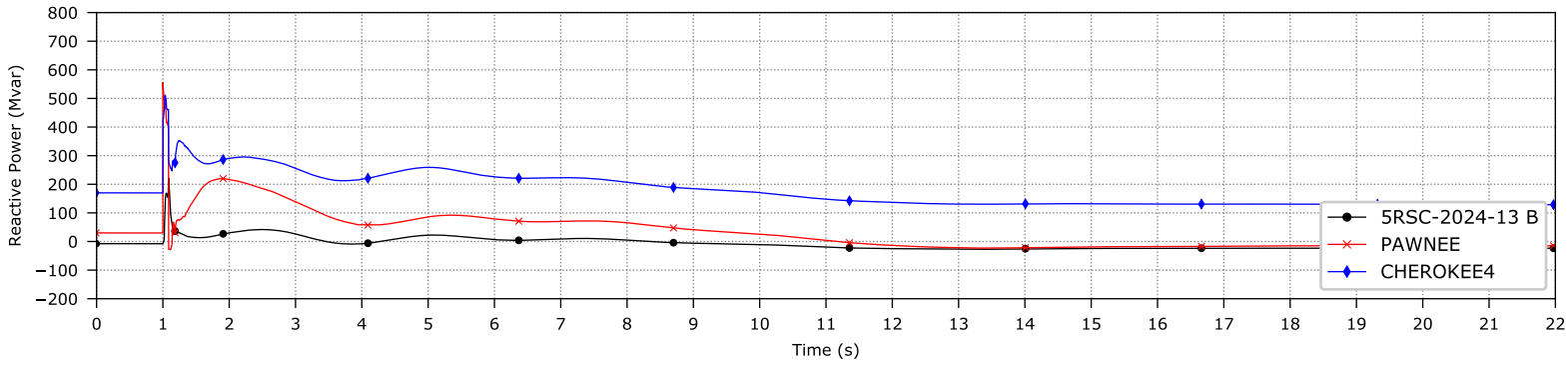


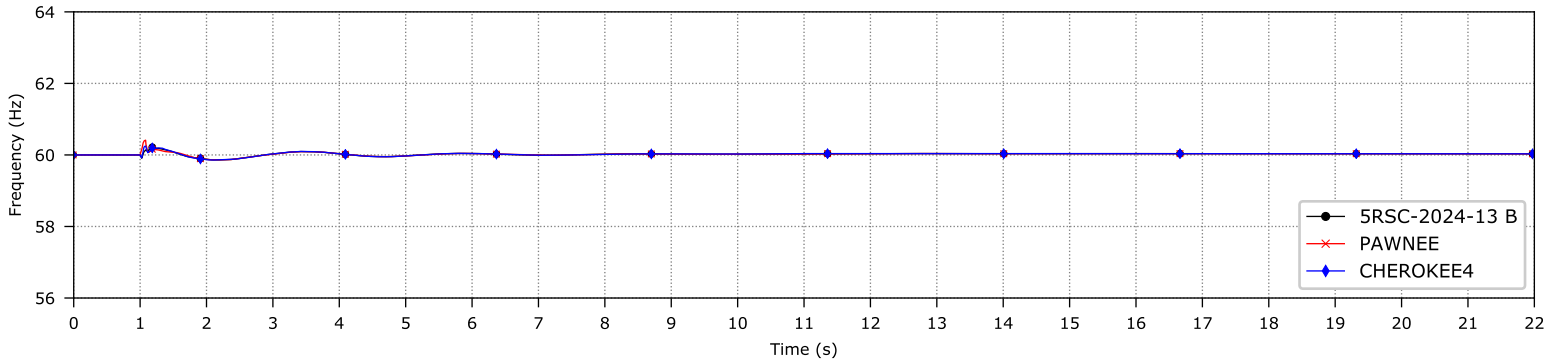


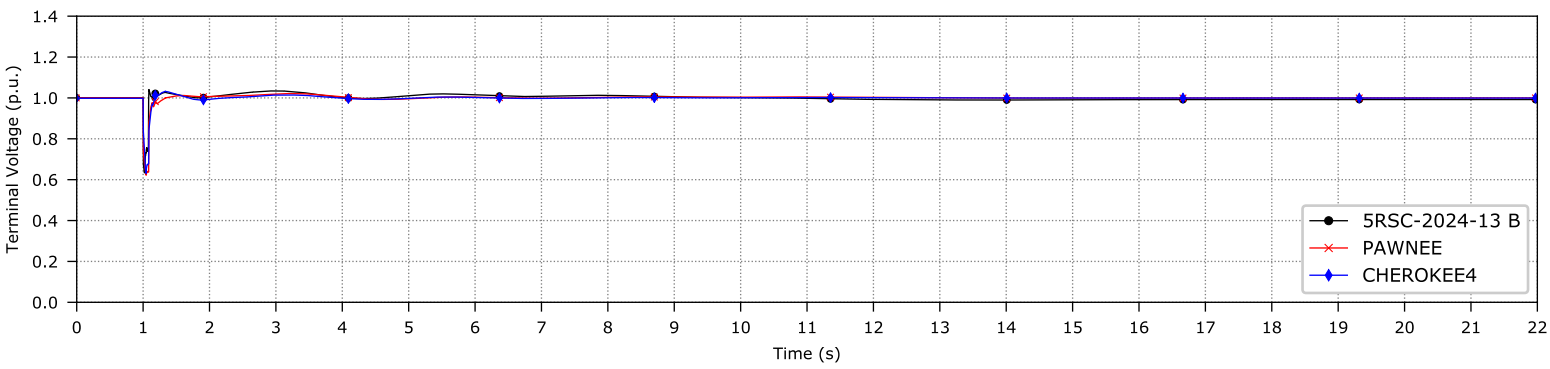
Ref. No. 06 - LoTC_62

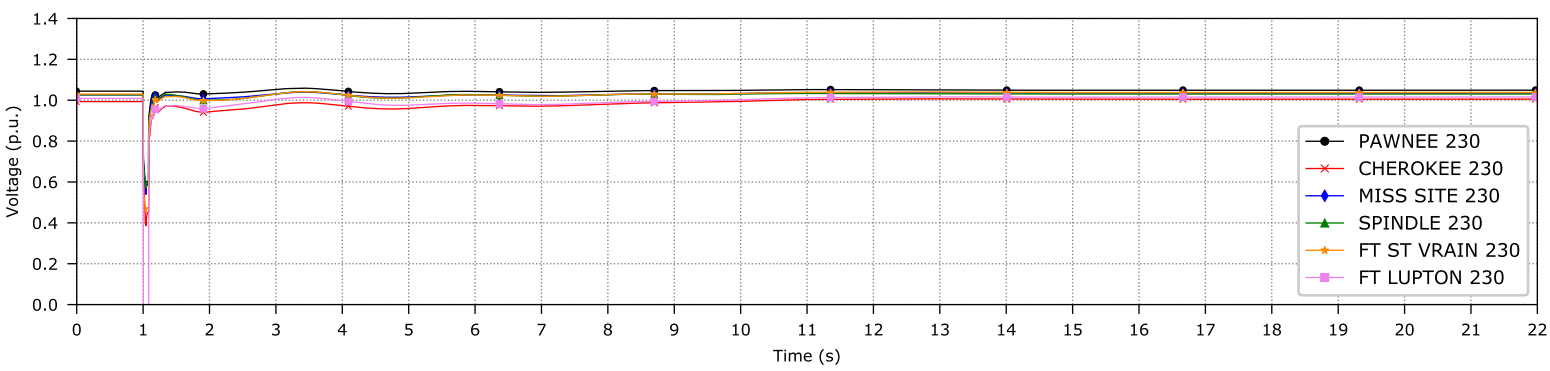




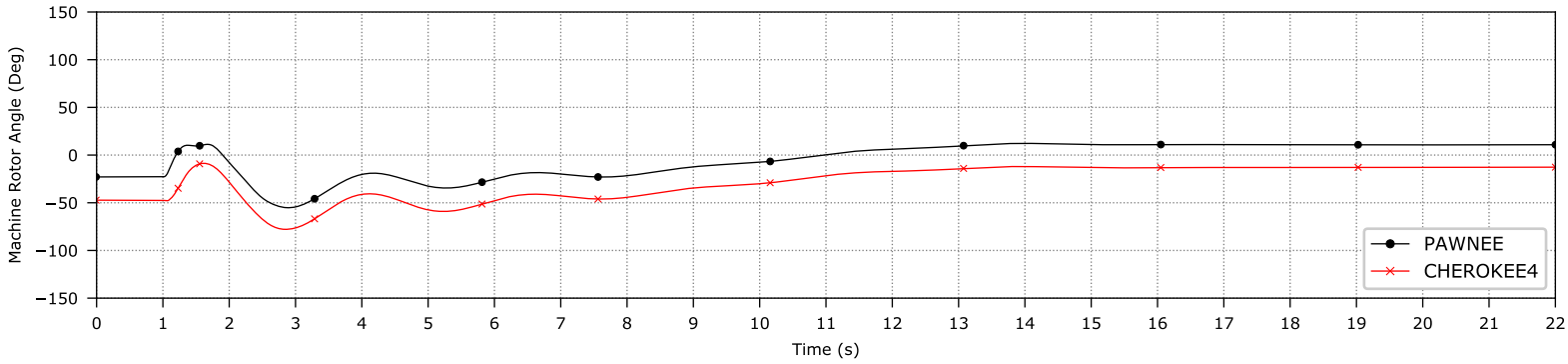


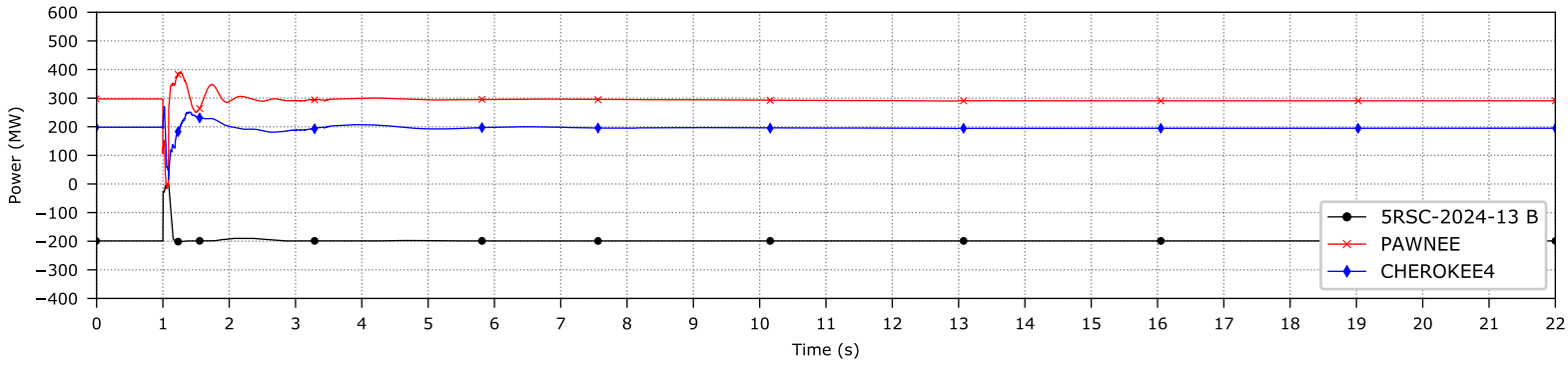


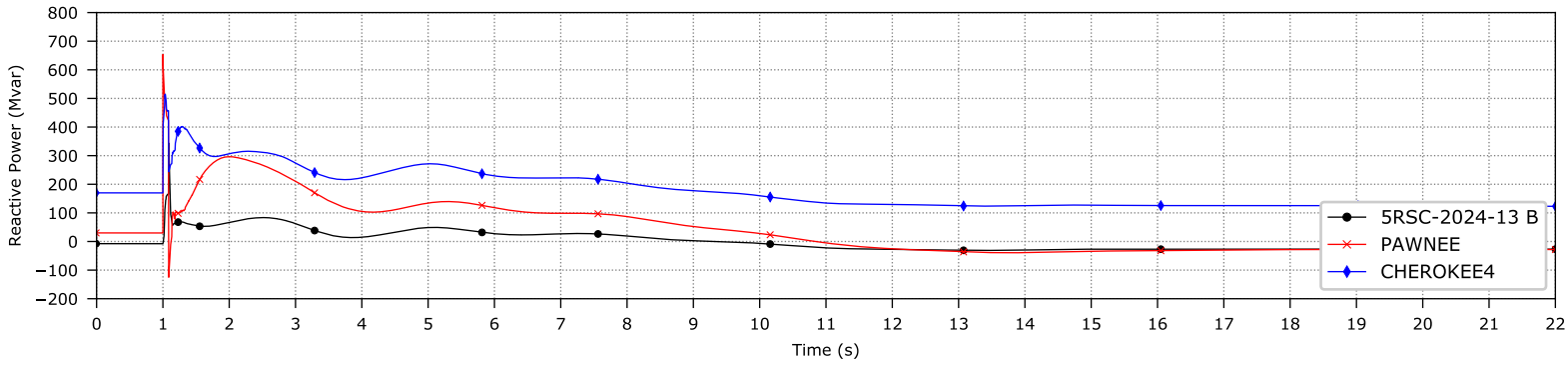


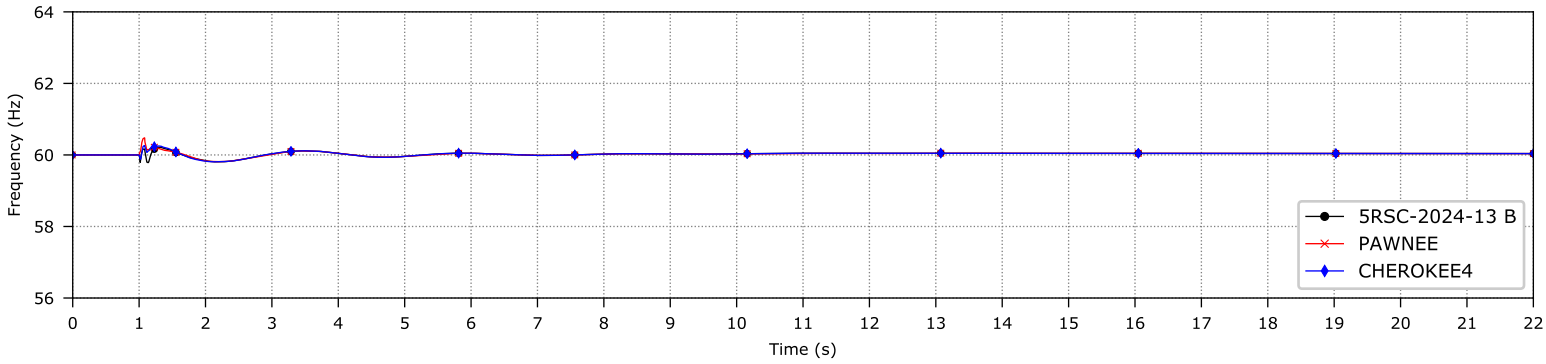


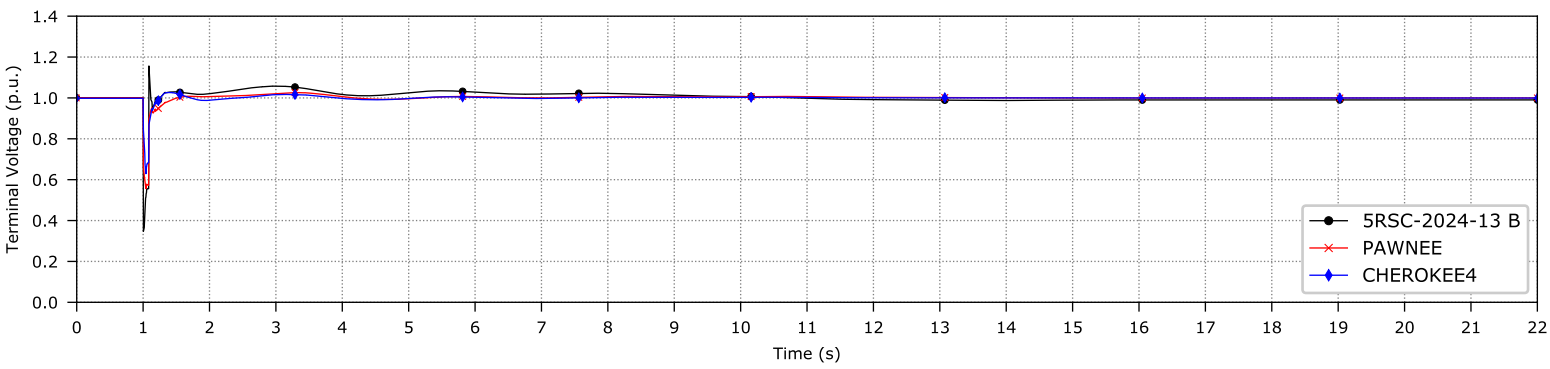
Ref. No. 07 - LoTC_63

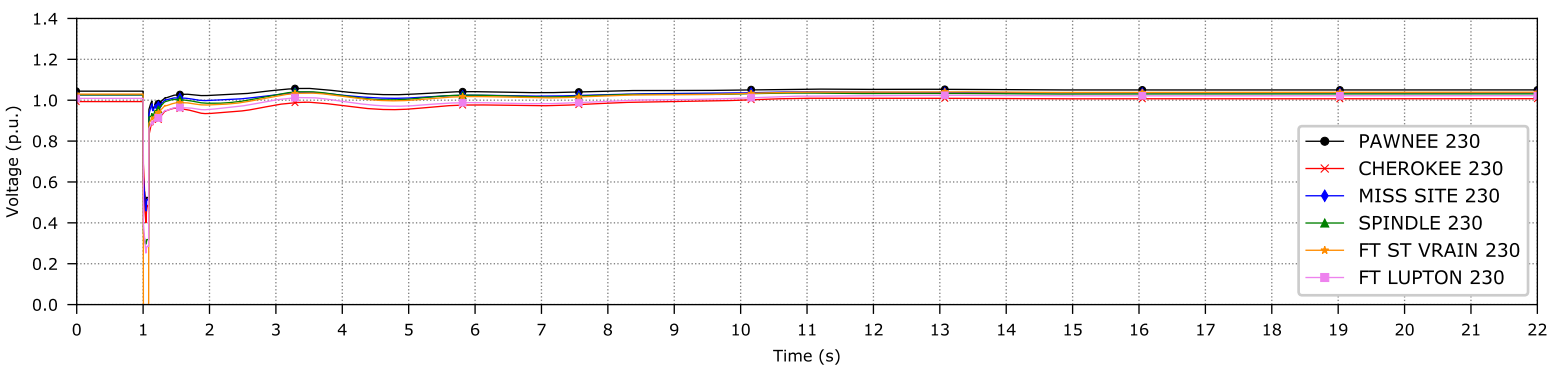












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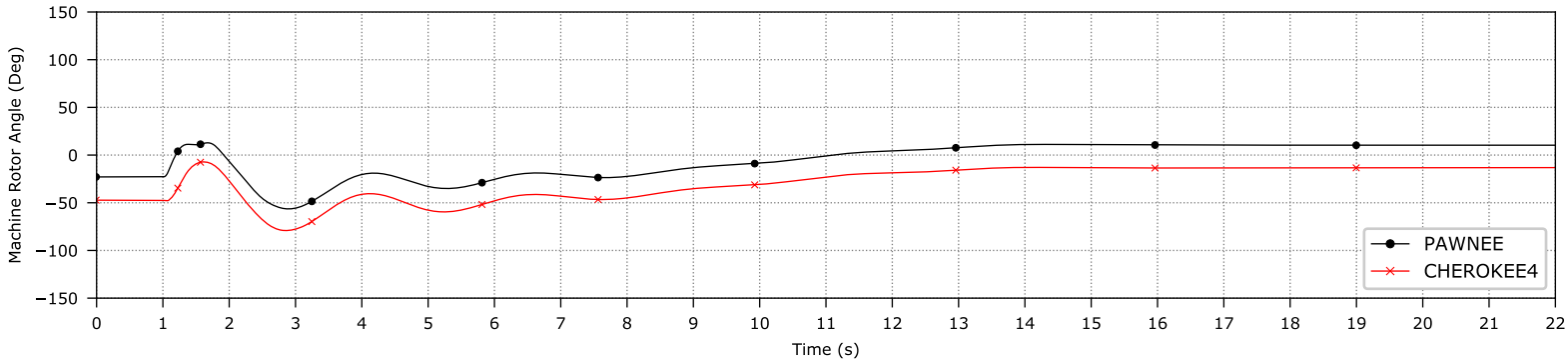
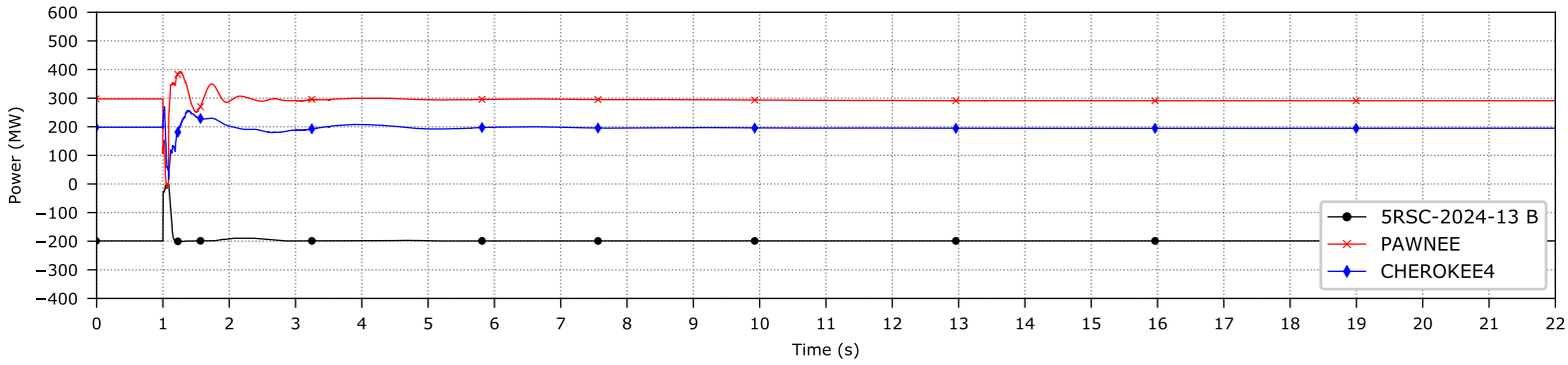
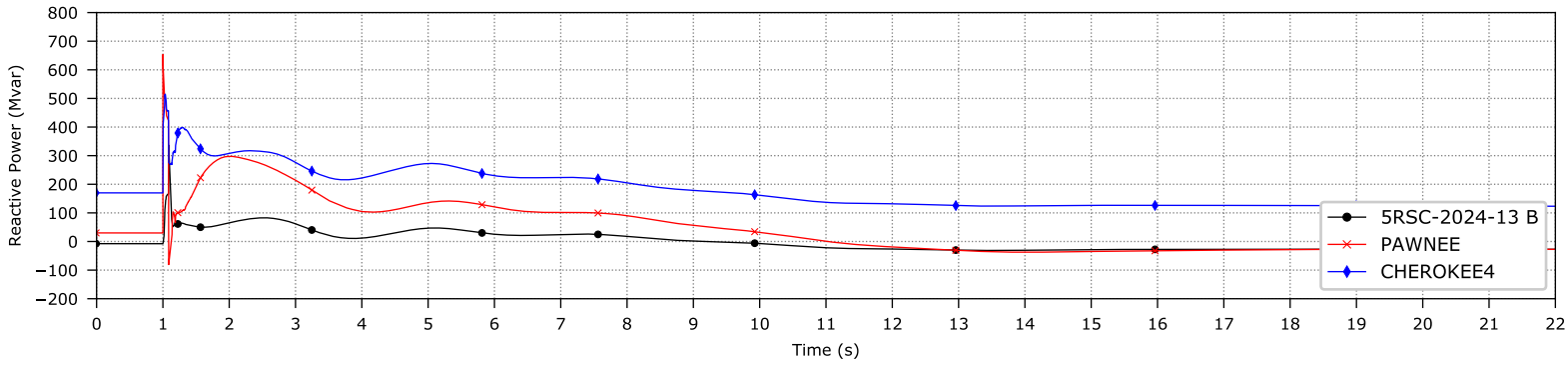
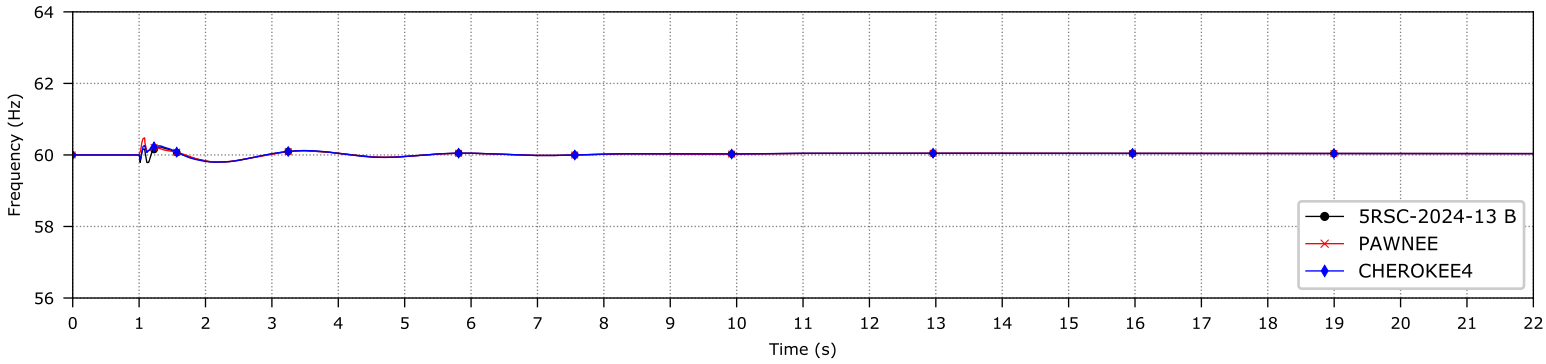
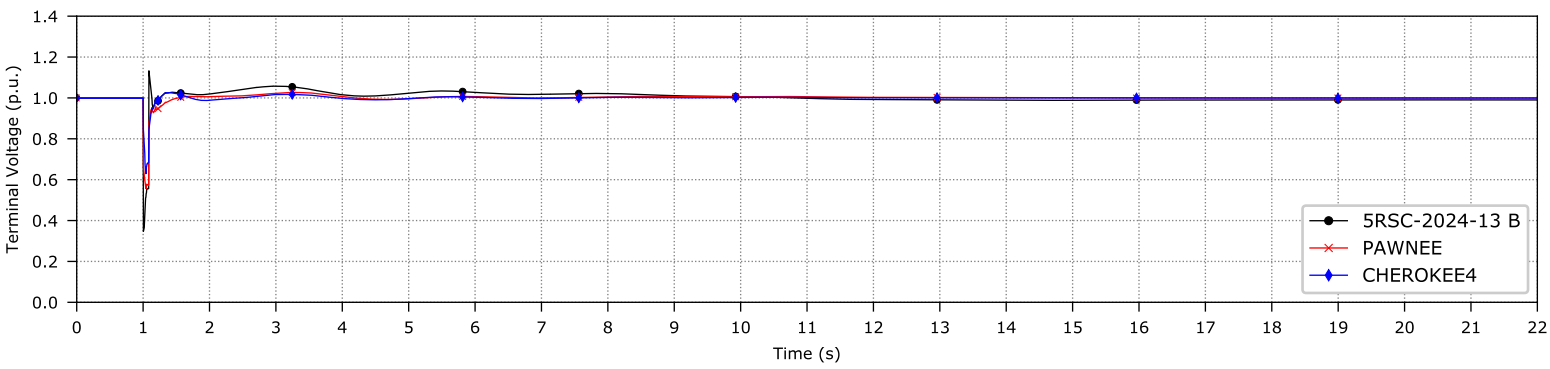
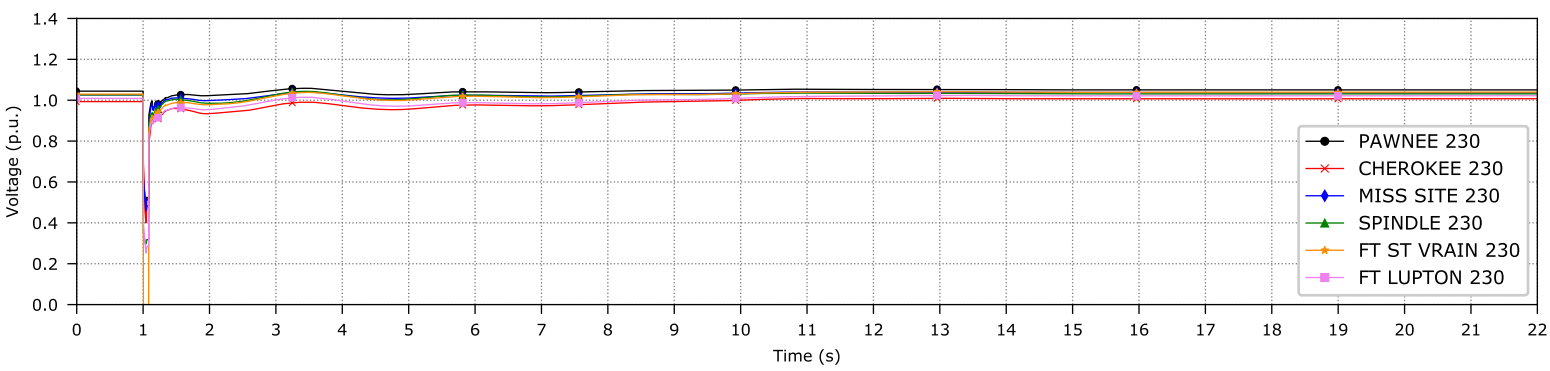




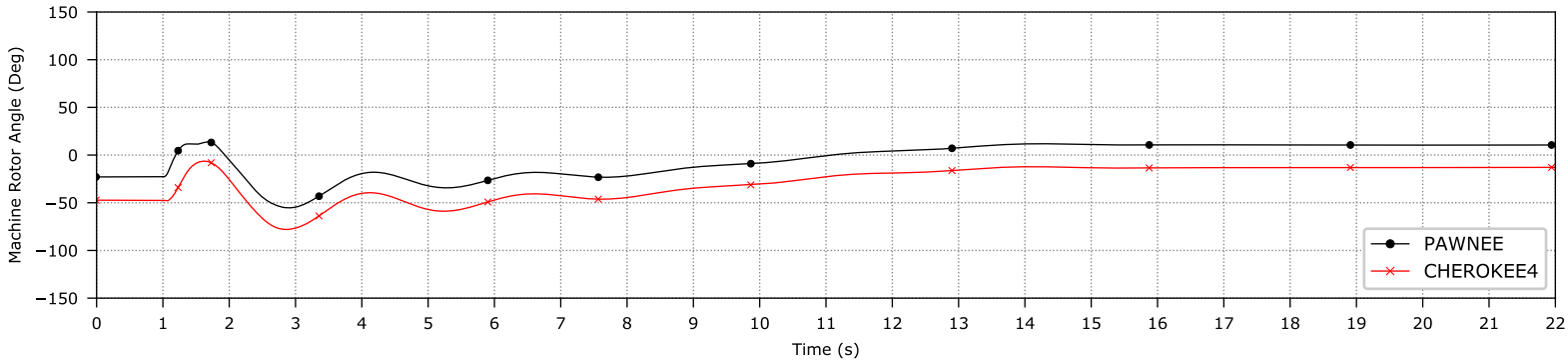


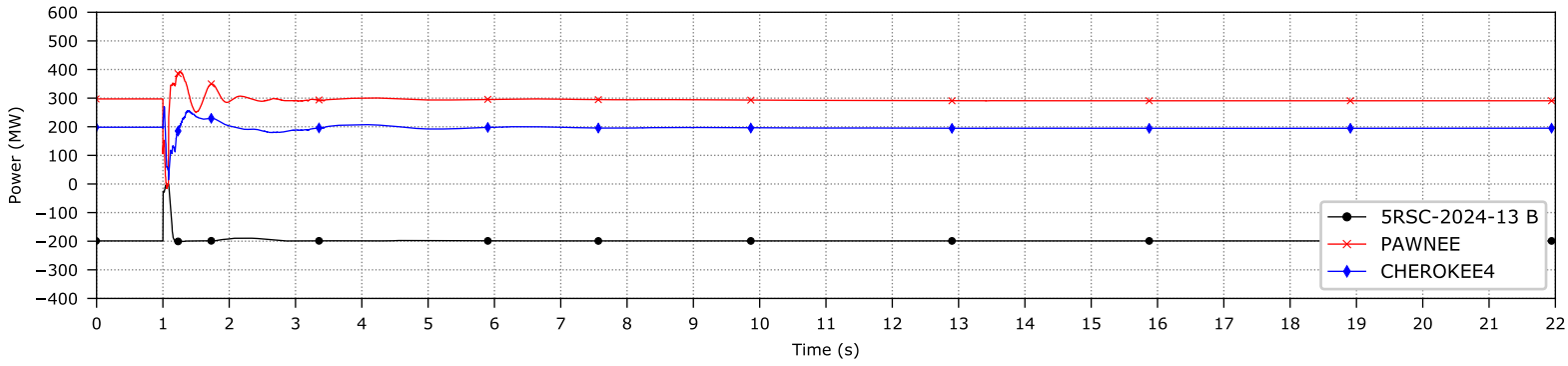


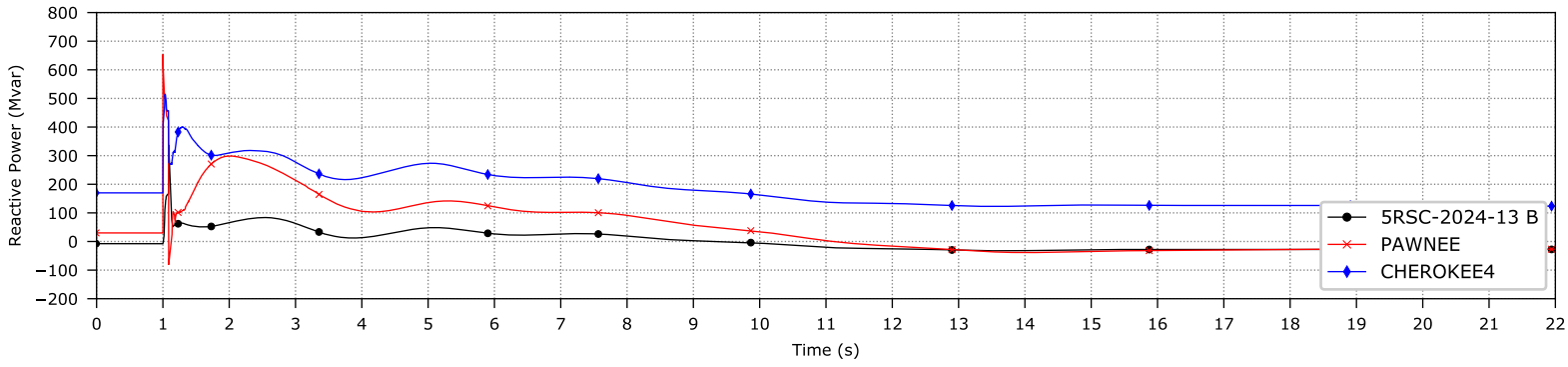


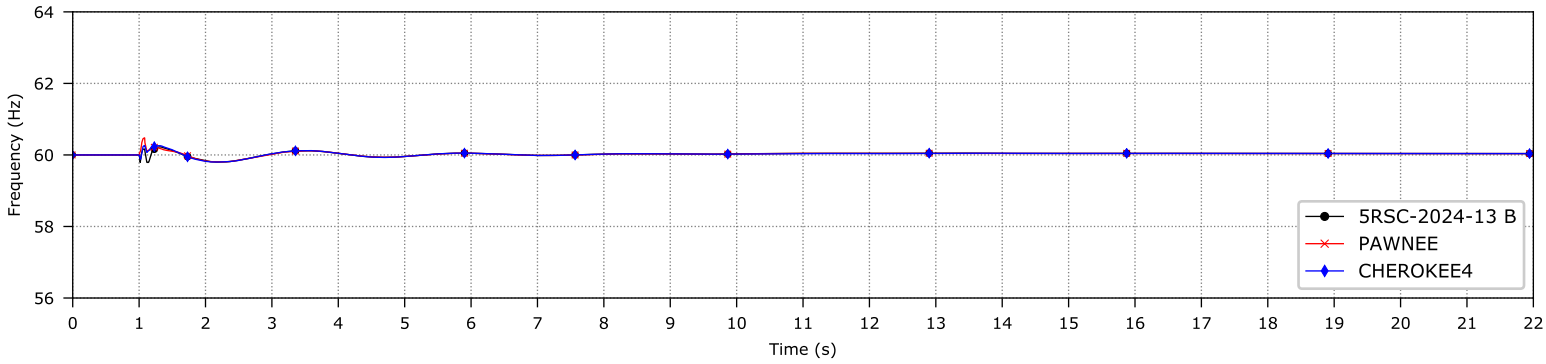


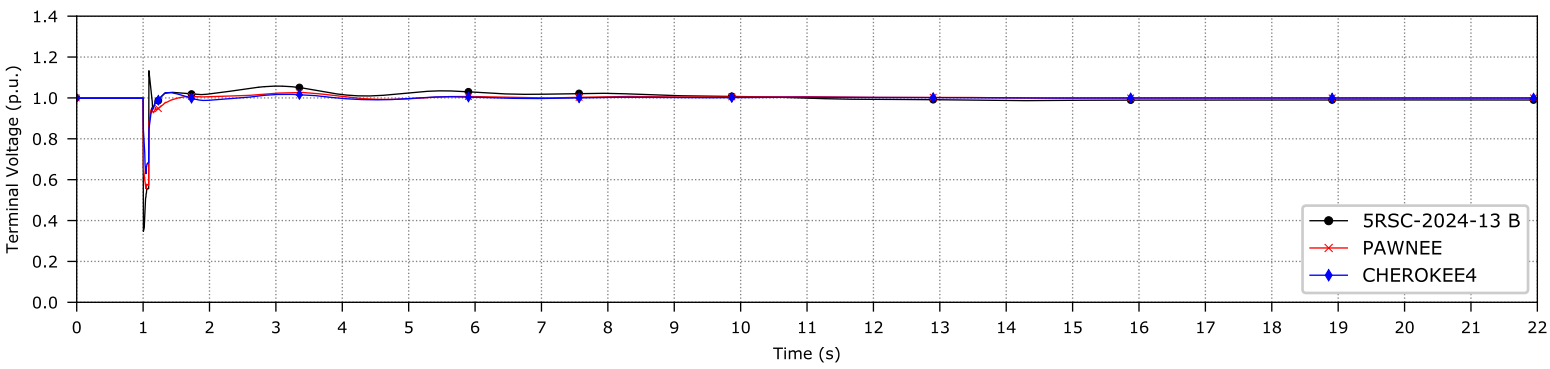
Ref. No. 09 - LoTC_65

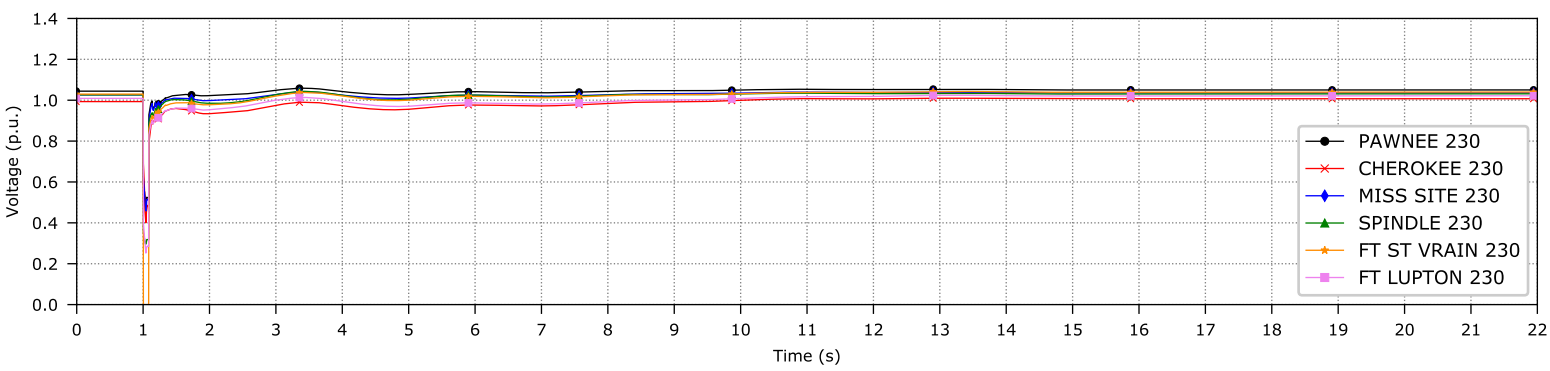




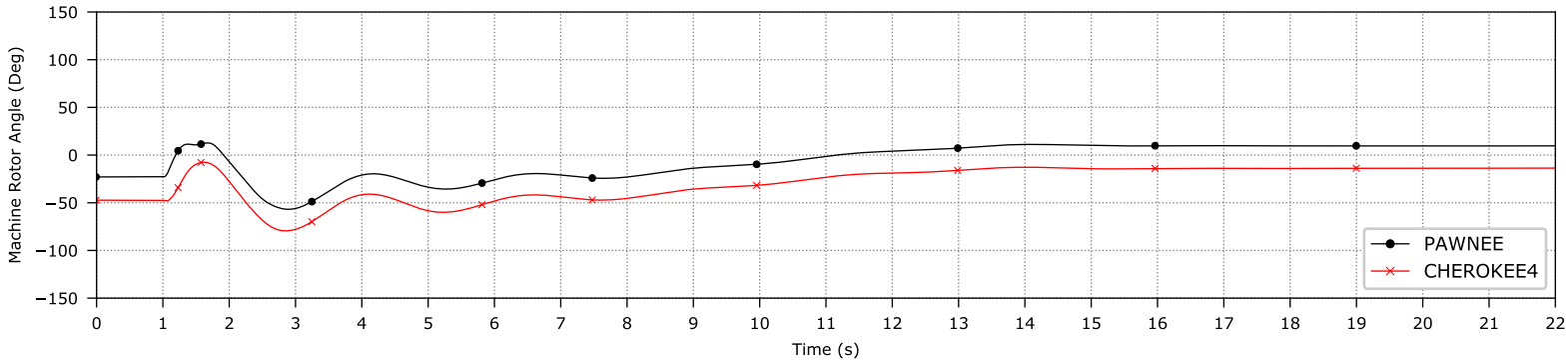


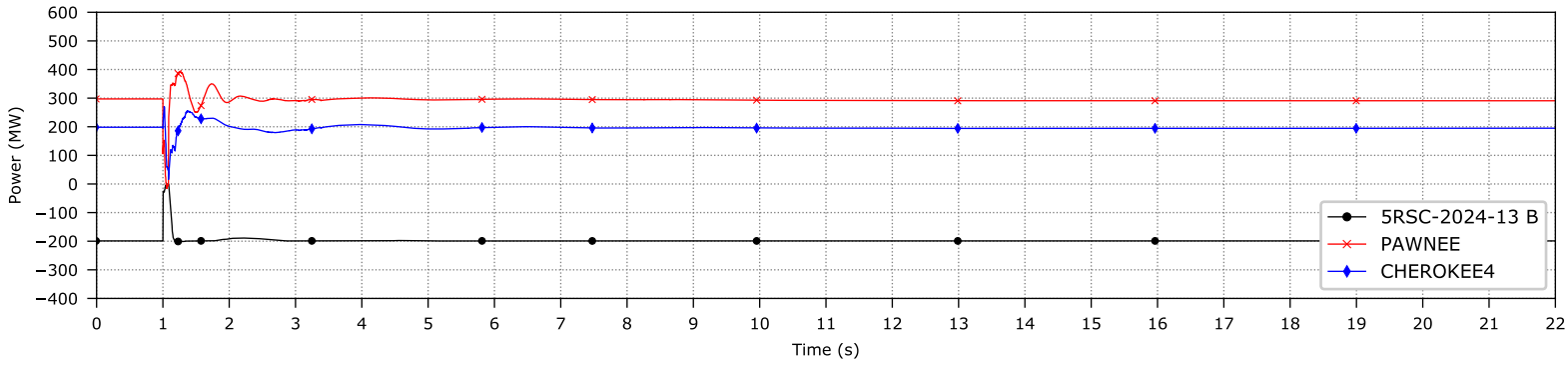


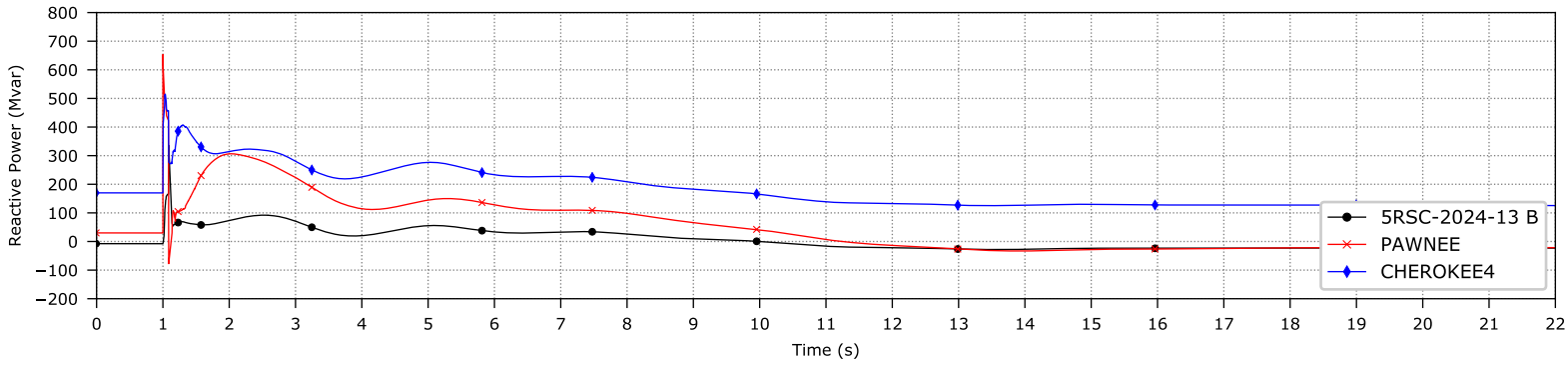


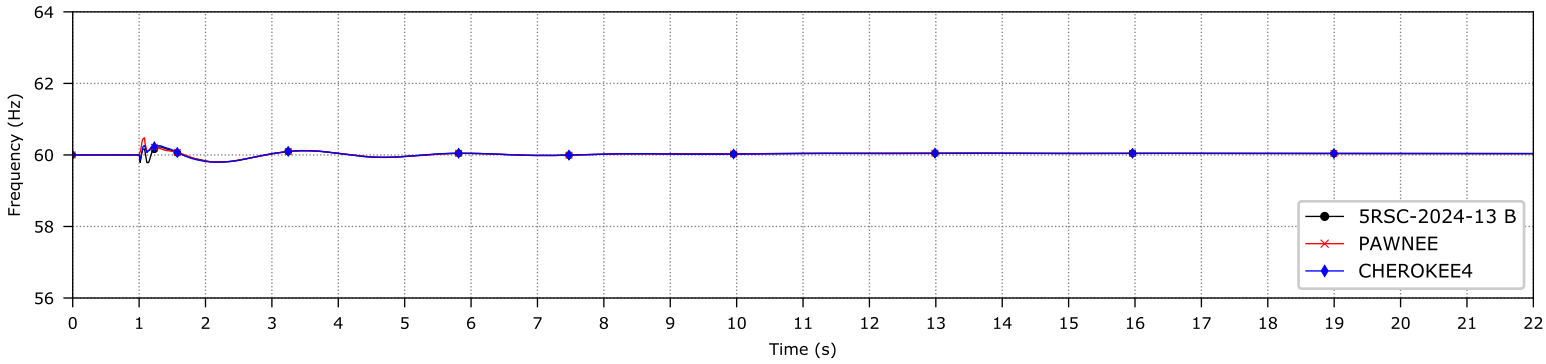


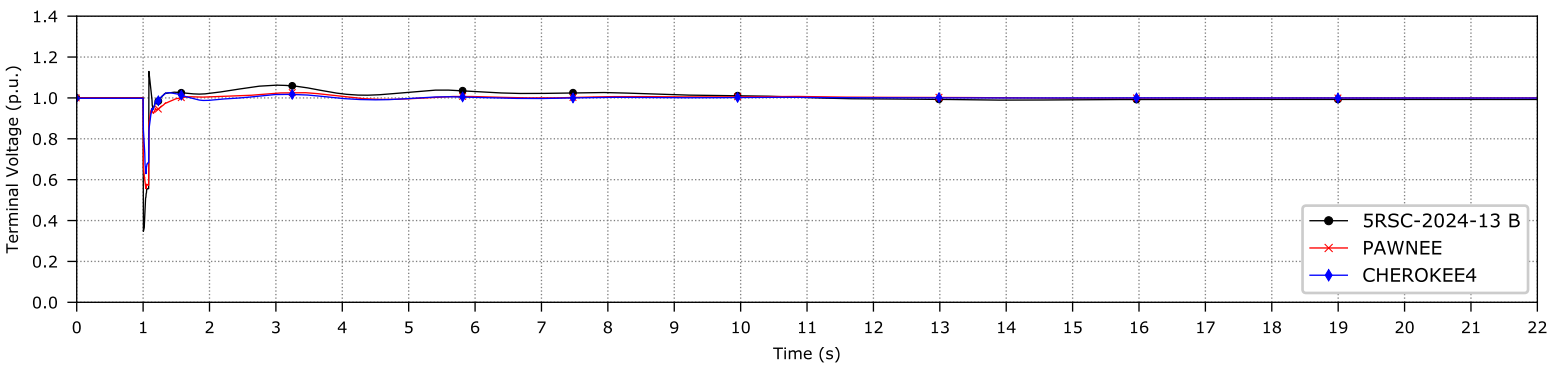
Ref. No. 10 - LoTC_66

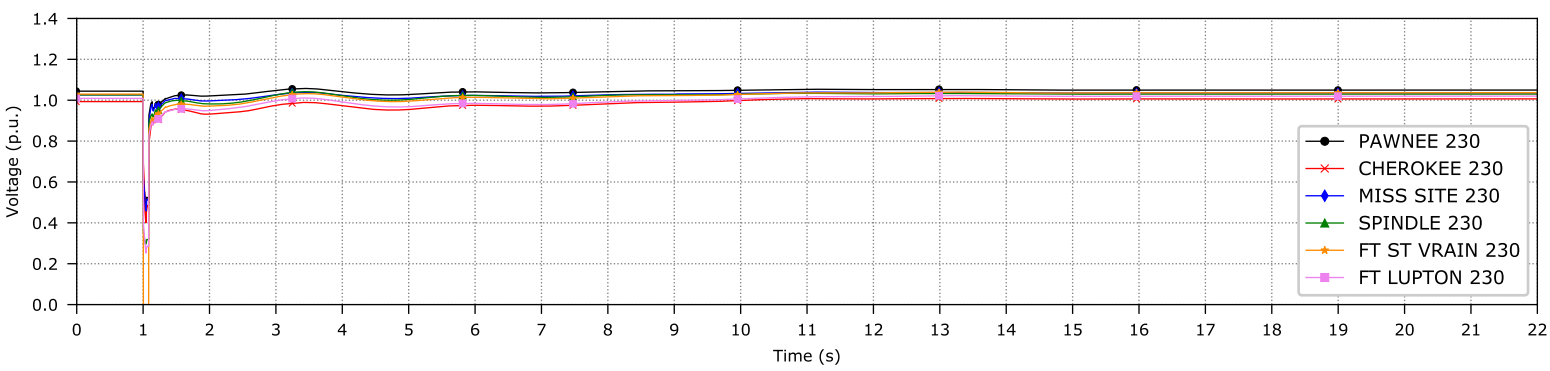




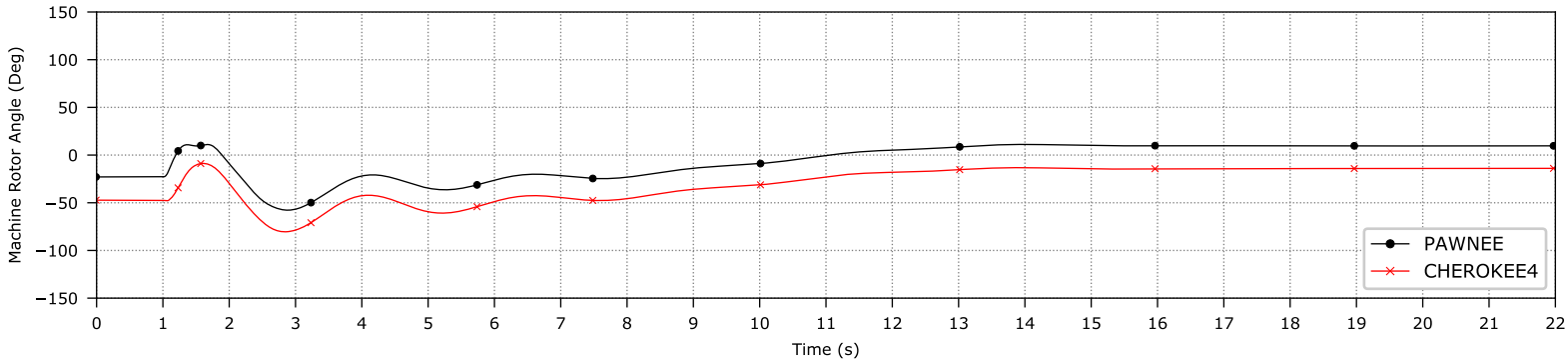


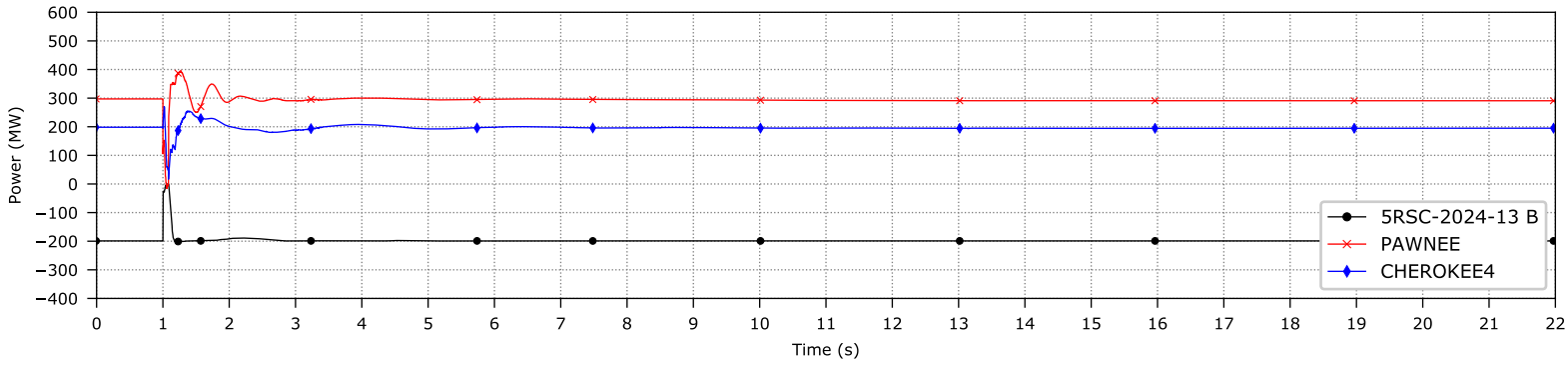


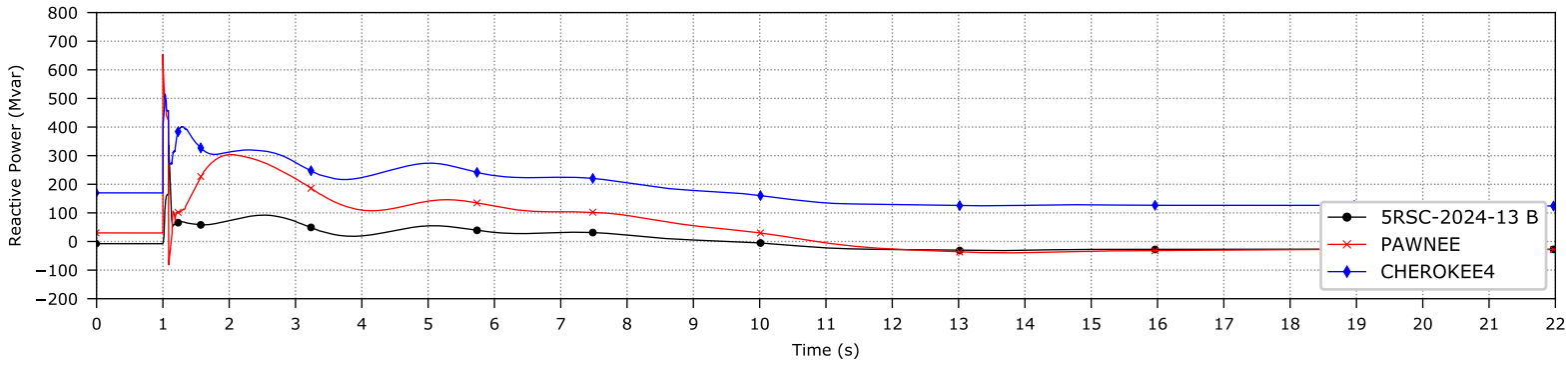


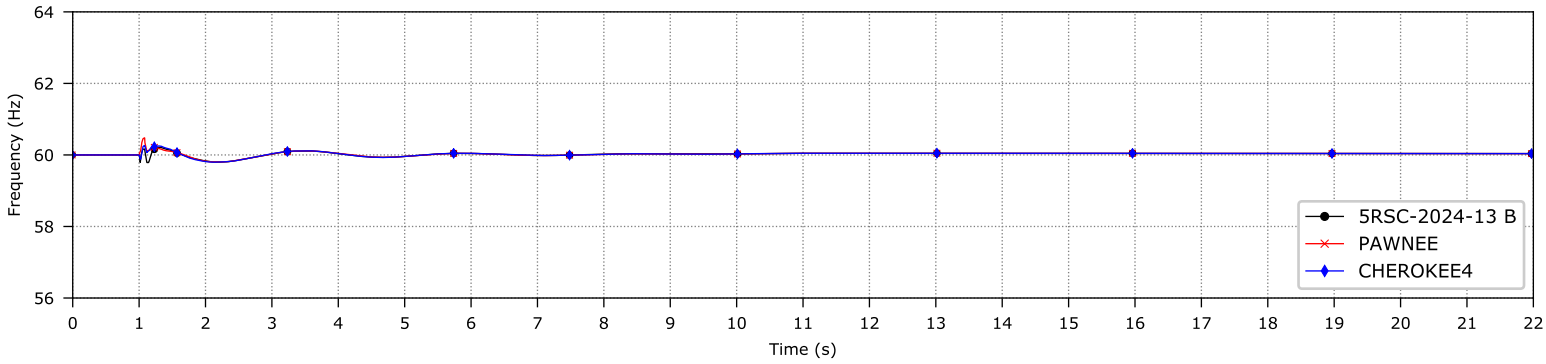


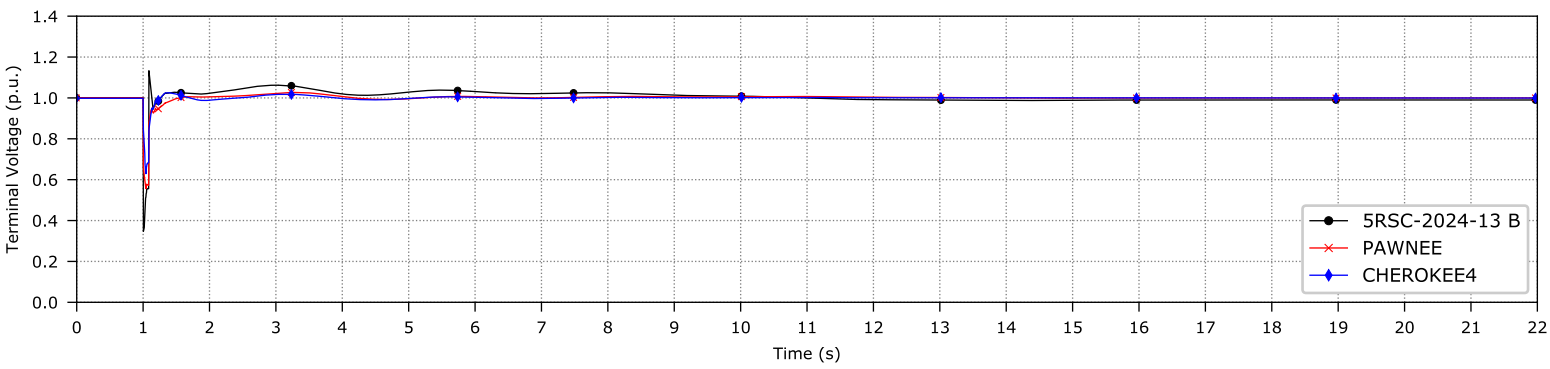
Ref. No. 11 - LoTC_67

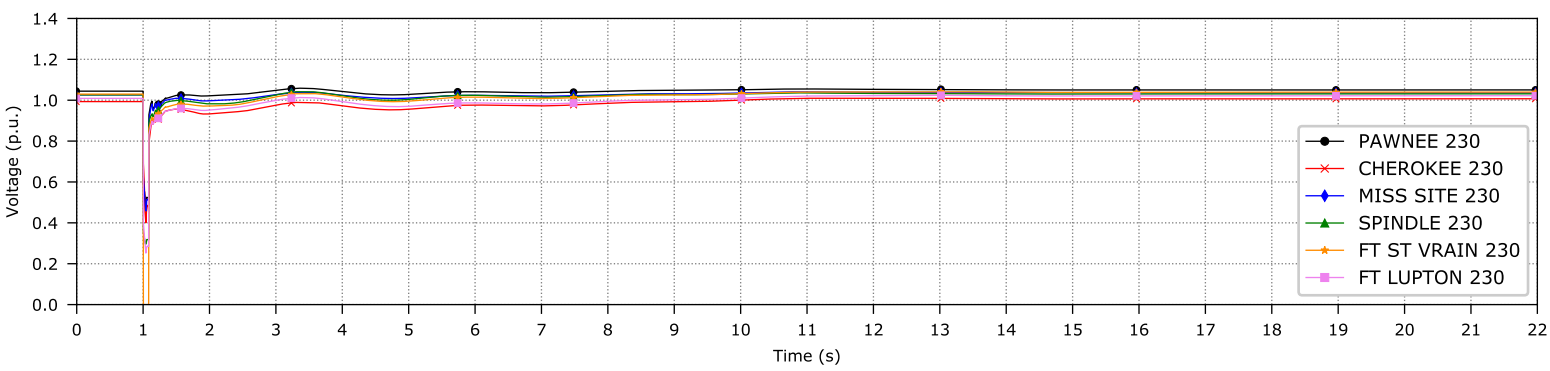




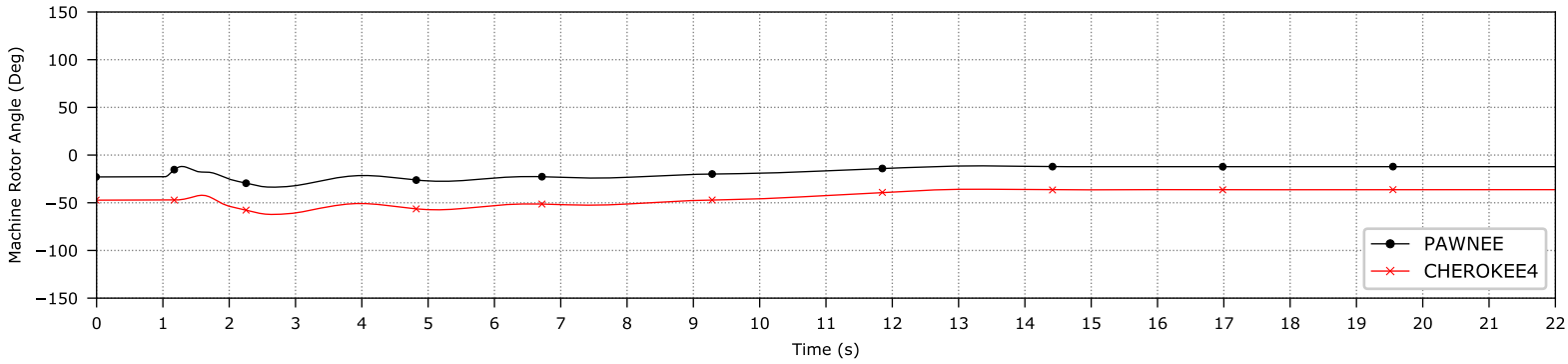


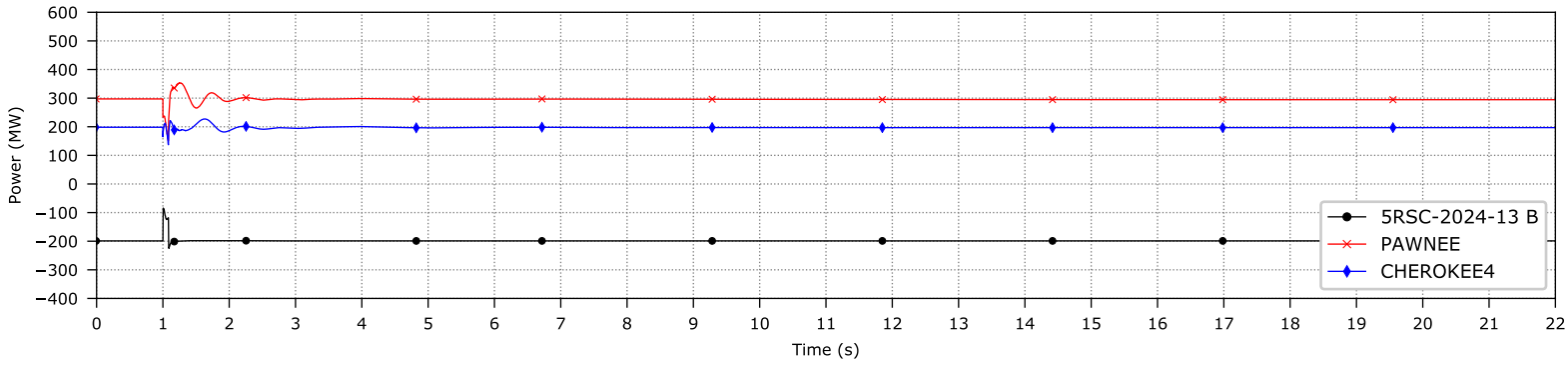


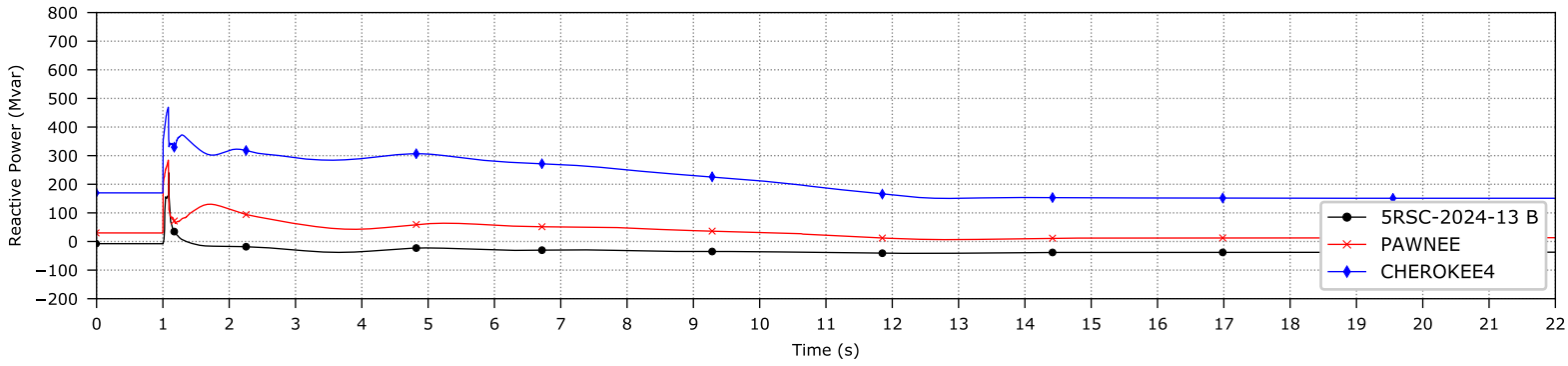


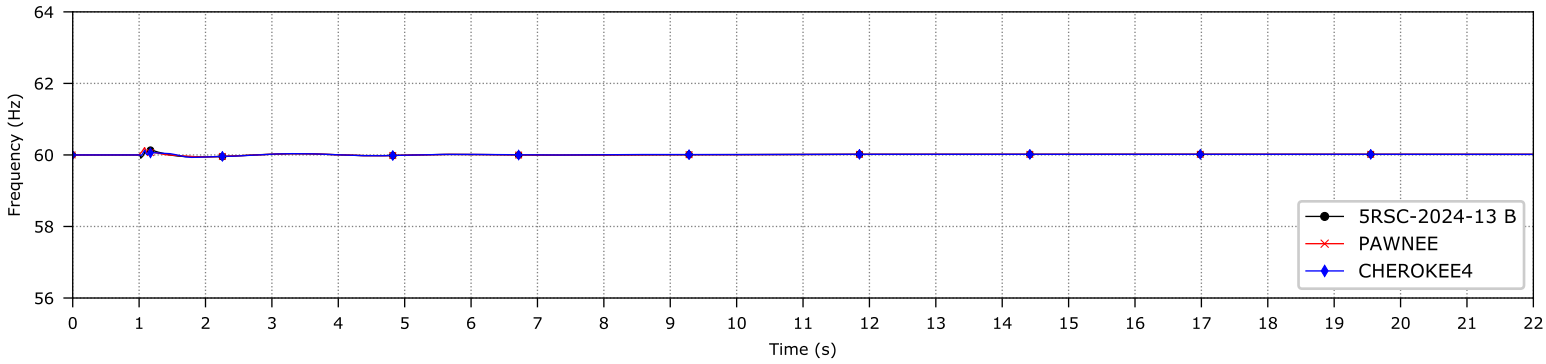


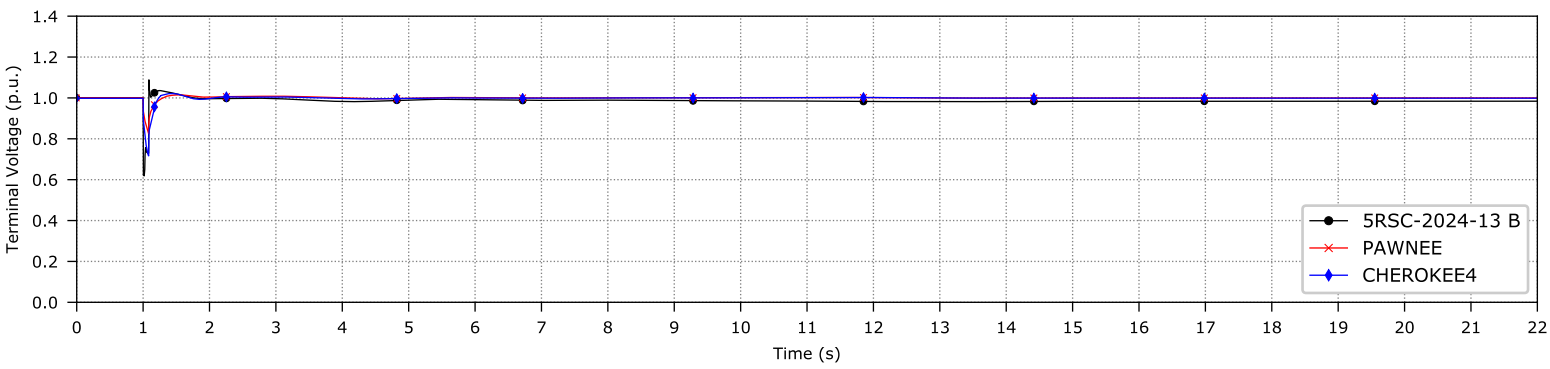
Ref. No. 12 - LoTC_74

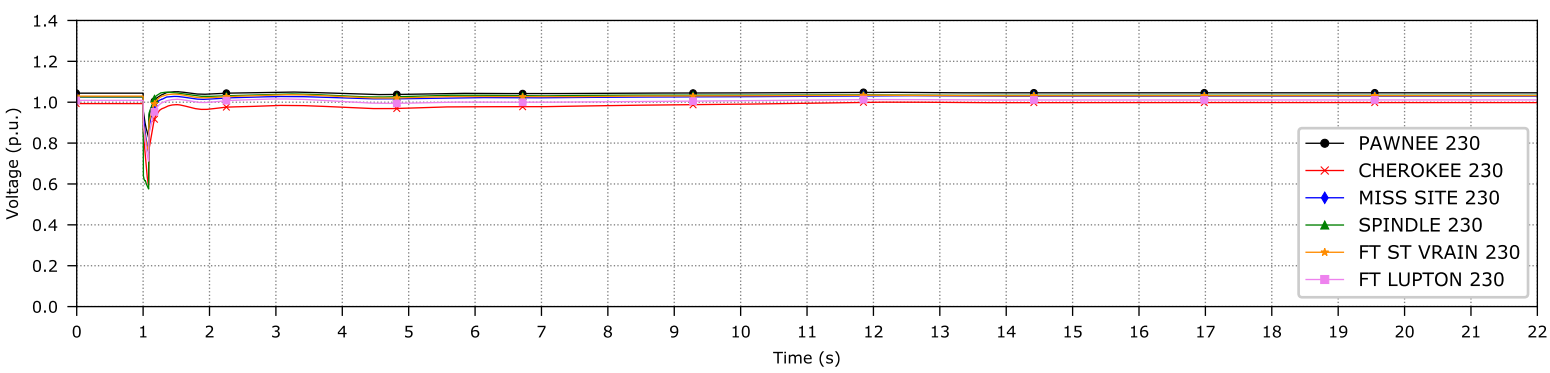




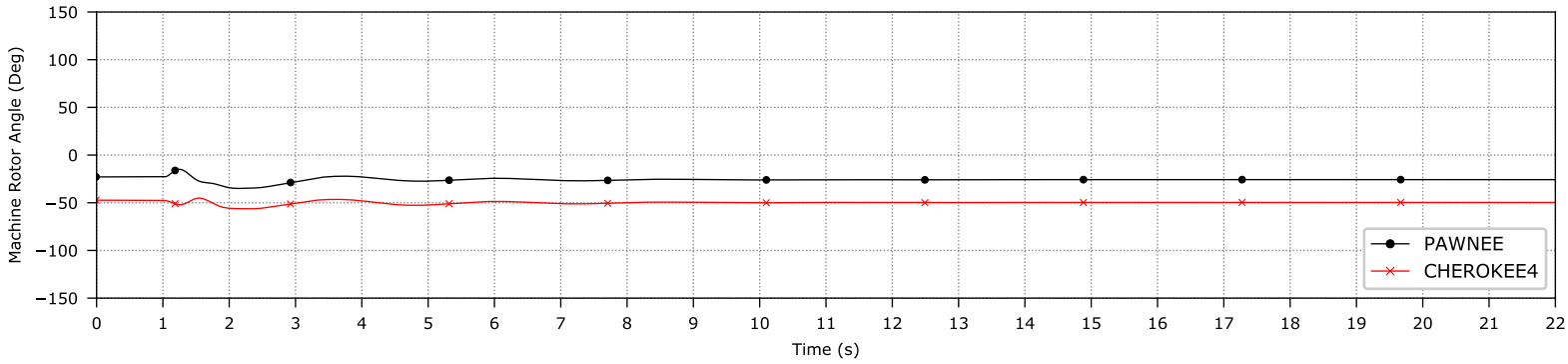


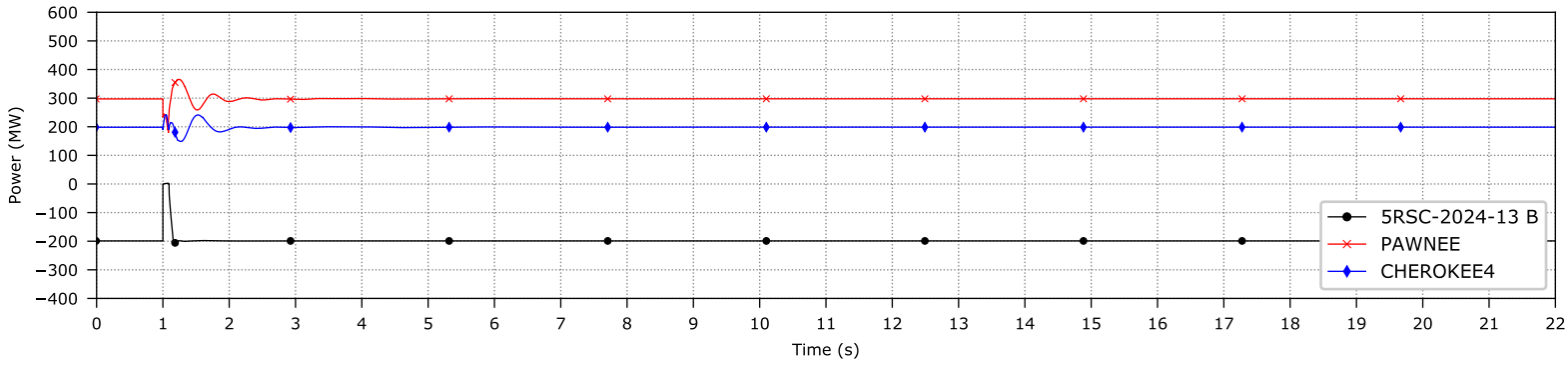


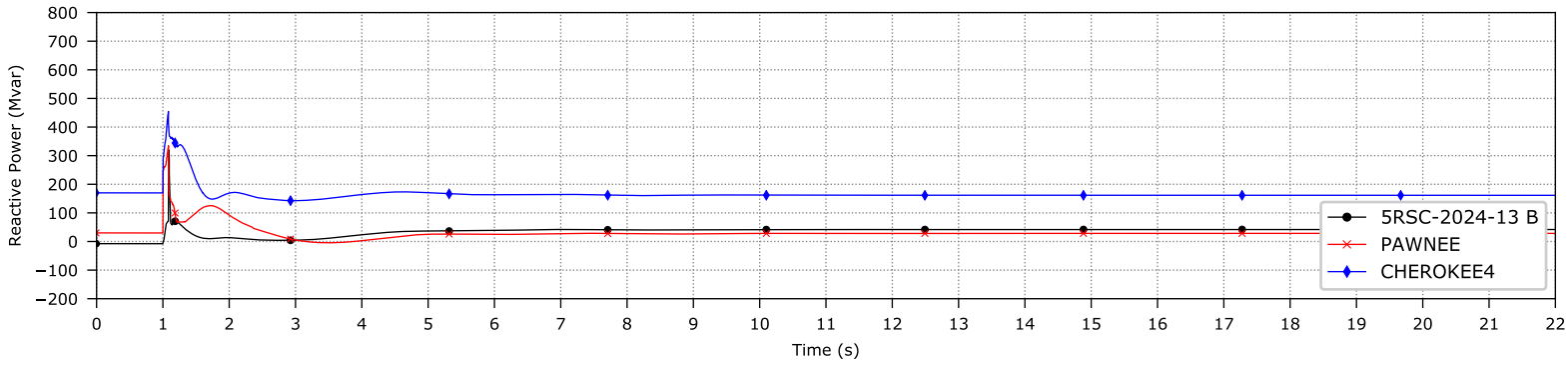


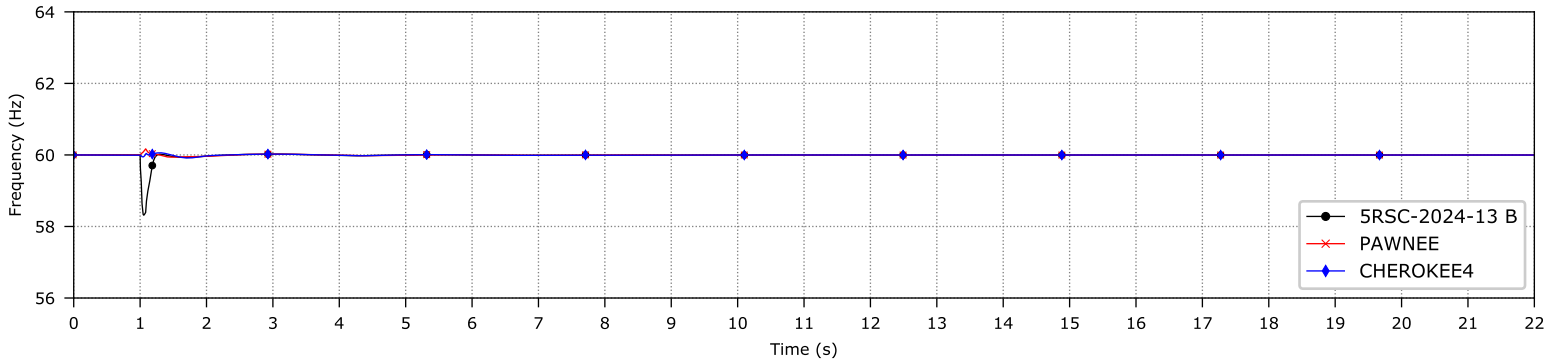


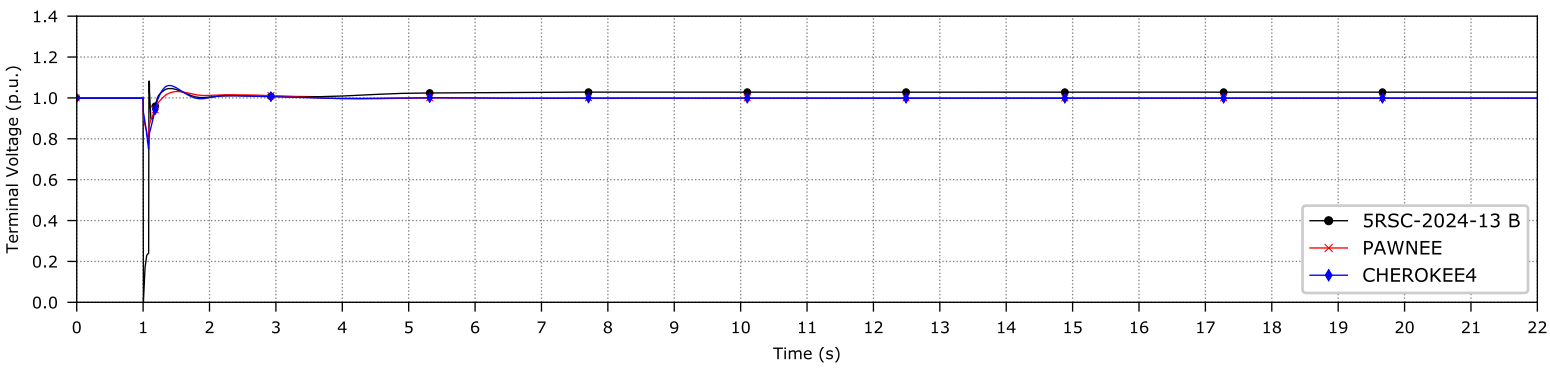
Ref. No. 13 - LoTC_140

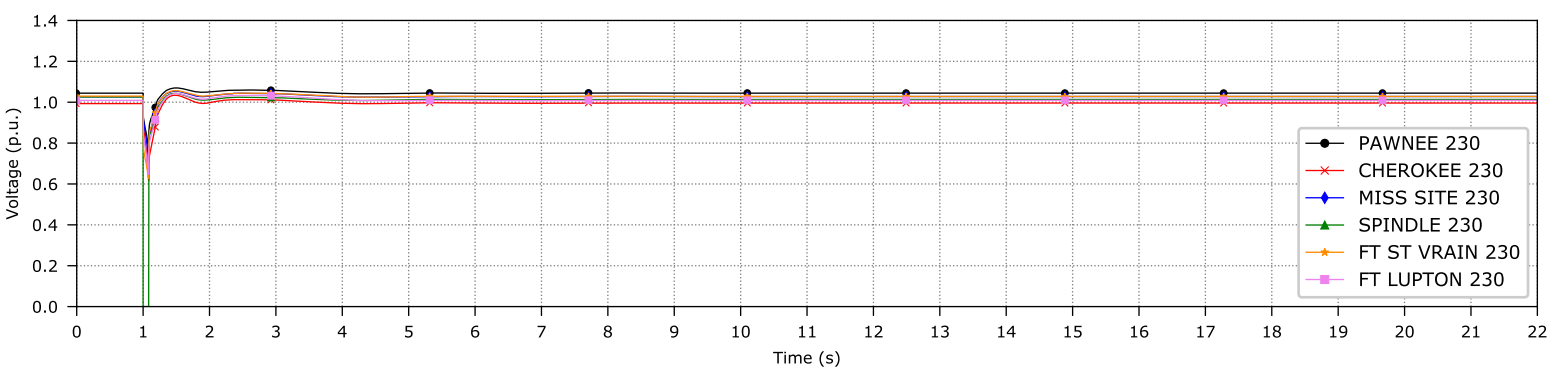




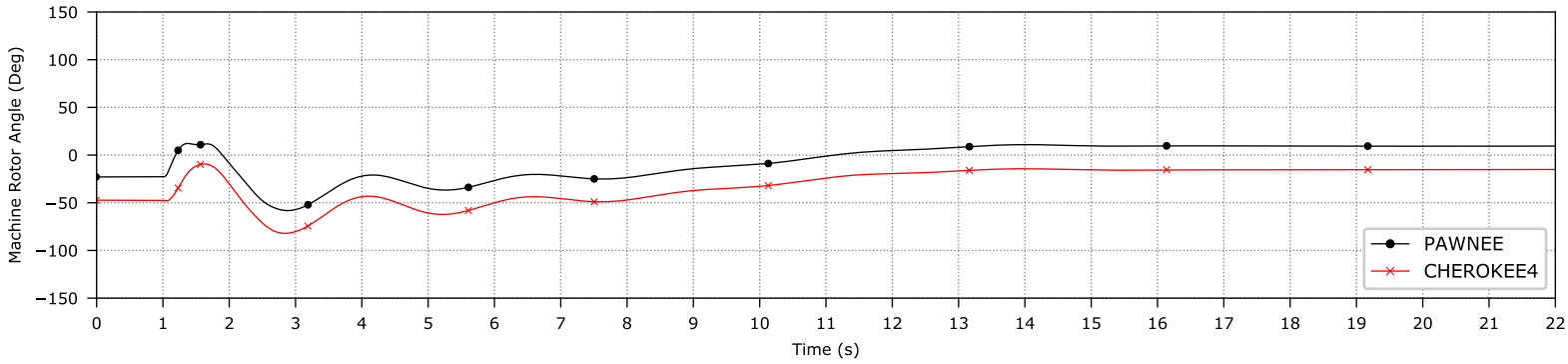


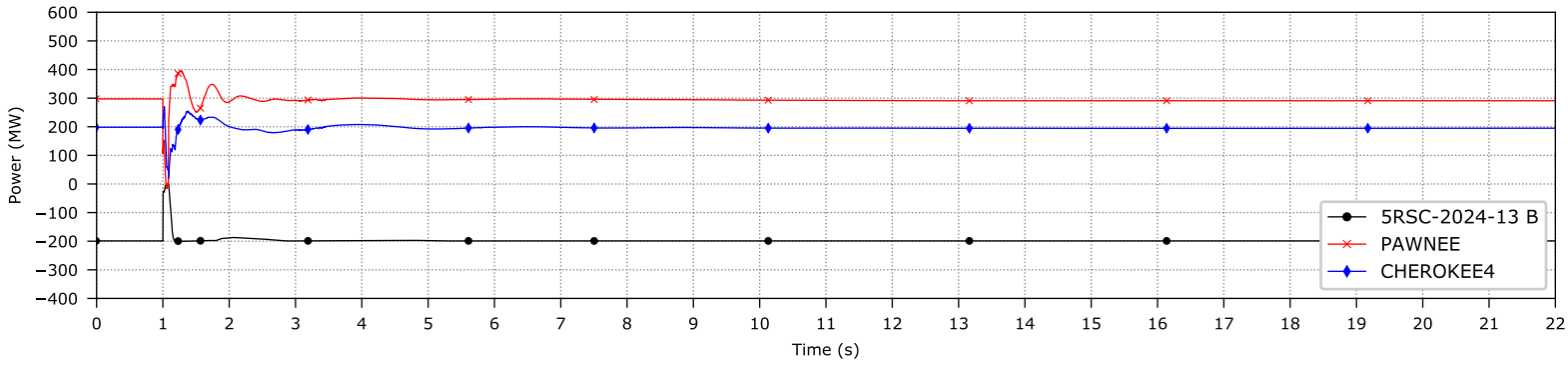


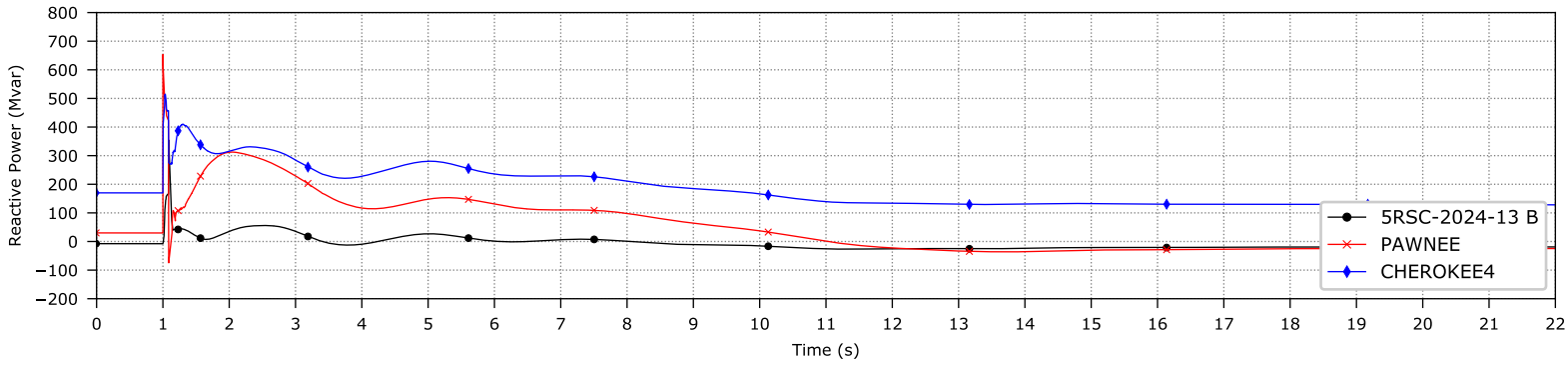


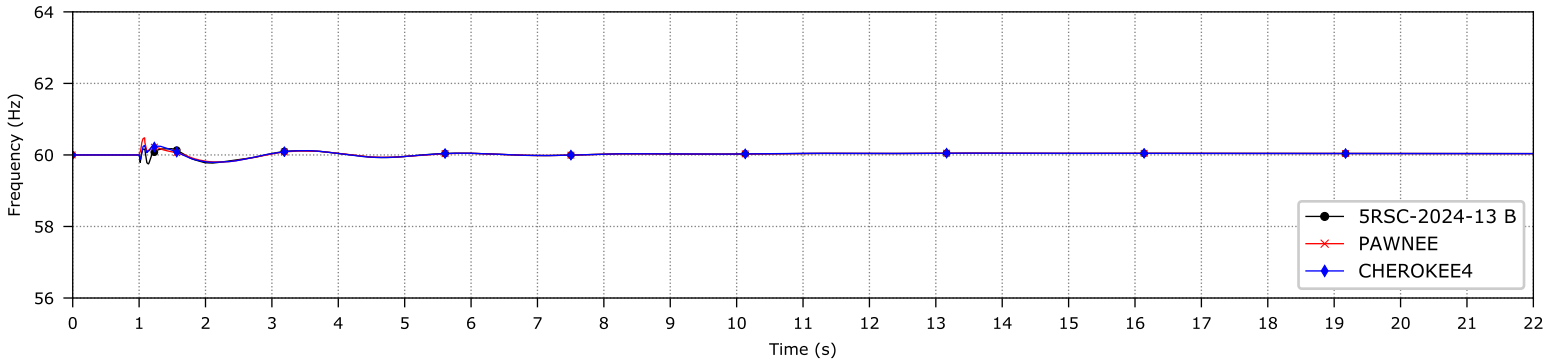


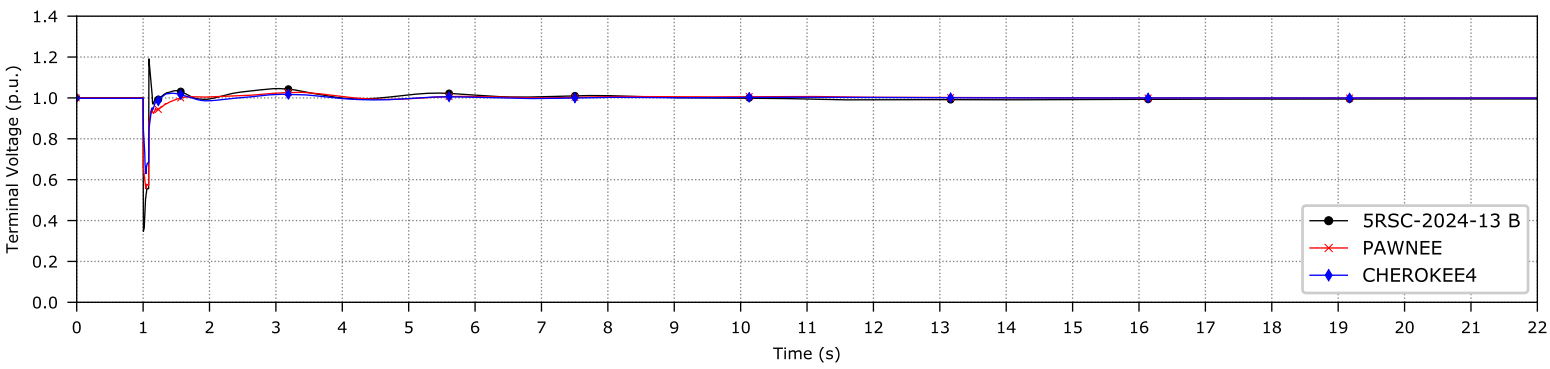
Ref. No. 14 - LoTC_141

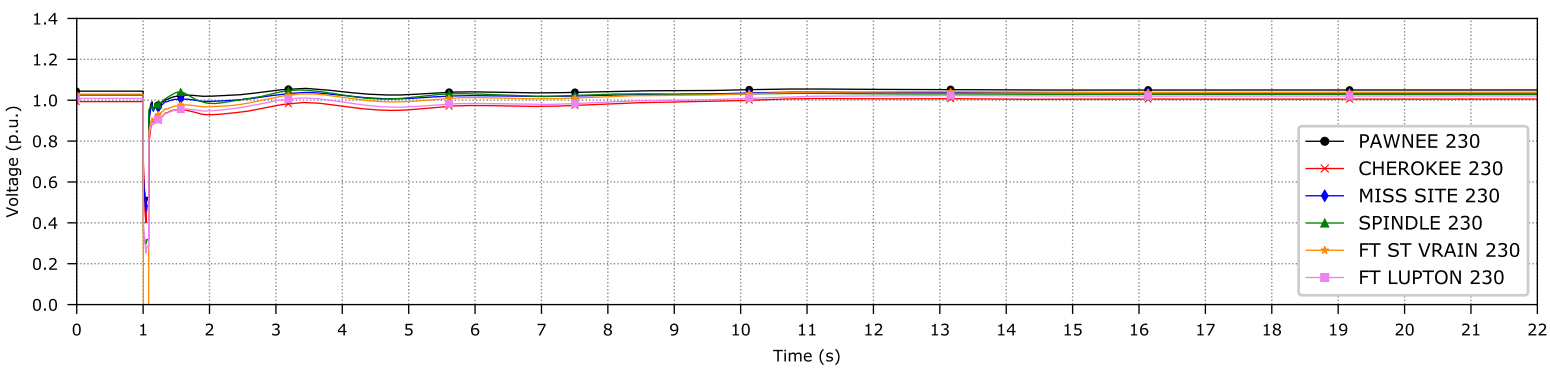




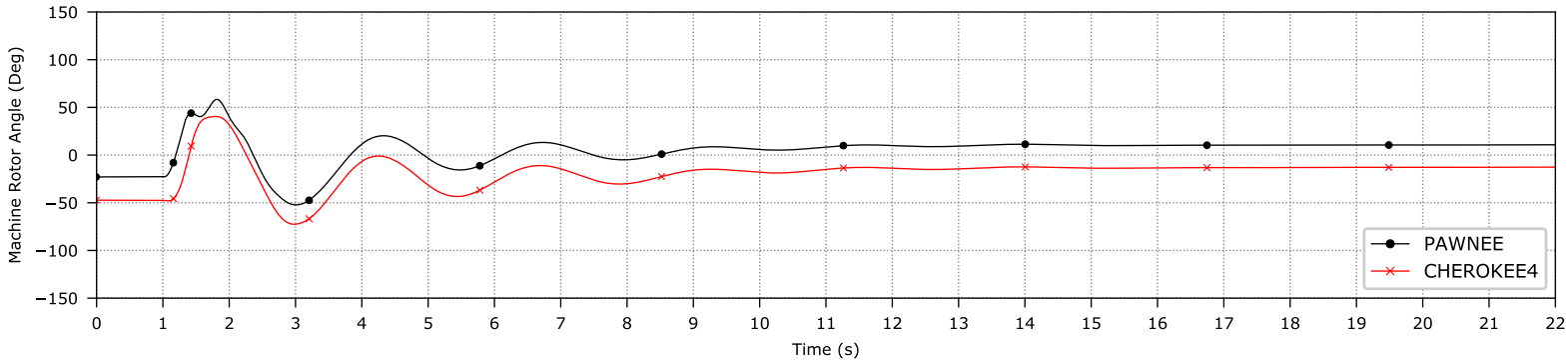


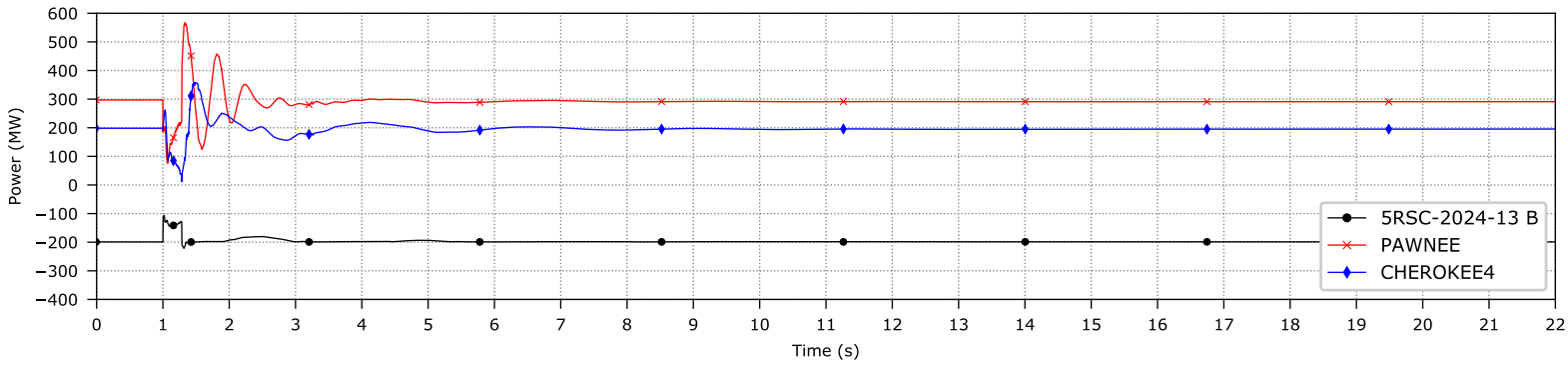


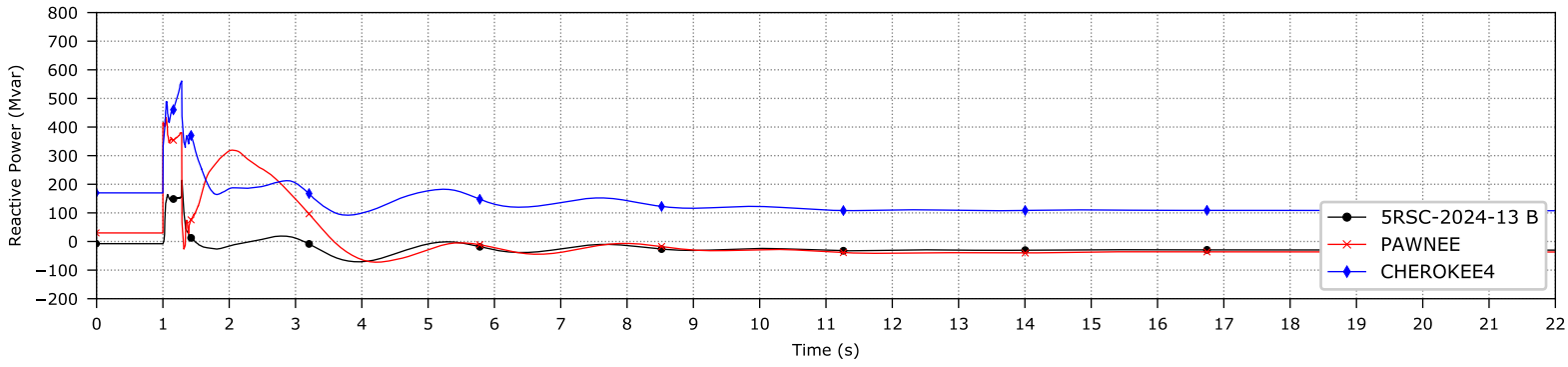


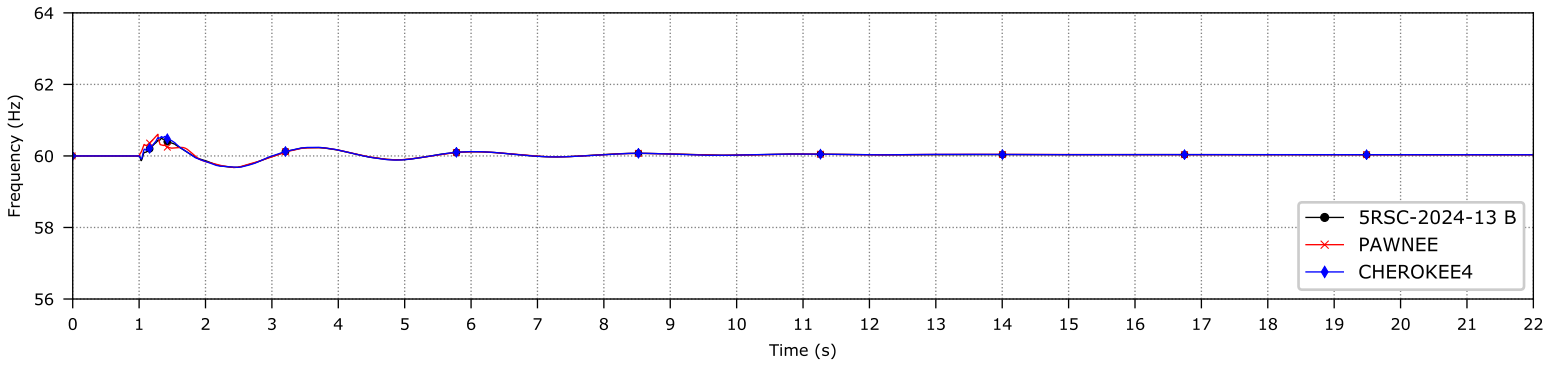


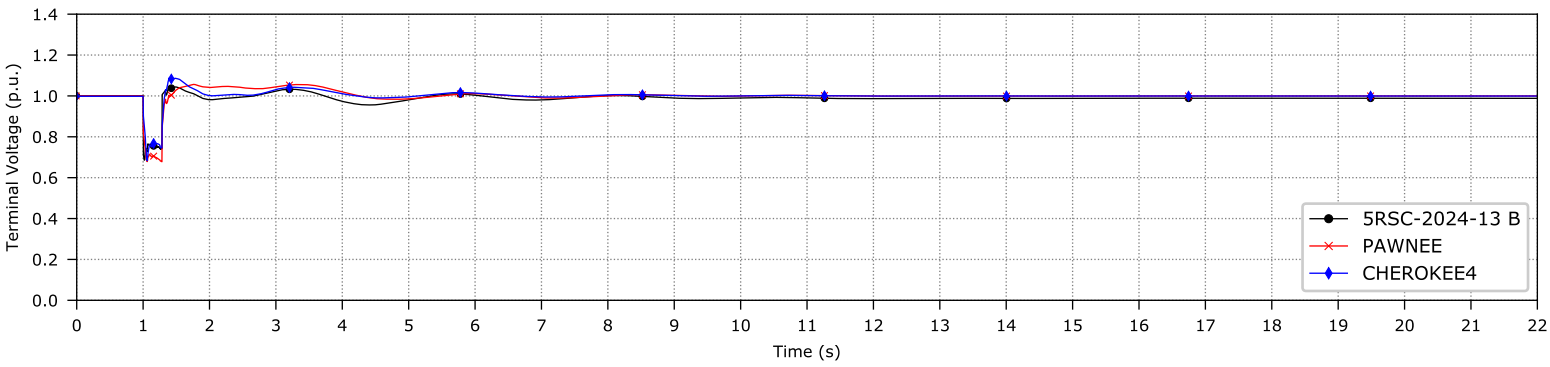
Ref. No. 17 - BF_057a

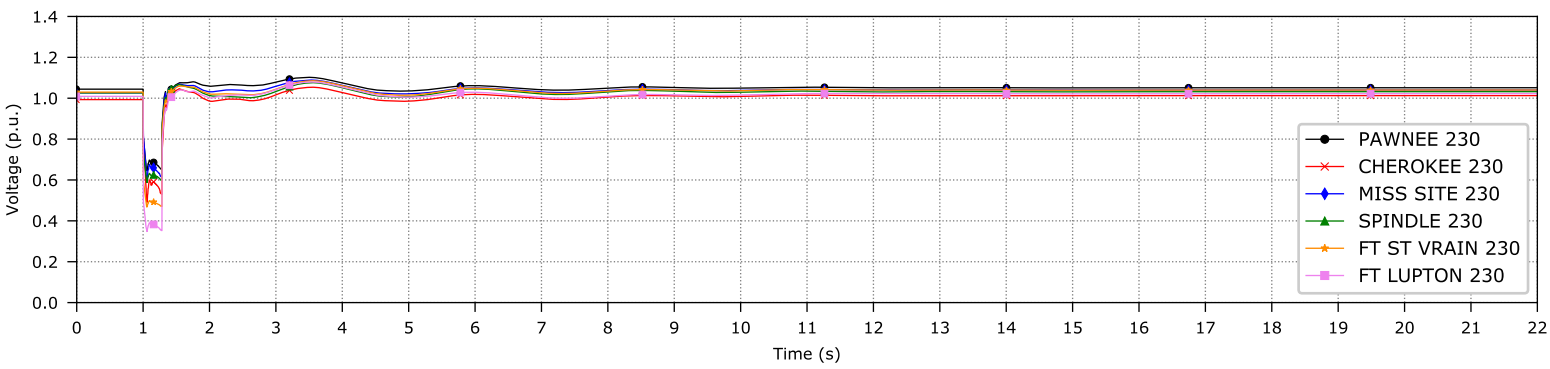




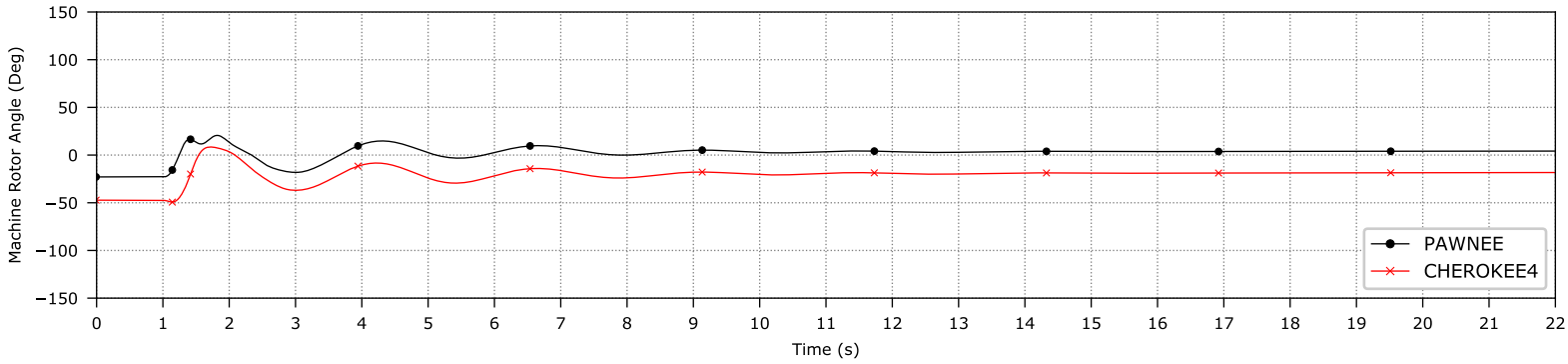


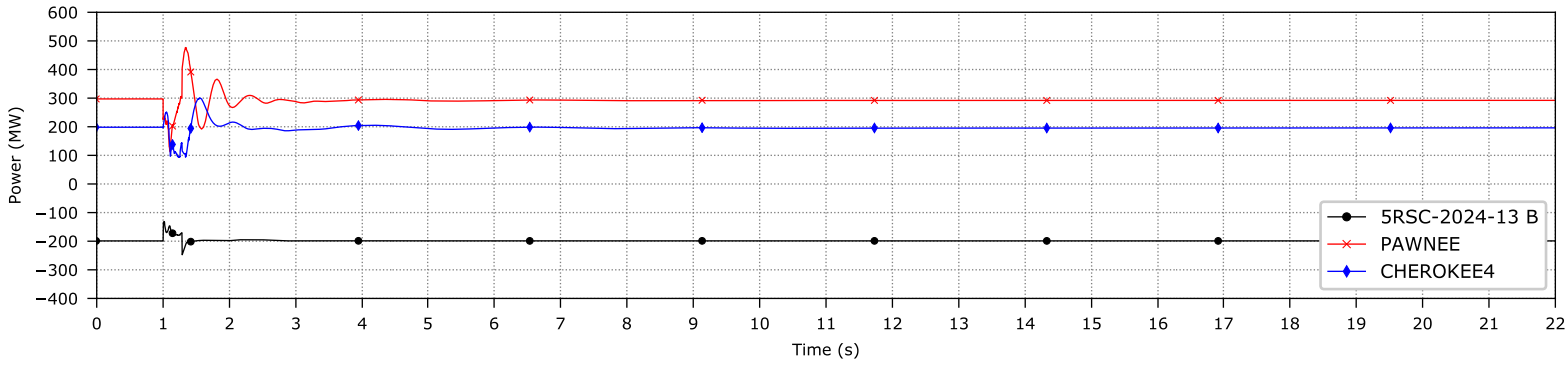


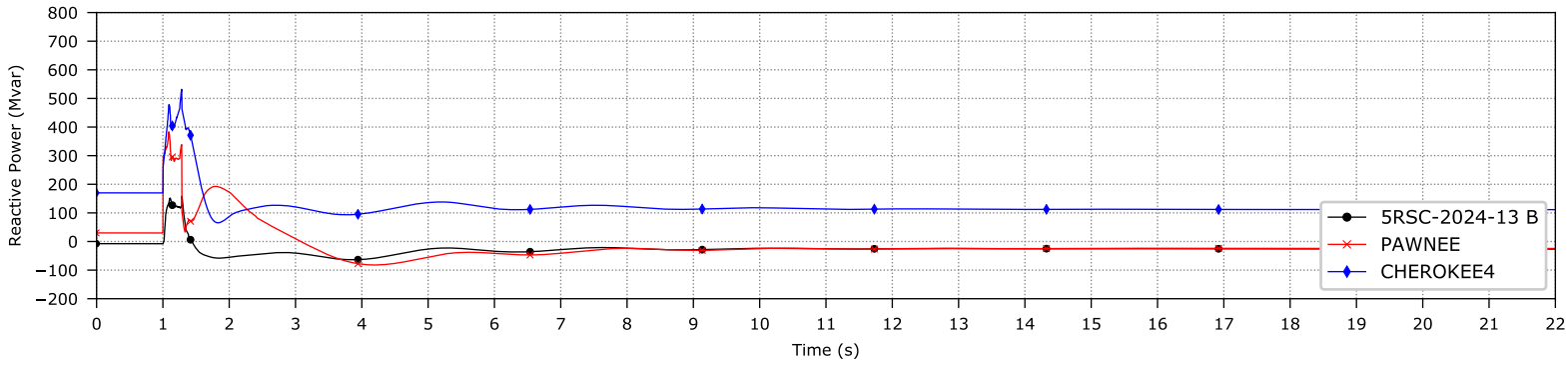


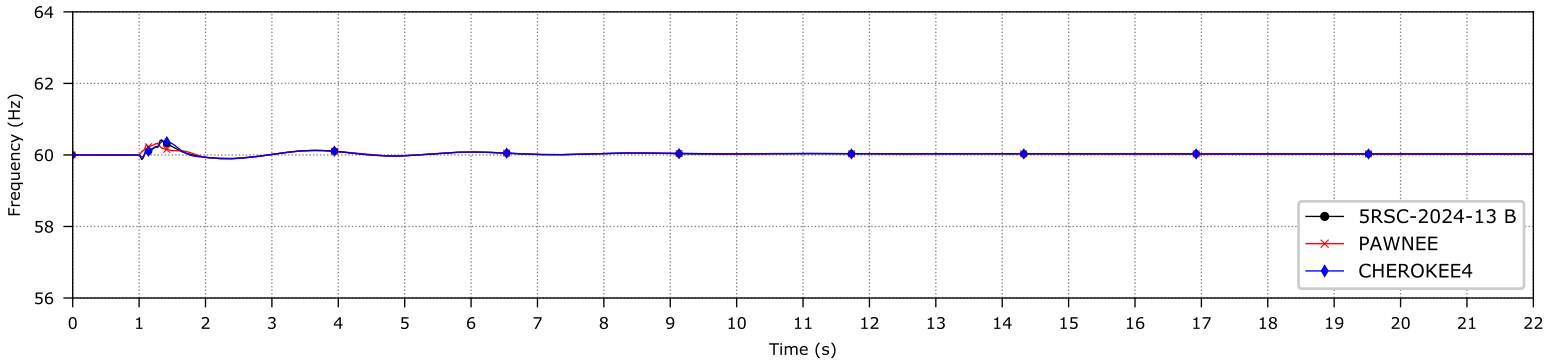


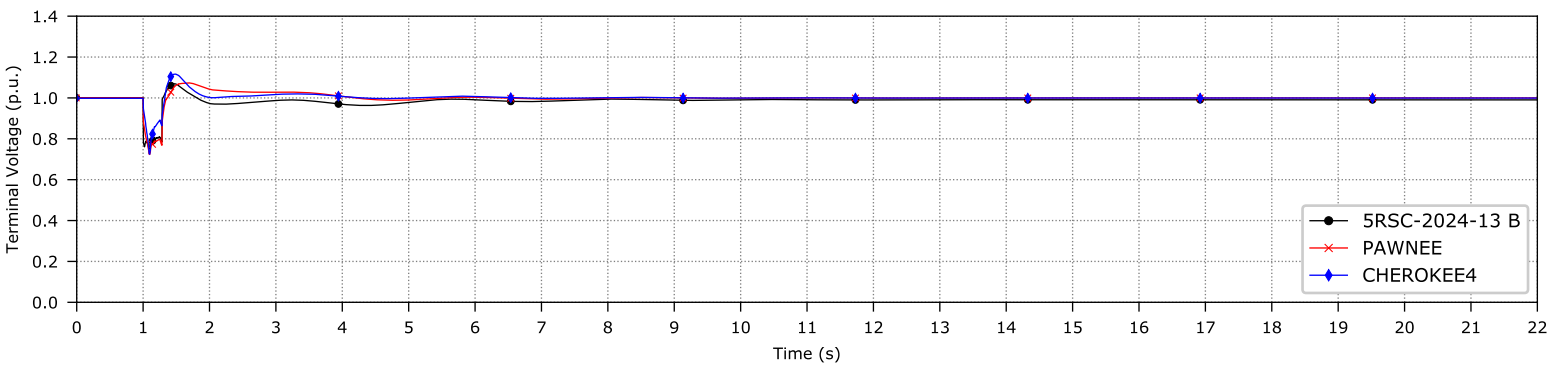
Ref. No. 19 - BF_058a

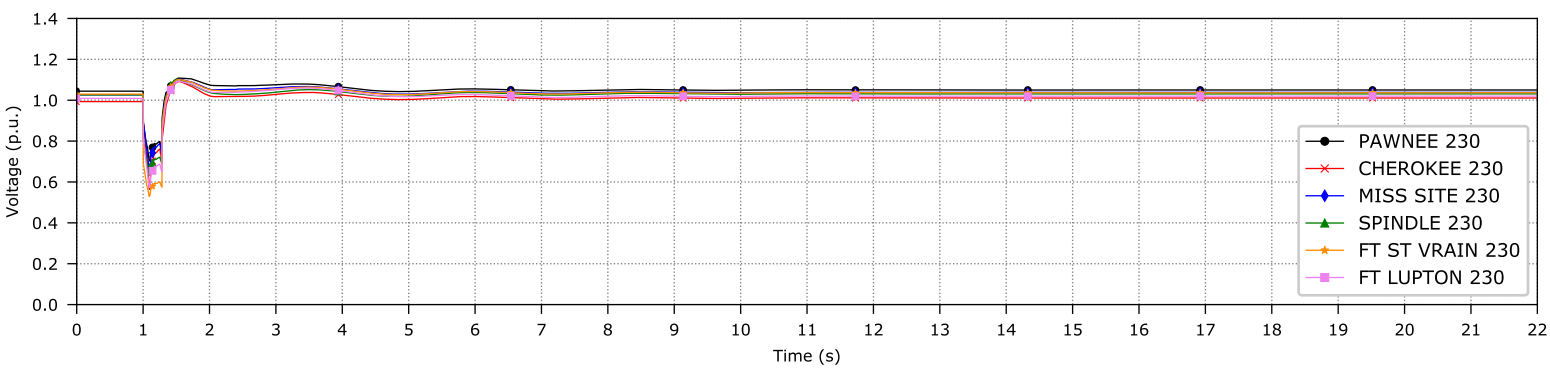




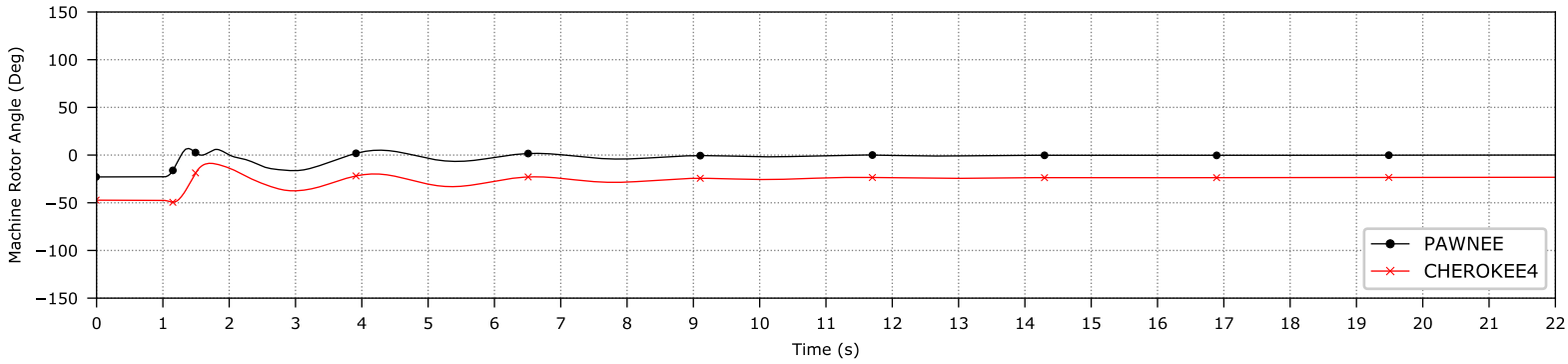


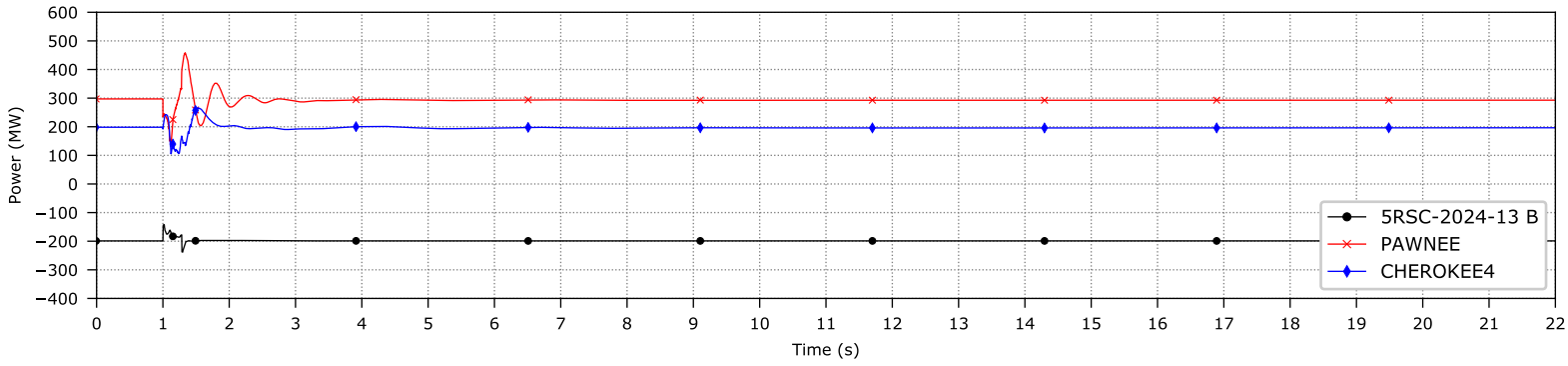


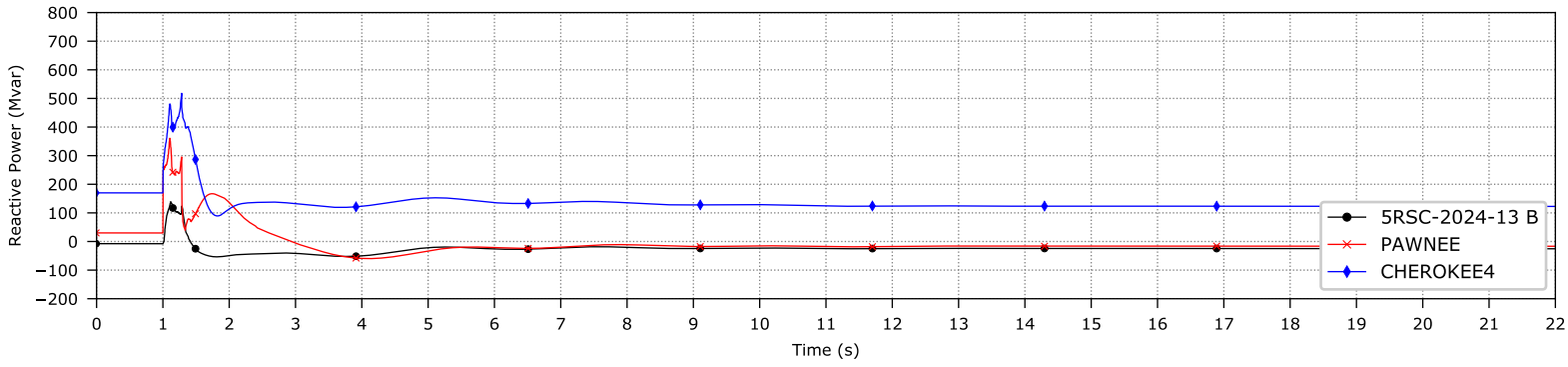


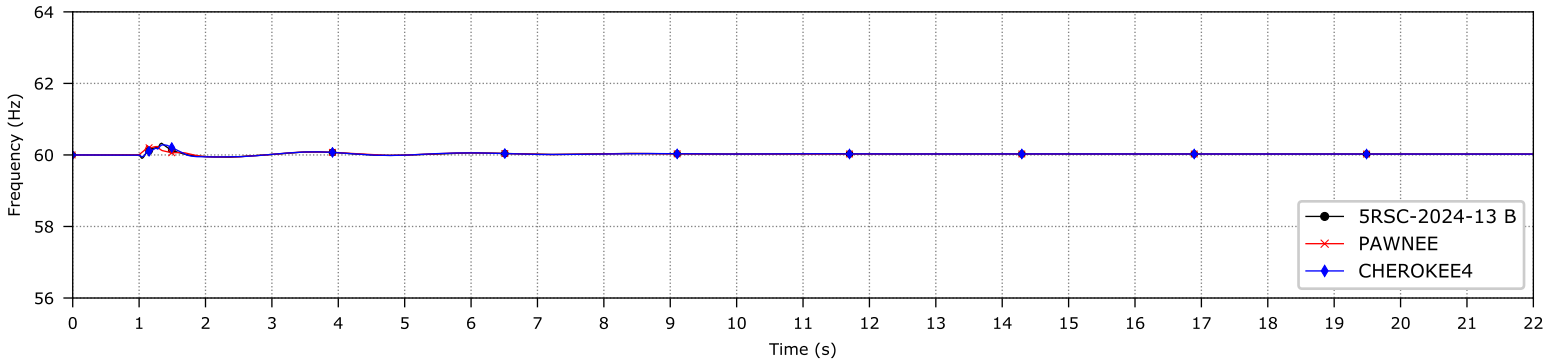


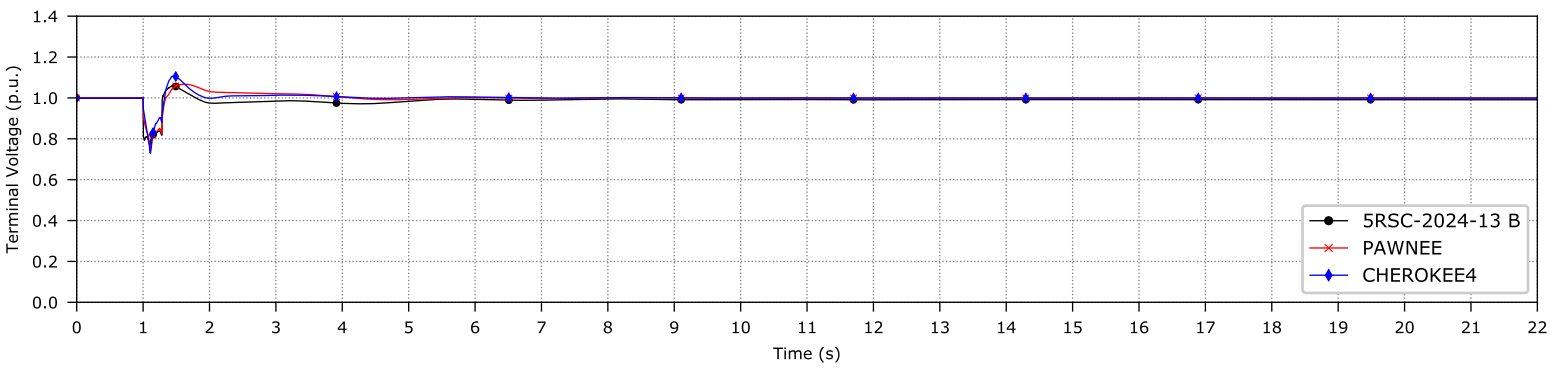
Ref. No. 20 - BF_058c

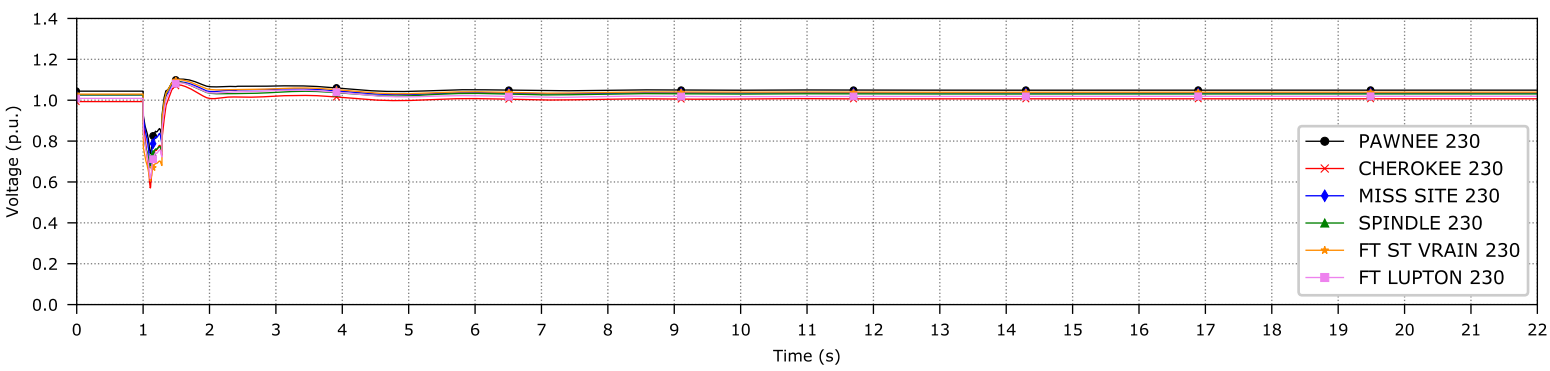




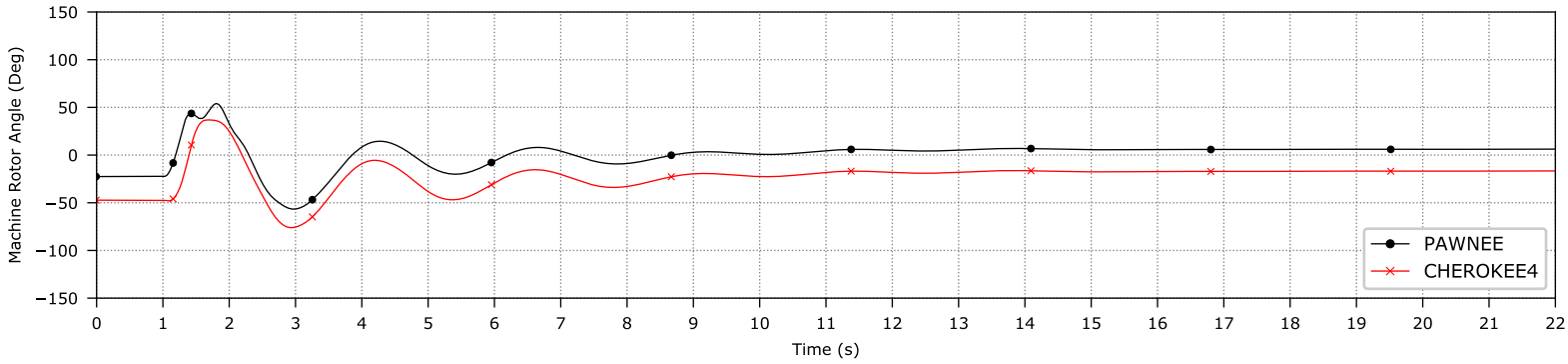


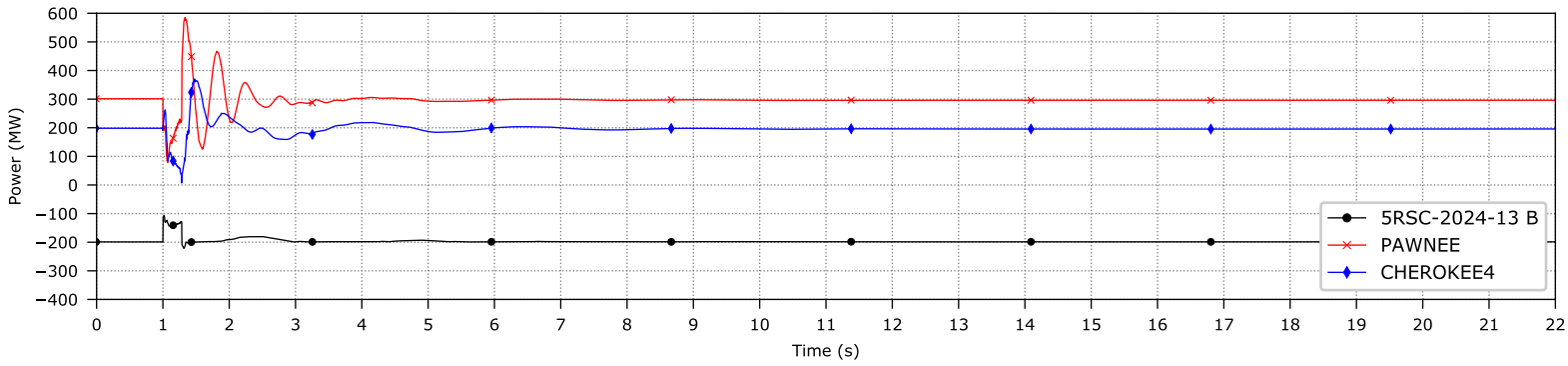


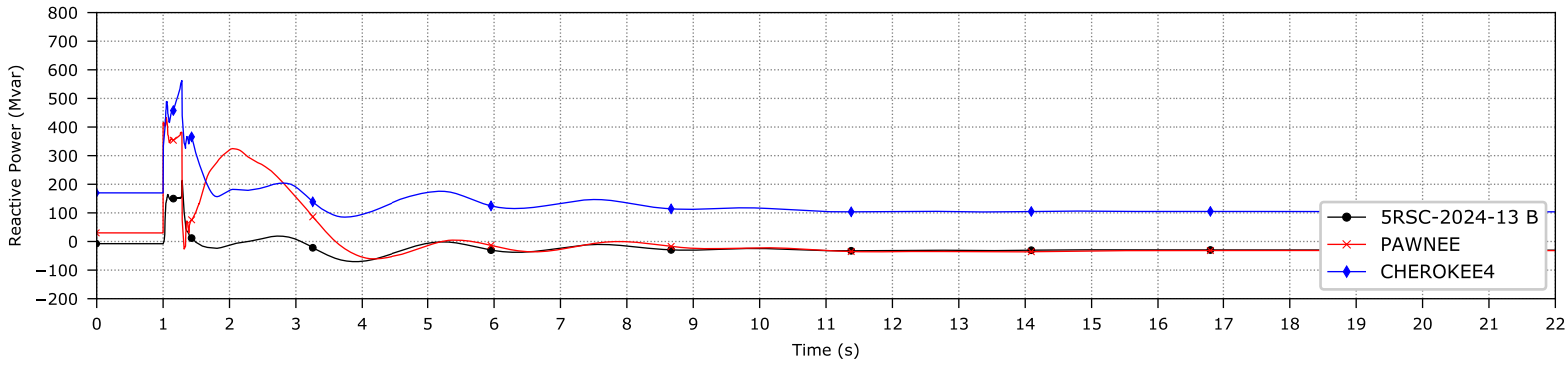


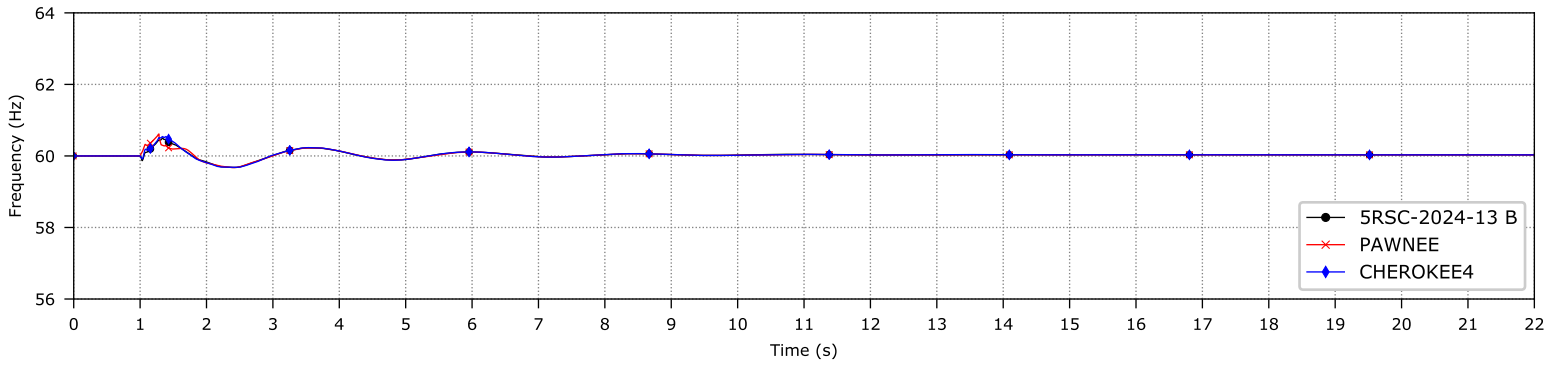


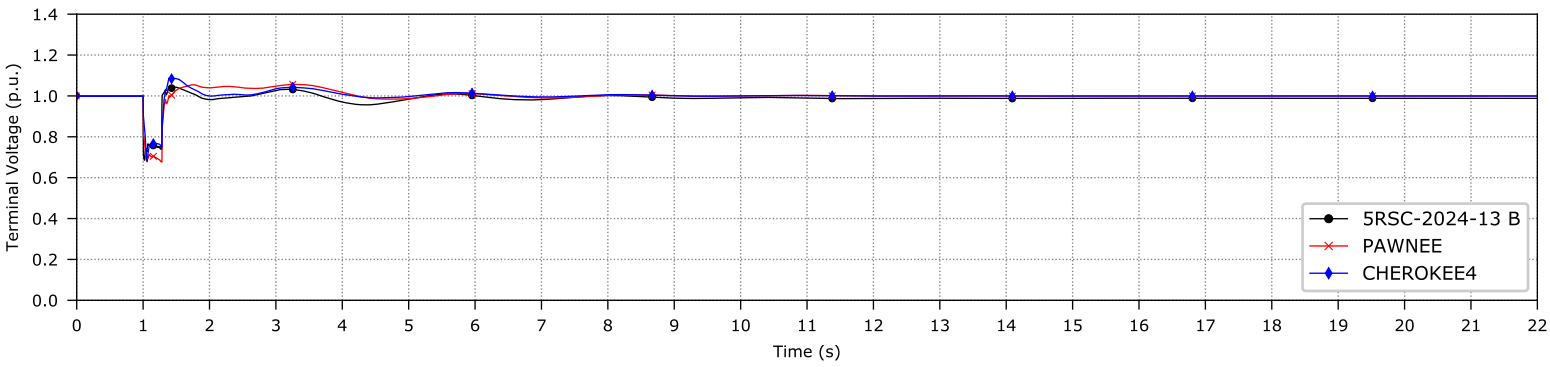
Ref. No. 21 - BF_058d

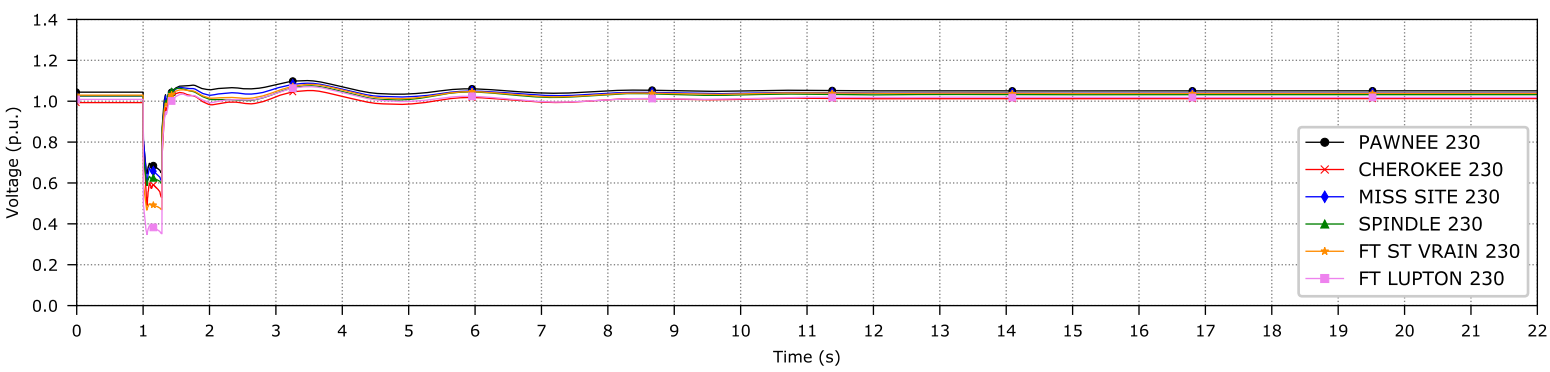




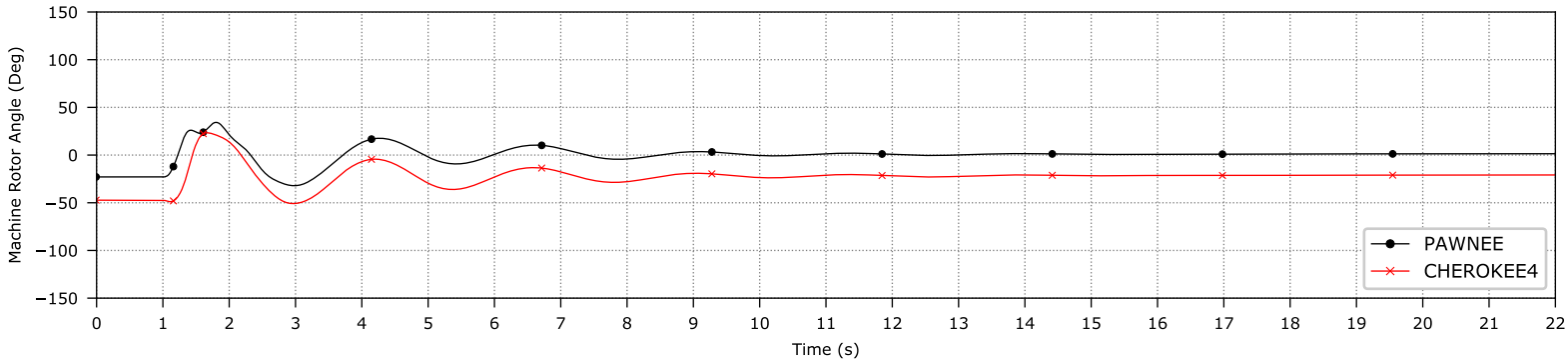


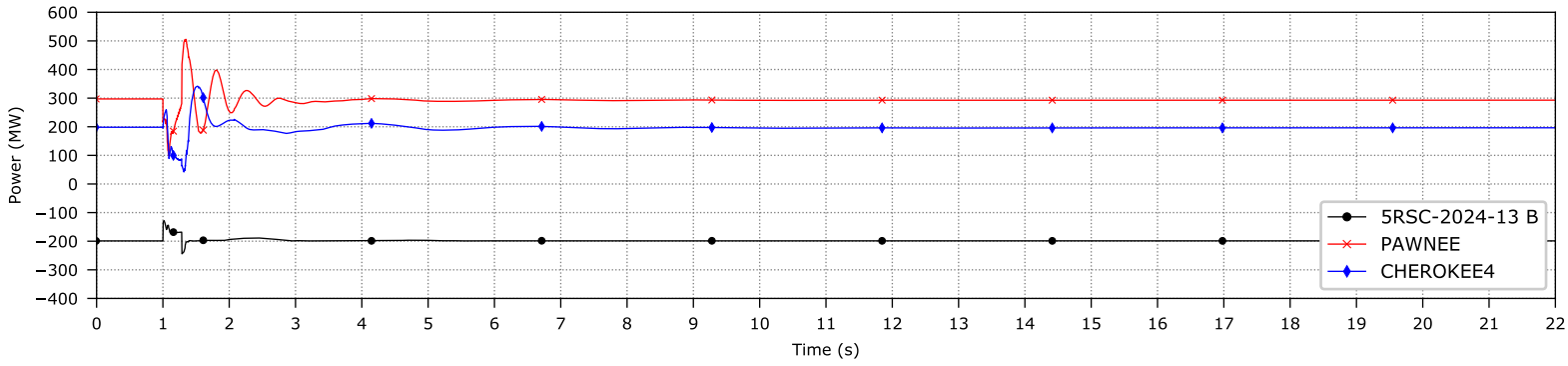


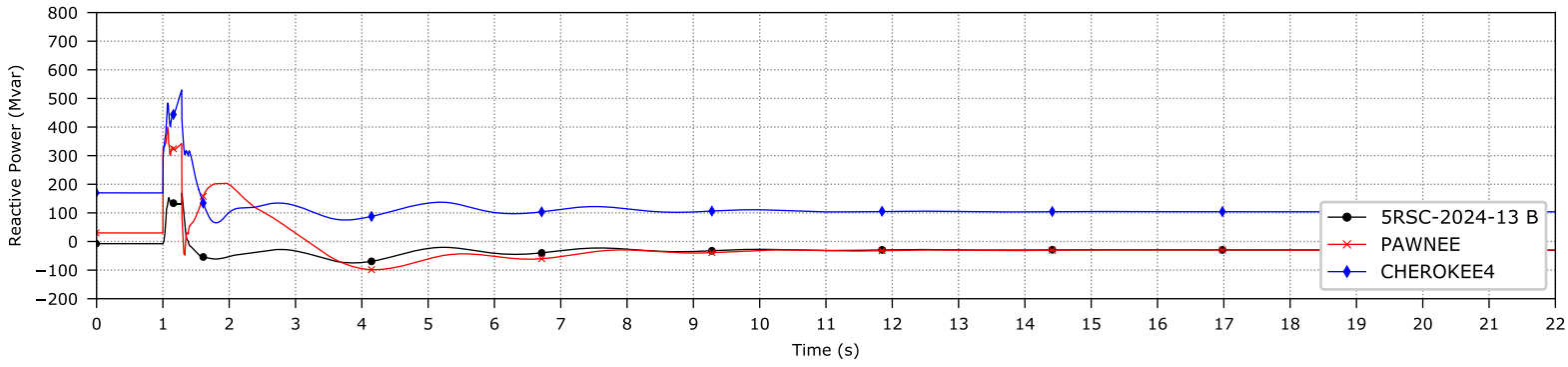


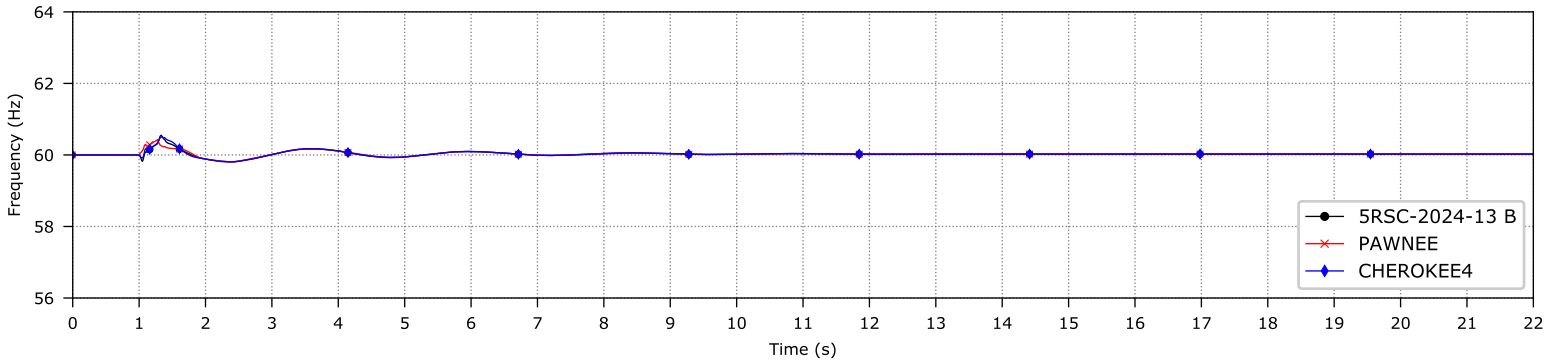


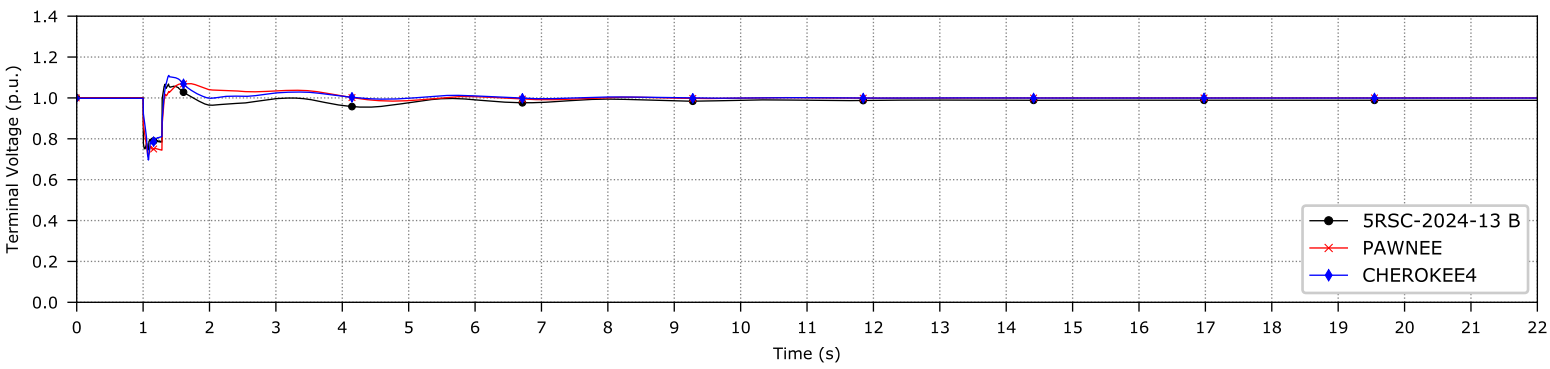
Ref. No. 22 - BF_058e

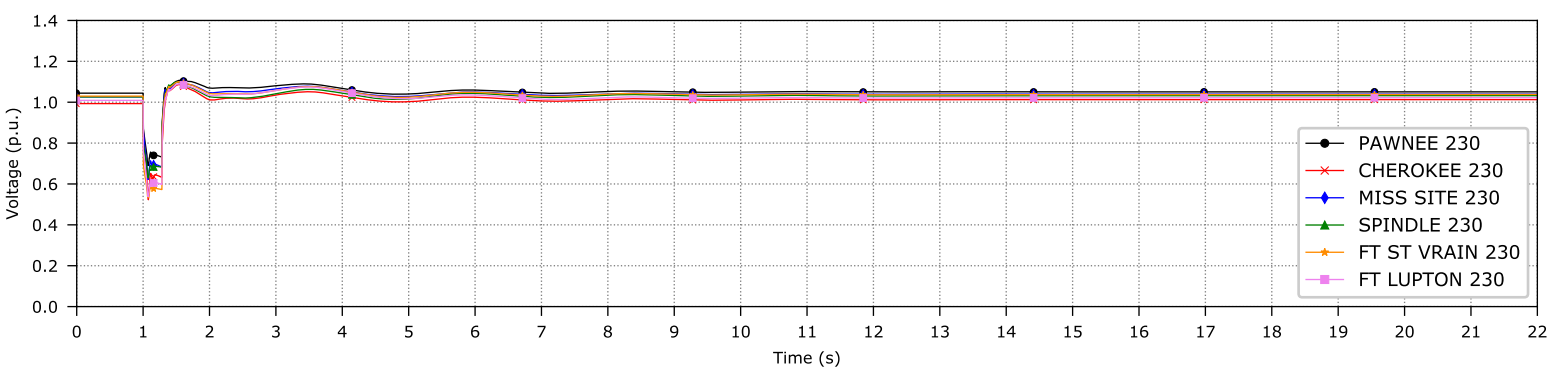




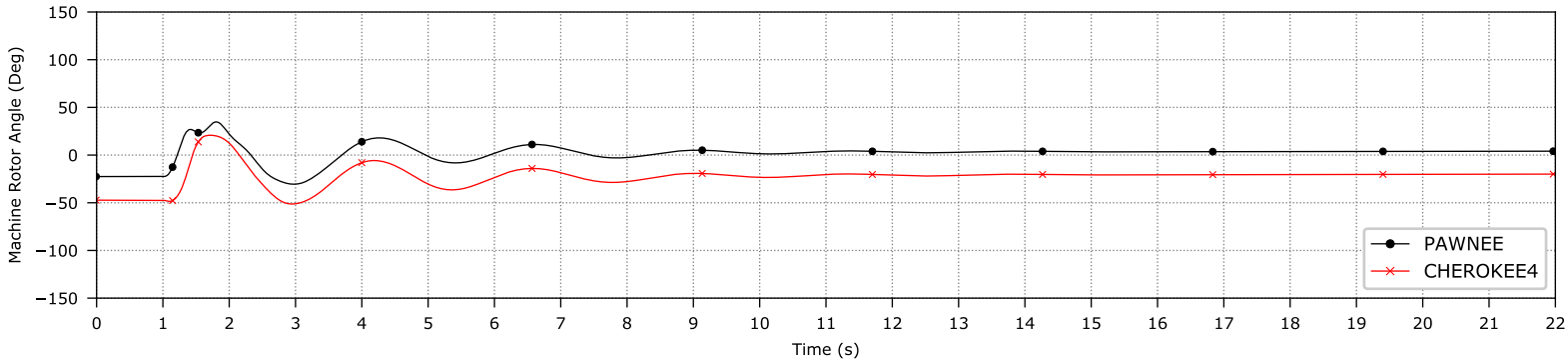


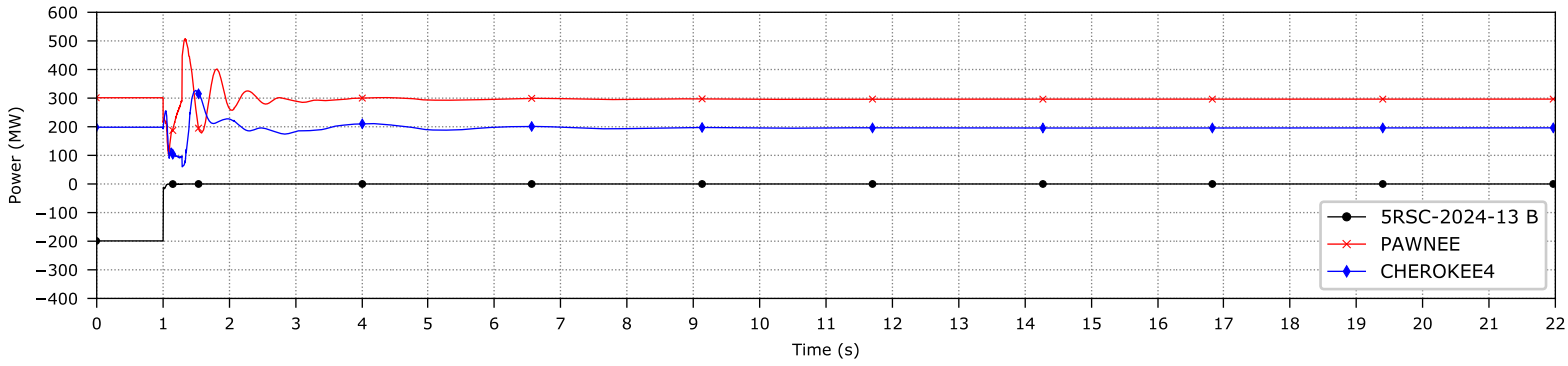


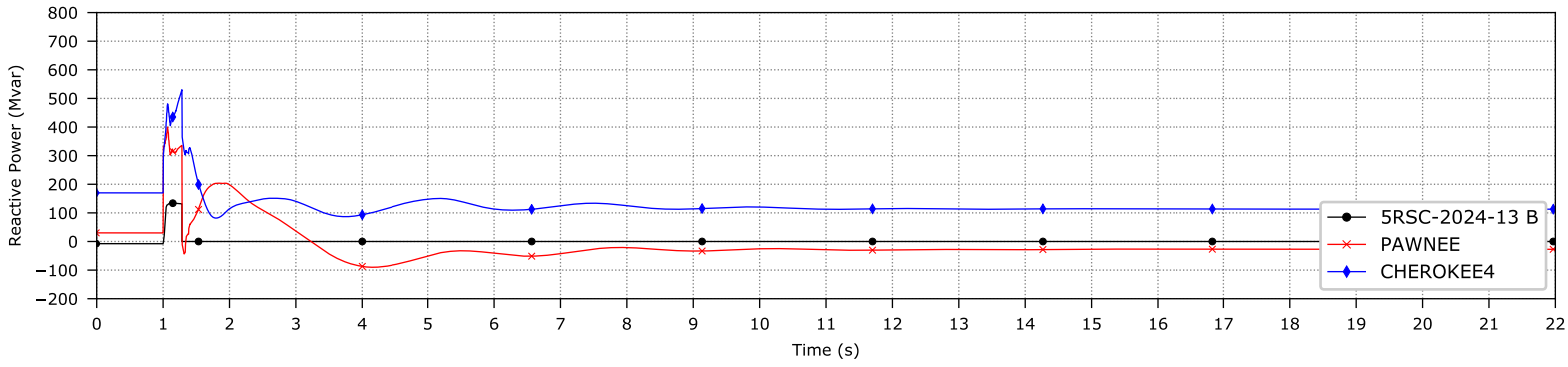


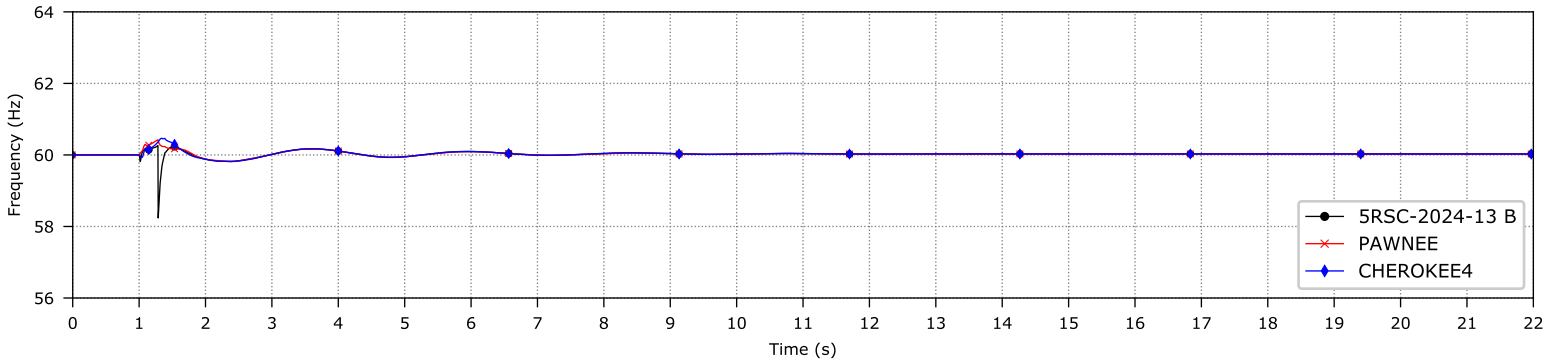


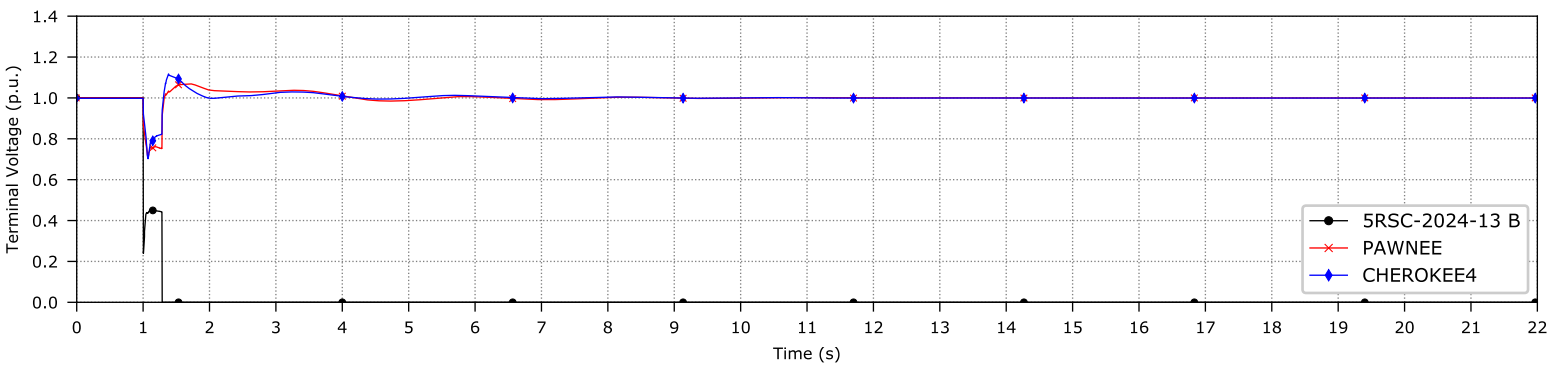
Ref. No. 23 - BF_145a

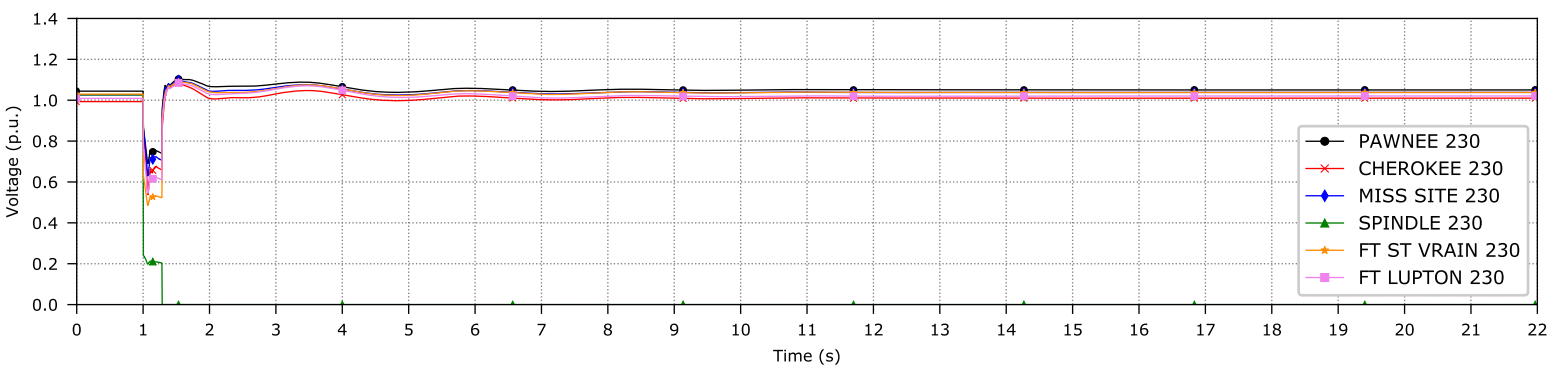




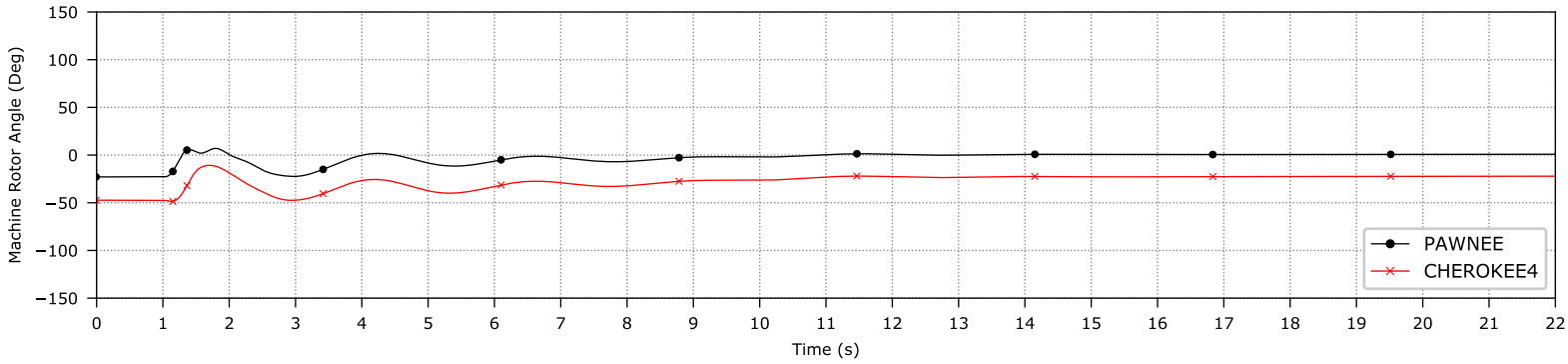


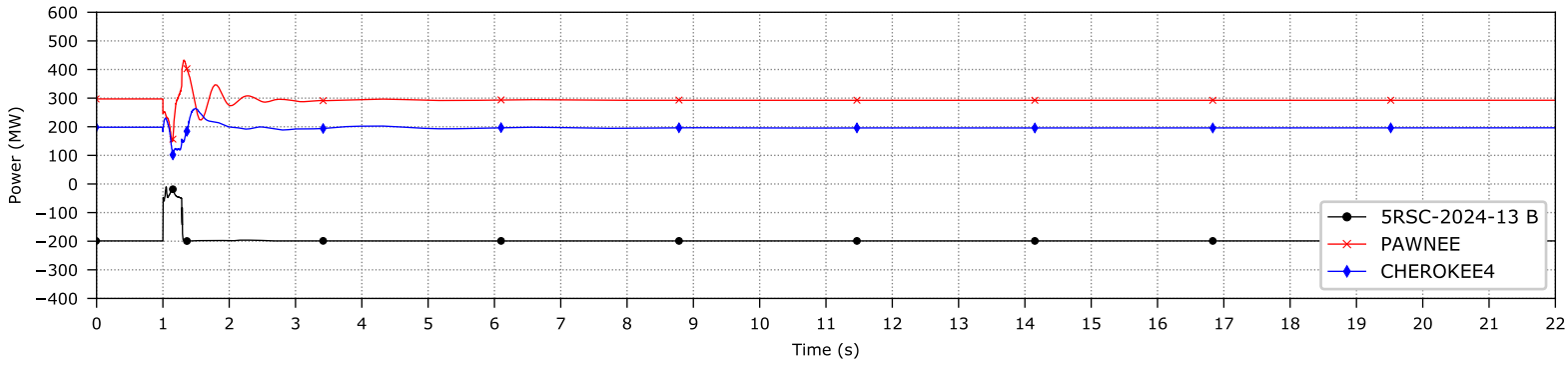


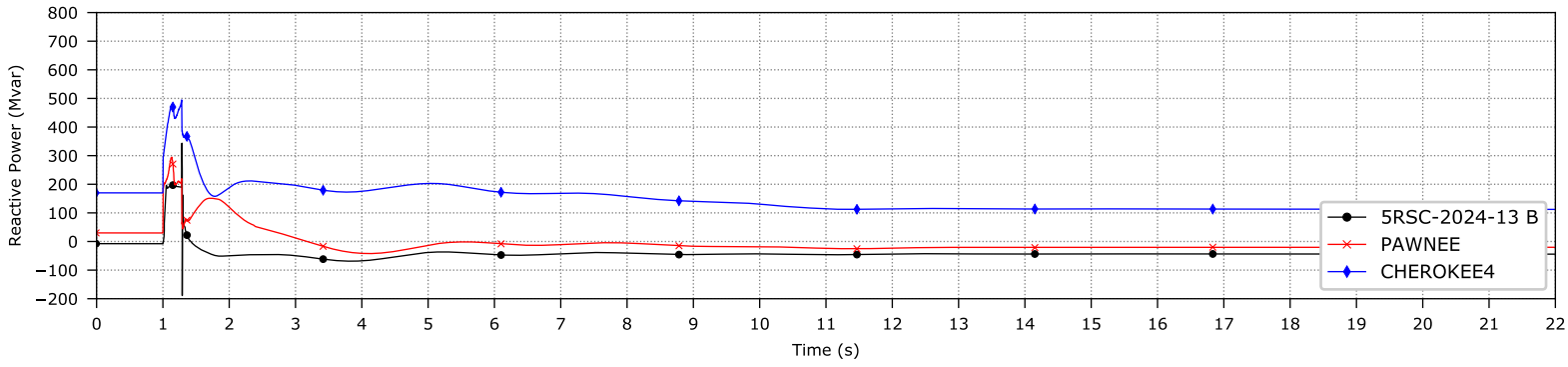


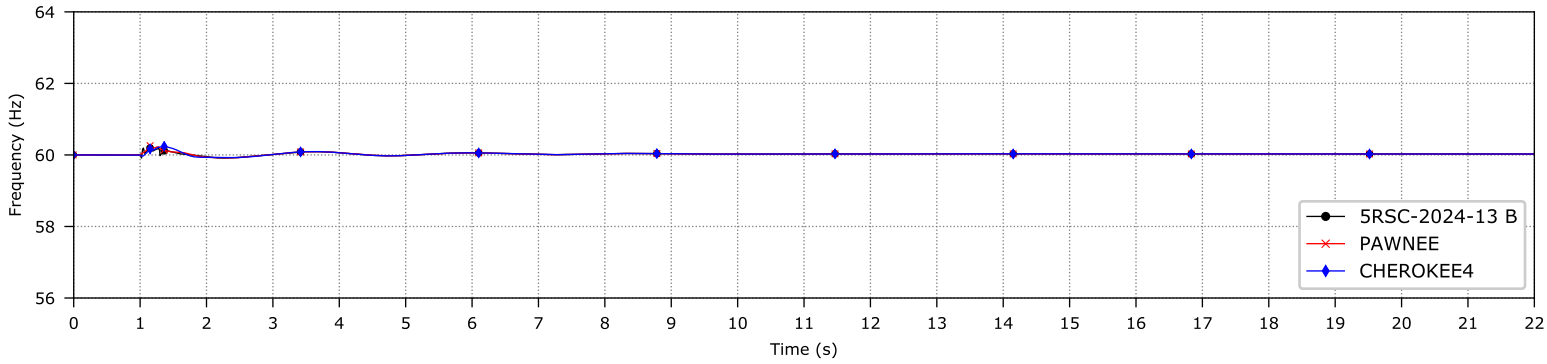


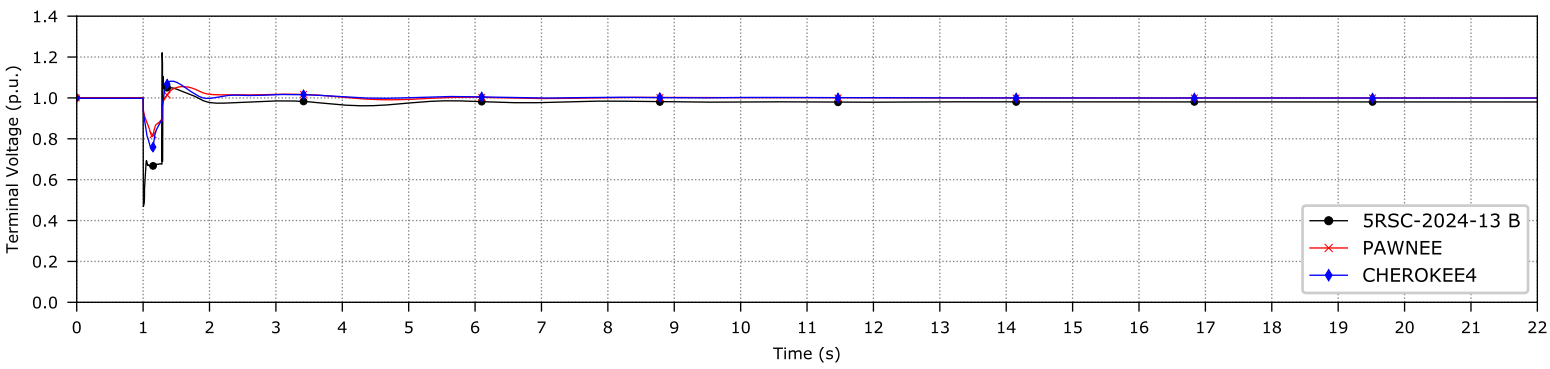
Ref. No. 24 - BF_148a

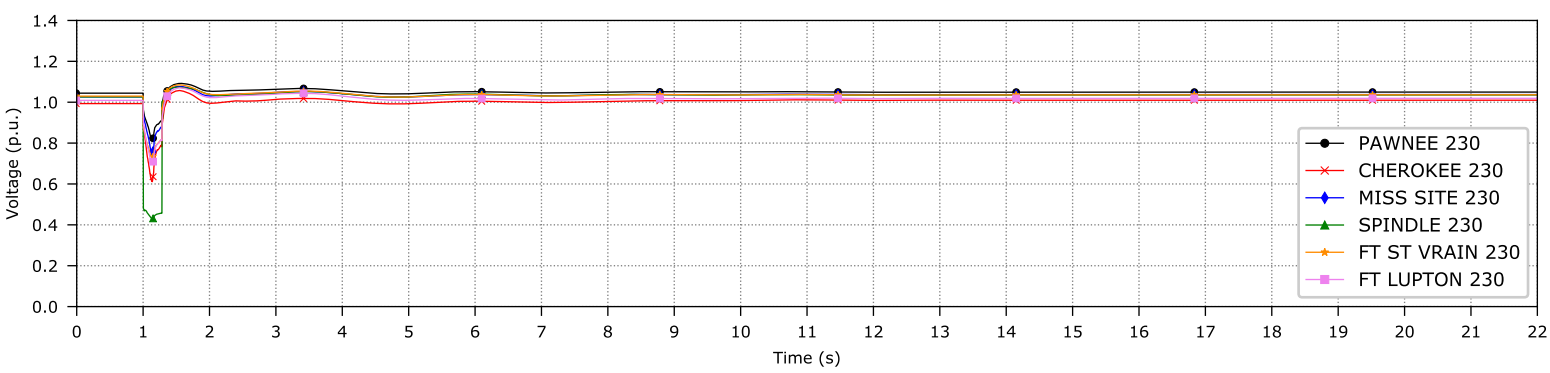




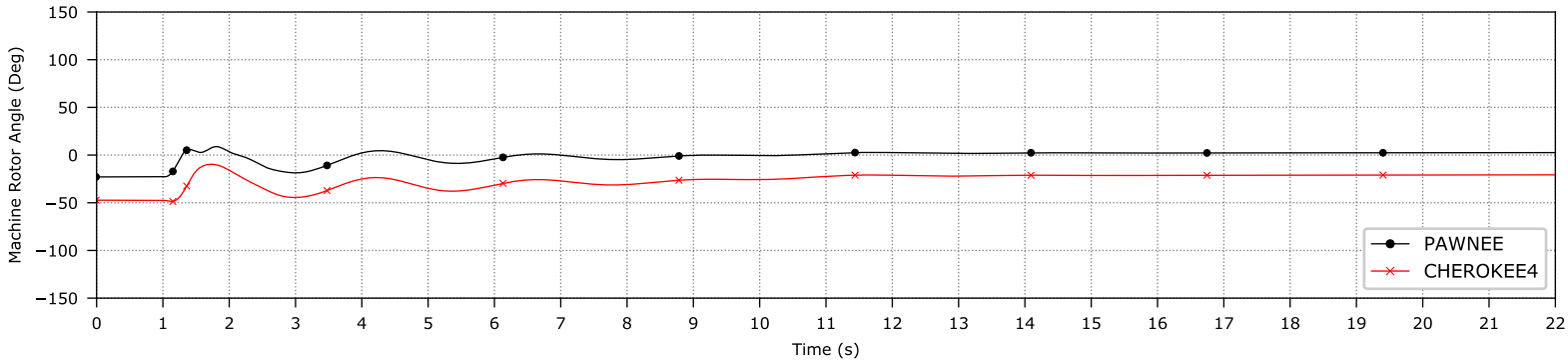


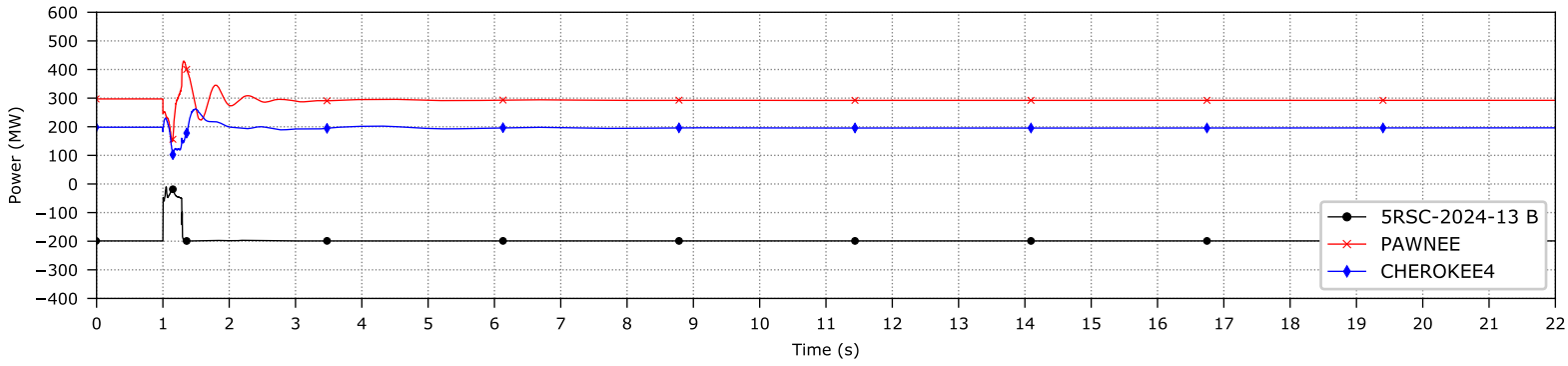


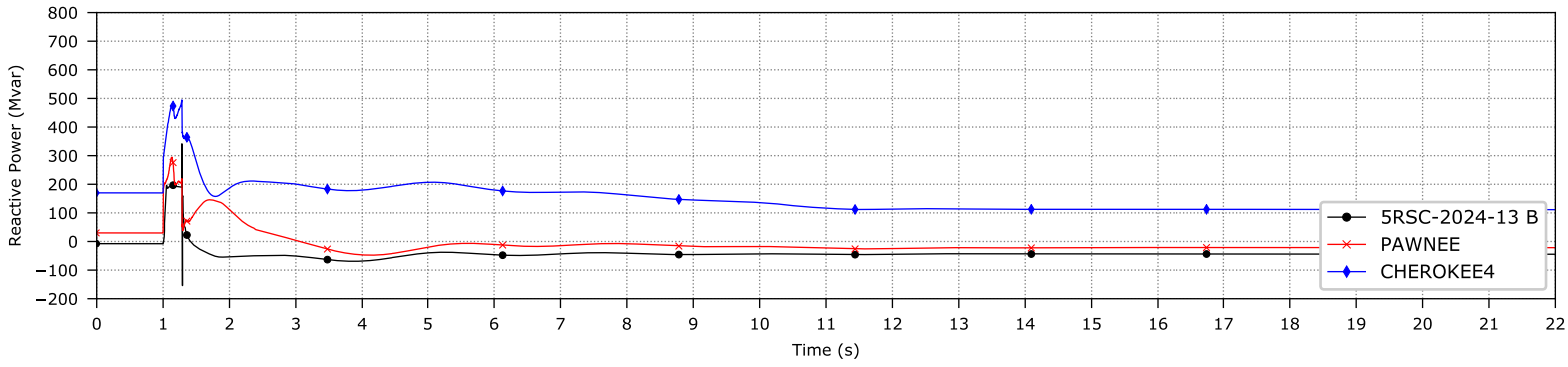


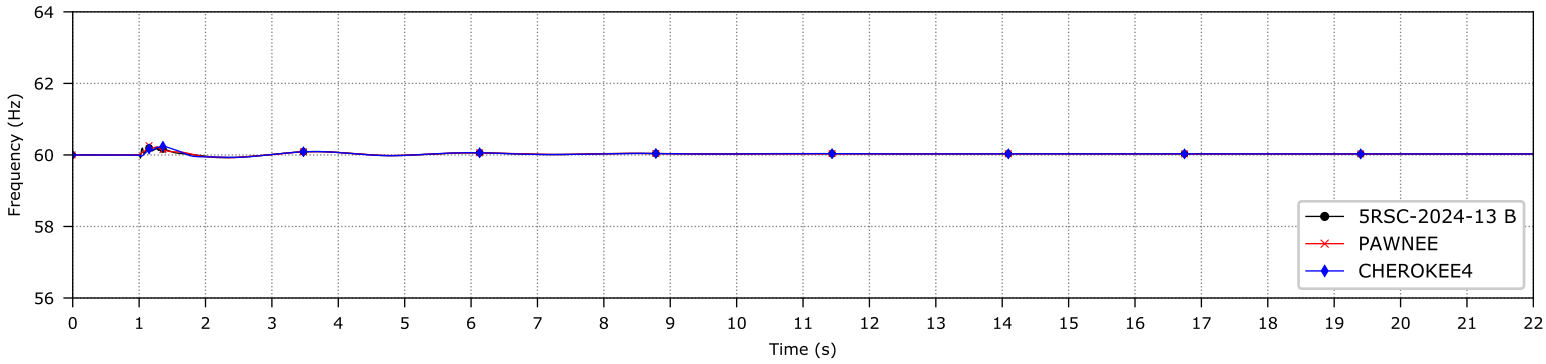


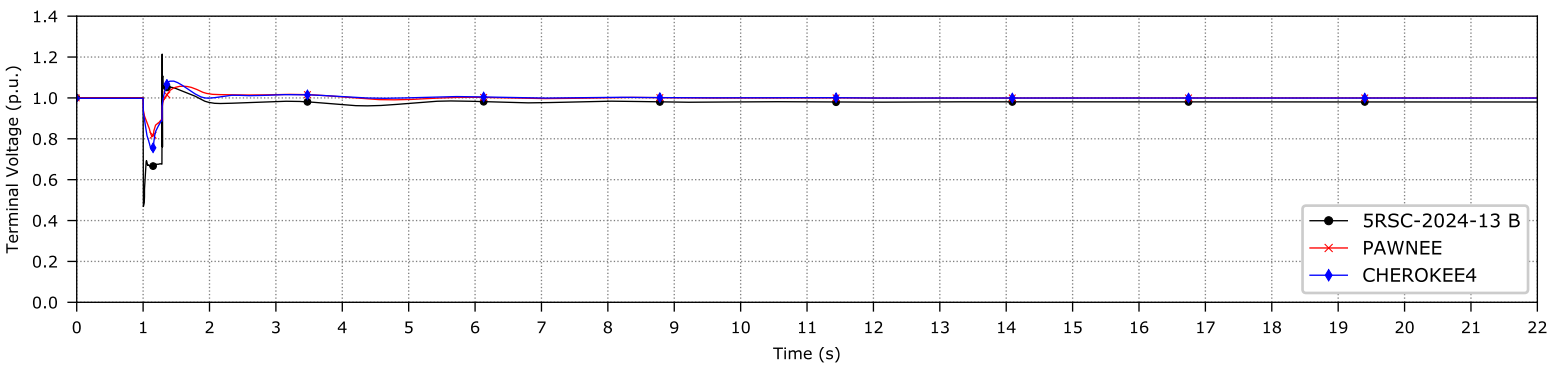
Ref. No. 25 - BF_148d

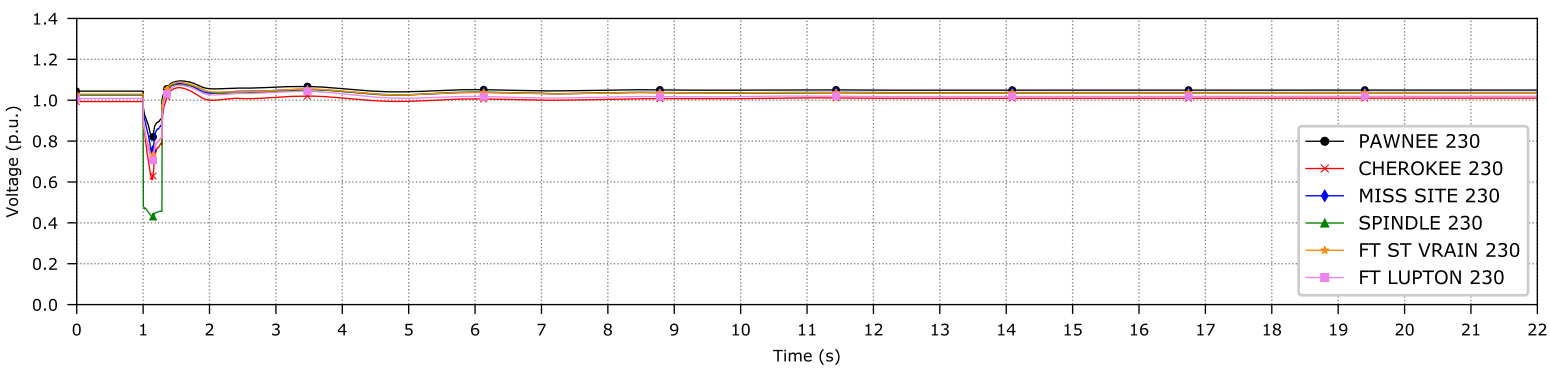




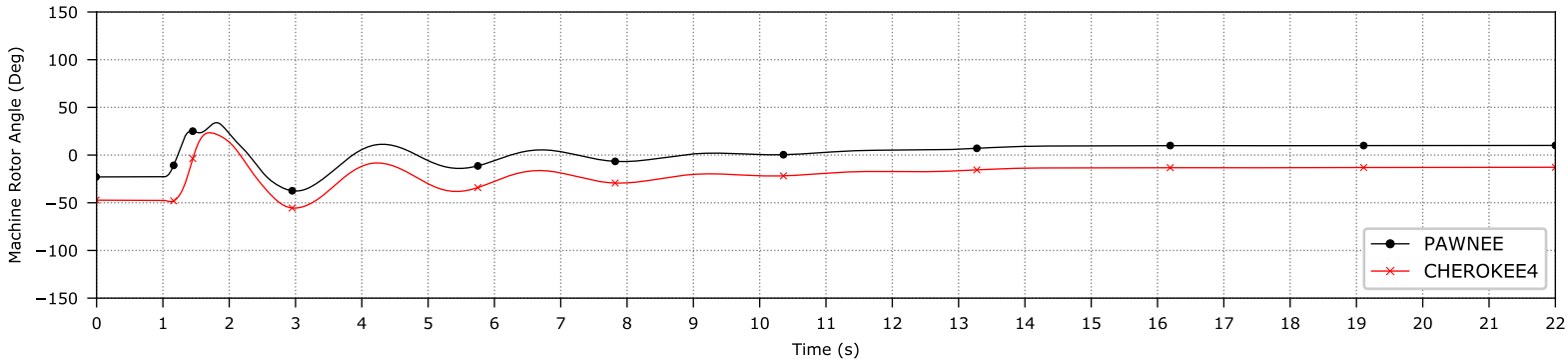


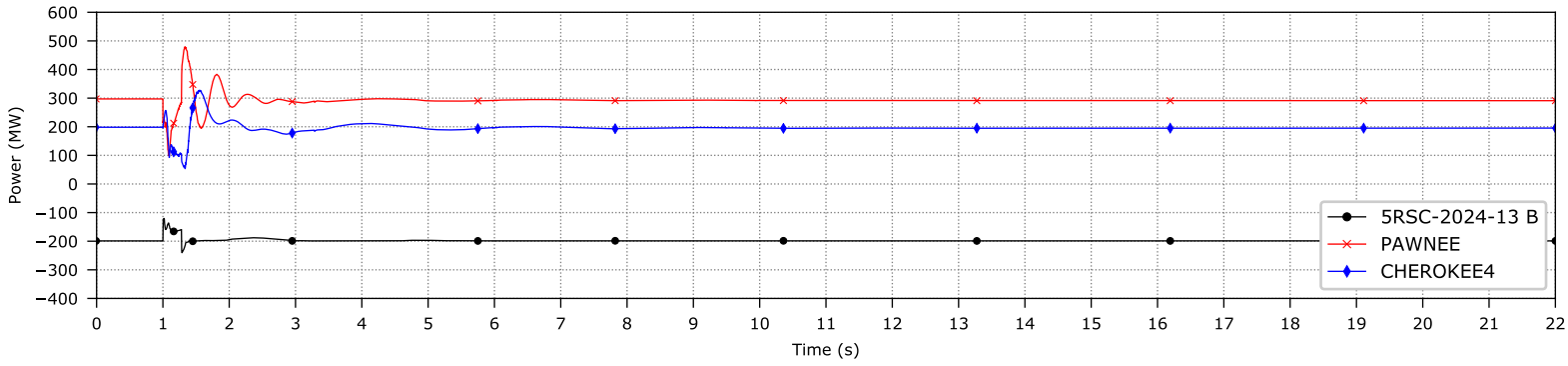


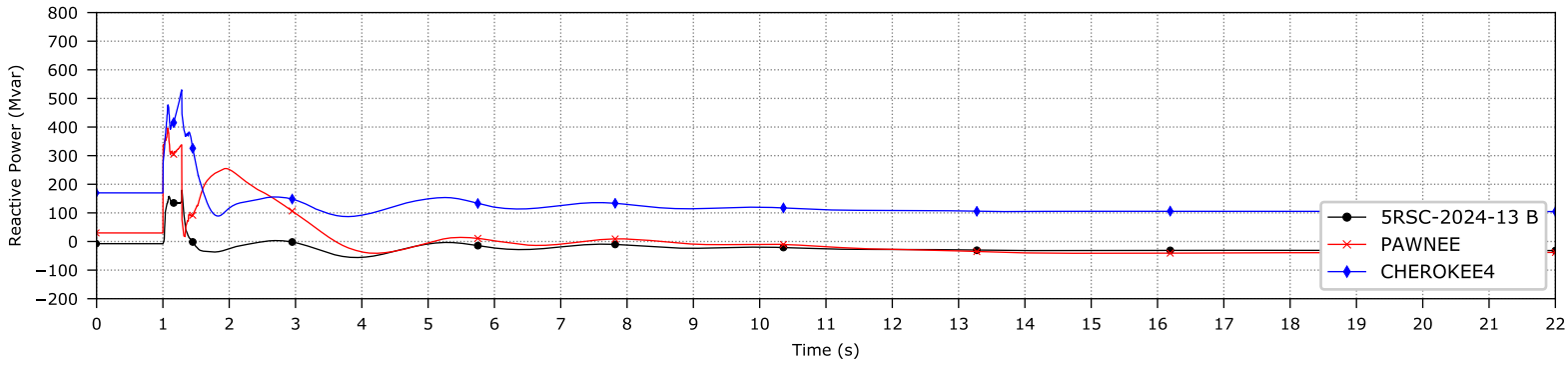


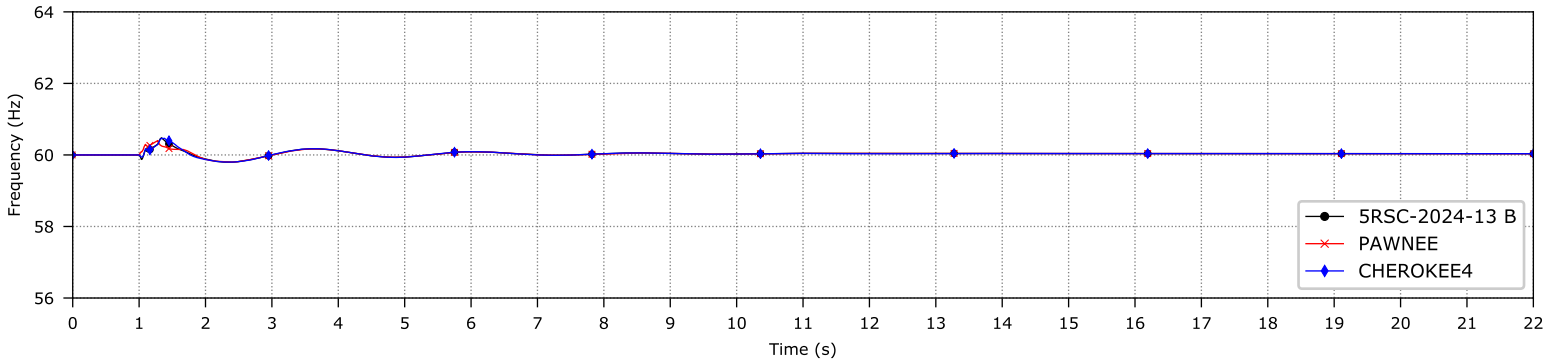


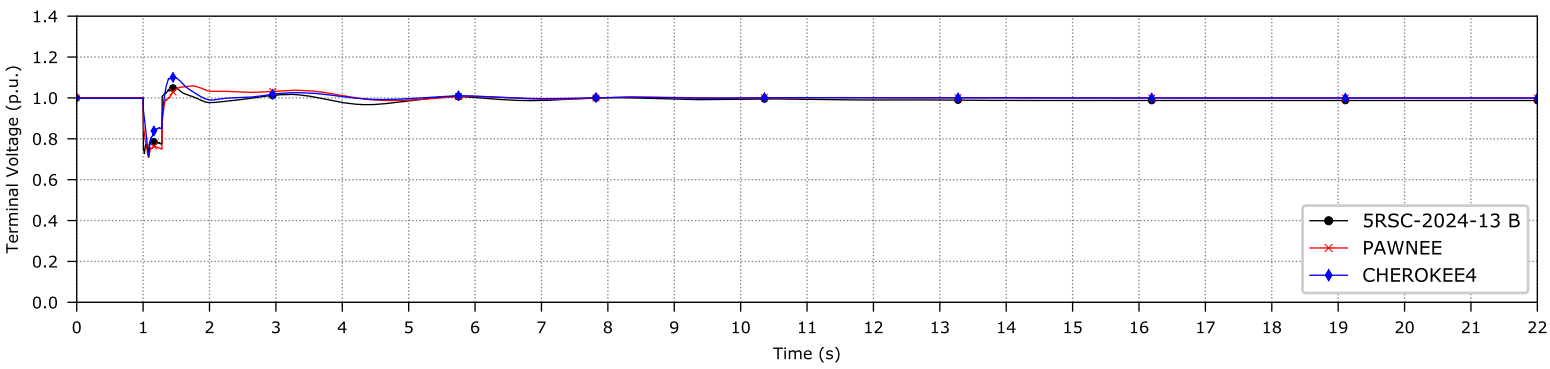
Ref. No. 26 - BF_151c

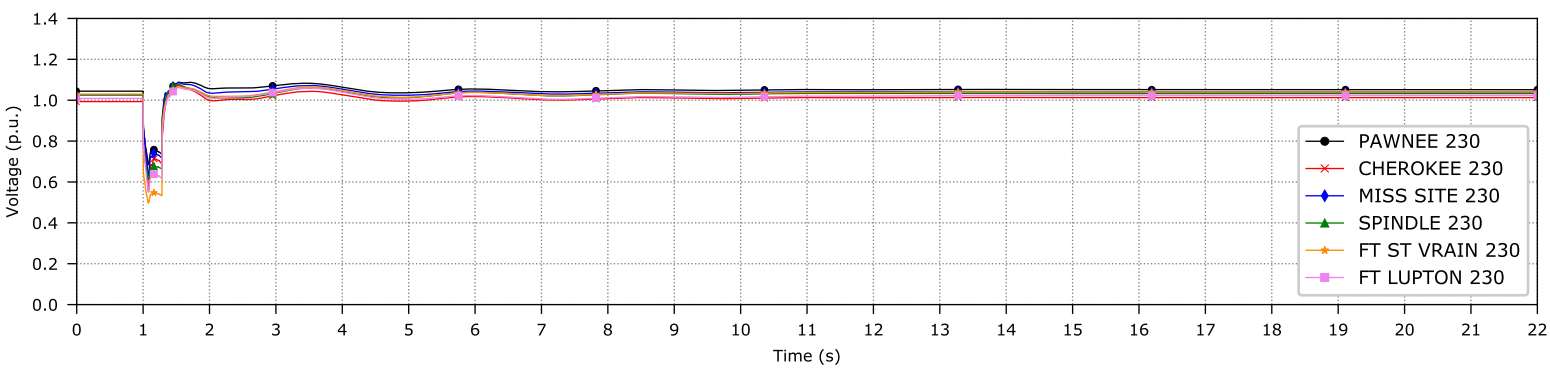




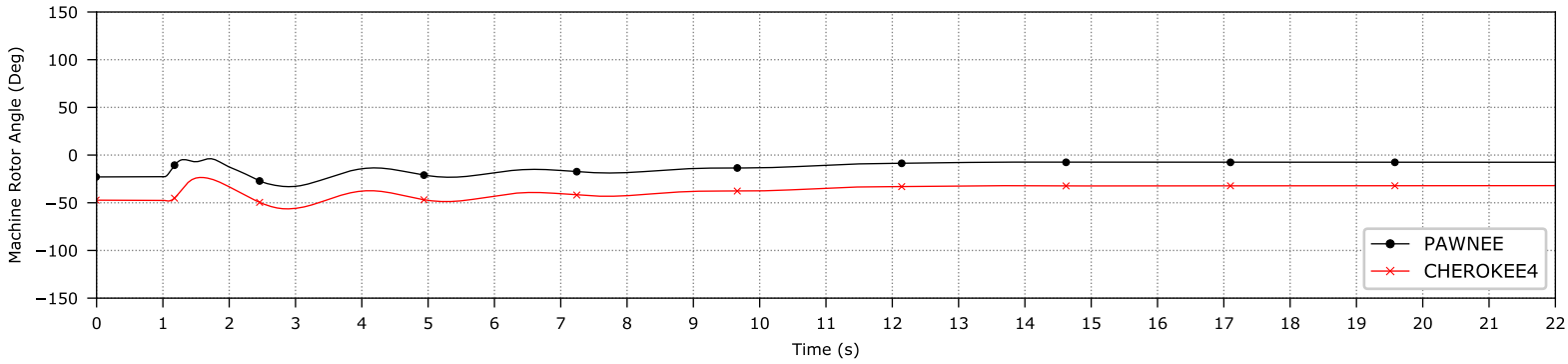


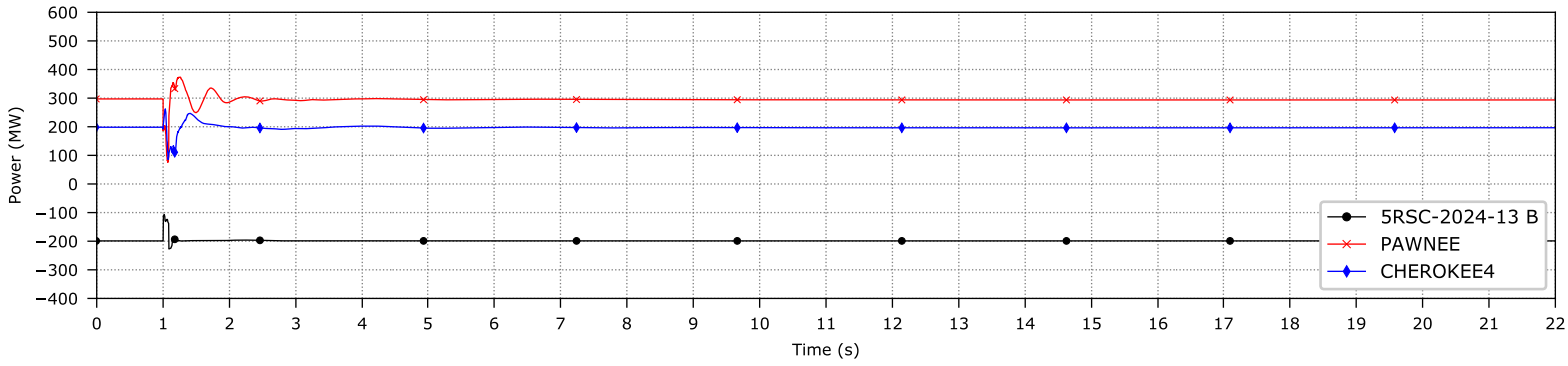


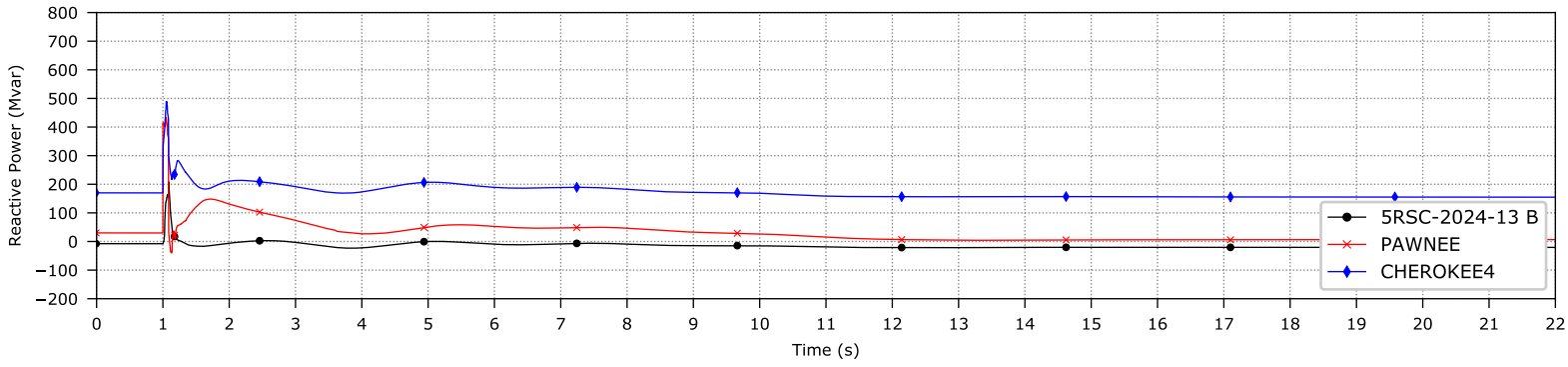


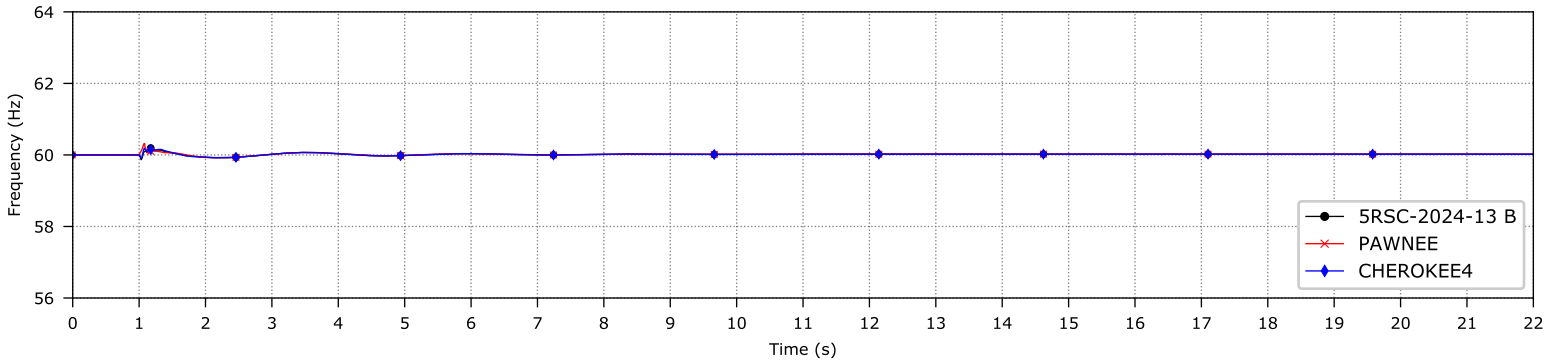


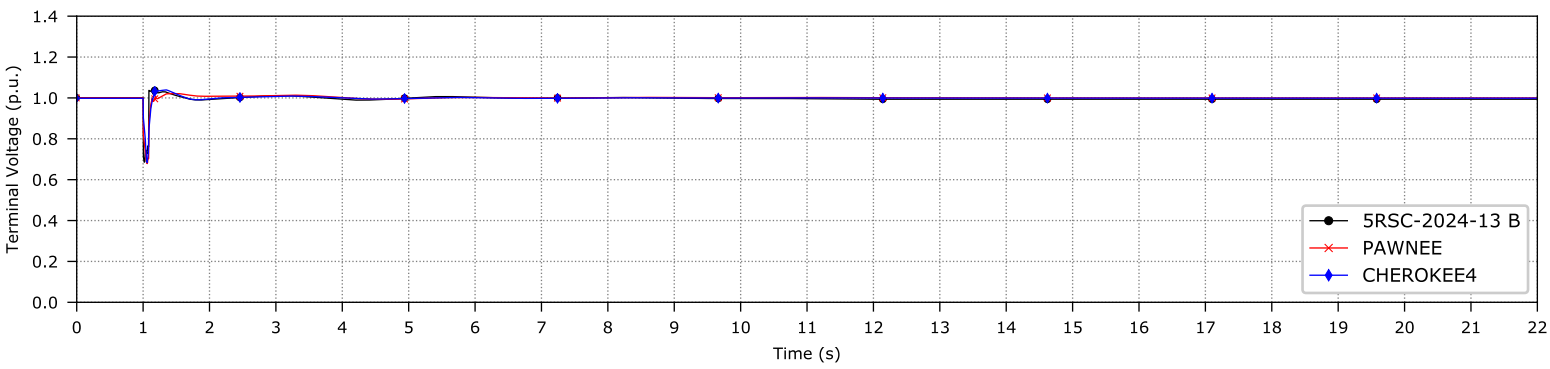
Ref. No. 27 - P7_76

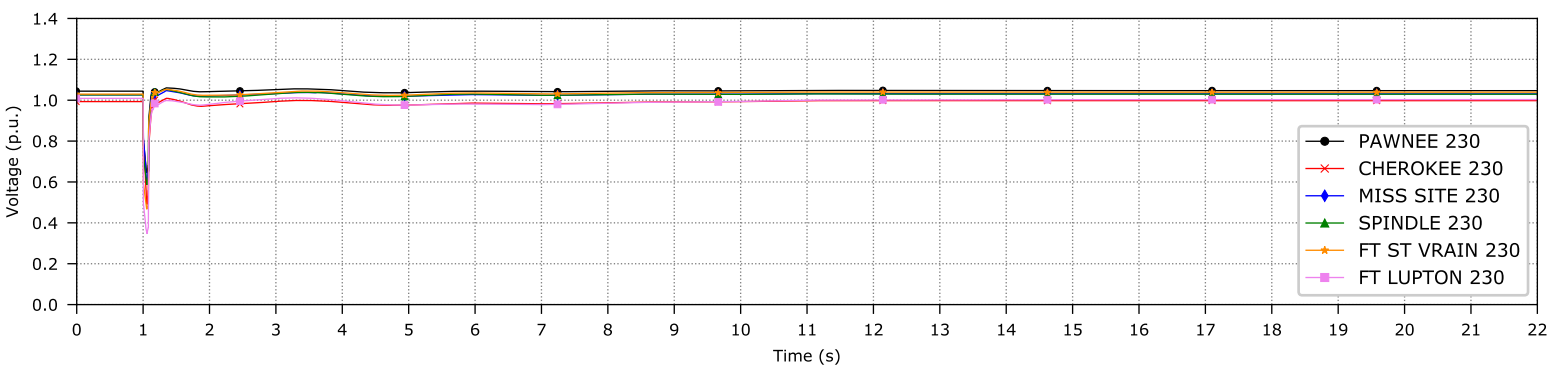


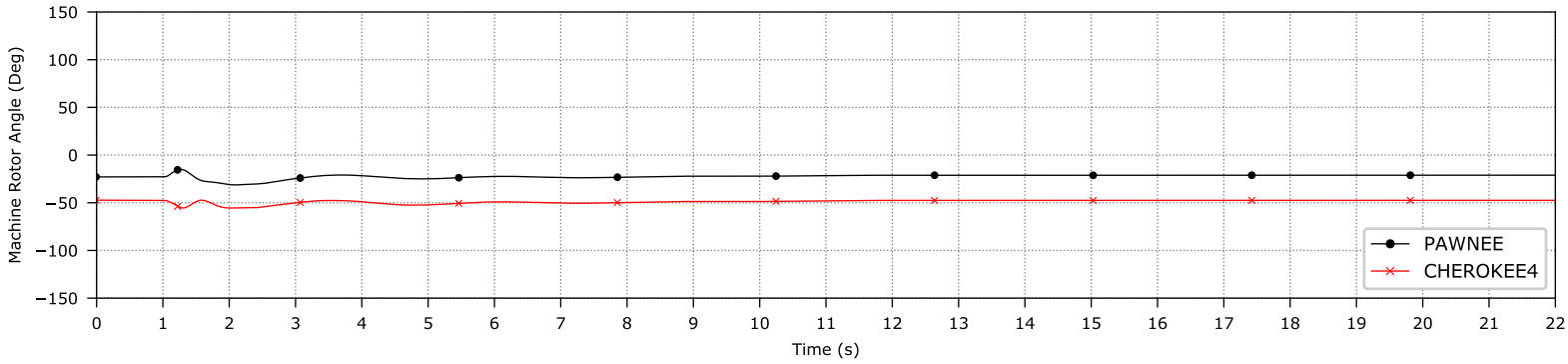


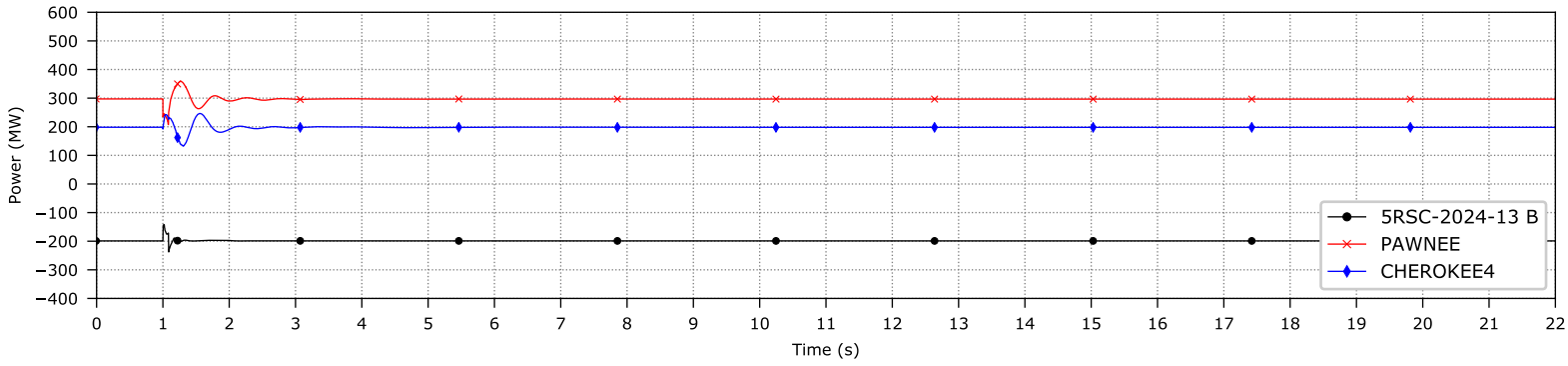


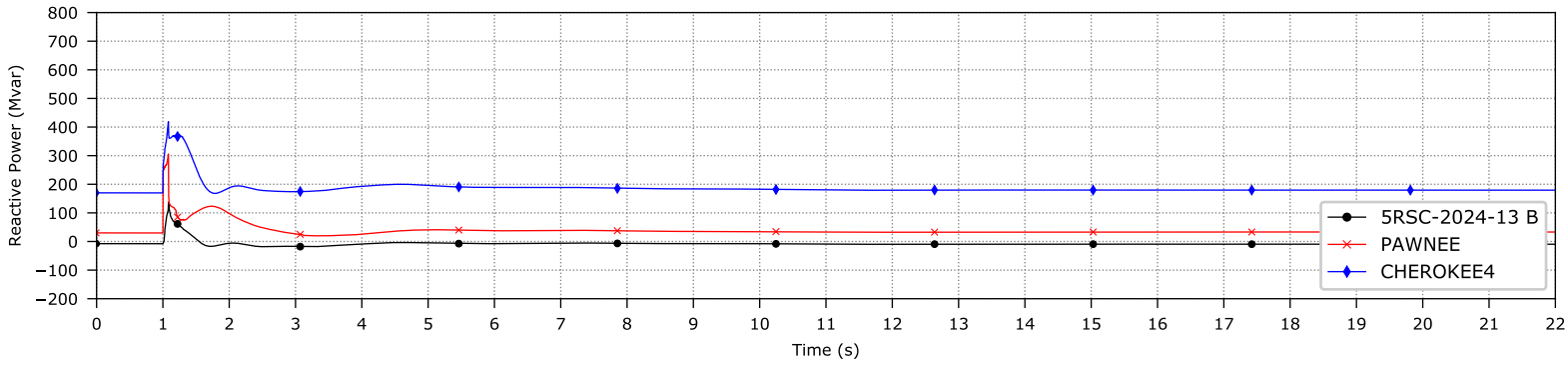


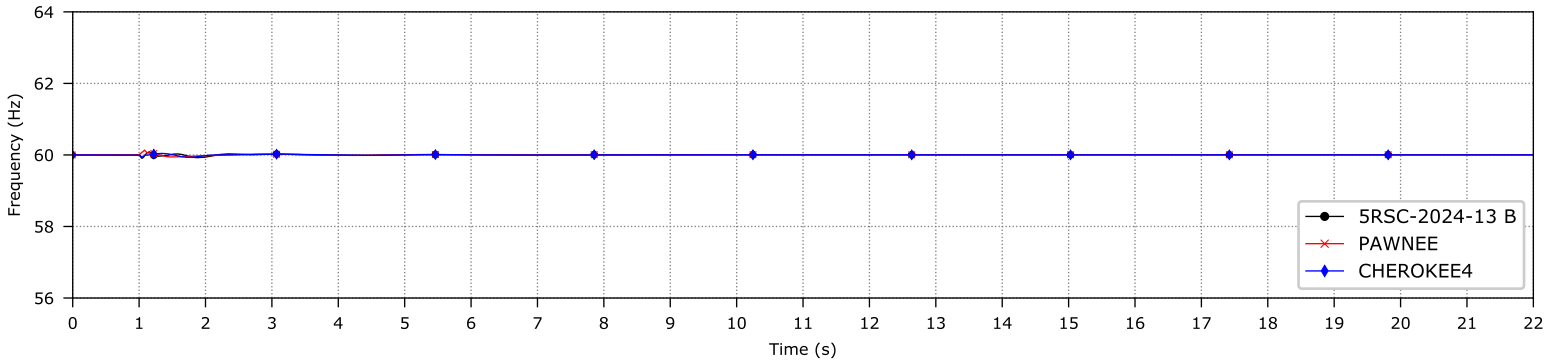


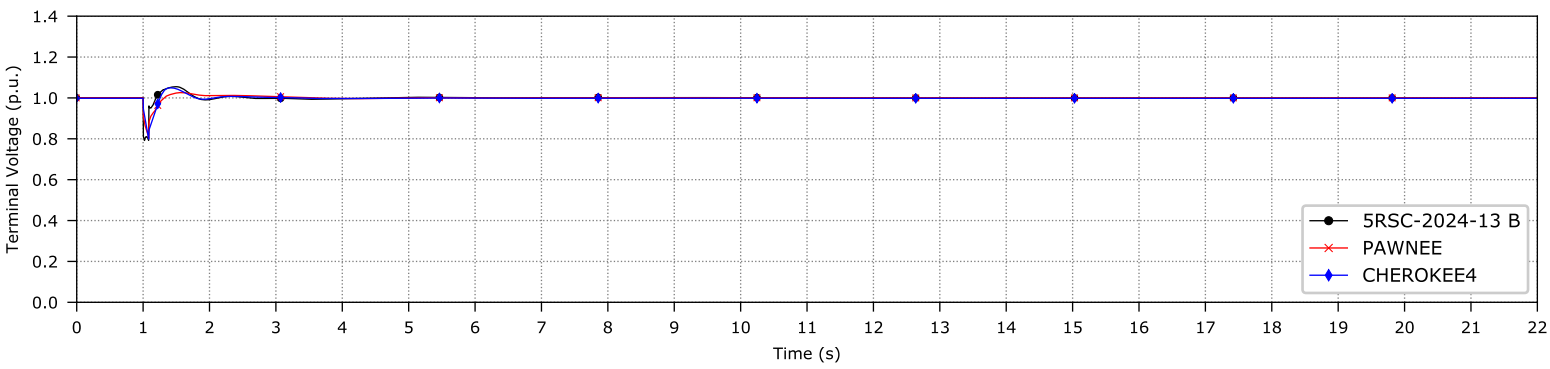


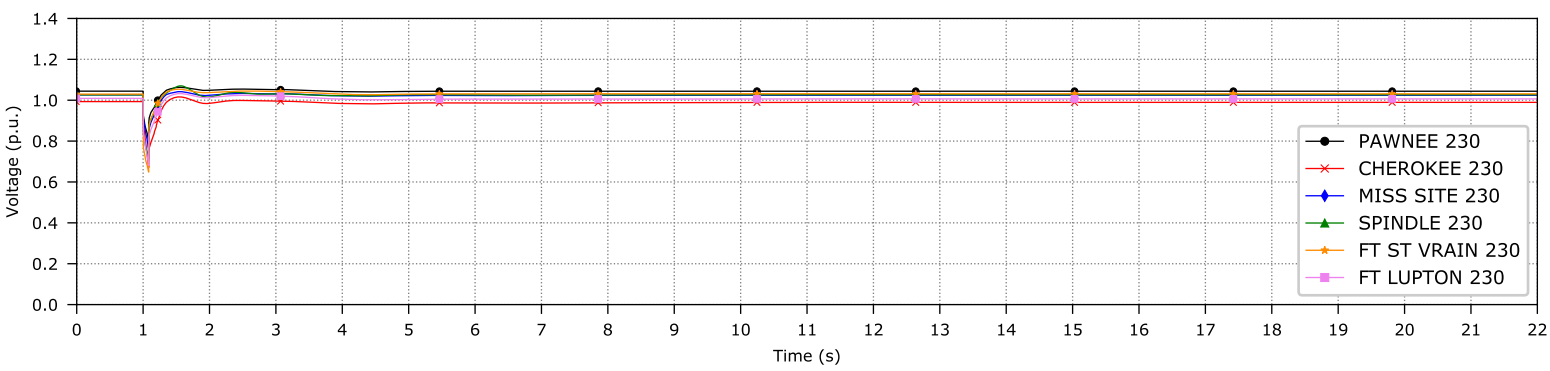

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

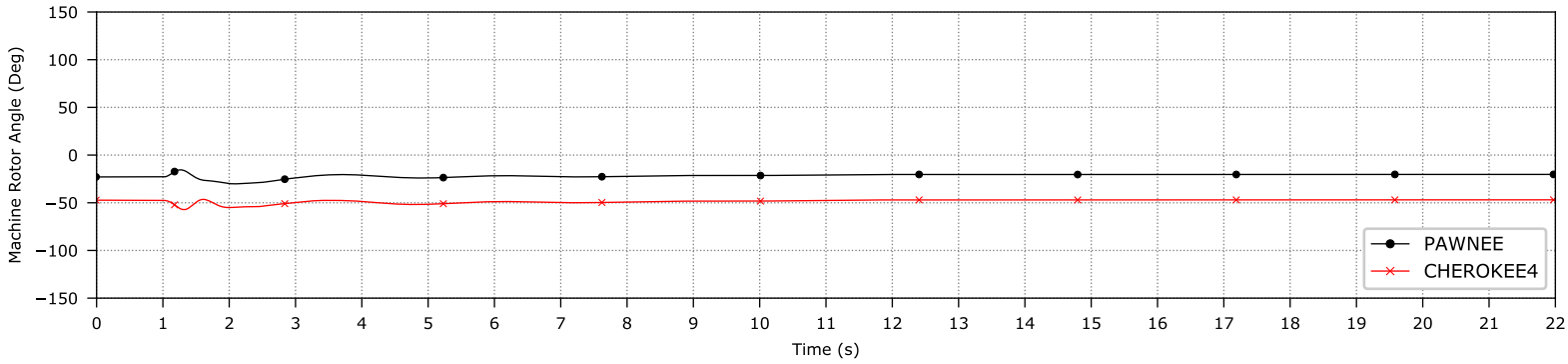

Reactive Power (Mvar)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

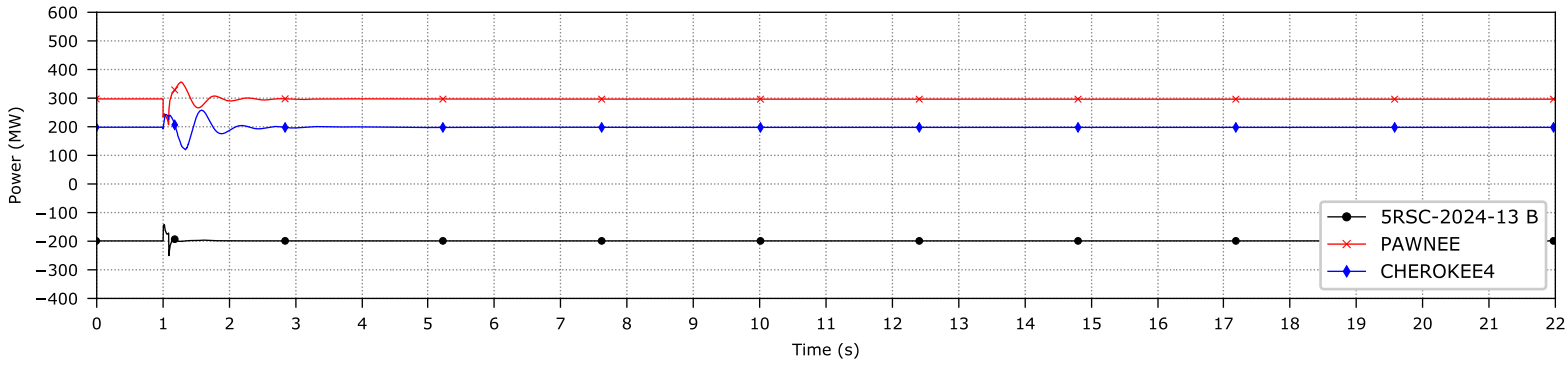

Frequency (Hz)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

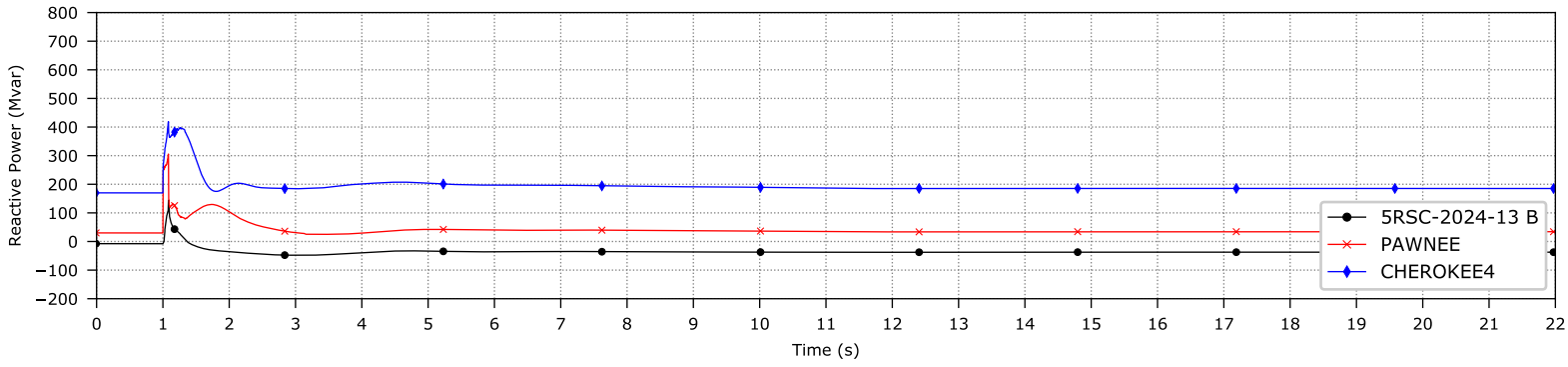

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

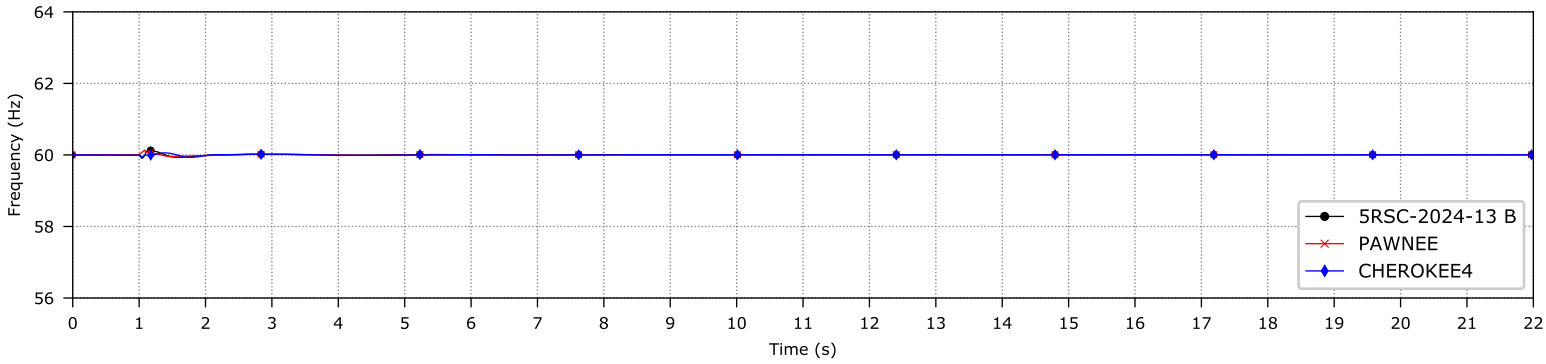

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

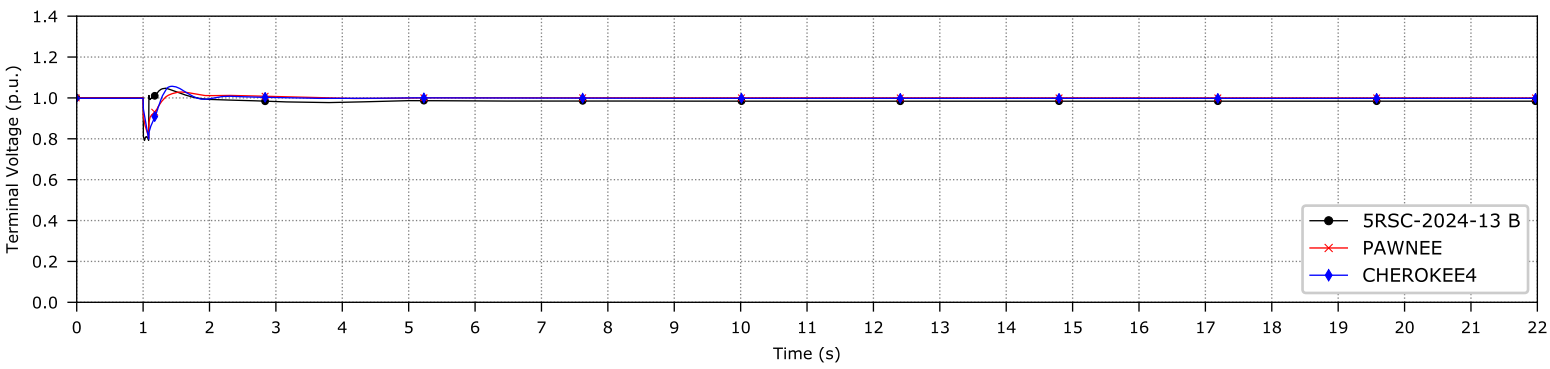
Ref. No. 29 - P7_88

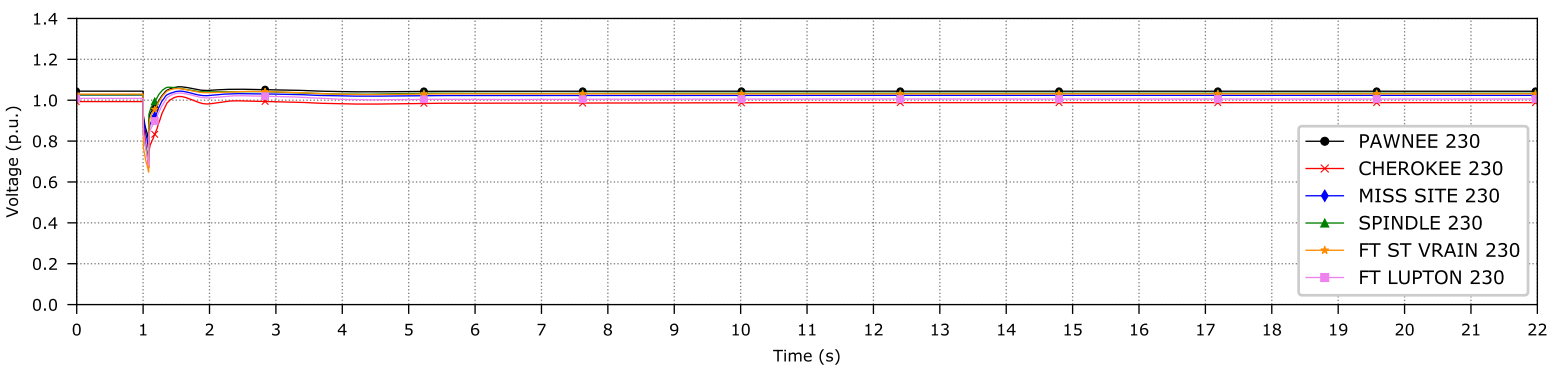




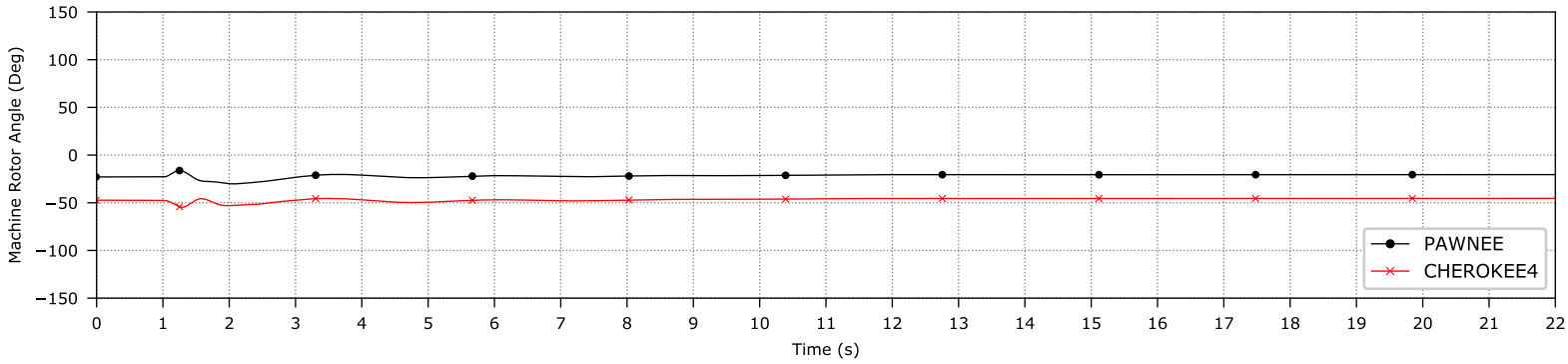


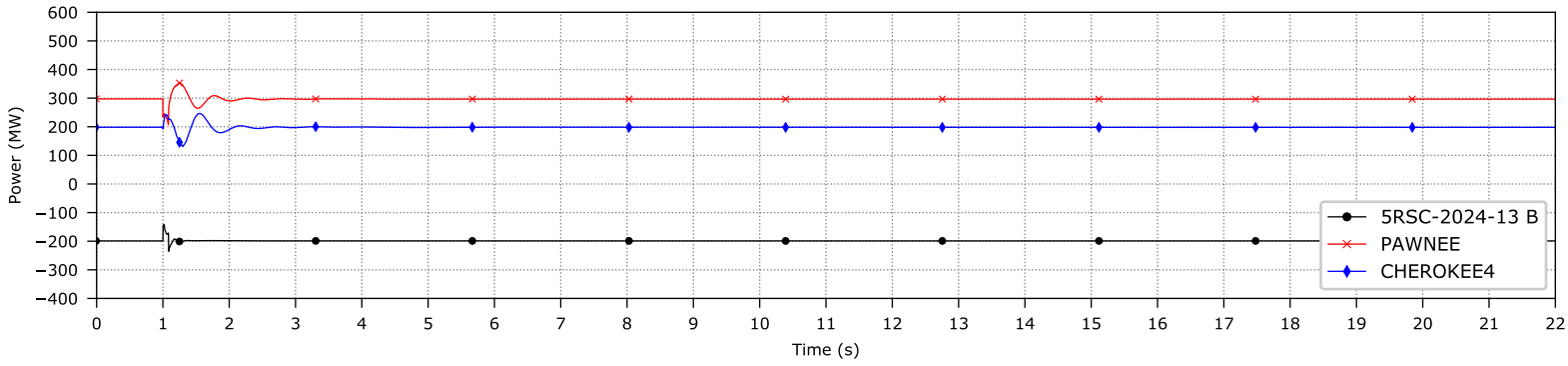


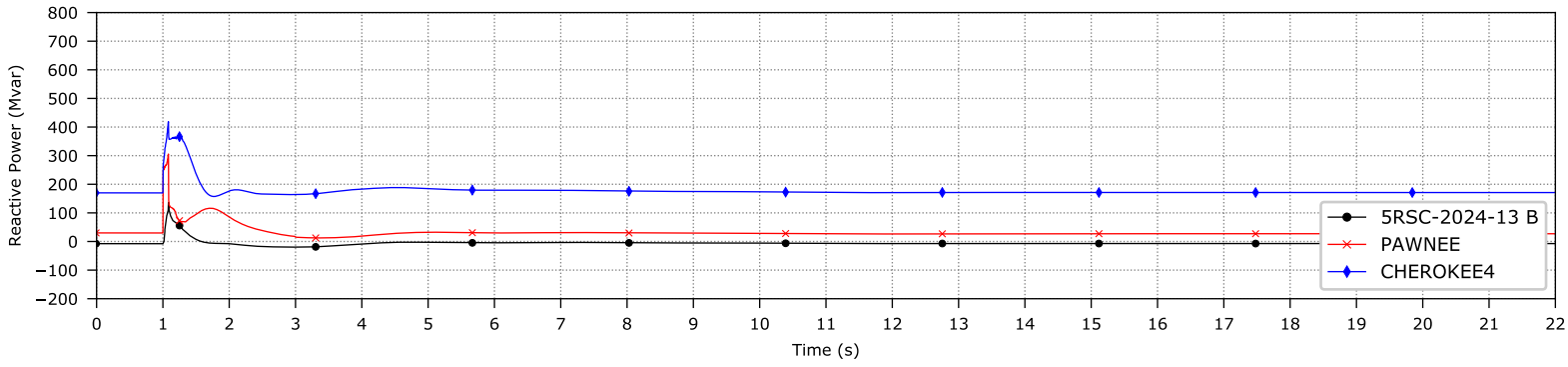


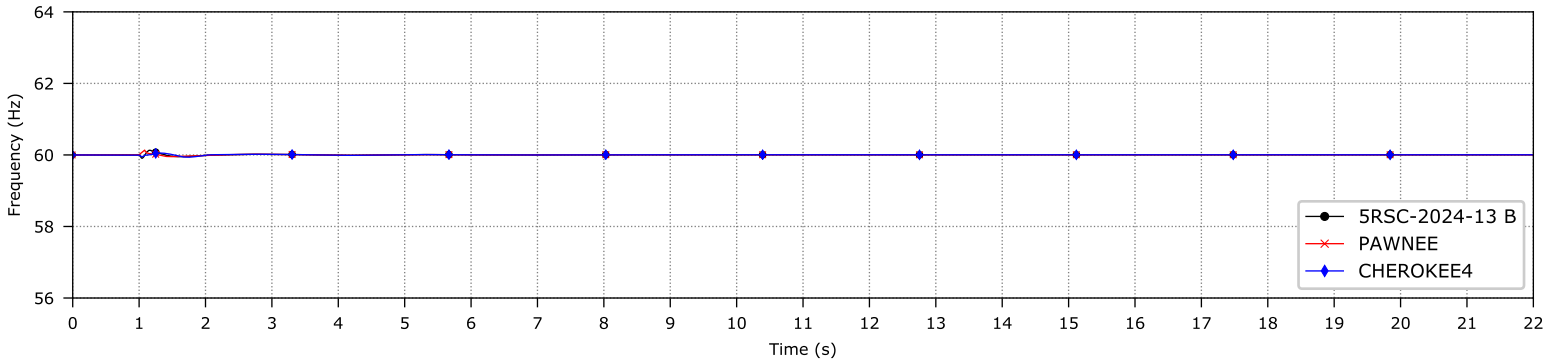


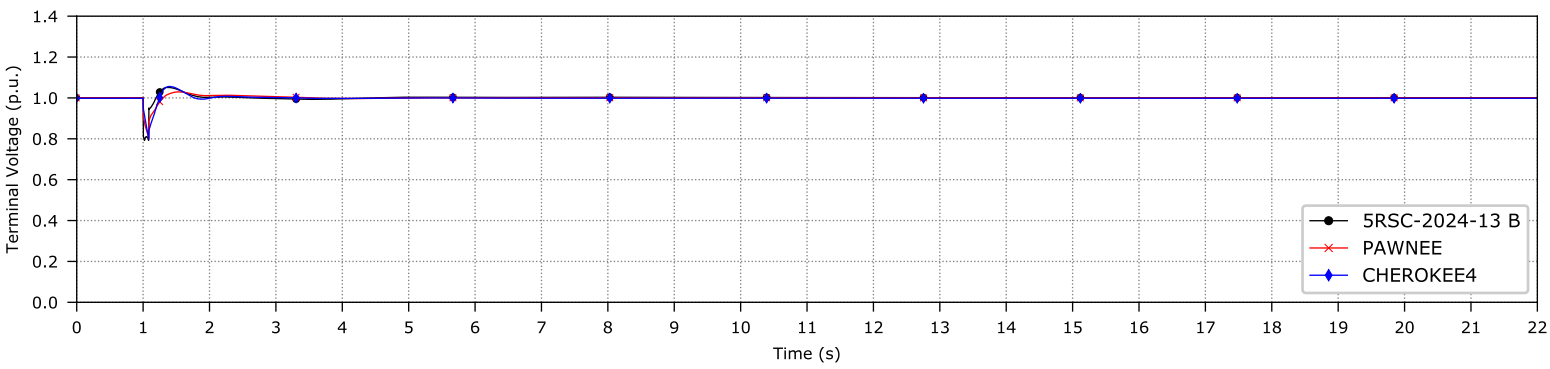
Ref. No. 30 - P7_89

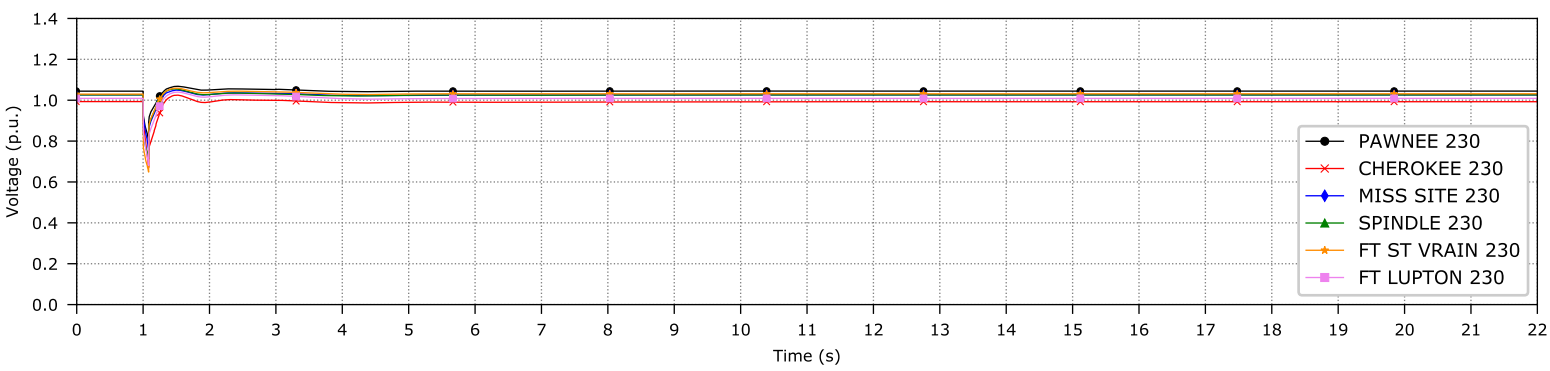




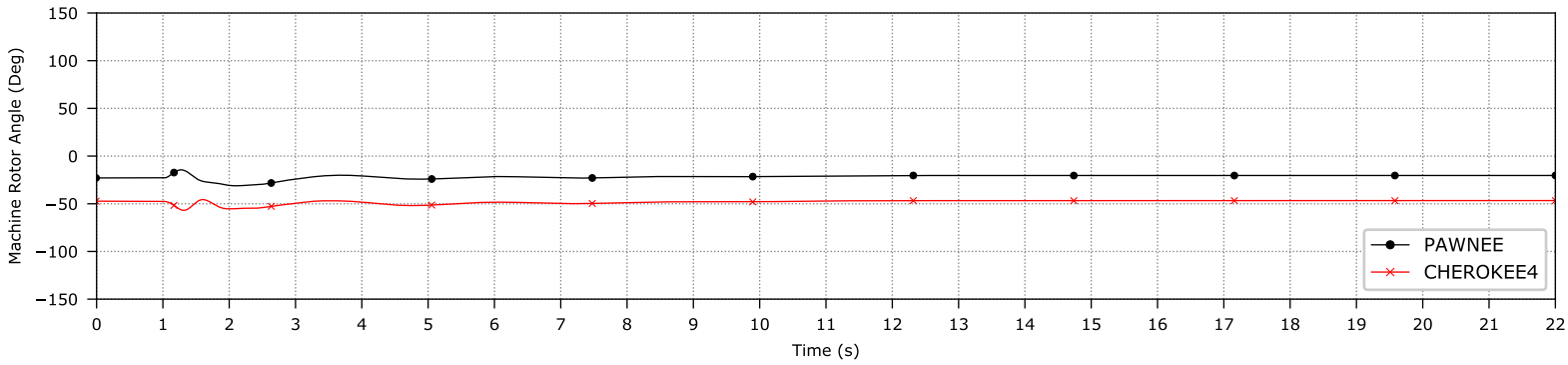


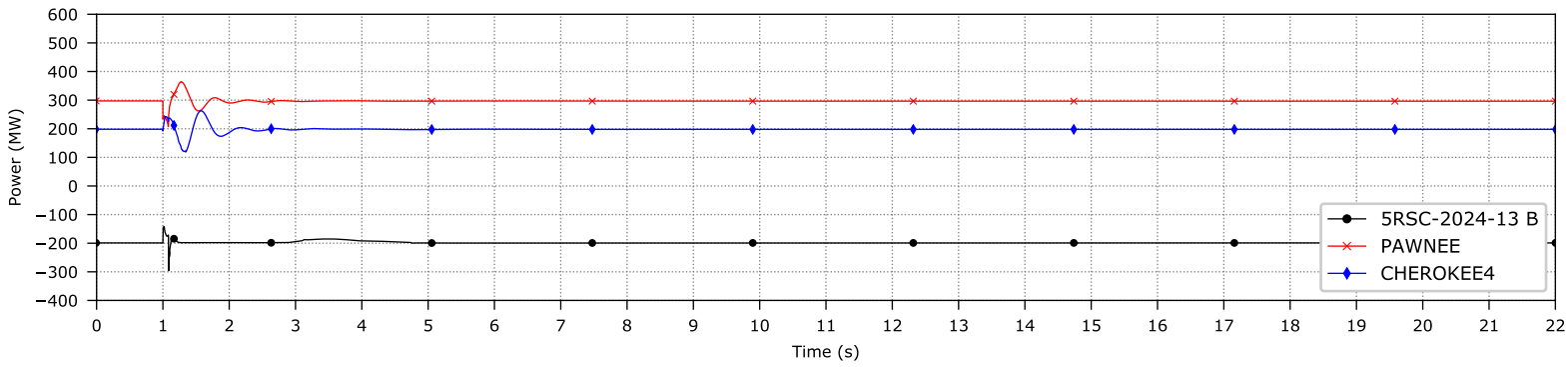


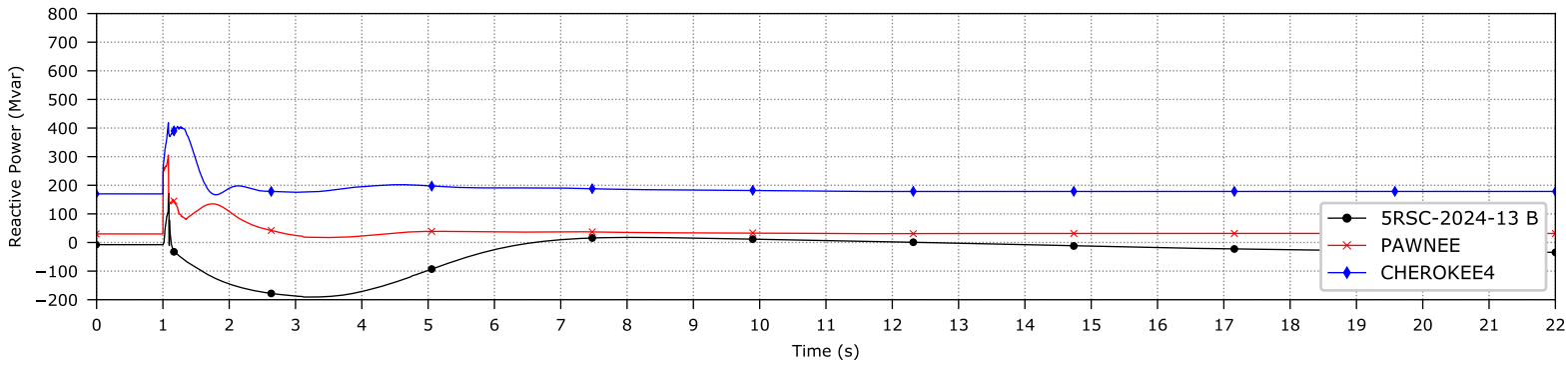


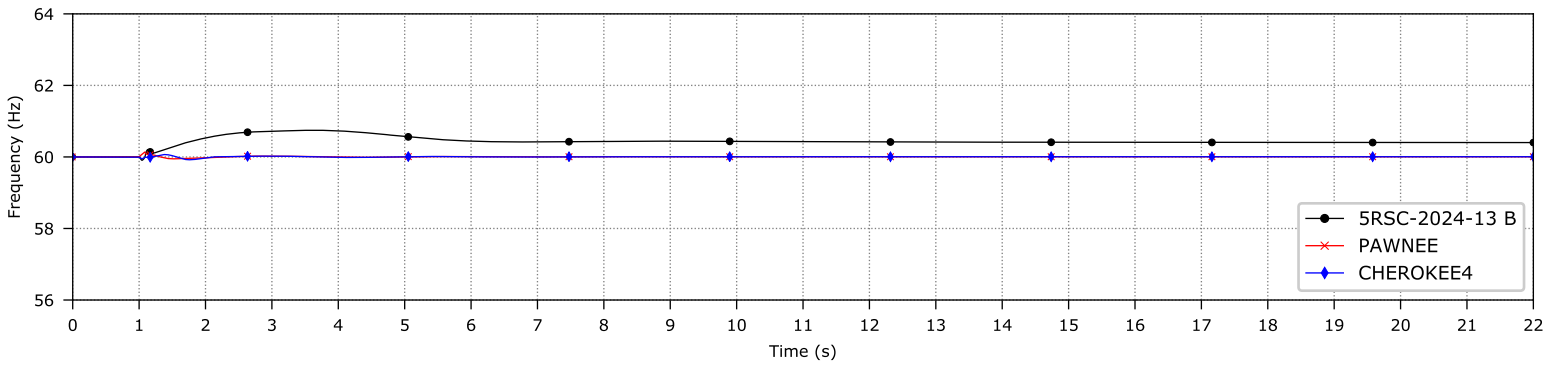


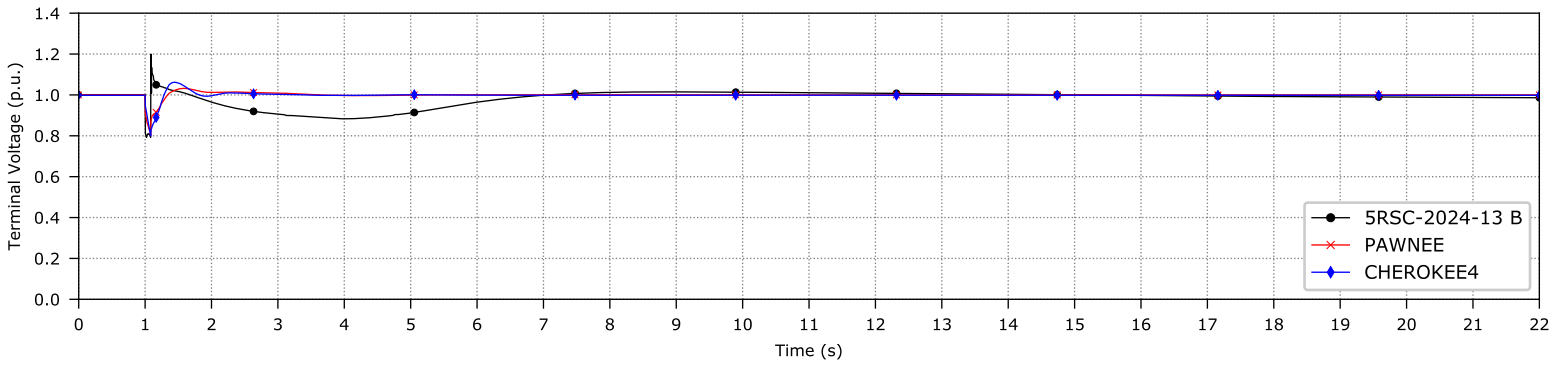
Ref. No. 31 - P7_90

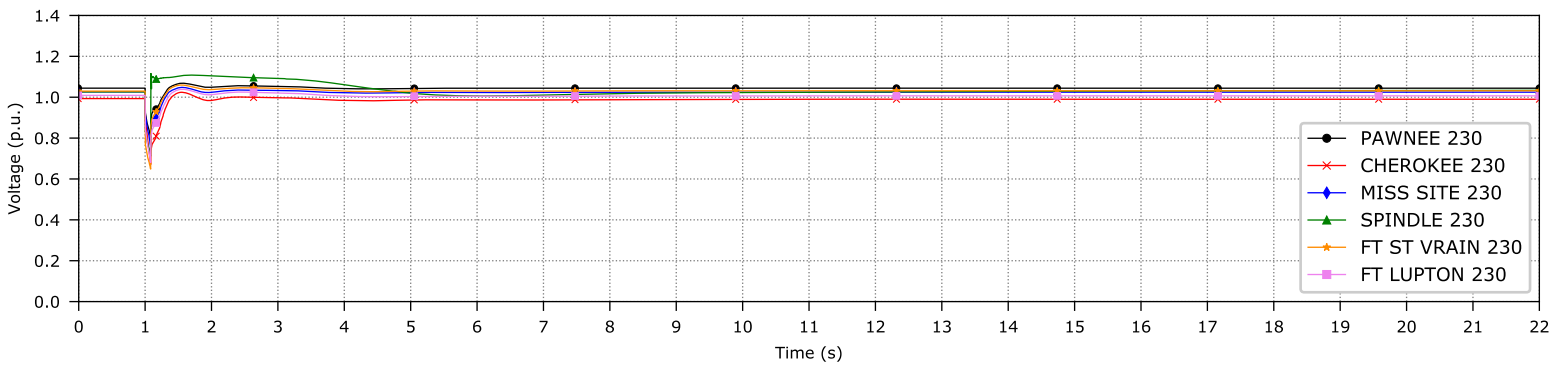




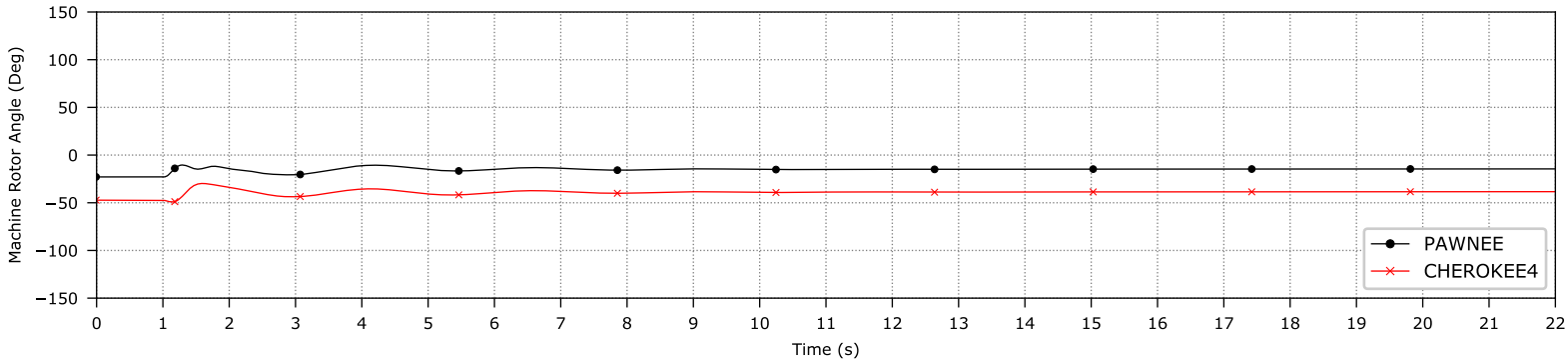


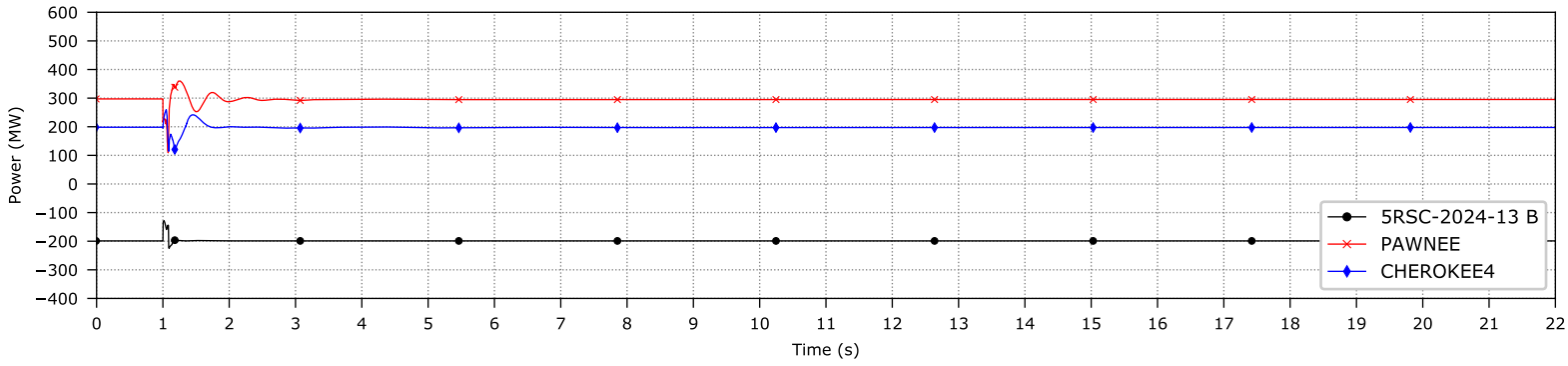


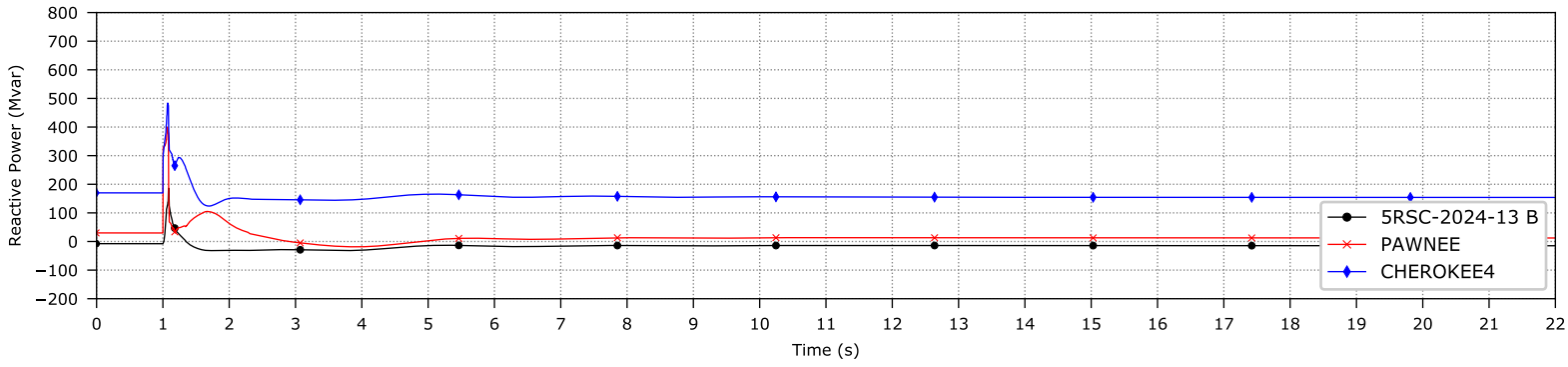


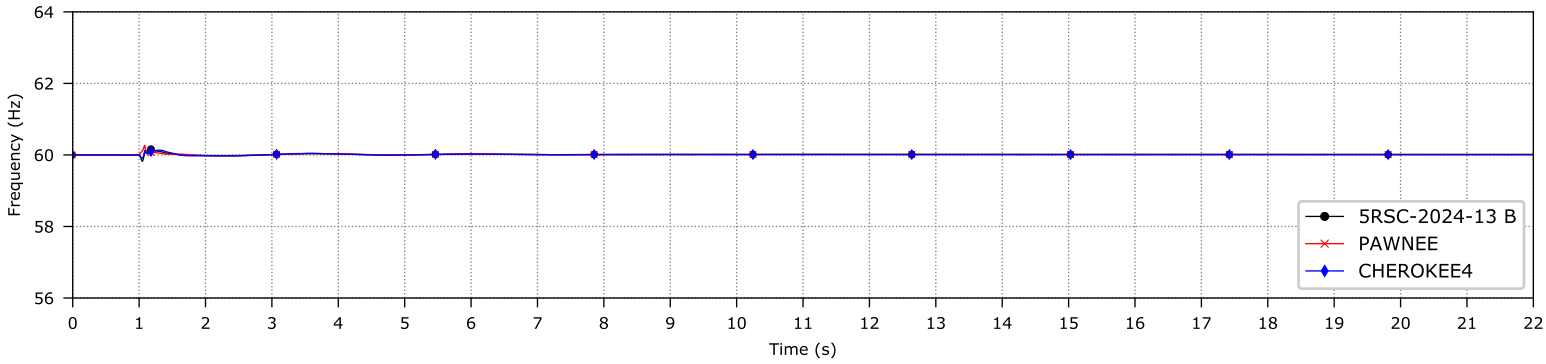


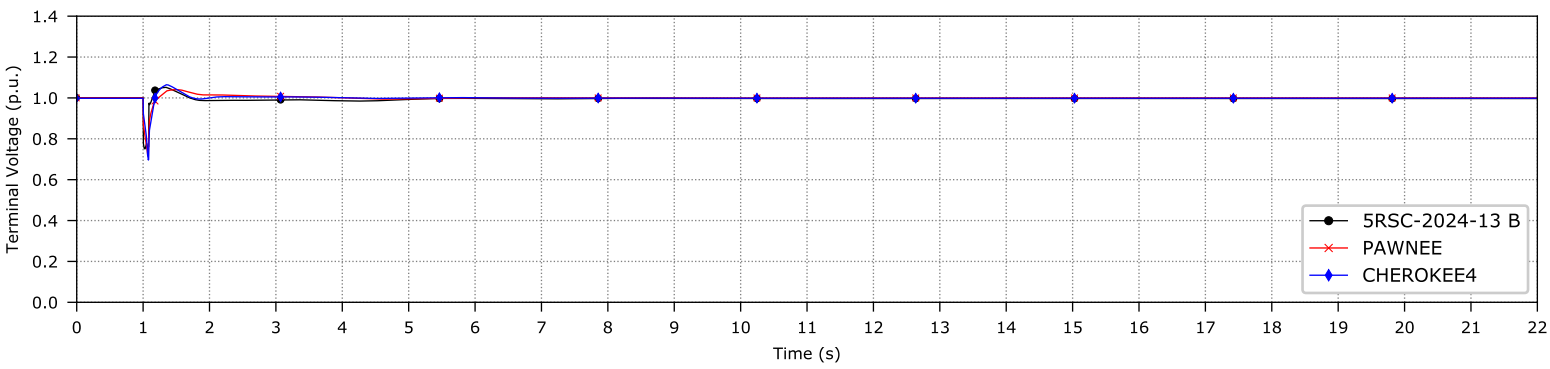
Ref. No. 32 - P7_92

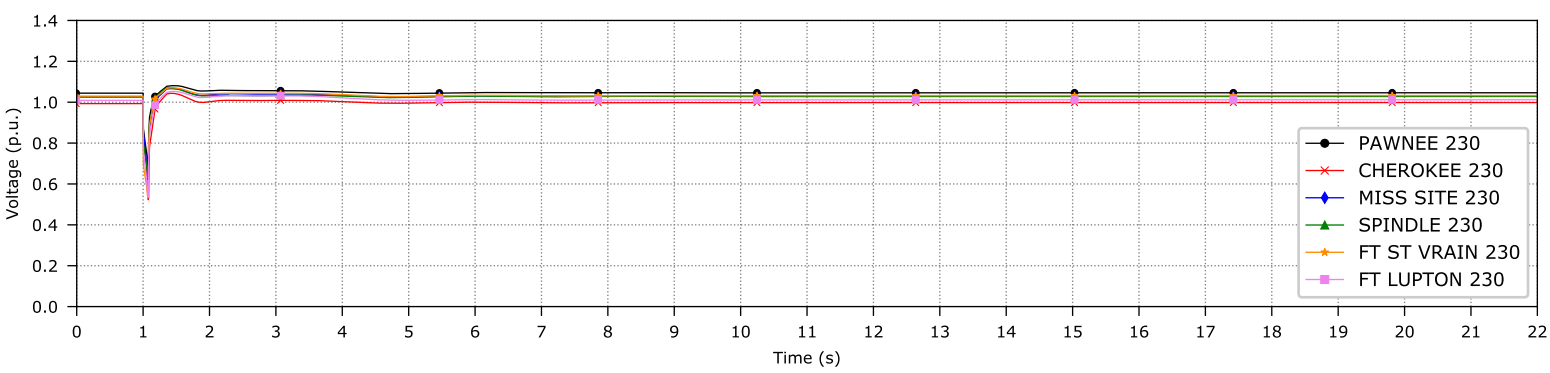




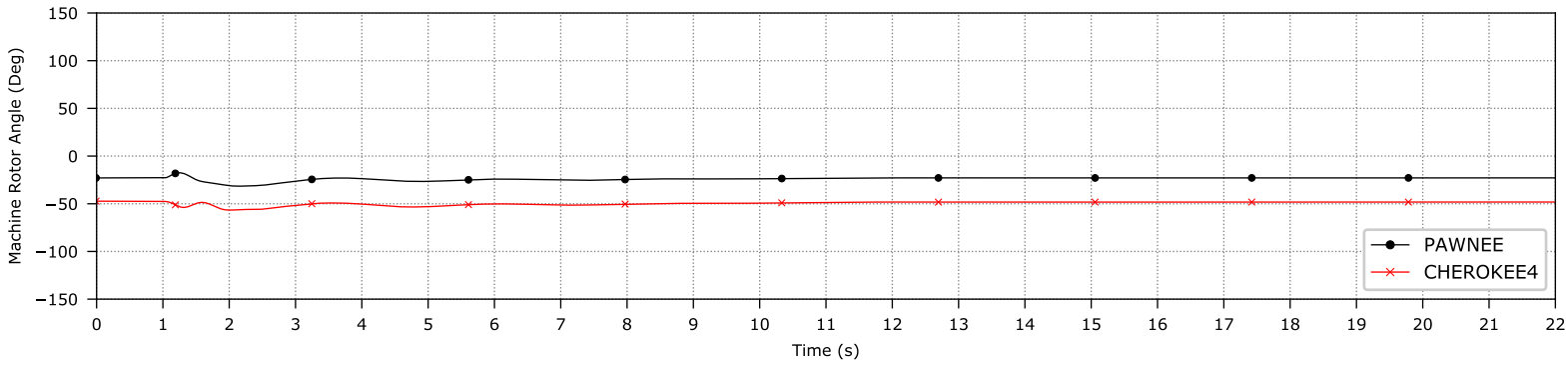


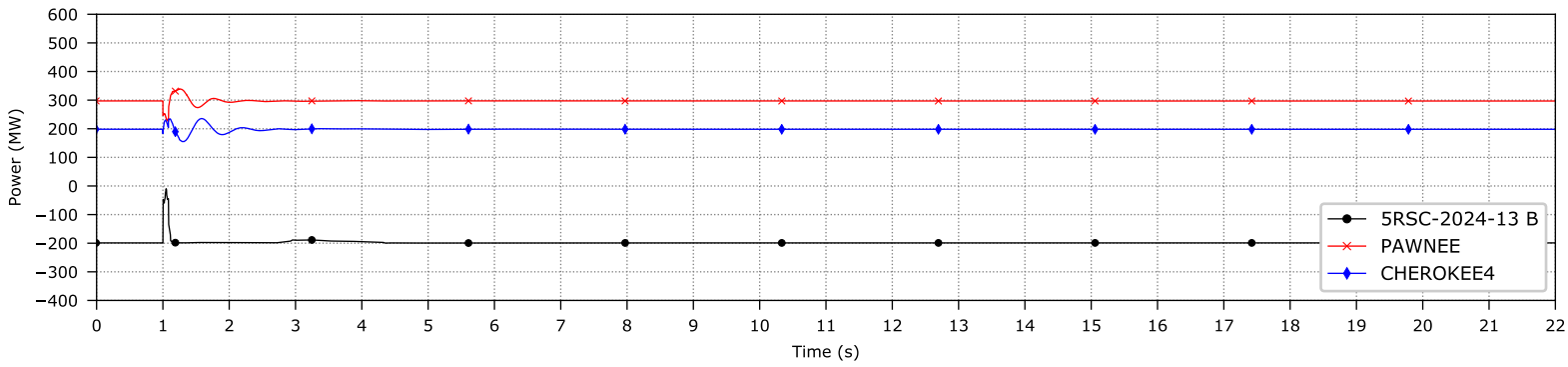


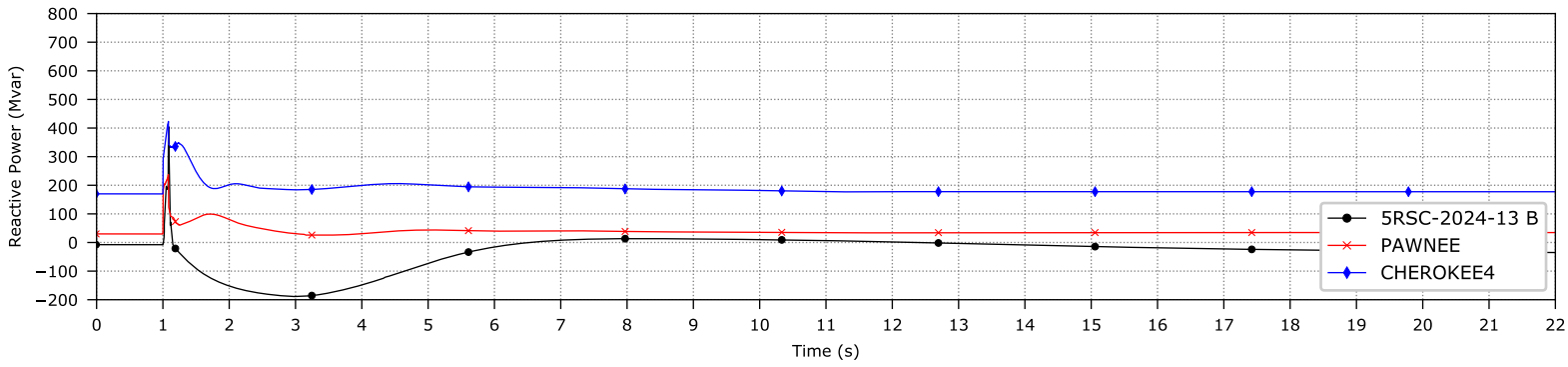


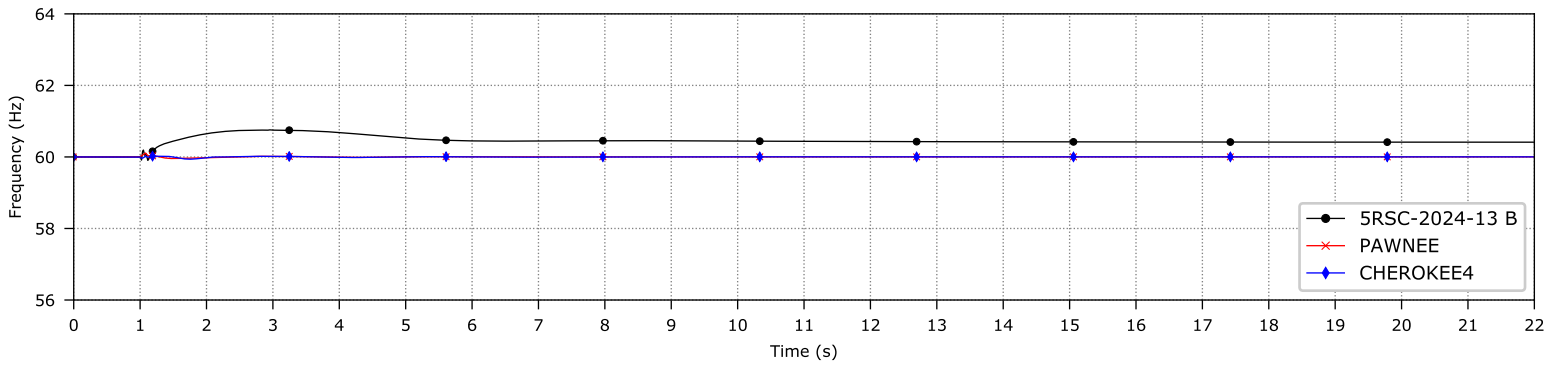


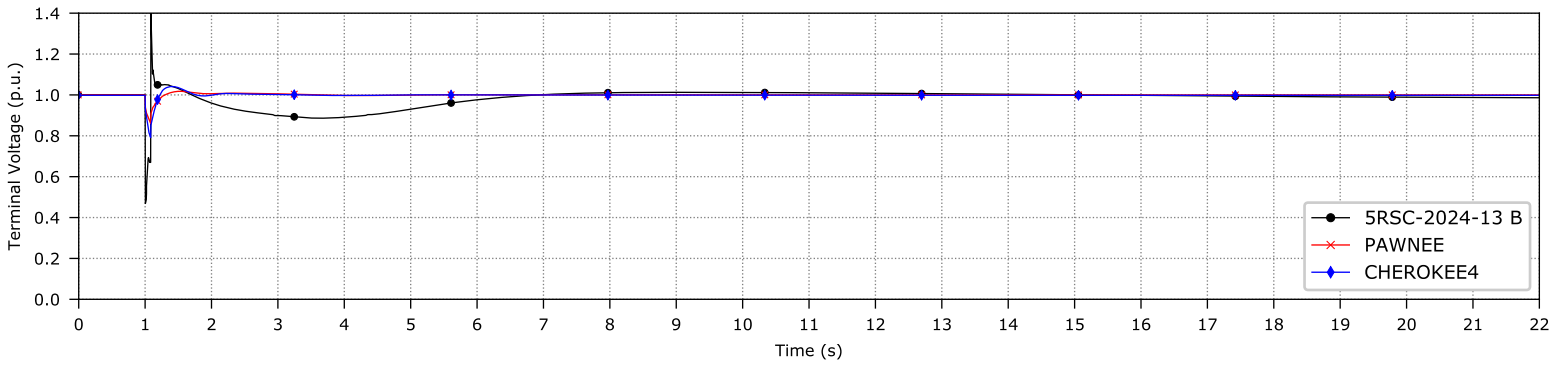
Ref. No. 33 - P7_93

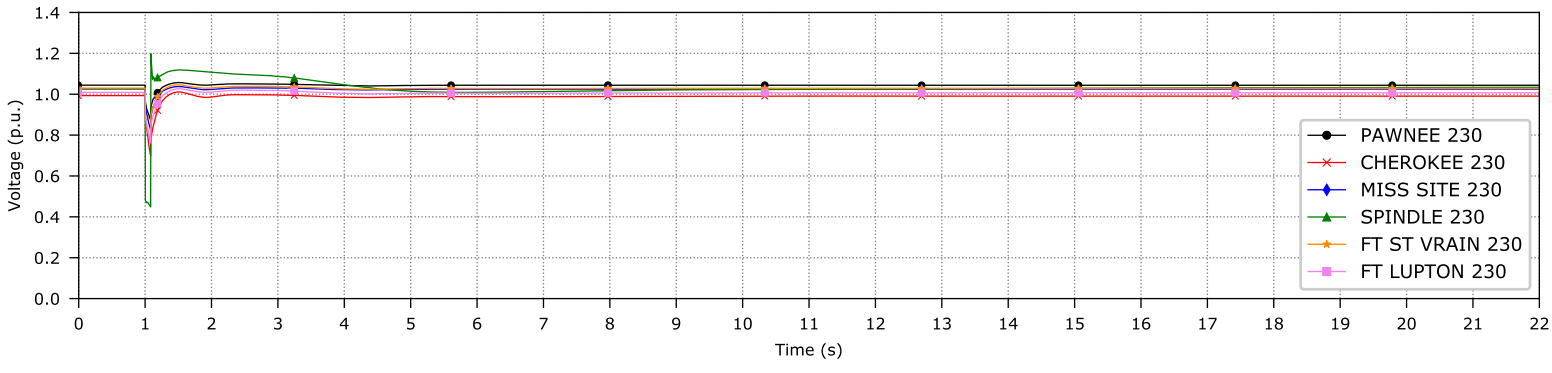


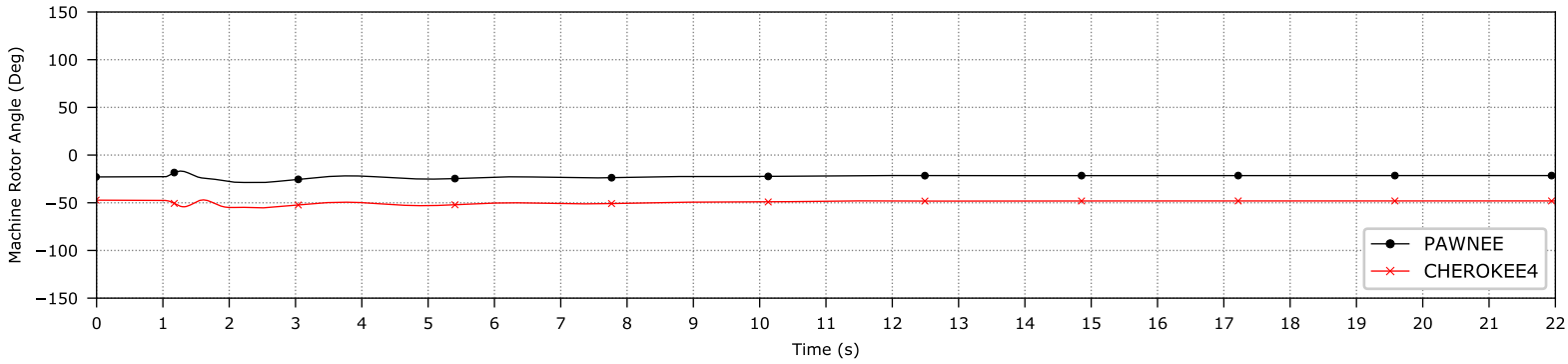


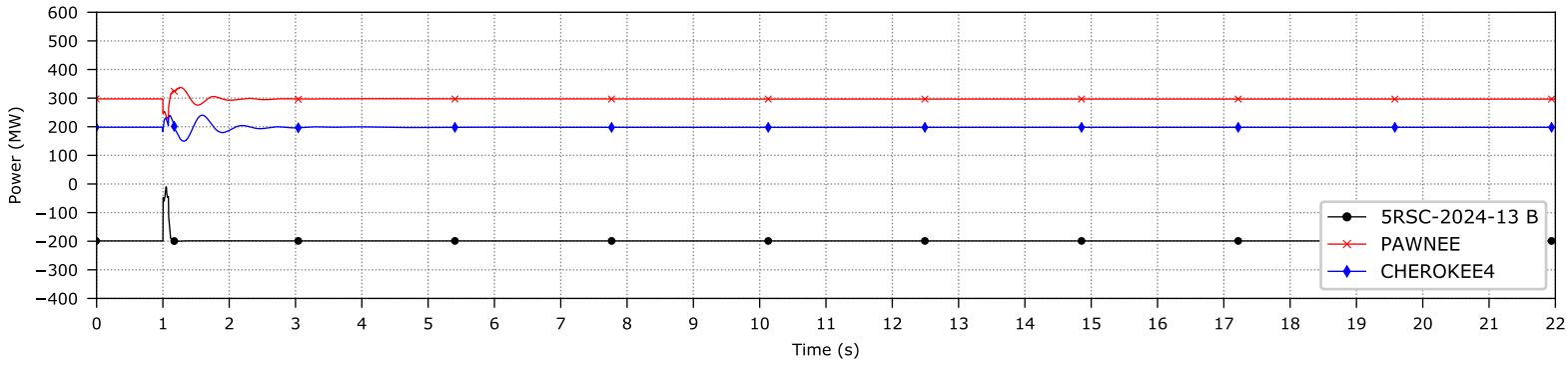


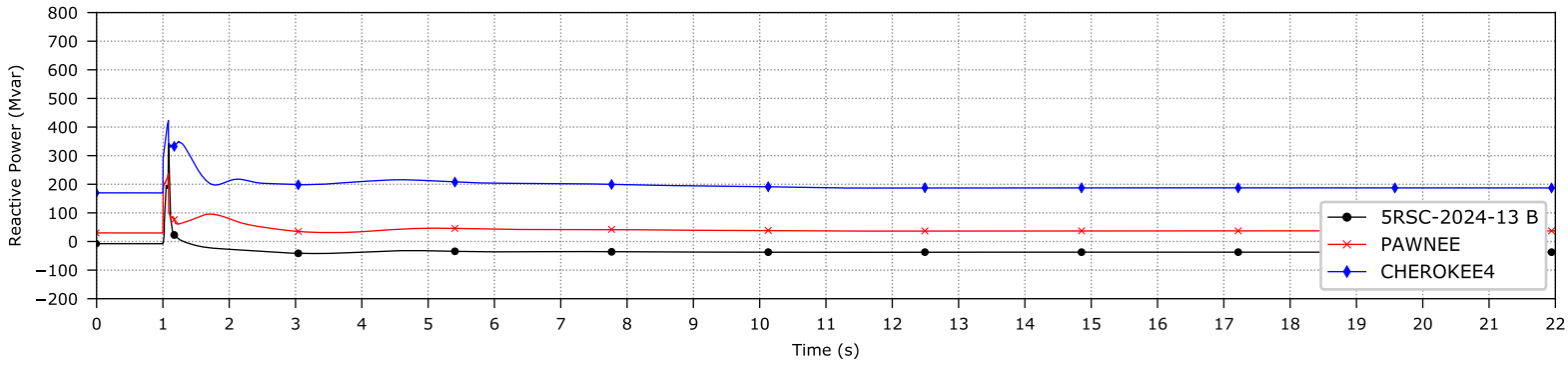


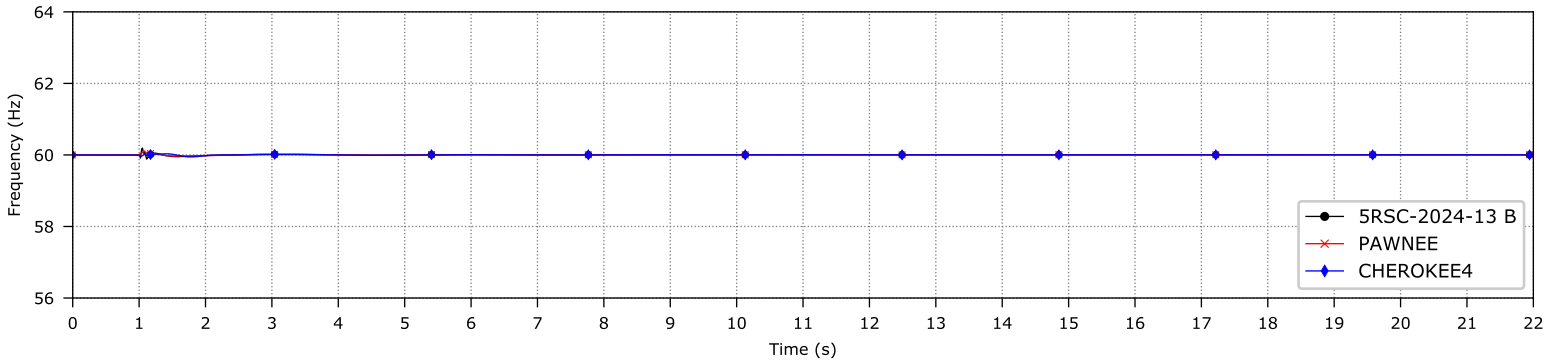


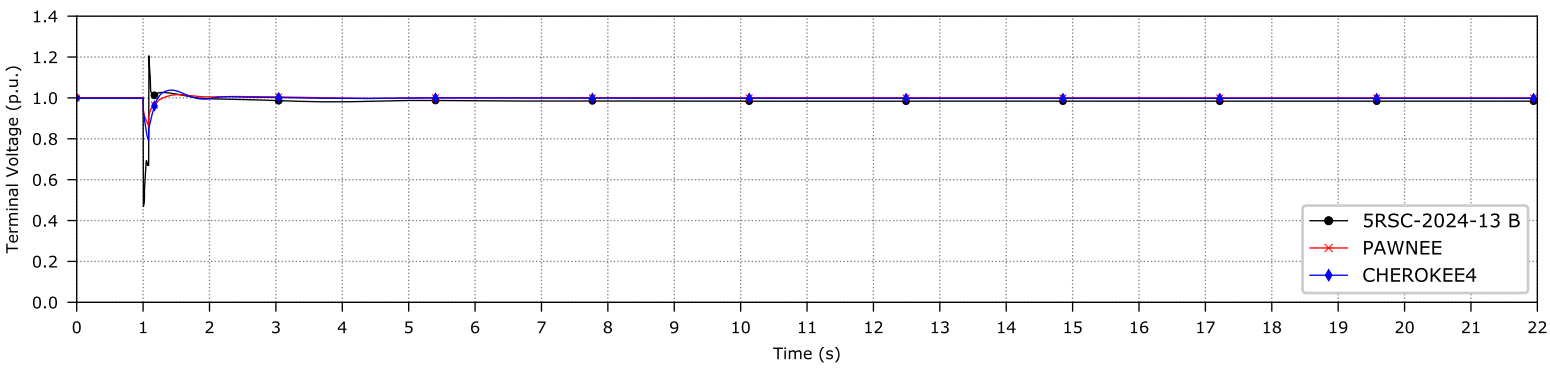


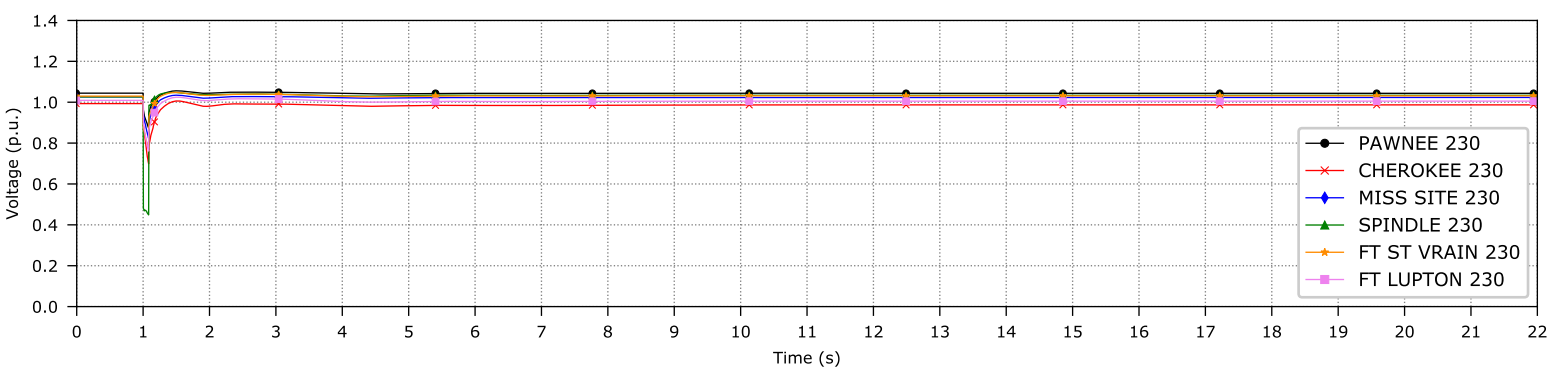

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
CHEROKEE4

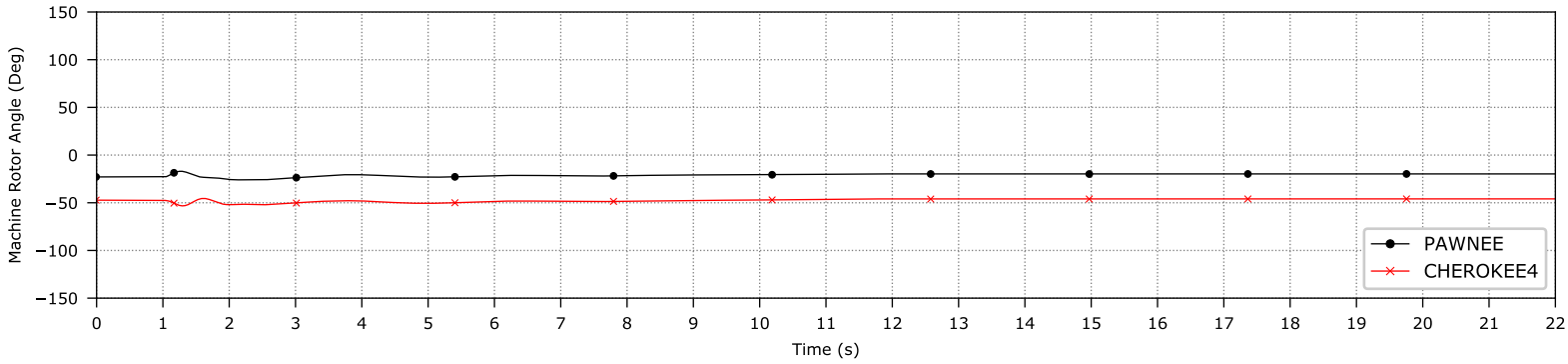

Power (MW)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

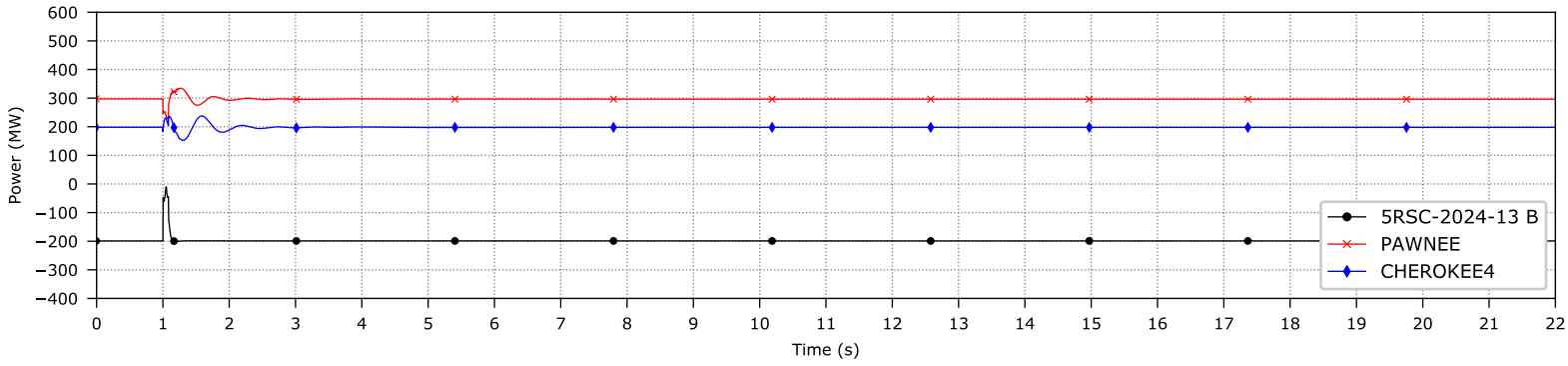

Reactive Power (Mvar)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

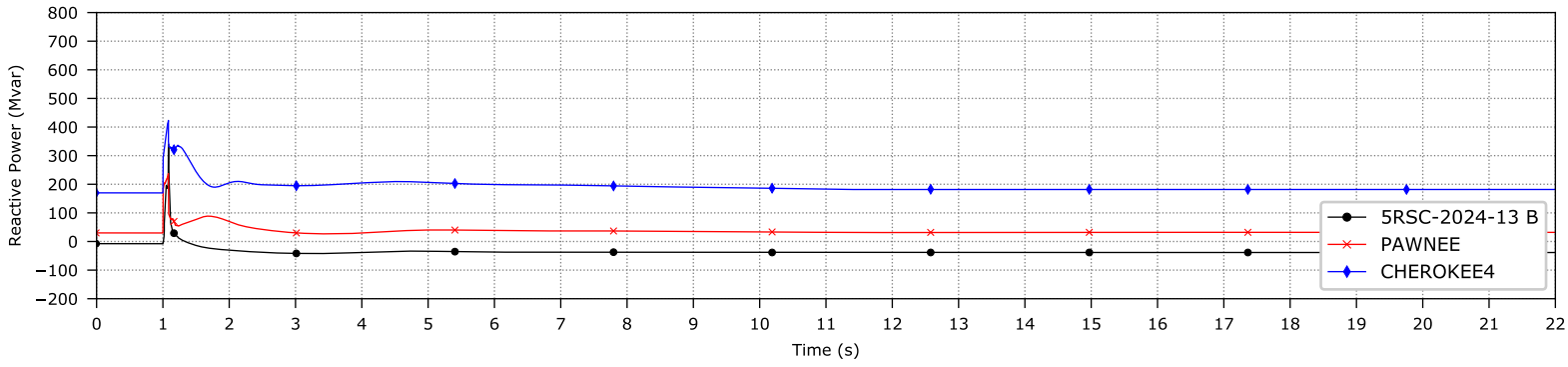

Frequency (Hz)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

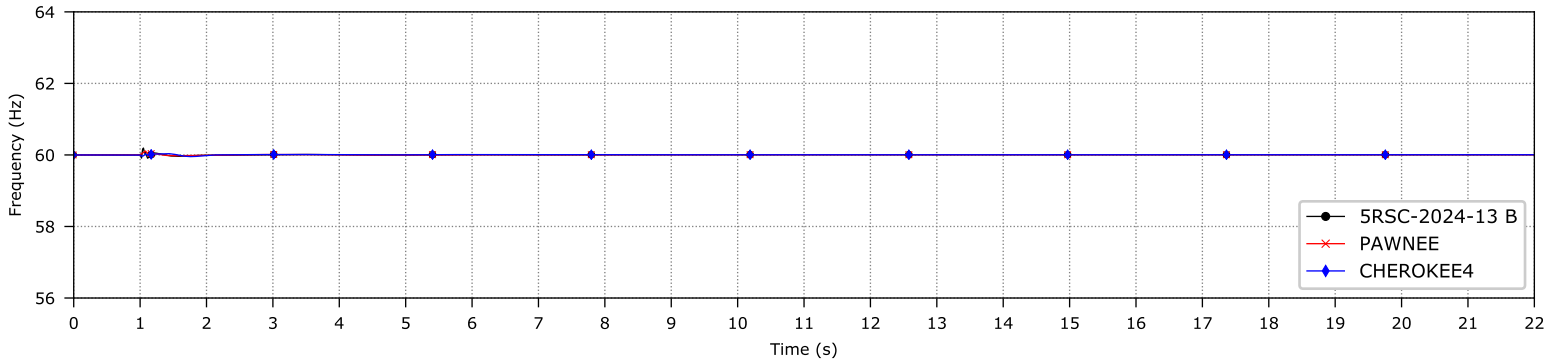

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

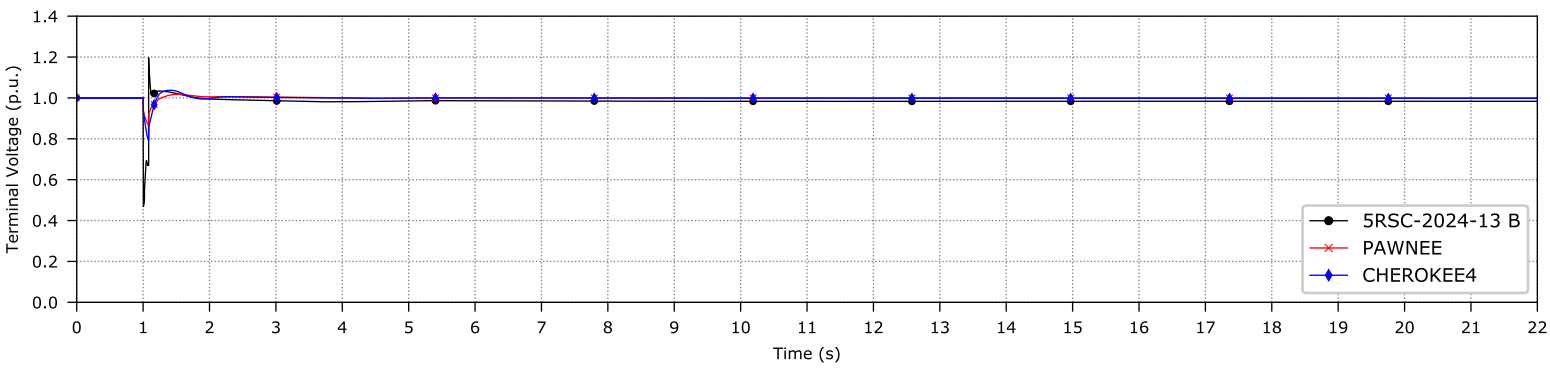

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

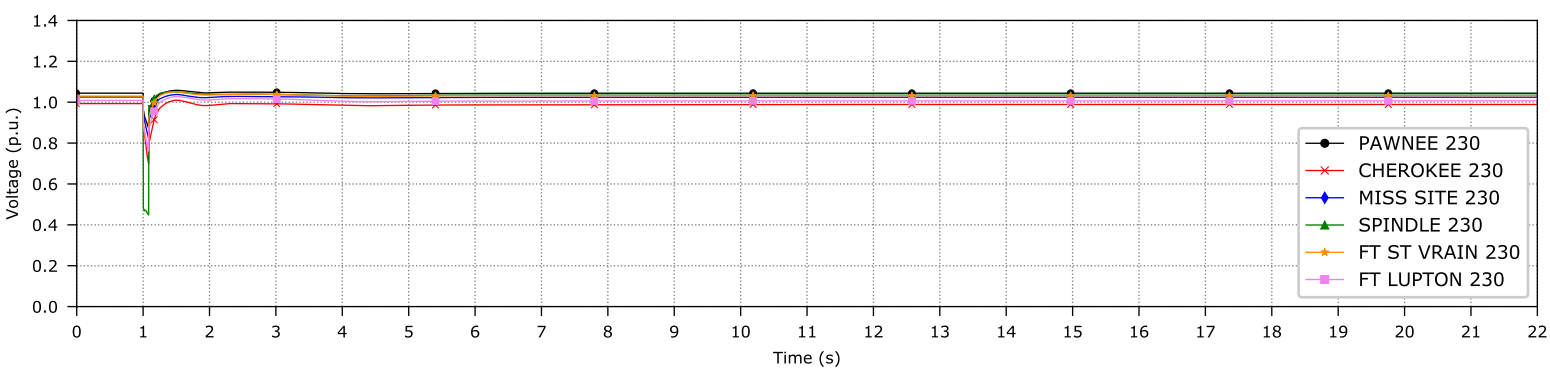

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
CHEROKEE4


Power (MW)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4


Reactive Power (Mvar)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

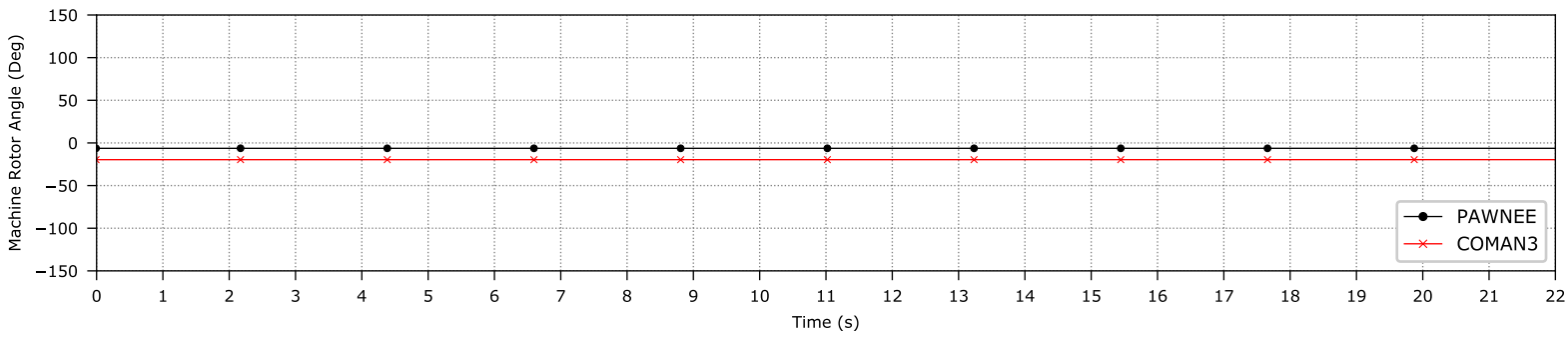

Frequency (Hz)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

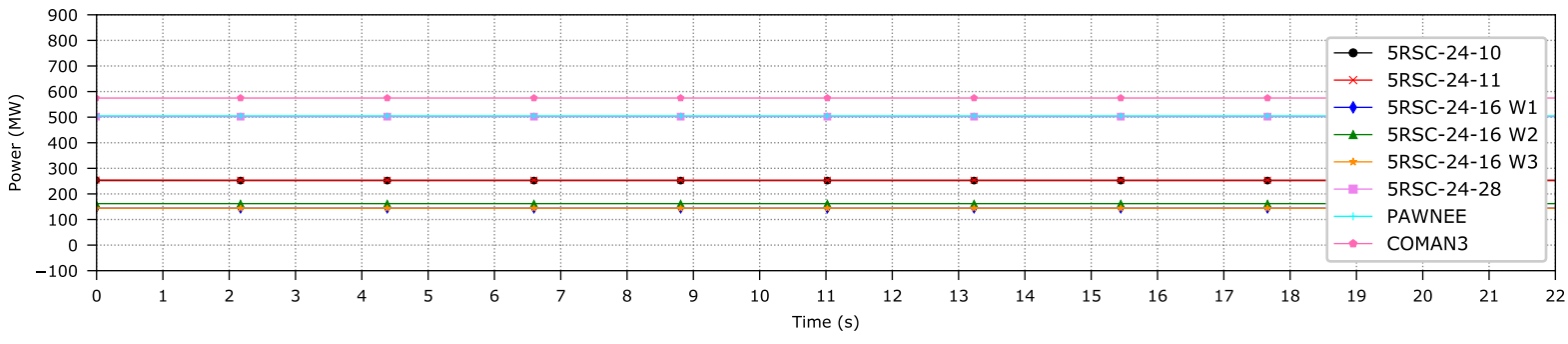

Terminal Voltage (p.u.)
Time (s)
5RSC-2024-13 B
PAWNEE
CHEROKEE4

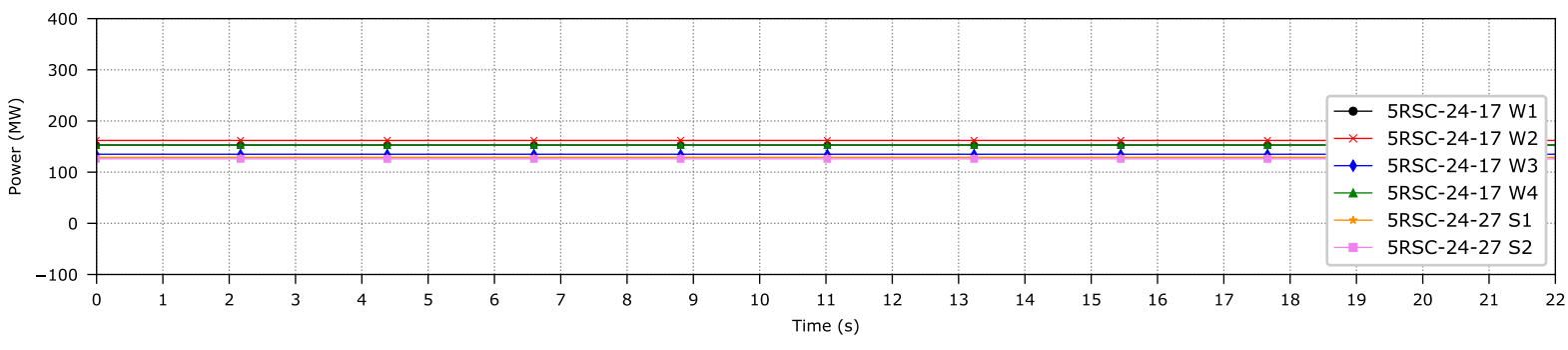

Voltage (p.u.)
Time (s)
PAWNEE 230
CHEROKEE 230
MISS SITE 230
SPINDLE 230
FT ST VRAIN 230
FT LUPTON 230

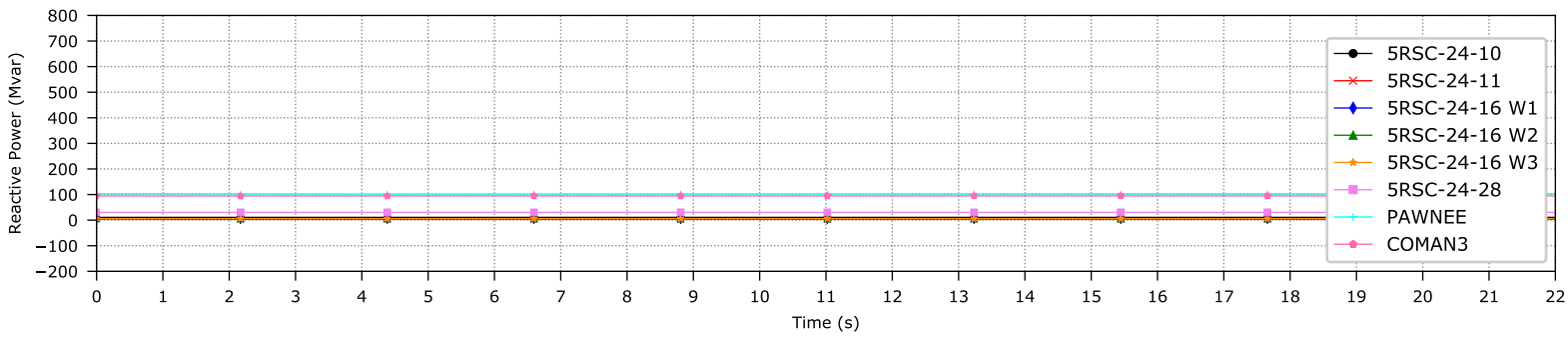
2027 EAST – TRANSIENT STABILITY PLOTS

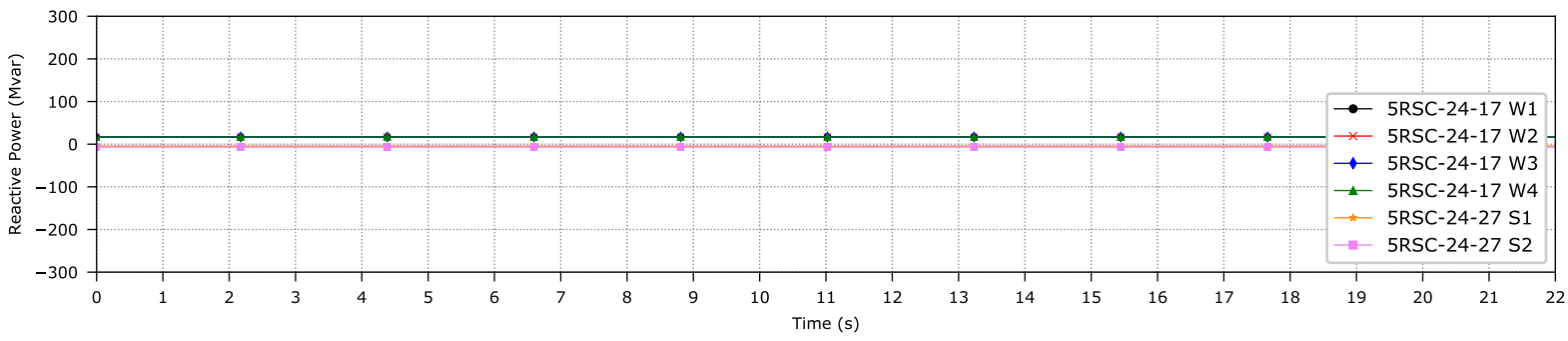
Ref. No. 01 - Flatrun

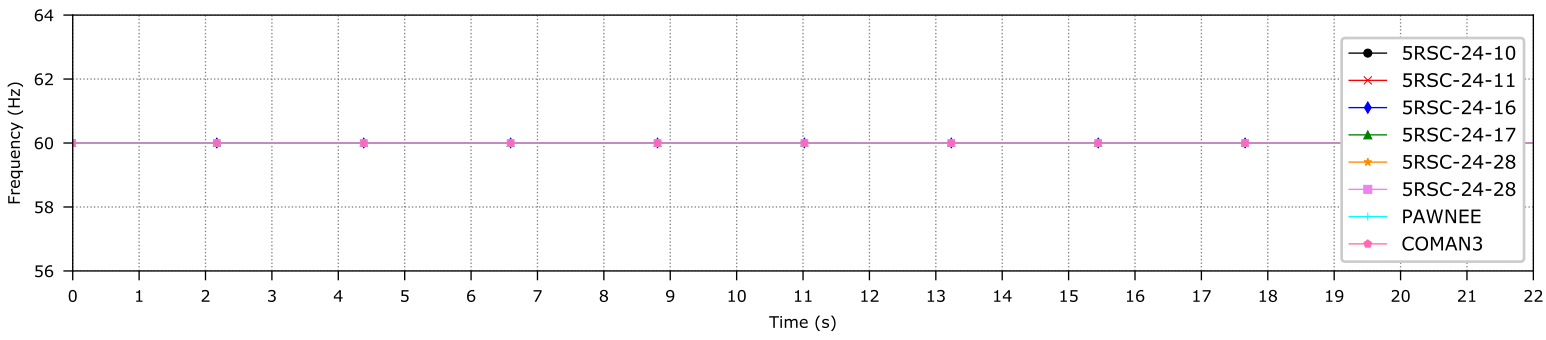


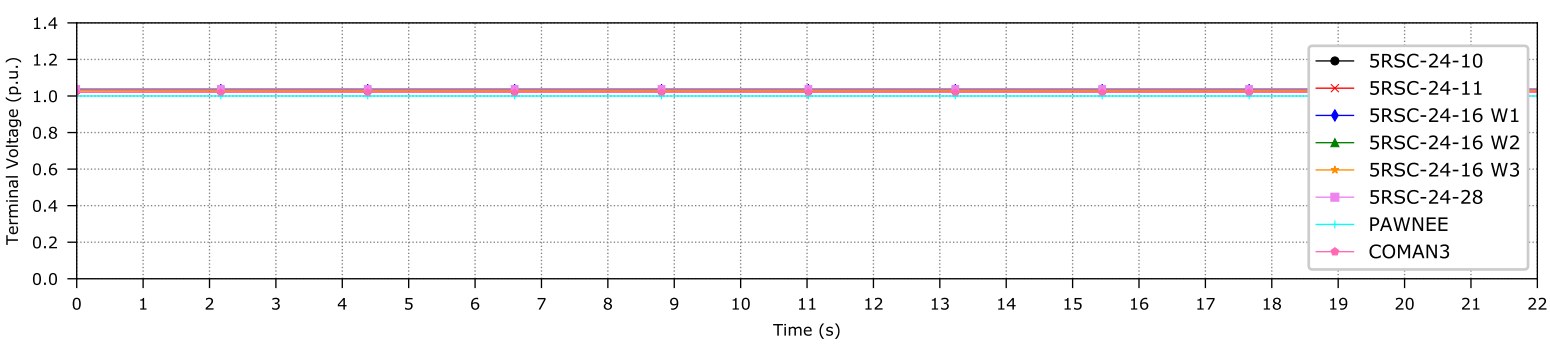


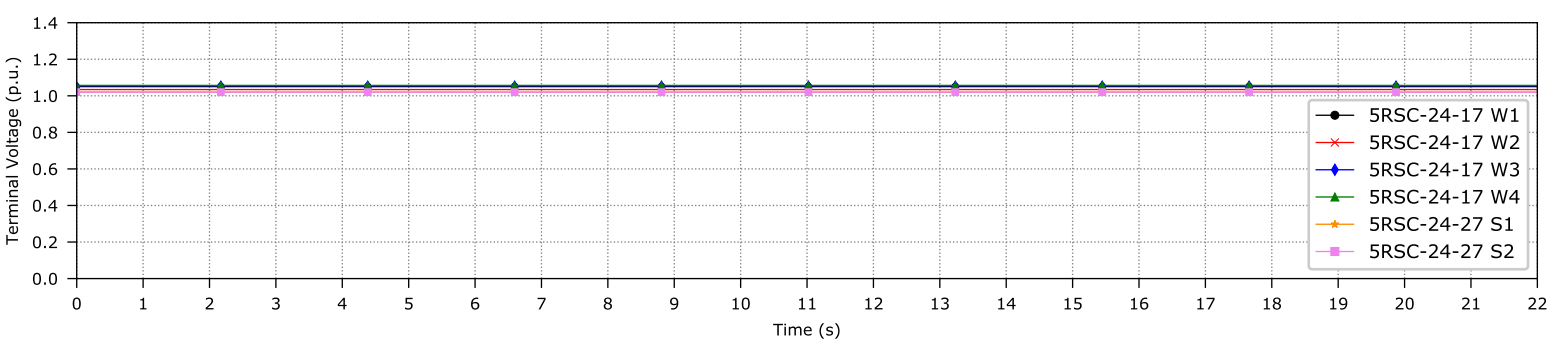


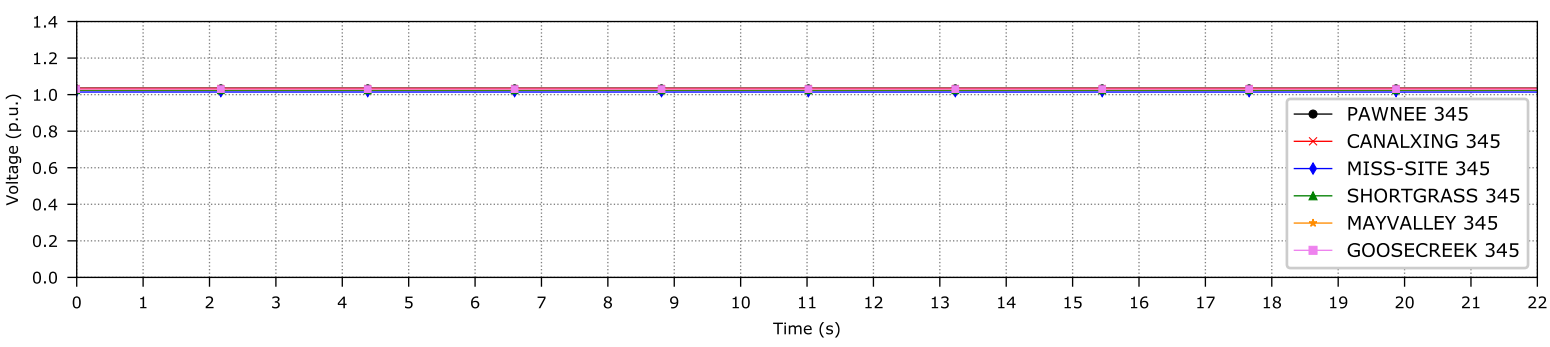




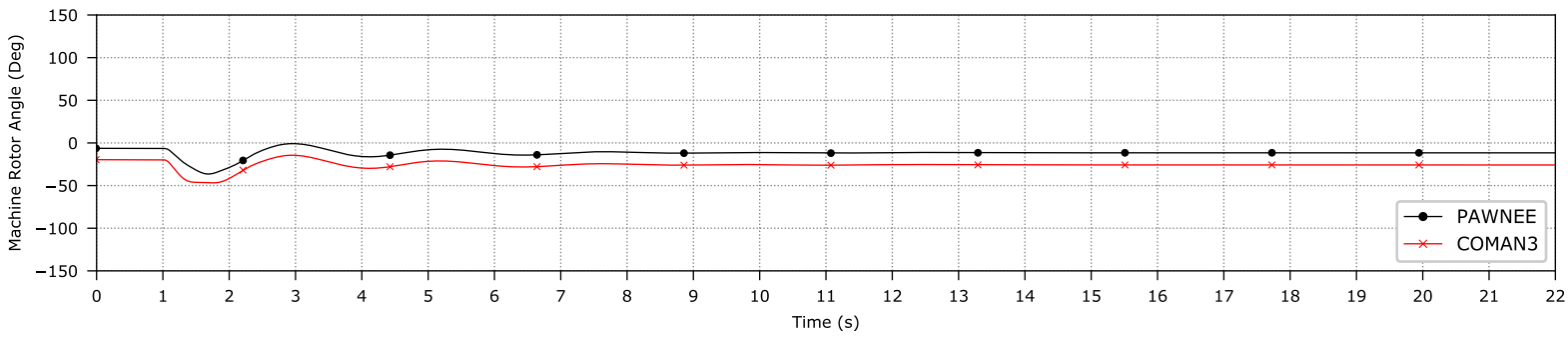


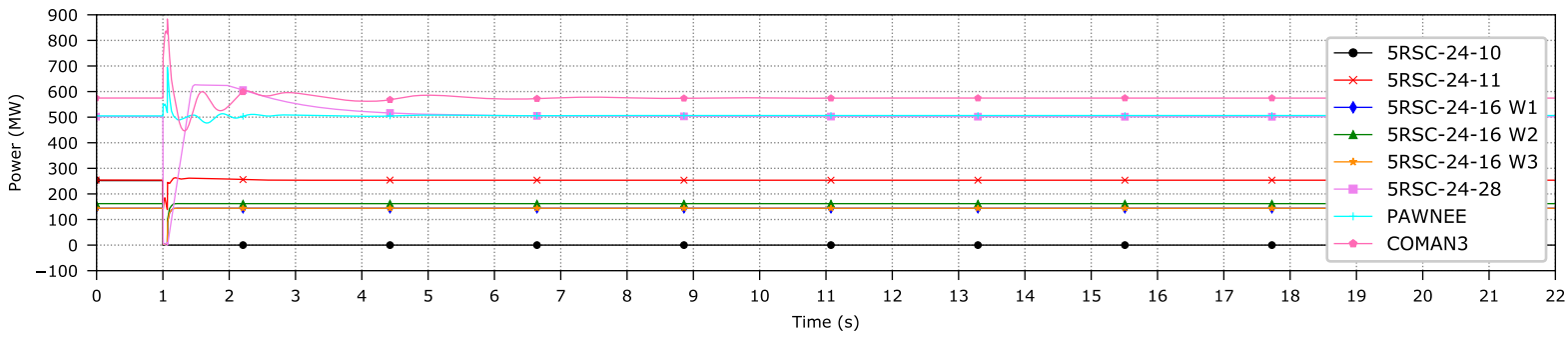


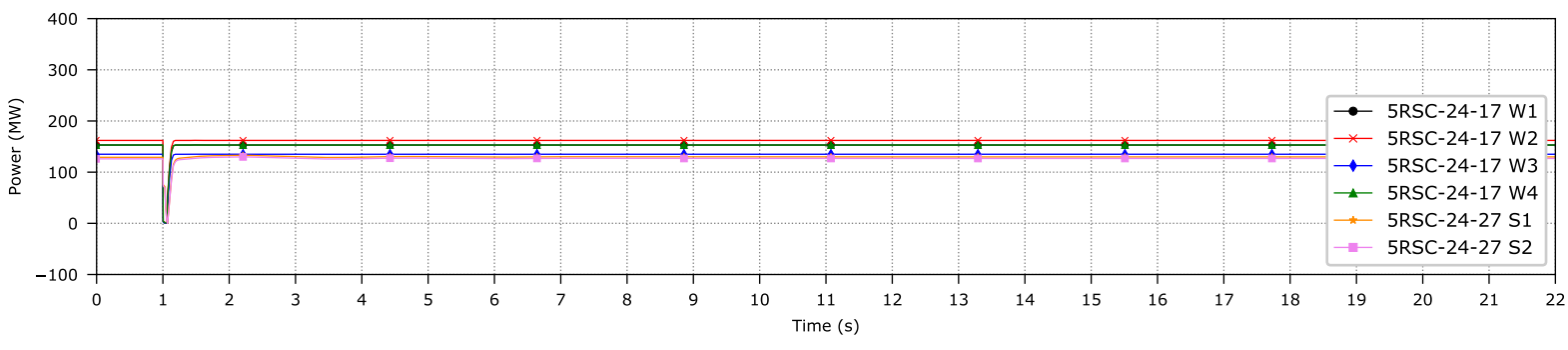


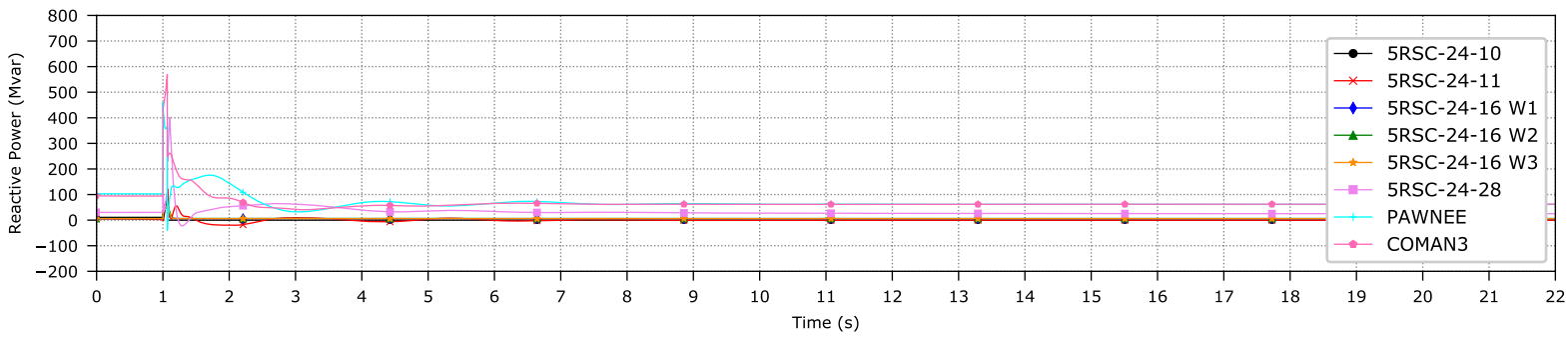


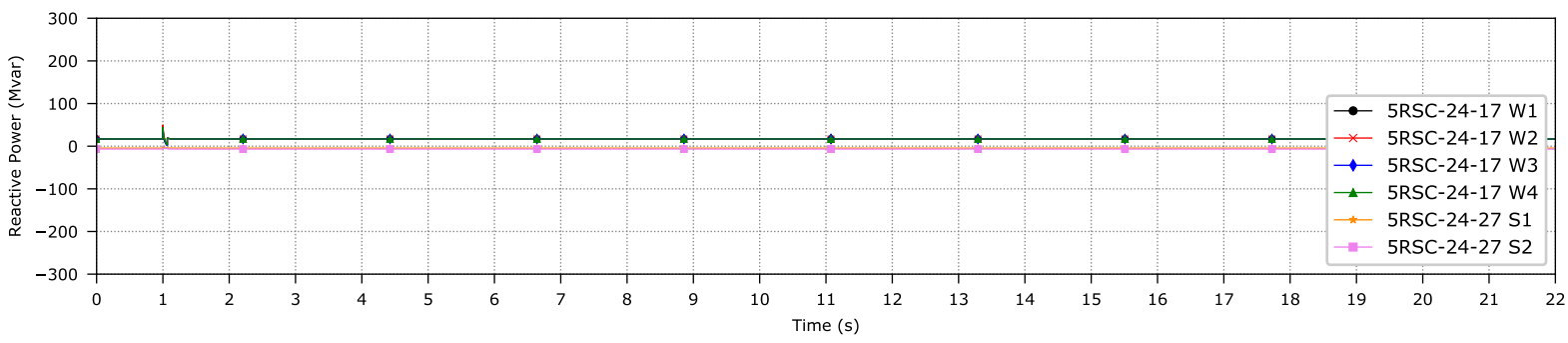
Ref. No. 02 - 5RSC-2024-10

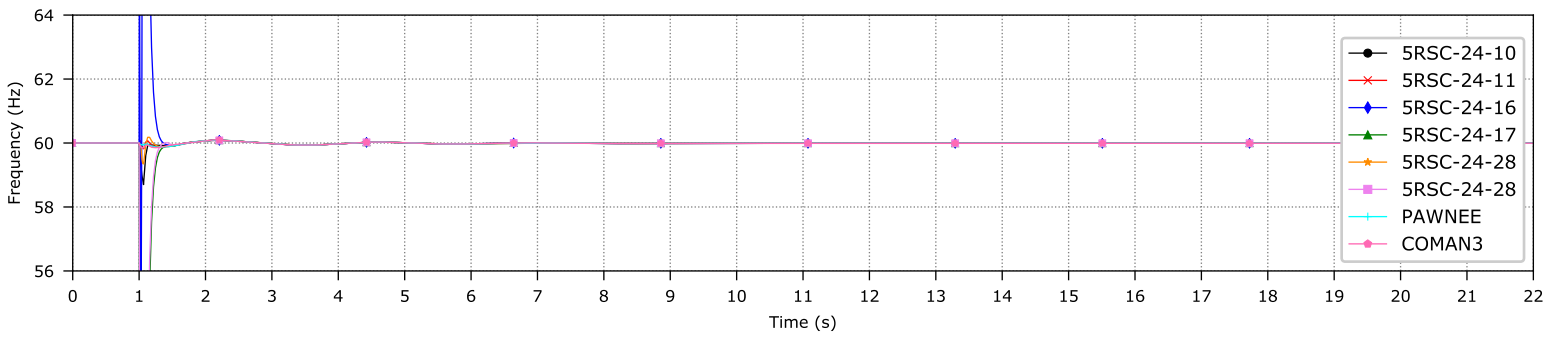


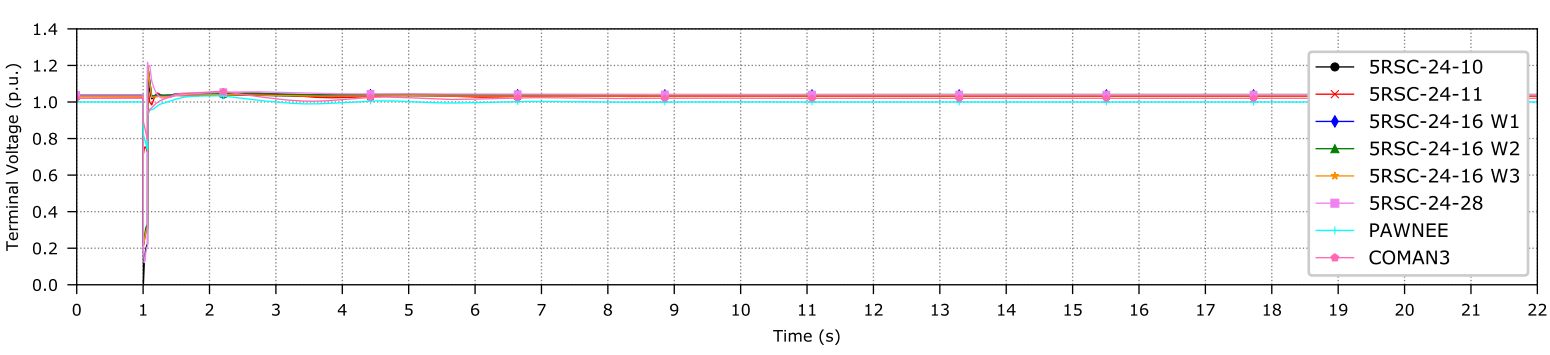


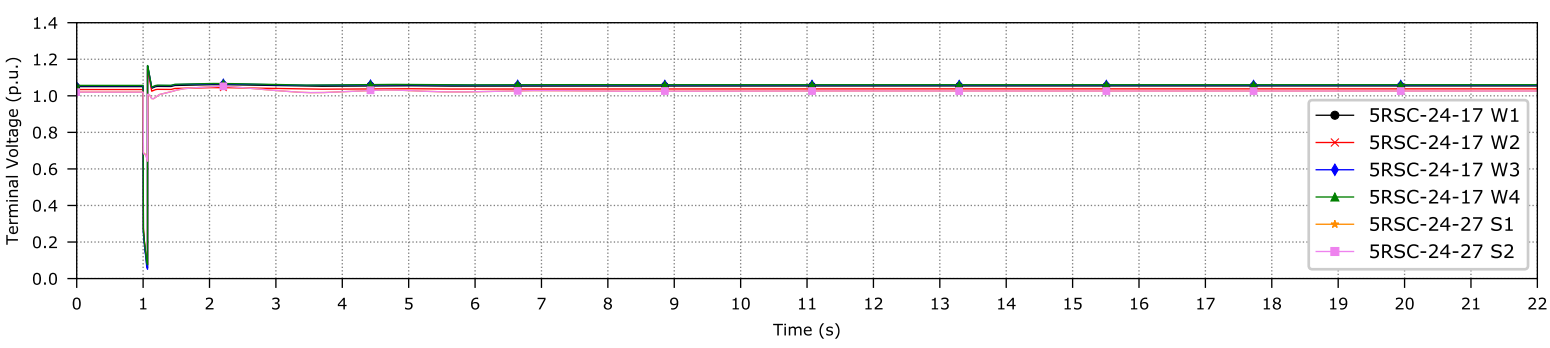


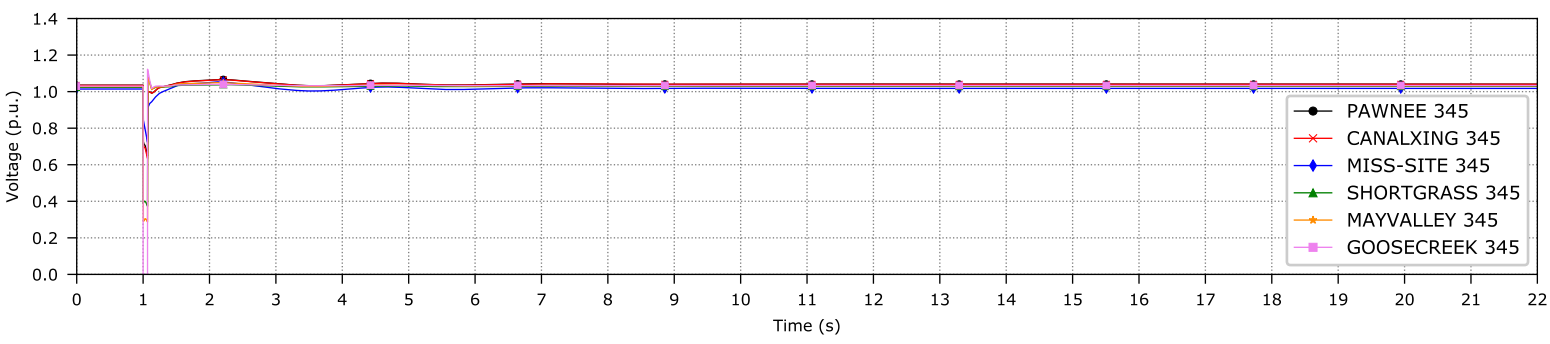




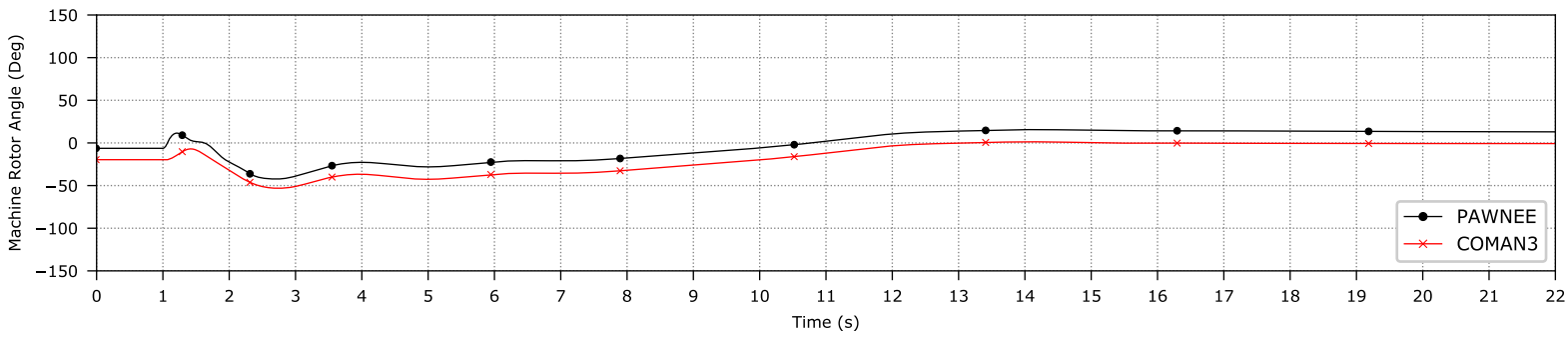


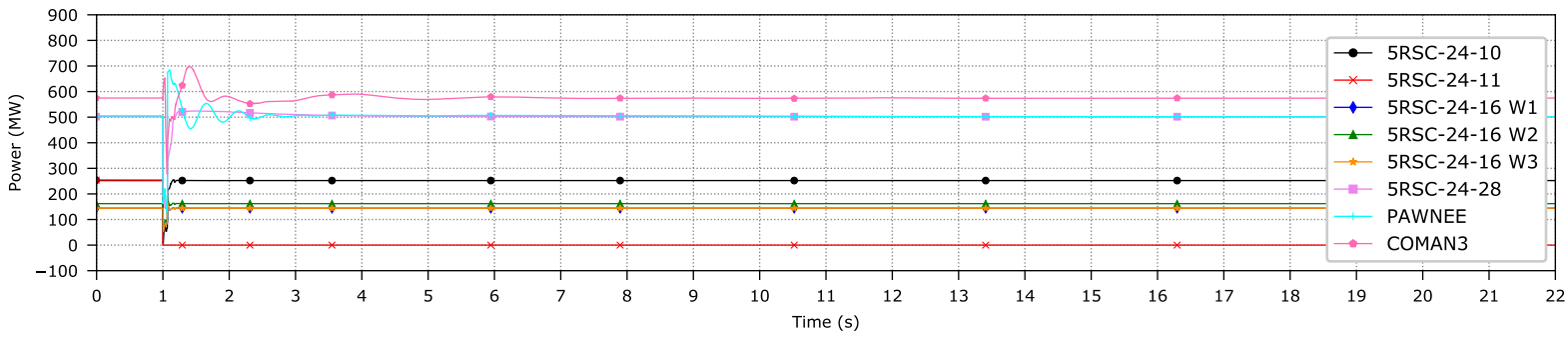


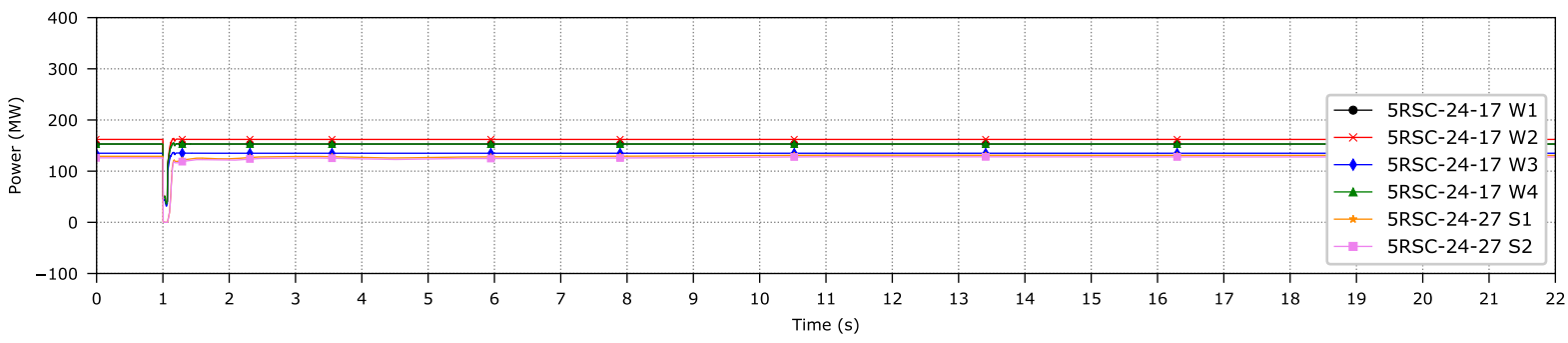


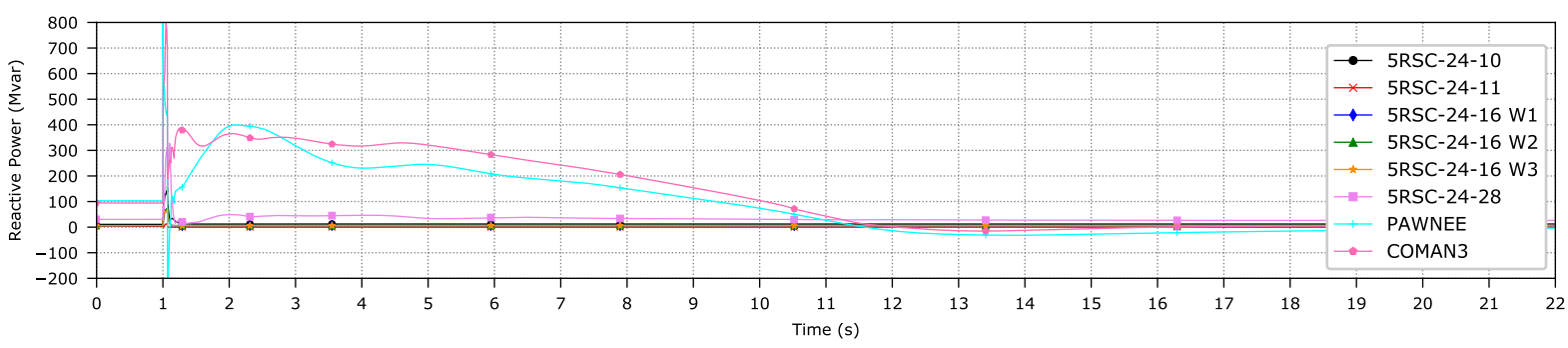


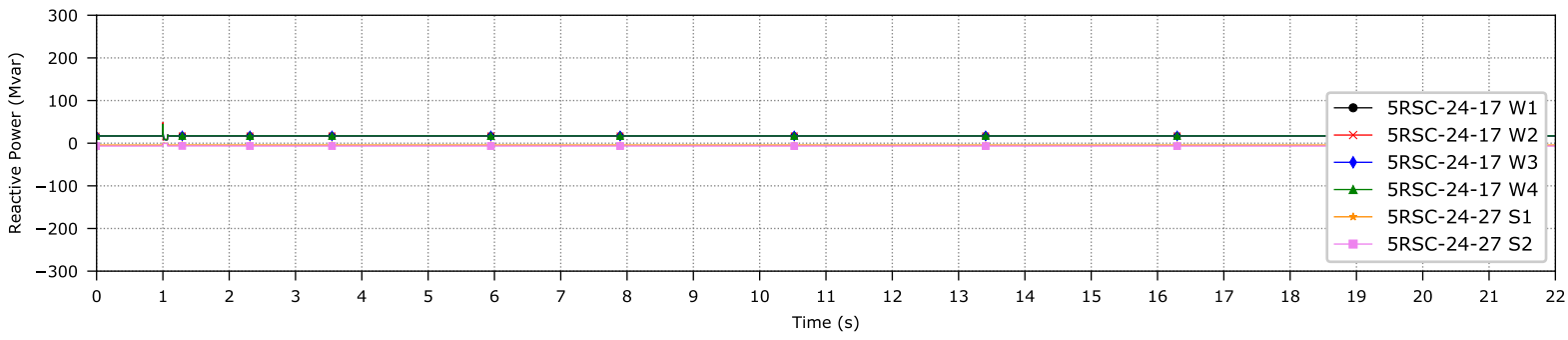
Ref. No. 03 - 5RSC-2024-11

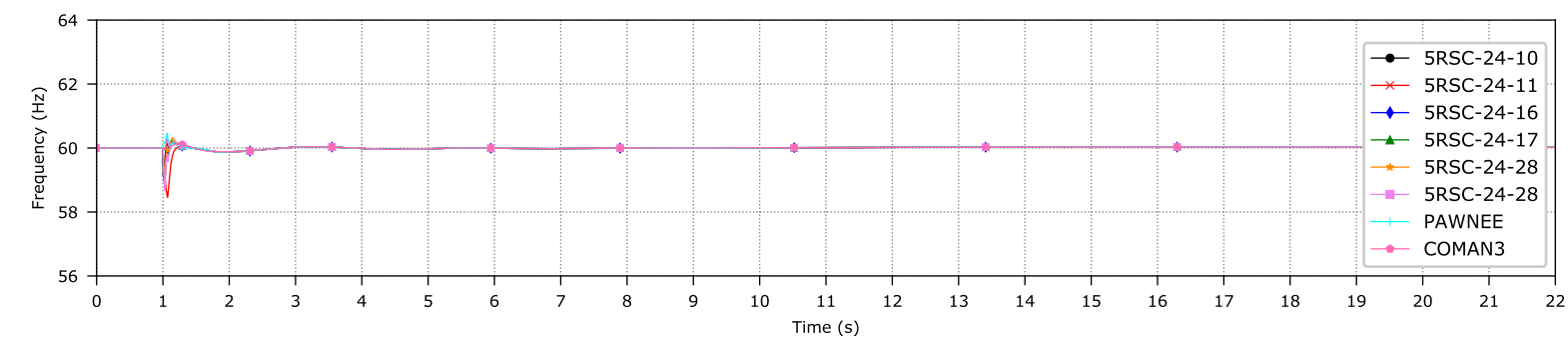


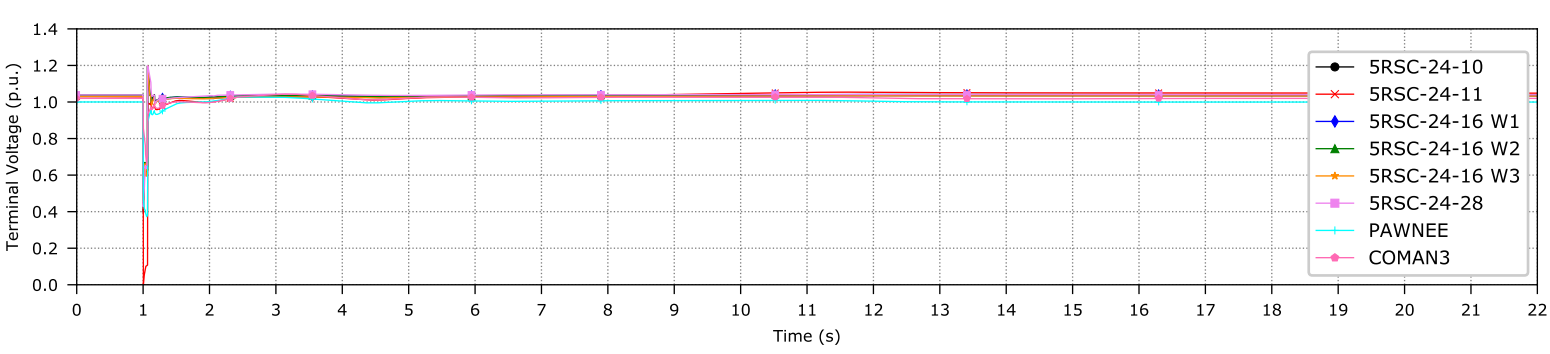


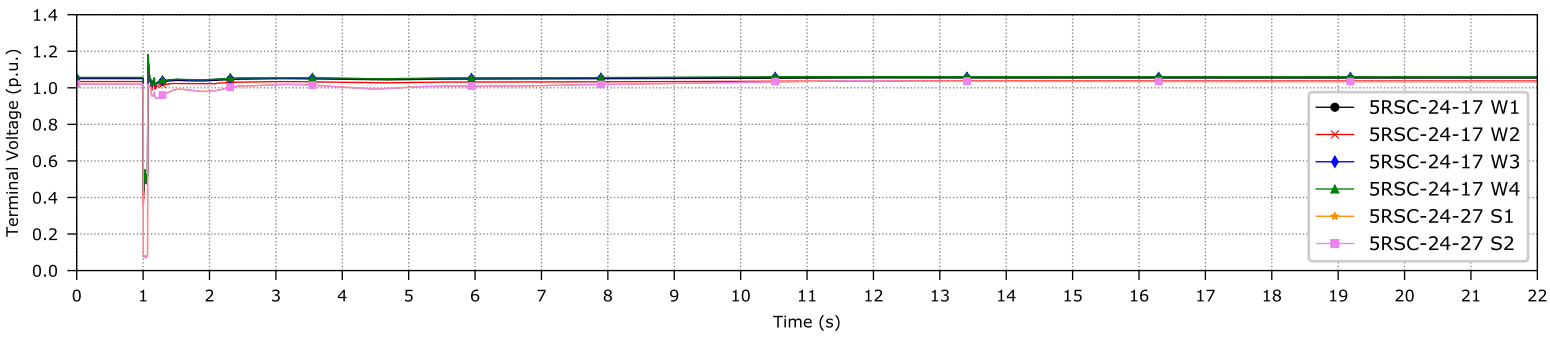


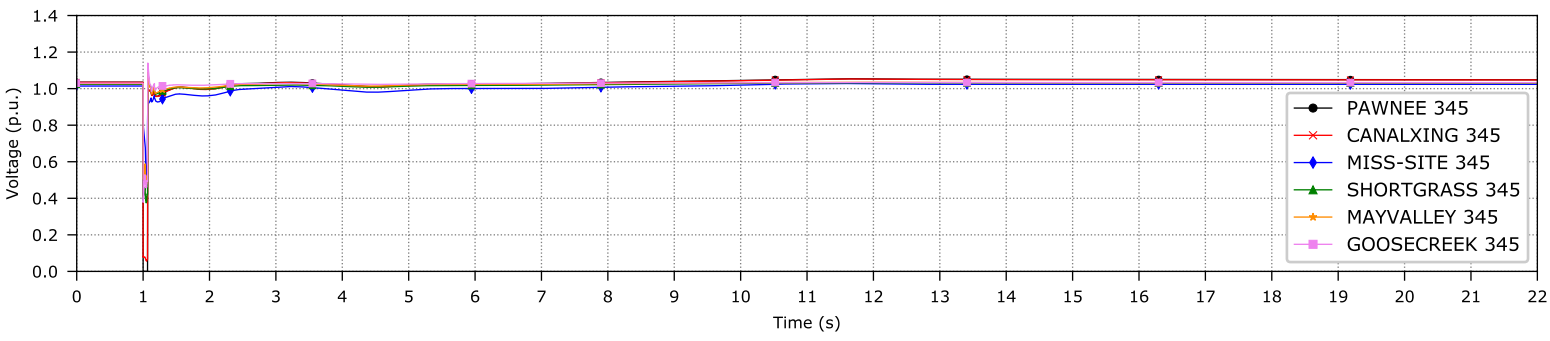












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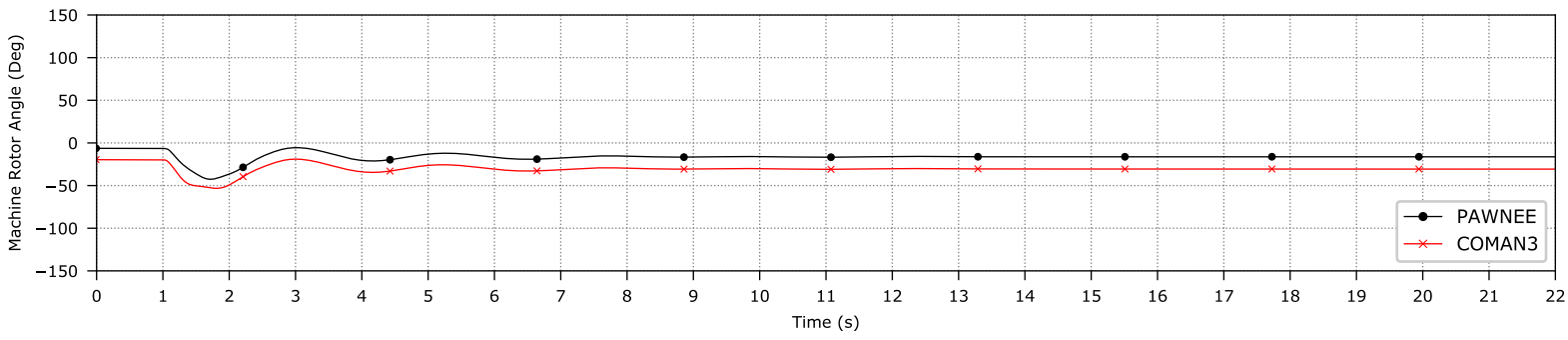
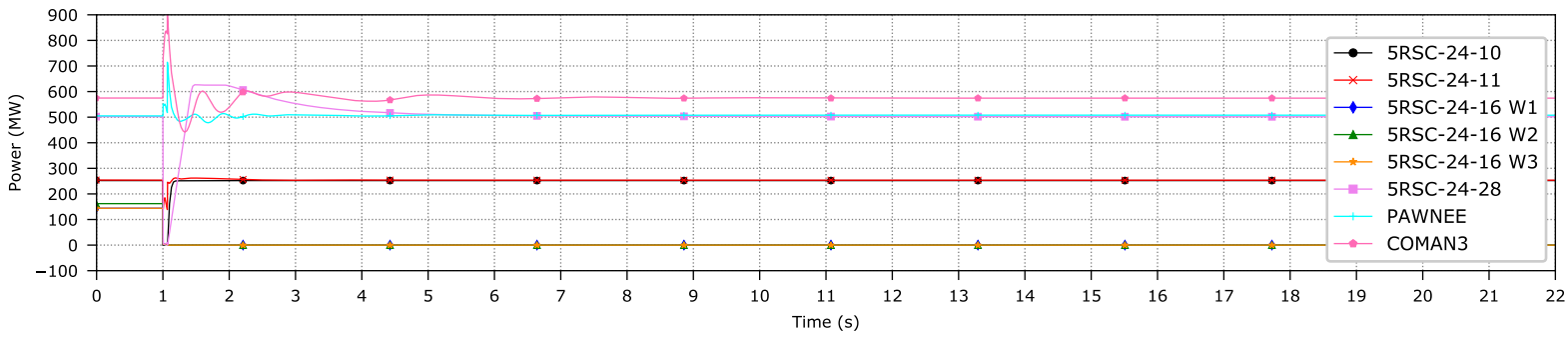
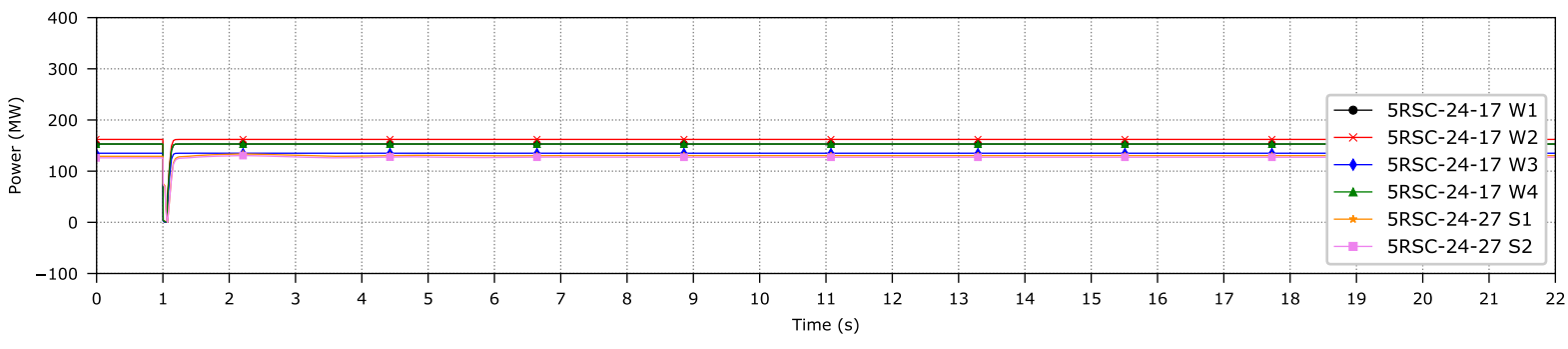
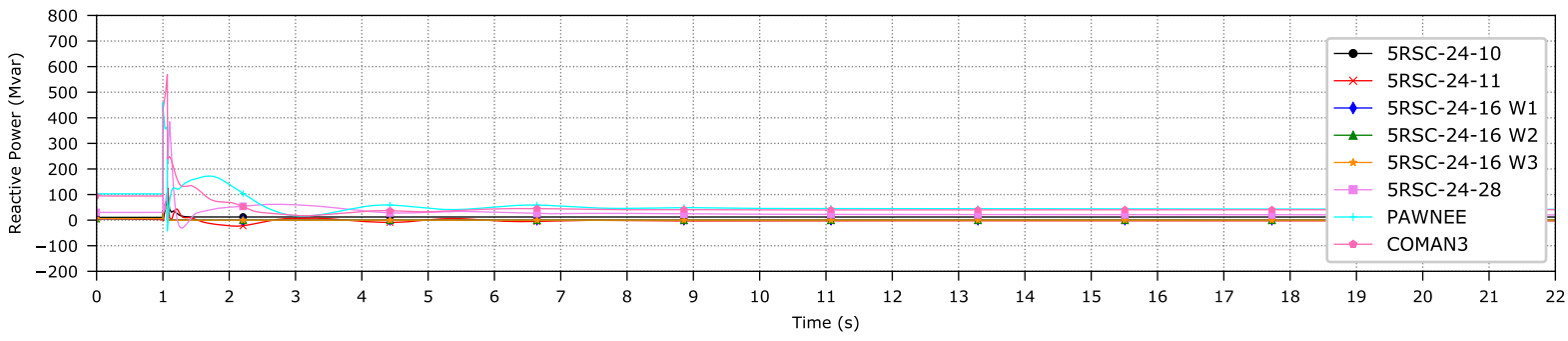
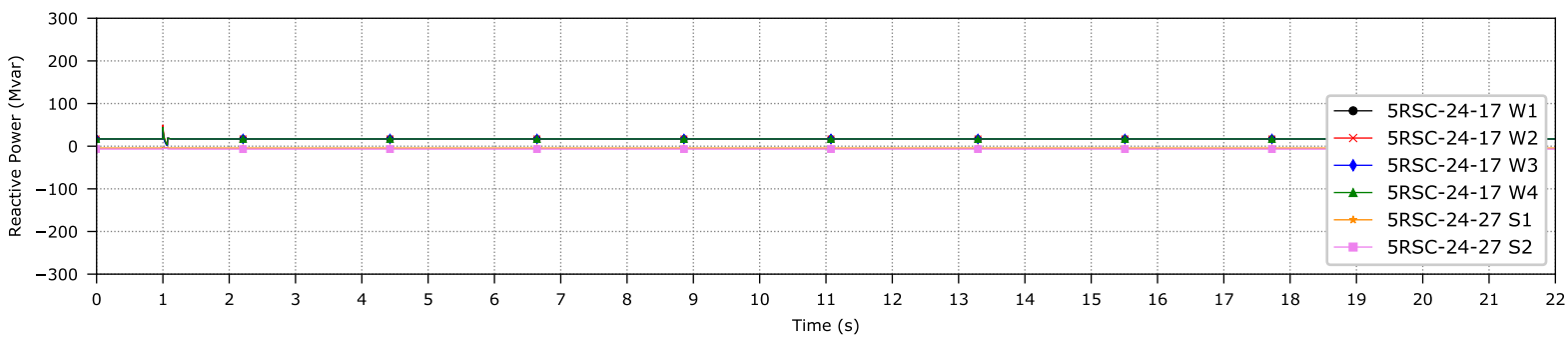
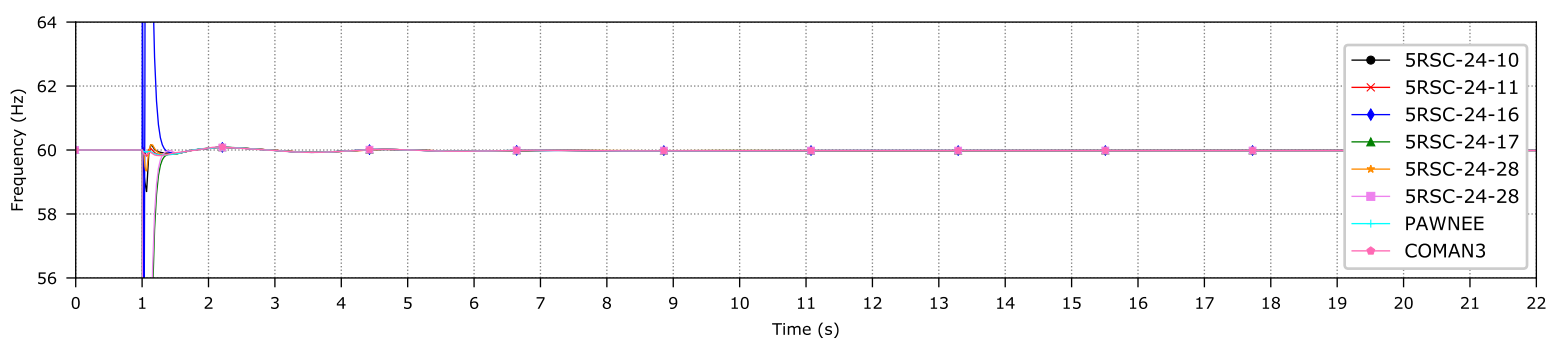


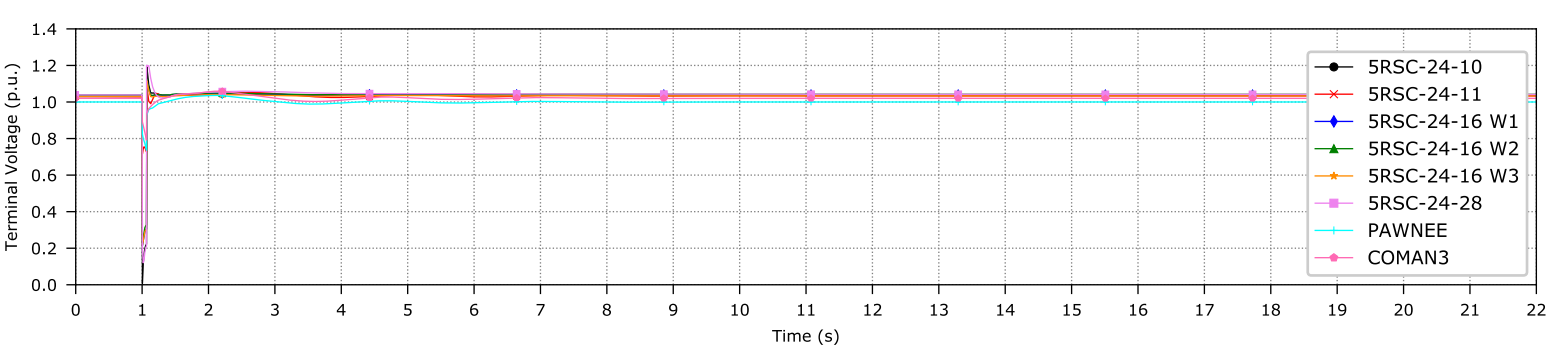


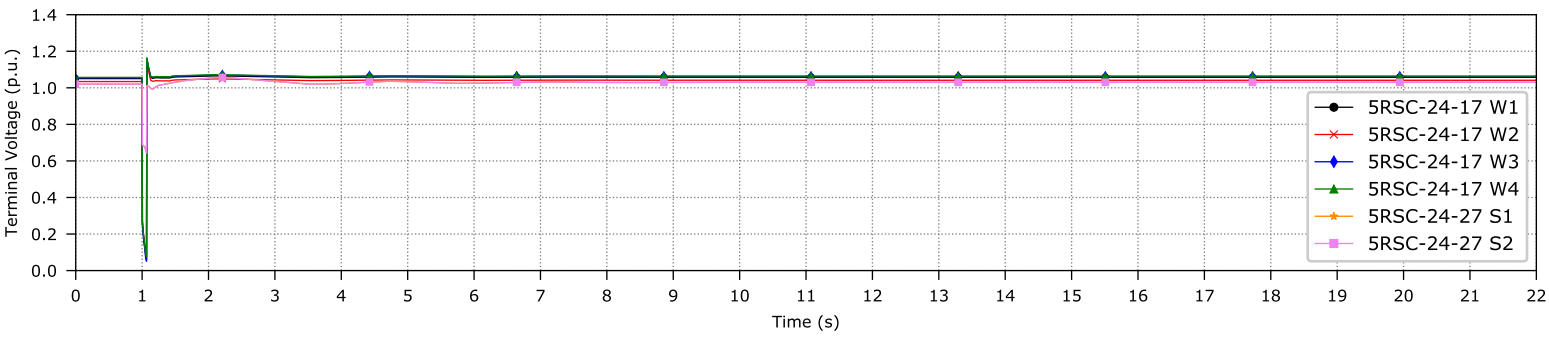


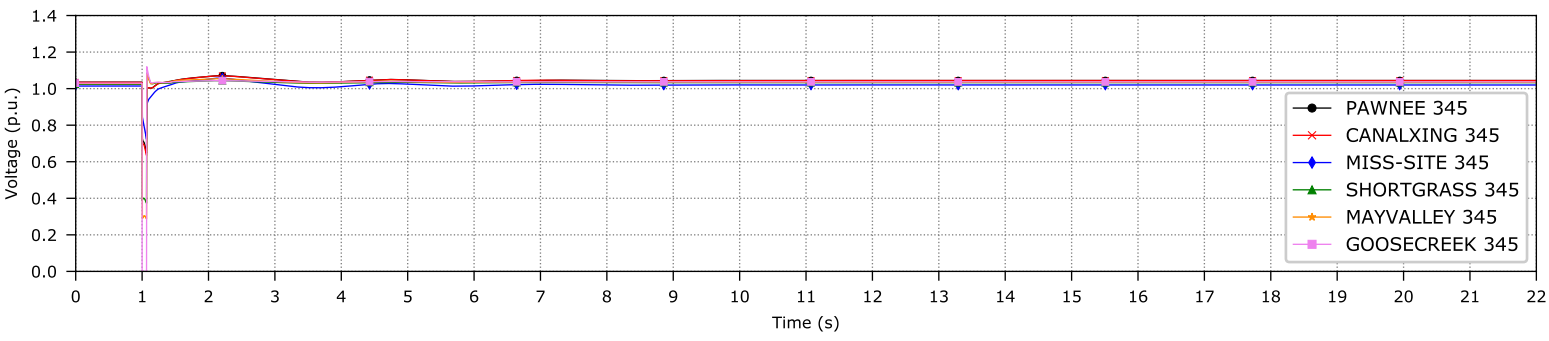




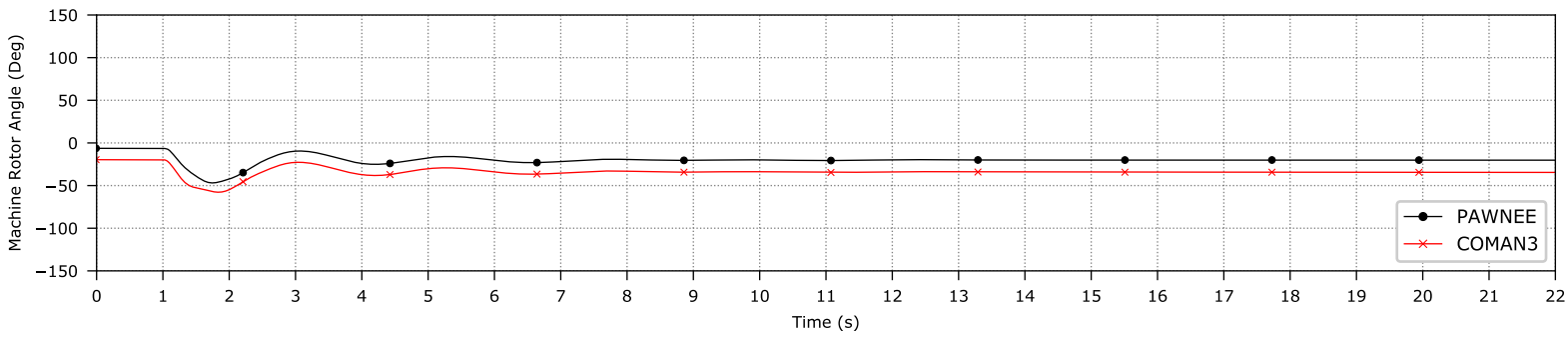


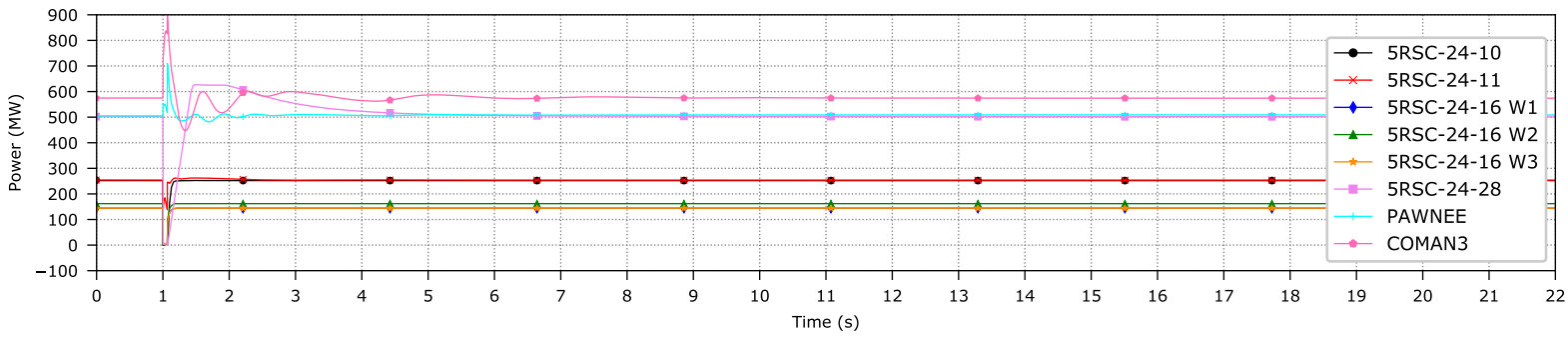


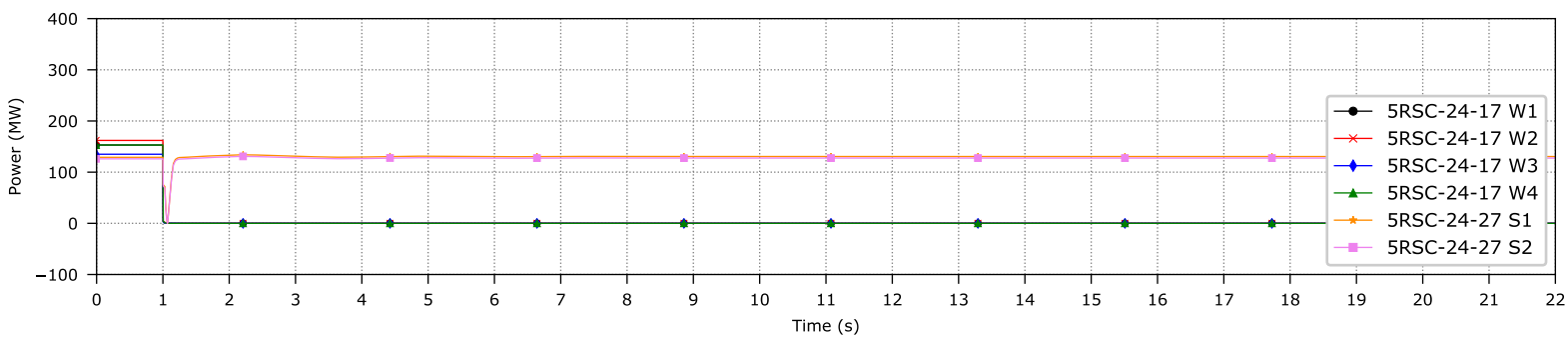


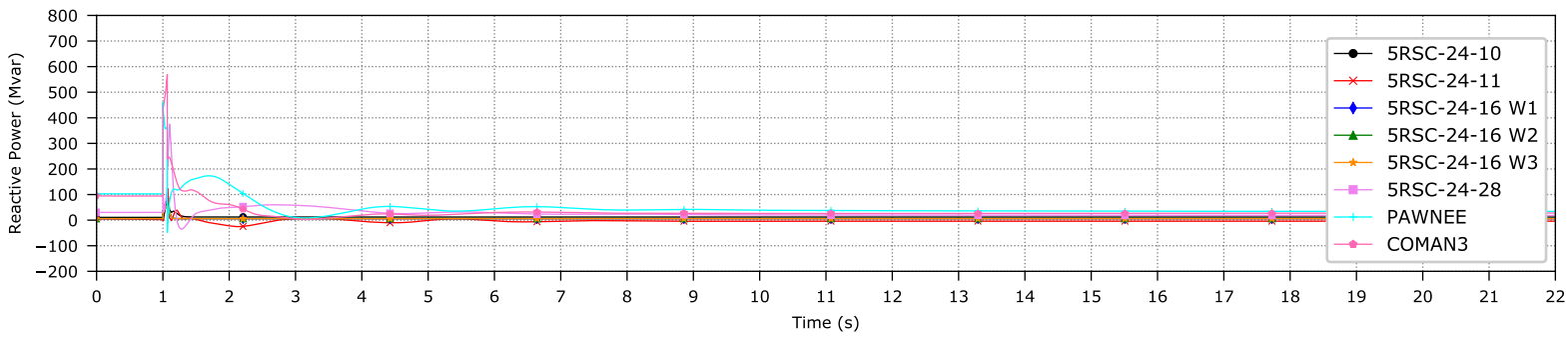


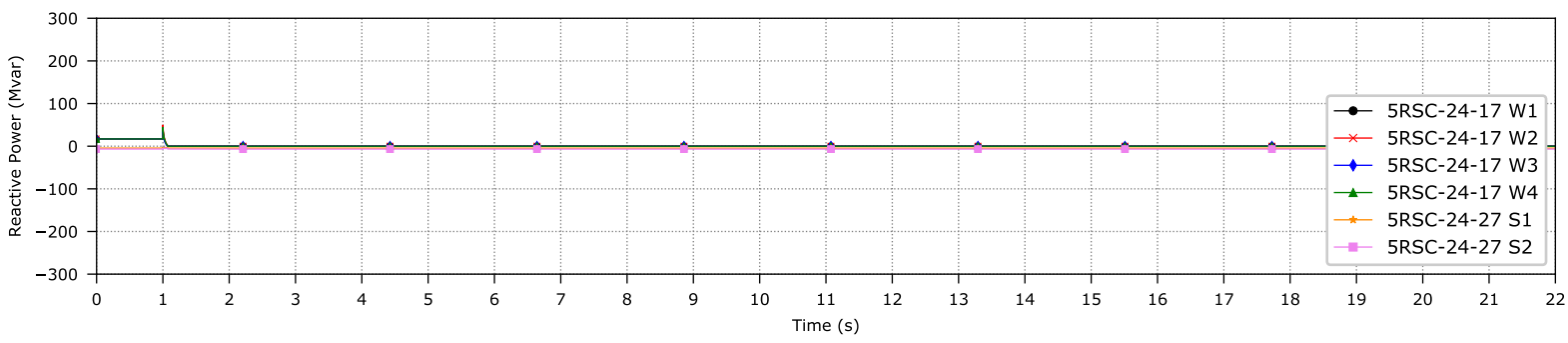
Ref. No. 05 - 5RSC-2024-17

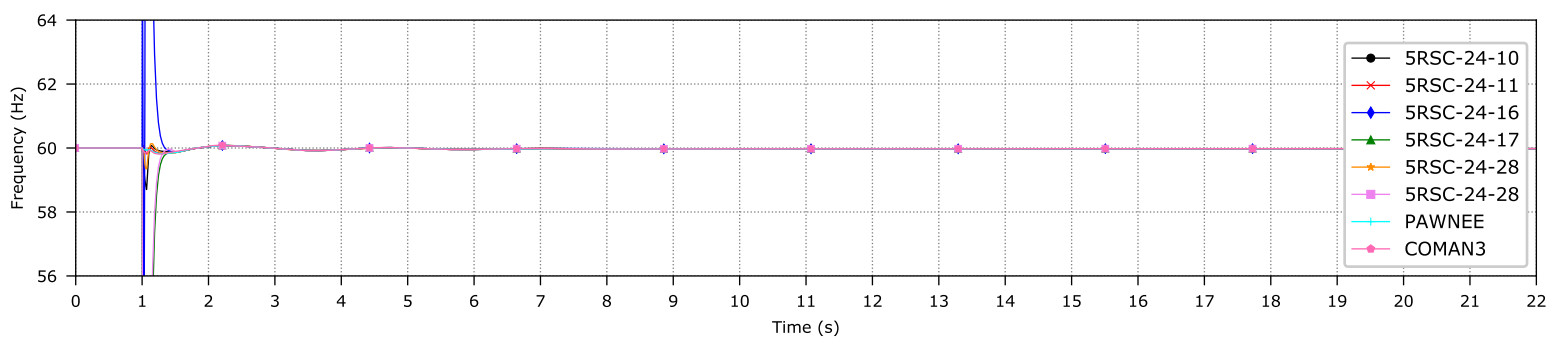


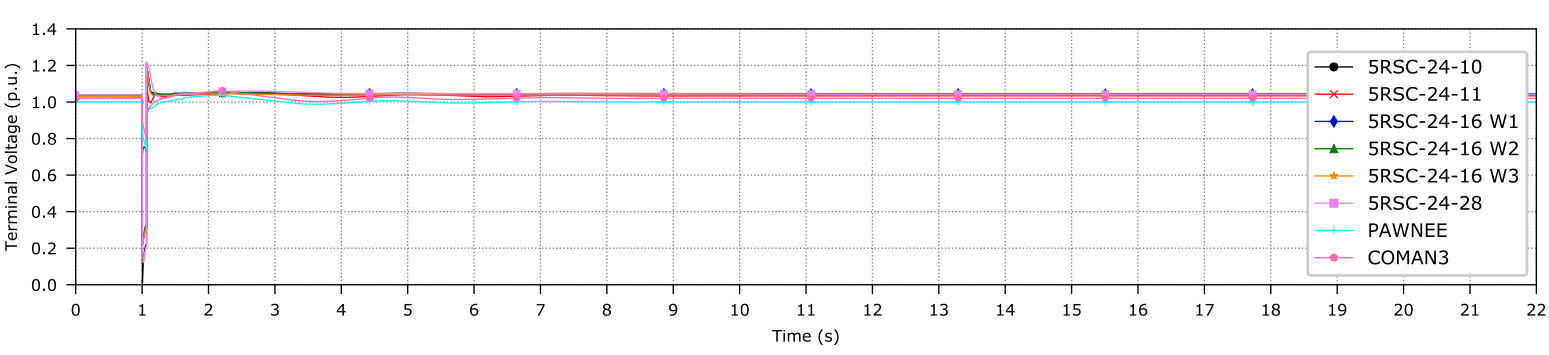


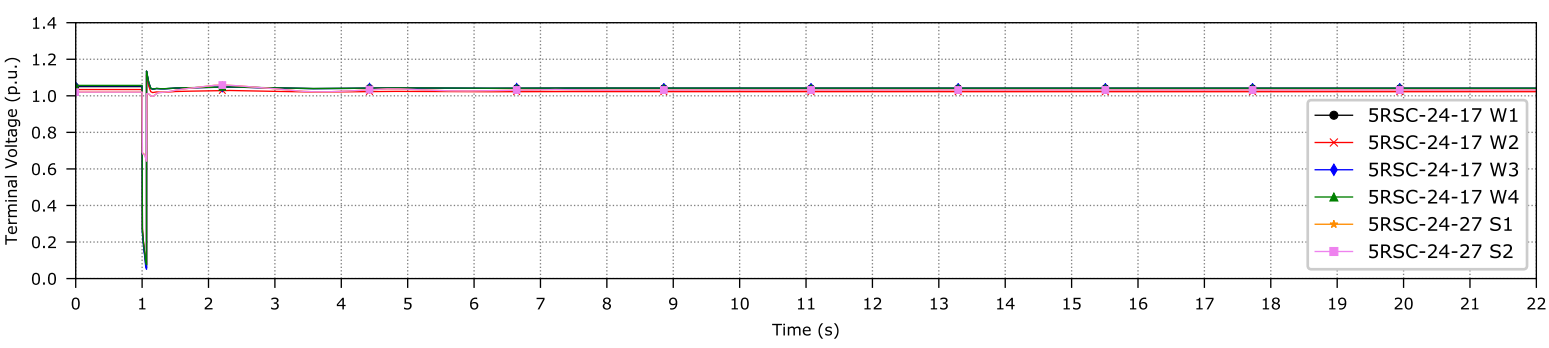


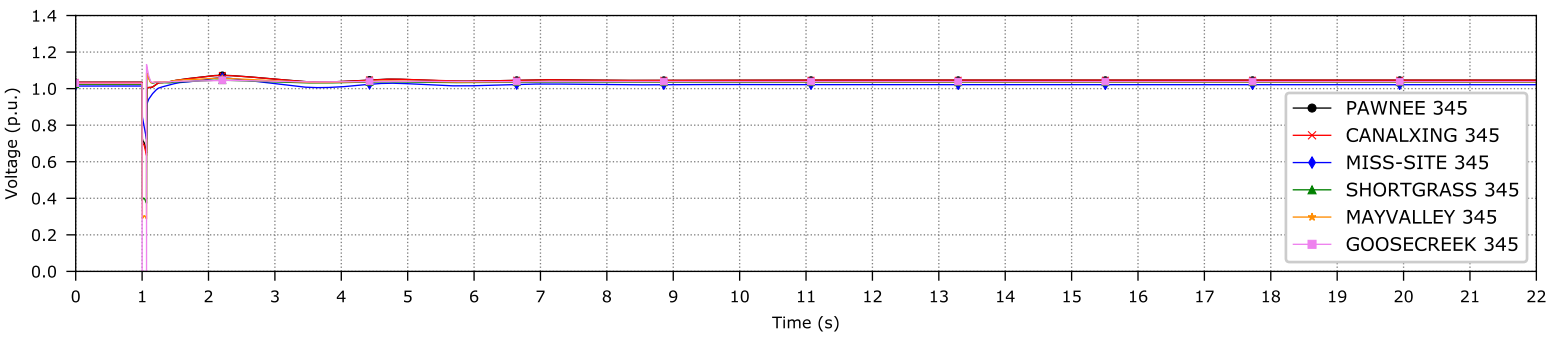




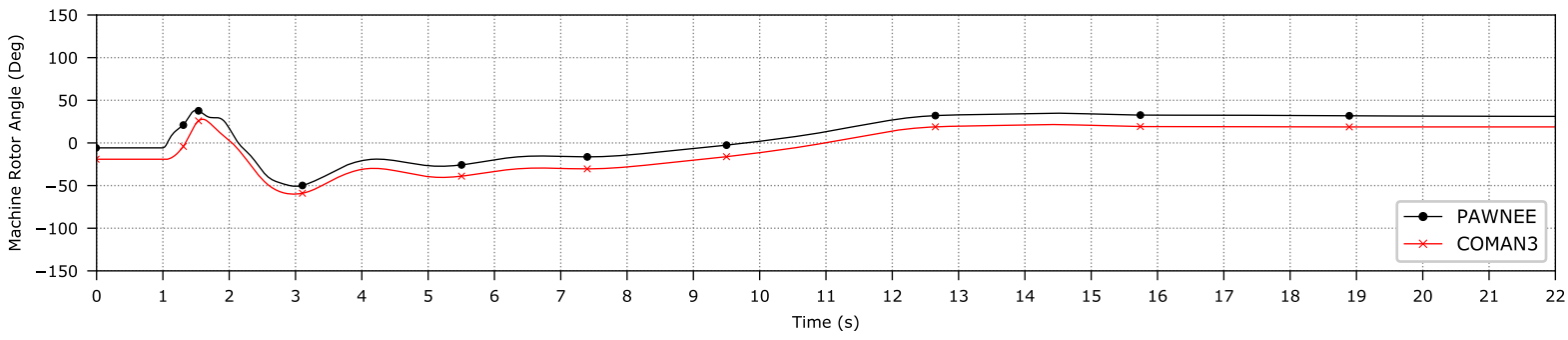


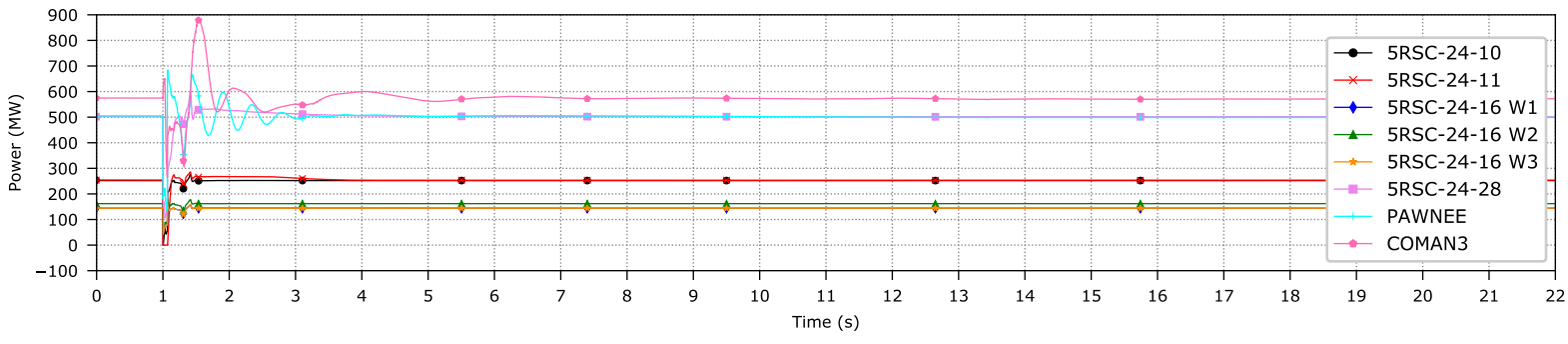


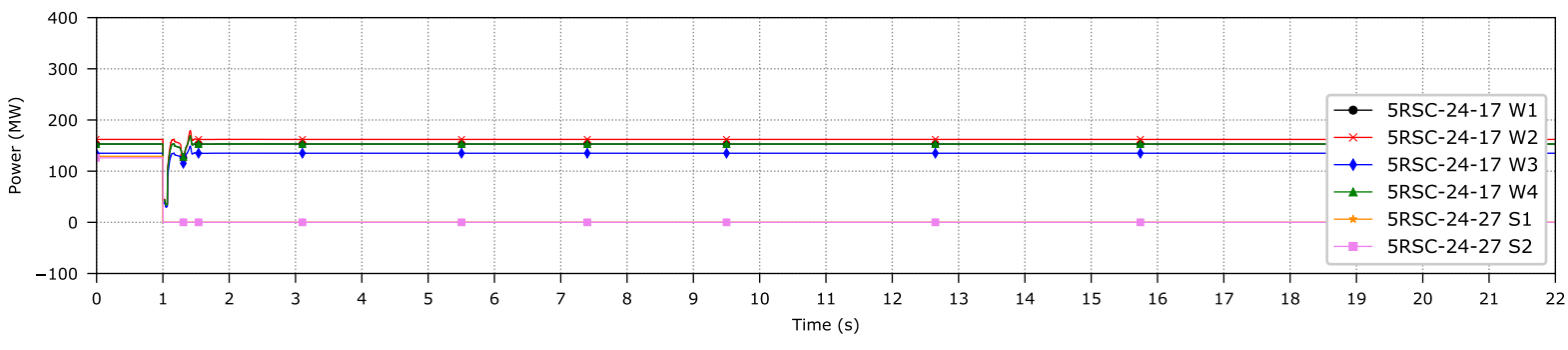


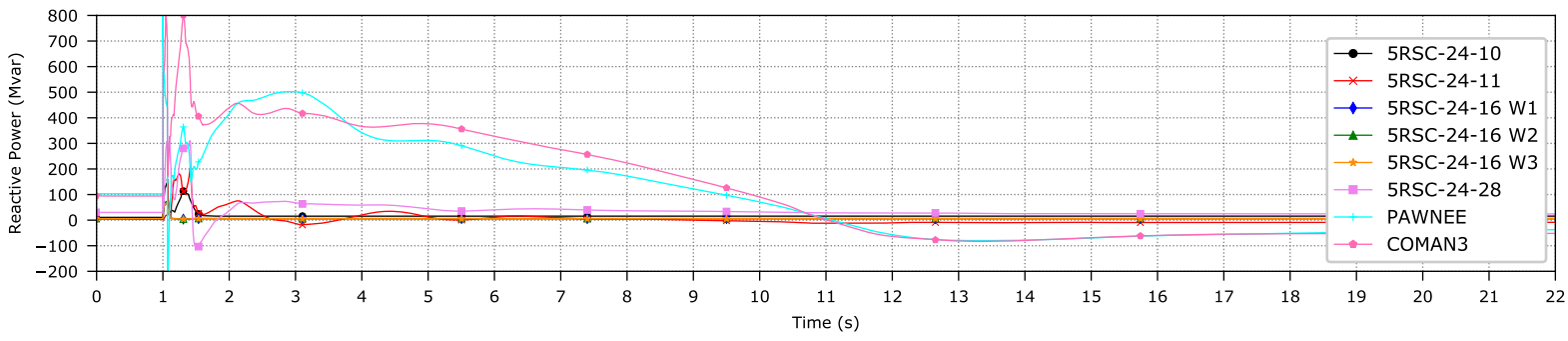


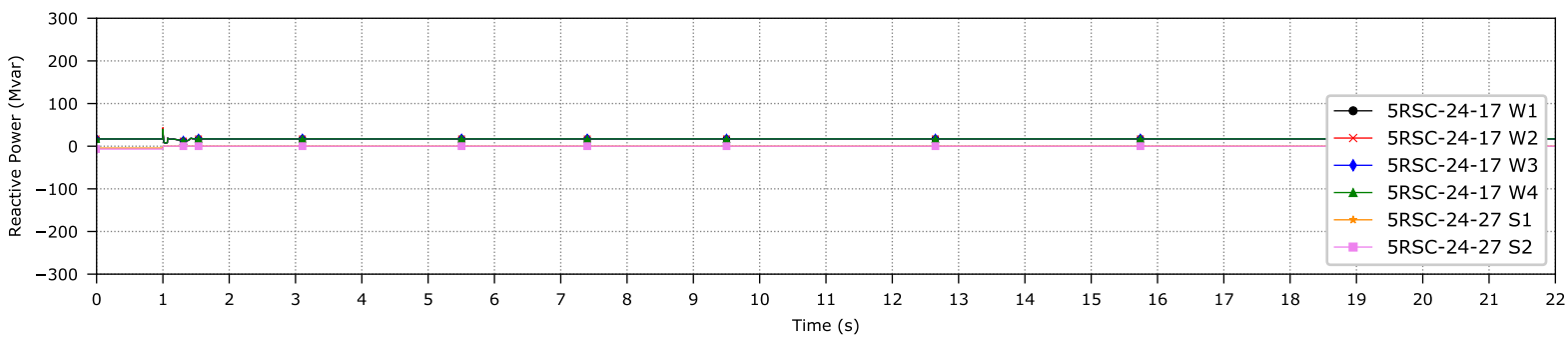
Ref. No. 06 - 5RSC-2024-27

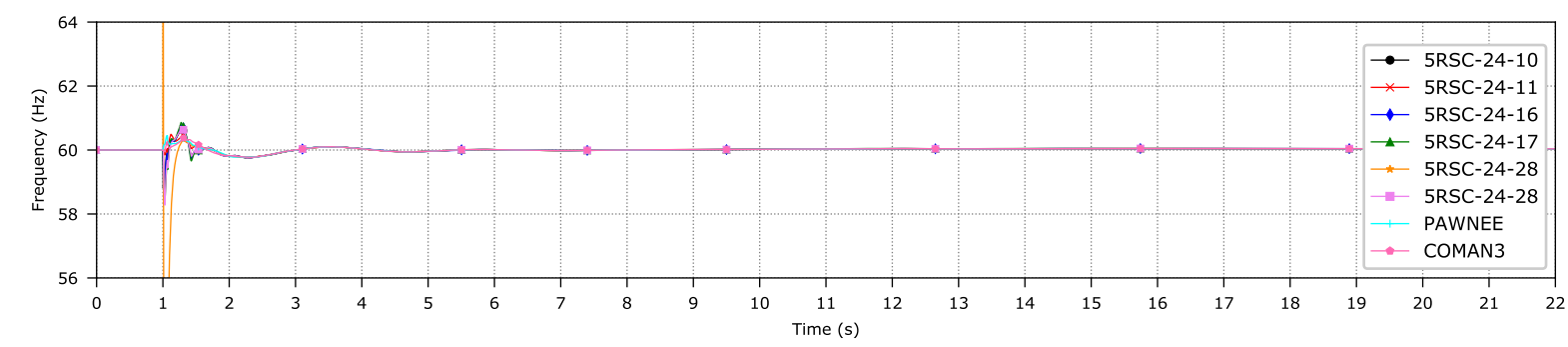


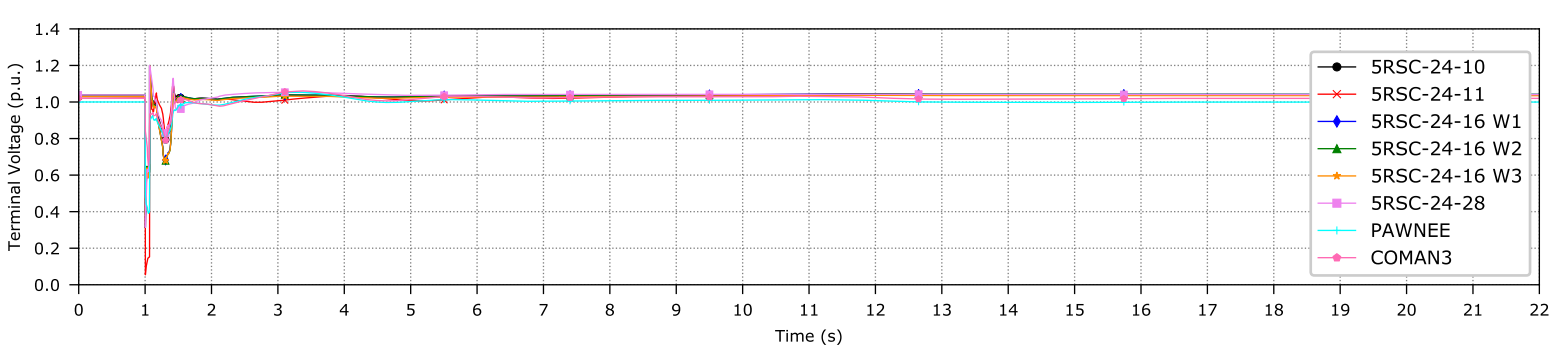


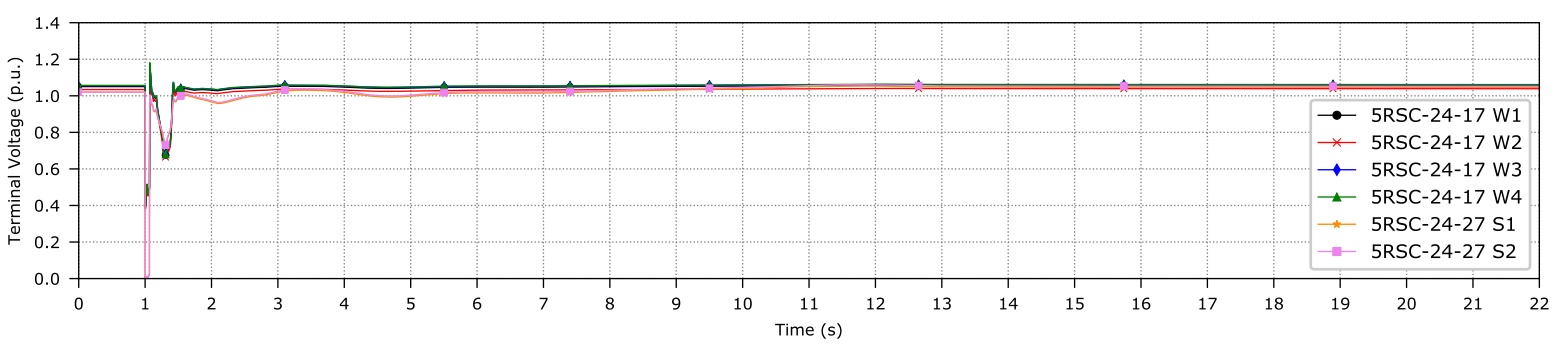


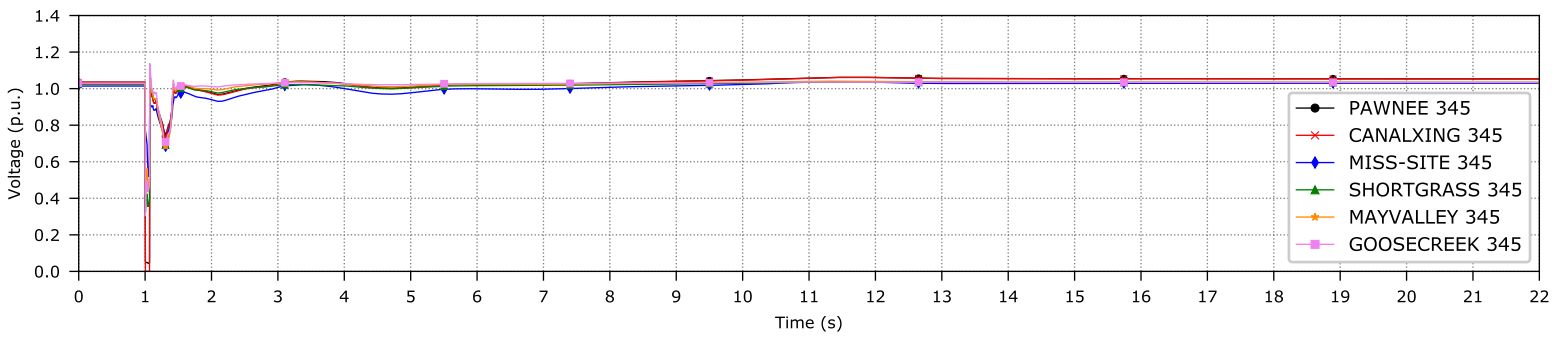




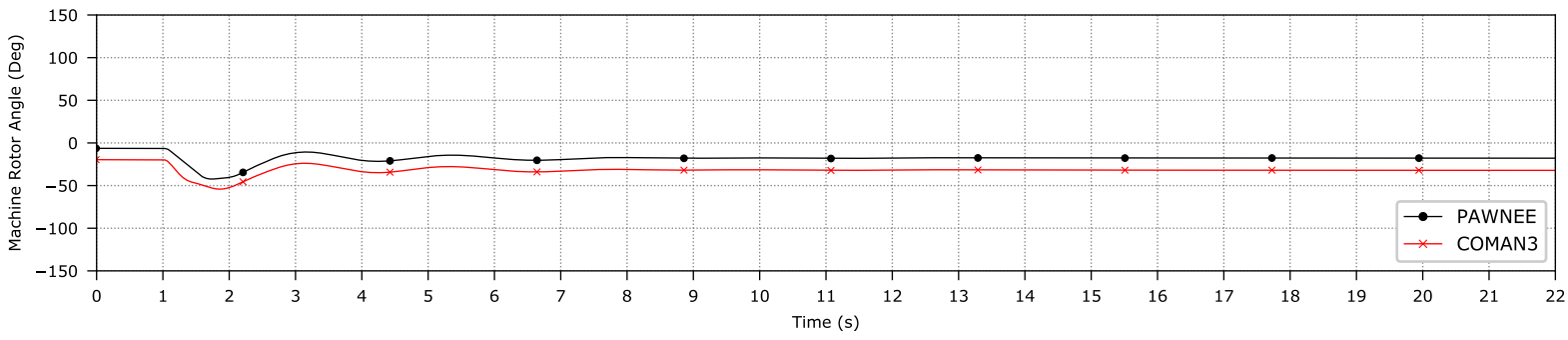


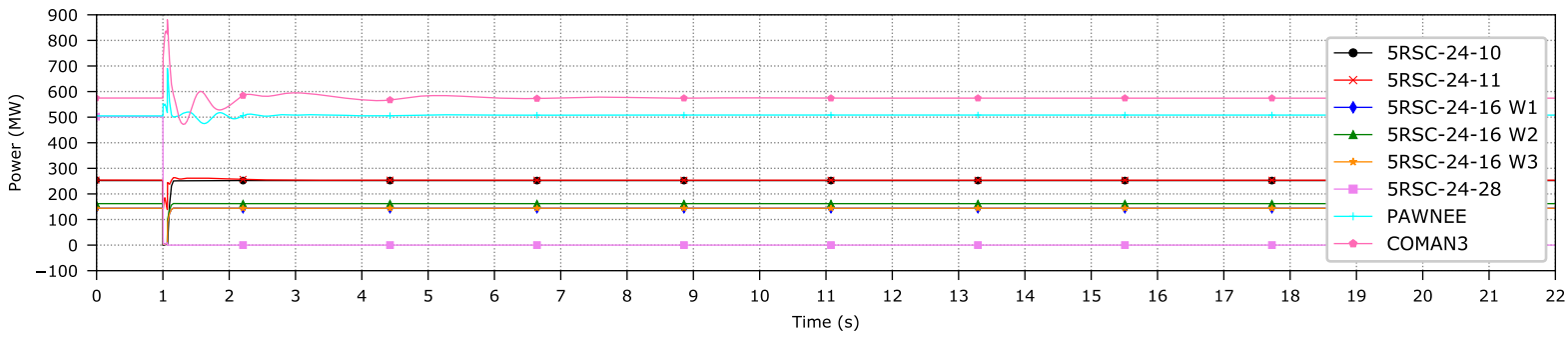


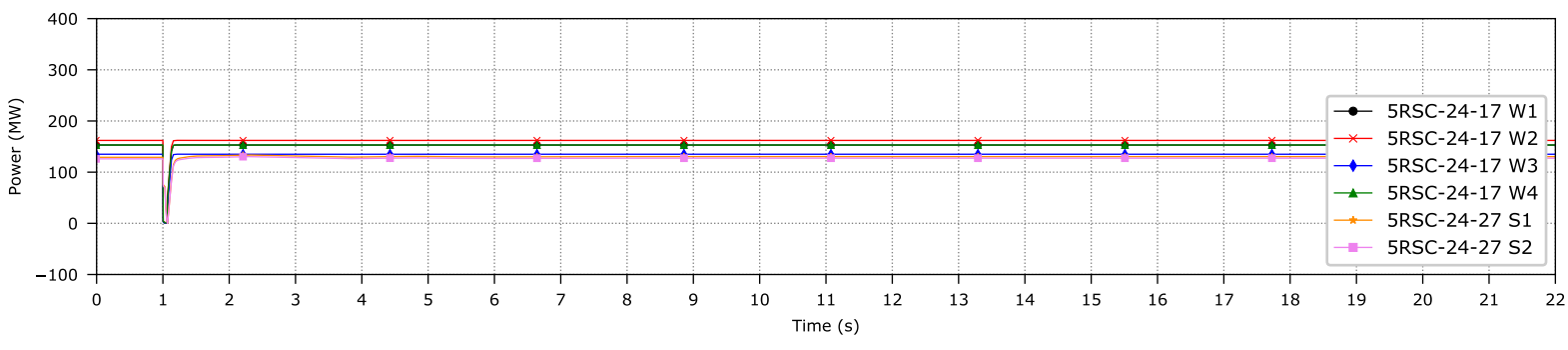


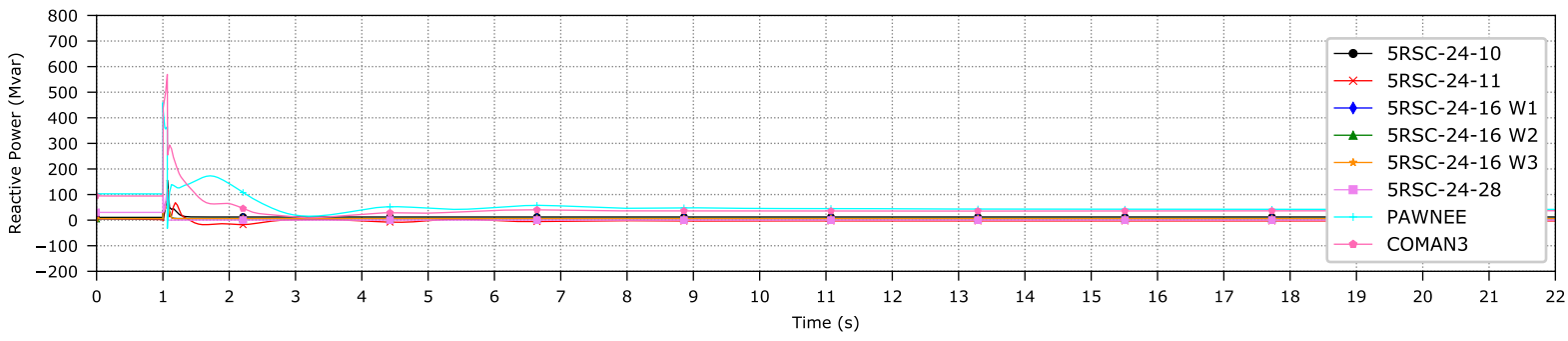


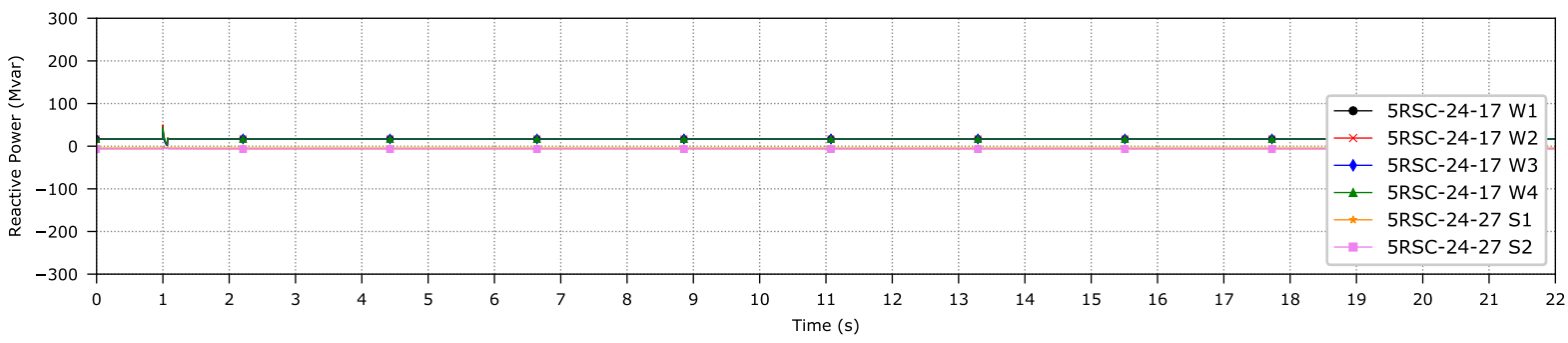
Ref. No. 07 - 5RSC-2024-28

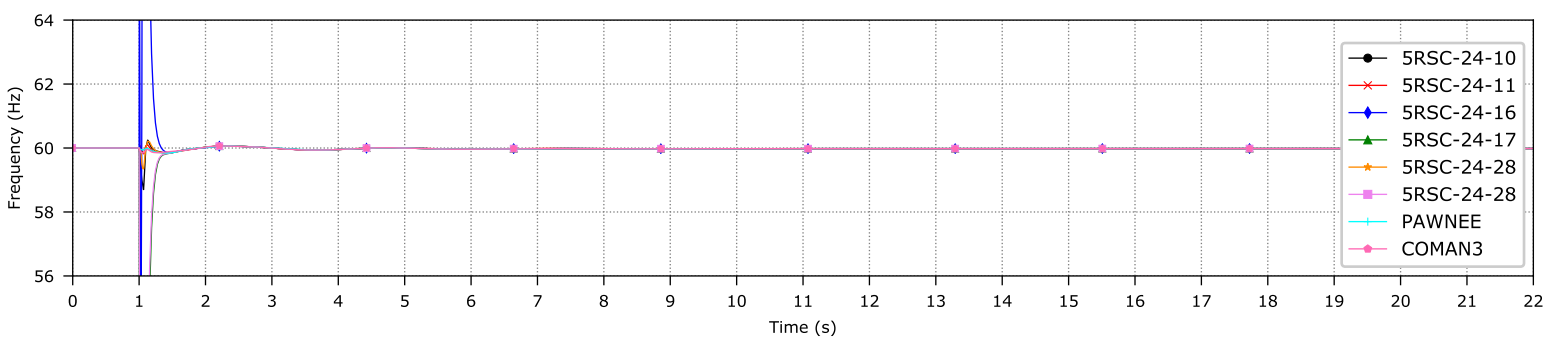


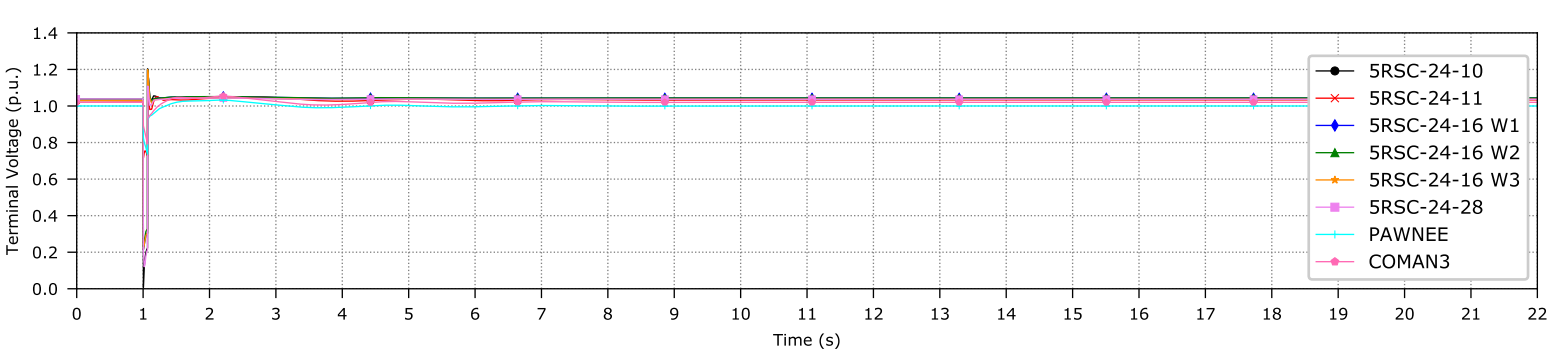


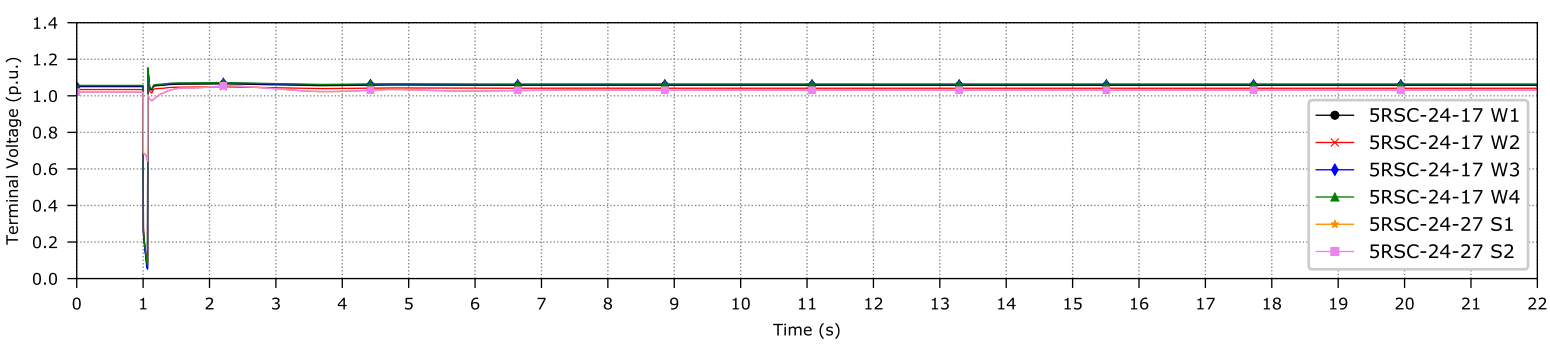


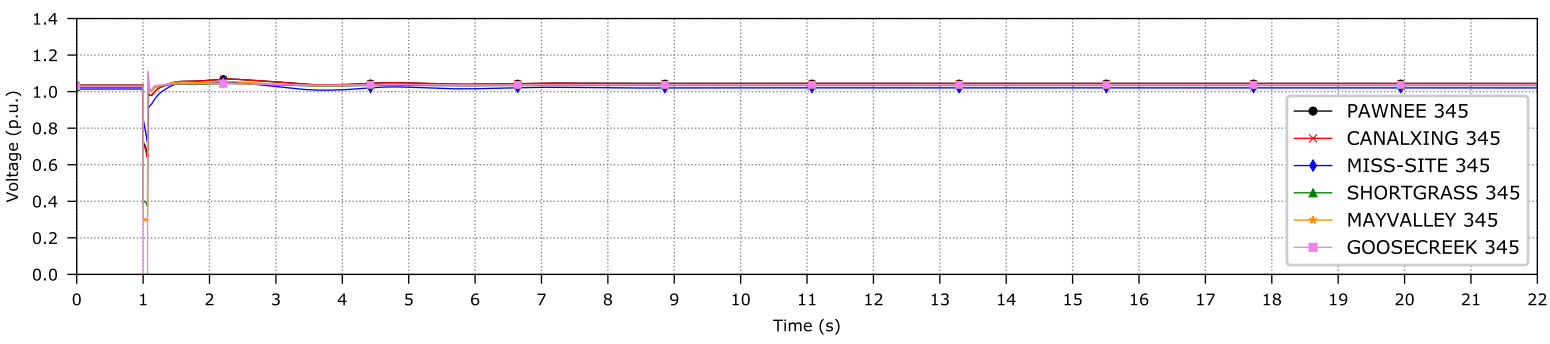




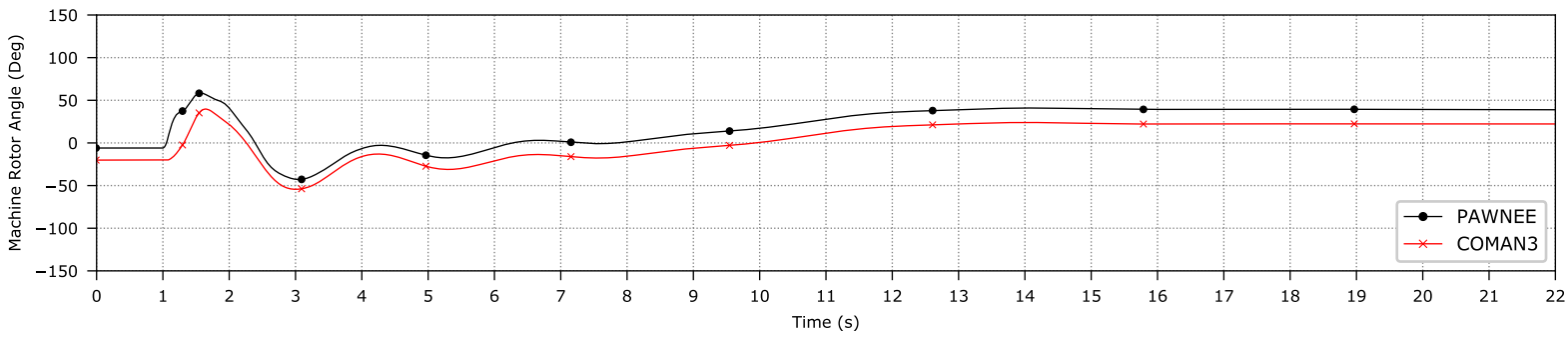


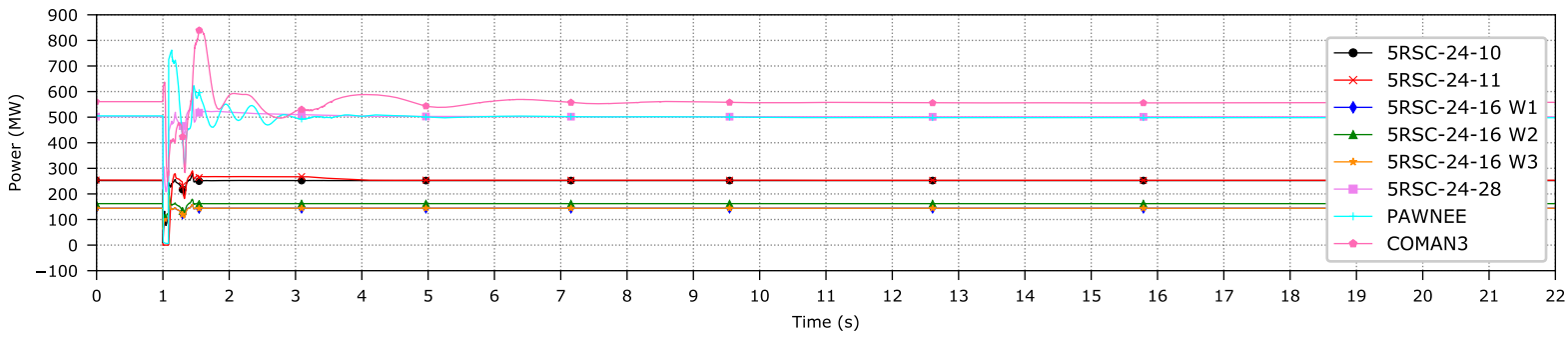


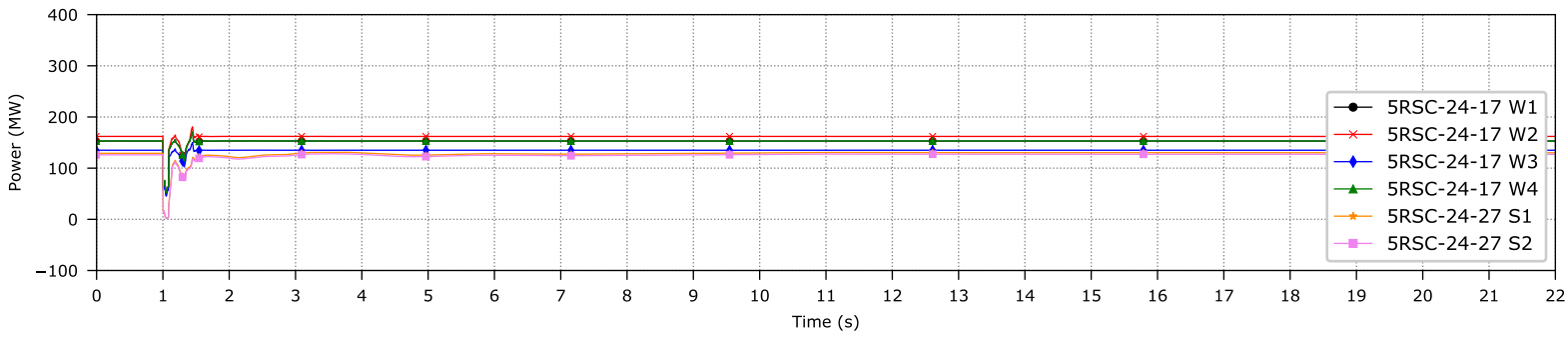


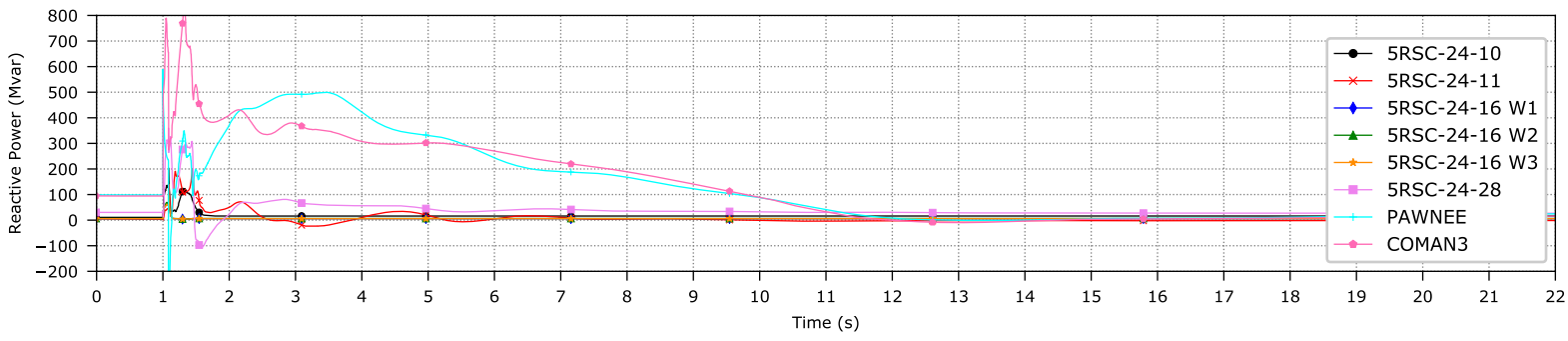


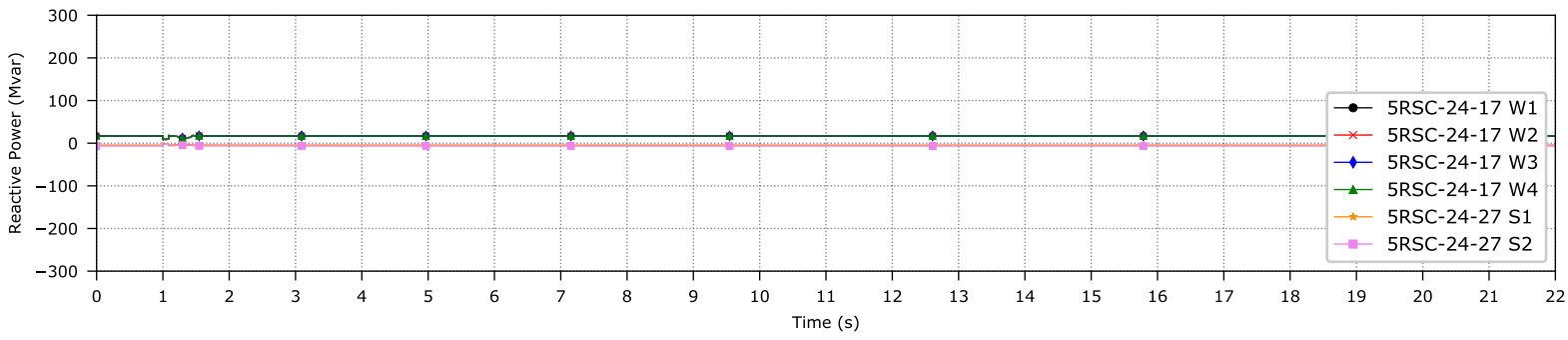
Ref. No. 08 - LoTC_084

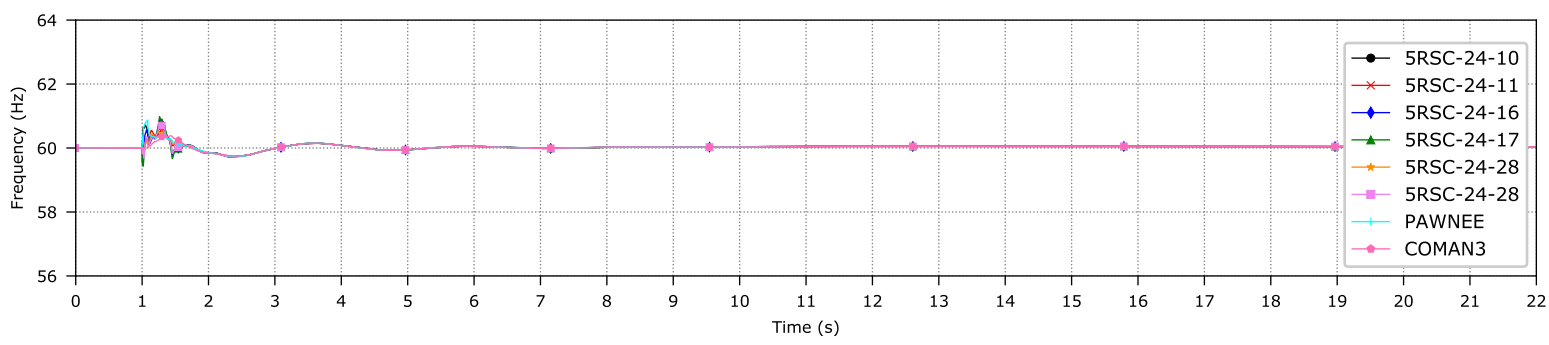


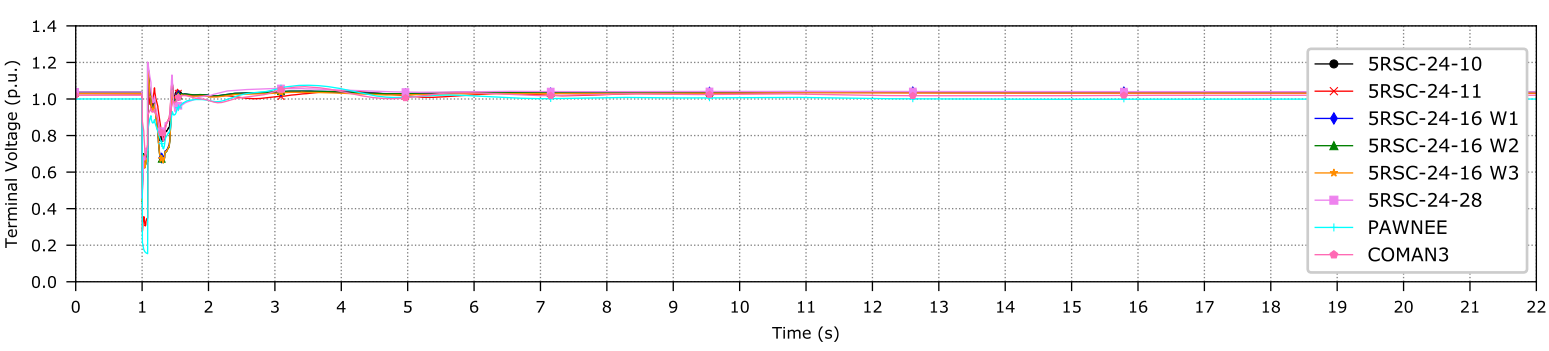


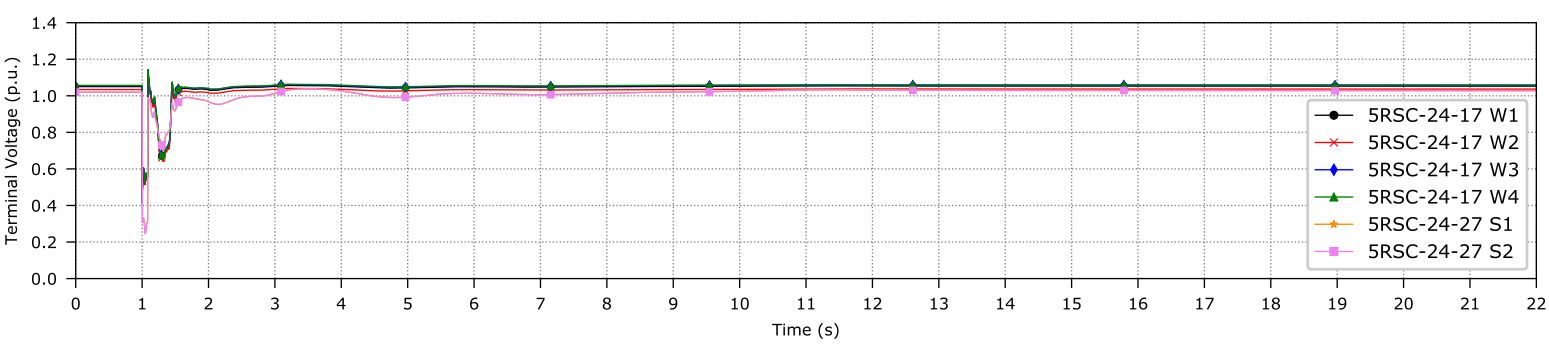


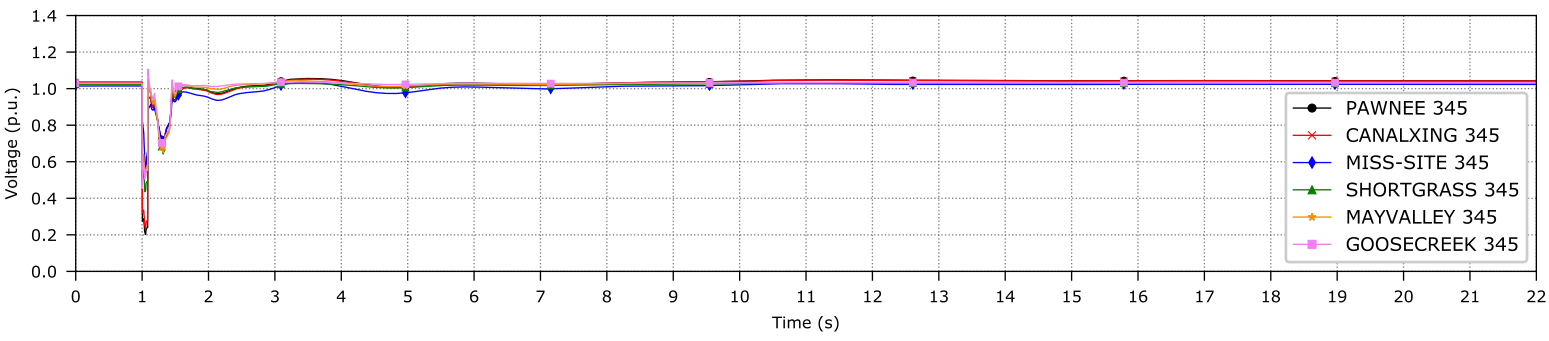




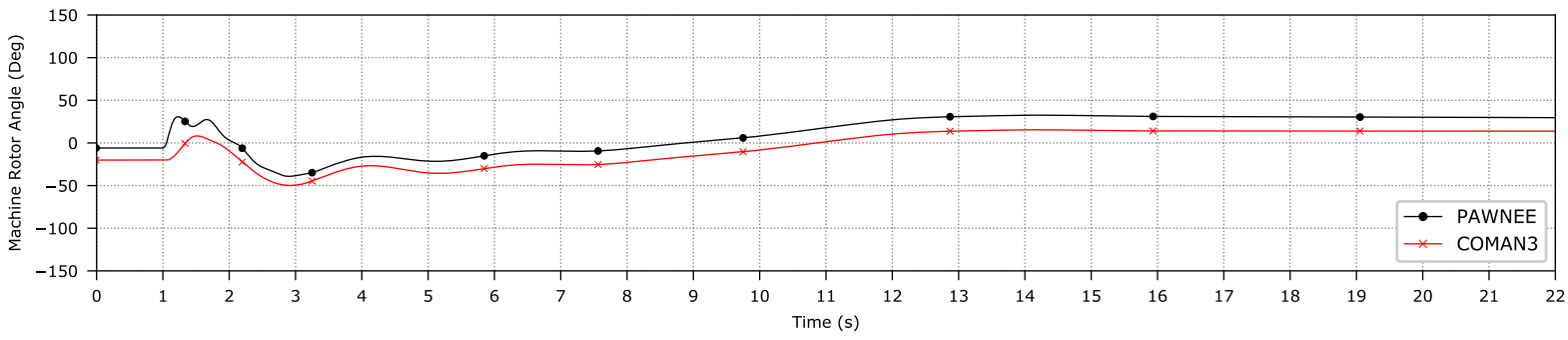


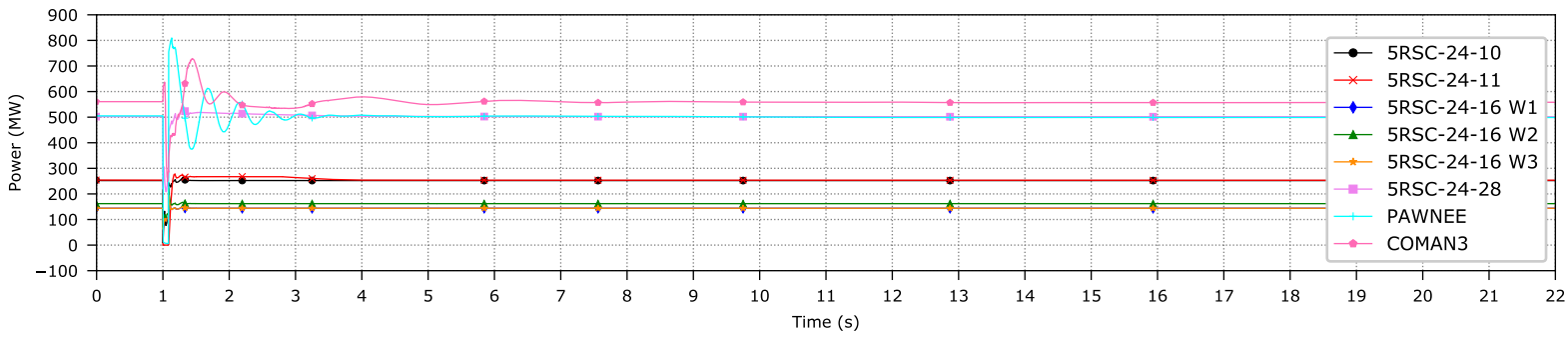


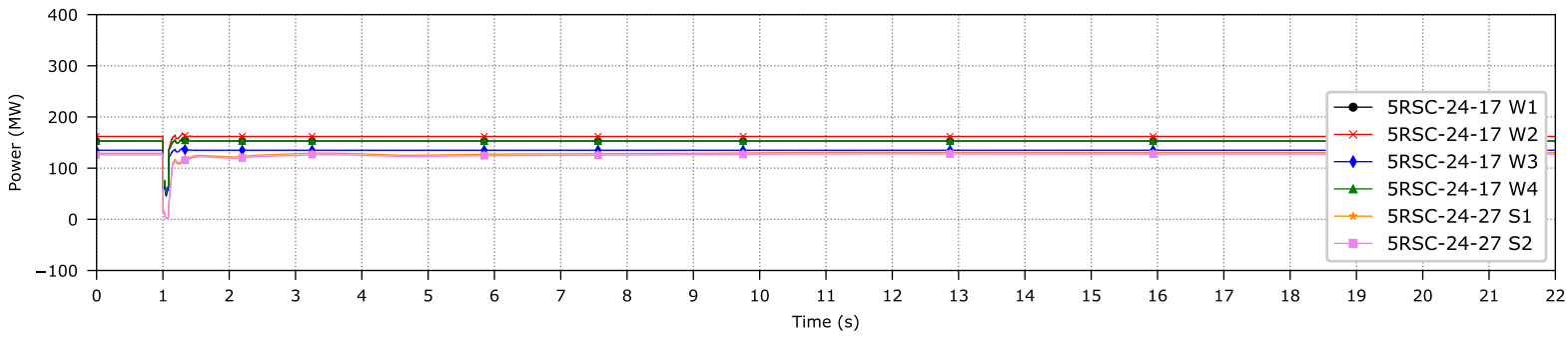


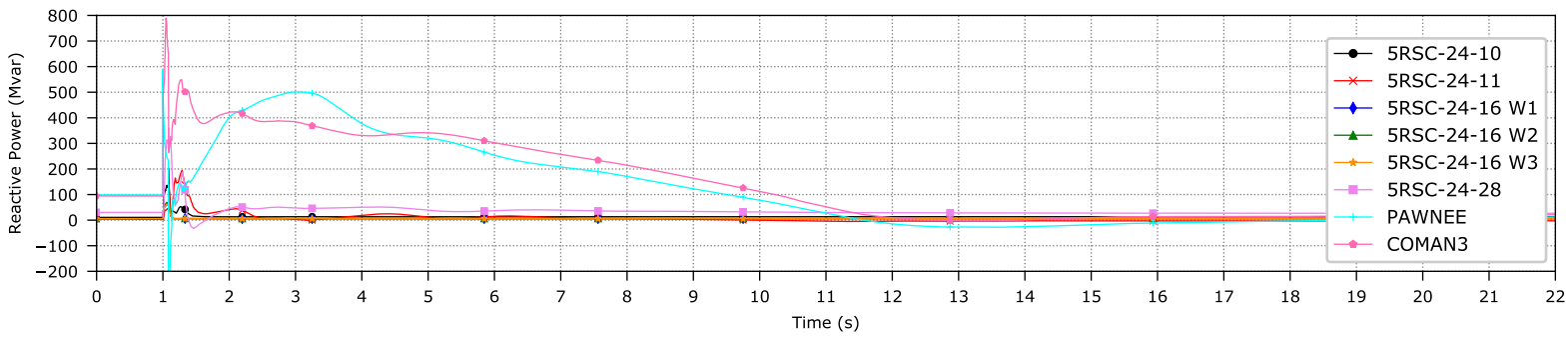


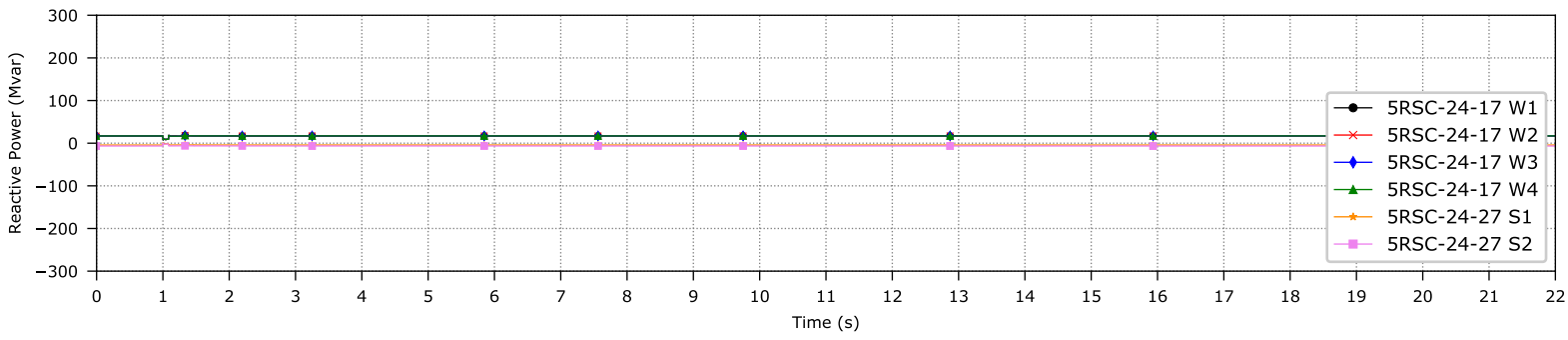
Ref. No. 09 - LoTC_085

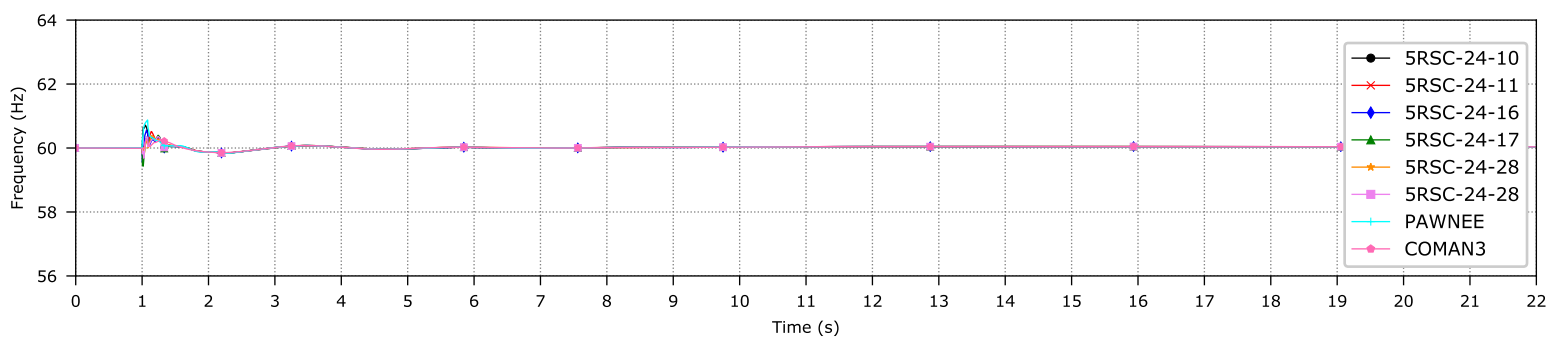


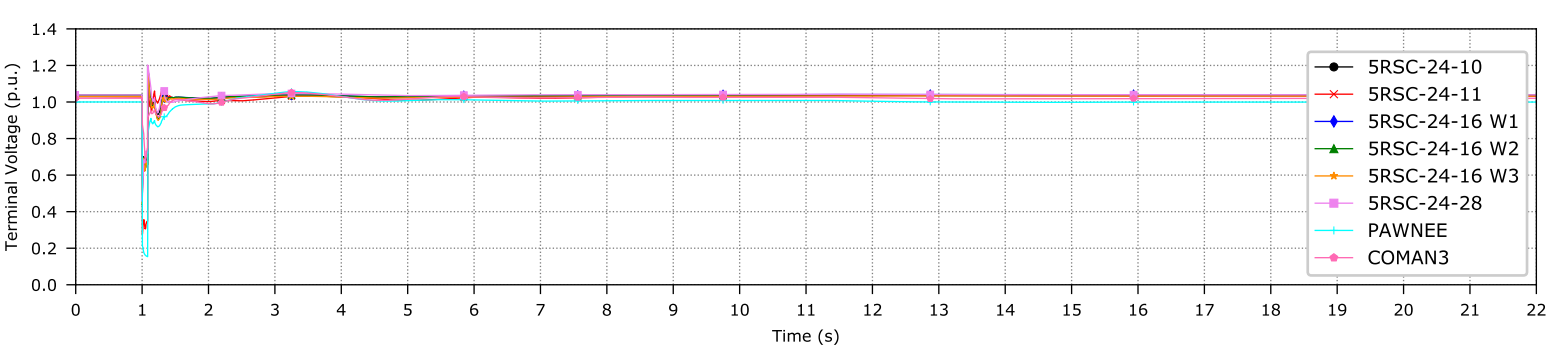


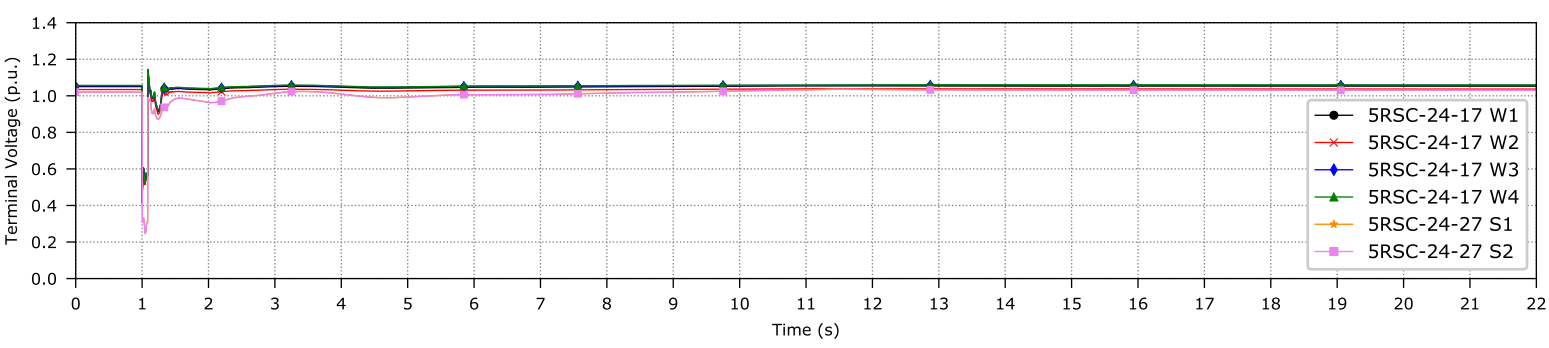


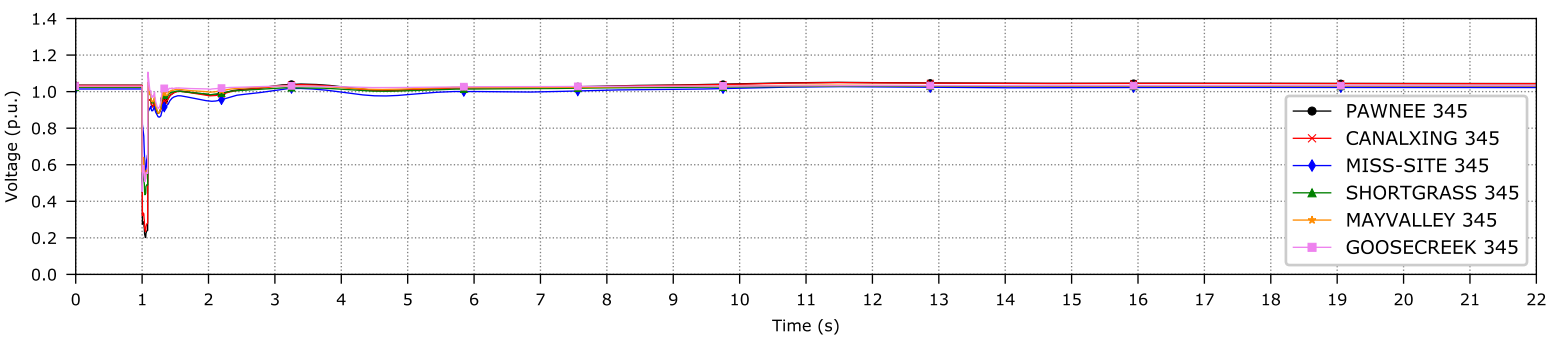




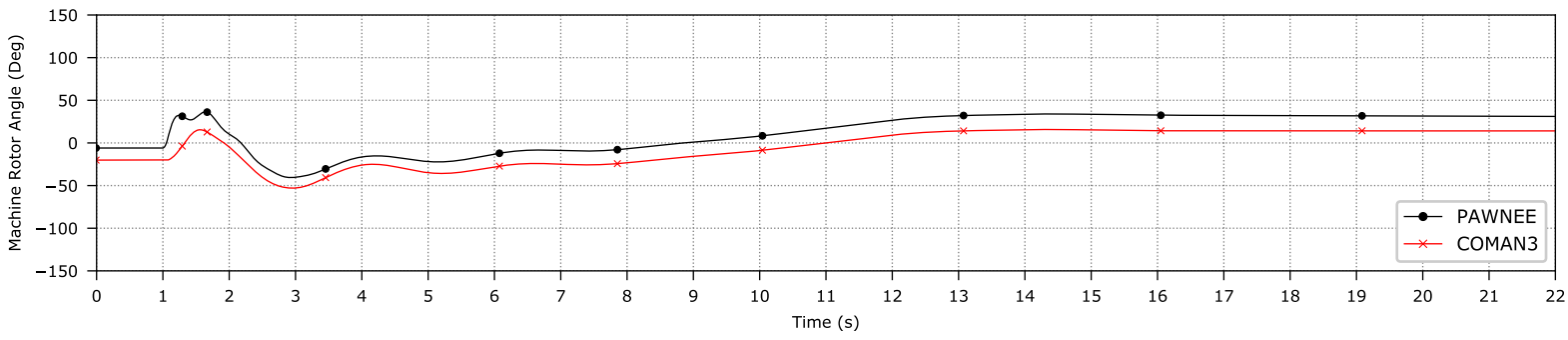


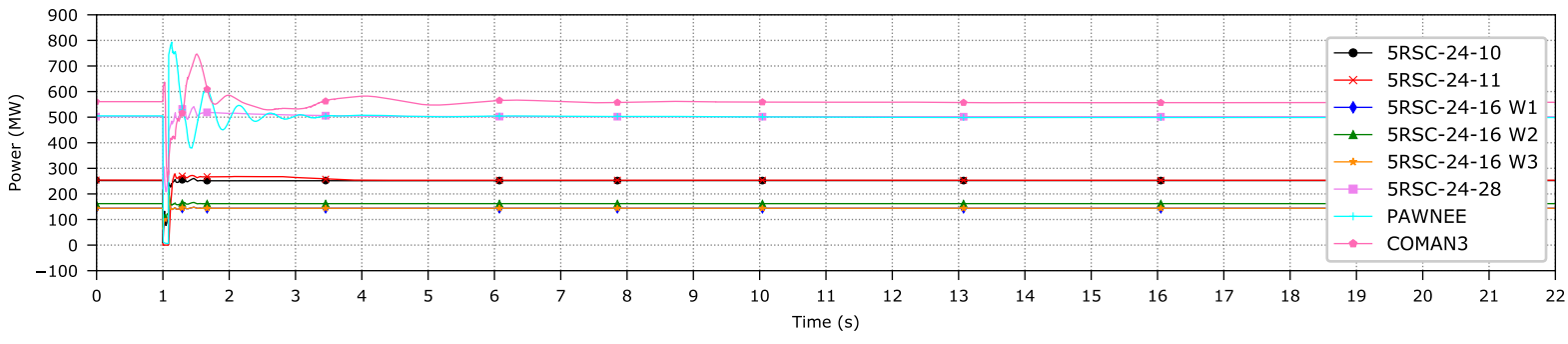


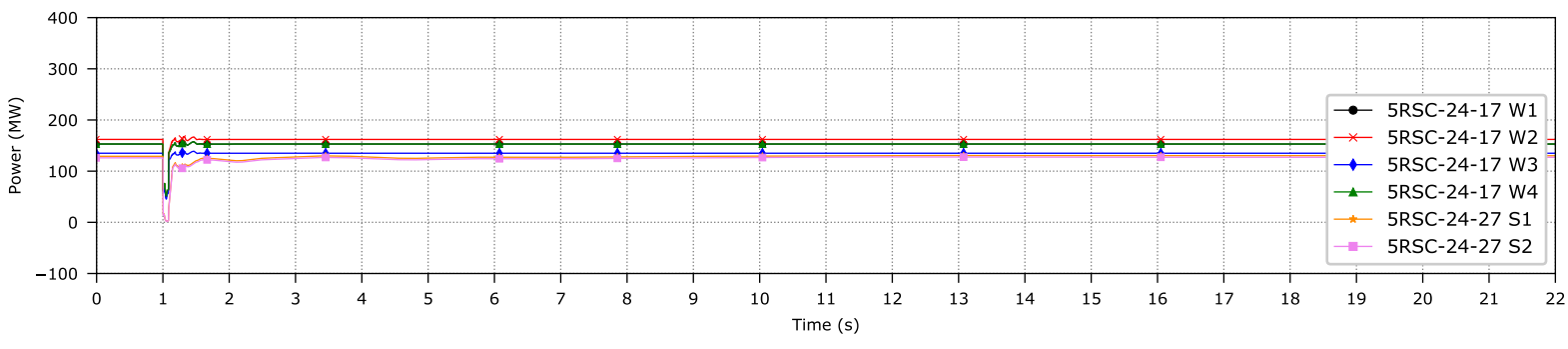


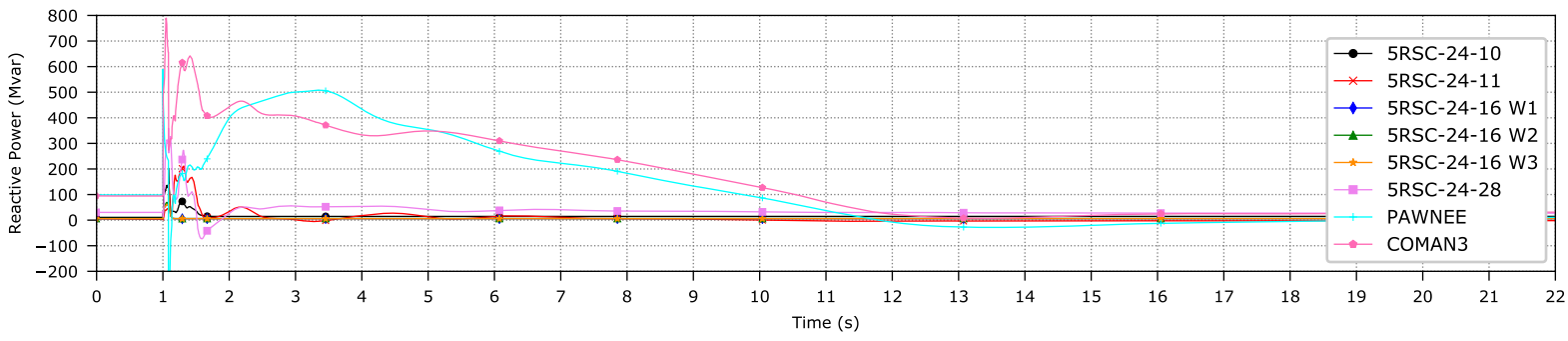


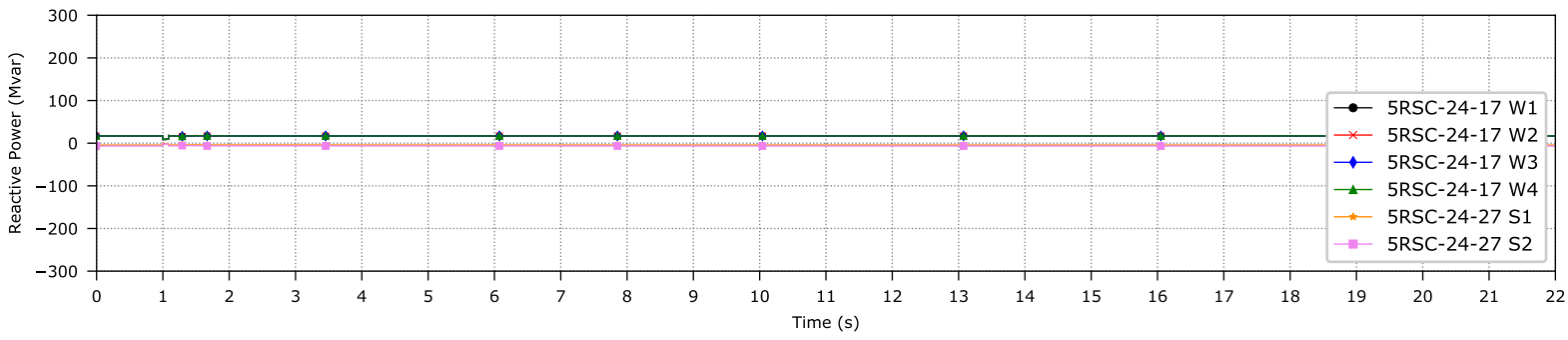
Ref. No. 10 - LoTC_087

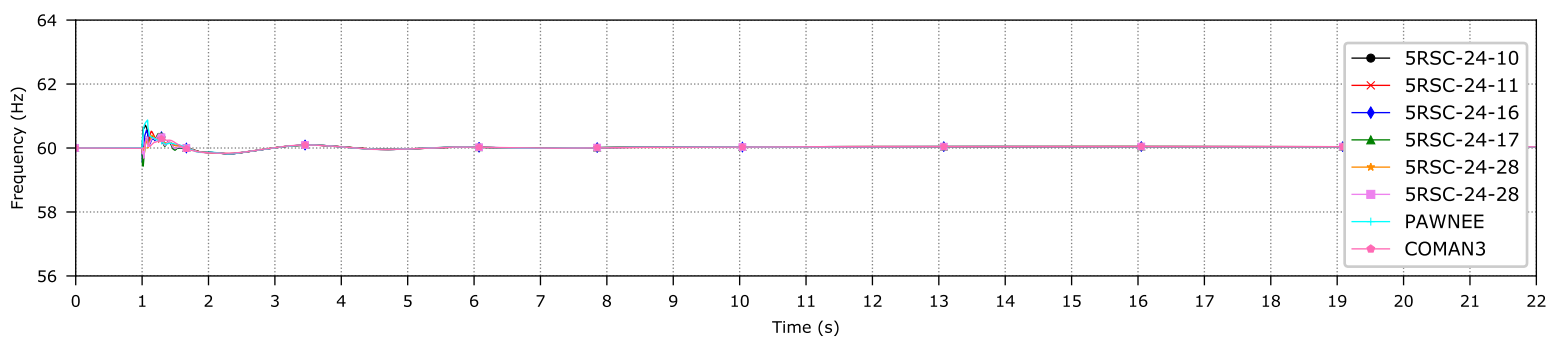


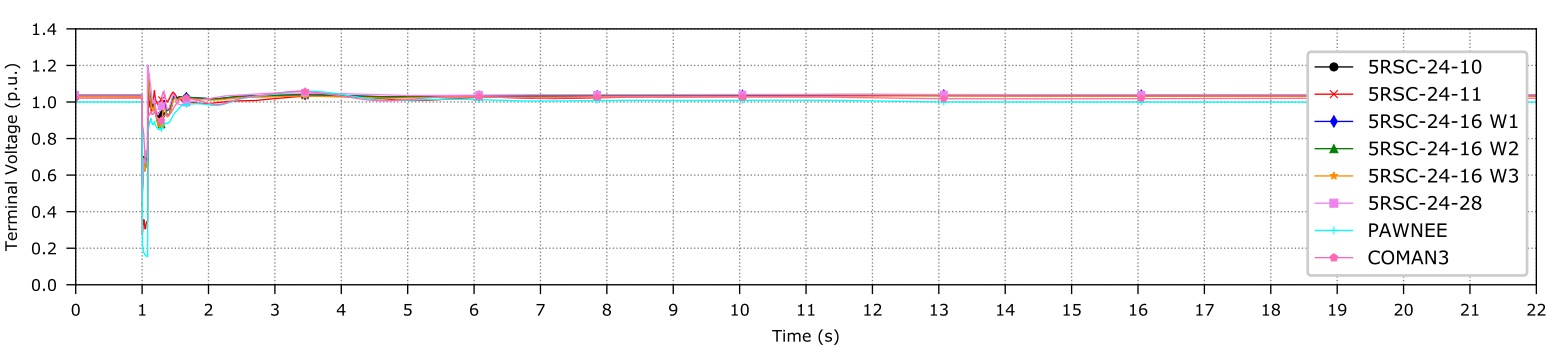


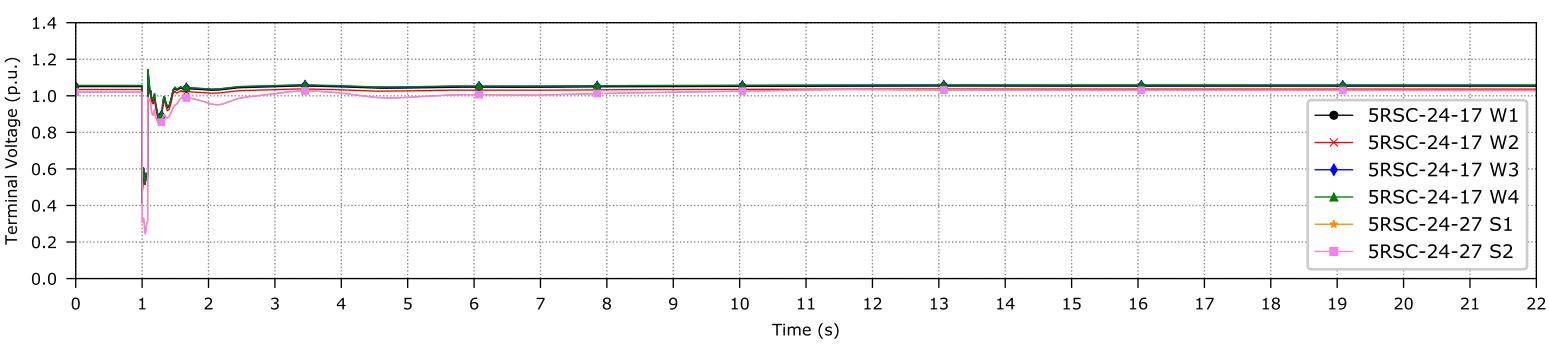


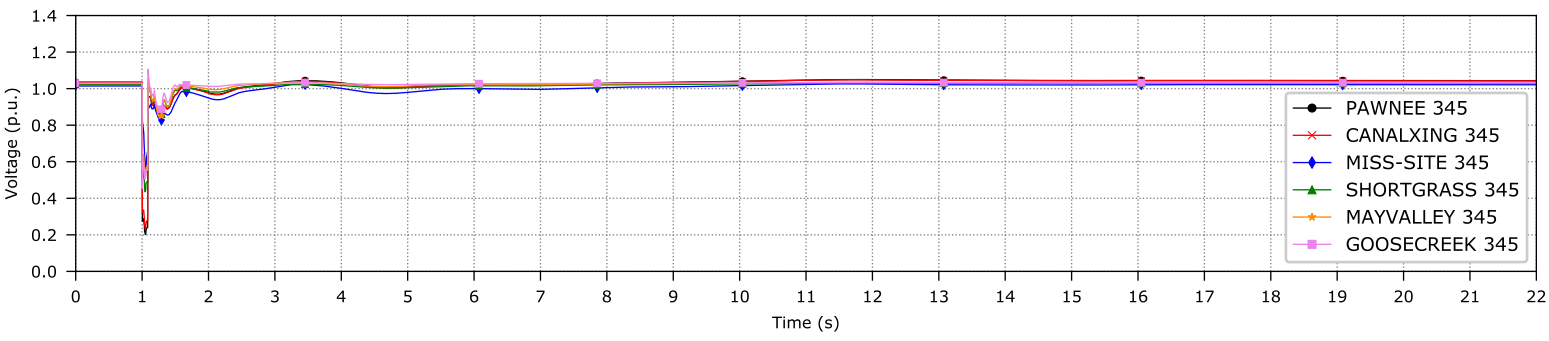




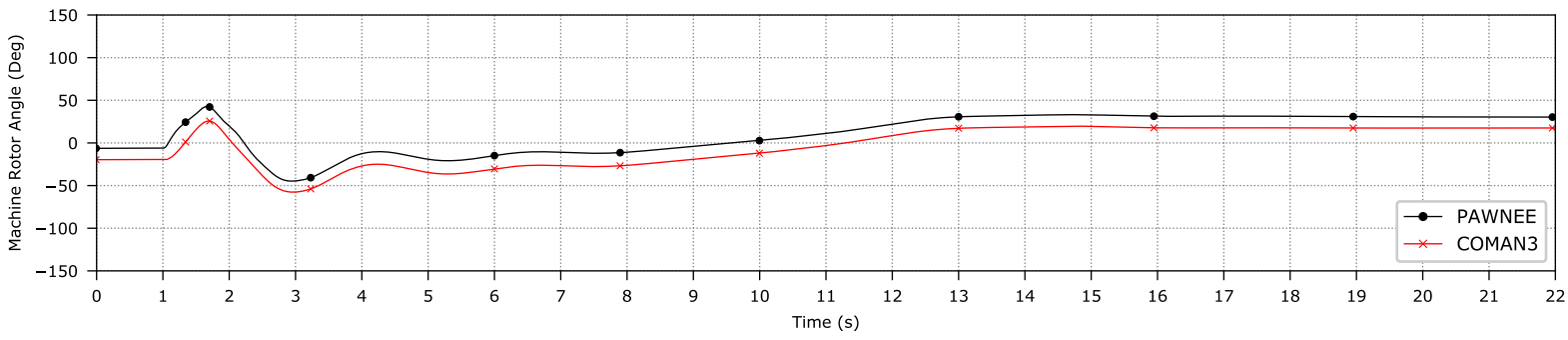


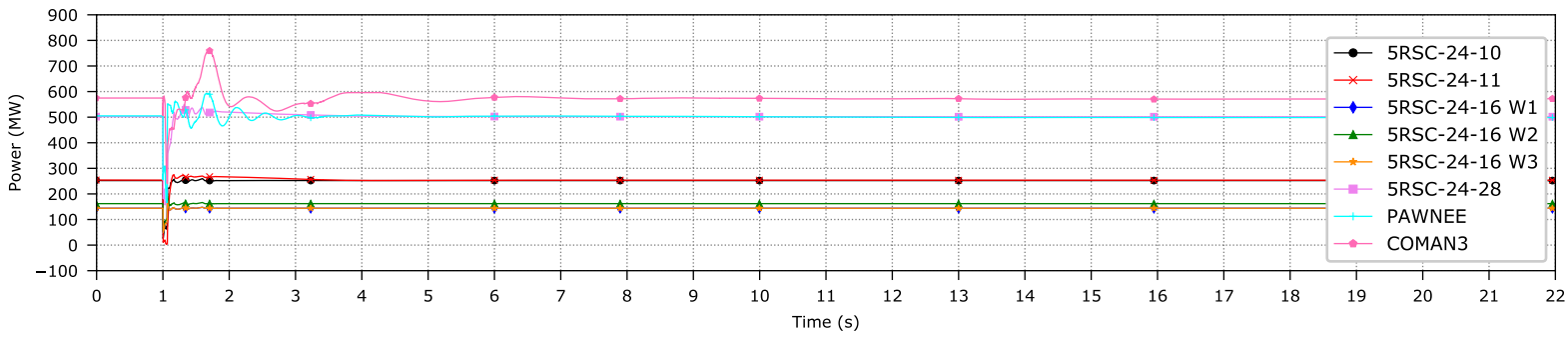


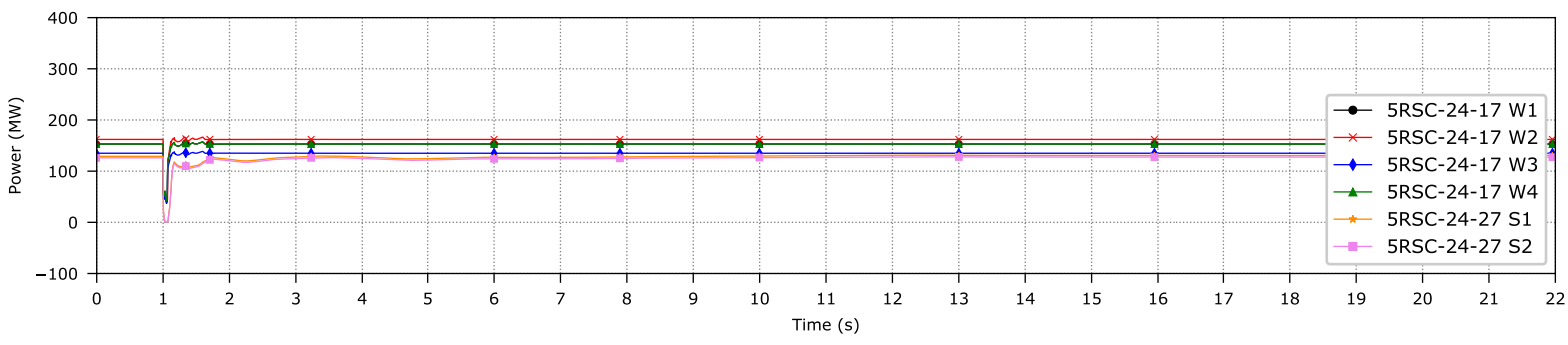


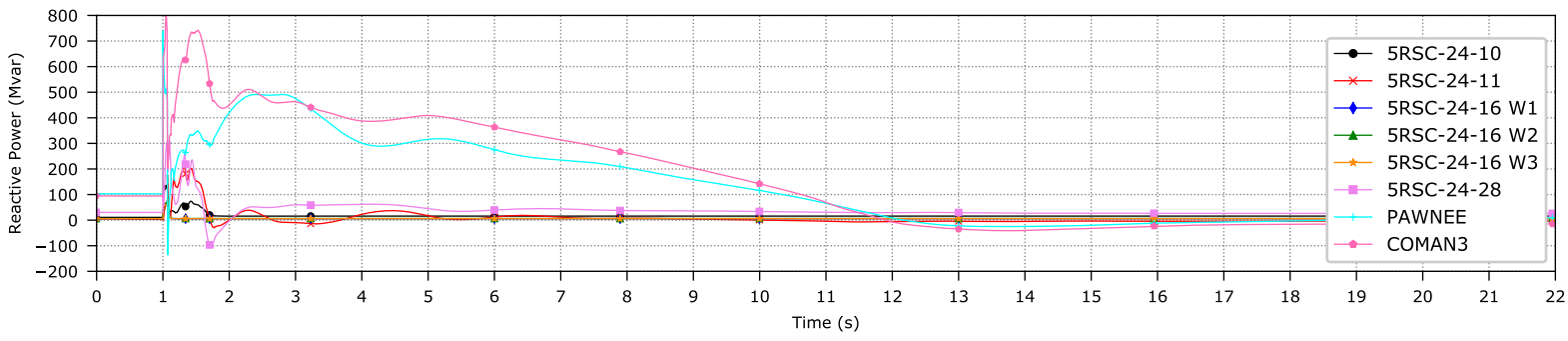


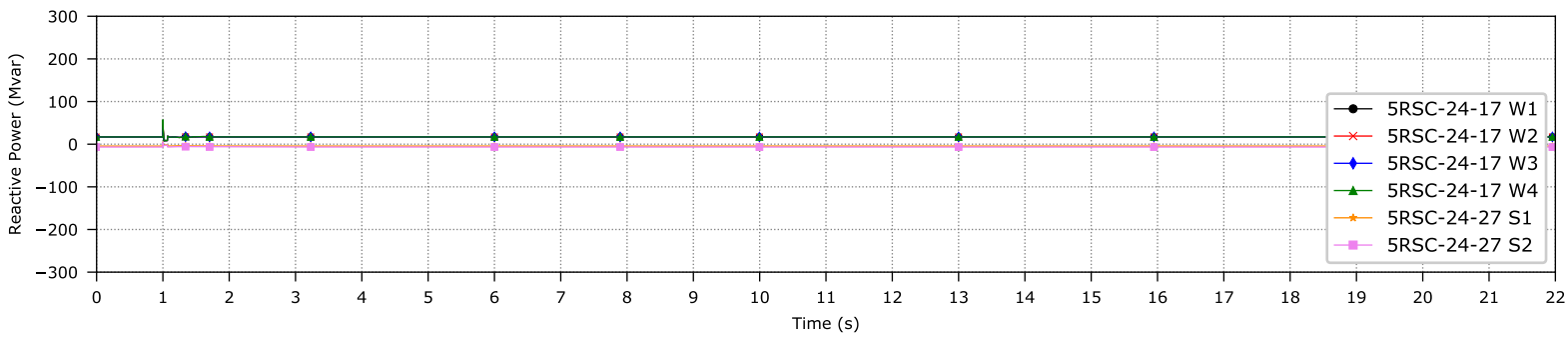
Ref. No. 11 - LoTC_152

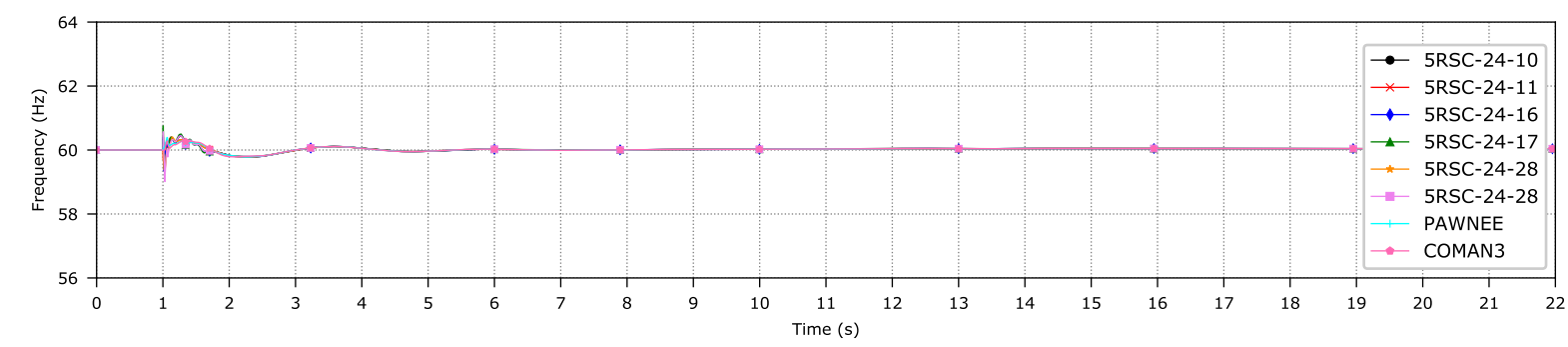


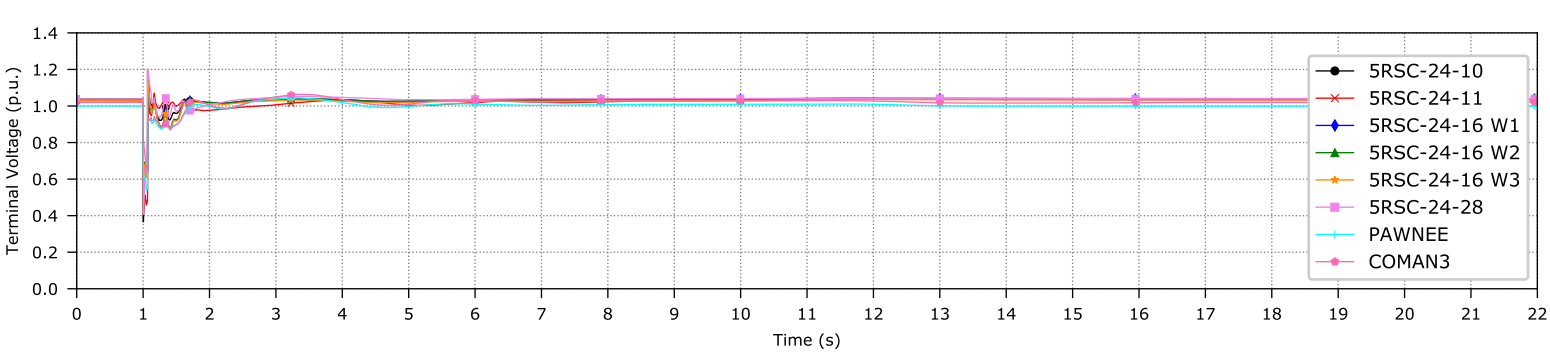


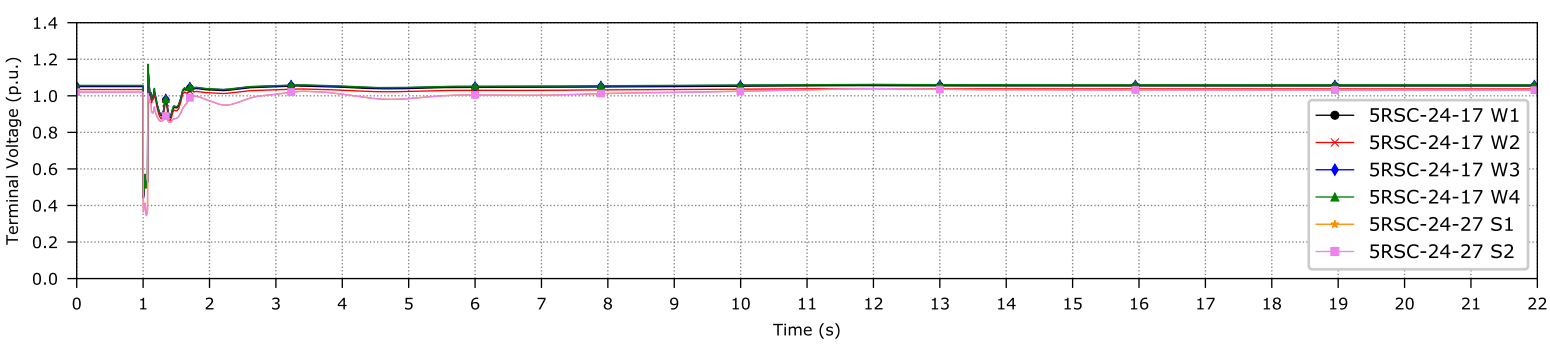


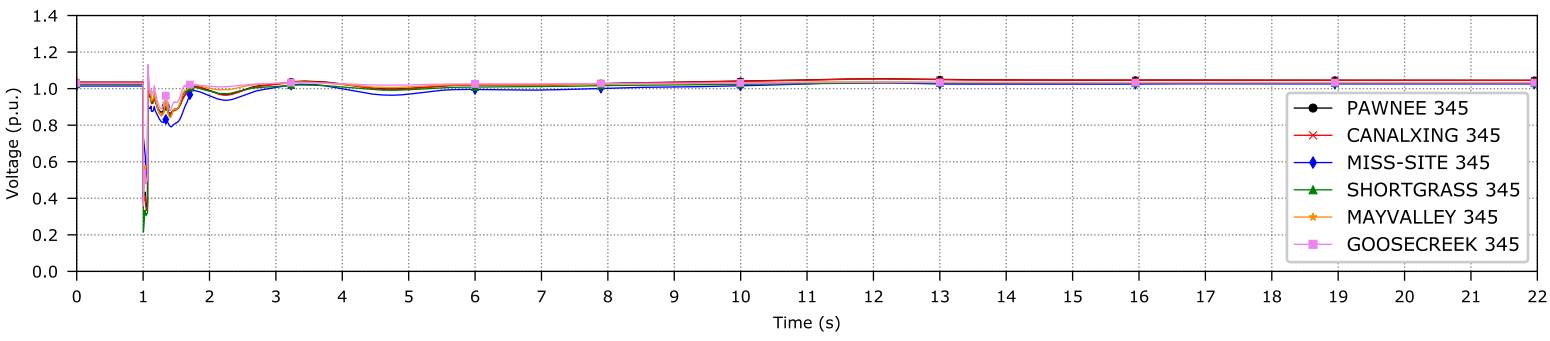




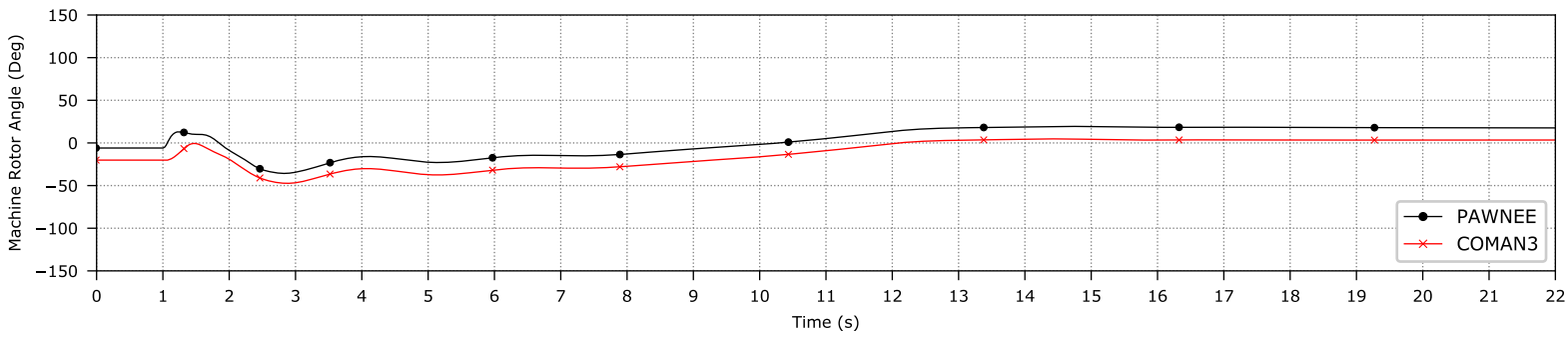


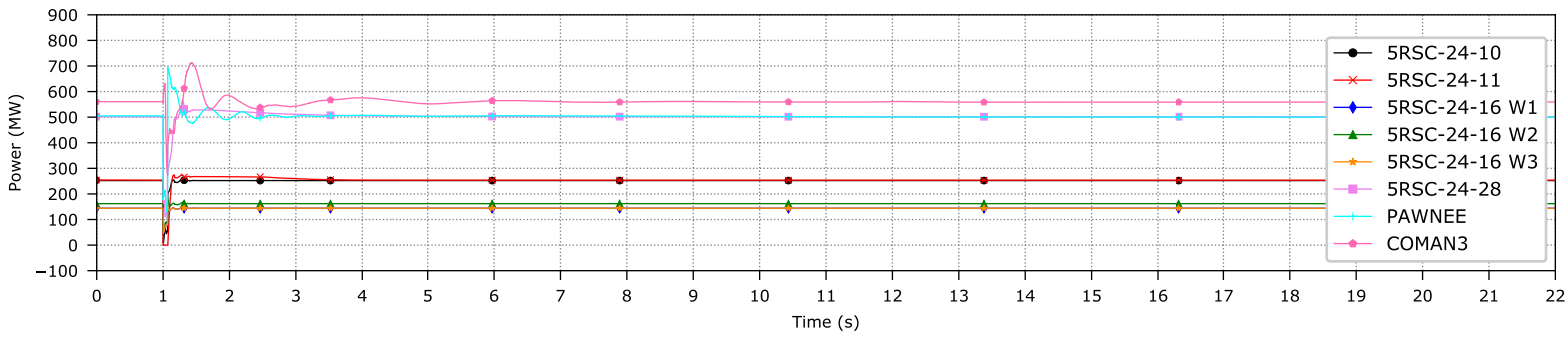


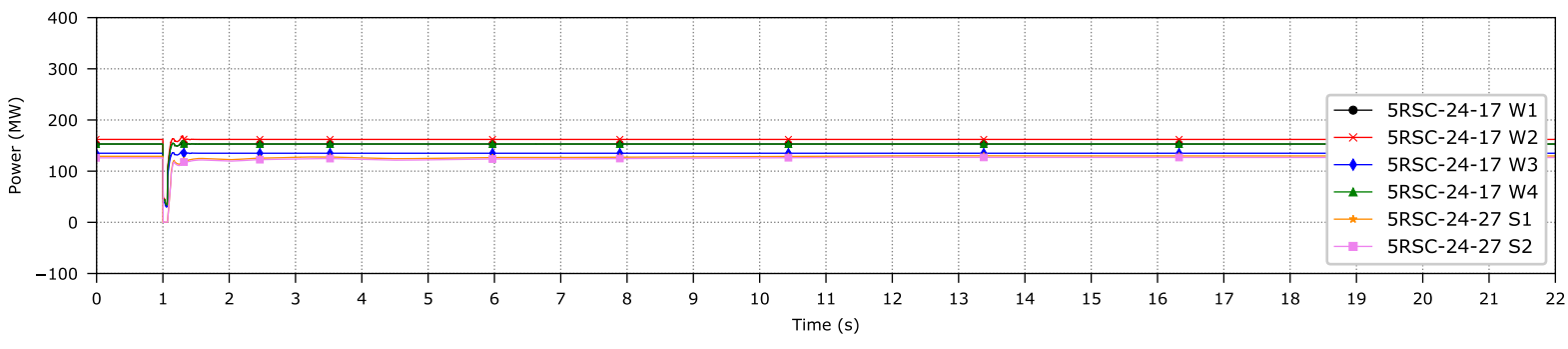


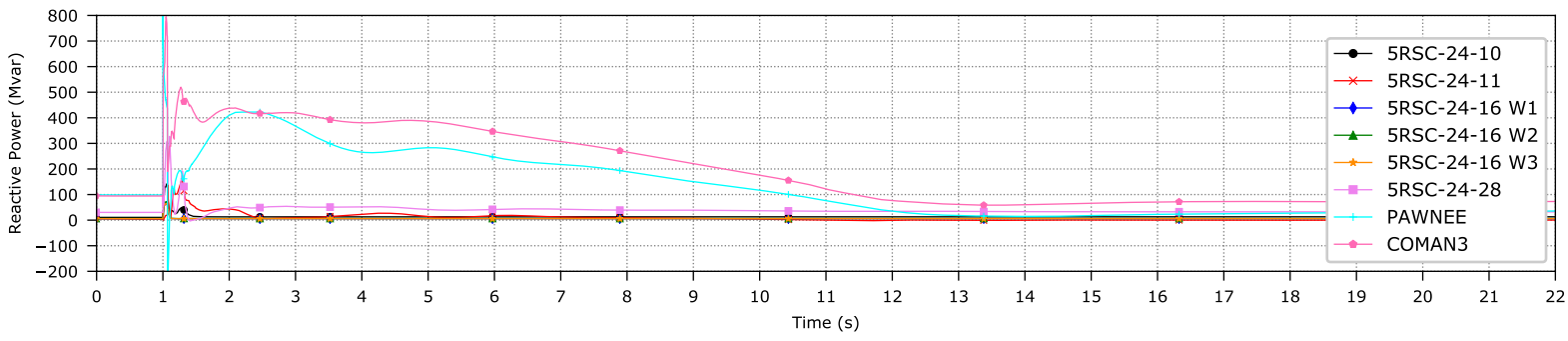


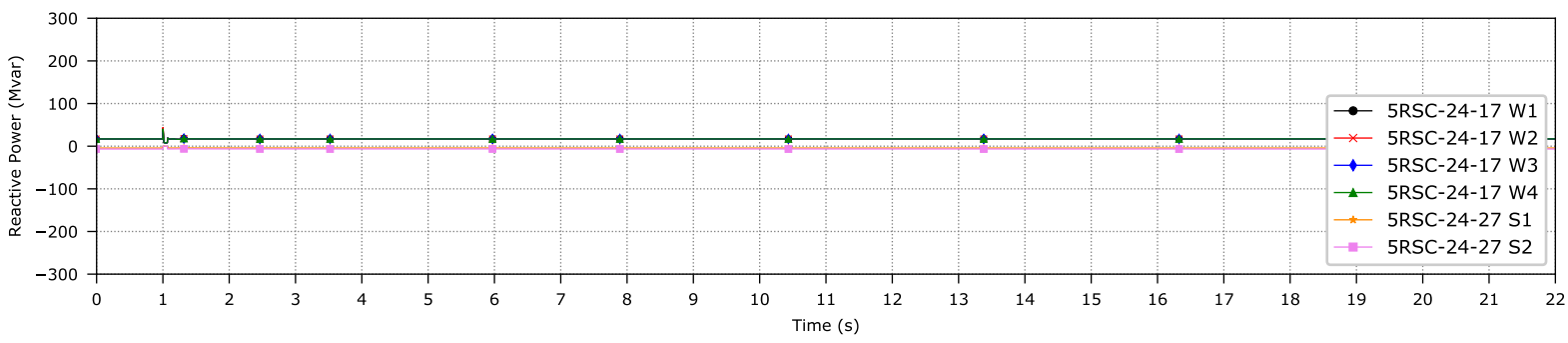
Ref. No. 12 - LoTC_293

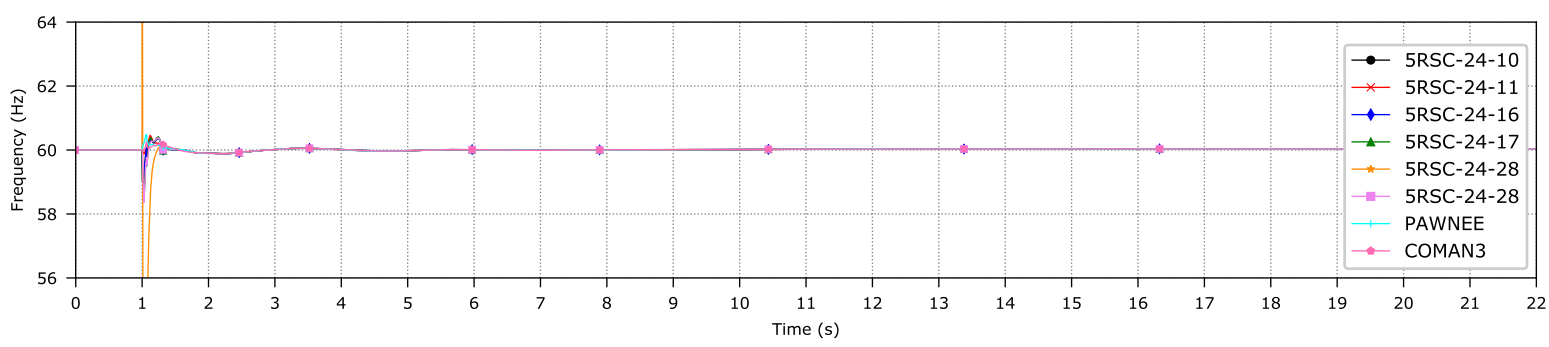


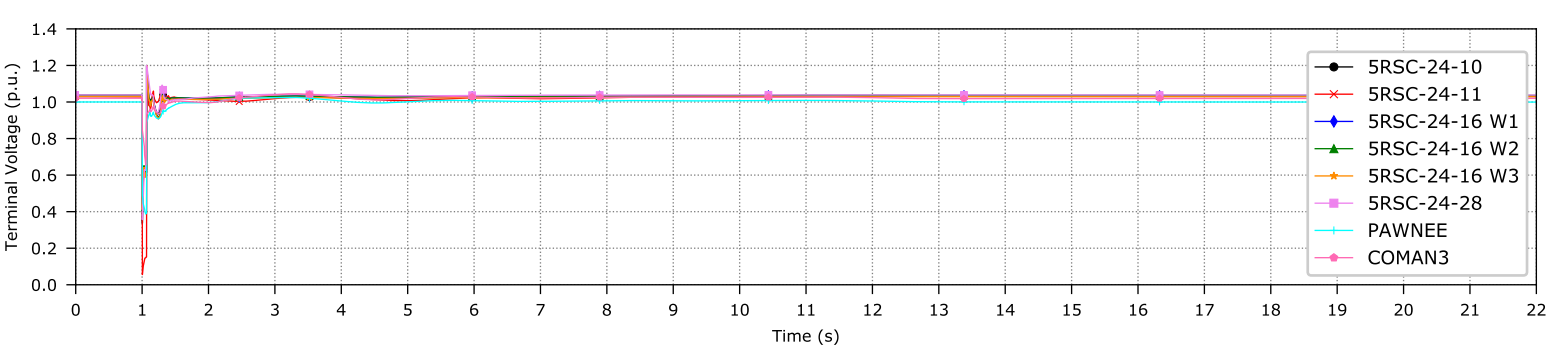


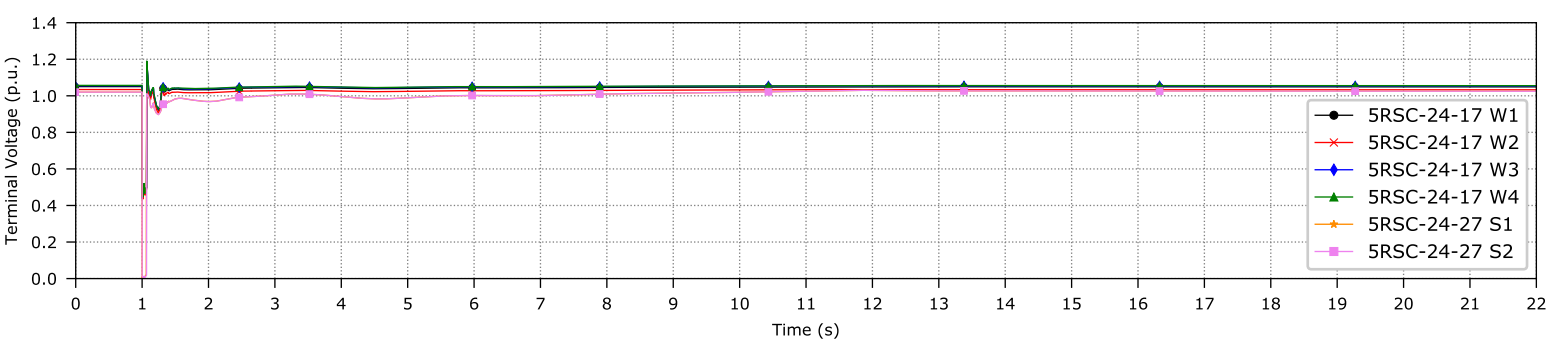


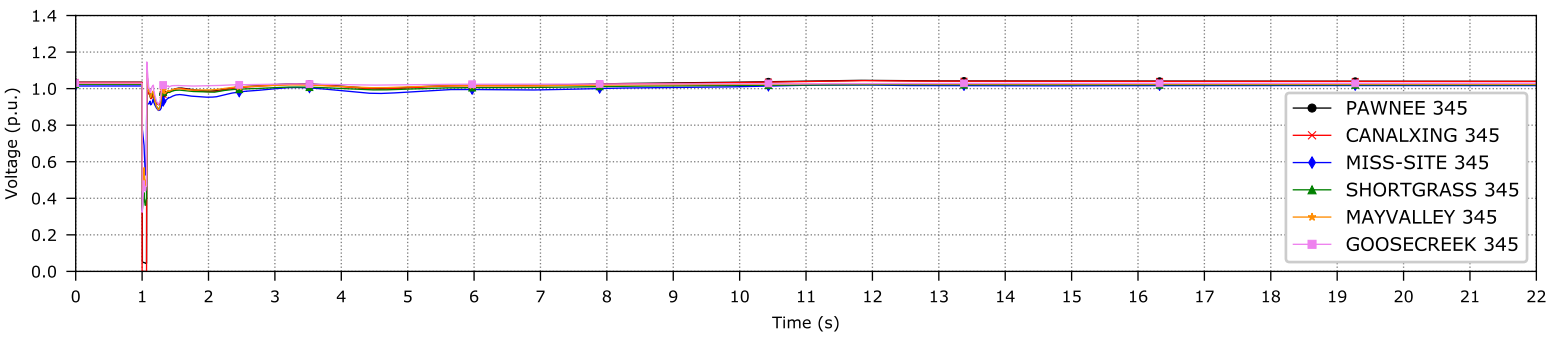




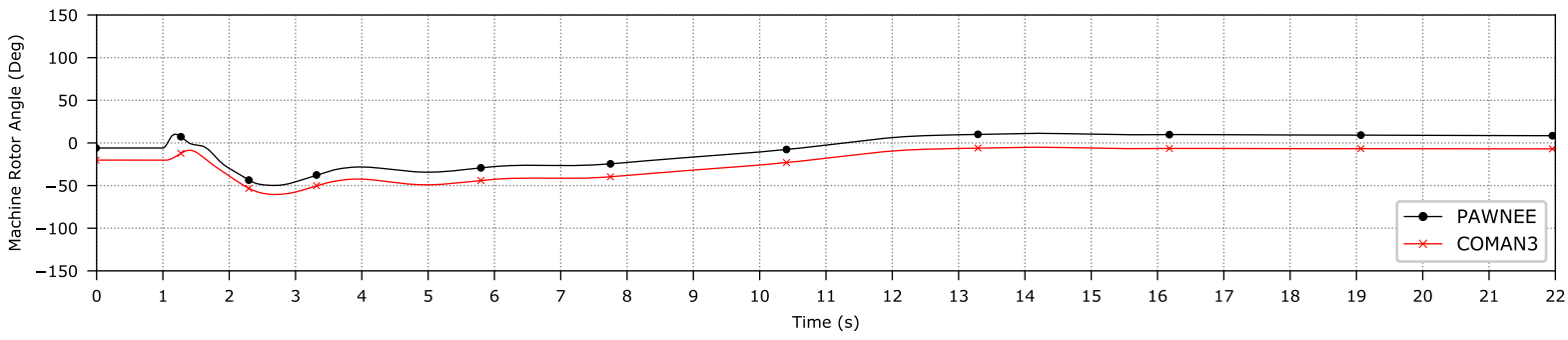


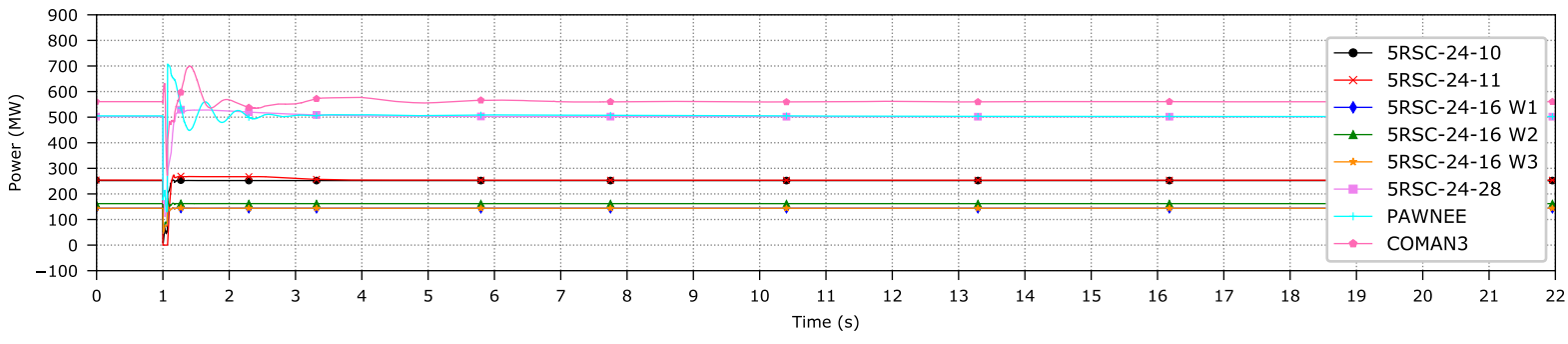


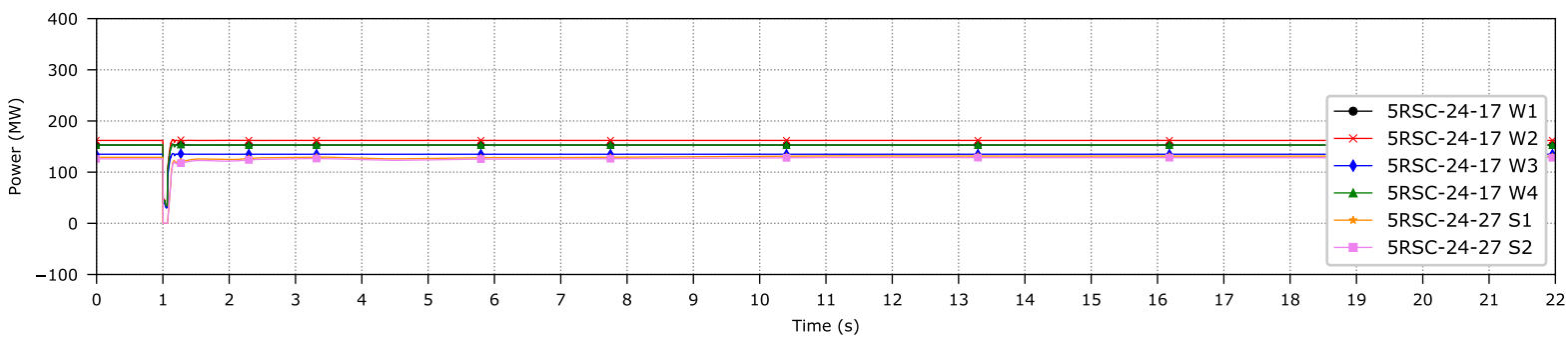


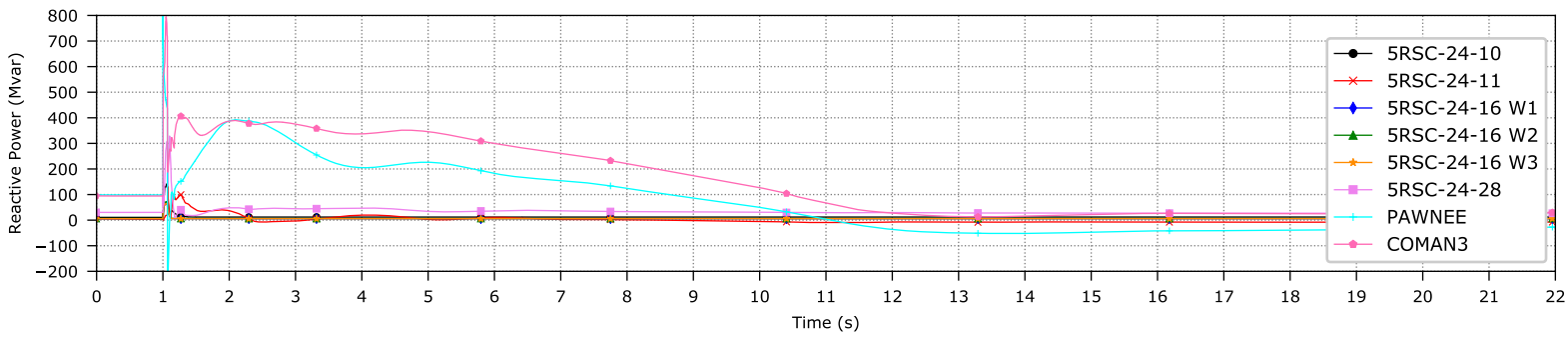


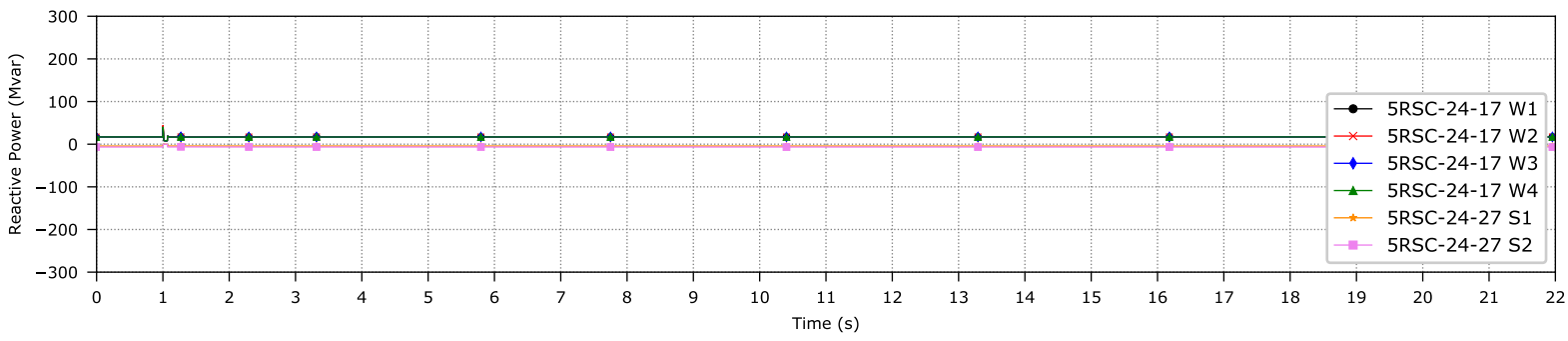
Ref. No. 13 - LoTC_294a

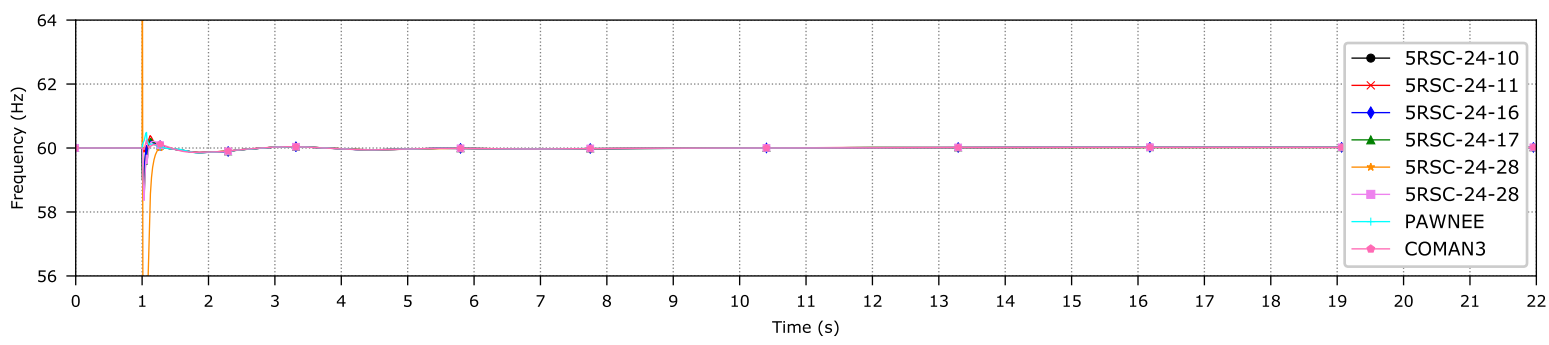


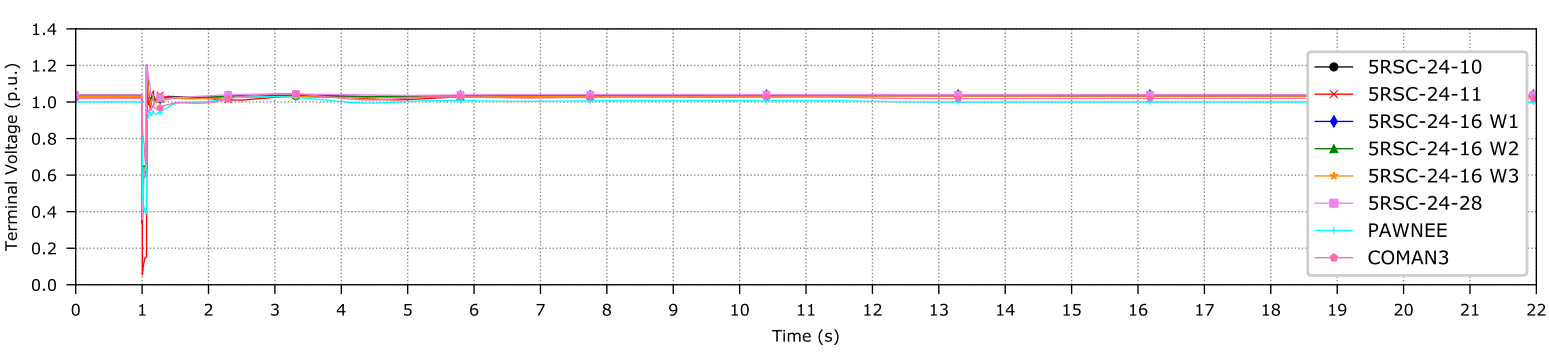


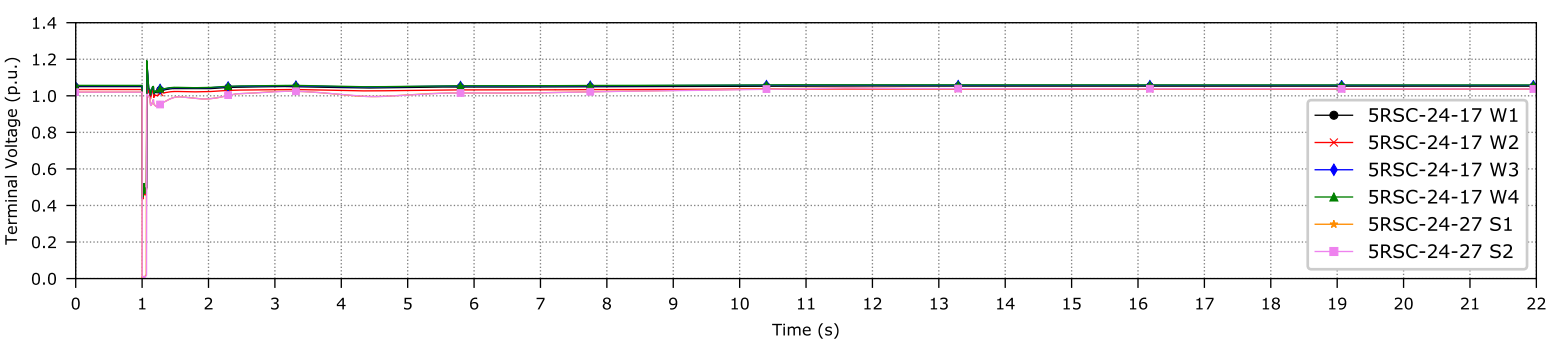


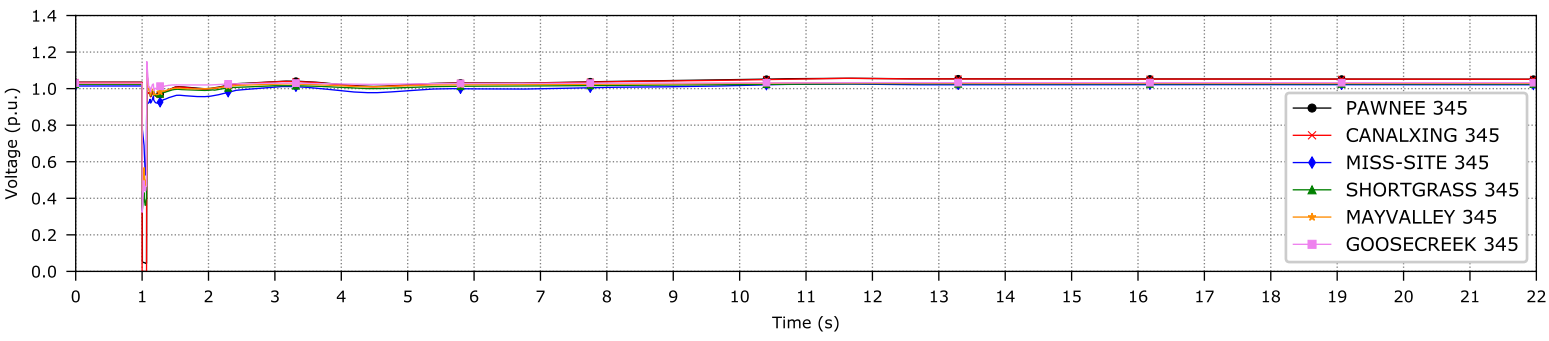




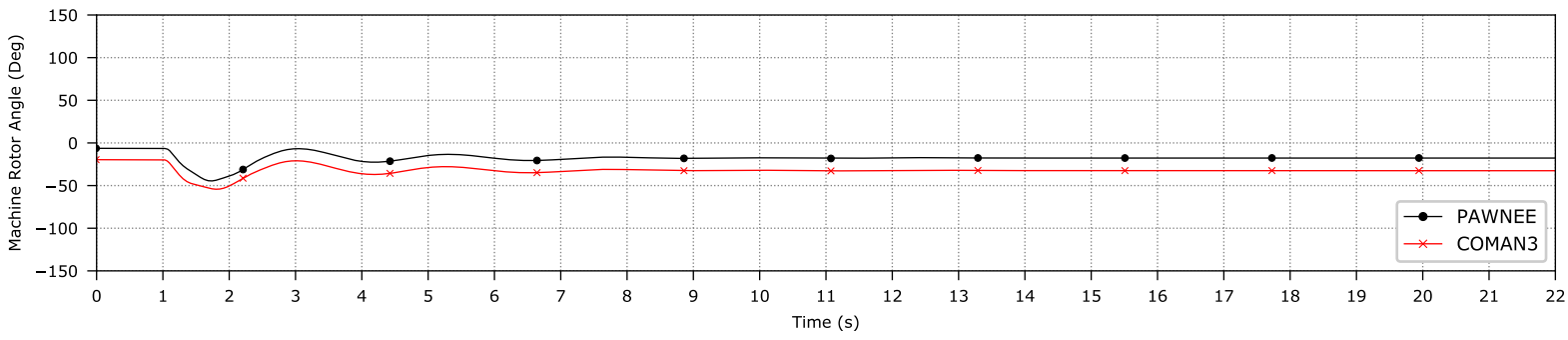


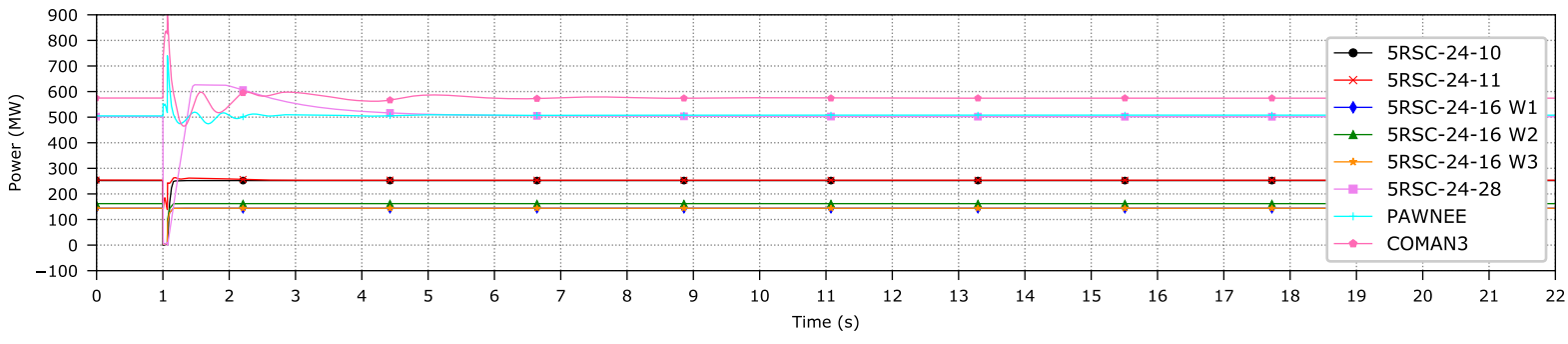


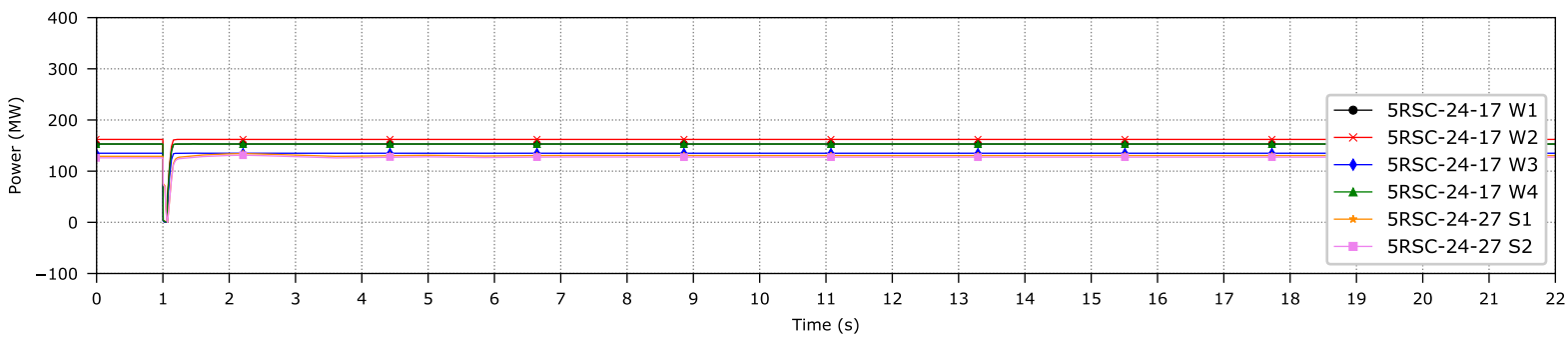


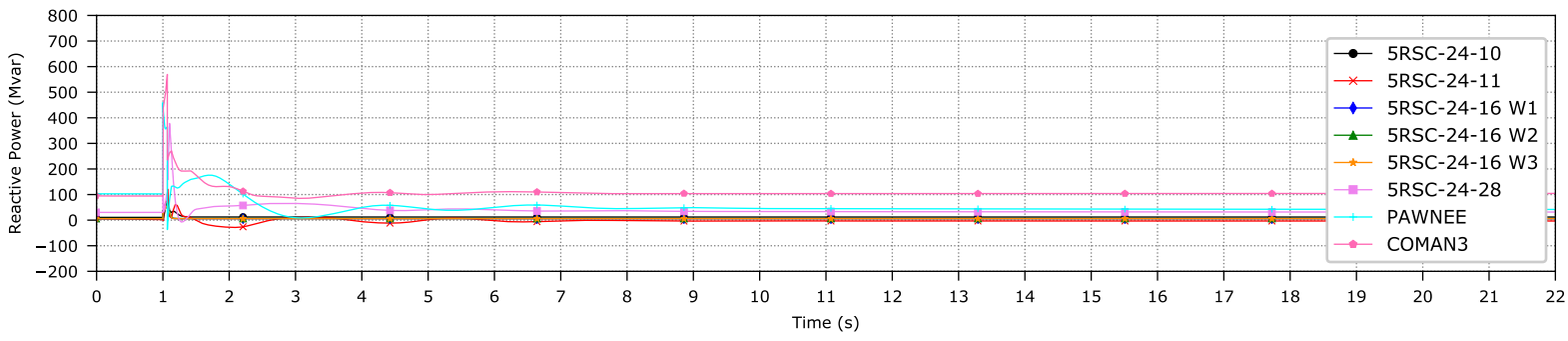


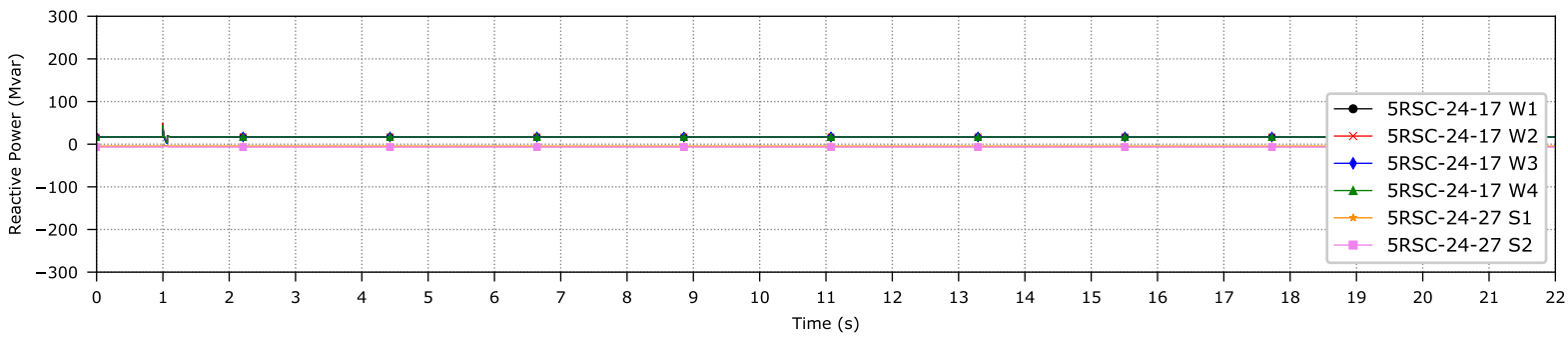
Ref. No. 14 - LoTC_294b

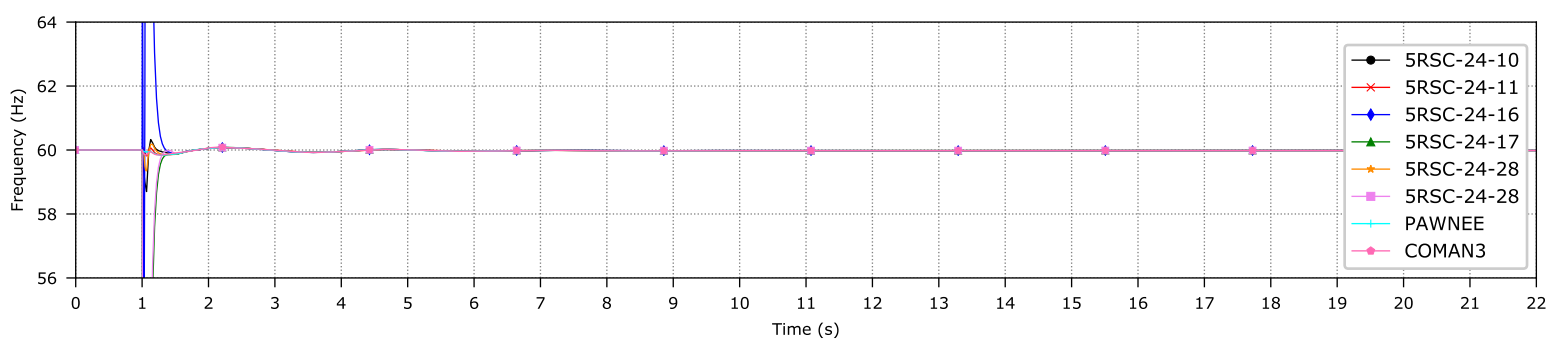


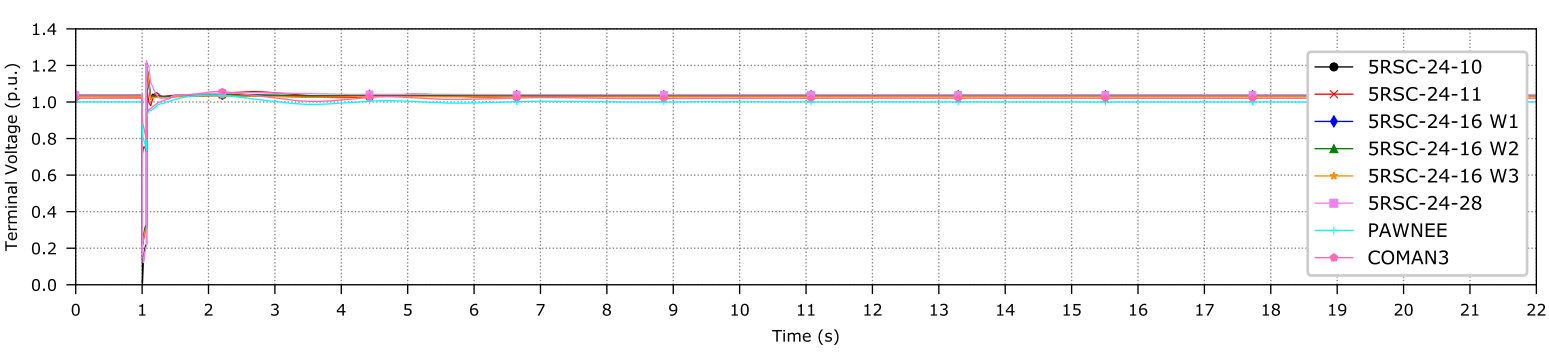


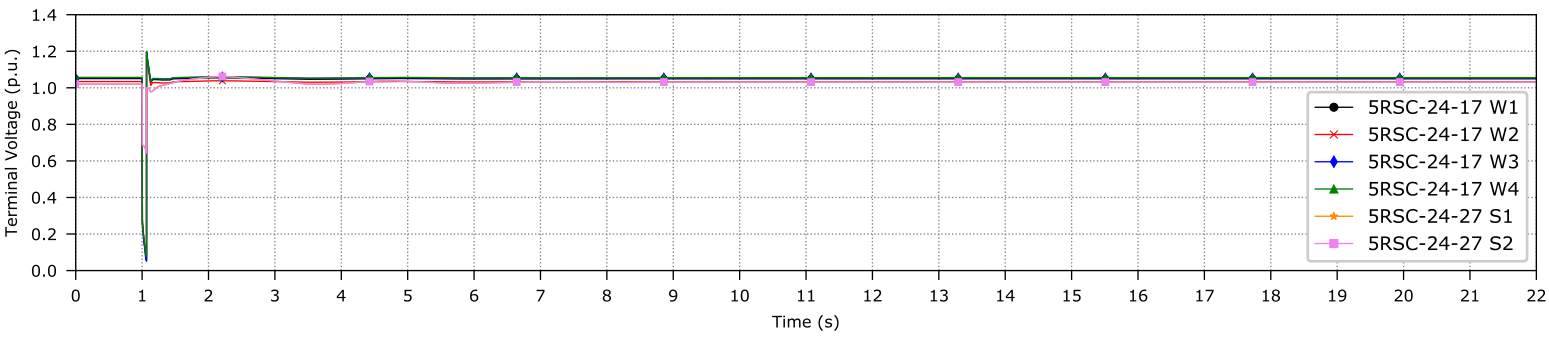


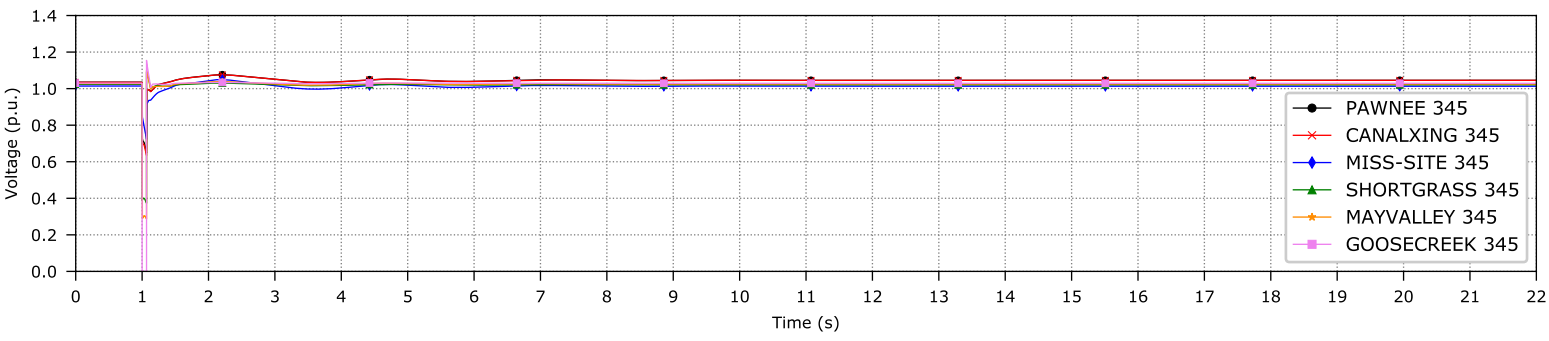




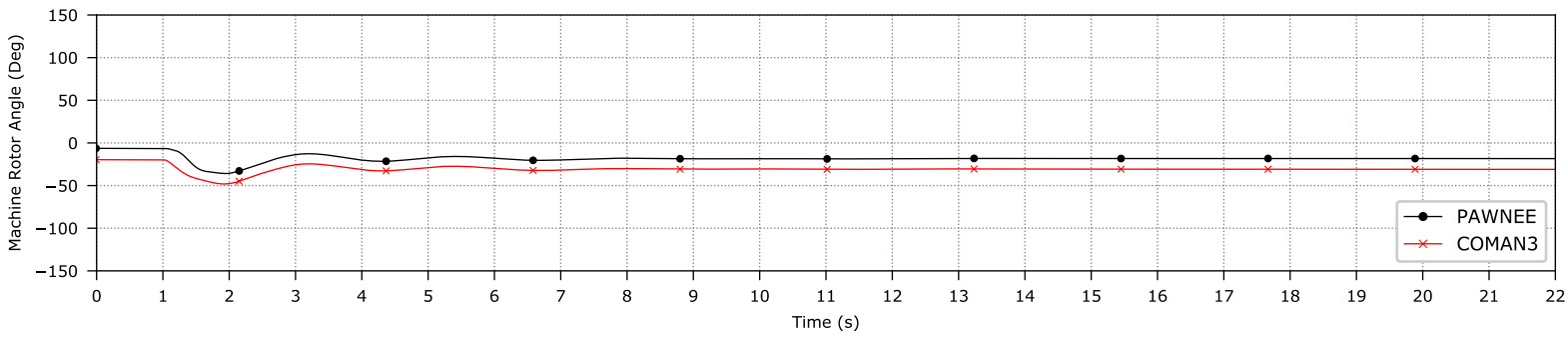


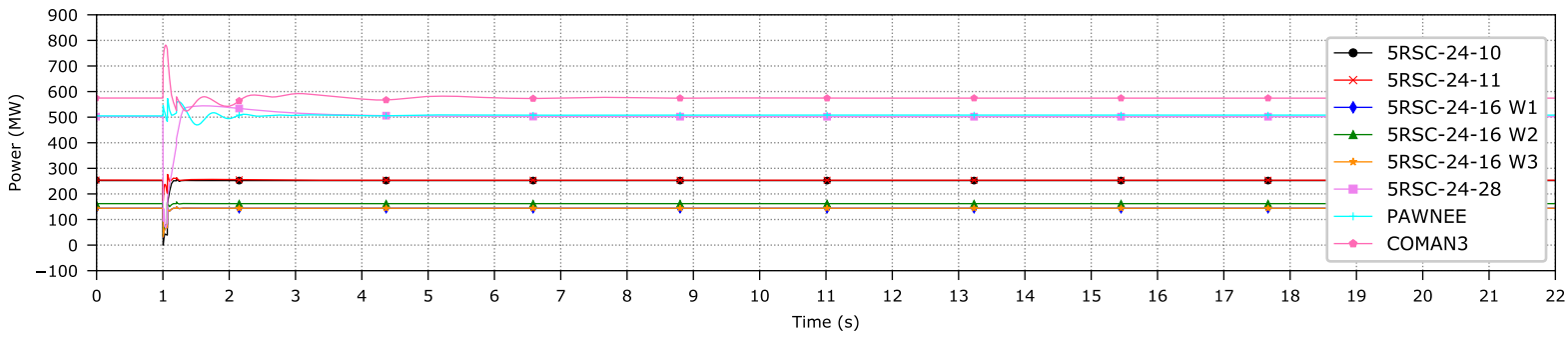


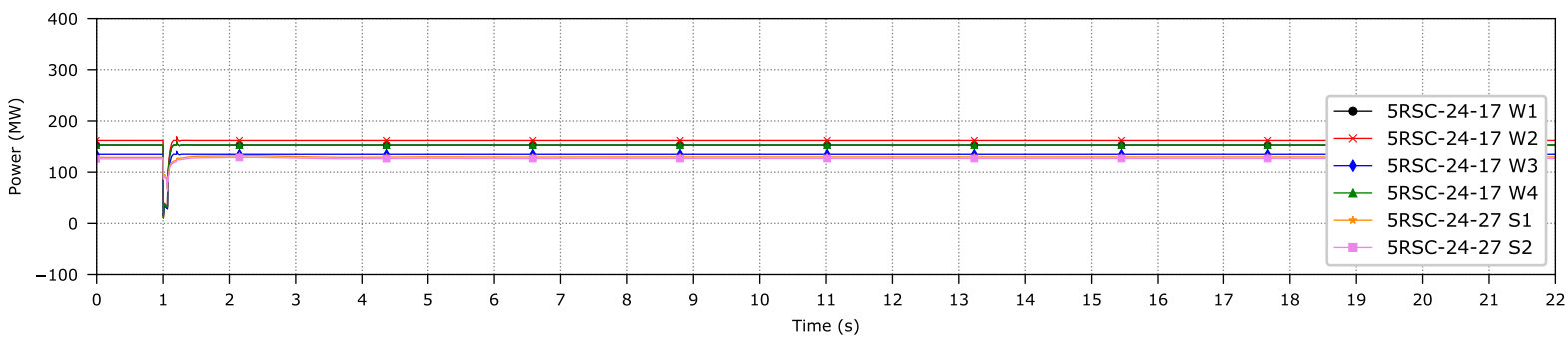


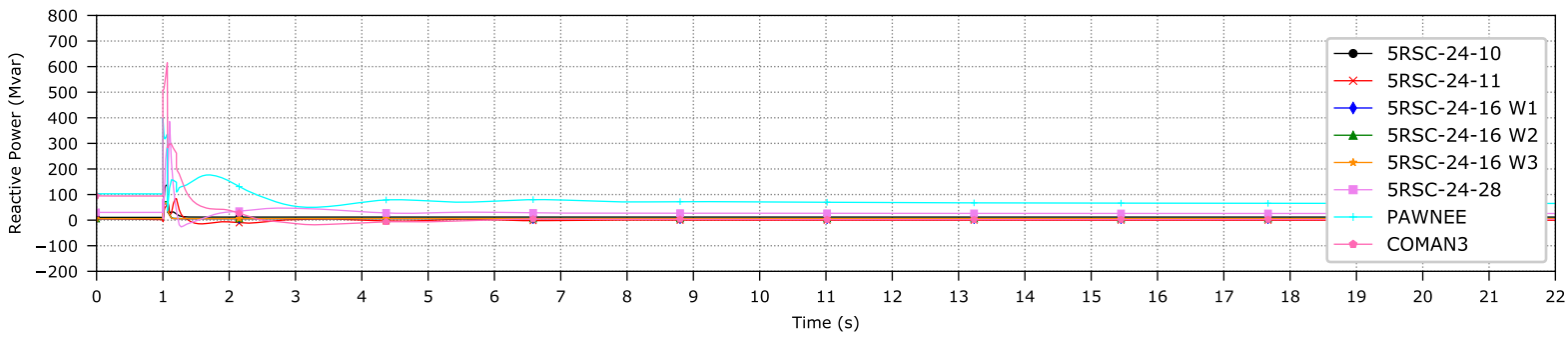


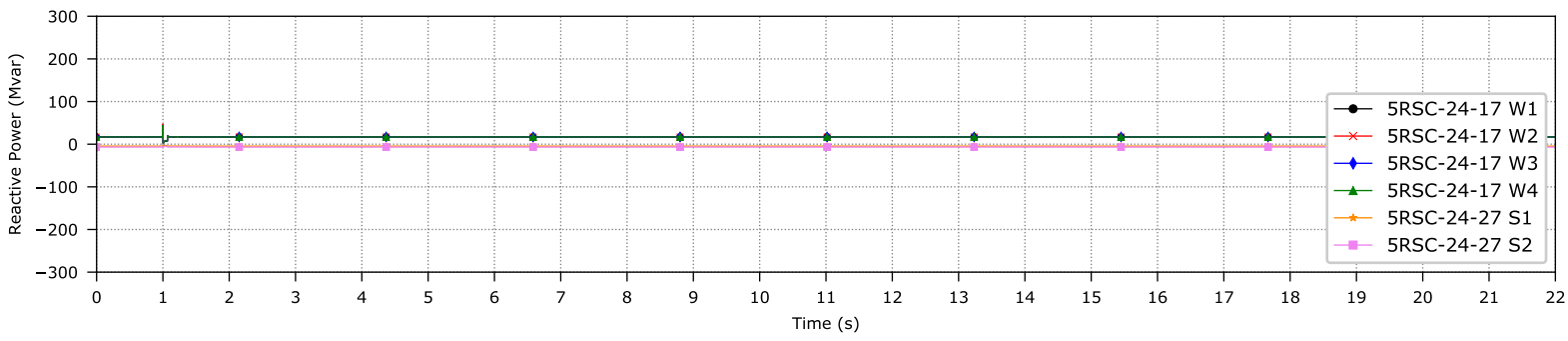
Ref. No. 15 - LoTC_295b

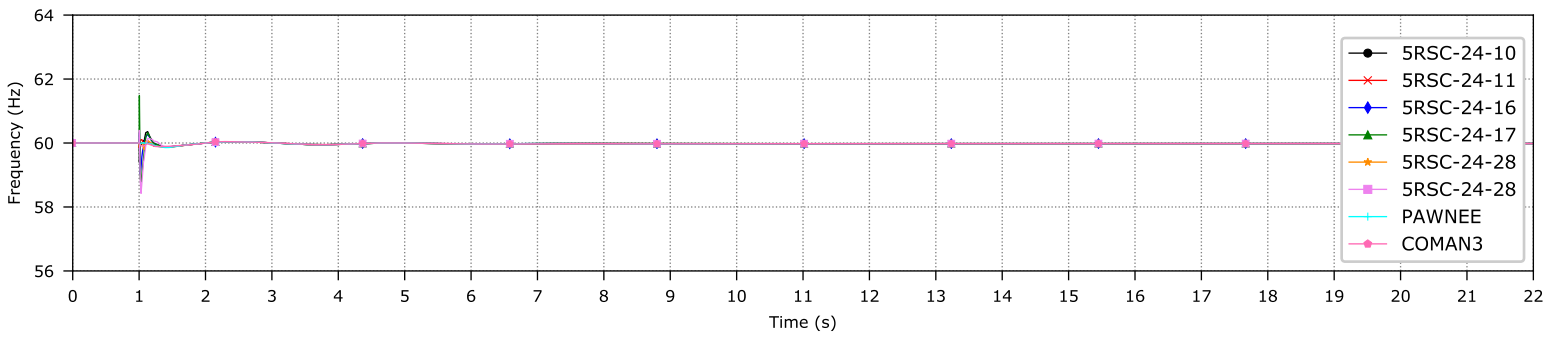


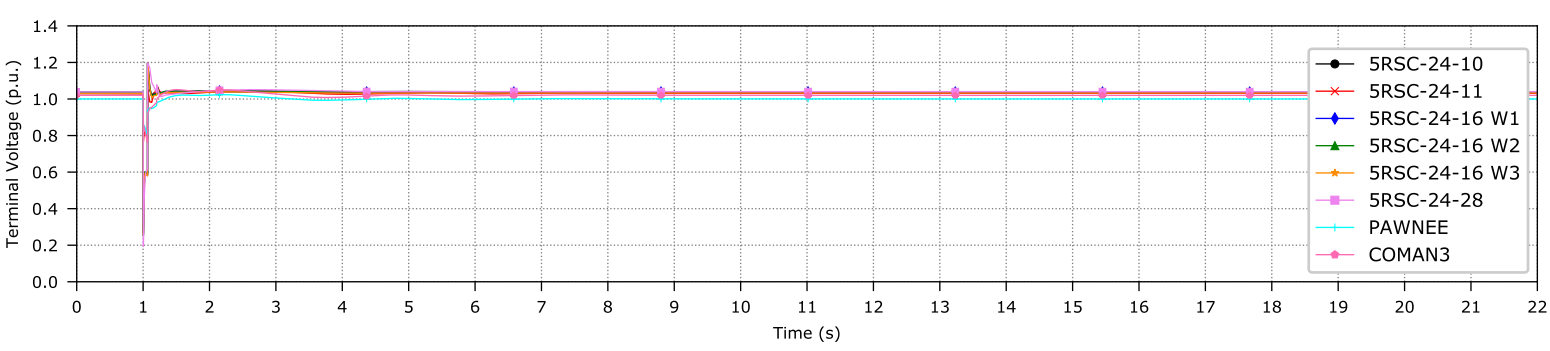


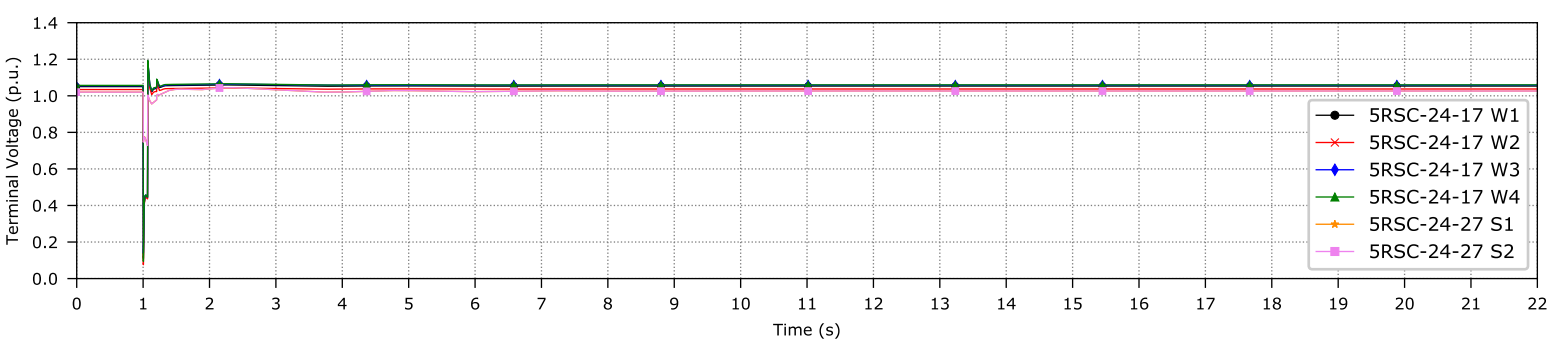


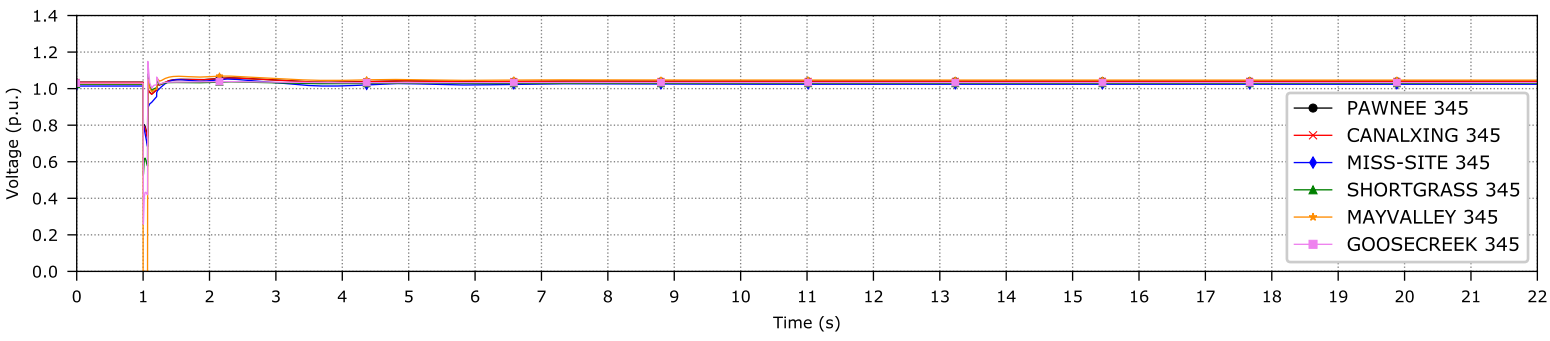




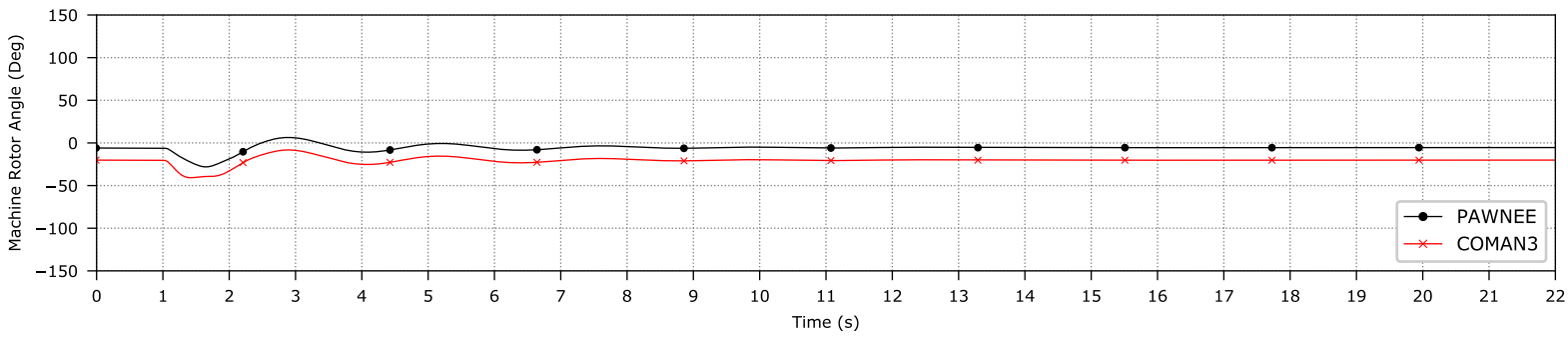


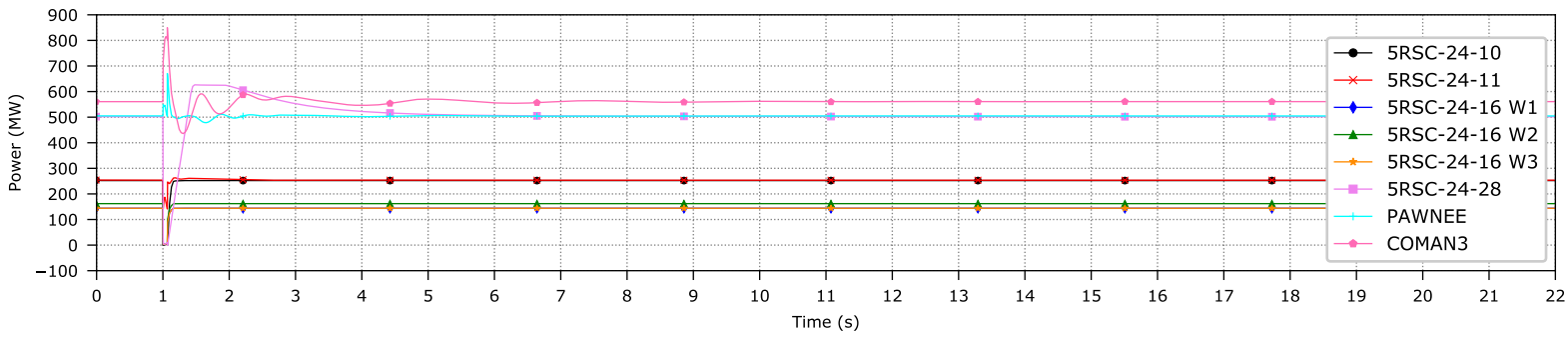


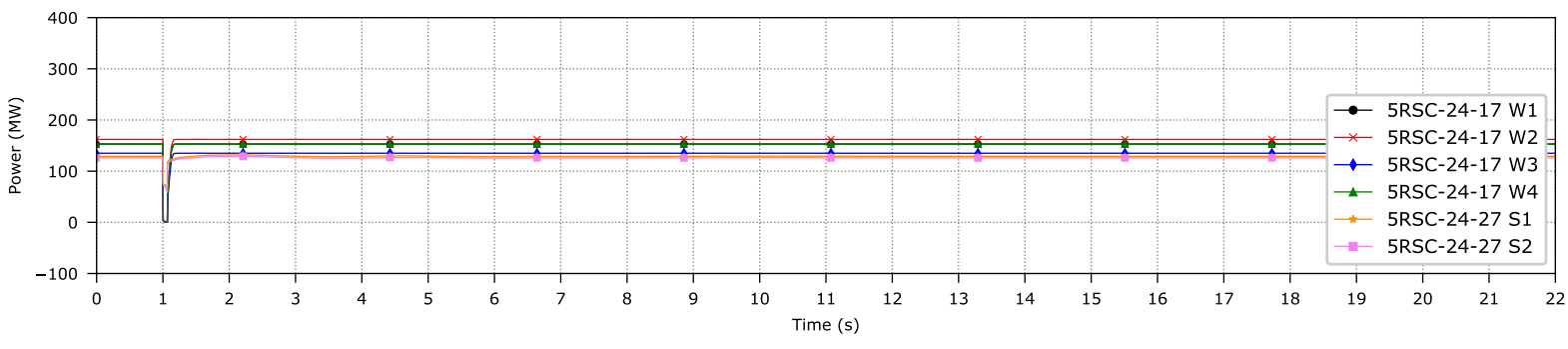


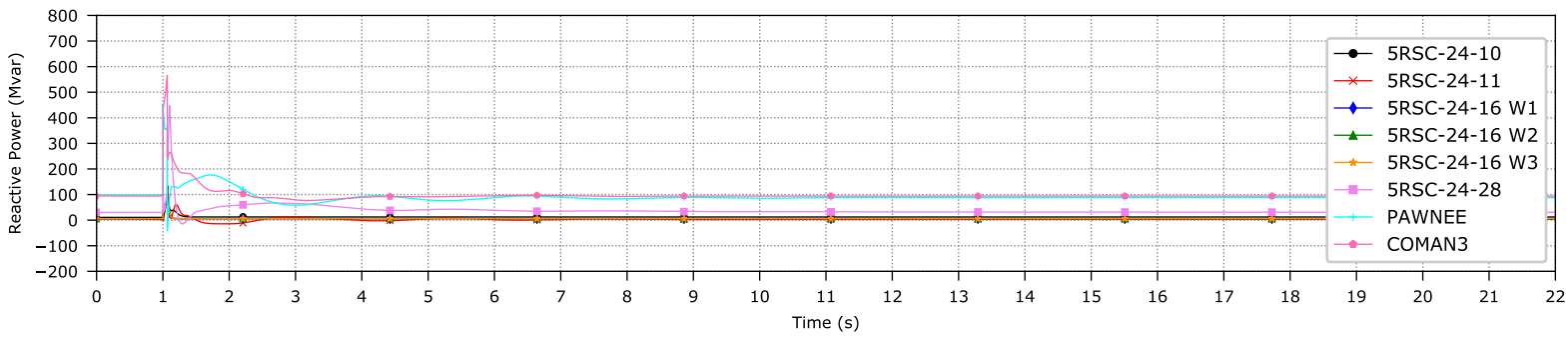


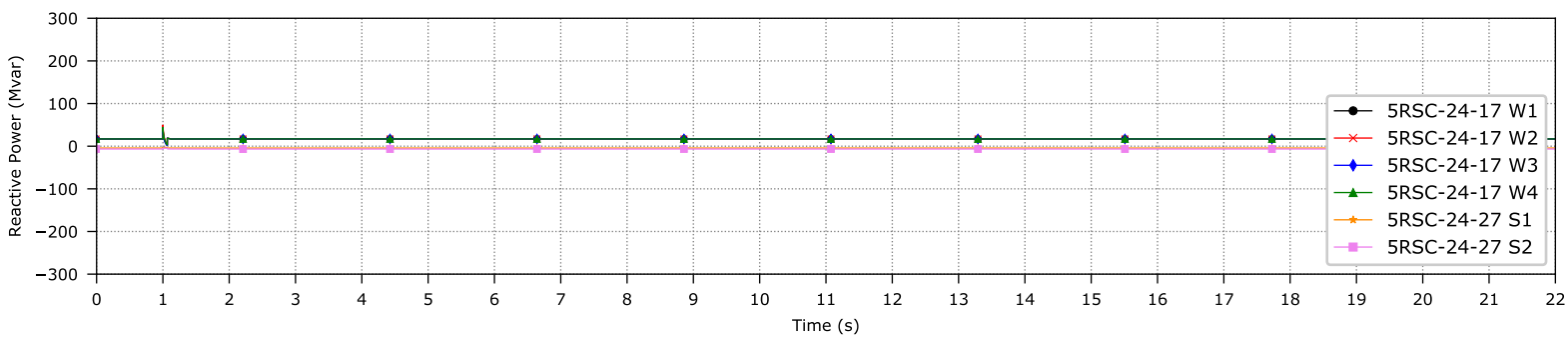
Ref. No. 16 - LoTC_297

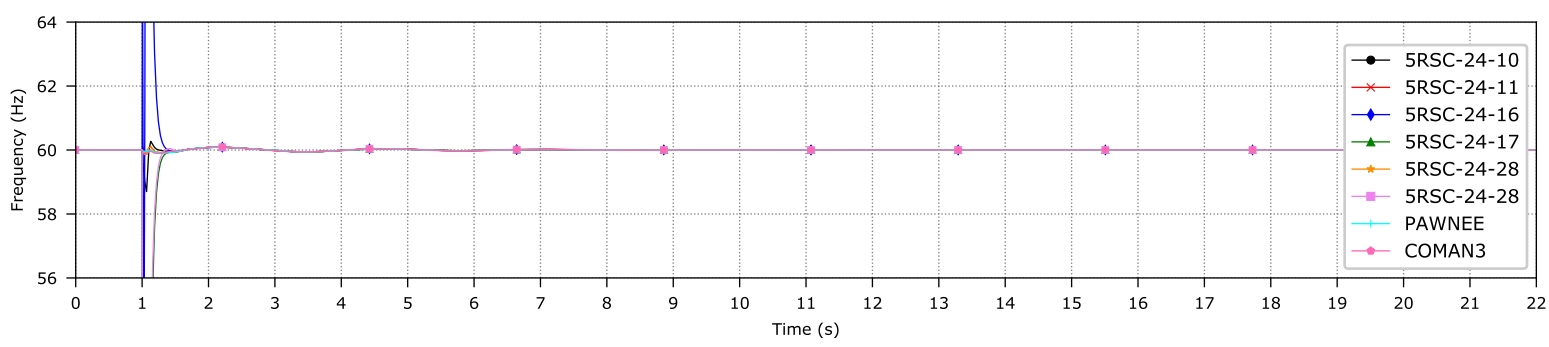


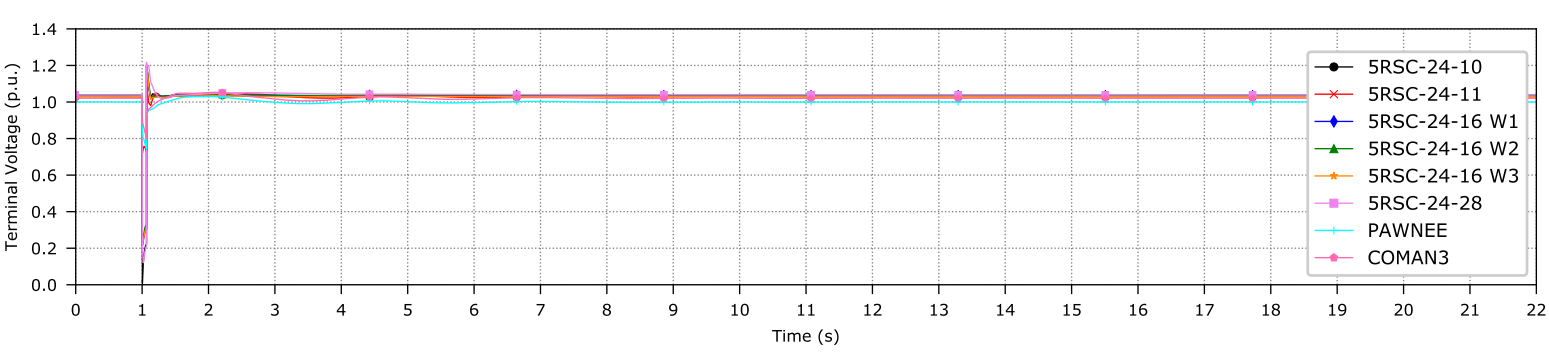


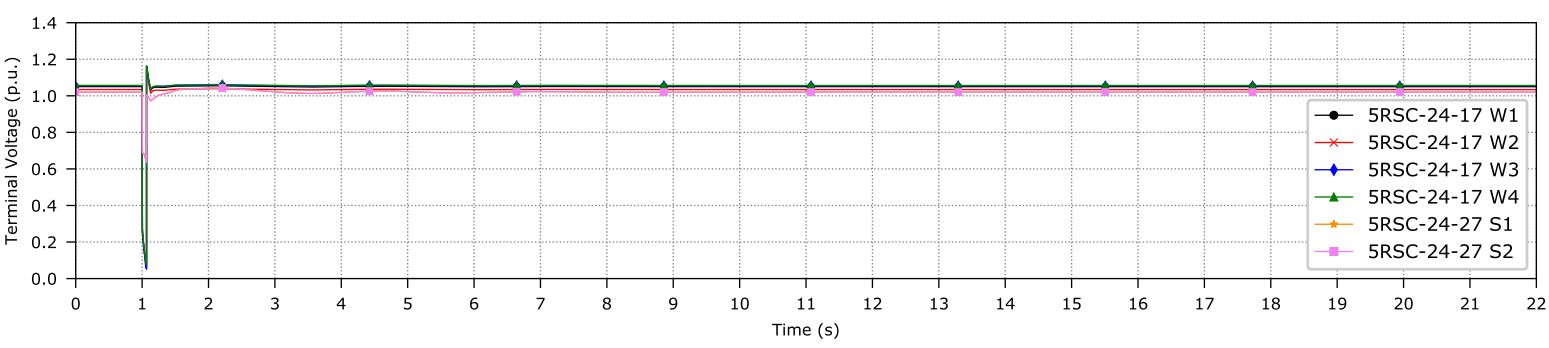


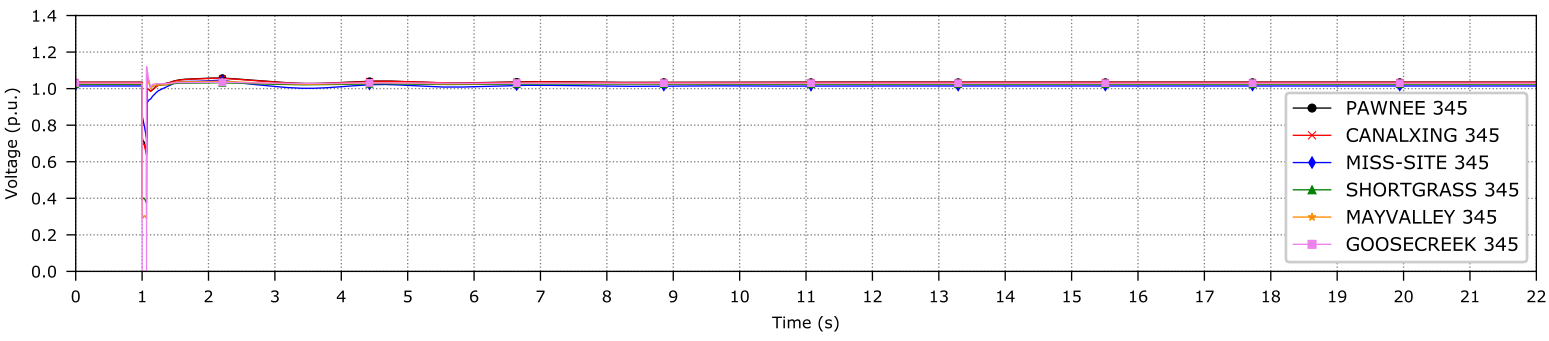




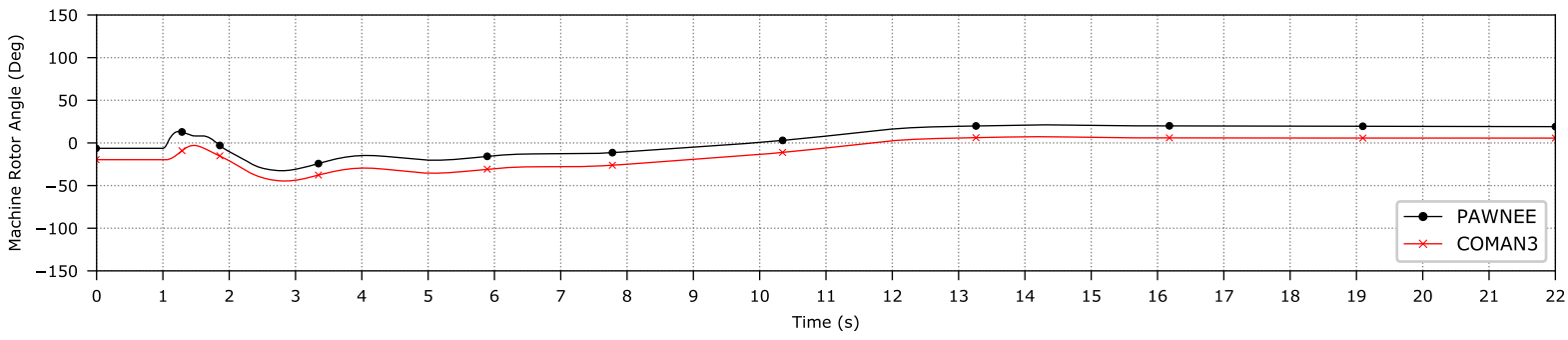


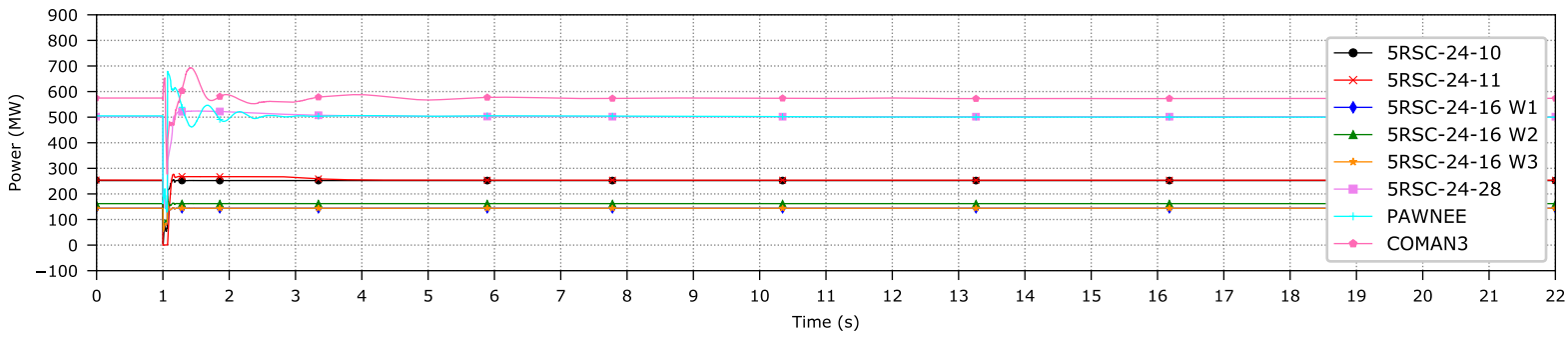


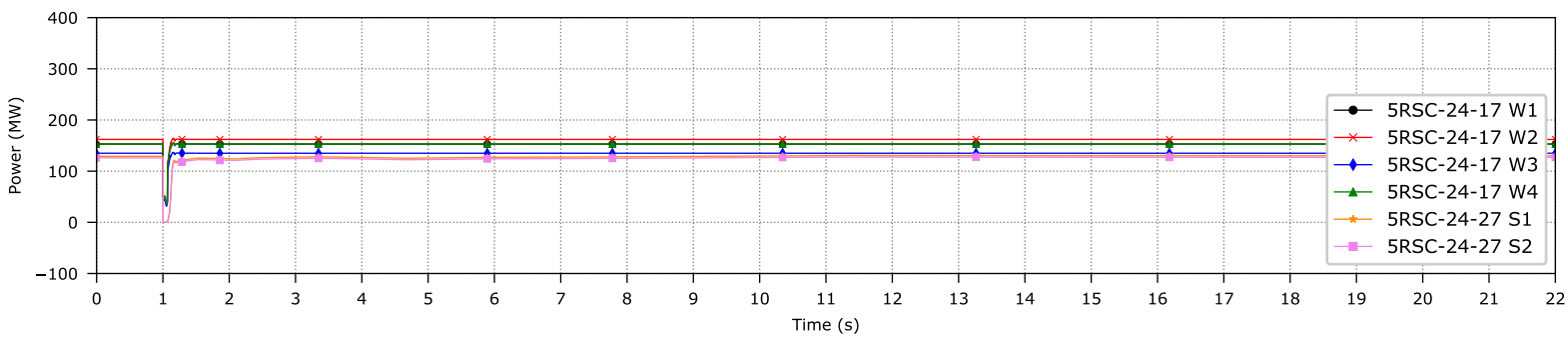


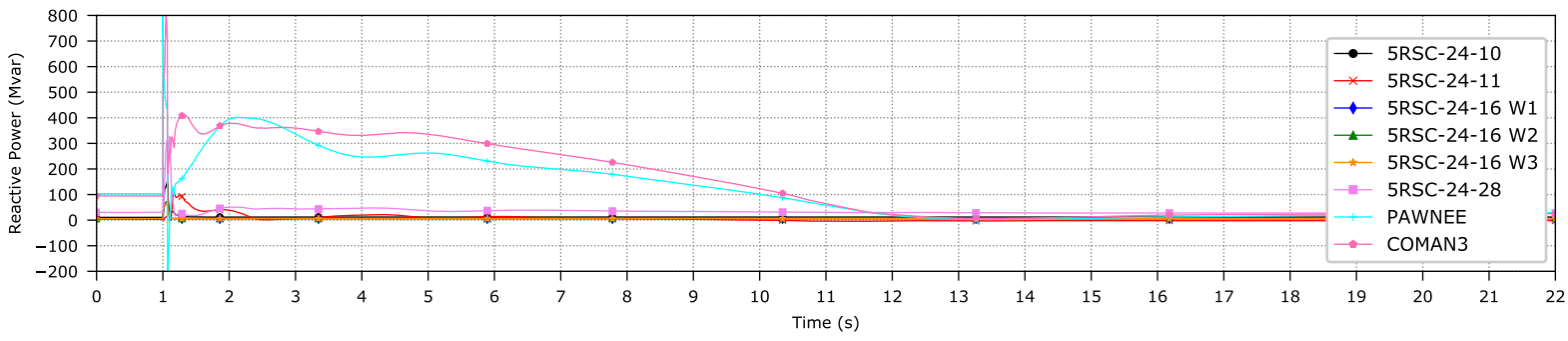


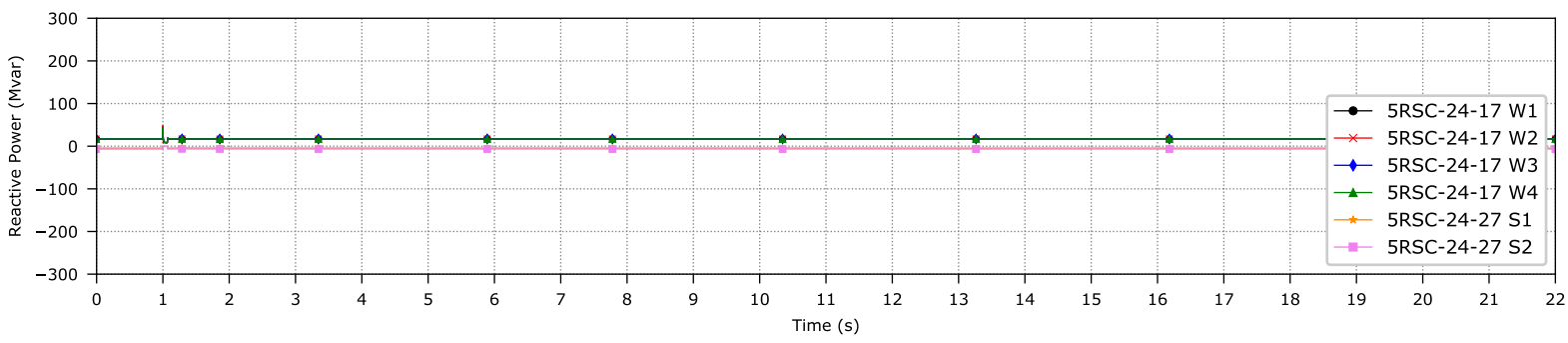
Ref. No. 17 - LoTC_303

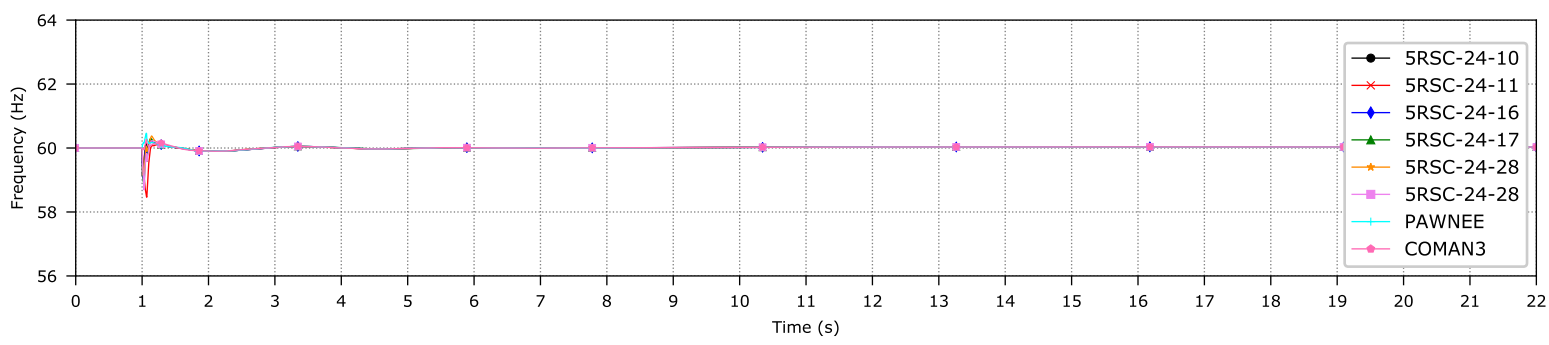


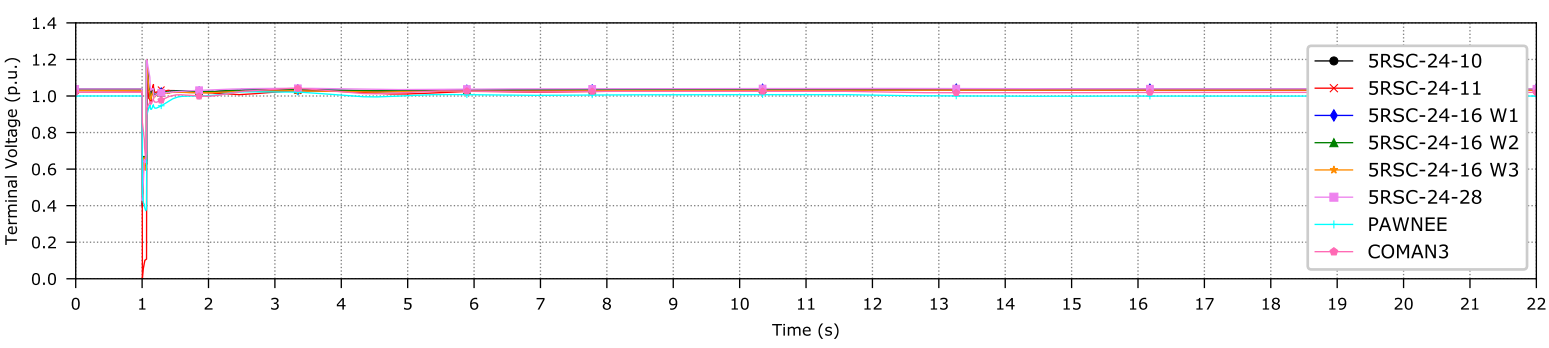


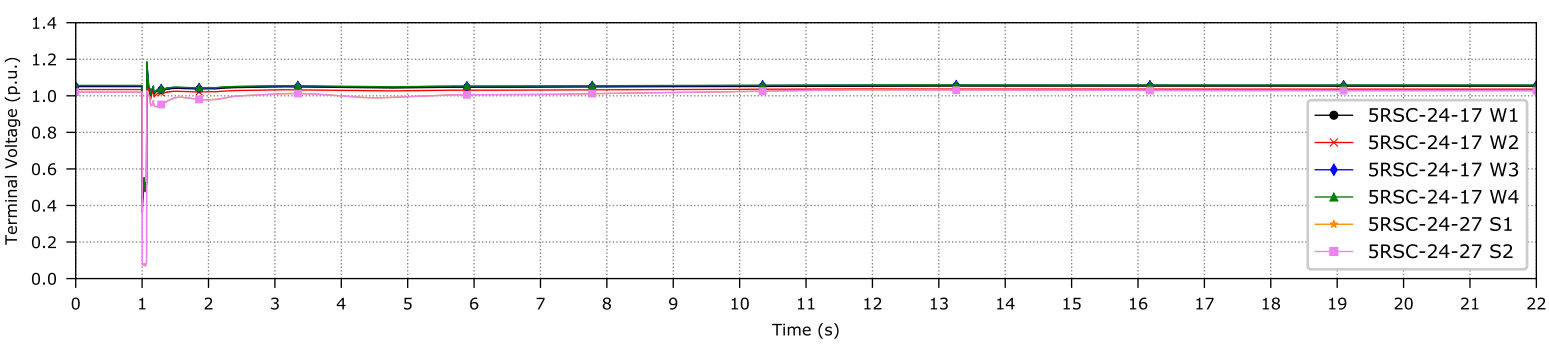


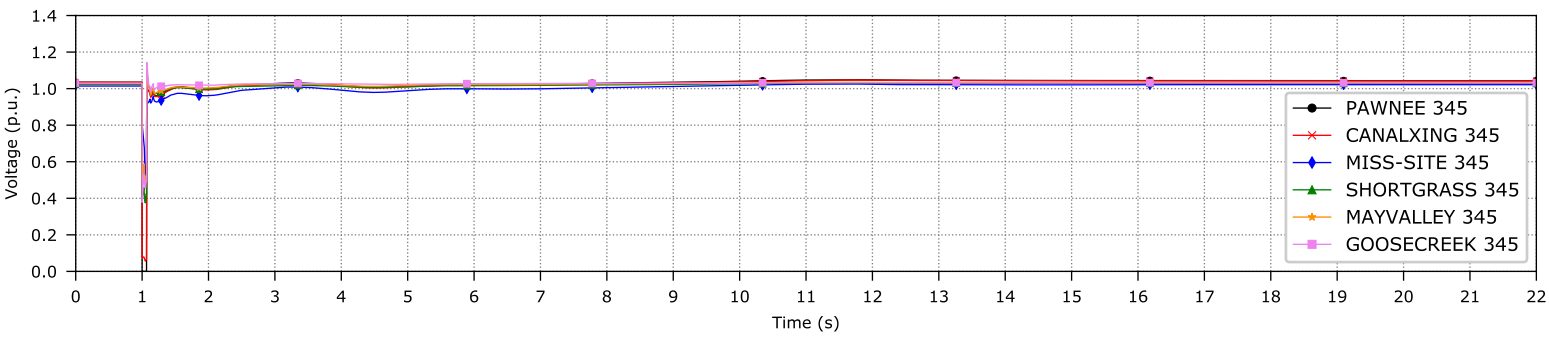




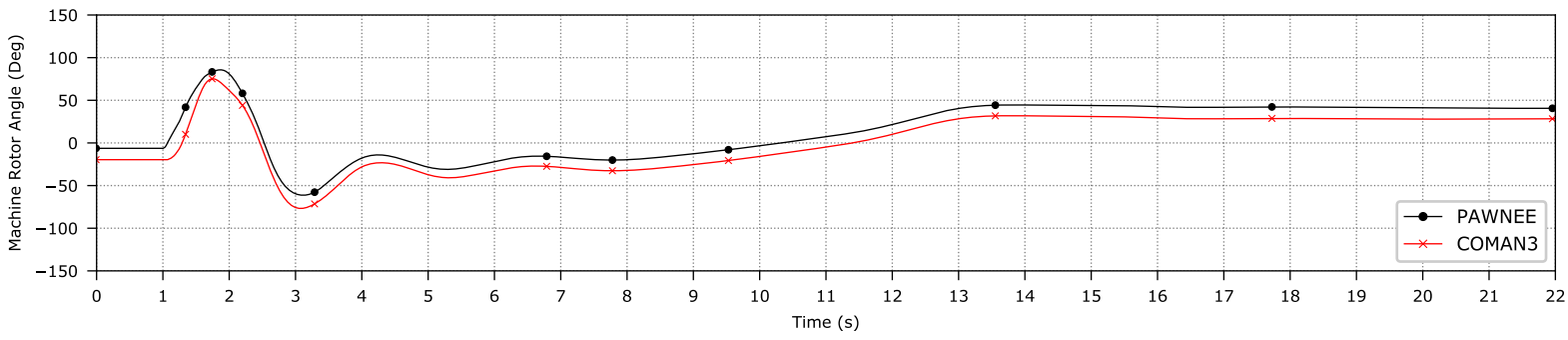


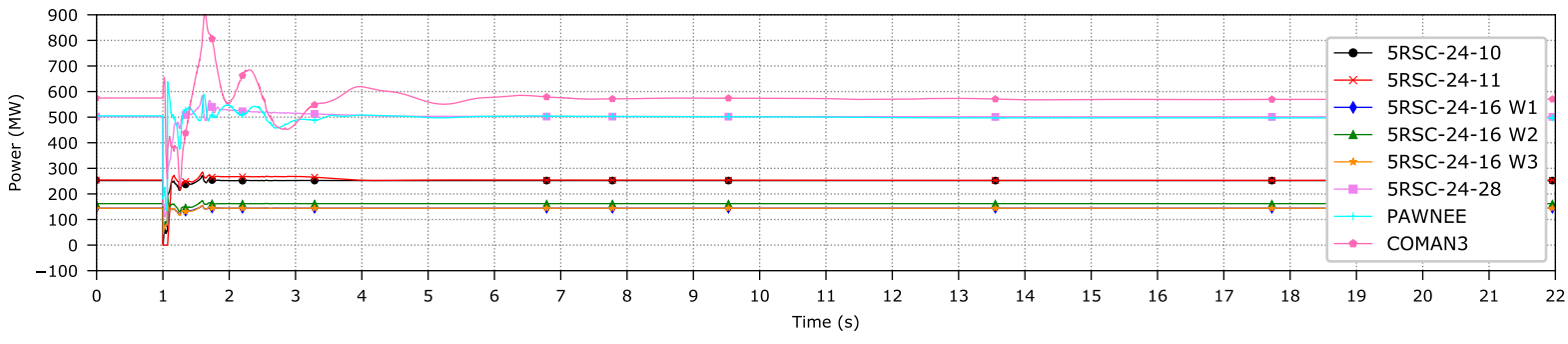


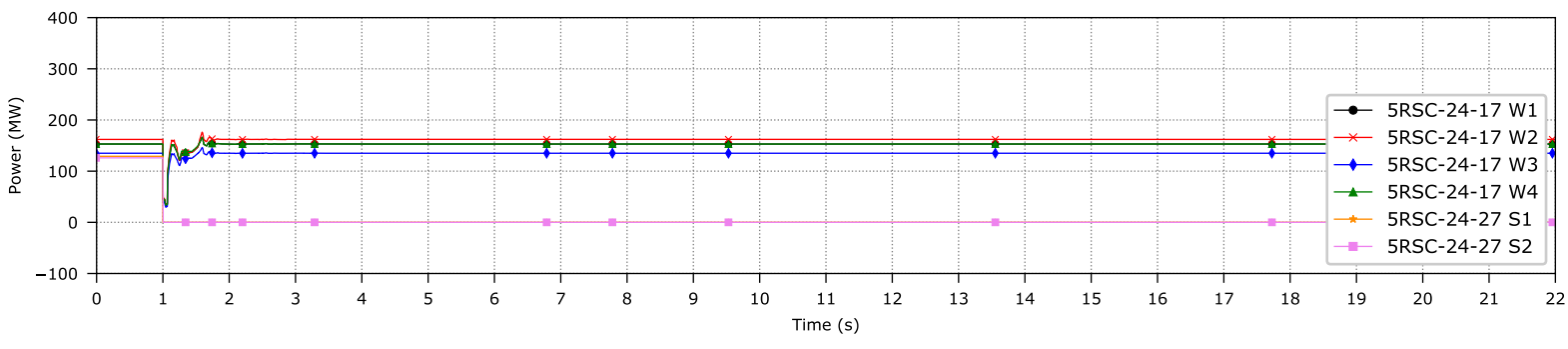


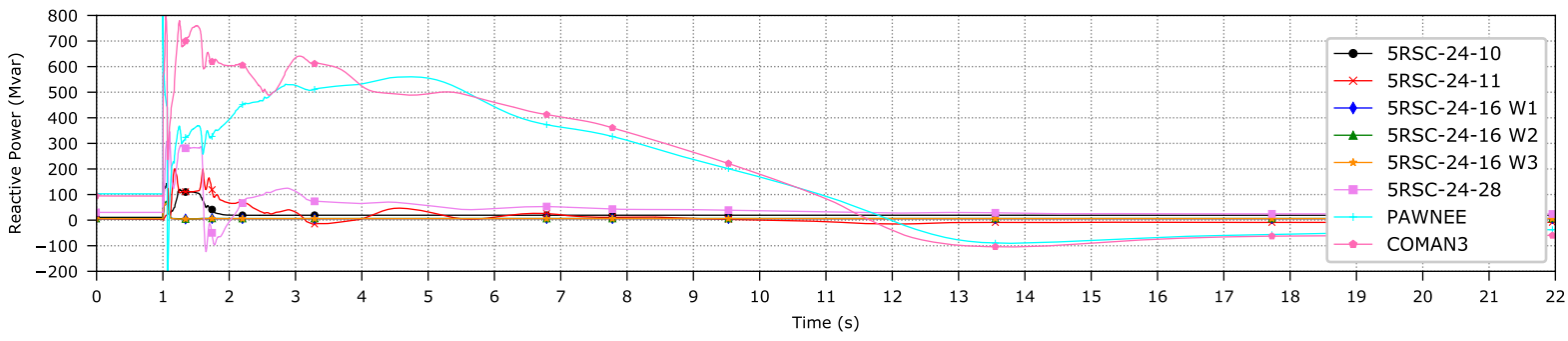


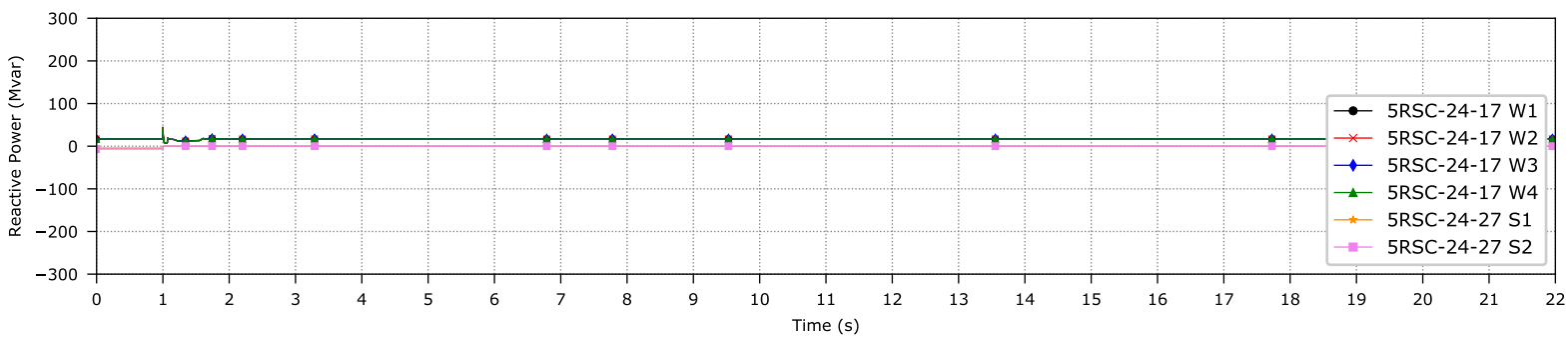
Ref. No. 18 - LoTC_305

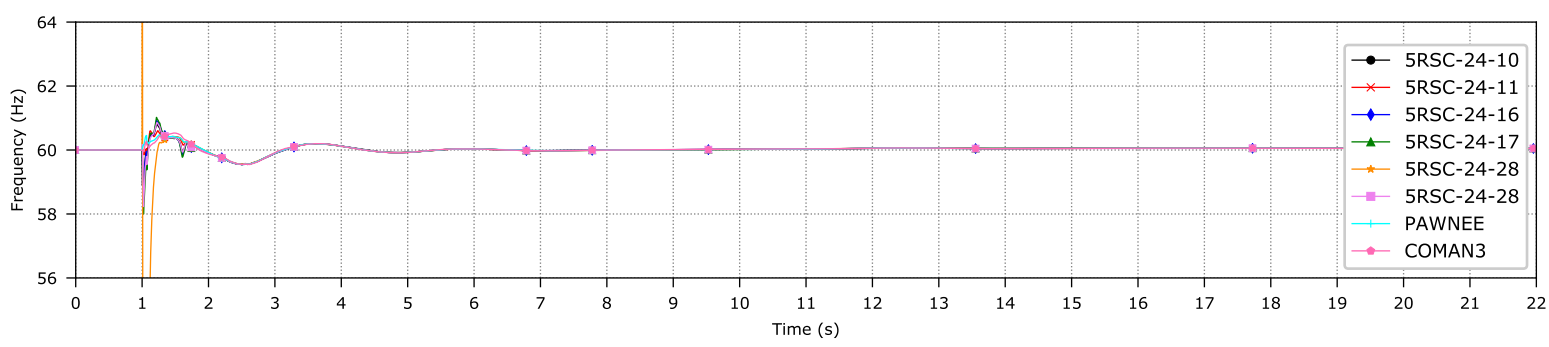


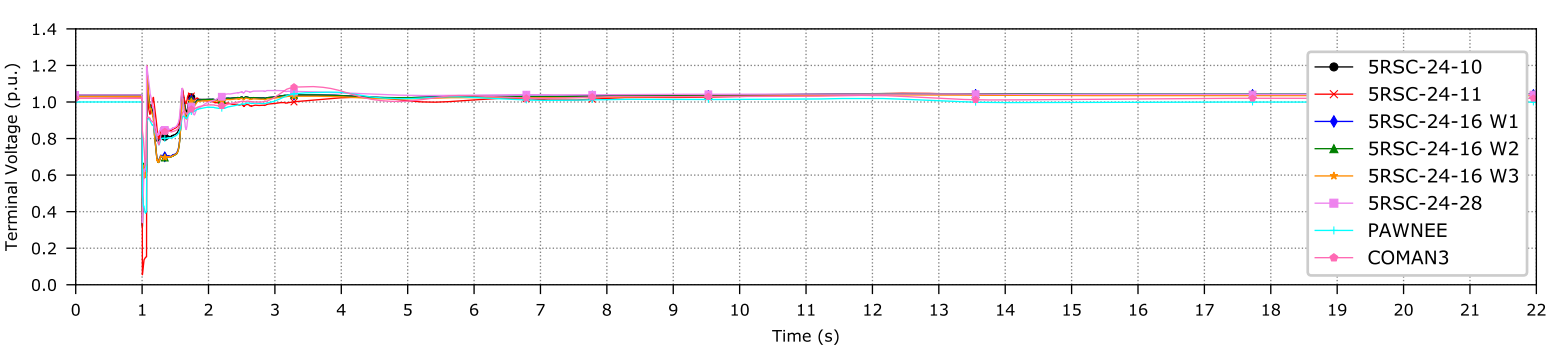


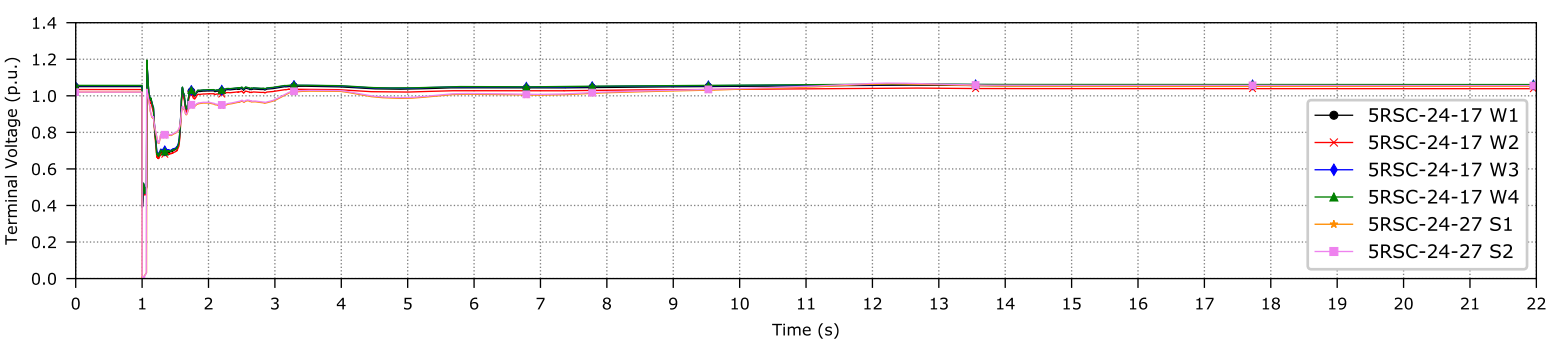


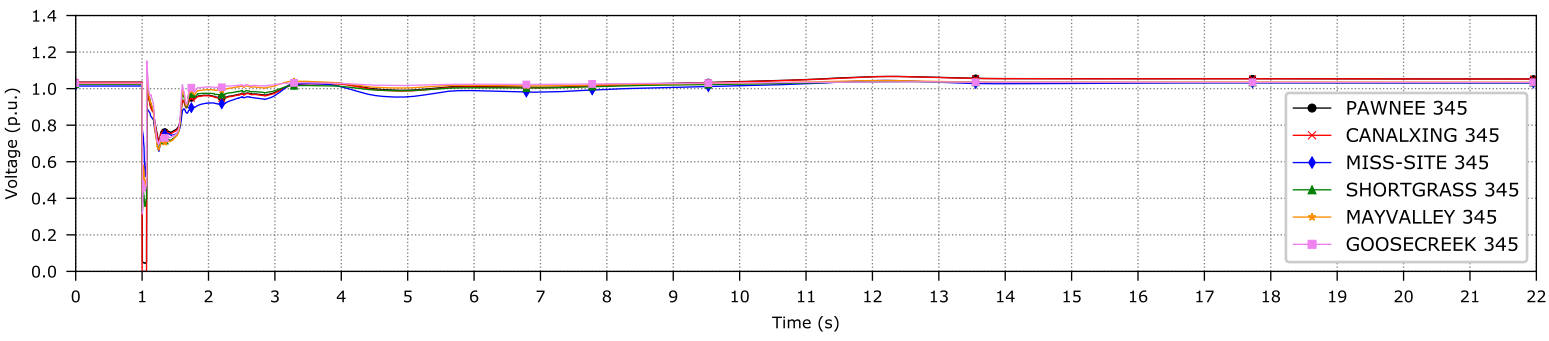




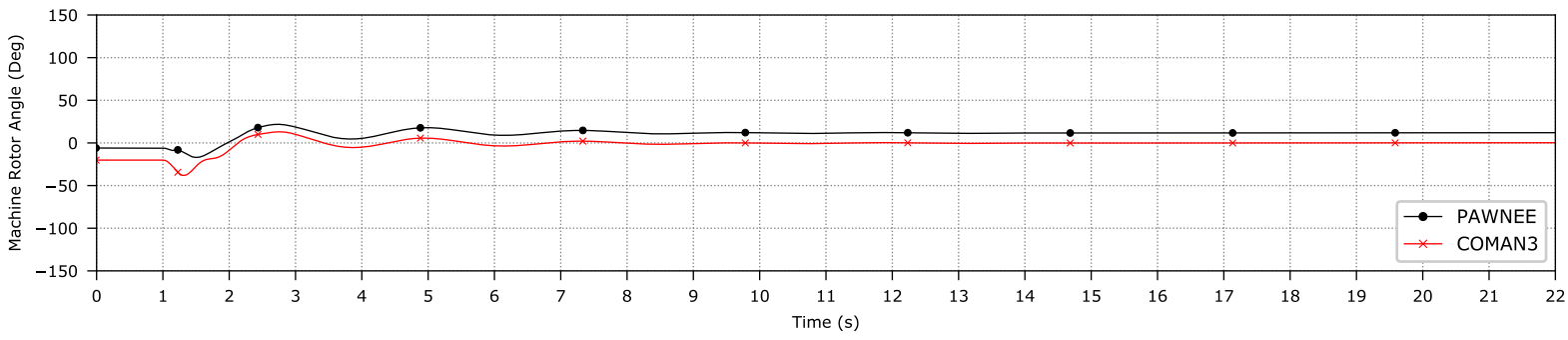


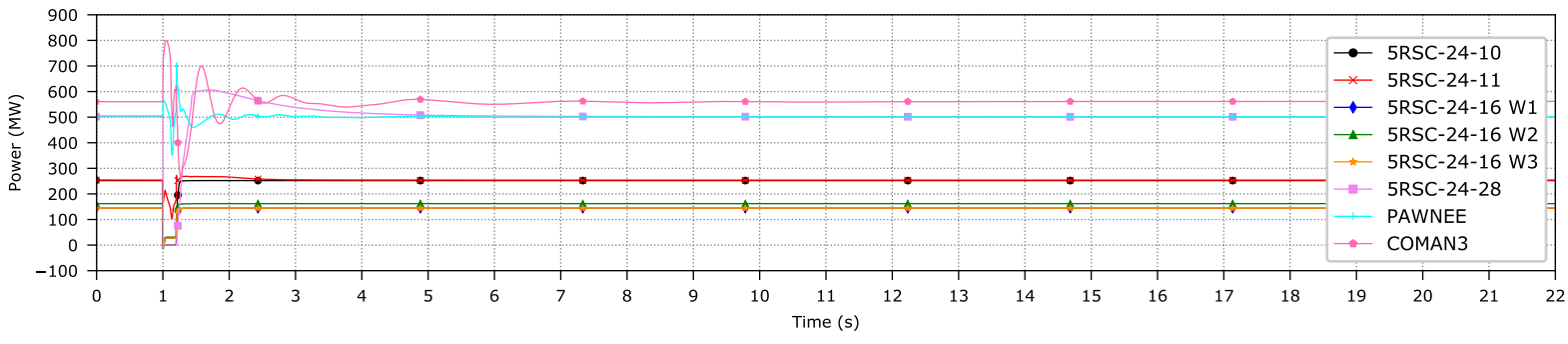


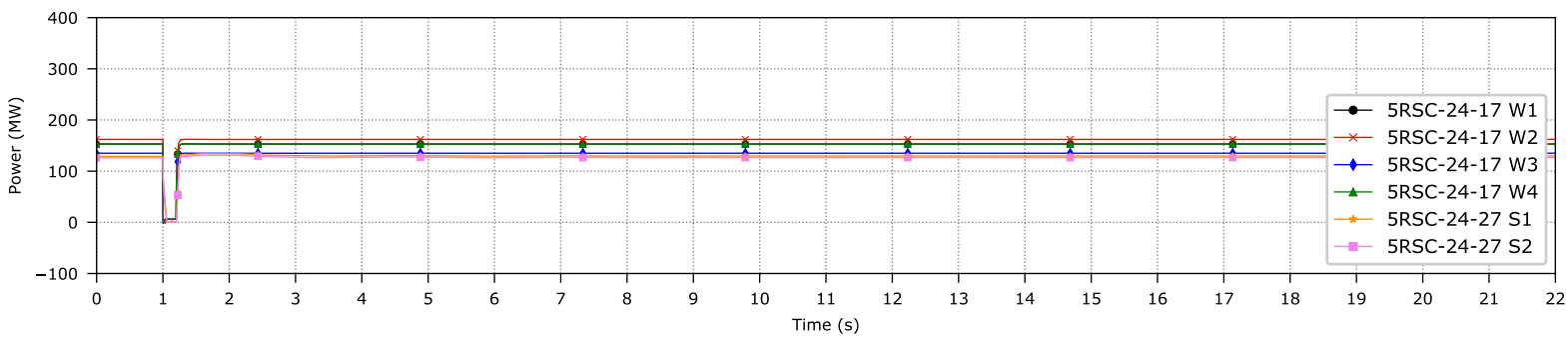


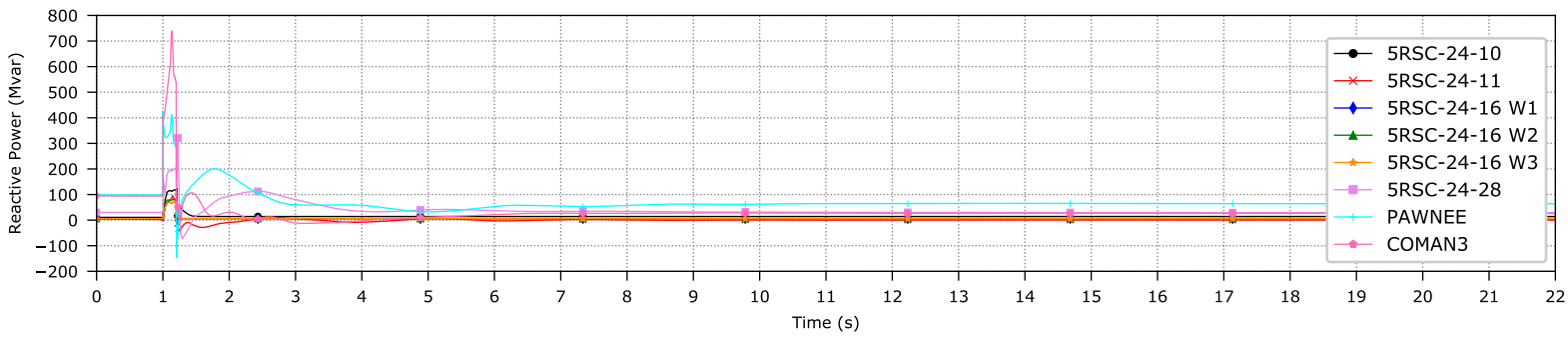


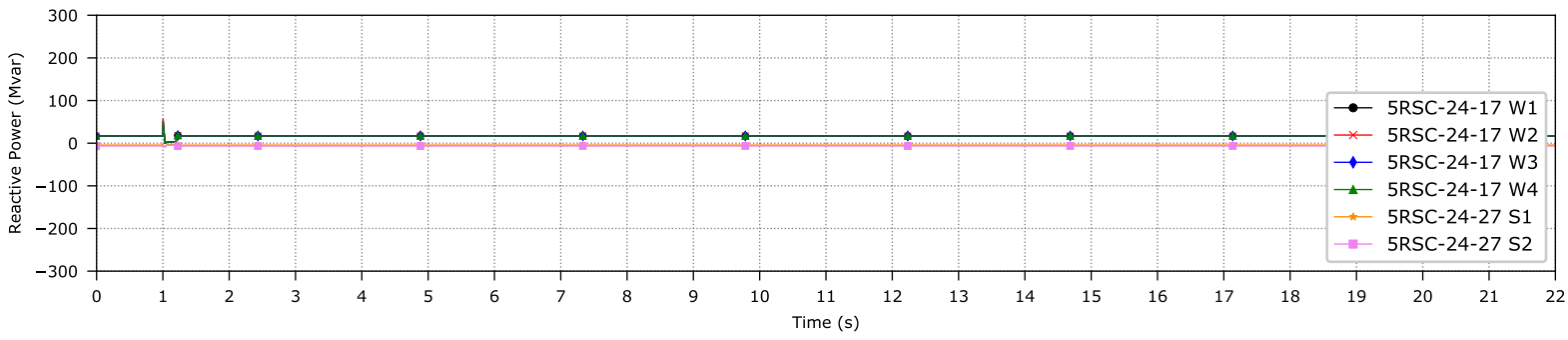
Ref. No. 19 - BF_034

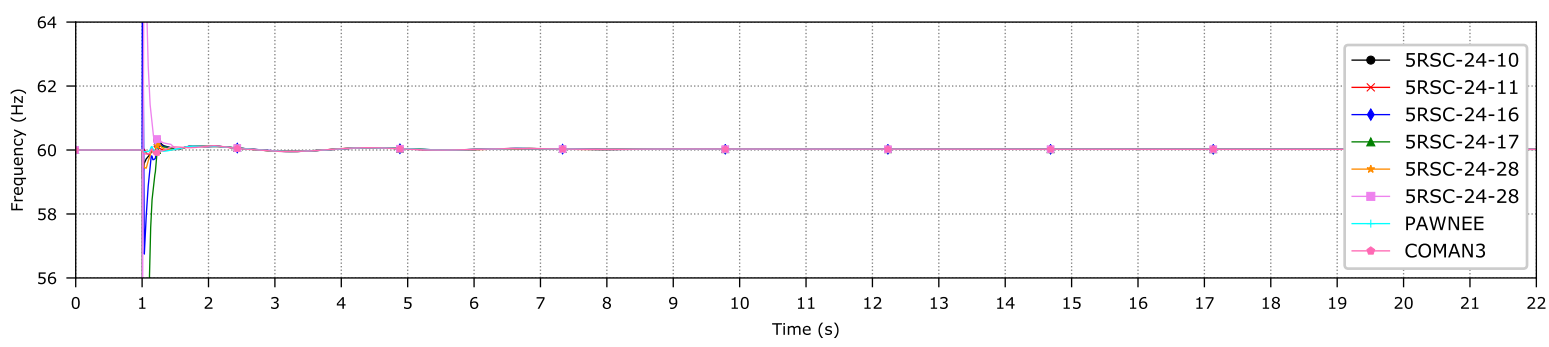


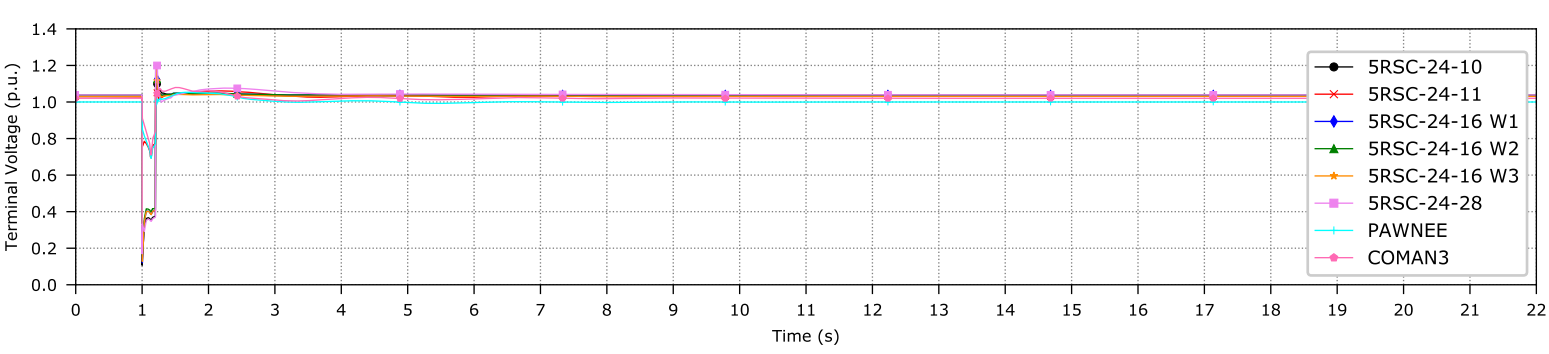


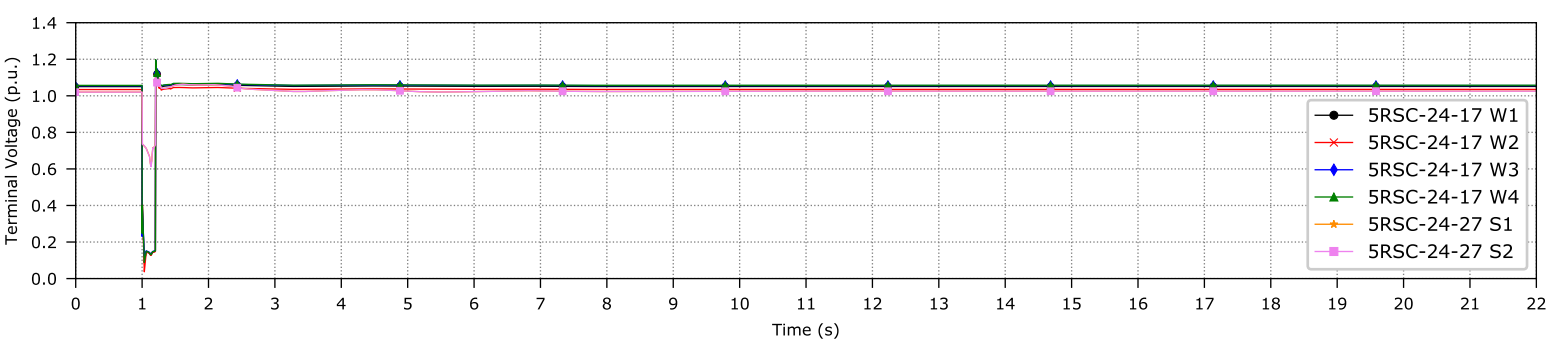


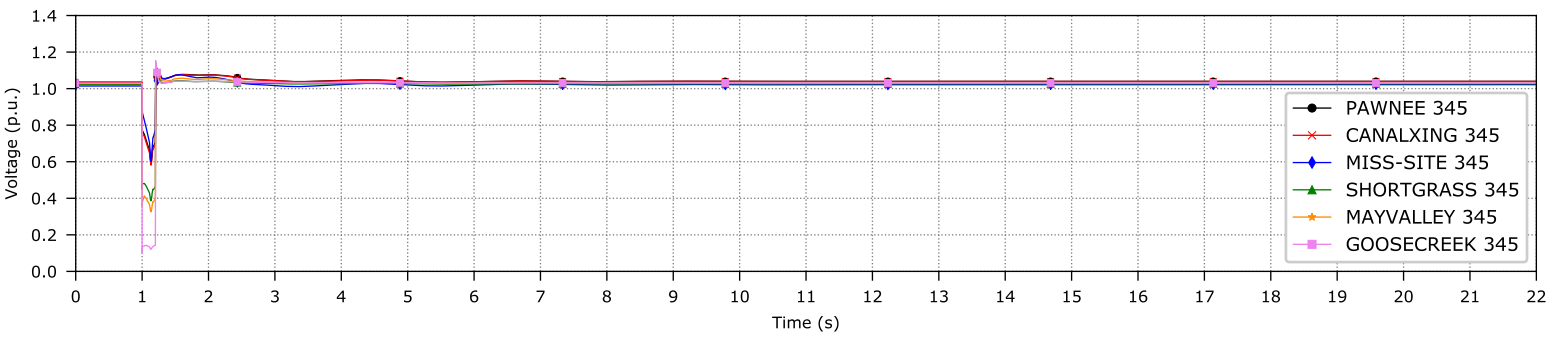




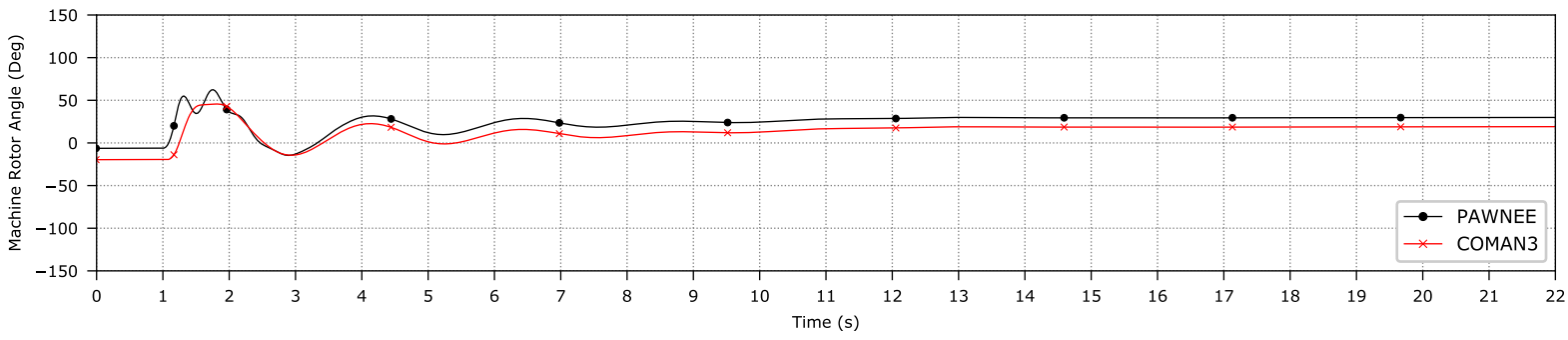


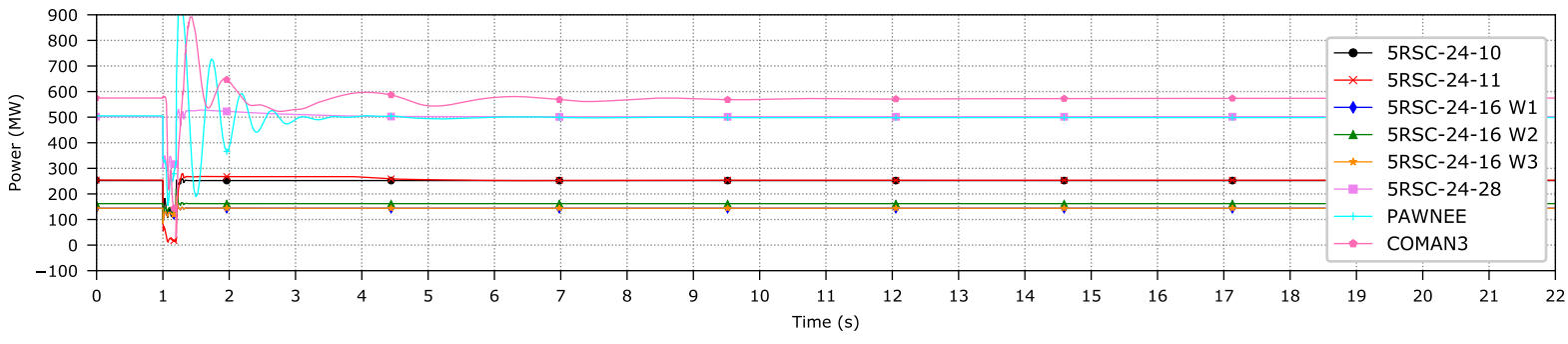


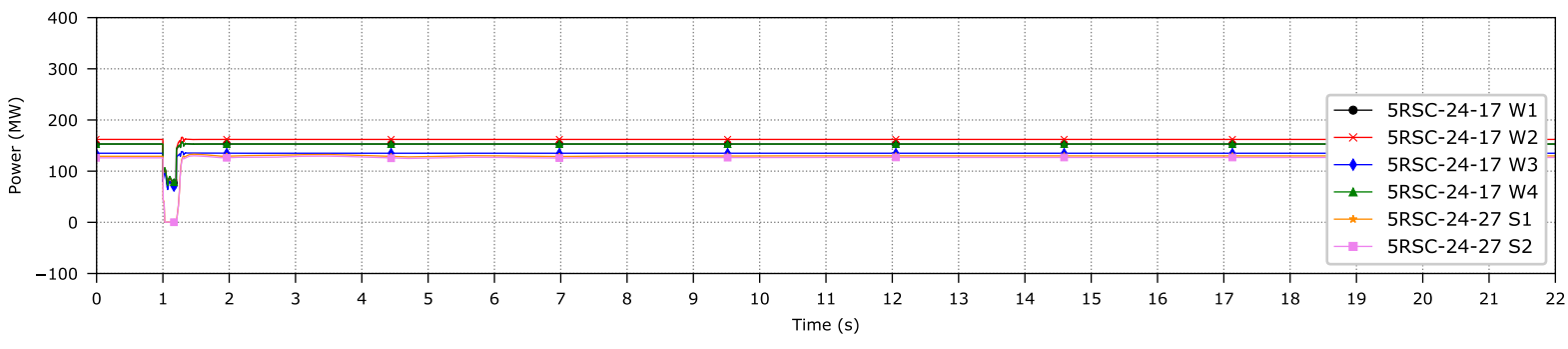


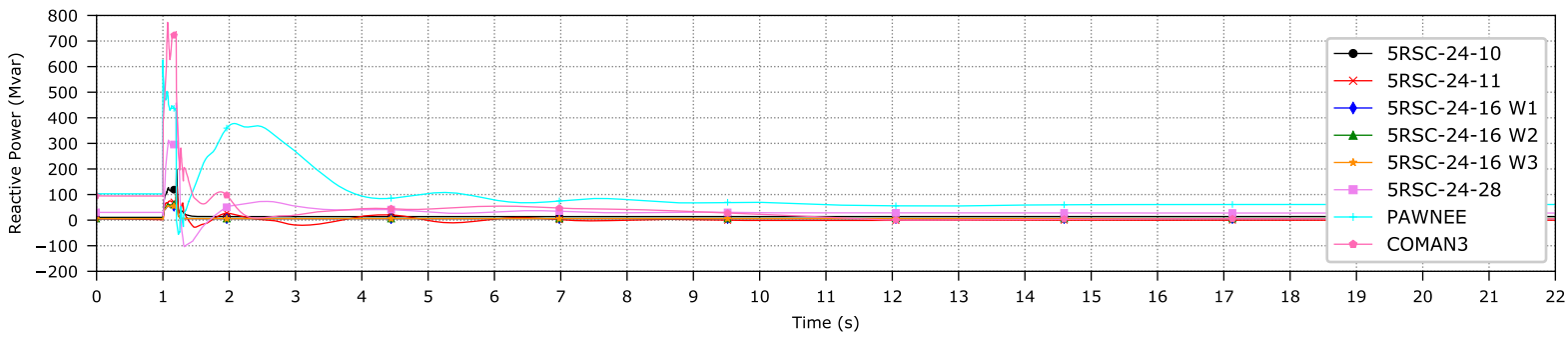


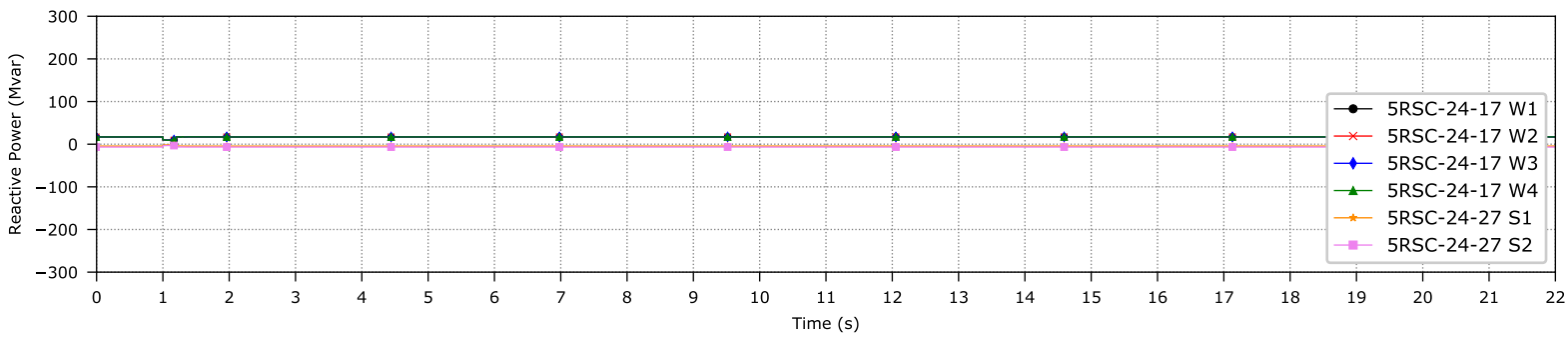
Ref. No. 20 - BF_154a

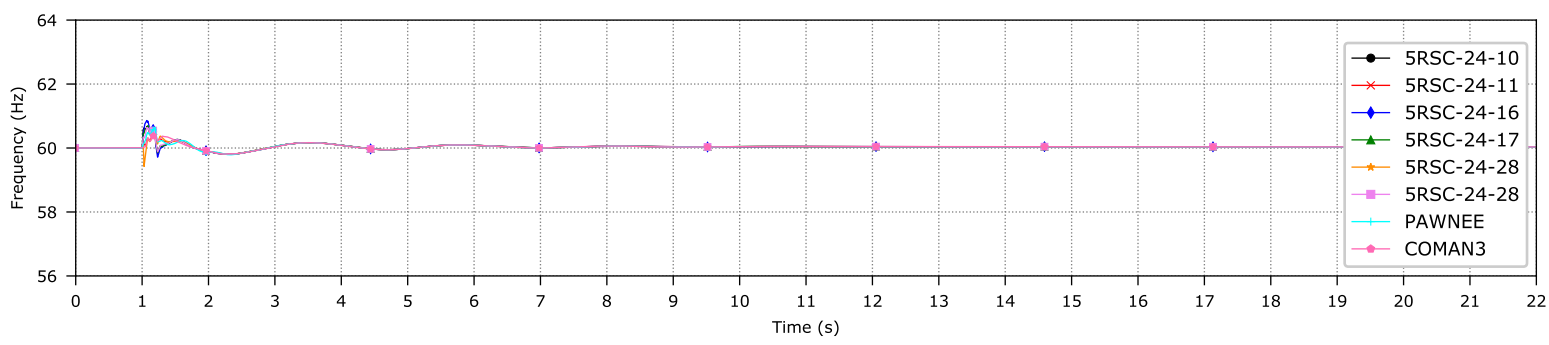


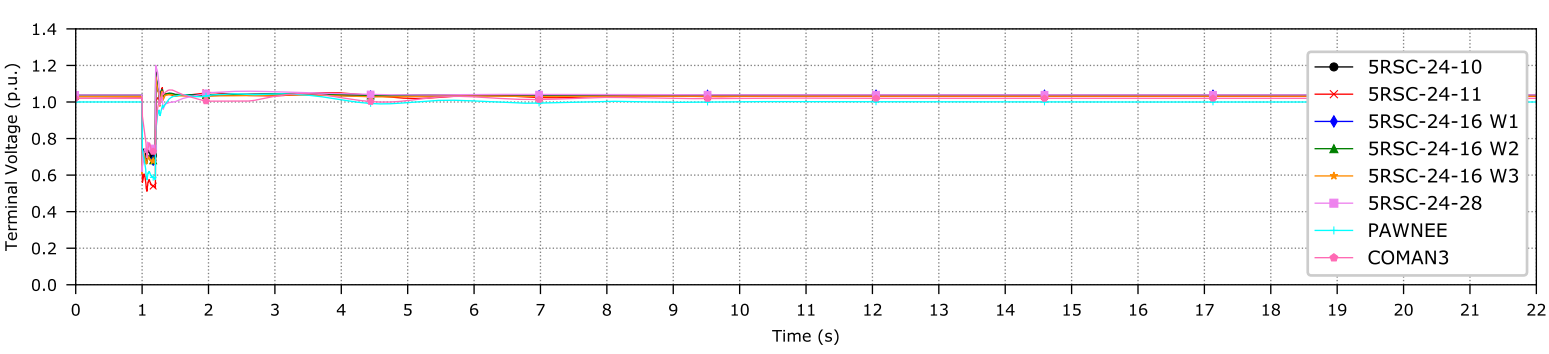


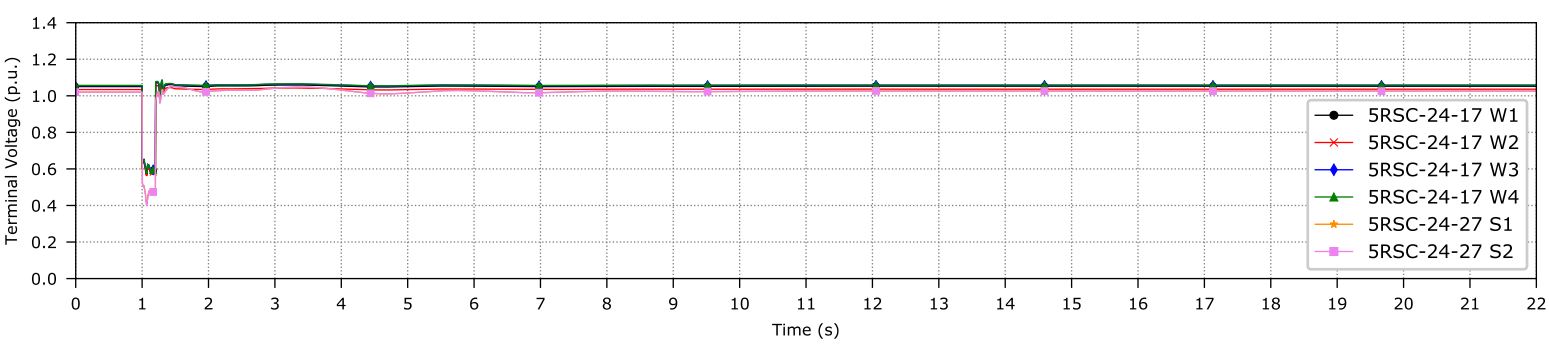


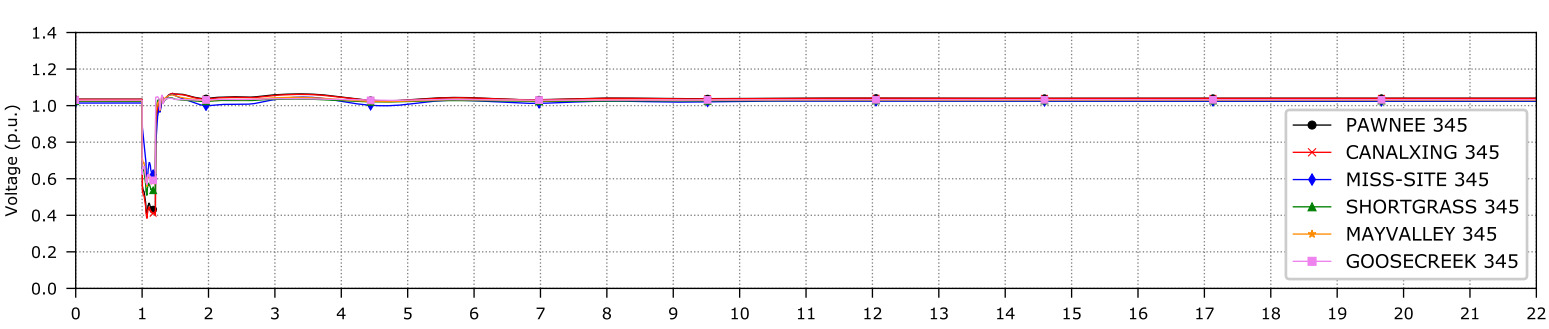




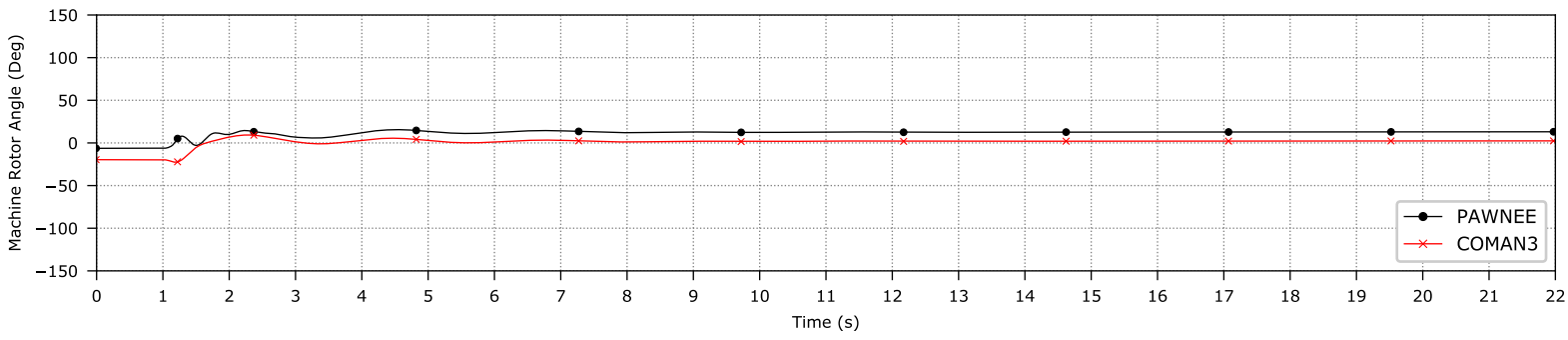


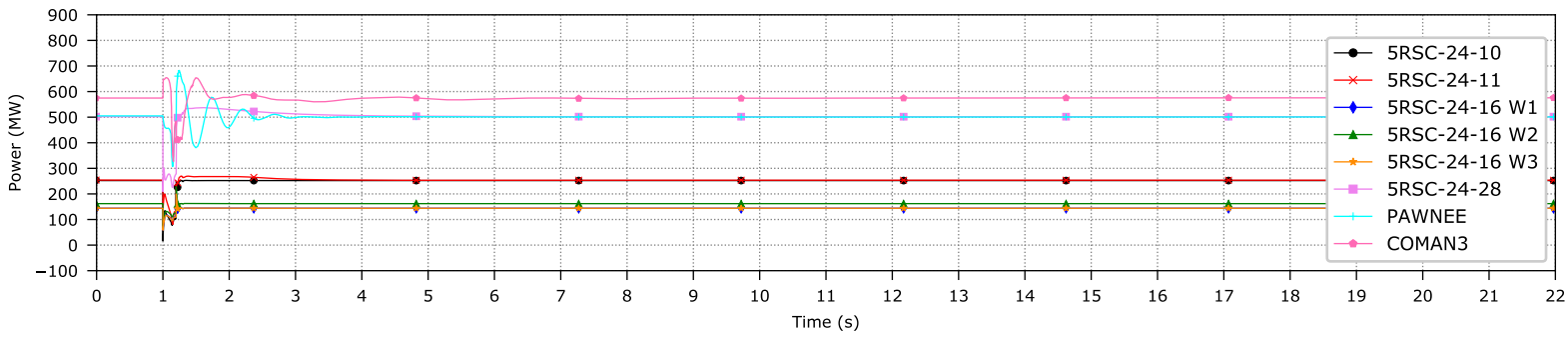


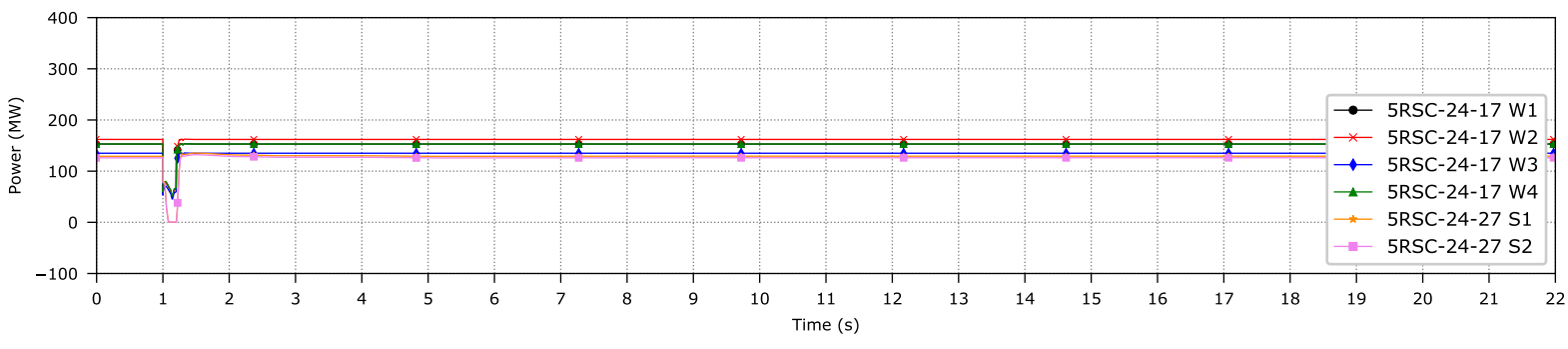


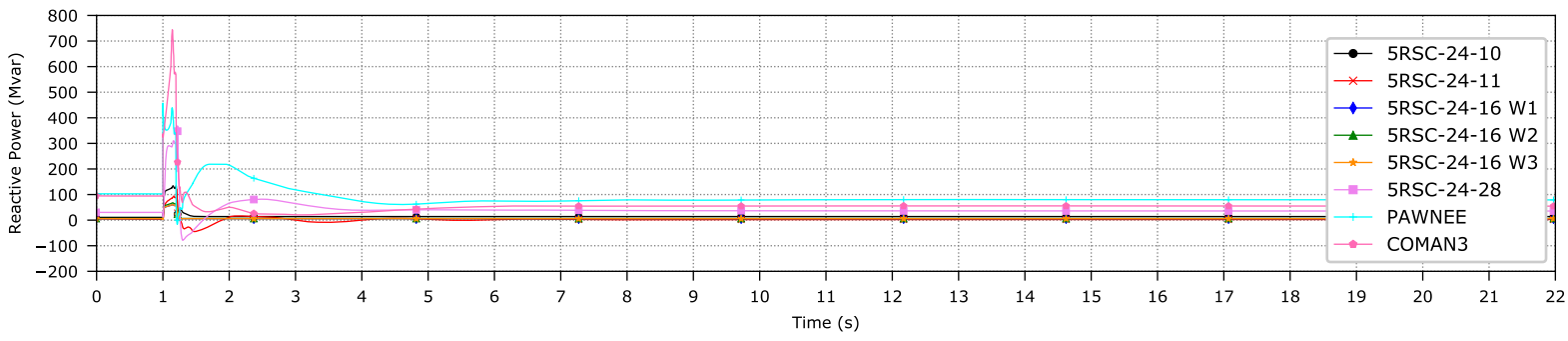


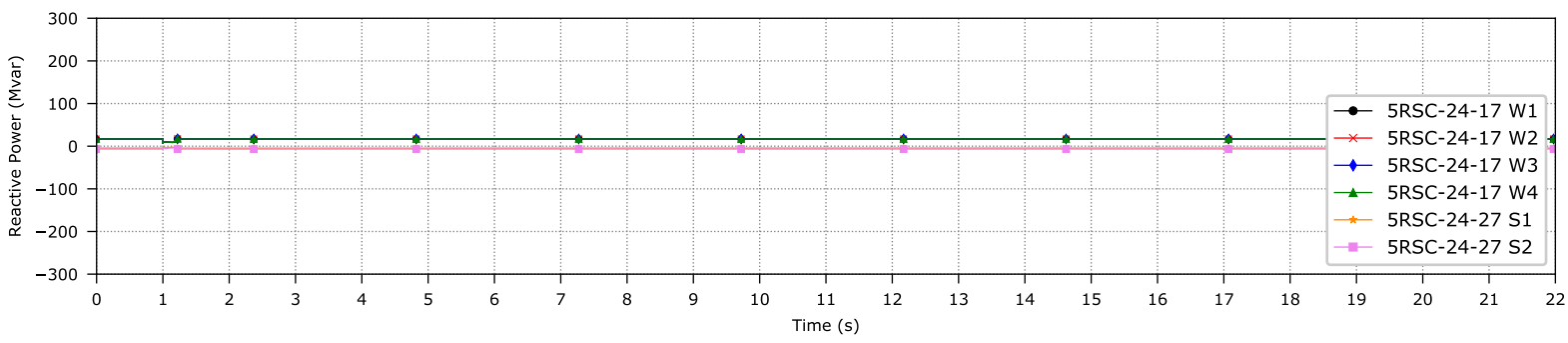
Ref. No. 21 - BF_155a

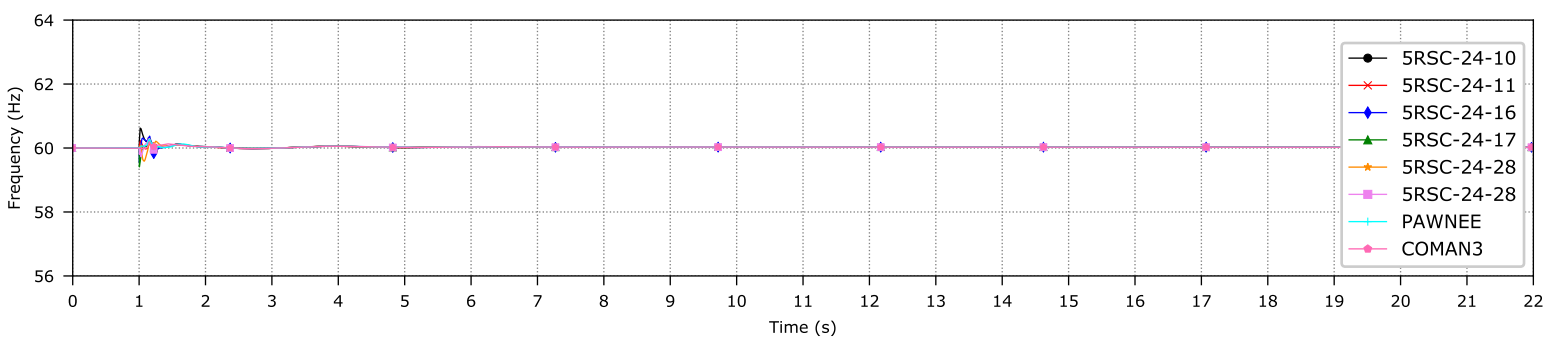


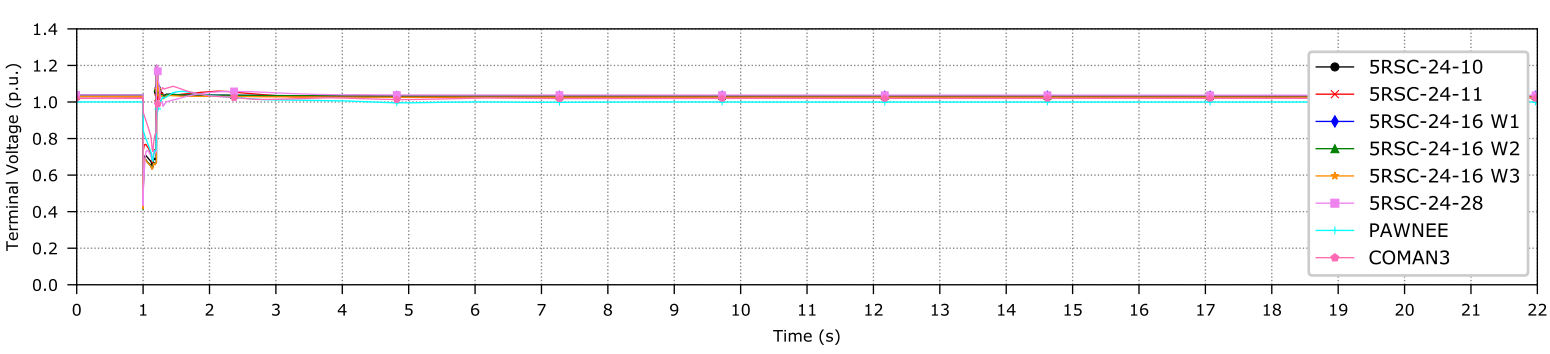


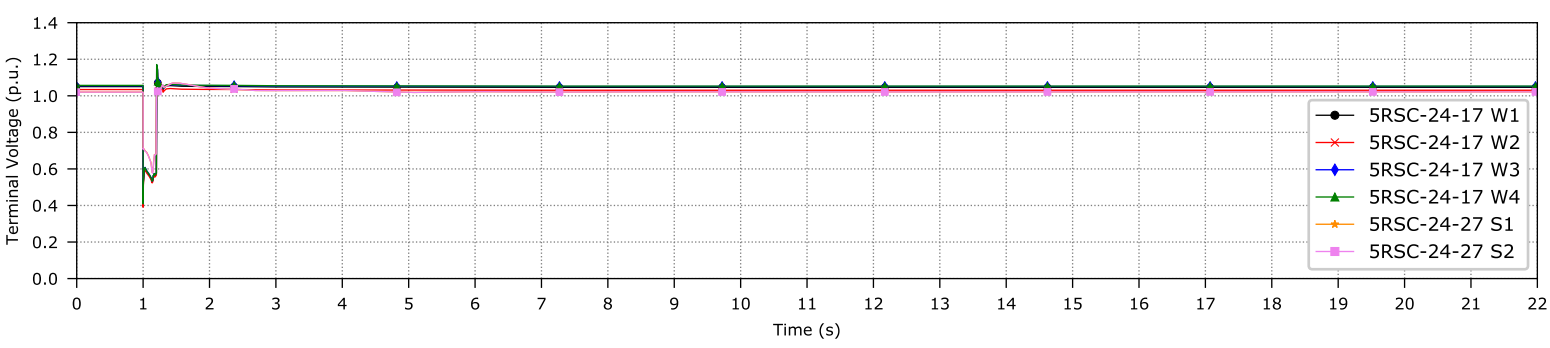


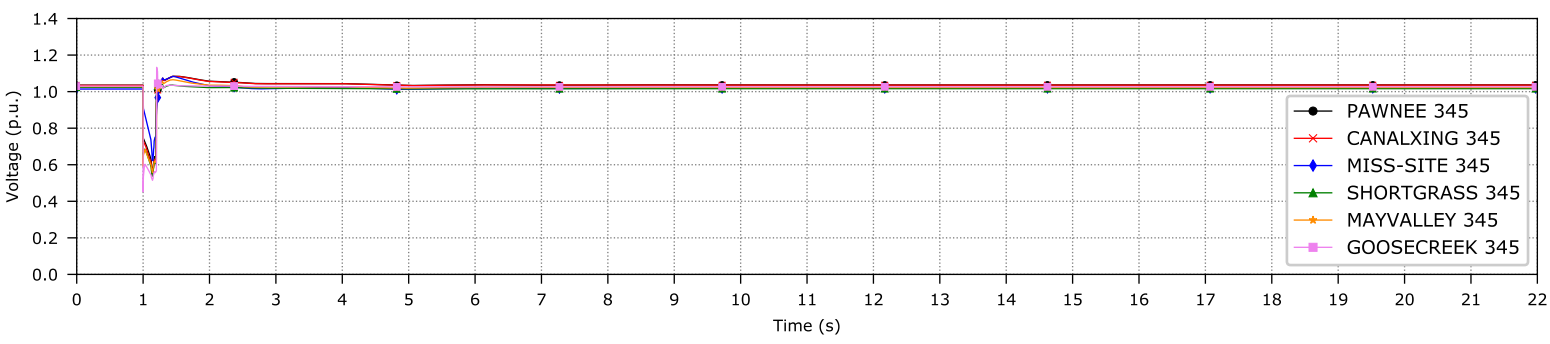




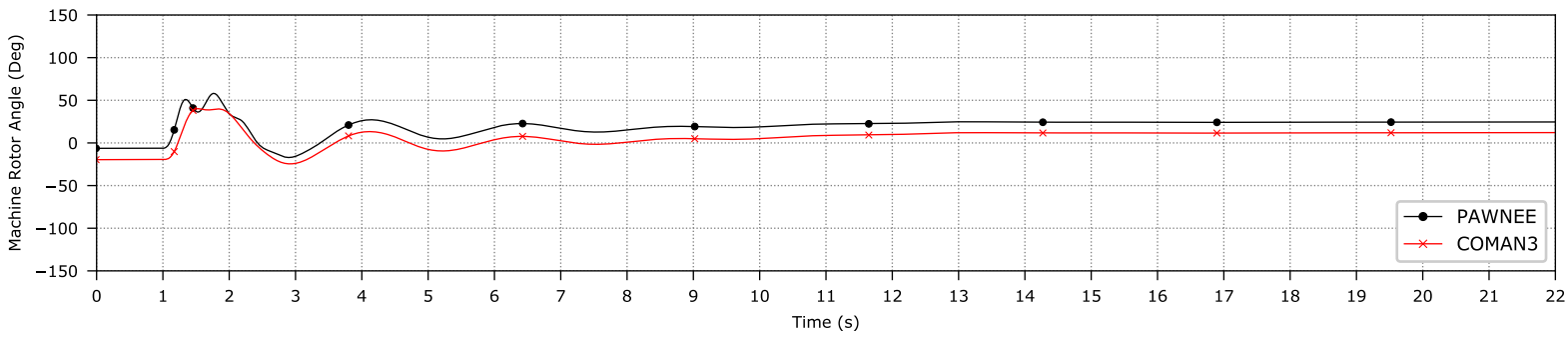


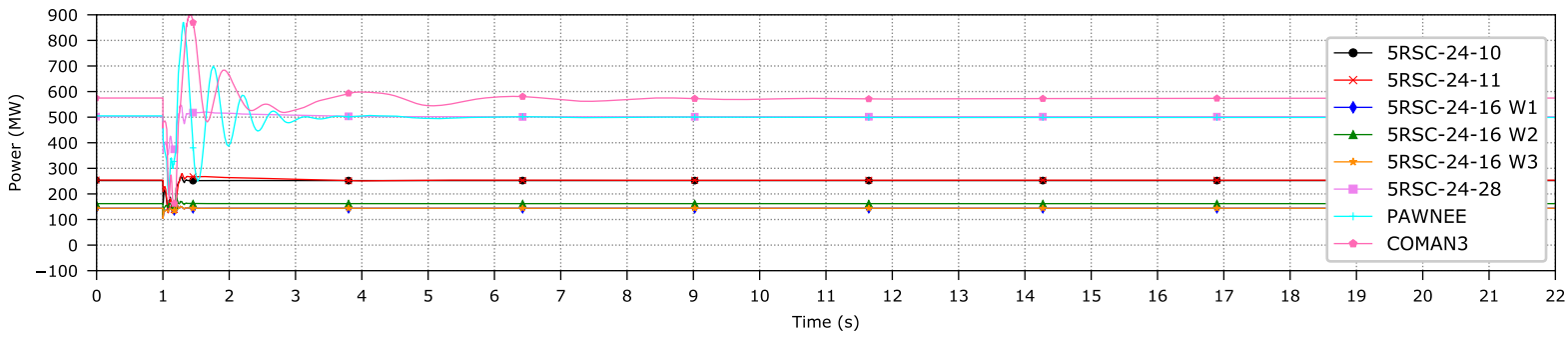


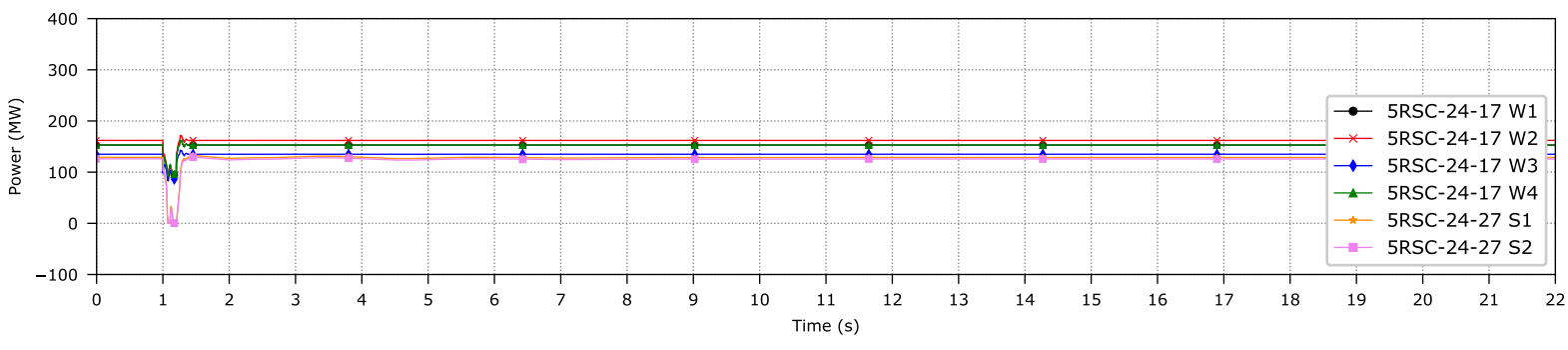


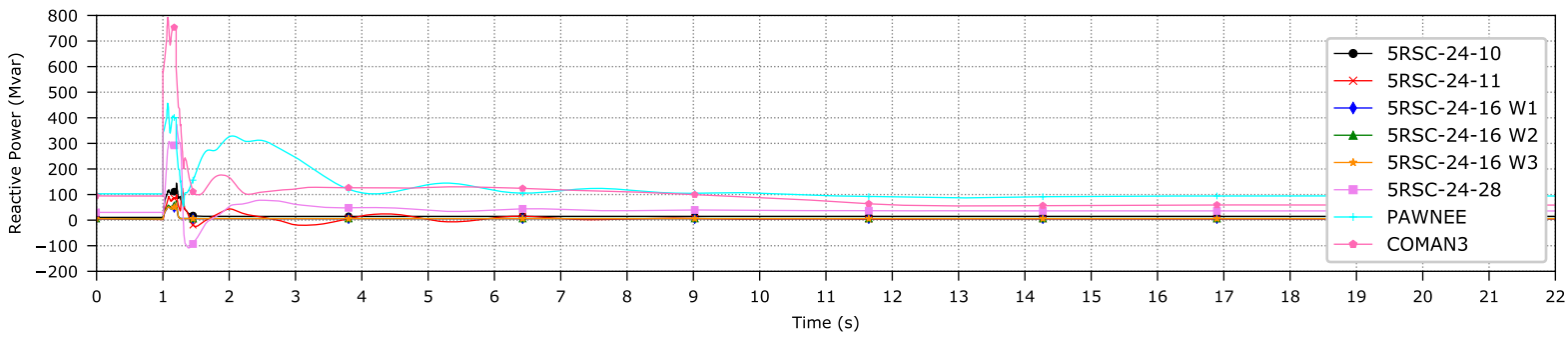


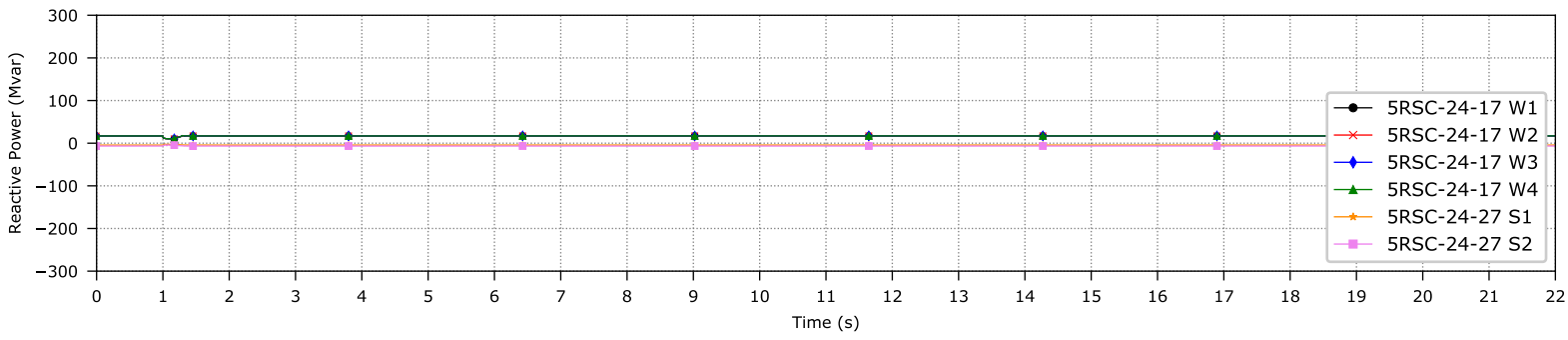
Ref. No. 22 - BF_156b

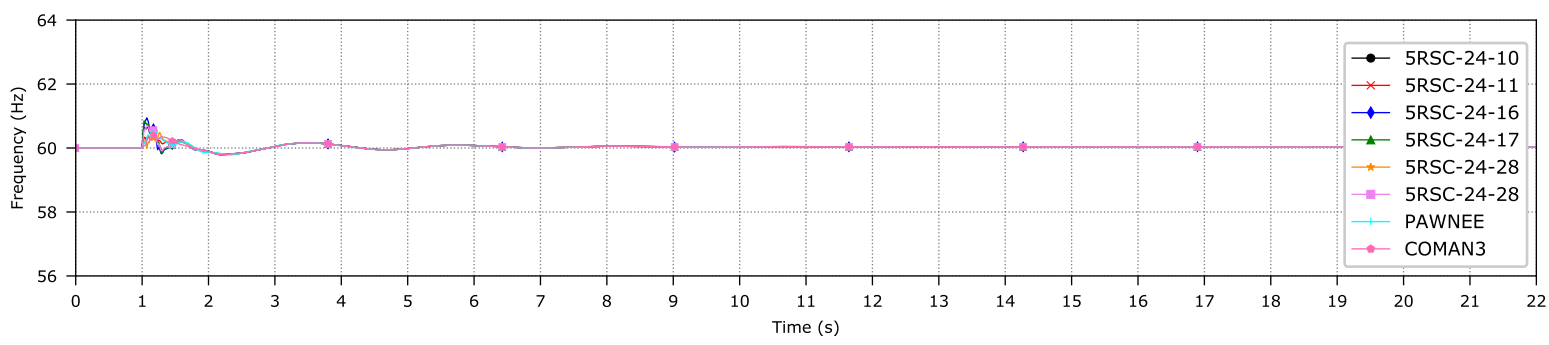


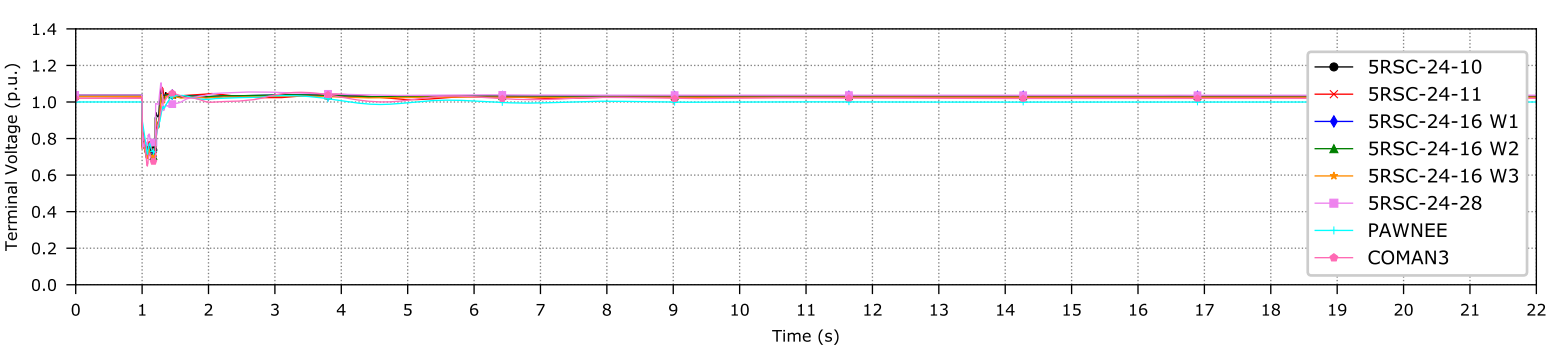


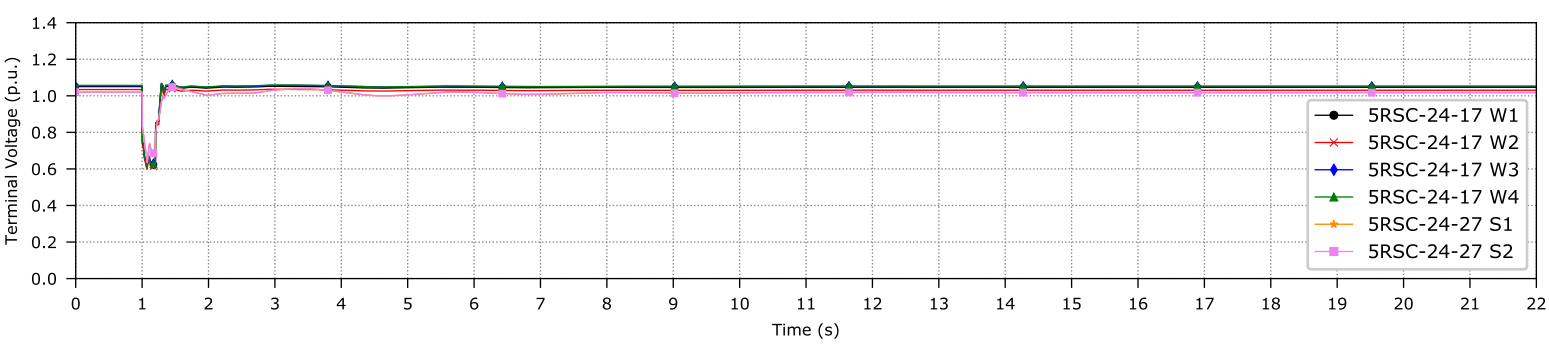


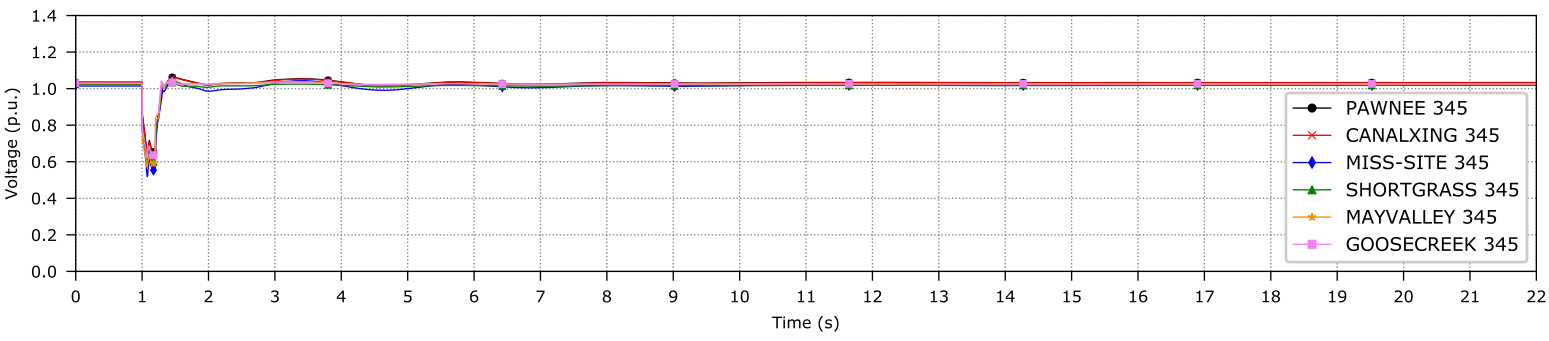












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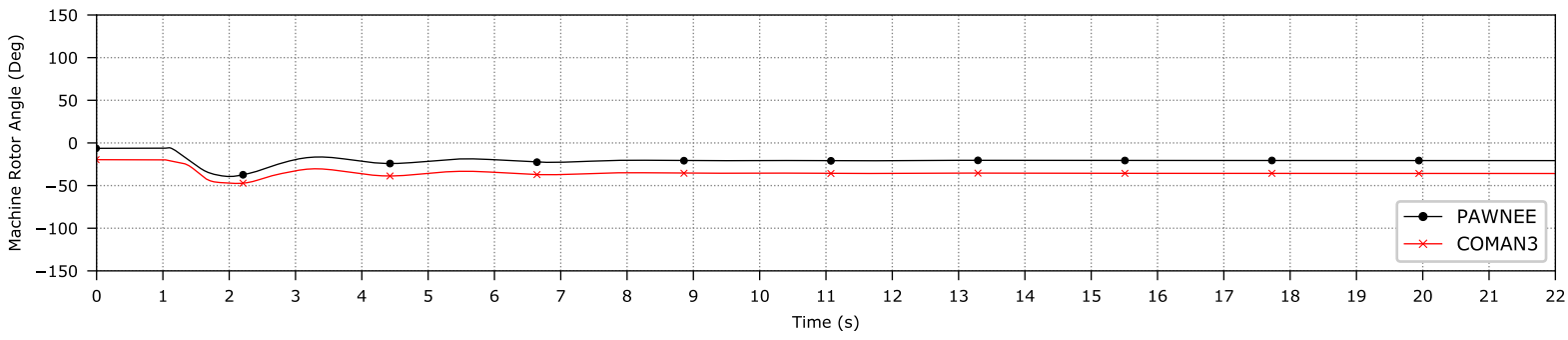
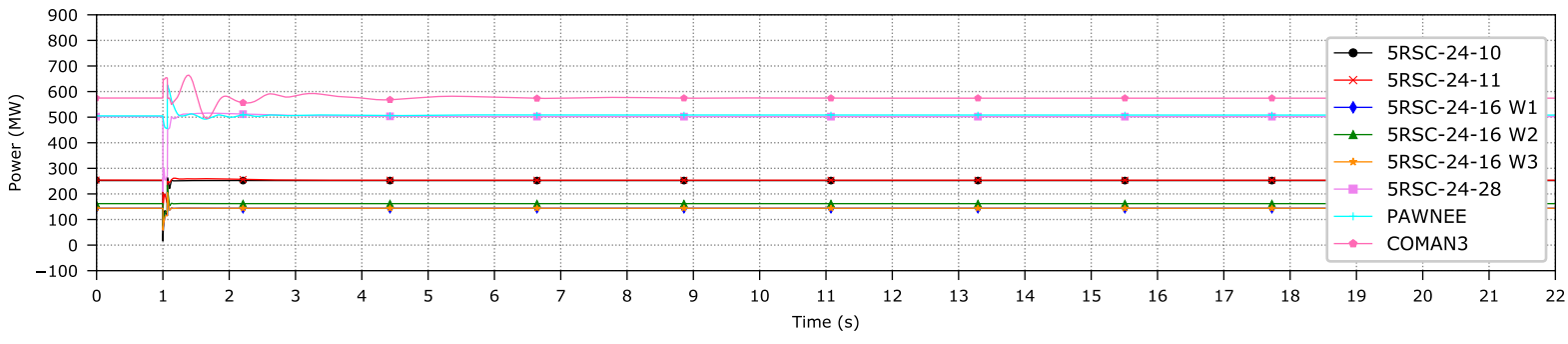
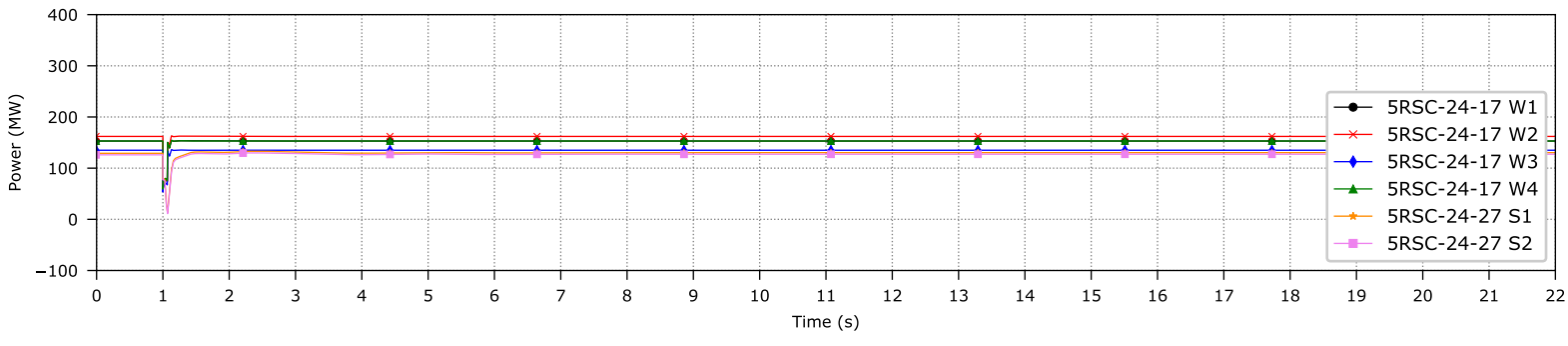
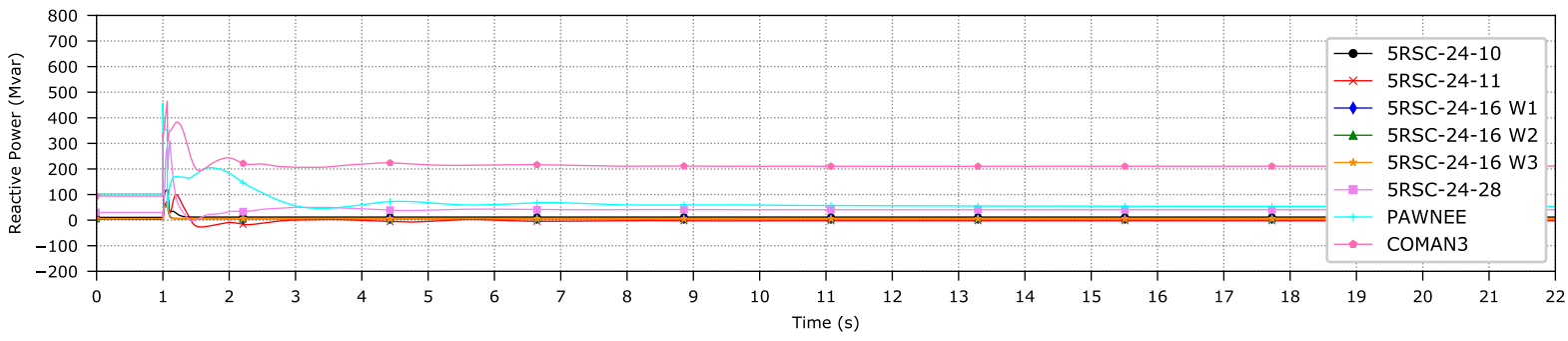
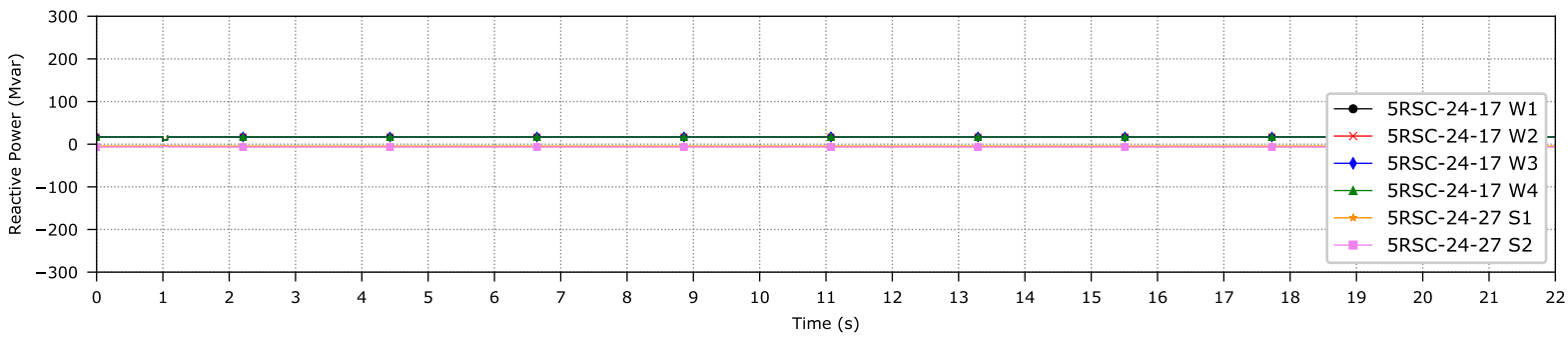
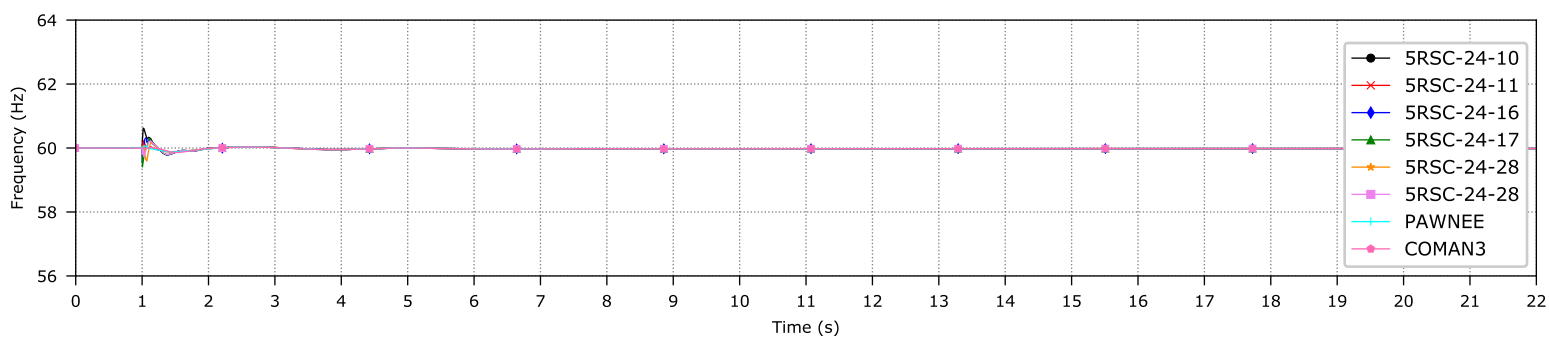


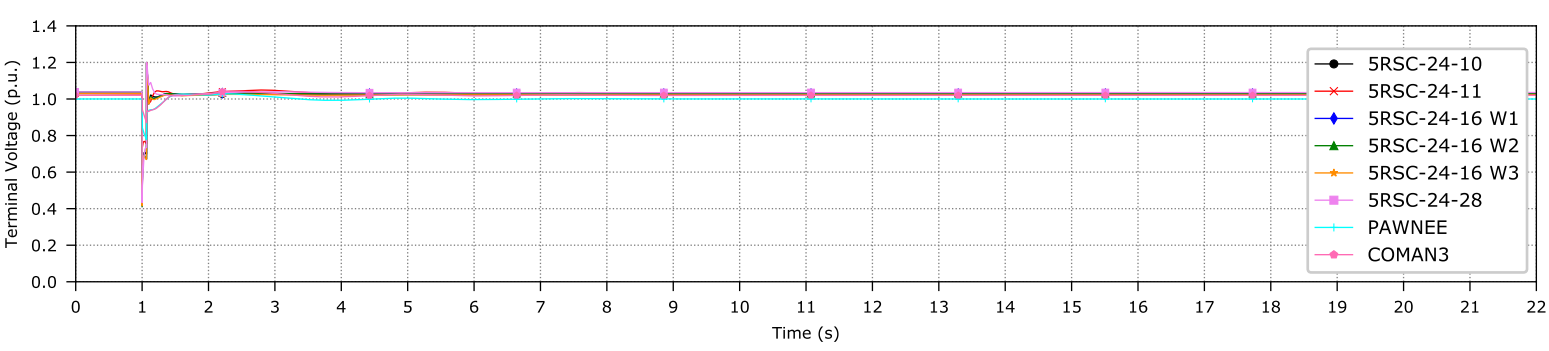


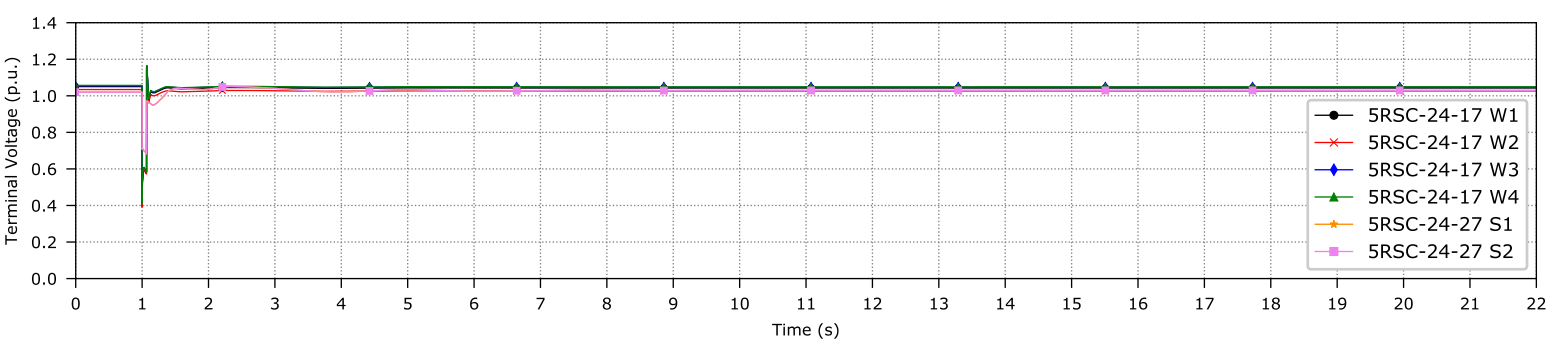


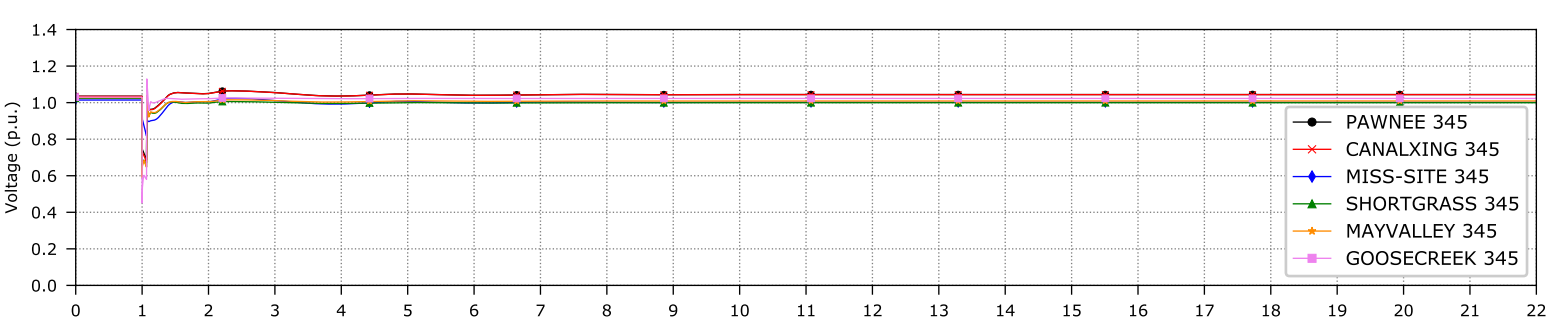




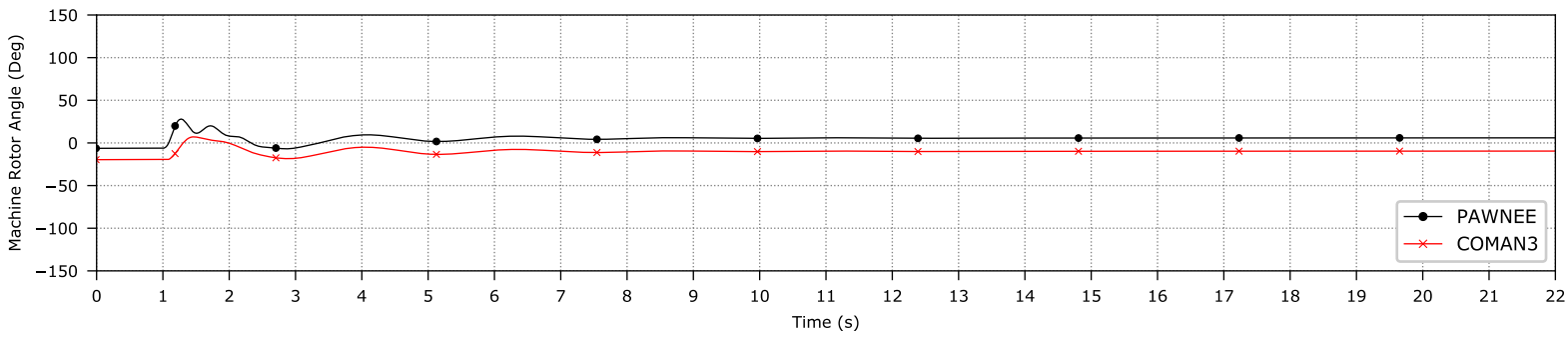


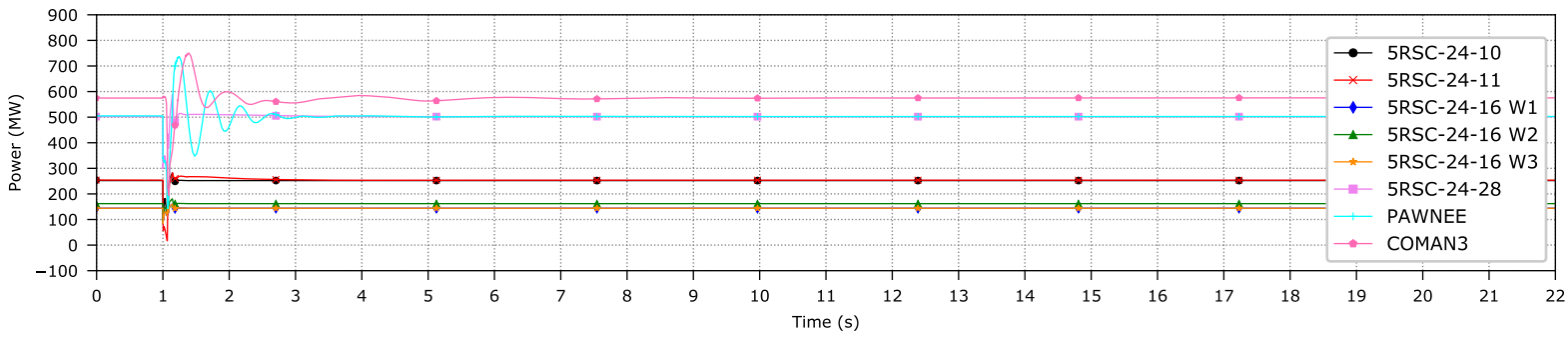


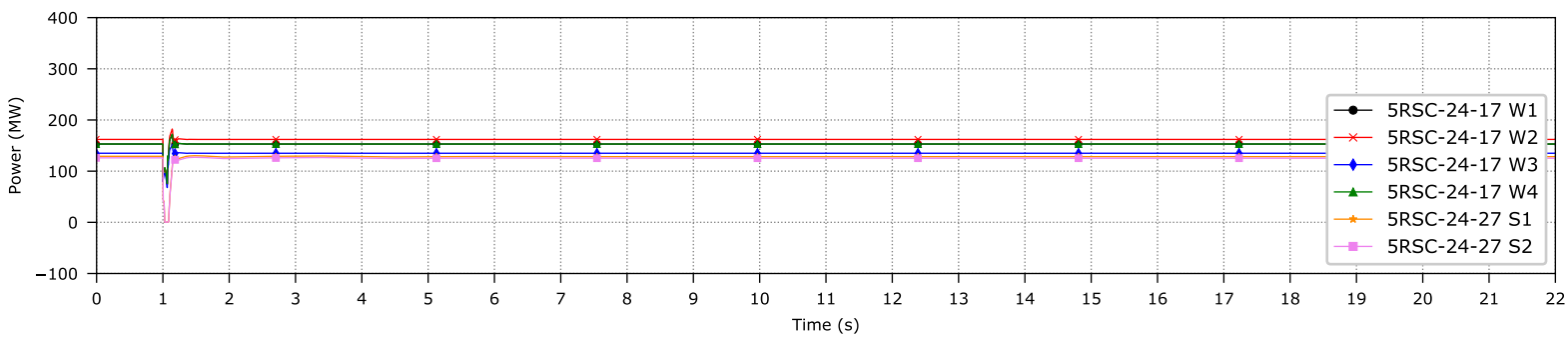


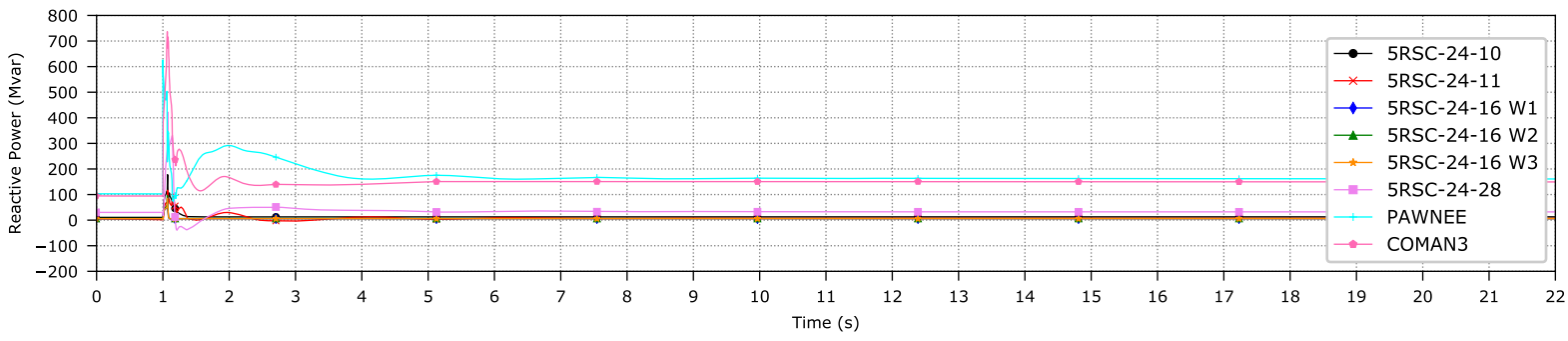


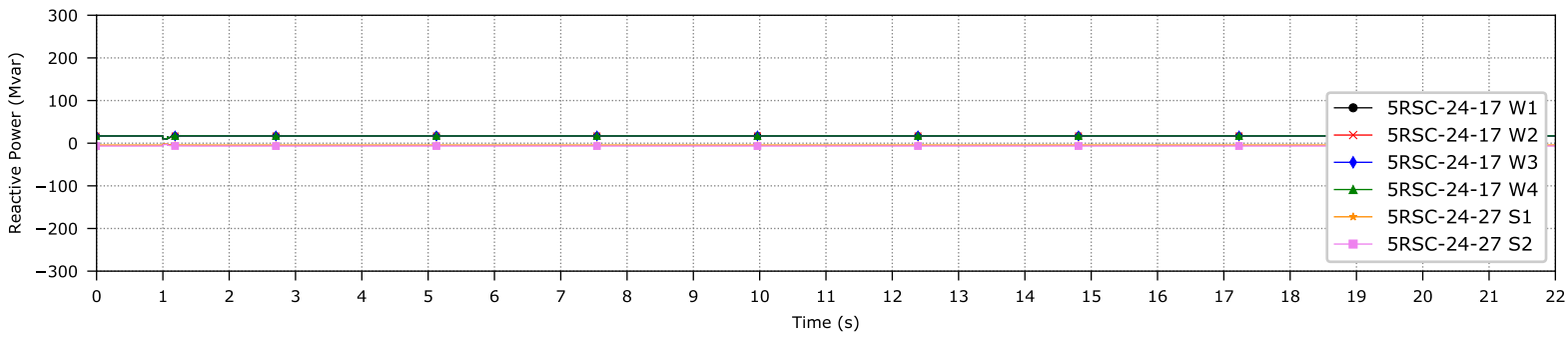
Ref. No. 24 - P7_160

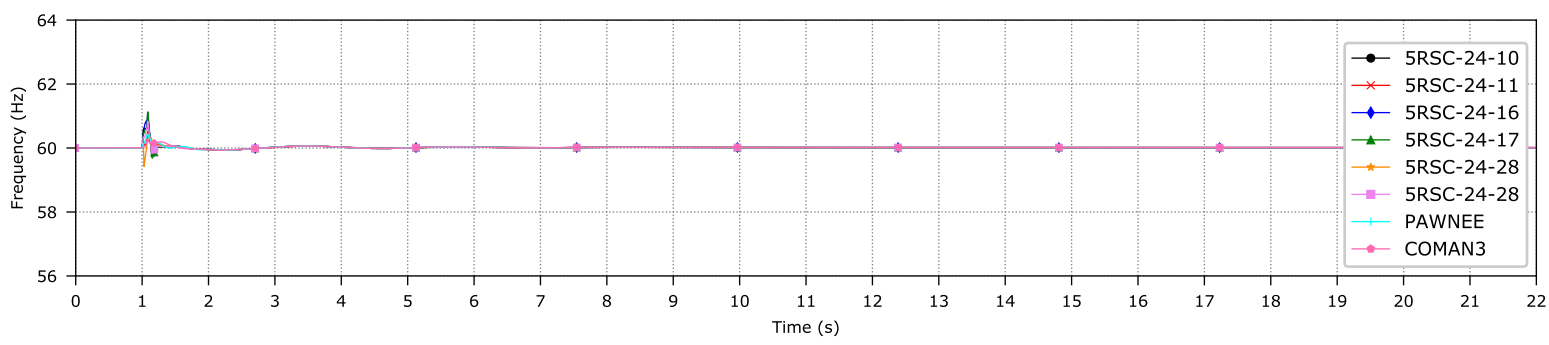


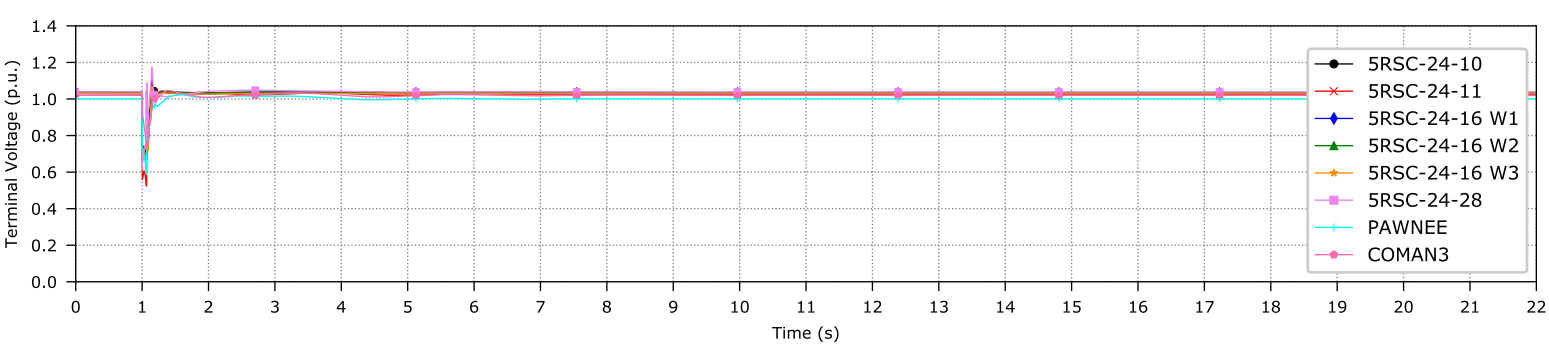


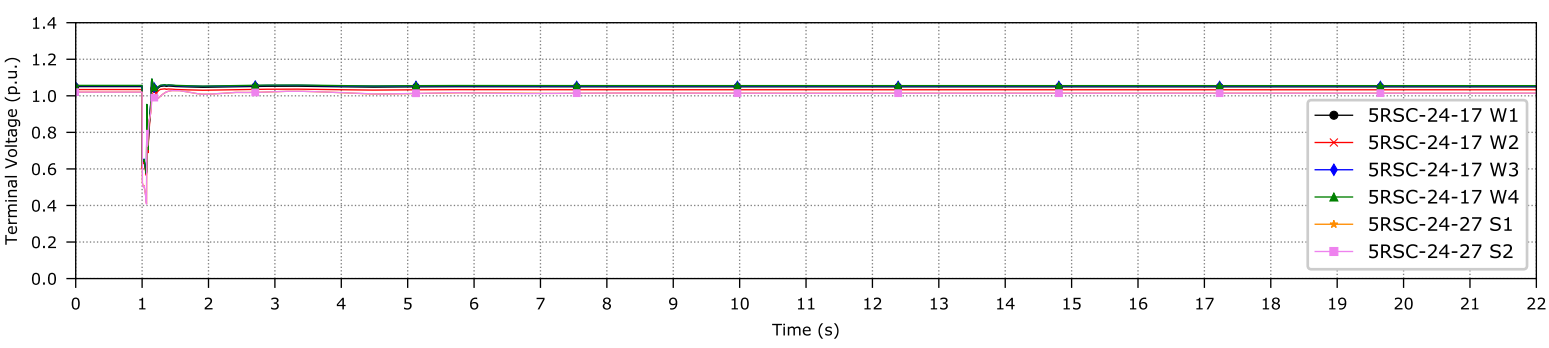


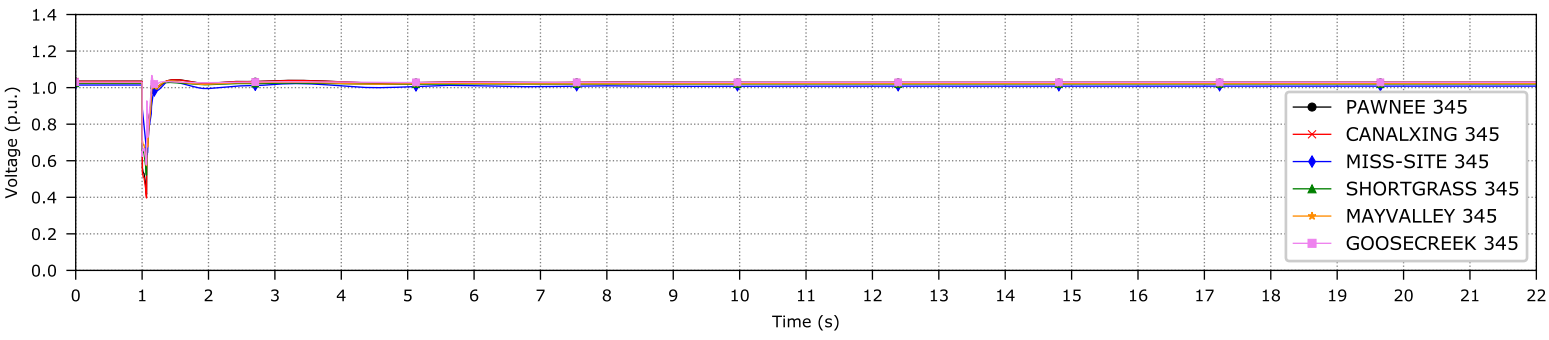




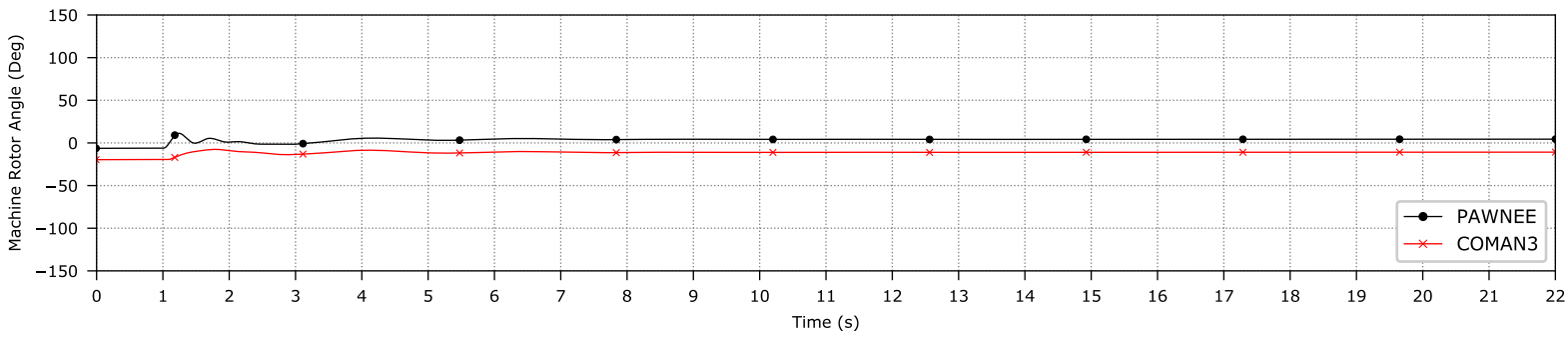


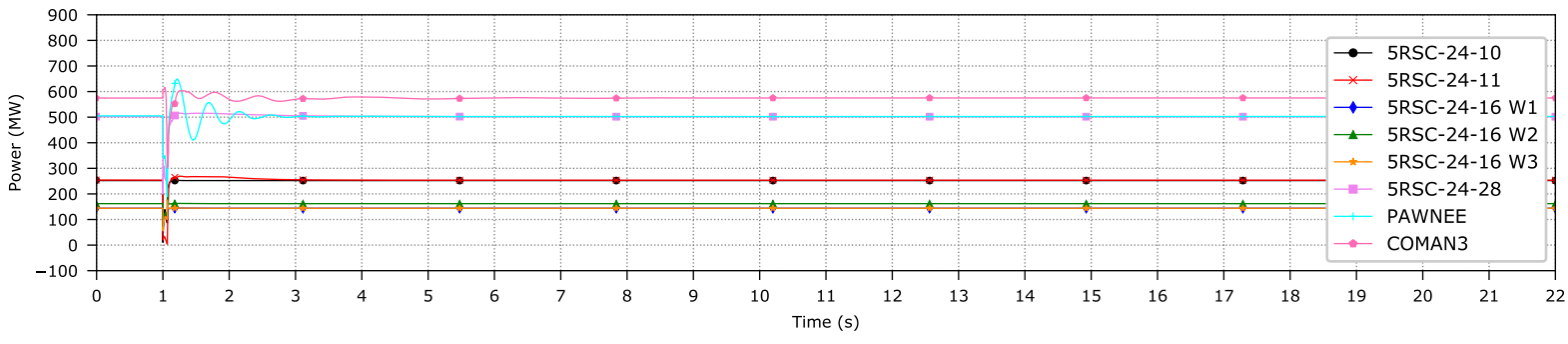


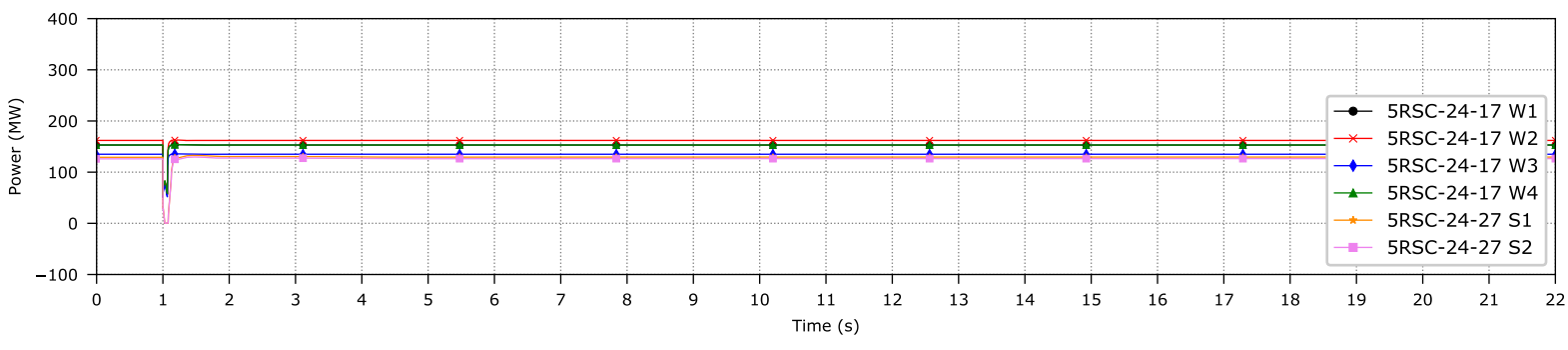


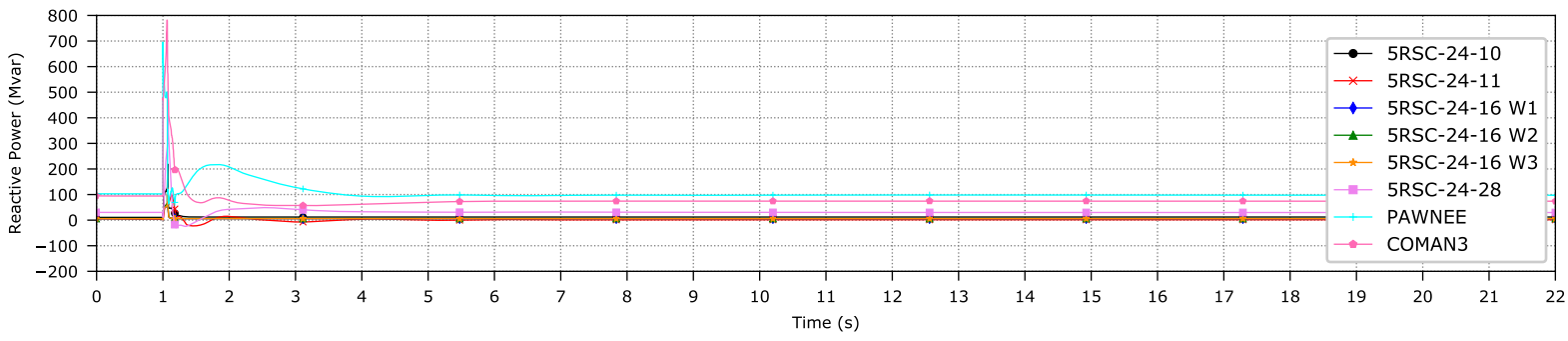


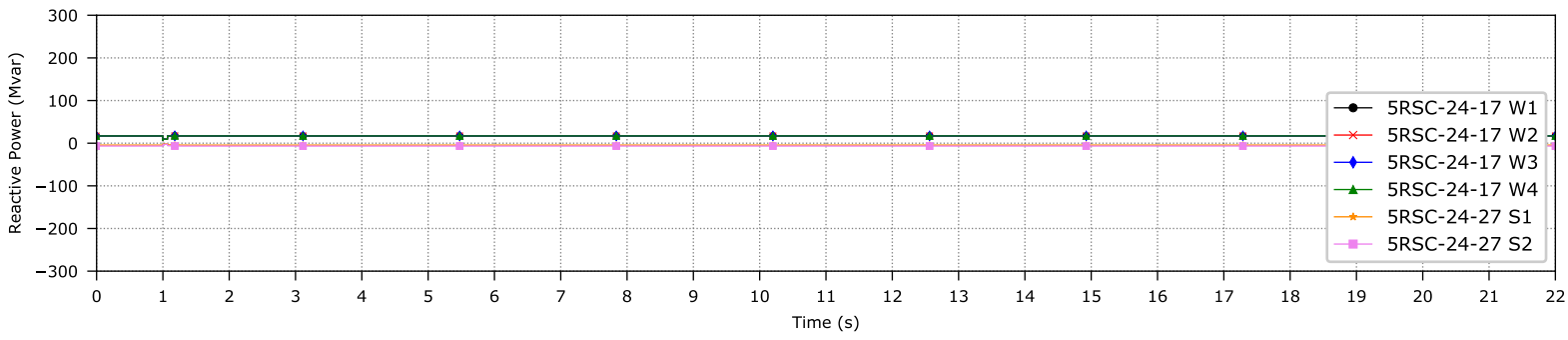
Ref. No. 25 - P7_161

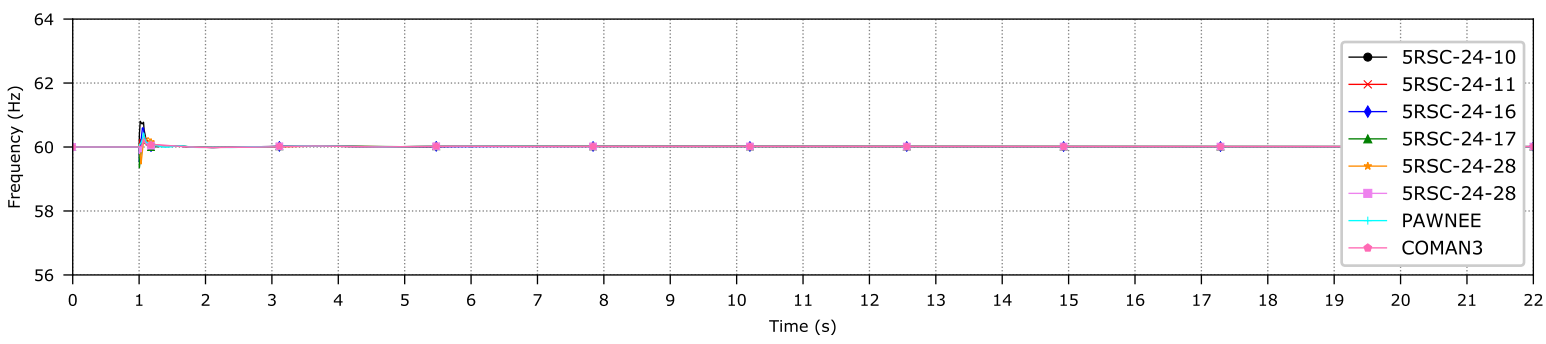


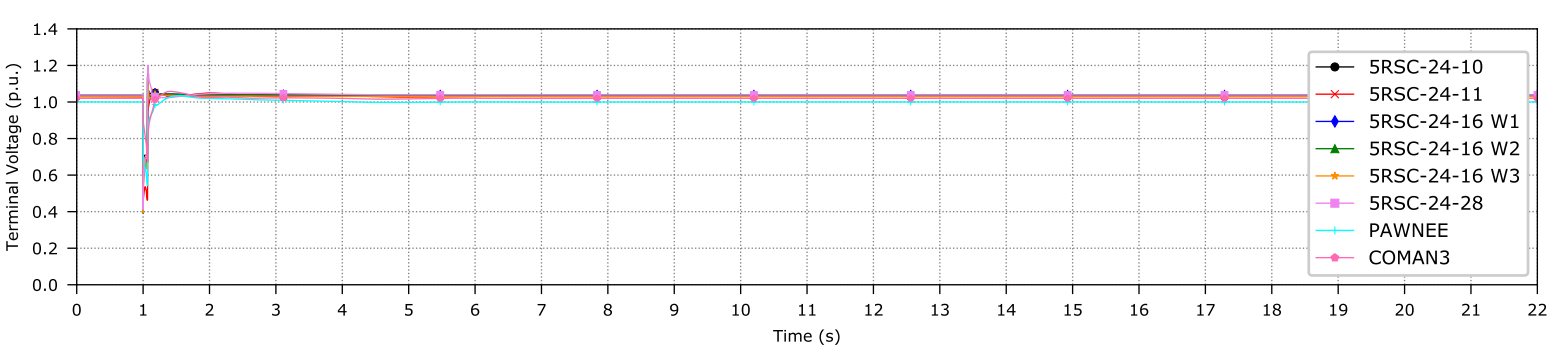


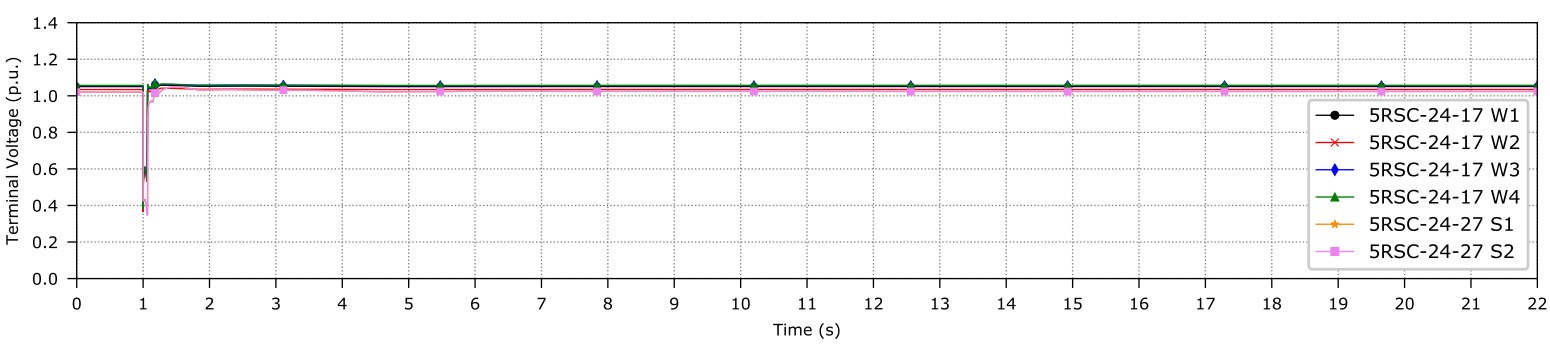


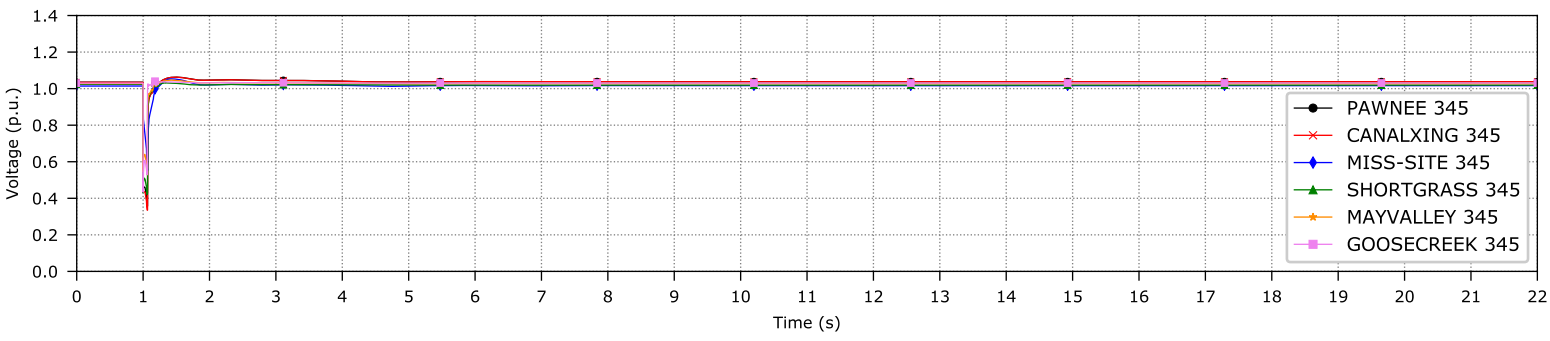












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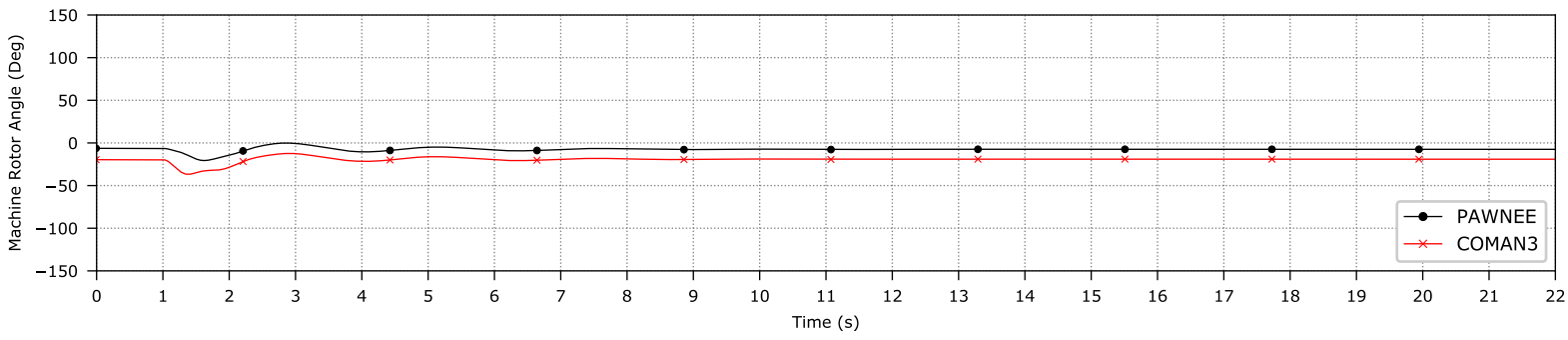
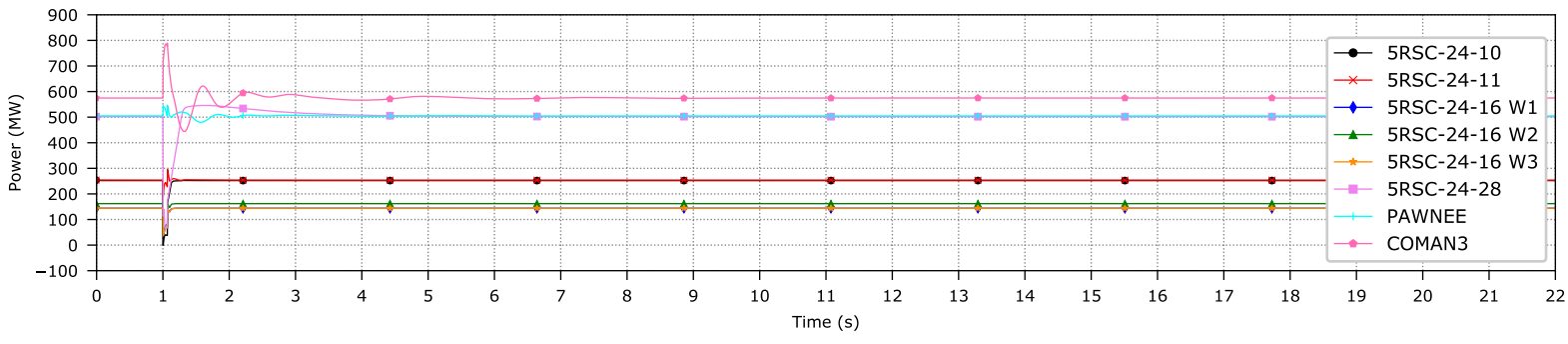
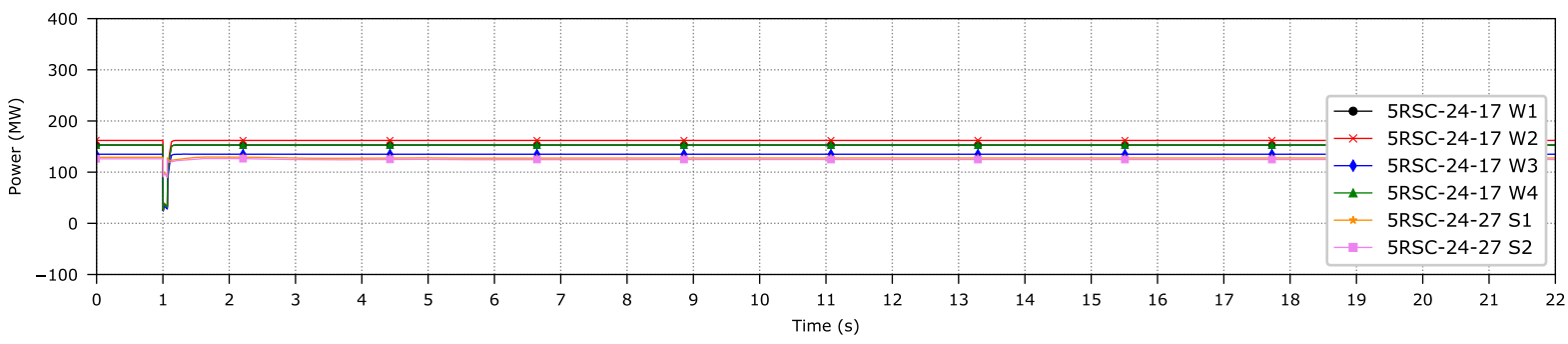
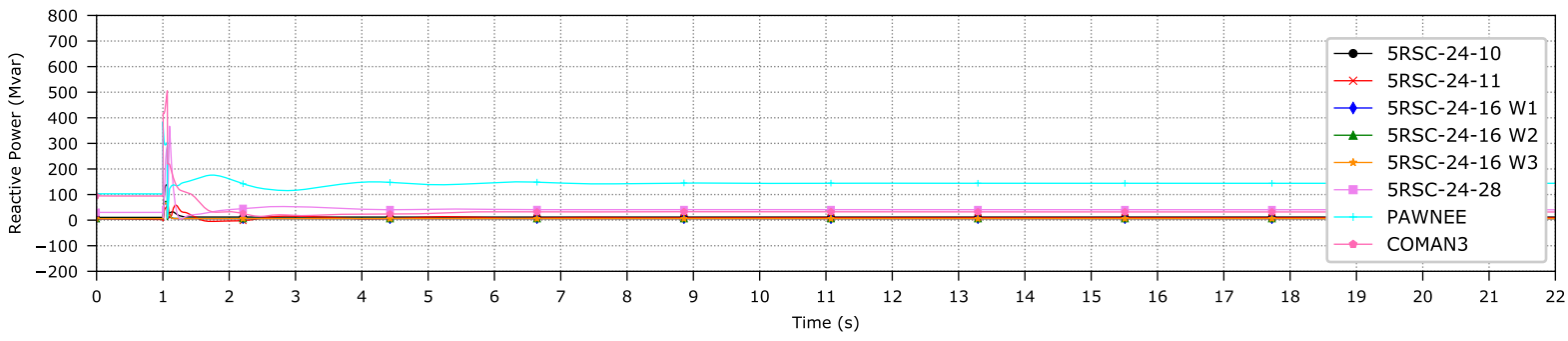
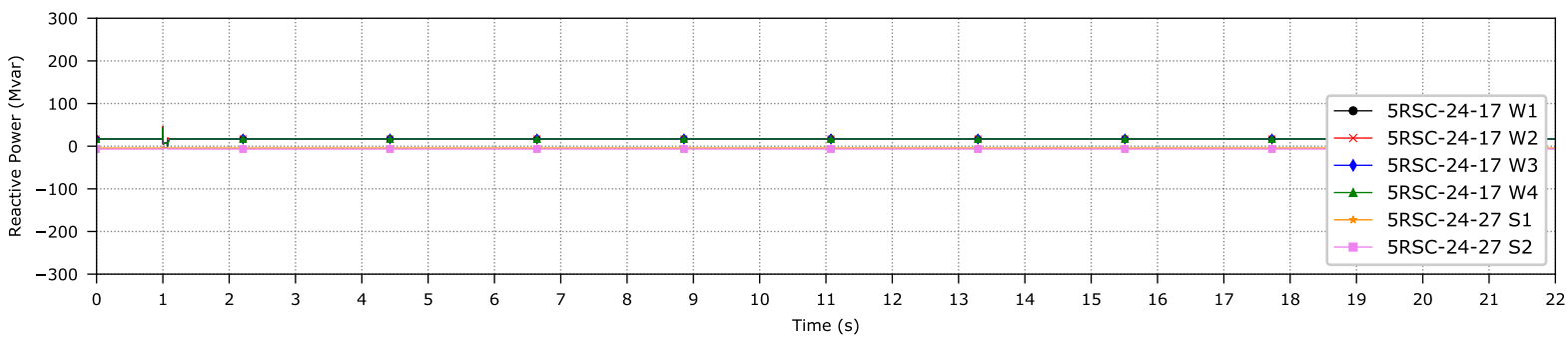
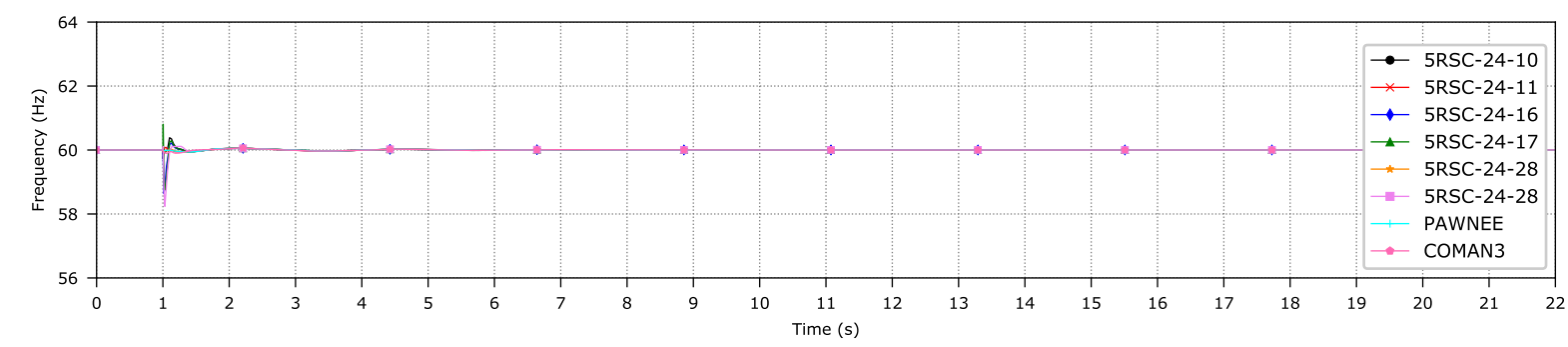


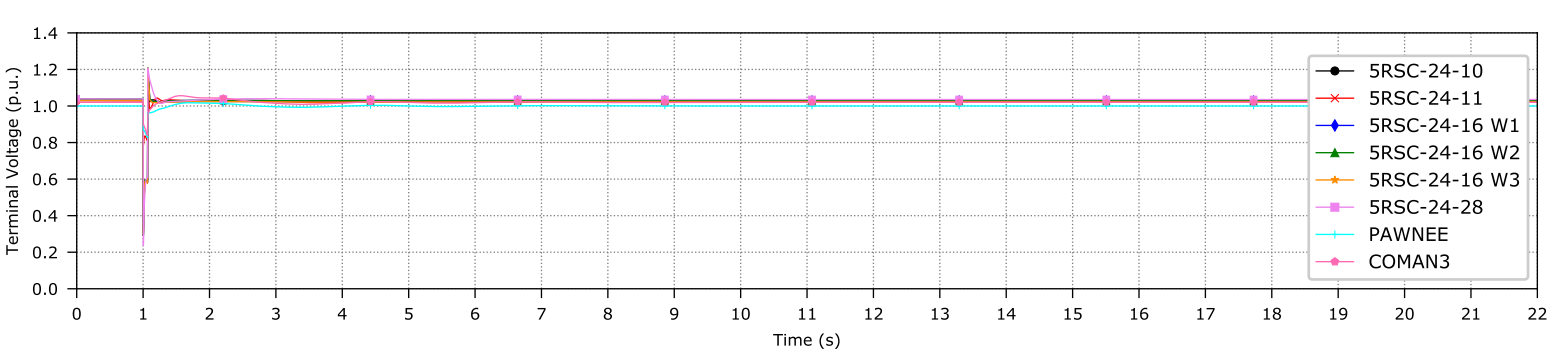


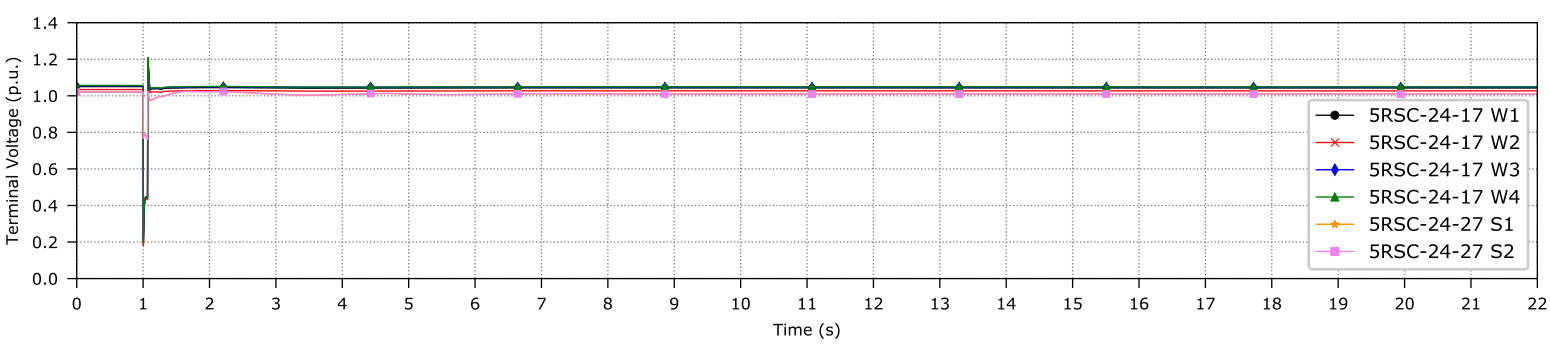


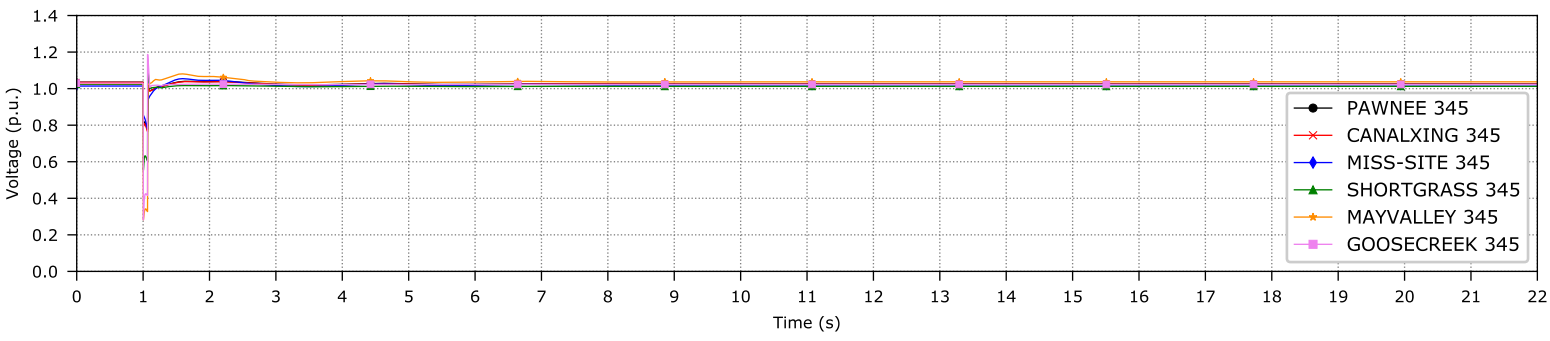






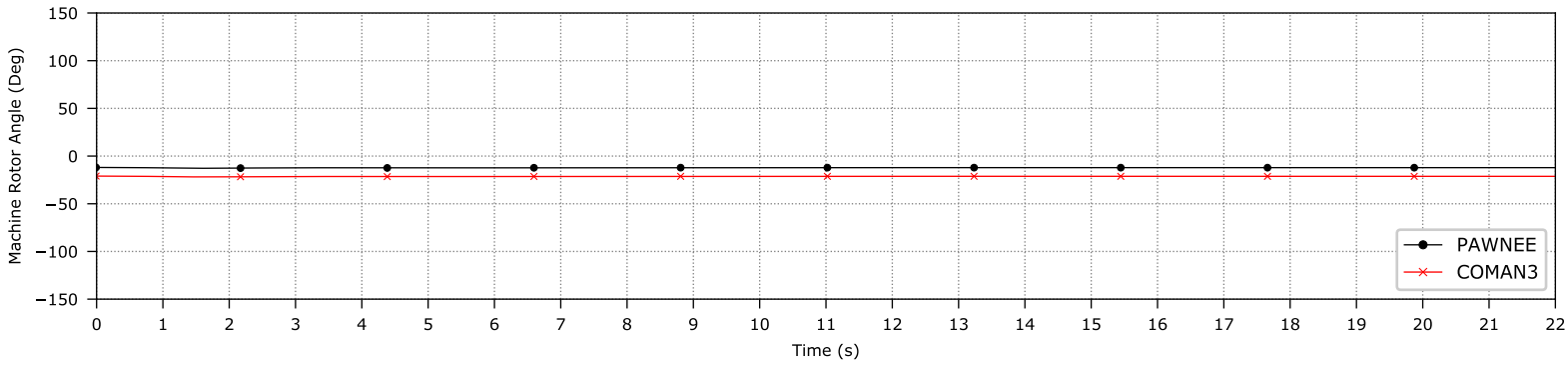


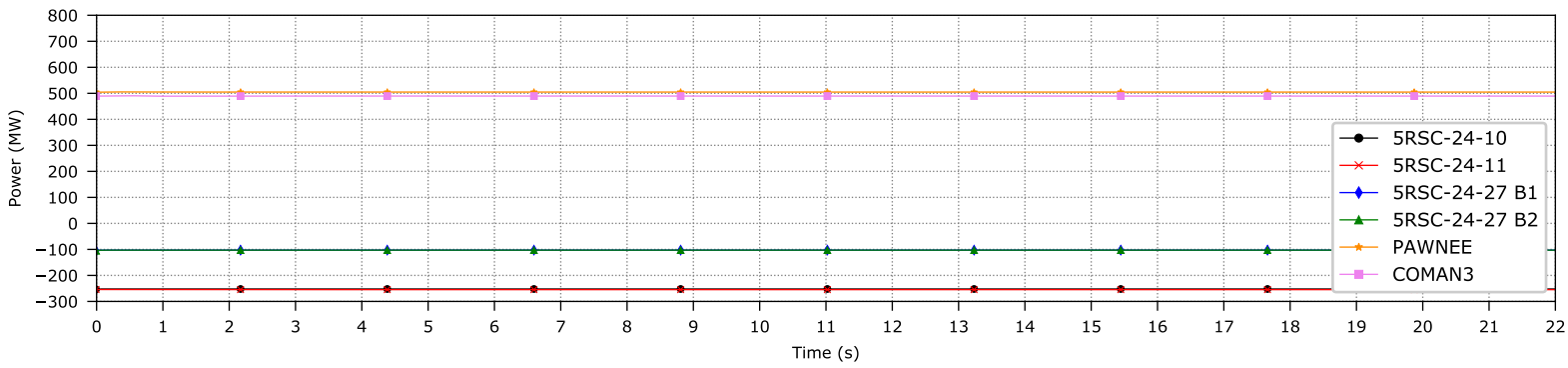


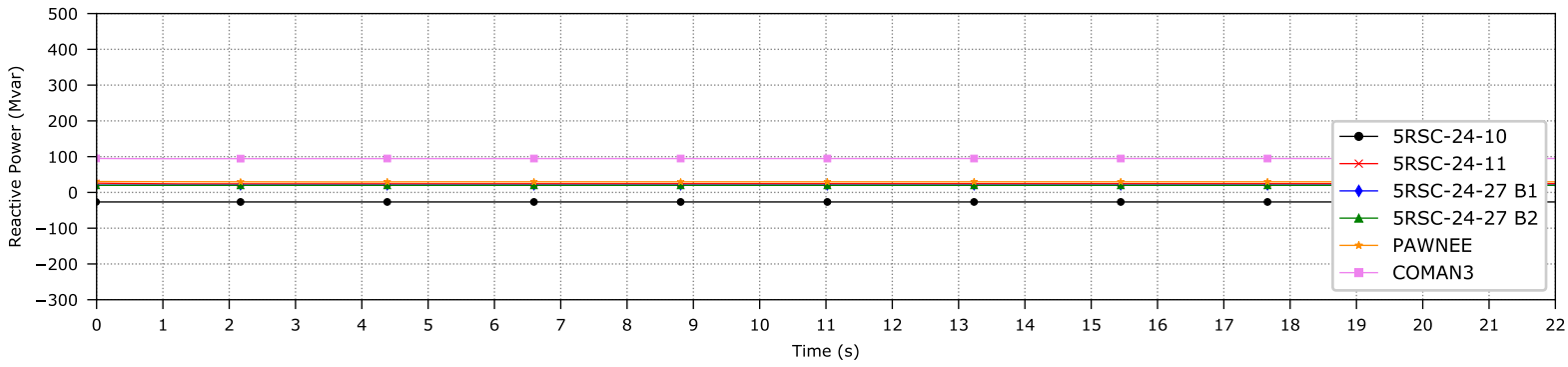


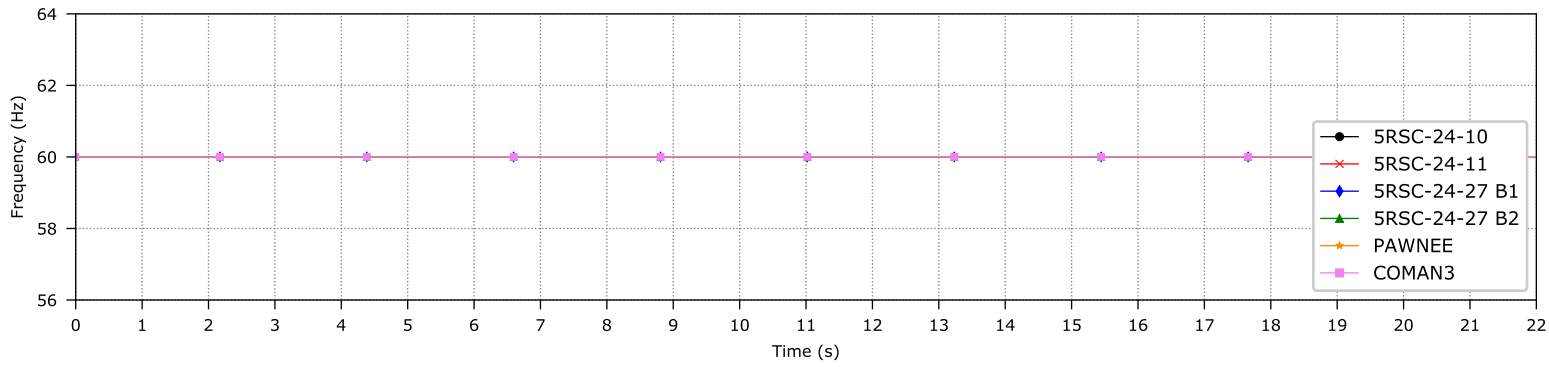
2027 EAST GRID CHARGING – TRANSIENT STABILITY PLOTS

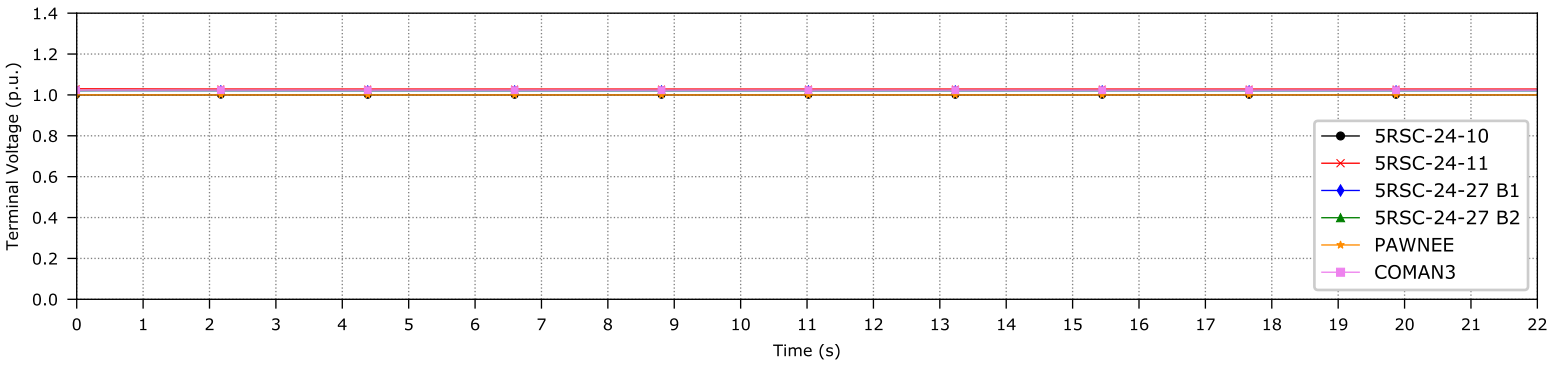
Ref. No. 01 - Flatrun

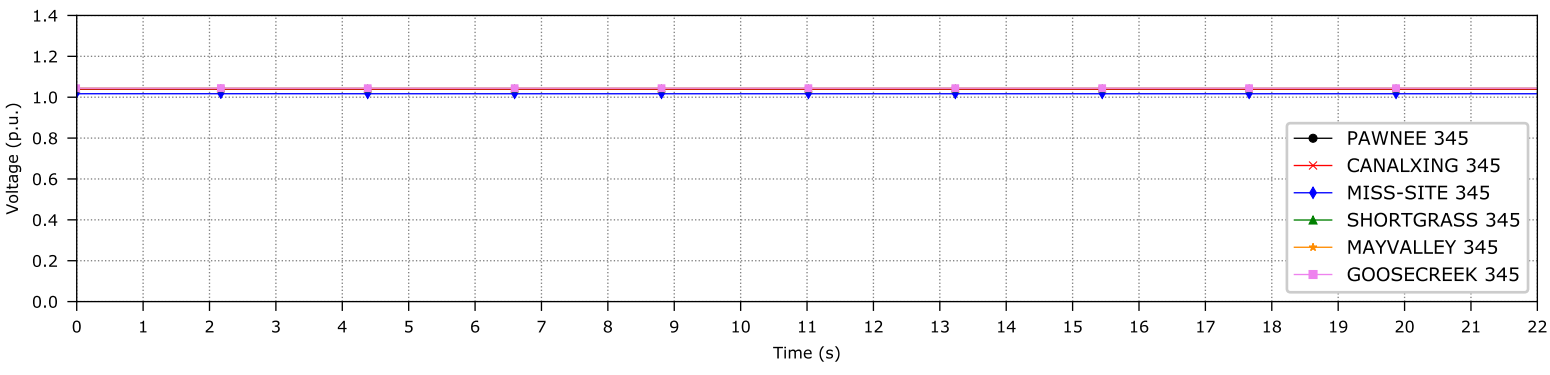




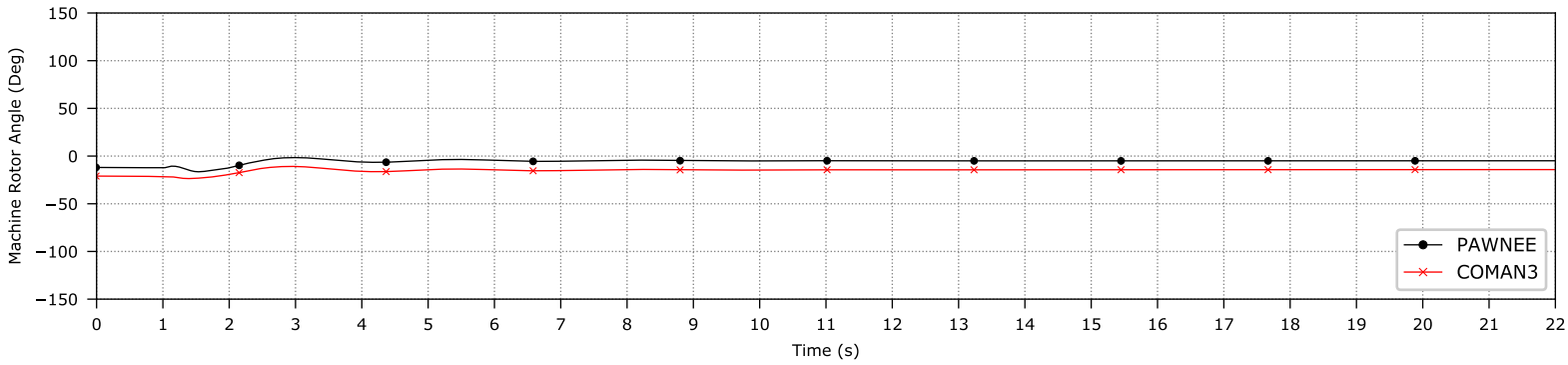


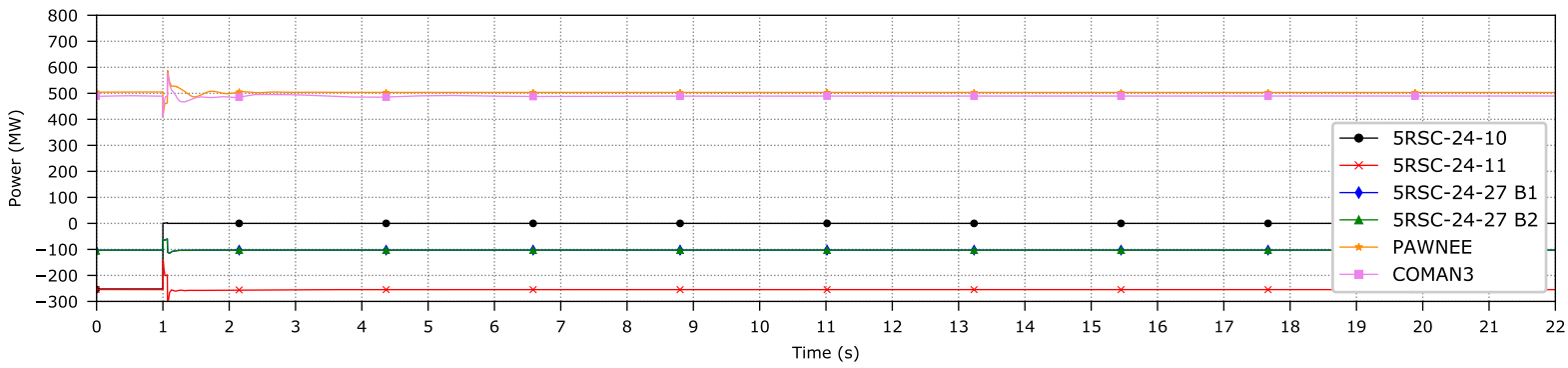


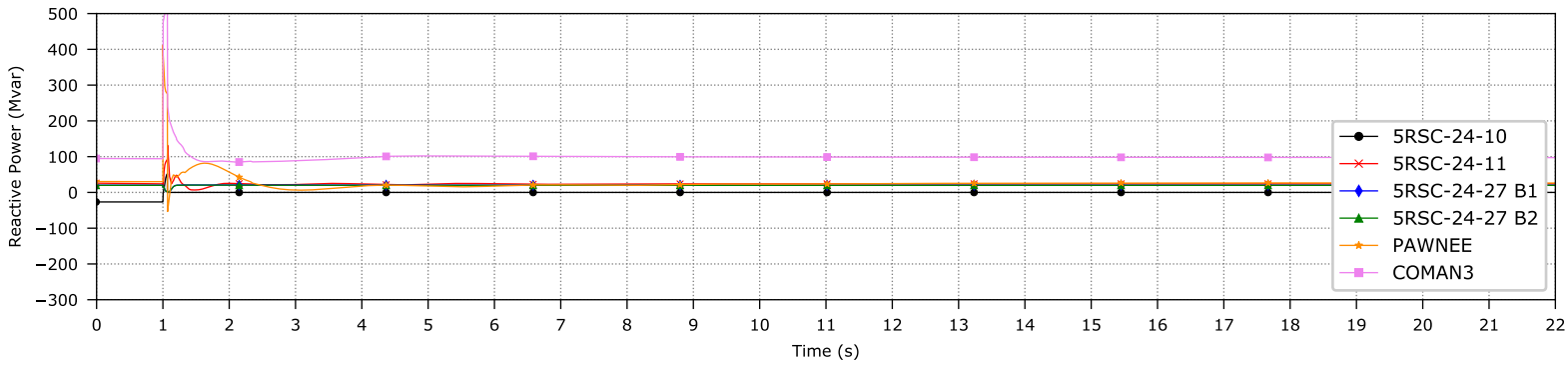


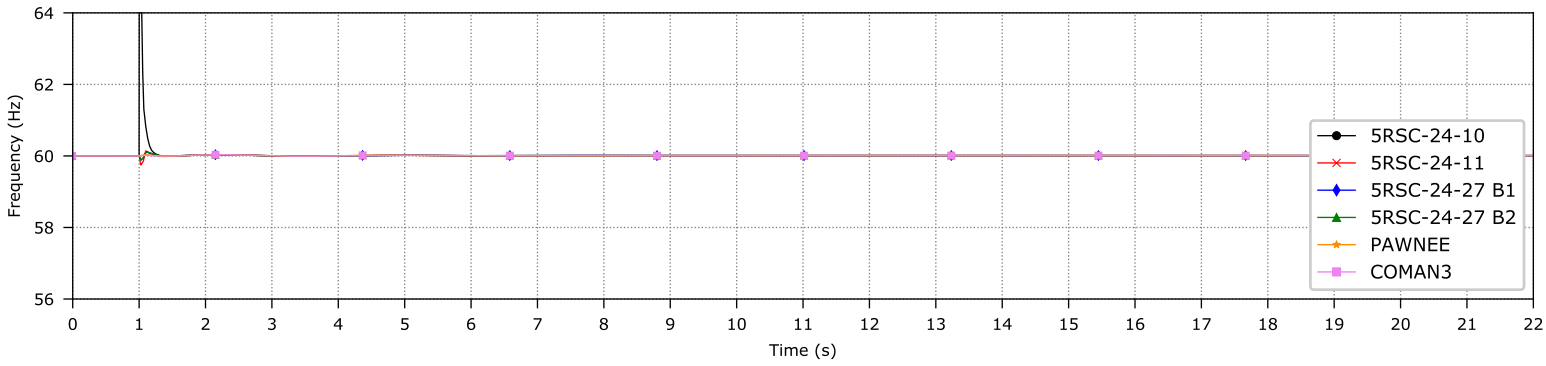


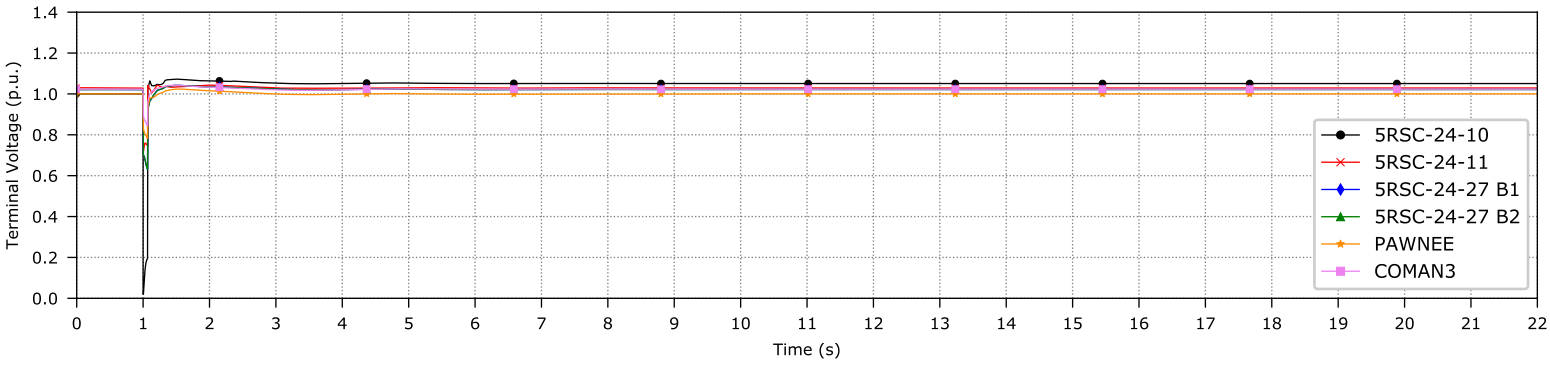
Ref. No. 02 - 5RSC-2024-10

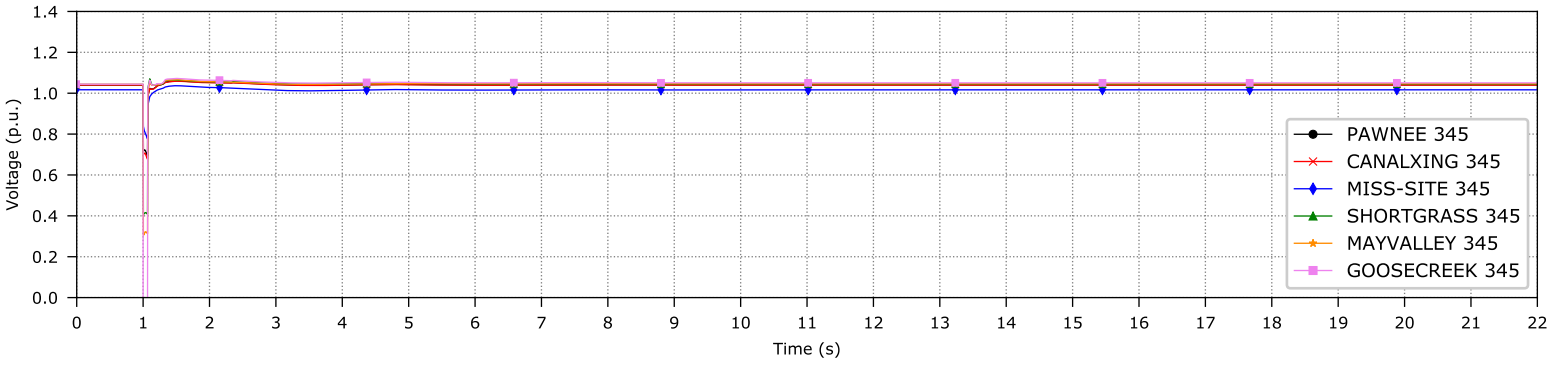


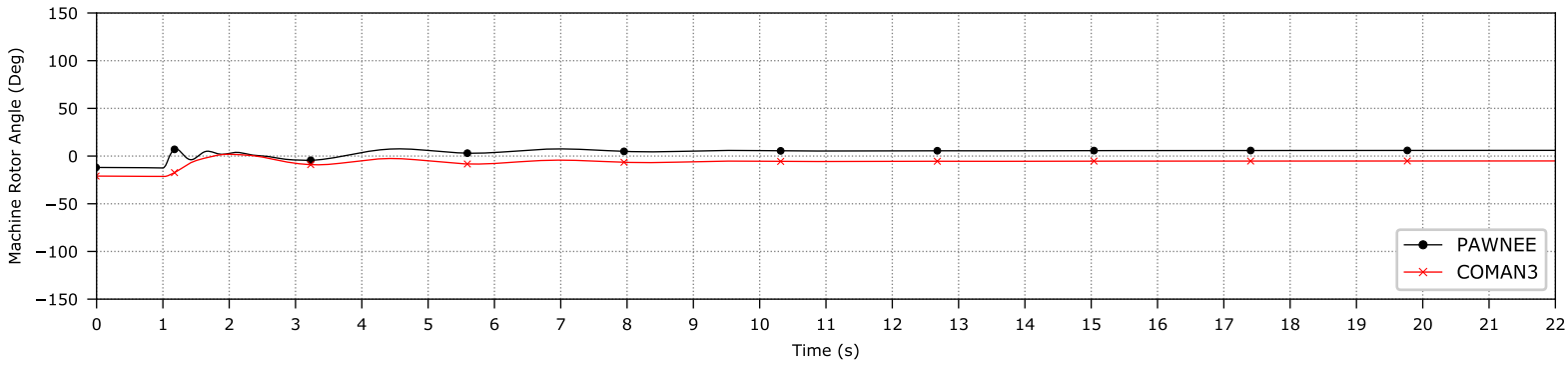


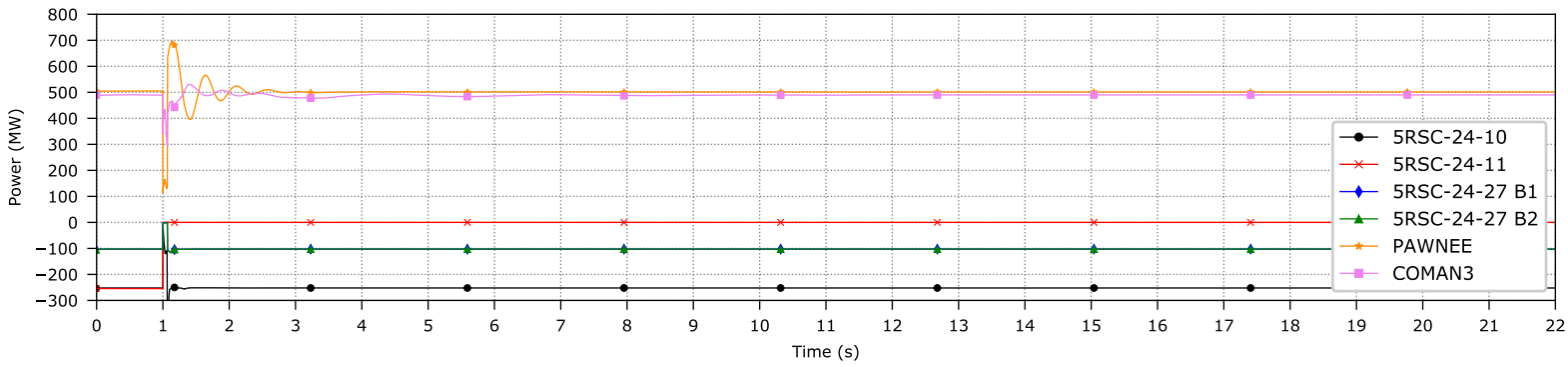


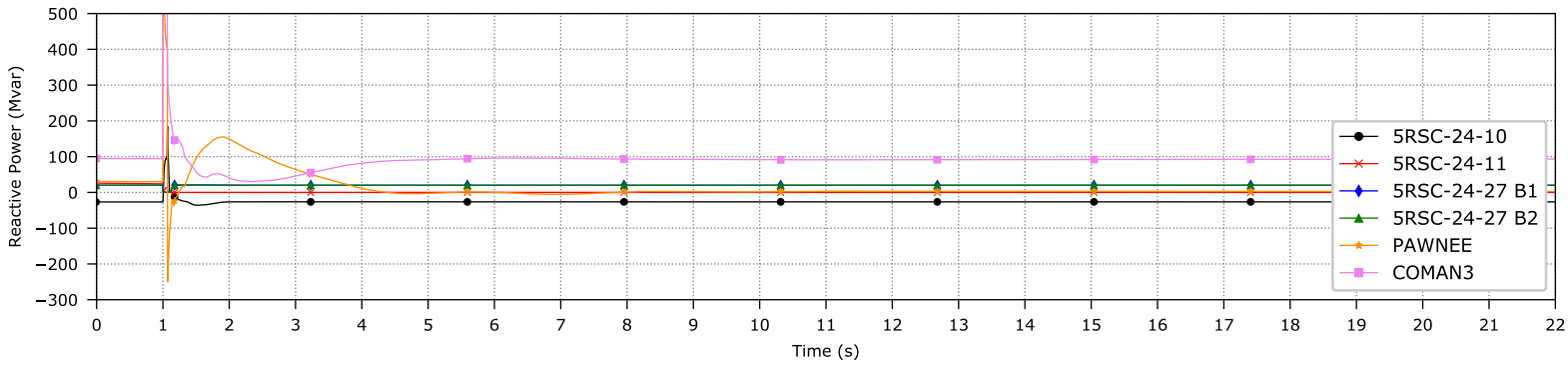


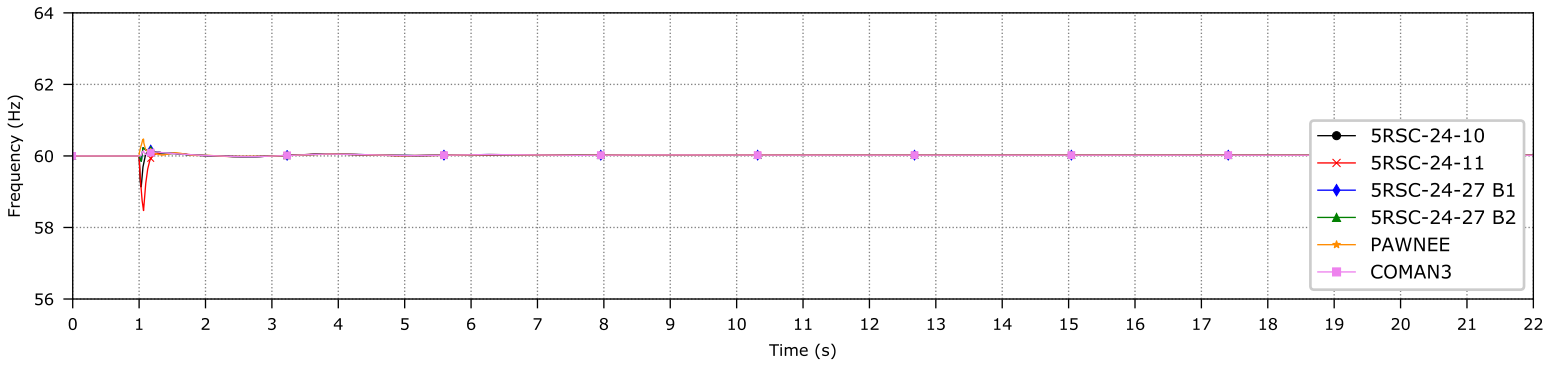


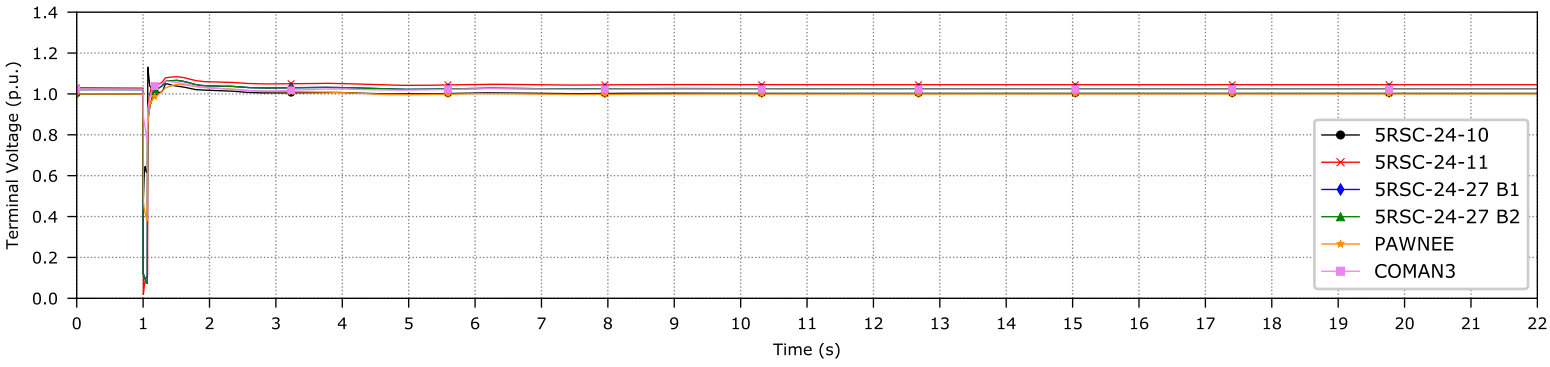


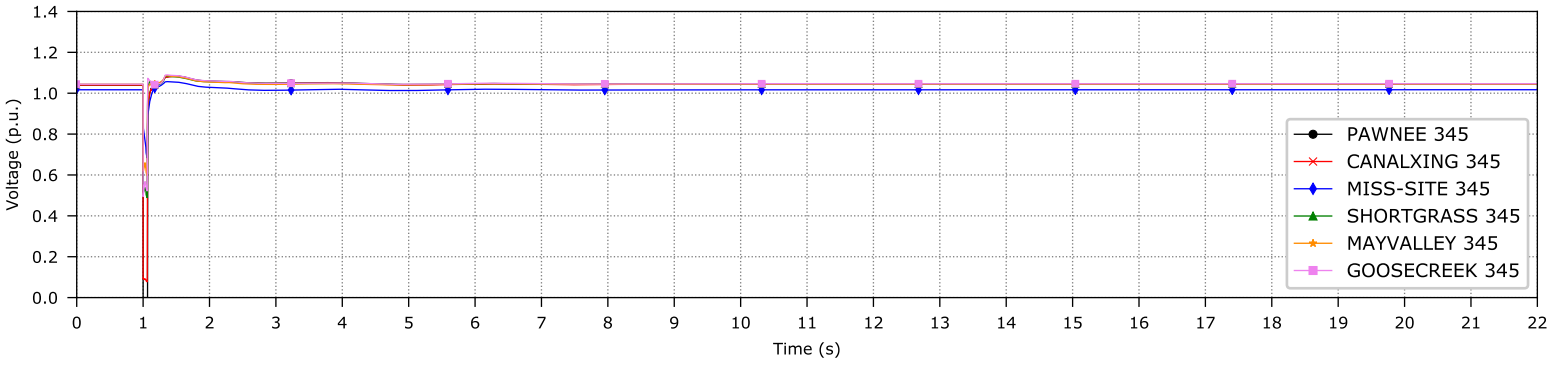

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3

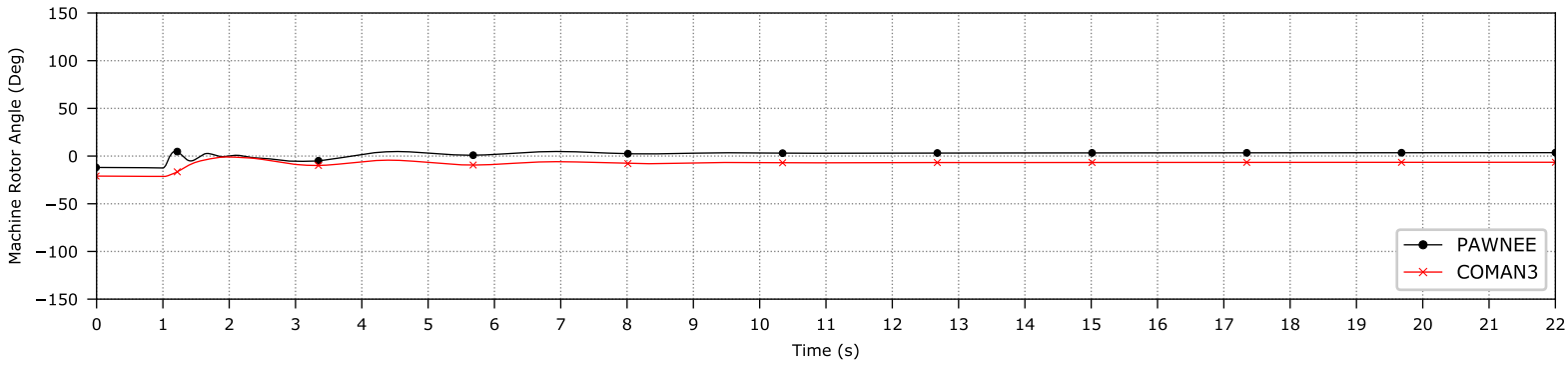

Power (MW)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

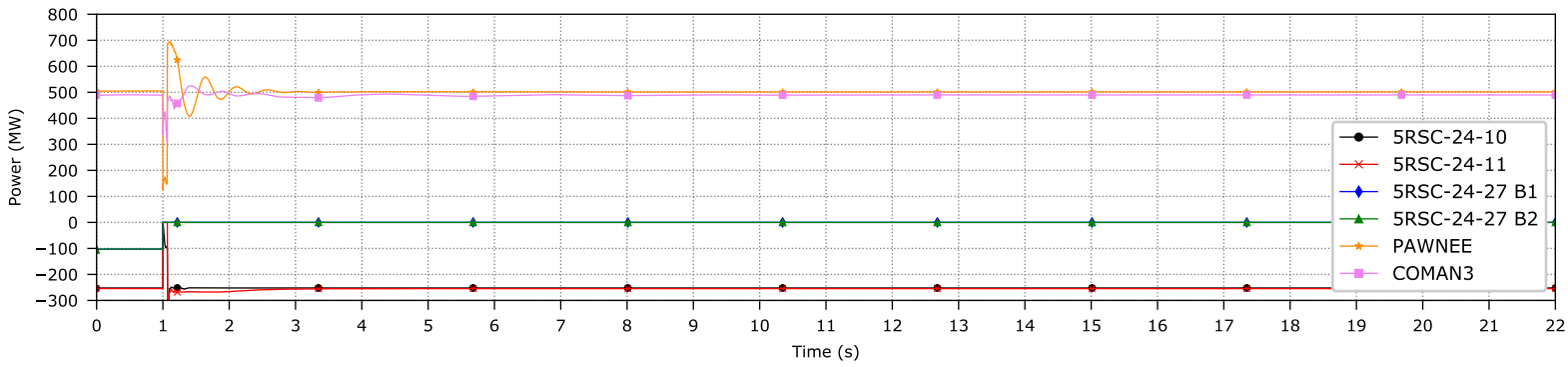

Reactive Power (Mvar)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

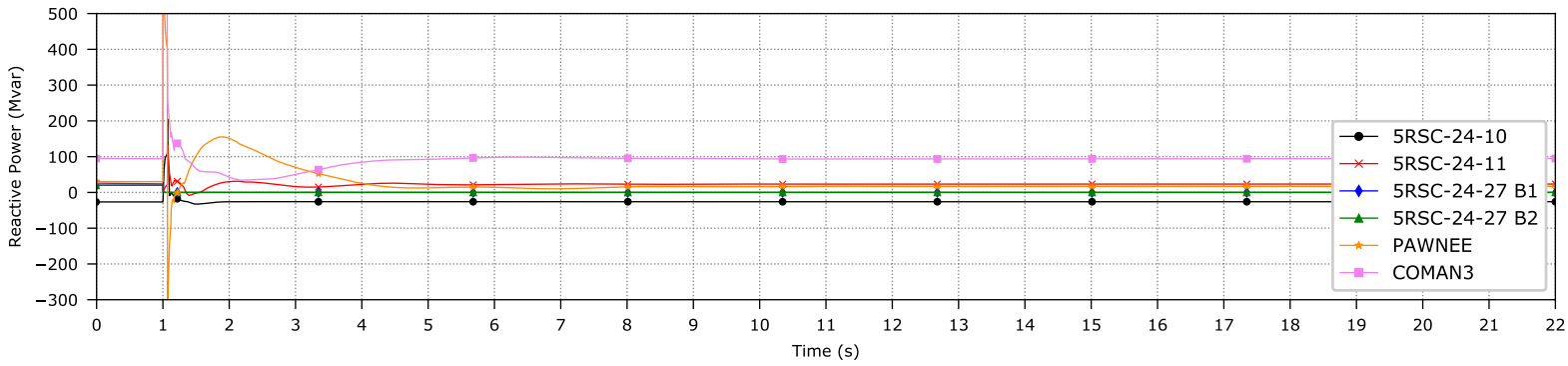

Frequency (Hz)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

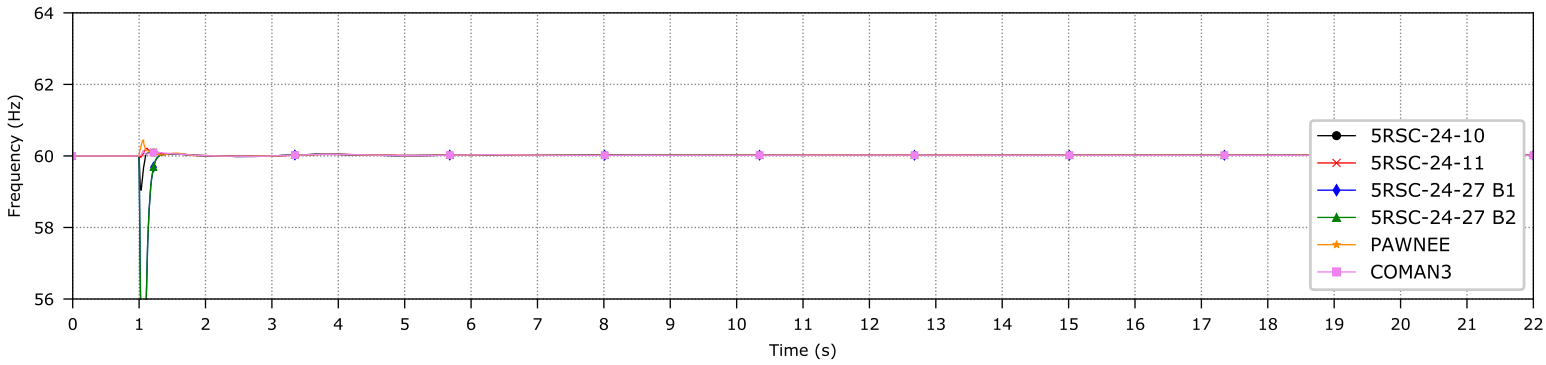

Terminal Voltage (p.u.)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

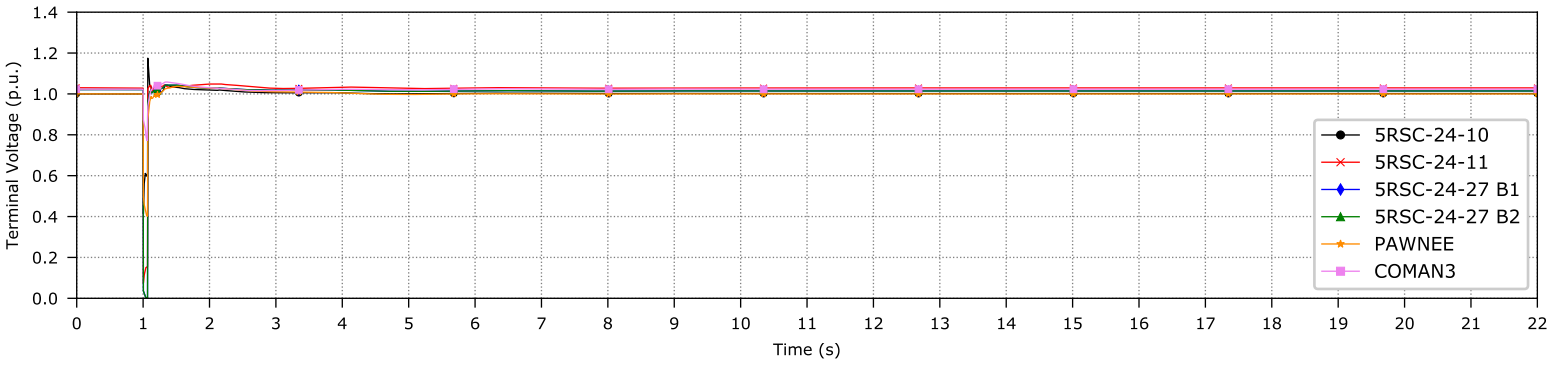

Voltage (p.u.)
Time (s)
PAWNEE 345
CANALXING 345
MISS-SITE 345
SHORTGRASS 345
MAYVALLEY 345
GOOSECREEK 345

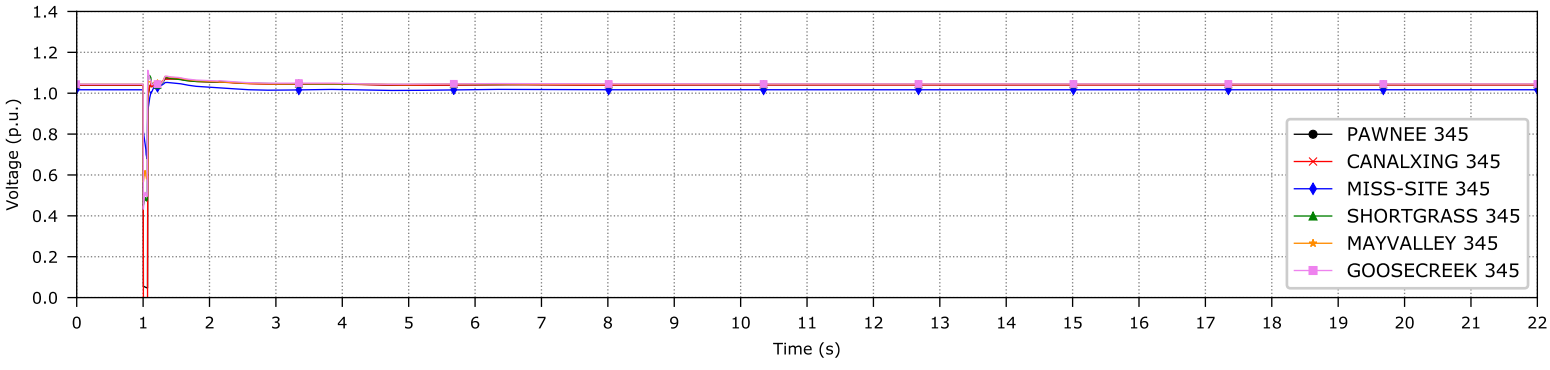

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

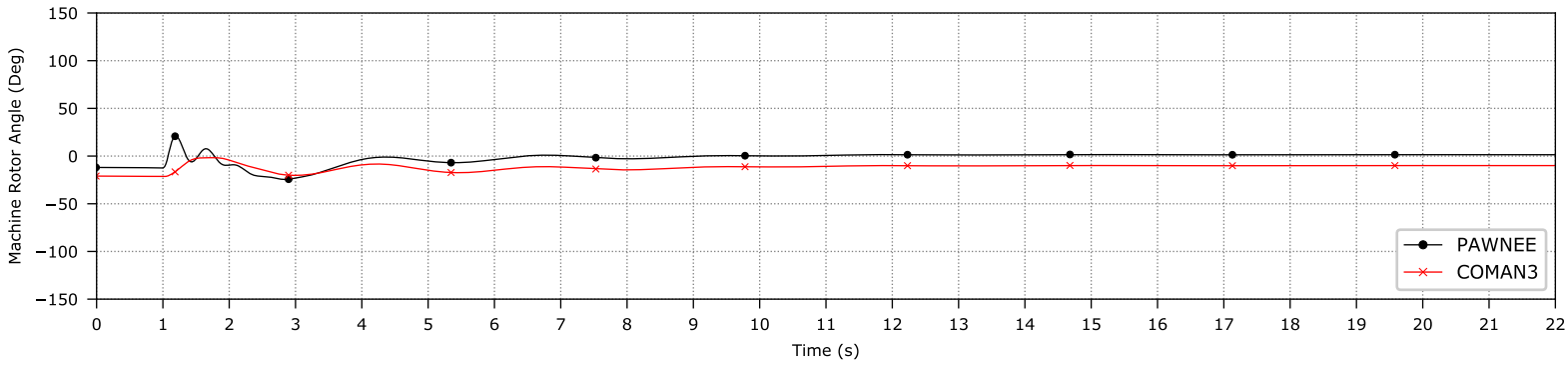

Reactive Power (Mvar)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

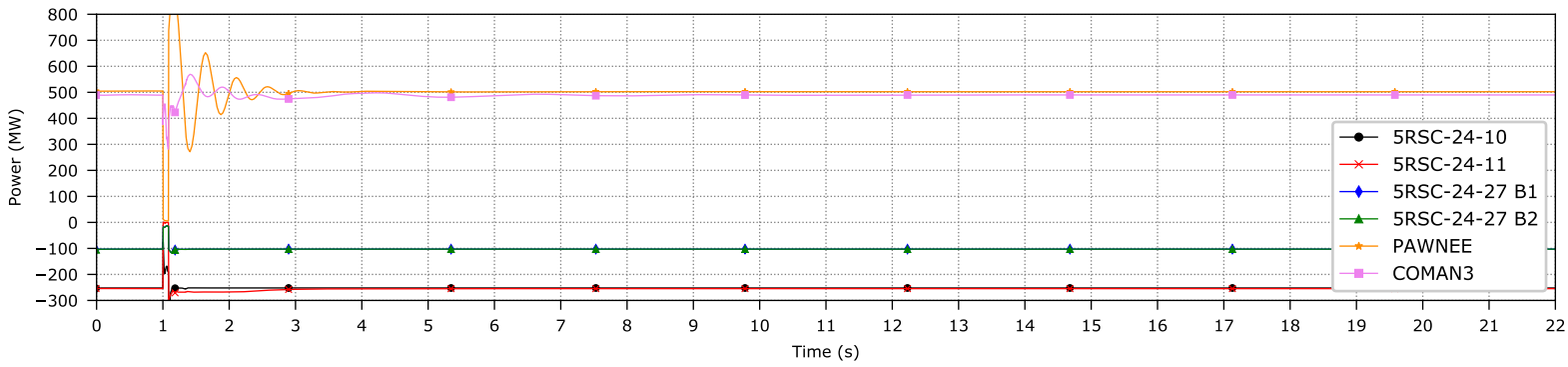

Frequency (Hz)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

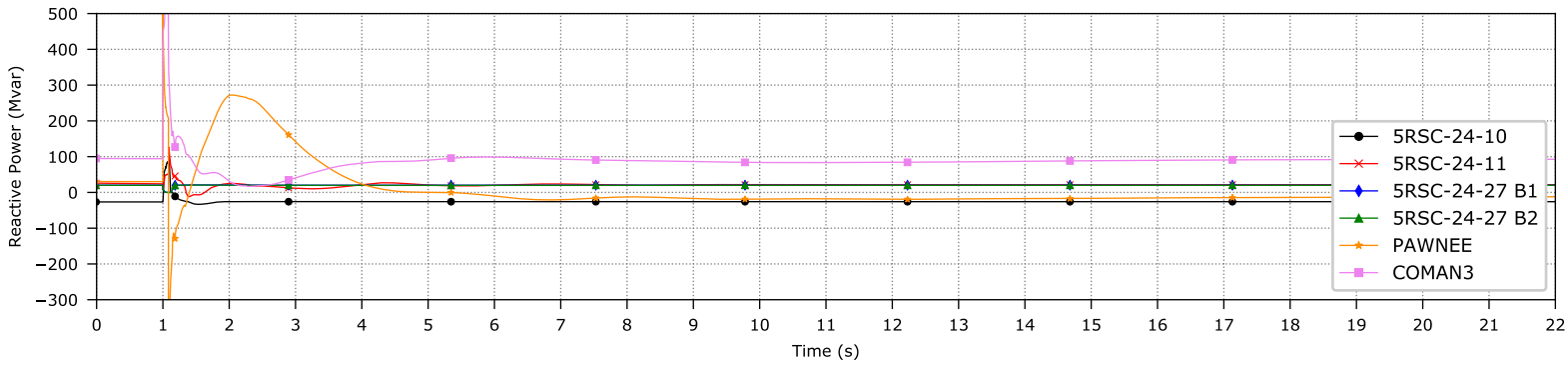

Terminal Voltage (p.u.)
Time (s)
5RSC-24-10
5RSC-24-11
5RSC-24-27 B1
5RSC-24-27 B2
PAWNEE
COMAN3

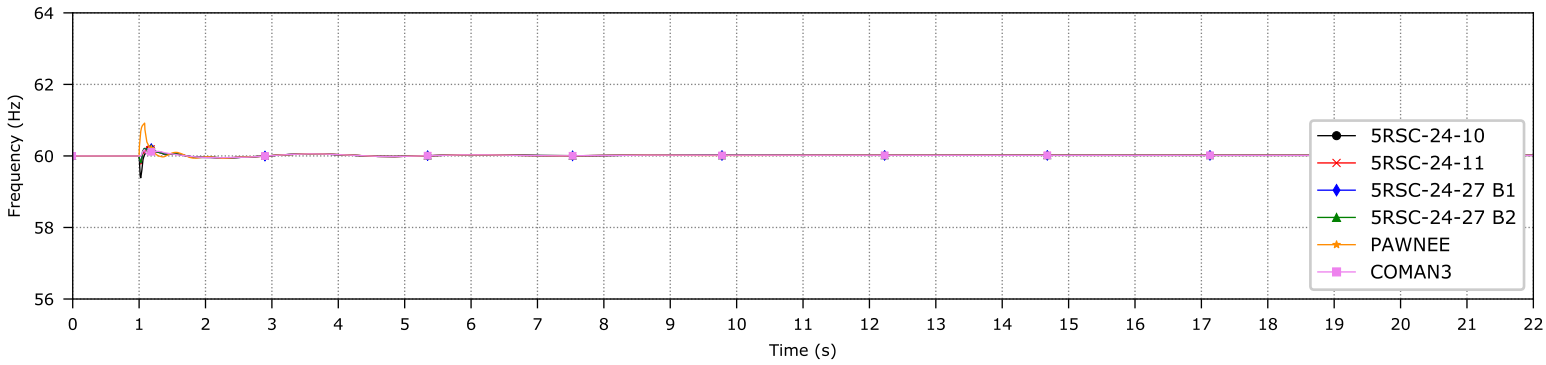

Voltage (p.u.)
Time (s)
PAWNEE 345
CANALXING 345
MISS-SITE 345
SHORTGRASS 345
MAYVALLEY 345
GOOSECREEK 345

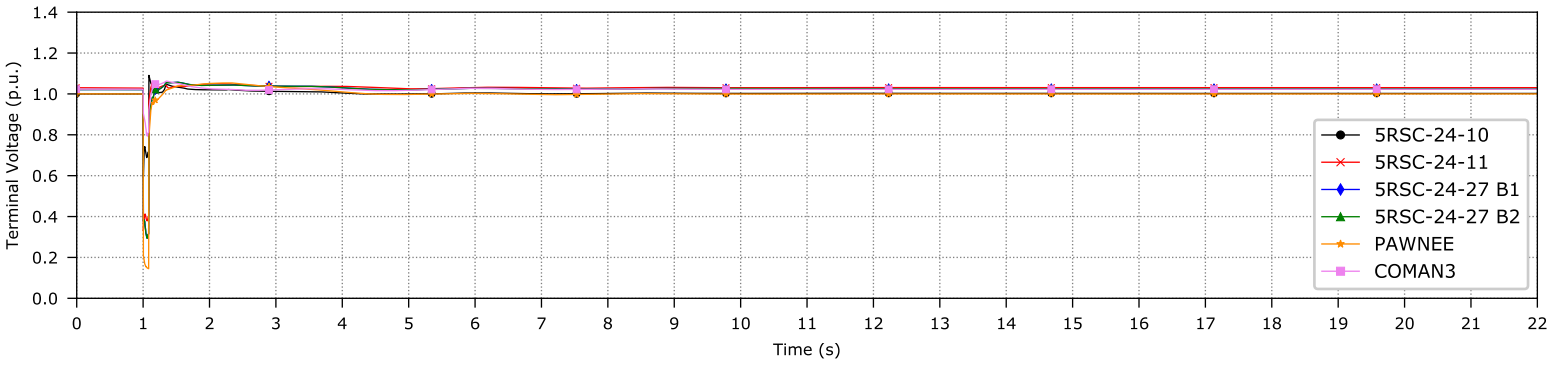
Ref. No. 08 - LoTC_084

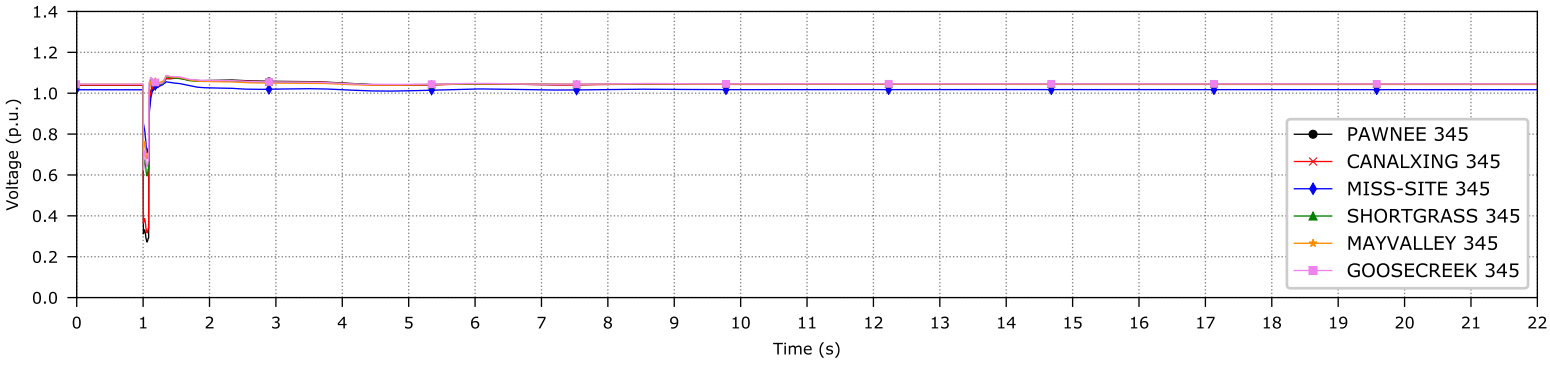




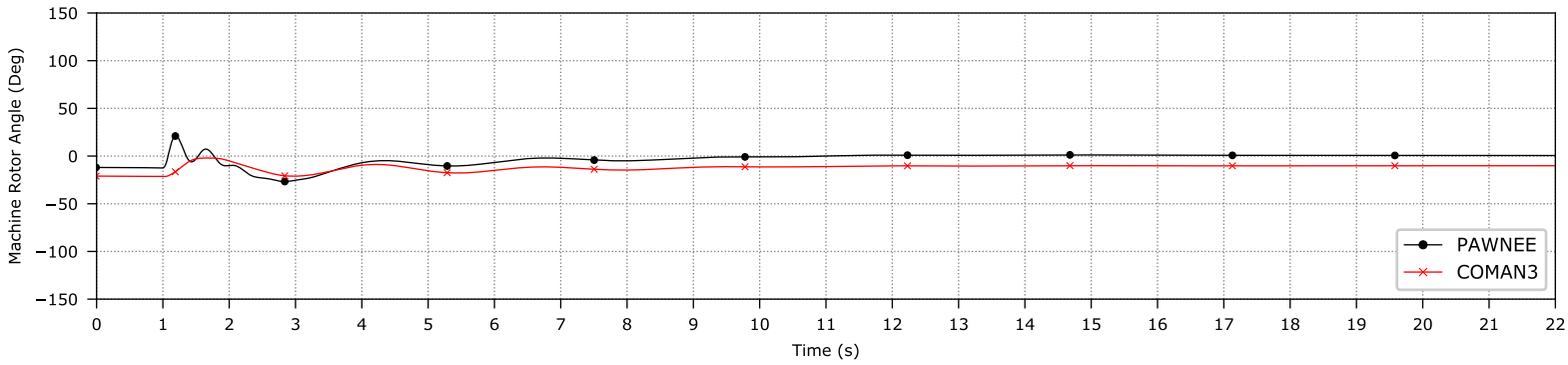


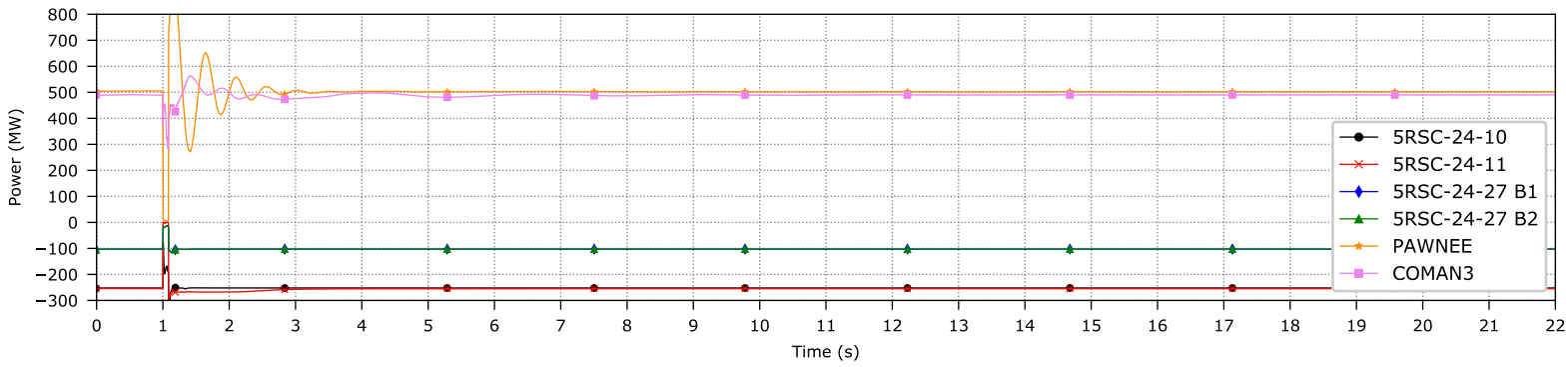


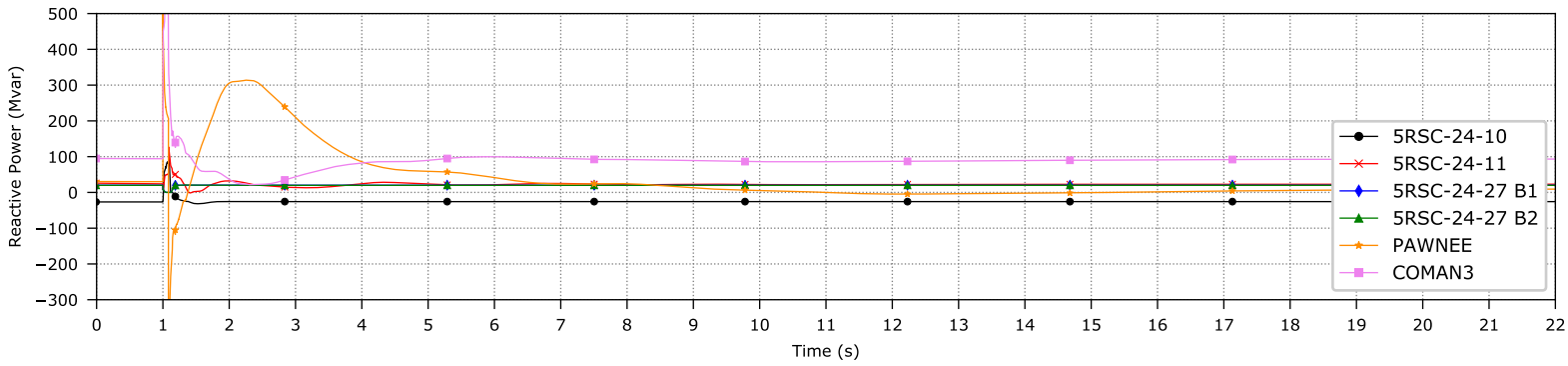


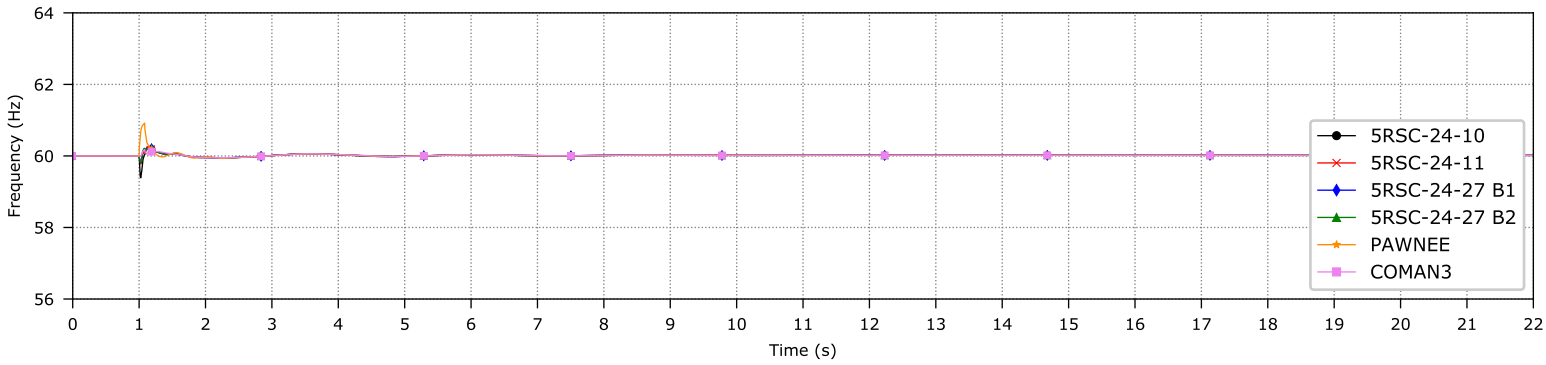


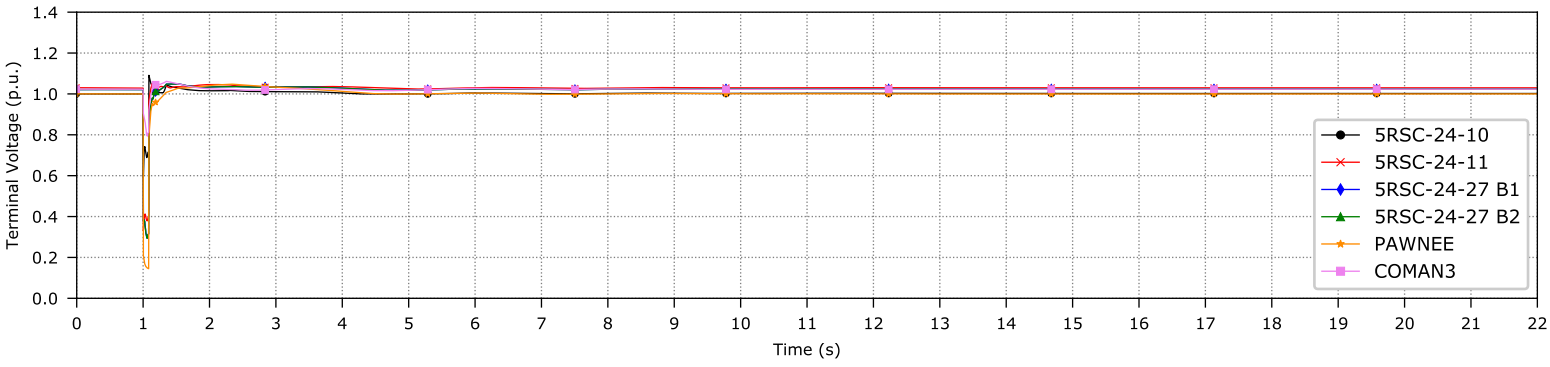
Ref. No. 09 - LoTC_085

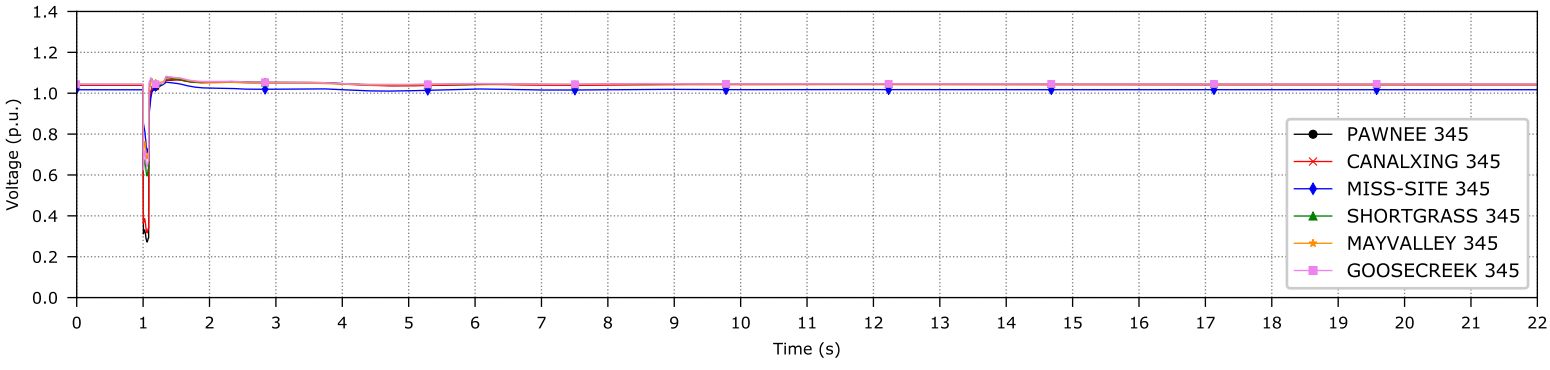




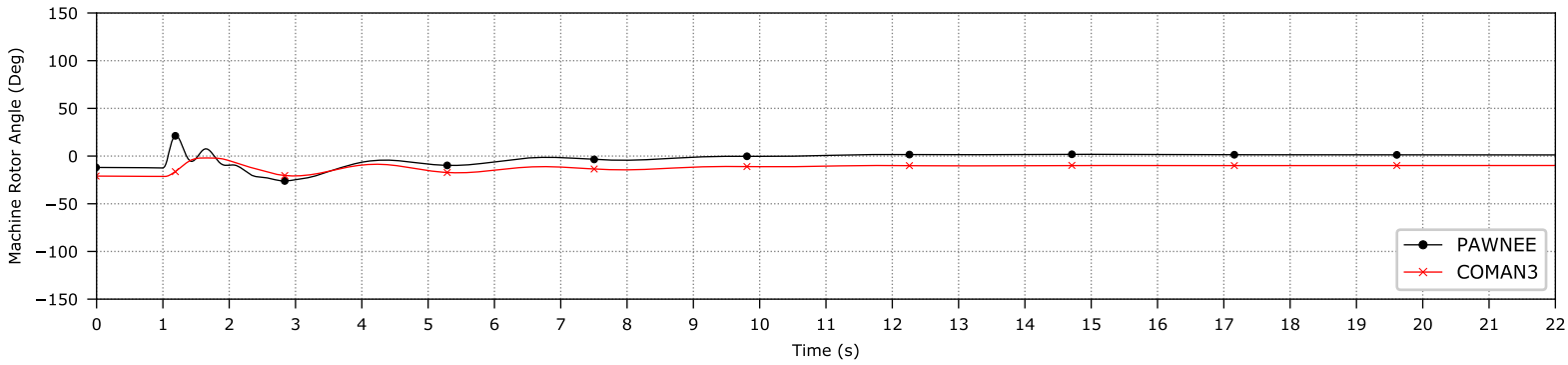


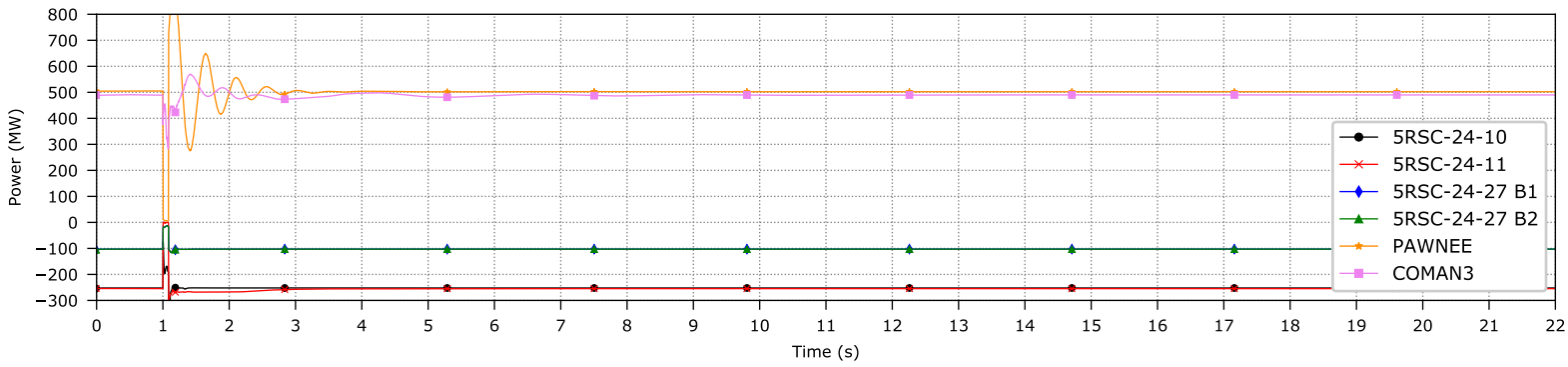


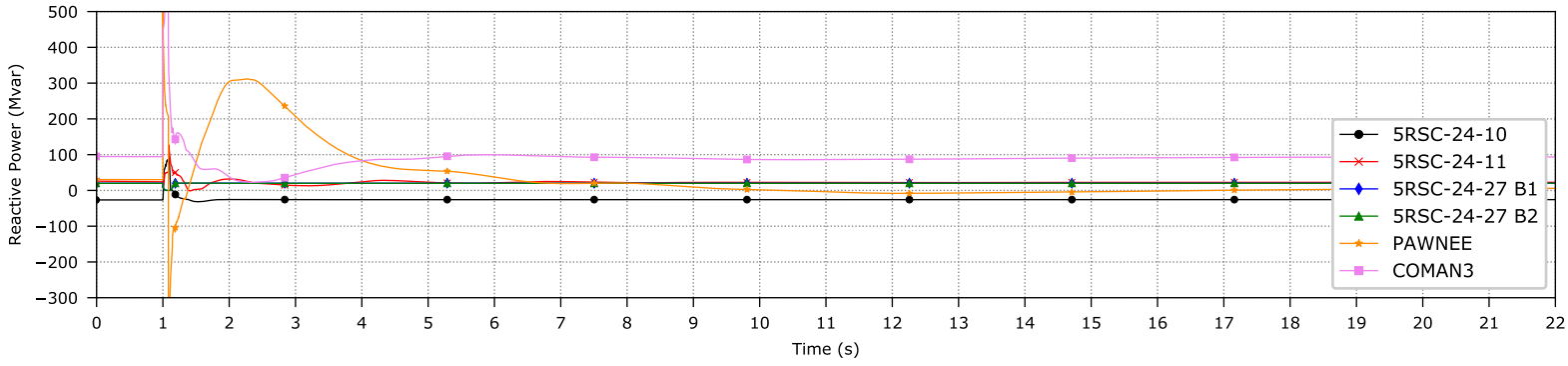


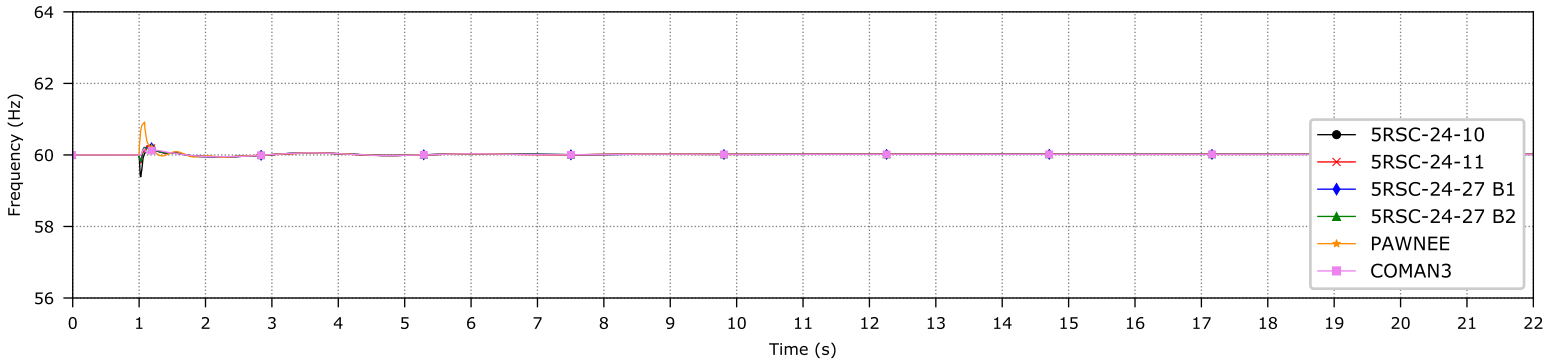


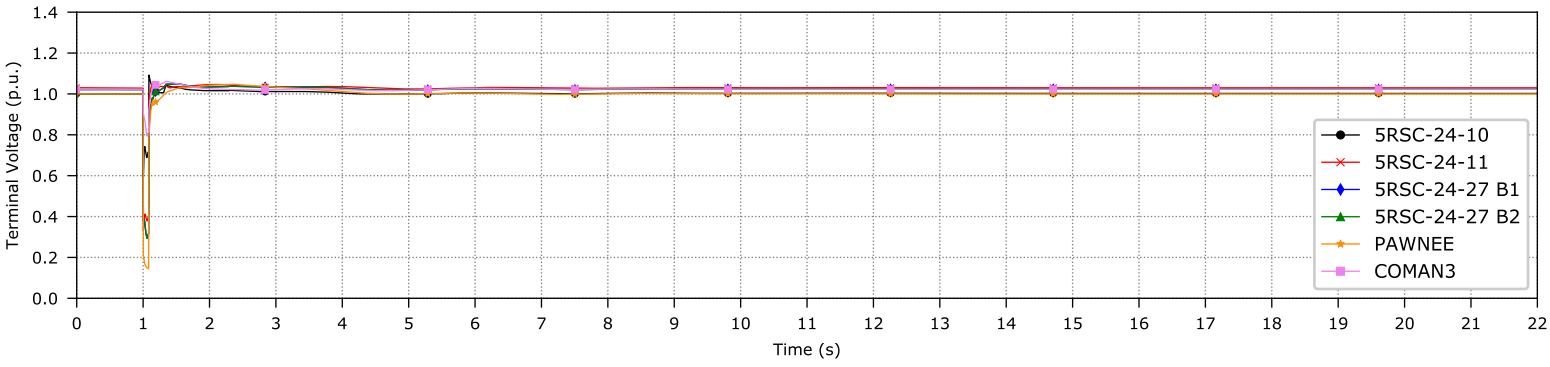
Ref. No. 10 - LoTC_087

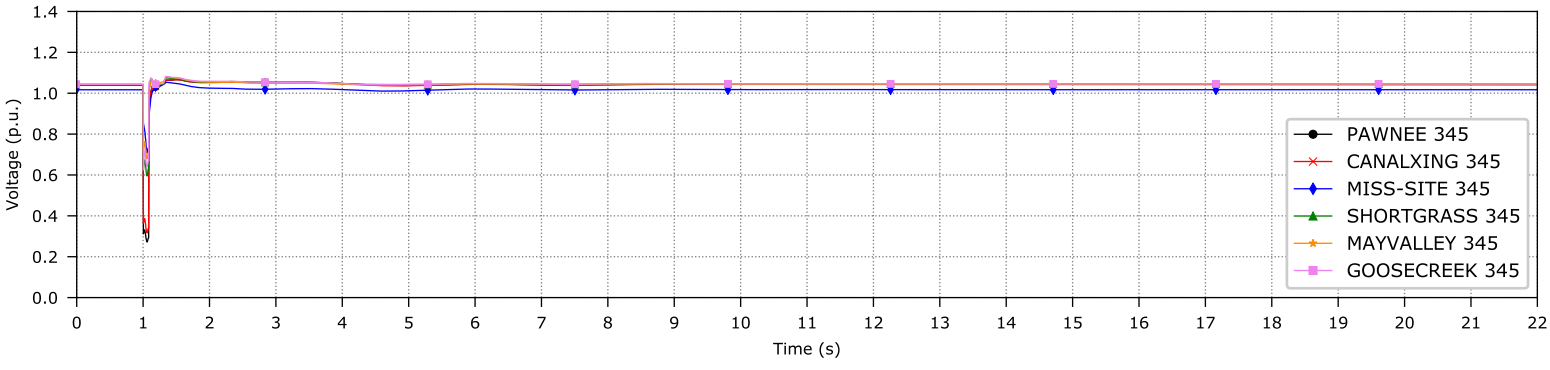




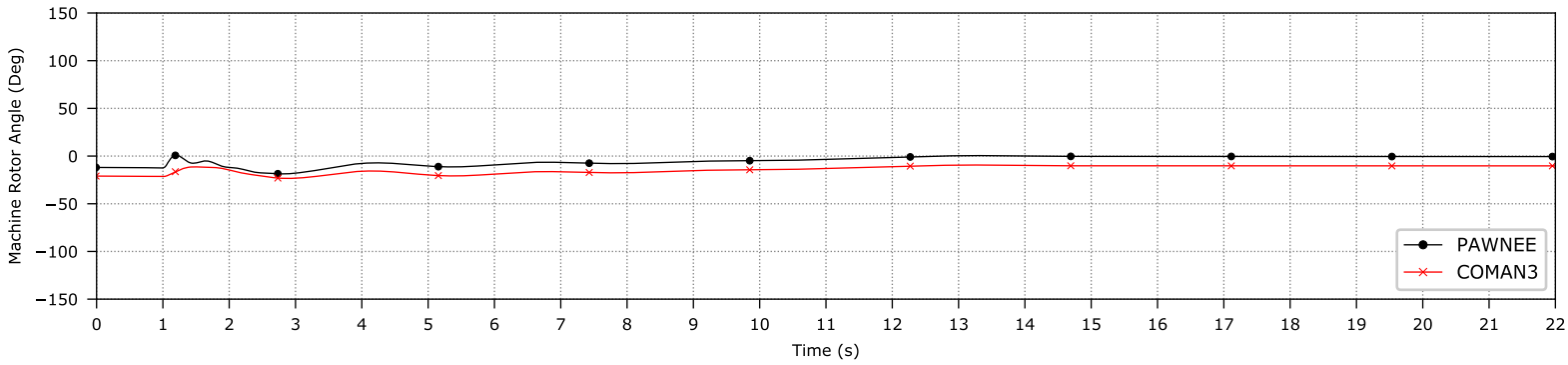


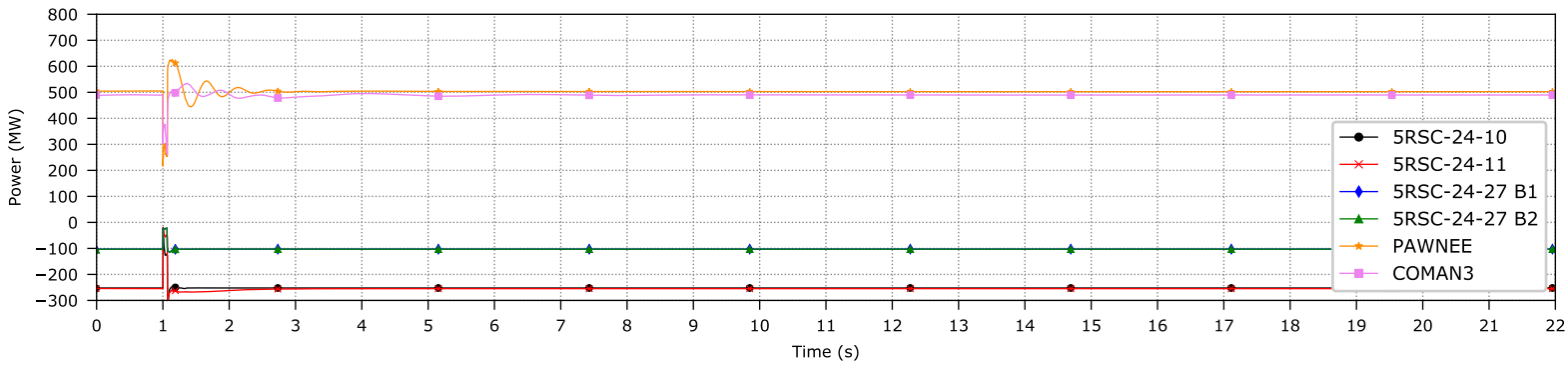


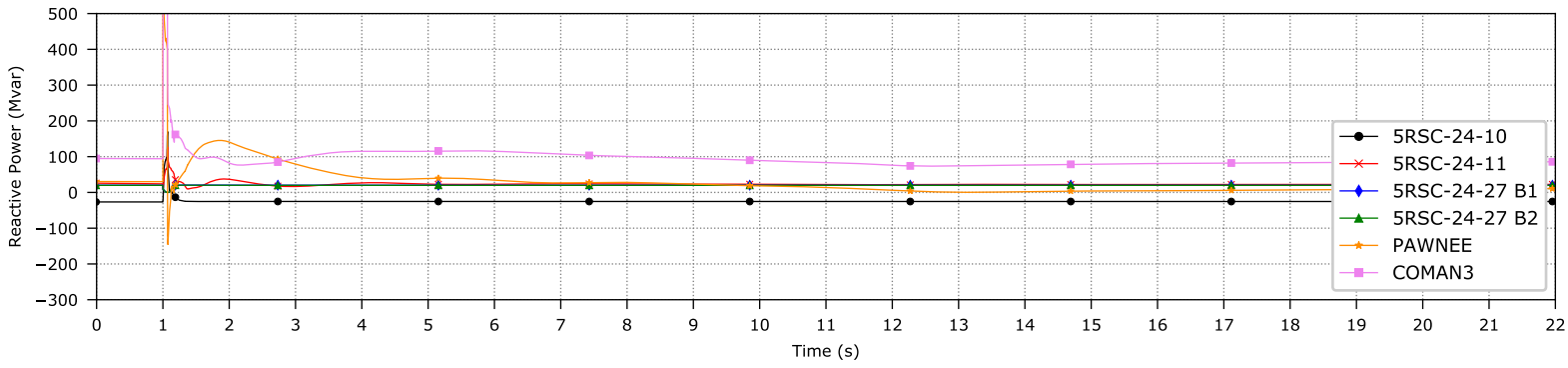


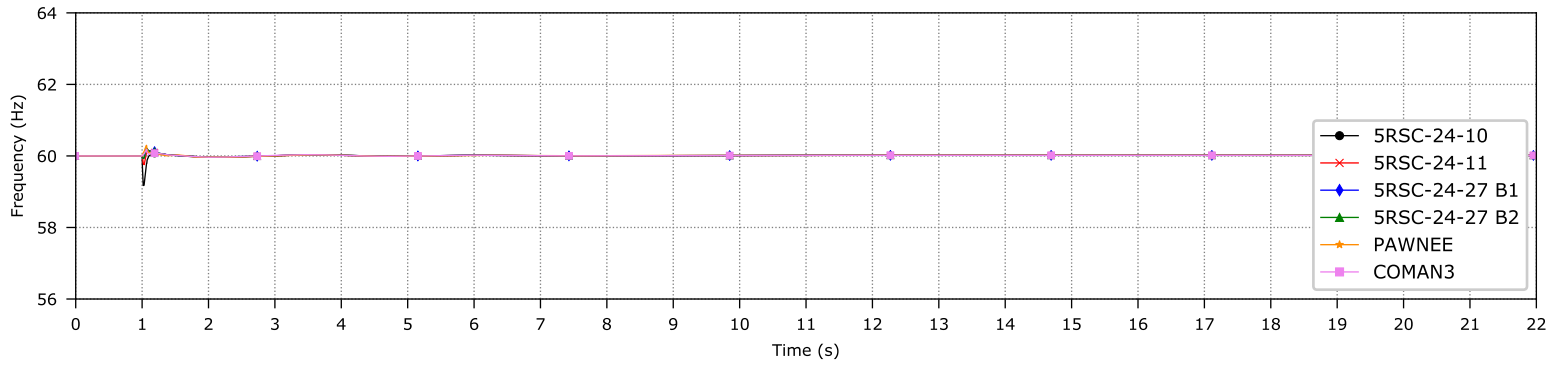


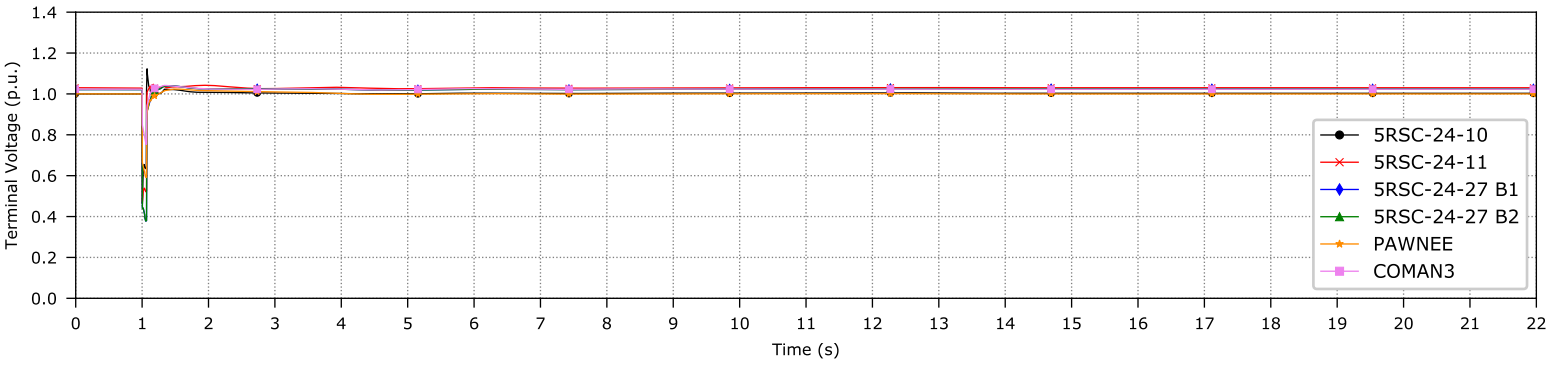
Ref. No. 11 - LoTC_152

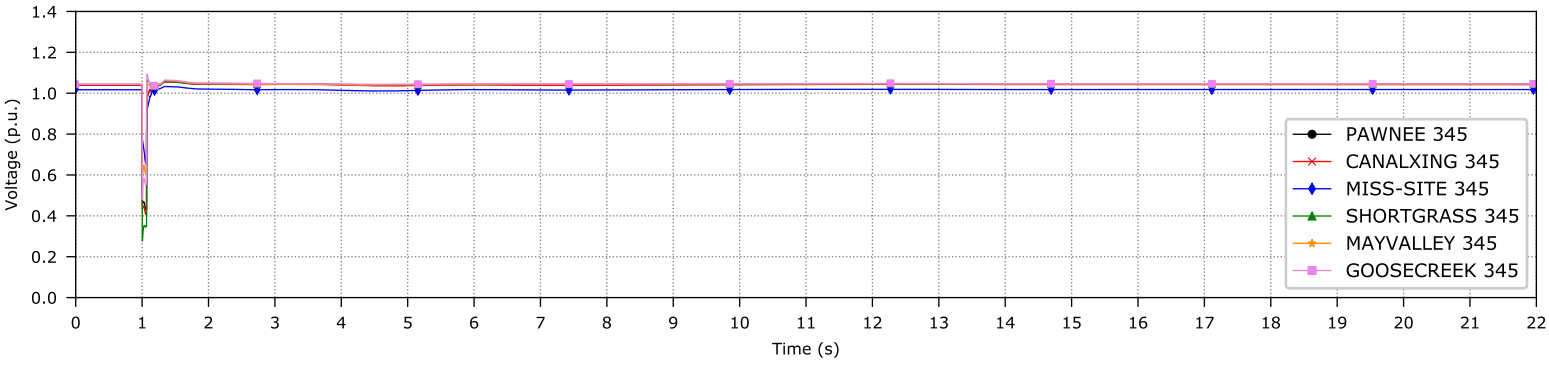




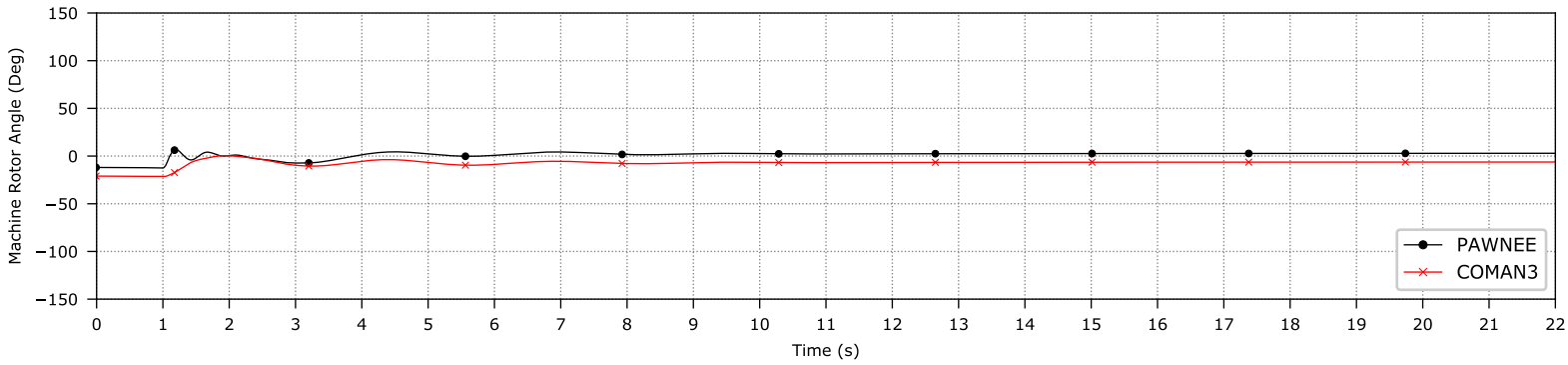


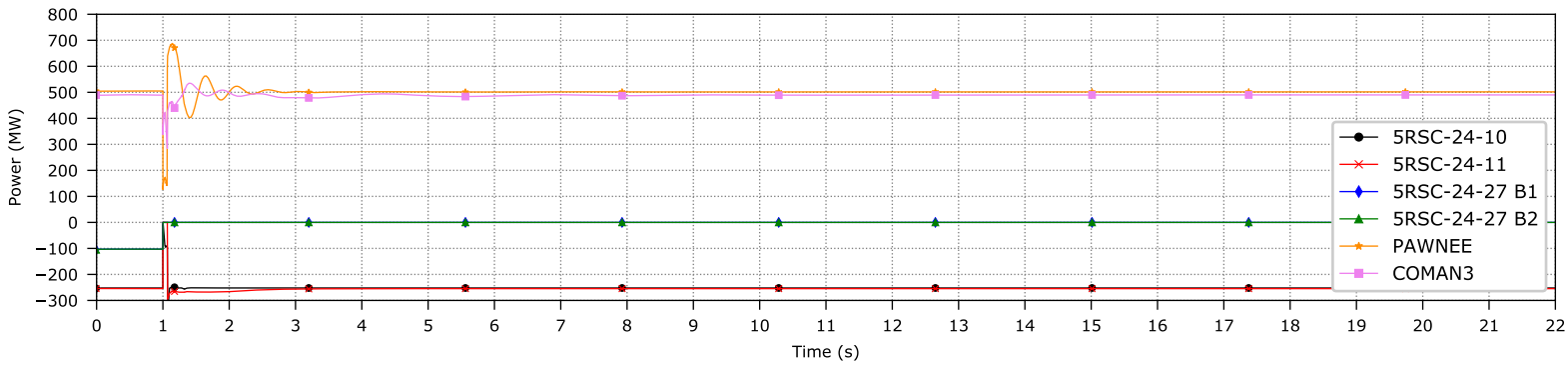


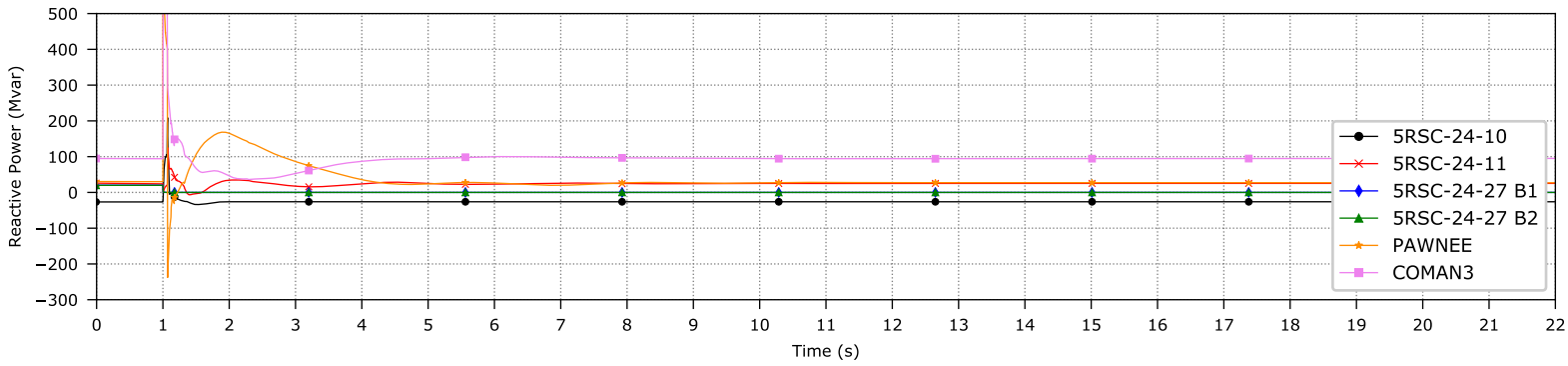


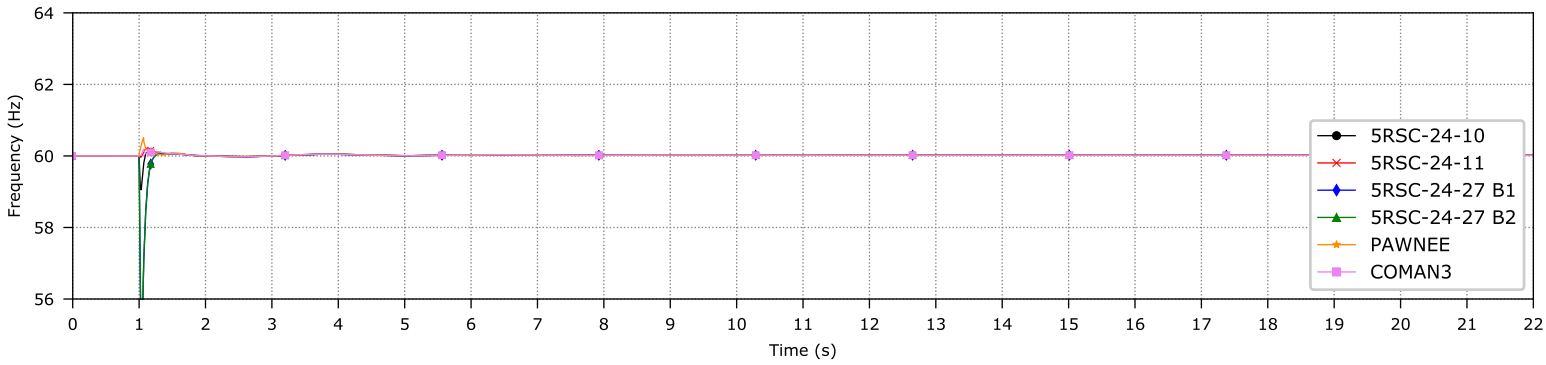


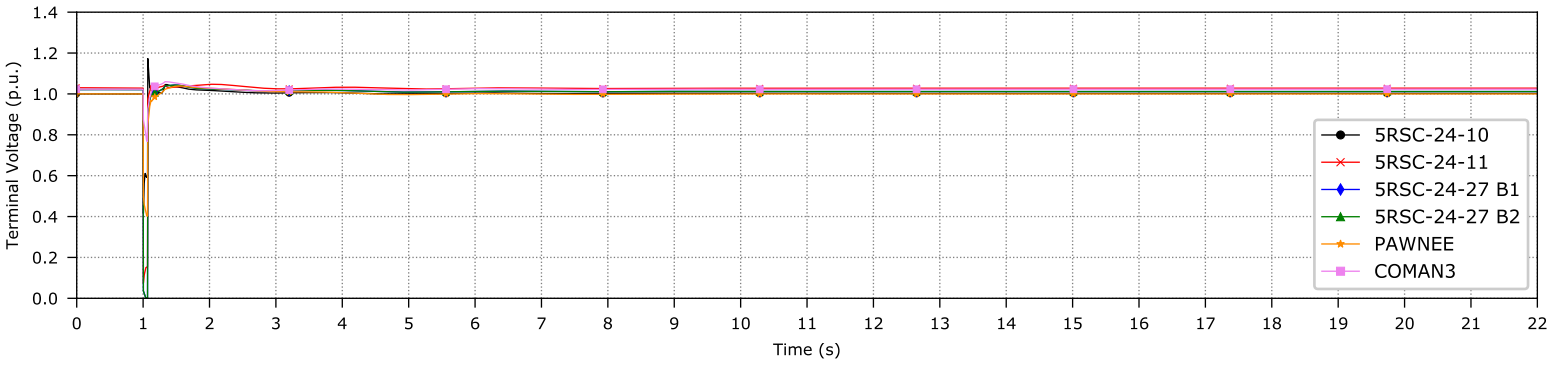
Ref. No. 12 - LoTC_293

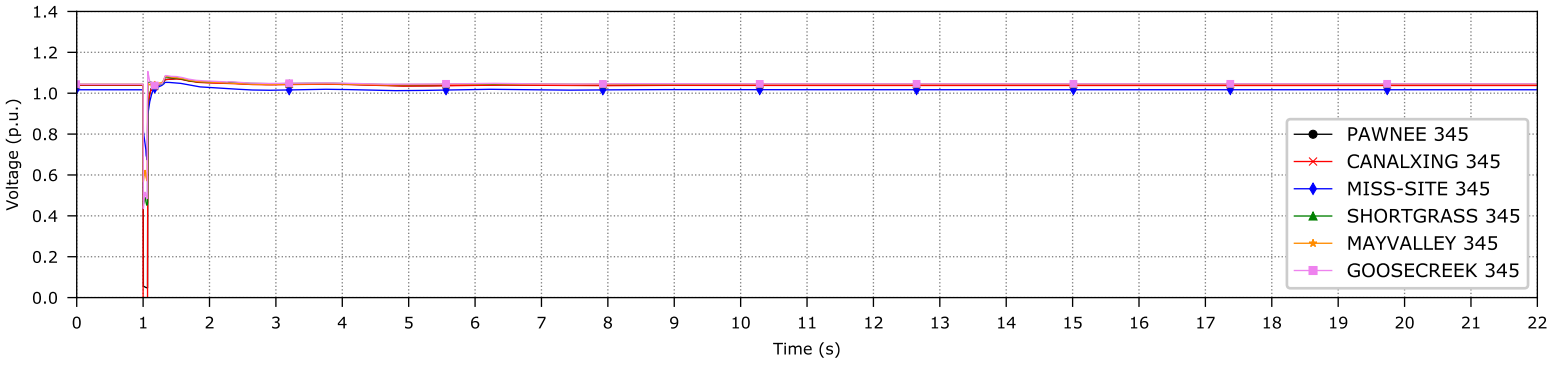




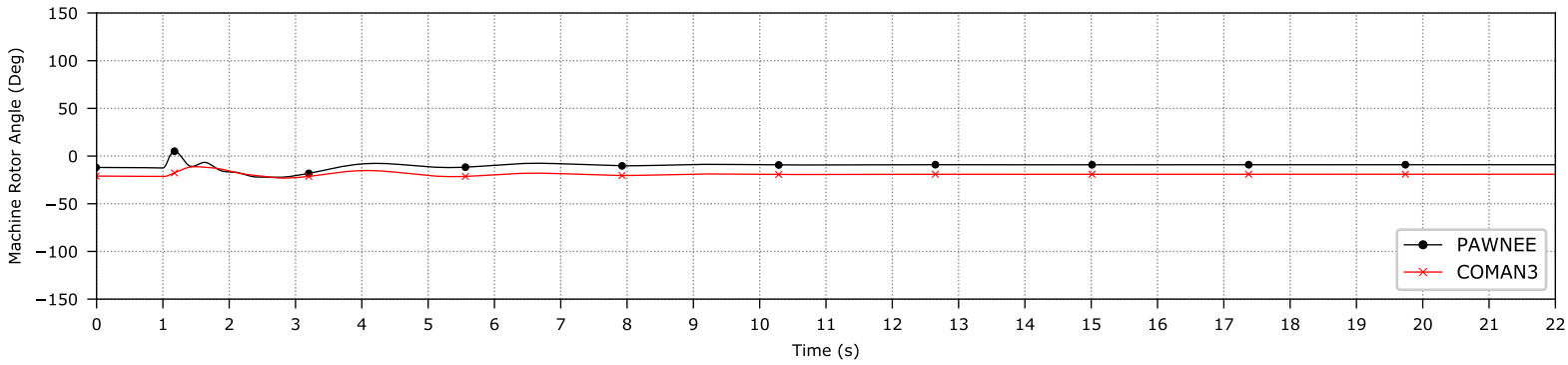


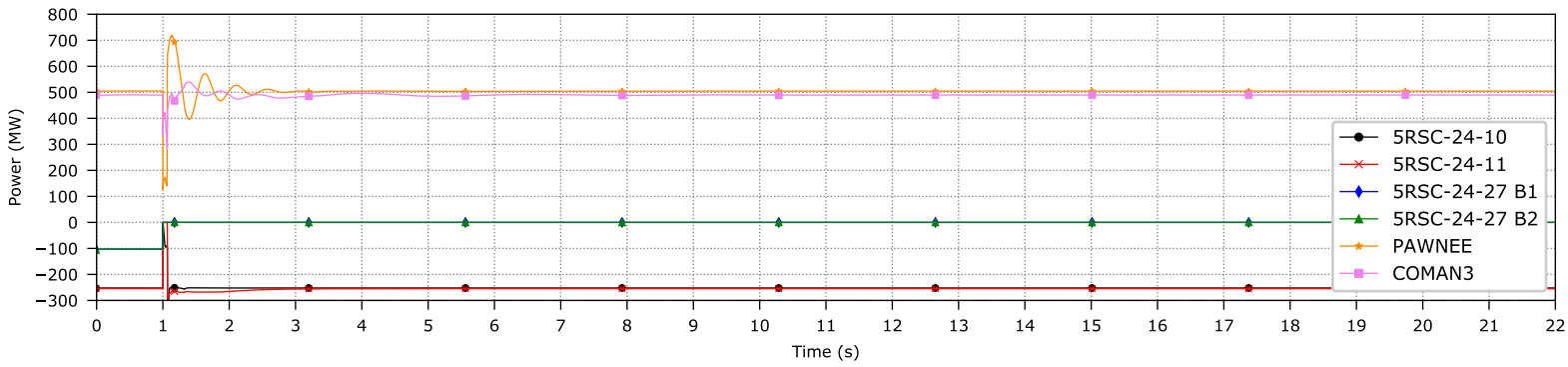


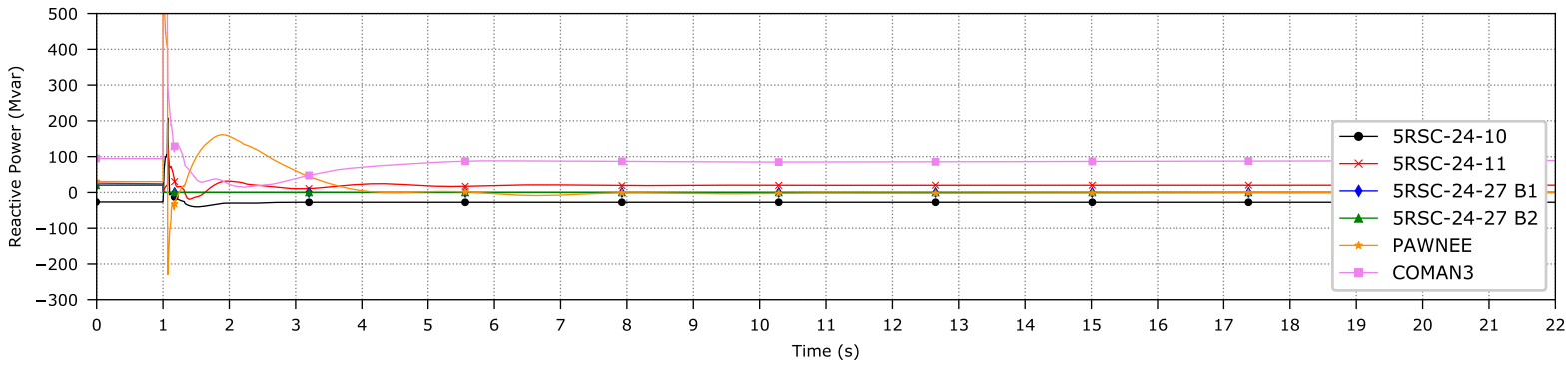


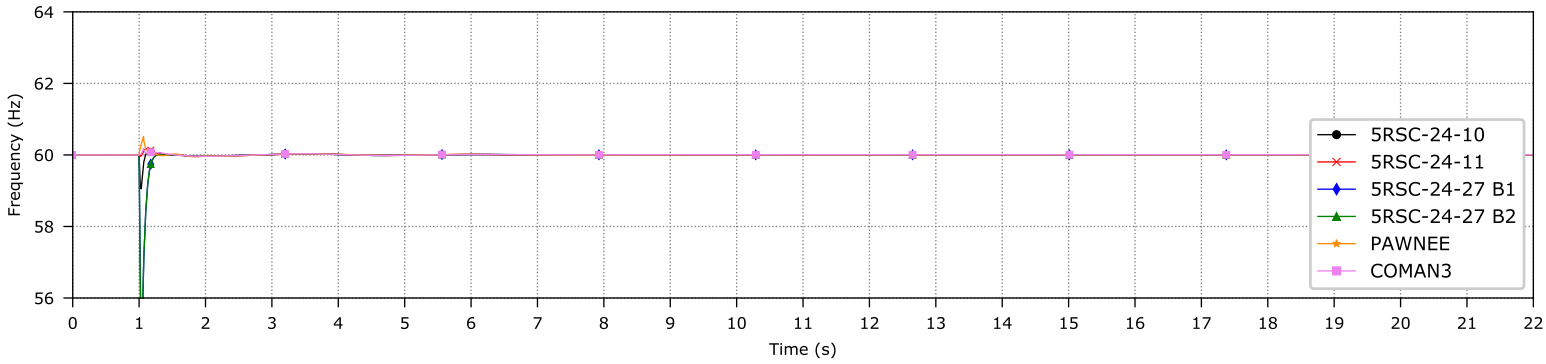


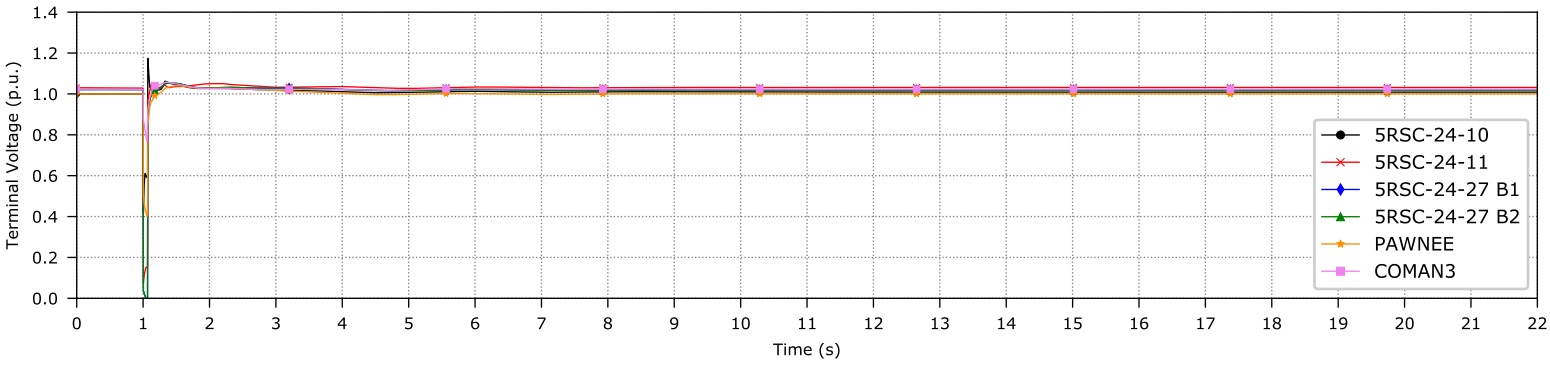
Ref. No. 13 - LoTC_294a

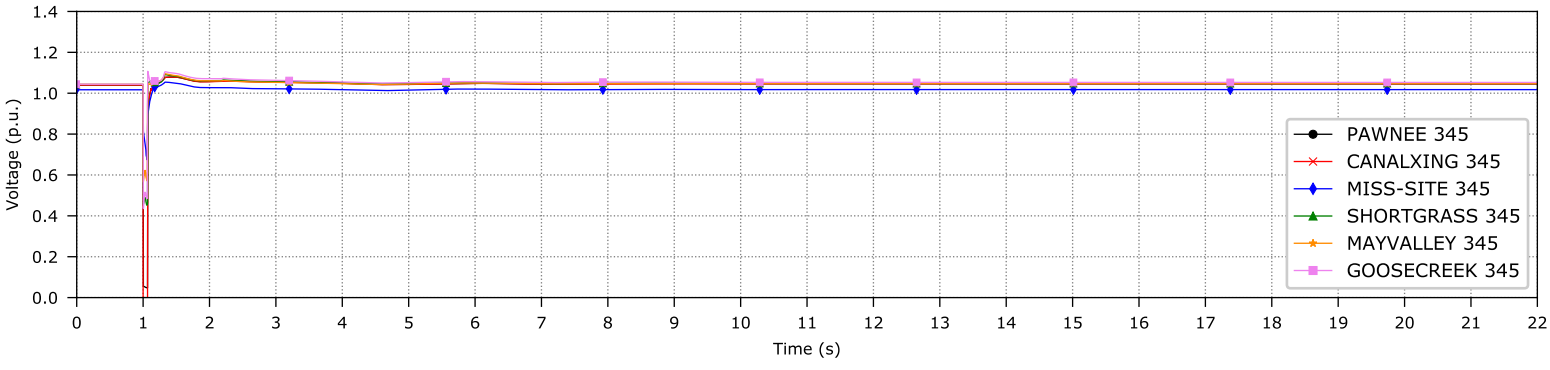




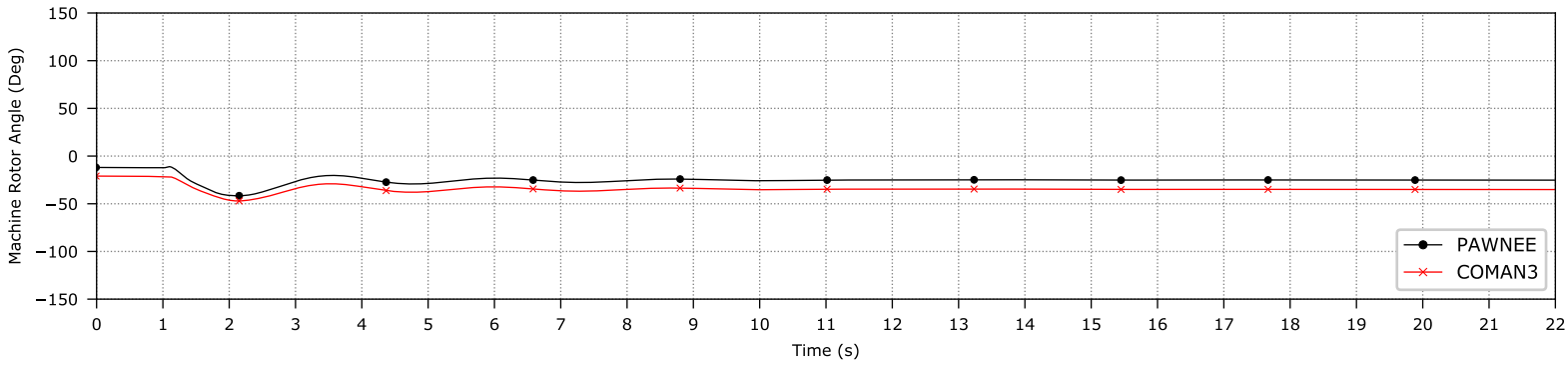


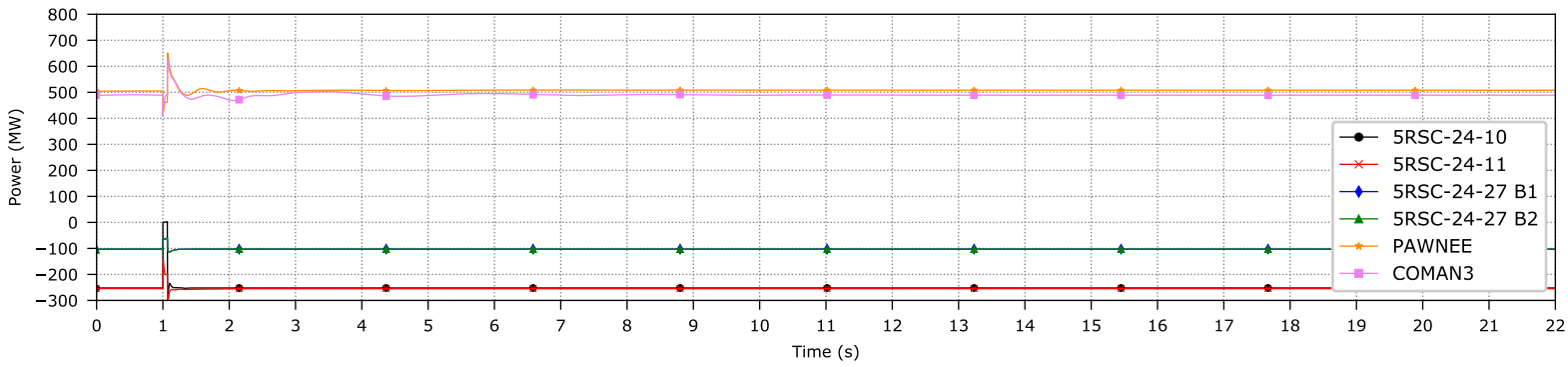


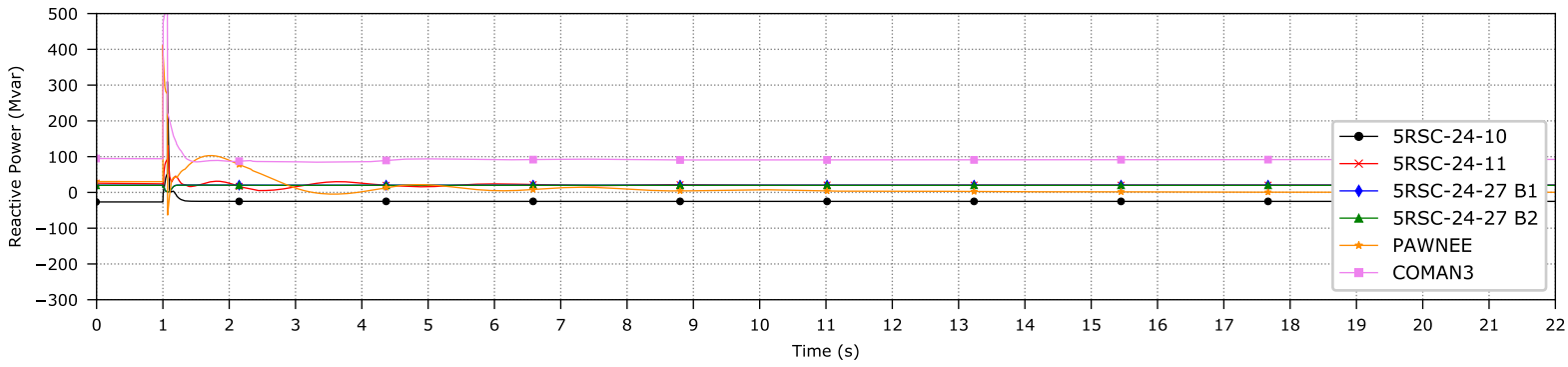


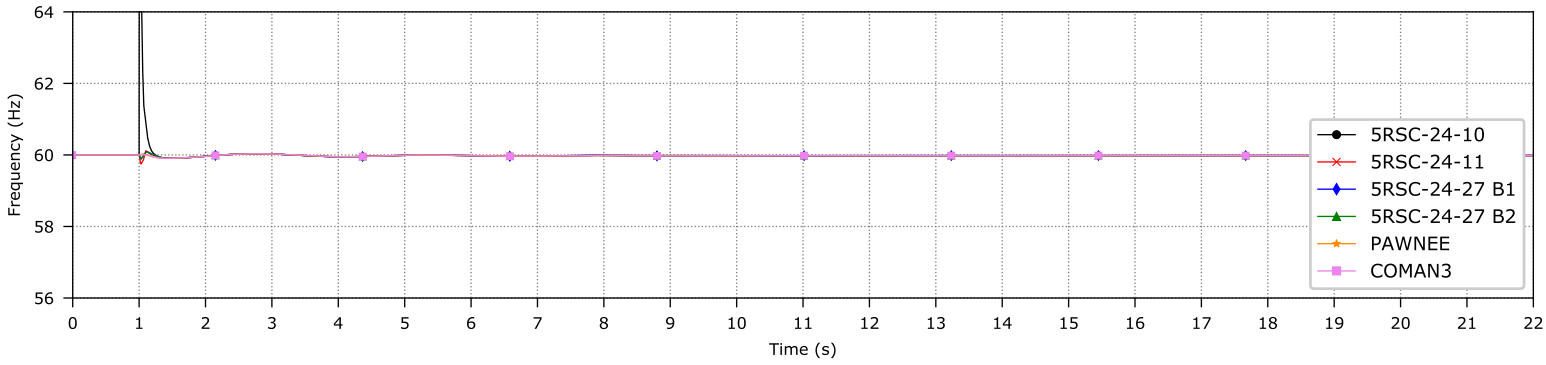


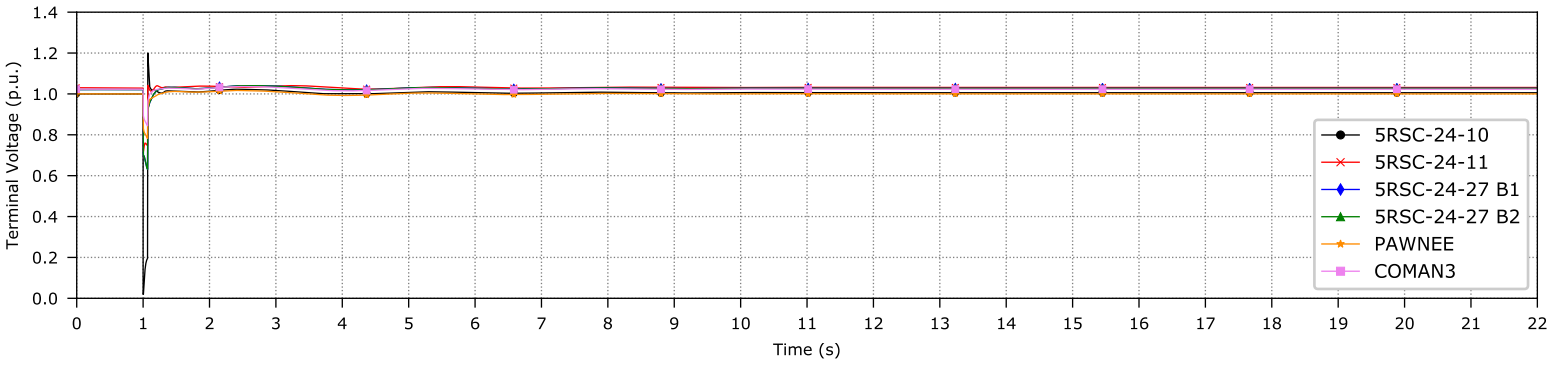
Ref. No. 14 - LoTC_294b

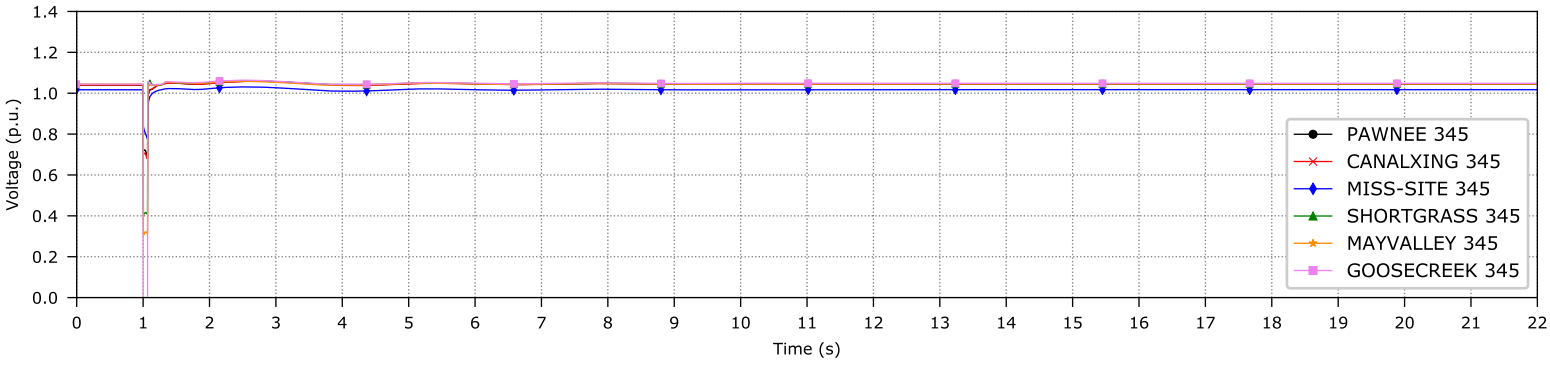




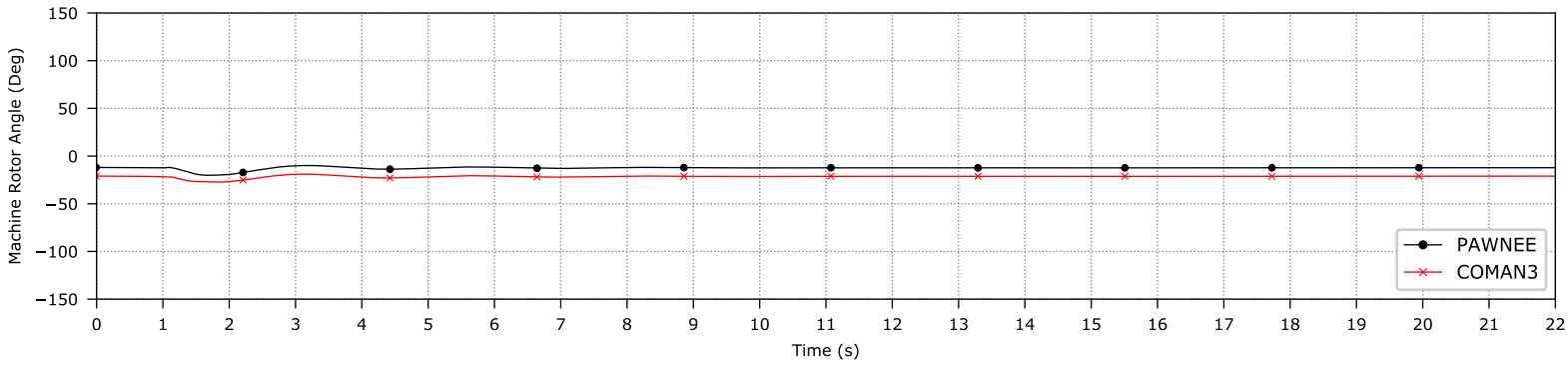


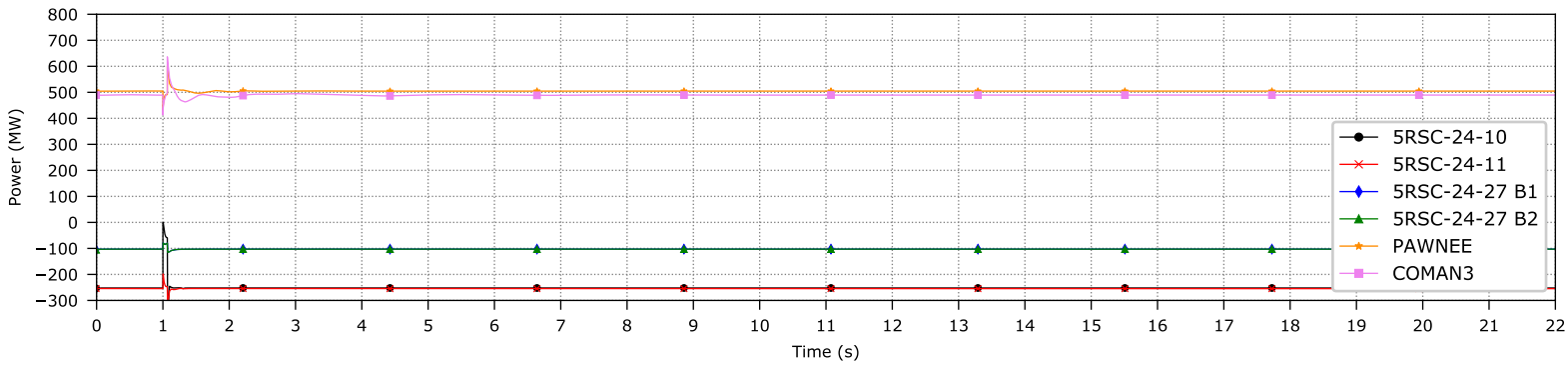


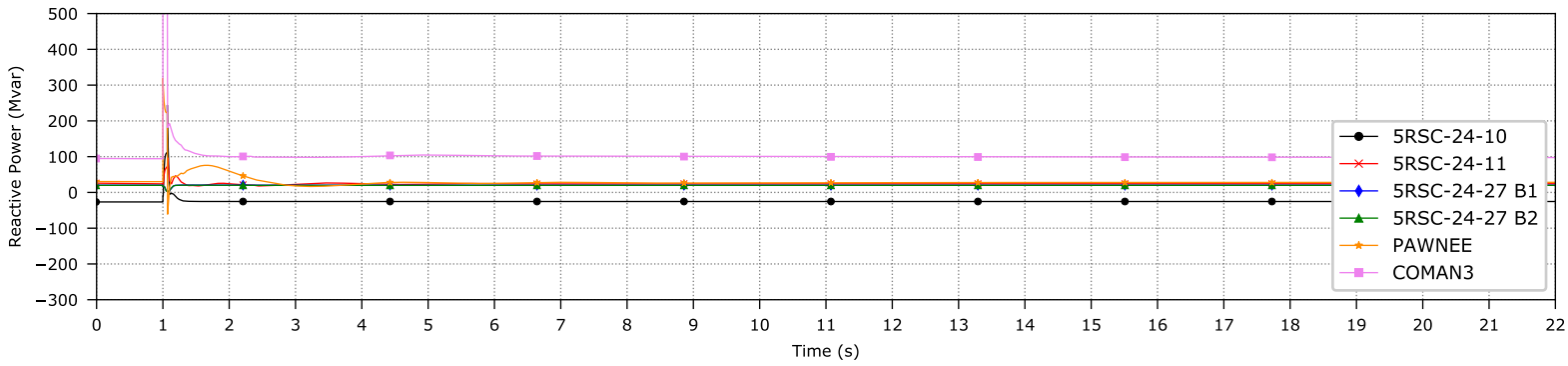


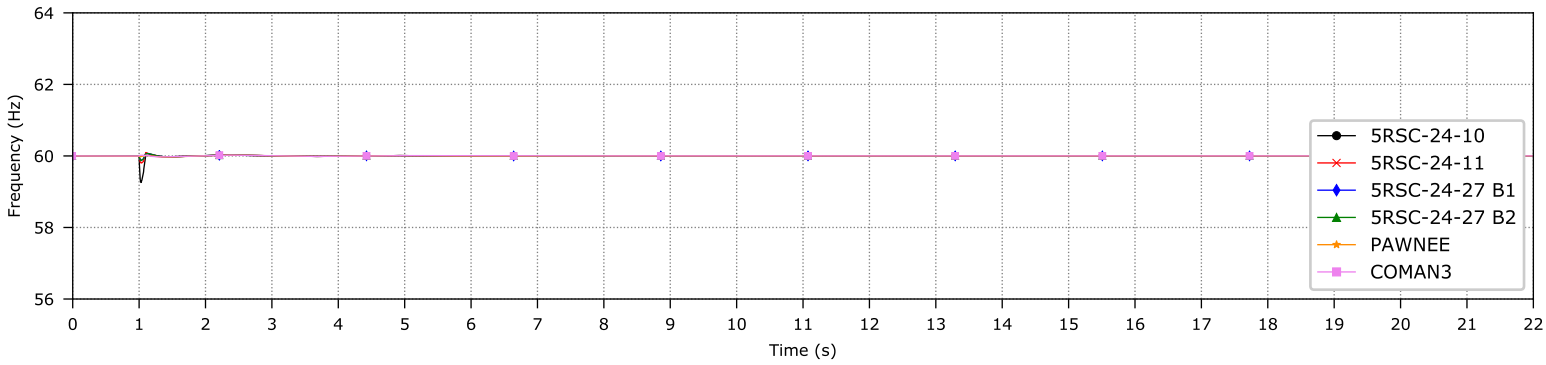


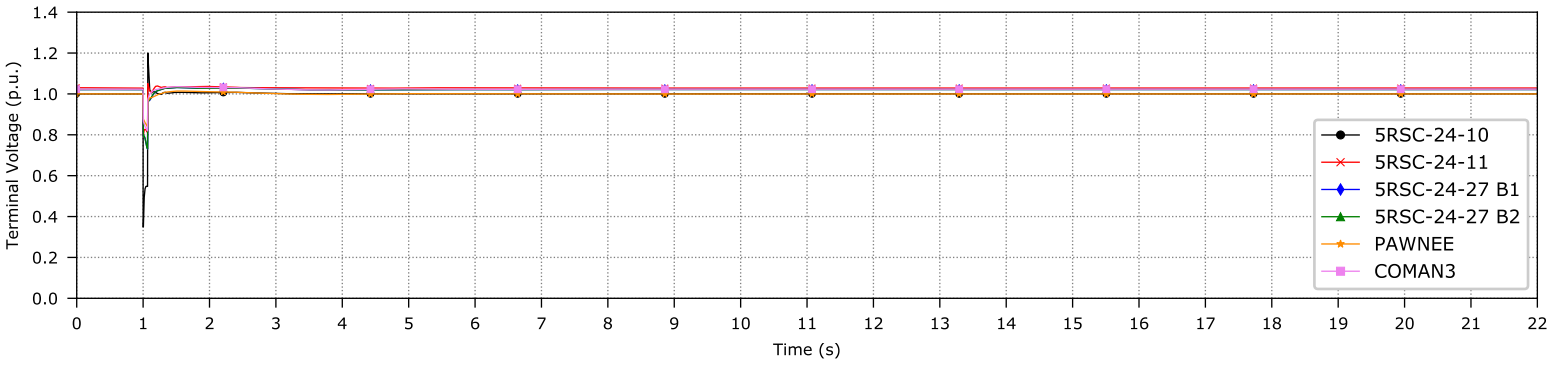
Ref. No. 15 - LoTC_295b

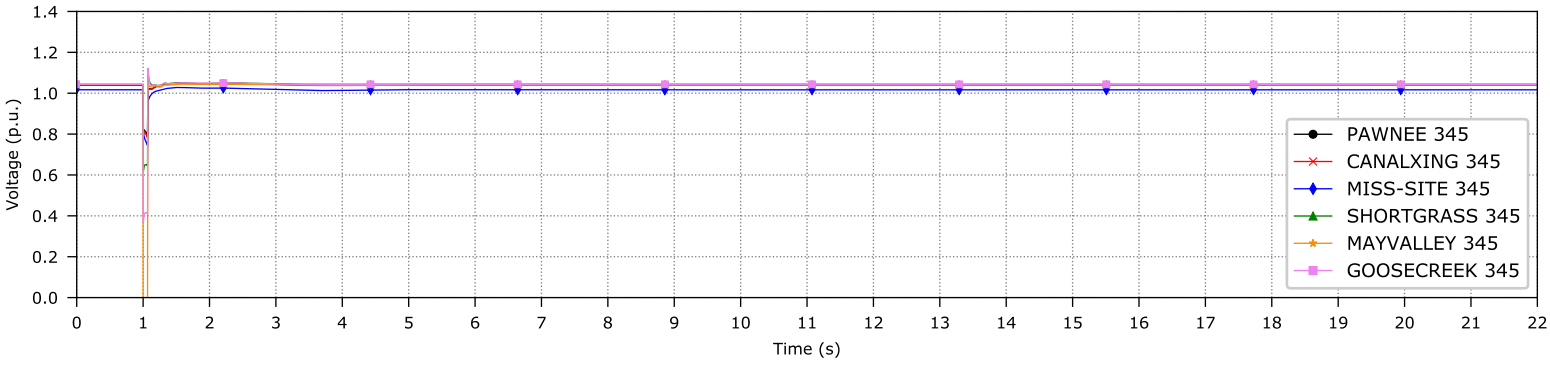




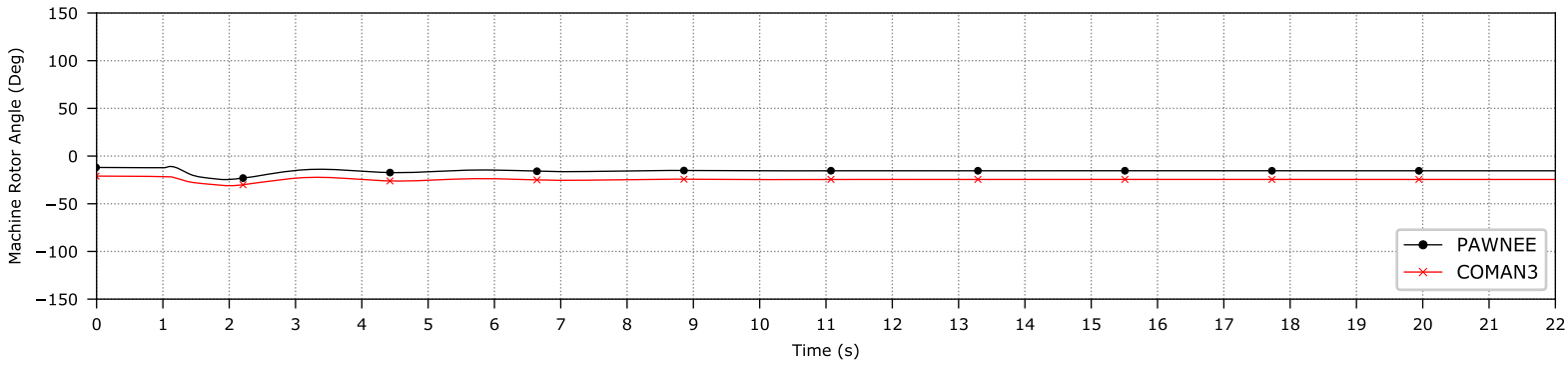


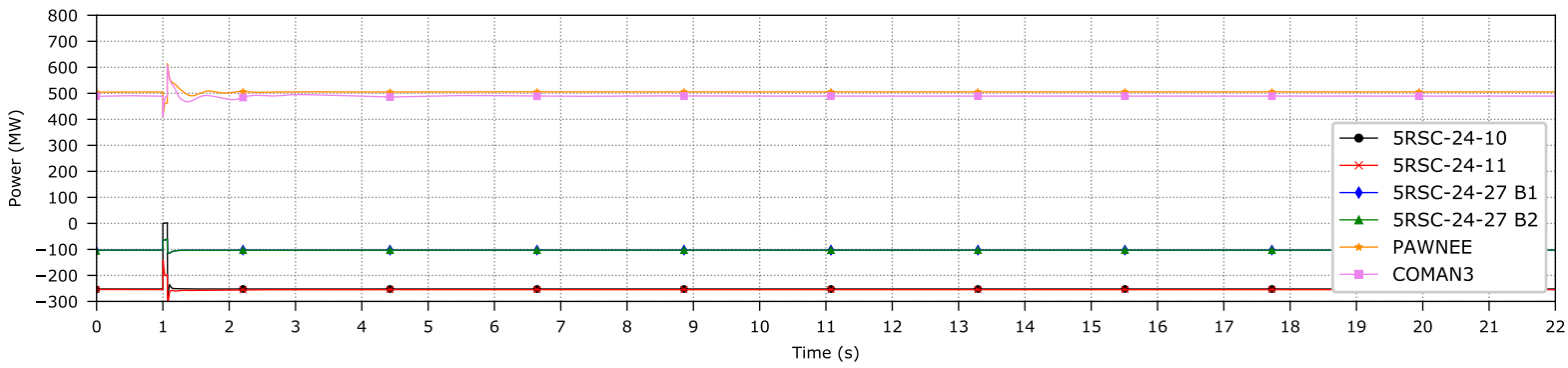


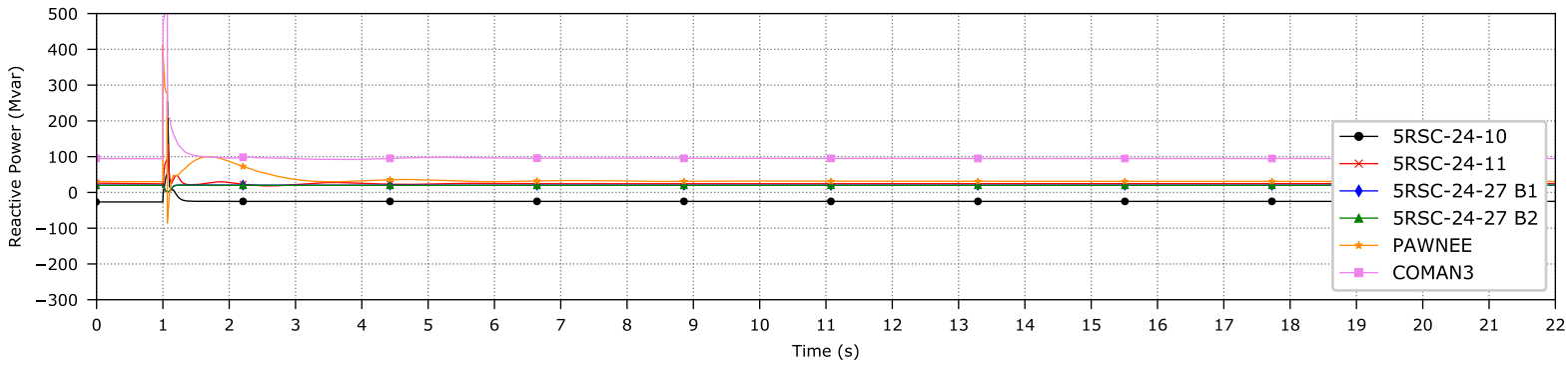


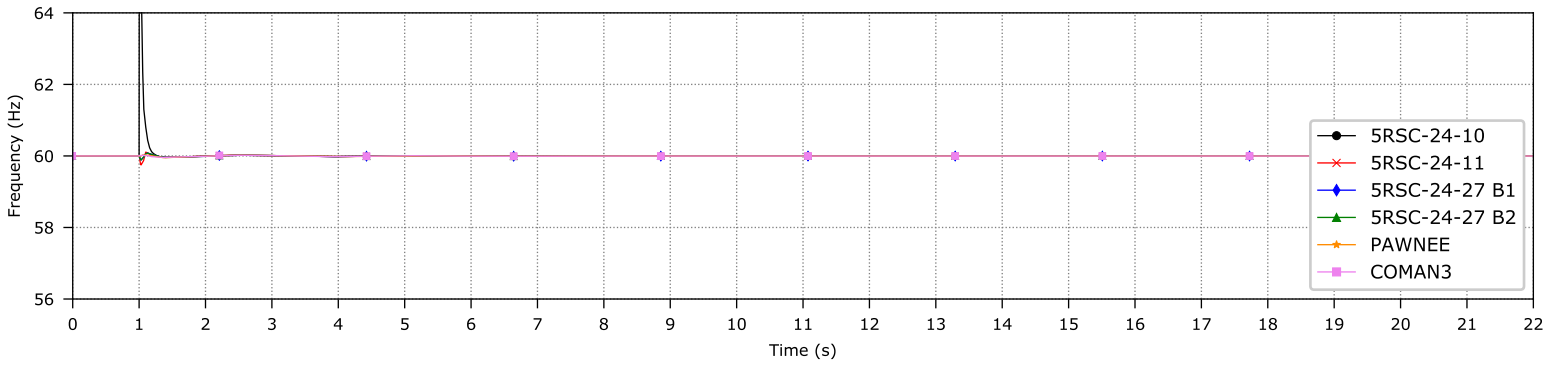


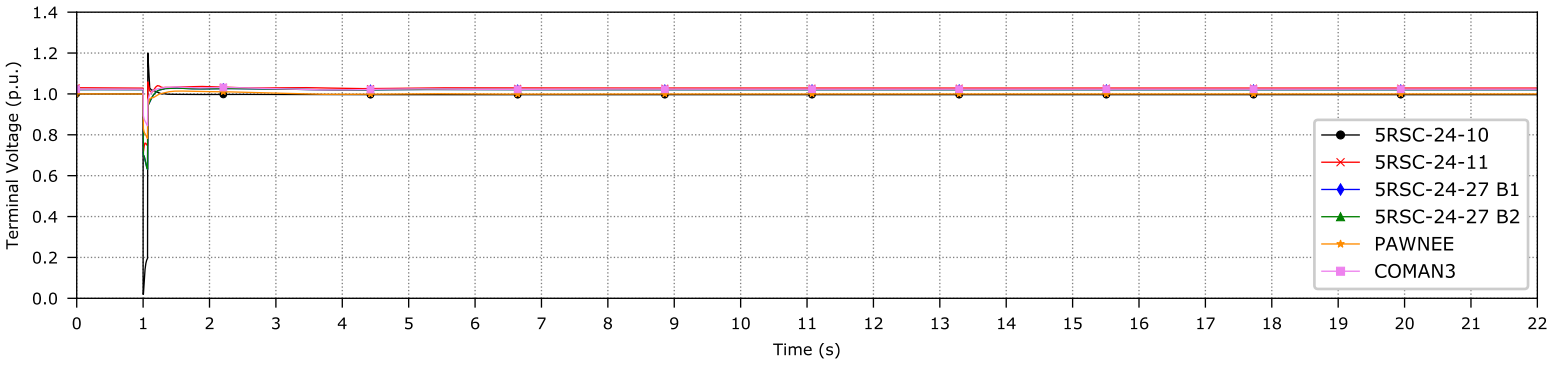
Ref. No. 16 - LoTC_297

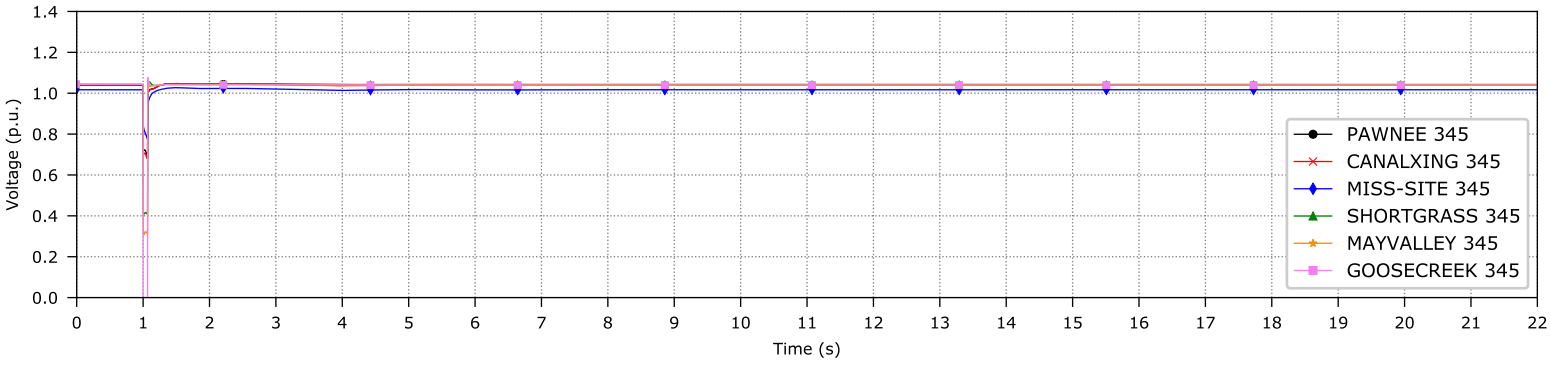




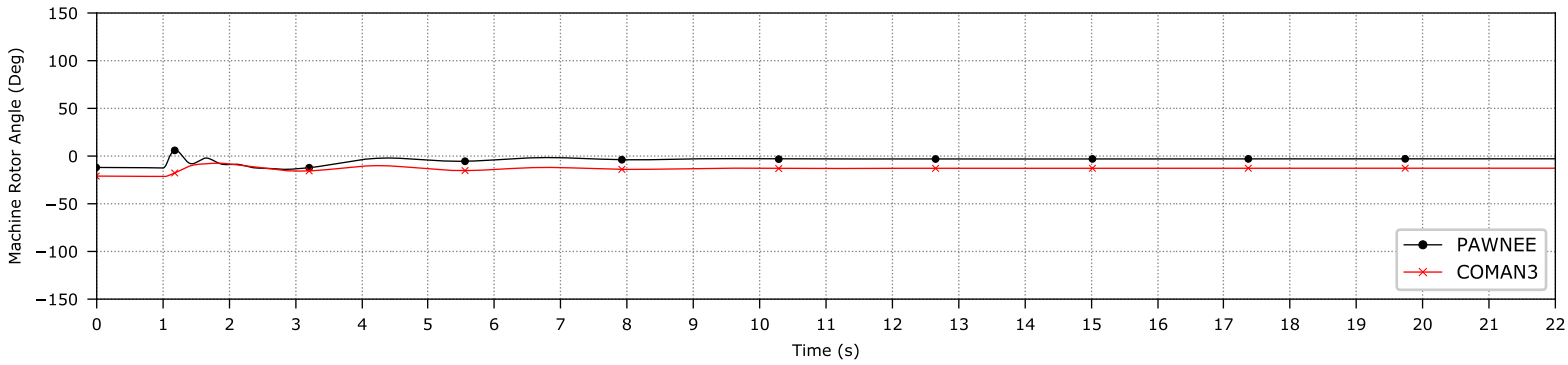


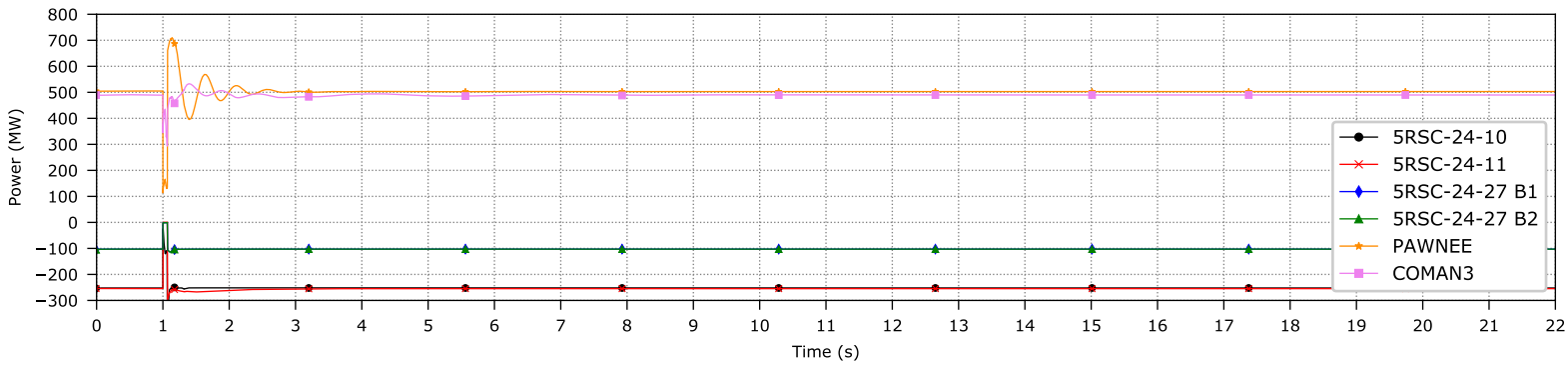


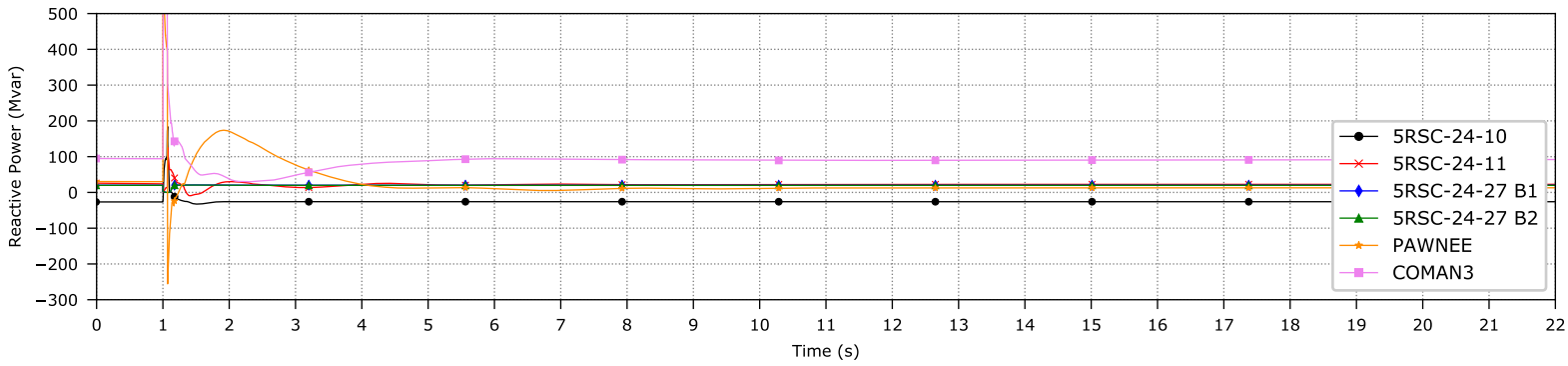


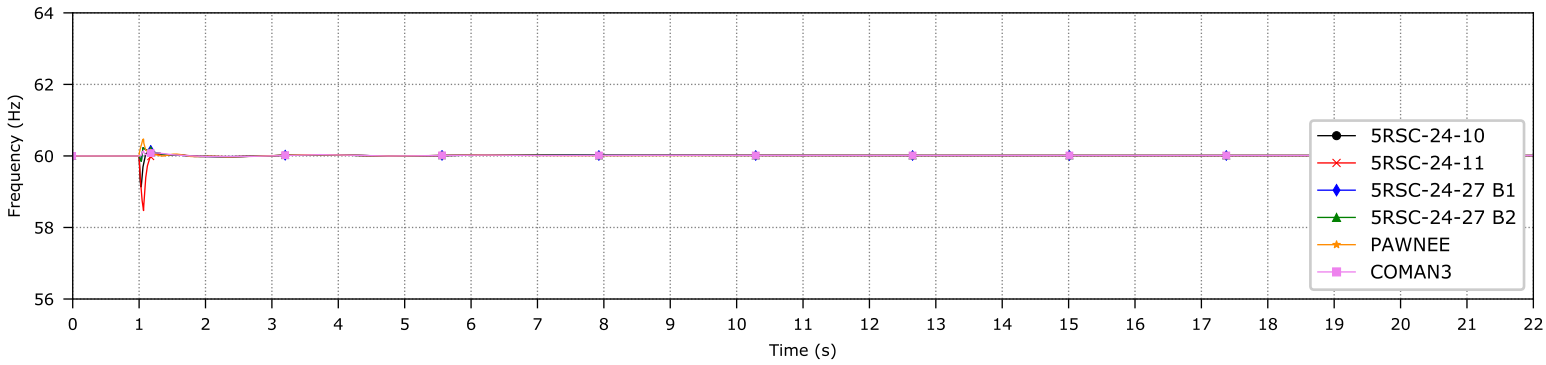


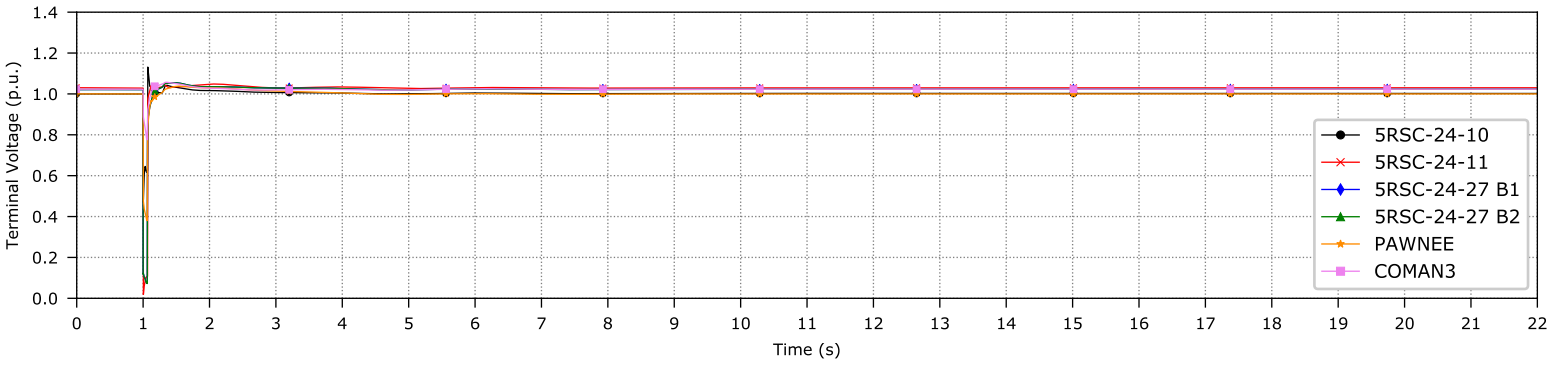
Ref. No. 17 - LoTC_303

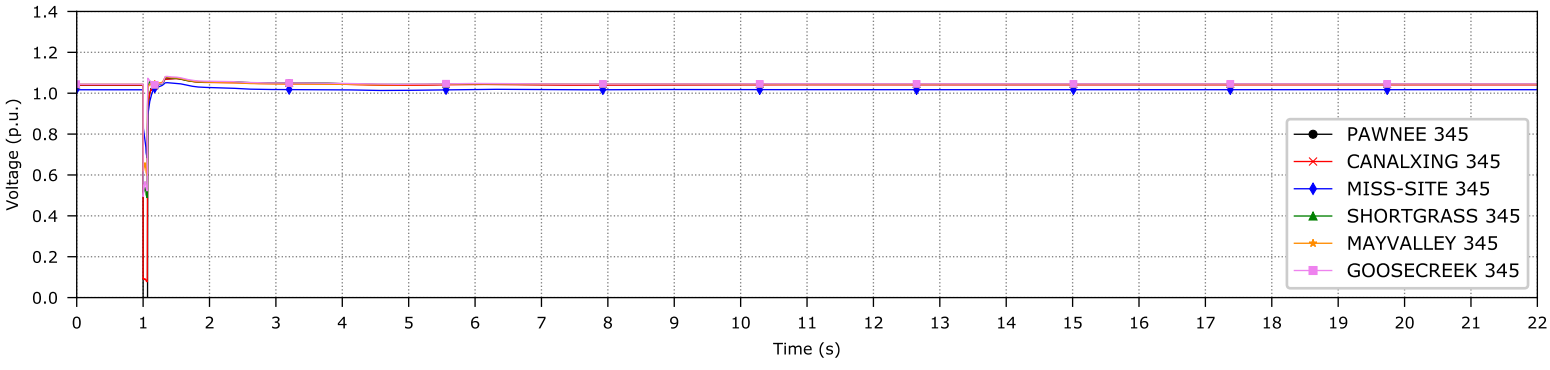




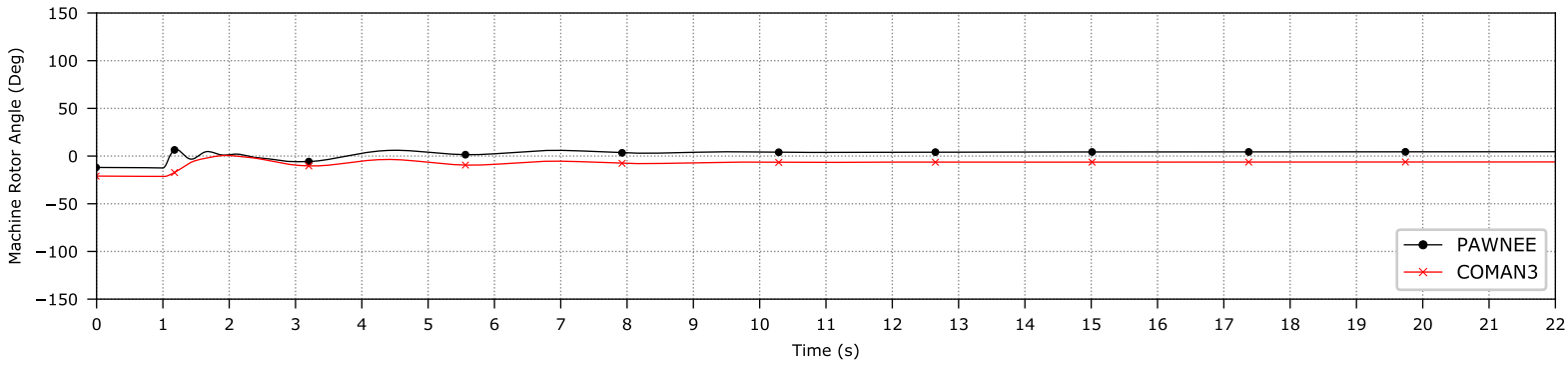


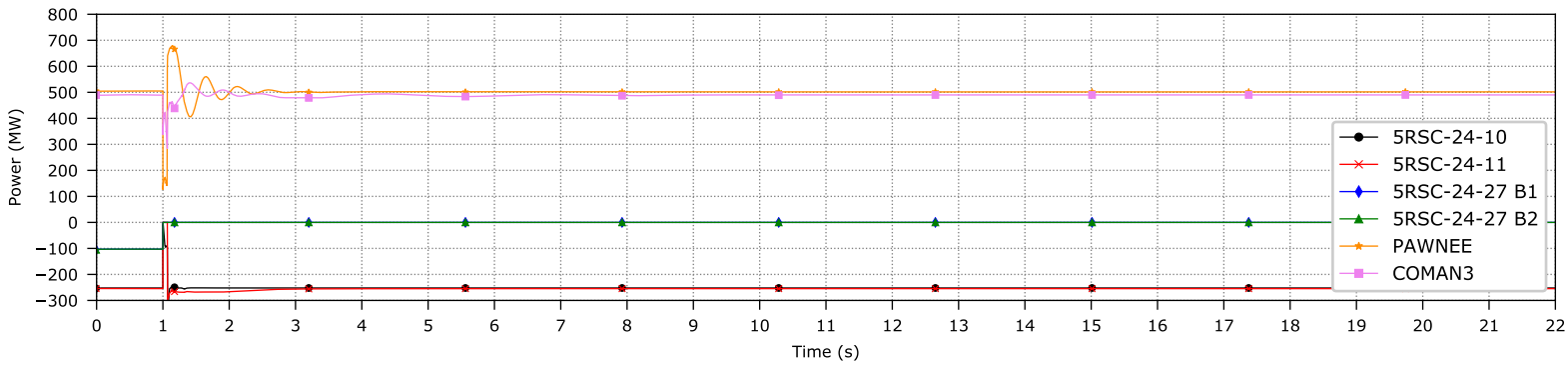


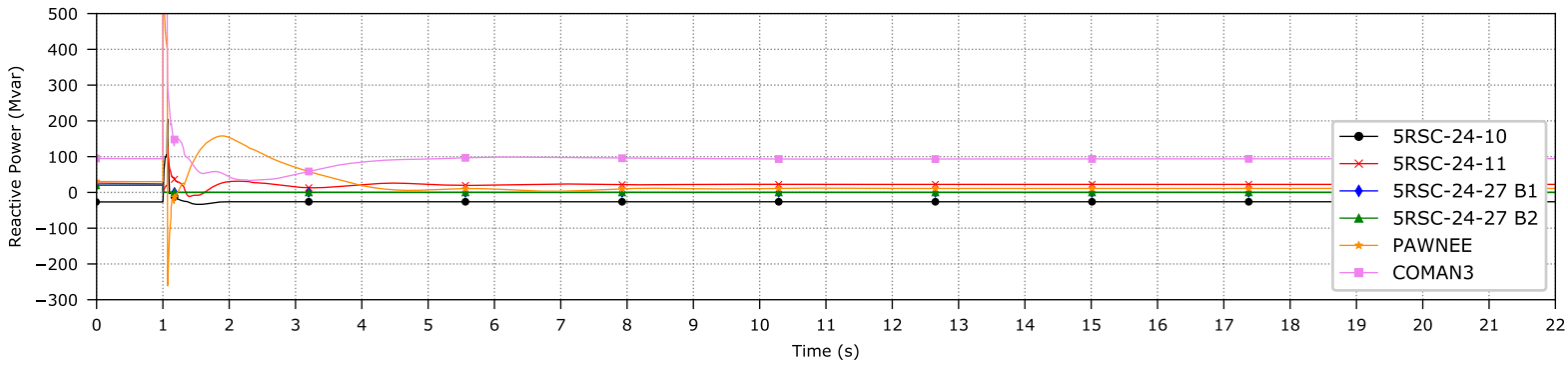


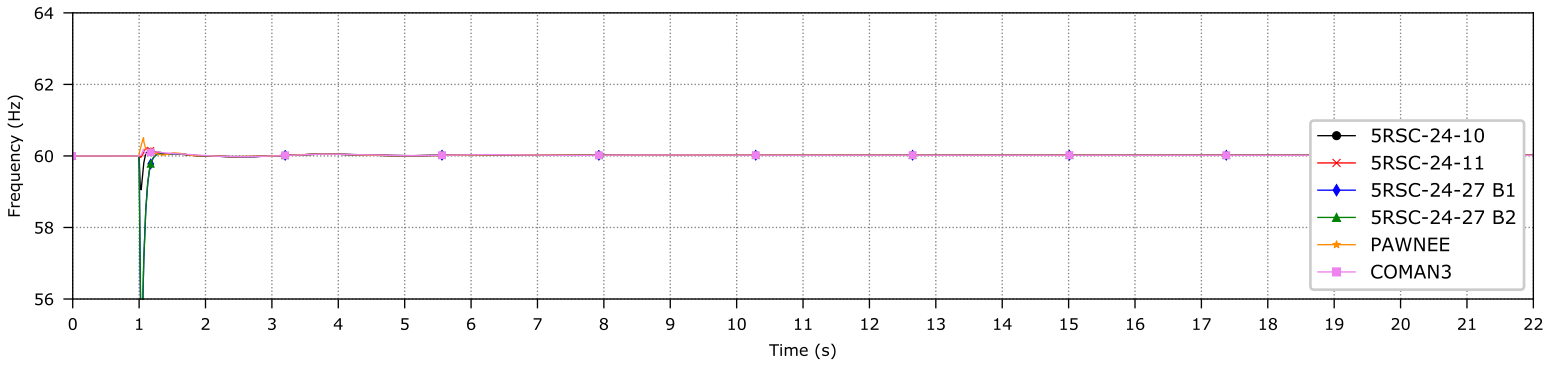


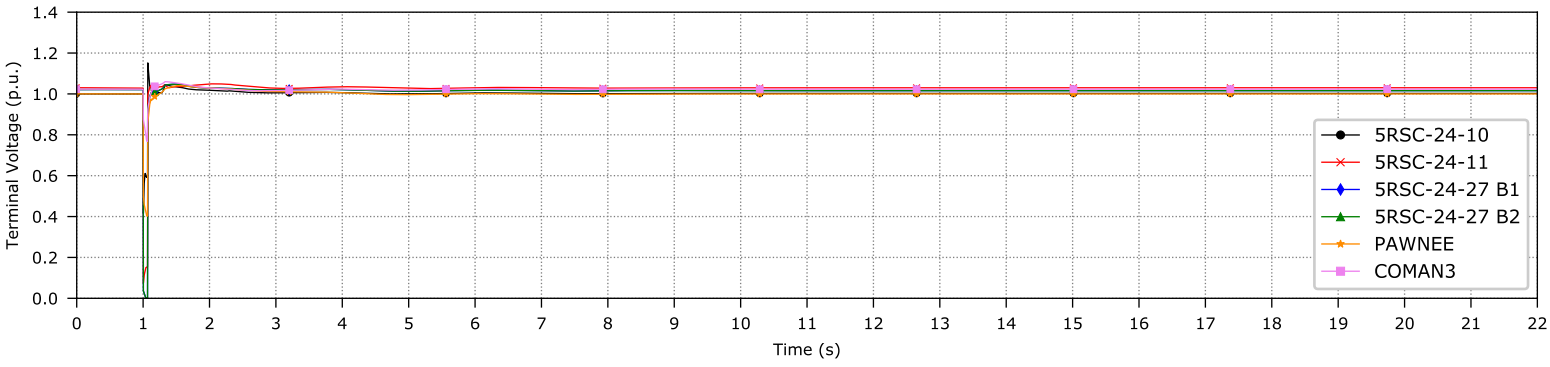
Ref. No. 18 - LoTC_305

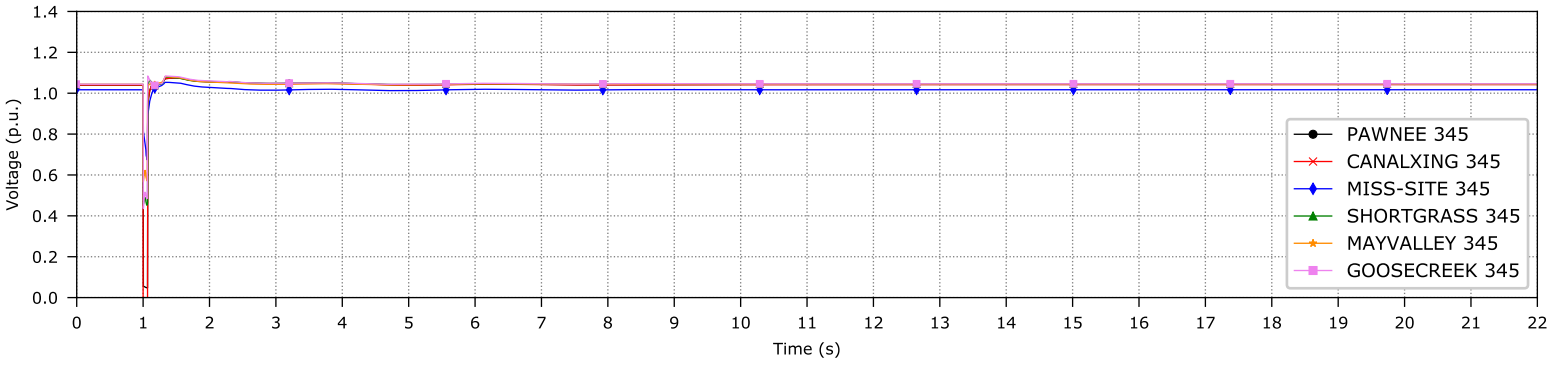




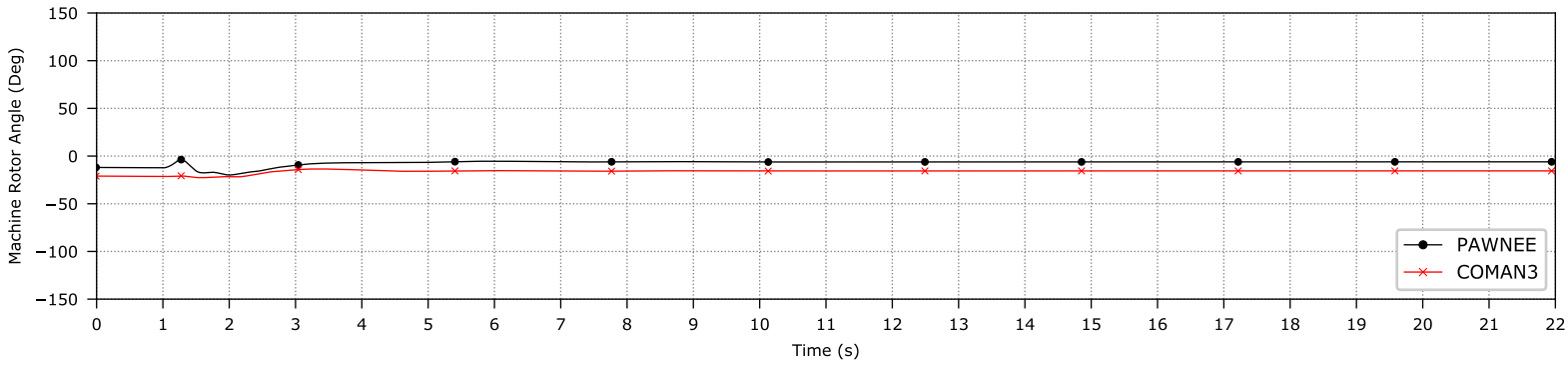


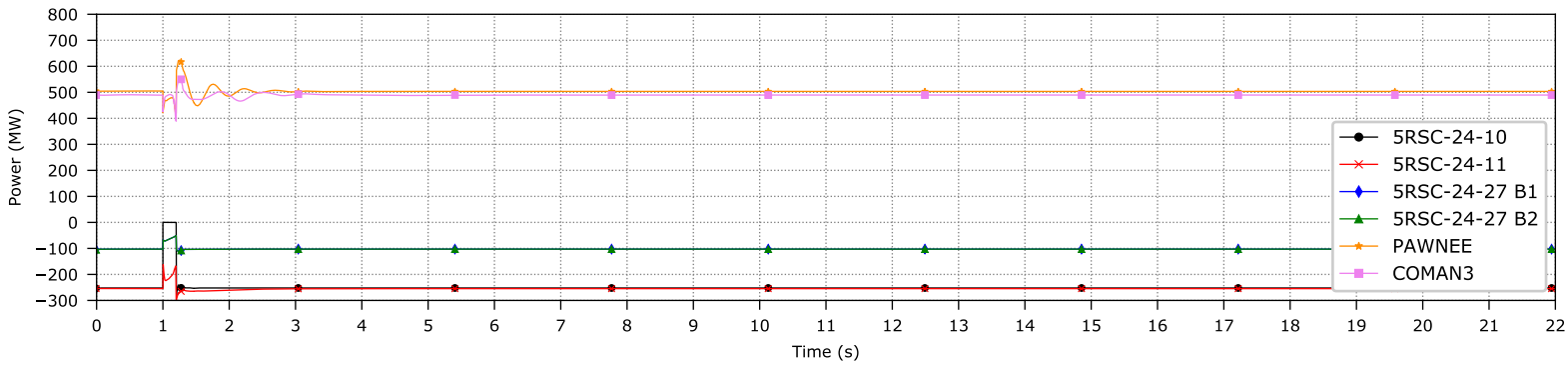


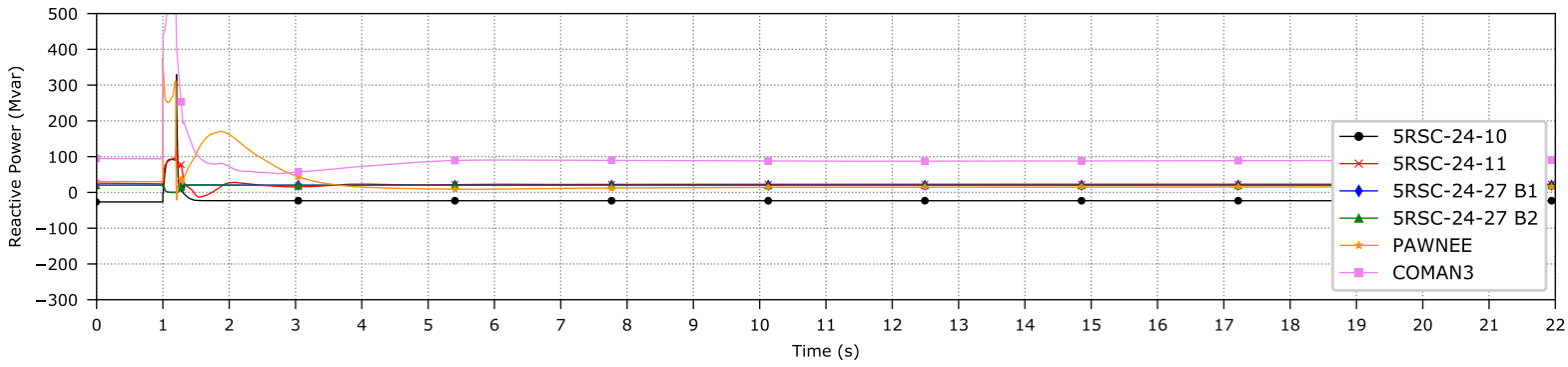


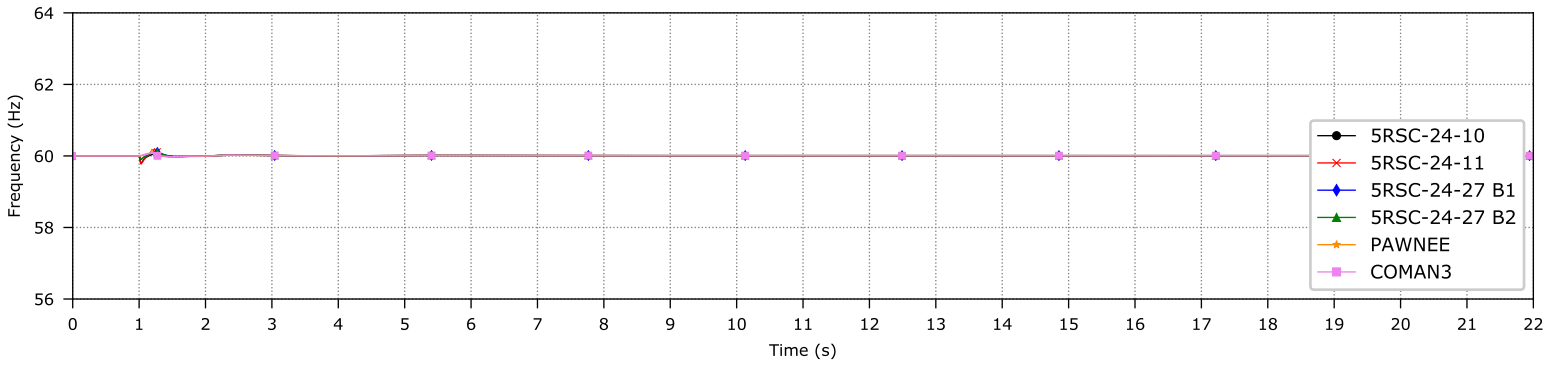


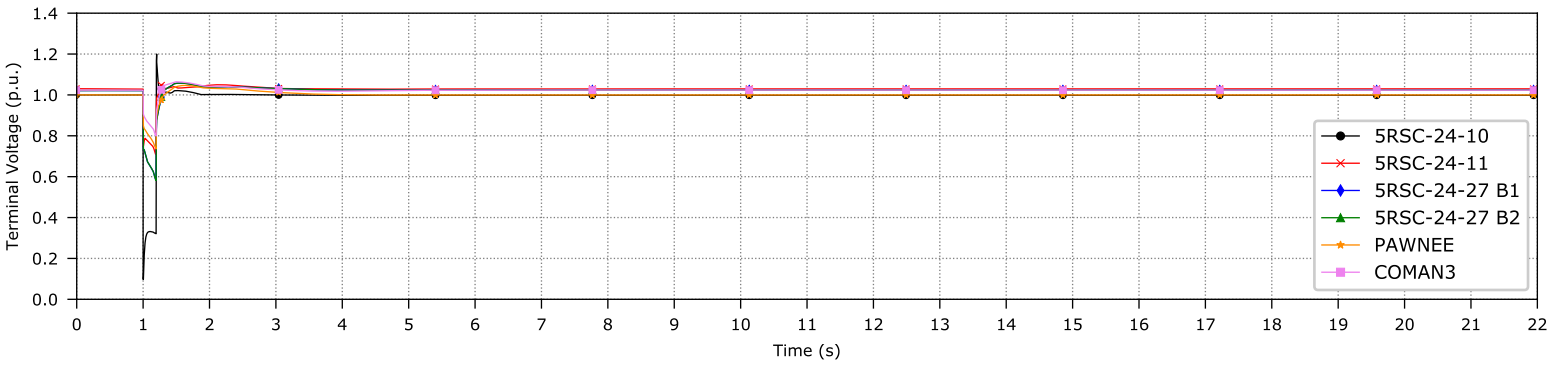
Ref. No. 19 - BF_034

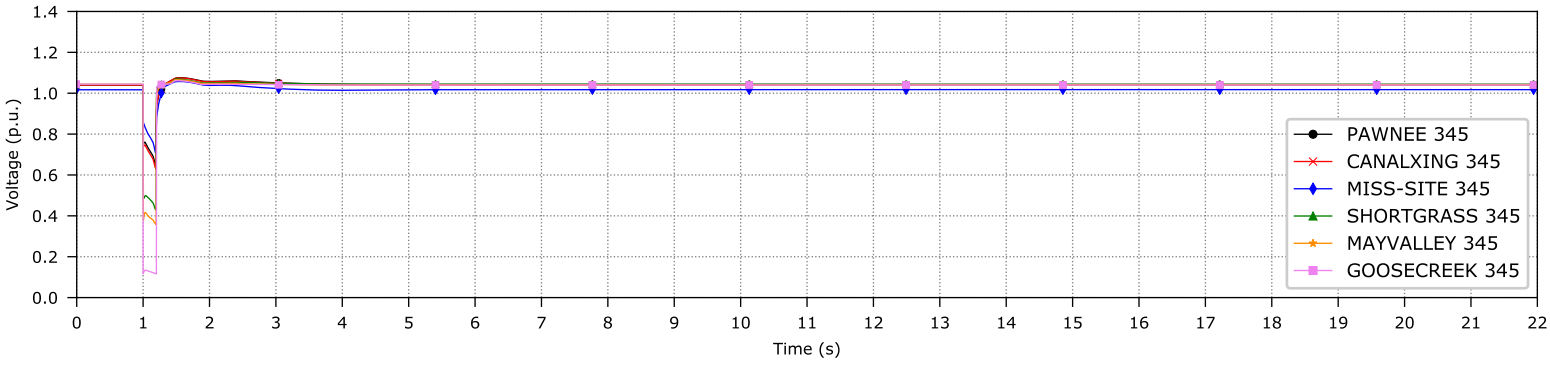




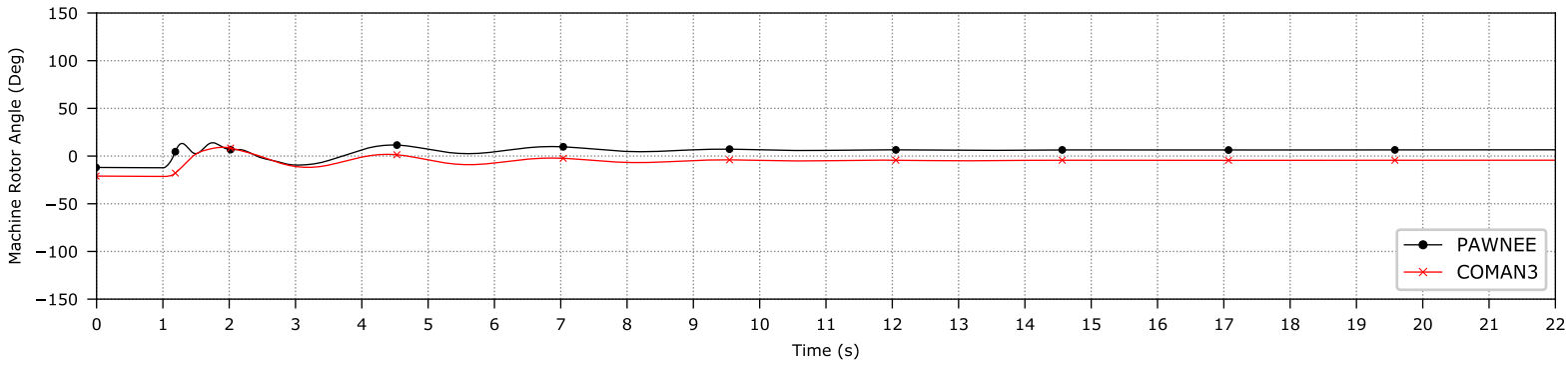


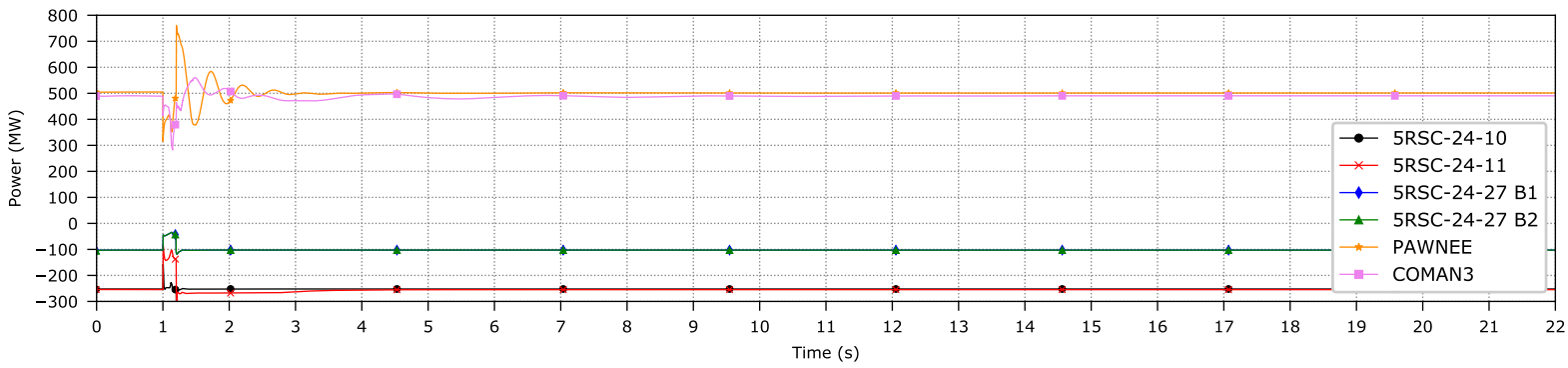


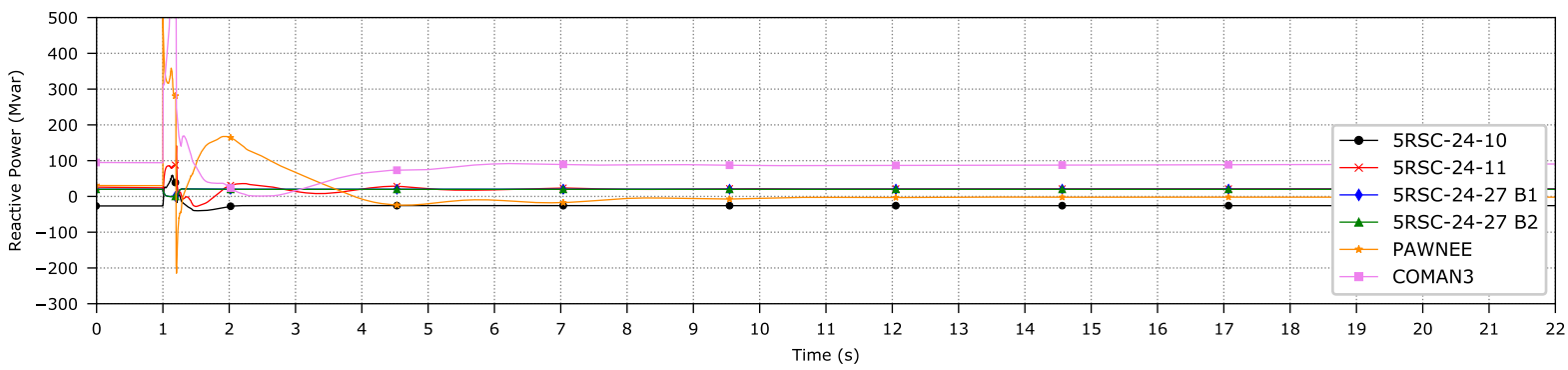


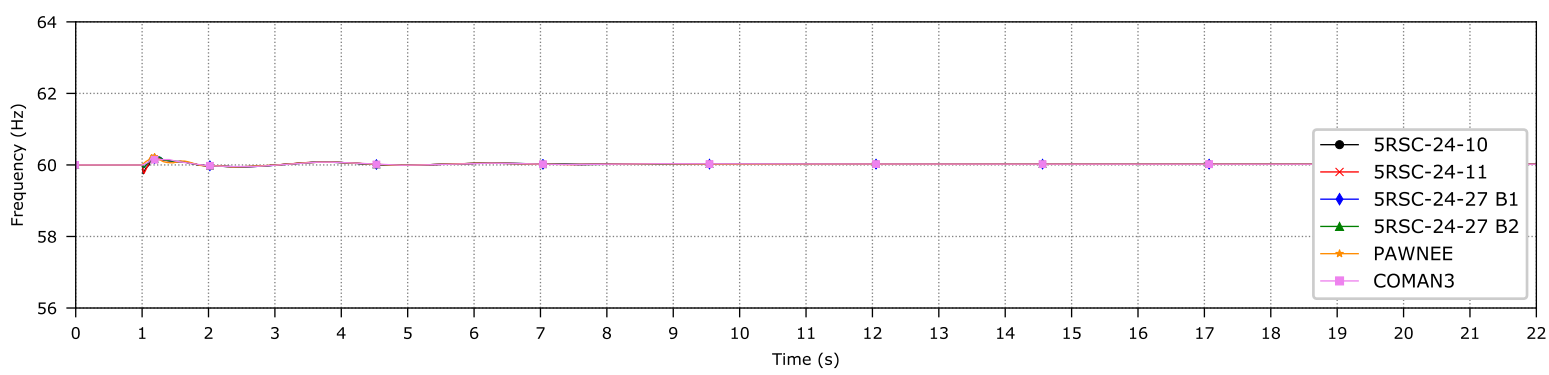


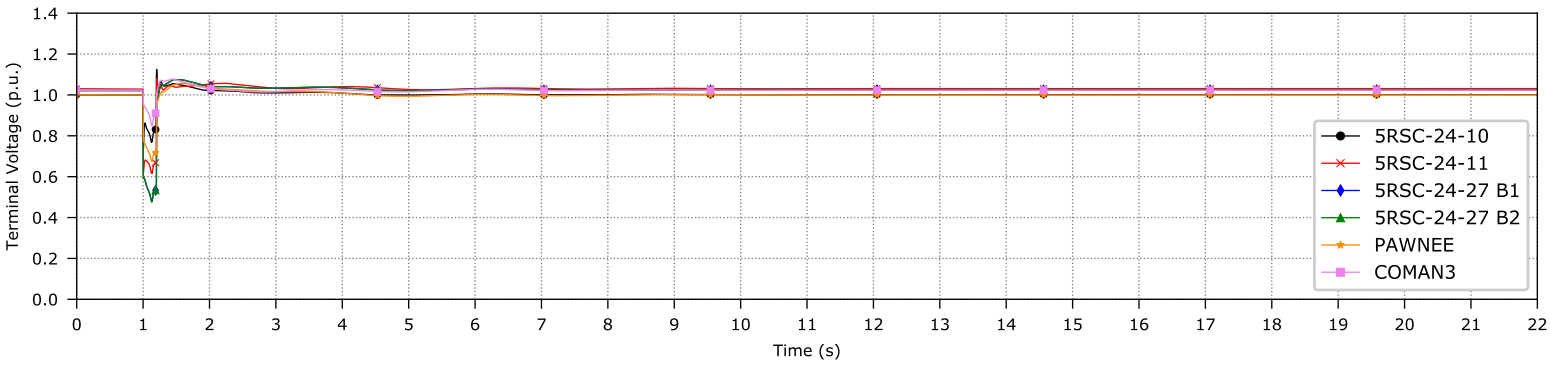
Ref. No. 20 - BF_154a

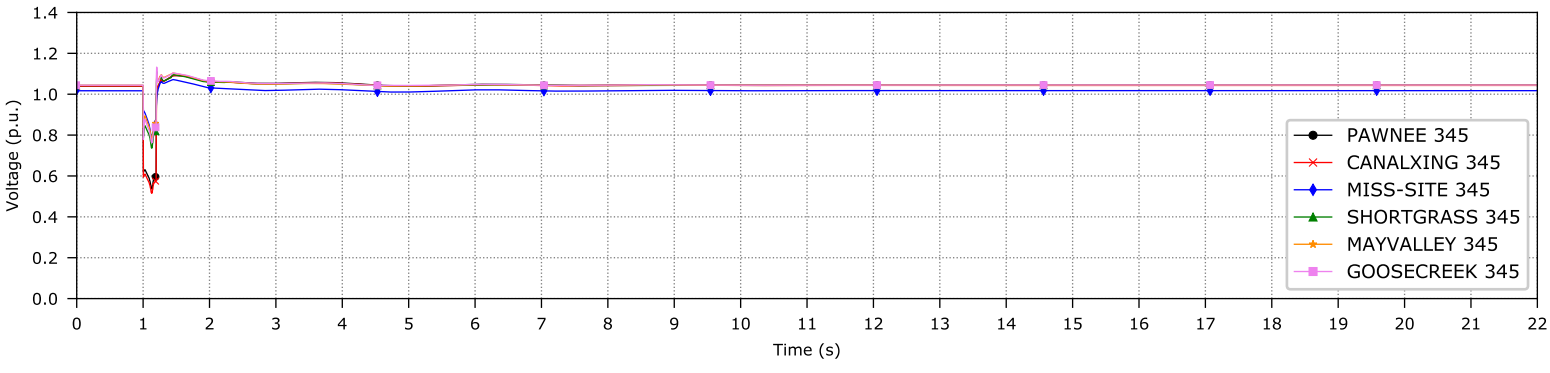




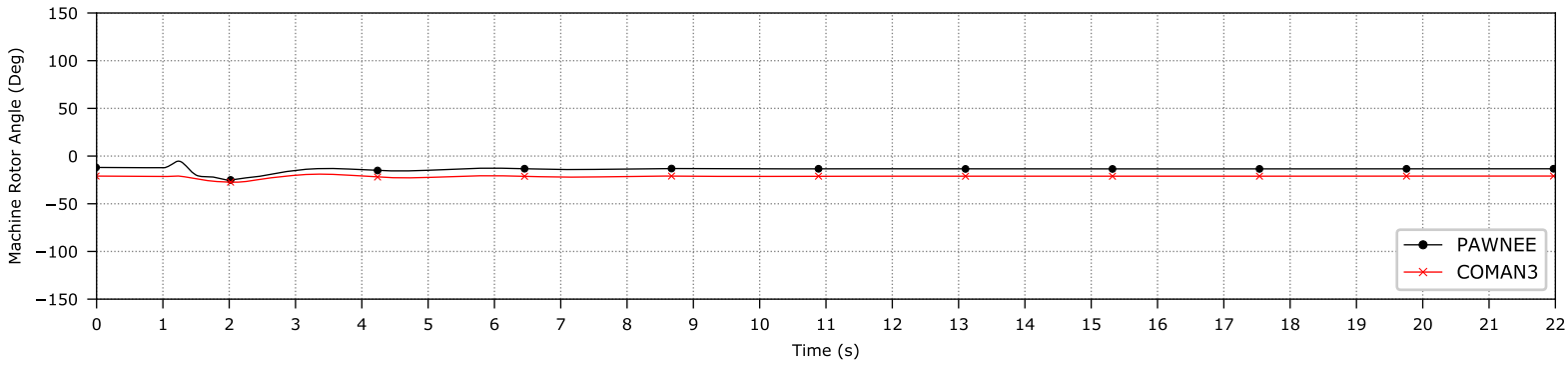


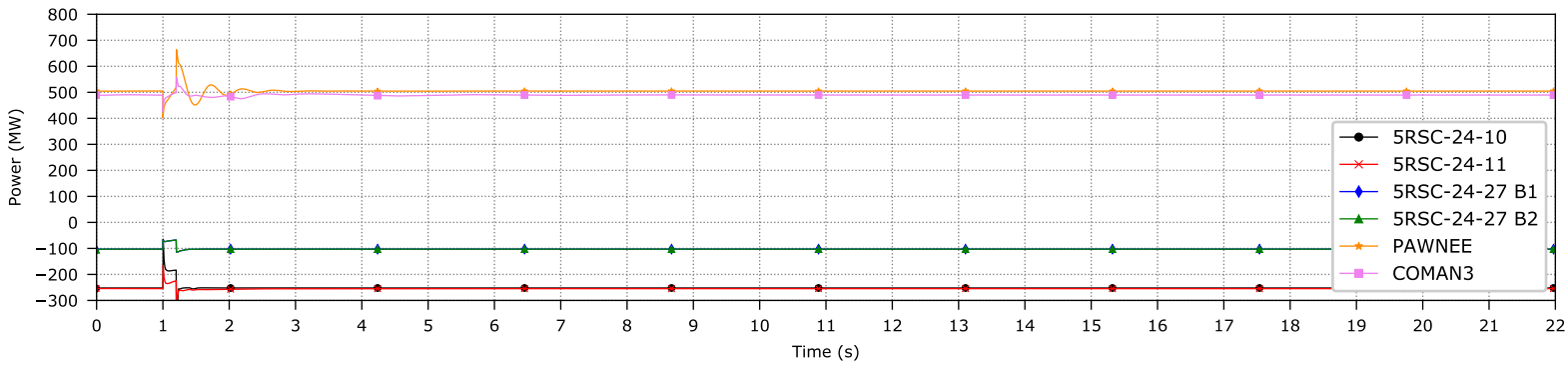


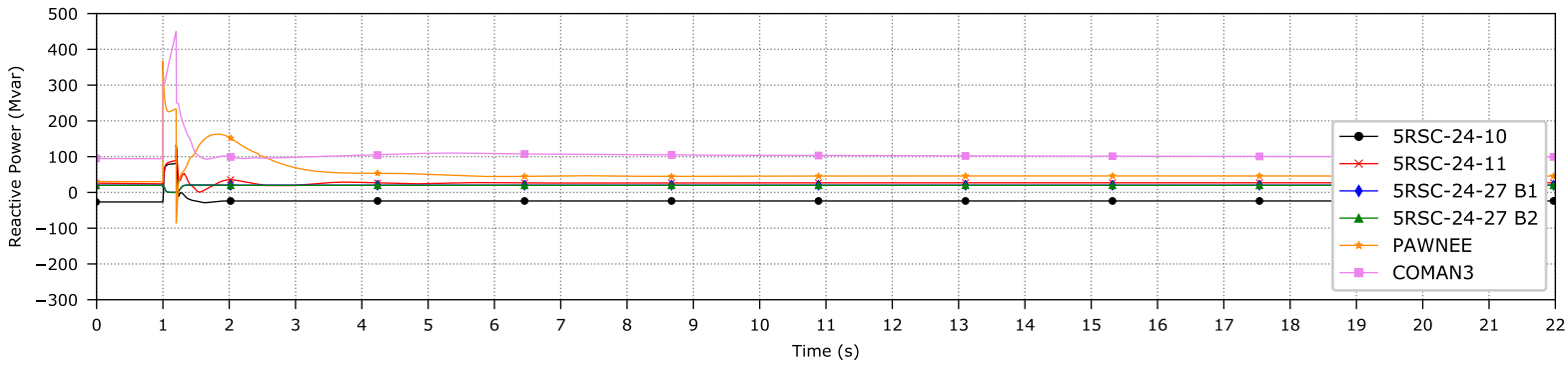


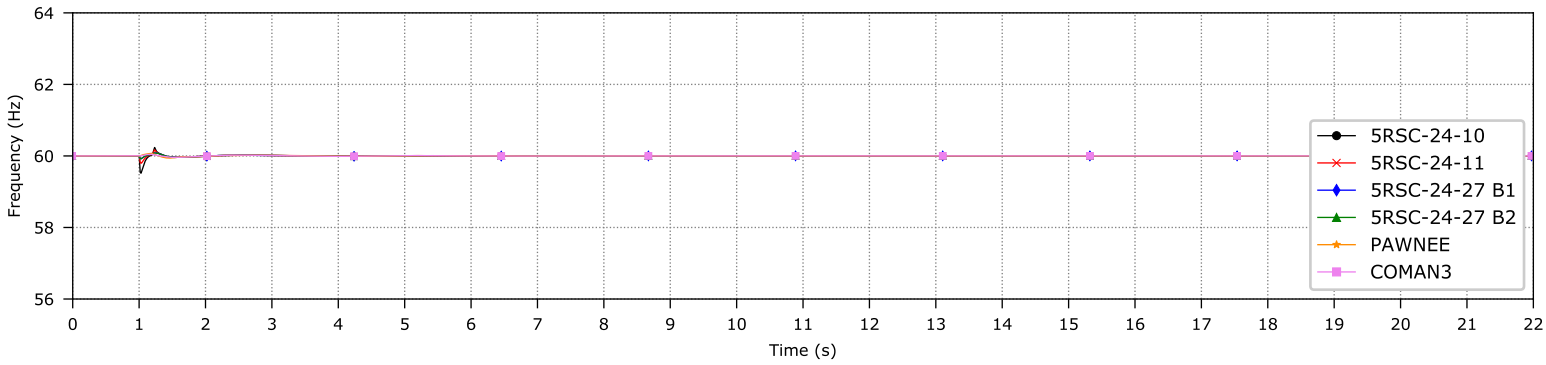


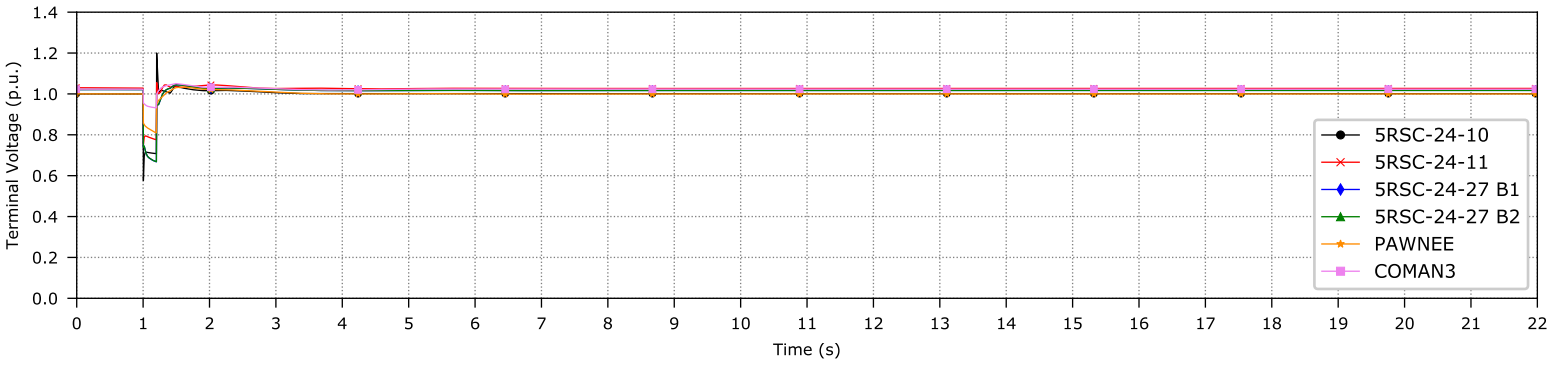
Ref. No. 21 - BF_155a

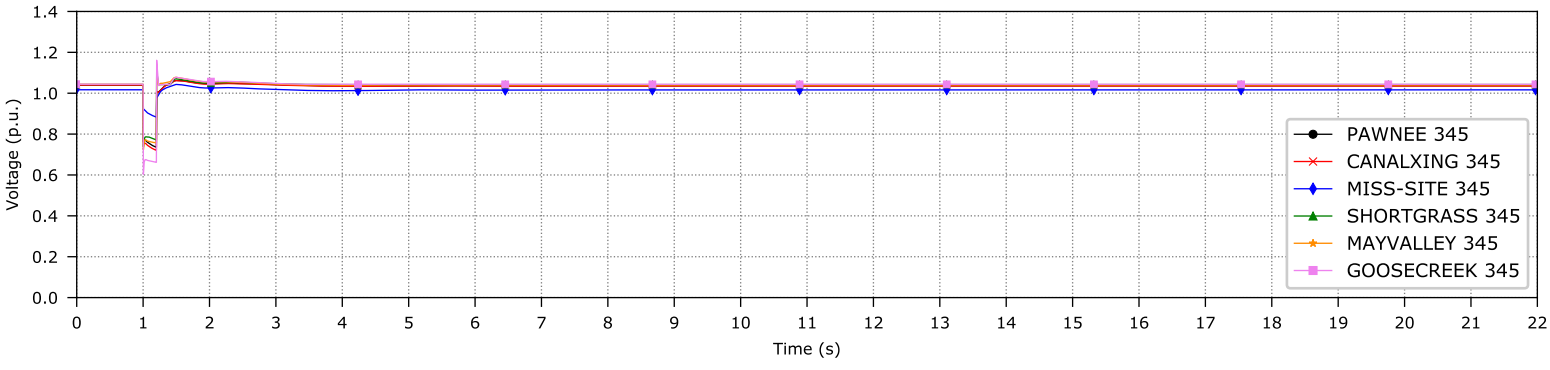




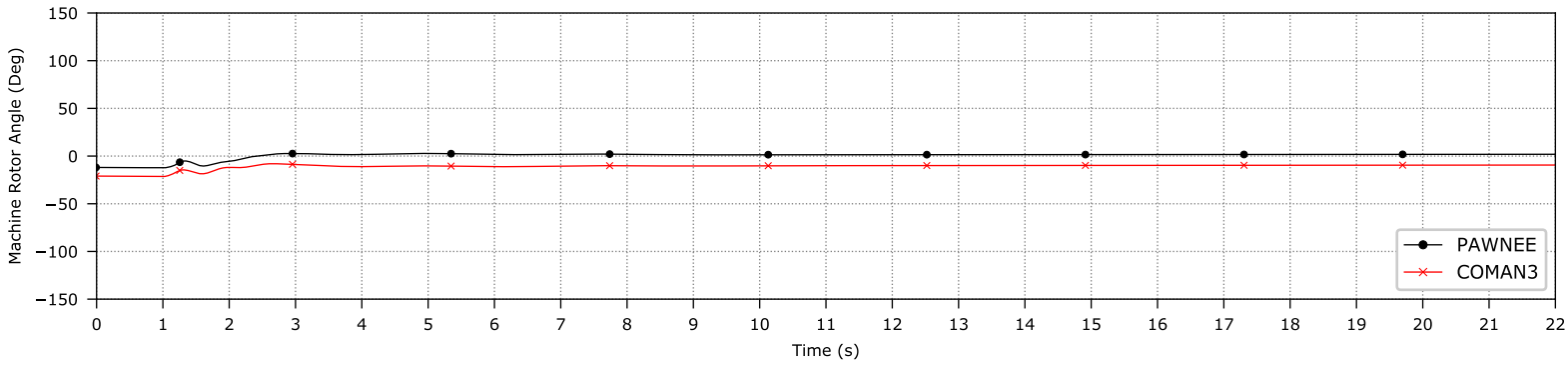


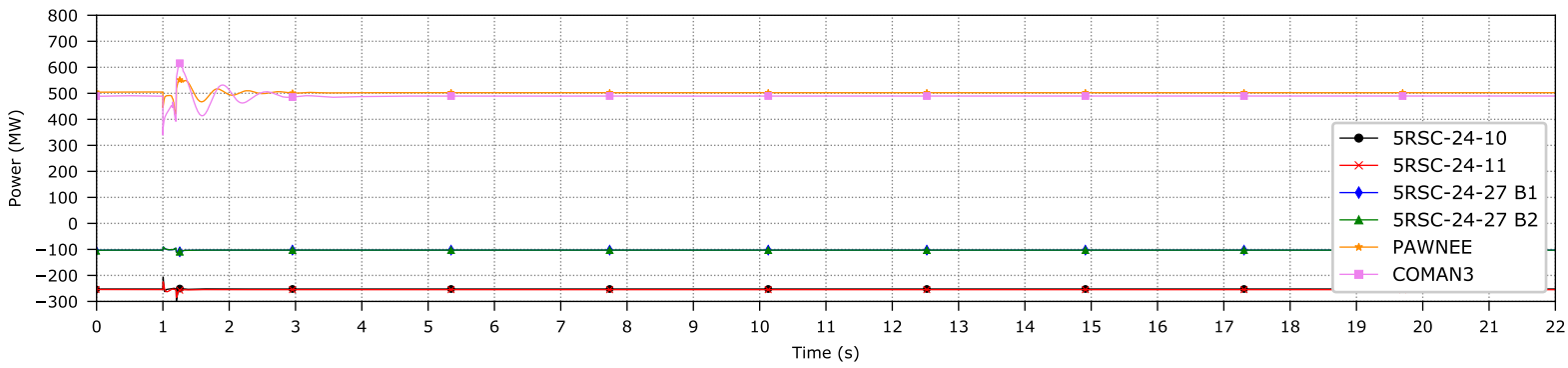


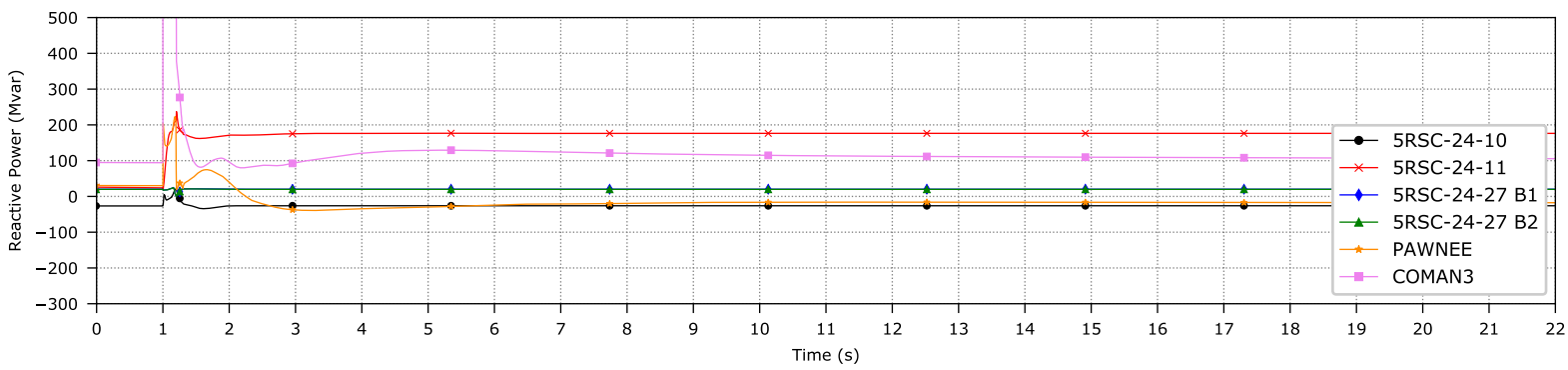


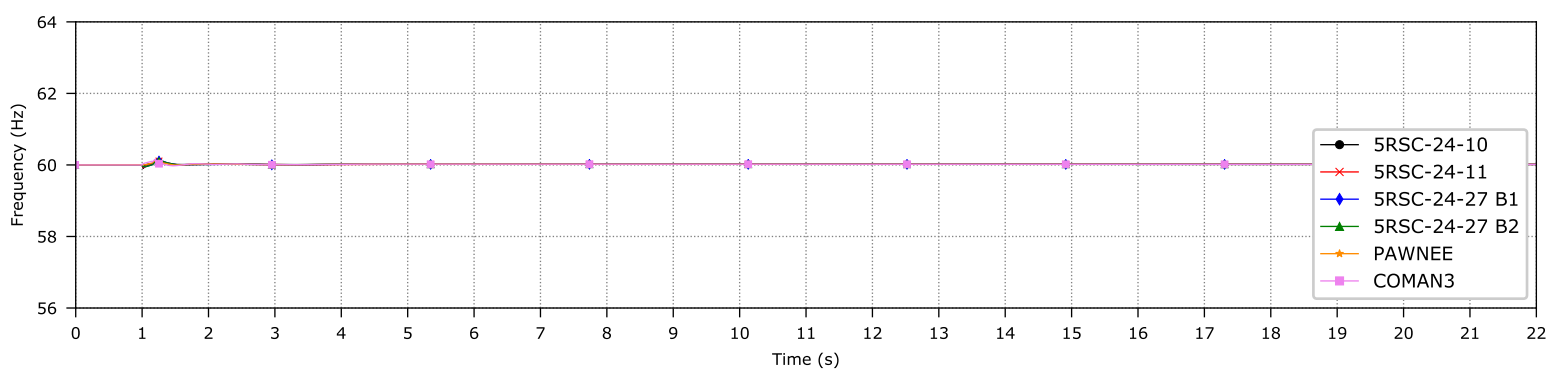


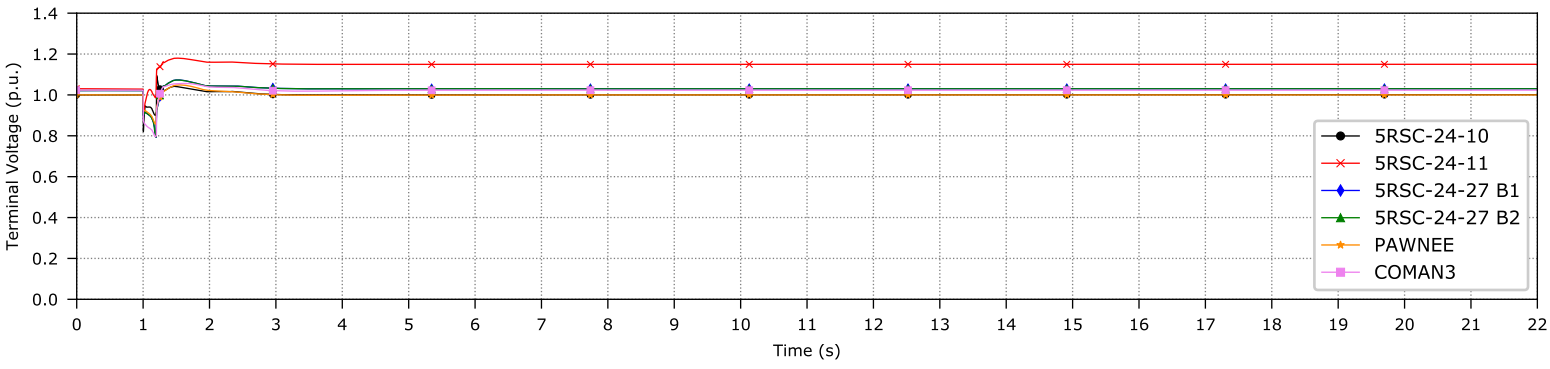
Ref. No. 22 - BF_156b

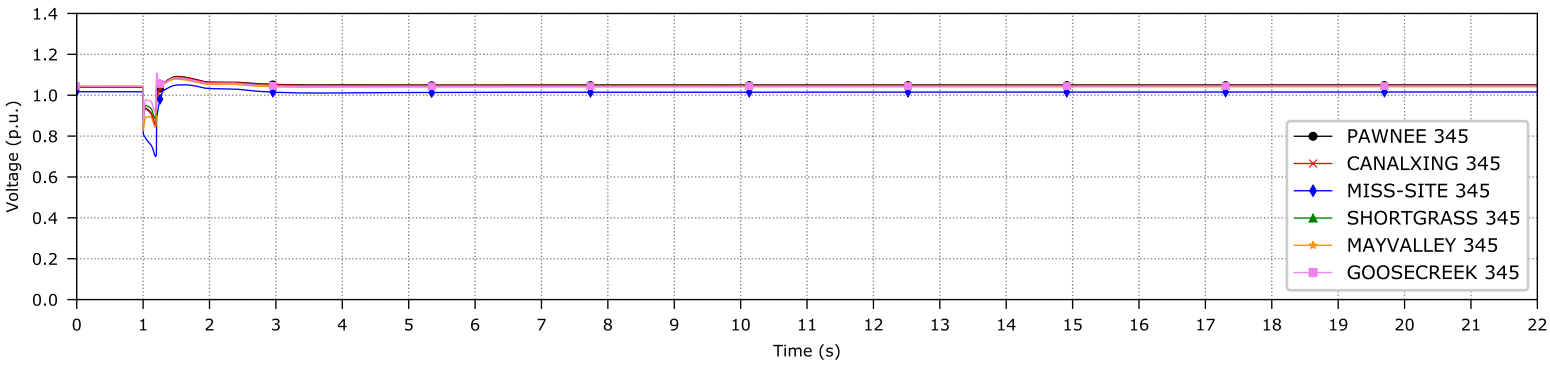




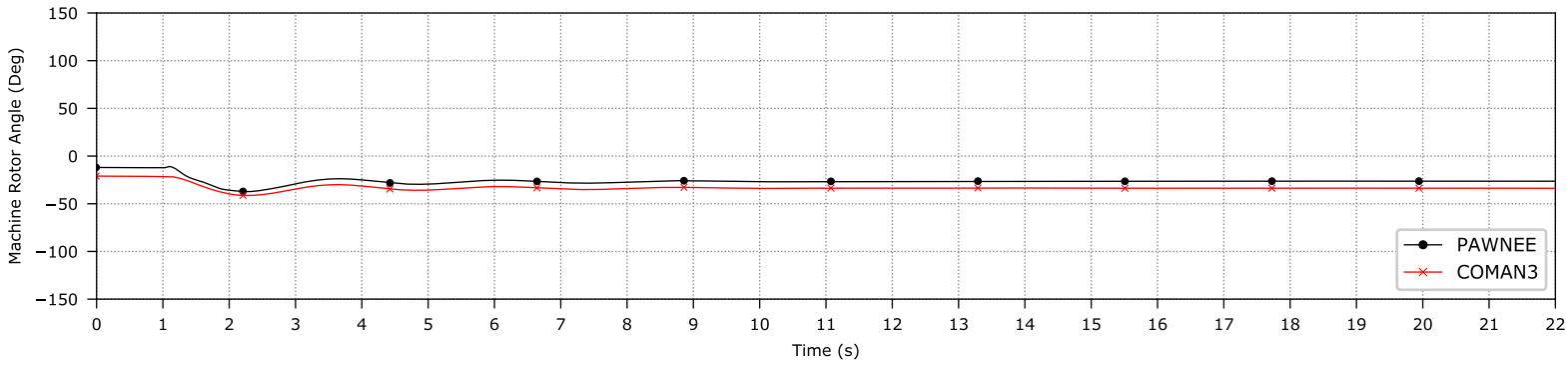


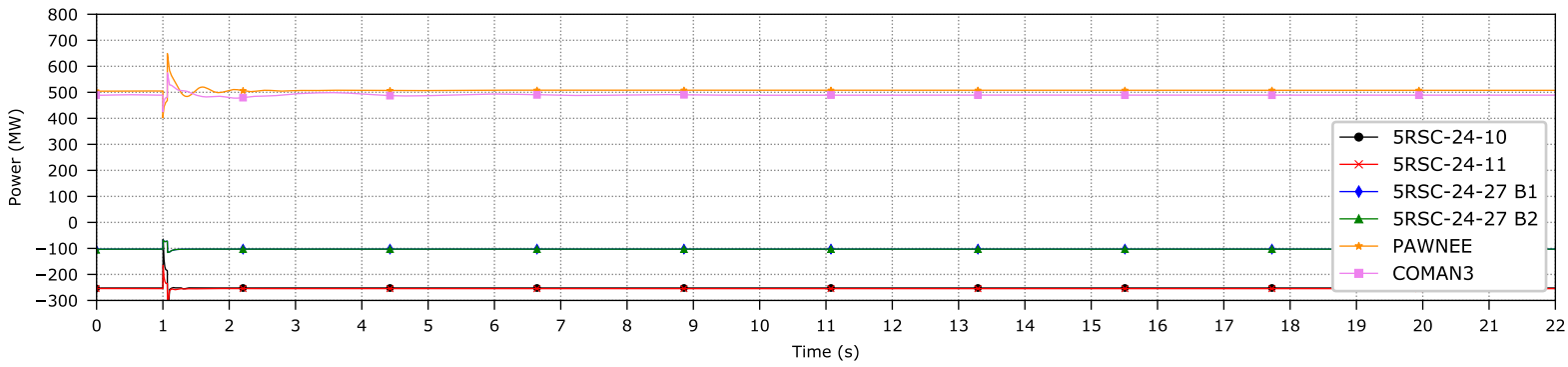


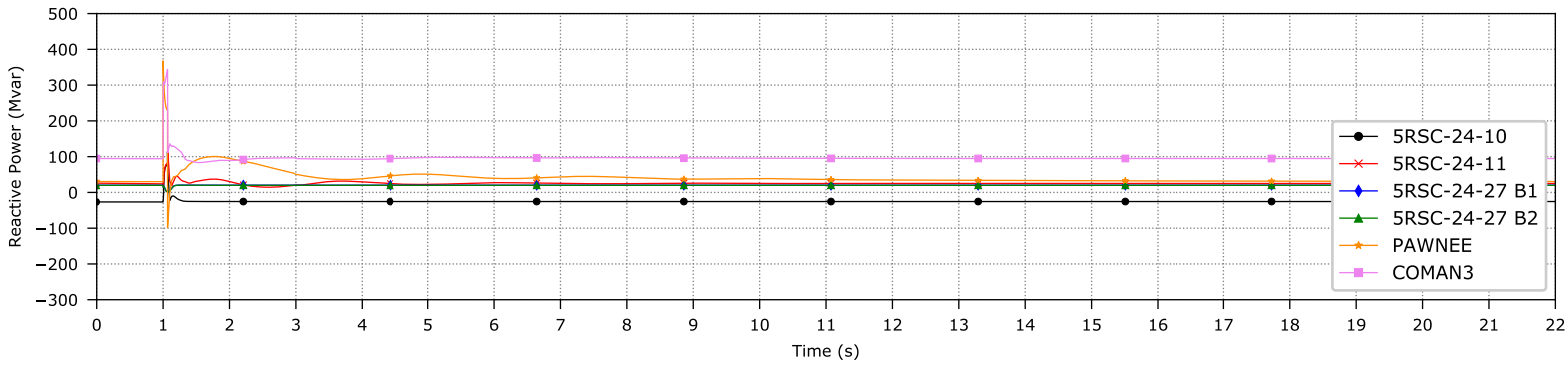


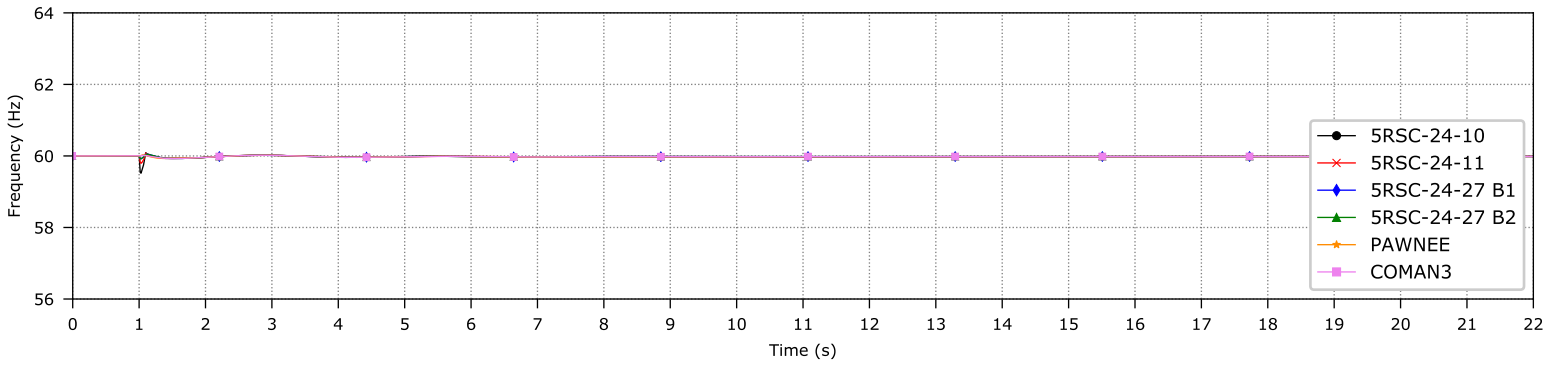


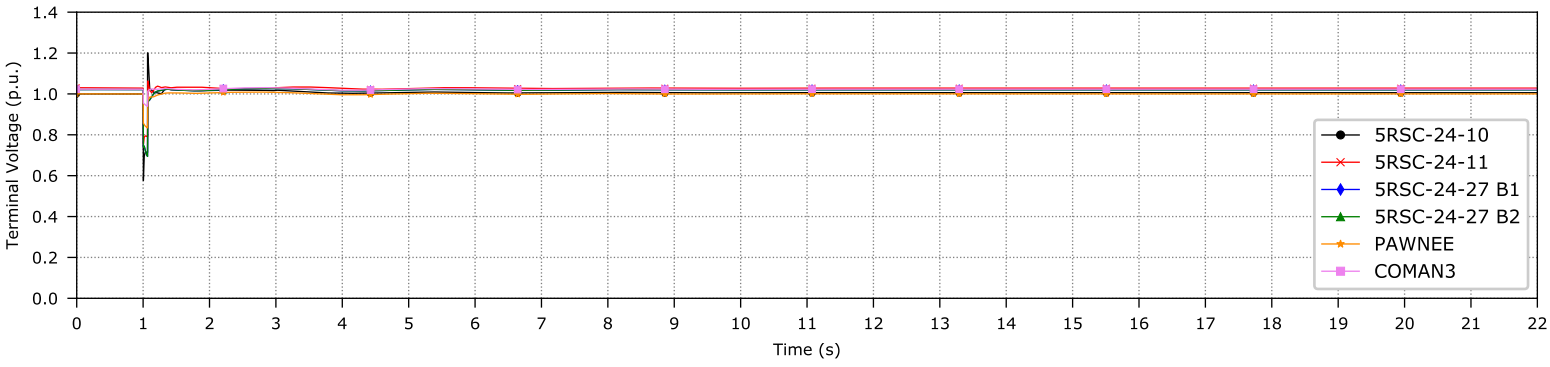
Ref. No. 23 - P7_159

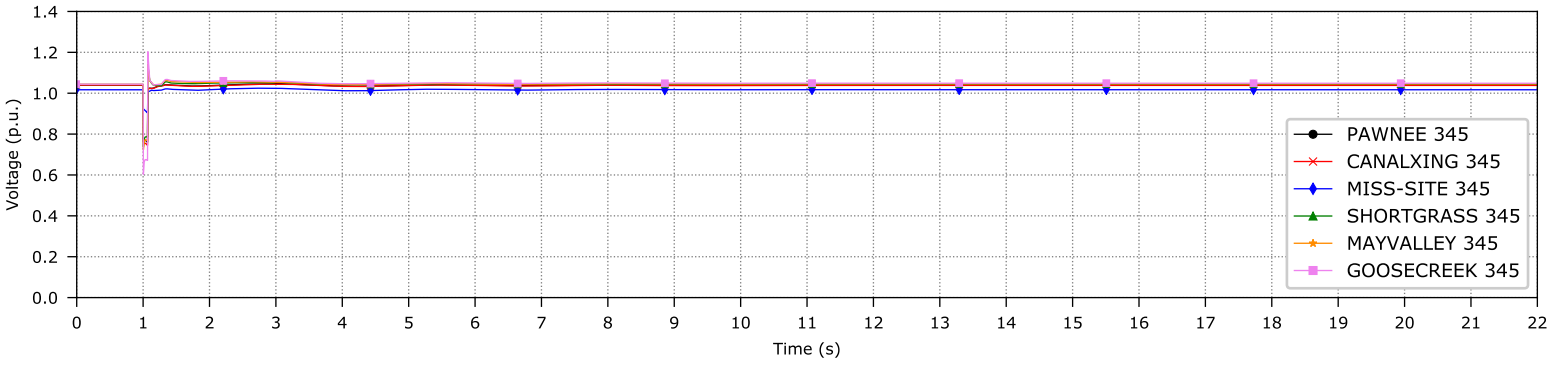




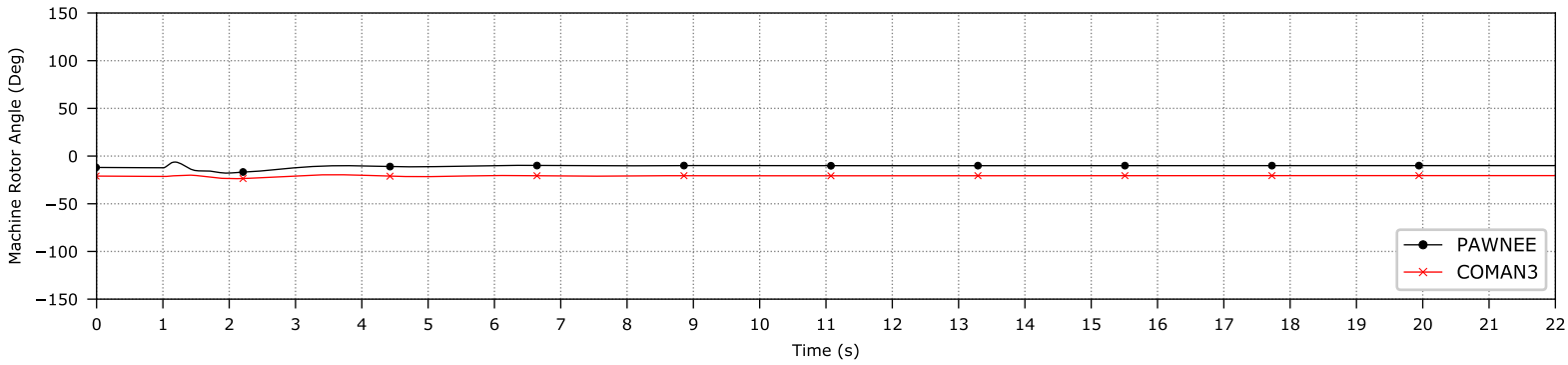


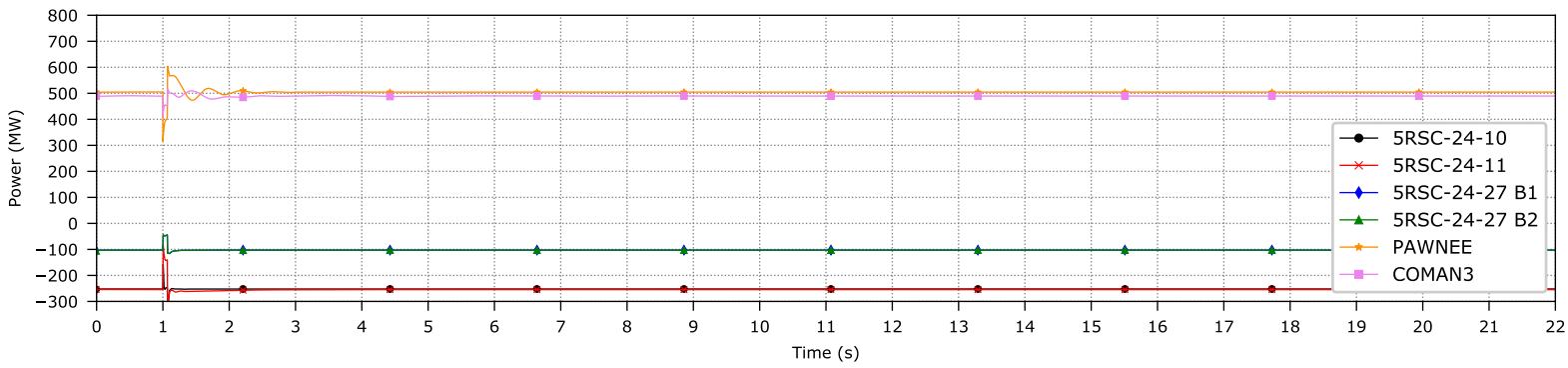


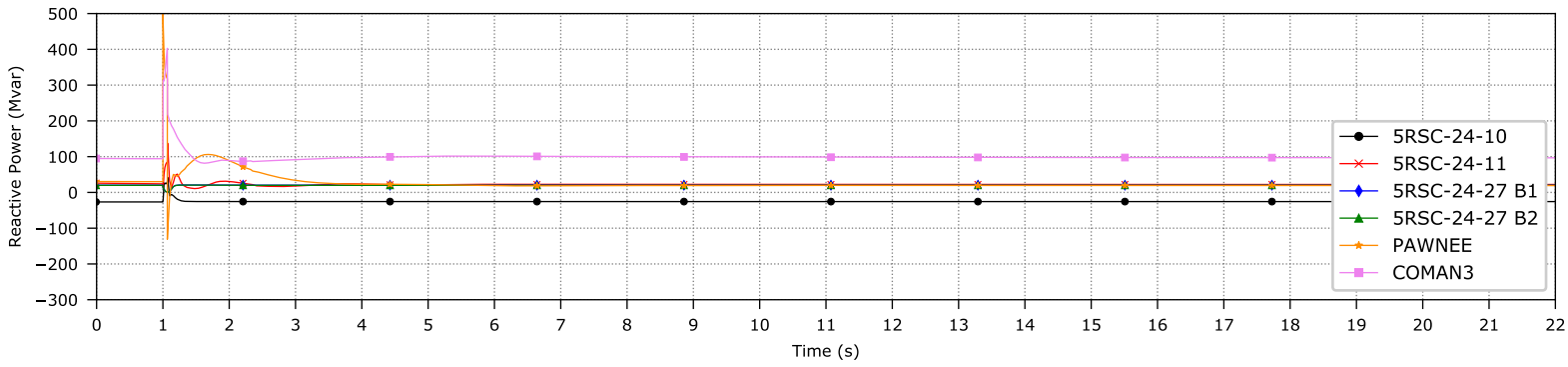


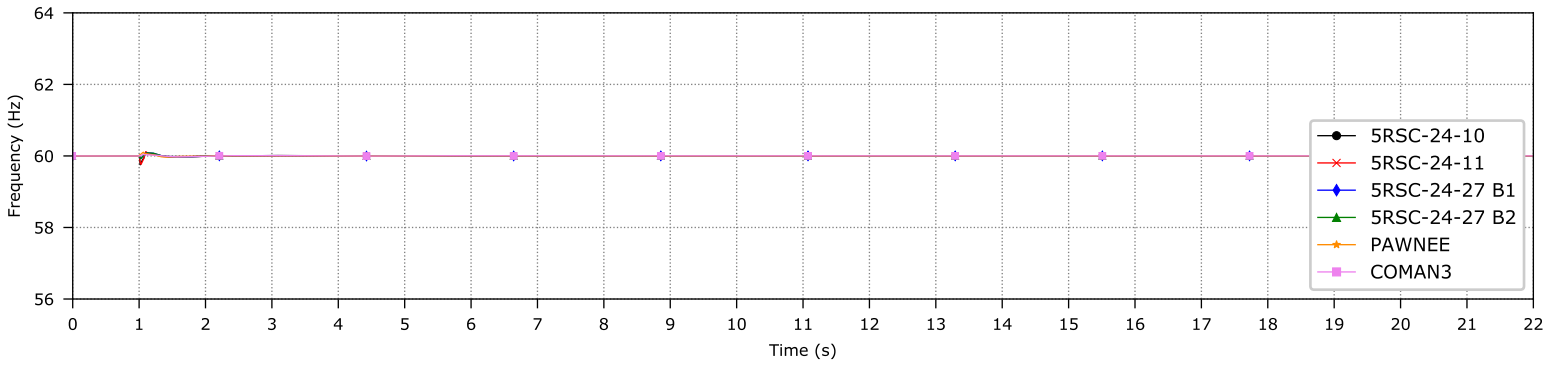


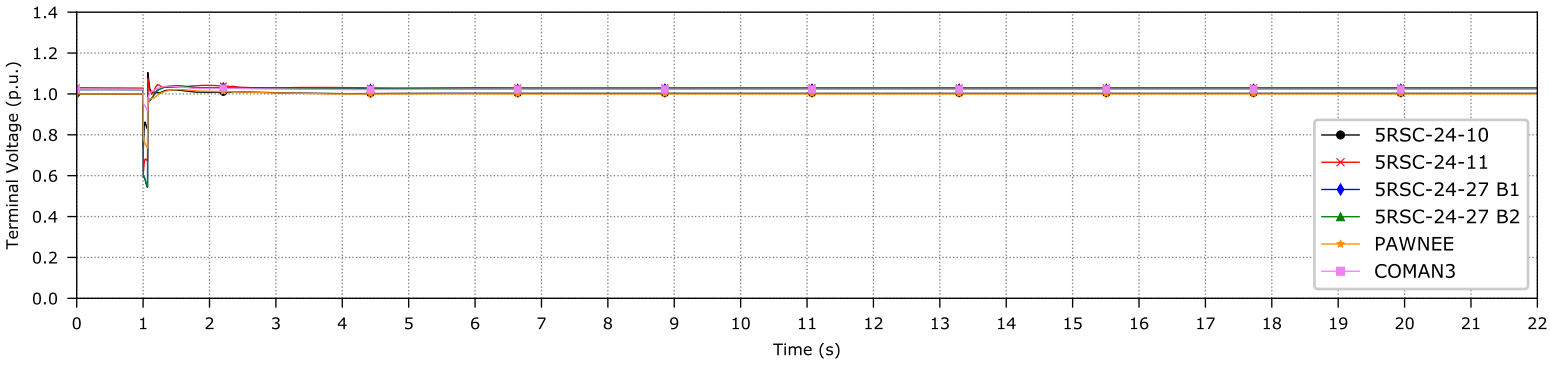
Ref. No. 24 - P7_160

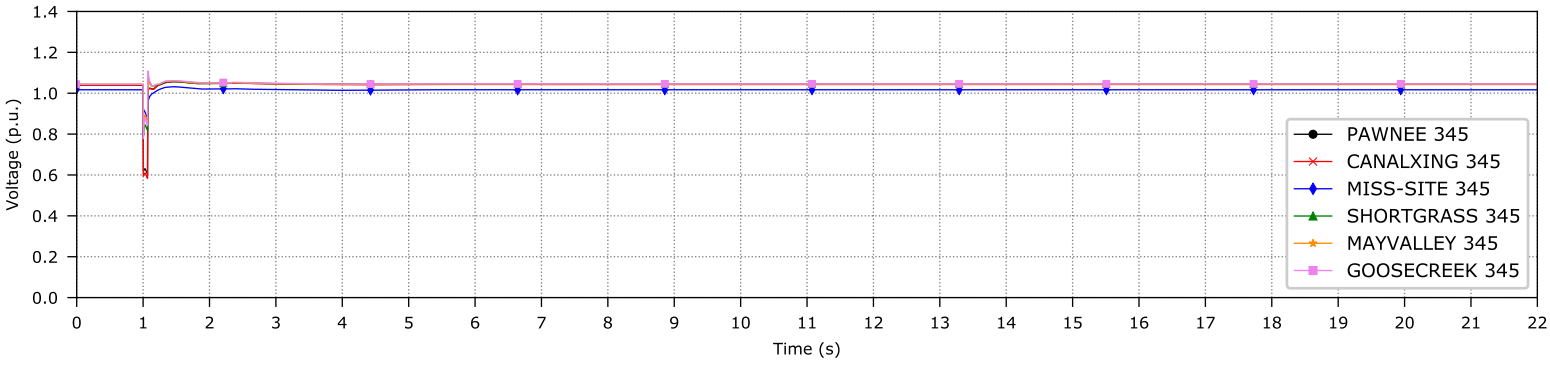




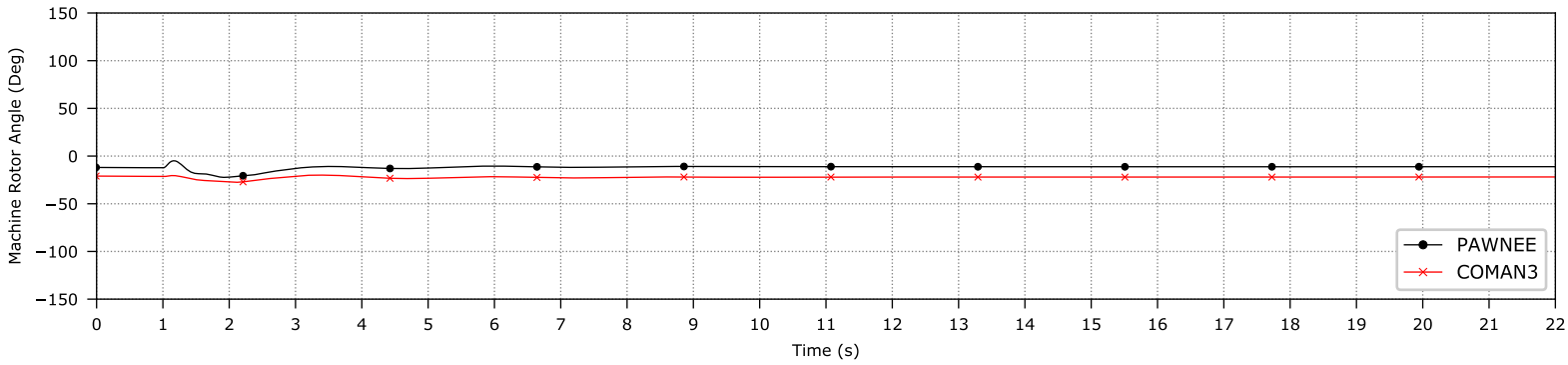


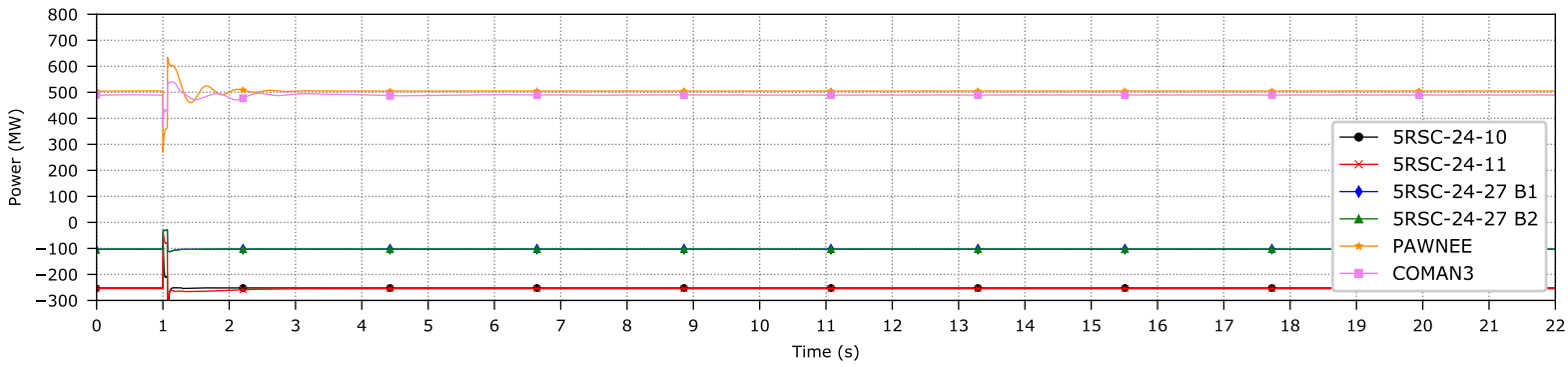


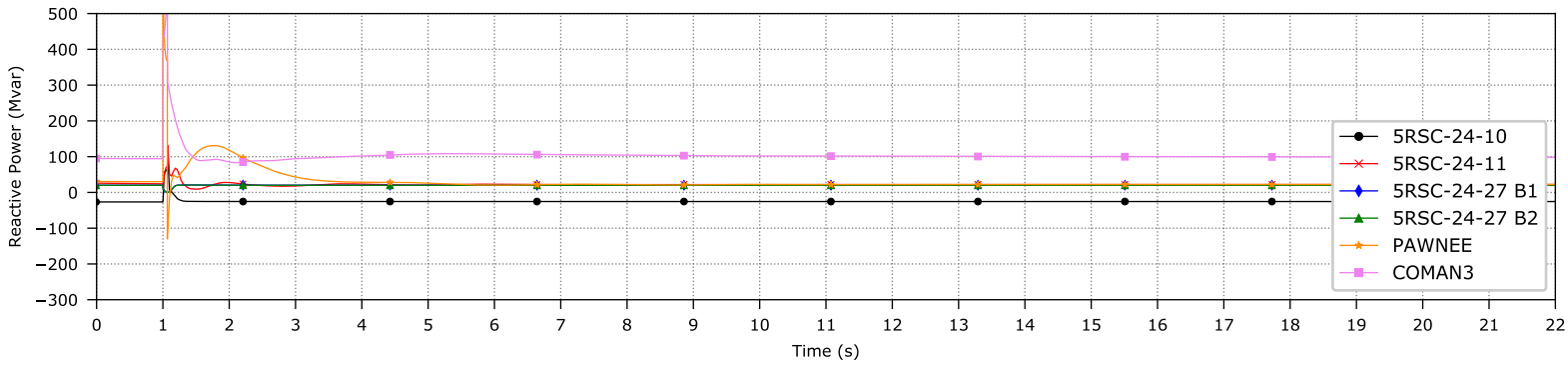


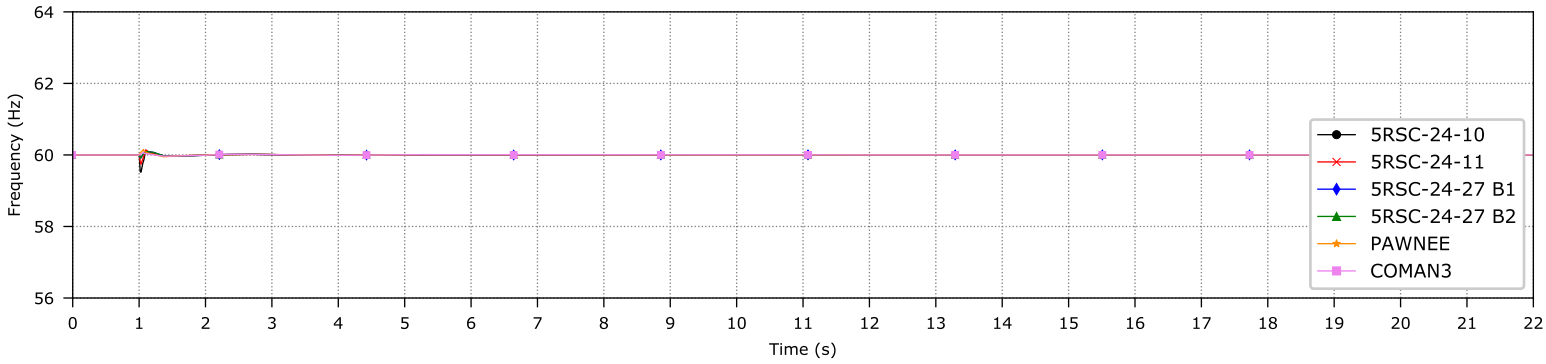


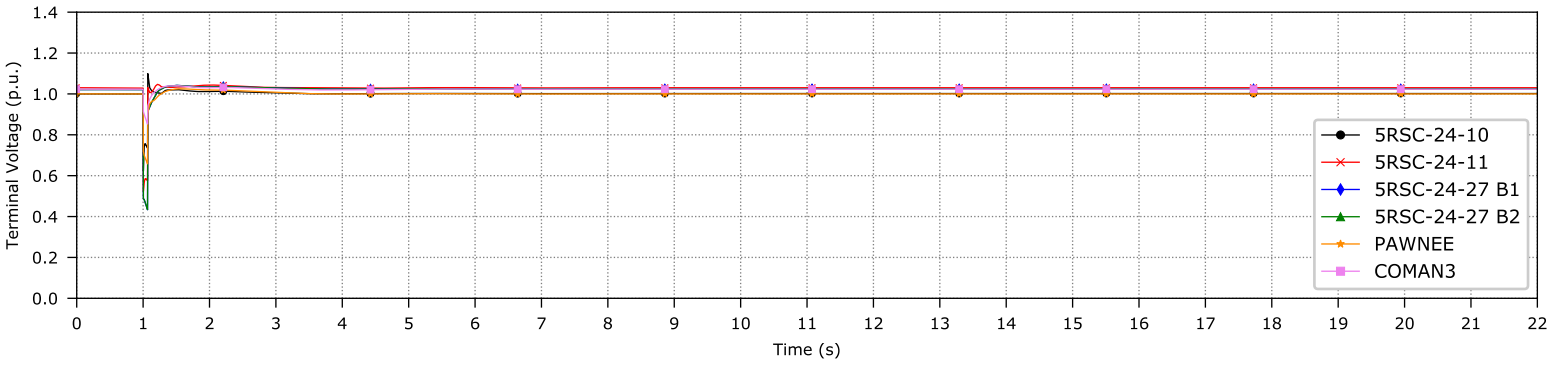
Ref. No. 25 - P7_161

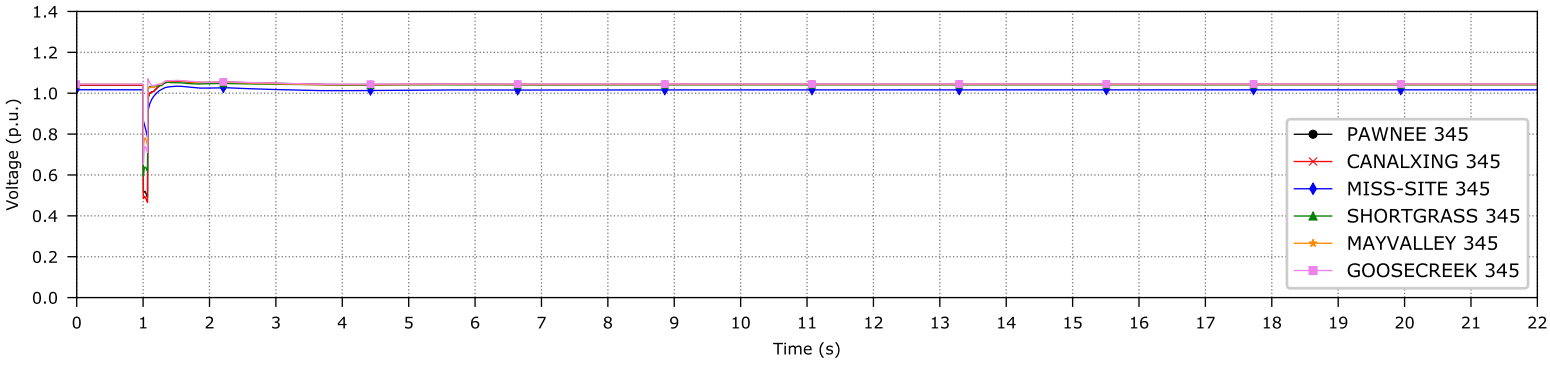




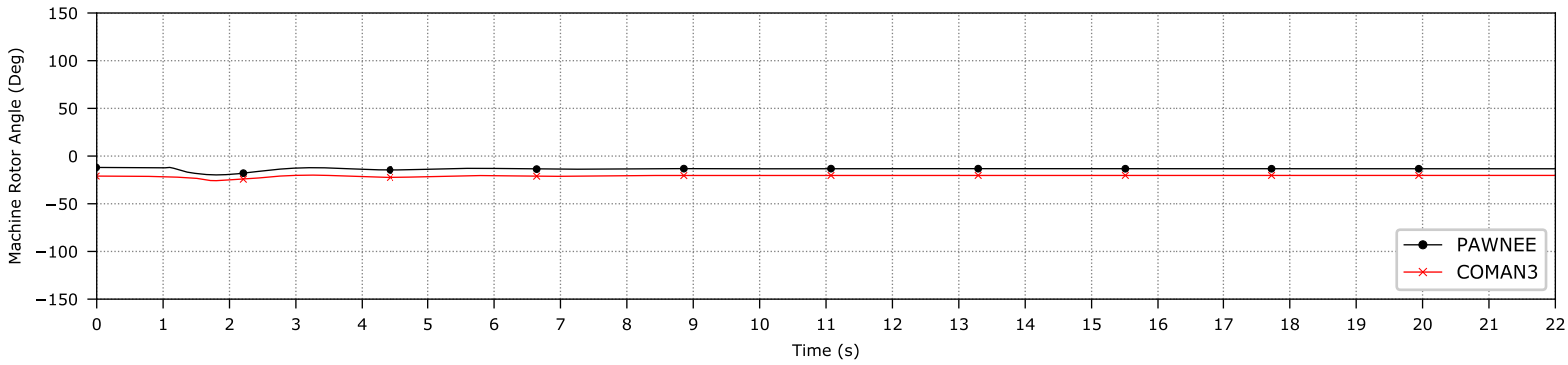


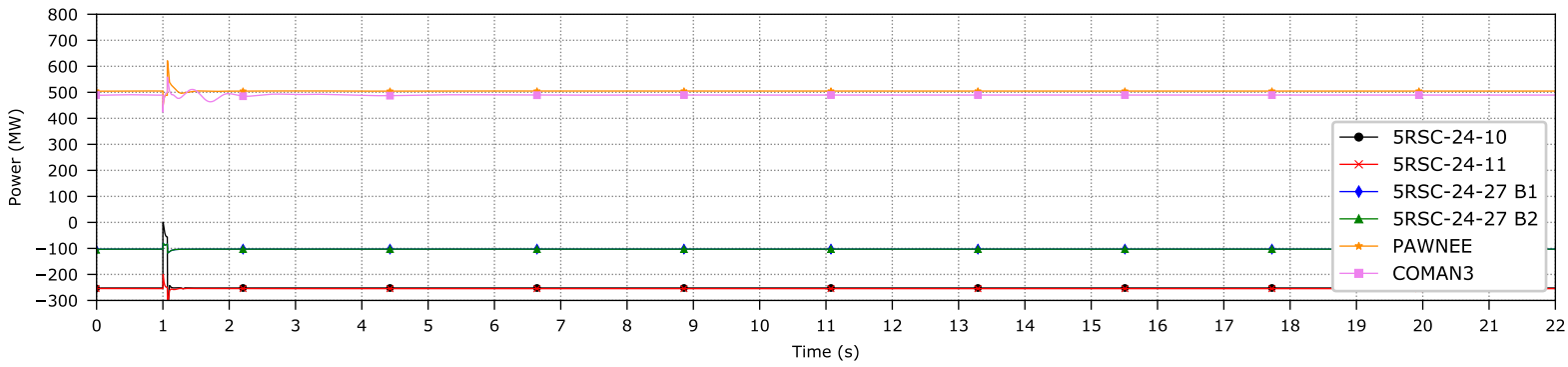


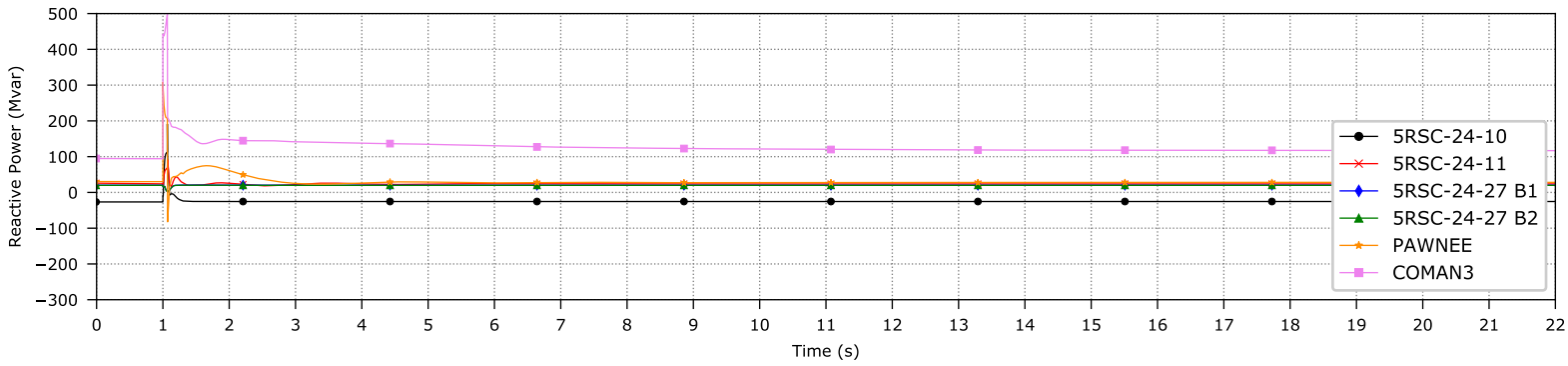


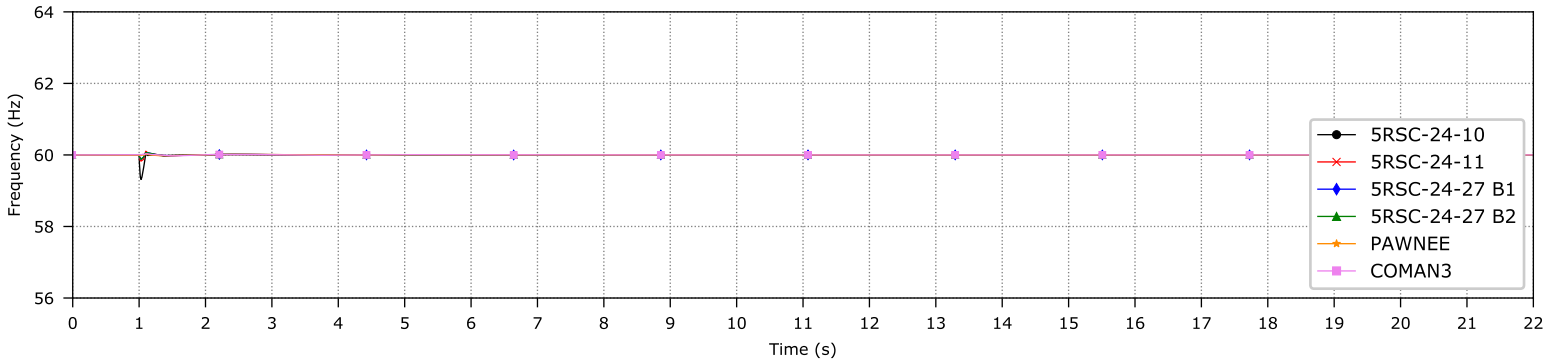


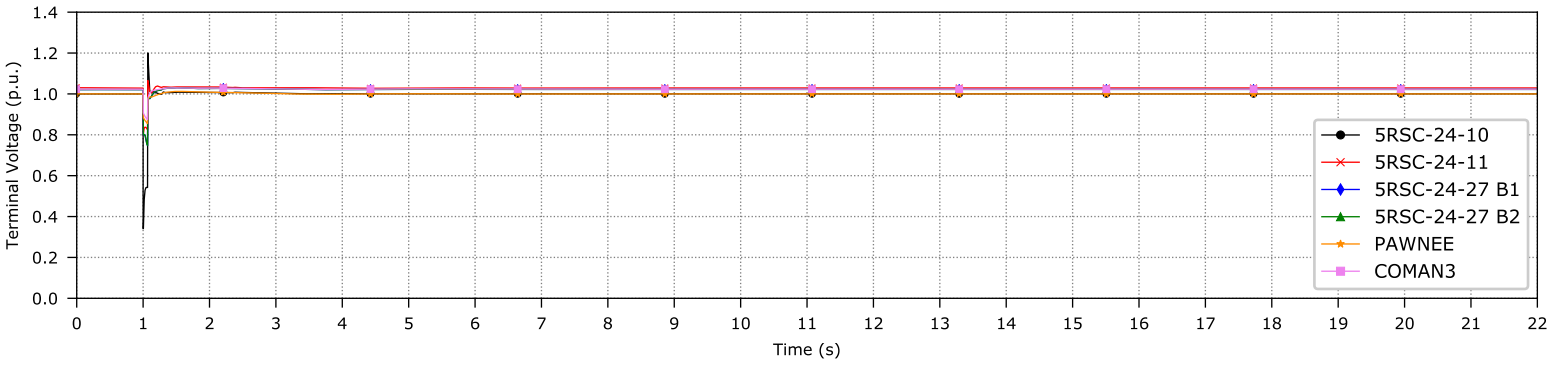
Ref. No. 26 - P7_162

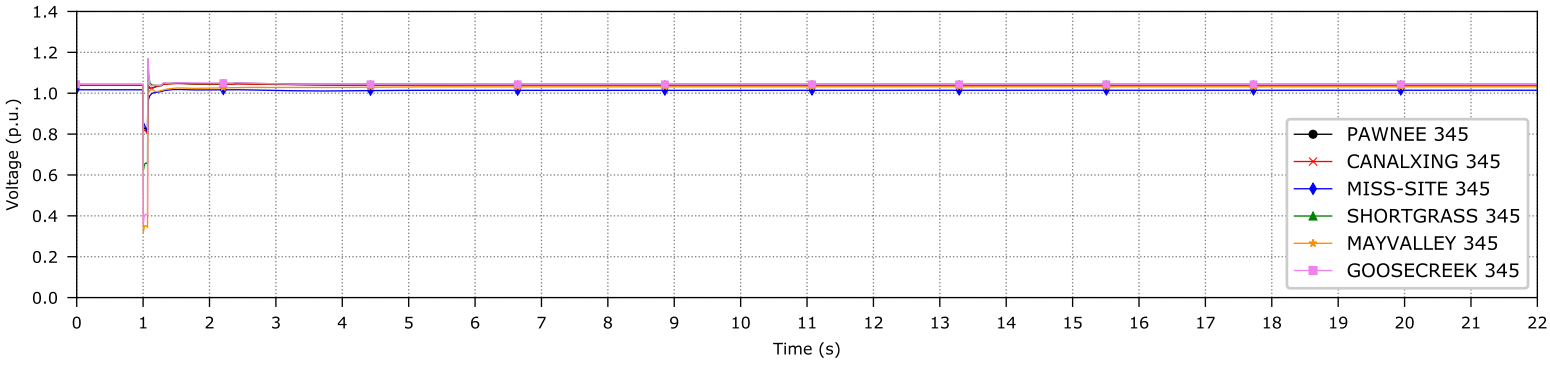






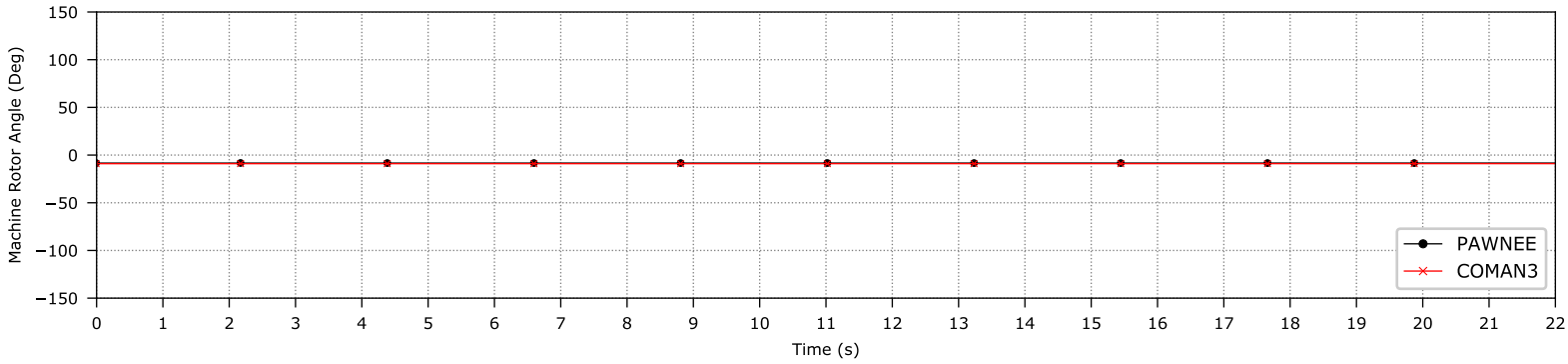


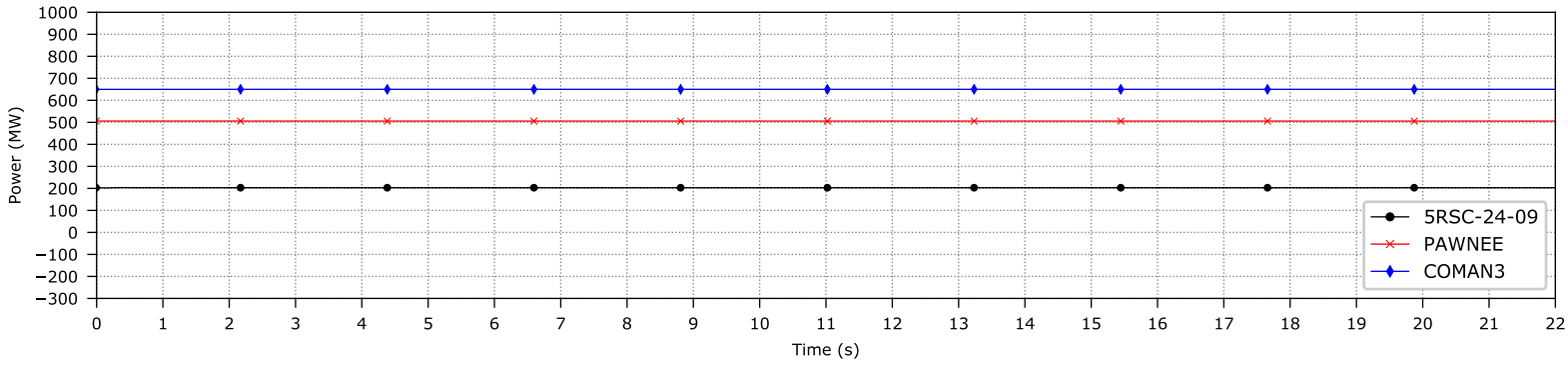


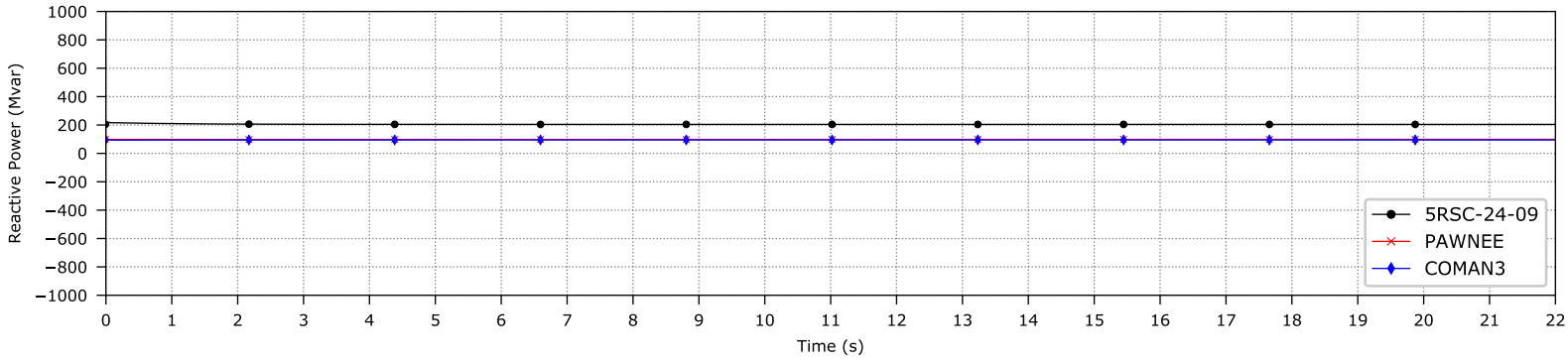


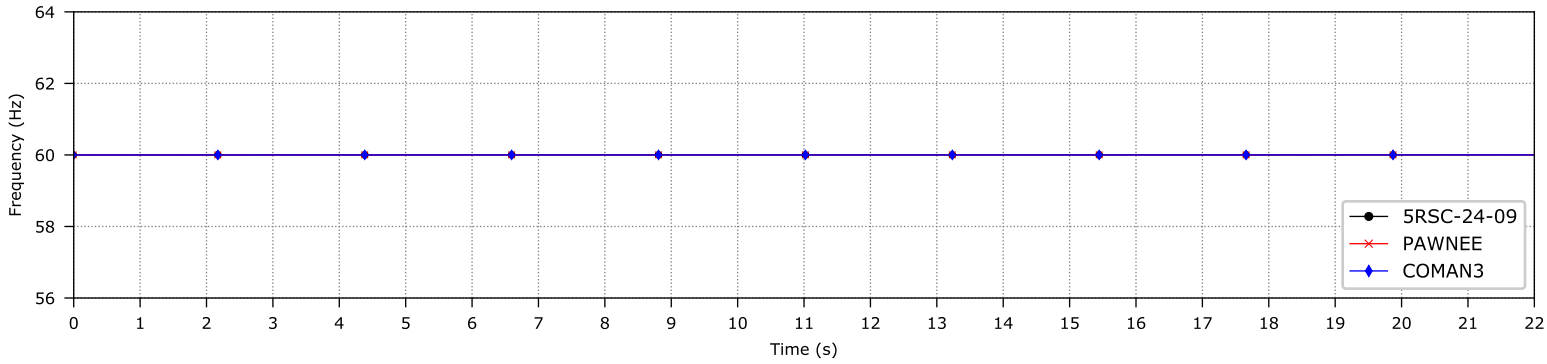
2028 WESTERN SLOPE – TRANSIENT STABILITY PLOTS

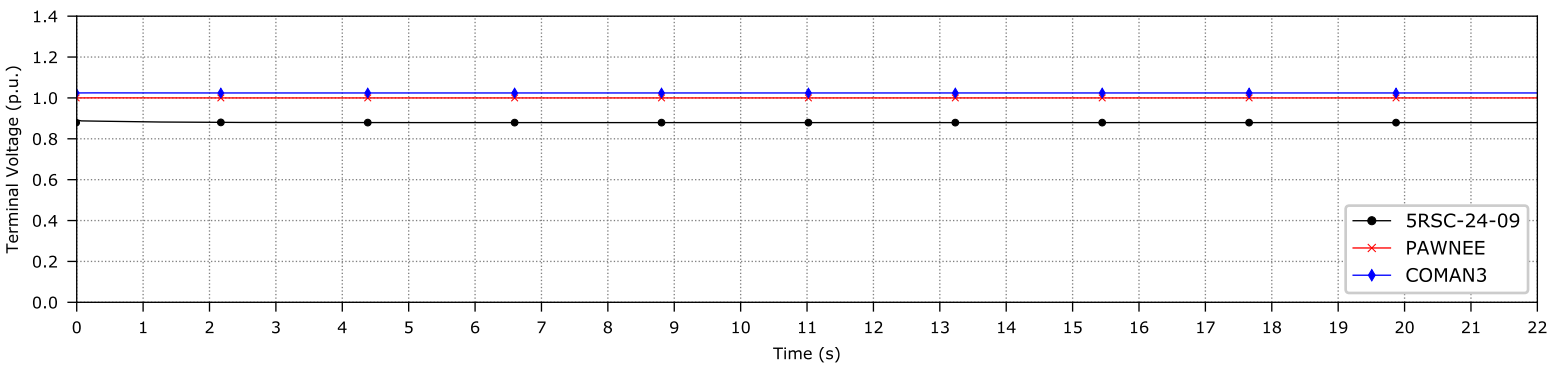
Ref. No. 01 - Flatrun

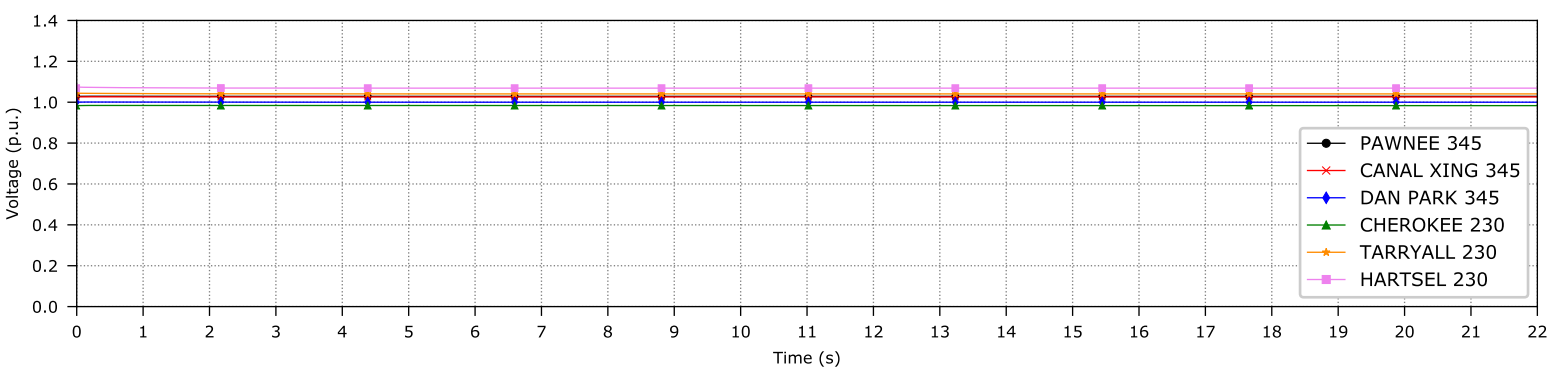


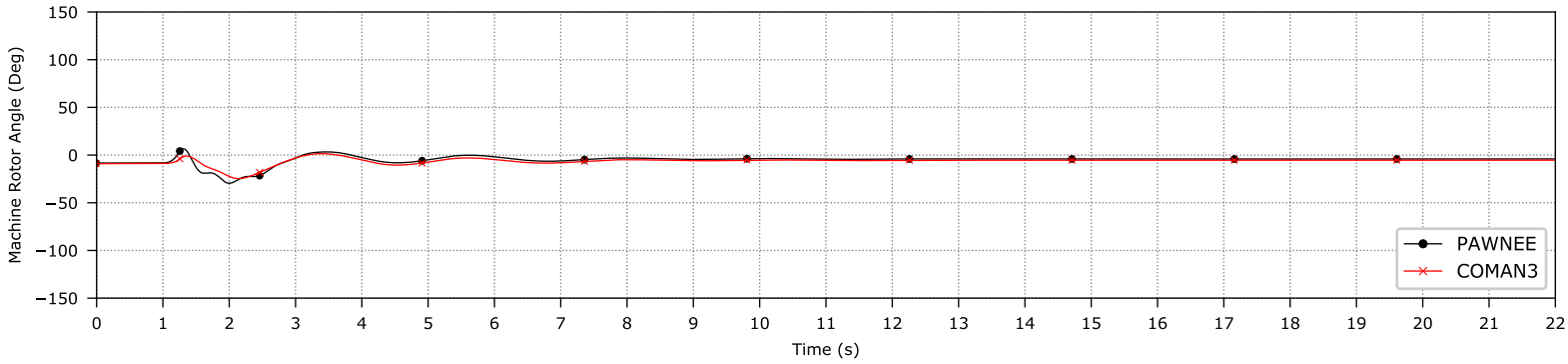


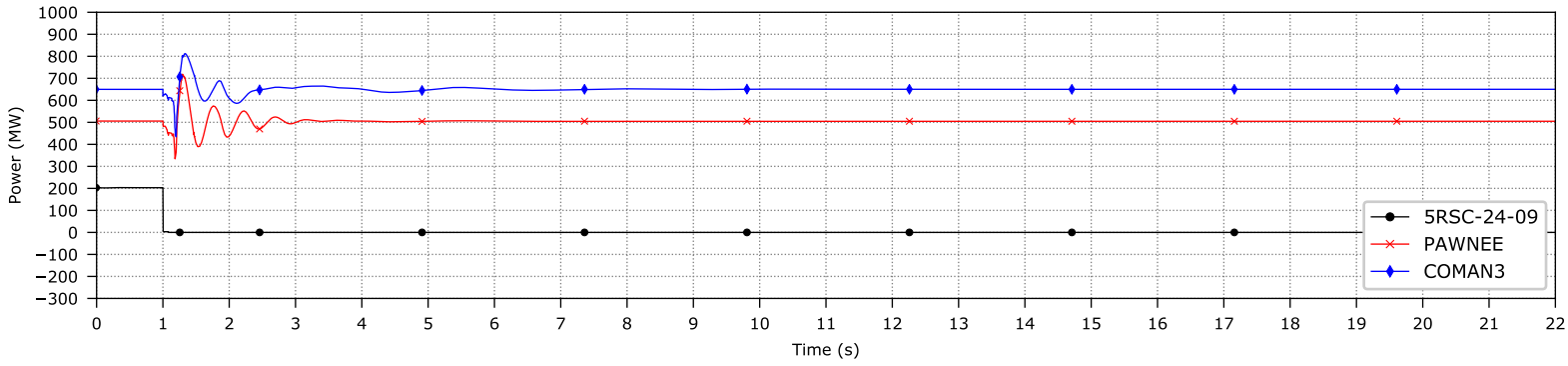


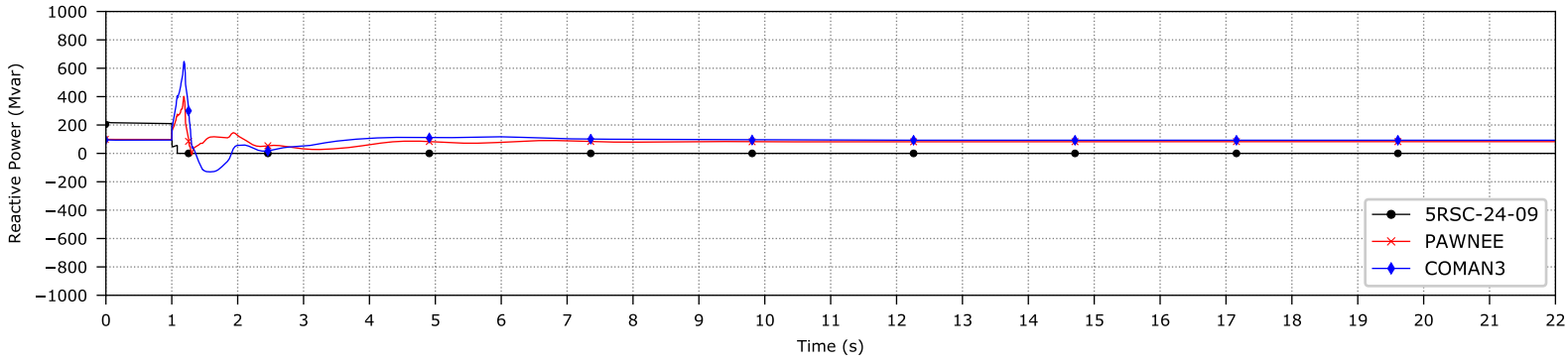


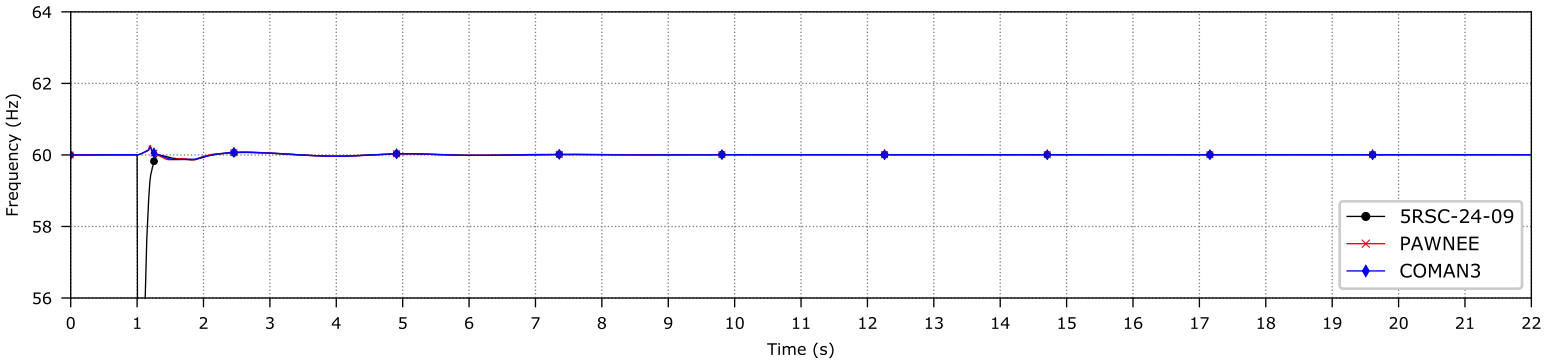


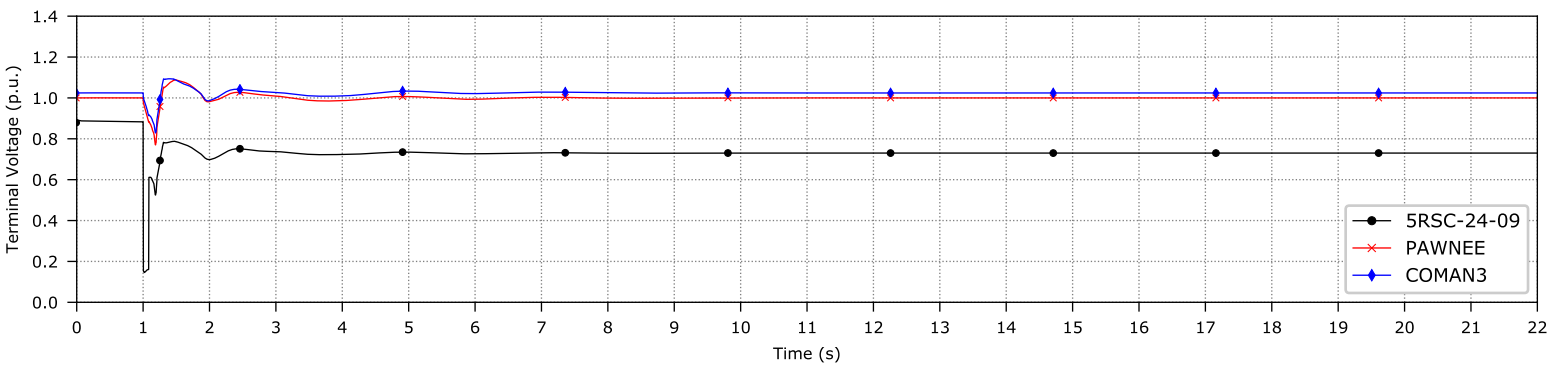


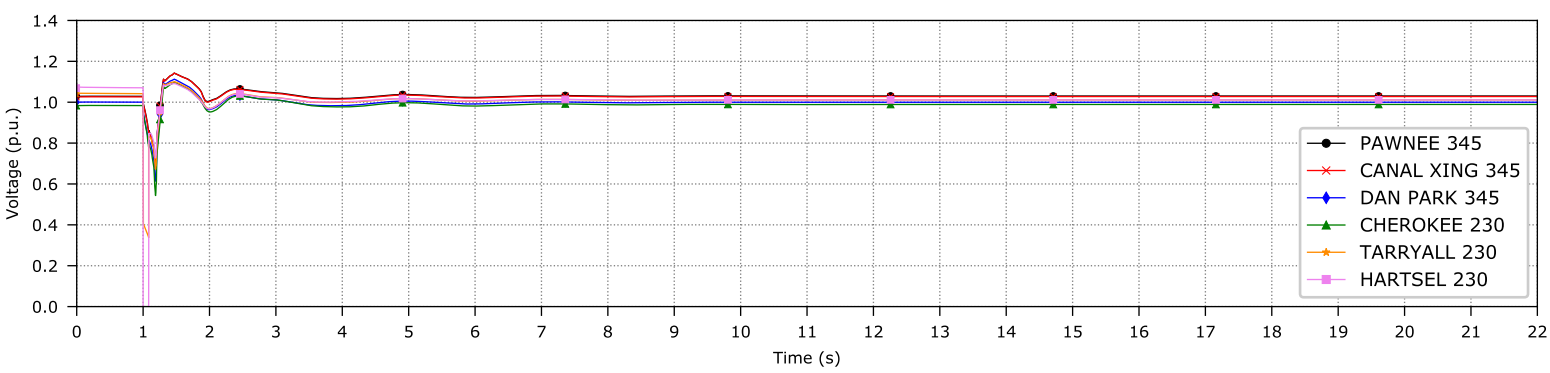

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-24-09
PAWNEE
COMAN3

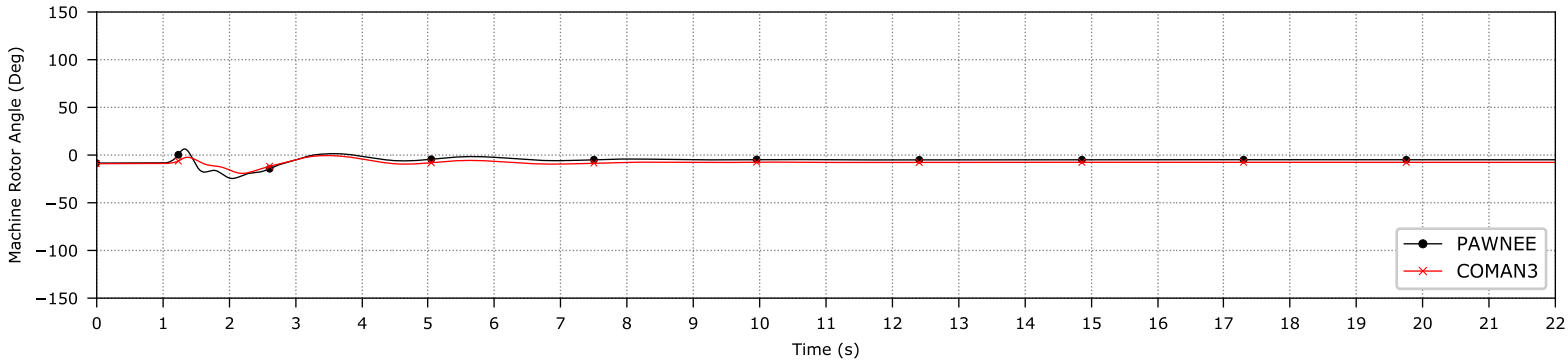

Reactive Power (Mvar)
Time (s)
5RSC-24-09
PAWNEE
COMAN3

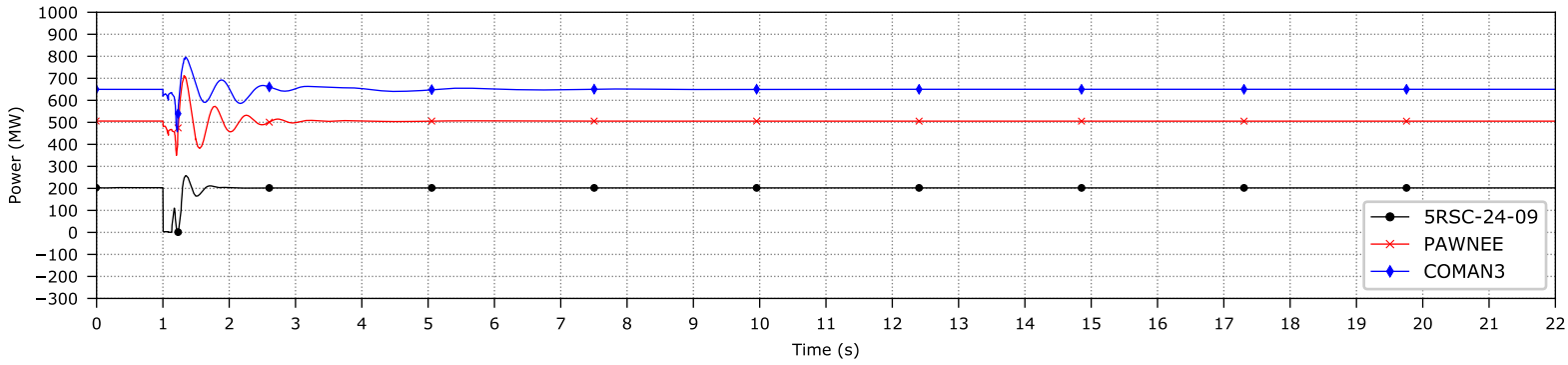

Frequency (Hz)
Time (s)
5RSC-24-09
PAWNEE
COMAN3

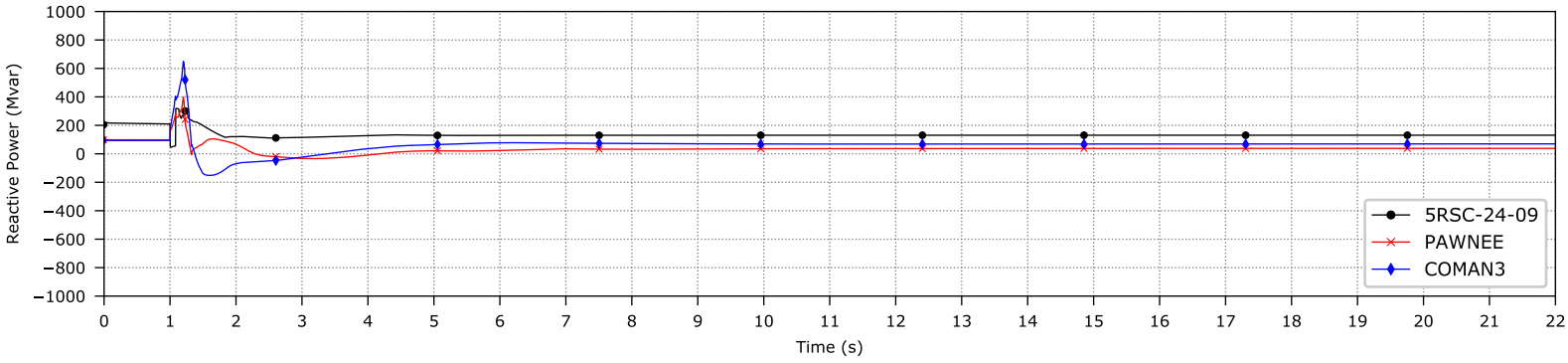

Terminal Voltage (p.u.)
Time (s)
5RSC-24-09
PAWNEE
COMAN3

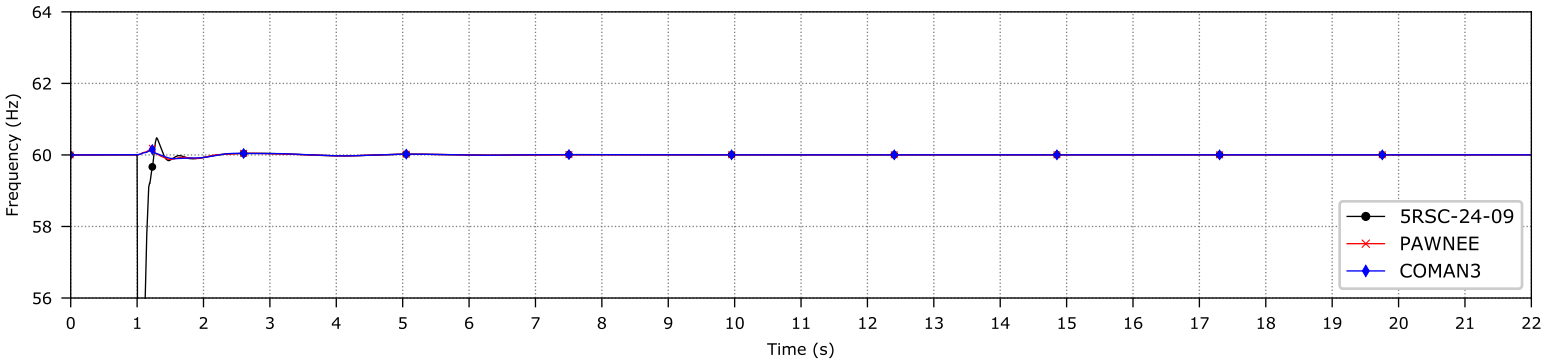

Voltage (p.u.)
Time (s)
PAWNEE 345
CANAL XING 345
DAN PARK 345
CHEROKEE 230
TARRYALL 230
HARTSEL 230

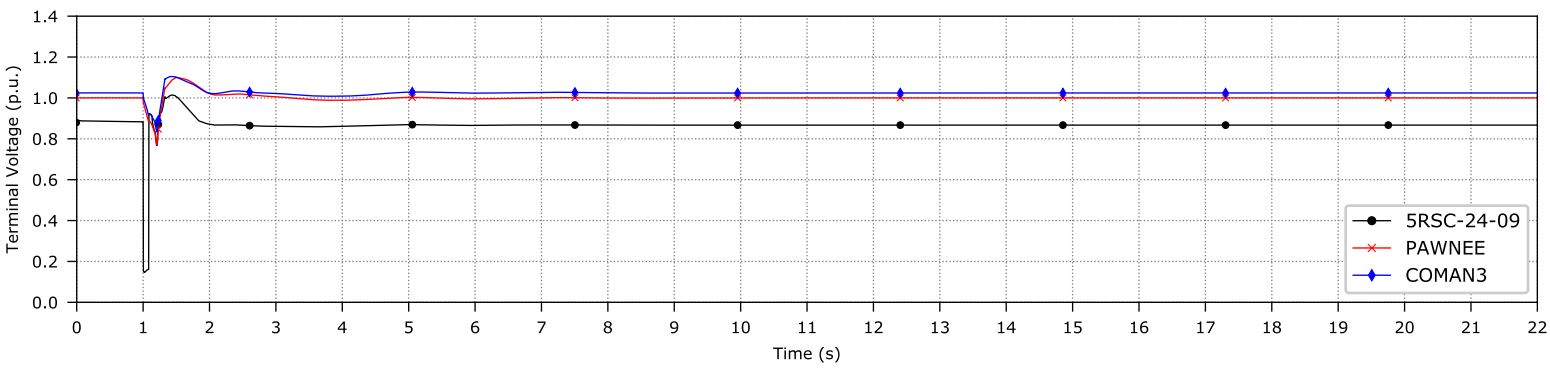
Ref. No. 03 - LoTC_29

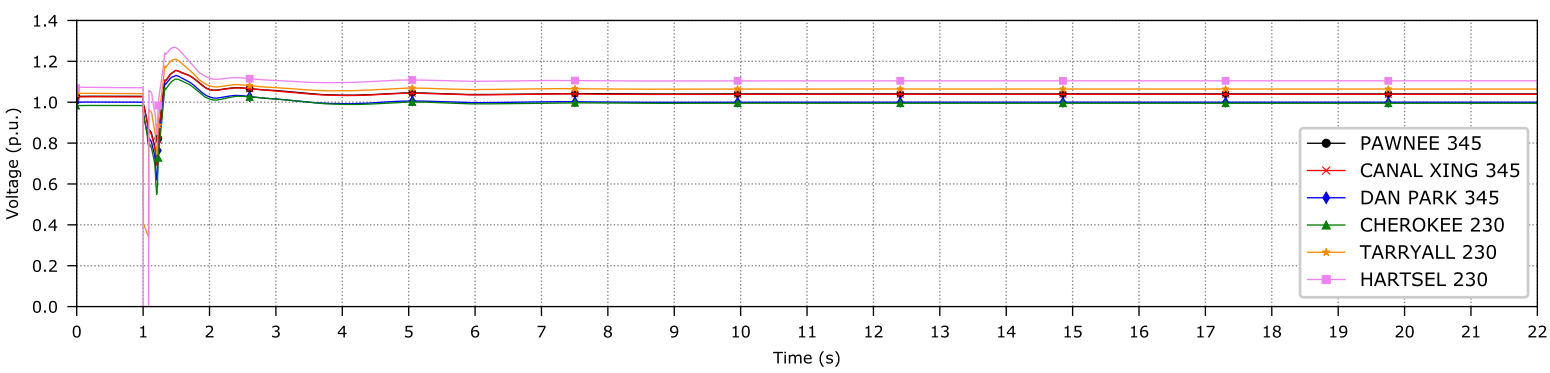












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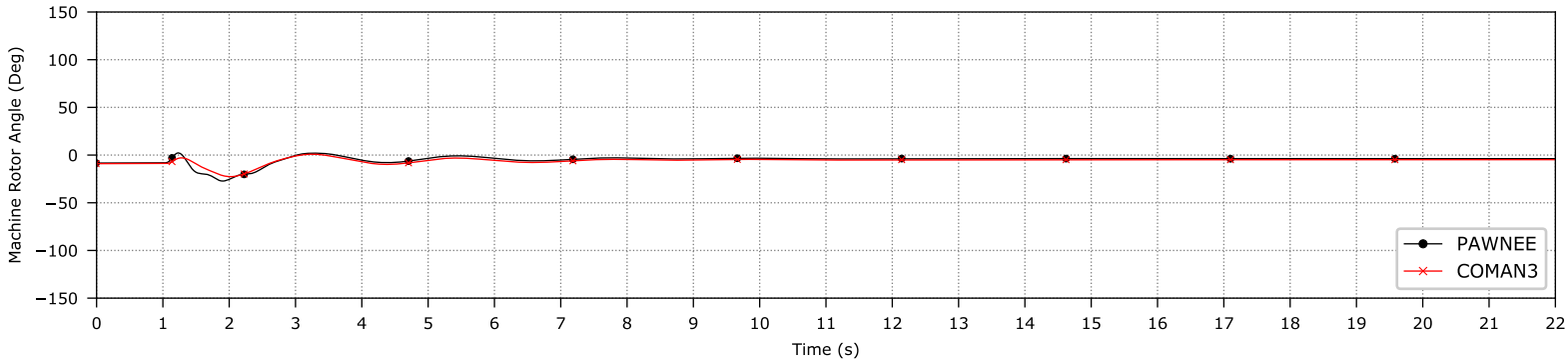
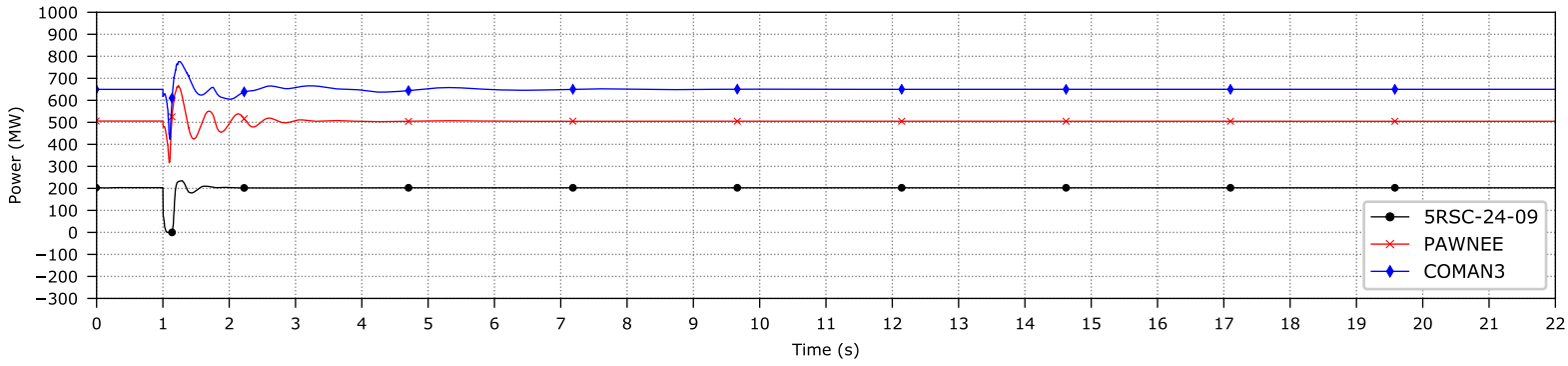
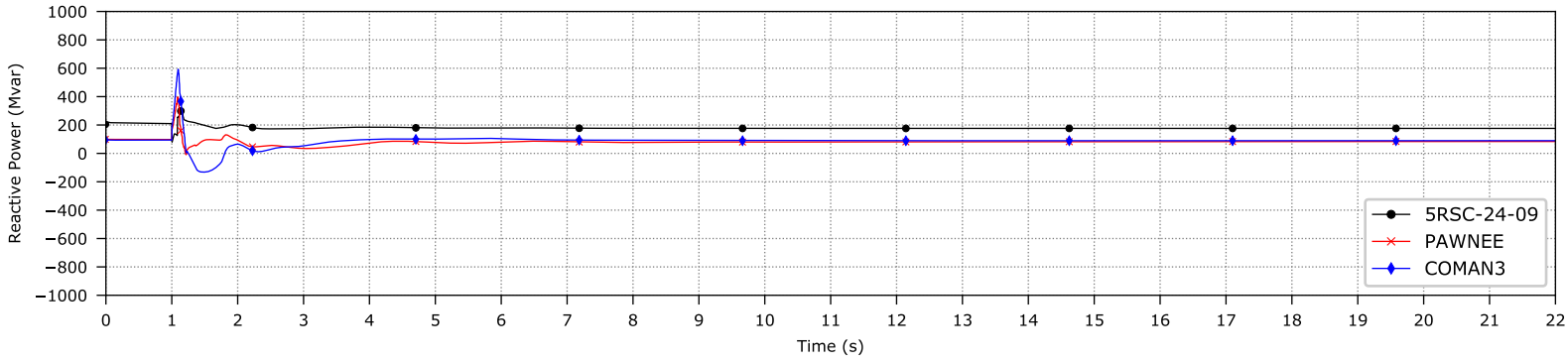
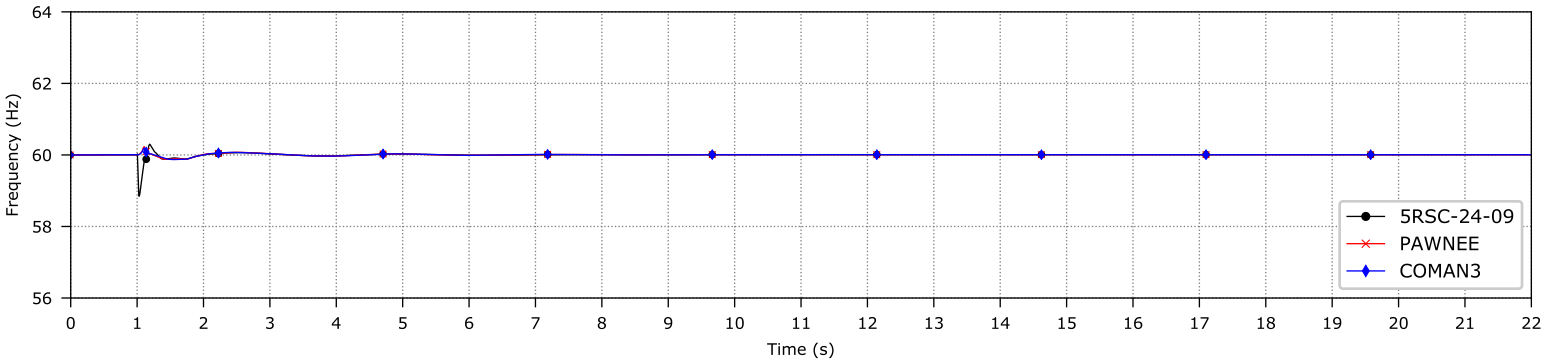
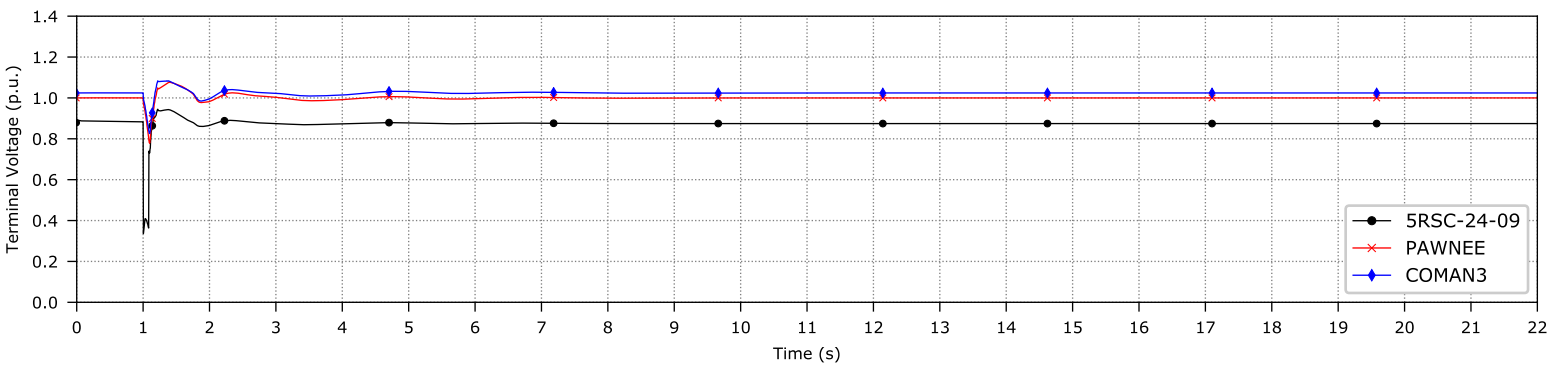
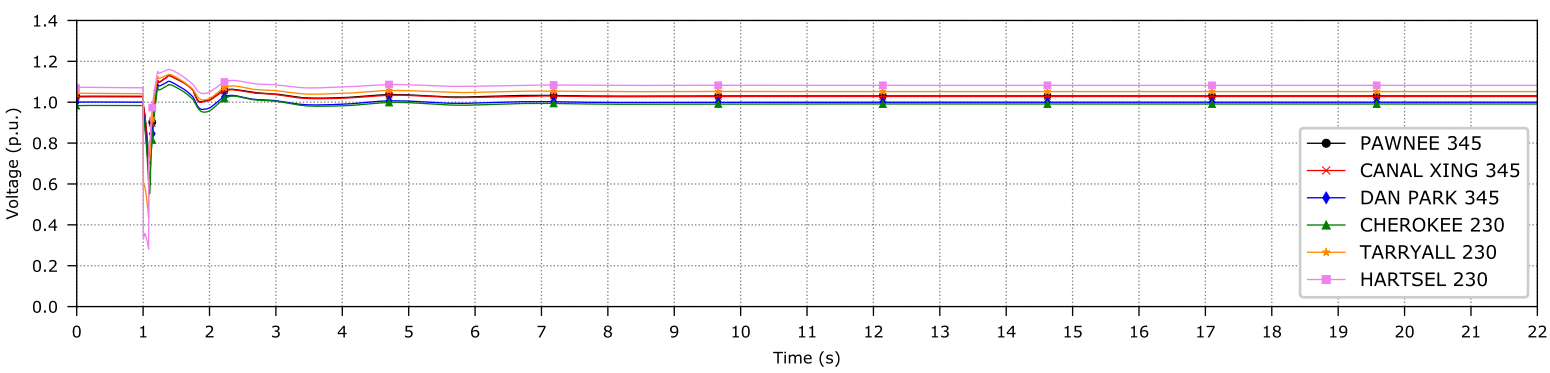




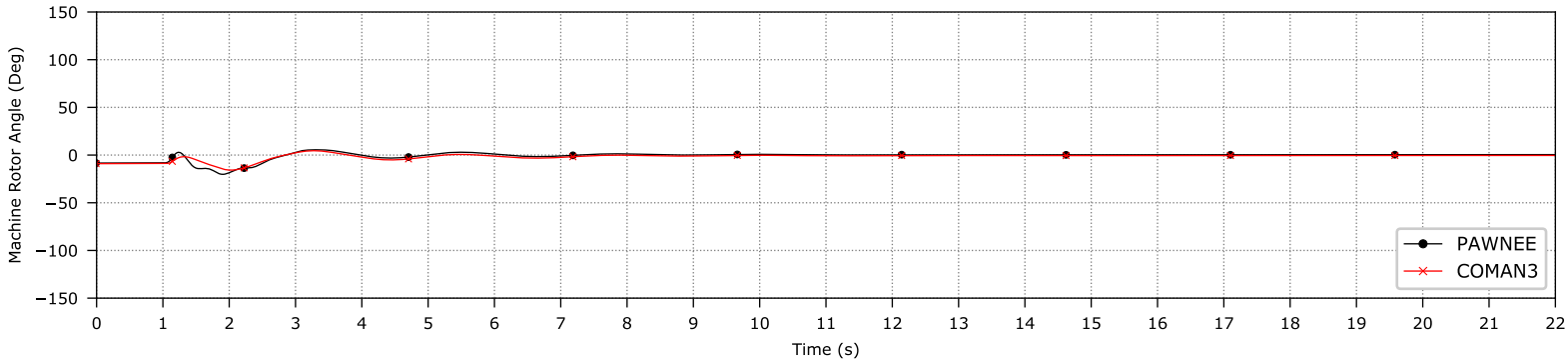


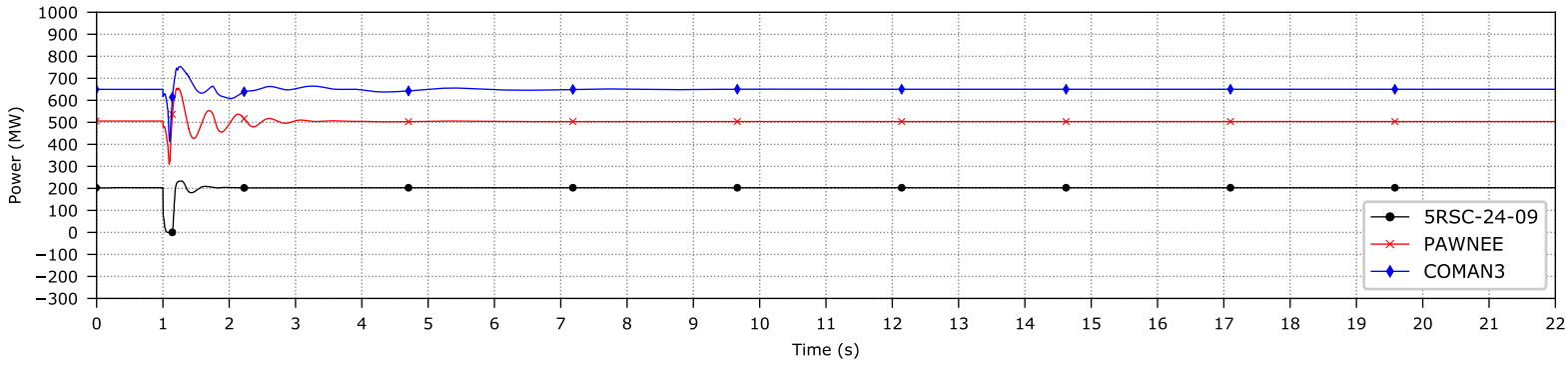


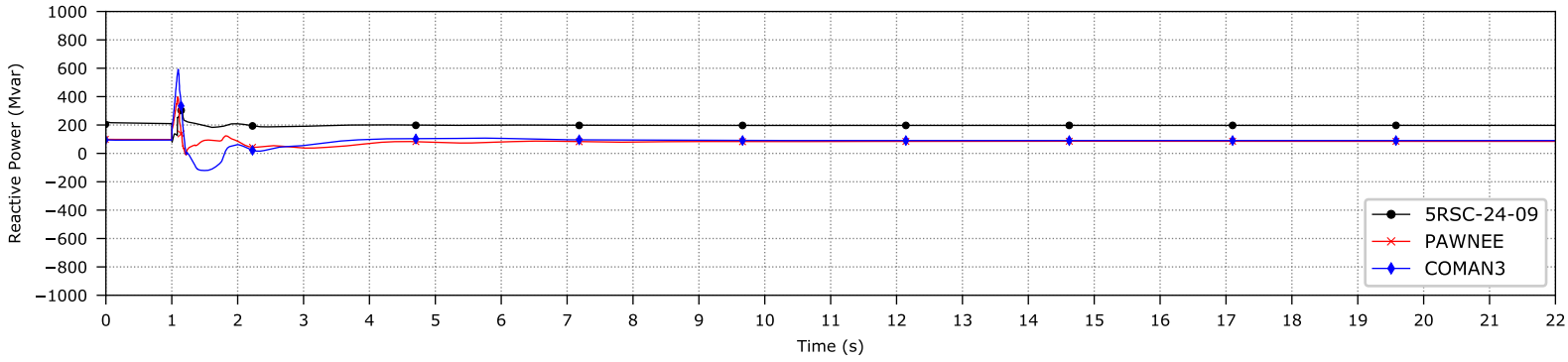


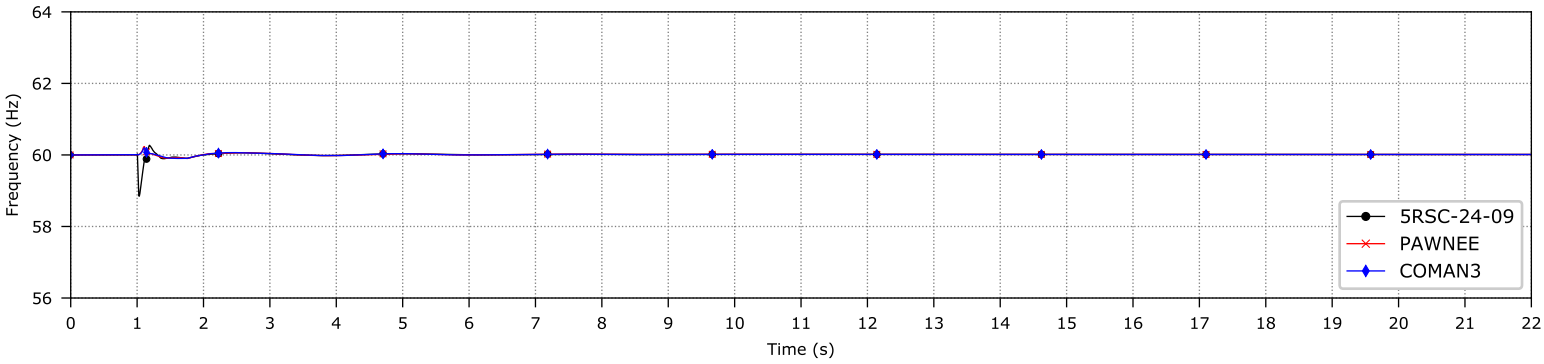


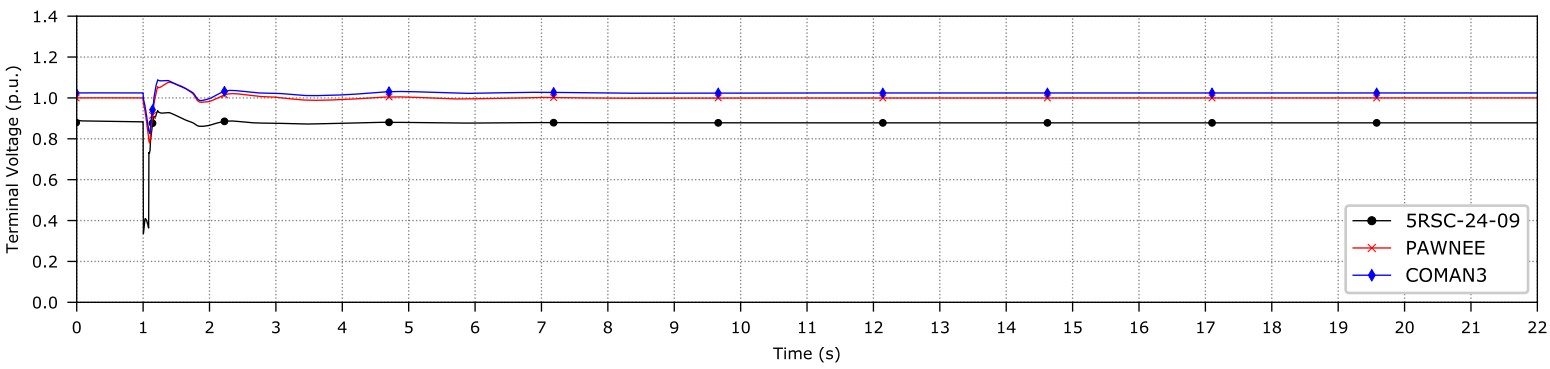
Ref. No. 05 - LoTC_31

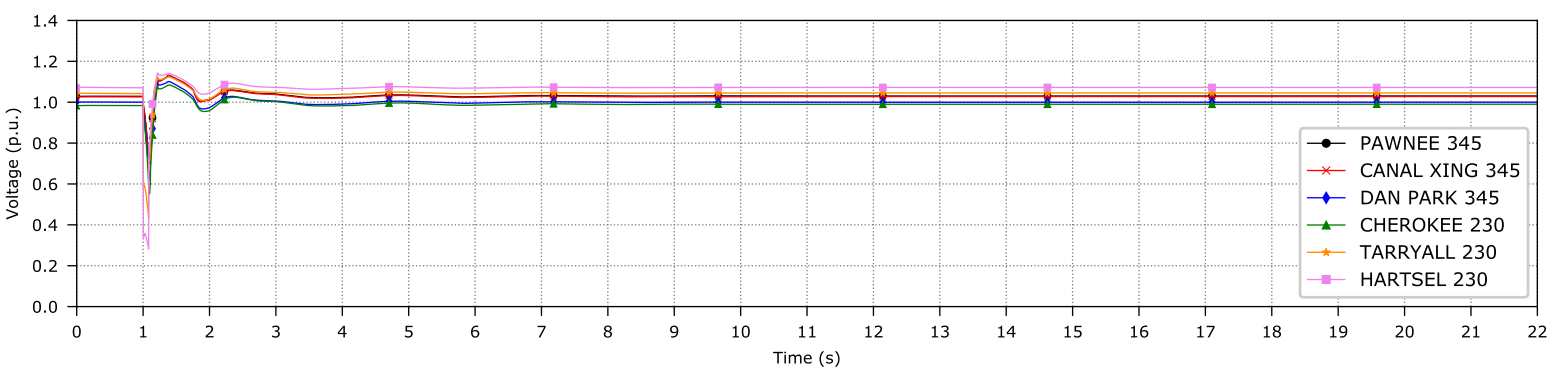




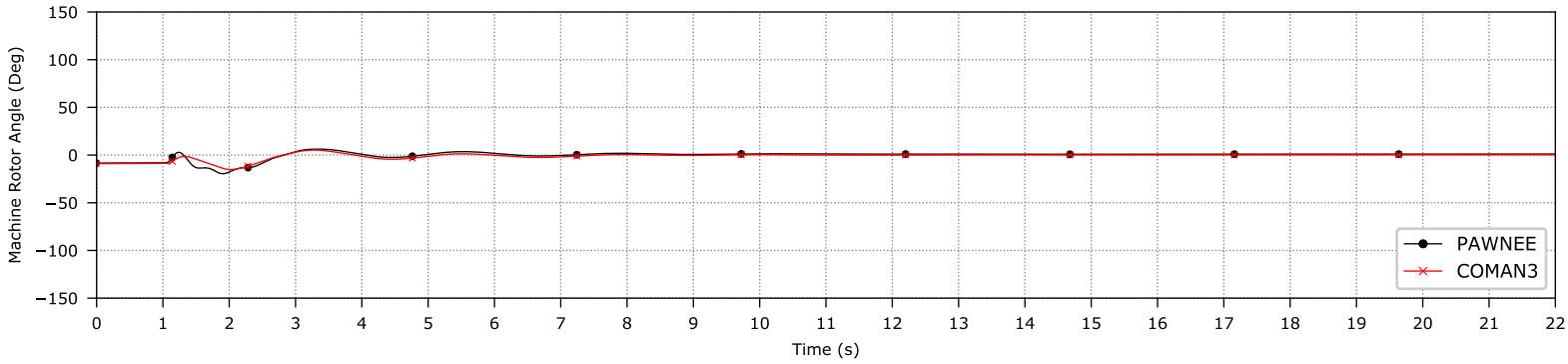


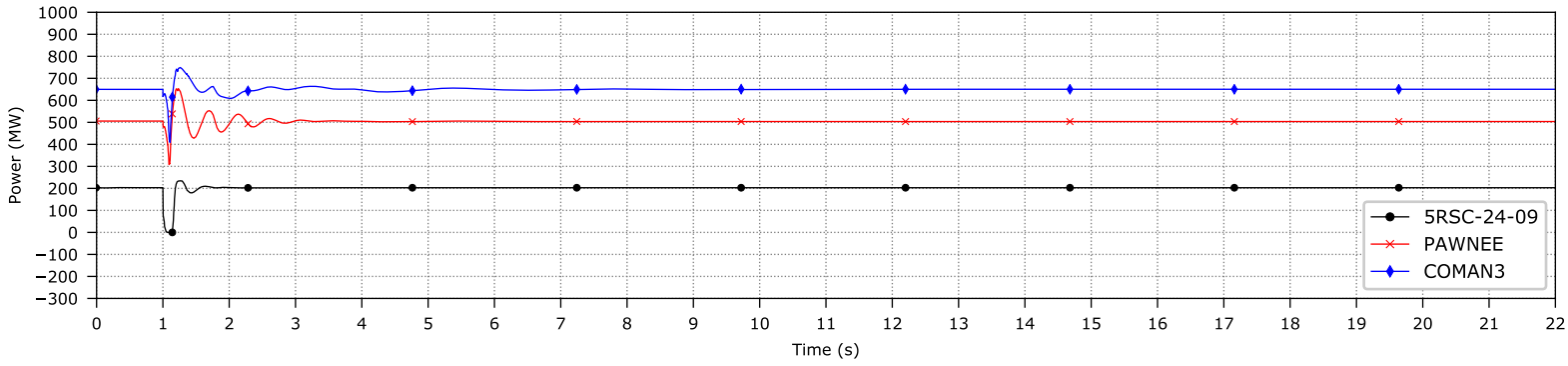


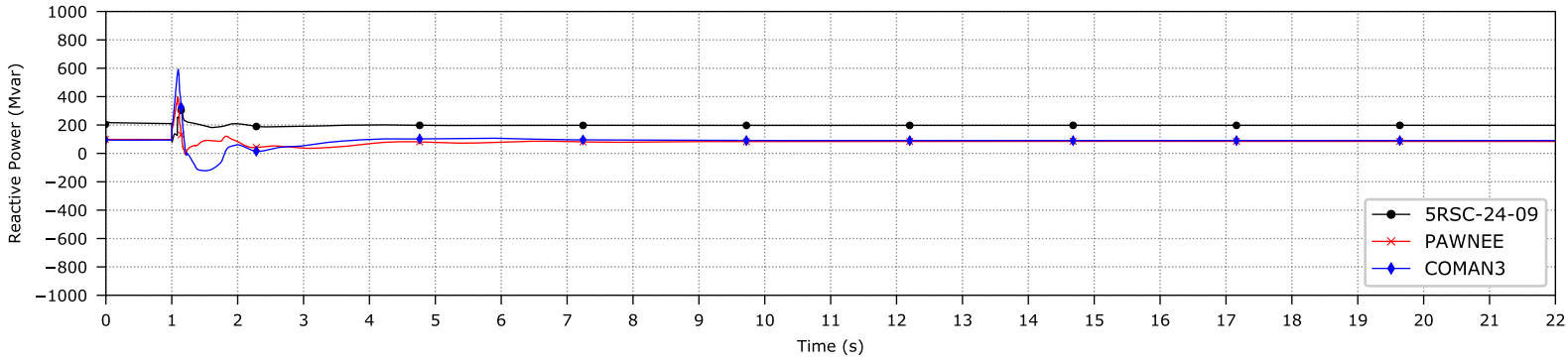


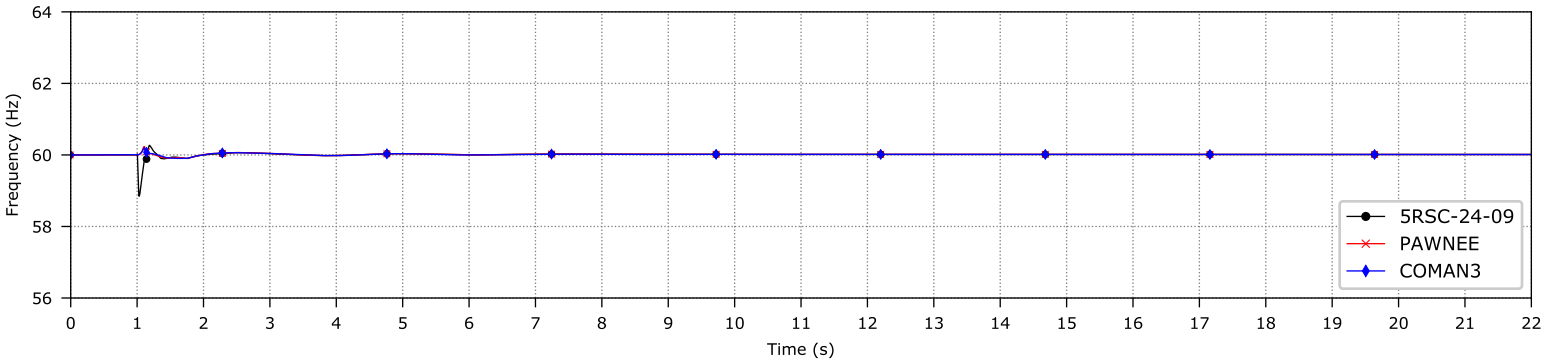


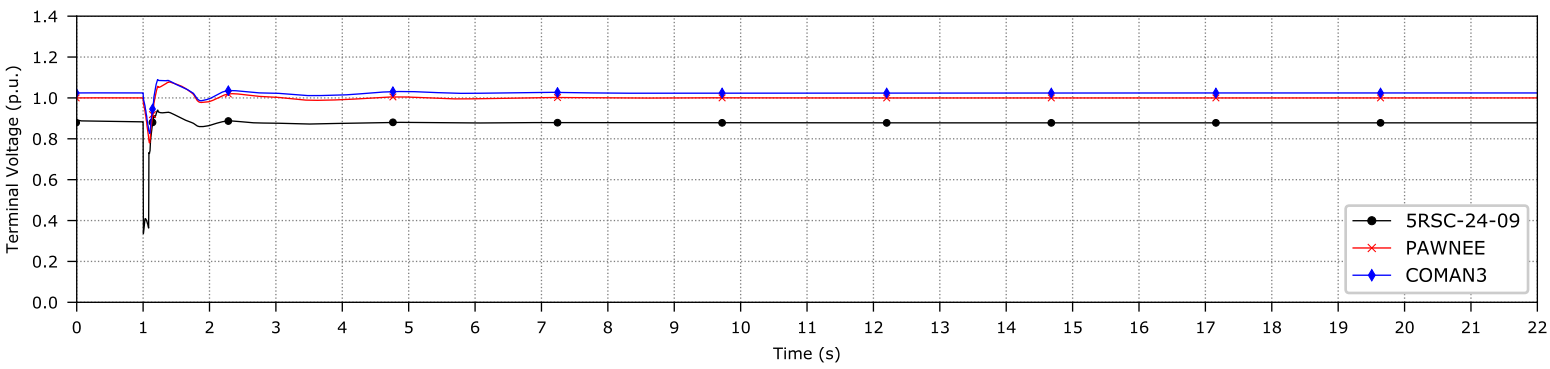
Ref. No. 06 - LoTC_47

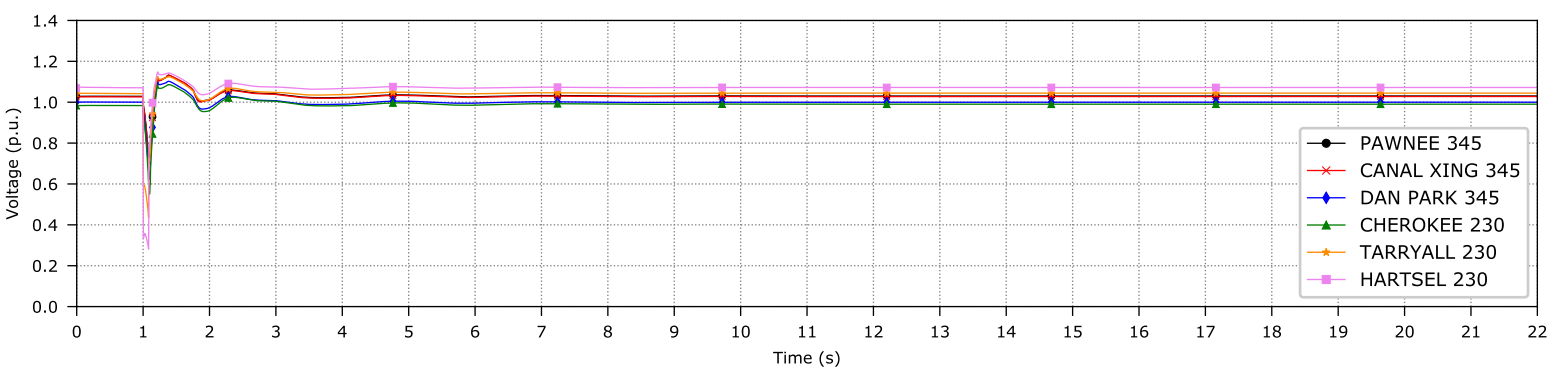




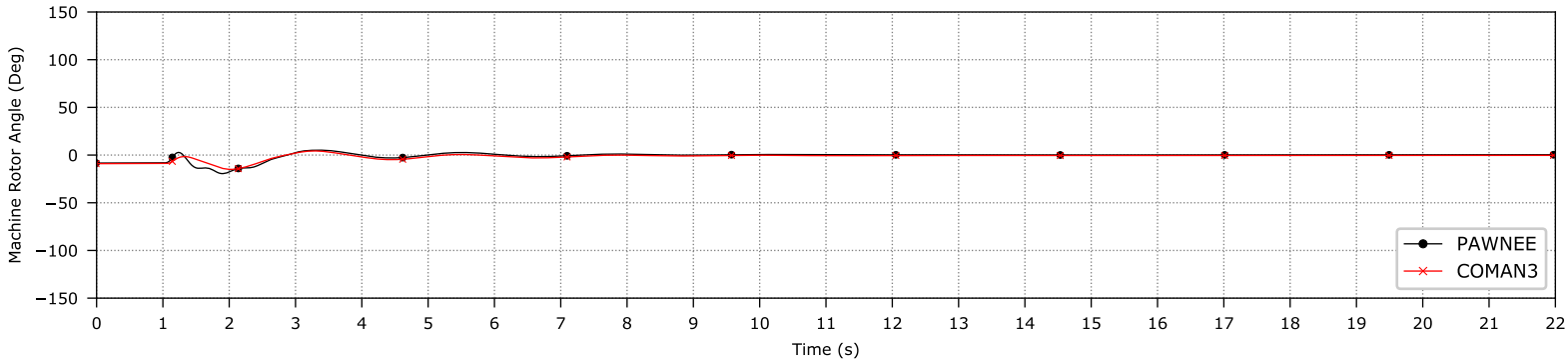


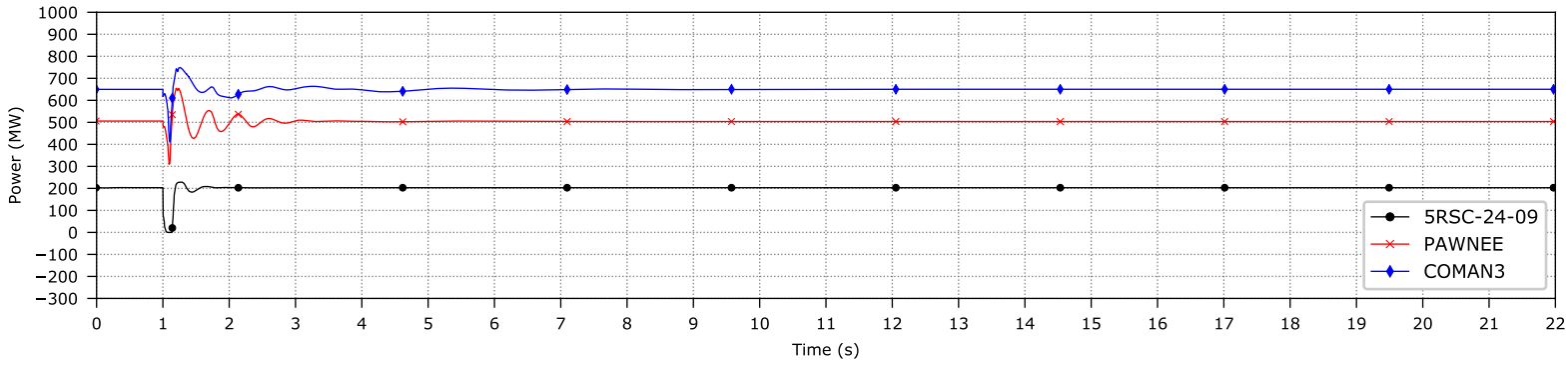


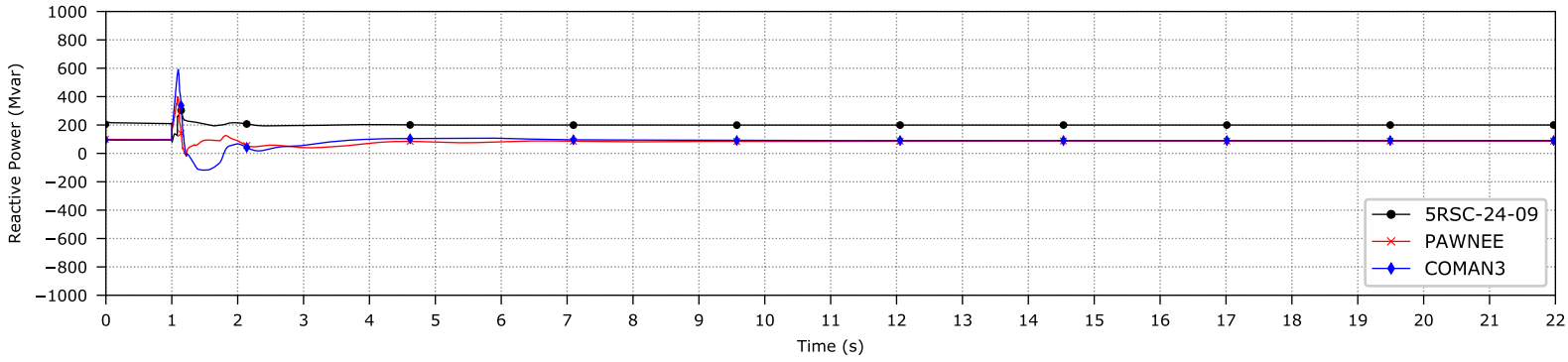


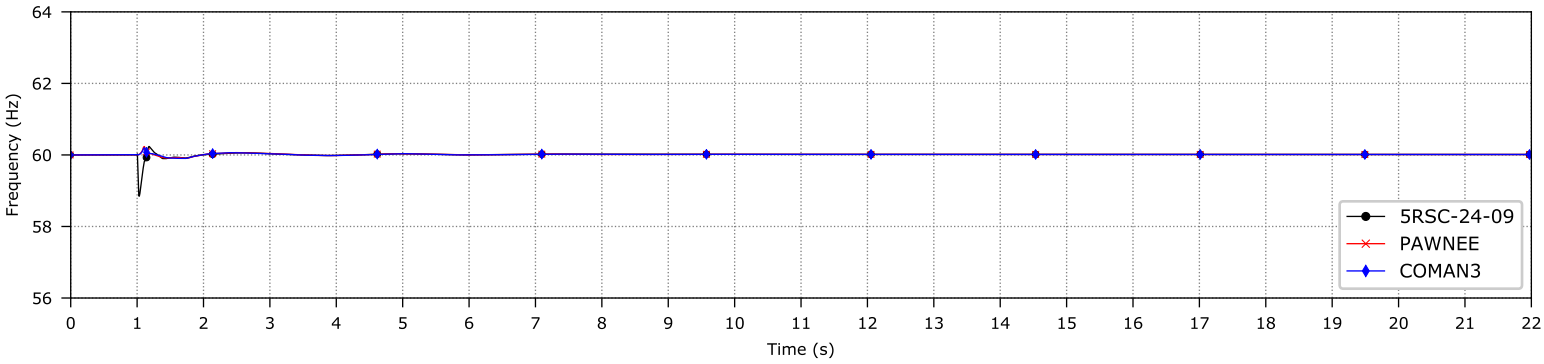


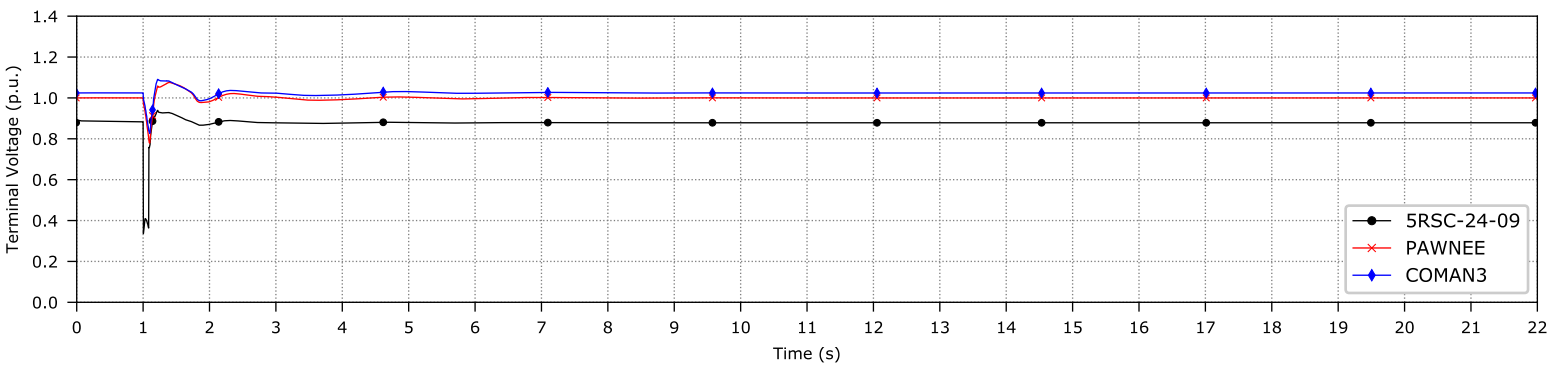
Ref. No. 07 - LoTC_89

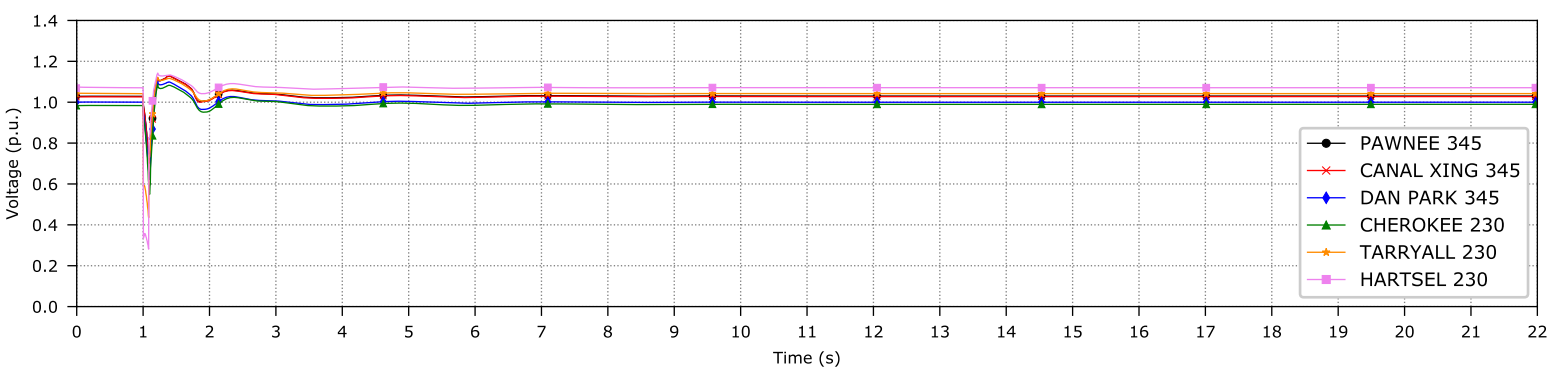




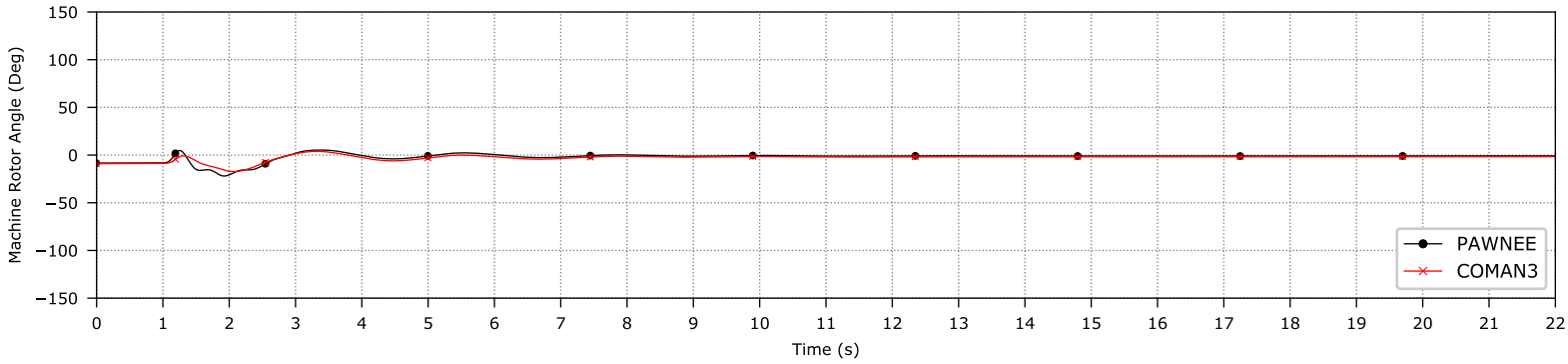


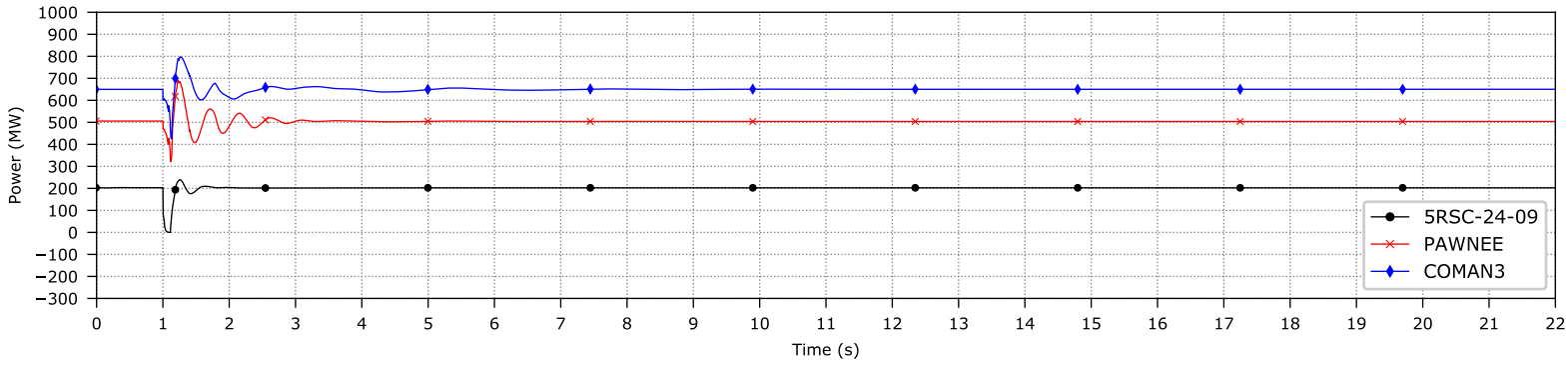


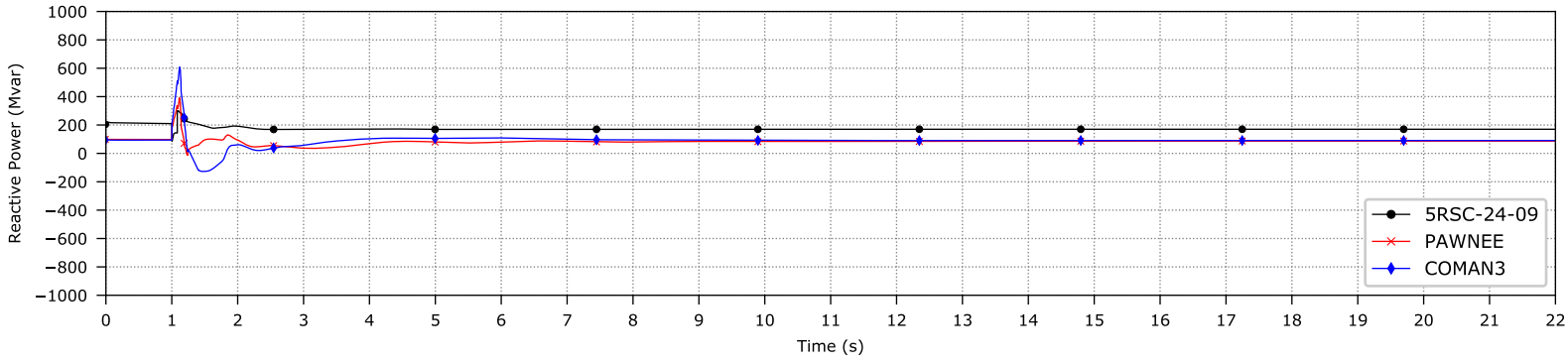


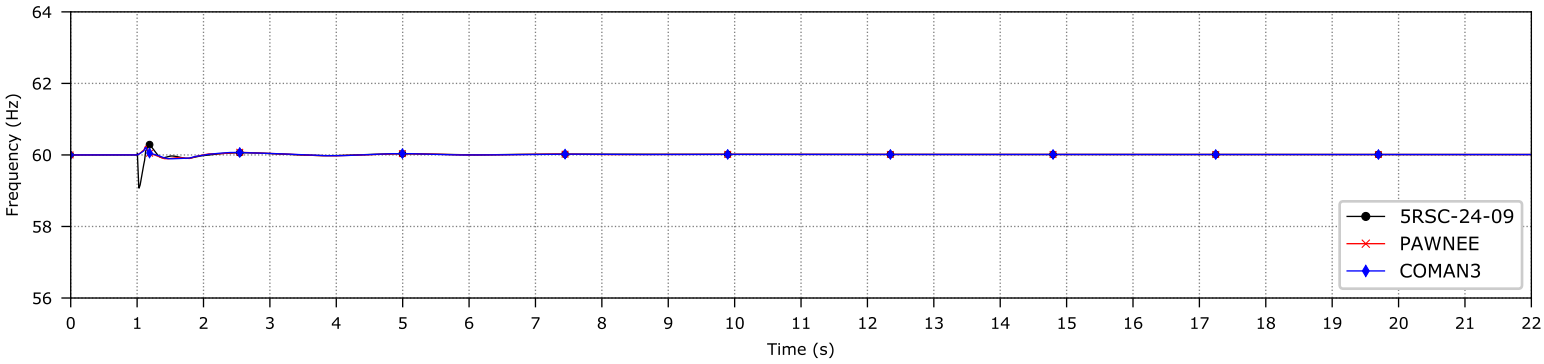


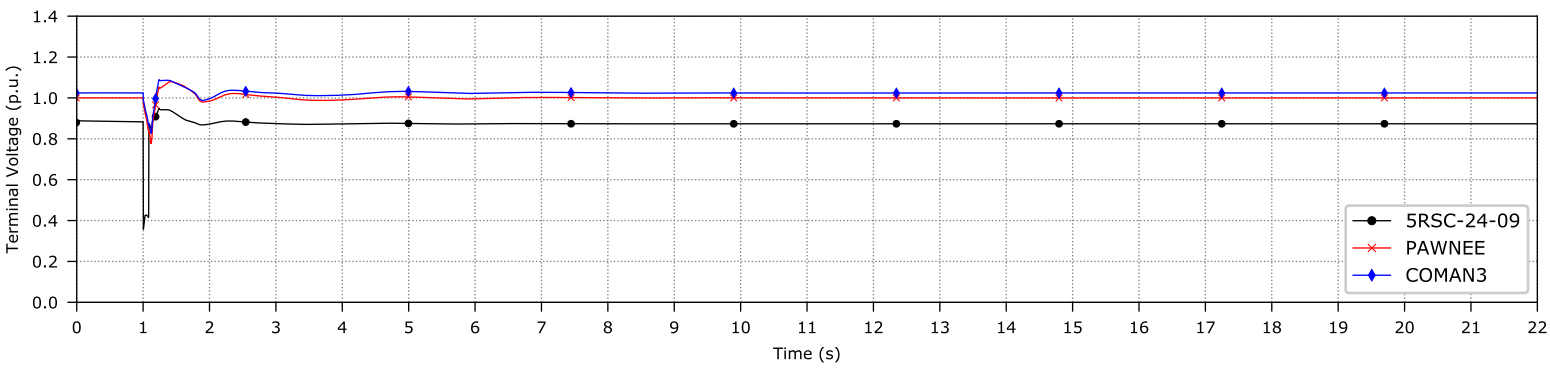
Ref. No. 08 - LoTC_128

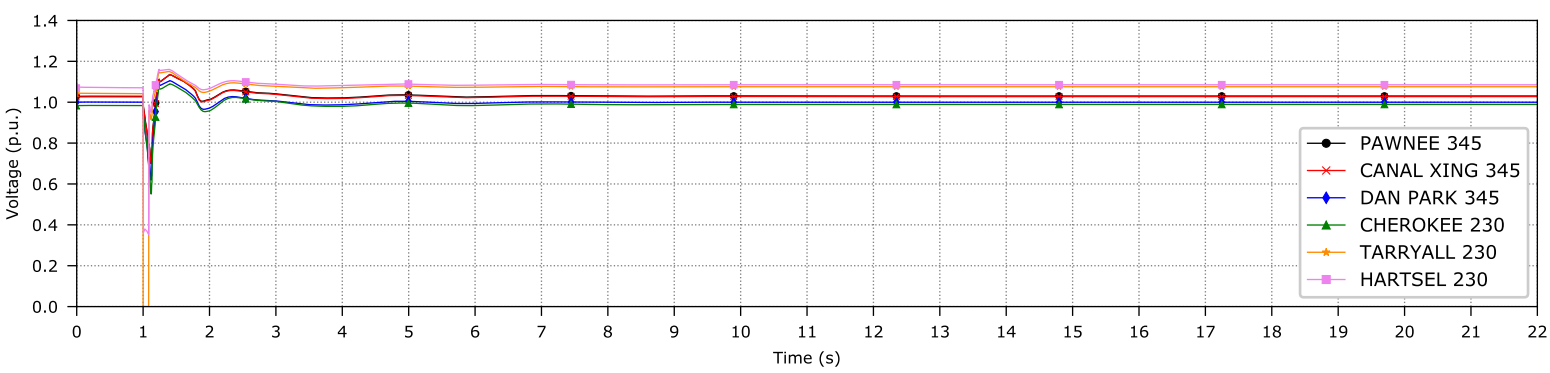












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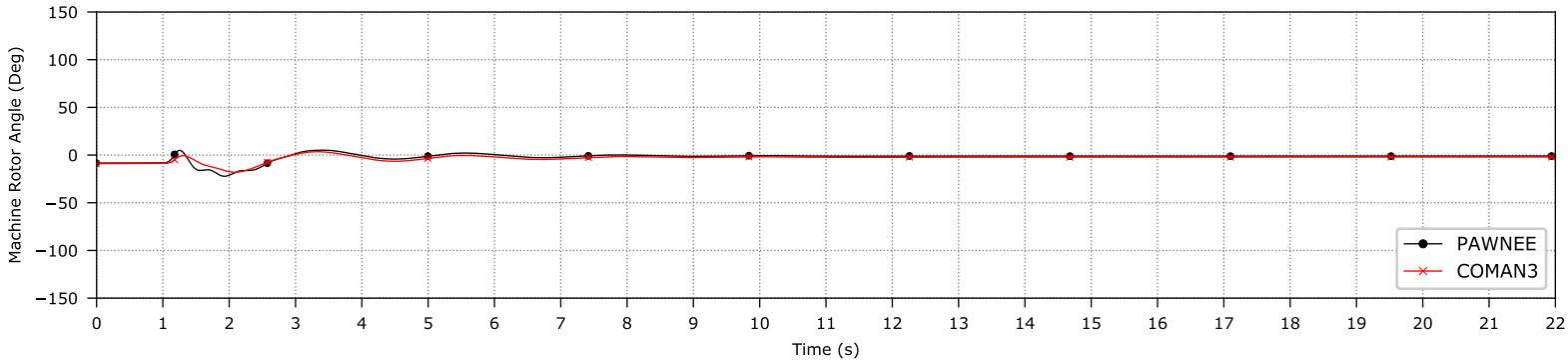

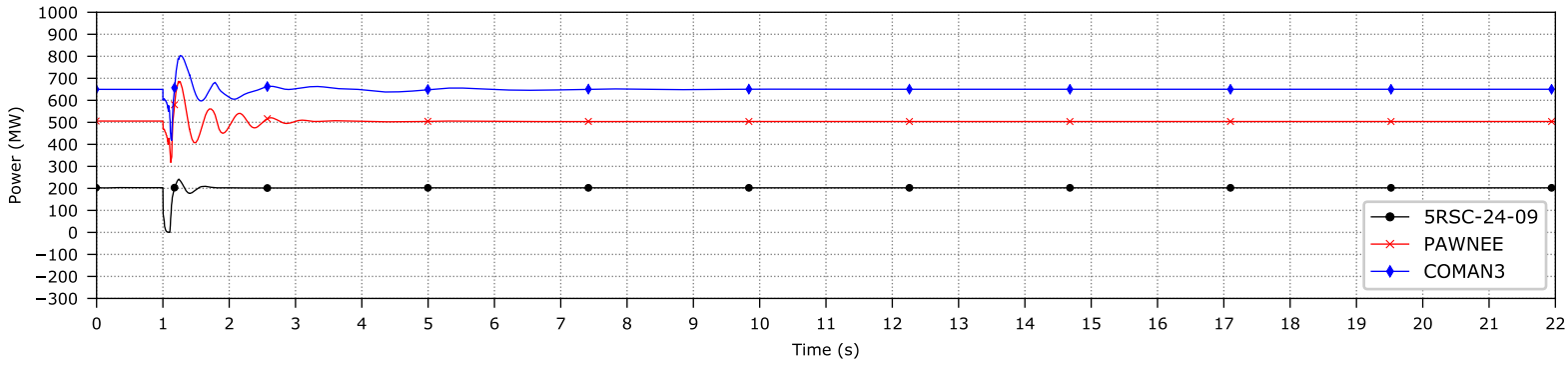

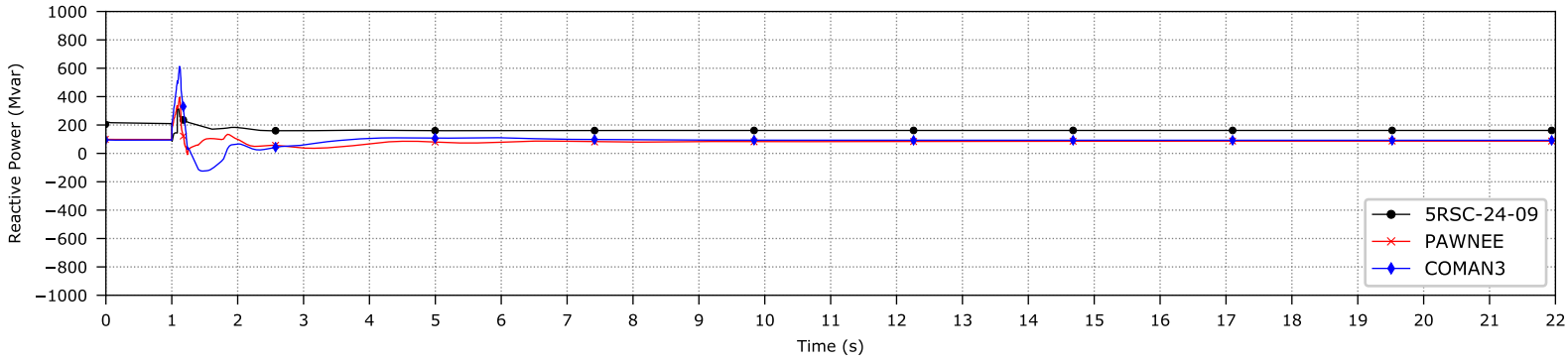

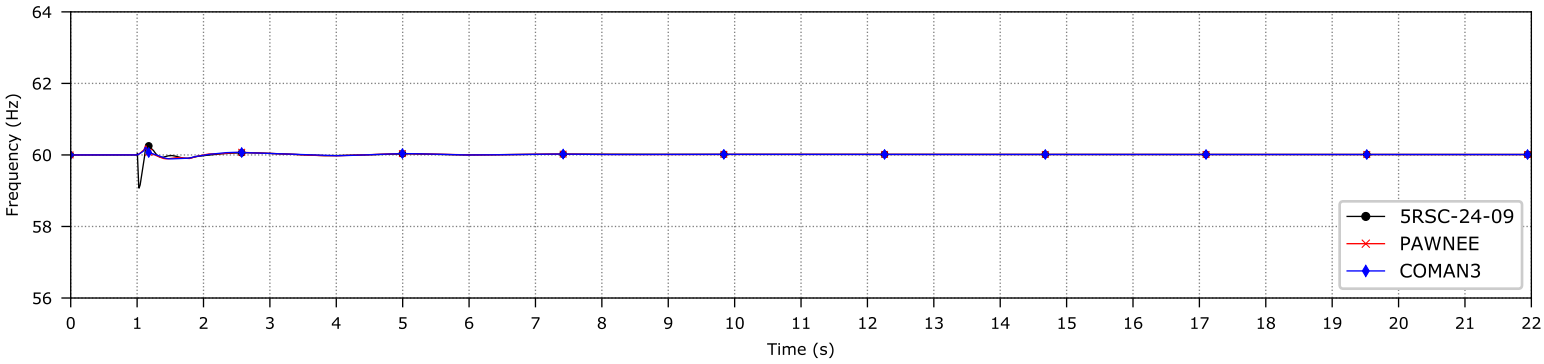

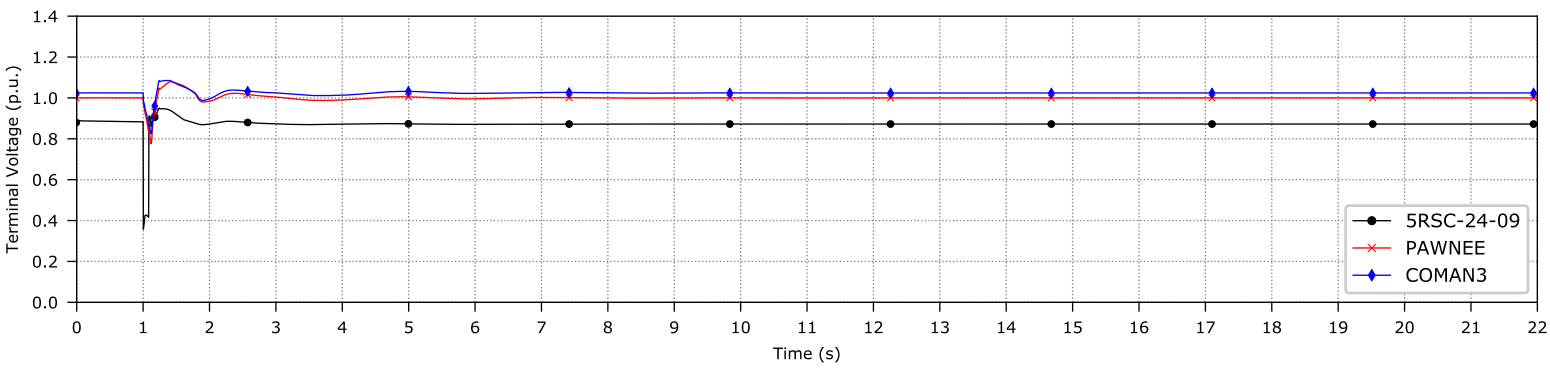

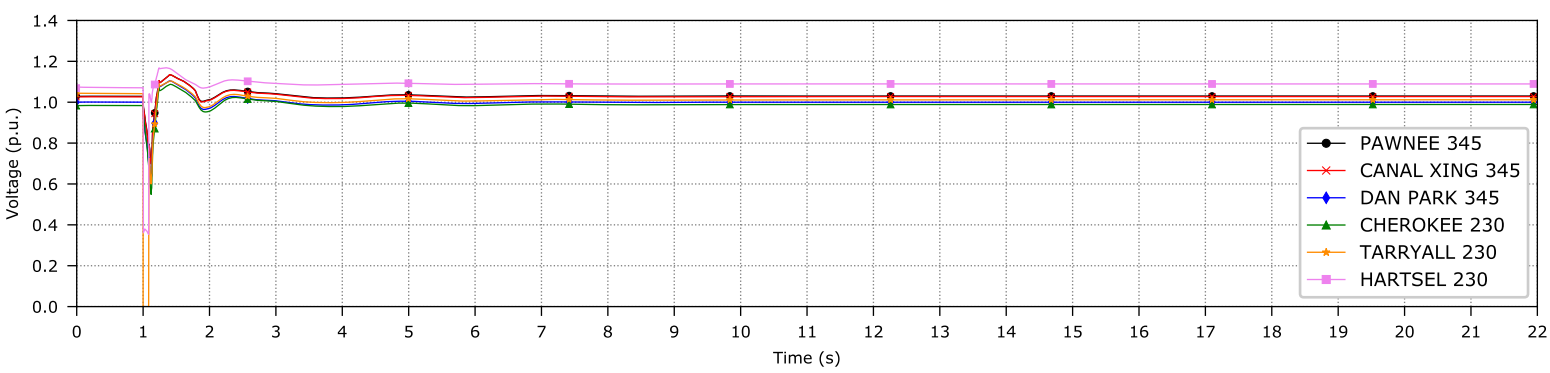

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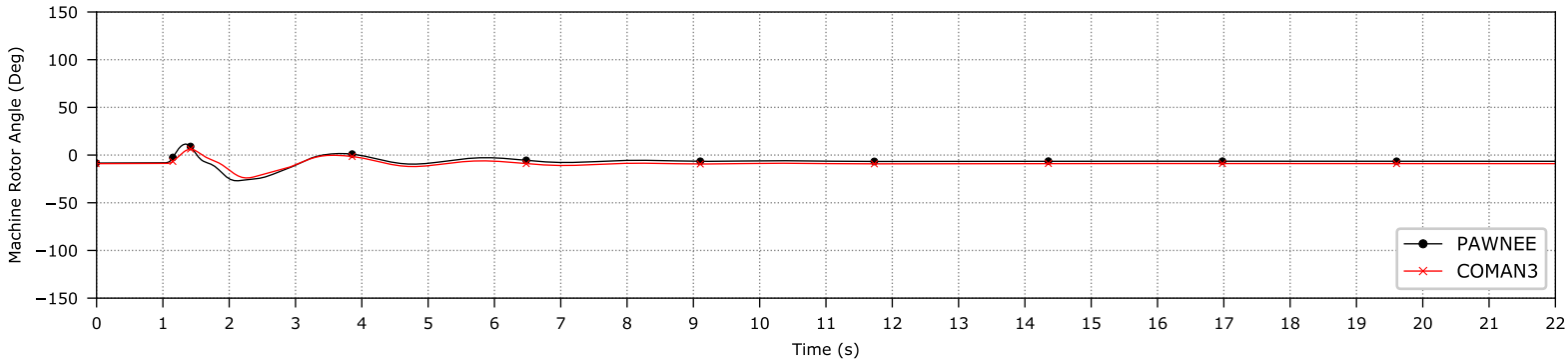

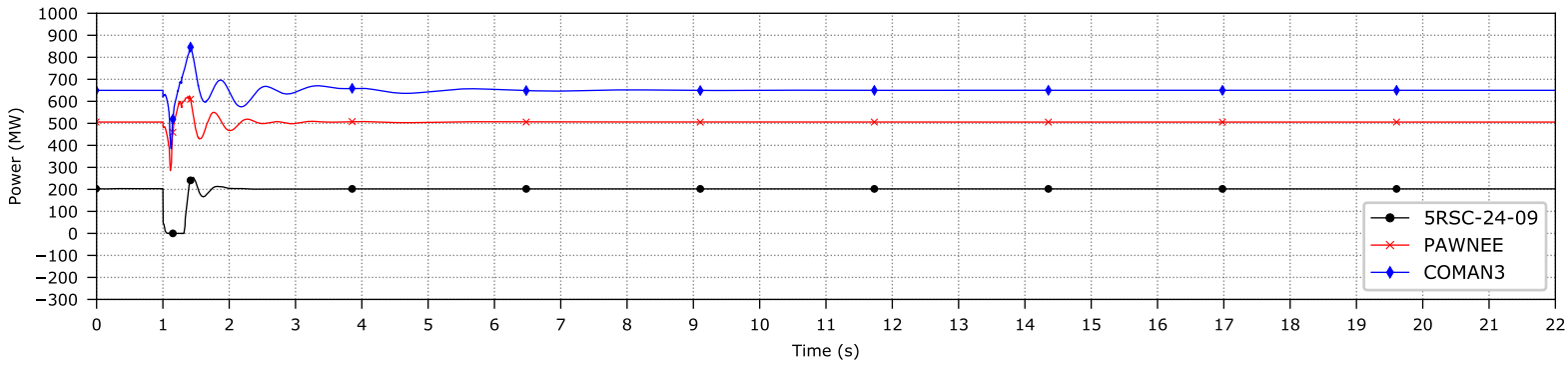

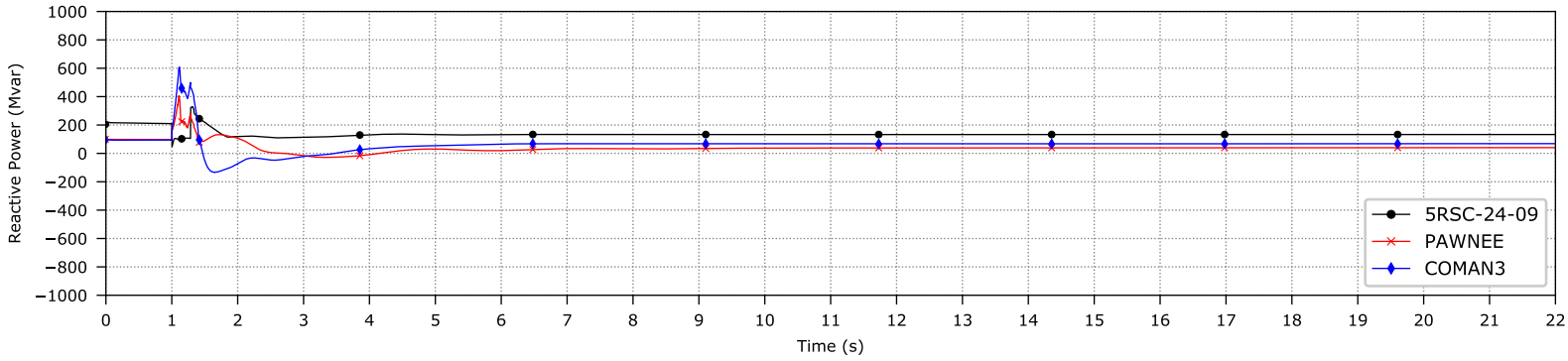

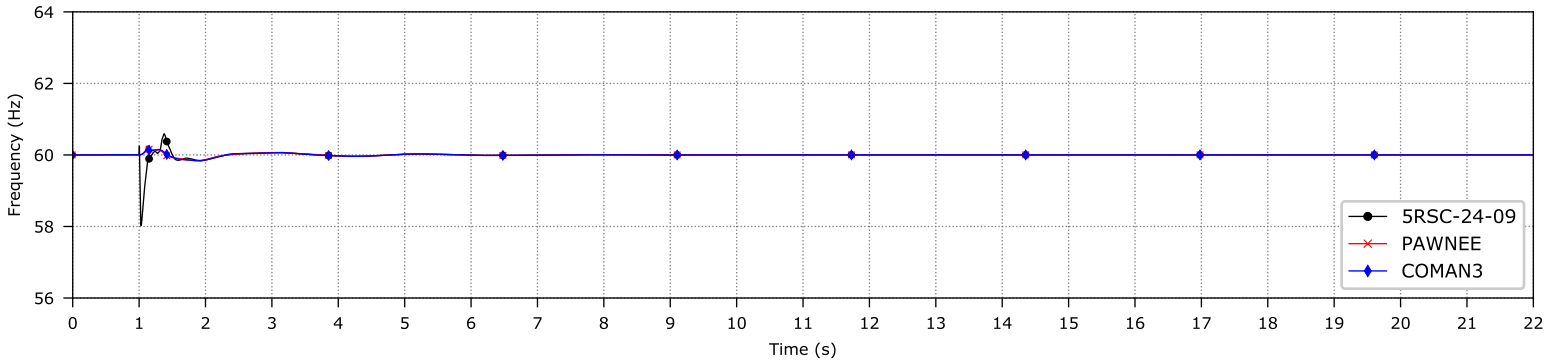

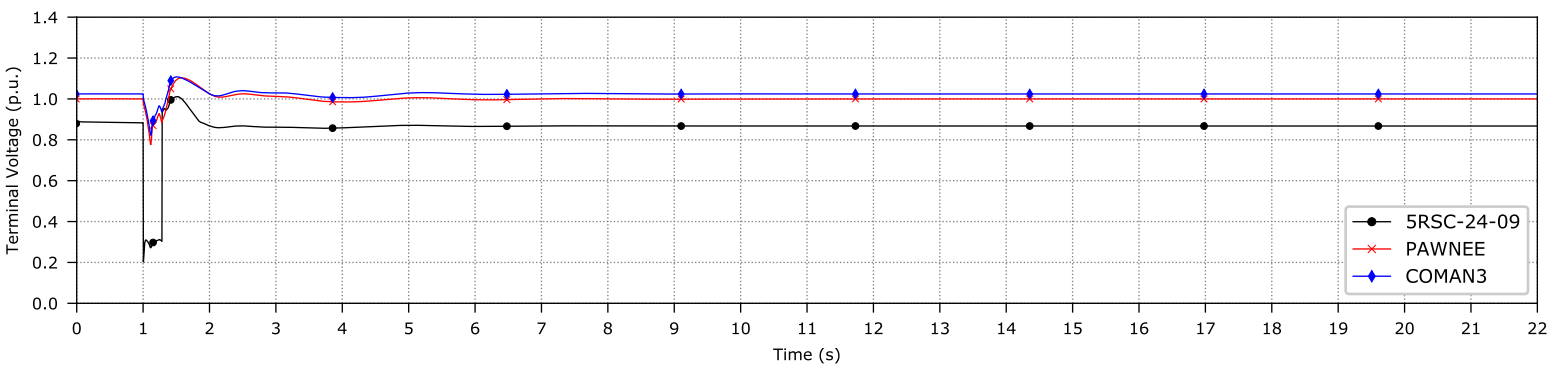

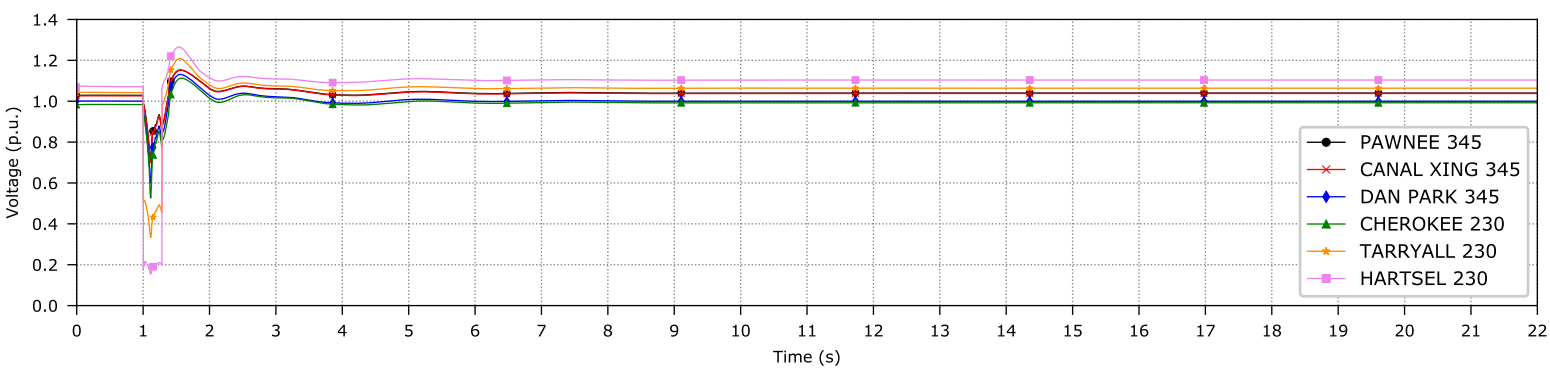

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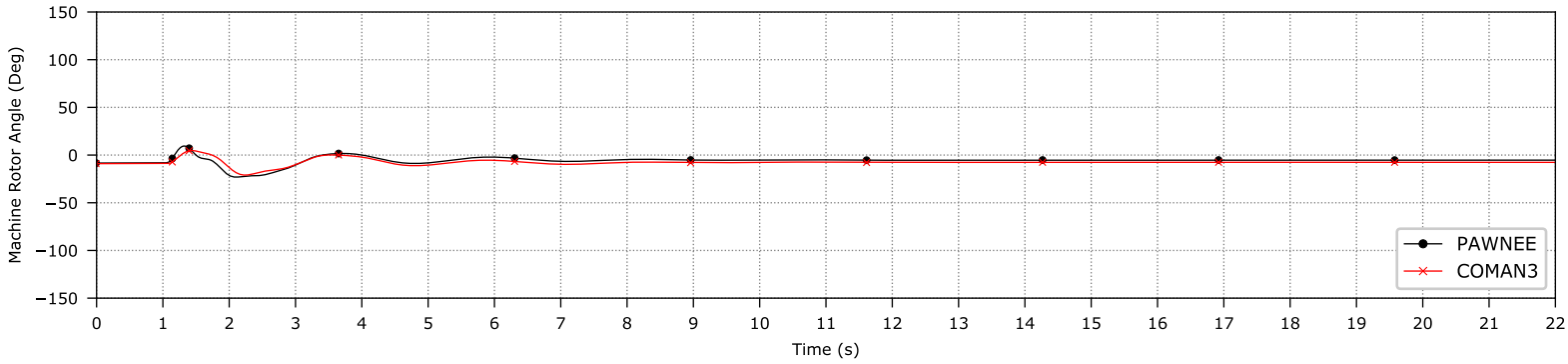

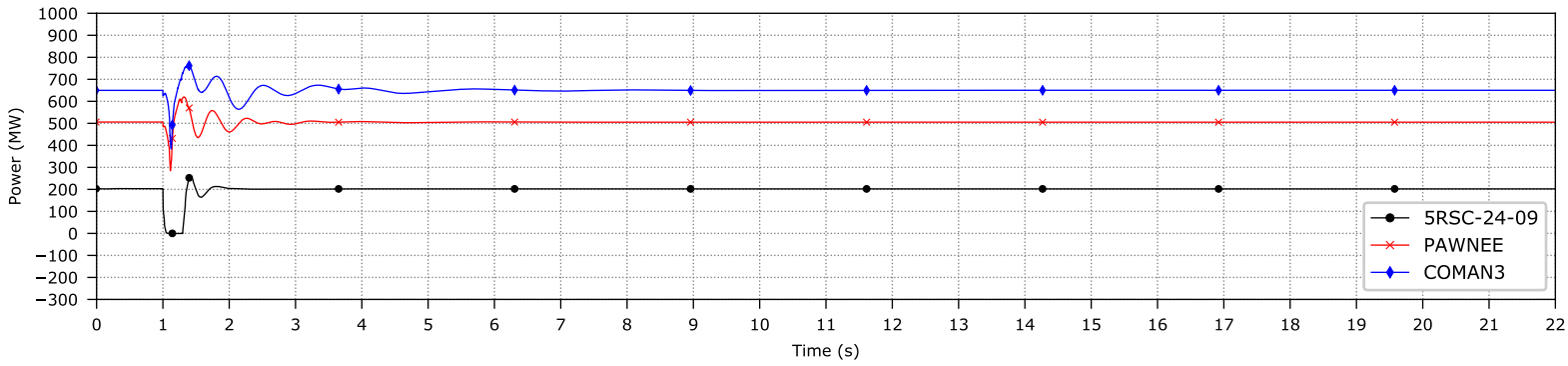

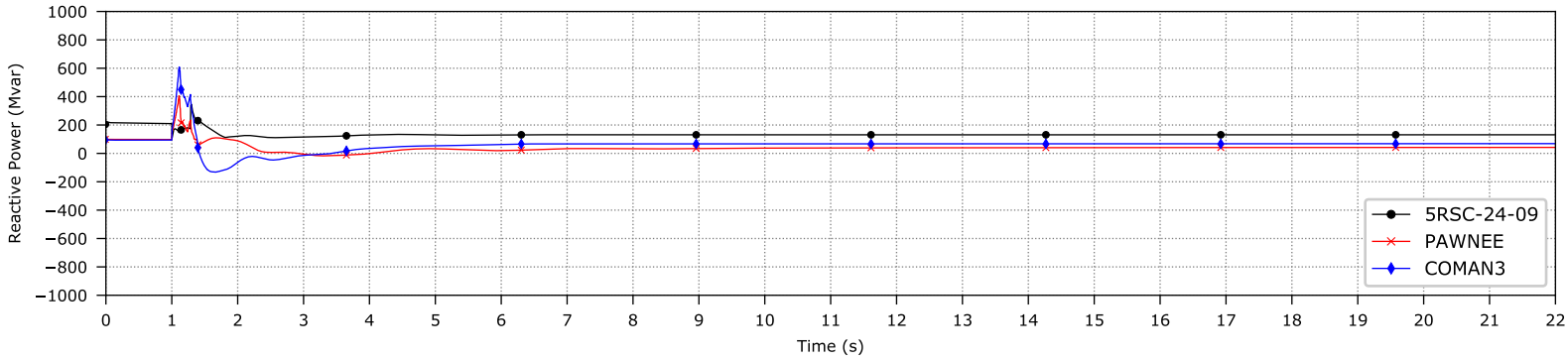

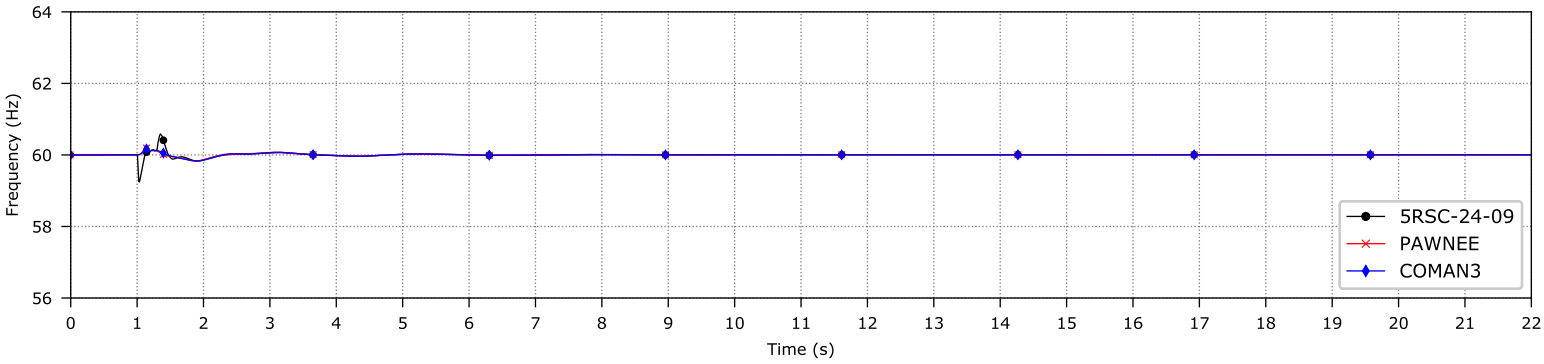

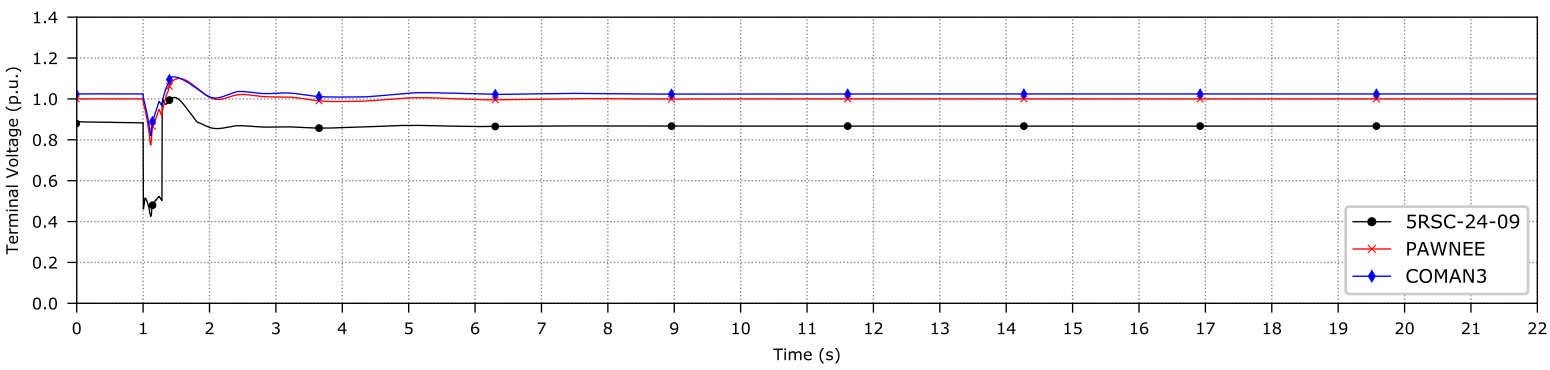

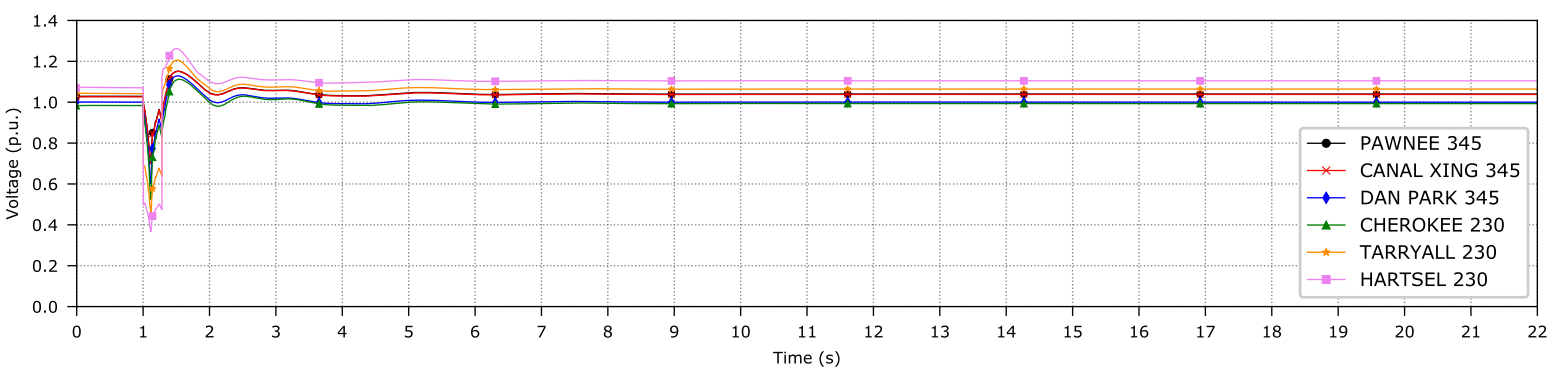

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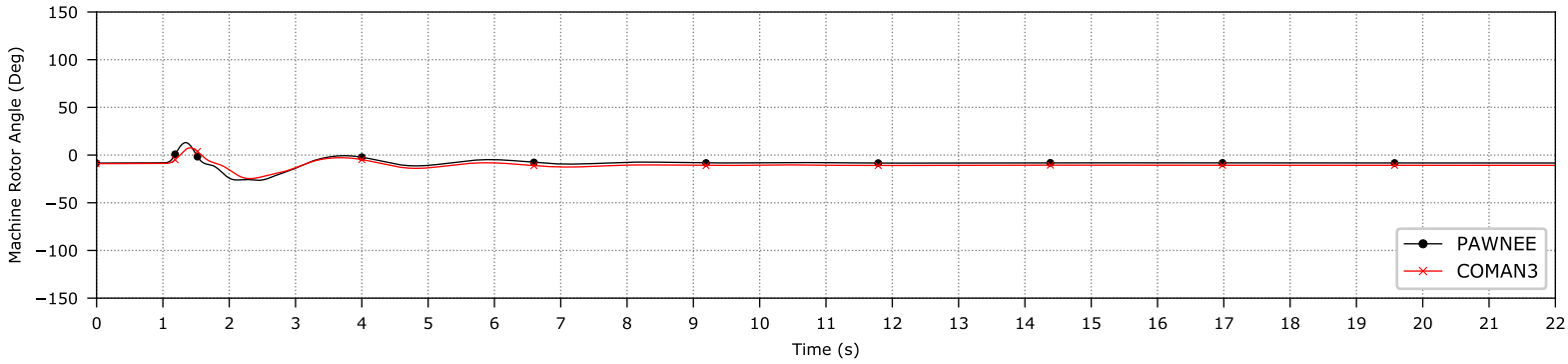

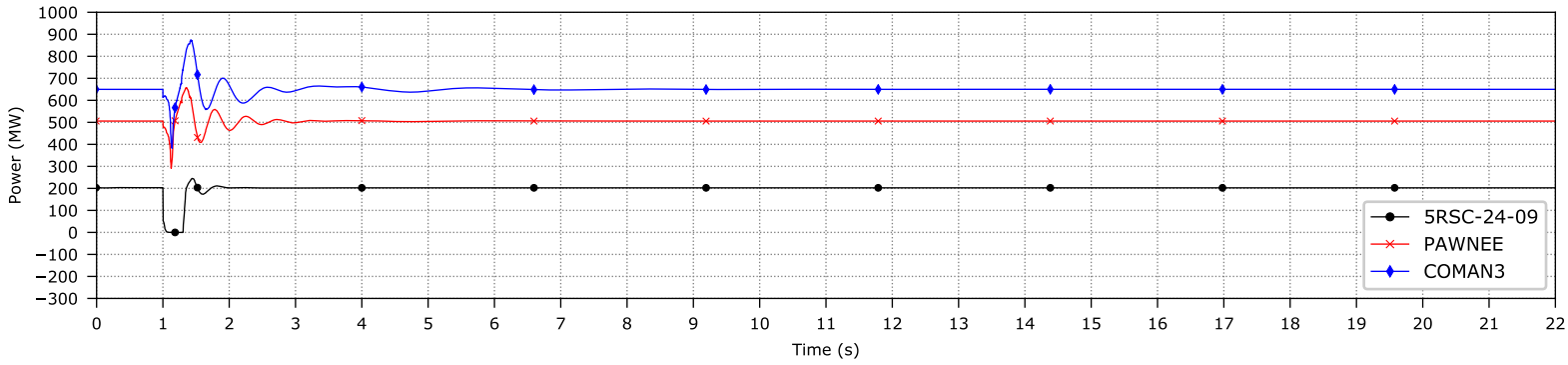

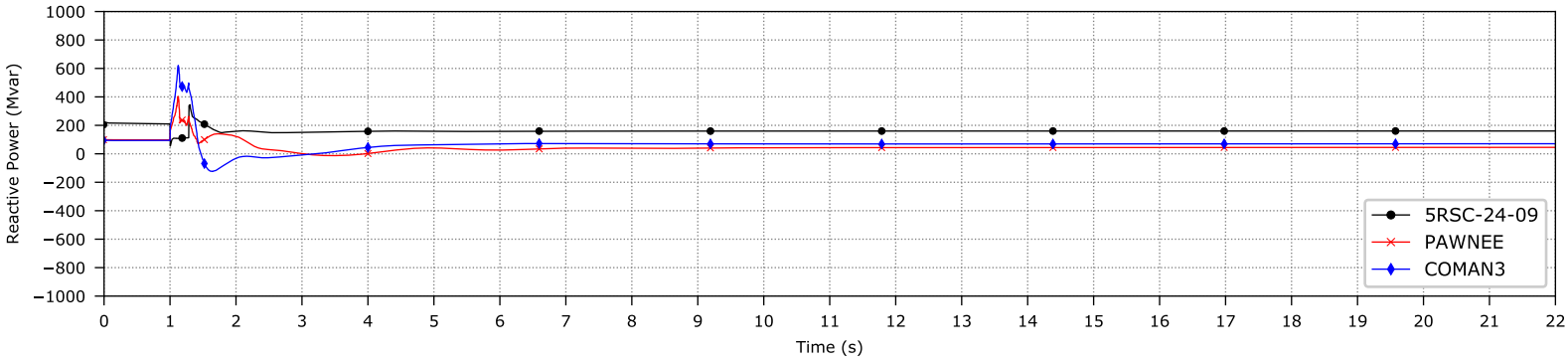

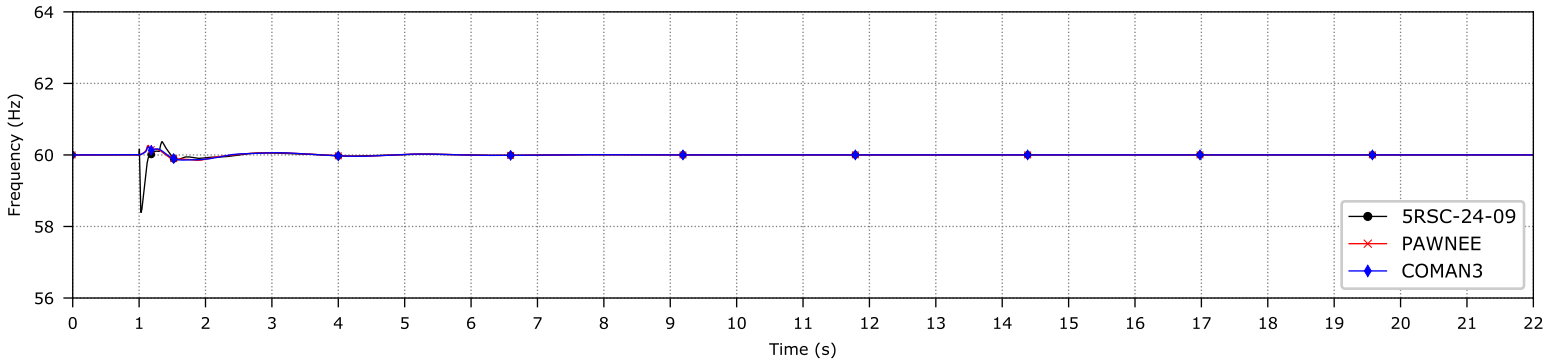

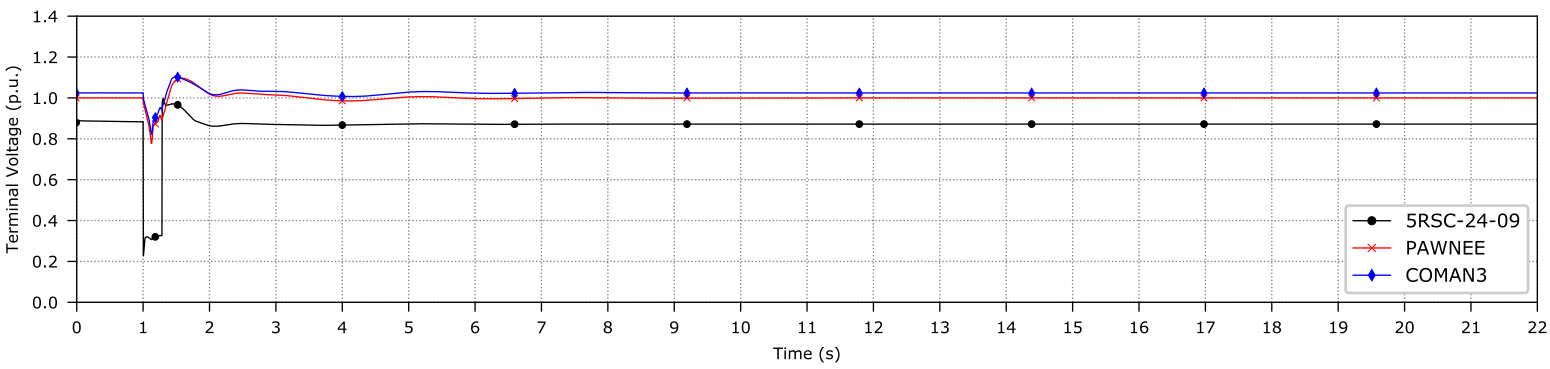

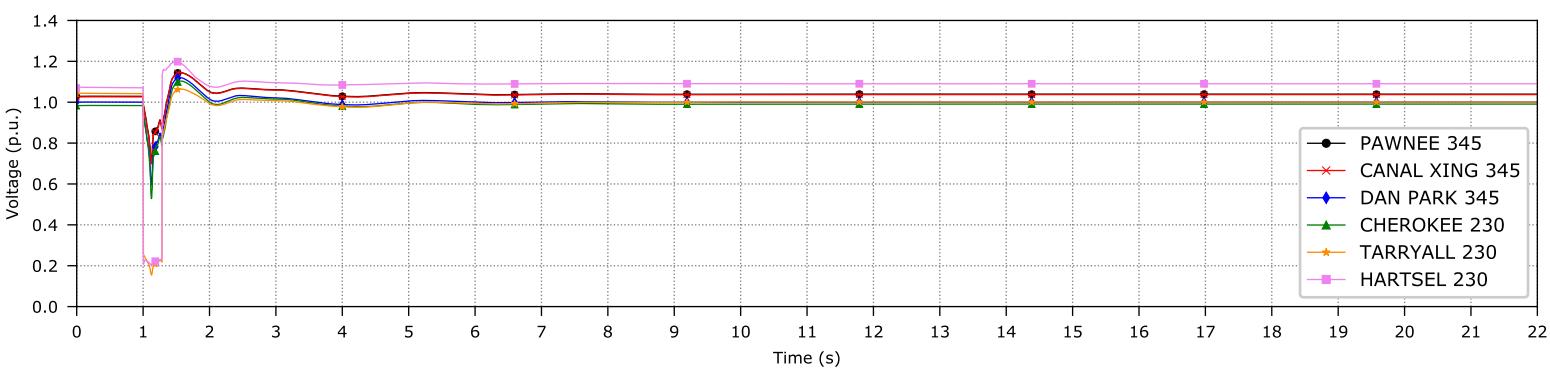

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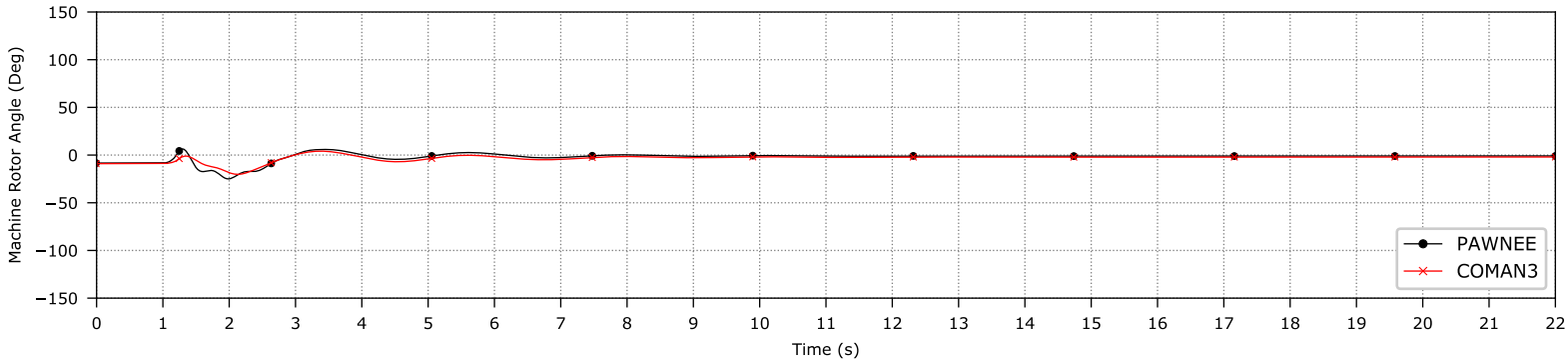
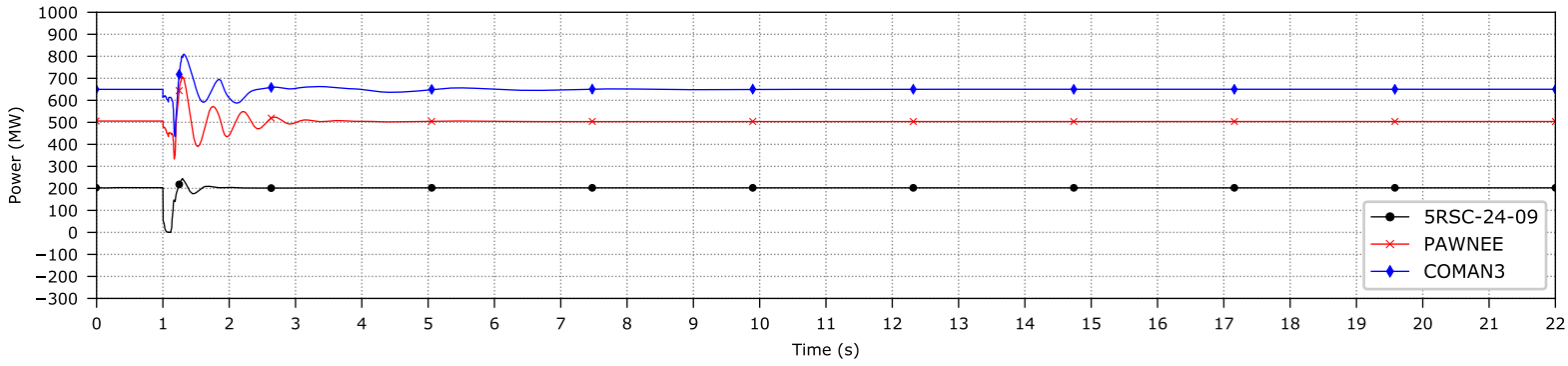
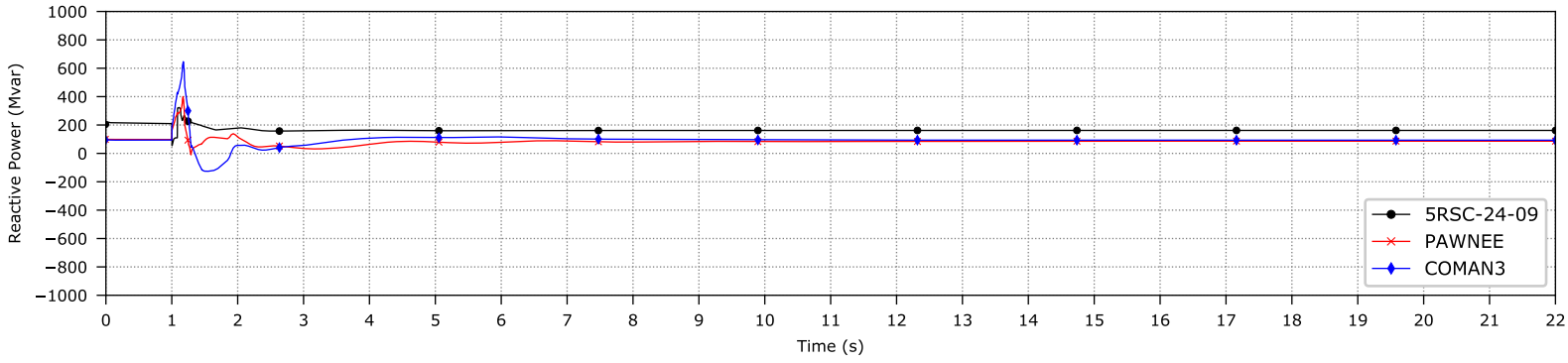
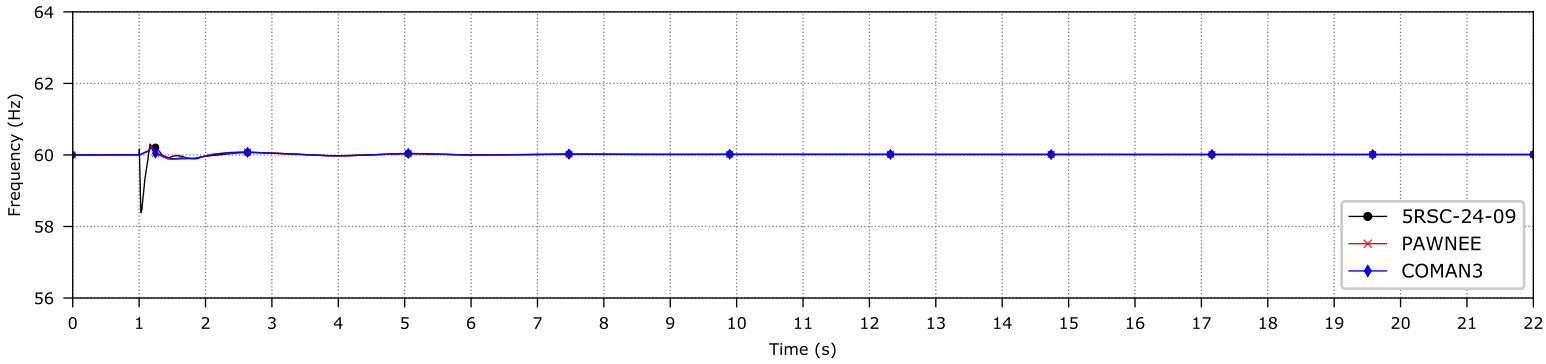
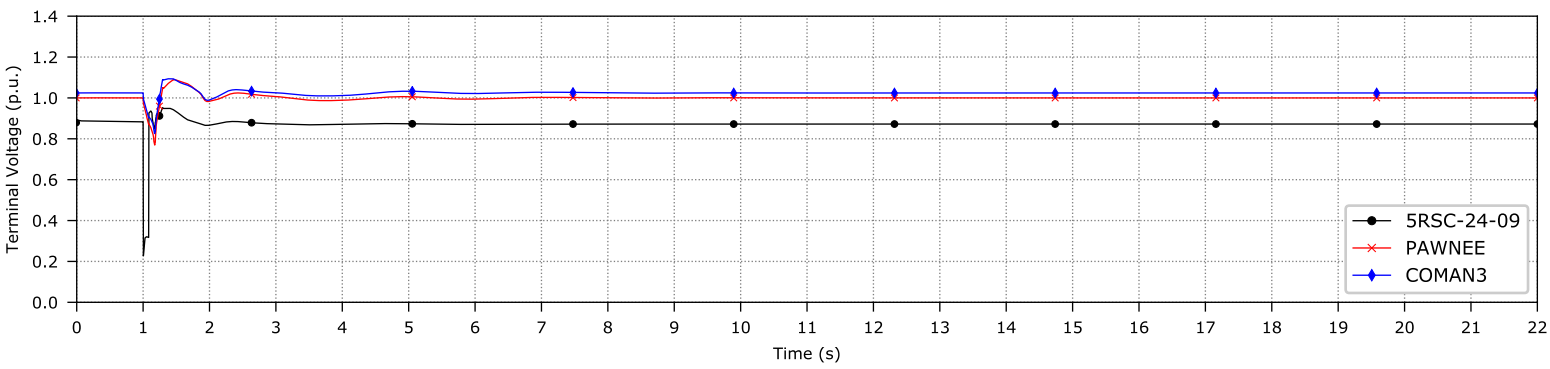
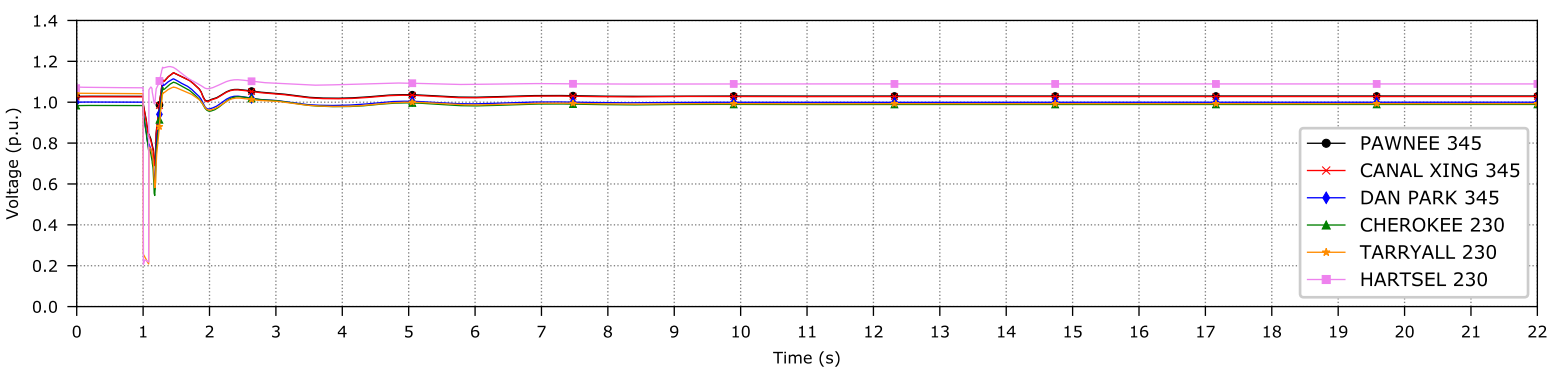






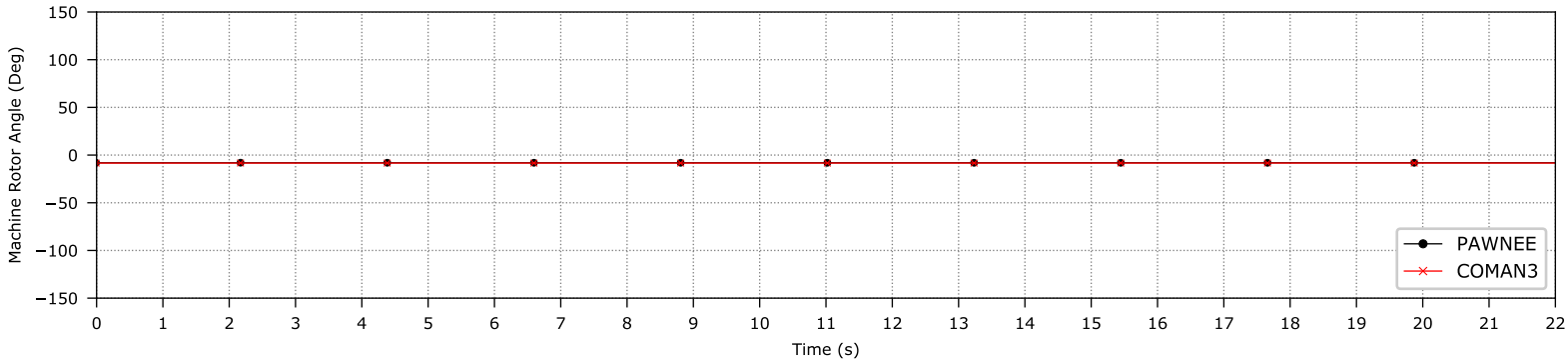


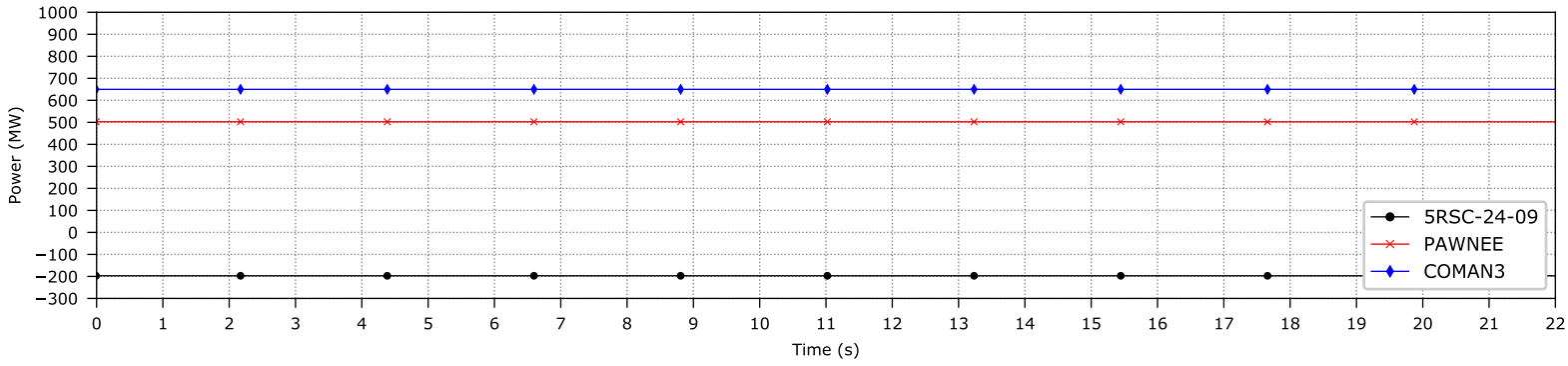


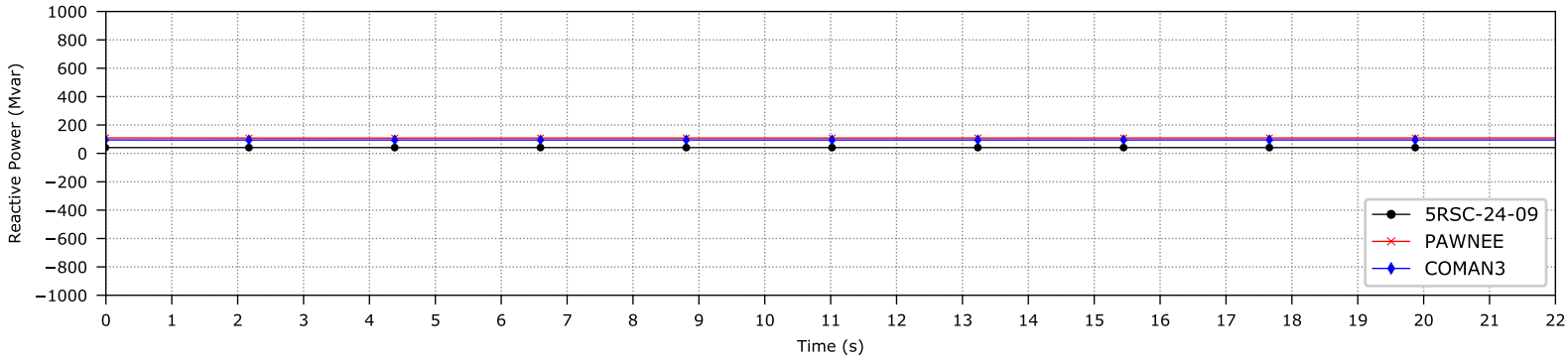


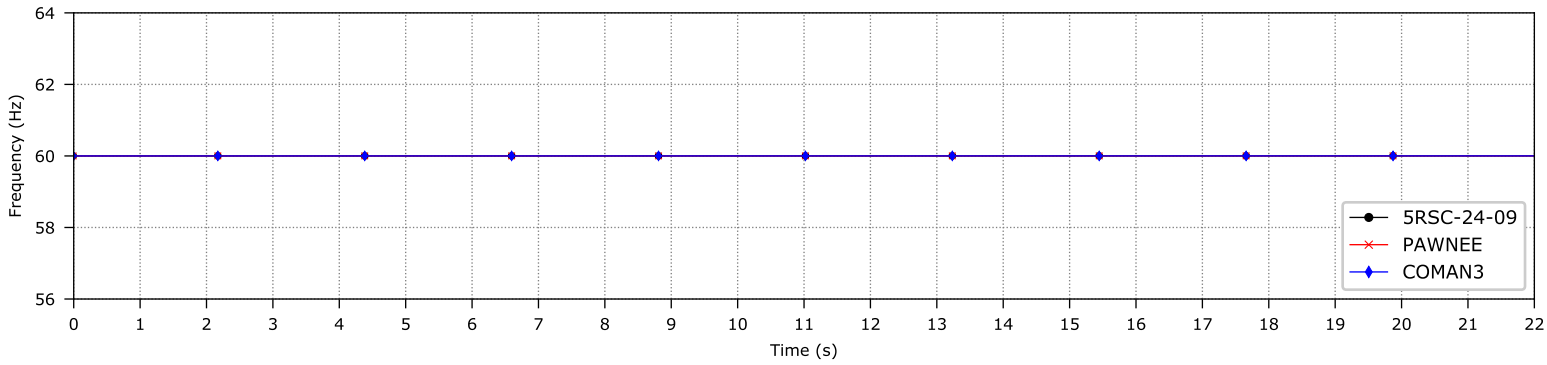
2028 WESTERN SLOPE GRID CHARGING – TRANSIENT STABILITY PLOTS

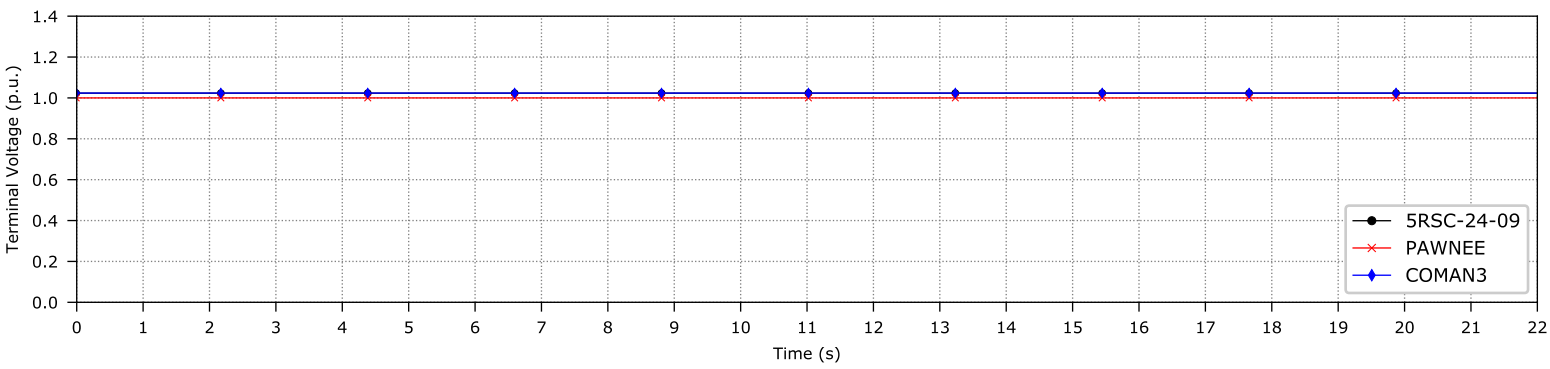
Ref. No. 01 - Flatrun

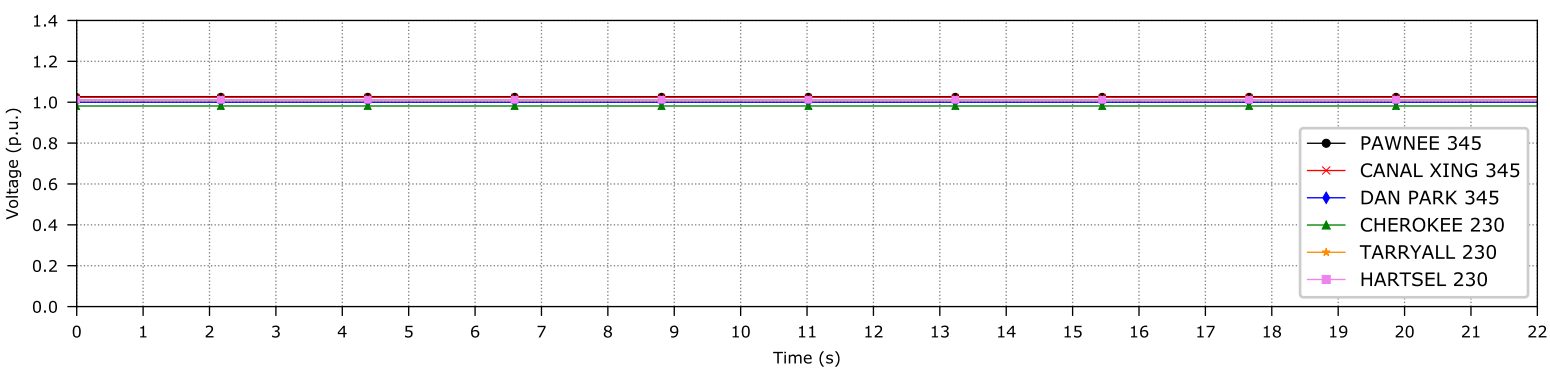




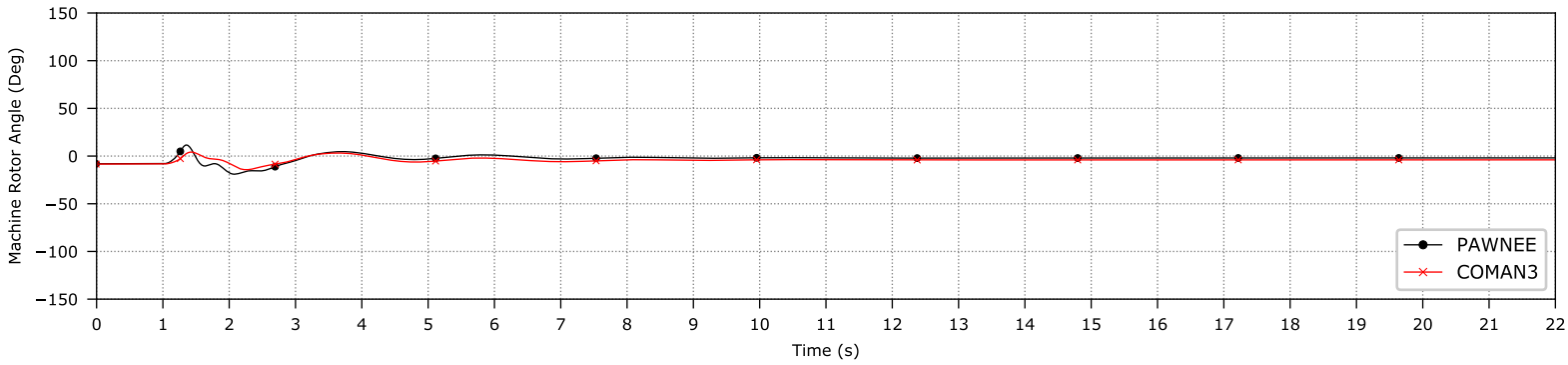


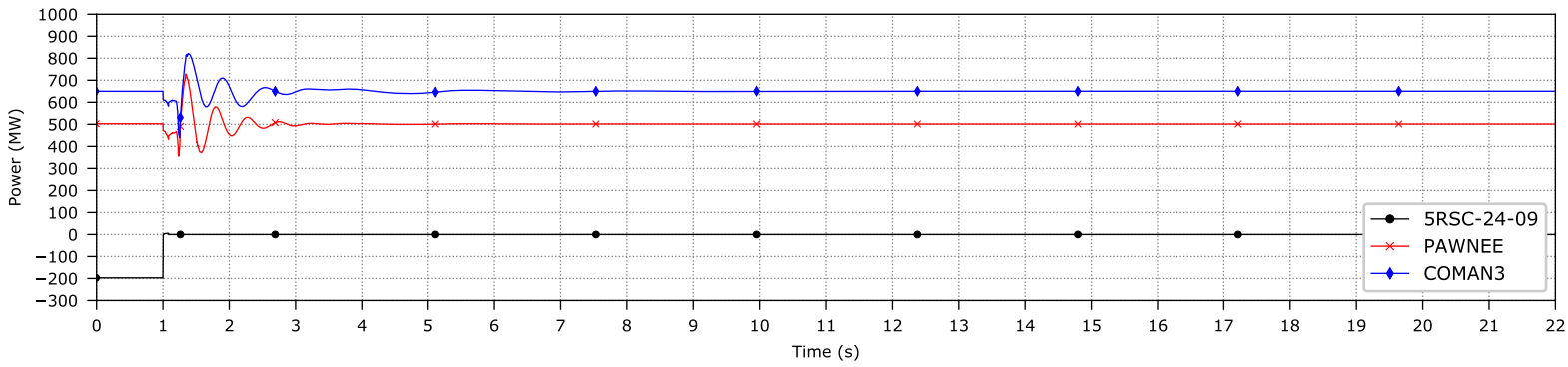


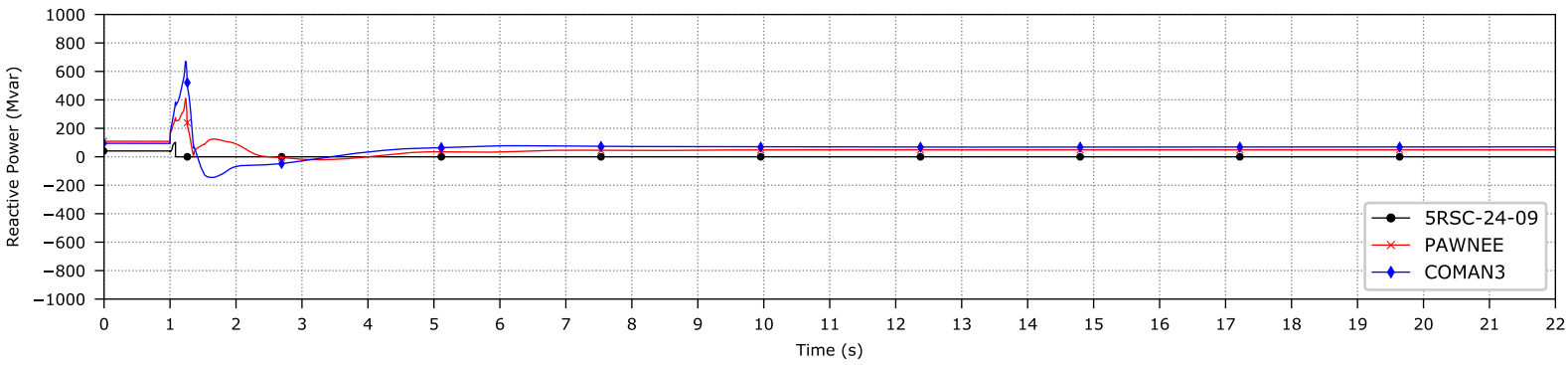


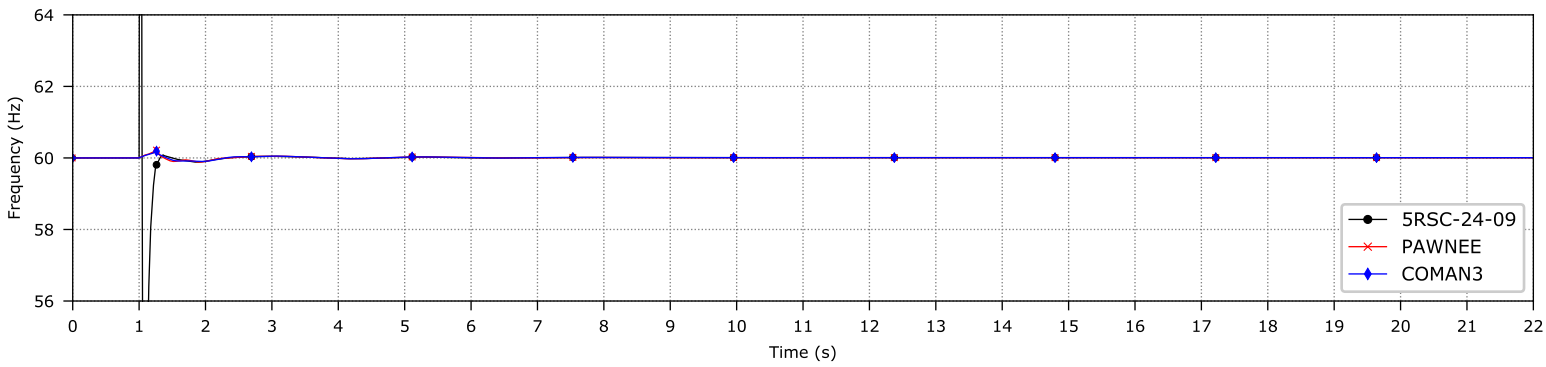


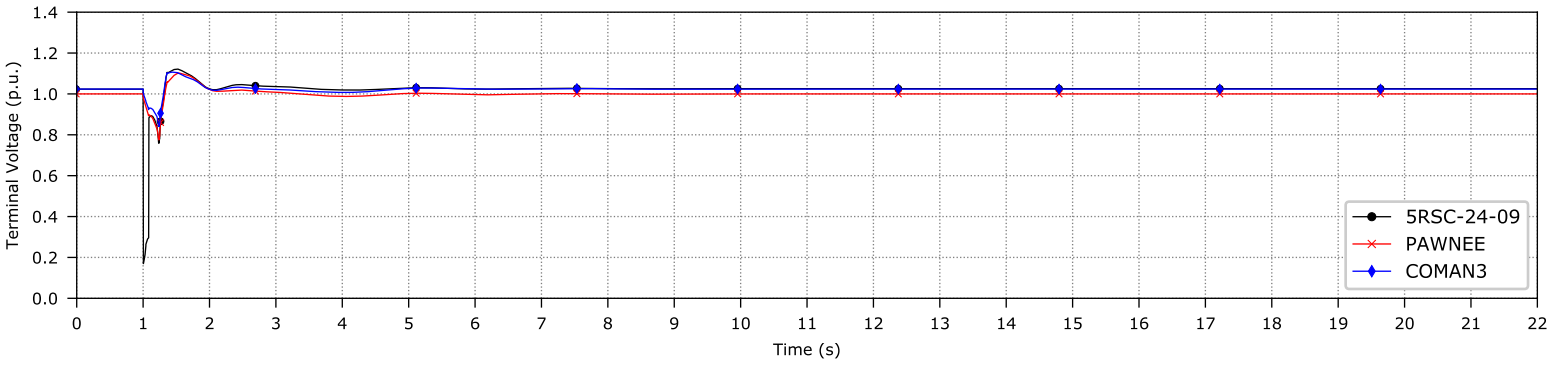
Ref. No. 02 - 5RSC-2024-09

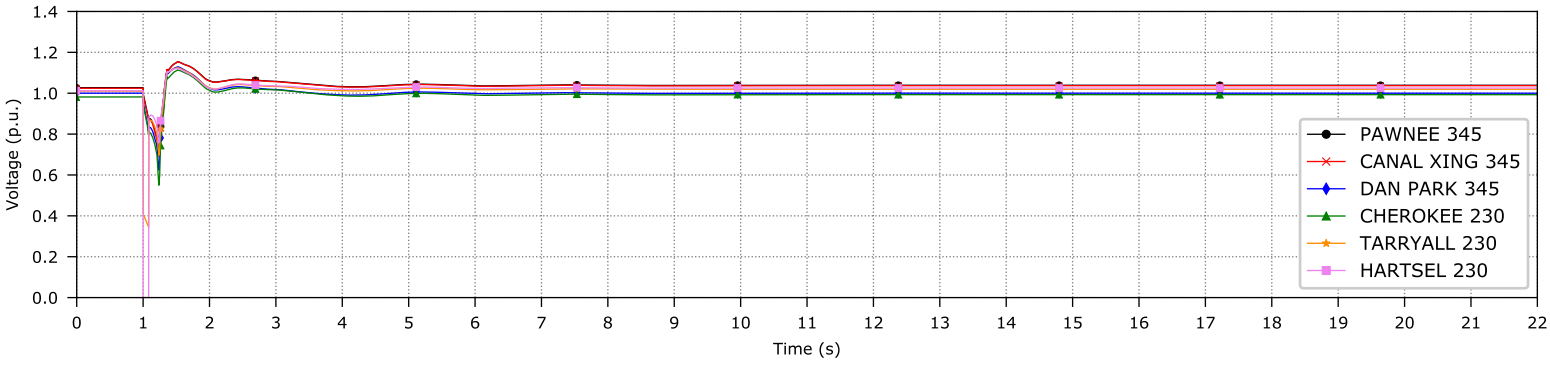




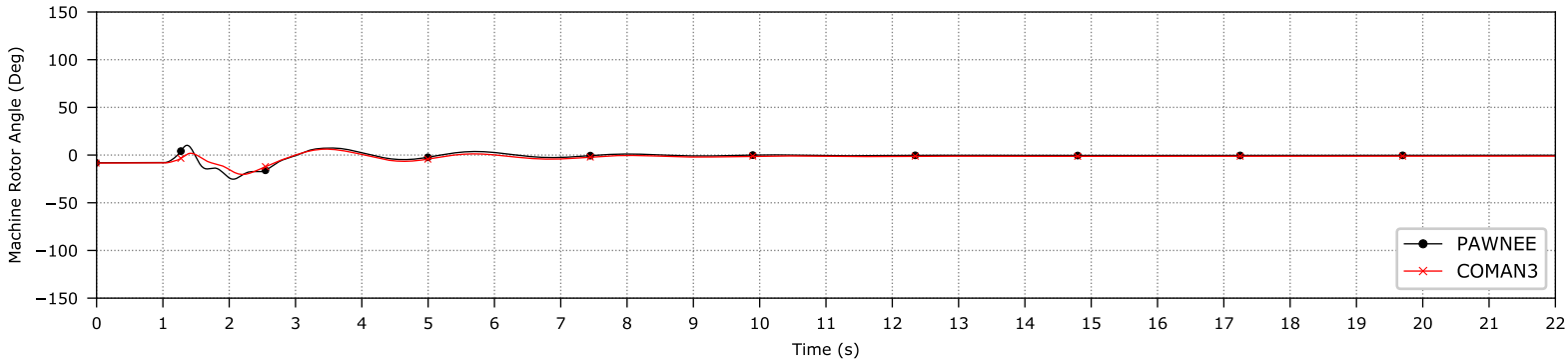


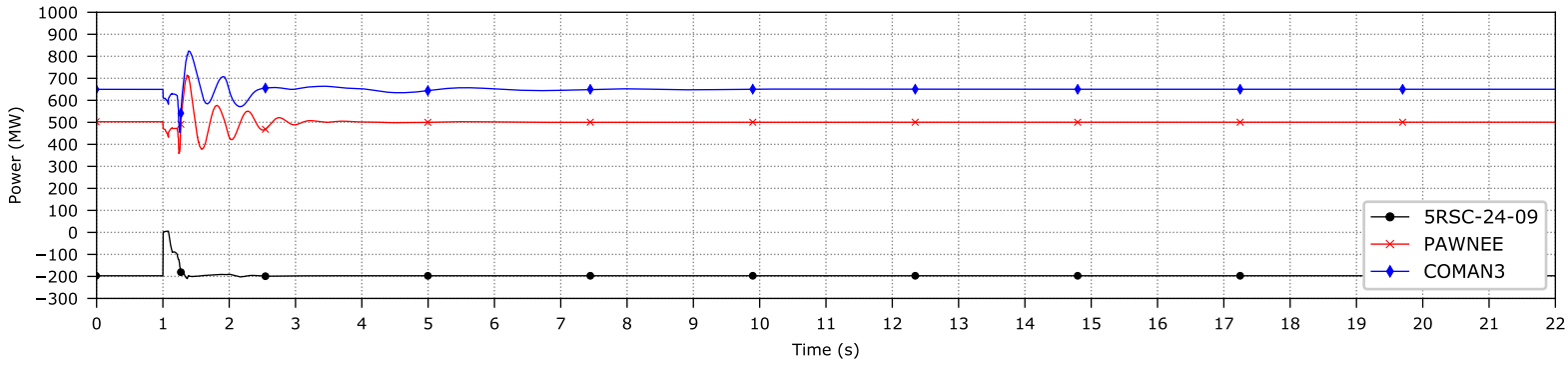


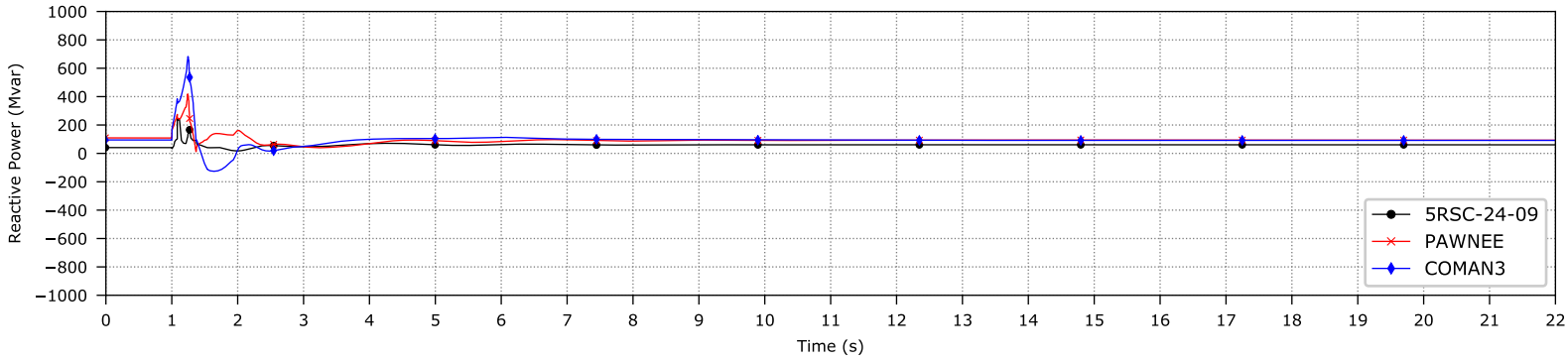


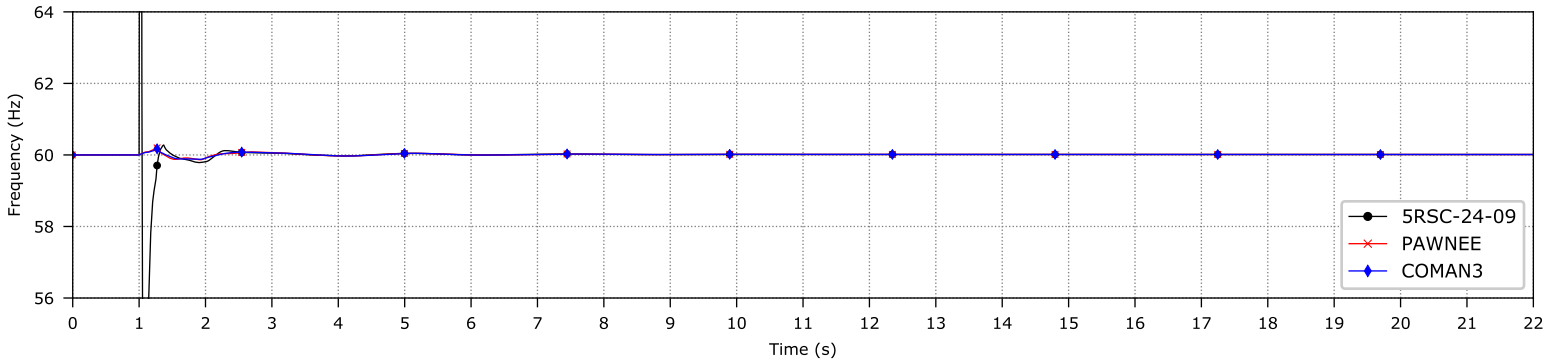


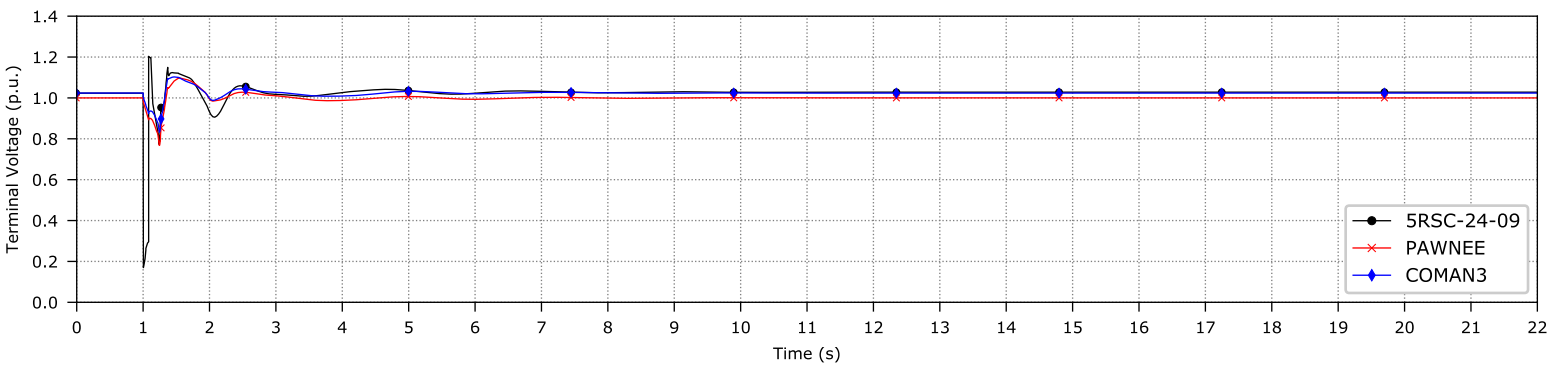
Ref. No. 03 - LoTC_29

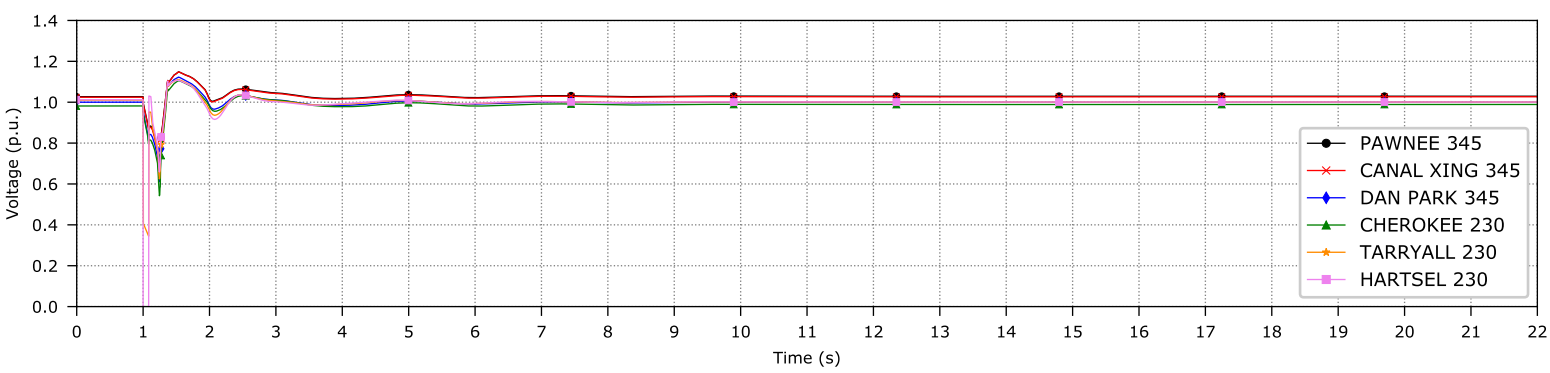




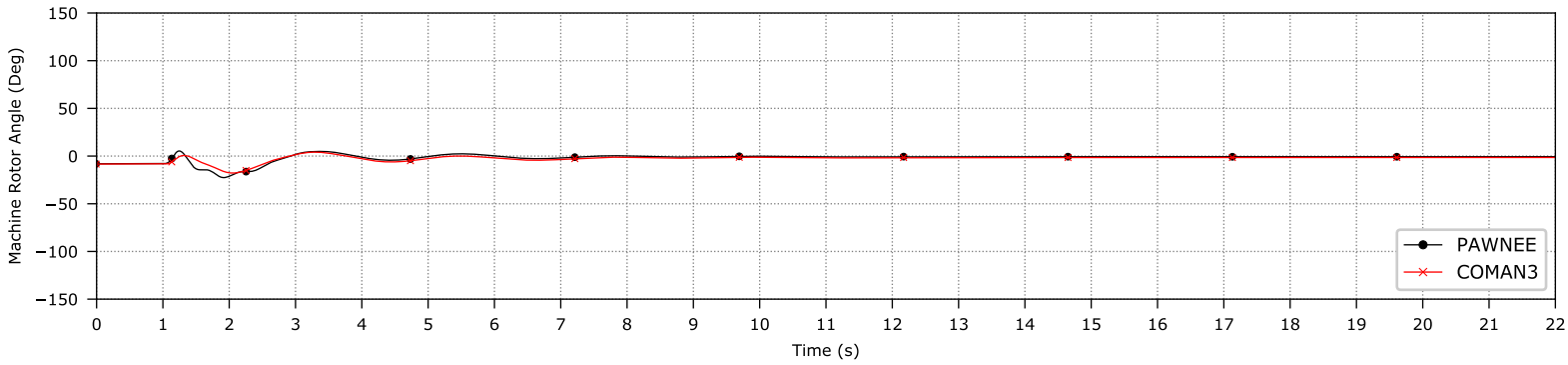


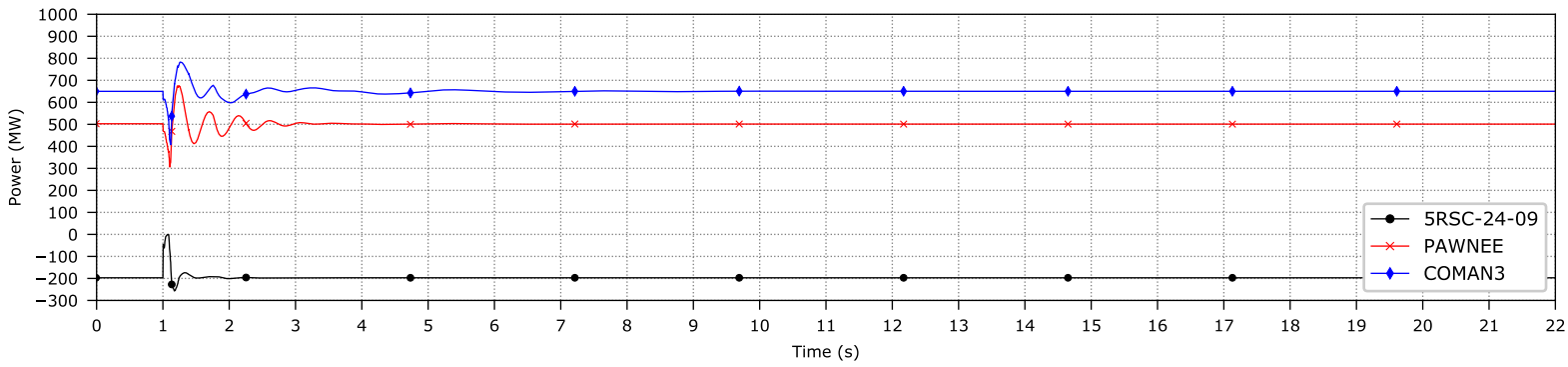


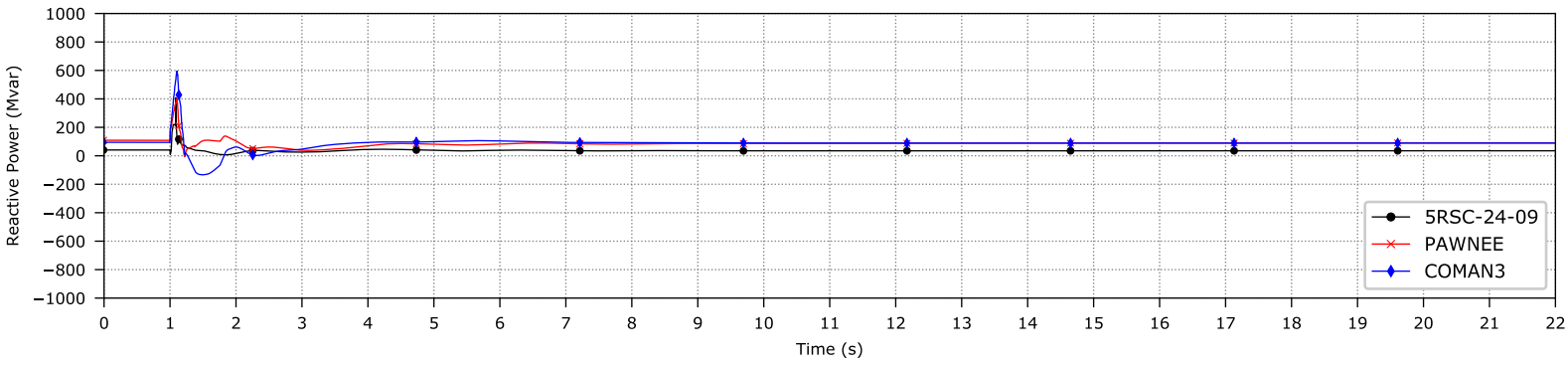


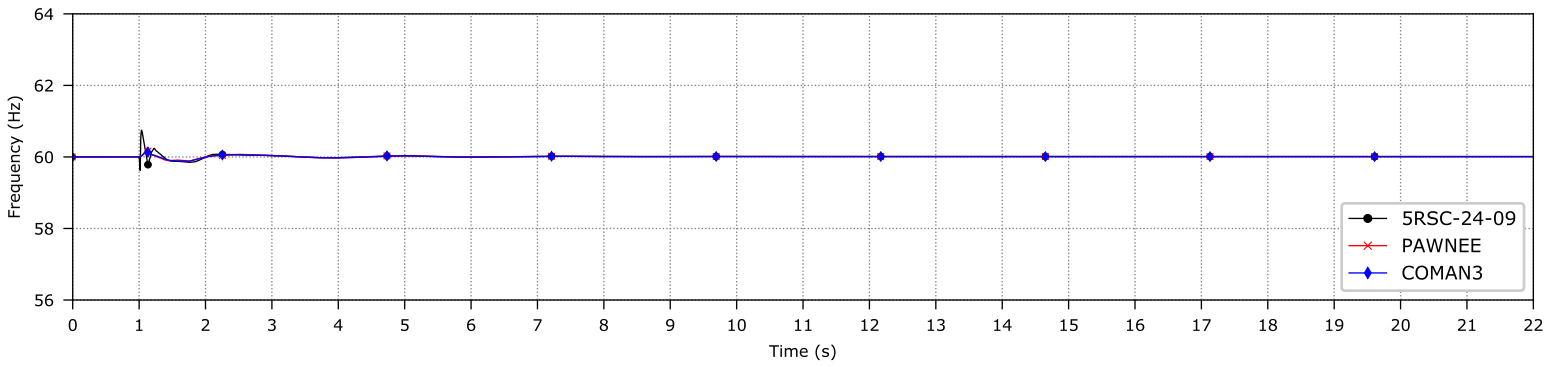


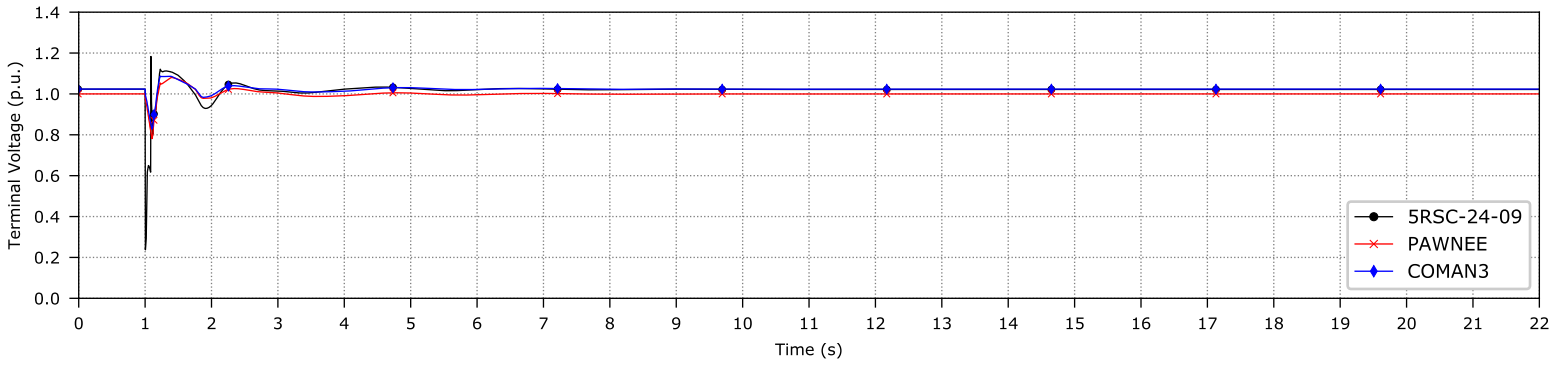
Ref. No. 04 - LoTC_30

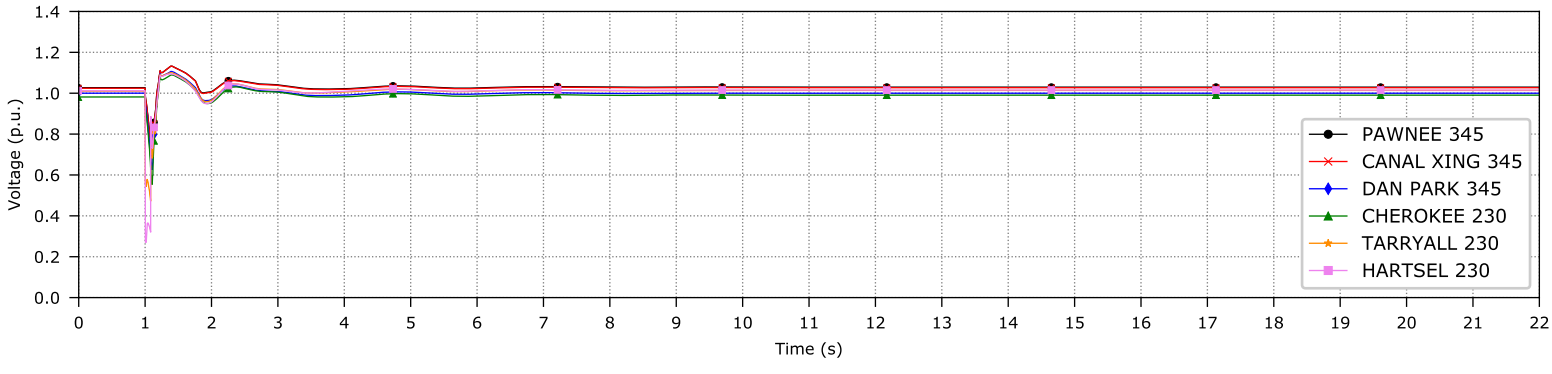












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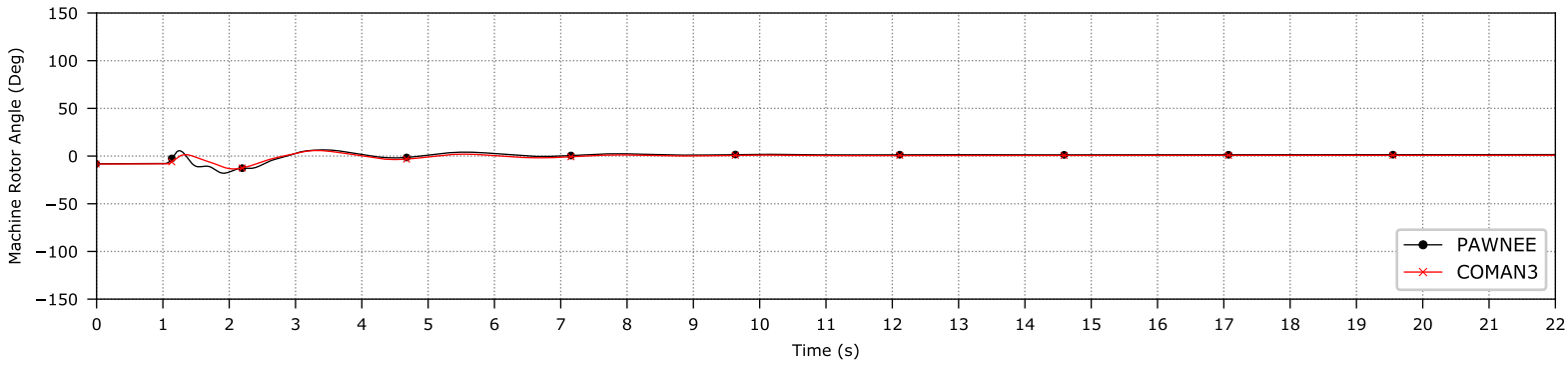

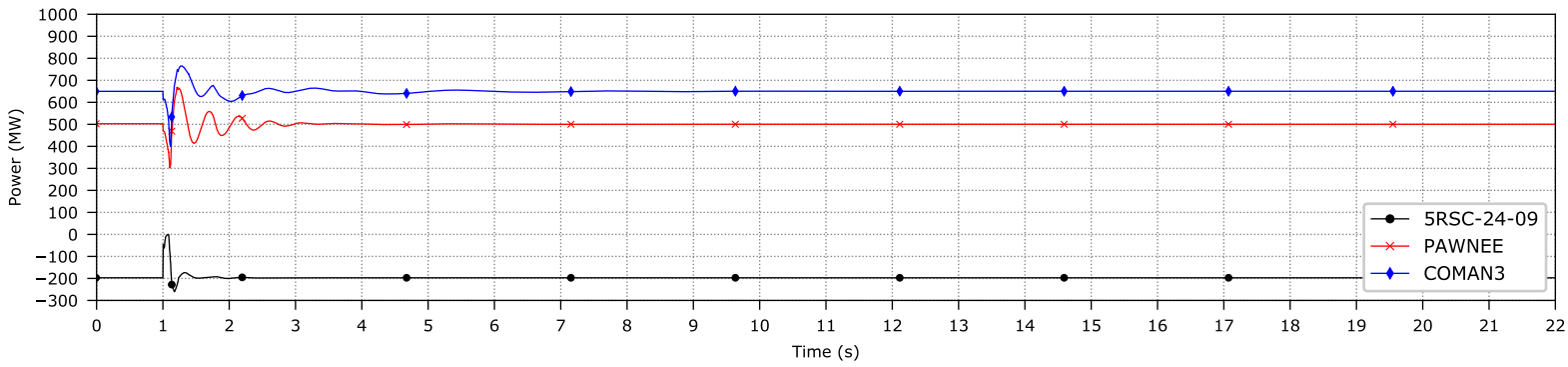

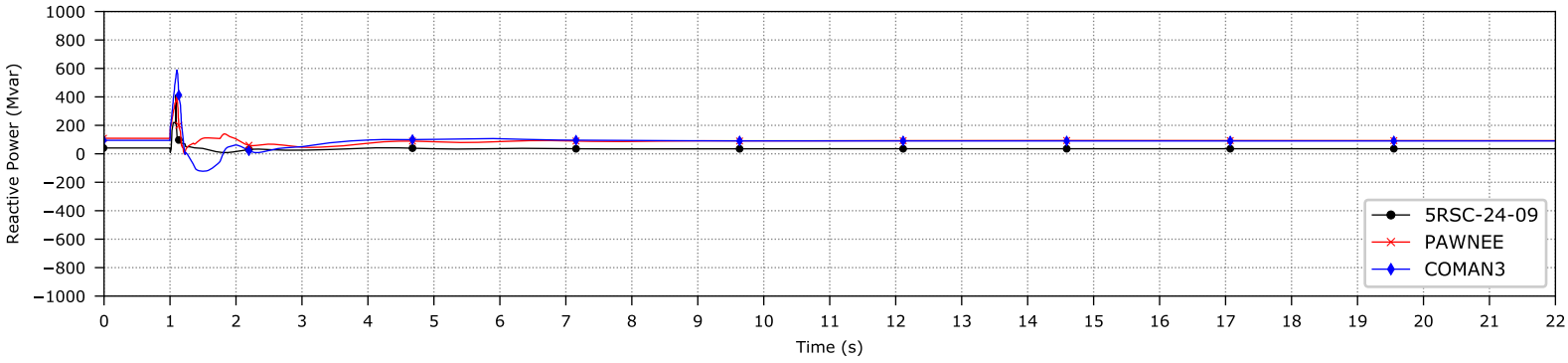

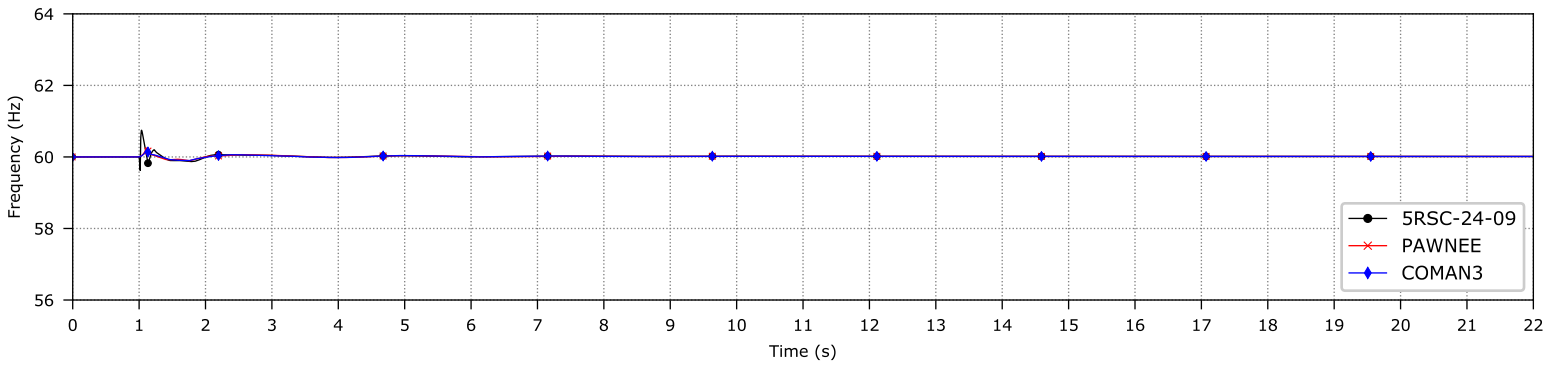

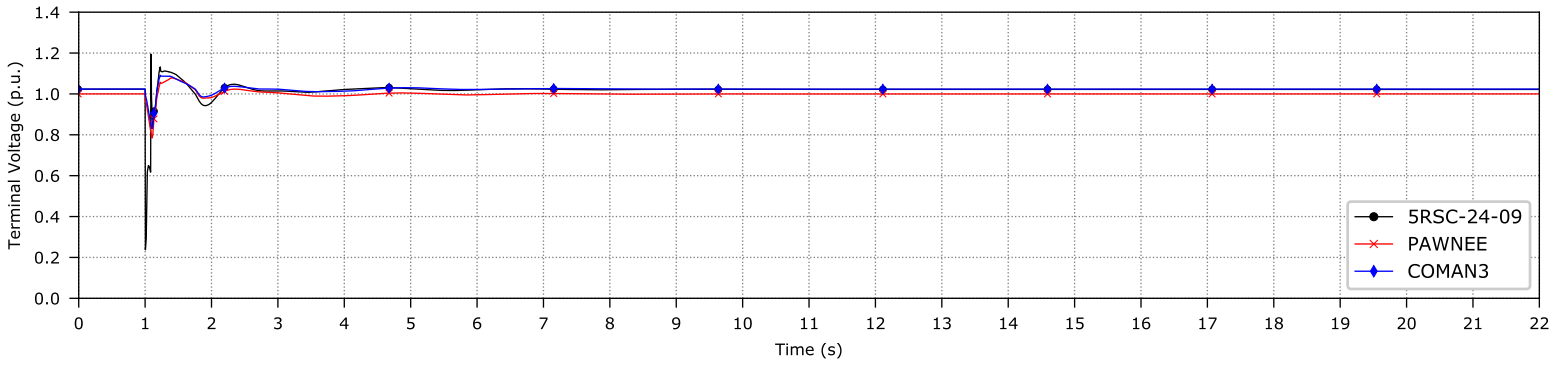

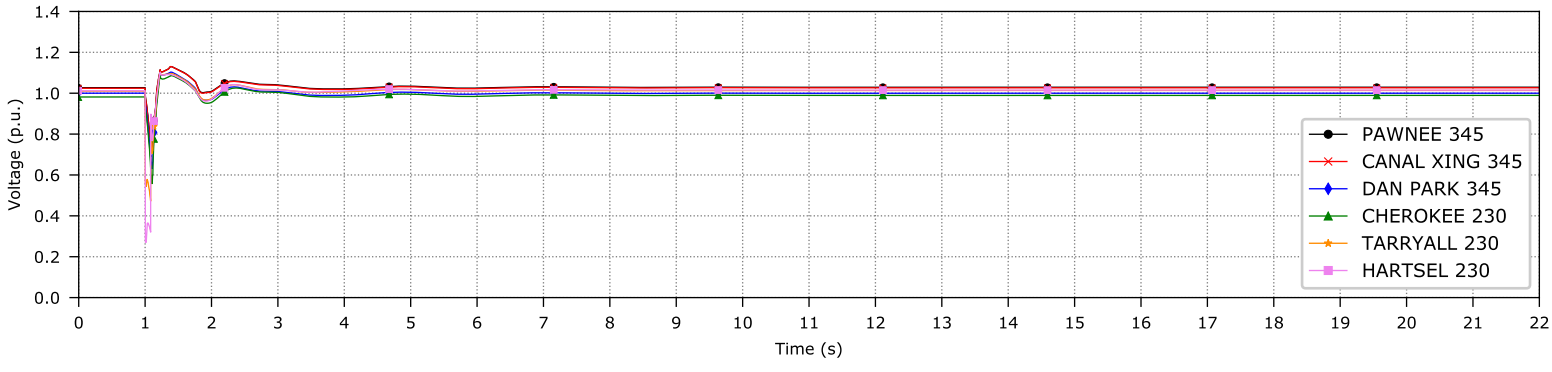

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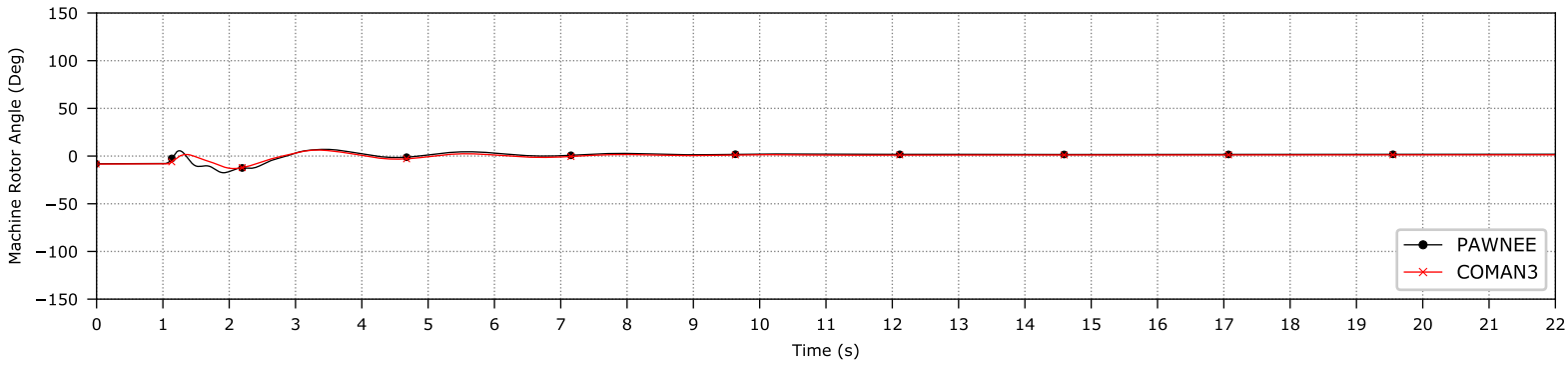

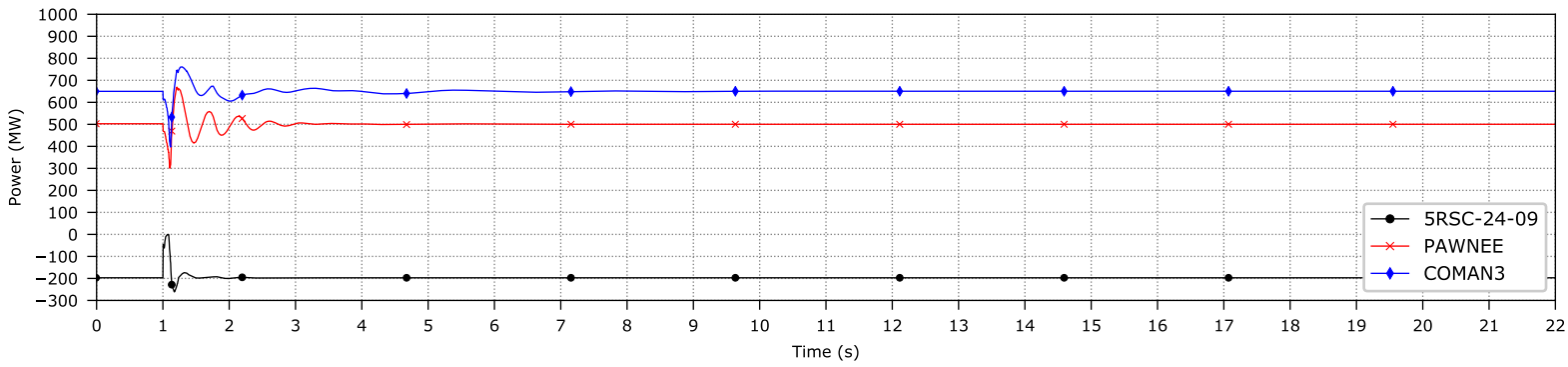

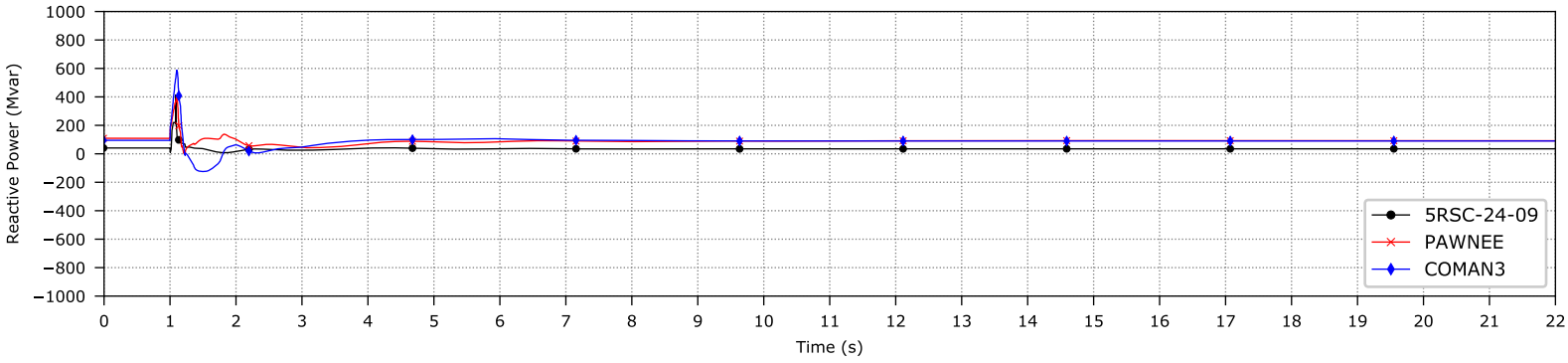

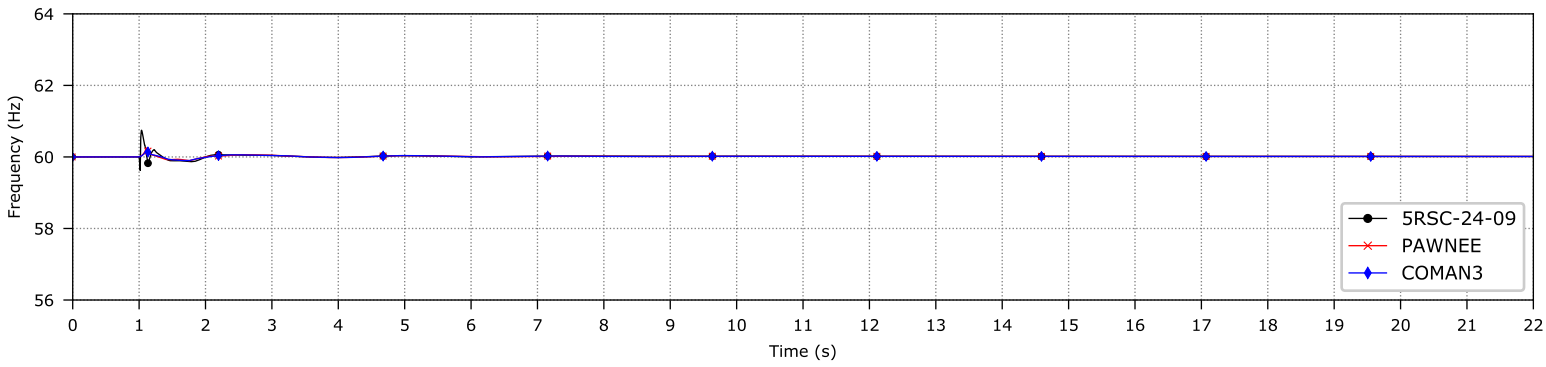

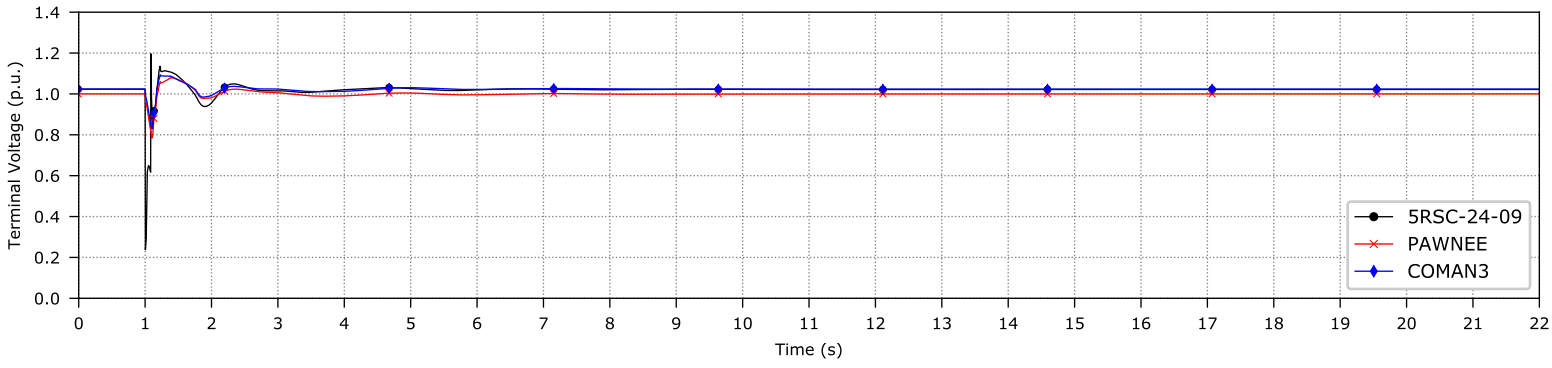

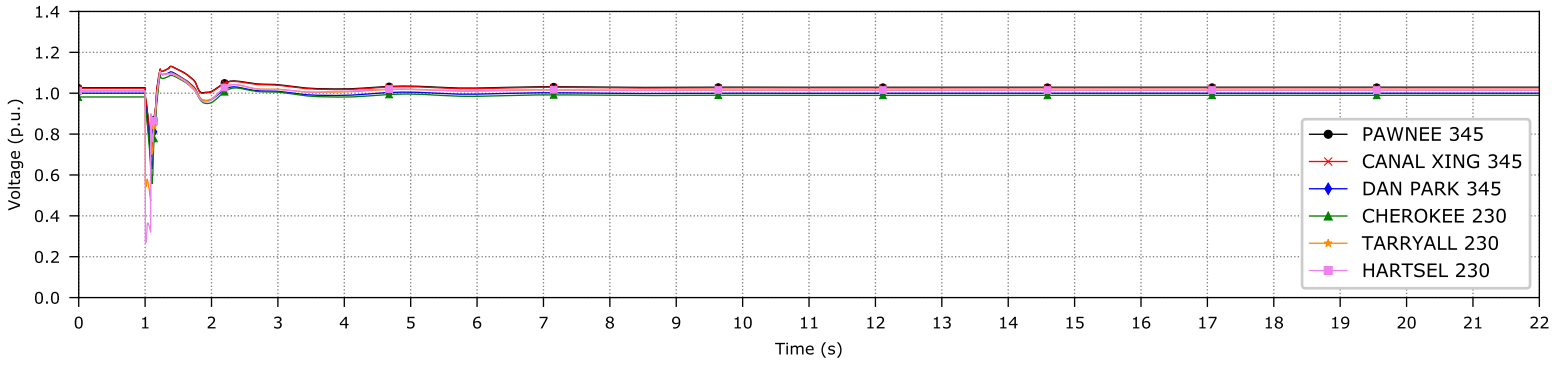

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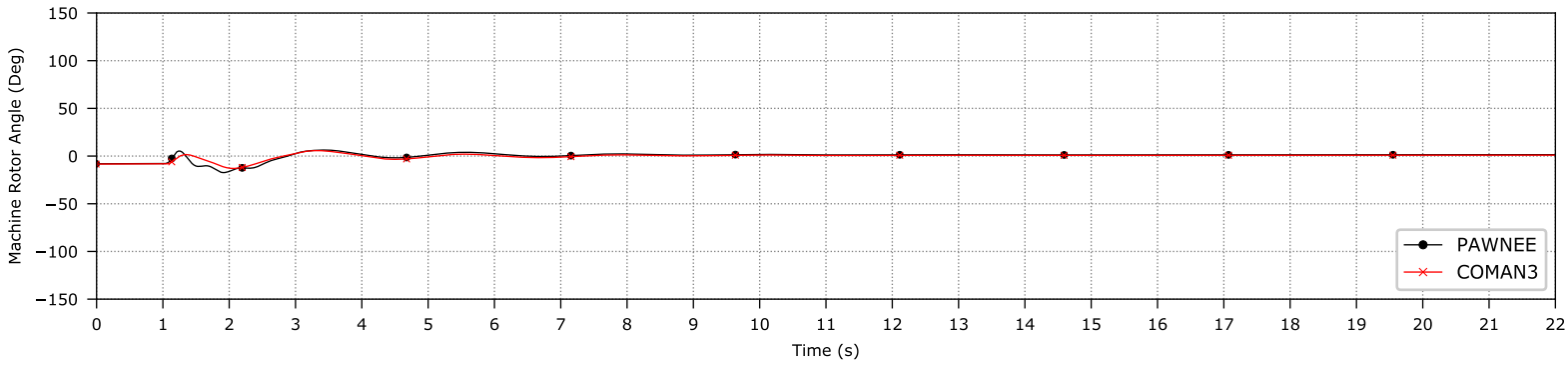

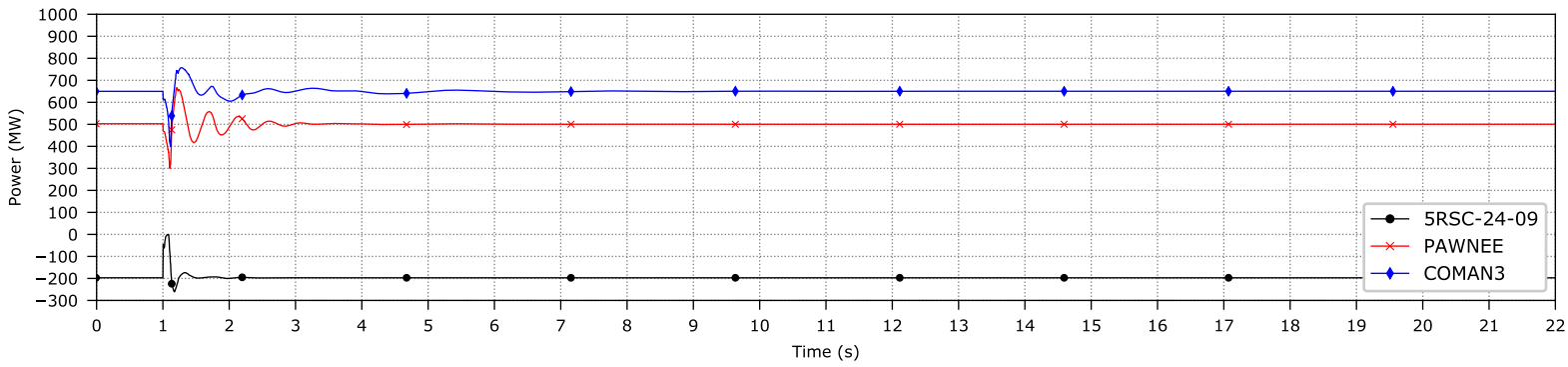

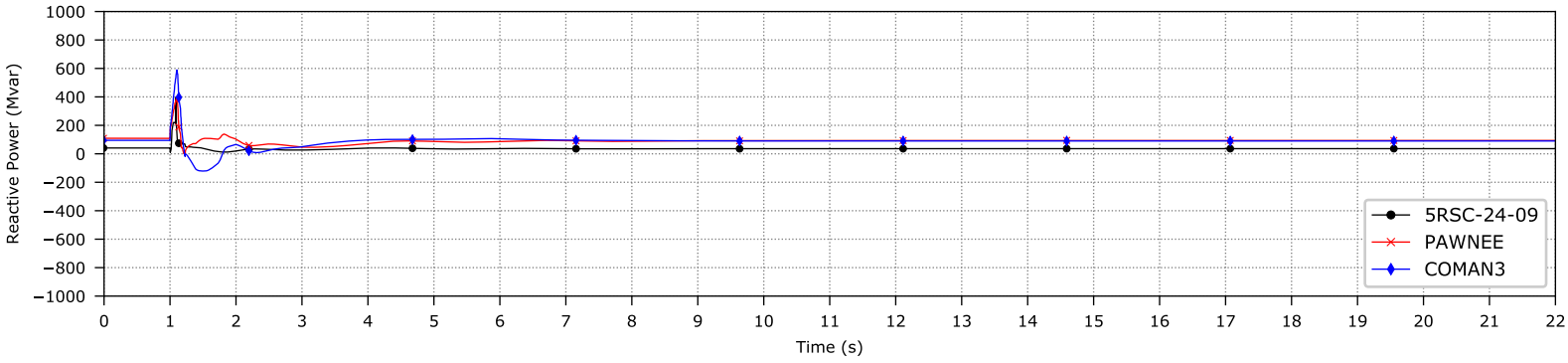

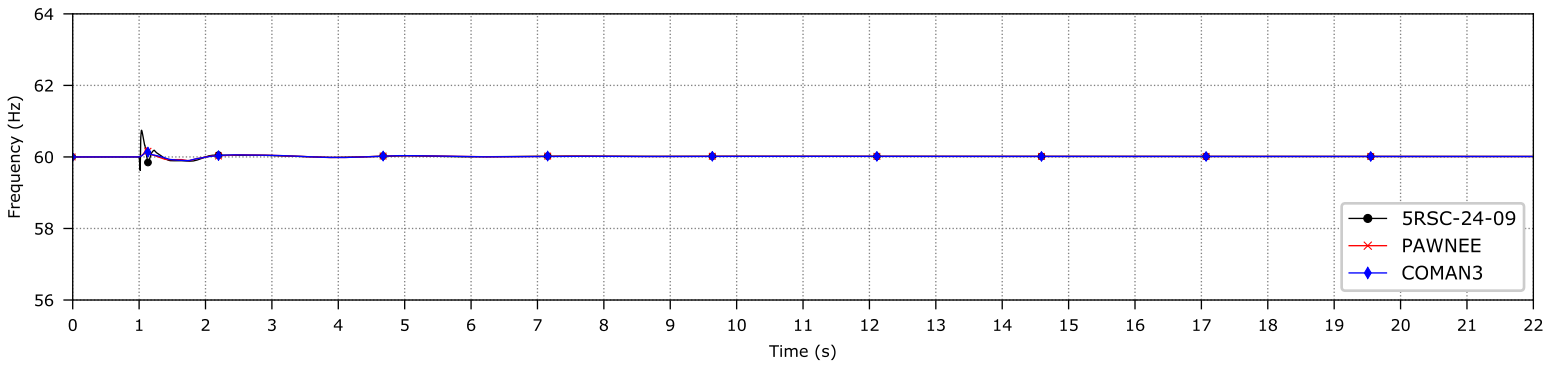

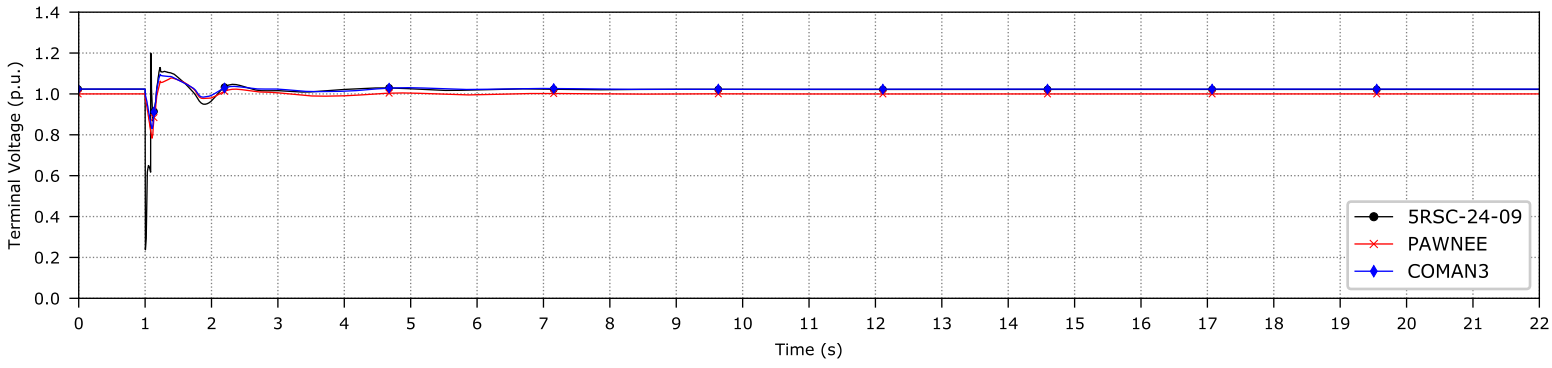

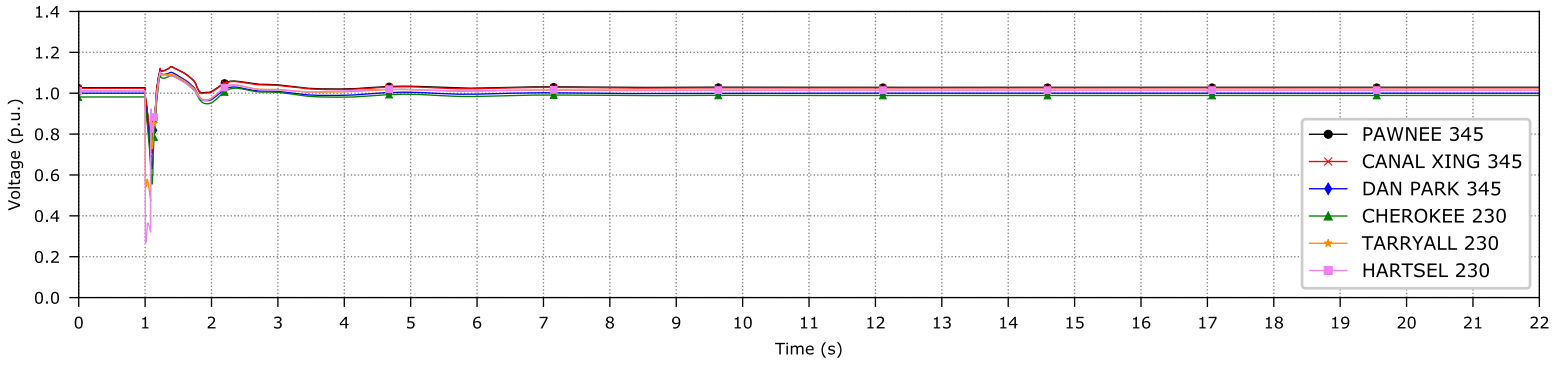

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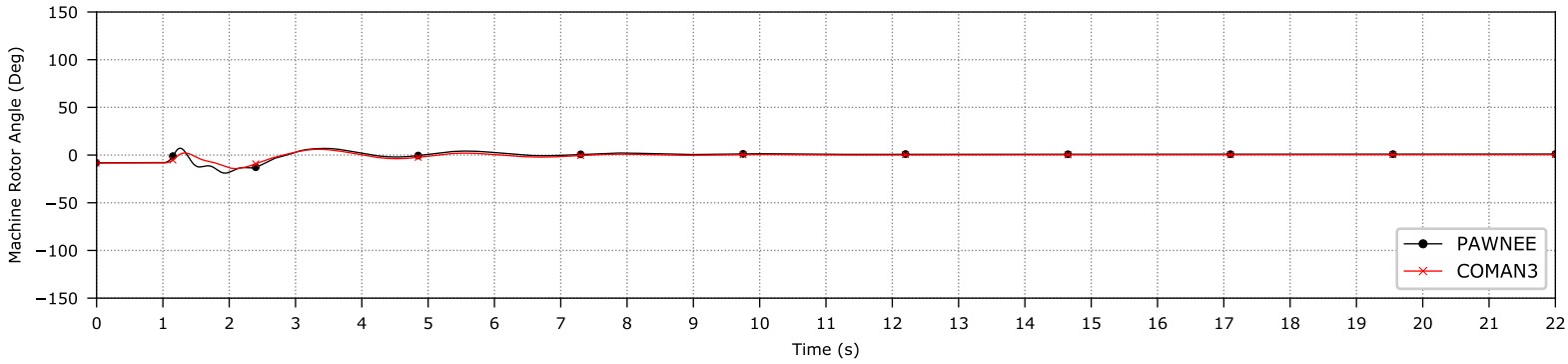

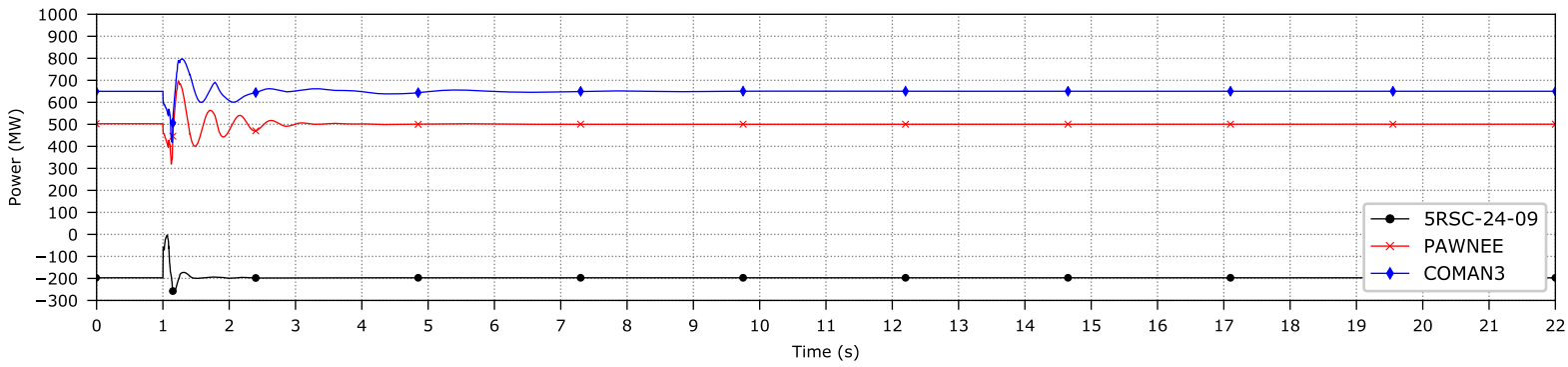

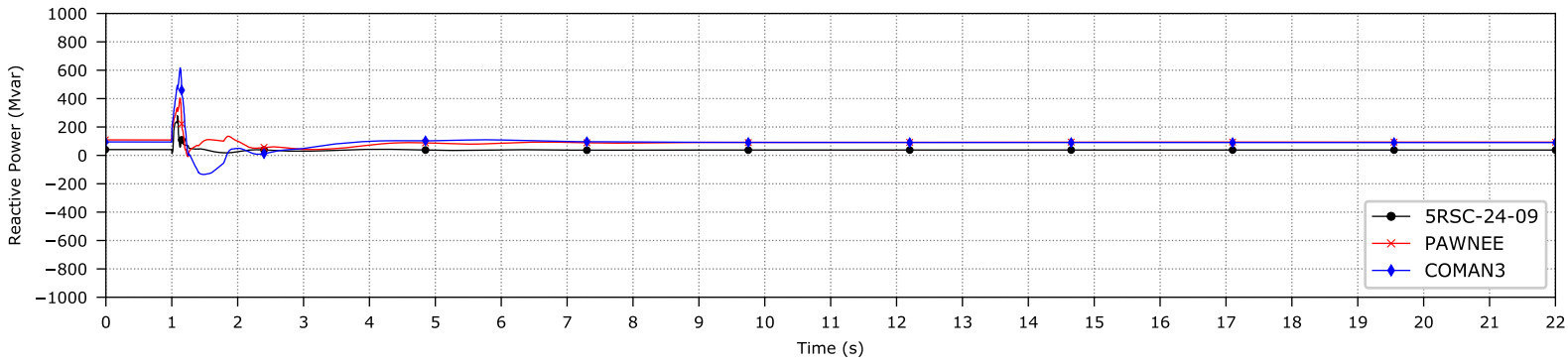

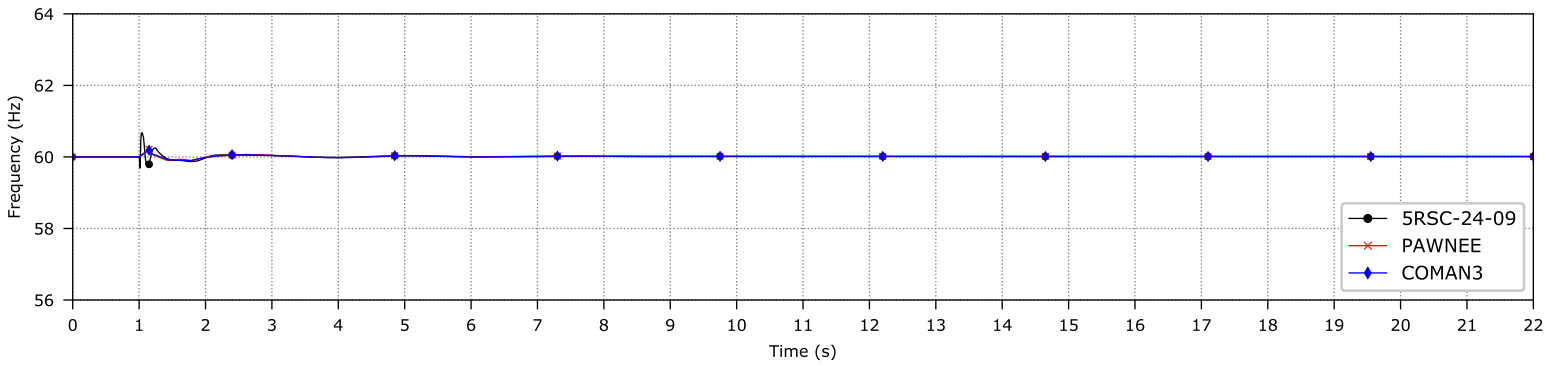

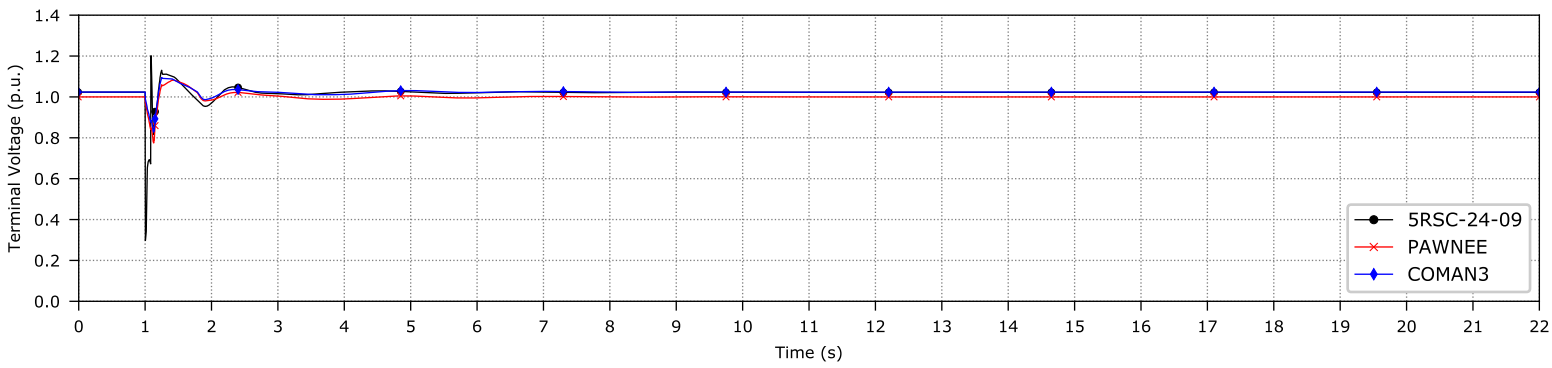

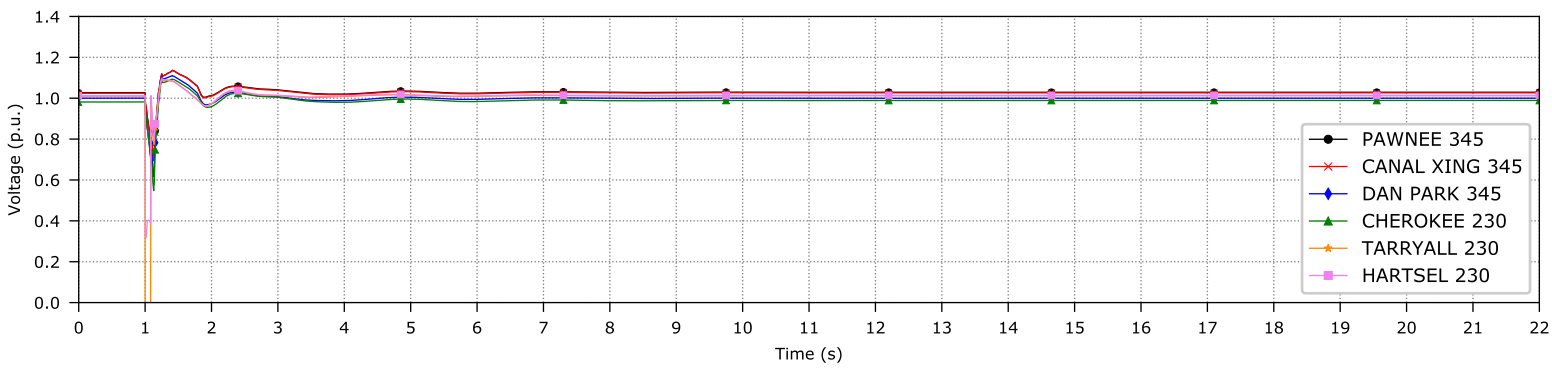

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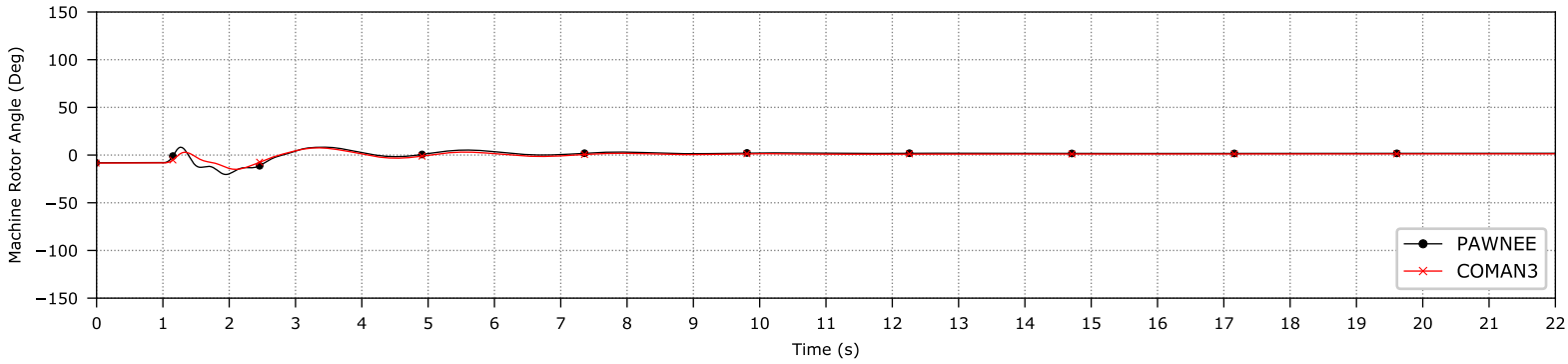

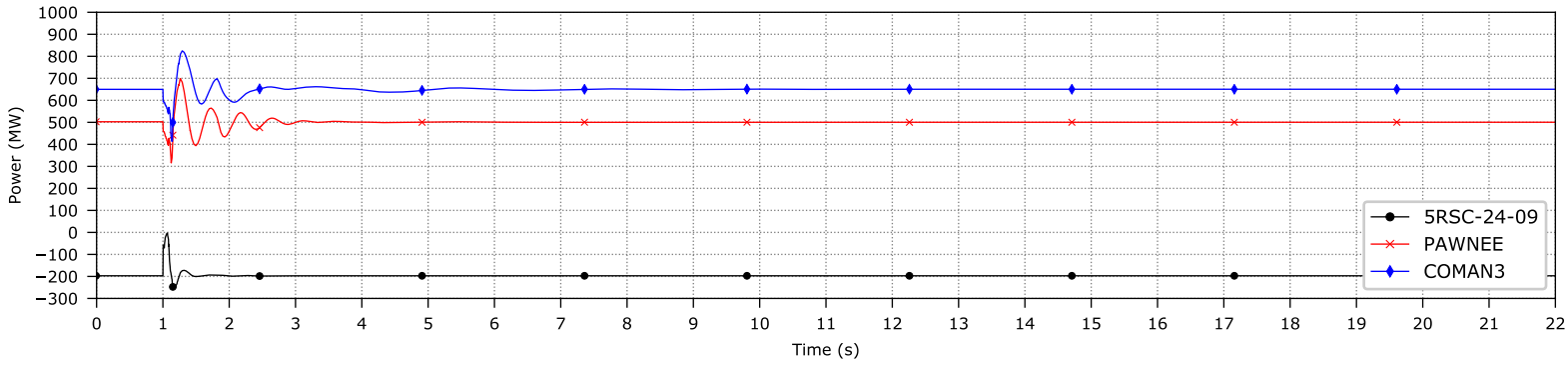

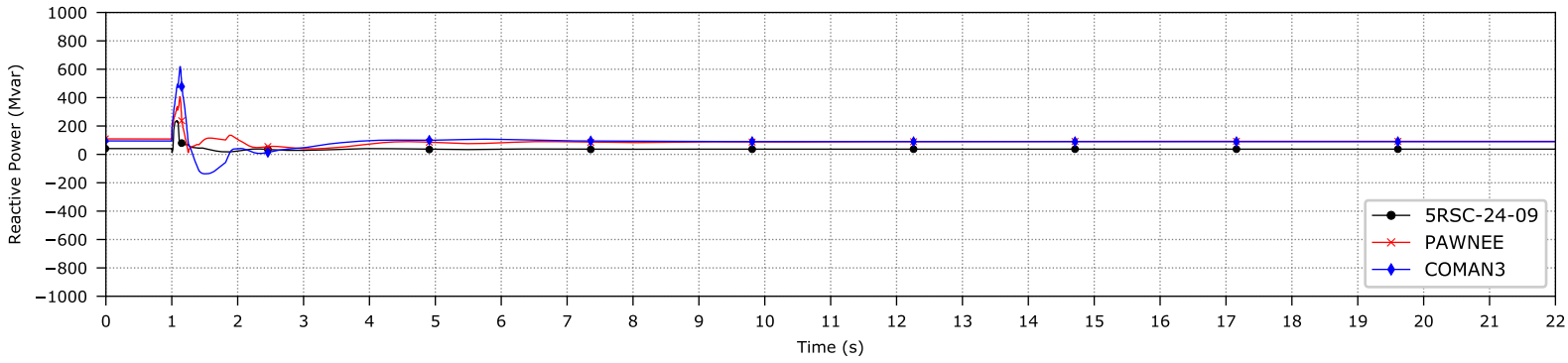

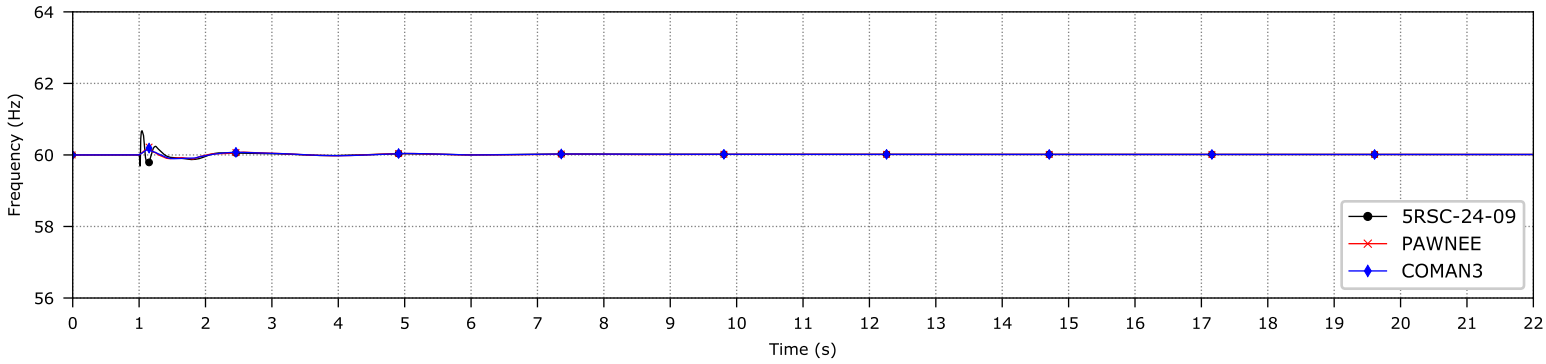

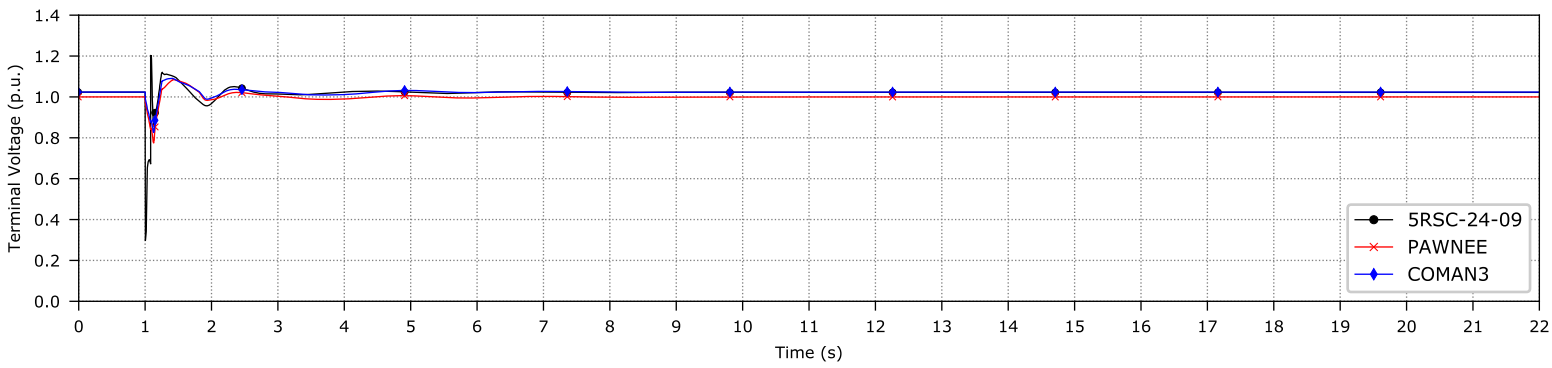

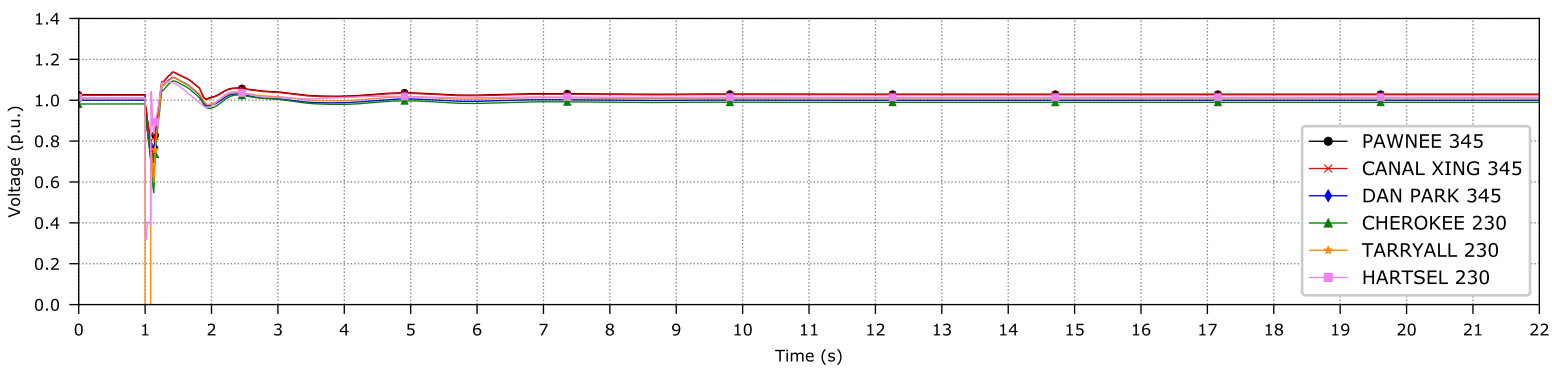

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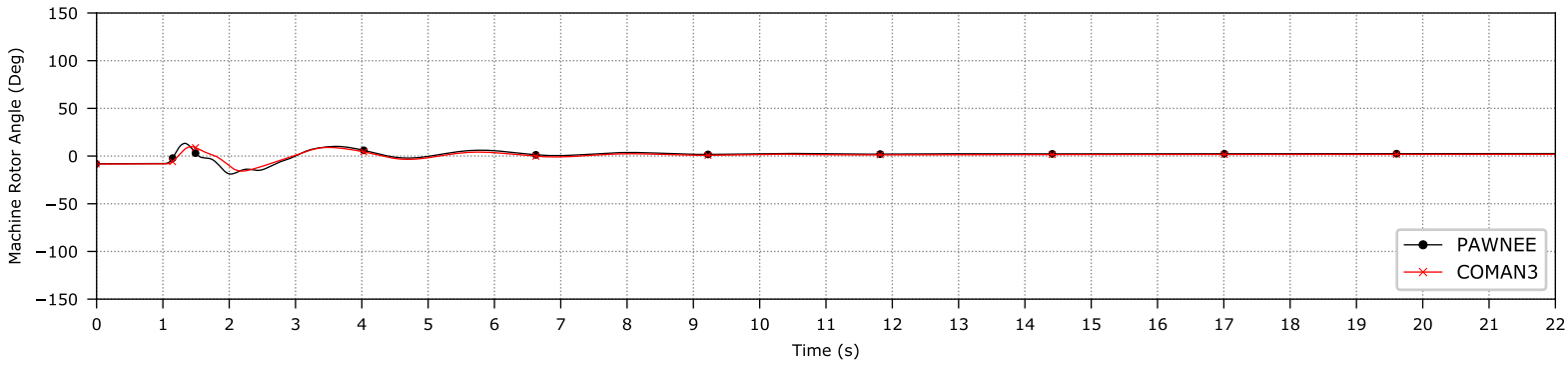

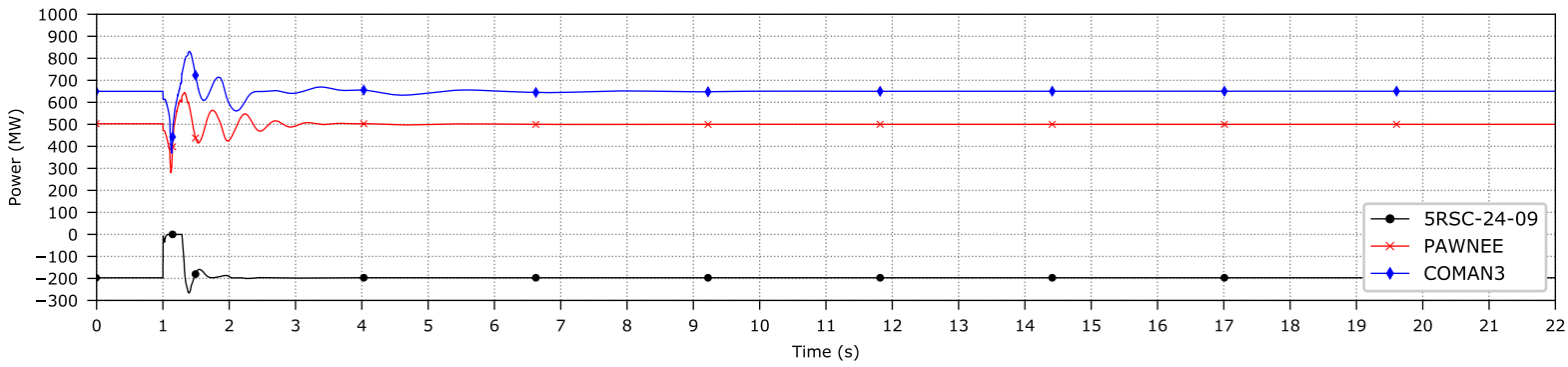

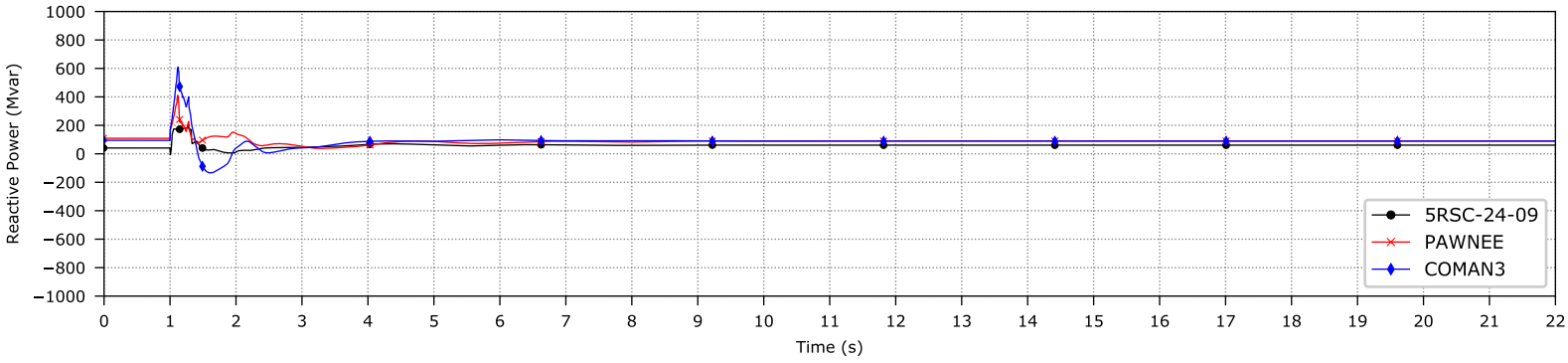

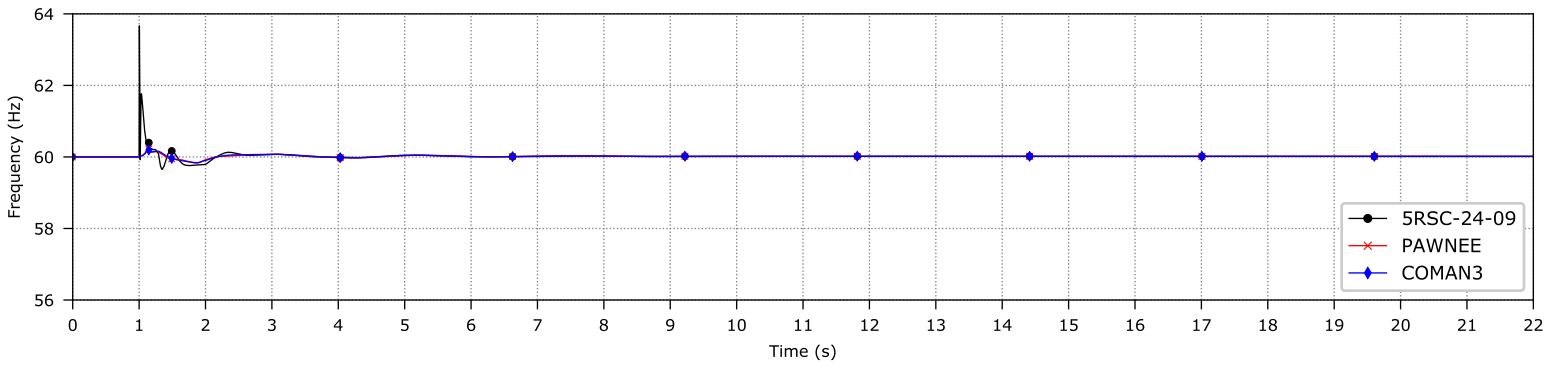

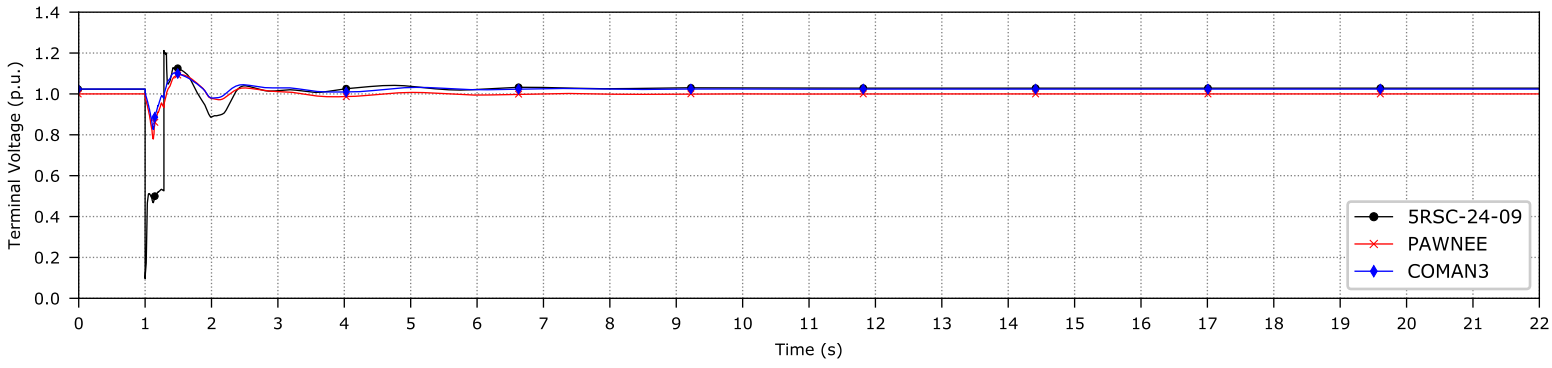

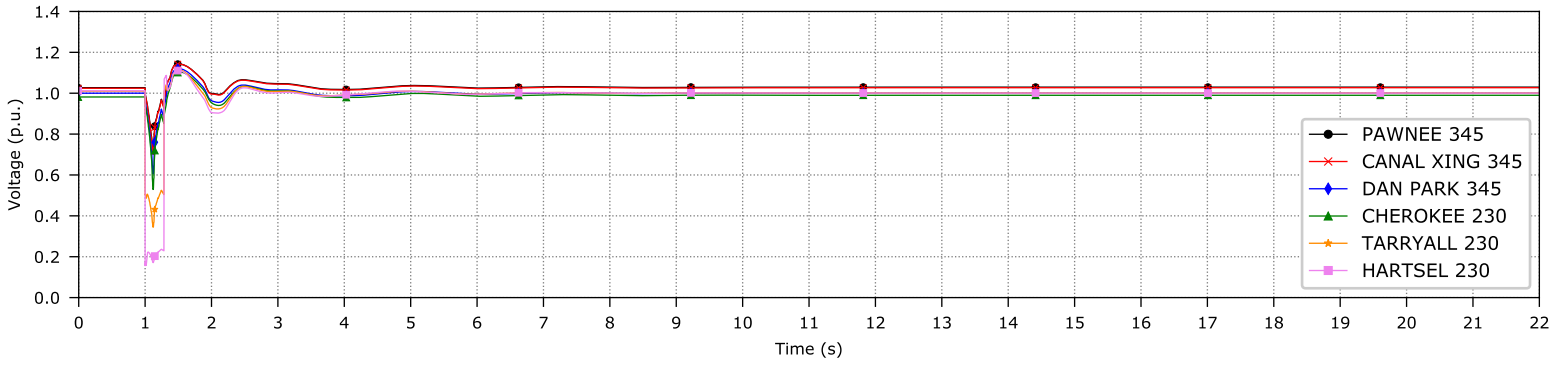

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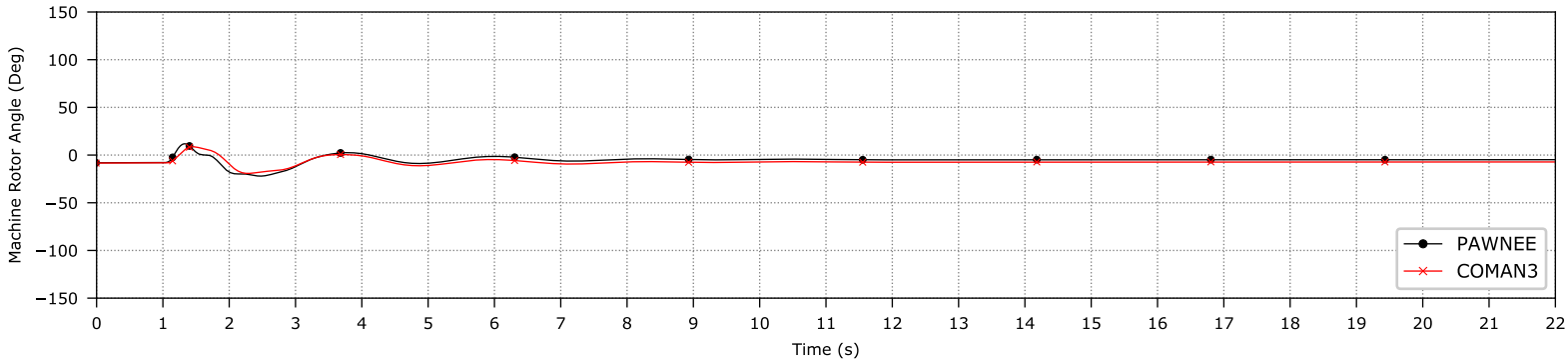
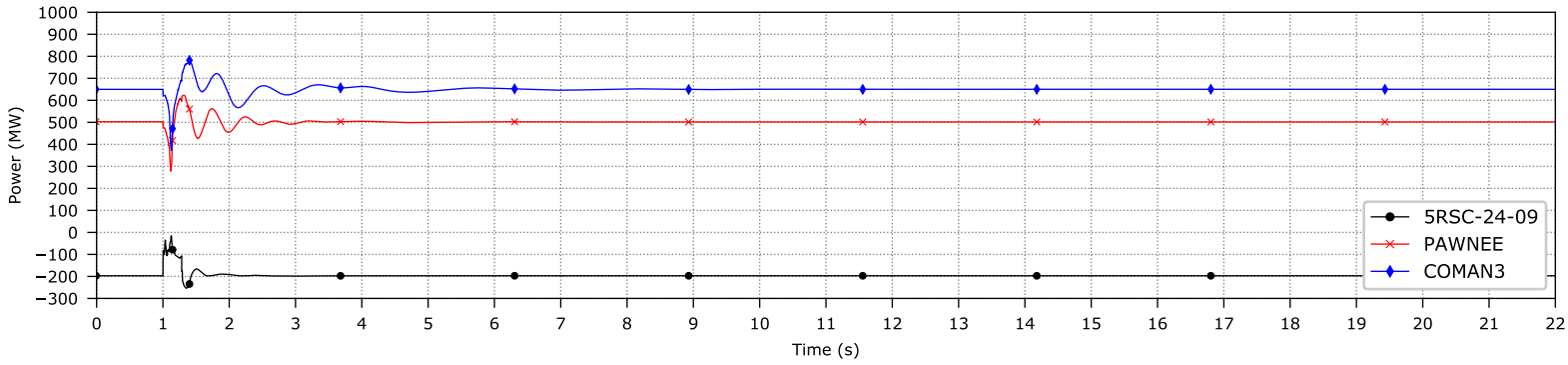
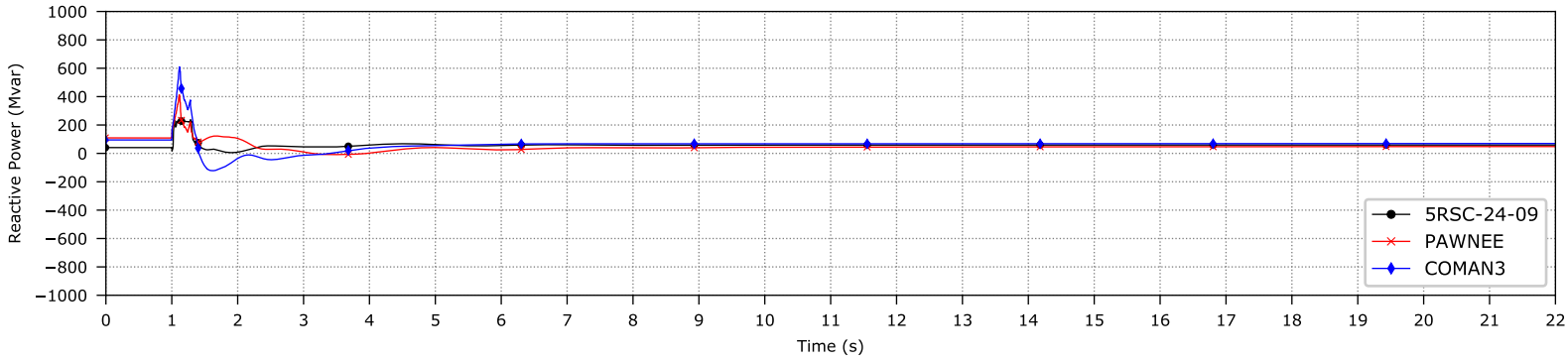
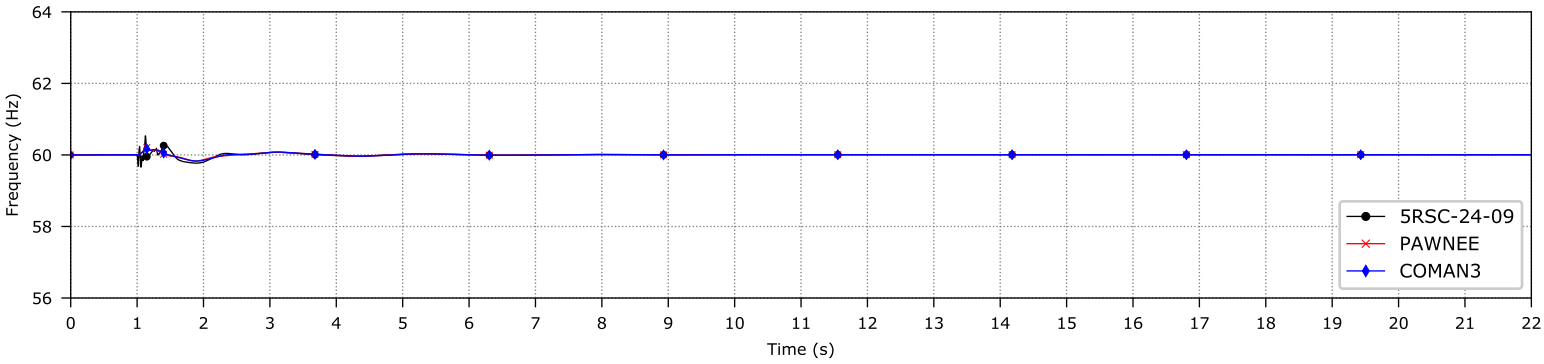
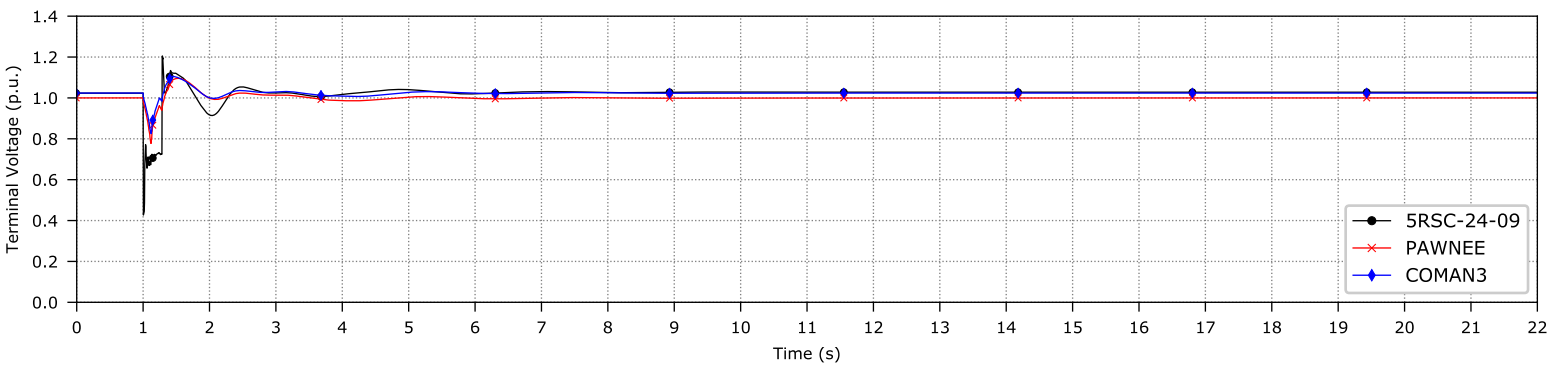
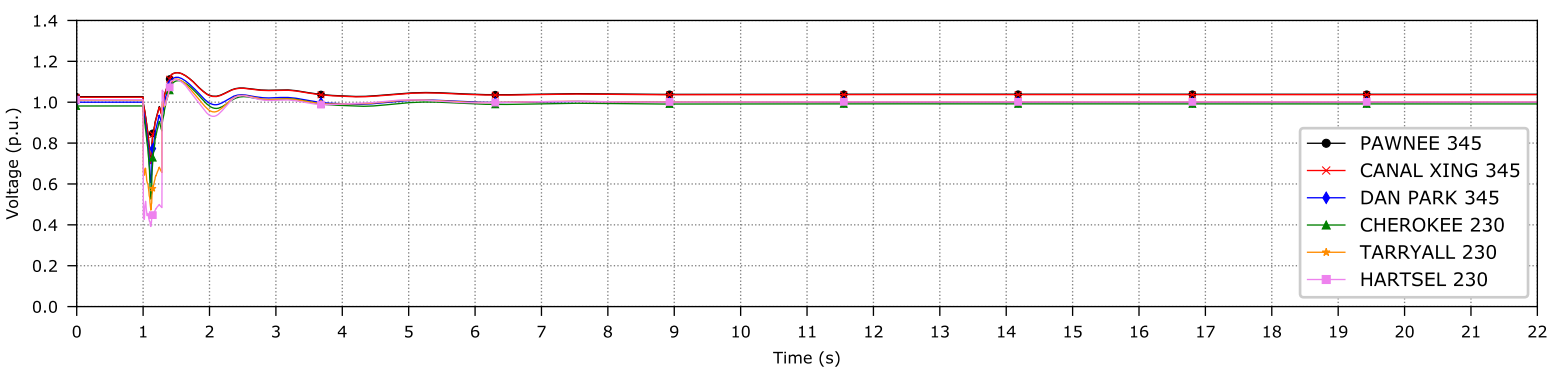




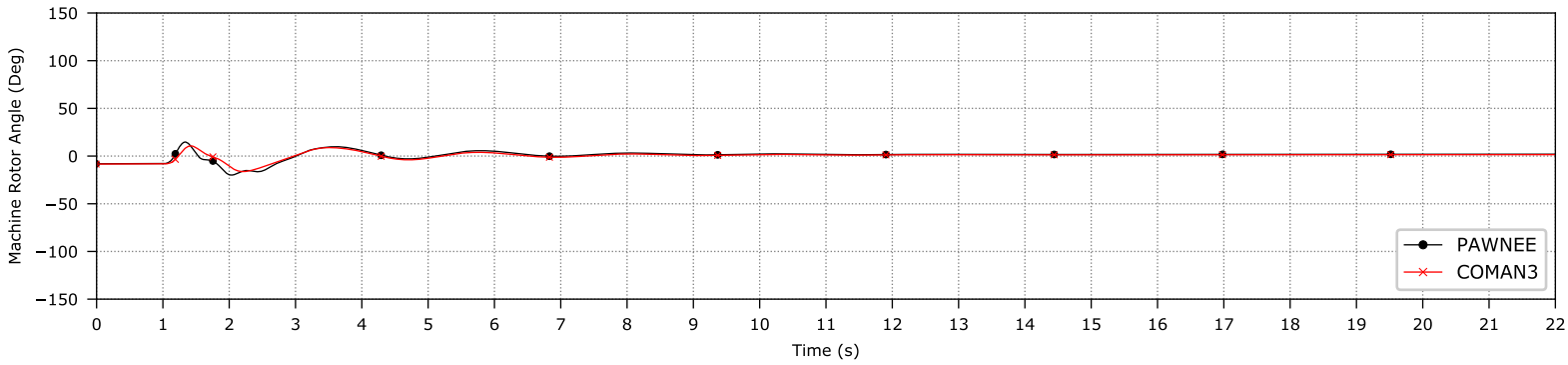


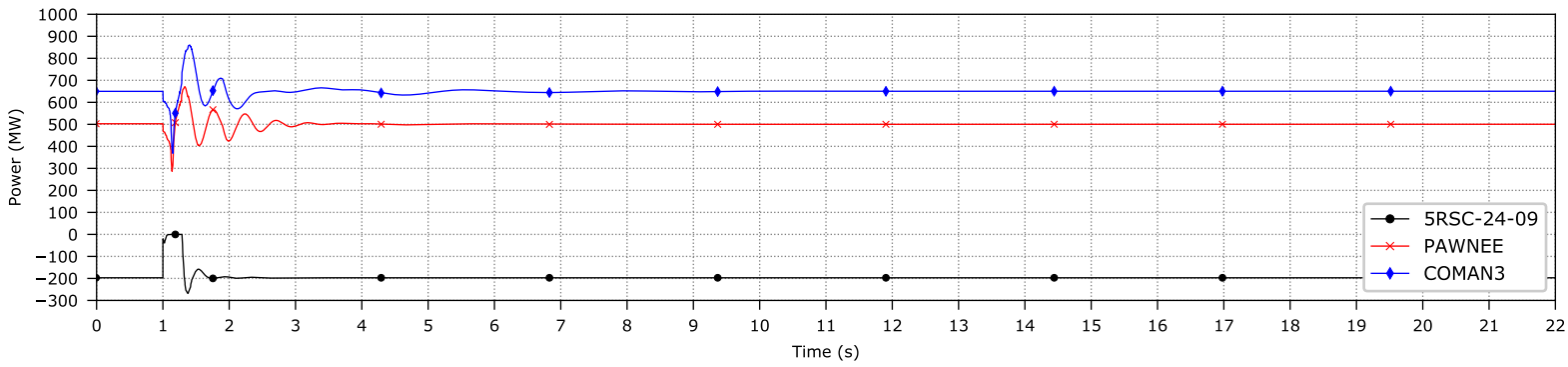


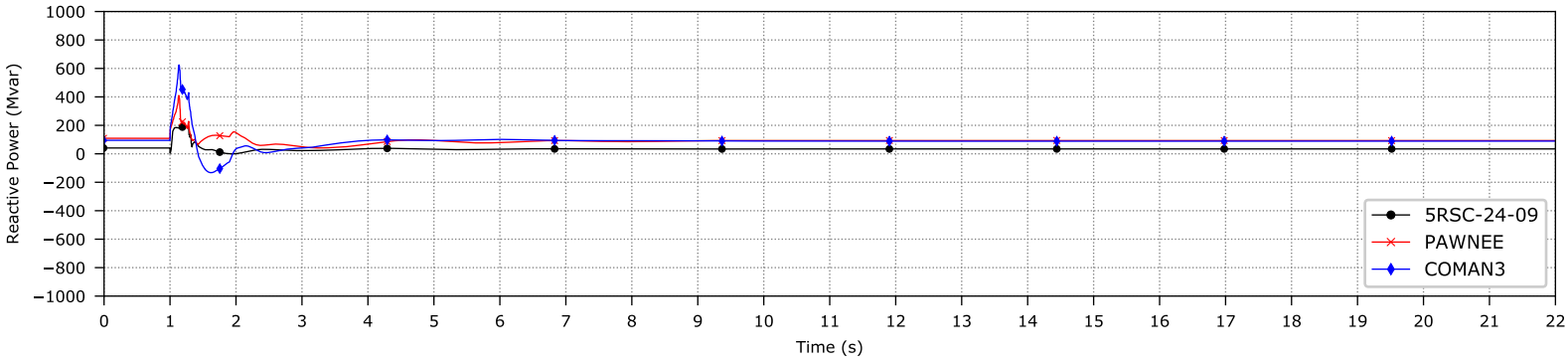


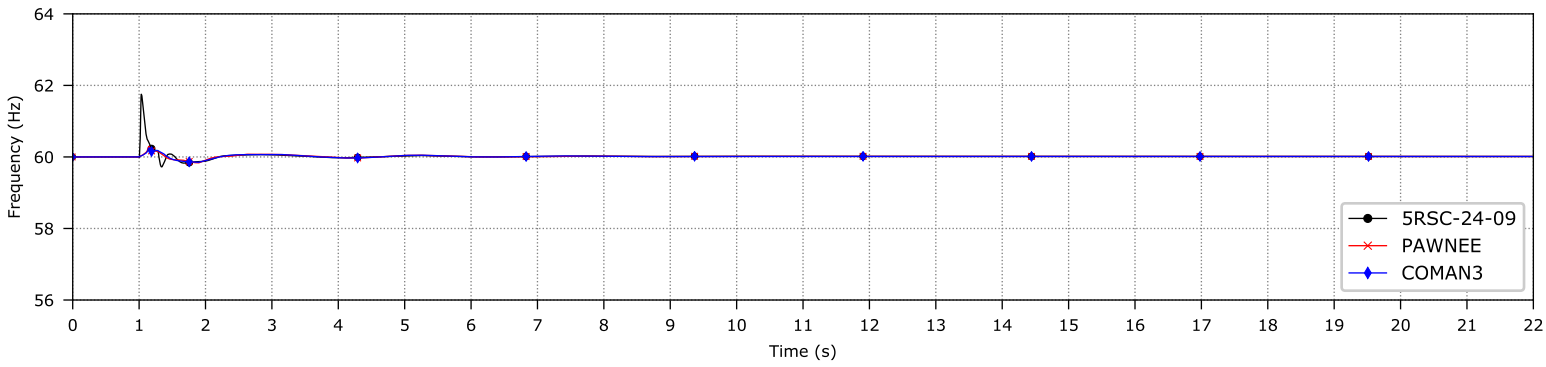


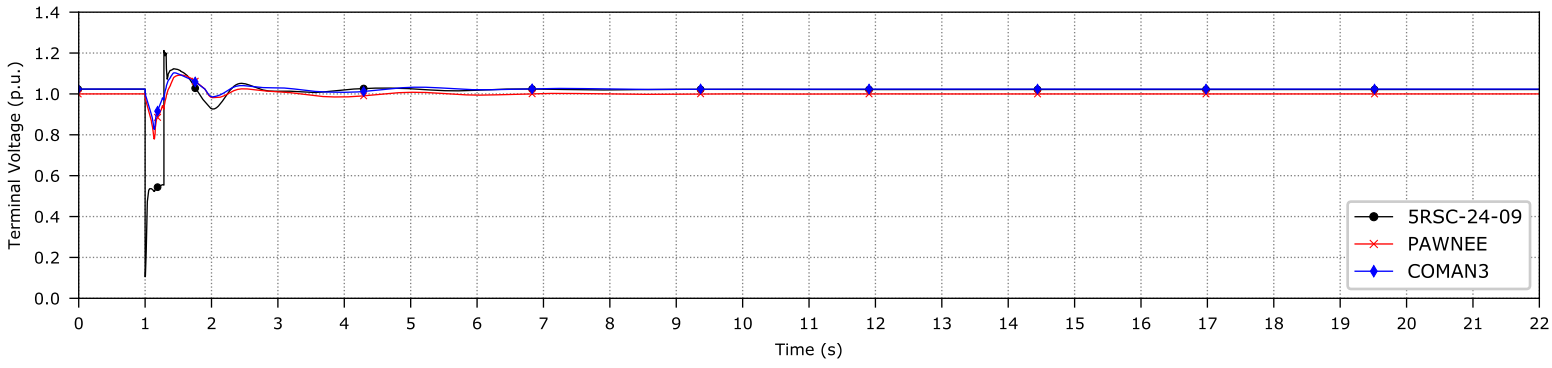
Ref. No. 12 - BF_137a

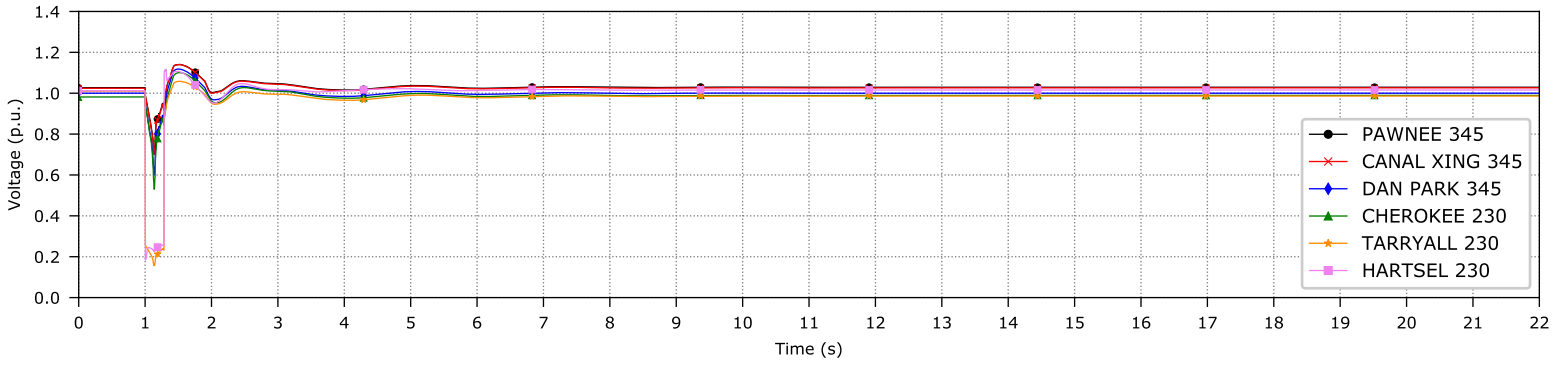




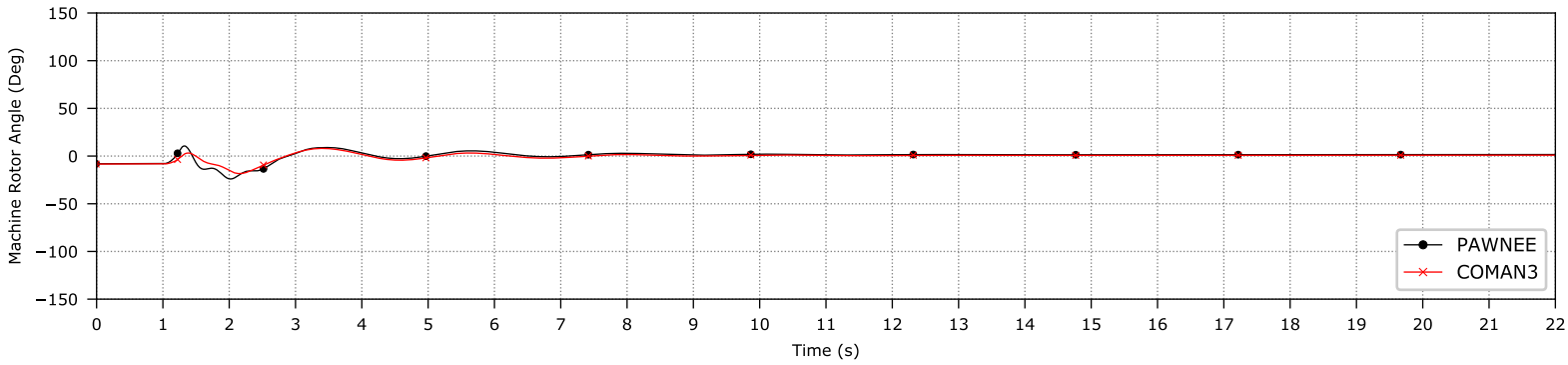


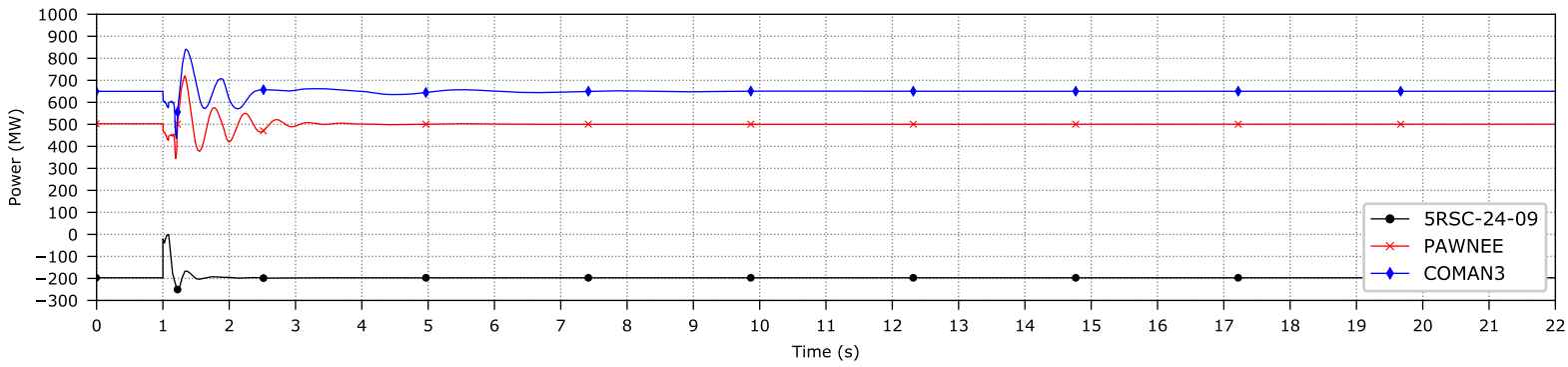


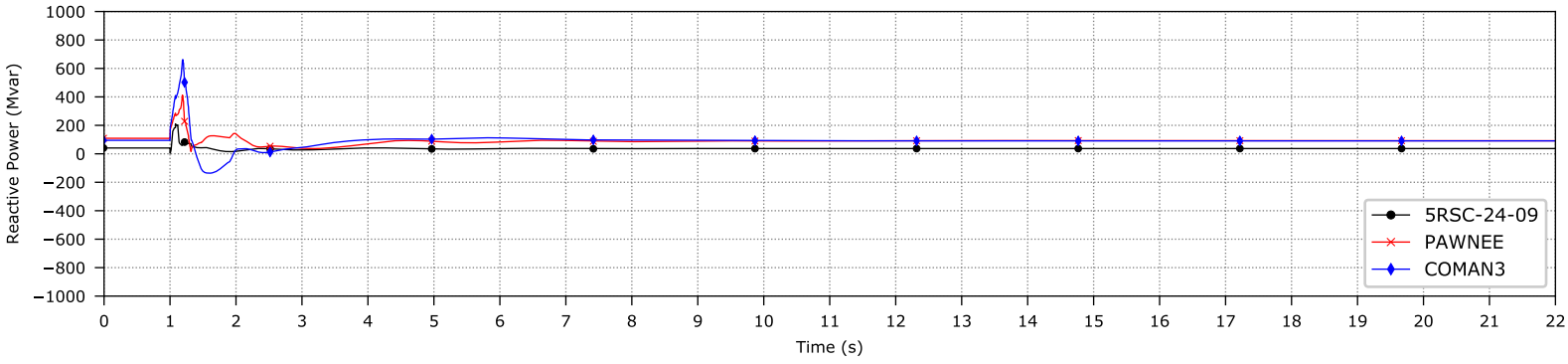


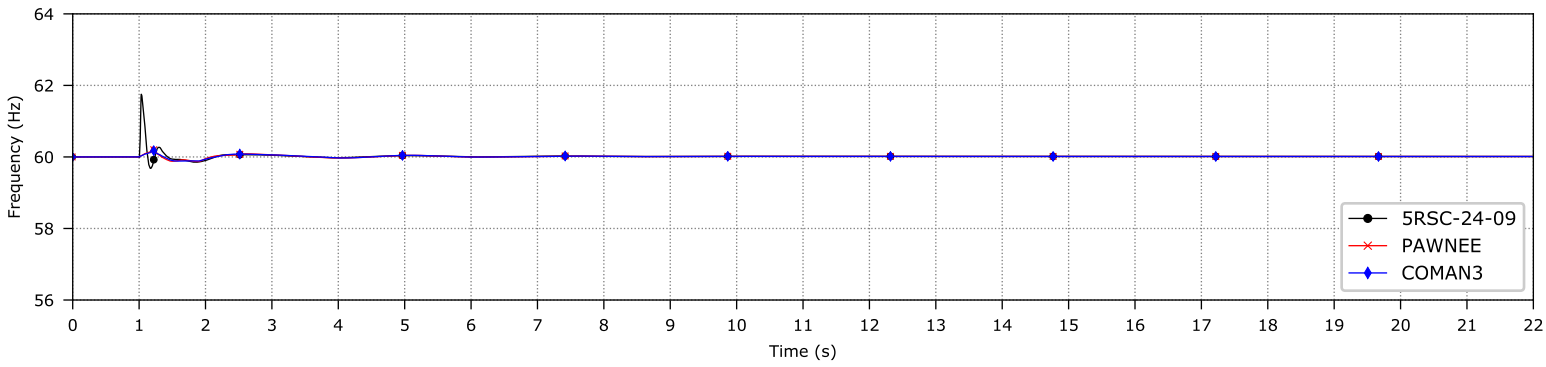


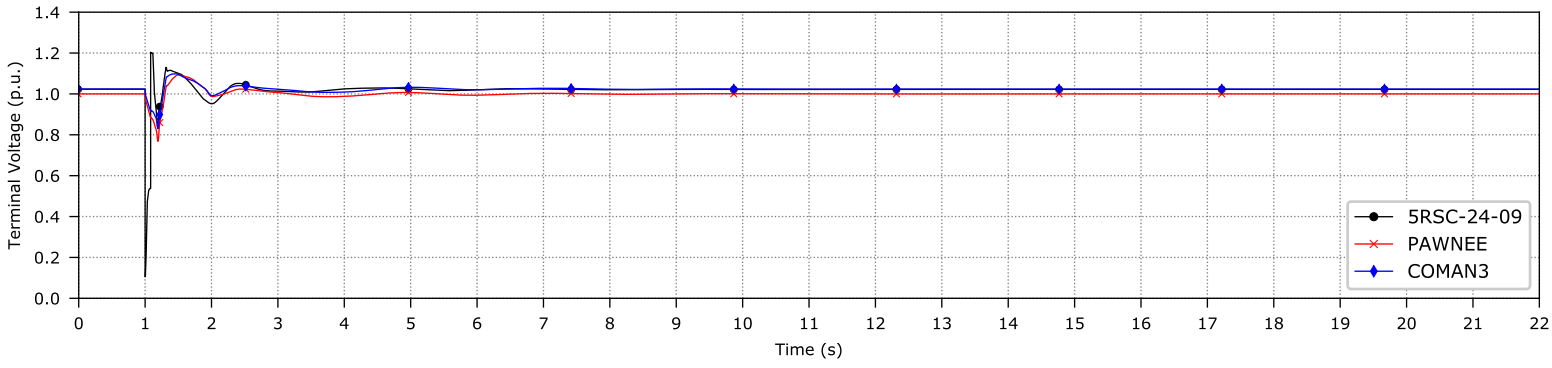
Ref. No. 13 - P7_114

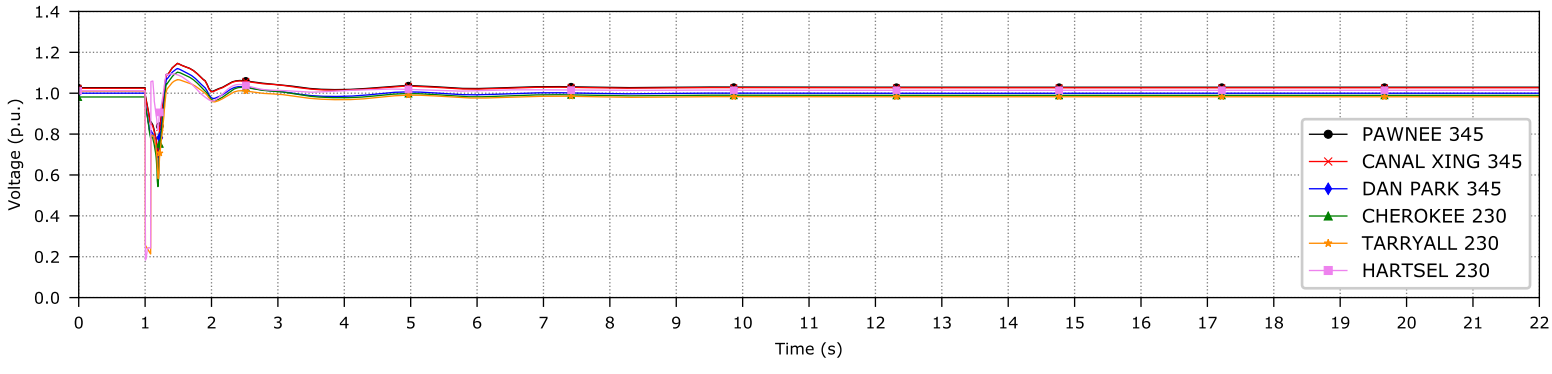






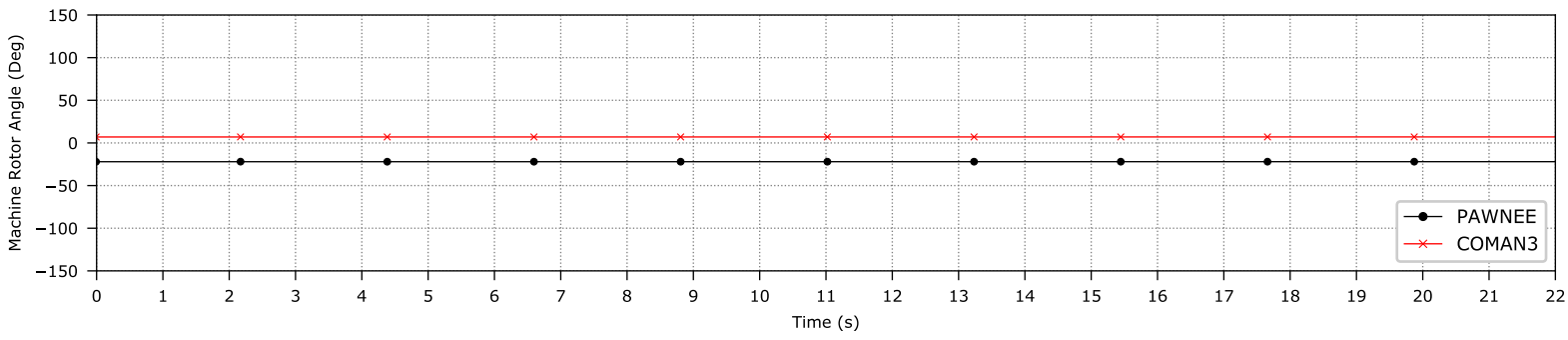


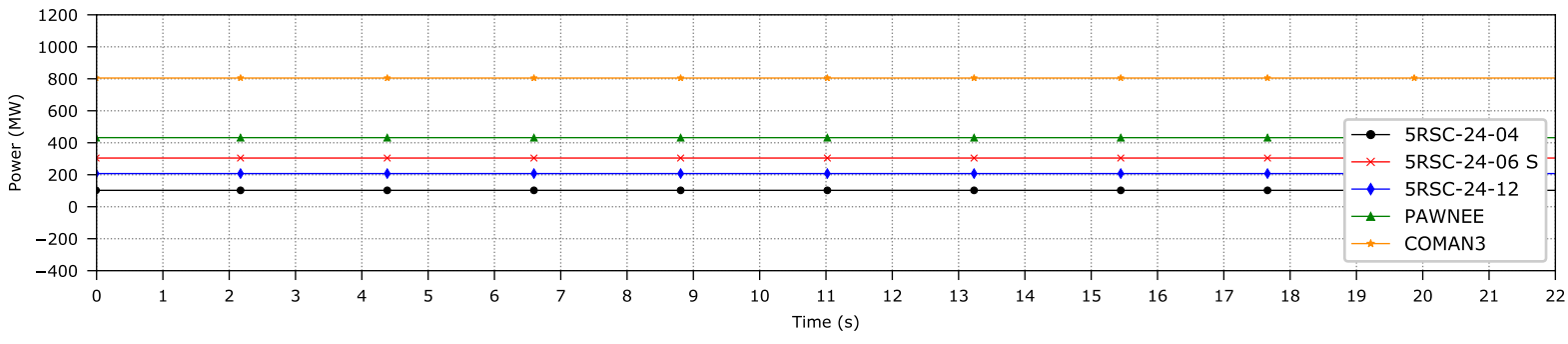


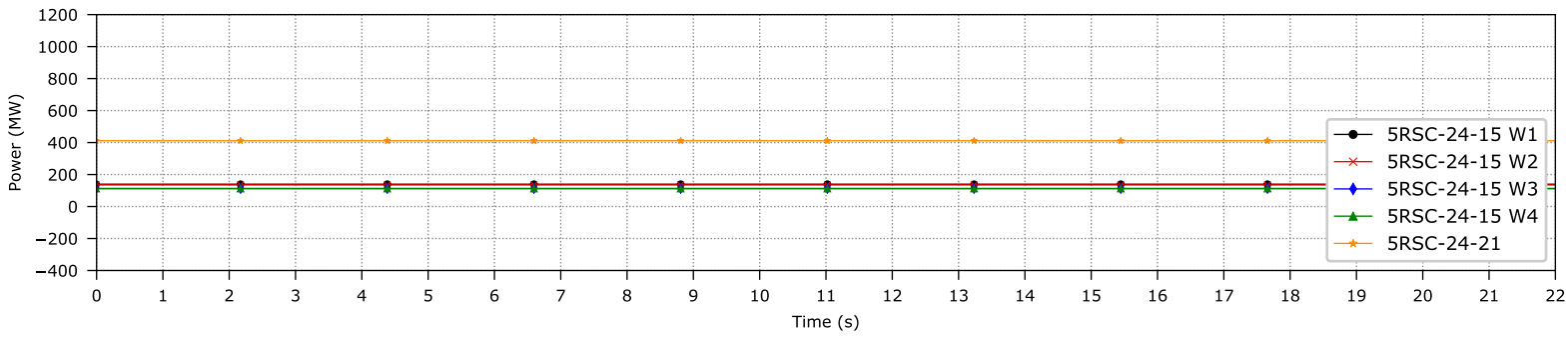


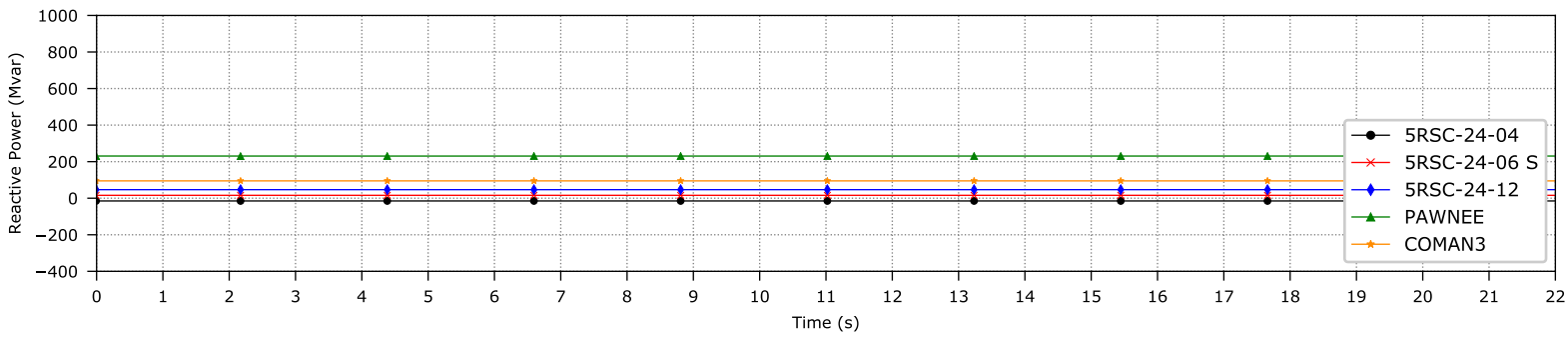
2029 SOUTH – TRANSIENT STABILITY PLOTS

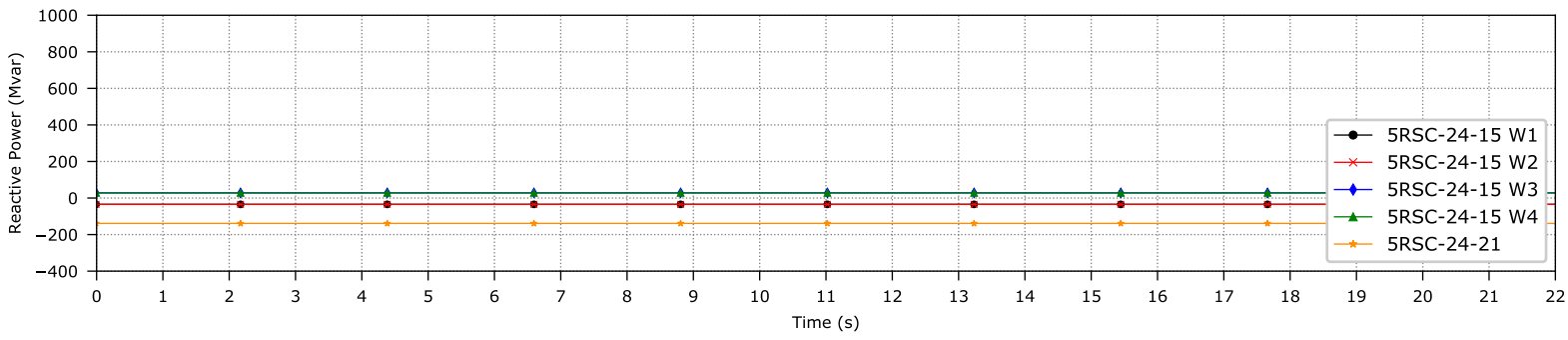
Ref. No. 01 - Flatrun

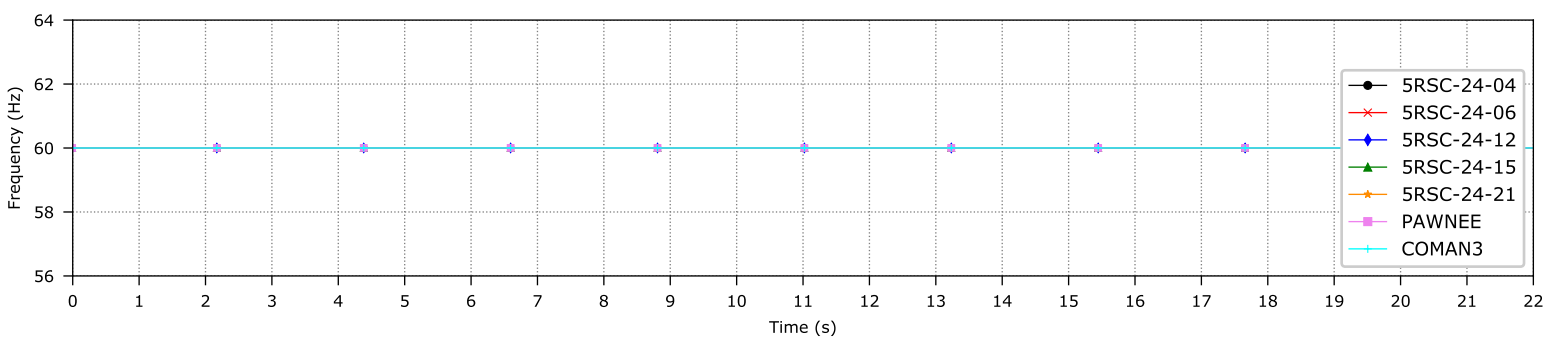


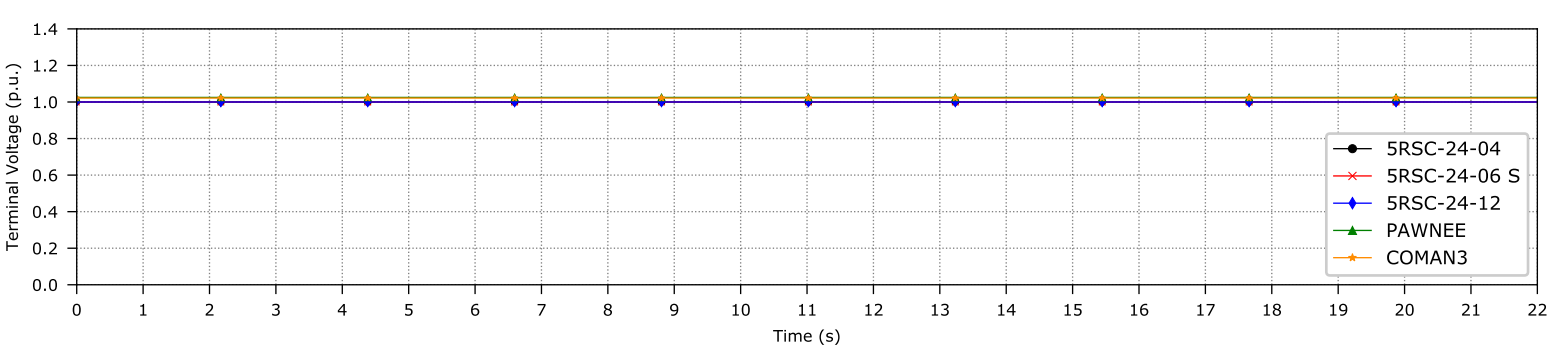


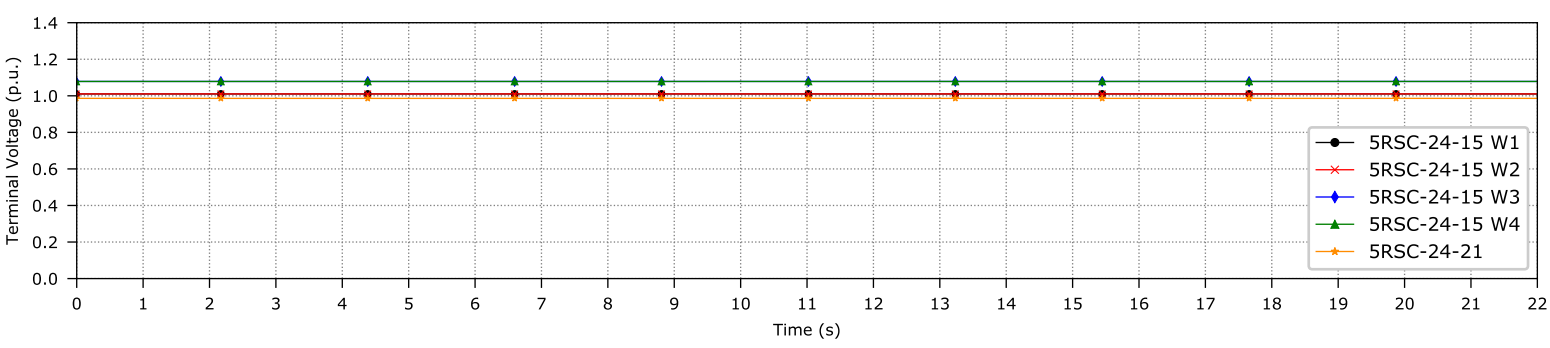


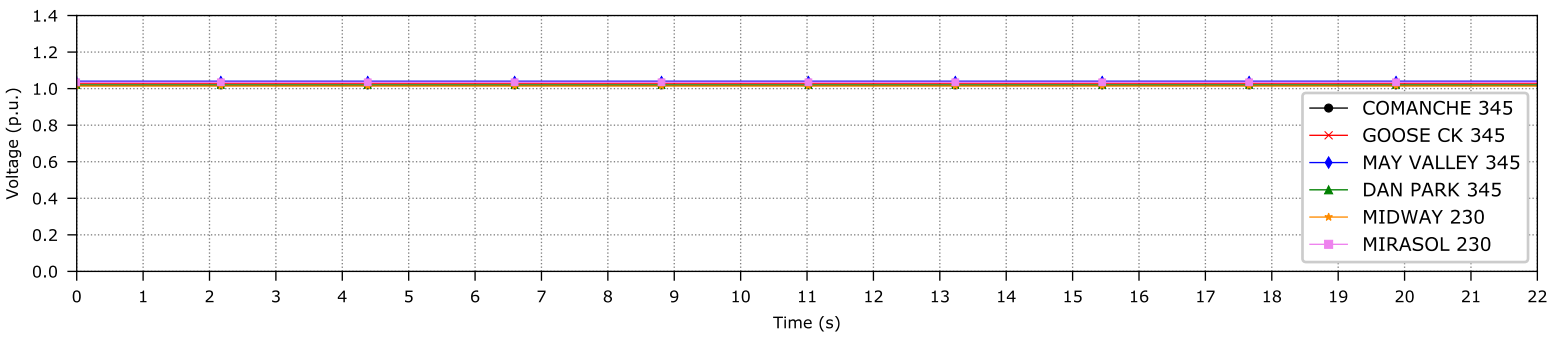




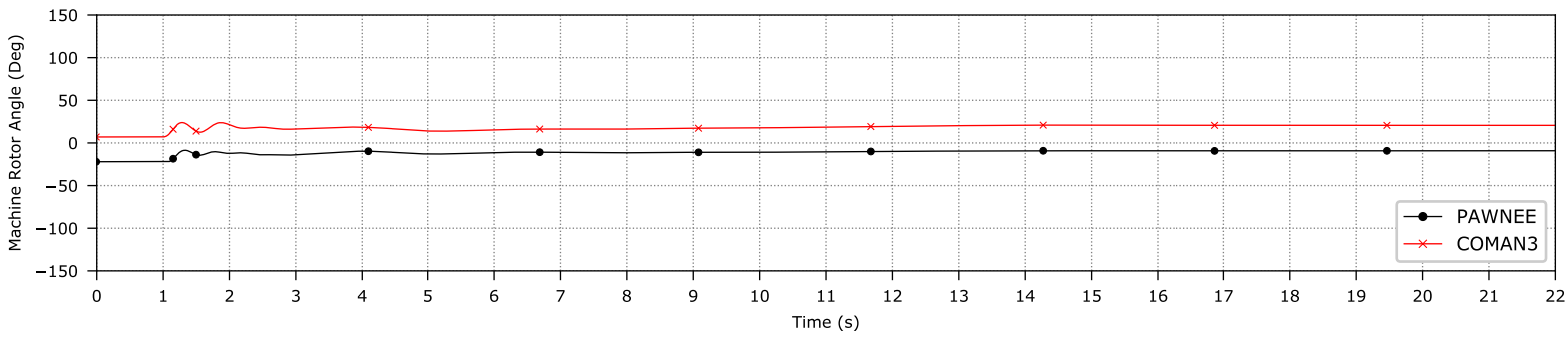


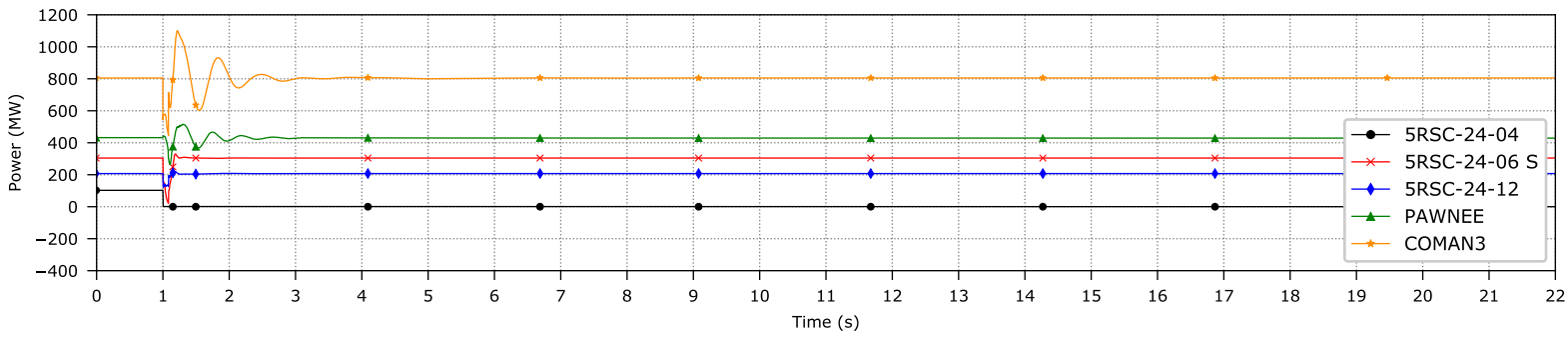


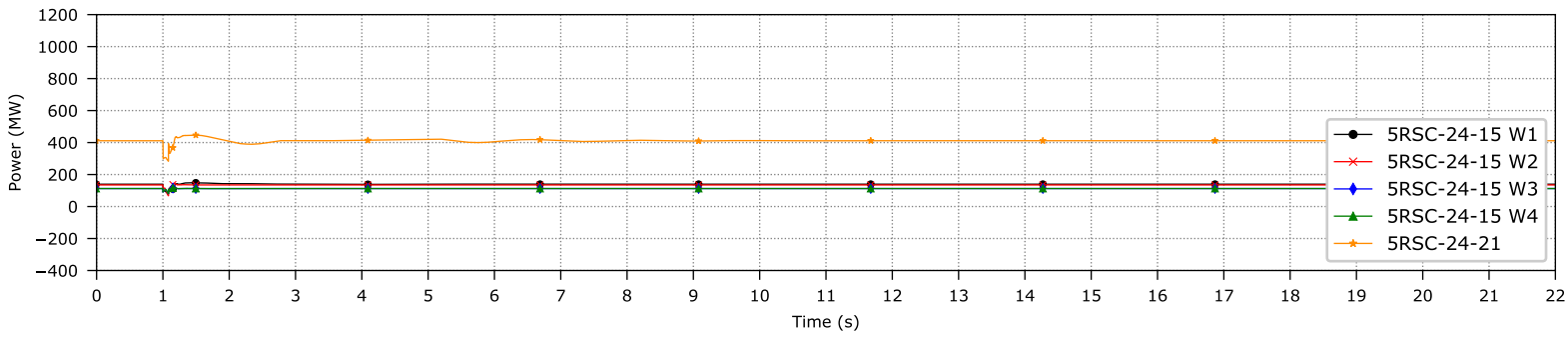


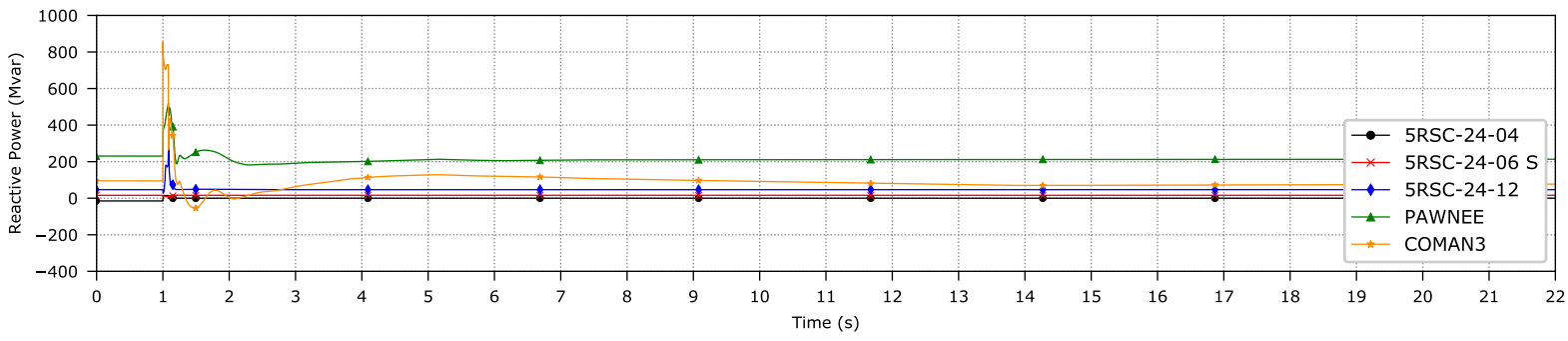


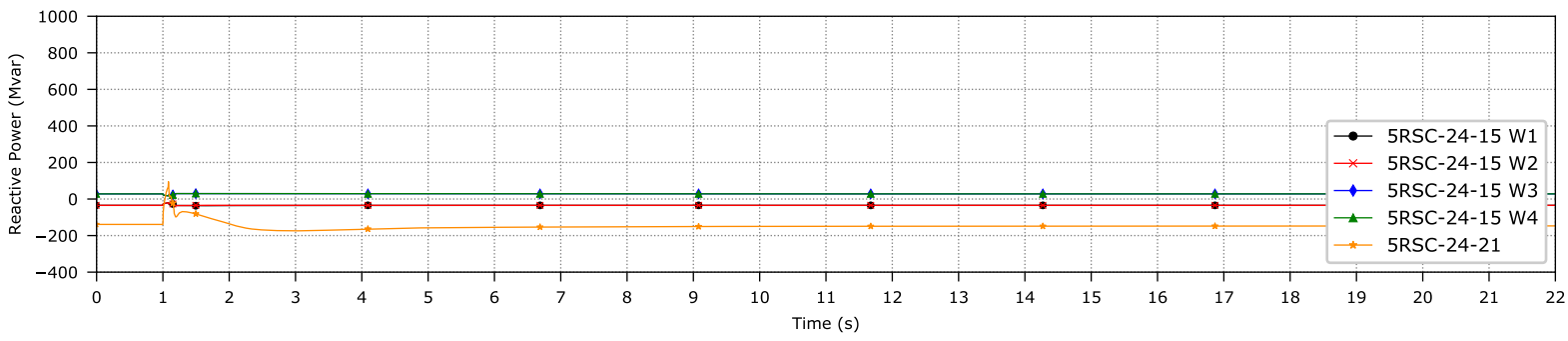
Ref. No. 02 - 5RSC-2024-04

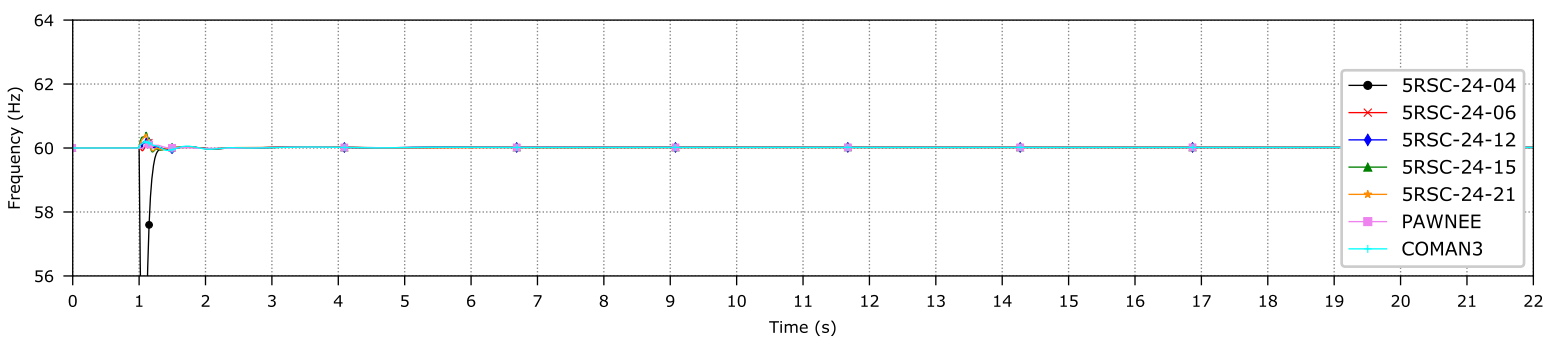


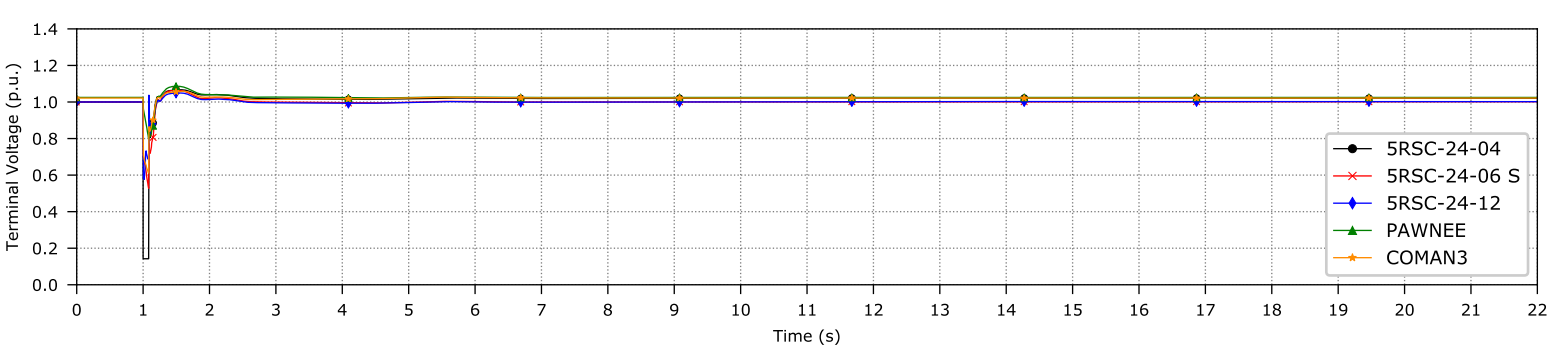


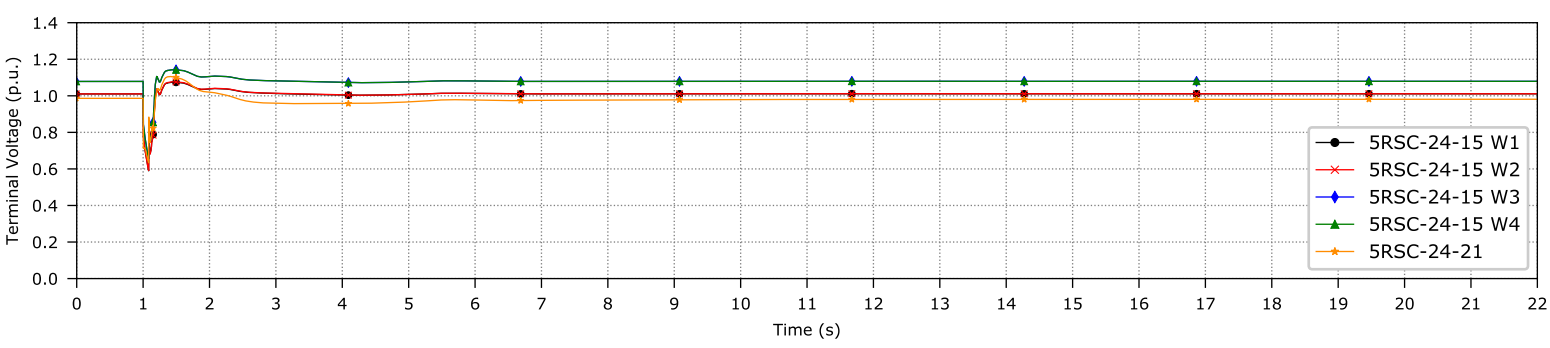


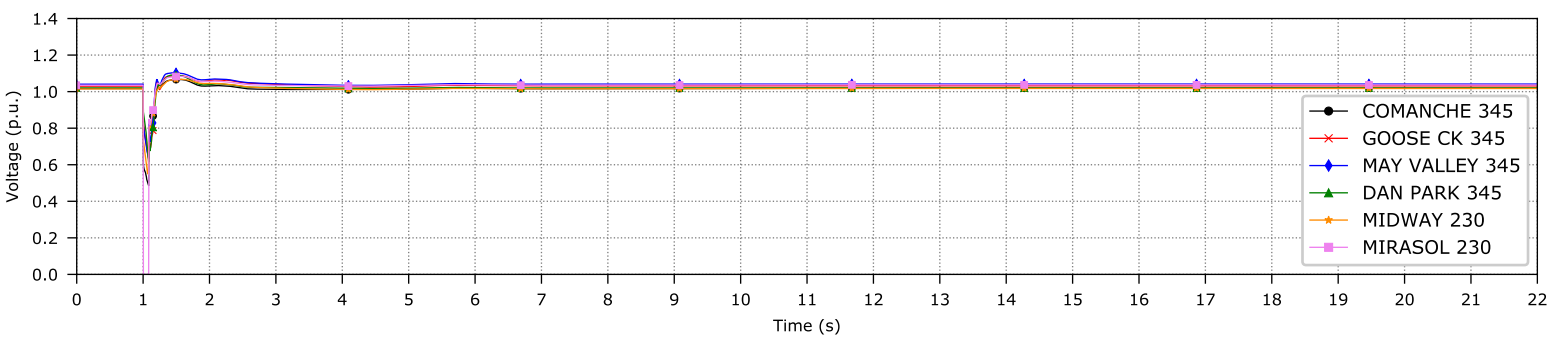




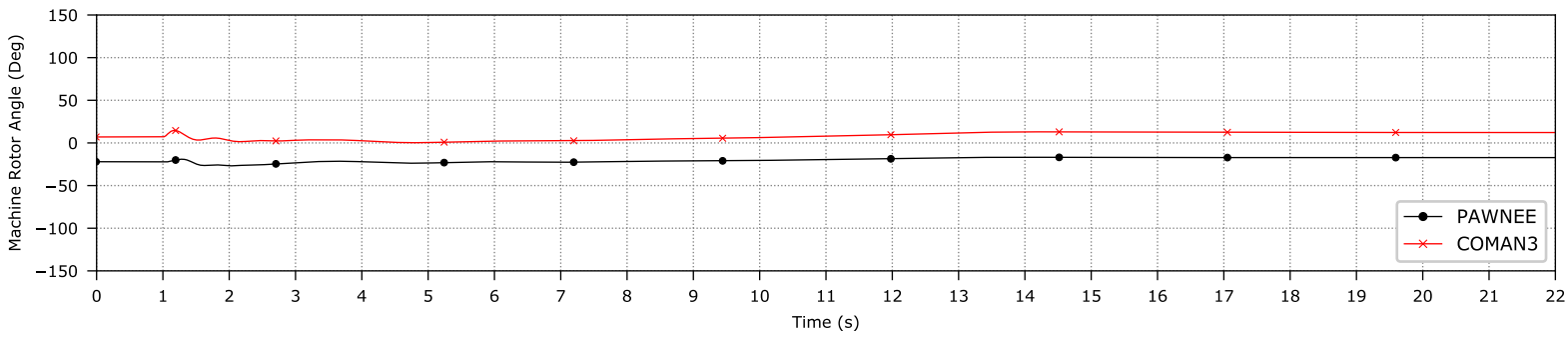


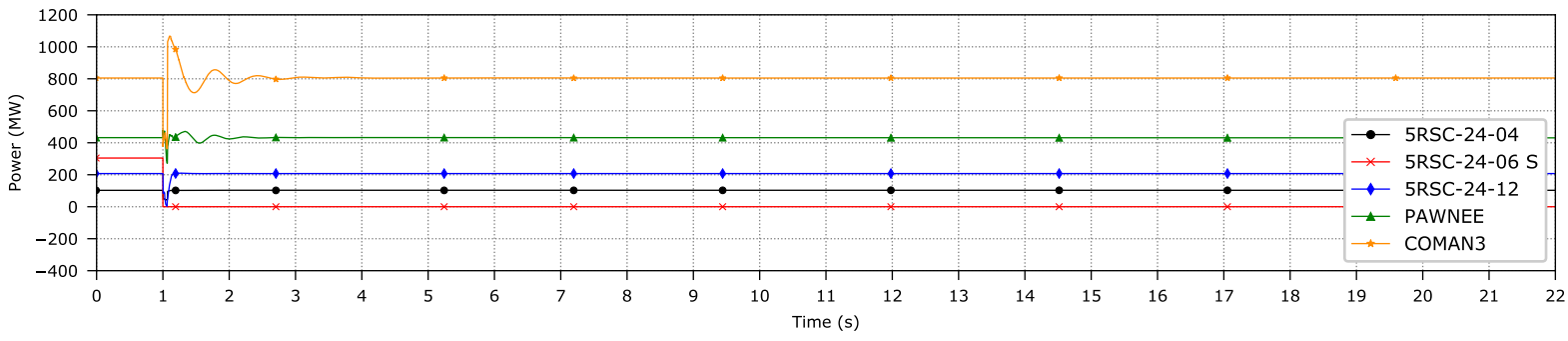


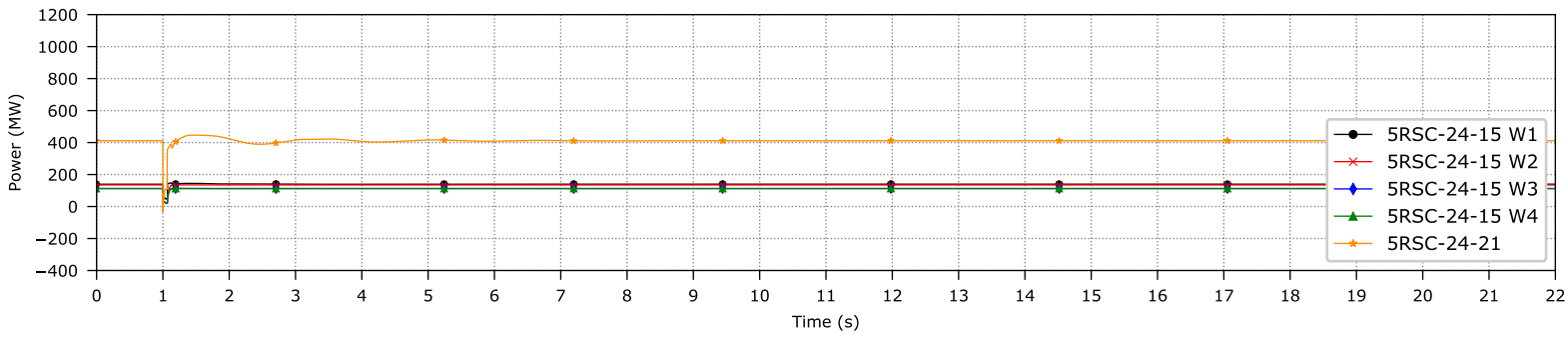


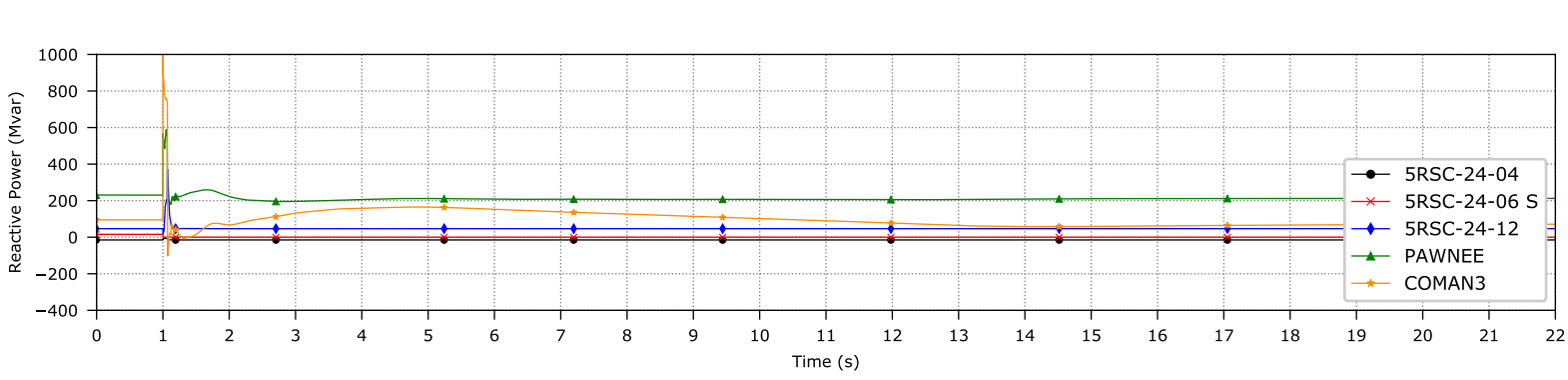


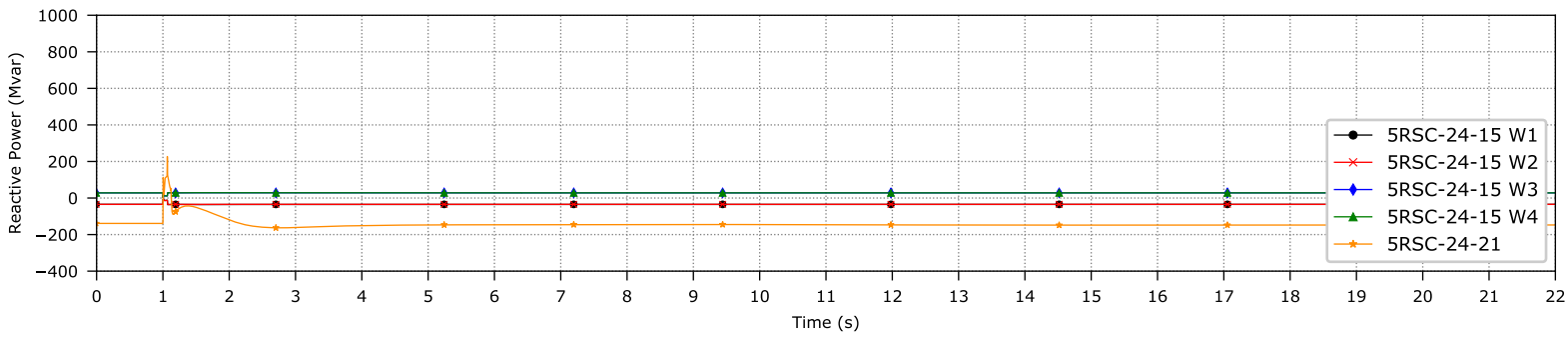
Ref. No. 03 - 5RSC-2024-06

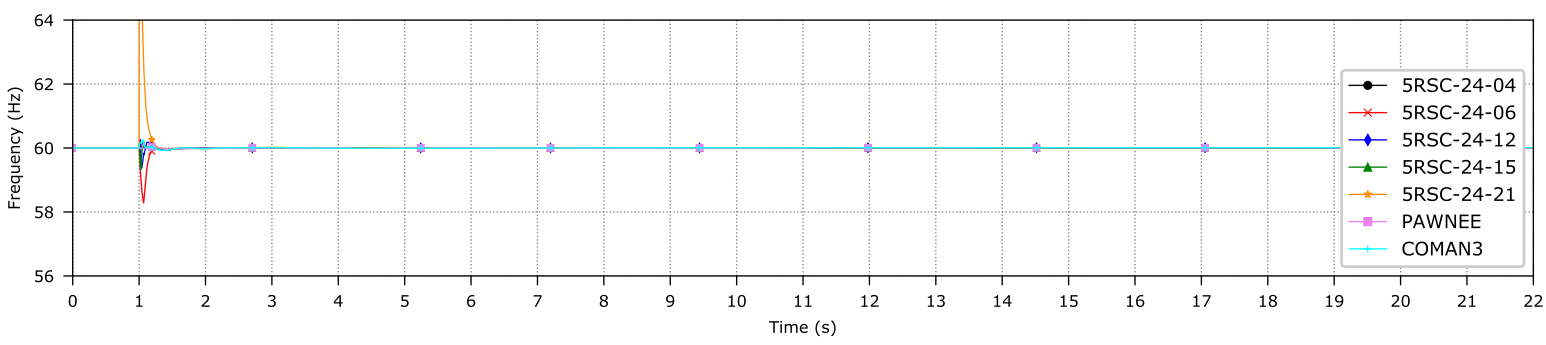


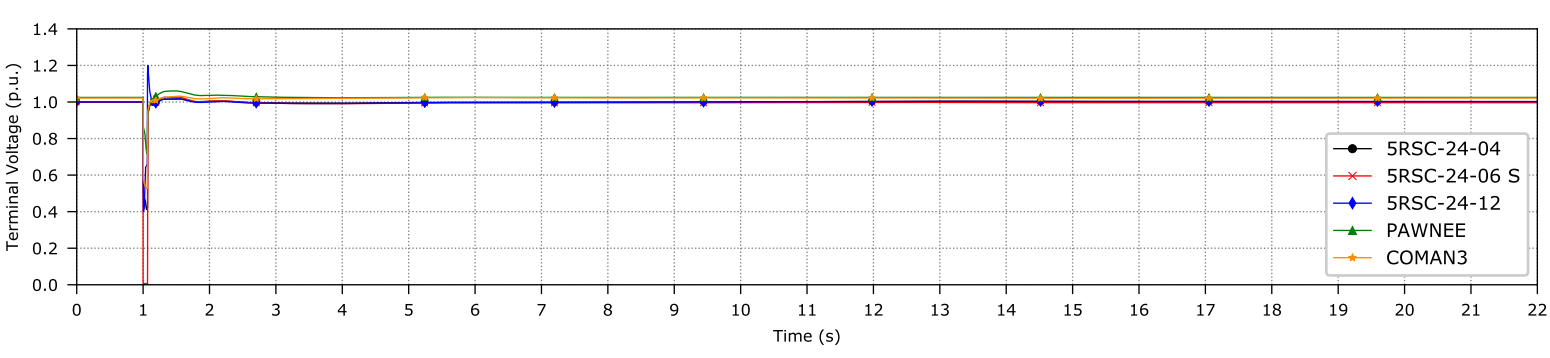


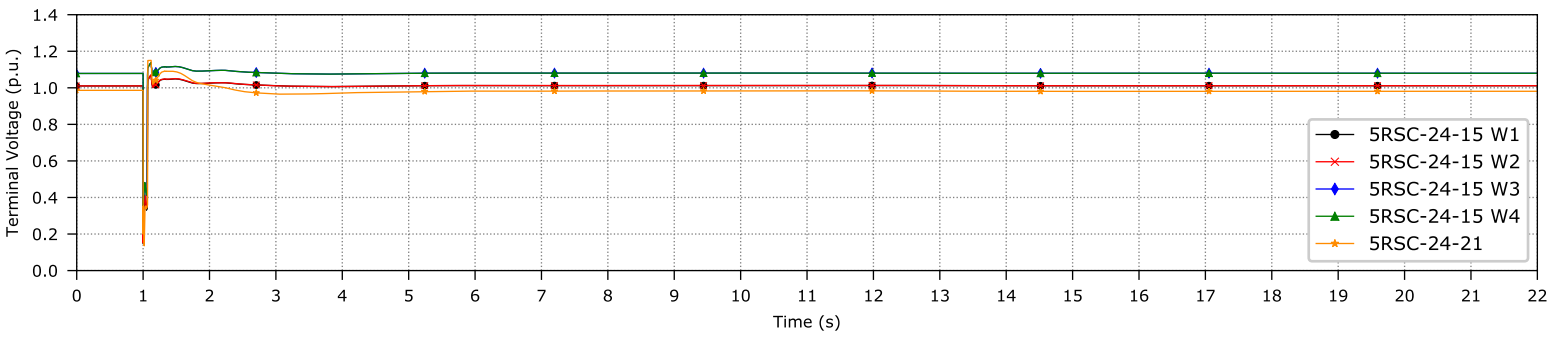


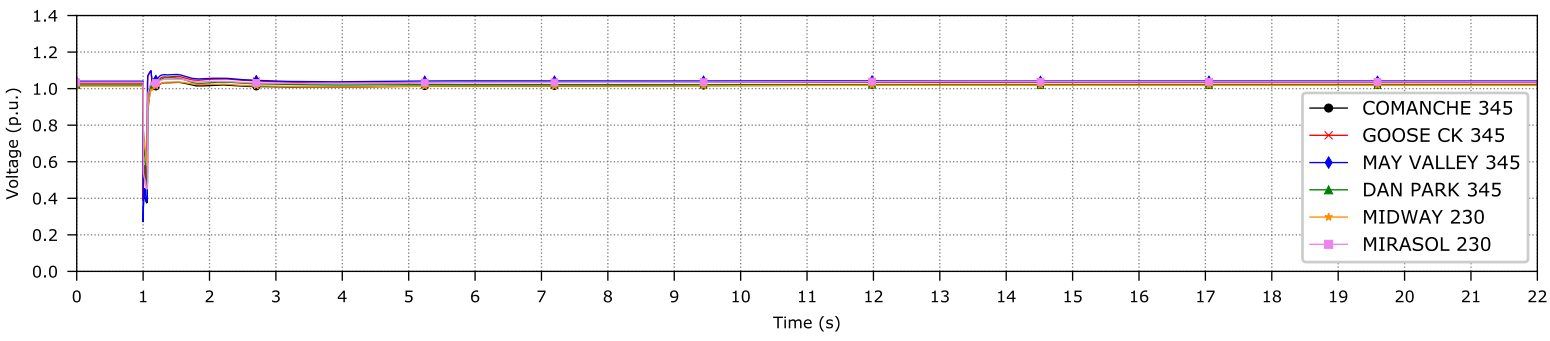












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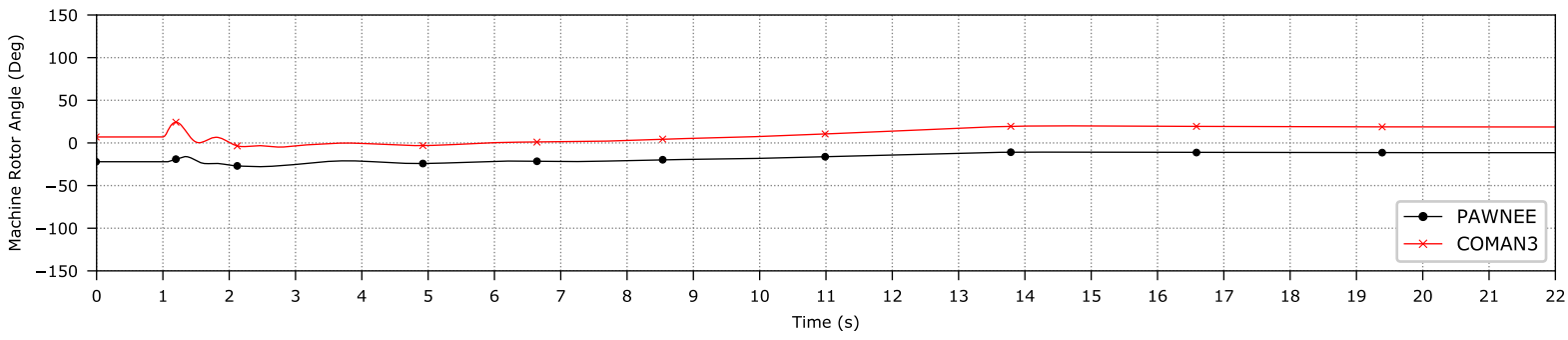
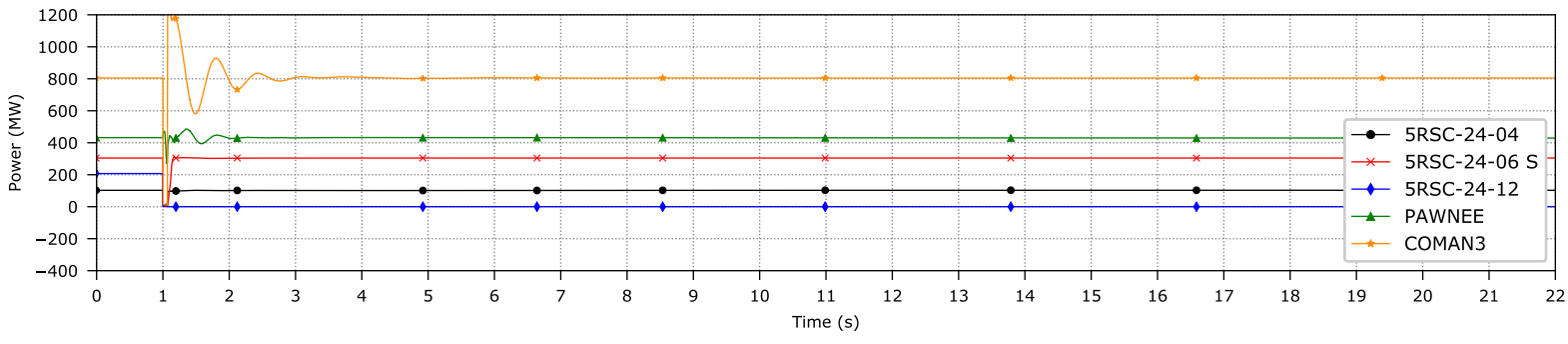
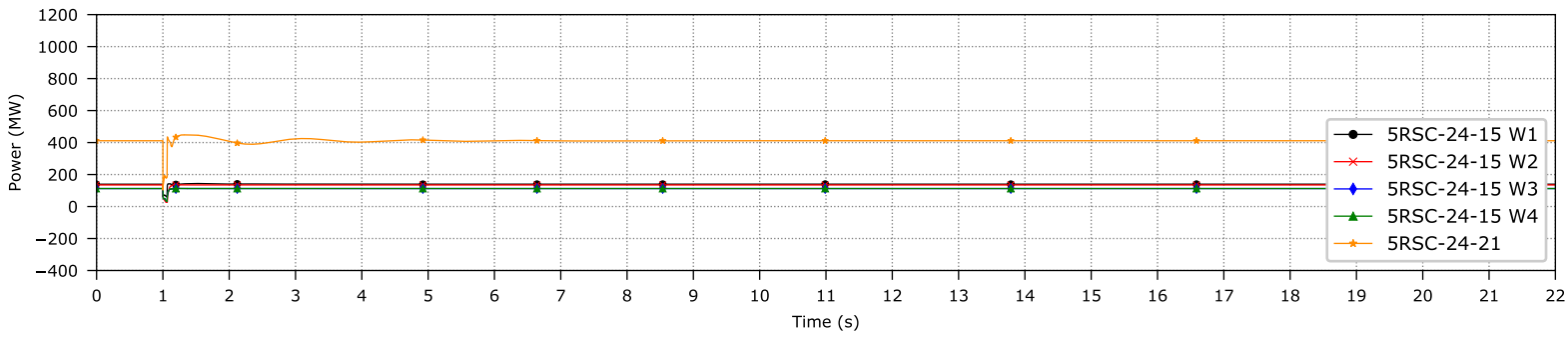
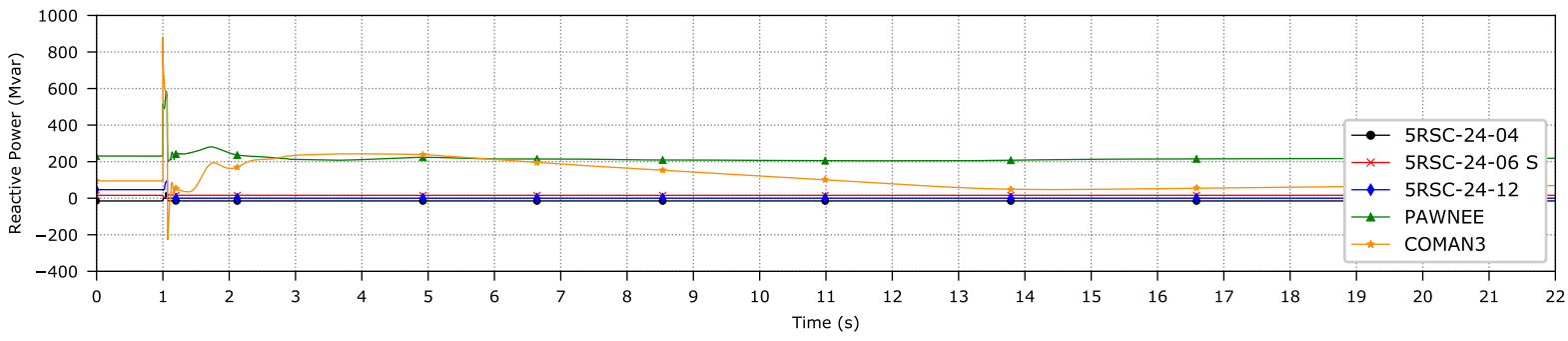
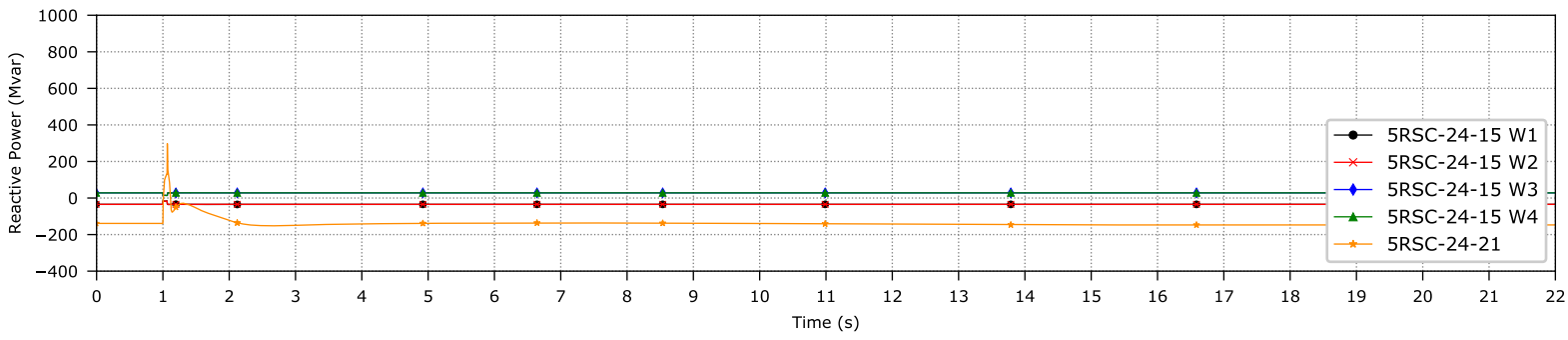
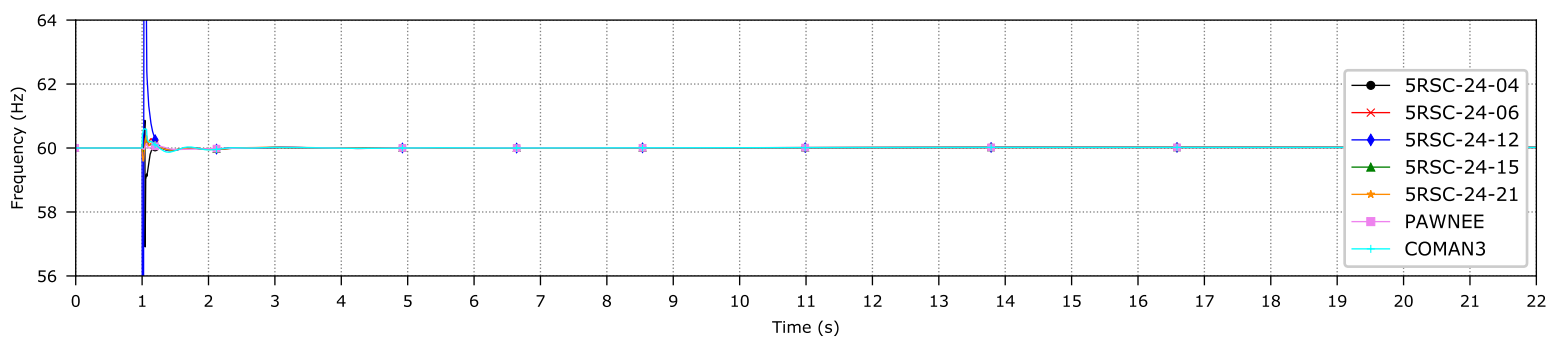


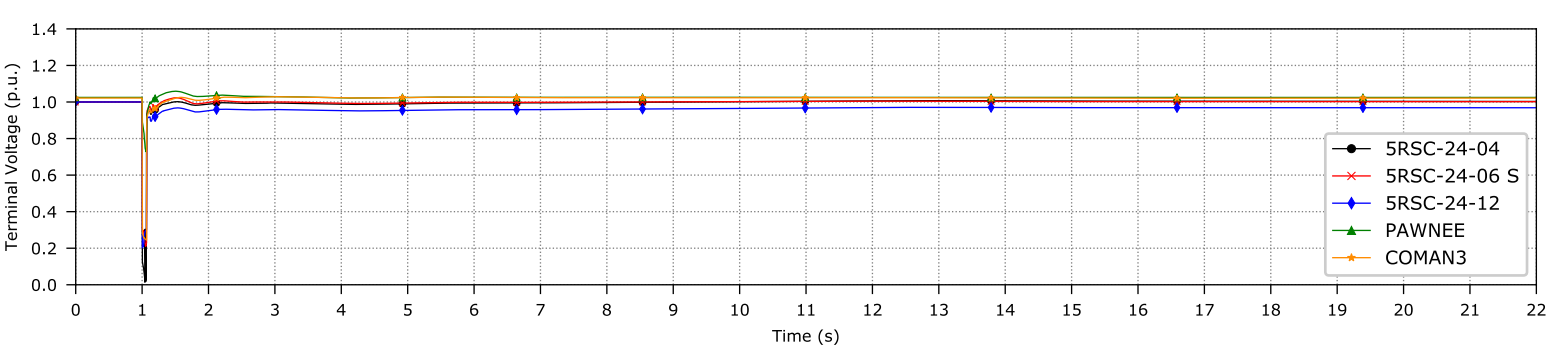


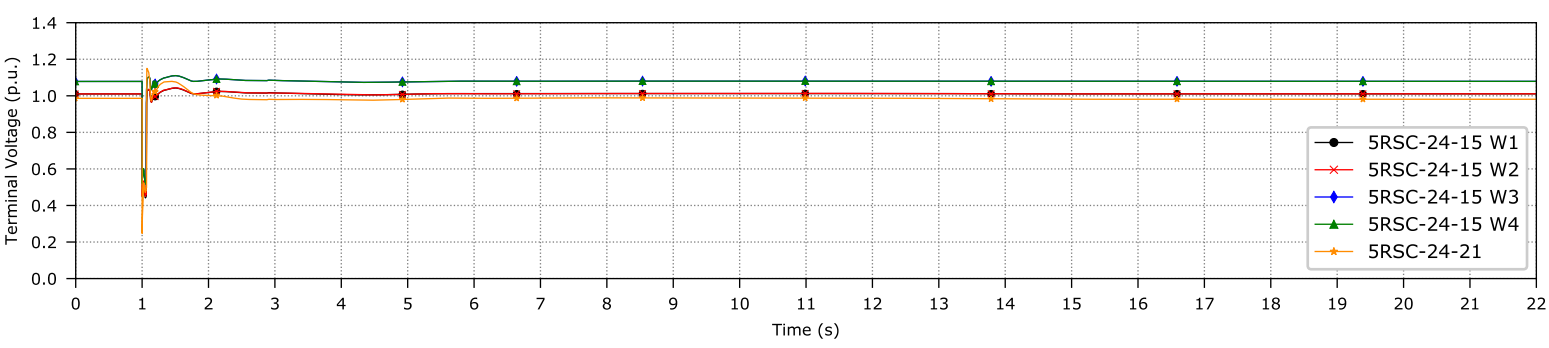


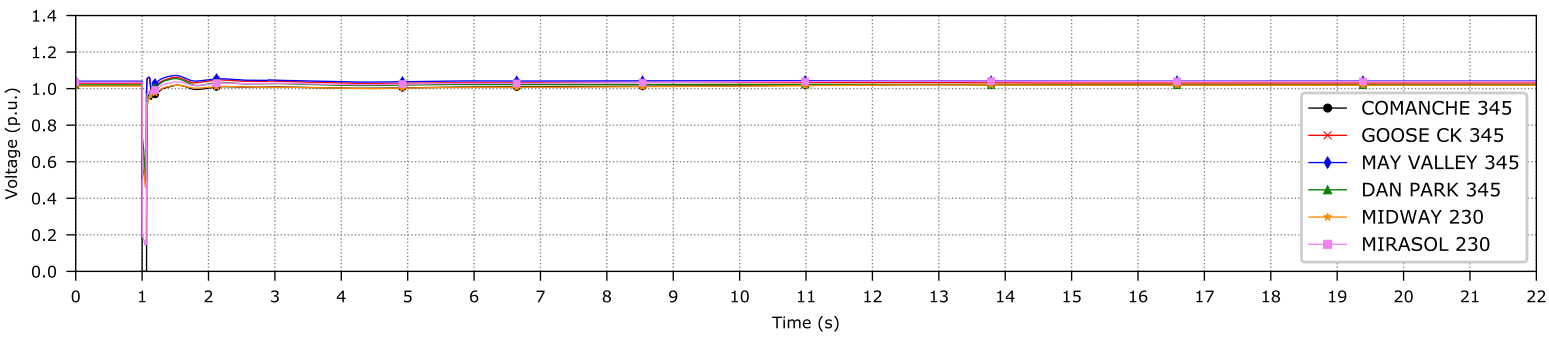




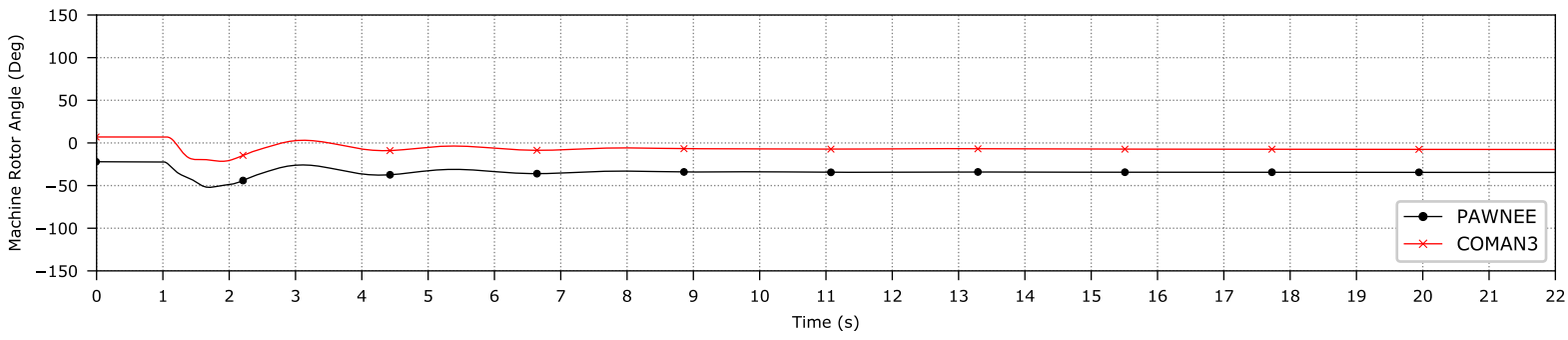


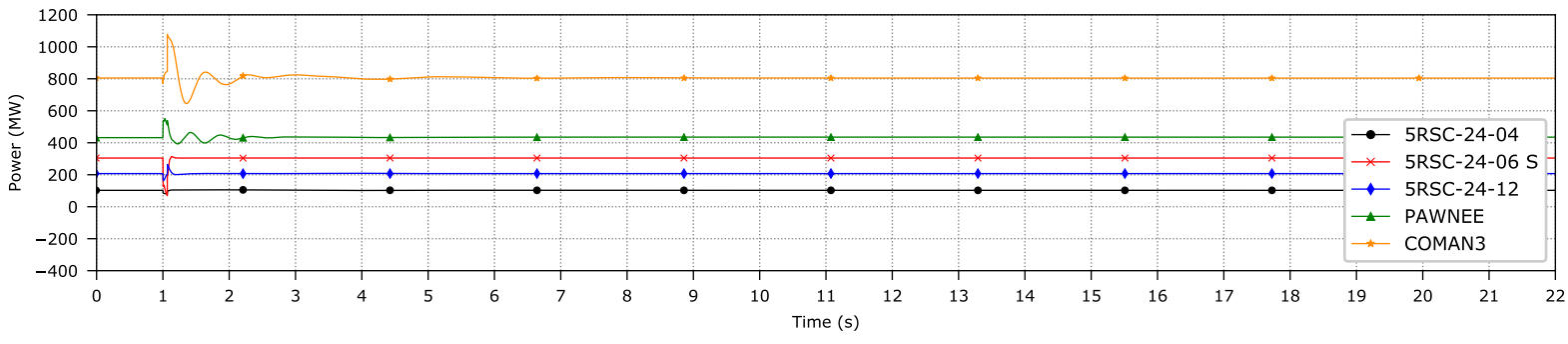


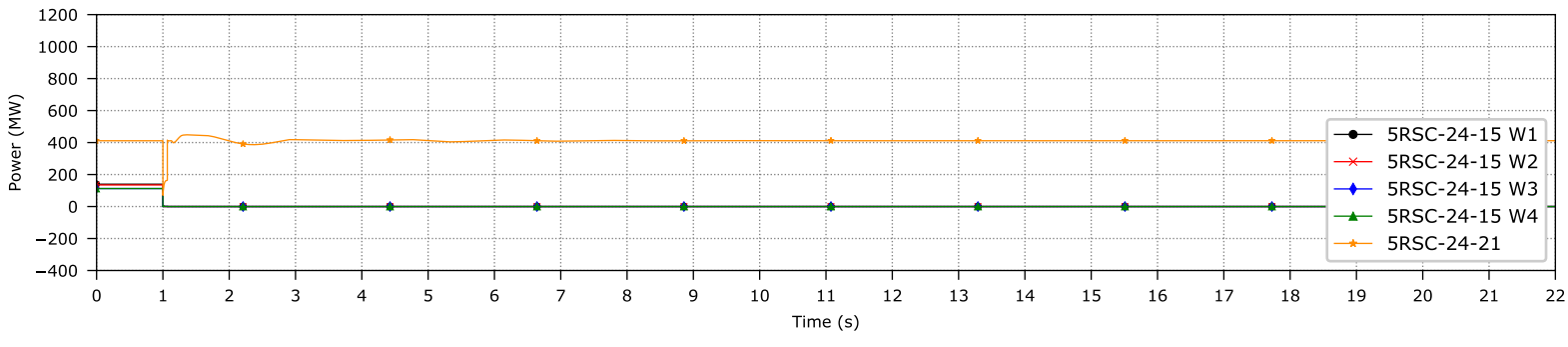


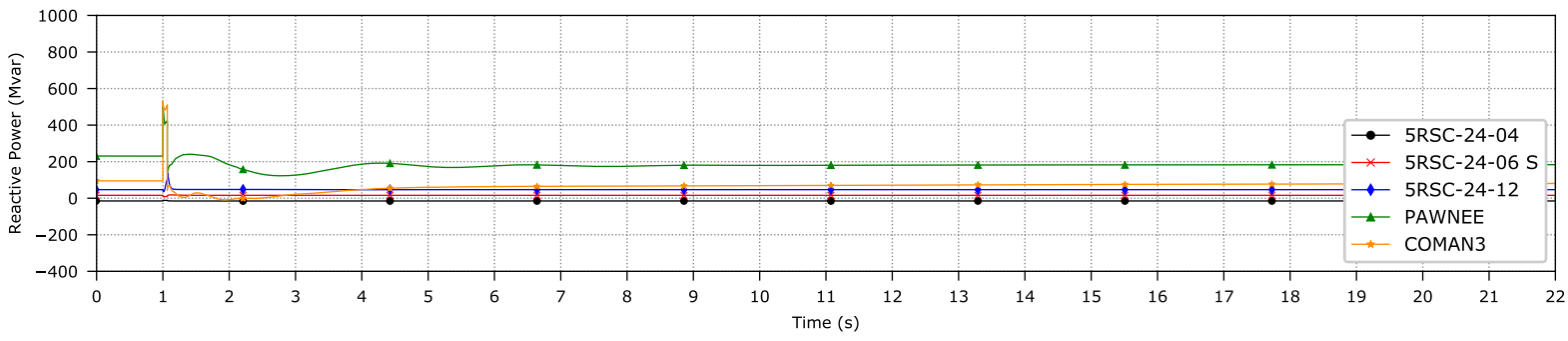


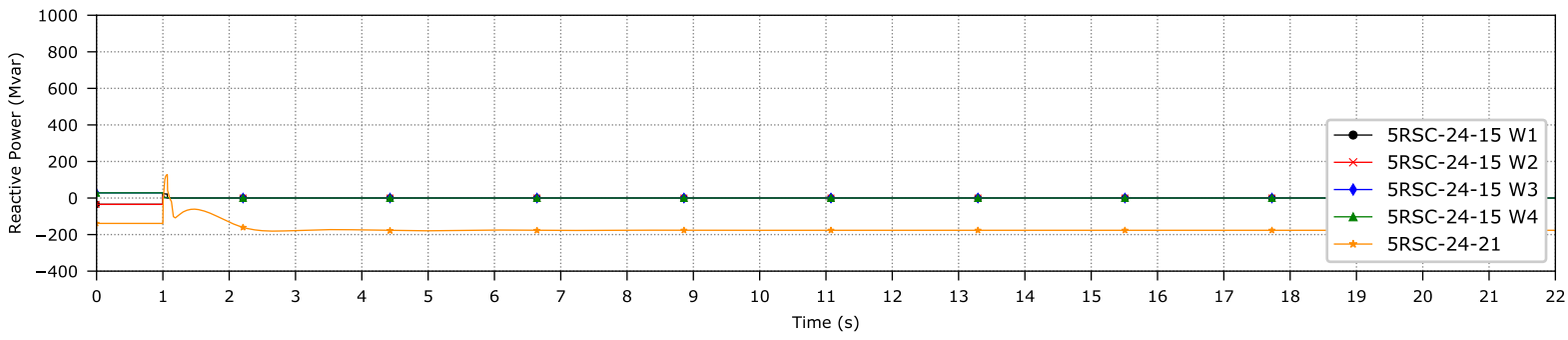
Ref. No. 05 - 5RSC-2024-15

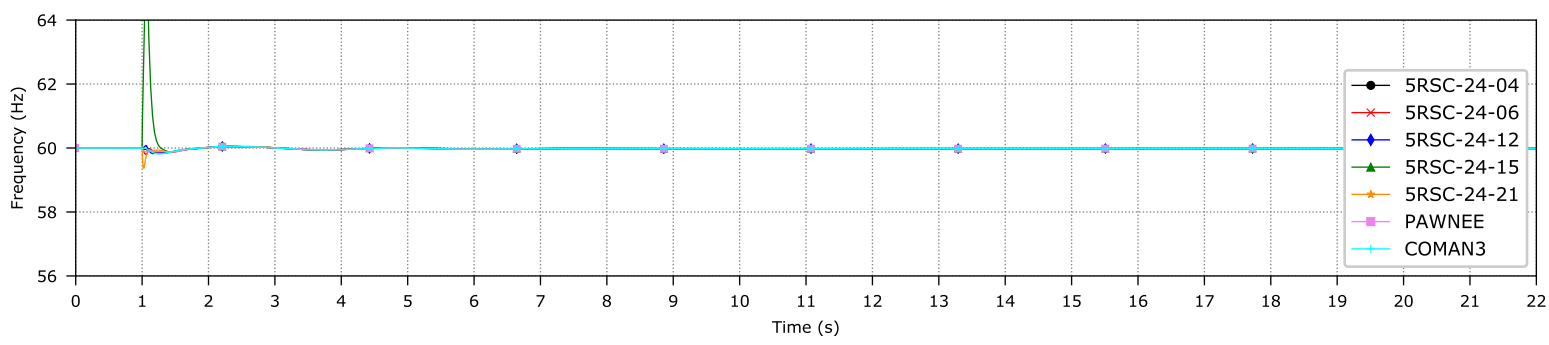


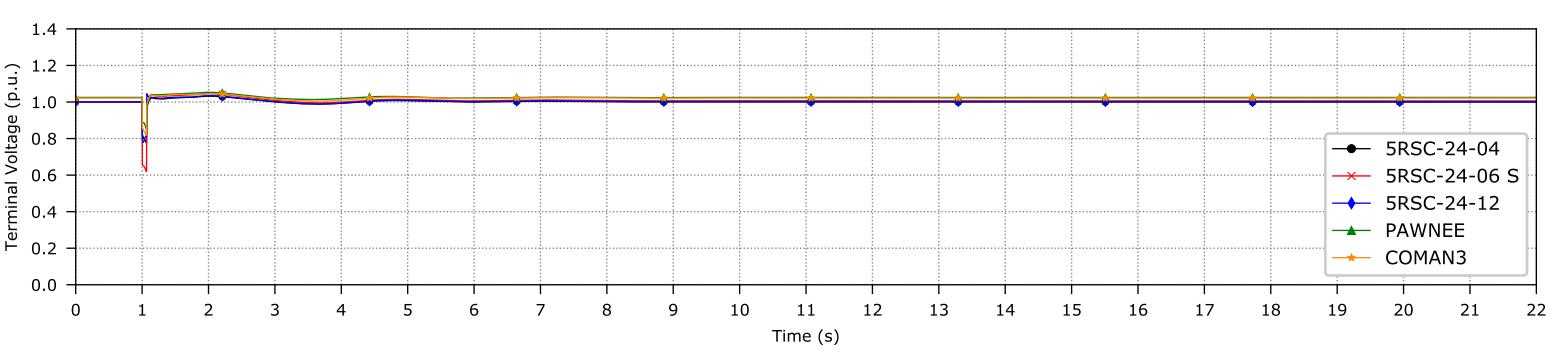


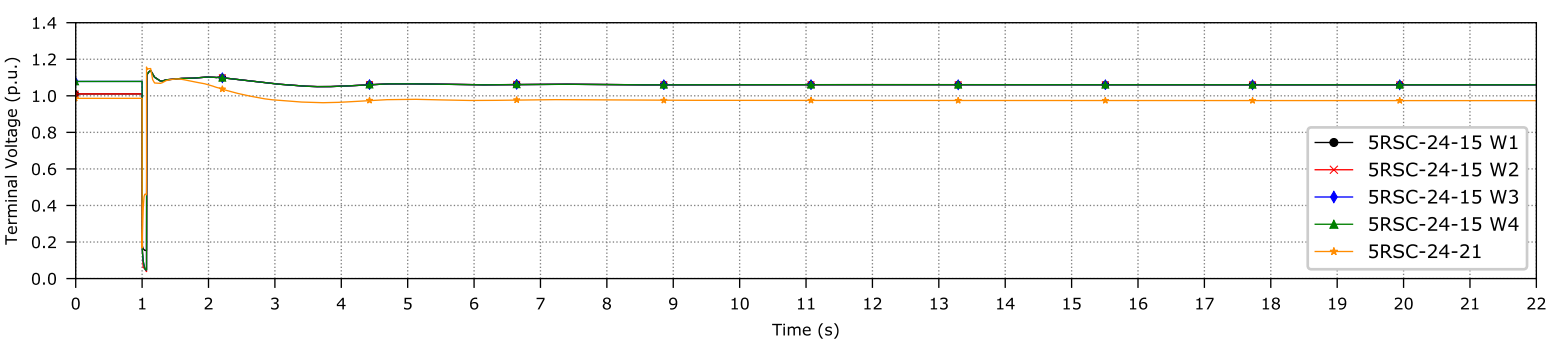


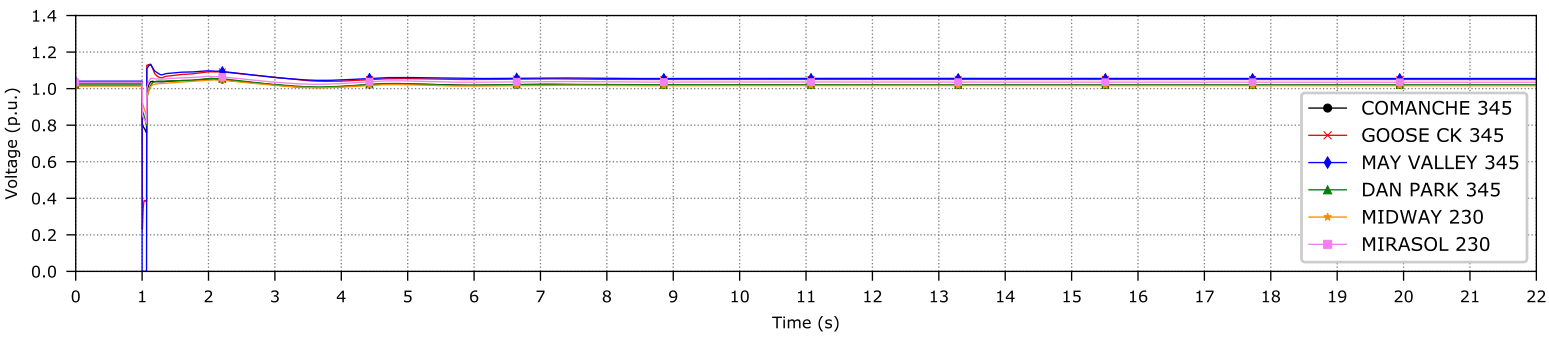




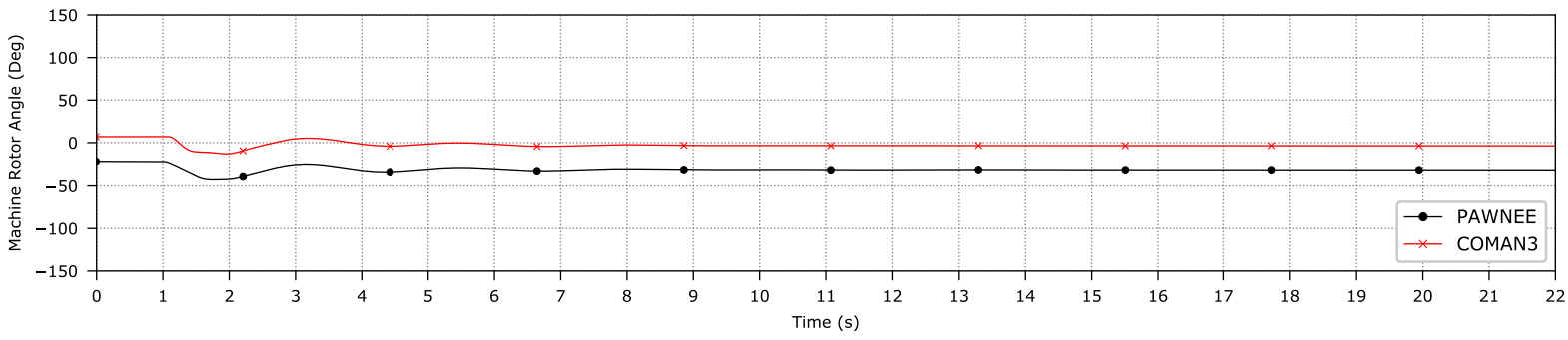


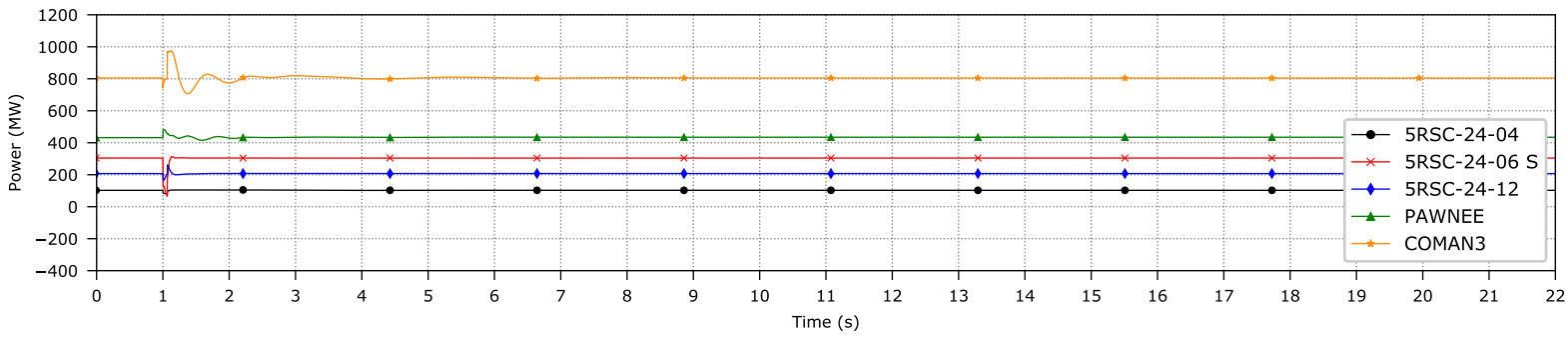


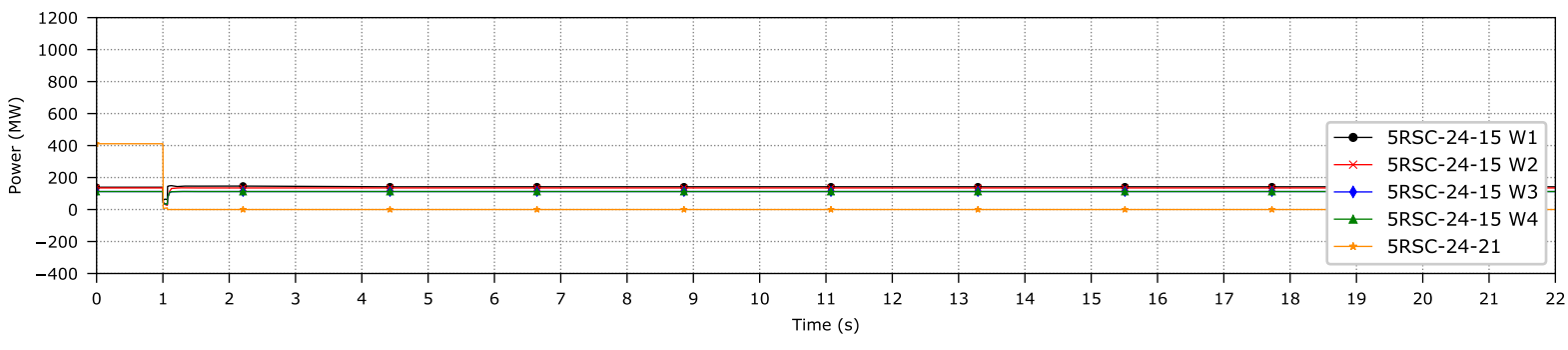


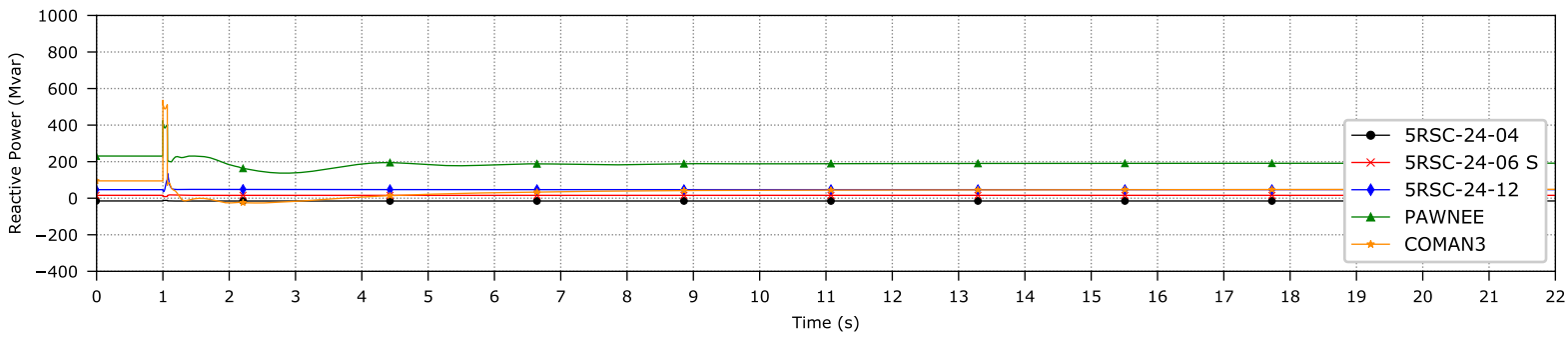


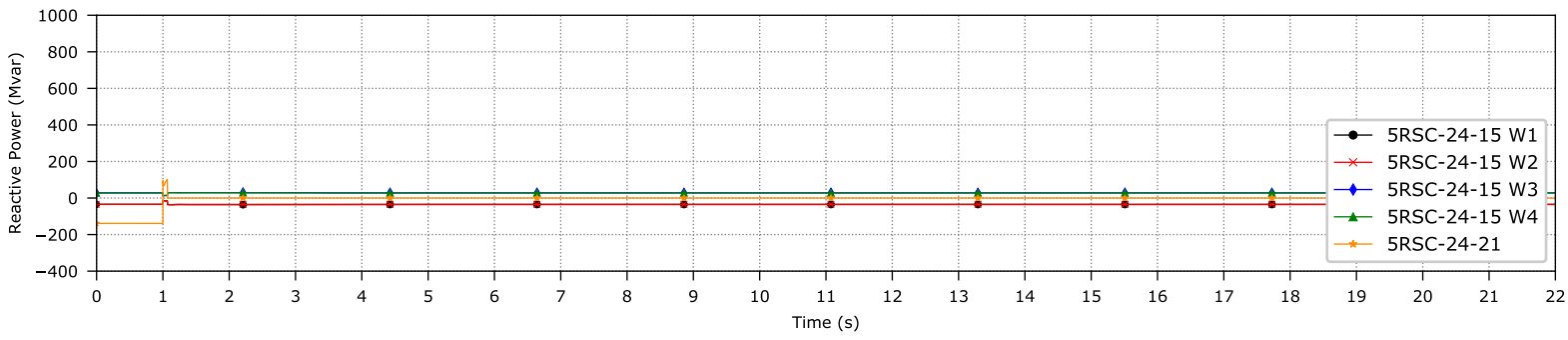
Ref. No. 06 - 5RSC-2024-21

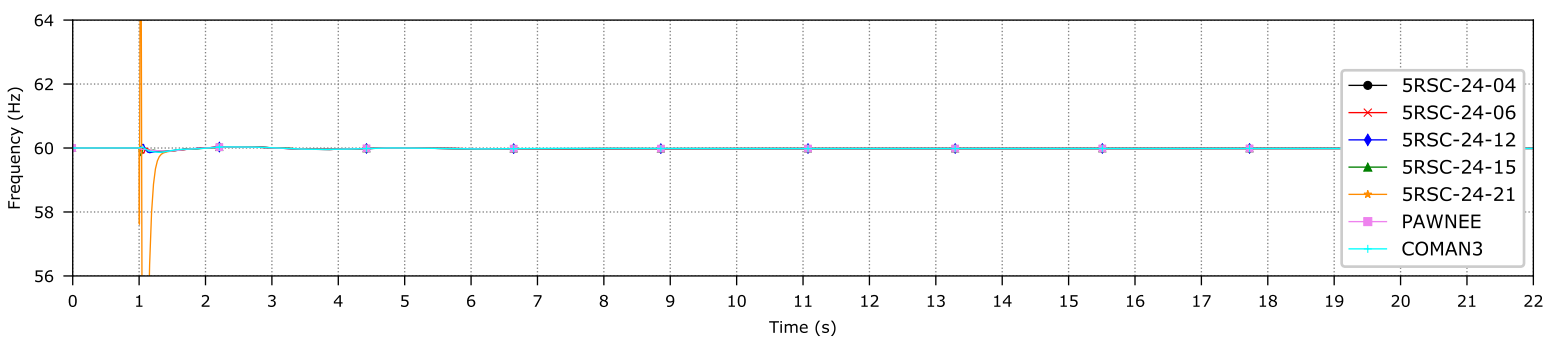


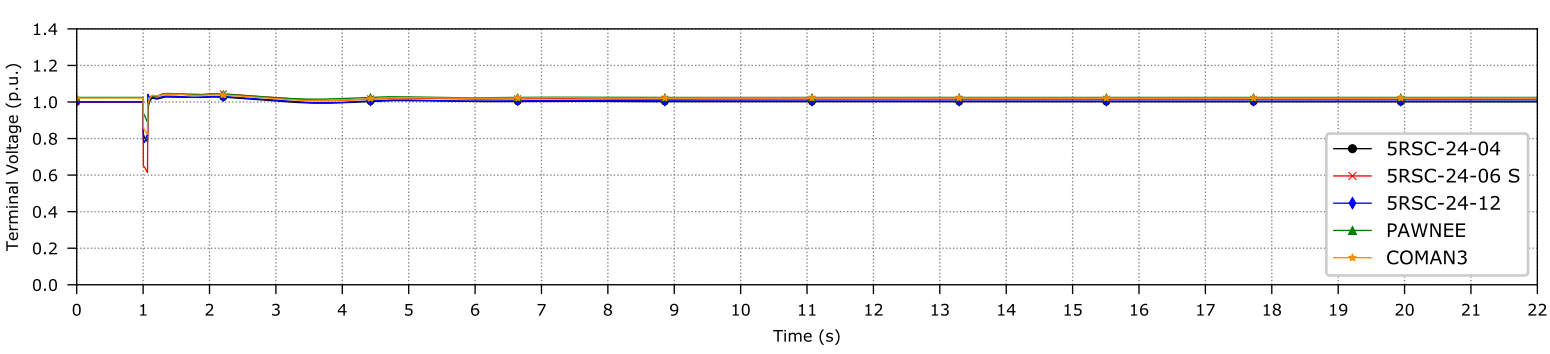


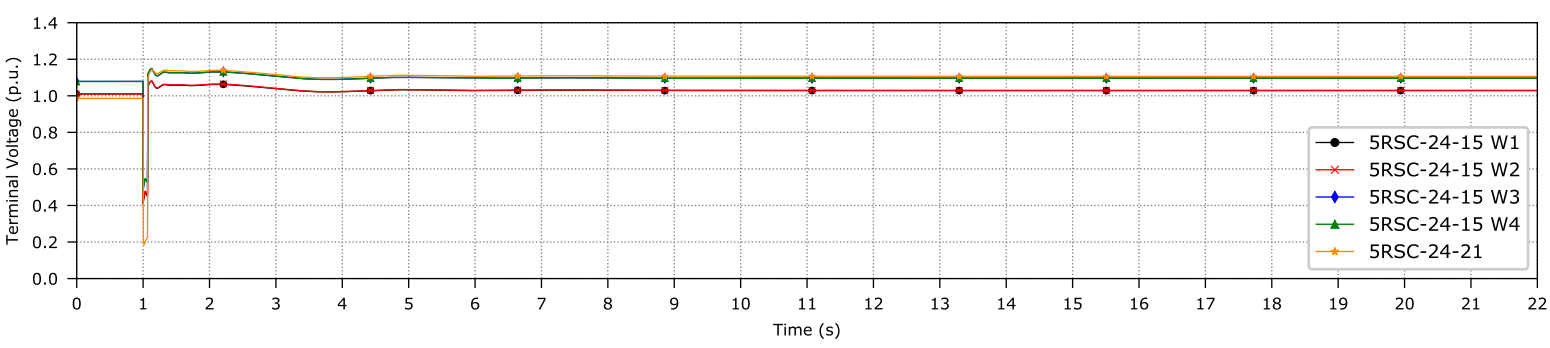


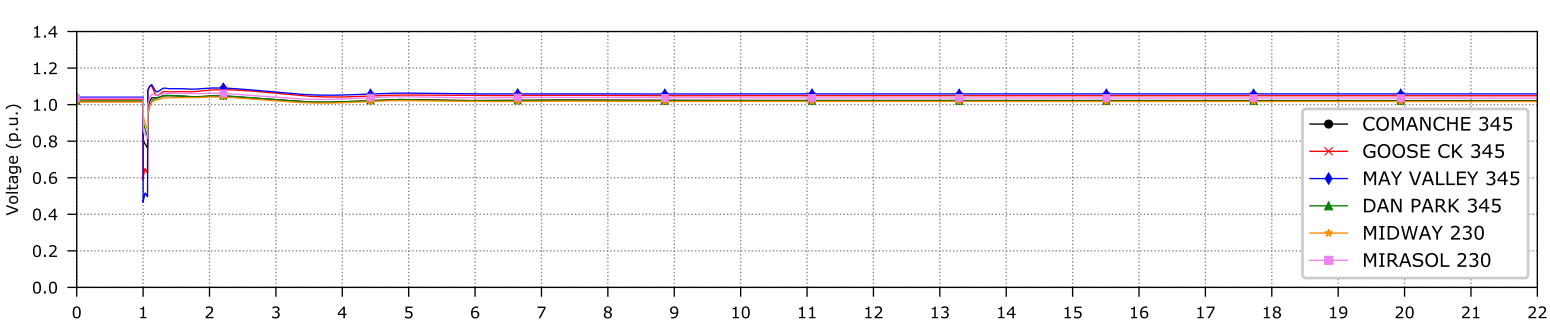




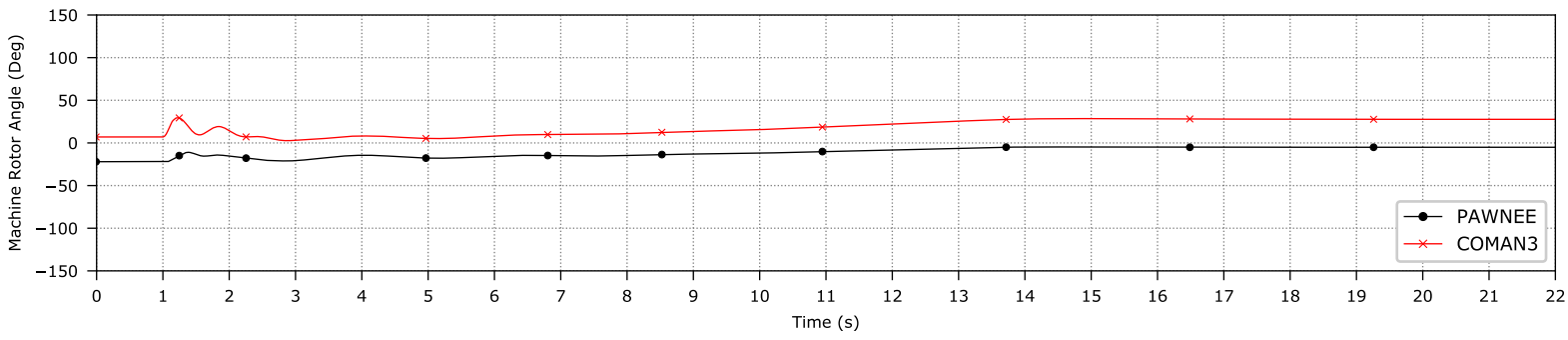


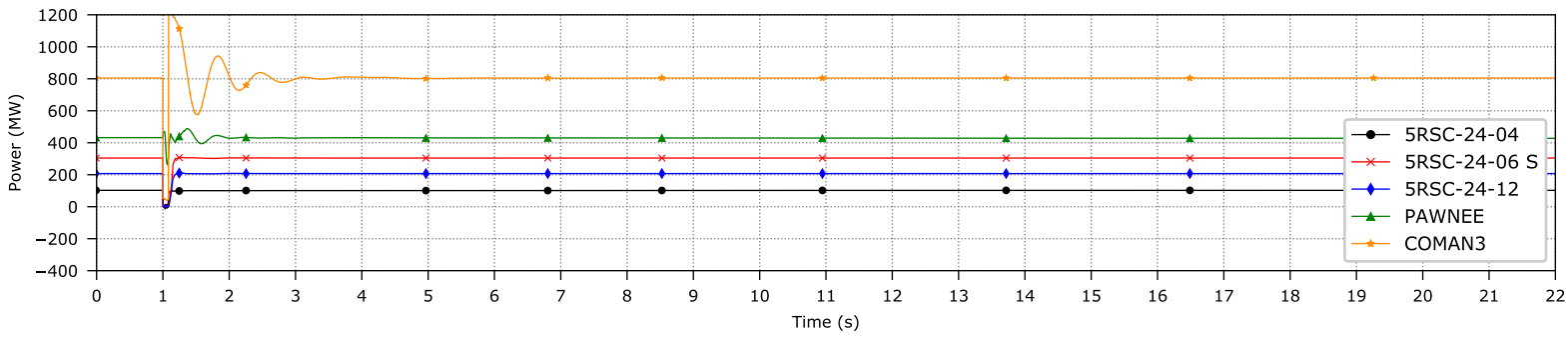


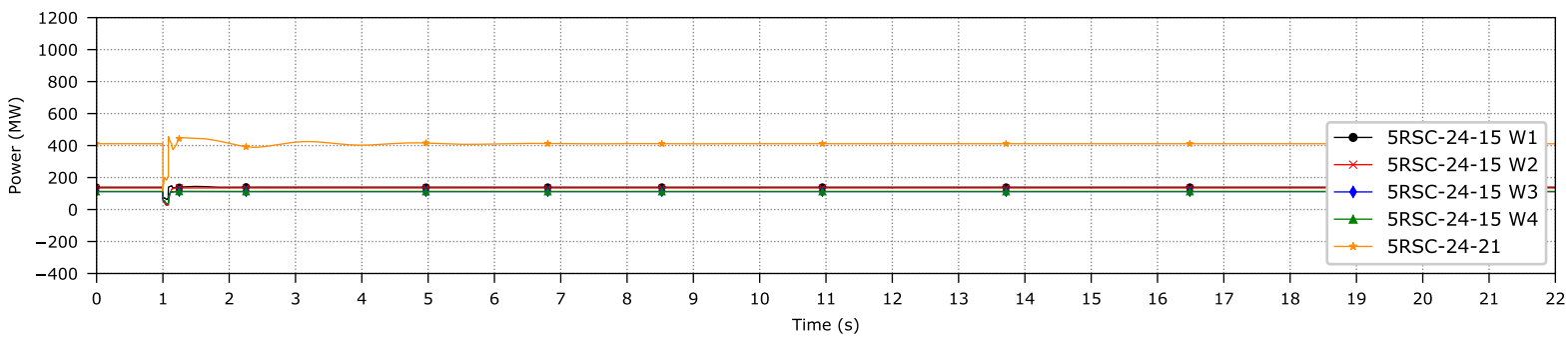


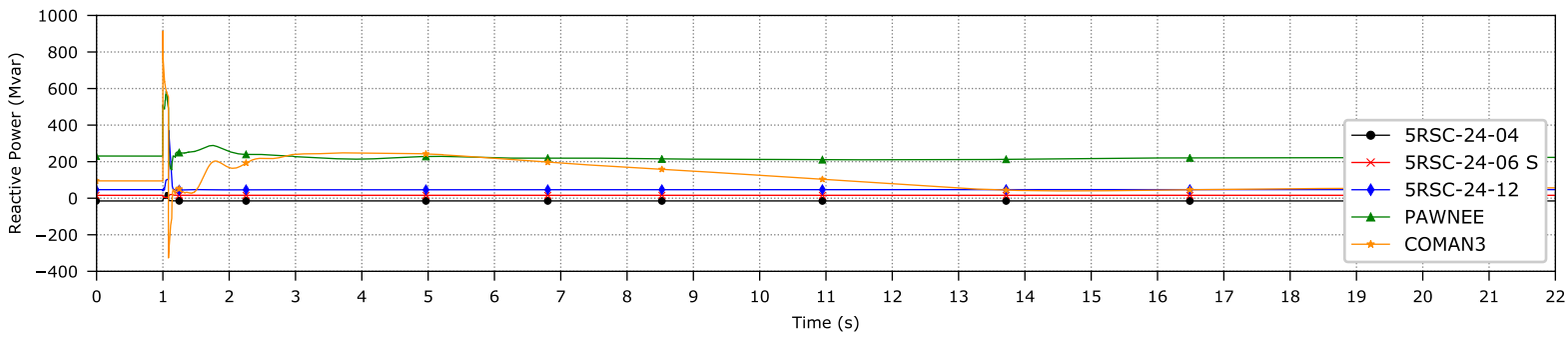


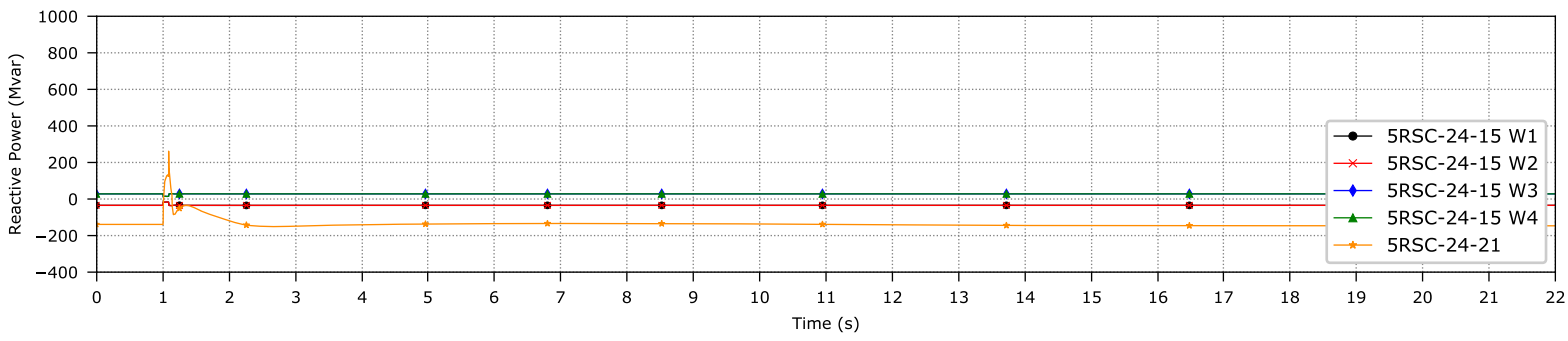
Ref. No. 07 - LoTC_79

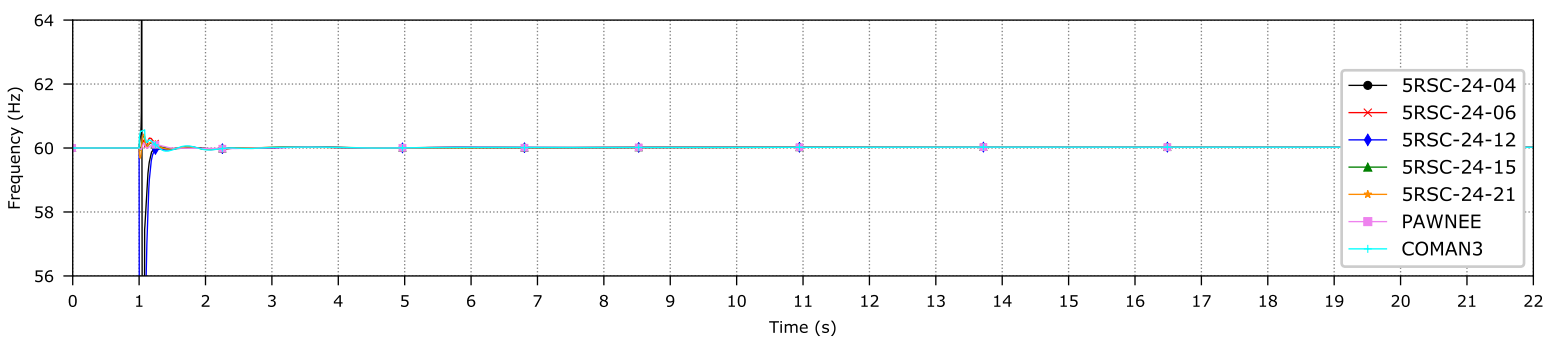


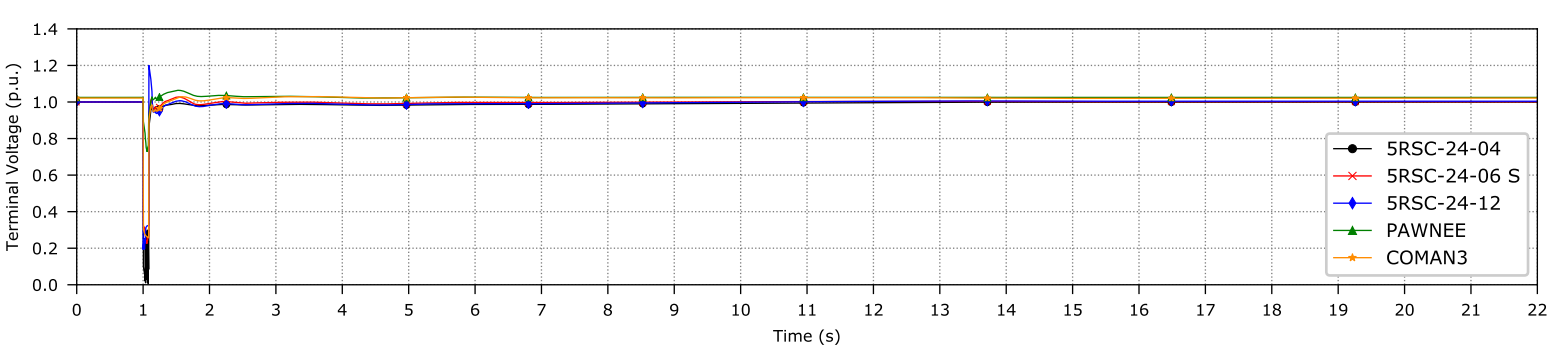


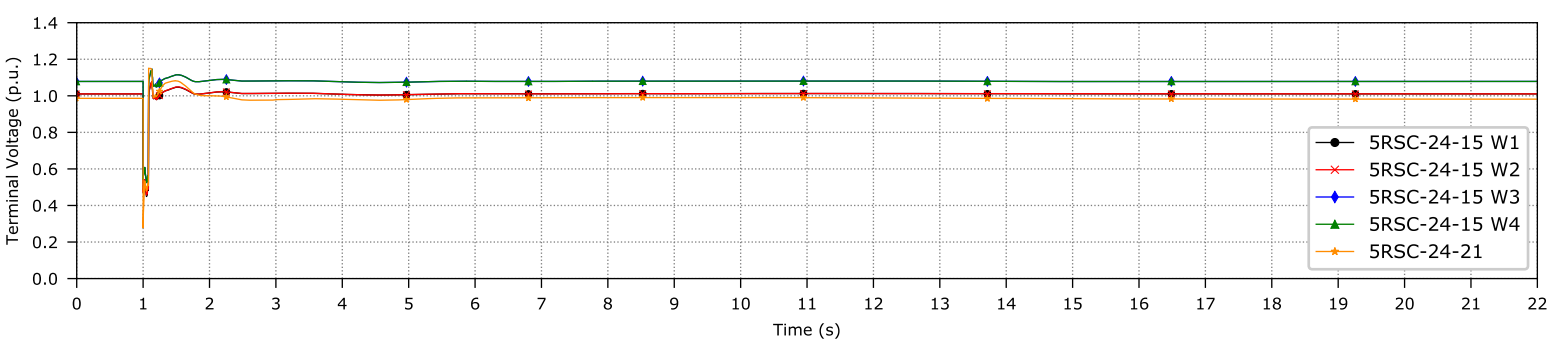


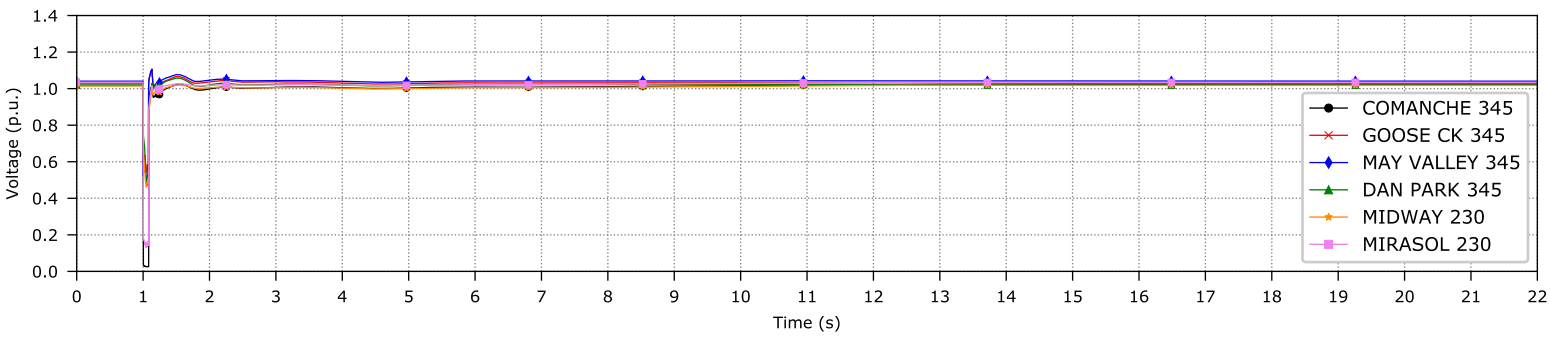




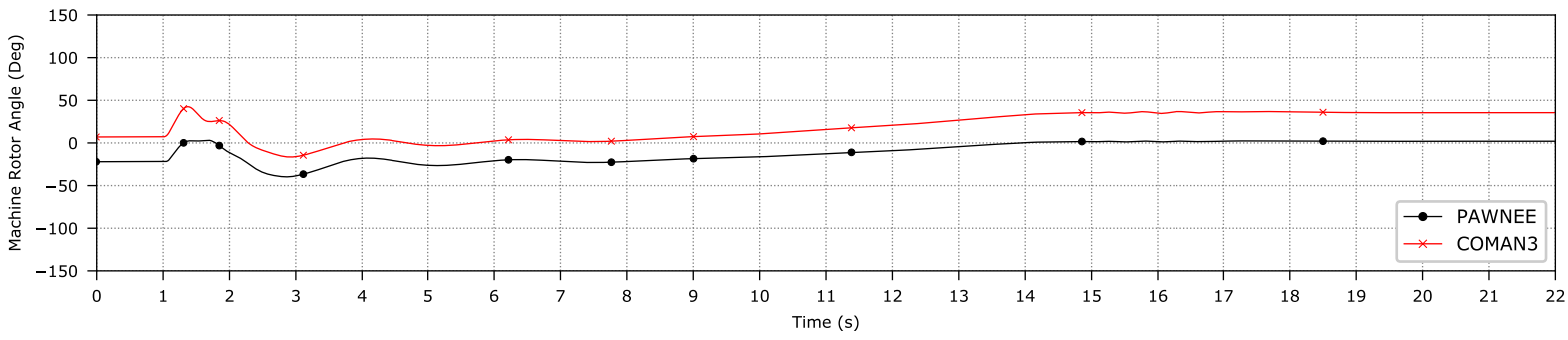


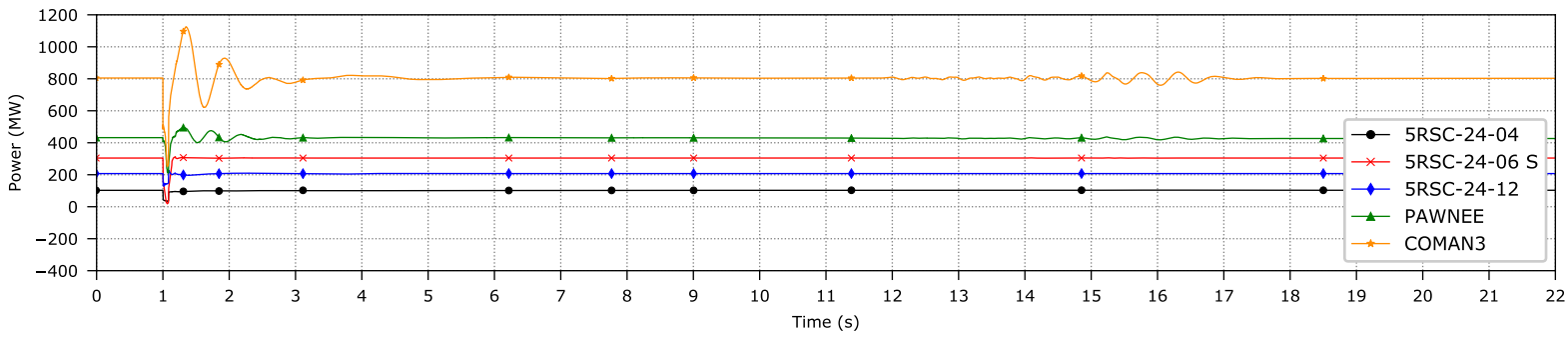


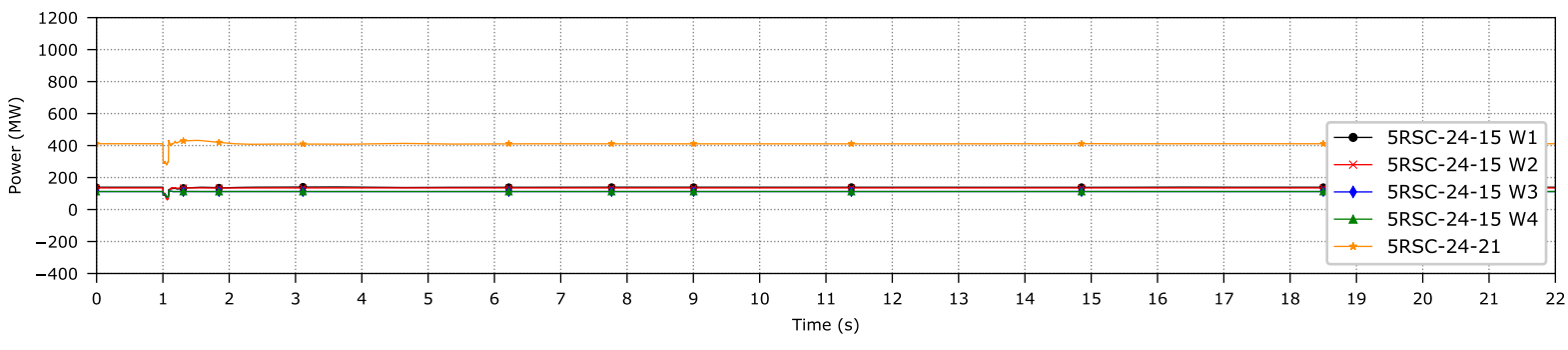


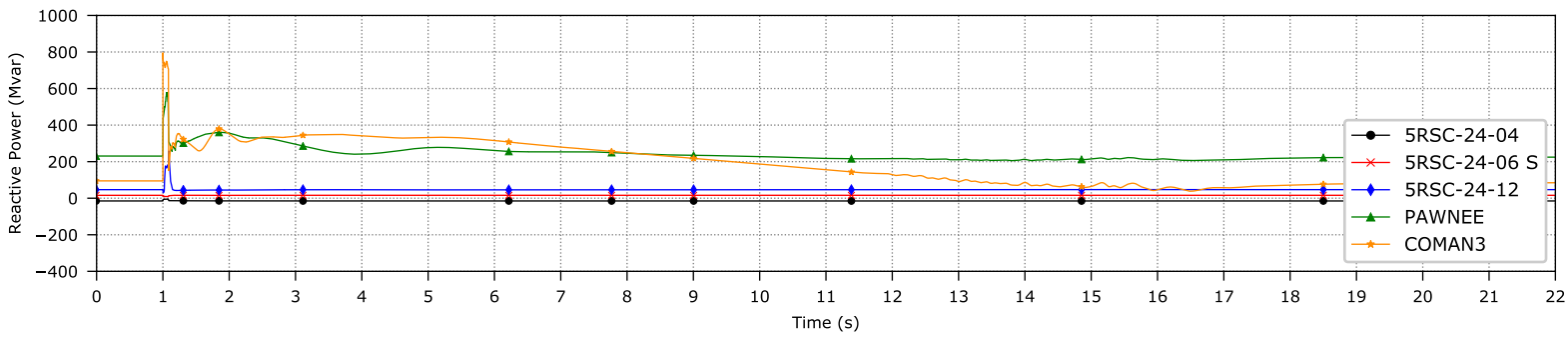


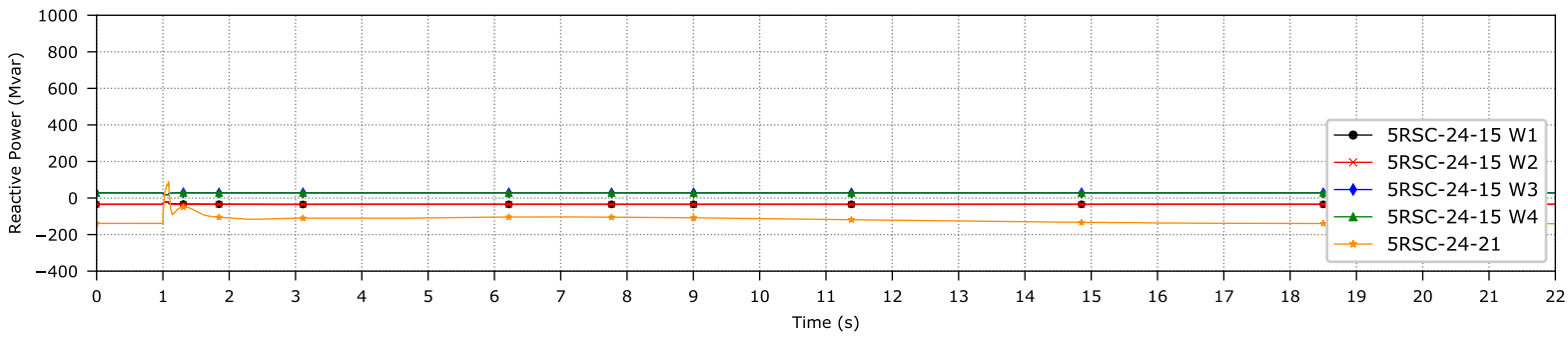
Ref. No. 08 - LoTC_102

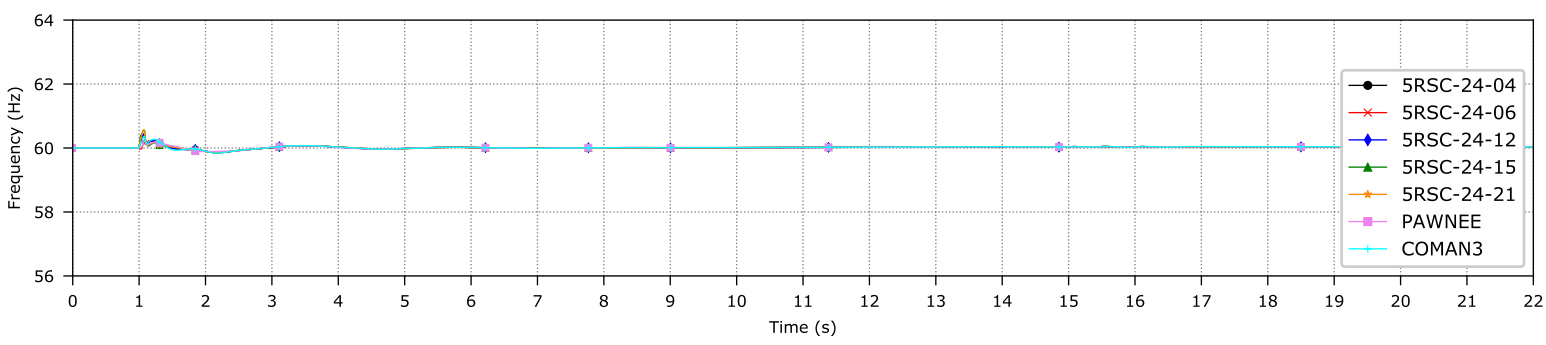


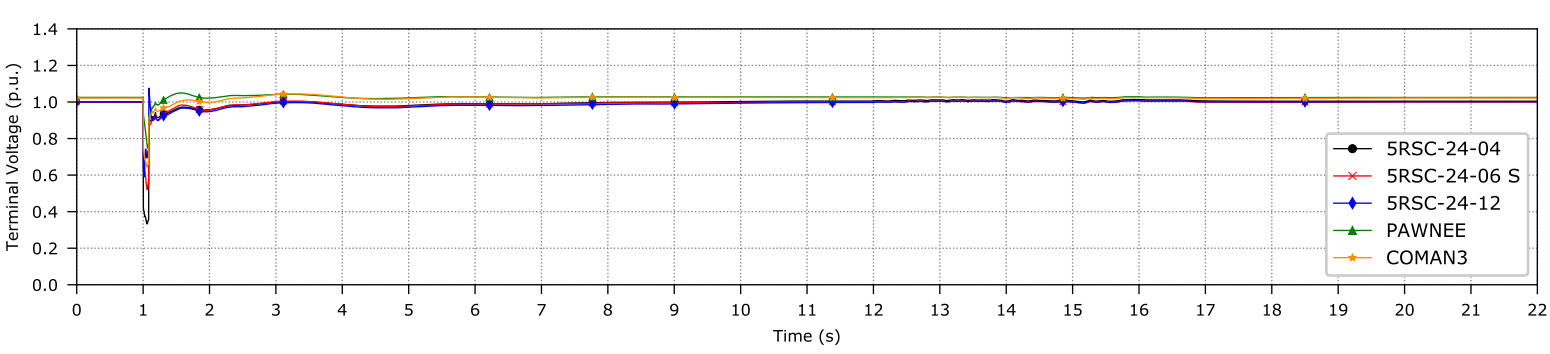


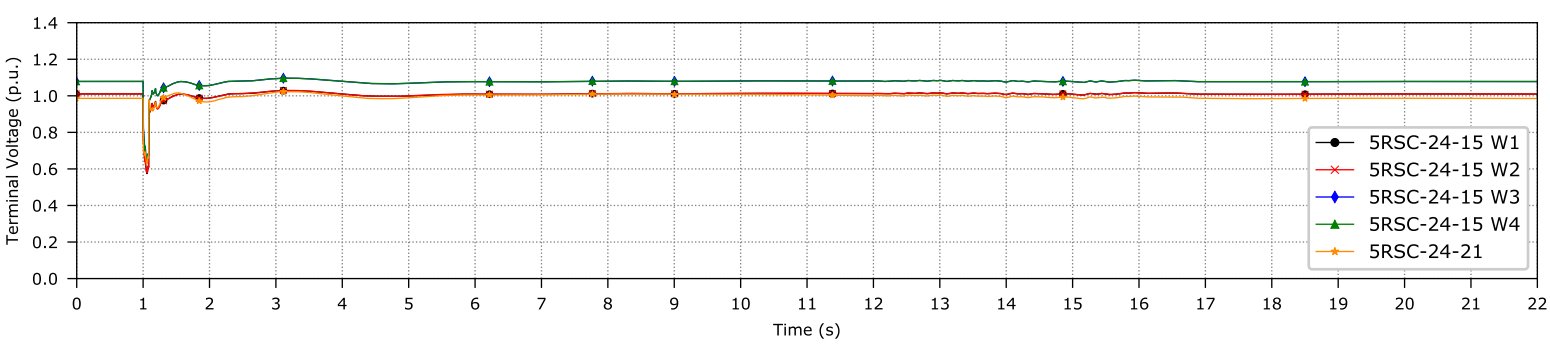


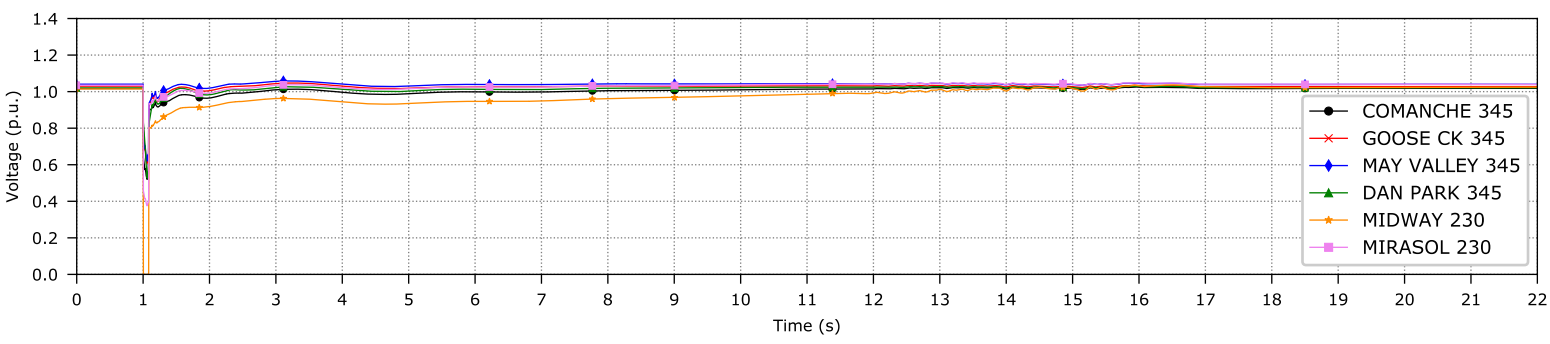




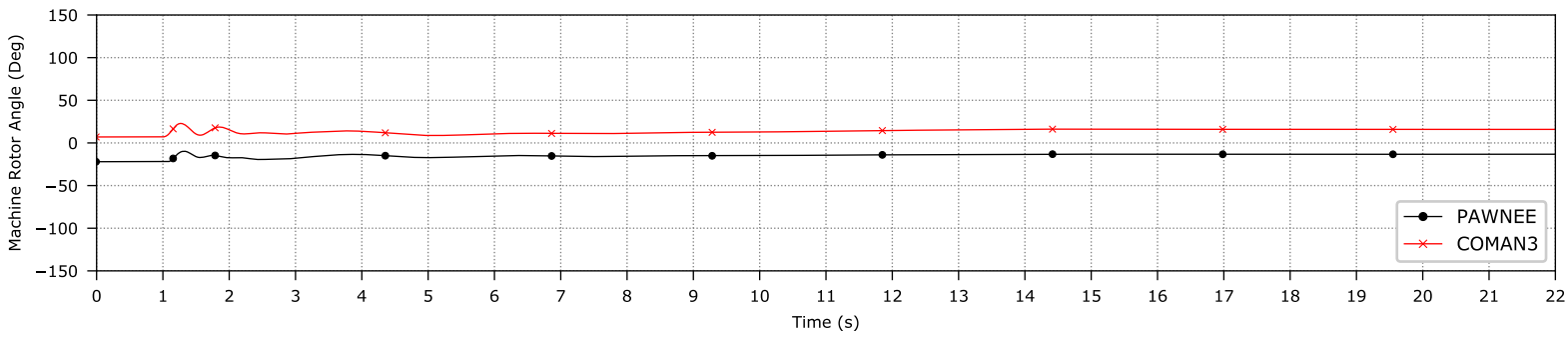


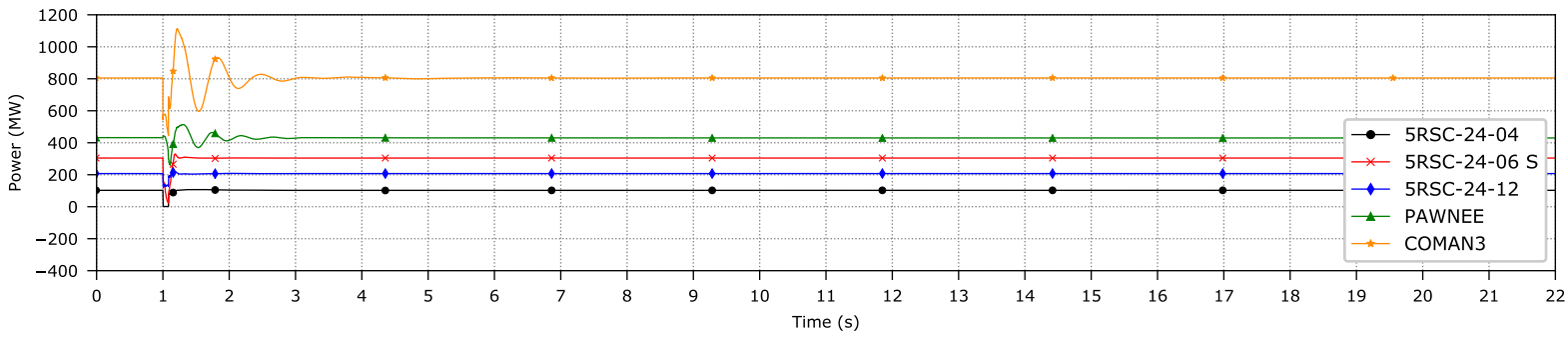


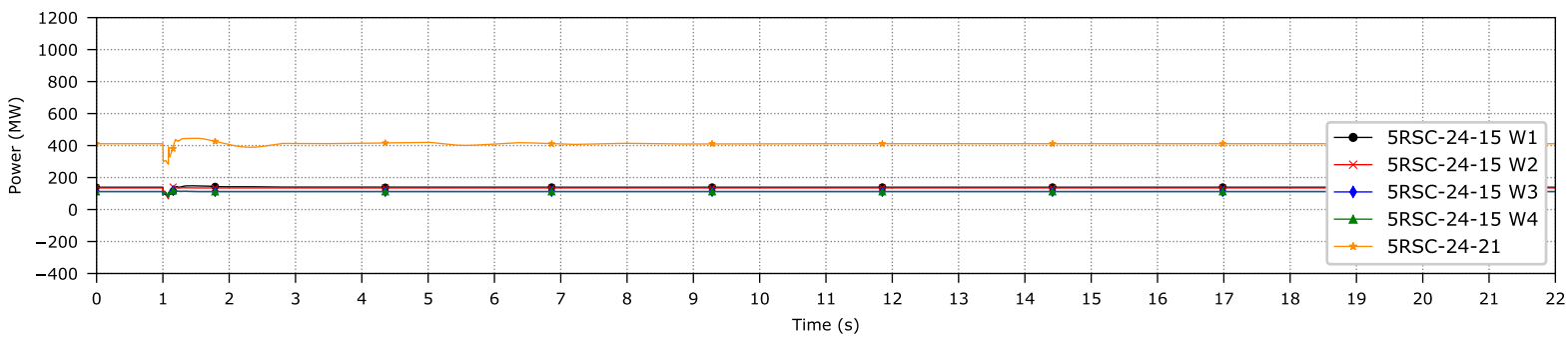


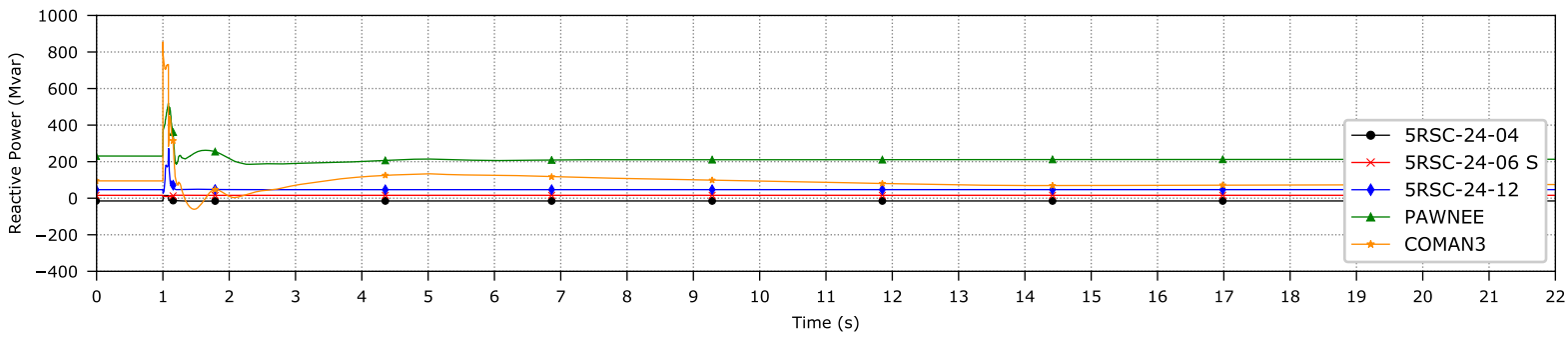


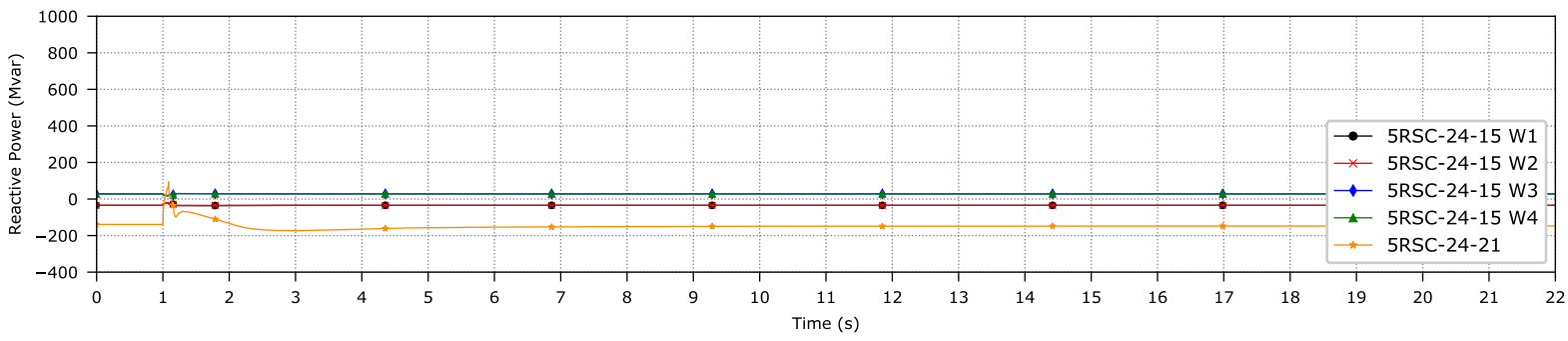
Ref. No. 09 - LoTC_103

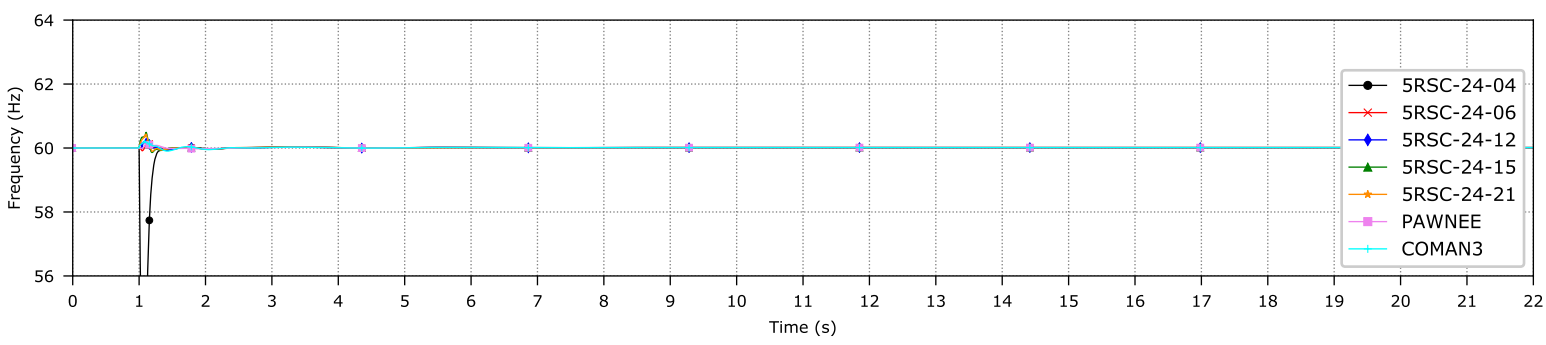


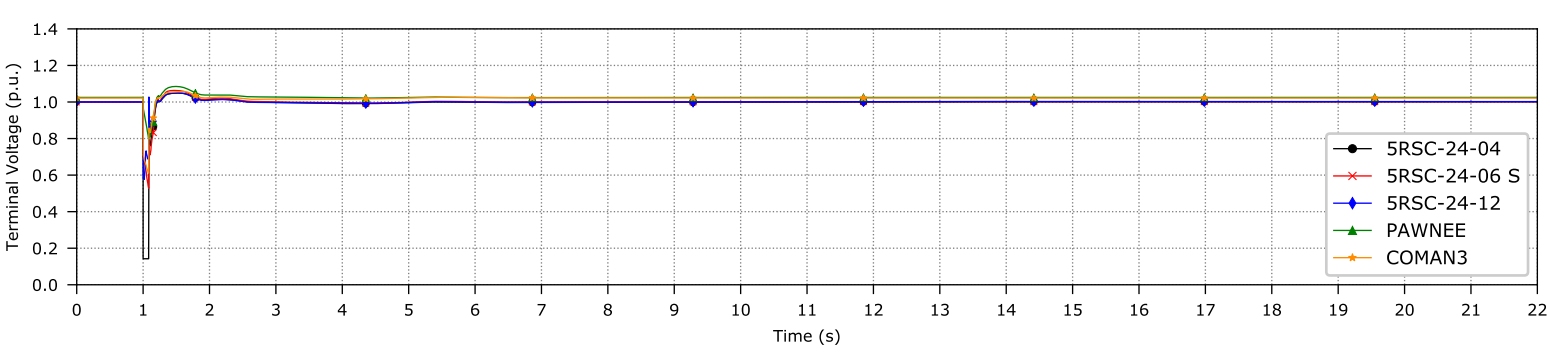


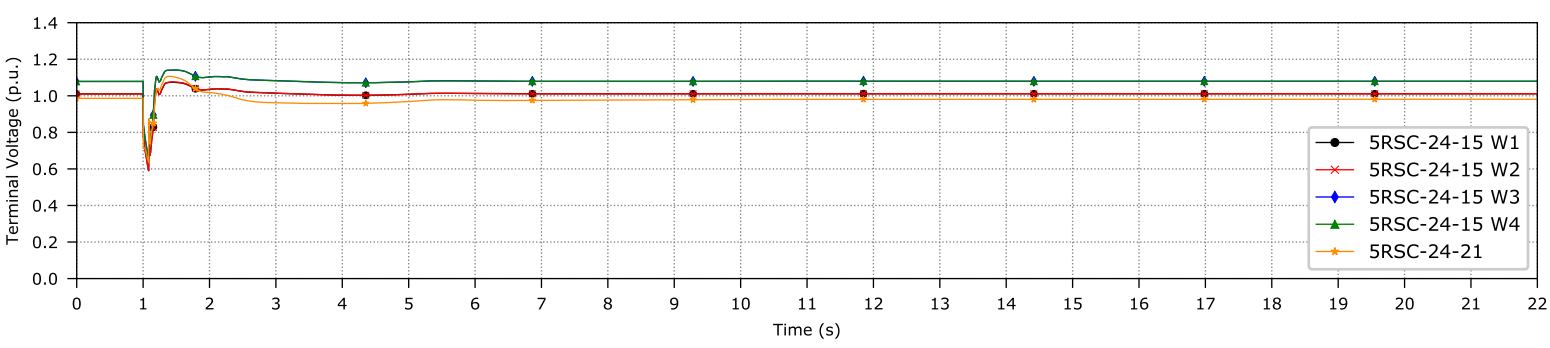


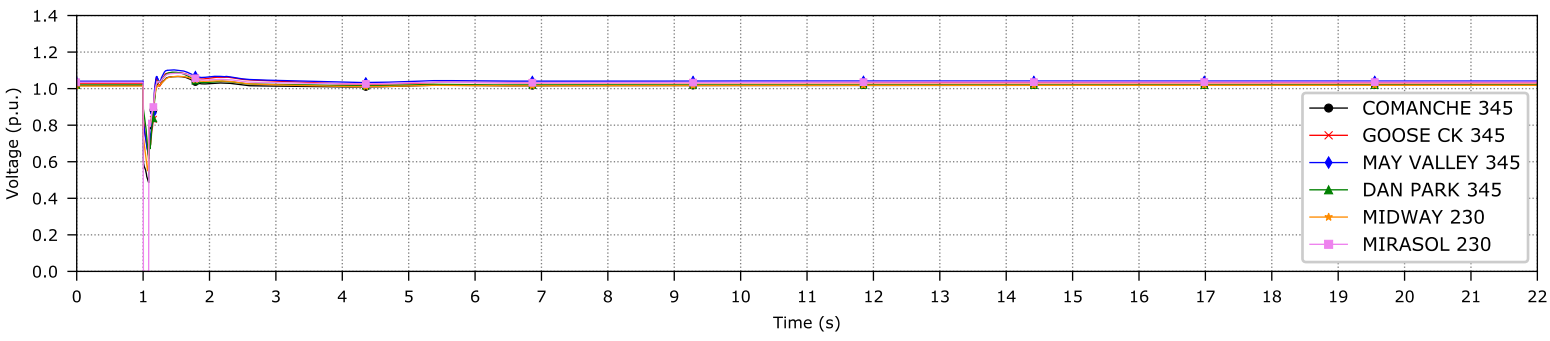




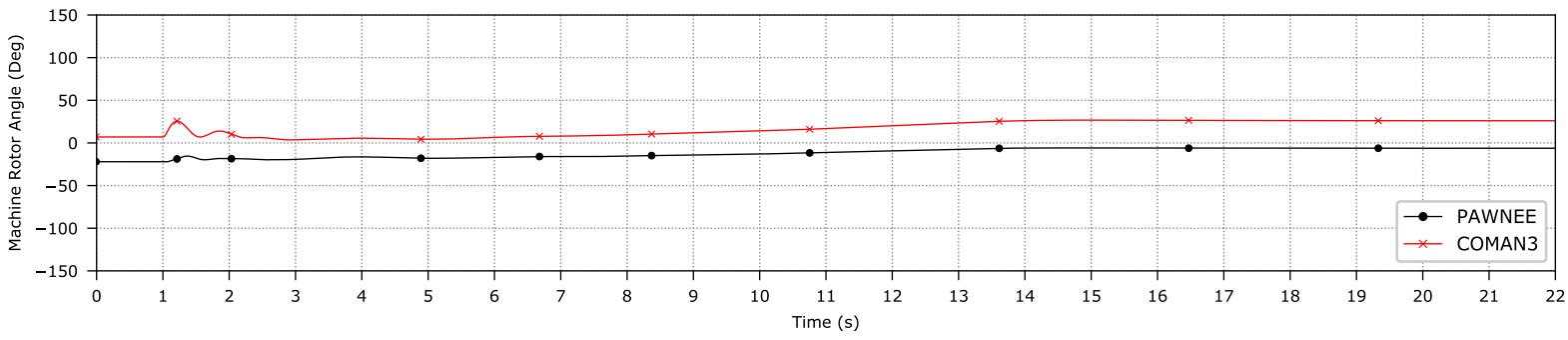


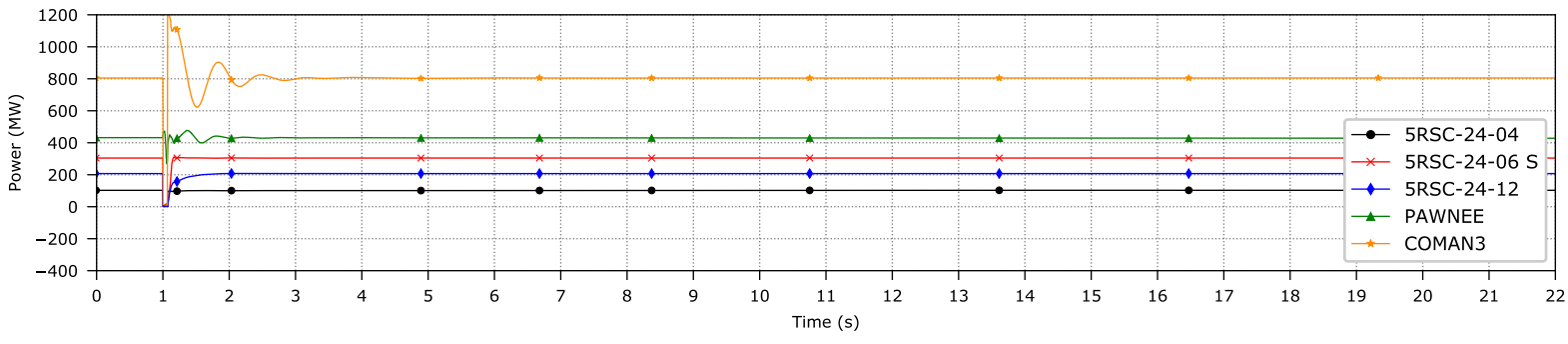


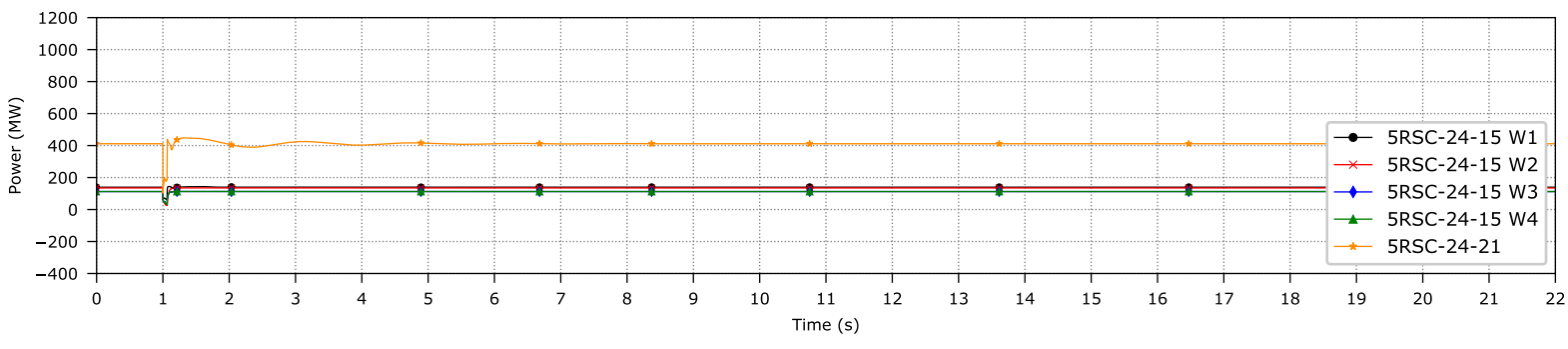


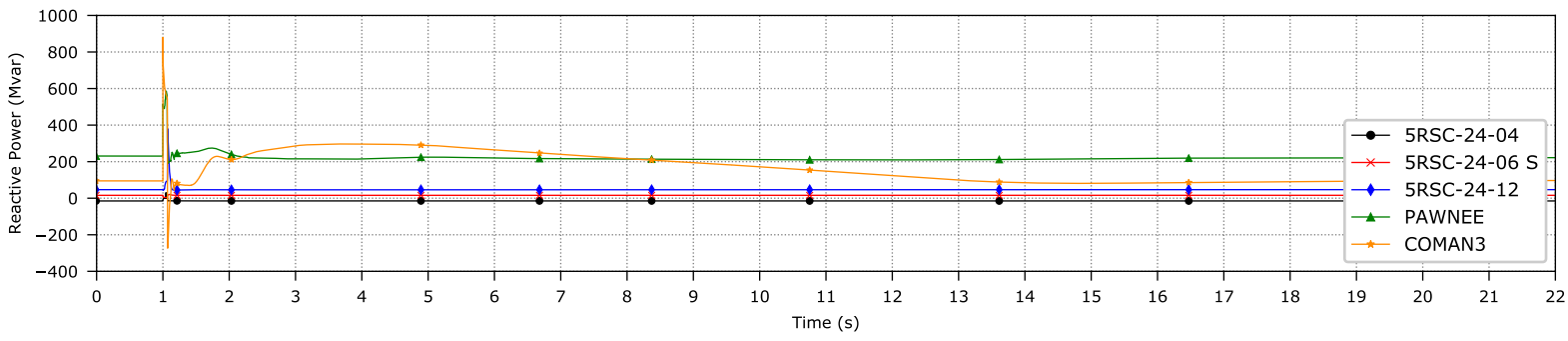


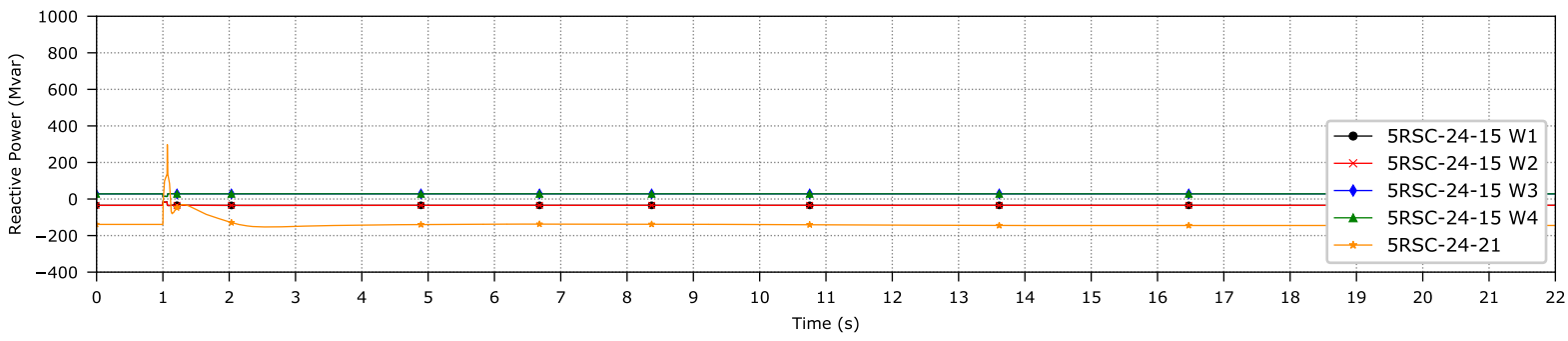
Ref. No. 10 - LoTC_147

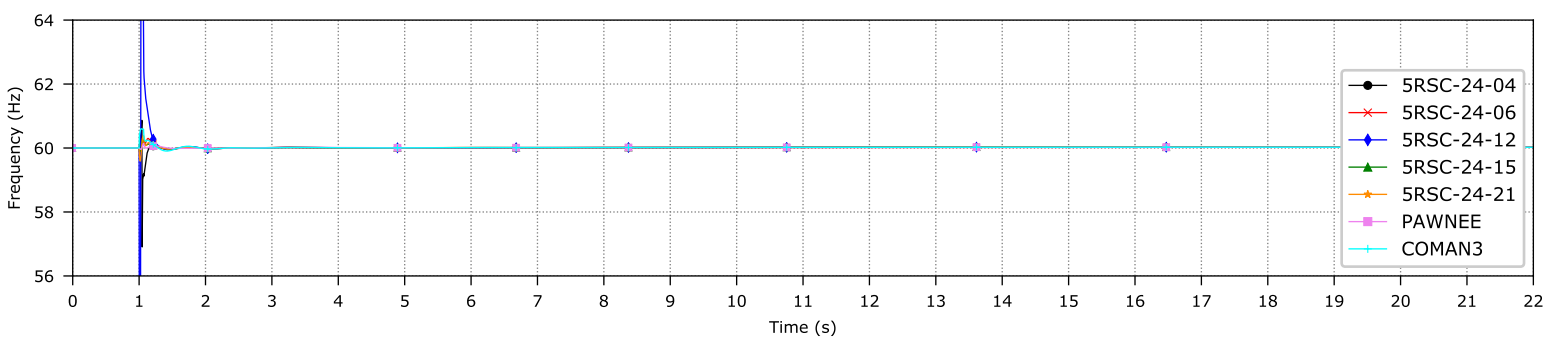


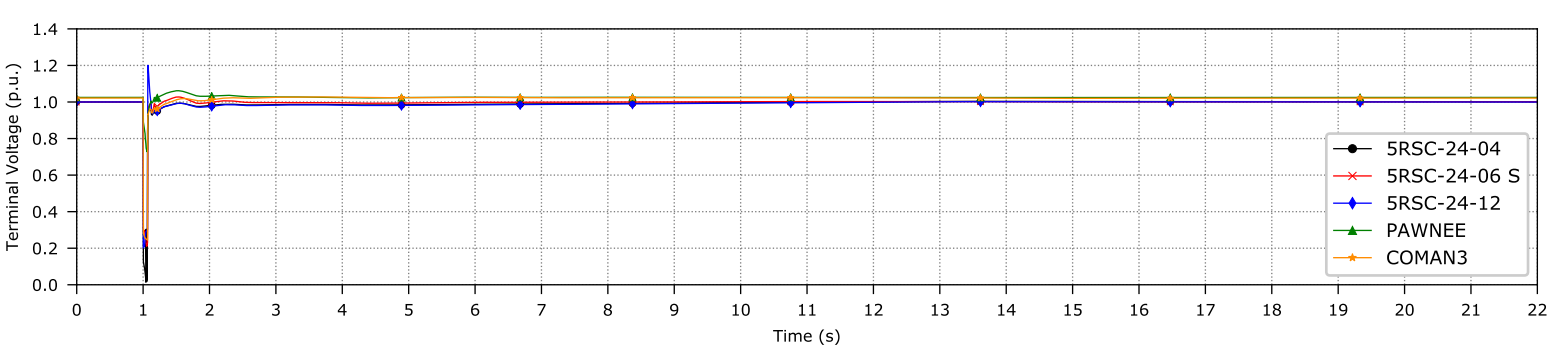


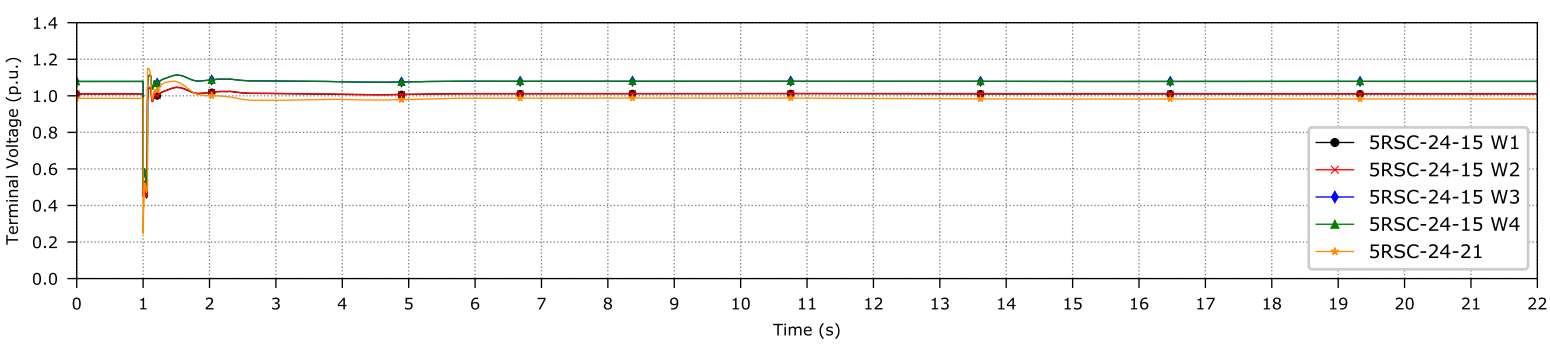


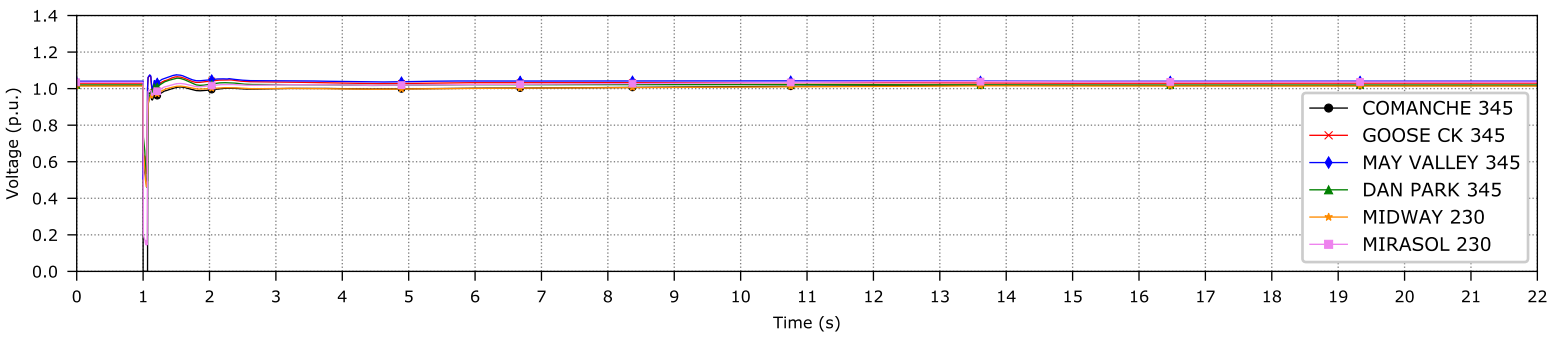




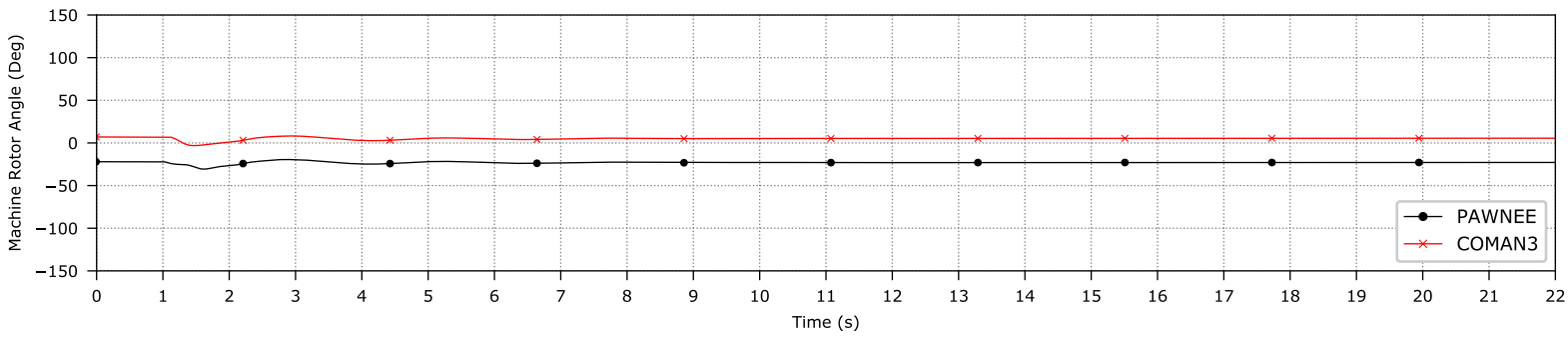


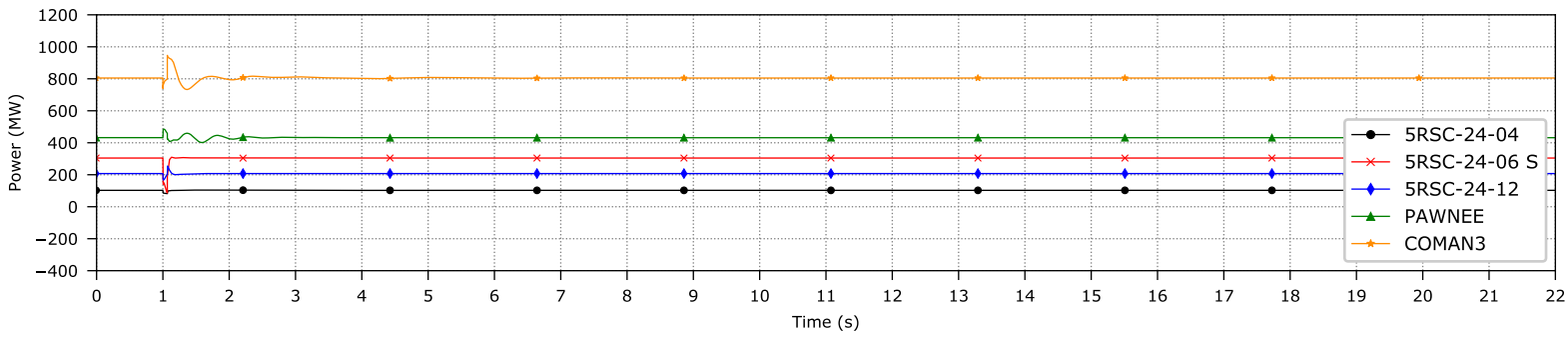


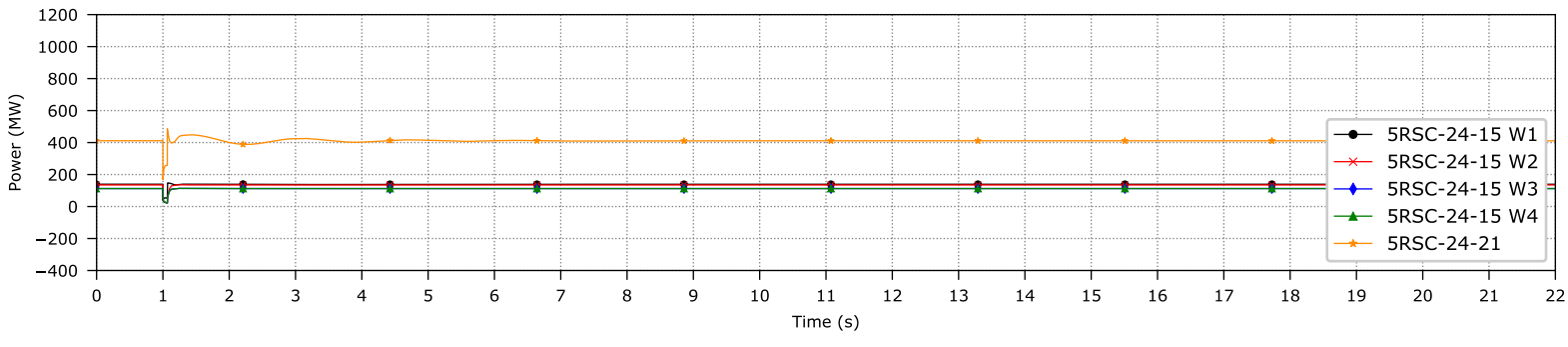


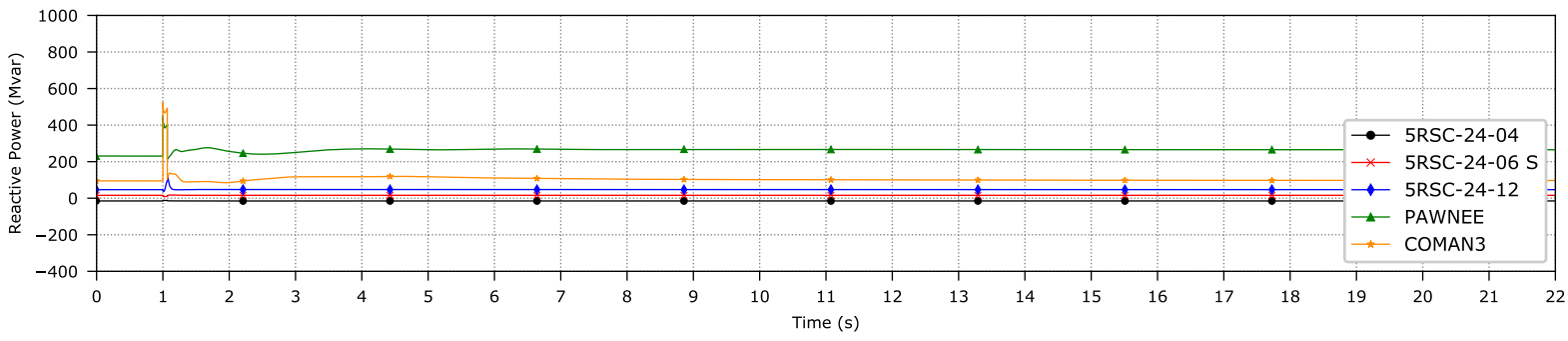


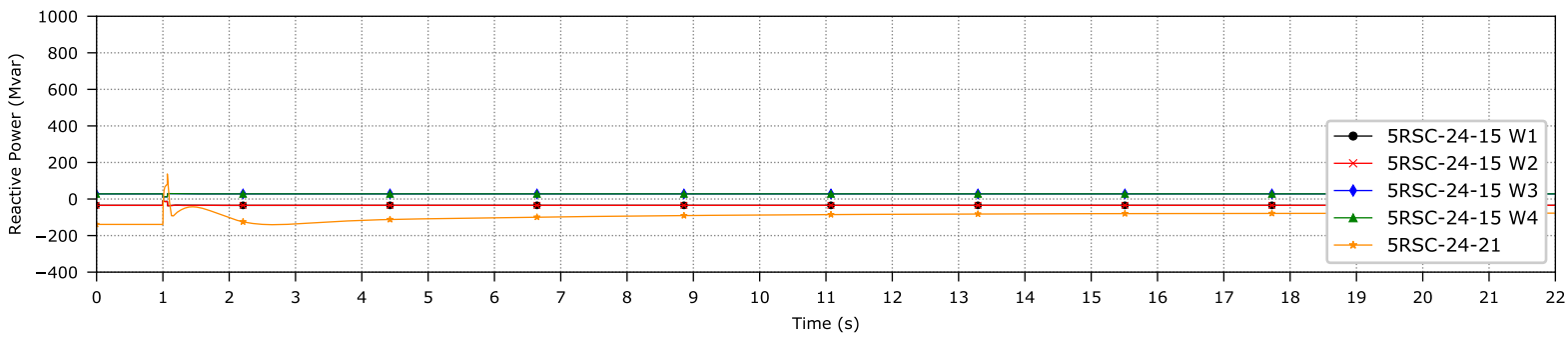
Ref. No. 11 - LoTC_316b

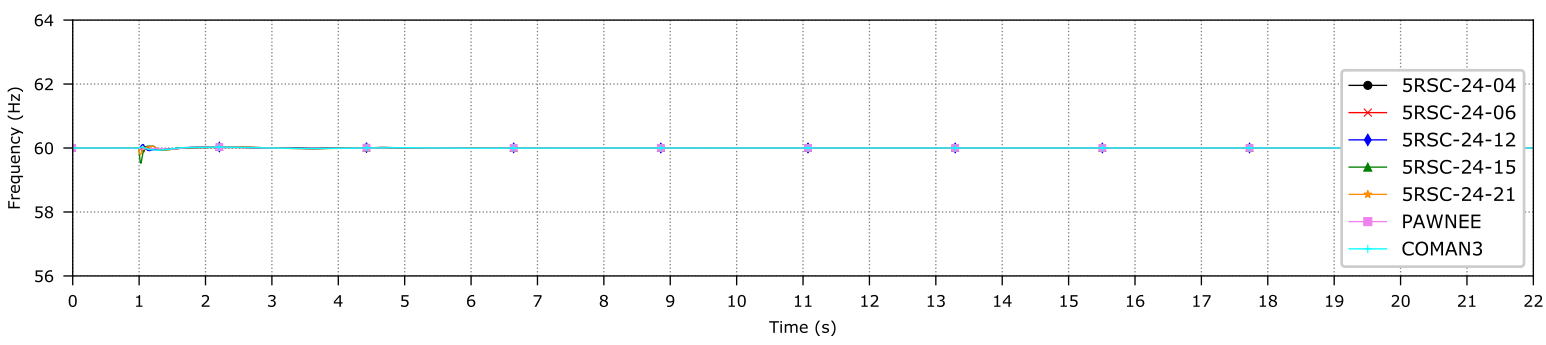


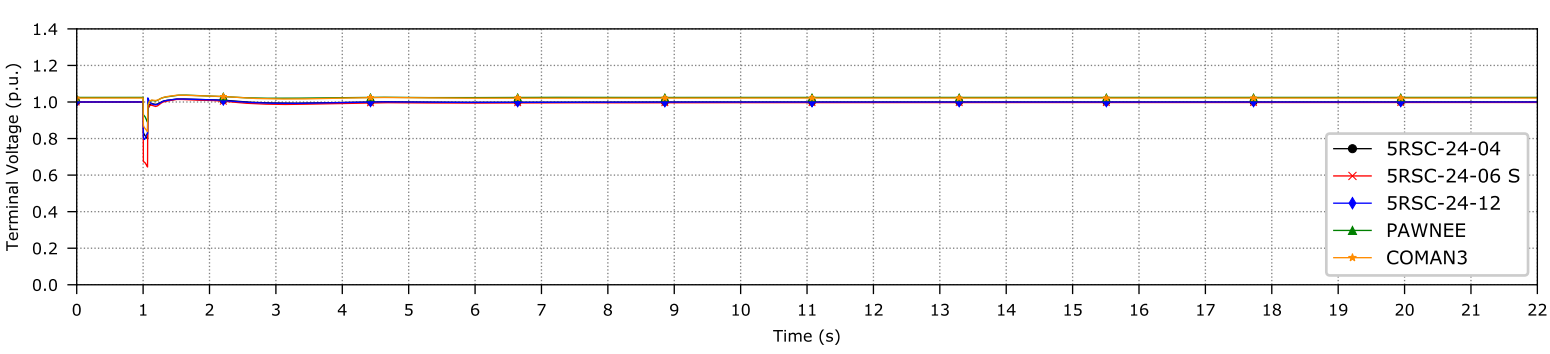


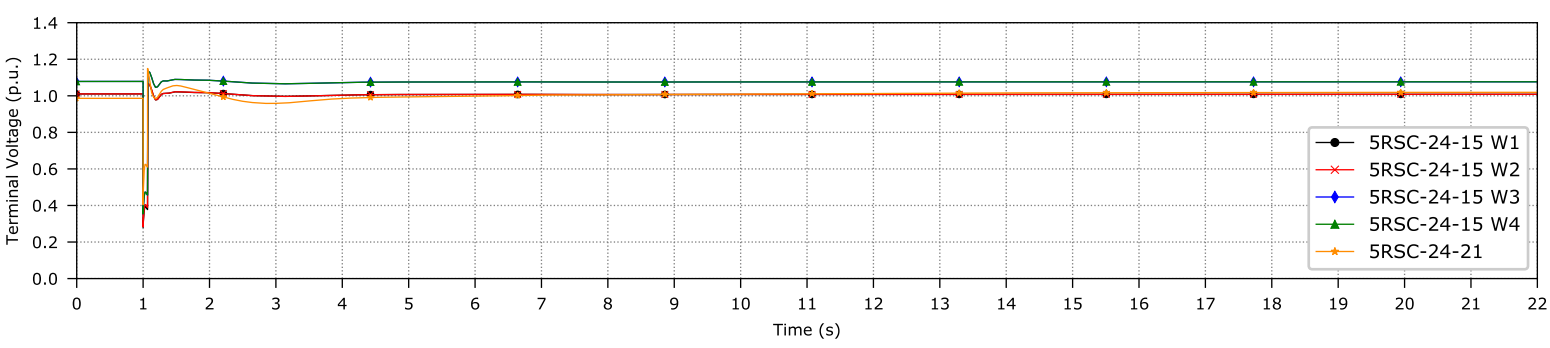


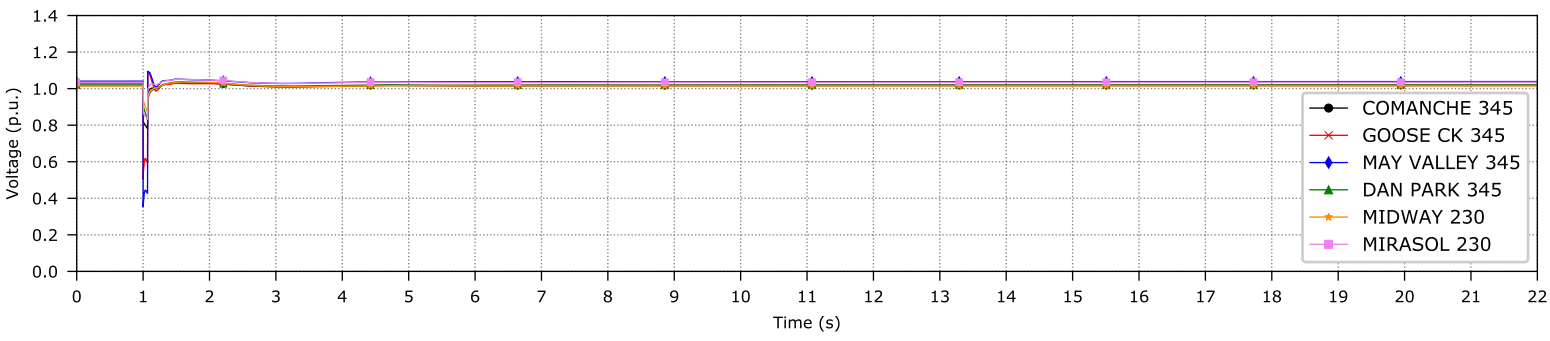




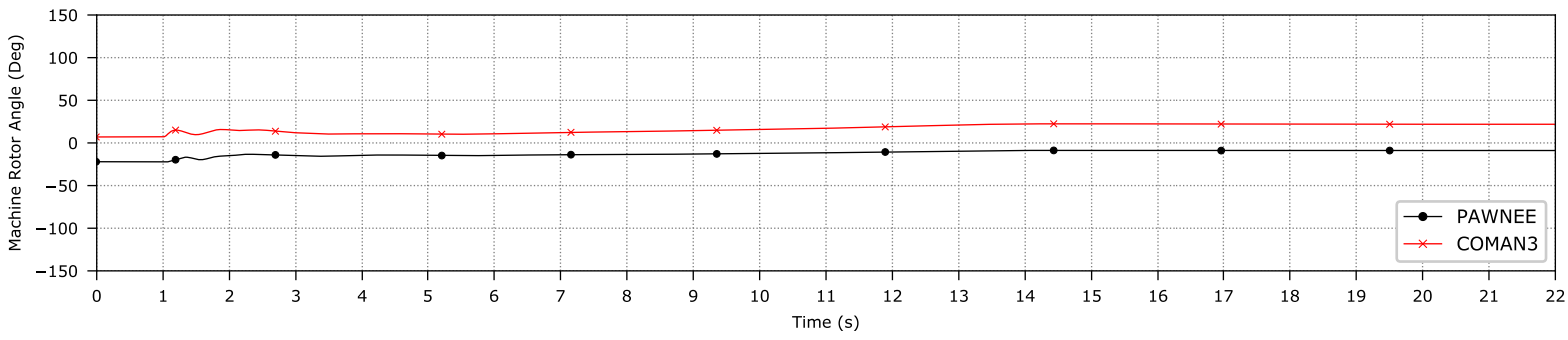


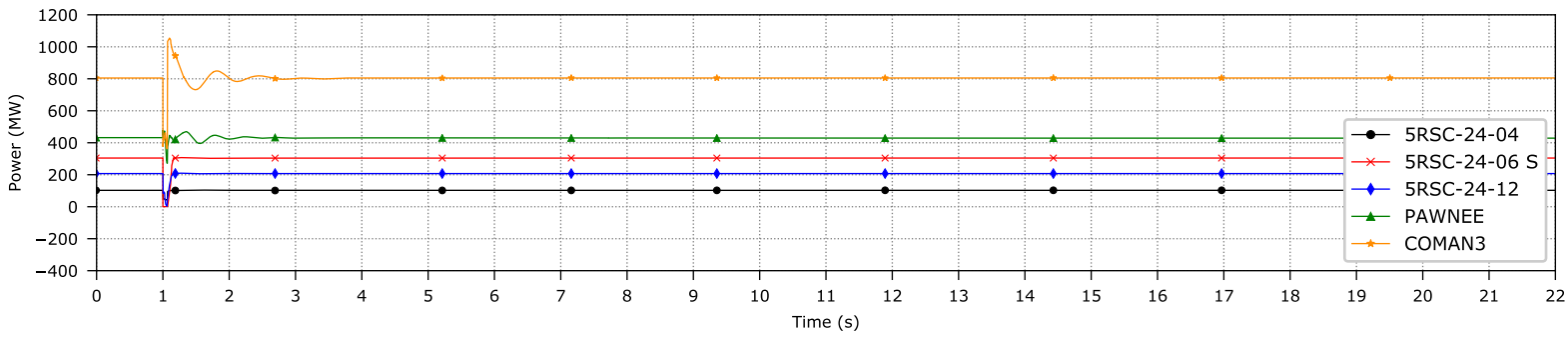


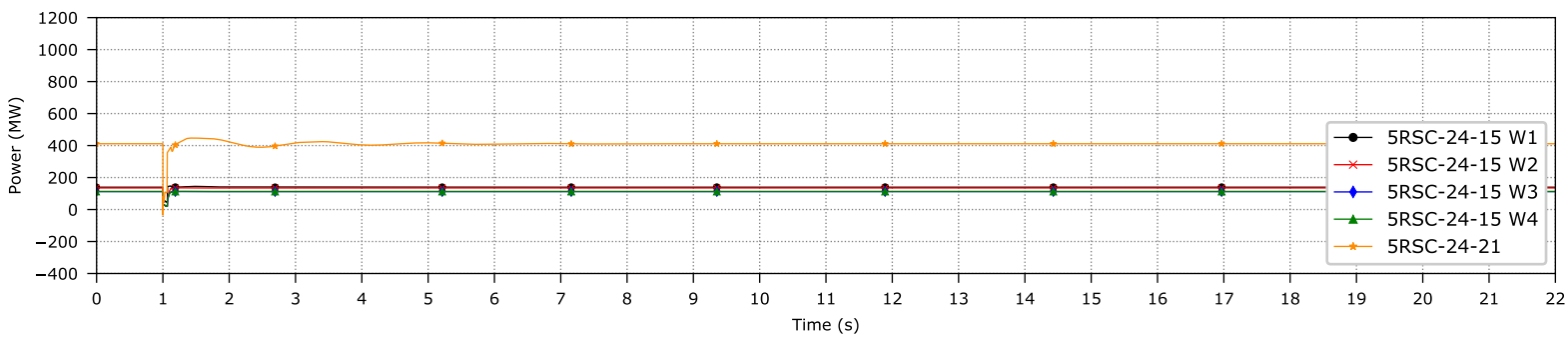


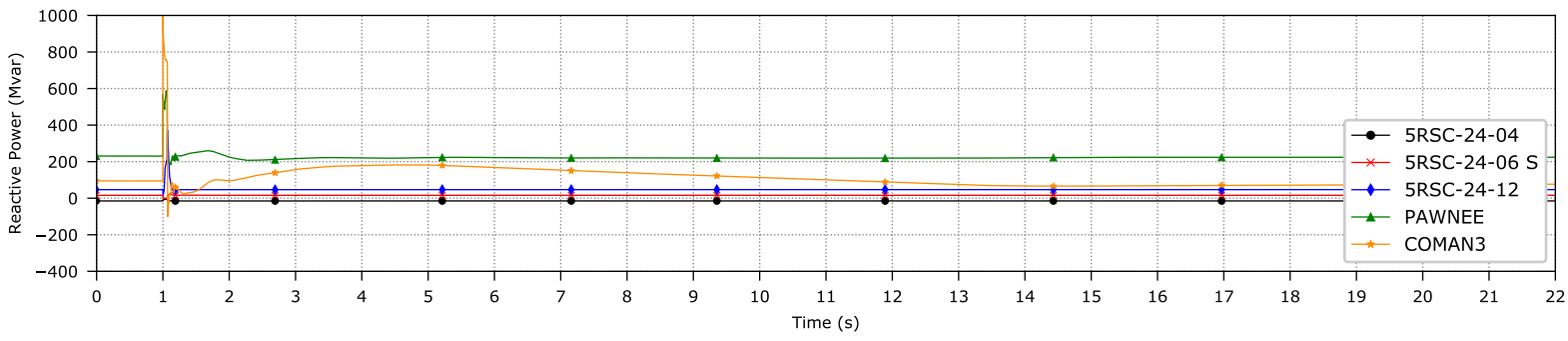


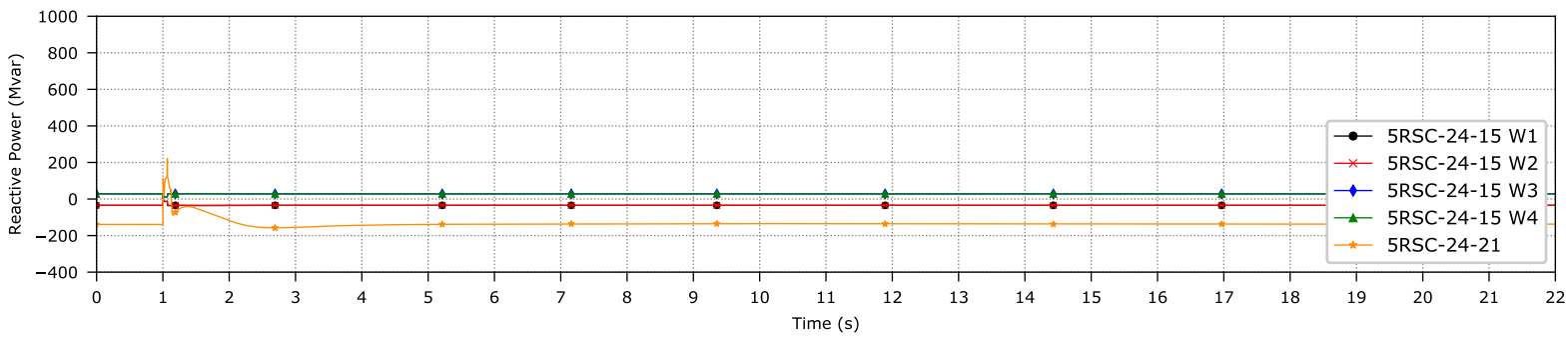
Ref. No. 12 - LoTC_317

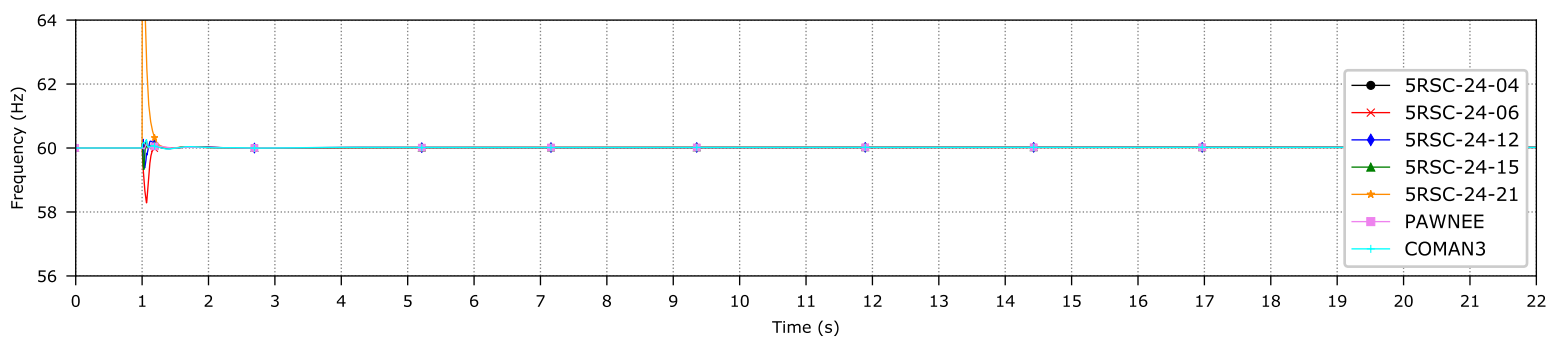


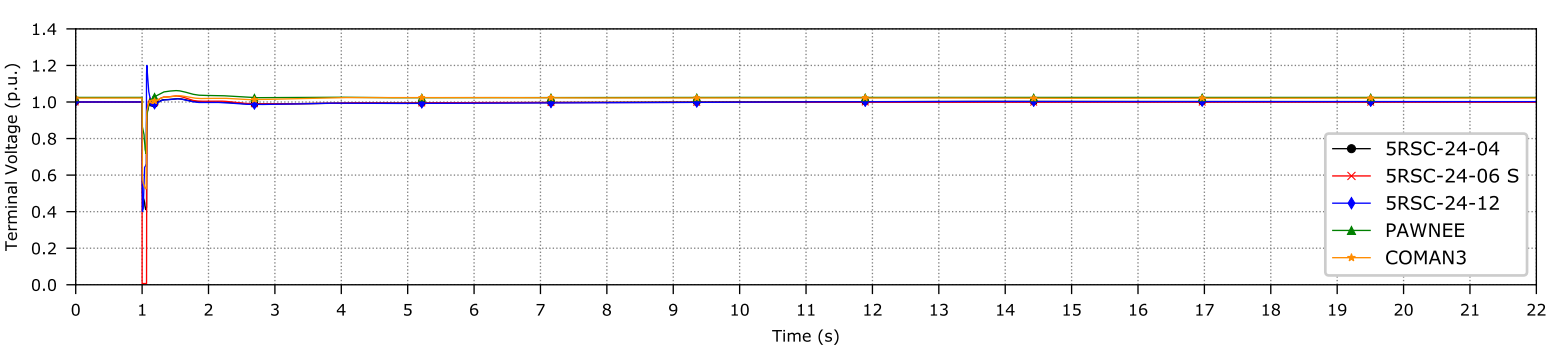


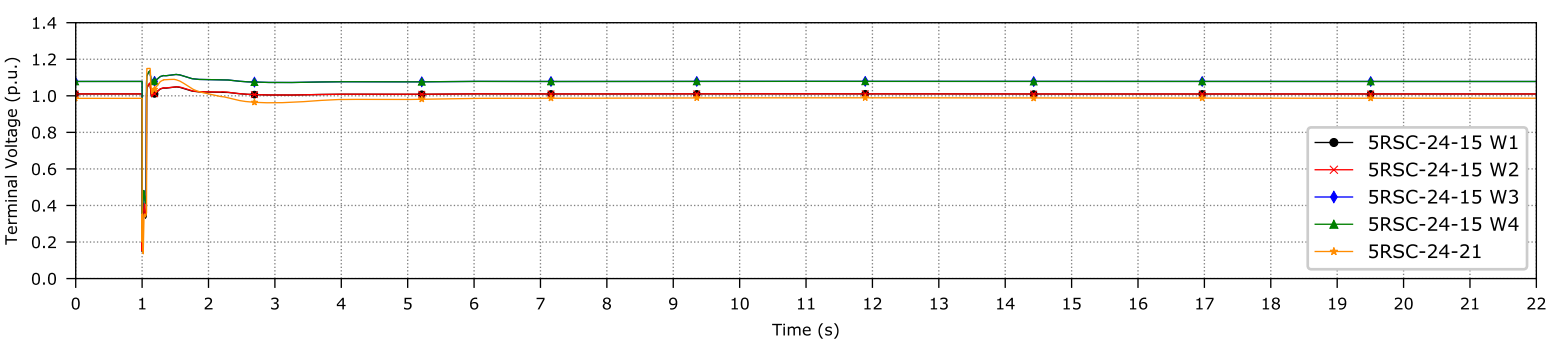


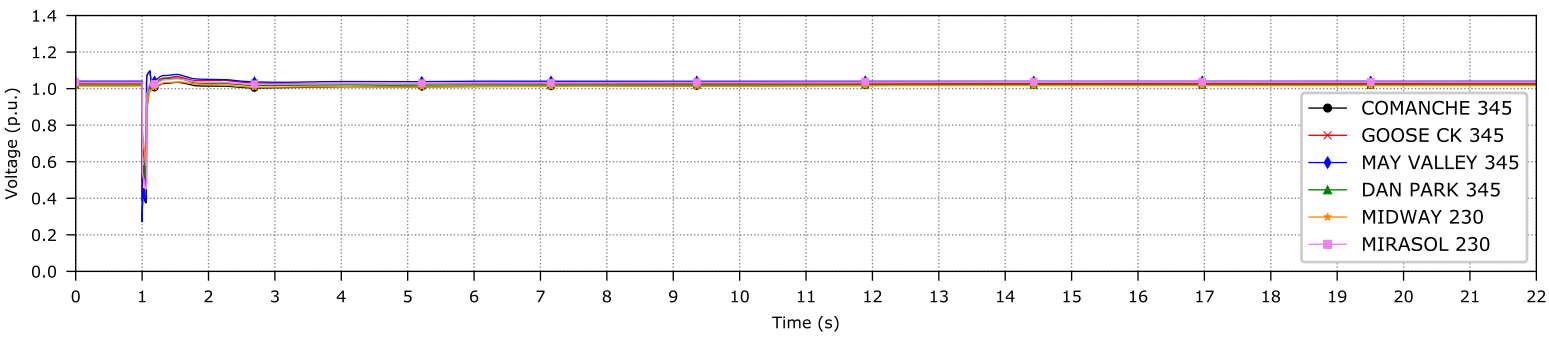




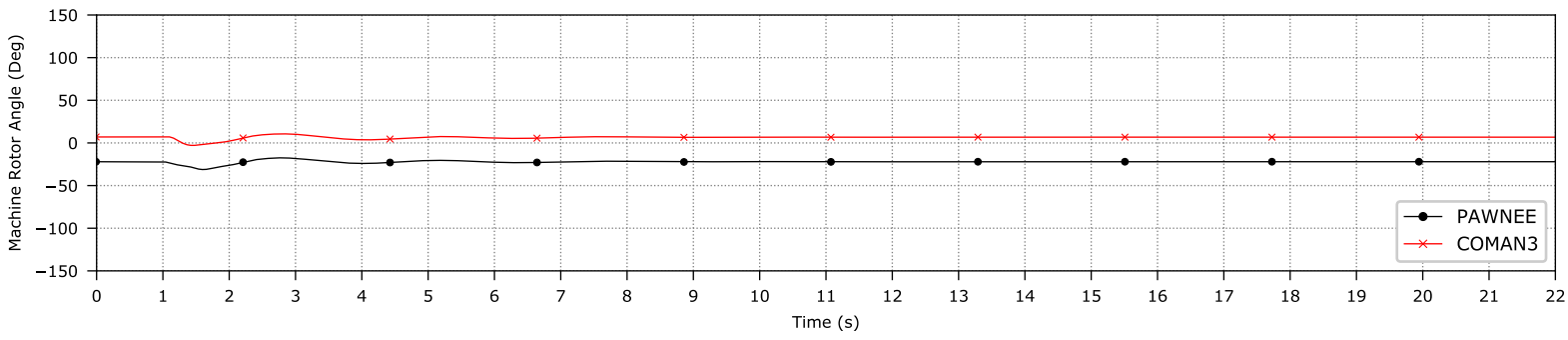


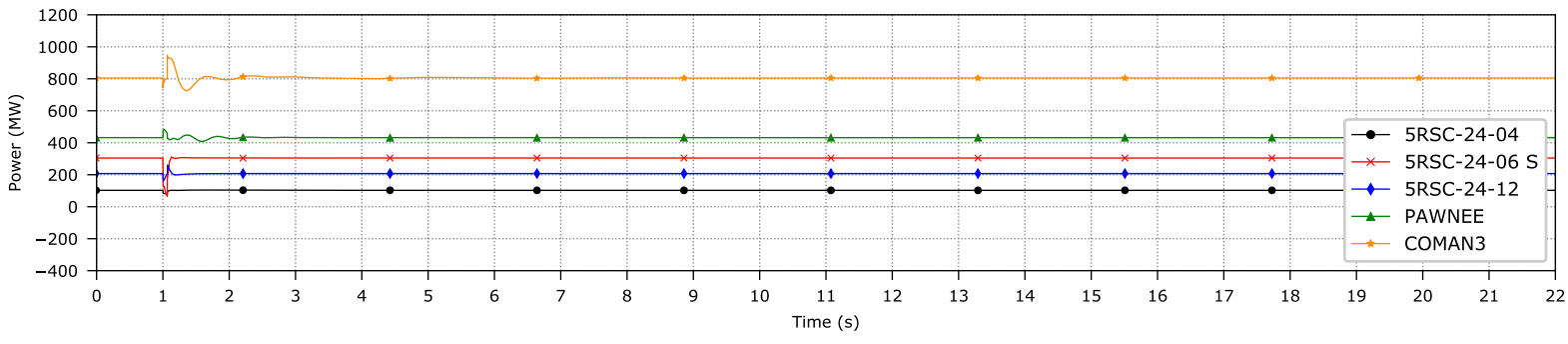


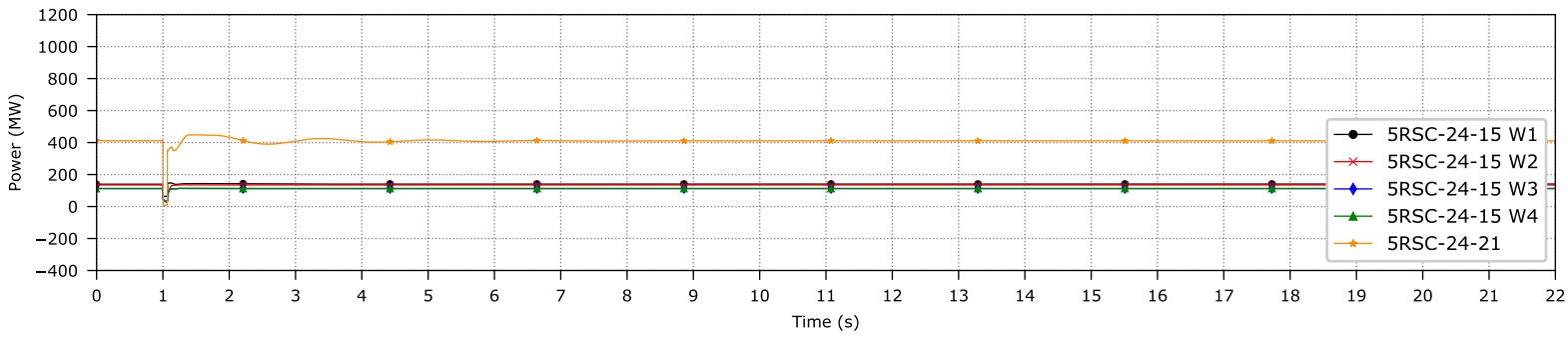


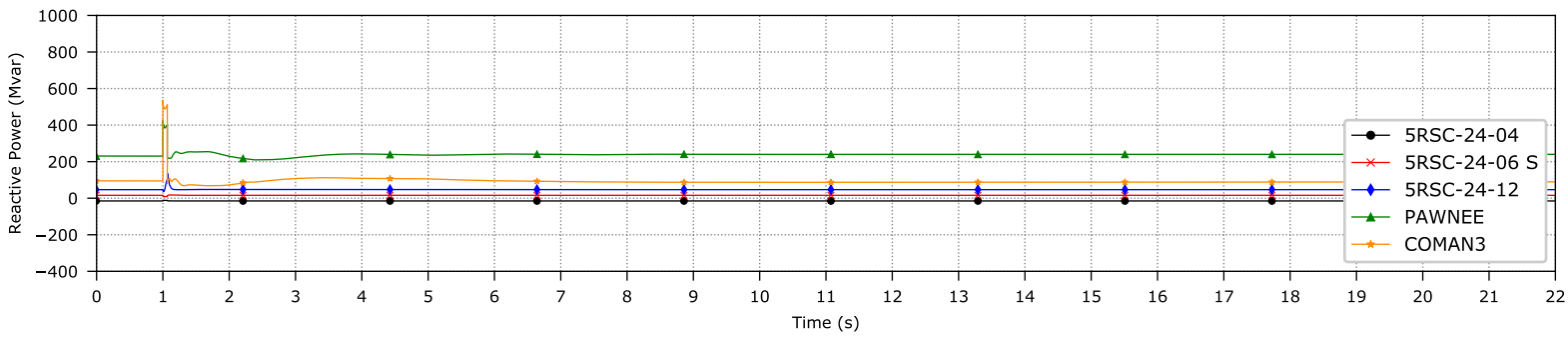


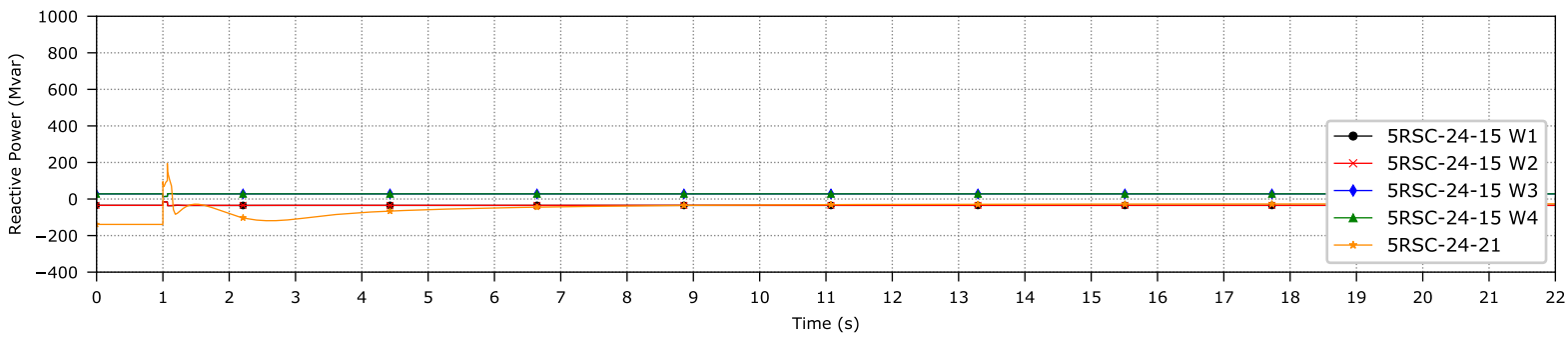
Ref. No. 13 - LoTC_318a

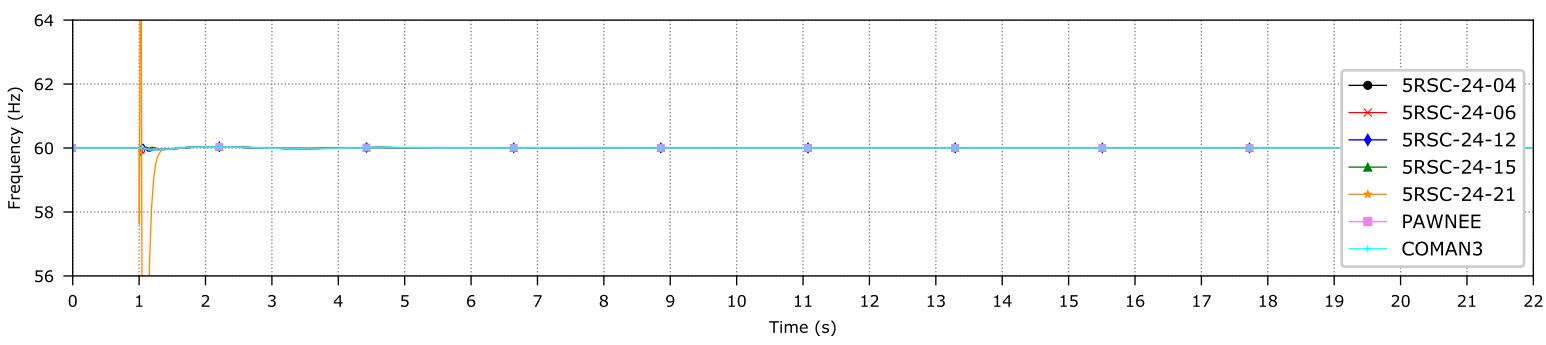


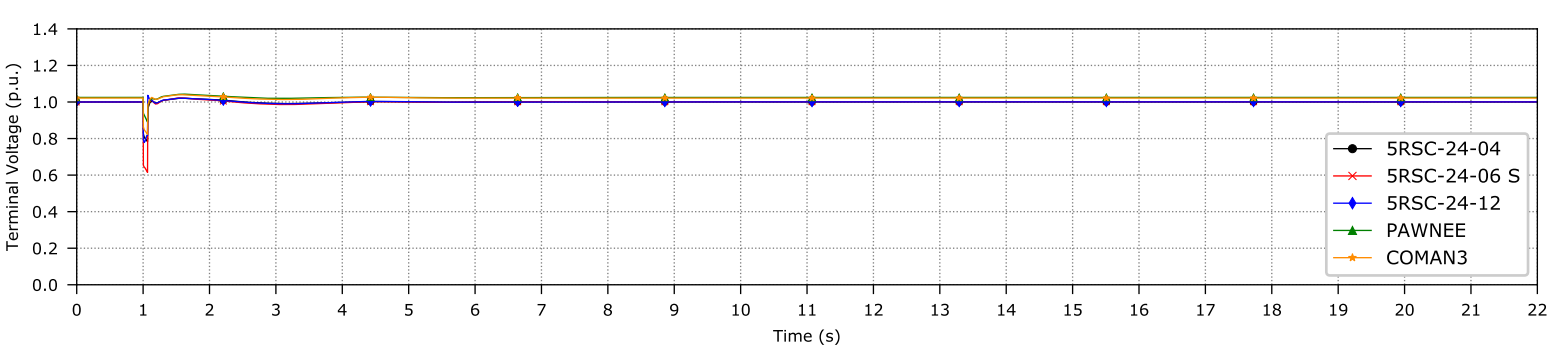


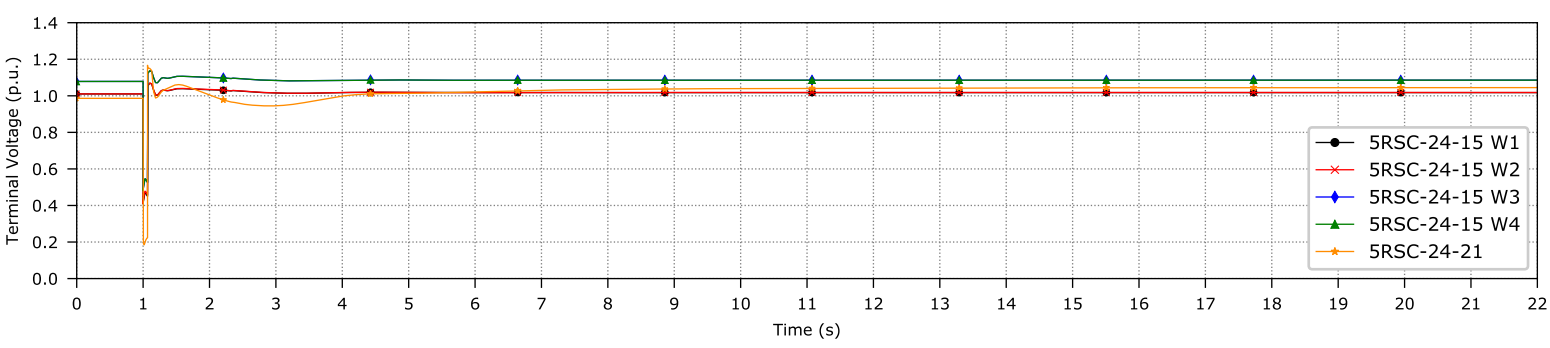


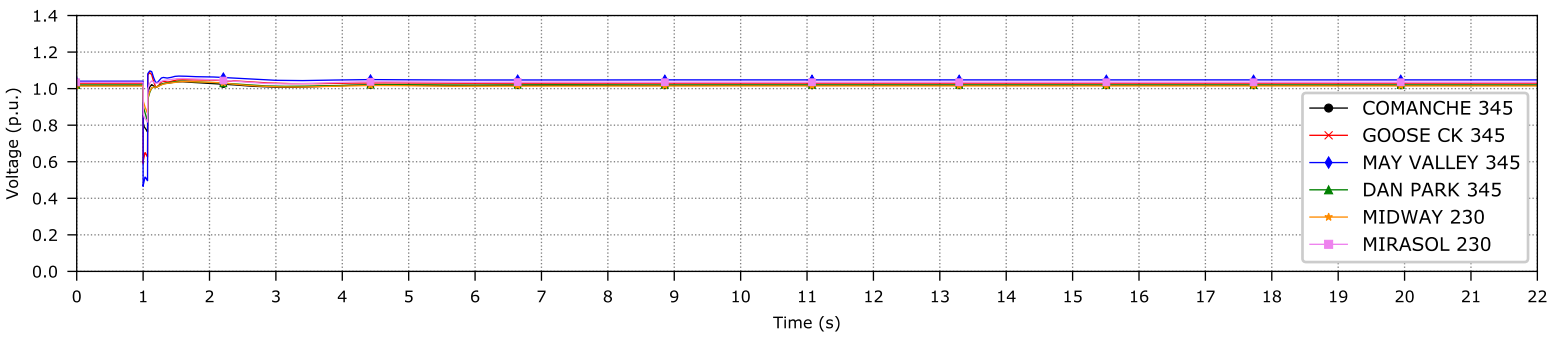




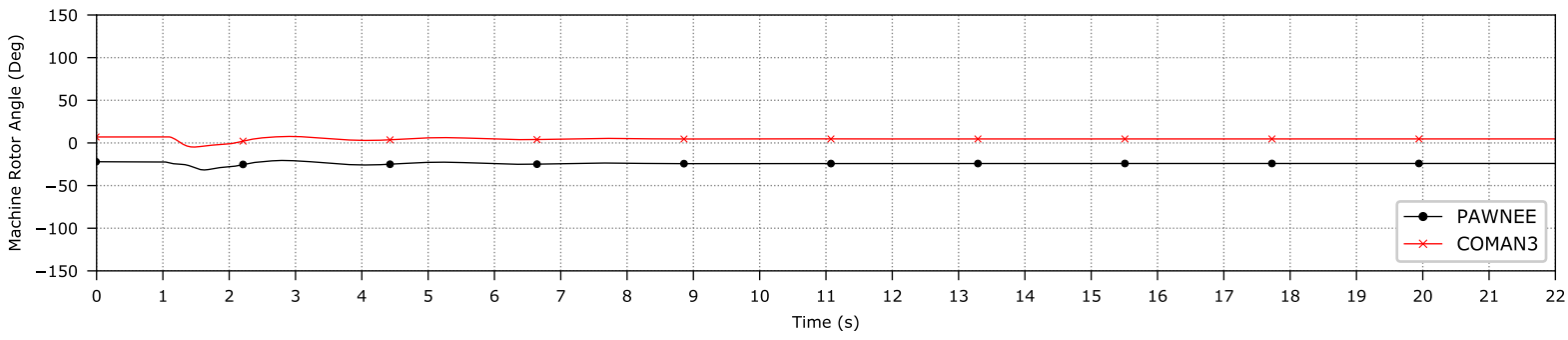


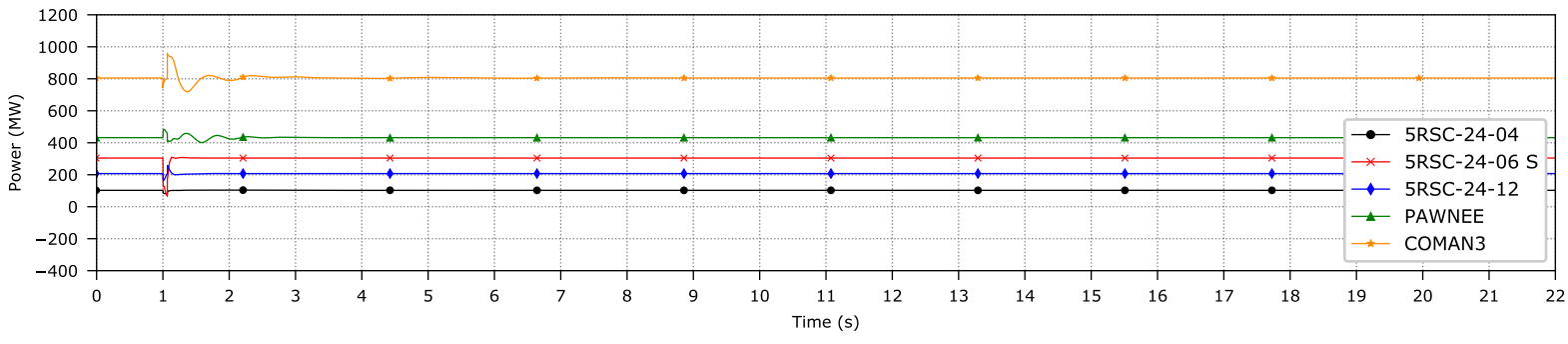


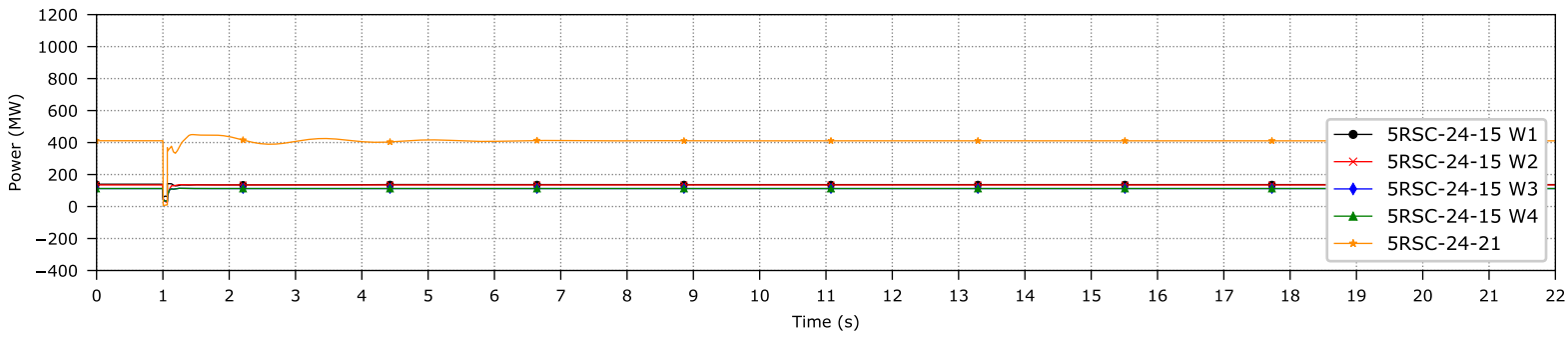


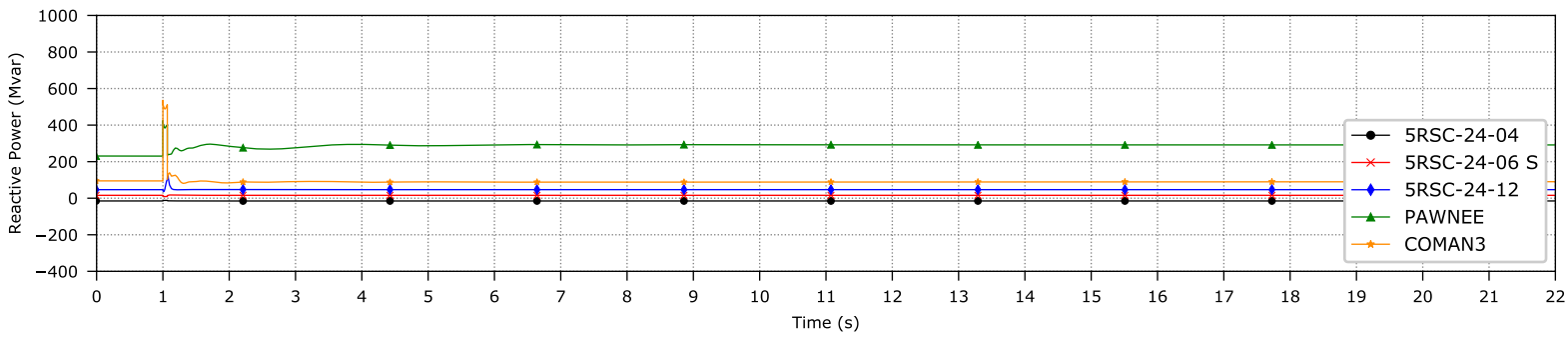


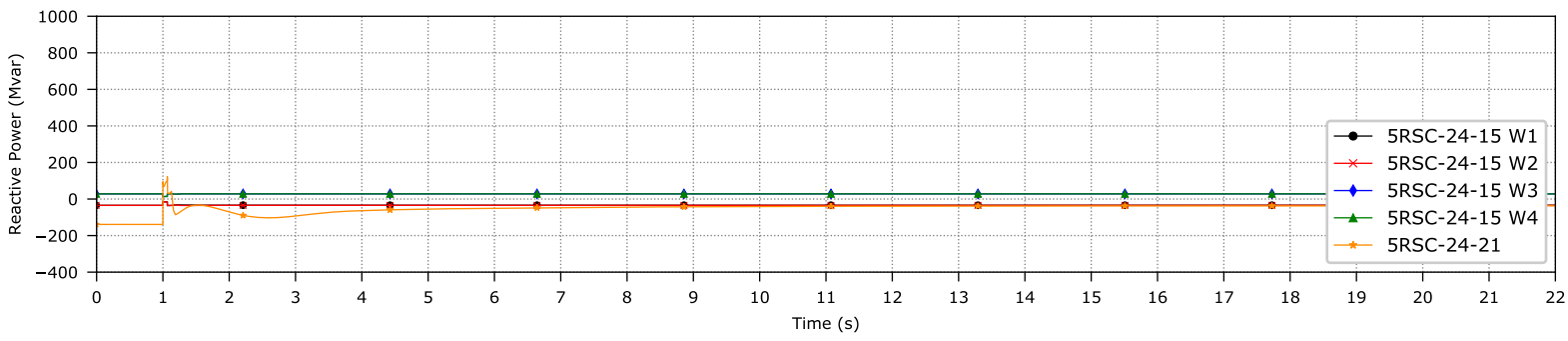
Ref. No. 14 - LoTC_318b

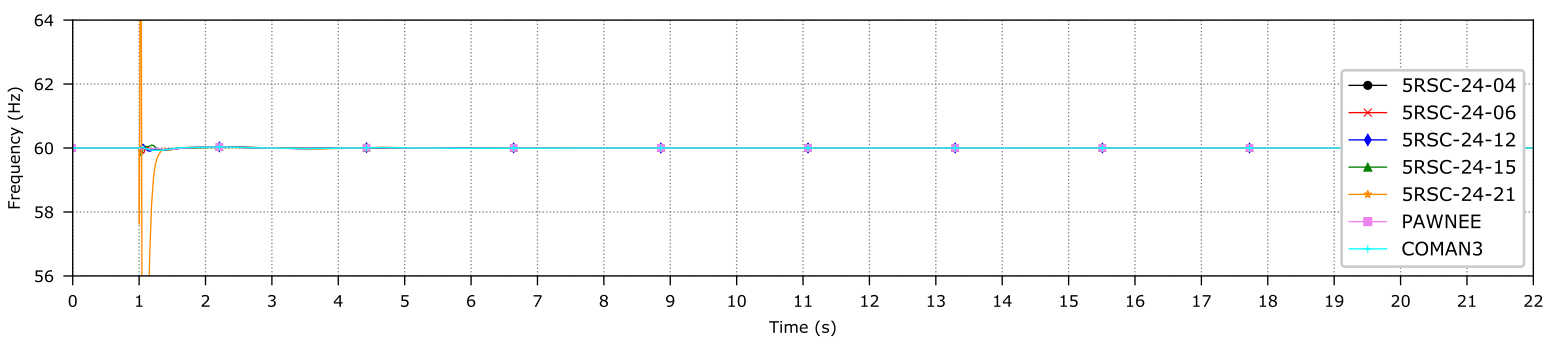


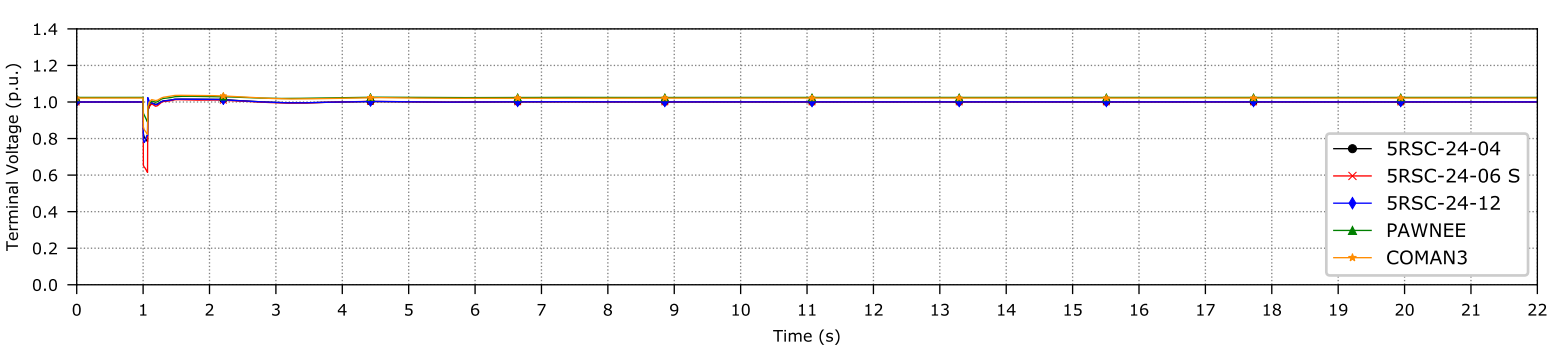


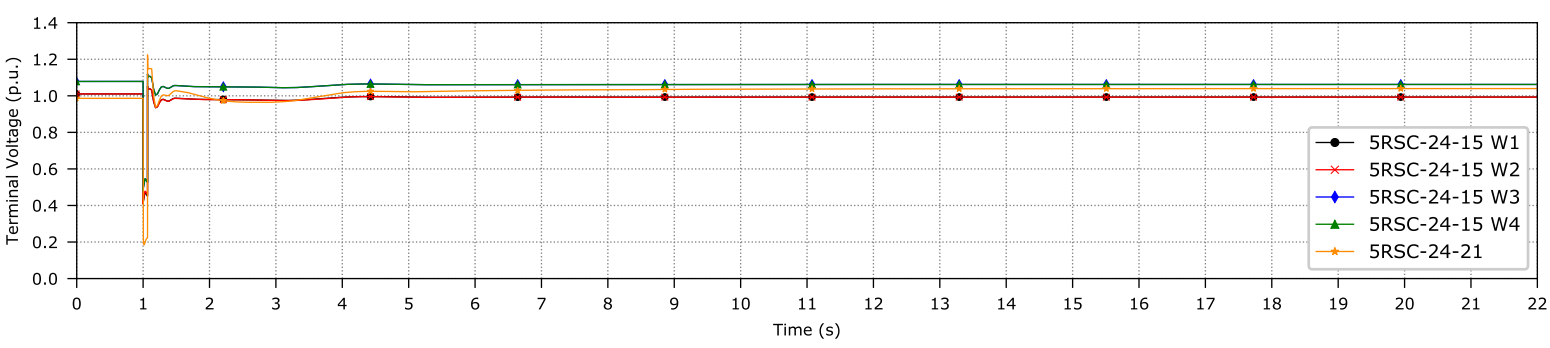


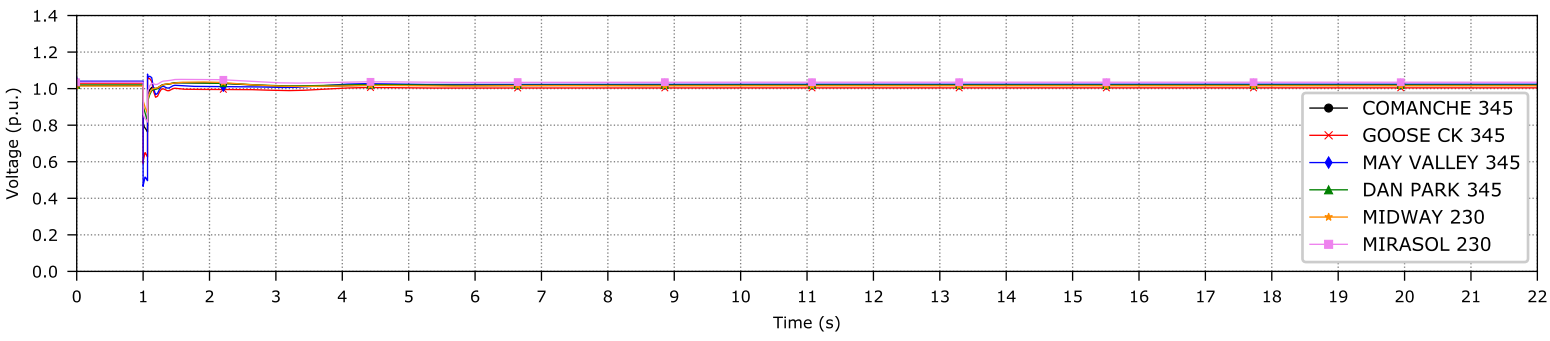




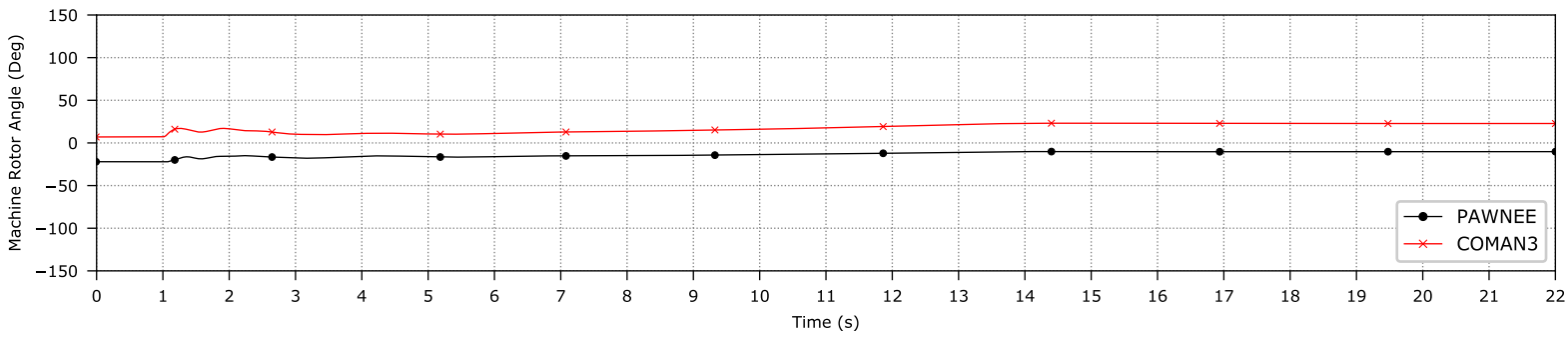


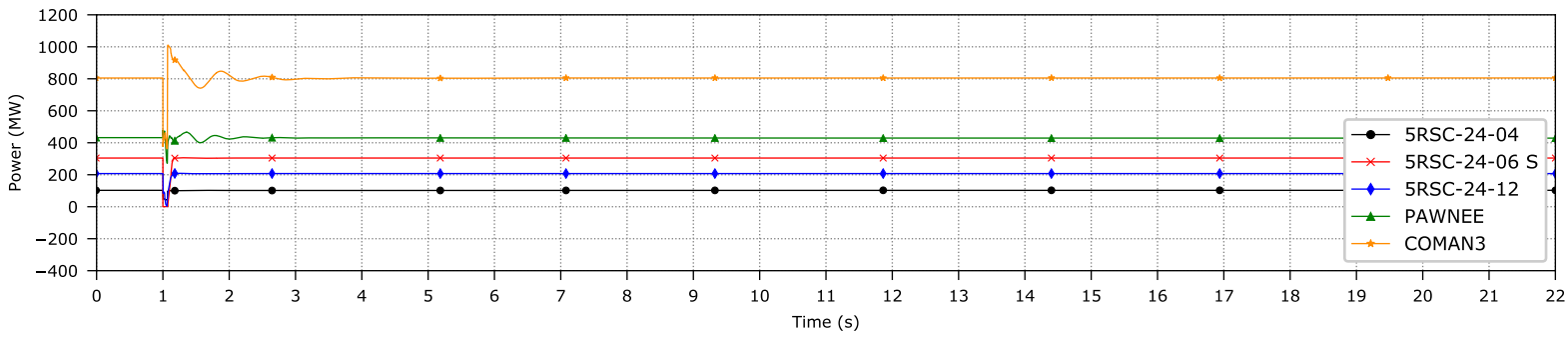


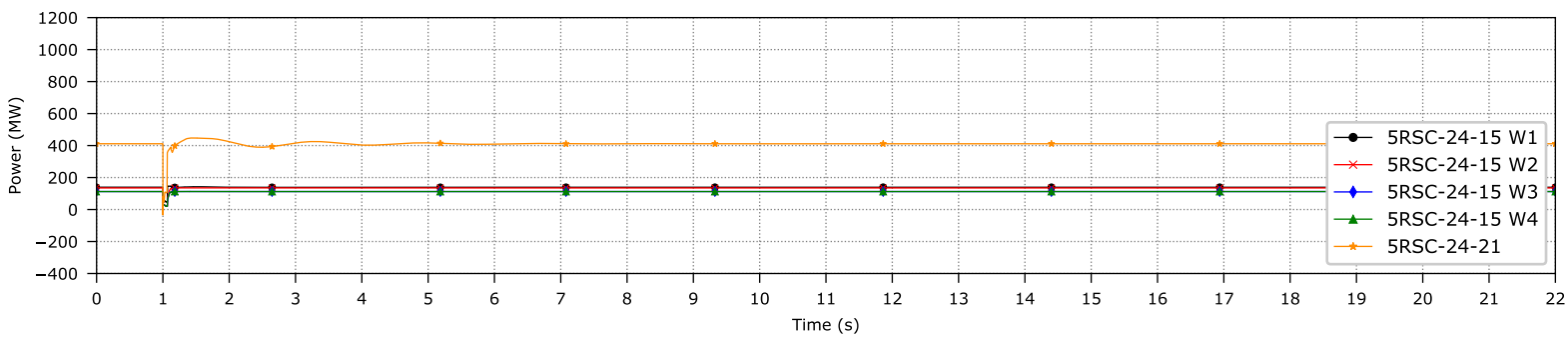


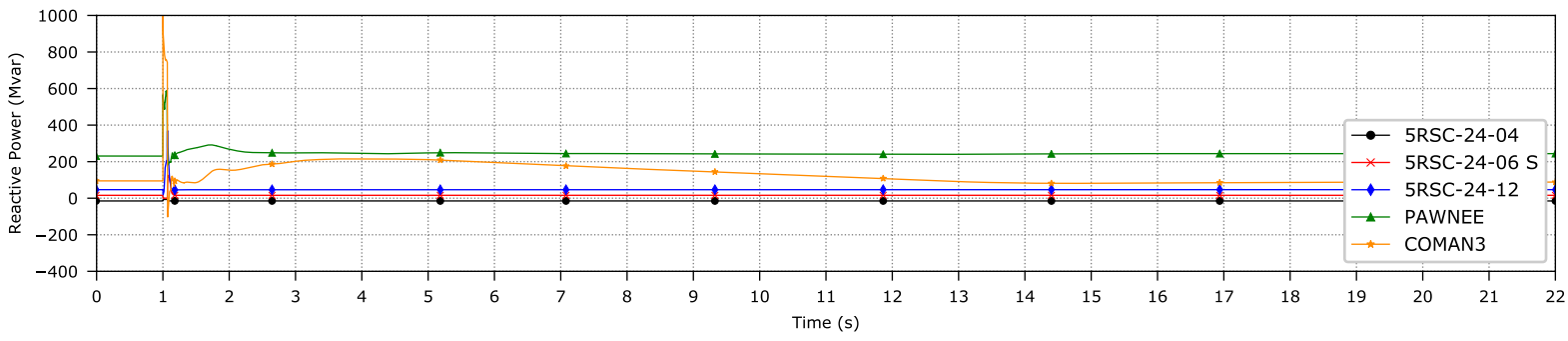


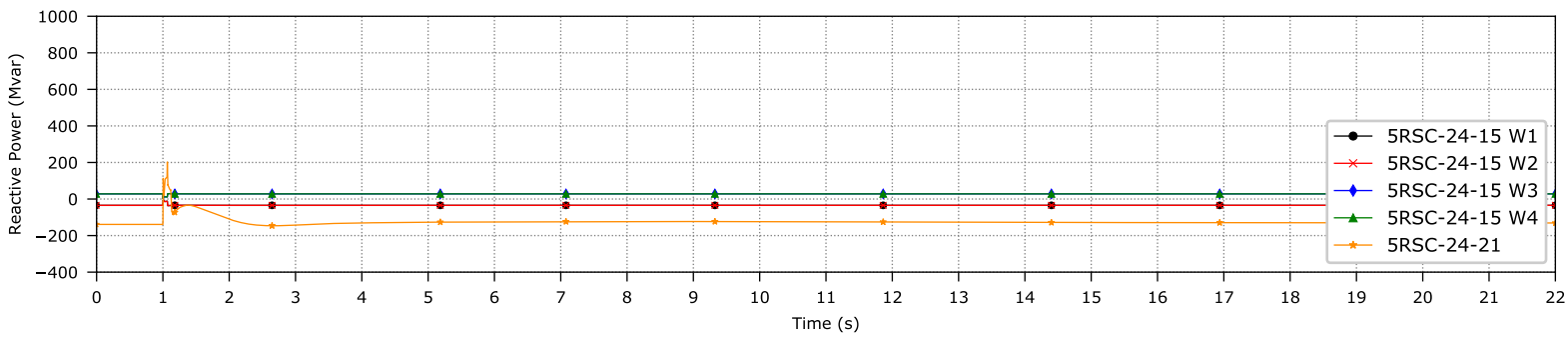
Ref. No. 15 - LoTC_324

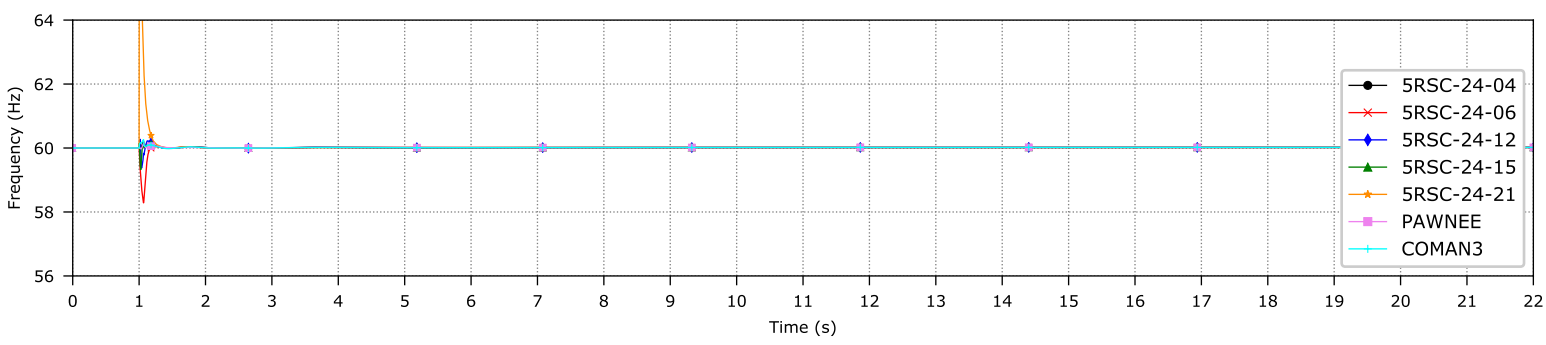


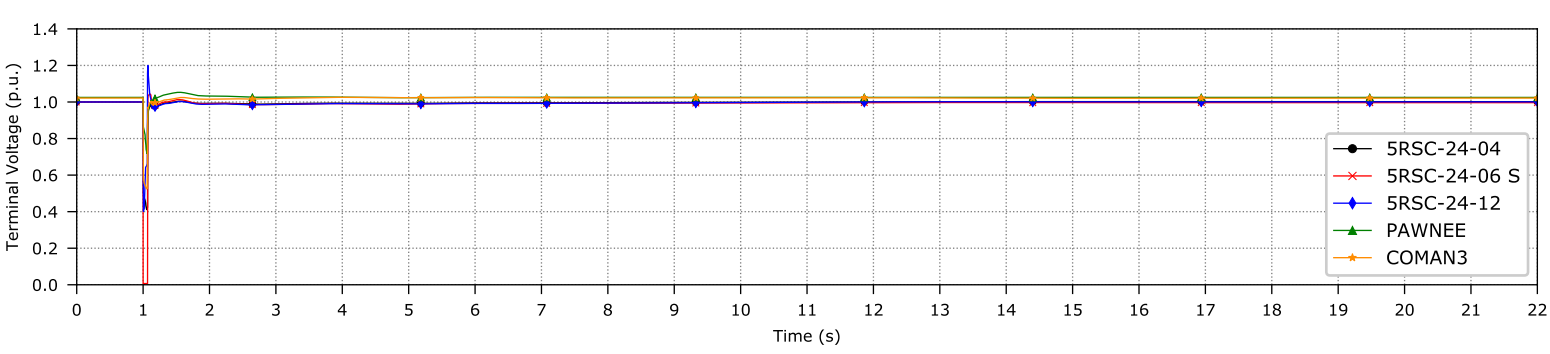


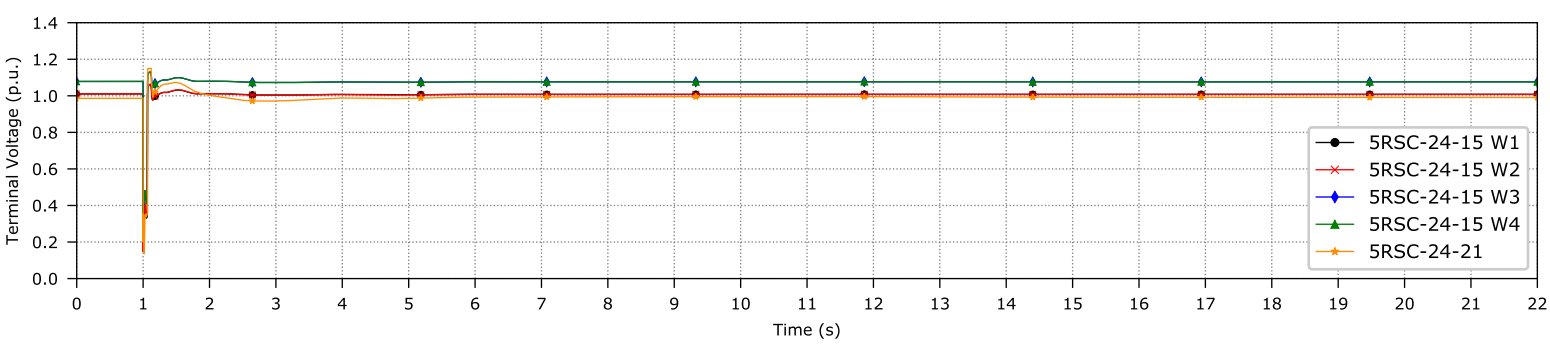


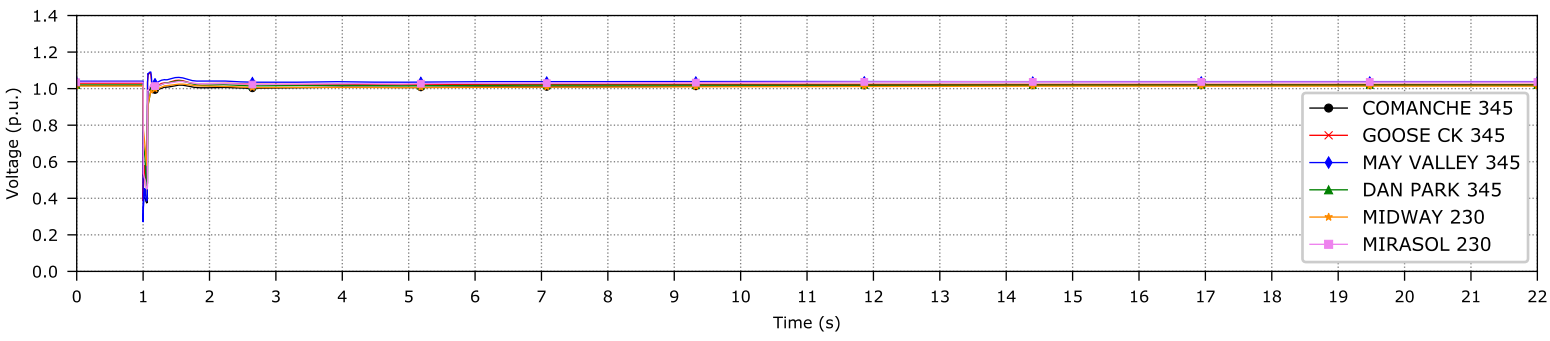




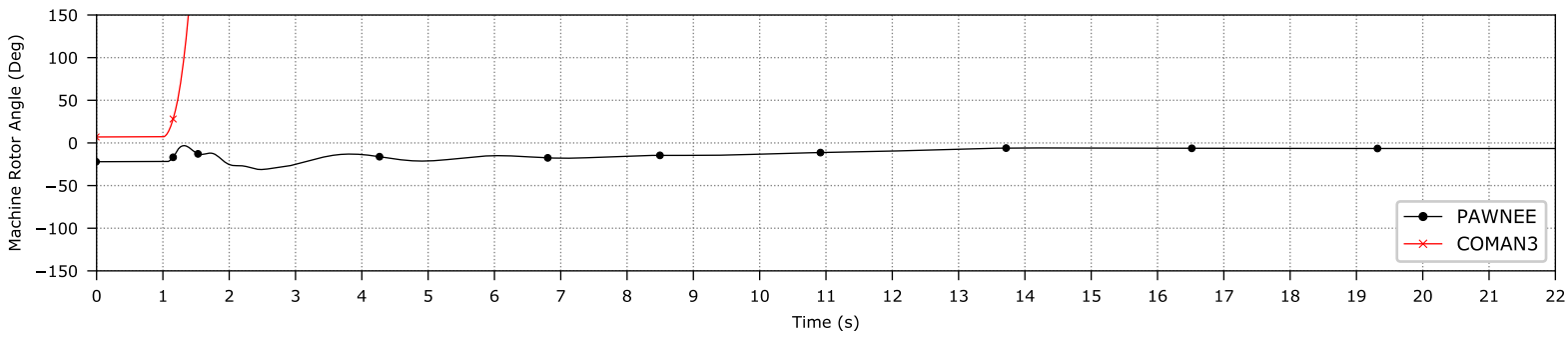


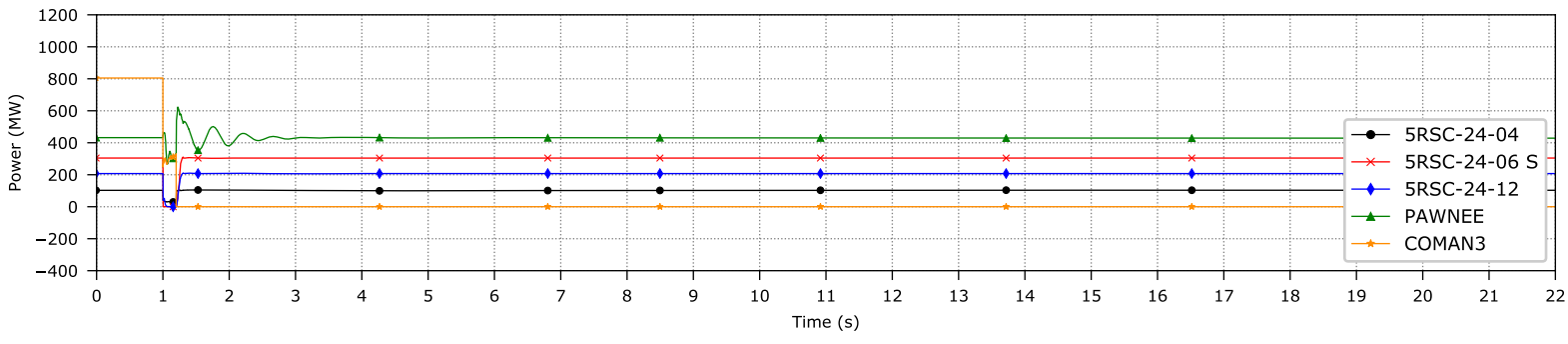


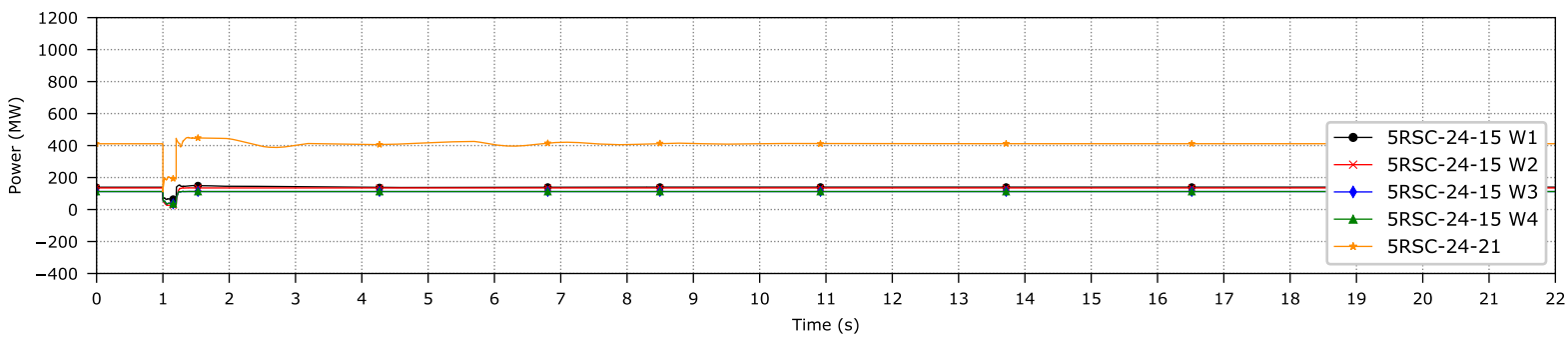


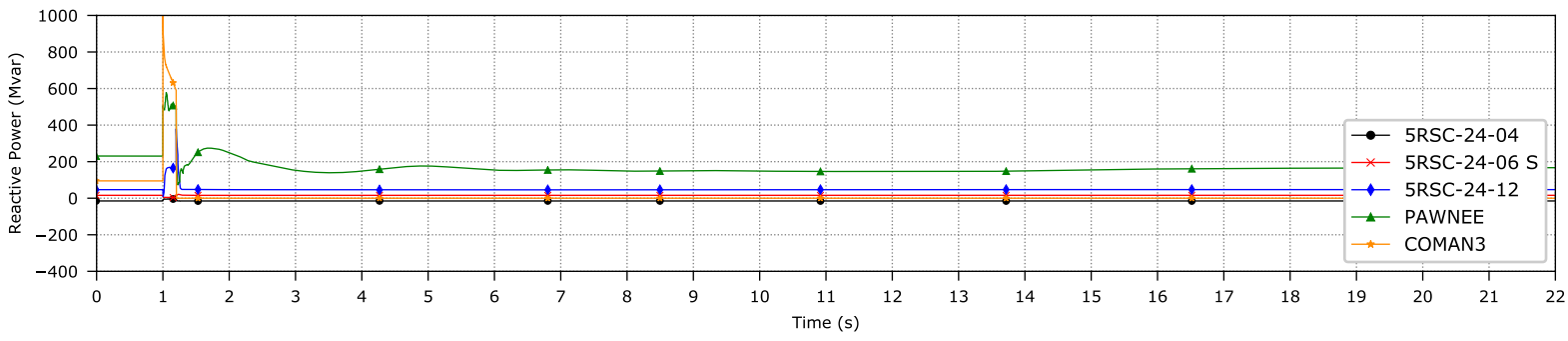


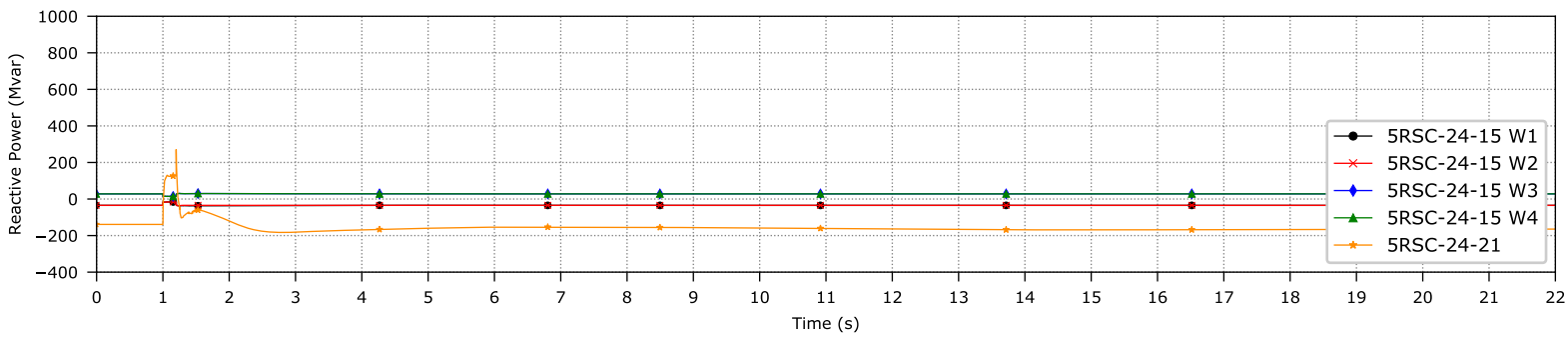
Ref. No. 16 - BF_039b

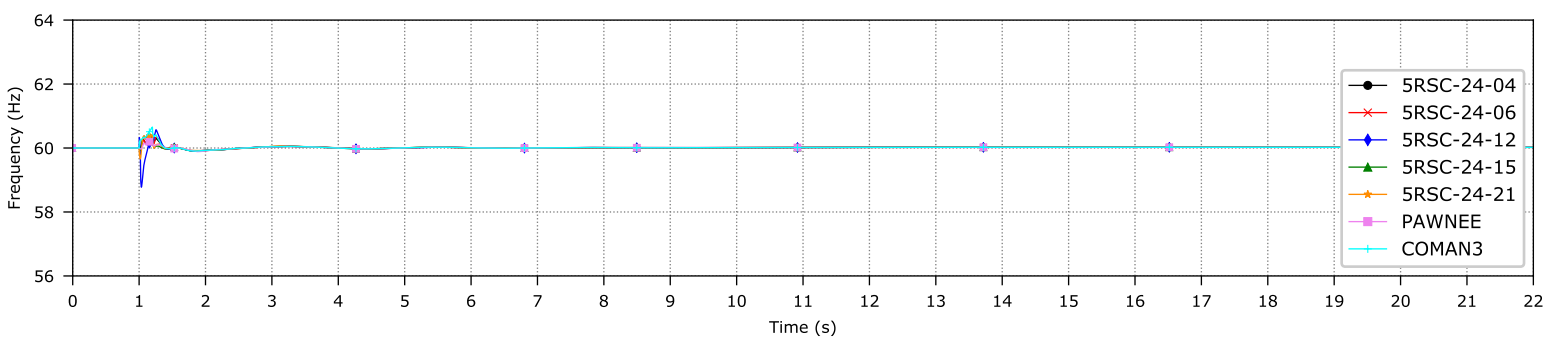


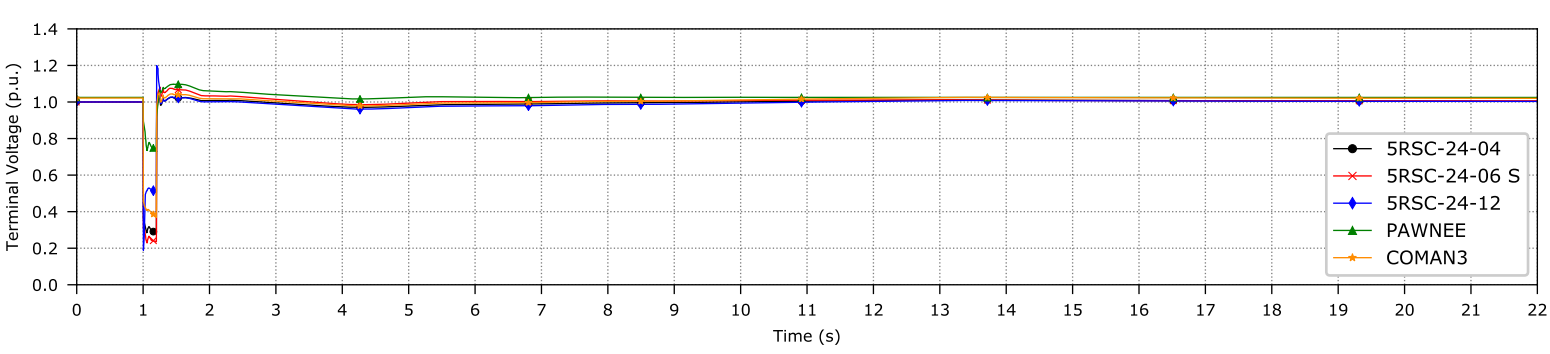


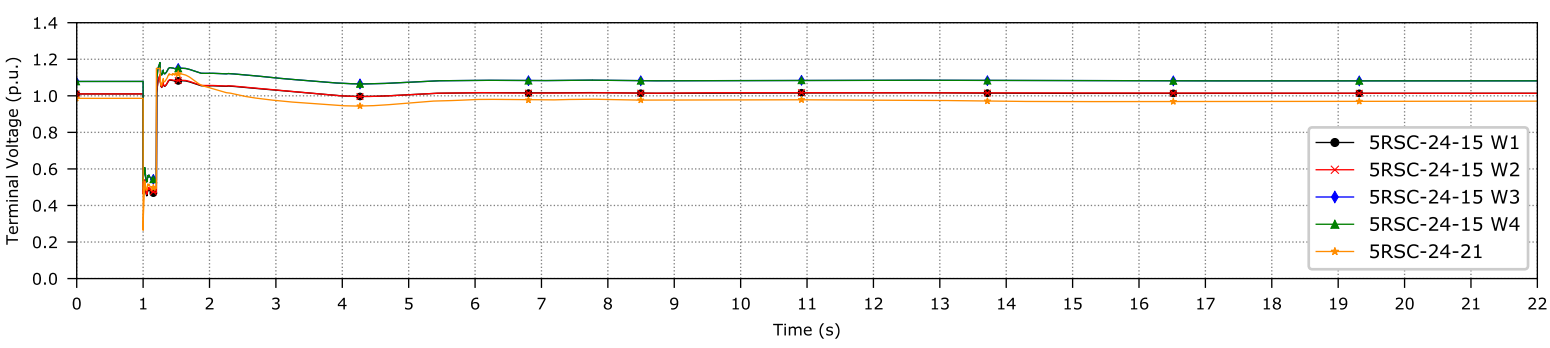


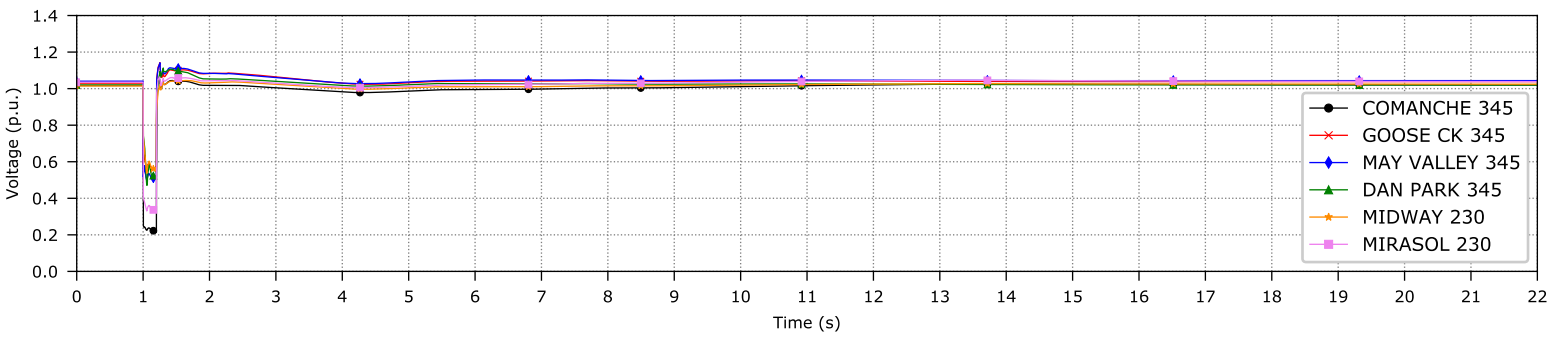




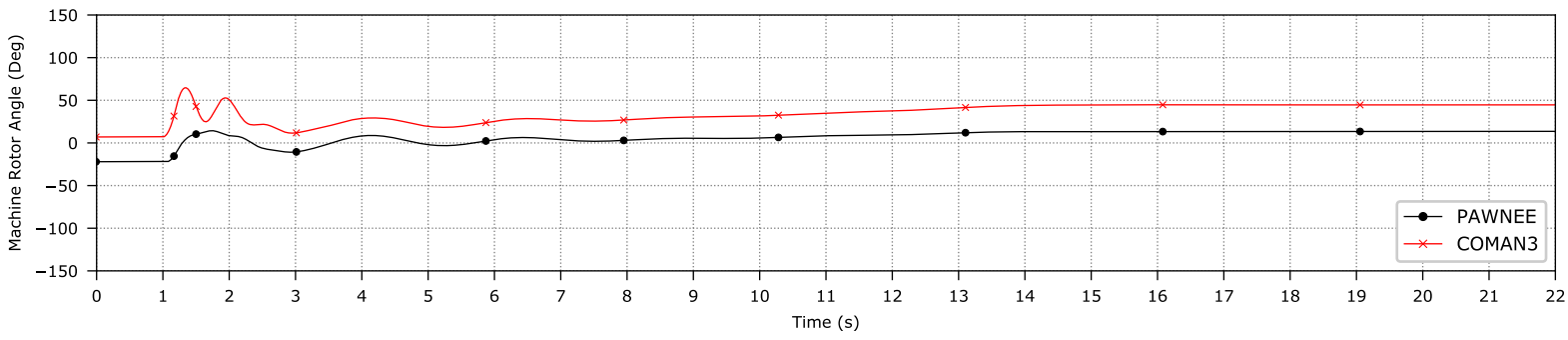


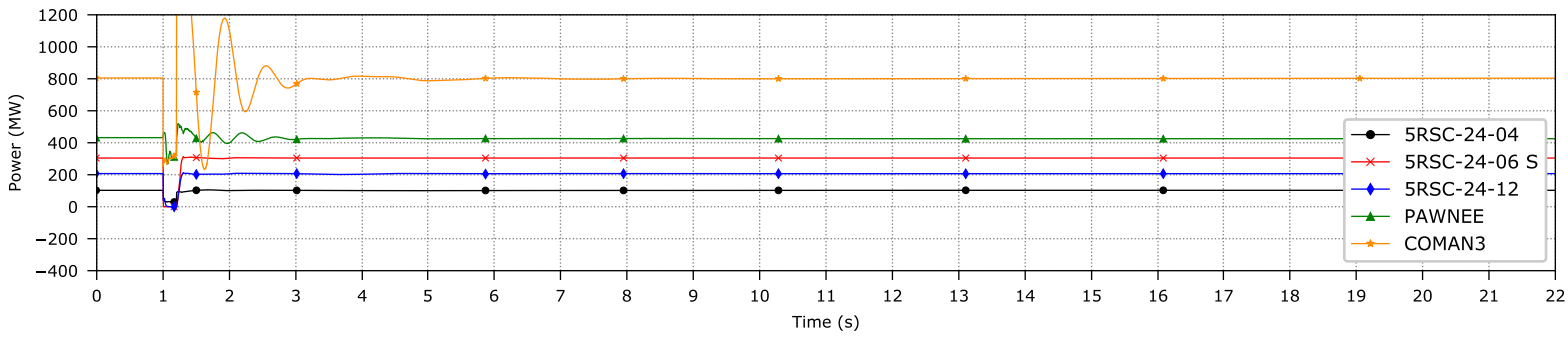


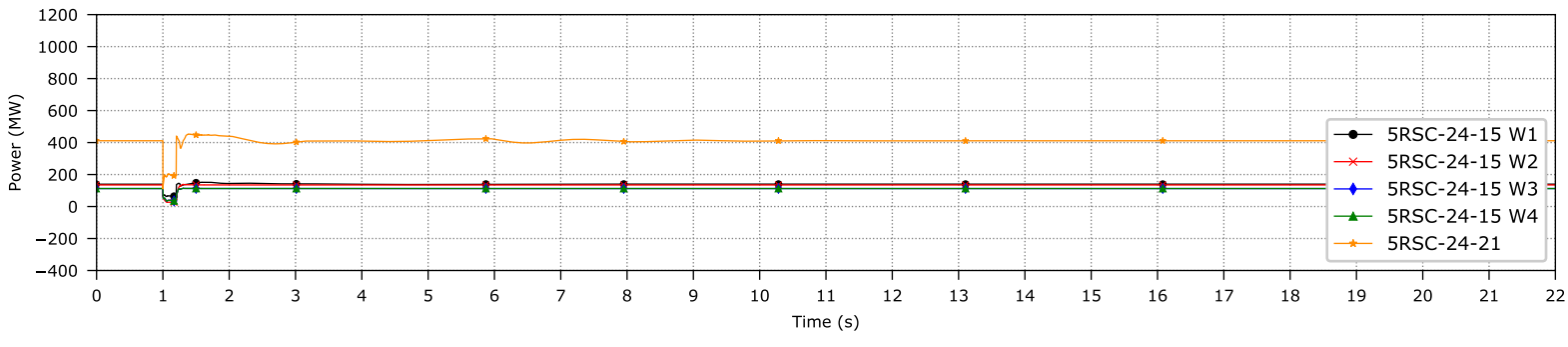


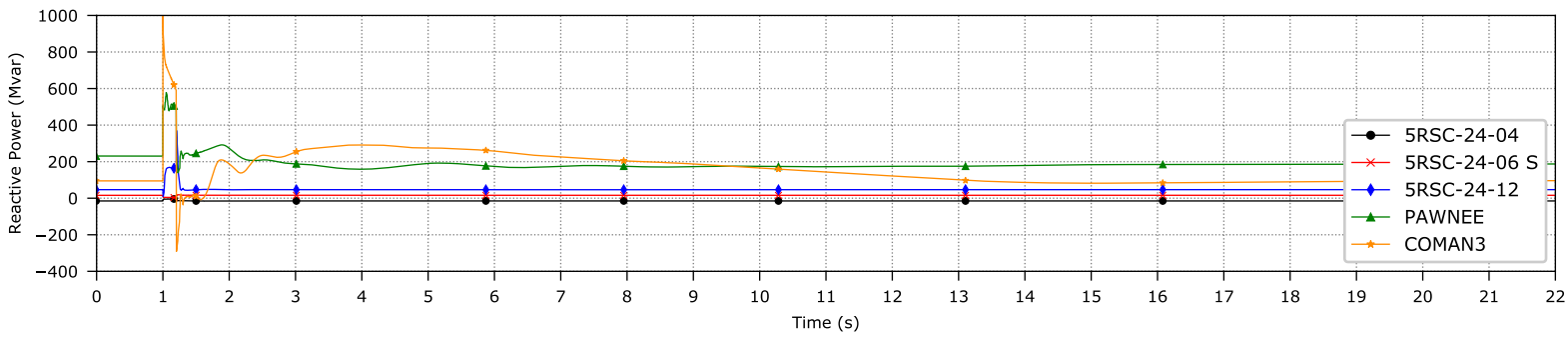


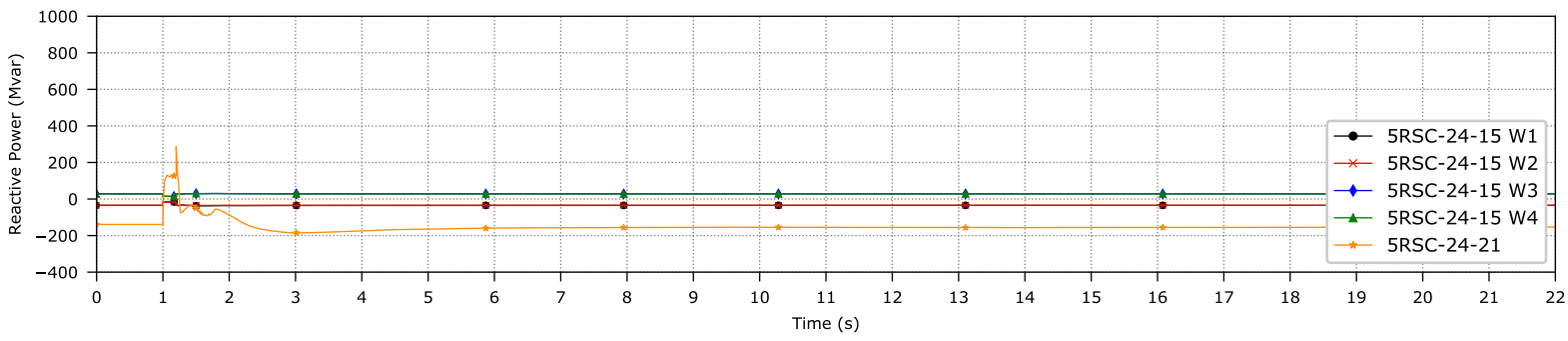
Ref. No. 17 - BF_039e

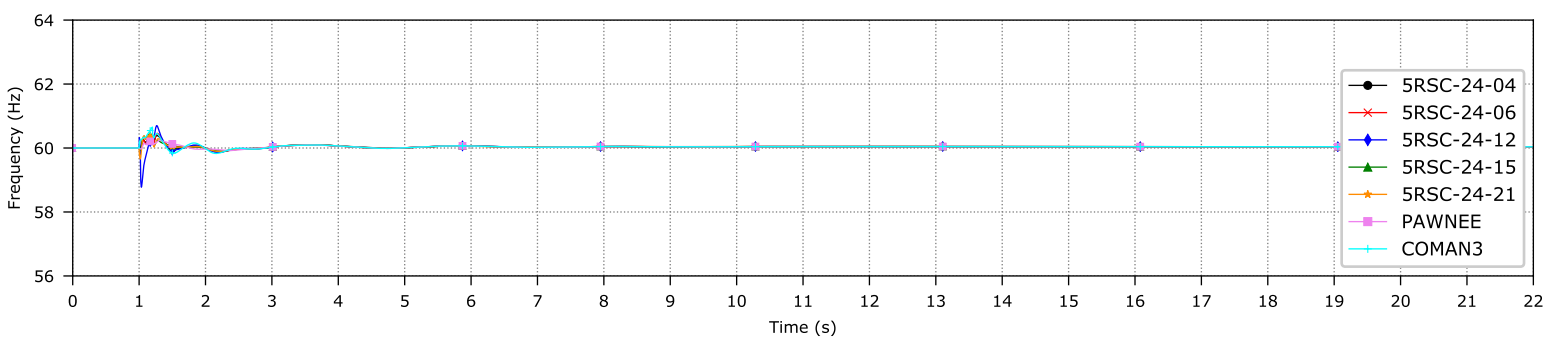


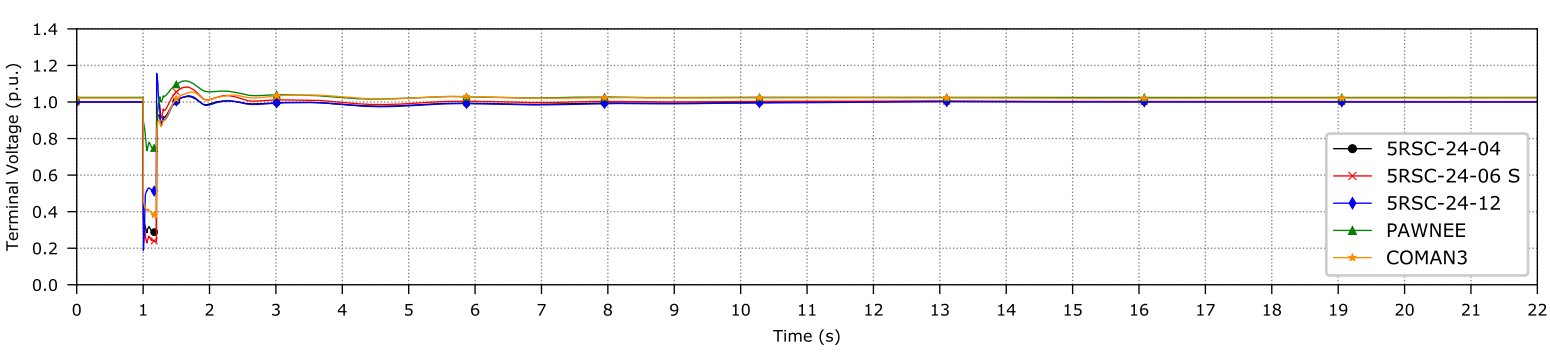


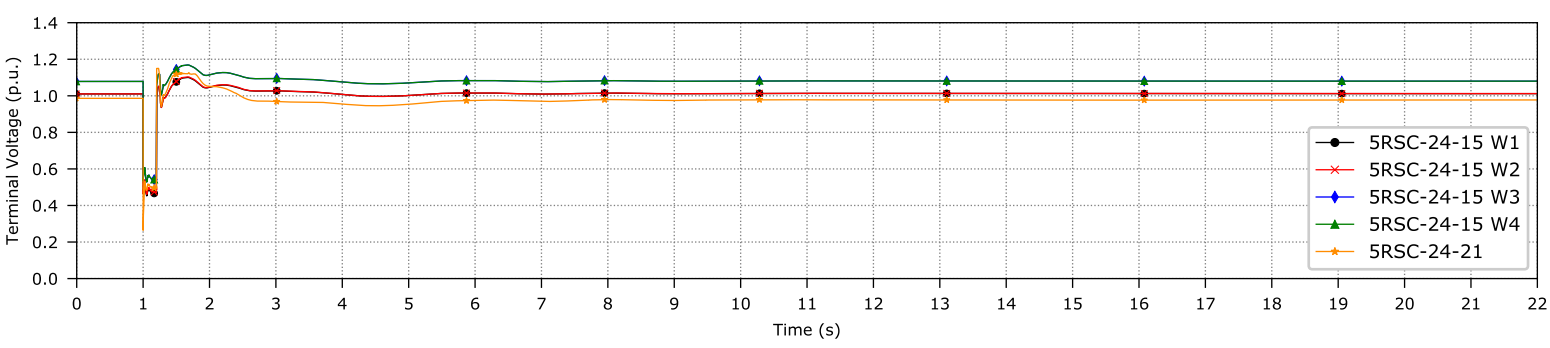


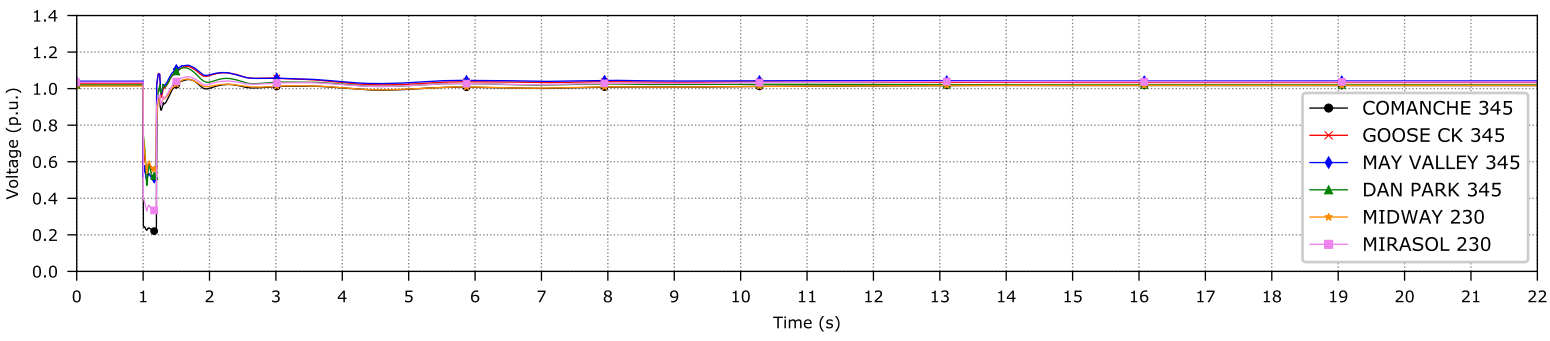












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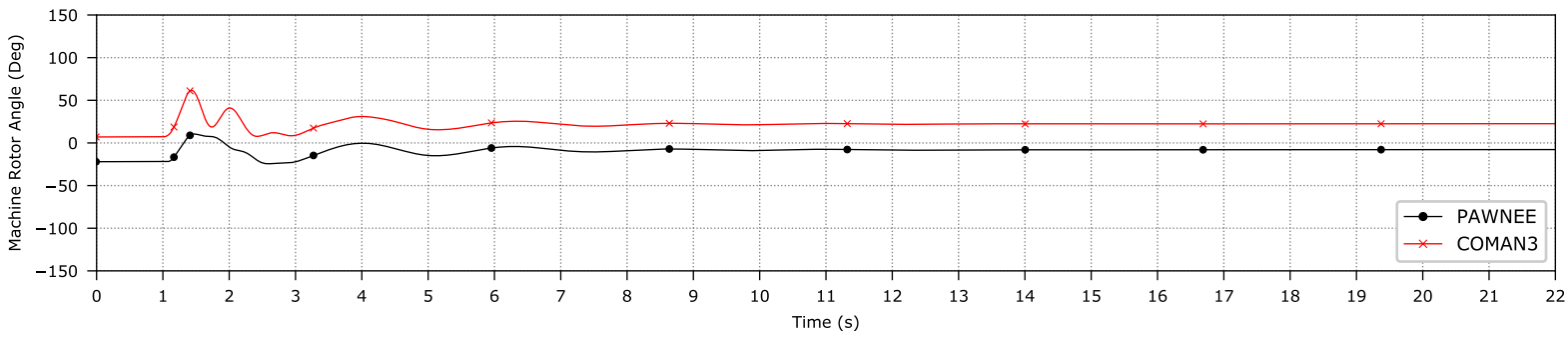
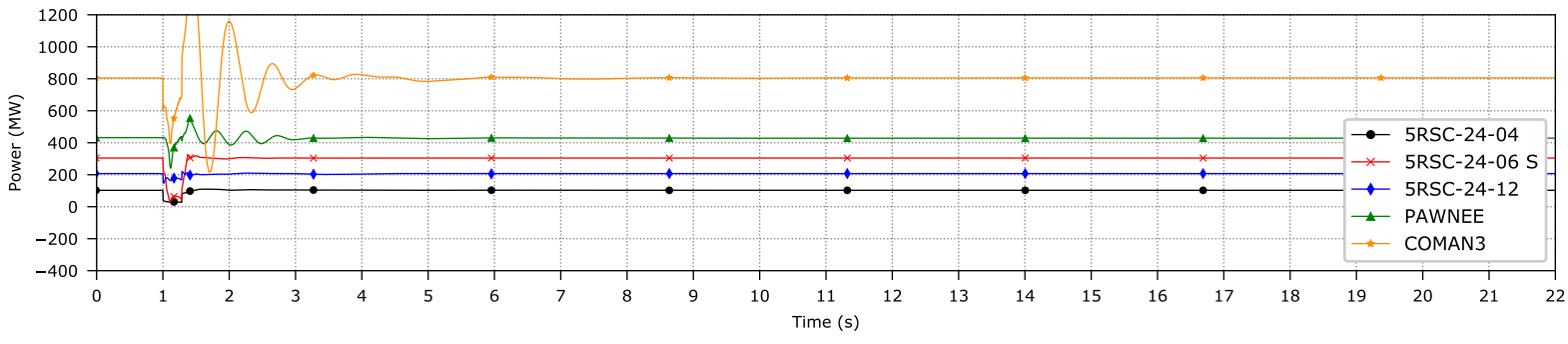
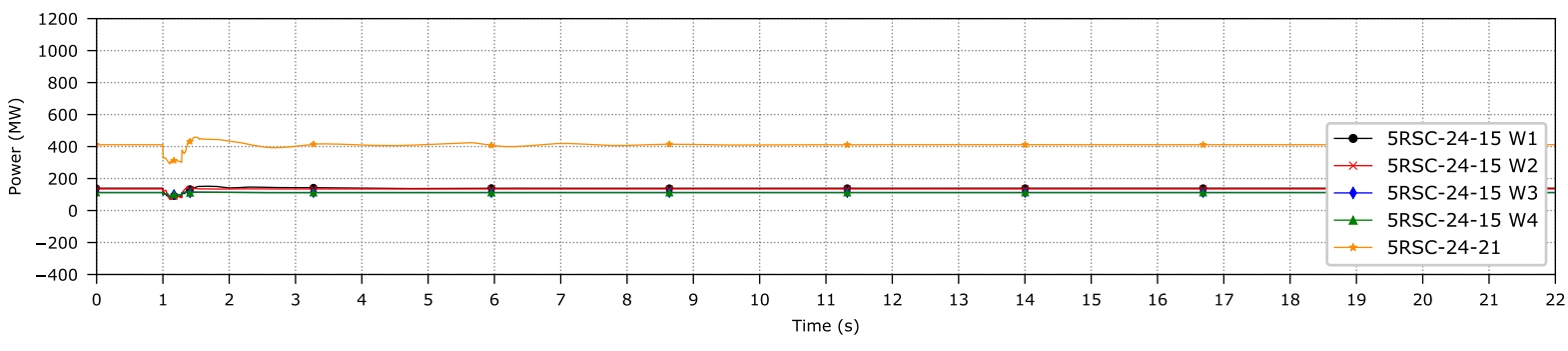
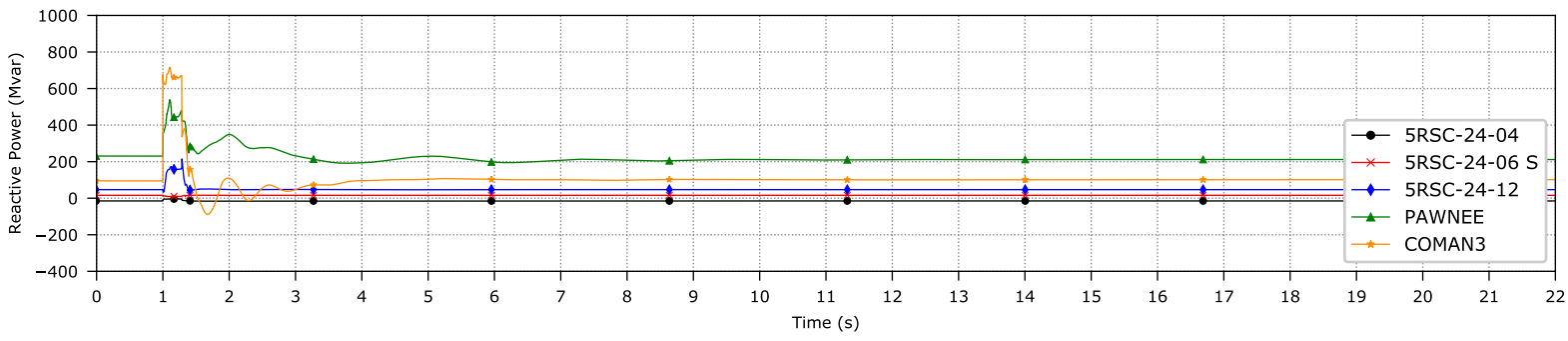
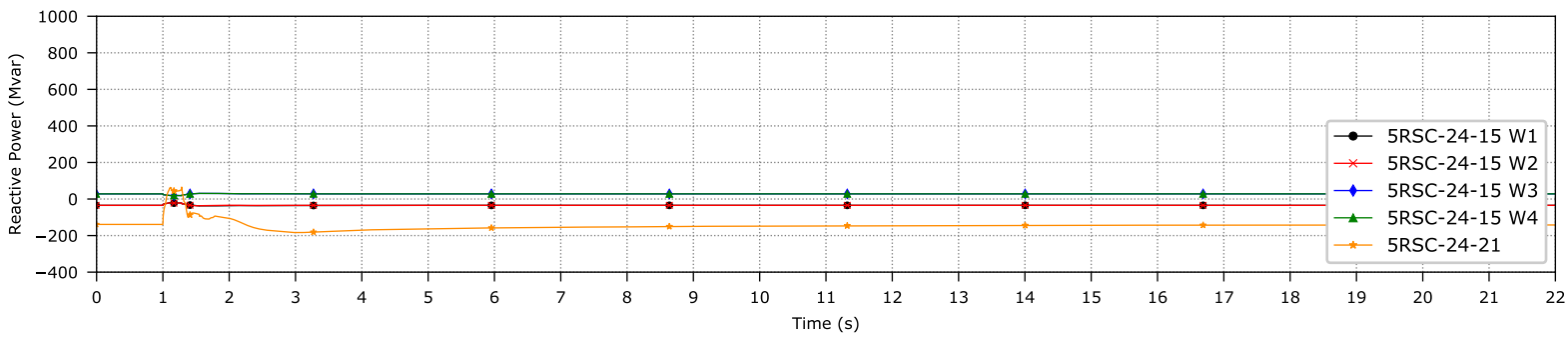
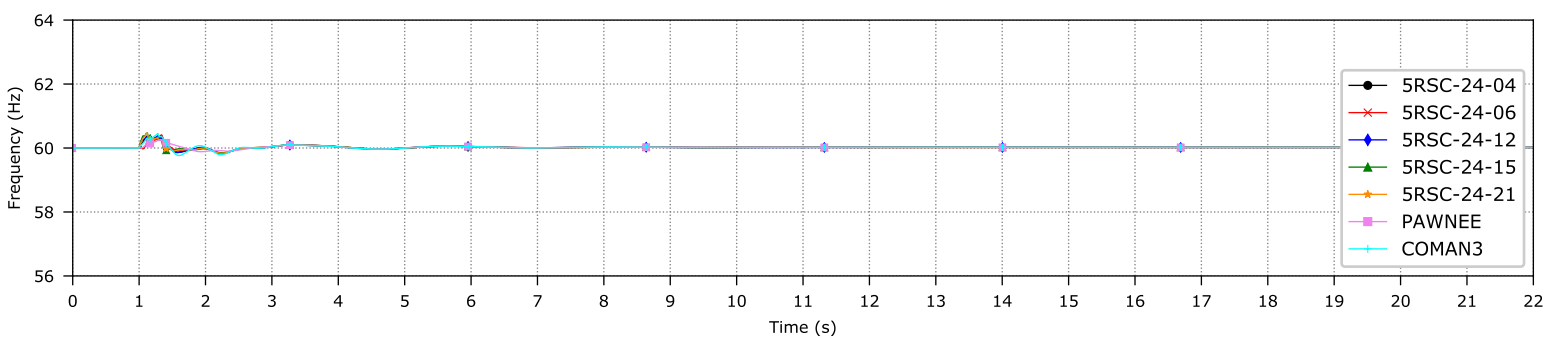


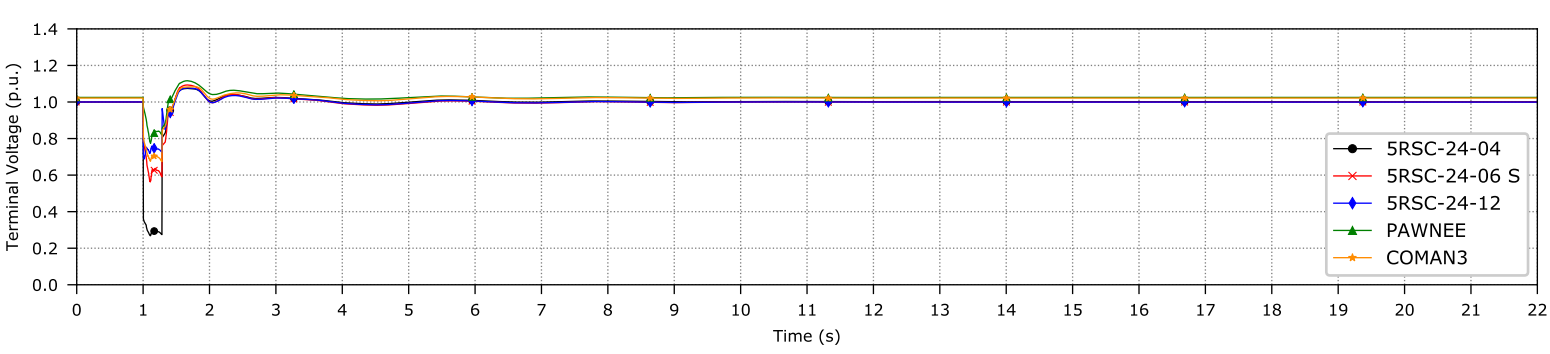


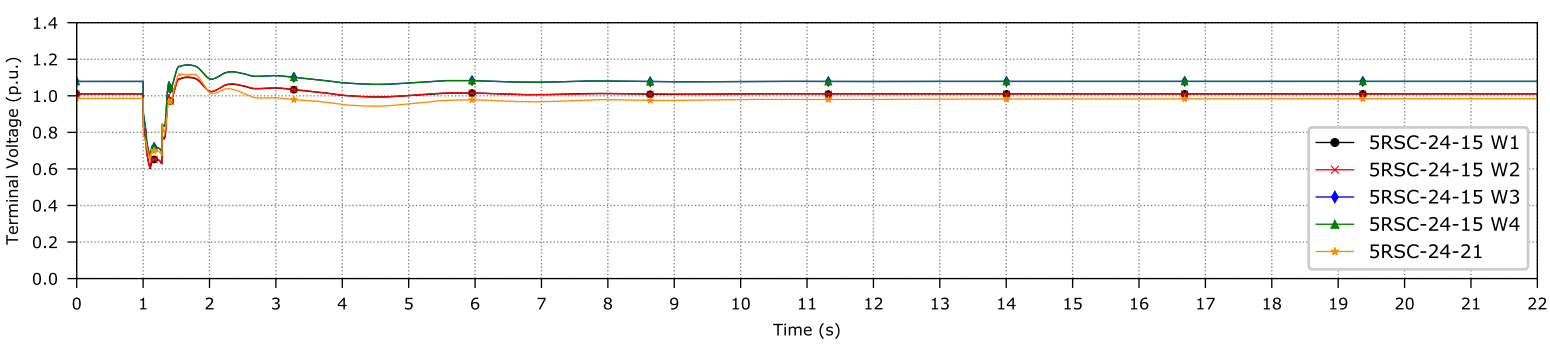


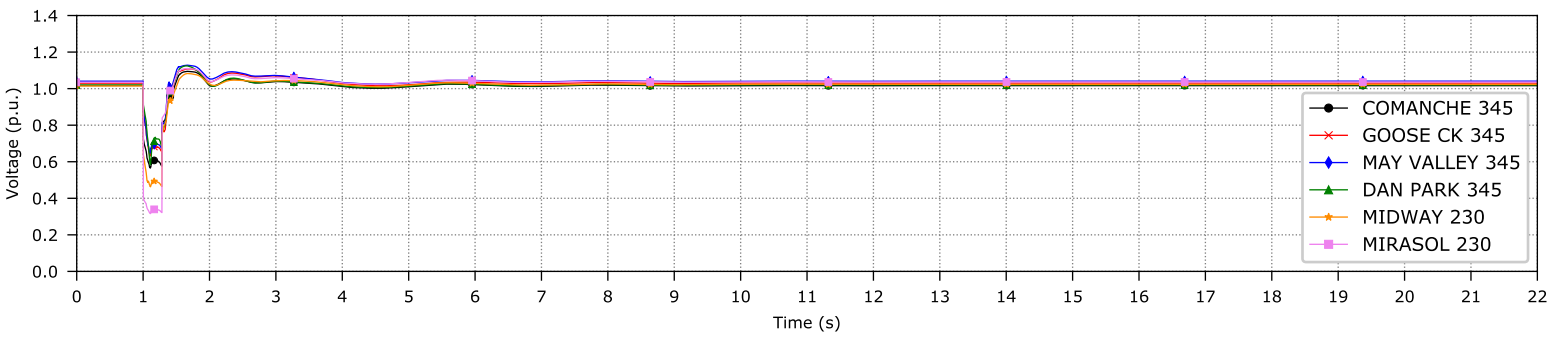




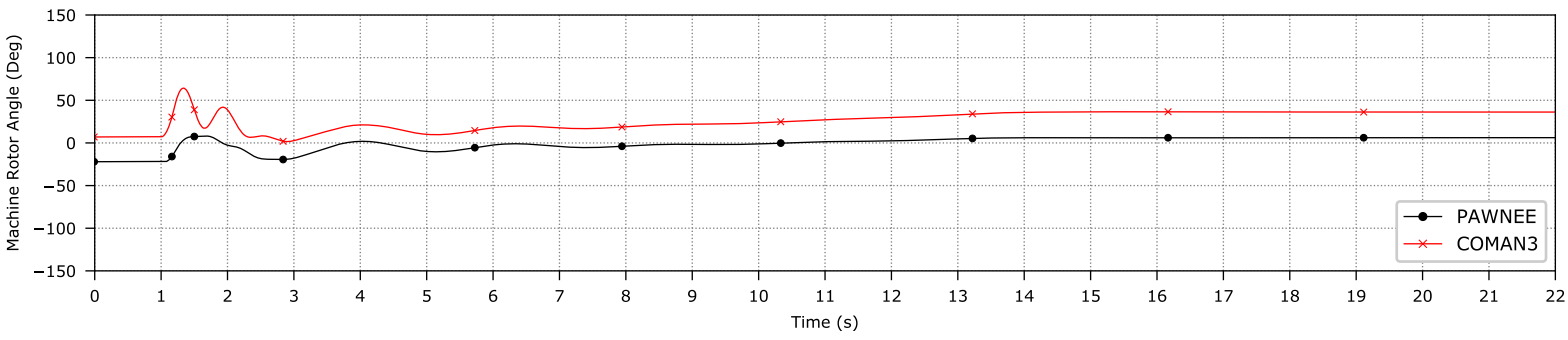


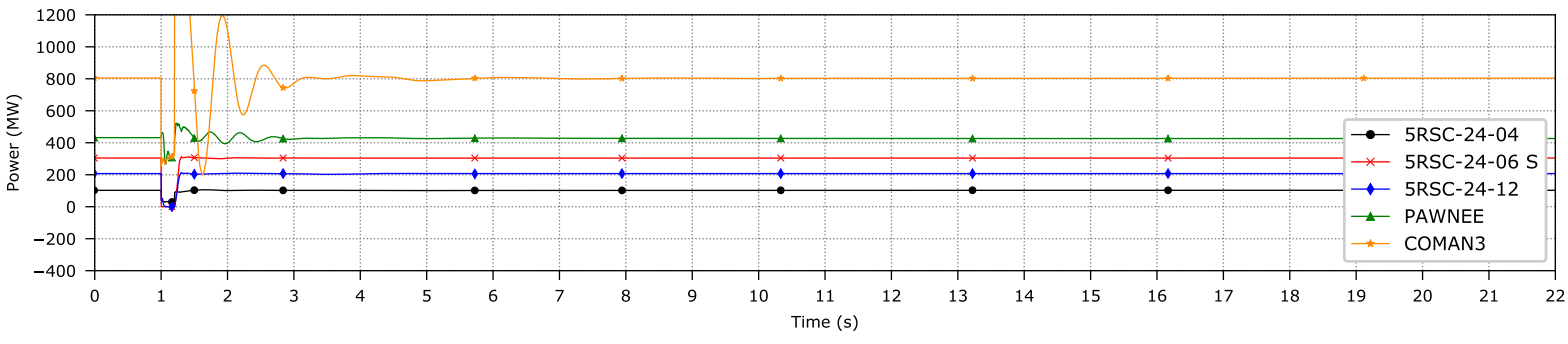


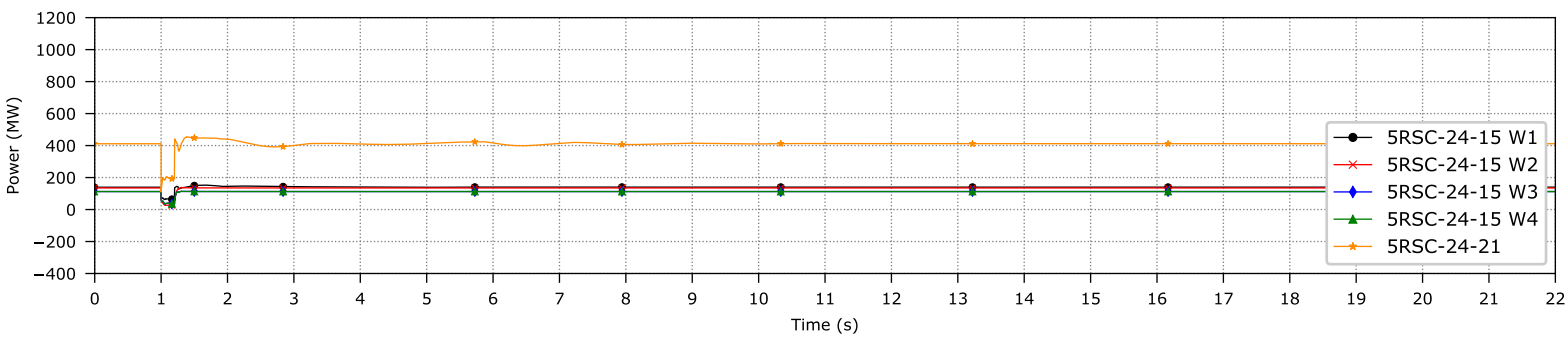


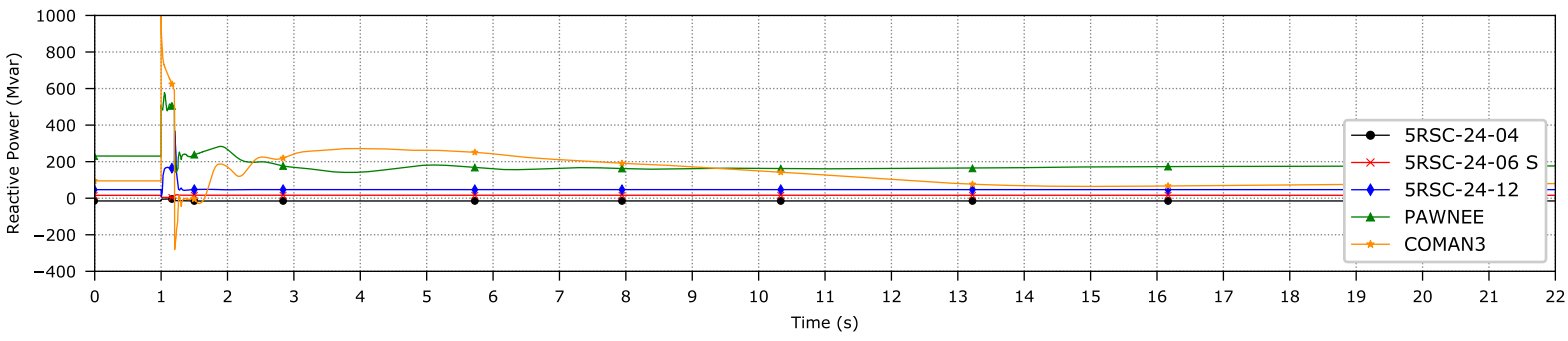


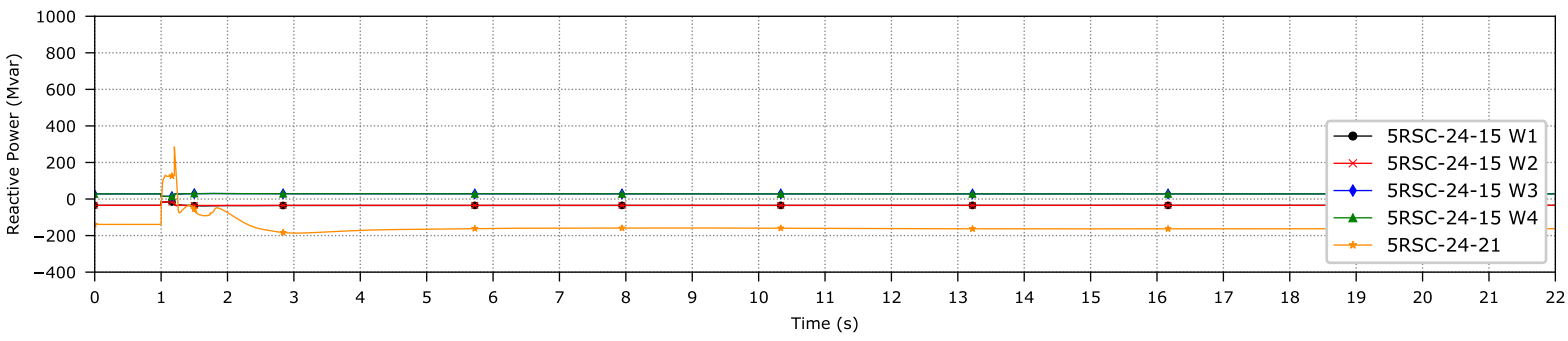
Ref. No. 19 - BF_140a

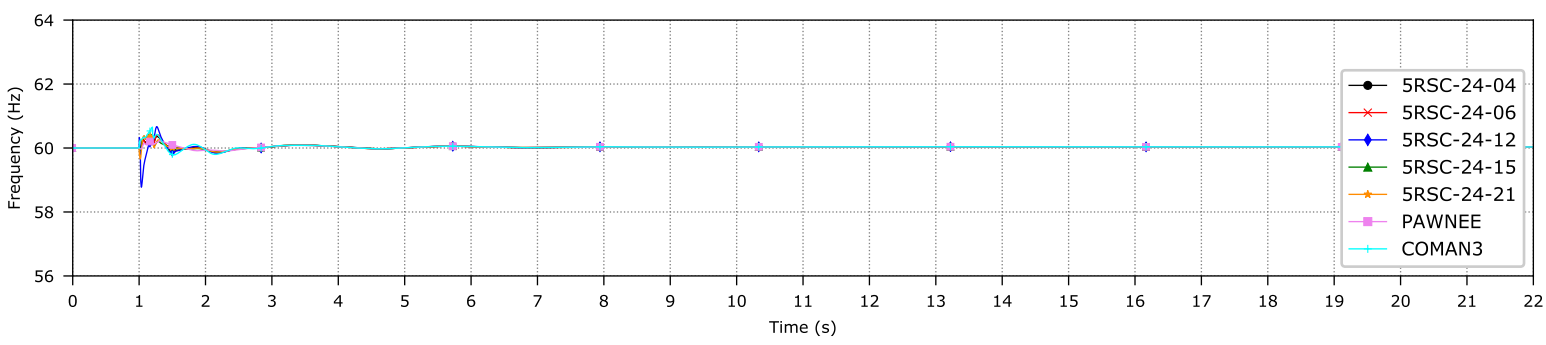


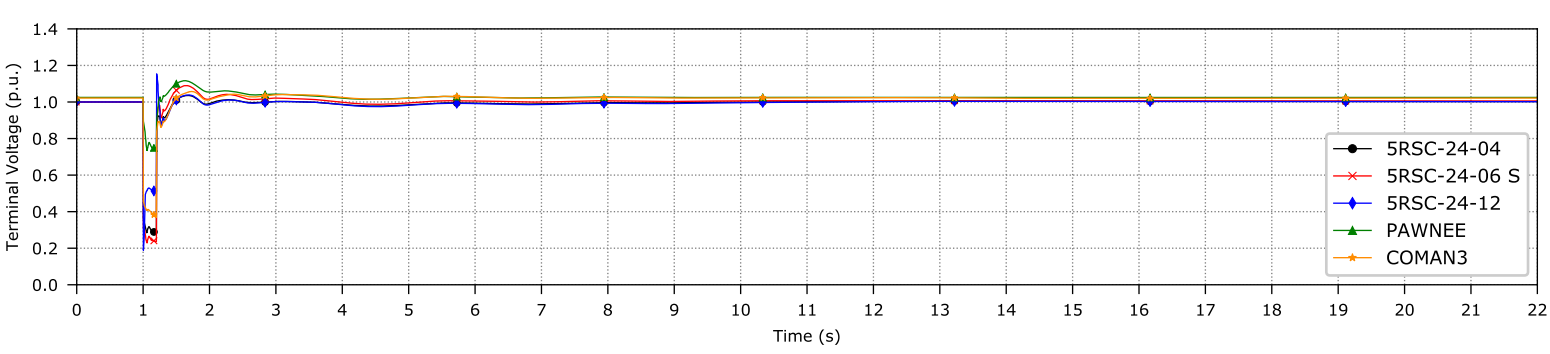


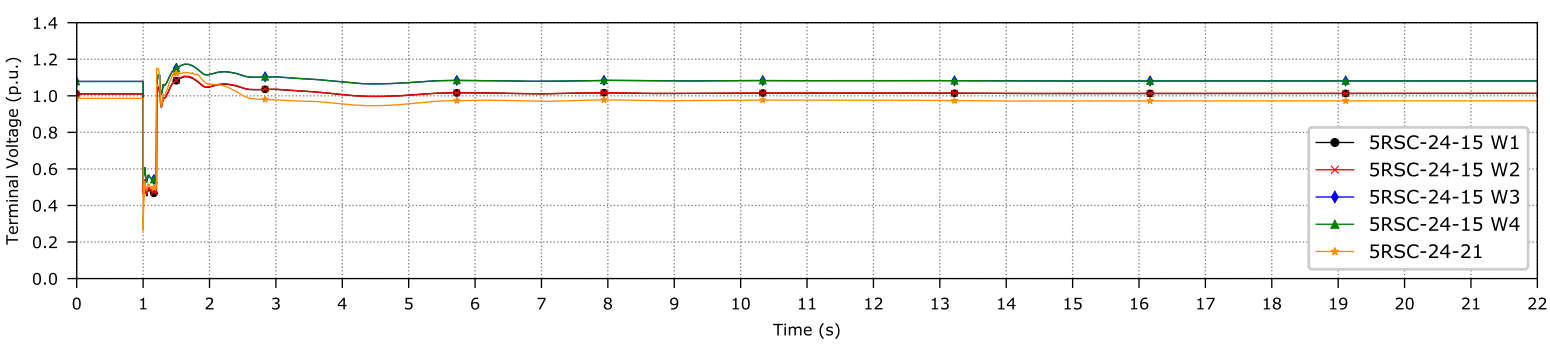


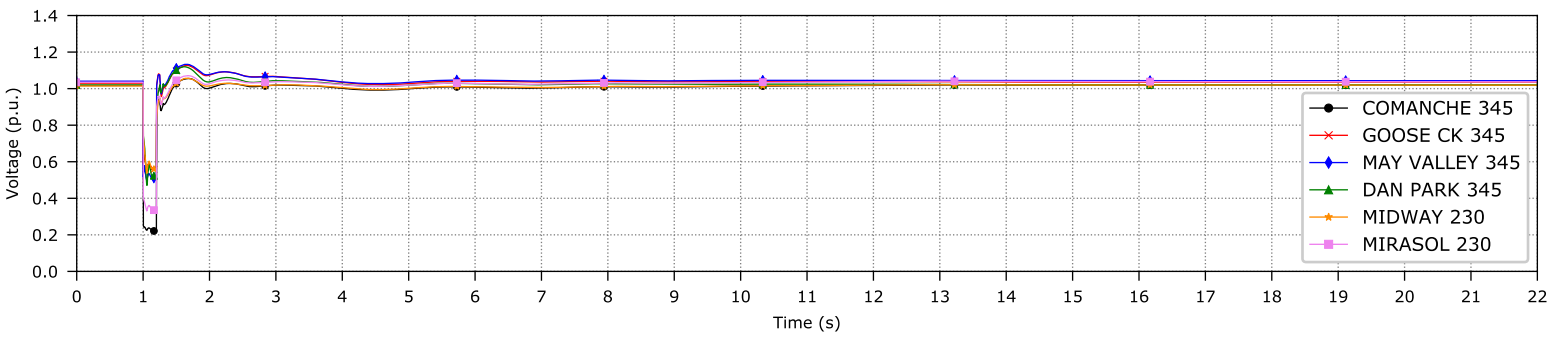




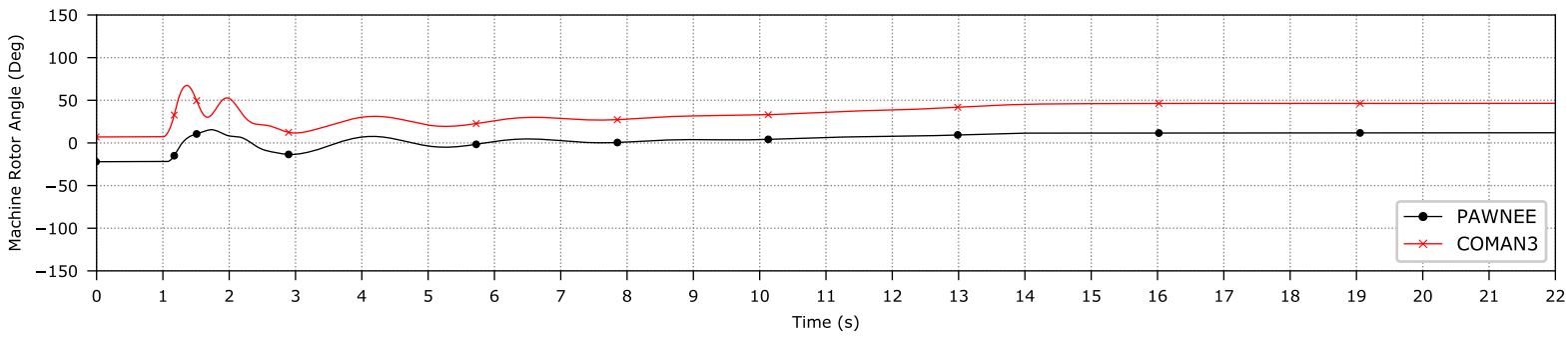


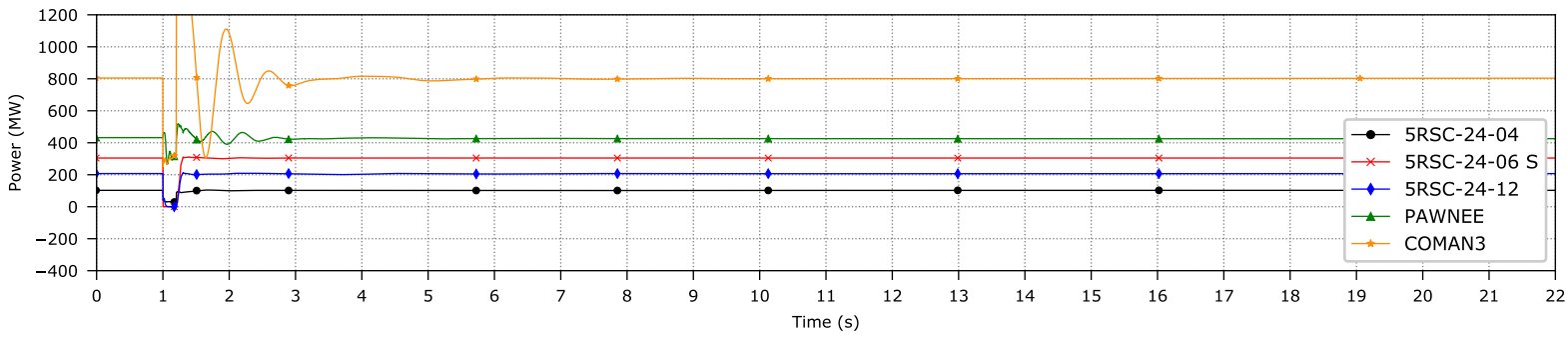


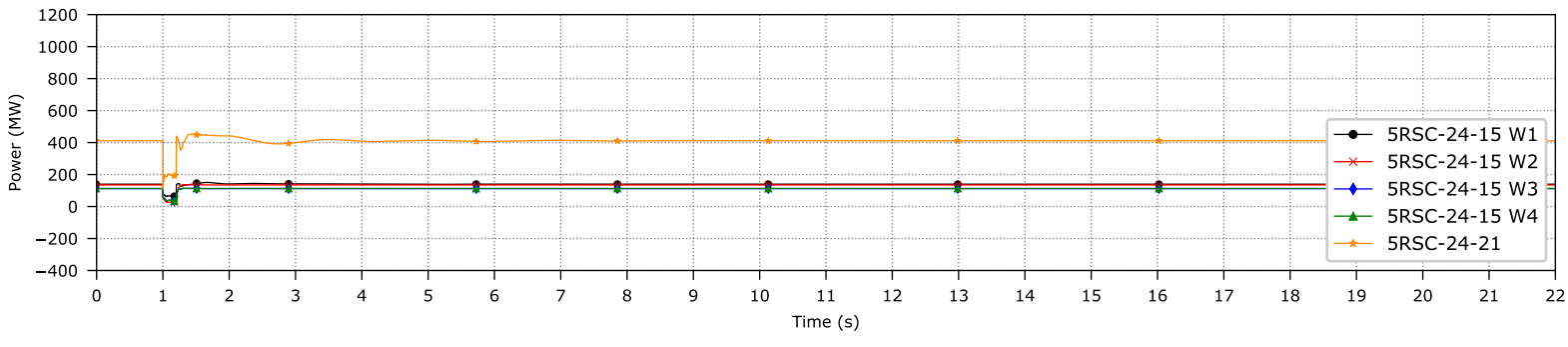


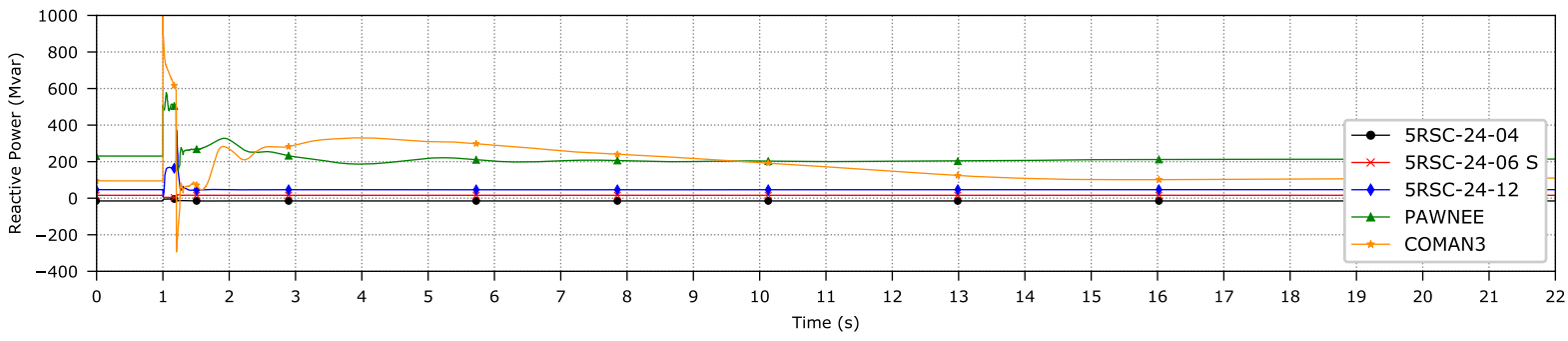


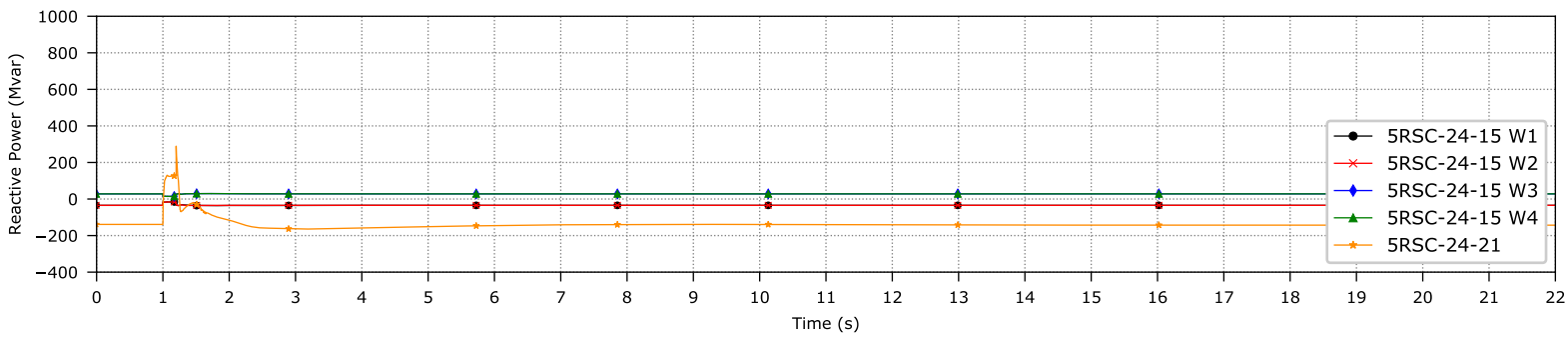
Ref. No. 20 - BF_140b

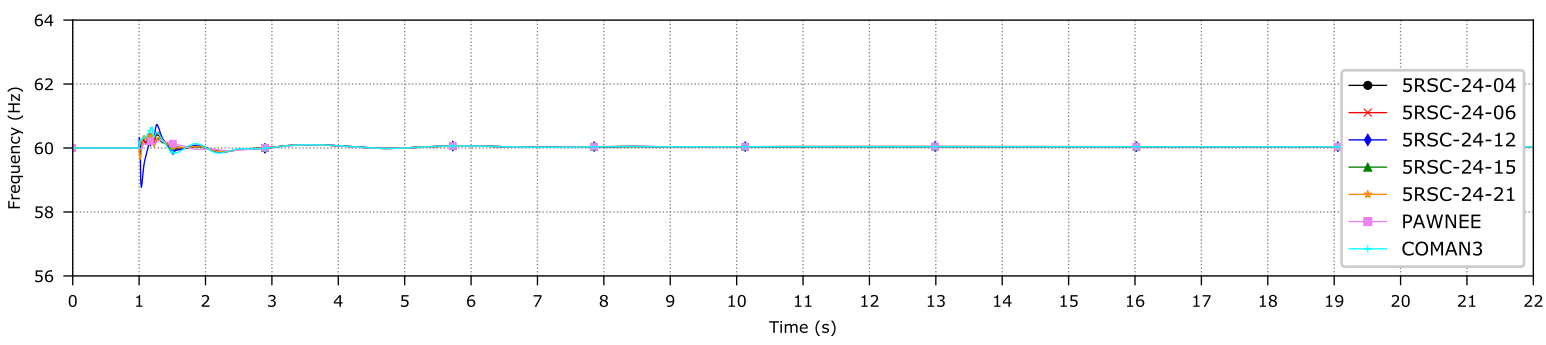


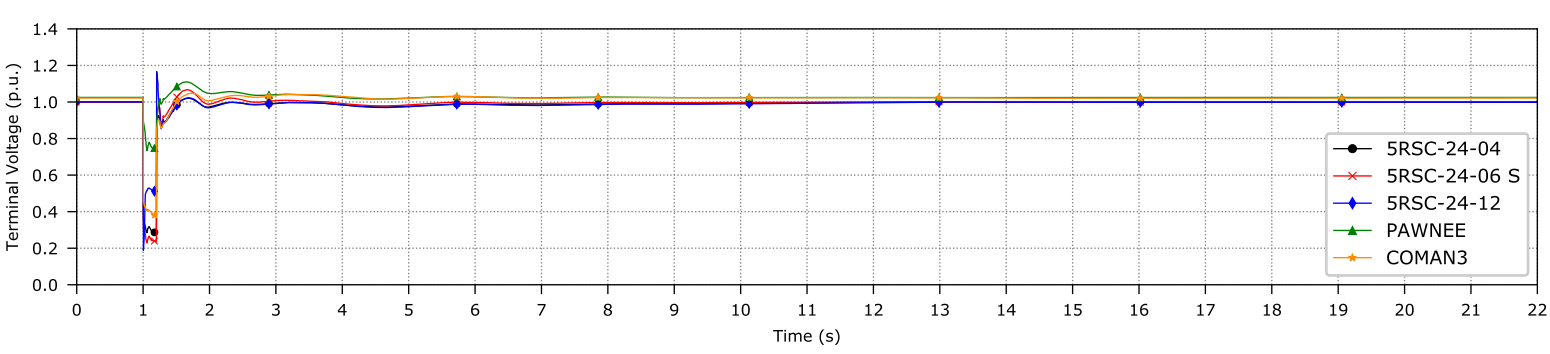


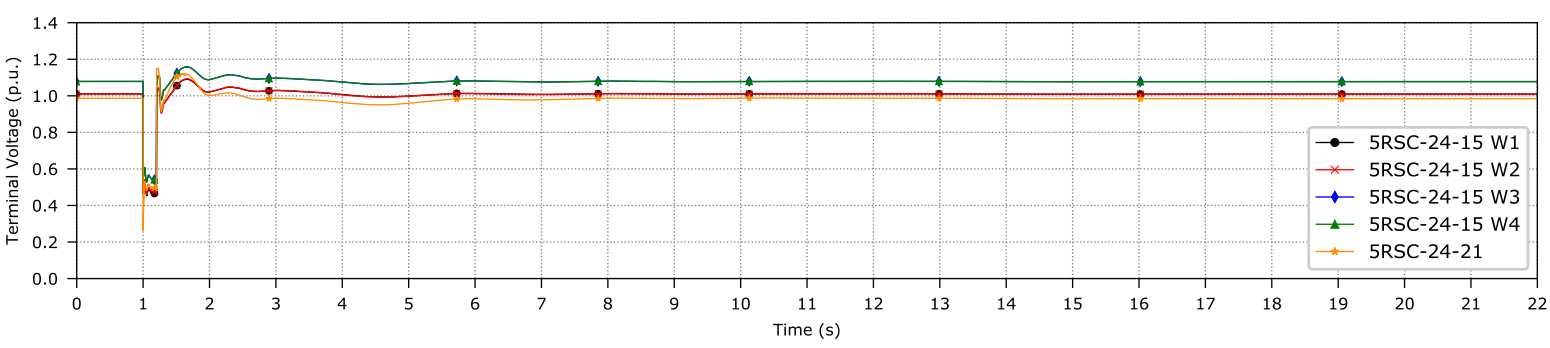


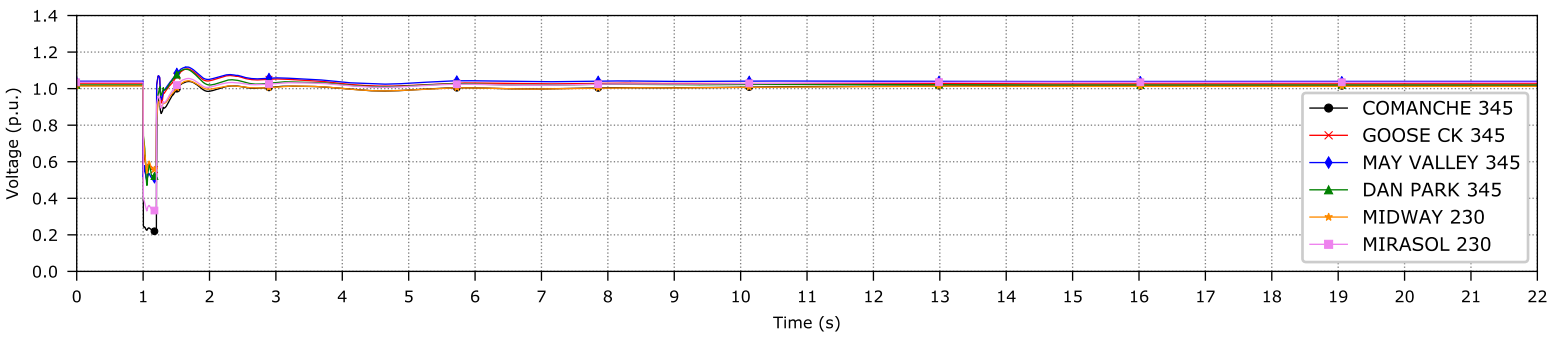




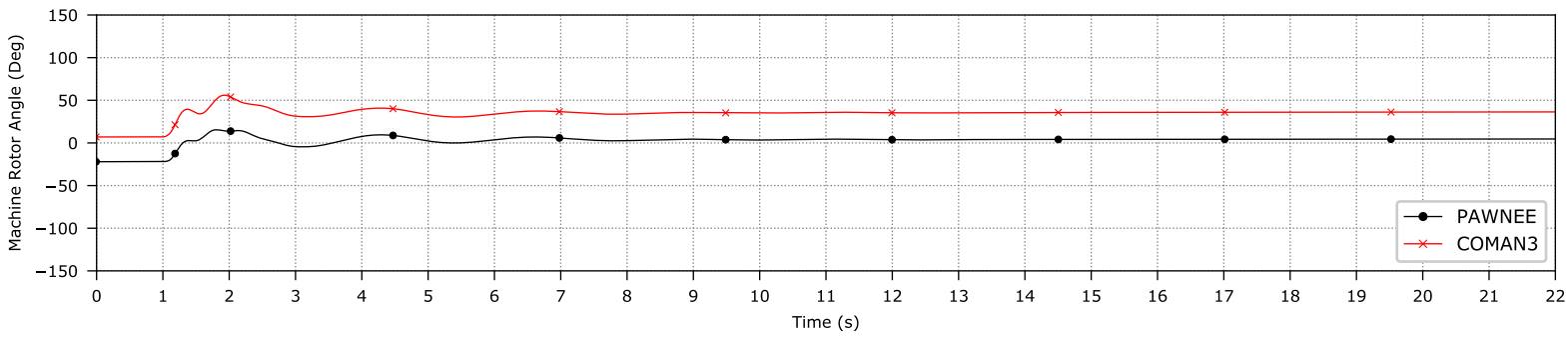


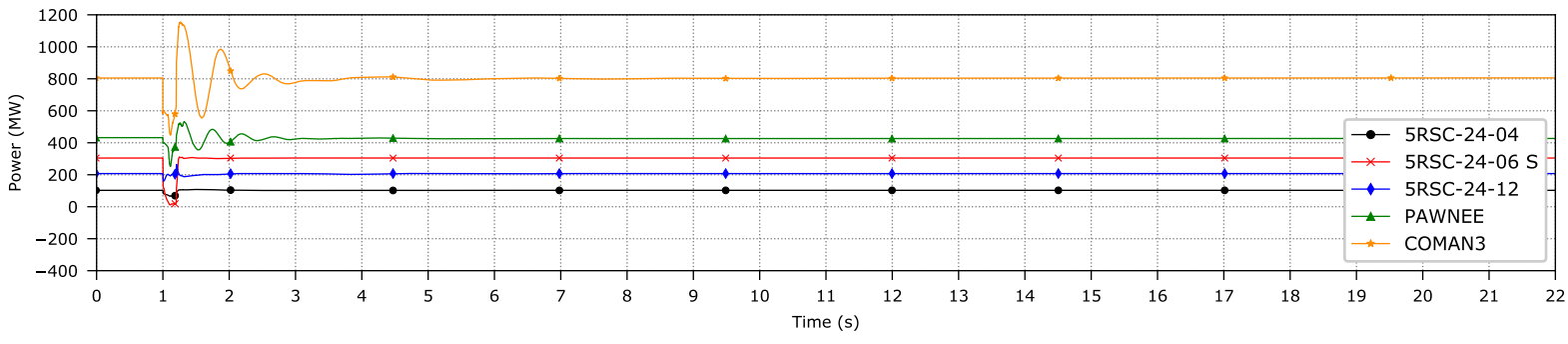


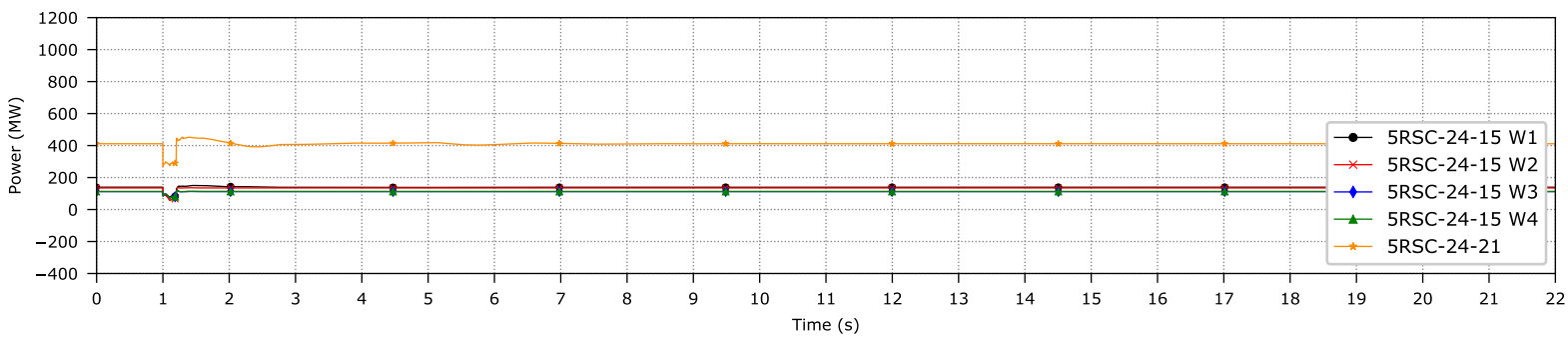


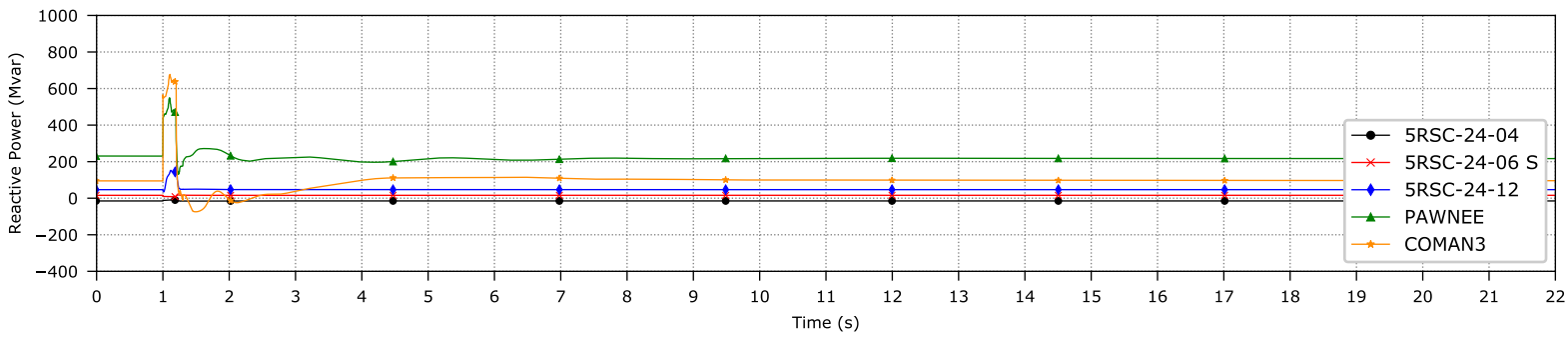


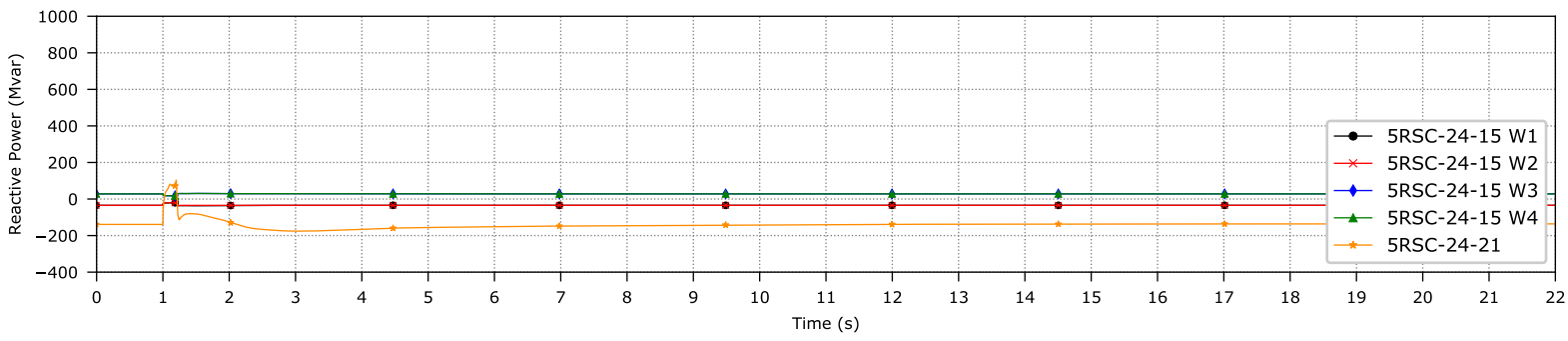
Ref. No. 21 - BF_156a

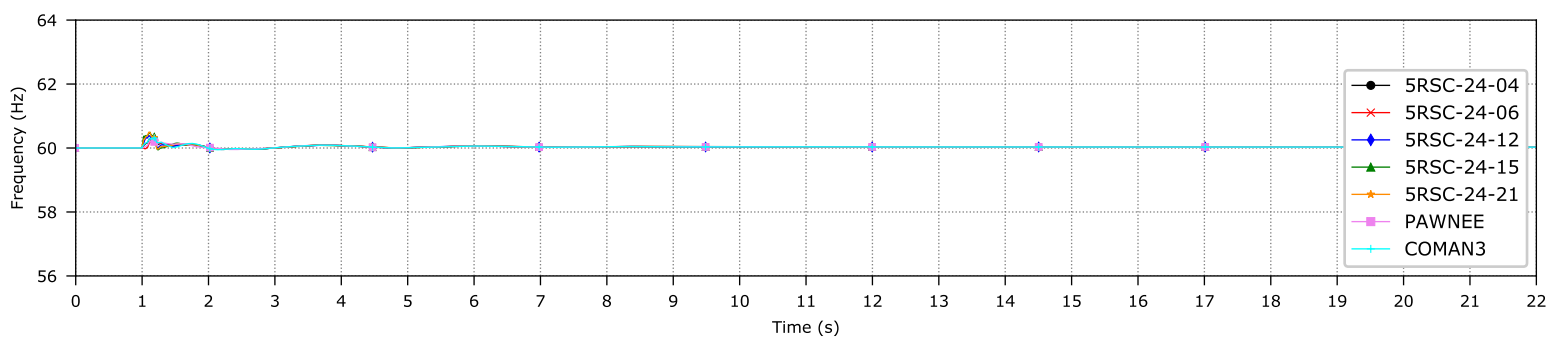


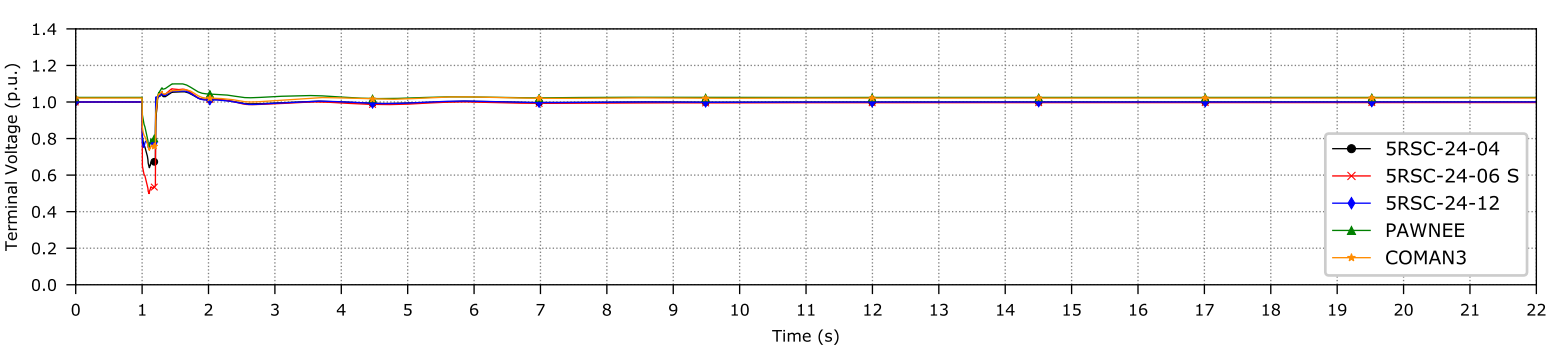


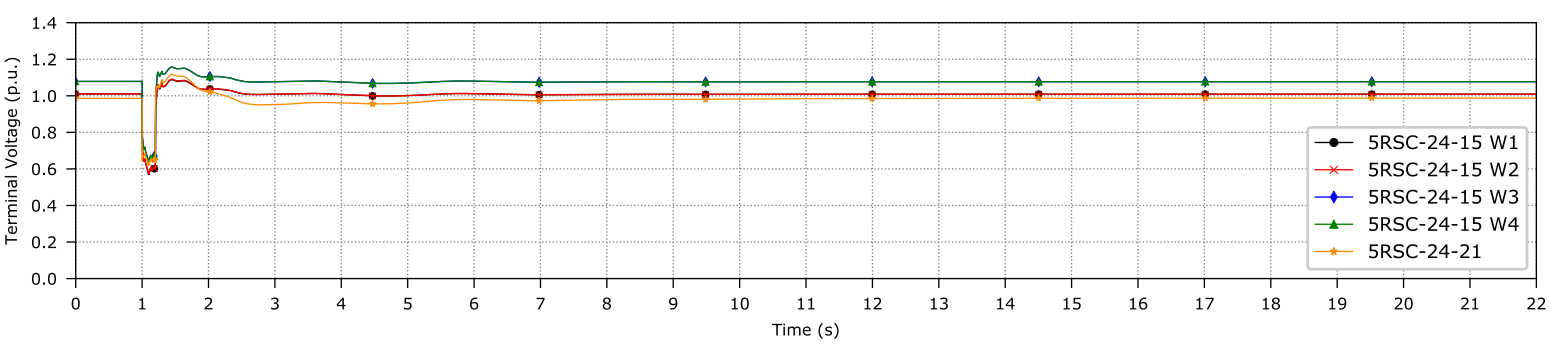


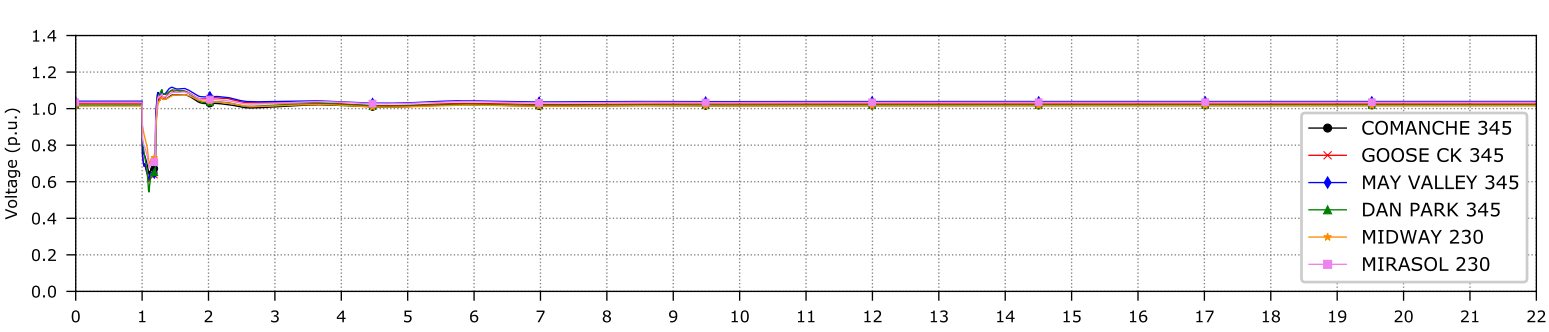




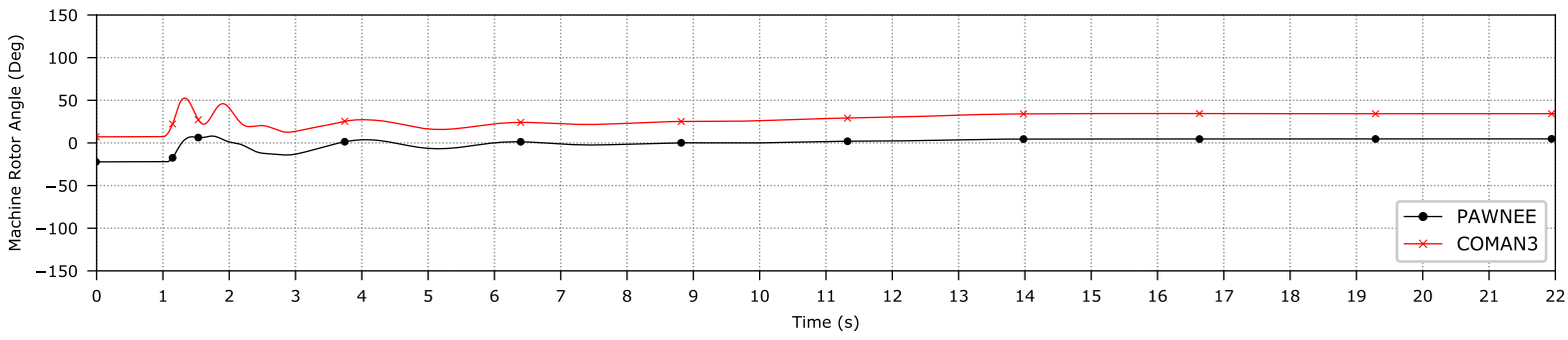


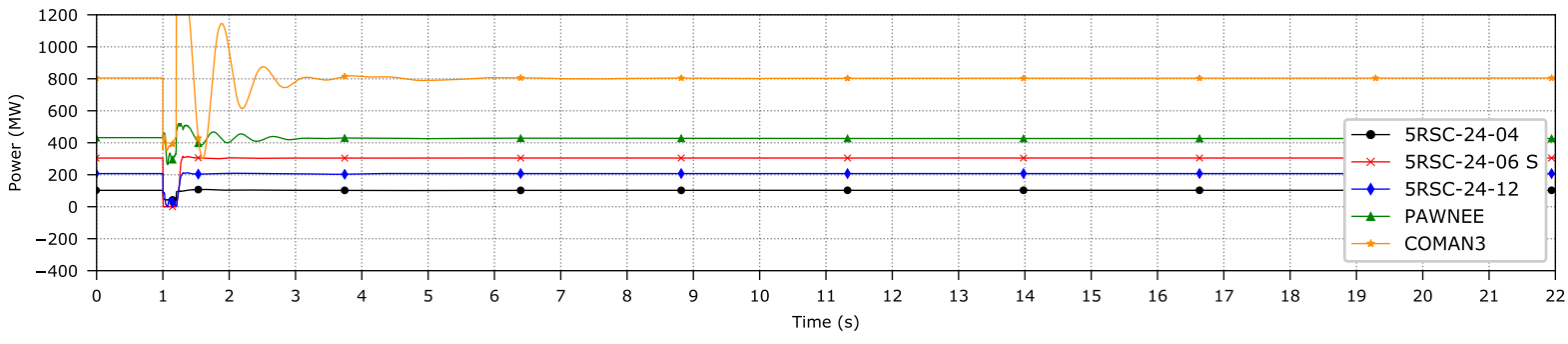


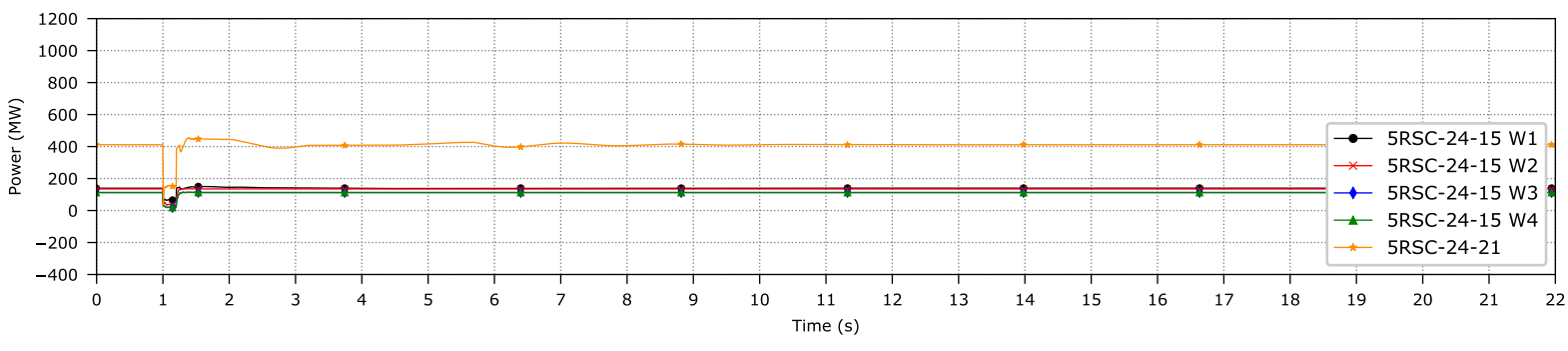


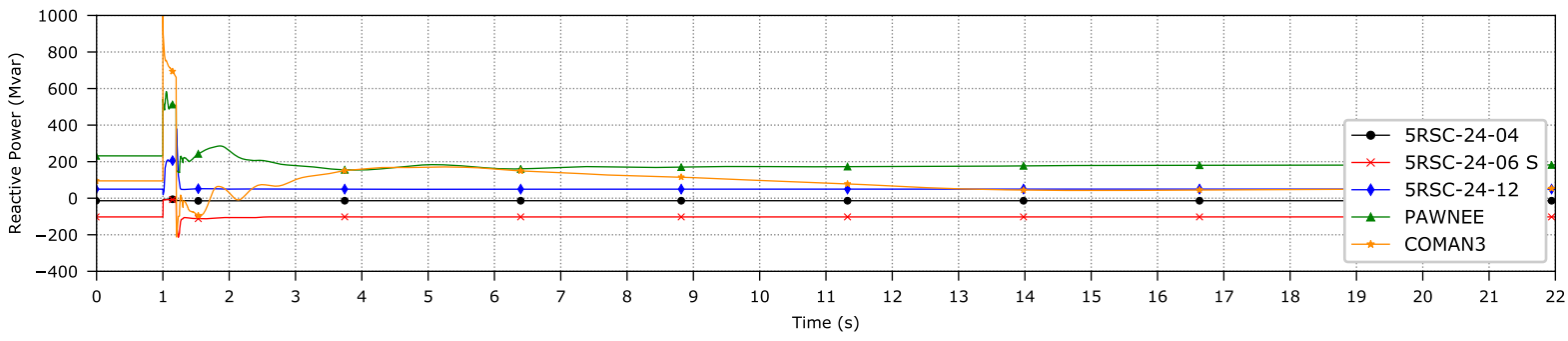


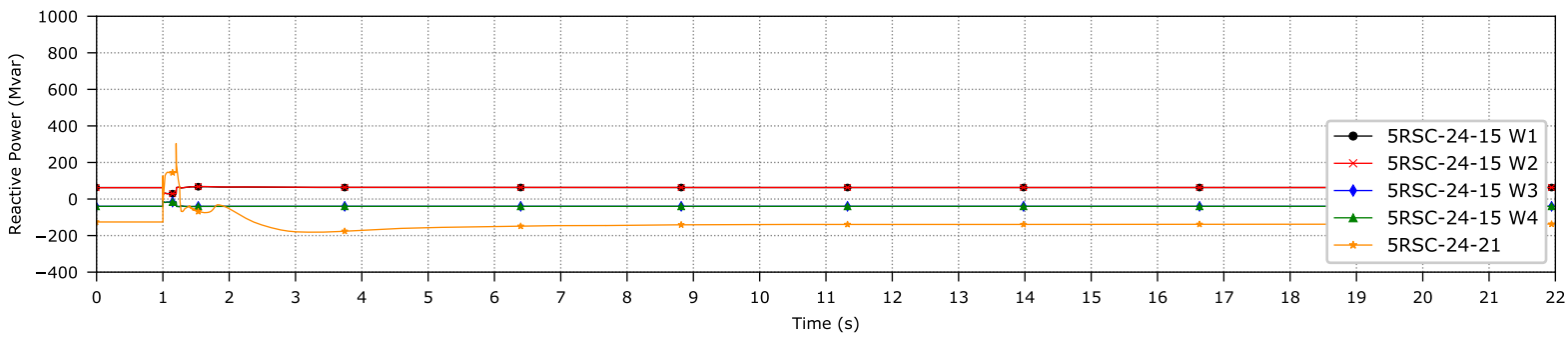
Ref. No. 22 - BF_157a

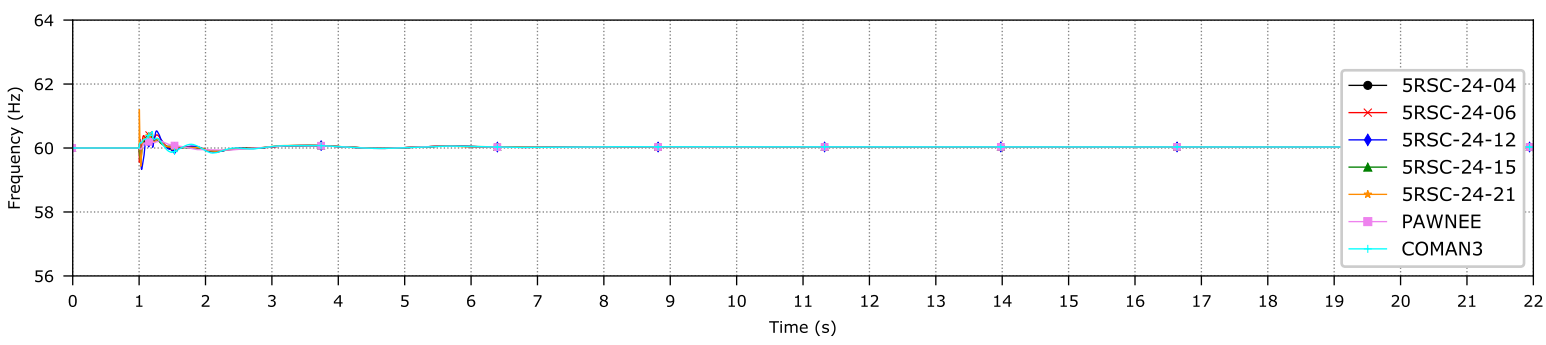


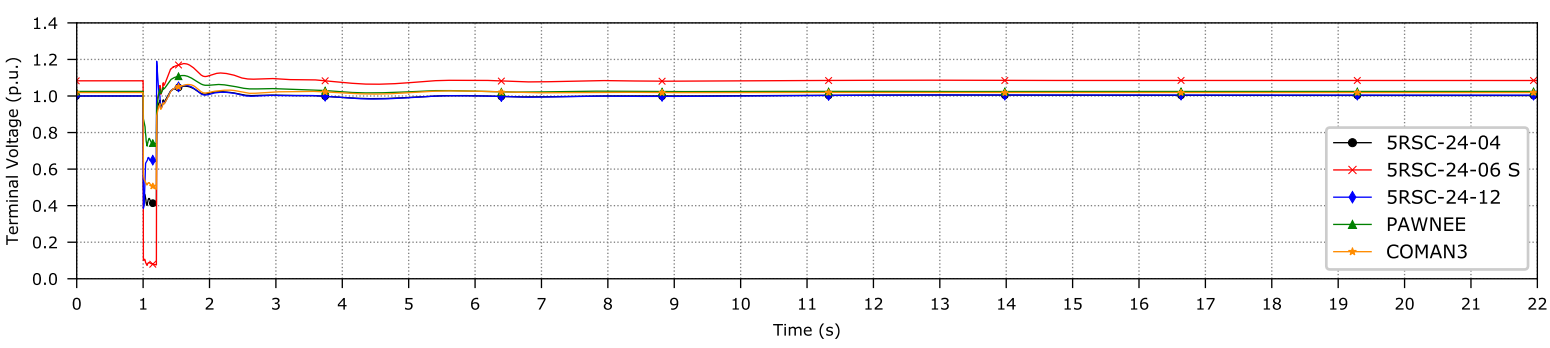


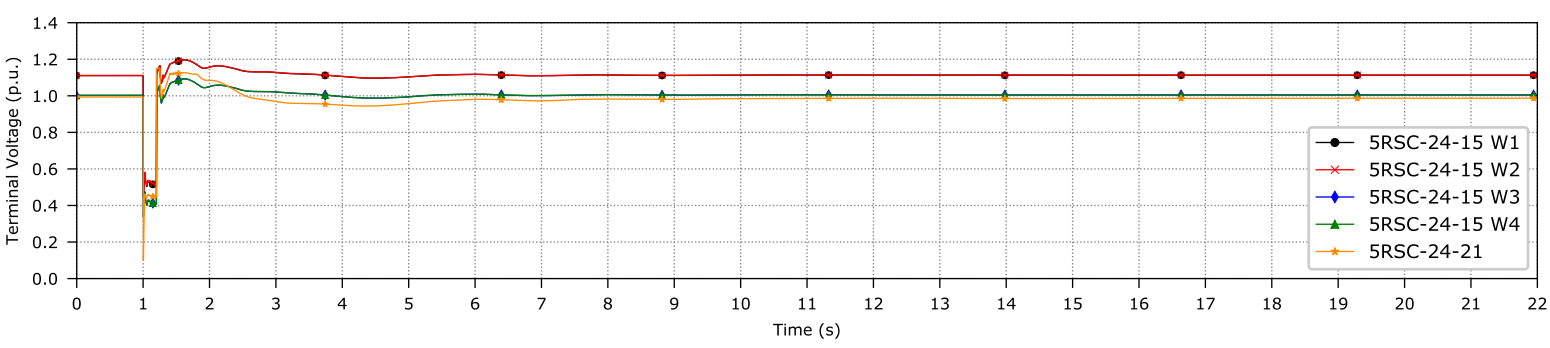


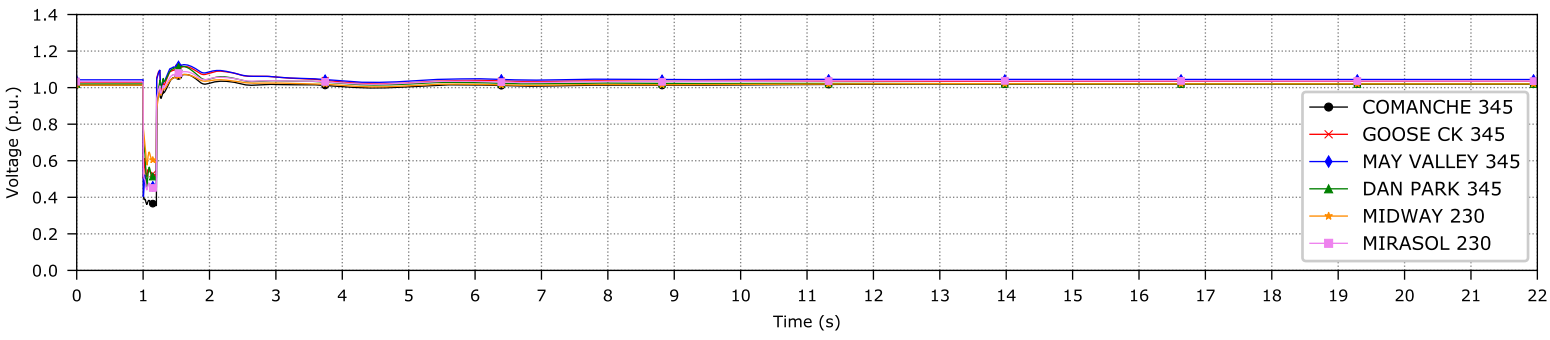




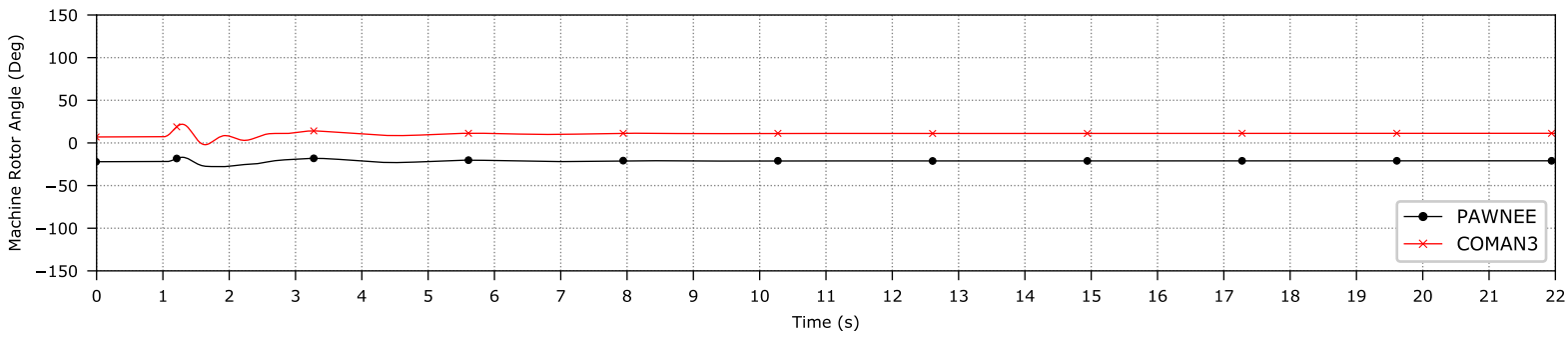


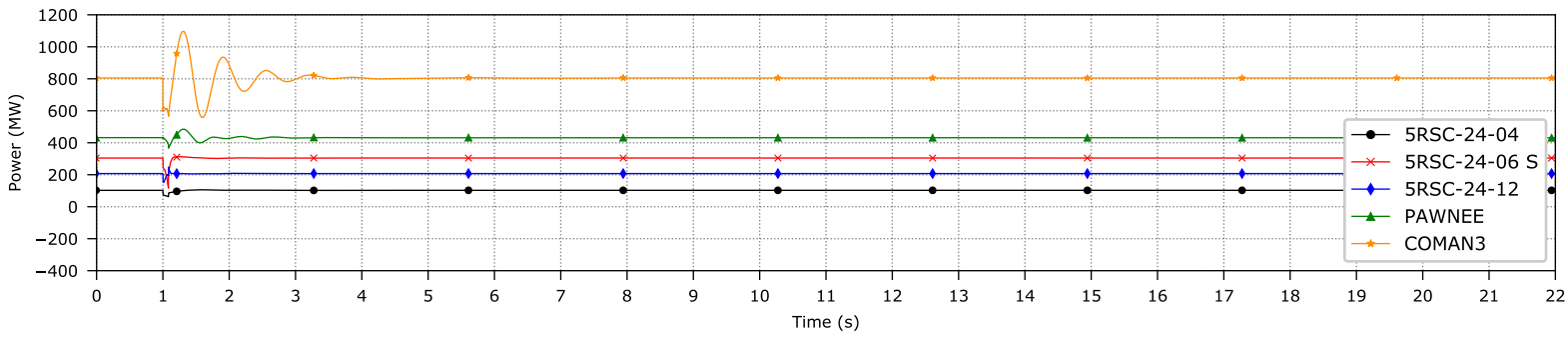


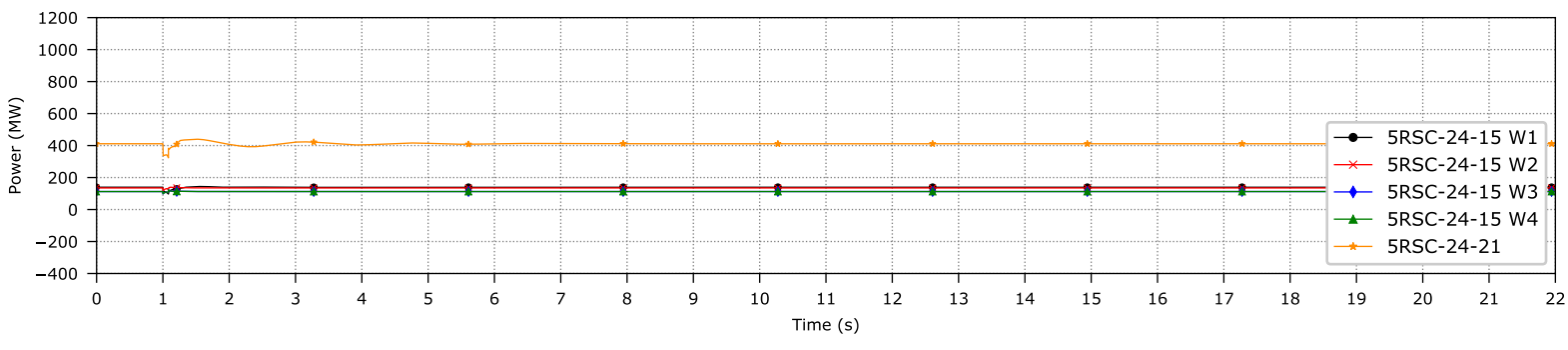


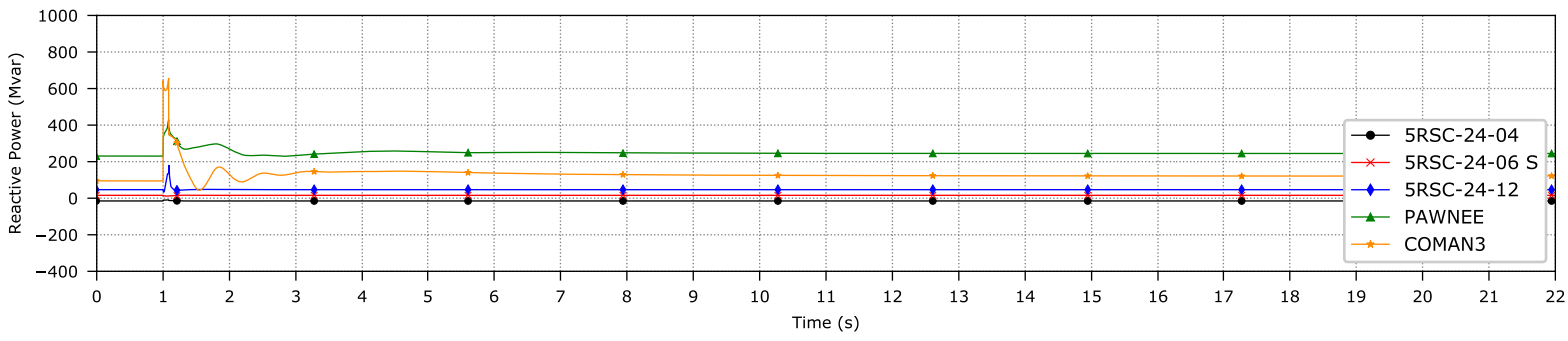


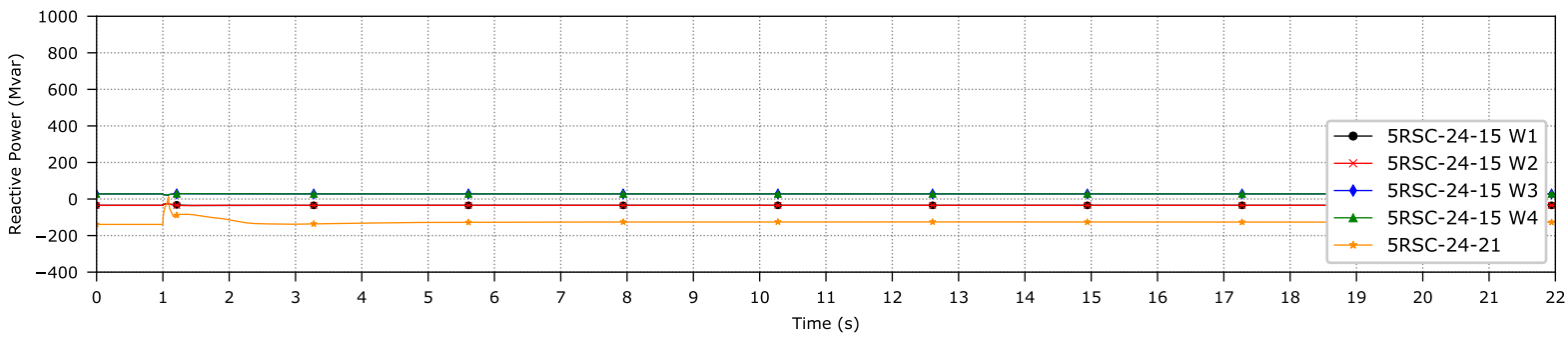
Ref. No. 23 - P7_53

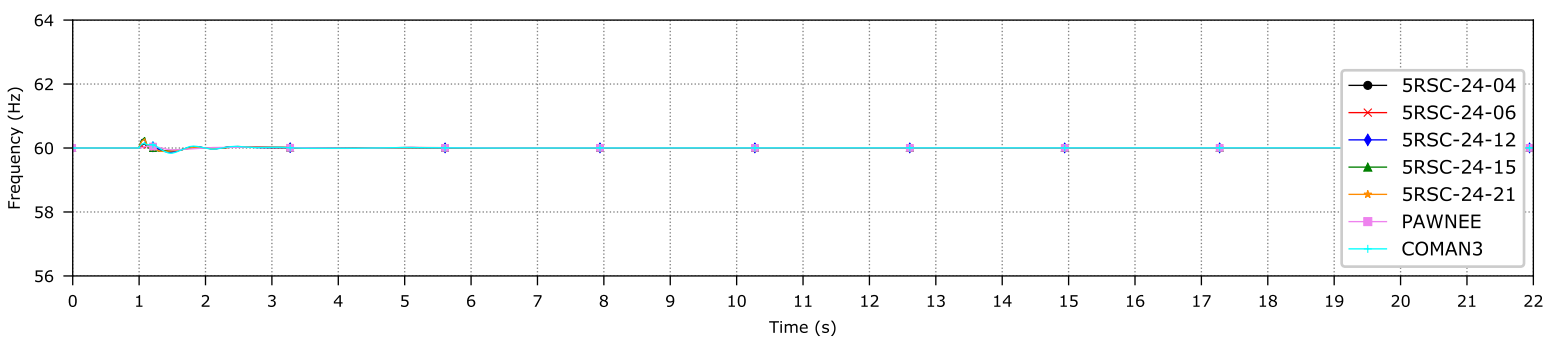


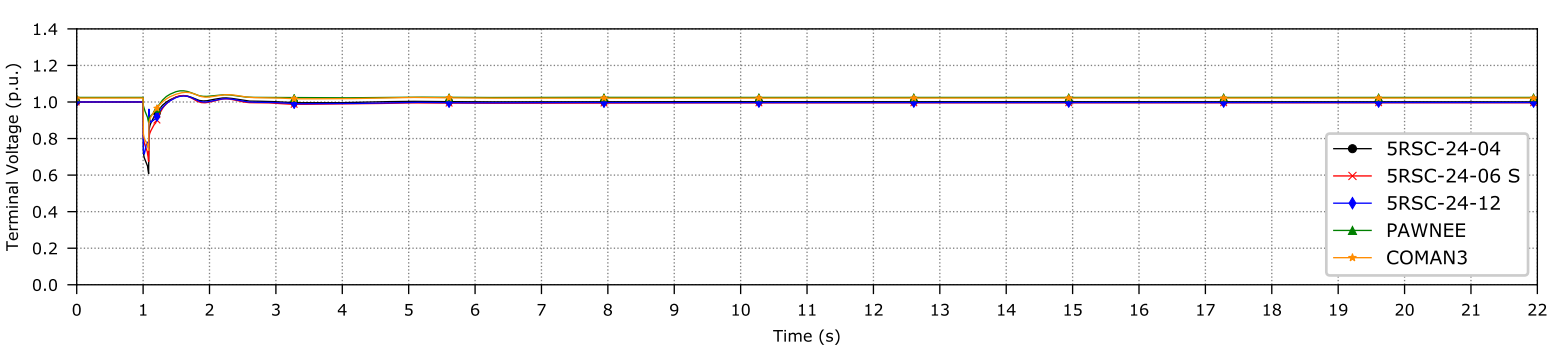


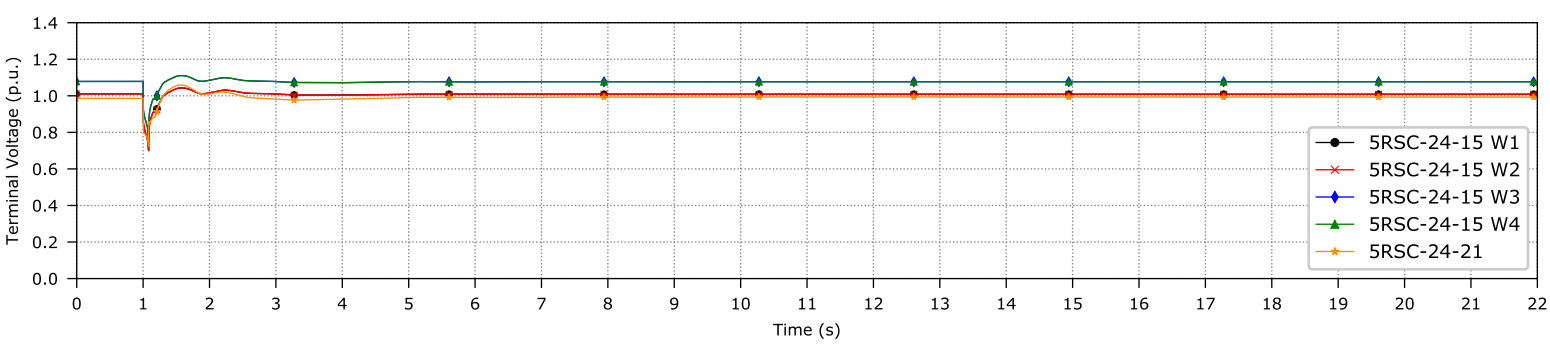


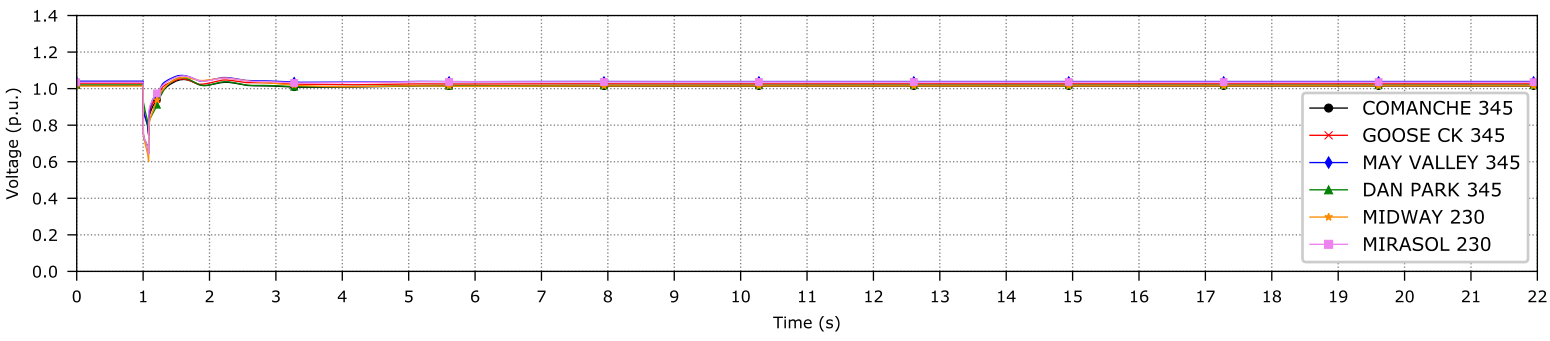












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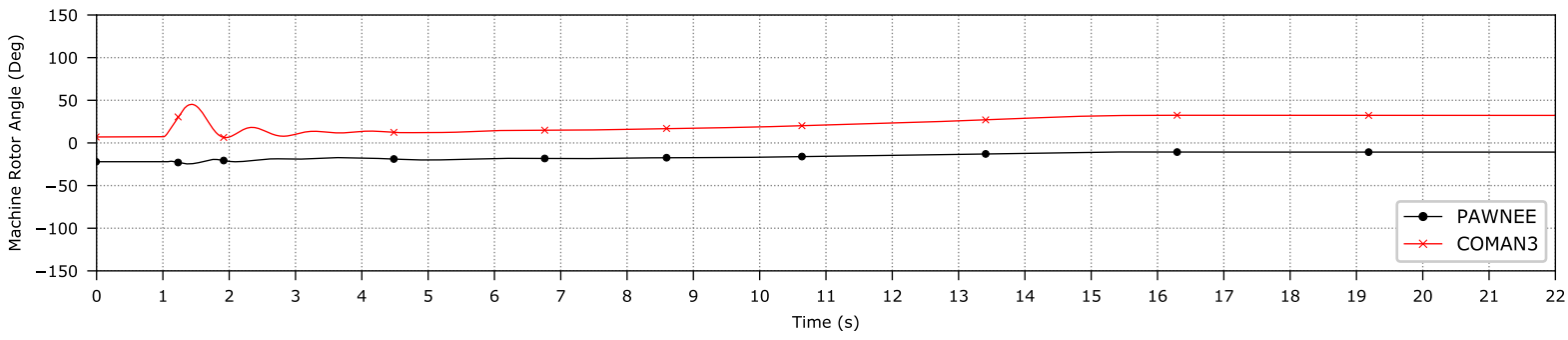
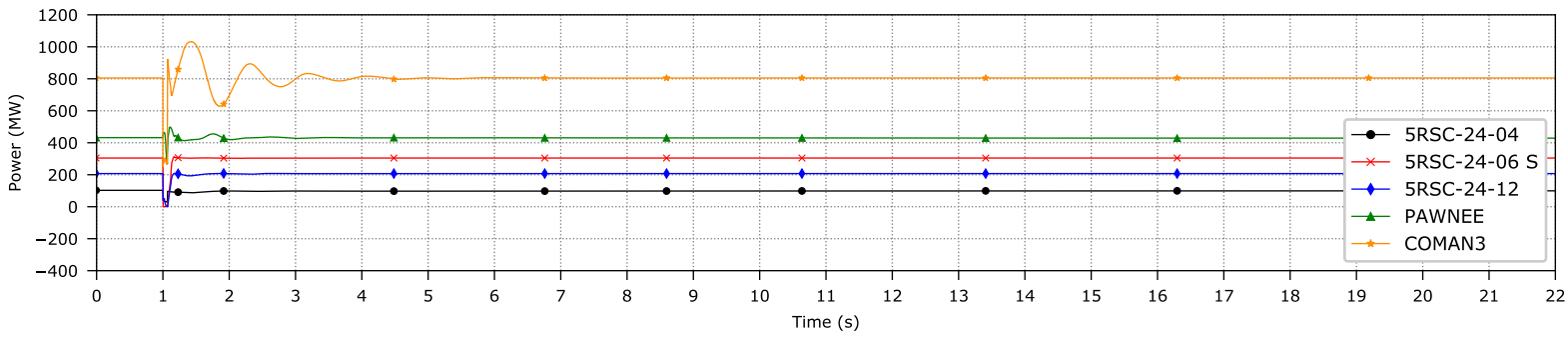
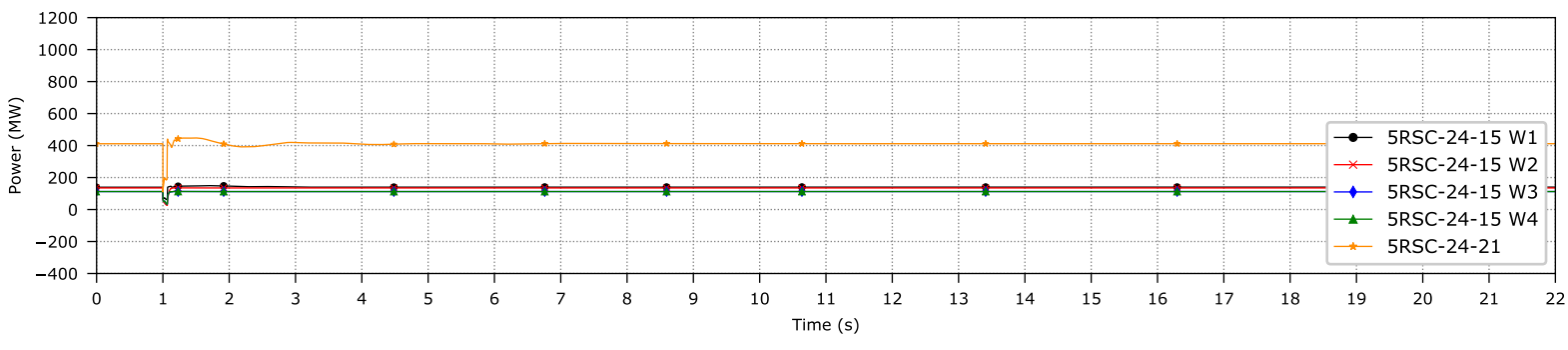
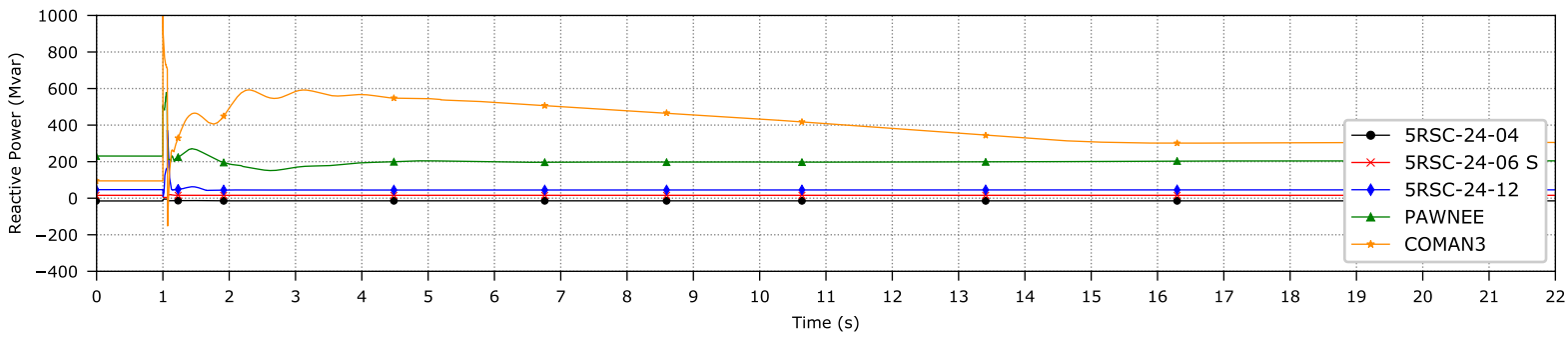
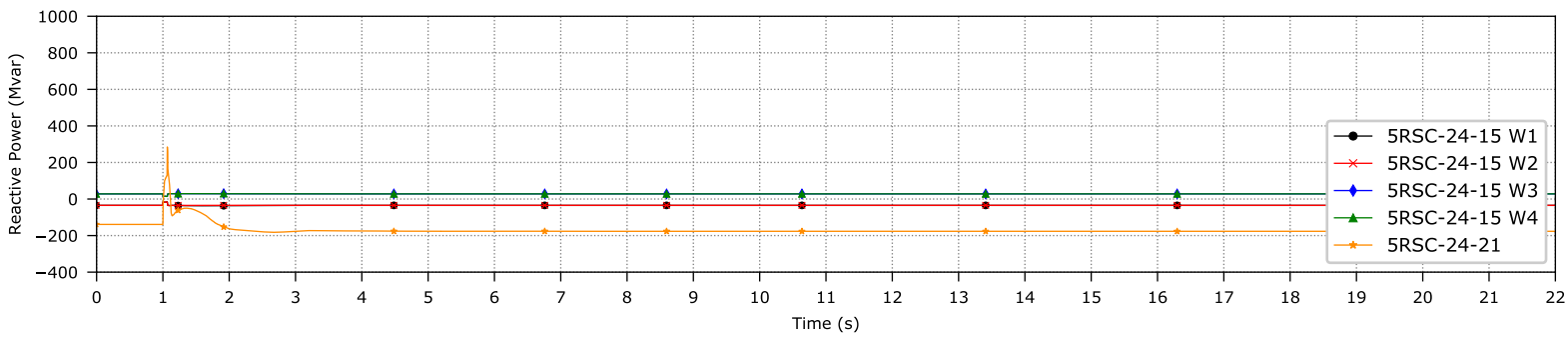
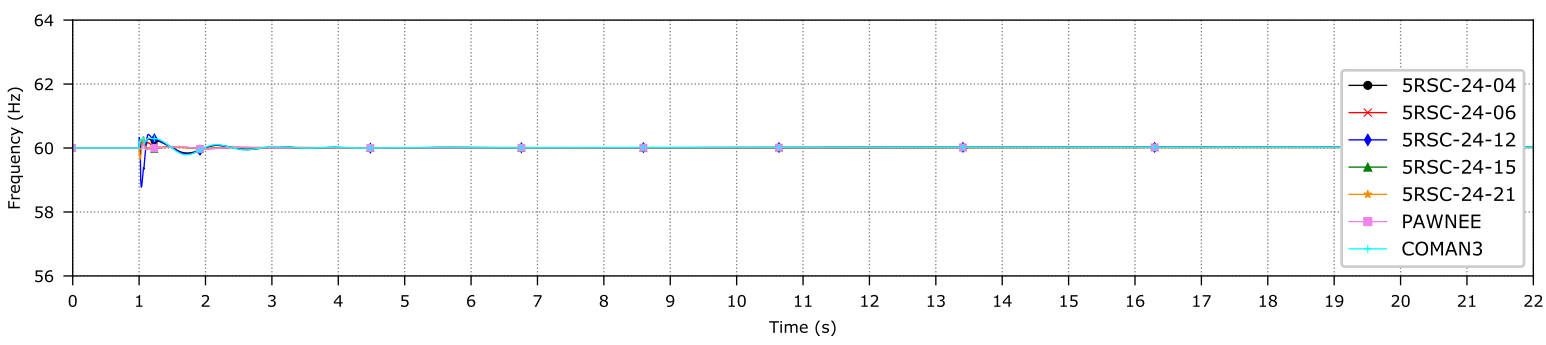


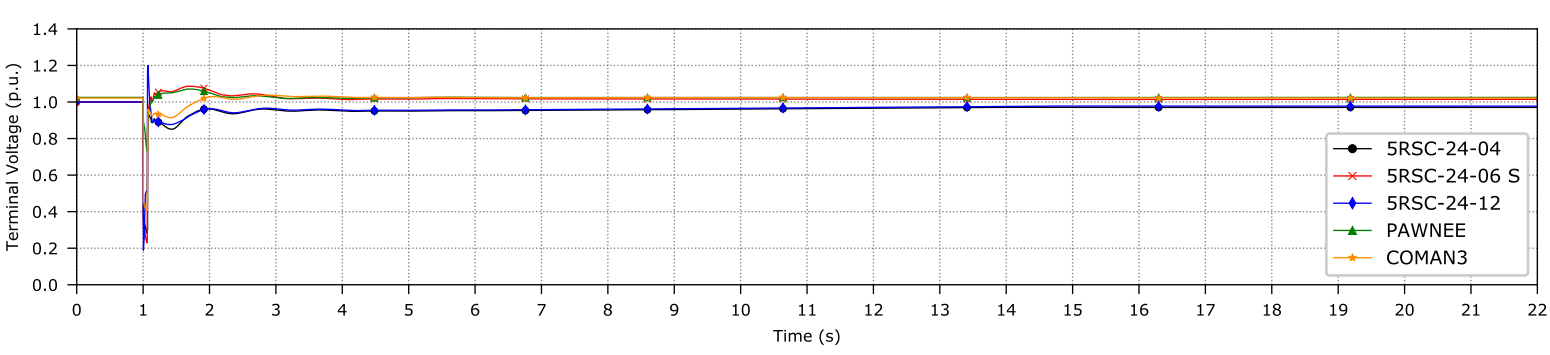


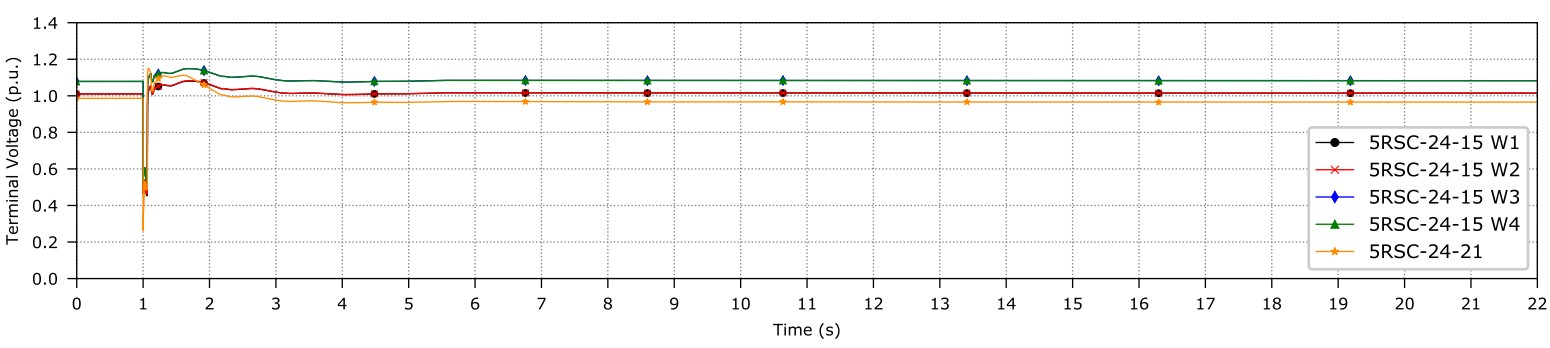


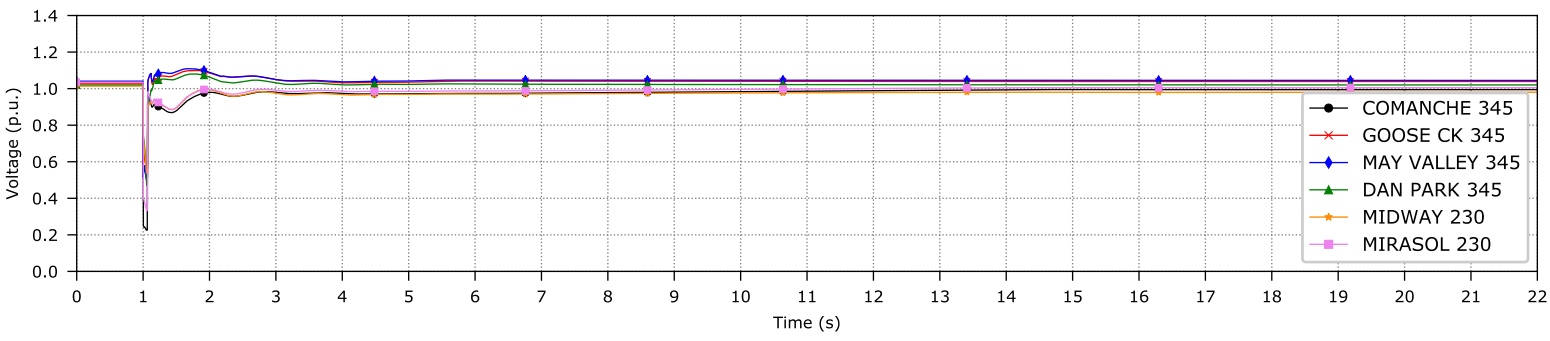




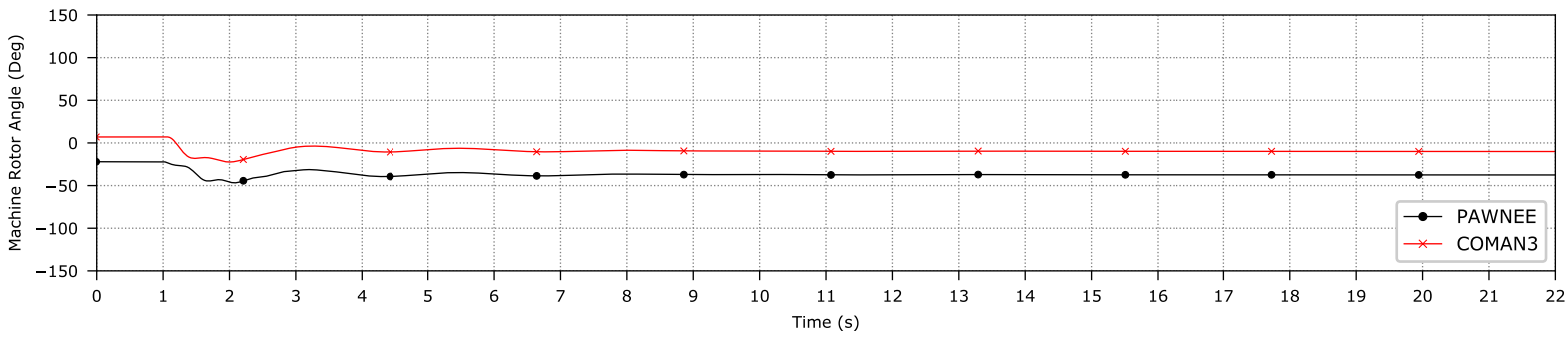


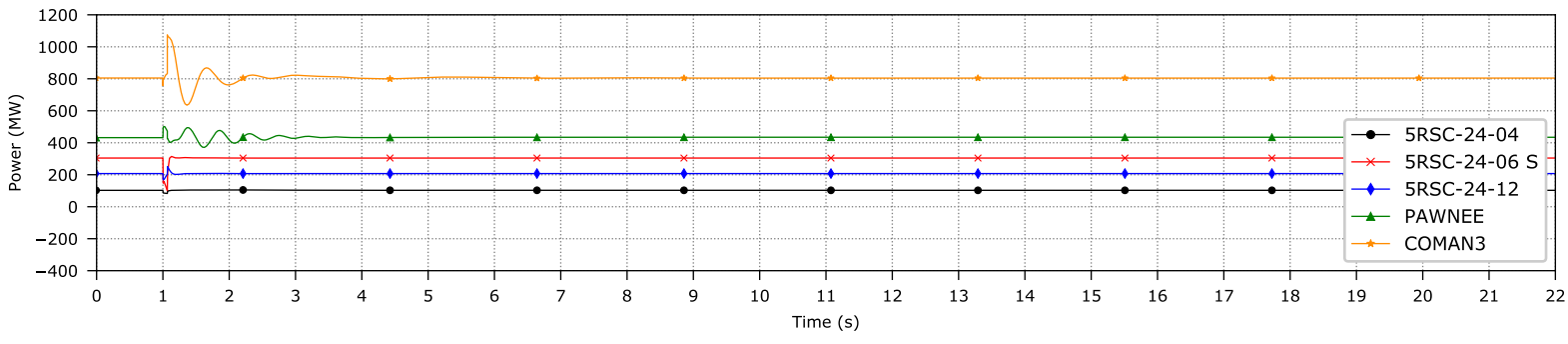


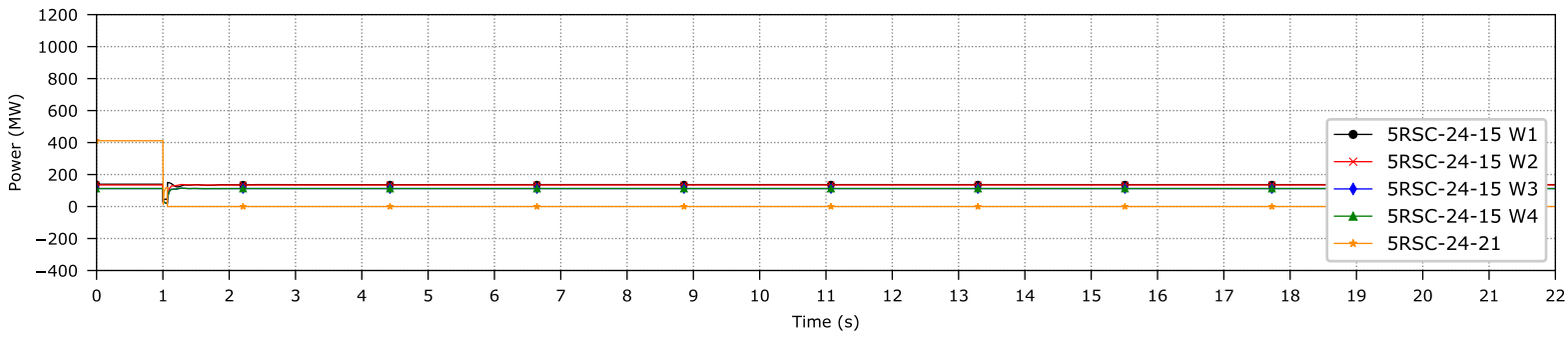


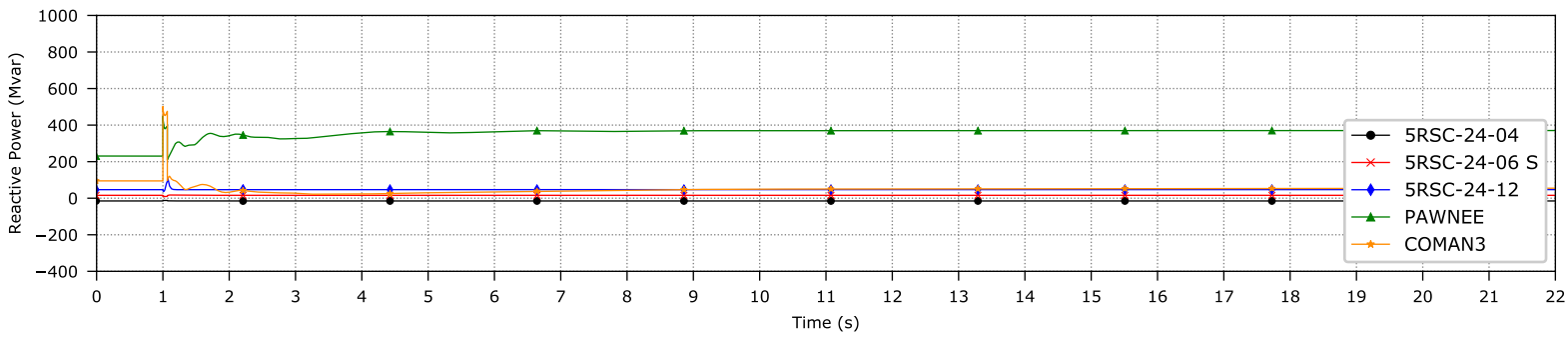


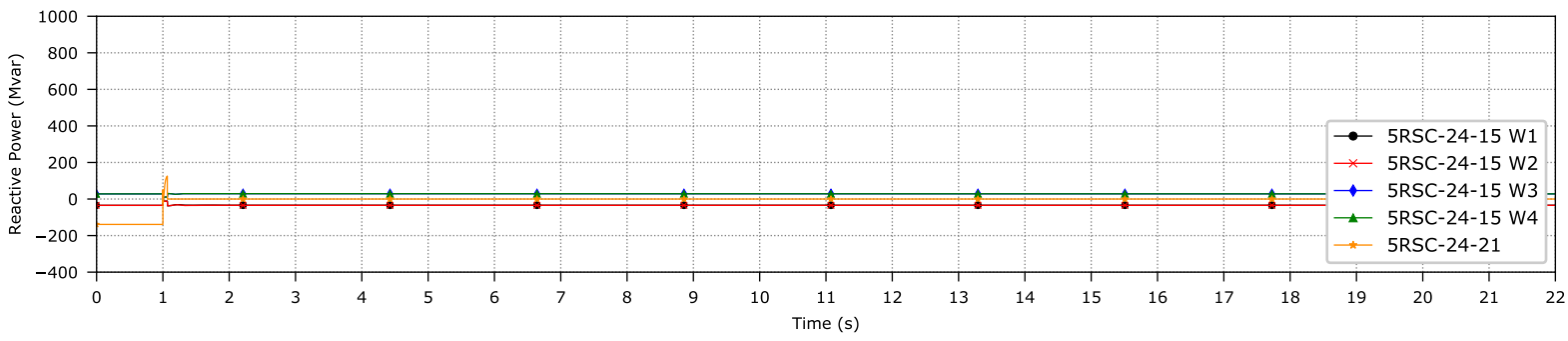
Ref. No. 25 - P7_163

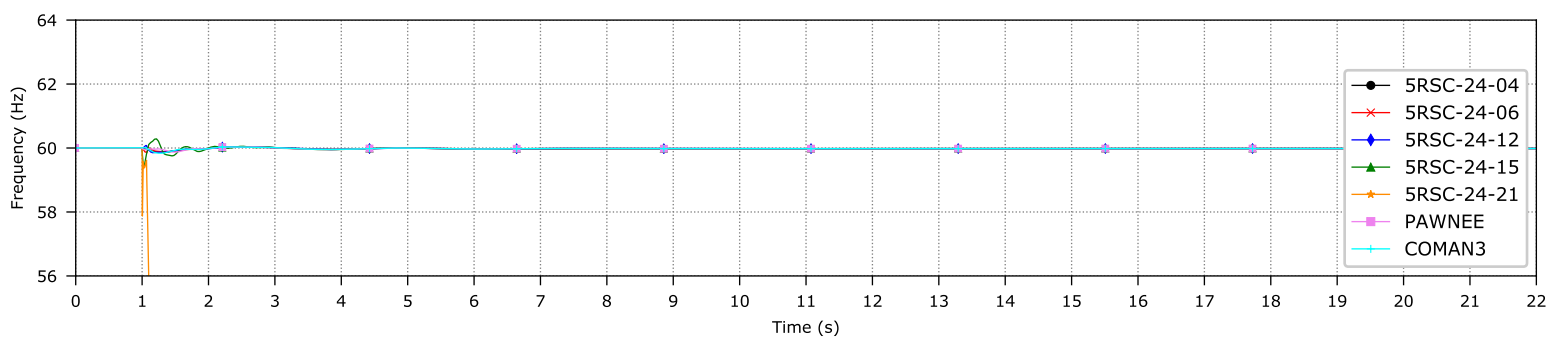


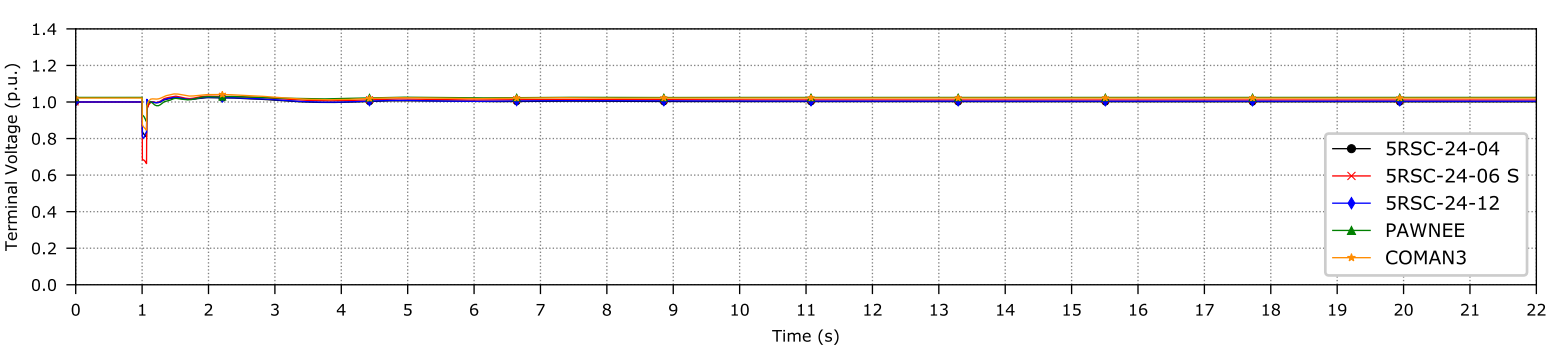


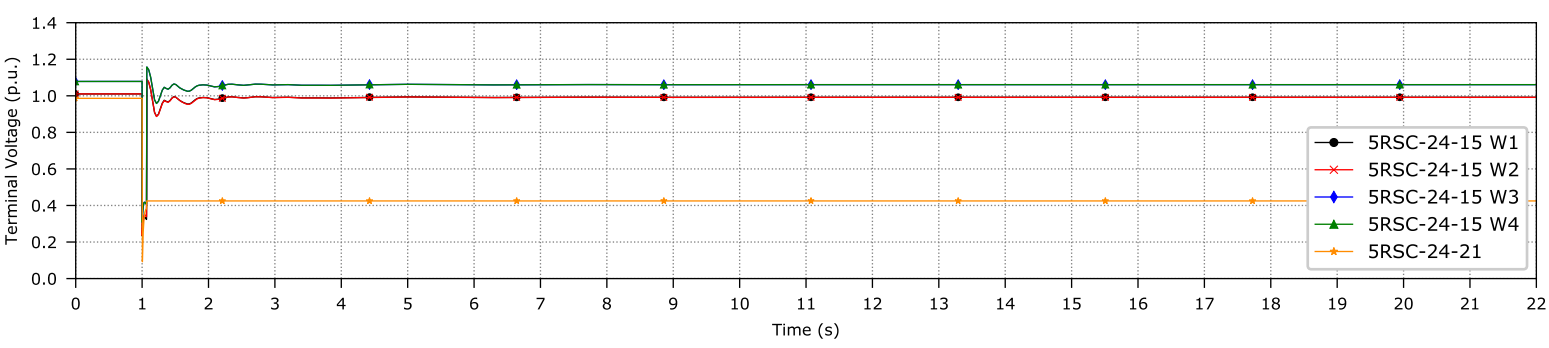


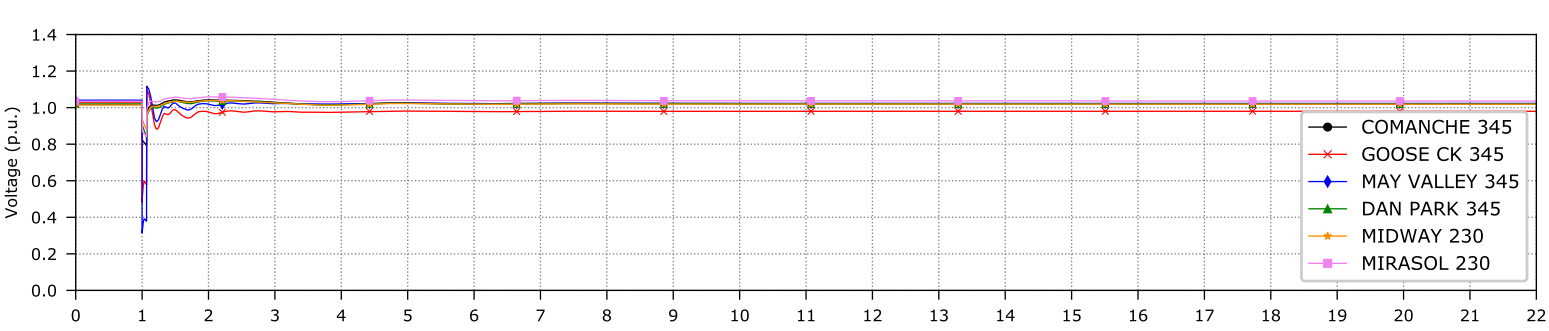




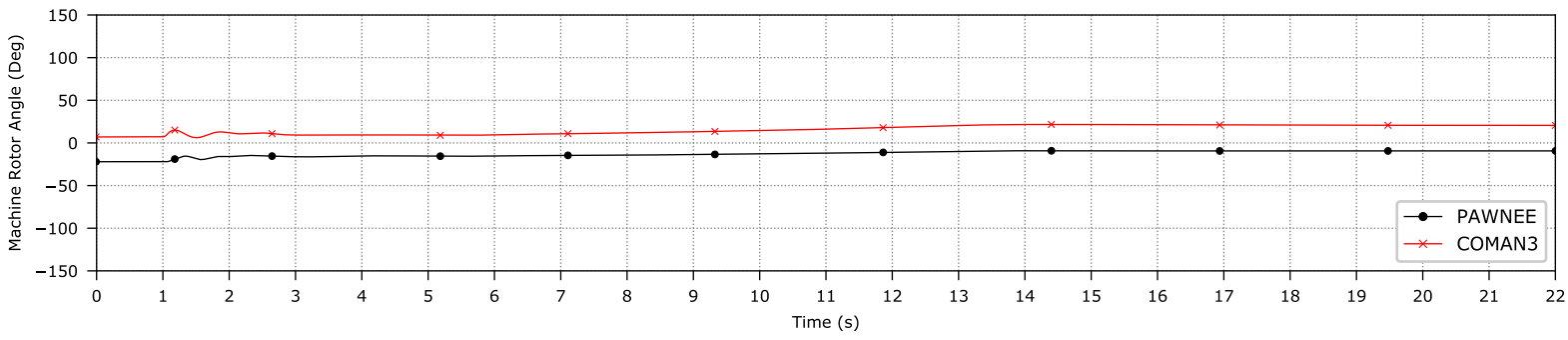


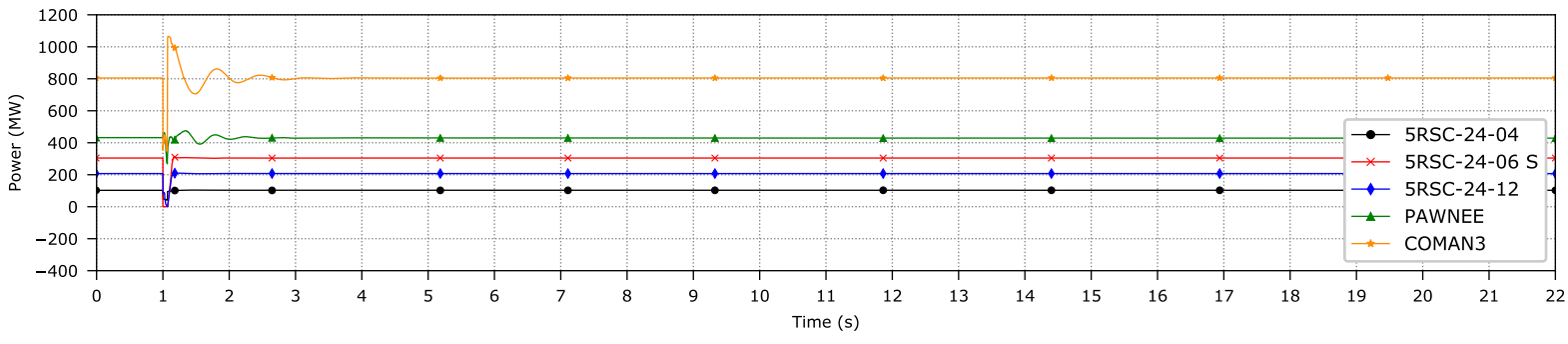


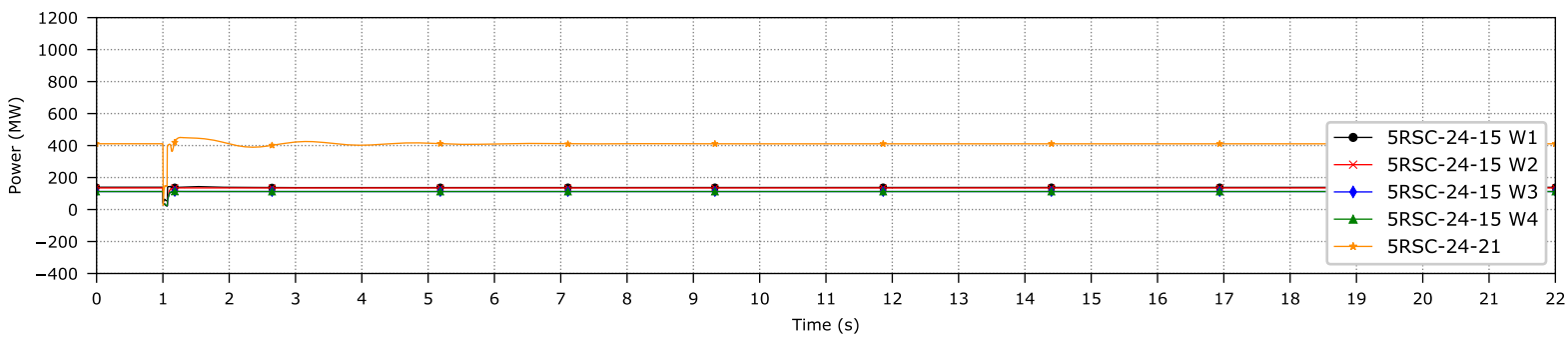


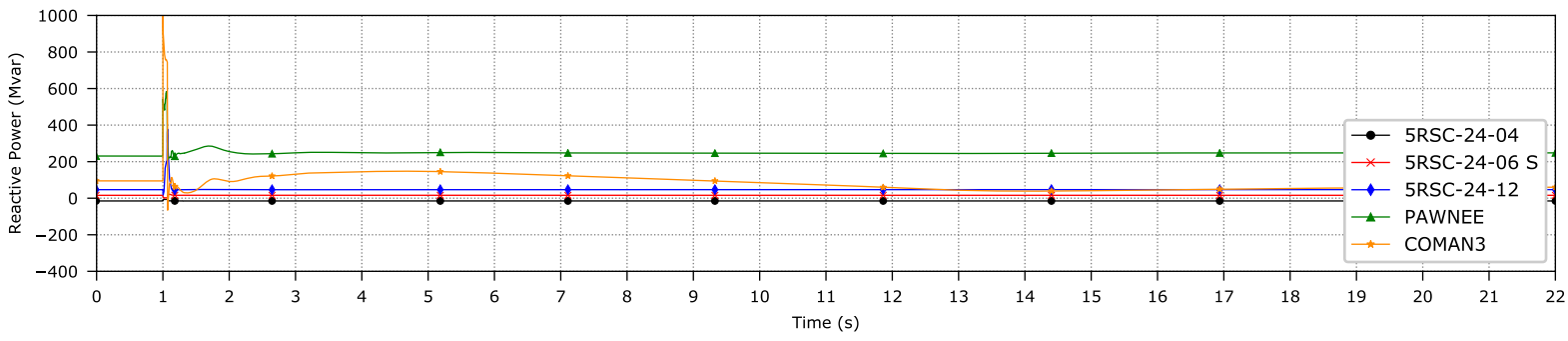


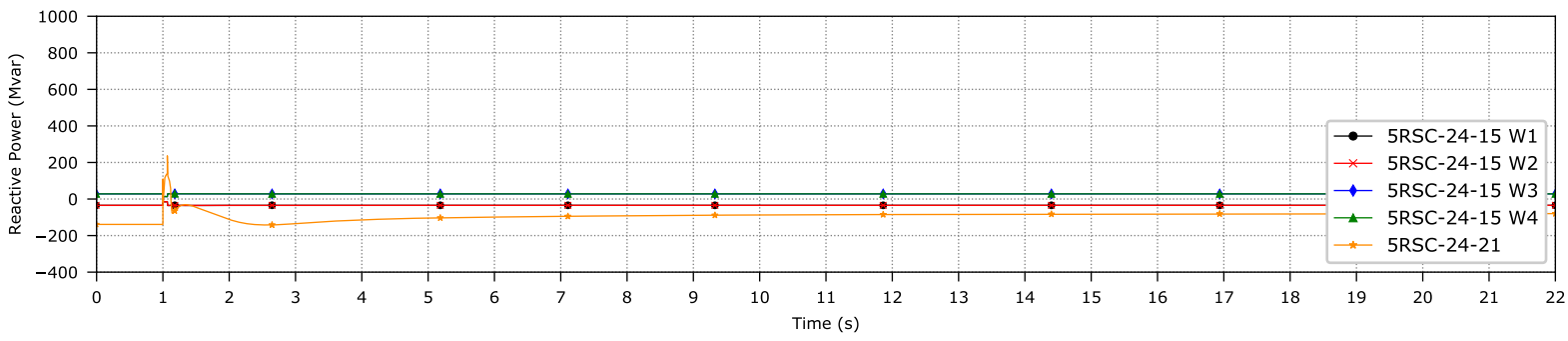
Ref. No. 26 - P7_164

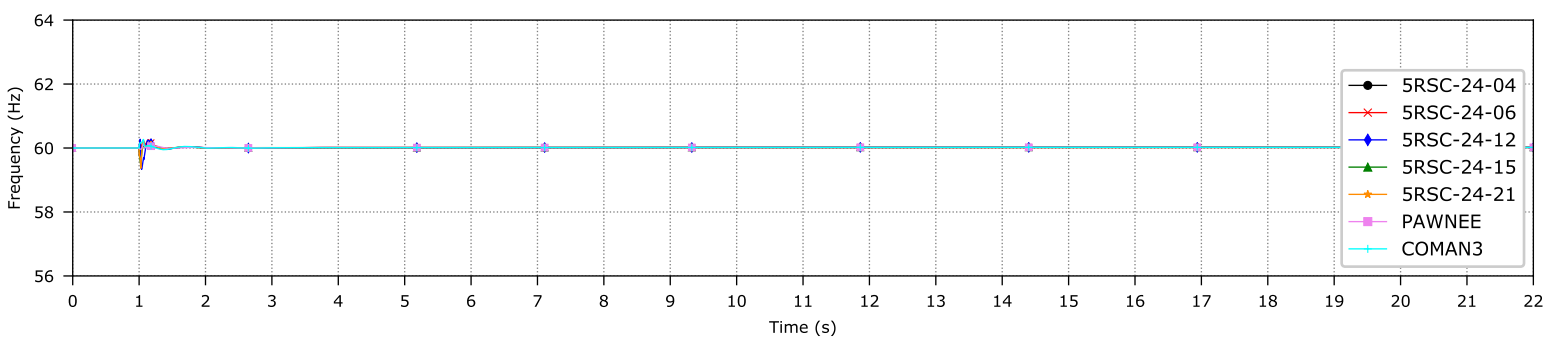


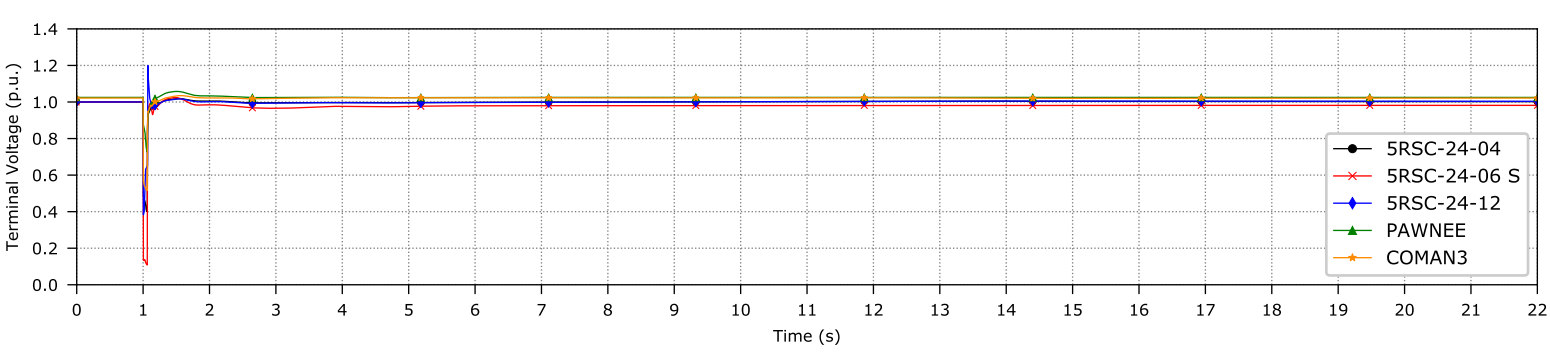


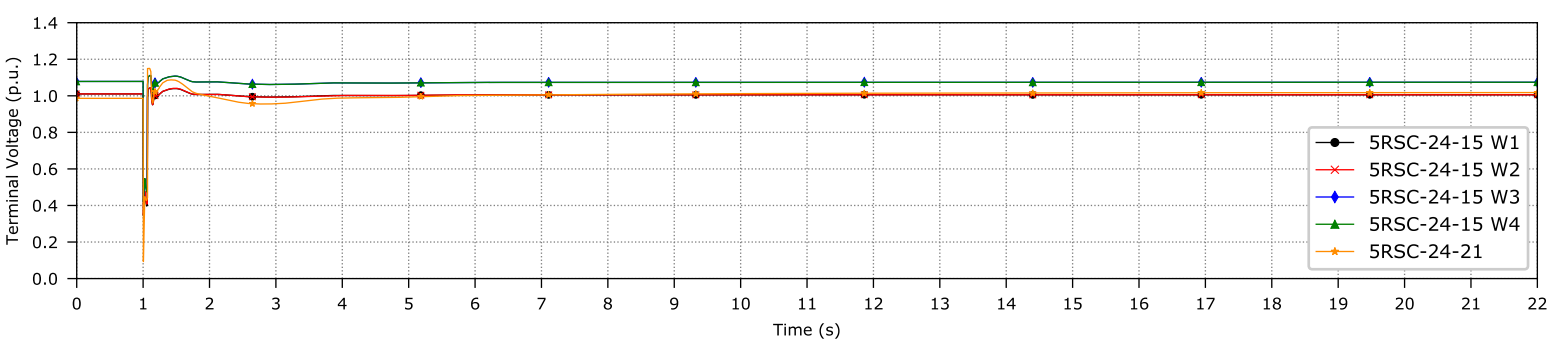


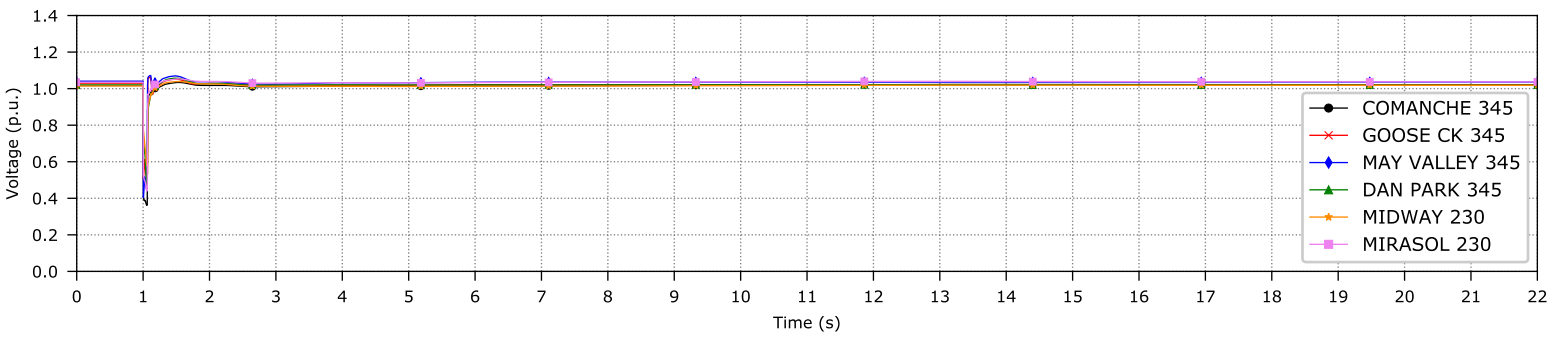












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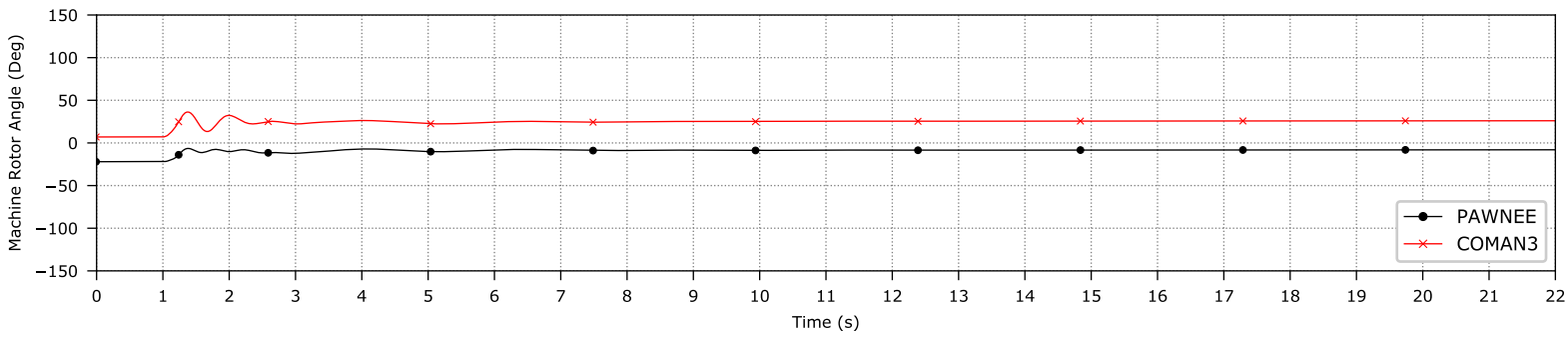
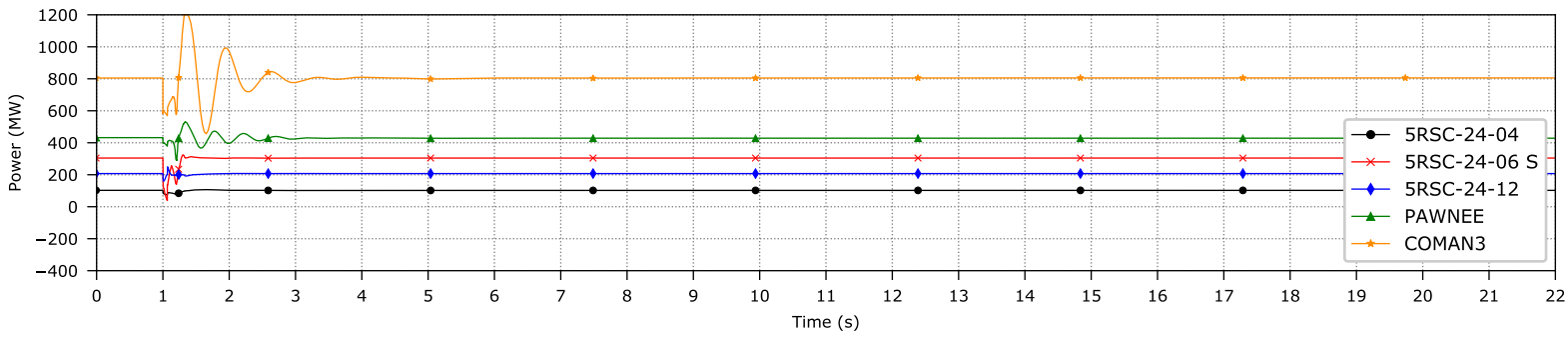
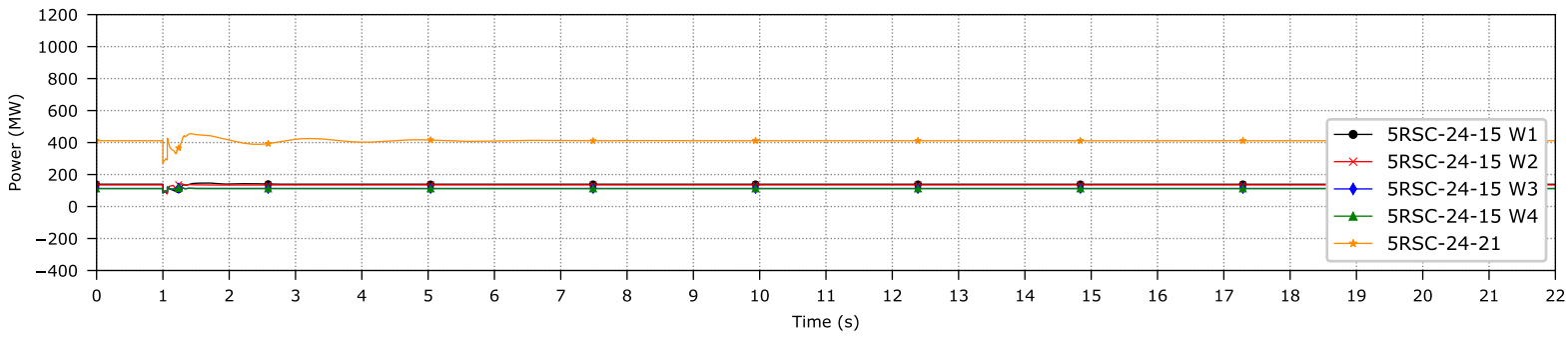
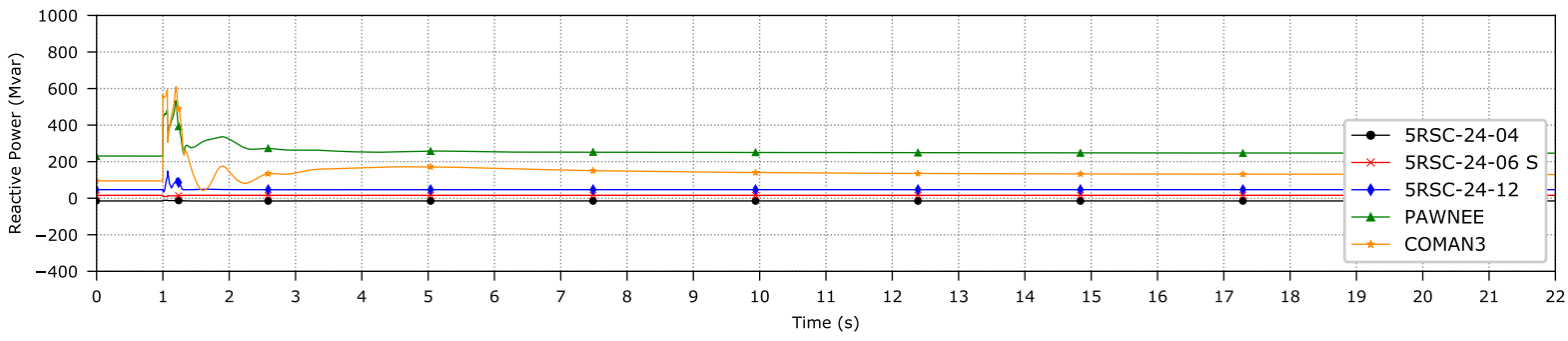
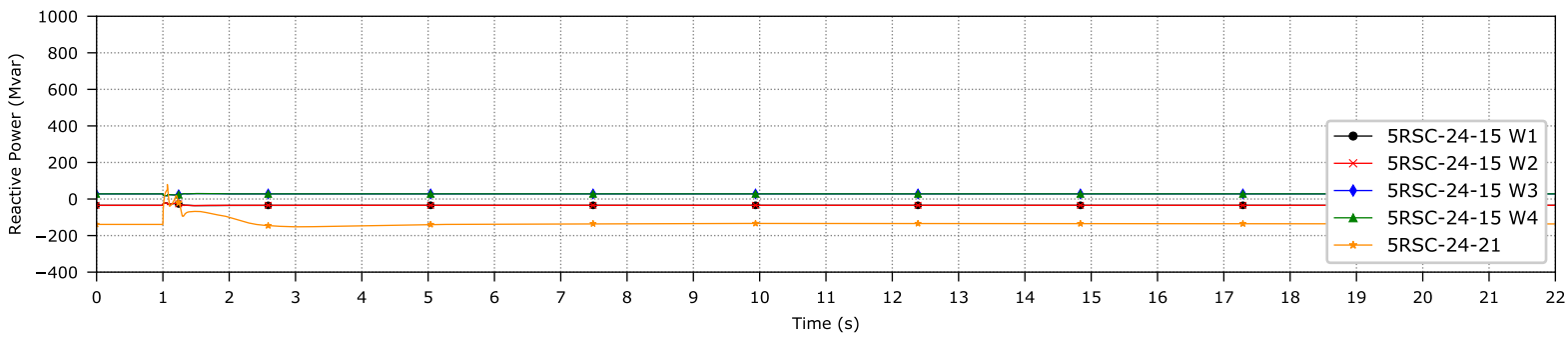
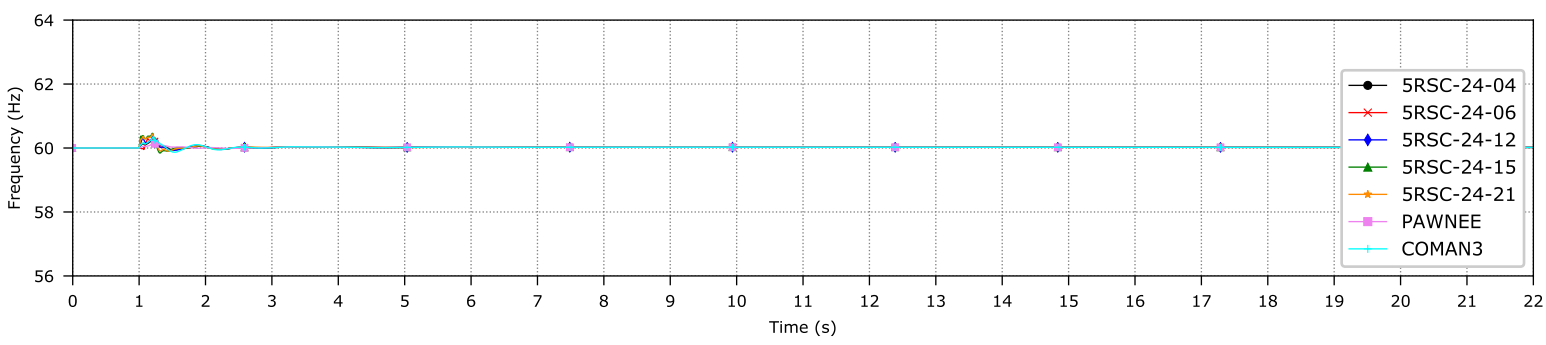


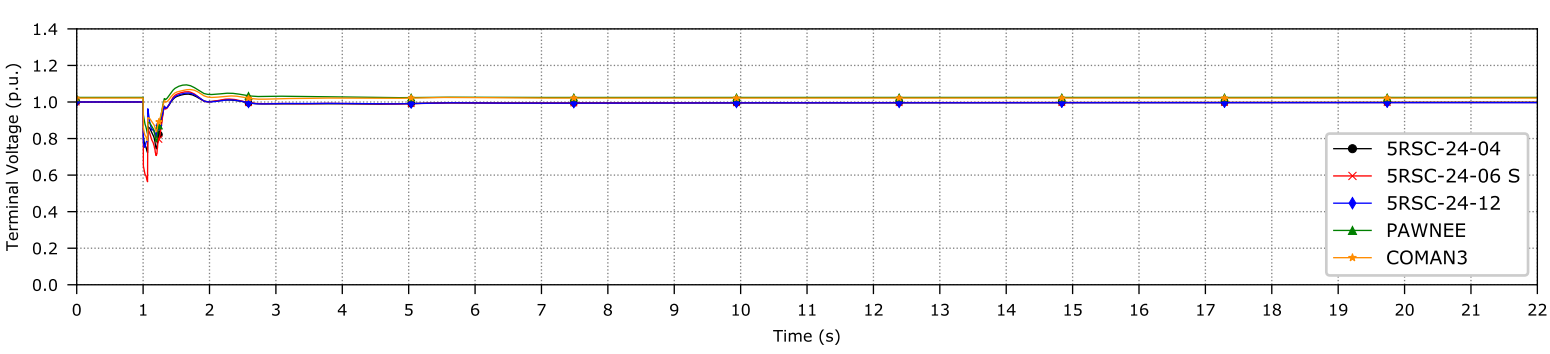


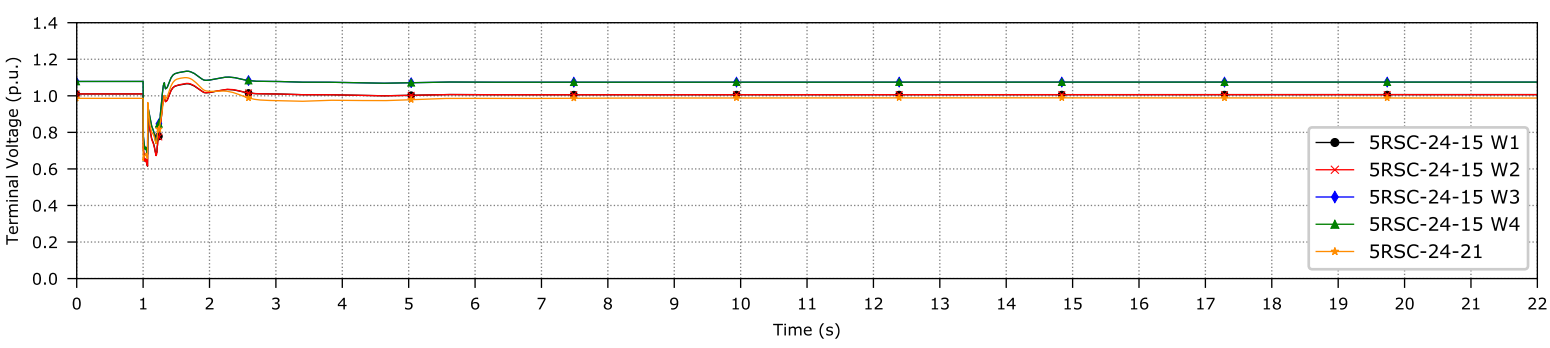


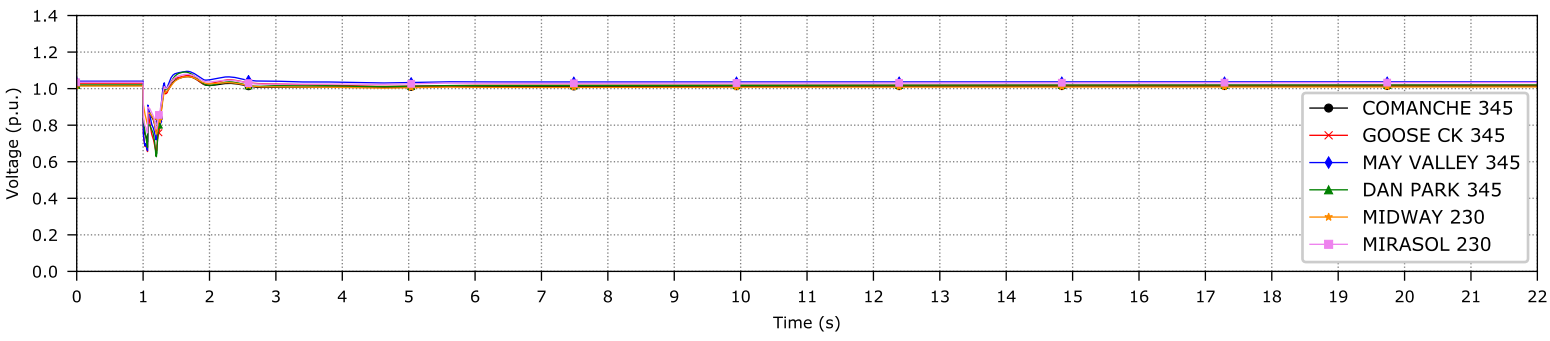






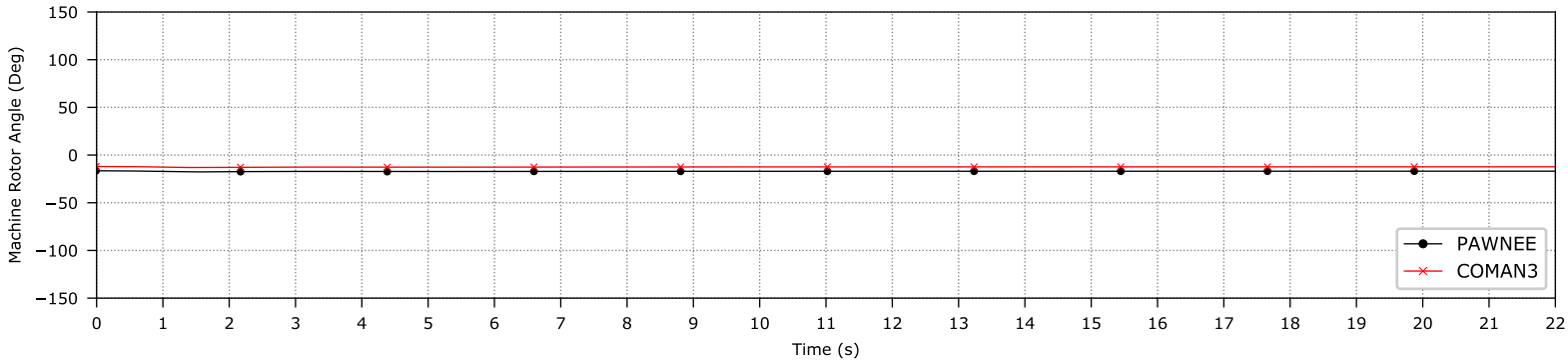


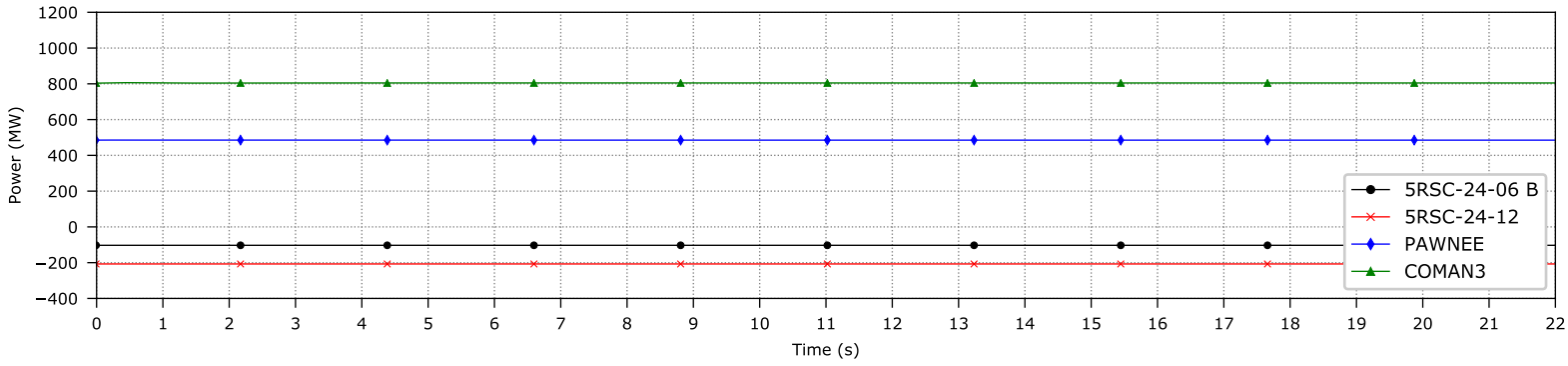


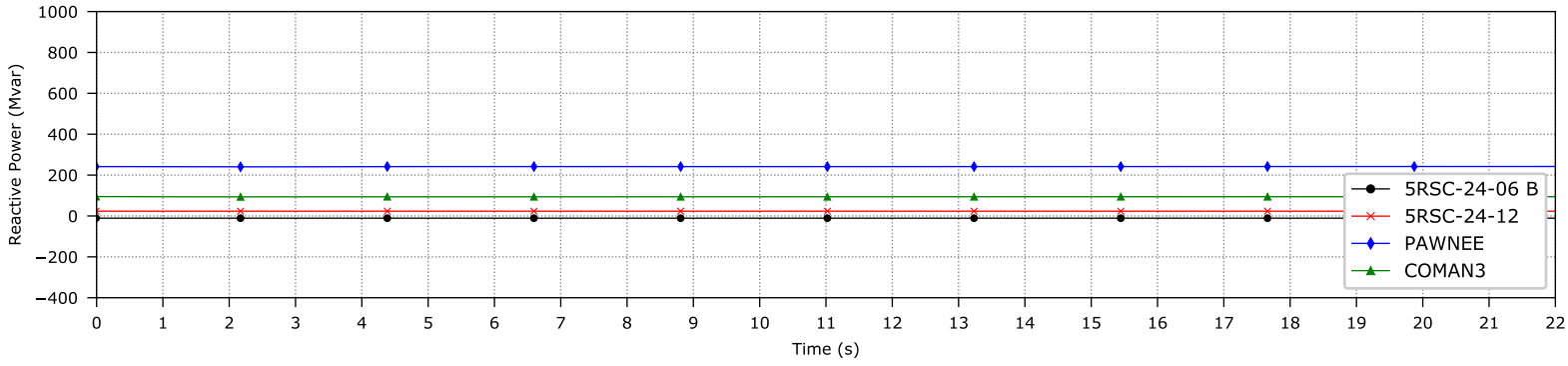


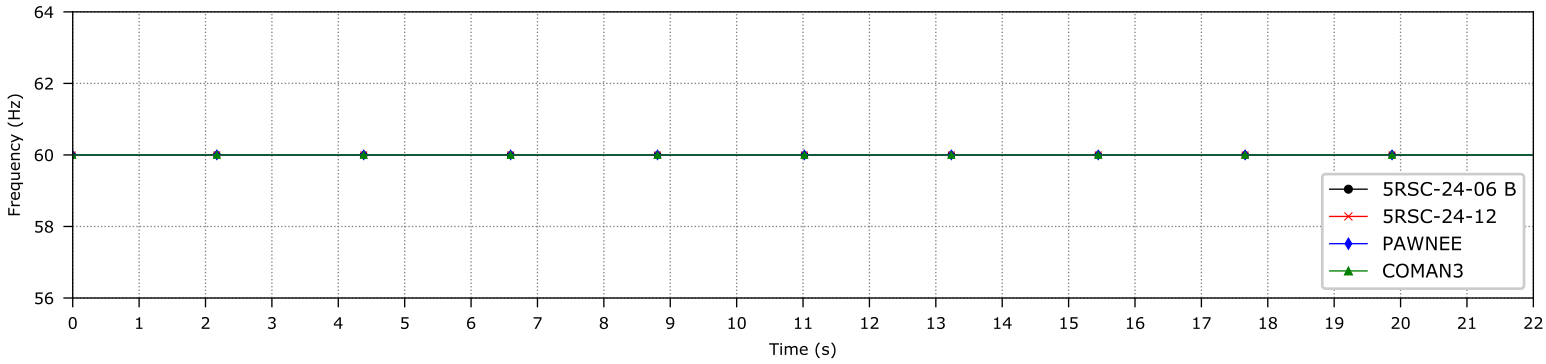
2029 SOUTH GRID CHARGING – TRANSIENT STABILITY PLOTS

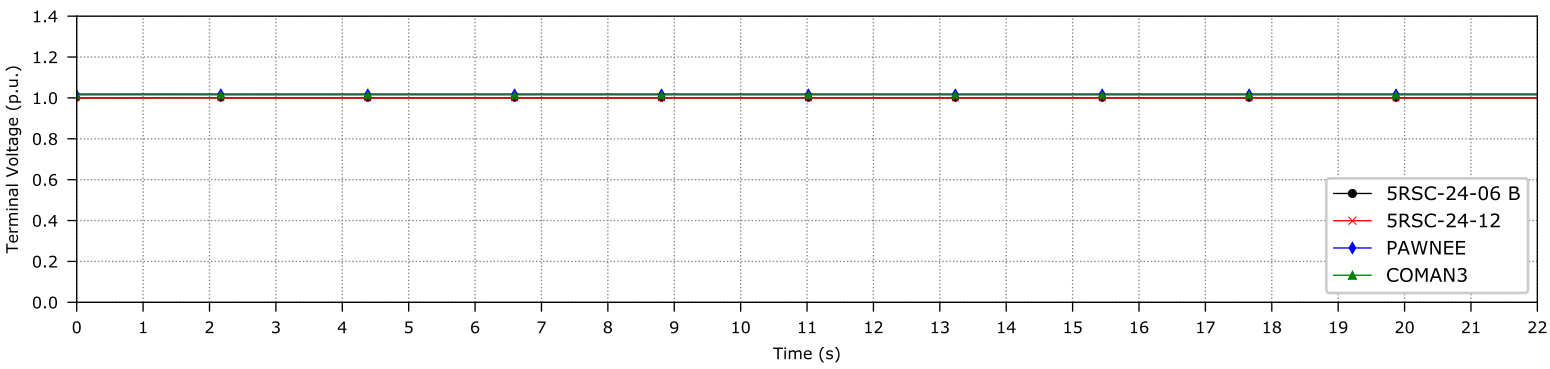
Ref. No. 01 - Flatrun

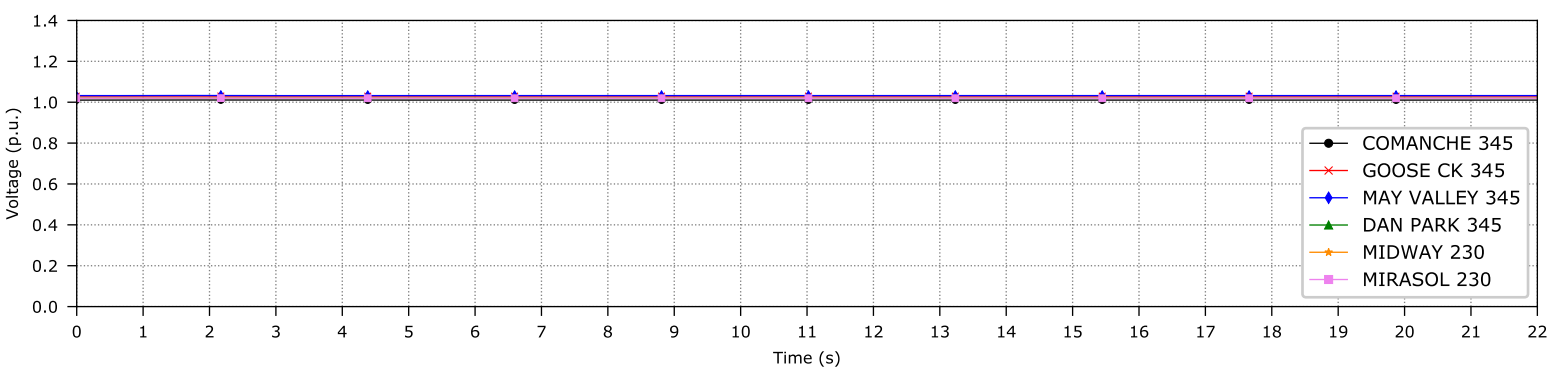


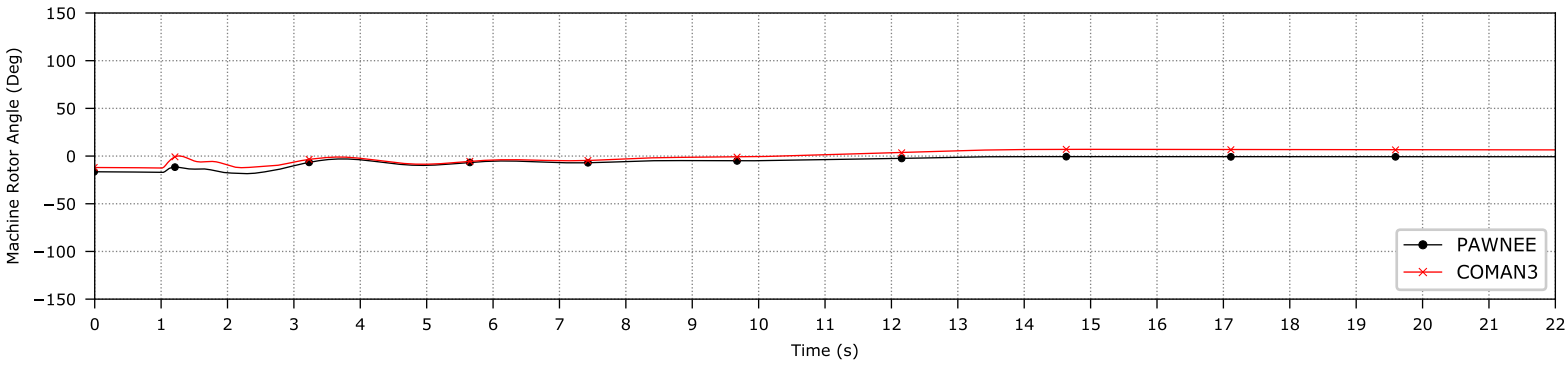


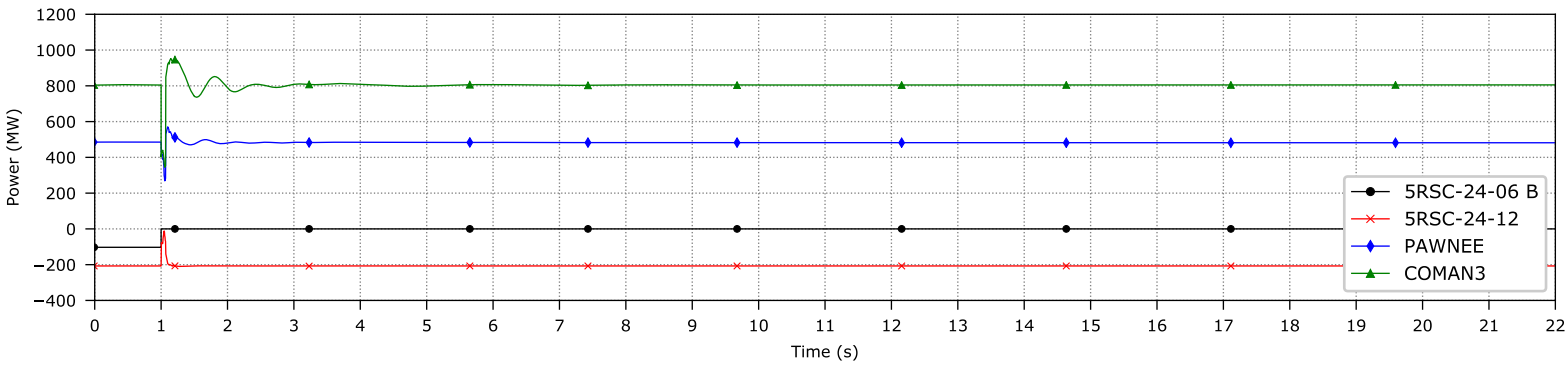


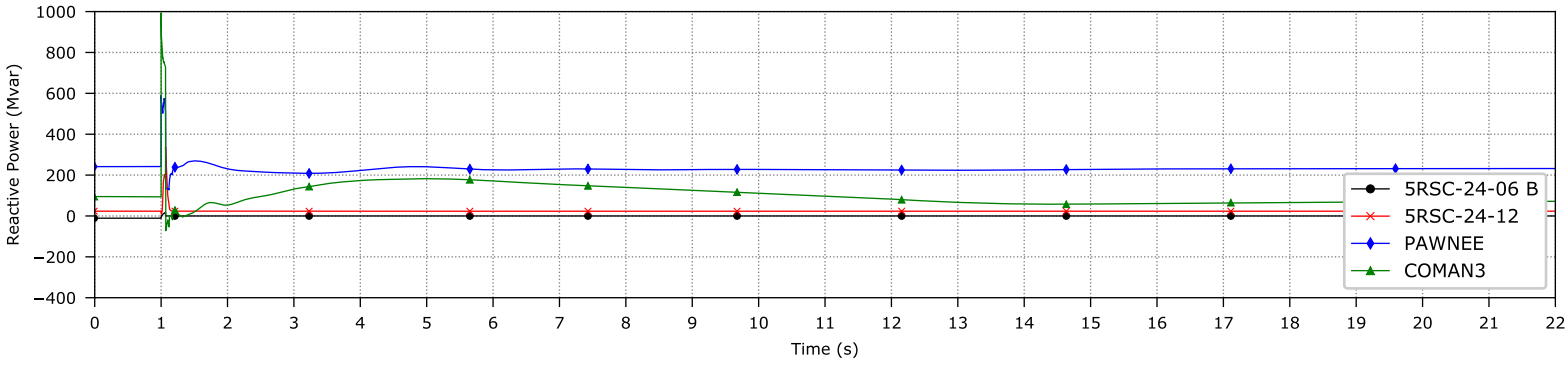


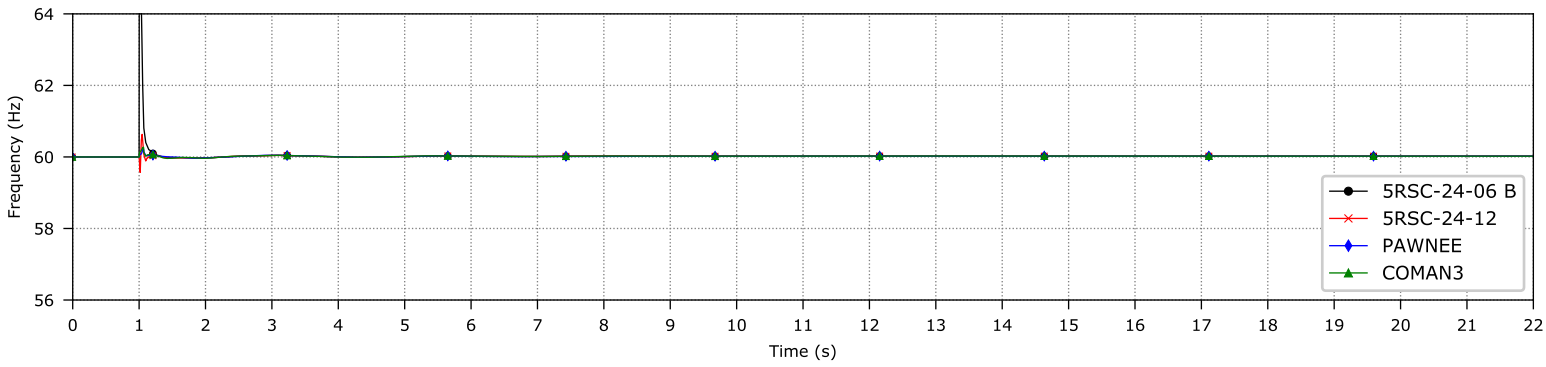


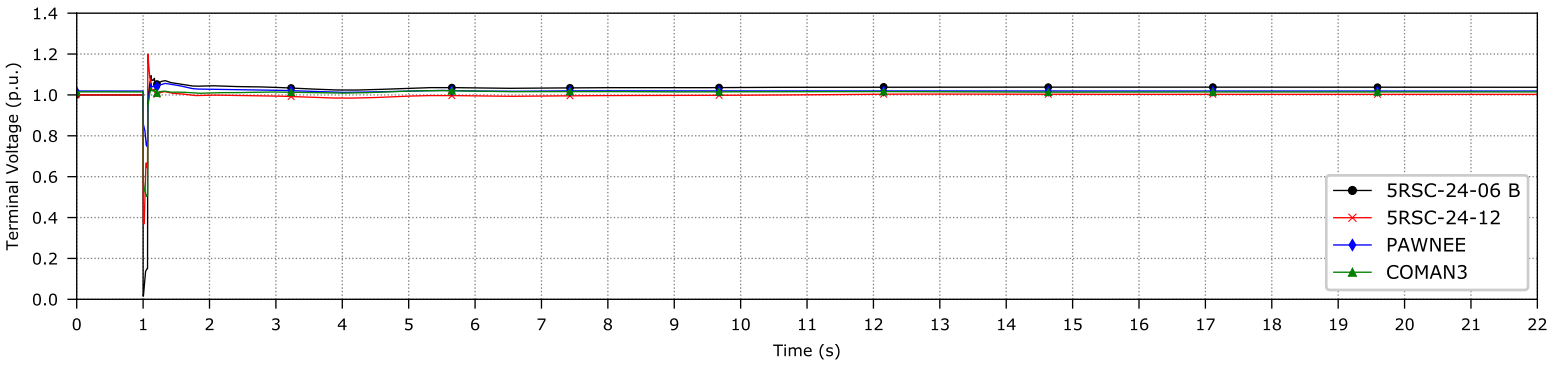


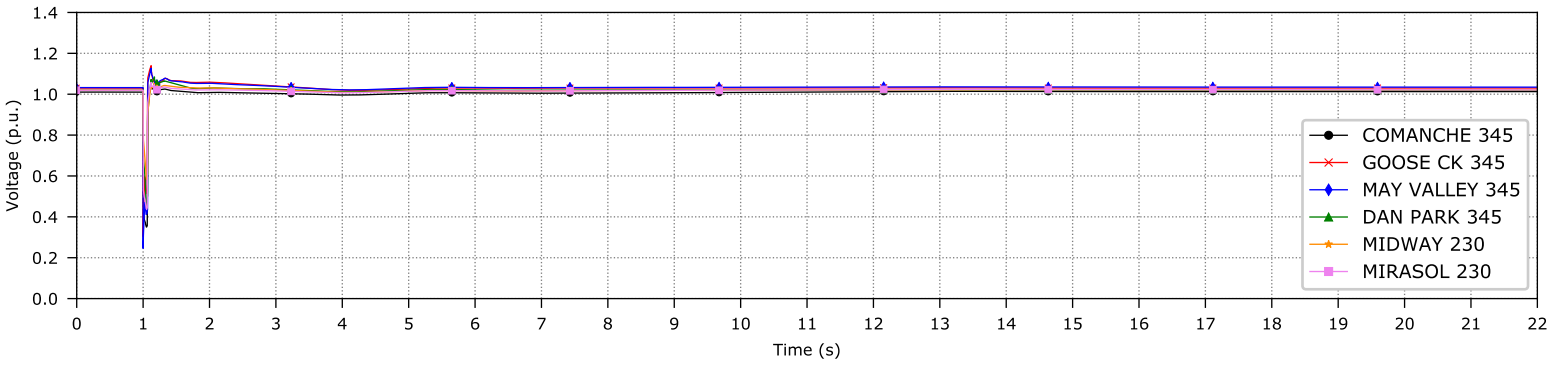

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3

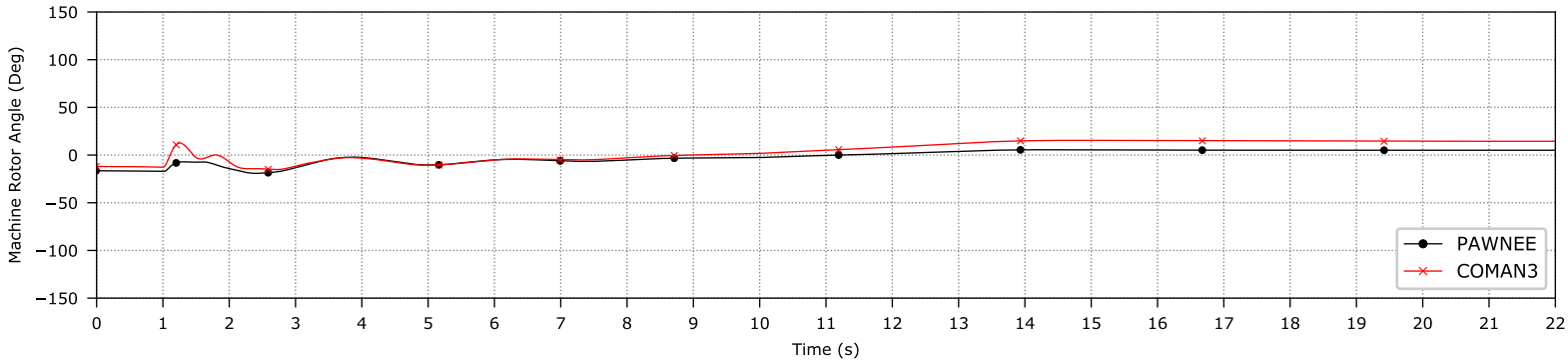

Power (MW)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

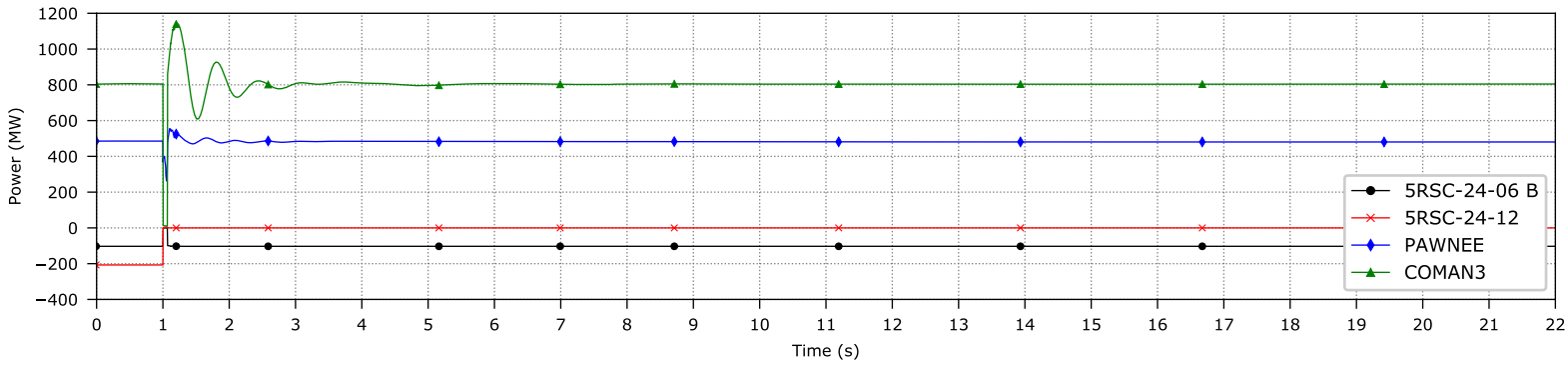

Reactive Power (Mvar)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

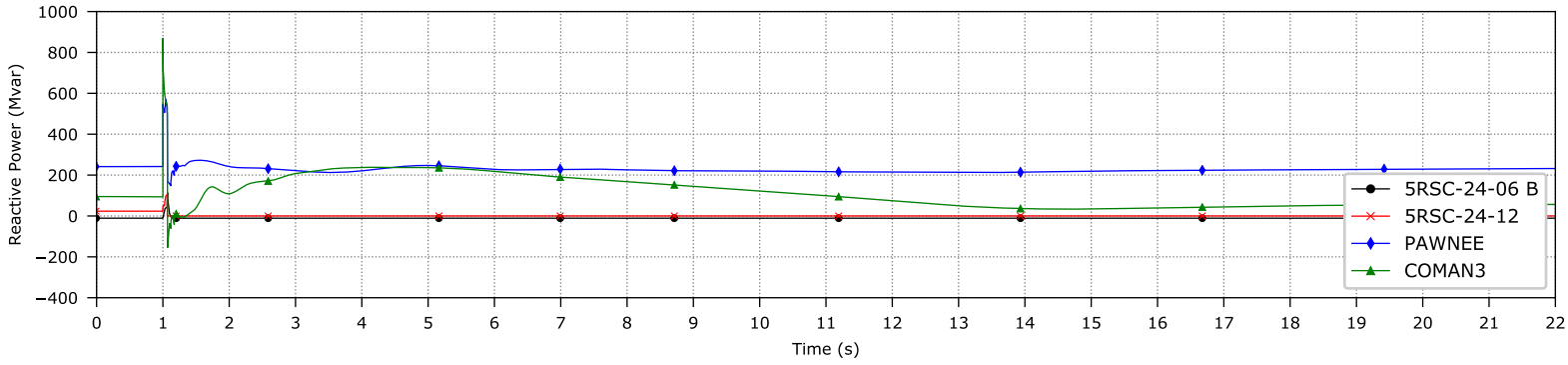

Frequency (Hz)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

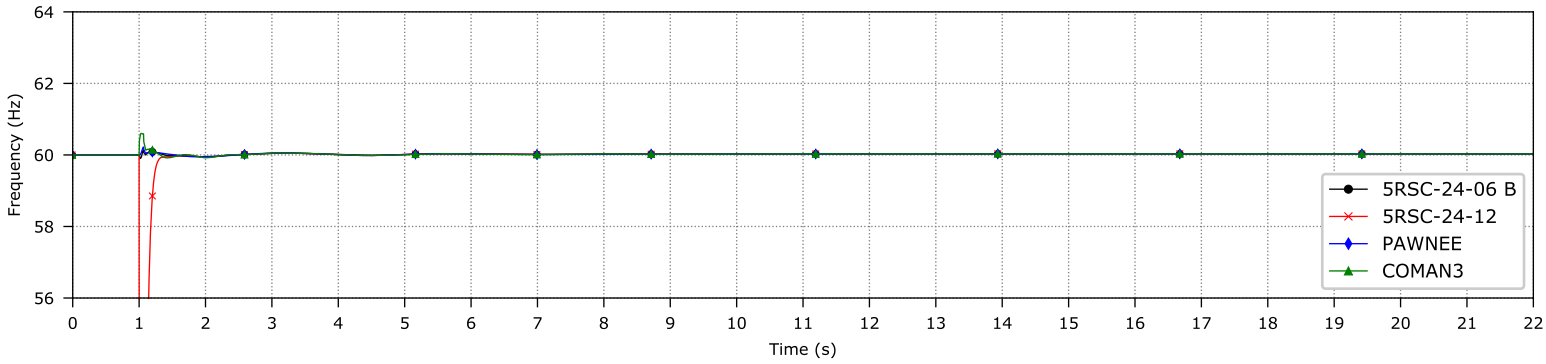

Terminal Voltage (p.u.)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

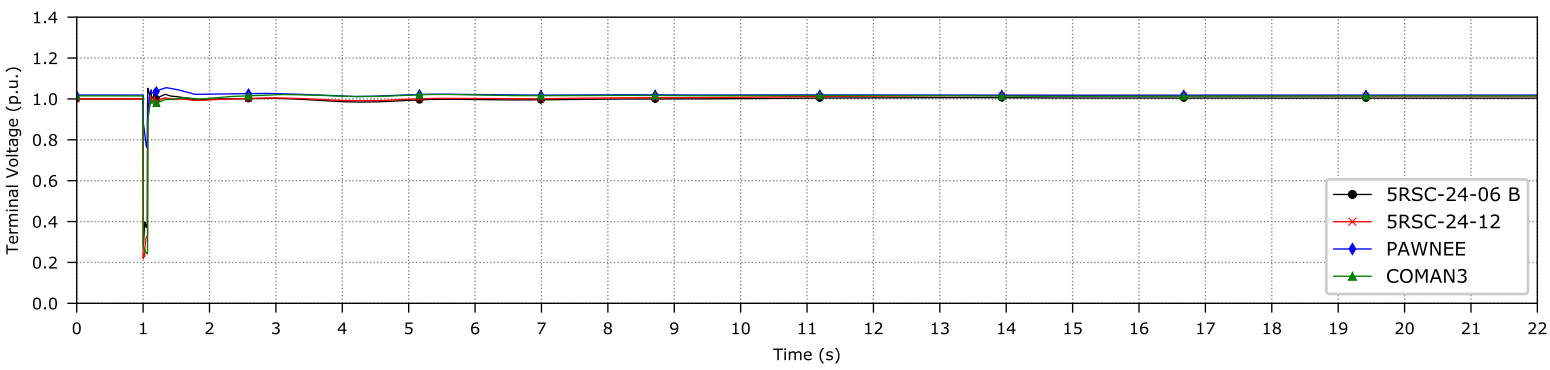

Voltage (p.u.)
Time (s)
COMANCHE 345
GOOSE CK 345
MAY VALLEY 345
DAN PARK 345
MIDWAY 230
MIRASOL 230

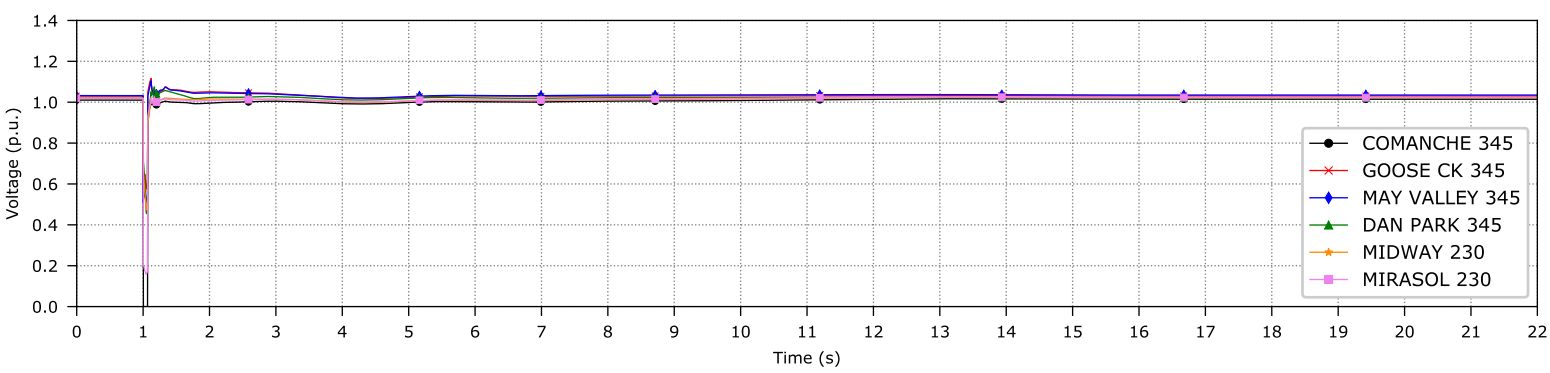

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

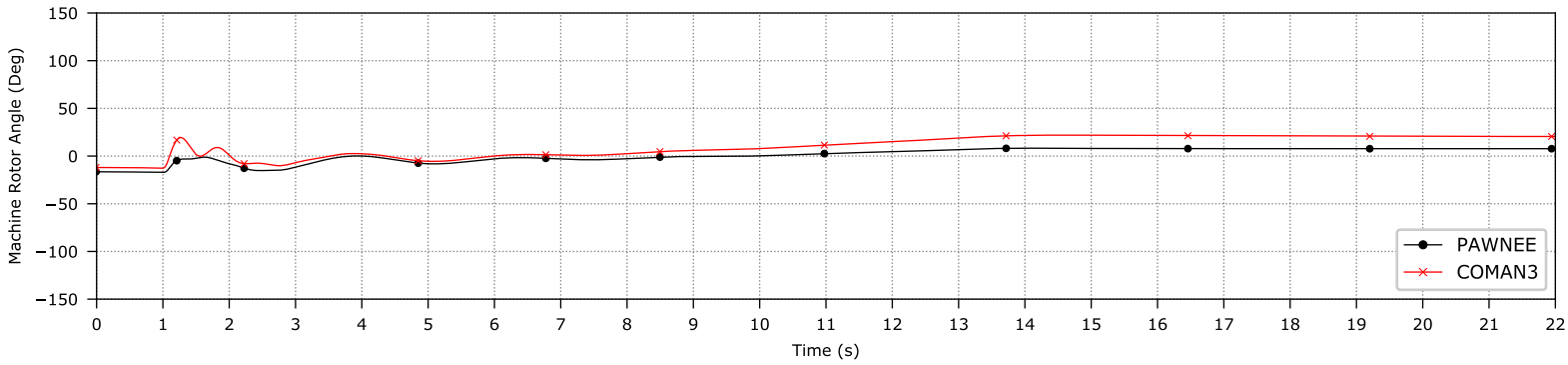

Reactive Power (Mvar)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

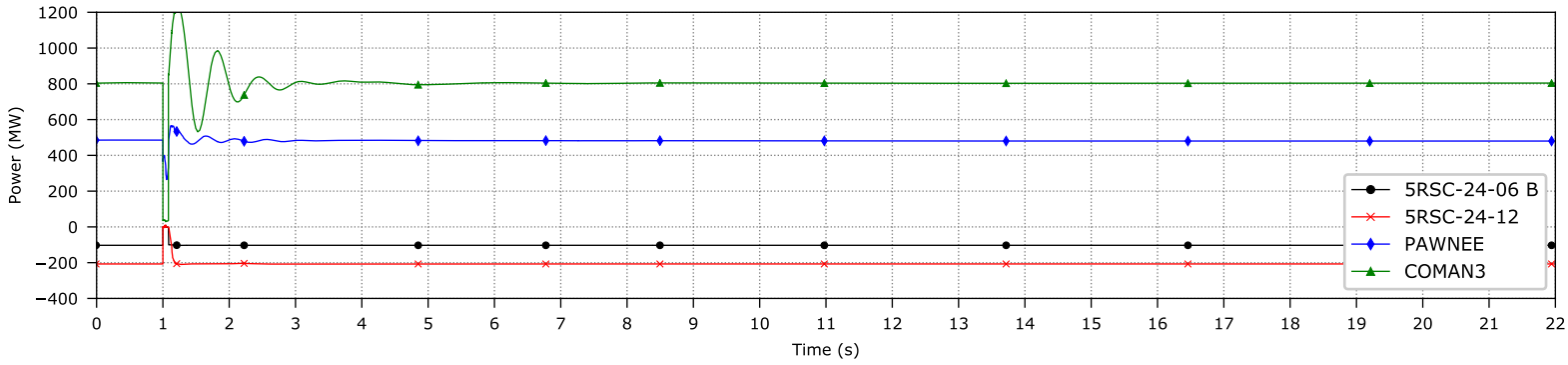

Frequency (Hz)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

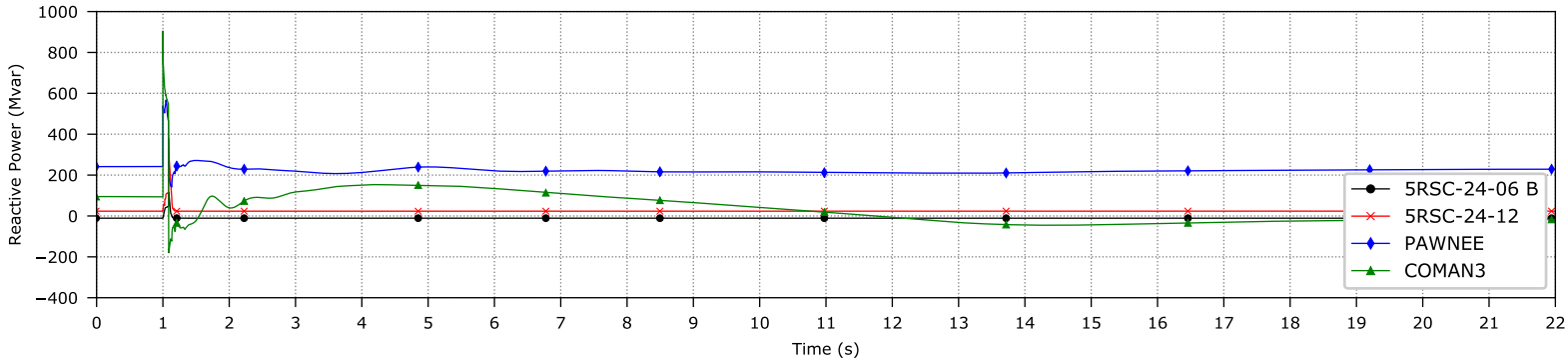

Terminal Voltage (p.u.)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

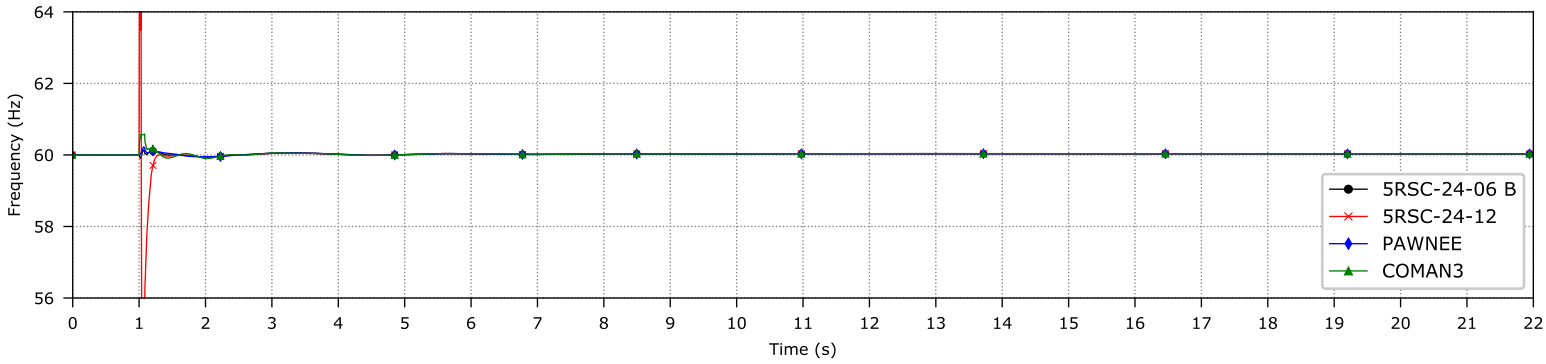

Voltage (p.u.)
Time (s)
COMANCHE 345
GOOSE CK 345
MAY VALLEY 345
DAN PARK 345
MIDWAY 230
MIRASOL 230

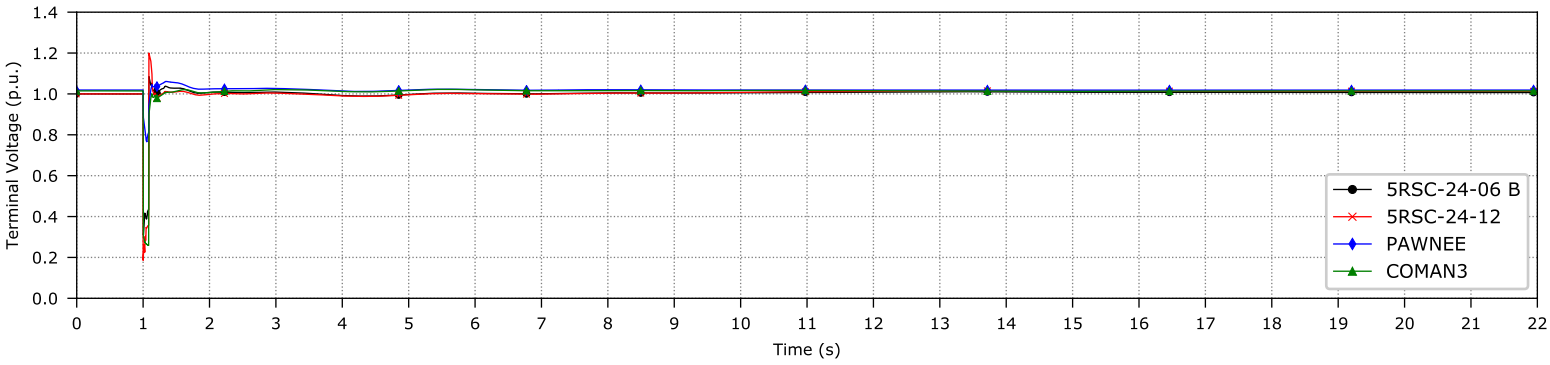
Ref. No. 07 - LoTC_79

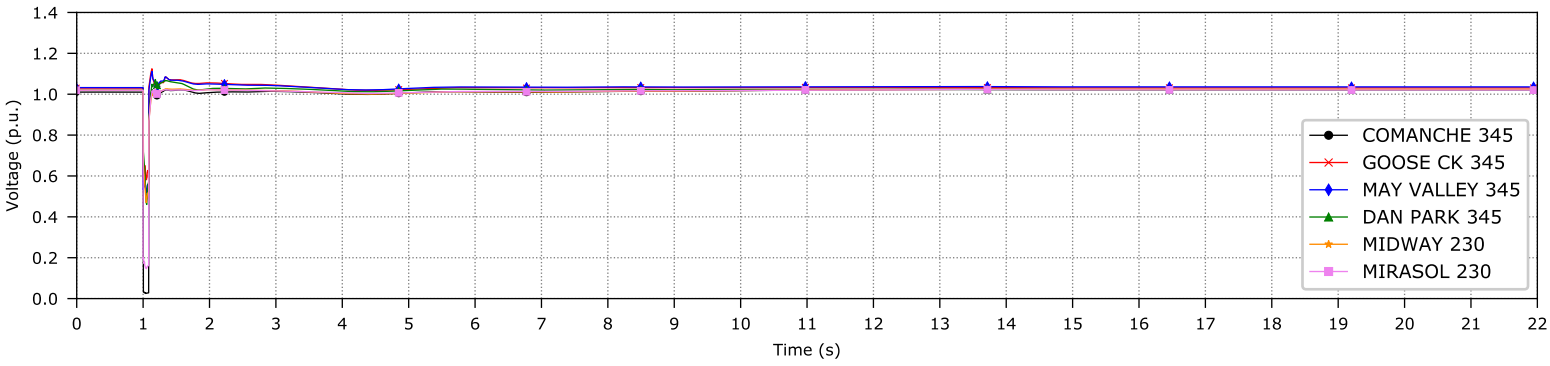




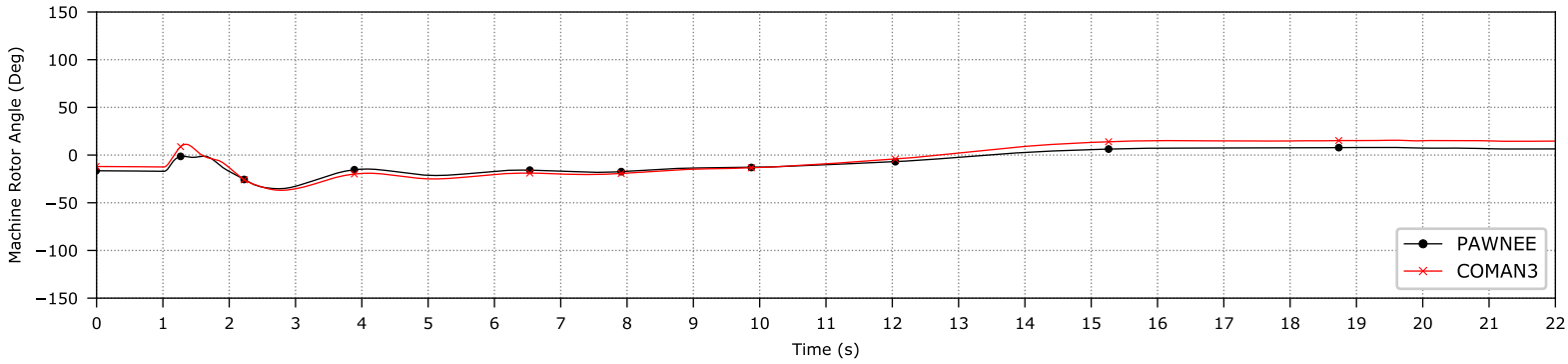


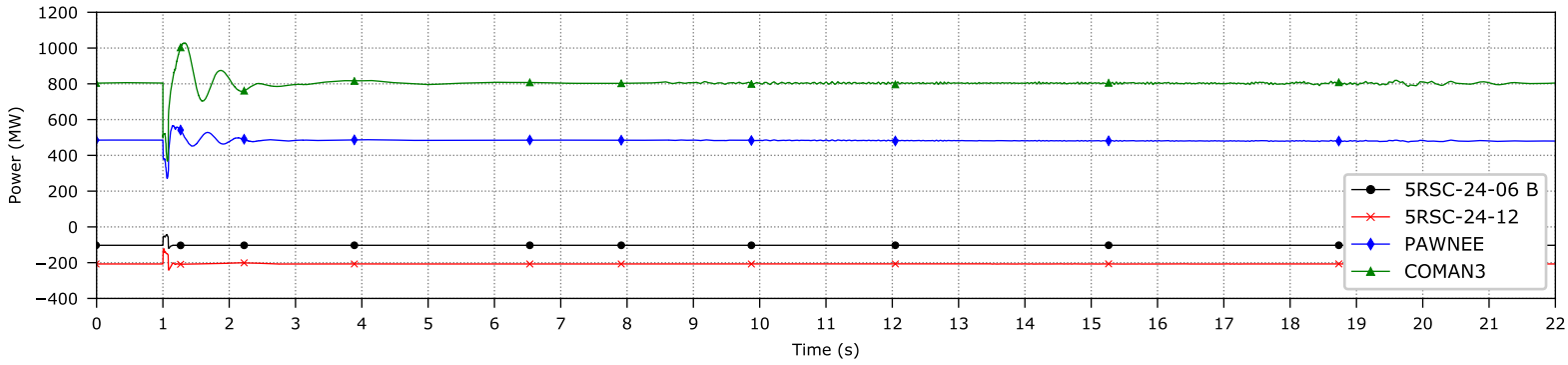


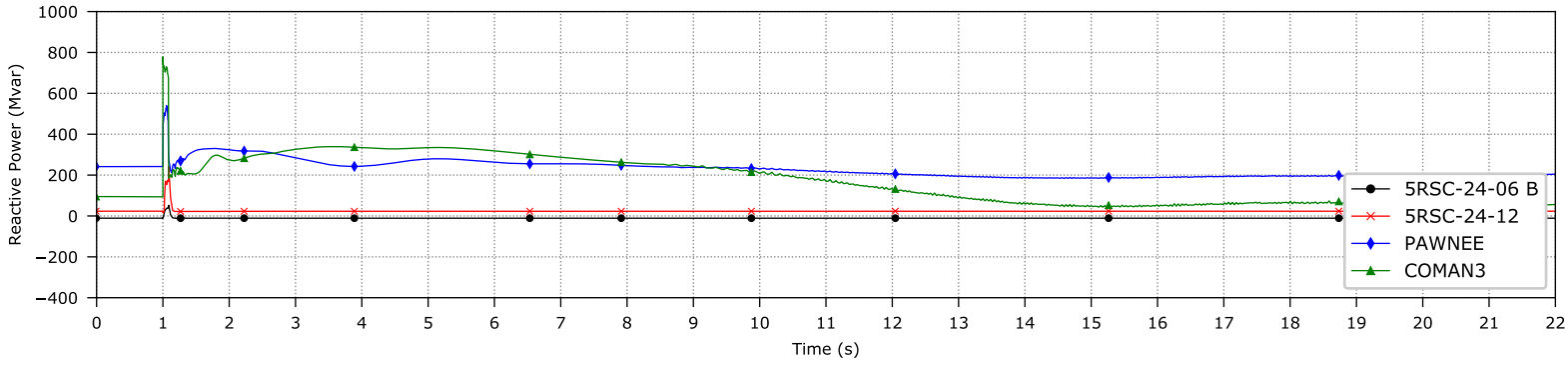


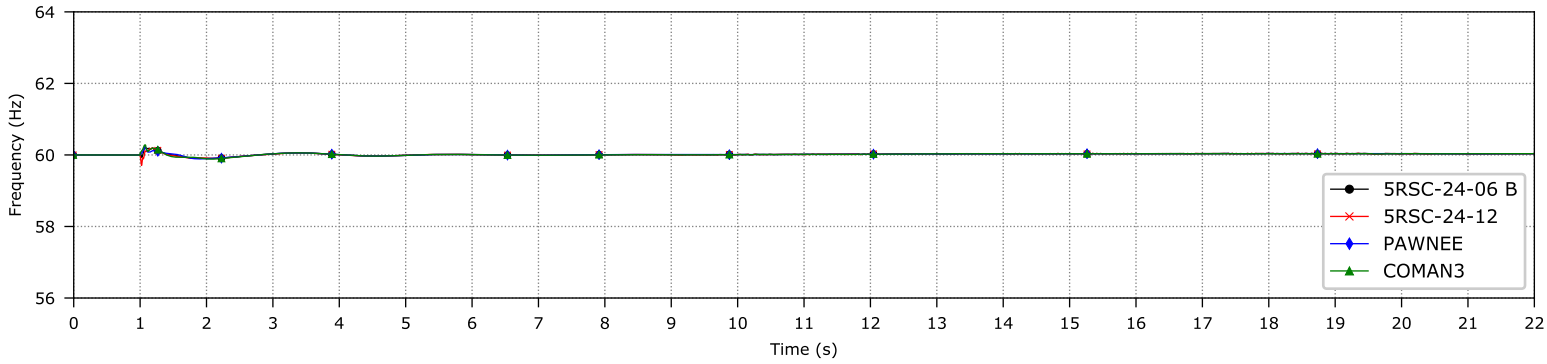


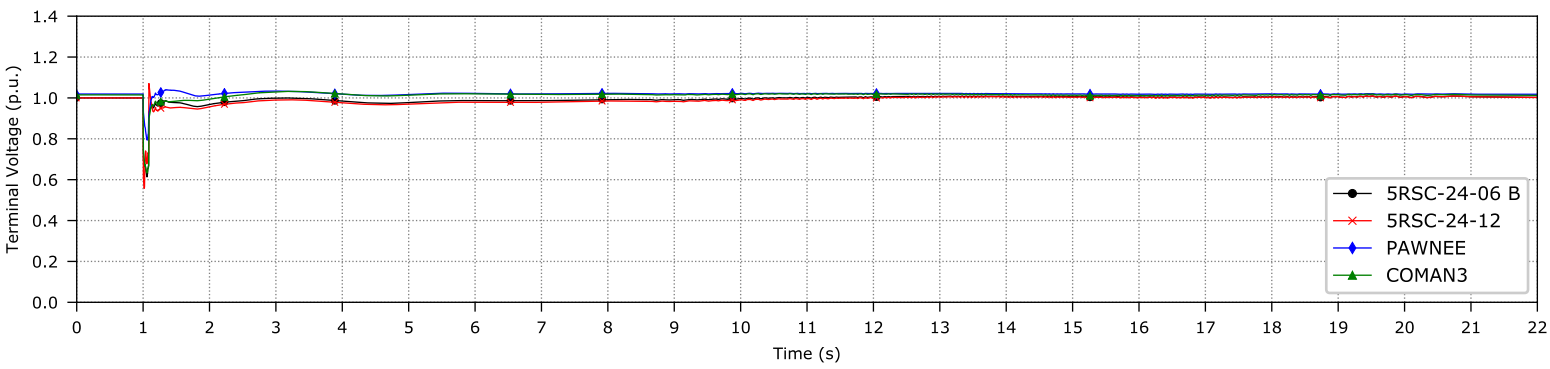
Ref. No. 08 - LoTC_102

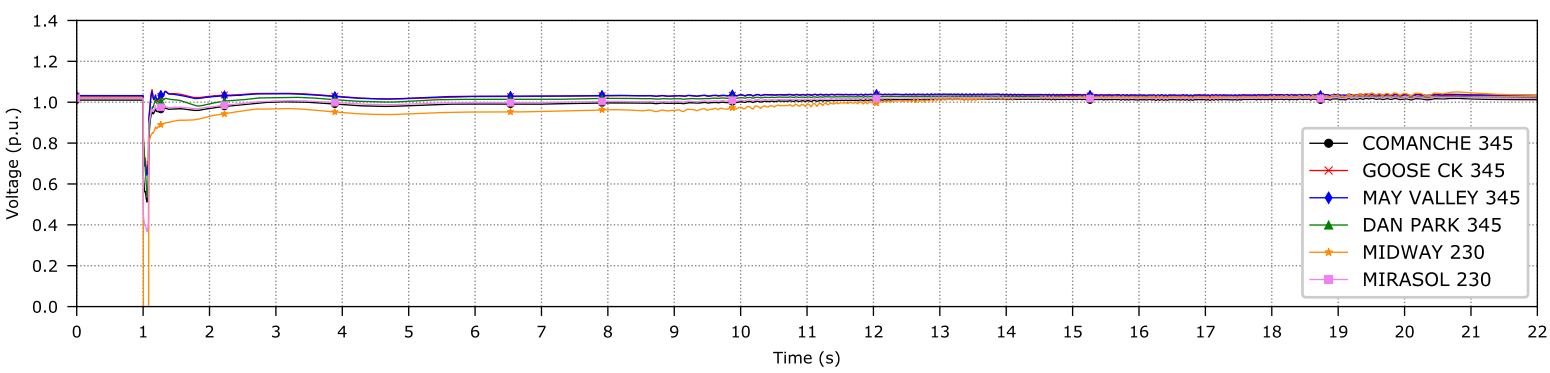




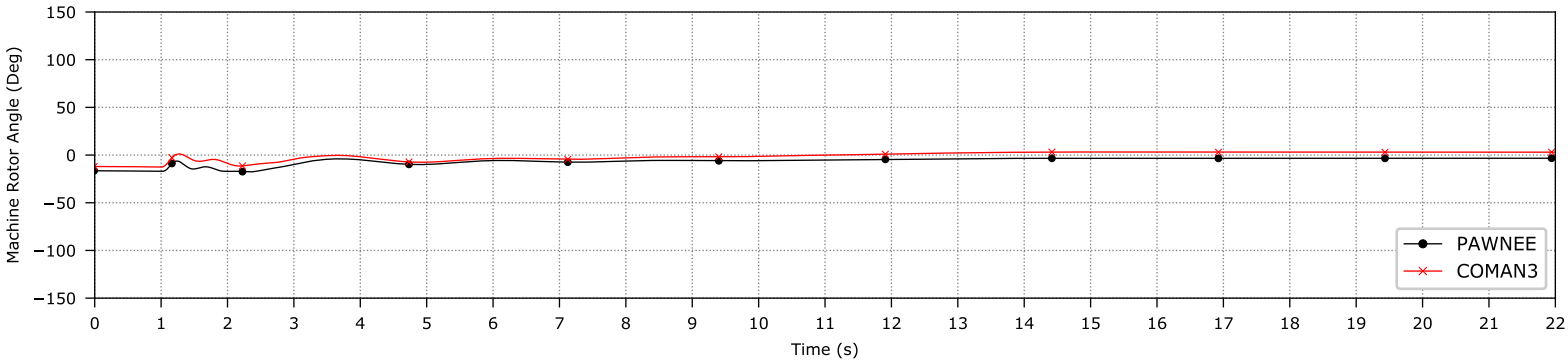


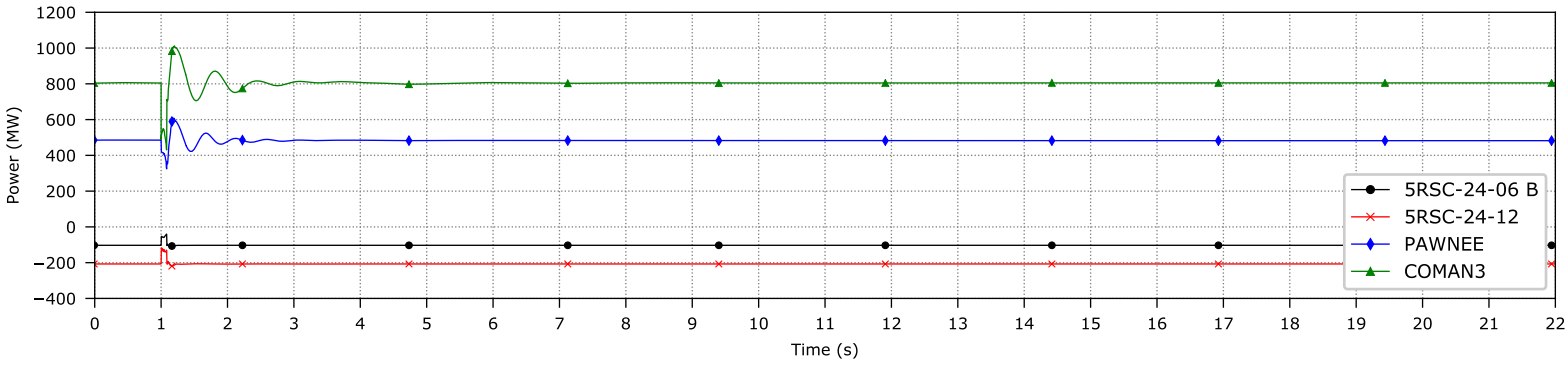


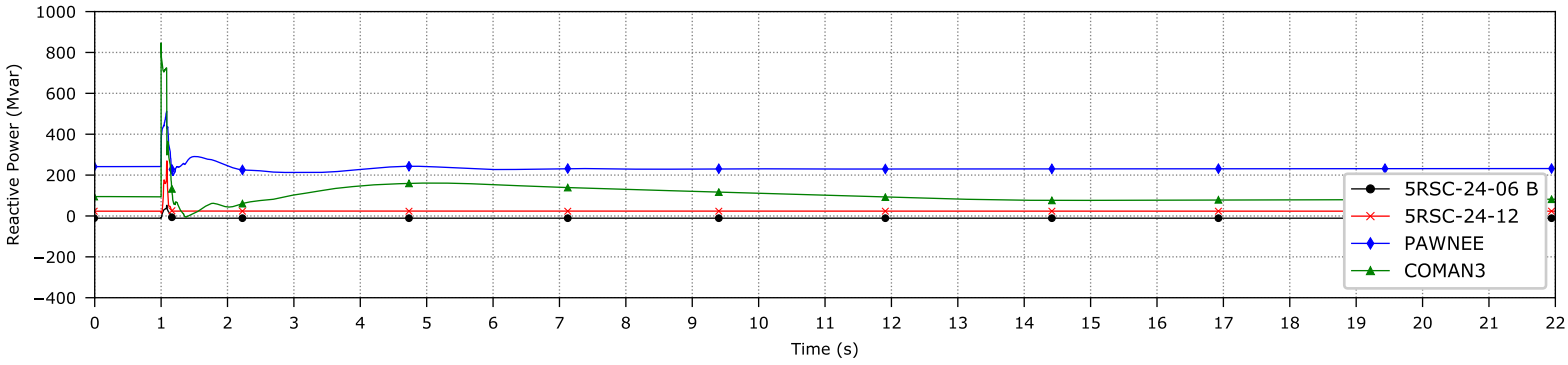


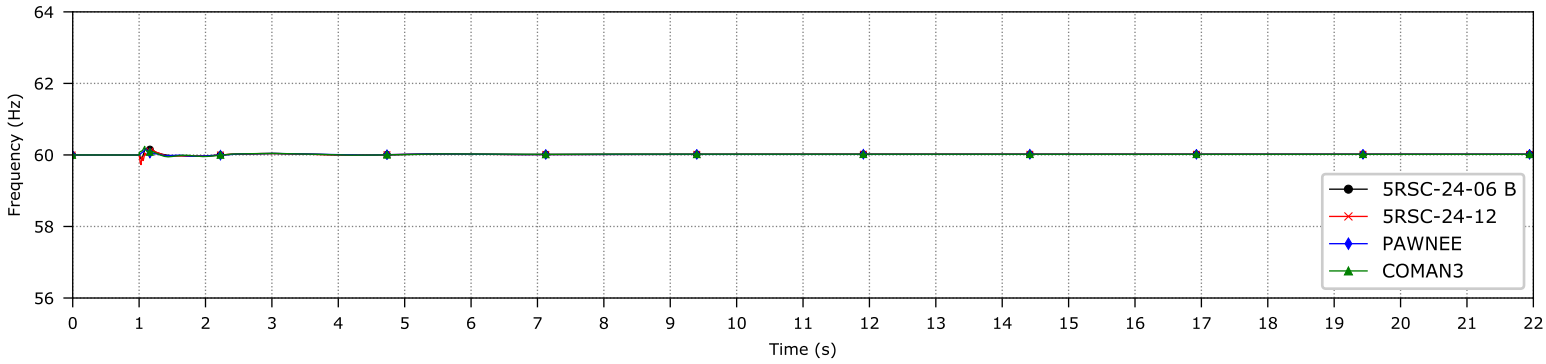


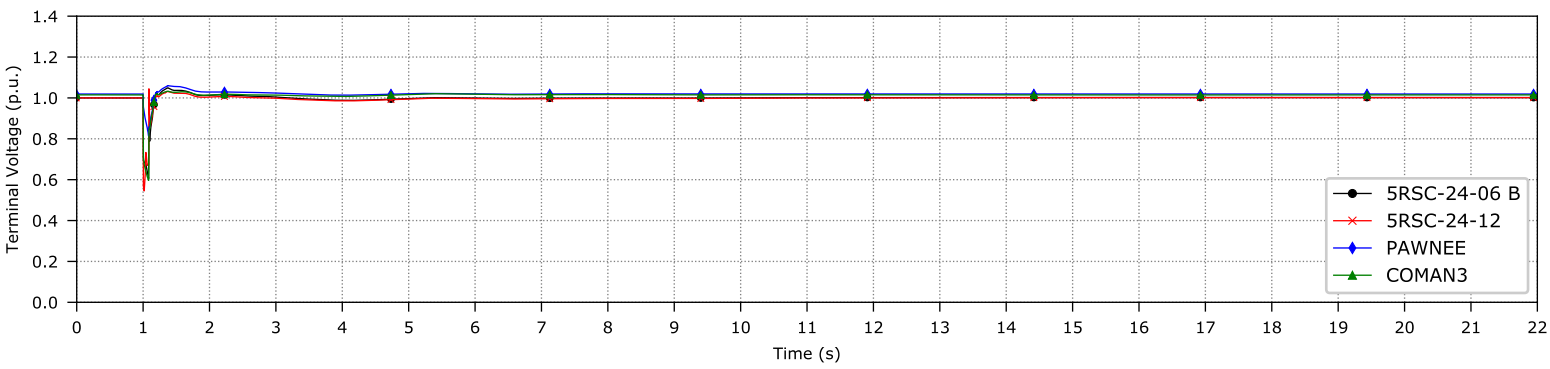
Ref. No. 09 - LoTC_103

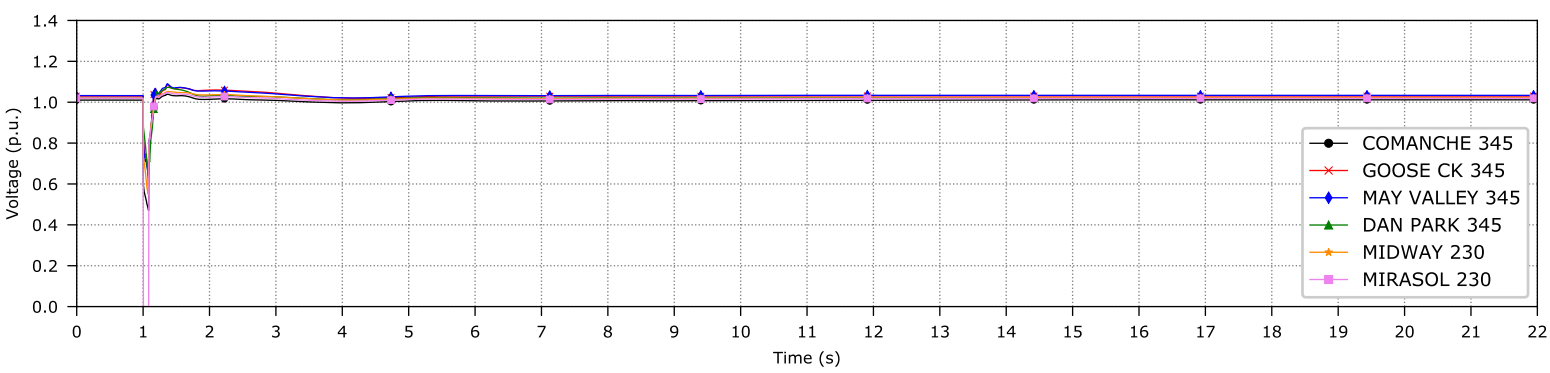




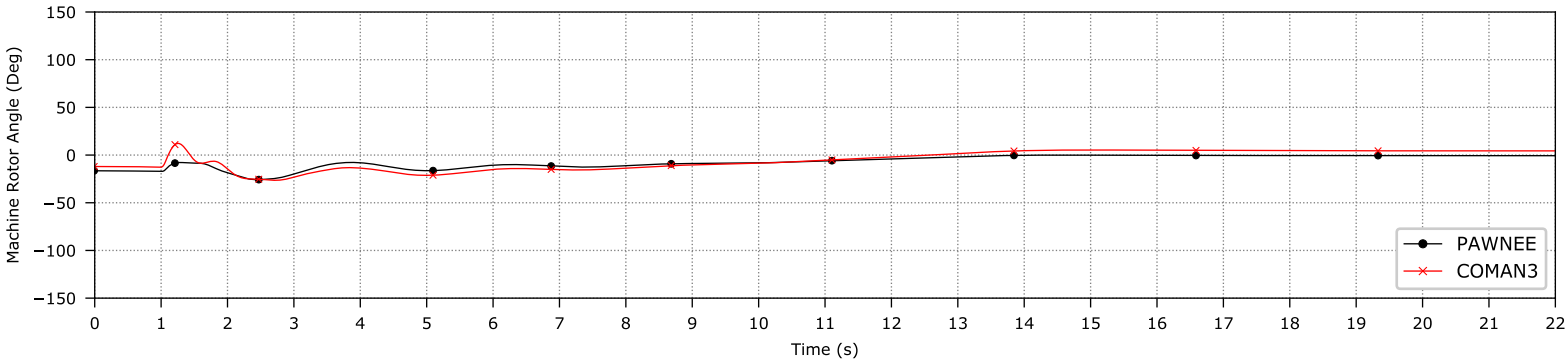


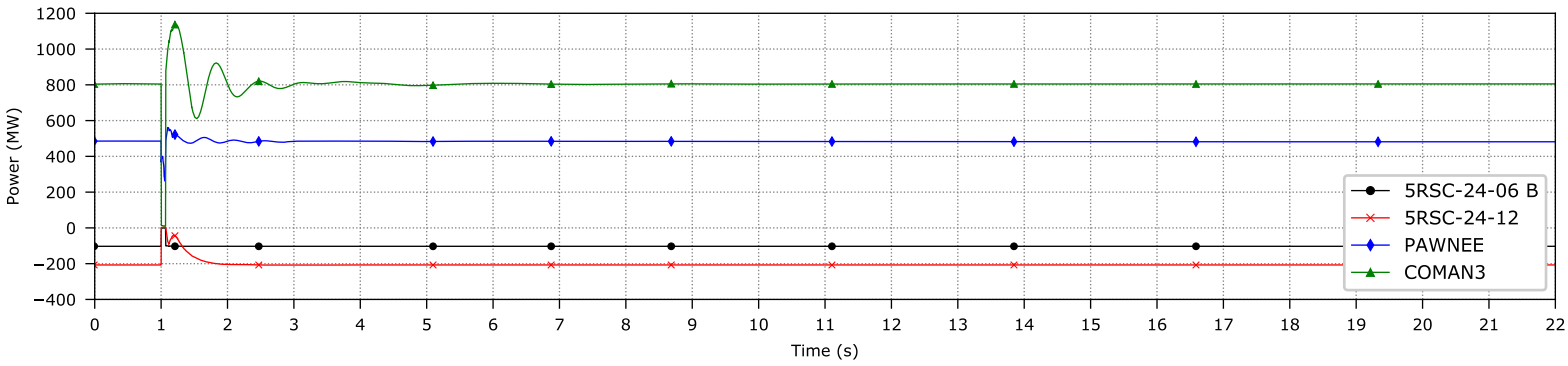


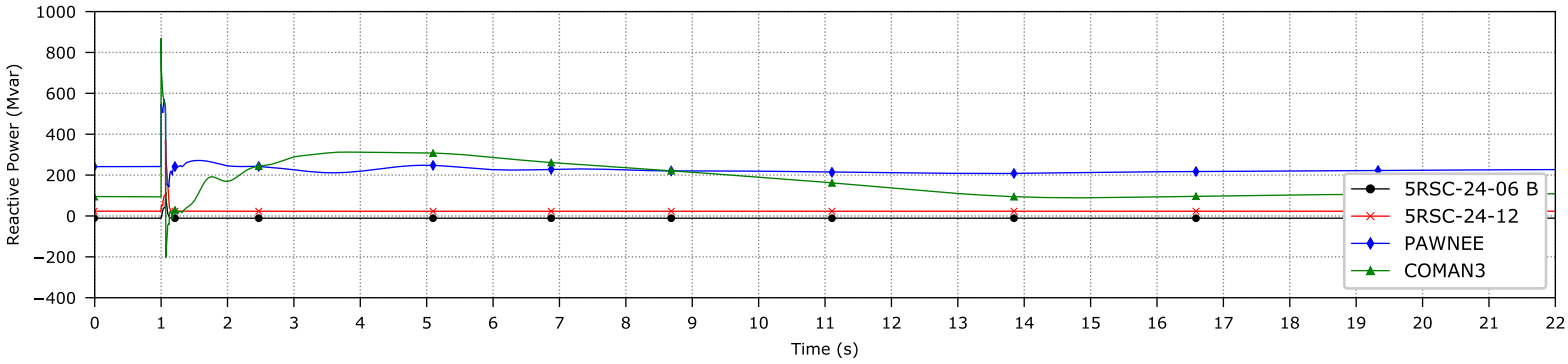


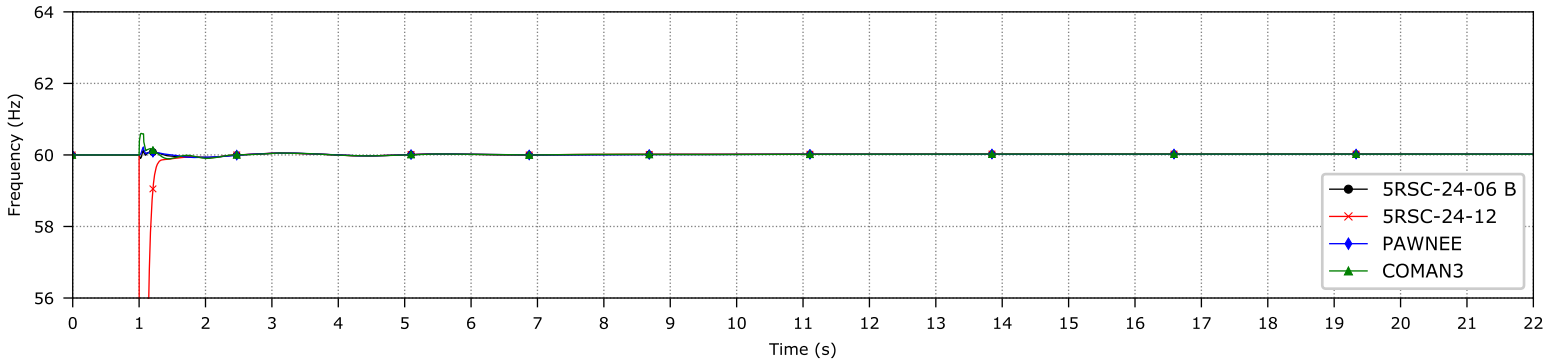


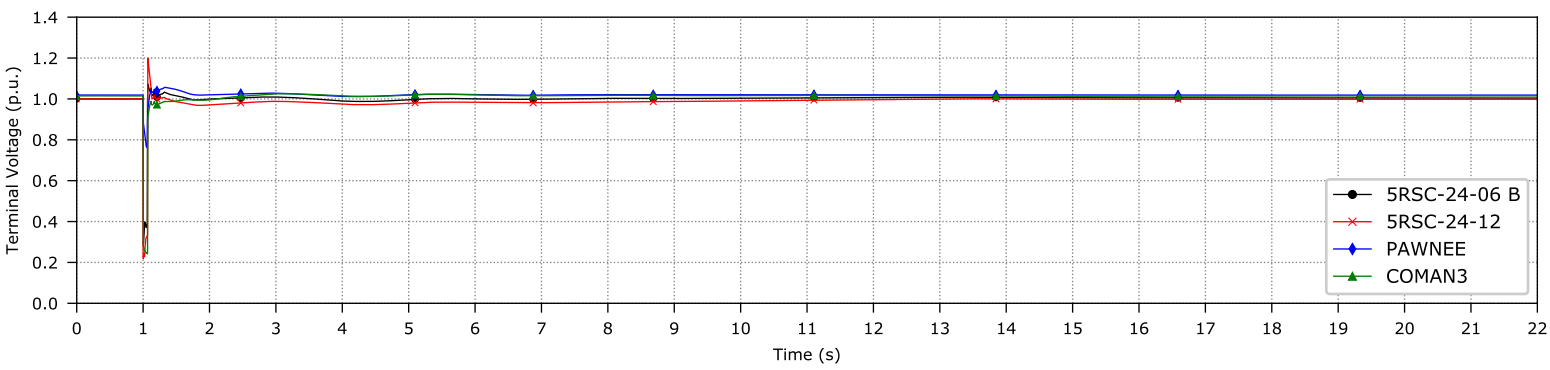
Ref. No. 10 - LoTC_147

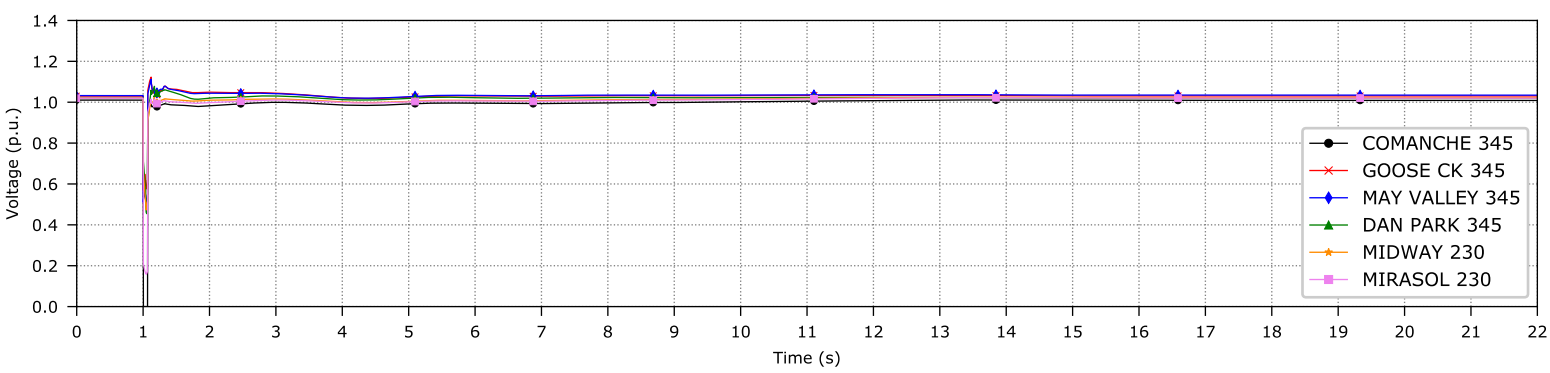




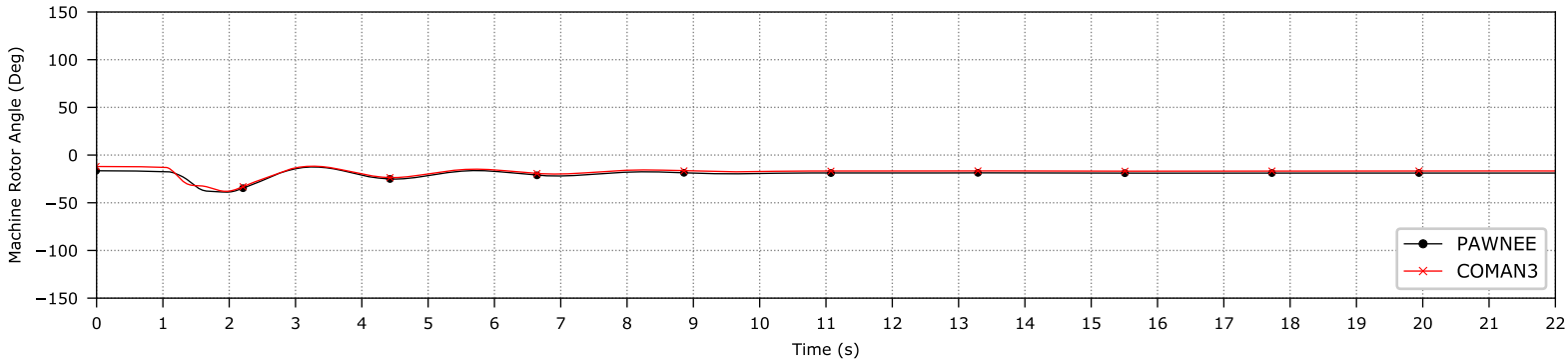


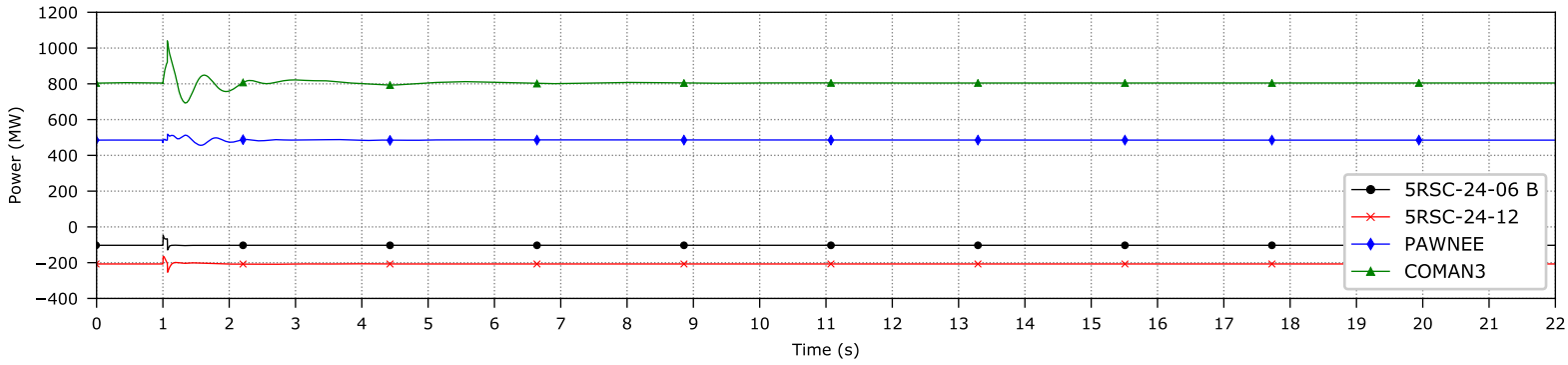


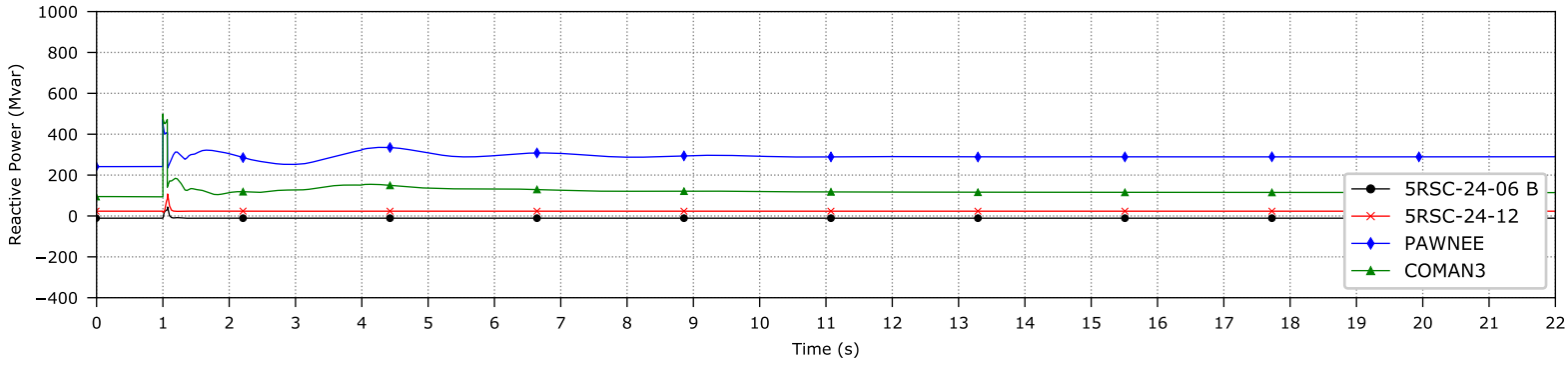


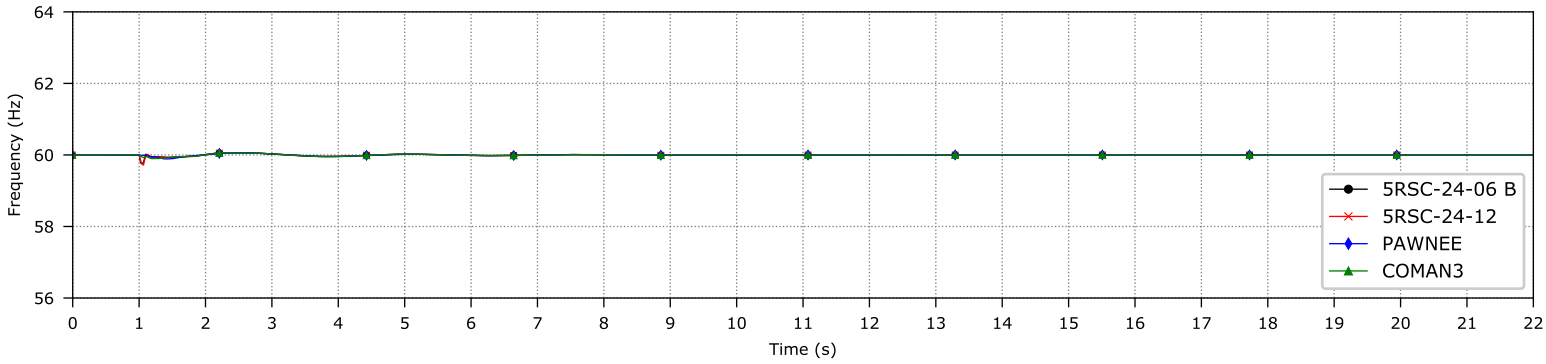


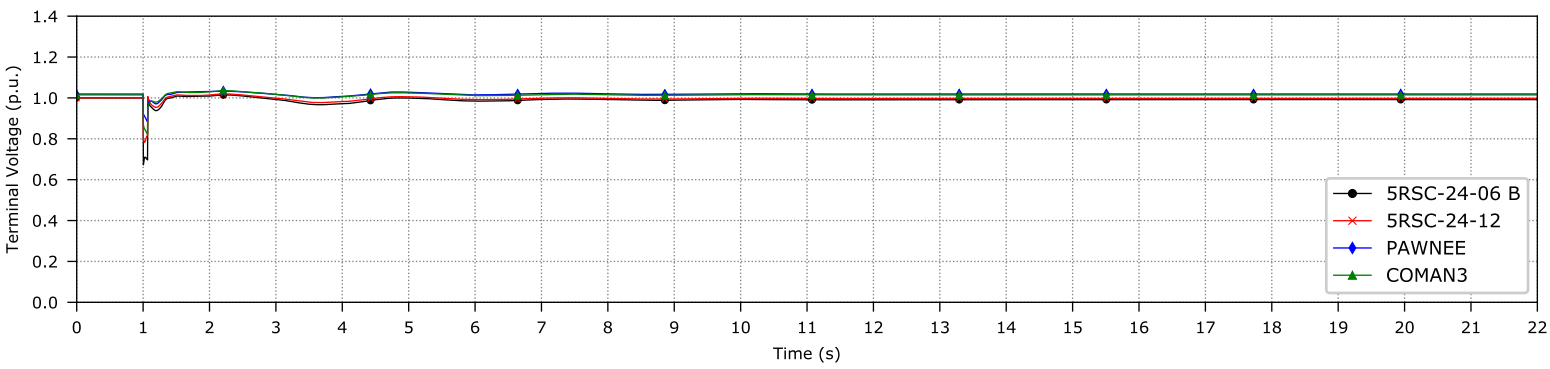
Ref. No. 11 - LoTC_316b

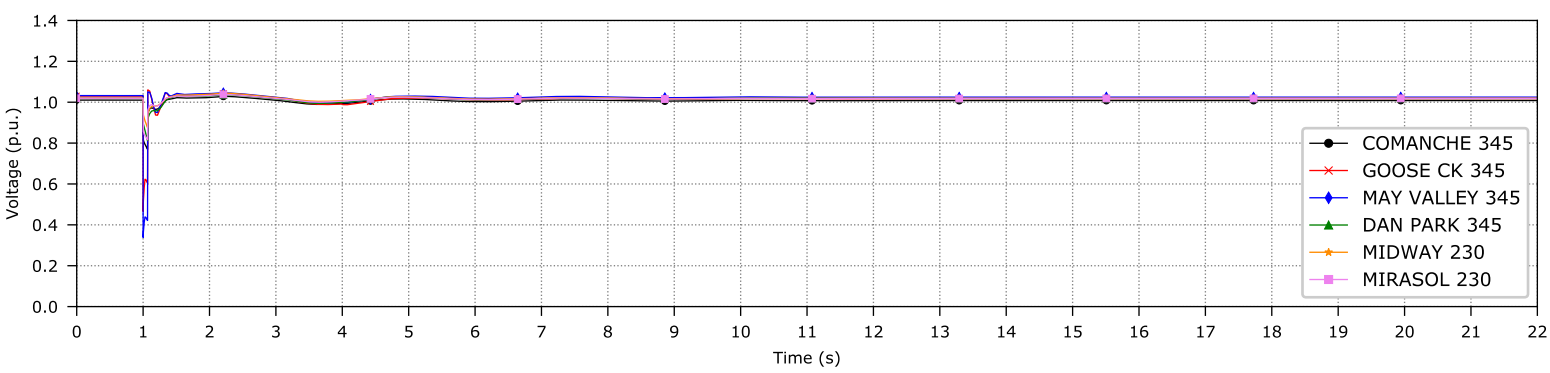




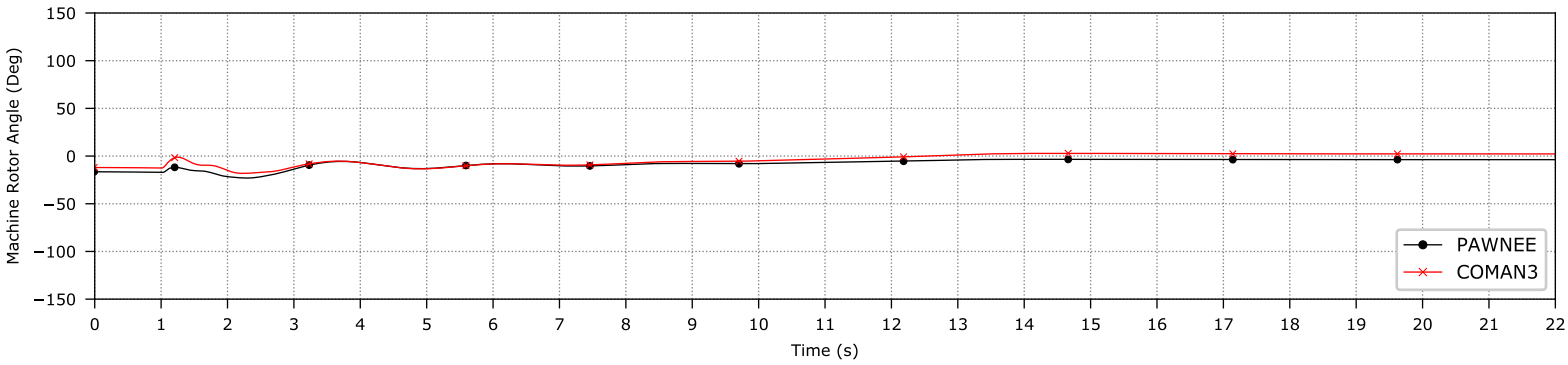


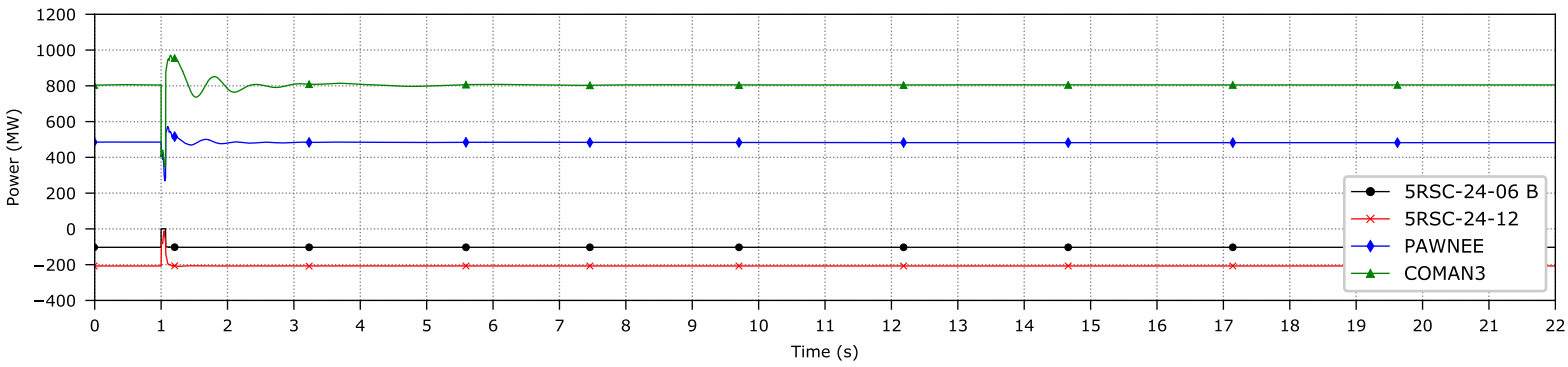


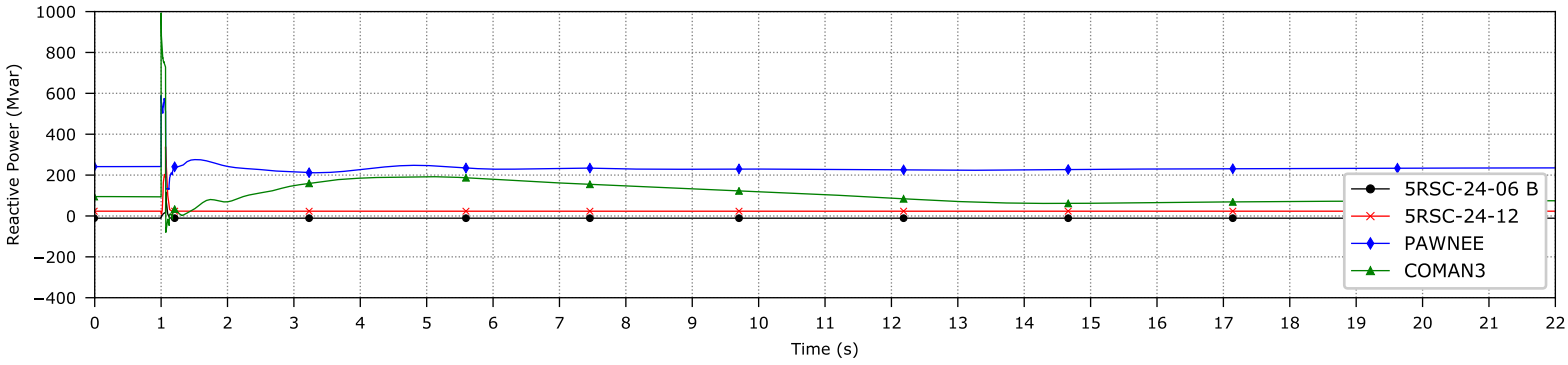


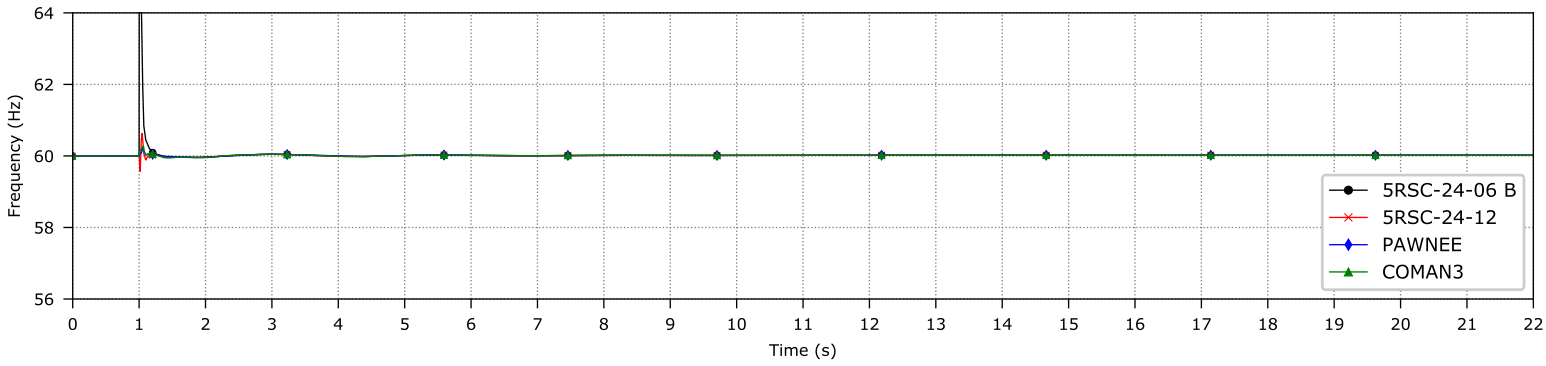


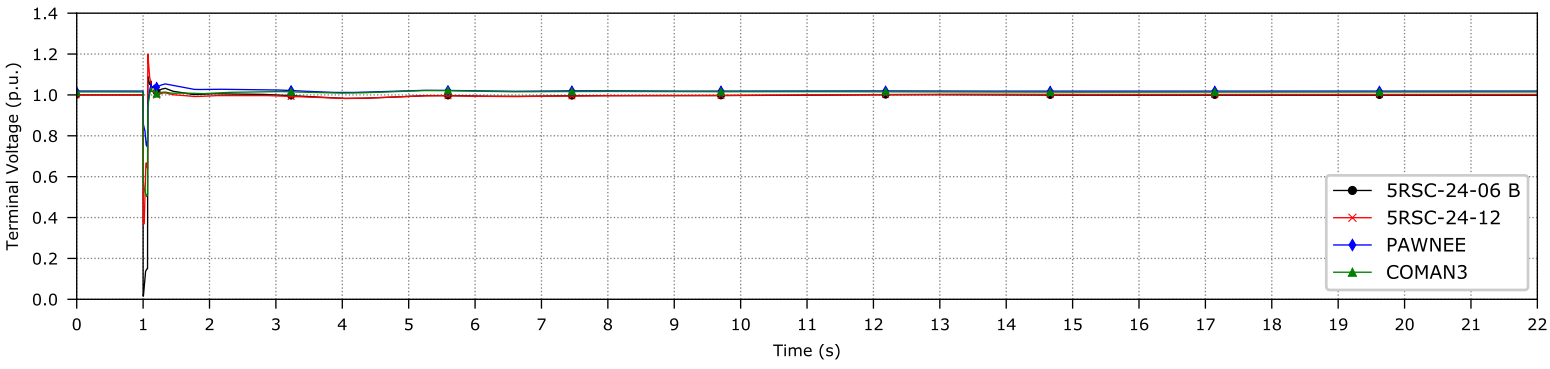
Ref. No. 12 - LoTC_317

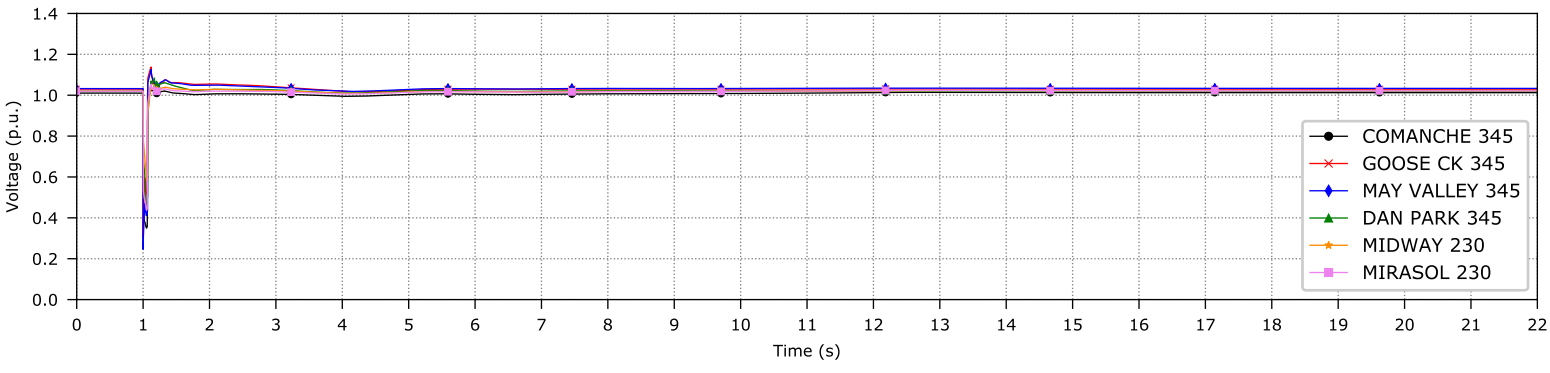




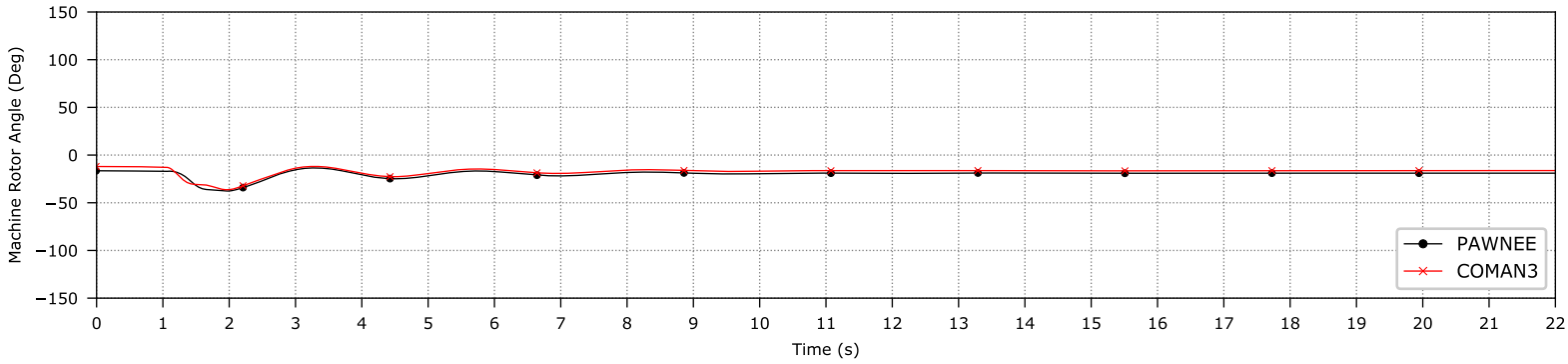


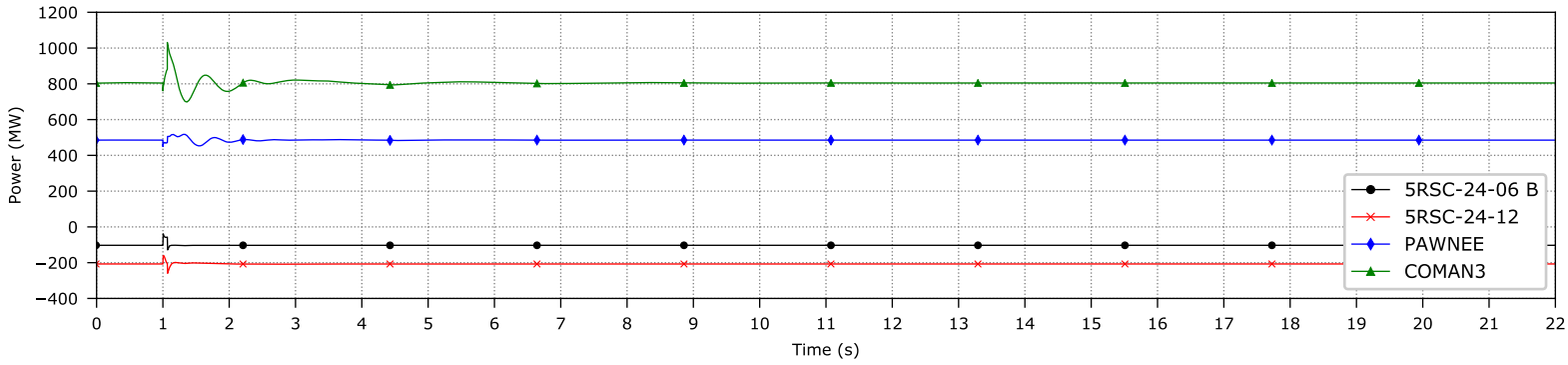


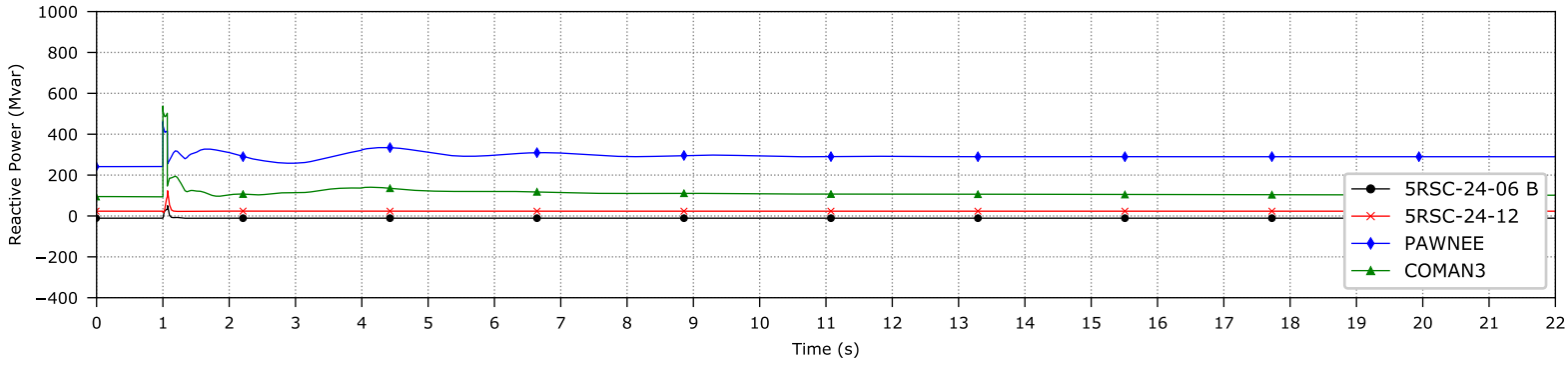


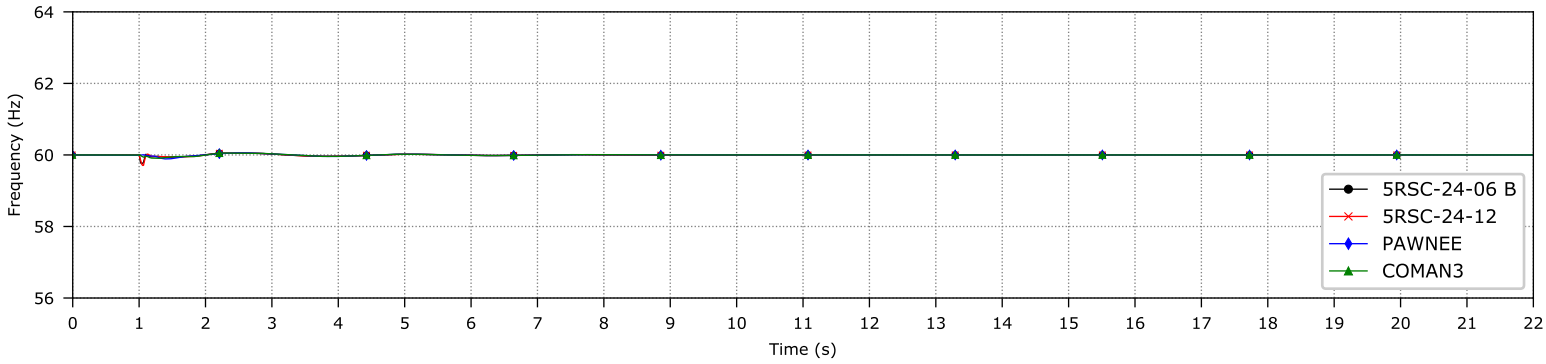


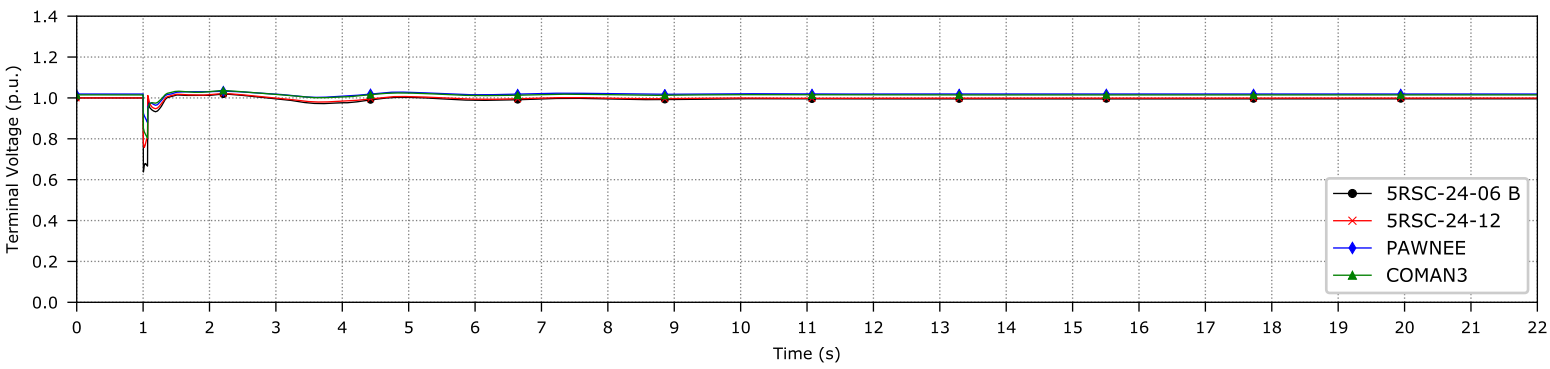
Ref. No. 13 - LoTC_318a

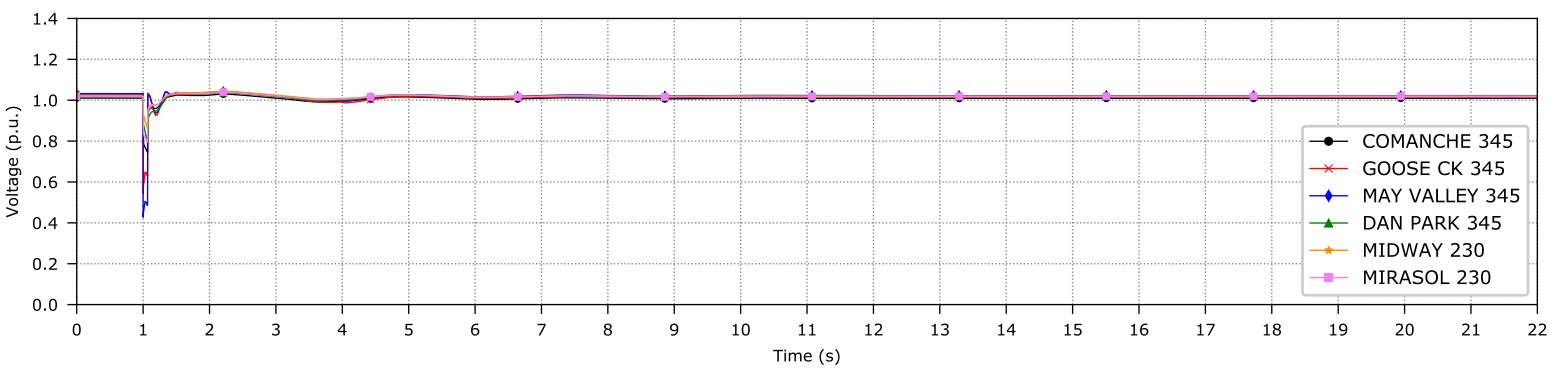




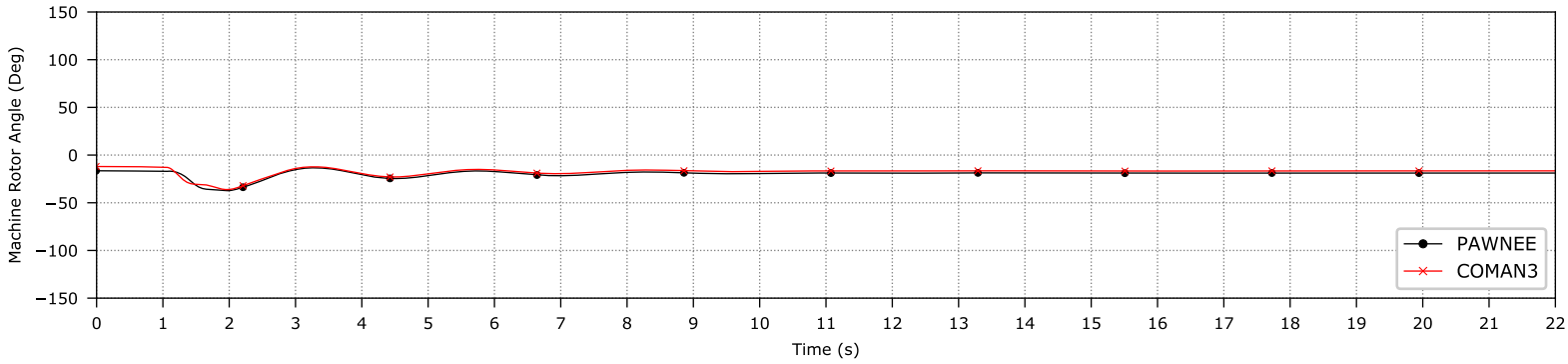


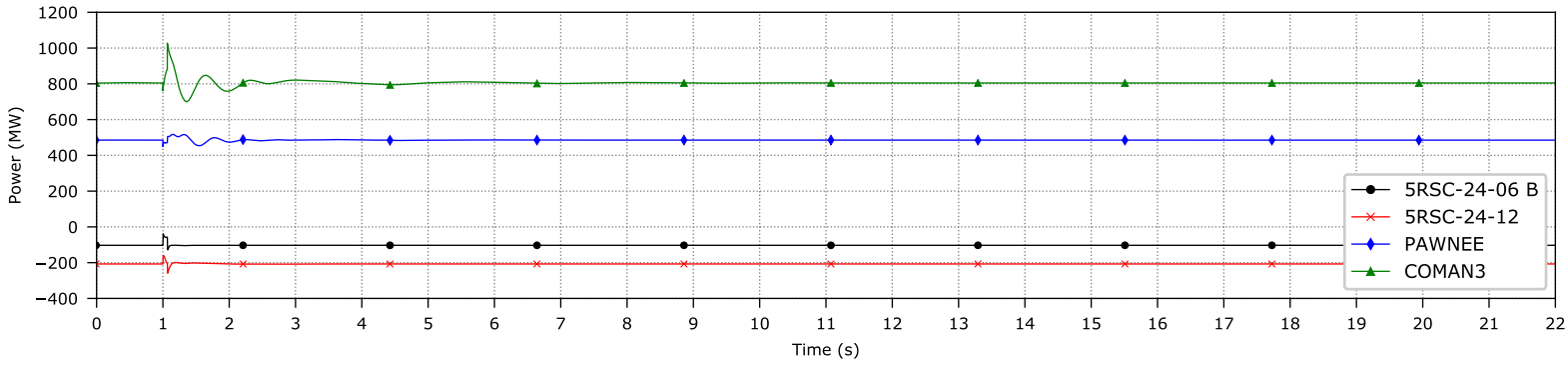


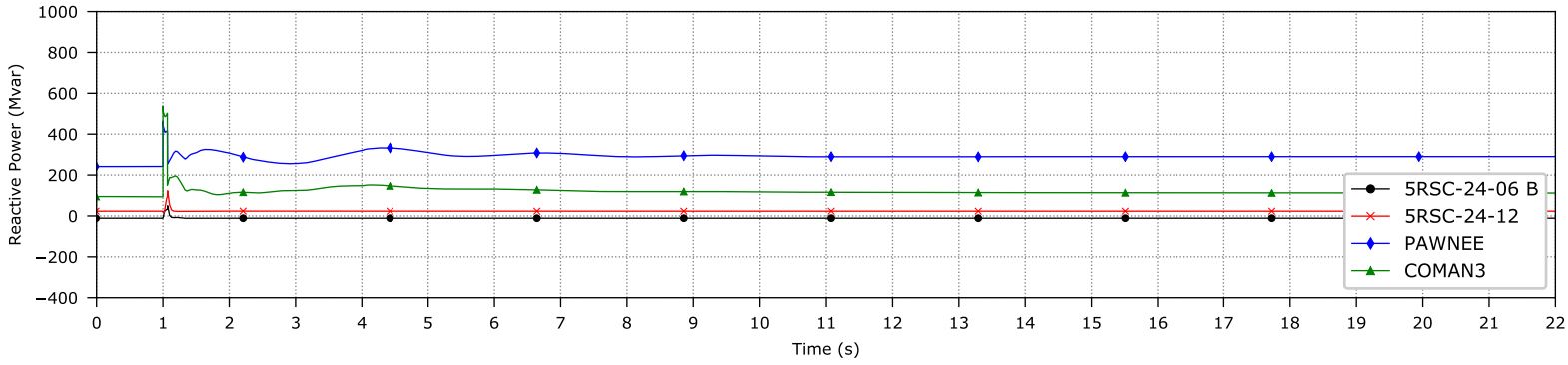


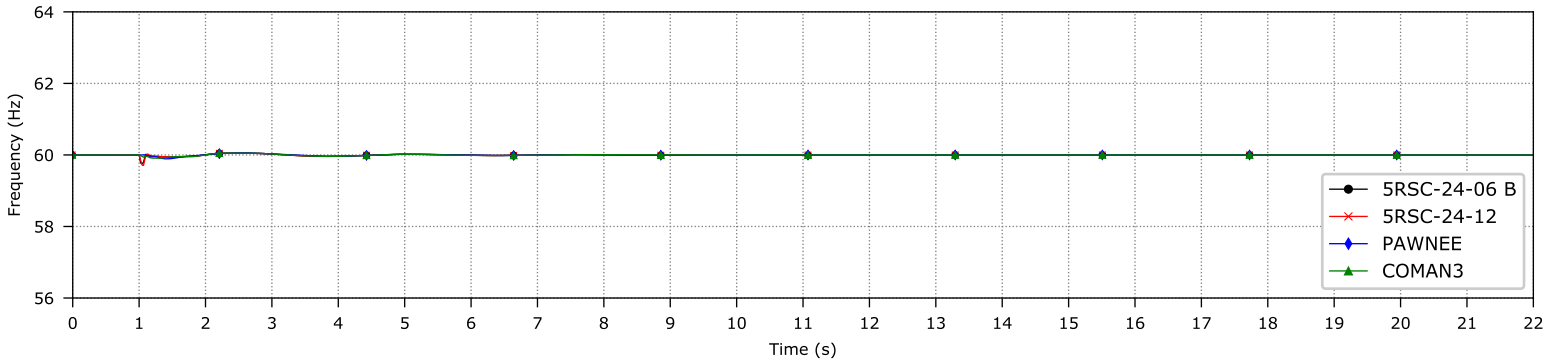


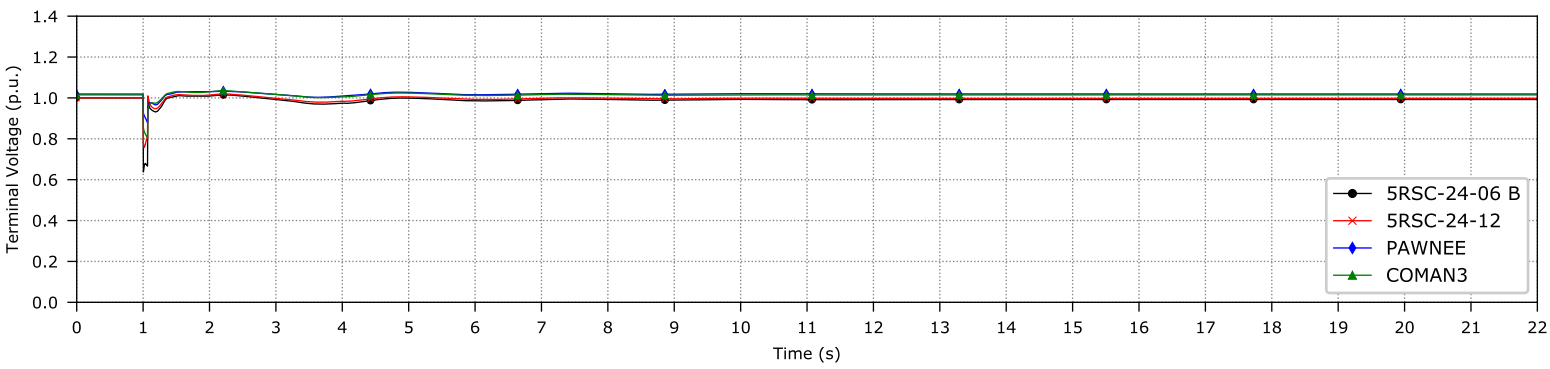
Ref. No. 14 - LoTC_318b

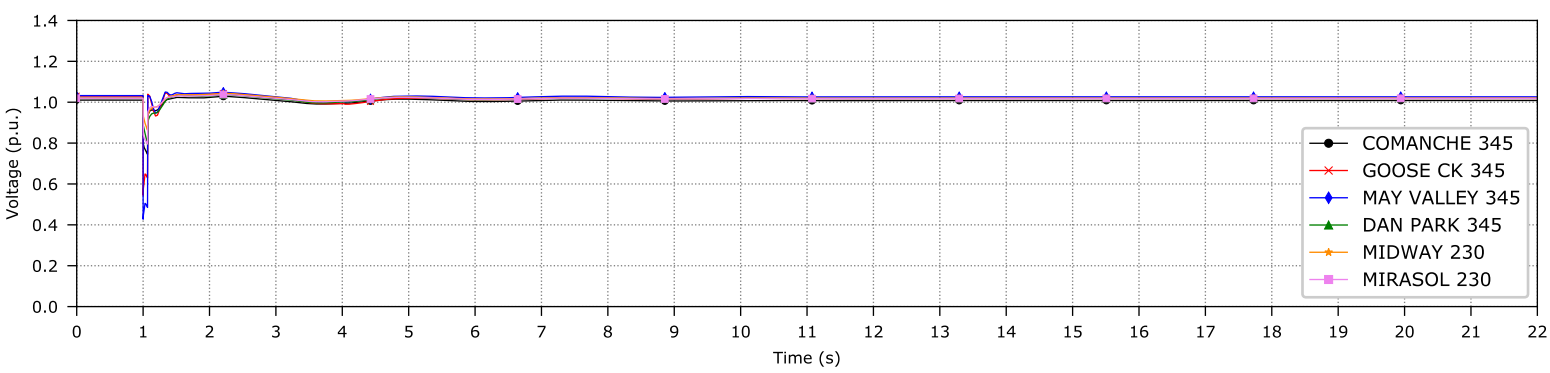




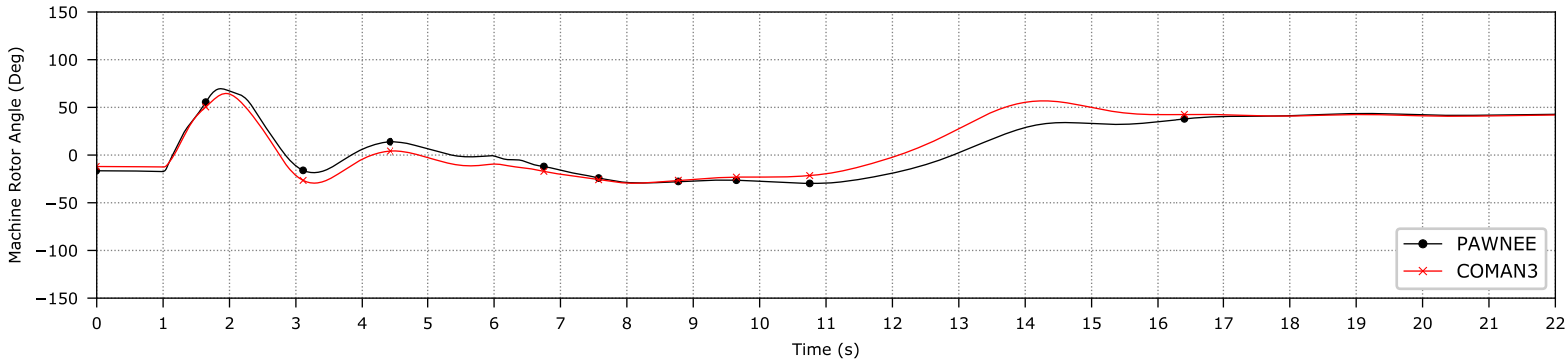


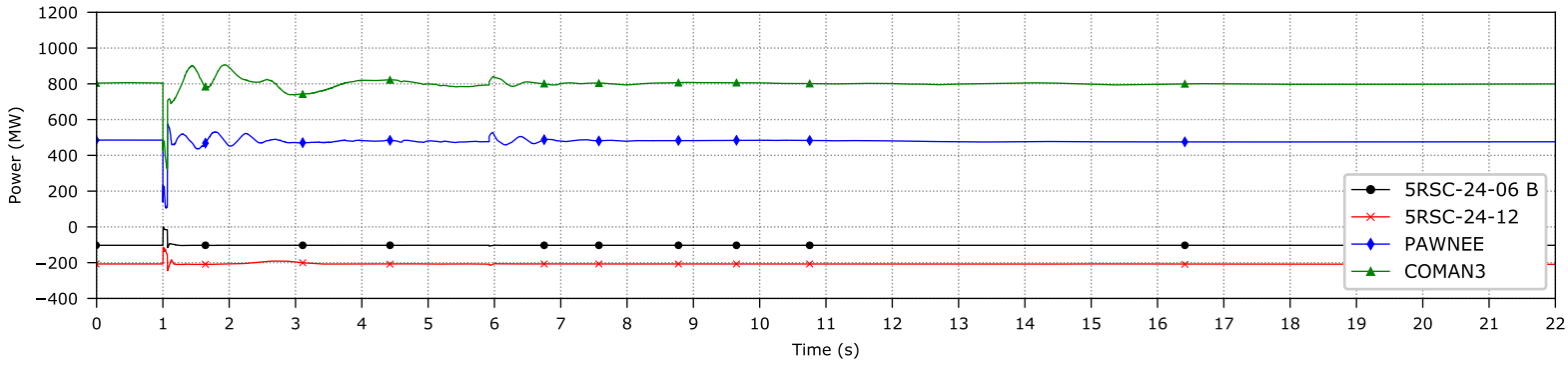


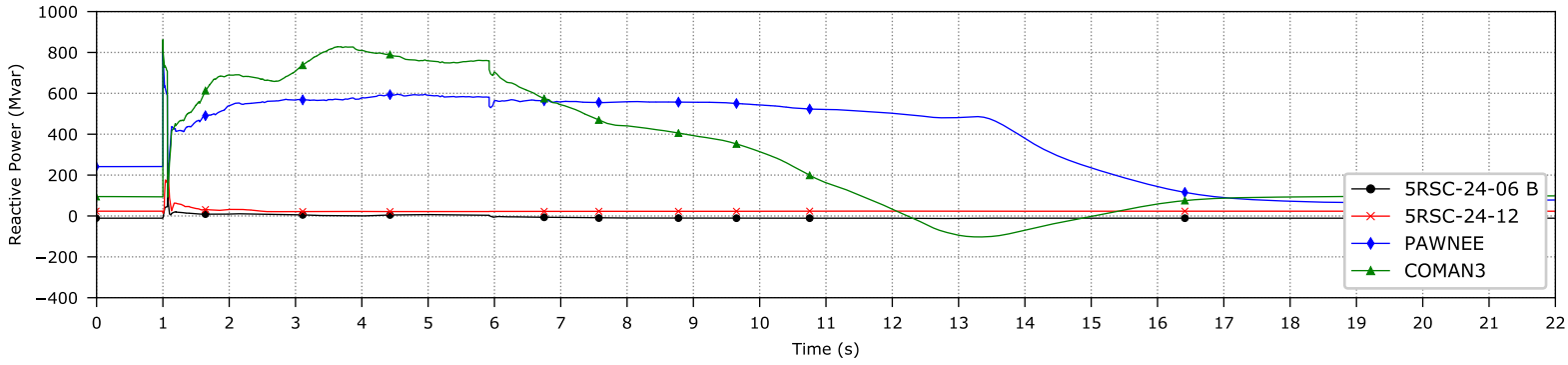


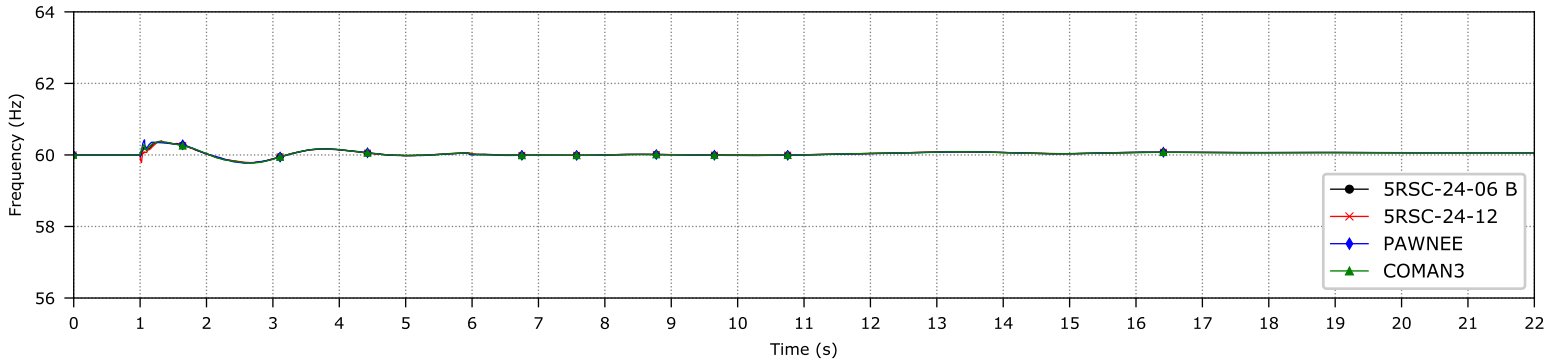


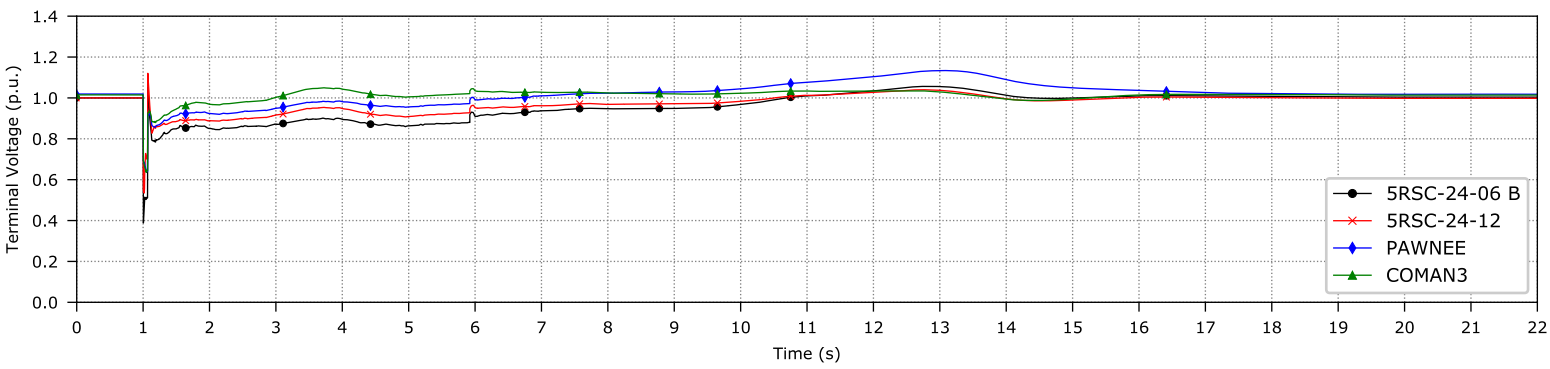
Ref. No. 15 - LoTC_324

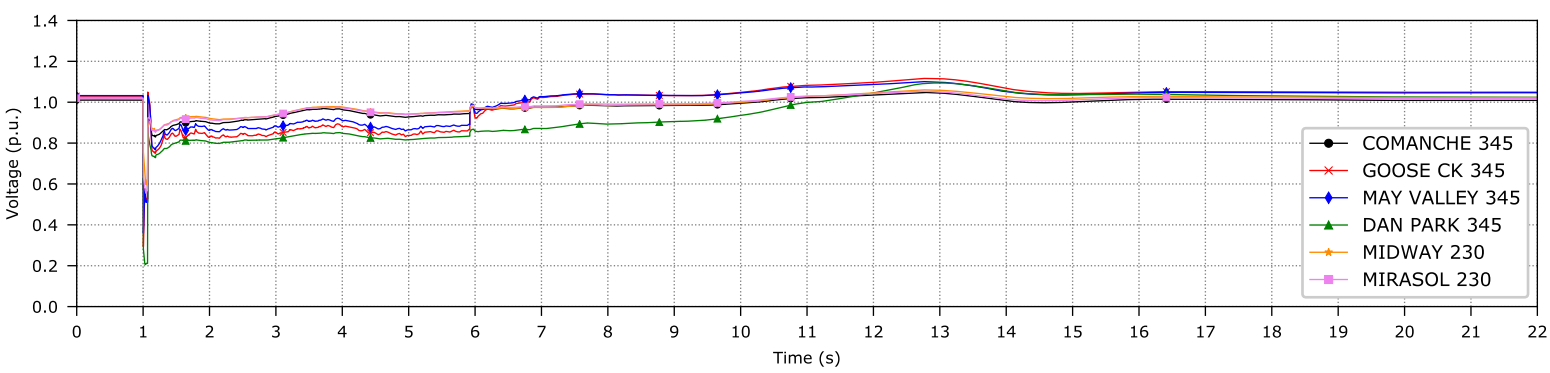




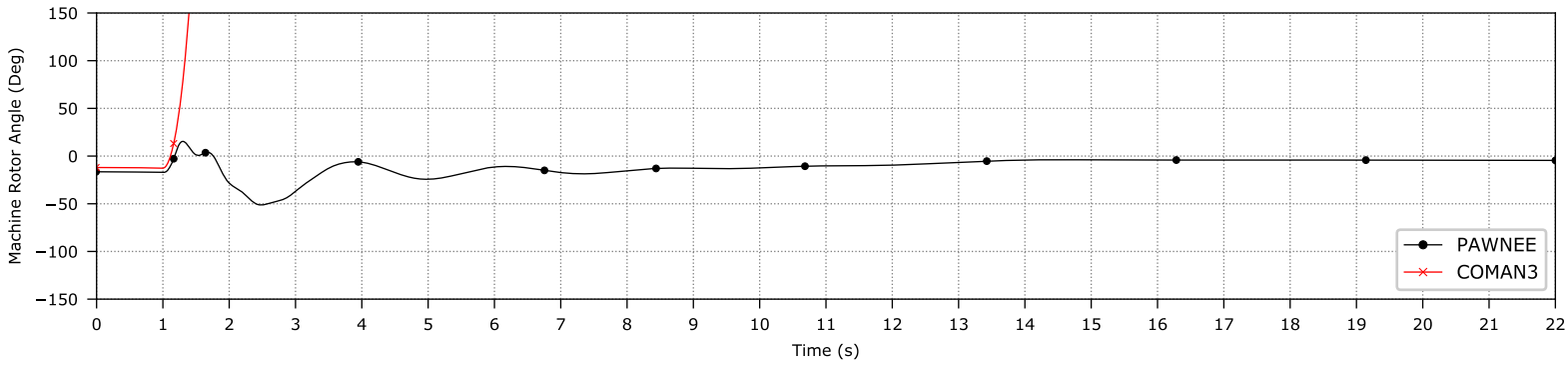


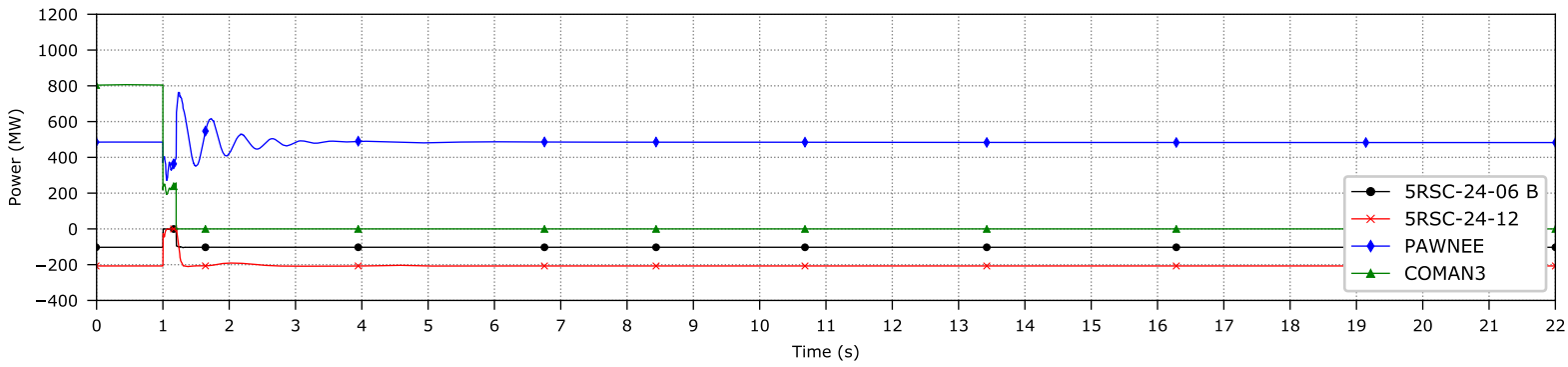


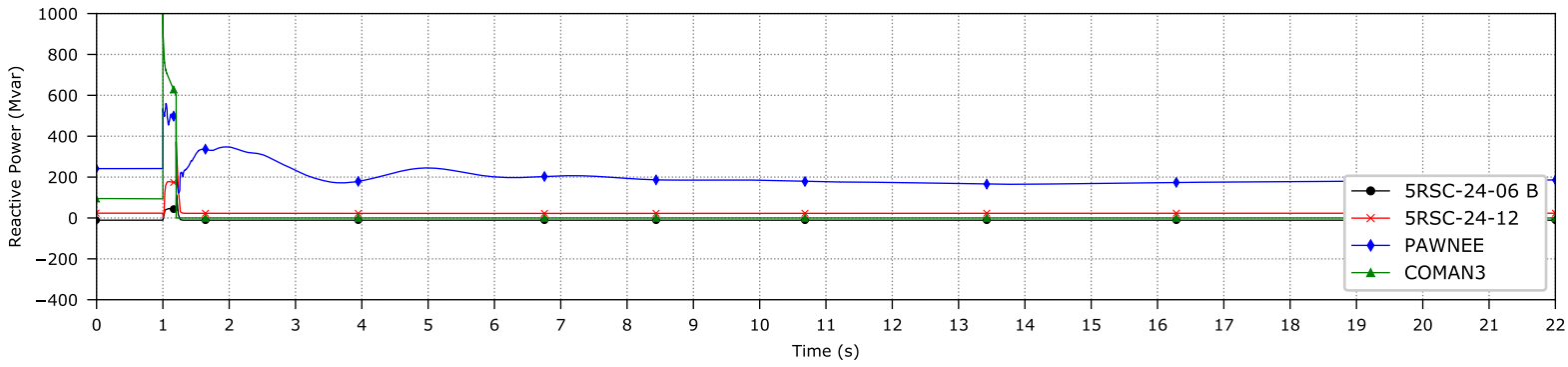


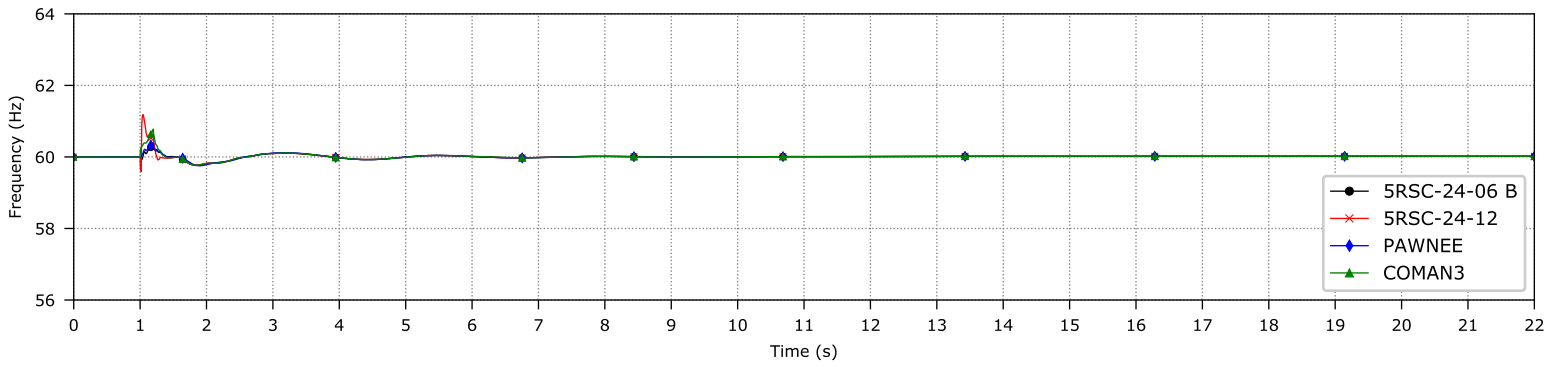


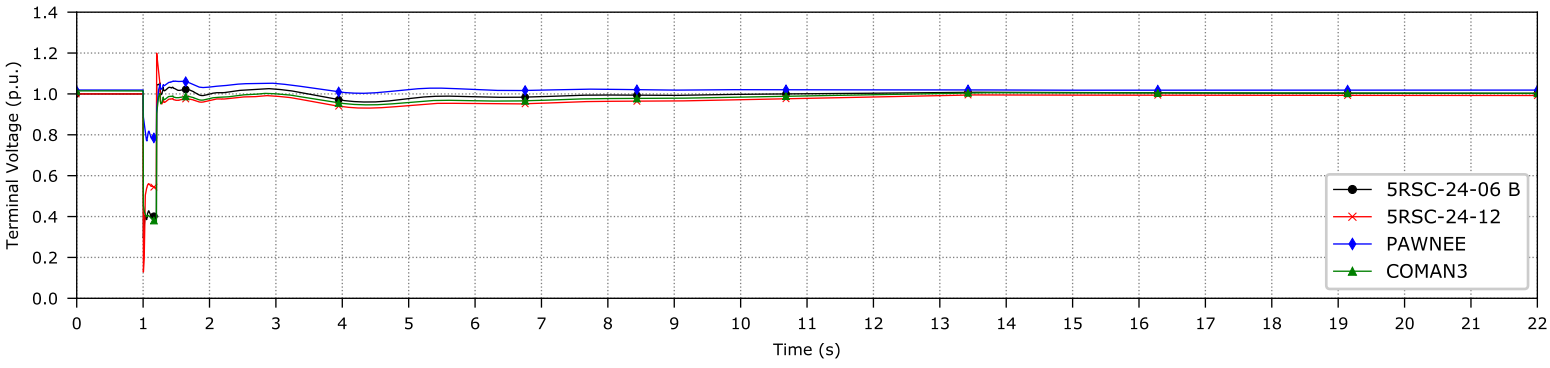
Ref. No. 16 - BF_039b

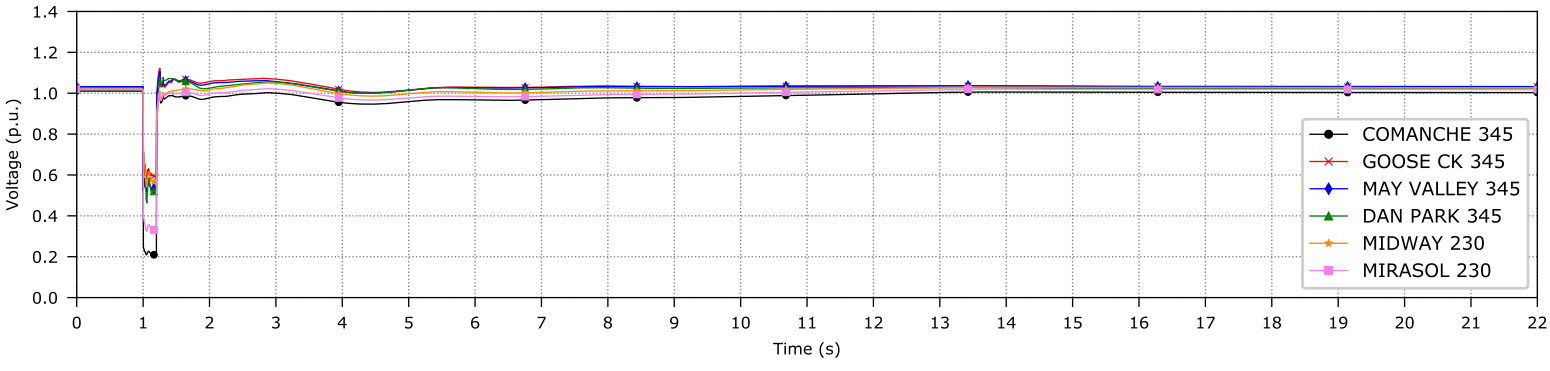




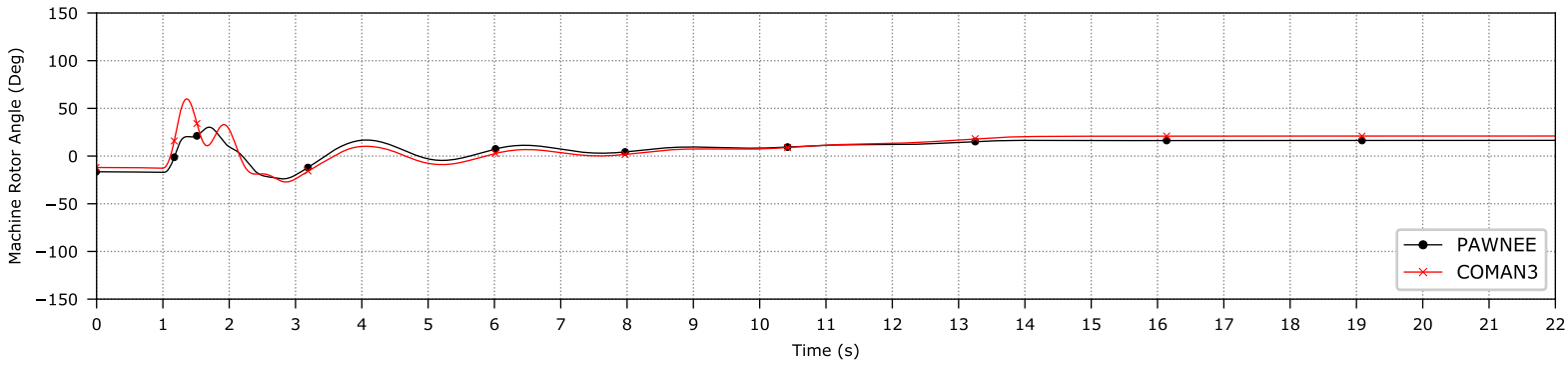


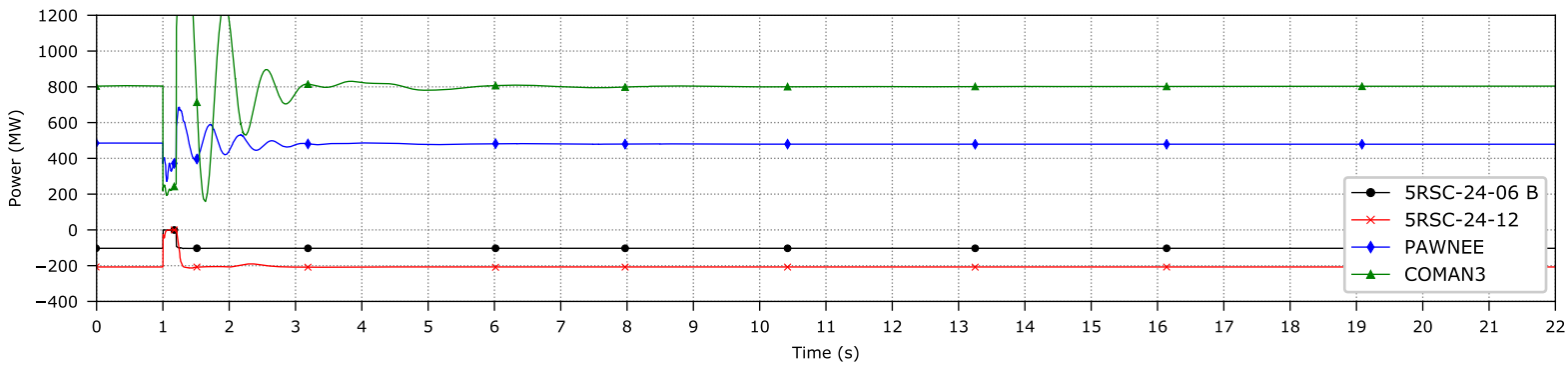


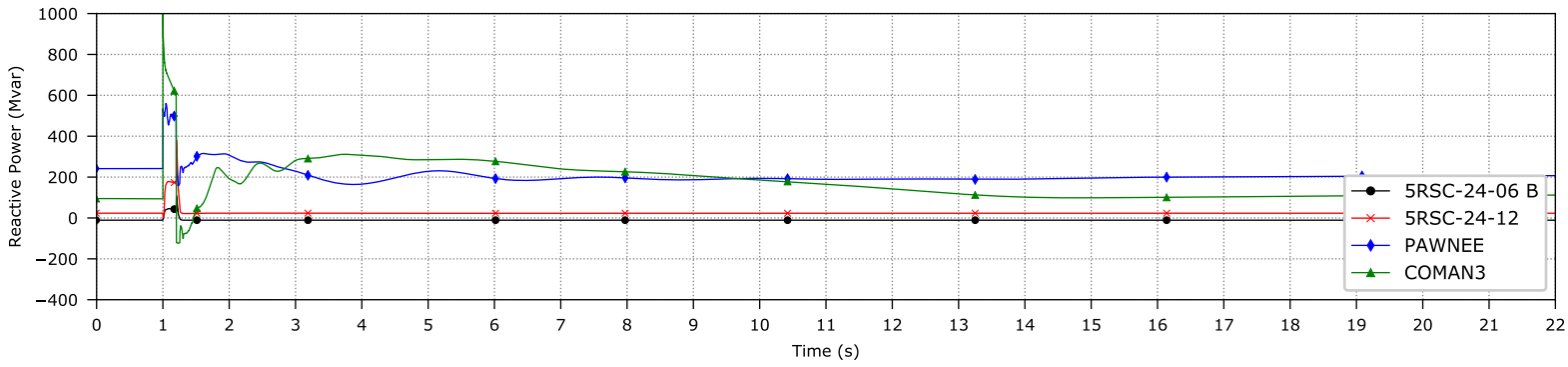


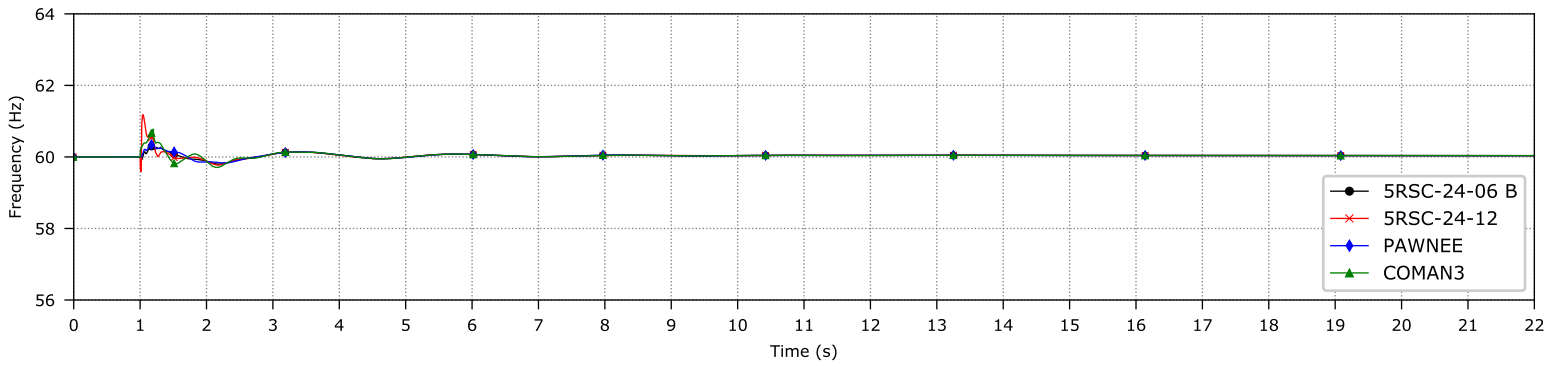


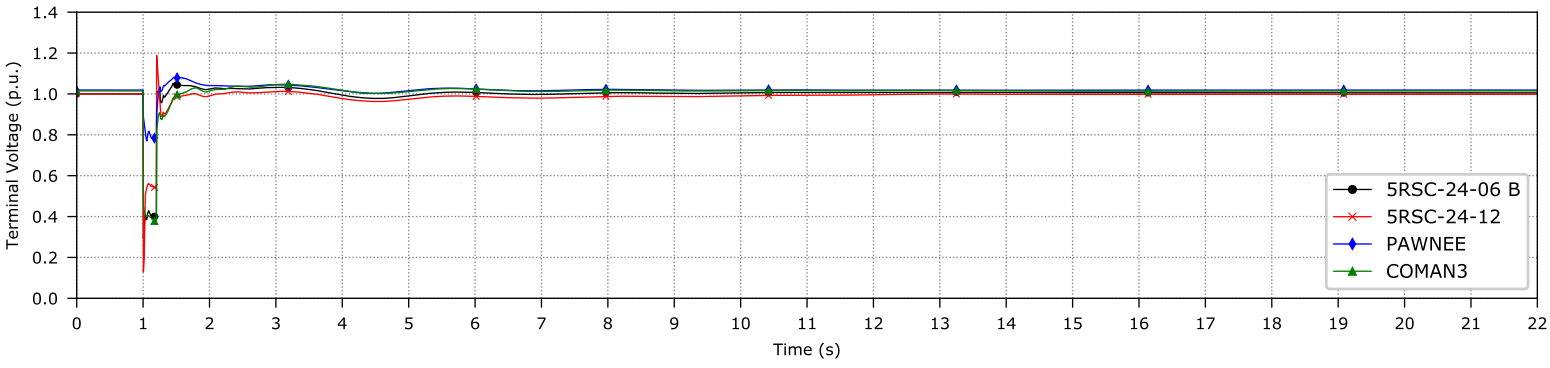
Ref. No. 17 - BF_039e

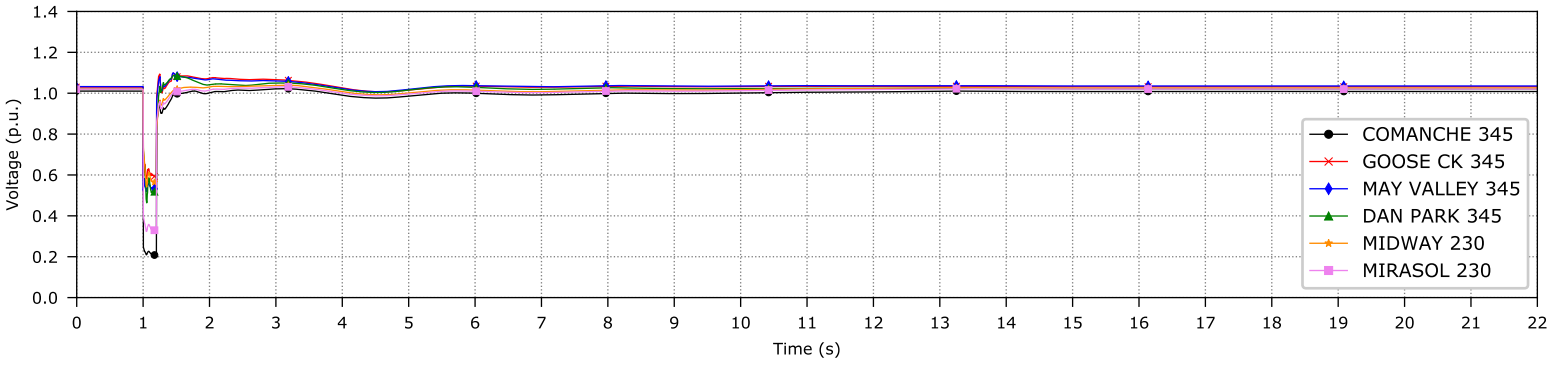












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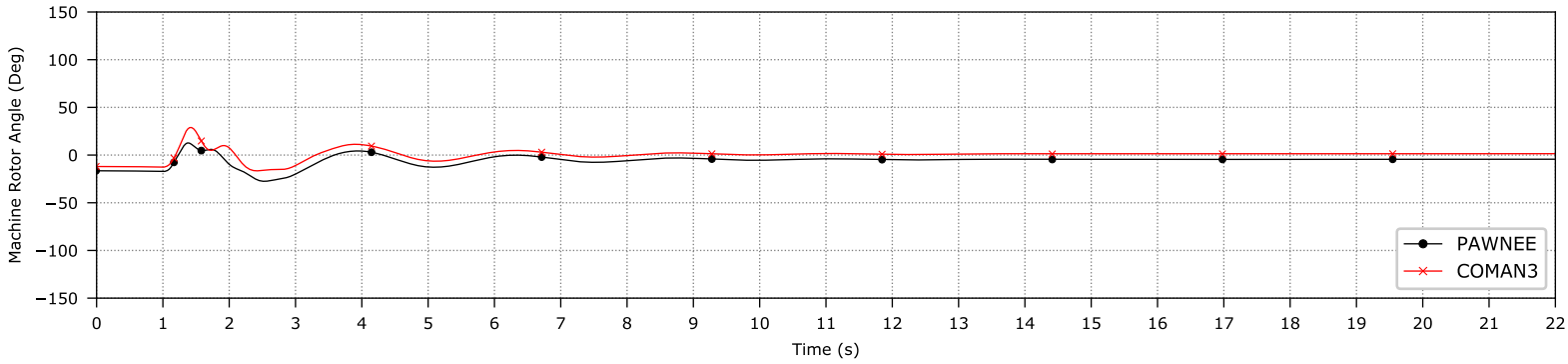

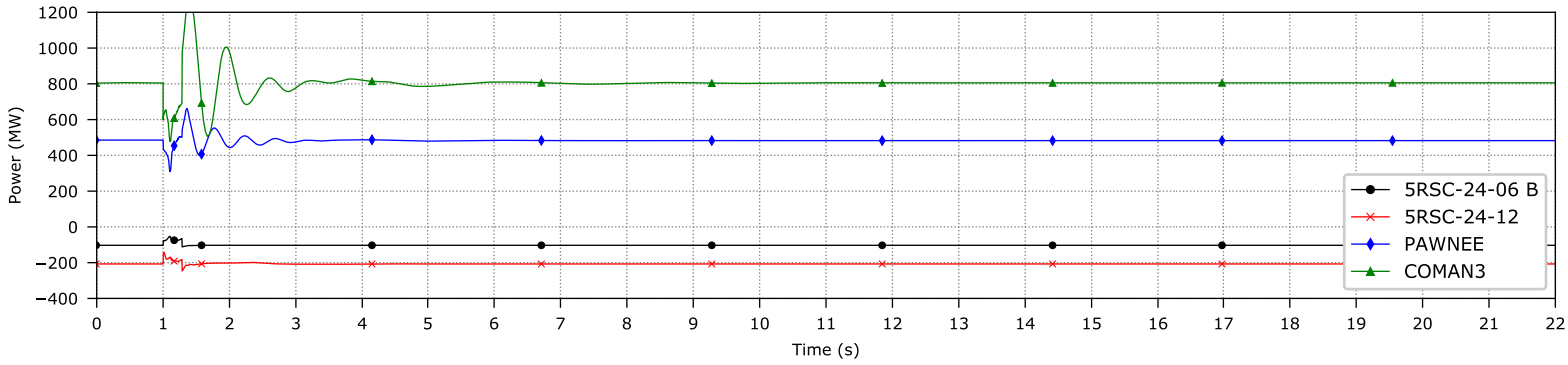

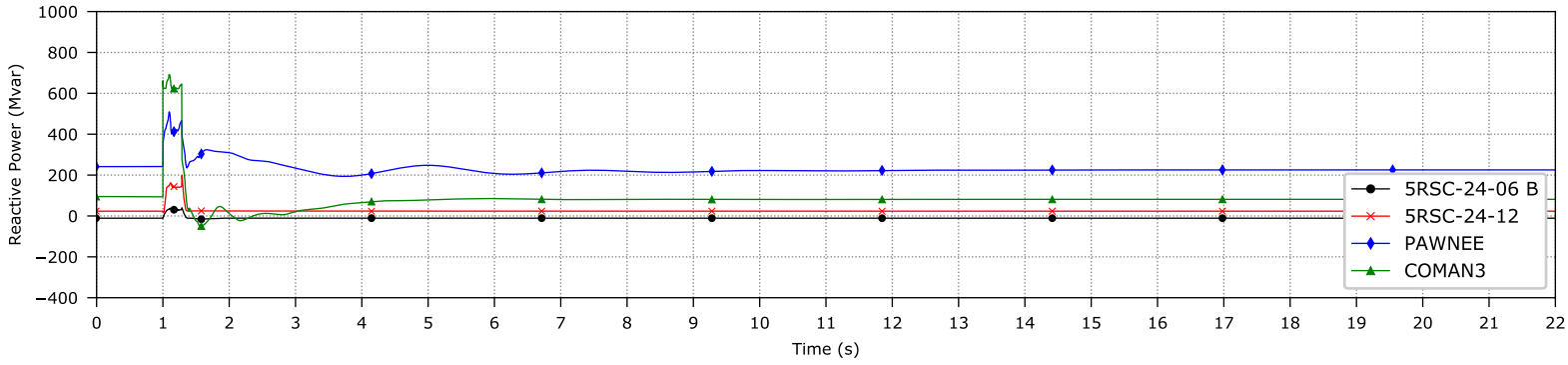

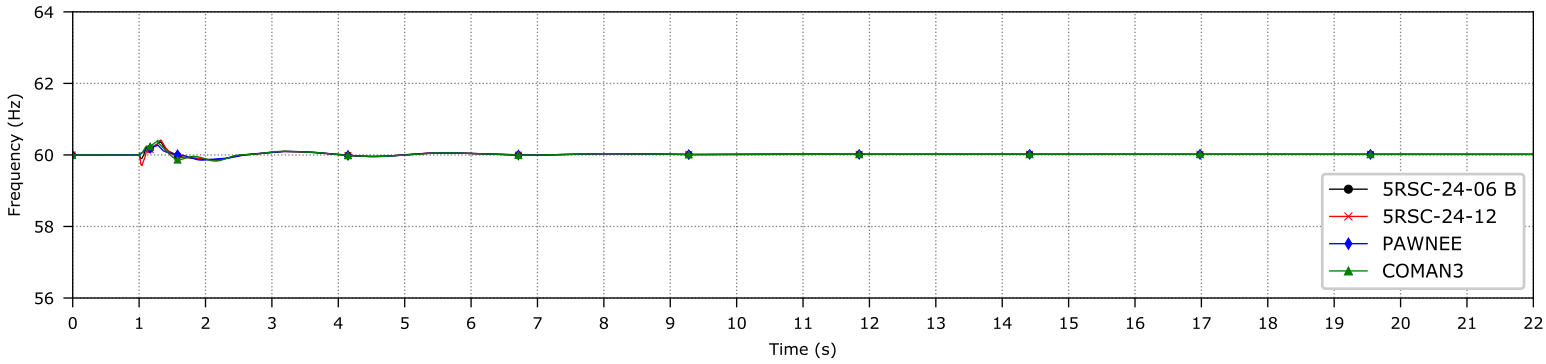

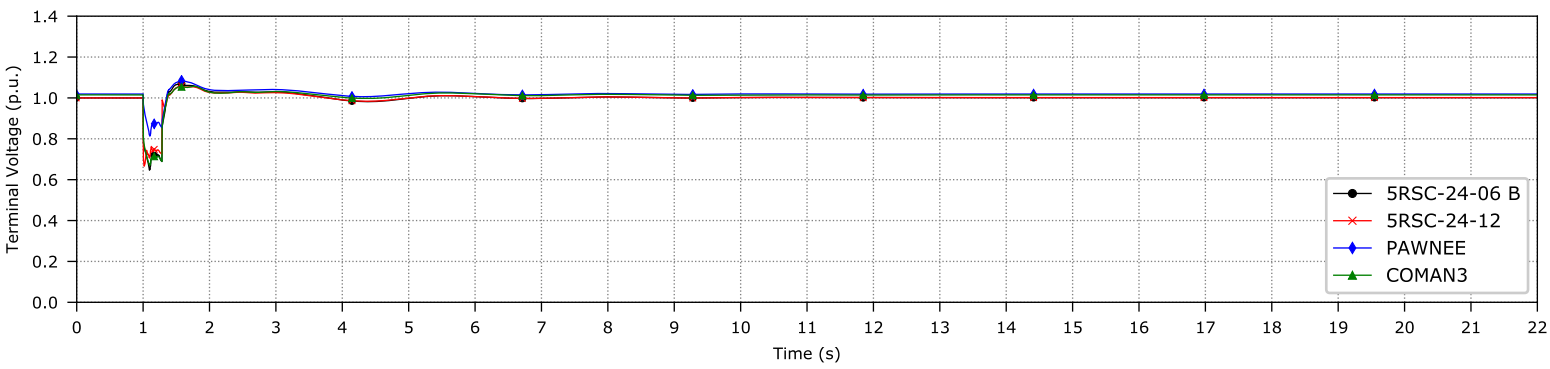

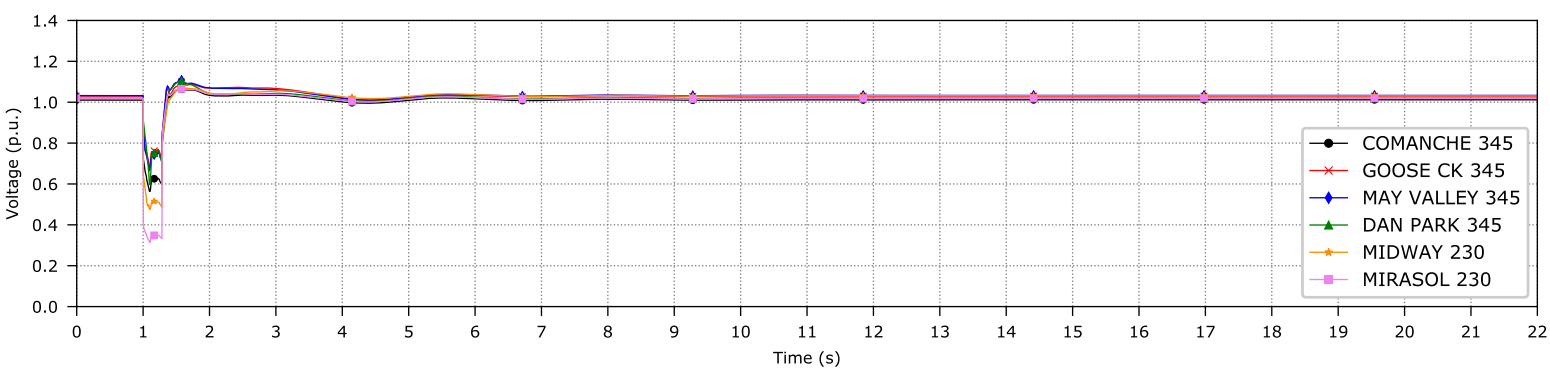

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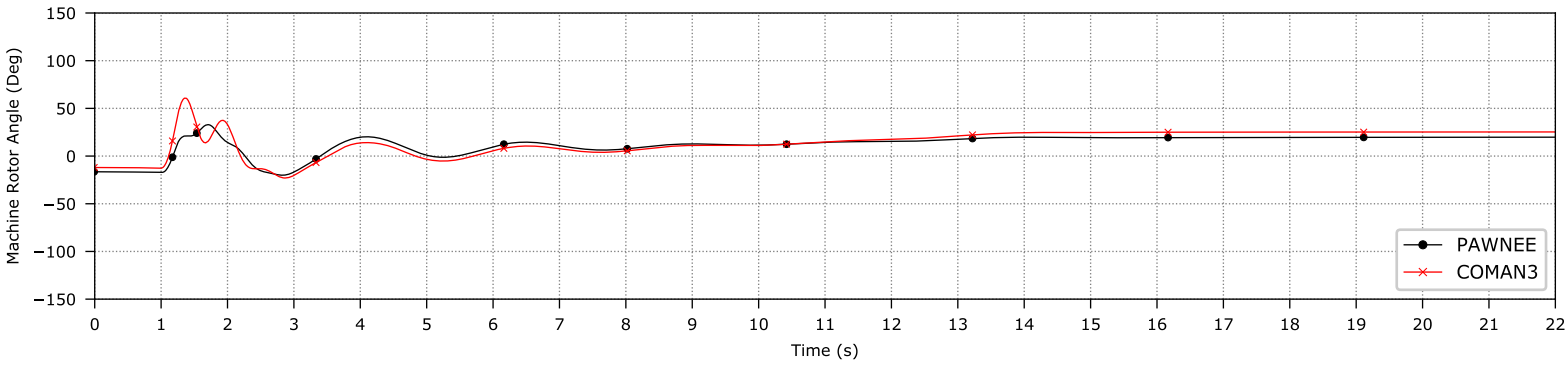

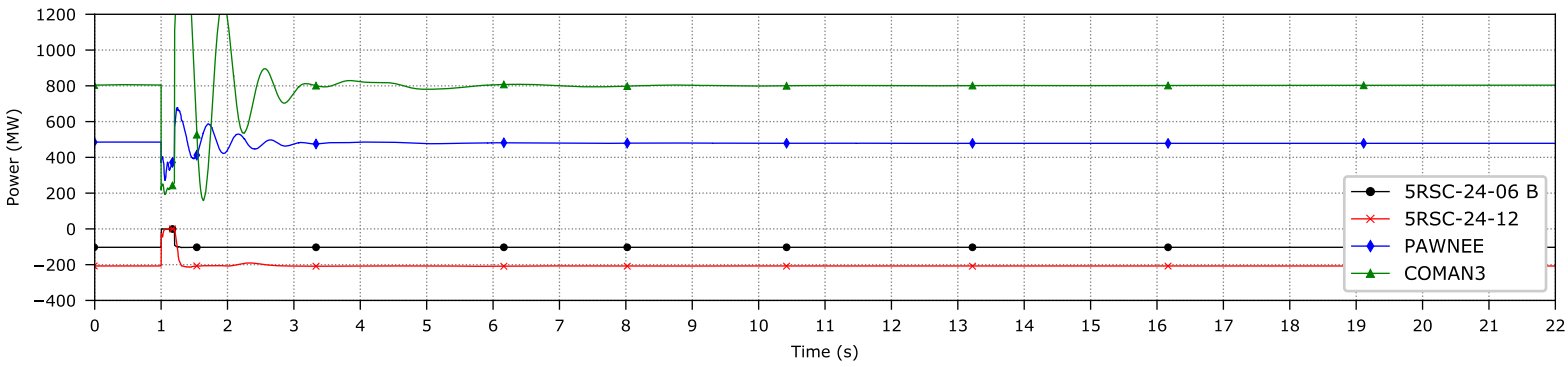

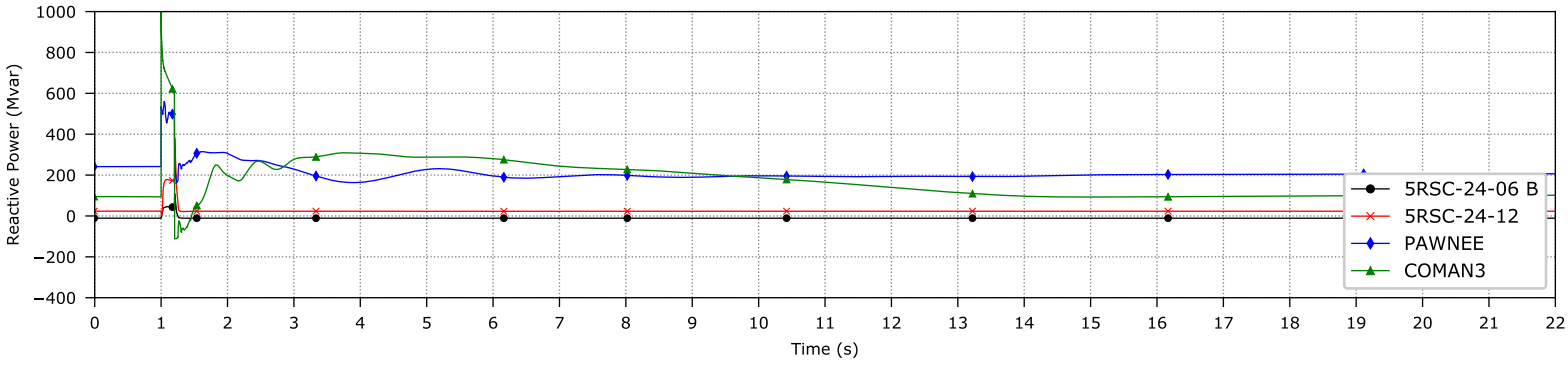

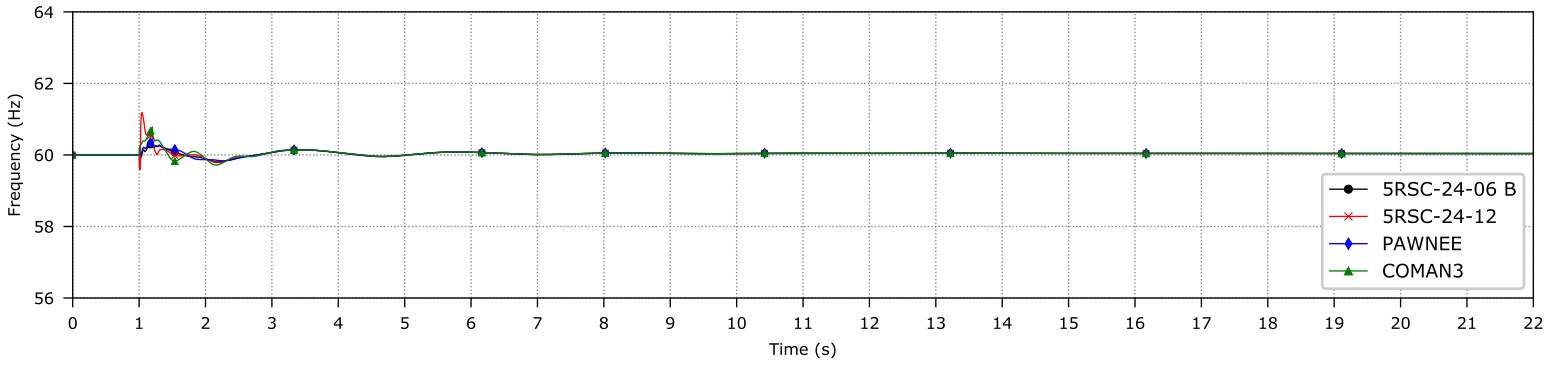

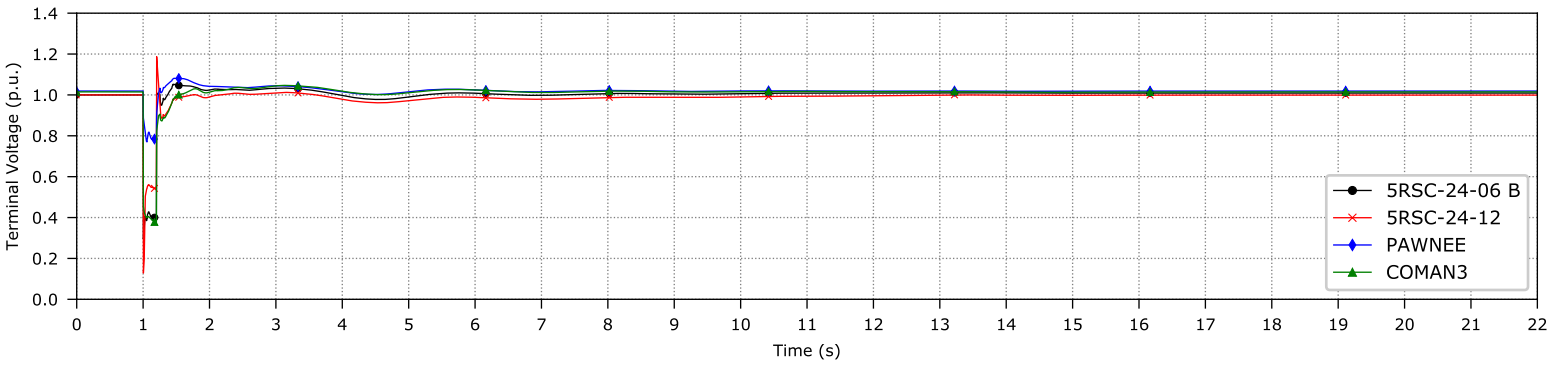

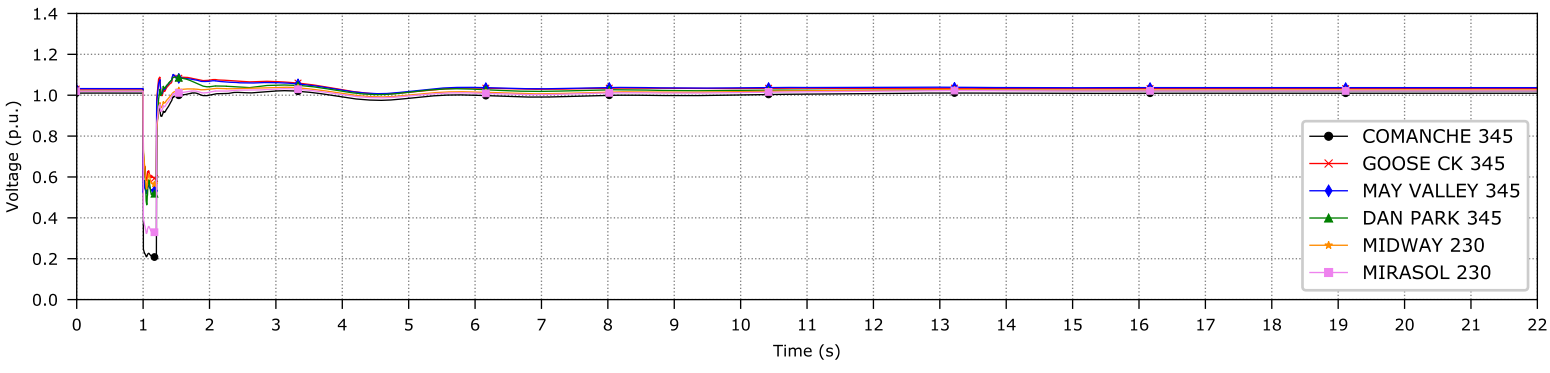

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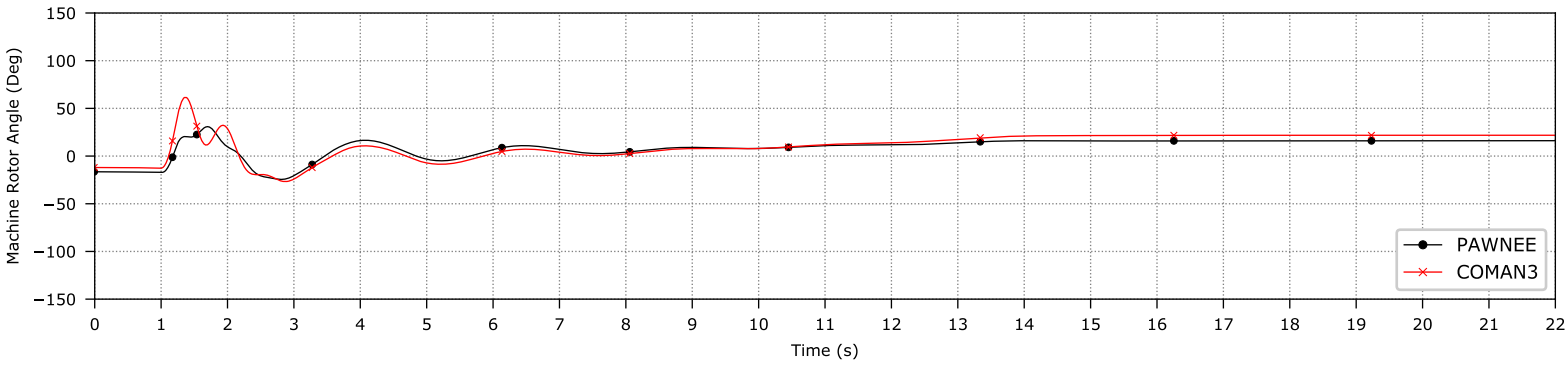

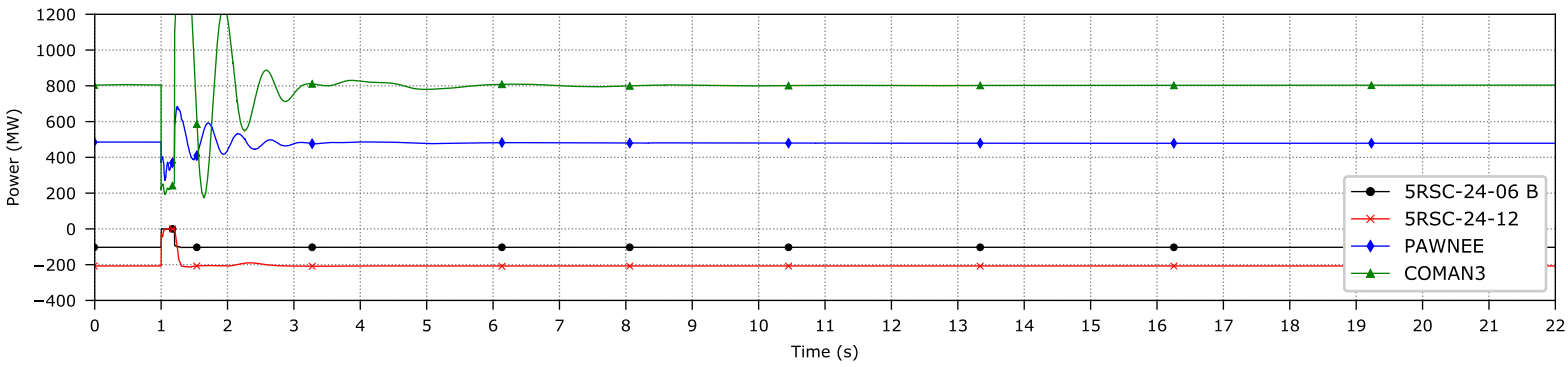

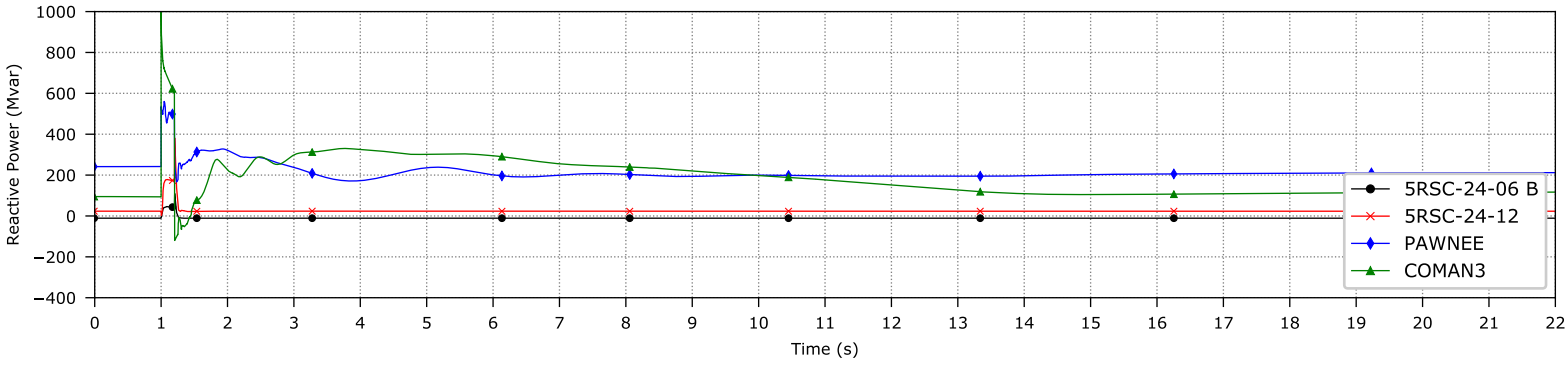

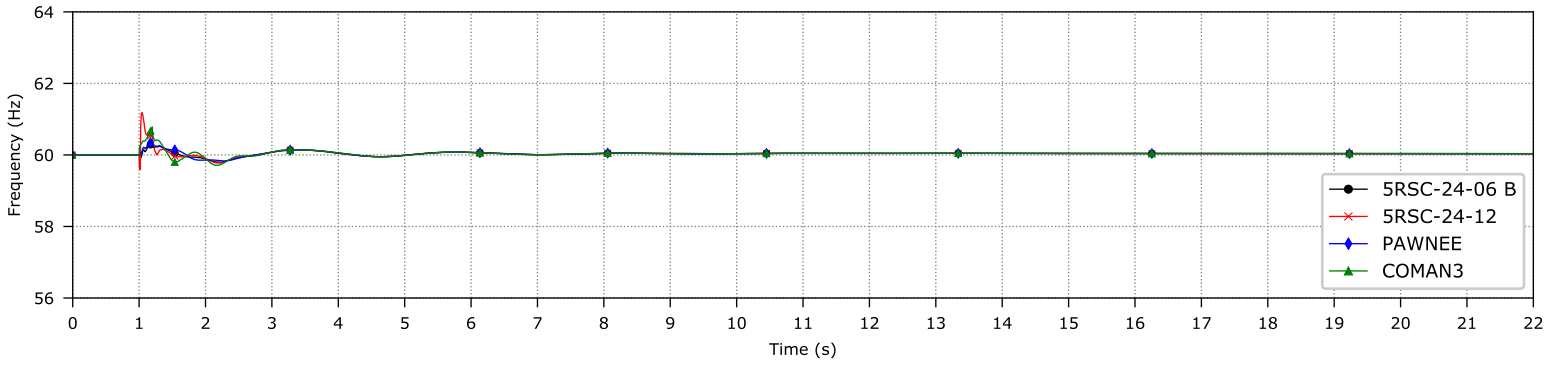

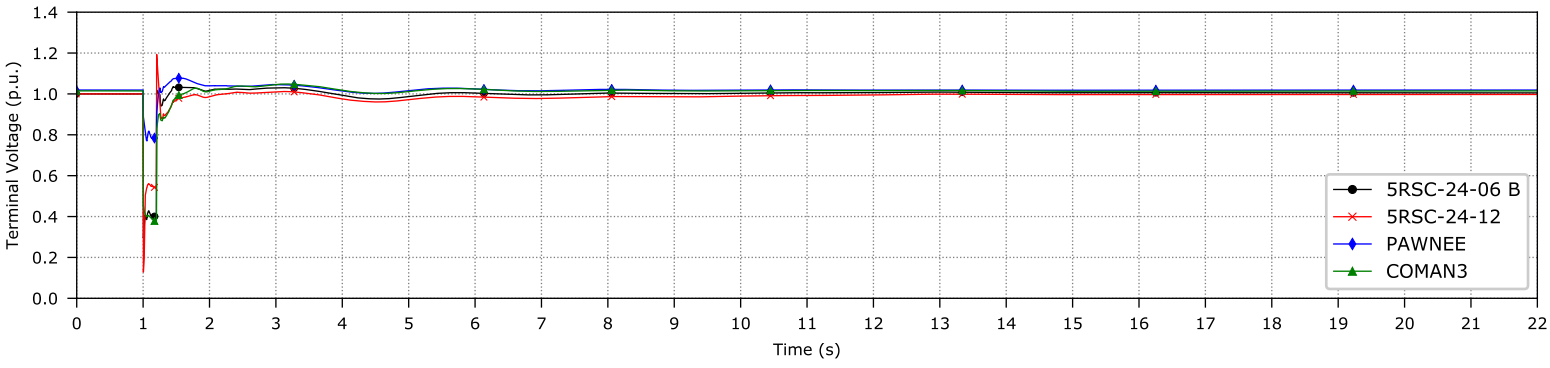

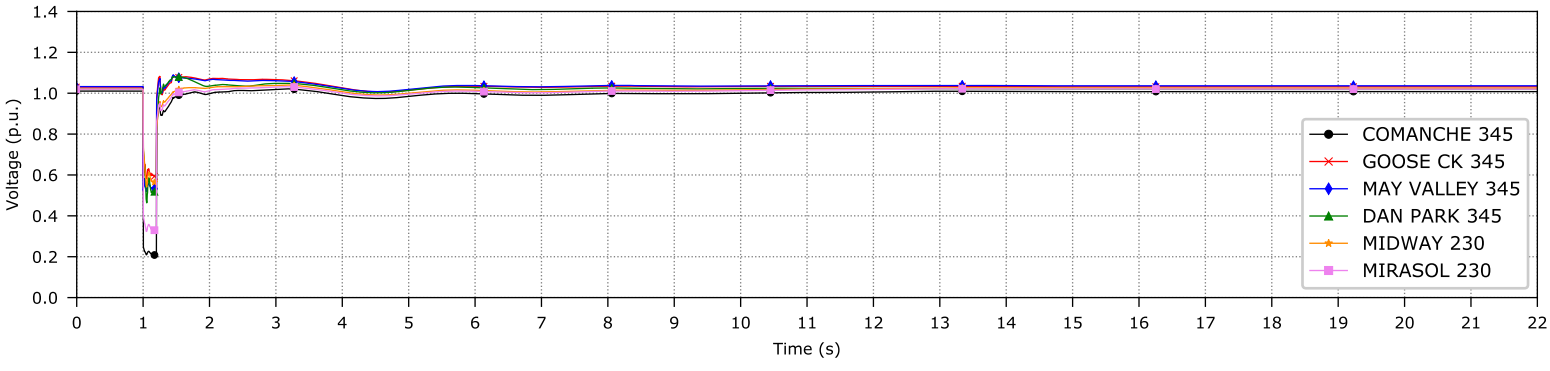

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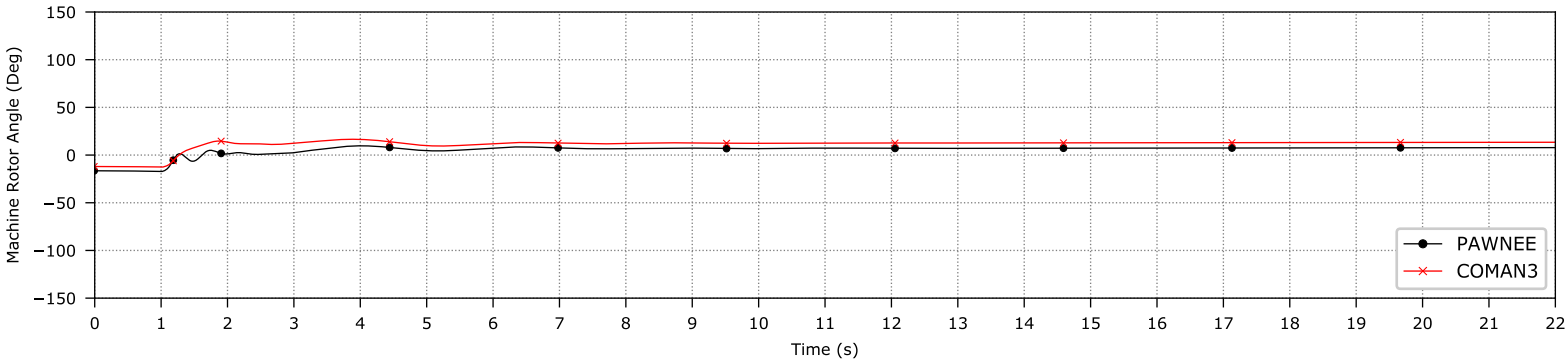

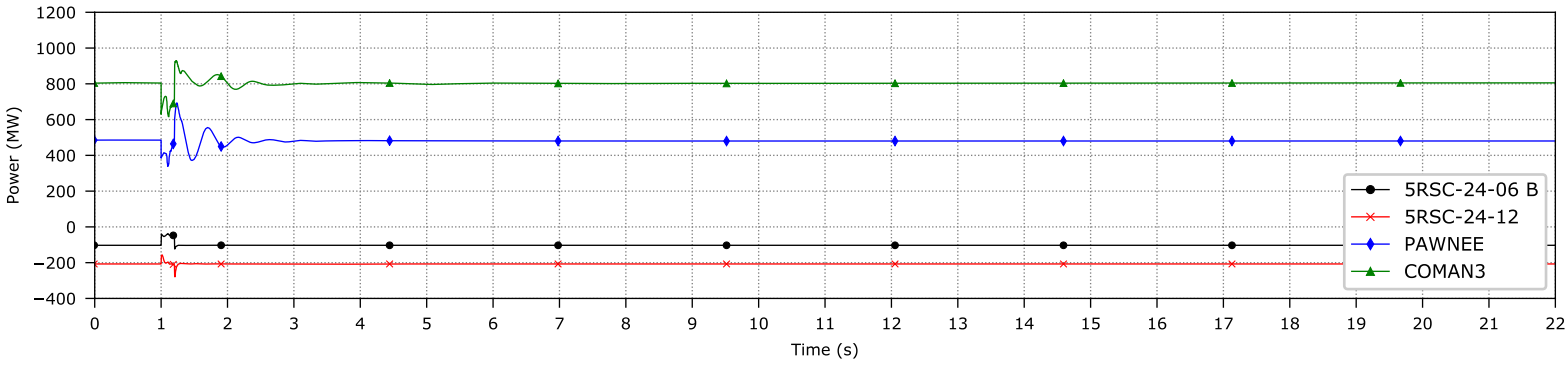

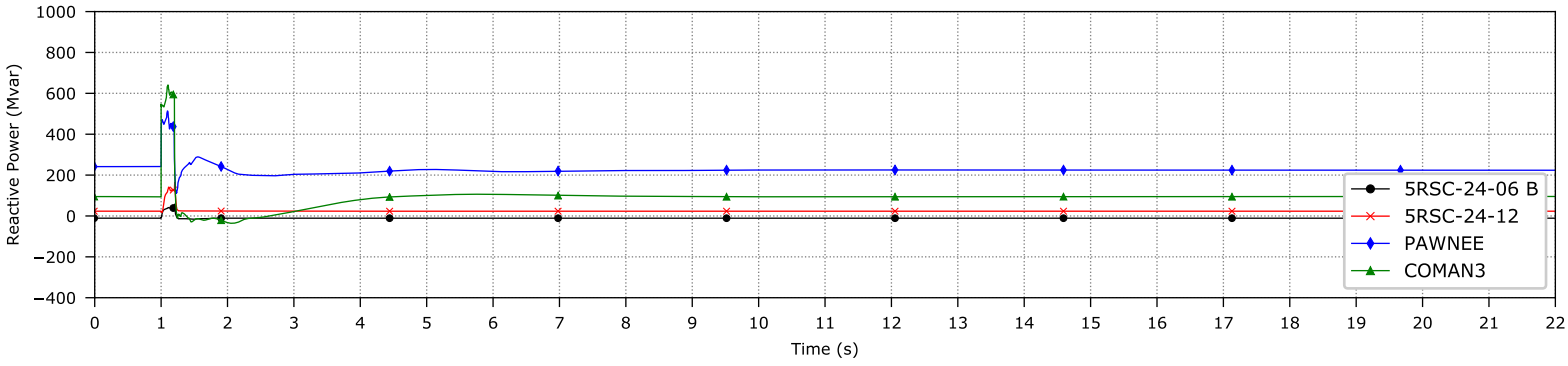

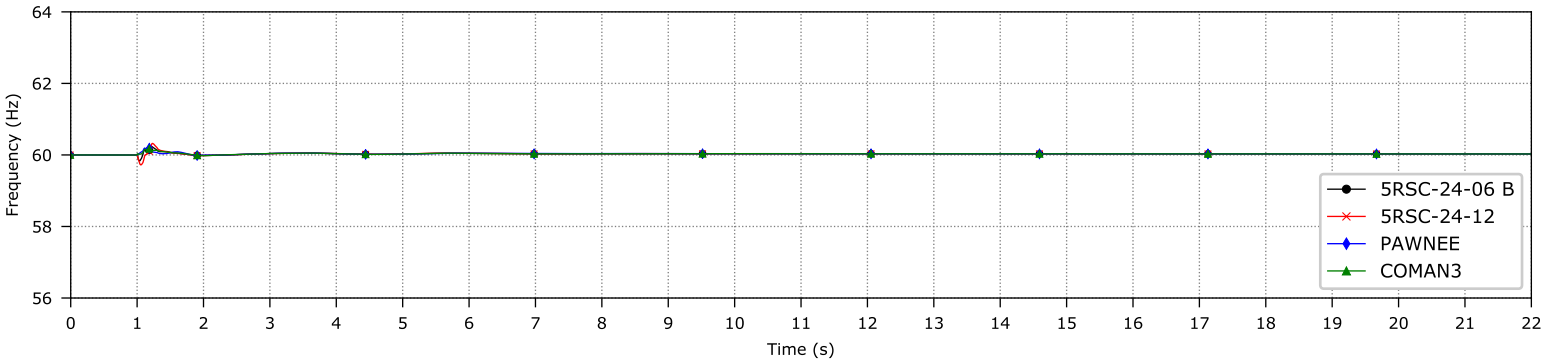

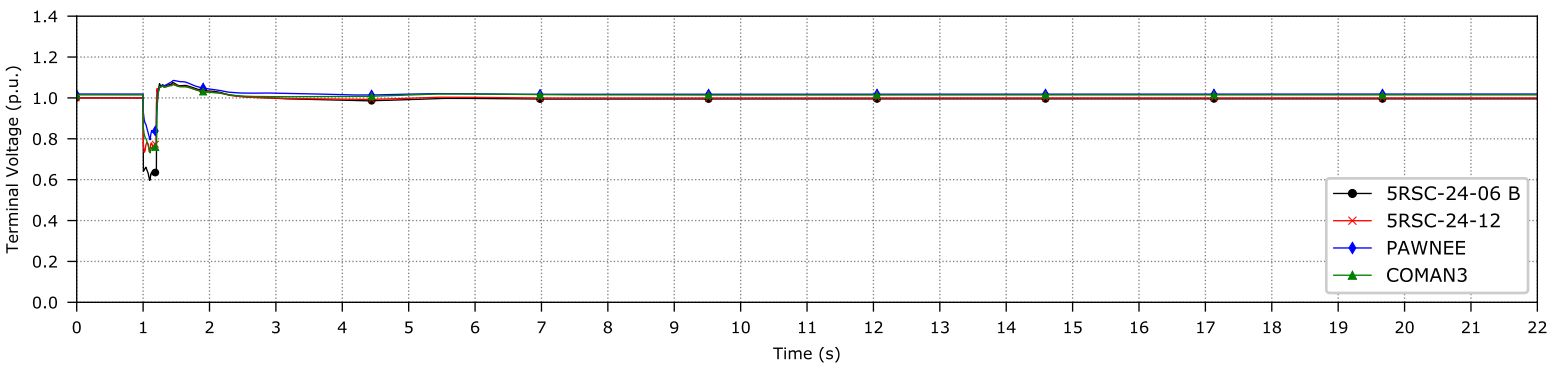

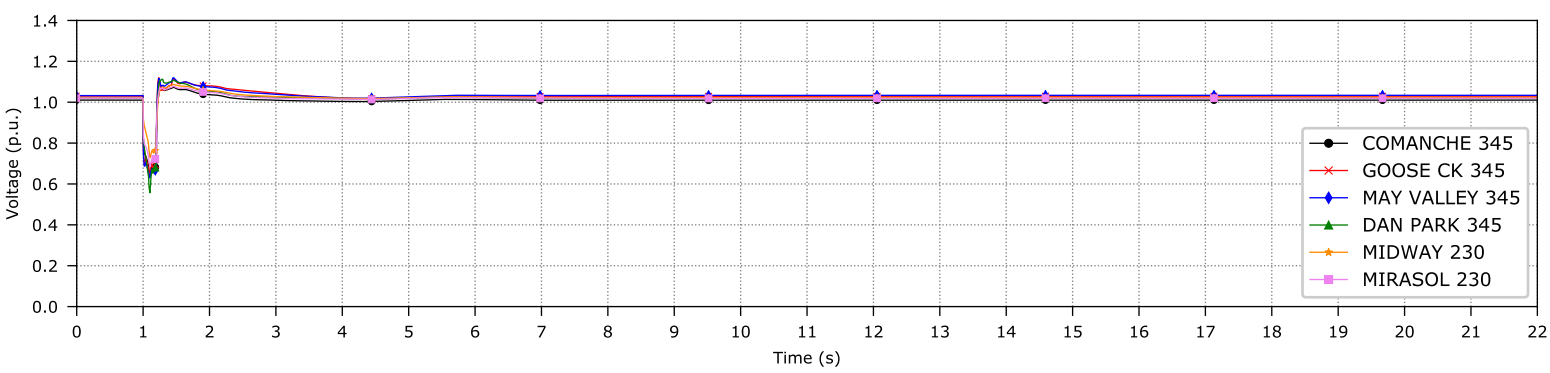

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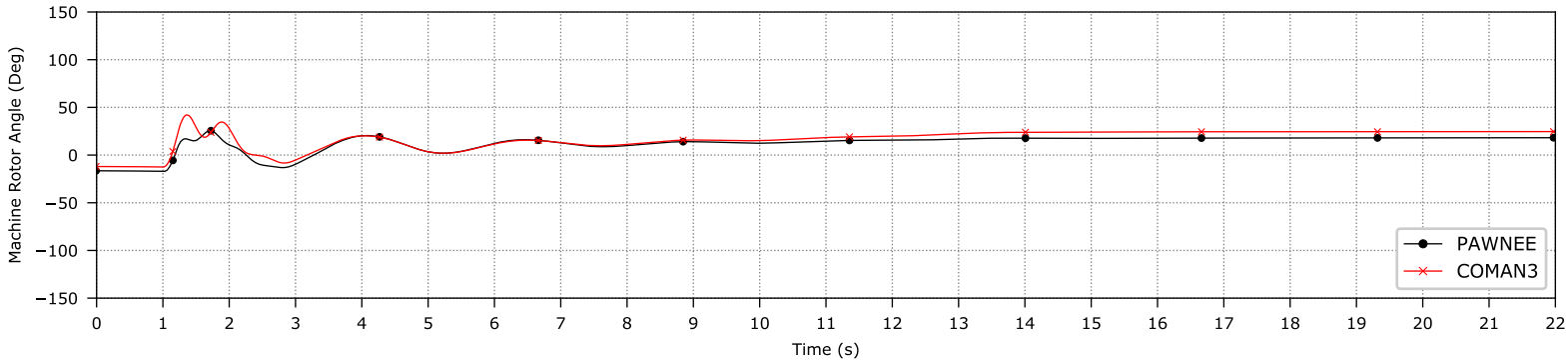
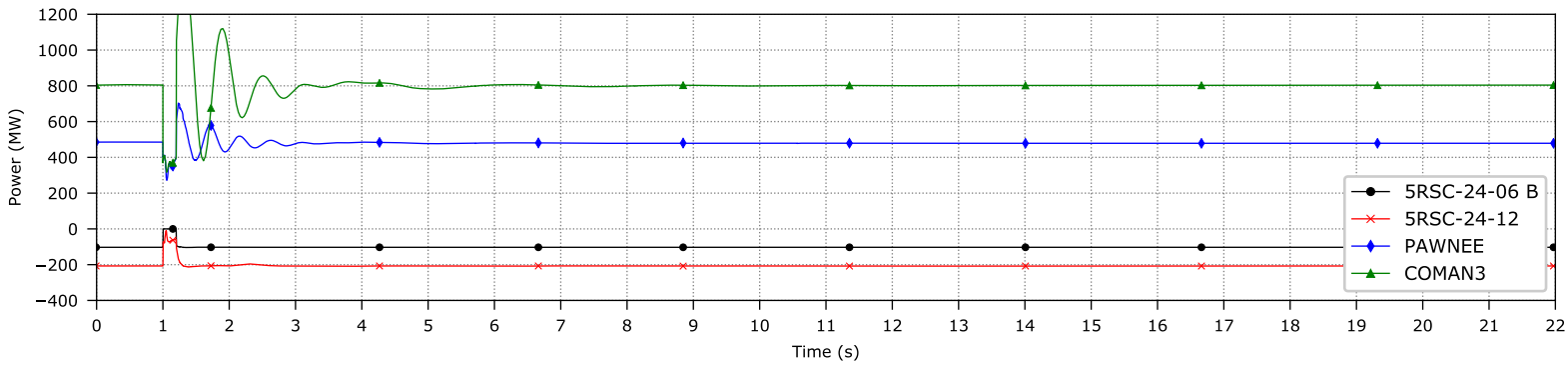
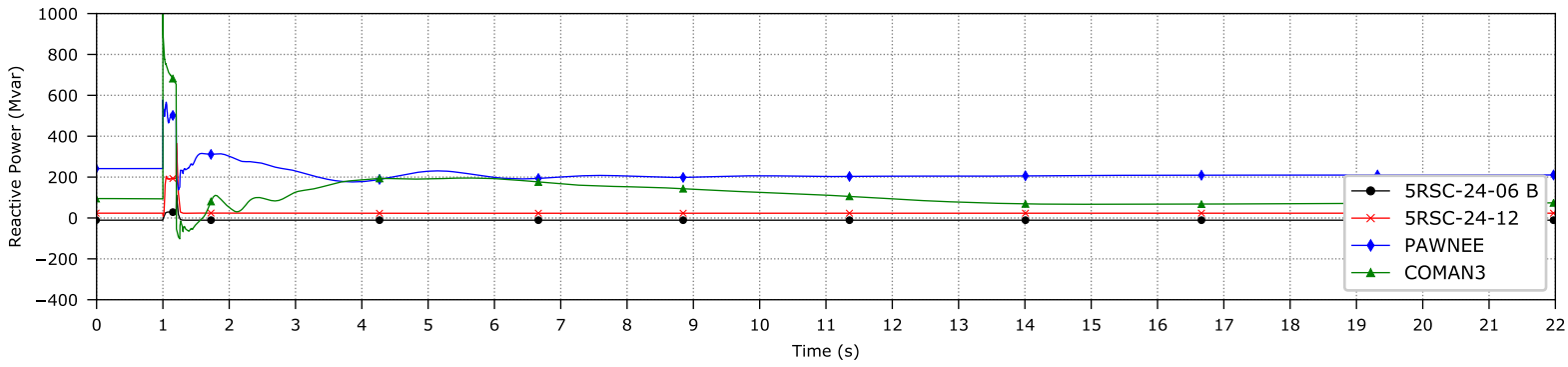
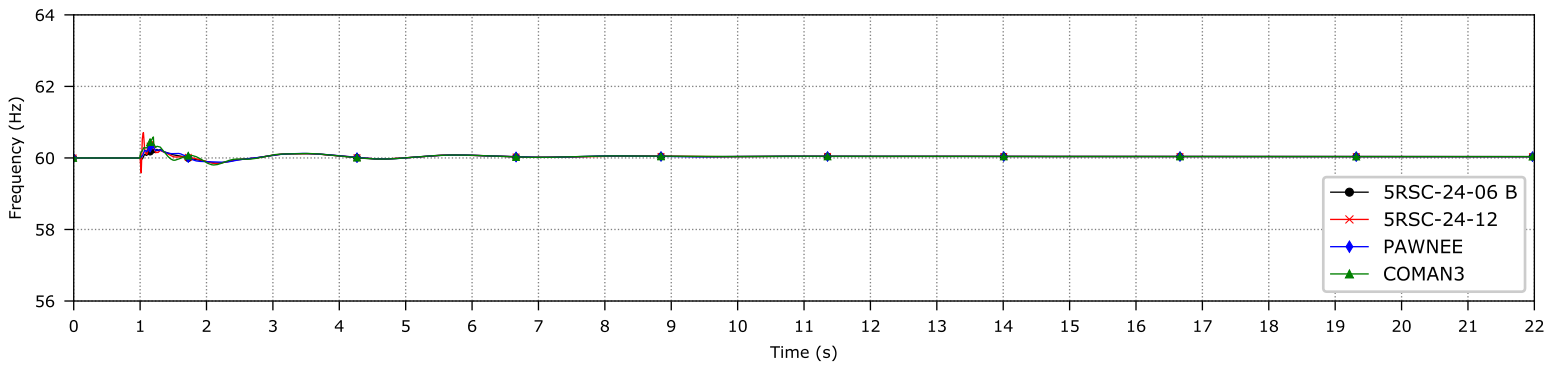
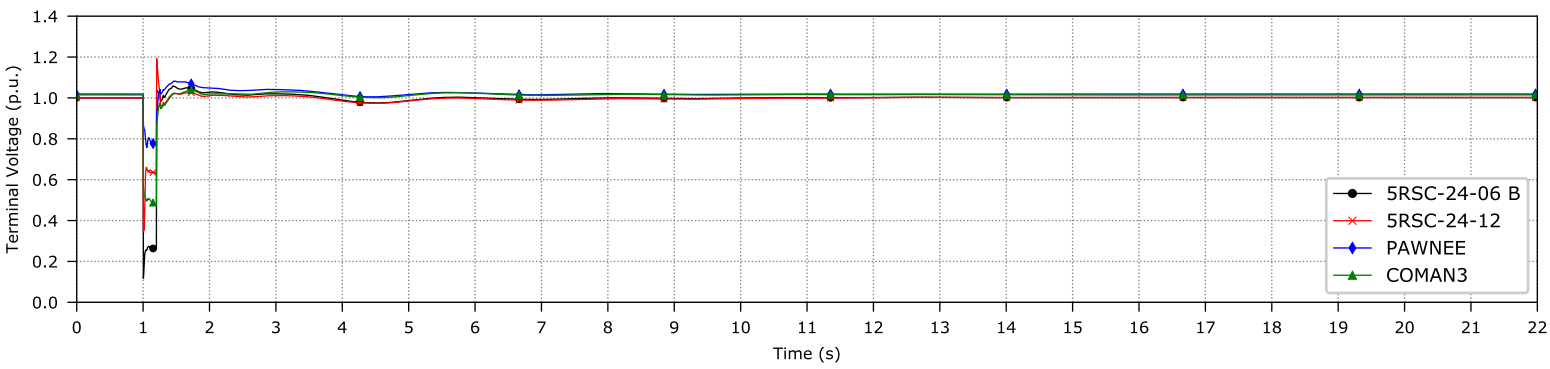
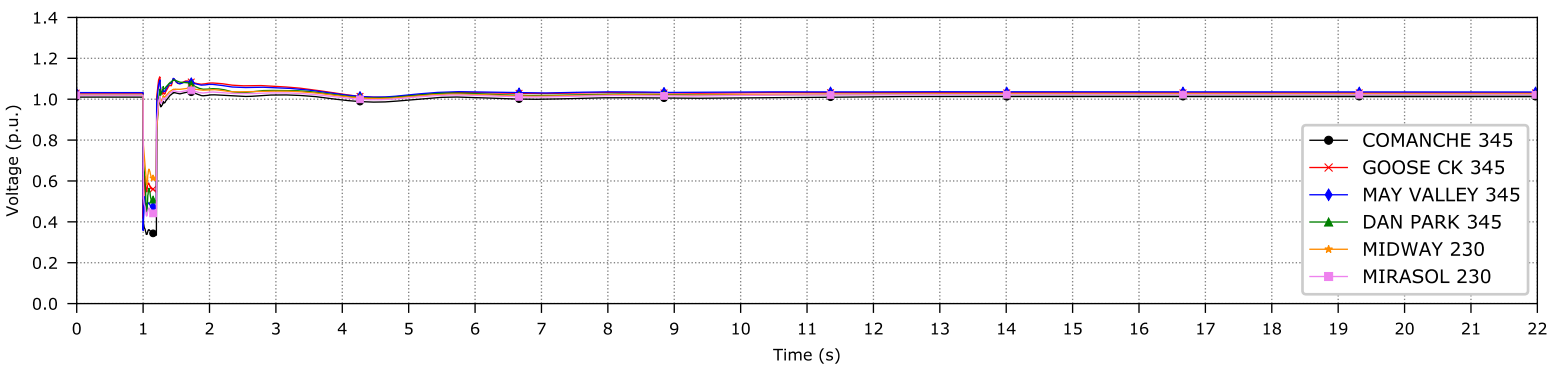


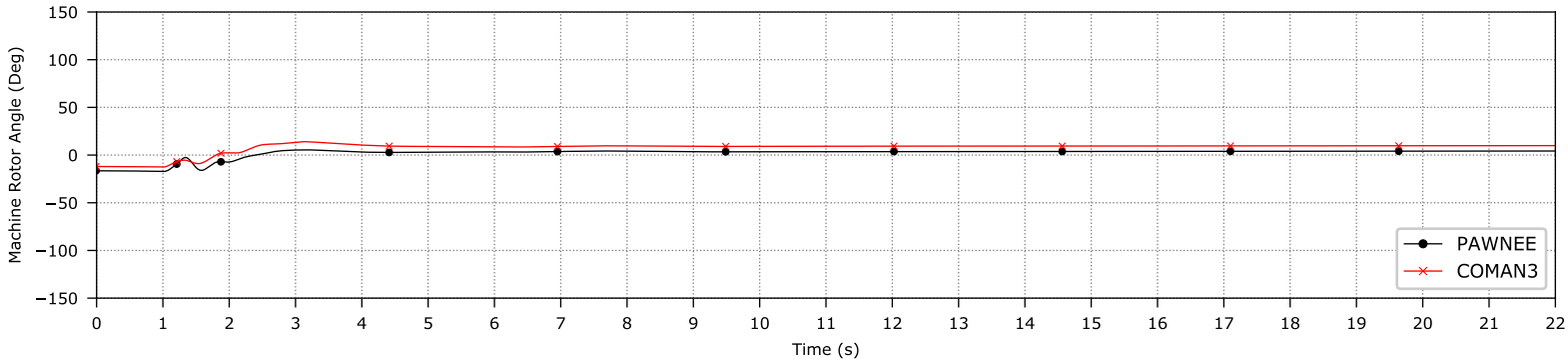


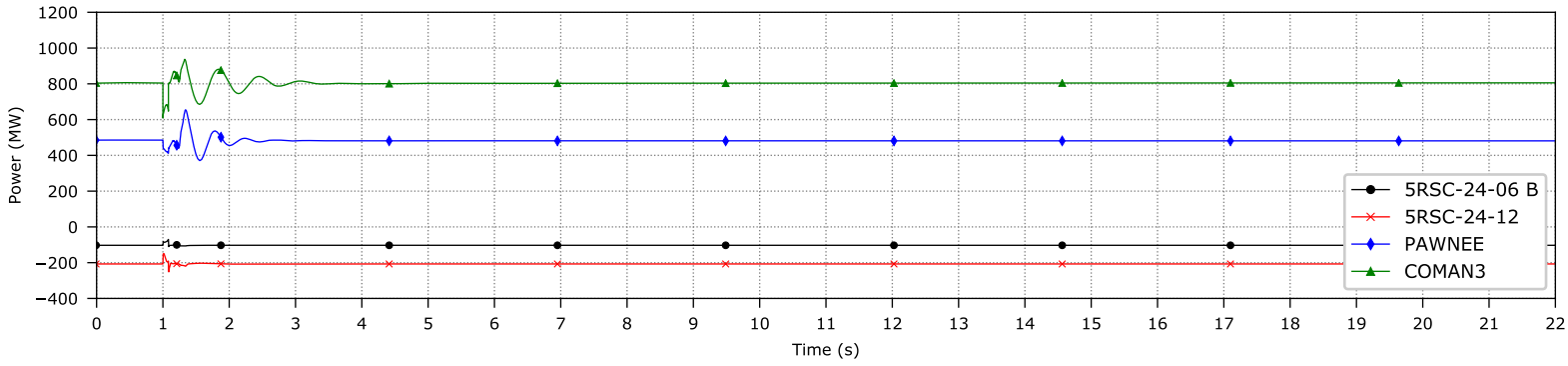


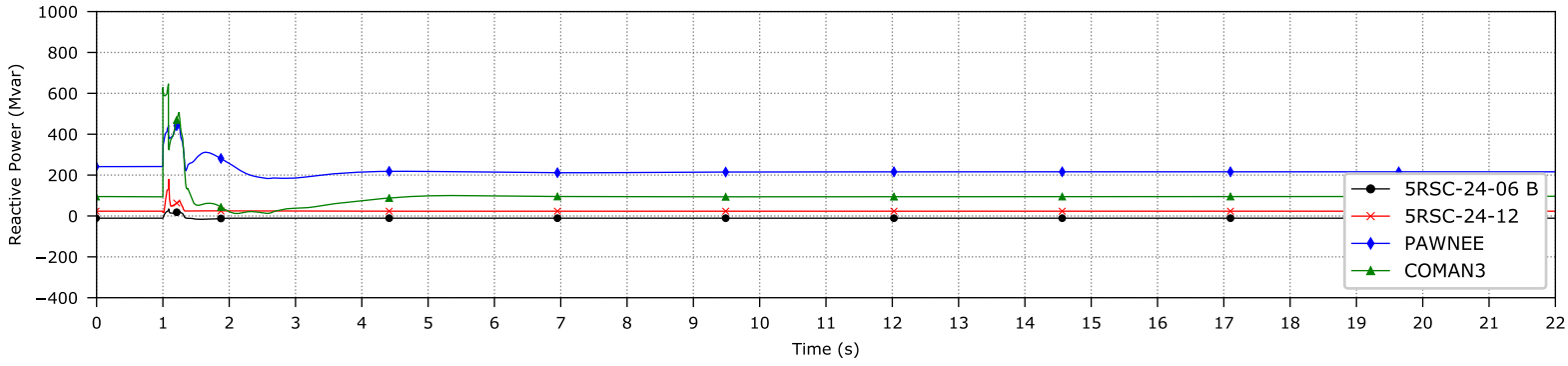


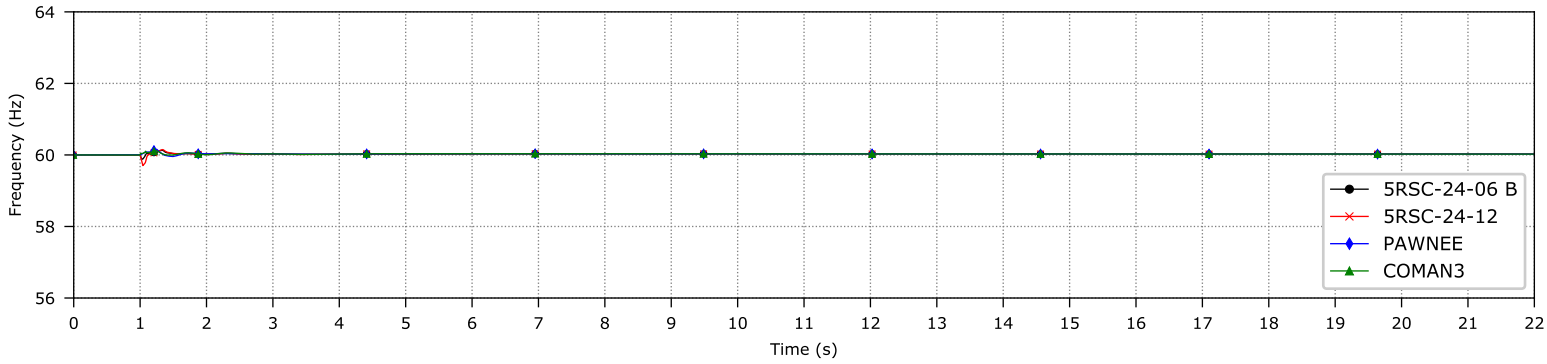


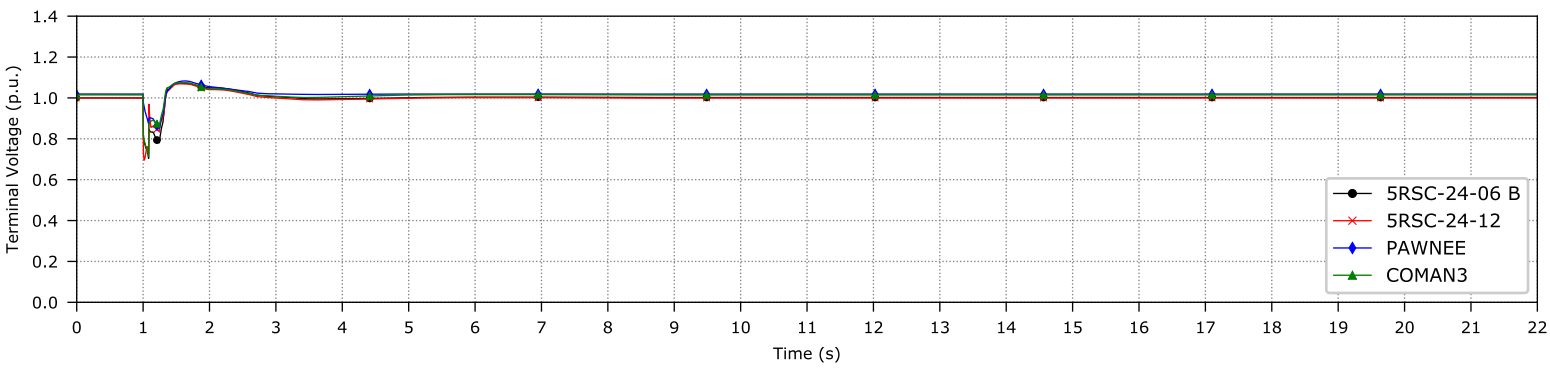


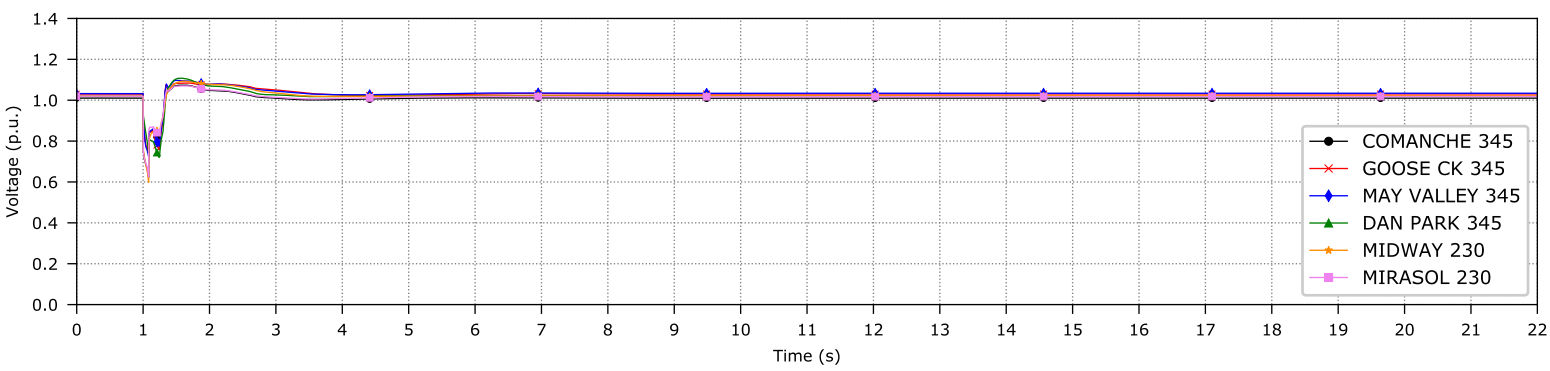

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

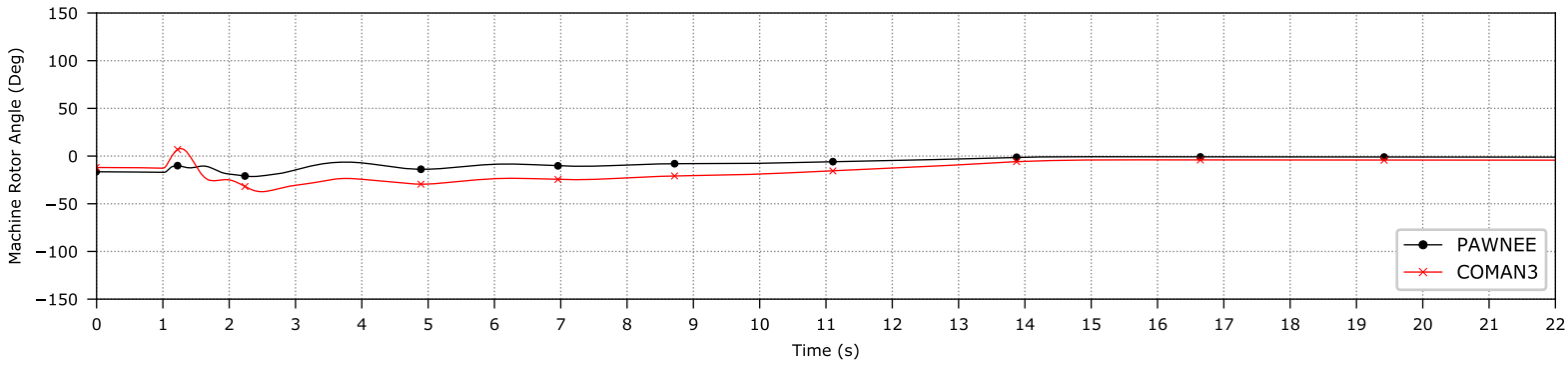

Reactive Power (Mvar)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

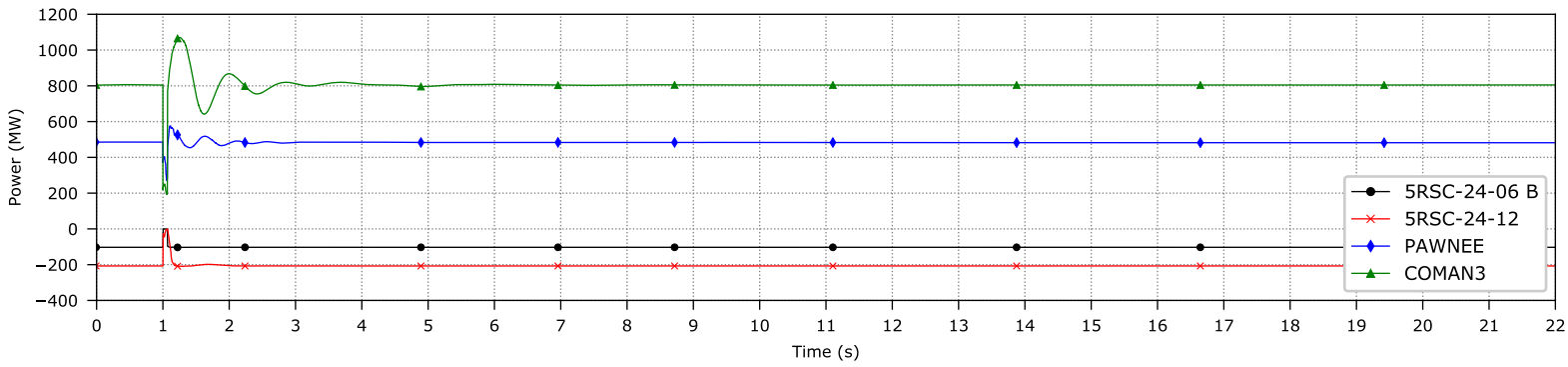

Frequency (Hz)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

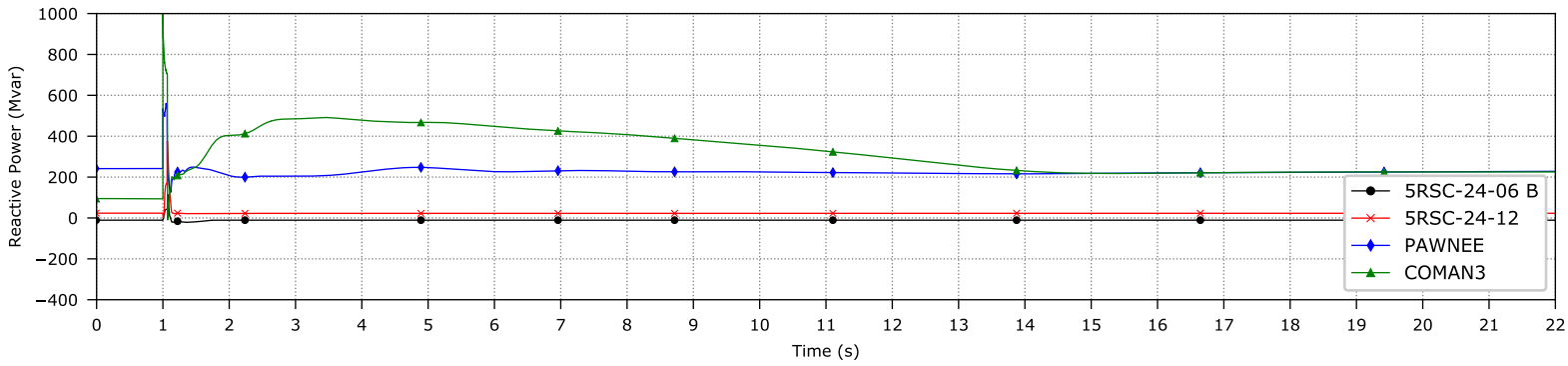

Terminal Voltage (p.u.)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

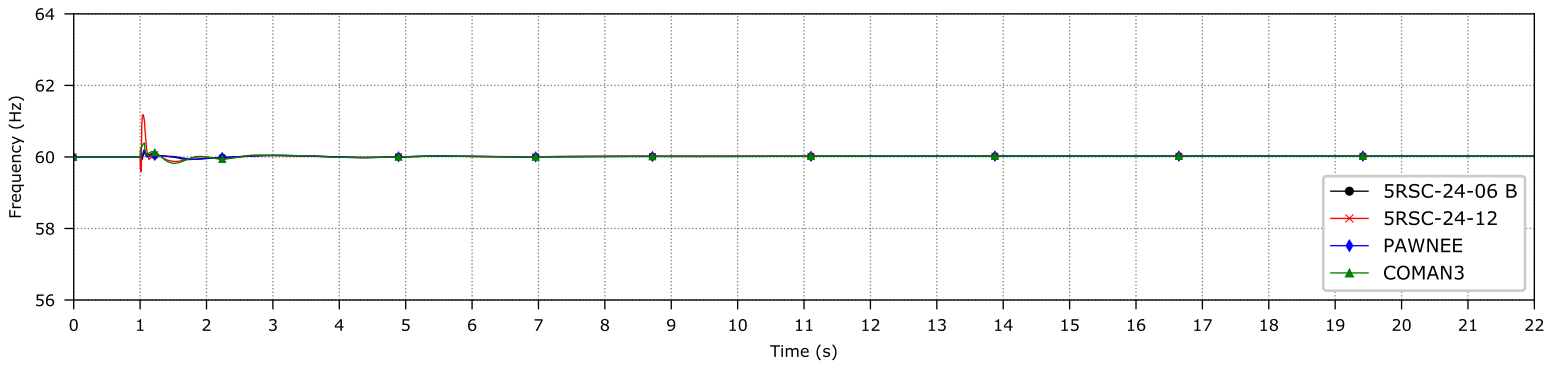

Voltage (p.u.)
Time (s)
COMANCHE 345
GOOSE CK 345
MAY VALLEY 345
DAN PARK 345
MIDWAY 230
MIRASOL 230

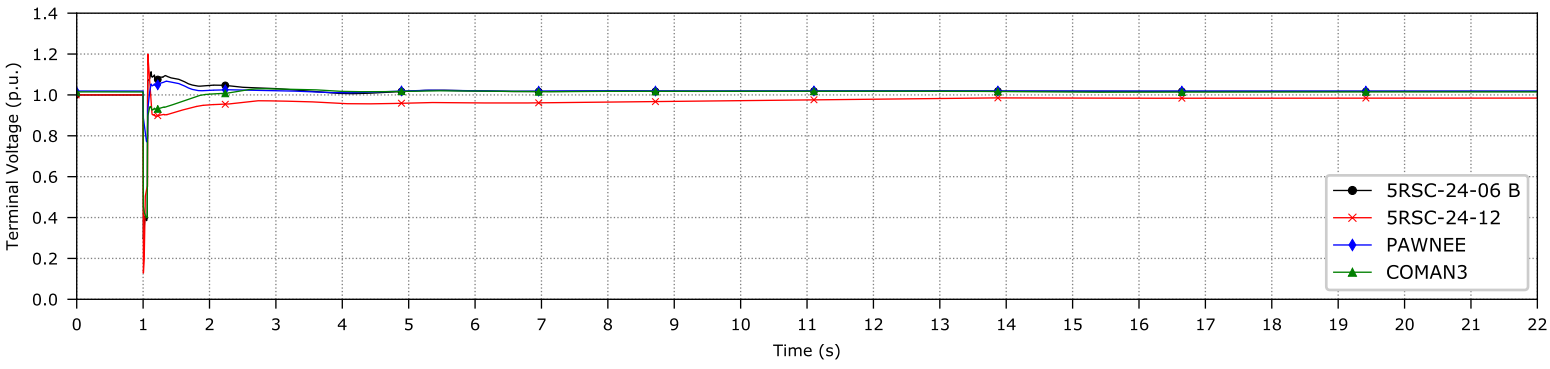
Ref. No. 24 - P7_55

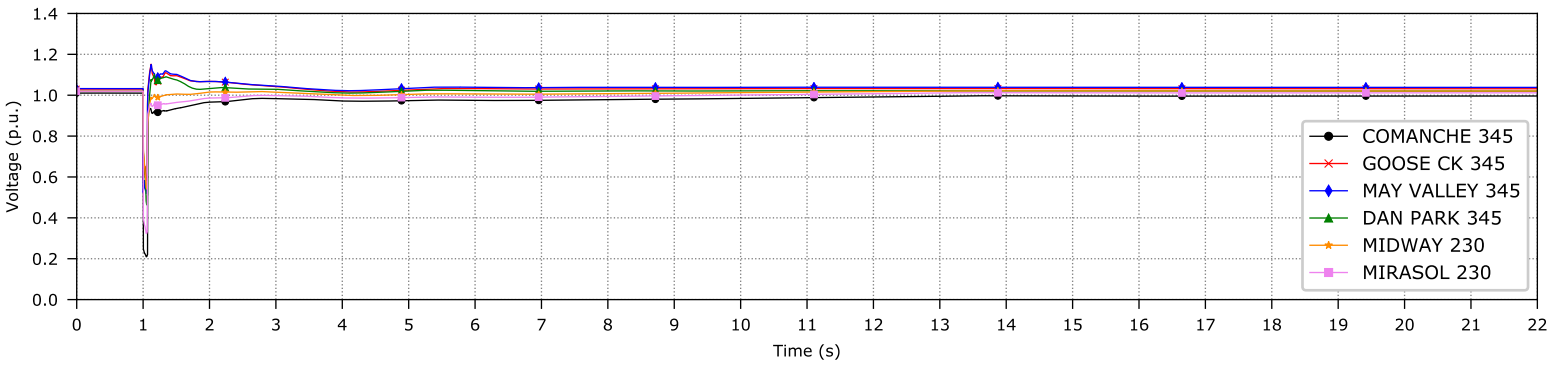


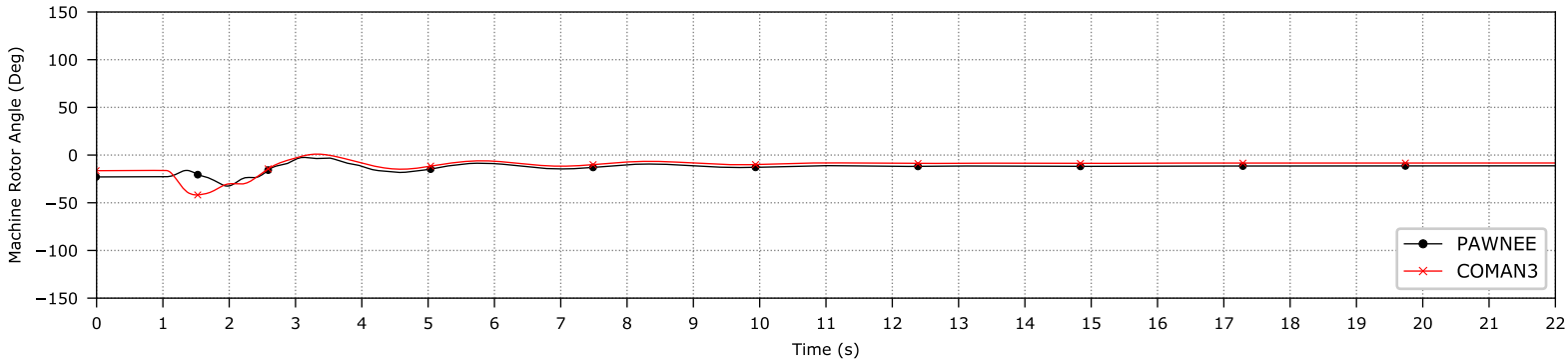


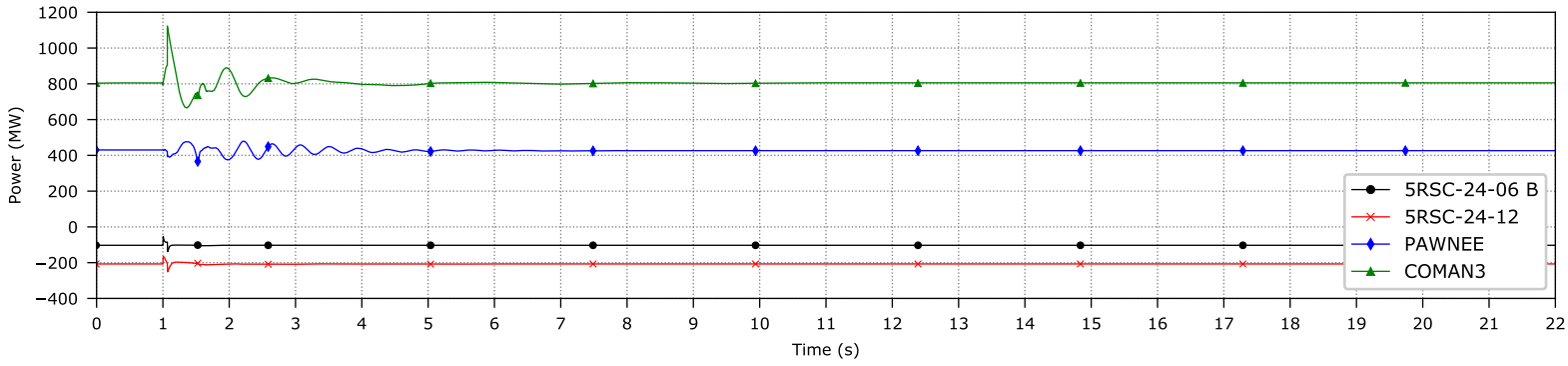


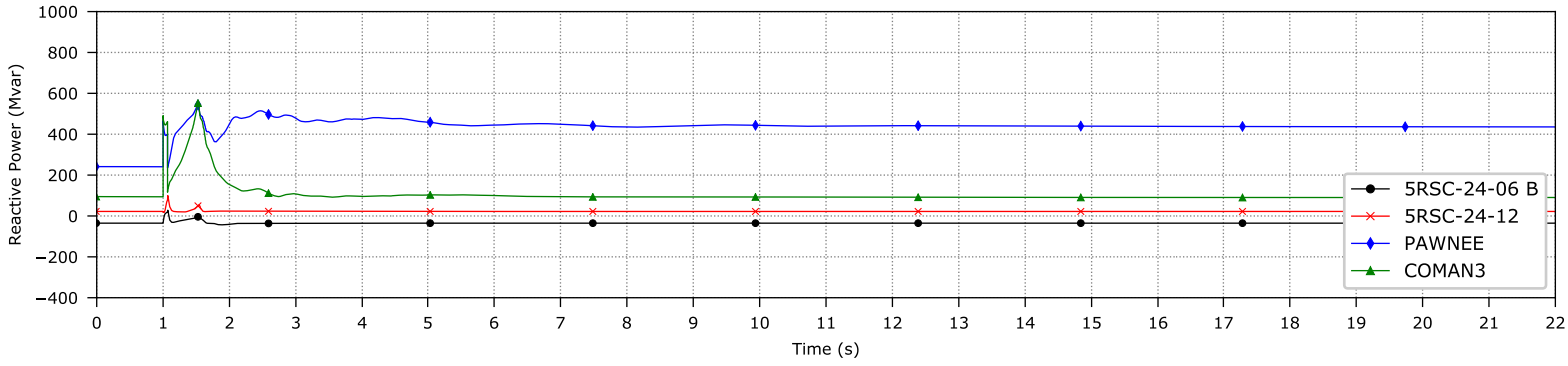


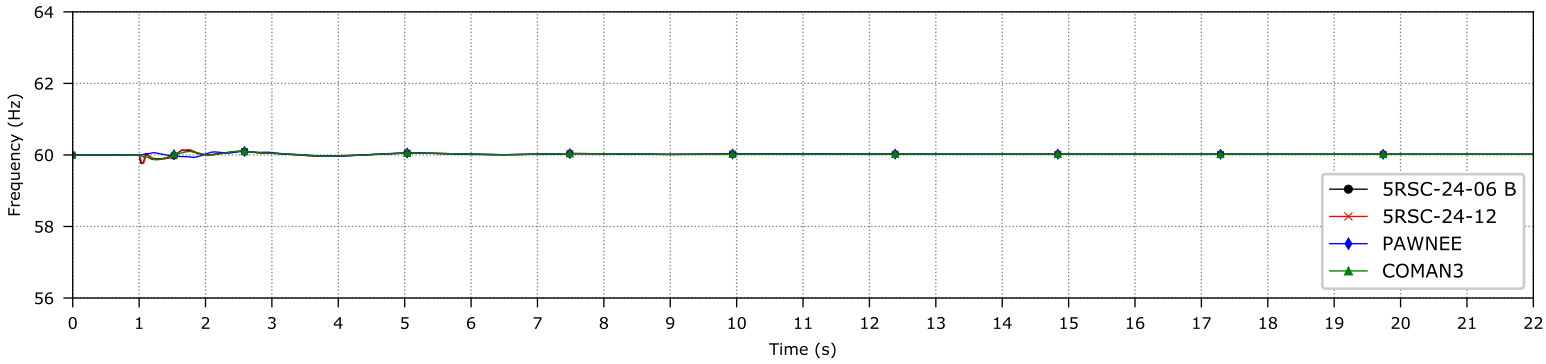


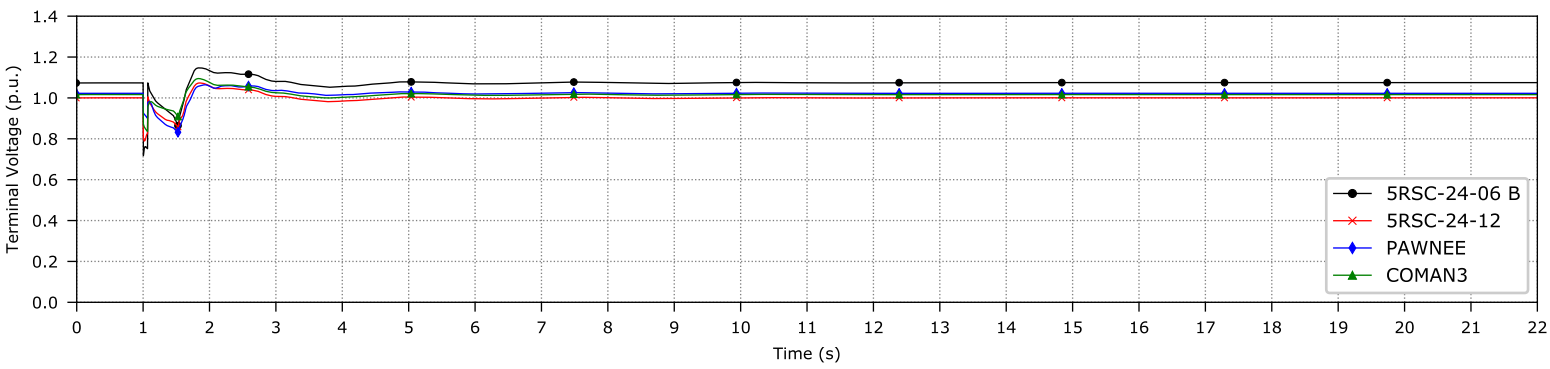


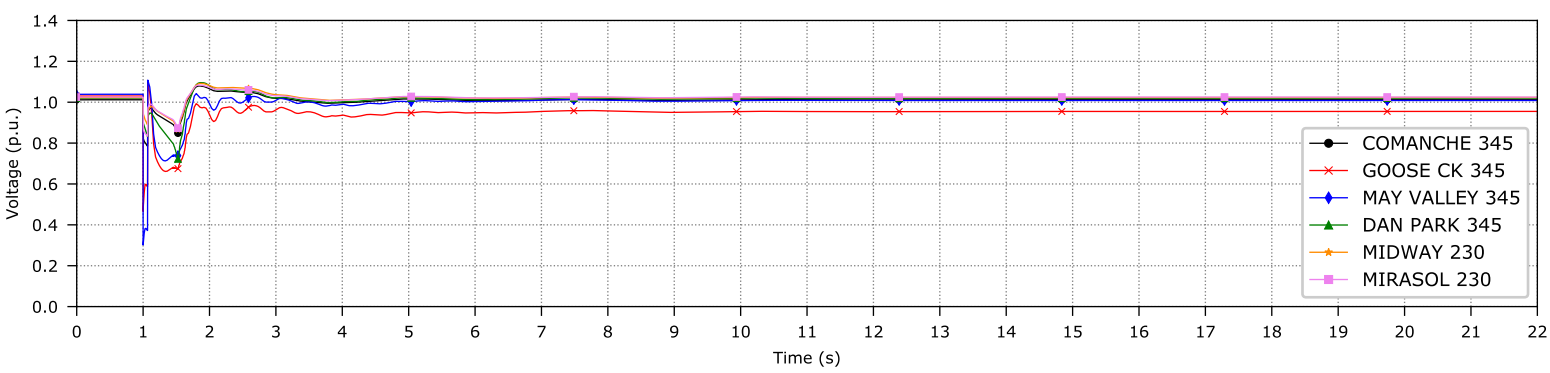

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3

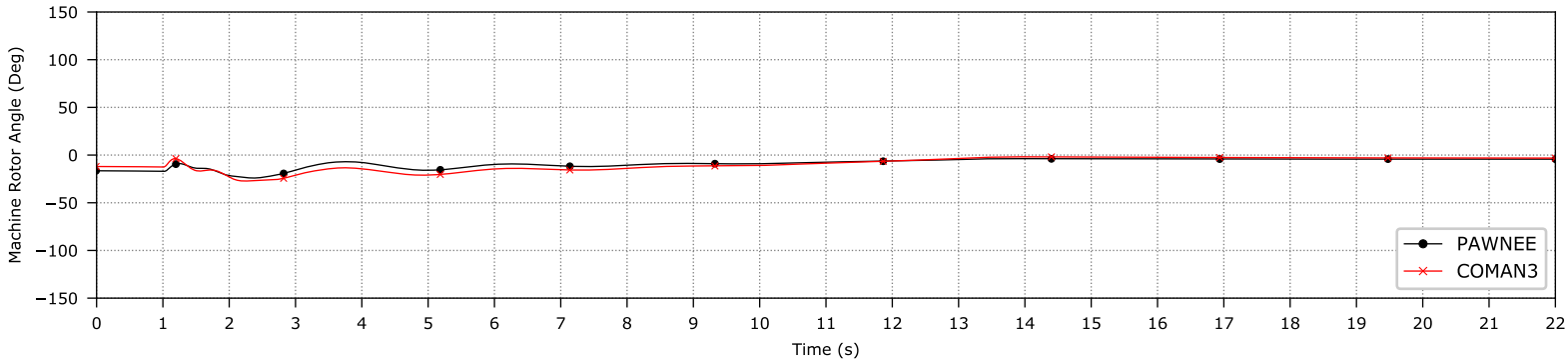

Power (MW)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

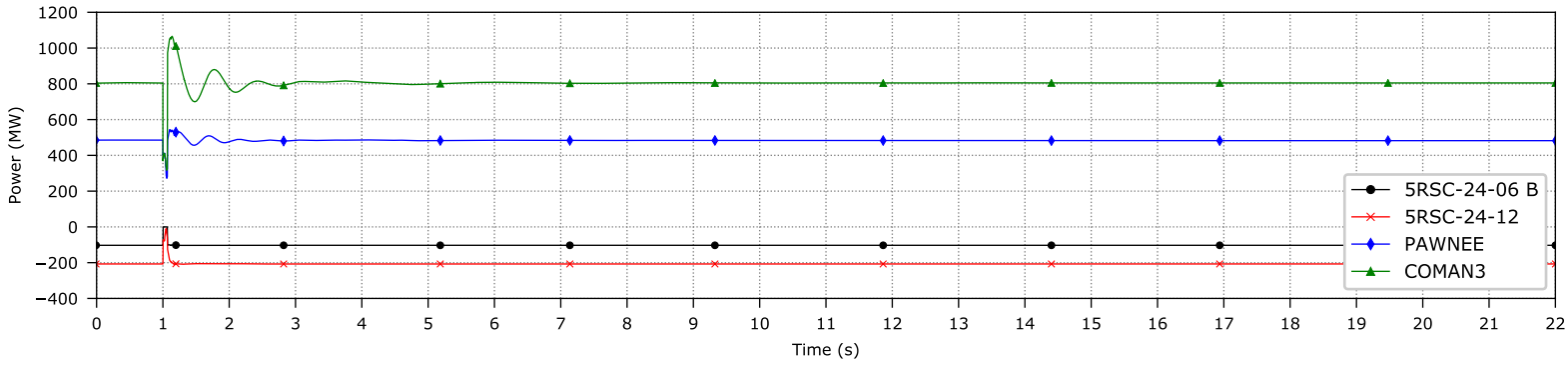

Reactive Power (Mvar)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

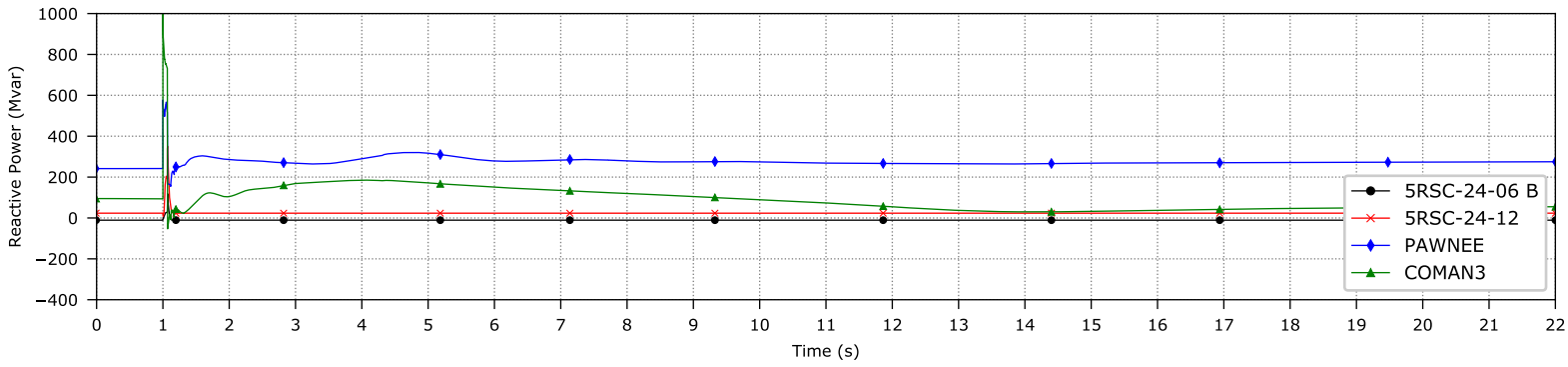

Frequency (Hz)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

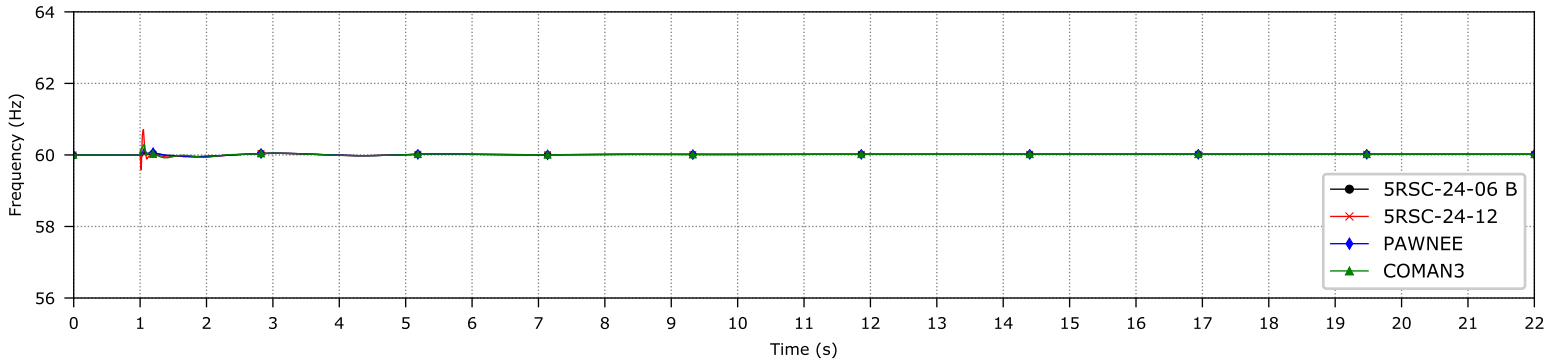

Terminal Voltage (p.u.)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3

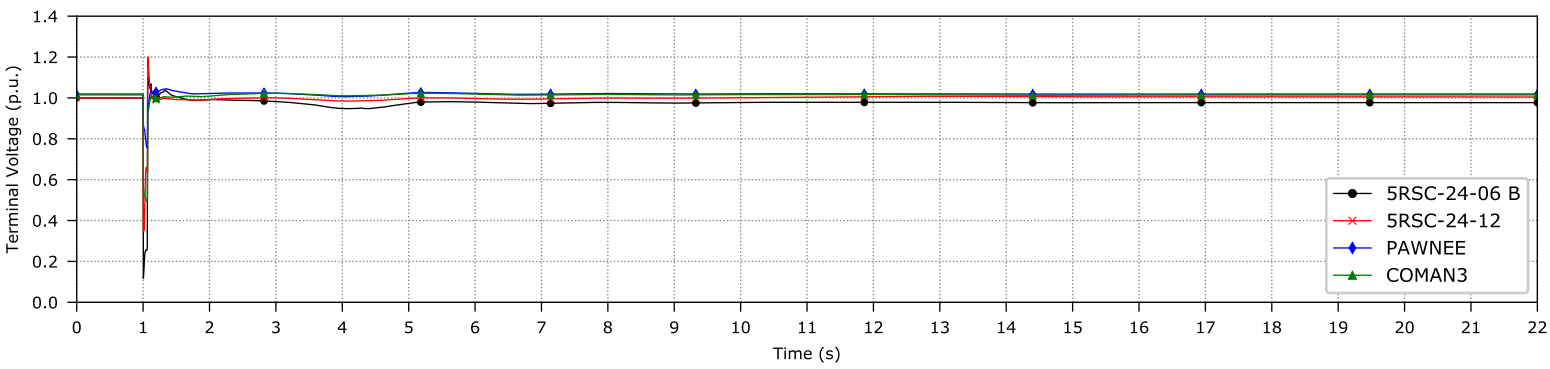

Voltage (p.u.)
Time (s)
COMANCHE 345
GOOSE CK 345
MAY VALLEY 345
DAN PARK 345
MIDWAY 230
MIRASOL 230

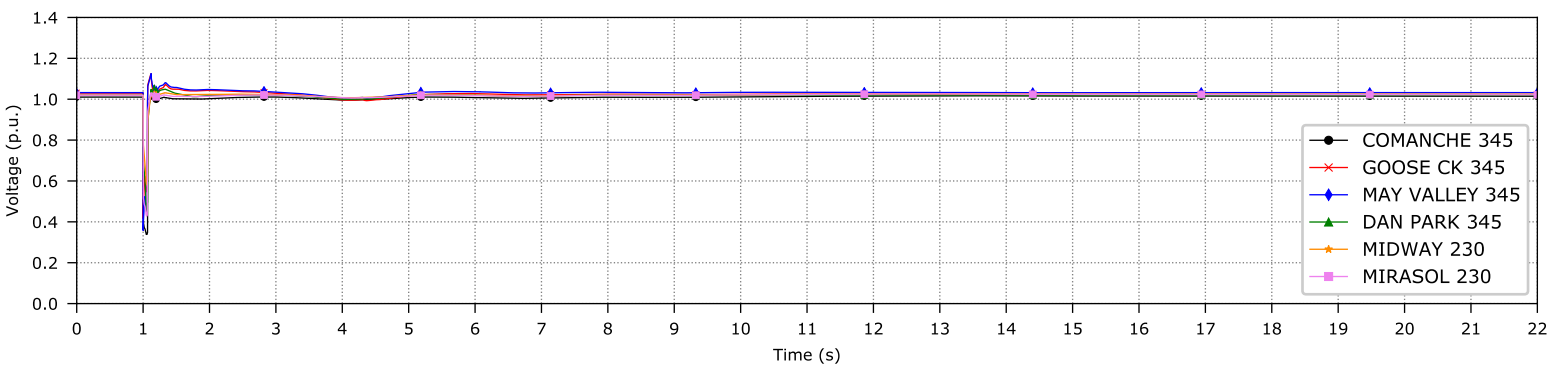
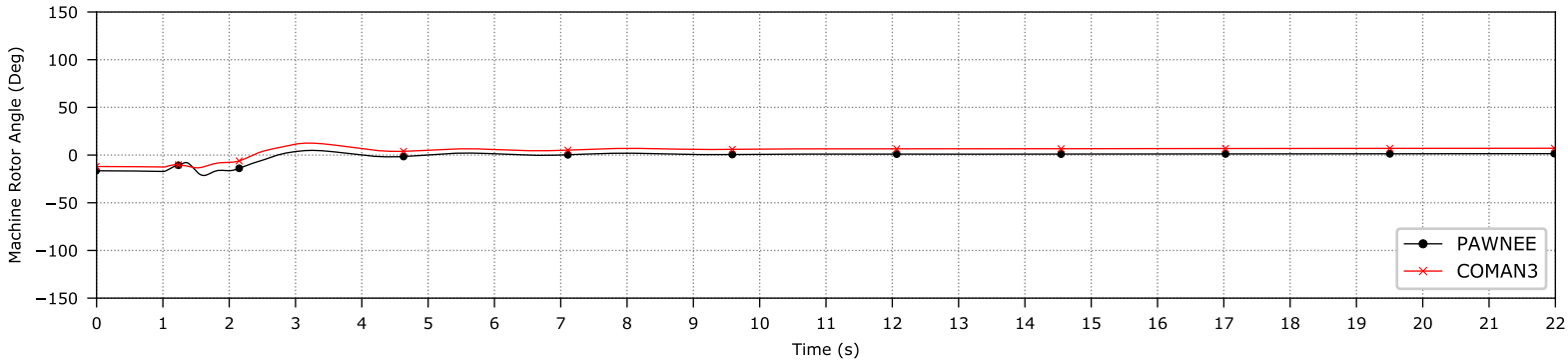
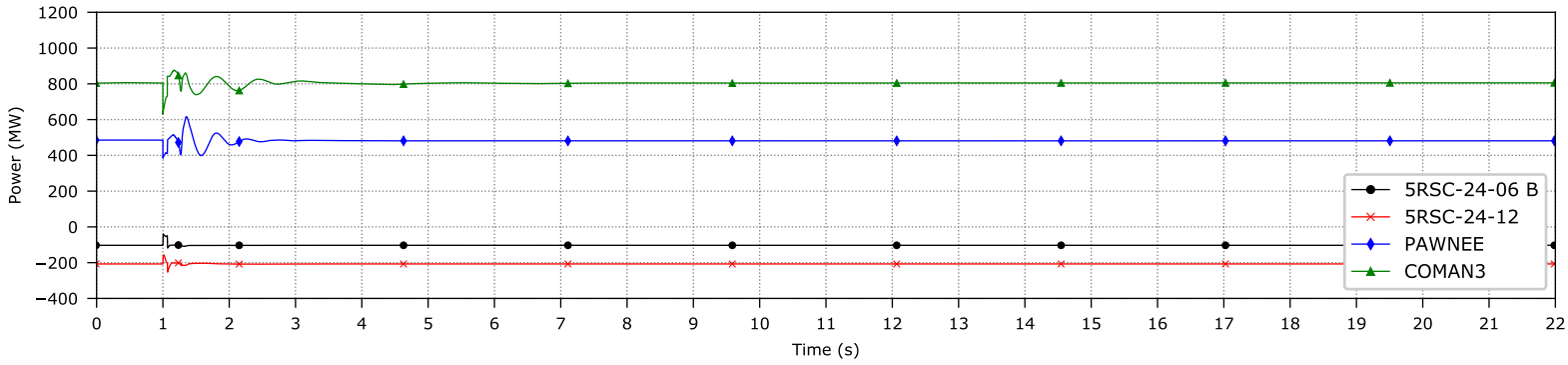
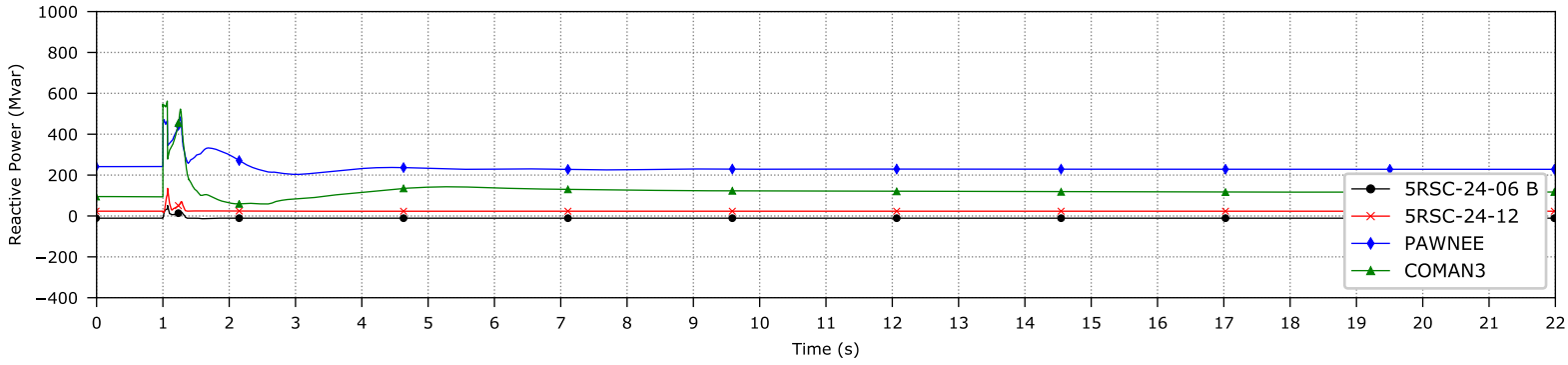
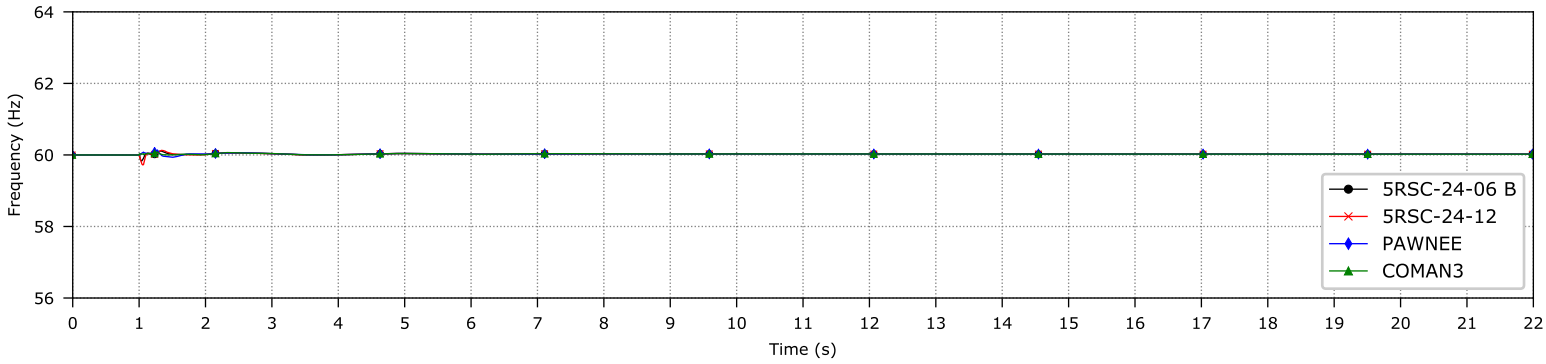
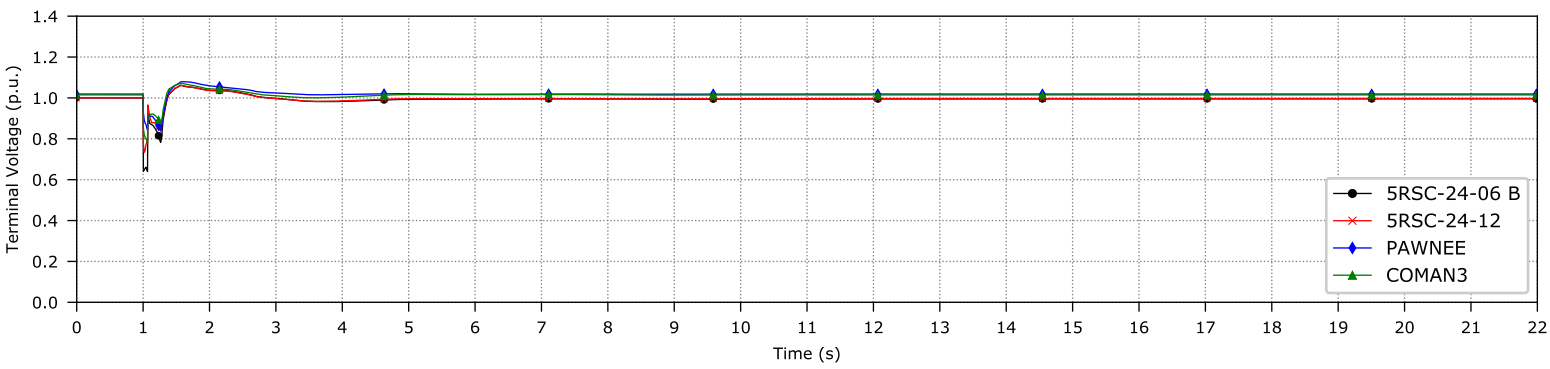
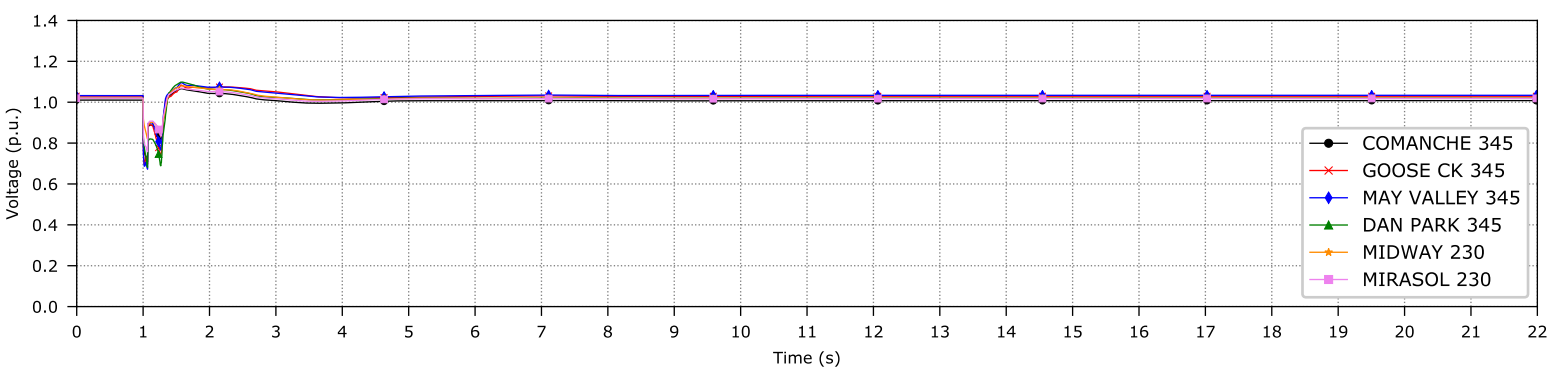

Machine Rotor Angle (Deg)
Time (s)
PAWNEE
COMAN3


Power (MW)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3


Reactive Power (Mvar)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3


Frequency (Hz)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3


Terminal Voltage (p.u.)
Time (s)
5RSC-24-06 B
5RSC-24-12
PAWNEE
COMAN3


Voltage (p.u.)
Time (s)
COMANCHE 345
GOOSE CK 345
MAY VALLEY 345
DAN PARK 345
MIDWAY 230
MIRASOL 230

Ref. No. 27 - P7_165