PSCAD Interactions Study and PSLF Transient Stability Study for 238MW Colorado Green II Wind Farm

FINAL REPORT

Report Submitted

to

Xcel Energy

from

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Introduction

The Colorado Green II wind farm project is a new installation of 238MW of wind generation near Lamar CO. Electranix was contracted to perform interaction studies using the PSCAD Electromagnetic transients program. Additionally, a transient stability study on the Colorado Green system was performed using GE's PSLF program. The back to back DC link at Lamar was modeled in detail for this study, using PSCAD and PSLF models provided by Siemens AG.

Executive Summary

Transient stability study results show that the addition of 238MW of wind generation at Colorado Green does not affect the system adversely. Certain contingencies caused violations of the NERC/WECC criteria for Class B disturbances, but these violations were evident before the addition of the wind farm as well as after. In particular, a 3-phase fault on the Comanche 230kV bus followed by the removal of a single unit at Comanche caused system instability in the region of the Bravo Dome compressor motors, both in the case with the new wind farm in and in the case without the new generation.

PSCAD interaction study results also show that the addition of Colorado Green 2 does not adversely affect the system. All cases run were electro-mechanically stable. No harmonic interaction was evident, except that the system exhibited a large impedance at the second harmonic, which could have an impact on transient over-voltages, outside the scope of this study. It must be noted that the GE supplied PSCAD model for the wind farm does not include any representation of the voltage control capability. Without a droop characteristic, the DC link AC voltage controller and the wind farm voltage controller would fight and result in VAR looping. This has been observed during commissioning tests at the DC link, and is currently under investigation by GE.

The manufacturers of both the HVDC link and the wind farms at Colorado Green should update their PSLF and PSCAD models to properly represent new data from commissioning tests at Lamar.

1. Study Methodology – Transient Stability

Xcel Energy provided PSLF load flow cases and dynamic model data for the base conditions used in this study. The latest dynamic models for the GE 1.5 MW wind turbines were added by Electranix. *After completion of the study work, updated wind models were released unofficially by GE (December 16, 2004). Since the original models were suspect as a cause of several reported machine trips, all cases were repeated using the updated model to identify the correct machine tripping. Appendix 1 includes the updated trip lists, but retains the original study results using the official GE wind models.* Siemens AG provided PSLF models and control data required for the General Power Flow Controller (GPFC) at Lamar. All transient stability studies were performed using GE PSLF version 14.2 and GE PLOT version 14.2.

The transient stability model of the wind turbines at the existing Wind farm at Colorado Green 1 (CG1) included low voltage ride-through (LVRT) capability, but the new wind farm (CG2) used an improved LVRT whose settings were taken from the equivalent PSCAD model provided by GE. In general the improved LVRT at CG2 was able to withstand much more severe faults, and did not trip except during very close-in bolted faults.

The cases used in this study were as follows:

- Case 1: The first base case was derived from 10walgen8.sav, provided by Xcel Energy. This case includes several network upgrades to the WECC base case, including a new 750MW cross-compound machine at Comanche, 2 additional 345kV rated circuits between Lamar 230kV and Boone 230kV, and a new circuit between Comanche and Midway, through which flows all the 750MW from the new Comanche generator. Power flow through the DC link at Lamar was East to West. (See Appendix 2)

  The additions to this case by Electranix were as follows:
  - The simple generator at Lamar was replaced with detailed DC link PSLF model. The east side of the Lamar DC link was modeled up to the 340MW machine at Holcomb 22kV, and system equivalent circuits were placed at Holcomb 115kV, Holcomb 345kV, and Potter County 345KV. DC control included control of the switched capacitor banks at the Lamar 53kV buses.
  - Detailed models for the GE 1.5 MW wind turbines were added at CG1 and CG2. Updated models for these turbines were released unofficially by GE on December 16th 2004, and these models were used to re-run the cases and update the machine trip table shown in Appendix 1.

- Case 2: The second base case was identical to the first case, except the 238MW of wind turbines at CG2 were switched out. The generation required to balance the load flow was added proportionally to all the generators in WECC zone 706.

Output Monitoring

Faults were applied and contingencies examined according to Table 1, which includes all the contingencies specified for examination by Xcel Energy. Each fault was applied for both base cases, except the case of sudden loss of CG2 due to a wind gust.

For each of the faults shown in Table 1, Table 2 shows the quantities that were monitored. This list of quantities was specified by Xcel Energy. As results bore further investigation, additional monitor points were examined according to the specific contingency.

Discussion of PSLF Low Voltage Ride-Through Settings

All parameters for the GE 1.5MW wind turbine model were the default values recommended by GE with the exception of the low voltage ride-through (LVRT) settings. These protection levels are variable according to specific wind farms, and must be set correctly in order to predict wind farm tripping with accuracy. The LVRT settings for CG1 are different from those at CG2, and consequentially the fault cases which produced tripping were different for these two wind farms. LVRT settings for the CG1 wind farm were taken from the PSCAD model provided by GE. These values were validated for PSLF by Bill Price of GE Wind. The CG1 settings are:

"dvtrp1" -0.25 "dvtrp2" -0.30 "dvtrp3" -0.70 "dvtrp4" 0.10 "dvtrp5" 0.16 "dvtrp6" 0.30 "dttrp1" 1.0 "dttrp2" 0.20 "dttrp3" 0.01 "dttrp4" 1.00 "dttrp5" 0.20 "dttrp6" 0.02

Unfortunately, the exact protection settings to be used at CG2 were unknown, and so these levels were assumed to be the same as those used in the PSCAD model. These settings used for CG2 are:

"dvtrp1" -0.25 "dvtrp2" -0.30 "dvtrp3" -0.850 "dvtrp4" 0.10 "dvtrp5" 0.16 "dvtrp6" 0.30 "dttrp1" 1.0 "dttrp2" 0.20 "dttrp3" 0.01 "dttrp4" 1.00 "dttrp5" 0.20 "dttrp6" 0.02

Table 1 – Fault Case List for CG2 Transient Stability Study

Bus	Fault and Clearing	Outage #
Col Green 230kV	3-Phase fault on CG-Lamar 230kV at CG; Clear and Open CG-Lamar 230kV after 6 cycles	S1
Lamar 230kV	3-Phase fault on CG-Lamar 230kV at Lamar; Clear and Open CG-Lamar 230kV after 6 cycles	S2
	3-Phase fault on Lamar-Boone 230kV #1 at Lamar; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S3
Lamar 115kV	3-Phase fault on Lamar-Willow Ck. 115kV at Lamar; Clear and Open Lamar-Willow Ck.115kV after 6 cycles	S4
	3-Phase fault on Lamar-Vilas 115kV at Lamar; Clear and Open Lamar-Vilas 115kV after 6 cycles	S5
Boone 230kV	3-Phase fault on Lamar-Boone 230kV #1 at Boone; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S6
	3-Phase fault on Boone-Midway 230kV #1 at Boone; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S7
	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S8
Boone 115kV	3-Phase fault on Boone-LaJuntaT 115kV at Boone; Clear and Open Boone-LaJuntaT 115kV after 6 cycles	S9
	3-Phase fault on Boone-LaJuntaW 115kV at Boone; Clear and Open Boone-LaJuntaW 115kV after 6 cycles	S10
	3-Phase fault on Boone-DOT Tap 115kV at Boone; Clear and Open Boone-DOT Tap 115kV after 6 cycles	S11
Comanche 230kV	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S12
	3-Phase bus fault at Commanche; Clear fault and Disconnect Comanche G1	S13
Midway 230kV	3-Phase fault on Boone-Midway 230kV #1 at Midway; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S14
Midway 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Midway; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S15
Daniel's Pk 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Daniels Pk; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S16
Col Green II 34.5kV	Sudden Loss of 238 MW Power at Colorado Green II due to Wind Gust	S17
Comanche 345kV	3-Phase Bus Fault at Comanche 345kV; Clear and Open Comanche-Midway 345kV #1 after 6 cycles	S18
Comanche 3 22kV	3-Phase Bus Fault at Comanche 345kV; Clear and drop Comanche G3 750MW	S19
	Sudden Loss of 750 MW Power at Comanche G3 -	S20

Table 2 – Measured Quantities

Bus voltages, frequencies, angles were monitored for Generators at:	Bus voltage was monitored at the following buses:
- Colorado Green	- Springfield 69 kV
- Lamar HVDC	- Vilas 115 kV
- City of Lamar 25 MW Gen	- Walsh 69 kV
- Comanche G1	- Willow Creek 115 kV
- Fountain Valley G1	- Willow Creek 69 kV
- Rd Nixon G1	- LaJuntaT 115 kV
- Arapahoe G4	- LaJuntaW 115 kV
- Cherokee G4	- Rd Nixon 230 kV
	- Reader 115 kV

2. Study Methodology – PSCAD Interactions

The PSCAD interaction study at Colorado Green II used Case 1 (Described above) as a starting case. PSCAD Version 4 and E-TRAN 1.2 were used in this study. The system represented is shown in Figure 1. The PSCAD circuit was generated by E-TRAN by direct translation of the base case 1 loadflow file used in the transient stability test. Network equivalents (not shown) are generated for the network which is 5 or more busses away from the Lamar 230 kV bus. The network equivalents are +ve sequence multi-port (i.e. they include off-diagonal elements representing remote transmission between busses), and are valid for steady state, short circuit and open circuit conditions.

Data for the new 750 MW cross-compound machine at Comanche (Comanche 3) was taken from the transient stability model provided by Xcel Energy. As well, detailed device data was available from previous studies. This data was substituted for the loadflow data (using the E-TRAN Substitution Library feature) for the following devices:

- Lamar and Boone 230/115 3 winding auto-transformers
- 230 kV lines: Lamar-Boone, Boone-Midway, Midway-Comanche, Lamar-Colorado Green
- Back to Back DC Link. The DC link is still in construction so a preliminary model was used (the latest PSCAD V4 model available from Siemens).
- Comanche Generators (1 and 2) and control systems
- CG I and CG II wind turbine model (details given below)

The detailed device data includes frequency dependent representations (for example transmission lines and HVDC filters), non-linearities (transformer saturation) as well as +ve, -ve and 0 sequence data (transformer grounding, tertiaries, wye-delta windings etc.).

The remaining devices were represented with translations based on the loadflow data. Transmission lines longer then 15 km are translated by E-TRAN as Bergeron traveling wave lines, whereas shorter lines are represented by pi sections.

16 cases were run (Table 3), and for each case the system was observed for possible interactions between devices, particularly the new wind farm at Colorado Green (CG2). Harmonic impedance plots were created, as seen from the Lamar 230kV bus, to see if interesting resonances exist. The cases used in the interaction study were as follows:

Cases 1-10: LLLG Line Faults for both dc power directions:

- Lamar Boone 230 kV
- Lamar Colorado Green 230 kV
- Lamar Willow Creek 115 kV line (no reclose)
- Lamar Finney 345 kV
- Finney Potter 345 kV

Cases 11-16: Other Cases (both dc power directions):

- trip of Comanche 3 generator (909 MVA)
- trip of Holcomb generator
- trip of feeders to Colorado Green I wind farms

HVDC Cross-tripping controls in PSCAD model

Cross-tripping controls in the HVDC link were disabled for the interaction studies. Currently, these controls cause a power order reduction in the DC link and place the DC link into a voltage control mode when the 230kV line from Boone to Lamar is opened. Since the network upgrades used in the study included additional circuits between Boone and Lamar the line was no longer radial, and the cross-trip functionality was not required.

Notes regarding deficiencies in PSCAD model

The PSCAD model provided by GE for the wind farm had several observed problems. First, it is currently unable to generate harmonics, and therefore any interactions that could result from harmonics generated by the real wind farm can not be predicted. Additionally, dynamically opening the lines feeding the wind farm caused a crash in PSCAD. Although this crash did not occur in the very simple case provided by GE, the model should be capable of operating in a stable fashion in larger systems and in any study. Further discussion of this issue is provided in the PSCAD interactions section of this report.

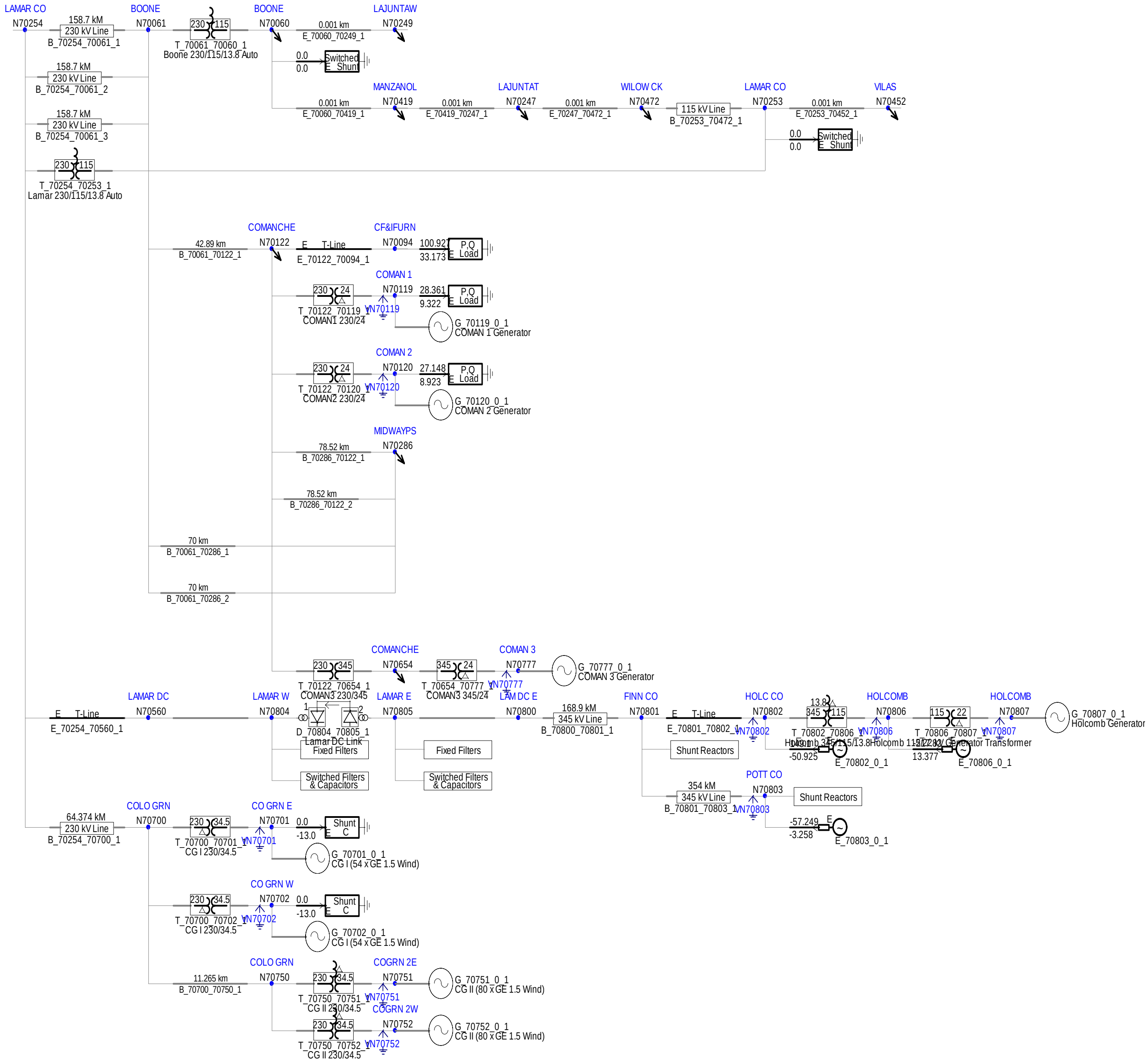


Figure 1: System Single Line Diagram

The Colorado Green I wind farm system was represented using 6 lumped wind farm models (3 for each of the 230/34.5 kV transformers) as shown in Figure 2:

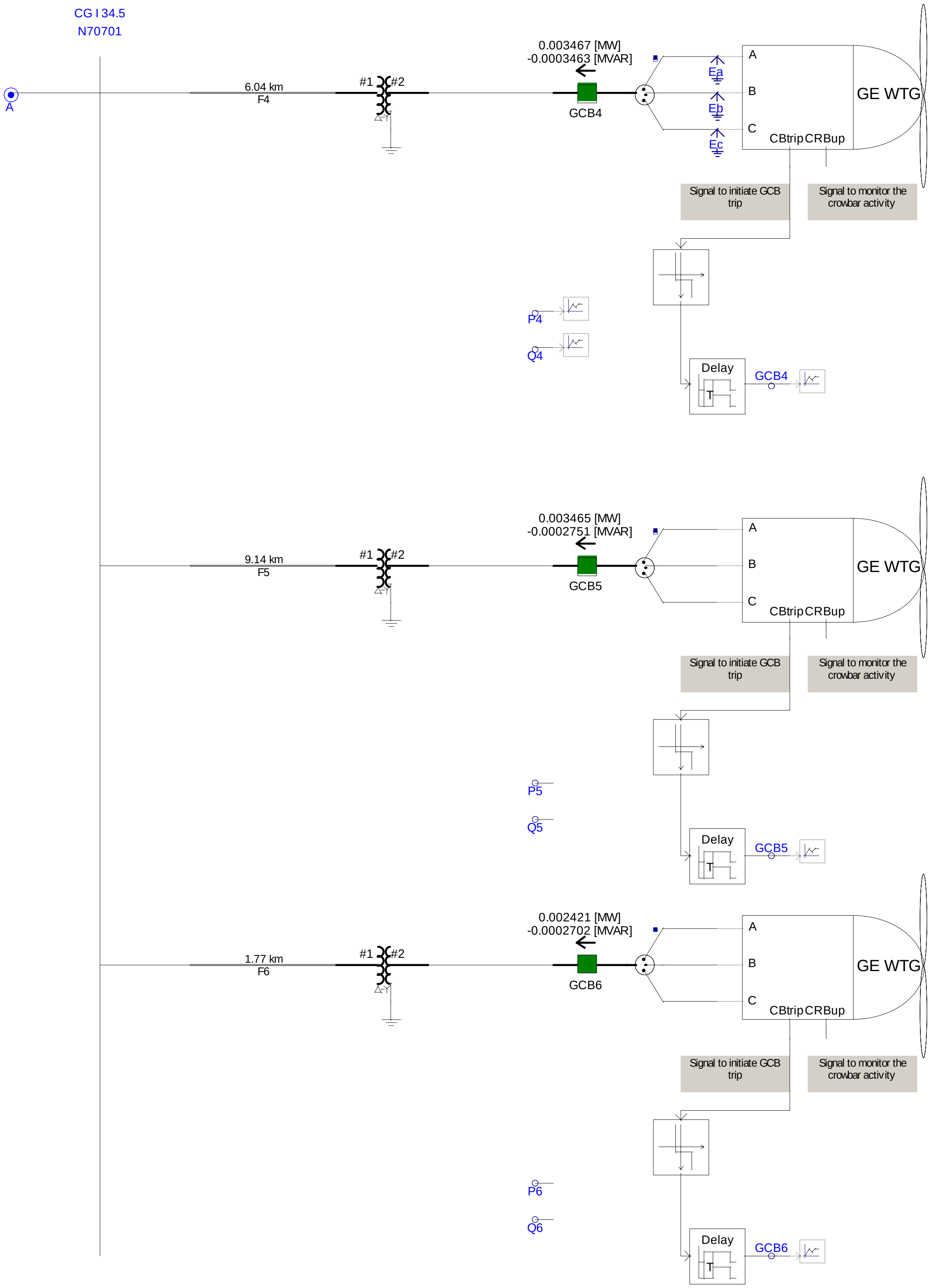


Figure 2: Colorado Green I (Partial) Single Line Diagram

The Colorado Green II wind farm system was represented using 2 lumped wind farm models (1 for each of the 230/34.5 kV transformers). The model used for the transmission lines and main transformers for CG I and CG II are shown in Figure 3. A total of 160 units (1.5 MW each for 240 MW total) was added for CG II. Data for the 230 kV transmission line and 3 winding transformer for CG II was provided by Xcel Energy.

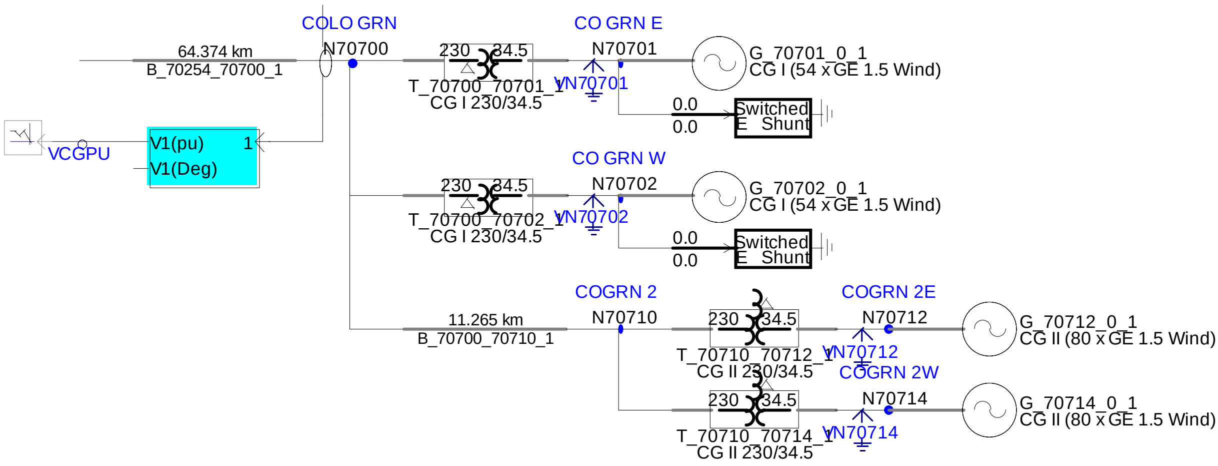


Figure 3: Colorado Green II Single Line Diagram

PSCAD Low Voltage Ride-Through Settings

The latest PSCAD model of the GE Wind VAR 1.5 MW turbines was used for both the CGI and CGII turbines (as recommended by GE). The CGI turbines have the default GE ride-through capability (LVRT), but the CGII turbines will have an improved LVRT capability. The difference between the two LVRT settings can have a significant effect on fault studies. The LVRT turbines can stay connected during many faults, and can therefore contribute higher short circuit currents, whereas the non-LVRT turbines tend to trip more frequently. GE recommended the use of the latest PSCAD model for both CG I and CG II wind turbines, with modifications made to the protection system in order to model the LVRT and non-LVRT options.

3. Transient Stability Results

Transient stability study results show that the addition of 238MW of wind generation at Colorado Green does not affect the system adversely. Certain contingencies caused violations of the NERC/WECC criteria for Class B disturbances, but these violations were evident before the addition of the CG2 wind farm. In particular, a 3-phase fault on the Comanche 230kV bus followed by the removal of a single unit at Comanche caused system instability near Bravo Dome, both in the case with the new wind farm in and in the case without the new generation. A list of machine tripping is shown in Table 3.

Table 3 – List of Faults Applied and Associated Machine Tripping

Bus	Case List for Colorado Green II Transient Stability Studies			
	Fault and Clearing	Outage #	*Base Case 1 (CGII IN)	**Base Case 2 (CGII OUT)
Col Green 230kV	3-Phase fault on CG-Lamar 230kV at CG; Clear and Open CG-Lamar 230kV after 6 cycles	S1	CG1 trip on UV	CG1 trip on UV
Lamar 230kV	3-Phase fault on CG-Lamar 230kV at Lamar; Clear and Open CG-Lamar 230kV after 6 cycles	S2	No Trip	CG1 trip on UV
	3-Phase fault on Lamar-Boone 230kV #1 at Lamar; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S3	No Trip	CG1 trip on UV
Lamar 115kV	3-Phase fault on Lamar-Willow Ck. 115kV at Lamar; Clear and Open Lamar-Willow Ck.115kV after 6 cycles	S4	No Trip	No Trip
	3-Phase fault on Lamar-Vilas 115kV at Lamar; Clear and Open Lamar-Vilas 115kV after 6 cycles	S5	No Trip	No Trip
Boone 230kV	3-Phase fault on Lamar-Boone 230kV #1 at Boone; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S6	No Trip	No Trip
	3-Phase fault on Boone-Midway 230kV #1 at Boone; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S7	No Trip	No Trip
	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S8	CG1 trip on UV	No Trip
Boone 115kV	3-Phase fault on Boone-LaJuntaT 115kV at Boone; Clear and Open Boone-LaJuntaT 115kV after 6 cycles	S9	No Trip	No Trip
	3-Phase fault on Boone-LaJuntaW 115kV at Boone; Clear and Open Boone-LaJuntaW 115kV after 6 cycles	S10	No Trip	No Trip
	3-Phase fault on Boone-DOT Tap 115kV at Boone; Clear and Open Boone-DOT Tap 115kV after 6 cycles	S11	No Trip	No Trip
Comanche 230kV	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S12	No Trip	No Trip
	3-Phase bus fault at Commanche; Clear fault and Disconnect Comanche G1	S13	CG1 trip on UV Sol'n Diverges at Clapham after 2.5s	CG1 trip on UV Rosebud trip on OF after 0.2s
Midway 230kV	3-Phase fault on Boone-Midway 230kV #1 at Midway; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S14	No Trip	No Trip
Midway 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Midway; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S15	No Trip	No Trip
Daniel's Park 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Daniels Pk; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S16	No Trip	No Trip
Col Green II 34.5kV	Sudden Loss of 238 MW Power at Colorado Green II due to Wind Gust	S17	No Trip	N/A
Comanche 345kV	3-Phase Bus Fault at Comanche 345kV; Clear and Open Comanche-Midway 345kV #1 after 6 cycles	S18	No Trip	No Trip
Comanche 3 22kV	3-Phase Bus Fault at Comanche 345kV; Clear and drop Comanche G3 750MW	S19	CG1 trip on UV	CG1 trip on UV
	Sudden Loss of 750 MW Power at Comanche G3 -	S20	No Trip	No Trip

*Base Case 1 is from case 10wallgen8.sav, provided by Xcel Energy. Case includes:
- CG2 generating 238 MW
- Comanche 3 generating 750 MW, power flowing to Midway via two 345kV lines
- Network Upgrades in place from Boone-Lamar 230kV

Additions to base case 2 are:
- Lamar back to back DC link added using PSLF loadflow and transient stability models provided by Siemens.
- System modeled east of Lamar DC link up to a system equivalent at Potter County, and including a generator model of Holcomb and a network equivalent for Finney 115kV system.

**Base Case 2 is the same case as Base Case 1, with the wind turbines at Colorado Green II switched out. In order to balance the loadflow, power was added in zone 706, using PSLF function 'SCAL'

All cases were checked to ensure conformance with the NERC/WECC Performance Standard for Class B disturbances outlined in "Table W-1: NERC/WECC Planning Standards, April 2003" (Appendix III). With a few exceptions, machine angles showed sufficient damping and voltage/frequency deviations were within these tolerances. The observed violations of these guidelines are shown in Table 4. Note that in all of these violations, the system was not made worse by the addition of CG2, and in some cases the system response was improved.

Table 4 – List of Violations to the NERC/WECC Performance Standard

Contingency	Violation	Comments
Case 1 – S3	Steady State OV at Lamar E/W 53kV ~1.08pu	This may be due to problems not yet resolved in the new Lamar DC model voltage/SVD controls
Case 2 – S3	Steady State OV at Lamar E/W 53kV ~1.08pu	Same as above
Case 2 – S6	Steady State OV at Lamar E/W 53kV ~1.08pu	Same as above
Case 1 – S4	Marginal Steady State OV at CTY Lamar 14kV ~ 1.051pu	-
Case 2 – S4	Marginal Steady State OV at CTY Lamar 14kV ~ 1.051pu	-
Case 1 – S10	Steady State UV at LaJuntaW 115kV ~0.93pu	This fault opens the only link to the stronger 115kV system. The 69kV system is unable to support the voltage fully
Case 2 – S10	Steady State UV at LaJuntaW 115kV ~0.93pu	Same as above
Case 1 – S13	Solution diverges near Bravo Dome Compressor Motors	The inclusion of the Gladstone-Walsenburg 230kV line creates a sensitivity to Bus faults at Commanche
Case 2 – S13	Load at Bravo Dome trips on Underfrequency	Same as above

Additional Observations.

- After reactor/capacitor switch, time delay for voltage regulation is up to 3 seconds. Siemens has been approached regarding a possible problem in the PSLF DC link model controls.
- CTY Lamar Machine angles take a long time to damp out 0.1 Hz oscillations. (>20 seconds)

A complete compilation of the PSLF transient stability results and output plots may be seen in Appendix I.

4. PSCAD Interaction Study Results

Results from the interaction study show that in general the addition of 238MW of wind at Colorado Green do not adversely affect the network. All cases proved to be electromechanically stable.

Care should be taken to consider interaction between the voltage control capabilities at Lamar HVDC and the wind farm. Field tests have shown that such an interaction exists, and deficiencies in the wind farm model prevent this from being analyzed using PSCAD.

No harmonic interactions were evident, although a large 2nd harmonic network impedance could have negative TOV implications (outside study scope).

Discussion of PSCAD Output and Observed Interactions

All output plots for this interactions study are available in Appendix 4 of this report. Table 5 discusses some of the major events visible in these cases.

Table 5 – Discussion of PSCAD Output in Appendix 4

PSCAD Fault Case	Notes Regarding Observed Interaction
Case 1, Case 6	CG1 and CG2 trip due to Lamar 230kV fault. This result confirms similar tripping in the transient stability cases. (See Table 3)
Case 5	DC link trips on group differential protection when Finney-Potter 345kV line recloses. This indicates either a control setting error in the DC link or some other model bug, since a group differential trip should only occur during a converter fault.
Case 6	HVDC fails commutation during recovery, causes wind farm to trip
Case 2, Case 7	GE Wind farm model blows up if open circuited. The breaker is opened at Lamar and the line left connected at CG only. Therefore the Colorado Green voltage is not realistic after 0.2 seconds.
Case 3, Case 8	The 115kV voltage at Willow Creek was measured on the line side of the breaker – when the breaker trips the line (no reclose) voltage goes to zero due to incorrect measurement location.
Case 10	DC link fails commutation when the Finney-Potter 345kV line recloses.

Discussion of Interaction Between Voltage Controllers

The lack of a voltage control capability in the GE wind model prevented interactions between the wind farm and the DC link from being studied. Without a droop characteristic, the DC link AC voltage controller (PI type) and the wind farm voltage controller (also PI) would work against each other and result in VAR looping. These interactions have been observed in commissioning tests at the Lamar HVDC site.

This VAR looping should be fixed by the addition of a droop controller to the CG1 controls. This is currently under investigation by GE. This issue must be resolved for the new wind farm at CG2 as well, since the same problem will occur there without appropriate control additions, and prompt attention to these additions may reduce cost and inconvenience after the new wind farm has been installed.

Energization of Lamar 230/53kV Transformer

A report showing the Energization of the Lamar 230/53kV Transformer has been included in Appendix 5. Since this study was undertaken using the system 'as is' with none of the planned network upgrades in place, it may be considered a worst case scenario, and the study was not repeated here. It should be noted that during commissioning tests at Lamar, energization of this transformer resulted in tripping of a significant number of wind turbines at Colorado Green 1. Since the PSCAD analysis was not able to replicate this tripping, the controls at the wind farm should be adjusted by GE, or updated protection settings provided for the PSCAD model.

Harmonic Impedance Analysis

Harmonic interactions were not evident from system studies. Figure 4 shows a graph of the +ve sequence harmonic impedances as seen from the Lamar 230 kV bus. The system included the DC link 230/53 transformer and the triple tuned filters on the 53 kV bus (the filter impedances show up as low impedances on the graph but the series resonant frequencies are reduced because of the impedance of the transformer).

The addition of the CG II wind farm has very little effect on the harmonic impedances, however the system does have a relatively high impedance at the 2nd harmonic. This could have an impact on transient over-voltages (not studied in this project) due to the harmonic components of inrush current during fault recovery or during transformer energization tests.

It should also be noted that the PSCAD wind farm model is currently unable to generate harmonics, and therefore any interactions that could result from harmonics generated by the real wind farm can not be predicted.

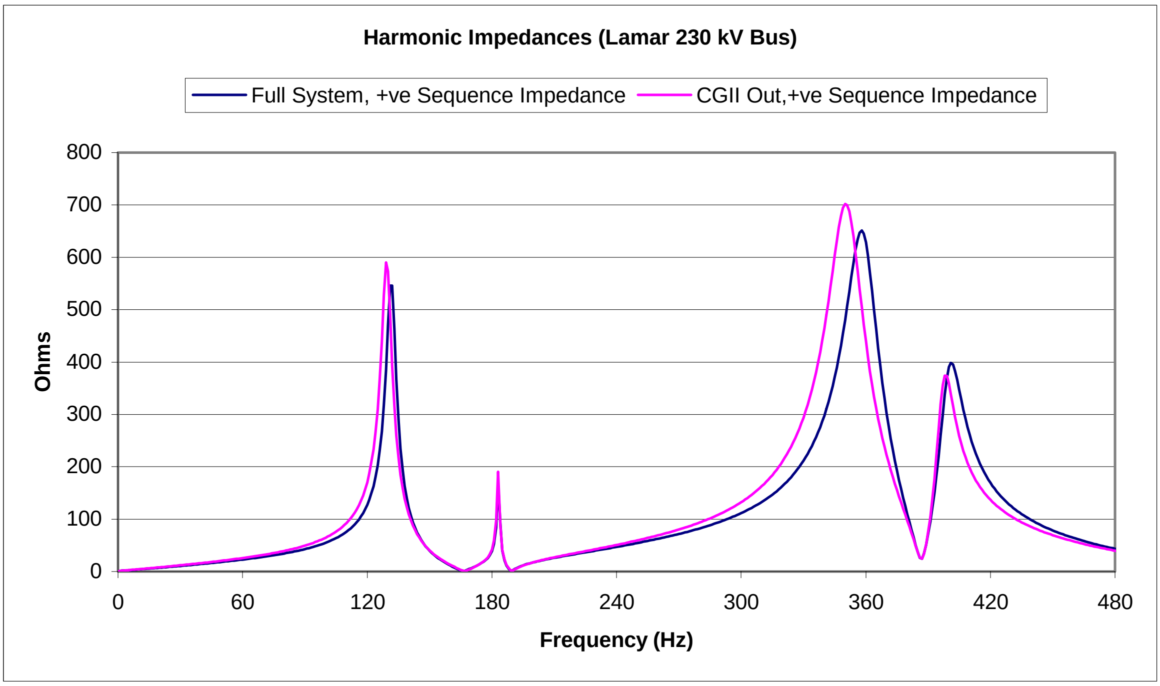


Figure 4: Harmonic Impedances of Lamar 230 kV Bus
(with and without the new CG II line and Wind Generators)

5. Conclusions

Transient stability study results show that the addition of 238MW of wind generation at Colorado Green does not affect the system adversely. Certain contingencies caused violations of the NERC/WECC criteria for Class B disturbances, but these violations were evident before the addition of the wind farm. In particular, a 3-phase fault on the Comanche 230kV bus followed by the removal of a single unit at Comanche caused system instability in the vicinity of the Bravo Dome compressor motors, both in the case with the new wind farm in and in the case without the new generation.

PSCAD Interaction study results show that in general the addition of 238MW of wind at Colorado Green do not adversely affect the network. All cases proved to be electromechanically stable. Care should be taken to consider interaction between the voltage control capabilities at Lamar HVDC and the wind farm. Field tests have shown that such an interaction exists, and deficiencies in the wind farm model prevent this from being analyzed using PSCAD. GE is currently aware of this issue and are investigating.

No harmonic interactions were evident, although a large 2^{nd} harmonic network impedance could have negative TOV implications (outside study scope).

6. Acknowledgements

We would like to acknowledge the assistance of Jim Whitaker of Xcel Energy for valuable guidance in this project and for his extensive experience with this area of the transmission network. We would also like to acknowledge the assistance of GE Wind for providing detailed models of the GE 1.5 MW wind turbines used at the Colorado Green site, and Siemens AG for providing the detailed PSLF models of the Lamar DC link and support for this model.

Appendix I – Colorado Green Transient Stability Study

Case List and Machine Trip Record - See also ammended table on following page

Bus	Case List for Colorado Green II Transient Stability Studies			
	Fault and Clearing	**Outage #**	***Base Case 1 (CGII IN)**	****Base Case 2 (CGII OUT)**
Col Green 230kV	3-Phase fault on CG-Lamar 230kV at CG; Clear and Open CG-Lamar 230kV after 6 cycles	S1	CG1 trip on UV CG2 trip on OV	CG1 trip on UV
Lamar 230kV	3-Phase fault on CG-Lamar 230kV at Lamar; Clear and Open CG-Lamar 230kV after 6 cycles	S2	CG1 trip on UV CG2 trip on OV	CG1 trip on UV
	3-Phase fault on Lamar-Boone 230kV #1 at Lamar; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S3	CG1 trip on UV	CG1 trip on UV
Lamar 115kV	3-Phase fault on Lamar-Willow Ck. 115kV at Lamar; Clear and Open Lamar-Willow Ck.115kV after 6 cycles	S4	CG1 trip on UV	No Trip
	3-Phase fault on Lamar-Vilas 115kV at Lamar; Clear and Open Lamar-Vilas 115kV after 6 cycles	S5	CG1 trip on UV	No Trip
Boone 230kV	3-Phase fault on Lamar-Boone 230kV #1 at Boone; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S6	No Trip	CG1 trip on UV
	3-Phase fault on Boone-Midway 230kV #1 at Boone; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S7	No Trip	CG1 trip on UV
	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S8	No Trip	CG1 trip on UV
Boone 115kV	3-Phase fault on Boone-LaJuntaT 115kV at Boone; Clear and Open Boone-LaJuntaT 115kV after 6 cycles	S9	CG1 trip on UV	No Trip
	3-Phase fault on Boone-LaJuntaW 115kV at Boone; Clear and Open Boone-LaJuntaW 115kV after 6 cycles	S10	CG1 trip on UV	No Trip
	3-Phase fault on Boone-DOT Tap 115kV at Boone; Clear and Open Boone-DOT Tap 115kV after 6 cycles	S11	CG1 trip on UV	No Trip
Comanche 230kV	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S12	No Trip	CG1 trip on UV
	3-Phase bus fault at Commanche; Clear fault and Disconnect Comanche G1	S13	Rosebud trip OF	CG1 trip on UV Rosebud trip OF
Midway 230kV	3-Phase fault on Boone-Midway 230kV #1 at Midway; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S14	No Trip	CG1 trip on UV
Midway 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Midway; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S15	CG1 trip on UV	CG1 trip on UV
Daniel's Park 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Daniels Pk; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S16	CG1 trip on UV	No Trip
Col Green II 34.5kV	Sudden Loss of 238 MW Power at Colorado Green II due to Wind Gust	S17	No Trip	N/A
Comanche 345kV	3-Phase Bus Fault at Comanche 345kV; Clear and Open Comanche-Midway 345kV #1 after 6 cycles	S18	No Trip	No Trip
Comanche 3 22kV	3-Phase Bus Fault at Comanche 345kV; Clear and drop Comanche G3 750MW	S19	No Trip	No Trip
	Sudden Loss of 750 MW Power at Comanche G3 -	S20	No Trip	No Trip

***Base Case 1** is from case 10wallgen8.sav, provided by Xcel Energy. Case includes:
- CG2 generating 238 MW
- Comanche 3 generating 750 MW, power flowing to Midway via two 345kV lines
- Network Upgrades in place from Boone-Lamar 230kV

Additions to base case 2 are:
- Lamar back to back DC link added using PSLF loadflow and transient stability models provided by Siemens.
- System modeled east of Lamar DC link up to a system equivalent at Potter County, and including a generator model of Holcomb and a network equivalent for Finney 115kV system.

****Base Case 2** is the same case as Base Case 1, with the wind turbines at Colorado Green II switched out. In order to balance the loadflow, power was added in zone 706, using PSLF function 'SCAL'

Appendix I Amendment – Colorado Green Transient Stability Study

Amended Machine Trip Record using GE wind models received December 16, 2004

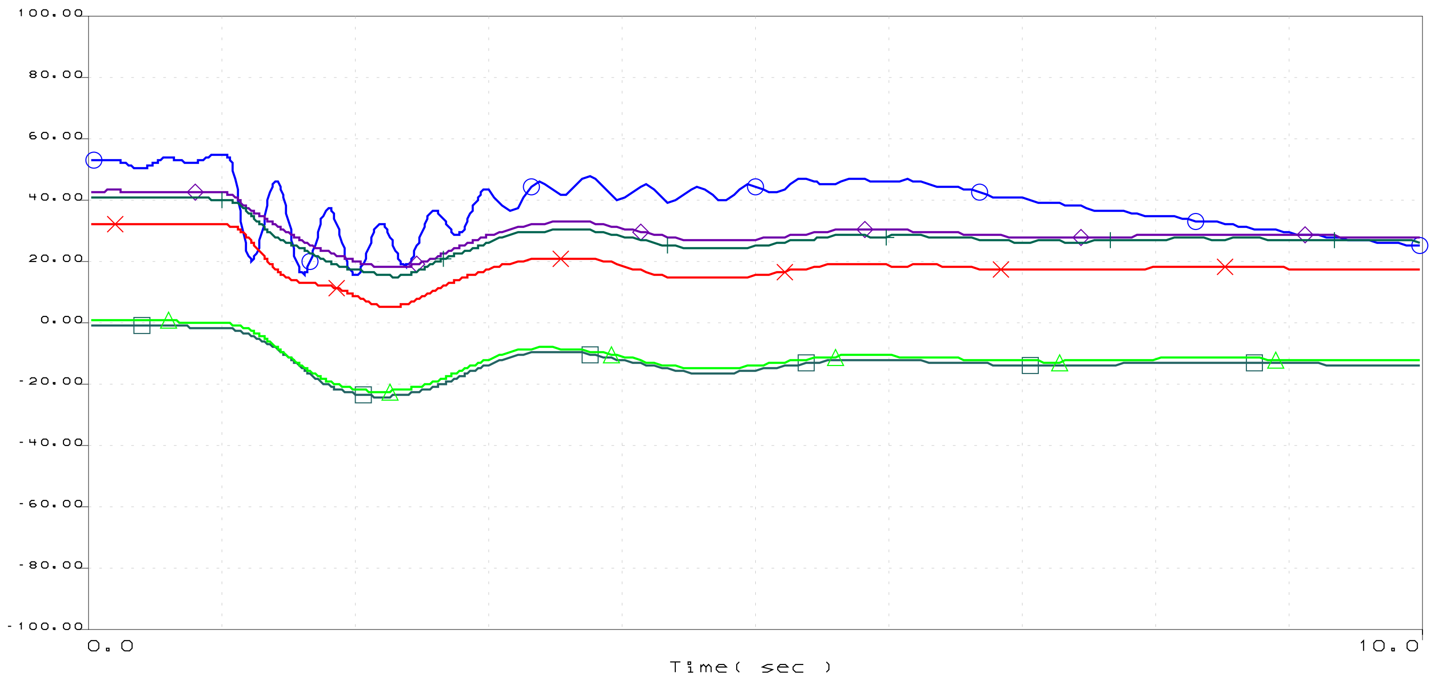
Bus	Case List for Colorado Green II Transient Stability Studies			
	Fault and Clearing	**Outage #**	***Base Case 1 (CGII IN)**	****Base Case 2 (CGII OUT)**
Col Green 230kV	3-Phase fault on CG-Lamar 230kV at CG; Clear and Open CG-Lamar 230kV after 6 cycles	S1	CG1 trip on UV	CG1 trip on UV
Lamar 230kV	3-Phase fault on CG-Lamar 230kV at Lamar; Clear and Open CG-Lamar 230kV after 6 cycles	S2	No Trip	CG1 trip on UV
	3-Phase fault on Lamar-Boone 230kV #1 at Lamar; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S3	No Trip	CG1 trip on UV
Lamar 115kV	3-Phase fault on Lamar-Willow Ck. 115kV at Lamar; Clear and Open Lamar-Willow Ck.115kV after 6 cycles	S4	No Trip	No Trip
	3-Phase fault on Lamar-Vilas 115kV at Lamar; Clear and Open Lamar-Vilas 115kV after 6 cycles	S5	No Trip	No Trip
Boone 230kV	3-Phase fault on Lamar-Boone 230kV #1 at Boone; Clear and Open Lamar-Boone 230kV #1 after 6 cycles	S6	No Trip	No Trip
	3-Phase fault on Boone-Midway 230kV #1 at Boone; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S7	No Trip	No Trip
	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S8	CG1 trip on UV	No Trip
Boone 115kV	3-Phase fault on Boone-LaJuntaT 115kV at Boone; Clear and Open Boone-LaJuntaT 115kV after 6 cycles	S9	No Trip	No Trip
	3-Phase fault on Boone-LaJuntaW 115kV at Boone; Clear and Open Boone-LaJuntaW 115kV after 6 cycles	S10	No Trip	No Trip
	3-Phase fault on Boone-DOT Tap 115kV at Boone; Clear and Open Boone-DOT Tap 115kV after 6 cycles	S11	No Trip	No Trip
Comanche 230kV	3-Phase fault on Boone-Comanche 230kV #1 at Boone; Clear and Open Boone-Comanche 230kV #1 after 6 cycles	S12	No Trip	No Trip
	3-Phase bus fault at Commanche; Clear fault and Disconnect Comanche G1	S13	CG1 trip on UV Sol'n Diverges at Clapham after 2.5s	CG1 trip on UV Rosebud trip on OF after 0.2s
Midway 230kV	3-Phase fault on Boone-Midway 230kV #1 at Midway; Clear and Open Boone-Midway 230kV #1 after 6 cycles	S14	No Trip	No Trip
Midway 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Midway; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S15	No Trip	No Trip
Daniel's Park 345kV	3-Phase fault on Midway-Daniels Pk 345kV #1 at Daniels Pk; Clear and Open Midway-Daniels Pk 345kV #1 after 6 cycles	S16	No Trip	No Trip
Col Green II 34.5kV	Sudden Loss of 238 MW Power at Colorado Green II due to Wind Gust	S17	No Trip	N/A
Comanche 345kV	3-Phase Bus Fault at Comanche 345kV; Clear and Open Comanche-Midway 345kV #1 after 6 cycles	S18	No Trip	No Trip
Comanche 3 22kV	3-Phase Bus Fault at Comanche 345kV; Clear and drop Comanche G3 750MW	S19	CG1 trip on UV	CG1 trip on UV
	Sudden Loss of 750 MW Power at Comanche G3 -	S20	No Trip	No Trip

***Base Case 1** is from case 10wallgen8.sav, provided by Xcel Energy. Case includes:
- CG2 generating 238 MW
- Comanche 3 generating 750 MW, power flowing to Midway via two 345kV lines
- Network Upgrades in place from Boone-Lamar 230kV

Additions to base case 2 are:
- Lamar back to back DC link added using PSLF loadflow and transient stability models provided by Siemens.
- System modeled east of Lamar DC link up to a system equivalent at Potter County, and including a generator model of Holcomb and a network equivalent for Finney 115kV system.

****Base Case 2** is the same case as Base Case 1, with the wind turbines at Colorado Green II switched out. In order to balance the loadflow, power was added in zone 706, using PSLF function 'SCAL'

Electranix Corporation
December 17, 2004



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-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
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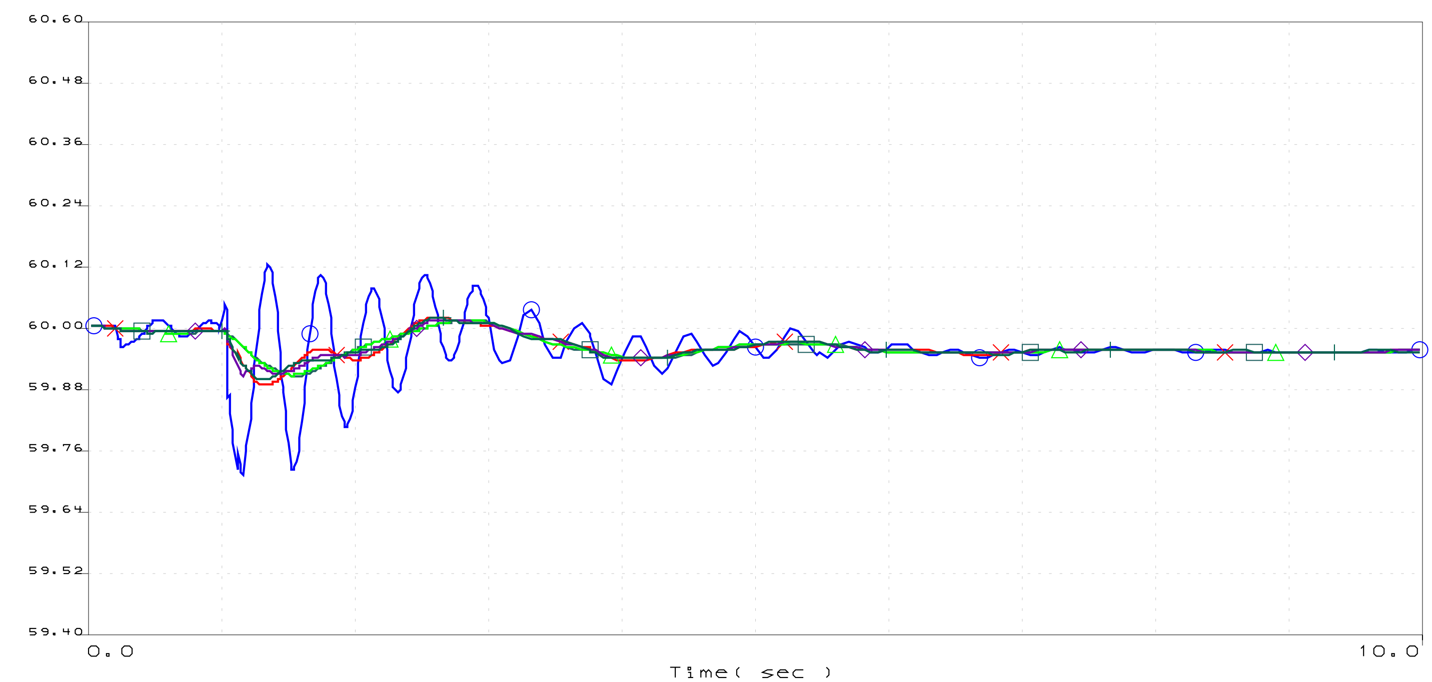
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



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59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
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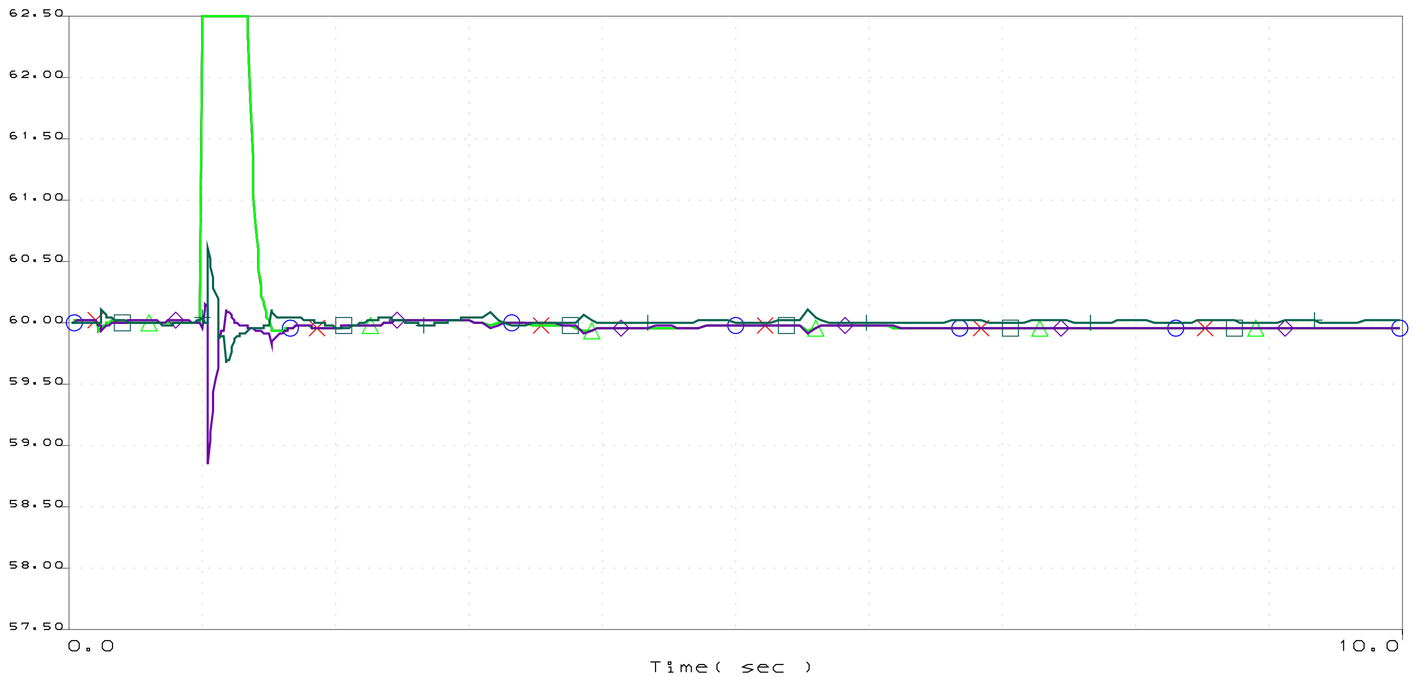
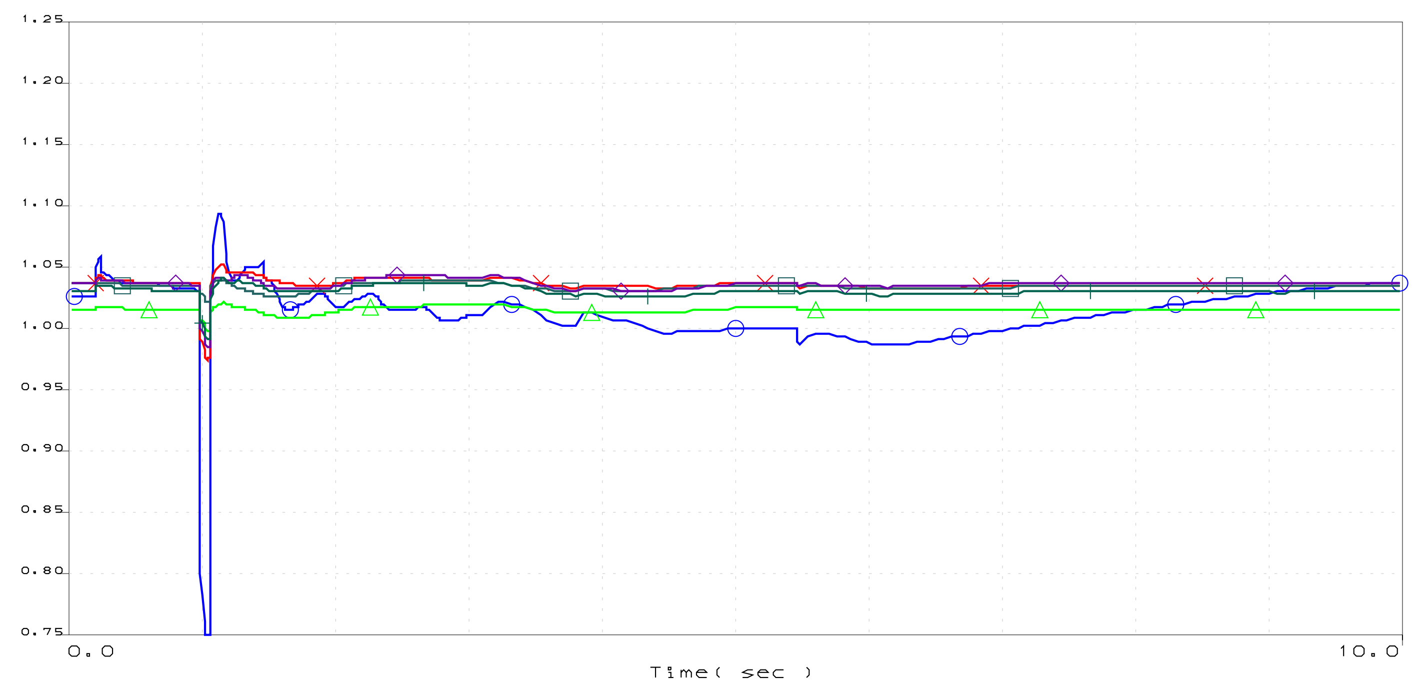


○ 57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



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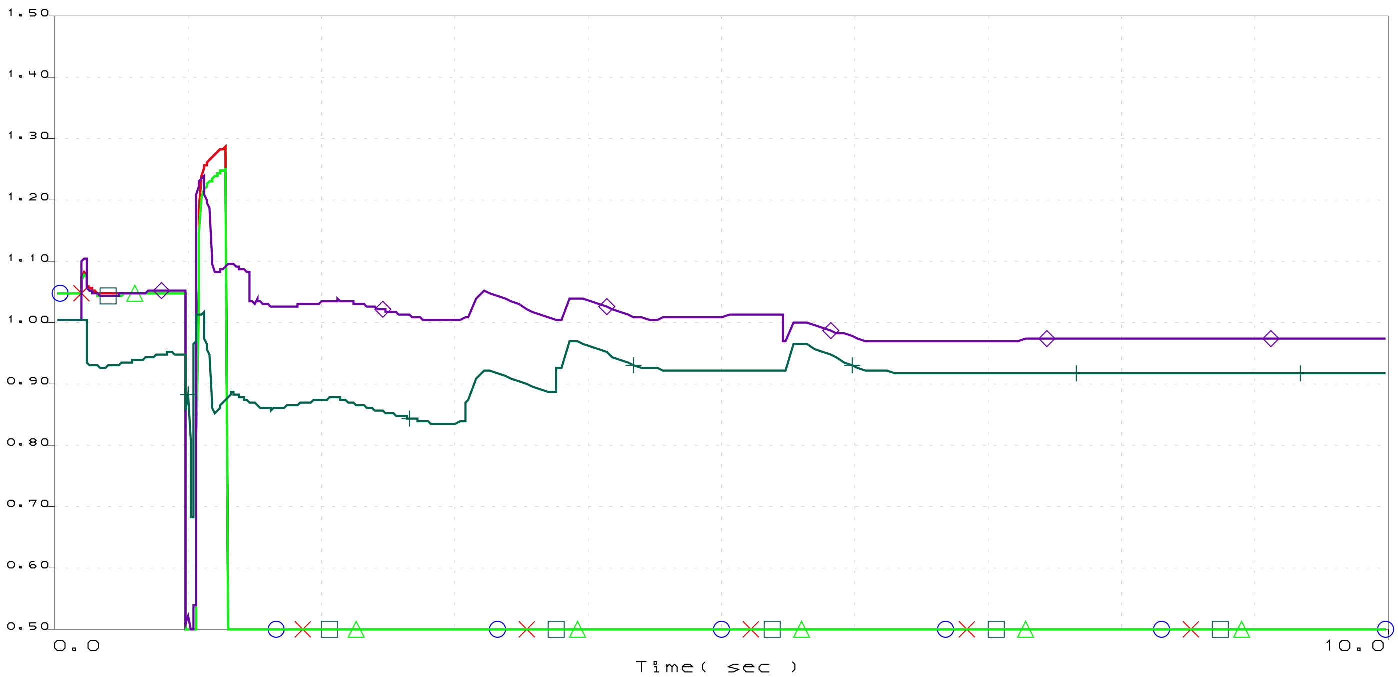
△ 0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



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0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
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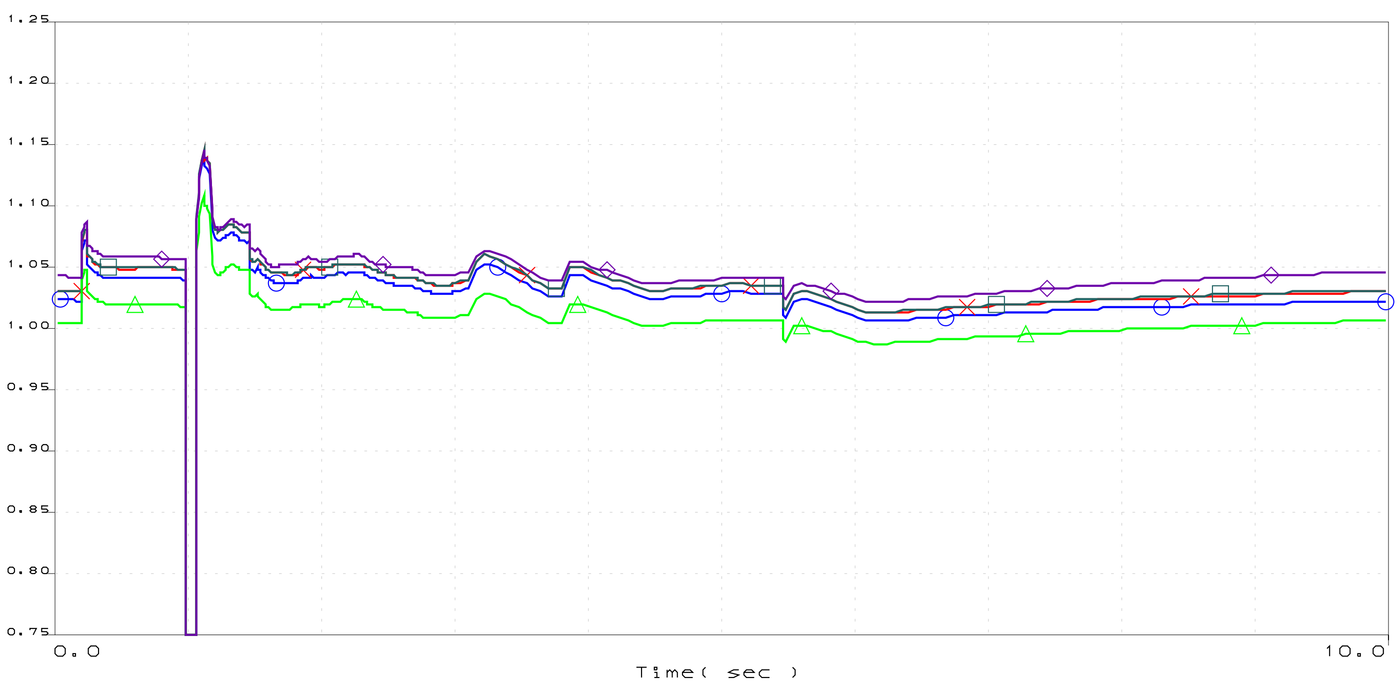
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



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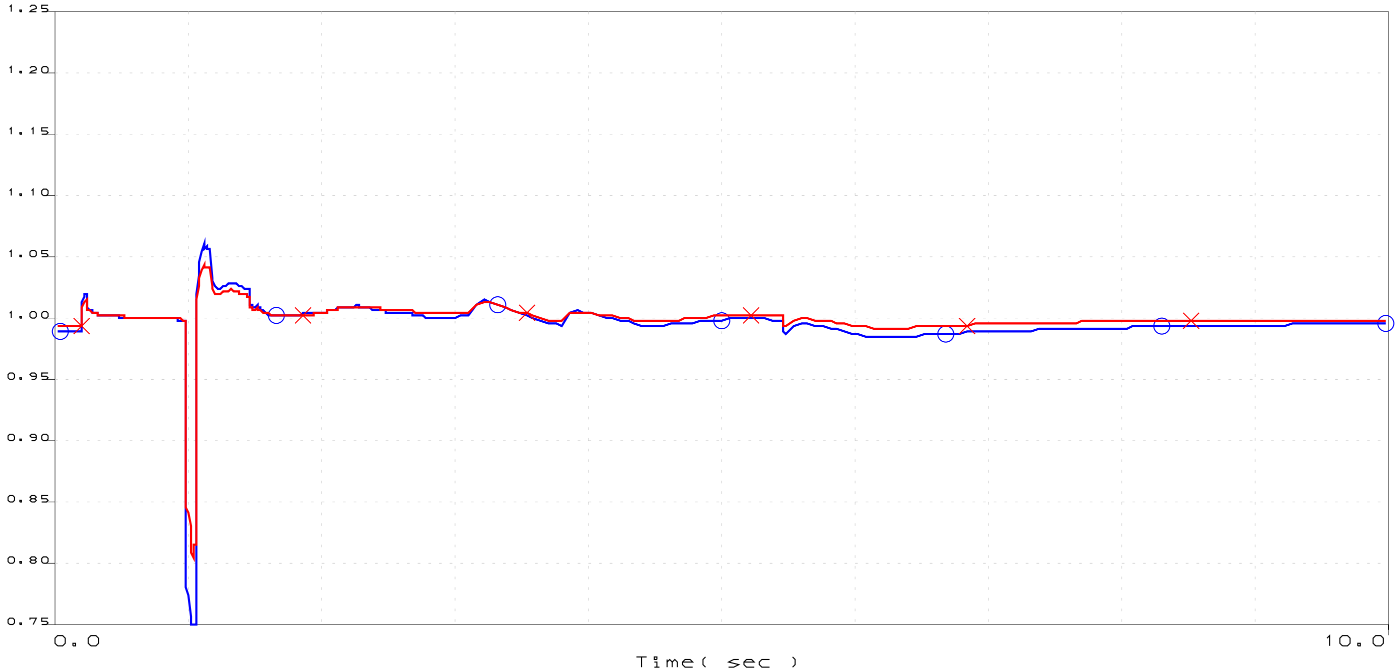

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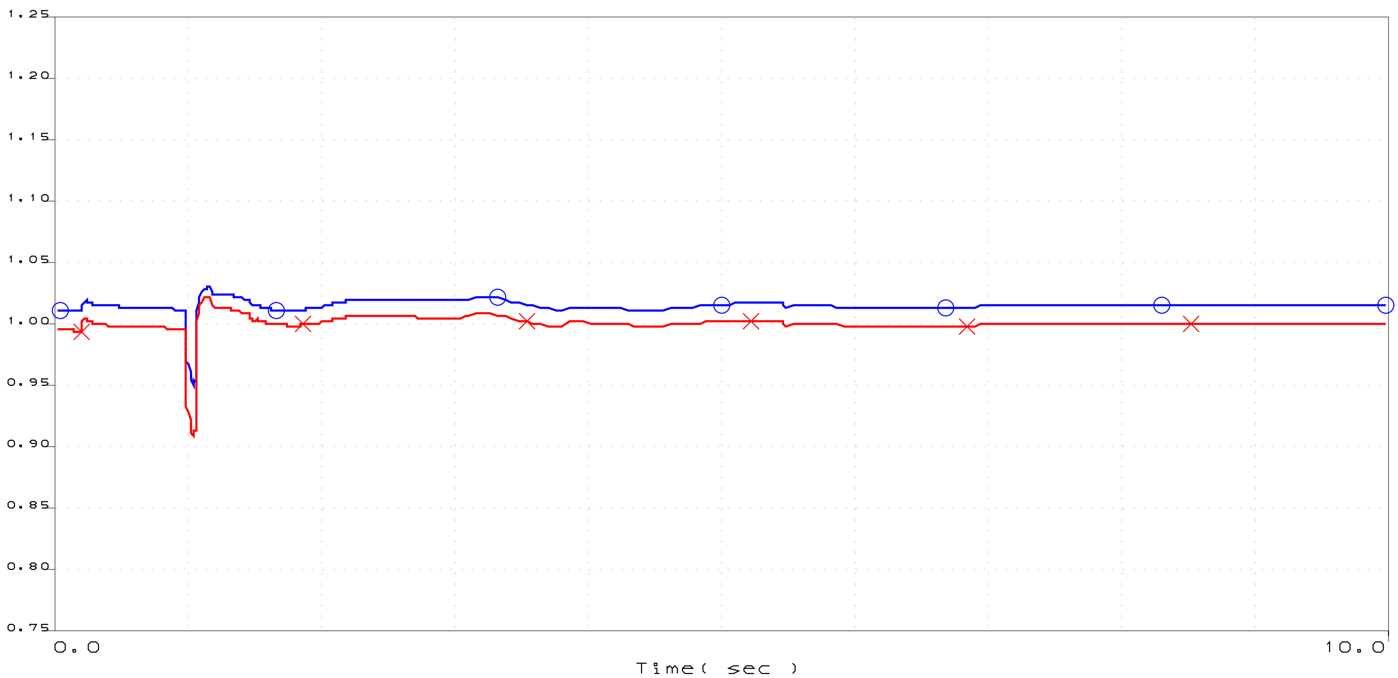

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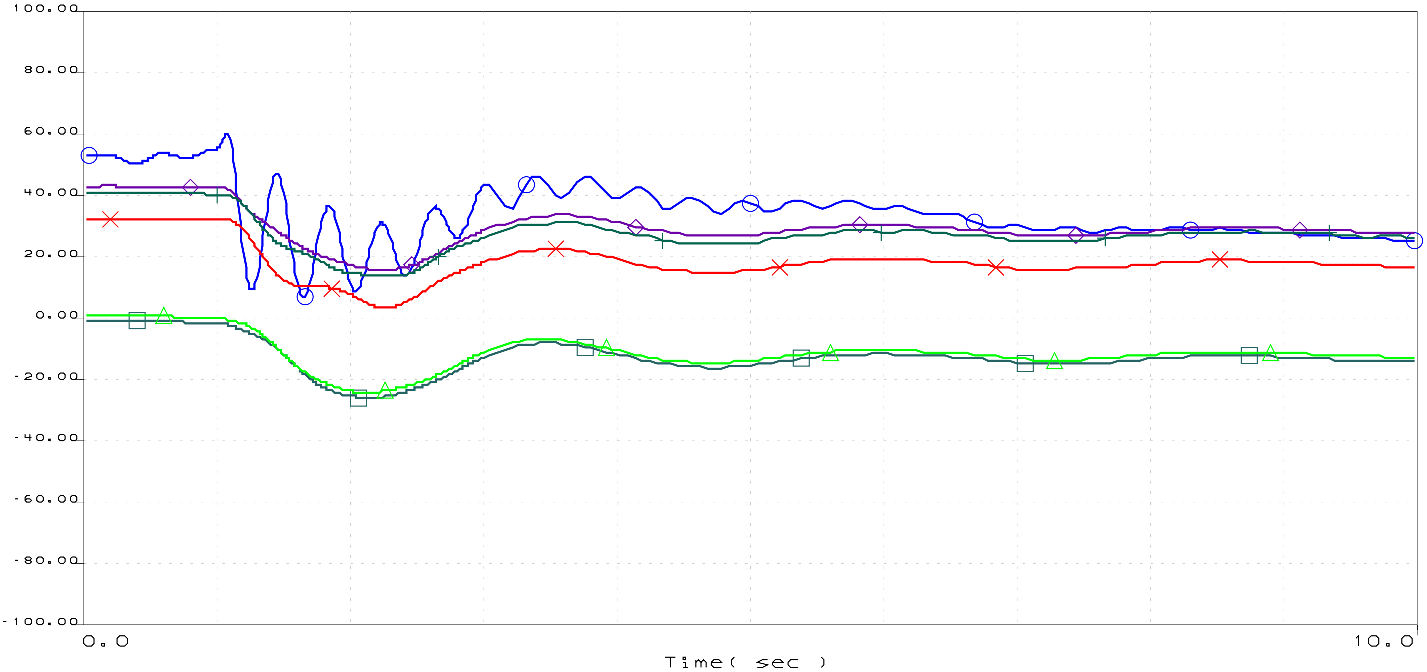

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-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
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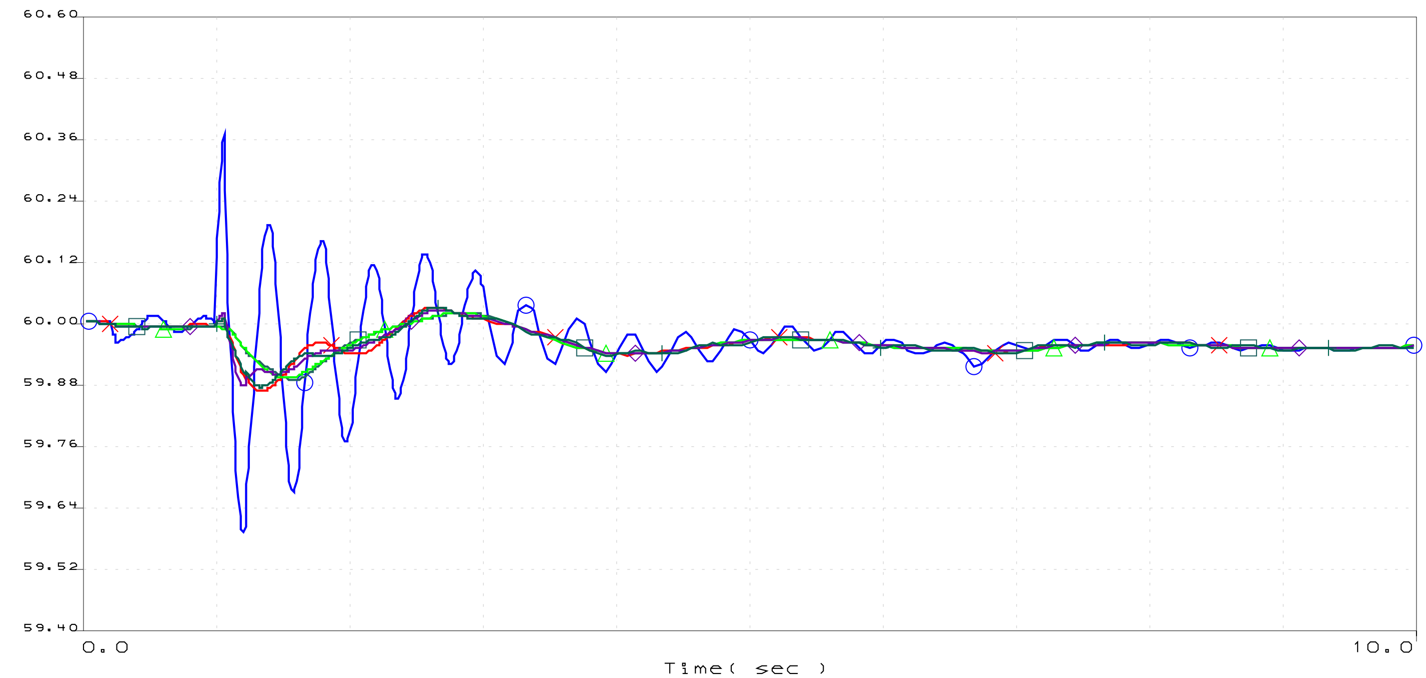

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59.4	fbug	70034	ARAP3	13.8	1	1	60.6
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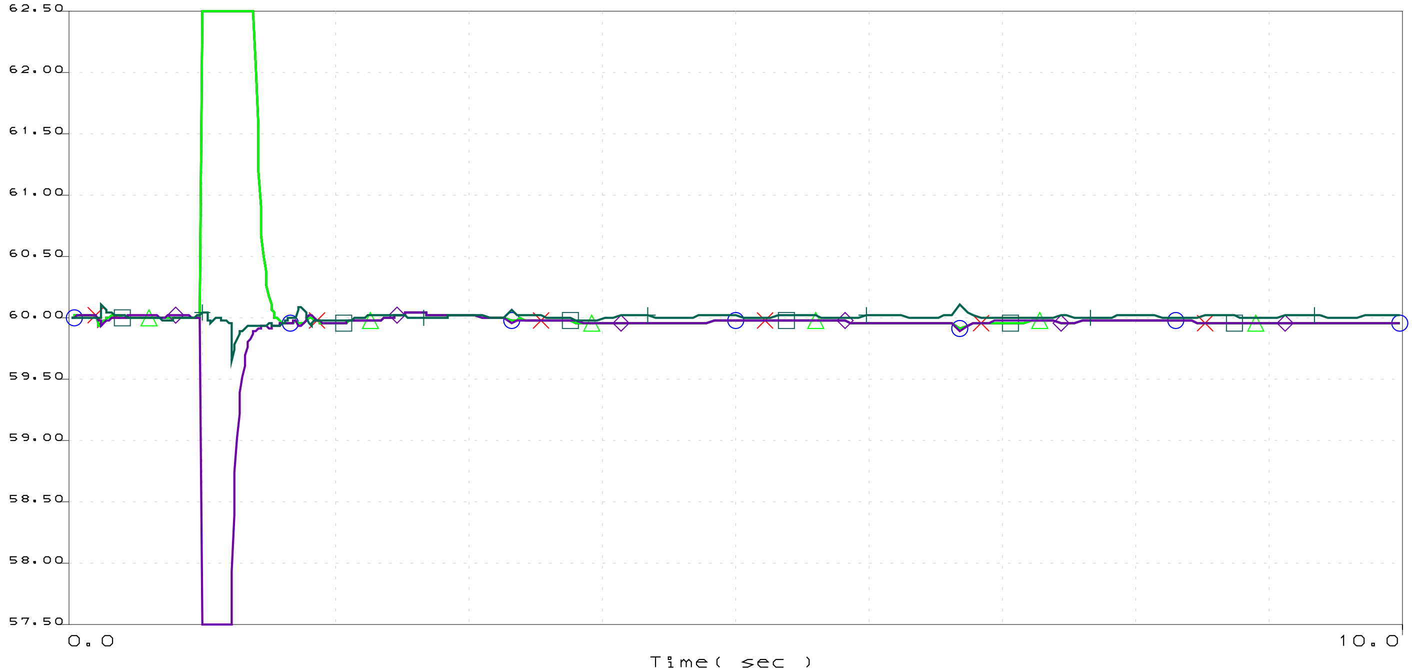
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



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× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
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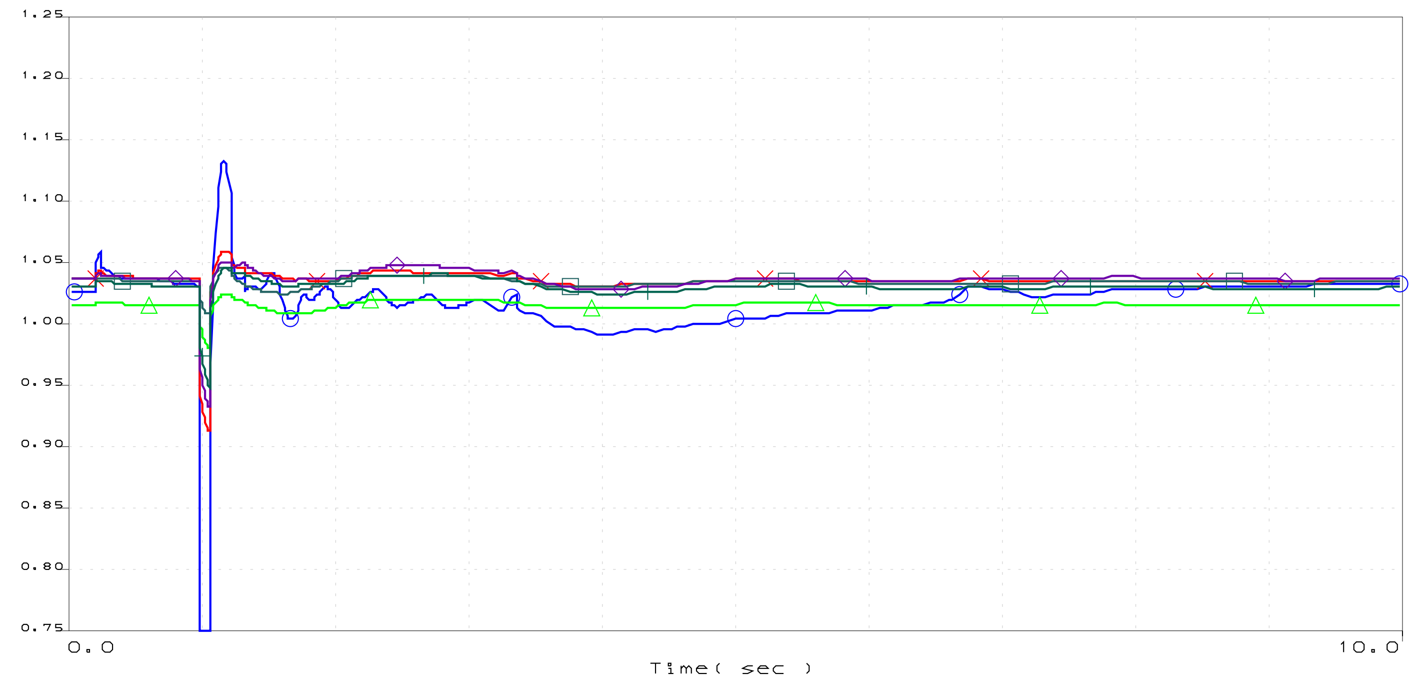

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△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
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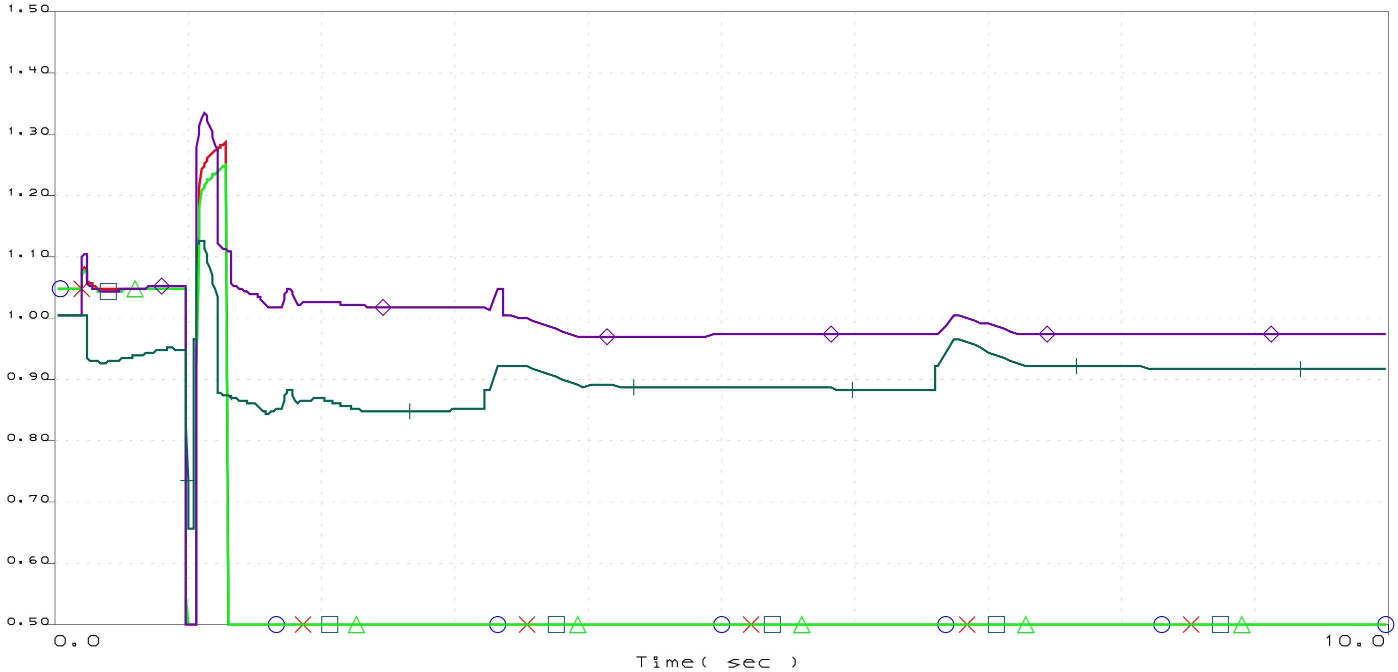
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



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□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
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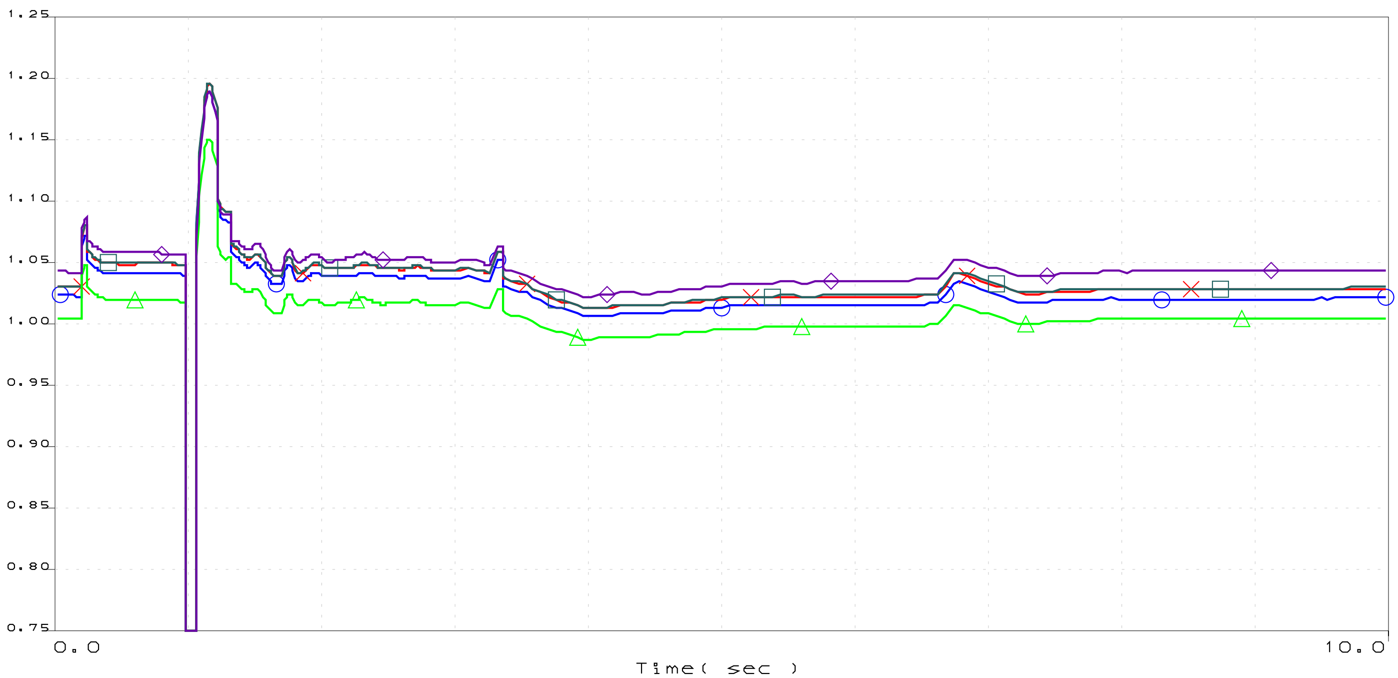

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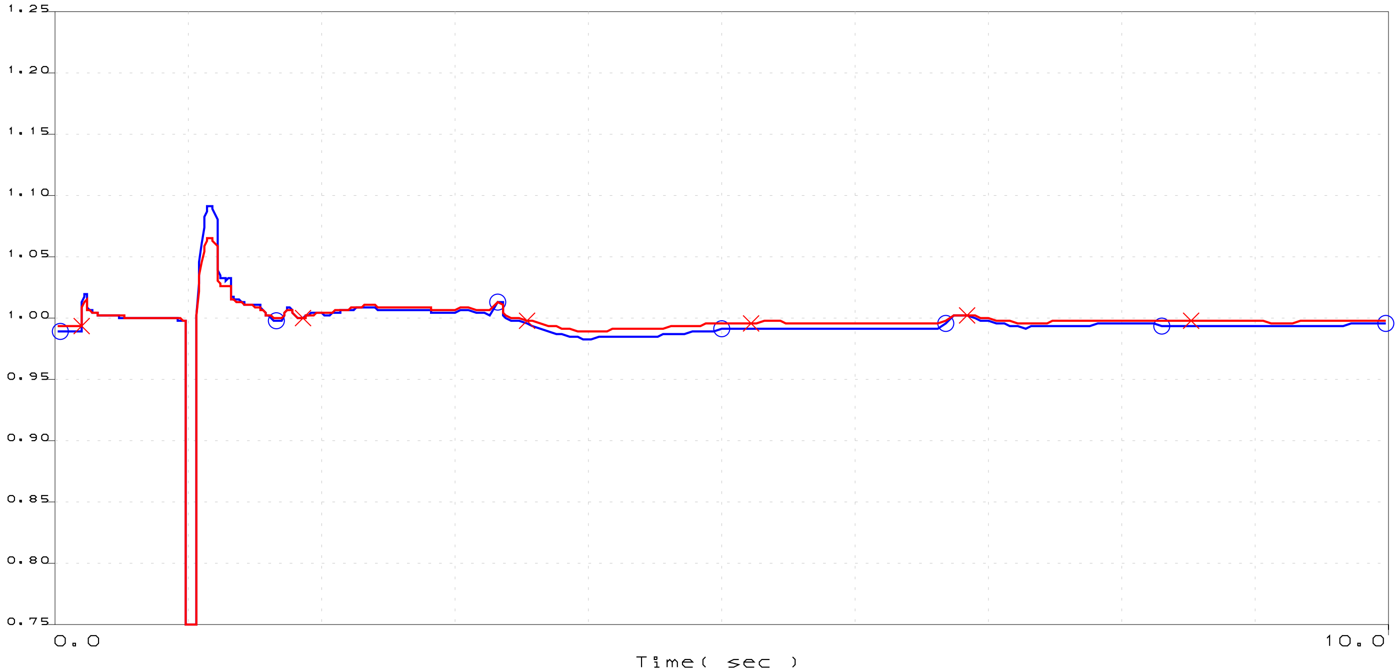

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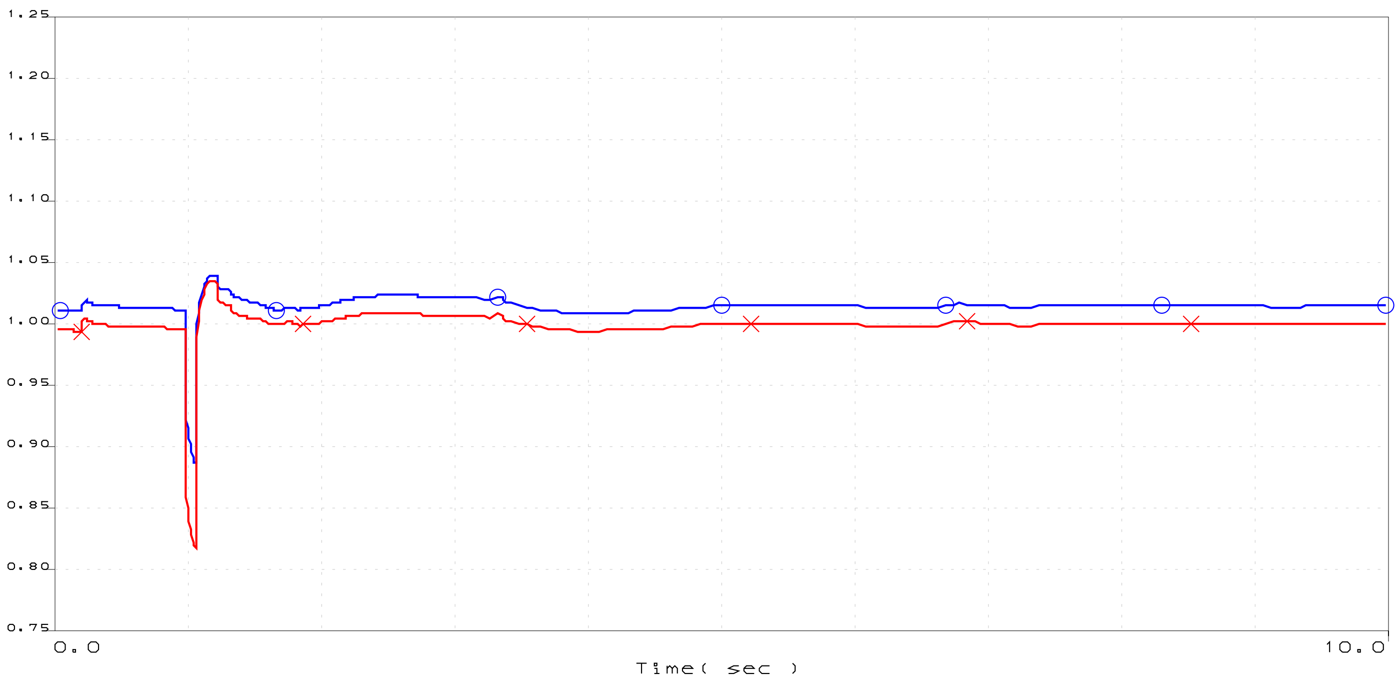

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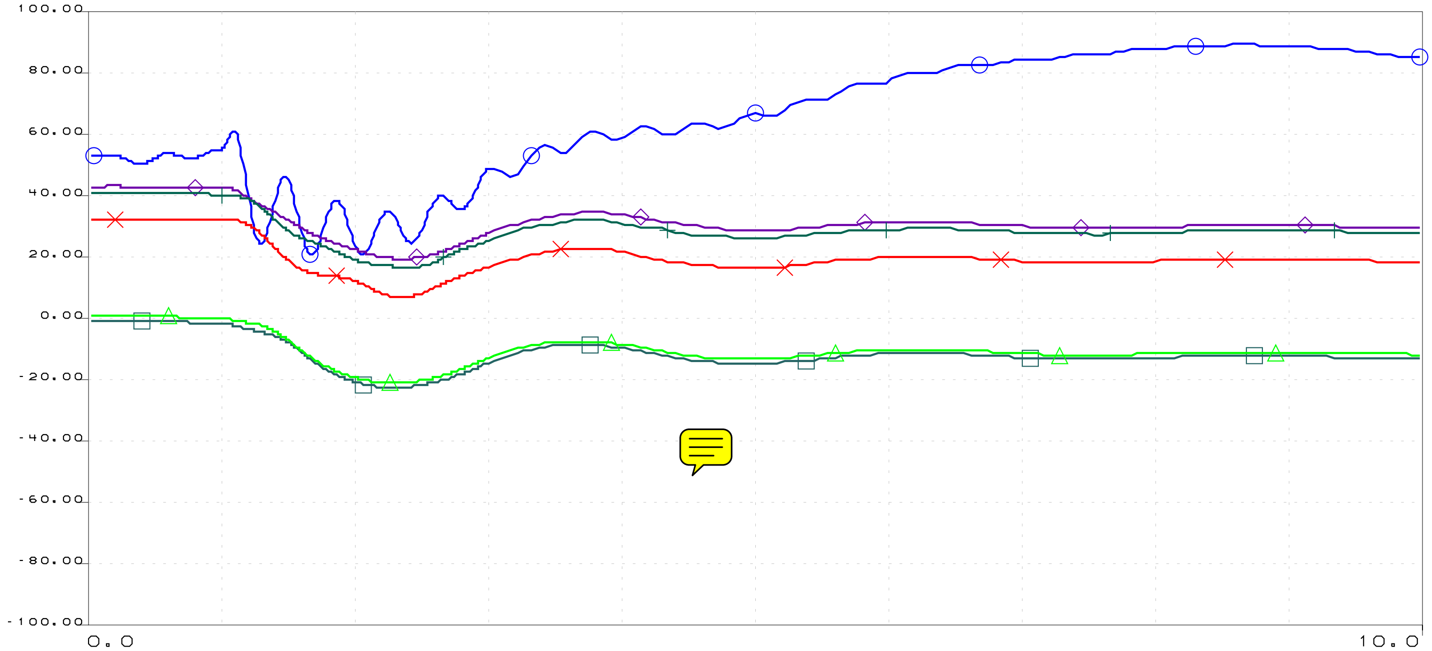

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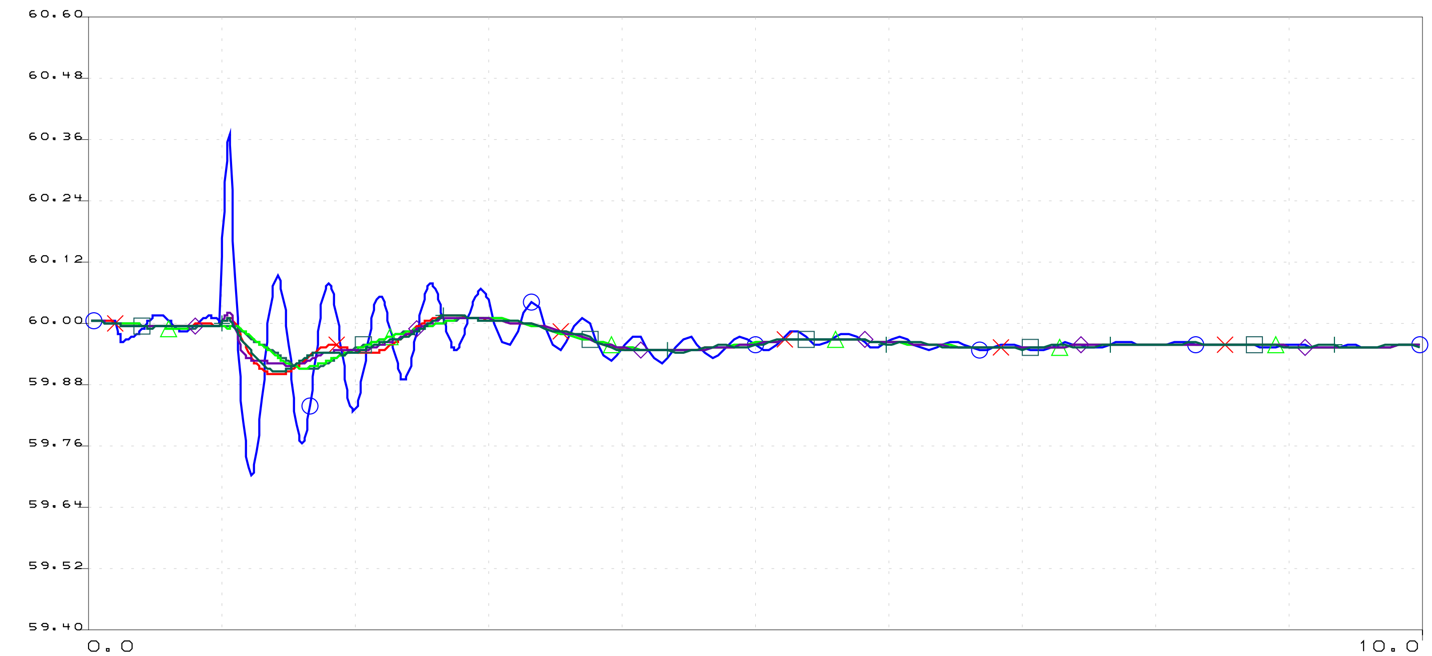
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



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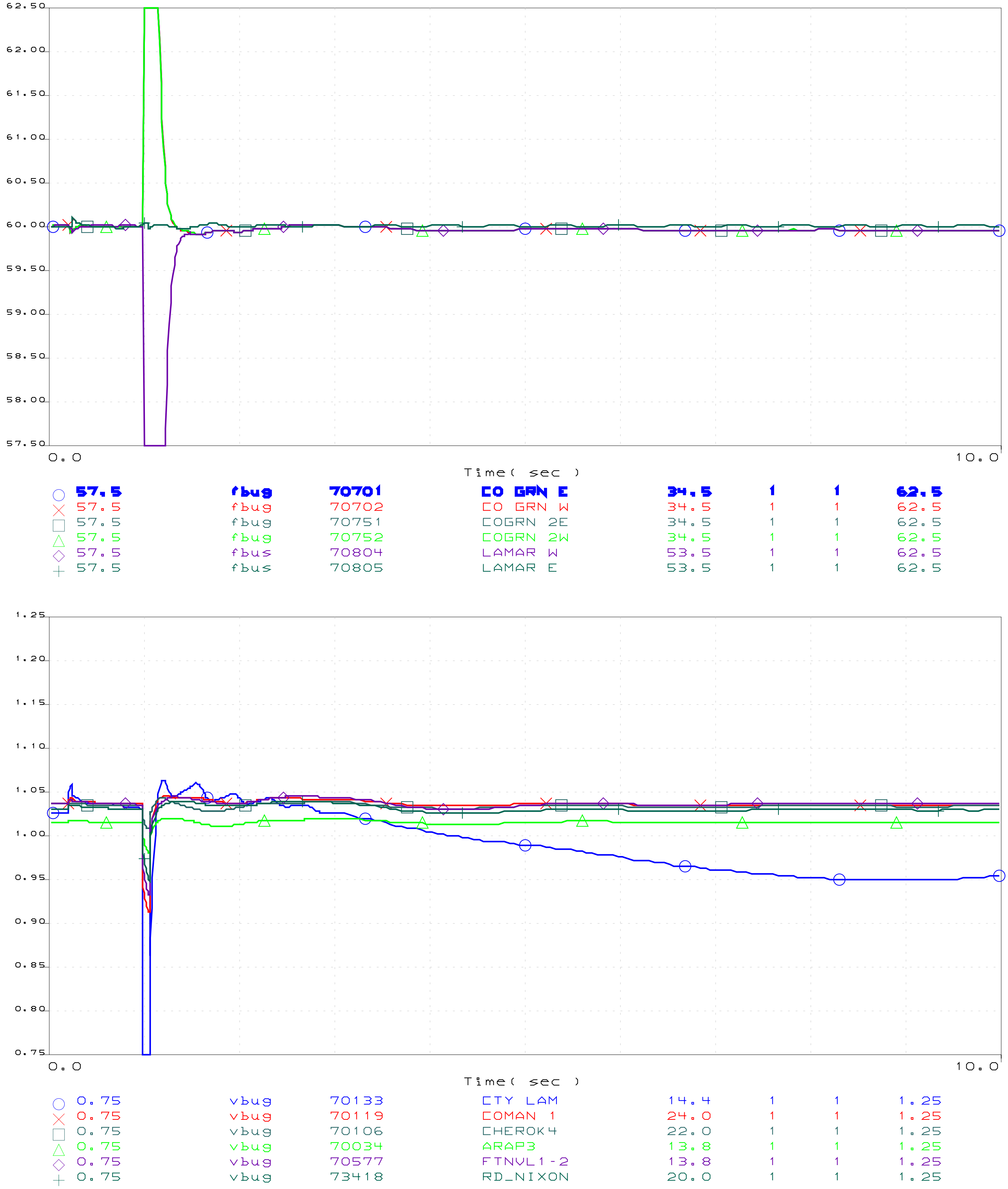
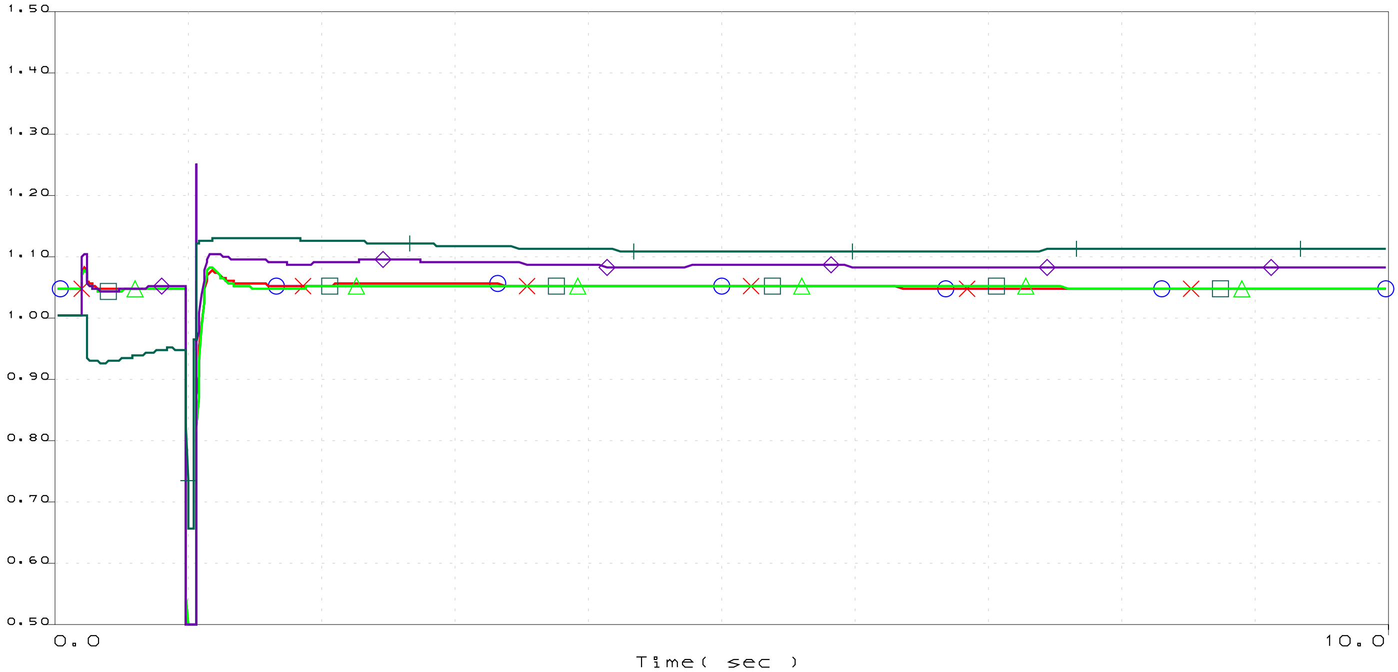
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



Case1S3.chf

Wed Nov 24 11:49:30 2004



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0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
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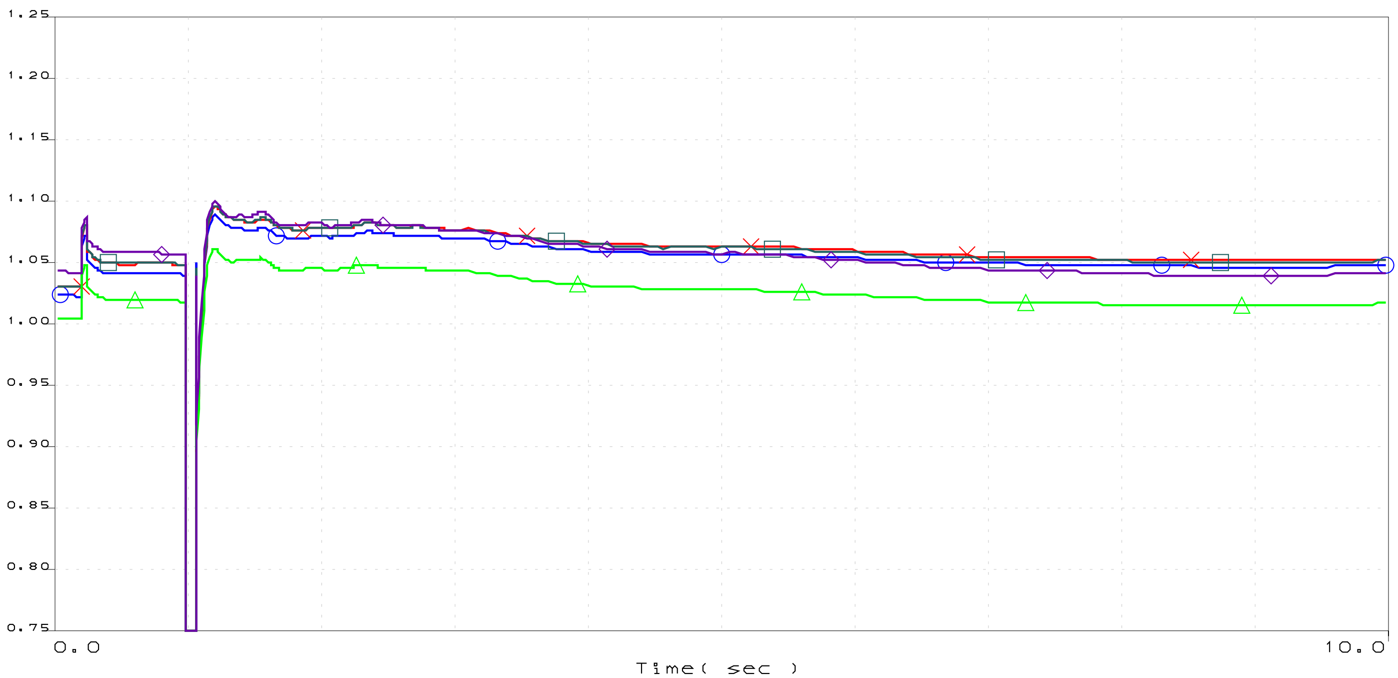

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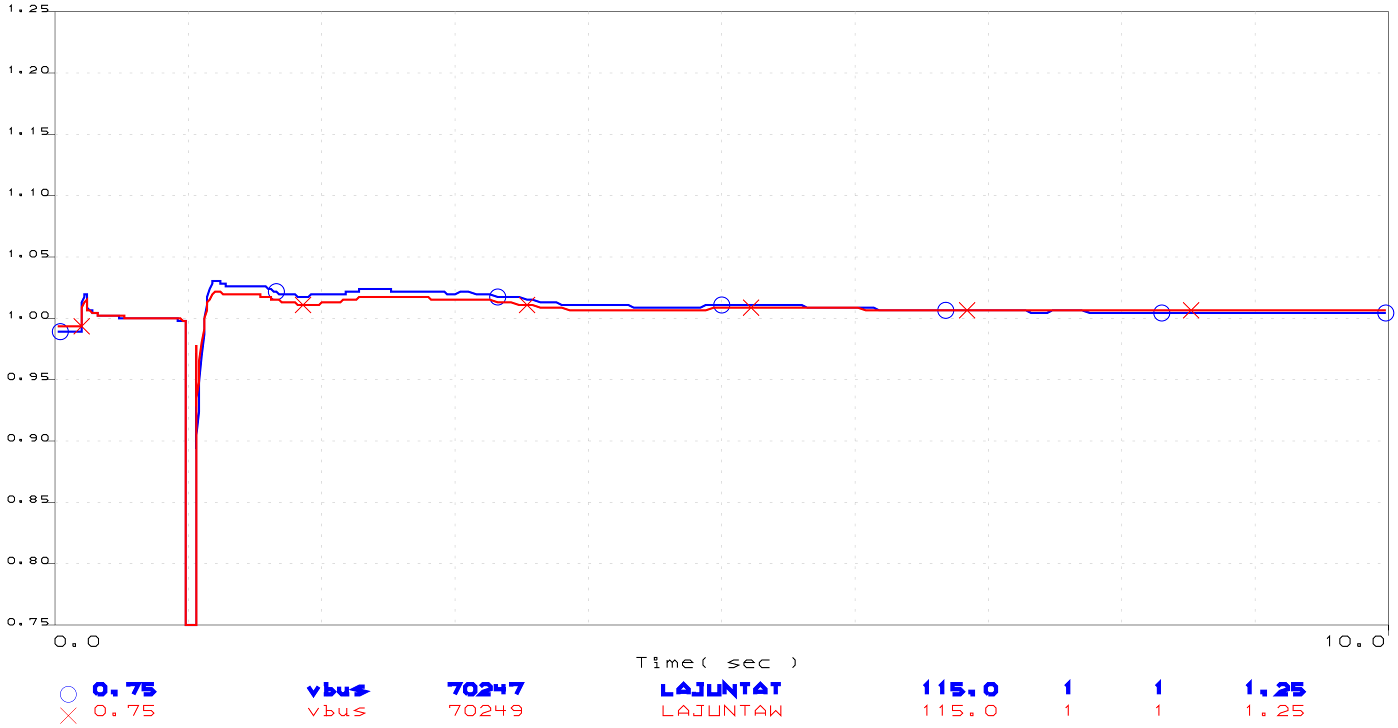

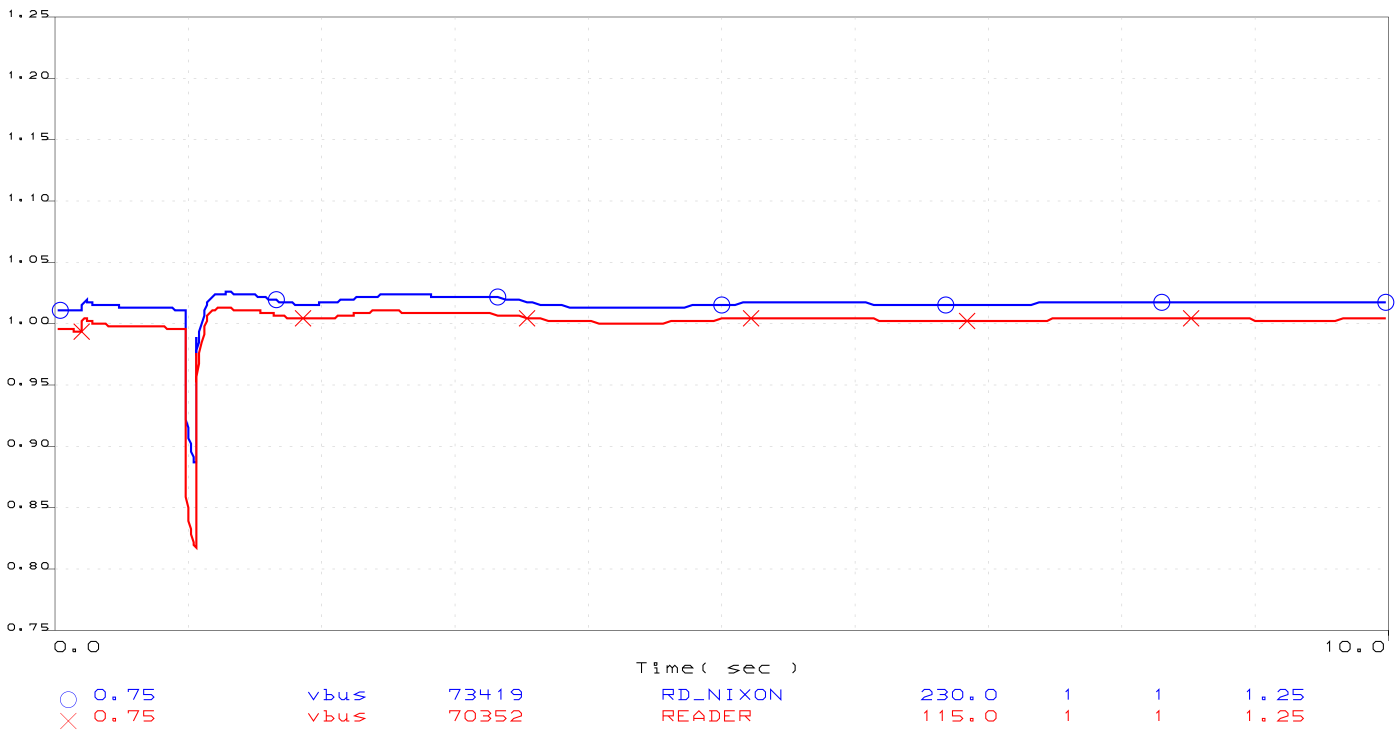

Case1S3.chf

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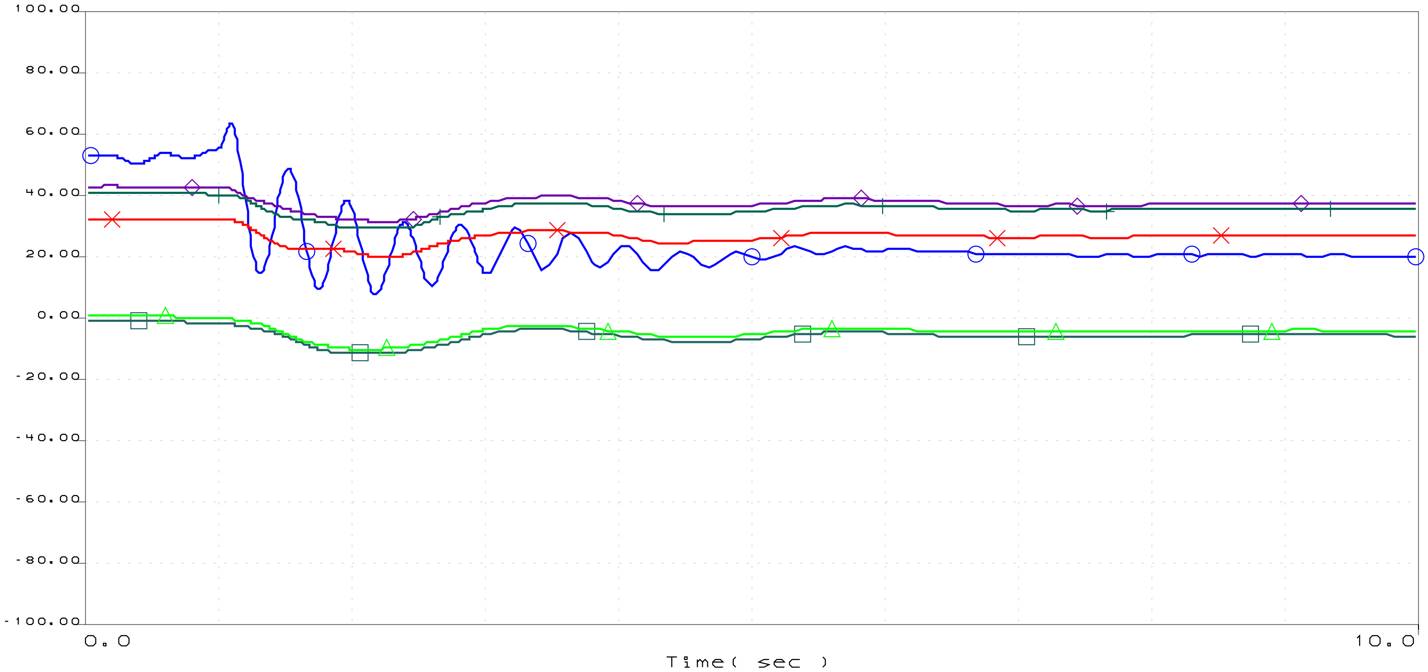

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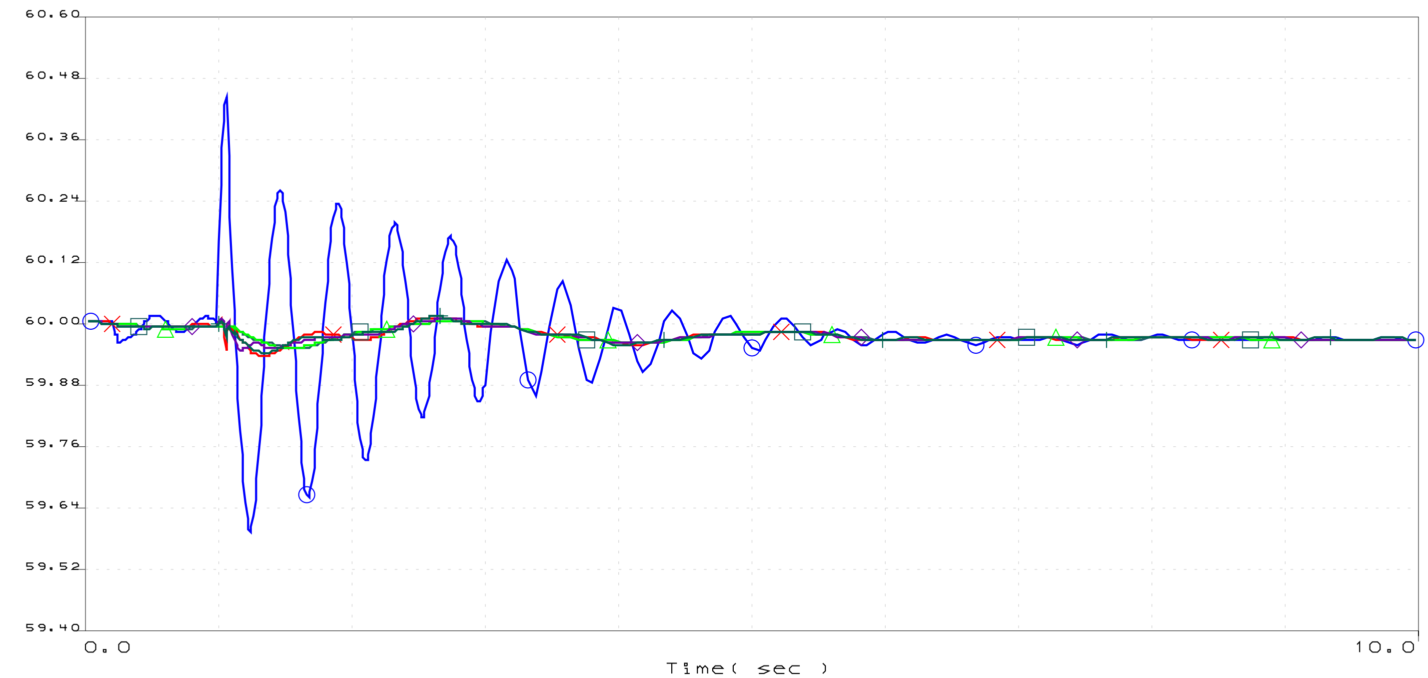
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



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59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
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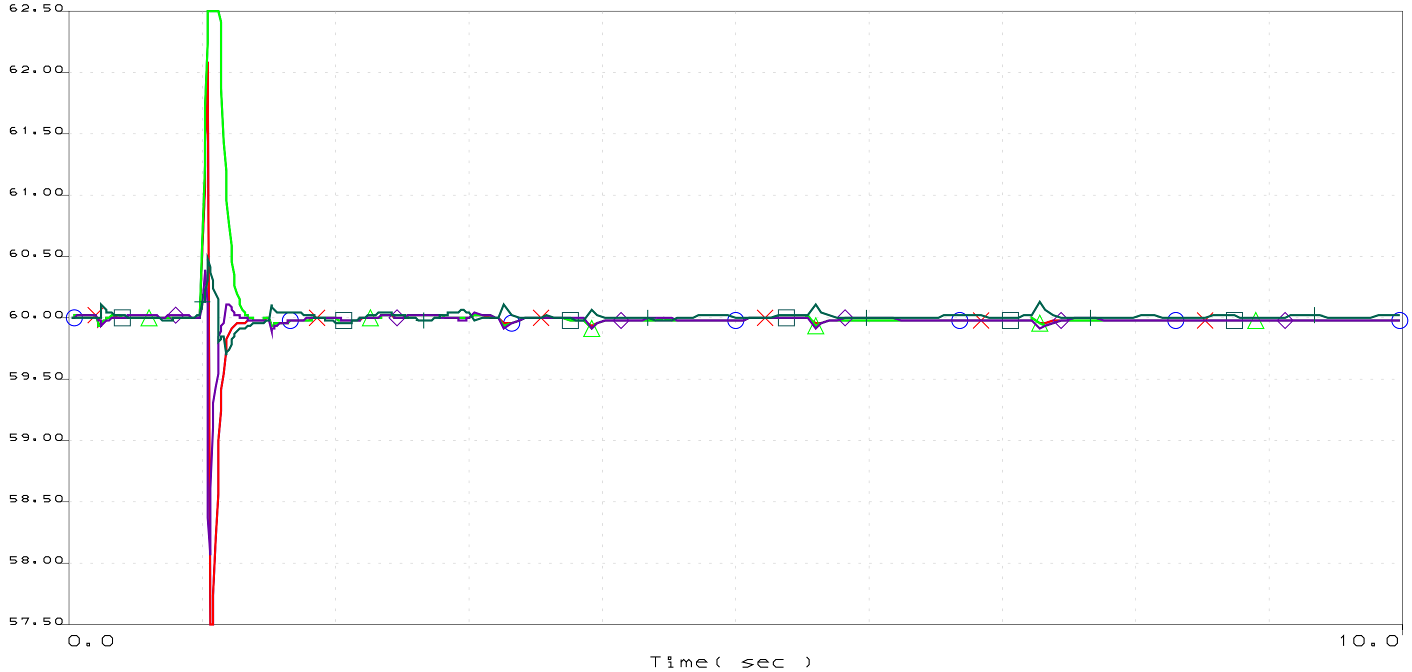
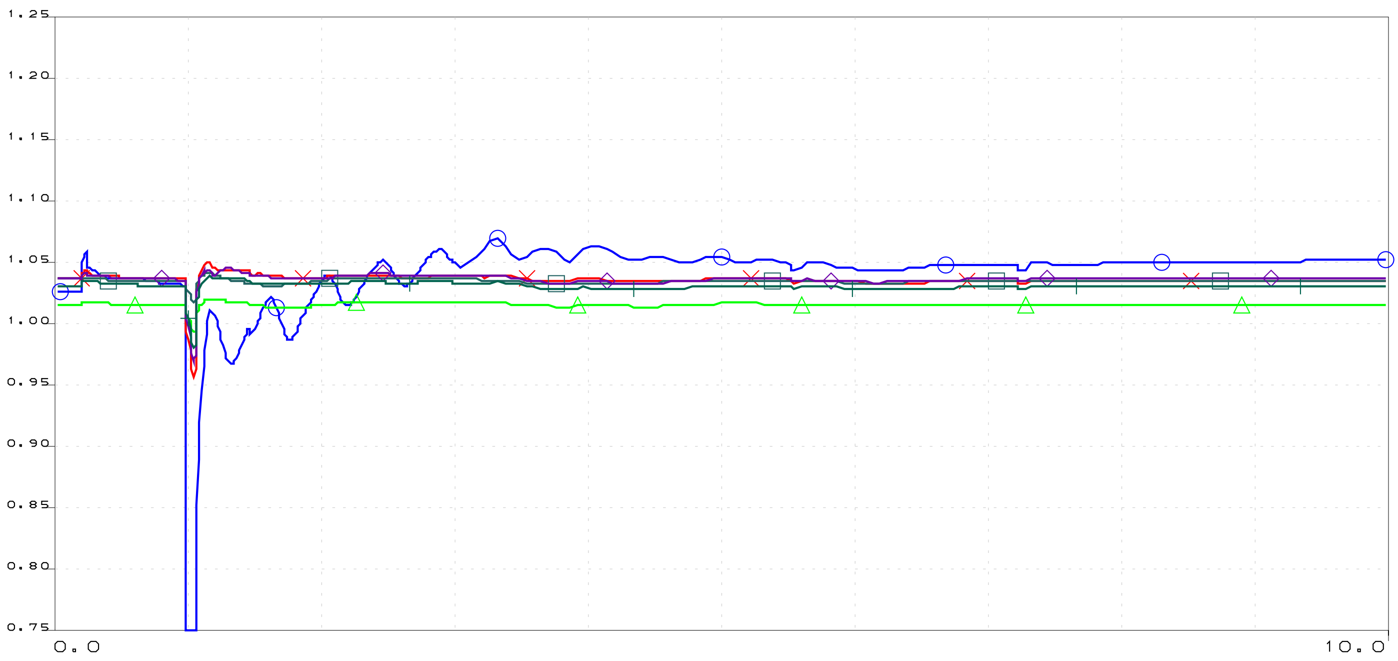
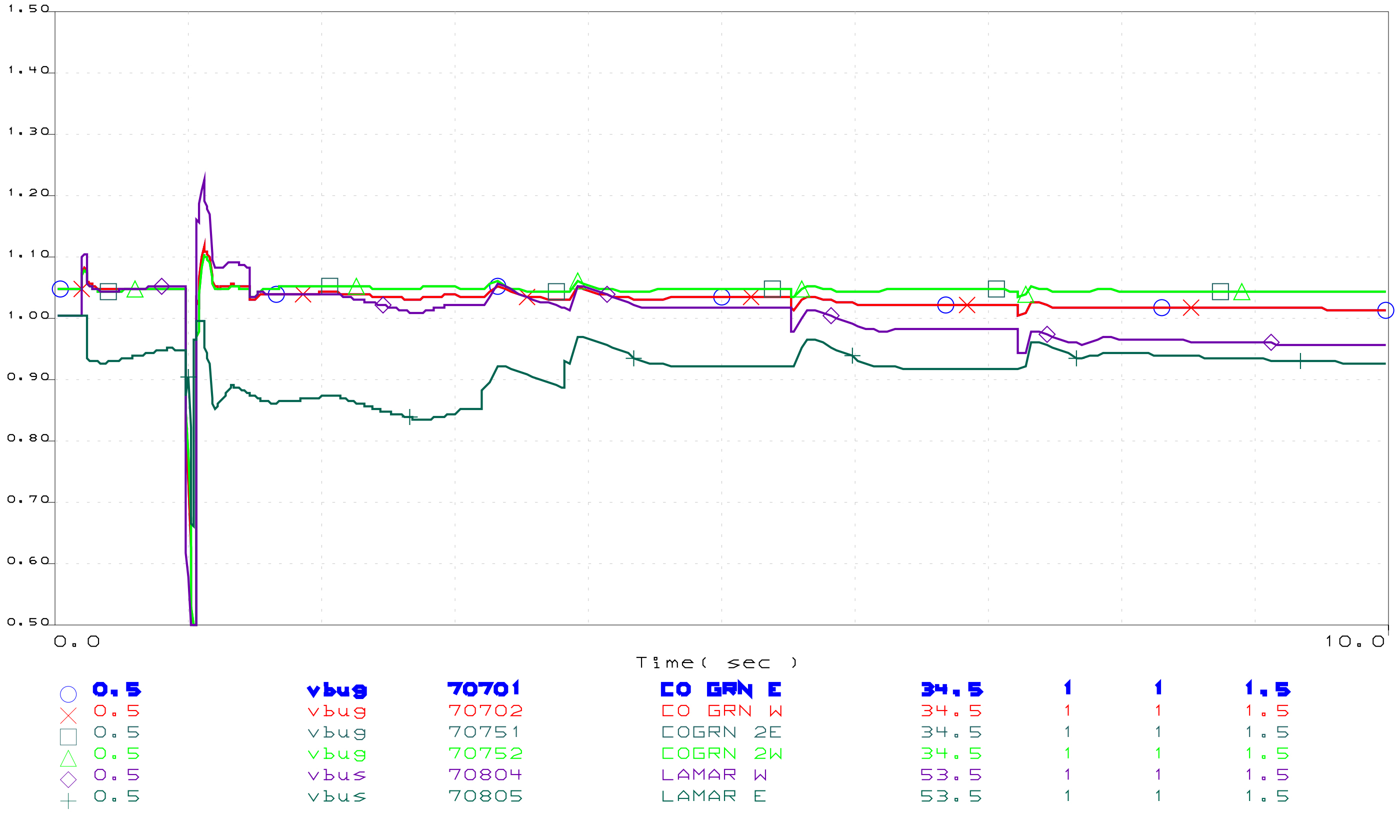
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6

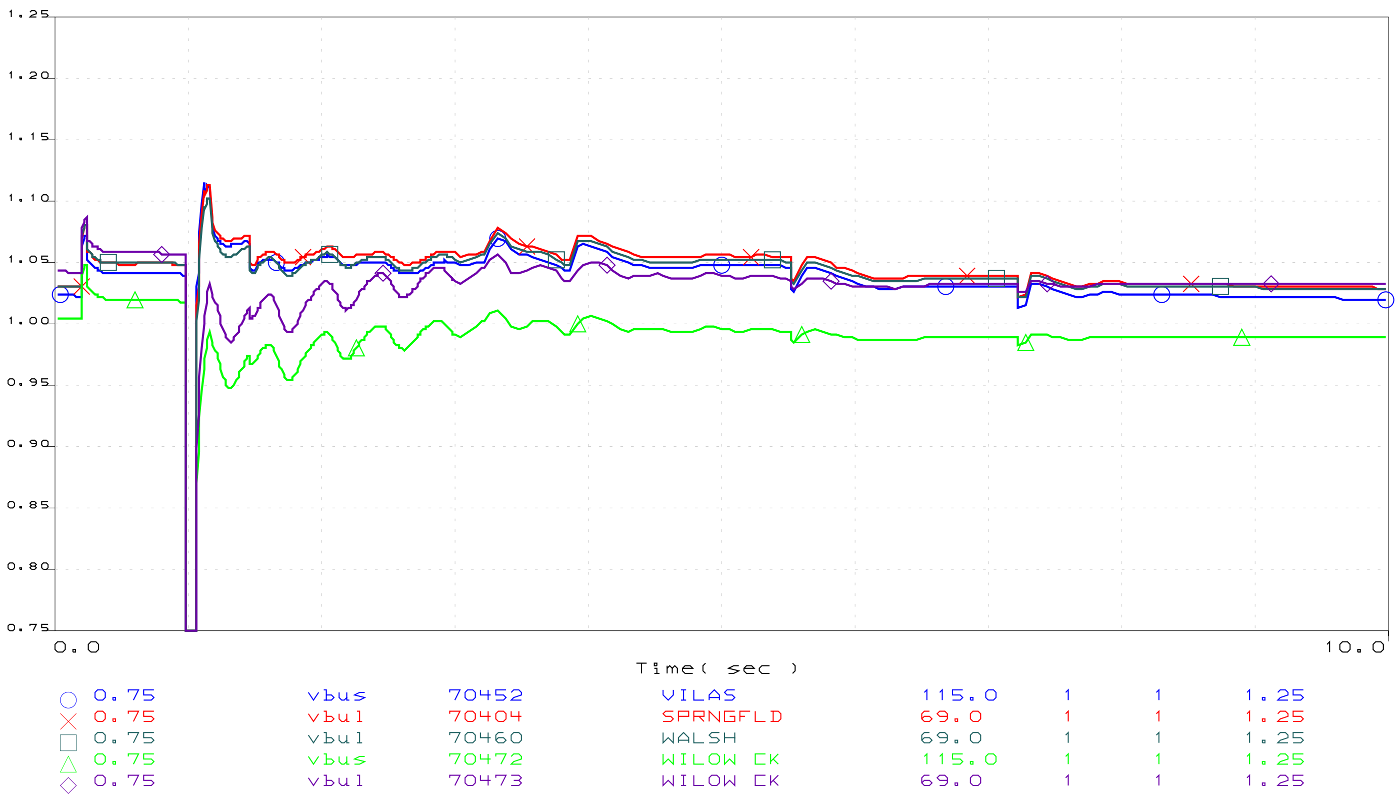


57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25





Case154.chf

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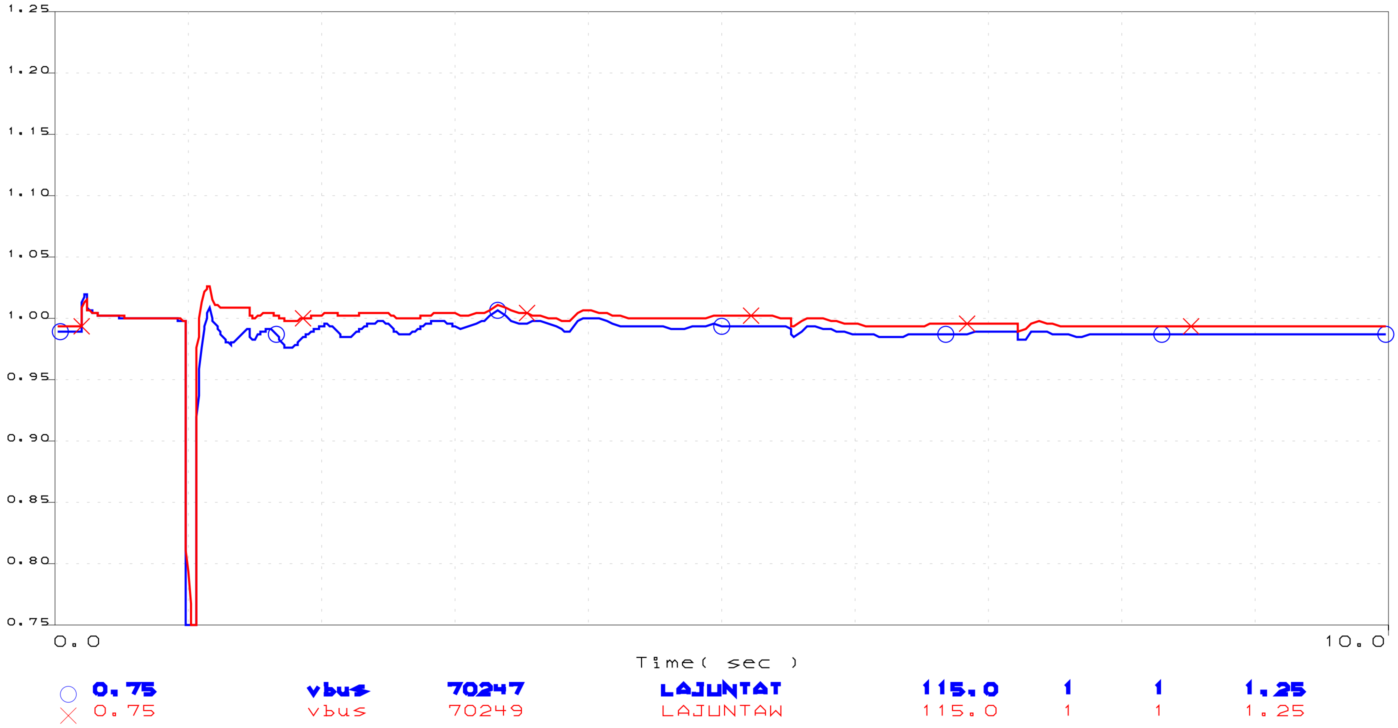
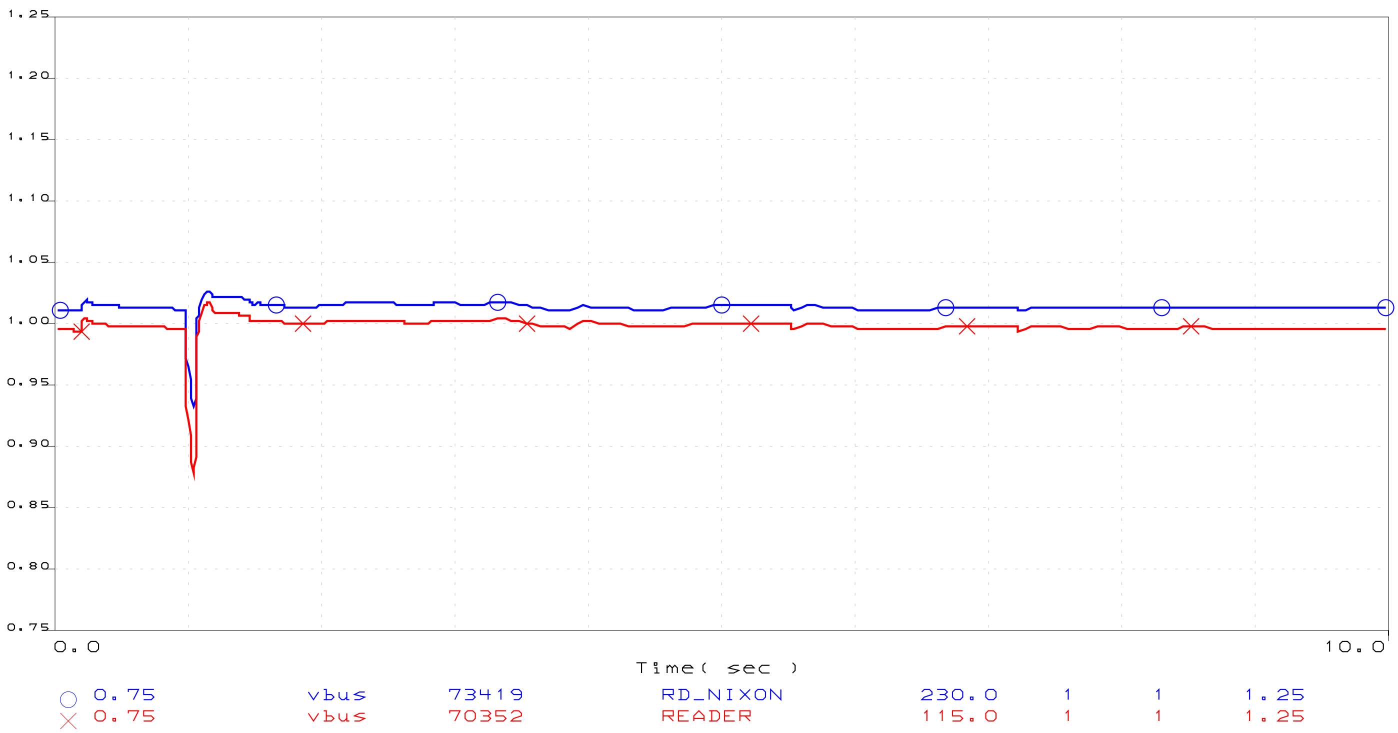
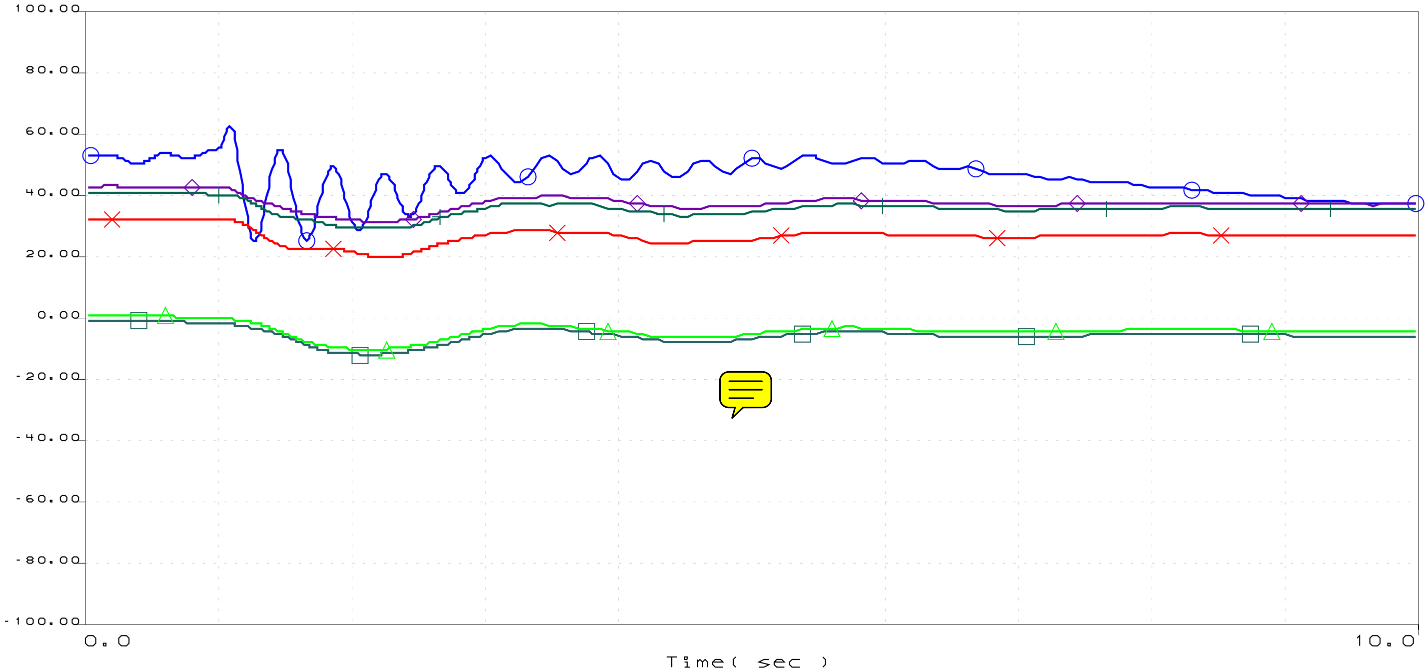


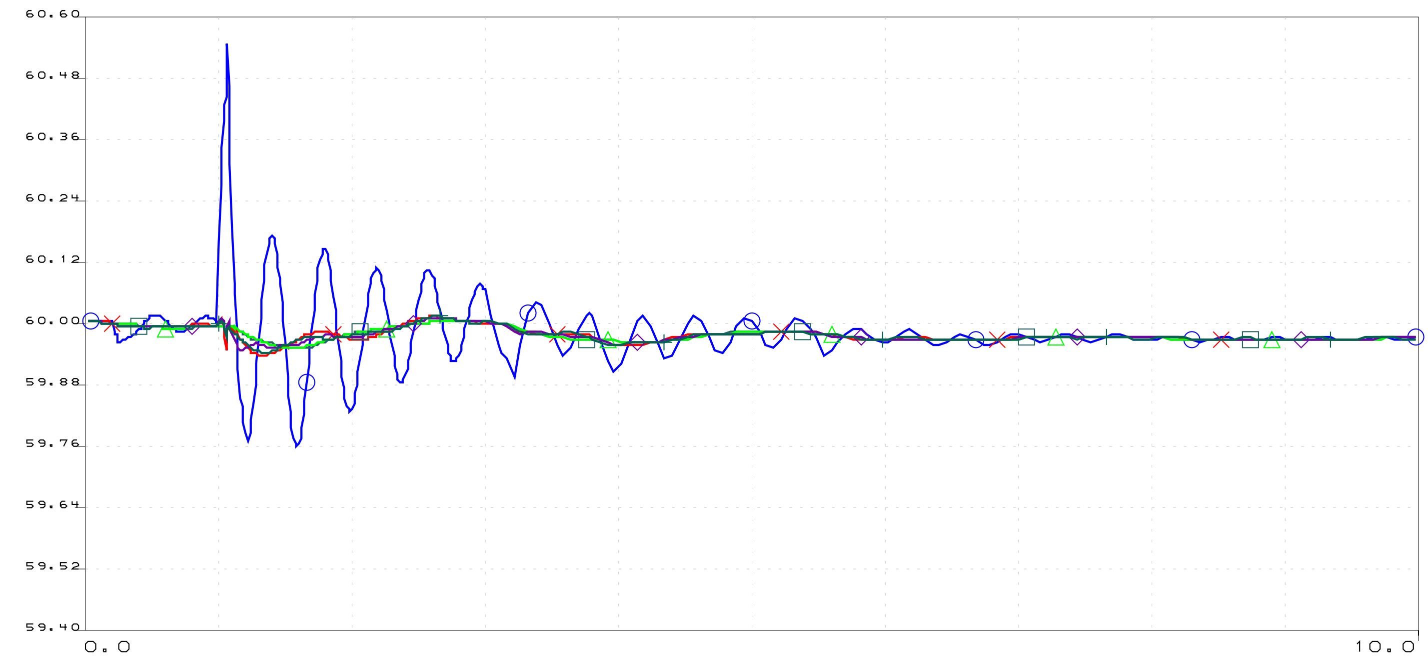
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25



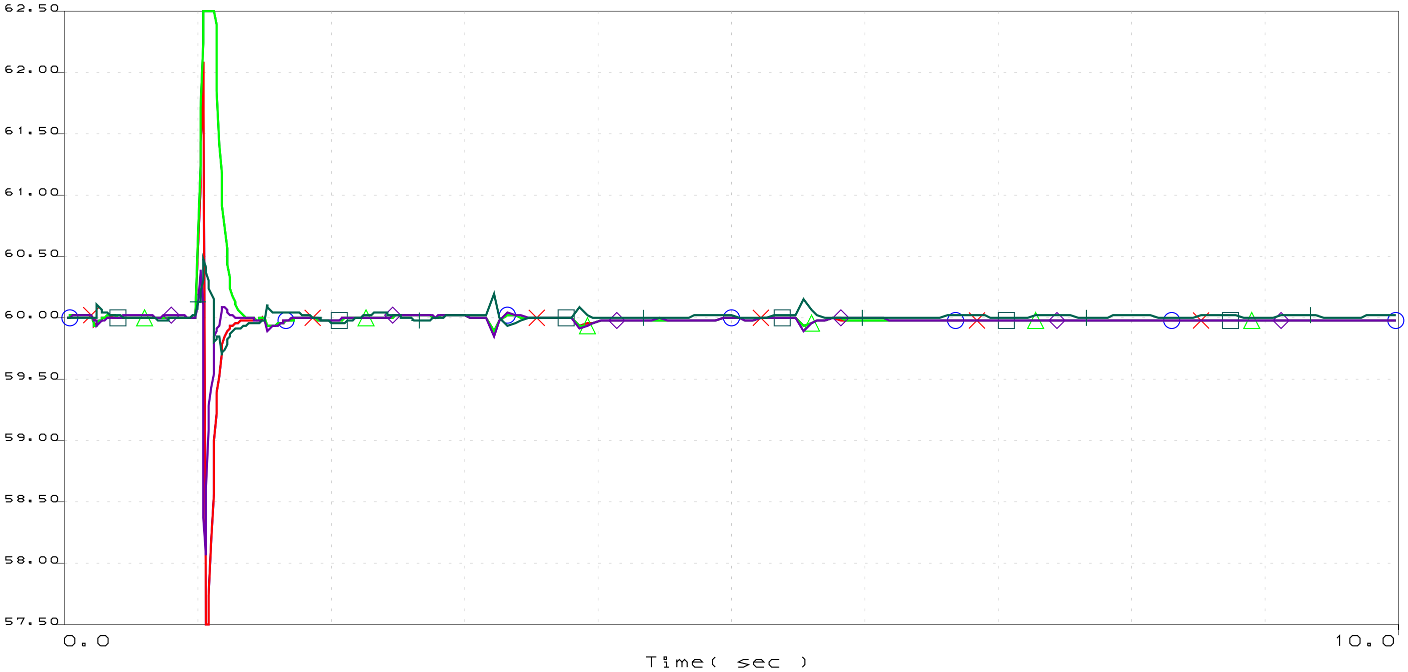
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



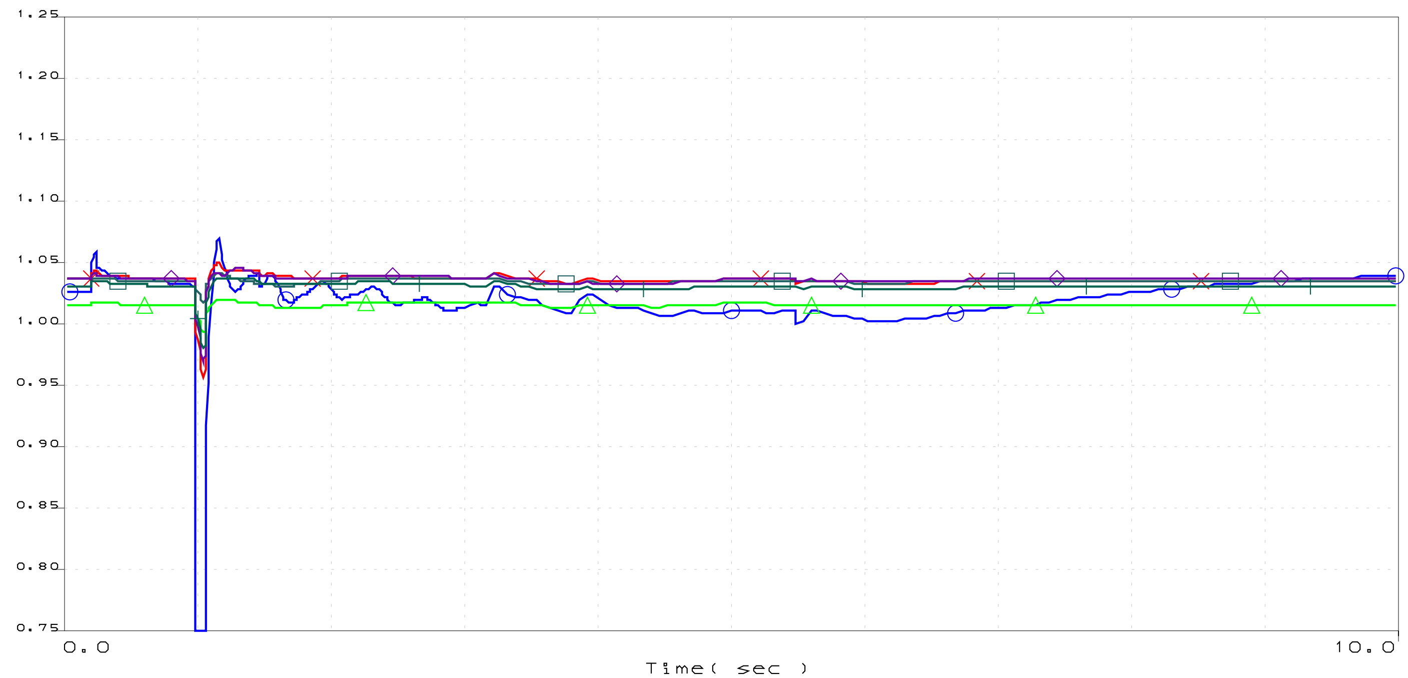
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



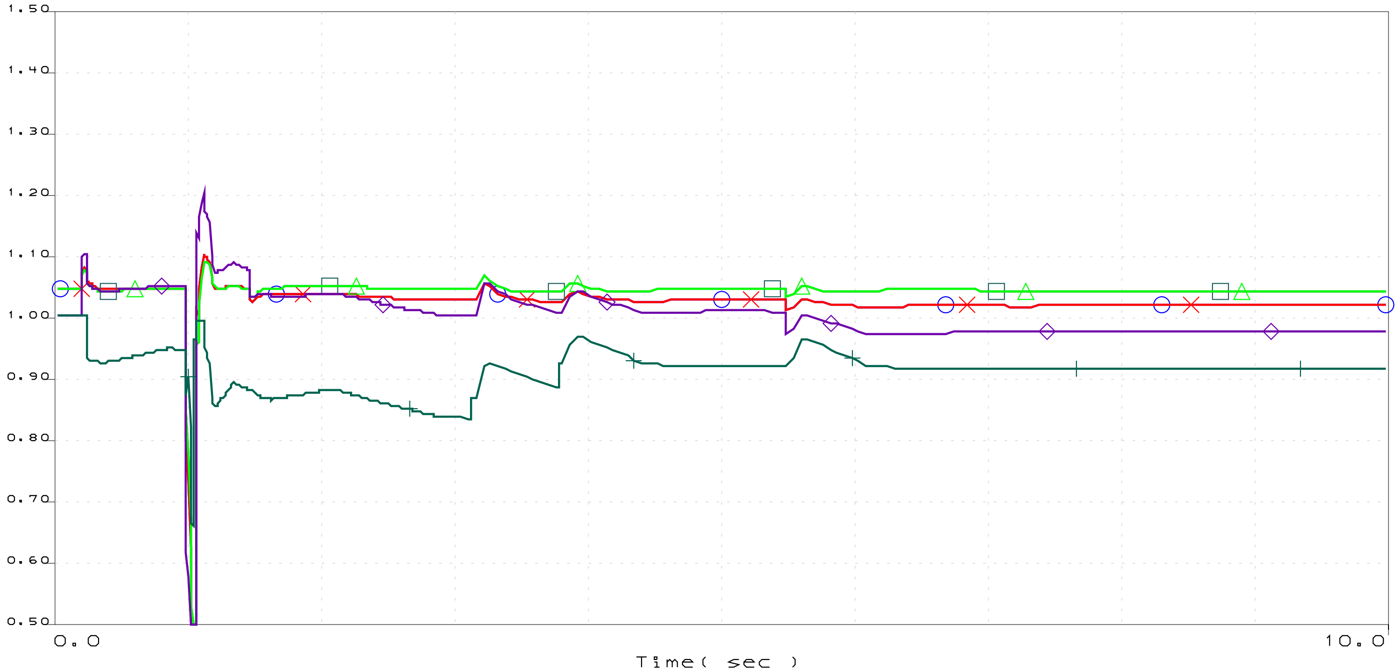
59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



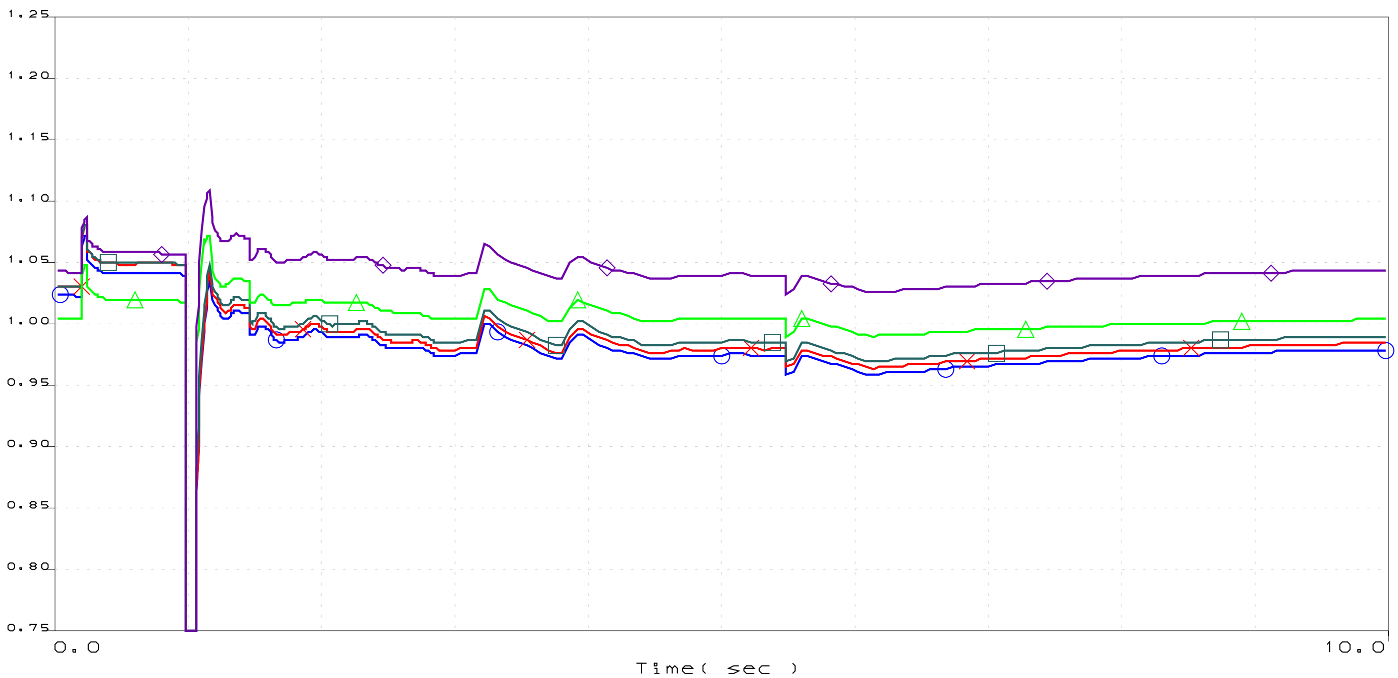
○	57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
×	57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□	57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△	57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇	57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+	57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○	0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
×	0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□	0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△	0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇	0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+	0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case155.chf

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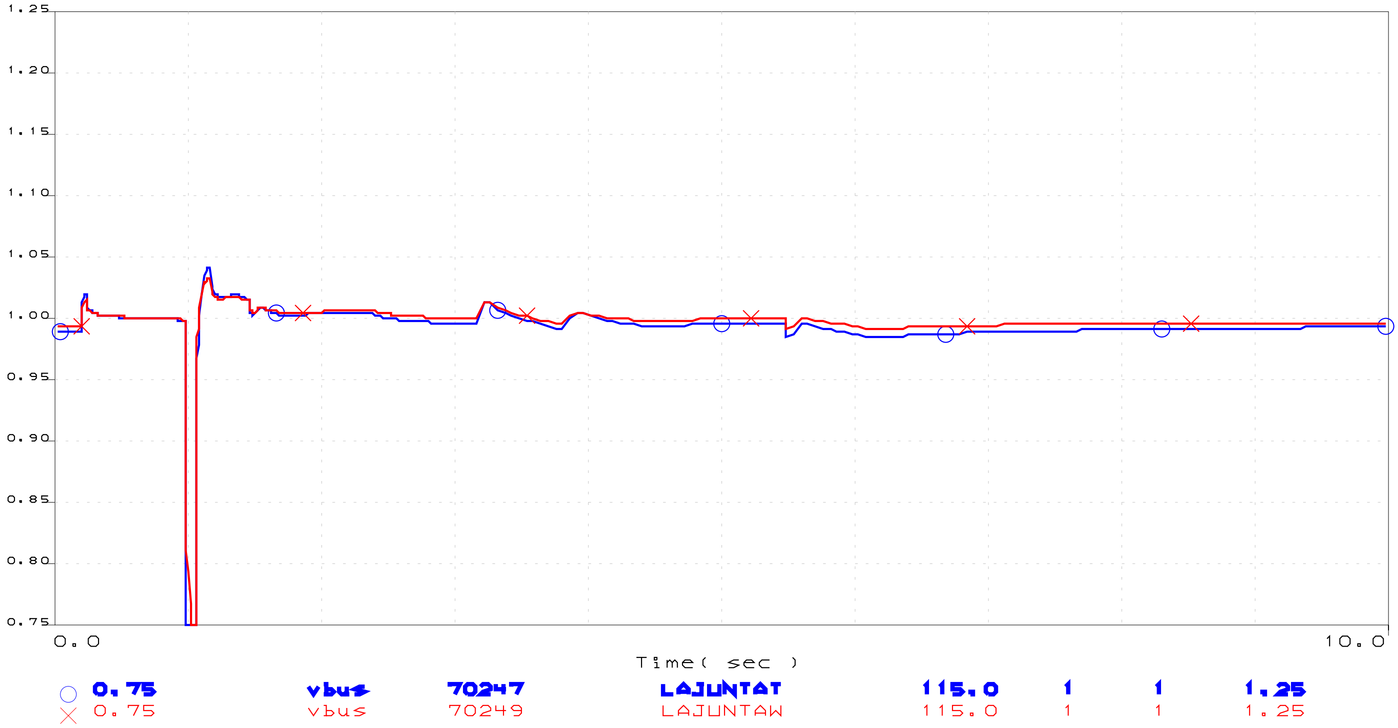
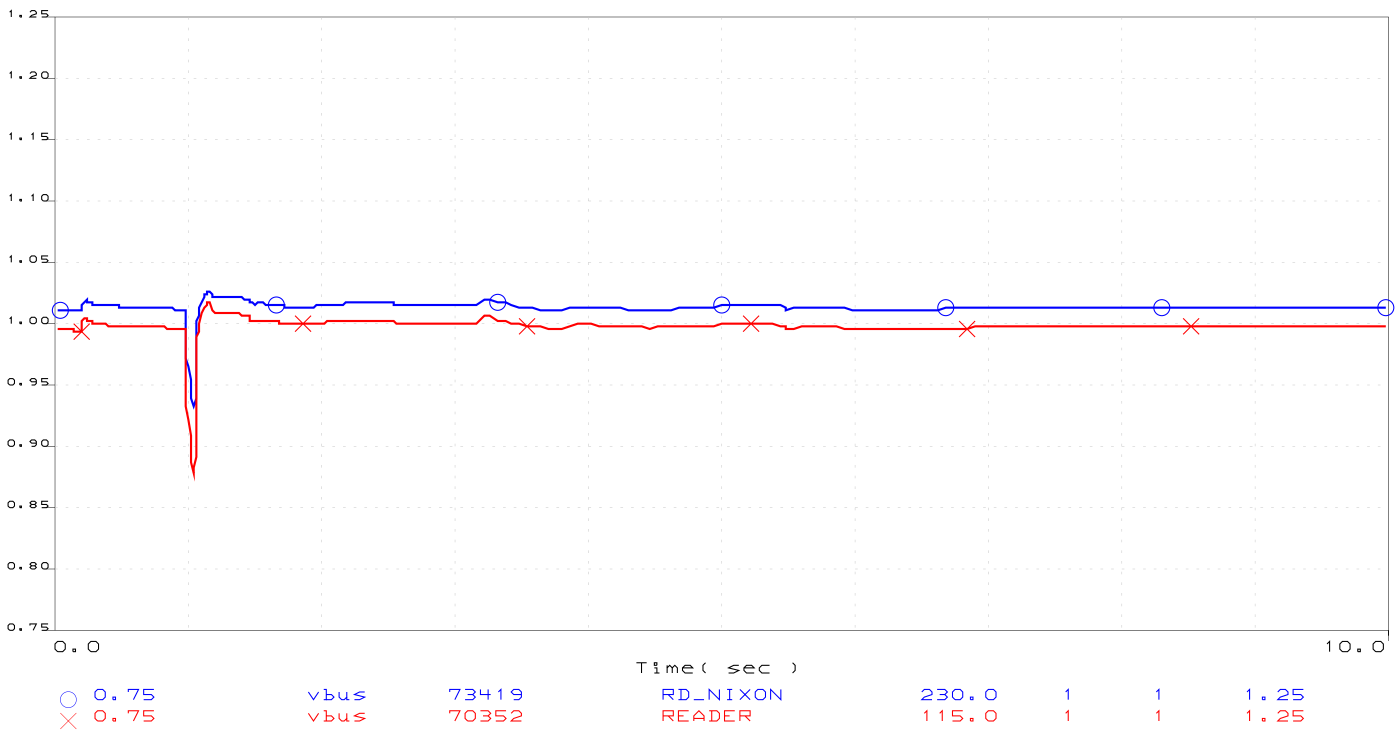
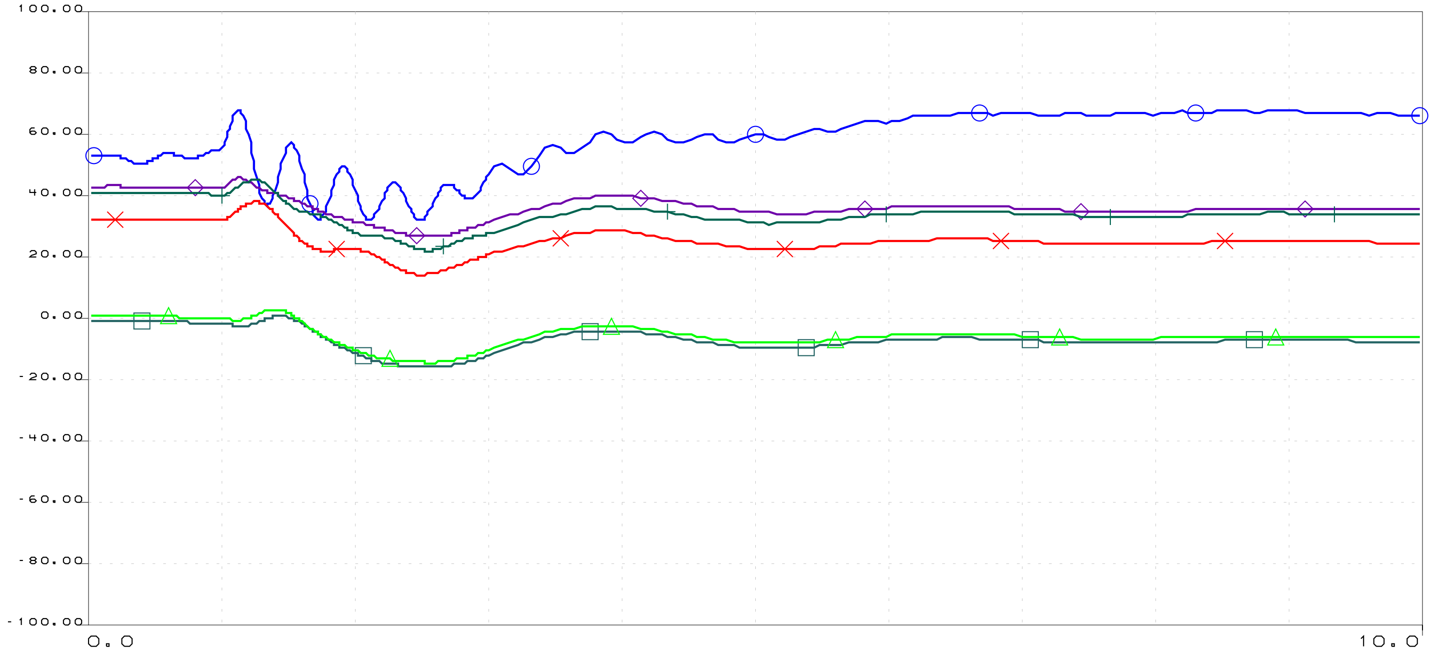


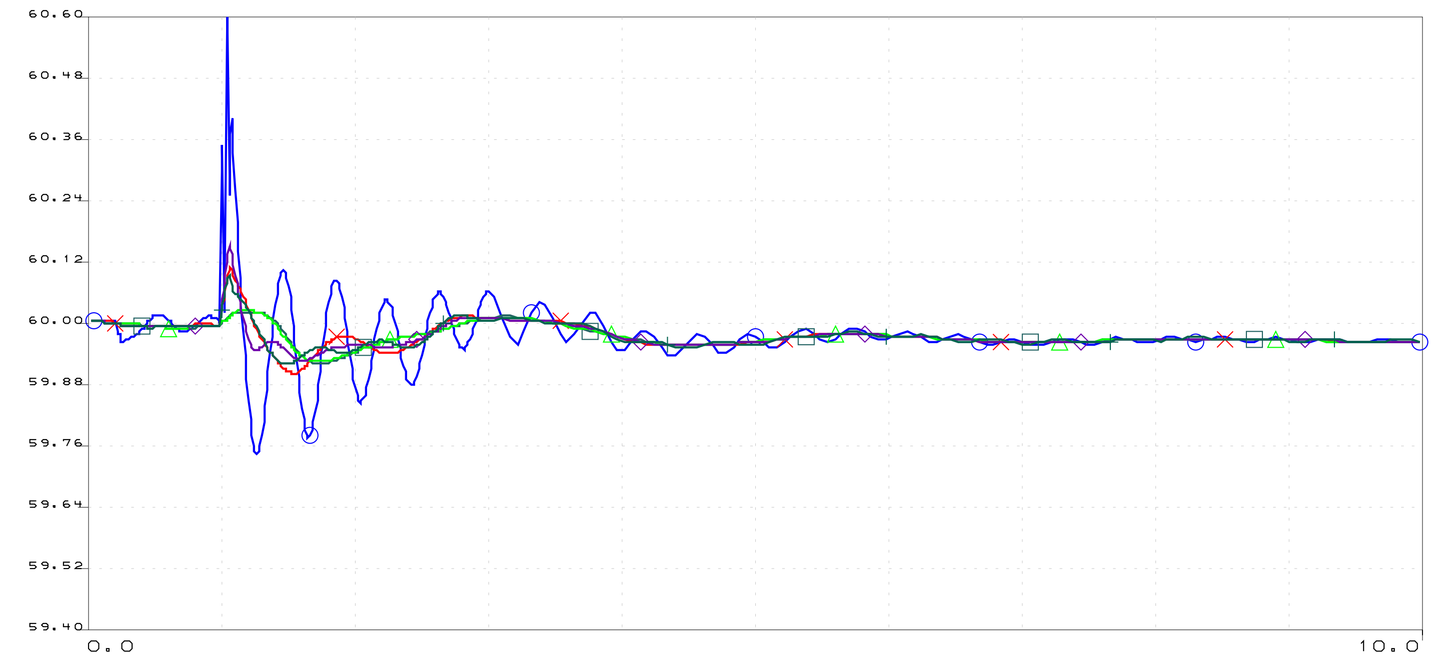


Case155.chf

Wed Nov 24 11:50:10 2004



-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6

Case156.chf

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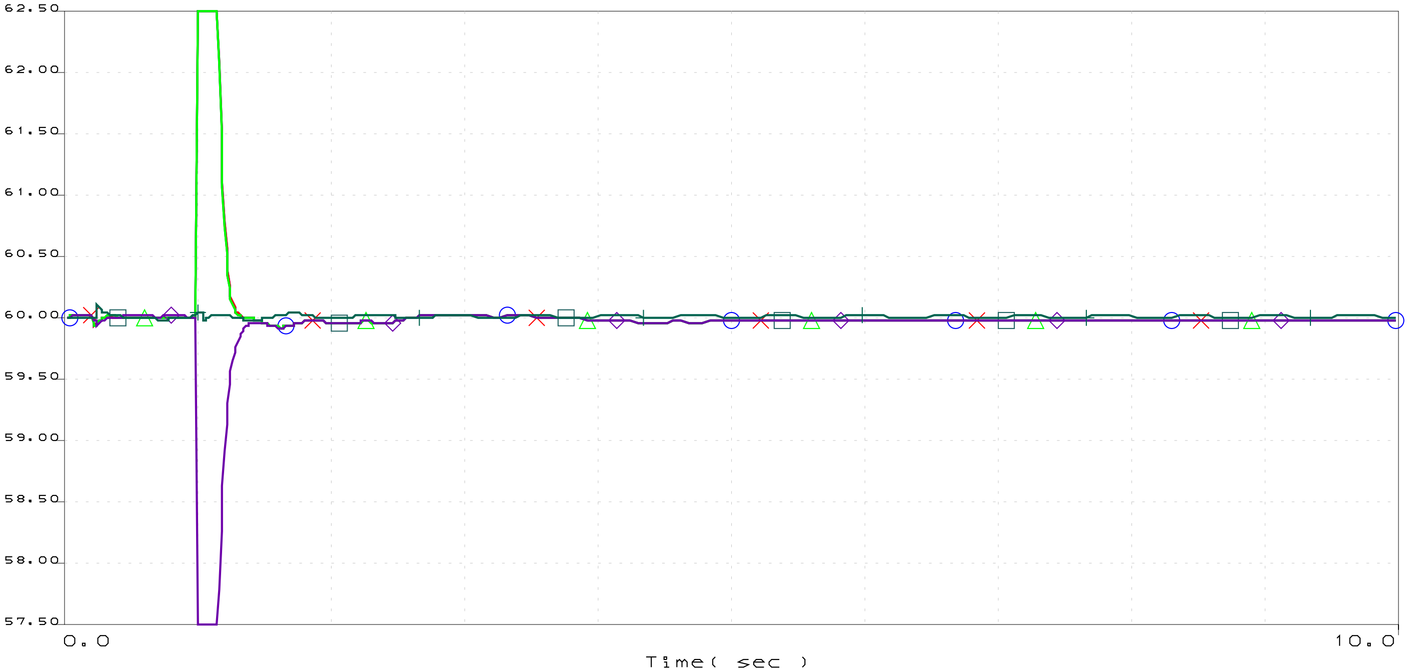
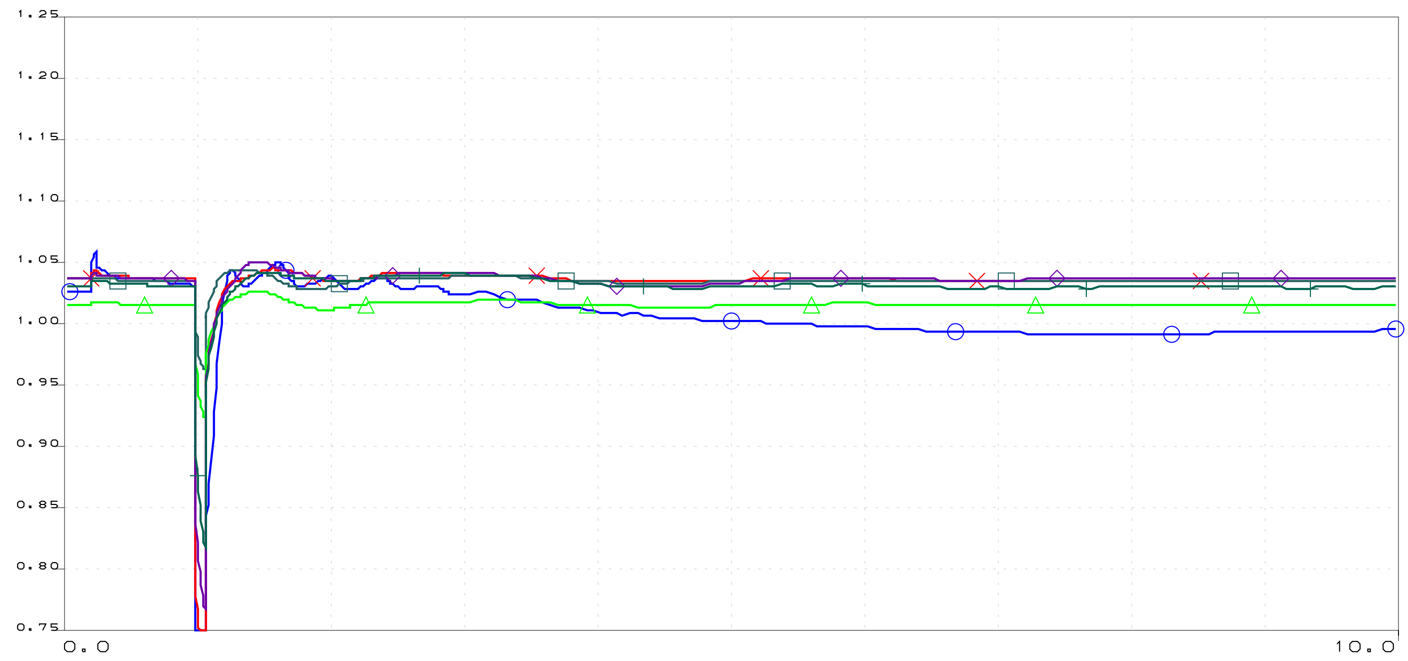


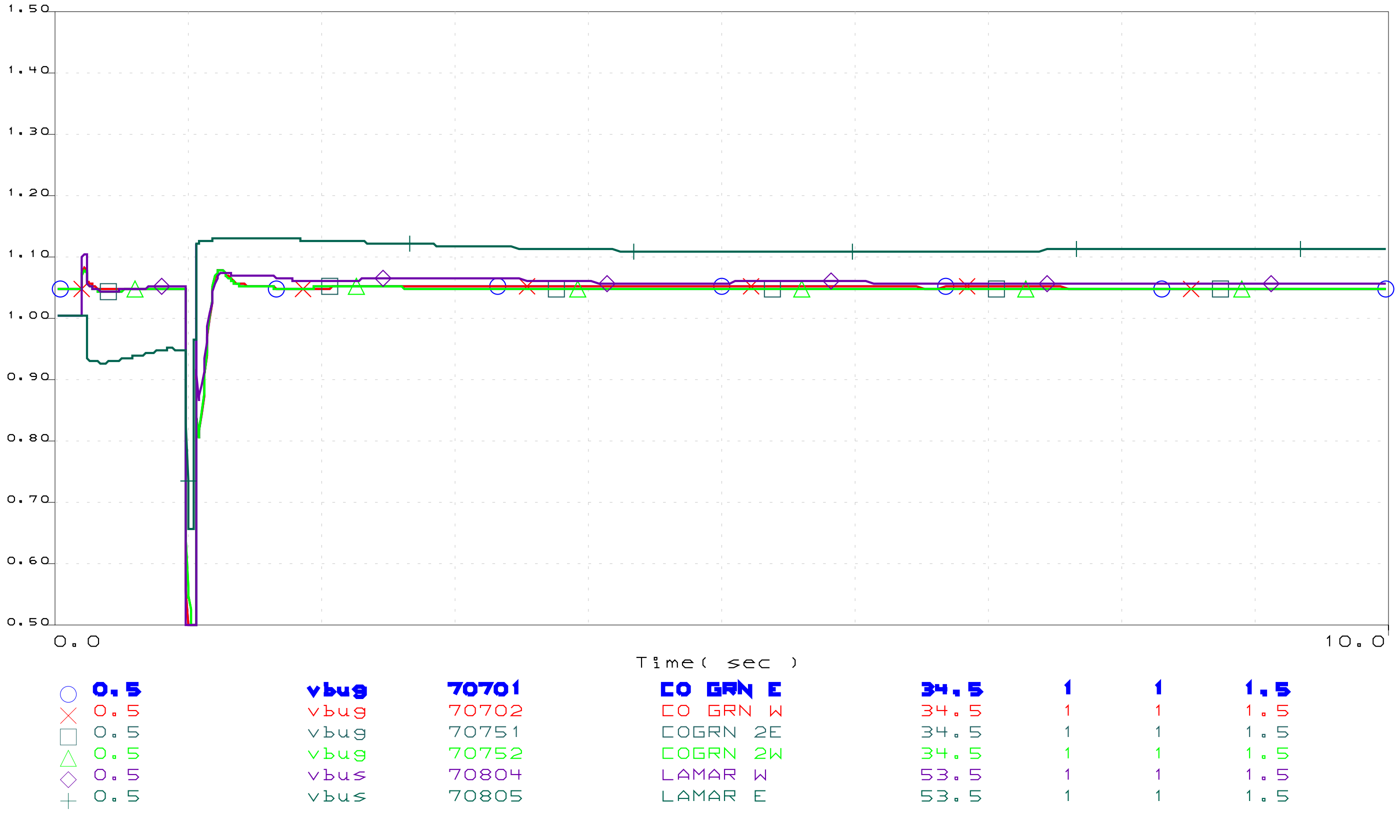
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5

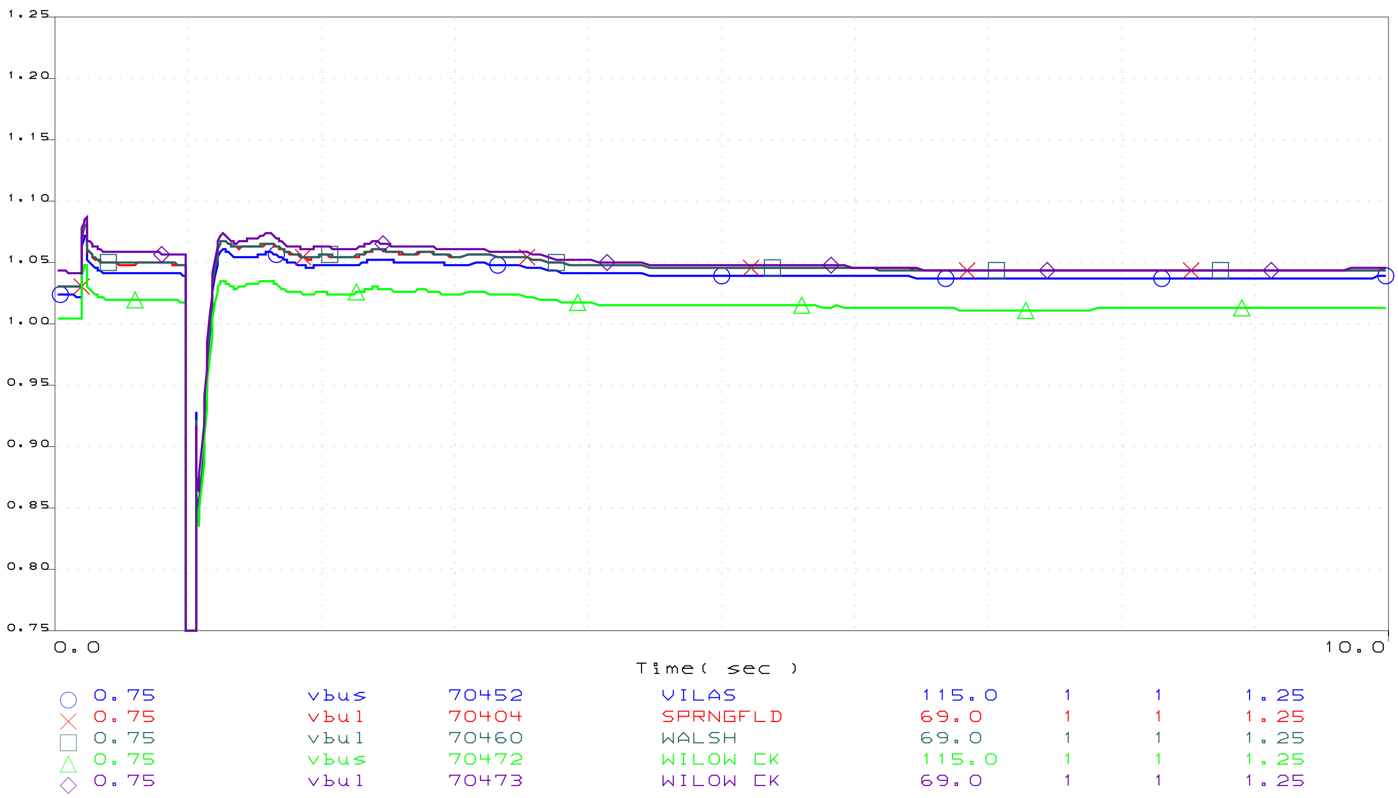


○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

Case1S6.chf

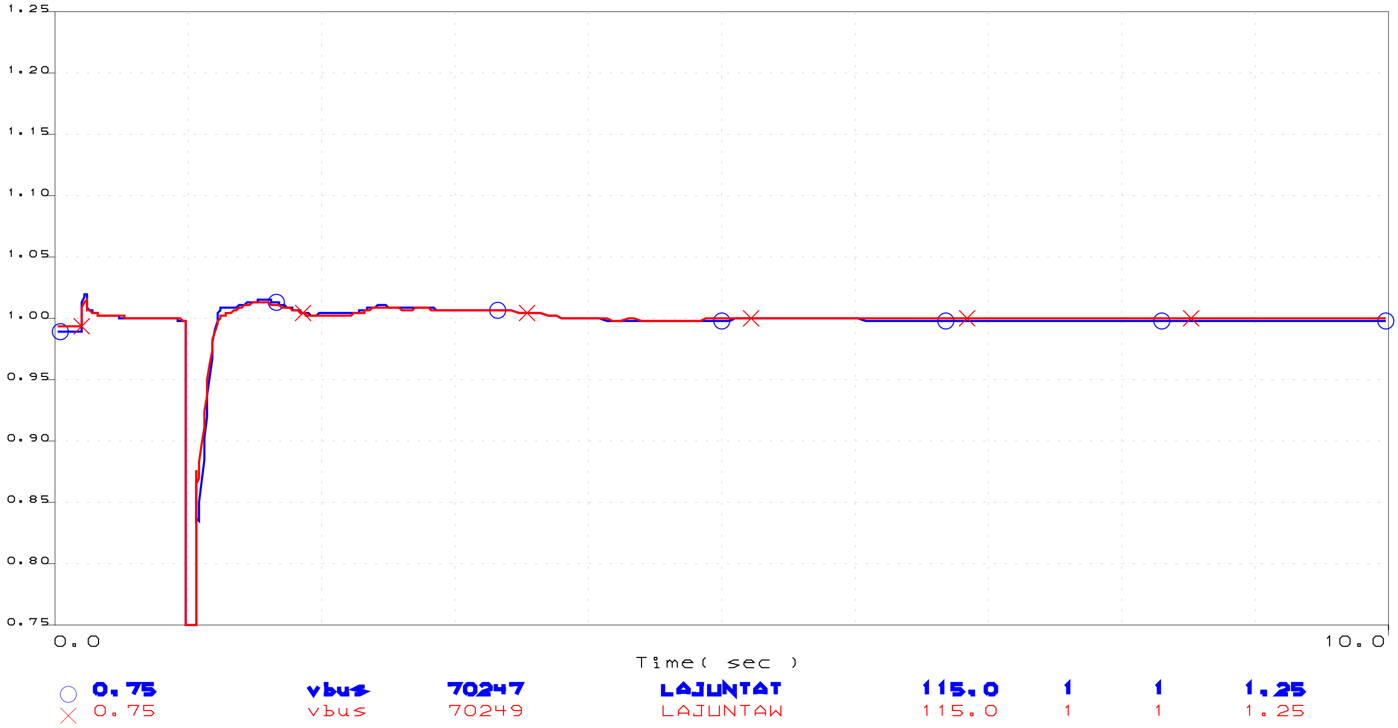
Wed Nov 24 11:50:23 2004

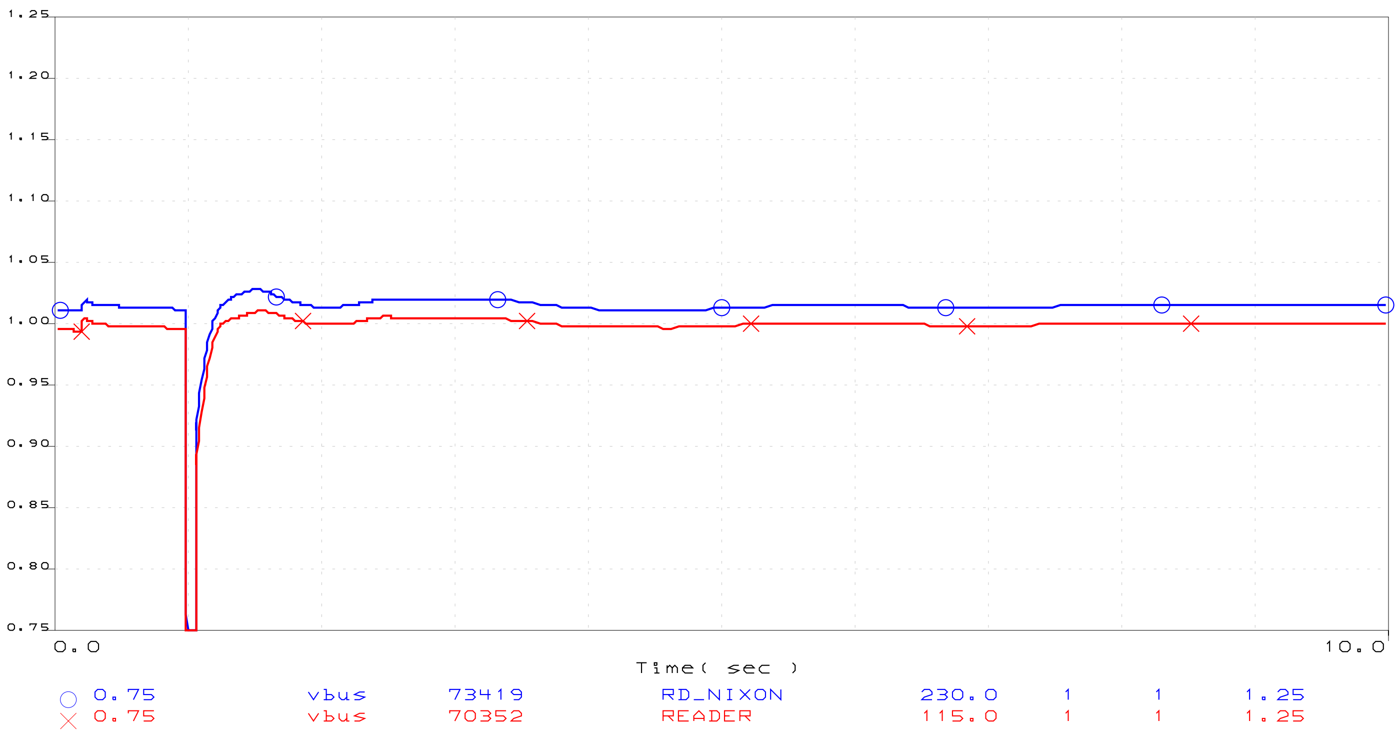




Case156.chf

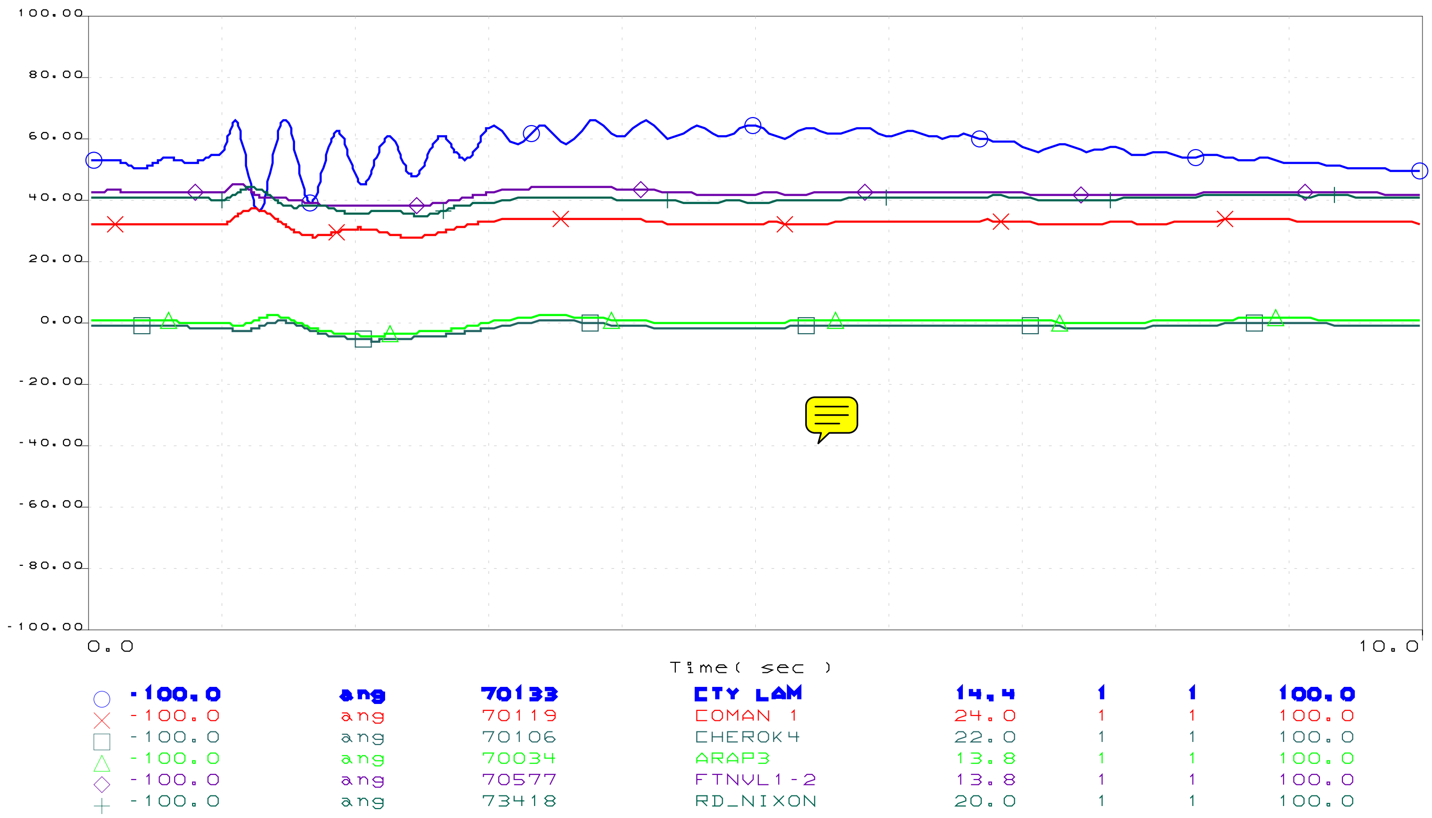
Wed Nov 24 11:50:23 2004



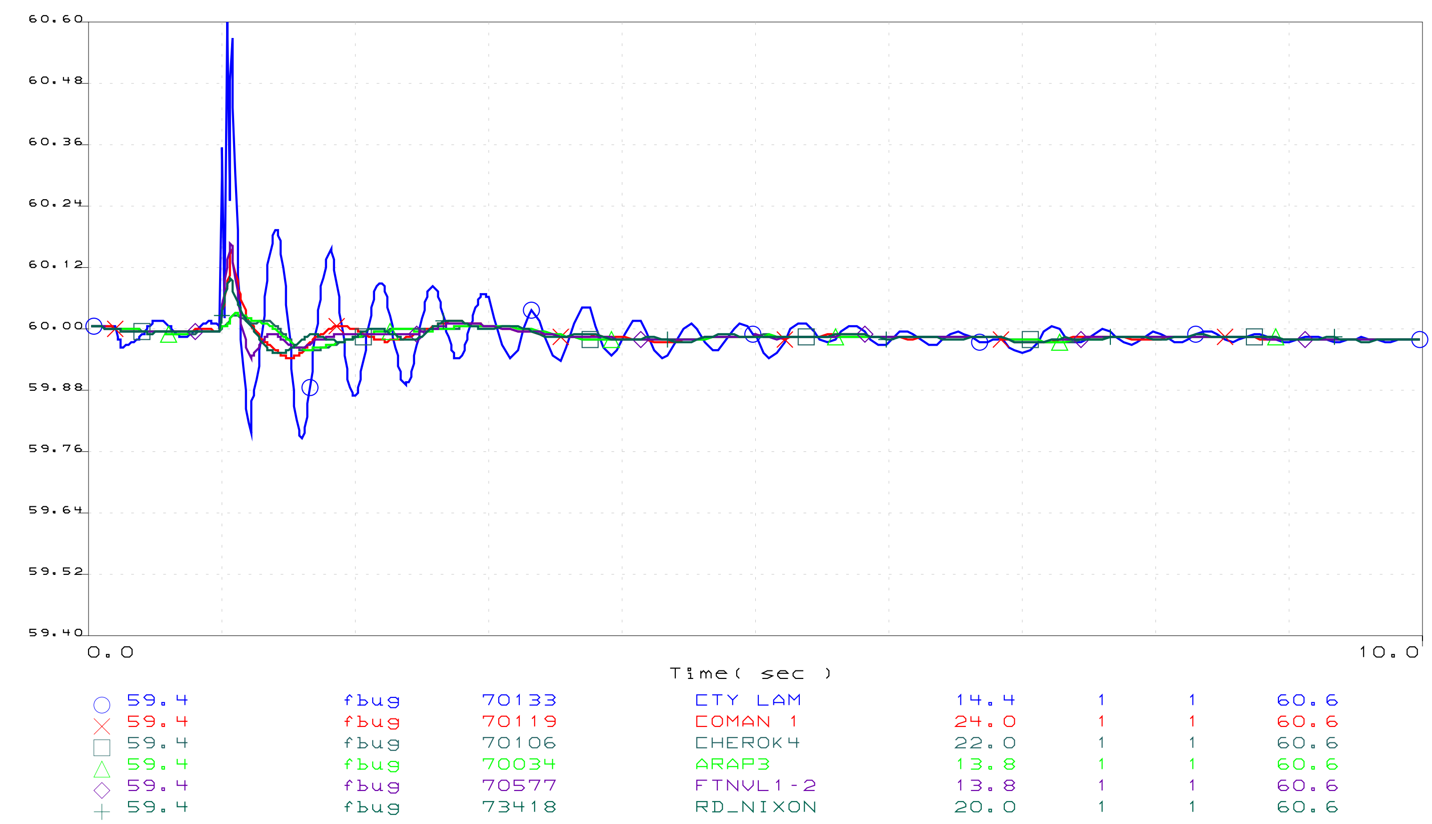


Case156.chf

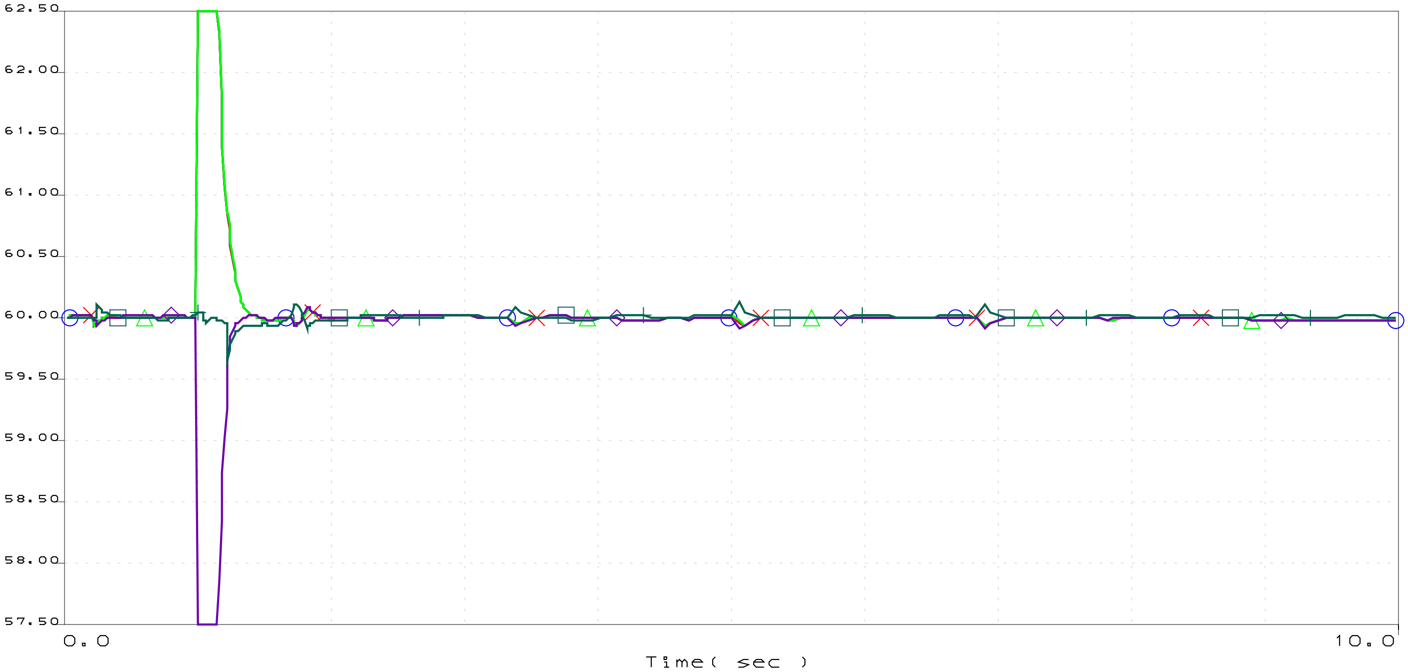
Wed Nov 24 11:50:23 2004



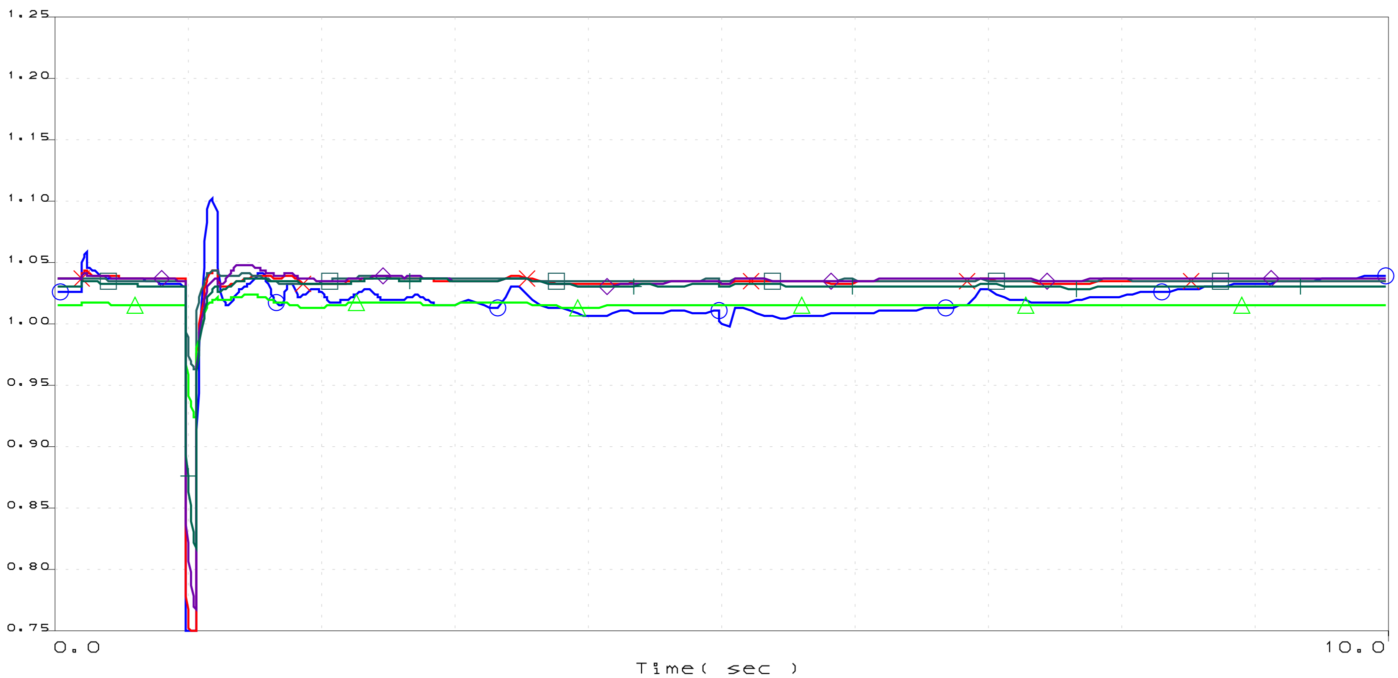
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
-100.00
0.0
10.0
Time(sec)
-100.0 ang 70133 CTY LAM 14.4 1 1 100.0
-100.0 ang 70119 COMAN 1 24.0 1 1 100.0
-100.0 ang 70106 CHEROK4 22.0 1 1 100.0
-100.0 ang 70034 ARAP3 13.8 1 1 100.0
-100.0 ang 70577 FTNVL1-2 13.8 1 1 100.0
-100.0 ang 73418 RD_NIXON 20.0 1 1 100.0



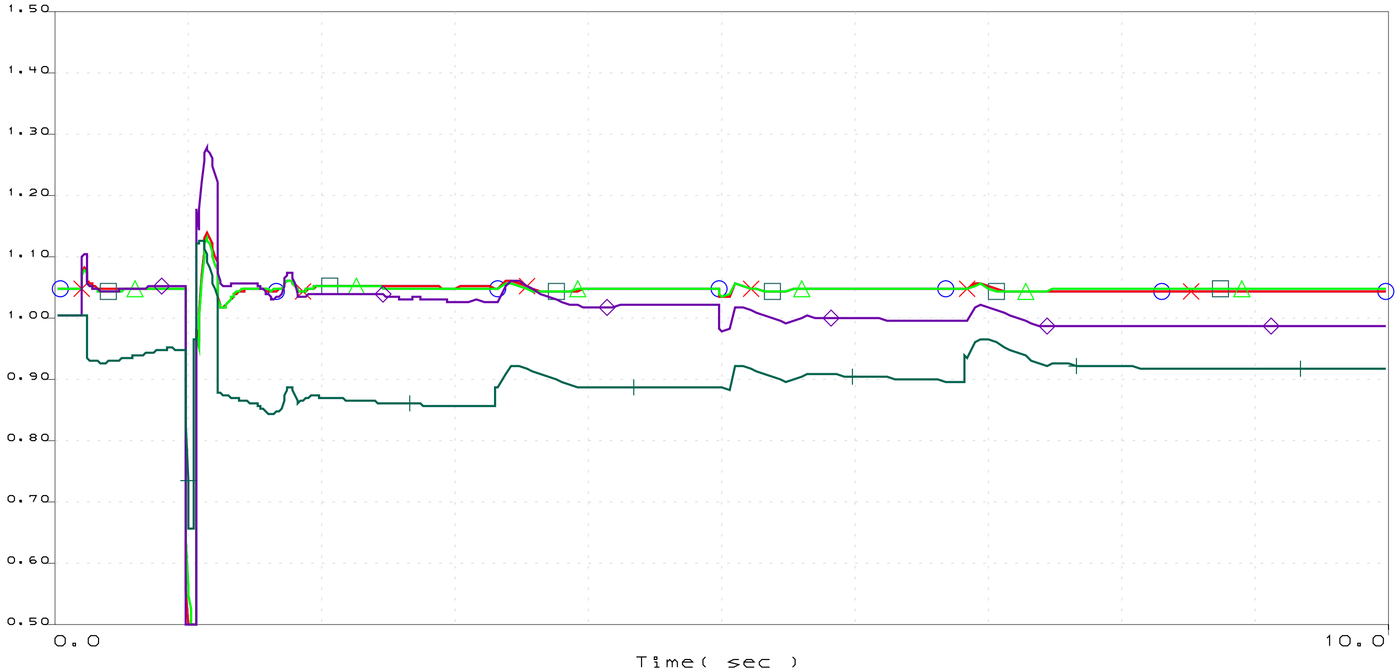
60.60
60.48
60.36
60.24
60.12
60.00
59.88
59.76
59.64
59.52
59.40
0.0
10.0
Time(sec)
59.4 fbug 70133 CTY LAM 14.4 1 1 60.6
59.4 fbug 70119 COMAN 1 24.0 1 1 60.6
59.4 fbug 70106 CHEROK4 22.0 1 1 60.6
59.4 fbug 70034 ARAP3 13.8 1 1 60.6
59.4 fbug 70577 FTNVL1-2 13.8 1 1 60.6
59.4 fbug 73418 RD_NIXON 20.0 1 1 60.6



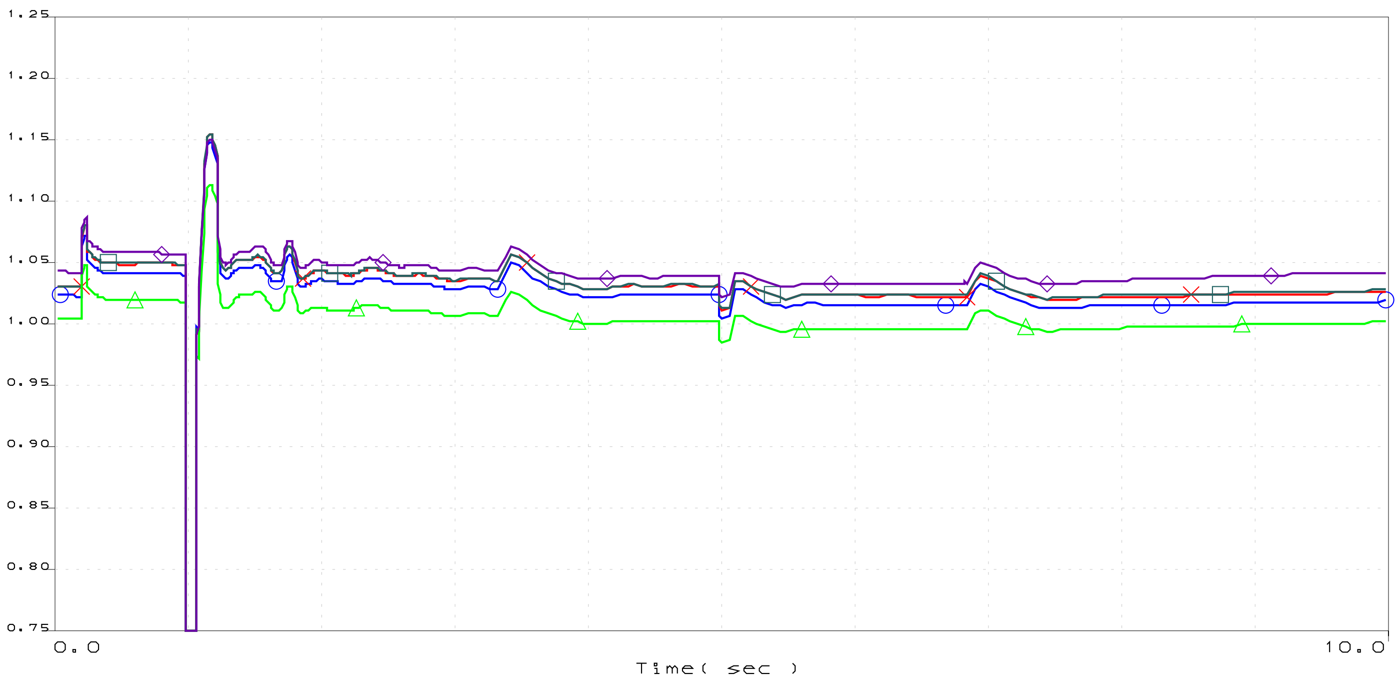
○ 57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○ 0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case157.chf

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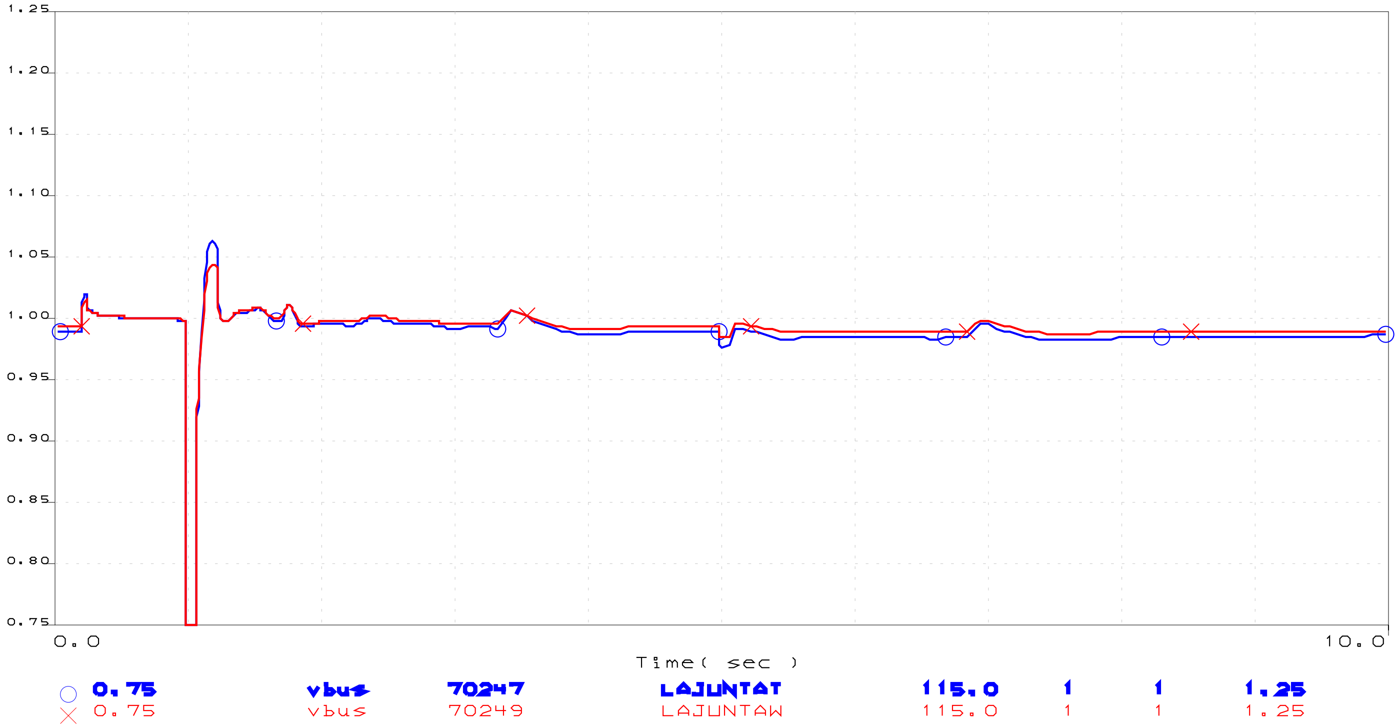
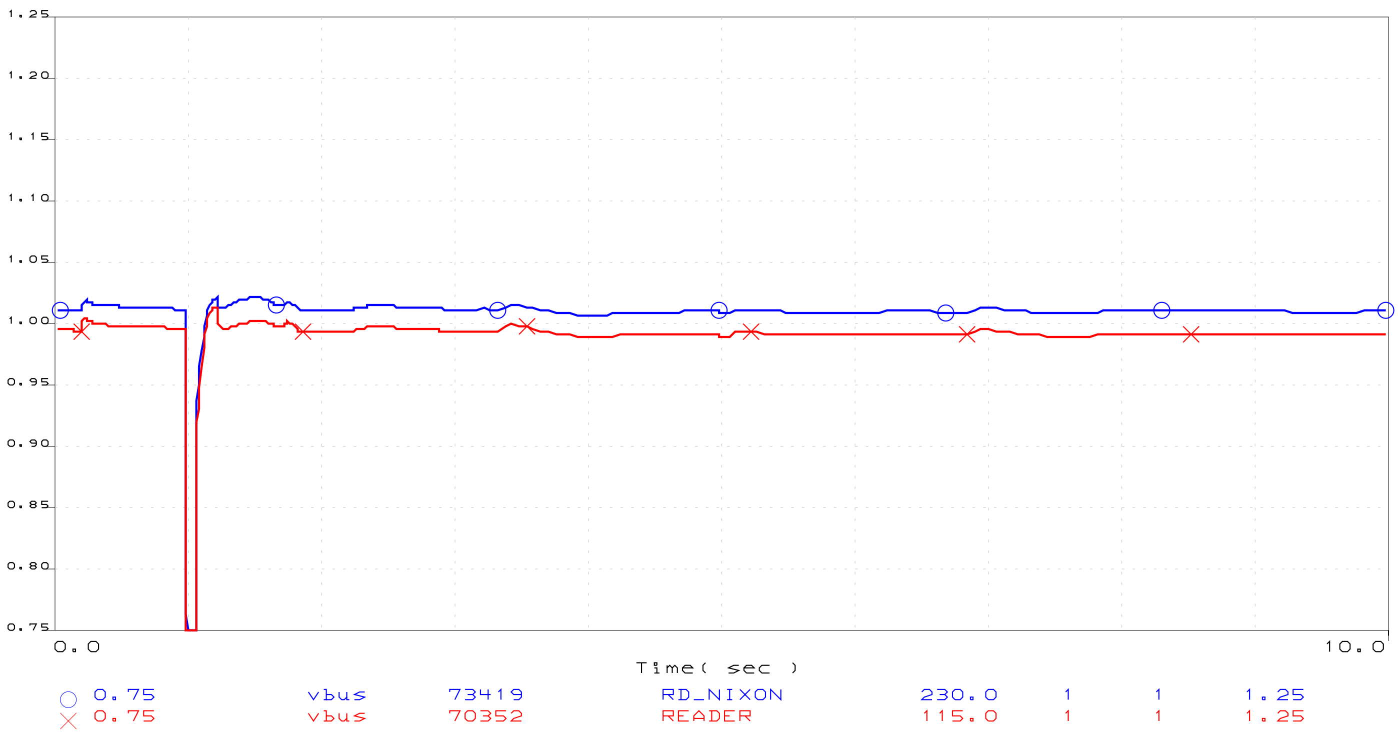
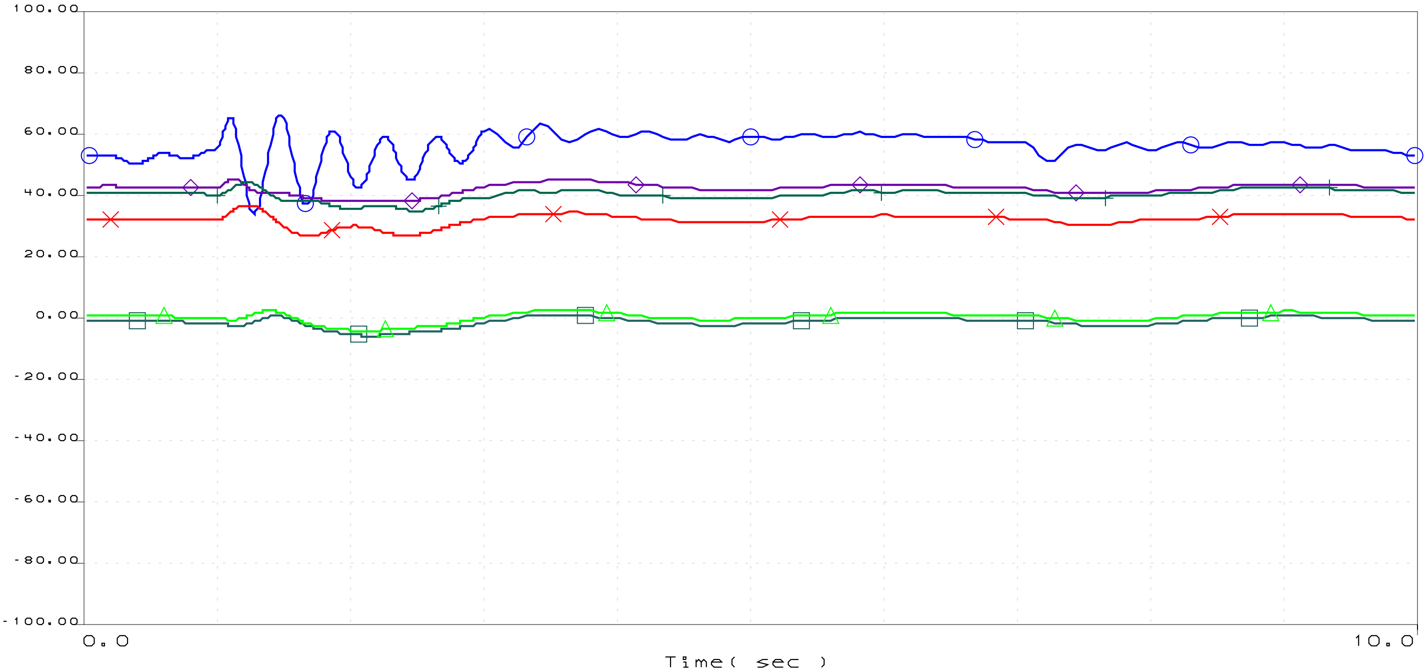
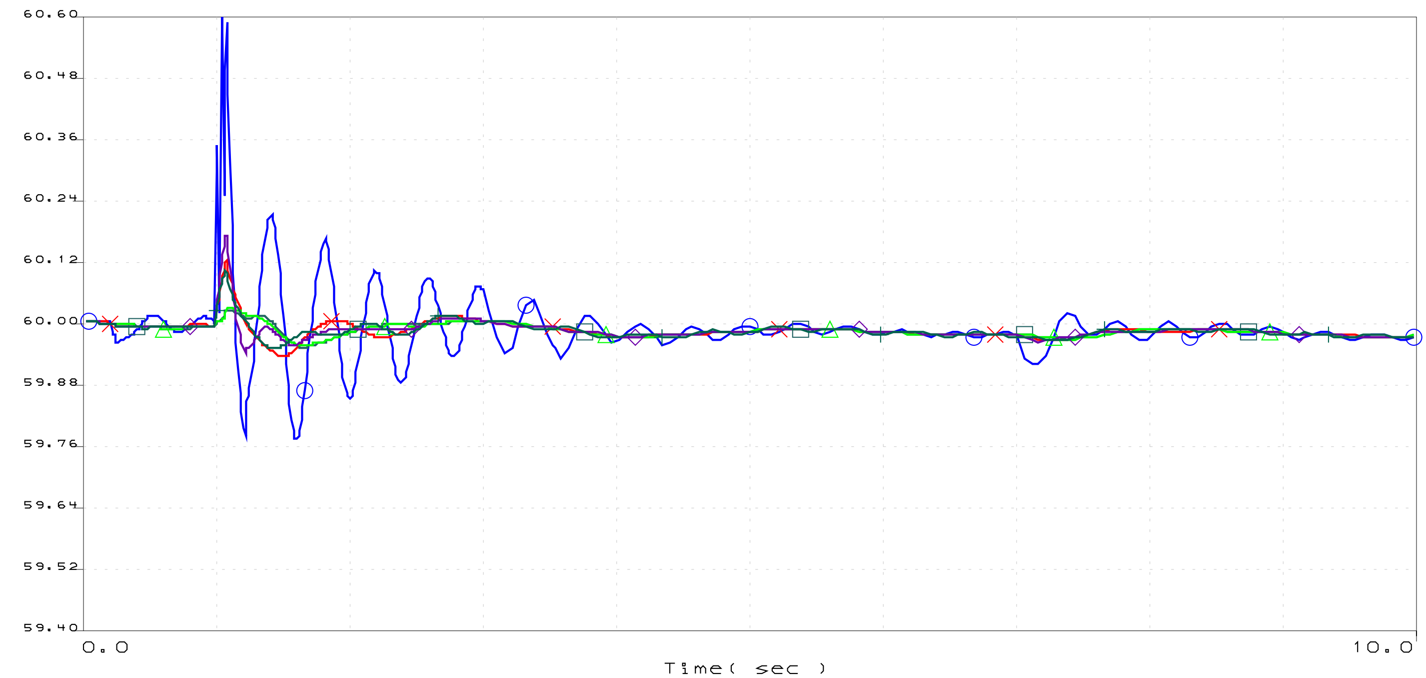

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25

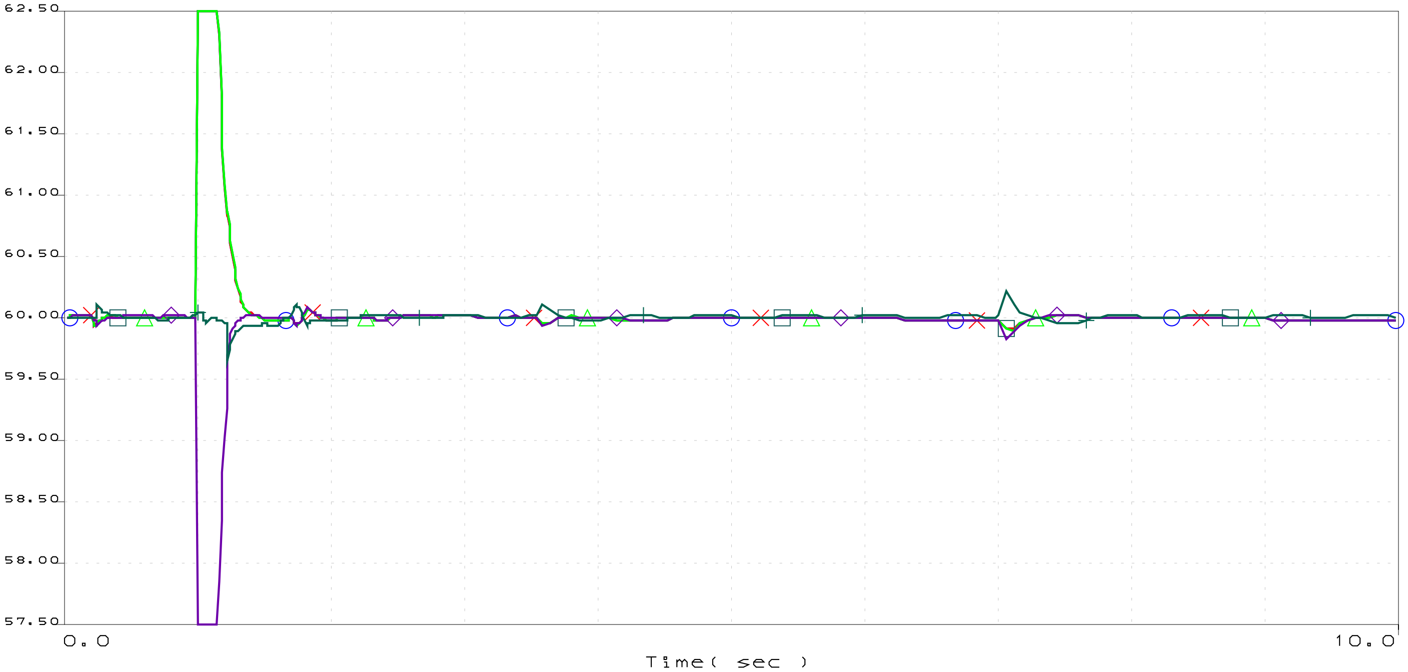

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



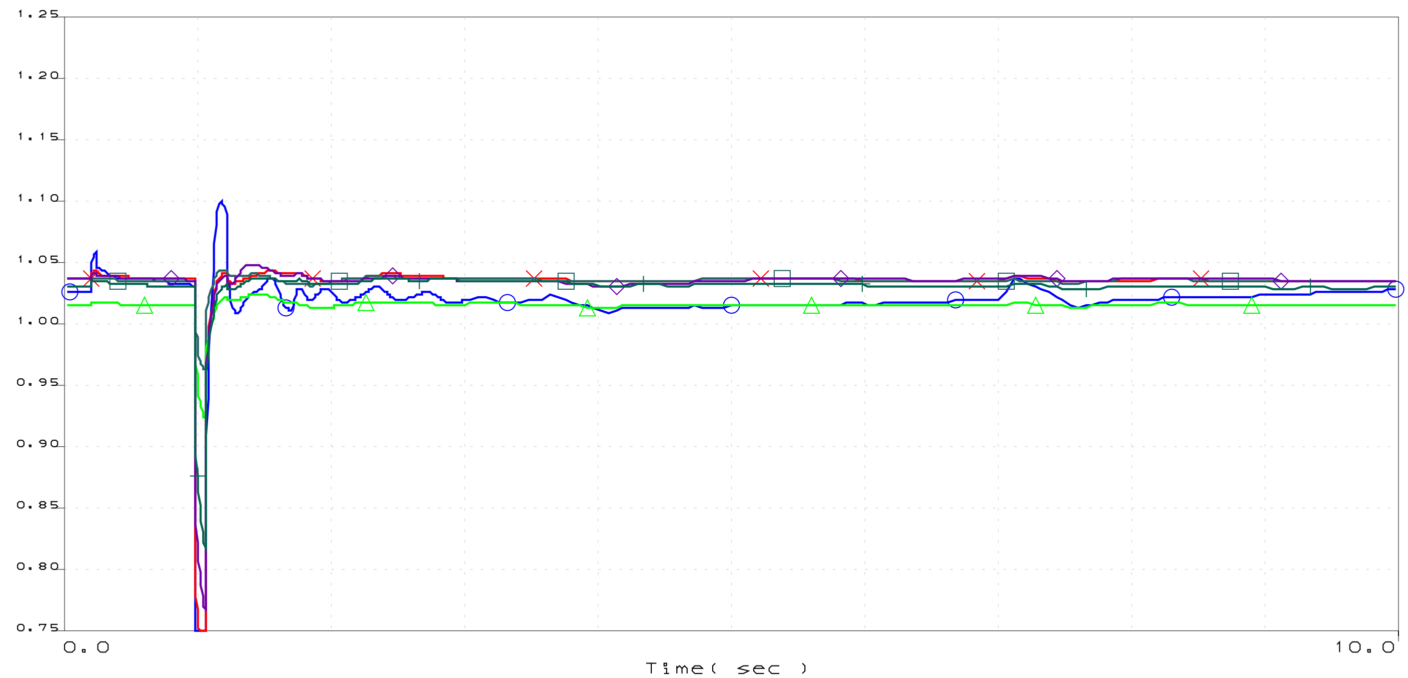
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



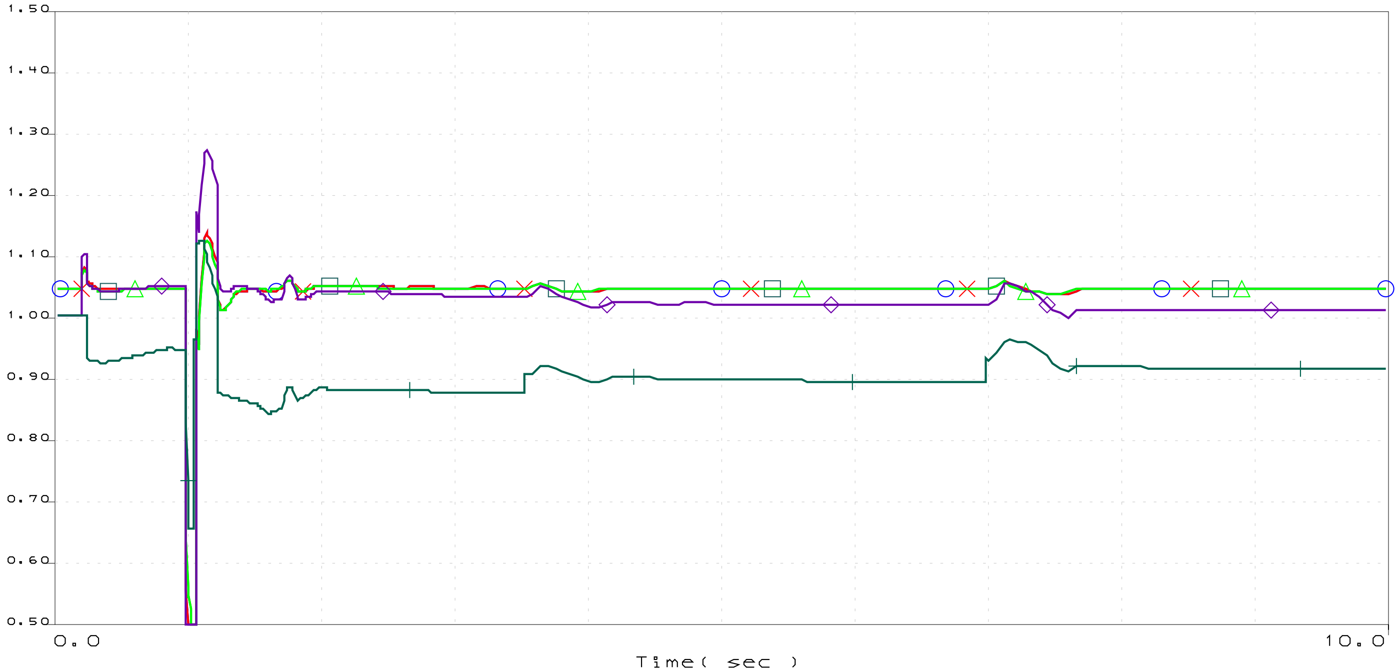
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



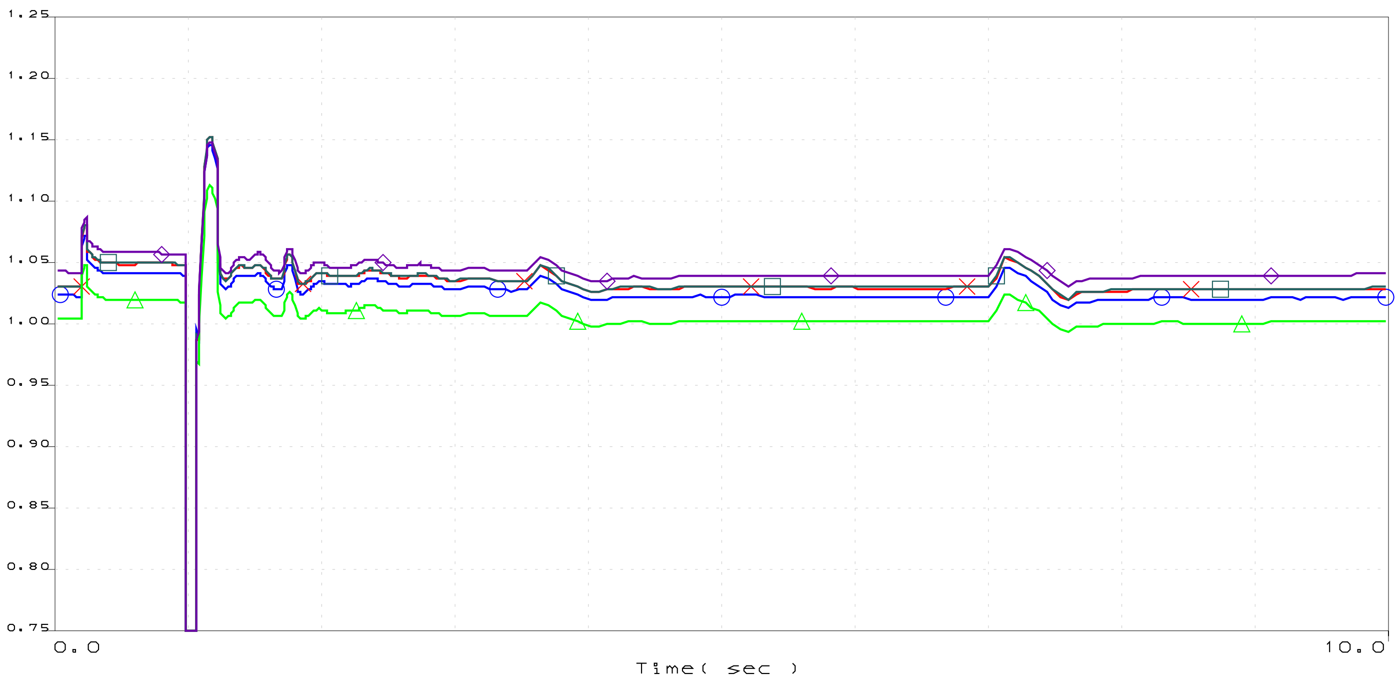
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



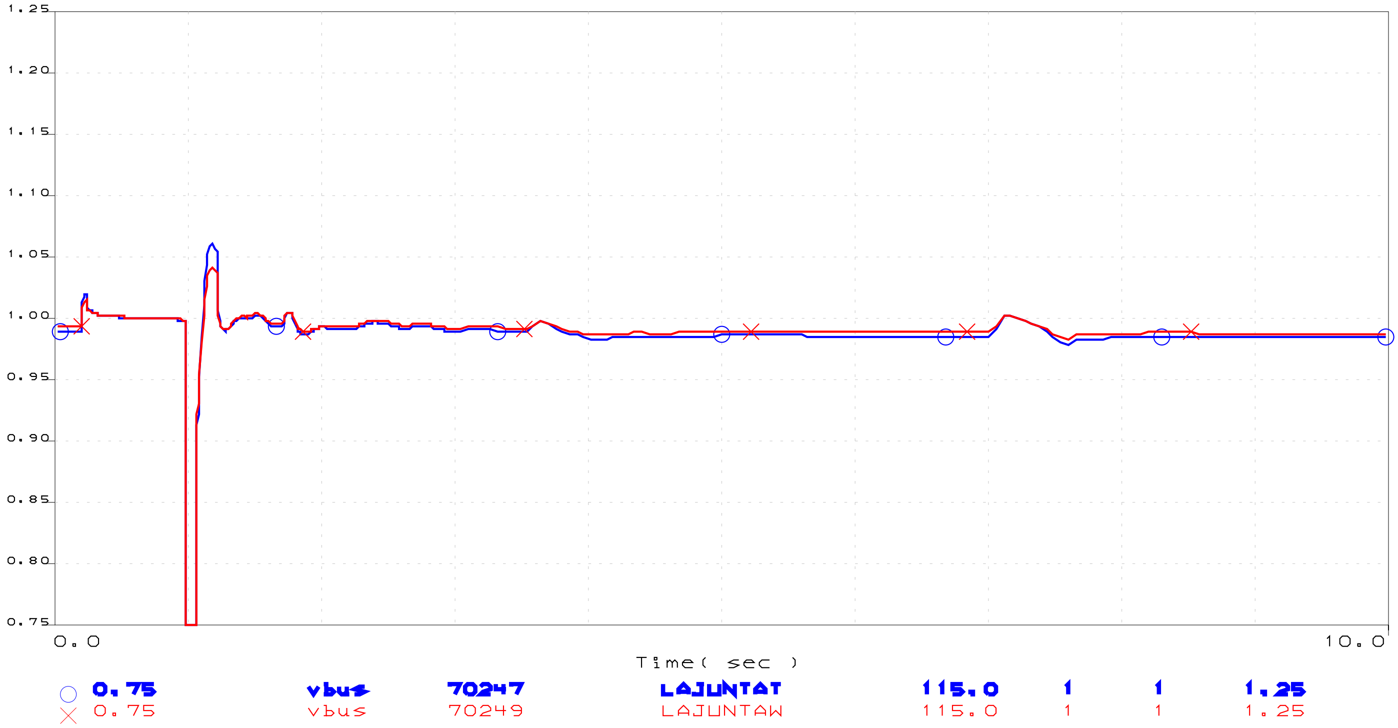
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

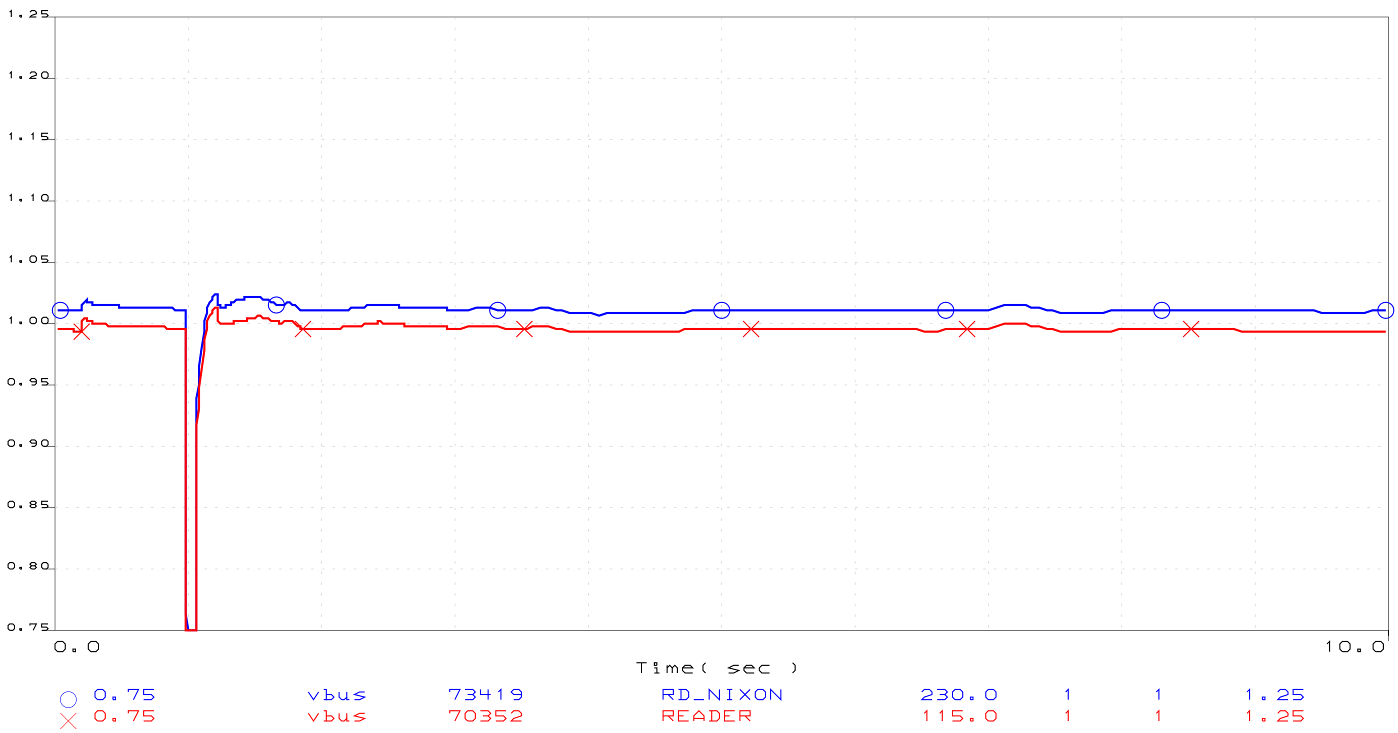


○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25





Case158.chf

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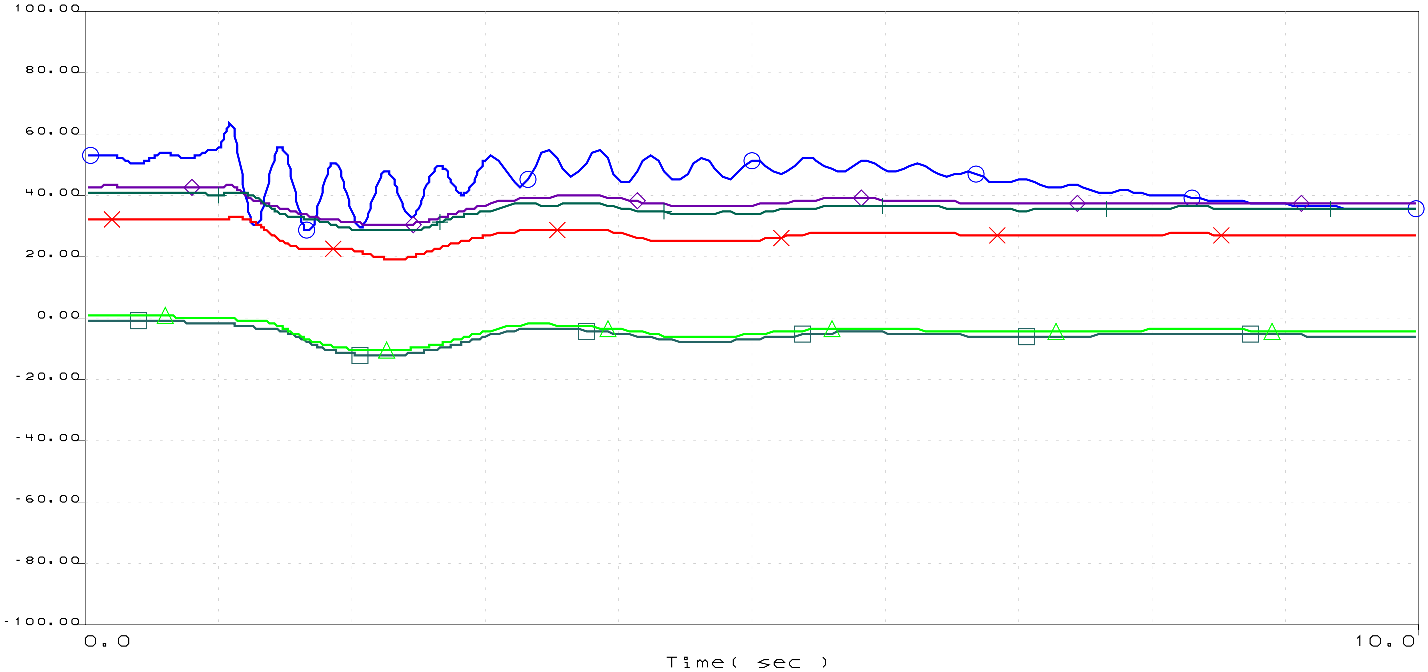
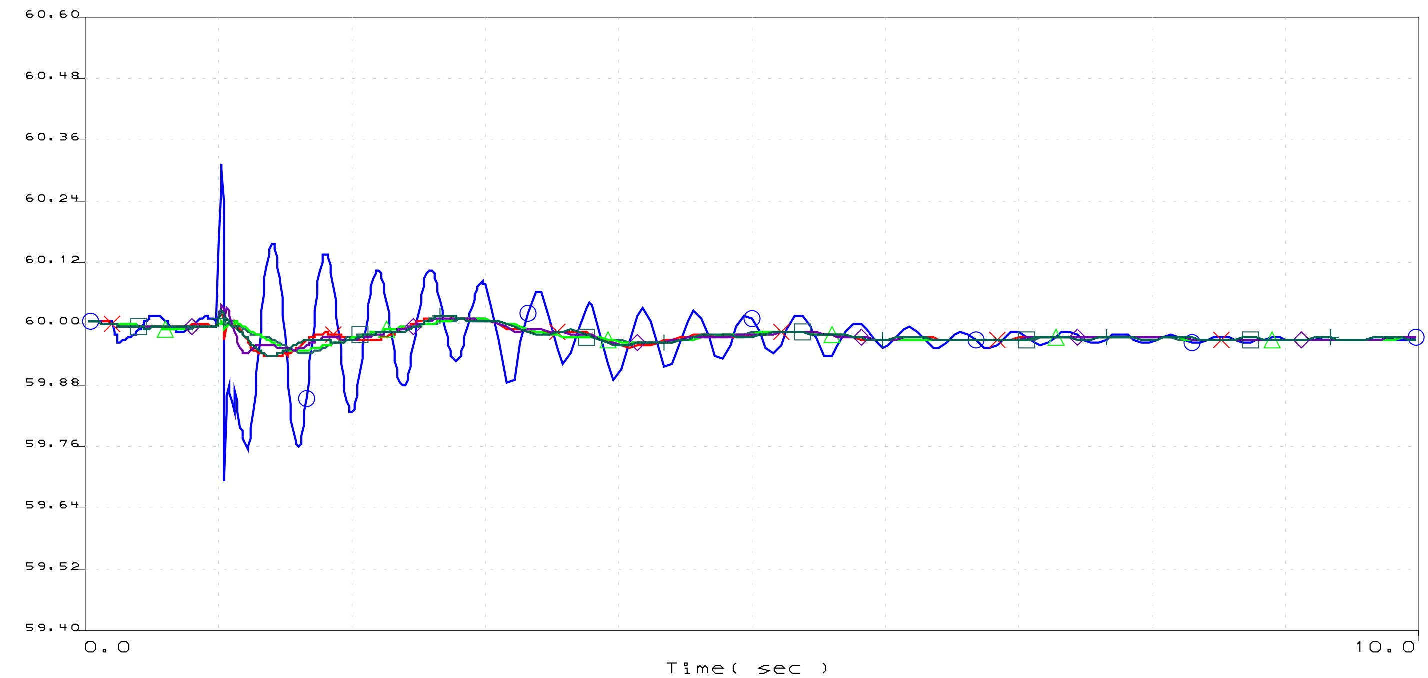
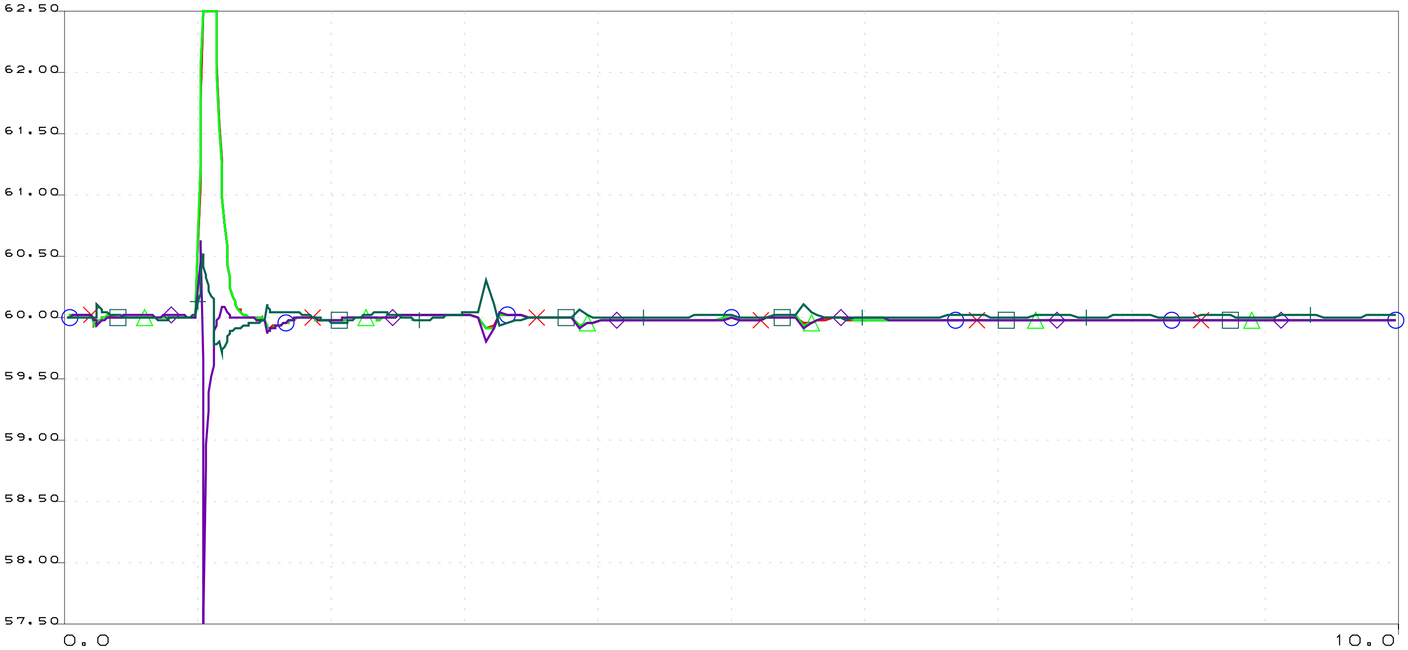


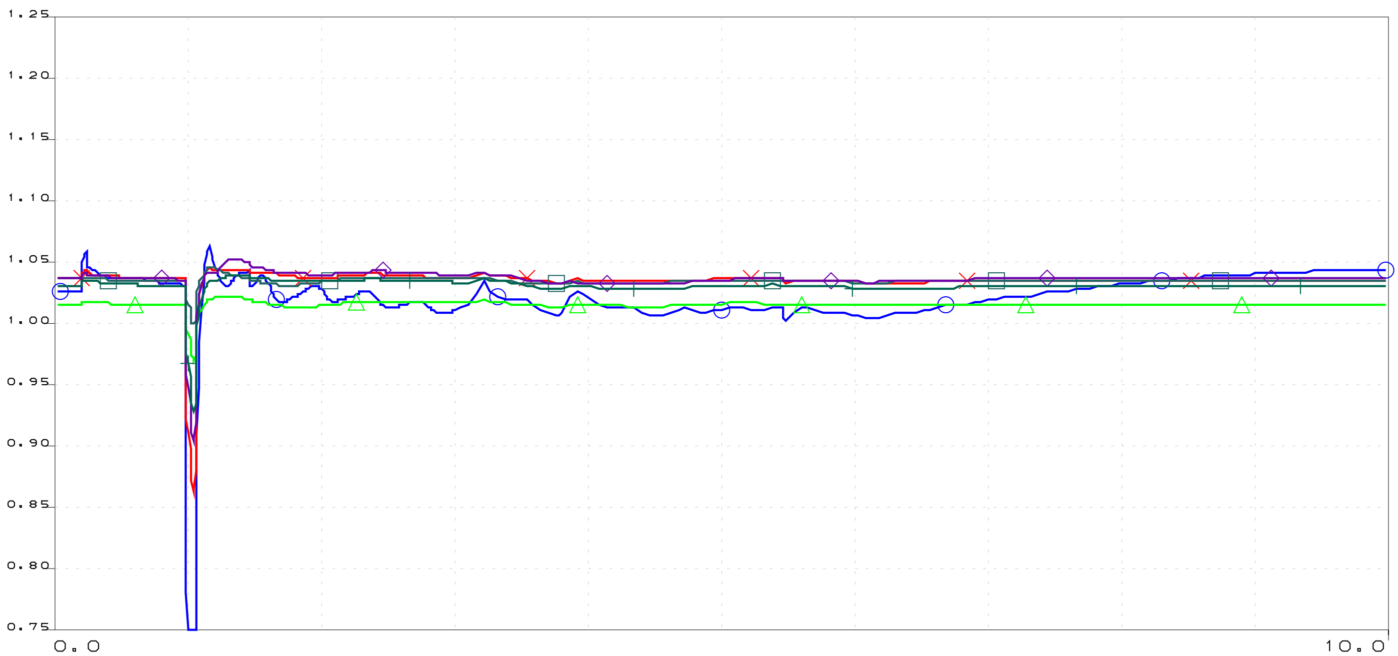
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
0.75	vbug	70034	ARAP3	13.8	1	1	1.25
0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25

Case159.chf

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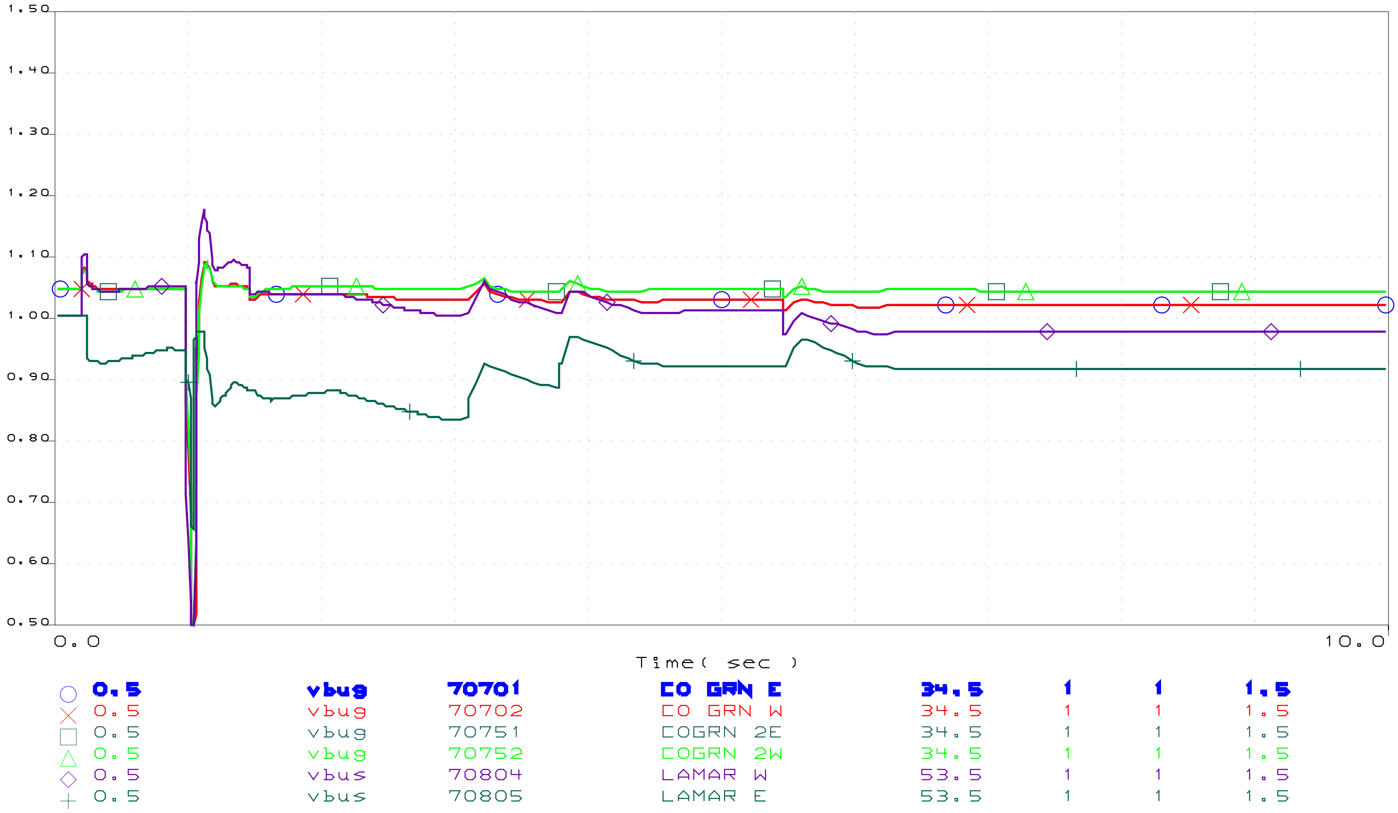
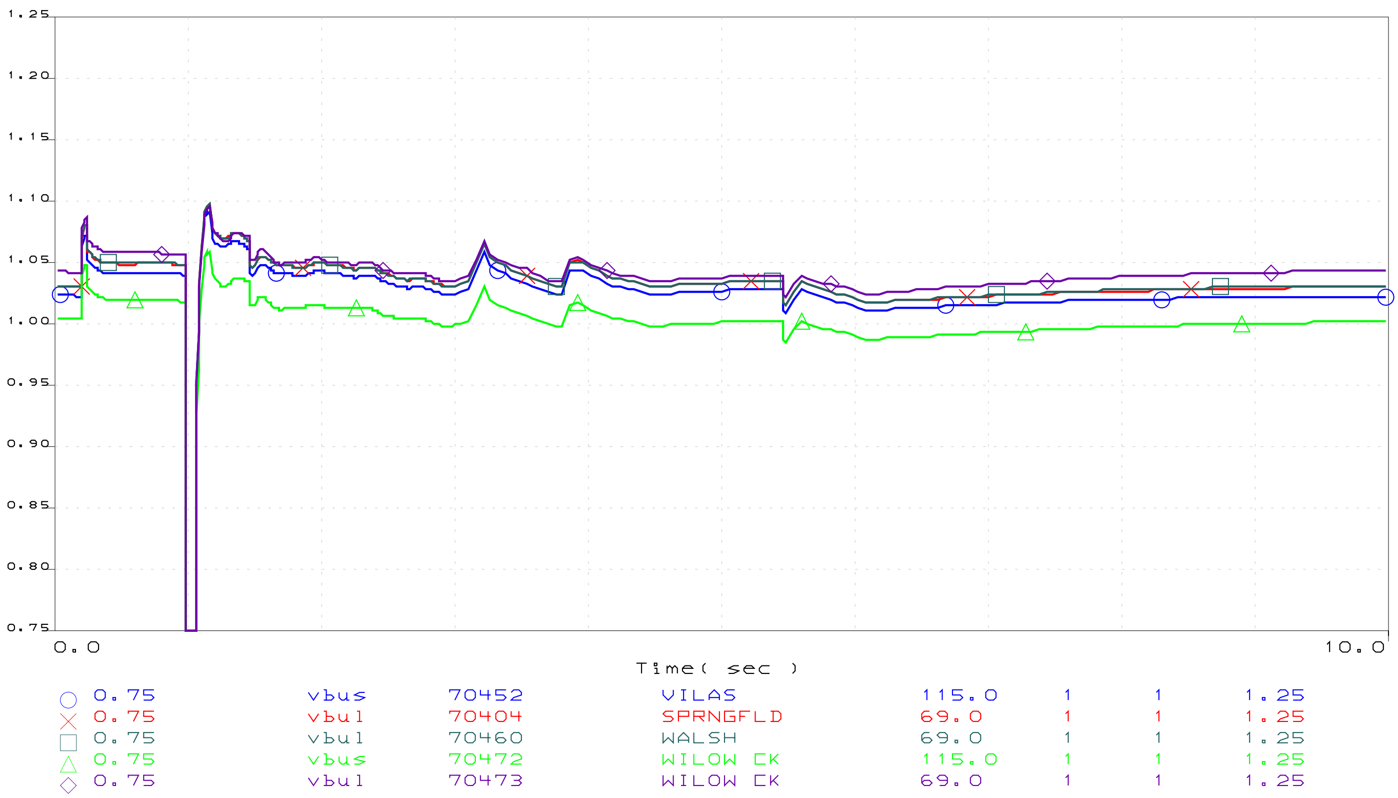
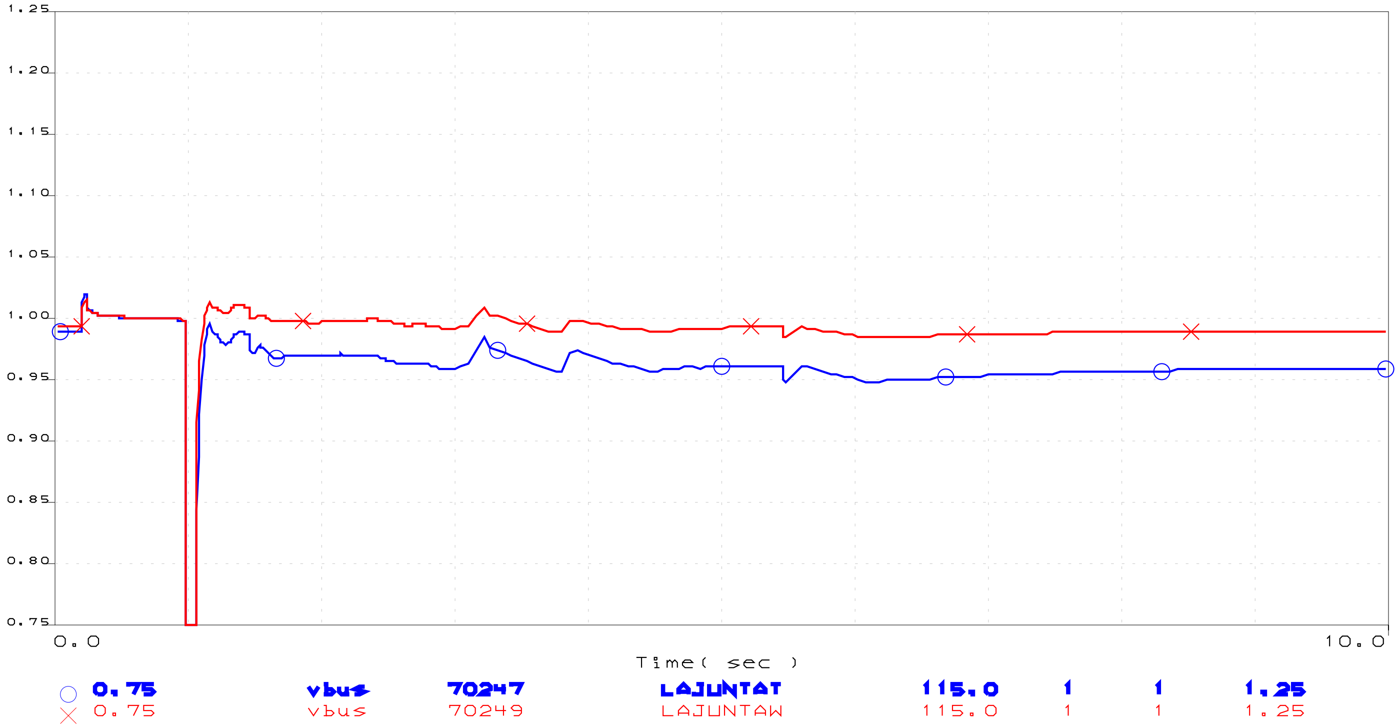
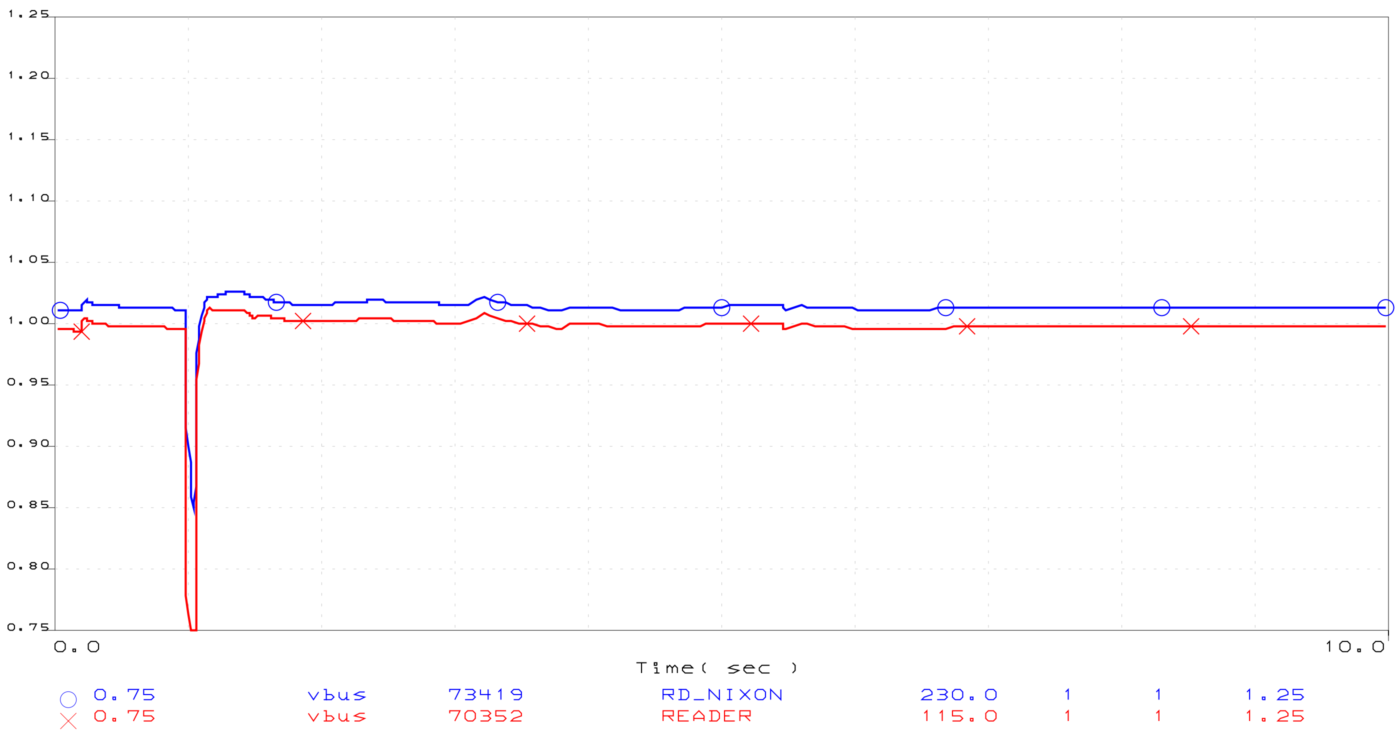

1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.0
10.0
Time(sec)
0.5 vbug 70701 CO GRN E 34.5 1 1 1.5
0.5 vbug 70702 CO GRN W 34.5 1 1 1.5
0.5 vbug 70751 COGRN 2E 34.5 1 1 1.5
0.5 vbug 70752 COGRN 2W 34.5 1 1 1.5
0.5 vbus 70804 LAMAR W 53.5 1 1 1.5
0.5 vbus 70805 LAMAR E 53.5 1 1 1.5

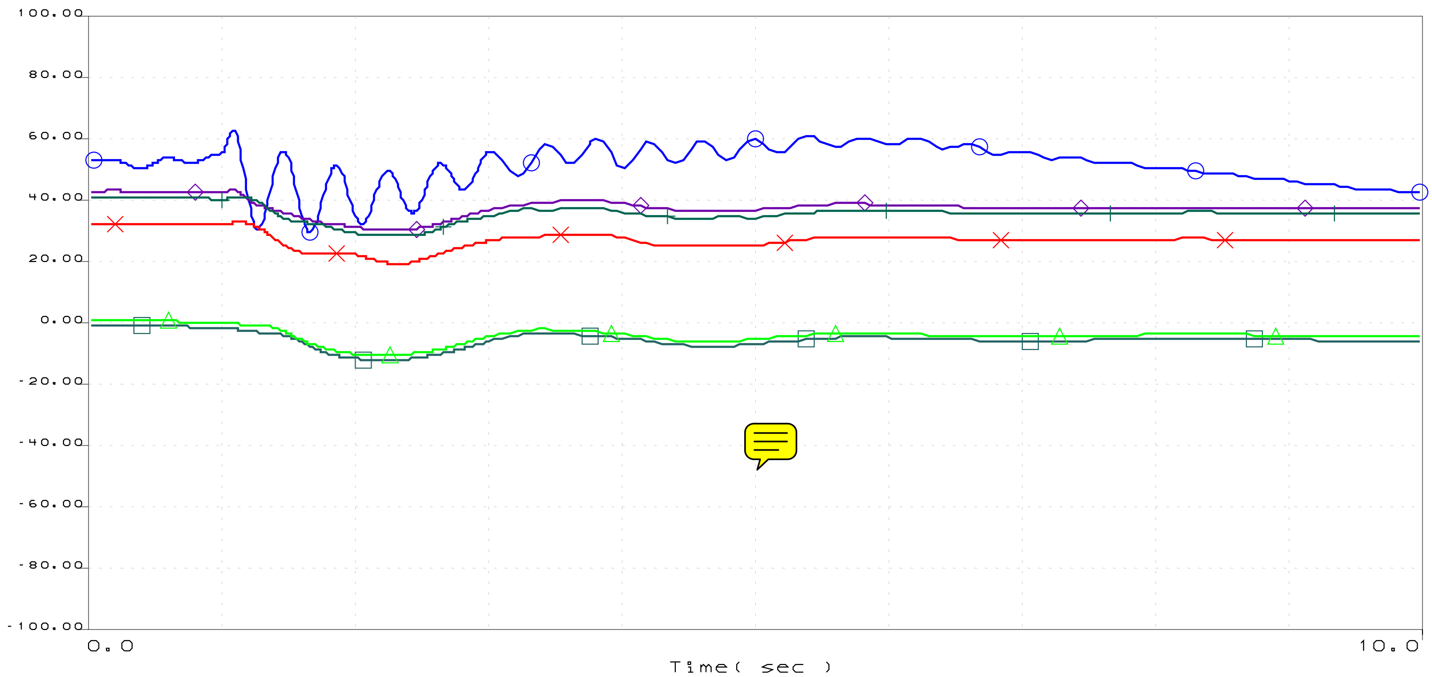

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70452 VILAS 115.0 1 1 1.25
0.75 vbul 70404 SPRNGFLD 69.0 1 1 1.25
0.75 vbul 70460 WALSH 69.0 1 1 1.25
0.75 vbus 70472 WILOW CK 115.0 1 1 1.25
0.75 vbul 70473 WILOW CK 69.0 1 1 1.25



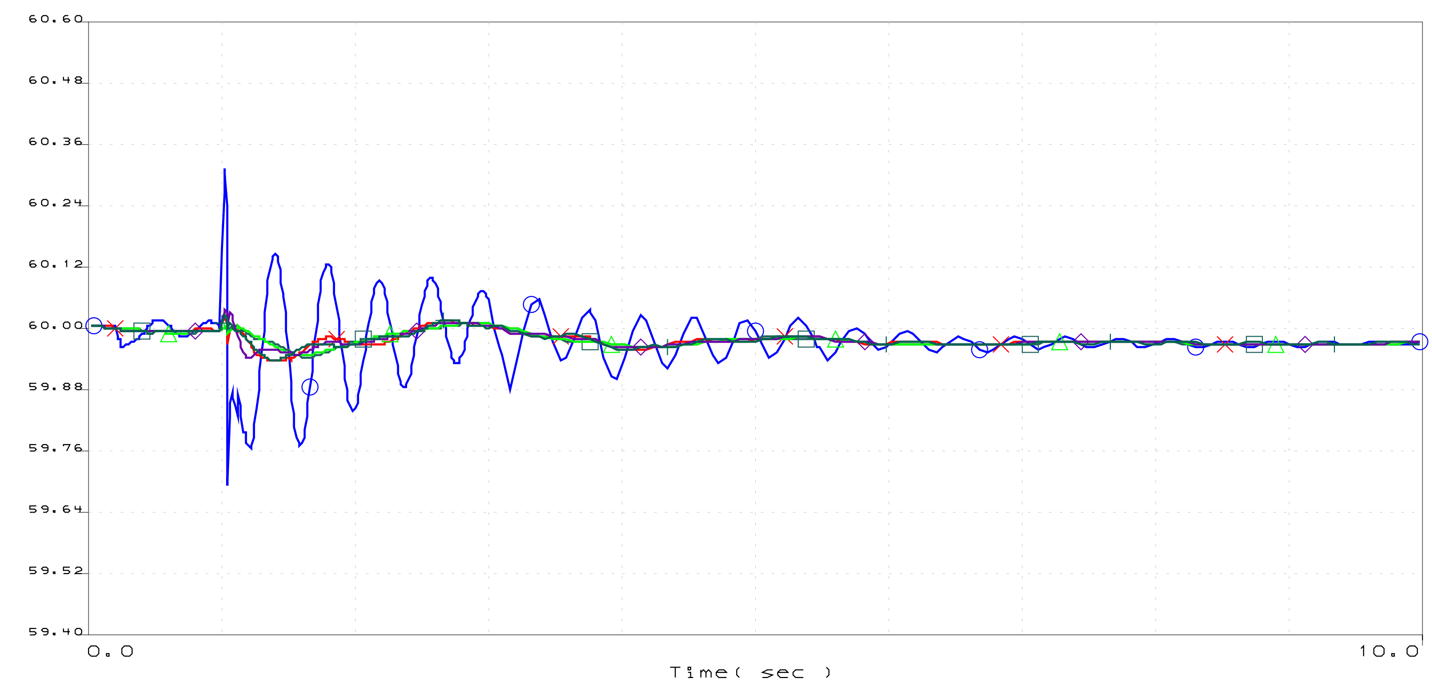


Case159.chf

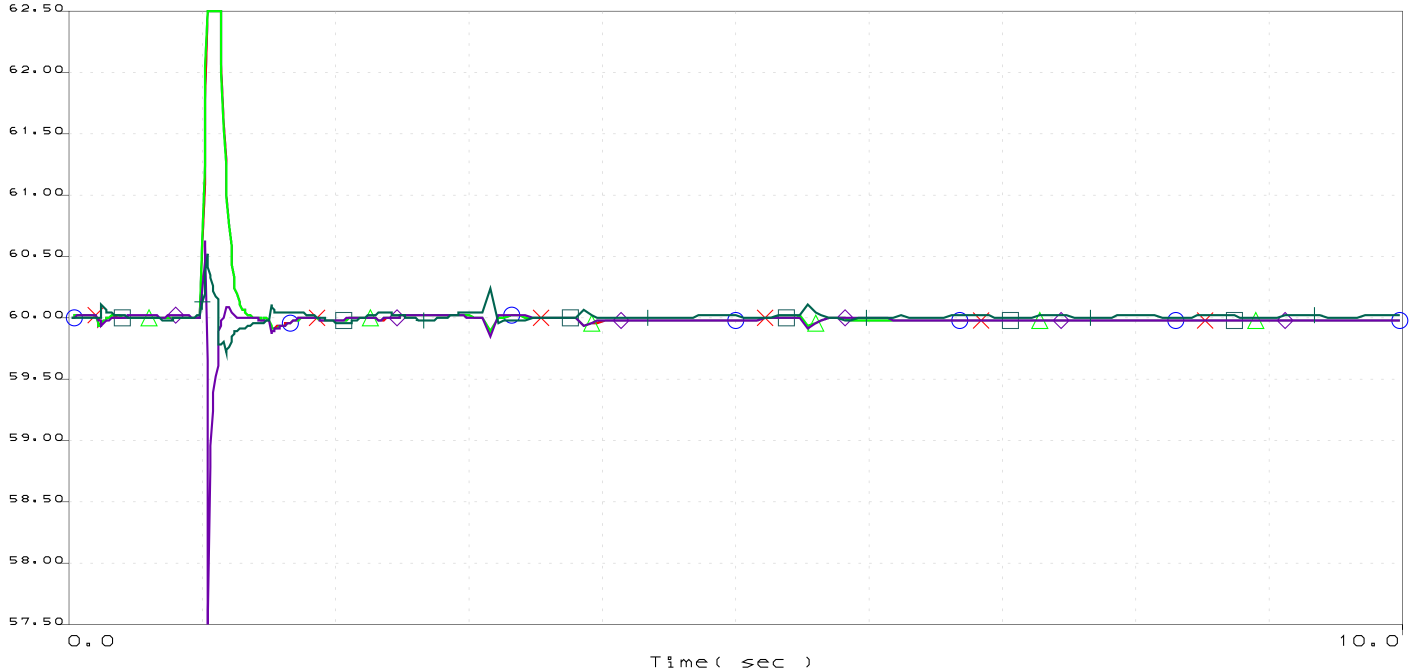
Wed Nov 24 11:50:55 2004



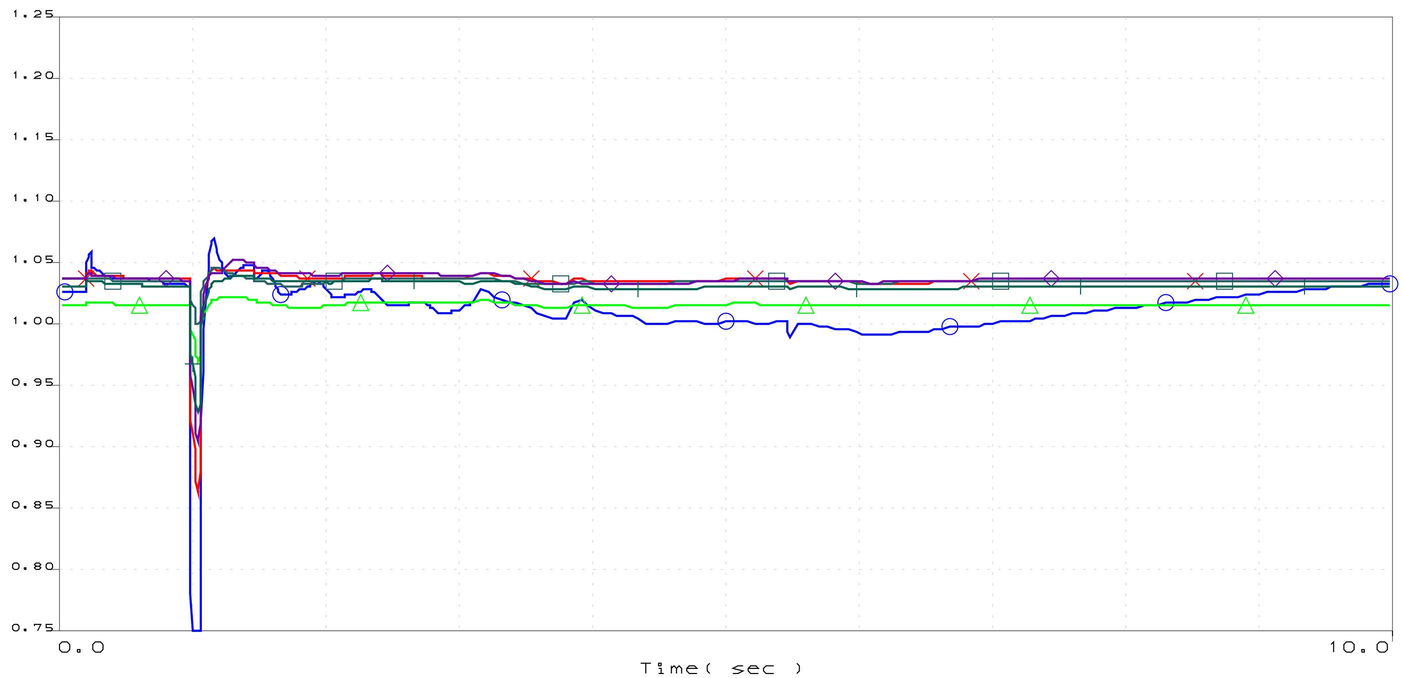
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



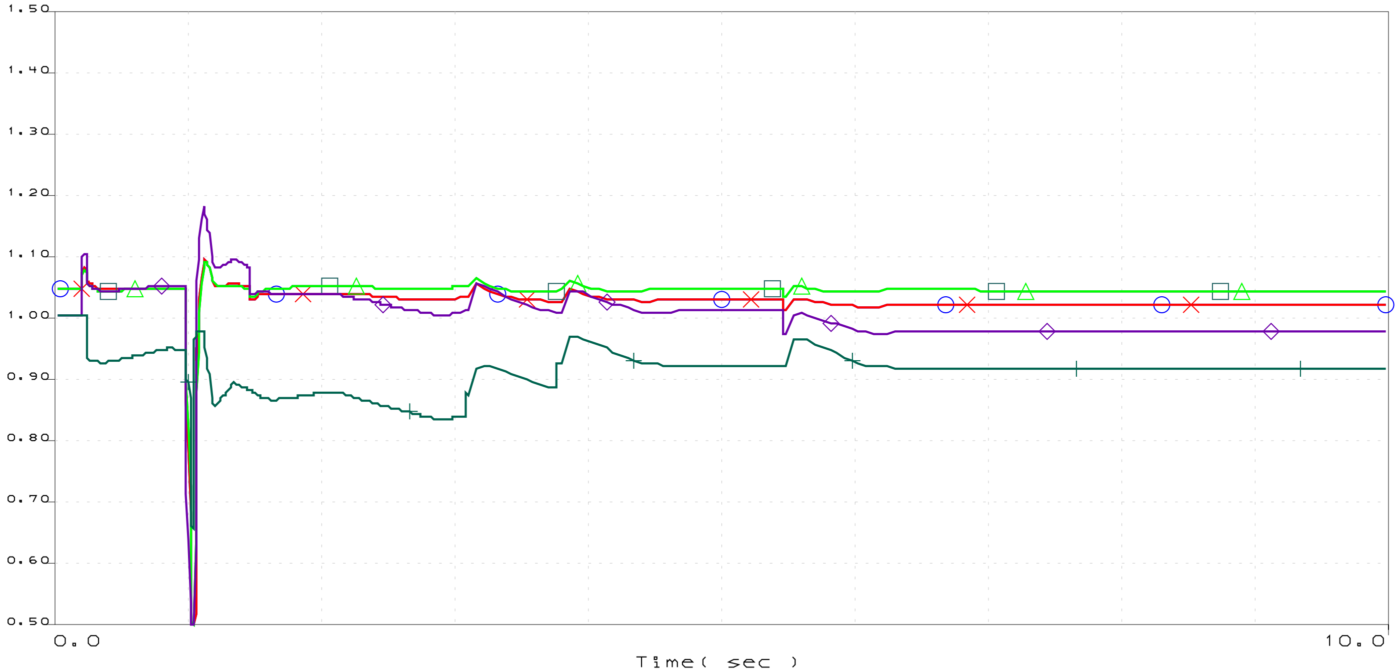
59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



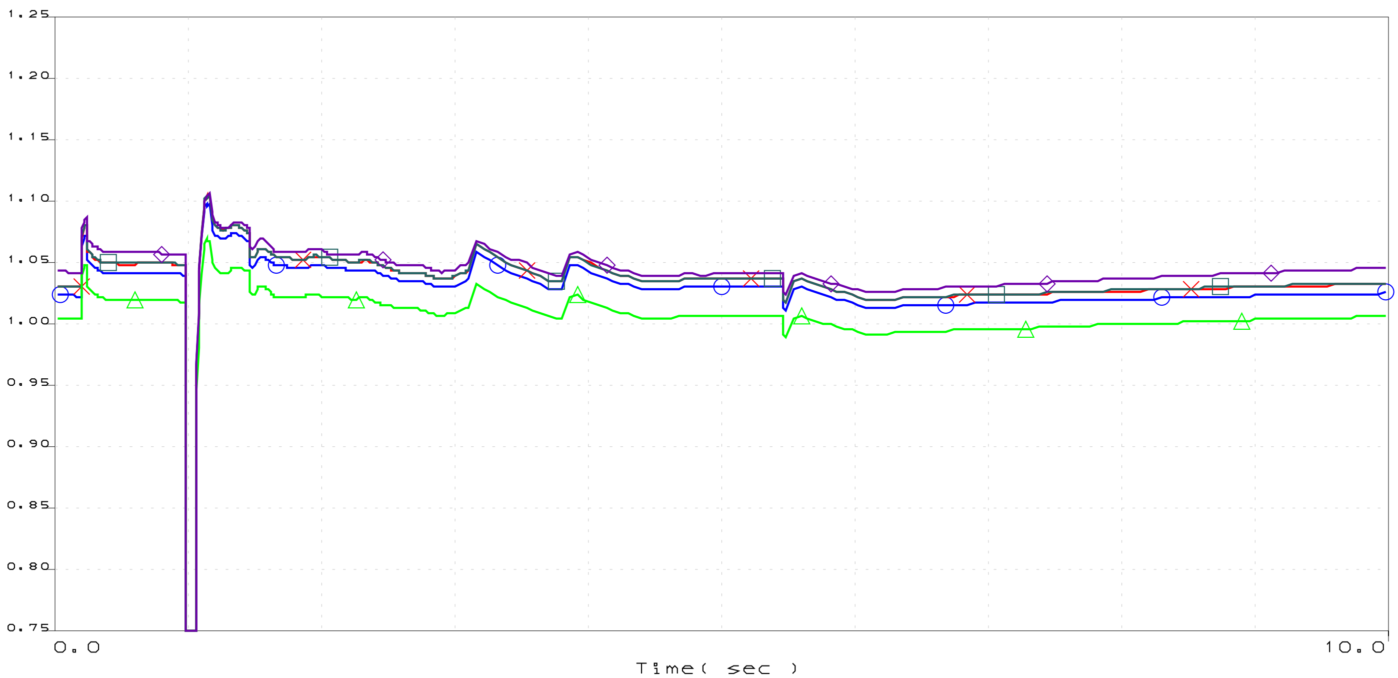
○	**57.5**	**fbus**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
×	57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□	57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△	57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇	57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+	57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○	0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
×	0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□	0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△	0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇	0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+	0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



0.5	vbug	70701	CO GRN E	34.5	1	1	1.5
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case1S10.chf

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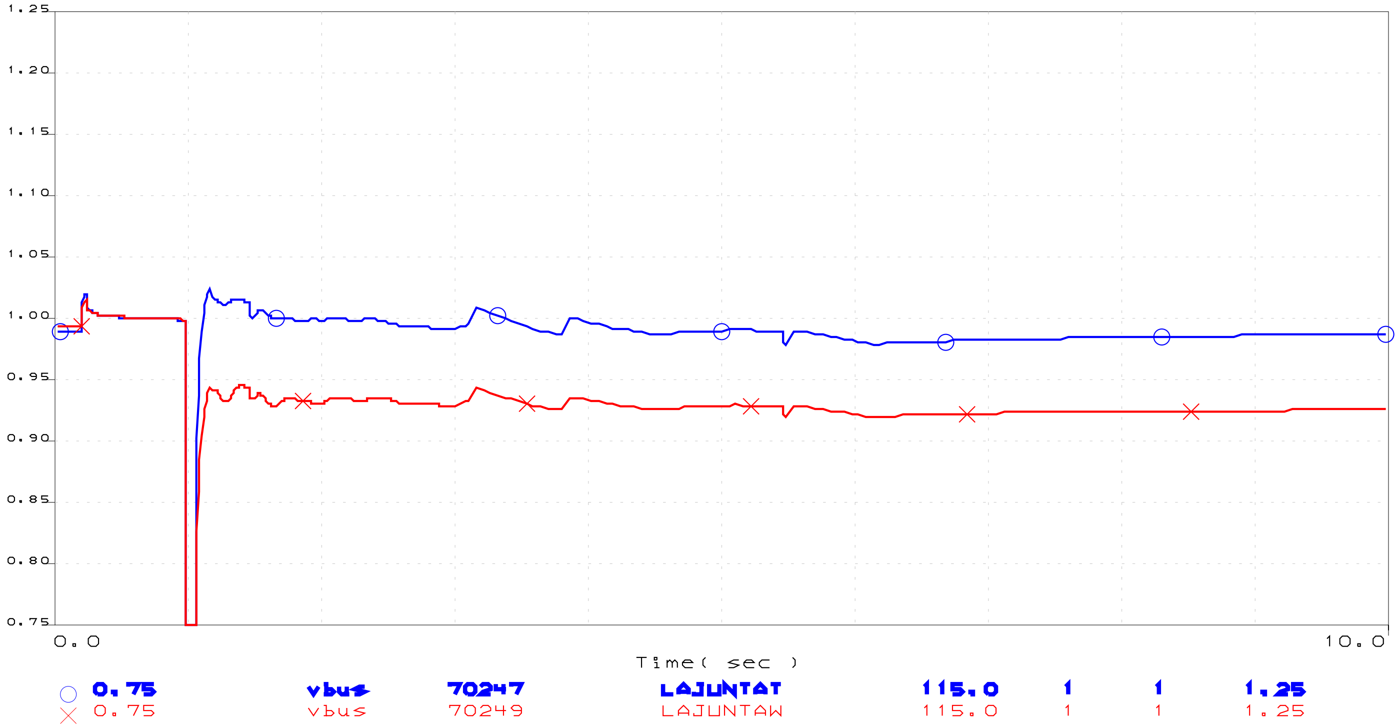
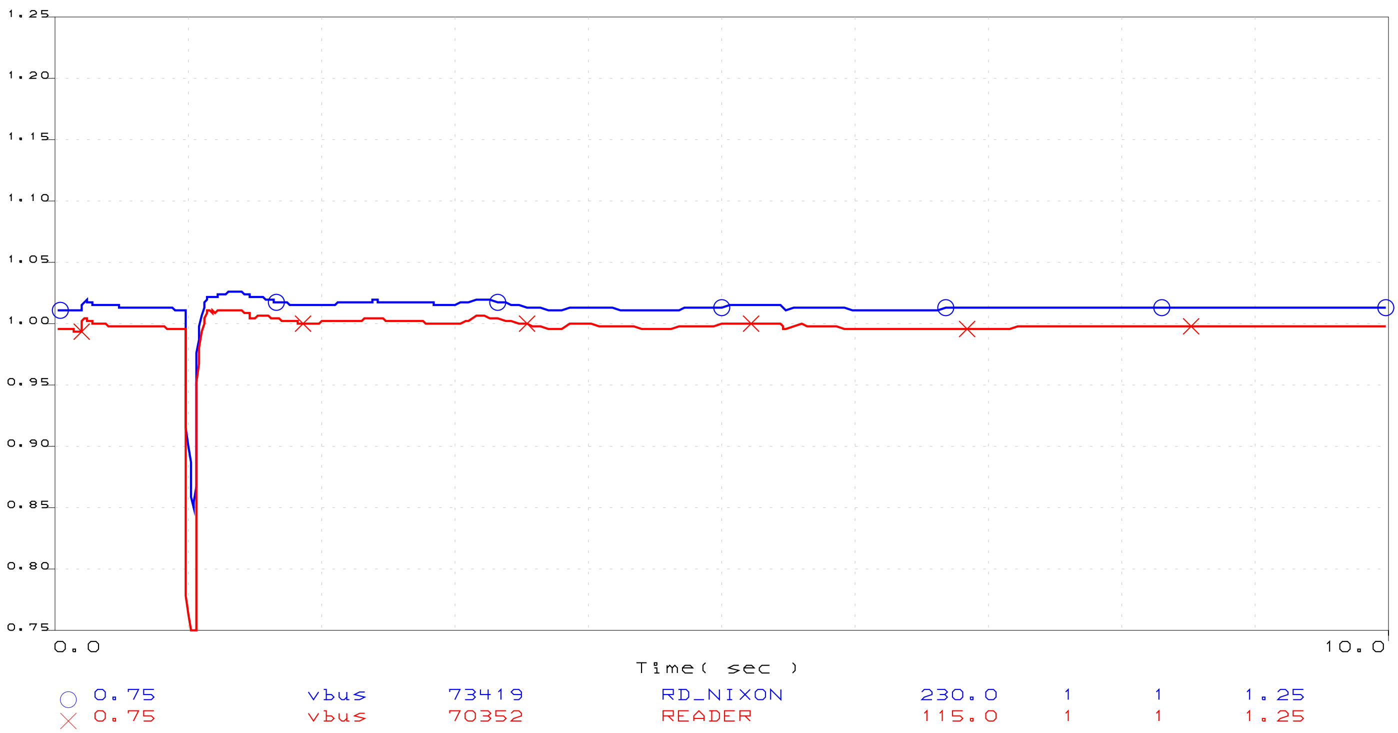
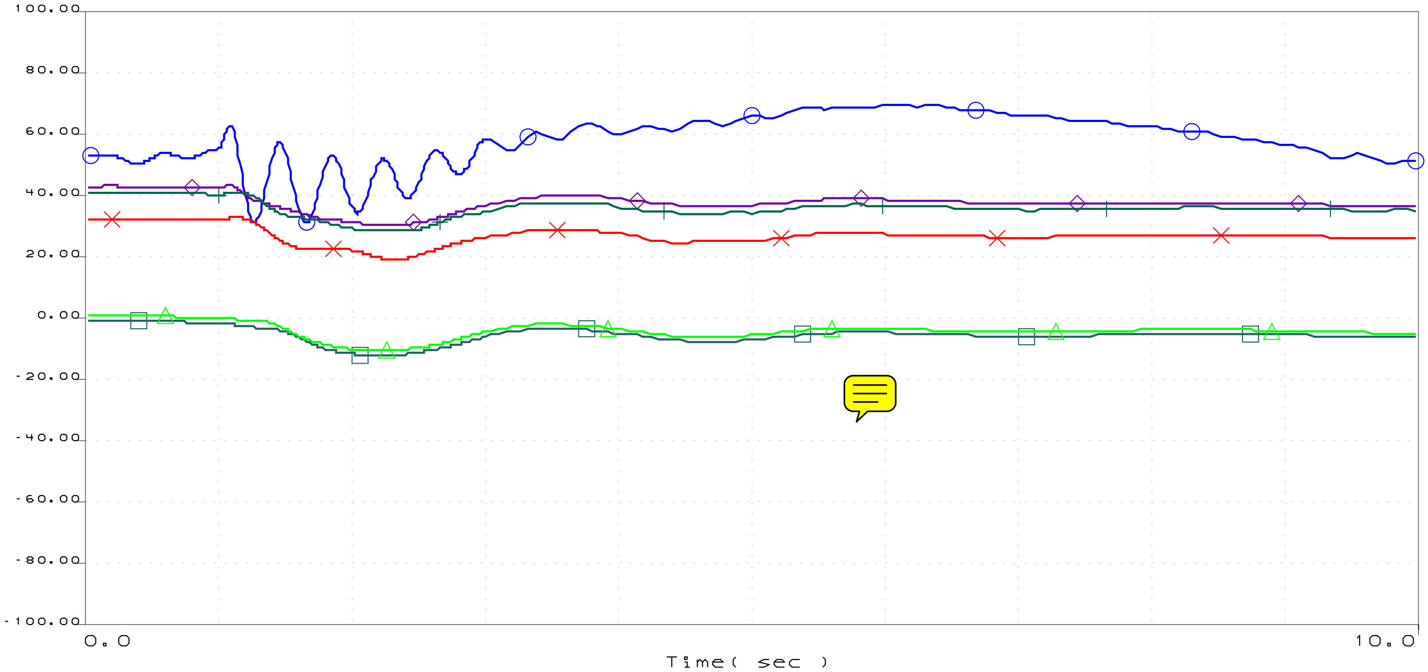


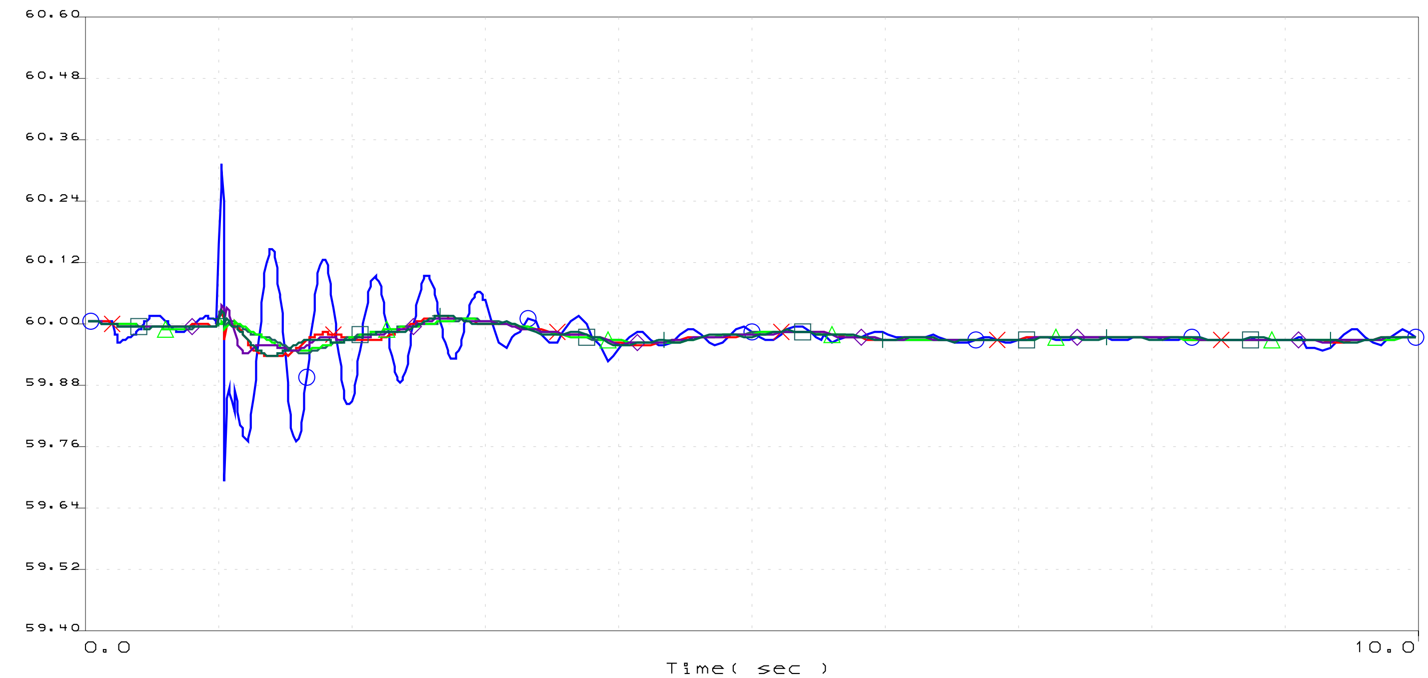


Case1S10.chf

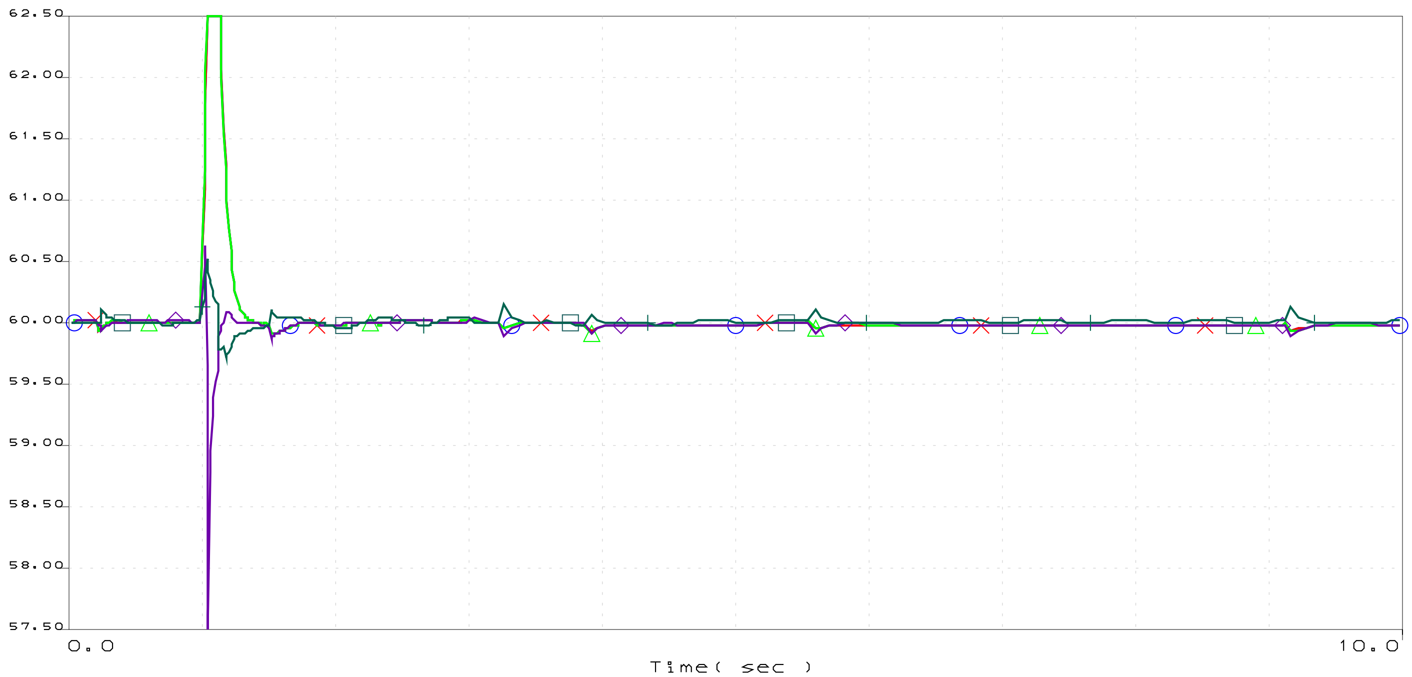
Wed Nov 24 11:51:07 2004



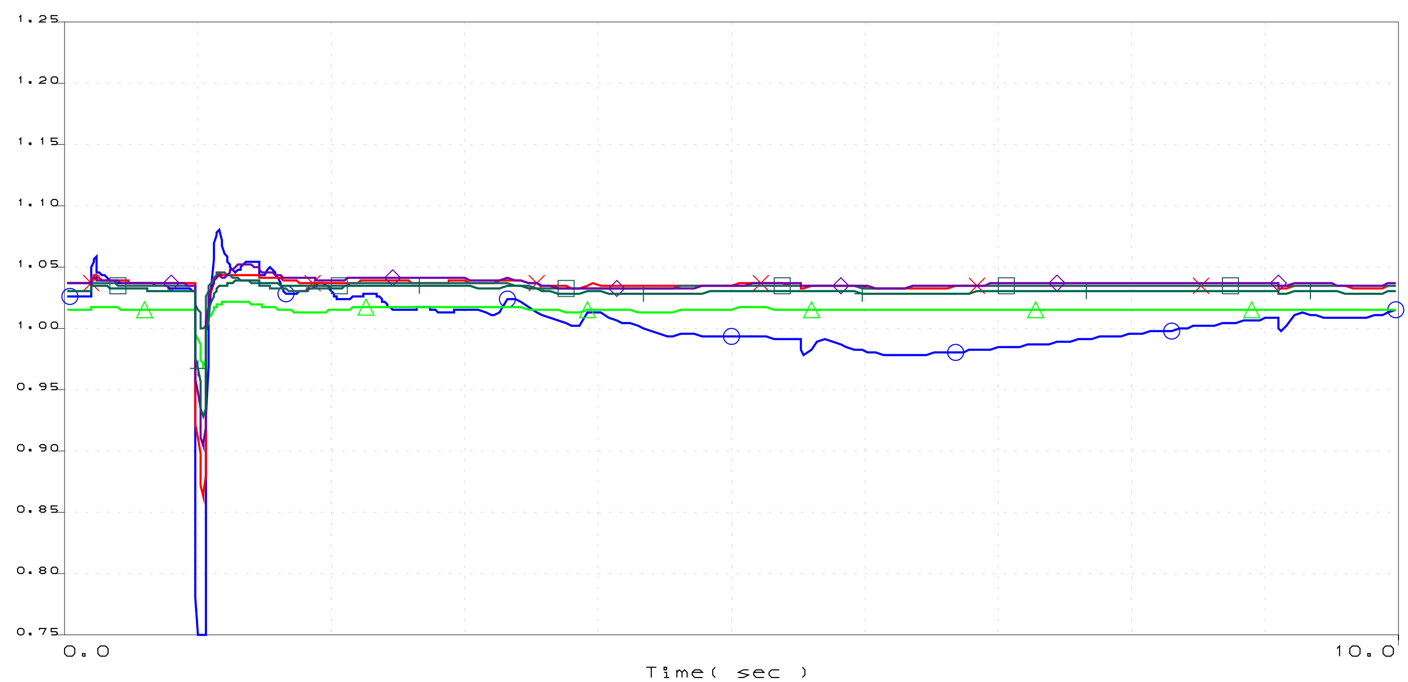
○	**-100.0**	**ang**	**70133**	**CTY LAM**	**14.4**	**1**	**1**	**100.0**
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



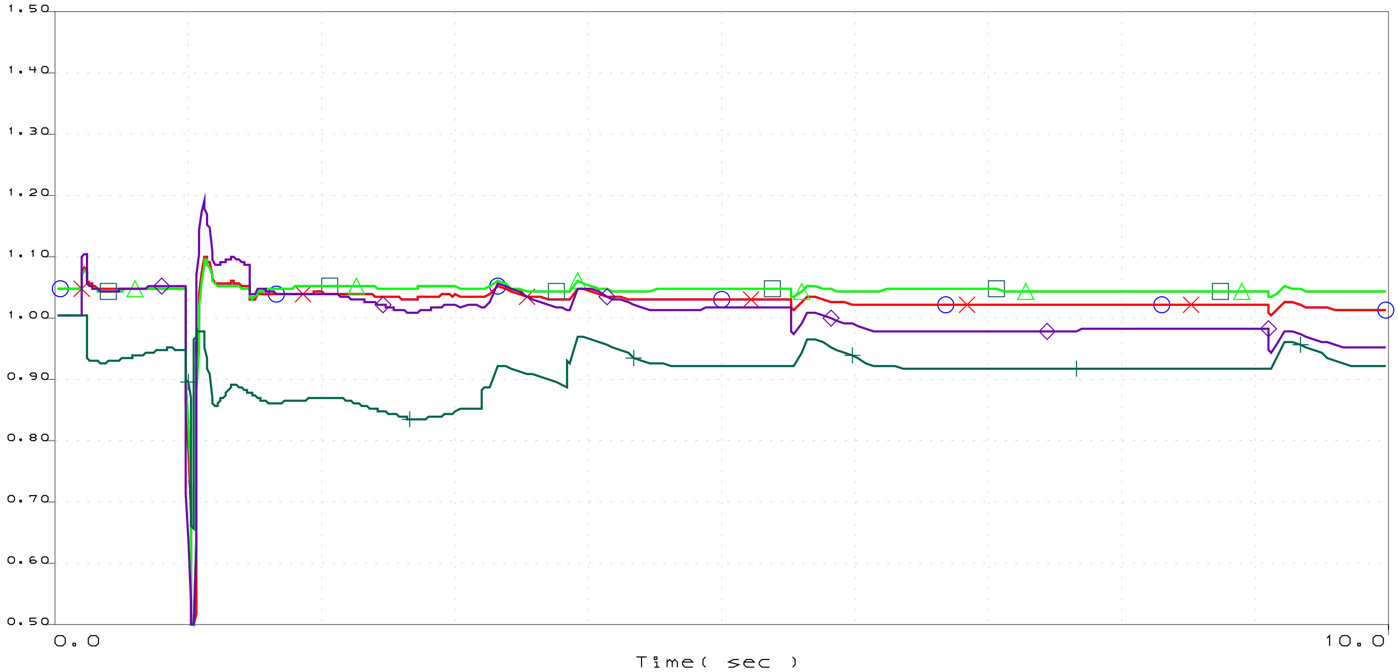
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



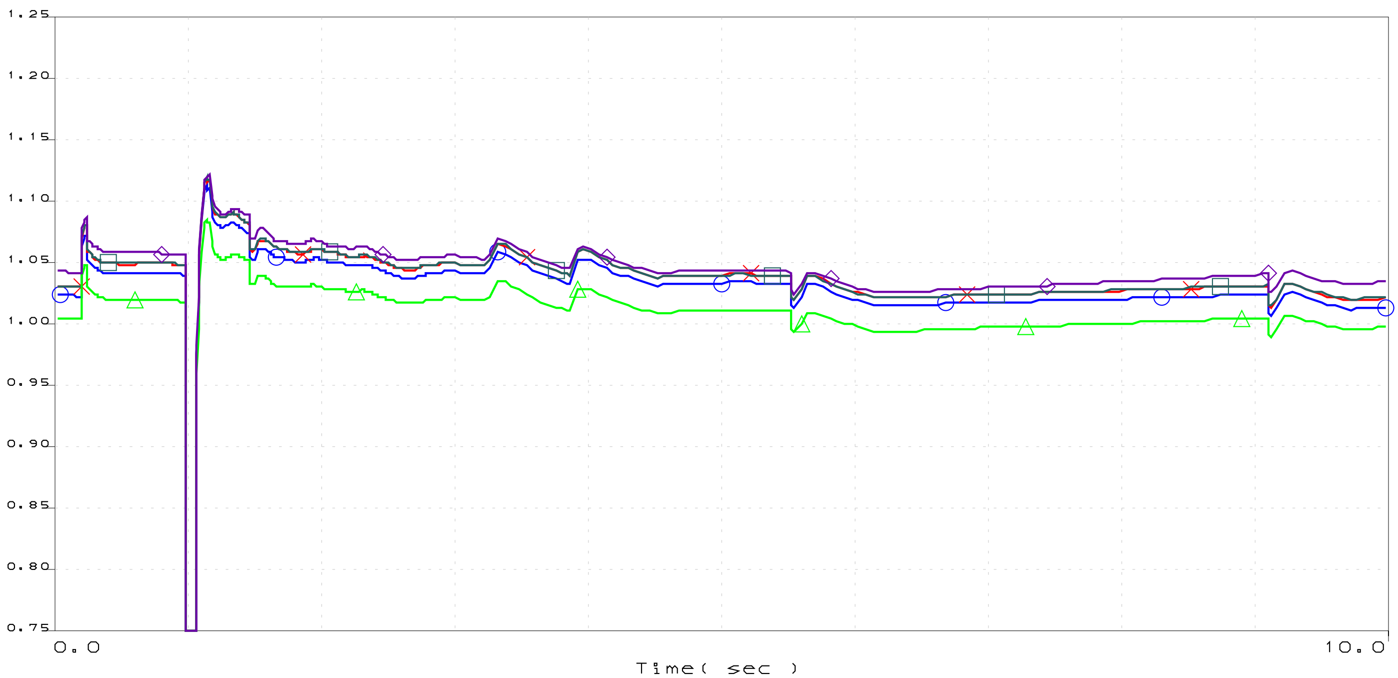
57.5	**fbus**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case1S11.chf

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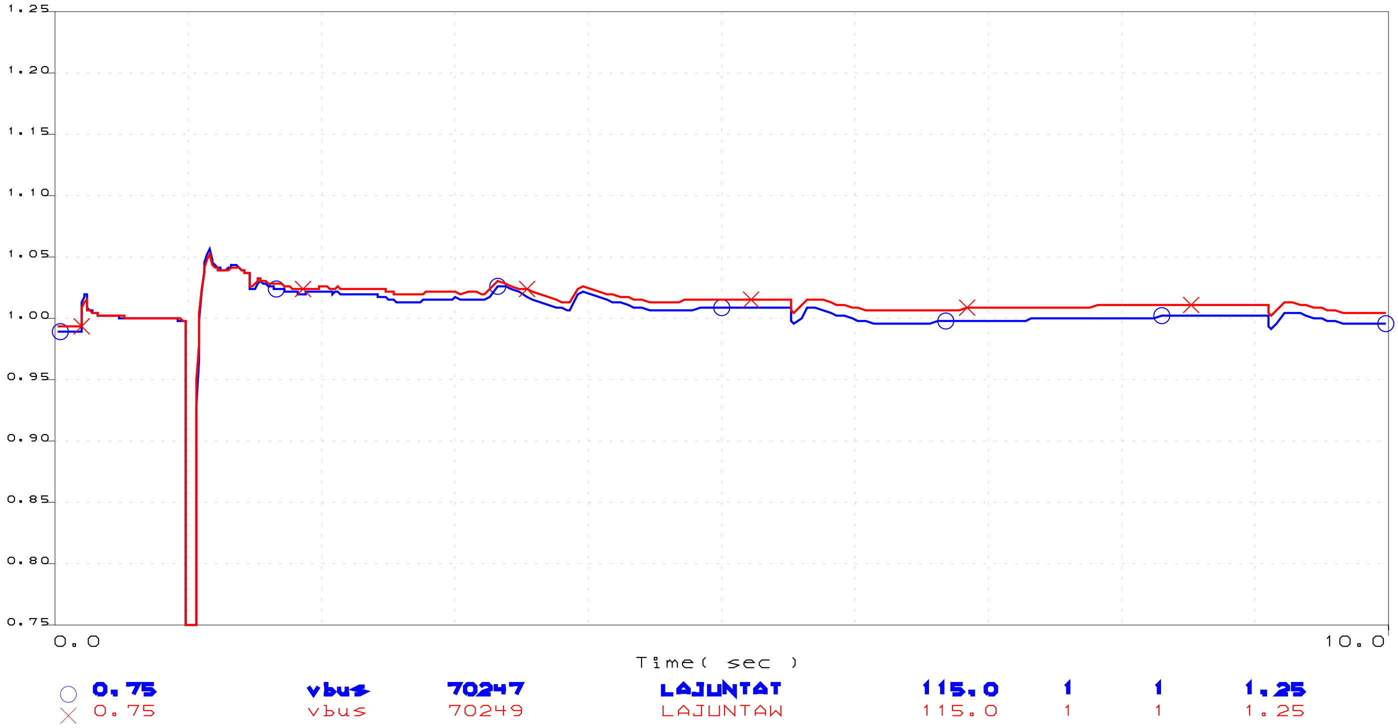
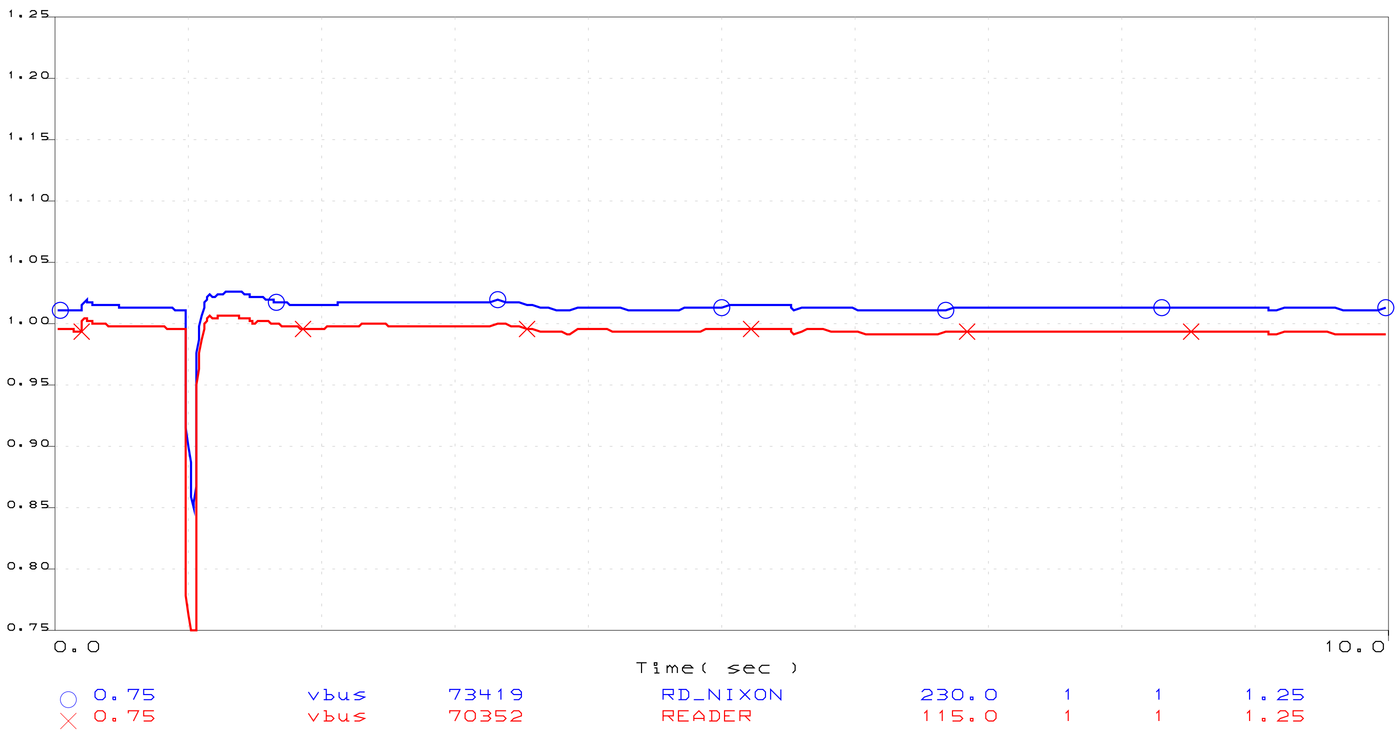
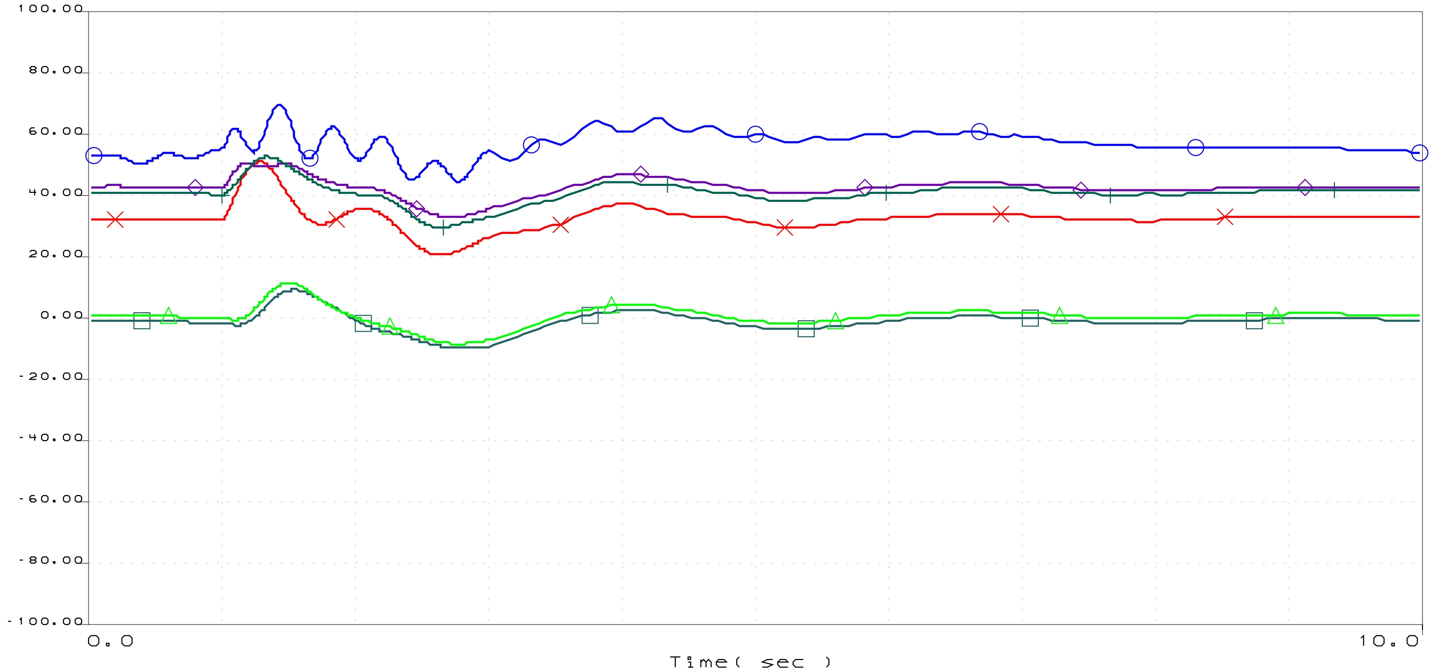


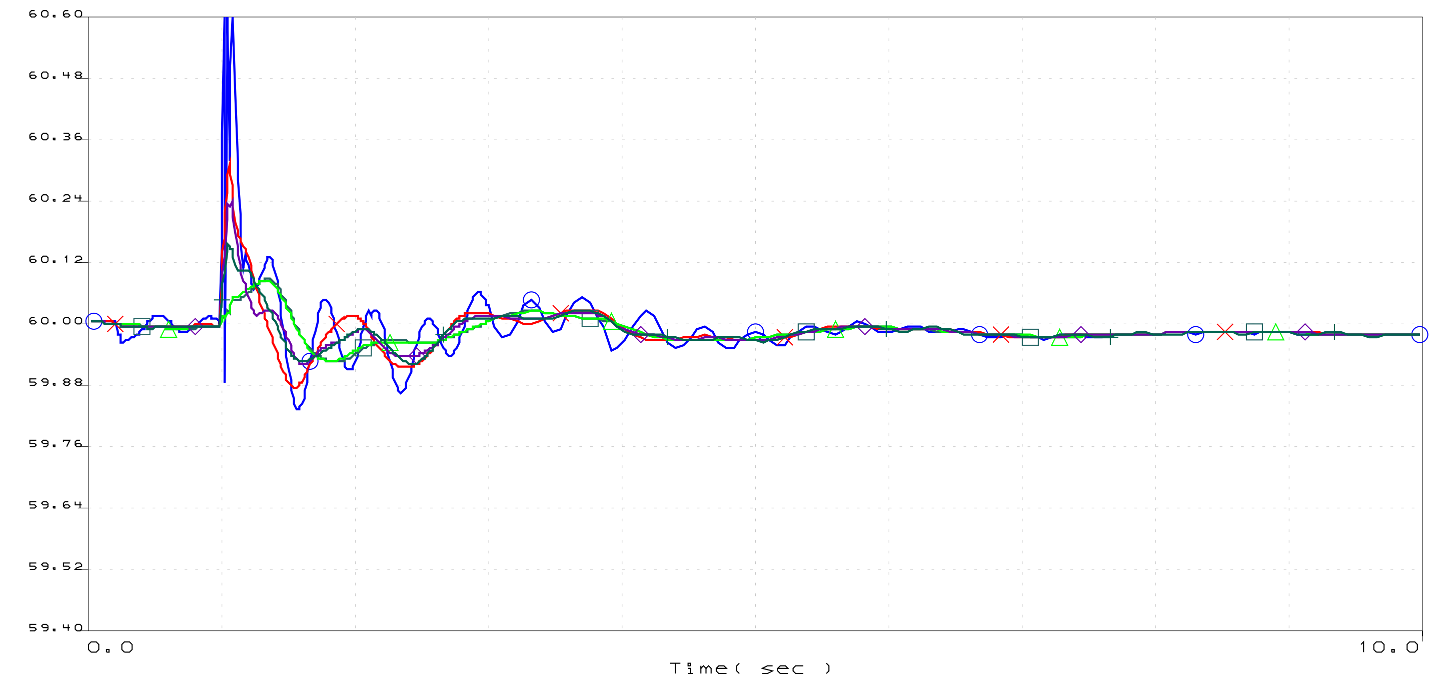


Case1511.chf

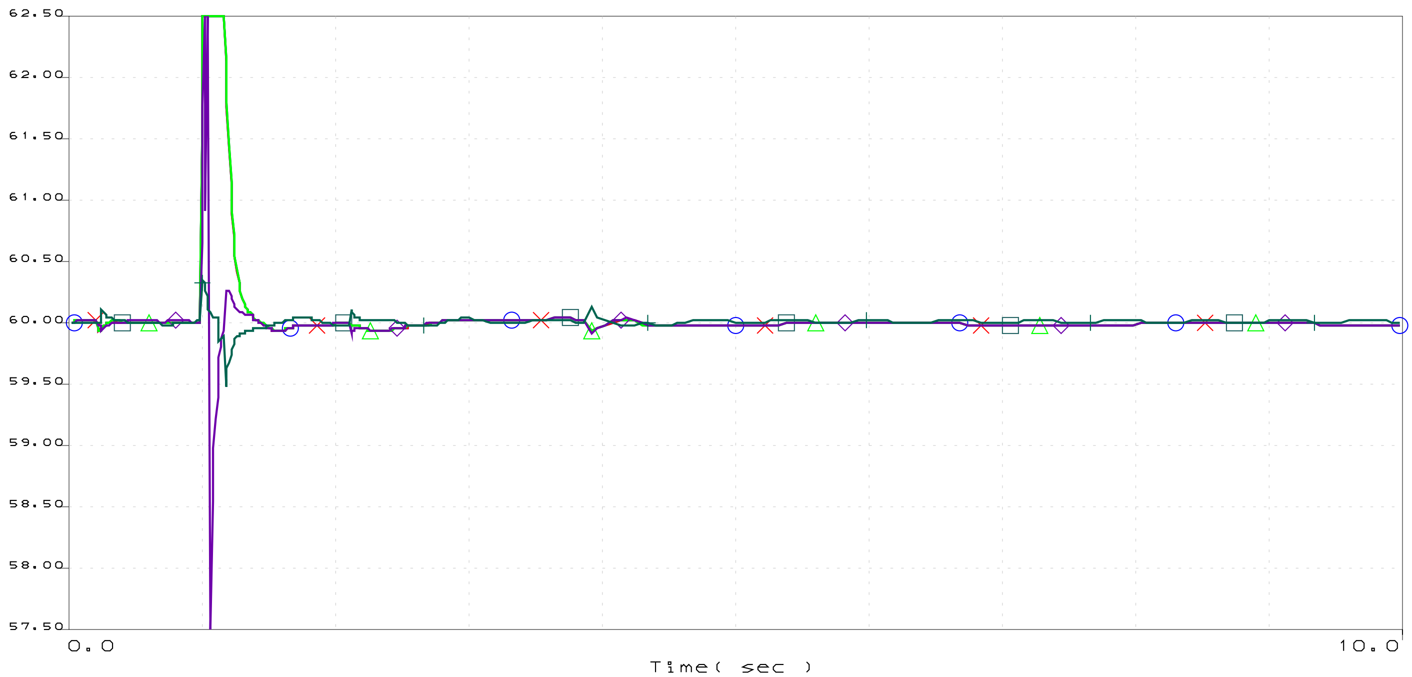
Wed Nov 24 11:51:20 2004



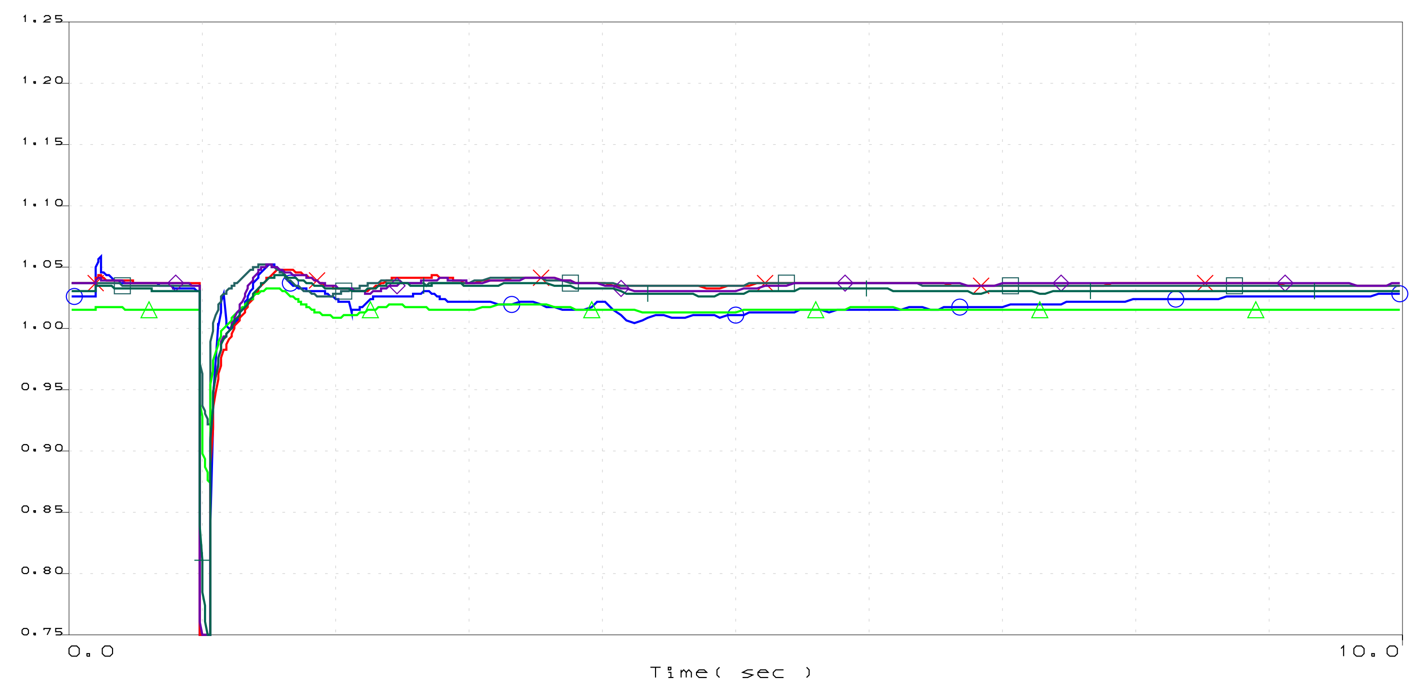
○ -100.0	ang	70133	CTY LAM	14.4	1	1	100.0
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



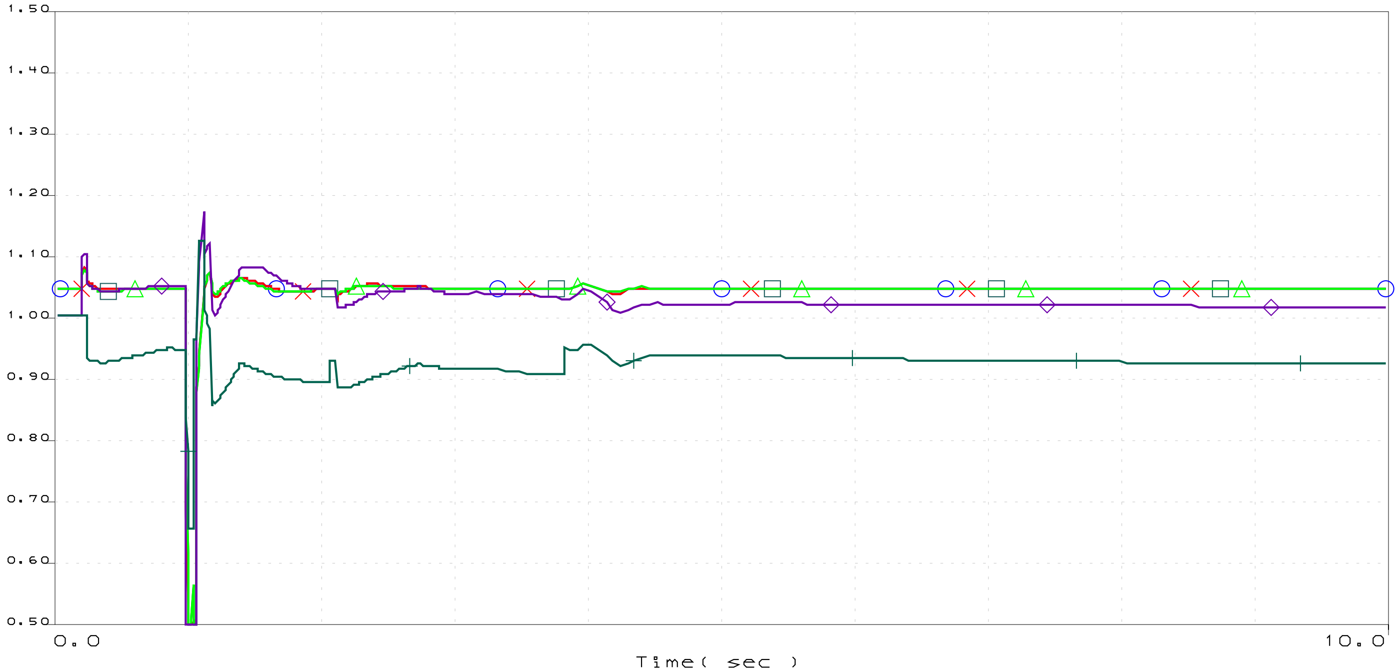
○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



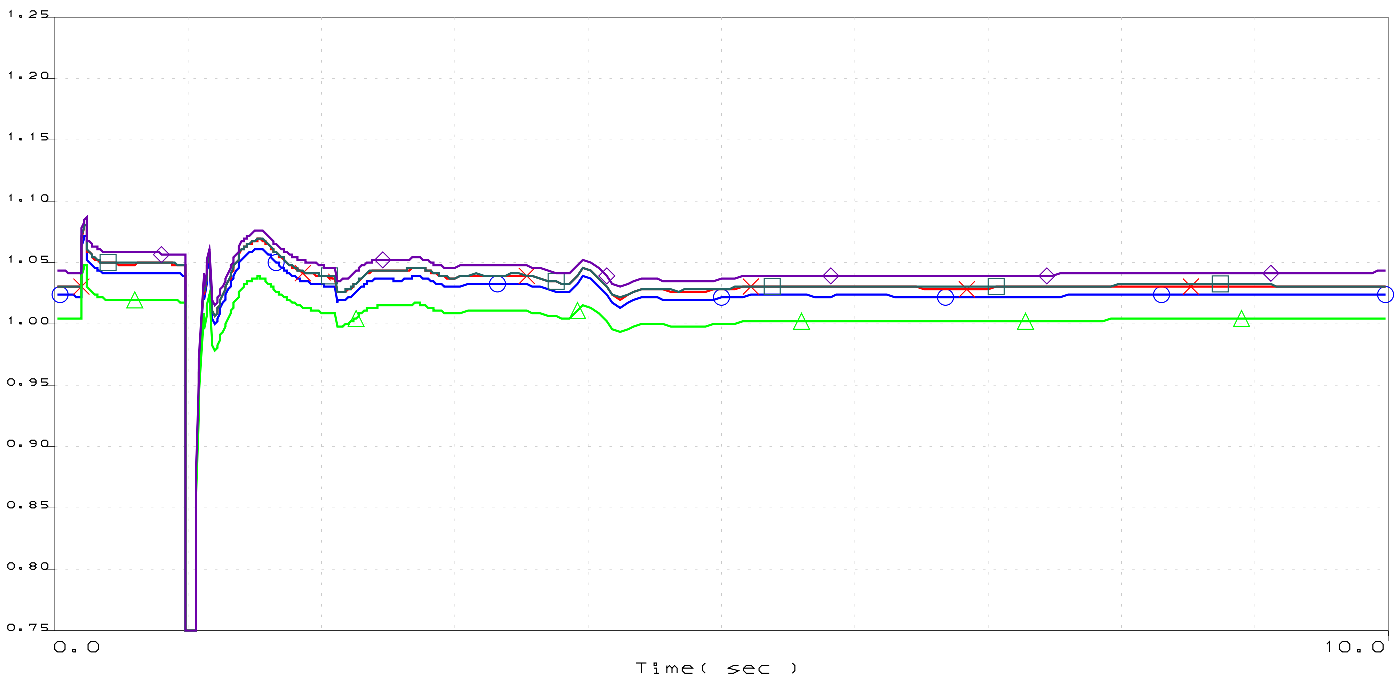
○ 57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



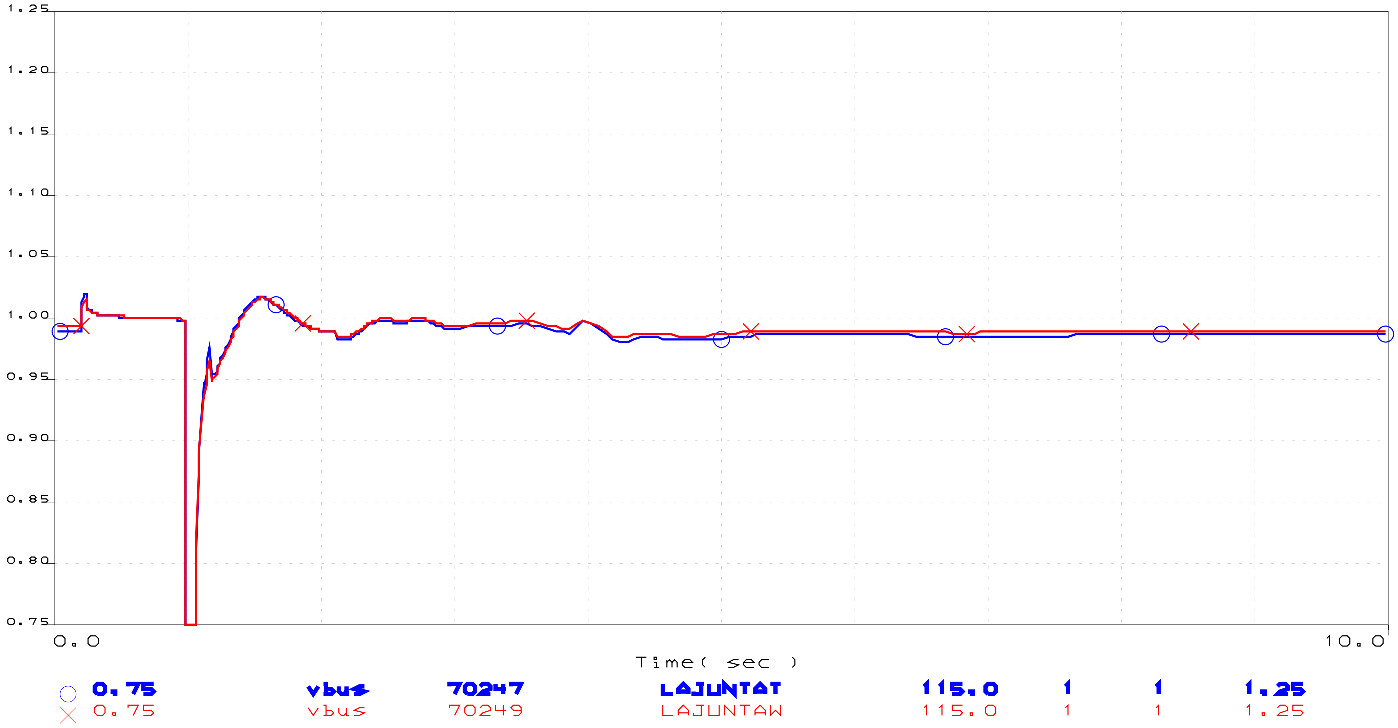
○ 0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25

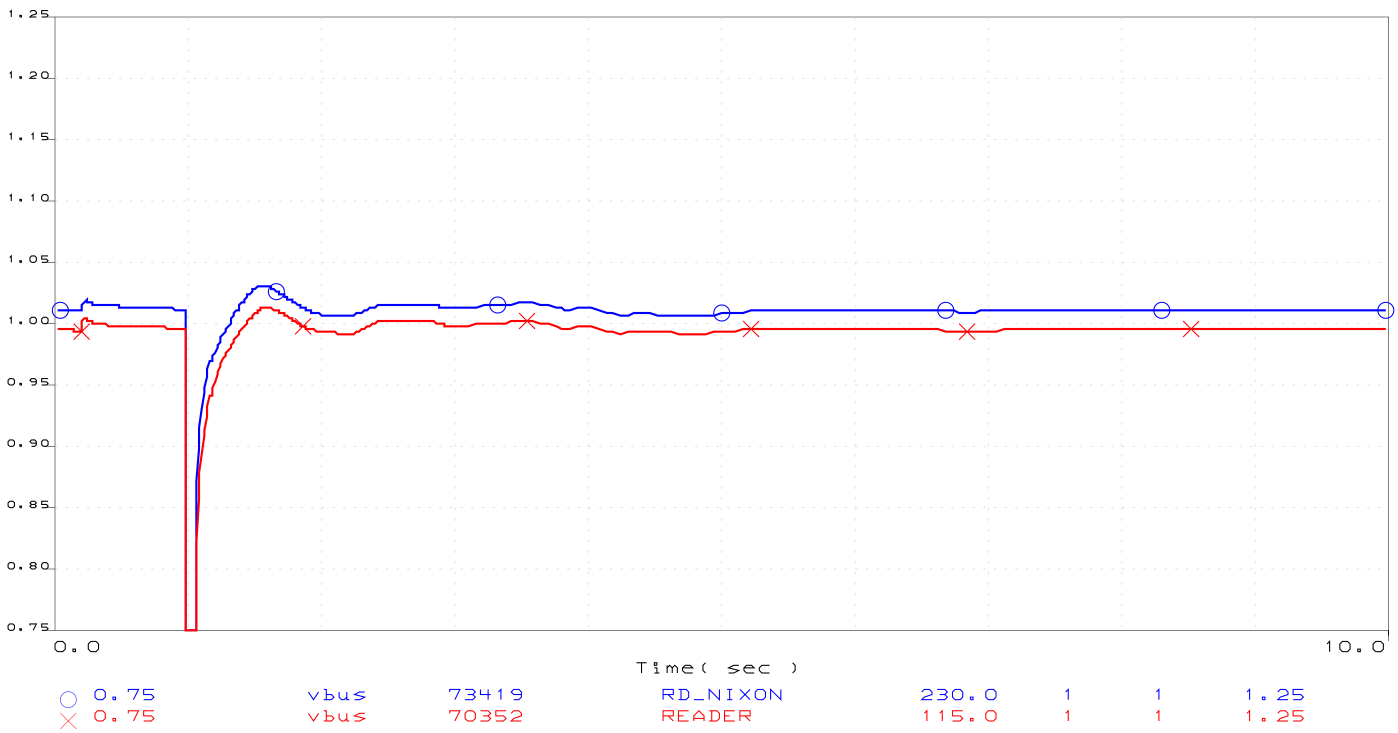


0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25





Case1S12.chf

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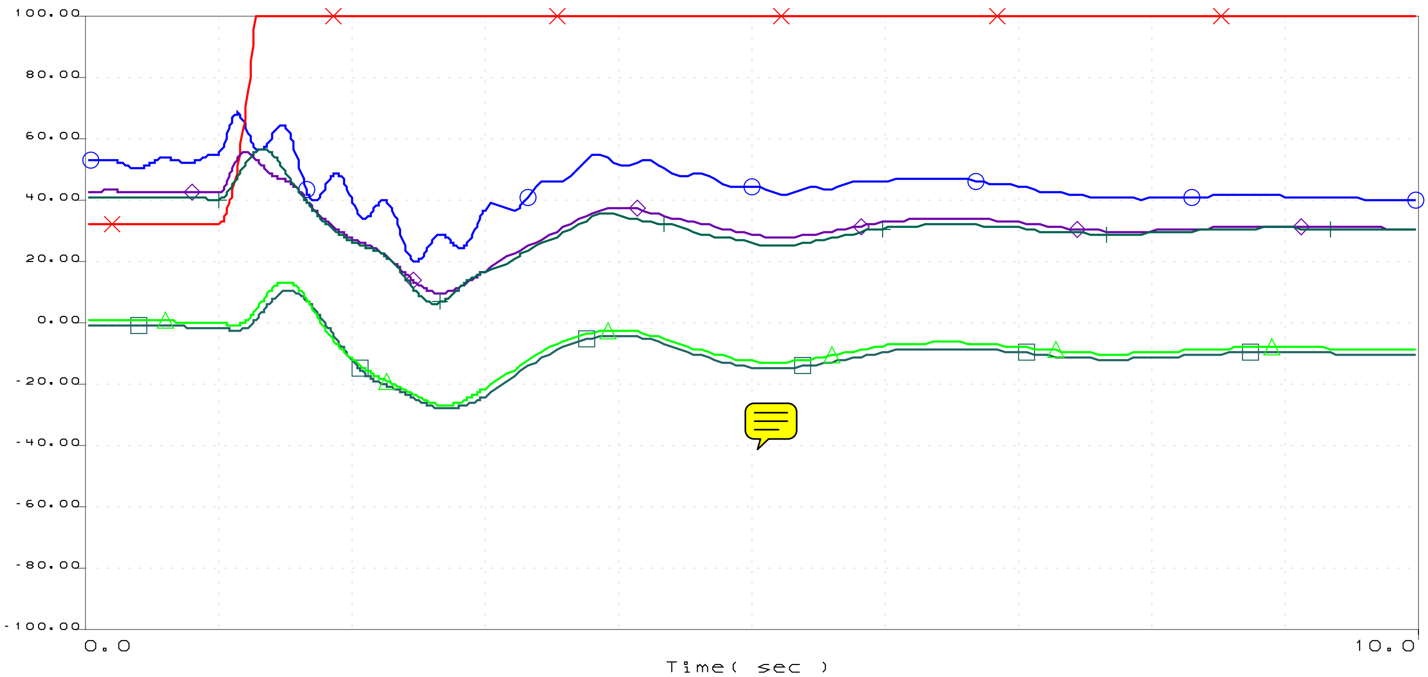
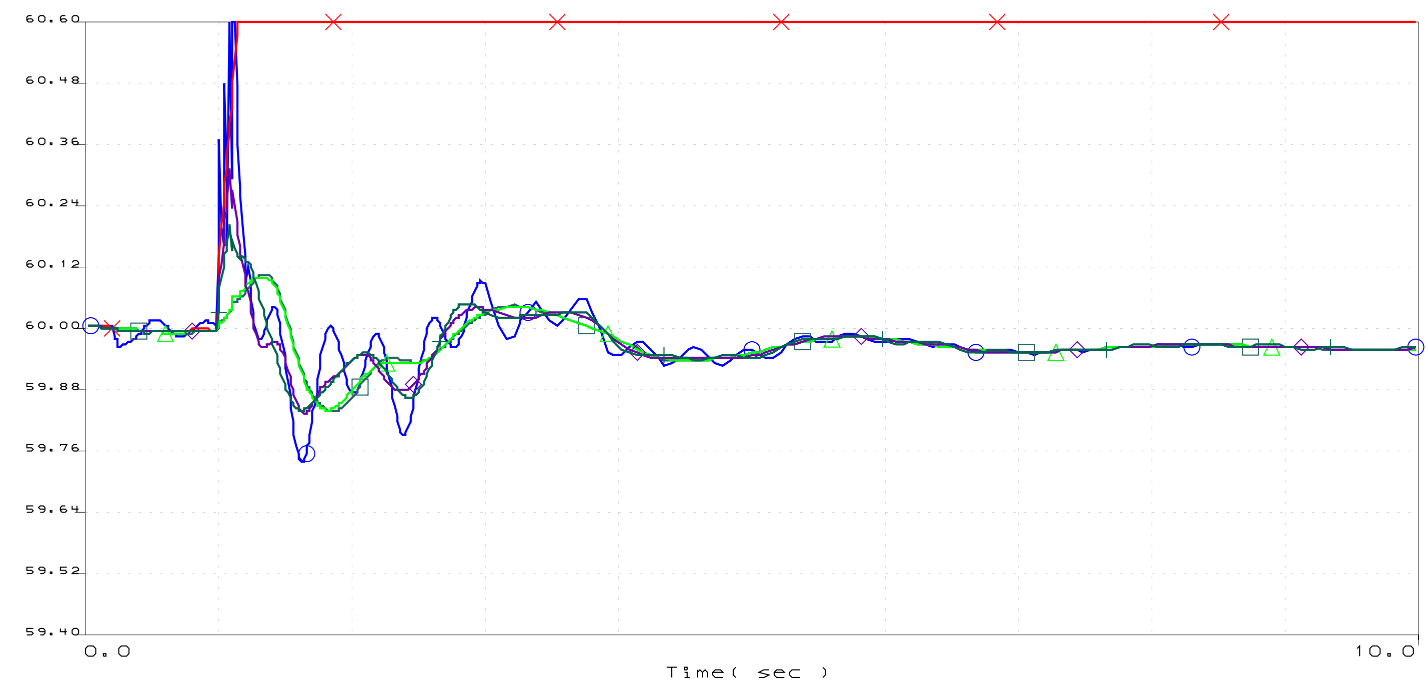
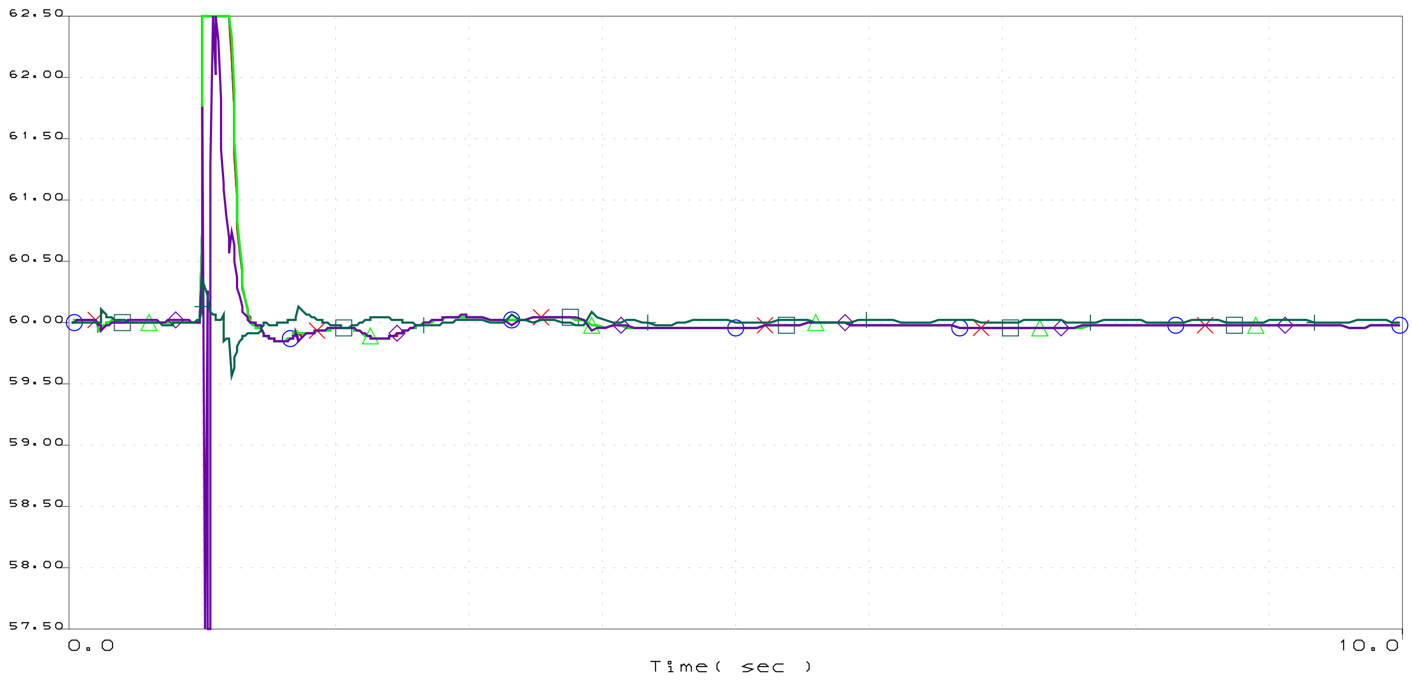


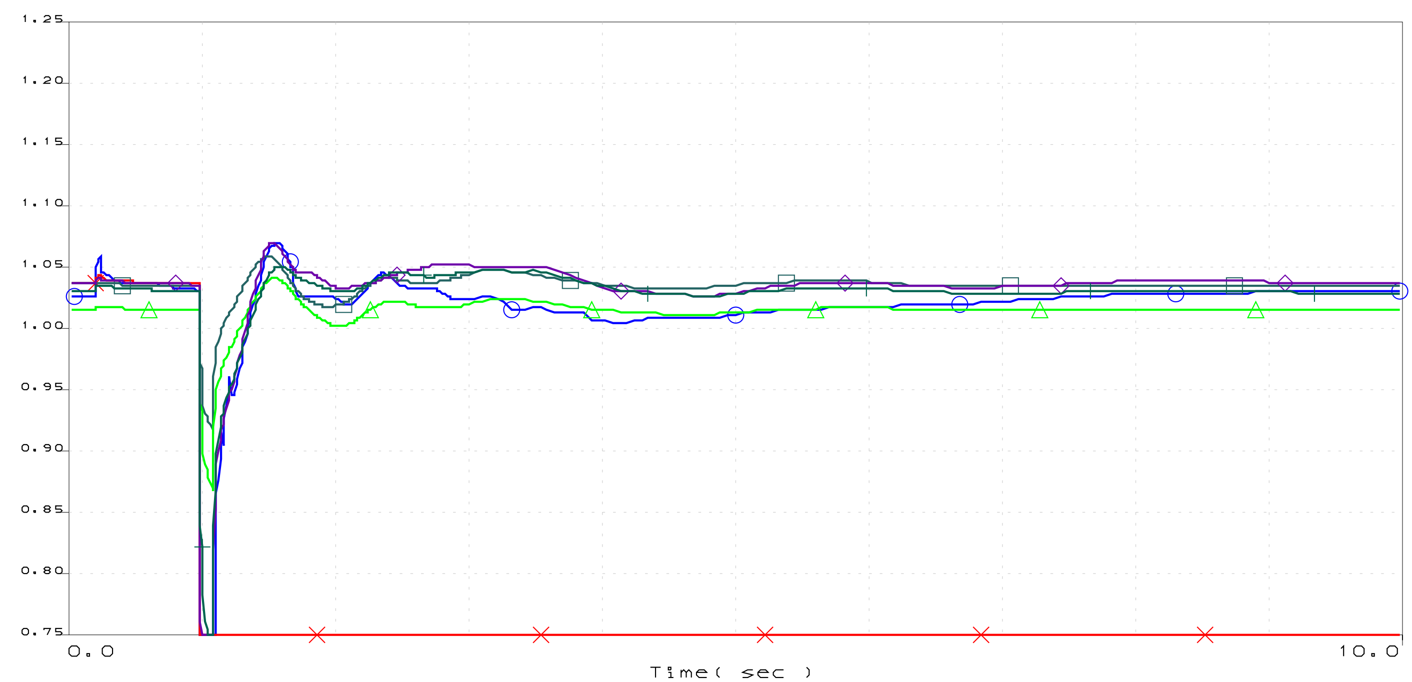
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
0.75	vbug	70034	ARAP3	13.8	1	1	1.25
0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25

Case1S13.chf

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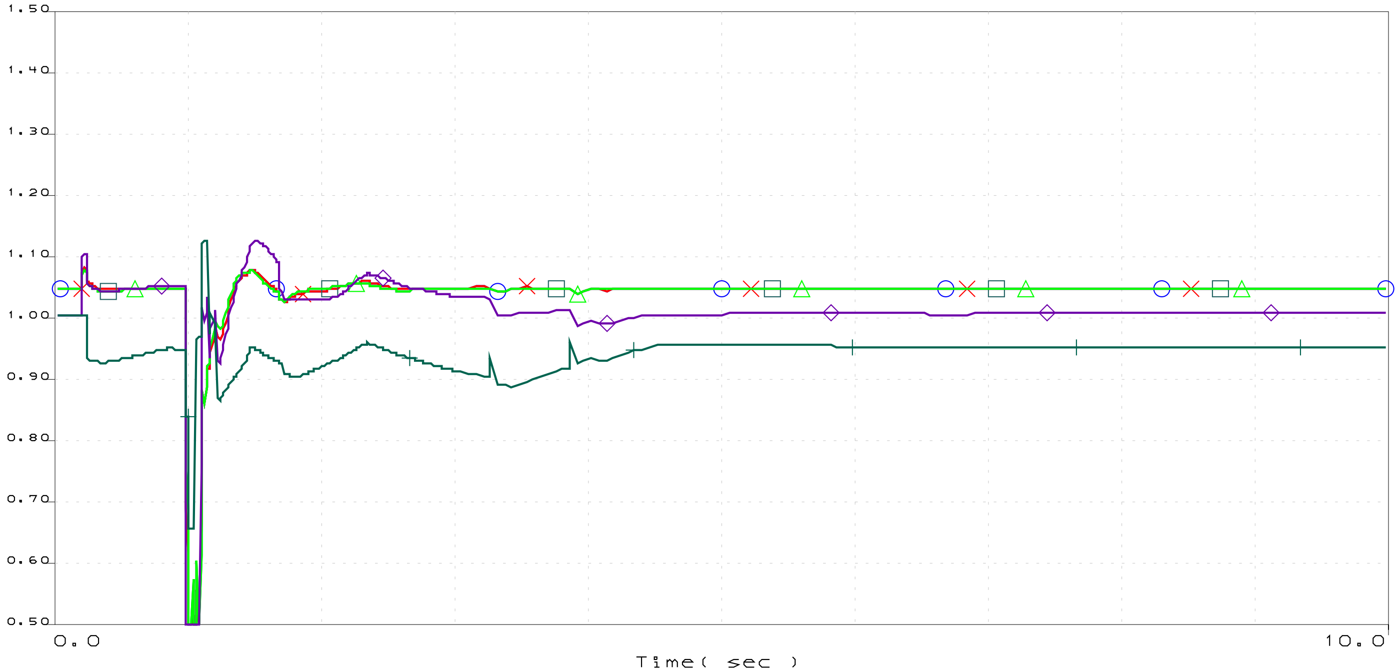
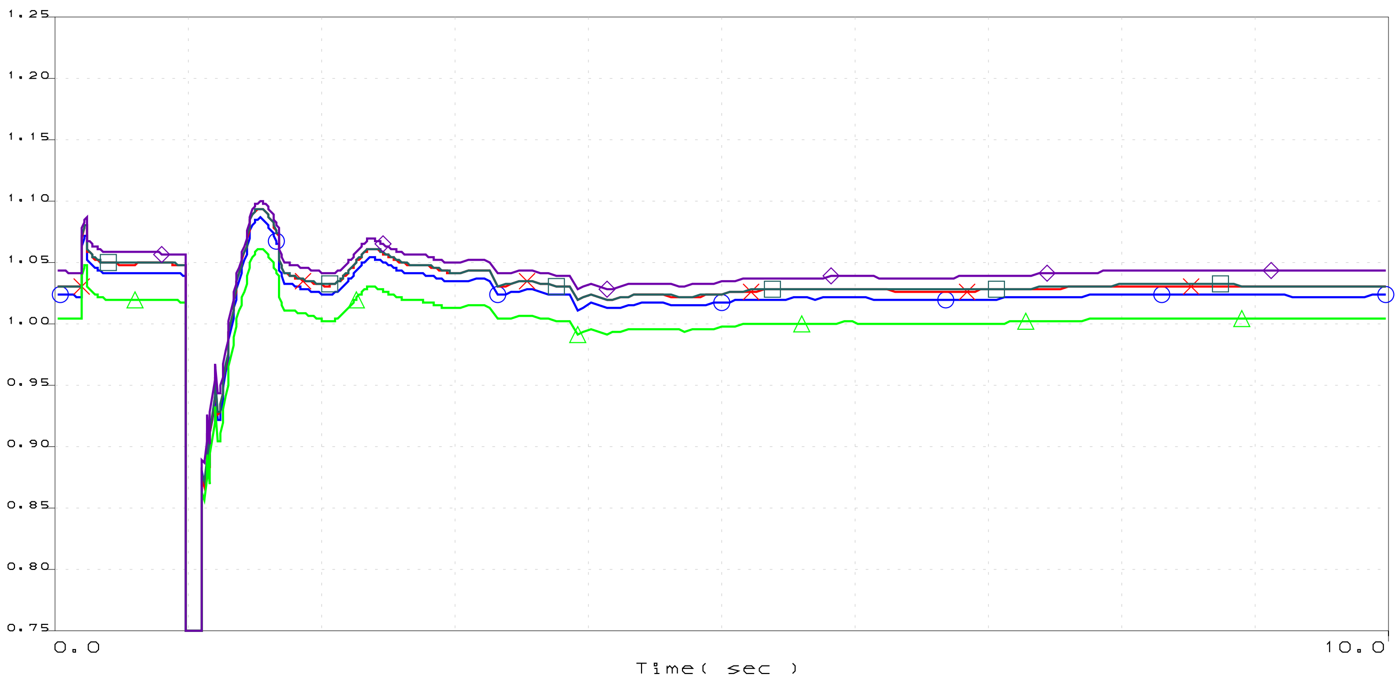
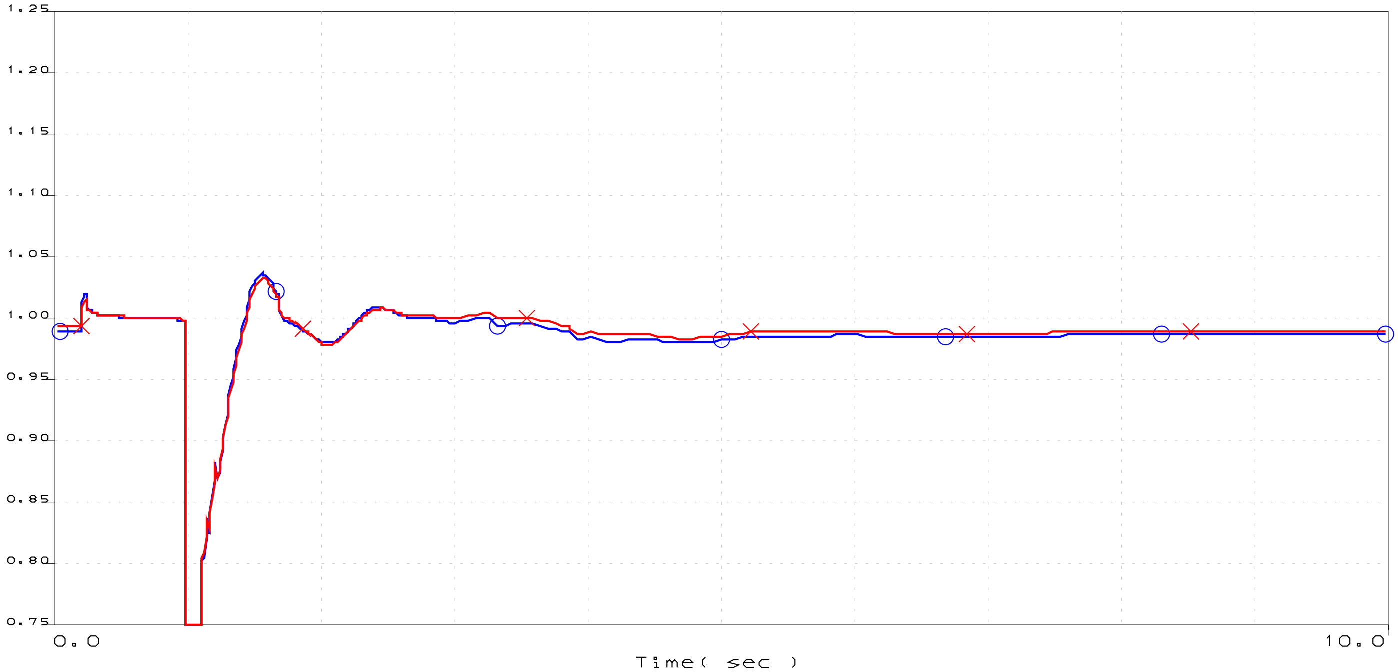


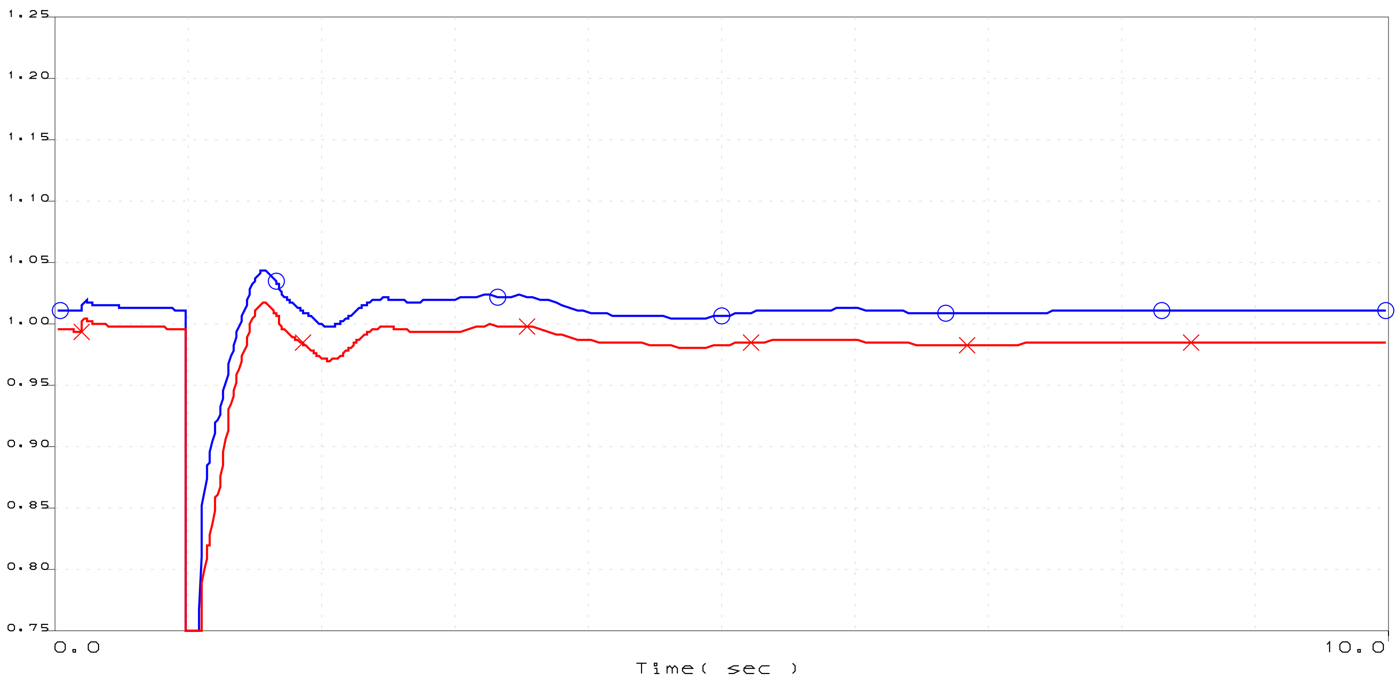
0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

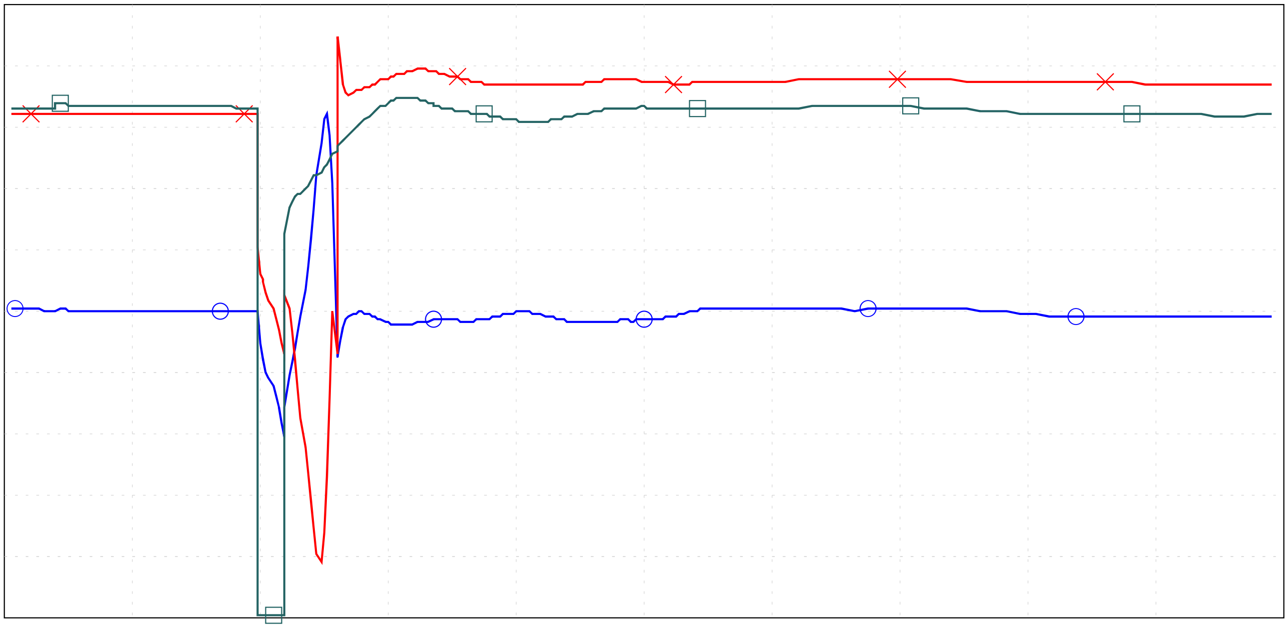


0.75	vbus	70247	LAJUNTAT	115.0	1	1	1.25
0.75	vbus	70249	LAJUNTAW	115.0	1	1	1.25

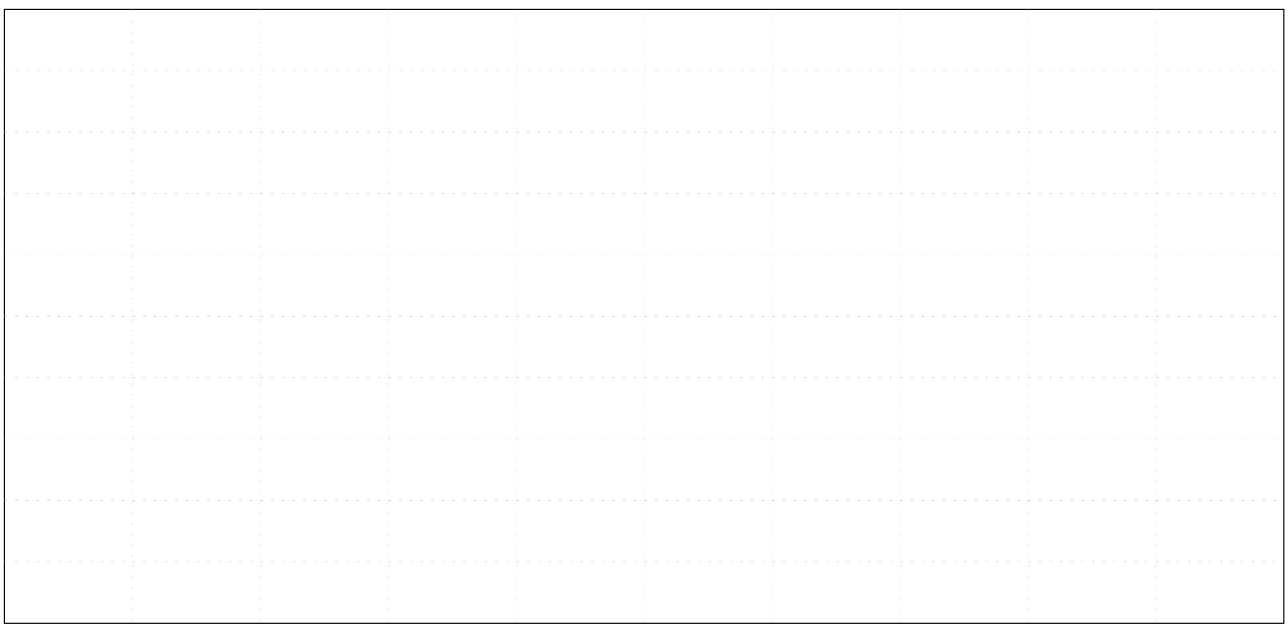


0.75	vbus	73419	RD_NIXON	230.0	1	1	1.25
0.75	vbus	70352	READER	115.0	1	1	1.25

5 Second detail for Rosebud Trip on OF
Case1 S13 - 3-Phase fault on Comanche
230kV bus, loss of Comanche 1 generator



○ 57.5	fbus	12062	ROSEBUD	115.0	1	1	62.5
× 0.0	vbug	12063	ROSEBUD	13.8	1	1	1.25
□ 0.0	vbus	70122	COMANCHE	230.0	1	1	1.25



10wallgen8; from 10WALLGEN4; DP-WATER 345x2
all qued gens in service sched to cher and stvrn
5/19/04

case1s13.chf

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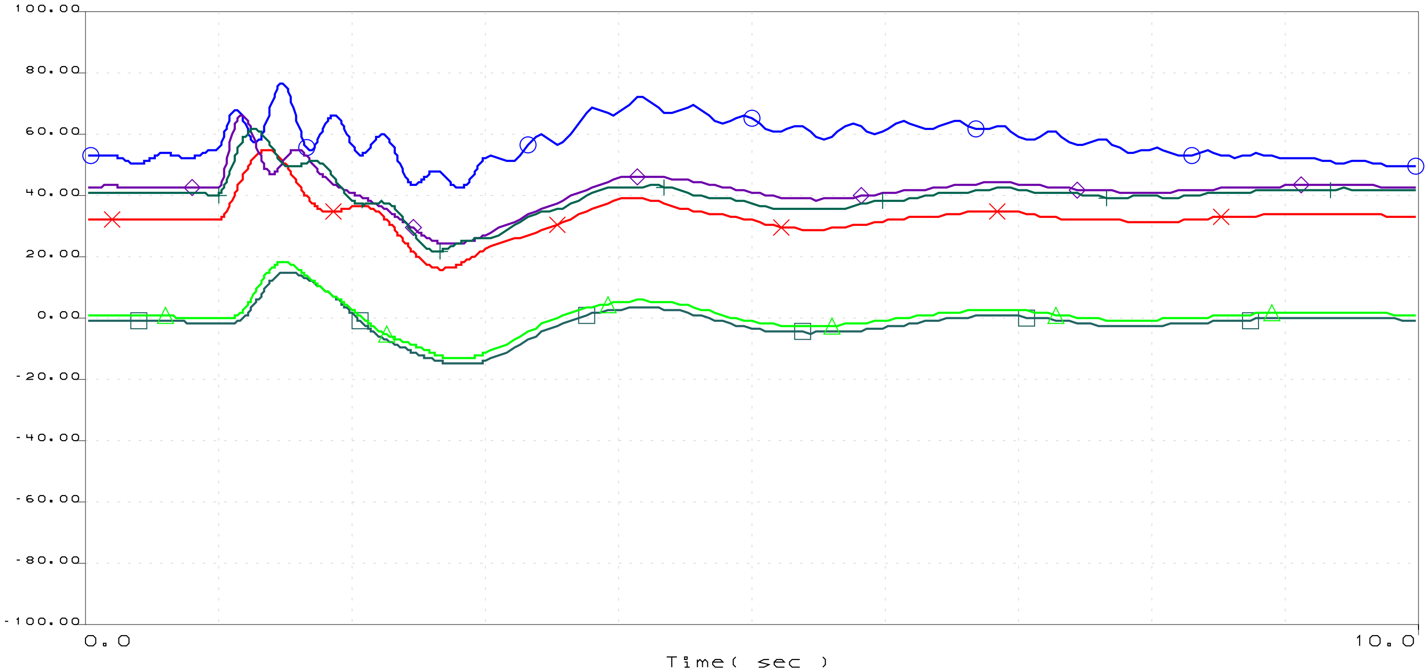
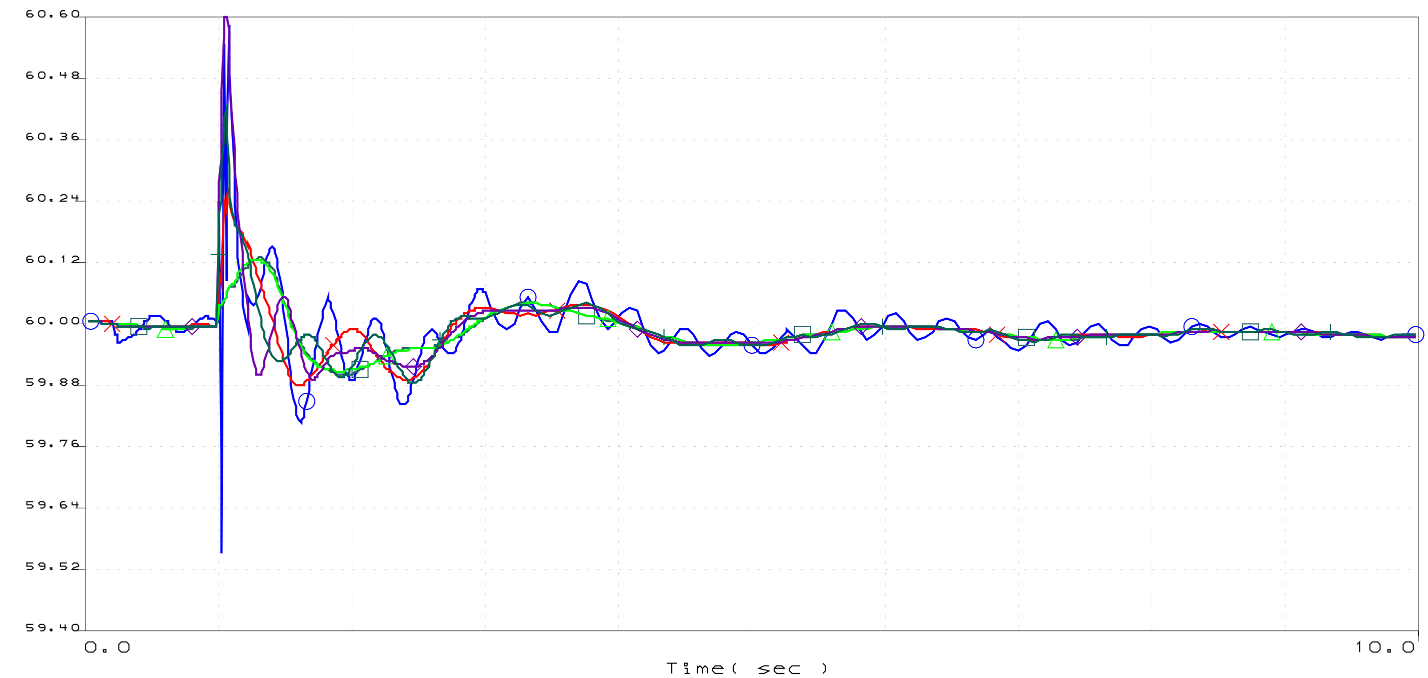
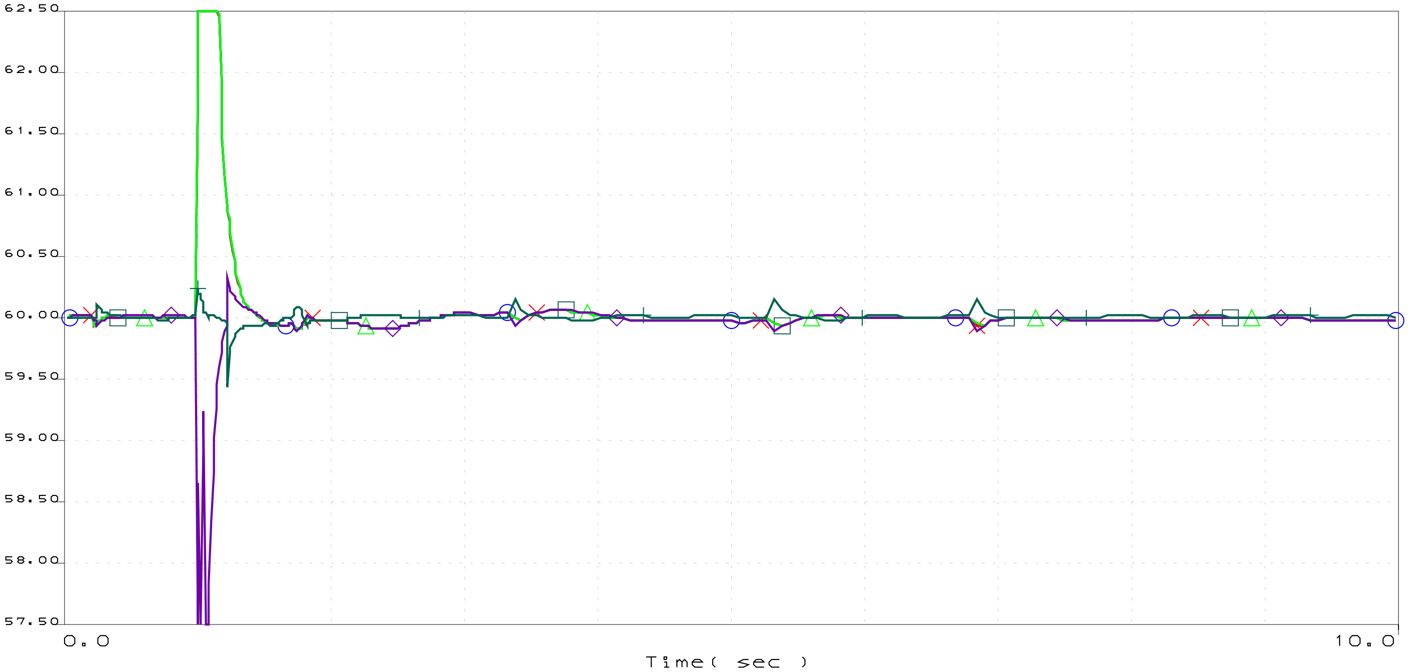


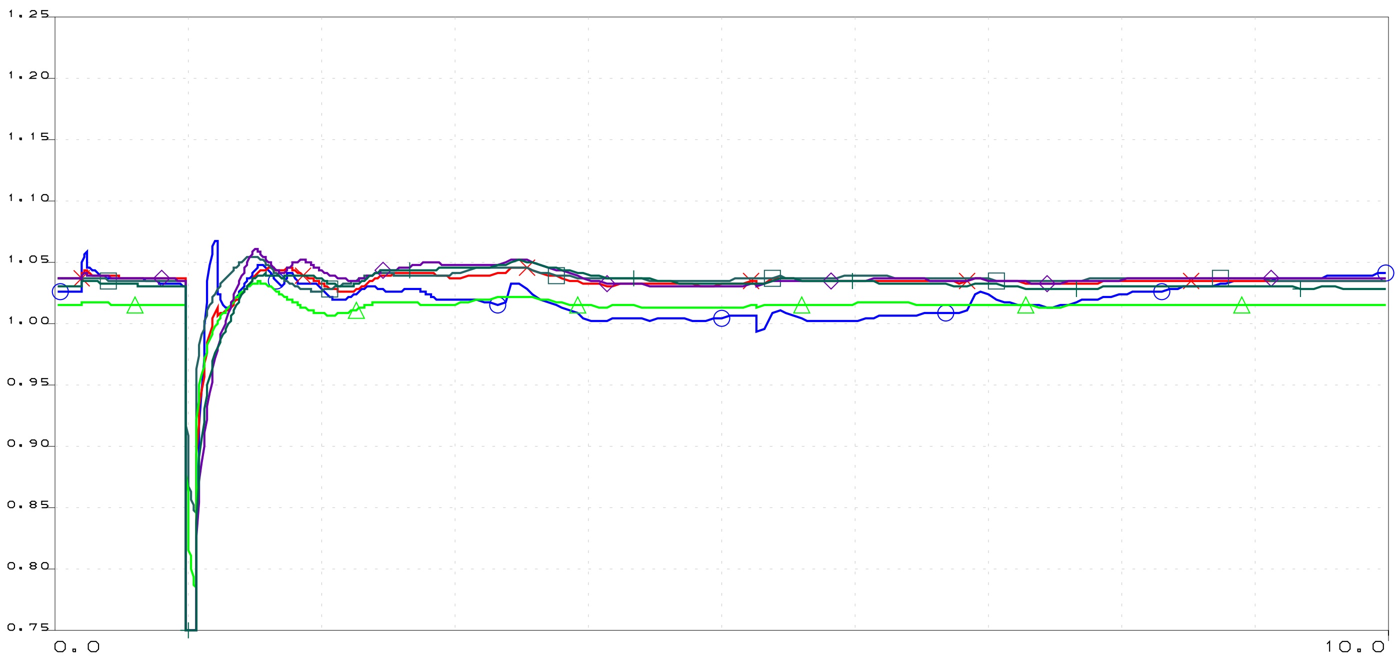
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6

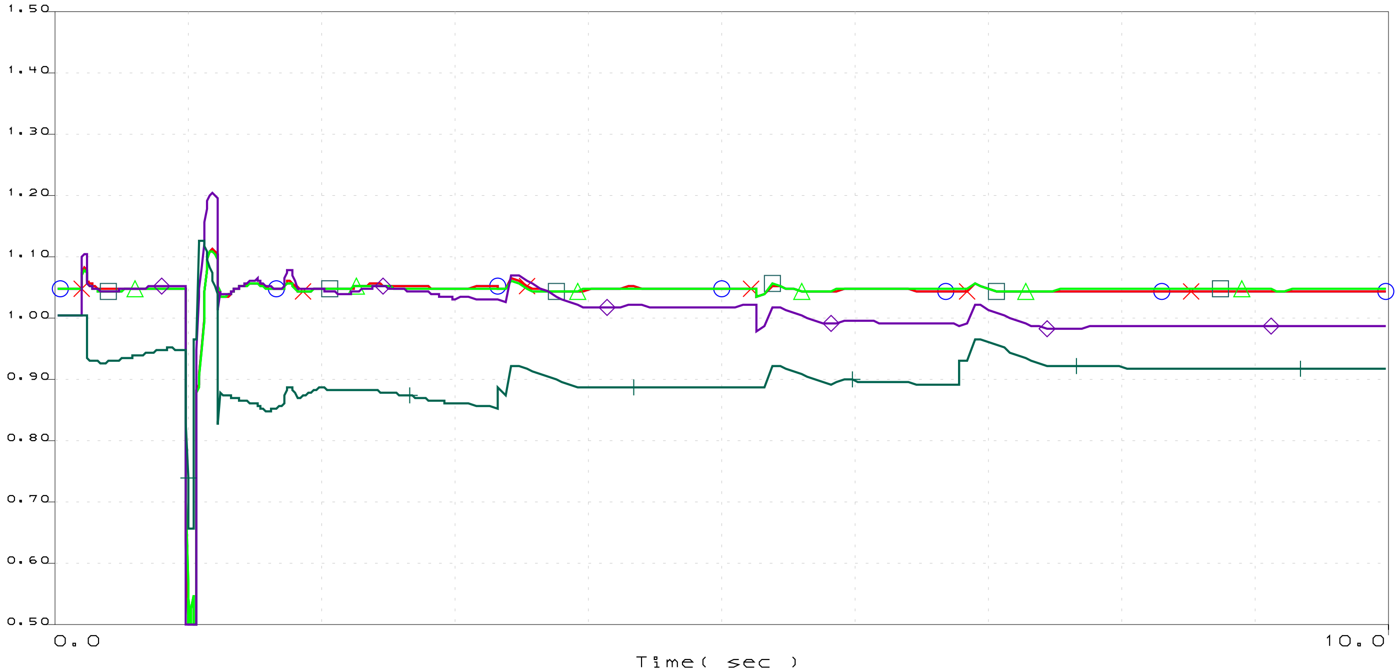


○	**57.5**	**fbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
×	57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□	57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△	57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇	57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+	57.5	fbus	70805	LAMAR E	53.5	1	1	62.5

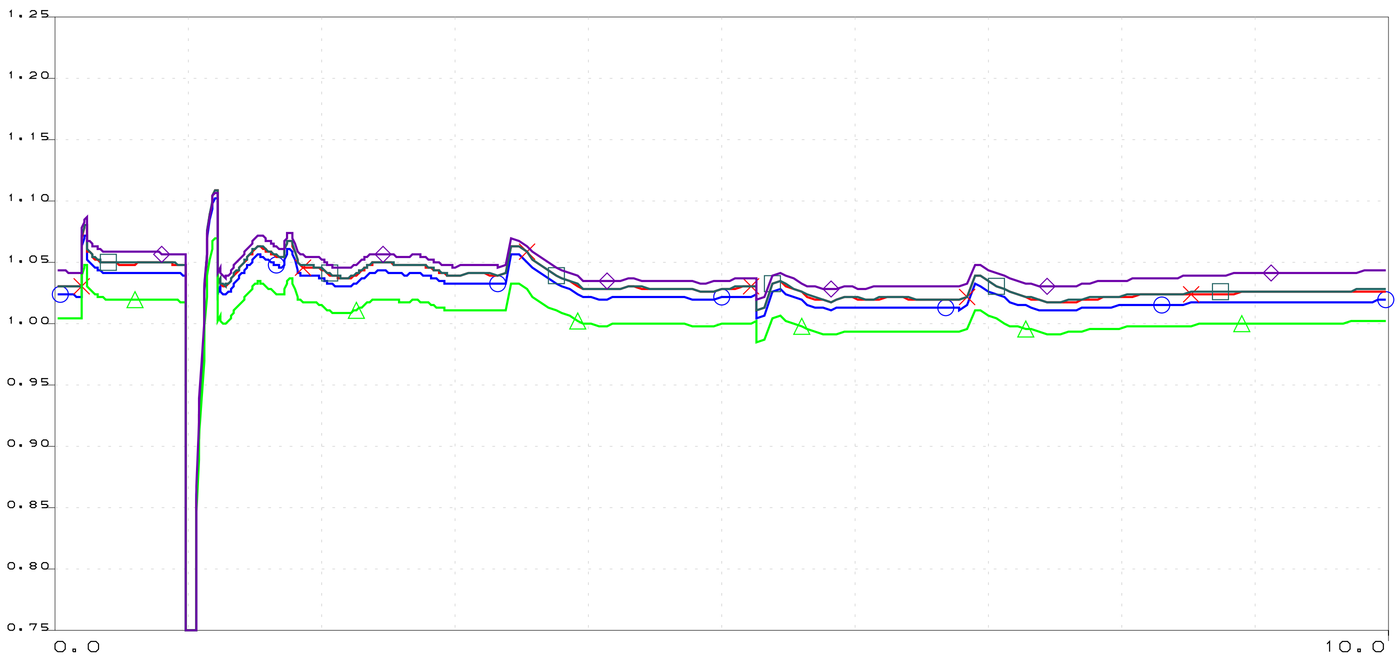


○	0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
×	0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□	0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△	0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇	0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+	0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25

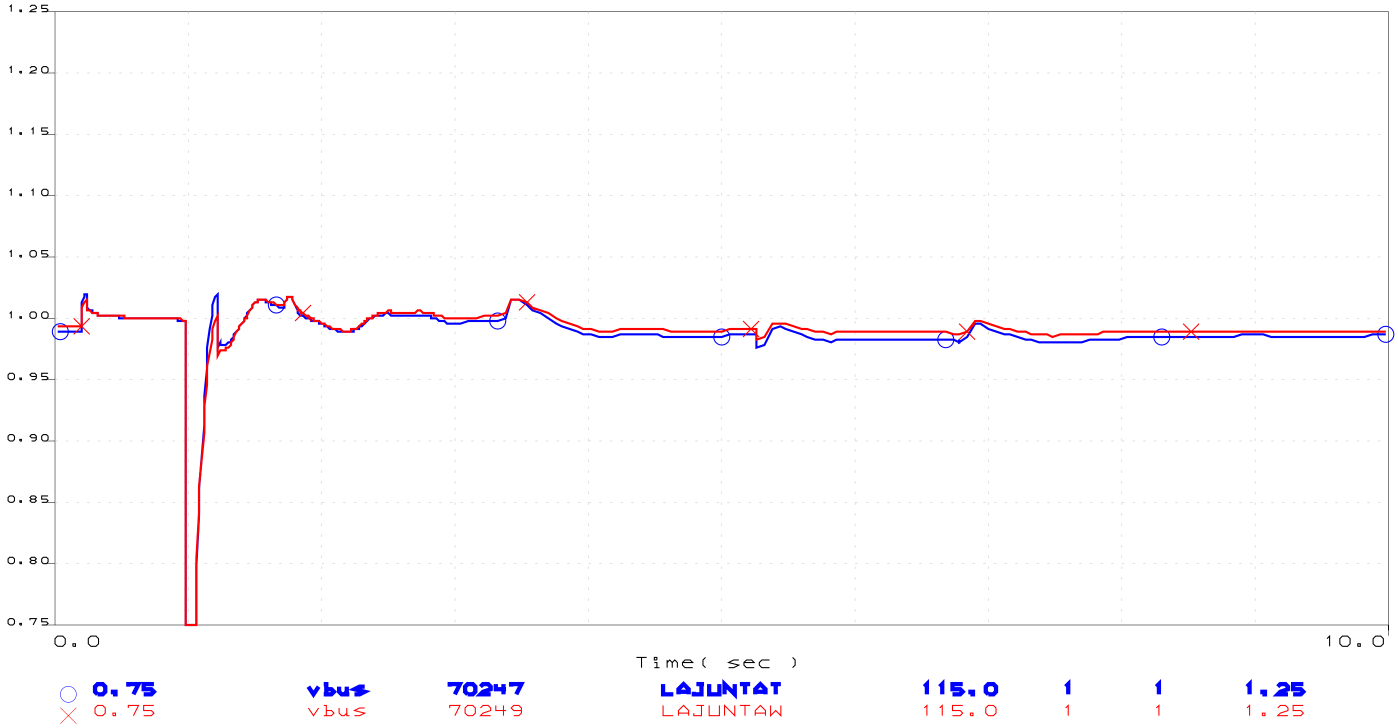
Case1S14.chf	Wed Nov 24 11:52:03 2004

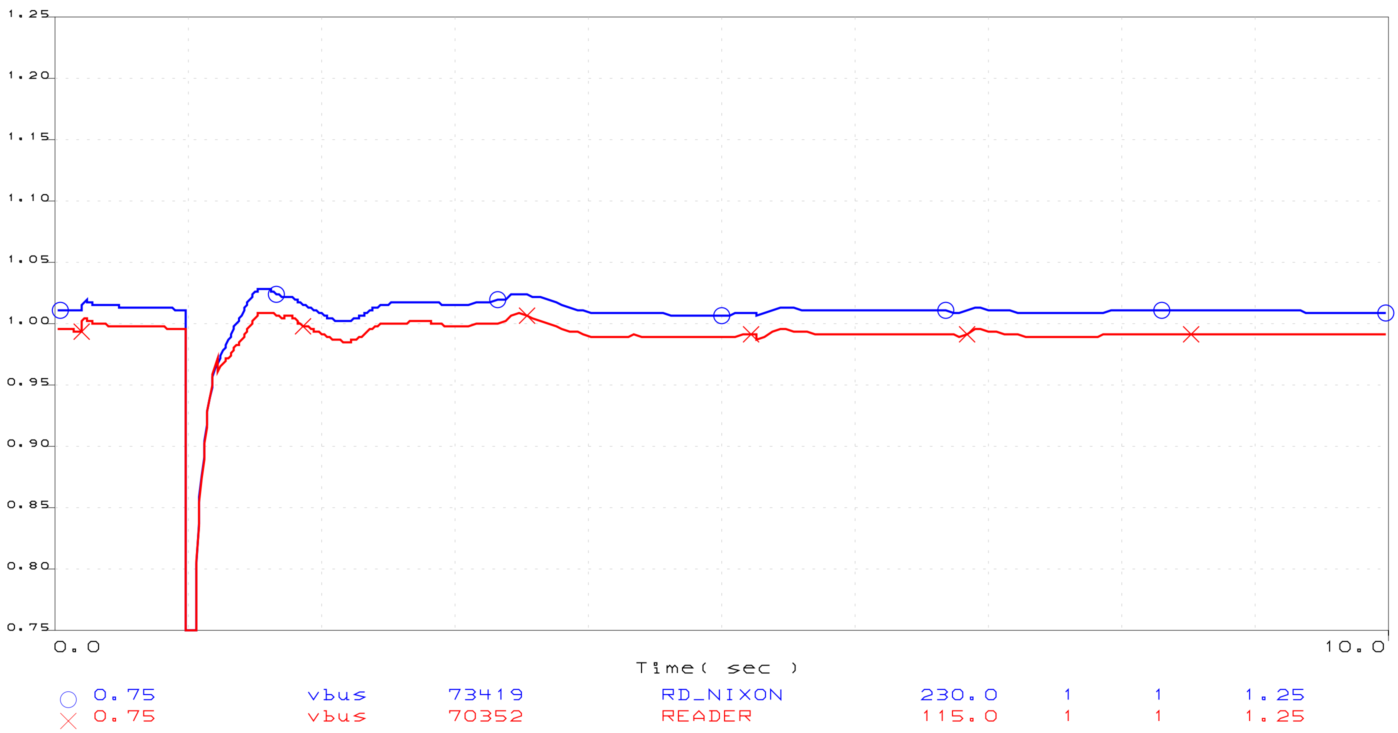


○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



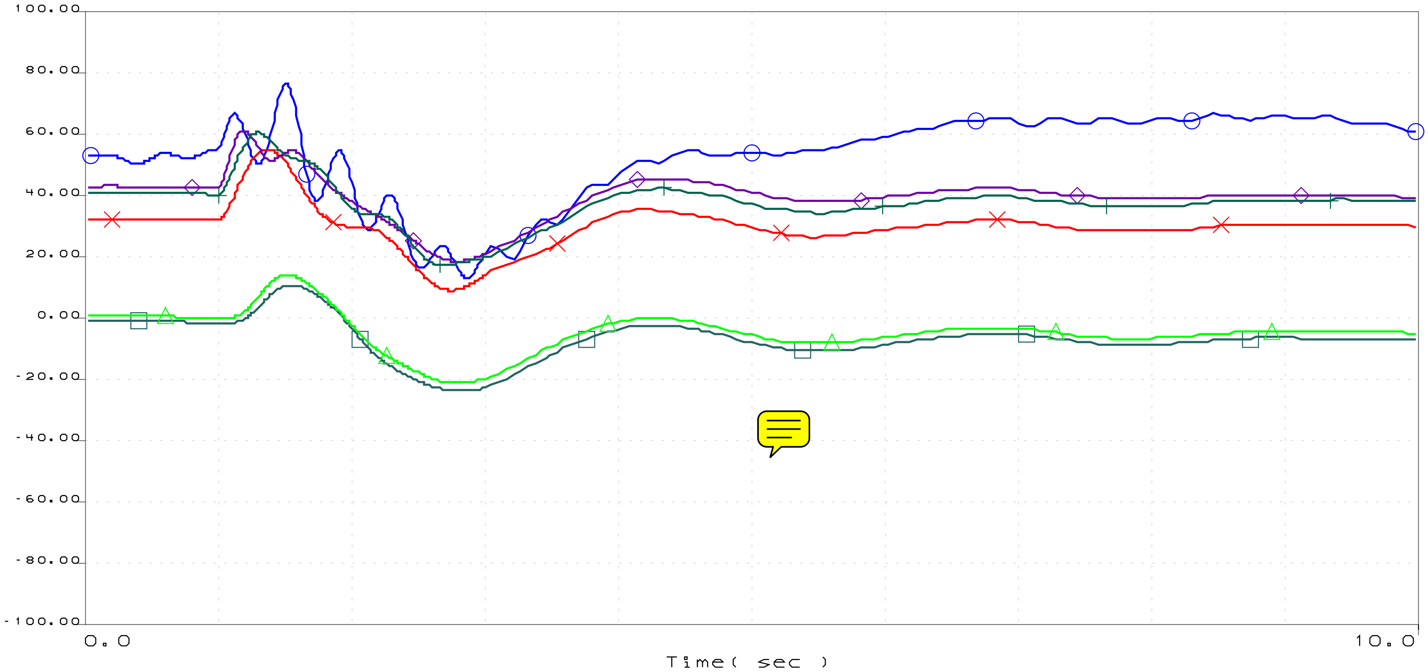
○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25



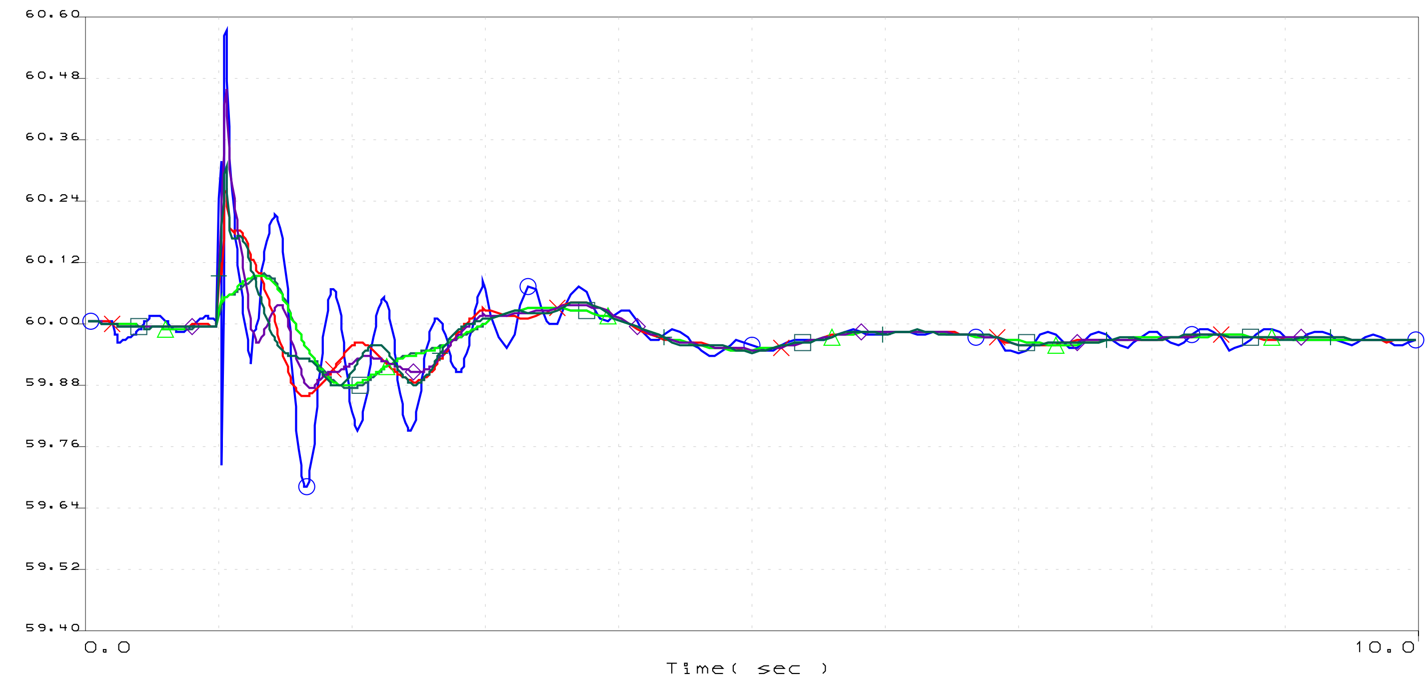


Case1S14.chf

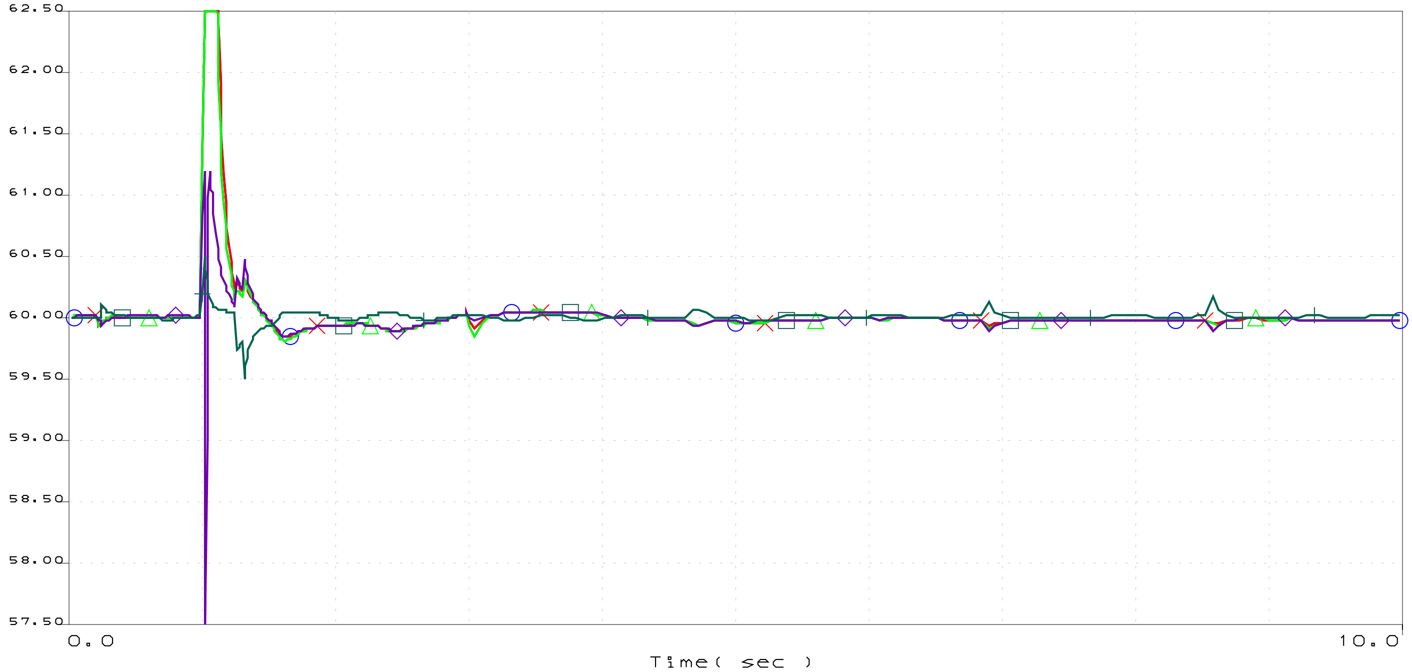
Wed Nov 24 11:52:03 2004



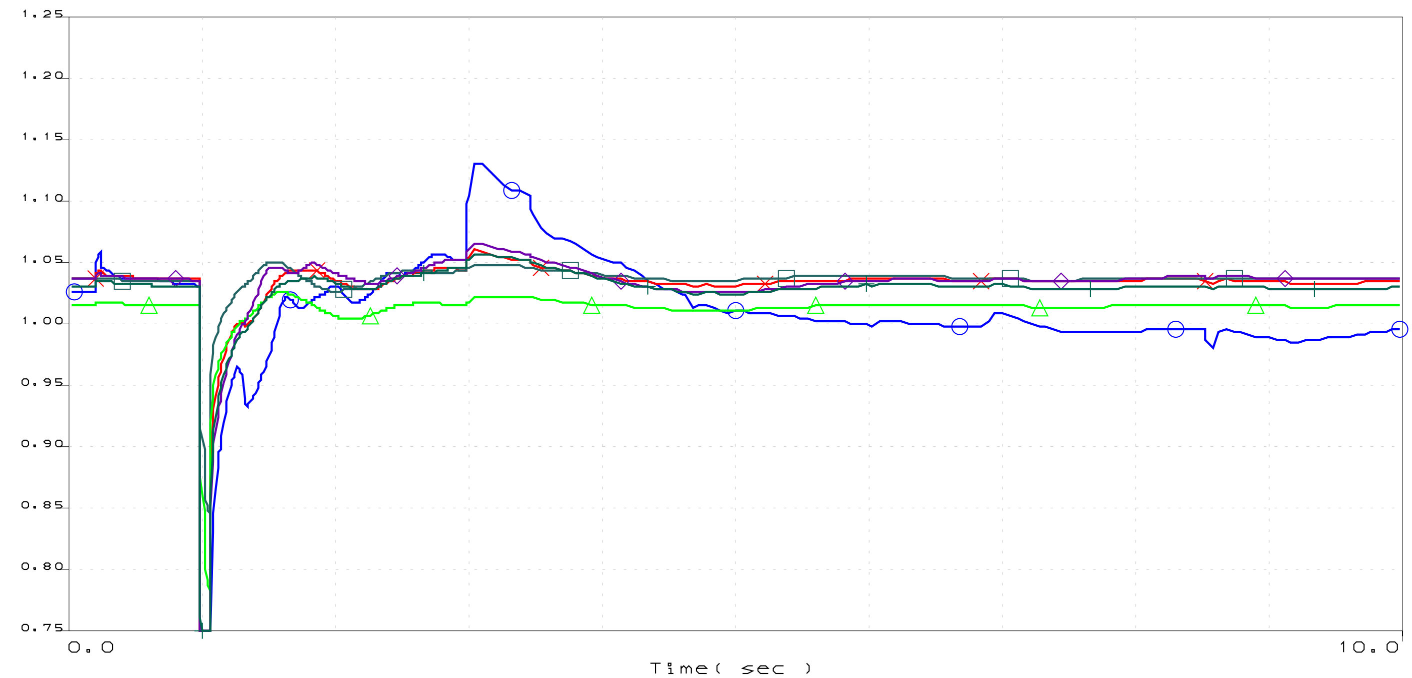
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



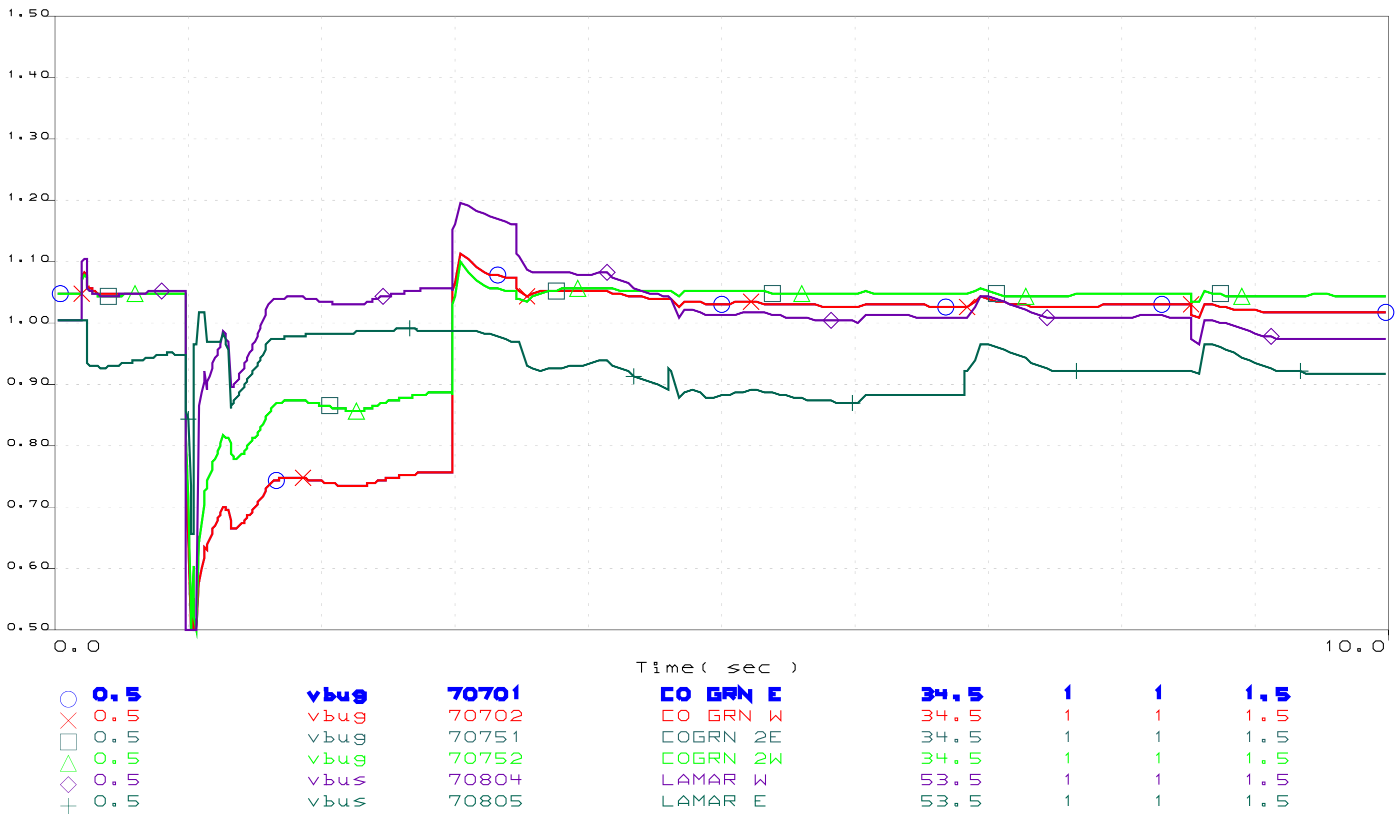
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6

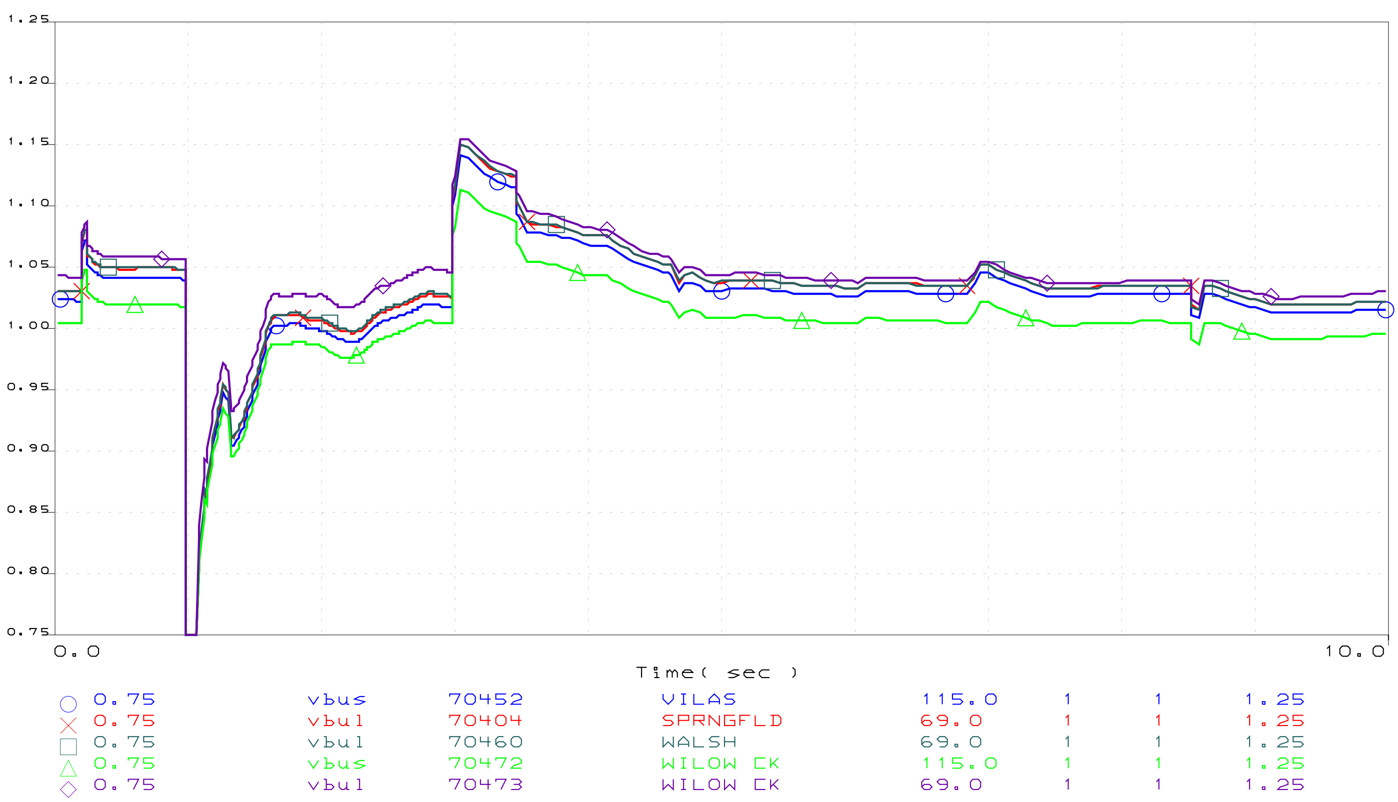


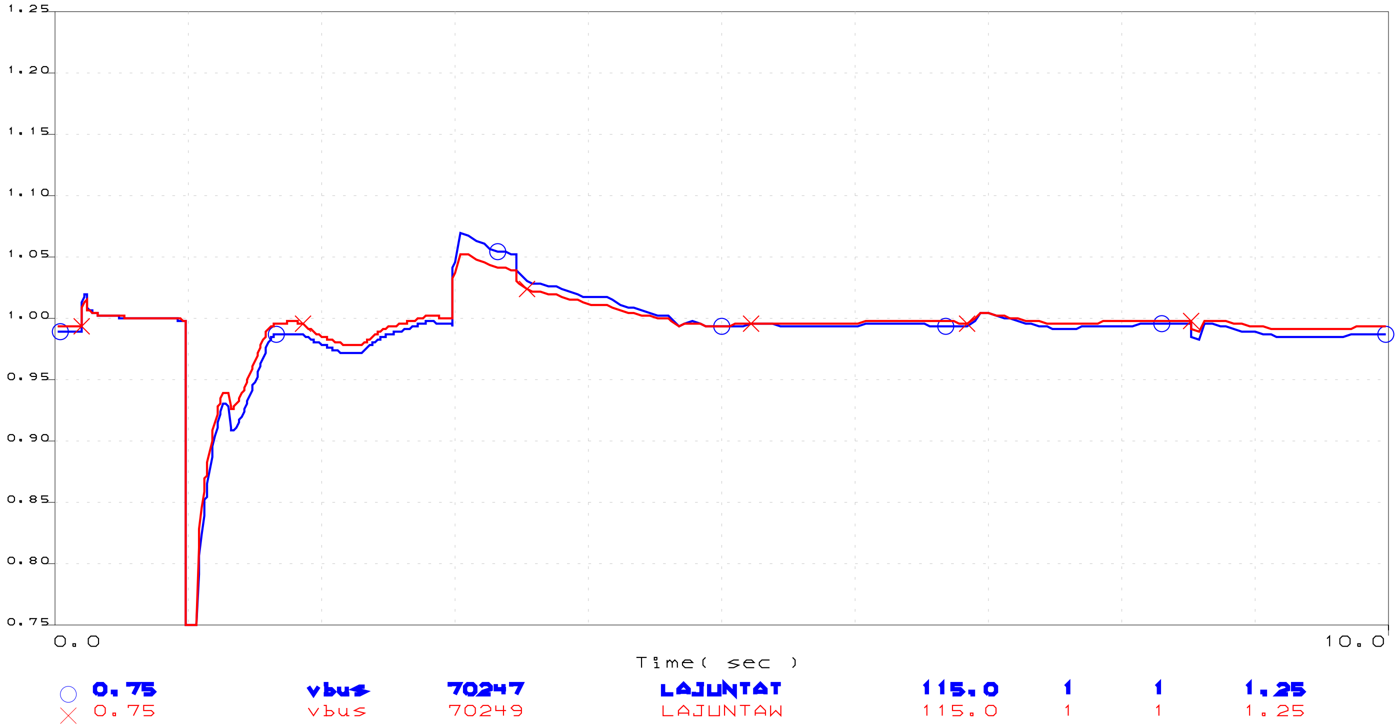
○ 57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5

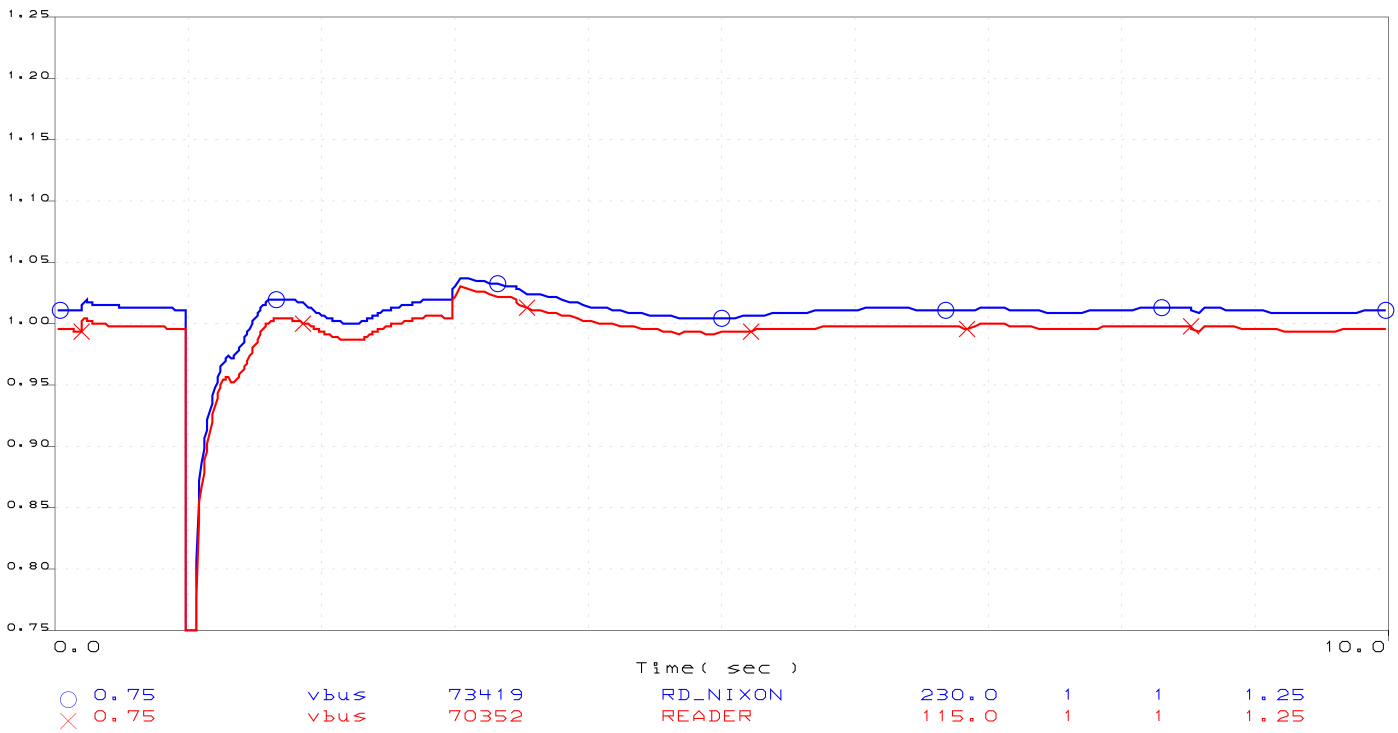


○ 0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25


1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.0
10.0
Time(sec)
0.5 vbug 70701 CO GRN E 34.5 1 1 1.5
0.5 vbug 70702 CO GRN W 34.5 1 1 1.5
0.5 vbug 70751 COGRN 2E 34.5 1 1 1.5
0.5 vbug 70752 COGRN 2W 34.5 1 1 1.5
0.5 vbus 70804 LAMAR W 53.5 1 1 1.5
0.5 vbus 70805 LAMAR E 53.5 1 1 1.5


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70452 VILAS 115.0 1 1 1.25
0.75 vbul 70404 SPRNGFLD 69.0 1 1 1.25
0.75 vbul 70460 WALSH 69.0 1 1 1.25
0.75 vbus 70472 WILOW CK 115.0 1 1 1.25
0.75 vbul 70473 WILOW CK 69.0 1 1 1.25





Case1S15.chf

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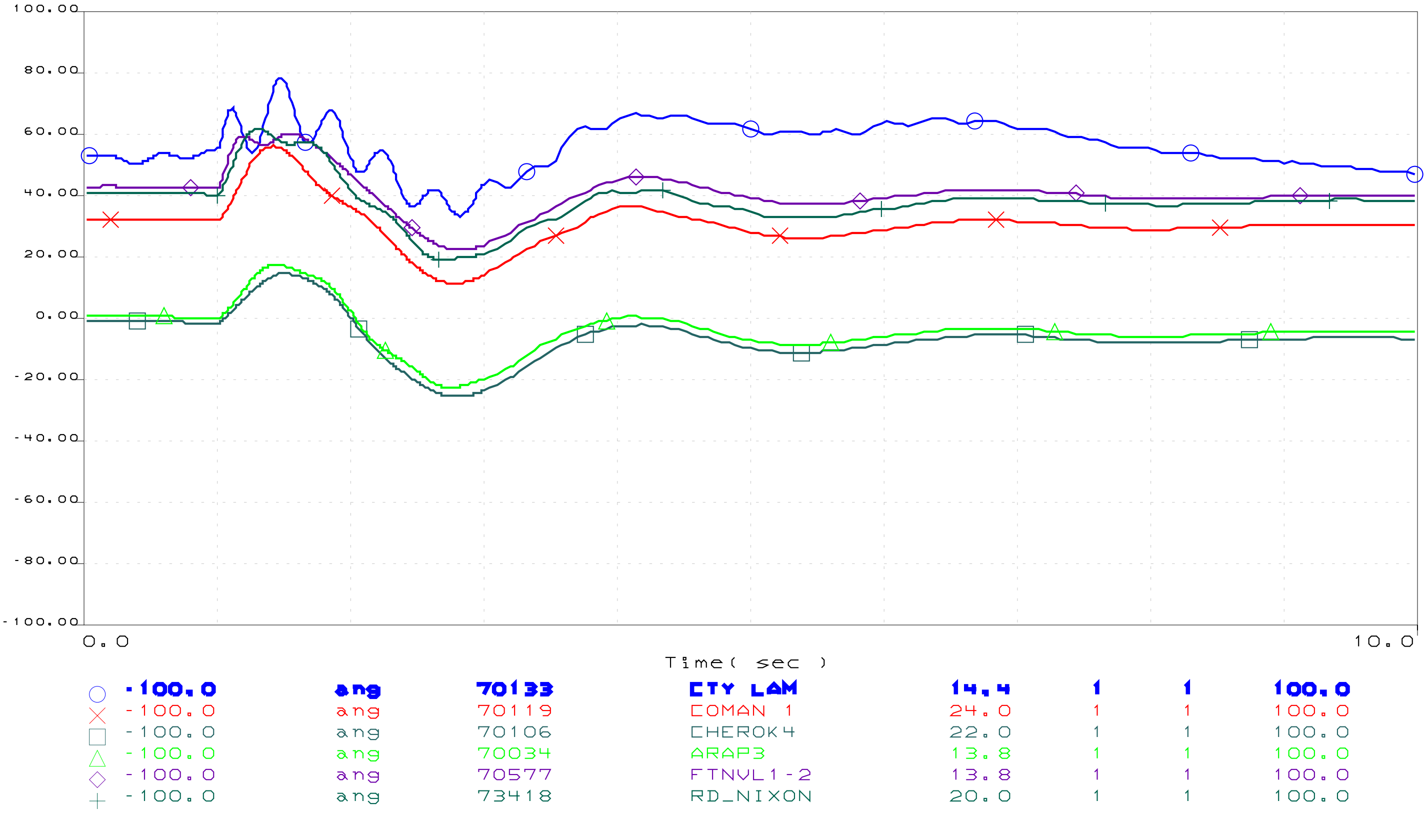
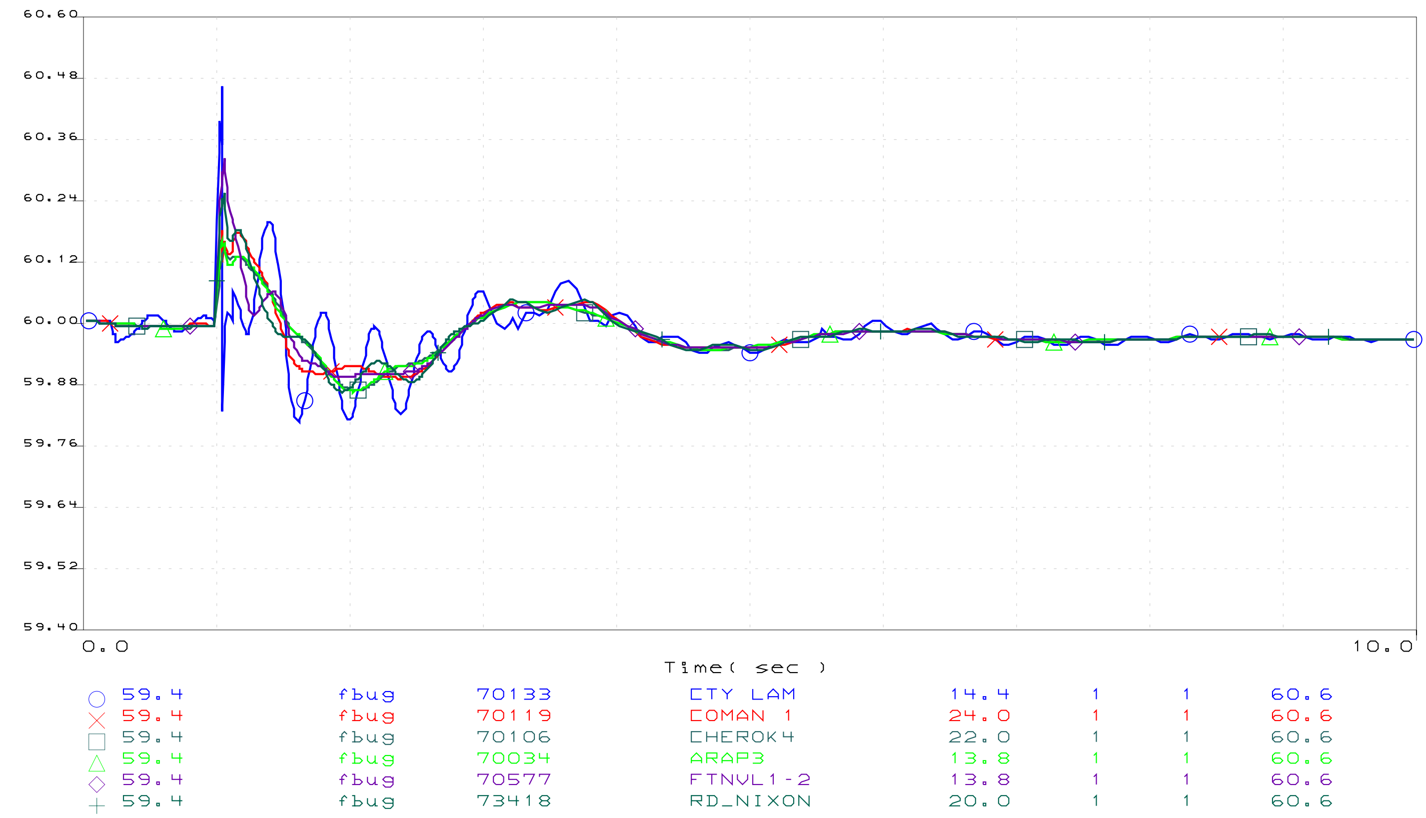
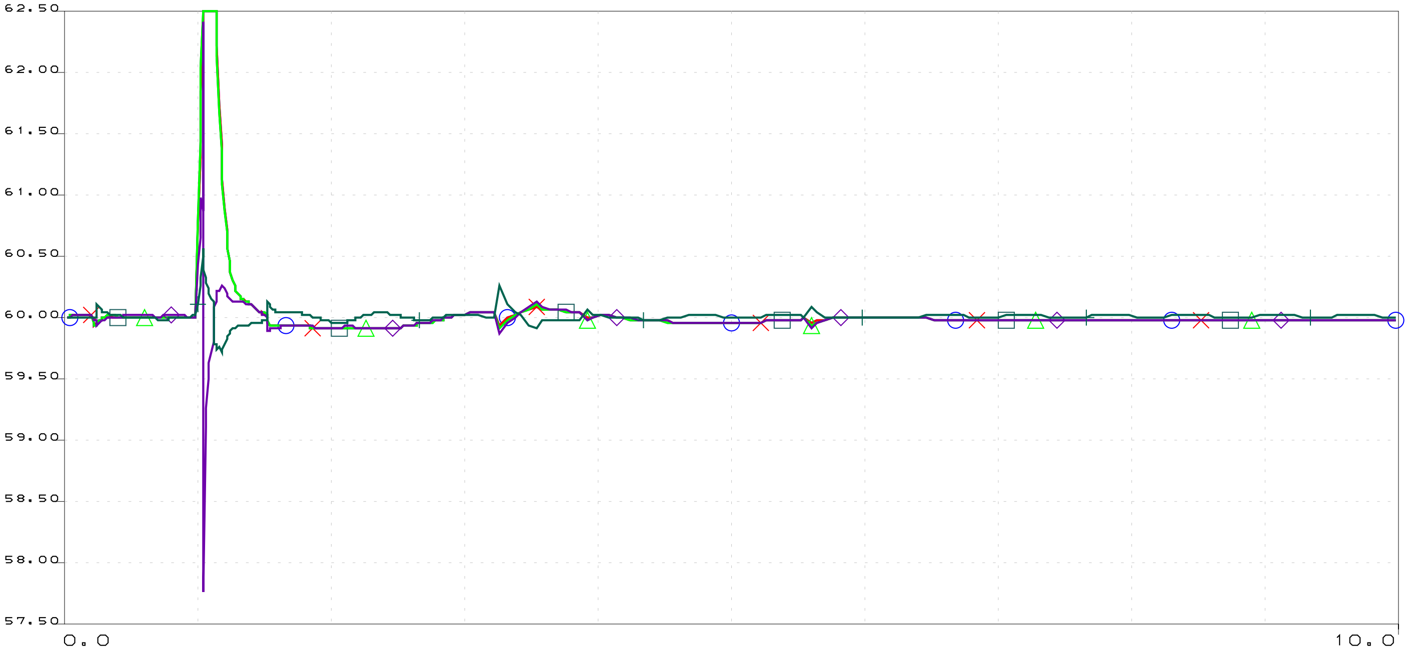


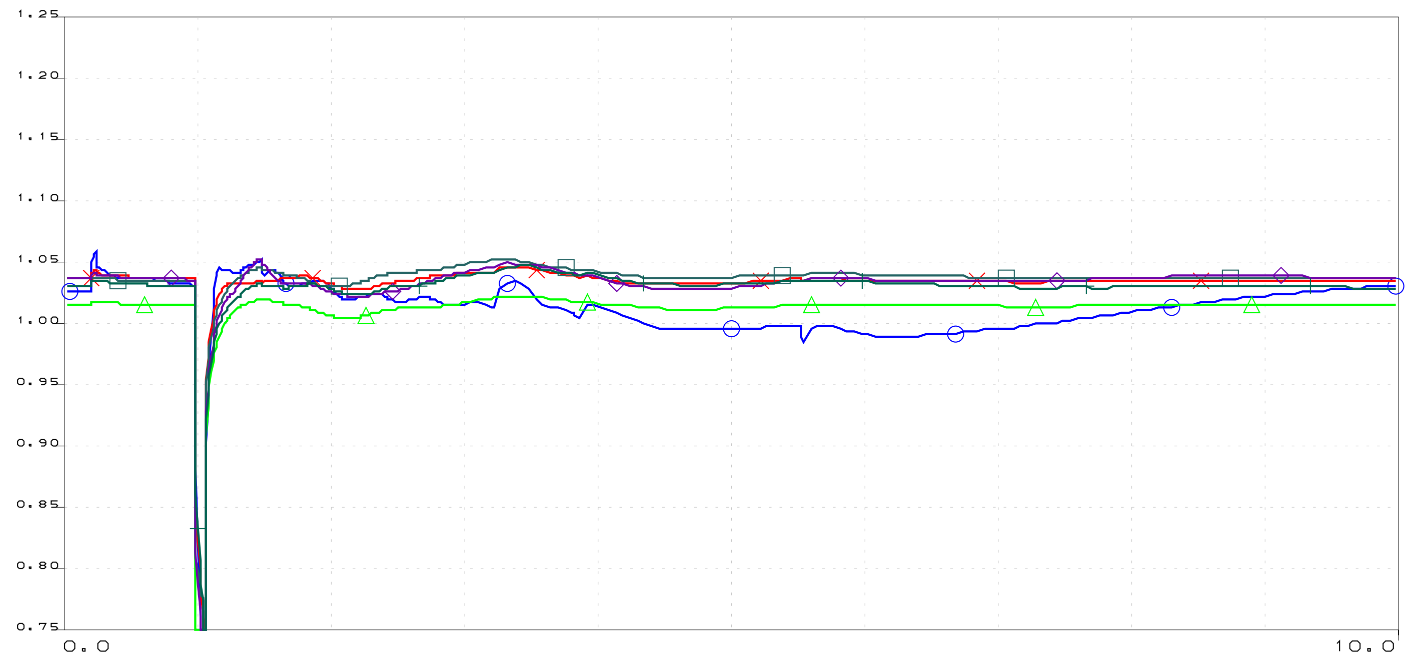


Case1S16.chf

Wed Nov 24 11:52:28 2004

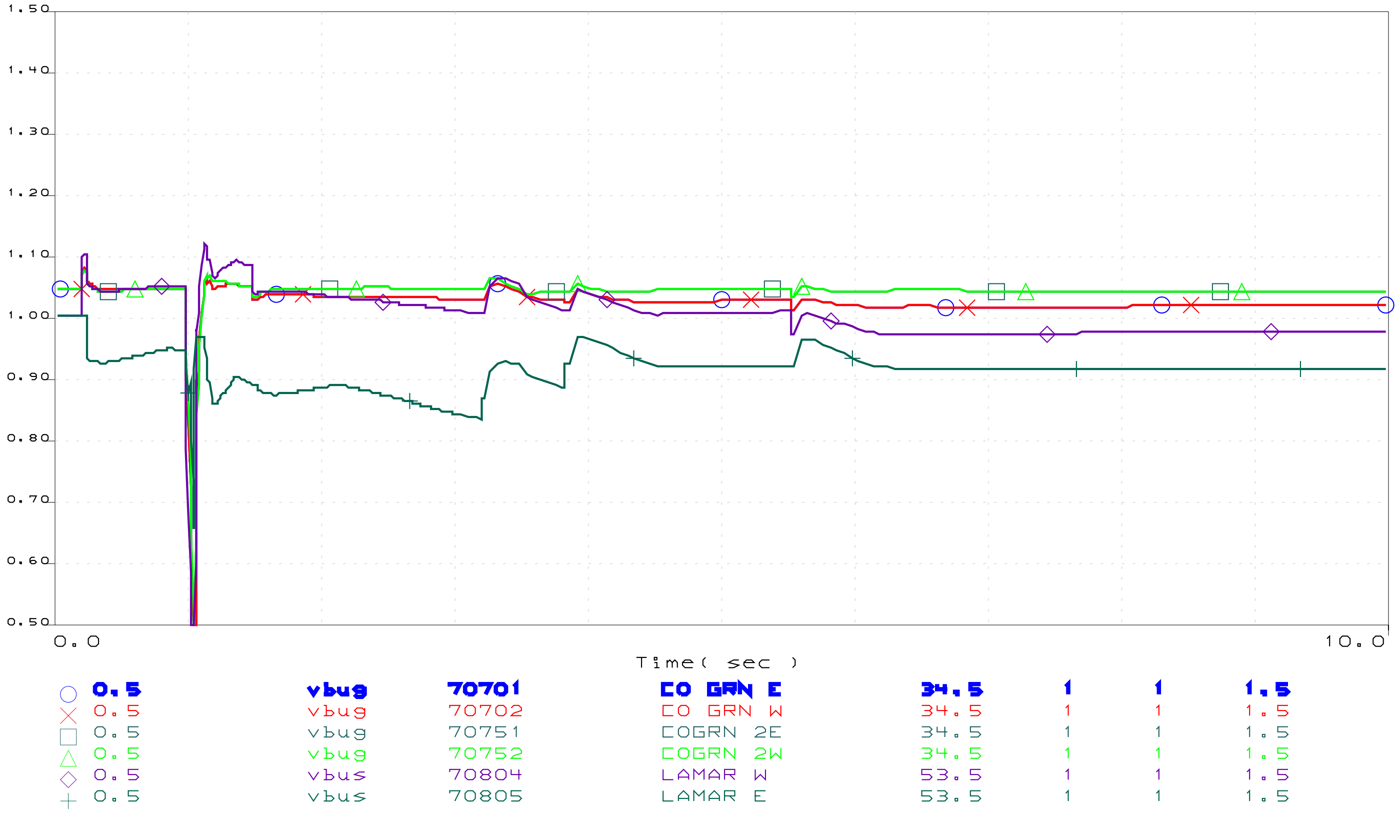


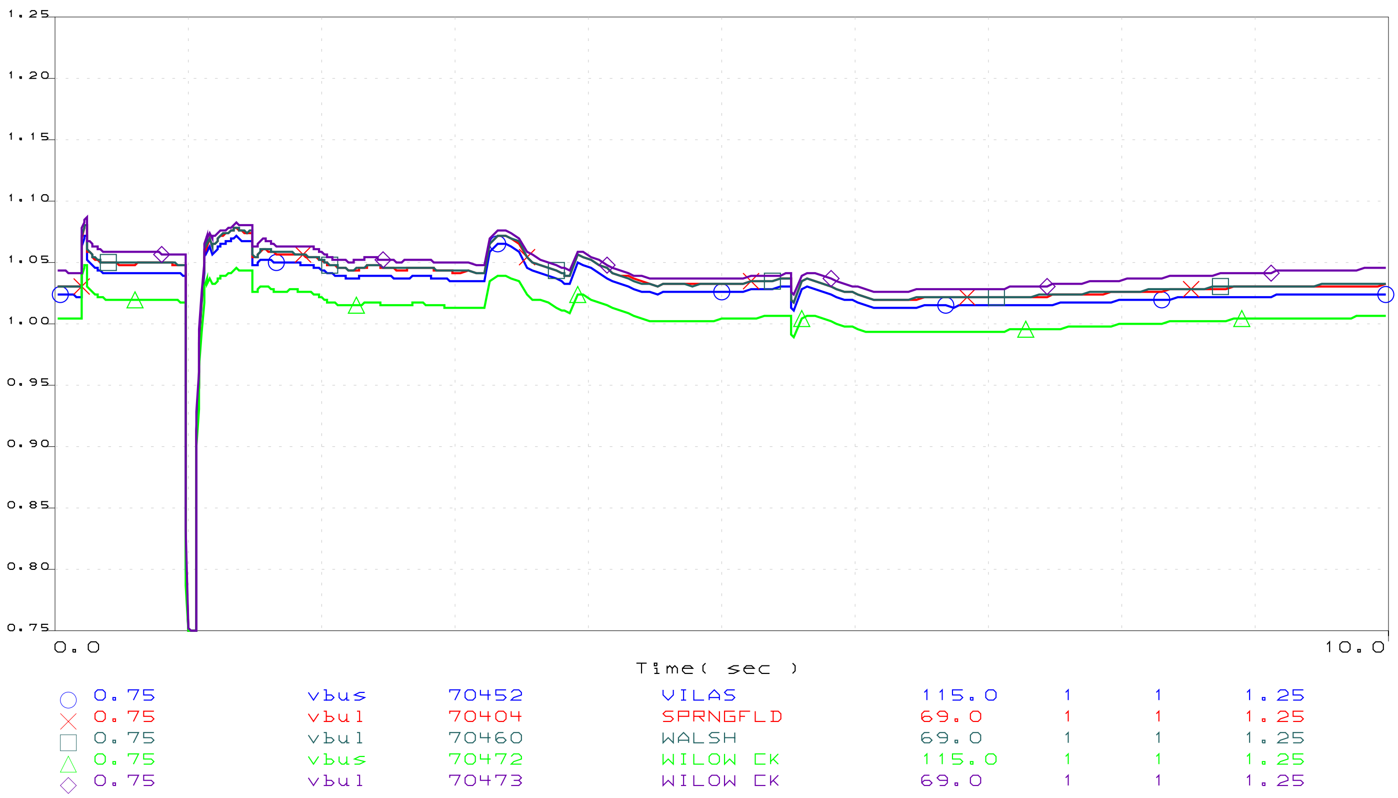
57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
0.75	vbug	70034	ARAP3	13.8	1	1	1.25
0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25

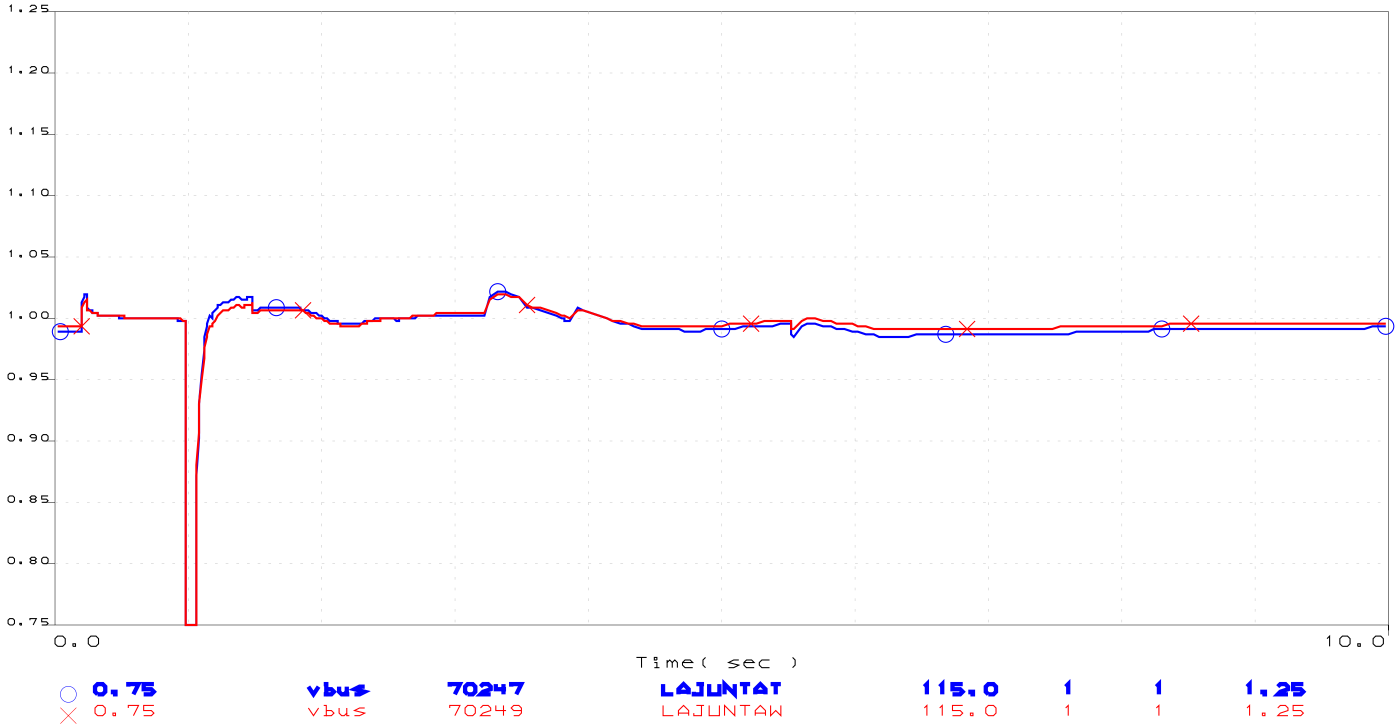
Case1S16.chf Wed Nov 24 11:52:28 2004

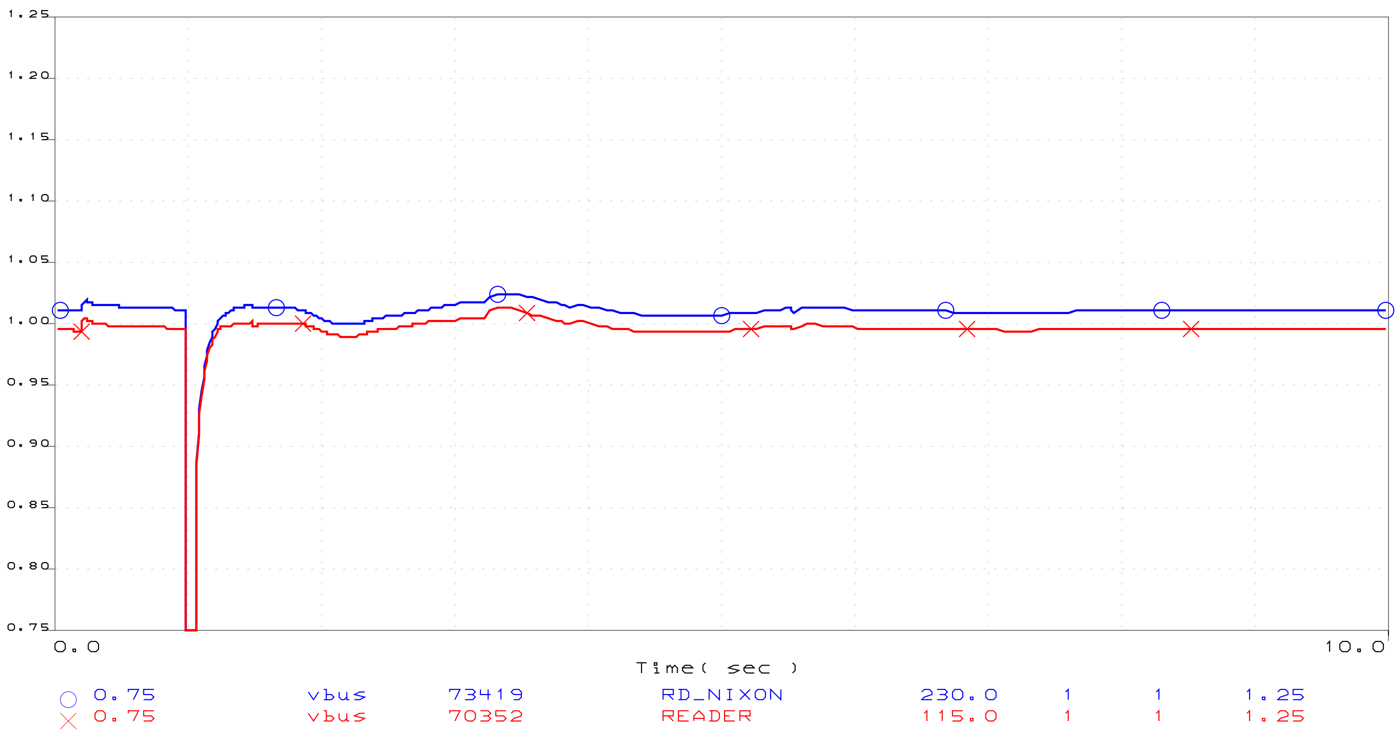




Case1S16.chf

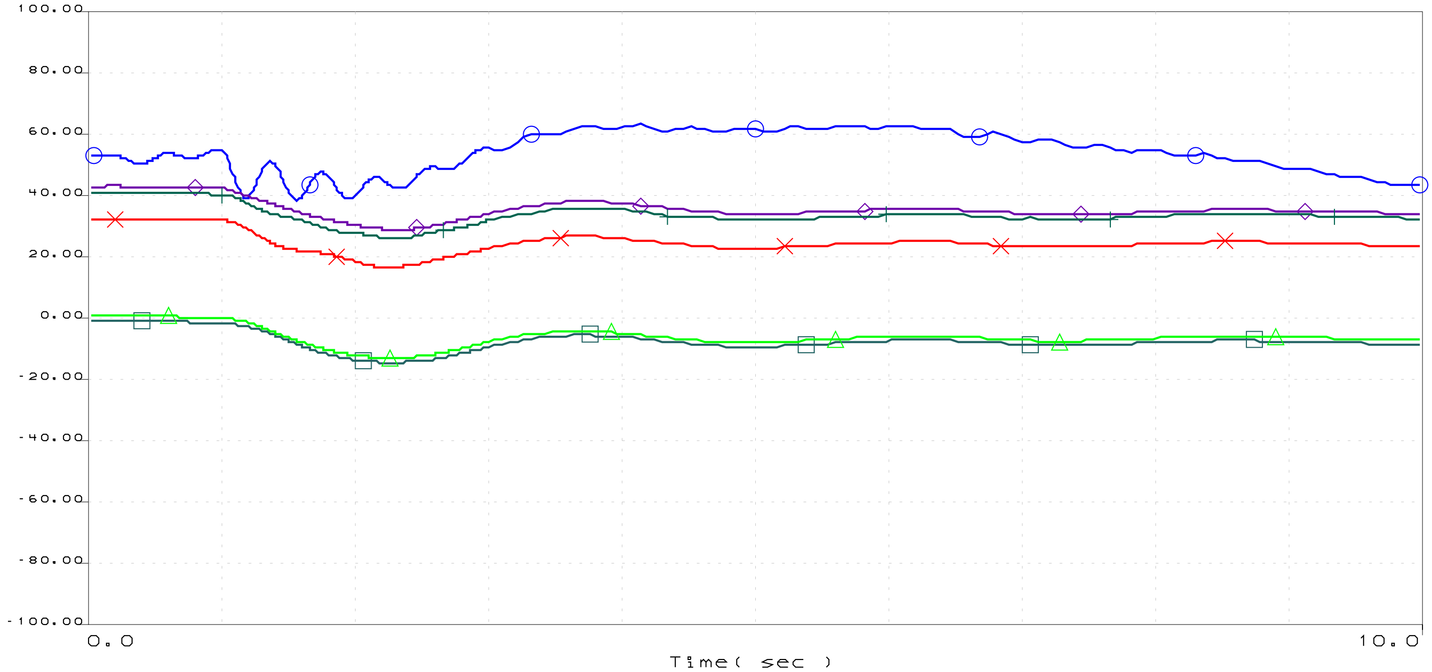
Wed Nov 24 11:52:28 2004



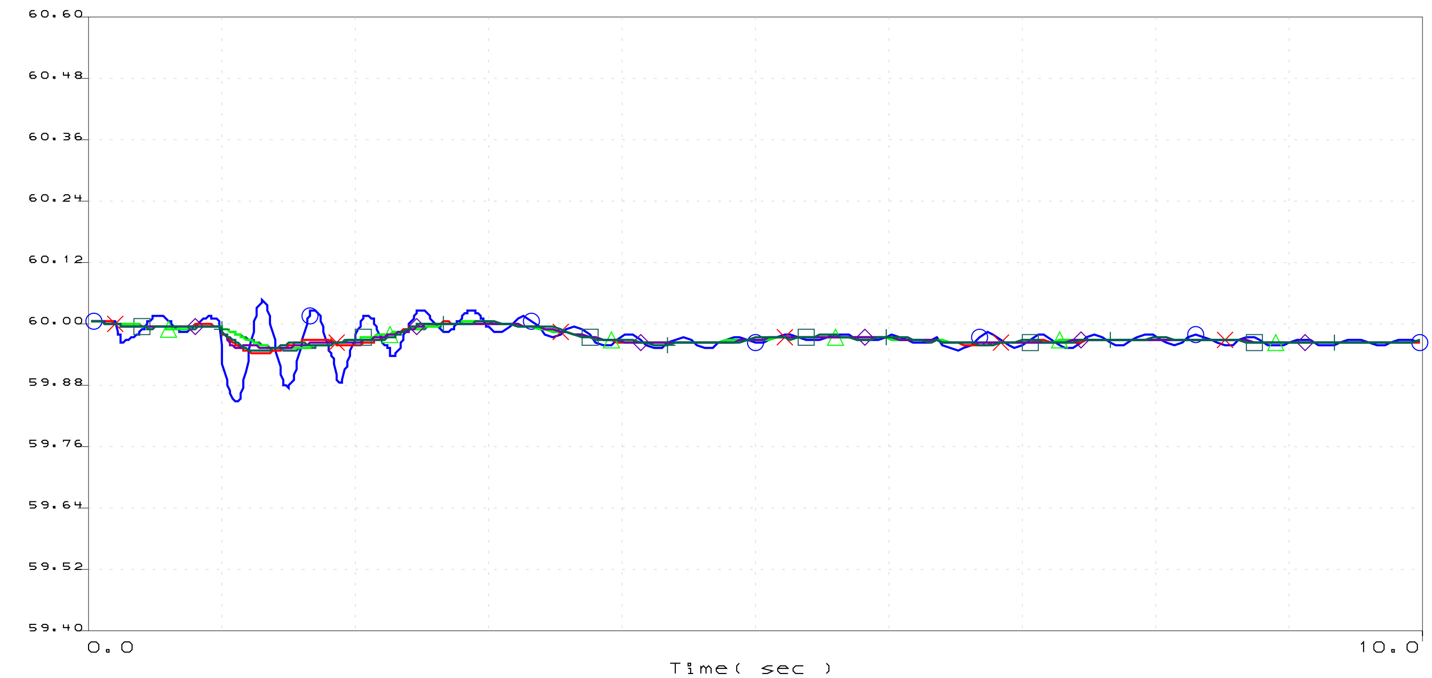


Case1S16.chf

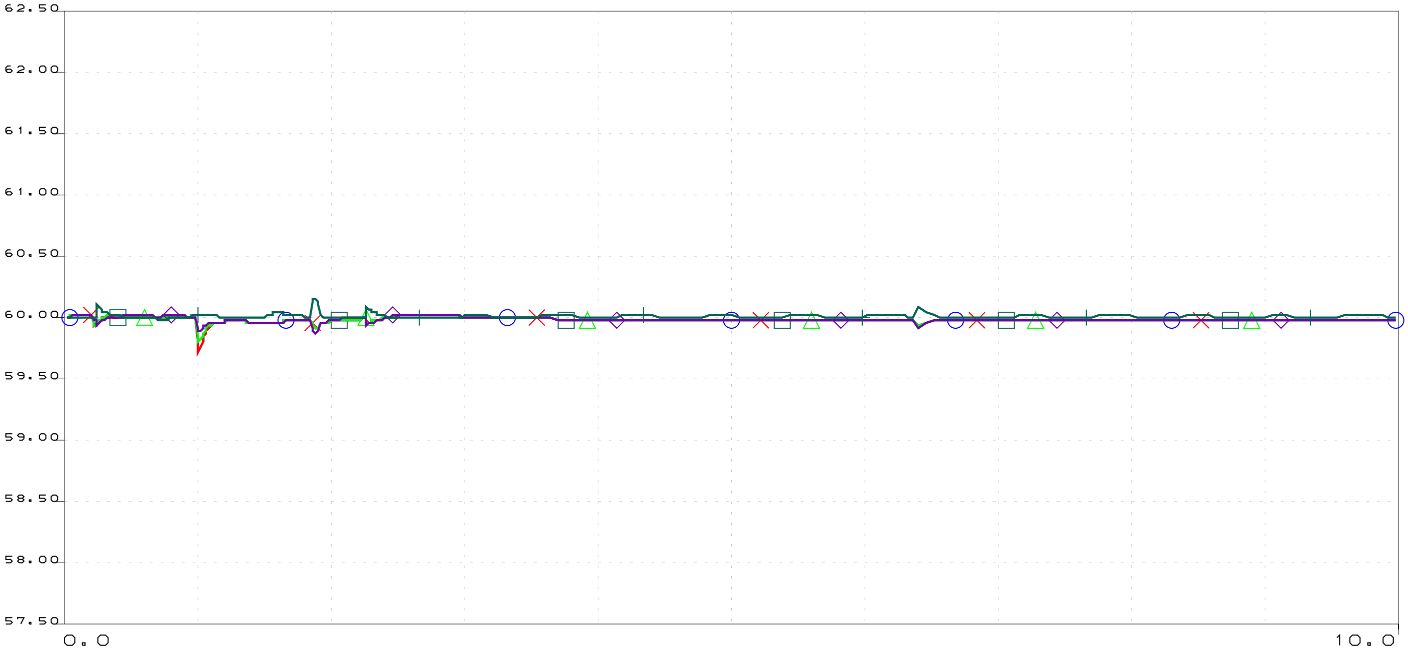
Wed Nov 24 11:52:28 2004



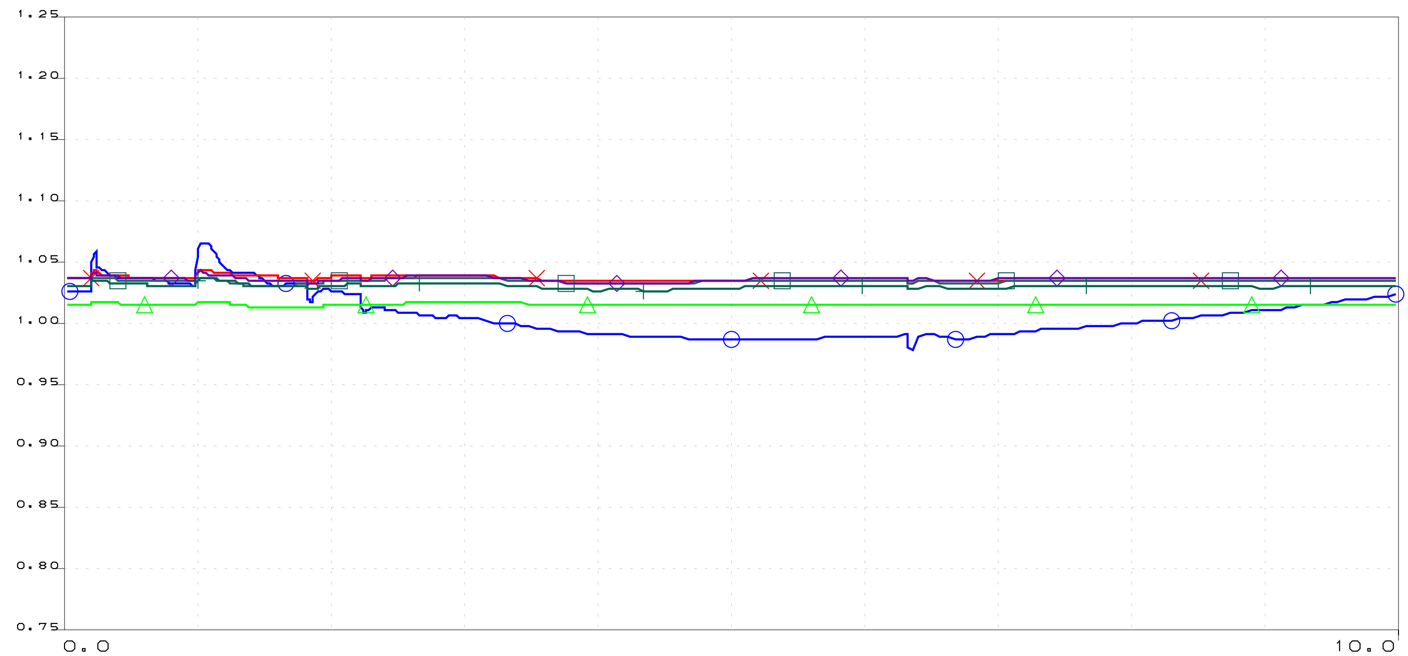
○ -100.0	ang	70133	CTY LAM	14.4	1	1	100.0
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



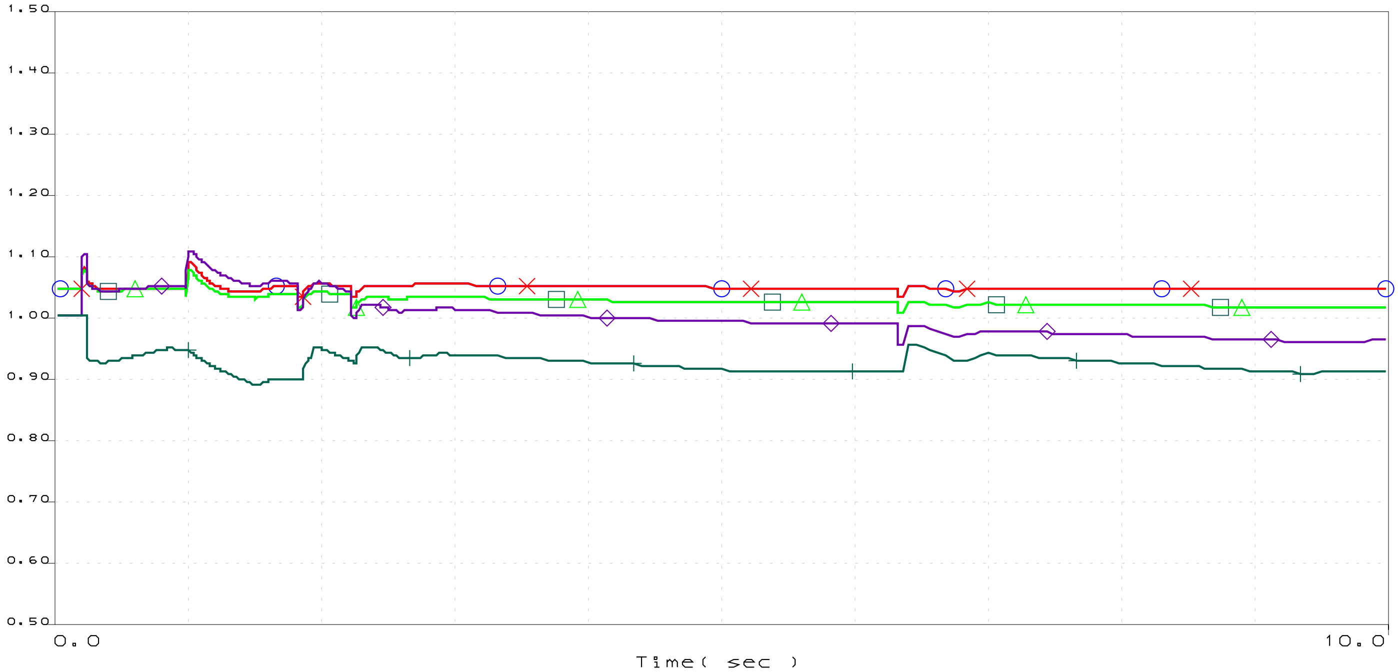
○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



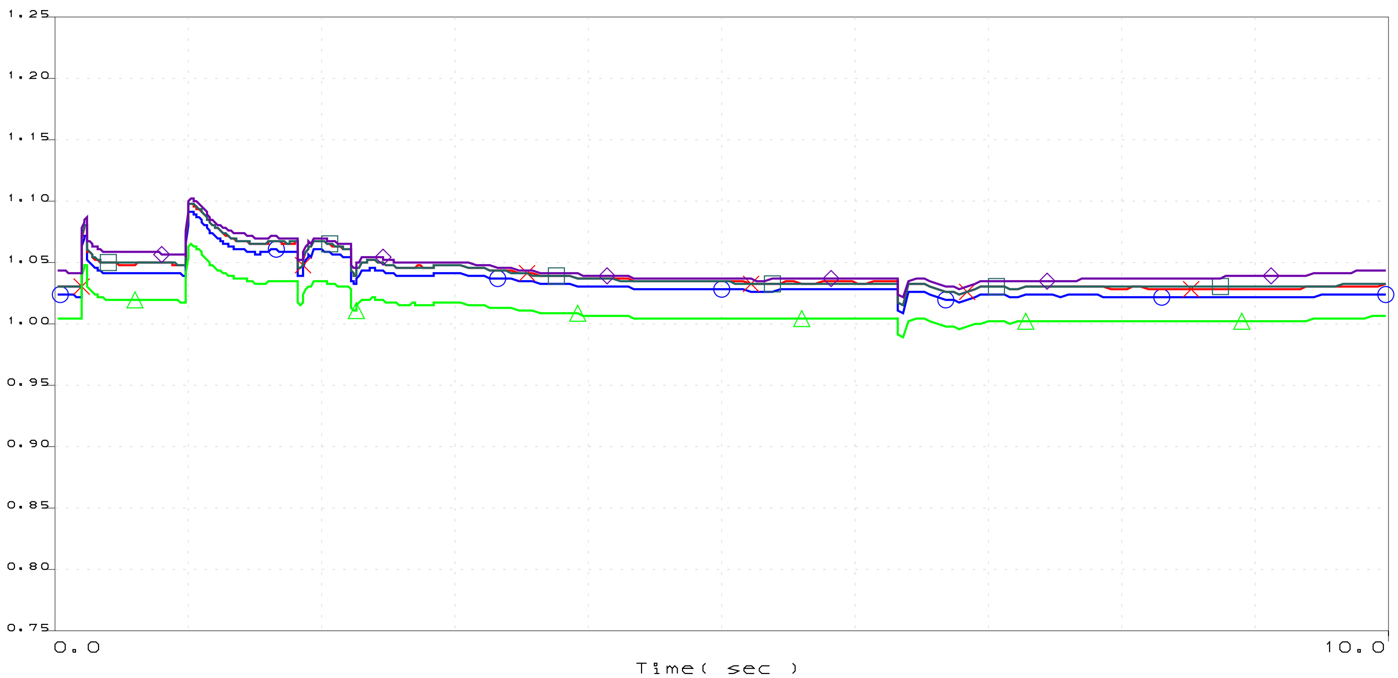
○ **57.5**	**fbus**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



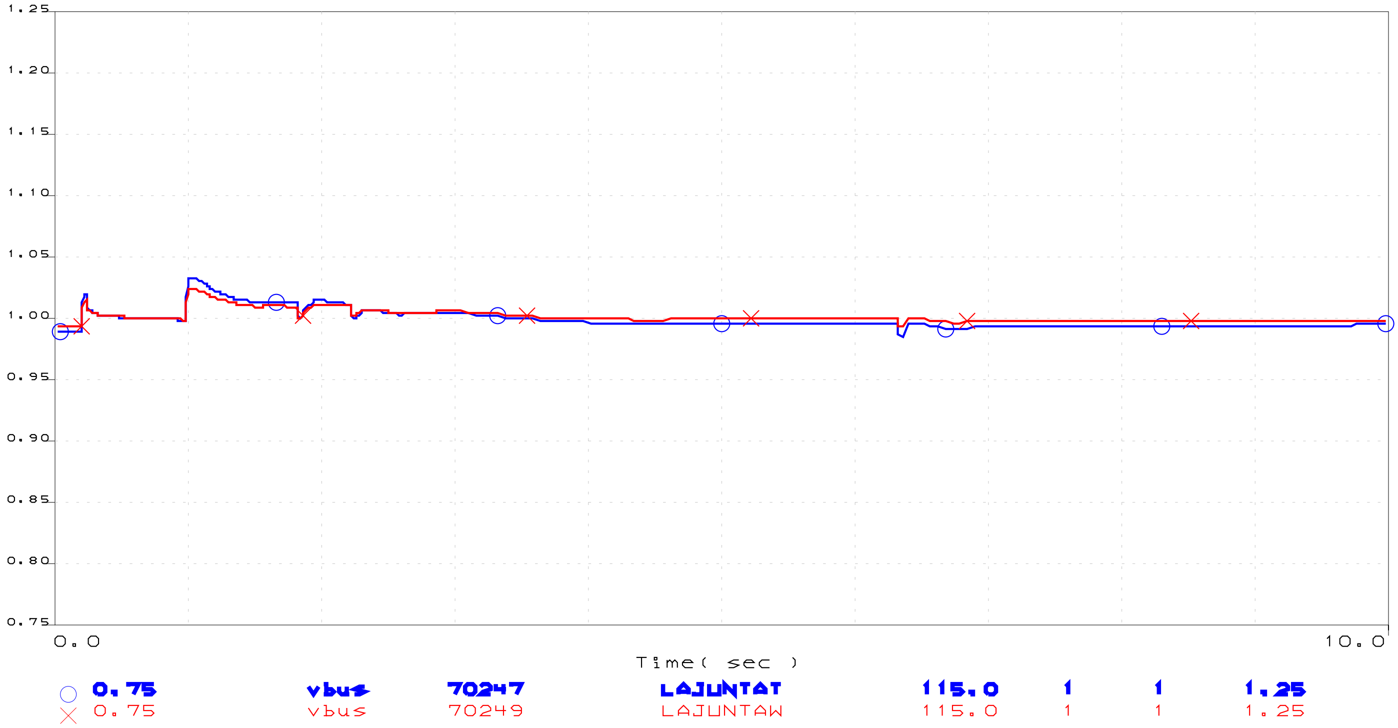
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

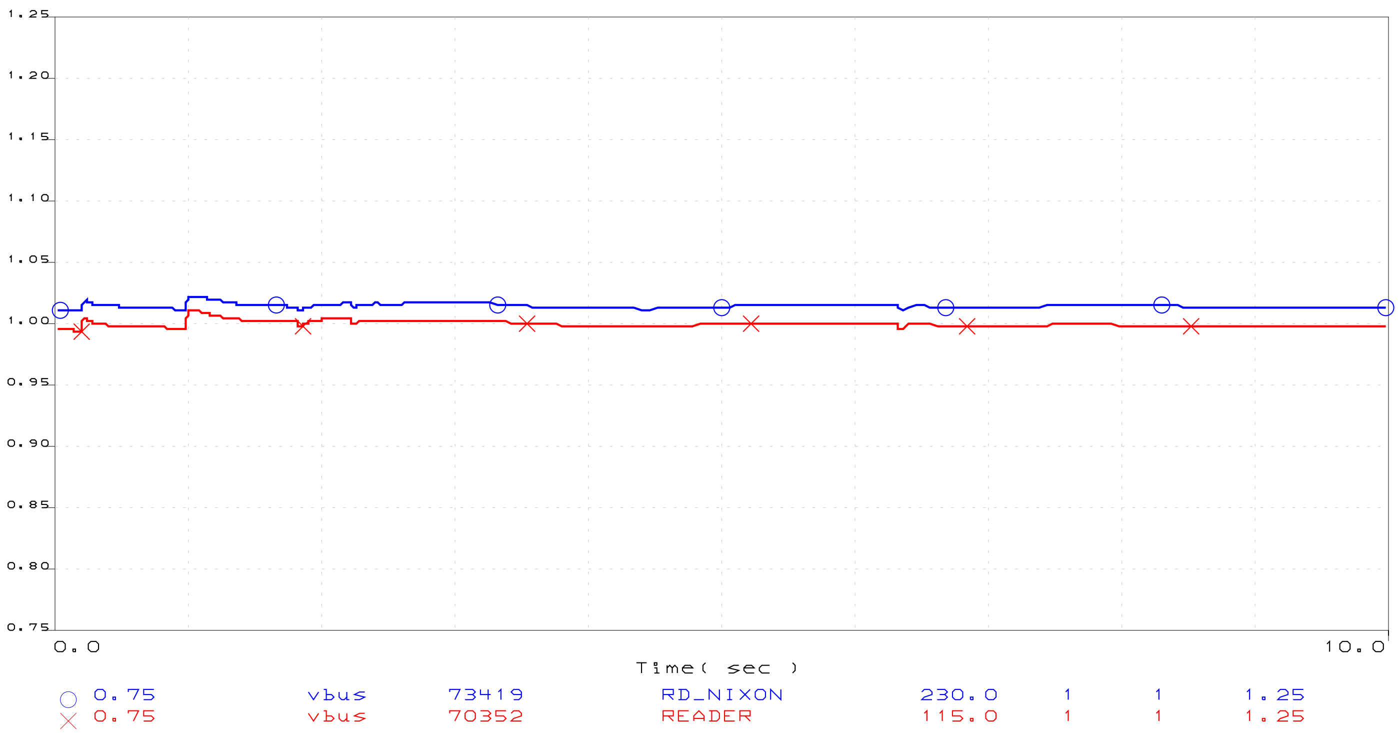


0.5	vbug	70701	CO GRN E	34.5	1	1	1.5
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25





Case1S17.chf

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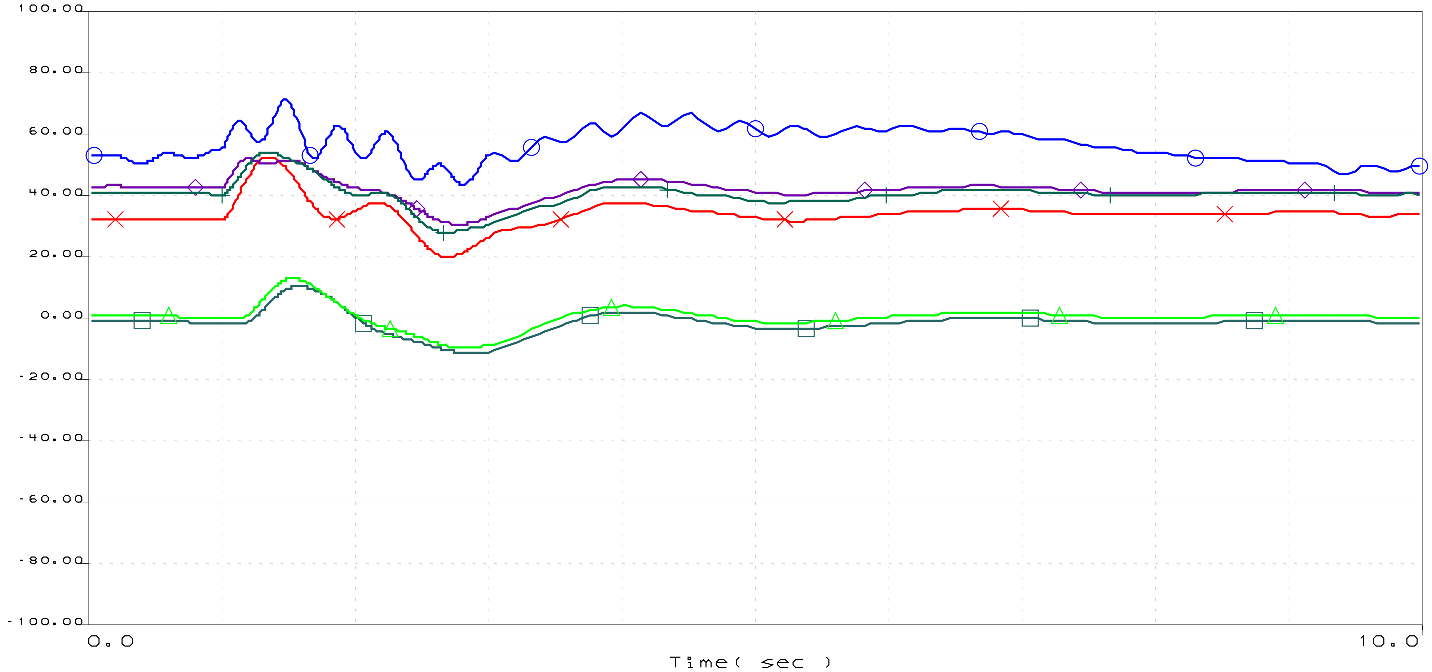
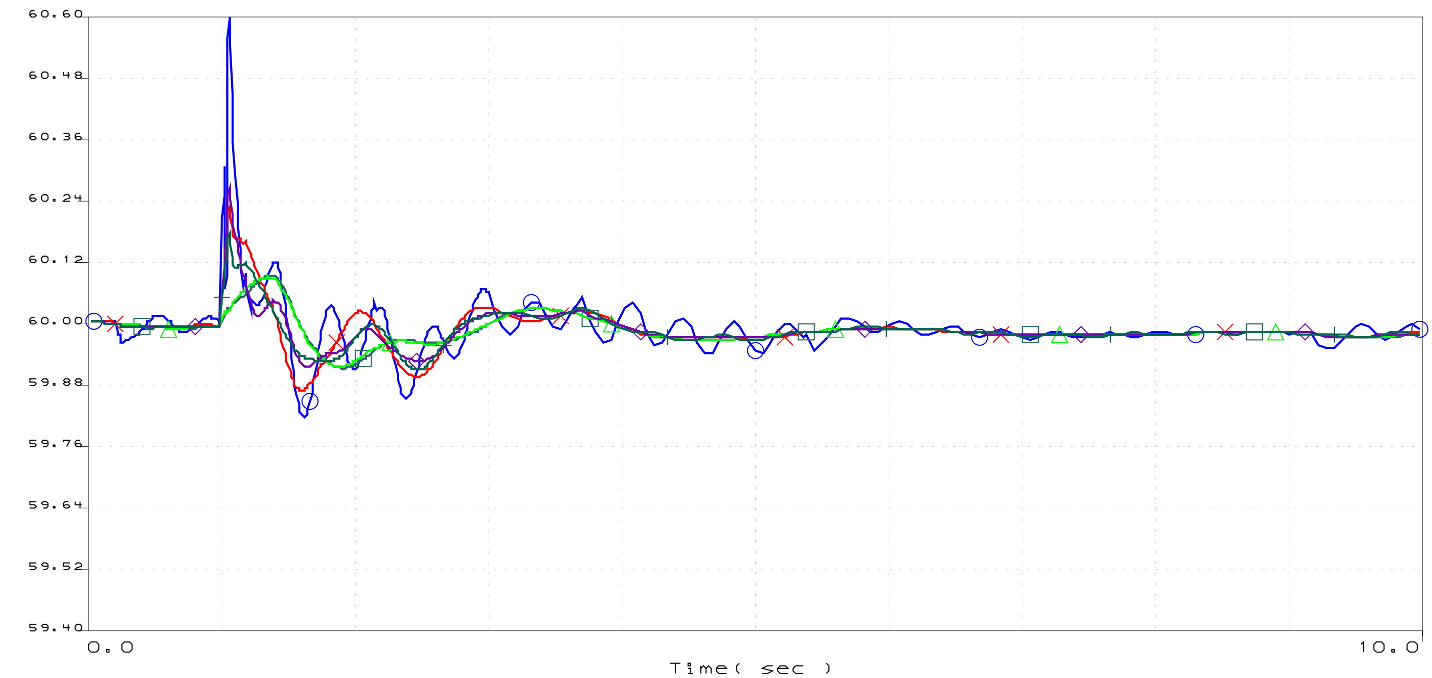
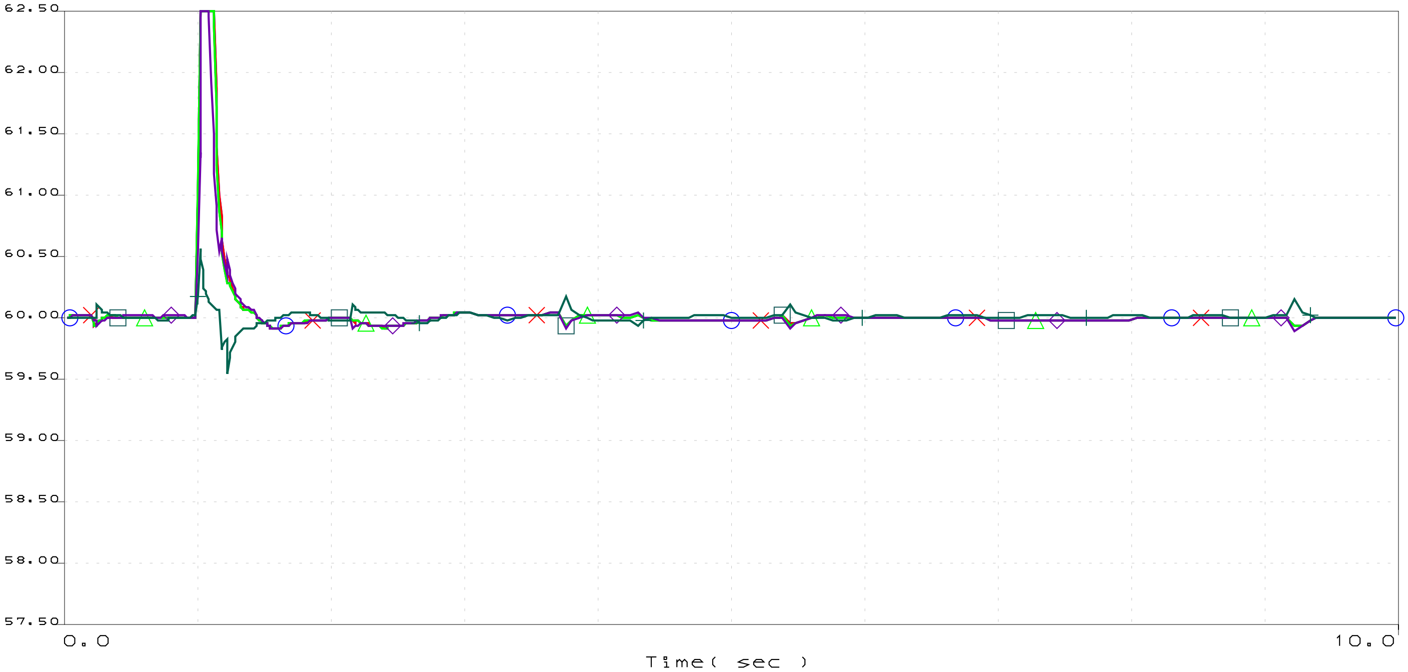


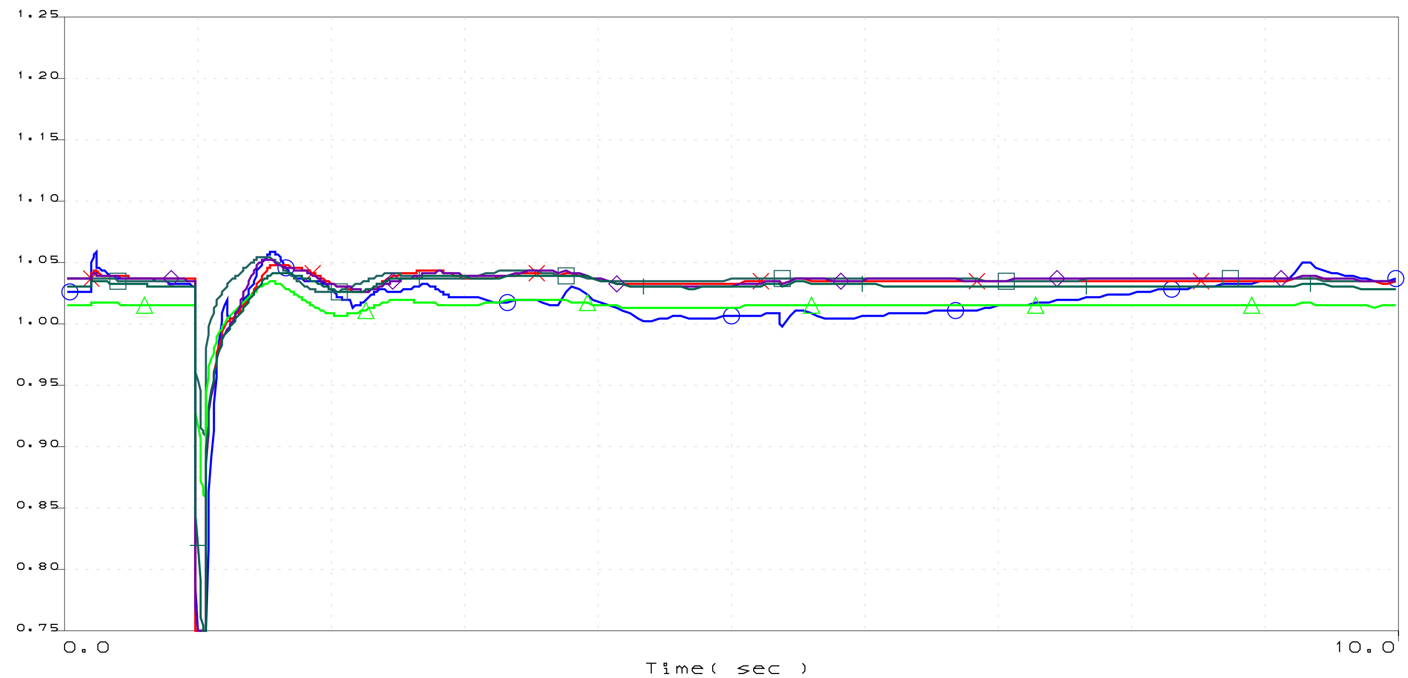
○ -100.0	ang	70133	CTY LAM	14.4	1	1	100.0
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



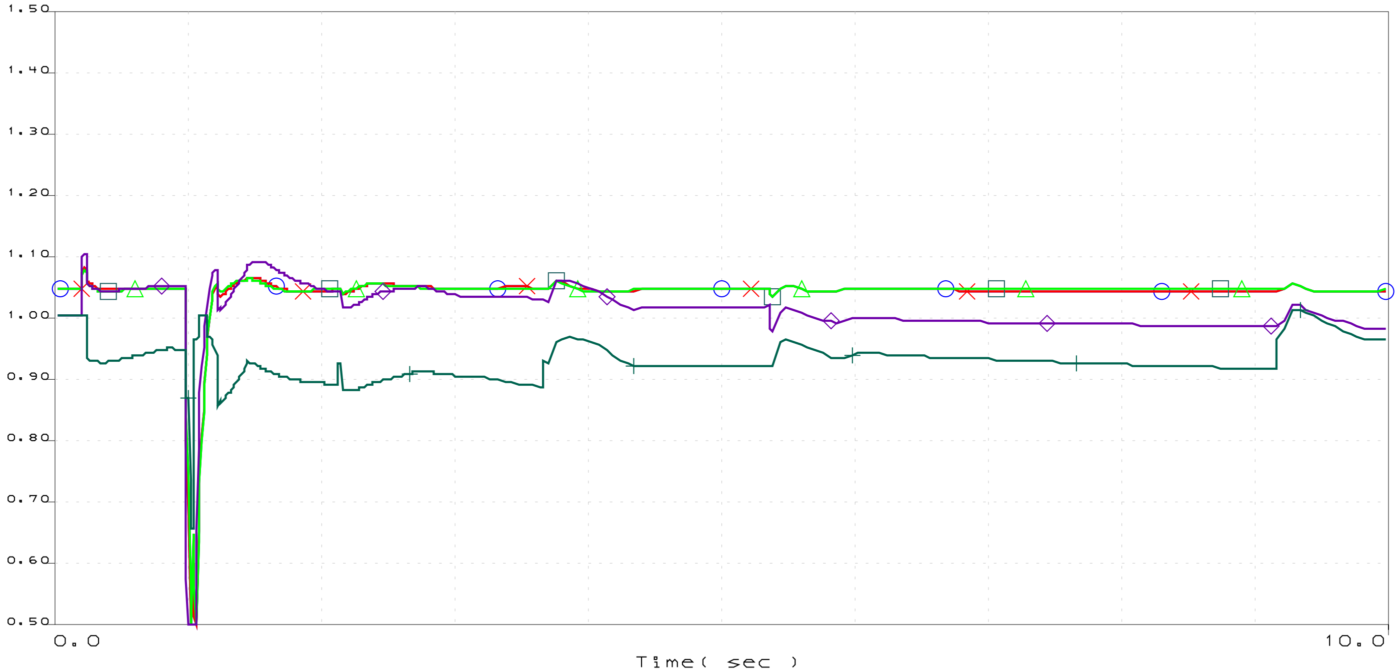
○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



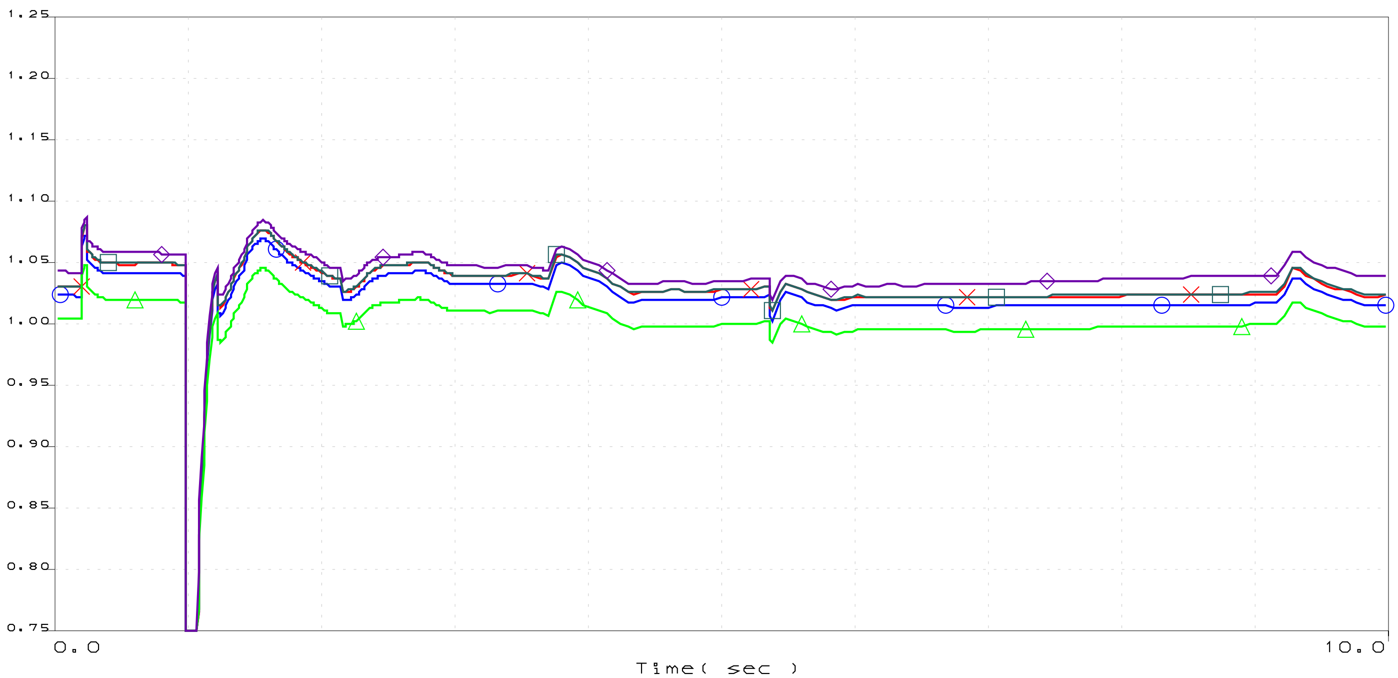
○ **57.5**	**fbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
× 57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○ 0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case1S18.chf

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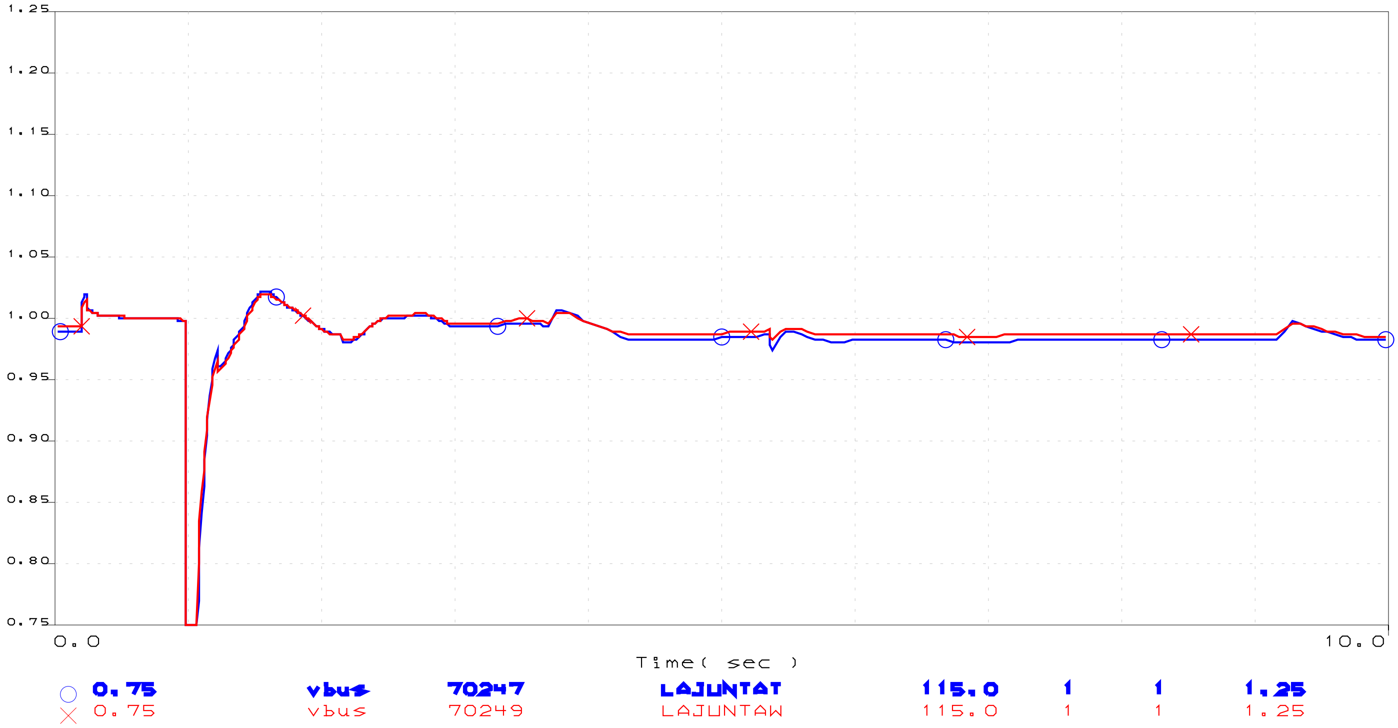
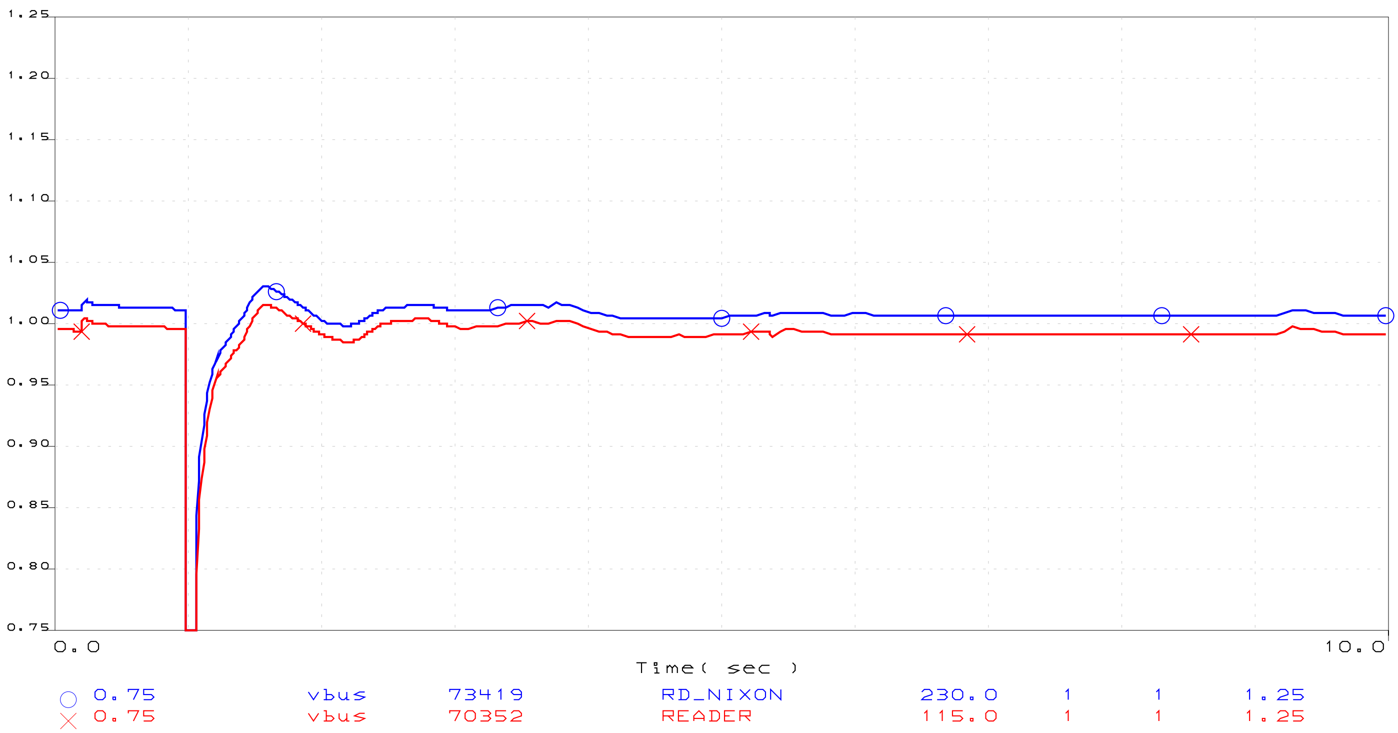
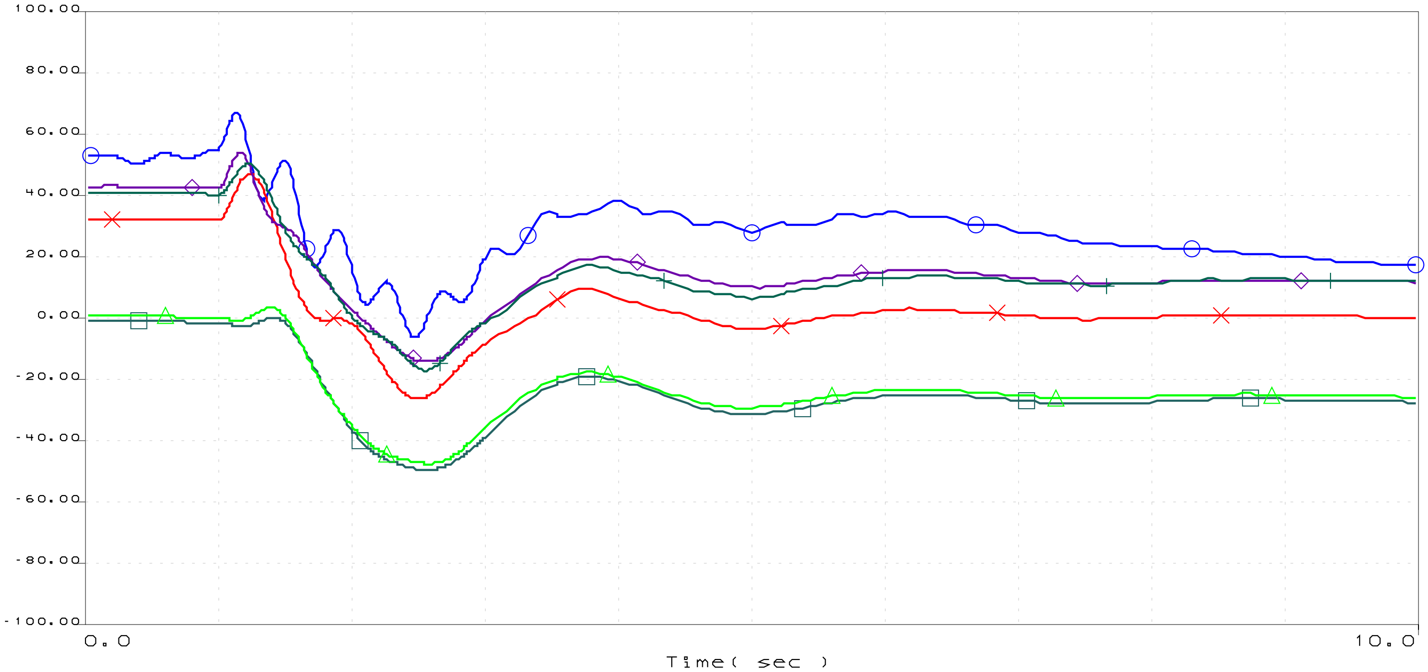


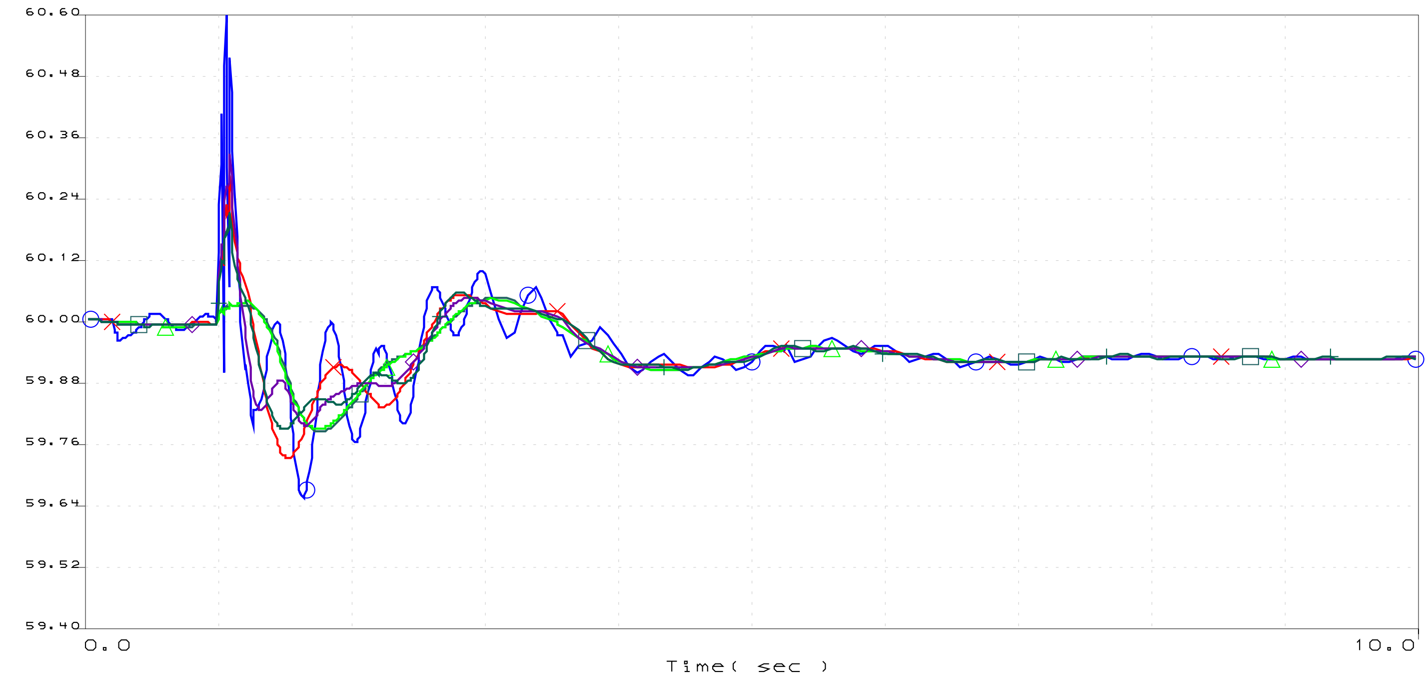


Case1S18.chf

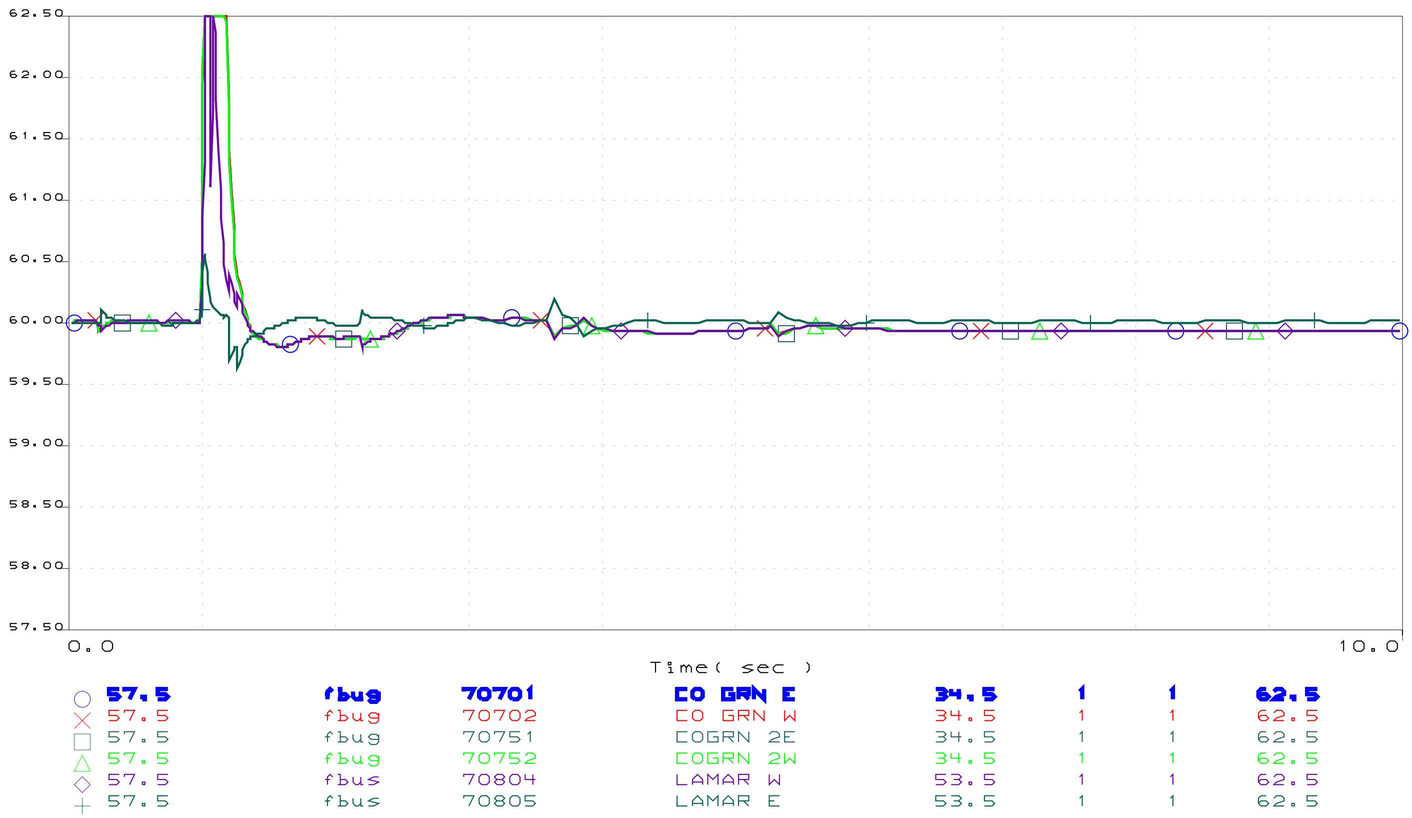
Wed Nov 24 11:52:55 2004

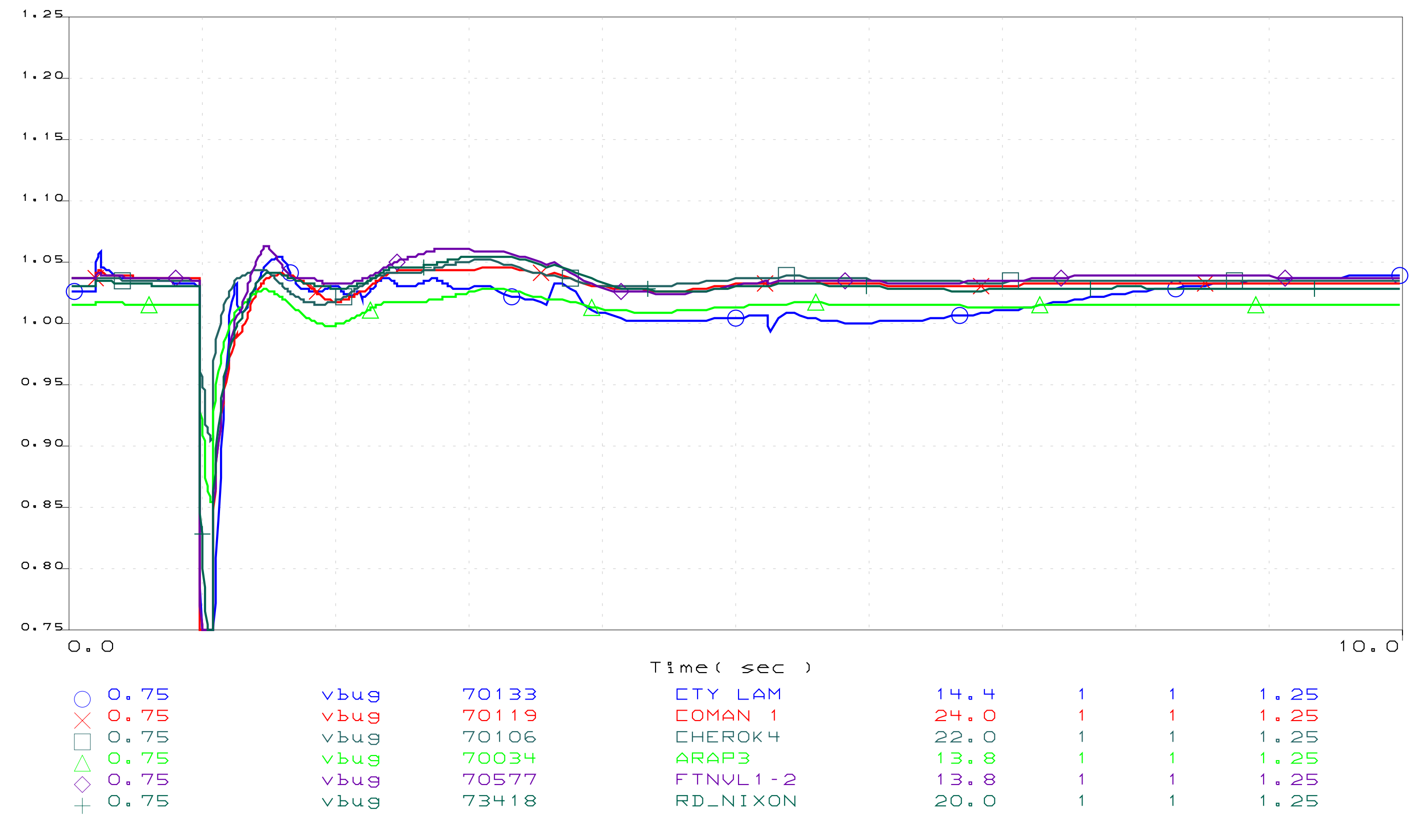


○ **-100.0**	**ang**	**70133**	**CTY LAM**	**14.4**	**1**	**1**	**100.0**
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6





Case1S19.chf

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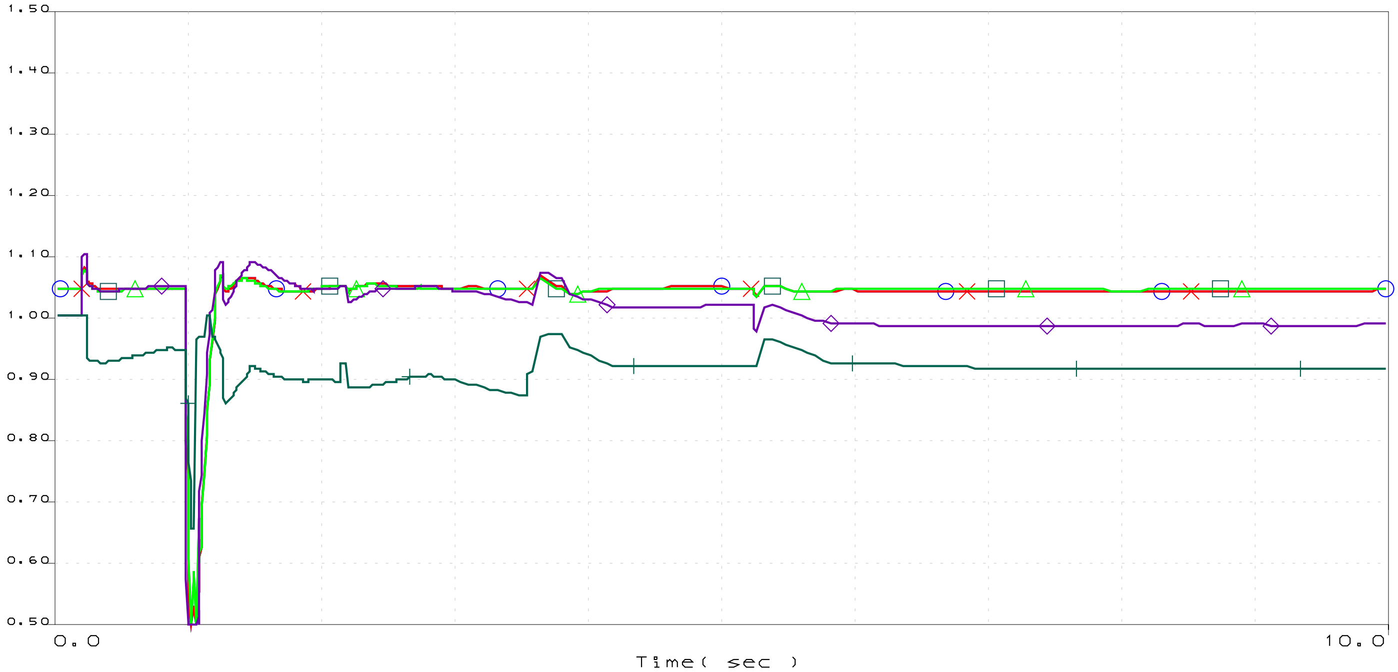
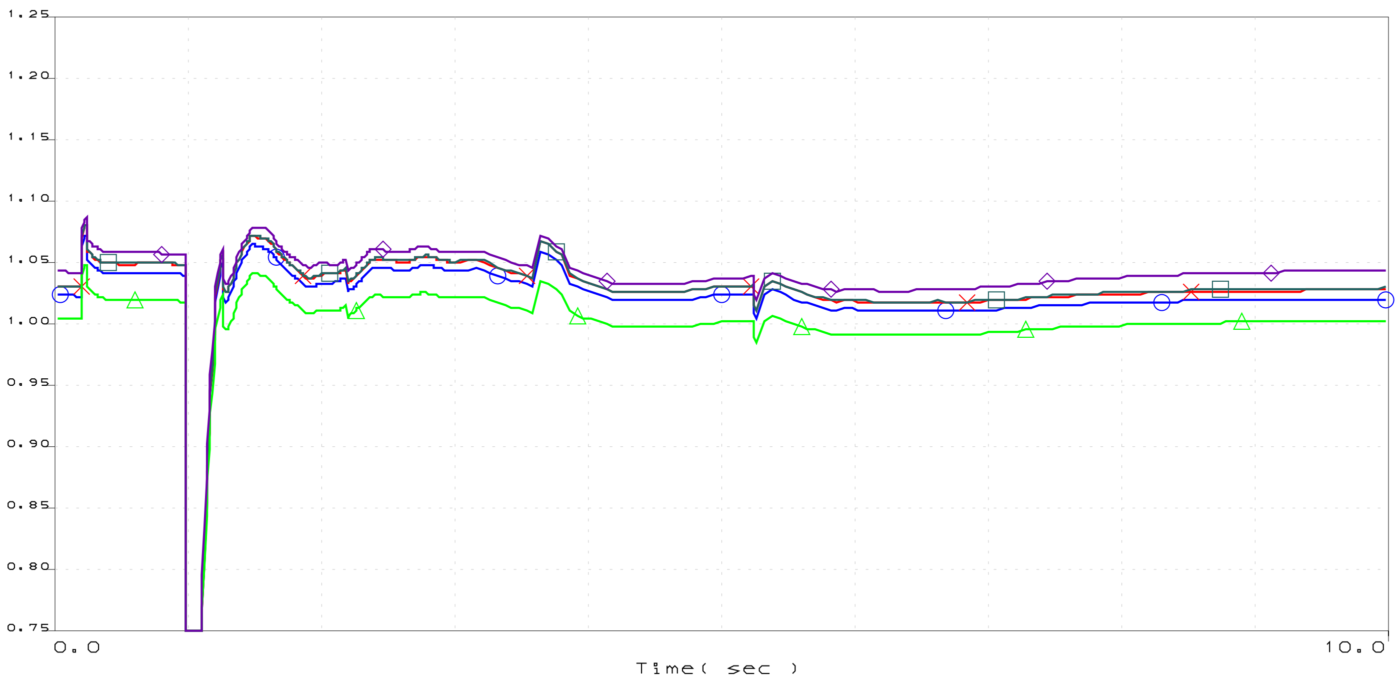


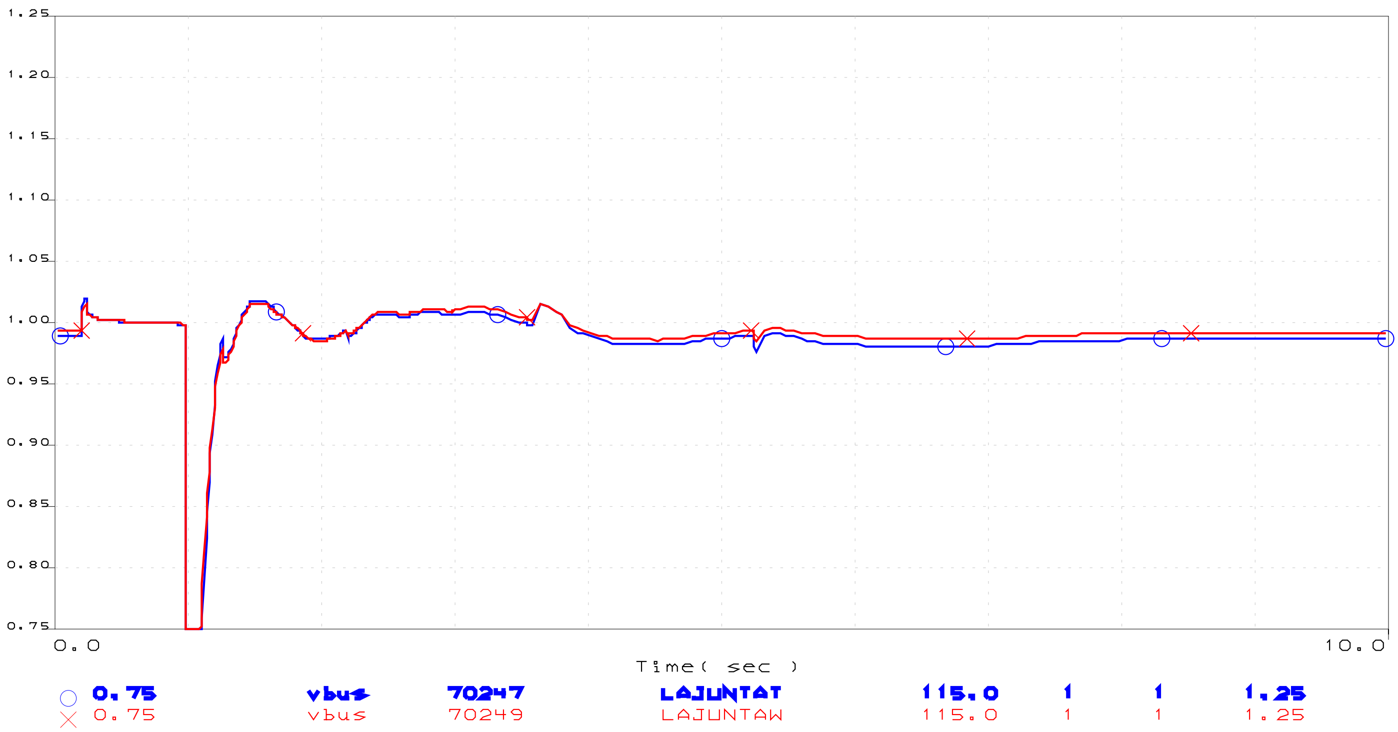
0.5	vbug	70701	CO GRN E	34.5	1	1	1.5
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5

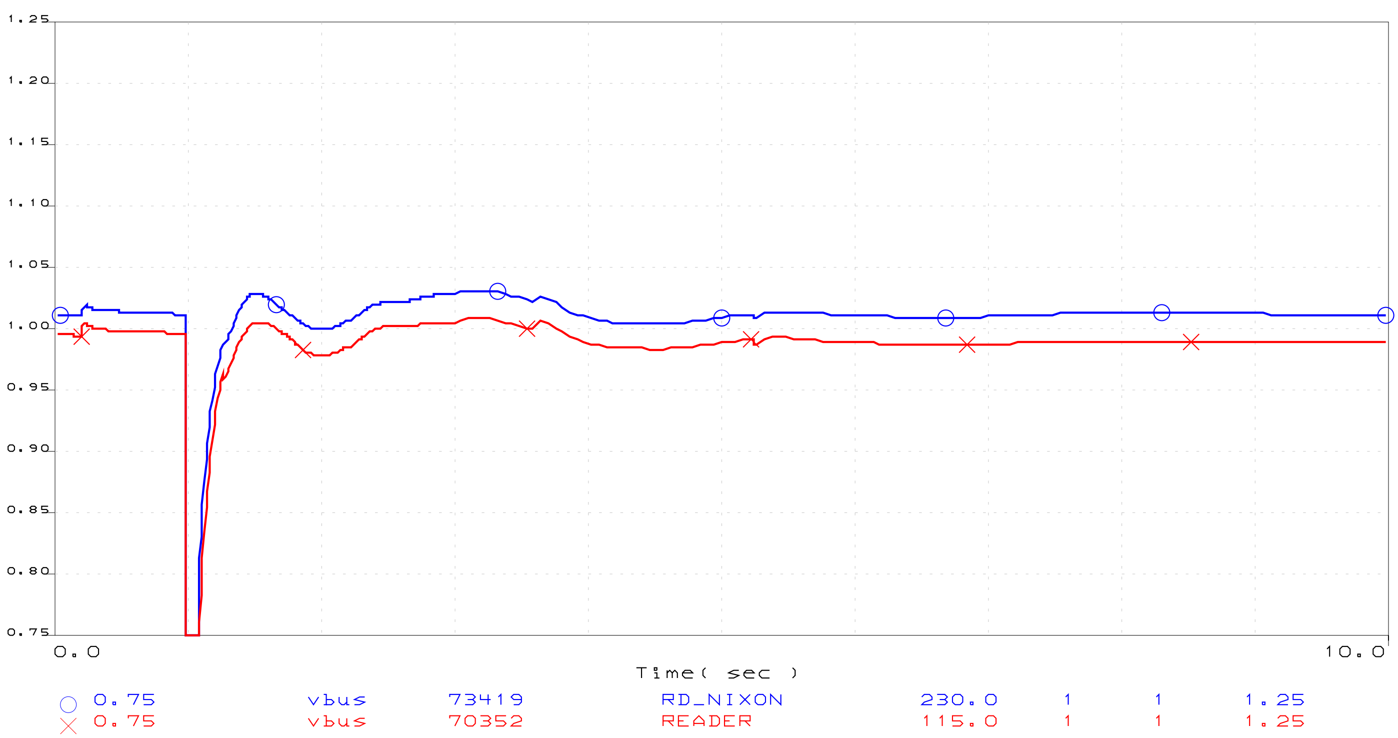


0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case1519.chf

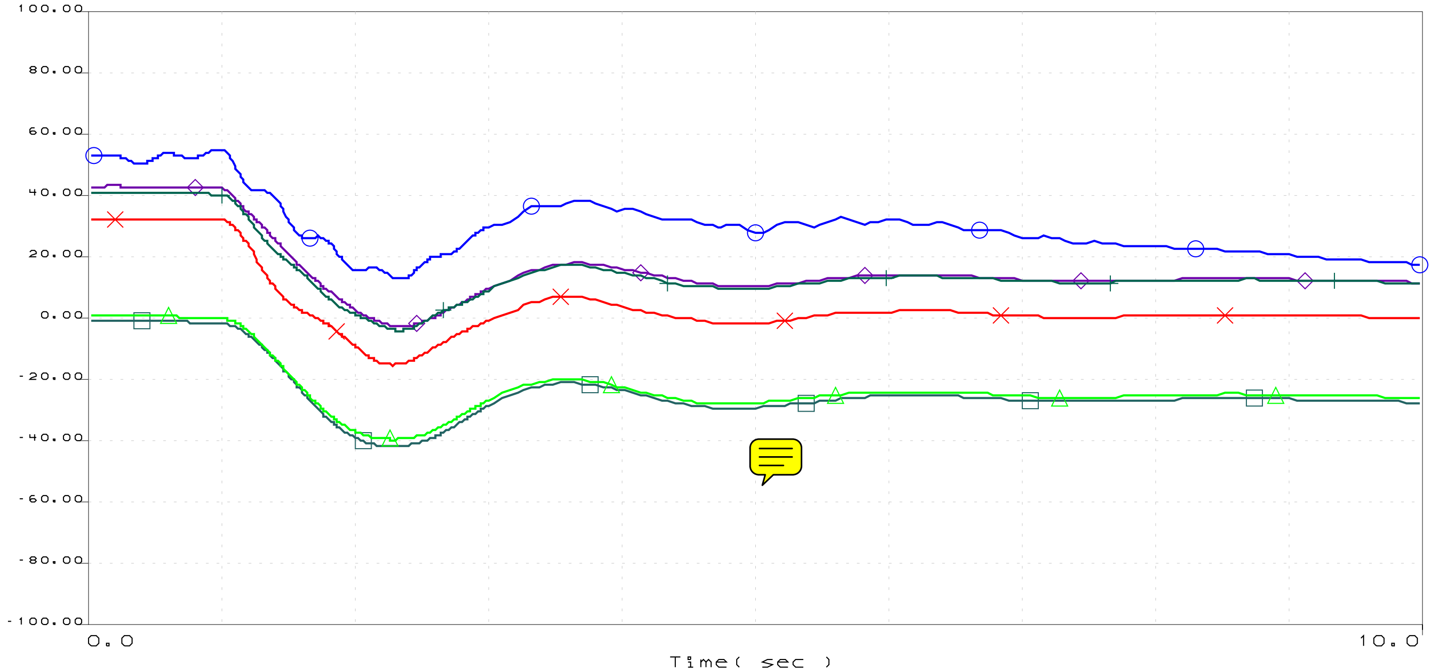
Wed Nov 24 11:53:06 2004



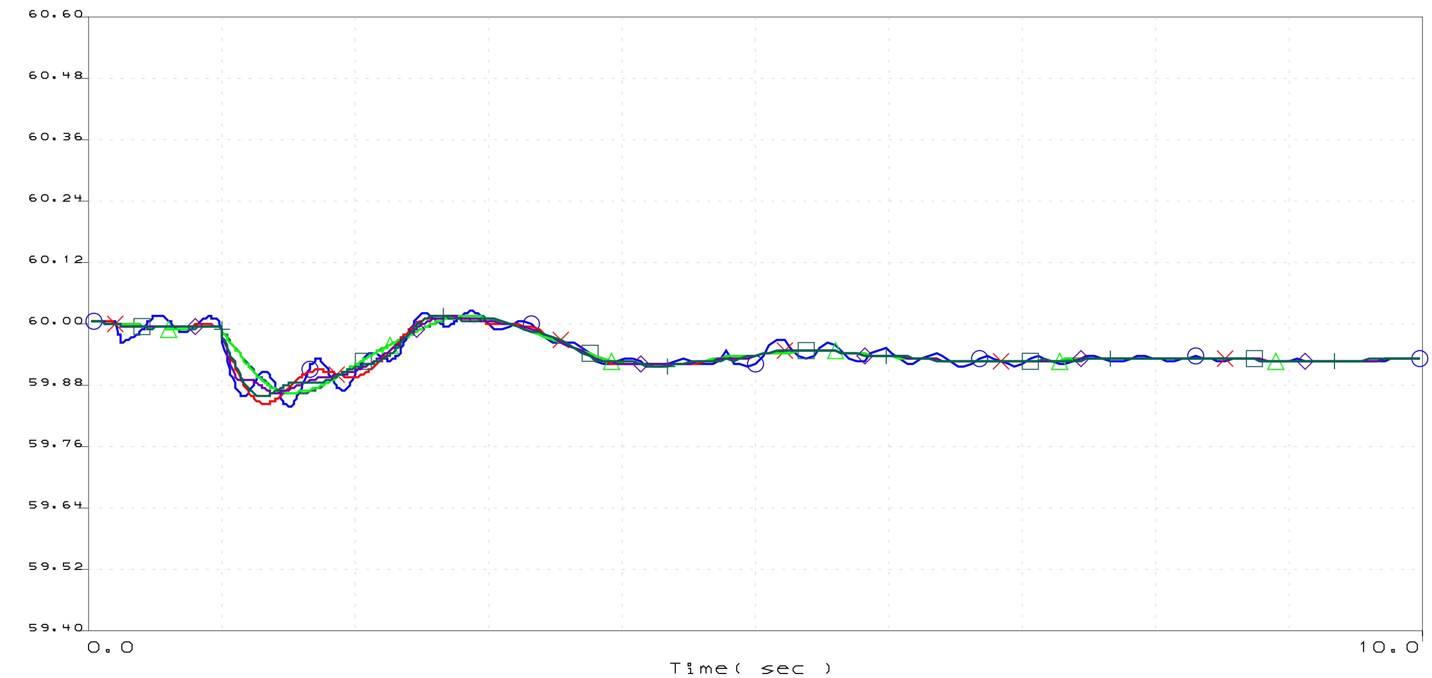


Case1S19.chf

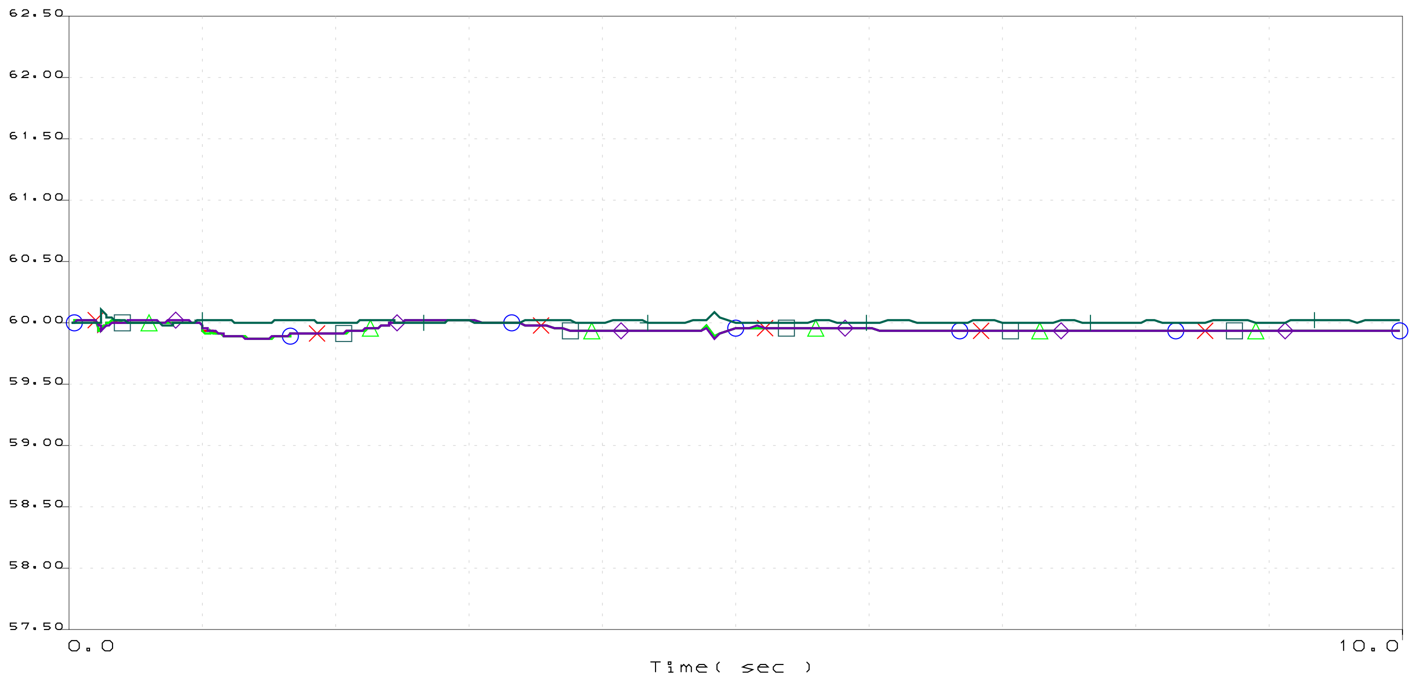
Wed Nov 24 11:53:06 2004



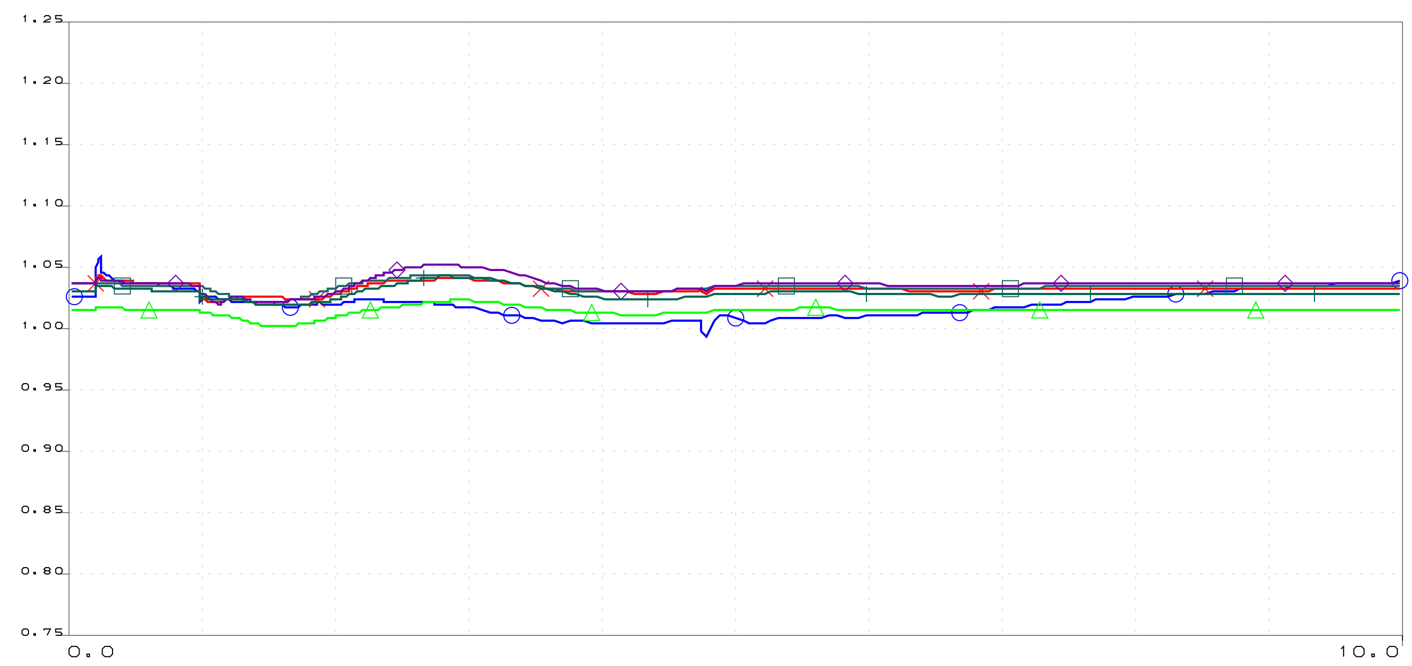
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



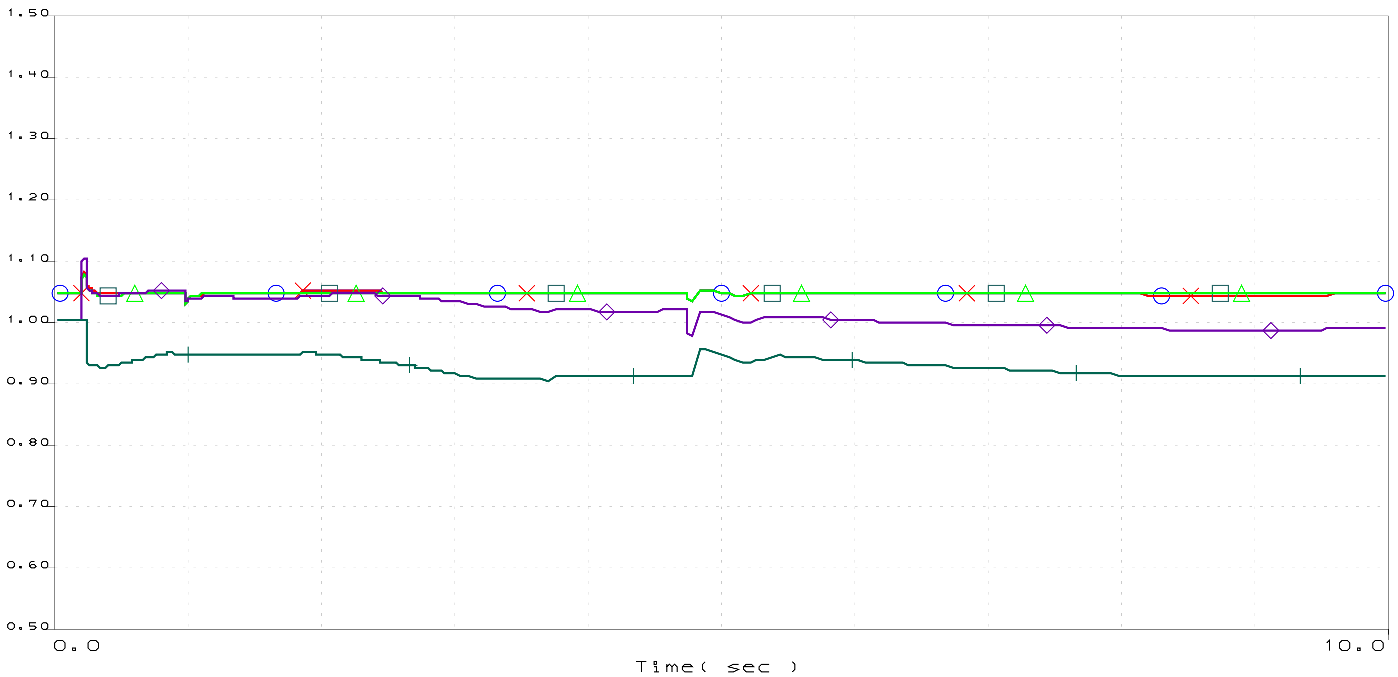
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



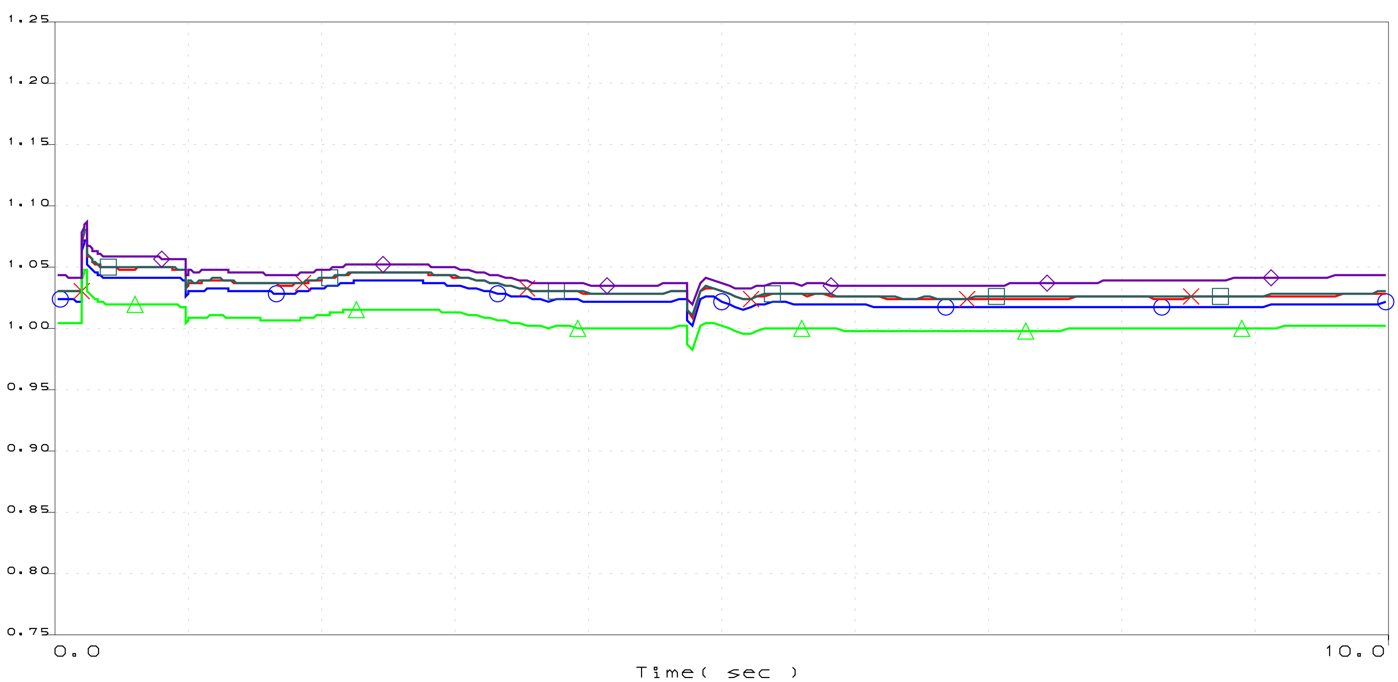
57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
0.75	vbug	70034	ARAP3	13.8	1	1	1.25
0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case1S20.chf

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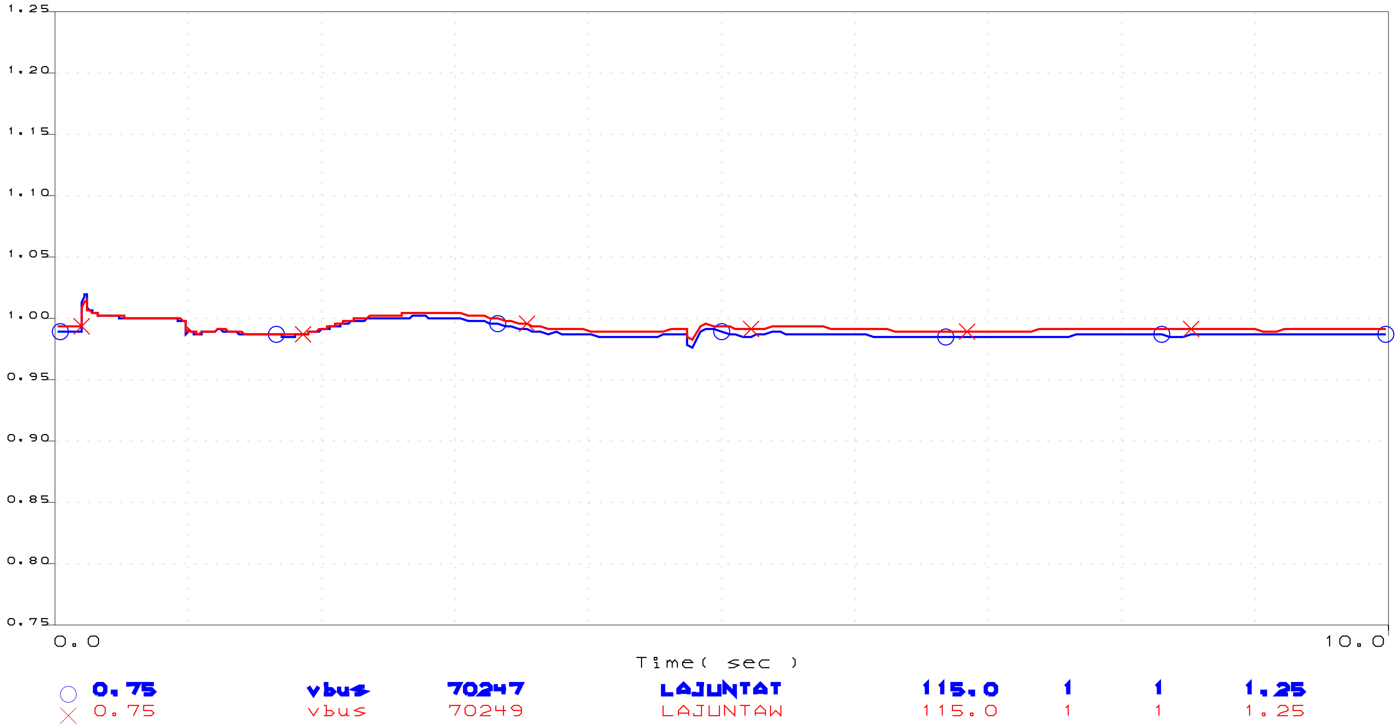
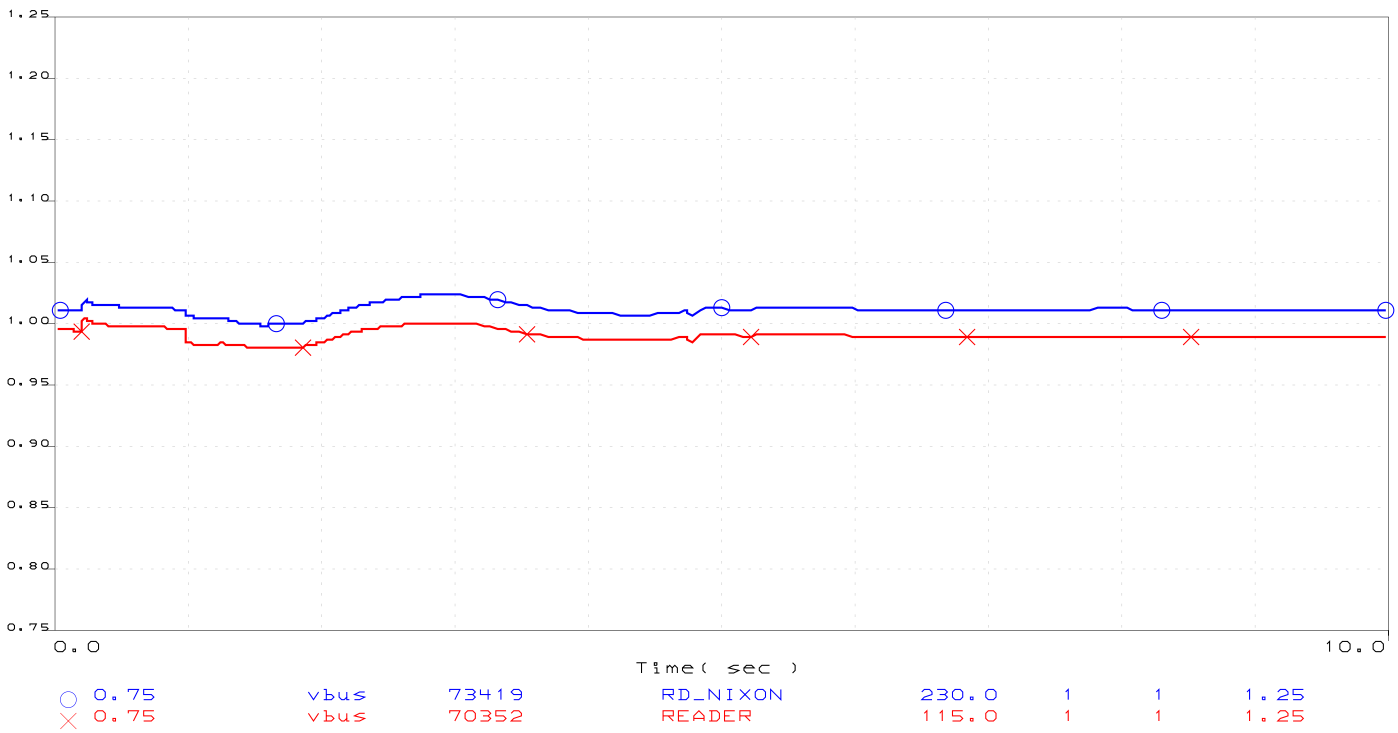
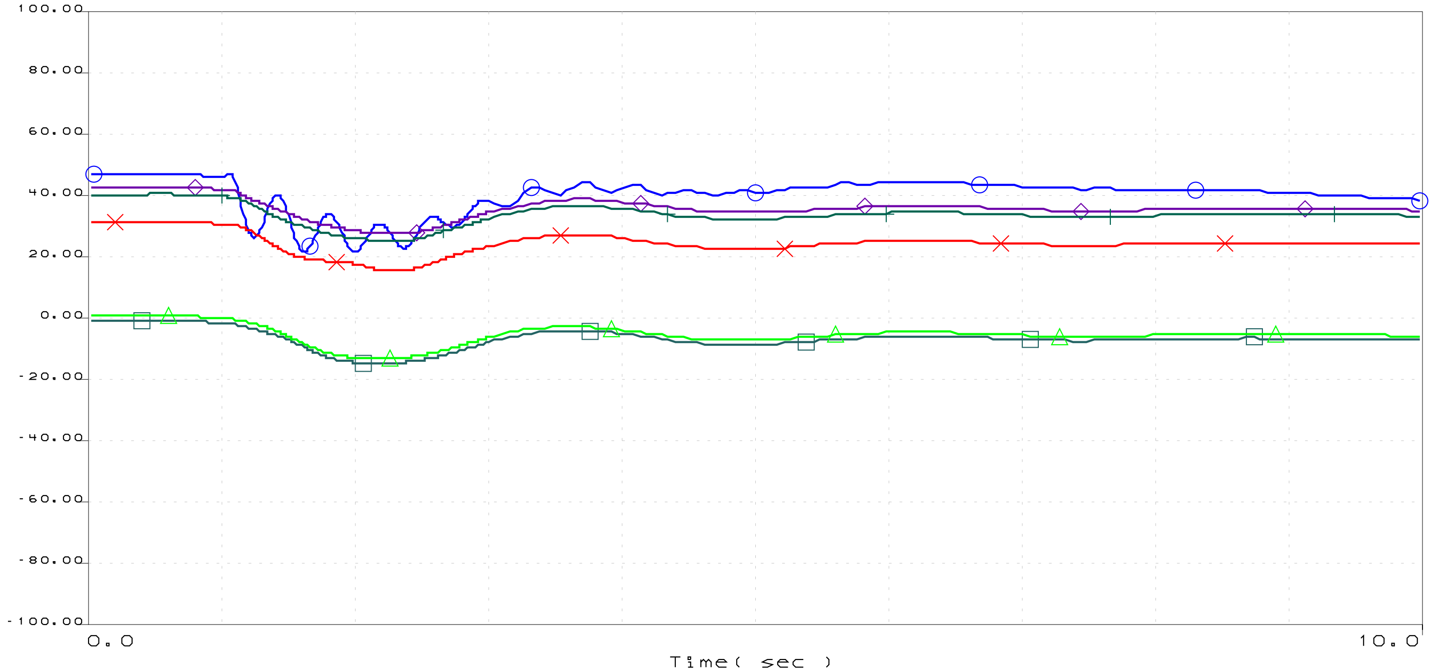
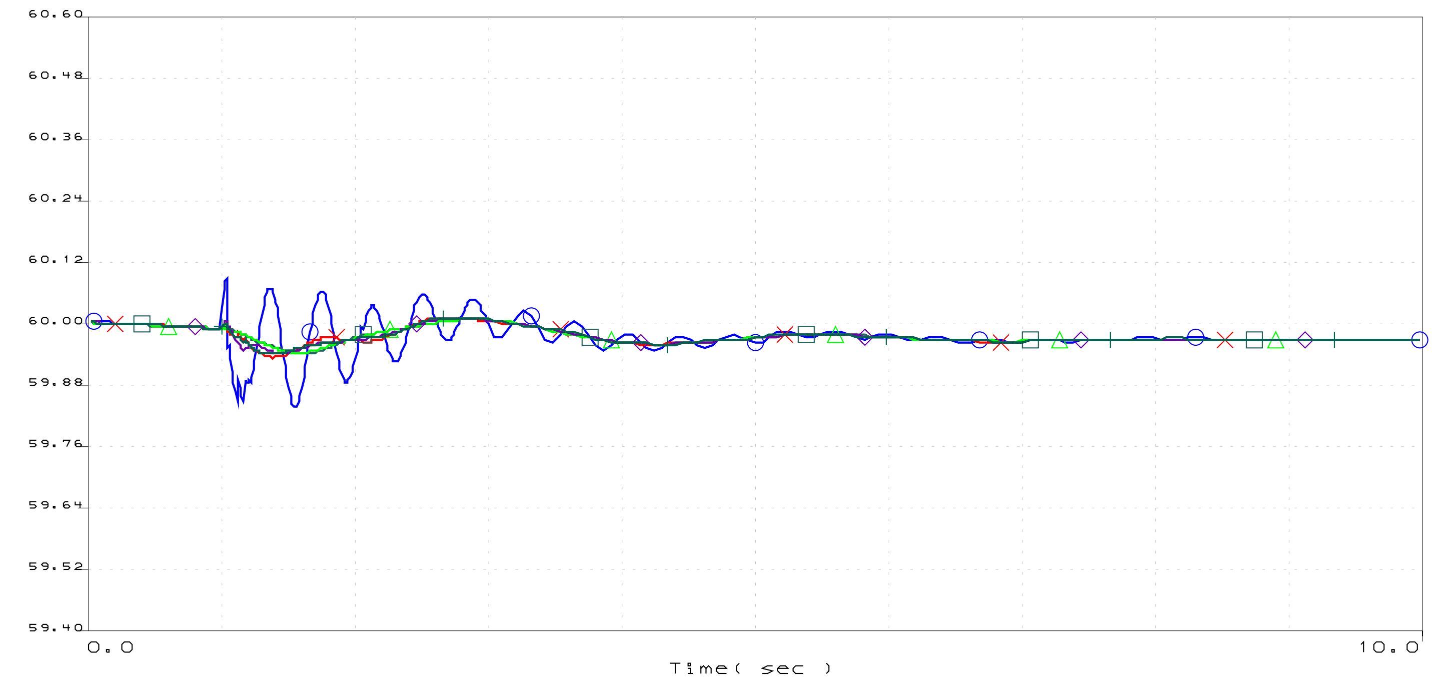

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25

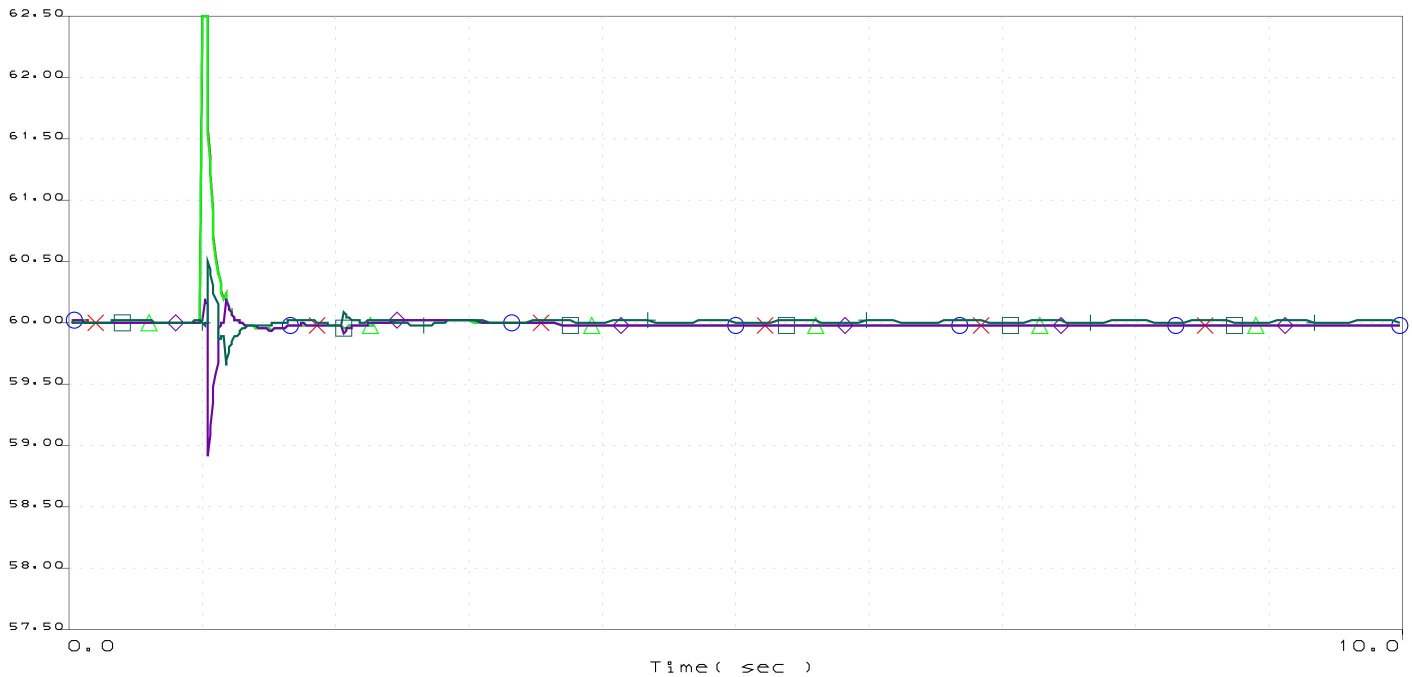

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



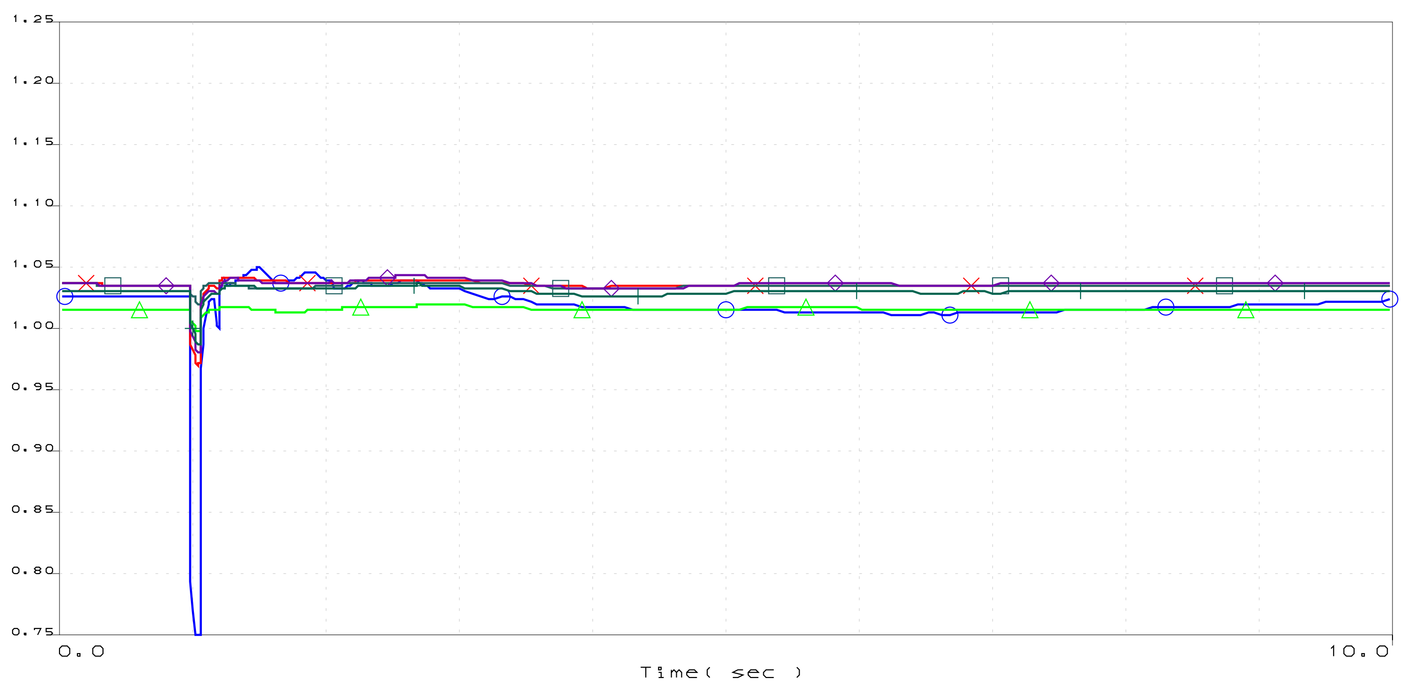
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



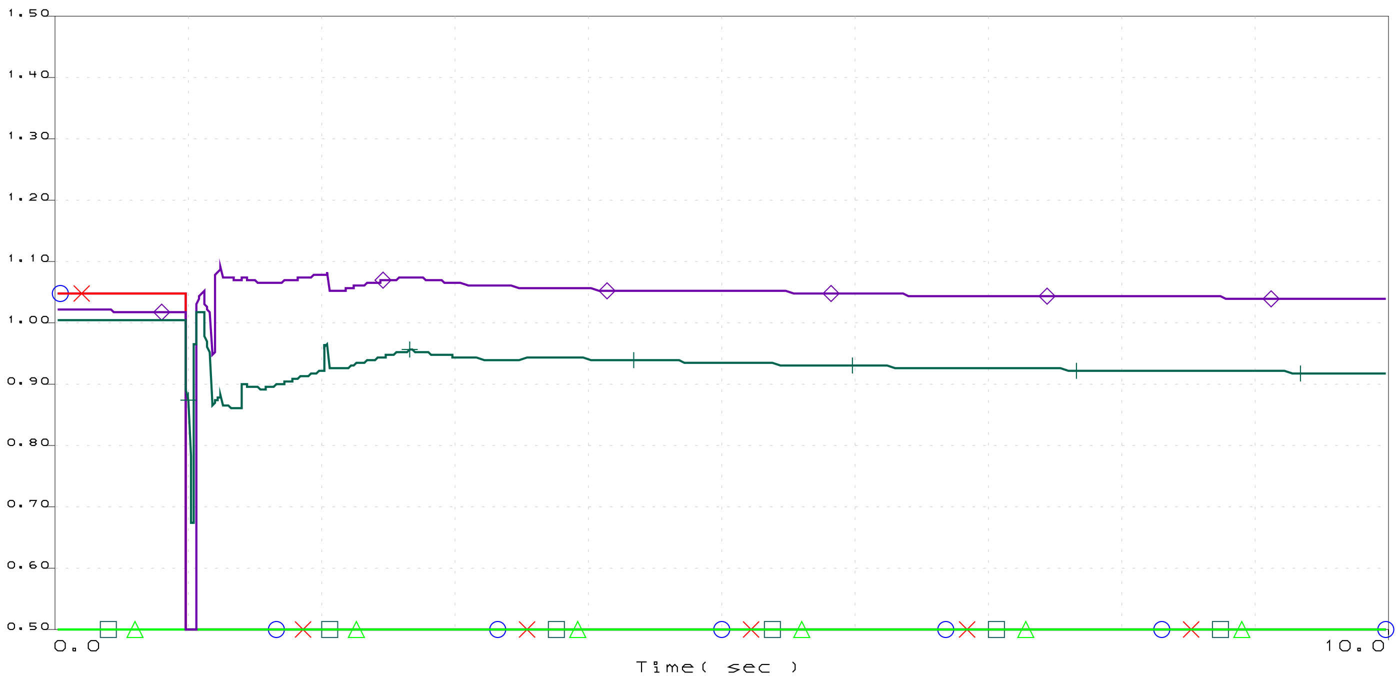
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



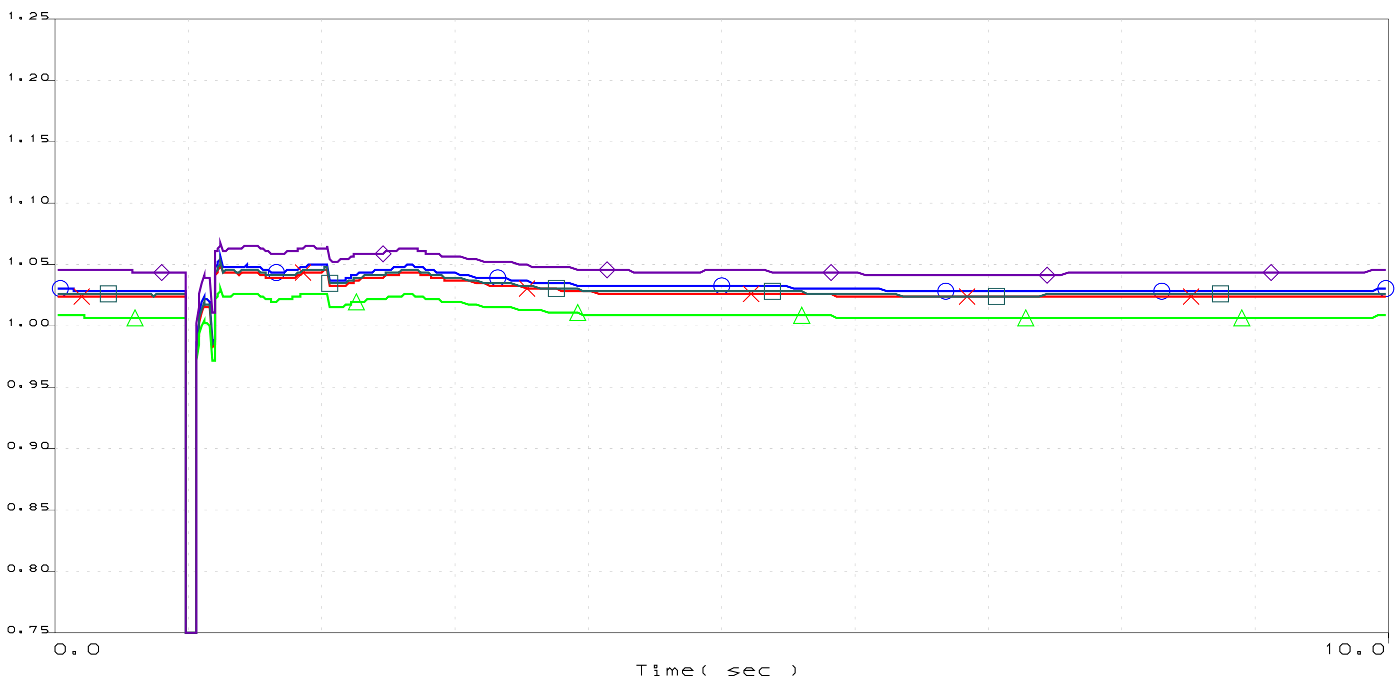
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case2S1.chf

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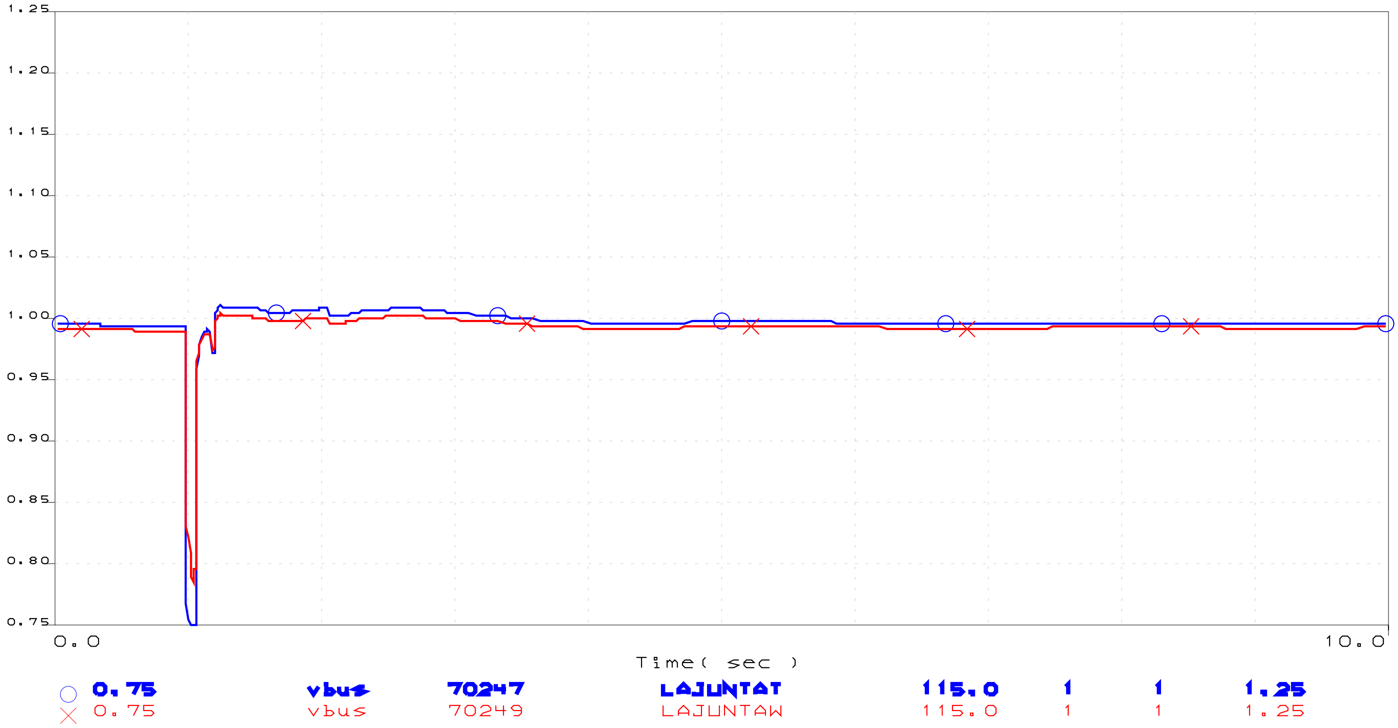
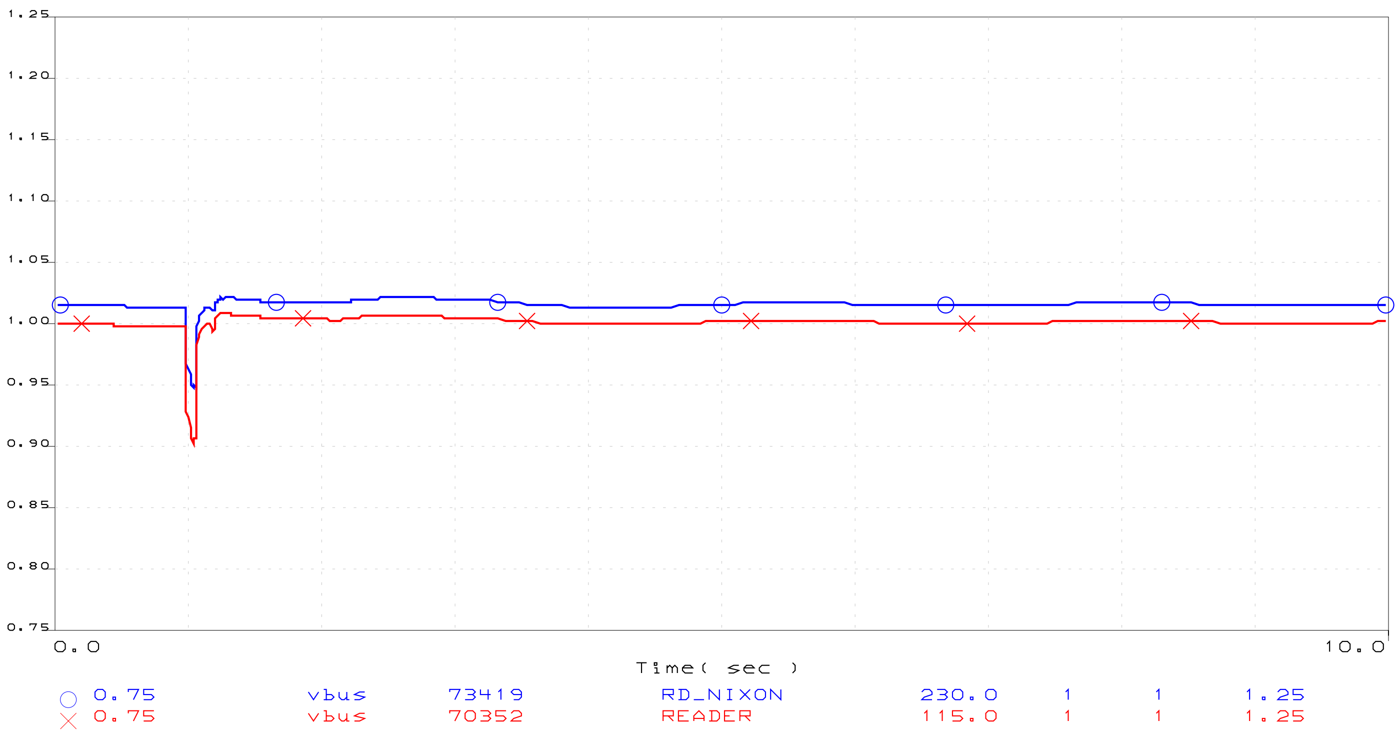
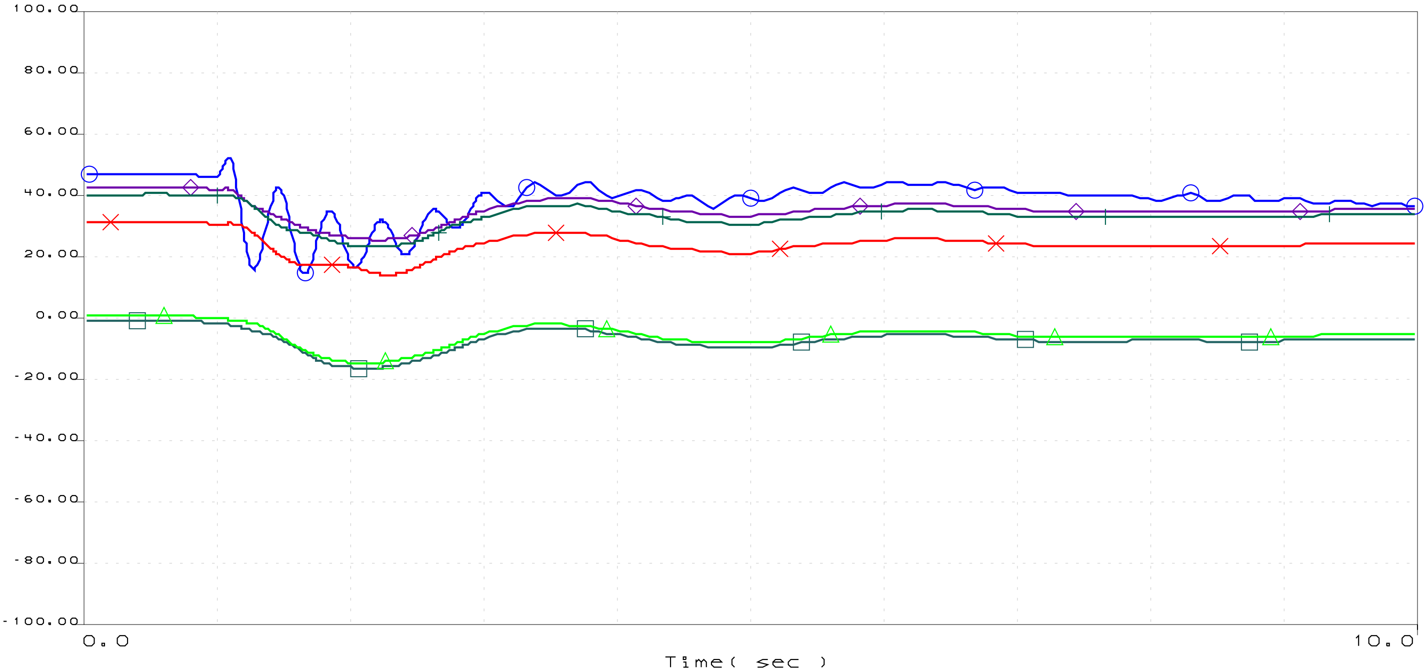


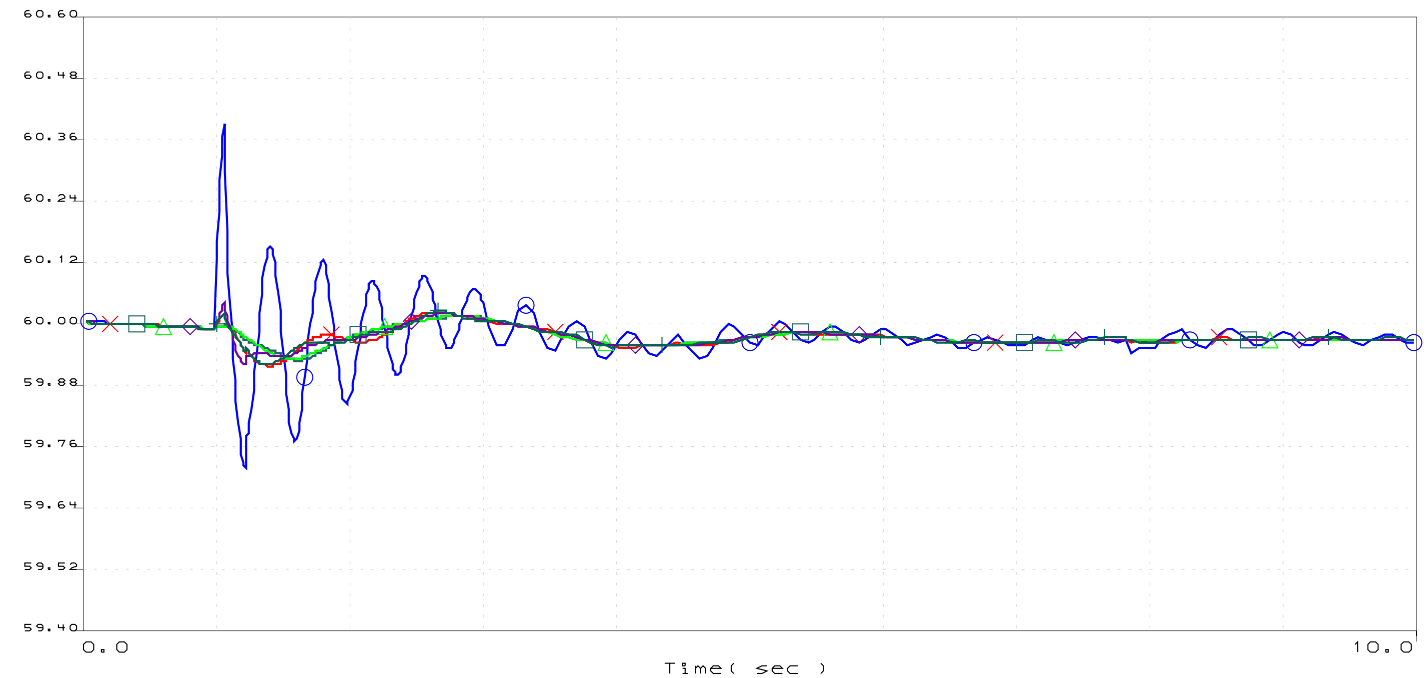


Case2S1.chf

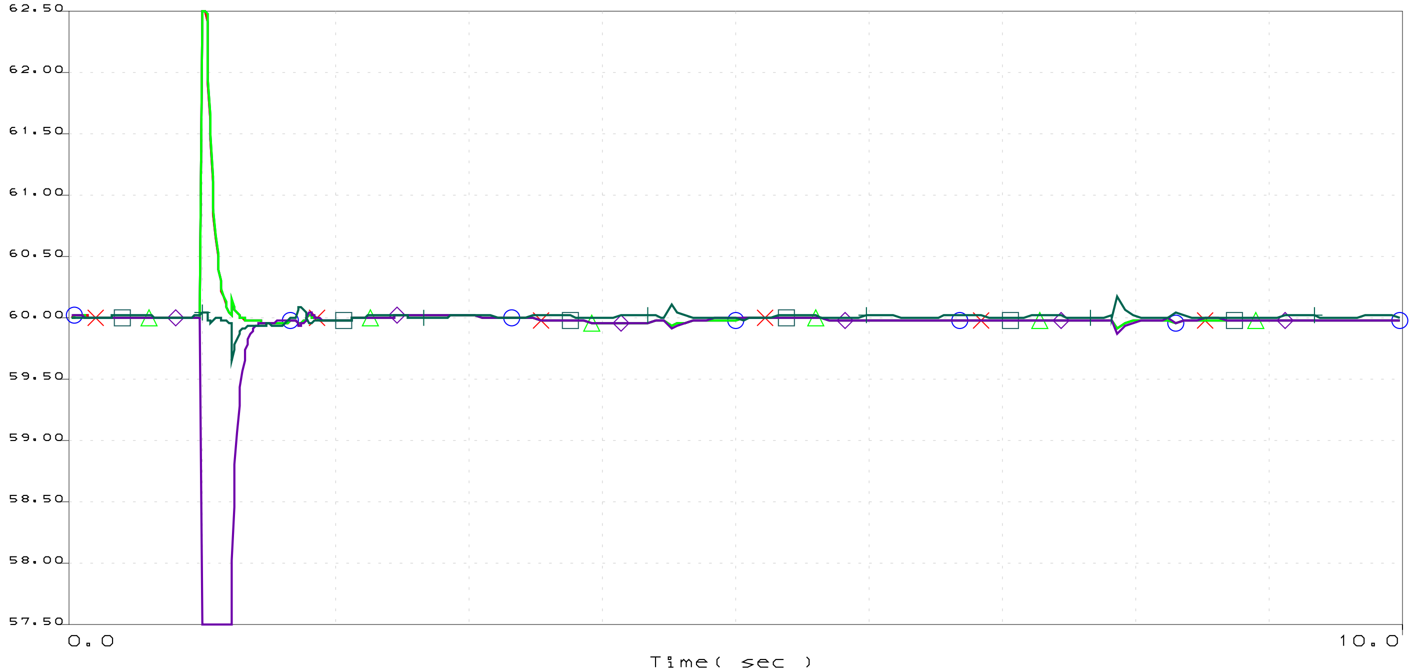
Wed Nov 24 11:53:31 2004



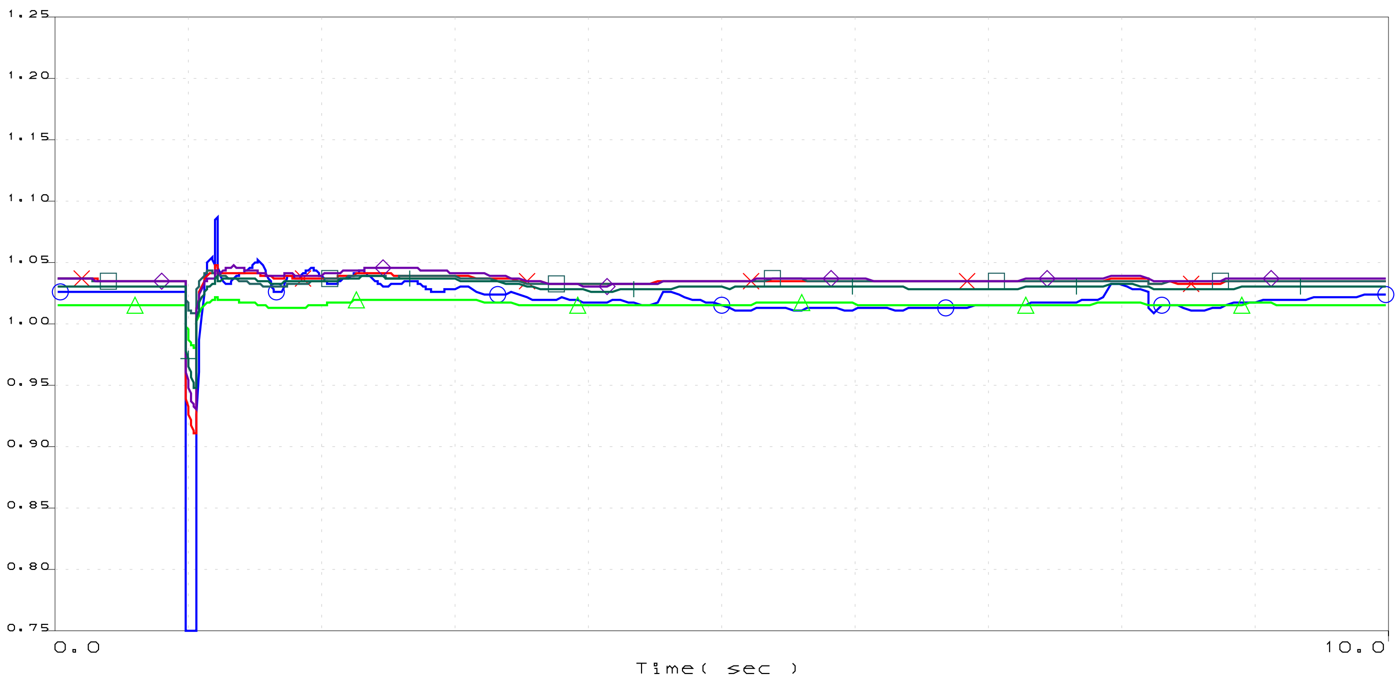
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



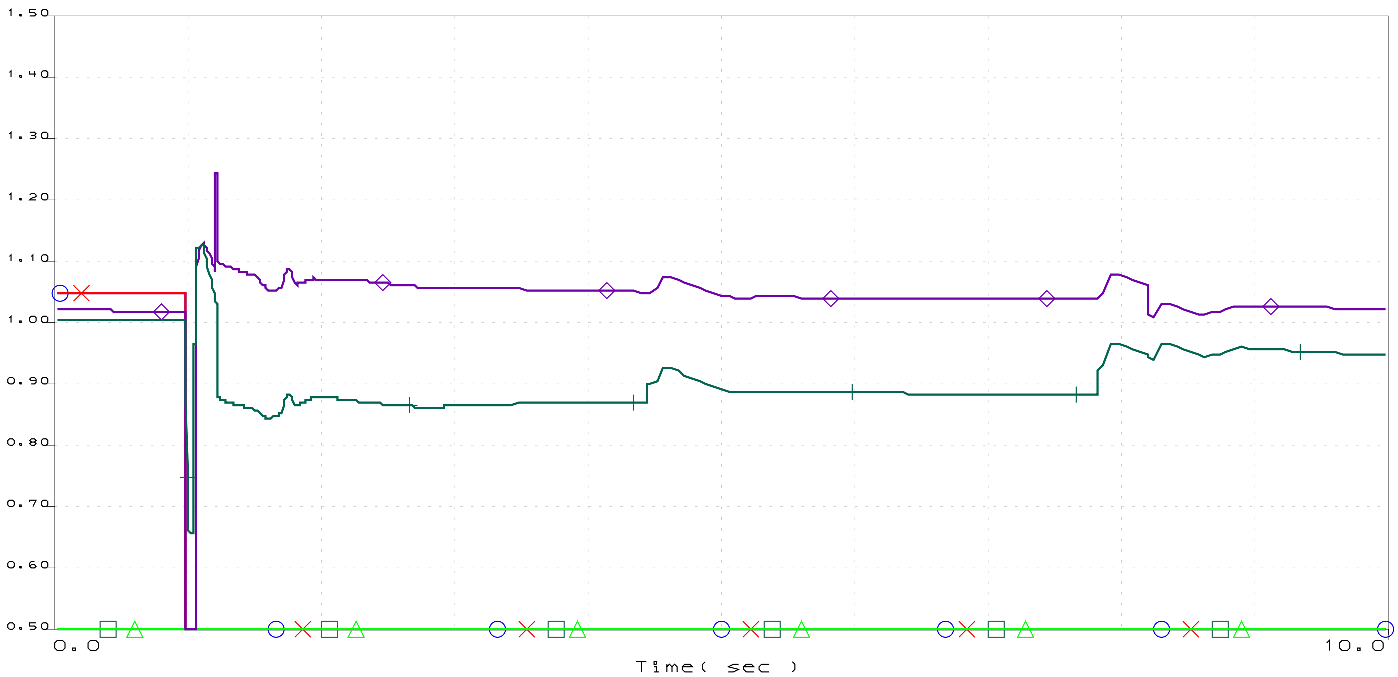
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



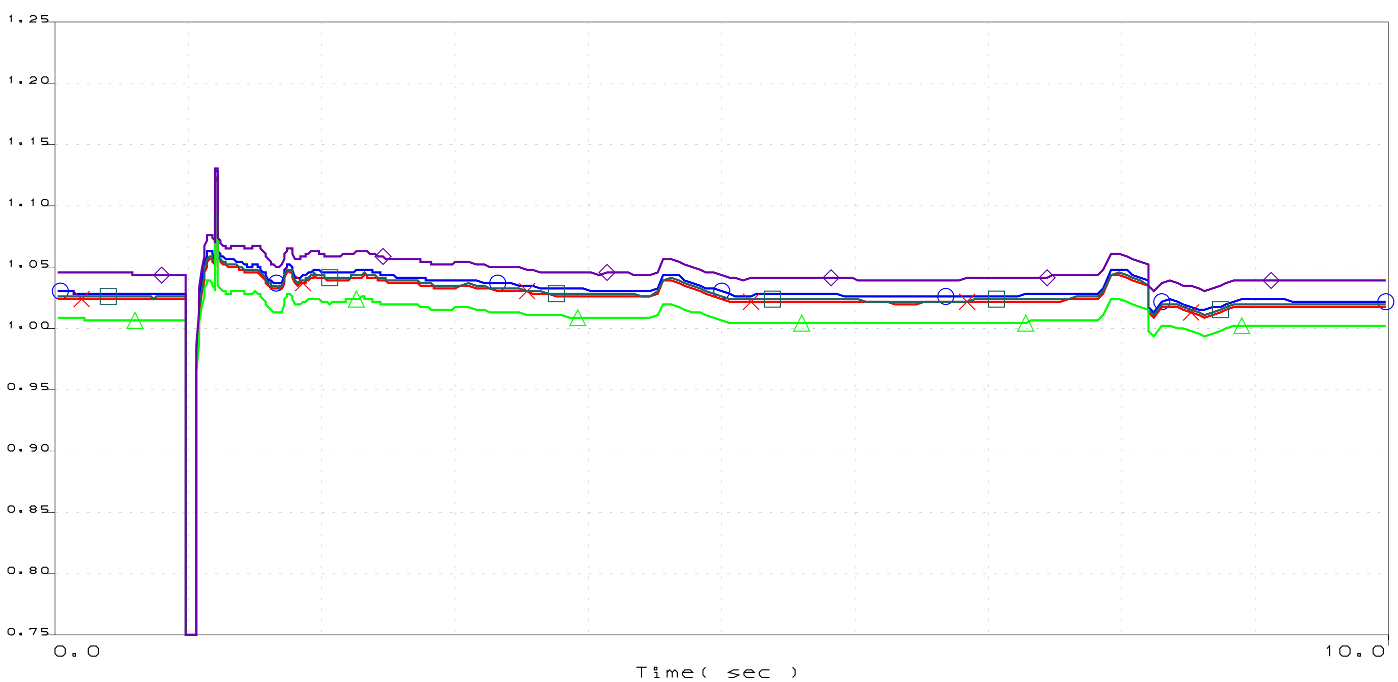
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

Case2S2.chf

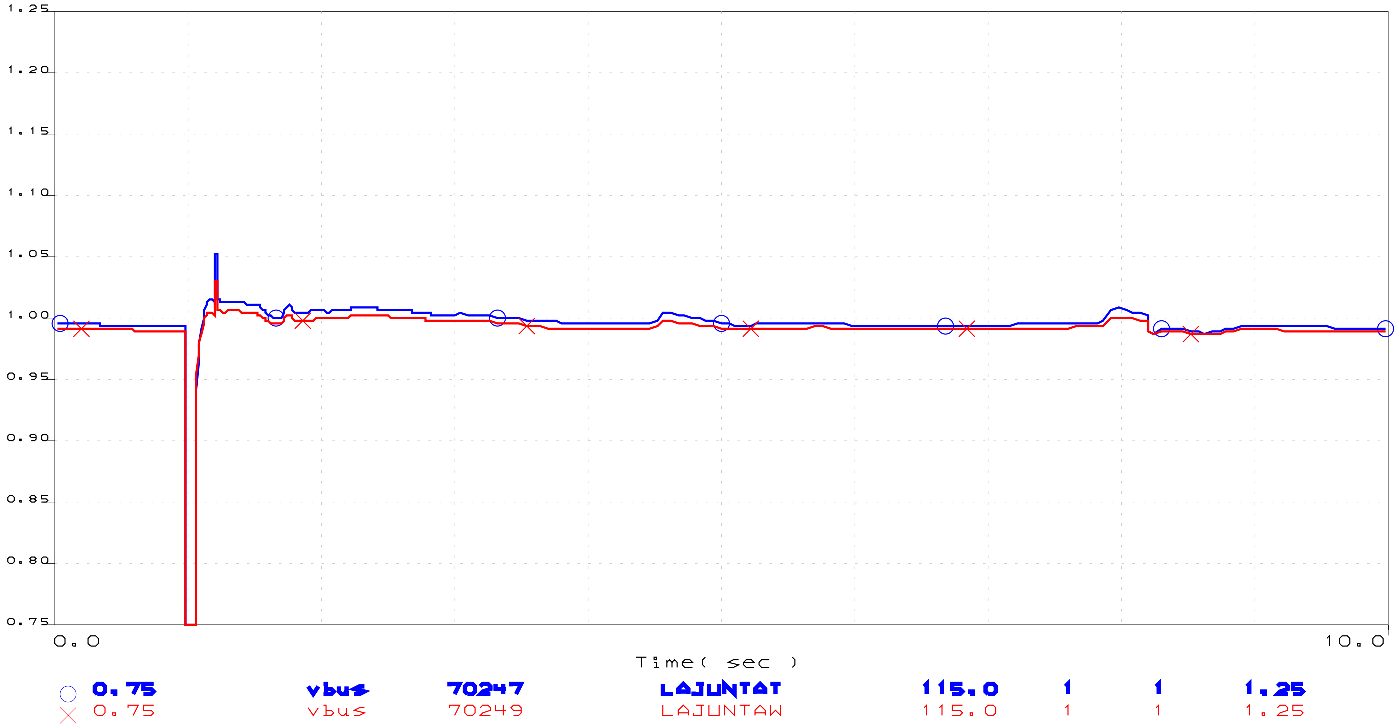
Wed Nov 24 11:53:41 2004

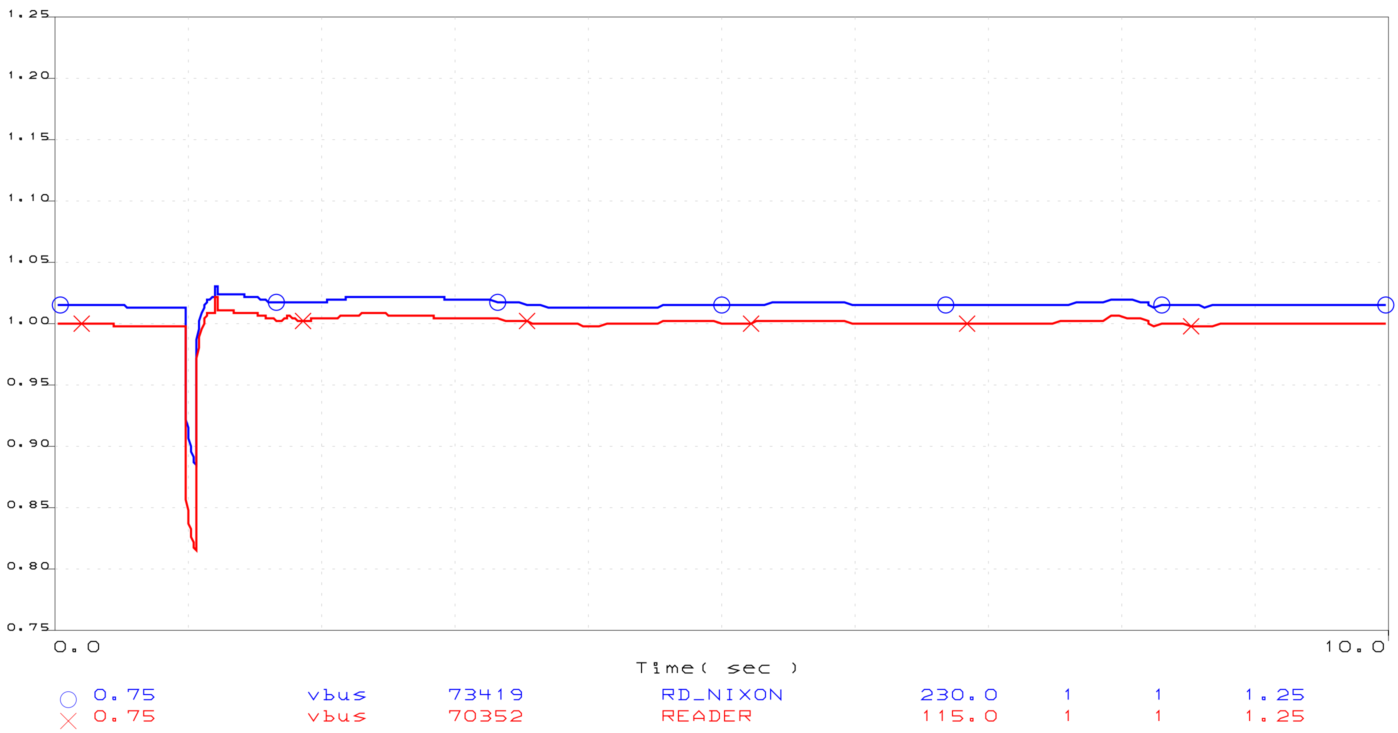


○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



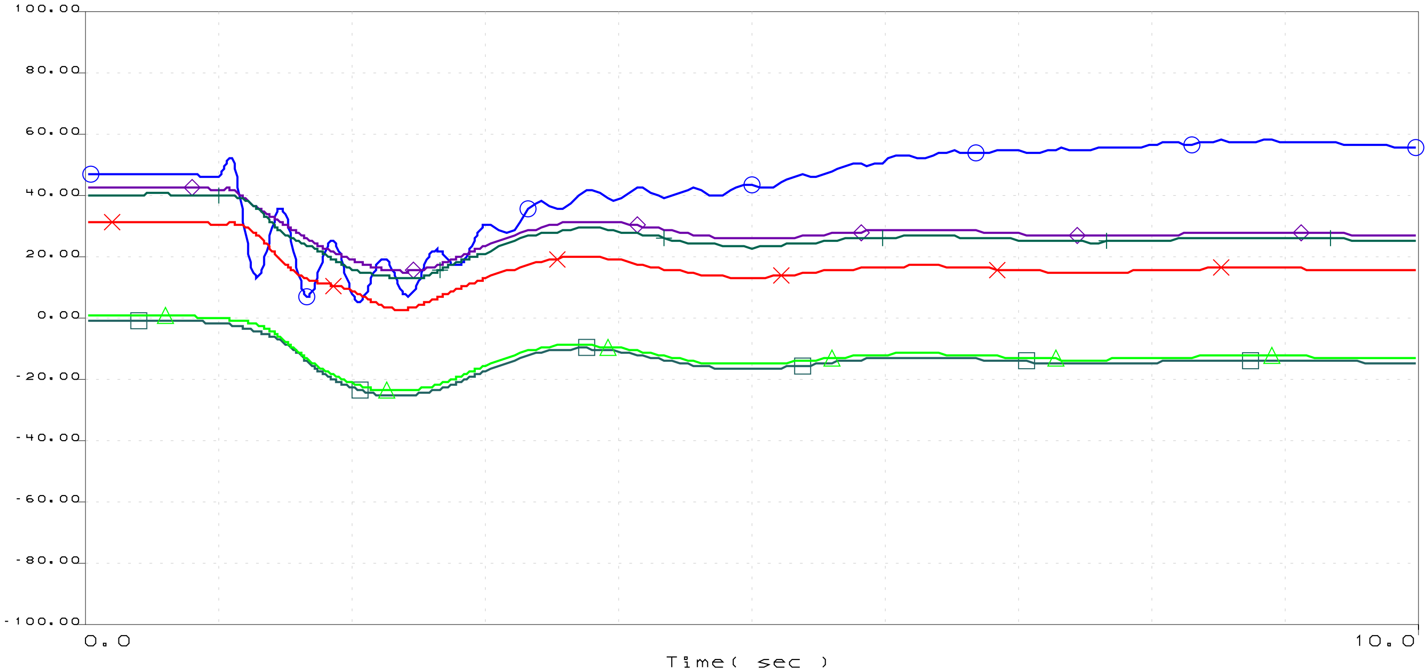
○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25



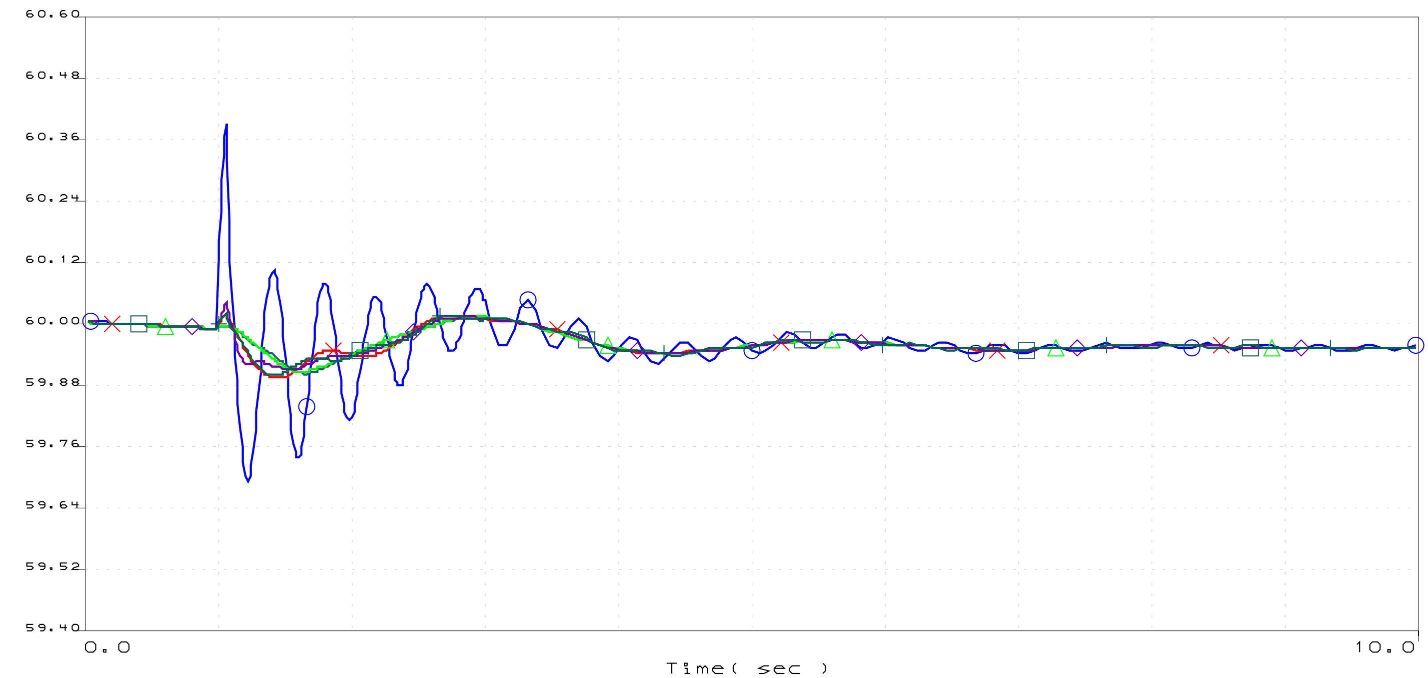


Case2S2.chf

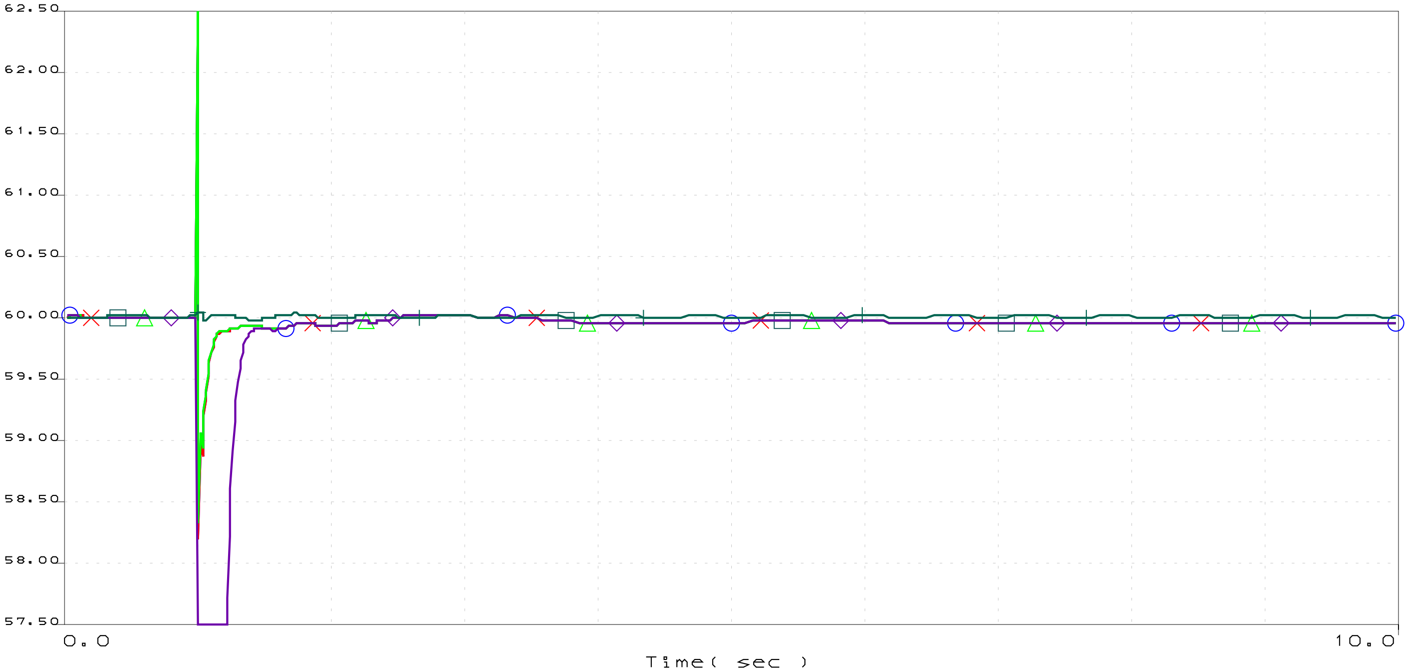
Wed Nov 24 11:53:41 2004



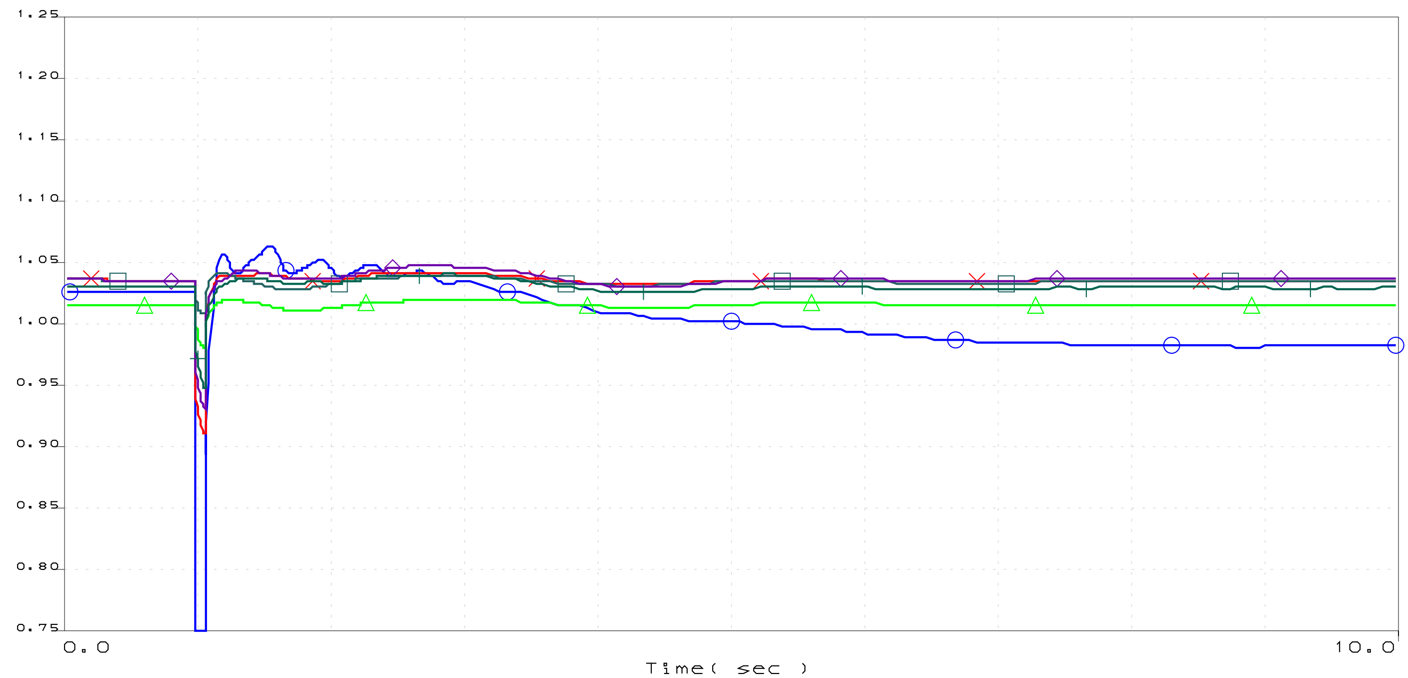
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



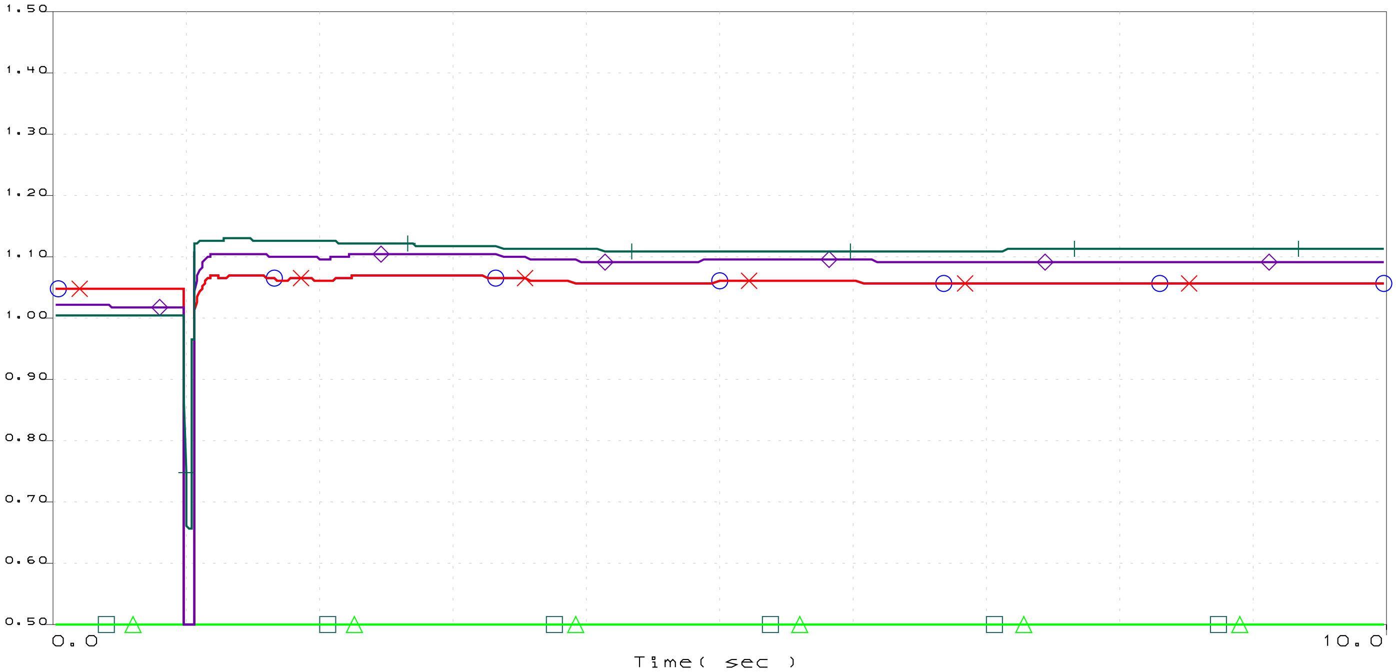
59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



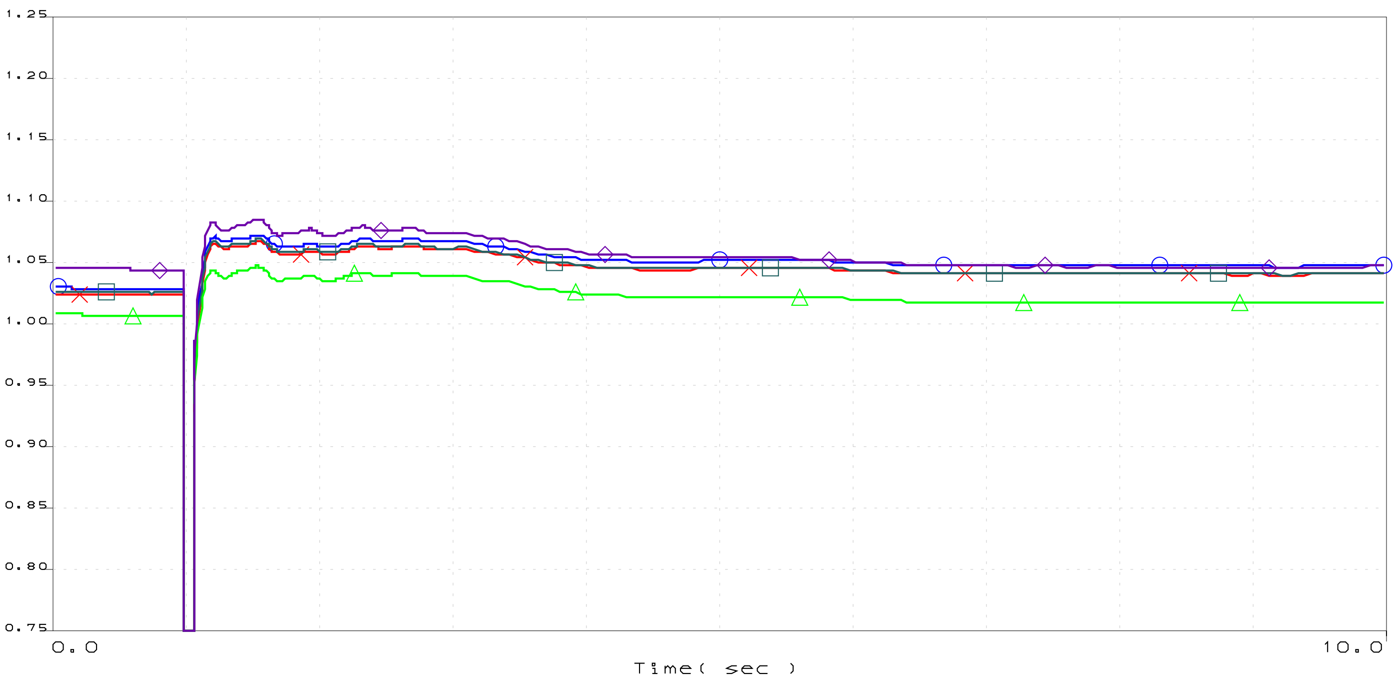
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

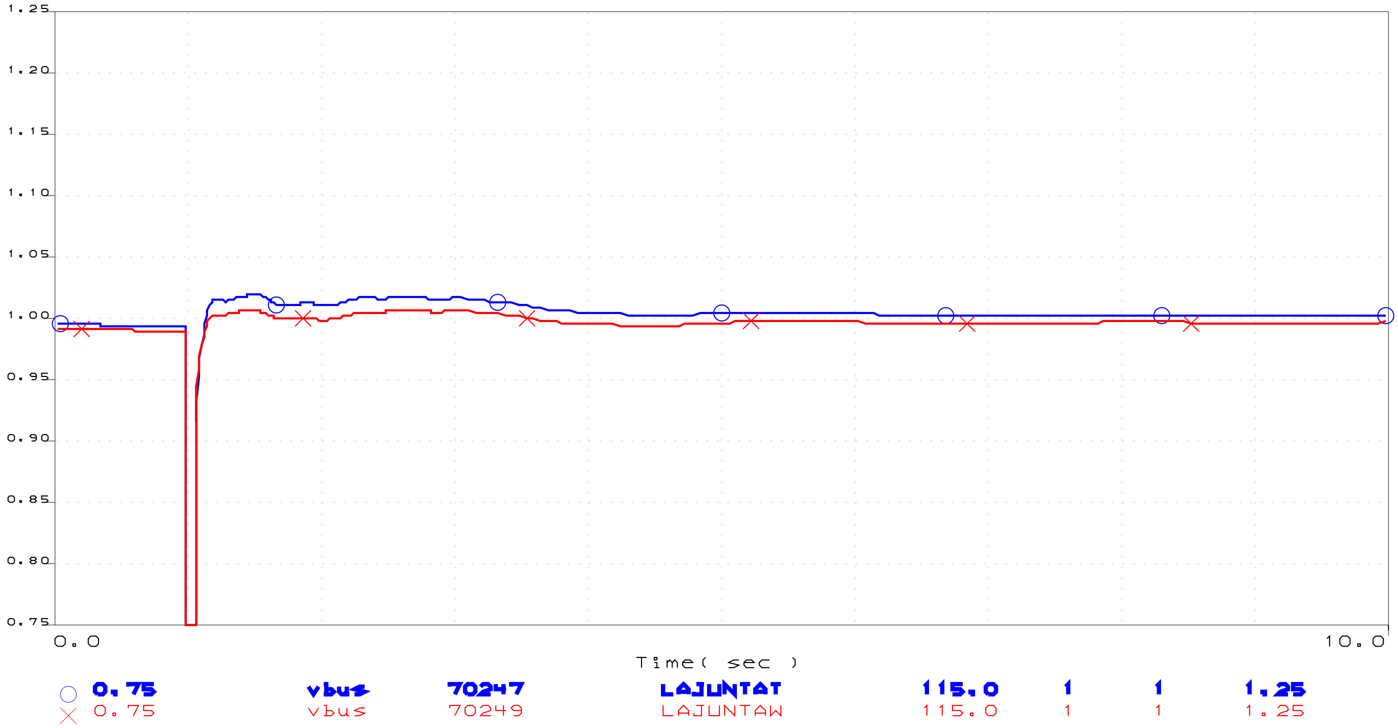


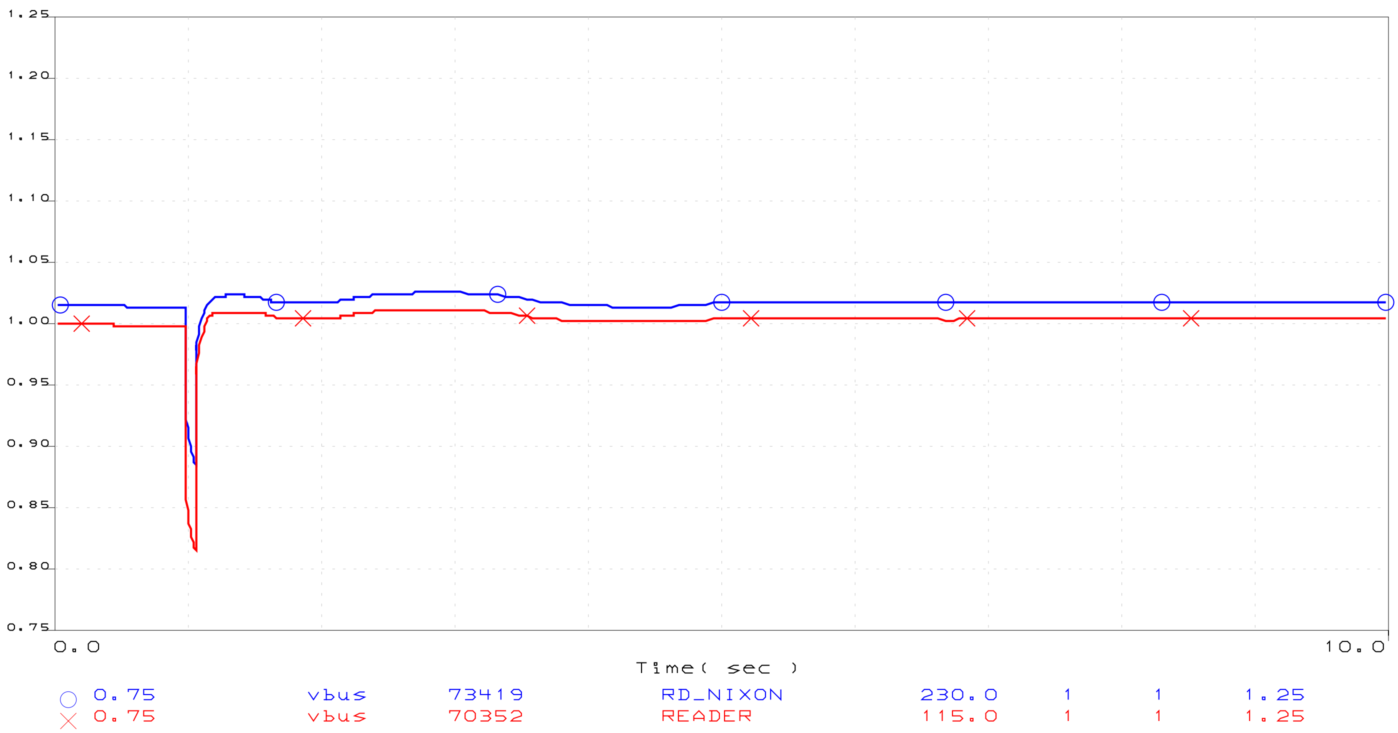
○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

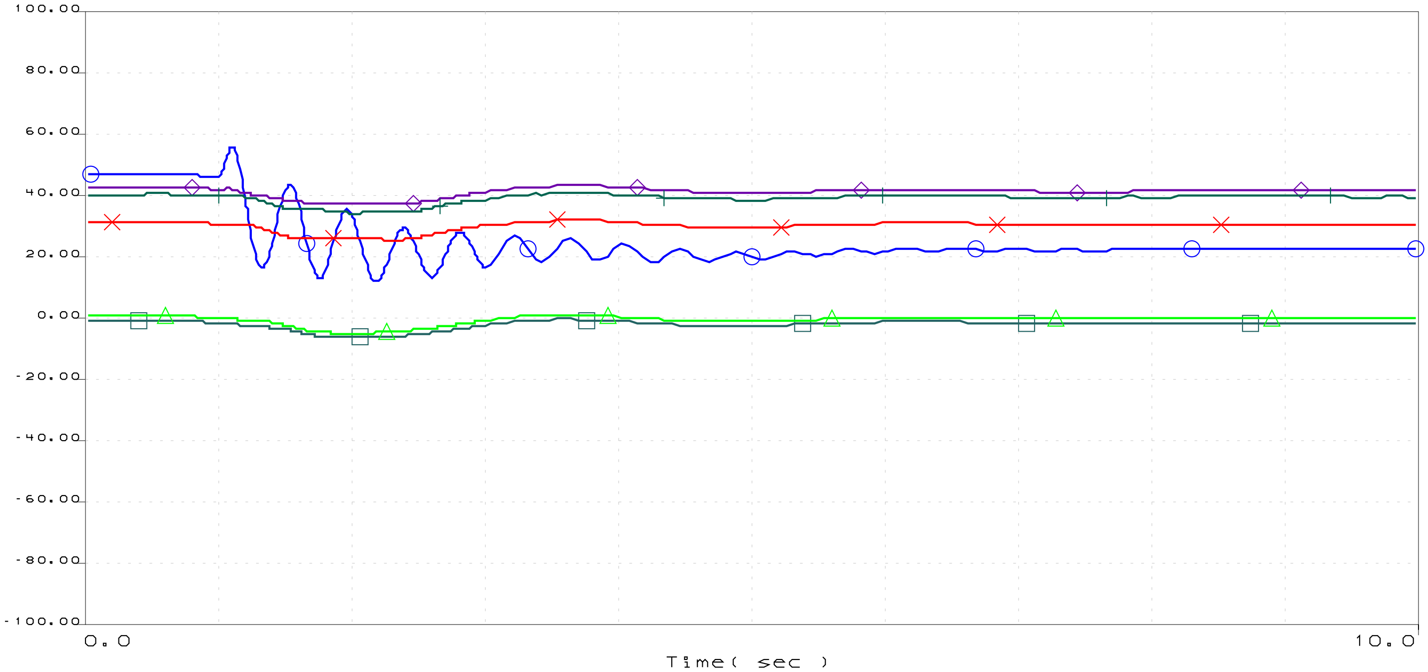
Case2S3.chf Wed Nov 24 11:53:52 2004



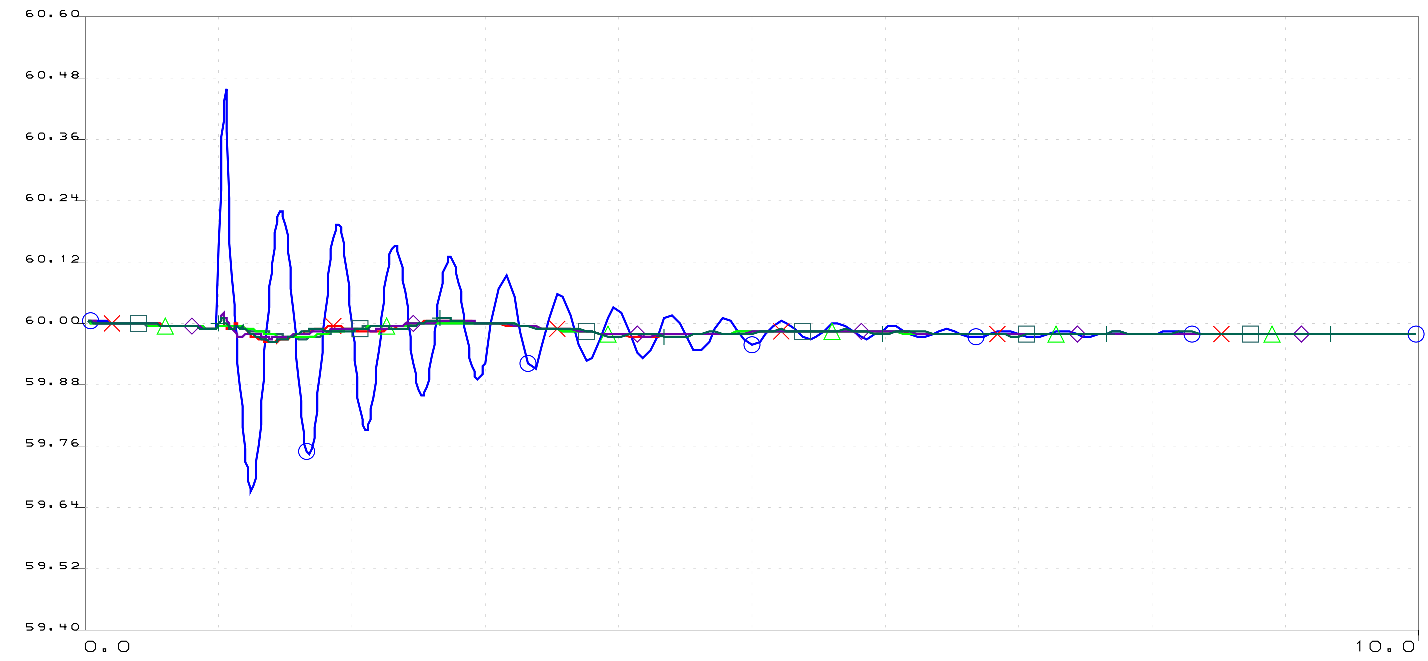


Case2S3.chf

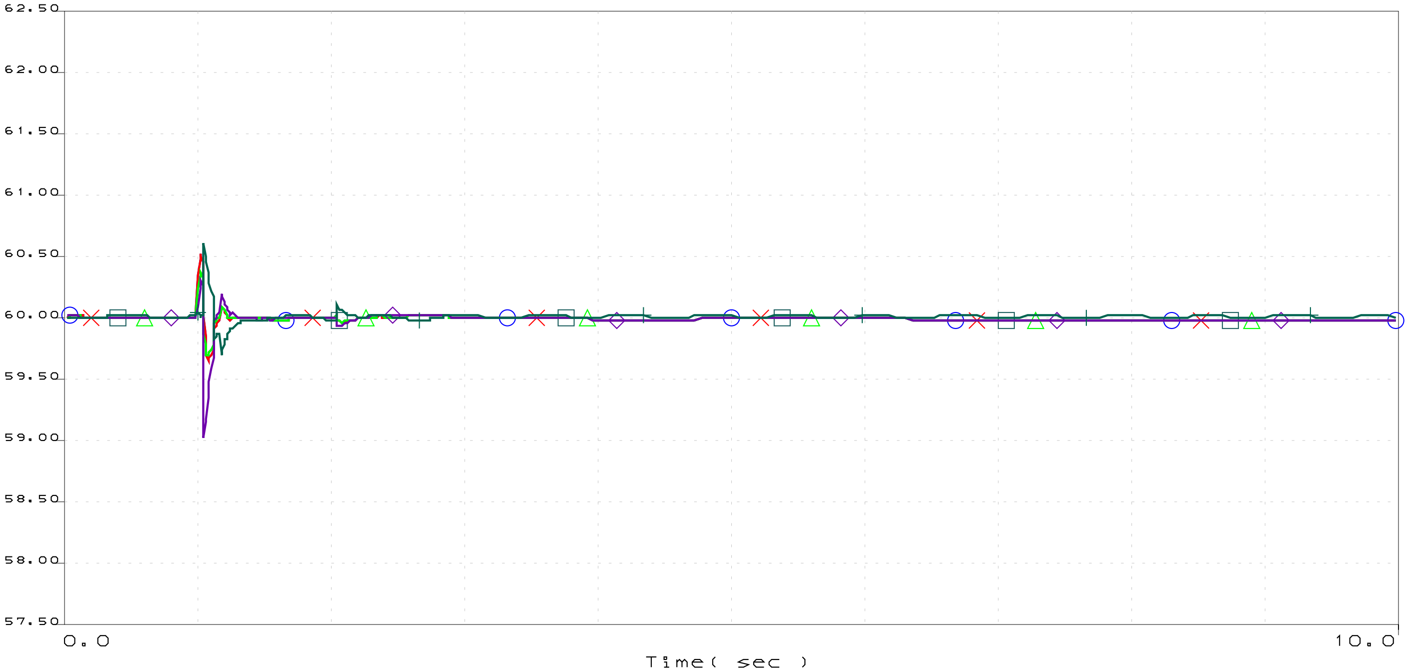
Wed Nov 24 11:53:52 2004



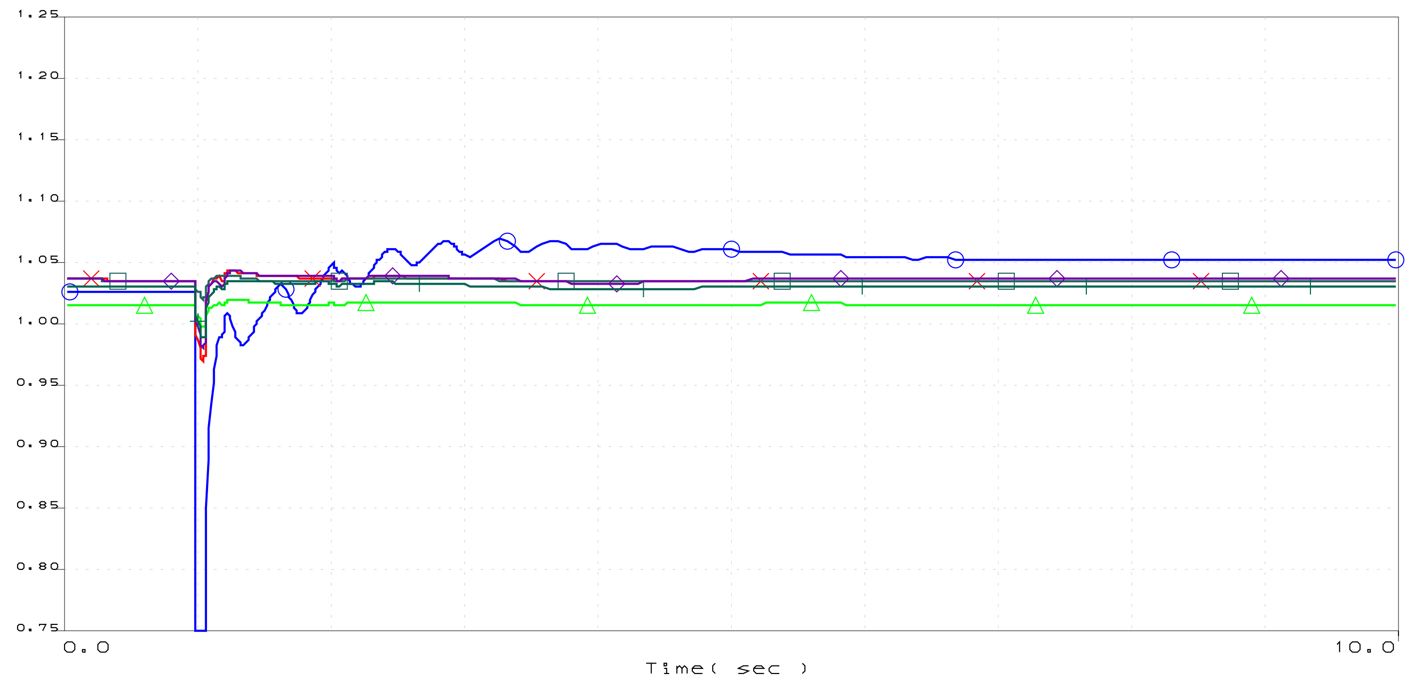
○ -100.0	ang	70133	CTY LAM	14.4	1	1	100.0
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



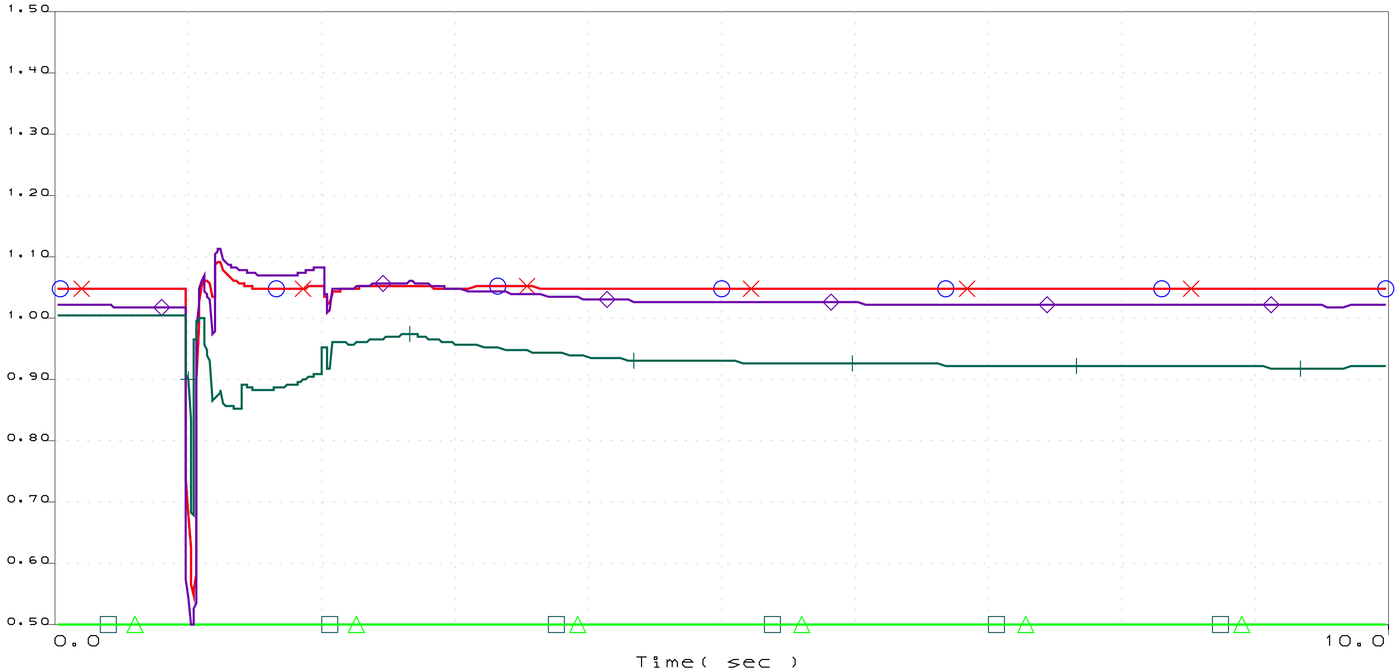
○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



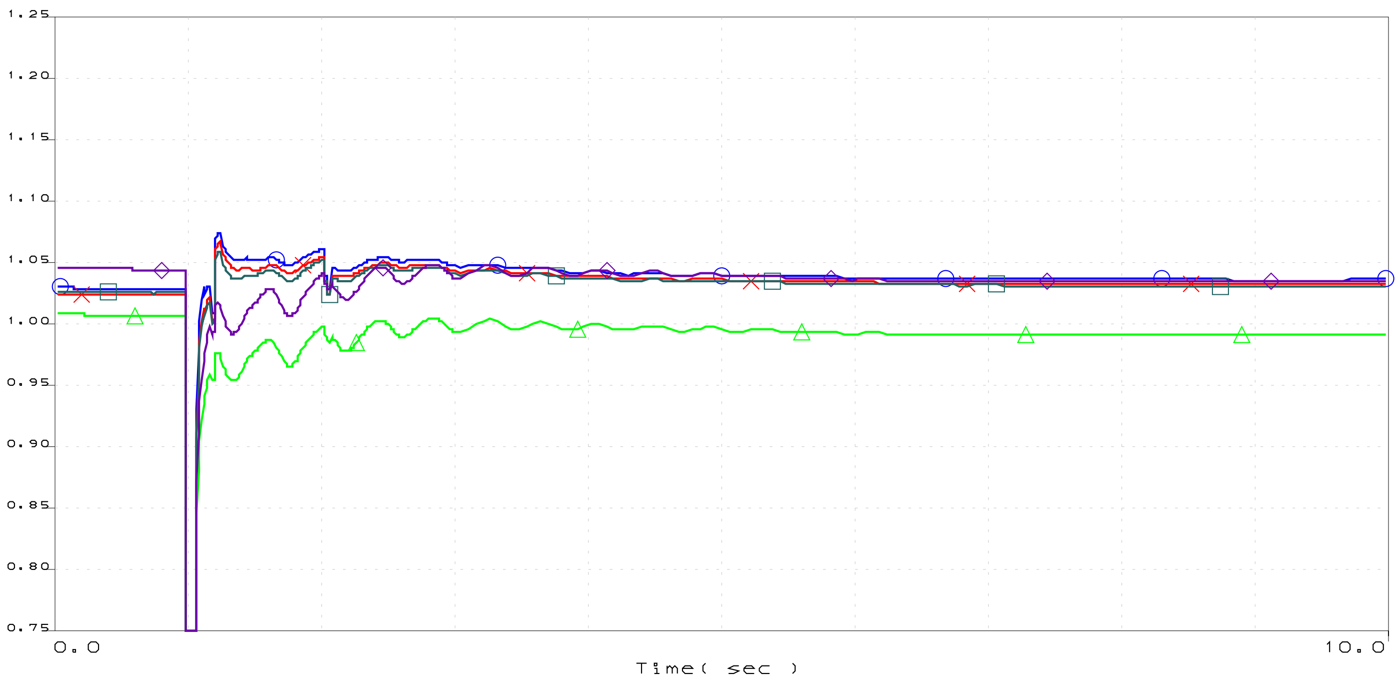
57.5	fbug	70701	CO GRN E	34.5	1	1	62.5
57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
0.75	vbug	70034	ARAP3	13.8	1	1	1.25
0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



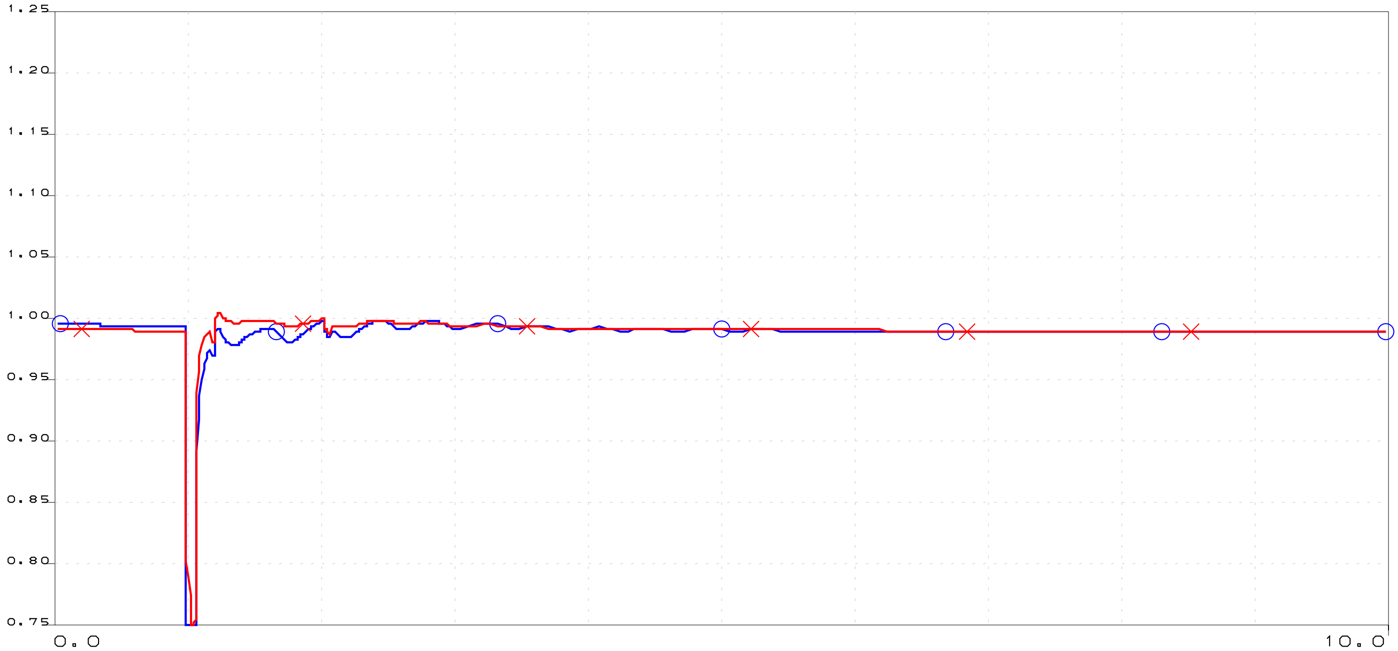
0.5	vbug	70701	CO GRN E	34.5	1	1	1.5
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



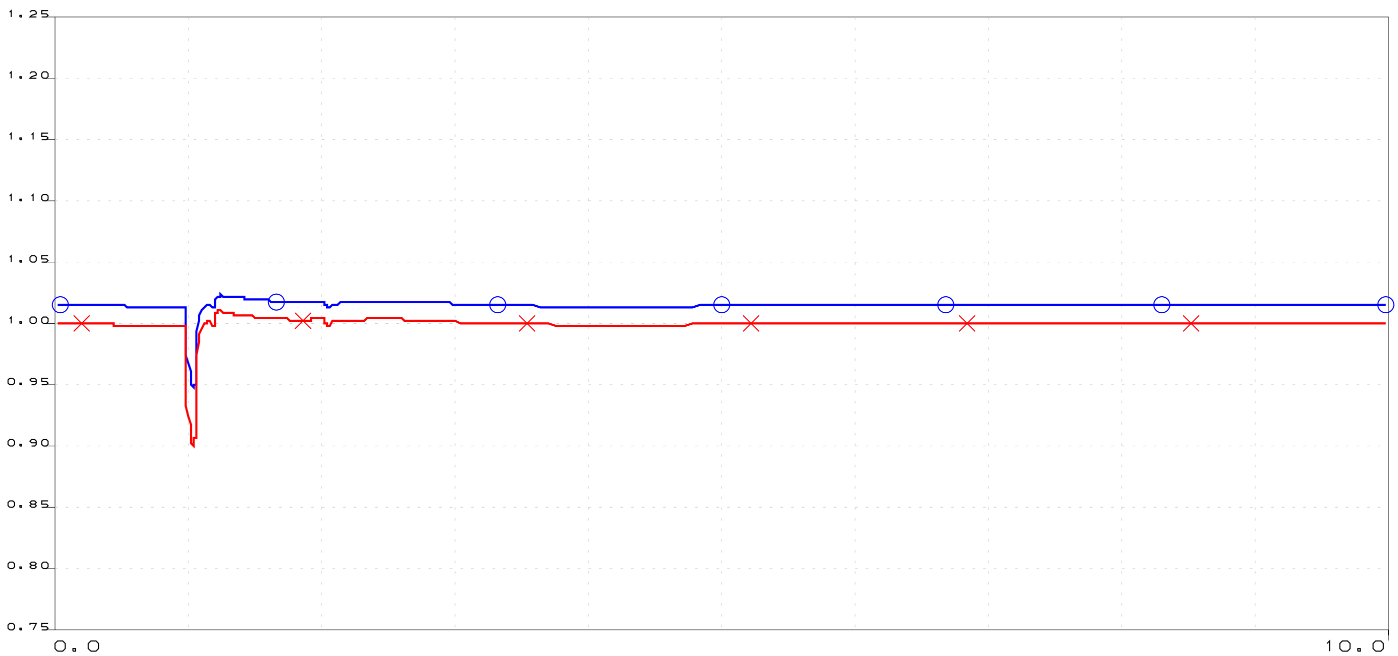
0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case254.chf

Wed Nov 24 11:54:04 2004



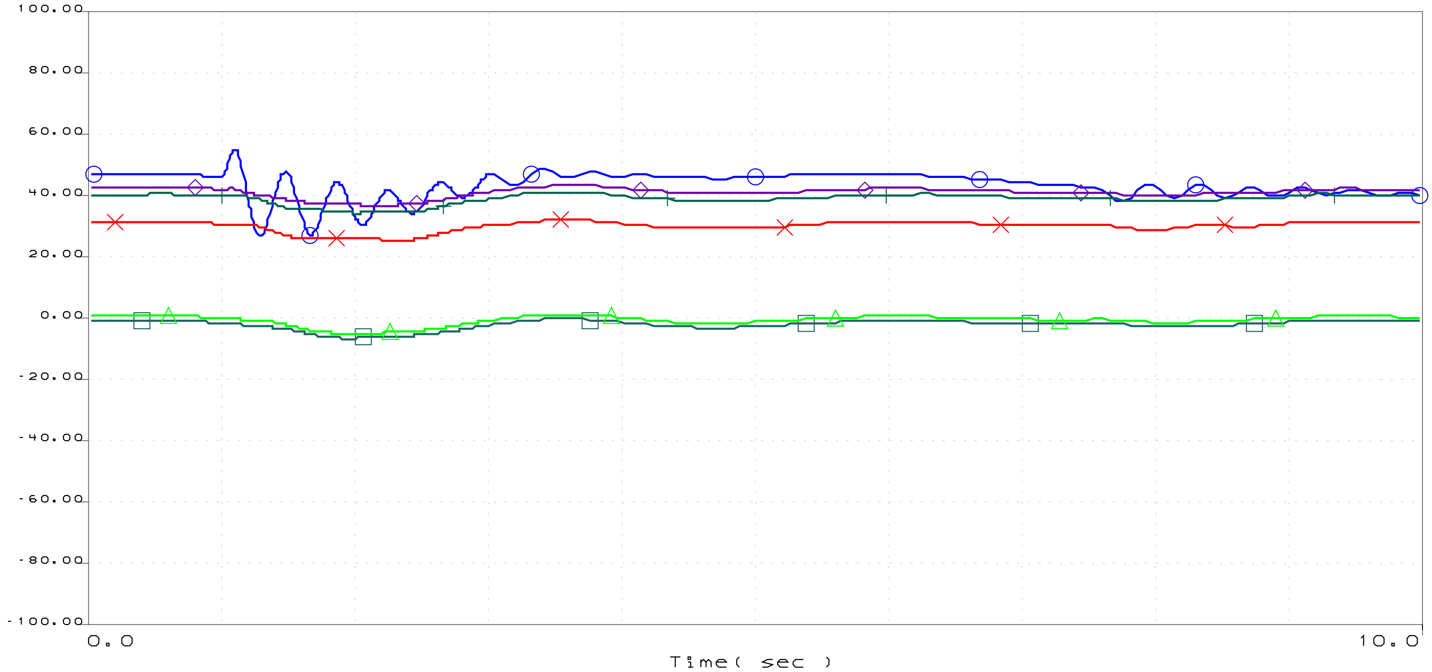
0.75	vbus	70247	LAJUNTAT	115.0	1	1	1.25
0.75	vbus	70249	LAJUNTAW	115.0	1	1	1.25



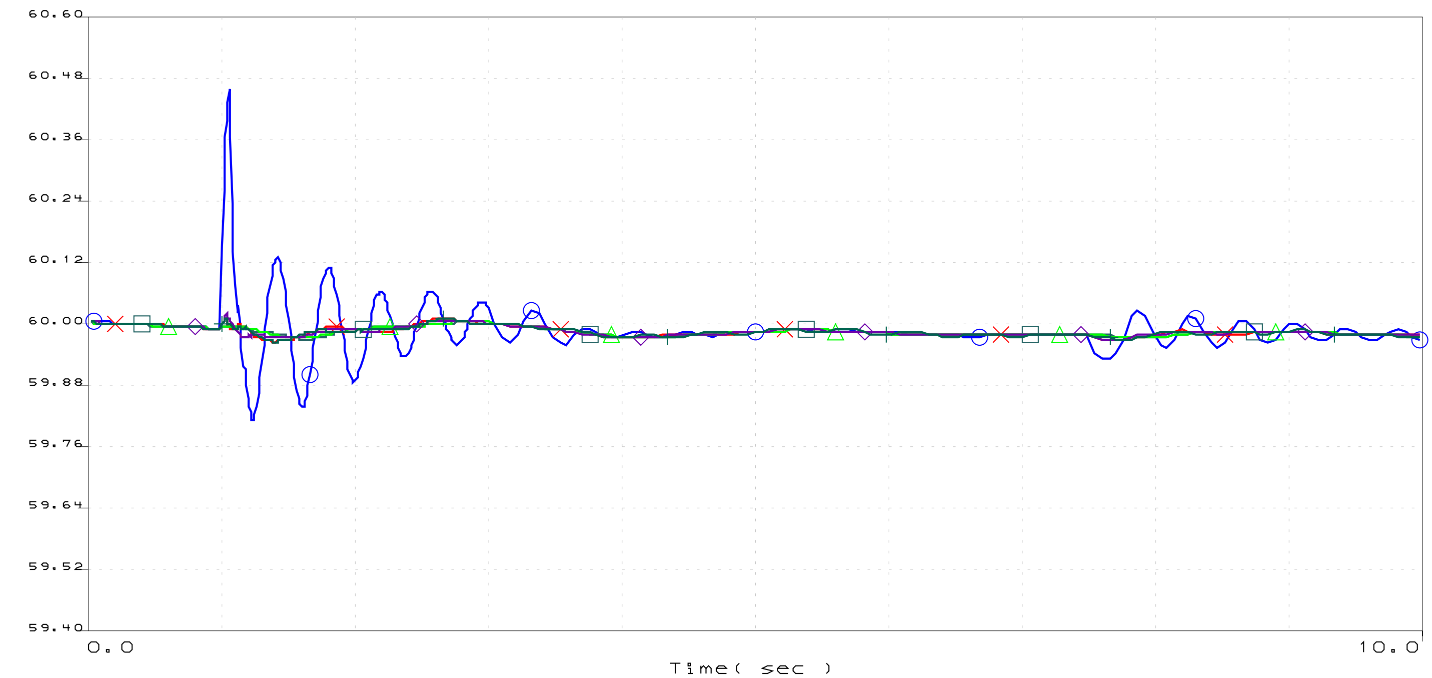
0.75	vbus	73419	RD_NIXON	230.0	1	1	1.25
0.75	vbus	70352	READER	115.0	1	1	1.25

Case254.chf

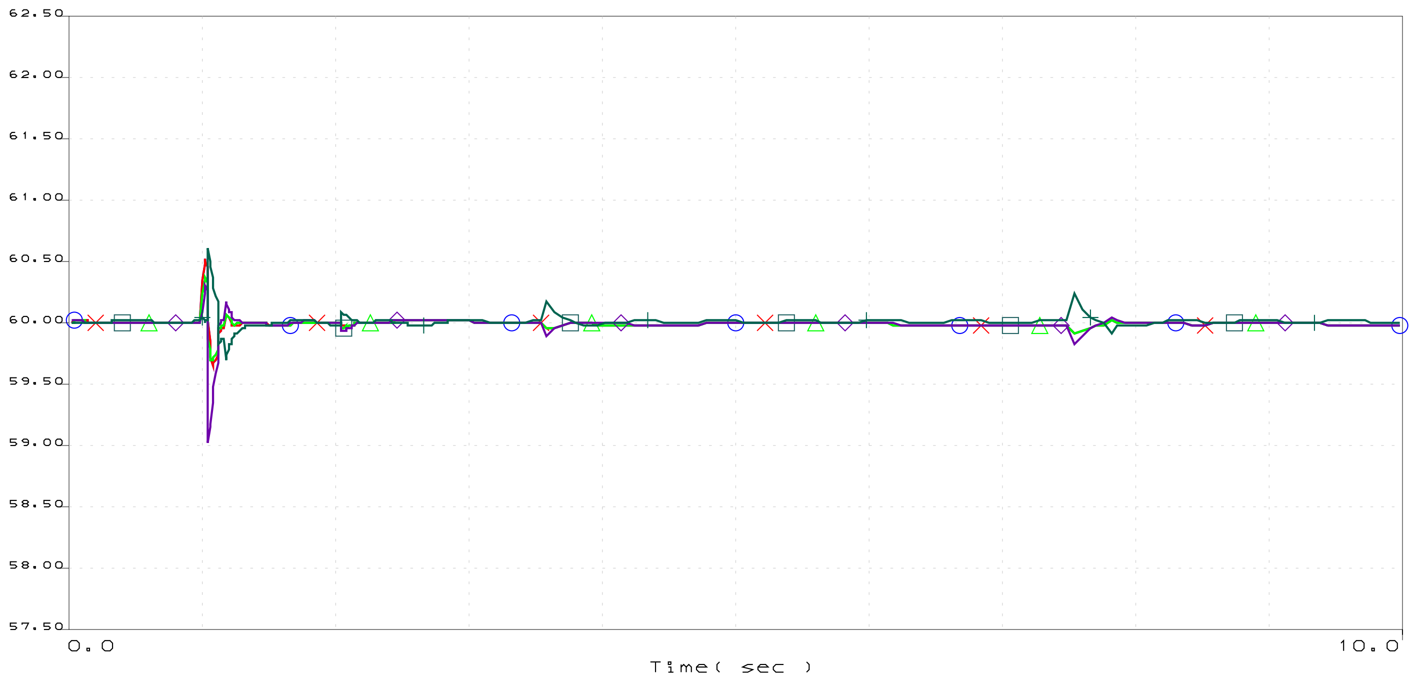
Wed Nov 24 11:54:04 2004



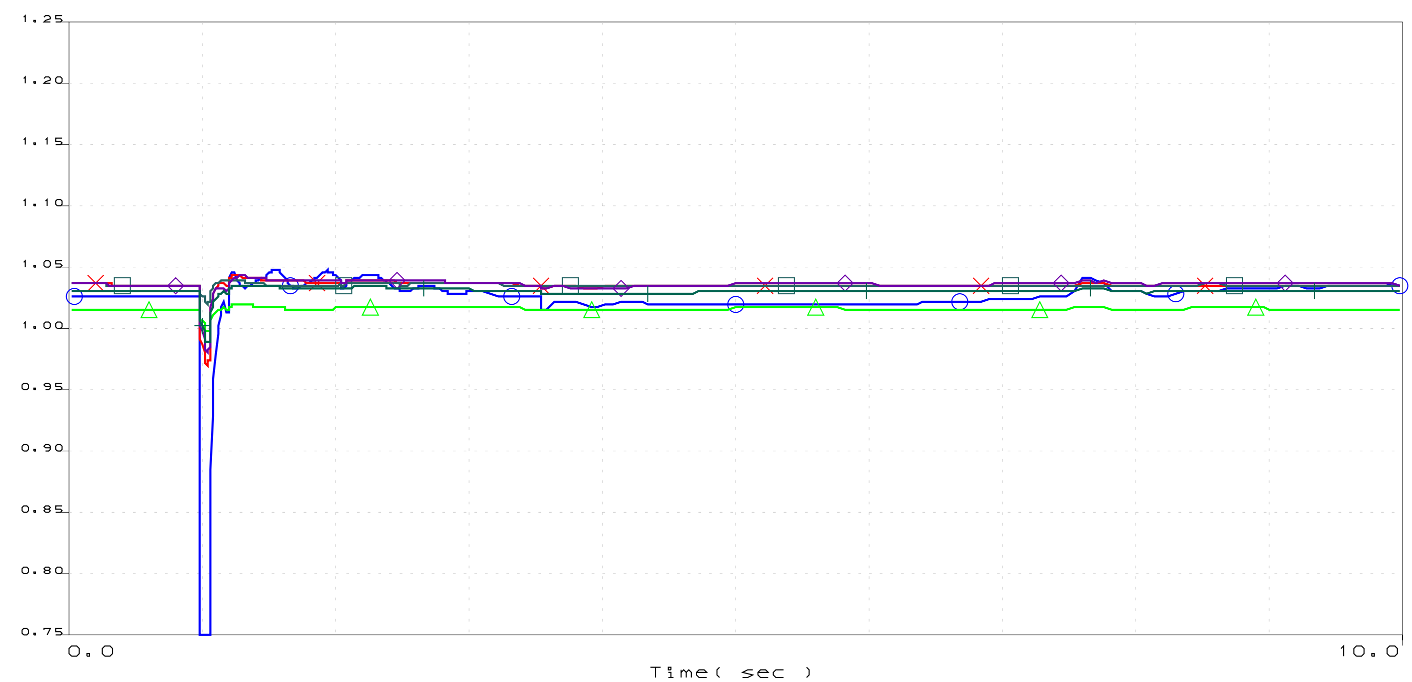
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



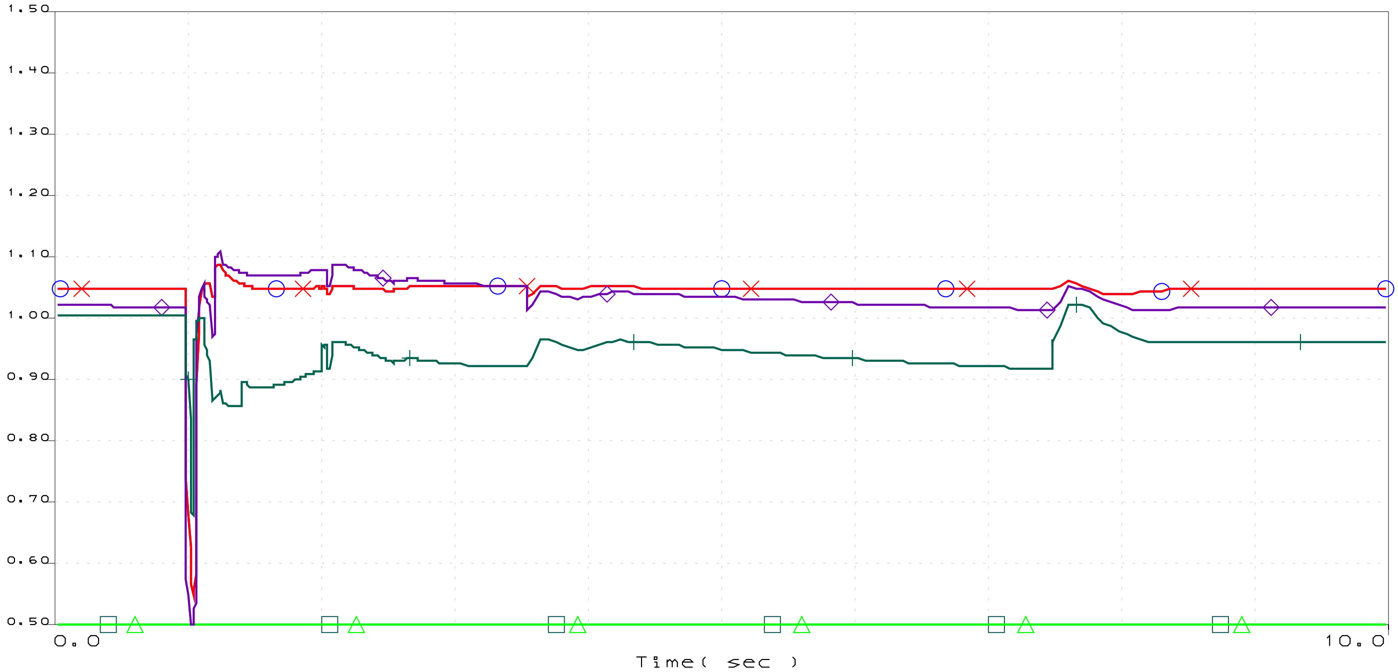
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



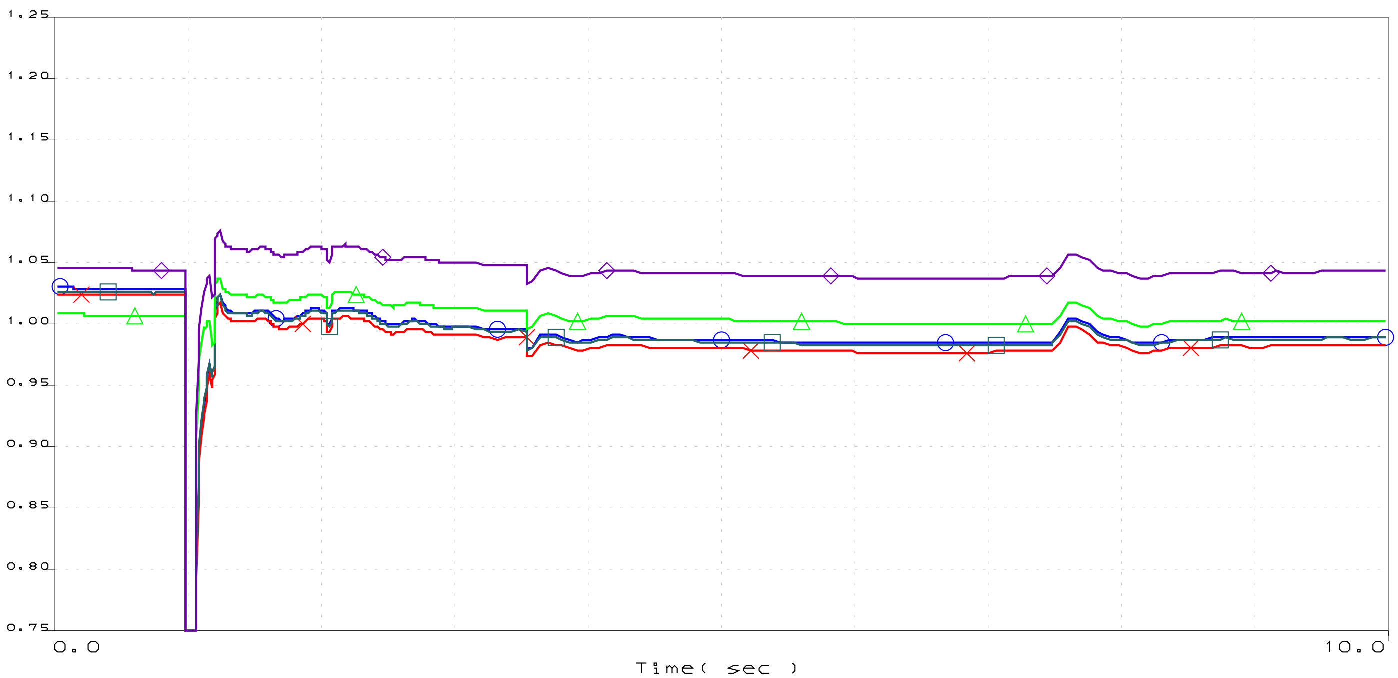
57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



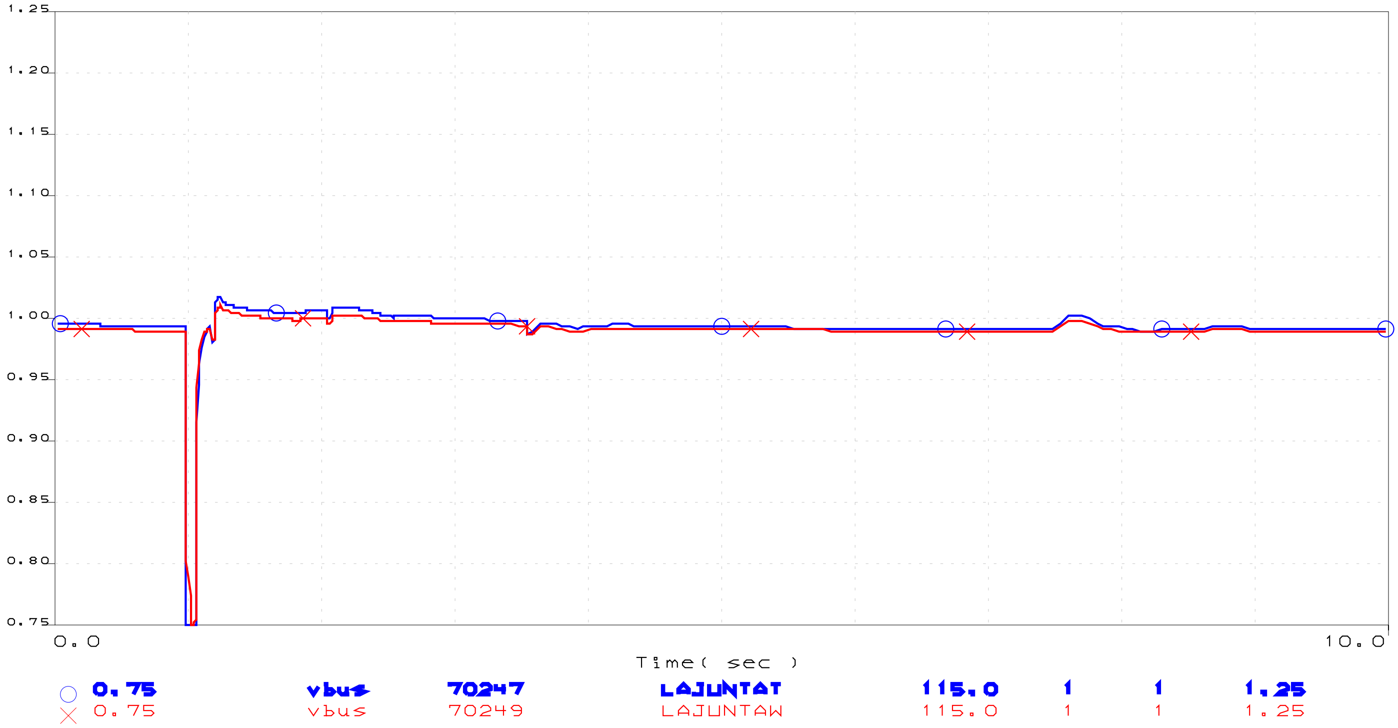
0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

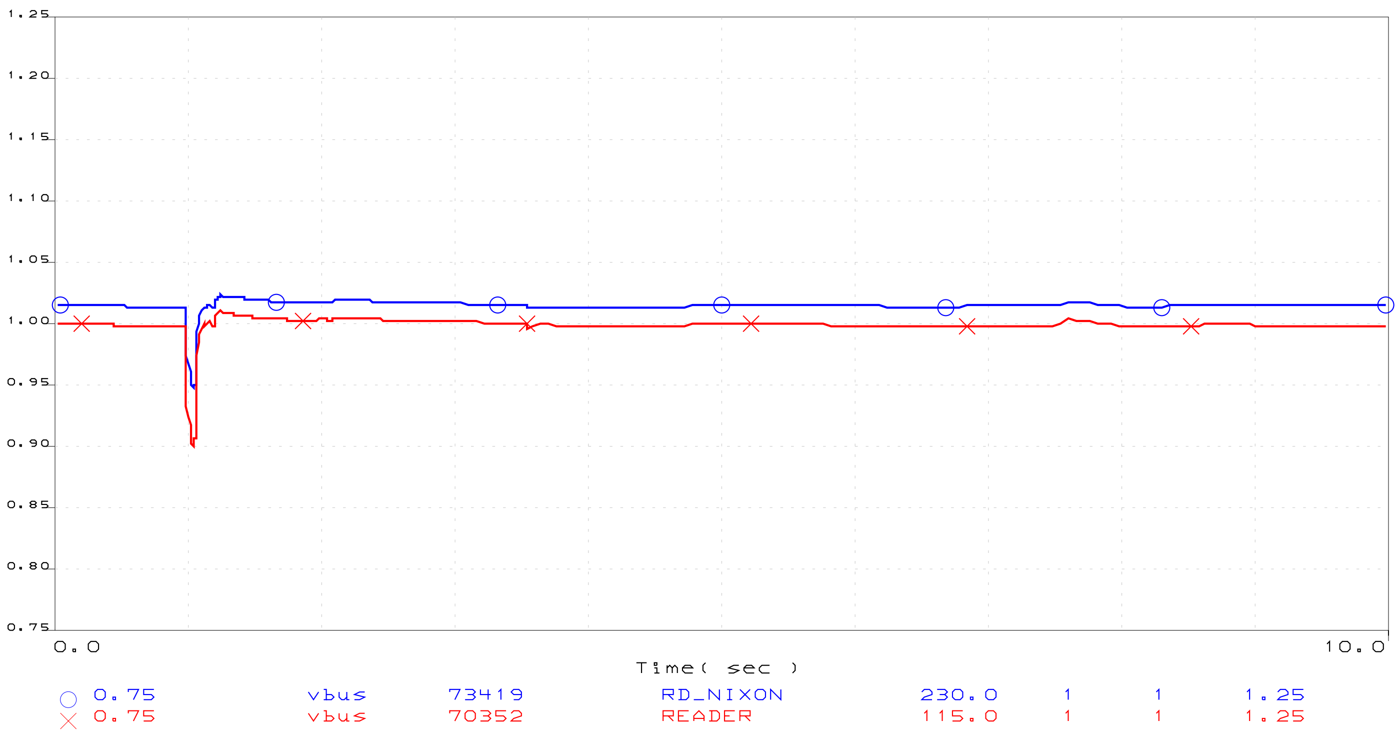


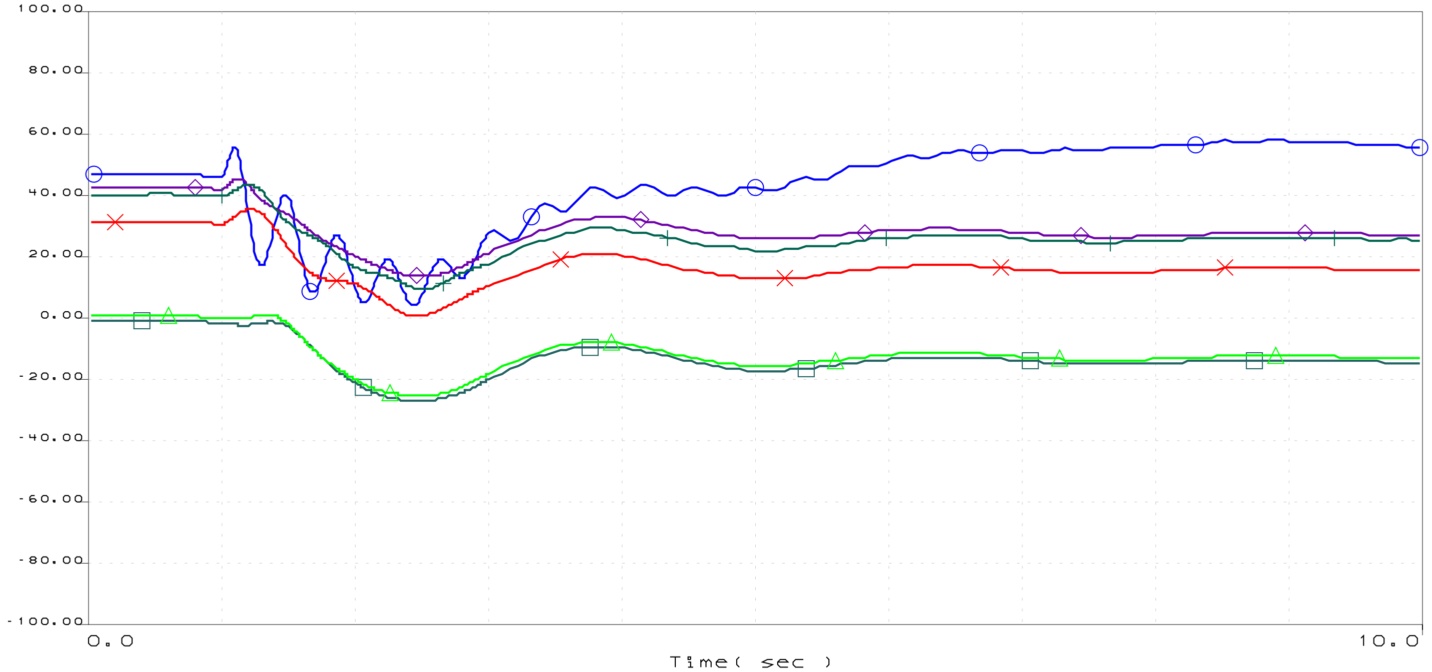
○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



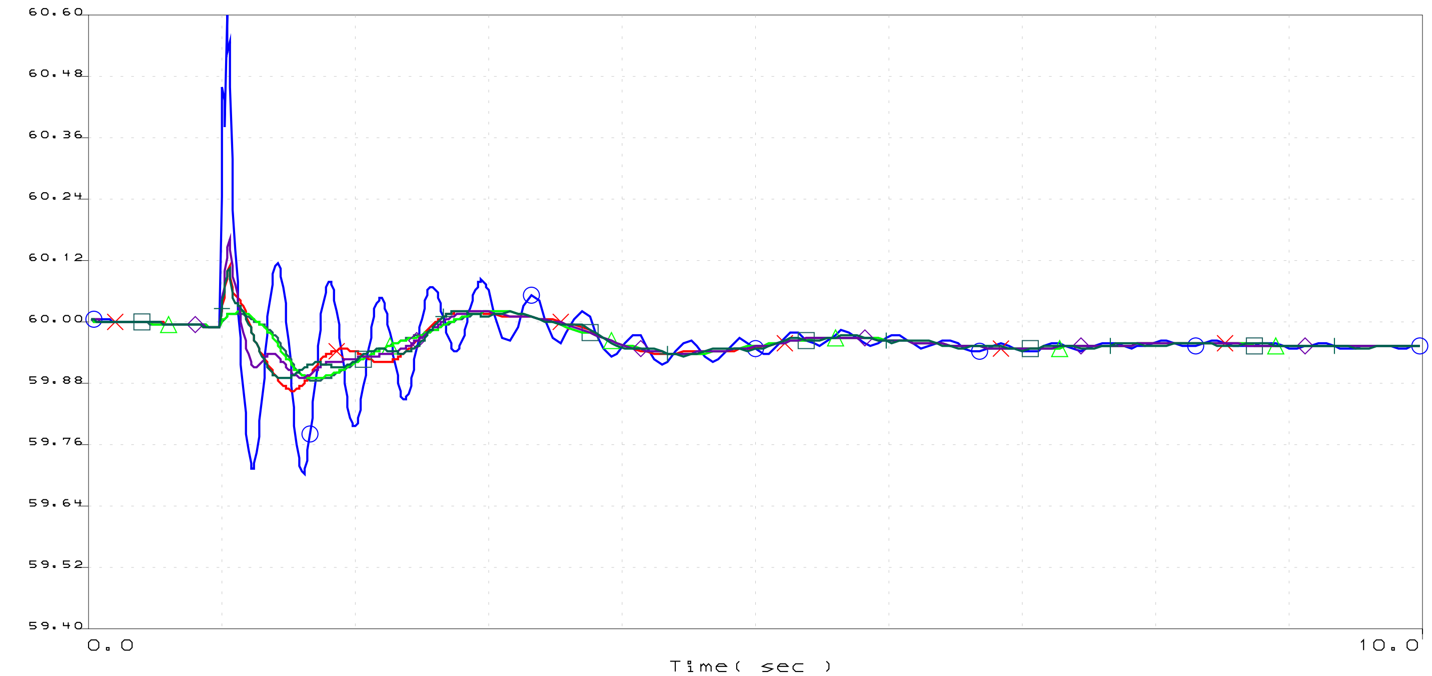
○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25

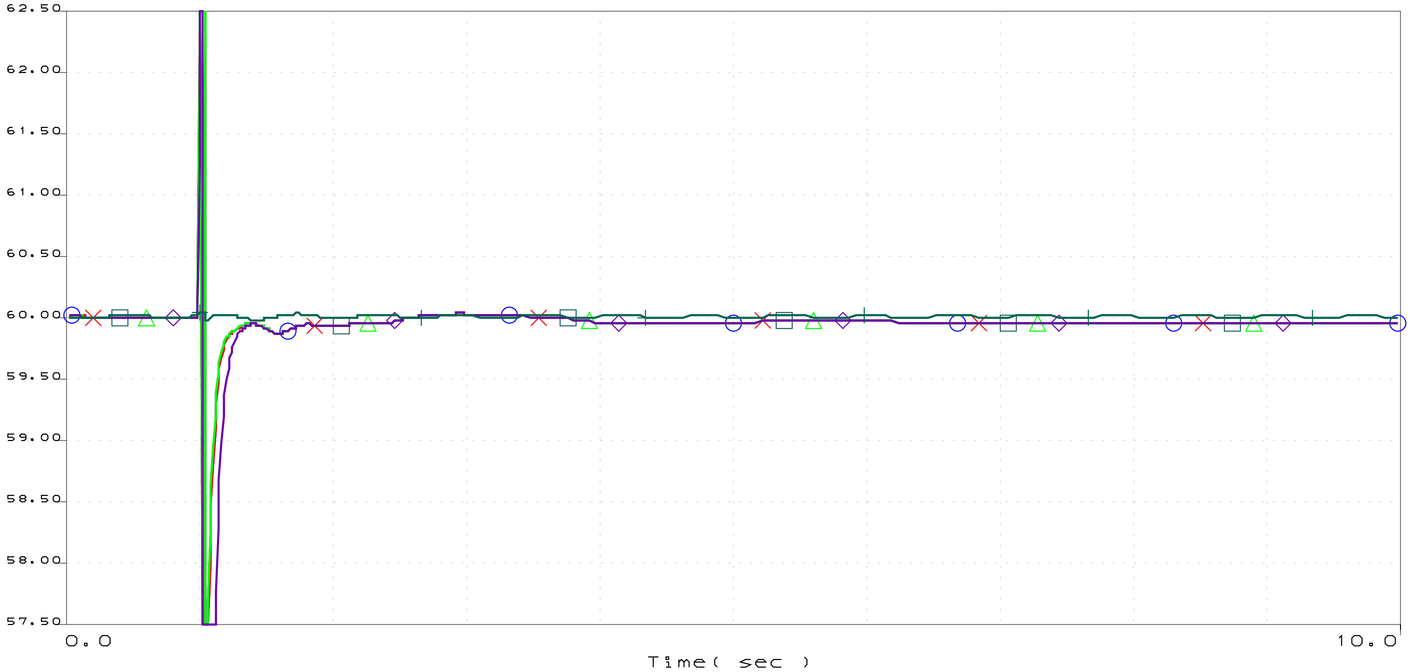

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



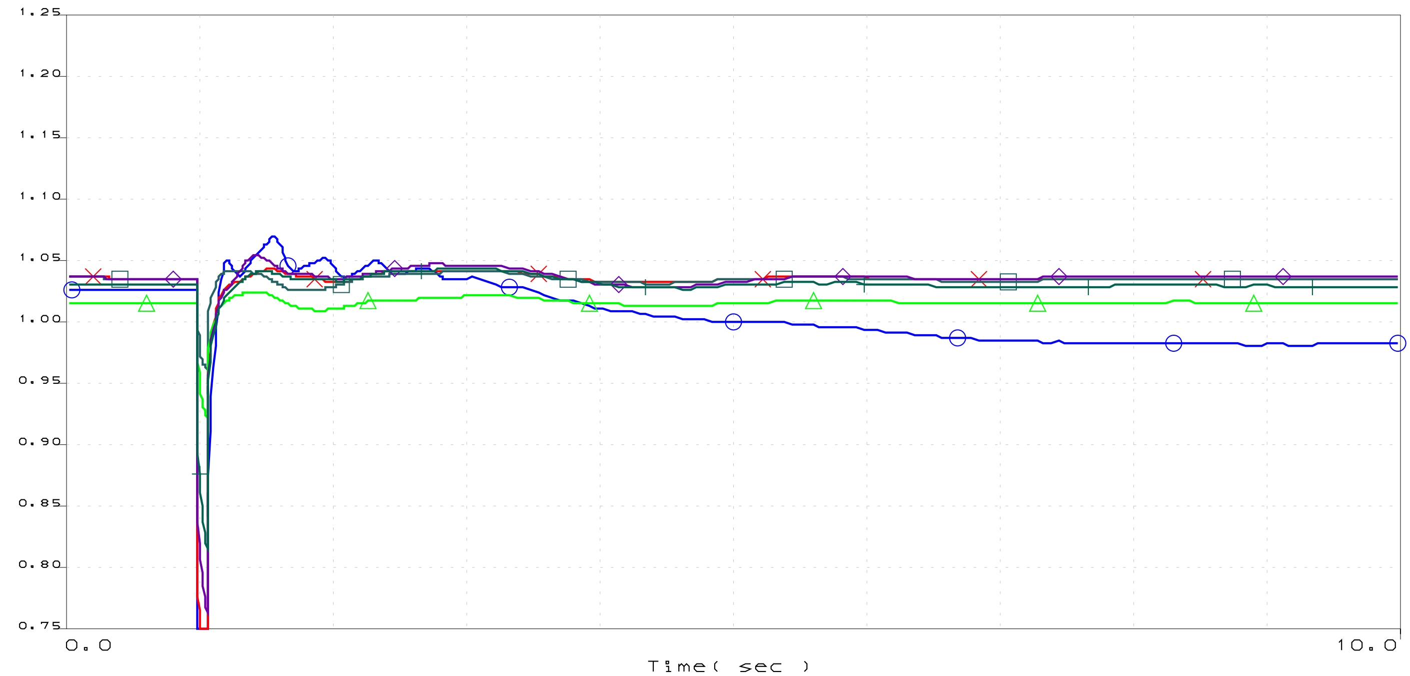
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



○	57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
×	57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□	57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△	57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇	57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+	57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○	0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
×	0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□	0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△	0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇	0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+	0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

Case256.chf

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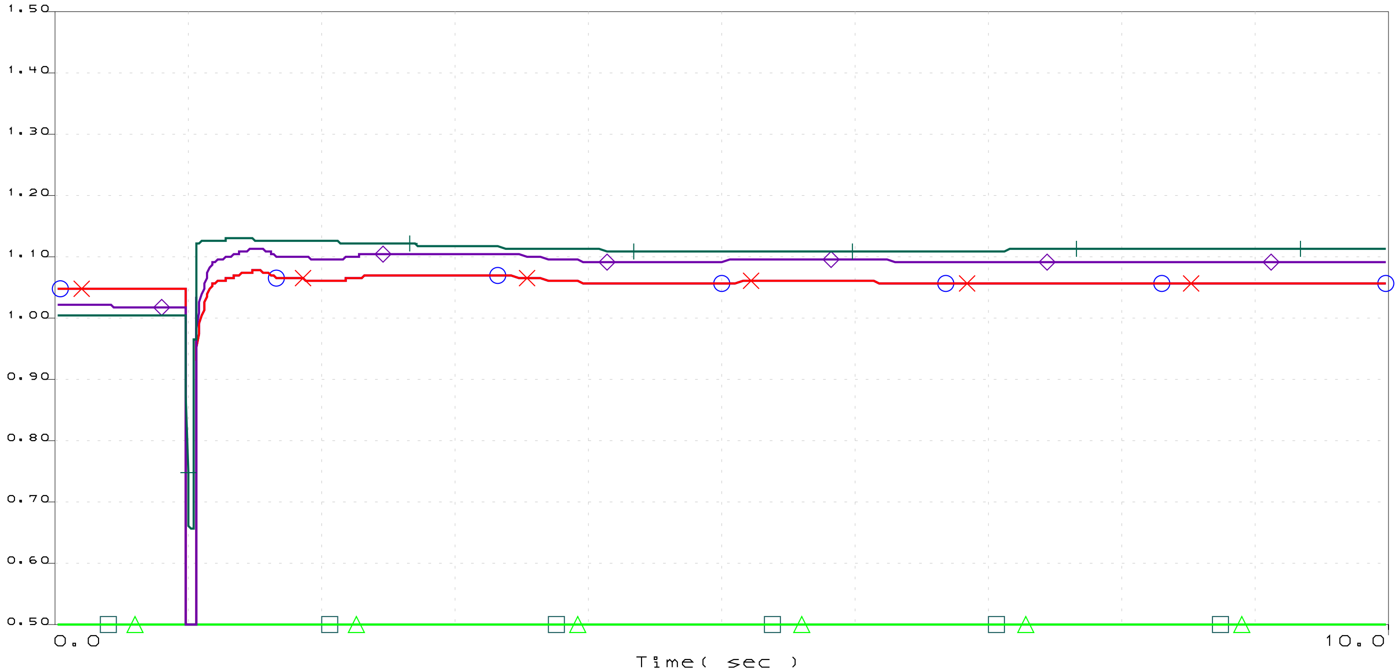
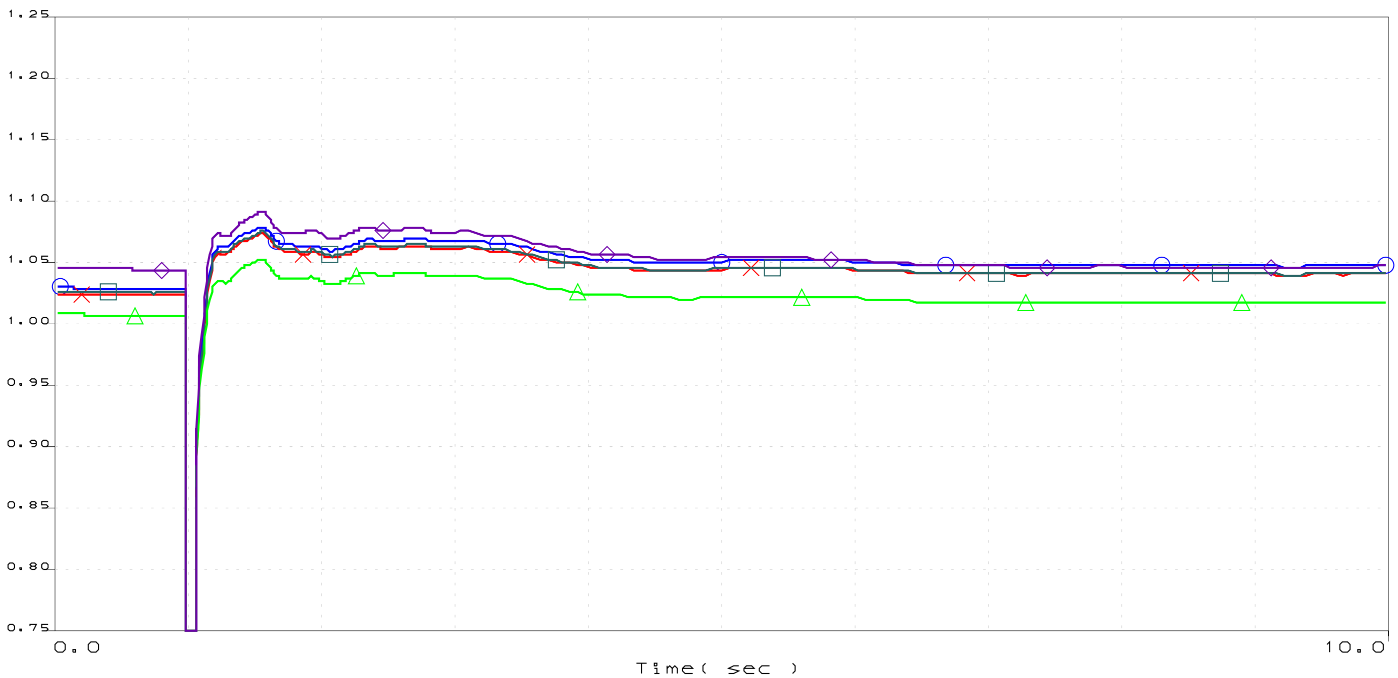
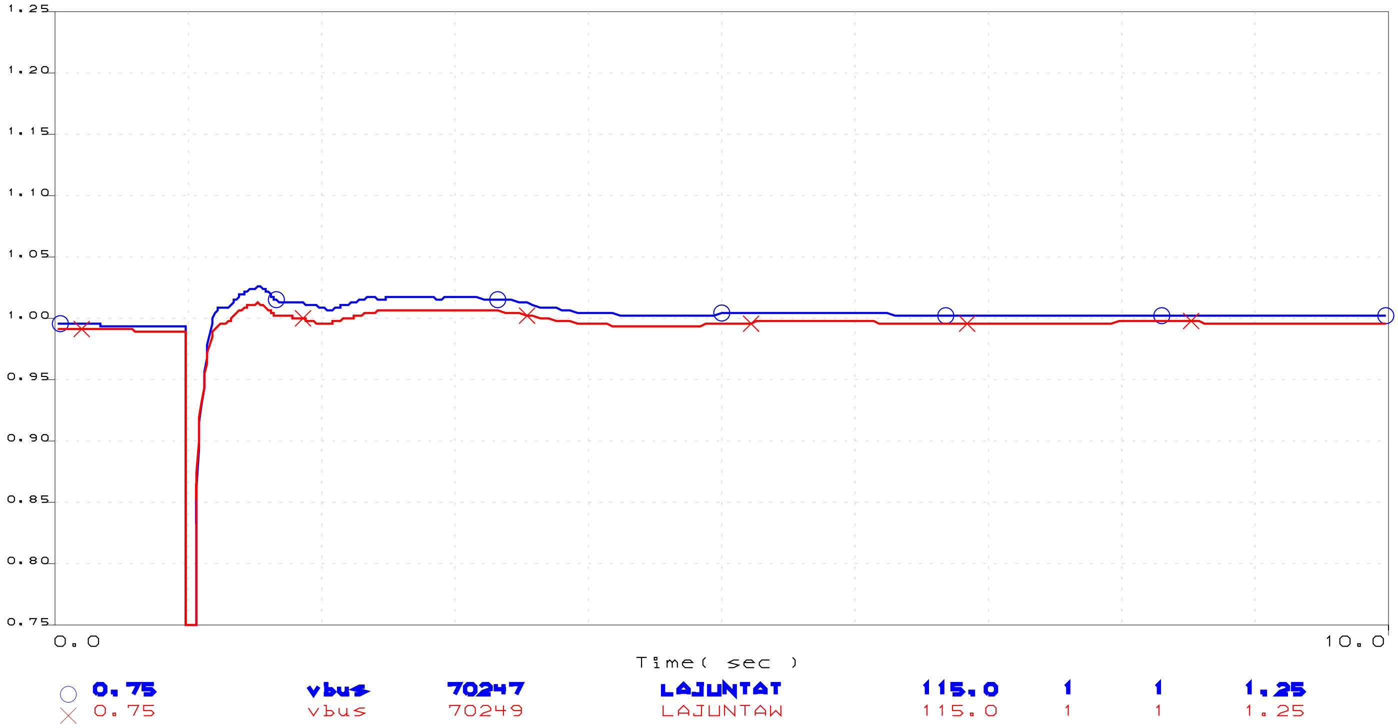
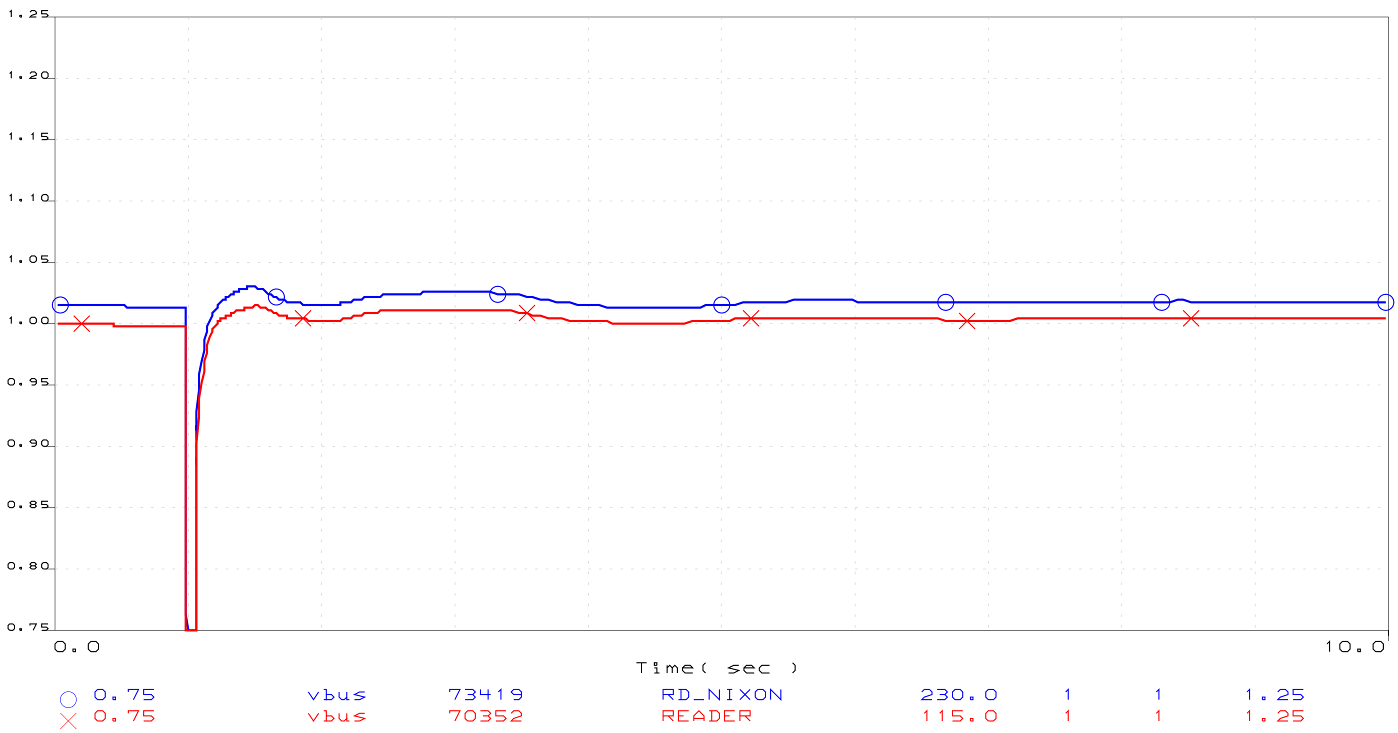


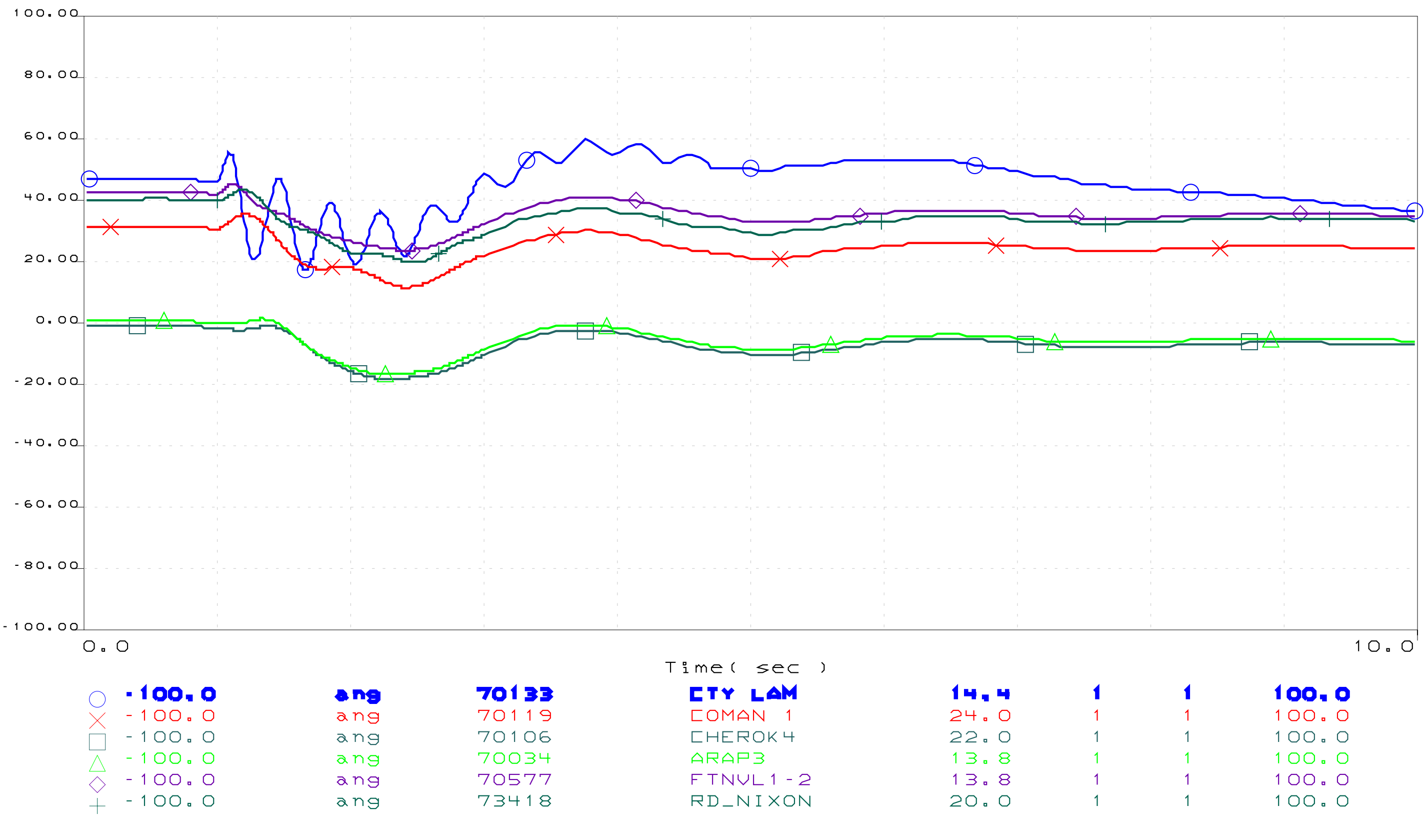
0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5

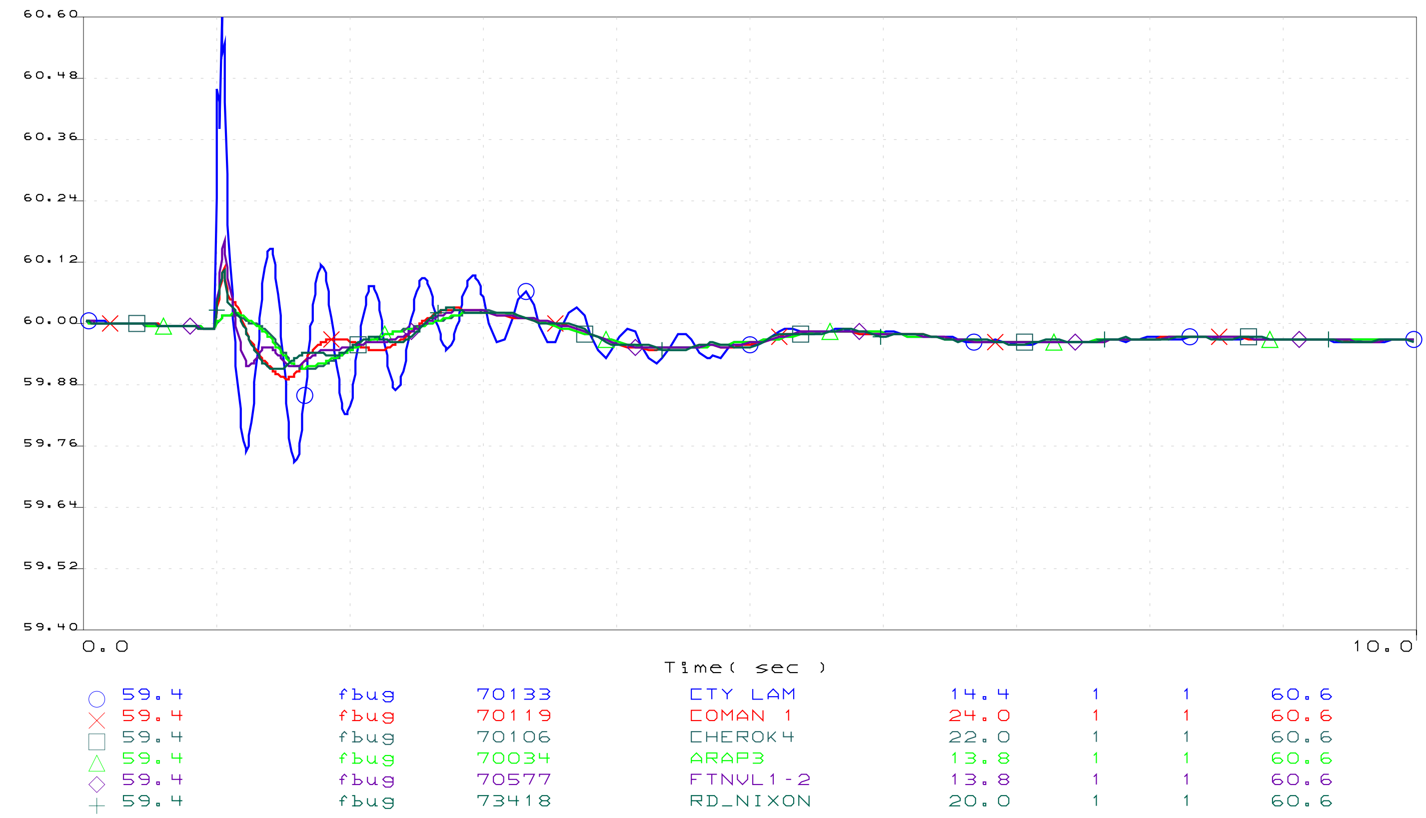


0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25





Case257.chf

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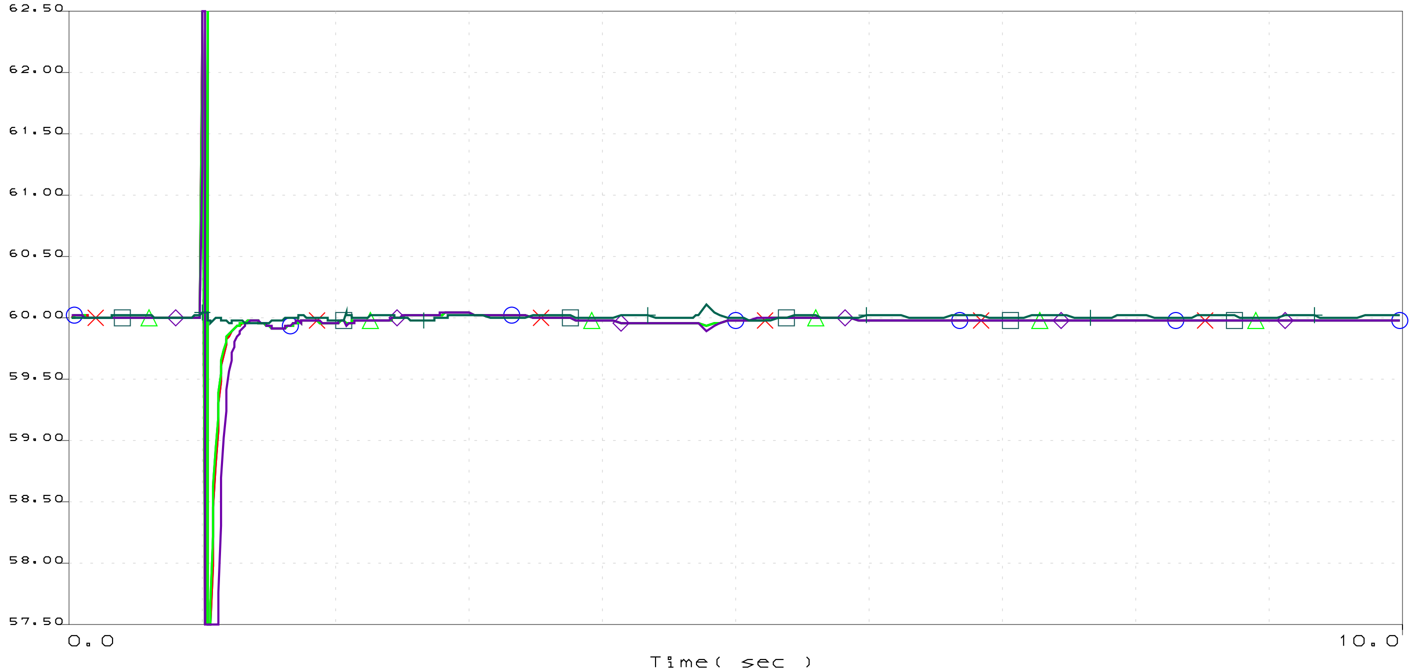
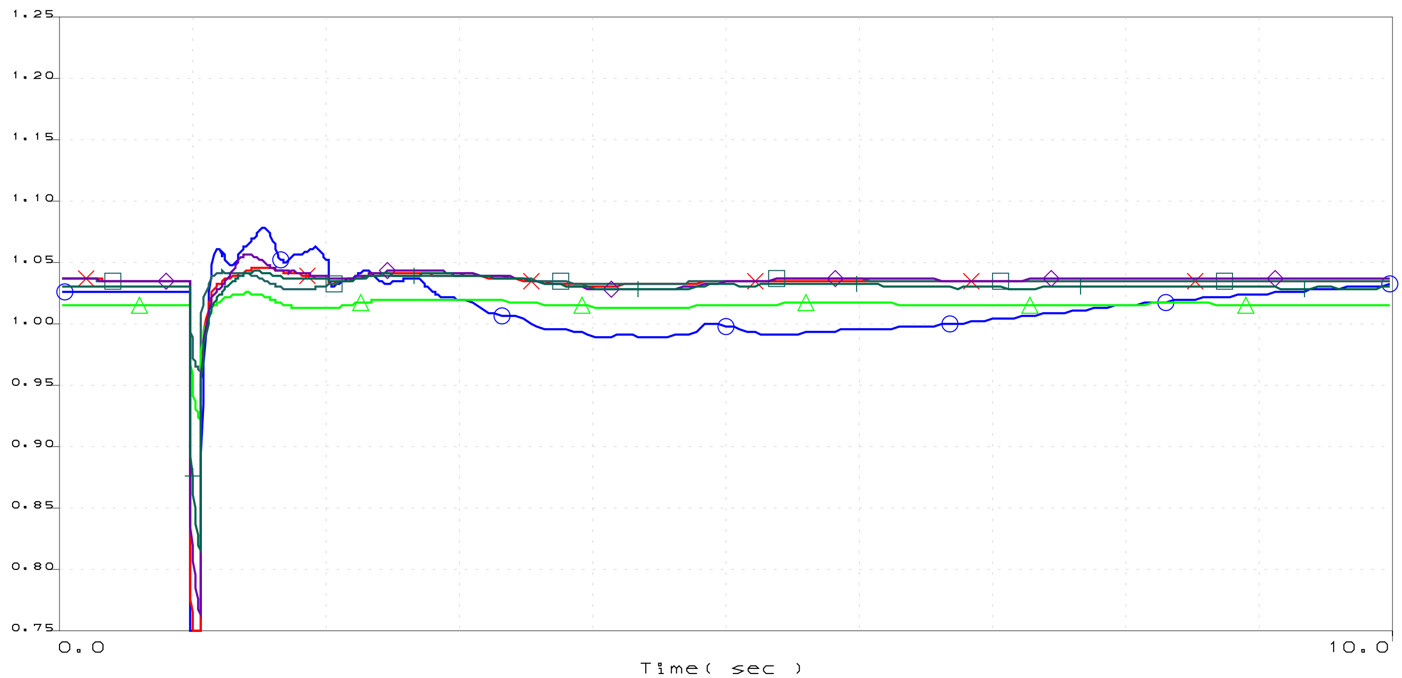
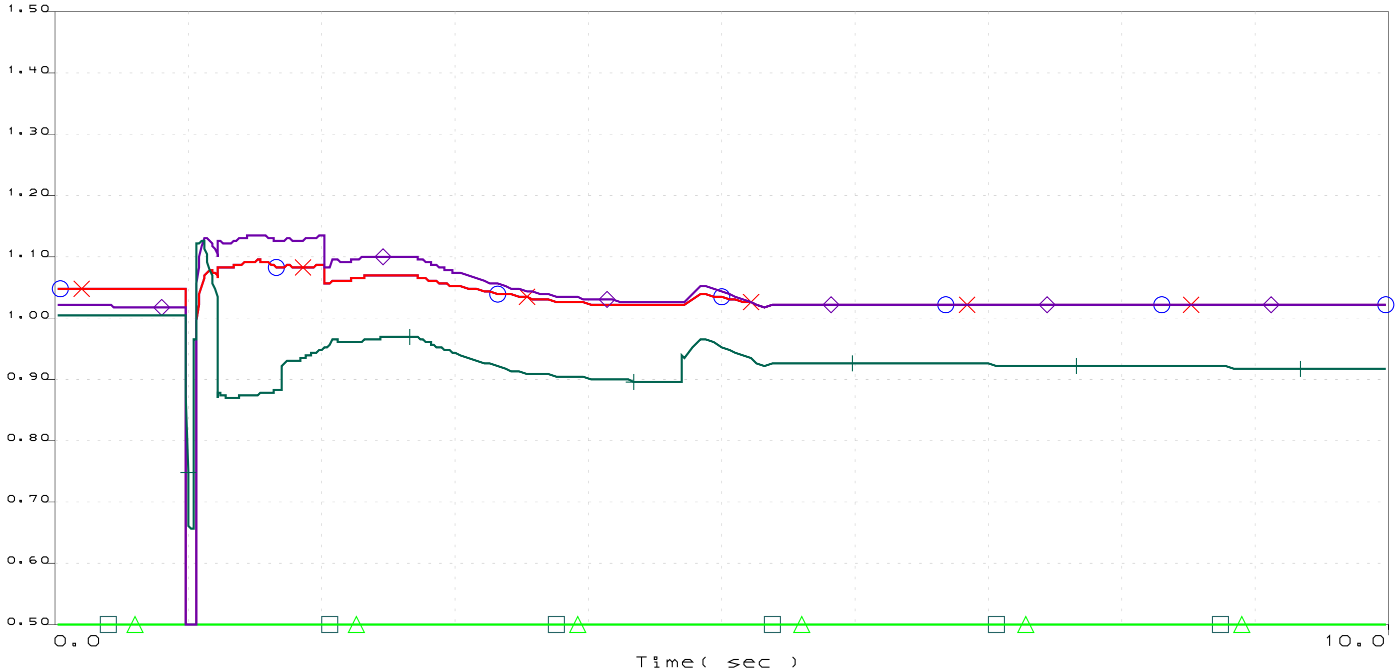


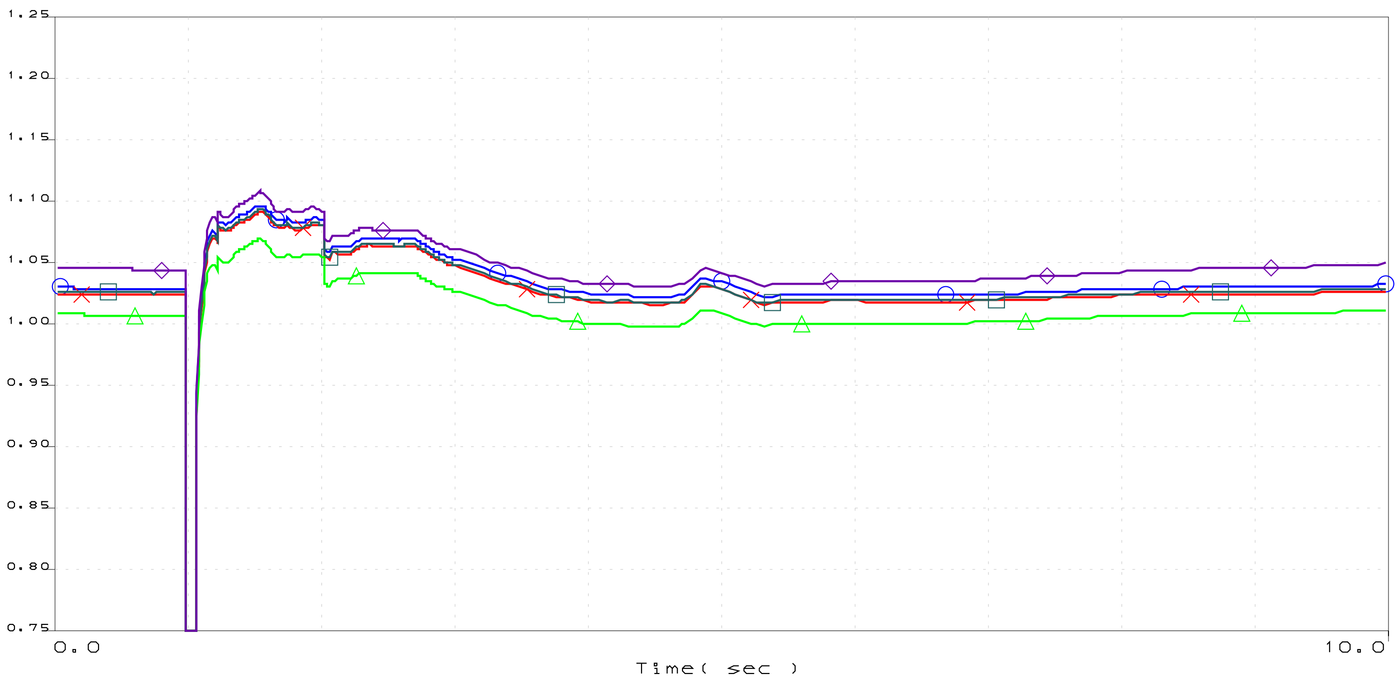
57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case257.chf

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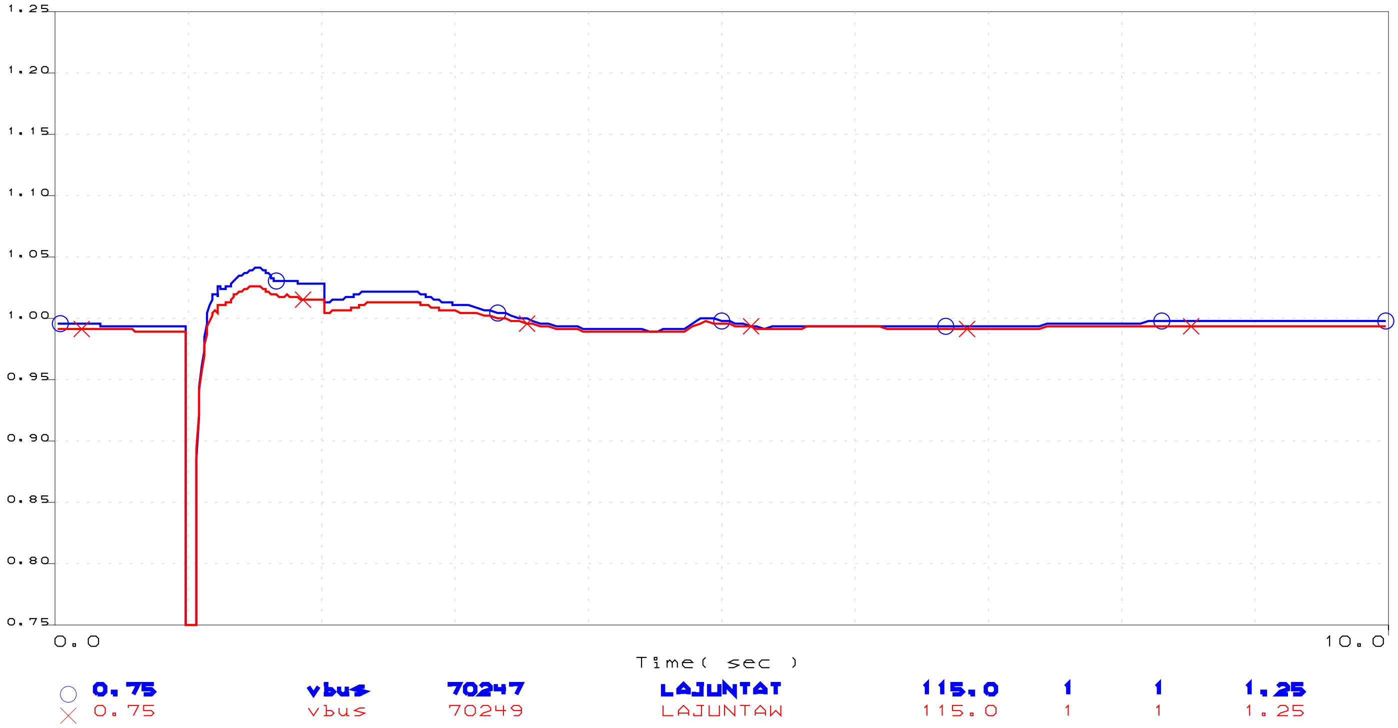
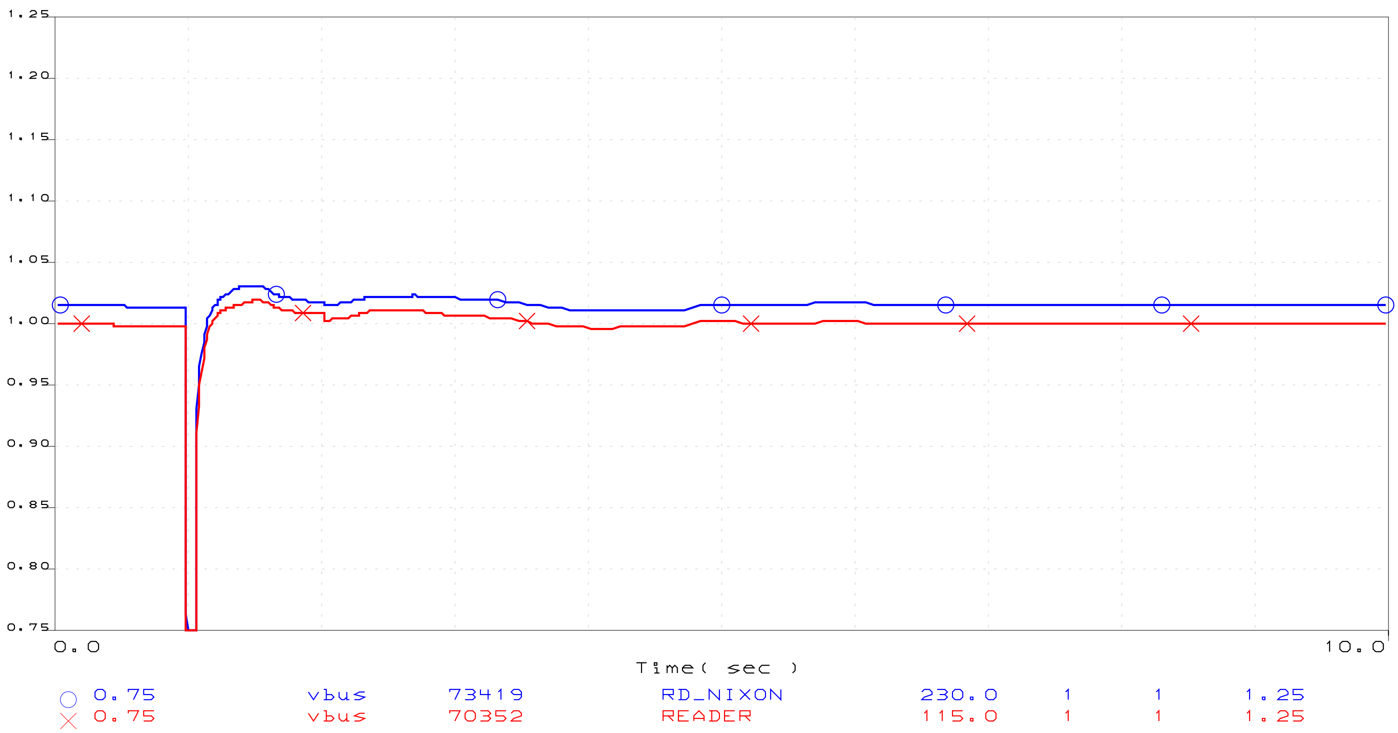
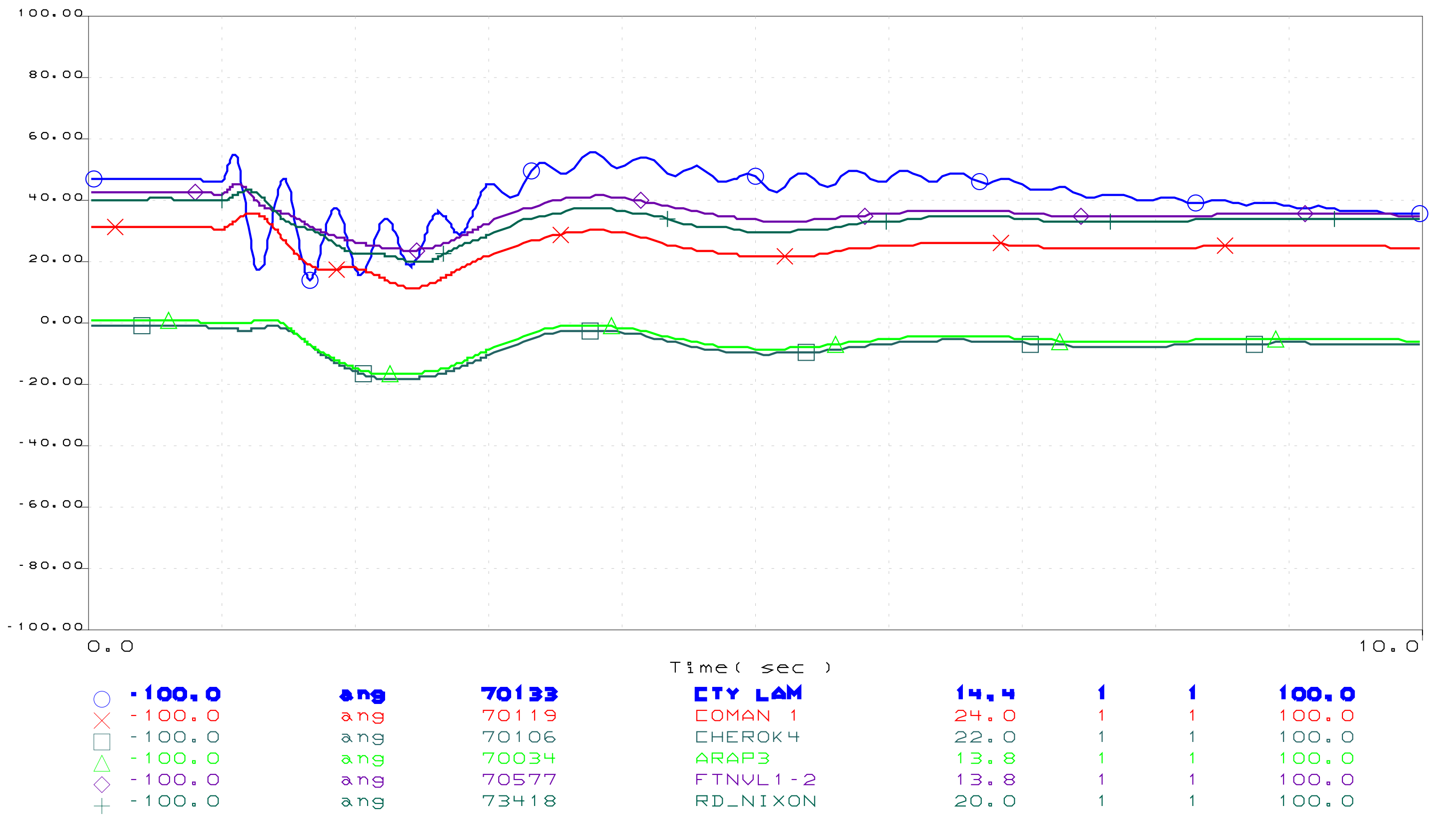
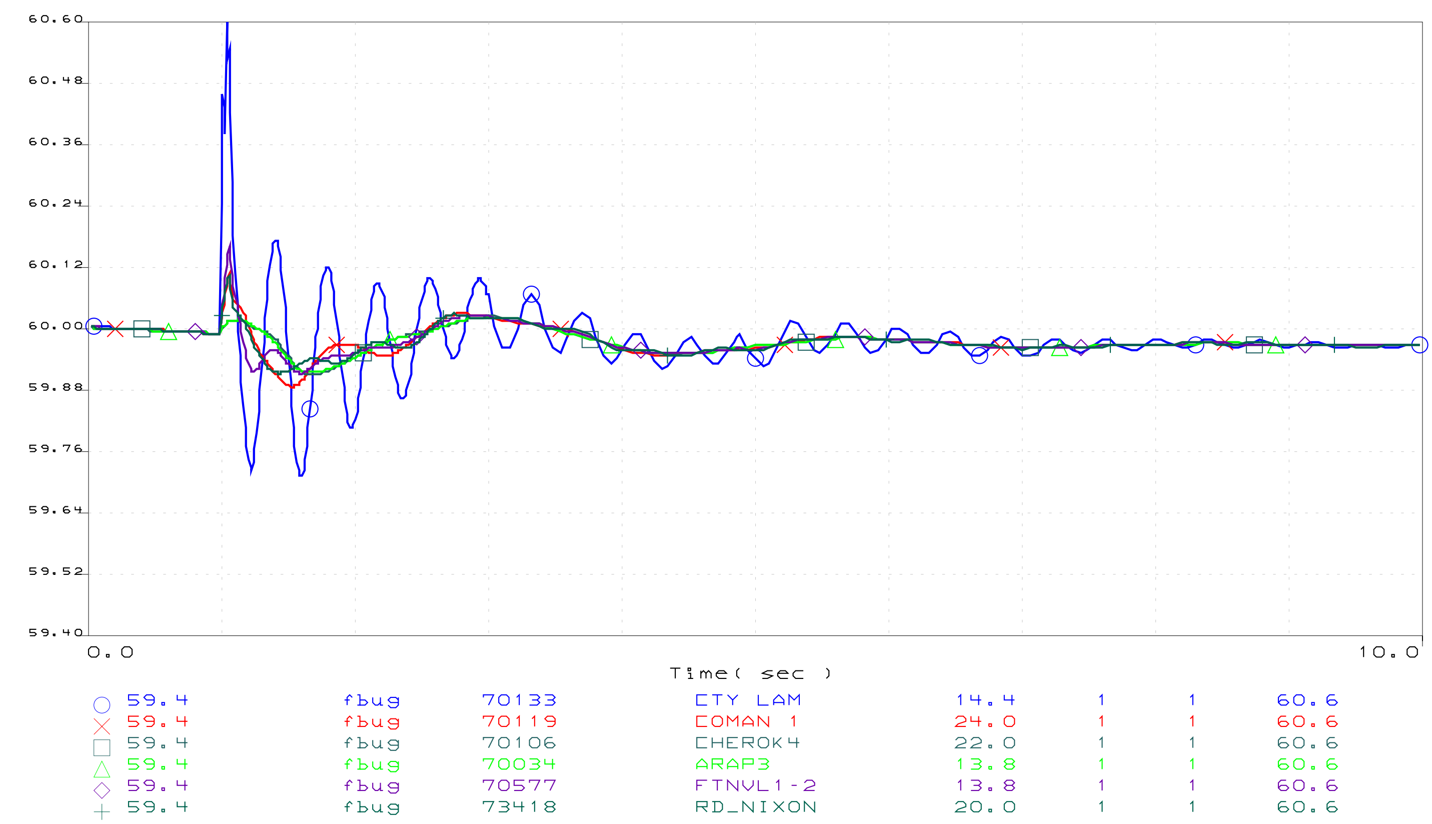




Case257.chf

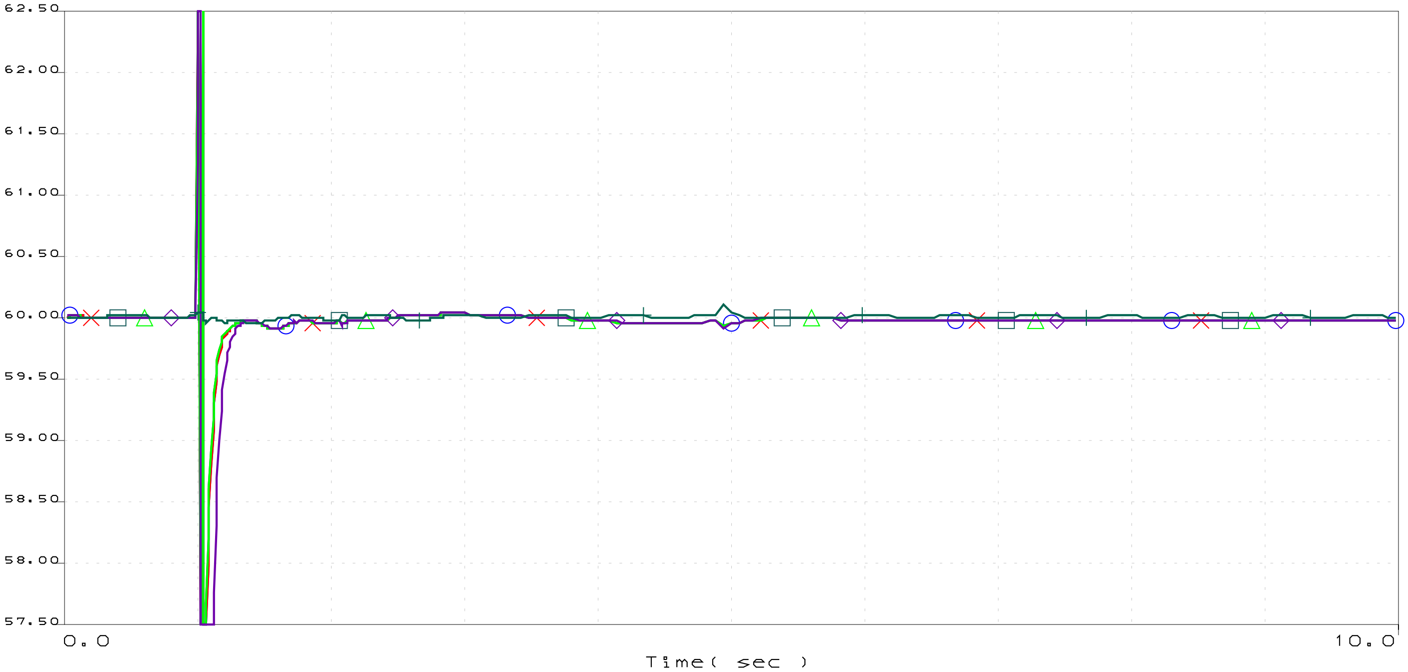
Wed Nov 24 11:54:43 2004



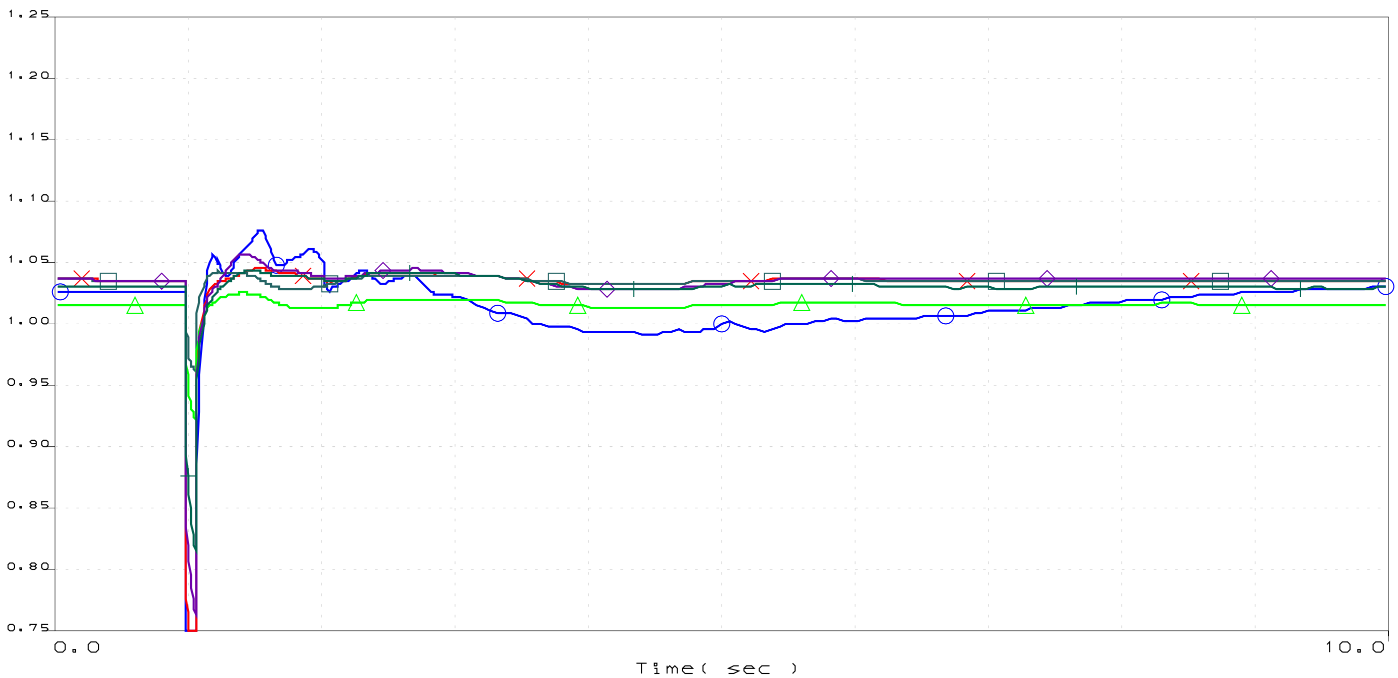


Case258.chf

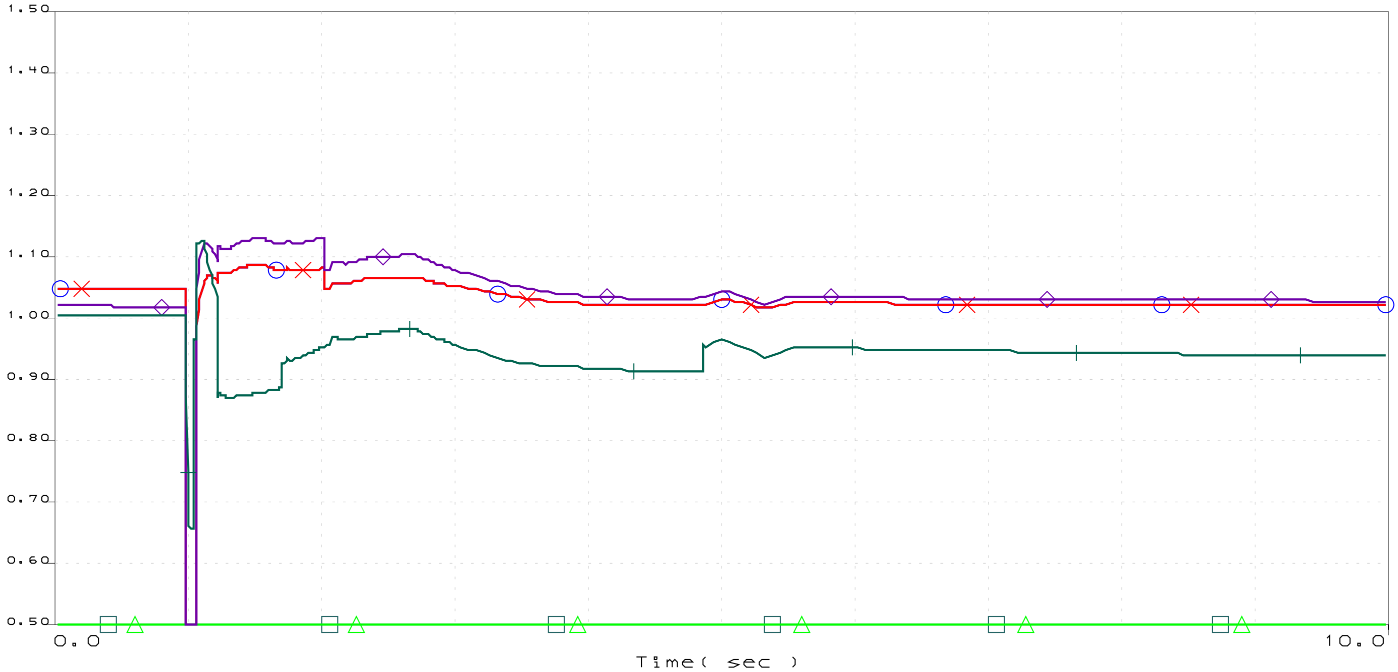
Wed Nov 24 11:54:58 2004



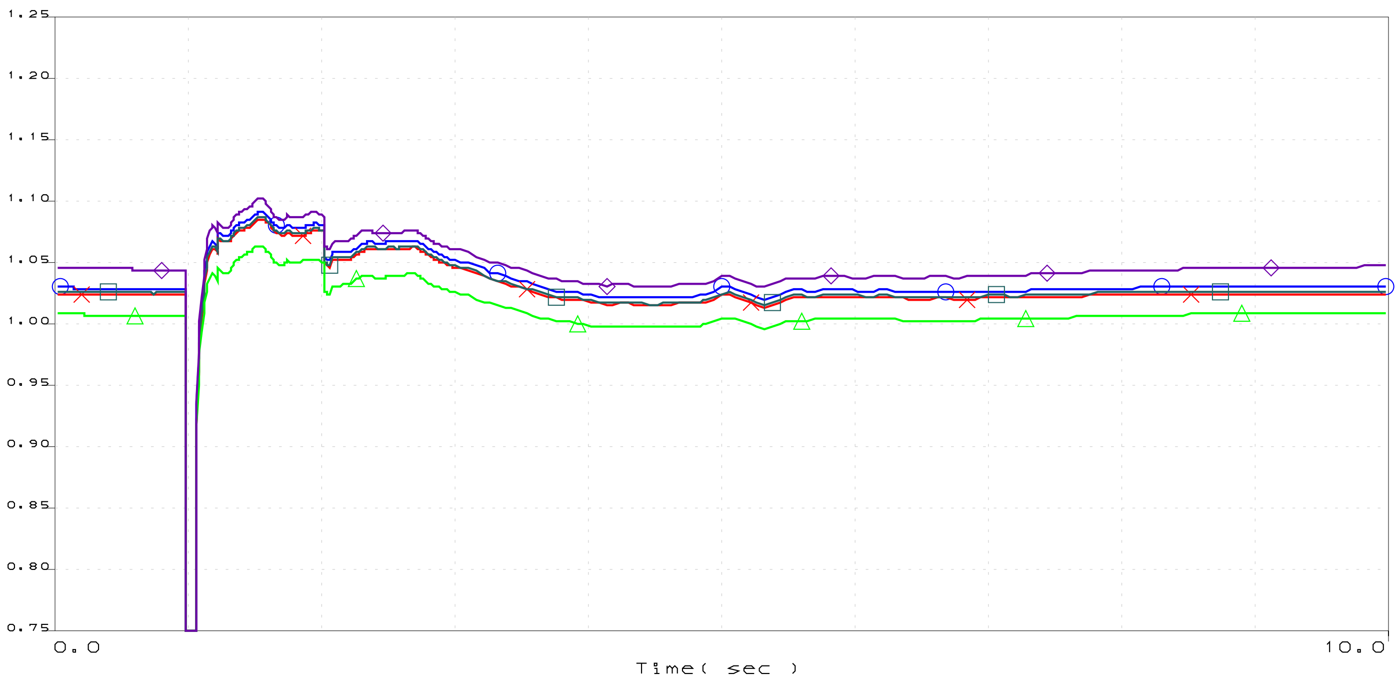
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case258.chf

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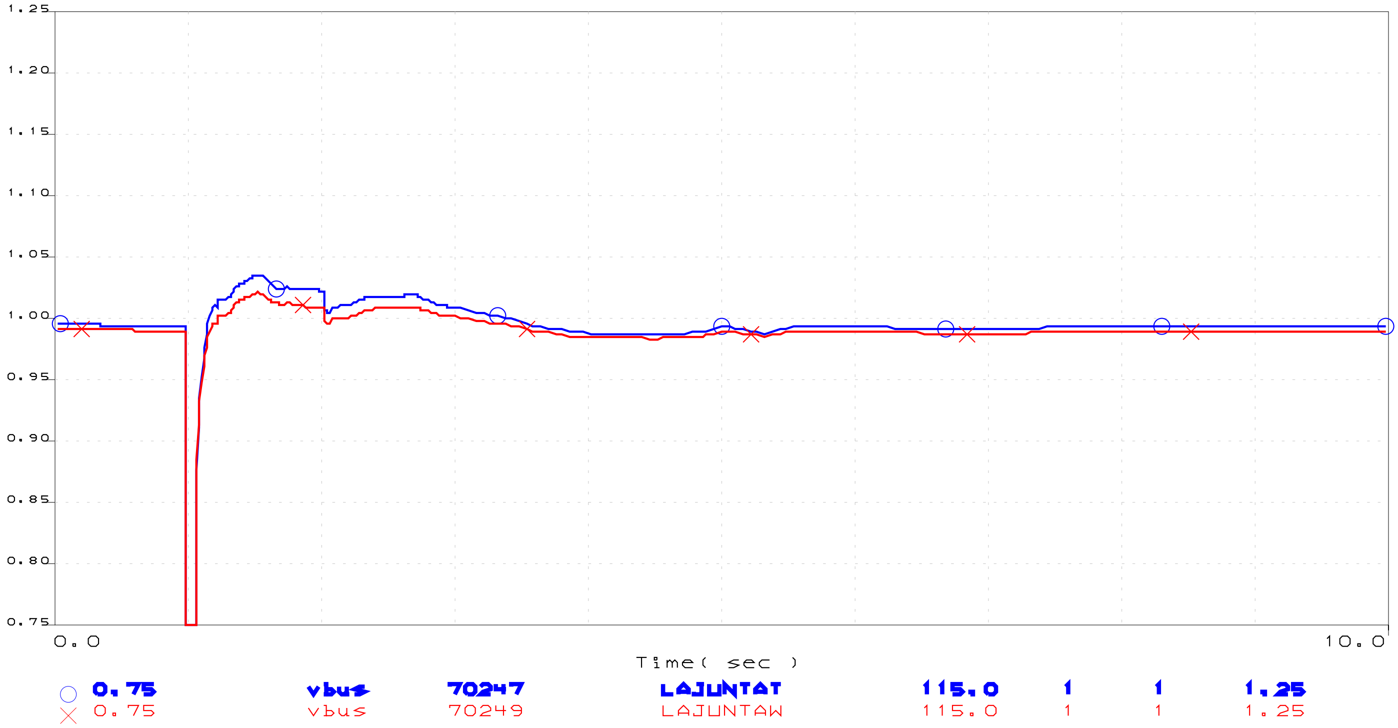
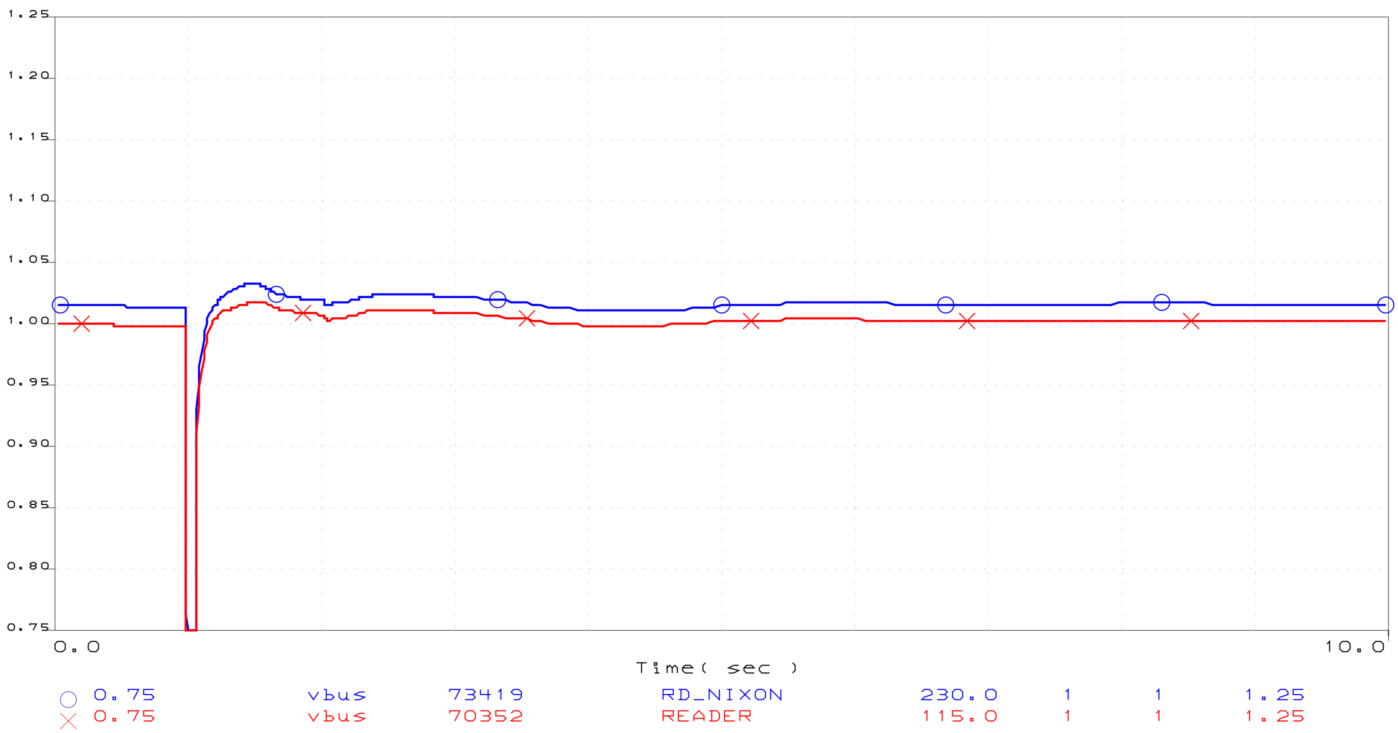
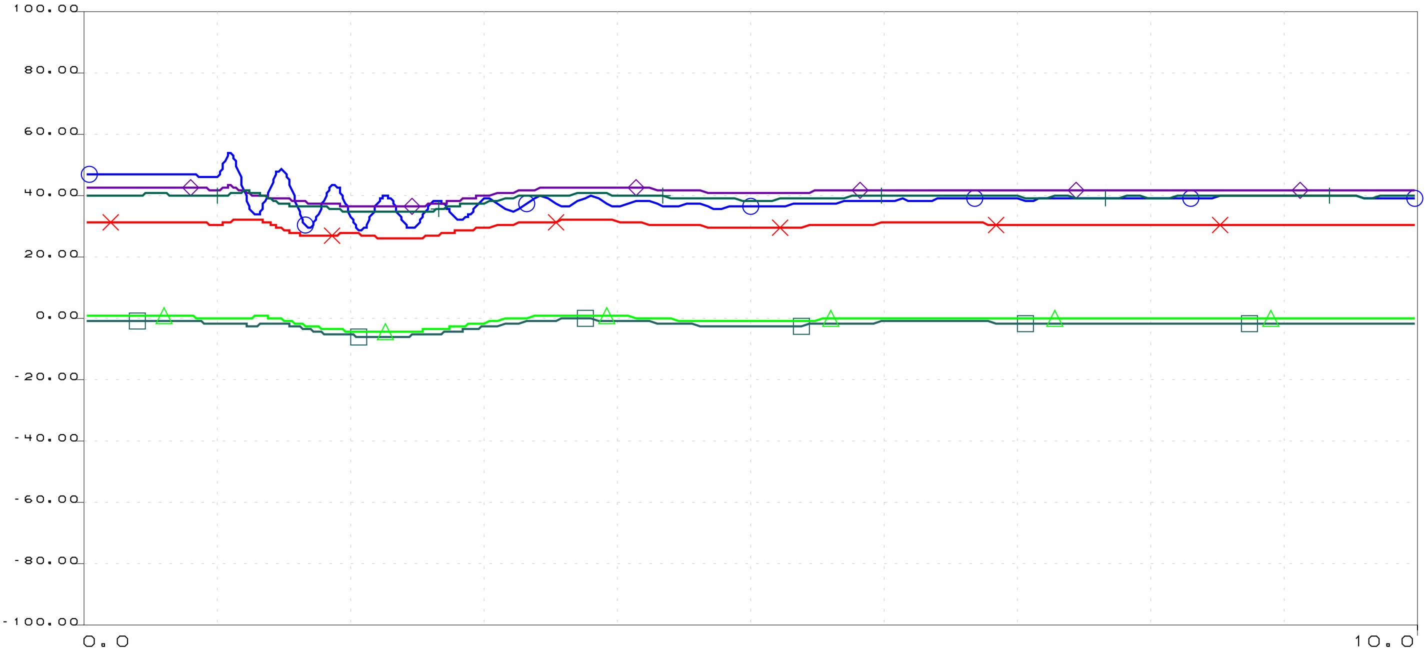


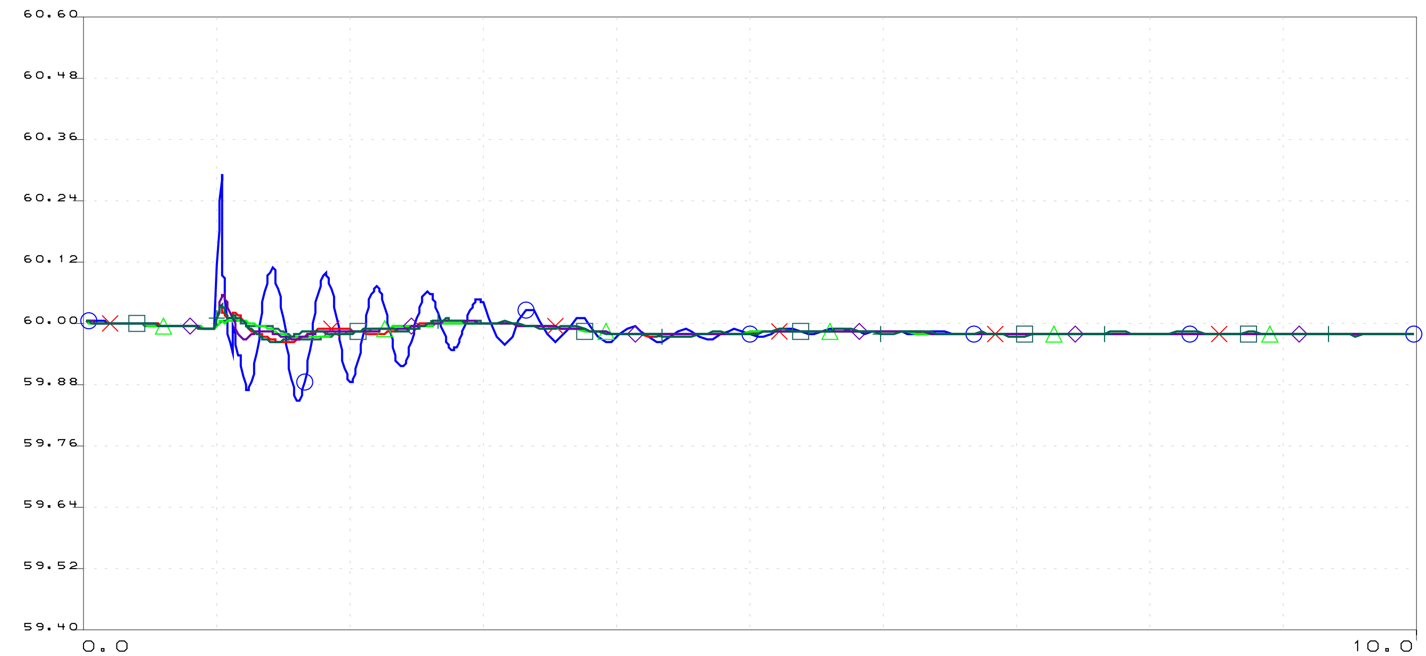


Case258.chf

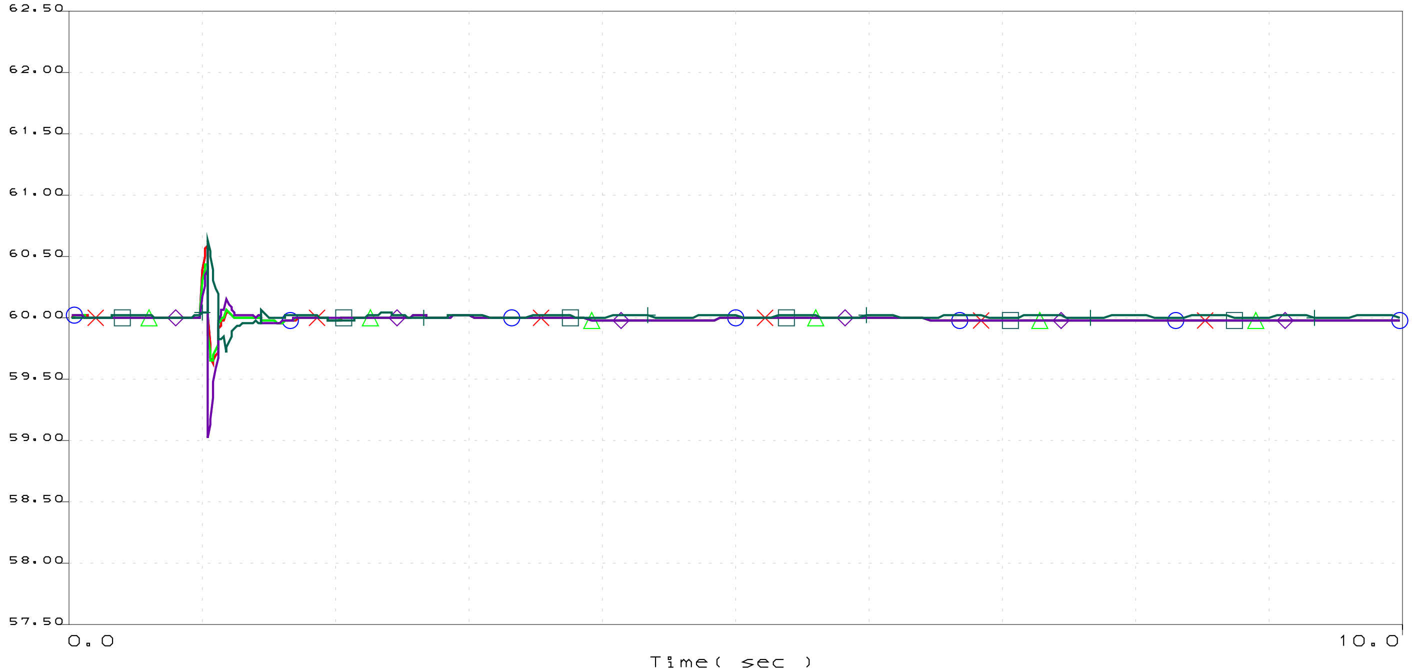
Wed Nov 24 11:54:58 2004



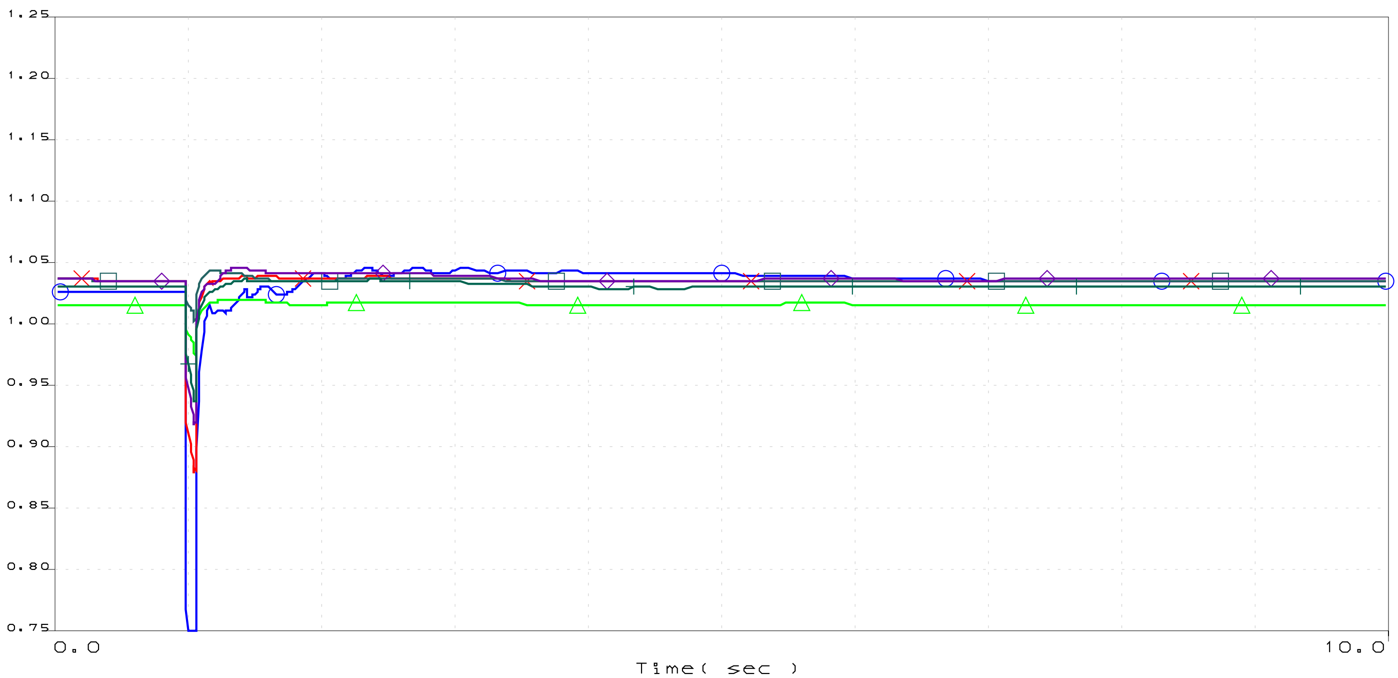
○	**-100.0**	**ang**	**70133**	**CTY LAM**	**14.4**	**1**	**1**	**100.0**
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



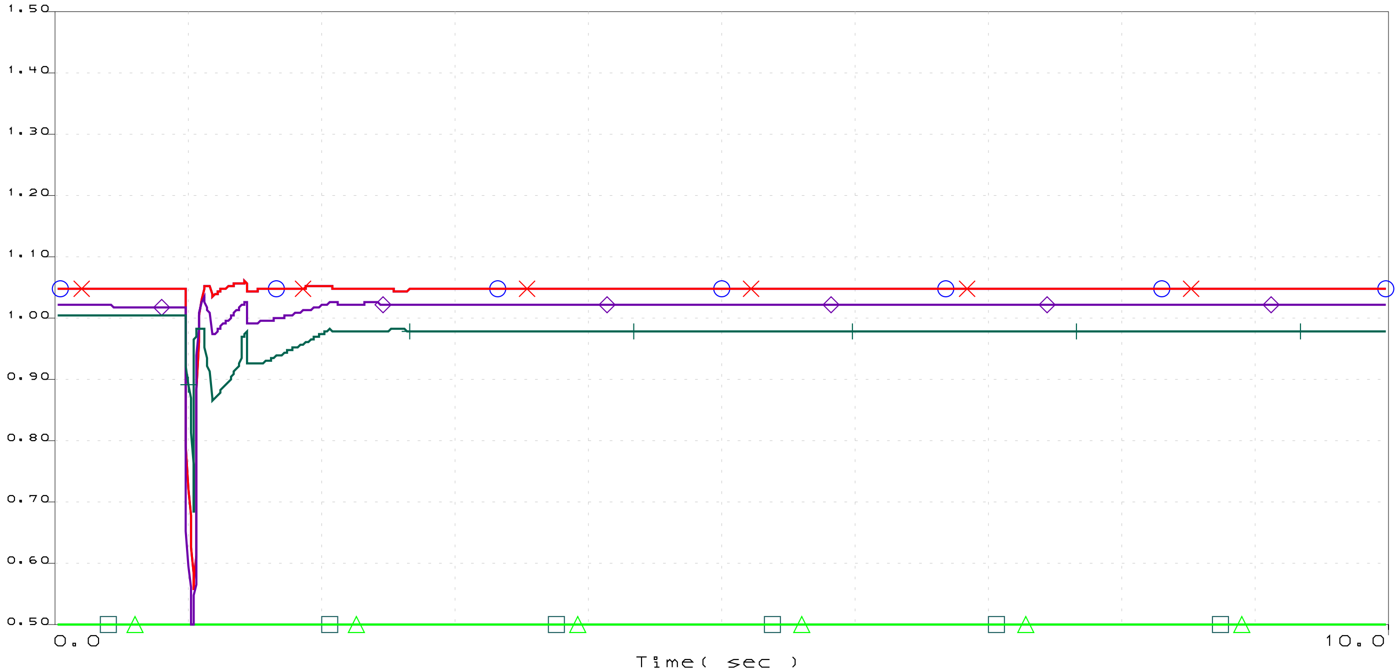
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



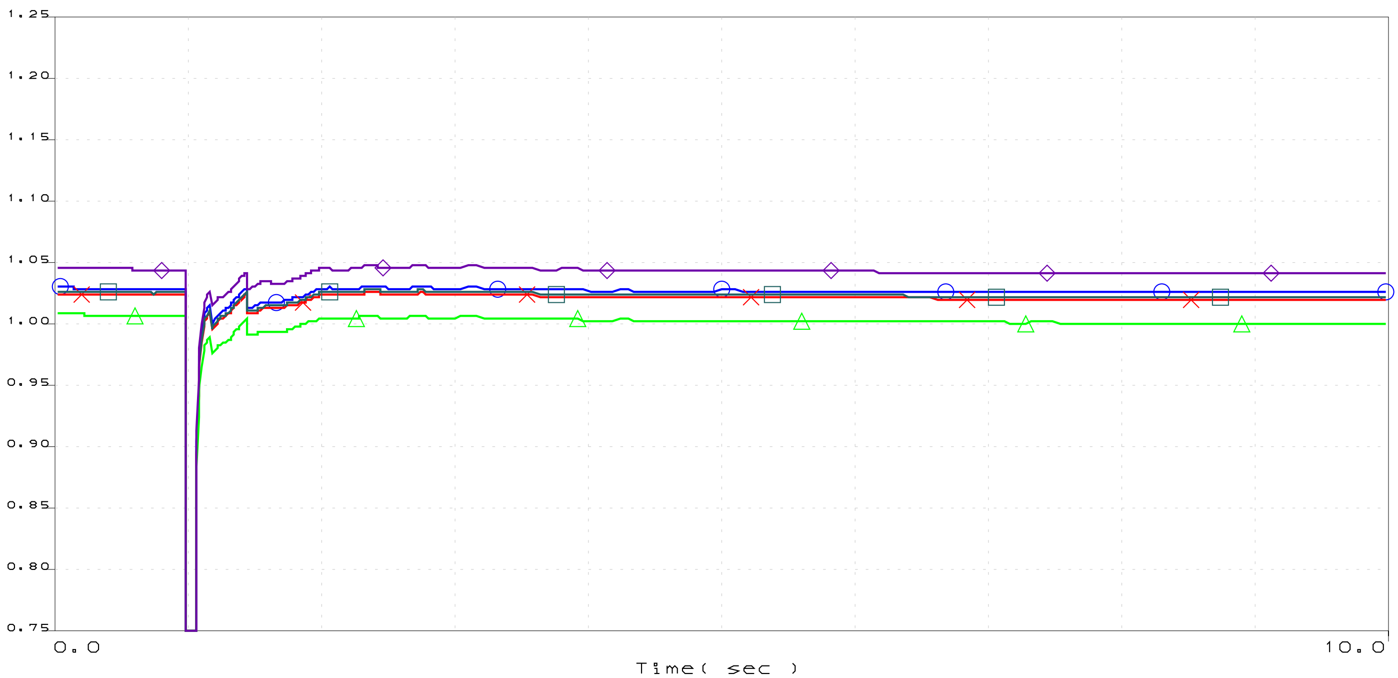
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



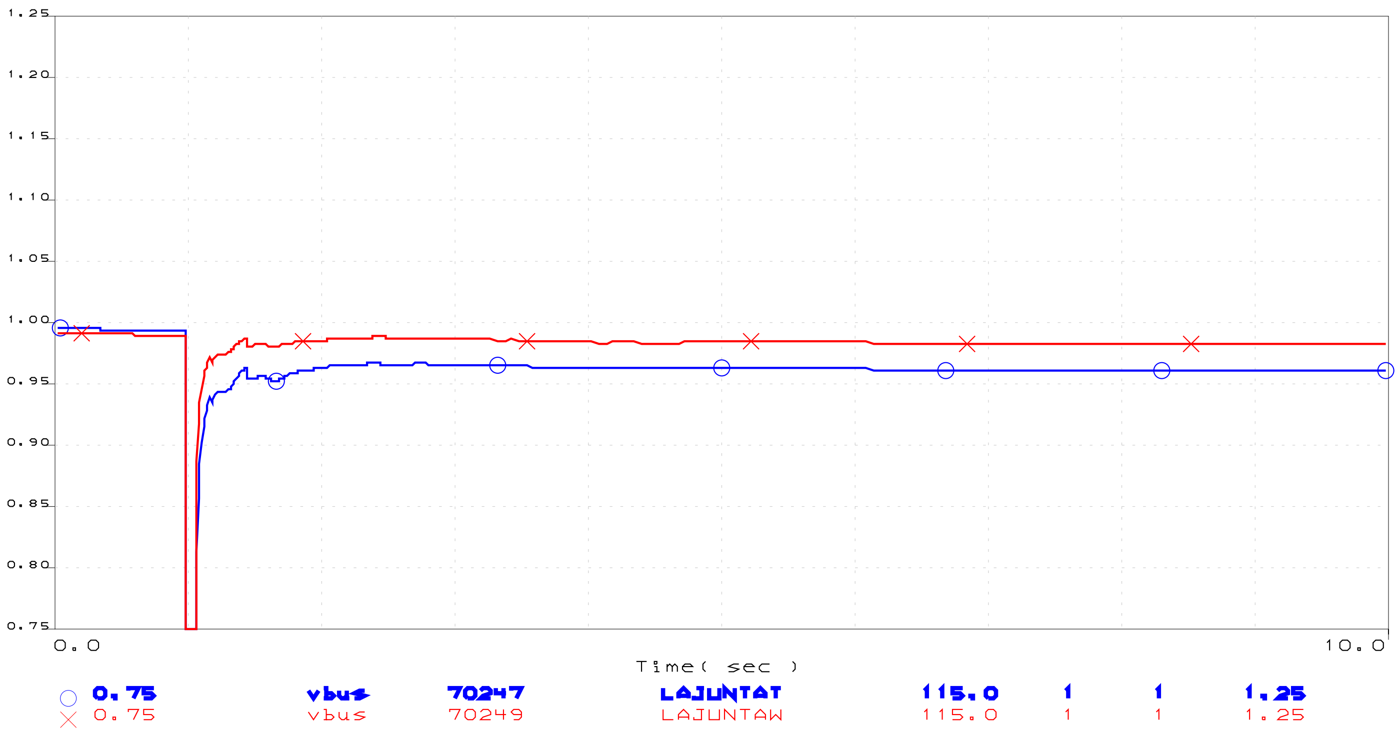
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

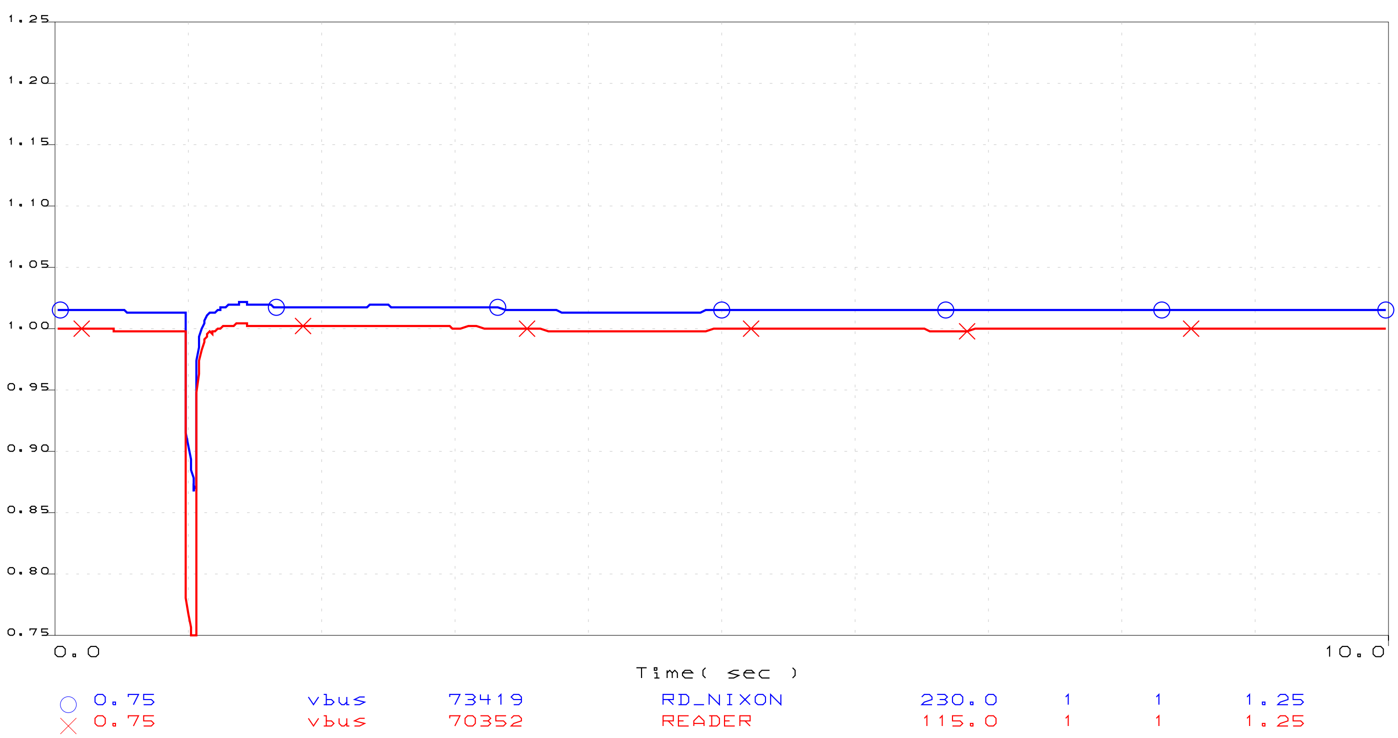


0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25





Case259.chf

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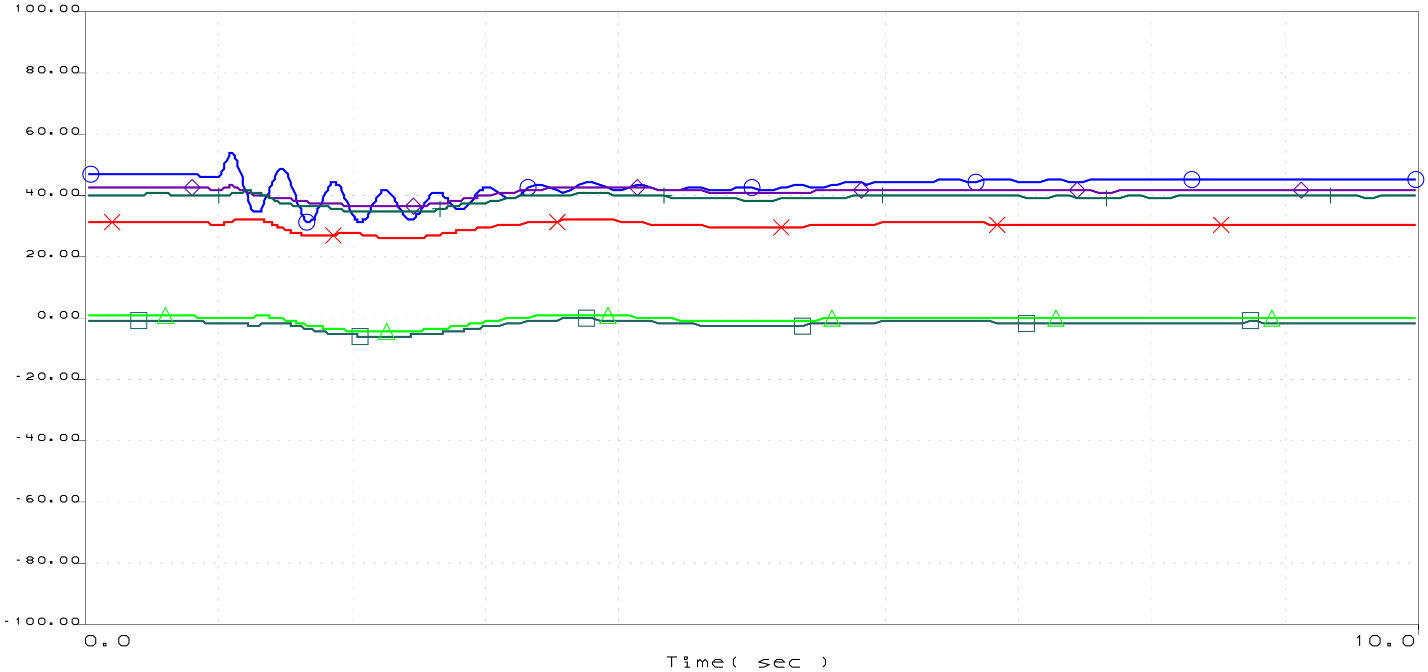
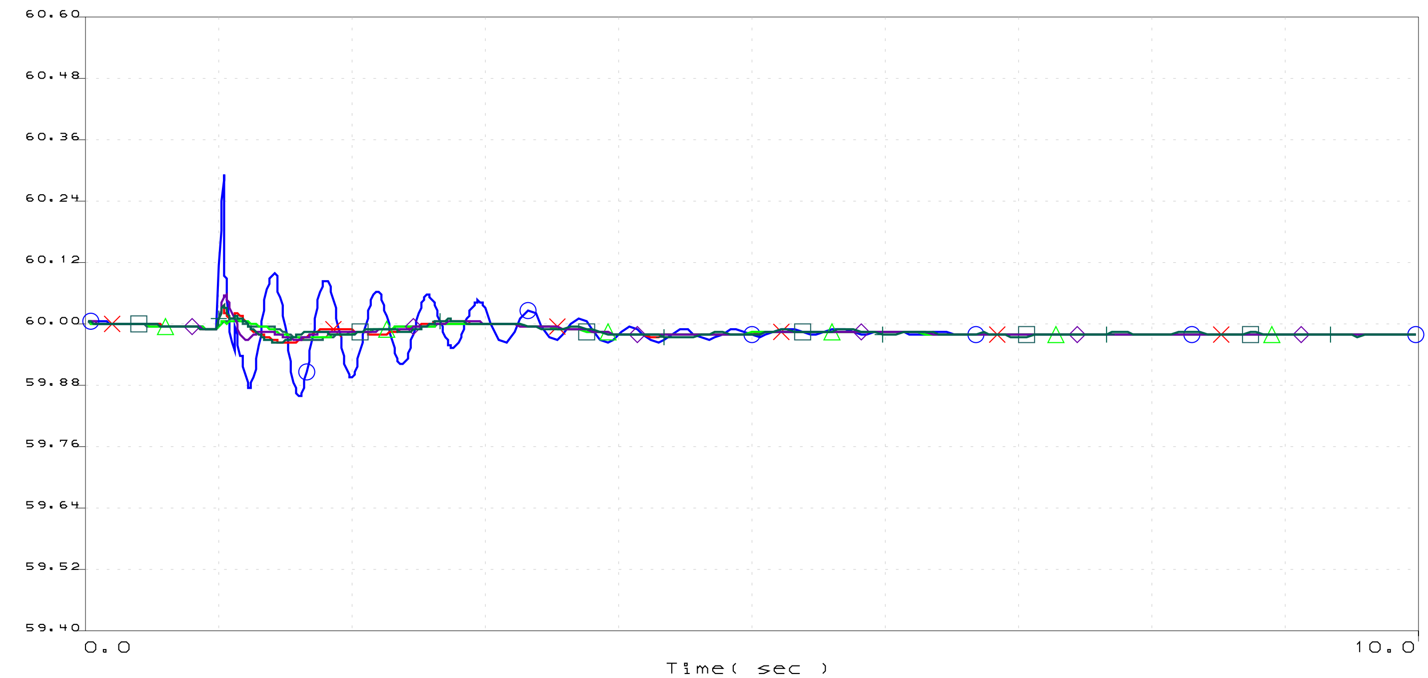
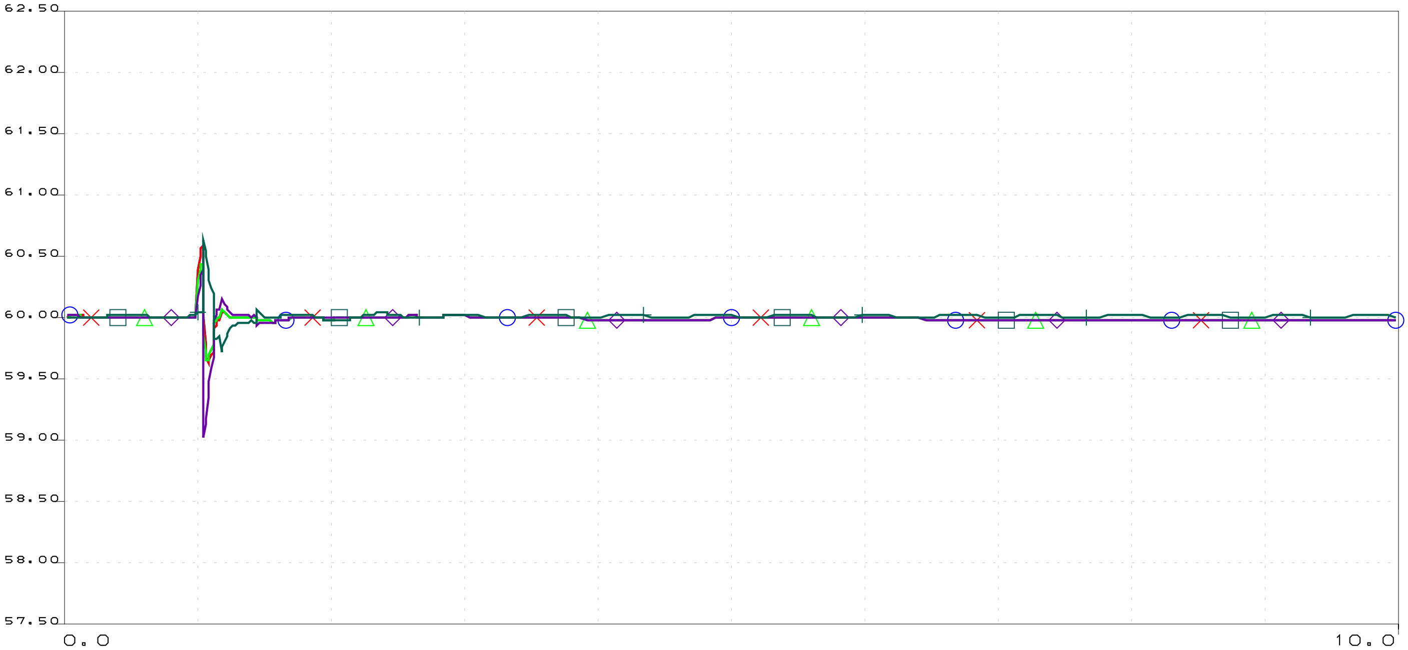


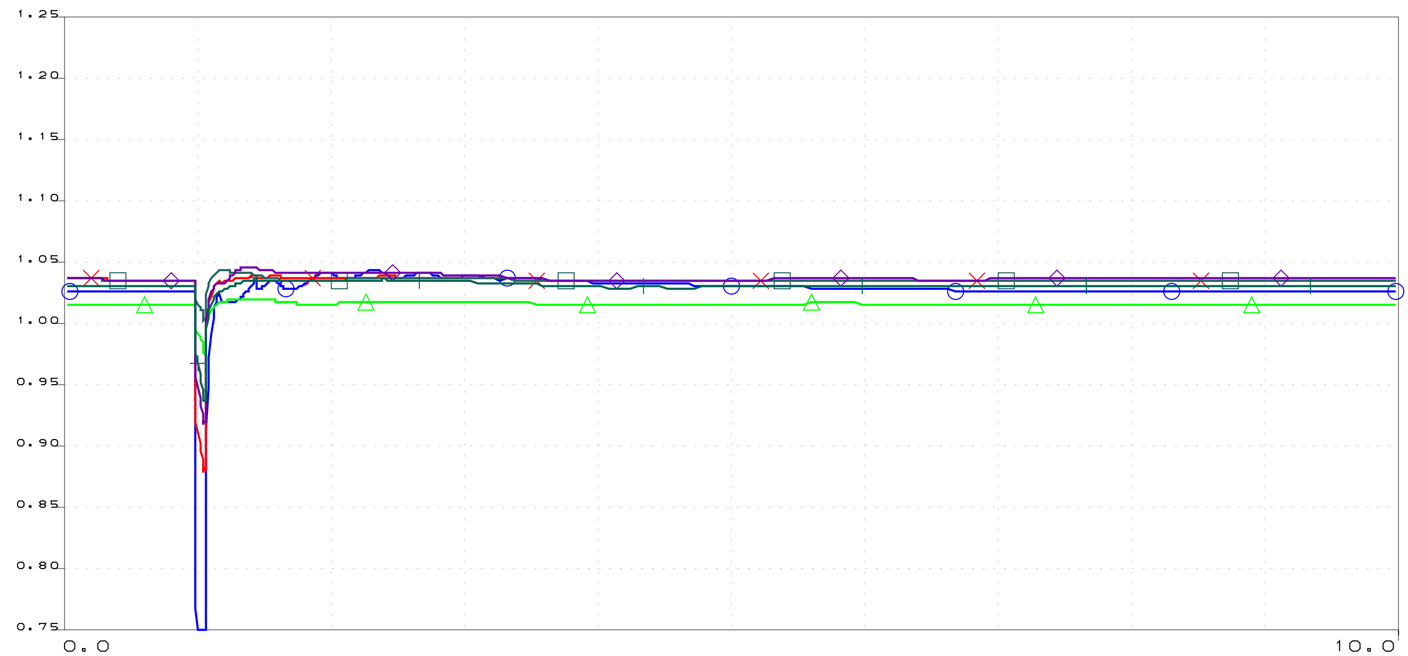
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



57.5	**fbus**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

Case2S10.chf

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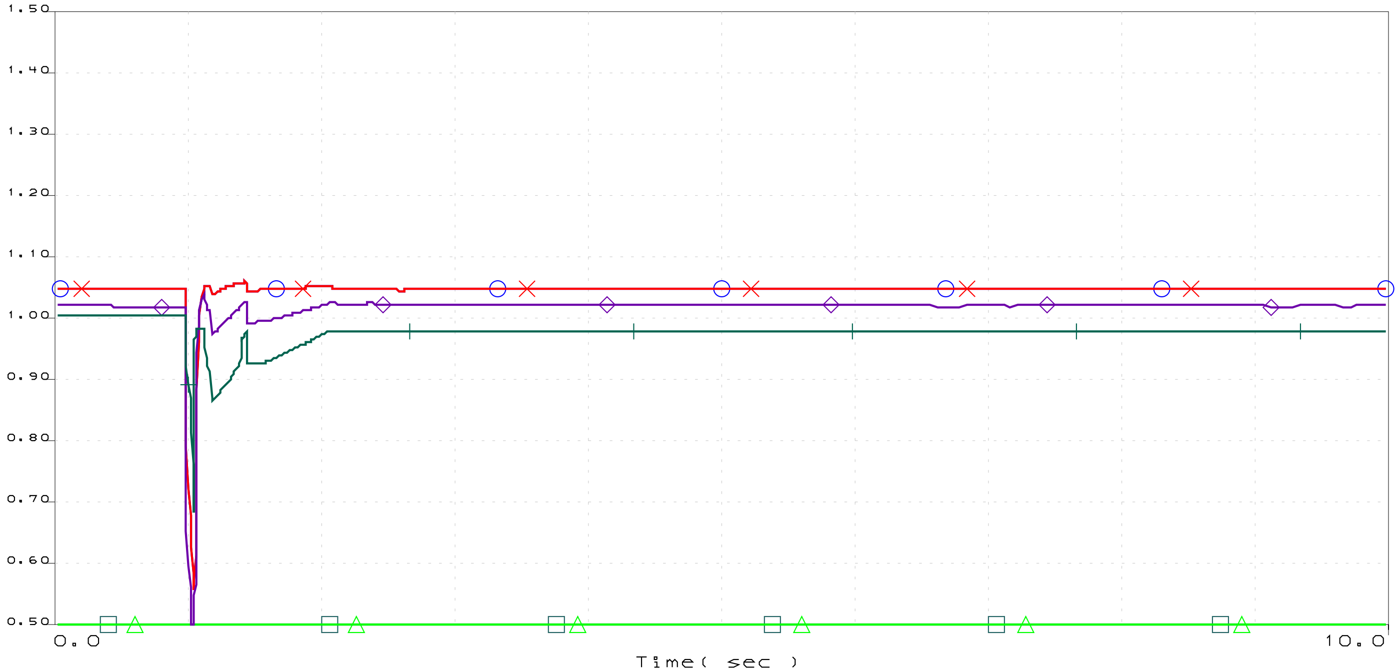
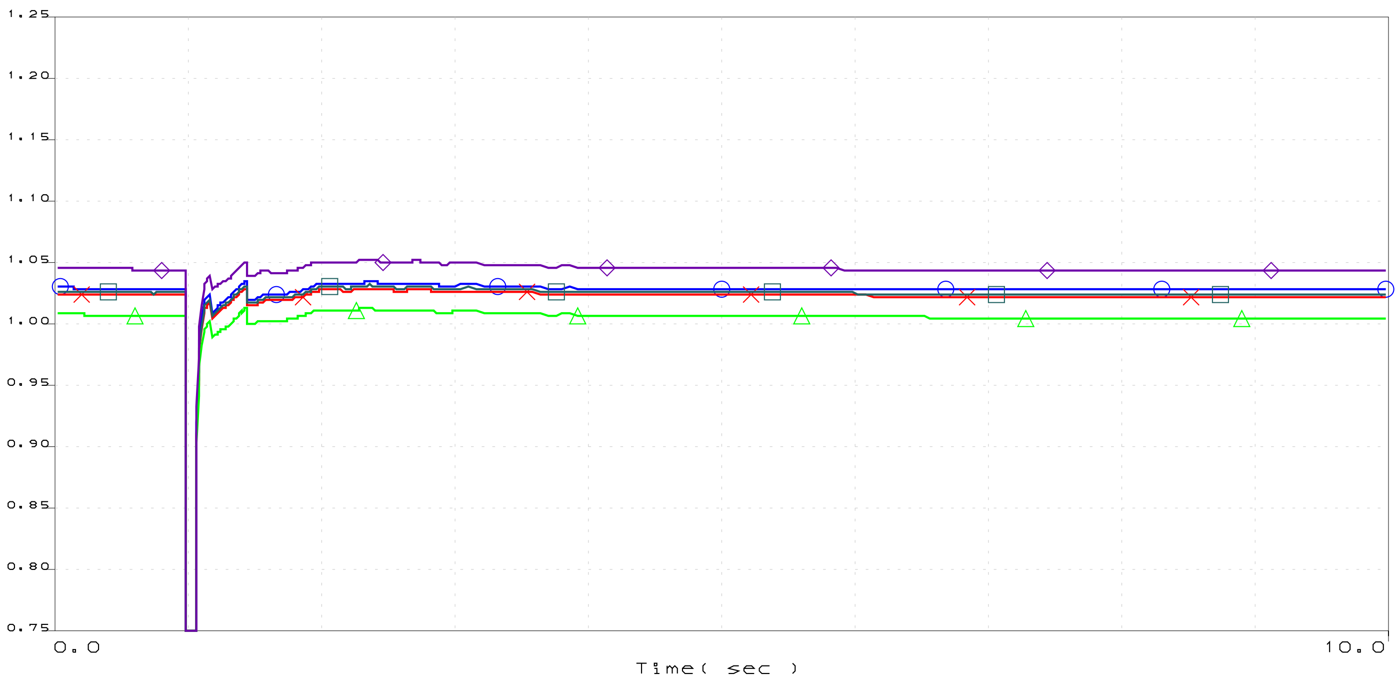


0.5	**vbus**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbus	70702	CO GRN W	34.5	1	1	1.5
0.5	vbus	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbus	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbus	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbus	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbus	70473	WILOW CK	69.0	1	1	1.25

Case2S10.chf

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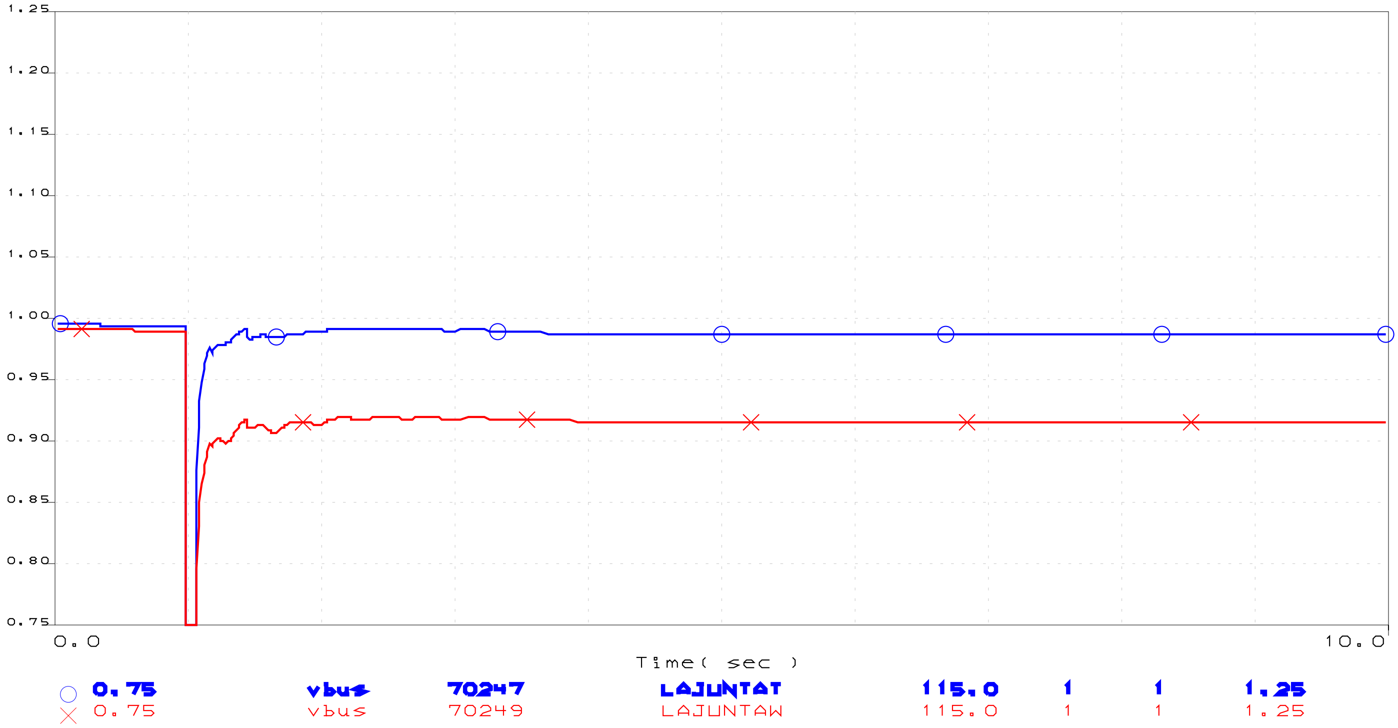
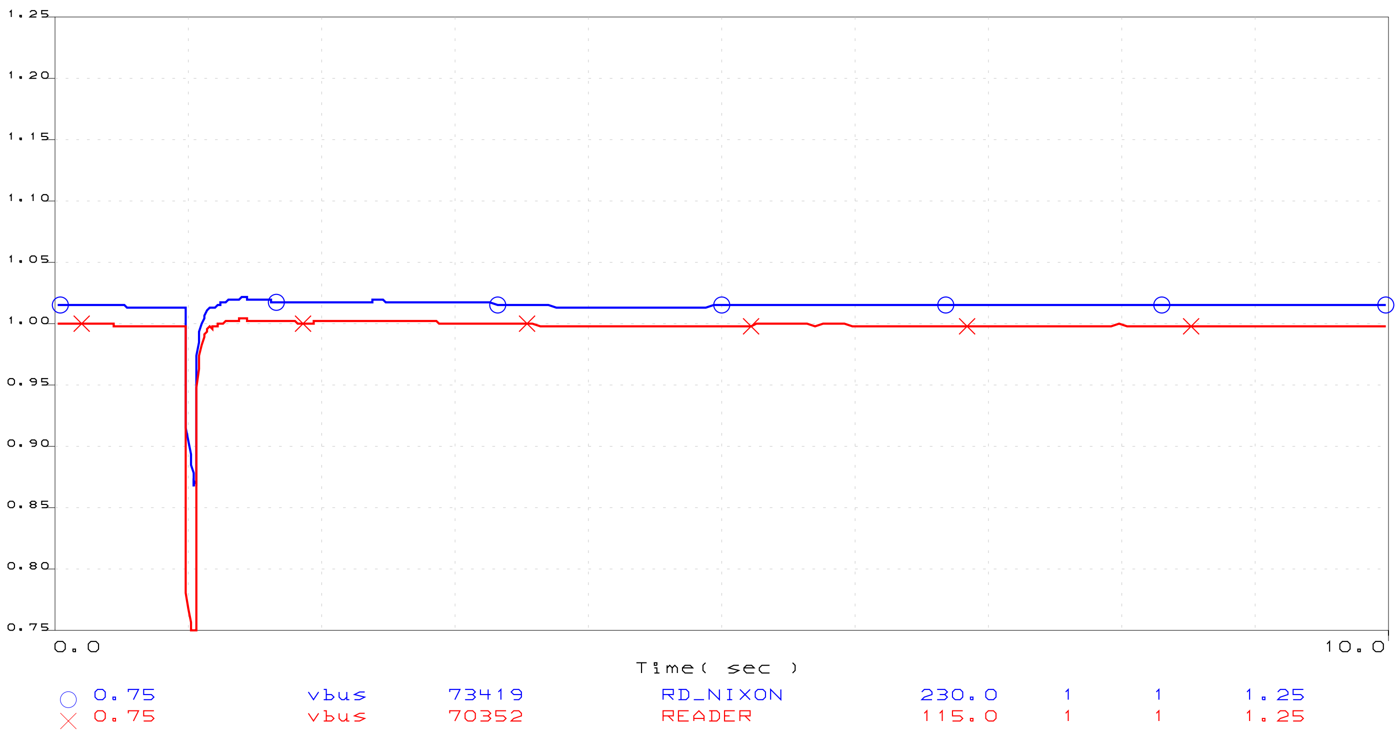
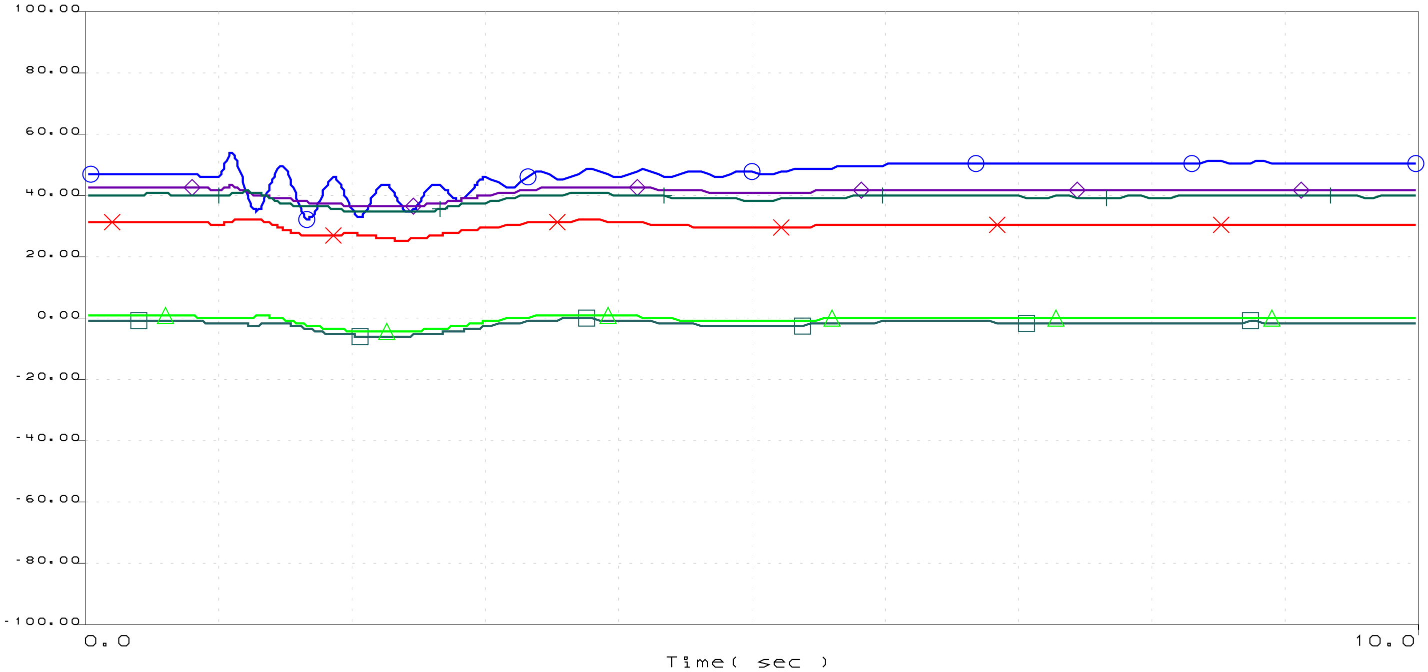
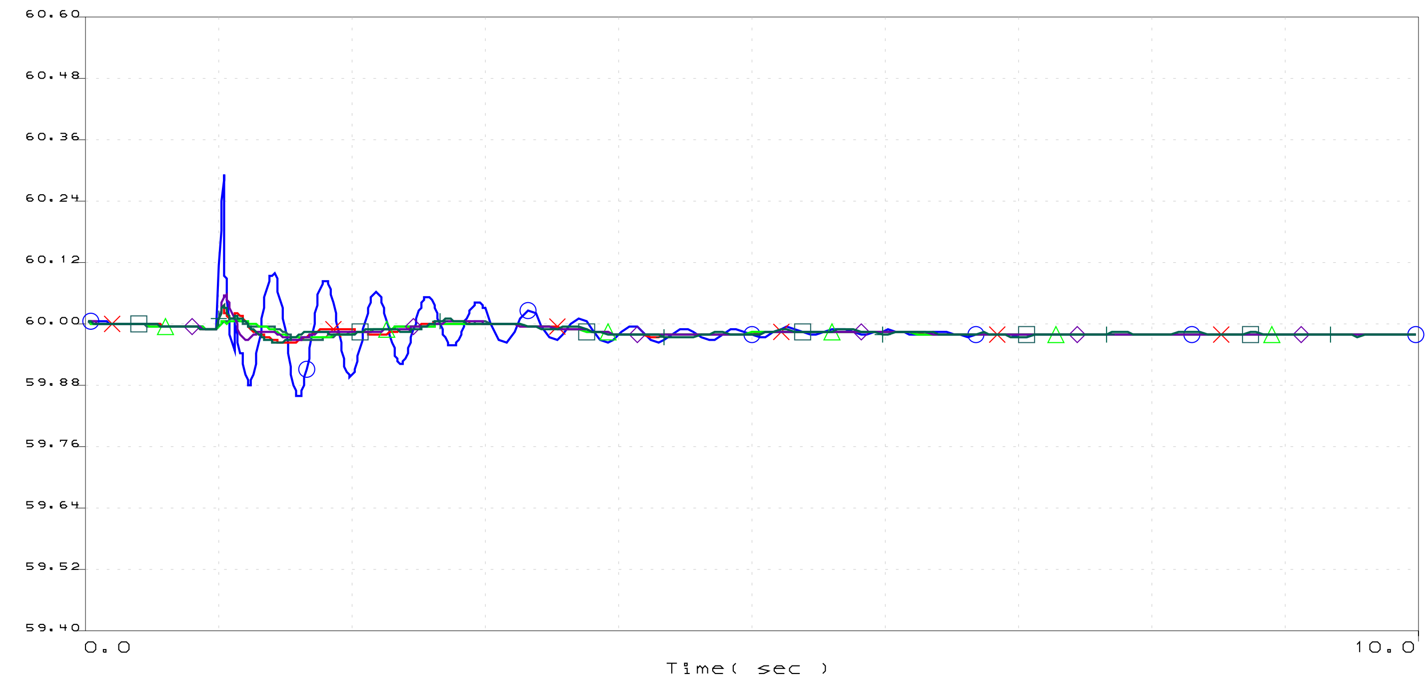

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25

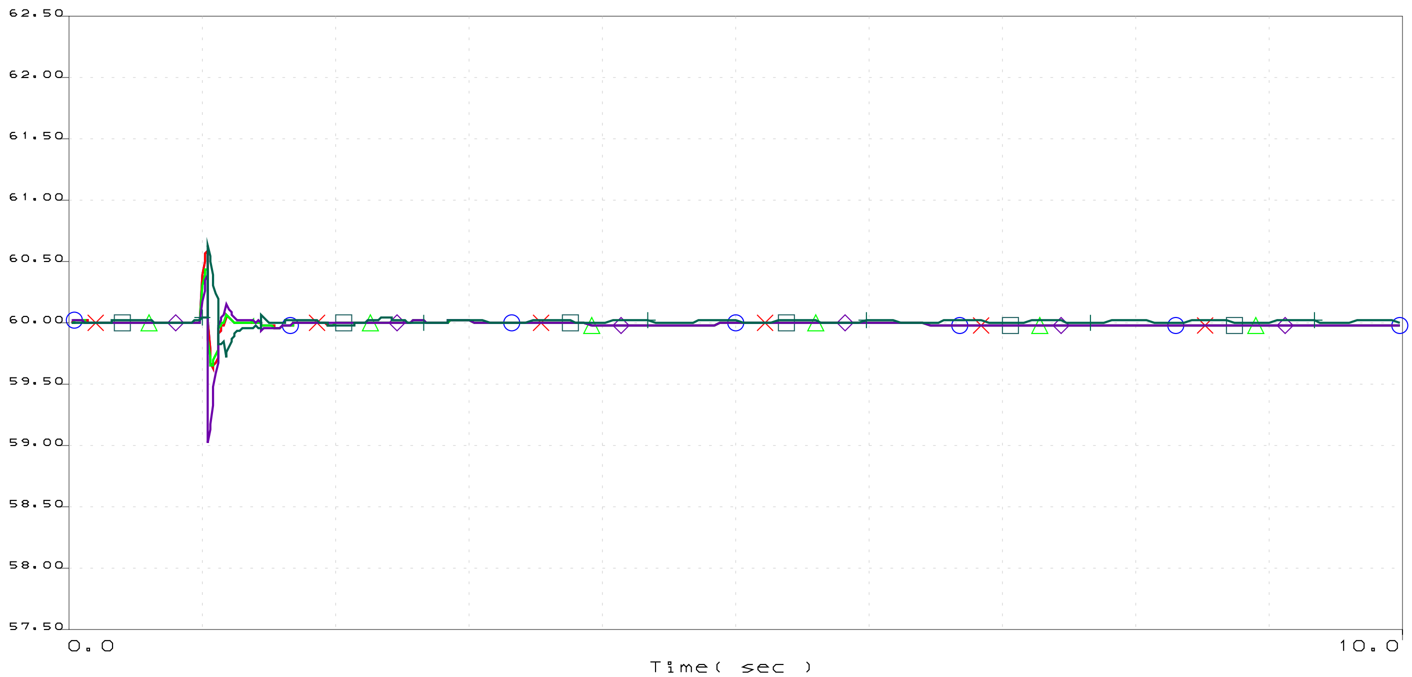

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



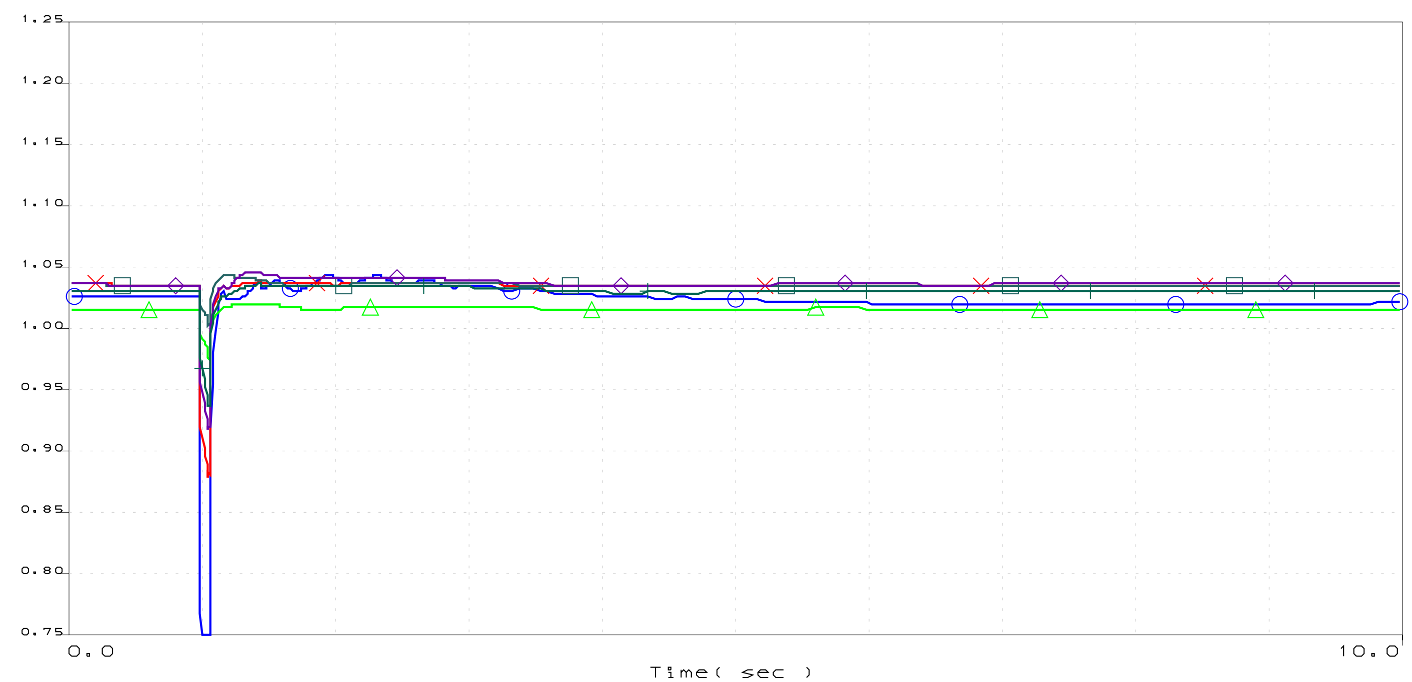
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



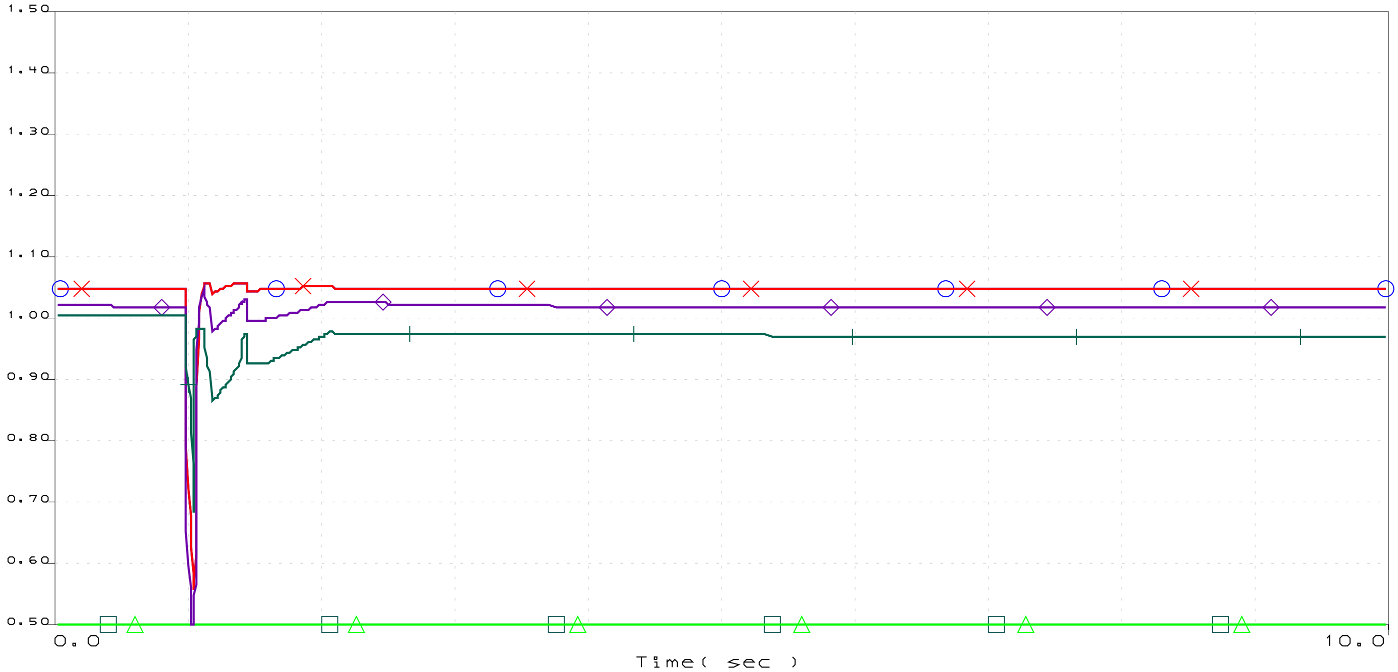
59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



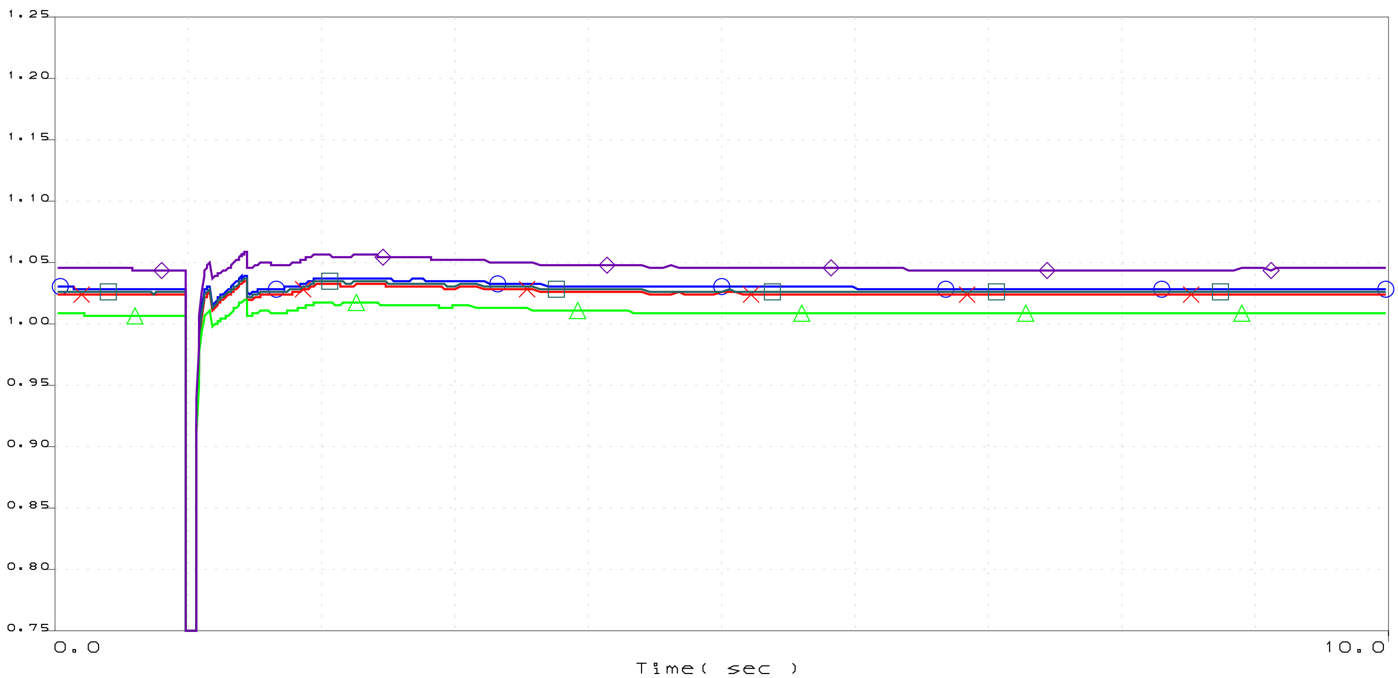
○	**57.5**	**fbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
×	57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
□	57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
△	57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
◇	57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+	57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



○	0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
×	0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
□	0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
△	0.75	vbug	70034	ARAP3	13.8	1	1	1.25
◇	0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
+	0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25



0.5	**vbus**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbus	70702	CO GRN W	34.5	1	1	1.5
0.5	vbus	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbus	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case2S11.chf

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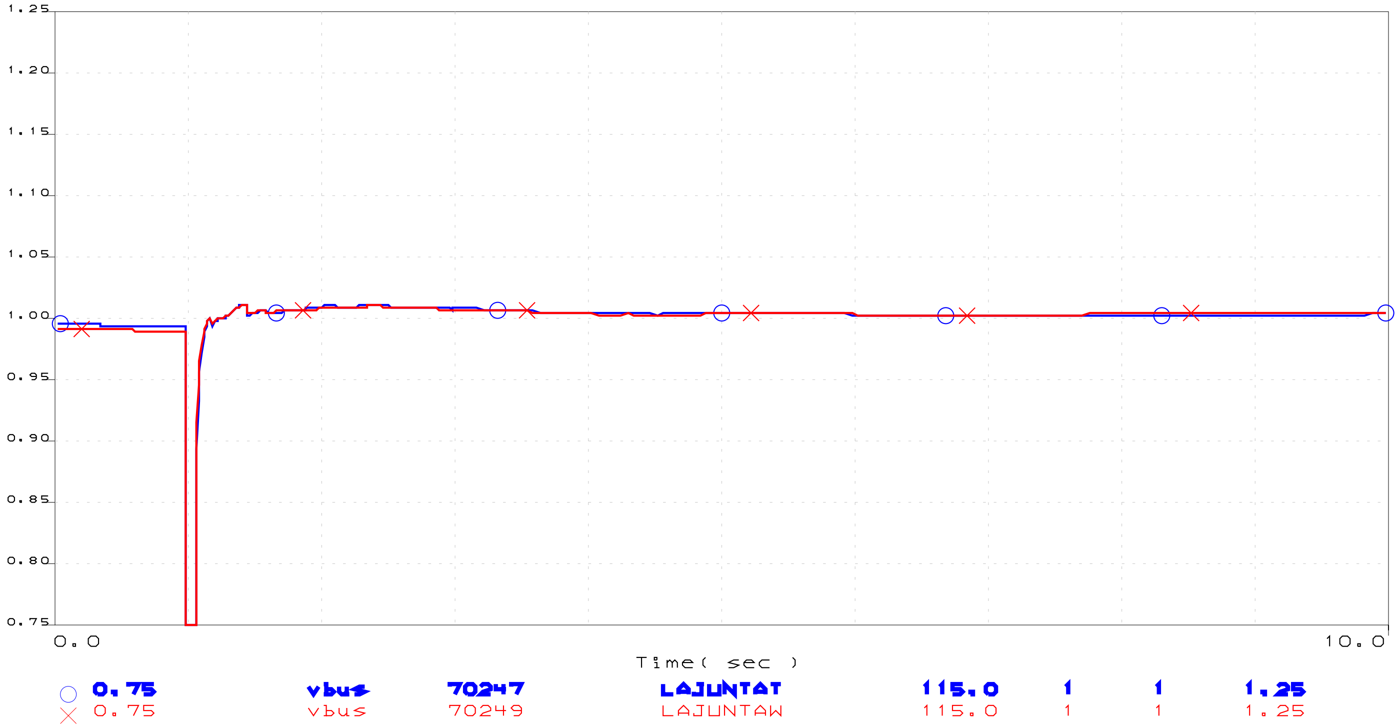
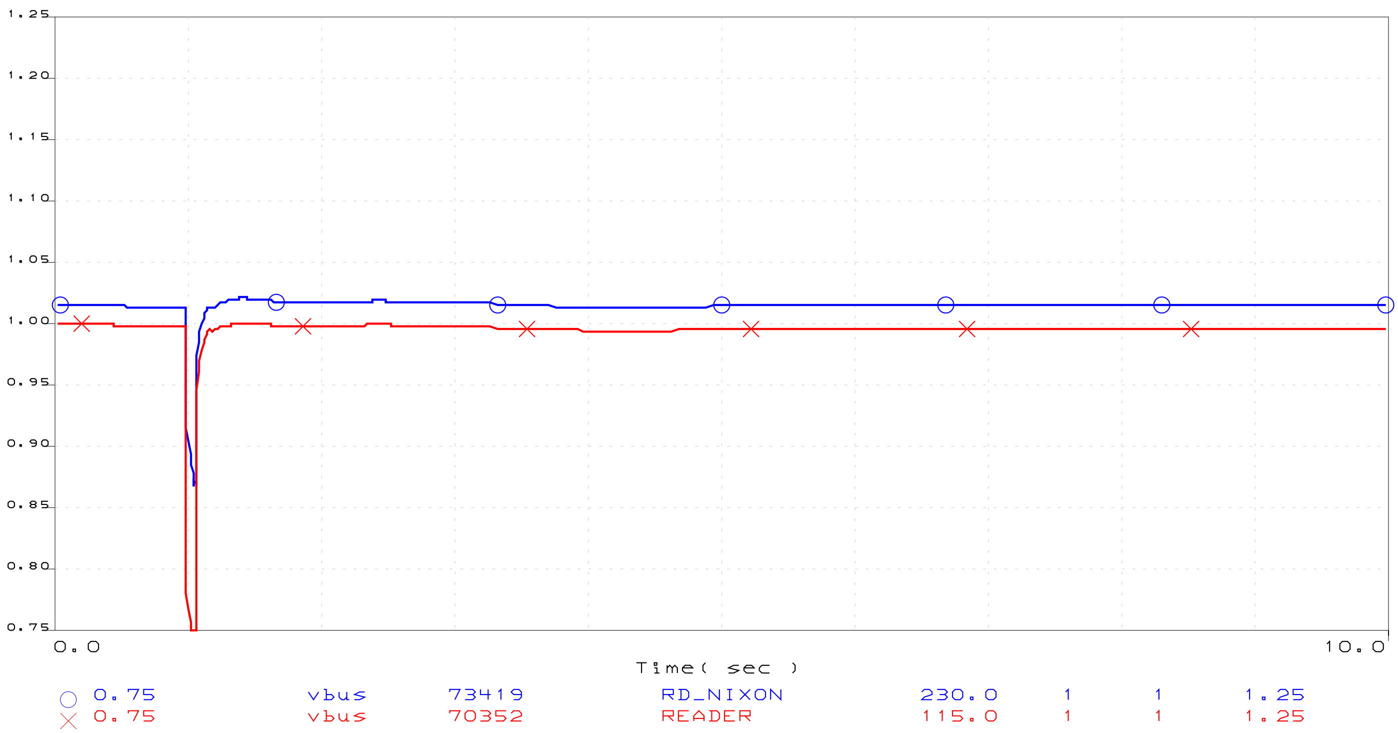
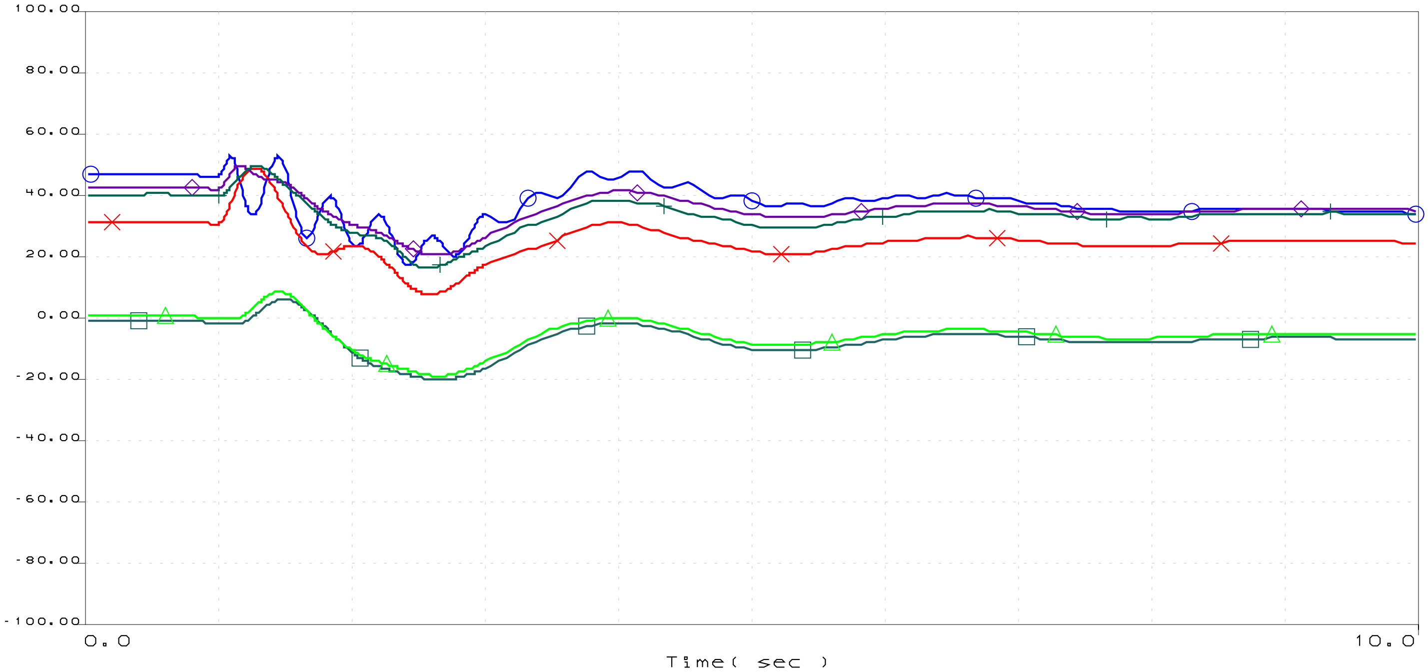
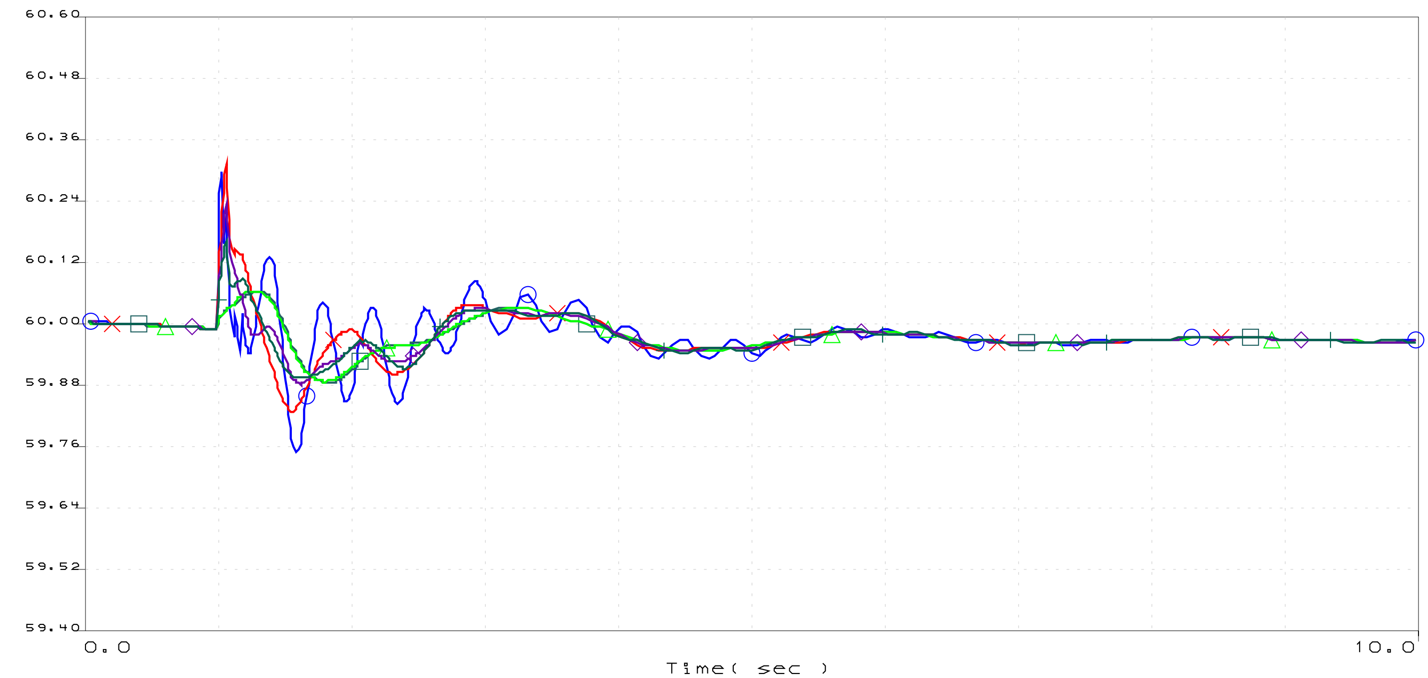

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25

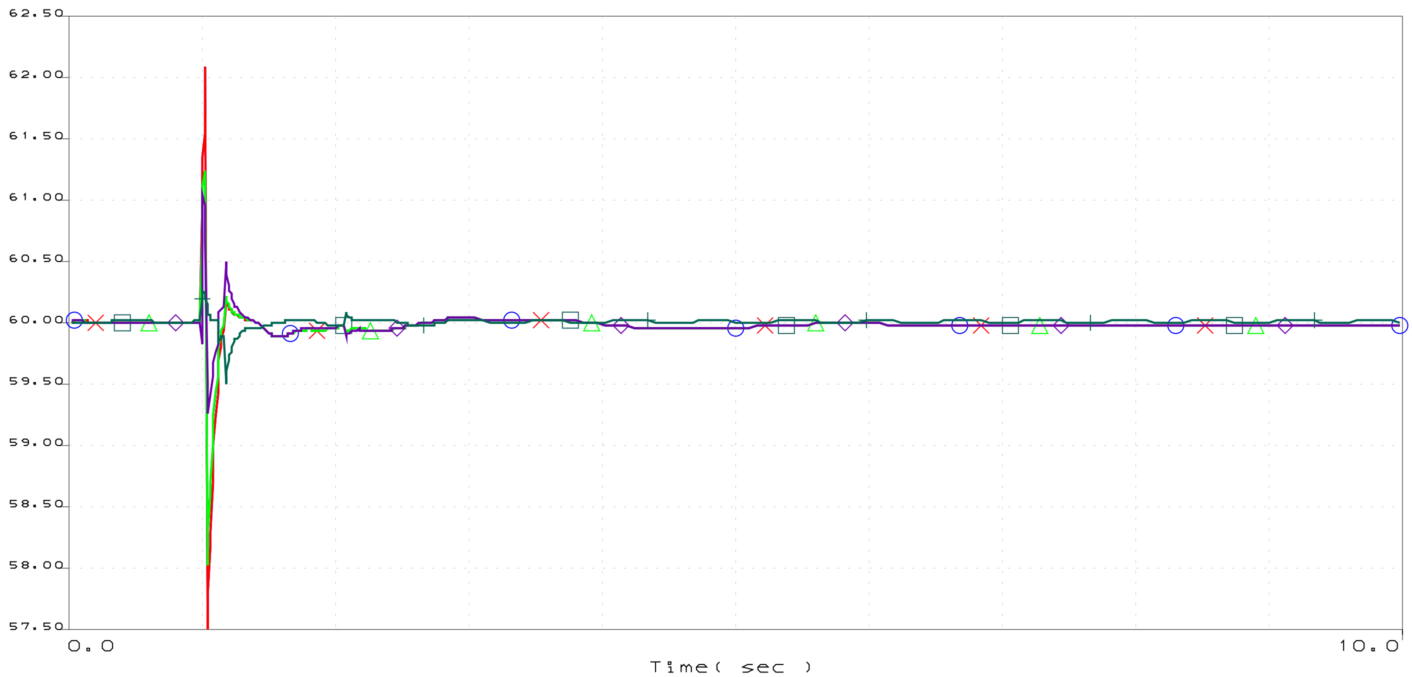

1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



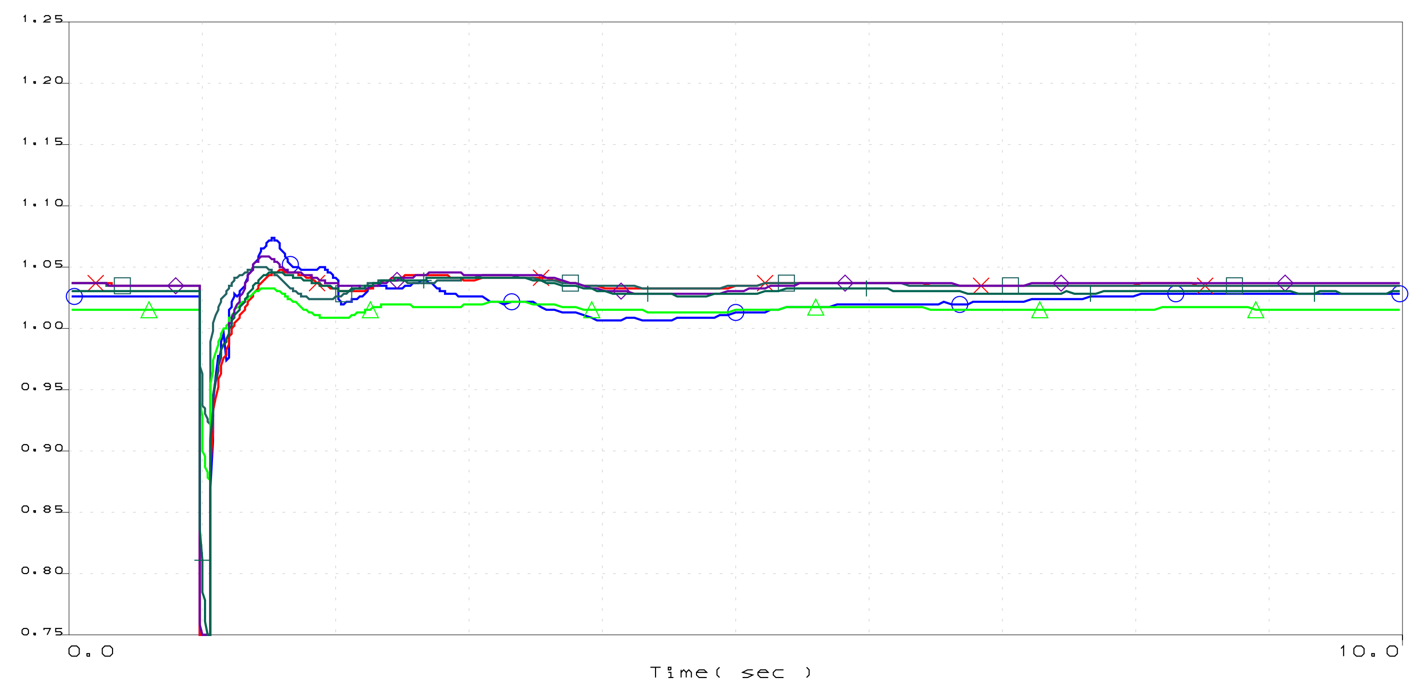
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



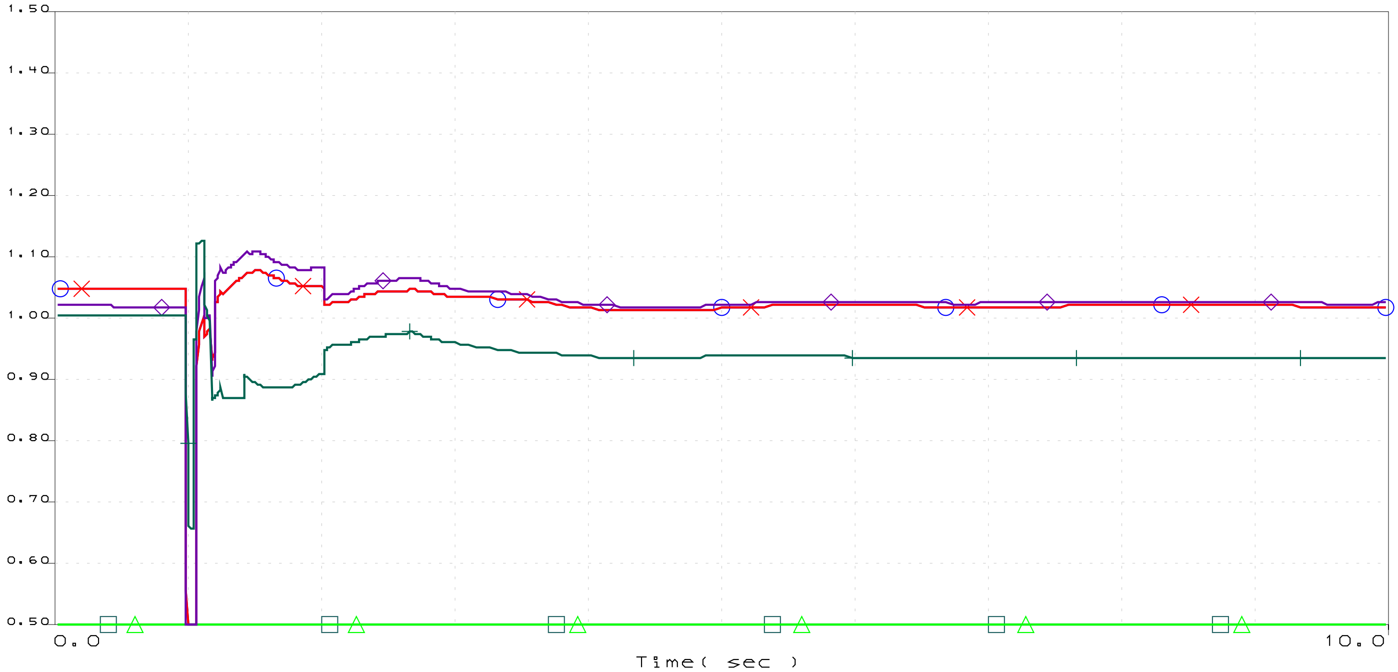
59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



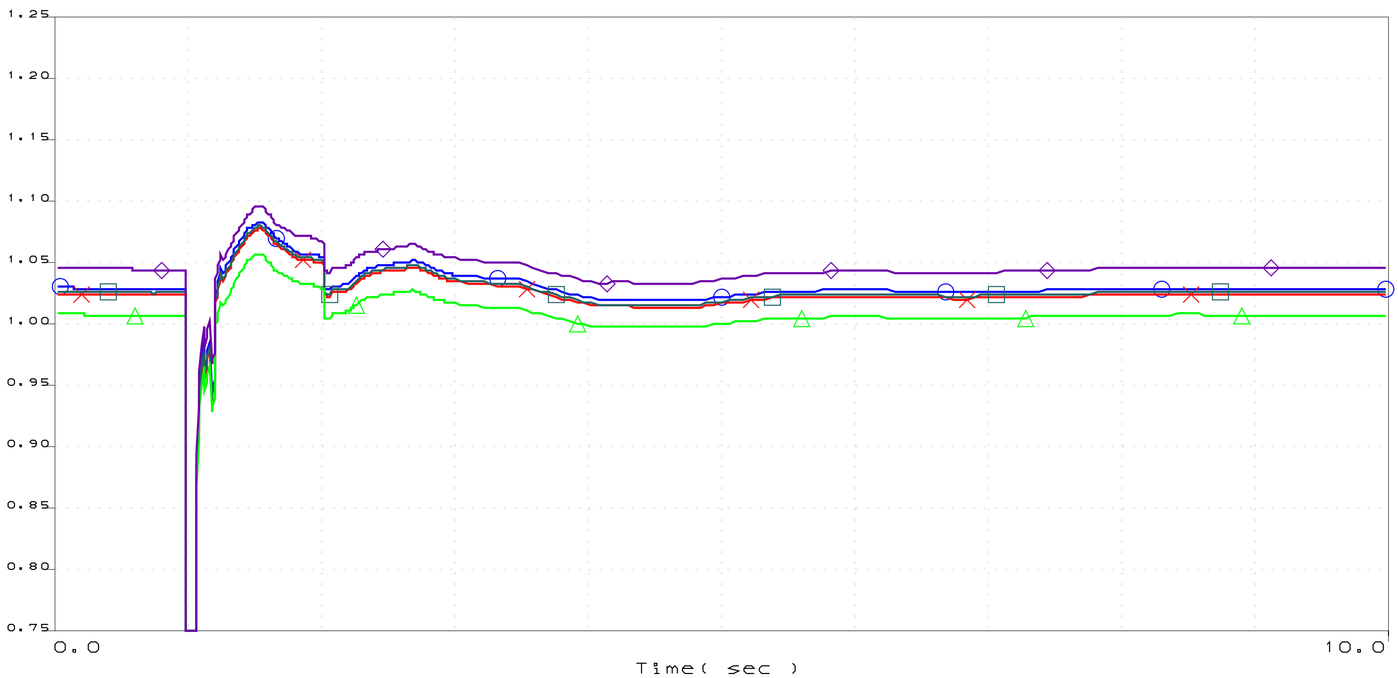
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



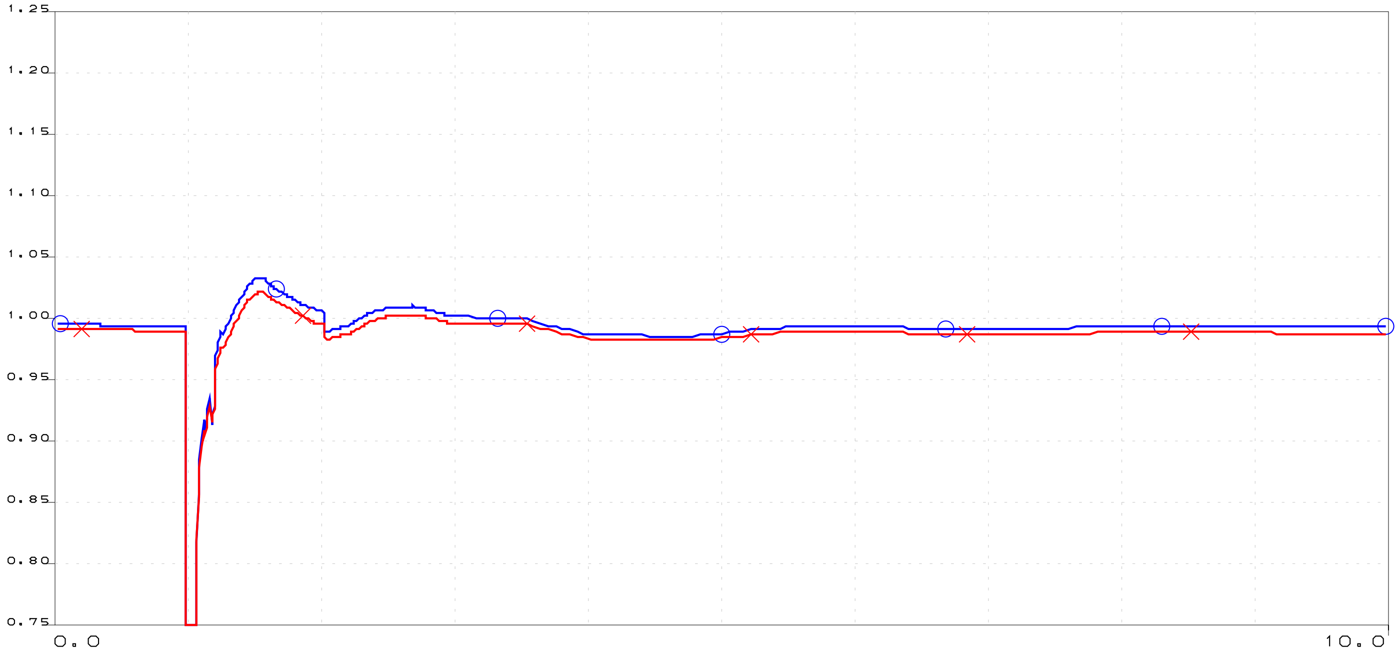
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



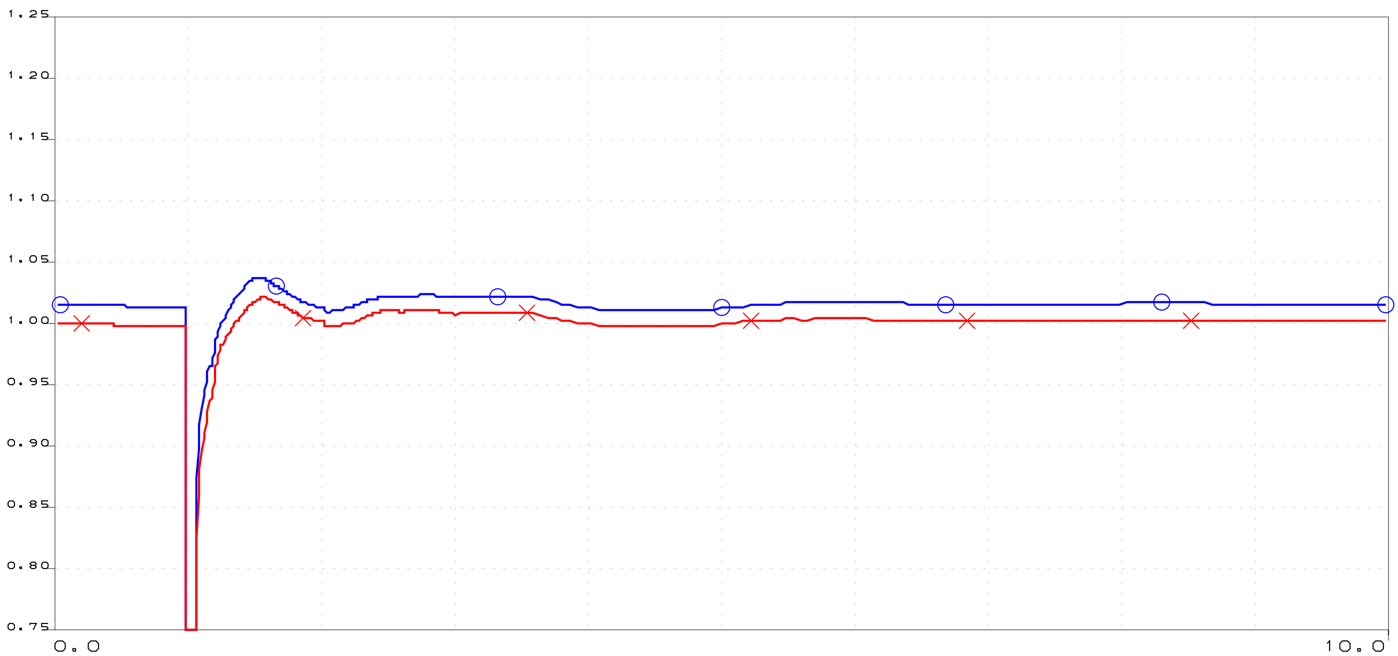
0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



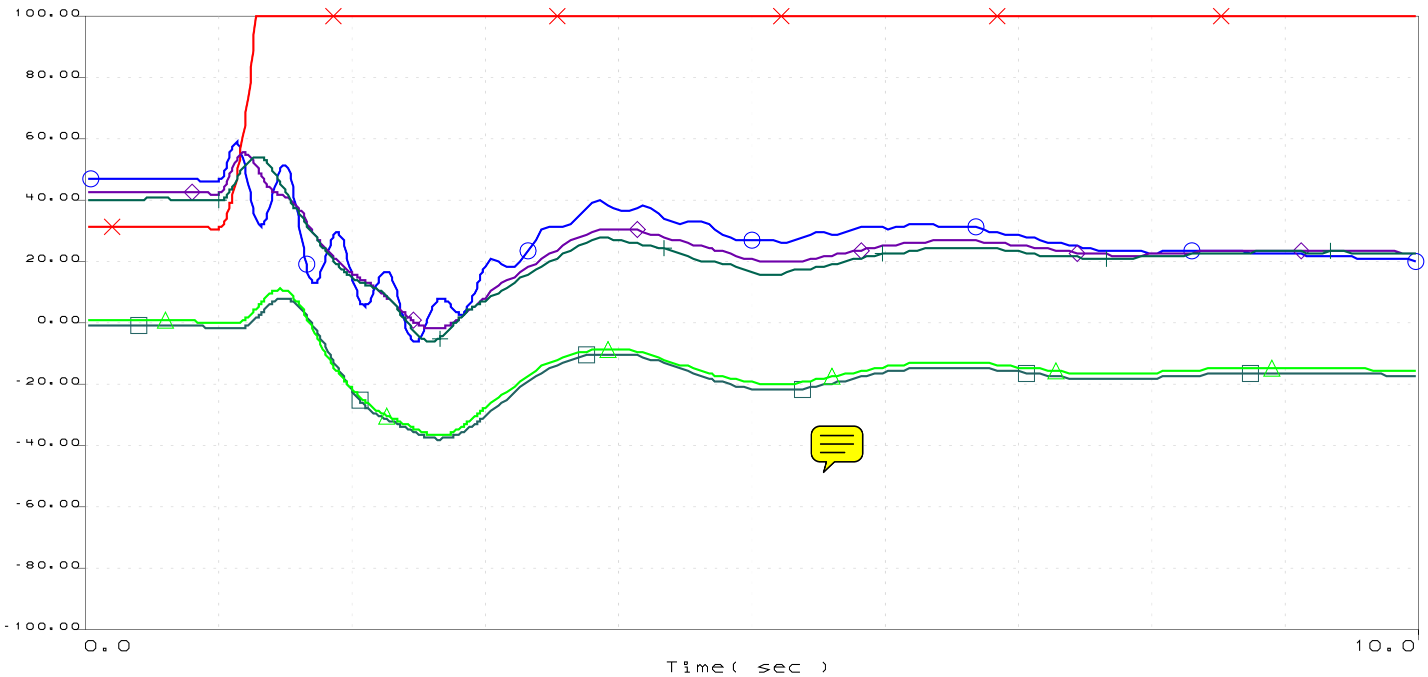
0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25



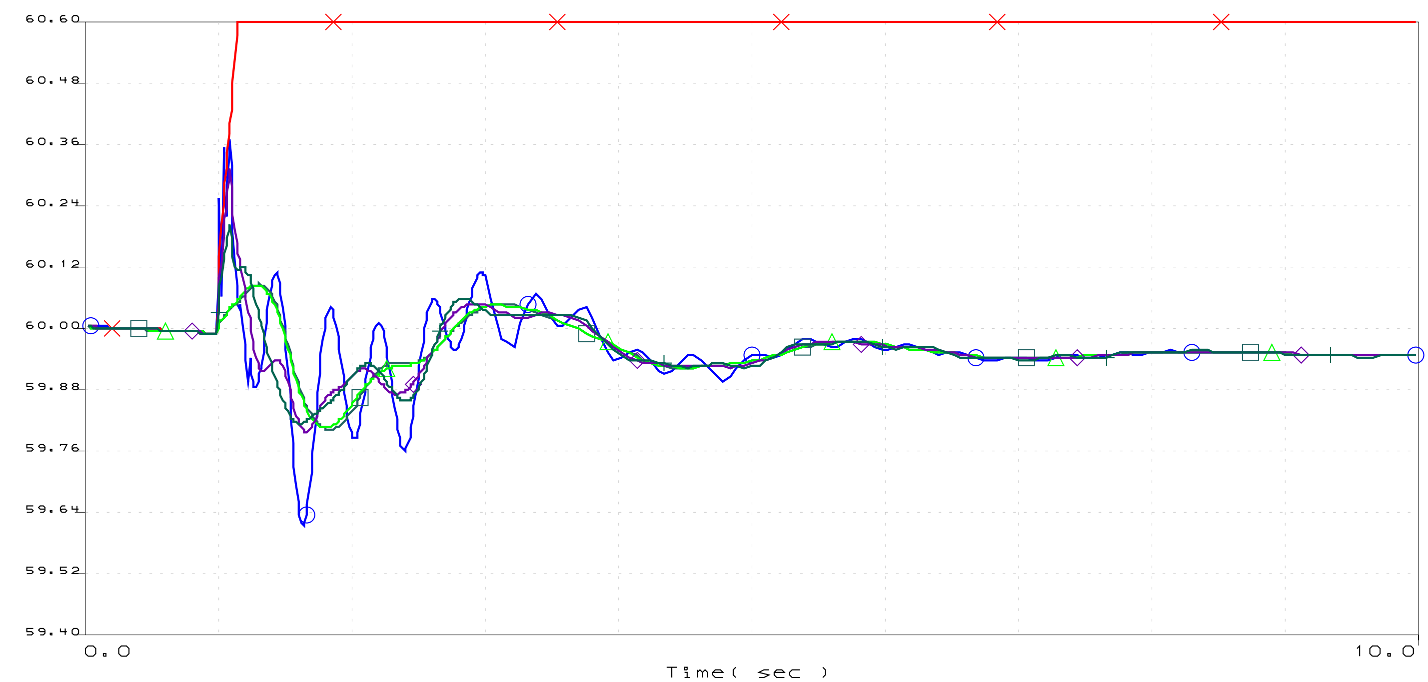
○ 0.75	vbus	70247	LAJUNTAT	115.0	1	1	1.25
× 0.75	vbus	70249	LAJUNTAW	115.0	1	1	1.25



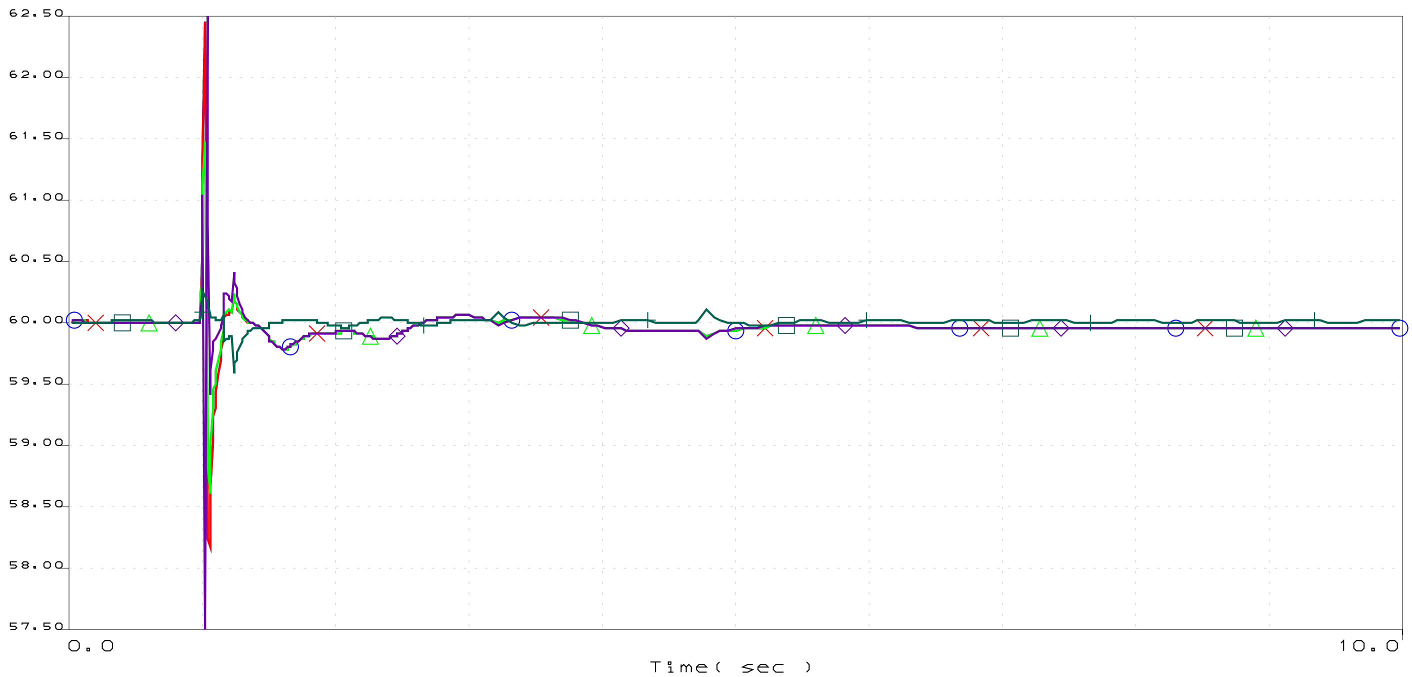
○ 0.75	vbus	73419	RD_NIXON	230.0	1	1	1.25
× 0.75	vbus	70352	READER	115.0	1	1	1.25



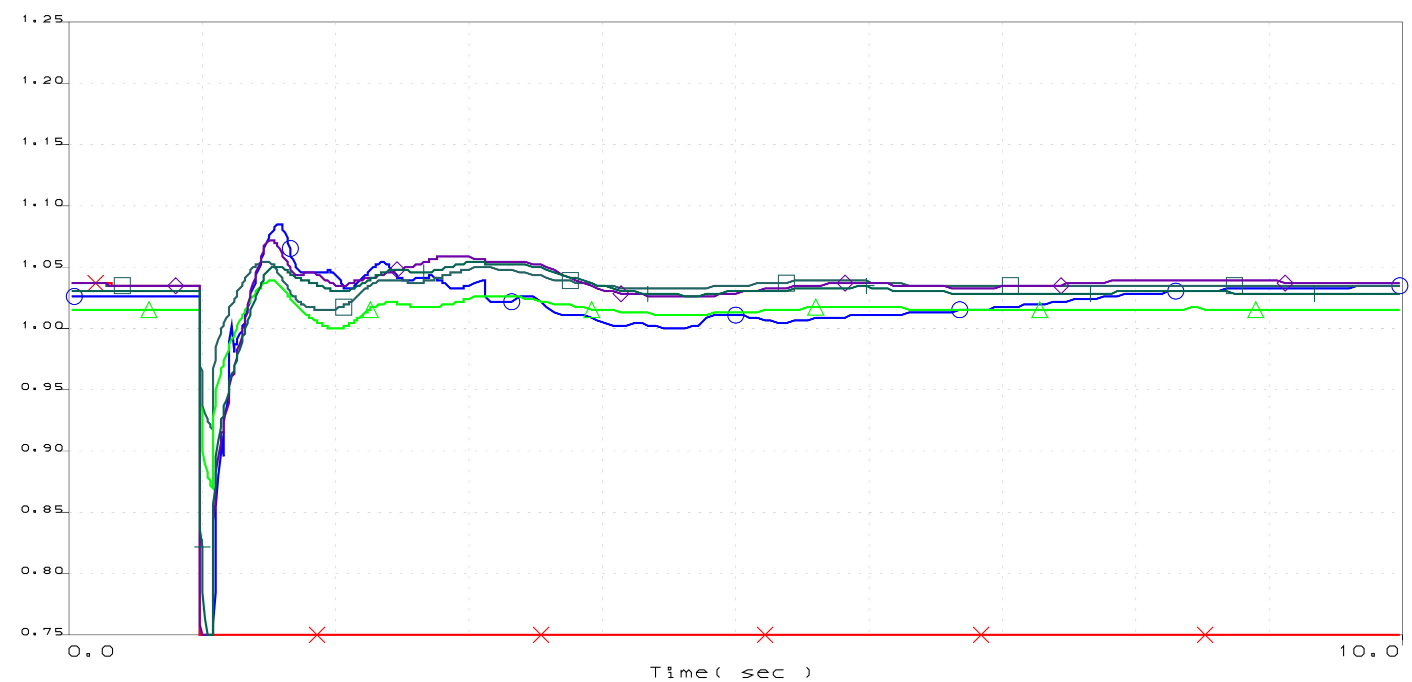
○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



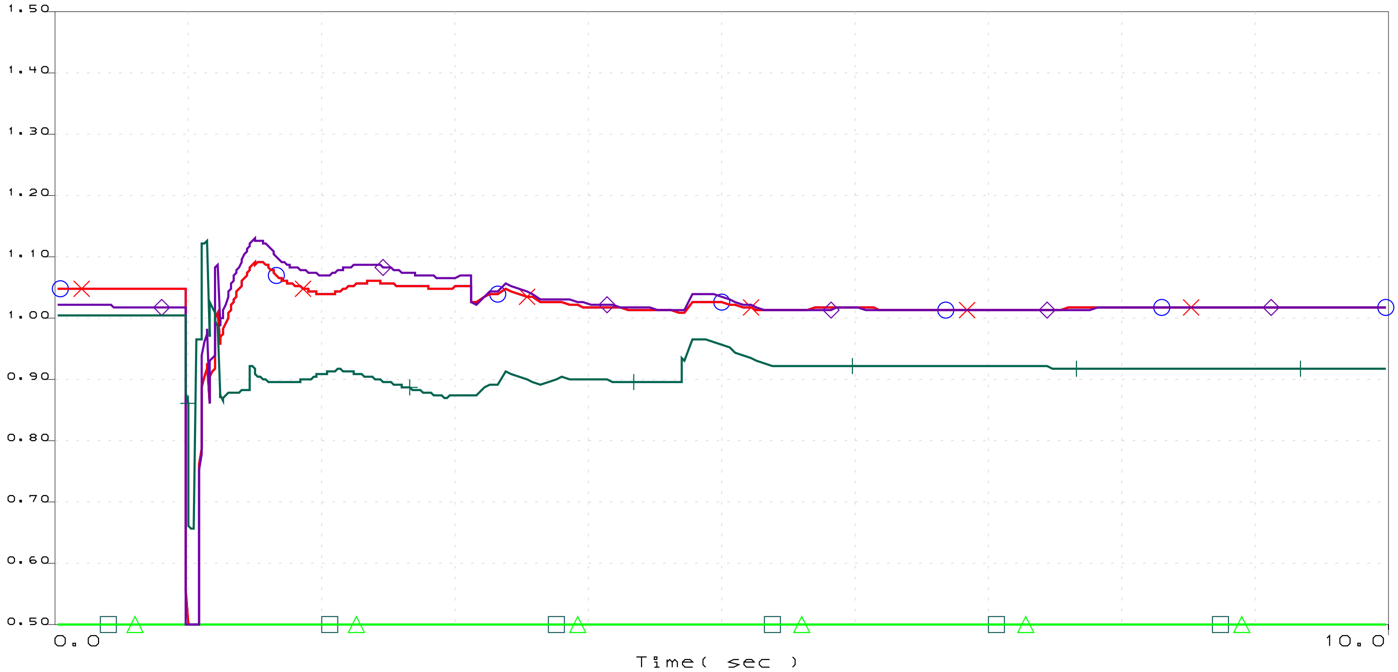
○	59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
×	59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□	59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



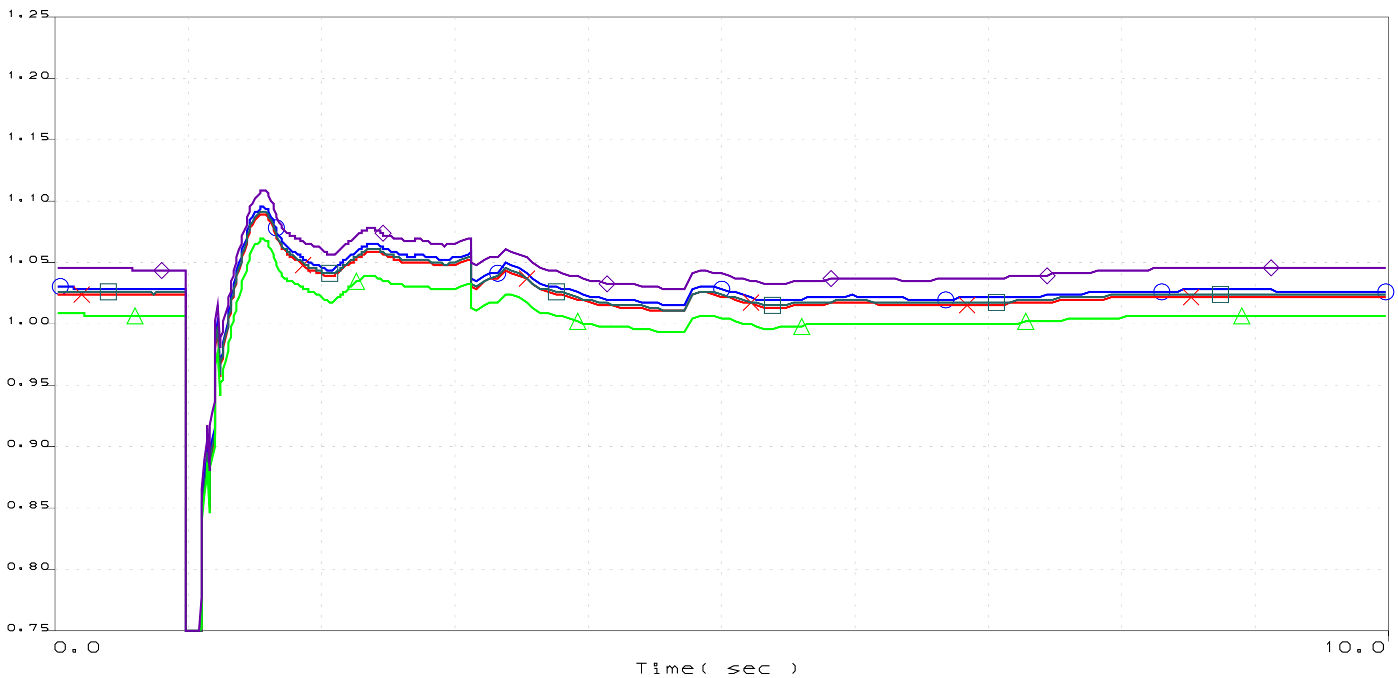
57.5	**fbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**62.5**
57.5	fbug	70702	CO GRN W	34.5	1	1	62.5
57.5	fbug	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbug	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



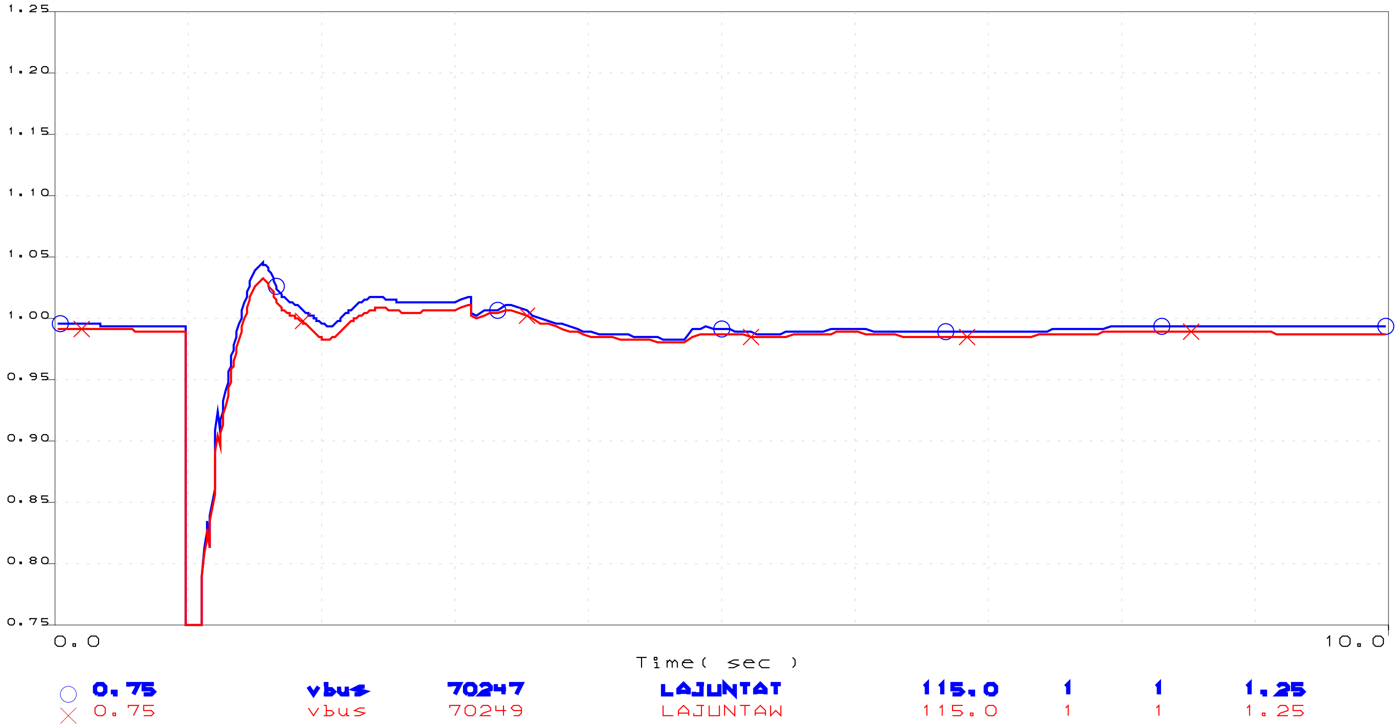
0.75	vbug	70133	CTY LAM	14.4	1	1	1.25
0.75	vbug	70119	COMAN 1	24.0	1	1	1.25
0.75	vbug	70106	CHEROK4	22.0	1	1	1.25
0.75	vbug	70034	ARAP3	13.8	1	1	1.25
0.75	vbug	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbug	73418	RD_NIXON	20.0	1	1	1.25

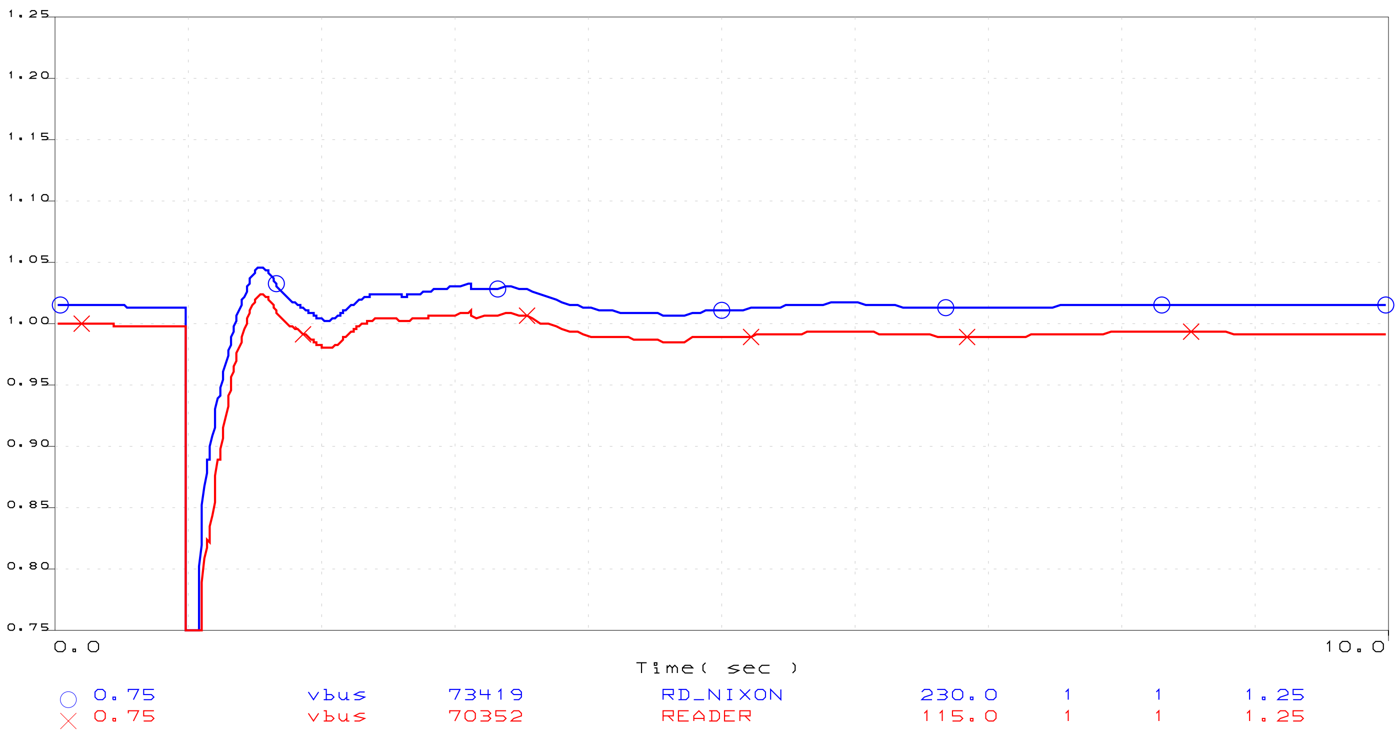


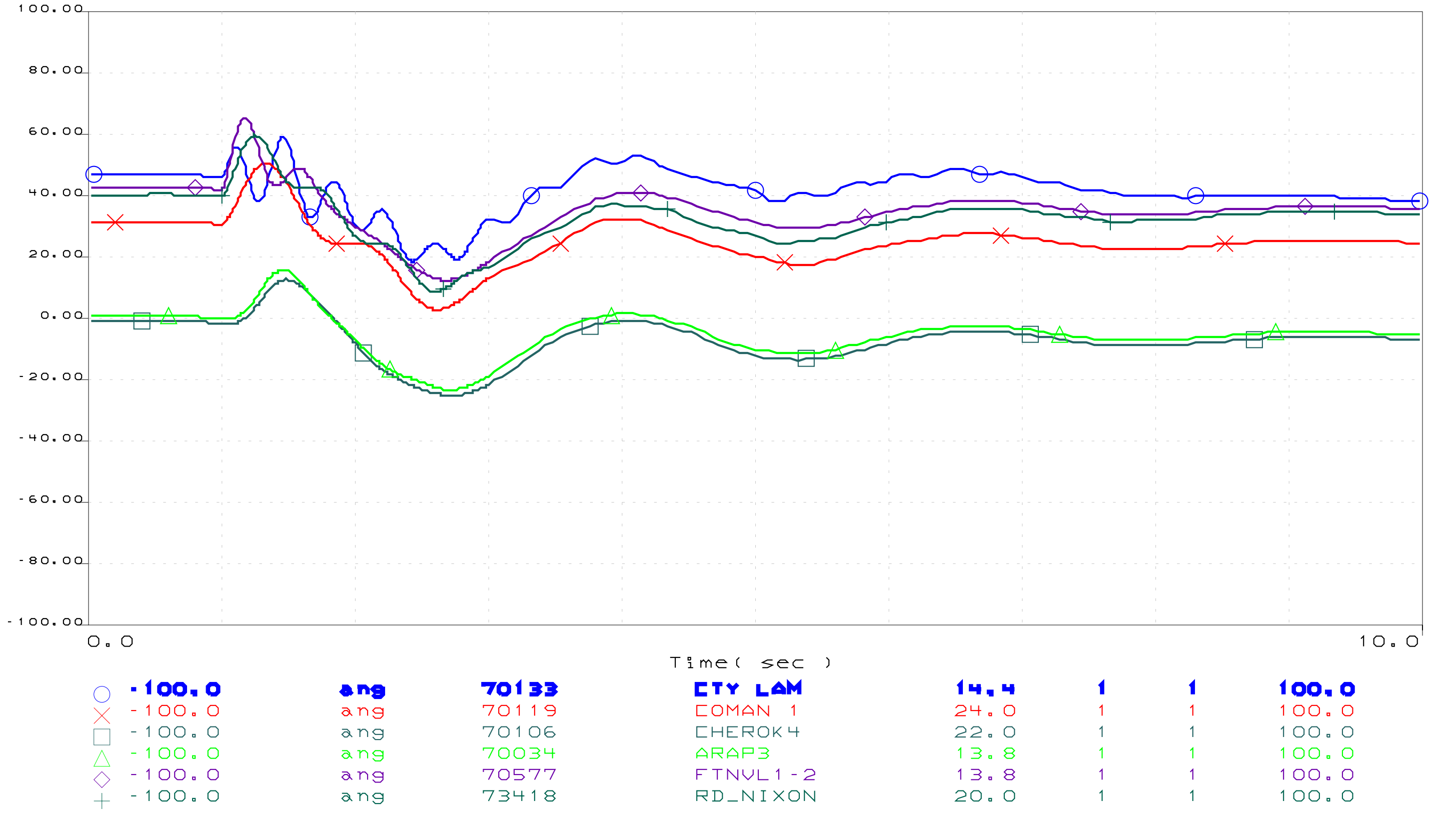
0.5	vbug	70701	CO GRN E	34.5	1	1	1.5
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5

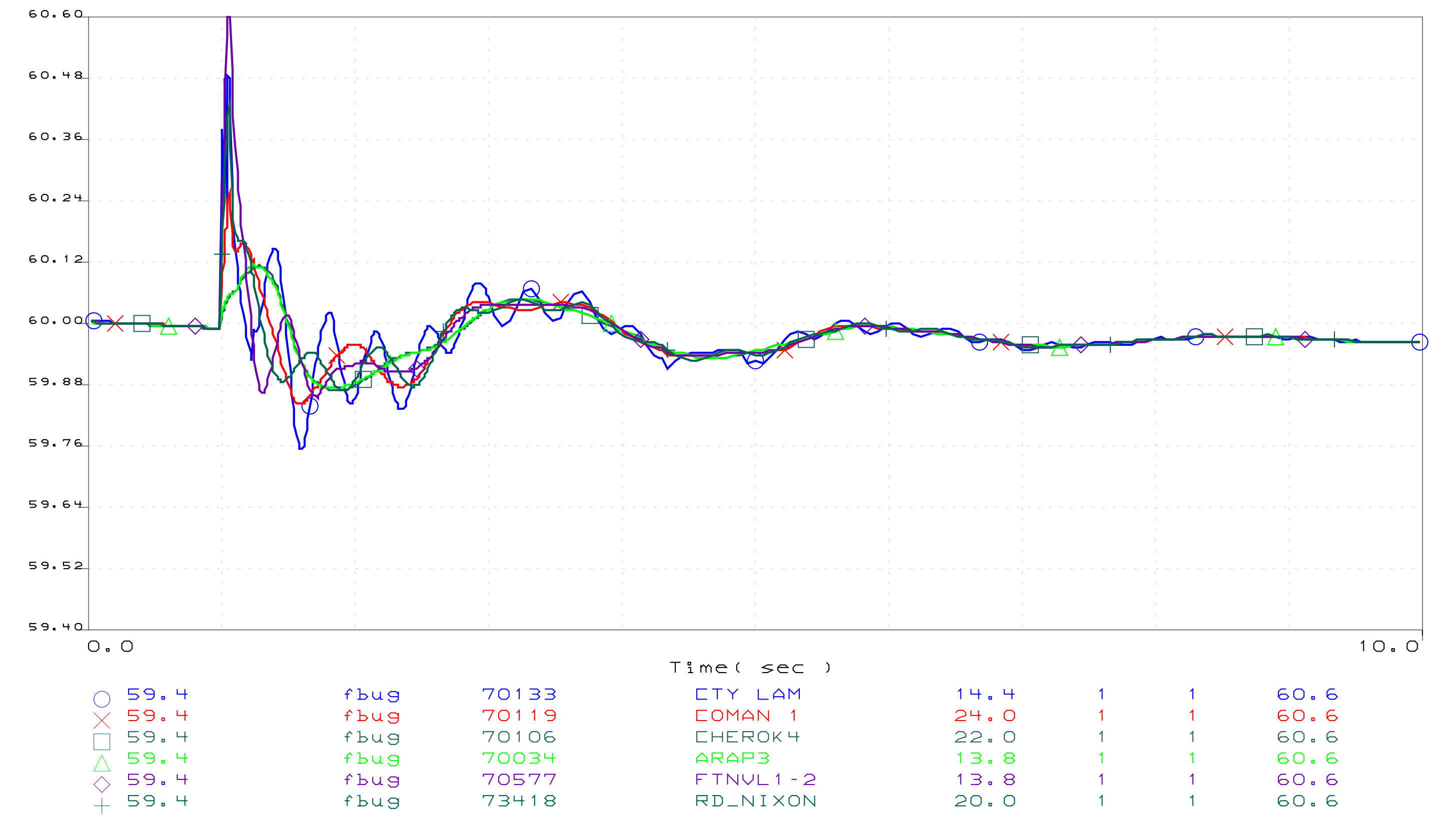


0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25





Case2S14.chf

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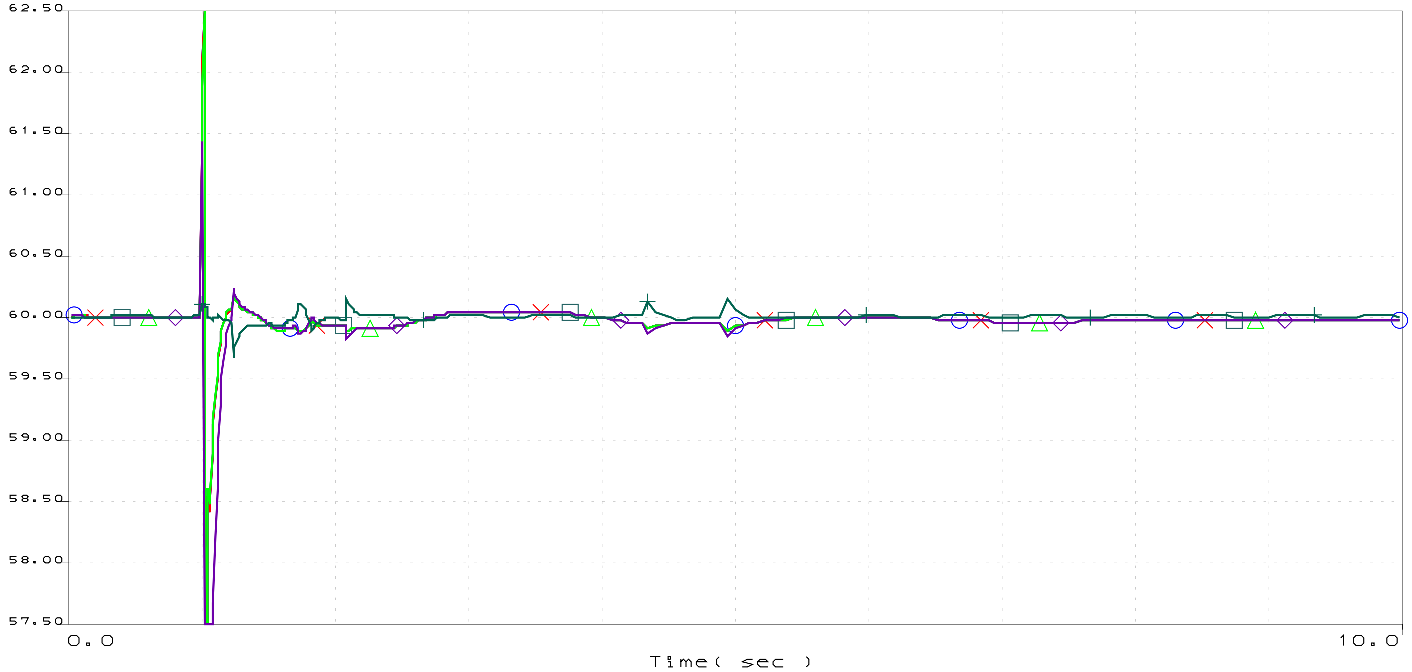
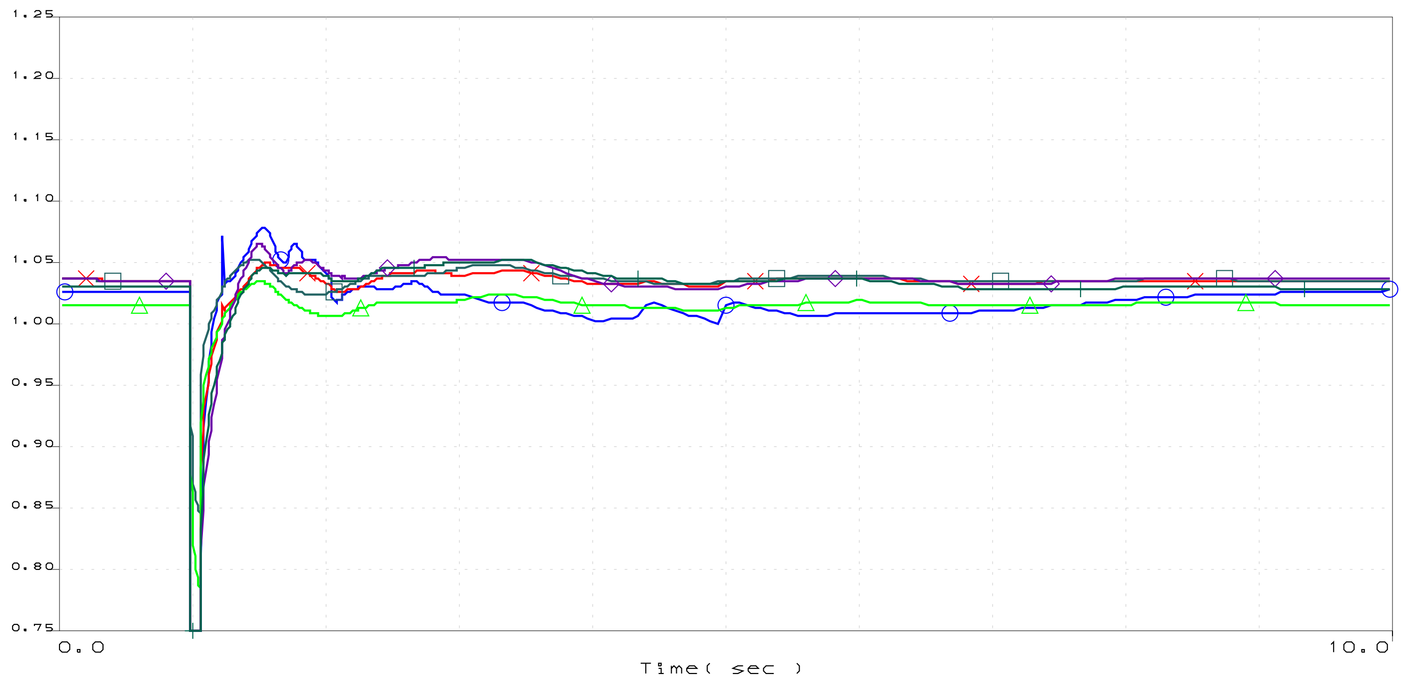


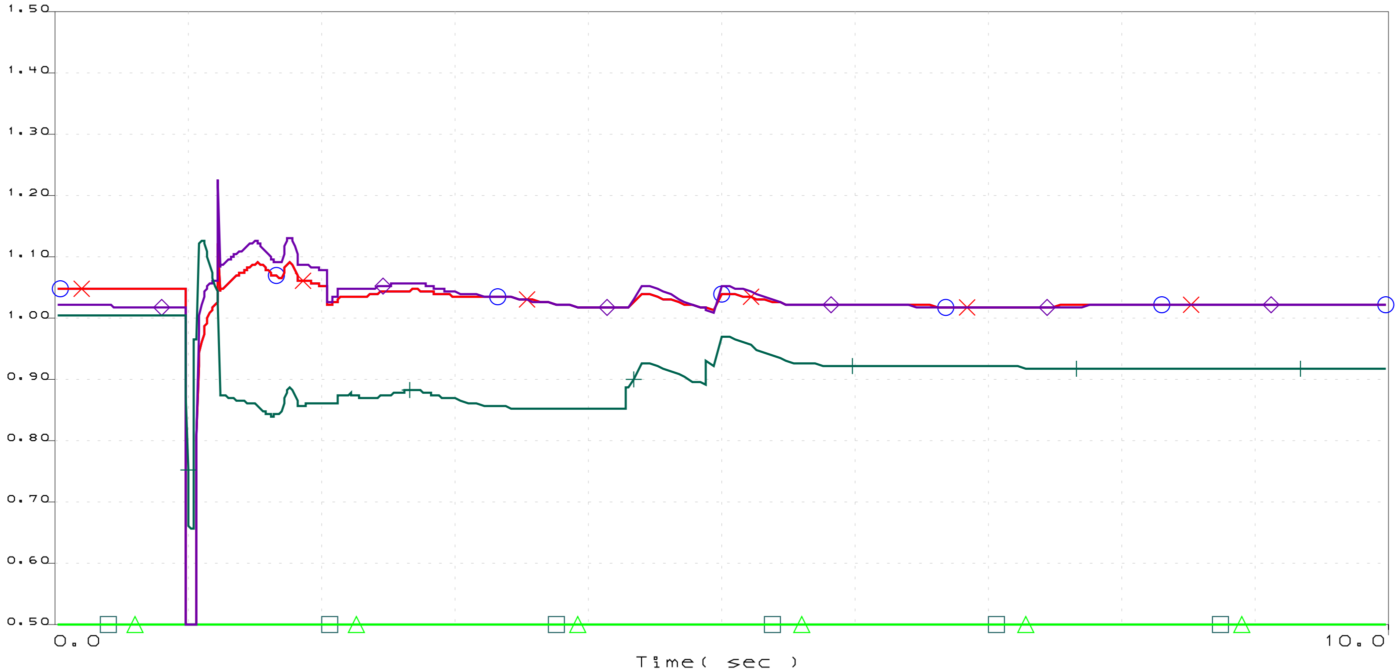
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



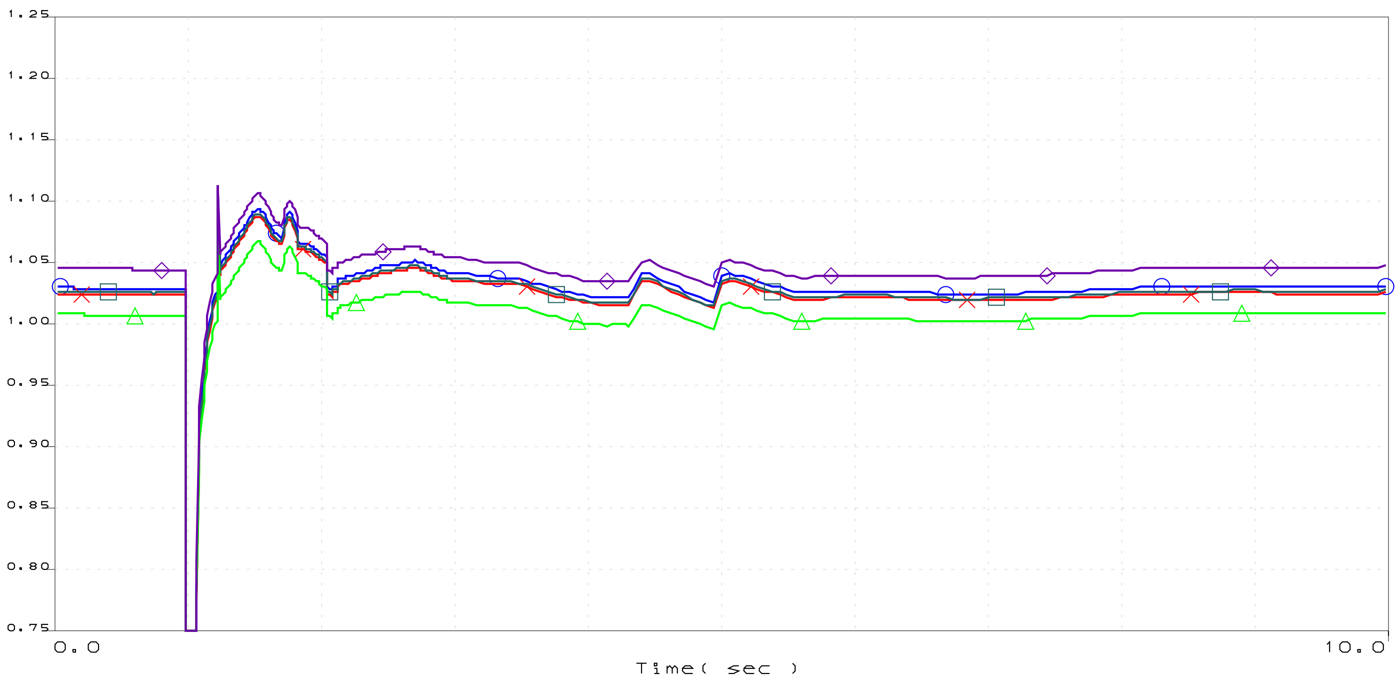
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

Case2S14.chf

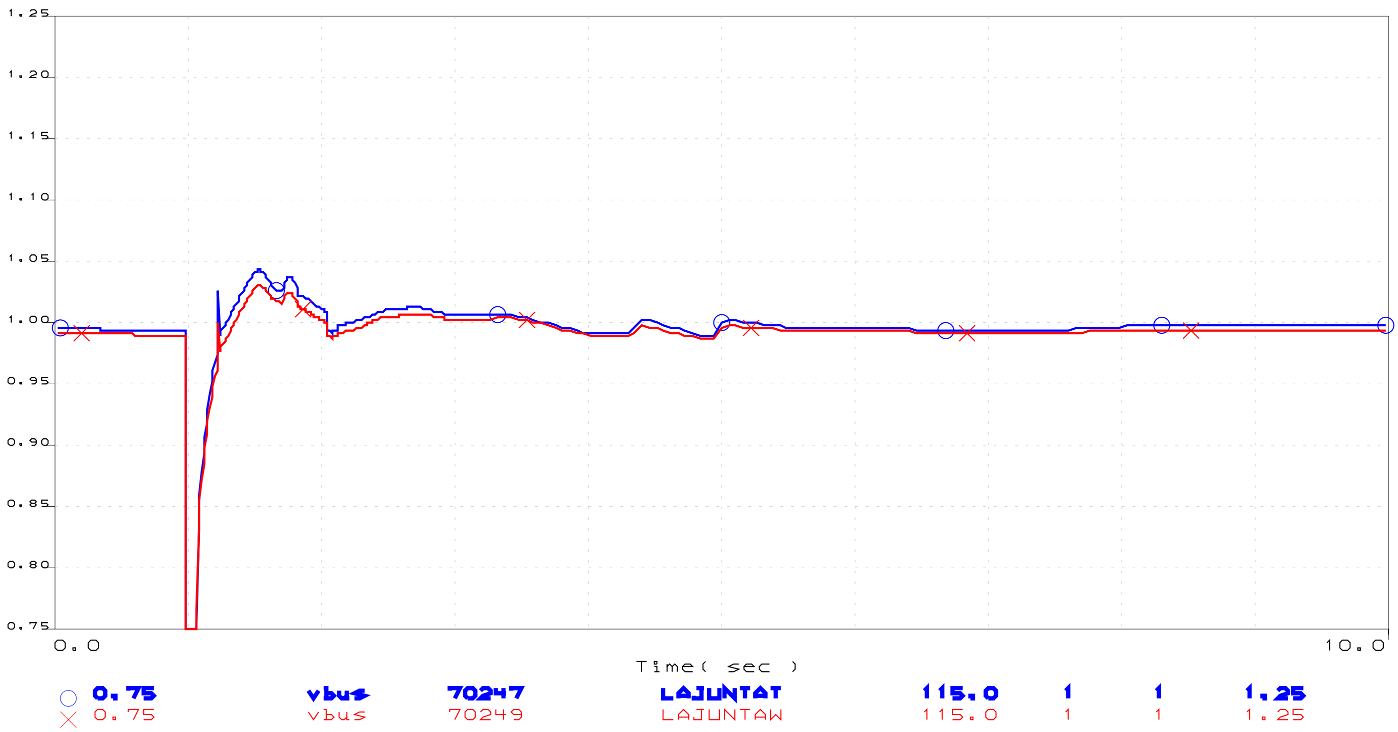
Wed Nov 24 11:57:46 2004

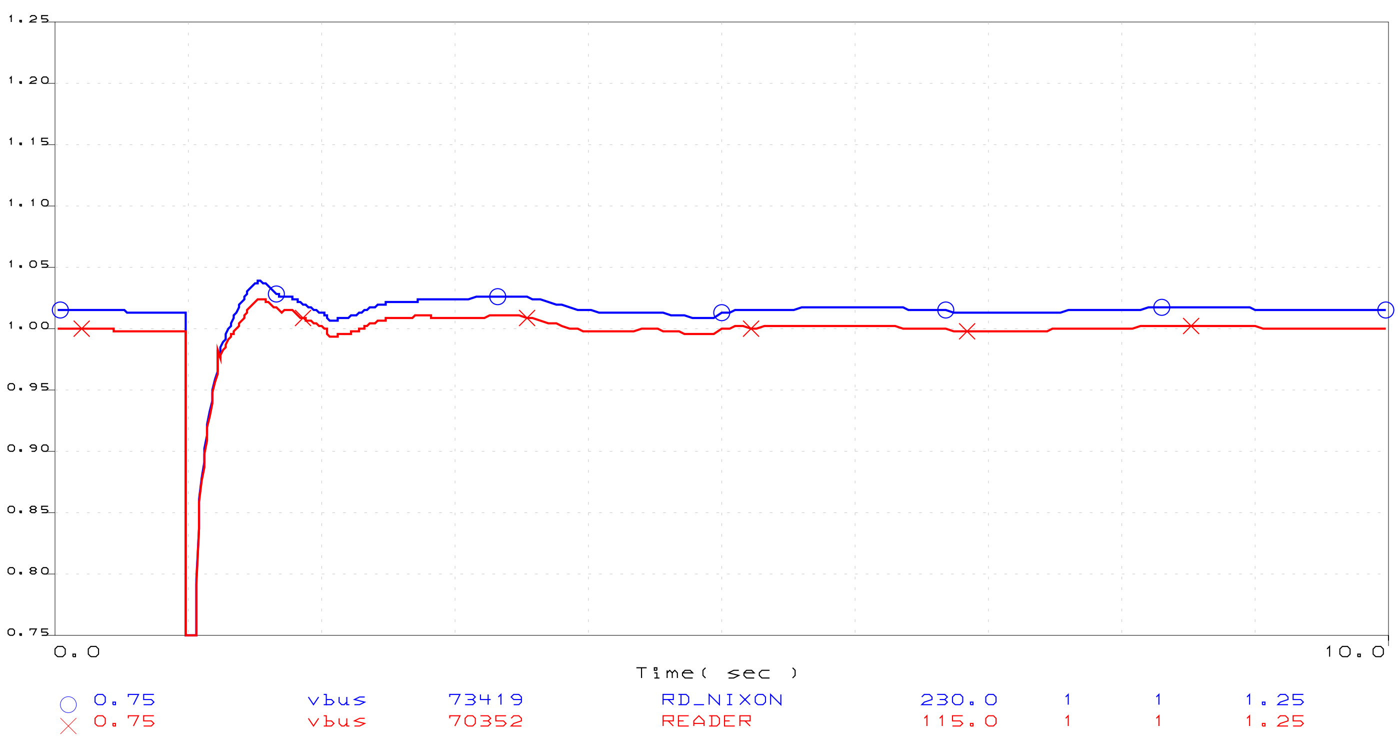


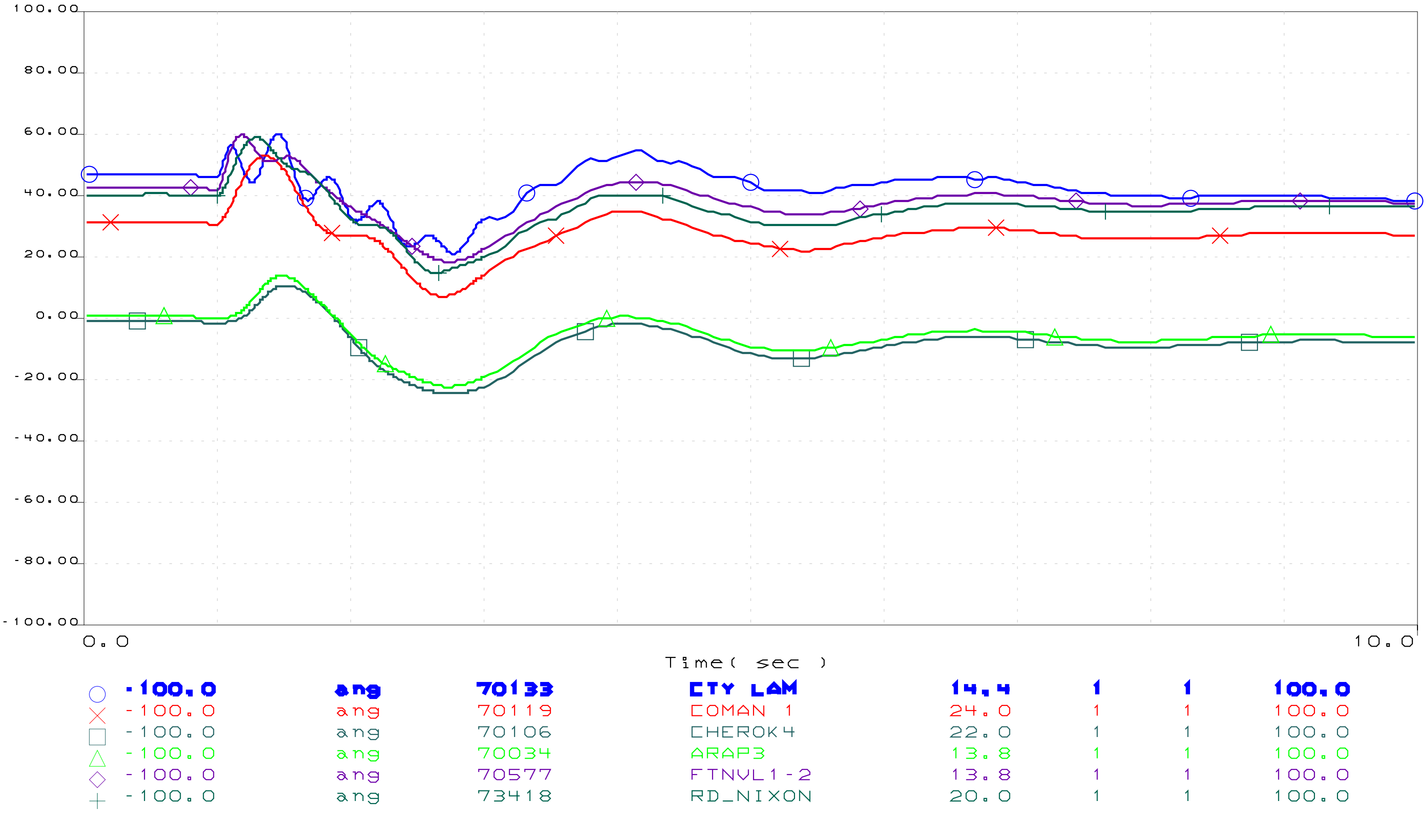
0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5

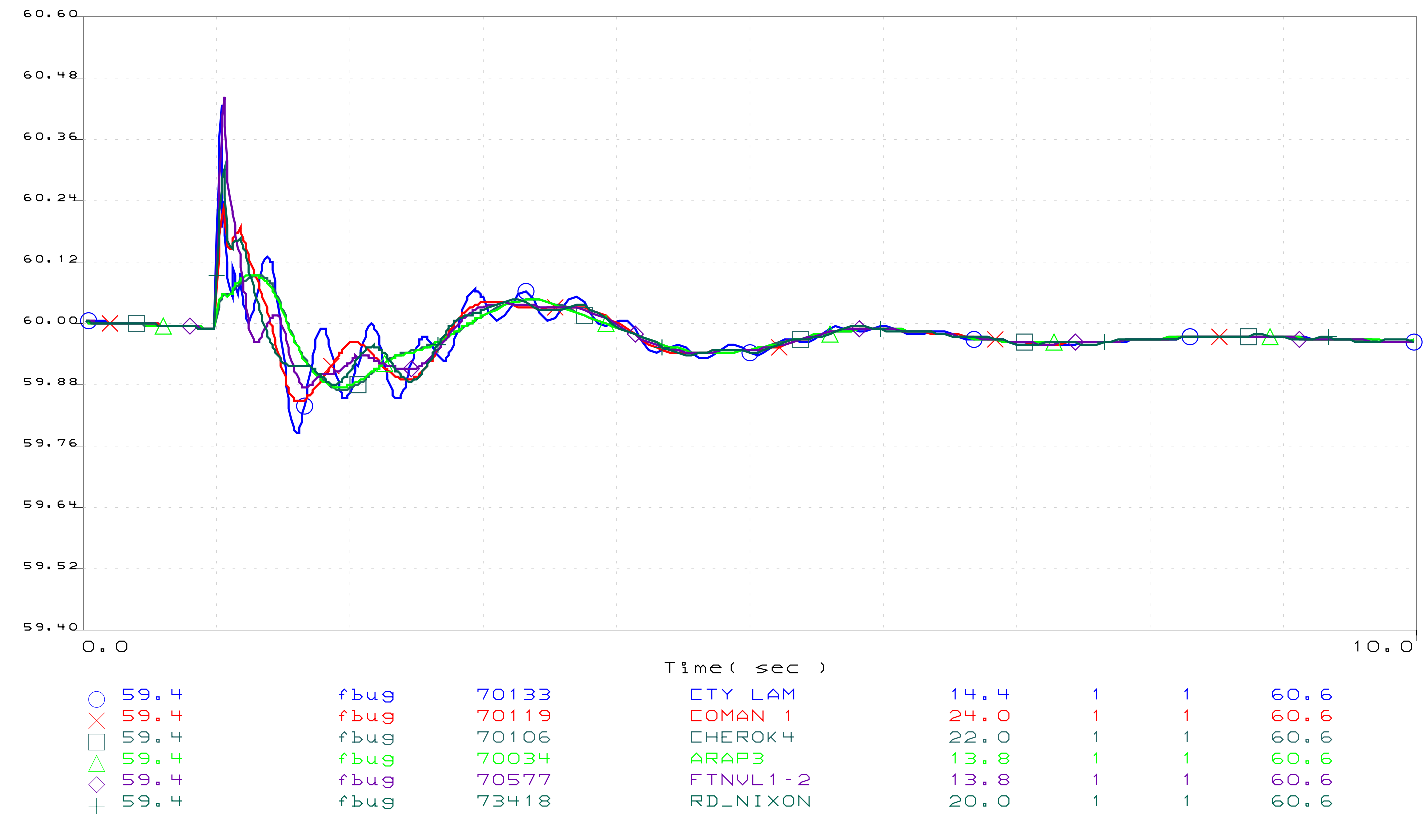


0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25


1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25





Case2515.chf

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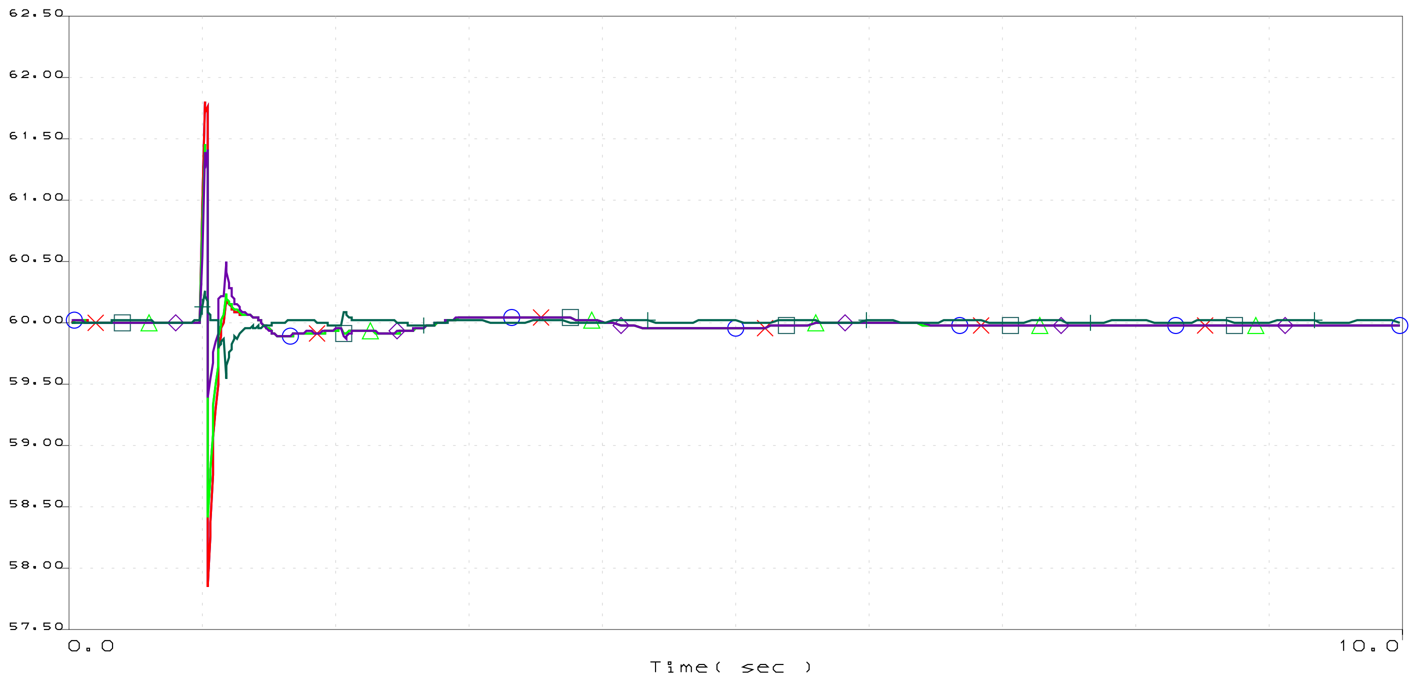
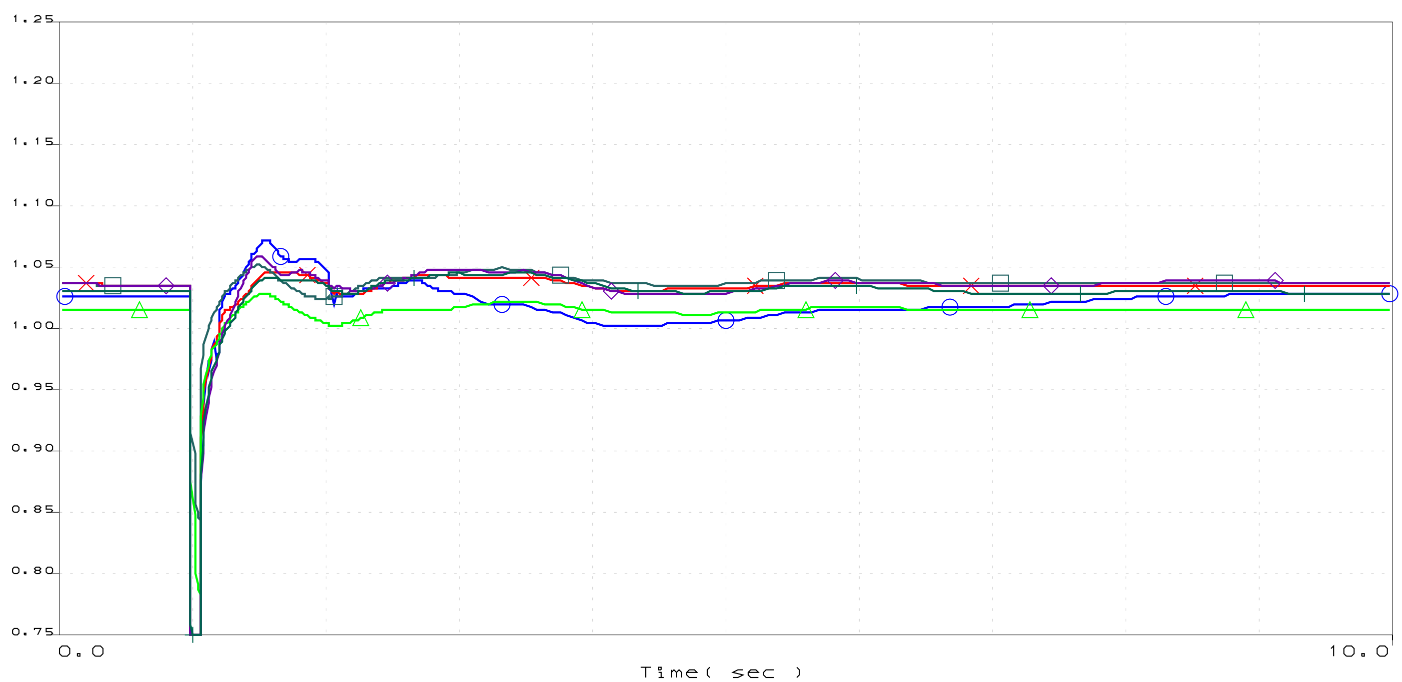
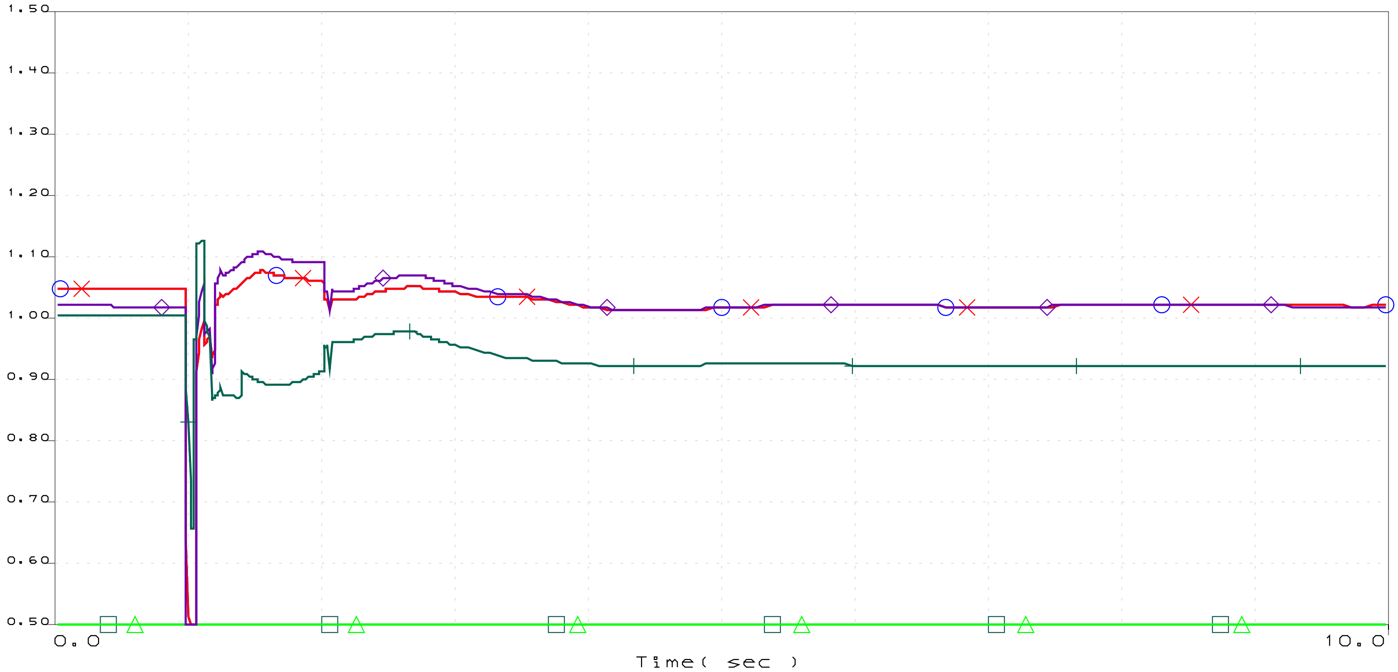


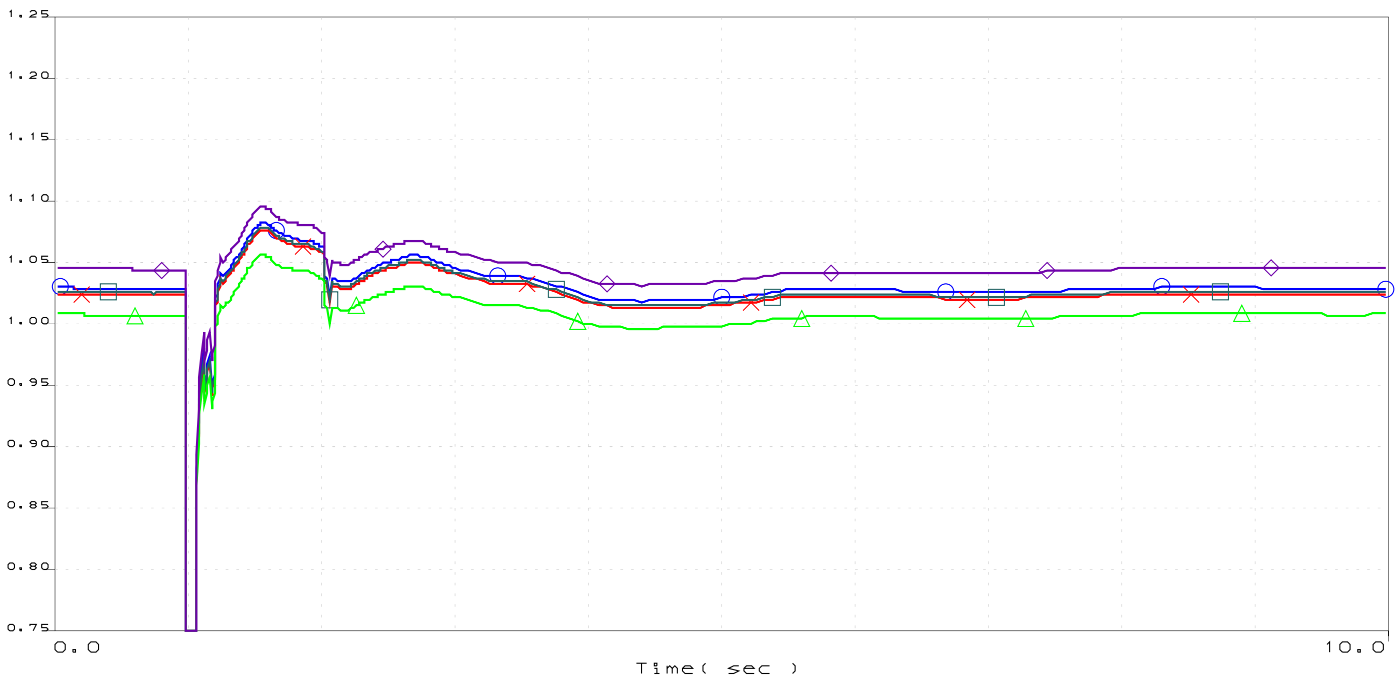
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



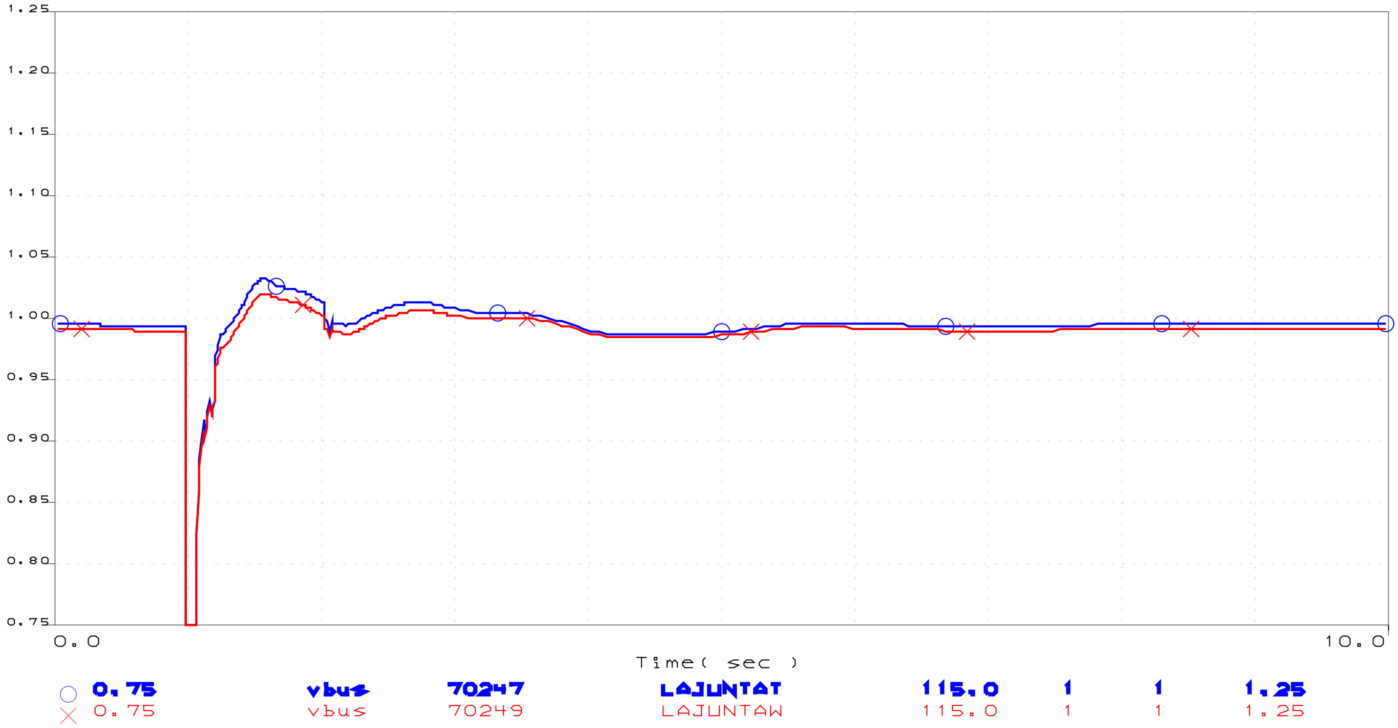
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

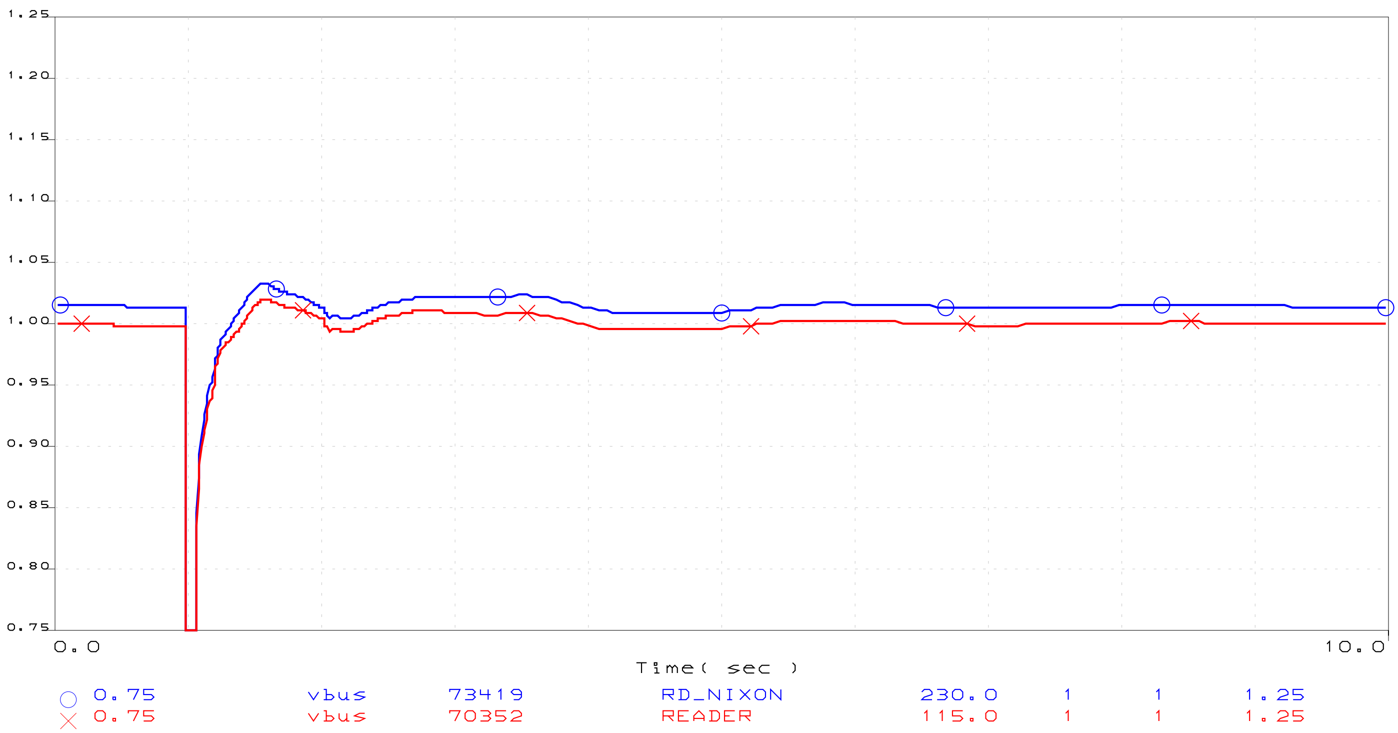


0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



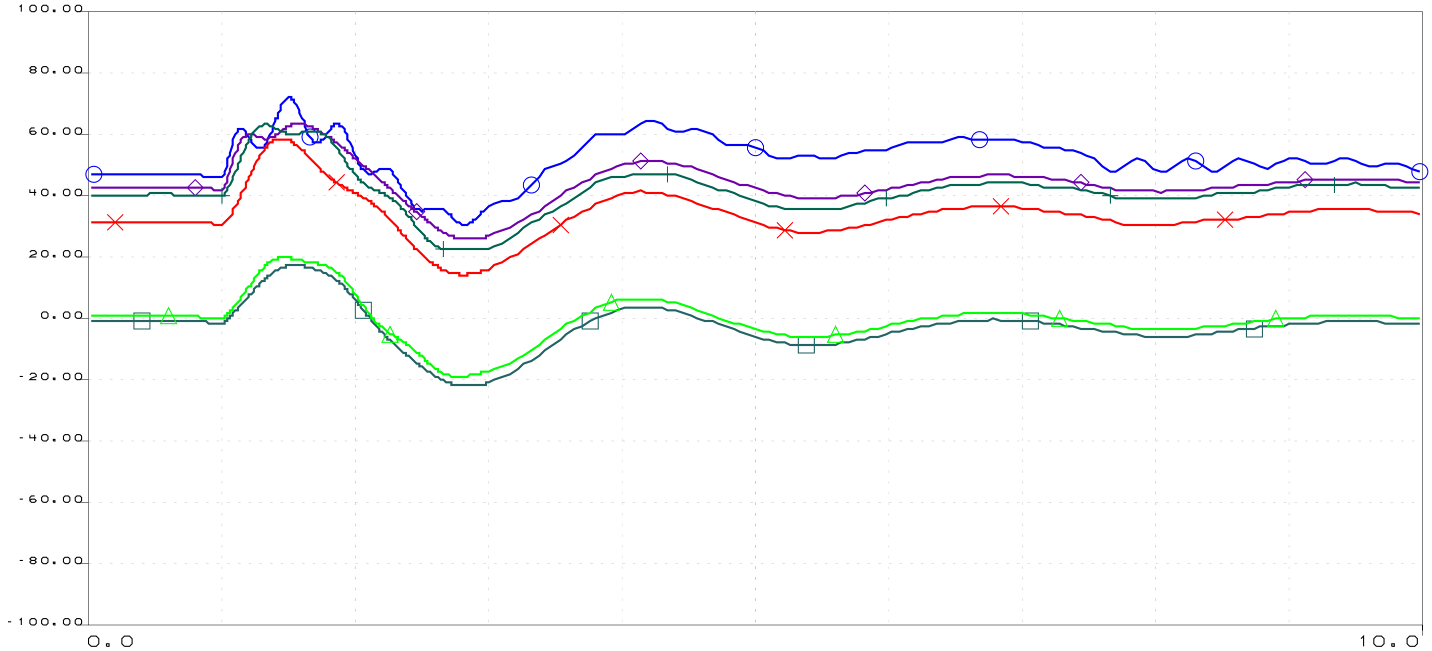
0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25



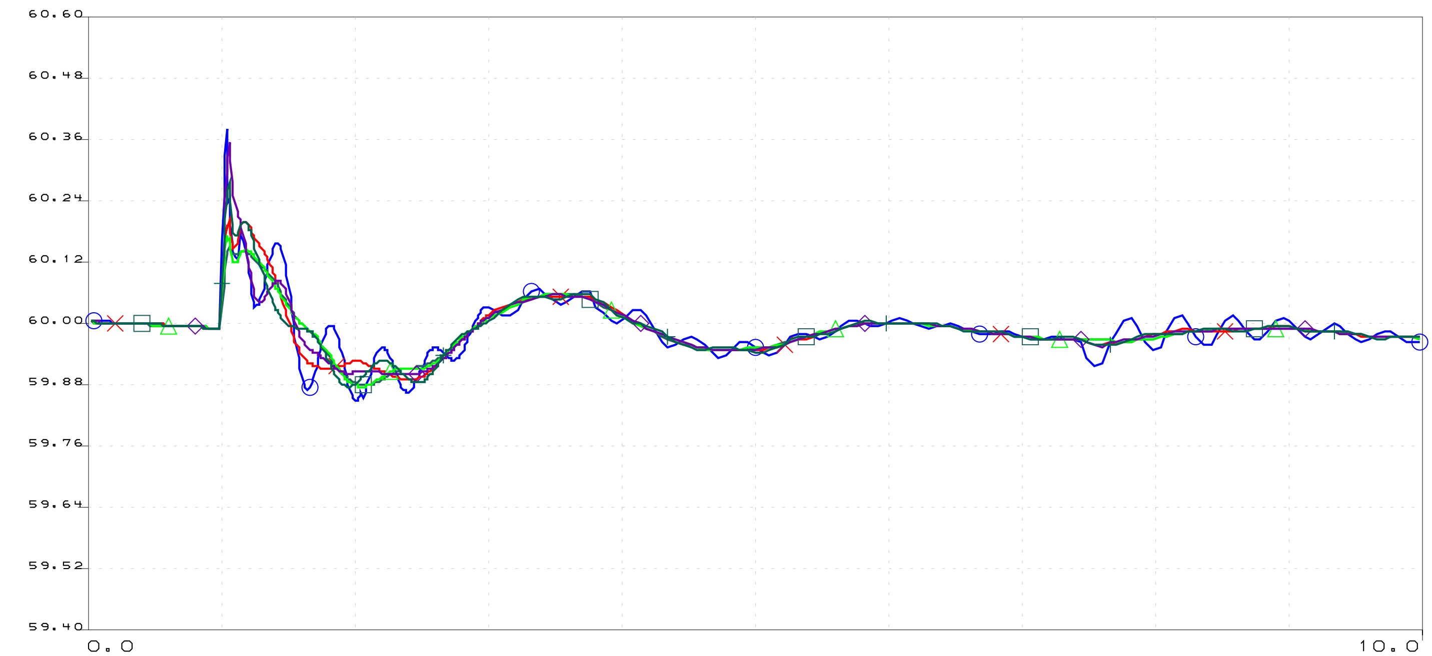


Case2S15.chf

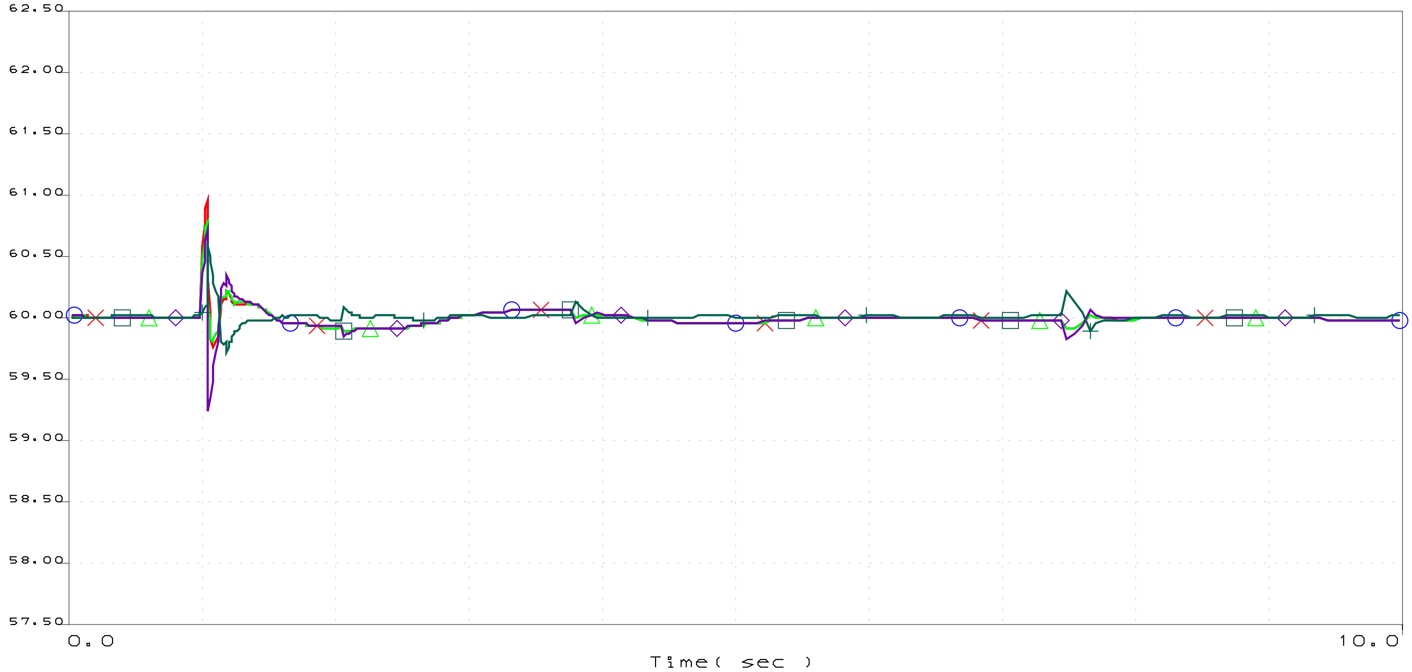
Wed Nov 24 11:58:30 2004



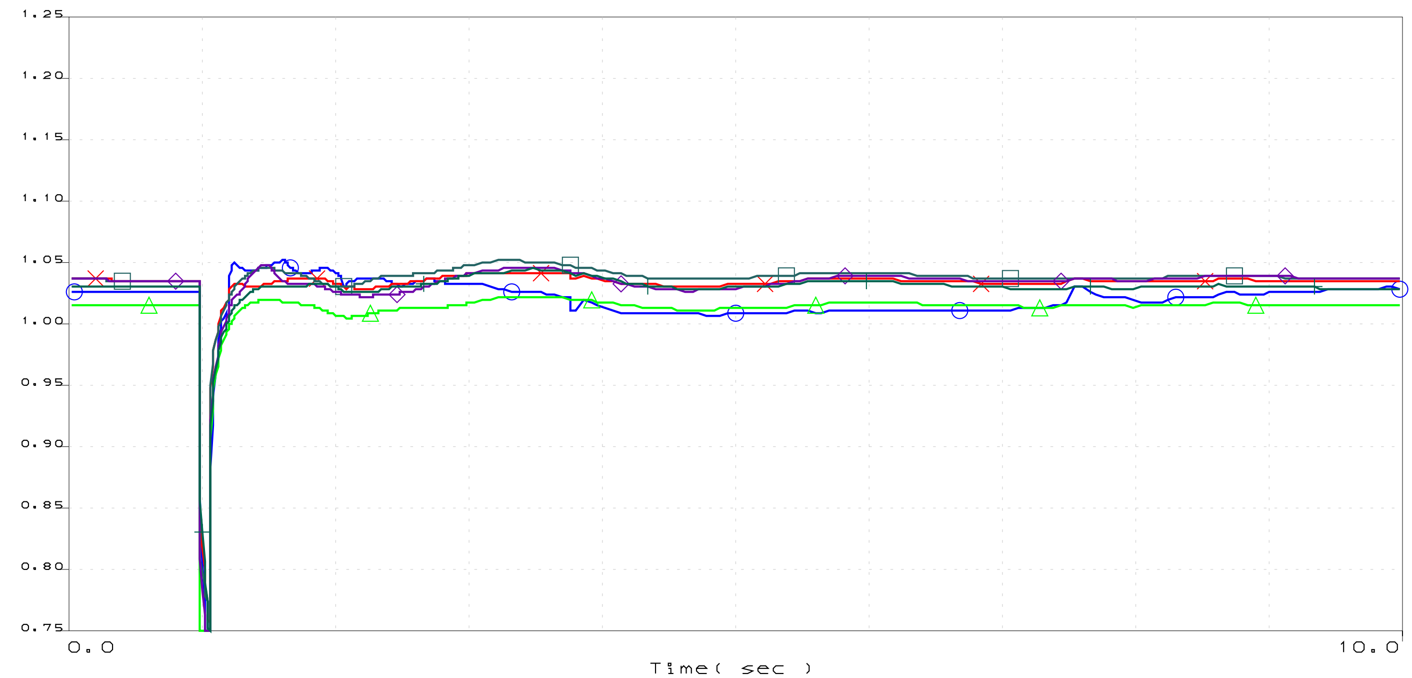
-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
-100.0	ang	70034	ARAP3	13.8	1	1	100.0
-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
59.4	fbug	70034	ARAP3	13.8	1	1	60.6
59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



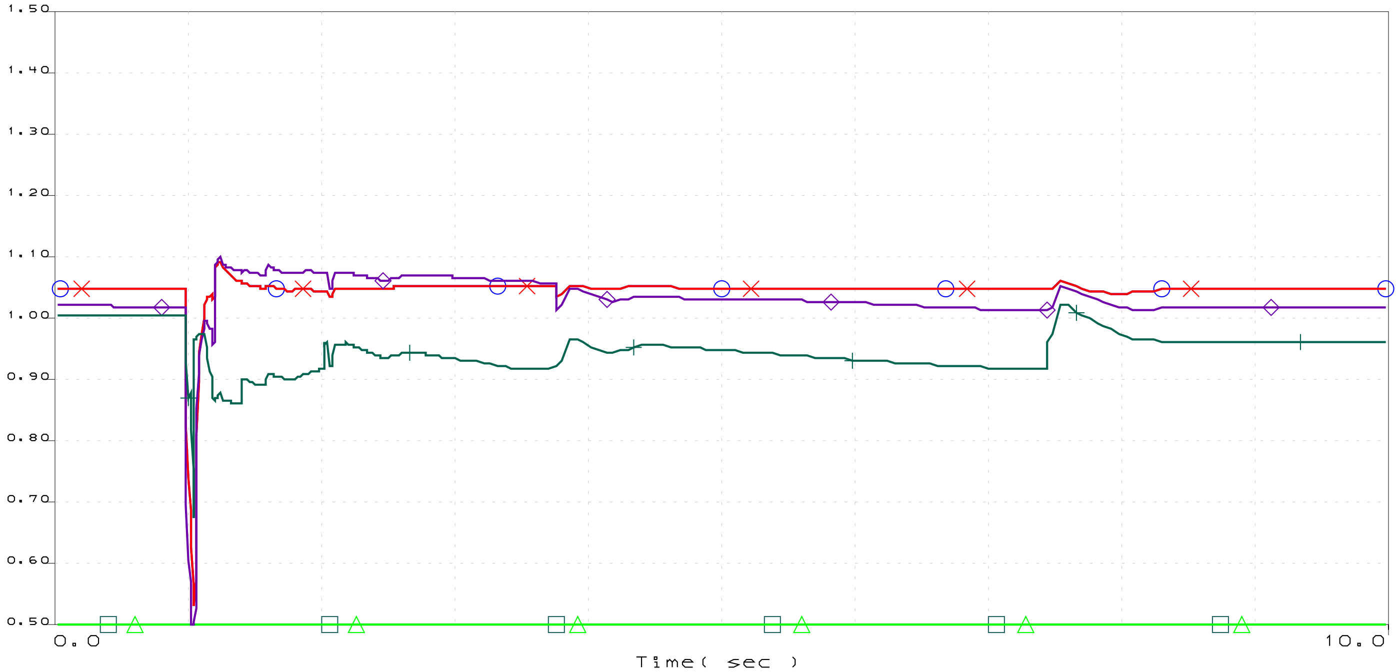
57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



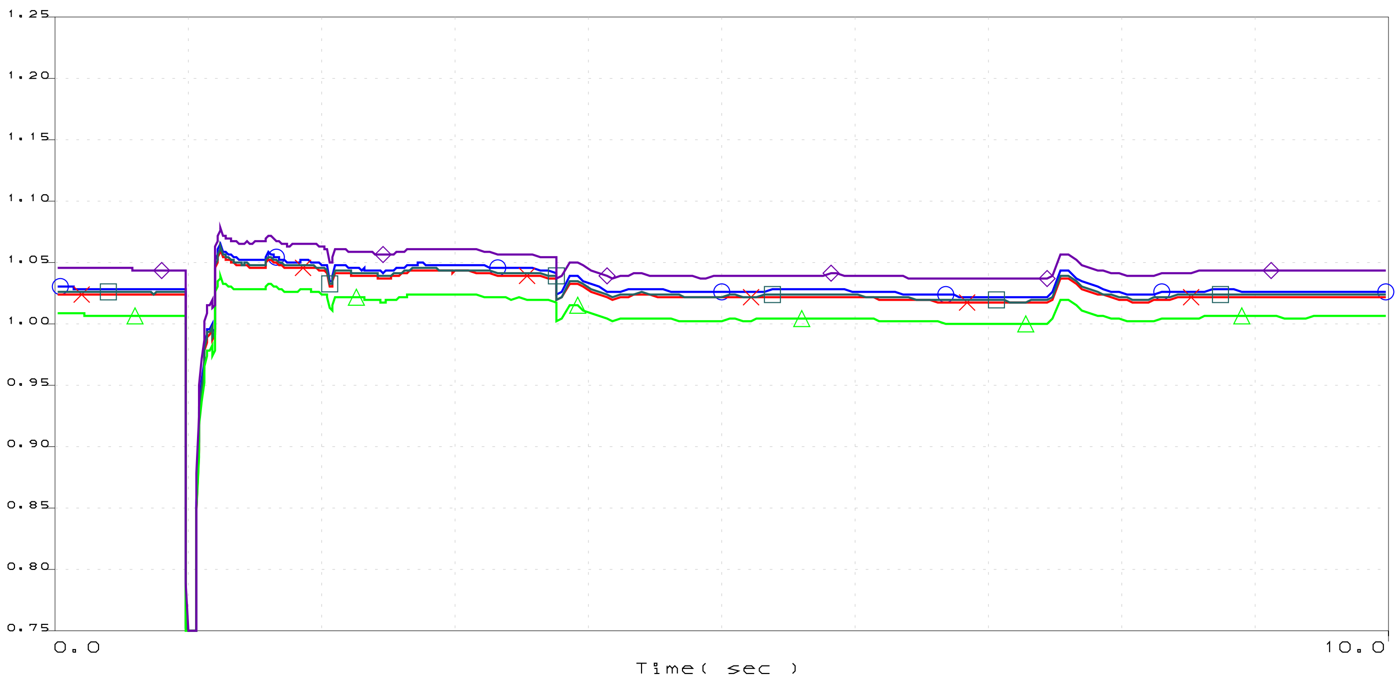
0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25

Case2S16.chf

Wed Nov 24 11:59:10 2004



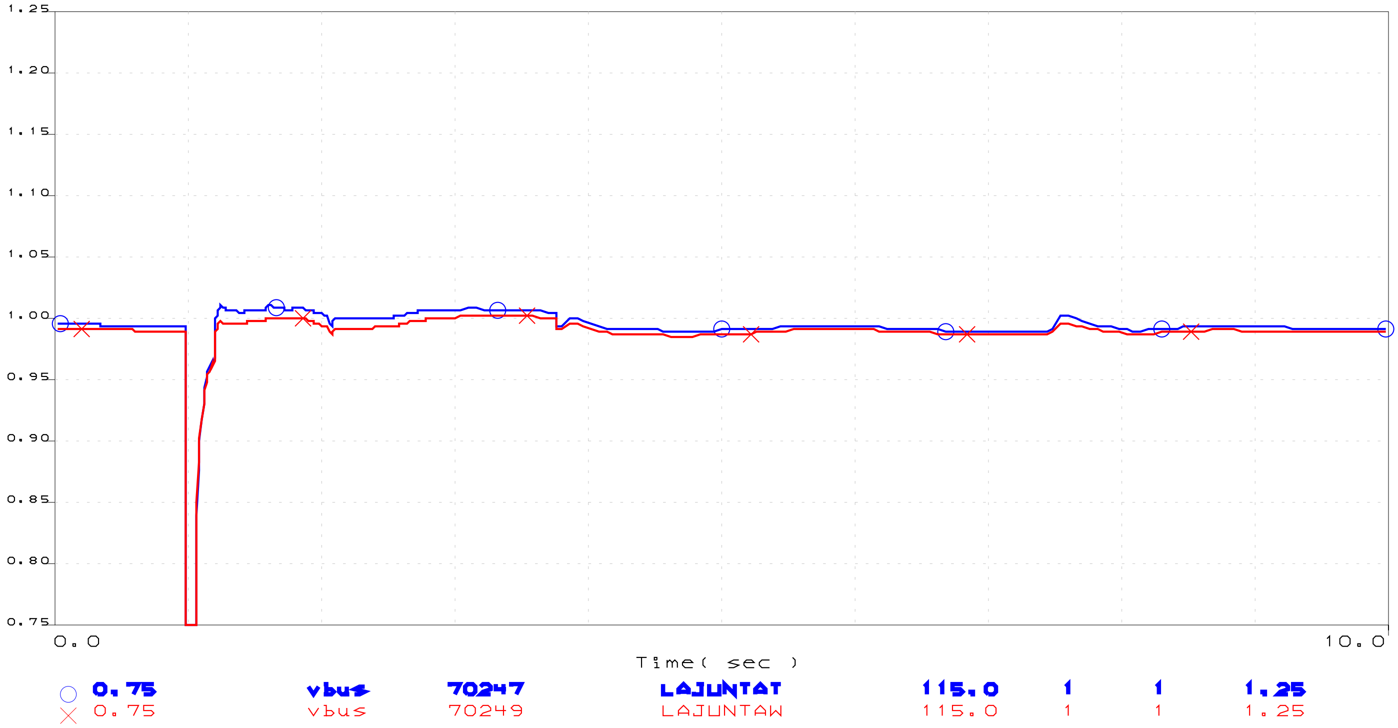
0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5

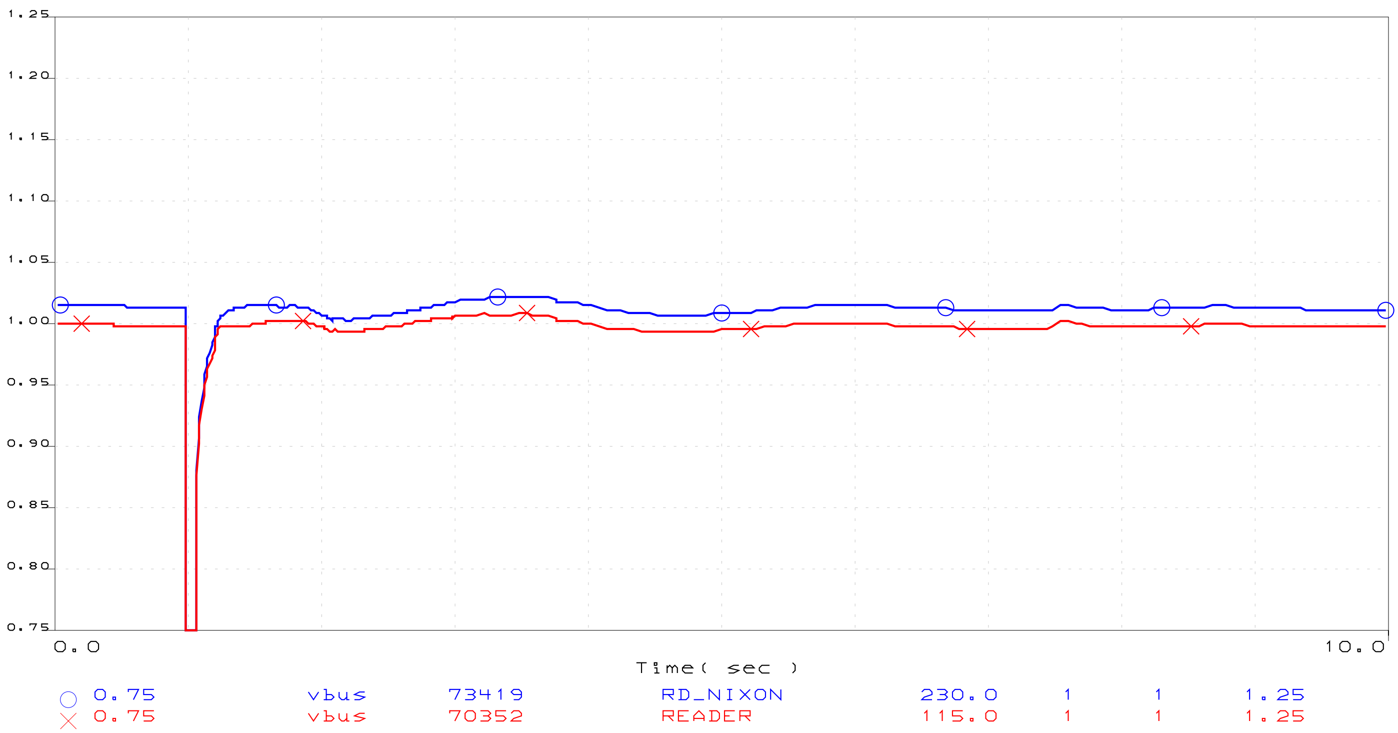


0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case2S16.chf

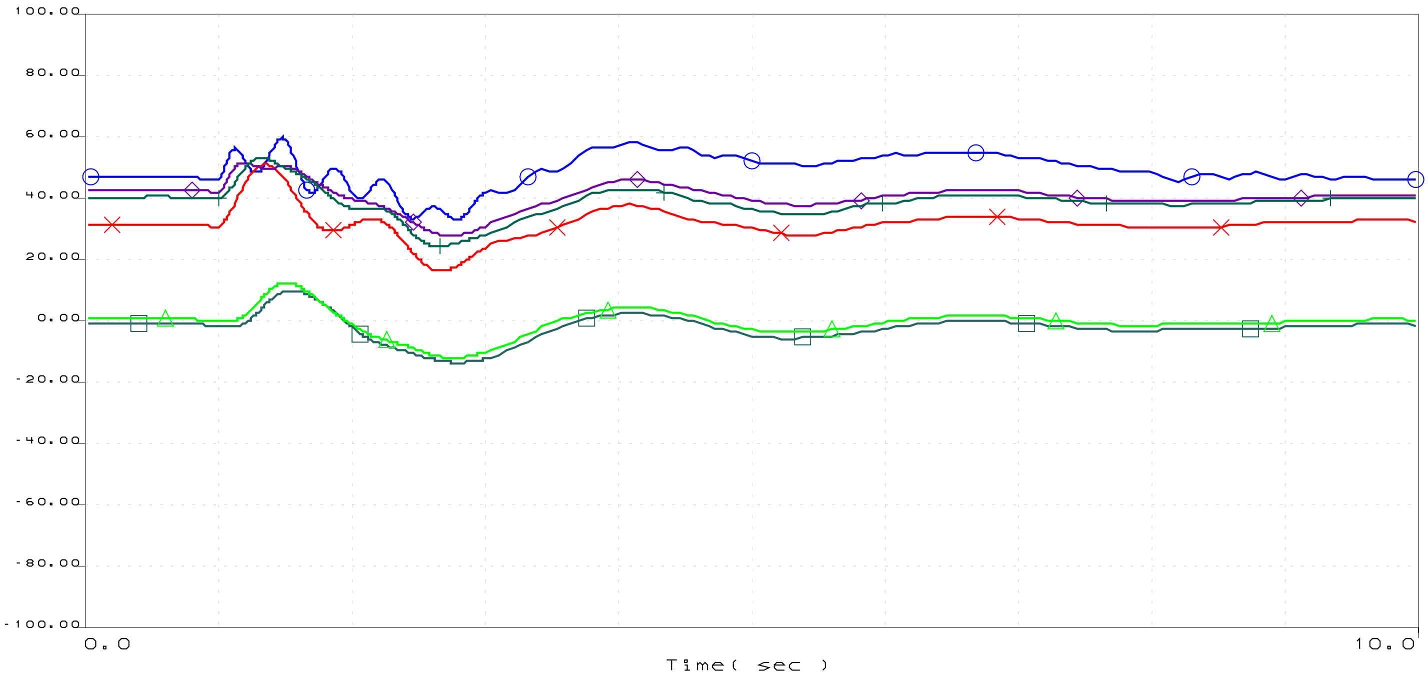
Wed Nov 24 11:59:10 2004



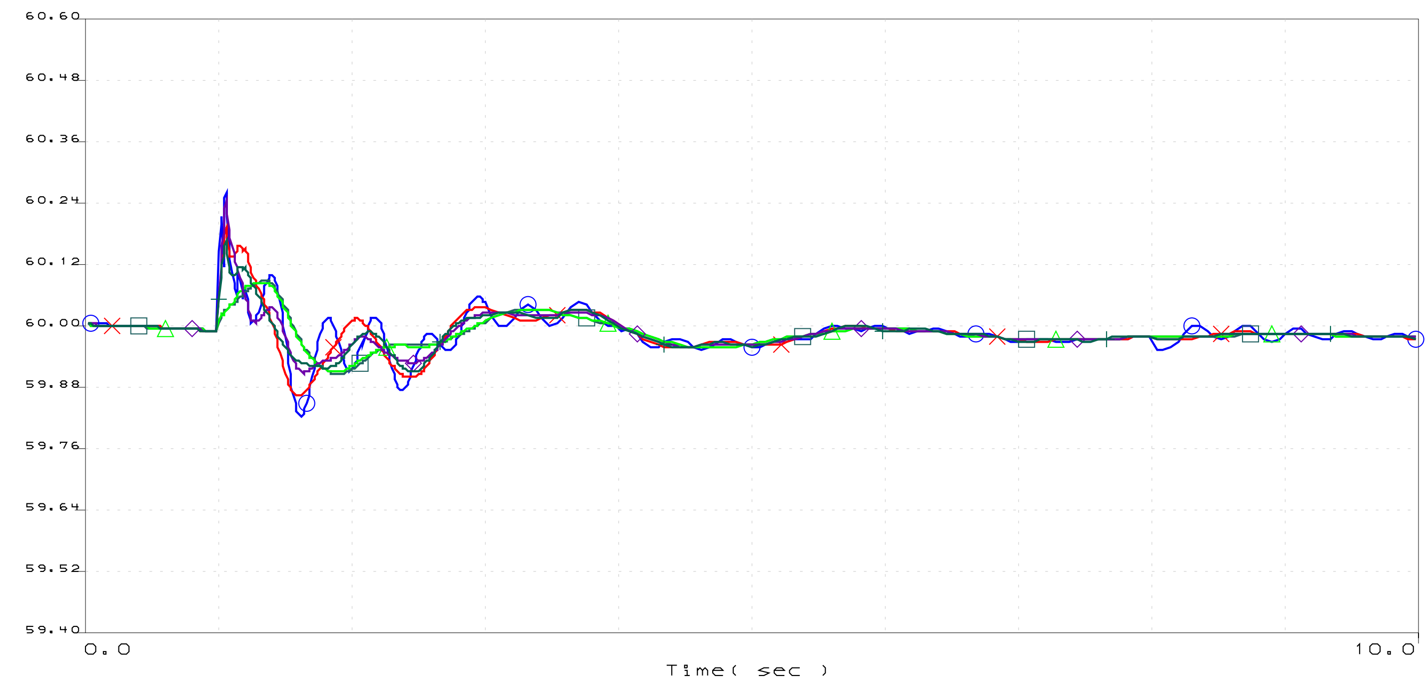


Case2S16.chf

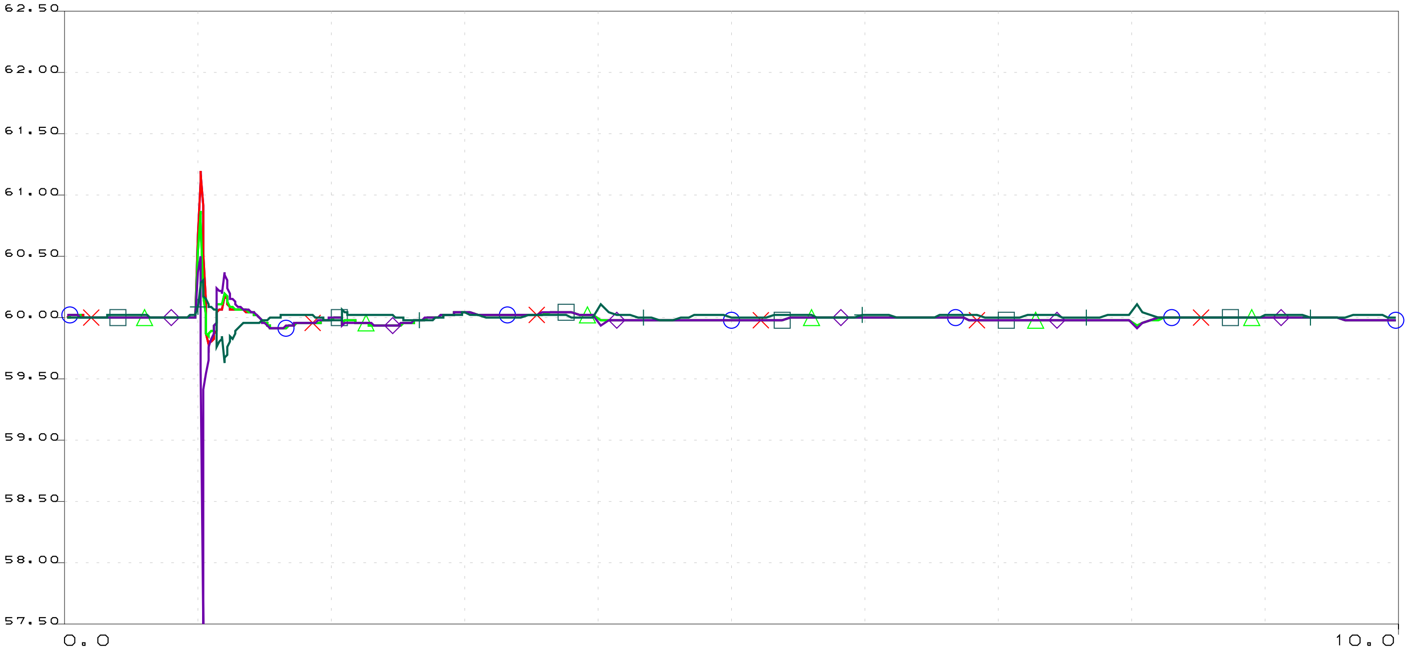
Wed Nov 24 11:59:10 2004



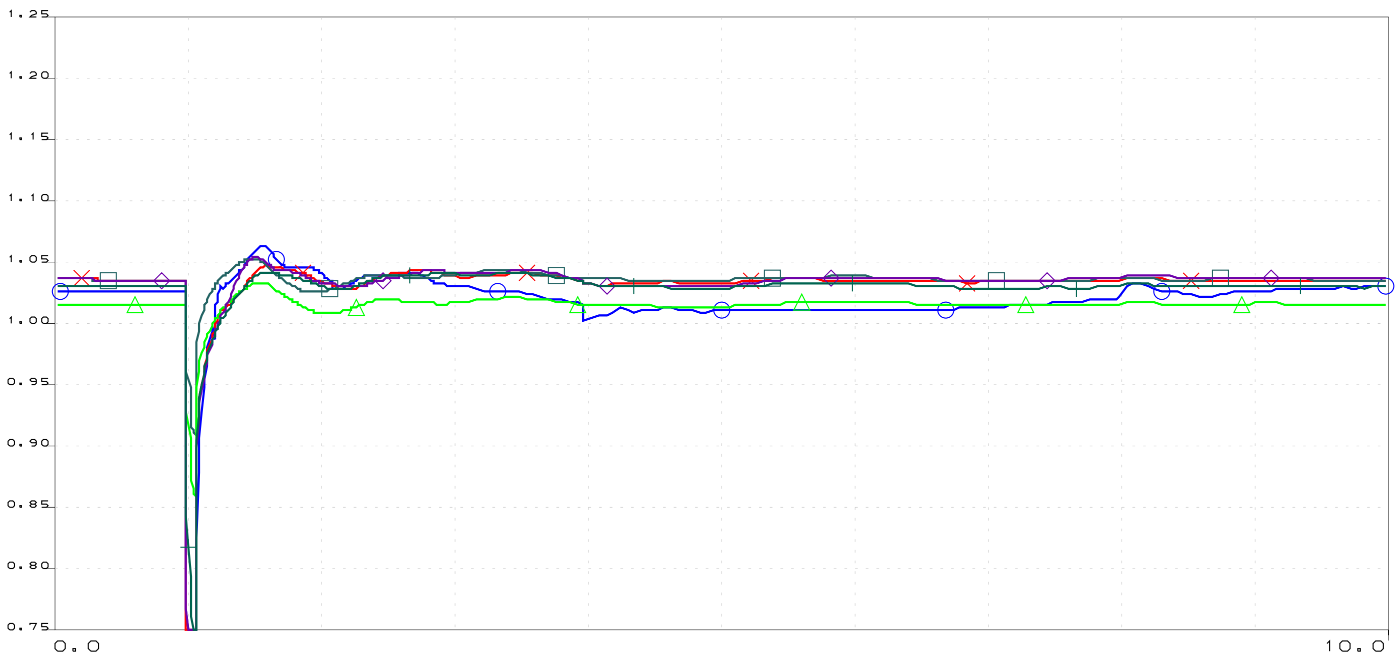
○ -100.0	ang	70133	CTY LAM	14.4	1	1	100.0
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



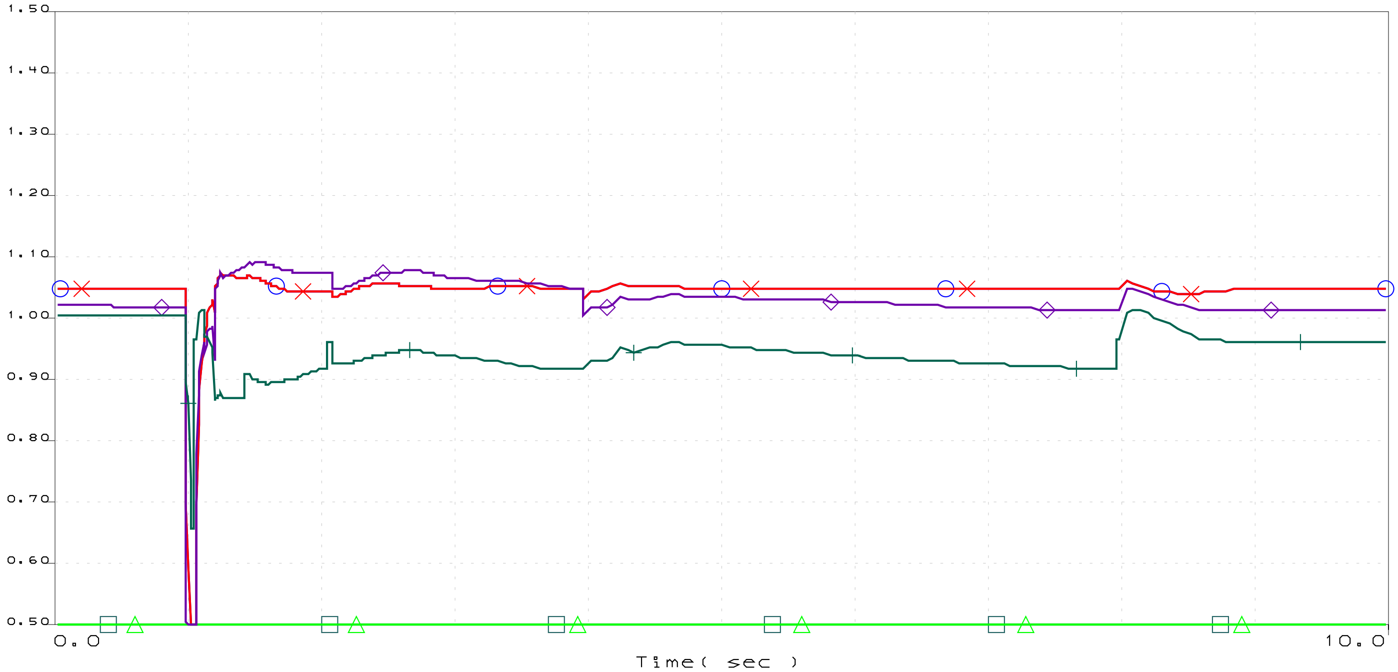
○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



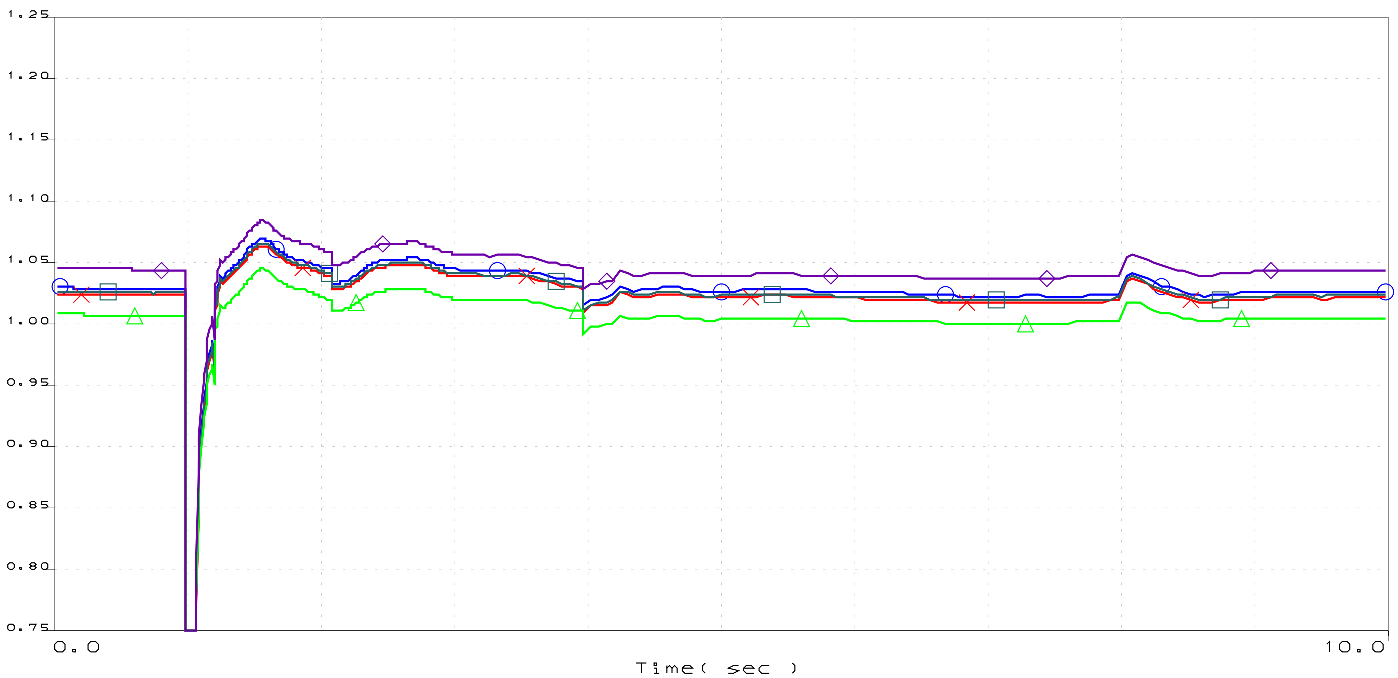
57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
0.75	vbus	70034	ARAP3	13.8	1	1	1.25
0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



0.5	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



0.75	vbus	70452	VILAS	115.0	1	1	1.25
0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
0.75	vbul	70460	WALSH	69.0	1	1	1.25
0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
0.75	vbul	70473	WILOW CK	69.0	1	1	1.25

Case2518.chf

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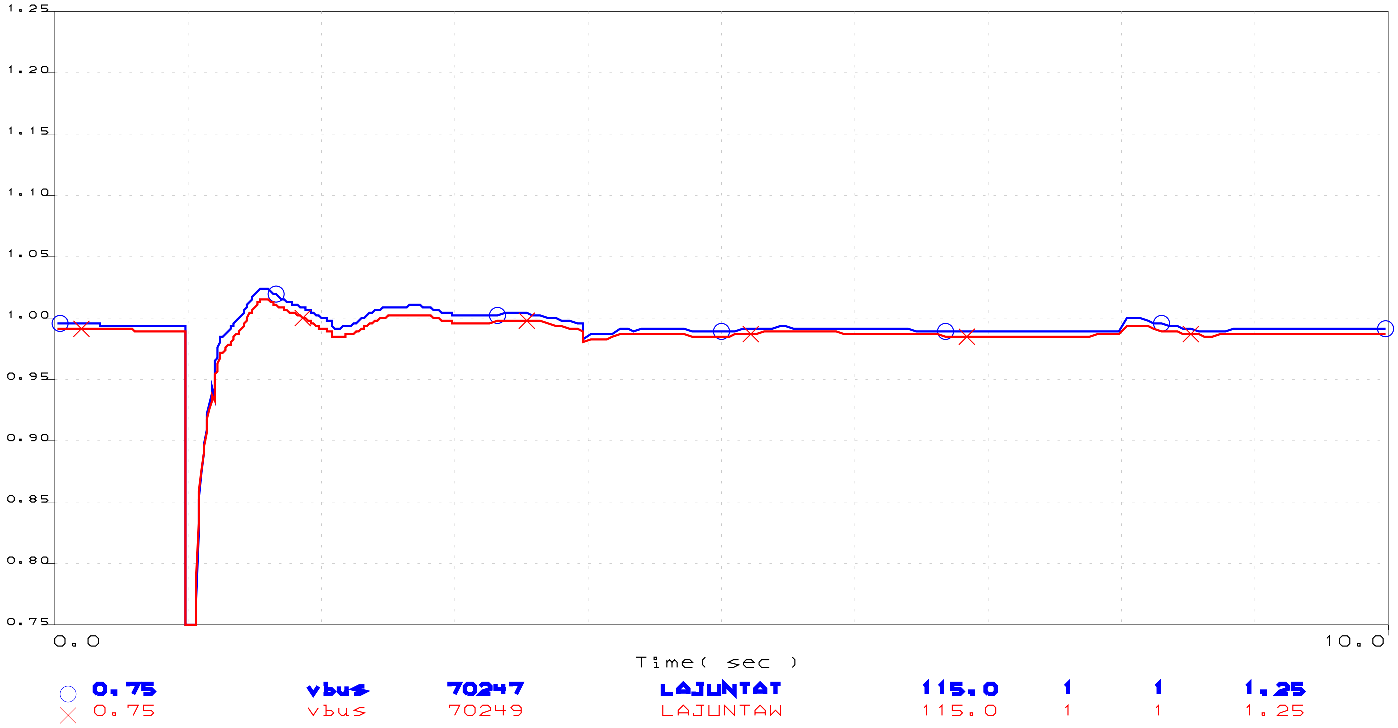
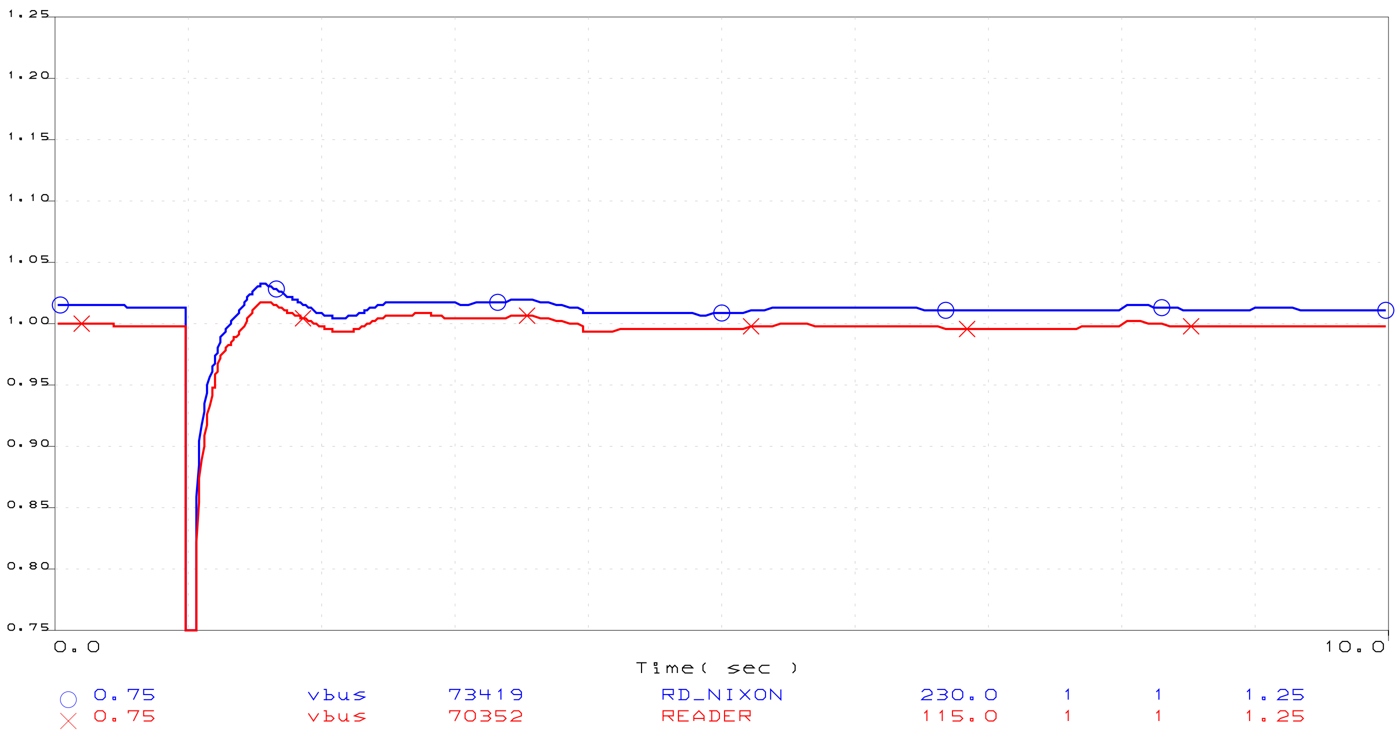
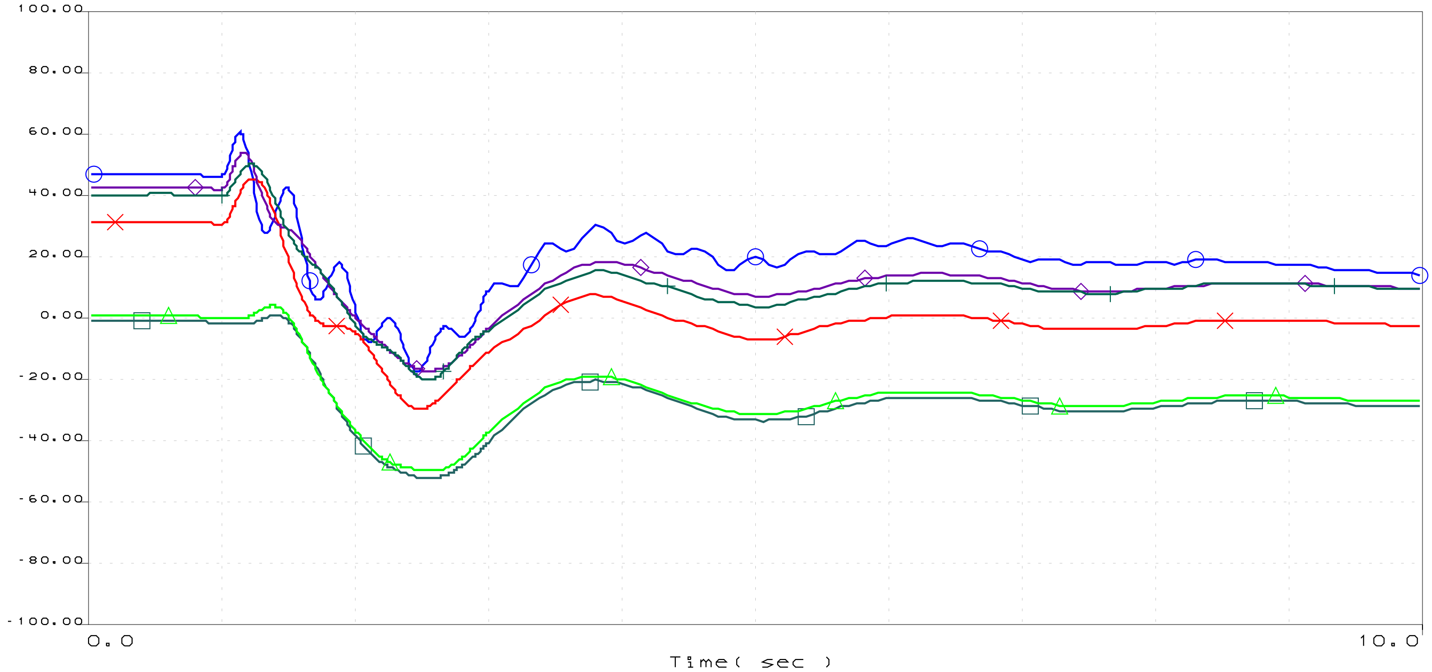


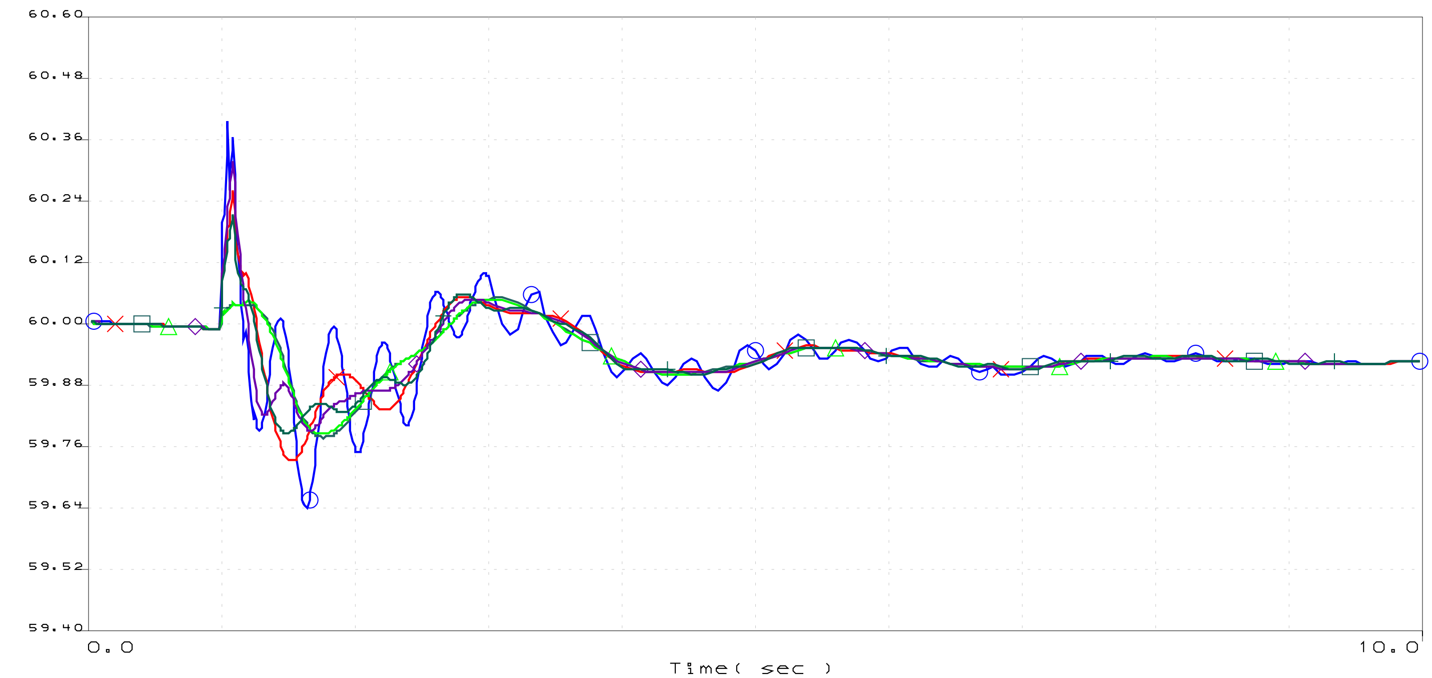
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70247 LAJUNTAT 115.0 1 1 1.25
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25



1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 73419 RD_NIXON 230.0 1 1 1.25
0.75 vbus 70352 READER 115.0 1 1 1.25



○	-100.0	ang	70133	CTY LAM	14.4	1	1	100.0
×	-100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□	-100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△	-100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇	-100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+	-100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



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△	59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇	59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+	59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6

Case2S19.chf

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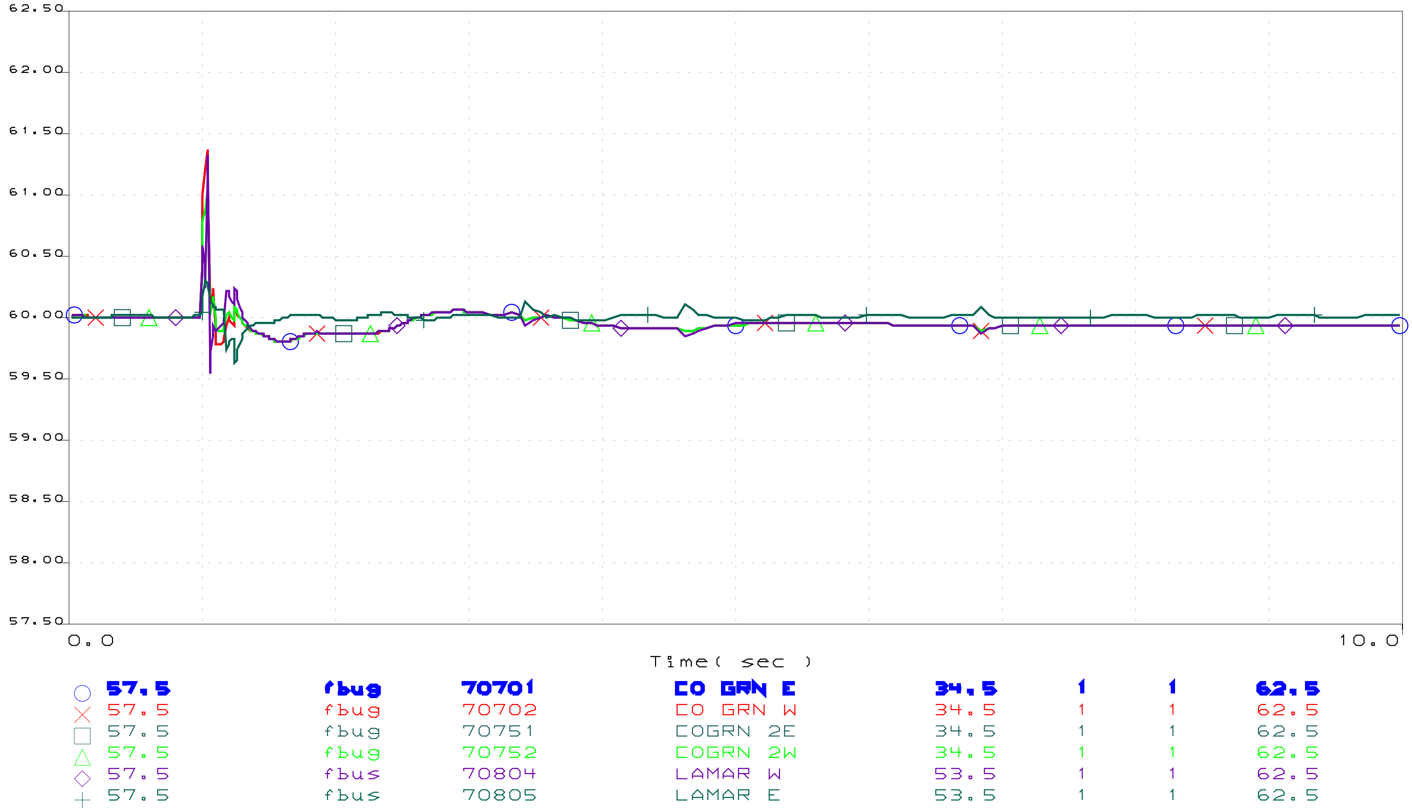
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62.00
61.50
61.00
60.50
60.00
59.50
59.00
58.50
58.00
57.50
0.0
10.0
Time(sec)
57.5 fbus 70701 CO GRN E 34.5 1 1 62.5
57.5 fbus 70702 CO GRN W 34.5 1 1 62.5
57.5 fbus 70751 COGRN 2E 34.5 1 1 62.5
57.5 fbus 70752 COGRN 2W 34.5 1 1 62.5
57.5 fbus 70804 LAMAR W 53.5 1 1 62.5
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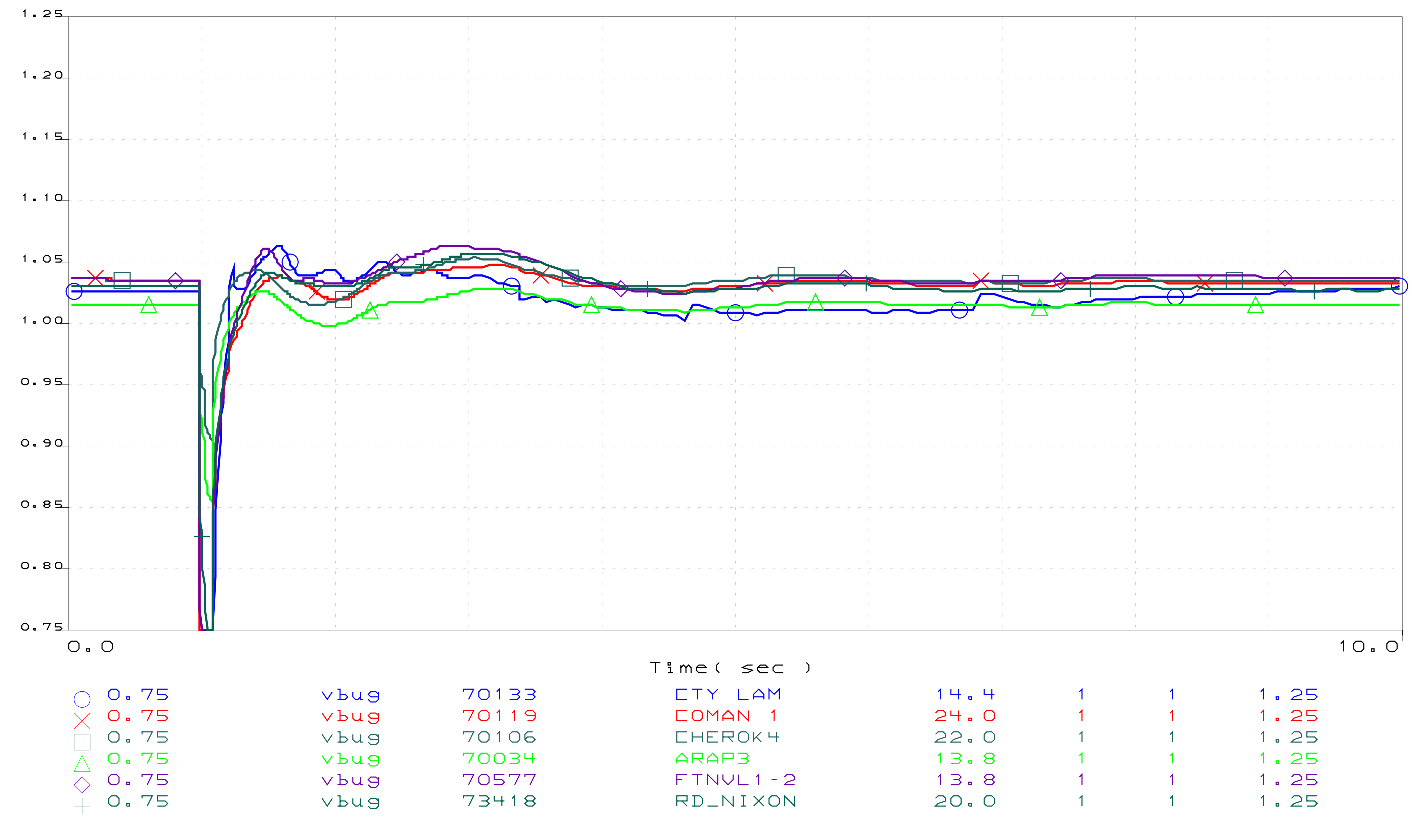
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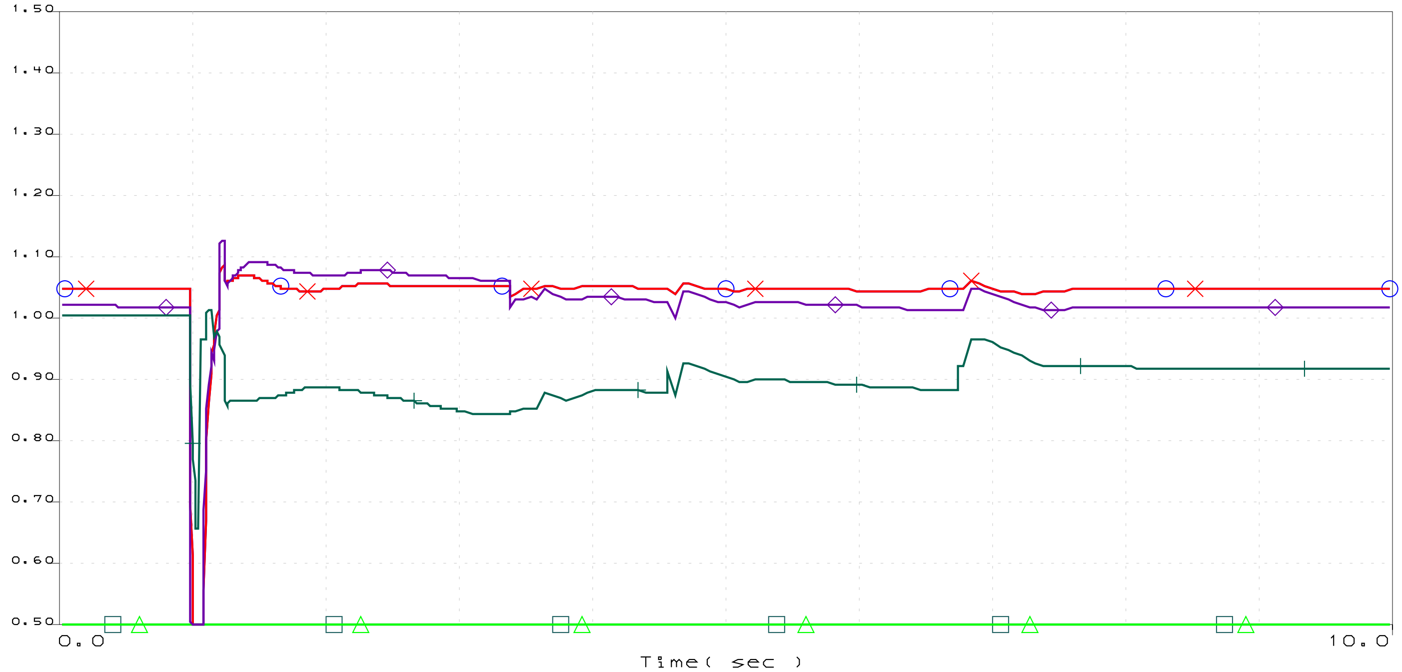
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
0.75 vbus 70133 CTY LAM 14.4 1 1 1.25
0.75 vbus 70119 COMAN 1 24.0 1 1 1.25
0.75 vbus 70106 CHEROK4 22.0 1 1 1.25
0.75 vbus 70034 ARAP3 13.8 1 1 1.25
0.75 vbus 70577 FTNVL1-2 13.8 1 1 1.25
0.75 vbus 73418 RD_NIXON 20.0 1 1 1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
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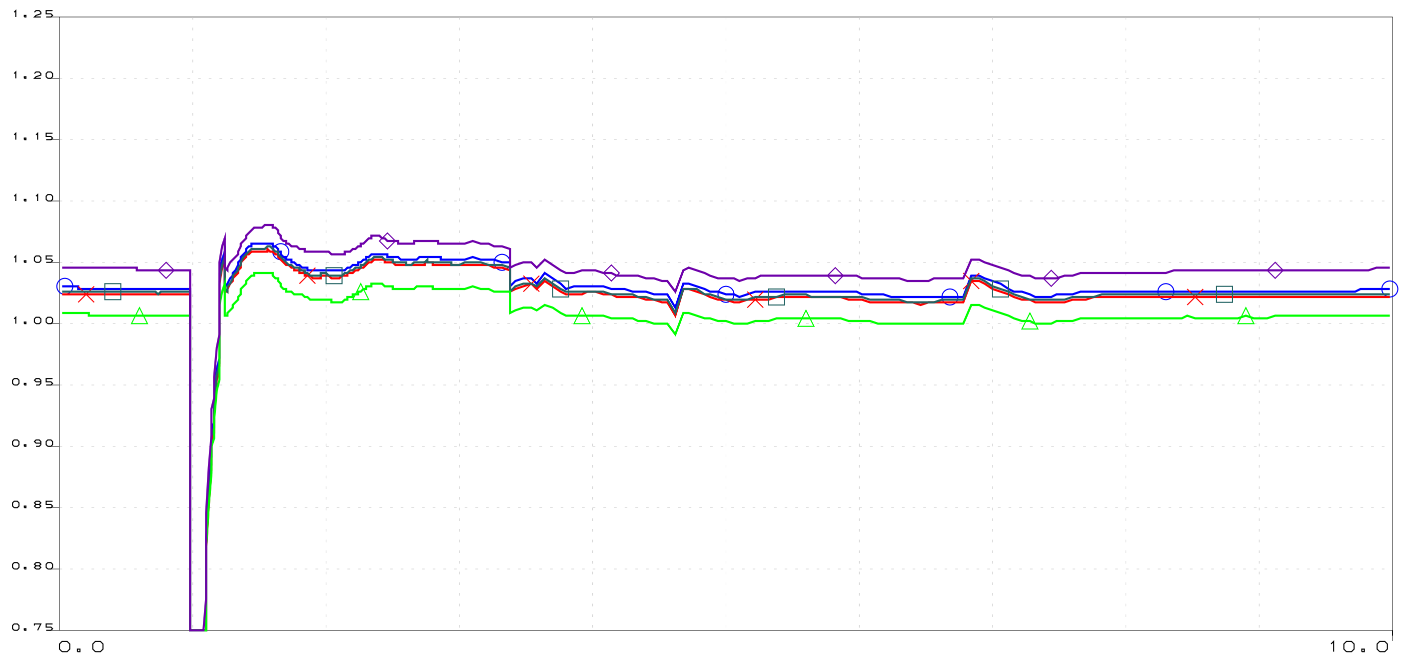
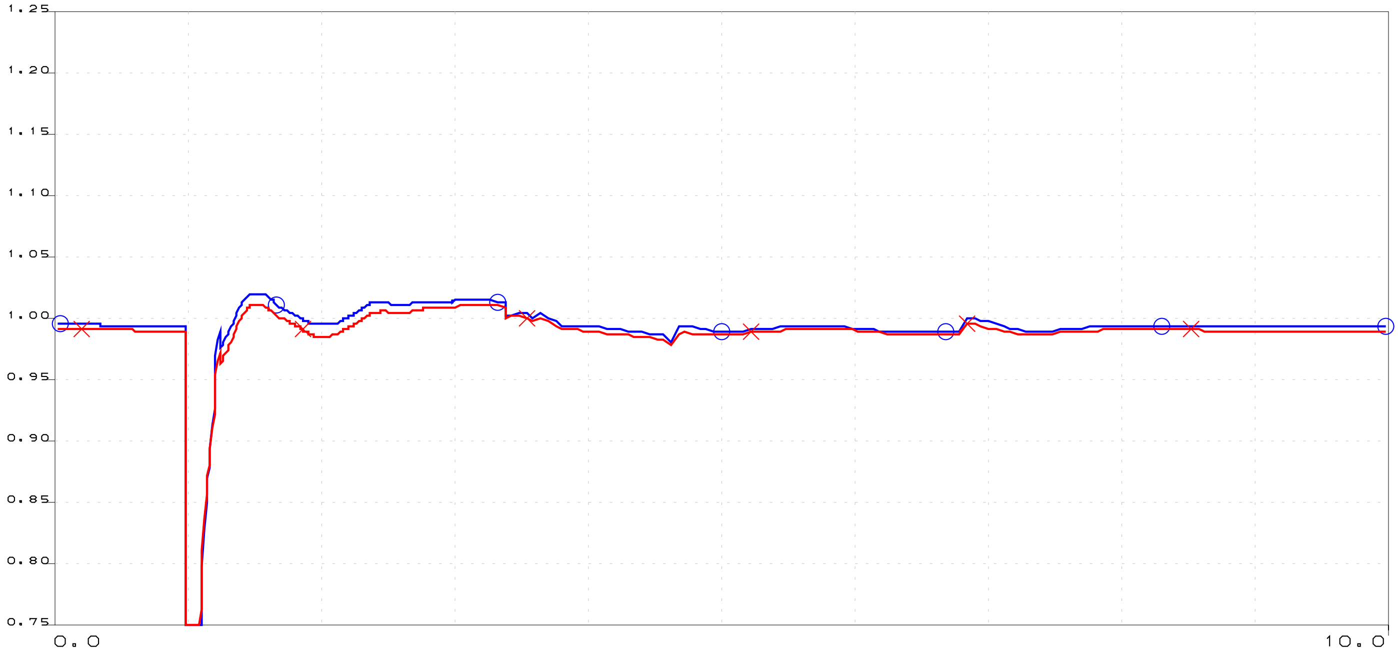
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25



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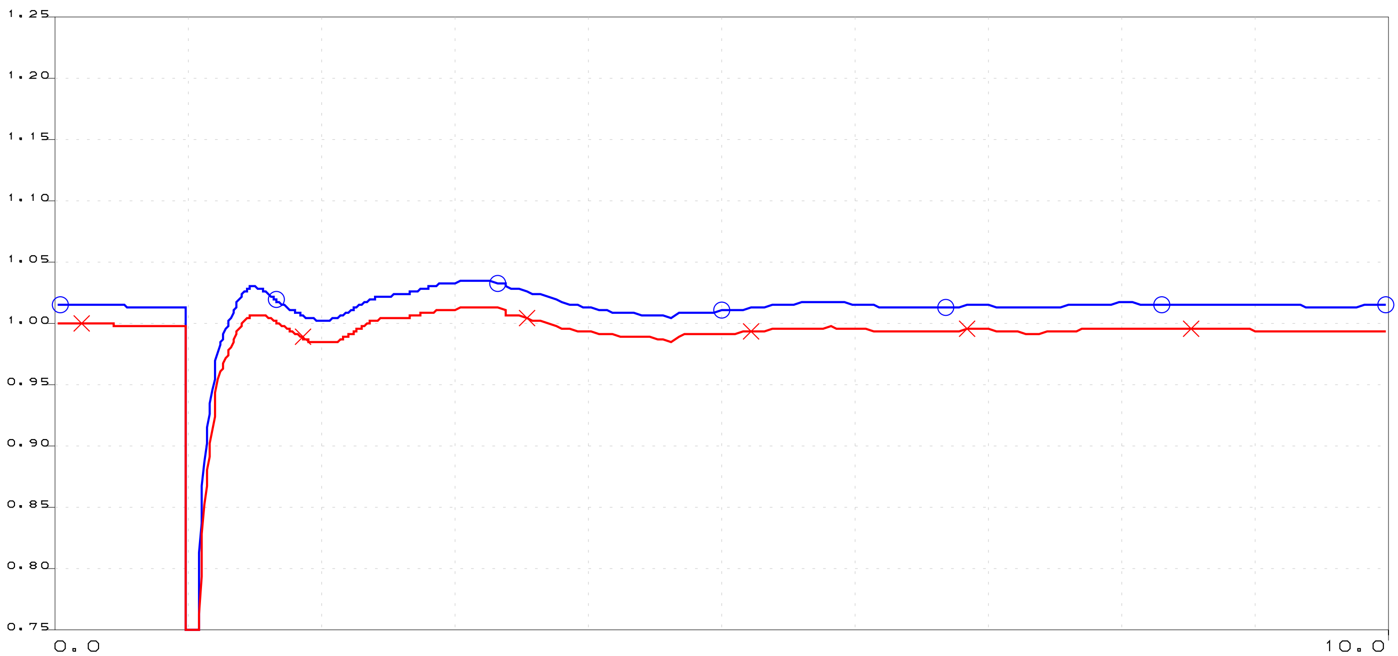
×	0.75	vbus	70249	LAJUNTAW	115.0	1	1	1.25



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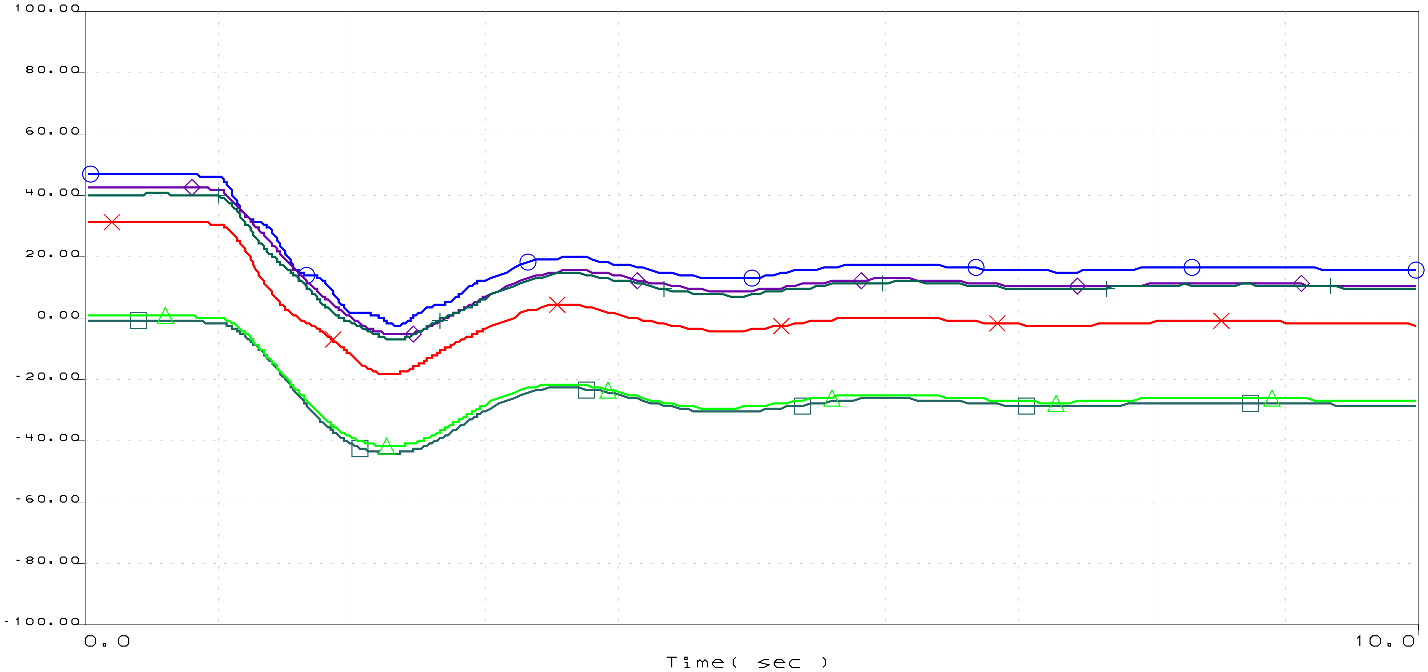
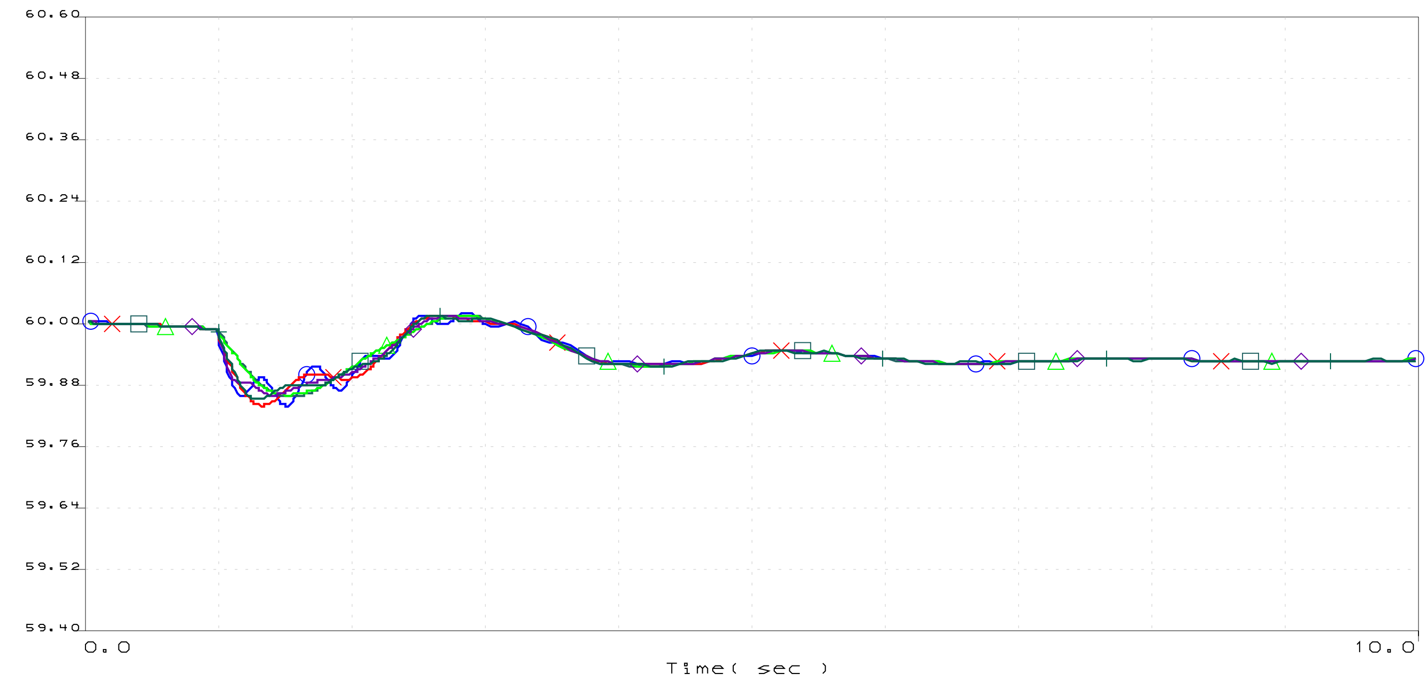
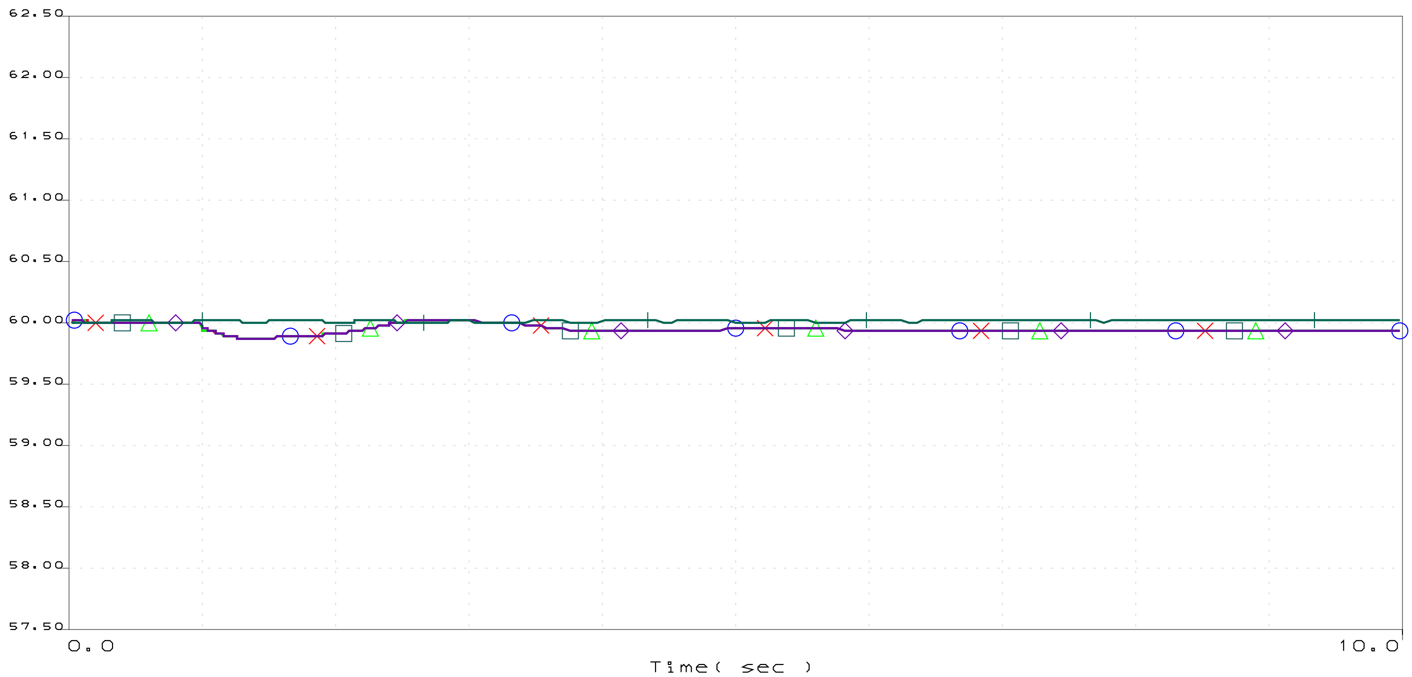
×	0.75	vbus	70352	READER	115.0	1	1	1.25



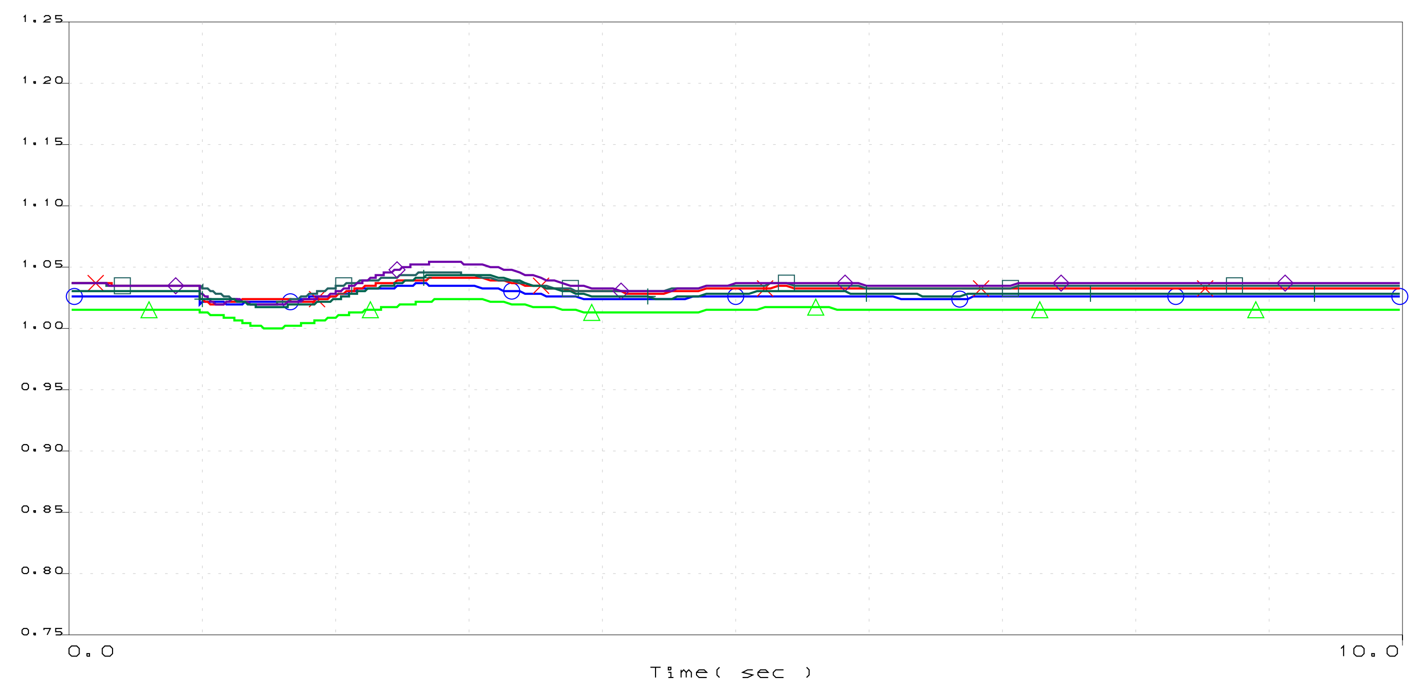
○ -100.0	ang	70133	CTY LAM	14.4	1	1	100.0
× -100.0	ang	70119	COMAN 1	24.0	1	1	100.0
□ -100.0	ang	70106	CHEROK4	22.0	1	1	100.0
△ -100.0	ang	70034	ARAP3	13.8	1	1	100.0
◇ -100.0	ang	70577	FTNVL1-2	13.8	1	1	100.0
+ -100.0	ang	73418	RD_NIXON	20.0	1	1	100.0



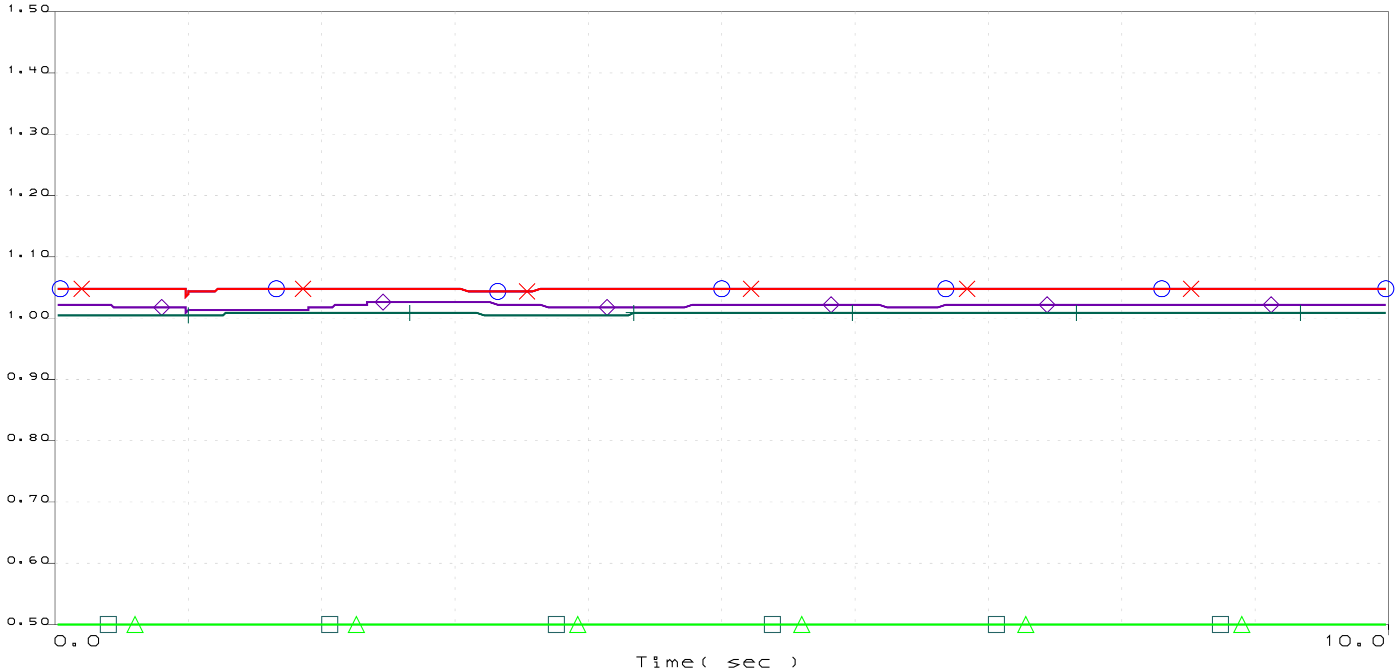
○ 59.4	fbug	70133	CTY LAM	14.4	1	1	60.6
× 59.4	fbug	70119	COMAN 1	24.0	1	1	60.6
□ 59.4	fbug	70106	CHEROK4	22.0	1	1	60.6
△ 59.4	fbug	70034	ARAP3	13.8	1	1	60.6
◇ 59.4	fbug	70577	FTNVL1-2	13.8	1	1	60.6
+ 59.4	fbug	73418	RD_NIXON	20.0	1	1	60.6



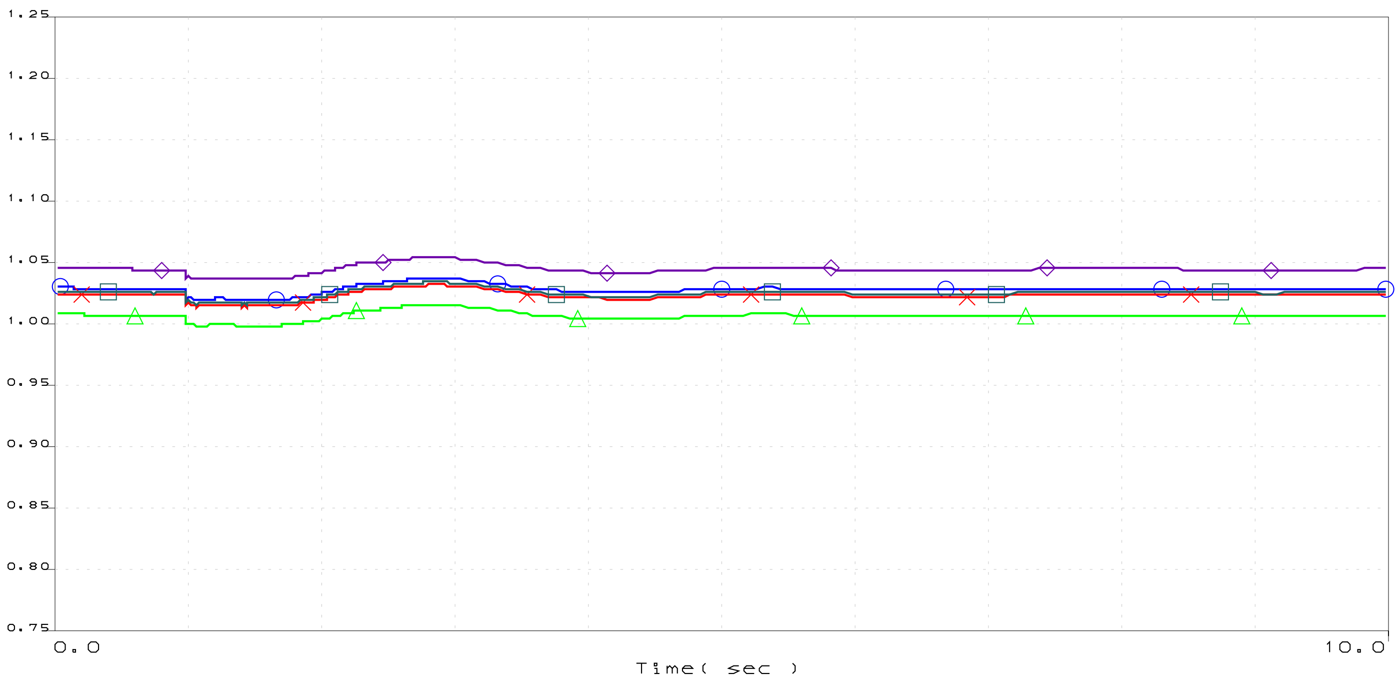
○ 57.5	fbus	70701	CO GRN E	34.5	1	1	62.5
× 57.5	fbus	70702	CO GRN W	34.5	1	1	62.5
□ 57.5	fbus	70751	COGRN 2E	34.5	1	1	62.5
△ 57.5	fbus	70752	COGRN 2W	34.5	1	1	62.5
◇ 57.5	fbus	70804	LAMAR W	53.5	1	1	62.5
+ 57.5	fbus	70805	LAMAR E	53.5	1	1	62.5



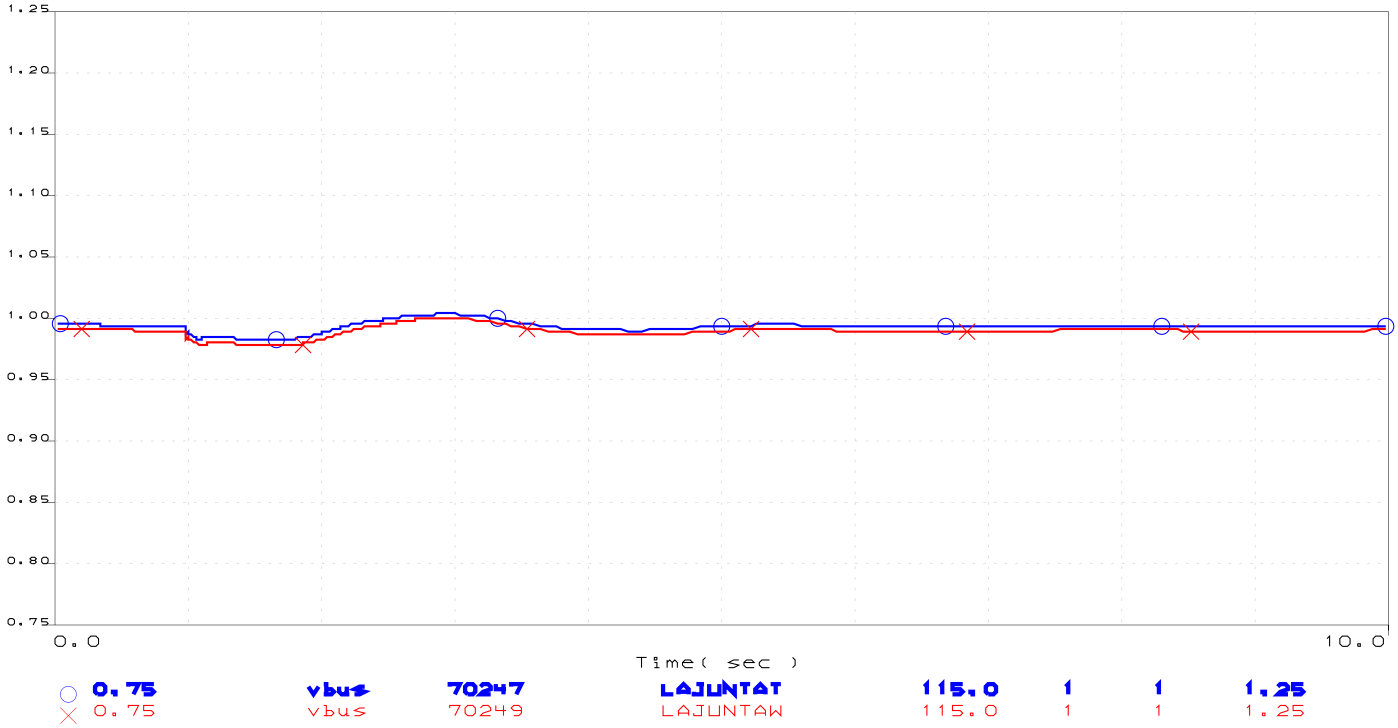
○ 0.75	vbus	70133	CTY LAM	14.4	1	1	1.25
× 0.75	vbus	70119	COMAN 1	24.0	1	1	1.25
□ 0.75	vbus	70106	CHEROK4	22.0	1	1	1.25
△ 0.75	vbus	70034	ARAP3	13.8	1	1	1.25
◇ 0.75	vbus	70577	FTNVL1-2	13.8	1	1	1.25
+ 0.75	vbus	73418	RD_NIXON	20.0	1	1	1.25



○	**0.5**	**vbug**	**70701**	**CO GRN E**	**34.5**	**1**	**1**	**1.5**
×	0.5	vbug	70702	CO GRN W	34.5	1	1	1.5
□	0.5	vbug	70751	COGRN 2E	34.5	1	1	1.5
△	0.5	vbug	70752	COGRN 2W	34.5	1	1	1.5
◇	0.5	vbus	70804	LAMAR W	53.5	1	1	1.5
+	0.5	vbus	70805	LAMAR E	53.5	1	1	1.5



○	0.75	vbus	70452	VILAS	115.0	1	1	1.25
×	0.75	vbul	70404	SPRNGFLD	69.0	1	1	1.25
□	0.75	vbul	70460	WALSH	69.0	1	1	1.25
△	0.75	vbus	70472	WILOW CK	115.0	1	1	1.25
◇	0.75	vbul	70473	WILOW CK	69.0	1	1	1.25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1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.0
10.0
Time(sec)
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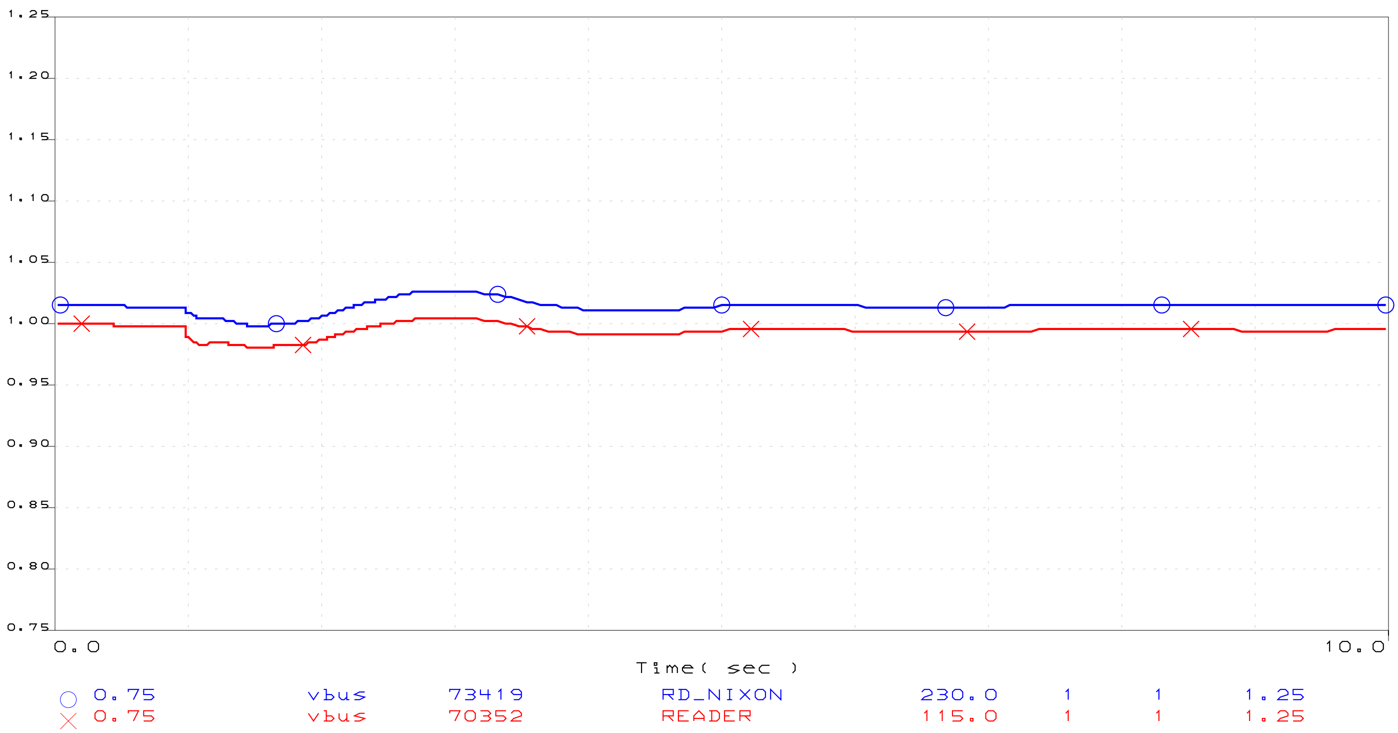
0.75 vbus 70249 LAJUNTAW 115.0 1 1 1.25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1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
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Time(sec)
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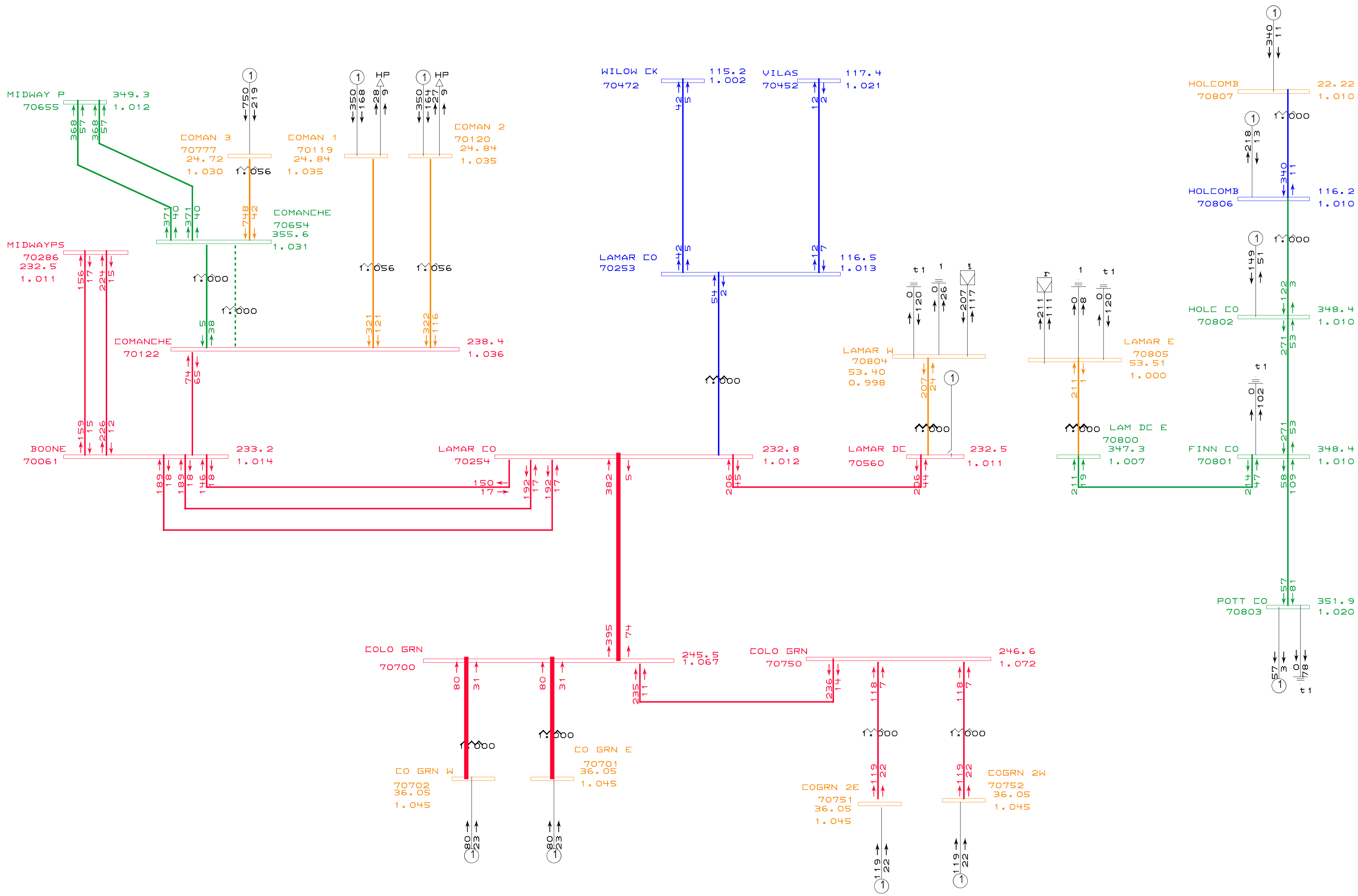
0.75 vbus 70352 READER 115.0 1 1 1.25



pslf_cg2\cg2base1.sav

Fri Nov 19 13:54:21 2004

10wallgen8; from 10WALLGEN4; DP-WATER 345x2 all qued gens in service sched to cher and stvrn 5/19/04		PSLF Program lamar_cg2_net Rating =1

Appendix III – NERC/WECC Performance Standard

WECC DISTURBANCE-PERFORMANCE TABLE
OF ALLOWABLE EFFECTS ON OTHER SYSTEMS

NERC and WECC Categories	Outage Frequency Associated with the Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard (See Note 2)
A	Not Applicable	Nothing in addition to NERC		
B	≥ 0.33	Not to exceed **25%** at load buses or **30%** at non-load buses. Not to exceed **20% for more than 20 cycles** at load buses.	Not below **59.6** Hz for 6 cycles or more at a load bus.	Not to exceed **5%** at any bus.
C	0.033 – 0.33	Not to exceed **30%** at any bus. Not to exceed **20% for more than 40 cycles** at load buses.	Not below **59.0** Hz for 6 cycles or more at a load bus.	Not to exceed **10%** at any bus.
D	< 0.033	Nothing in addition to NERC		

Table W-1: NERC/WECC Planning Standards, April 2003

1. *The WECC Disturbance-Performance Table applies equally to either a system with all elements in service, or a system with one element removed and the system adjusted.*

2. *As an example in applying the WECC Disturbance-Performance Table, a Category B disturbance in one system shall not cause a transient voltage dip in another system that is greater than 20% for more than 20 cycles at load buses, or exceed 25% at load buses or 30% at non-load buses at any time other than during the fault.*

3. *Additional voltage requirements associated with voltage stability are specified in Standard I-D. If it can be demonstrated that post transient voltage deviations that are less than the values in the table will result in voltage instability, the system in which the disturbance originated and the affected system(s) should cooperate in mutually resolving the problem.*

4. *Refer to Figure W-1 for voltage performance parameters.*

5. *Load buses include generating unit auxiliary loads.*

6. *To reach the frequency categories shown in the WECC Disturbance-Performance Table for Category C disturbances, it is presumed that some planned and controlled islanding has occurred. Underfrequency load shedding is expected to arrest this frequency decline and assure continued operation within the resulting islands.*

7. *For simulation test cases, the interconnected transmission system steady state loading conditions prior to a disturbance should be appropriate to the case. Disturbances should be simulated at locations on the system that result in maximum stress on other systems. Relay action, fault clearing time, and reclosing practice should be represented in simulations according to the planning and operation of the actual or planned systems. When simulating post transient conditions, actions are limited to automatic devices and no manual action is to be assumed.*

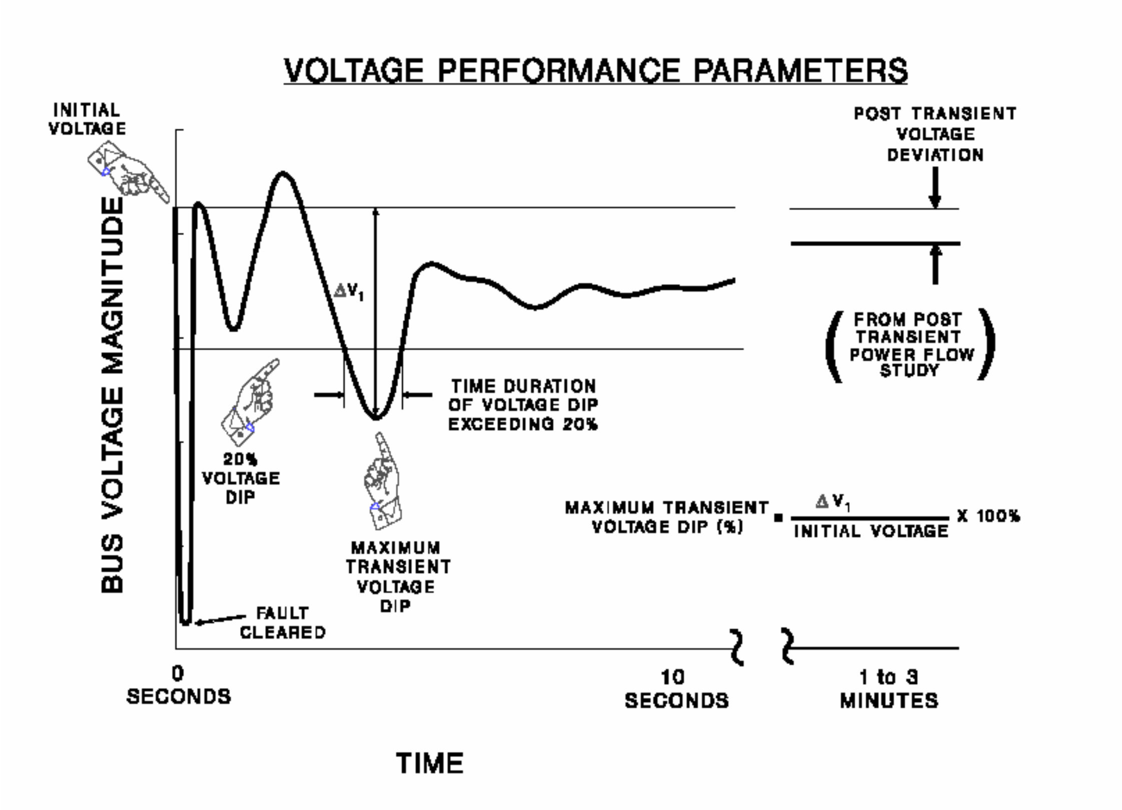
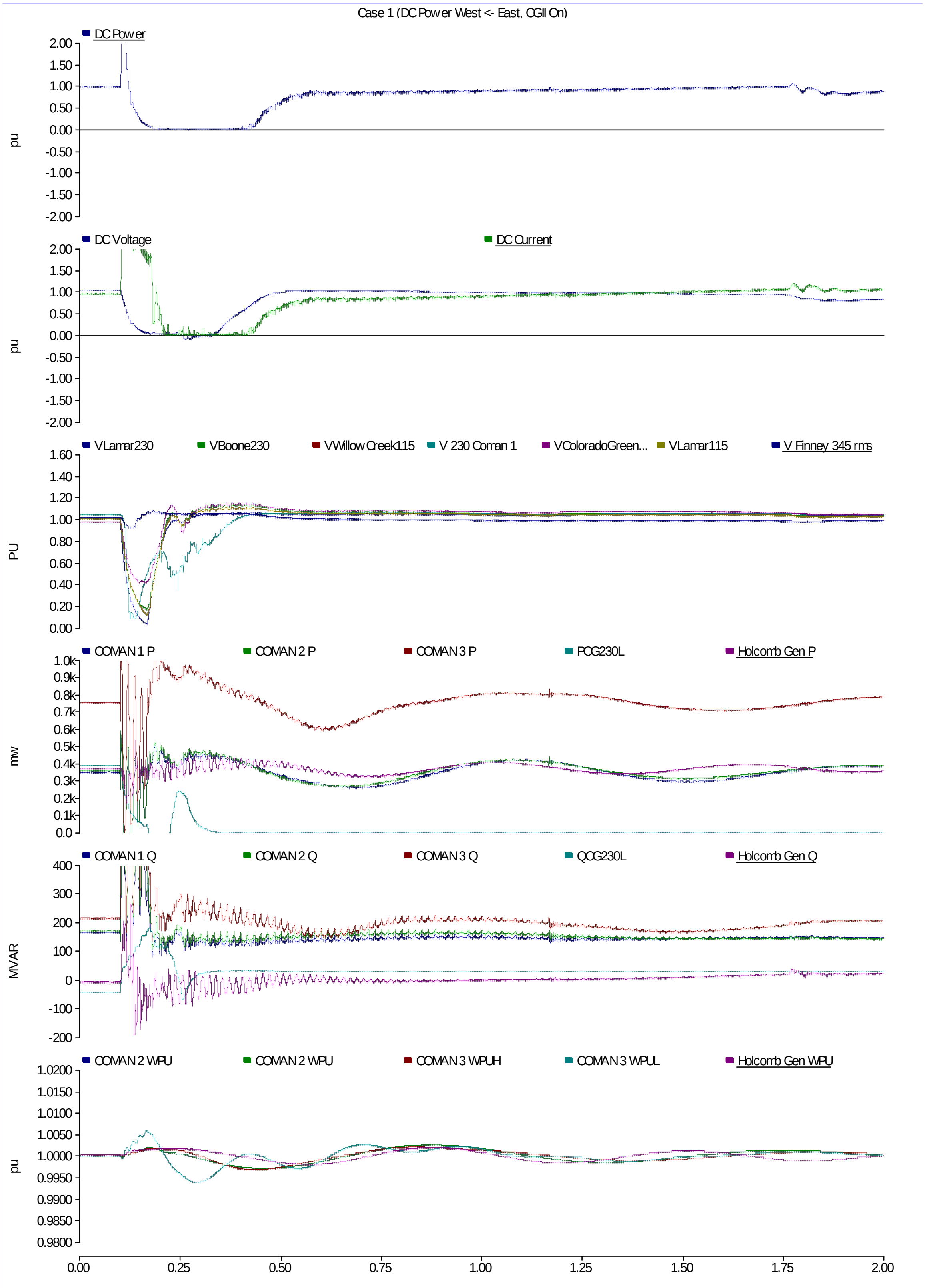
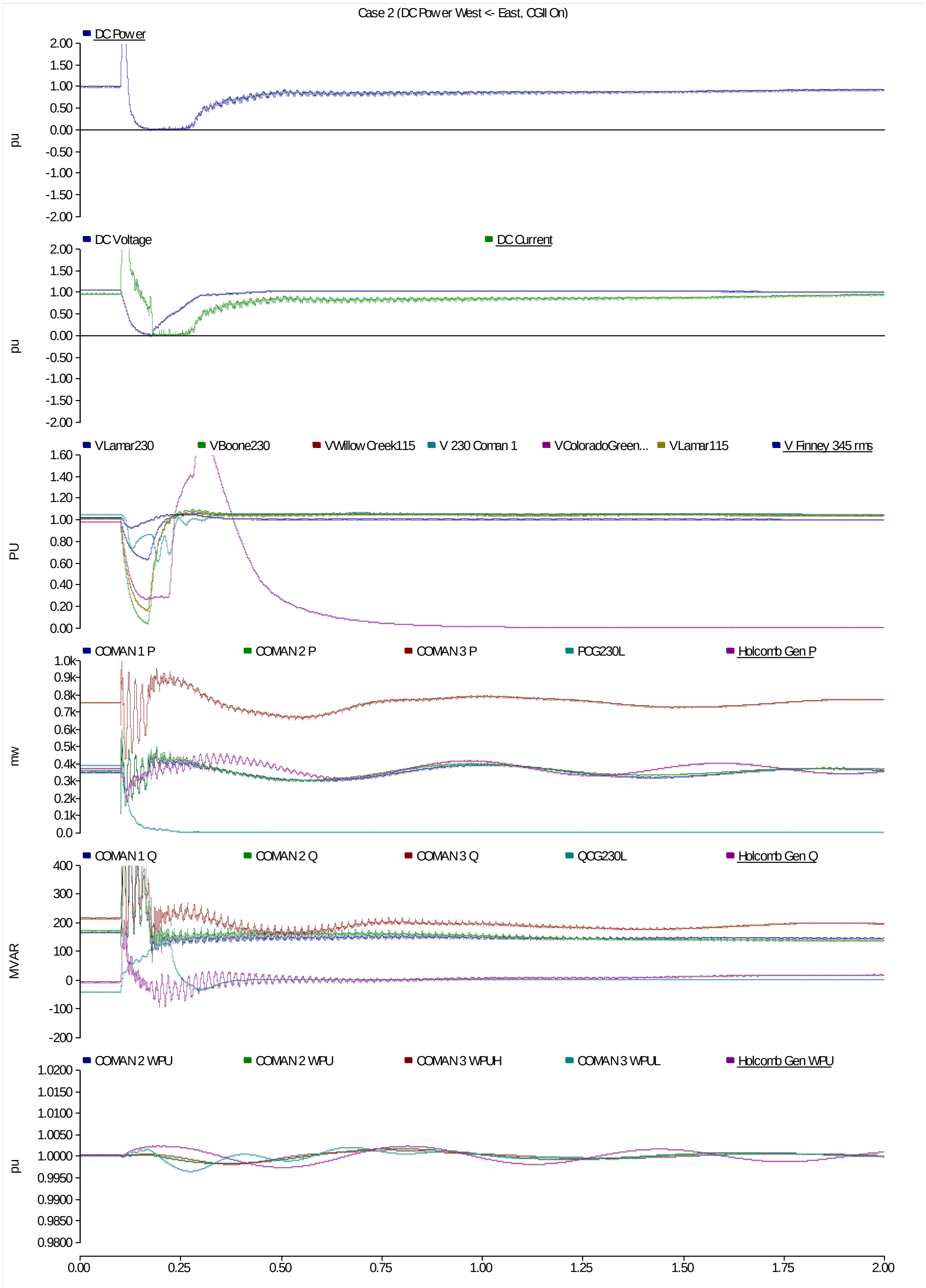


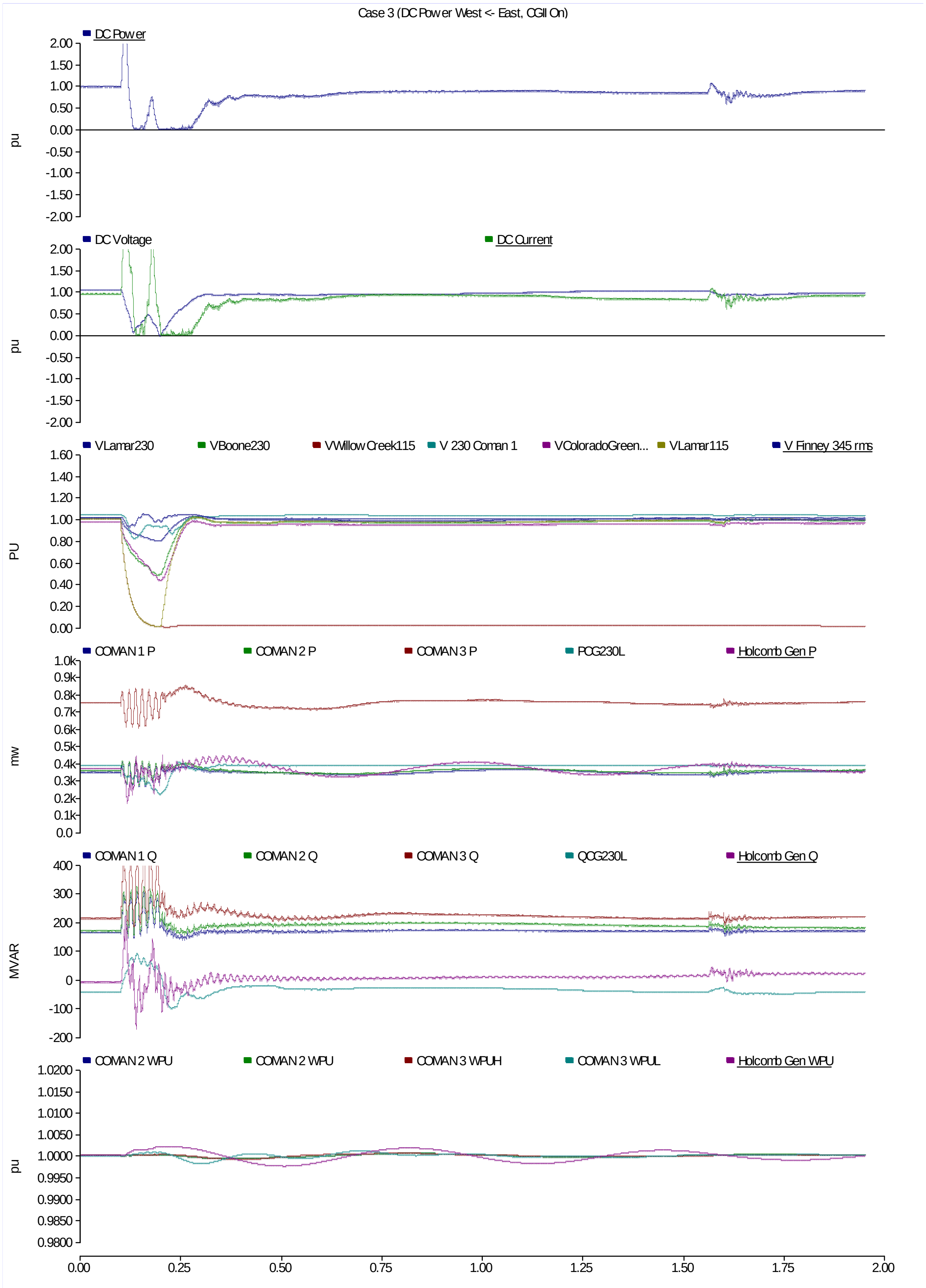
Figure W-1: NERC/WECC Planning Standards, April 2003



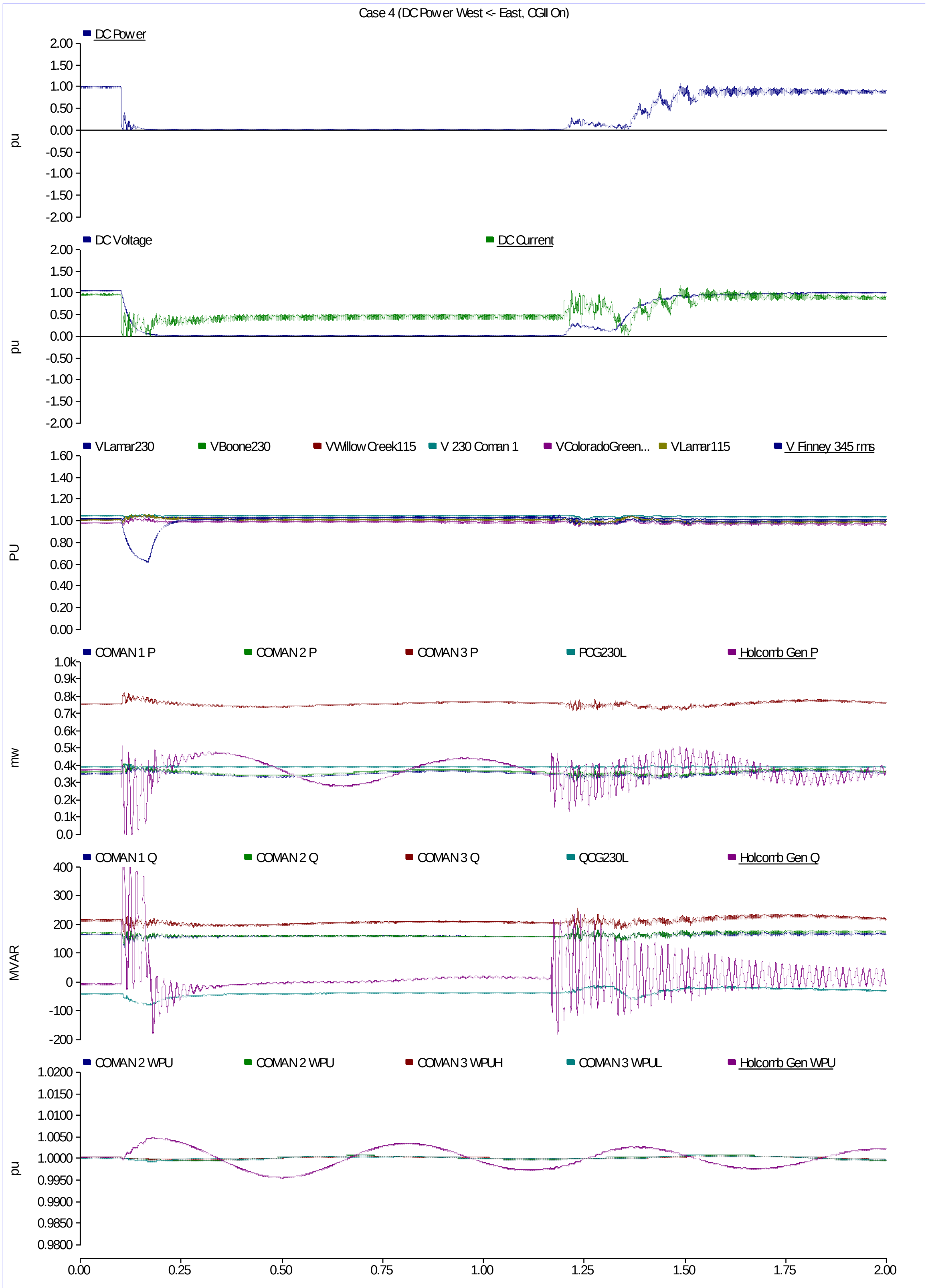
Case 1 (HVDC 210 MW West<-East, Fault on Lamar-Boone 230 kV line, line clearing after 4 cycles, reclose after 1 second)



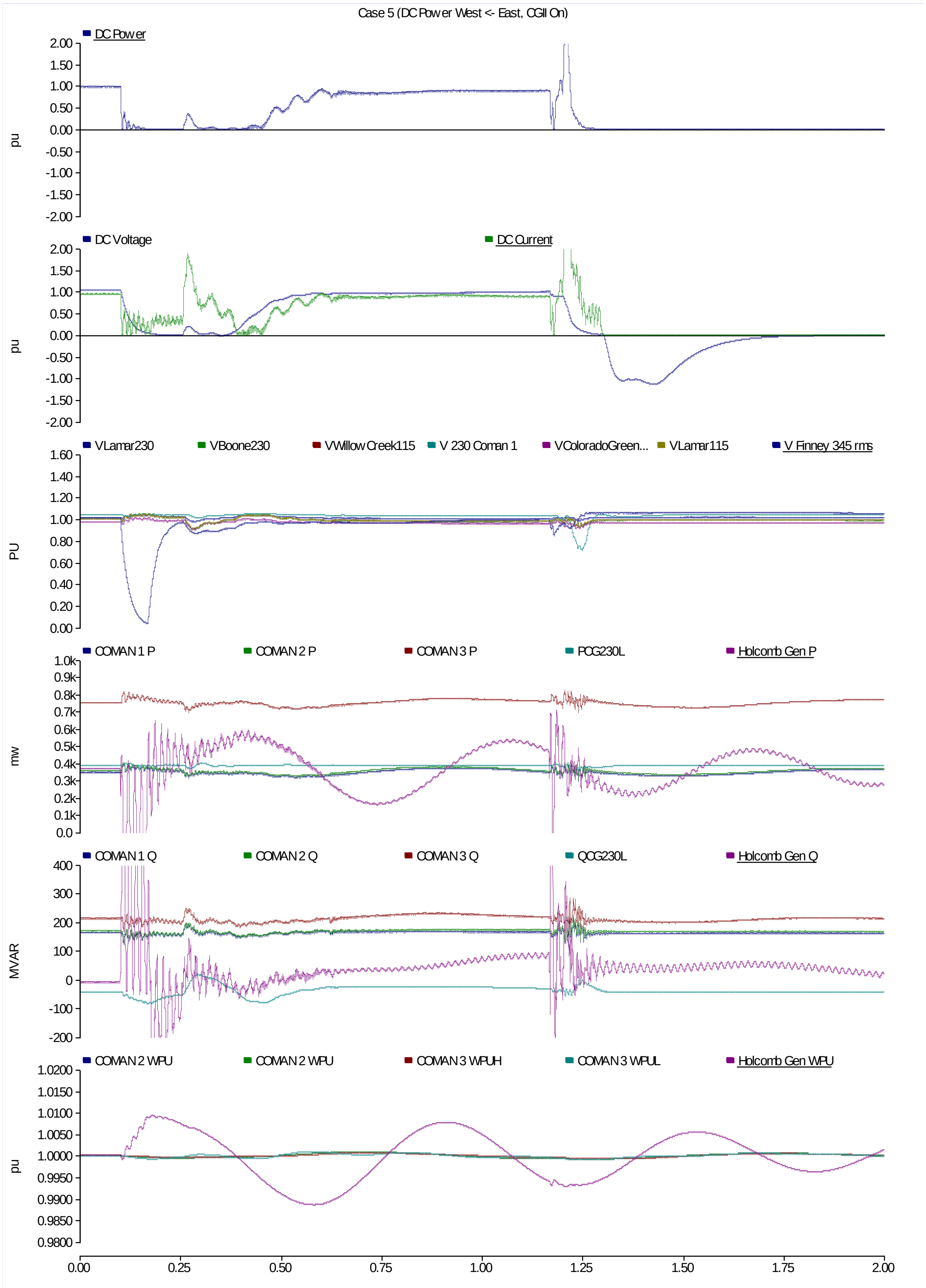
Case 2 (HVDC 210 MW West<-East, Fault on Lamar-Colorado Green 230 kV line, line clearing after 4 cycles, no reclose)



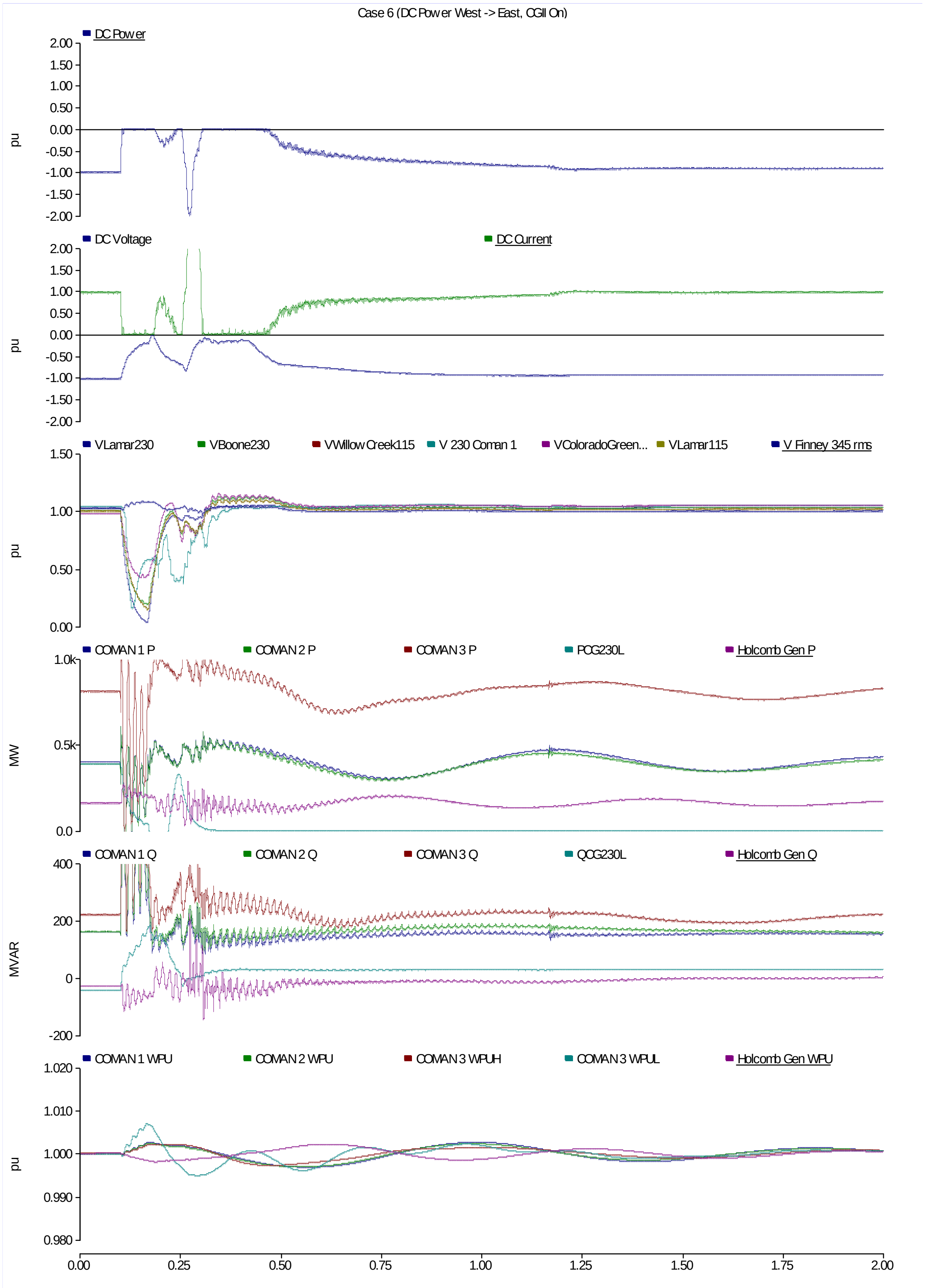
Case 3 (HVDC 210 MW West<-East, Fault on Lamar-Willow Creek 115 kV line, line clearing after 6 cycles, no reclose)



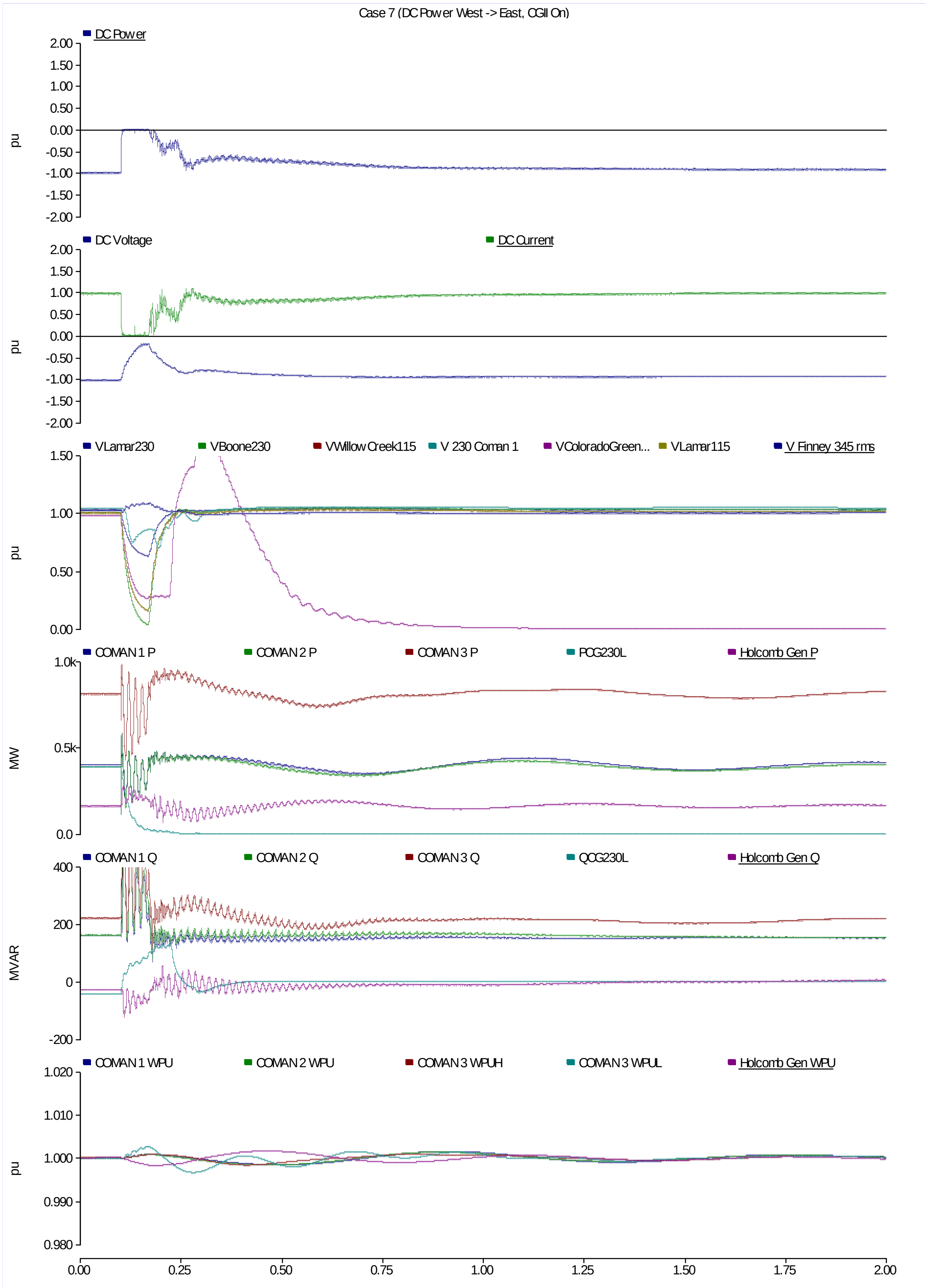
Case 4 (HVDC 210 MW West<-East, Fault on Lamar-Finney 345 kV line, line clearing after 4 cycles, reclose after 1 second)



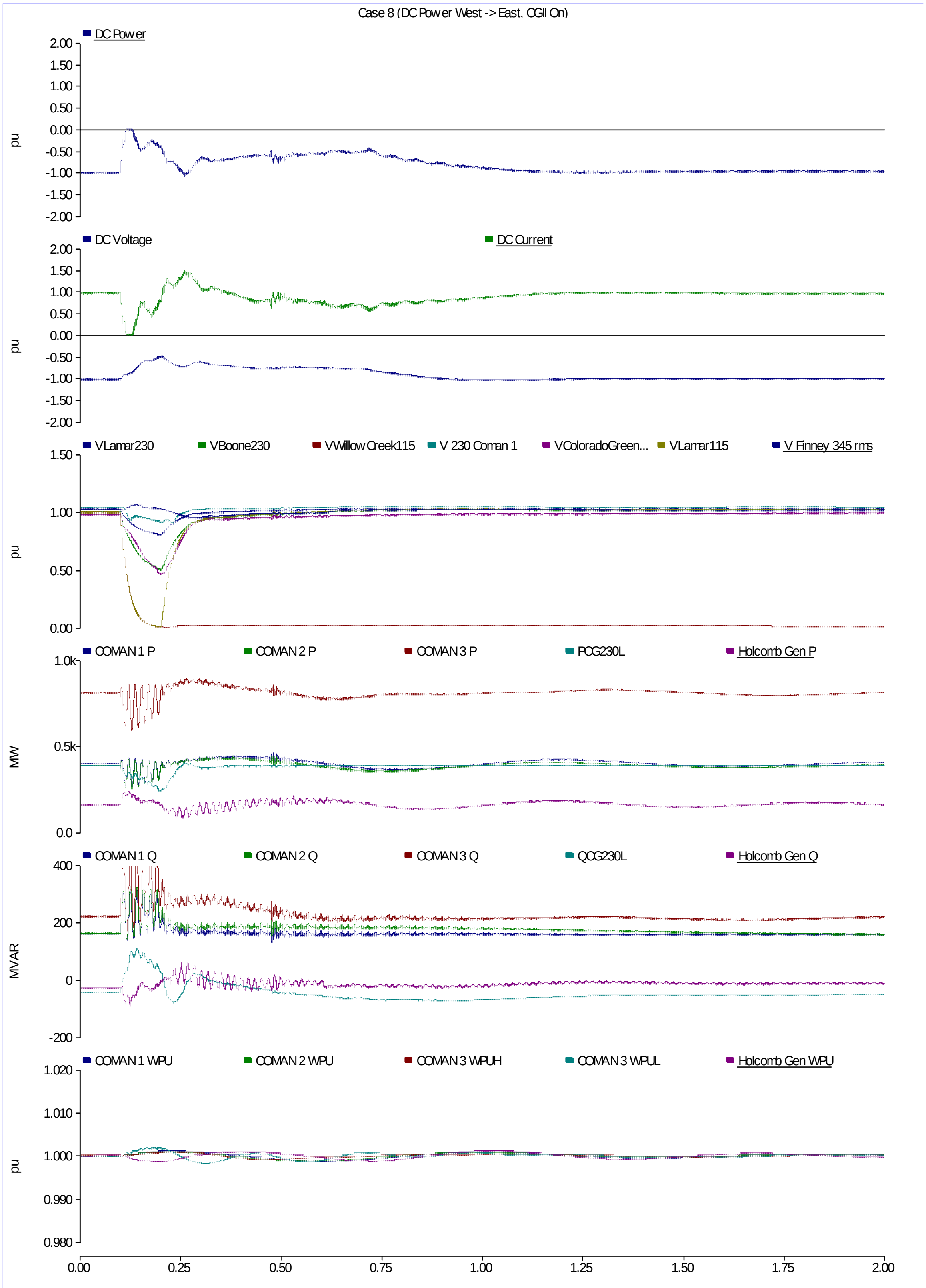
Case 5 (HVDC 210 MW West<-East, Fault on Finney – Potter 345 kV line, line clearing after 4 cycles, reclose after 1 second)



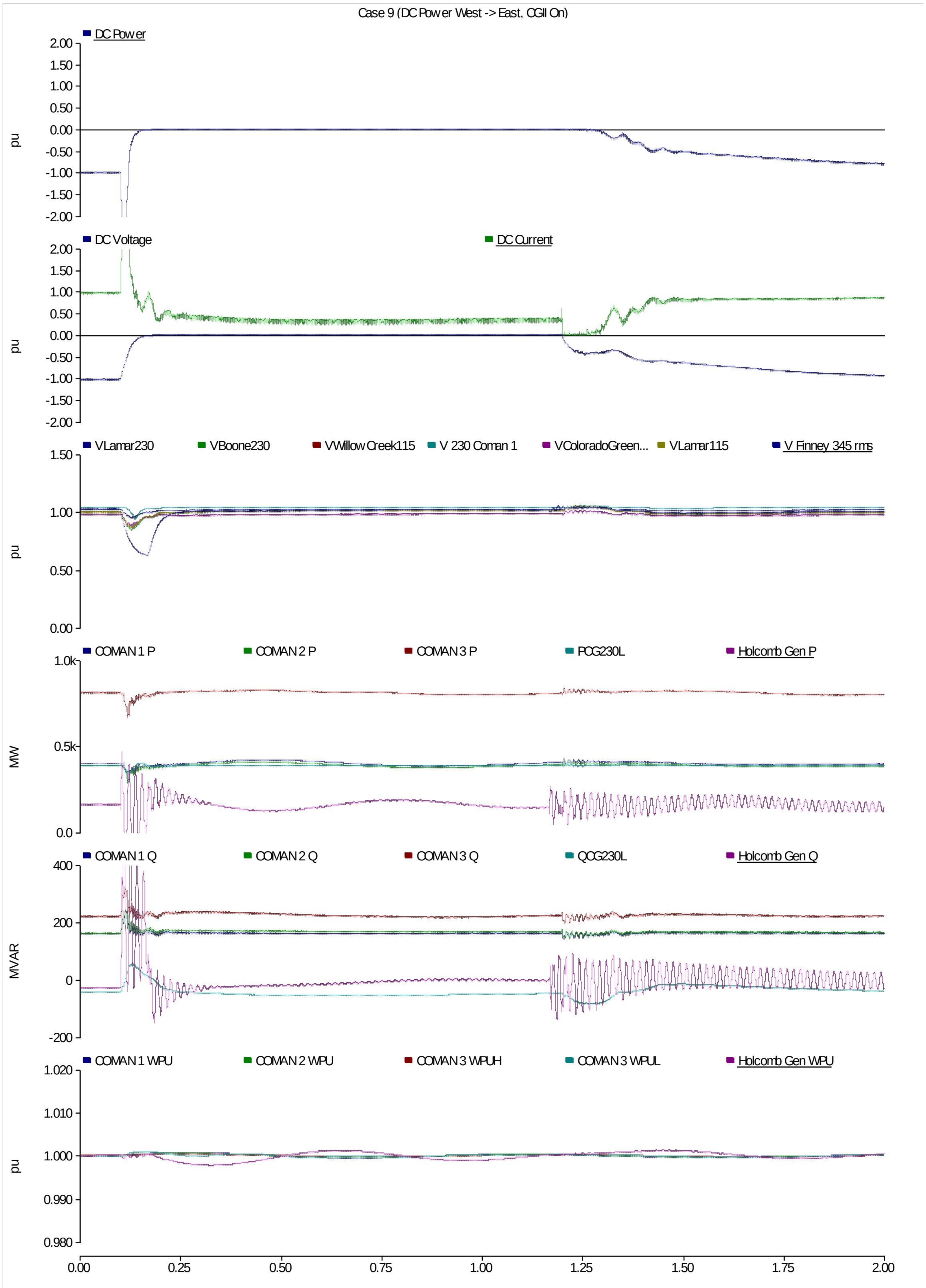
Case 6 (HVDC 210 MW West->East, Fault on Lamar-Boone 230 kV line, line clearing after 4 cycles, reclose after 1 second)



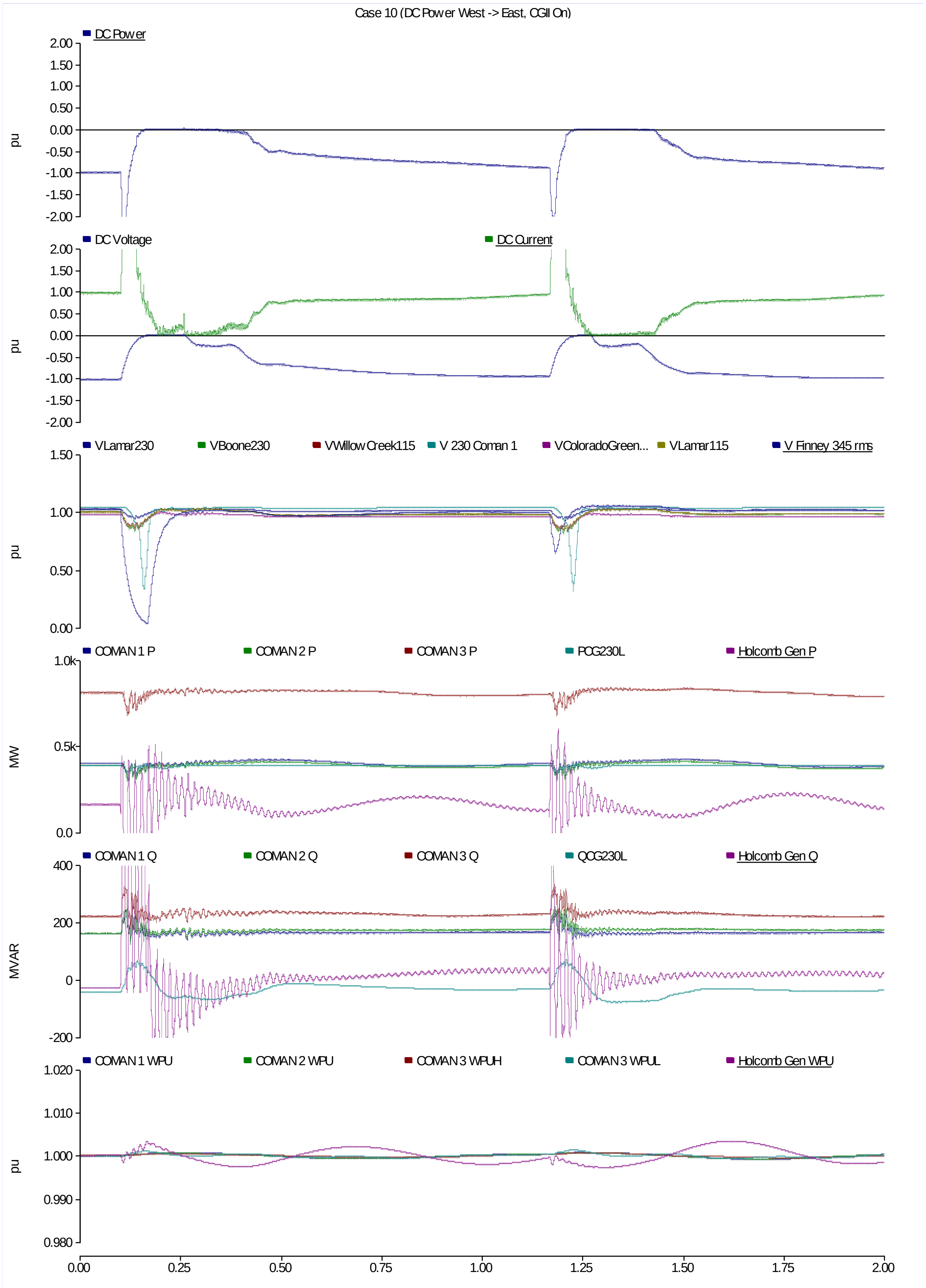
Case 7 (HVDC 210 MW West->East, Fault on Lamar-Colorado Green 230 kV line, line clearing after 4 cycles, no reclose)



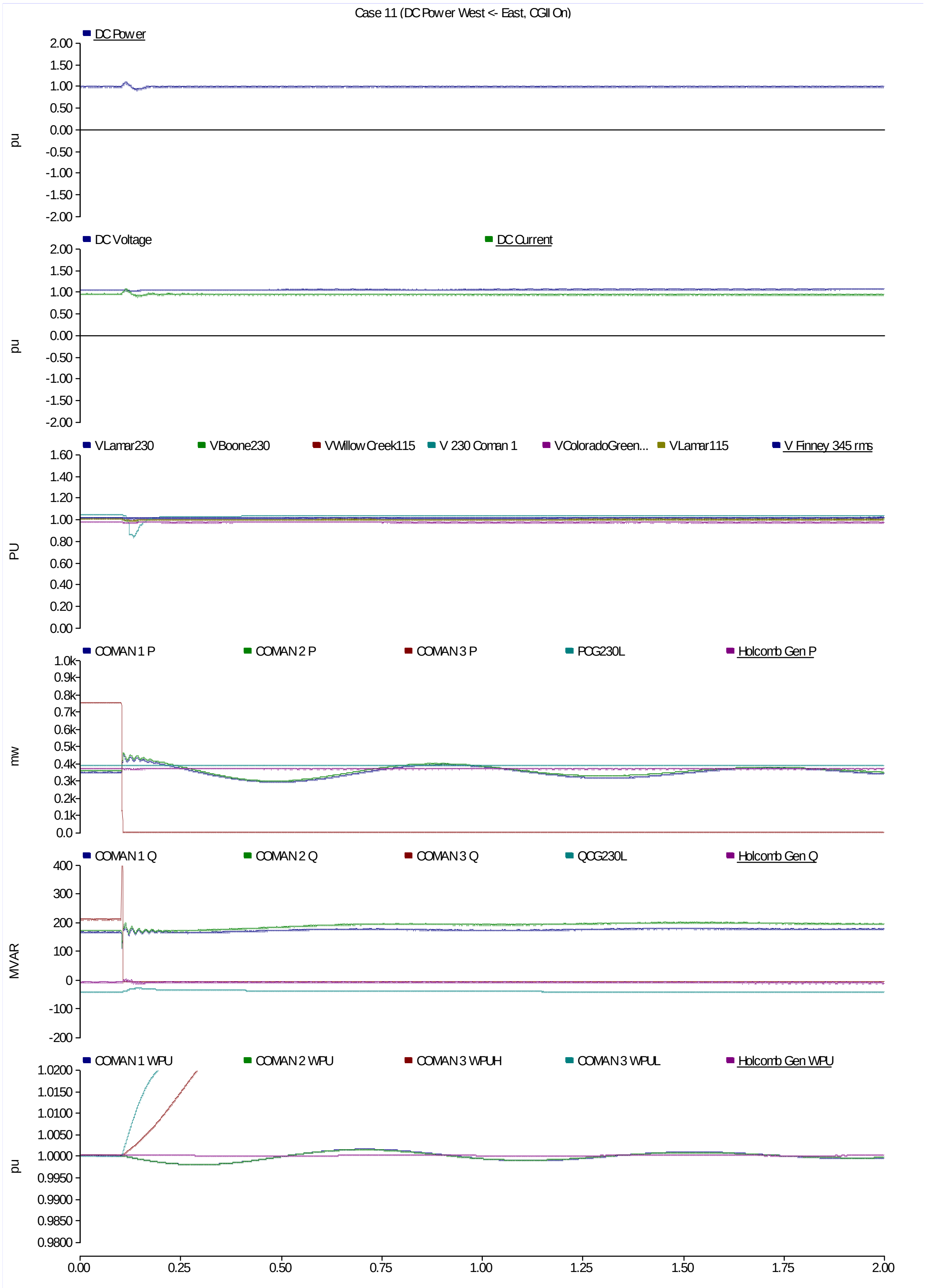
Case 8 (HVDC 210 MW West->East, Fault on Lamar-Willow Creek 115 kV line, line clearing after 6 cycles, no reclose)



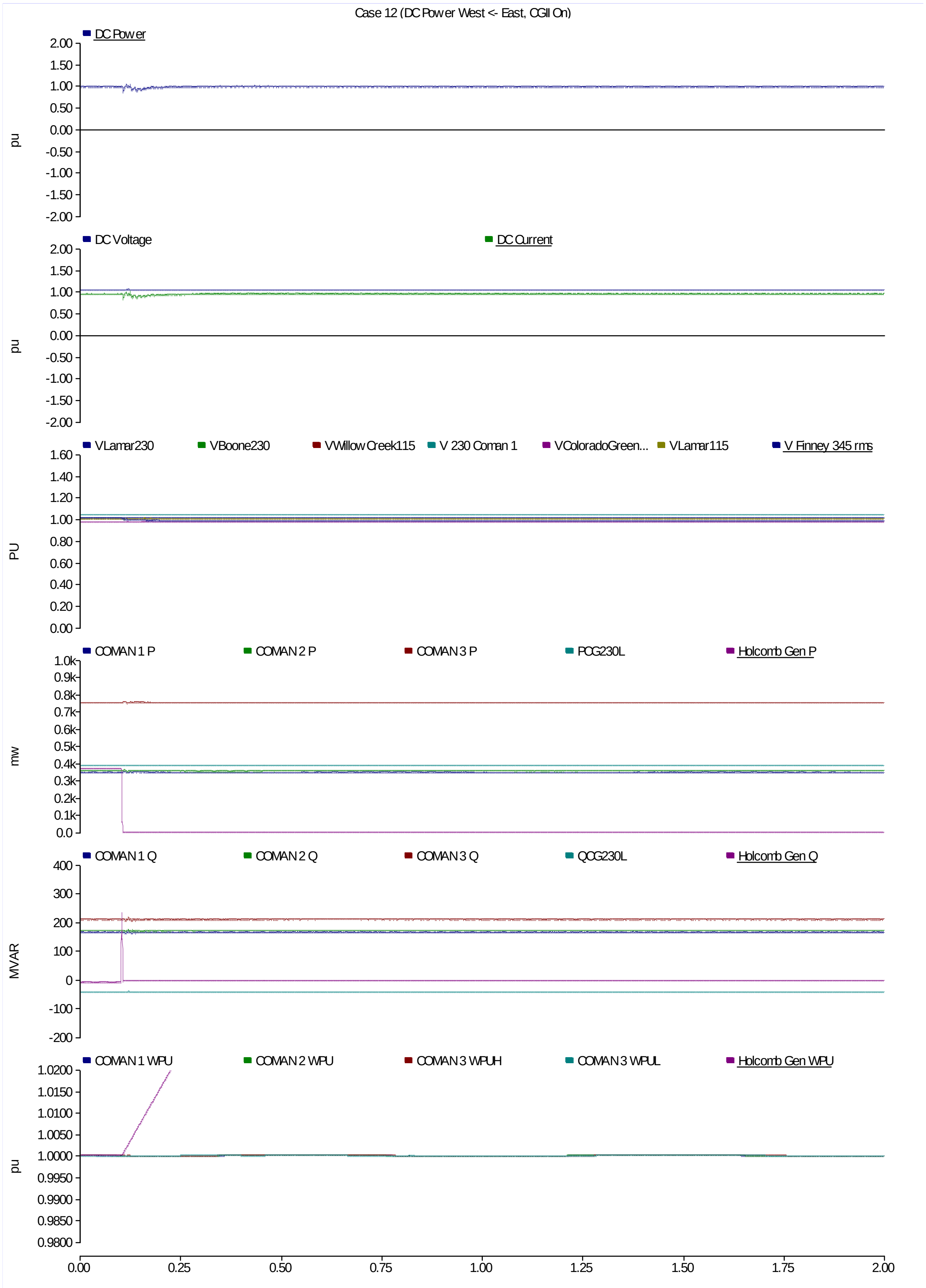
Case 9 (HVDC 210 MW West->East, Fault on Lamar-Finney 345 kV line, line clearing after 4 cycles, reclose after 1 second)



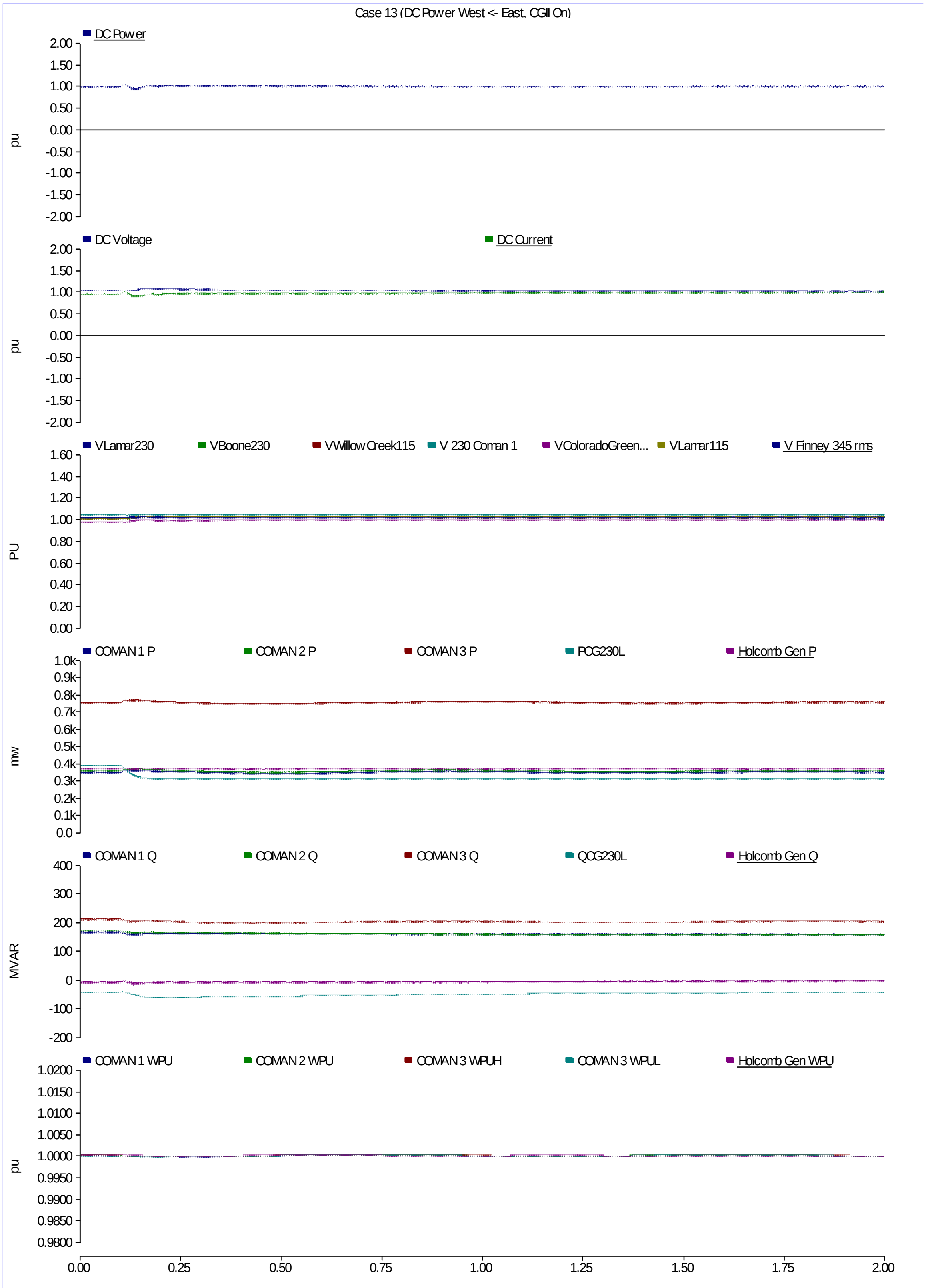
Case 10 (HVDC 210 MW West->East, Fault on Finney – Potter 345 kV line, line clearing after 4 cycles, reclose after 1 second)



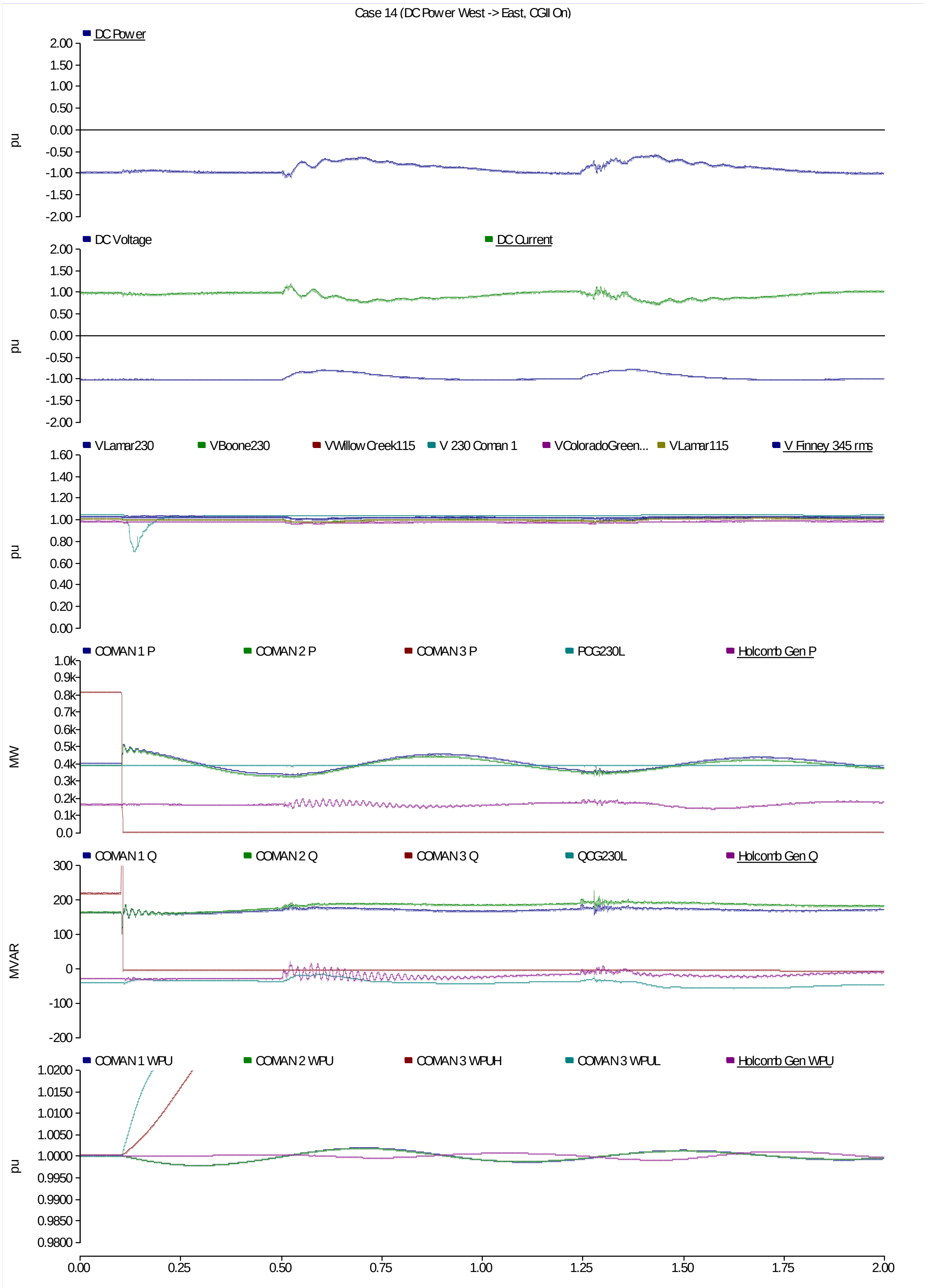
Case 11 (HVDC 210 MW West<-East, Trip of COMAN 3 Generator)



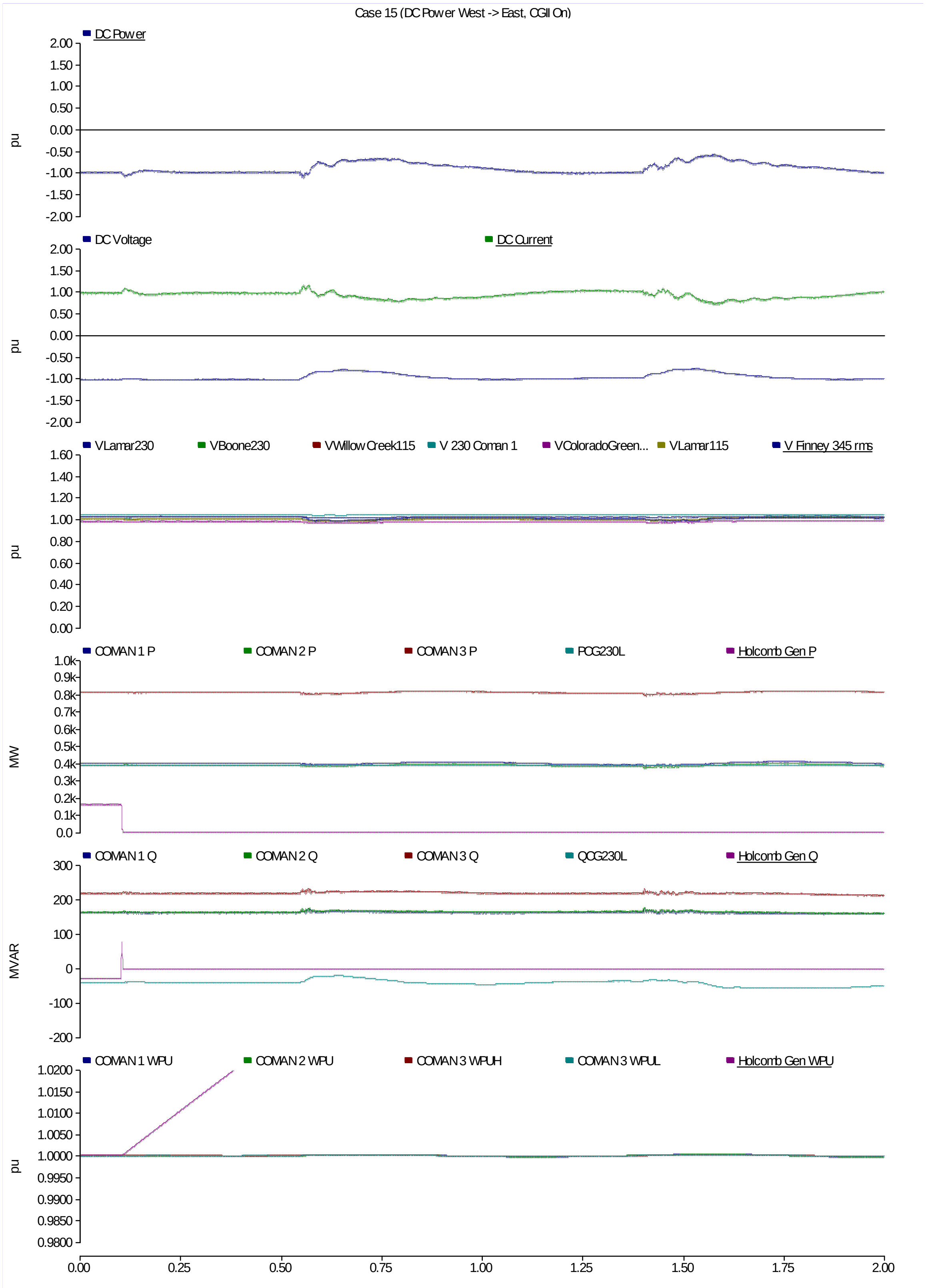
Case 12 (HVDC 210 MW West<-East, Trip of Holcomb Generator)



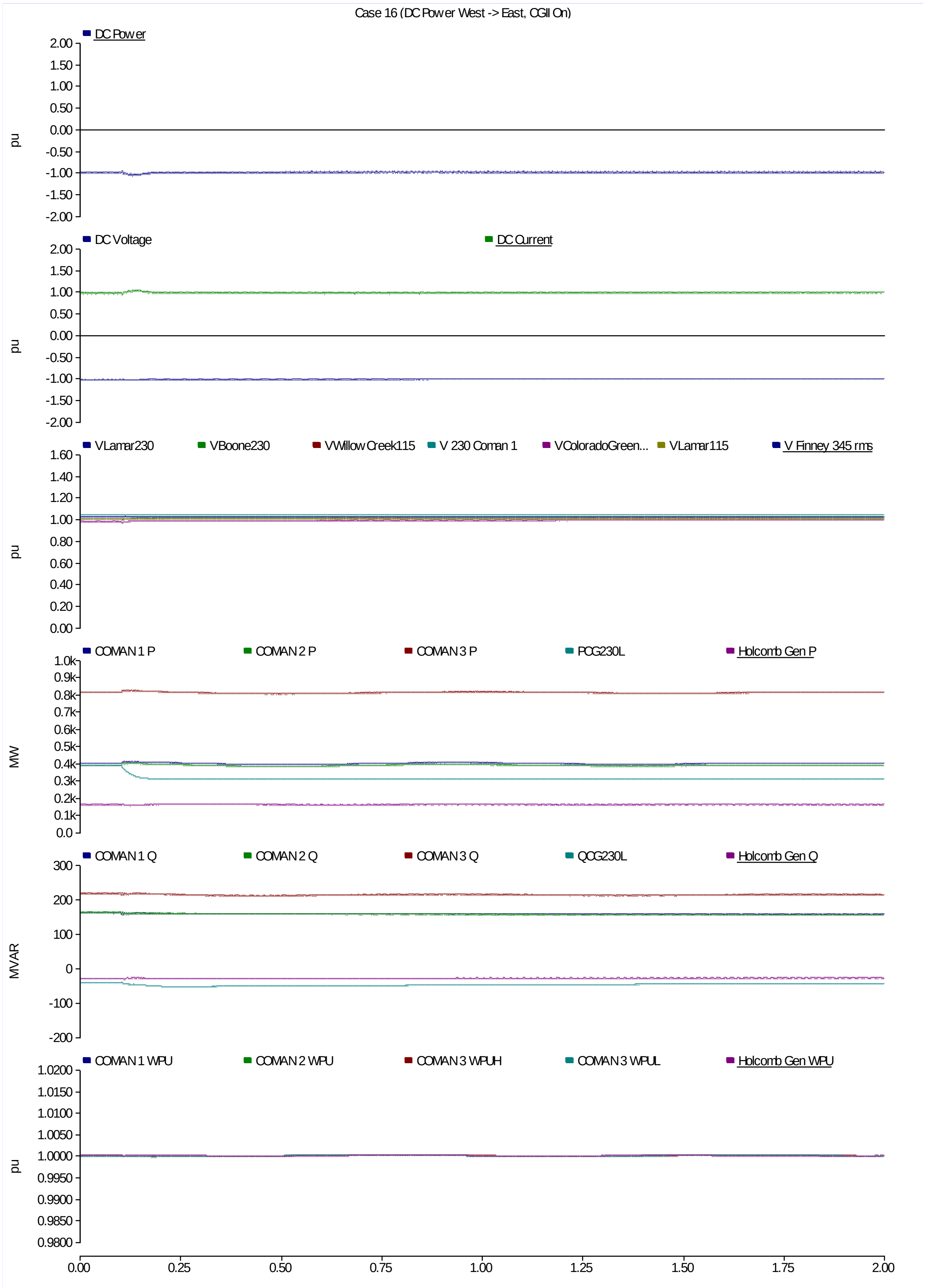
Case 13 (HVDC 210 MW West<-East, Trip of CG I Generator Transformer)



Case 14 (HVDC 210 MW West->East, Trip of COMAN 3 Generator)



Case 15 (HVDC 210 MW West->East, Trip of Holcomb Generator)



Case 16 (HVDC 210 MW West->East, Trip of CG I Generator Transformer)

ELECTRANIX
Electranix Corporation
107 – 865 Waverley St.,
Winnipeg, Manitoba, R3T 5P4, Canada
T +1 204 953 1832 F +1 204 953 1839
daw@electranix.com www.electranix.com

November 4th, 2004
File: X056

Xcel Energy
Ernie Poggi, P.E.
Lead Engineer, Lamar HVDC Converter Station,
550 15th Street,
Denver, CO 80202

Dear Ernie,

ENERGIZATION OF TRANSFORMERS AT LAMAR

1. INTRODUCTION

During energizing tests at the Lamar dc link, and in particular the energizing of the 230/53 kV transformer, it was found that one of seven energizations caused all units of the Colorado Green wind farm to trip. On another of the seven energizations, 20% of the wind turbines tripped.

The energization tests were repeated in simulation using the most recent version of the Colorado Green PSCAD wind turbine models (see Appendix). In addition, the 230/115 kV autotransformer at Lamar was energized to see if doing so caused any wind turbines to trip.

2. CONCLUSIONS AND RECOMMENDATION

There were no cases found which resulted in wind farm tripping, although many cases closely resembled measured data from actual energization tests.

It is recommended that GE Wind review their protection settings on the Colorado Green wind turbine/generators and reset them to survive this disturbance and comply with how their PSCAD model performs.

3. STUDY METHODOLOGY

The PSCAD electro-magnetic transient simulation program was used for this study. A suitable model has been developed from previous studies. The system represented in this study is shown in Figure 1.

Each transformer was individually energized. The core in each was magnetized with remanence at 80% rated flux in one leg and 40% rated flux in the other two legs. Each transformer was energized 168 times, with circuit breaker closing times spread across one cycle. Each pole closed individually but with the spread of pole closings being randomly confined to ¼ cycle.

The settings for the wind turbine protections and operations as provided by GE Wind are as shown in Figure 2.

Results for compar

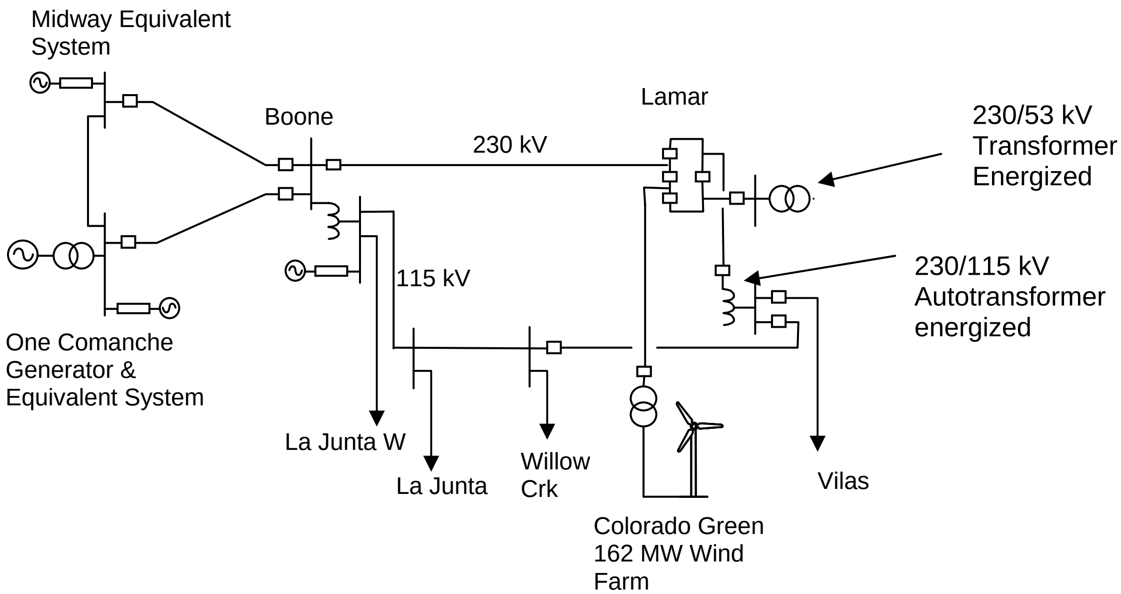


Figure 1: Single Line Diagram of the System being modelled in PSCAD

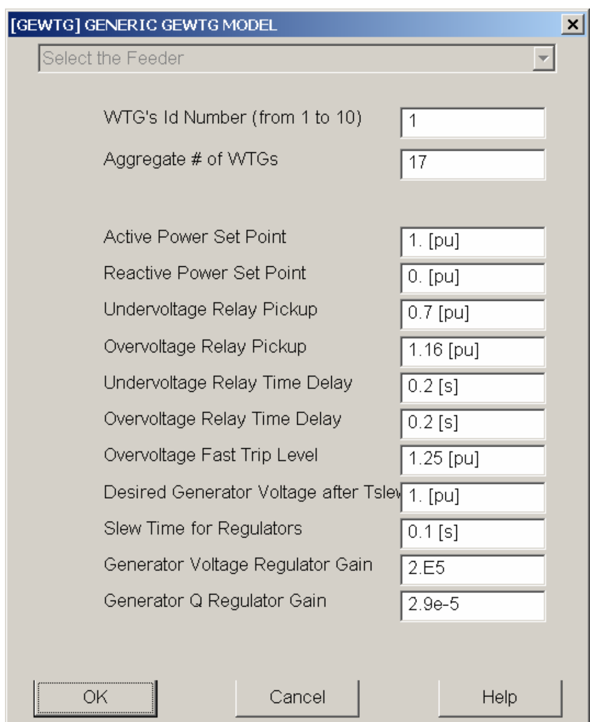


Figure 2: Setting options provided by GE Wind for the Colorado Green PSCAD model.

3. RESULTS FROM ACTUAL ENERGIZATION TEST

A recording from the energization test of the 250/53 kV transformer that caused the Colorado Green wind farm to trip out is shown in Figure 3.

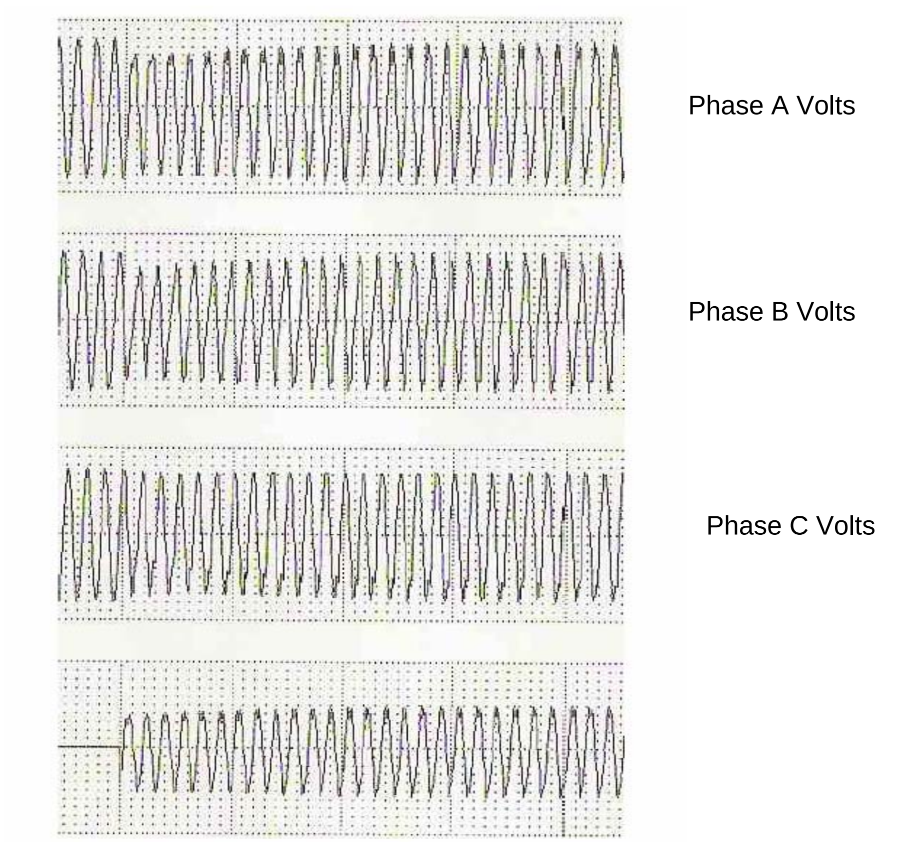


Figure 3- Measured Line Voltages at Lamar 230 kV bus during Energization of 230/53kV Transformer

4. SIMULATION TEST RESULTS

For the energization of the 230/53 kV transformer by simulation, a severe case is shown in Figure 4. The simulation result is similar but not identical to the actual system measurement of Figure 3. The differences are due to not knowing the state of magnetic remenance in the transformer core when it was energized, or knowing exactly on the voltage wave shape where the poles of the circuit breaker closed.

The top trace in Figure 4 is inrush current on Phase C in kA. The second trace are rms voltages, which are oscillatory as a consequence of the voltage distortion, and the last four traces are the voltage waveshapes similar to Figure 3.

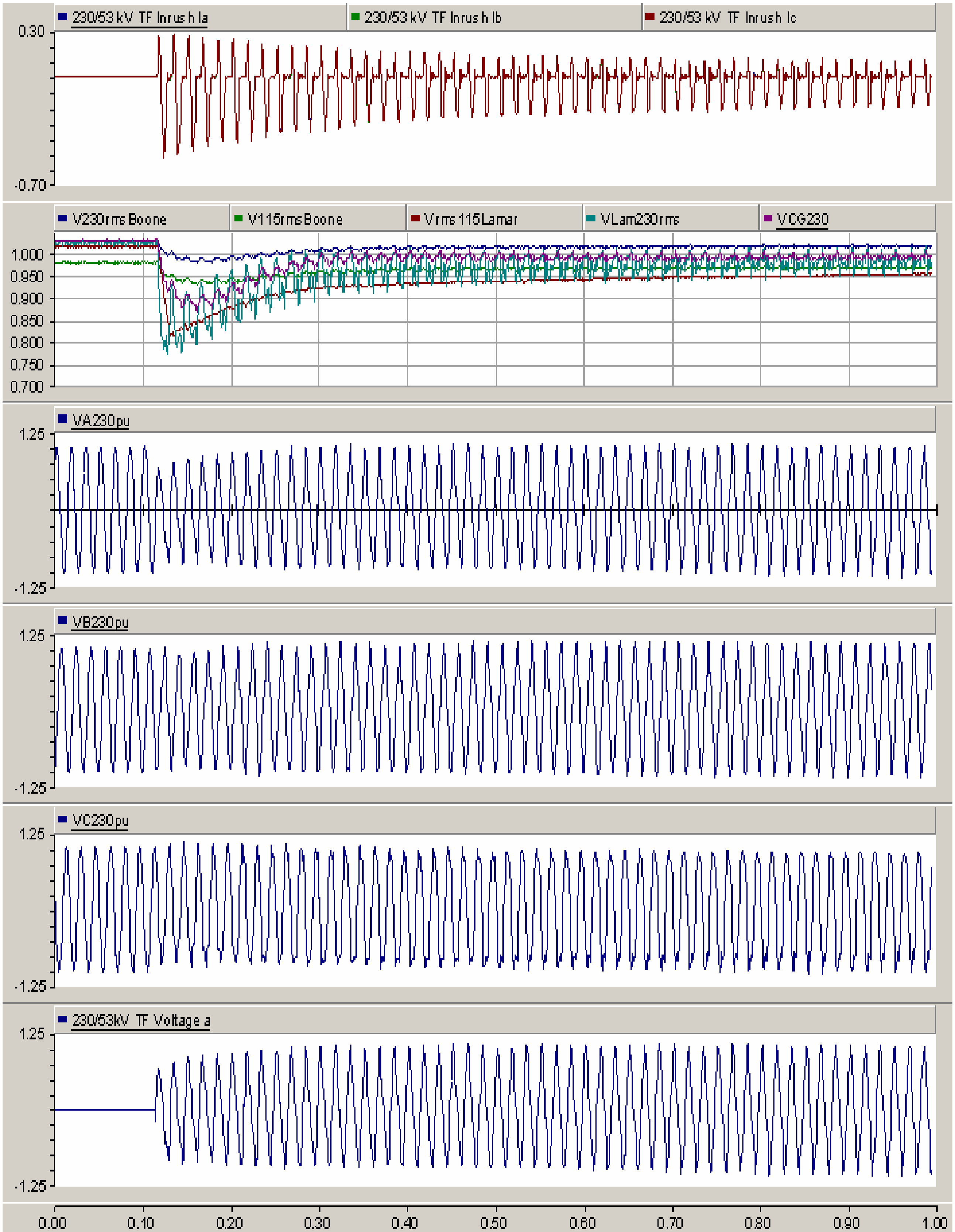


Figure 4: Simulated results for energizing of 230/53 kV transformer at Lamar.

The rms voltage measurement of the 230 kV bus dipped to 80% at Lamar (Traces Vrms115Lamar and VLam230rms in Figure 4) and dipped to approximately 88% at Colorado Green 230 kV bus (Trace VCG230) for this severe simulation case.

The simulation results for the energization of the Lamar 230/115 kV autotransformer showed much less impact on system voltage. The rms voltage measurements for a severe case are shown in Figure 5. Here the voltage dip is only a few percent and the impact on the system is negligible.

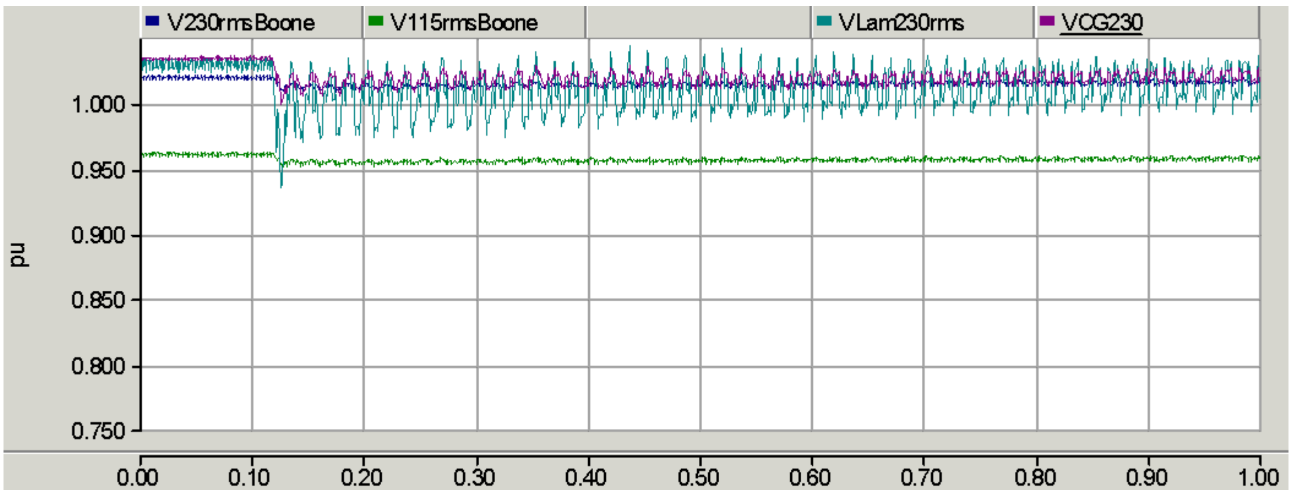


Figure 5: Simulated results of rms voltages for energizing of the 230/115 kV autotransformer at Lamar

Dennis Woodford, P.Eng,
Andrew Isaacs
Electranix Corporation

Cc	Rick Chapel	Xcel Energy
	Jim Whitaker	Xcel Energy
	Kevin Pera	Xcel Energy
	Moe Aslam	Siemens
	Randy Wachal	MHI

APPENDIX

-----Original Message-----
From: MacDowell, Jason (GE Energy) [mailto:jason.macdowell@ps.ge.com]
Sent: Thursday, October 21, 2004 9:32 AM
To: Whitaker, James D
Cc: Nemila, John A (GE Energy); Phillips, Norman C (GE Energy); Houghtaling, David W (GE Energy); Drobnjak, Goran (GE Energy); Larsen, Einar V (GE Energy); MacDowell, Jason (GE Energy)
Subject: RE: Colorado Green PSCAD Modeling Data for Lamar HVDC Studies

Jim,

I have attached the updated PSCAD models. These models include snapshot capability, as requested. We have run some initial tests using these models and they work to our satisfaction. If Dennis and/or Garth have questions or issues, they should feel free to contact Goran Drobnjak (518-385-9045).
Concerning technical content, the model documentation will remain the same with the exception of the statement: "At this moment the WTG PSCAD model does not support snapshot feature available in PSCAD." We will modify this statement and send the document through the proper approval channels before releasing it.

Please feel free to contact me if you have any questions.

Best Regards,
Jason

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