



INTERCONNECTION FACILITIES STUDY REPORT

GEN-2016-115
(IFS-2016-002-24)

Published September 2019

By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
6/11/2019	SPP	Initial draft report issued.
07/15/2019	SPP	Final report issued. Corrected Transmission Owner name on Summary page, revised turbine technology, turbine quantity and total MWs.
9/13/2019	SPP	Revised final report issued to include the updates from the material modification study.

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SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2016-115 IFS-2016-002-24 is for a 300 MW generating facility located in Atchison County, Missouri. The Interconnection Request was studied in the DISIS-2016-002 for Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). The interconnection customer elected not to pursue NRIS in the Facility Study Agreement. The Interconnection Customer's original requested Commercial Operation Date is 12/1/2019 and was revised to 12/31/2019 and then again to 11/16/2020 in the Facility Study Agreement.

The interconnecting Transmission Owner, Transource Missouri (TMO) performed a detailed IFS at the request of SPP. The full report is included in Appendix A. SPP has determined that full Interconnection Service will be available after the assigned Transmission Owner Interconnection Facilities (TOIF), Non-Shared Network Upgrades, Shared Network Upgrades, Previous Network Upgrades, and Affected System Upgrades that are required for full interconnection service are completed.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, Network Upgrades, other direct assigned upgrades, cost estimates, and associated upgrade lead times needed to grant the requested Interconnection Service.

PHASE(S) OF INTERCONNECTION SERVICE

It is not expected that Interconnection Service will occur in phases. However, full Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

CREDITS/COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

Interconnection Customer shall be entitled to compensation in accordance with Attachment Z2 of the SPP OATT for the cost of SPP creditable-type Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, that are not otherwise refunded to the Interconnection Customer. Compensation shall be in the form of either revenue credits or incremental Long Term Congestion Rights (iLTCR).

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of fifty one (51) Vestas V150-4.2 MW, twenty two (22) Vestas V120-2.2 MW, and eighteen (18) Vestas V110-2.0 MW wind generators for a total generating nameplate capacity of 298.6 MW.

The Interconnection Customer's Interconnection Facilities to be designed, procured, constructed, installed, maintained, and owned by the Interconnection Customer at its sole expense include:

- 34.5 kV underground cable collection circuits;
- 34.5 kV to 345 kV transformation substation with associated 34.5 kV and 345 kV switchgear;
- Two (2) 345/34.5 kV 96/128/160 MVA step-up transformers to be owned and maintained by the Interconnection Customer the Interconnection Customer's substation;
- A 14.6 mile overhead 345 kV line to connect to the Rock Creek 345 kV Substation which connects to the Point of Interconnection ("POI") at the 345 kV bus at existing Transmission Owner substation Nebraska City-Mullen Creek (Holt County MO) 345kV that is owned and maintained by Transmission Owner;
- All transmission facilities required to connect the Interconnection Customer's substation to the POI;
- Equipment at the Interconnection Customer's substation necessary to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 95% lagging and 95% leading in accordance with Federal Energy Regulatory Commission (FERC) Order 827. Additionally, approximately 22.9 Mvars¹ of reactors will be required to compensate for injection of reactive power into the transmission system under no/reduced generating conditions. The Interconnection Customer may use turbine manufacturing options for providing reactive power under no/reduced generation conditions. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met.

The Interconnection Customer shall coordinate relay, protection, control, and communication system configurations and schemes with the Transmission Owner.

¹ This approximate minimum reactor amount is needed for the current configuration of GEN-2016-115 as studied in the DISIS-2016-001 Impact Studies and Modification Study.

TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADE(S)

To facilitate interconnection, the interconnecting Transmission Owner will perform work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities.

Table 1 and **Table 2** lists the Interconnection Customer's estimated cost responsibility for Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) and provides an estimated lead time for completion of construction. The estimated lead time begins when the Generator Interconnection Agreement has been fully executed.

Table 1: Transmission Owner Interconnection Facilities (TOIF)

Transmission Owner Interconnection Facilities (TOIF)	Total Cost Estimate (\$)	Allocated Percent (%)	Allocated Cost Estimate (\$)	Estimated Lead Time
<u>Transmission Owner's Holt County 345 kV Interconnection Substation:</u> Update protection schemes.	\$100,000	100%	\$100,000	3 Months
Total	\$100,000	100%	\$100,000	

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	Z2 Type²	Total Cost Estimate (\$)	Allocated Percent (%)	Allocated Cost Estimate (\$)	Estimated Lead Time
<u>OPPD Substation Upgrades:</u> The expansion of the Holt substation to accommodate the interconnection will required protection scheme revisions at the OPPD S3458 substation.	Non - Creditable	\$7,553	100%	\$7,553	4-6 Weeks
Total		\$7,553	100%	\$7,553	

² Indicates the method used for calculating credit impacts under Attachment Z2 of the Tariff.

SHARED NETWORK UPGRADE(S)

The Interconnection Customer's share of costs for Shared Network Upgrades is estimated in **Table 3** below.

Table 3: Interconnection Customer Shared Network Upgrades

Shared Network Upgrades Description	Z2 Type	Total Cost Estimate (\$)	Allocated Percent (%)	Allocated Cost Estimate (\$)	Estimated Lead Time
None	N/A	\$0	N/A	\$0	N/A
Total		\$0		\$0	

All studies have been conducted assuming that higher-queued Interconnection Request(s) and the associated Network Upgrade(s) will be placed into service. If higher-queued Interconnection Request(s) withdraw from the queue, suspend or terminate service, the Interconnection Customer's share of costs may be revised. Restudies, conducted at the customer's expense, will determine the Interconnection Customer's revised allocation of Shared Network Upgrades.

PREVIOUS NETWORK UPGRADE(S)

Certain Previous Network Upgrades are **currently not the cost responsibility** of the Interconnection Customer but will be required for full Interconnection Service.

Table 4: Interconnection Customer Previous Network Upgrade(s)

Previous Network Upgrade(s) Description	Current Cost Assignment	Estimated In-Service Date
None	\$0	N/A

Depending upon the status of higher- or equally-queued customers, the Interconnection Request's in-service date is at risk of being delayed or Interconnection Service is at risk of being reduced until the in-service date of these Previous Network Upgrades.

AFFECTED SYSTEM UPGRADE(S)

To facilitate interconnection, the Affected System Transmission Owner will be required to perform the facilities study work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities. **Table 5** displays the current impact study costs as part of the Affected System Impact review. The Affected System facilities study could provide revised costs and will provide each Interconnection Customer's allocation responsibilities for the upgrades.

Table 5: Interconnection Customer Affected System Upgrade(s)

Affected System Upgrades Description	Total Cost Estimate (\$)	Allocated Share (%)	Allocated Cost Estimate (\$)
<u>None</u>	\$0	N/A	\$0
Total	\$0		\$0

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 300 MW can be granted. Full Interconnection Service will be delayed until the TOIF, non-shared NU, shared NU, previously allocated, affected system, etc that are required for full interconnection service are completed. The Interconnection Customer's estimated cost responsibility for TOIF, non-shared NU, shared NU, previously allocated, affected system, etc that are required for full interconnection service are summarized in the table below.

Table 6: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilities	\$100,000
Network Upgrades	\$7,553
Total	\$107,553

A draft Generator Interconnection Agreement will be provided to the Interconnection Customer consistent with the final results of this IFS report. The Transmission Owner and Interconnection Customer will have 60 days to negotiate the terms of the GIA consistent with the SPP Open Access Transmission Tariff (OATT).

APPENDICES

A: TRANSMISSION OWNER'S INTERCONNECTION FACILITIES STUDY REPORT AND NETWORK UPGRADES REPORT(S)

See next page for the Transmission Owner's Interconnection Facilities Study Report and Network Upgrades Report(s).



Transource Missouri
Facility Study for Southwest Power Pool
Generation Interconnection Request
GEN-2016-115

Studies prepared by Kansas City Power & Light Transmission Planning on
behalf of Transource Missouri
August 22, 2019

Executive Summary

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (Tariff) and at the request of SPP, KCP&L Transmission Planning performed the following Facility Study on behalf of Transource Missouri (TMO) to satisfy the Facility Study Agreement executed by the requesting Interconnection Customer (Customer) for SPP Generation Interconnection Request Gen-2016-115. The request for interconnection was placed with SPP in accordance with the Tariff, which covers new generation interconnections on SPP member's transmission system. The Customer requests interconnection service for a 300-MW wind farm to interconnect at the existing Rock Creek 345kV substation owned by Enel Green Power North America (Enel) and deliver the power to TMO's Holt County substation through the existing Rock Creek to Holt County 345kV line. The Customer has proposed a commercial operation date for the wind farm of November 16, 2020. The estimated cost of interconnection is \$100,000.

This Facility Study does not guarantee the availability of transmission service necessary to deliver the additional generation to any specific point inside or outside the SPP transmission system. The transmission network facilities may not be adequate to deliver the additional generation output to the transmission system. If the Customer requests firm transmission service under the SPP Tariff at a future date, Network Upgrades or other new construction may be required to provide the service requested under the SPP Tariff.

Interconnection Facilities

The primary objective of this study is to identify the transmission owner network upgrades and interconnection facilities. The Customer desires to interconnect a 300-MW wind farm using 18 Vestas V110-2.0 MW Mk10C, 23 Vestas V120-2.2 MW, and 51 Vestas V150-4.2 MW wind turbines at the existing Rock Creek 345kV substation. The proposed commercial operation date for the wind farm is November 16, 2020. The proposed point of interconnection is Enel's Rock Creek 345kV substation. A one-line diagram of the GEN-2016-115 (Outlaw) Interconnection, Rock Creek 345kv and Holt County 345kV Substations is shown in Appendix A.

Estimated Costs for TOIF and Network Upgrades

Transmission Owner Interconnection Facilities (TOIF)

Updates to protection schemes will need to be coordinated at TMO's Holt County substation in Holt County, near Fairfax, Missouri. These updates are estimated at \$100,000. The lead time for these updates is approximately three months.

TMO System Protection Coordination	<u>\$100,000</u>
Total	\$100,000

Network Upgrades

None.

The total cost estimate for the required Network Upgrades and the Transmission Owner Interconnection Facilities (TOIF).

\$	100,000	TOIF
\$	0	Network Upgrades
\$	100,000	Total

Short Circuit Fault Duty Evaluation

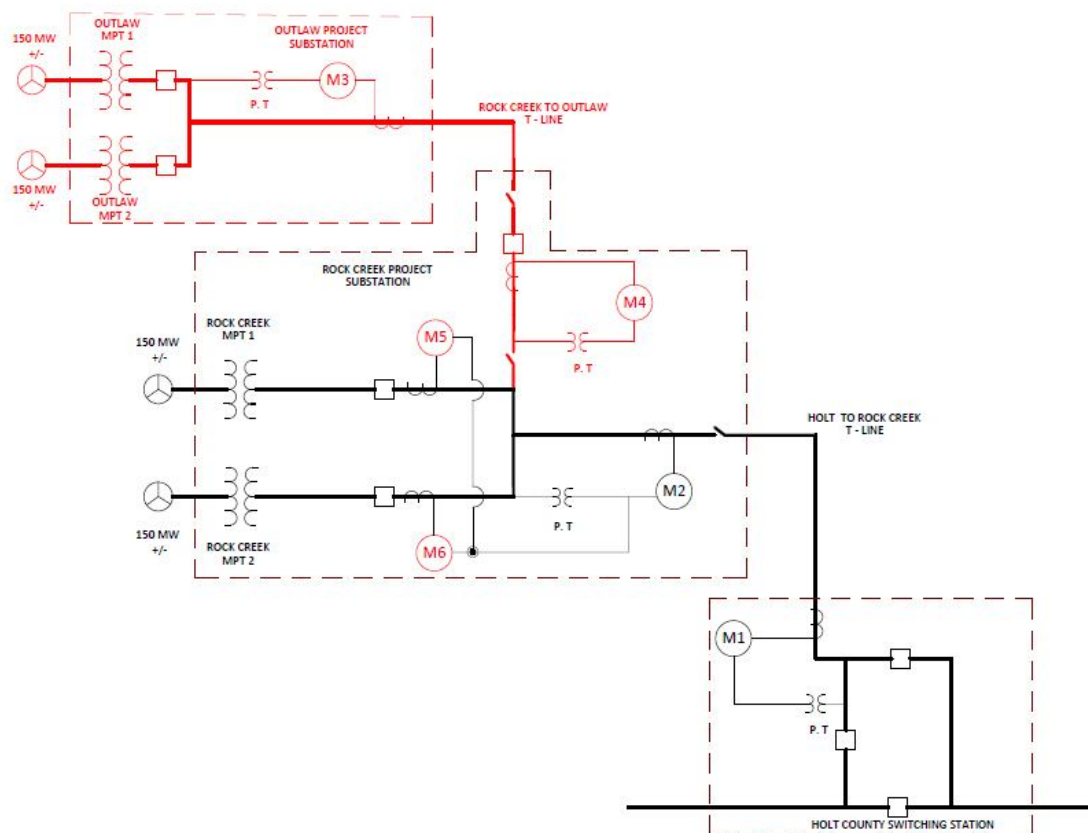
KCP&L engineering staff reviewed short circuit analysis for the Holt County 345 kV substation to determine if the added generation would cause the available fault currents to exceed the interrupting capability of any existing circuit breakers. The fault currents are within circuit breaker interrupting capability with the addition of the Gen-2016-115 wind farm.

Other Required Interconnection Facilities

No other equipment additions have been identified for this proposed generator interconnection.

SENSITIVE

Appendix A: One-Line Diagram of GEN-2016-115 (Outlaw) Interconnection, Rock Creek 345kv and Holt County 345kV Substations





Facility Study for Southwest Power Pool Generation Interconnection Request

GEN-2016-115 (IFS-2016-002)

Revision History			
Revision Date	Version	Change Description	Author
April 15, 2019	0	Initial Study	K. Wells
September 3, 2019	1	POI Change	K. Wells

Executive Summary

A generation interconnection customer has requested Energy Resource Interconnection Service (ERIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for the purpose adding a 300 MW wind generating facility in Missouri. A Definitive Interconnection System Impact Study (DISIS-2016-002) was performed by SPP and completed in August 2018 to study this generation interconnection (GI) request. The GI request is identified in SPP's generation interconnection queue as GEN-2016-115.

The original point of interconnection (POI) for this 300 MW GI request is on the KCPL system at the Holt County switching station. OPPD conducted a facility study for GEN-2016-115 at this POI. The results of OPPD's facility study are summarized below.

After issuance of revision 0 of this report, the POI was changed to Rock Creek switching station. SPP issued an Impact Restudy report in July 2019. OPPD has reviewed this report and determined that the revision 0 results documented below remain bounding and applicable.

Detailed Costs and Project Schedule for Required Interconnection

The expansion of the Rock Creek substation to accommodate the interconnection will required protection scheme revisions at the OPPD S3458 substation.

Upgrades	Initiating Study	Lead Time	Costs
S3458 Relay Settings	DISIS-2016-002	4-6 weeks	\$7,553.00

Steady State Powerflow Study Results:

- OPPD performed a validation of the SPP study and no thermal or voltage constraints with a significant impact were identified for TPL-001-4 (system intact, single contingency & multiple contingency) conditions for the addition of GEN-2016-115.

Stability Study Results:

- OPPD reviewed the SPP results, which show that GEN-2016-115 created an instability issue in the area of the KCPL Holt county substation. OPPD validated the SPP proposed solution and confirmed successful mitigation without any OPPD corrective actions. OPPD disturbances for S3458 were also simulated with no adverse impacts.

Short Circuit Study Results:

- OPPD performed a short circuit study on the OPPD area in addition to the SPP study results. The fault currents from the GEN-2016-115 wind farm do not cause any OPPD equipment ratings to be exceeded.

Steady State Analysis

Computer Programs

Steady-state analysis was performed using PSS®E version 33.

Methodology

SPP models from IFS-2016-002 were used to perform the study. Models were provided both for Base cases representing system conditions without the GEN-2016-115 project and for cases where GEN-2016-115 project was added and dispatched at 300 MW. Nonlinear (AC) contingency analysis was performed on both the base and study cases and the incremental impact of the GEN-2016-115 project was evaluated by comparing flows and voltages with and without the proposed interconnection.

The steady state contingency analysis performed covered all contingencies (P1 through P7) represented in NERC standard TPL-001-4.

Steady State Model

The following SPP DIS 2016 models series were used in this analysis.

- DIS1602BC13ALL_17WP0
- DIS1602BC13ALL_18G0
- DIS1602BC13ALL_18SP0
- DIS1602BC13ALL_21L0
- DIS1602BC13ALL_21SP0
- DIS1602BC13ALL_21WP0
- DIS1602BC13ALL_26SP0
- DIS1602TC13ALL_17WP0
- DIS1602TC13ALL_18G0
- DIS1602TC13ALL_18SP0
- DIS1602TC13ALL_21L0
- DIS1602TC13ALL_21SP0
- DIS1602TC13ALL_21WP0
- DIS1602TC13ALL_26SP0

Cases were solved with transformer tap adjustment enabled, area interchange enabled, phase shifter adjustment enabled and switched shunt adjustment enabled.

The model parameters used in this study for GEN-2016-115 are documented in Section A.1 of Appendix A.

Contingency Criteria

Contingencies considered for steady-state analysis includes:

- System intact (no contingencies)
- Single Contingency analysis
 - All transmission facilities 69 kV and above in OPPD's control area (area 645) and select neighboring transmission facilities 345kV and above near the POI.
- Multiple Contingency analysis
 - All transmission facilities 100 kV and above in OPPD's control area (area 645) and select neighboring transmission facilities 345kV and above near the POI. NOTE: 69kV was monitored for information only.

As part of the multiple contingency analysis, an N-1-1 analysis was performed to evaluate the impacts of planned prior outages. Planned prior outages that may be problematic are typically scheduled during light load conditions.

For all contingency and post-disturbance analyses, cases were solved with transformer tap adjustment enabled, area interchange adjustment enabled, phase shifter adjustment enabled and switched shunt adjustment enabled.

Monitored Elements

All transmission facilities 100 kV and above in OPPD's control system were monitored. 69kV was also monitored for information only.

Thermal loadings were monitored for 90% and above for the system intact and single event contingency analysis and 95% and above for the N-1-1 analysis.

Voltages were monitored outside the range of 0.95 to 1.05 pu for both the base case and change case.

Reliability Margins

All system elements were monitored using the applicable facility ratings.

Performance Criteria

A branch is considered a significantly affected facility (SAF) if both of the following conditions are met:

- 1) The branch is loaded above its applicable normal or emergency rating for the post-change case.
- 2) The distribution factor is greater than 20% for ERIS.

For non-linear contingency analysis, distribution factors are calculated as follows:

Project MW

$$DF = 100 \times \frac{MVA \text{ flow (with Project)} - MVA \text{ flow (w/o Project)}}{Project \text{ MW}}$$

A voltage impact is considered significant if both of the following conditions are met; all significant voltage impacts must be resolved before a project can receive interconnection service.

- 1) The bus voltage is outside of applicable normal or emergency limits for the post-change case.
- 2) The change in bus voltage between the change case and base case is greater than 0.01 per unit (pu).

Contingency Analysis Results

The incremental impact of the proposed interconnection on individual facilities was evaluated by comparing flows and voltages without and with the project. Analysis was performed using PSS®E activity ACCC.

System Intact Conditions

There were no facilities that met the SAF criteria for voltage or thermal conditions for NERC TPL-001-4 category P0 (pre-contingency) conditions.

Single & Multiple Event Contingencies

There were no facilities that met the SAF criteria for voltage or thermal conditions for NERC TPL-001-4 category P1, P2, P3, P4, P5, P6 and P7 conditions.

Stability Study

Computer Programs

Stability analyses was performed using PSS®E version 33.

Methodology

Analysis was performed using PSS®E activity RUN to recreate both the SPP disturbance that created the instability, and the proposed mitigation.

Disturbance 20

1. Apply fault at Holt 345kV bus
2. Clear fault after 5 cycles
3. Wait 20 cycles and then reclose the line back into the fault
4. Leave fault for 5 cycles and then trip the line and clear the fault

Disturbance 20A (i.e. 20 mitigated)

1. Apply fault at Holt 345kV bus
2. Clear fault after 5 cycles
3. Wait 20 cycles and then reclose the line back into the fault
4. Leave fault for 5 cycles and then trip the line and clear the fault
5. Adjust GEN-2014-021 (Rock Creek) to +0.98pf (i.e. 30MVAR each) **(MITIGATION)**
6. Trip all Mullin Creek reactors (100MVAR) **(MITIGATION)**

In addition, the above disturbances were analyzed without reclosing to confirm that reclosing strategy does not impact the results. Reclosing is not currently implemented on this line.

Additional analysis was also performed by simulating the OPPD S3458 TPL disturbances in the 2026 Summer model. All disturbances were stable without mitigation, with the exception of Extreme Event 2b. This is an existing TPL issue that is mitigated by the tripping of the Nebraska City Units. That mitigation remain effective with the generation addition. Reference attachments.

Stability Model

The short circuit study was performed on the SPP provided 10 year stability model MDWG16-26S_DIS1602_G13_cnv.

Results

The results of the OPPD study validate the results of the SPP study and no additional mitigations are required to OPPD facilities.

Short Circuit Study

Computer Programs

Short-Circuit analyses was performed using PSS®E version 33.

Methodology

Analysis was performed using PSS®E activity ANSI_2, which calculates fault currents according to the IEEE Std. C37.010-1999. The following assumptions were made during execution of activity ANSI:

- Maximum operating voltage is 1.05 pu
- Transformer impedance correction was not applied to zero-sequence transformer impedances
- For branches and machines with a zero value of resistance in the positive or zero sequence network, the zero value was replaced with a non-zero resistance equal to the positive or zero sequence reactance divided by a scaling factor. A scaling factor of 83 for branches and a factor of 252 for machines were used.
- The fault-current multiplying factors include the effects of dc decrement only
- Reactance is used to determine short-circuit current magnitudes (E/X calculation)
- Contact parting times are the minimum parting times shown in Figure 10 of IEEE Standard C37.010-1999, i.e., three-cycle contact parting time for 5-cycle breaker, two-cycle contact parting time for 3-cycle breaker, and 1.5-cycle contact parting time for 2-cycle breaker.

For both three-phase and single-line-to-ground faults, activity ANSI calculates the symmetrical fault current, the X/R ratio and the fault-current multiplying factor from IEEE Standard C37.010-1999 for determining the adequacy of the interrupting capability of breakers rated on a symmetrical current basis.

Results were produced for a transmission-system topology of all branches in service for all buses within the OPPD area with the GEN-2016-115 generation both in and out of service. These results were then compared to determine if a significant impact was present.

Short-Circuit Model

The short circuit study was performed on the SPP provided 10 year stability model MDWG16-26S_DIS1602_G13. This was consistent with the method used in the SPP IFS study. PSSE activity FLAT_2 was executed on the model to prepare it for fault calculation.

Results

Results, from the base case and the study case, for asymmetrical fault current were compared to study the impact of adding GEN-2016-115. Based on margin available in the latest TPL study, results were reviewed for busses with a fault current increase of greater than or equal to 100 amps.

The results of the short circuit analysis showed the 345kV substation S3458 was the only substation with an increase greater than 100 amps. The increase was equal to 379 amps, or 1.2%. This resulted in a bus fault current of 33.634kA compared to a breaker interrupt rating of 50kA. As a result, the fault current increase from the GEN-2016-115 addition does not cause any OPPD equipment ratings to be exceeded.

Attachments

Steady State Mon File

```
MONITOR BRANCHES IN SUBSYSTEM mon
MONITOR TIES FROM SUBSYSTEM mon
MONITOR VOLTAGE RANGE SUBSYSTEM mon .95 1.05
monitor voltage range bus 640320 0.95 1.05 /PLTSMTH8 69kV
monitor voltage range bus 640362 0.95 1.05 /STERLNG7 115kV
monitor voltage range bus 640171 0.95 1.05 /FIRTH 7 115kV
monitor voltage range bus 640278 0.95 1.05 /SHELDON7 115kV
monitor voltage range bus 640173 0.95 1.05 /FREMONT7 115kV
monitor voltage range bus 640336 0.95 1.05 /SCHUYLR7 115kV
monitor voltage range bus 640409 0.95 1.05 /WINSLOW7 115kV
monitor voltage range bus 640281 0.95 1.05 /N.BEND 7 115kV
monitor voltage range bus 645061 0.95 1.05 /FLTWTR1W 690V
monitor voltage range bus 648500 0.95 1.05 /FLTWTRX9 34.5kV

END
```

Steady State Sub File

```
SUBSYSTEM 'con'
JOIN
  AREA 645
  KVRANGE 69 999
END
SKIP BUS 648503
SKIP BUS 648504
SKIP BUS 648506
SKIP BUS 648507
SKIP BUS 648508
SKIP BUS 648509
SKIP BUS 648510
SKIP BUS 648511
SKIP BUS 648512
SKIP BUS 648513
SKIP BUS 648514
SKIP BUS 648515
SKIP BUS 648516
SKIP BUS 648517
SKIP BUS 648518
```

SKIP BUS 648519
SKIP BUS 648520
SKIP BUS 648521
SKIP BUS 648522
SKIP BUS 648523
SKIP BUS 648524
SKIP BUS 648525
SKIP BUS 648526
SKIP BUS 645062
SKIP BUS 645063
SKIP BUS 645064
SKIP BUS 645065
SKIP BUS 645066
SKIP BUS 645067
SKIP BUS 645068
END

SUBSYSTEM 'mon'
JOIN
AREA 645
KVRANGE 69 999
END

SKIP BUS 648503
SKIP BUS 648504
SKIP BUS 648506
SKIP BUS 648507
SKIP BUS 648508
SKIP BUS 648509
SKIP BUS 648510
SKIP BUS 648511
SKIP BUS 648512
SKIP BUS 648513
SKIP BUS 648514
SKIP BUS 648515
SKIP BUS 648516
SKIP BUS 648517
SKIP BUS 648518
SKIP BUS 648519
SKIP BUS 648520
SKIP BUS 648521
SKIP BUS 648522
SKIP BUS 648523
SKIP BUS 648524
SKIP BUS 648525

SKIP BUS 648526
 SKIP BUS 645062
 SKIP BUS 645063
 SKIP BUS 645064
 SKIP BUS 645065
 SKIP BUS 645066
 SKIP BUS 645067
 SKIP BUS 645068
 END

SUBSYSTEM 'Ext-5buses-100kV'

JOIN

KVRANGE 100 999

BUS 300039	/* Area 330	7FAIRPT	345.0
BUS 300068	/* Area 330	5CHILLI	161.0
BUS 300073	/* Area 330	5GENTRY	161.0
BUS 300076	/* Area 330	5FAIRPT	161.0
BUS 300087	/* Area 330	5HICKCK	161.0
BUS 300094	/* Area 330	5LOCUST	161.0
BUS 300104	/* Area 330	5NODWAY	161.0
BUS 300107	/* Area 330	5OSBORN	161.0
BUS 301310	/* Area 330	5REX	161.0
BUS 301347	/* Area 330	5WINSLOW	161.0
BUS 345408	/* Area 356	7OVERTON	345.0
BUS 530583	/* Area 531	POSTROCK7	345.0
BUS 532772	/* Area 536	STRANGR7	345.0
BUS 532857	/* Area 536	TECHILL6	230.0
BUS 532913	/* Area 536	KELLY 5	161.0
BUS 532920	/* Area 536	TECHILL5	161.0
BUS 533152	/* Area 536	CIRCLVL3	115.0
BUS 533153	/* Area 536	COLINE 3	115.0
BUS 533157	/* Area 536	FORBES 3	115.0
BUS 533165	/* Area 536	HTI JCT3	115.0
BUS 533172	/* Area 536	QUINTON3	115.0
BUS 533176	/* Area 536	SHAWNEE3	115.0
BUS 533177	/* Area 536	6 GOLDN3	115.0
BUS 533181	/* Area 536	TECHILW3	115.0
BUS 533182	/* Area 536	TECHILE3	115.0
BUS 533183	/* Area 536	WM BROS3	115.0
BUS 533187	/* Area 536	27CROCO3	115.0
BUS 533197	/* Area 536	HARTLND3	115.0
BUS 533202	/* Area 536	TEC 3	115.0
BUS 533203	/* Area 536	TEC E 3	115.0
BUS 533210	/* Area 536	ENEMAHA3	115.0

BUS 533212	/* Area 536	BROWNC03	115.0
BUS 533217	/* Area 536	KELLY 3	115.0
BUS 533252	/* Area 536	MIDLADN3	115.0
BUS 533270	/* Area 536	STULL T3	115.0
BUS 533322	/* Area 536	BAILEYV3	115.0
BUS 533331	/* Area 536	GOFF 3	115.0
BUS 533337	/* Area 536	SENECA 3	115.0
BUS 533338	/* Area 536	SMITTYV3	115.0
BUS 533348	/* Area 536	TCSENCA3	115.0
BUS 541197	/* Area 541	MULLNCR7	345.0
BUS 541199	/* Area 541	ST JOE 3	345.0
BUS 541200	/* Area 541	PHILL 7	345.0
BUS 541201	/* Area 541	SIBLEY 7	345.0
BUS 541202	/* Area 541	SIBLEY 5	161.0
BUS 541203	/* Area 541	NASHUA 5	161.0
BUS 541230	/* Area 541	RNRIDGE5	161.0
BUS 541253	/* Area 541	ST JOE 5	161.0
BUS 541254	/* Area 541	EAST 5	161.0
BUS 541256	/* Area 541	IND PRK5	161.0
BUS 541257	/* Area 541	COOK 5	161.0
BUS 541258	/* Area 541	WOODBIN5	161.0
BUS 541350	/* Area 541	IATAN5	161.0
BUS 541355	/* Area 541	EDMOND5	161.0
BUS 541369	/* Area 541	MIDWAY_5	161.0
BUS 541394	/* Area 541	AVENUECTY 5	161.0
BUS 541400	/* Area 541	EASTOWN7	345.0
BUS 541401	/* Area 541	EASTOWN5	161.0
BUS 541411	/* Area 541	MC REAC1	345.0
BUS 541412	/* Area 541	MC REAC2	345.0
BUS 541413	/* Area 541	MC REAC3	345.0
BUS 541414	/* Area 541	SIB REA1	345.0
BUS 541500	/* Area 541	KETCHEM7	345.0
BUS 541501	/* Area 541	OSBORN7	345.0
BUS 541510	/* Area 541	HOLT 7	345.0
BUS 541511	/* Area 541	ROCKCK7	345.0
BUS 541517	/* Area 541	HOLT_REACT7	345.0
BUS 542972	/* Area 541	HAWTH 7	345.0
BUS 542980	/* Area 541	NASHUA 7	345.0
BUS 542982	/* Area 541	IATAN 7	345.0
BUS 543028	/* Area 541	NASHUA-5	161.0
BUS 543029	/* Area 541	SHOLCRK5	161.0
BUS 543665	/* Area 541	HAWTHN5	161.0
BUS 584510	/* Area 640	GEN-2015-007	345.0
BUS 601006	/* Area 600	SPLT RK3	345.0

BUS 601029	/* Area 600	LKFLDXL3	345.0
BUS 601034	/* Area 600	NOBLES 3	345.0
BUS 603016	/* Area 600	SPLT RK7	115.0
BUS 631041	/* Area 627	LAKEFLD L1 5	161.0
BUS 631138	/* Area 627	LAKEFLD3	345.0
BUS 631193	/* Area 627	HUNTLEY3	345.0
BUS 631194	/* Area 627	LAKEFLD L2 5	161.0
BUS 631197	/* Area 627	LEDYARD3	345.0
BUS 635000	/* Area 635	CBLUFFS3	345.0
BUS 635001	/* Area 635	CBLUFFS5	161.0
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BUS 635005	/* Area 635	SUB702 5	161.0
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BUS 635017	/* Area 635	ATCHSN 3	345.0
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BUS 635034	/* Area 635	CLRND 5	161.0
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BUS 635041	/* Area 635	TEAKWOOD 5	161.0
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BUS 635200	/* Area 635	RAUN 3	345.0
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BUS 635202	/* Area 635	NEAL S 5	161.0
BUS 635203	/* Area 635	NEAL N 5	161.0
BUS 635206	/* Area 635	IDA CO 3	345.0
BUS 635220	/* Area 635	INTCHG 5	161.0
BUS 635221	/* Area 635	KELLOGG5	161.0
BUS 635223	/* Area 635	PLYMOTH5	161.0
BUS 635225	/* Area 635	MORNSD 5	161.0
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BUS 635368	/* Area 635	OBRIEN 3	345.0

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BUS 635570	/* Area 635	ORIENT 3	345.0
BUS 635580	/* Area 635	ARBR HL 3	345.0
BUS 635589	/* Area 635	ECLIPSE3	345.0
BUS 635590	/* Area 635	FALLOW 3	345.0
BUS 635600	/* Area 635	GRIMES 3	345.0
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BUS 635631	/* Area 635	BOONVIL5	161.0
BUS 635632	/* Area 635	EARLHAM5	161.0
BUS 635635	/* Area 635	MADISON3	345.0
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BUS 635641	/* Area 635	NORWLK5	161.0
BUS 635700	/* Area 635	SYCAMOR3	345.0
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BUS 636003	/* Area 635	BVR CRK 3	345.0
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BUS 640113	/* Area 640	CLRWATR7	115.0
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BUS 640119	/* Area 640	COL.CO7	115.0
BUS 640122	/* Area 640	COL.DRY7	115.0
BUS 640124	/* Area 640	COL.SE 7	115.0
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BUS 640126	/* Area 640	E.COL. 4	230.0
BUS 640127	/* Area 640	COLMB.E7	115.0
BUS 640131	/* Area 640	COLMB.W4	230.0
BUS 640133	/* Area 640	COLMBUS4	230.0
BUS 640134	/* Area 640	KELLY 7	115.0

BUS 640136	/* Area 640	COLMBUS7	115.0
BUS 640139	/* Area 640	COOPER 3	345.0
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BUS 640235	/* Area 640	HUMBOLT7	115.0
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BUS 640293	/* Area 640	NELIGH 7	115.0
BUS 640296	/* Area 640	NORFK.N7	115.0
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BUS 640305	/* Area 640	ONEILL 7	115.0
BUS 640312	/* Area 640	PAULINE3	345.0
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BUS 640318	/* Area 640	PETRSG7	115.0
BUS 640328	/* Area 640	RISNGCY7	115.0
BUS 640330	/* Area 640	RIVERDL4	230.0
BUS 640336	/* Area 640	SCHUYLR7	115.0
BUS 640340	/* Area 640	SEWARD 7	115.0
BUS 640342	/* Area 640	SHELCKR3	345.0
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BUS 640345	/* Area 640	SILVRCK7	115.0
BUS 640347	/* Area 640	SPALDNG7	115.0
BUS 640349	/* Area 640	SPENCER7	115.0
BUS 640357	/* Area 640	STANTON7	115.0
BUS 640361	/* Area 640	STEINER7	115.0
BUS 640362	/* Area 640	STERLNG7	115.0
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BUS 640374	/* Area 640	SWEET W3	345.0
BUS 640378	/* Area 640	TEKAMAH7	115.0
BUS 640381	/* Area 640	THEDFRD7	115.0
BUS 640386	/* Area 640	TWIN CH4	230.0
BUS 640387	/* Area 640	TWIN CH7	115.0
BUS 640400	/* Area 640	W.POINT7	115.0
BUS 640402	/* Area 640	WAHOO 7	115.0
BUS 640409	/* Area 640	WINSLOW7	115.0
BUS 640413	/* Area 640	YORK SW7	115.0
BUS 640426	/* Area 640	STEELEC7	115.0
BUS 640444	/* Area 640	PETERSBRG.N7	115.0
BUS 640500	/* Area 640	THEDFRD3	345.0
BUS 640510	/* Area 652	HOLT.CO3	345.0
BUS 640520	/* Area 640	ANTELOPE 3	345.0
BUS 640521	/* Area 640	ANTELOPE 7	115.0
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BUS 640583	/* Area 640	ROSEMONT 7	115.0
BUS 640590	/* Area 640	MONOLITH 3	345.0
BUS 640591	/* Area 640	MONOLITH 7	115.0
BUS 650114	/* Area 650	NW68HOLDRG3	345.0
BUS 650169	/* Area 650	70&BLUFF 5	161.0
BUS 650185	/* Area 650	WAGENER 3	345.0
BUS 650189	/* Area 650	103&ROKEBY3	345.0
BUS 650205	/* Area 650	4&MORTON 7	115.0
BUS 650210	/* Area 650	NW70FAIRFD7	115.0
BUS 650214	/* Area 650	NW68HOLDRG7	115.0
BUS 650215	/* Area 650	19&ALVO 7	115.0
BUS 650216	/* Area 650	SW27&F 7	115.0
BUS 650226	/* Area 650	NW12&ARBOR7	115.0
BUS 650228	/* Area 650	27FLETCHER7	115.0

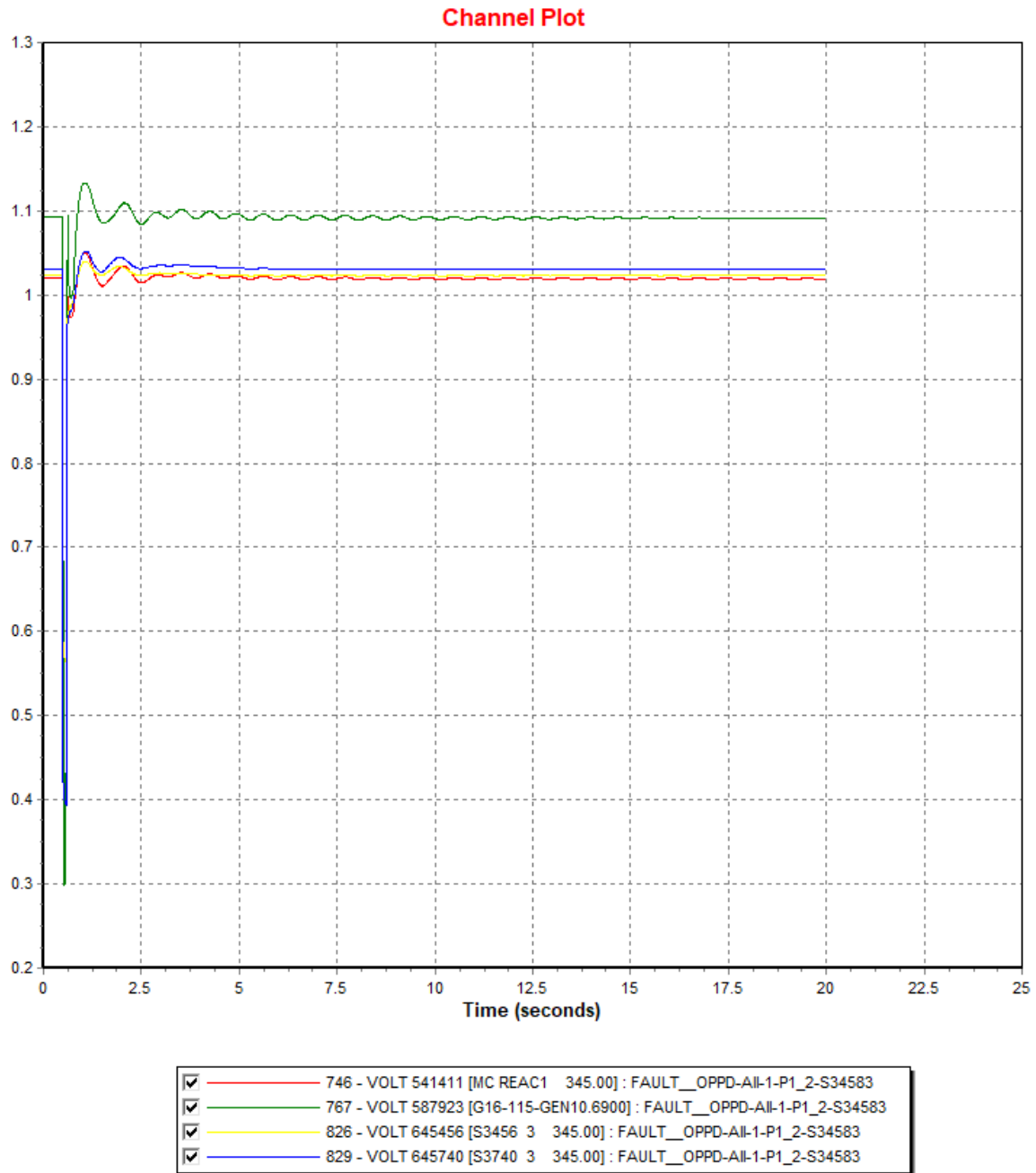
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BUS 650230	/* Area 650	2&N 7 115.0
BUS 650238	/* Area 650	20PIONEERS7 115.0
BUS 650242	/* Area 650	FOLSM&PHIL7 115.0
BUS 650246	/* Area 650	SW7&BENNET7 115.0
BUS 650247	/* Area 650	40&BENNET 7 115.0
BUS 650250	/* Area 650	40&ROKEBY 7 115.0
BUS 650255	/* Area 650	56&PLR 7 115.0
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BUS 650259	/* Area 650	59CRNHUSKR7 115.0
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BUS 650261	/* Area 650	56&I80 7 115.0
BUS 650262	/* Area 650	57&GARLAND7 115.0
BUS 650267	/* Area 650	84LEIGHTON7 115.0
BUS 650269	/* Area 650	70&BLUFF 7 115.0
BUS 650270	/* Area 650	70&CALVERT7 115.0
BUS 650271	/* Area 650	81&OCHENEY7 115.0
BUS 650272	/* Area 650	91&A 7 115.0
BUS 650273	/* Area 650	93&O 7 115.0
BUS 650274	/* Area 650	91&HWY2 7 115.0
BUS 650275	/* Area 650	84&BLUFF 7 115.0
BUS 650276	/* Area 650	76&ROKEBY 7 115.0
BUS 650277	/* Area 650	TBGS_A 7 115.0
BUS 650278	/* Area 650	TBGS_B 7 115.0
BUS 650279	/* Area 650	120&ALVO 7 115.0
BUS 650283	/* Area 650	WAVERLY 7 115.0
BUS 650284	/* Area 650	84FLETCHER7 115.0
BUS 650285	/* Area 650	WAGENER 7 115.0
BUS 650290	/* Area 650	ROKEBY 7 115.0
BUS 652398	/* Area 652	VFODNES4 230.0
BUS 652475	/* Area 652	BONESTL7 115.0
BUS 652478	/* Area 652	GREGORY7 115.0
BUS 652501	/* Area 652	ARMOUR 7 115.0
BUS 652506	/* Area 652	FTTHOMP3 345.0
BUS 652507	/* Area 652	FTTHOMP4 230.0
BUS 652509	/* Area 652	FTRANDL4 230.0
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BUS 652514	/* Area 652	HURON 4 230.0
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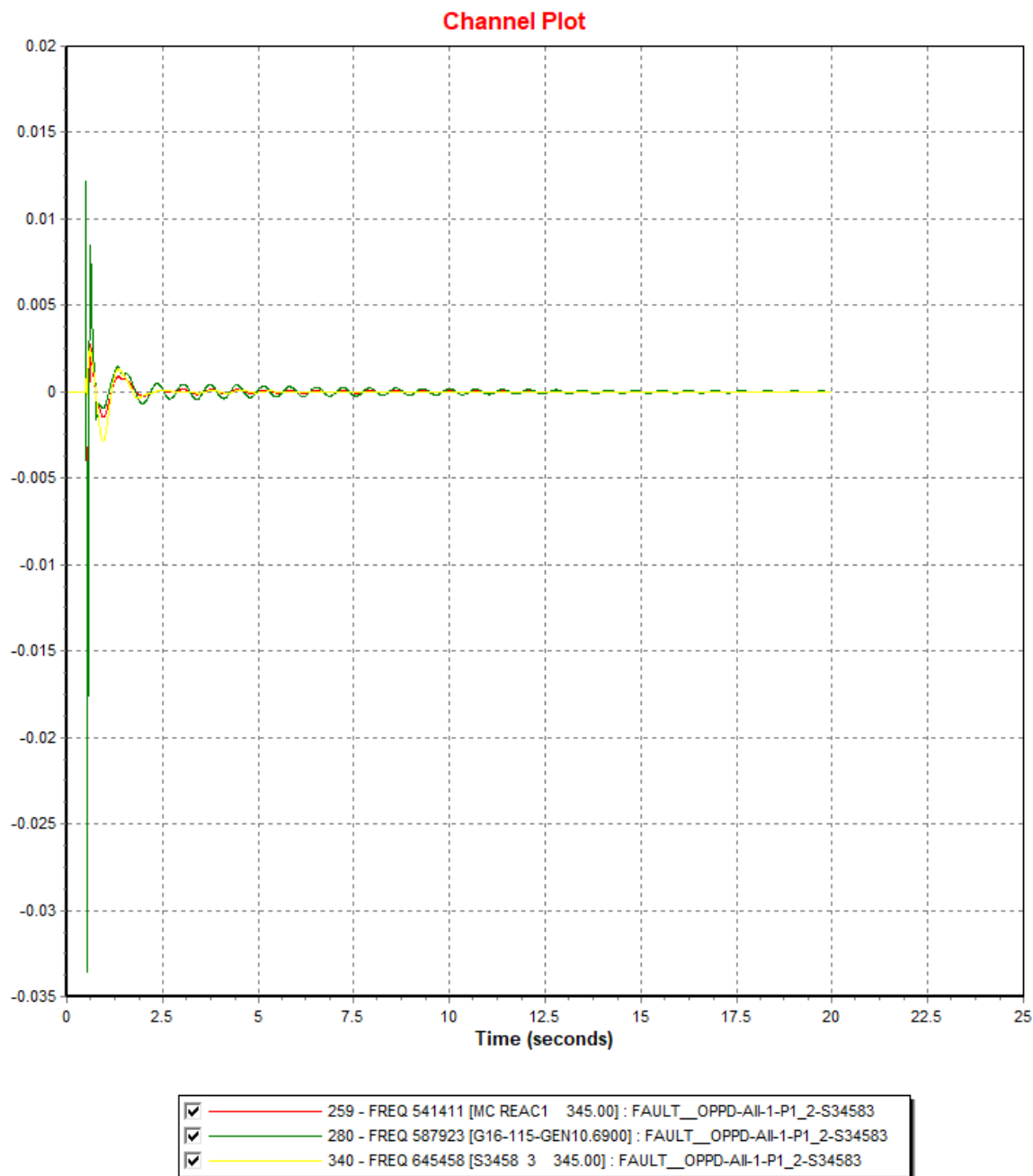
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BUS 652530	/* Area 652	WATERTN4	230.0
BUS 652532	/* Area 652	GR PRAIRIE 3	345.0
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BUS 652552	/* Area 652	SIOUXCY2	230.0
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BUS 652567	/* Area 652	DENISON4	230.0
BUS 652606	/* Area 652	LETCHER4	230.0
BUS 652607	/* Area 652	WESSINGTON 4	230.0
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BUS 652614	/* Area 652	CARPENTER 4	230.0
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BUS 652864	/* Area 652	SIOUXCY-LNX3	345.0
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BUS 653871	/* Area 640	GR ISLD-LNX3	345.0
BUS 655418	/* Area 652	FREEMAN-ER7	115.0
BUS 655468	/* Area 652	VFODNES-ER7	115.0
BUS 655475	/* Area 652	LAKPLAT-ER4	230.0
BUS 655484	/* Area 652	RASMUSN-ER4	230.0
BUS 655487	/* Area 652	SULLYBT-ER4	230.0
BUS 655490	/* Area 652	WHTSWAN-ER7	115.0
BUS 659122	/* Area 652	STORLA__ -BE4	230.0
BUS 659188	/* Area 652	PHILIP_T-BE4	230.0
BUS 659205	/* Area 652	BROADLND-BE4	230.0
BUS 659295	/* Area 652	SD.PW1__ -BE4	230.0
BUS 659311	/* Area 652	PAHOJA__ -BE4	230.0
BUS 659900	/* Area 652	EAGLE__ -NI4	230.0
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BUS 660026	/* Area 652	NAPA JCT7	115.0
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END			
END			

OPPD Disturbances

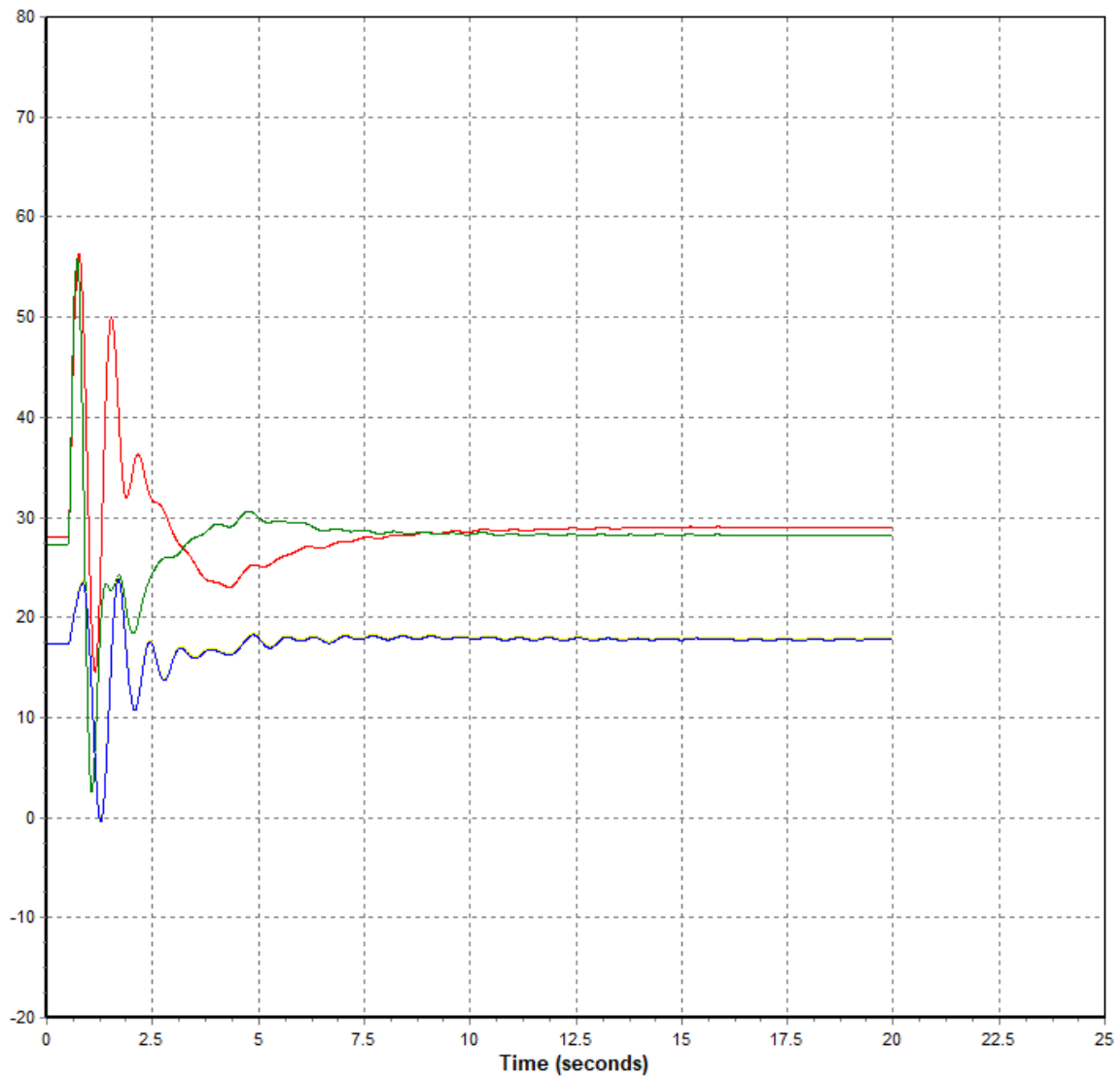
Category	Faulted Bus			Outage or System Adjustment				Circuit				Clear Fault	Description
	Fault Type	Bus Name	Voltage (kV)	Bus Number	Run For Cycles/Set Scale (MW, Max, Min)	Action	Element	From Bus	To Bus	Tertiary Bus	Circuit ID		
P1_2	3PH	S3458 3	345.00	645458	4.5	Open	Transmission Circuit	645458	640139		1	Yes	3-PH fault at S3458 on S3458-Cooper. Normal clearing.
P3_2						Prior Outage	Generator	635024			4		Prior outage of Council Bluffs Unit 4. 3-PH fault at S3458 on S3458-S3456. Normal clearing.
P4_2	SCMU-L-G	S3458 3	345.00	645458	4.5	Open	Transmission Circuit	645458	645456		1	Yes	SLG Fault at S3458 on S3458-Cooper followed by a stuck breaker opening the west bus. Delayed clearing.
P6_1.1	SCMU-L-G	S3458 3	345.00	645458	9	Prior Outage	Transmission Circuit	645458	640139		1	Yes	Prior outage of S3458-S3740. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
P6_1.1	3PH	S3458 3	345.00	645458	4.5	Open	Transmission Circuit	645458	645456		1	Yes	Prior outage of S3458-S3740. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
P6_1.1	3PH	S3458 3	345.00	645458	4.5	Prior Outage	Transmission Circuit	645458	640139		1	Yes	Prior outage of S3458-S3740. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
P6_1.1	3PH	S3458 3	345.00	645458	4.5	Prior Outage	Transmission Circuit	645458	640139		1	Yes	Prior outage of S3458-S3740. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
Extreme_2 b	3PH	S3458 3	345.00	645458	4.5	Open	Transmission Circuit	645458	645456		1	Yes	3-PH fault at S3458 on S3458-Cooper followed by a stuck breaker opening the west bus. Delayed clearing.
Extreme_2 f	3PH	S3458 3	345.00	645458	9	Open	Transmission Circuit	645458	640139		1	Yes	Prior outage of S3458-S3740. 3-PH fault at S3458 on S3458-Cooper. Normal clearing.
						Prior Outage	Transmission Circuit	645455	645740		1		SLG Fault at S3458 on S3458-Cooper followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU-L-G	S3458 3	345.00	645458	4.5	Open	Transmission Circuit	645458	640139		1	Yes	Prior outage of S3458-Cooper. SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU-L-G	S3458 3	345.00	645458	9	Prior Outage	Transmission Circuit	645458	640139		1	Yes	SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU-L-G	S3458 3	345.00	645458	4.5	Open	Transmission Circuit	645458	645456		1	Yes	Prior outage of S3458-Cooper. SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU-L-G	S3458 3	345.00	645458	9	Prior Outage	Transmission Circuit	645458	640139		1	Yes	SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU-L-G	S3458 3	345.00	645458	4	Open	Transmission Circuit	645458	640139		1	Yes	Prior outage of S3458-Cooper. SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.
	SCMU-L-G	S3458 3	345.00	645458	9.5	Open	Transmission Circuit	645458	640139		1	Yes	SLG Fault at S3458 on S3458-S3456 followed by a stuck breaker opening the west bus. Delayed clearing.

Stability Output Plots

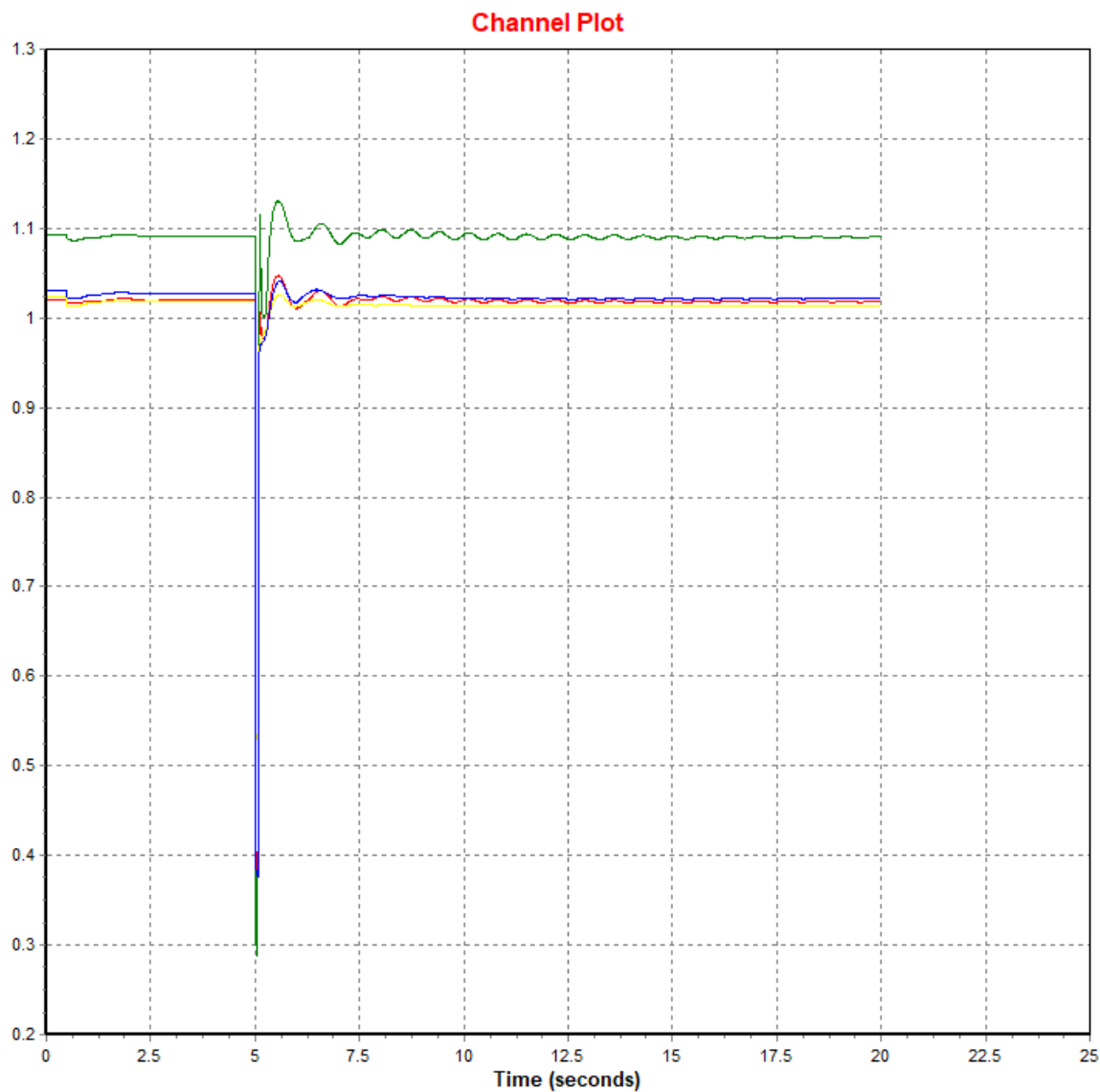




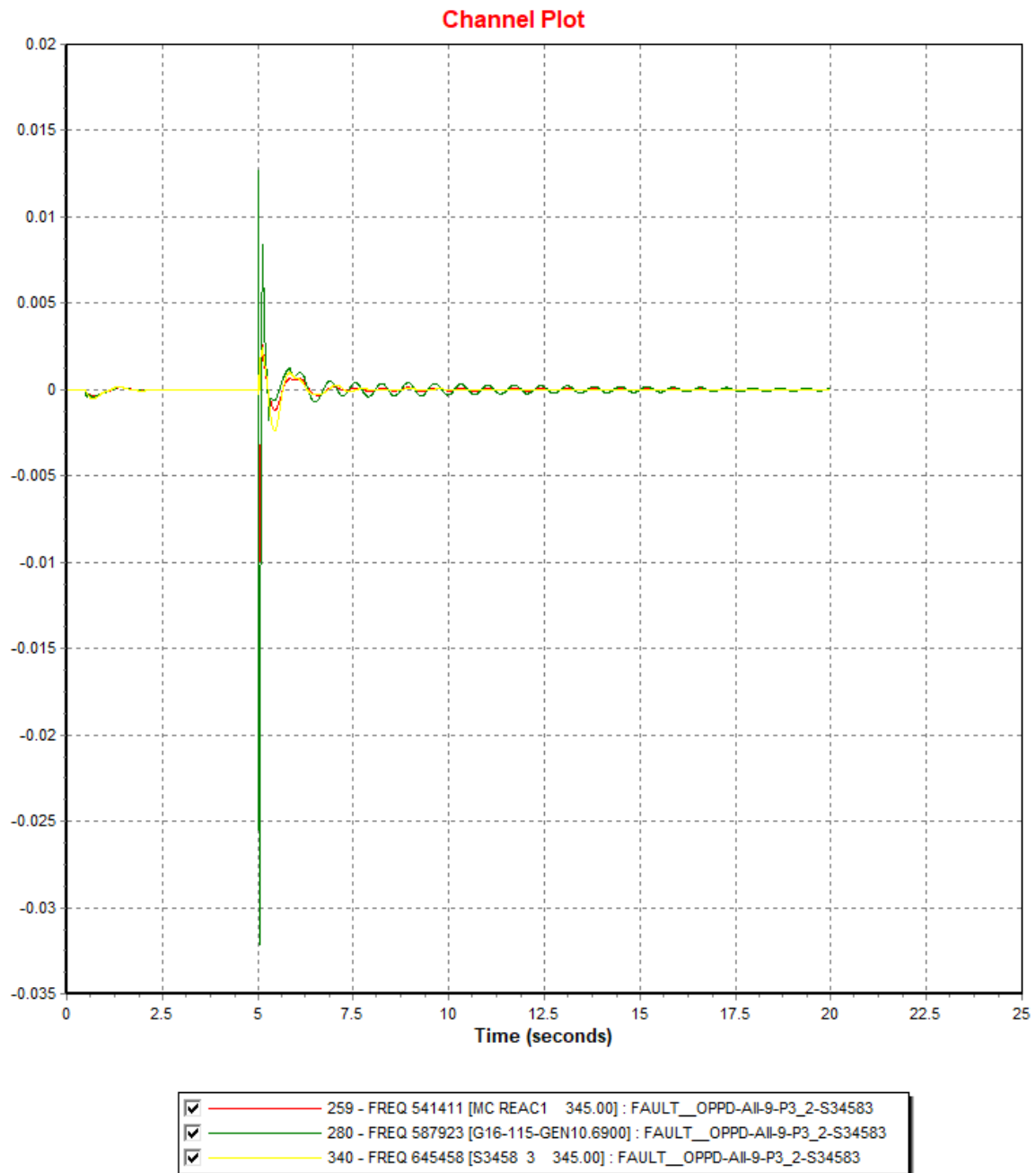
Channel Plot



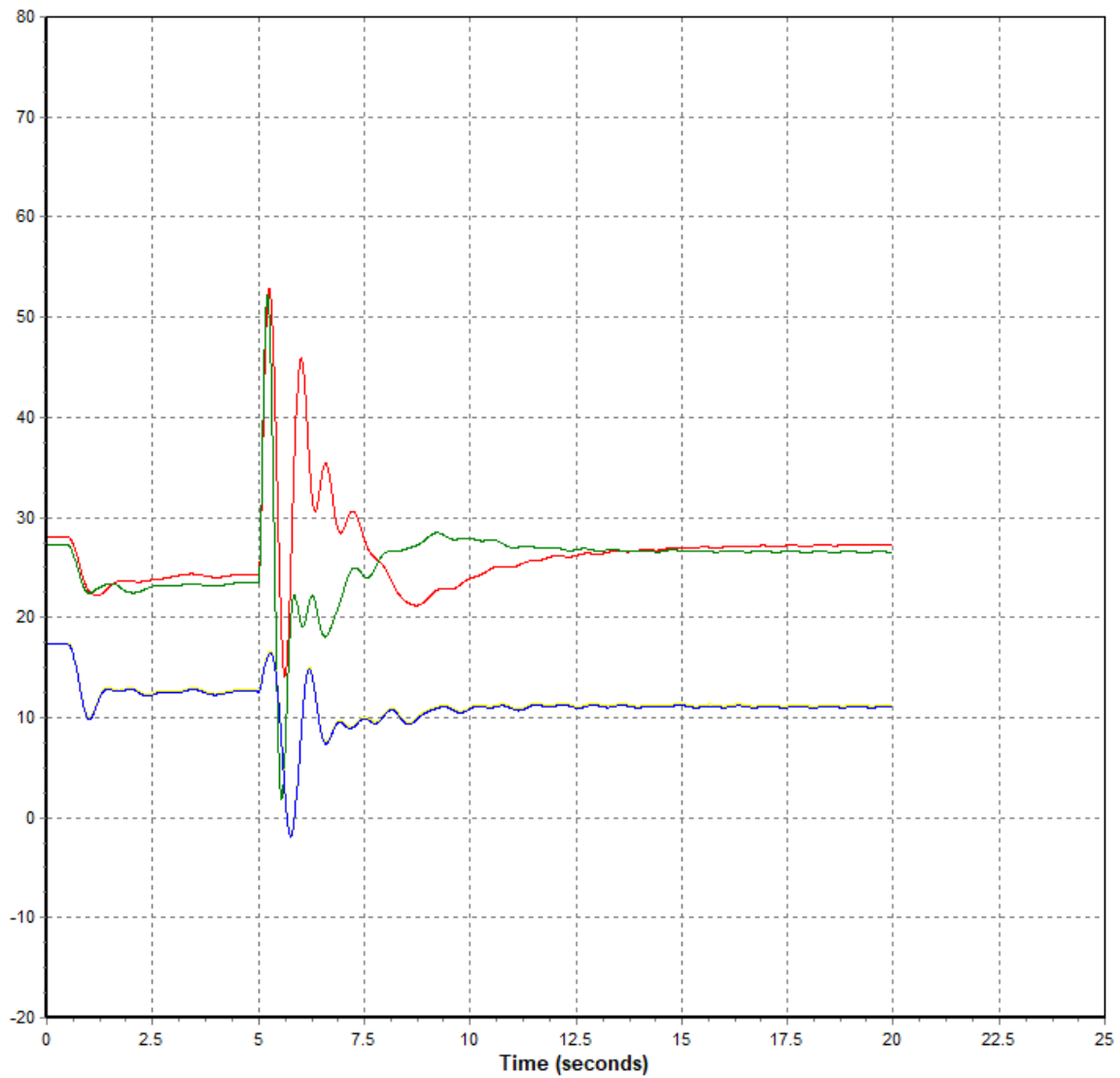
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<input checked="" type="checkbox"/>	767 - VOLT 587923 [G16-115-GEN10.6900] : FAULT__OPPD-AII-9-P3_2-S34583
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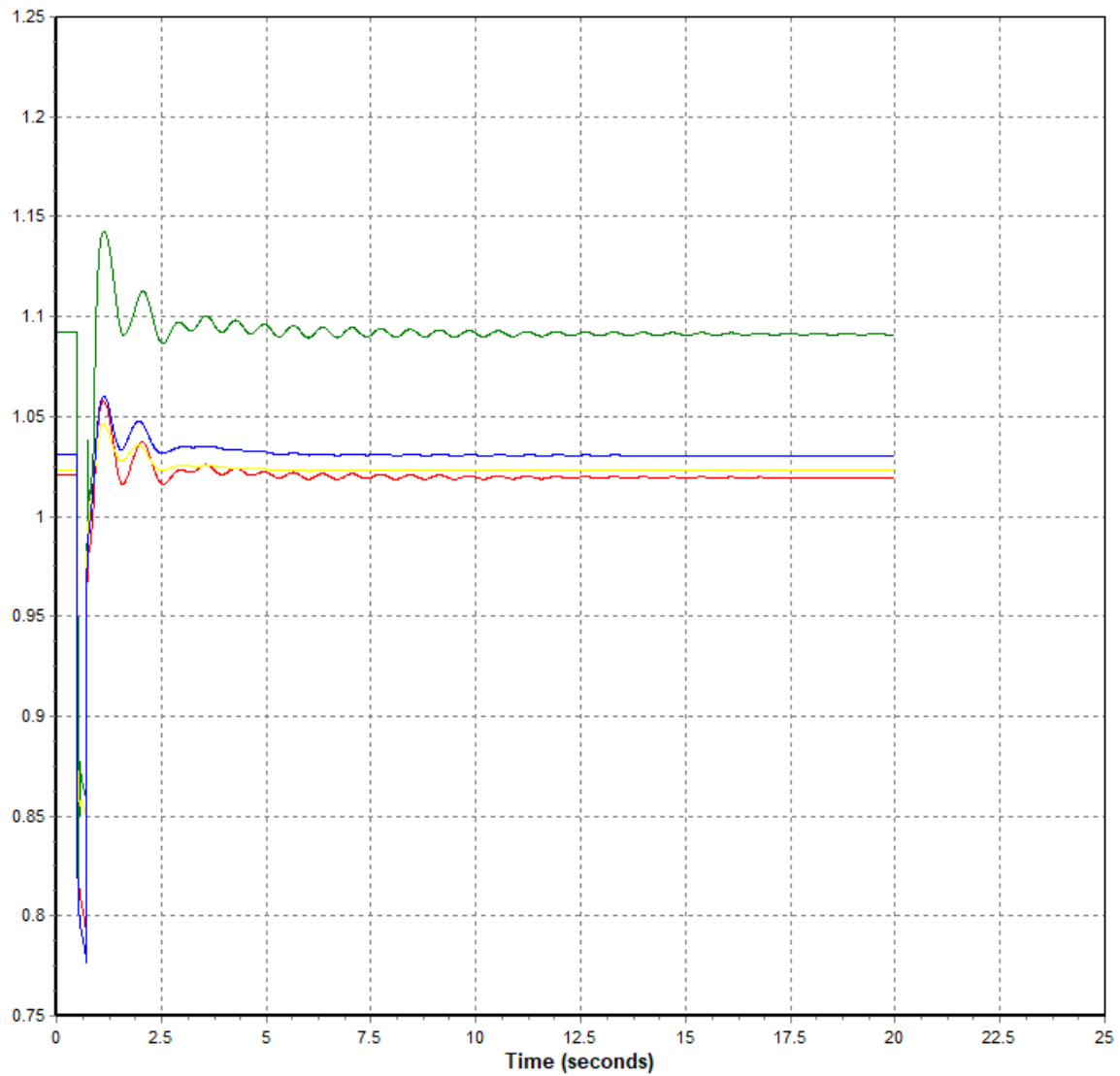


Channel Plot

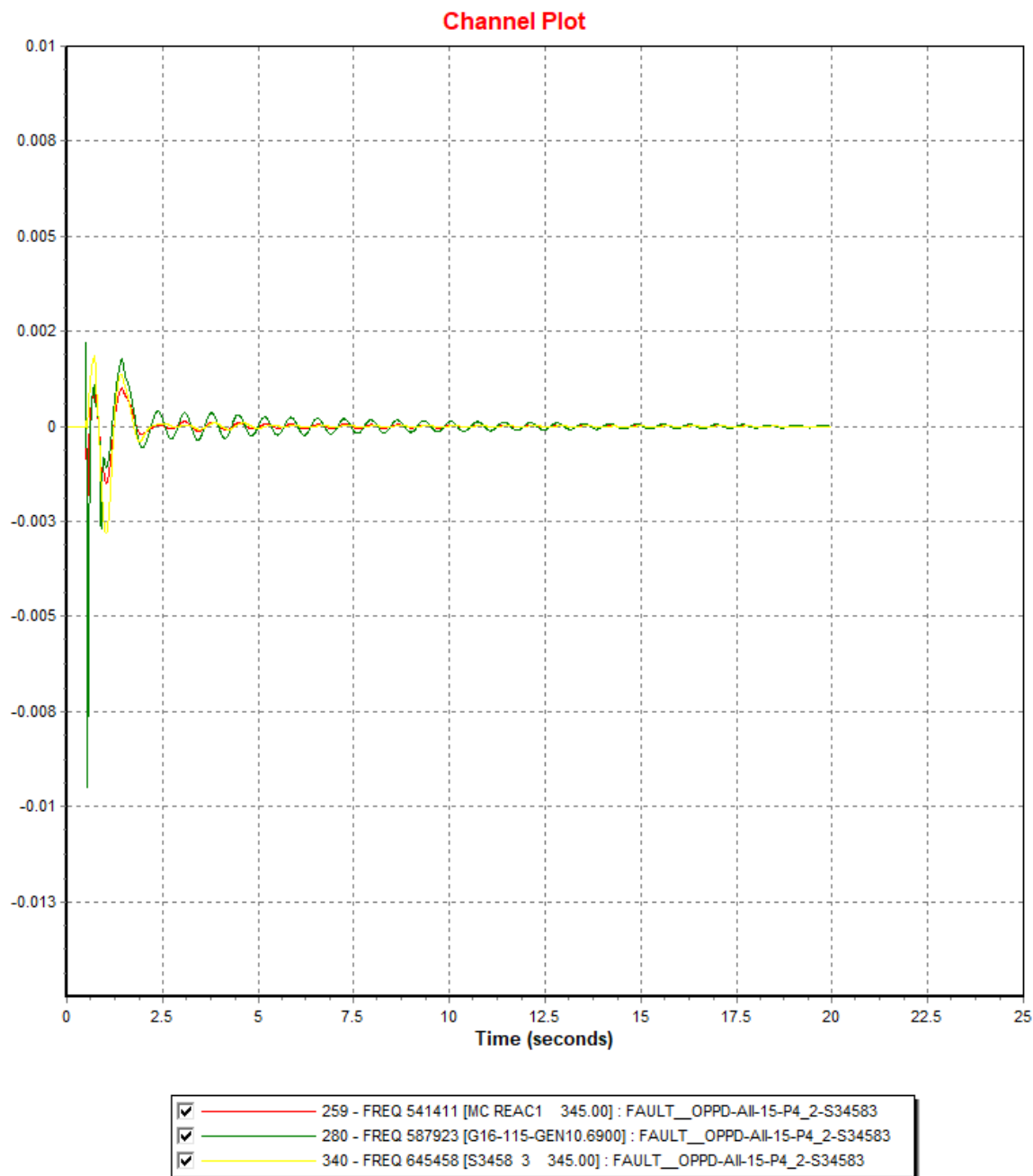


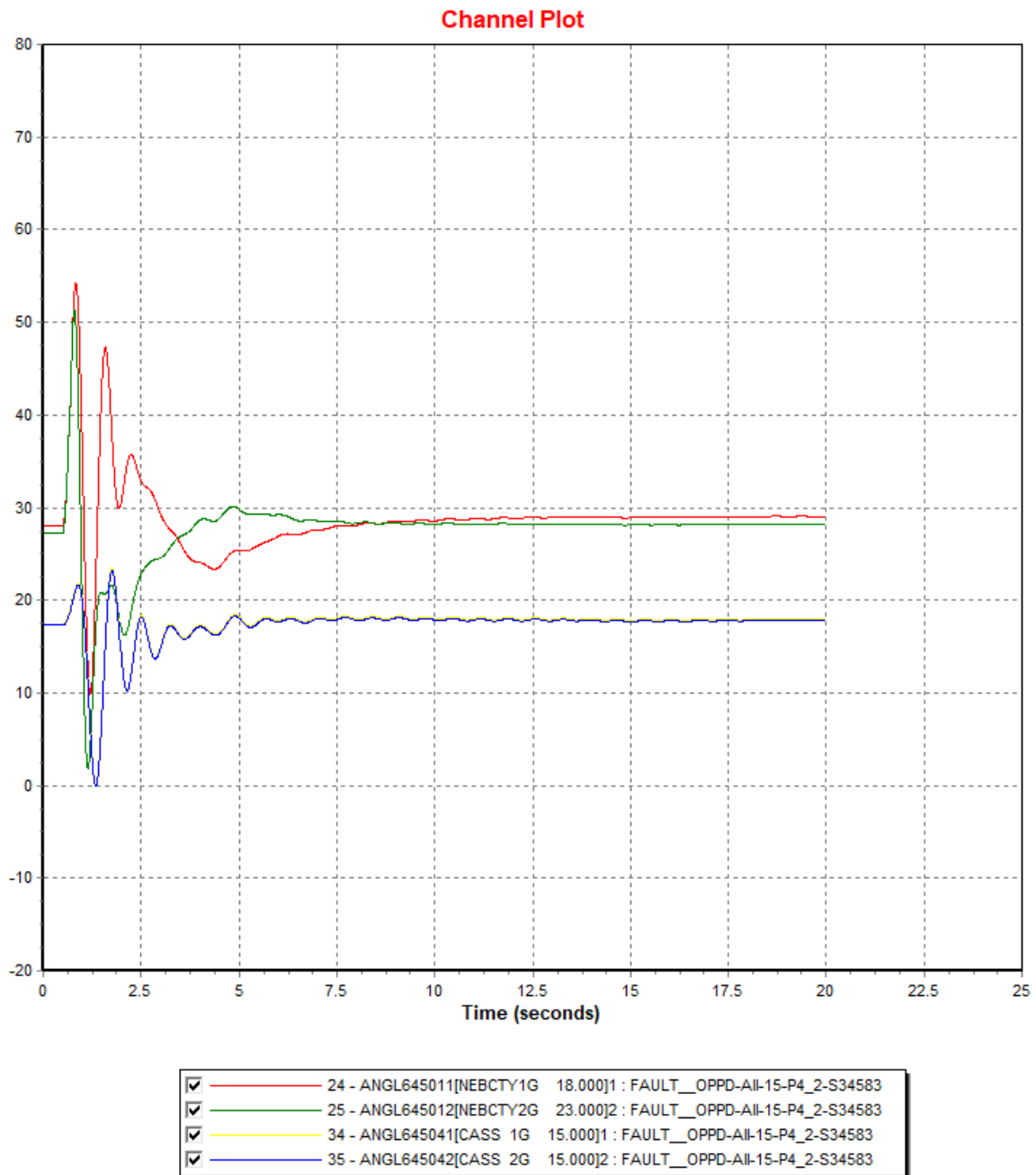
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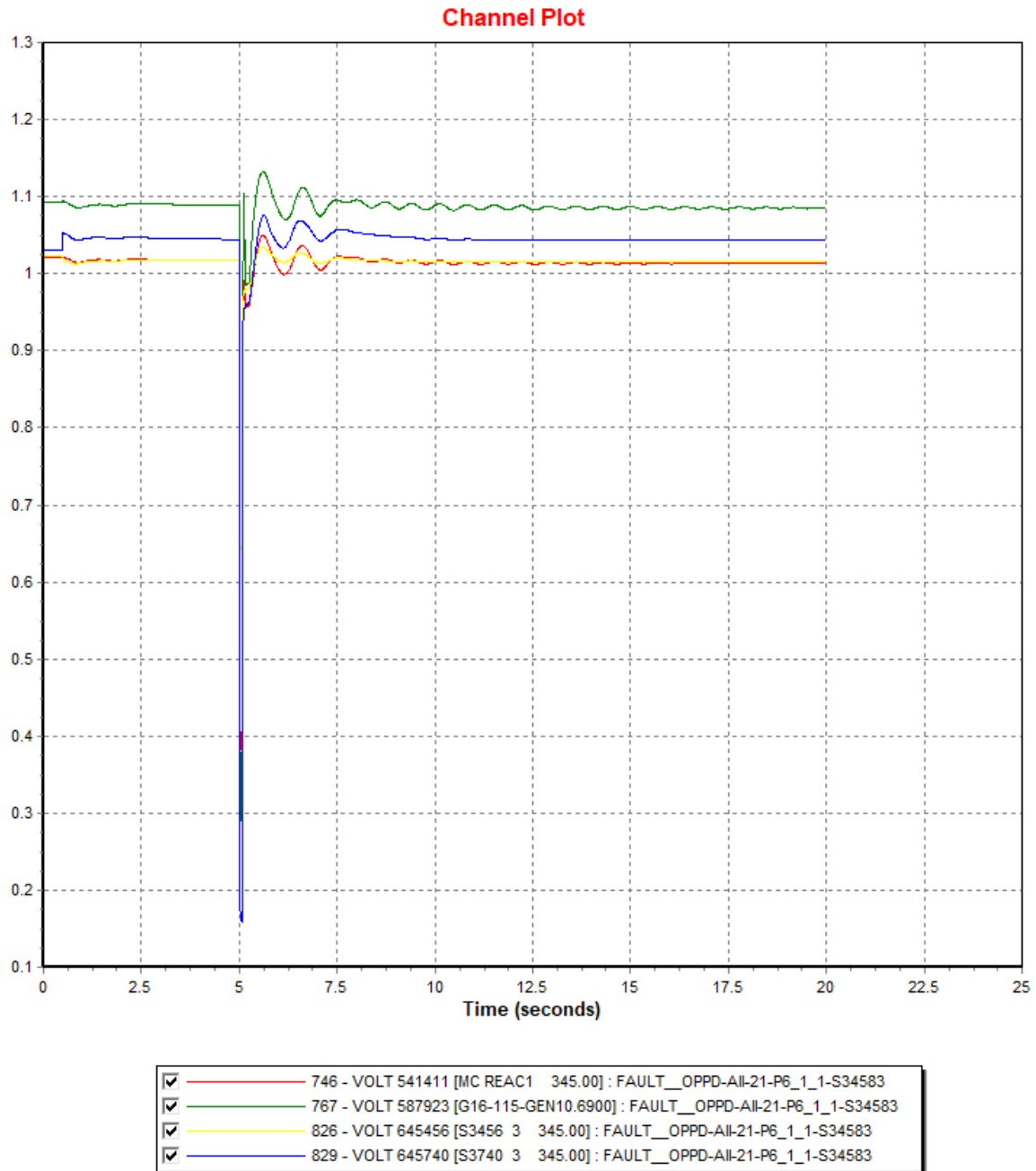
Channel Plot

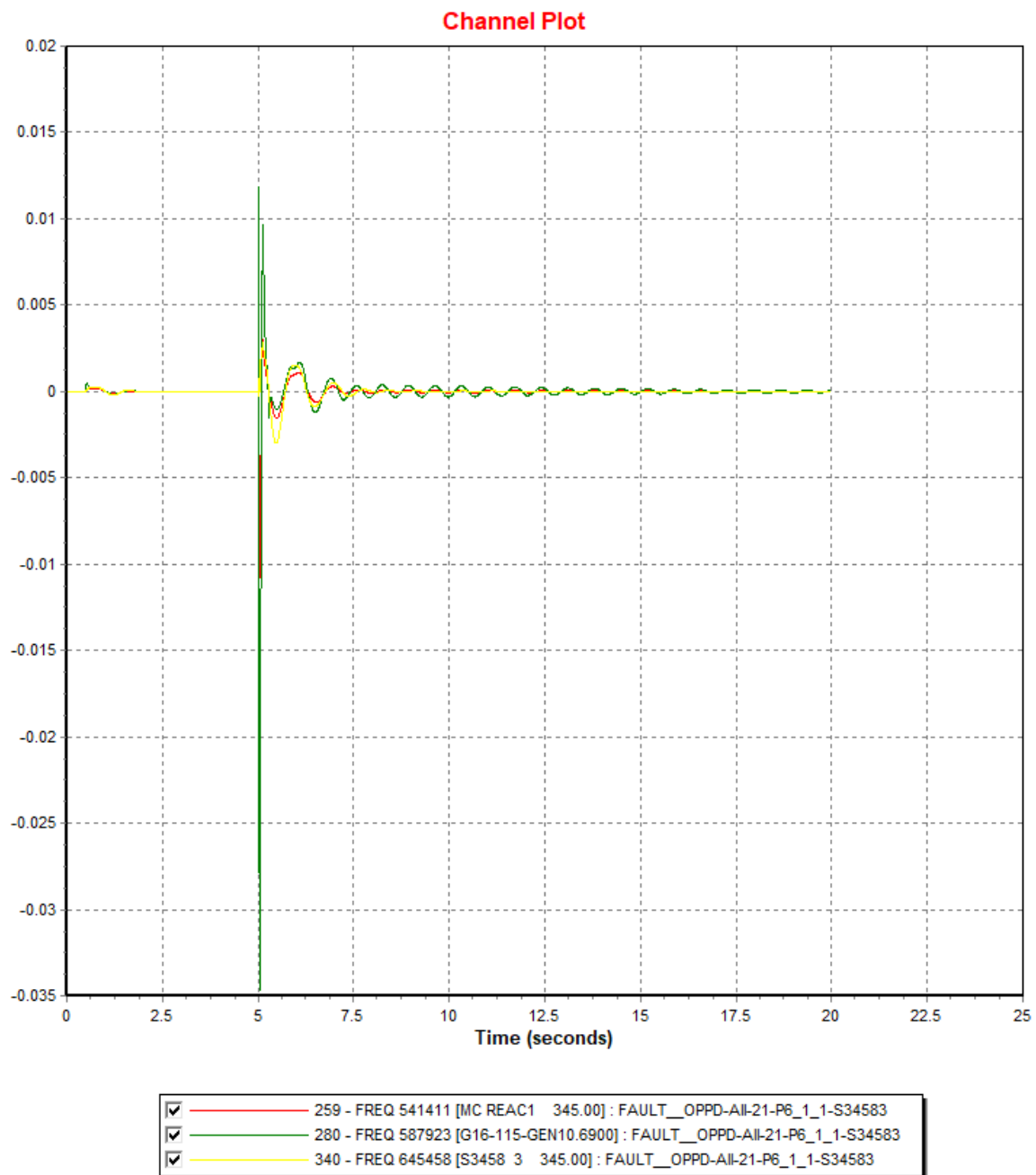


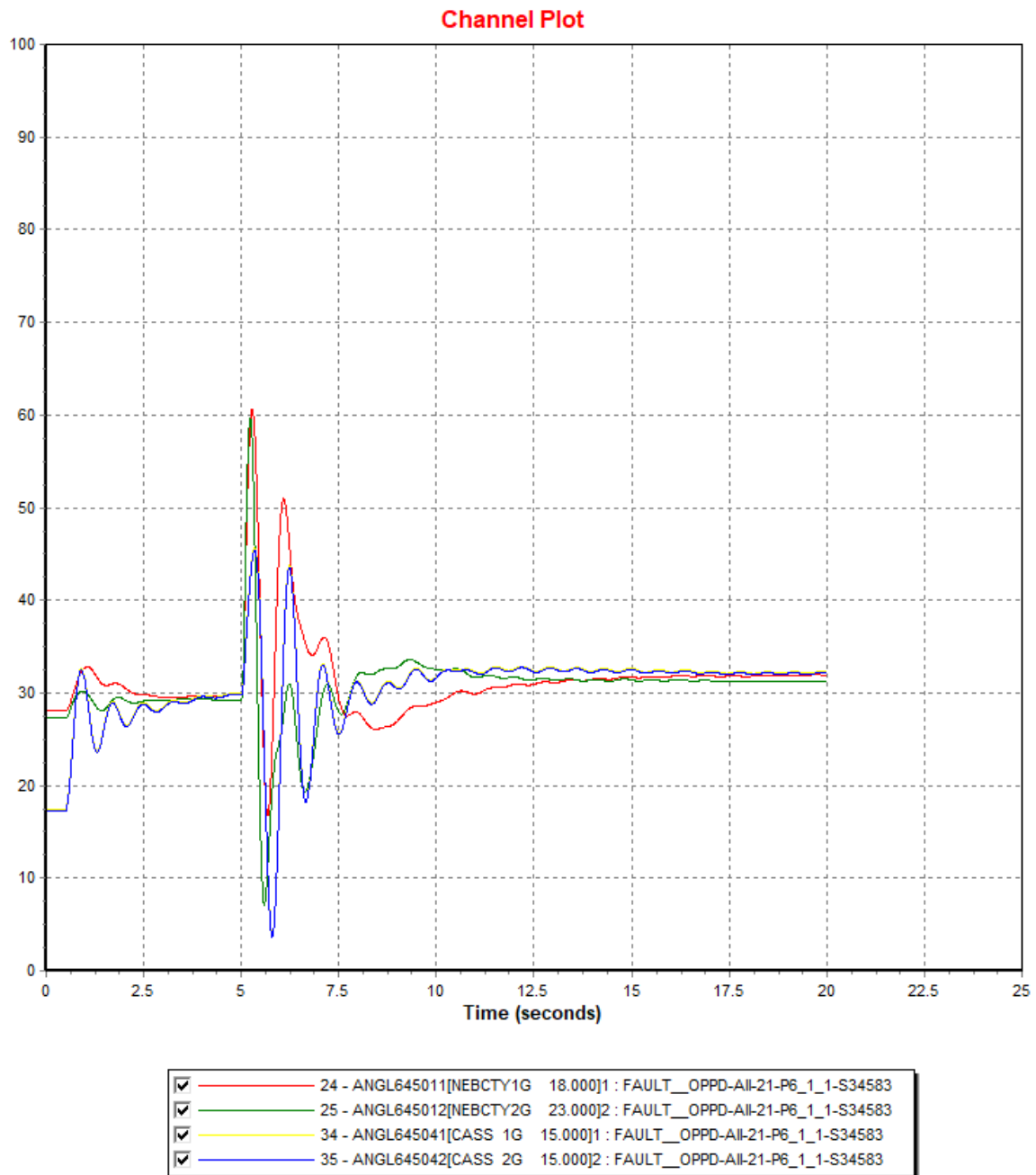
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<input checked="" type="checkbox"/>	767 - VOLT 587923 [G16-115-GEN10.6900] : FAULT__OPPD-AII-15-P4_2-S34583
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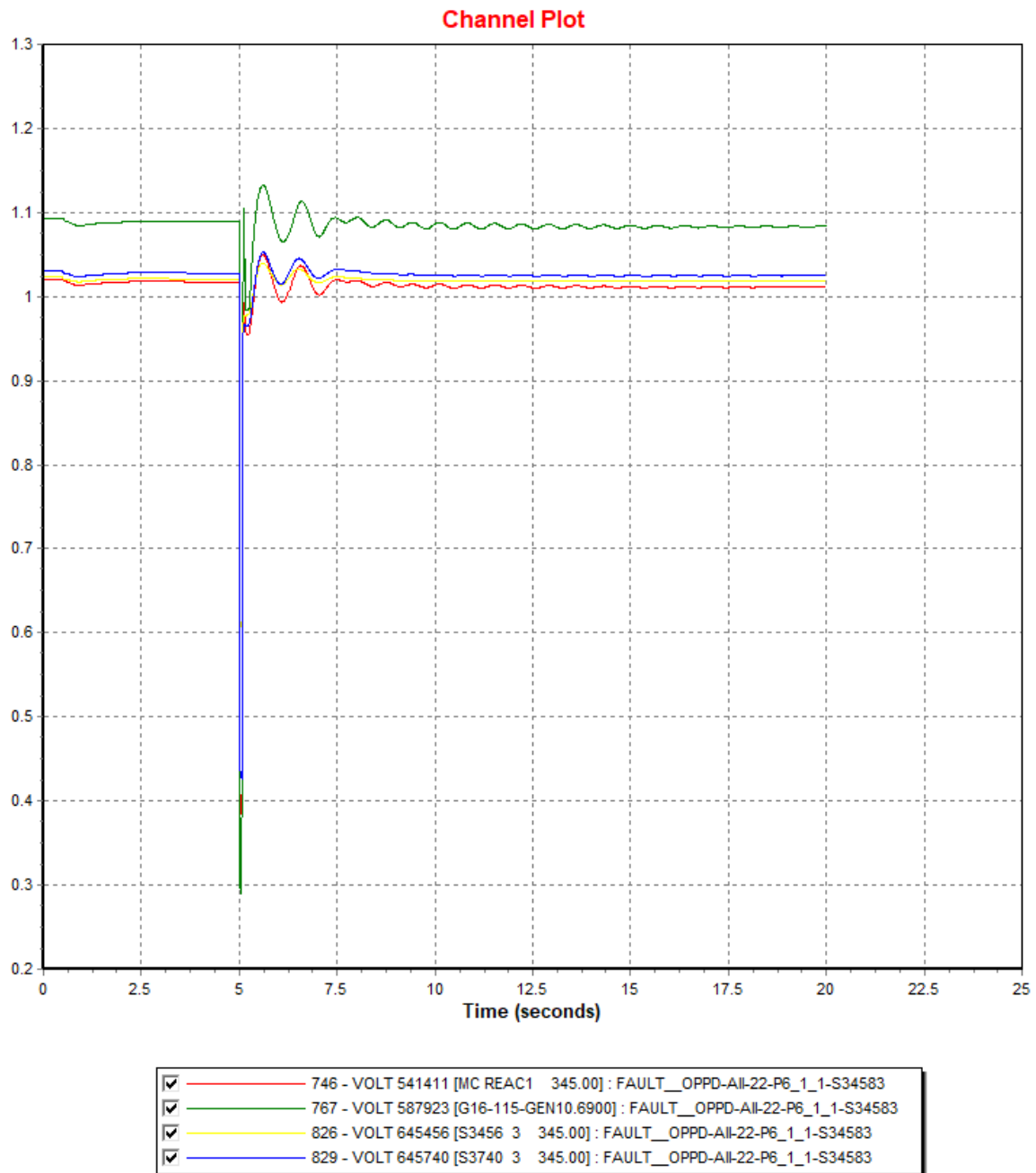


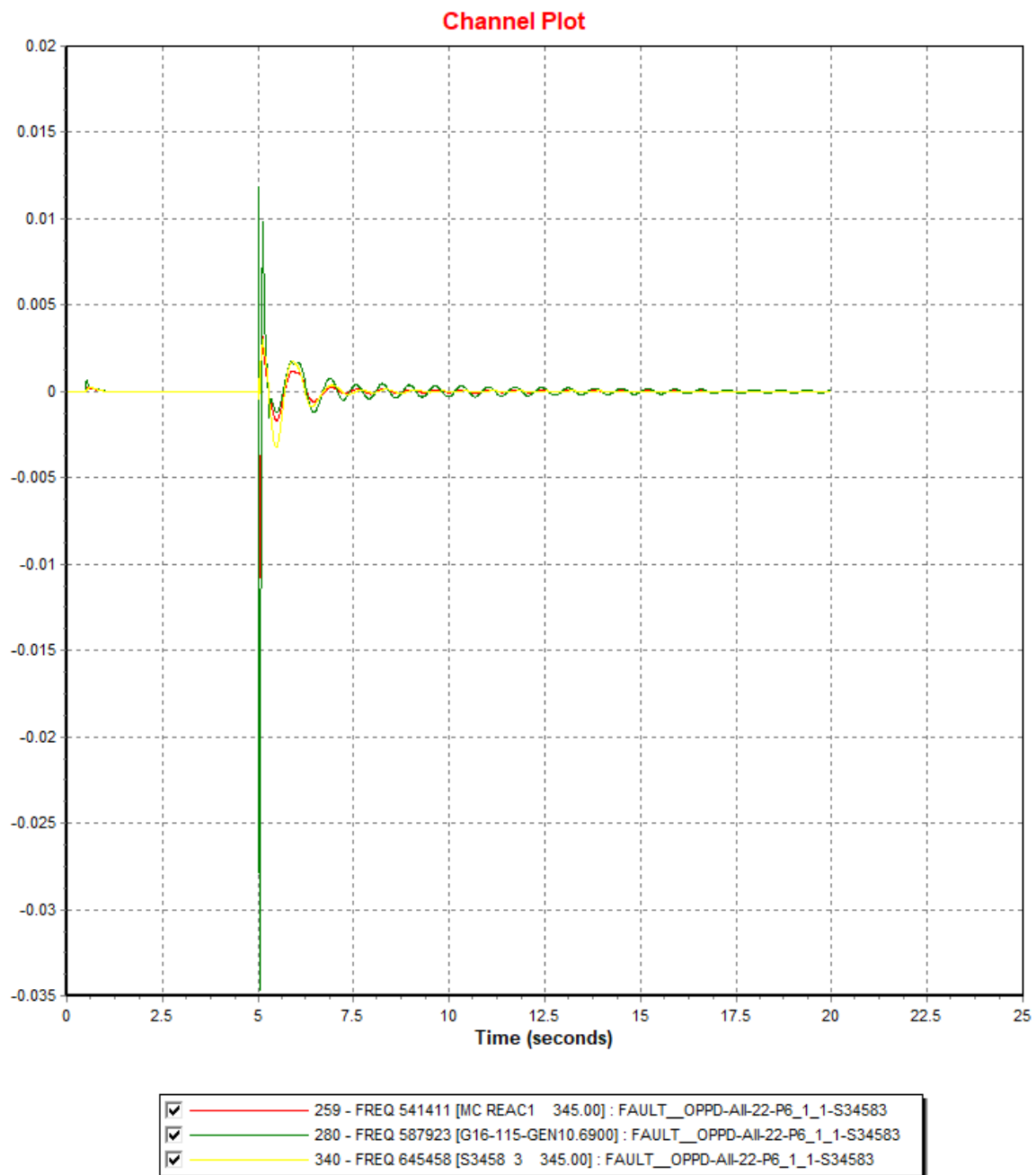




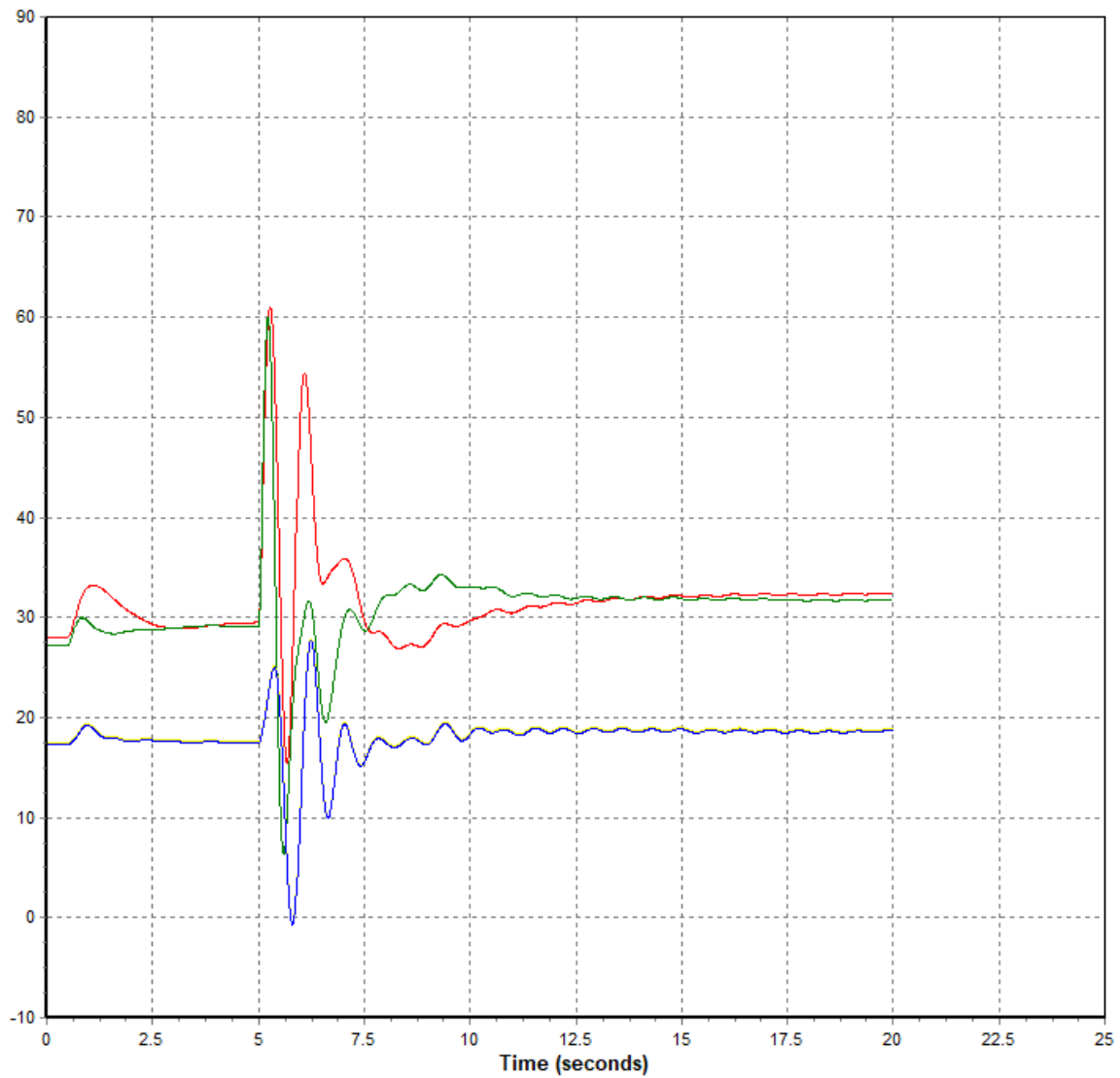




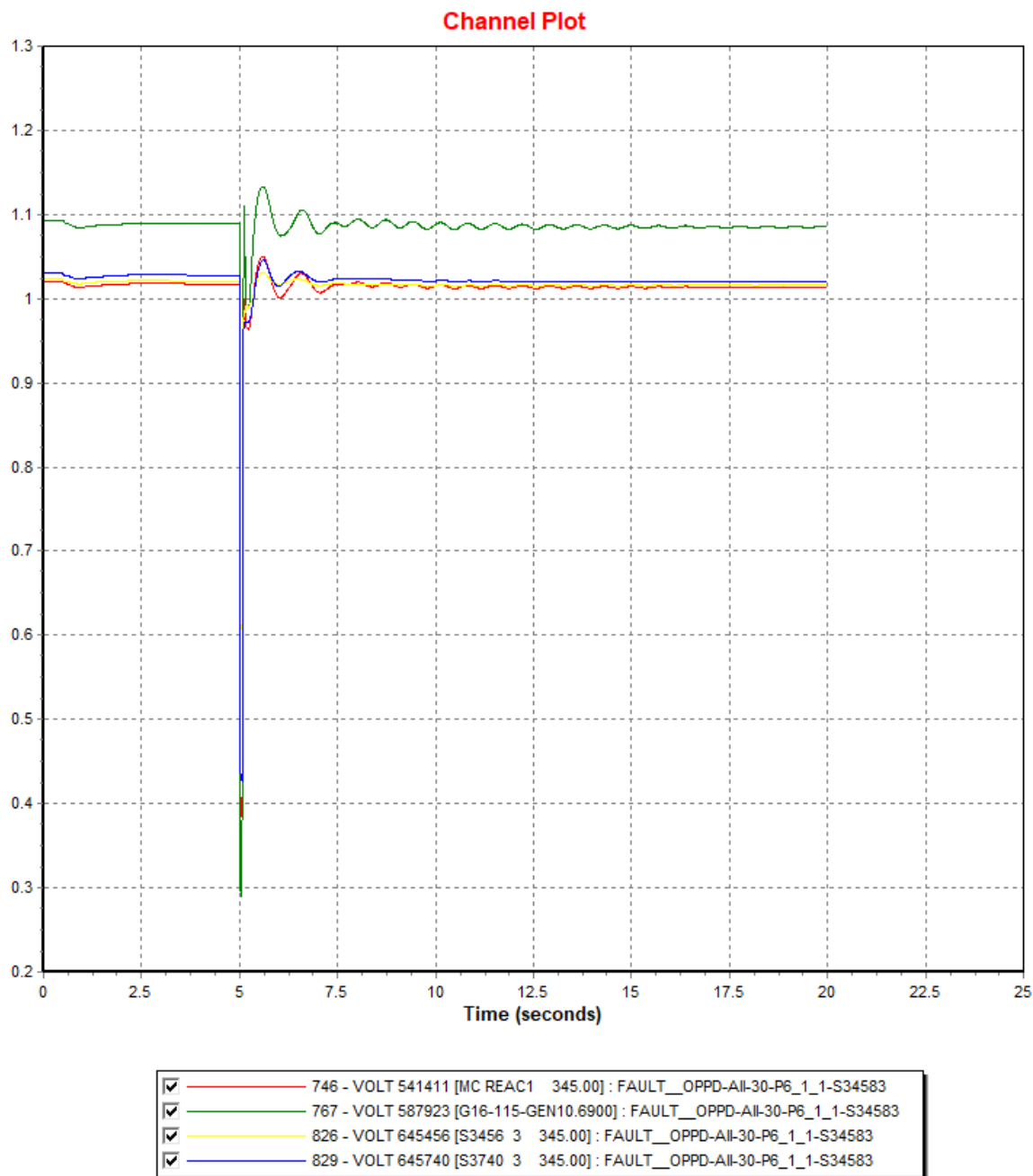


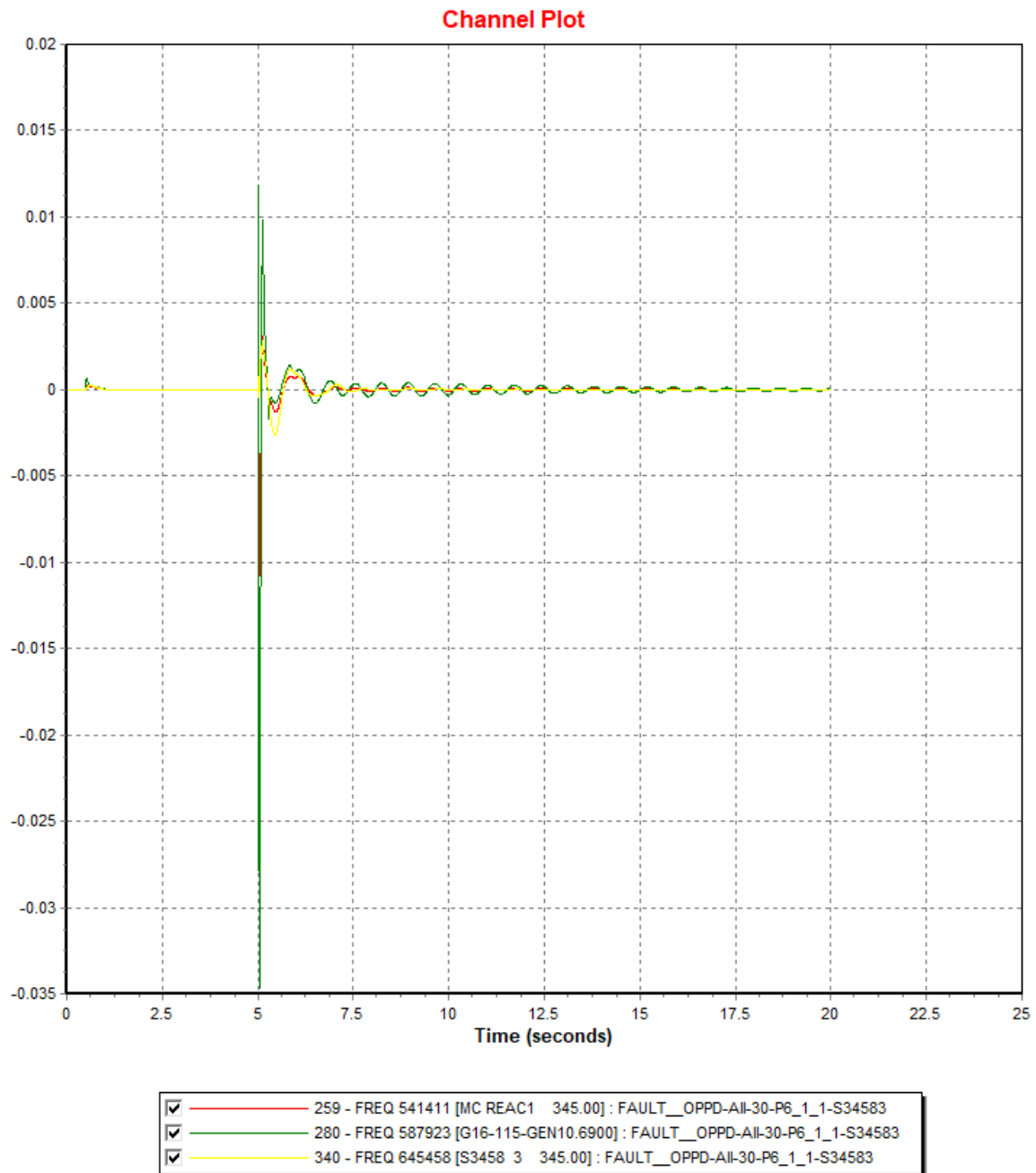


Channel Plot

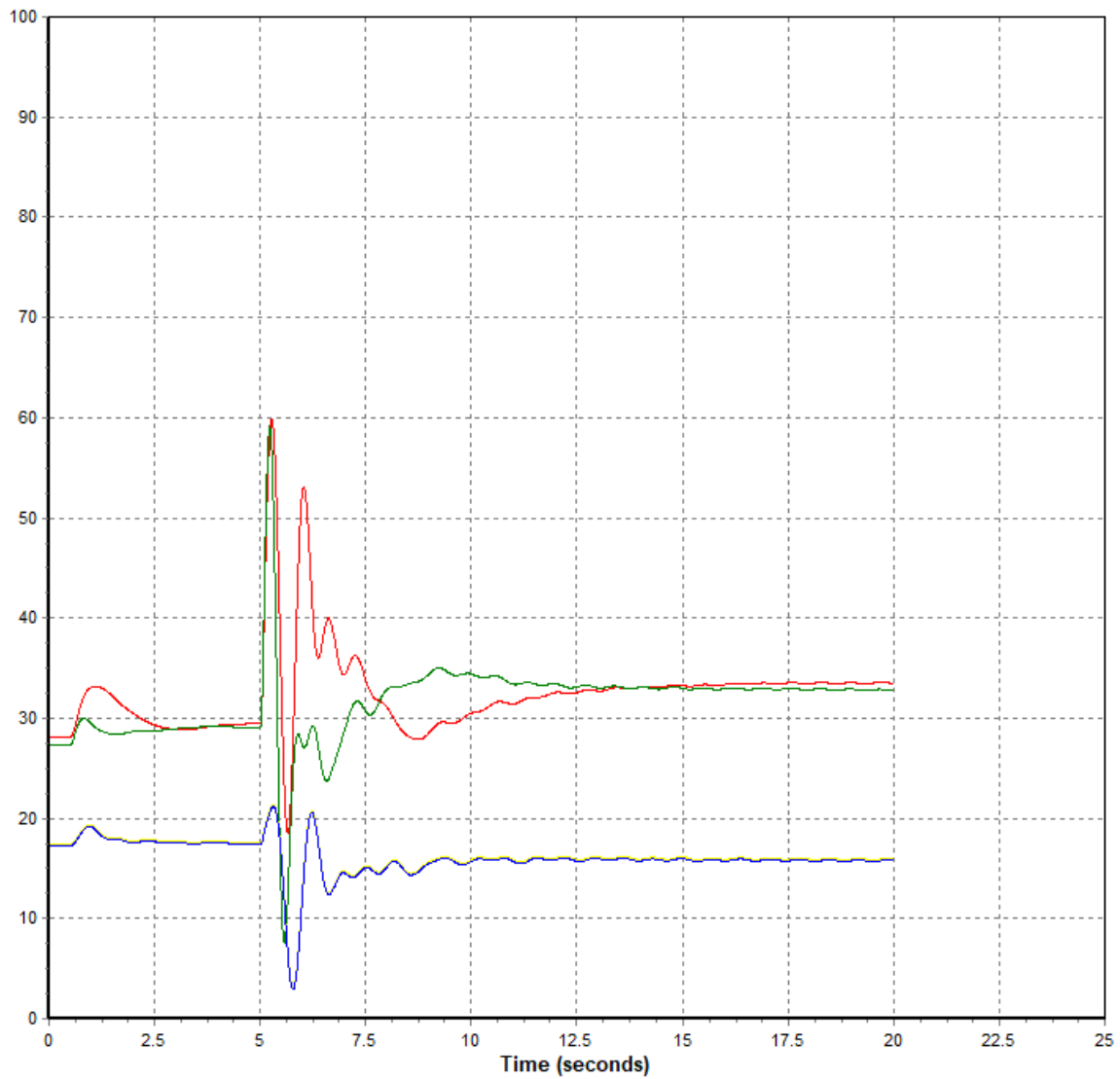


<input checked="" type="checkbox"/>	24 - ANGL645011[NEBCTY1G 18.000]1 : FAULT__OPPD-AII-22-P6_1_1-S34583
<input checked="" type="checkbox"/>	25 - ANGL645012[NEBCTY2G 23.000]2 : FAULT__OPPD-AII-22-P6_1_1-S34583
<input checked="" type="checkbox"/>	34 - ANGL645041[CASS 1G 15.000]1 : FAULT__OPPD-AII-22-P6_1_1-S34583
<input checked="" type="checkbox"/>	35 - ANGL645042[CASS 2G 15.000]2 : FAULT__OPPD-AII-22-P6_1_1-S34583





Channel Plot



<input checked="" type="checkbox"/>	24 - ANGL645011[NEBCTY1G 18.000]1 : FAULT__OPPD-AII-30-P6_1_1-S34583
<input checked="" type="checkbox"/>	25 - ANGL645012[NEBCTY2G 23.000]2 : FAULT__OPPD-AII-30-P6_1_1-S34583
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<input checked="" type="checkbox"/>	35 - ANGL645042[CASS 2G 15.000]2 : FAULT__OPPD-AII-30-P6_1_1-S34583

