

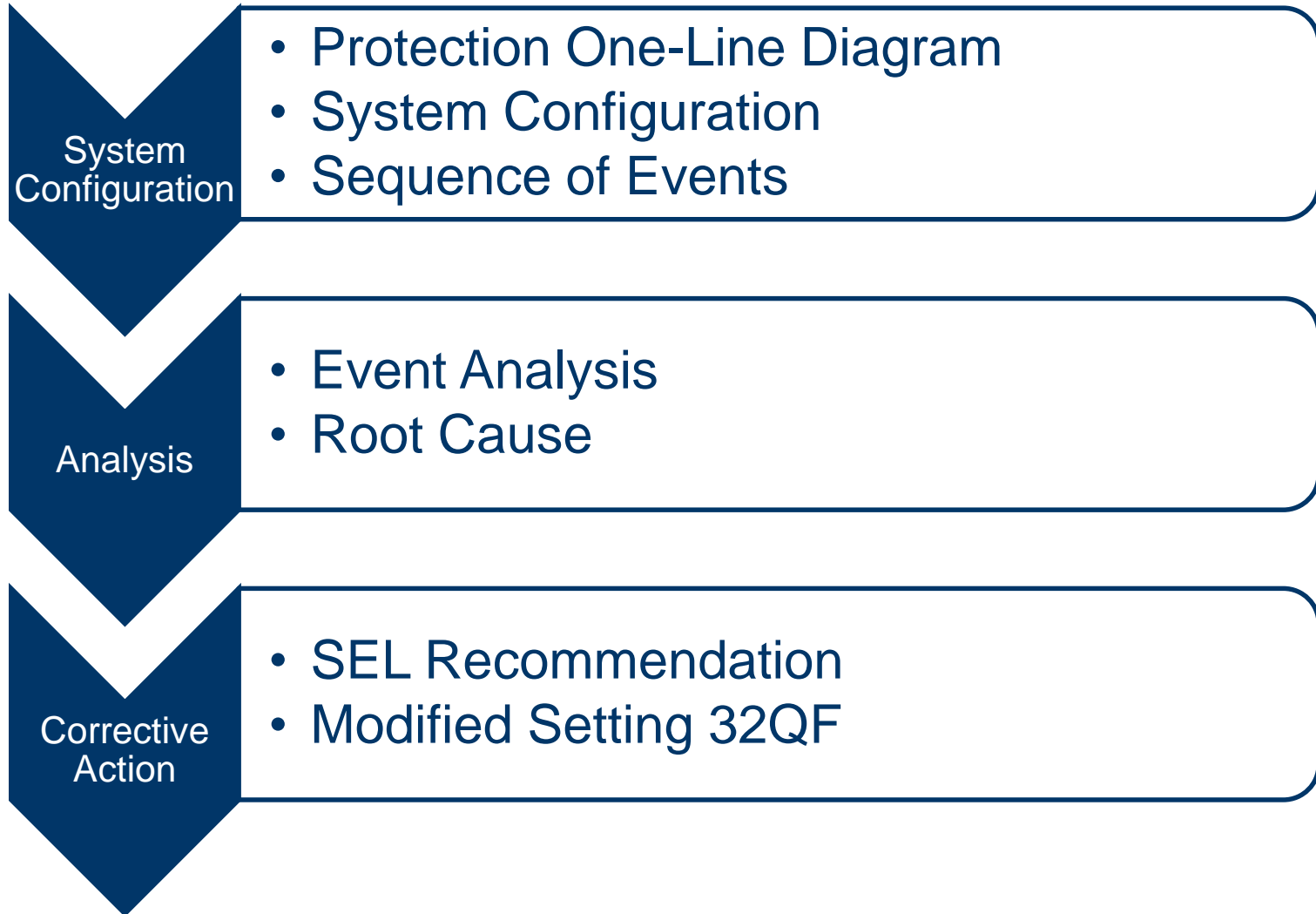
BEN 230/115 kV Autotransformer Protection System Misoperation

WECC RWG

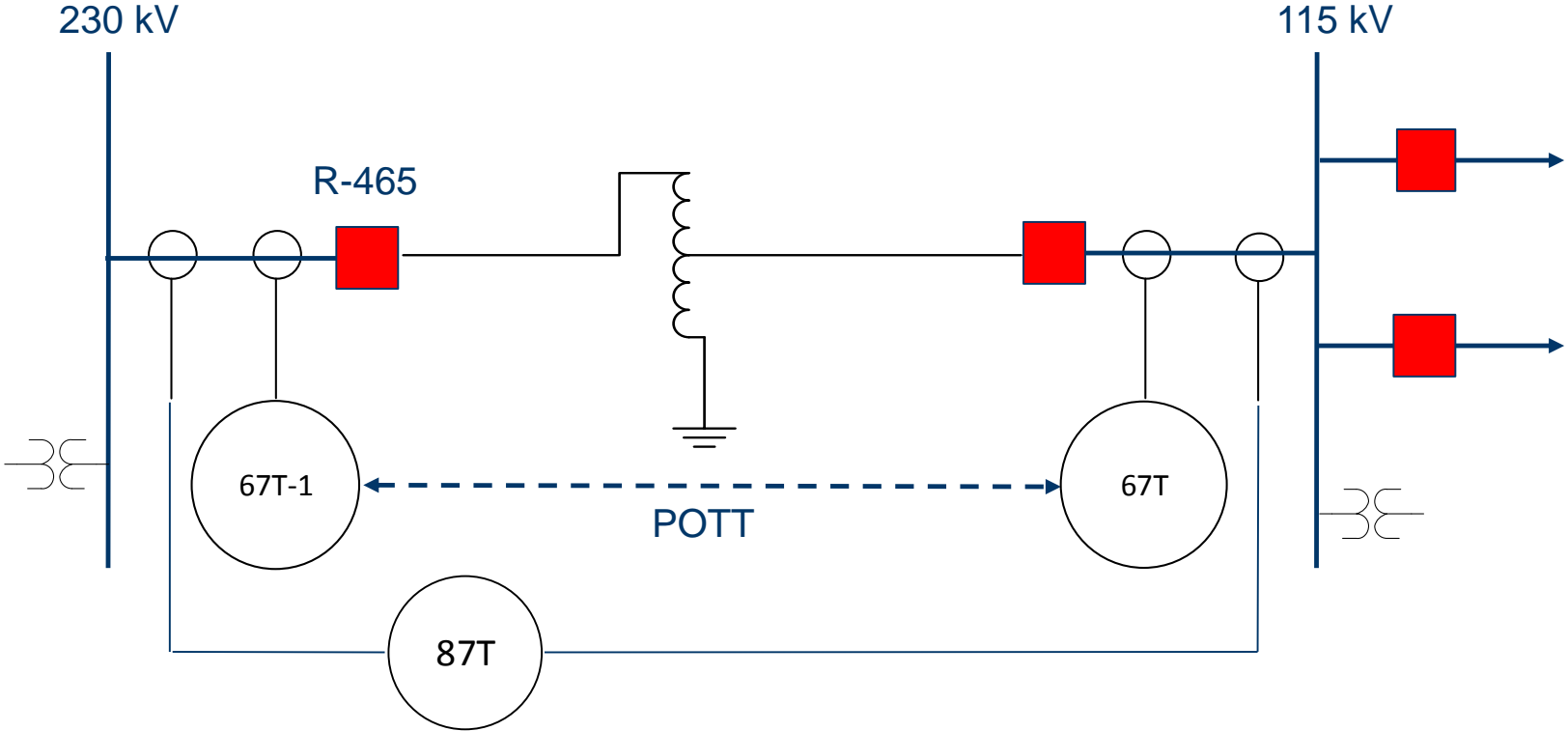
12/7/18



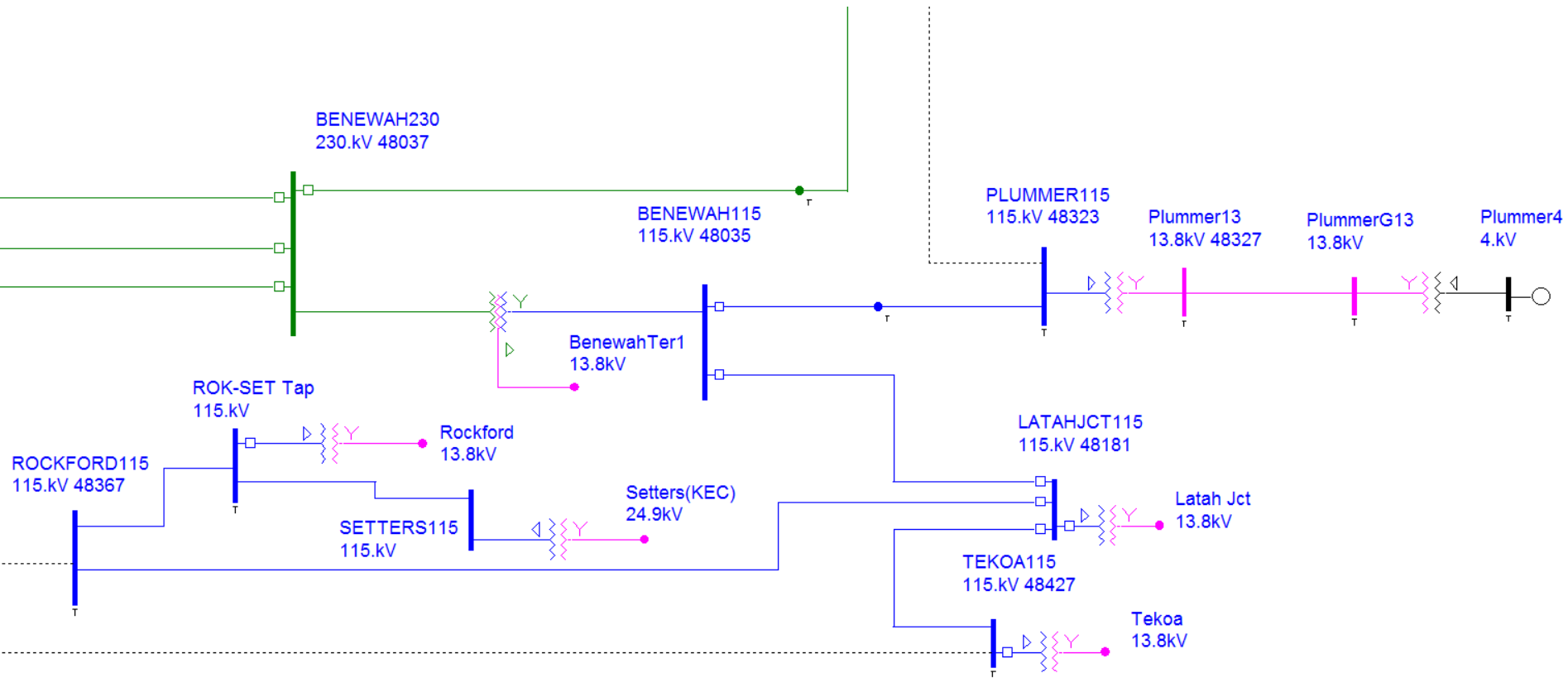
Misoperation



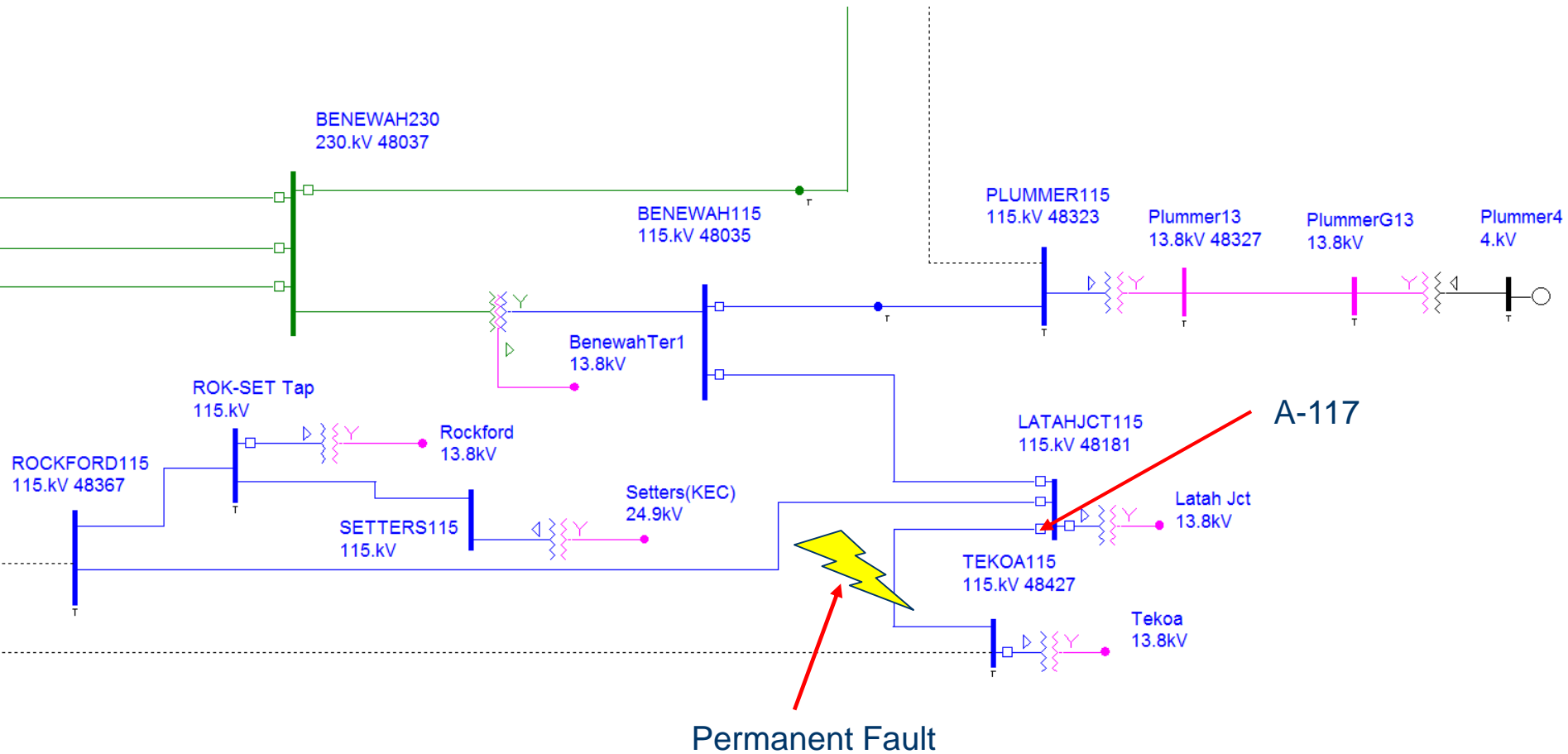
BEN Autotransformer Protection System



System Configuration



Sequence of Events



Sequence of Events

Event-Time	Field-Time	Text	Priority	Location	Category	Exception
10/31/2018 10:08:59	10/31/2018 10:08:56.655	LATAHJCT-115KV A6/A117 HL IND (BEN) DEAD LINE	4	LATAHJCT	XMISSION	S224
10/31/2018 10:08:59	10/31/2018 10:08:56.616	LATAHJCT-115KV A6 HL IND DEAD LINE	4	LATAHJCT	XMISSION	S224
10/31/2018 10:08:59	10/31/2018 10:08:56.627	LATAHJCT-115KV A117 HL IND DEAD LINE	4	LATAHJCT	XMISSION	S224
10/31/2018 10:08:59	10/31/2018 10:08:56.655	LATAHJCT-115KV HOT BUS IND DEAD BUS	4	LATAHJCT	XMISSION	S224
10/31/2018 10:08:59	10/31/2018 10:08:56.442	LATAHJCT-115KV A117 GCB OPEN	1	LATAHJCT	XMIS_BKR	S206
10/31/2018 10:08:59	10/31/2018 10:08:56.606	BENEWAH-115KV A537 HL IND DEAD LINE	4	BENEWAH	XMISSION	S224
10/31/2018 10:08:59	10/31/2018 10:08:56.571	BENEWAH-115KV A536 HL IND(OLD A535) DEAD LINE	4	BENEWAH	XMISSION	S224
10/31/2018 10:08:59	10/31/2018 10:08:56.437	BENEWAH-230KV R465 GCB OPEN	1	BENEWAH	XMIS_BKR	S206
10/31/2018 10:08:53	10/31/2018 10:08:49.754	LATAHJCT-115KV A117 HL IND HOT LINE	4	LATAHJCT	XMISSION	S202
10/31/2018 10:08:53	10/31/2018 10:08:49.631	LATAHJCT-115KV A117 GCB CLOSED	1	LATAHJCT	XMIS_BKR	S203
10/31/2018 10:08:35	10/31/2018 10:08:29.593	LATAHJCT-115KV A117 HL IND DEAD LINE	4	LATAHJCT	XMISSION	S224
10/31/2018 10:08:35	10/31/2018 10:08:29.503	LATAHJCT-115KV A117 GCB OPEN	1	LATAHJCT	XMIS_BKR	S206
10/31/2018 10:08:29	10/31/2018 10:08:27.385	LATAHJCT-115KV A117 HL IND HOT LINE	4	LATAHJCT	XMISSION	S202
10/31/2018 10:08:29	10/31/2018 10:08:27.334	LATAHJCT-115KV A117 GCB CLOSED	1	LATAHJCT	XMIS_BKR	S203
10/31/2018 10:08:27	10/31/2018 10:08:25.500	LATAHJCT-115KV A117 HL IND DEAD LINE	4	LATAHJCT	XMISSION	S224
10/31/2018 10:08:27	10/31/2018 10:08:25.206	LATAHJCT-115KV A117 GCB OPEN	1	LATAHJCT	XMIS_BKR	S206

SCADA Status with Time

Sequence of Events

SO Log

LAT 115KV A117 GCB T/R/T/R/T. This caused TKO to lose power because GAR A114 is a star point. The last reclose at LAT caused BEN R465 to trip. This de-energized the 115kv bus at LAT and the 115kv bus at BEN. A161 at PLM is a normal open point, which de-energized PLM. The A164 MOAS between 3HT and 9CE is normally open as well. ROC, HOP(IPL), MIC(IPL), SETTER(KEC), were de-energized. The fault miles was recorded at 15 miles from LAT, which puts the fault between LAT and GAR. Nick Samuals found broken insulator and glass on the ground at structure 16/2 between TKO and GAR.

Event Analysis

➤ Protection System:

- Suspect BEN breaker R-465 operation
- 67T-1 Relay History

67T-1/R-9616/20151201
BEN/R-465/AUTO #1

Date: 10/31/2018 Time: 10:39:37.087
Serial Number: 2007052317

#	DATE	TIME	EVENT	LOCAT	CURR	GRP	TARGETS
10568	10/31/2018	09:08:56.404	BG T	\$\$\$\$. \$\$	669	1	Z2_COMM B_PHASE GROUND
10567	10/31/2018	09:08:29.471	BG	\$\$\$\$. \$\$	672	1	
10566	10/31/2018	09:08:25.173	BG	\$\$\$\$. \$\$	672	1	

Event Analysis

➤ Protection System:

- 67T-1 Relay SER

10/31/2018	09:08:56.402	FORWARD DIRGROUND	ASSERTED
10/31/2018	09:08:56.402	RMTRIPSEND	ASSERTED
10/31/2018	09:08:56.404	PERMTRIPREC	ASSERTED
10/31/2018	09:08:56.404	OUT20286T1	ASSERTED
10/31/2018	09:08:56.404	OUT206BK1TC#2	ASSERTED
10/31/2018	09:08:56.414	RECDIRECTTRIP	ASSERTED
10/31/2018	09:08:56.437	BK252A CONTACT	DEASSERTED

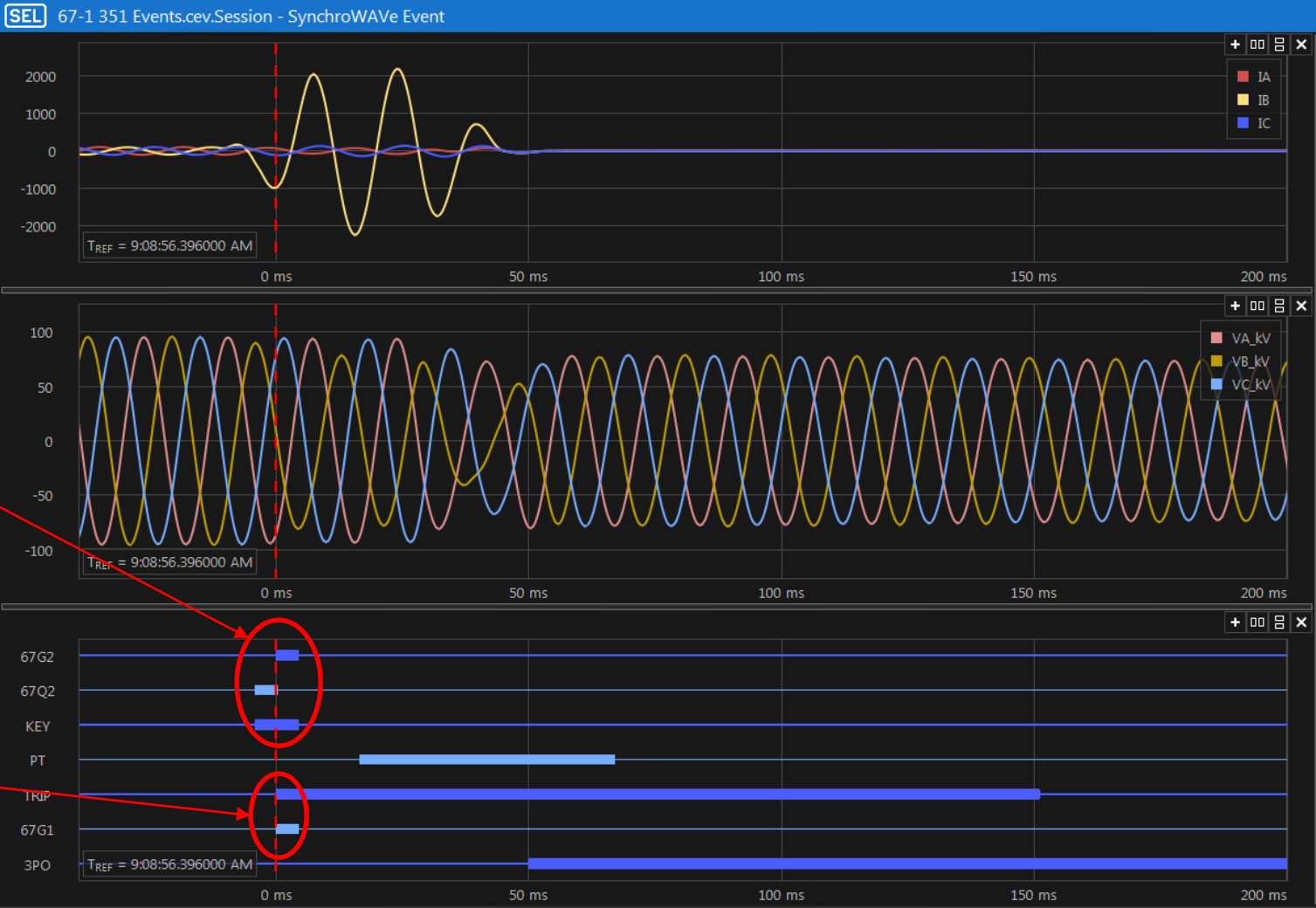
- 67T-1 Relay Trip equation evaluation

TR := M1P OR Z1G OR 67P1 OR 67G1 OR 51S1T OR 51S2T OR 51S3T
TRCOMM := (67P2 OR 67Q2 OR 67G2) AND NOT LOP

Event Analysis 67T-1



Event Analysis 67T



POTT

TRIP

Root Cause 67T

➤ Impedance Settings:

- $Z1MAG = 1.23$
- $Z1ANG = 88.10$
- $Z0MAG = 1.10$
- $Z0ANG = 88.10$

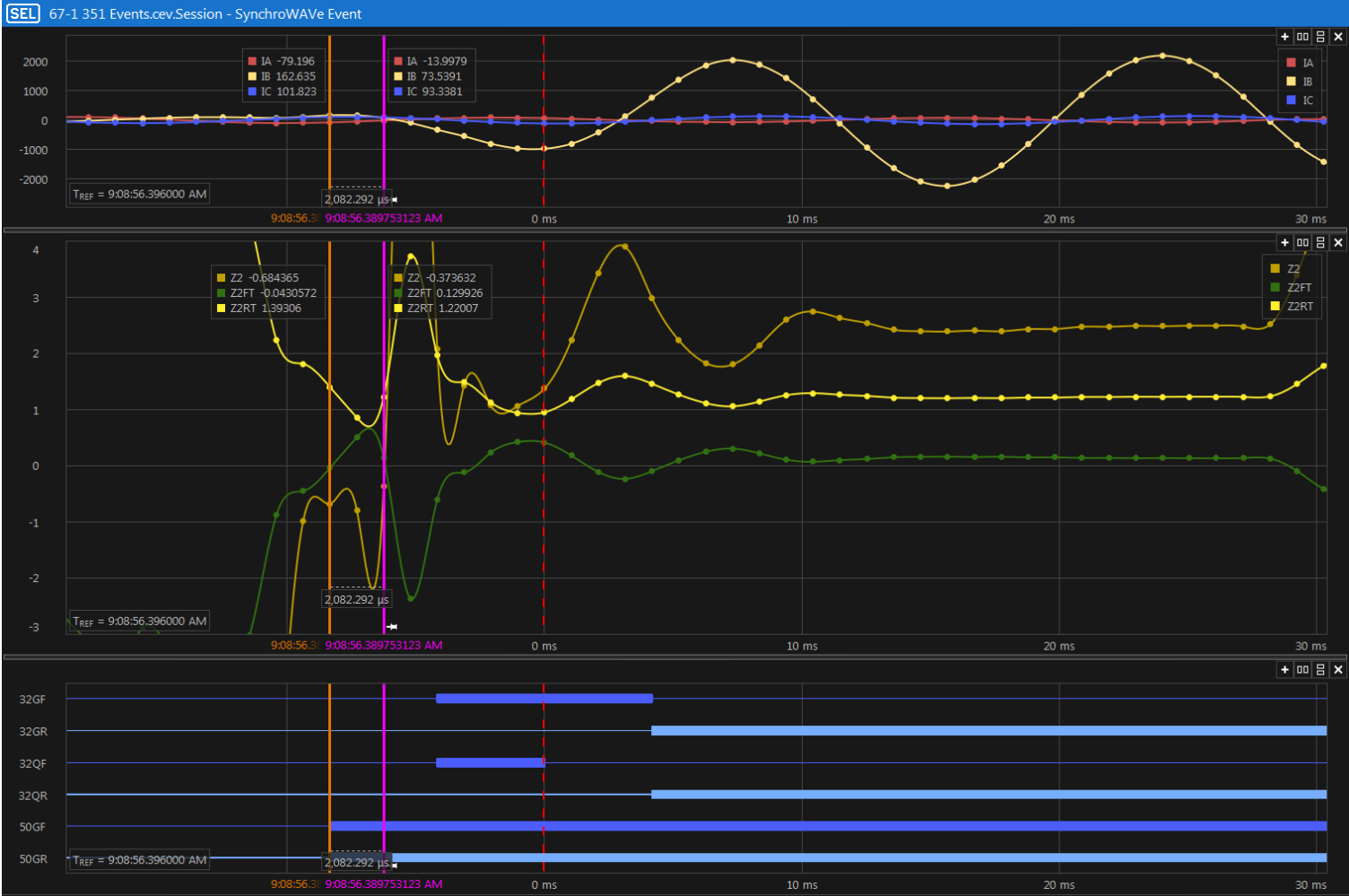
➤ Directional settings:

- $ORDER = QVI$
- $Z2F = 0.60$
- $Z2R = 0.80$
- $50QFP = 0.50$
- $50QRP = 0.25$
- $a2 = 0.10$
- $k2 = 0.20$

➤ Auto Calculation 2006

- $Z2F = 0.5 * Z1MAG$
- $Z2R = Z2F + 0.2$

Root Cause 67T



SEL Recommendation

- Fault study to determine Thevenin impedance
 - Strong source, Lowest source impedance
 - If $Z2$ equivalent < 0.5 use $0.5 * Z1MAG$ or AUTO
 - If $Z2$ equivalent > 0.5 use $Z2F = -0.3$ and $Z2R = 0.3$. For low $V2$ around 0 no forward or reverse declared. Allows for load switching and transformer energization.

Modified Setting

