Synchronous Condenser Controls Testbed using RTDS

Project Objectives

Denden Tekeste

Synchronous Condenser Replica Controls

Hardware In Loop Testbed Using RTDS

Team Members

- Dr. Om Nayak – Nayak
- Cesar Guerriero – Protection and Controls – Siemens
- Murat Sezer-System Engineer – Siemens
- Sylvain Grandidier- AVR/GCP Engineer – Siemens
- Denden Tekeste – Project Engineer- SDG&E

Background

San Onofre Nuclear Generating Station (SONGS) which had an installed capacity of 2,246 MW, was retired on June 7, 2013 and a total of about 6,100MW of generation in the LA Metro Area is also expected to retire by the end of 2020 because of compliance with the State Water Resources Control Board (SWRCB) once-through cooling (OTC) regulations.

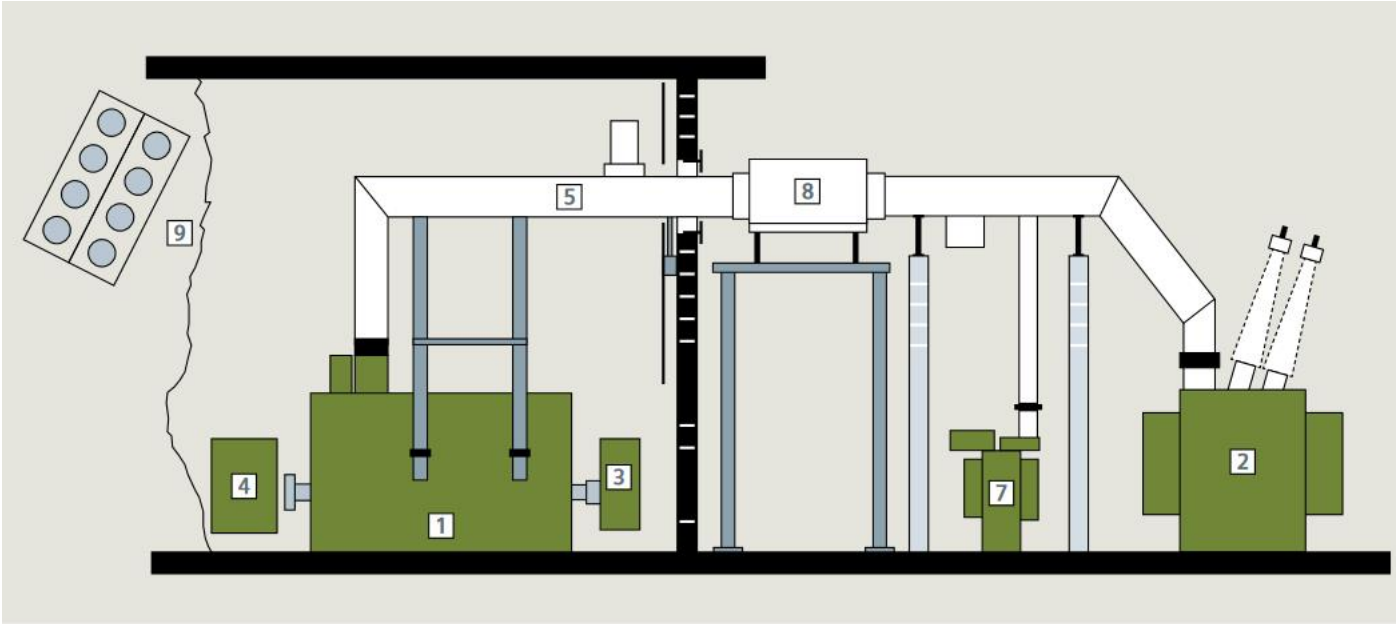
The retirement of these generating facilities will stress the existing transmission system and impact its ability to provide reliable electricity service to customers in the LA Metro and San Diego areas.

To mitigate the above impact, seven (7) 225/125MVar synchronous condensers units were approved among others Transmission generators and system grades.

Syncon Application

Its purpose is not to convert electric power to mechanical power or vice versa, but to adjust conditions on the electric power transmission grid.
Its field is controlled by a voltage regulator to either generate or absorb reactive power as needed to adjust the grid's voltage, or to improve power factor.
The condenser’s installation and operation are identical to large electric motors or generators.
Increasing the device's field excitation results in its furnishing reactive power (vars) to the system. Its principal advantage is the ease with which the amount of correction can be adjusted.
Unlike a capacitor bank, the amount of reactive power from a synchronous condenser can be continuously adjusted.

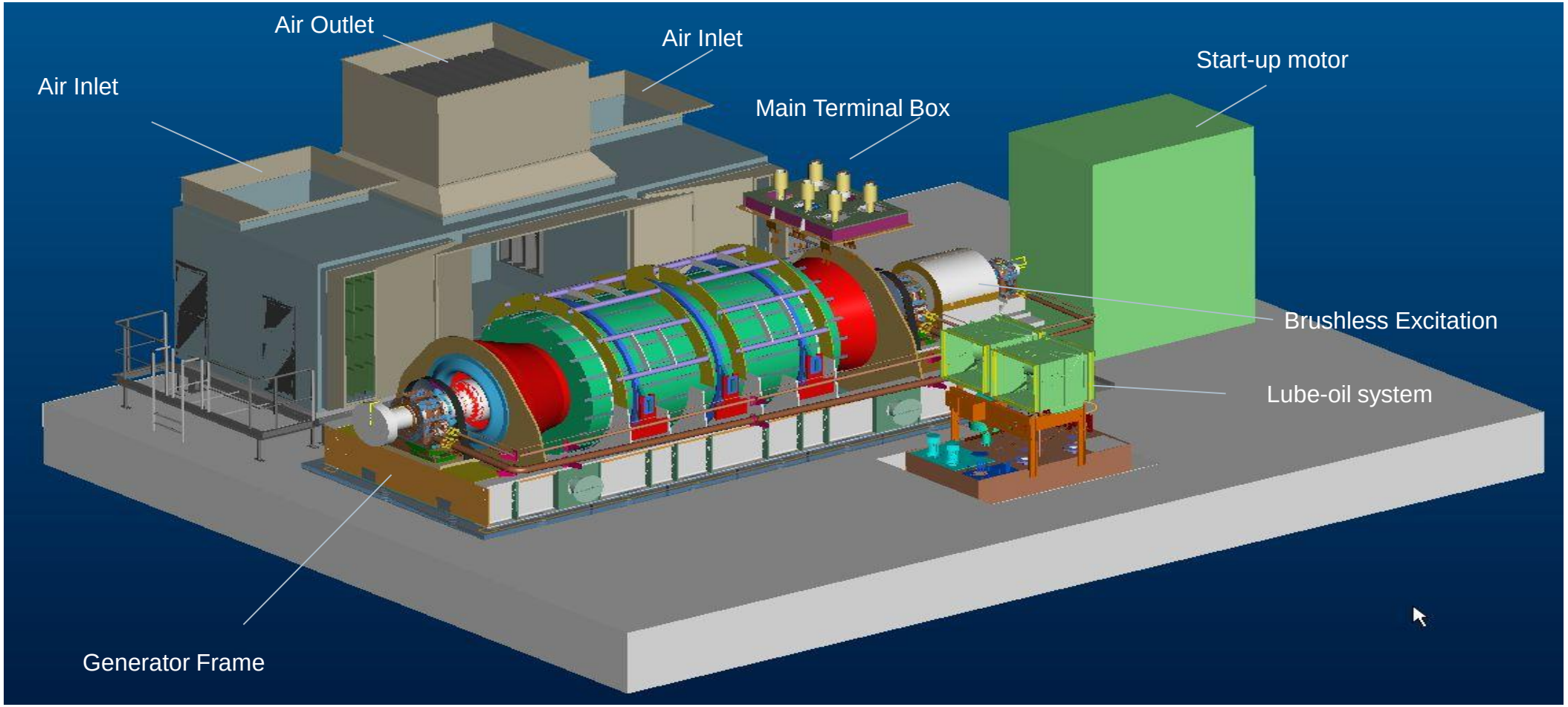
Synchronous Condenser Project Equipment



1. Synchronous generator
2. Generator step-up transformer
3. Static/brushless excitation
4. Pony motor/starting frequency converter
5. Isolated phase bus duct
6. Control and protection system
7. Auxiliary transformer
8. Generator circuit breaker
9. Optional external coolers
10. Complete civil and construction works

Siemens in-house equipment

Synchronous Condenser Components



Inside View of SDGE Plant

Benefits of Replica Controls

Compliance

Maintenance

Training

Support

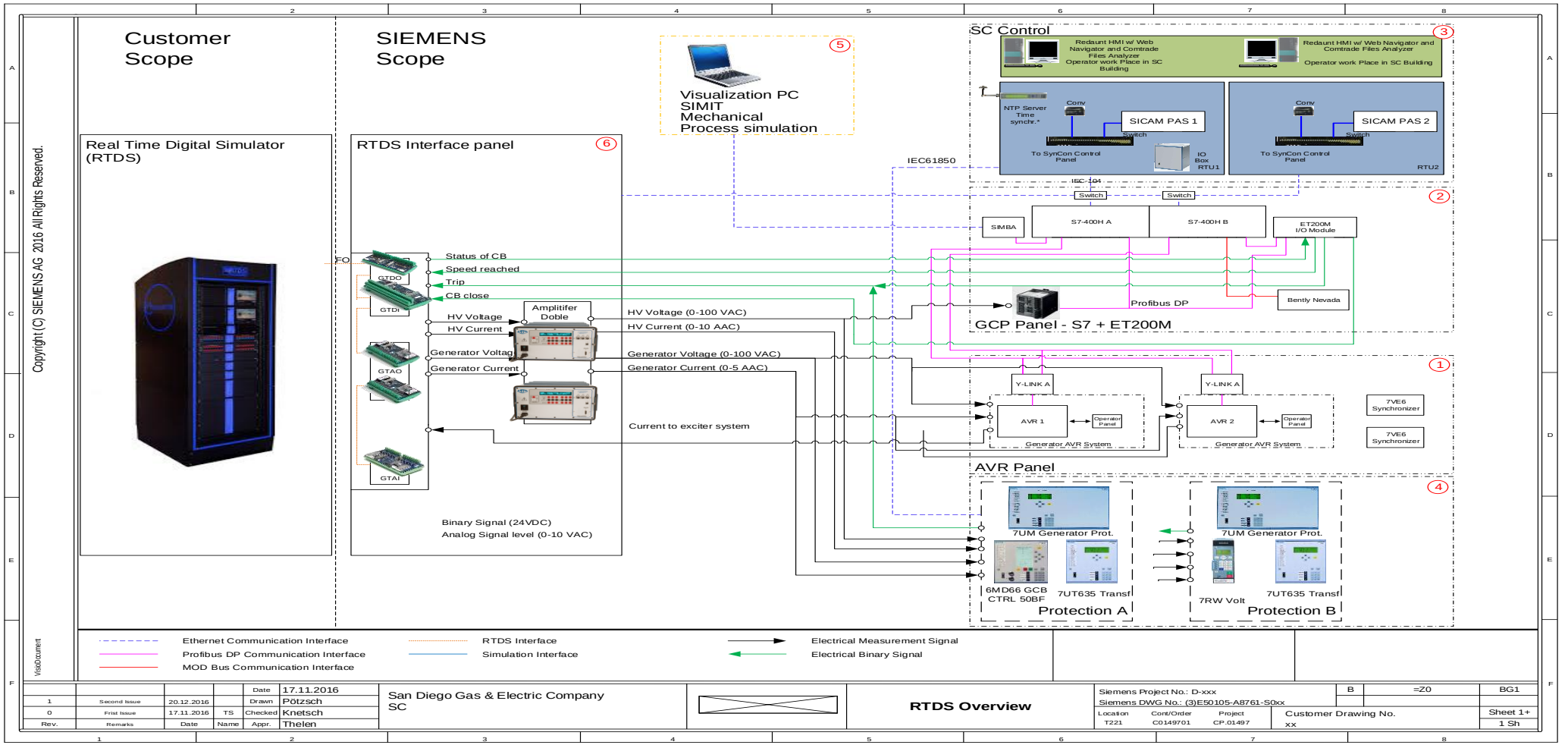
Testing

Tuning

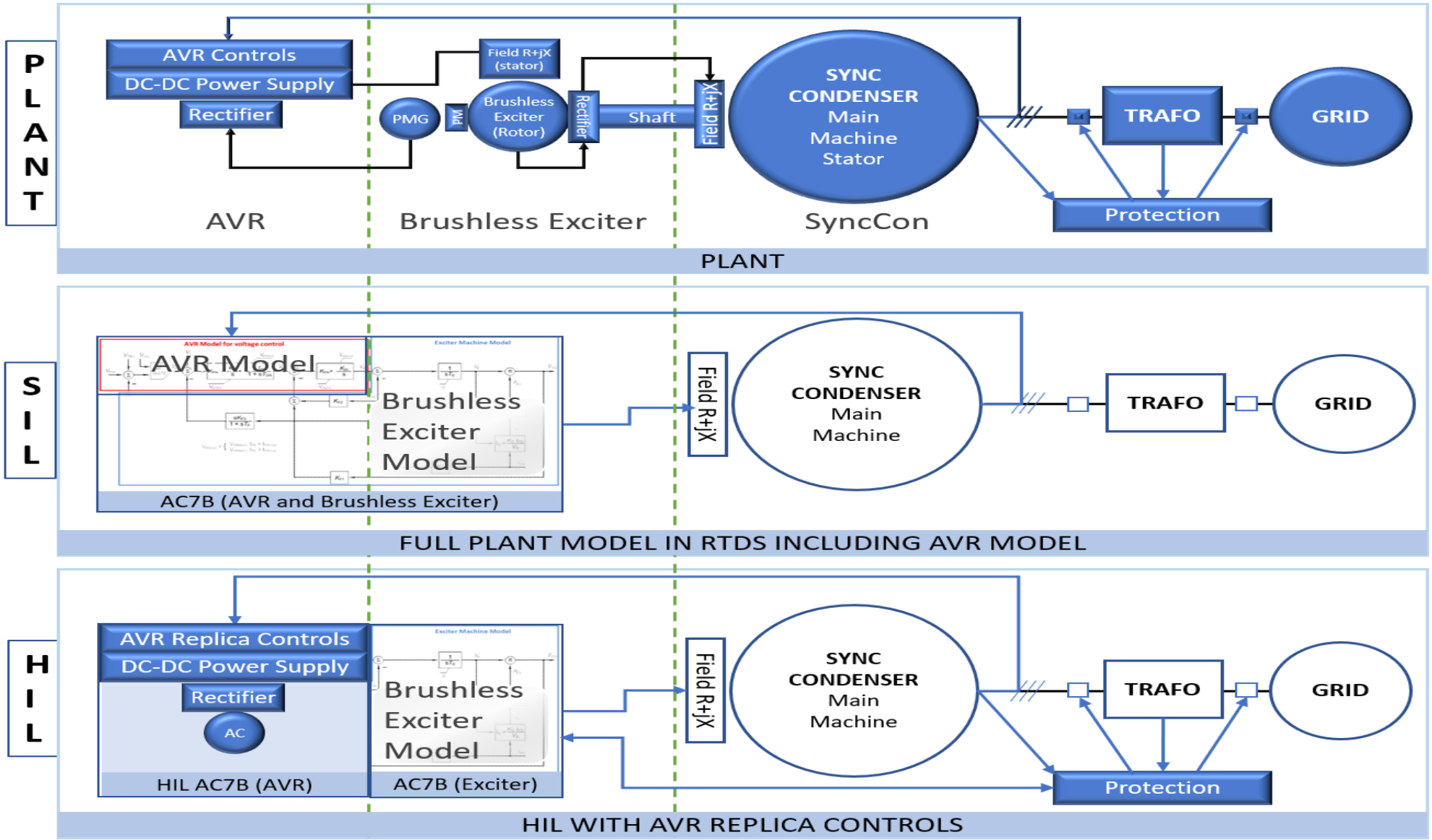
Validation

1. Patch management per NERC-CIP requirement, i.e., Firmware release testing
2. Analyze the impact of synchronous condenser related faults on the grid
3. Investigate interaction among synchronous condenser, SDG&E has 7 units now
4. Investigate impact of proposed network changes and control modifications
5. Train utility personnel on theory and operation of the condensers and its controls
6. Test upgrades and refurbishment
7. Reduce research and development time
8. Test quicker and more easily
9. Improve quality control and improve reliability
10. Do customized and exhaustive testing
11. Test protection and controls in real time

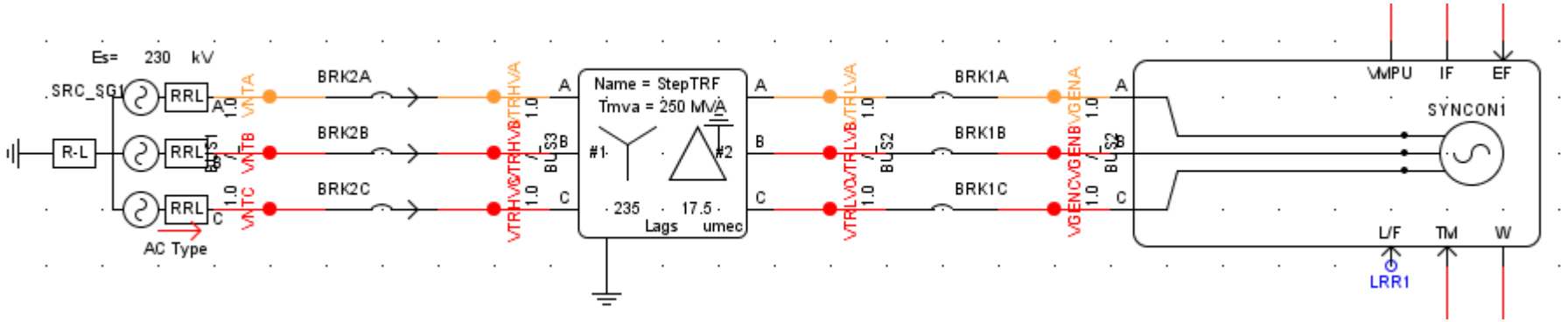
Project overview



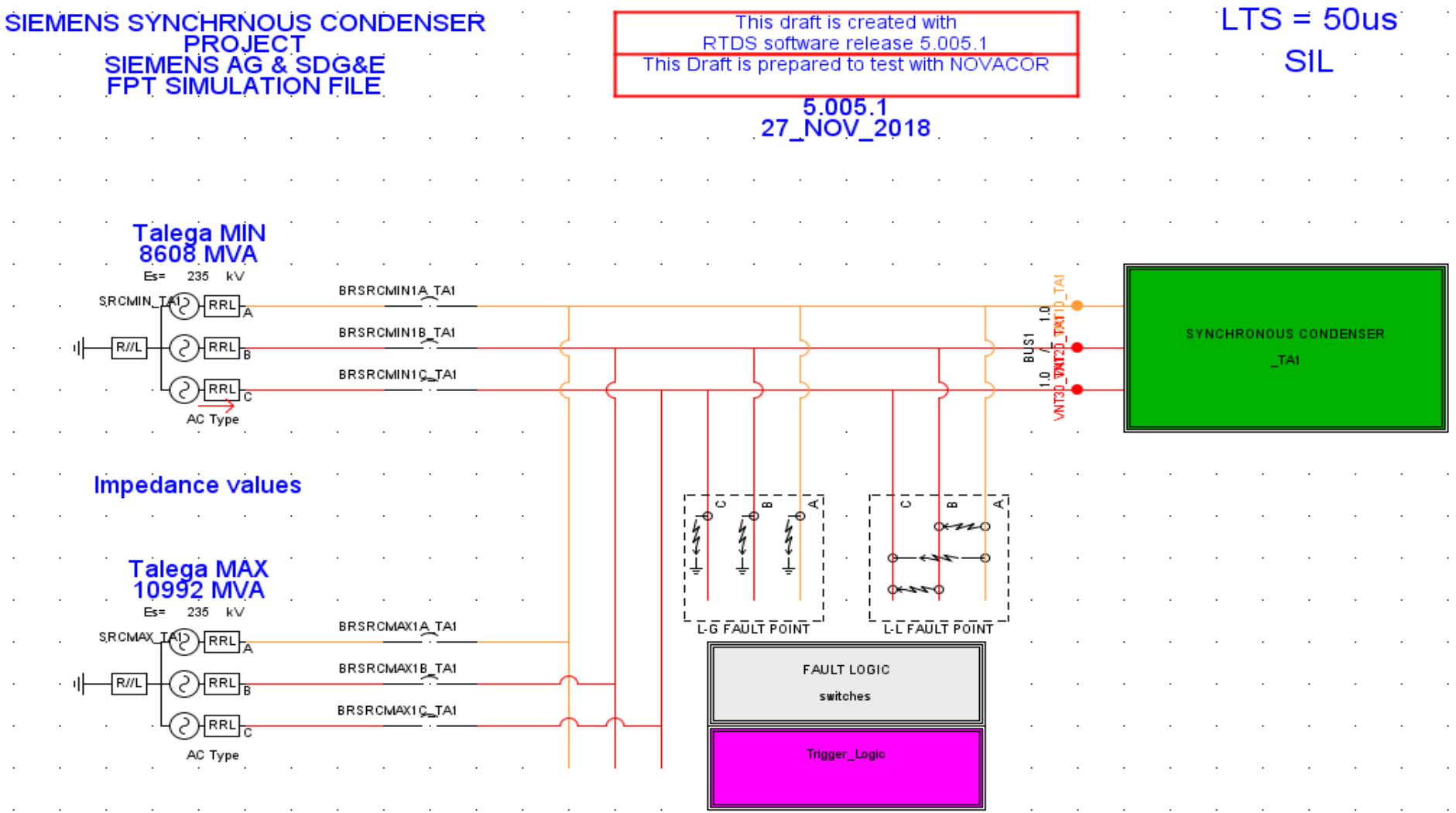
Synchronous Condenser with Brushless Exciter



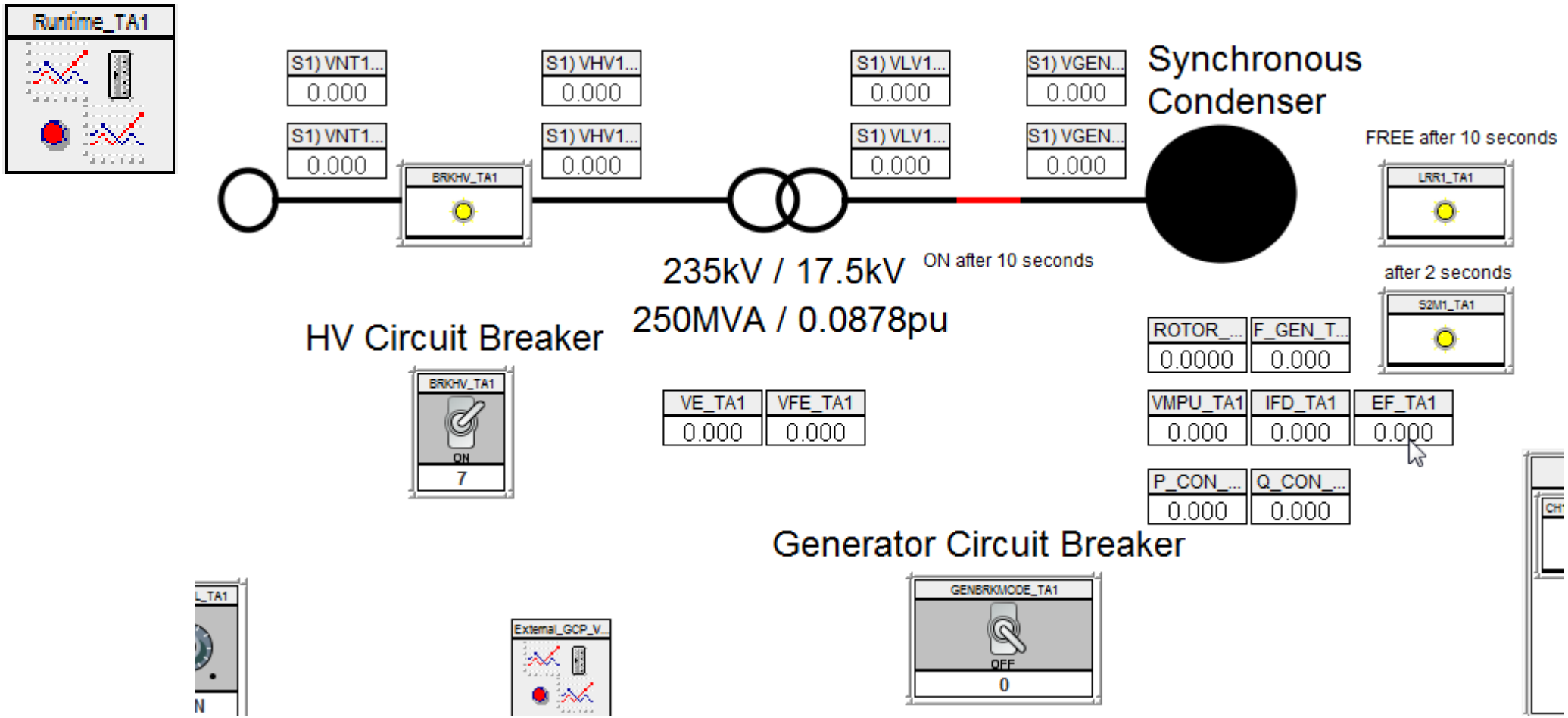
RTDS Model


Es= 230 kV
SRC_SG1
R-L
RRL
RRL
RRL
AC Type
BRK2A
BRK2B
BRK2C
Name = StepTRF
Tmva = 250 MVA
#1
#2
235
17.5
Lags
umec
BRK1A
BRK1B
BRK1C
VMPU
IF
EF
SYNCON1
LF
TM
W
LRR1

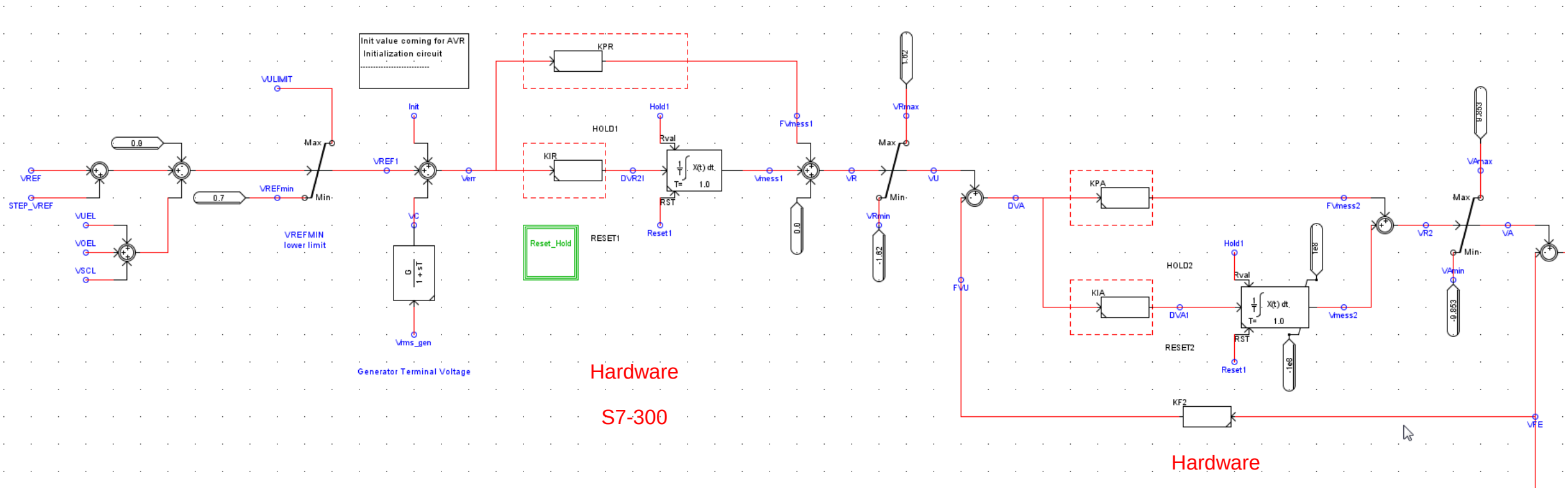
SYNCON DRAFT FILE



Talega_1 Runtime File



AVR Controls



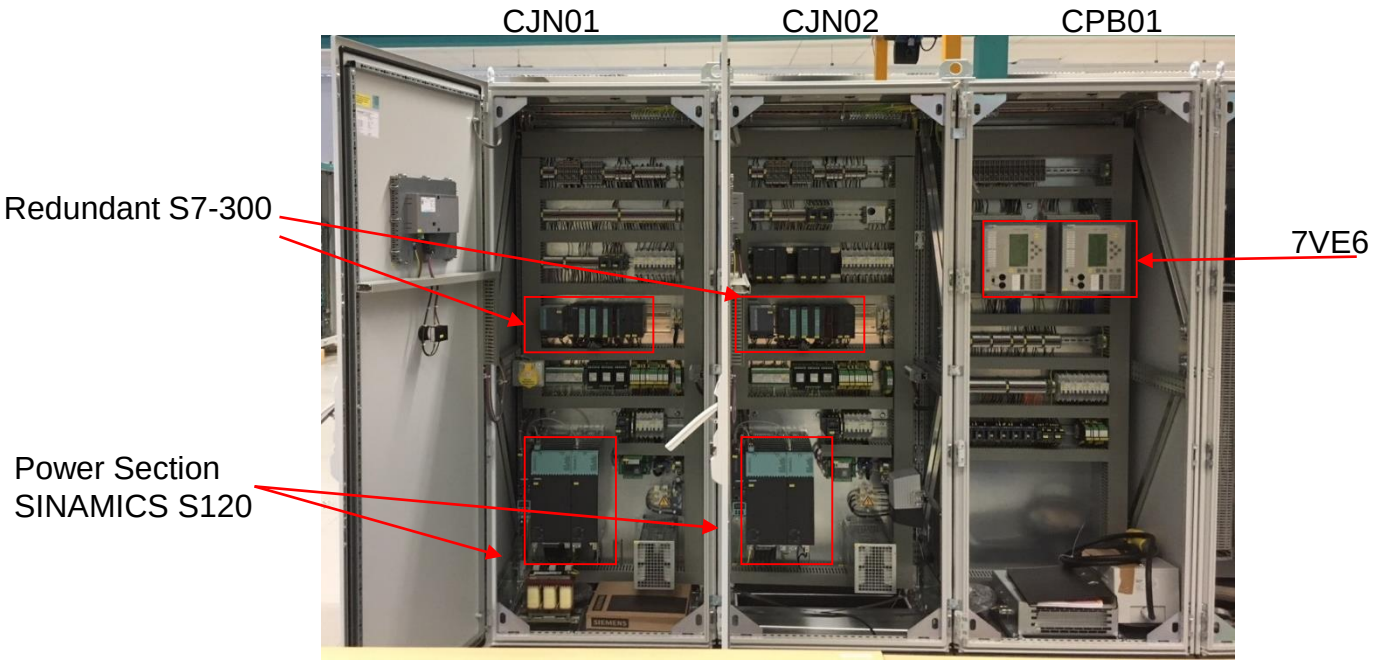
Hardware

S7-300

Hardware

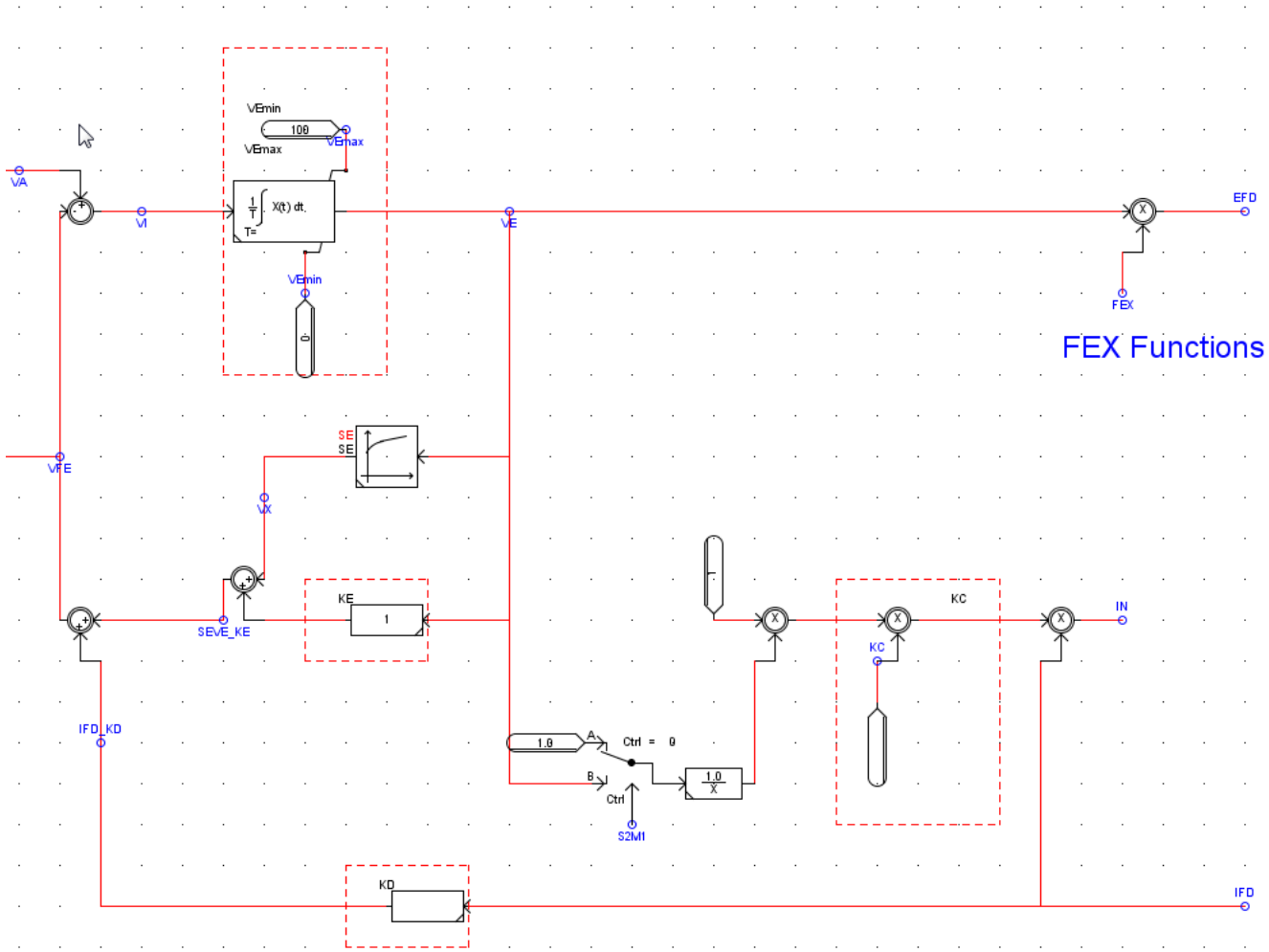
SINAMICS

AVR CARBINET



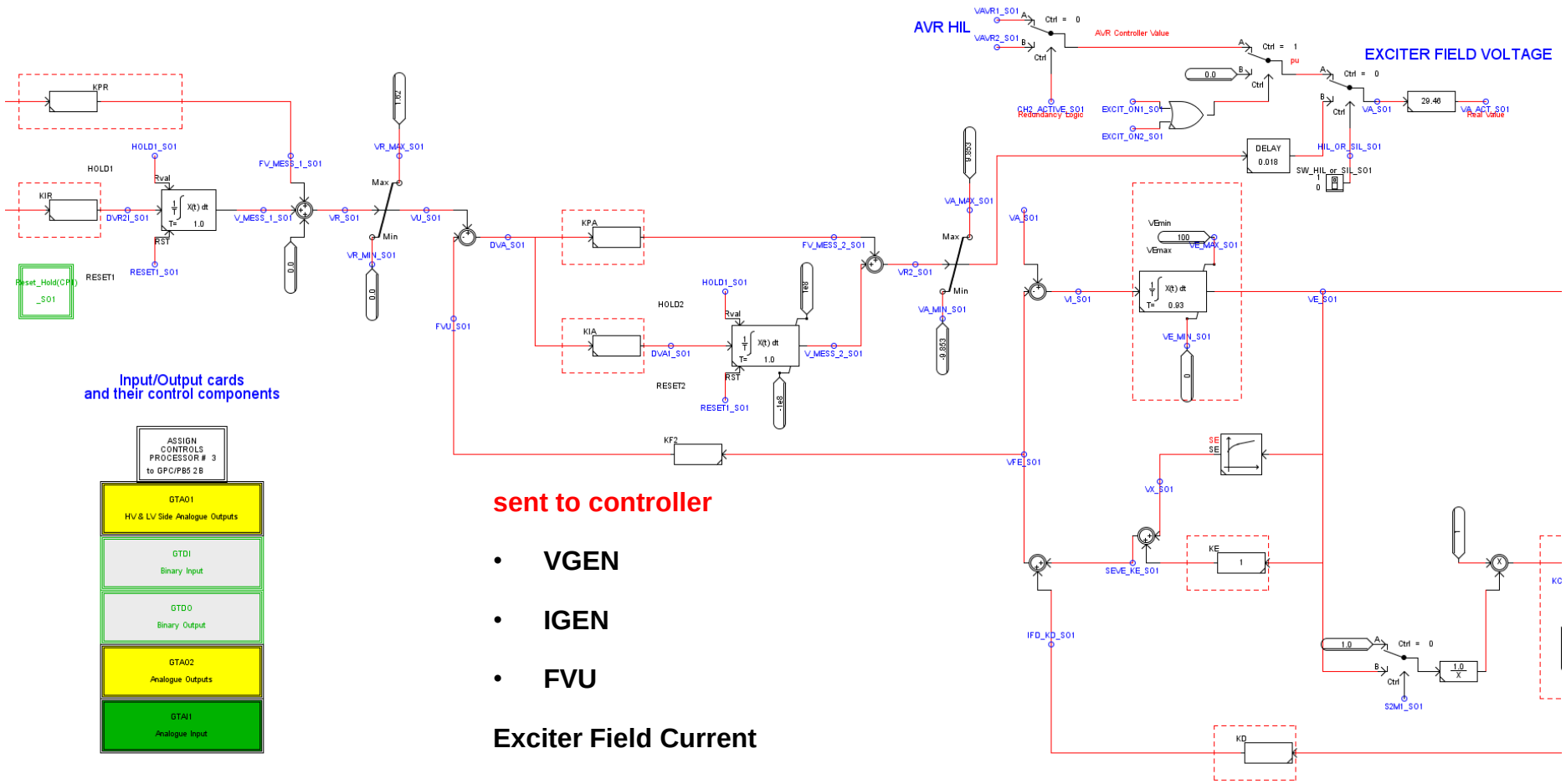
- Each cabinet CJN01 and CJN02 contains an AVR channel.
- Each channel has its own measurement evaluation unit for generator terminal voltage and generator terminal current, its own S7 300 processor unit where the voltage control is implemented and its own SINAMICS S120 power section
- The Cabinet CPB01 contains the synchronization device 7VE6 used to synchronize the frequencies and voltages of the generator and the HV system

Exciter Model



This part is representing excitation machine, and the same for SIL and HIL models

SIL Test Model



sent to controller

- **VGEN**
- **IGEN**
- **FVU**

Exciter Field Current

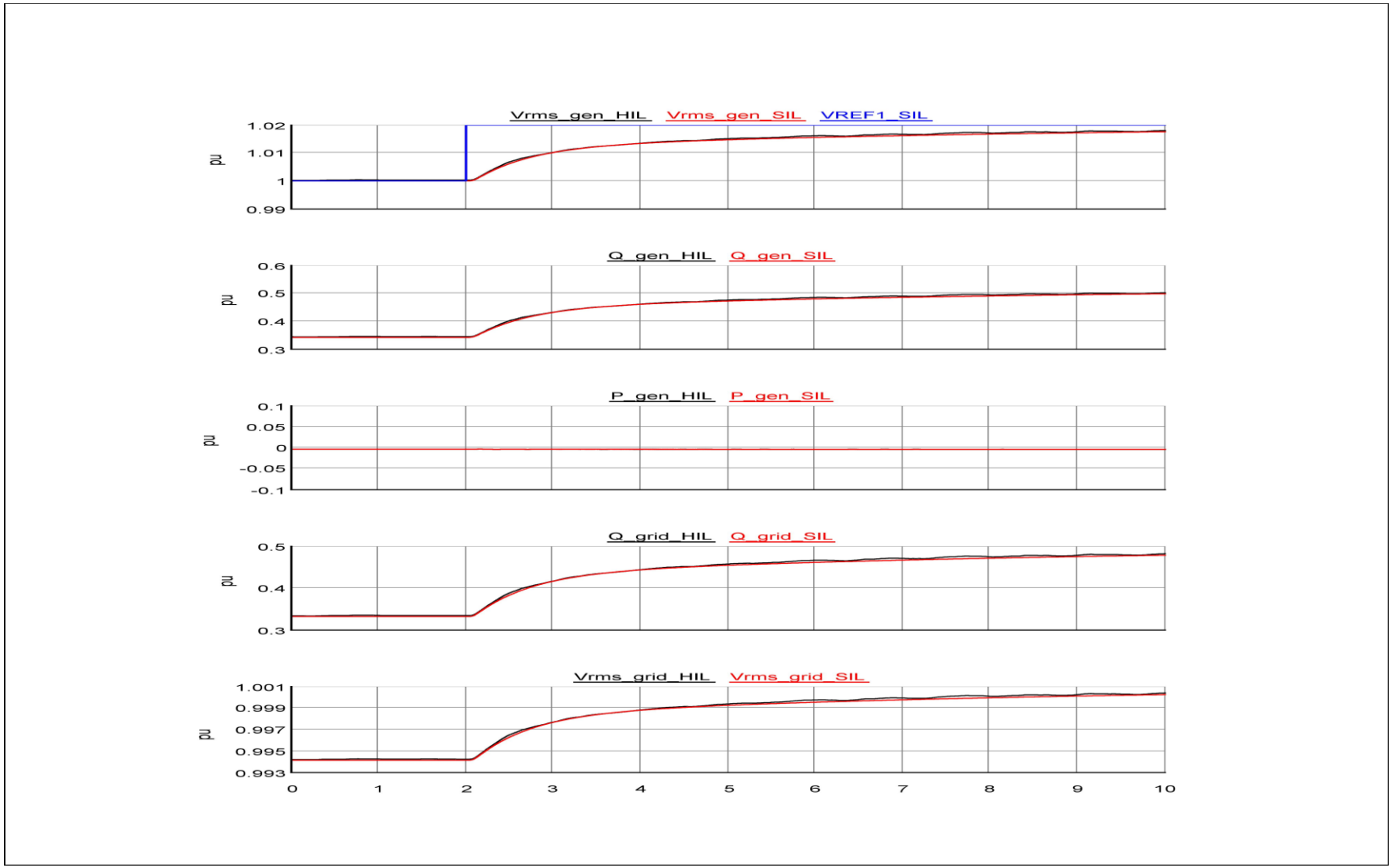
received from controller

- **VA**

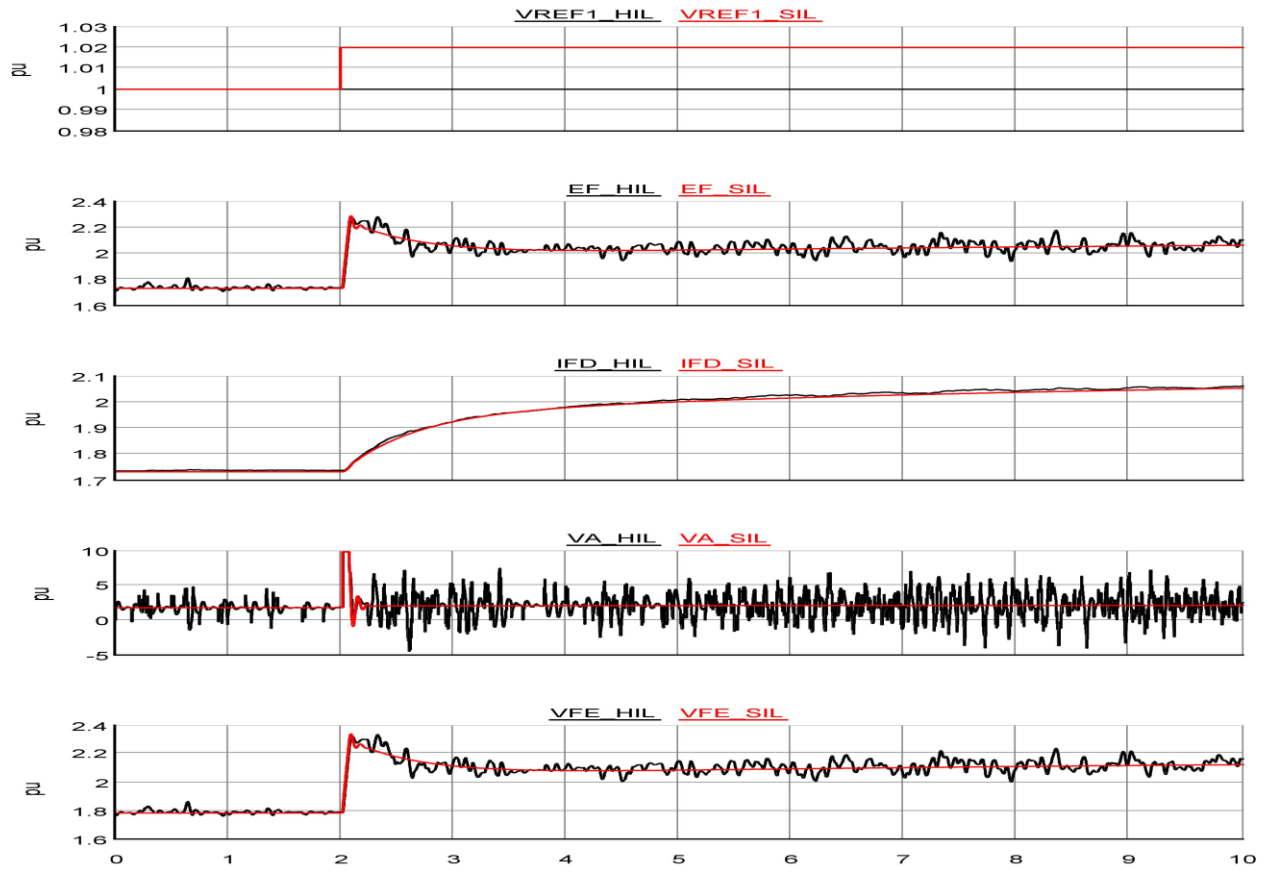
Exciter Field Voltage

Online Step Change

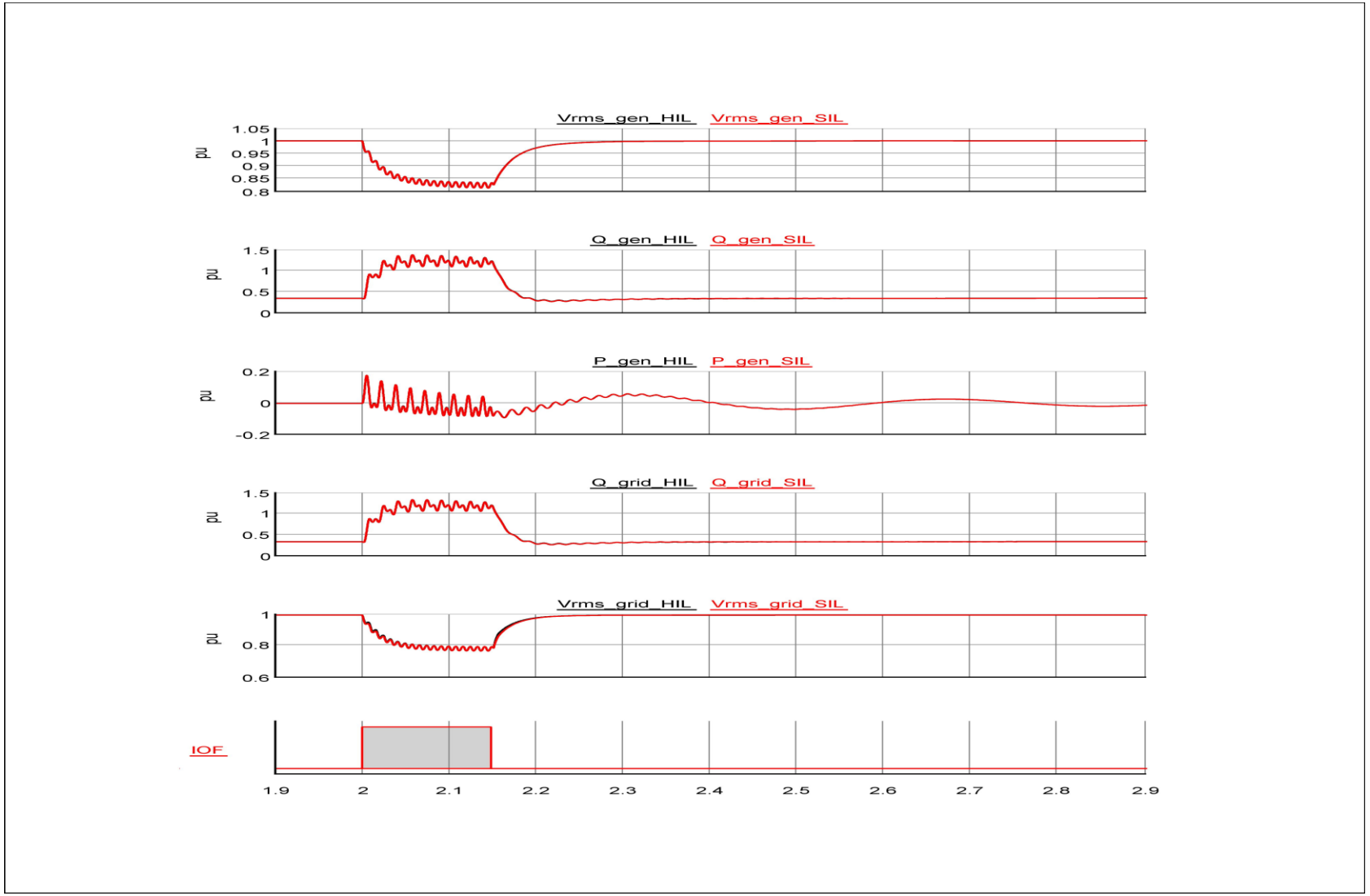
Close Match Between SIL and HIL Results



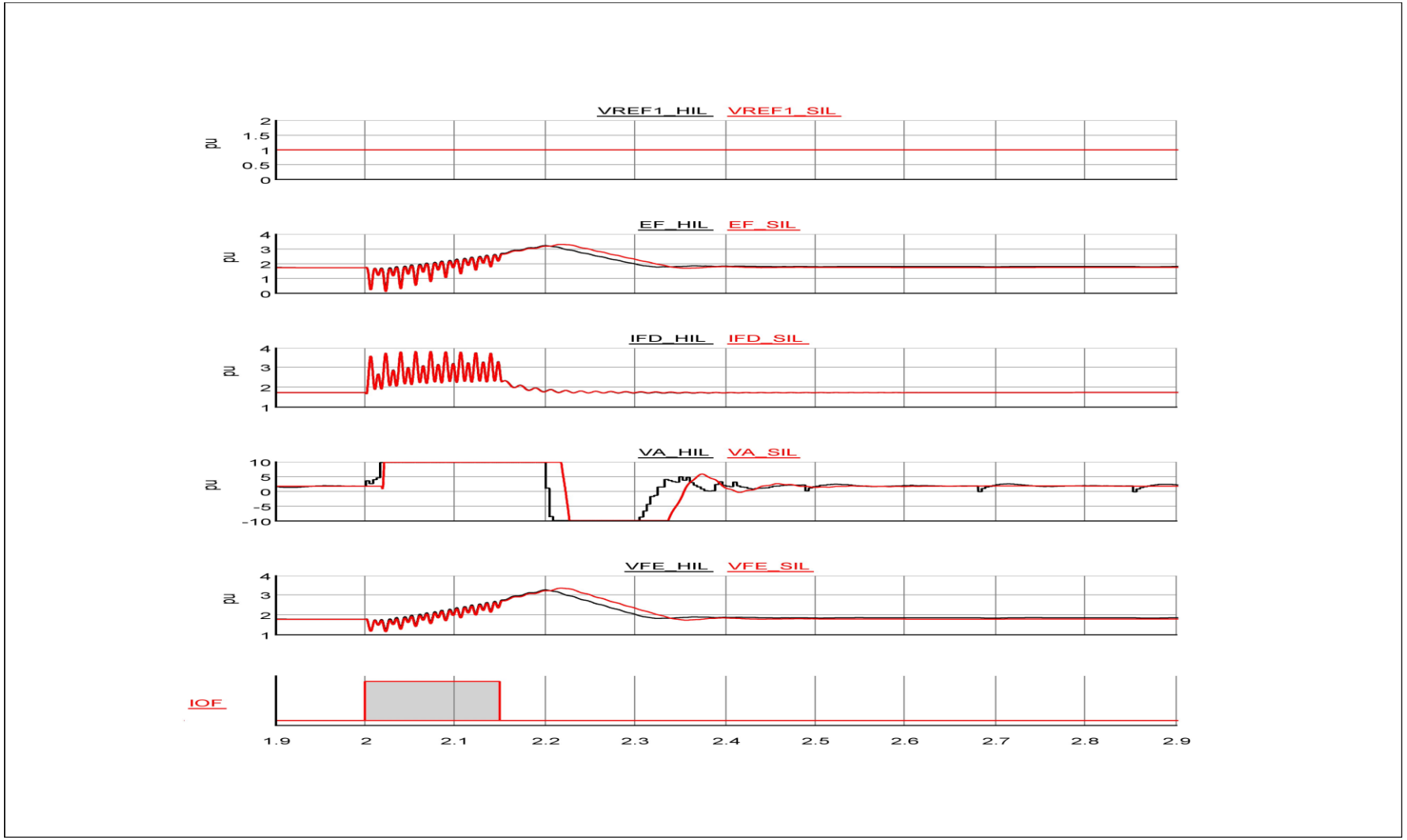
Online Step Change



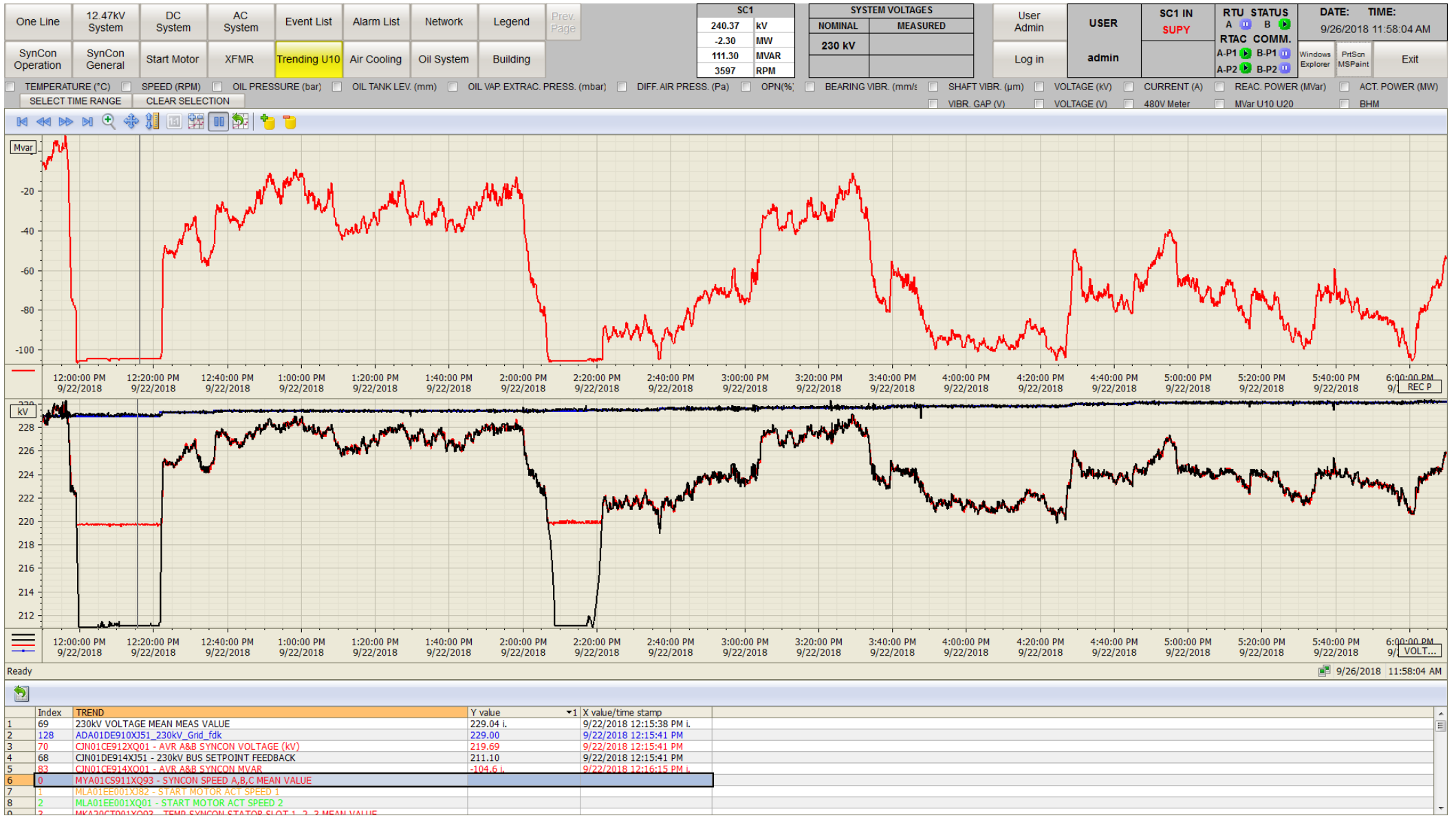
Three phase fault

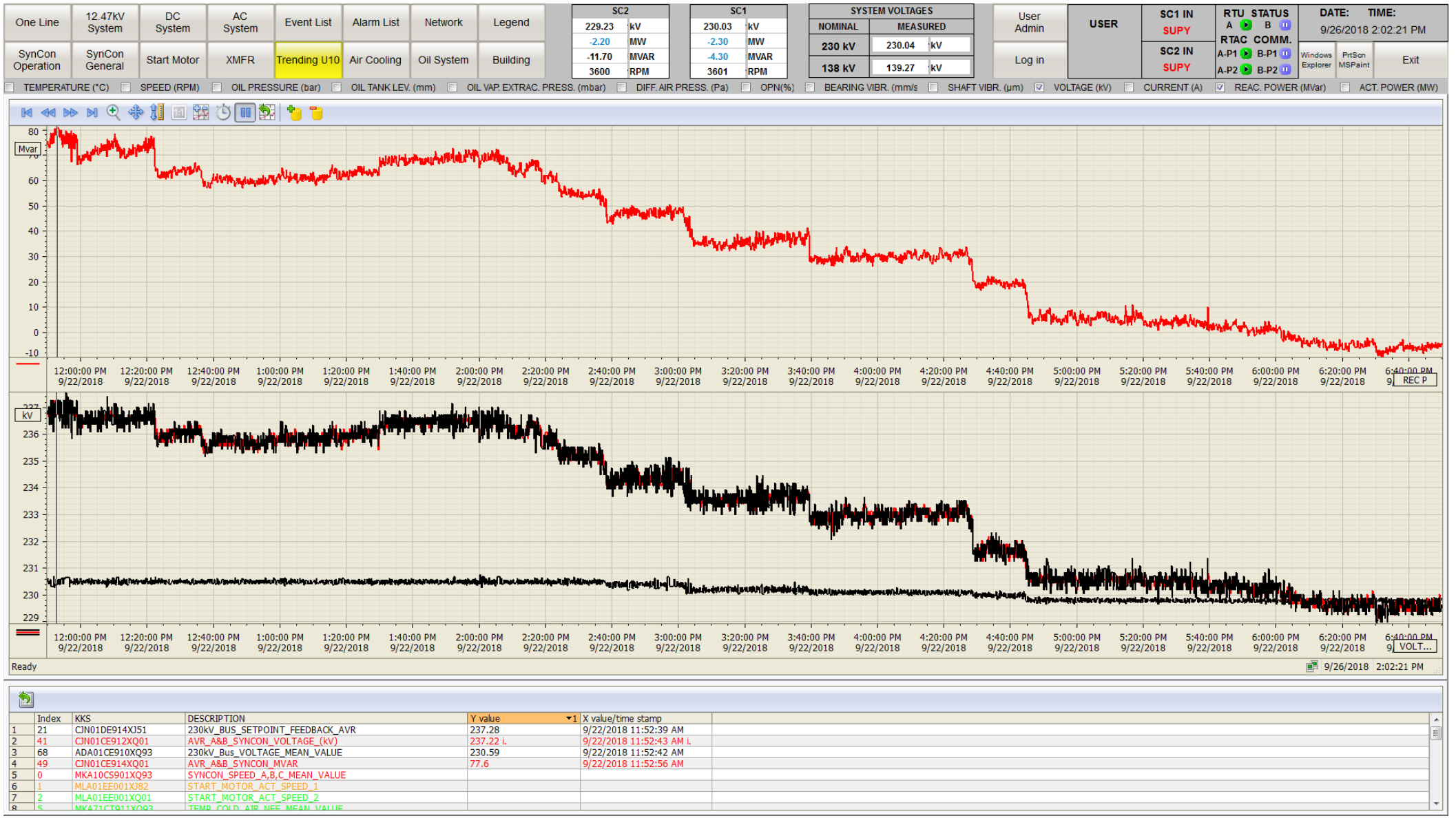


Three phase fault



Significant Reactive Power Shift Upon a Small Change in Reference





	Index	KKS	DESCRIPTION	Y value	X value/time stamp
1	21	CJN01DE914XJ51	230kV_BUS_SETPOINT_FEEDBACK_AVR	237.28	9/22/2018 11:52:39 AM
2	41	CJN01CE912XQ01	AVR_A&B_SYNCON_VOLTAGE_(kV)	237.22 i.	9/22/2018 11:52:43 AM i.
3	68	ADA01CE910XQ93	230kV_Bus_VOLTAGE_MEAN_VALUE	230.59	9/22/2018 11:52:42 AM
4	49	CJN01CE914XQ01	AVR_A&B_SYNCON_MVAR	77.6	9/22/2018 11:52:56 AM
5	0	MKA10CS901XQ93	SYNCON_SPEED_A,B,C_MEAN_VALUE		
6	1	MLA01EE001XJ82	START_MOTOR_ACT_SPEED_1		
7	2	MLA01EE001XQ01	START_MOTOR_ACT_SPEED_2		
8	5	MKA71CT911XQ93	TEMP_COLD_AIR_NEE_MEAN_VALUE		

QUESTIONS?