

# Users Manual

## AQ-SIM F215

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# 1 AQ-SIM F215 SIMULATOR

AQ-SIM F215 simulates basic outgoing feeder protection and control application.



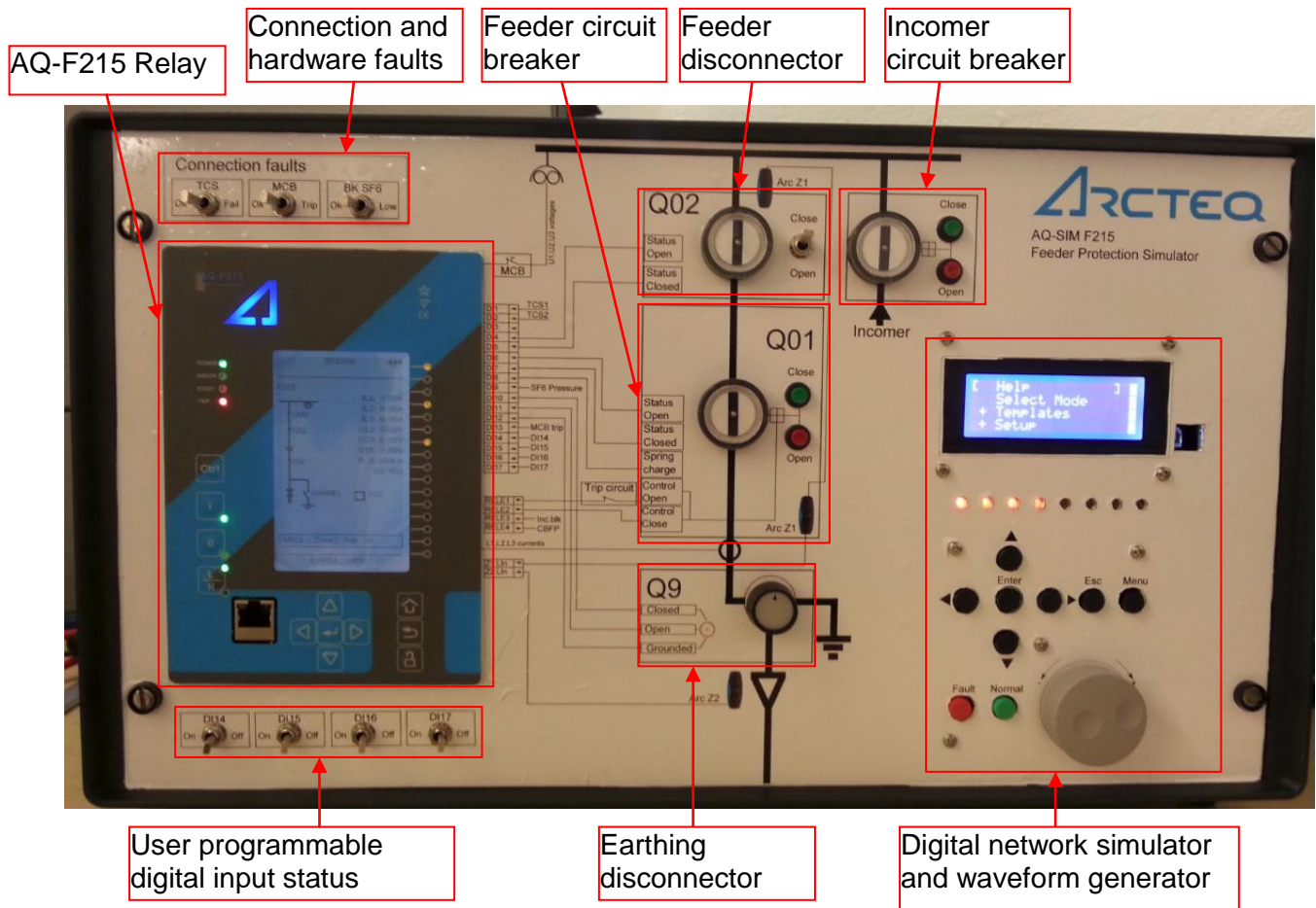
In the picture above is presented the front side of the simulator. Simulator consists of protection relay, feeder protection model and simulator unit.

Simulator includes voltage and current measurements for the relay. Also incomer breaker, bus disconnector, feeder breaker and feeder earthing disconnector are modelled. Simulator takes care of correct current and voltage feedings based into the feeder switch arrangements. In the simulator are pre programmed faults (Overcurrent, feeder arc fault, bus arc fault, current unbalance, earthfault and user programmed fault) as well as hardware faults (broken trip circuit, voltage measurement fuse fault, and breaker SF6 pressure alarm) which can be applied to relay and so demonstrate the relay operations.

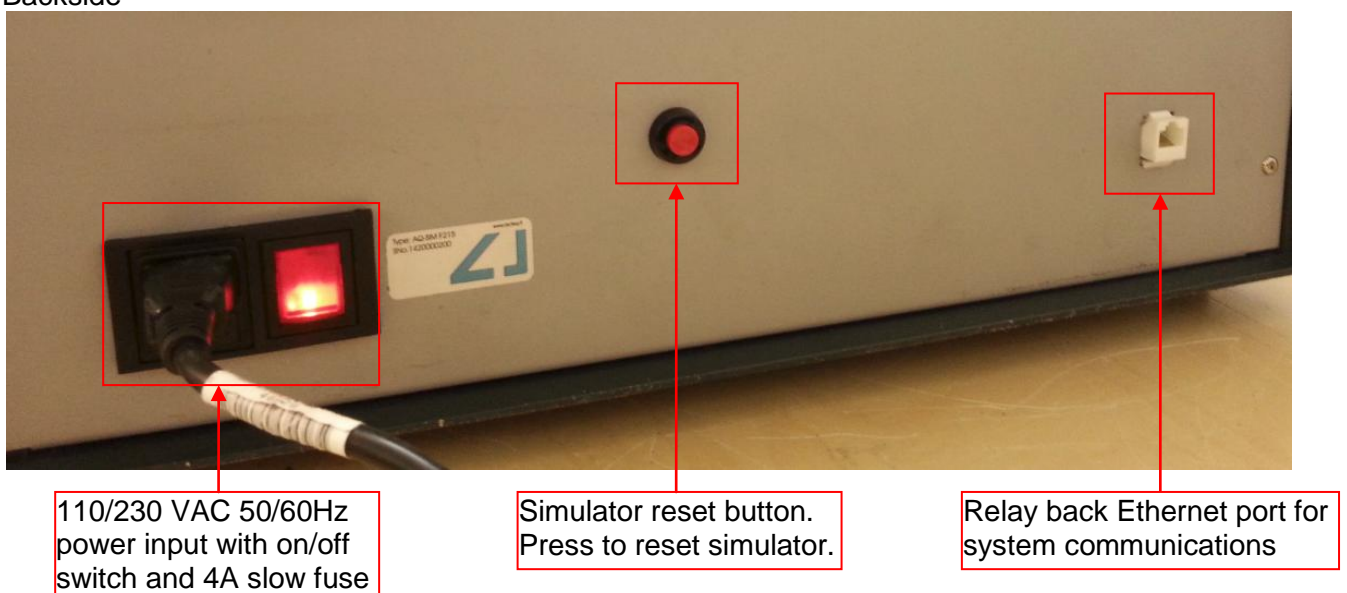
Simulator is full digital design so it can be upgraded easily to match different requirements. Factory defaults can be modified in the simulator menus by user. When the simulator is powered off the simulator will be reset to factory defaults allowing always the same starting point for the users in case if the simulator setting is gone wrong.

## 2 SIMULATOR PARTS

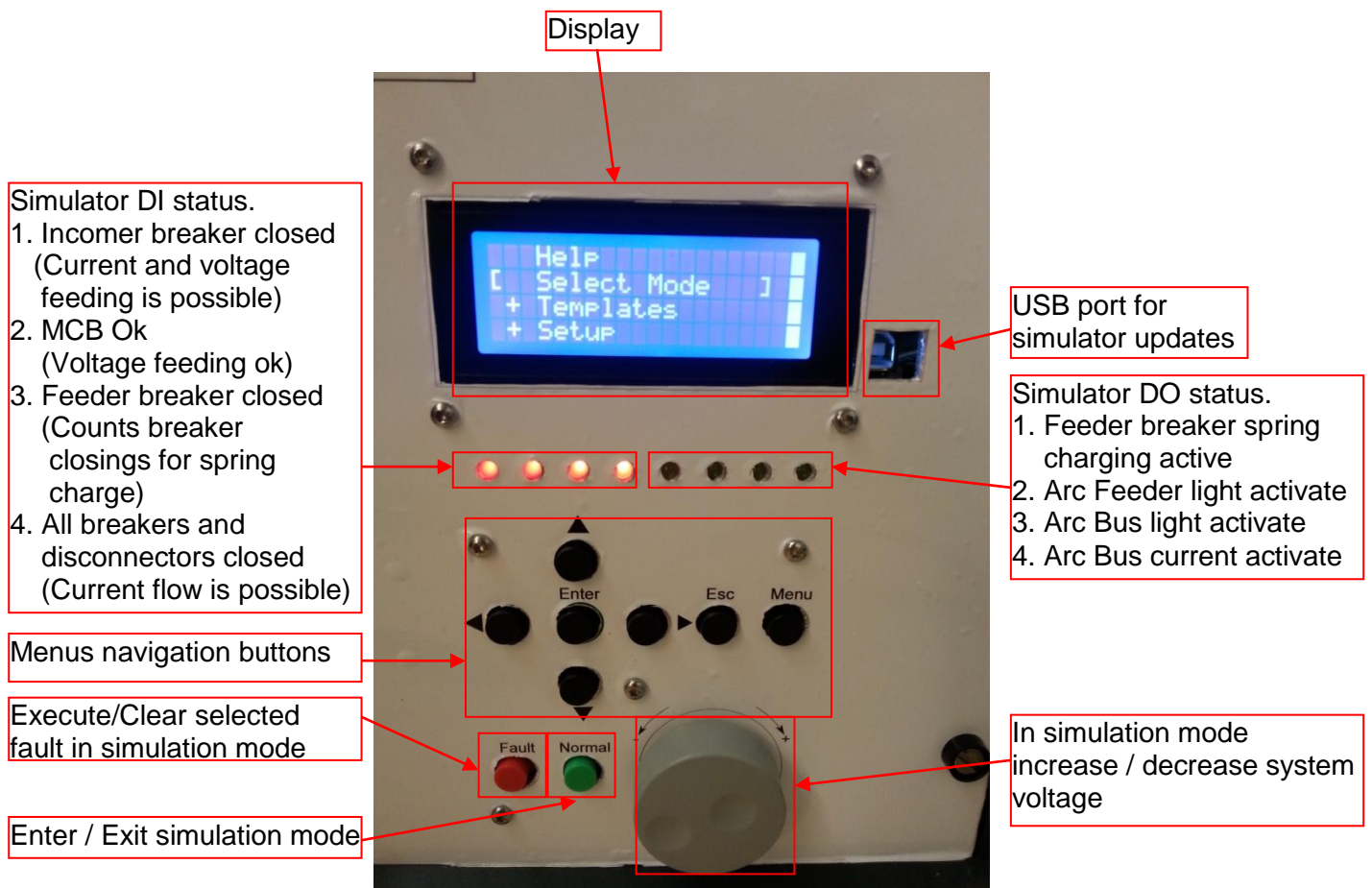
### Frontside



### Backside



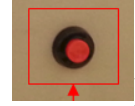
## Digital network simulator controls





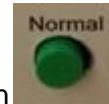
### 3 SIMULATOR USAGE

Simulator is easy to use. Plug 110 – 230 VAC 50/60Hz power cord, switch power on and wait to relay to start. Now the simulator is ready to be used. (If simulator does not start directly and shows

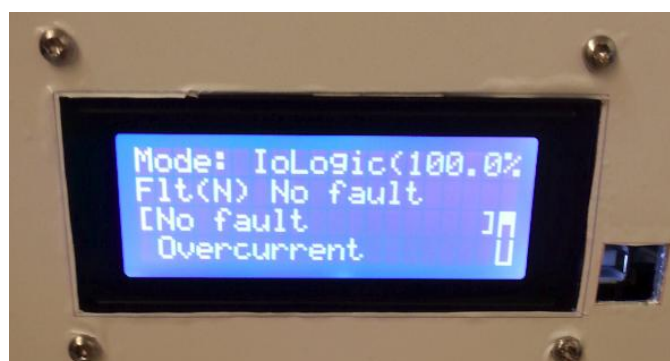


2 rows of white squares in the display, press the red button in backside of the simulator:

Simulator starts to configuration mode (not yet simulating) from where if wanted, basic settings can

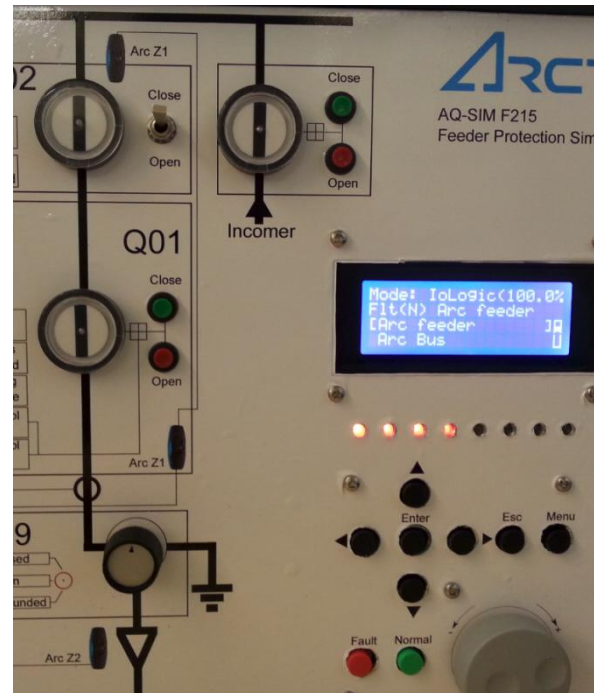
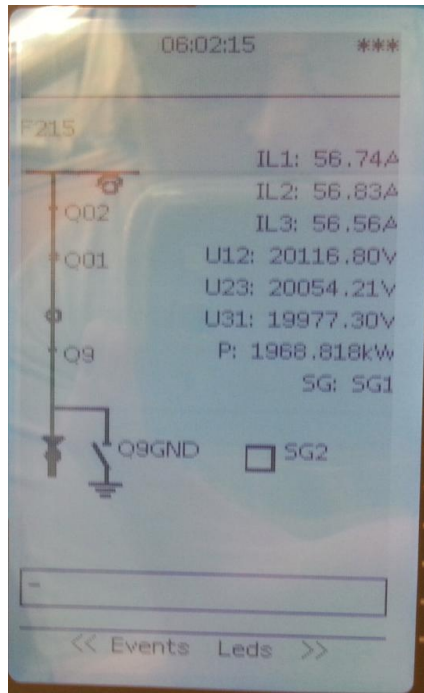


be set. If the factory setting is ok, just press in the bottom green button (Normal) and the simulator starts to simulate normal load situation with nominal load current and nominal voltages.



When the simulator is started it feeds by default 100% voltage and nominal load current with no fault selected.

If all disconnectors and breakers are closed and VT:s are healthy (MCB switch is ok) all four simulator DI channels should be on and in the relay mimic should be seen system voltages and phase currents as in the figure below.

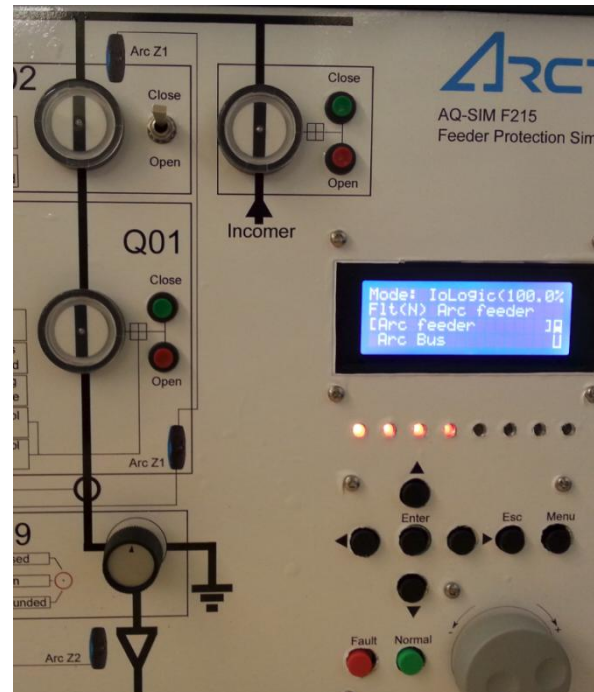
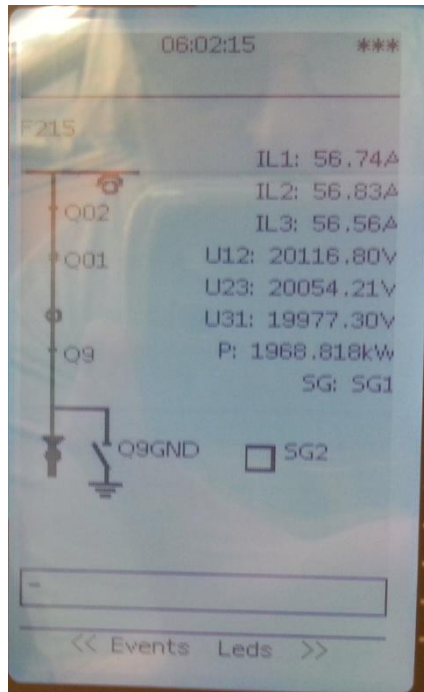


This is now the starting situation of the simulator and it is ready for starting demonstration.

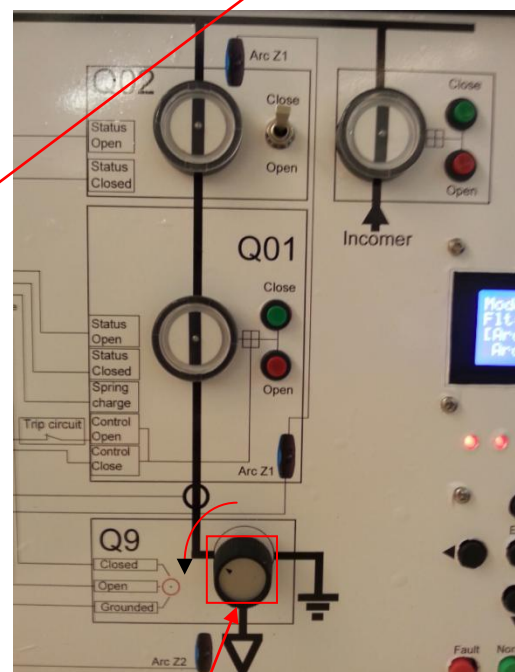
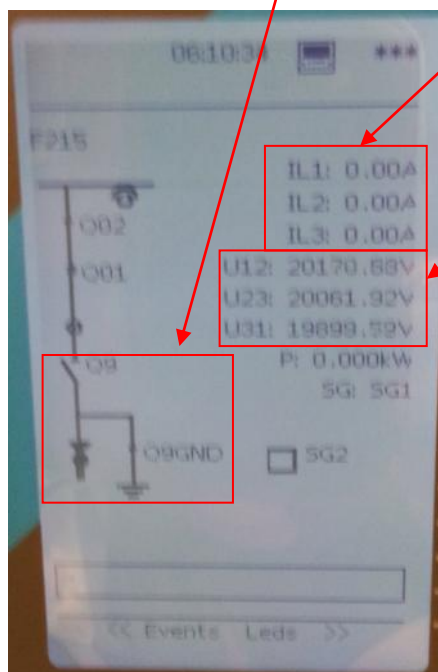
### 3.1 THINGS TO SHOW IN NORMAL SITUATION

Mimic

Normal operation



Line is grounded (follow mimic and see that currents are not flowing, voltages are still ok)

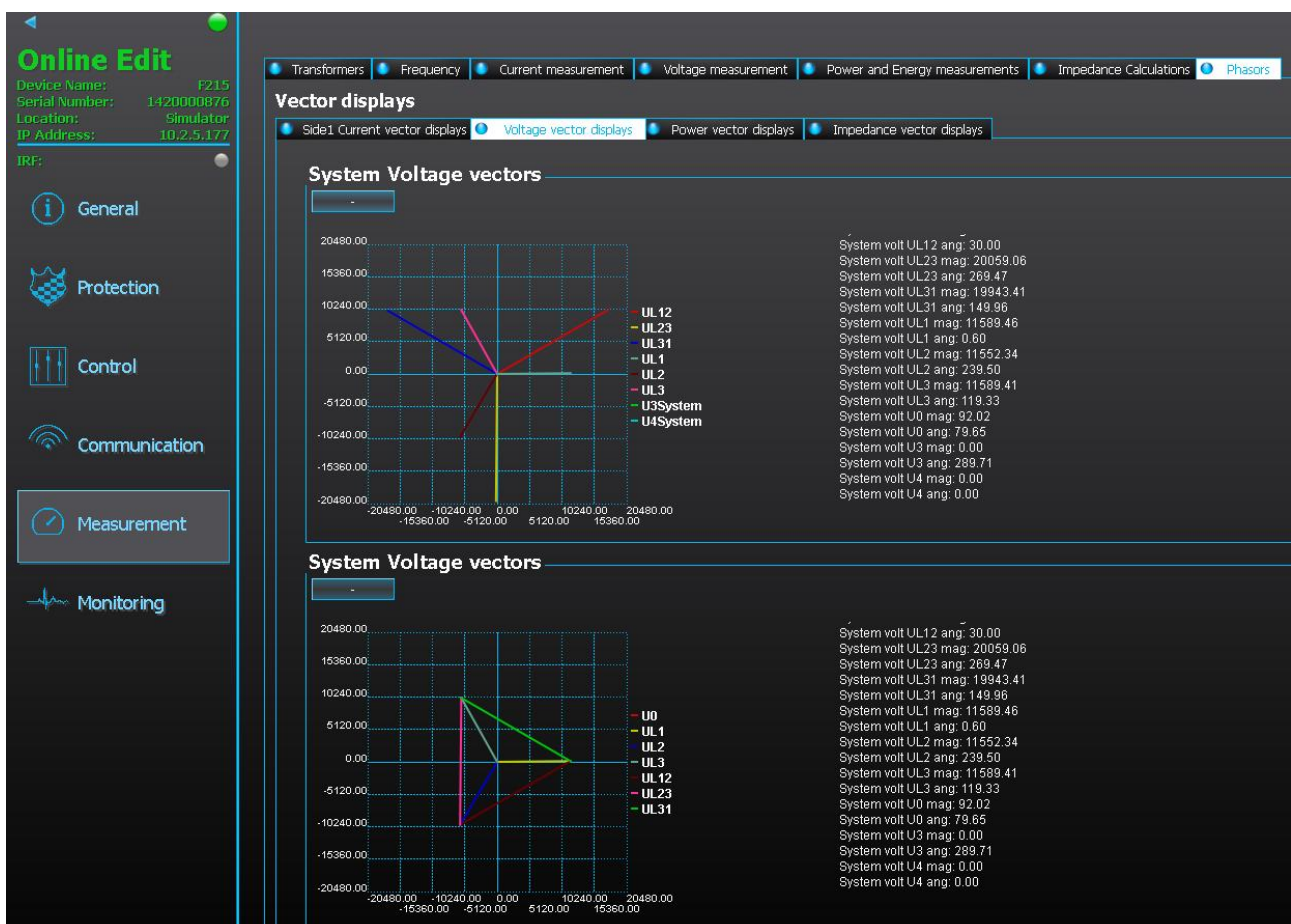
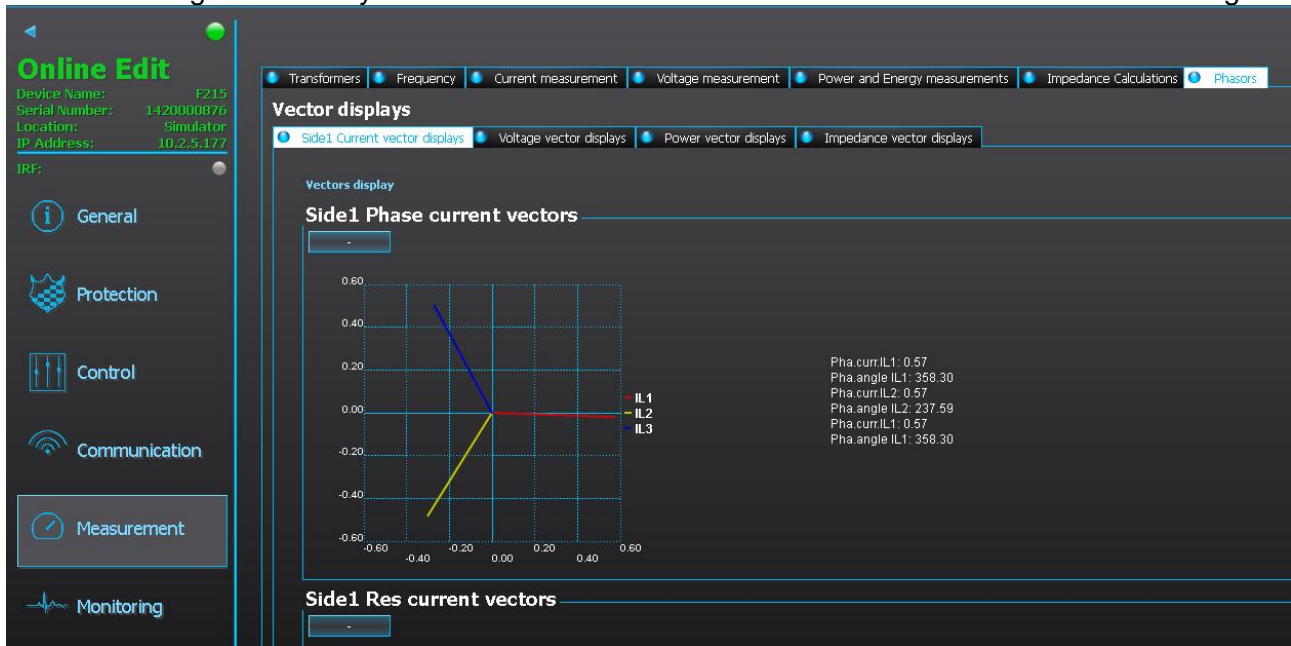


Turn knob 2 times to CCW

Similar way you can demonstrate other hardware and connection to the relay and the feeder.

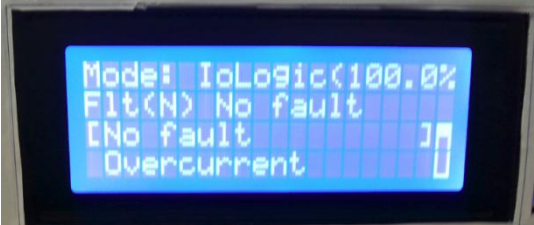

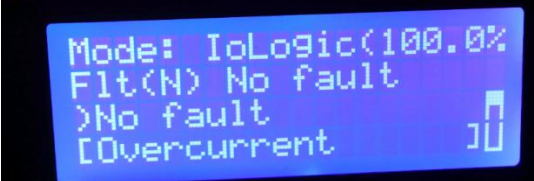

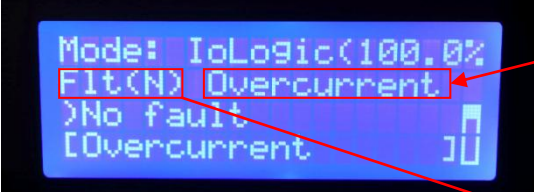

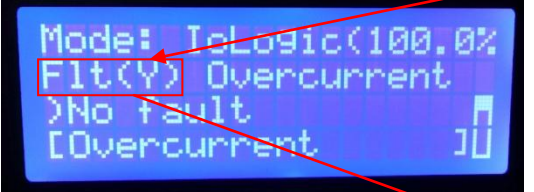

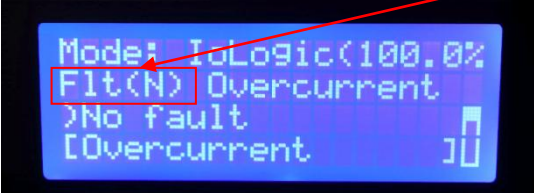


From the configuration tool you can show the measurements and vectors of currents and voltages.

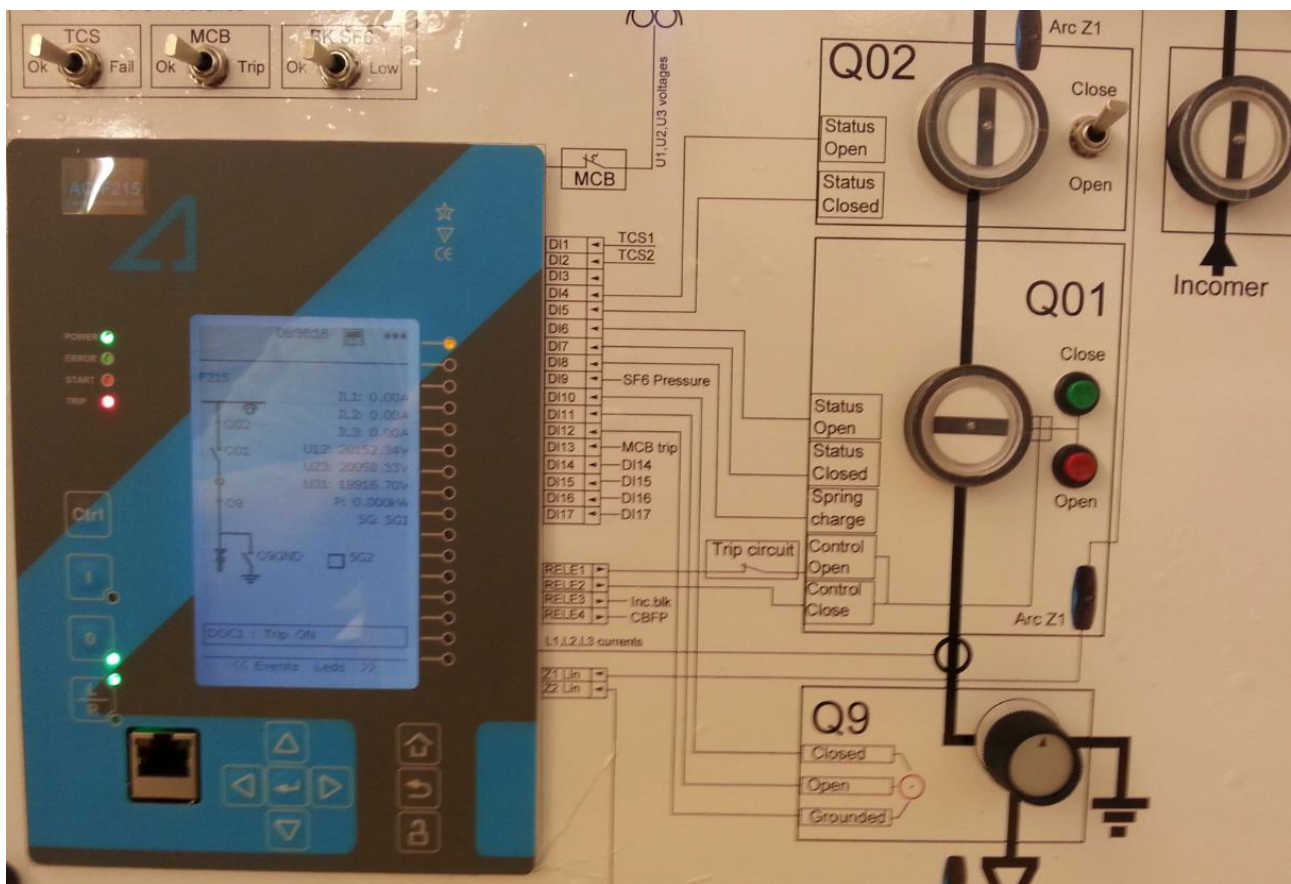


### 3.2 FAULT 1 OVERCURRENT FAULT

In the simulator with arrow key down select the cursor to “Overcurrent” and press simulator enter button.

	
	
	<p>Fault is now selected but not yet applied.</p> <p>To apply selected fault press “Fault” button in the simulator</p> 
	<p>Now fault is fed to the relay and it trips for overcurrent.</p> <p>After fault is applied and relay has tripped press the button again to stop feeding the fault</p> 
	

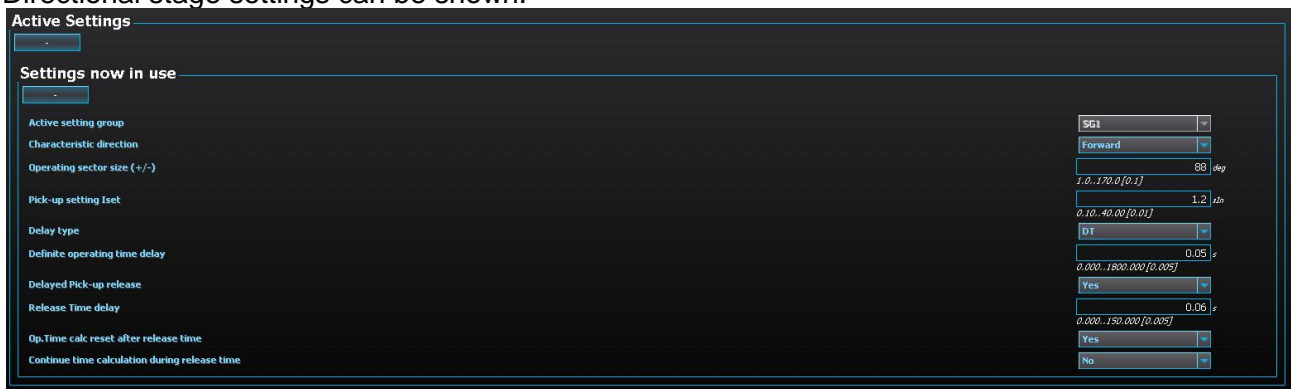
Relay trips the outgoing feeder breaker and indicates trip of directional overcurrent.



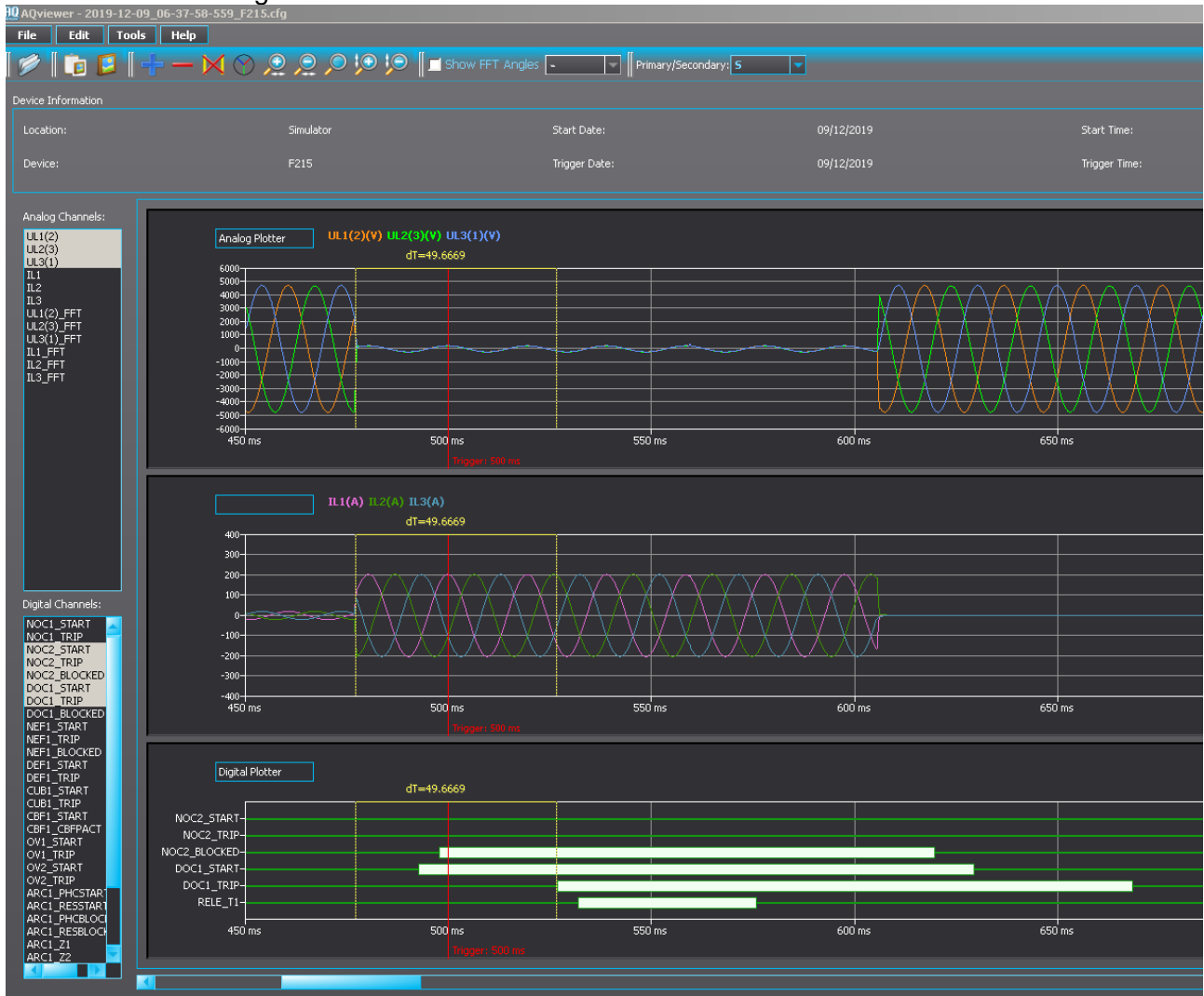
Relay event list can be demonstrated. This fault is tripped by directional overcurrent function by using voltage memory. This can be seen in the event list.

5304	2970	OBJ1: Final trip On	09.12.2019 08:37:58.647
5303	2965	OBJ1: Open Command Off	09.12.2019 08:37:58.647
5302	2945	OBJ1: Object Open	09.12.2019 08:37:58.647
5301	2944	OBJ1: Object Intermediate	09.12.2019 08:37:58.642
5300	2953	OBJ1: Open Request Off	09.12.2019 08:37:58.607
5299	2826	CBF1: Signal On	09.12.2019 08:37:58.604
5298	2816	CBF1: Start ON	09.12.2019 08:37:58.604
5297	2954	OBJ1: Open Command On	09.12.2019 08:37:58.602
5296	2952	OBJ1: Open Request On	09.12.2019 08:37:58.602
5295	4802	DOC1: Trip ON	09.12.2019 08:37:58.598
5294	5702	UV1: Undervoltage Block On	09.12.2019 08:37:58.574
5293	4810	DOC1: Using voltmem On	09.12.2019 08:37:58.573
5292	4809	DOC1: Measuring live angle Off	09.12.2019 08:37:58.573
5291	1348	NOC2: Block ON	09.12.2019 08:37:58.568
5290	4800	DOC1: Start ON	09.12.2019 08:37:58.563
5289	4096	DR1: Recorder triggered On	09.12.2019 08:37:58.559
5288	1280	NOC1: Start ON	09.12.2019 08:37:58.558
5287	4754	ARC1: Ph Current Start On	09.12.2019 08:37:58.552

Directional stage settings can be shown:



Disturbance recording can be shown:



From the recording can be seen the application. NOC2 is instant non-directional back up protection which is blocked by directional overcurrent DOC1 when the voltages are measurable. Operating time was set to 50 ms and the trip was given in 49.7 ms from the start of the fault.



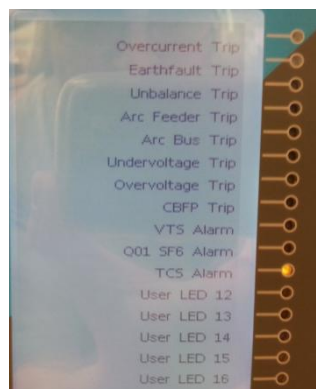
### 3.2.1 SPECIAL CASES TRIP CIRCUIT FAULT (TCS)

Trip circuit fault is broken connection or burned tripping coil of the breaker. In this fault the opening of the breaker is not possible because the trip signal cannot reach the breaker opening system electronically.

Activate trip circuit fault to the system by switching the TCS switch on:

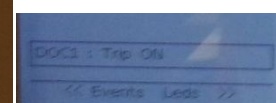
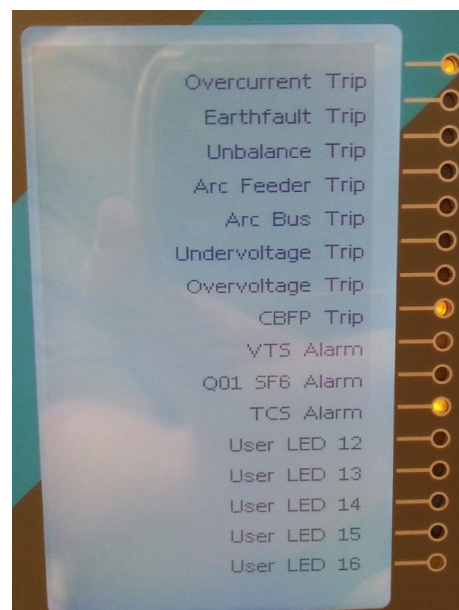
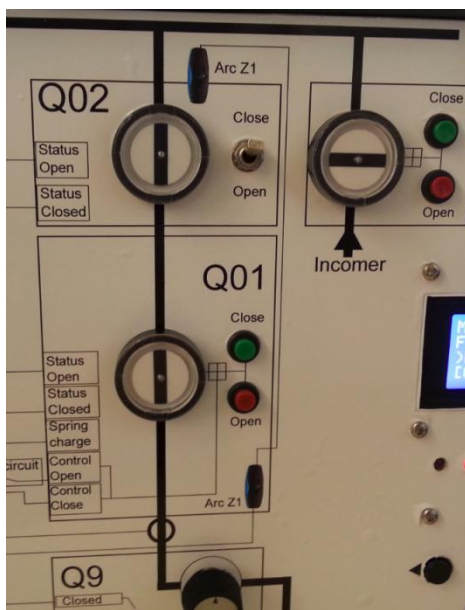


Demonstrate from the relay that it has noticed that the trip circuit is not healthy and TCS alarm is on.



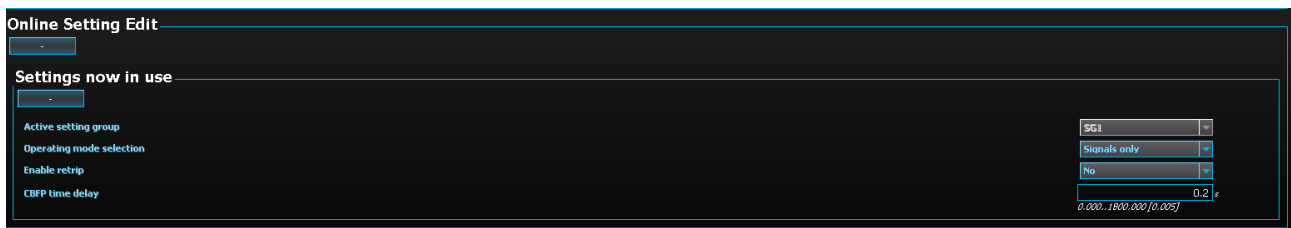
Apply the fault similarly than in normal case (press the Fault button to apply and again to clear the fault)

Demonstrate that the incomer breaker has operated and the relay shows CBFP trip indication and the tripping function is DOC1 directional overcurrent function.

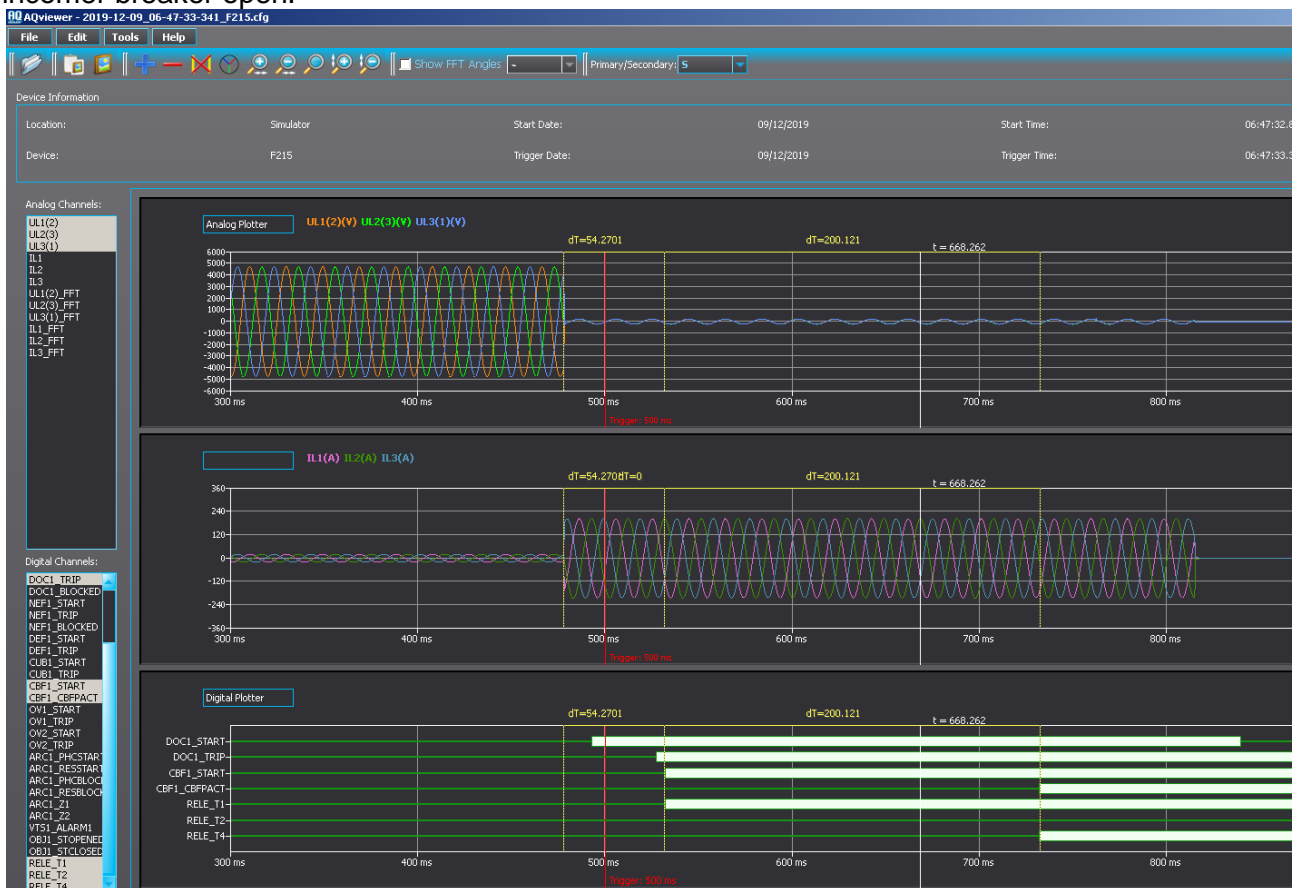




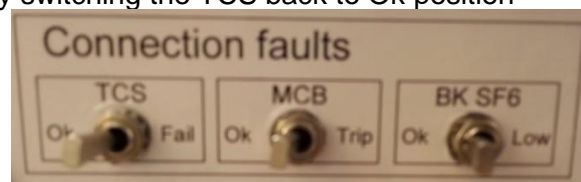
Demonstrate from configuration tool the settings of CBFP (200 ms)



Demonstrate disturbance recorder that the DOC1 function tried tripping but the breaker did not open and the CBFP activated in 200 ms from the first failed trip attempt and tripped the main incomer breaker open.



Clear the trip circuit fault by switching the TCS back to Ok position

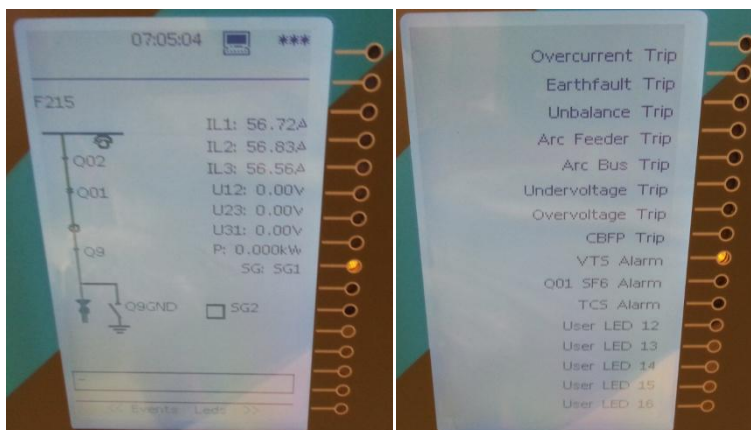


### 3.2.2 SPECIAL CASES MCB (MINIATURE CIRCUIT BREAKER) TRIP

To simulate voltage transformer fuse failure switch MCB to “trip” position. This causes that the voltages cannot be measured.

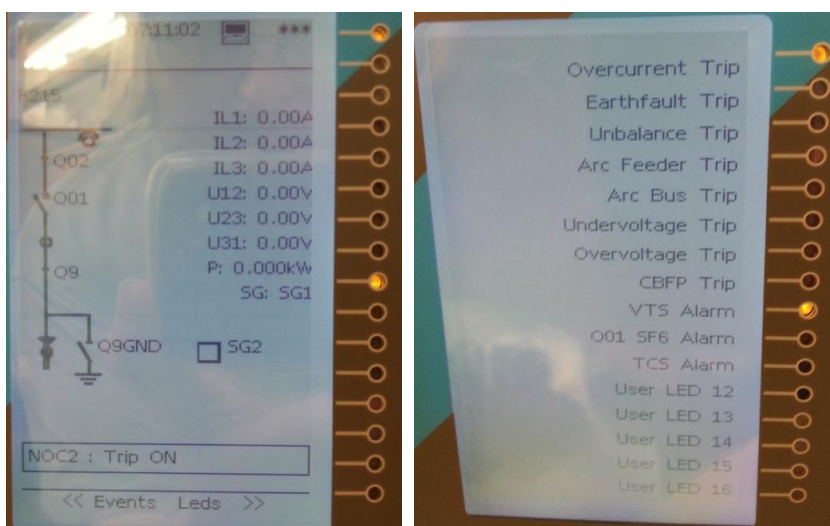


Demonstrate from relay that voltages are not measurable but currents still flow so the system is alive and in use. Also demonstrate that the VTS Alarm is activated.

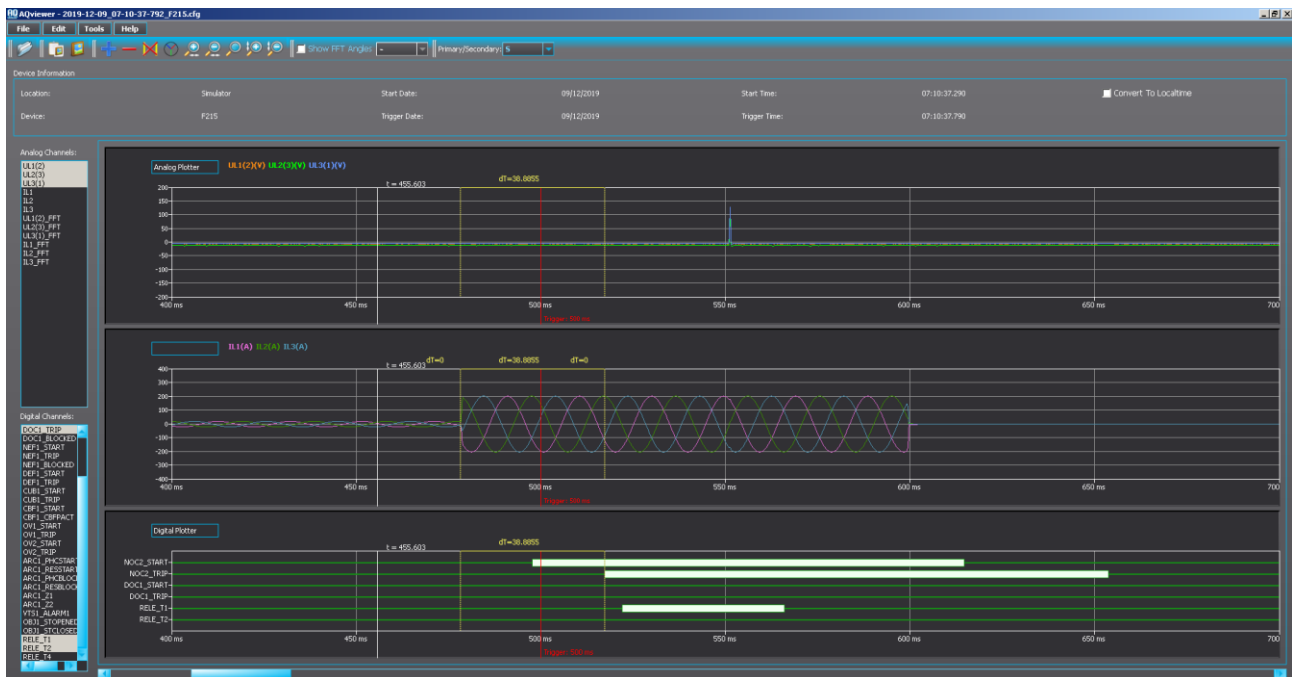


Apply the fault similarly than in normal case (press the Fault button to apply and again to clear the fault)

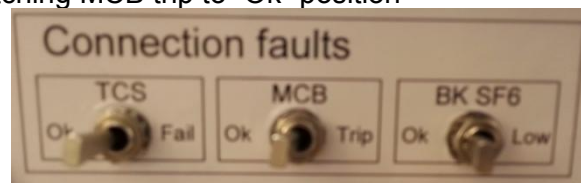
Demonstrate that the NOC2 function did trip this time (since the DOC1 function cannot operate when the VTS alarm is blocking its operation).



Demonstrate from disturbance recording that non directional backup overcurrent protection NOC2 did trip the fault.



Clear the fuse fault by switching MCB trip to “Ok” position



### 3.2.3 SPECIAL CASES BREAKER SF6 PRESSURE LOW

When breaker SF6 pressure is low it is not allowed to operate breaker at all, it cannot be allowed to close or open even there is fault. (in the simulator pushbutton “Close” and “Open” buttons still allow operation) This can be demonstrated that if the control is done by the relay it will not operate breaker open or close since the SF6 level is low. With traditional pushbuttons this needs separate relaying to block the controls and indicate control system fault in case of low gas pressure. With relay the safe control and alarm indication can be combined.

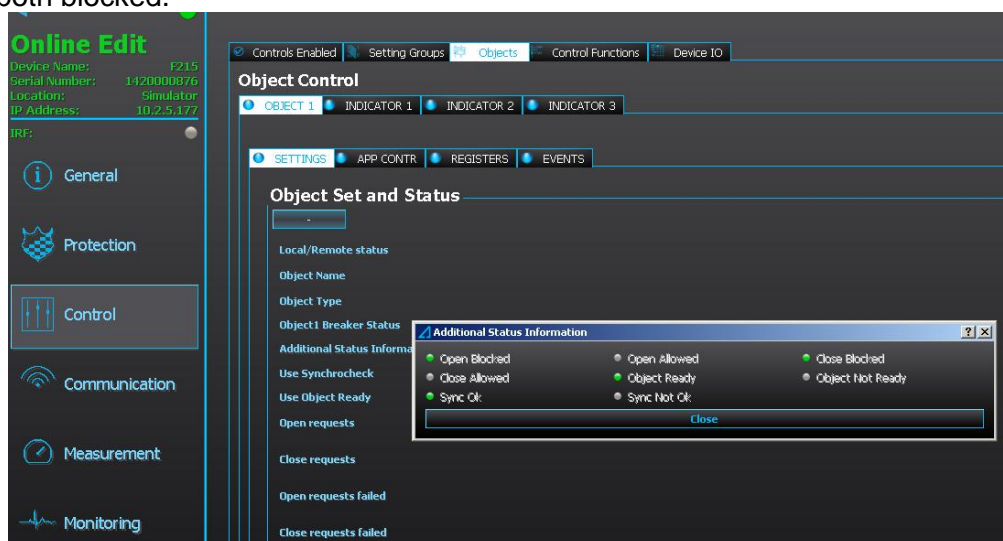
Activate gas pressure alarm by switching the BK SF6 switch to “Low”



Demonstrate relay that it recognizes the low gas pressure

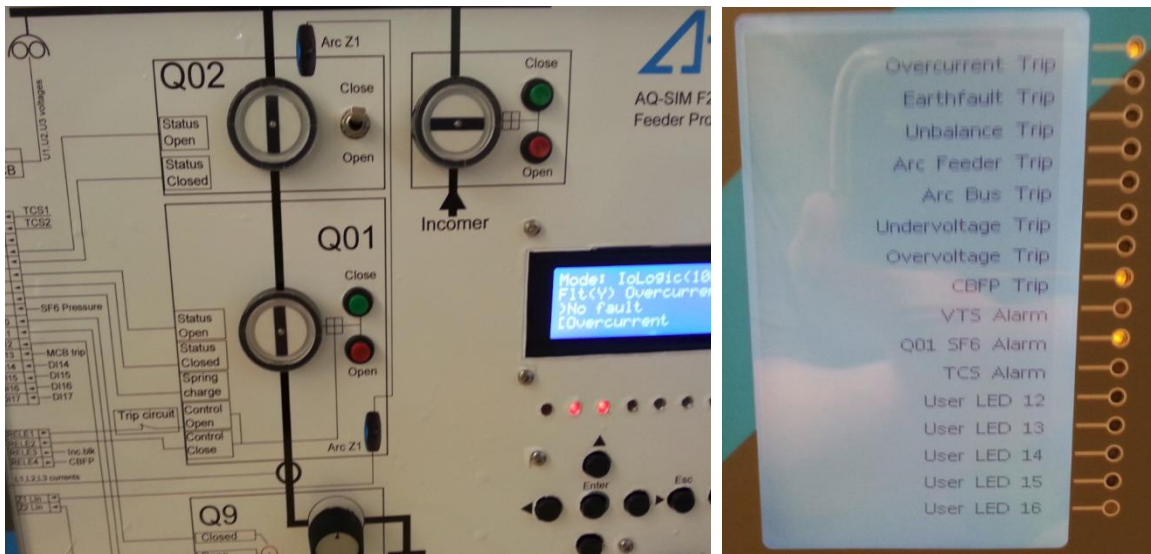


Also in the configuration tool under objects can be seen that the breaker object controls open and close are both blocked.



Apply the fault similarly than in normal case (press the Fault button to apply and again to clear the fault)

Demonstrate that the faulty breaker stays closed and the incomer breaker is tripped open by CBFP function.



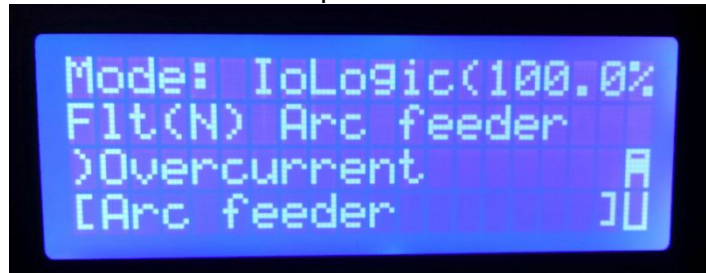
Clear the low SF6 pressure alarm by setting the “BK SF6” switch to “Ok” position.





### 3.3 FAULT 2 ARC FAULT IN THE FEEDER (ZONE2)

Arc fault in the feeder includes overcurrent and light input from sensor Z2  
Activate “Arc feeder” fault in the simulator and press fault button.



Demonstrate that the Arc feeder alarm is on indicating that this feeder has been in fault. In this fault also the overcurrent protection trips. Demonstrate that the protection is selective and only the feeder breaker is tripped.



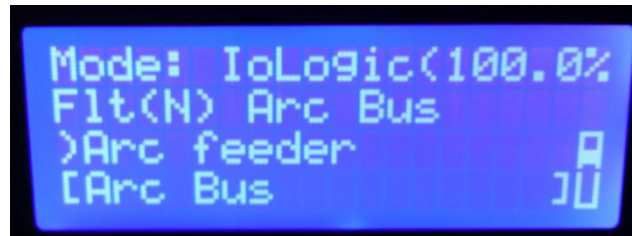
Demonstrate in the disturbance recording that the operating of the Arc protection is very fast compared to overcurrent trip. (In the simulator the light information comes through aux relay so it is delayed by additional 5ms. This time can be deducted from the operating time result).



### 3.4 FAULT 3 ARC FAULT IN THE BUS

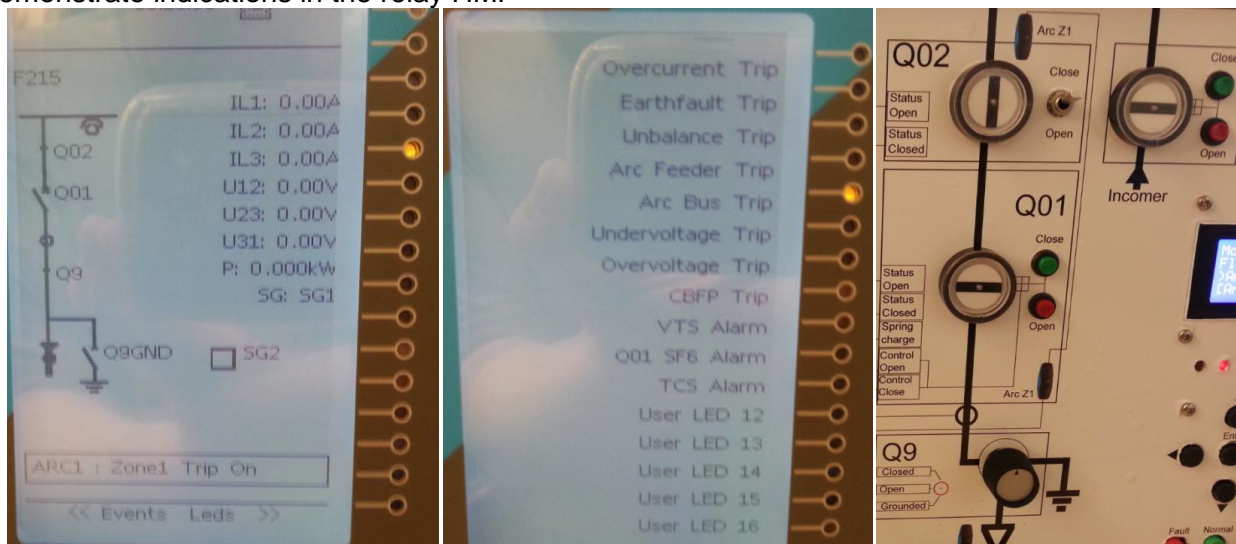
This fault occurs in the bus section of this relay. Current information comes from incomer current measurement and the Z1 sensor of this simulator relay is activated.

Activate “Arc Bus” fault in the simulator and press fault button.



Demonstrate that in the bus fault incomer breaker as well as outgoing feeder breaker are tripped. If the load of the feeder is supplying motor loads or similar which can backfeed short circuit current it should be separated from fault as well.

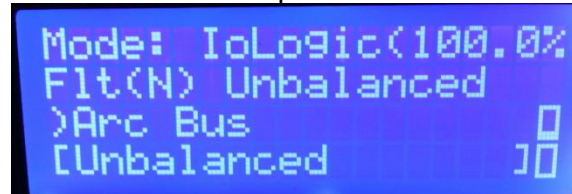
Demonstrate indications in the relay HMI



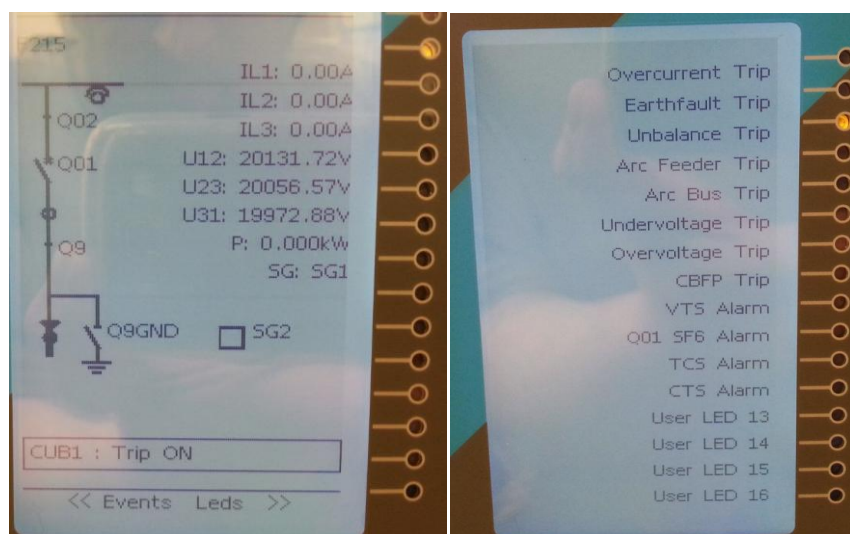
### 3.5 FAULT 4 UNBALANCE FAULT

Unbalance fault / CT supervision demonstration. In this fault phase L2 current is drop to zero. This is used for activate I2 unbalance protection (CUB1) and current transformer supervision.

Activate "Unbalanced" fault in the simulator and press fault button.



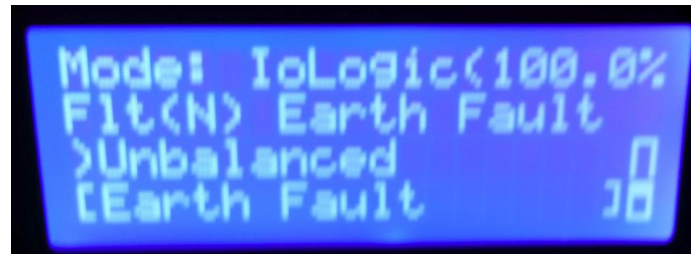
Demonstrate the HMI indications



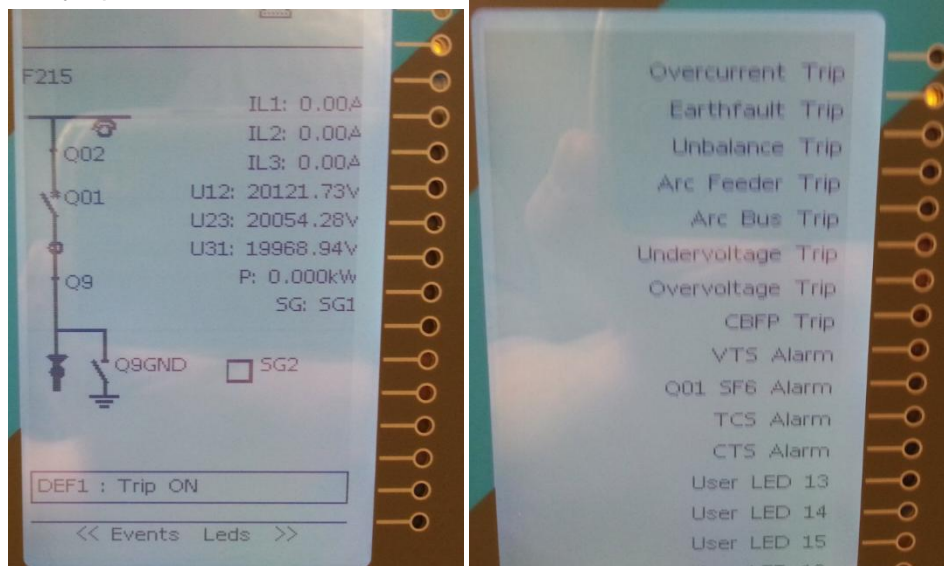
### 3.6 FAULT 5 EARTHFAULT

In the simulator the earth fault is applied through calculated  $U_0$  and  $I_0$ . Two stages, directional and non-directional back-up stages are activated.

Activate "Earth Fault" fault in the simulator and press fault button.



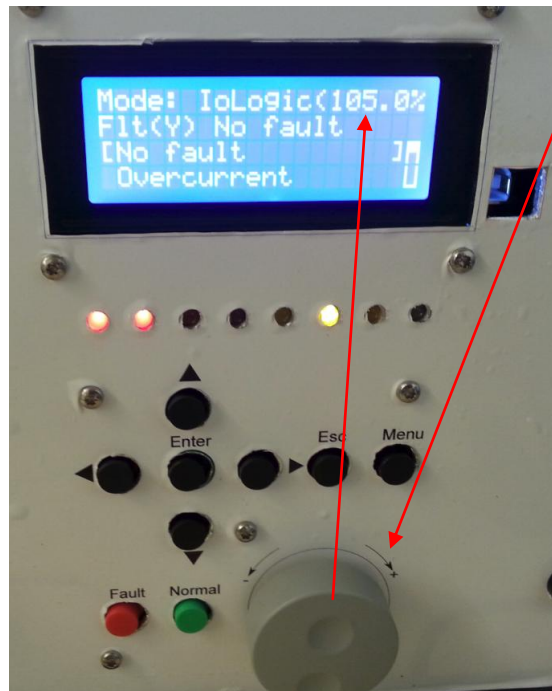
Demonstrate relay operation from the HMI.



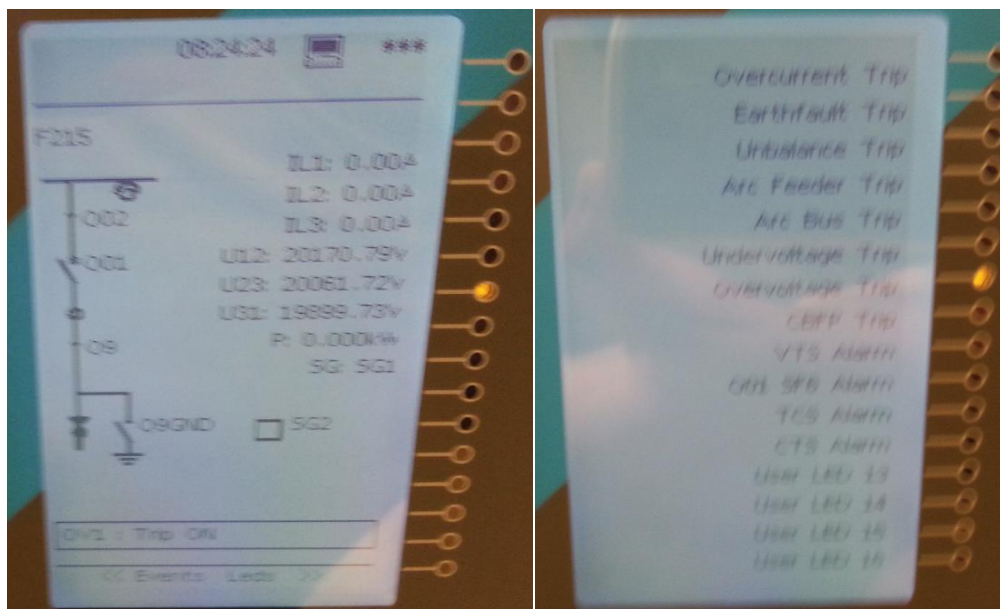


### 3.7 OVERVOLTAGE

Overvoltage can be set to relay by turning simulator rotary switch on clockwise.



Turn the knob until relay trips from overvoltage. Demonstrate relay HMI.





### 3.8 UNDERVOLTAGE

Overvoltage can be set to relay by turning simulator rotary switch on counter clockwise.



Turn the knob until relay trips from undervoltage. Demonstrate relay HMI.

