APPLICATION NOTE

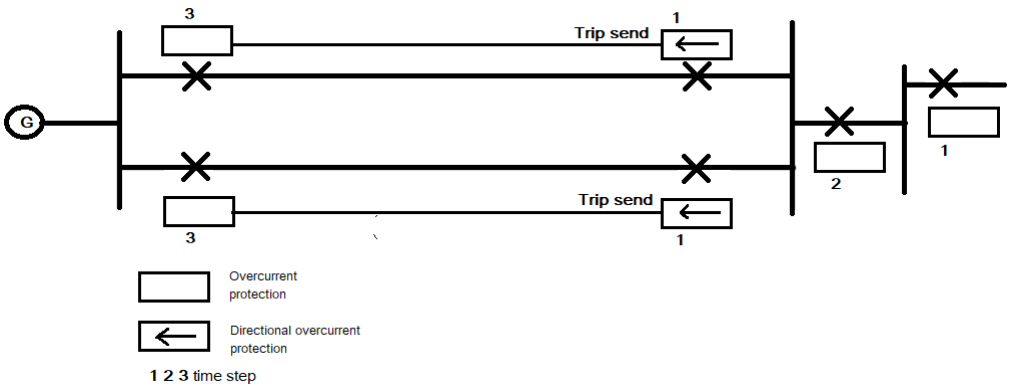
Testing of directional overcurrent protection with SVERKER 900

1. When to use Directional OverCurrent

For parallel lines and in power networks with several incoming feeding points directional overcurrent protection is commonly used to get good selectivity.

Disconnecting of parallel lines in a radial power network can be done with two directional and two none directional protections. (see picture)

For the directional protection to operate correctly at close fault, it has to work correctly at very low voltage.



Function of Directional OverCurrent

In order to determine the direction of the error, at least one main voltage is required which is compared to one of the missing phases. If the fault is two or three phased, the protection must be able to remember the voltage just before the fault. The setting of the protection function to detect the error can be made single-phase, two-phase or three-phase. The setting chosen depends on the structure of the network and the setting choices in the monitoring relay. In this application, single-phase and two-phase detection is used, see pictures below.

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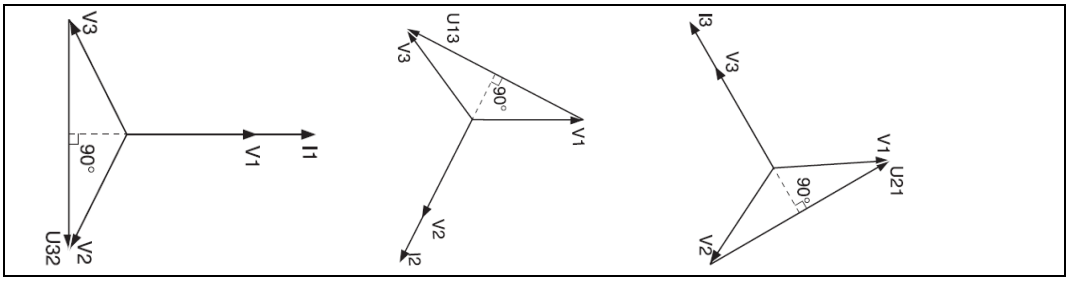
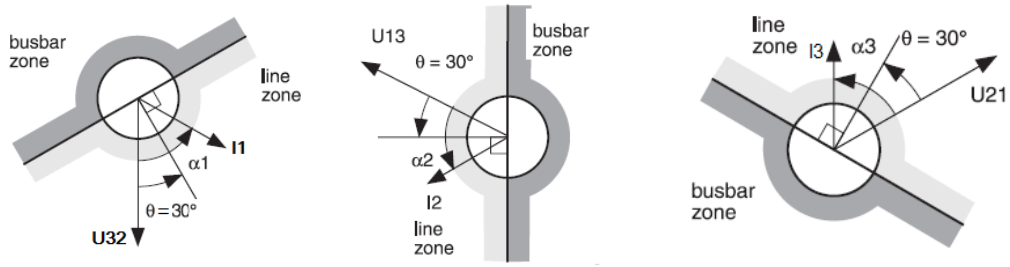
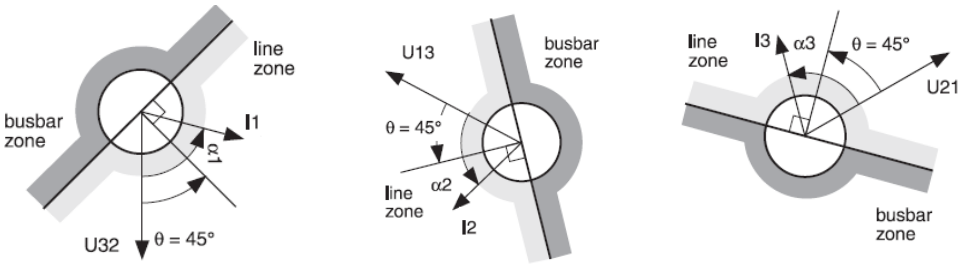


2. Instrument used at testing

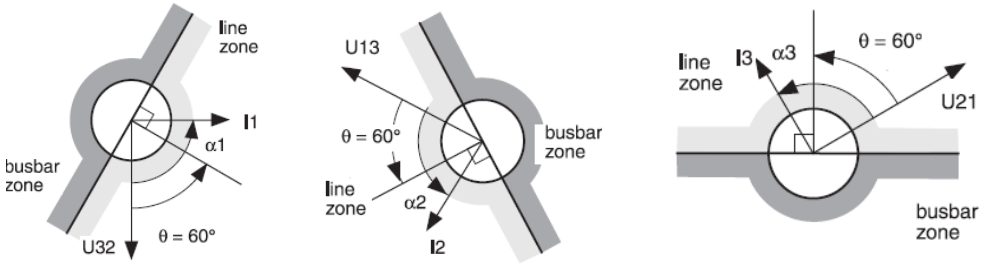
To test the protective function amplitude and zone limits, the "main" instrument can be used.
For time test of two or three-phase failures, the protection must feel stable state before error and the "Pre-fault, Fault" or "Sequence" instrument must be used.
Below are examples of 1-phase and 2-phase errors. Different characteristic angles of the error can be selected, usually 30, 45 or 60 degrees. See pictures below.



Fault tripping in line zone with angle 30 degree.



Fault tripping in line zone with angle 45 degree.



Fault tripping in line zone with angle 60 degree.

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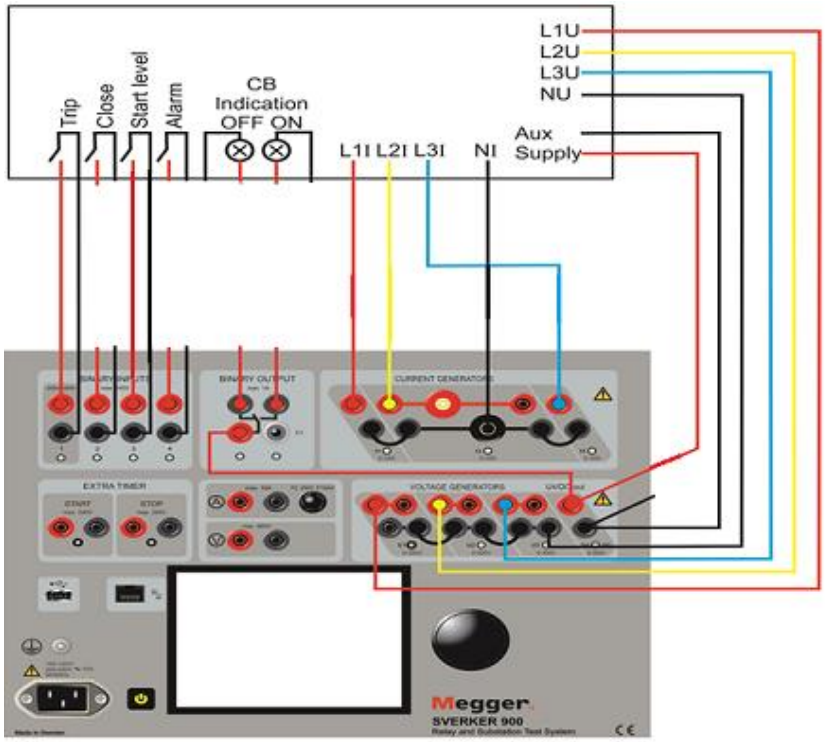
Connect according to drawing below.

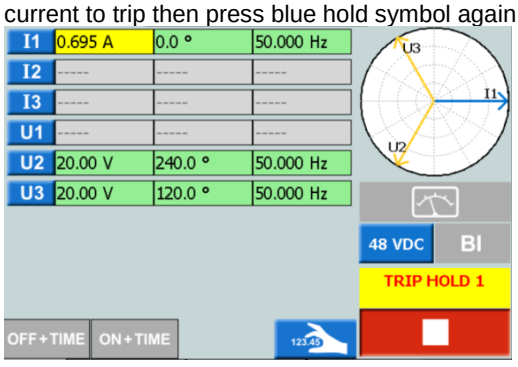


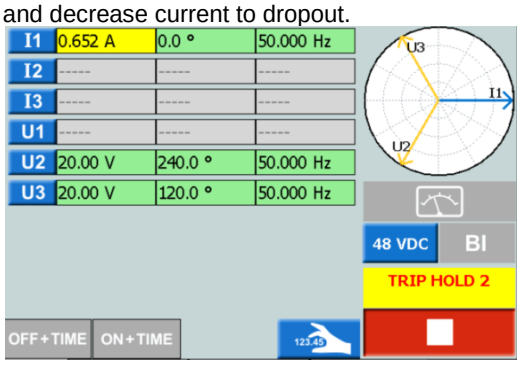
If start contact is not available use start diode or lower trip delay to minimum.
Use existing auxiliary voltage if available. In this example Sepam protection type S84 is used.
For other protections all values have to be adjusted to that specific test object.

Main Instrument with Hold function.

Pickup/dropout for protection with one phase fault selection, protection set to 0.7A and characteristic set to 30 degree.

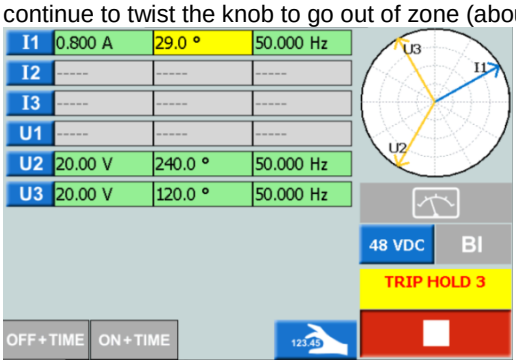
Test1: Set current to 0.65A and angel to 0 degree, voltage over activating level about 20V select BI1 to changing contact dry or wet (if voltage is used) press start and blue hold symbol increase current to trip then press blue hold symbol again and decrease current to dropout.

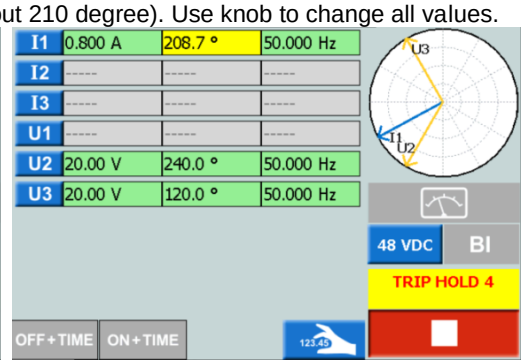




Angel zone test for phase I1

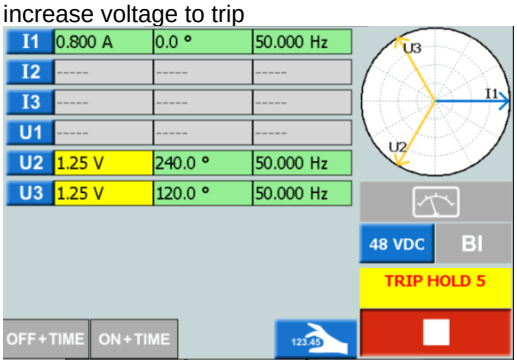
Test2: Go out of zone by setting angel to over 30 degree and set current above trip level, press hold again and go into zone by lower angel to trip (about 30 degree) press hold again and continue to twist the knob to go out of zone (about 210 degree). Use knob to change all values.





Voltage low limit test for pick up

Test3: Lower the voltage to about 0.5V and turn the angel back to inside zone press hold and increase voltage to trip



The other two combinations can be tested the same way: I2=ON, U1andU3=ON, I3=ON U1andU2=ON. All changes can be made with keypad if each test is made individually.

Main Hold: Result

1. Pick up value I1 # 2. Drop out value I1 # 3. First zone limit at about 30 degree
4. Second zone limit at about 210 degree # 5. Voltage low limit for activating trip.

#	I1: A	°	U2: V	U3: V
1	0.695	0.0	20.00	20.00
2	0.652	0.0	20.00	20.00
(2/1)	0.938			
3	0.800	29.0	20.00	20.00
4	0.800	208.7	20.00	20.00
(4/3)				
5	0.800	0.0	1.25	1.25

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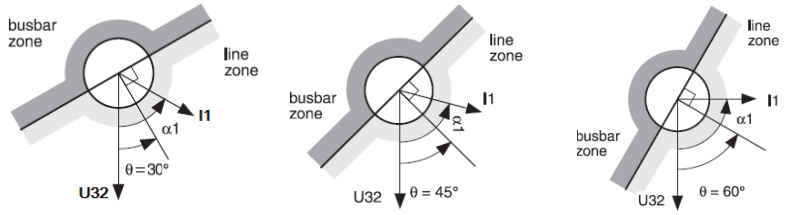
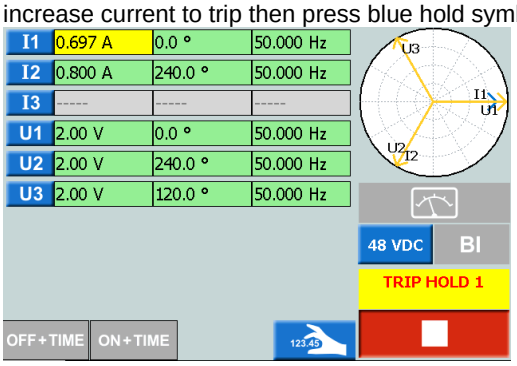
Trip area at characteristic angle, see fault tripping zones for phase I1.

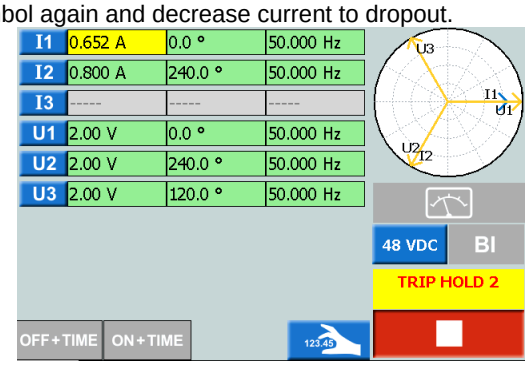
#	I1: °	
1	29.6	Angle 30°
2	210.2	
(2/1)		
3	44.3	Angle 45°
4	225.2	
(4/3)		
5	59.5	Angle 60°
6	240.3	
(6/5)		



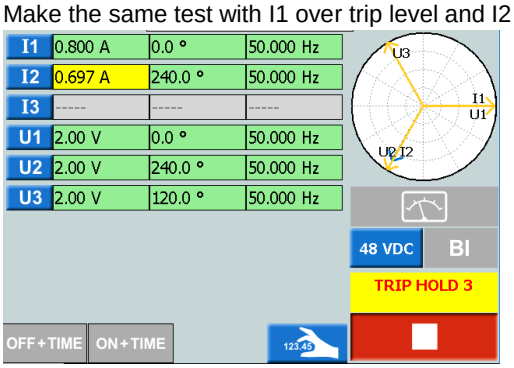
Pickup/dropout for protection with two phase fault selection, protection set to 0,7A

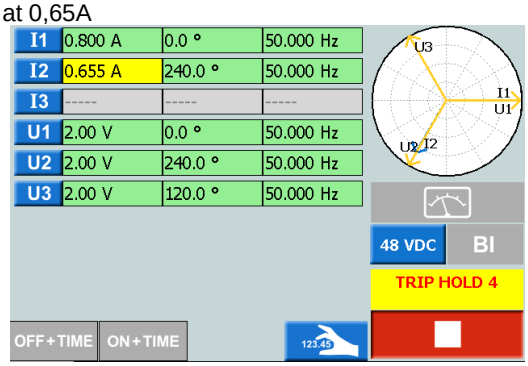
Test 1: Set I1 current to 0.65A, I2 over trip level and voltage over activating level.
Select BI1 to changing contact dry or wet (if voltage is used) press start and blue hold symbol increase current to trip then press blue hold symbol again and decrease current to dropout.





Make the same test with I1 over trip level and I2 at 0,65A





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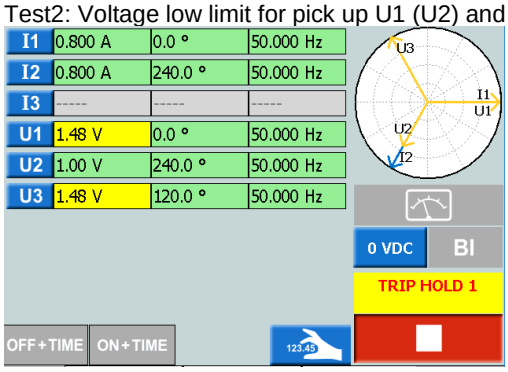
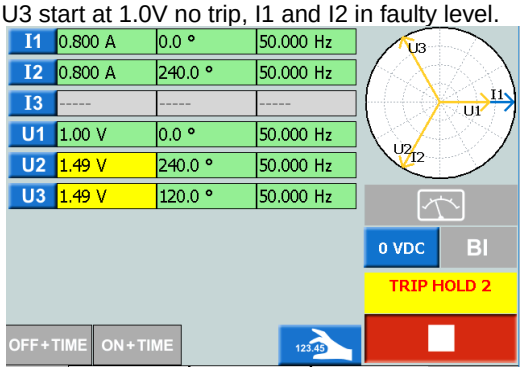
Main Hold: Result

1. Pick up value I1: A (I2: A set to fault)
2. Drop out value I1: A (I2: A set to fault)
3. Pick up value I2: A (I1: A set to fault)
4. Drop out value I2: A (I1: A set to fault)

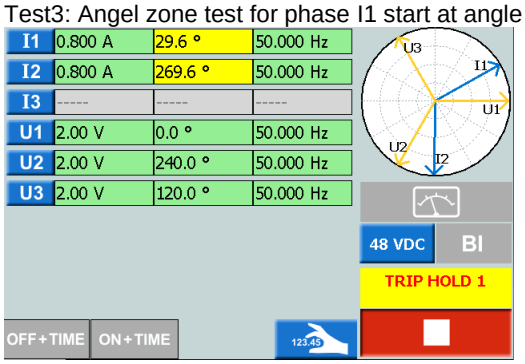
#	I1: A	I2: A
1	0.696	0.800
2	0.650	0.800
(2/1)	0.934	
3	0.800	0.696
4	0.800	0.653
(4/3)		0.938

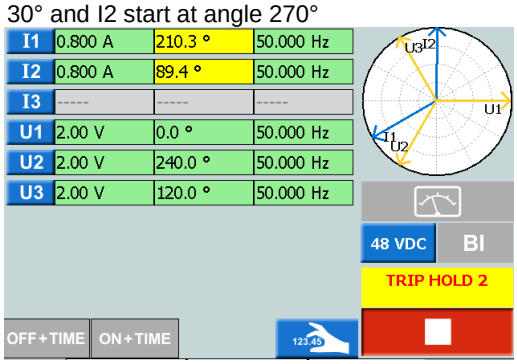
Test2: Voltage low limit for pick up U1 (U2) and U3 start at 1.0V no trip, I1 and I2 in faulty level.





Test3: Angel zone test for phase I1 start at angle 30° and I2 start at angle 270°





Main Hold:Result

Two phase fault voltage pick up
PU U1=1.48V / U2=1.00V / U3=1.48V
PU U1=1.00V / U2=1.49V / U3=1.49V

Main Hold:Result

Pick up	Drop out
I1:29.6°	I1:210.3°
I2:269.6°	I2:89.4°

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Result from same test as above with U1(U3) and U2, I2 and I3 in faulty level.
Angel zone test for phase I2 start at angle 90° and I3 start at angle 330°

#	I2: °	I3: °	U1: V	U2: V	U3: V
1	240.0	120.0	1.26	1.26	1.00
2	240.0	120.0	1.26	1.00	1.26
(2/1)				0.794	1.260
3	90.3	329.5	2.00	2.00	2.00
4	276.4	150.8	2.00	2.00	2.00
(4/3)					

#1: U1andU2 voltage Pu
#2: U1andU3 voltage PU

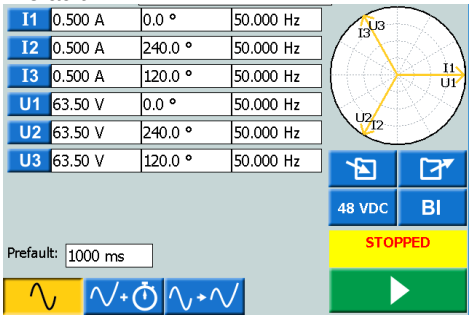
#3: I1 and I3 first zone angle

#4: I1 and I3 second zone angle

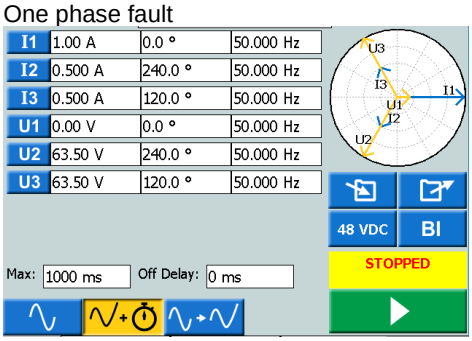
Test in Pre fault/Fault Instrument

Time test for one and two phase fault, protection set to 500ms

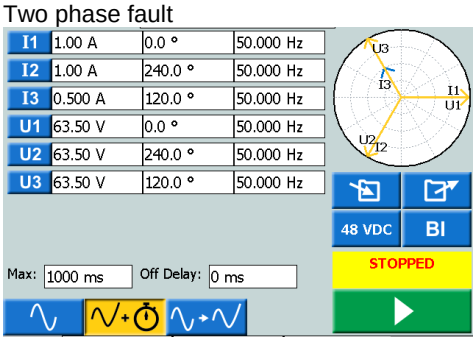
Prefault



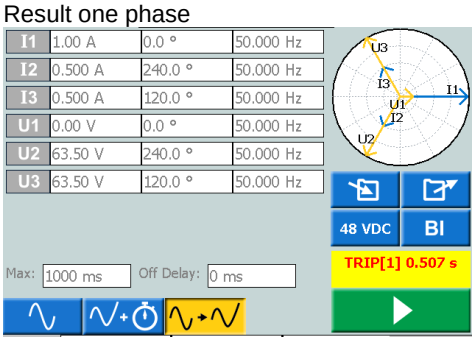
One phase fault



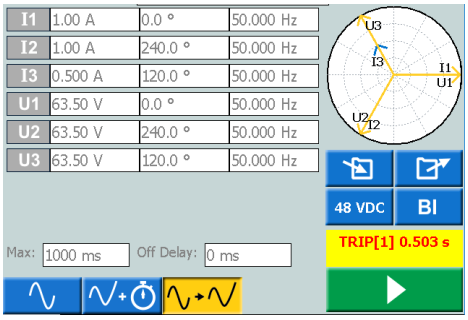
Two phase fault



Result one phase



Result two phase



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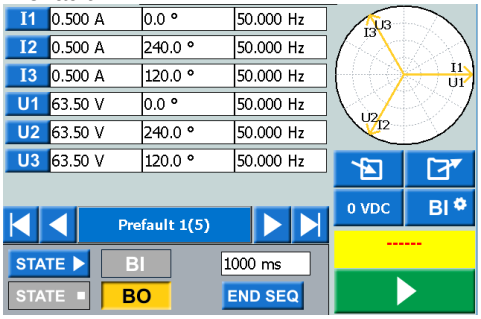
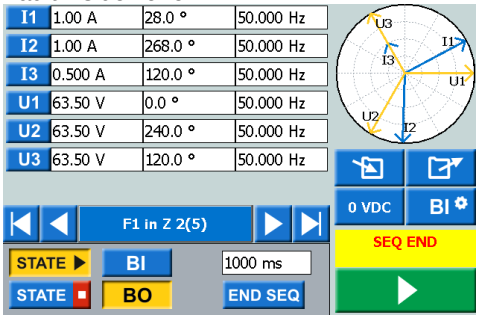
Test in Sequence Instrument

Check of zone and time test, zone borders are checked with 2degree above and below limit.
The zone for phase I1and I2 at setting 30deegre.

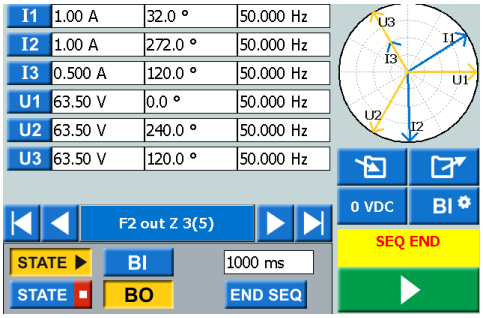
Pre fault



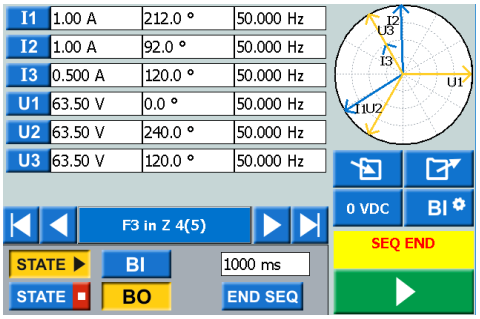
Fault inside zone



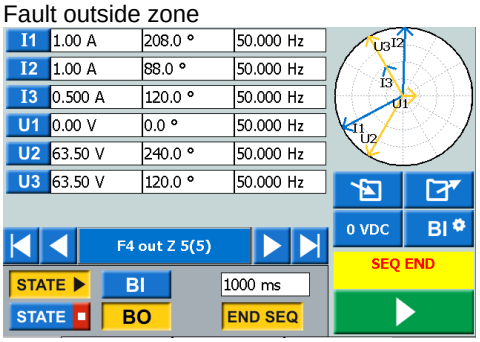
Fault outside zone



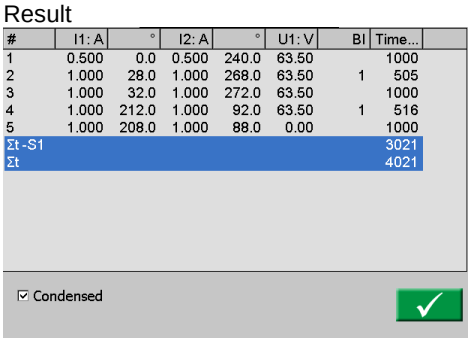
Fault inside zone



Fault outside zone



Result



#	I1: A	°	I2: A	°	U1: V	BI	Time...
1	0.500	0.0	0.500	240.0	63.50		1000
2	1.000	28.0	1.000	268.0	63.50	1	505
3	1.000	32.0	1.000	272.0	63.50		1000
4	1.000	212.0	1.000	92.0	63.50	1	516
5	1.000	208.0	1.000	88.0	0.00		1000
Σt -S1							3021
Σt							4021

Condensed