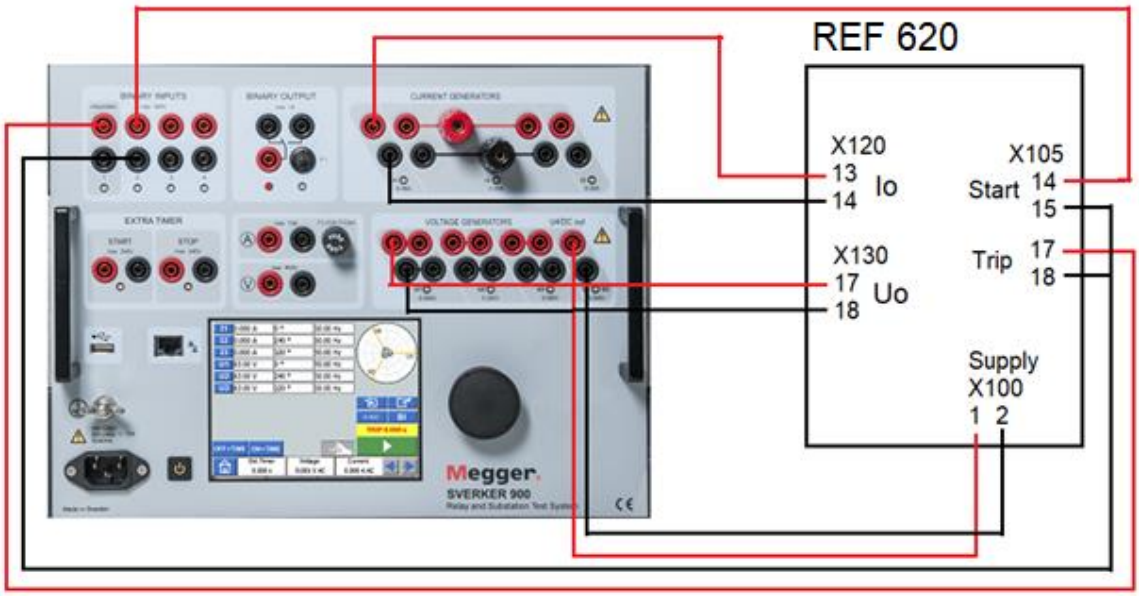
Directional earth-fault protection

Intermittent and transient functions in the REF620 feeder protection relay

Test connections



Connections between the REF620 and SVERKER 900:

REF620		SVERKER 900		
X100	1 and 2	U4gen	red and black	100V supply
X120	13 and 14	I1gen	red and black	Io current
X130	17 and 18	U1gen	red and black	Uo voltage
X105	14 and 15	BI2	red and black	Start
X105	17 and 18	BI1	red and black	Trip

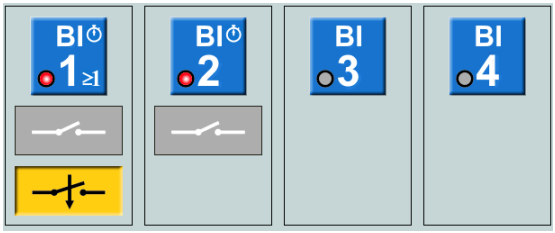
Protection secondary settings:
Io = 36 mA, Uo = 11 V, Operate delay time = 1200 ms, Reset delay time = 500 ms,.
Directional mode = Forward

Intermittent function

REF620: The intermittent function is set to three consecutive faults and gives a start at the fourth fault.
SVERKER 900: The fault current is set to 80 mA to simulate the high current generated at the intermittent earth fault. The zero voltage is set to 20 V ; the configuration is made in 13 states. The fault states and the first two memory states are set to 20 ms. The memory states have times selected to get the trip as close to set time 1,2 s as possible. In generator configuration, set U4gen to aux voltage DC. Set “Advanced mode” in SVERKER configuration.

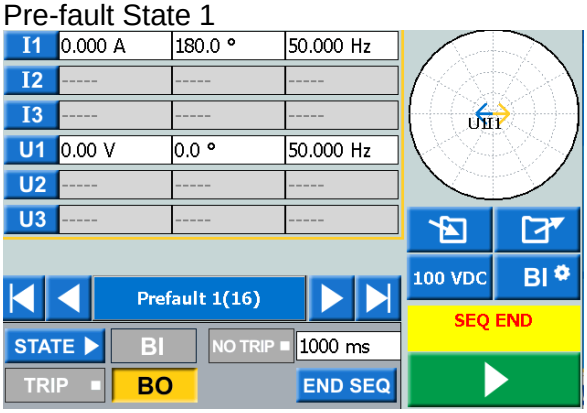
Tests are performed in "Sequence Instrument".

Set BI configuration BI to dry contact and auxiliary voltage 100 VDC to 100 V DC
Preparations for sequence: Make three states as below, : first state **"Pre-fault",** second state **"Fault 1"** third state **"Memory 1"**. Set BI1 and BI2 see picture below. Copy state 2 and insert as states 4, 6, 8, 10 and 12 name them successively, fault 2 to fault 6. Copy state 3 and insert as states 5, 7, 9, 11 and 13 name them successively memory 2 to memory 6. For the result to come close to operate delay time set the **"Memory"** time of states 7 and 9 to 450 ms, state 11 to 170ms and state 13 to 50ms. In addition. State 13 should be set to **"END SEQ".**

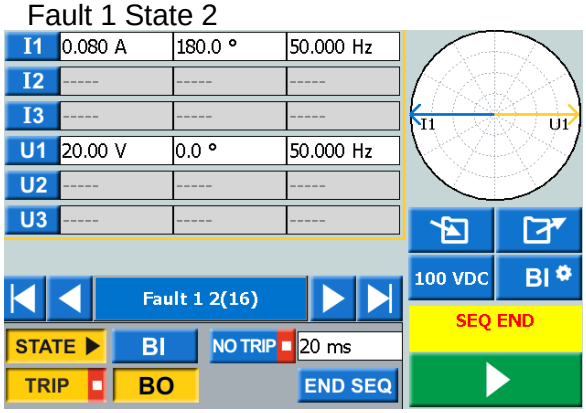


In state 2 and 3 set BI1 to turn off Sverker and BI2 to note parameter values and time but current feeding continues.

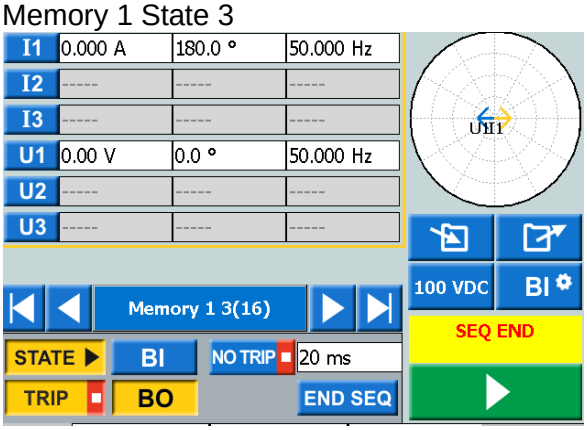
Pre-fault State 1



Fault 1 State 2



Memory 1 State 3

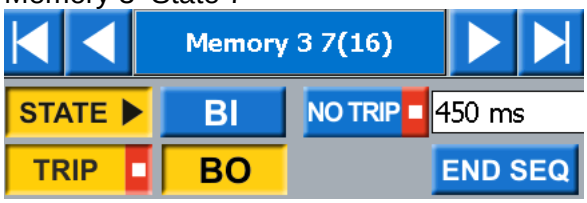


Result

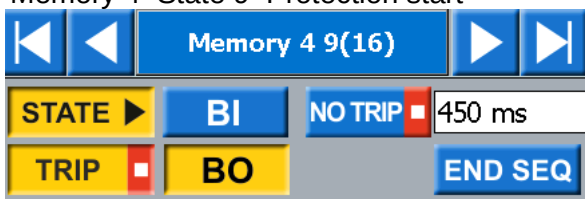
S#	I1: A	U1: V	Rec...	/Stat...	BI1	BI2	Rec...
1	0.000	0.00	0	0	0	0	Start
1	0.000	0.00	1000	1000	0	0	Time...
2	0.080	20.00	1020	20	0	0	Time...
3	0.000	0.00	1040	20	0	0	Time...
4	0.080	20.00	1060	20	0	0	Time...
5	0.000	0.00	1080	20	0	0	Time...
6	0.080	20.00	1100	20	0	0	Time...
7	0.000	0.00	1550	450	0	0	Time...
8	0.080	20.00	1570	20	0	0	Time...
9	0.000	0.00	1578	8	0	1	Event
9	0.000	0.00	2020	450	0	1	Time...
10	0.080	20.00	2040	20	0	1	Time...
11	0.000	0.00	2210	170	0	1	Time...
12	0.080	20.00	2237	27	1	1	Event
12	0.080	20.00	2230	20	1	1	Time...
13	0.000	0.00	2237	7	1	1	Trig
Σt -S1			1237				
Σt			2237				

As the protection is set to minimum three consecutive *"spikes"* the protection starts after the fourth "*spike"* in state 9 presented as "Event" in the result. When the protection receives a *"spike"* after the delayed time set in the protection is reached, it sends a trip in state 13 presented as "Trig" in the result and the feeding is turned off.

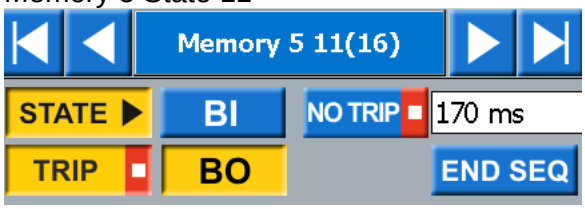
Memory 3 State 7



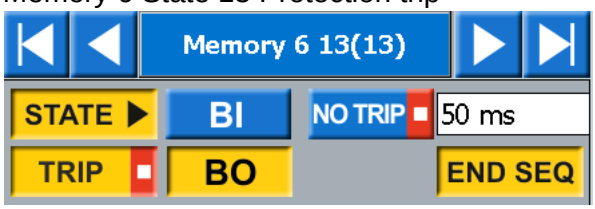
Memory 4 State 9 Protection start



Memory 5 State 11



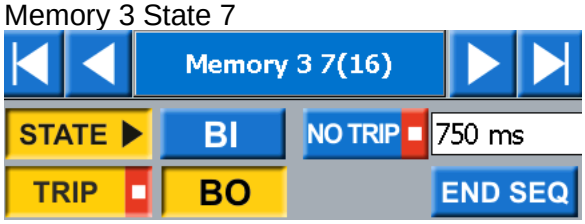
Memory 6 State 13 Protection trip



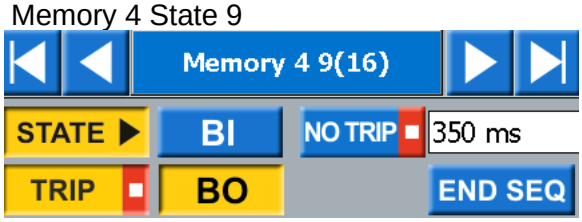
For more information about copy states see SVERKER manual chapter 4.6 Sequencer instrument.

The same sequence can be used for other settings in the REF620, but adjustments must be done in the memory states. Below is an example with “Reset delay time” set to 800ms, wherein 11 states are needed. Change memory time in states 7, 9, and 11. Set state 11 to “END SEQ”.

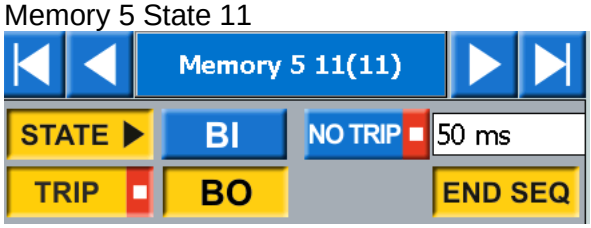
Memory 3 State 7



Memory 4 State 9



Memory 5 State 11



Result

S#	I1: A	U1: V	Rec...	/Stat...	BI1	BI2	Rec...
1	0.000	0.00	1000	1000	0	0	Time...
2	0.080	20.00	1020	20	0	0	Time...
3	0.000	0.00	1040	20	0	0	Time...
4	0.080	20.00	1060	20	0	0	Time...
5	0.000	0.00	1080	20	0	0	Time...
6	0.080	20.00	1100	20	0	0	Time...
7	0.000	0.00	1850	750	0	0	Time...
8	0.080	20.00	1870	20	0	0	Time...
9	0.000	0.00	1879	9	0	1	Event
9	0.000	0.00	2220	350	0	1	Time...
10	0.080	20.00	2240	20	0	1	Time...
11	0.000	0.00	2248	8	1	1	Trig
Σt-S1			1248				

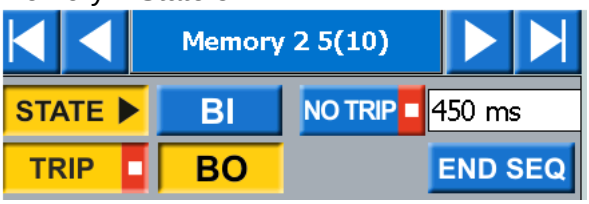
The time set in memory states must always be less than the reset delay time, otherwise the function will reset and start from the beginning

The easiest way to test the intermittent function is to make four fault states 2, 4, 6 and 8 with a 20ms time. Make three memory states 3, 5 and 7 and set in between the fault states with a 20ms time. Including pre-fault state, this makes 8 states. The protection will start in state 9 after the fourth fault. Add fault states with 20ms time and memory states between the fault states with time set within “Reset delay time” before next fault until “Operate delay time” has been reached. When the next fault comes, the protection will trip. The total time might not be close to “Operate delay time” but the function will be checked. For the protection to trip, it always needs one more fault state after full “Operate delay time” has been reached.

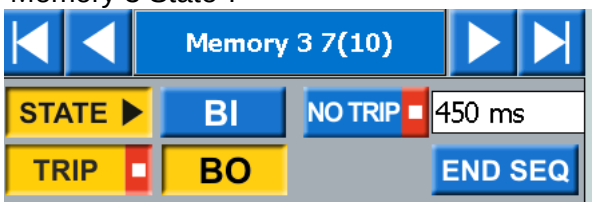
Transient function

REF620: The transient function always starts after second fault.
SVERKER 900: Use the same sequence as the one used for Intermittent function with **“Reset delay time”** set to 500ms. Change memory time in states 5, 7 and 9 set state 10 to **“END SEQ”.** Protection starts in state 5 and trips in state 10.

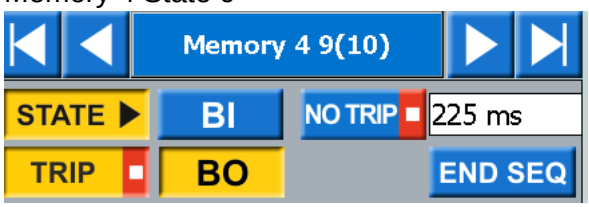
Memory 2 State 5



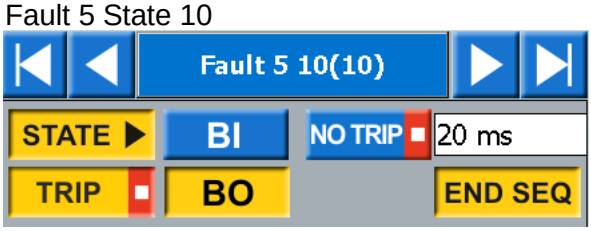
Memory 3 State 7



Memory 4 State 9



Fault 5 State 10



Result

S#	I1: A	U1: V	Rec...	/Stat...	BI1	BI2	Rec...
1	0.000	0.00	1000	1000	0	0	Time...
2	0.080	20.00	1020	20	0	0	Time...
3	0.000	0.00	1040	20	0	0	Time...
4	0.080	20.00	1060	20	0	0	Time...
5	0.000	0.00	1071	11	0	1	Event
5	0.000	0.00	1510	450	0	1	Time...
6	0.080	20.00	1530	20	0	1	Time...
7	0.000	0.00	1980	450	0	1	Time...
8	0.080	20.00	2000	20	0	1	Time...
9	0.000	0.00	2225	225	0	1	Time...
10	0.080	20.00	2232	7	1	1	Trig
Σt -S1			1232				
Σt			2232				

The protection starts after the second *“spike”* in state 5 presented as an “Event” in the result. When delayed time set in the protection is reached and a final *“spike”* is received in state 10 the protection trips. The feeding is turned off and presented as a “Trig” in the result.

With this changed sequence the “Transient function” can be tested with other setting values for “Reset delay time” in REF620 but adjustments must be done in the memory states.
The times set in memory states must be below “Reset delay time”.