

7SR224 Recloser Controller

Overcurrent Relay

Document Release History

This document is issue **2010/05**. The list of revisions up to and including this issue is:

2008/11	First draft
2009/09	First Issue. Software version updated
2010/04	Third Issue. Software version updated
2010/05	Fourth Issue. Document formatted due to rebrand

Software Revision History

2008/10	2435H80011R4-3	First issue with Single/Triple Autoreclose function
2009/09	2435H80011R4c-3b	Maintenance Release without change to this function
2010/04	2435H80011R4d-4	Phase allocation and sequence, no change to this function

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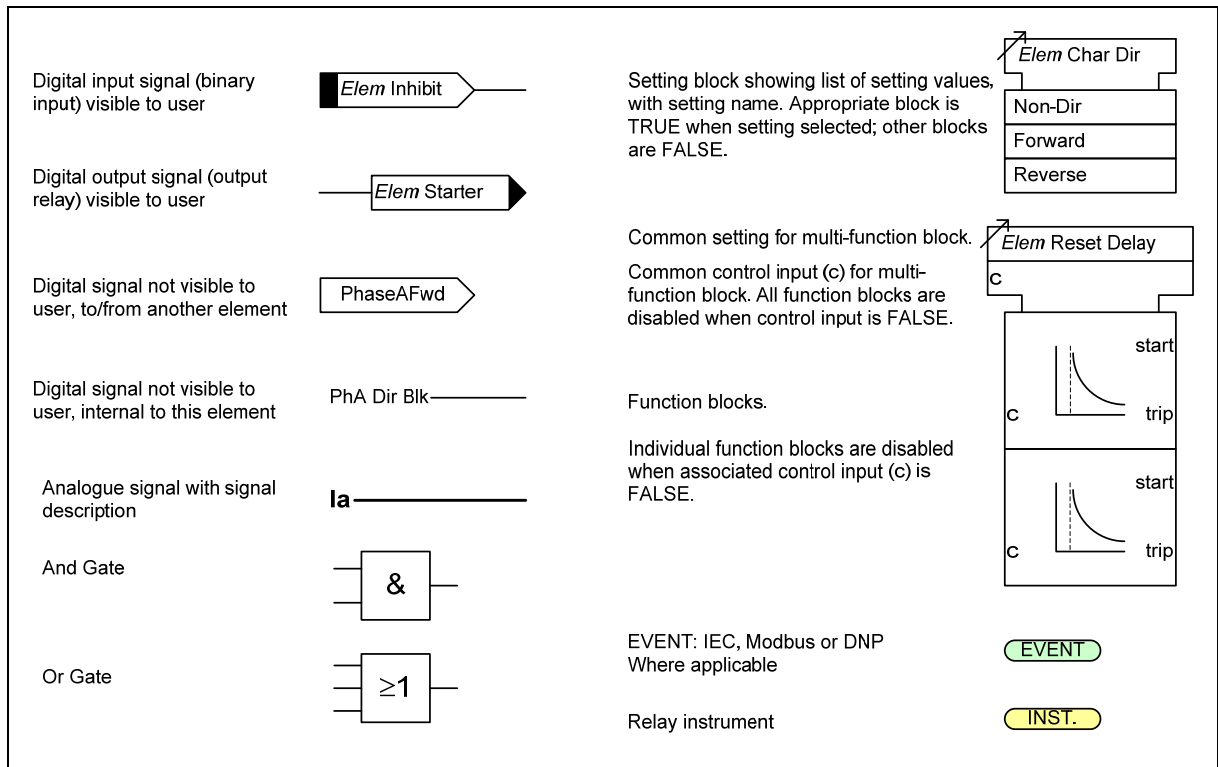
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Symbols and Nomenclature

The following notational and formatting conventions are used within the remainder of this document:

- Setting Menu Location MAIN MENU>SUB-MENU
- Setting: ***Elem name -Setting***
- Setting value: **value**
- Alternatives: **[1st] [2nd] [3rd]**



Section 1: Description of Feature

1.1 Single Triple Autoreclose

This additional functionality is available as an ordering option when required to suit application requirements. Three pole commands and controls available in the standard controller are replaced by pole segregated inputs. Operations counters, Circuit Breaker Fail and I²T functions are available on a pole by pole basis, these replace the standard functionality.

The capacitor test function which is used to test the condition of the capacitor network is duplicated in the Single/Triple recloser to provide extended functionality for monitoring of the additional capacitor networks to suit phase segregated Recloser mechanisms. The three capacitor networks are tested simultaneously.

In a system where the three phases of the supply are used independently to provide single phase to neutral connected loads, the three phases of the Recloser can be tripped and reclosed separately to produce less interruption to the unfaulted phases and to provide better co-ordination with single phase devices fitted downstream. This function allows the asynchronous reclosing sequences in the three phases to be controlled by a single controller device at the point where the three independent single phase reclosers are adjacent, i.e. before the split point. The controller provides phase segregated protection elements as well as elements such as earth fault for which the phase selection is not clearly defined. The controller provides logic and settings to allow trip and reclose of different phase combinations to provide the fastest clearance of faults with minimum system disruption. Standard 3 pole tripping elements such as voltage elements can be configured to start or lockout the autoreclose function using quicklogic, virtual I/O and the external AR start input to suit operational requirements.

The practice of single phase HV distribution systems is commonly used in some countries, particularly in rural areas where loading is light.

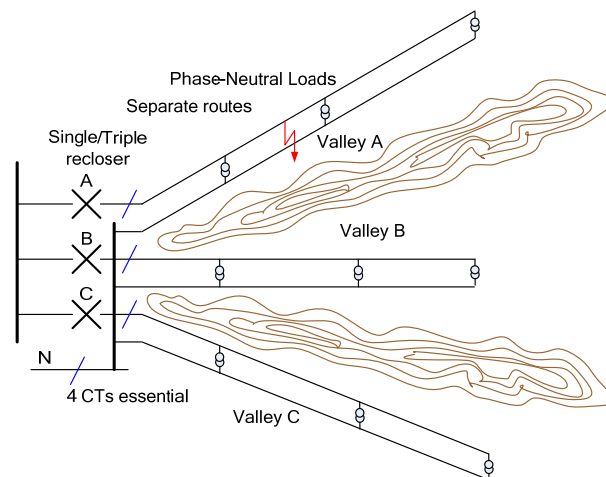


Figure 1.1-1 Typical arrangement of Single/Triple Recloser

The Single/Triple controller has three modes of operation and operation mode can be changed by settings and relay inputs. This means that the response to a fault can be variable to suit system requirements.

Mode A, 3P Trip 3P LO, allows only three pole tripping and 3 poles are tripped regardless of the fault type, Three pole Autoreclose can be set to execute for any protection element. The Lockout state applies to all poles. This allows the recloser to operate as a standard three pole device.

Mode B, 1P Trip 3P LO, allows 1P trips for faults diagnosed as affecting only 1 phase and generated from elements which will start an autoreclose sequence. For faults detected by these protection elements which are diagnosed as affecting more than one phase, three pole trips are issued and three pole autoreclose is executed. Three pole trips are therefore issued for all fault detections for which single pole autoreclose will not return the recloser to the three poles closed state. Lockout is a three pole condition and logic in the controller ensures that in this Mode the recloser is never left in a single pole open condition for an extended period. A single pole reclose sequence in progress will be converted to three pole reclose or terminated by Lockout by the generation of a three pole trip if a simultaneous fault or fail to reclose occurs.

Mode C, 1P Trip 1P LO, allows the three poles of the recloser to operate independently for fault detections which are diagnosed as affecting a single pole only. The Lockout condition on one phase, resulting from a non-reclosing protection element operation or failure to reclose during a sequence, is independent of the other poles. Single or two pole Lockout and the accompanying single or two pole open condition is allowed to exist indefinitely and does not affect the autoreclose sequences subsequently applied to the other pole(s). Fault detections which are diagnosed as affecting more than one pole will trip and reclose the affected two or three poles.

If Single pole Trip is allowable then each Recloser can each be independently Tripped and Closed as a single pole Circuit Breaker. In some circumstances all three Reclosers must be Tripped and Closed as a three pole device. Each Recloser has its own Trip/Close circuits and CB Open/Closed Auxiliary contacts. Each Recloser has its own Manual Trip & Lockout handle. Each Recloser also has its own external push button switches to provide local electrical Trip/Close input signals. The I/O matrices and the internal logic of the Single/Triple Controller is extended, compared to the standard Controller, to include interfaces to suit this additional functionality. The Controller provides logic and interlocking to ensure that correct operation occurs in all modes.

The controller provides three independent autoreclose elements whose operations are automatically internally linked and sequences synchronized as applicable to suit the setting selections, type of fault applied and progress of sequences. Each pole has independent shot counters which are used to select the required deadtime and control the application of Instantaneous Element Blocks on a pole by pole basis to achieve co-ordination with other single pole devices in the system.

1.1.1 Mode A – 3P Trip 3P LO

Mode A allows the three single pole Reclosers to operate in three pole mode as a standard three pole Recloser.

Protection elements operations are issued to all of the pole segregated trip outputs simultaneously and all autoreclose sequences are three pole. If any pole goes to Lockout for CB Fail to Close, a three pole trip and lockout is issued

All Manual Open and Close commands for the Recloser, from binary inputs or via serial comms to the Controller are simultaneously applied to all three poles. For example, a 'Open CB A' command will open only pole 'A' when the controller is set in Mode C, but all three phases will be opened if this command is raised when the controller is set to Mode A.

Although the tripping logic and control functions operate in three pole mode, the operations counters are still executed on a pole by pole basis. This allows the correct co-ordination with single pole reclose equipment downstream. Separate counts are recorded for each phase for Phase fault High set and Delayed trips and checked against the Number of Trips to Lockout settings. The Protection Trip counter which is used to inhibit Instantaneous protection during Delayed shots is common for all phases and Earth Faults.

1.1.2 Mode B – 1P Trip 3P LO

Mode B provides single pole tripping and reclose to minimize disruption to load connected on the unfaulted phases in a three phase system. Mode B will only allow single pole trips to be issued if autoreclose follows, to return the recloser to a normal 3 poles closed condition. This mode should be used on a 3 phase system where it is undesirable to allow the system to have a single pole open for any extended period of time but where a transient single pole open condition during autoreclose can minimize disruption to supply on the unfaulted phases.

The operation of any tripping protection element which does not start autoreclose will cause a three pole trip. Single pole tripping is not allowed if Autoreclose is disabled or switched out. Single Pole tripping is only allowed if the affected phase can be identified. Earth Fault and SEF elements which are operated by residual current cannot discern the phase affected by the fault and the operation of these elements must be used in conjunction with phase element starters to diagnose the faulted phase for single pole tripping.

Two phase tripping is never allowed in Mode B. Any fault detection affecting more than one phase will cause a three pole trip. If a protection element operates on a second phase during a single pole autoreclose dead time, the controller will force a three pole trip of the recloser which may be followed by a three pole reclose.

If a single pole autoreclose is not successful, when Lockout is reached, the controller will force a three pole trip of the recloser.

The External Trip input is assumed to have caused a three pole trip and will start a three pole reclose sequence.

All Manual Open and Close commands for the Recloser, from binary inputs or via serial comms to the Controller are simultaneously applied to all three poles. For example, a 'Open CB-A' command will open only pole 'A' when the controller is set in Mode C, but all three phases will be opened if this command is raised when the controller is set to Mode B.

The Line Check & Hot Line working functions prevent autoreclose from executing and therefore these functions also force any affected trip to be three pole only.

The table below shows the single/three pole tripping decision logic:

State	Supplementary Starter State Data	S/T ACTION
SEF Op	No other Starters or Outputs raised	3PTrip & 3PARC
SEF Op	E/F Starter or Output raised, no other Starters or Outputs raised	3PTrip & 3PARC
SEF Op	Any single P/F pole X Starter or Output raised	1PXTrip & 1PXARC
SEF Op	Two Three P/F pole Starters or Outputs raised	3PTrip & 3PARC
E/F Op	No other Starters or Outputs raised	3PTrip & 3PARC
E/F Op	SEF Starter or Output Raised	3PTrip & 3PARC
E/F Op	Any single P/F pole X Starter or Output raised	1PXTrip & 1PXARC
E/F Op	Two Three P/F pole Starters or Outputs raised	3PTrip & 3PARC
SEF E/F PF Op	one two poles in OPEN but NOT @ Lockout State i.e. Trip due to second pole while first is in Dead time	3PTrip & 3PARC
Pole X Op	No other Starters or Outputs raised	1PXTrip & 1PXARC
Pole X Op	SEF Starter or Output and/or E/F Starter or Output raised	1PXTrip & 1PXARC
Pole X Op	Any other P/F starter or Output raised	3PTrip & 3PARC
A79Prime Lockout=True	Next A pole ARC Config Element operation forces <i>Three pole Trip & Lockout</i>	<i>Three pole Trip & Lockout</i>
B79Prime Lockout=True	Next B pole ARC Config Element operation forces <i>Three pole Trip & Lockout</i>	<i>Three pole Trip & Lockout</i>
C79Prime Lockout=True	Next C pole ARC Config Element operation forces <i>Three pole Trip & Lockout</i>	<i>Three pole Trip & Lockout</i>
	Any pole Trip & Lockout Command	3PTrip & Lockout
	The following are all Three pole Trip regardless of MODE	3P ACTION
External Trip	X – Don't Care	3PTrip & 3PARC as per settings / mapping
	3P Trip & Reclose Command	3PTrip & Reclose
Non ARC	Any other non-ARC element operation e.g. Voltage / Frequency [unless mapped to External ARC Start]	3PTrip & Lockout

Table 1 Mode B operation - Logic Table of Element operation / Starter states determining the Single / three pole (Triple) Trip & ARC logic.

1.1.3 Mode C – 1P Trip 1P LO

Mode C provides phase segregated control of three independent single pole reclosers. Operation of the single pole reclosers can be synchronized to suit the applied fault to provide the correct clearance sequence whilst retaining the ability to provide independent single pole sequences running concurrently for separate coincident faults on different poles.

Any pole can reach the Lockout state due to a persistent fault or a failure of plant. This results in a single pole open condition which will remain until manual action is taken to restore. The operation of the controller for subsequent faults on the other phases is not affected by the Open or Lockout state on the previously faulted phase.

During coincident, independent autoreclose sequences on two or three phases, the issue of the independent close pulses is aligned so that if the fault is actually multi-phase and persistent, Close Onto Fault and the start of subsequent Deadtimes are aligned. This avoids the possible scenario where the fault duration is extended by passing fault from one phase to another by re-energising a second phase with ionization still in the vicinity from Close onto Fault of the first pole to reclose.

Independent sequence counters are incorporated for each pole. The number of shots to Lockout are counted separately on each pole, for High set, Delayed and total number of shots. This means that if faults are detected on two or more phases simultaneously, during an autoreclose sequence that was already In Progress on one phase, the controller may be executing shot 1 for one pole whilst on shot 2 for another. One Pole may actually count to Lockout before the other, which will continue with further shots and also whilst one pole blocks instantaneous protection to go to Delayed protection only, the other phase will continue to operate with Instantaneous protection unblocked. This is correct operation and allows the single pole reclosers to retain correct co-ordination with other single pole devices in the system.

In Mode C the controller handles Manual Open and Close commands to the three single pole Reclosers on an individual pole basis. For example *Open CB-A* and *Close CB-A* do not affect poles B or C. Similarly the *Trip and Lockout* inputs are provided for each pole separately but *Trip and Reclose* is provided as a three pole function only. The External Trip function is provided as a three pole function only.

The operation of any tripping protection element which does not start autoreclose will cause a three pole trip. Single Pole tripping is only allowed if the affected phase can be identified. Earth Fault and SEF elements which are operated by residual current cannot discern the phase affected by the fault and the operation of these elements must be used in conjunction with phase element starters to diagnose the faulted phase for single pole tripping.

Two phase tripping is allowed in Mode C. Any fault detection affecting more than one phase will cause a trip of the affected phases. If a protection element operates on a second phase during a single pole autoreclose dead time, the controller will issue a single pole trip of the second pole of the recloser which will be followed by a single pole reclose of this pole also. The Close Pulses to the two poles will be aligned

If a single pole autoreclose is not successful and Lockout is reached, this applies to the affected pole only. The controller will not force a three pole trip of the recloser.

State	Supplementary Starter State Data	S/T ACTION
SEF Op	No other Starters or Outputs raised	3PTrip & 3PARC
SEF Op	E/F Starter or Output raised, no other Starters or Outputs raised	3PTrip & 3PARC
SEF Op	Any single P/F pole X Starter or Output raised	1PXTrip & 1PXARC
SEF Op	Two P/F, pole Y and pole Z, Starters or Outputs raised	2PYZTrip & 2PYZARC
SEF Op	Three P/F pole Starters or Outputs raised	3PTrip & 3PARC
E/F Op	No other Starters or Outputs raised	3PTrip & 3PARC
E/F Op	SEF Starter or Output Raised	3PTrip & 3PARC
E/F Op	Any single P/F pole X Starter or Output raised	1PXTrip & 1PXARC
E/F Op	Two P/F, pole Y and pole Z, Starters or Outputs raised	2PYZTrip & 2PYZARC
E/F Op	Three P/F pole Starters or Outputs raised	3PTrip & 3PARC
SEF E/F Op	AND one two poles in OPEN but NOT @ Lockout State i.e. Trip due to second pole while first is in Dead time	3PTrip & 3PARC
SEF E/F Op	AND one pole in OPEN but NOT @ Lockout State AND Pole X Starter or Output raised i.e. Trip due to second pole to Ground fault while first pole is in Dead time	1PXTrip & 1PXARC
SEF E/F Op	AND one pole X already in Lockout state	3PTrip & 3PARC
SEF E/F Op	AND two poles X & Y already in Lockout state	3PTrip & 3PARC
Pole X Op	No other Starters or Outputs raised	1PXTrip & 1PXARC
Pole X Op	SEF Starter or Output and/or E/F Starter or Output raised	1PXTrip & 1PXARC
Pole X Op	One other Pole Y P/F starter or Output raised	2PXYTrip & 2PXYARC
Pole X Op	Two P/F, pole Y and pole Z, Starters or Outputs raised	3PTrip & 3PARC
Pole X Op	AND 1 2 poles Y & Z already in Lockout state [don't care]	1PXTrip & 1PXARC
A79Prime Lockout=True	Next A pole ARC Config Element operation forces Pole A Trip & Lockout	<i>Single pole A Trip & Lockout</i>
B79Prime Lockout=True	Next B pole ARC Config Element operation forces Pole B Trip & Lockout	<i>Single pole B Trip & Lockout</i>
C79Prime Lockout=True	Next C pole ARC Config Element operation forces Pole C Trip & Lockout	<i>Single pole C Trip & Lockout</i>
	Single Pole Trip & Lockout command	1PTrip & 1P Lockout
	The following are all Three pole Trip regardless of MODE	3P ACTION
External Trip	X – don't Care	3PTrip & 3PARC as per settings / mapping
	3P Trip & Reclose command	3PTrip + 3PARC
Non ARC Config Prot'n	Any other non-ARC element operation e.g. Voltage / Frequency [unless mapped to External ARC Start]	3PTrip

Table 2 Mode C operation - Logic Table of Element operation / Starter states determining the Single/Two/Three pole (Triple) Trip & ARC logic.