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GE Power Management

Modular Recloser

DAR 2000

Instructions
GEK-106211

DAR 2000

MODULAR RECLOSER

These instructions do not purport to cover all details or variations in equipment nor provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

1. PRODUCT DESCRIPTION

DAR 2000 relay is a multiple shots, modular, solid state electronic recloser. It has been designed to automatically reclose HV circuit breakers (3 phase) previously tripped by the operation of any protective relay.

By using programmable integrated circuits, it has been possible to reach a high degree of integration, having all the desired features for a reclosing system in a minimum size device.

The power supply module of DAR 2000 has been designed using a DC – DC converter, with galvanic isolation between primary and secondary.

DAR 2000 includes a five digits reclosures counter, manually resetable.

Figure 1, at the end of this instruction manual, chapter Figures List, shows a front view of a DAR 2000 relay.

There are DAR 2000 relay models for different Reclose Initiation conditions:

1. Operation of the protective relays and opening of the circuit breaker.

2. Operation of the protective relay (only).

3. Opening of the circuit breaker (only).

This system limits the duration of the reclosing operation to a specific time, programmable by the user. If the status of the breaker is given to the system, among other pieces of information given to the DAR 2000, and the system detects that the breaker does not close in the programmed time, the recloser goes to the Lock-Out status or to the Reset status, depending on the DAR 2000 model chosen.

DAR 2000 includes blocking features that keep the system in the Lock-Out status for the following conditions:

1. The fault persists after the number of shots programmed in the relay.

2. DAR 2000 recloser cannot perform the reclosing operation, after the time set, because the system does not meet the reclosing conditions required (No Reclosing Conditions).

3. After a reclosing command issued by the DAR 2000 system, and after the closing time set in the relay, the circuit breaker remains open. For this feature to be in service, it is necessary to let the DAR 2000 system know the status of the breaker by wiring one auxiliary contact of the circuit breaker to the relay. (There are models that resets under this situation instead of blocking, depending on the user preferences).

4. After a manual closing command, issued using an external switch or through the DAR 2000 system itself, a protection trip occurs in the reset time set in the recloser.

The relay includes a feature (programmable by using jumper J2 in the RLM board), that allows automatic reset from the Lock-Out status after the 'reset time' set in the system.

The Reclose Cancel / Blocking signal can be set as pulse signal by using jumper J4 in the RLM board.

The Blocking time, after a manual closing command, is programmable, and it will be equal to the Reset time after a successful closing operation.

After the first reclosing operation, any trip that may occur in the Blocking time, will be understood by the DAR 2000 system as associated to the same fault that persists in the power system. DAR 2000 will perform the set of shots programmed until the last one is reached; after that, if a new trip is issued by a protective relay in the blocking time, DAR 2000 system will move to the Lock-Out status. If the Blocking time expires without any trip is issued, the system will move to the Reset status, being ready for a completely new cycle of reclosing attempts.

DAR 2000 includes on the frontal name plate a reset push-button that allows the user to reset the system from any possible internal status.

Once the reclosing cycle has been initiated, the external 'reclose in progress' contacts are closed, to allow the user to block the instantaneous tripping functions of the protective devices after the first trip.

2. MODEL LIST

The complete list of different models available for DAR 2000 systems is as follows:

DAR	2	-	0	-	A	0	0	0	-	0	0	-	
		0											Without Testing Block.
		1											With Testing Block.
				0									Reclose initiation by Protection trip and 52 opening or only by 52 opening. System blocking after a failure to close.
				1									Reclose initiation by Protection trip and 52 opening or only by 52 opening. System resets after a failure to close.
				2									Reclose initiation only by a protection trip.
									A				Power Supply: 48 Vdc
									B				Power Supply: 110 / 125 Vdc
									C				Power Supply: 220 / 250 Vdc
												A	Revision level.

3. INPUT SIGNALS

The operation of the DAR 2000 system depends on the activation or deactivation of several external signals that are described in this chapter. These signals come from external contacts from other devices, and get into the logic circuits of the DAR 2000 system through special contact converters in the DAR 2000 system. By means of opto-couplers, the contact converters keep the galvanic isolation between the DAR 2000 system and the electric installation in the substation.

These signals are:

1. Tripping outputs coming from protective relays:

    - Instantaneous trip - CC1.
    - Time delayed trip - CC2.

2. Line circuit breaker status information:

    - Auxiliary contact 52/b - CC3.

3. External Reclose Cancel / Block - CC4.
4. No reclosing conditions - CC5.
5. External manual closing command (pulse) - CC6.
6. Manual closing command through the DAR 2000 system (pulse) - CC7.
7. Recloser remote reset command (pulse) - CC8.

4. OUTPUT CONTACTS

DAR 2000 system issues while operating the following digital output signals, through its output contacts (dry contacts, free of voltage):

1. Auxiliary voltage exists: switched contact.
2. Reclose in progress: two normally open contacts.
3. Reclose command: two normally open contacts.
4. Recloser in Lock-out status, Blocked: two normally open contacts.

5. TARGET OUTPUTS AND SIGNALING

DAR 2000 includes 4 LED (Light Emitting Diodes) in the front name plane of the Power Supply Module, FSR, to quickly have the necessary information of the status of the recloser system:

1. Auxiliary voltage exists (green LED, Vdc label).
2. Reclose in progress (red LED, RP label).
3. Recloser Blocked / Lock-out status (red LED, L/O label).
4. Recloser Blocked / Lock-out status due to No Reclosing Conditions (red LED, NRC label).
5. Closures count (5 digit mechanism).

6. SETTINGS AND CONTROL ELEMENTS

Settings and control elements located in the frontal nameplate of the power supply, FSR:

1. ON / OFF switch.
2. Reclosures counter reset push-button.

Settings and control elements located in the frontal nameplate of the logic module, RLM:

1. Three sets of 8 micro-switches each, for the time setting associated to each reclosing attempt for the three timed shots.
2. One 8 micro-switches set for the Blocking / Reset time.
3. One 4 micro-switches set to select the reclosing scheme.
4. One system manual reset push-button.

Settings and control elements located inside the logic module, RLM:

1. Dwell time, or duration of the closing command, programmable using one 8 micro-switches set.
2. Automatic reset time, programmable using one 8 micro-switches set.
3. Hold Mode YES / NO, programmable using J1 jumper IN / OUT. This setting states if, after the reclosing time delay expires, being the No Reclosing Conditions input ON, the system must wait (IN) or not (OUT), during a maximum time set by the Blocking time, for the input to become OFF, to issue a reclosing command.
4. Automatic reset (J2 - IN / OUT). This setting states if the recloser will leave the Lock-out status automatically (IN position), after the time set using the automatic reset time switch.
5. Blocking output mode (continuous / pulse, J4 jumper L / P). This setting states if the contacts and the LED for the Lock-out status must remain ON until the system leaves to the reset status (L position) or if user prefers to have them ON for 50 ms only (pulse mode, P position).
6. One / Multiple shots (J6 - IN / OUT). This setting states if DAR 2000 system will perform just one reclosing attempt, (IN position), or if it will perform the complete set of reclosing attempts programmed (OUT).
7. Circuit breaker status reclose initiation only (J5 IN / OUT). This setting states if the recloser will be initiated just with the circuit breaker status (IN position).

7. ELEMENTARY DIAGRAM

Figure 2, in the Figures List chapter, at the end of this instruction manual, shows the elementary diagram for DAR 2000. In this diagram user will find all the inputs and outputs defined in previous chapters.

8. APPLICATION

More than 80% of the faults that may take place on distribution lines are temporary, transient faults, that can be removed from the system by the temporary disconnection of the faulty line from the rest of the electrical network. Due to this fact, and in order to maintain the maximum power delivery continuity to the consumers, recloser systems like DAR 2000, are used.

From the transient faults, most of them can be completely removed from the system by keeping the line disconnected less than 10 sec. Approximately 10% needs between 10 to 50 sec to be removed. Just a few of them precise times longer than 50 sec.

Time between the circuit breaker trip and the reclosing is called 'dead time' or 'reclosing time'.

This time must be long enough to assure the air de-ionization that formed the fault path, and also to assure the reset and stabilization of the circuit breaker mechanisms. Times varying between 0.4 to 120 seconds are practically used, though field experiences shown that times between 10 to 15 seconds assure the maximum success possibilities.

A typical solution used is apply a quick reclosing with a time delay of less than 10 sec. Power delivery continuity may be improved by adding two or more reclosing attempts with a longer time delay, until 120 seconds.

Another important time that must be set in any reclosing device is the so called 'Reset time after a reclosing operation' or also called 'Blocking time'. This refers to the time that the circuit breaker must remain closed, without any new fault being detected, for the recloser to move to the Reset / Ready status. This is why this time setting is called 'Reset time'.

This time is particularly important under frequent fault conditions, as for example during bad weather conditions, storms, or conductors hits during strong winding conditions. In these situations, a reset time too long may take the relay to the Lock-out status, causing undesired power delivery interruptions. This time depends on the nature of the faults, the most probable ones, etc. Good results may be obtained with times between 5 to 100 seconds.

There are different reclosing schemes depending on the decision taken after detecting that the circuit breaker has not closed. In these cases, the system waits for a time that varies between some seconds to minutes since the reclosing command is issued. After this time expires, the recloser may move to the Lock-out status or to the reset status, depending on the application. There are DAR 2000 systems for both possible applications.

8.1. Instantaneous Reclose

This reclosing attempt consists on trying to reclose the circuit breaker instantaneously just after its opening, without any intentional time delay. This reclosing mode may be disabled.

8.2. Instantaneous Trips Blocking

DAR 2000 system provides one 'Reclose in Progress' digital output that may be used to block the instantaneous tripping functions of the protective relays after the first trip is issued. This feature allows to coordinate the protective relays with feeders protected by fuses. (Fuse saving).

This coordination consists on protect or save the fuses with one instantaneous trip. After this first trip, and the reclosing of the circuit breaker, the instantaneous tripping functions are blocked so the fuse operates and blows.

The result of this practice is to interrupt the service to the smallest area possible due to permanent faults in these feeders, and to return servicing the loads quickly for transient faults.

8.3. Reclose Initiation

As mentioned in previous sections, in the DAR 2000 family of relays there are different models depending on the way user wants to initiate the reclosing operation:

1. One model needs information regarding the trip of the protective relays and the status of the circuit breaker (by means of the appropriate external logic, this model may be used for reclose initiation by circuit breaker status only.)

2. A different model only initiates by a protective relay trip.

The main difference between these two models is the meaning of the closing time setting. For the model using the circuit breaker status to initiate, this setting is used to define the time window the relay waits to detect the closing of the circuit breaker after a reclosing command is issued, to decide if a closing failure has occurred. For the model that only initiates by a protective relay trip, this setting is the dwell time, (the time the output contacts issuing the reclosing command remains closed, independently on the circuit breaker status.)

Figures 3, 4 and 5 show the different reclose initiate circuits applicable for each model and option.

8.4. Manual Closing

Any fault appearing just after issuing a manual closing command is considered to be a permanent fault and caused by circumstances existing before the closing command was issued. Due to this reason, if a trip occurs just after a manual closing command, the recloser will not perform any reclosing attempt, and will move to the Lock-out status.

DAR 2000 relays include two manual closing command inputs. The activation on any of them must be done by using a pulse signal. These inputs are:

1. External Manual Closing Command.
2. Manual Closing Command through the DAR 2000 reclosing system.

Activating the first input, DAR 2000 begins counting the blocking / reset time set. If a trip occurs in this time, the system moves to the internal Lock-out status. If this time expires without any trip coming in, the system will move to the internal reset / ready status.

The second input, to manually close the circuit breaker through the recloser, is used in those applications where user prefers the DAR 2000 system to close the circuit breaker. By doing this, the closing circuit of the DAR 2000 system will be tested or checked, each time the user issues a manual closing command. If this feature is used, DAR 2000 system will close the circuit breaker after the time set for the first shot.

After the closing command is issued, the relay begins to count the blocking / reset time, in the same way that when an External Manual Closing Command is issued, as previously described.

When only the circuit breaker status input is used to initiate the reclosing operation, an auxiliary contact from the circuit breaker control panel must be used to inform the DAR 2000 relay whether the circuit breaker has been open or closed manually or by the tripping of a protective relay. If no information is received from the circuit breaker control panel, any opening of the circuit breaker will initiate the recloser. See figure 3 at the end of this instruction book on how to do the appropriate external connections, and avoid initiate the recloser for undesired situations.

Using the wiring diagram described in figure 3, the initiation of the recloser is done using an auxiliary contact from the circuit breaker (52/b) and a normally open contact that will close with the manual closing command, and will remain closed until the next manual opening. For the closing command, a contact that will remain closed for the duration of this command, will be used.

8.5. Closing Command

DAR 2000 includes an internal setting that allows to program the time the output reclosing contacts must be closed.

For those DAR models using the circuit breaker status information, the closing command ends when the appropriate indication from the circuit breaker closing is received by the system. If this closing indication is not received in the closing time set in the DAR 2000, this situation is consider to be a failure to close, and the recloser will move to the Lock-out status or will reset, depending on the particular DAR 2000 model.

For the model that only is initiated by the tripping output from the protective relays, the duration of the closing command is always the closing time set, independently on the operation of the breaker.

8.6. Reset Status

When the Lock-out status is reached, DAR 2000 relays can be reset in the following ways:

1. Pushing the reset push-button located in the front name plane of the RLM module.
2. Energizing, using a pulse signal, the external manual reset input.
3. Issuing a manual closing command, using the control panel directly to the circuit breaker or through the recloser.
4. Setting the automatic resetting feature to YES. In this case, the system will move from Lock-out to the Reset / Ready status after the programmed reset time.

8.7. Reclose Cancel

The recloser initiation may be blocked energizing continuously the blocking input, corresponding to the CC4 contact converter. This blocking operation also blocks the manual closing through the recloser.

Once the recloser has been initiated and is in progress, the reclosing command remains blocked while the No Reclosing Conditions input is energized. (contact converter CC5).

The continuous energization of the Remote Reset input, contact converter CC8, also keeps the reclosing blocked permanently, so no status change is allowed in the system.

8.8. Practical Hints on Application

When an automatic reclosing operation is desired, the following hints should be taken into account:

1. Circuit breaker blocking: in order to assure a successful first reclose of the circuit breaker, if it is an instantaneous reclosing, it is necessary that the circuit breaker mechanism includes a device to allow the closing operation only when the opening operation has been completely performed.

2. Undervoltage devices: when instantaneous reclosing is required in substations including undervoltage relays, these relays must be set with a time delay long enough to take into account the reclosing waiting time, to avoid undesired trips.
3. Protective relays: protective relays tripping the circuit breaker must open their tripping output contacts before the circuit breaker begins the closing operation, to avoid tripping the circuit breaker immediately again, even without any fault in the power system.
4. Closing circuits: It is essential that the closing circuit assures the complete closing of the circuit breaker even in the case the closing circuit being interrupted before the closing operation is completed.
5. Circuit Breaker Breaking Capability: The rated cycle of openings and closings of the circuit breaker must be taken into consideration before applying a reclosing relay and before selecting any reclosing program.

9. TECHNICAL SPECIFICATIONS

9.1. Timers

- Instantaneous reclosing : 50 ms.
- First timed reclosing : 0.1 to 25.5 s. Step: 0.1 s.
- Second timed reclosing : 1 to 255 s. Step: 1 s.
- Third time reclosing : 1 to 255 s. Step: 1 s.
- Blocking / Reset time : 1 to 255 s. Step: 1 s.
- Closing time : 0.1 to 25.5 s. Step: 0.1 s.
- Automatic reset time : 1 to 255 s. Step: 1 s.
- Holding / waiting time : equal to Blocking time

9.2. Burdens

Battery voltage	48 Vdc	110 / 125 Vdc	220 / 250 Vdc
Control Inputs	0.9 W	2 W	3.6 W
Power Supply			
• Reset status	1.5 W	1.8 W	2.2 W
• Maximum (40 ms)	5.5 W	6.6 W	8 W

9.3. Input Contacts

- Minimum operating voltage : 25 Vdc
- Minimum energizing time : 10 ms.

9.4. Output Contacts

Reclosing and blocking	Make and carry 30 A (ANSI C37.90). Break 180 va resistive @ 125 / 250 Vdc Break 600 va inductive @ 125 / 250 Vdc
Blocking	Make and carry 30 A (ANSI C37.90). Break 180 va resistive @ 125 / 250 Vdc Break 600 va inductive @ 125 / 250 Vdc
Reclose in progress	Continuous 3 A. Make and carry 5 A for 30 s. Break 25 va inductive @ 125 / 250 Vdc

Battery voltage monitor	Continuous 3 A. Make and carry 5 A for 30 s. Break 25 va inductive @ 125 / 250 Vdc

9.5. Timers Accuracy

- ± 5 % or 25 ms.

9.6. Power Supply

- Operating range: ± 20 % of rated values.
- Maximum ripple permissible: 15 %

9.7. Temperature

- Operating range: - 20° C to + 55° C.
- Storage range: - 40° C to + 65° C.

9.8. Insulation Test Voltage

- 2 kV 50 / 60 Hz, one minute.

9.9. Impulse Voltage Withstand

- 5 kV peak, 1.2 / 50 microsec., 0.5 joules.

9.10. Interference Tests Withstand

- 1 MHz, 2.5 kV peak (longitudinal mode)
- 1 kV peak (transversal mode).

Decay time to half initial voltage: 3 to 6 cycles.
Repetition frequency: 500 cycles per second.

10. OPERATING PRINCIPLES

See figures at the end of this instruction book, figure 6, for the internal connections corresponding to the DAR 2000 model including a test block. For the model without test block, the same figure may be used, disregarding the items labelled TP (test point).

Figures 7, 8 and 9 represent the blocks diagrams for the different DAR 2000 models and operation modes:

Figure 7 : Describes the option with reclose initiation by protection trip and / or circuit breaker status, with blocking feature for a failure to close condition.
Figure 8 : Describes the option with reclose initiation by protection trip and / or circuit breaker status, with reset feature for a failure to close condition.
Figure 9 : Describes the option with reclose initiation by protection trip only.

These blocks diagrams are schematic logic representations of the DAR 2000 internal operation, and do not purport to represent the internal circuitry in full detail. The representation mode chosen is the one thought to be the most clear one, and even if it does not represent the physical reality, it does represent exactly the logical reality. For example, the timers; though in the diagrams each function has its corresponding timer, actually there is just one timer inside the relay, that is used by all the timed functions.

10.1. Recloser Operation

10.1.1. Reclose Initiation

As previously described, the reclose initiation command can be issued by:

1. the tripping of a protective relay and the opening of the circuit breaker.
2. Only by the opening of the circuit breaker.
3. Only by the tripping of a protective relay.

In any of these situations, the tripping and opening of the breaker caused by a fault taking place in the power system, drive to the energization of the contact converters, CC1 or CC2 and CC3, which generates a pulse output on OR2. This pulse initiates the sequencer S1, making it to move to the first reclosing attempt status and also initiates the reclosing timer TR. If this initiation is due to the energization of the IR (Instantaneous Trip) input, and the instantaneous reclosing mode is allowed, the sequencer S1 will move to the R1 status; if this initiation is due to the energization of the IRT (Time Delayed Trip) or if the instantaneous reclosing mode is not allowed, S1 sequencer will move to the status corresponding to the first timed reclosing attempt programmed (R2, R3 or R4).

The output of the sequencer energized defines the setting for the reclosing timer, through AND6, 7, 8 or 9 and OR10. It also energizes the Reclose in progress output,

through OR8, OR9, AND10 and T5. Timer T5 is used to delay the energization of the Reclose in progress output, in order to assure that, when this output is used to block the instantaneous tripping functions of the protective relays, its energization does not reset the protective relays before the circuit breaker opens.

When timer TR times out, the next steps depends on the setting for the Hold / Waiting function, and on the status of the No Reclosing Conditions input.

10.1.2. Hold Mode

1. If the No Reclosing Conditions input is off, the setting for the Hold / waiting mode has no effect on the operation of the DAR 2000 system. TR timer will energize the D Flip/Flop, T4 timer and TC timer (Closing timer), through AND13 and OR11.

2. If the No Reclosing Conditions input is on and the setting for the Hold / waiting mode is in the YES position, the expiration of TR timer will energize the H Flip/Flop and the starting of TE waiting timer, through AND11.

   If the No Reclosing Conditions input becomes off before TE times out, this timer will be reset through OR6 and NOT4, the D Flip/Flop and T4 timer input will be energized, and TC Closing timer will be initiated through NOT5, T2, AND14 and OR11. As the No Reclosing Conditions input resets the H Flip/Flop, T2 drop-out timer is necessary to allow the D Flip/Flop to be energized and the initiation of TC timer.

   If the No Reclosing Conditions input remains on when TE timer times out, L and NRC Flip/Flops will be energized through AND17, OR13 and OR16, sending the system to the Lock-out status, stopping and finishing the reclosing cycle and removing the Reclose in Progress signal resetting the S1 sequencer.

3. If the No Reclosing Conditions input is on and the Hold / waiting mode is in the NO position, at the expiration of the TR timer, L and NRC Flip/Flops will be activated through AND16, OR13 and OR16. These Flip/Flops, as previously described, will send the system to the Lock-out status, closing the cycle.

10.1.3. Closing Command

The activation of the D Flip/Flop causes the issuing of the closing command. T4 timer generates a pulse signal for the reclosures counter, that will increase its count by one. TC timer will determine the time the closing outputs will remain closed.

10.1.3.1. Models with information about the circuit breaker status.

If the contact converter associated to the 52/b is de-energized, meaning that the circuit breaker has closed, before TC timer finishes its count, it will be reset through NOT2 and OR12; D Flip/Flop will be reset through NOT2; B Flip/Flop will be energized through NOT2 and AND15; TB timer will be initiated through NOT2, AND15 and OR15. T3 timer is needed to generate a pulse signal to perform these last two actions.

As it has been explained, the duration of the closing command depends on the time it takes to the circuit breaker closed status information to be received.

If the contact converter associated to the 52/b remains energized, meaning that the circuit breaker is still open, and TC timer finishes its count, it will generate and output whose meaning will depend on the DAR 2000 model. If it is a DAR 2000 with blocking feature for a failure to close operation, then TC will energized L Flip/Flop, through OR16, blocking the recloser and cancelling the reclose cycle. If it is a DAR 2000 with reset feature for a failure to close, then TC will generate, through OR5, a reset command to all the different subsystems into the recloser.

10.1.3.2. Models without information about the circuit breaker status.

For these models, the closing time is the indicated by the setting, independently on the status of the circuit breaker.

When TC finishes its count, the same operations described before for the circuit breaker closing detection, are performed: D Flip/Flop de-energization, B Flip/Flop energization and TB timer initiation.

10.1.4. Reset Time

Once B Flip/Flop has been energized and TB timer initiated, the recloser waits for a new reclose initiation signal.

If TB timer times out without any new reclose initiation being received, its output will reset the complete system through OR3 and OR5, and will move the system to the ready / reset status, meaning that the closing operation has been successful. (TB timer is also called Reset Timer).

If before TB timer times out, a new reclose initiation is received, the pulse signal generated by P1 resets B Flip/Flop and TB timer through OR14. This pulse, through OR2, also moves on the sequencer to the following status, getting the system into a new reclosing process.

10.1.5. Cycle End

When the last reclose attempt is reached by the sequencer, BL output is activated, and then the output of OR7. If being this output active, a new reclose initiation is received before TB timer expires, L Flip/Flop will be activated through AND5 and OR16, moving the reclosing system to the Lock-out status due to a permanent fault condition.

As previously mentioned, if TB timer times out, the complete reclosing system, sequencer included, is reset. The resetting of the sequencer de-energizes the Reclose in progress signal.

10.1.6. Only one Reclosing Attempt

Independently on the number of reclosing attempts programmed in the DAR 2000 system, if the setting jumper J6, ONLY ONE ATTEMPT, is on the IN position, then the system will only perform one reclosing attempt. On the logic diagram, this is achieved in the following way: when B Flip/Flop is activated, after the first reclosing attempt, the output of OR7 gets active, allowing a new reclose initiation signal to block (send to the Lock-out status) the system, activating L Flip/Flop through AND5.

10.2. Manual Closing Command

10.2.1. External Manual Closing

An external manual closing command pulse resets the recloser, activates CMEL Flip/Flop and initiates through AND2 and OR15 the TB timer. The output from CMEL Flip/Flop keeps the OR7 output active, so if a new reclose initiation signal is received before TB timer expires, the recloser will move to the Lock-out status, through AND5. If TB timer times out, its output resets the complete system, CMEL Flip/Flop included.

10.2.2 Manual Closing through the Recloser System

A pulse for manual closing through the recloser system resets the system, activates the CMRL Flip/Flop and generates, through OR2, a pulse to move on the sequencer and to initiate the TR timer. When the reclosing time expires, a closing command, similar to the one generated in a regular reclosing cycle, is generated, and B Flip/Flop is activated during the blocking time. As CMRL Flip/Flop is active, the OR7 output is also active, so, in a similar way than for an external closing command, if a new reclose initiation is received before TB timer times out, the recloser system will be blocked (Lock-out), through AND5. If TB timer times out, its output will reset the complete system, CMRL Flip/Flop included.

10.3. Reset

Once the recloser has reached the Lock-out status, because of an activation of the L Flip/Flop, the resetting operation can be done in four different ways:

1. Manual Reset :

Pushing the PB1 push-button in the front name plate of module RLM, the system gets reset through OR19 and OR5.

2. Remote Reset :

Energizing the remote reset input (contact converter) of the DAR 2000 system resets the system, through OR19 and OR5.

3. Automatic Reset:

Once the Lock-out status has been reached, if the setting jumper J2 AUTOMATIC RESET, is on the IN position, then RR reset timer is initiated through P2. When RR timer expires, it resets the system through gate OR5.

4. Manual Close :

Both, an external closing command and a closing command through the recloser, will reset the DAR 2000 system before the closing operation begins.

10.4. Reclose Cancel / Blocking

The continuous activation of the Remote Reset input (contact converter) causes the permanent de-activation of the reclosing system. In the logic diagram this is achieved in the following way: OR19 and OR5 keeps the MR reset signal on.

The continuous activation of the BLOCKING input, prevent from a reclose initiation and from a manual closing command through the recloser, by blocking gates AND1 and AND4, respectively, through NOT1.

Finally, the energization of the No Reclosing Conditions input (contact converter) prevents, once the cycle has been initiated, from generating any reclosing command as mentioned above.

11. CONSTRUCTION

11.1. Case

DAR 2000 case is made of steel metal, with outline dimensions as shown in Figure 10.

The front cover is made of plastic, and can be fitted to the relay case by pressing on a rubber gasket located around the relay, which produces a dust-proof sealing.

RLM logic modules and the FSR power supply are mounted vertically. A DIN 41612 F connector located on the back panel is used for mechanical support and as the main electrical connection element. It keeps the module in its right place firmly.

DAR 2000 relays have two plastic slotted guides per module, one guide above and one guide beneath each module, with these guides a perfect module alignment is achieved.

11.2. Electrical Connections and Internal Wiring

Connection of the external wires is carried out at the four terminal blocks mounted in the outside the case. Each terminal block contains 12 screw terminals, each of 4 mm screwed diameter.

The connections to the modules and the connections between modules are made using 48 pins DIN 41612 F sockets. The bases of these sockets are mounted on blocks at 4 cm from the back of the relay case. The test block (optional) is mounted on the front.

11.3. Identification

The complete relay type data is stated on the frontal name plate of the power supply module.

On the upper and lower edge of the case, in the front of the case, there are two marking strips with the names and position of each module in the DAR 2000 system.

The terminal blocks are identified by characters located on the back plate, just over each block left edge (with the relay viewed from behind). There are four terminal blocks in each case and each one has a single code (from A to D) to avoid confusion when connecting the external wires.

At each terminal block, the coupling screws (1 to 12) are marked with engraved numbers.

11.4. Printed Circuit Board Modules

Each module comprises a Printed Circuit Board with a front panel. Two knobs are provided on the front panel for removing and inserting the module. Electrical connections are made by a male connector that fits in the female connector at the back of the relay case.

Each module has its own identification number, consisting of a three letter code followed by a three digit number. These are found at the bottom of each front panel. A description of the different modules of the relay follows.

11.4.1. FSR Power Supply Module

This 2 inches module includes the following items:

- Power Supply.
- Auxiliary relays.
- Electromechanical reclosures counter.
- Optical signalling LEDs (target outputs).

The power supply is a DC – DC converter, with galvanic isolation, that takes the DC voltage supply from the battery of the substation and generates from that the appropriate regulated voltage signals for the internal logic circuitry and the auxiliary relays in the DAR 2000 system:

- 5 Vdc: for logic circuitry power supply.
- 25 Vdc: for auxiliary relays and target outputs (LEDs) power supply.

Both voltage signals are isolated one from each other.

The FSR module has an ON / OFF switch in the frontal panel; in the OFF position, the power supply keeps the primary circuit energized, but the control oscillator is reset, preventing the secondary circuit from being energized.

Figure 11 shows a frontal view of the FSR module.

11.4.2. Logic Module RLM

This 1 3/4 inches module includes the following elements:

- Input circuits; optically isolated.
- Logic circuits.
- Output control circuits; optically isolated.
- Settings and Control elements.

11.4.2.1. Settings.

11.4.2.1.1. In the front panel.

The settings corresponding to the timers for the delayed reclosings (T2, T3 and T4) and for the Blocking timer (TB), are located in the frontal panel.

For all the timers, the setting units are seconds, and it is equal to the summation of all the microswitches located to the right.

Example:

For a time equal to 8.4 second for the second reclosing attempt, move the microswitches labelled 0.4, 1.6 and 6.4 to the right. In this way T2 will be:

$$T2 = (0.4 + 1.6 + 6.4) = 8.4 \text{ second}$$

In the frontal panel, the number of reclosings can also be programmed. This is done by setting a 4 microswitches device, at the lower part of the panel. Each microswitch correspond to one reclosing attempt. To enable a reclosing attempt, move the corresponding microswitch to the right position.

Finally, also in the frontal panel, there is a push button to reset the DAR 2000 system. By pushing this button, the system will be reset, independently on the status it was before pressing the button.

11.4.2.1.2. Inside the module:

The settings corresponding to the automatic reset timer (SW5) and the closing timer (SW6) can be found inside the module, on the printed circuit board. Each one consists on a 8 microswitches device. The setting unit is seconds, and it is equal to the summation of all the microswitches located to in the down position.

Also inside this module, the settings to define the different modes of operation of the recloser can be found:

Hold Mode (J1) IN / OUT	IN position: if the No Reclosing Conditions input is low when the reclosing time delay expires, the system issues a closing command. If the input is high, the system will remain in the waiting status for the time set as Blocking time, without issuing any command, until this input becomes low. If this input is not de-energized in the Blocking time, the system will be blocked (Lock-out status). OUT Position: If the No Reclosing Conditions input is low when the reclosing time delay expires, the system issues a closing command (as previously described). If the input is high, the system will move immediately to the Lock-out status.

Blocking (J4) L / P	L position: Once the Lock-out status has been reached, the auxiliary contacts and the target LEDs remain energized until the system moves to the reset status. P position: When the system gets to the Lock-out status, the auxiliary contacts and the target LEDs are energized just for 50 milliseconds.
One Reclosing attempt (J6)	IN position: Only the first reclosing attempt programmed will be performed. OUT position: All the reclosing attempts programmed will be performed.
Automatic reset (J2) IN / OUT	IN position: When the system reaches the Lock-out status, it will reset automatically after the automatic reset time programmed. OUT position: When the system reaches the Lock-out status, the system will only be reset if a manual closing command is issued or if it is reset through a reset command, remotely or manually.
Reclose Initiation only by circuit breaker status (J5) IN / OUT	IN position: set J5 in this position when only reclose initiations are desired if caused by the circuit breaker status. OUT position: set J5 in this position if a protection trip and / or the circuit breaker status can initiate the recloser.

Figure 12 shows a frontal view of the RLM module, with the location of all internal settings.

12. RECEPTION, HANDLING AND STORAGE

This relay is supplied to the customer in a special package, which adequately protects it during transportation, as long as this is performed under regular conditions.

Immediately after receiving the relay, the customer should check whether it shows any signs of transportation damage. If it is apparent that the relay has been damaged by inappropriate handling, it must be immediately advised in writing to the carrier, and the damage must be reported to the manufacturer.

If any module seems not to be perfectly aligned, this may be caused by a small displacement of the module towards the frontal cover, missing the appropriate connection to the back socket. A slight pushing on the frontal knobs of the module will be enough to ensure the right connection.

For unpacking the relay, regular precautions and care should be taken. Also be careful in order not to lose the screws supplied in the same box.

If it is not intended to install the relay immediately, it is recommended to store it in its original package, and keep it in a dry and dust-free place.

It is important to check whether the model number in the frontal name plate match the model number in your order.

13. RECEPTION TEST

Upon reception of the equipment, it is recommended to carry out an immediate visual check, as well as the tests that are described below, in order to make sure that the relay has not been damaged during transportation, and that the calibration done at the factory has not been modified. If the tests that have been carried out show that the relay need to be calibrated again, please refer to chapter DAR 2000 Calibration.

13.1. Visual Check

Make sure that the device type and complete model number indicated on the front plate matches the model number in the order. Unpack the relay and make sure that there are no broken parts and there are no signs that the relay has been damaged during transportation.

13.2. Electrical Tests

13.2.1. General Considerations

The energization of the digital inputs of the relay must be done using DC voltage, not rectified AC voltage, because if it is not properly smoothed, an incorrect operation of the input relays will be found, caused by the continuous voltage drops bellow the detection thresholds of the input circuits.

The start-stop clock used to measure the operating time of the relay must be correctly calibrated and its accuracy must be better than the relay accuracy. The clock must be capable of being started using normally open contacts or normally closed contacts.

The frequency meter used to calibrate the relay must be capable of measuring the frequency of a squared wave with an amplitude from 0 Vdc to 6 Vdc.

It is important to note that the accuracy of the tests performed depends on the equipment used. Functional tests performed with inadequate equipment are useful in order to check if the relay operates correctly, and then, its general characteristics are tested in an approximate way. Nevertheless, if the relay is calibrated under these conditions, its operating characteristics would be completely out of range and tolerance.

13.2.2. Initial Settings

Program on the relay the following settings:

Settings on the frontal panel.	Value
T2 (Time for the second attempt)	1.6 sec.
T3 (Time for the third attempt)	4 sec.
T4 (Time for the forth attempt)	8 sec.
TB (Blocking time)	16 sec.
SEL	1, 2, 3, 4 to the right

Internal Settings.	Value
SW5 (Automatic reset time)	10 sec.
SW6 (Closing time)	6 sec.
J1 (Hold / waiting mode)	IN
J4 (Blocking)	L
J2 (Automatic reset)	OUT
J6 (Only one attempt)	OUT
J5	OUT

13.2.3. Testing Circuit

Connect the relay following the drawing shown in figure 13.

This figure corresponds to a relay supplied as a stand alone system. If the DAR relay is supplied together with another relay (TOC, TCC, TCCV, etc.) as a complete protective system, then figures 12 and 13 can be used taking into account that the input / output terminal numbers in the figures must be changed to use the input / output terminal numbers of the system under test.

In case the tests are desired to be performed through the testing block (for those systems that include a testing block), the circuit must be wired taking into account the input / output numbers in brackets. For those input / output points without any number in brackets, the wiring must be done as for the model without testing block.

For models with reclose initiation by protection trip and circuit breaker status, close the S1 switch and leave S2, S3, S5 and S6 switches open in the testing circuit.

For models with reclose initiation only by protection trip, close S5 and S6 switches and leave S1, S2 and S3 switches open.

Apply rated voltage on points labelled Vdc(+) and Vdc(-) and turn on the power supply switch, on the frontal panel of the FSR module. The green LED will light up on the frontal panel of the relay and also lamp L4 in the testing circuit. These targets will remain on until the power supply switch is turned off or the relay is disconnected from the Vdc supply.

13.2.4. Reclosing Cycle

13.2.4.1. Models with reclose initiation by protection and circuit breaker status.

13.2.4.1.1. With blocking (Lock-out) feature.

1. Push, temporarily, P1 push-button in the test circuit. The following will happen:
    - RP LED will light up on the frontal panel of RLM module. L3 and L1 lamps, on the test circuit, will also light up, and the closures counter will increase by one.

2. Before 6 seconds open S1 switch, temporarily.
    - L1 lamp will turn out.

3. Before 16 seconds, push P1 again, temporarily. The following will happen:
    - L1 lamp will light up in 1.6 seconds, and the closures counter will increase by one.

4. Before 6 seconds, open S1 switch, temporarily:
    - L1 lamp will turn out.

5. Before 16 seconds, push P1 again, temporarily:
    - L1 lamp will light up in 4 seconds, and the closures counter will increase by one.

6. Before 6 seconds, open S1 switch temporarily:
    - L1 lamp will turn out.

7. Before 16 seconds, push P1 again, temporarily:
    - L1 lamp will light up in 8 seconds, and the closures counter will increase by one.

8. Before 6 seconds, open S1 switch temporarily:
    - L1 lamp will turn out.
9. Before 16 seconds, push P1 again temporarily:
    - RP LED and L3 lamp will turn out. L/O LED and L2 lamp will light up.

13.2.4.1.2. With reset feature.

1. Push the reset push-button, located on the frontal panel of the RLM module:
    - L/O LED and L2 lamp will turn out.

2. Repeat steps 1 to 8 of the previous section. Once this has been done, in 16 seconds:
    - RP LED and L3 lamp will turn out.

13.2.4.2. Models with reclose initiation by protection trip only.

13.2.4.2.1. With blocking (Lock-out) feature.

1. Push P1 temporarily in the testing circuit, the following will happen:
    - RP LED in the frontal panel of the RLM module, and L3 and L1 lamps in the testing circuit will light up. The closures counter will increase by one.
    - L1 lamp will turn out in 6 seconds.

2. Before 16 seconds, push P2 again temporarily. The following will happen:
    - L1 will light up and the closures counter increase by one in 1.6 seconds.
    - L1 lamp will turn out in 6 seconds.

3. Before 16 seconds, push P2 temporarily again. The following will happen:
    - L1 lamp will light up and the closures counter increase by one in 4 seconds.
    - L1 lamp will turn out in 6 seconds.

4. Before 16 seconds push P2 temporarily again. The following will happen:
    - L1 lamp will light up and the closures counter increase by one in 8 seconds.
    - L1 will turn out in 6 seconds.

5. Before 16 seconds, push P2 temporarily again. The following will happen:
    - RP LED and L3 lamp will turn out, L/O LED and L2 lamp will light up.

13.2.4.2.2. With reset feature.

1. Push the reset button located on the frontal panel of RLM module:
    - L/O LED and L2 lamp will turn out.

2. Repeat points 1 to 4 in the previous section. Once this has been done, in 16 seconds:
    - RP LED and L3 lamp will turn out.

13.2.5. External Manual Closing Command

13.2.5.1. With blocking (Lock-out) feature.

1. For models with reclose initiation by protection trip and circuit breaker status, keep S1 switch closed and S2, S3, S5 and S6 open. For models with reclose initiation only by protection trip, keep S5 and S6 closed and S1, S2 and S3 open.

2. Push P3 on the testing circuit. Before 16 seconds push P1:
    - L/O LED and L2 lamp will light up.

13.2.5.2. With reset feature.

1. Push the reset button, located on the frontal panel of the RLM module:
    - L/O LED and L2 lamp will turn out.

2. Push P3. Wait for 20 seconds and then push P1:
    - CC LED, L3 and L11 lamps will light up and the closures counter increase by one.

3. Before 6 seconds, push P5:
    - RP LED and L3 and L1 lamps will turn out.

13.2.6. Manual Closing Command through the Recloser.

13.2.6.1. With blocking (Lock-out) feature.

1. Push P4:
    - L1 will light up and the closures counter increase by one.

2a. For models with reclose initiation by protection trip and circuit breaker status, open S1 temporarily before 6 seconds:
    - L1 lamp will turn out.

2b. For models with reclose initiation by protection trip only, L1 will turn out by itself in 6 seconds.

3. Before 16 seconds push P1:
    - L/O LED and L2 lamp will light up.

13.2.6.2. With reset feature.

1. Push the reset button, located on the frontal panel of the RLM module:
    - L/O LED and L2 lamp will turn out.

2. Repeat 1 and 2 points of the previous section. Wait 20 seconds and push P1:
    - CC LED, L3 and L1 lamps will light up and the closures counter increase by one.

3. Before 6 seconds push P5:
    - RP LED, L3 and L1 lamp will turn out.

13.2.7. Closing Failure.

This test will only be performed on models with reclose initiation by protection trip and circuit breaker status.

1. Keep S1 closed.

2. Push P1:

- CC LED, L3 and L1 lamps will light up, and the closures counter increase by one.
- For models with blocking feature for a closing failure, in 6 seconds time, CC LED, L3 and L1 will turn out and L/O LED and L2 lamp will light up

For models with reset feature for a closing failure, in 6 seconds time RP LED and L3 and L1 lamps will turn out.

13.2.8. Automatic Reset

1. Turn off the ON/OFF switch. Withdraw the RLM module, and set the J2 jumper on the IN position. Put the module back in the relay and turn on the ON/OFF switch.

2. Repeat all the steps described in section 13.2.4.1.1. for models with reclose initiation by protection trip and circuit breaker status, (use 13.2.4.2.1. for models with reclose initiation by protection trip only), until the system is in the Lock-out status (RP, L/O LEDs and L2 and L3 lamps light up). Once this point has been reached, in 10 seconds time:

- RP and L/O LEDs, and L3 and L2 lamps will turn out.

13.2.9. Only one Reclosing Attempt and Reclose Cancel using a Pulse.

1. Turn off the ON/OFF switch. Withdraw the RLM module, and set the J2 jumper on the OUT position, jumper J6 on the IN position and J4 jumper on the P position. Put the module back in its place and turn on the ON/OFF switch.

2. Keep S1 closed for models with reclose initiation by protection trip and circuit breaker status, (S5 and S6 for models with reclose initiation by protection trip only).

3. Push P1:

- RP LED on the frontal panel of RLM module, and L3 and L1 lamps in the testing circuit will light up, and the closures counter increase by one.

4a. For models with reclose initiation by protection trip and circuit breaker status, before 6 seconds, open temporarily the S1 switch:

- L1 lamp will turn out.

4b. For models with reclose initiation by protection trip only, L1 lamp will turn out by itself in 6 seconds time.

5. Before 16 seconds push P1 again. The following will happen:

- RP LED and L3 lamp will turn out, L/O LED and L2 will light up for 50 milliseconds.

13.2.10. Reclose Cancel (Blocking)

1. Turn off the ON/OFF switch. Withdraw the RLM module and set J6 jumper on the OUT position and J4 jumper on the L position. Put the module back on its place and turn on the ON/OFF switch.

2. Close S2 switch on the testing circuit.

3. Push P1; nothing will happen.

4. Push P4; nothing will happen.

5. Open S2 switch.

13.2.11. No Reclosing Conditions Blocking

13.2.11.1. Hold mode on with NRC signal removing.

1. Close S3 switch on the testing circuit.

2. Push P1:
- RP LED on the frontal panel of the RLM module and L3 lamp on the testing circuit will light up.

3. Before 16 seconds, open S3 switch:
- L1 lamp will light up immediately and the closures counter increase by one.

4a. For models with reclose initiation by protection trip and circuit breaker status, before 6 seconds, open S1 temporarily:
- L1 lamp will turn out (for models with reclose initiation by protection trip only, L1 lamp will turn out by itself in 6 seconds.)
- In 16 seconds, RP LED and L3 lamp will turn out.

4b. For models will reclose initiation by protection trip only, L1 lamp will turn out by itself in 6 seconds.
- RP LED and L3 lamp will turn out In 16 seconds.

13.2.11.2. Hold mode on without NRC signal removing.

1. Close S3 switch on the testing circuit.

2. Push P1:
- RP LED on the frontal panel of the RLM module and L3 lamp on the testing circuit will light up.
- L/O and NRC LEDs, and L2 lamp will light up in 16 seconds.

13.2.11.3. Hold mode off.

1. Turn off the ON/OFF switch. Withdraw the RLM module and set J1 jumper on the OUT position. Put the module back on its place and turn on the ON/OFF switch.

2. Push P2:

- PR LED on the frontal panel of the RLM module and L3 lamp on the testing circuit will light up.
- In 1.6 seconds time, RP LED and L3 lamp will turn out, and L/O and NRC LEDs and L2 lamp will light up.

13.2.12. Reclosing Timers

1. Push the reset push-button, and all the ON targets will reset, lighting off.

2. Open S3 switch.

3. On the testing circuit, wire number (1) contact to the start-stop clock initiation input (normally open). Wire number (2) contact to the start-stop clock stop input (normally open).

4. Set microswitches number 2, 3 and 4 on the reclosing program selector (SEL) in the frontal panel of the RLM module to the left. Then push the reset push-button.

5. Push P1; the measured time will be in the 35 – 75 milliseconds range.

6. Set microswitch number 1 on the reclosing program selector (SEL) to the left and number 2 to the right. Then push the reset push-button.

7. Reset the start-stop clock. Push P1; the measured time will be in the 1.52 – 1.68 seconds range.

8. Set microswitch number 2 on the reclosing program selector (SEL) to the left and number 3 to the right. Then push the reset push-button.

9. Reset the start-stop clock. Push P1; the measured time will be in the 3.8 – 4.2 seconds range.

10. Set microswitch number 3 on the reclosing program selector (SEL) to the left and number 4 to the right. Then push the reset push-button.

11. Reset the start-stop clock. Push P1; the measured time will be in the 7.8 – 8.4 seconds range.

12. Set microswitch number 1 on the reclosing program selector (SEL) to the right and numbers 2, 3 and 4 to the left.

13.2.13. Blocking Time

1. For this test, both starting and stopping of the start-stop clock will be done using normally closed contacts. Wire number (2) contact to the start-stop initiation input. Wire number (4) contact to the stop input.

2. Push P1. When the reclosures counter has increased by one reset the start-stop clock and:

3a. For models with reclose initiation by protection trip and circuit breaker status, open S1 temporarily before 6 seconds. The start-stop clock will start counting; the time measured until RP LED and L3 lamp turn out will be in the 15.2 – 16.8 seconds range.

3b. For models with reclose initiation by protection trip only, in 6 seconds time, the start-stop clock will start counting; the time measured until RP LED and L3 lamp turn out will be in the 15.2 – 16.8 seconds range.

13.2.14. Automatic Reset Time

1. Wire both start-stop clock initiation input and stop input to number (3) contact. The starting will be using a normally open contact and the stopping by a normally closed contact.

2. Turn off the ON/OFF switch. Withdraw the RLM module and set the J2 jumper on the IN position. Put the module back on its place and turn on the ON/OFF switch.

3a. For models with reclose initiation by protection trip and circuit breaker status: reset the start-stop clock and push P1. When the reclosing has been performed, open temporarily S1 switch. Push P1 again; the system will move to the Lock-out status and the start-stop clock will start counting. The measured time until the system reaches the reset status again will be in the 9.5 – 10.5 seconds range.

3b. For models with reclose initiation by protection trip only: reset the start-stop clock and push P1. The reclosing will be performed and in 6 seconds L1 LED will turn out. Push P1 again; the system will move to the Lock-out status and the start-stop clock will start counting. The measured time until the system reaches the reset status again will be in the 9.5 – 10.5 seconds range.

13.2.15. Closing Time

1. Wire both start-stop clock initiation input and stop input to number (2) contact. The starting will be using a normally open contact and the stopping by a normally closed contact.

2. Reset the start-stop clock and push P1; the reclosing will be performed and the start-stop clock will start counting. The time measured will be in the 5.7 – 6.3 seconds range.

When the counting ends, the system will be in the following status:

- Blocked (in the Lock-out status), for models with reclose initiation by protection trip and circuit breaker status with blocking feature for a failure to close condition.
- Ready (in the Reset status), for models with reclose initiation by protection trip only and for the models with reset feature for a failure to close condition.

14. INSTALLATION

The relay should be installed in a clean, dry place, free from dust and vibration, and should be well lit to facilitate tests and inspections.

The relay should be mounted on a vertical surface. Figures 3 and 6 shown the external and internal connection diagrams respectively.

If the tests performed show that the system must be calibrated again, follow System Calibration chapter for instructions.

15. SYSTEM CALIBRATION

The only calibration that may be needed is the one regarding the time-base, common to all the timers in the DAR 2000 system. If the time results from the tests performed are out of the ranges specified in the Reception Test chapter, the time-base needs calibration.

If calibration is needed, turn off the ON/OFF switch and put the RLM module on a card extender. Set your frequency meter input between the chassis terminal in the down-right screw of the RLM board and pin #1 on U6.

Set your frequency meter to measure period. The measure must be in the 9.8 - 10.2 milliseconds range. If the result is out of this range, move P1 variable resistor until it is in the specified range.

16. PERIODIC MAINTENANCE & TESTING

Due to the important role of protective relays in the operation of the installation where they are applied, a program of periodic testing is recommended. Since the interval between periodic tests varies between different types of relays and installations, and based on the experience of the user with periodic tests, it is recommended that the points described in the Reception Tests chapter be verified at intervals ranging form one to two years.

17. FIGURES LIST

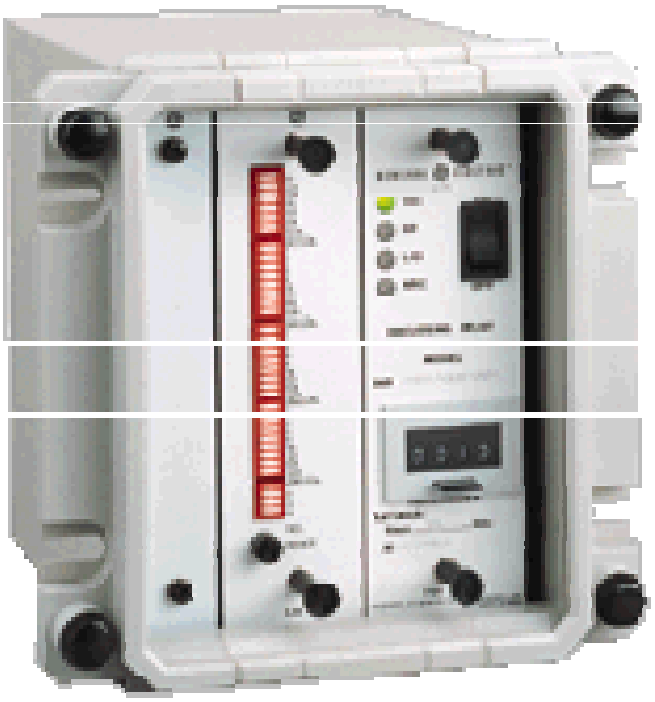

Figure 1: *Frontal view of a DAR 2000 relay.*

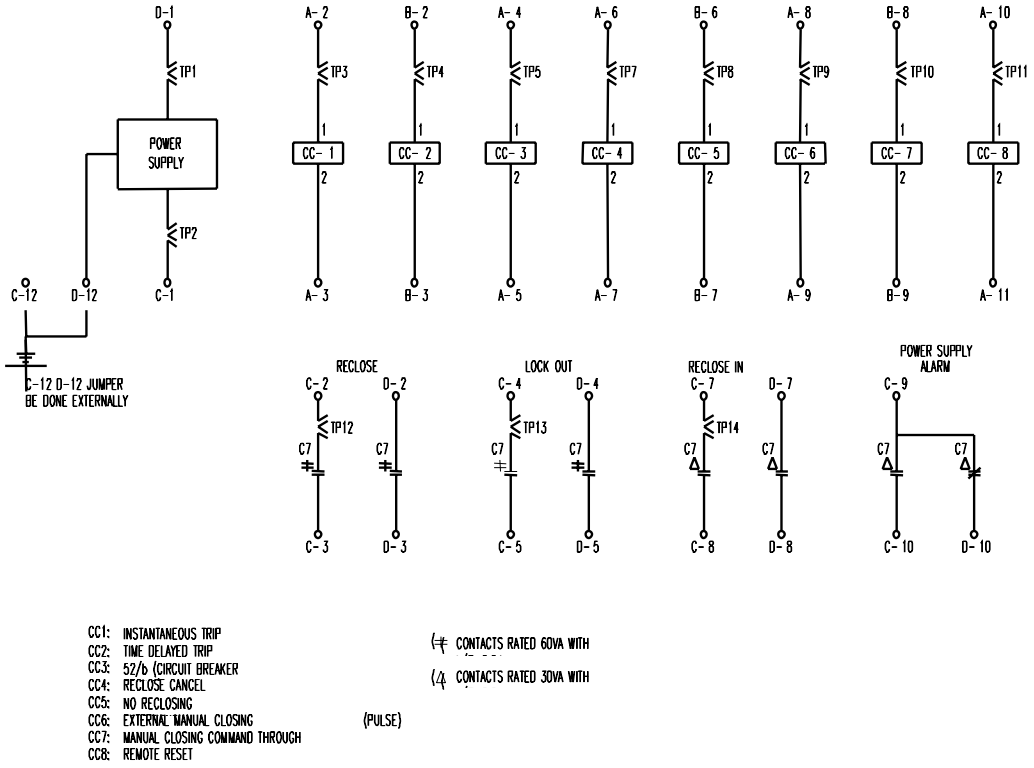

Figure 2 (226B6377): *External connections diagram for a DAR 2000 relay.*

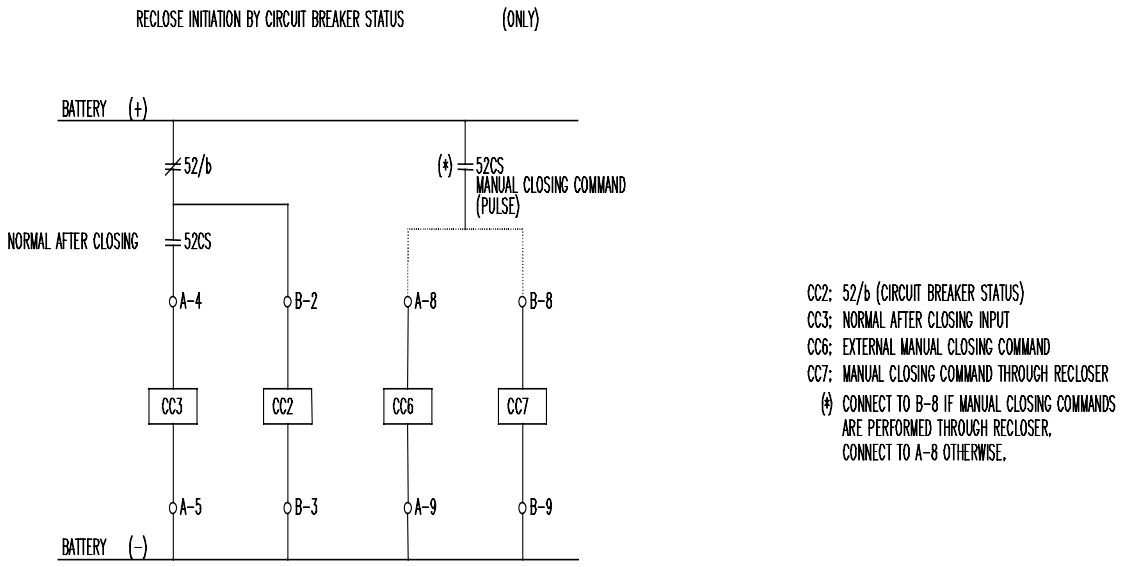

Figure 3 (226B6378F1): *Closing command connections for a DAR 2000 system with reclose initiation by circuit breaker status only.*

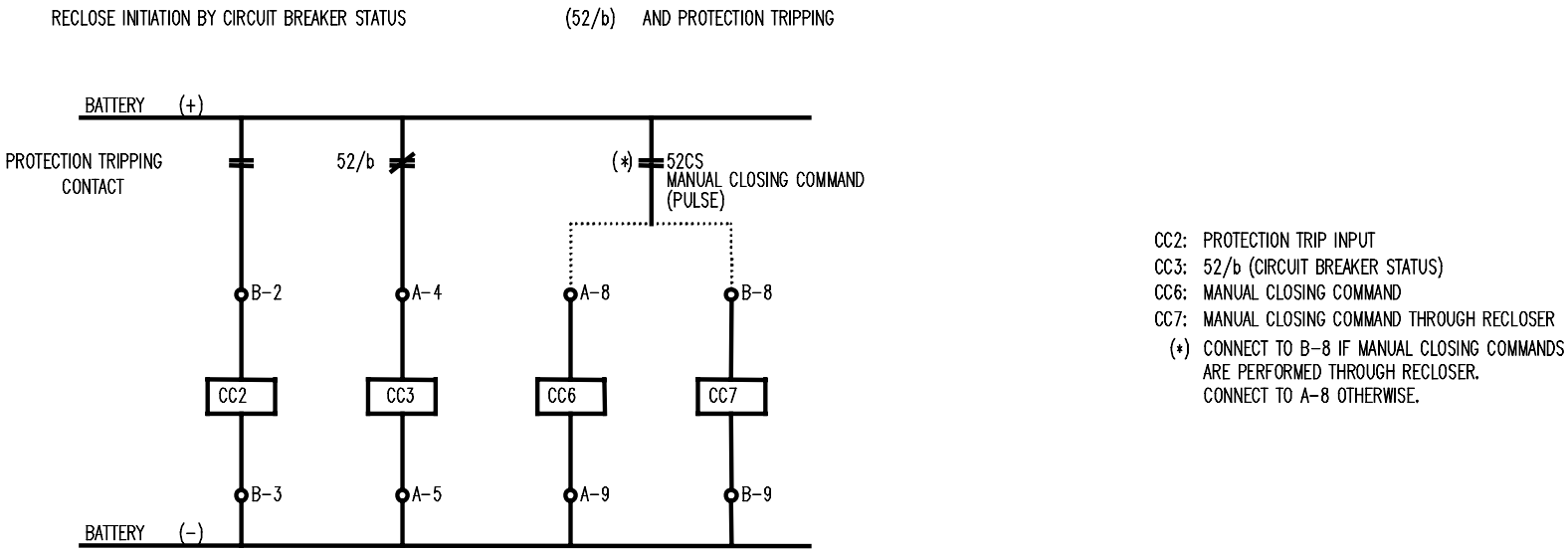

Figure 4 (226B6378F2): *Closing command connections for a DAR 2000 system with reclose initiation by protection trip and circuit breaker status.*

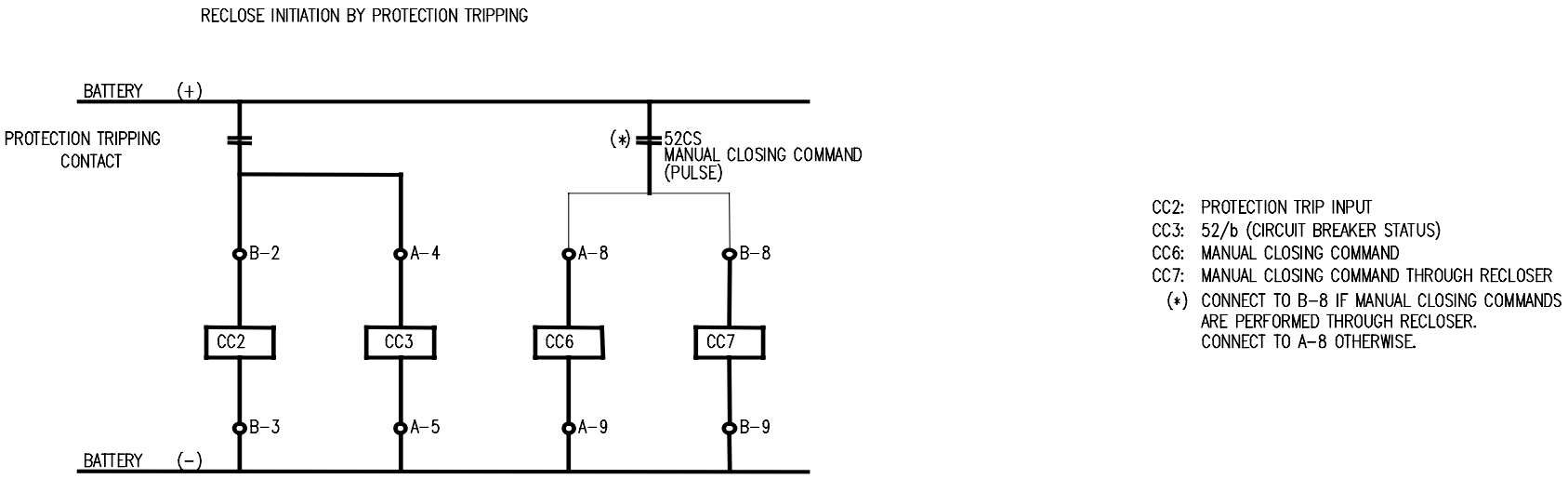

Figure 5 (226B6378F3): *Closing command connections for a DAR 2000 system with reclose initiation by protection trip only.*

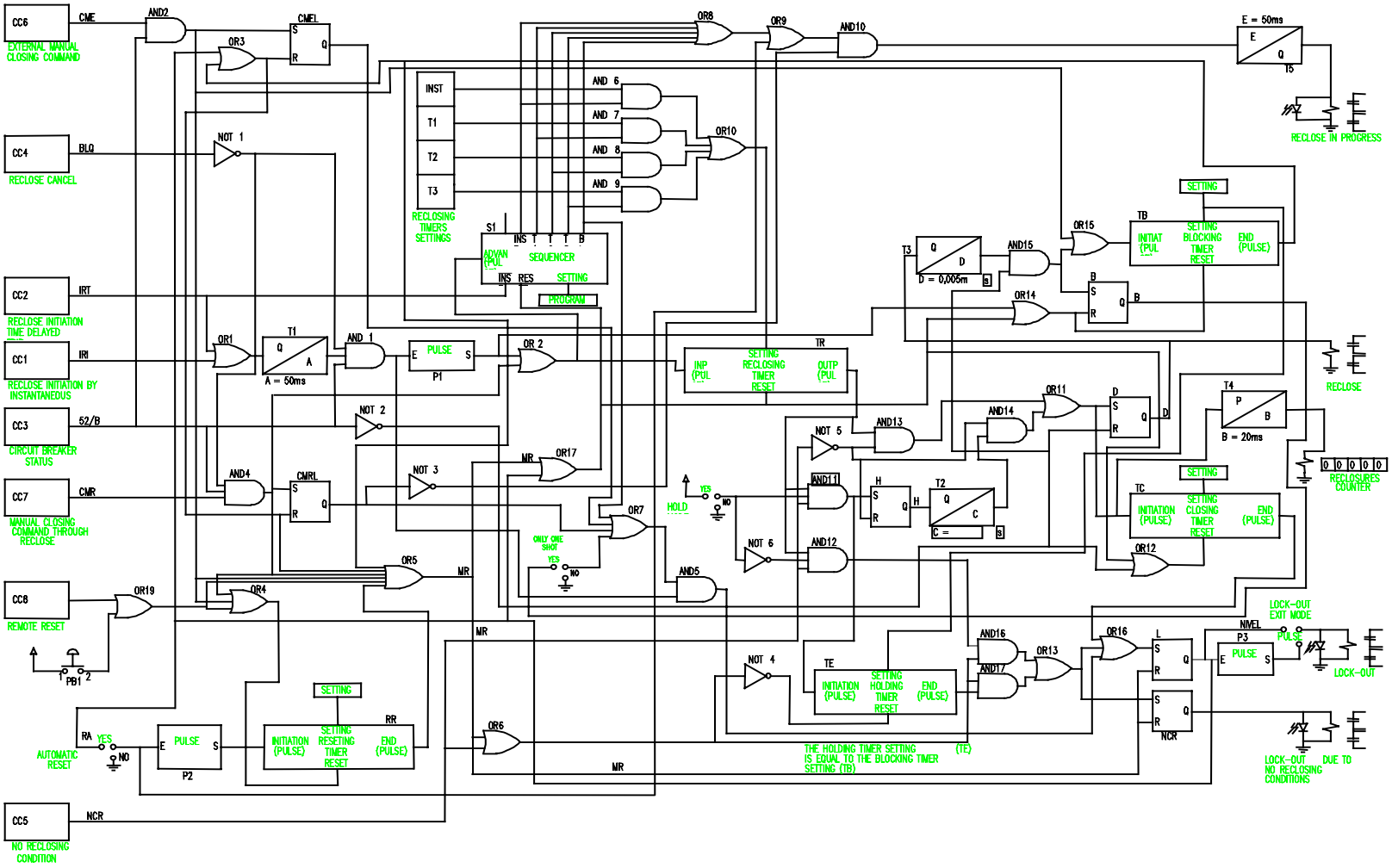

Figure 7 (189C4151F1): *Blocks diagram for a DAR 2000 relay with reclose initiation by protection trip and/or circuit breaker status with blocking feature for a closing failure condition.*

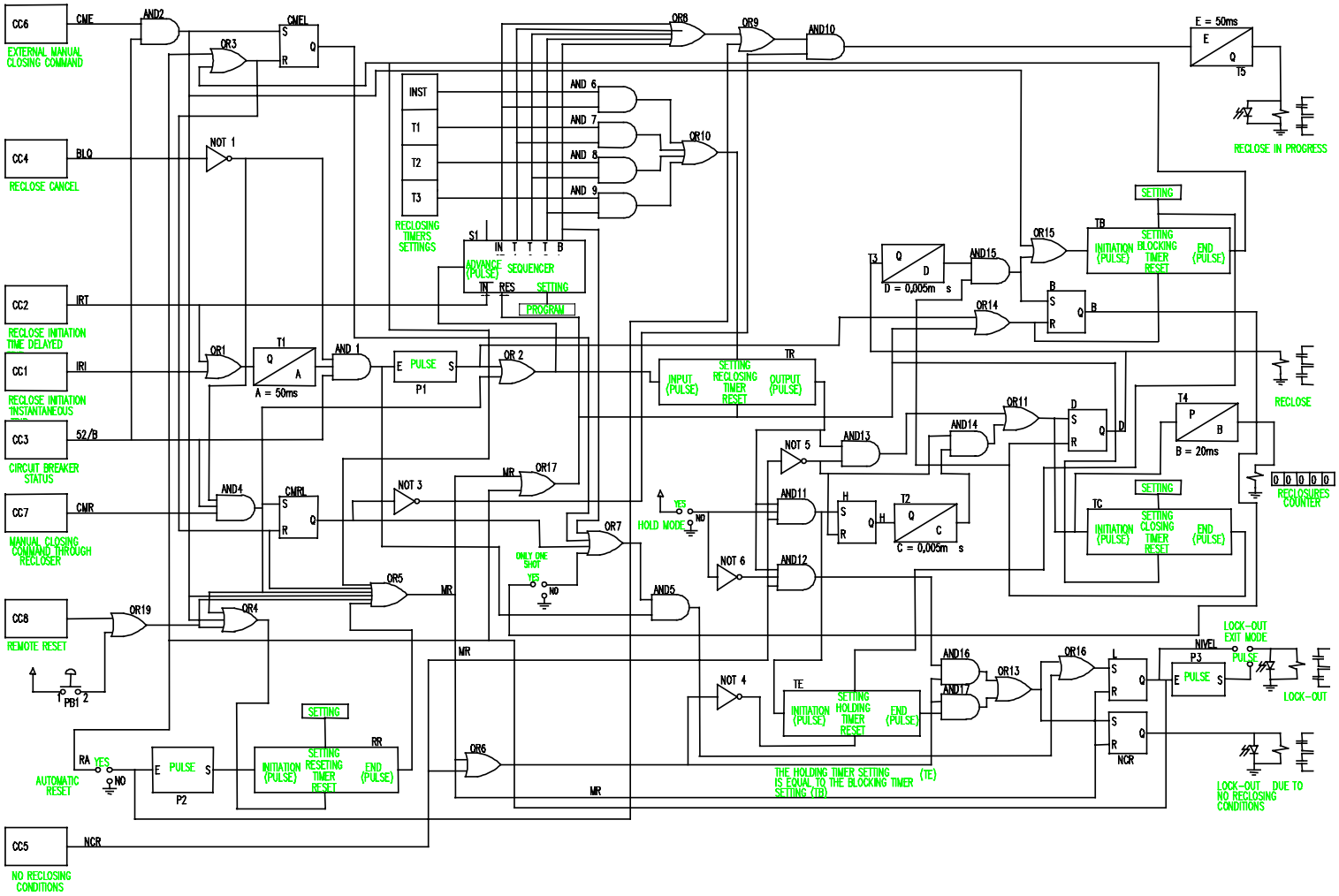

Figure 8 (189C4151F2): *Blocks diagram for a DAR 2000 relay with reclose initiation by protection trip and/or circuit breaker status with resetting feature for a closing failure condition.*

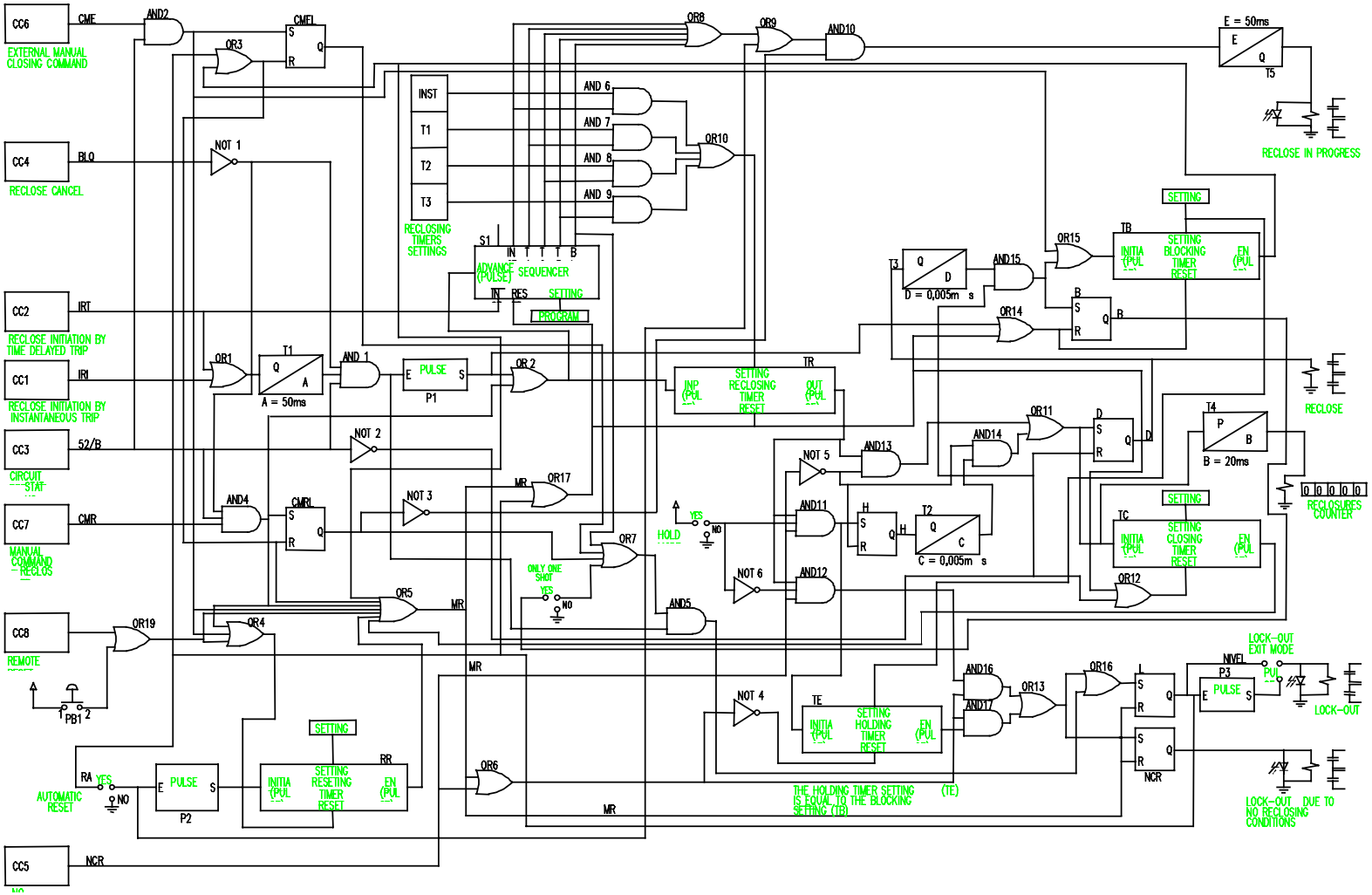

Figure 9 (189C4151F3): *Blocks diagram for a DAR 2000 relay with reclose initiation by protection trip.*

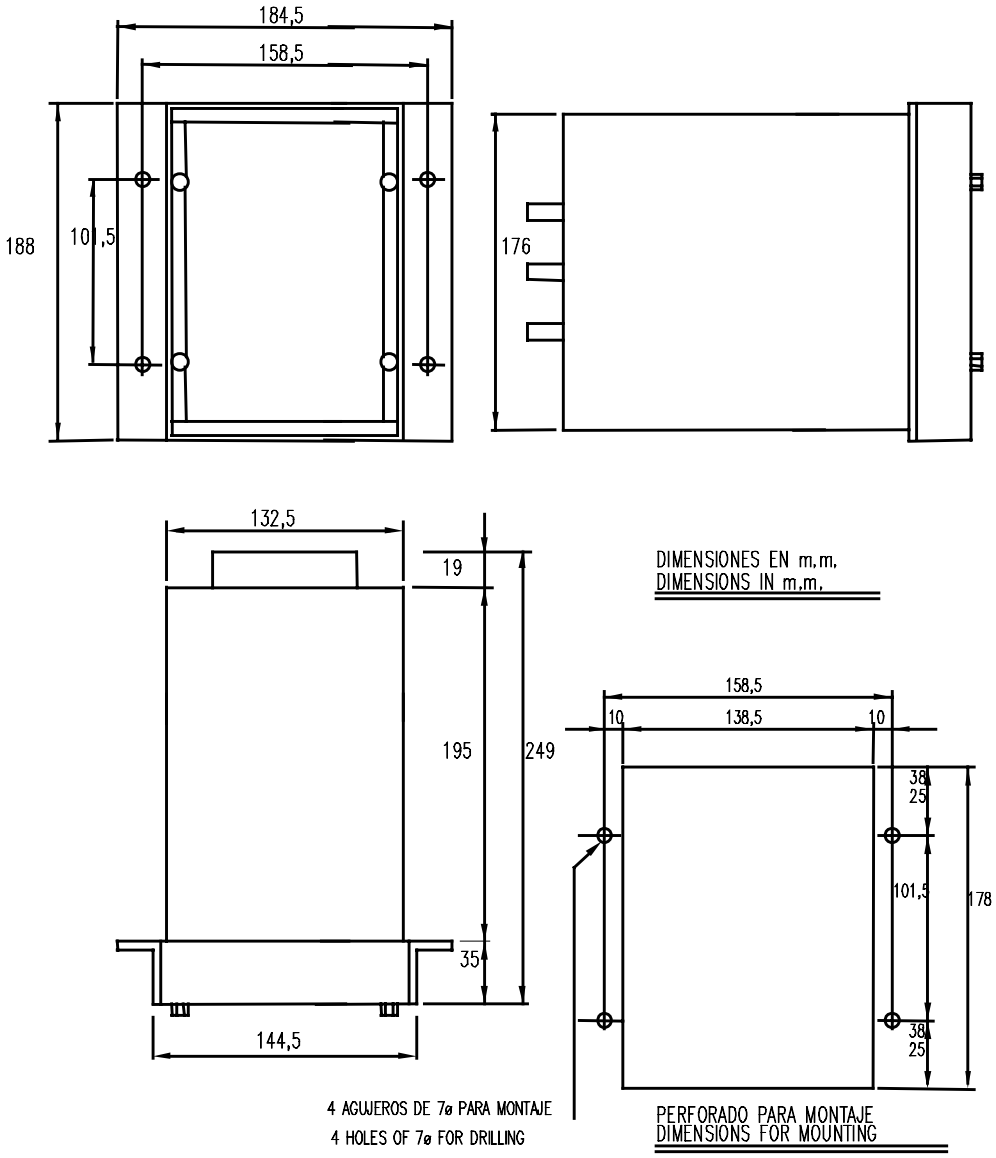

Figure 10 (301A7049F3): *Dimensions and drilling scheme.*

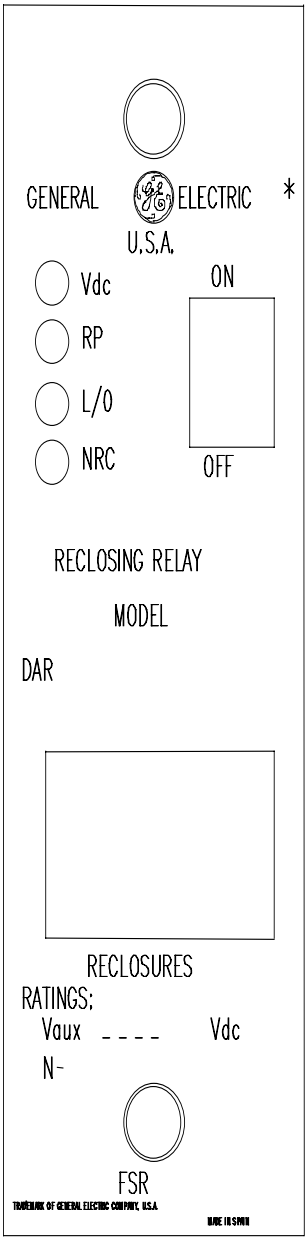

Figure 11 (226B7405F2): *FSR Module.*

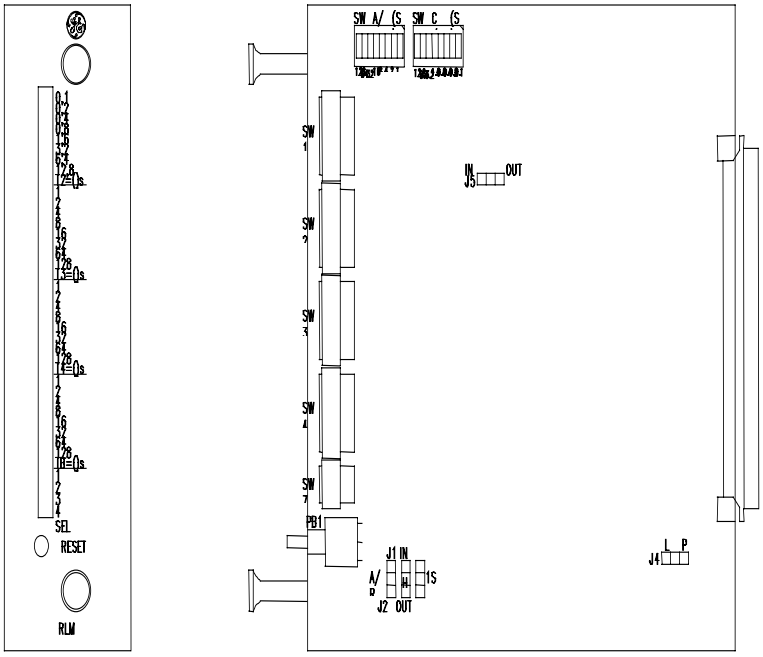

Figure 12 (226B7405F1): *RLM Module.*

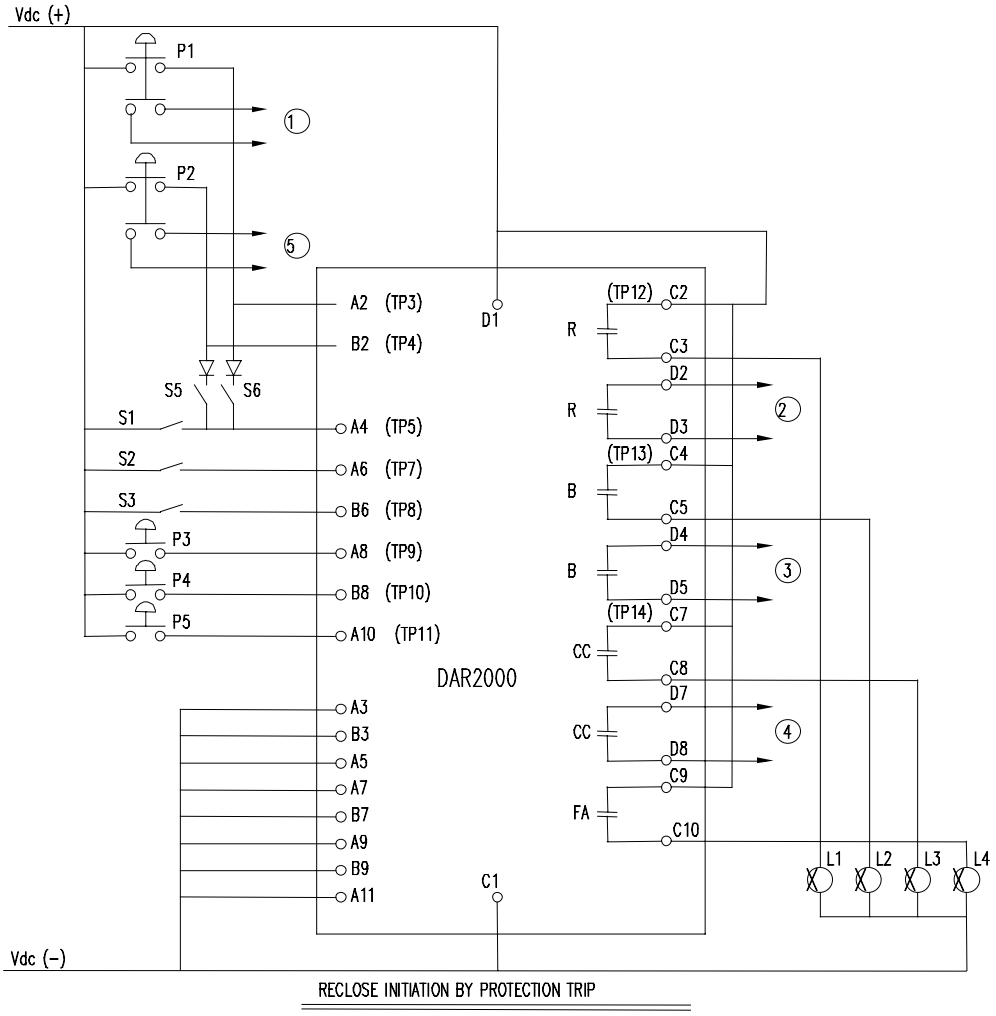

Figure 13 (226B6379F1): *Testing circuit scheme.*