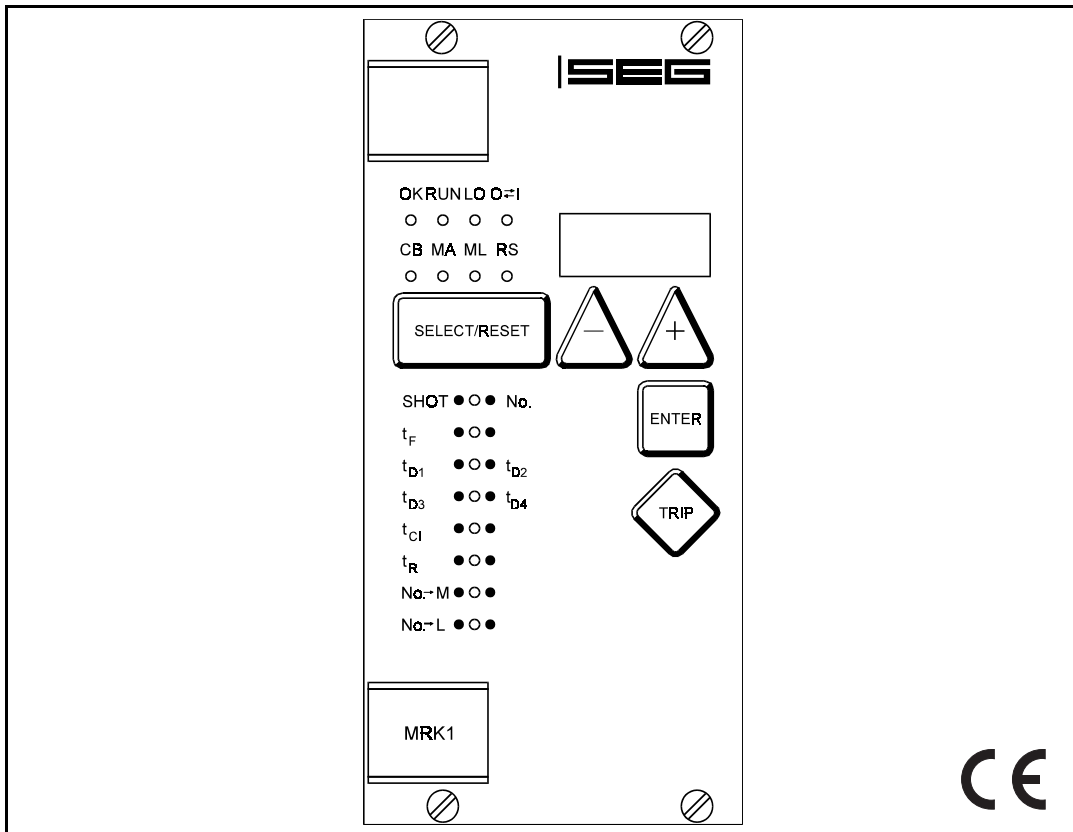


MRK1 - Auto reclosing relay



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Important:

For additional common data of all **MR**-relays please refer to manual "**MR** - Digital Multifunctional Relays".

1 Introduction and Application

In transmission line networks more than 70 % of the occurring faults are transient (electric arcs extinguish, branches are falling on the overhead lines etc.)

With the application of the automatic reclosing (AR) together with protection relays, many electric arcs are extinguished through temporary interruption of the energy supply. Without utilizing the automatic reclosing (AR) power supply interruptions would occur quite frequently. Statistics have shown that yet part of the faults remain after the first fast AR can be cleared with a longer 2nd AR interval.

The digital multi-shot, three phase auto reclosing relay **MRK1** fulfills these requirements for use on medium voltage transmission or distribution systems. The unit is used in cooperation with time overcurrent protection (e.g. **MR13**) or distance protection.

2 Features and Characteristics

- Independent adjustable timer for fault time, dead time, close impulse time and reclaim time.
- Four digit counter for registration of the completed auto reclosings
- Maintenance alarm and lock-out by reaching the preadjusted AR number
- External blocking and release
- Possibilities for supervision of the circuit breaker energy and synchronous condition
- Output relay for fast trip before the first AR/after the last AR (switchable with coding plug 2)
- Supervision whether a C. B. failure is present
- Optical indications of the AR functional sequence and the AR results
- External control through optically isolated inputs
- Number of auto reclosings, adjustable from 1 to 4

3 Design

3.1 Connections

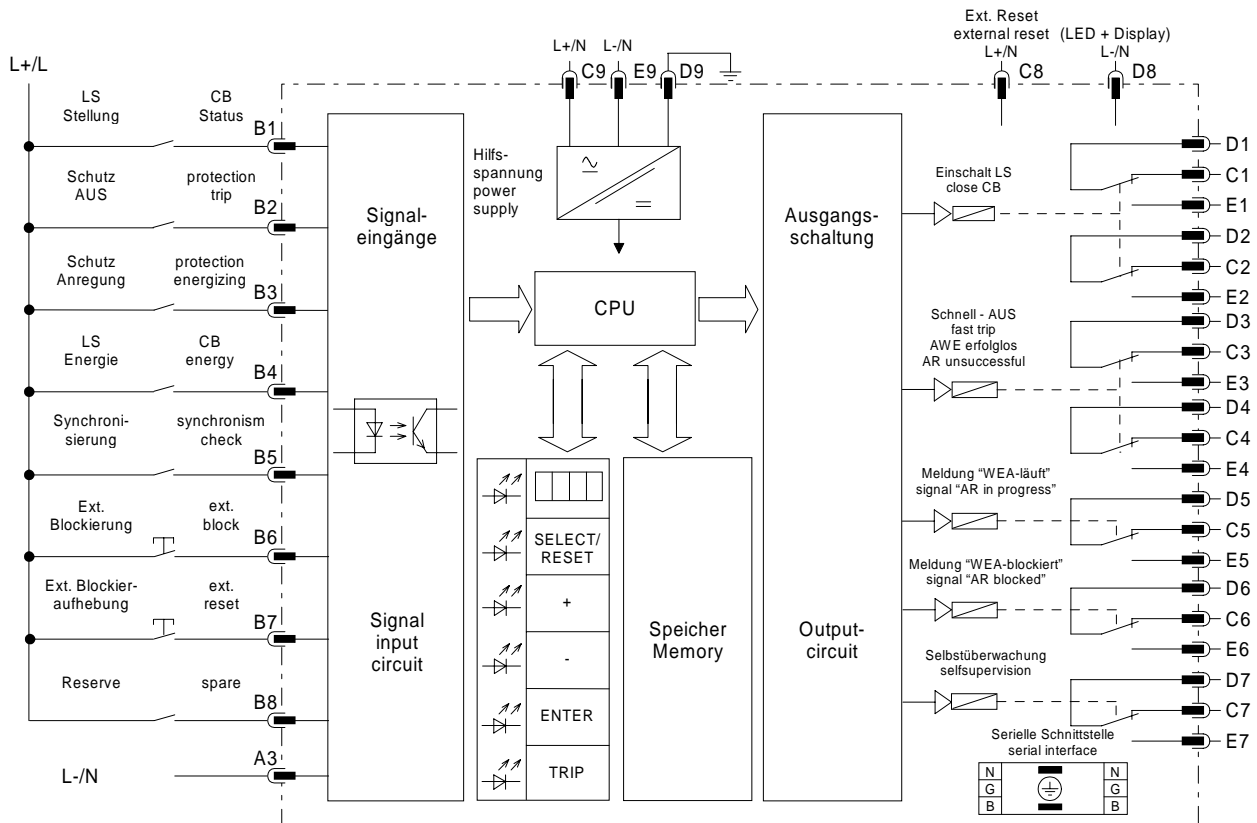


Fig. 3.1: Connection diagram

3.1.1 Information input circuits

With the aid of information inputs unit **MRK1** decides whether and when auto-reclosing will take place:

Circuit breaker position (B1)

With input B1 the position of C.B. can be supervised. When the circuit breaker is closed the auxiliary voltage is connected to input B1.

Tripping command from protection (B2)

When the tripping command takes place from the protection before the fault-timer has expired the unit changes from "starting"-status to "cycle"-status after the circuit breaker was switched off. (see also para. 4.3.4)

Protection-energized (B3)

When a protection is energized (e.g. from overcurrent time protection) a fault-timer is started. Unit **MRK1** changes from "ready"-status to the "starting"-status. (see also para. 4.3.4)

Circuit breaker energy (e.g. motor-wound spring-closed breakers) (B4)

Because the circuit breaker needs a certain time between two reclosing-attempts in order to close again, the ready signal of the C.B. (auxiliary voltage at B4) is checked before a new auto reclosing takes place. (see also para. 4.3.9)

Interlocking signal of the synchronizing unit (B5)

In order to prevent a reclosing of the unit at asynchronous phase position, input B5 is connected to a synchronizing unit. If no synchronous control is necessary, the auxiliary voltage is connected to B5.

External blocking input (B6) and reset of blocking (B7)

The unit is blocked when applying voltage to B6. This blocking can only be reset by external reset of blocking (aux. voltage at B7). The blocking has the priority during the simultaneous activation of B6 and B7.

Spare (B8)

This input is not used.

Common point of the inputs (A3)

All listed inputs have a common connection point for L- or N.

3.1.2 Output relays

One relay with two change-over contacts is used for reclosing. Relay 2 with two change-over contacts can be applied alternatively for signalling AR unsuccessful or fast tripping. The remaining 3 relays with one change-over contact are employed for signalling.

- Closing command to the circuit breaker (D1, C1, E1; D2, C2, E2)
- Fast trip/(D3, C3, E3; D4, C4, E4)
Signal AR unsuccessful
- Signal "AR in progress" (D5, C5, E5)
- Signal "AR blocked" (D6, C6, E6)
- Signal "self-supervision" (D7, C7, E7)

3.1.3 External Reset C8-D8

When applying voltage impulses to C8-D8 the display and the LED-indication can be reset.

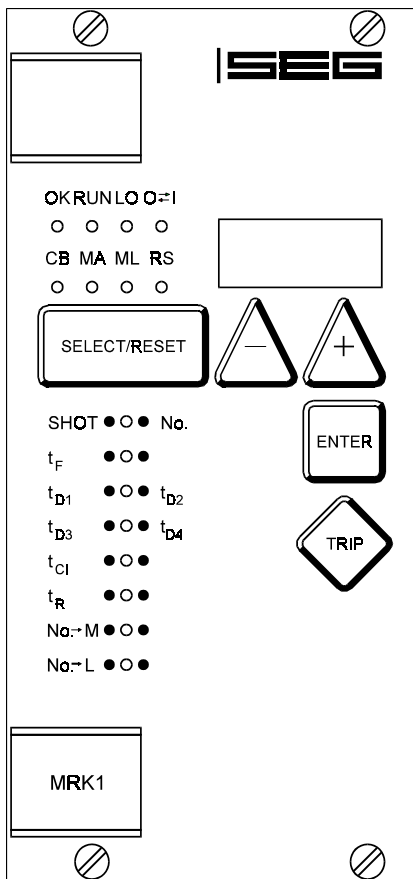


Fig. 3.1: Front plate

3.2 LEDs

Five pushbuttons for control and/or adjustment and 19 LEDs are on the front plate of unit **MRK1**. The LEDs on the left side of the display indicate the status, fault messages and AR- results. The function of the respective LED is indicated by the legend above the LED.

The LEDs on the left side beneath the <SELECT/RESET> pushbutton are provided for adjustments, their functions are shown with a legend on the right or left side of the LED.

3.2.1 Status LEDs

- OK: green, unit ready for AR operation
(dark: unit inactive)
- RUN: red, AR in progress
- LO: red, AR Locked Out, in- or external
- O→I: green, AR successful - red: AR unsuccessful
- CB: red, Circuit Breaker fault or defect
- MA: yellow, Maintenance Alarm
- ML: yellow, Maintenance Lock-Out
- RS: yellow, programming of slave address

3.2.2 Adjusting LEDs

- SHOT: green, number of the reclosing attempts
- No.: red, counter for accomplished AR operations
- t_F: green, Fault time
- t_{D1}: green, Dead time for the first reclosing attempt
- t_{D2}: red, Dead time for the second reclosing attempt
- t_{D3}: green, Dead time for the third reclosing attempt
- t_{D4}: red, Dead time for the fourth reclosing attempt
- t_{C1}: green, Close impulse time
- t_R: green, Reclaim time
- No.→M: green, number of reclosing operations to Maintenance alarm
- No.→L: green, number of reclosing operations to maintenance Lock-out

3.3 Code jumpers

Unit **MRK1** has three code jumpers. J1 is provided for password programming. J2 and J3 are for selection of the following functions:

J3 = OFF	Time overcurrent - protection application output relay (D3, C3, E3; D4, C4, E4) is programmed as fast trip relay	J2 = OFF	fast trip before the first AR
		J2 = ON	fas trip after last AR
J3 = ON (in preparation)	Output relay (D3, C3, E3; D4, C4, E4) is programmed as AR unsuccessfull	J2 = OFF	no function
		J2 = ON	AR unsuccessfull

3.4 Low/High range of functions blocking and reset

All relays of the *HIGH TECH LINE* have a wide-range power supply unit allowing to choose a suitable supply voltage. The operating threshold of the blocking and reset inputs, however, has to be defined by taking the supply voltage into account. The following two different operating thresholds can be adjusted:

- Low-range treshold $U_{AN} \geq 10\text{ V}$; $U_{AB} \leq 8\text{ V}$
- High-range treshold $U_{AN} \geq 70\text{ V}$; $U_{AB} = <60\text{ V}$

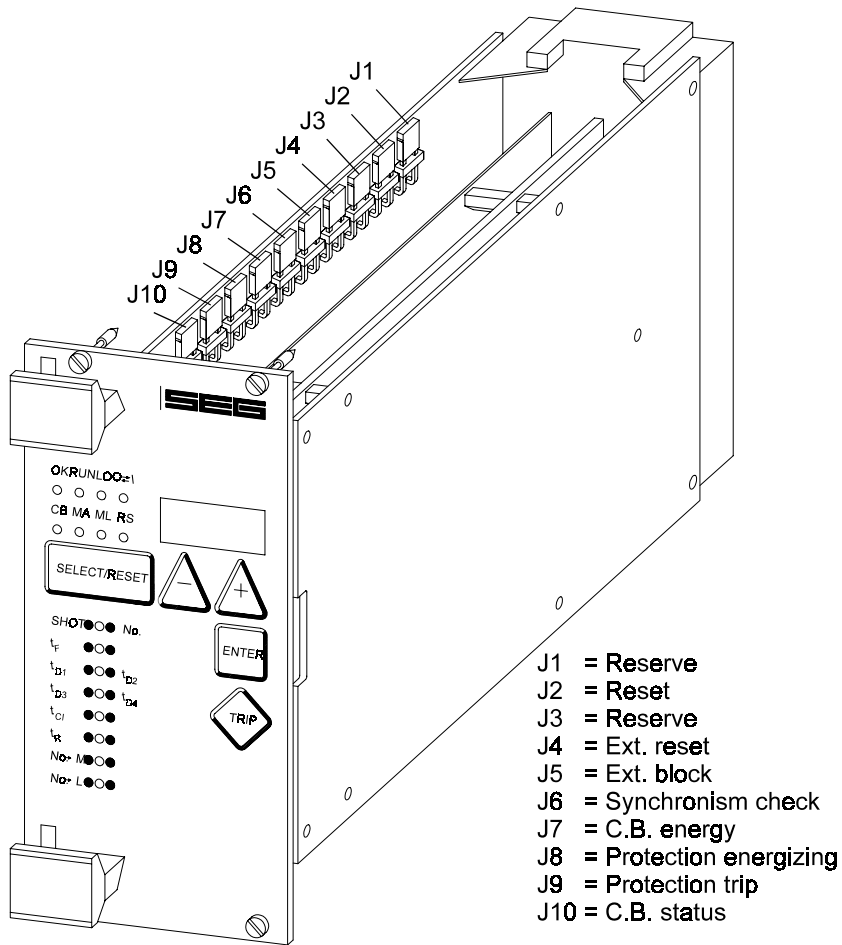


Fig. 3.3: Code jumper

Code jumper ON = Low range
 Code jumper OFF = High range

3.5 Display

Function	Display shows	Pressed pushbutton	Corresponding LED
Normal operation	SEG		
Operating functions: ready for autoreclosing operation auto reclosing in progress			OK green RUN red
Setting values: number of autoreclosing attempts	setting value	<SELECT/RESET><+><>	SHOT green
counter for accomplished auto reclosing operations	setting	<SELECT/RESET><+><>	No red
fault time	setting value in seconds	<SELECT/RESET><+><>	t _f green
dead time for first autoreclosing attempt	setting value in seconds	<SELECT/RESET><+><> one time for each value	t _{D1} green
dead time for sec. autoreclosing attempt	setting value in seconds		t _{D2} red
dead time for third autoreclosing attempt	setting value in seconds		t _{D3} green
dead time for fourth autoreclosing attempt	setting value in seconds		t _{D4} red
close impulse time	setting value in seconds	<SELECT/RESET><+><>	t _{C1} green
reclaim time	setting value in seconds	<SELECT/RESET><+><>	t _r green
number of autoreclosing operations to maintenance (alarm)	setting value	<SELECT/RESET><+><>	No→M green
number of autoreclosing operations to maintenance (lock-out)	setting value	<SELECT/RESET><+><>	No→L green
Slave address of serial interface	1 - 32	<SELECT/RESET><+><>	RS yellow
Recorded fault data	CB!!		0→1 red and CB red
Circuit breaker defective	CB??		CB red
No check-back is given after C.B.-OFF (≤ 200 ms)	CB!!		0→1 red and CB red
No message C.B.-ON occurs within the set t _r - time			
auto reclosing successful	CLOS		0→1 green
auto reclosing unsuccessful	OPEN		0→1 red
auto reclosing locked-out, in- or external			LO red
after dead time reclosing condition not fulfilled Before AR: <ul style="list-style-type: none"> No synchronizing signal (B4 = L) No C.B.-energizing signal (B4 = L), however, not before the first AR The C.B. positioning signal is available (B1 = H) Protection tripping signal is available (B2 = H) 	S/E?	0→1 red	
circuit breaker was manually switched off during reclaim time/closing to faulty line	MANU		
maintenance alarm			MA yellow
maintenance lock-out			ML yellow
Save parameter?	SAV?	<ENTER>	
Save parameter!	SAV!	<ENTER> for about 3 s	
Software version	First part (e.g. A00) Sec. part (e.g. 4.01)	<TRIP> one time for each part	
Manual trip	TRI?	<TRIP> three times	
Inquire password	PSW?	<SELECT/RESET> <+><><ENTER>	
Wrong password by manual trip	NO!!		
Relay tripped	TRIP	<TRIP>	
End of output relay test	END!		
Secret password input	XXXX	<SELECT/RESET> <+><><ENTER>	
System reset	SEG	<SELECT/RESET> for about 3 s	

Table 3.1: possible indication messages on the display

4 Working principle

4.1 Status descriptions

For the illustration of the functional sequence unit *MRK1* defines six status transitions.

4.1.1 "Inactive"

The relay is in "inactive" status when the following conditions are fulfilled:

- the circuit breaker is in position "OFF"
- the unit is not in "blocked" status
- the unit is not in "starting/cycle" status

A reaction of the unit to the protection incidents is not possible in "inactive" status. Therefore there can be no automatic reclosing.

4.1.2 "Reclaim time"

The relay is in "reclaim time" status when the reclaim time:

- has not yet expired
- not interrupted by other incidents.

Also no reaction of the unit to the protection incidents is possible in "reclaim time" status, therefore no automatic reclosing.

4.1.3 "AR-ready"

The relay is in position "AR-ready" status when the following conditions are fulfilled:

- the circuit breaker is in position "ON"
- the reclaim time has expired
- the unit is not in "blocked" status
- the unit is not in "starting cycle" status

Only in "AR-ready" status a reaction of the AR-unit to the protection incidents is possible!

4.1.4 "AR-starting"

In "AR-starting" status the start conditions for an automatic reclosing by means of the protection commands and the circuit breaker position are checked.

4.1.5 "AR-cycle"

The reclosing commands are carried out in "AR-cycle" status by means of the conditions and the results (AR successful or unsuccessful) are evaluated accordingly.

4.1.6 "AR-blocked"

Unit *MRK1* changes immediately to "AR-blocked" status when an external or internal blocking signal exists. No auto reclosing is possible in "AR-blocked" status. Only an external signal for cancellation of the blocking can cancel this status with the exception of the "blocking"-status by reaching the pre-adjusted AR-number for the maintenance lock-out. This "blocking"-status can also be cancelled when the counter (No.) had been reset (e.g. after the circuit breaker was serviced). See also para. 5.2.

In case unit *MRK1* is in "blocked" status, auxiliary voltage failure does not effect the "blocked" status, after recurrence of the auxiliary voltage "blocked" status still exists.

4.1.7 AR unsuccessful/fast tripping

Jumper J3 provides the choice whether relay 2 (D3, C3, E3 and D4, C4, E4) transmits the message "fast trip" (J3=off) or the message "AR unsuccessful". (J3=ON) Refer also to Sections 3.3 and 4.4.

4.2 Description of the status transition

AR-status transition matrix

from to	inactive	reclaim time	ready	starting	cycle	blocked
inactive		C.B. manual ON				external blocking signal
reclaim time			reclaim time expired			external blocking signal
ready	C.B. OFF			protection energized and/or tripped and C.B.-energy OK		external blocking signal
starting		starting conditions not fulfilled	start signal interrupted		start conditions fulfilled (fault time, C.B. OFF etc.)	external blocking signal
cycle			AR takes place			external or internal blocking signal
blocked	external reset of blocking					

 No status transition possible

From this table you can detect what status transitions of **MRK1** are possible. When the unit is for instance in "cycle" status (see also para. 4.1) only two status transitions are possible:

- status transition to "ready"-status when the auto reclosing takes place
- status transition to "blocked" status by external or internal blocking.

The grey shaded sections indicate that no transition is possible.

4.3 Functional sequence

To comprehend this chapter better it is essential to first read para. 4.1 and 4.2 carefully (status description and description for status transition).

4.3.1 Switching-on MRK1

Is the C.B. to be supervised in OFF position while switching on the **MRK1**, the unit changes into "inactive" status when applying the auxiliary voltage. The LED "OK" on the front plate remains dark. The unit is not ready for auto reclosing. If, however, the C.B. is in ON position when applying the auxiliary voltage, the unit changes into "reclaim time"-status and remains blocked during this period (from 1 s to 300 s adjustable). This is indicated at the unit by LED t_R . After expiration of the reclaim time the unit changes to "ready" status and is then ready for auto reclosing. LED "OK" signalizes this status.

In case unit **MRK1** is in "blocked" status before auxiliary voltage failure occurred, this condition remains also after recurrence of auxiliary voltage.

4.3.2 Circuit breaker manual closing

If the circuit breaker is closed manually to a faultless line, first the unit remains blocked during the reclaim time (adjustable 1 - 300 s) and then changes to "ready" status. If the circuit breaker is closed manually to a faulty line (e.g. short circuit), no AR follows. Unit **MRK1** remains in "inactive" status after protection tripping.

4.3.3 Circuit breaker manual open

When switching off the circuit breaker manually the unit changes at once without time delay from "ready" status into "inactive" status. The LED "OK" extinguishes, reclosing is not possible.

4.3.4 Starting AR

When the information "protection energized" or "protection tripping" is applied to inputs B2 or B3 from the protection devices, the unit changes from "ready" status to "starting" status. The LED "RUN" lights up red. The "starting" status begins with the start of a fault timer (t_f from 0.01 s to 2.0 s adjustable). A tripping timer (set at 0.2 s) is started when the mains protection tripping command takes place before expiration of the set fault time. The "start conditions not fulfilled" is evaluated and the **MRK1** is locked for the duration of the reclaim time when there is a time difference between mains protection-energized and tripping, which is larger than the set "fault time". If the OFF-signal of the C.B. appears before expiration of the tripping timer, it is evaluated as "start condition fulfilled" and the unit changes over to "cycle" status. If the OFF-signal does not appear, however, before expiration of the tripping timer, it will be evaluated as "start condition not fulfilled" and the unit is locked for the duration of the set reclaim time. Output relay "fast trip" is activated during „starting“ status (J2 and J3 = OFF factory pre-adjustment). After elapse of the time delay or after the OFF-signal of the C.B. had come up, the output relay is reset. This function can be used as unselective fast tripping in cooperation with a time overcurrent protection. When the coding plug J2 = ON, no fast tripping occurs during start.

4.3.5 Unsuccessful reclosing

After the start condition has been fulfilled the unit changes to "cycle" status. Now the dead time t_D is started. Unit **MRK1** can be programmed for reclosing of one to four times. For each reclosing a dead time has to be set (t_{D1} from 0.01 s to 99.9 s; $t_{D2} - t_{D4}$ from 0.2 s to 99.9 s). When the dead time has expired and also the other reclosing conditions have been fulfilled (in case the synchronous control is not necessary, voltage must be applied to input B5), the reclosing command is given to the circuit breaker. The reclosing command remains either as long as the ON-signal from the circuit breaker appears or the close-impuls-timer (adjustable from 0.05 s to 2.0 s) has expired. In the last case a failure of the circuit breaker is subjected. With the beginning of the reclosing command the reclaim timer is started. When a new OFF-signal of the circuit breaker appears within the reclaim time, an unsuccessful reclosing will be detected. Then the unit quits the "cycle" status and changes to the "inactive" status. The LED "RUN" extinguishes and the LEDs "O → I" lights up red and display shows "OPEN".

Note:

After expiration of the break time the synchronizing time is activated. It is set to 150 s. If within this time auxiliary voltage is applied to the terminals A3/B5, the **MRK1** switches on the C.B. immediately. If no synchronizing release is given within this time, the display – on account of the non-fulfilled switching on conditions – shows "S/E?".

4.3.6 Successful reclosing

If there is no OFF-signal of the circuit breaker and no protection tripping within the reclaim time a successful reclosing will be detected. The unit now quits the "cycle" status, changes over into the "ready" status and is ready for the next reclosing. The LED "O→I" indicates (Display shows "CLOS") green and signalizes a successful reclosing. The LED-display can be reset by pressing pushbutton <SELECT/RESET> for about 3 s.

4.3.7 Repeated reclosing

If the **MRK1** programmed for more than single reclosing a second dead time is started after a new OFF-signal from the circuit breaker has appeared. After expiration of this dead time a new reclosing command follows. The signal, whether an AR had been successful, follows either after a successful AR or - if unsuccessful - after all programmed reclosing attempts.

4.3.8 External blocking and reset of blocking

The unit is blocked for further reclosing attempts when an external blocking signal is present at information input B6, depending upon in which condition the *MRK1* is at the moment. This blocking can only be reset by an external blocking cancellation (B7)

4.3.9 Supervision of the circuit breaker ready information

Because the supervising unit of the circuit breaker energy store operates often after the first fast switch off (see also para. 3.1.1), the signal "C. B. not AR-ready" is not evaluated anymore after an introduced reclosing. The C. B. ready information is checked before an introduced AR and after the first unsuccessful attempt for further ARs. There will be a reclosing when the "circuit breaker ready" had been given before the begin of the reclosing cycle.

4.4 Operation and release of the output relays

Closing-relay (D1, C1, E1, D2, C2, E2)

Operation: at the end of the dead time (t_D) in case all closing conditions are fulfilled
Release: when the circuit breaker is switched on or when the closing impuls time (t_{cl}) has expired

„Fast trip“-Relay (D3,C3, E3; D4, C4, E4)

J2 = OFF

Operation: at AR starting
Release: when C.B. is switched off

J2 = ON

Operation: after last unsuccessful reclosing command
Release: when C.B. is switched off

"AR unsuccessful" (D3, C3, E3; D4, C4, E4)
J3=ON

Trip: If the circuit breaker is switched off again after the last permissible AR.
Reset: With the reset function the external blocking is cancelled.

Alarm relay "AR in progress" (D5, C5, E5)

Operation: when start conditions are fulfilled
Release: when all AR-cycles are terminated

Alarm relay "AR blocked" (D6, C6, E6)

Operation: when a blocking condition is present
Release: when the blocking had been cancelled

Self-supervision-alarm relay (D7, C7, E7)

Operation: after power "ON"
Release: at system hardware/software error

4.5 Blocking and cancellation of blocking

4.5.1 Blocking

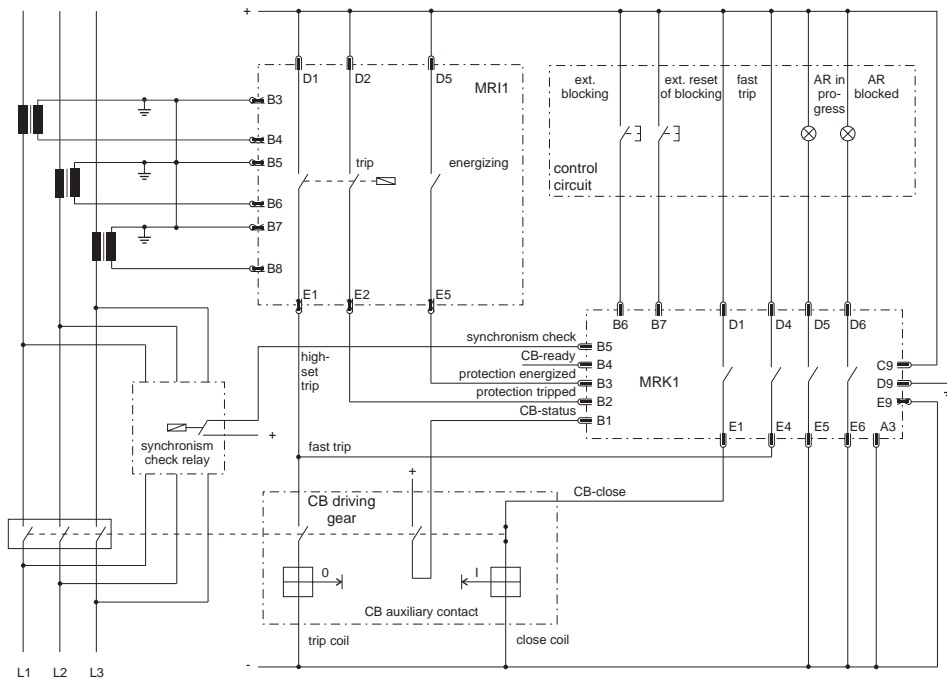
The AR-relay is blocked under the following conditions:

- the external block input is activated
- the pre-adjusted number of reclosings for the maintenance lock-out is reached
- When the reclosing shot is set to 0, the *MRK1* can also be blocked at site

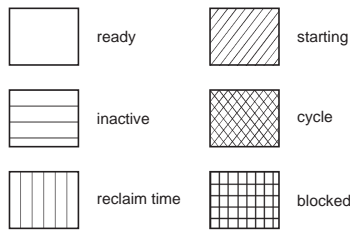
4.5.2 Cancellation of blocking

The maintenance lock-out is cancelled by reset the AR-counter (No.). All other blockages can only be cancelled through external reset of blocking (input B7).

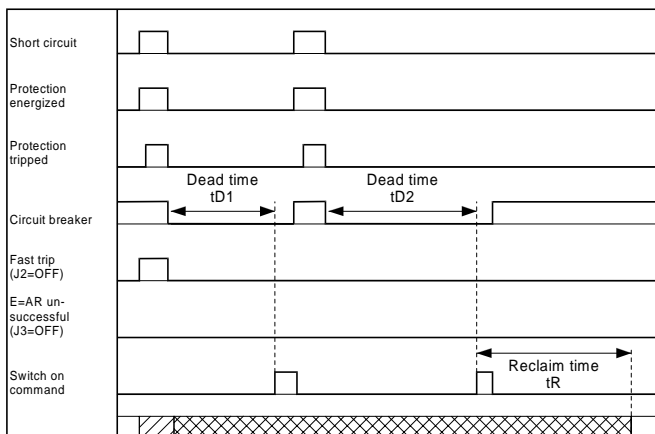
4.6 Circuit example: Connection diagram of MRK1 and MRI3



4.7 Time sequence diagrams of MRK1



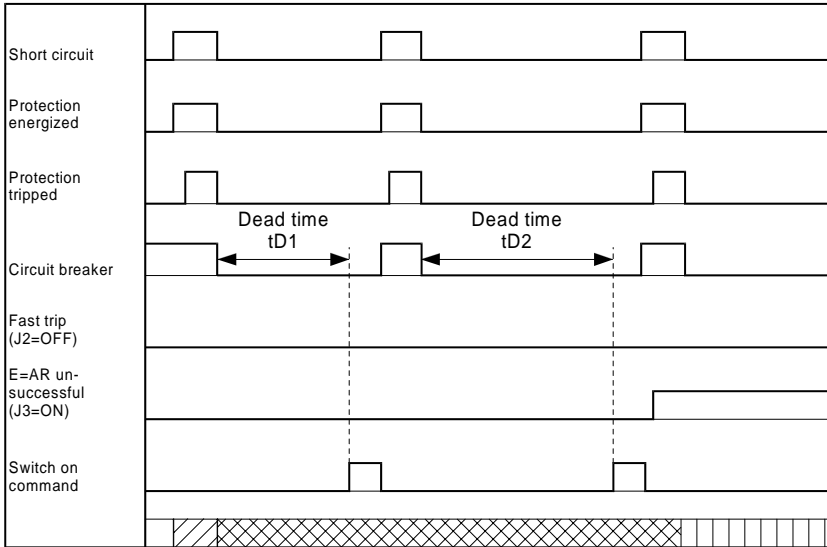
4.7.1 The unit is programmed for two shots, successful AR at the second shot



In case of a short circuit an energizing follows with subsequent tripping of the protection relay. The circuit breaker is switched off and the short circuit is cleared. After expiration of the dead time t_{D1} unit **MRK1** gives the reclosing command to the circuit breaker.

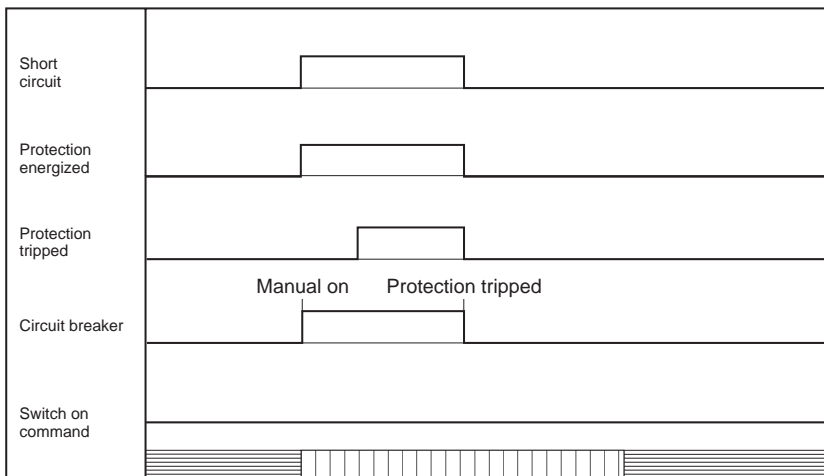
If the fault still exists the protection relay trips again and the above mentioned procedure is repeated as long until either the fault was removed (here after the second reclosing) or the number of the set SHOT's is reached.

4.7.2 The unit is programmed for two shots, unsuccessful AR



Here the time sequence as described in para. 4.7.1. The second reclosing shot is however unsuccessful.

4.7.3 Manual closing of the circuit breaker to faulty lines



Unit **MRK1** is in "inactive" status when the circuit breaker is switched off. When the C.B. is manually closed the reclaim time is started. In case there is a faulty line the C.B. is switched off by protection relay. After elapse of the reclaim time unit **MRK1** changes over to "inactive" status.

4.8 MRK1 and mains protection

The automatic reclosing cooperates in transmission line networks mainly with protection relays, e.g. time overcurrent protection or distance protection. In order to guarantee optimum cooperation between AR and protection these have to be coordinated with each other.

When the coding plugs are adjusted accordingly (see para. 3.3) the **MRK1** can be adapted to the different protection relays.

4.8.1 Cooperation with time overcurrent protection

Definite time overcurrent relays are normally used as time graded relays on radial feeders. The trip delay of such relays depending on the number of circuit sections to graded could be between 0.5 and 2 s.

These trip delays are however too long for the AR.

Therefore fast tripping from auto reclosing relay must be possible in case of cooperation with time overcurrent protection.

Unit **MRK1** can realize this application with the aid of output relay D4, C4, E4. The coding plugs J2 and J3 have to be in OFF-position. In case of faults and **MRK1** as standby to AR, undelayed switching off of the C.B. by means of output relay D4, C4, E4 follows. After this the output relay is reset. Thus it is guaranteed that the time overcurrent protection can work selectively acc. to the time grading diagram in case the fault still exists after reclosing.

For some important networks, an unselective fast tripping with following correction via AR is not allowed. In these cases, the function of fast trip output relay of **MRK1** can be changed by switching over the jumper J2 to ON position. By J2 = ON, there will be no fast trip from **MRK1** before reclosing. For a permanent fault, the fast trip output relay of **MRK1** trips instantaneously after the last auto reclosing.

4.8.2 Cooperation with distance protection (in preparation)

In ring- and grid system the distance protection is generally applied and is also used for radial networks when short trip delays are necessary.

For distance protection faults can however only be switched off instantaneously up to about 85% of the line length to be protected because of measurement technical reasons. In order to detect faults on the entire line length with instantaneous time the zone extension is used for cooperation with the AR. By zone extension the measuring range of the first distance zone is extended from about 85% to 110% - 120% of the line length to be protected, i.e. beyond the opposite station. Because of this all faults on the line are detected in instantaneous time. Prior to reclosing of the C.B. this extended distance zone of the AR is switched back to the normal setting. A permanent fault is then switched off selectively acc. to the grading diagram.

Zone extension differentiates between "overreaching" and "underreaching".

The zone extension (extended distance zone II) is effective in starting position by "overreaching". "Overreaching" to the normal stage is done after having given the first protective OFF command in case of failure:

- at types of failures for which AR is not approved of (e.g. fault time expired).
- at blocking, missing "standby" for switching off AR

The first step (normal distance zone I) is effective in starting position by "underreaching". When a fault occurs the first step of the distance protection is switched up to the zone extension; thus the distance protection can detect all faults on the line to be protected.

"Underreaching" ends with the first protection OFF command. The zone extension is at once switched back again to a normal stage when the AR is not permitted (e.g. fault time has expired before the OFF command).

Cooperation with distance protection can be realized by adjustment of coding plugs 2 and 3. For this J3 must be in "ON" position. In J2=OFF position output relay D4, C4, E4 works acc. to the principle "overreaching". When J2 is in position "ON" the relay works acc. to the principle "underreaching".

5 Operations and settings

For parameter setting a password has to be entered first. (Please refer to 4.4 of description "MR-Digital Multifunctional Relays")

5.1 Definitions of the setting values

Number of AR-SHOTS:

Indicates how often the circuit breaker may switch on again when a fault occurs.

Fault time (t_f):

Reclosing is permitted during this time. It starts with the energizing of the corresponding protection devices. A reclosing attempt follows only if the command time of the protection devices is shorter than the fault time set at **MRK1**.

Dead time (t_b):

Starts with the OFF-signal of the circuit breaker. No closing command to the circuit breaker is given till expiration of the set dead time.

Close impulse time (t_{ci}):

During close impulse time t_{ci} the close C. B. contact of **MRK1** is closed. It starts with expiration of the dead time and is interrupted earlier when the ON-signal of the circuit breaker is already present before expiration of the time.

Reclaim time (t_r):

This is the time during which - after switching on (also manually) or after AR - a subsequent reclosing is prevented. If the number of the set shots is reached, the **MRK1** is blocked for this time after the last reclosing attempt.

The reclaim time is started with the automatic closing command or by switching on manually. An OFF-command which occurs during the reclaim time leads to a final switching-off.

Number of reclosings till maintenance alarm (No.→M):

After a certain number of fault clearness the circuit breakers must be serviced/repaired. This can be supervised by two counters of the **MRK1**. The first counter (No.→M) must be set to a somewhat smaller value and is used for alarming. If the AR number reaches the set value, the LED MA (maintenance alarm) lights up yellow.

Number of ARs till maintenance lock-out (No.→L):

When the second counter has reached the preset value, the **MRK1** is blocked for the purpose of maintenance after reclosing had just taken place. Now the LED ML (maintenance lock-out) is yellow. The blocking can be cancelled by reset the counter No. (see para. 5.2)

If it maintenance check is not required, this function can be deactivated (EXIT).

5.2 AR-counter

Unit **MRK1** is equipped with a software counter. The reclosing commands given from the unit are registered with this counter (four digit). After each reclosing command the counter is automatically incremented. The AR-number previously carried out can be indicated on the display at anytime by means of the <SELECT/RESET>- pushbutton. The LED No. lights up. The counter must be decremented to 0 with the usual setting procedure, just like a setting parameter. At break down of the aux. voltage the number of the reclosing operations is stored. Herewith it is guaranteed that the preset maintenance intervals are being kept.

5.3 Adjustment of the slave address

Actuating pushbuttons <+> and <-> the slave address can be set in the range of 1 - 32.

6 Relay testing and commissioning

The following test instructions should help to verify the protection relay performance before or during commissioning of the protection system. To avoid a relay damage and to ensure a correct relay operation, be sure that:

- the auxiliary power supply rating corresponds to the auxiliary voltage on site.
- the rated current and rated voltage of the relay correspond to the plant data on site.
- the current transformer circuits and voltage transformer circuits are connected to the relay correctly.
- all signal circuits and output relay circuits are connected correctly.

6.1 Power-On

NOTE!

Prior to switch on the auxiliary power supply, be sure that the auxiliary supply voltage corresponds with the rated data on the type plate.

Switch on the auxiliary power supply to the relay and check that the message "ISEG" appears on the display and the self supervision alarm relay (watchdog) is energized (Contact terminals D7 and E7 closed).

6.2 Testing the output relays

NOTE!

Prior to commencing this test, always block the output circuits or interrupt in another way the output circuits which can cause the tripping of the circuit breaker if the breaker operation during this test is not desired. By pressing the pushbutton <TRIP> once the display shows the first part of the software version of the relay (e.g. „DOO-“). By pressing the pushbutton <TRIP> twice the display shows the second part of the software version of the relay (e.g. „4.01“). The software version should be quoted in all correspondence. After you have got a message "PSW?" on the display by pressing the pushbutton <TRIP> once more please enter the correct password to proceed with the test. The message "TRI?" will follow. Confirm this testing by means of pressing pushbutton <TRIP> again. All output relays should then be activated and the self supervision alarm relay (watchdog) be deactivated one after another with a time interval of 1 second. Thereafter, reset all output relays back to their normal positions by pressing the pushbutton <SELECT/RESET>.

6.3 Checking the set values

By repeatedly pressing the pushbutton <SELECT/RESET> all relay set values may be checked and set value modification can be done with the pushbutton <+><-> and <ENTER>. For detailed information about that, please refer to chapter 5.

6.4 Secondary test

6.4.1 Checking the CB status input circuit (B1/A3)

Apply the auxiliary voltage on the terminals B1/A3 (input for circuit breaker status). The LED tR (Reclaim time) lights up. After the preset time delay, the LED t_r has extinguished and the LED OK lights up green to indicate that the relay is ready for auto reclosing.

6.4.2 Checking the ext. blocking input circuit (B6/A3)

Apply the auxiliary voltage on the terminals B6/A3. The LED OK should be extinguished immediately, while the LED LO (Lockout) lights up red to indicate that the relay is blocked.

6.4.3 Checking the ext. reset input circuit (B7/A3)

Disconnect the auxiliary voltage on the terminals B6/A3 and apply it on the terminals B7/A3. The LED LO should be extinguished immediately, while the LED tR (Reclaim time) lights up until the preset reclaim time has elapsed. Thereafter, the LED OK lights up green again. The relay is ready for auto reclosing.

6.5 Primary injection test

Generally, a primary injection test could be carried out in the similar manner as the secondary test above described, with the difference that the protected power system should be, in this case, connected to the installed relays under test „on line“, and the other protective relays (e.g. overcurrent relay or distance relay) and circuit breaker driving gear to work together with auto reclosing relay should be connected to the **MRK1** relay. Since the cost and potential hazards are very high for such a test, especially if staged fault test are intended, primary injection tests are usually limited to very important protective relays to the power system. Because of its powerful combined indicating and measuring functions, you have still the possibilities to test the **MRK1** relay in the manner of a primary injection without extra expenditures and time consumption. In actual service, for example, the following steps may be checked that the **MRK1** relay works and is connected to the system correctly:

- Close the circuit breaker manually and check that the LED t_r (Reclaim time) lights up. After the preset delay time, the LED t_r is extinguished and the LED OK lights up green to indicate that the relay is ready for auto reclosing.
- Open the circuit breaker manually and check that the LED OK is extinguished immediately to indicate that the circuit breaker is not ready for auto-reclosing.

6.6 Maintenance

Maintenance testing is generally done on site at regular intervals. These intervals vary among users depending on many factors: e.g. the type of protective relays employed; the importance of the primary equipment being protected; the user's past experience with the relay, etc.

For electromechanical or static relays, maintenance testing will be performed at least once a year according to the experiences. For digital relays like **MRK1**, this interval can be substantially longer. This is because that:

- the **MRK1** relays are equipped with very wide self-supervision functions, so that many faults in the relay can be detected and signalized during the service. Important: The self-supervision output relay must be connected to a central alarm panel!
- the combined indicating functions in **MRK1** relay enable supervision the relay functions during service.
- the combined TRIP test function of the **MRK1** relay allows to test the relay output circuits by power system interrupt.

A testing interval of two years for maintenance will, therefore, be recommended.

During a maintenance testing, the relay functions including the reclosing cycles and output relay function as well as the operating time should be tested.

7 Technical data

7.1 MRK1 - Auto reclosing Relay

7.2 Input circuits

Circuit: optoelectronic coupler - isolated inputs (n.o. current circuit)

Inputs: circuit breaker status (B1-A3)
protection tripping (B2-A3)
protection energizing (B3-A3)
circuit breaker energy (B4-A3)
synchronism check (B5-A3)
external blocking (B6-A3)
external reset of blocking (B7-A3)
spare (B8-A3)

Input voltage: same as unit aux. voltage

Power consumption: 1W for each input

7.3 Output relays

Number: 5

Contacts: 2 potential free changeover contacts for close C. B. relay
1 potential free changeover contact for other relays

7.4 Setting ranges and steps

Setting parameter	Setting Range	Steps	Tolerance
Number of shots	0.1...4 (AR blocked at 0)	1	
AR - counter	0 - 9999	1	
Fault time t_f	0.01...2.0 s	0.01 s	3 % or 10 ms
Dead time t_{d1}	0.1...99.9 s	0.1 s	3 % or 10 ms
Dead time t_{d2}	0.2...99.9 s	0.1 s	3 % or 10 ms
Dead time t_{d3}	0.2...99.9 s	0.1 s	3 % or 10 ms
Dead time t_{d4}	0.2...99.9 s	0.1 s	3 % or 10 ms
Close time t_{cl}	0.05...2.0 s	0.01 s	3 % or 10 ms
Reclaim time t_r	1.0...300 s	1.0 s	3 % or 10 ms
Number of AR till maintenance alarm (No.M)	1...999/EXIT	1	
Number of AR till maintenance lock-out (No.L)	1...999/EXIT	1	

Fixed parameter	Value	Tolerance	Remarks
Tripping time	200 ms	< 10 ms	This time starts with the protection tripping command and is interrupted by the C.B. OFF-signal. When this time has expired, a C.B. defect is present.
Energy wait time	200 ms	< 10 ms	During this time the C.B. stand-by is supervised before reclosing. It can be deactivated by applying the aux. voltage to connection B4.
Synchronous wait time	150 s	< 10 ms	During this time the synchronous condition is supervised before reclosing. It can be deactivated by applying aux. voltage to connection B5.
Protection wait time	500 ms	< 10 ms	This time starts with the protection tripping command/ activation command after reclosing and is interrupted by the C.B. OFF-signal. When this period has expired, the fast tripping is interrupted.
C.B. wait time	100 ms	< 10 ms	This time starts with the C.B. OFF-signal after unsuccessful reclosing and is interrupted by the protection OFF-command. When this time has expired, a manual open of the circuit breaker is present.
Relay test time	1000 ms	< 10 ms	With a time interval of 1 s the output relays operate one after the other during test mode (trip).
Default password	++++		Can be programmed anew with jumper J1 (see para. 4.3)

7.5 System data

Design standard:

VDE 0435, part 303; IEC255-4
 VDEW ring book - protection technique
 Requirement to the C.B.'s: DIN VDE 0670

8 Order form

Auto reclosing relay	MRK1-	
Housing (12TE)	19"-rack Flush mounting	A D

Technical data subject to change without notice!

Setting-list MRK1

Project: _____ SEG job.-no.: _____

Function group: = _____ Location: ± _____ Relay code: - _____

Relay functions: _____ Password: _____

Function		Unit	Default settings	Actual settings
	Number of shots		0	
No.	Counter for reclosing		0	
t_F	Fault time t_F	s	0.01	
t_{D1}	Dead time t_{D1}	s	0.1	
t_{D2}	Dead time t_{D2}	s	0.2	
t_{D3}	Dead time t_{D3}	s	0.2	
t_{D4}	Dead time t_{D4}	s	0.2	
t_{C1}	Close time t_{C1}	s	0.05	
t_R	Reclaim time t_R	s	1.0	
No.M	Number of AR till maintenance alarm (No.M)		1	
No.L	Number of AR till maintenance lock-out (No.L)		1	
RS	Slave address of the serial interface		1	

Setting of code jumpers

Code jumper	J1		J2		J3	
	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting
Plugged						
Not plugged	X		X		X	



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