MANUAL

HighTECH Line | PROTECTION TECHNOLOGY MADE SIMPLE

MRIK3-C | DIGITAL TIME-OVERCURRENT RELAY WITH CONTROL FUNCTION AND AUTO-RECLOSING

DIGITAL TIME-OVERCURRENT RELAY WITH CONTROL FUNCTION AND AUTO-RECLOSING

Original document

English

Revision: B

Contents

1. Comments on the manual

This manual explains in general the tasks of device planning, parameter setting, installation, commissioning, operation and maintenance of the MRIK3-C device.

The manual serves as working basis for:

- Engineers in the protection field,
- commissioning engineers,
- people dealing with setting, testing and maintenance of protection and control devices,
- as well as trained personnel for electrical installations and power stations.

All functions concerning the type code will be defined. Should there be a description of any functions, parameters or inputs/outputs which do not apply to the device in use, please ignore that information.

All details and references are explained to the best of our knowledge and are based on our experience and observations.
This manual describes the (optionally) full featured versions of the devices.

All technical information and data included in this manual reflect their state at the time this document was issued. We reserve the right to carry out technical modifications in line with further development without changing this manual and without previous notice. Hence no claim can be brought based on the information and descriptions this manual includes.

Text, graphic and formulae do not always apply to the actual delivery scope. The drawings and graphics are not true to scale. We do not accept any liability for damage and operational failures caused by operating errors or disregarding the directions of this manual.

No part of this manual is allowed to be reproduced or passed on to others in any form, unless SEG Electronics GmbH have approved in writing.

This user manual is part of the delivery scope when purchasing the device. In case the device is passed on (sold) to a third party, the manual has to be handed over as well.

Any repair work carried out on the device requires skilled and competent personnel who need to be well aware especially of the local safety regulations and have the necessary experience for working on electronic protection devices and power installations (provided by evidence).

1.1 Information Concerning Liability and Warranty

SEG Electronics GmbH does not accept any liability for damage resulting from conversions or changes carried out on the device or planning (projecting) work, parameter setting or adjustment changes done by the customer.

The warranty expires after a device has been opened by others than SEG Electronics GmbH specialists.

Warranty and liability conditions stated in SEG Electronics GmbH General Terms and Conditions are not supplemented by the above mentioned explanations.

1.2 IMPORTANT DEFINITIONS

The signal definitions shown below serve the safety of life and limb as well as for the appropriate operating life of the device.

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE is used to address practices not related to personal injury.

CAUTION, without the safety alert symbol, is used to address practices not related to personal injury.

1.3 How to use this instruction

In this instruction the technical description of all MRIK3-C versions is included. The user is given a comprehensive insight into the various applications, the selection, installation, setting of parameters and putting into operation of the MRIK3-C.

The manual MR- Digital multifunction relay describes the common part of the MRIK3-C relay functionality e.g. how to change parameters. The manual describe the device function which is equal to all HighTechLine device types based on micro controller technology. E.g. MRI3, MRIK3, MRN3, MU3, etc.

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`docs.SEGelectronics.de`

If your publication is not there, please contact your customer service representative to get the latest copy.

1.4 Electrostatic Discharge Awareness

CAUTION

All electronic equipment is electro static-sensitive, some components more than others. To protect these components from electro static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. **Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).**

2. **Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.**

3. **Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.**

4. **Do not remove any printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:**

Do not touch any part of the PCB except the edges.

- **Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.**

- **When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.**

2. Introduction and Application

The digital net protection relay MRIK3-C an universal time - over -current and earth fault relay with integrated control- and supervision function as well as optional an integrated auto reclosing function The earth fault protection is applicable for insulated and compensated grids. The controlling of the circuit breaker take place by the means of the front plate via push button in the case of a local operation, the remote operation can be done via digital inputs or via the serial communication interface.
The earth-fault supervision is either realised in Holmgreen connection or by means of a core-type current transformer. The MRIK3-C is available with rated currents of 1 A or 5 A.

3. Characteristics and Features

- Microprocessor technology with self-supvervision,
- Measuring of phase currents as RMS value,
- Digital filtering of the earth current with discrete Fourier analysis, by which the influence of interference signals, such as harmonics and transient DC components during an earth-fault are suppressed.
- Two sets of parameters,
- Operation cycle counter,
- Suppression of an LED indication after activation (LED flash),
- Selectable protective functions : Definite time overcurrent protection (DMT) and inverse time overcurrent protection (IMT),
- Selectable IMT trip characteristics of IEC 255-4:
  - Normal inverse (Type A)
  - Very inverse (Type B)
  - Extremely inverse (Type C)
  - Special-purpose characteristics eg. RINV, LINV and RXIDG in earth path
- Reset mode for DMT/IMT trip characteristics is selectable,
- Definite element for short-circuit high-speed trip
- Defined time overcurrent protection without directional feature (DEFT)
- Inverse time overcurrent protection without directional feature (INV)
- Two element defined- or inverse time earth fault protection,
- Optionally with integrated directional feature for the earth fault element.
- Control of the CB via potential free auxiliary relays,
- Supervision of the CB via digital wide range inputs,
- Remote indication of the CB position via serial interface.,
- CB failure protection,
- Display of the measuring values as primary quantities,
- Measuring of the phase currents during short-circuit free operation,
- Blocking of the individual protective elements or the trip elements can be set freely,
- The protective functions can be freely allocated to the output relays. (Relay Matrix),
- automatic auto reclosing (optional),
- free assignment of protective function for every reclosing separately adjustable,
- Free assignment of the input function to the digtial input,
- Saving of trip values and the switch-off times (t_{CBFP}) of 25 fault events (voltage fail-safe),
- Recording of up to 8 fault events with time stamp,
- Display of date and time,
- Trip via digital inputs,
- Rack mounting, with self-acting short-circuit mechanism for CT circuits,
- Possibility of serial data exchange via the RS485 or RS232 interface, with Modbus Protocol.
- The minimum operating time including boot time (power-on-time) is <100ms

4. Design

4.1 Connections

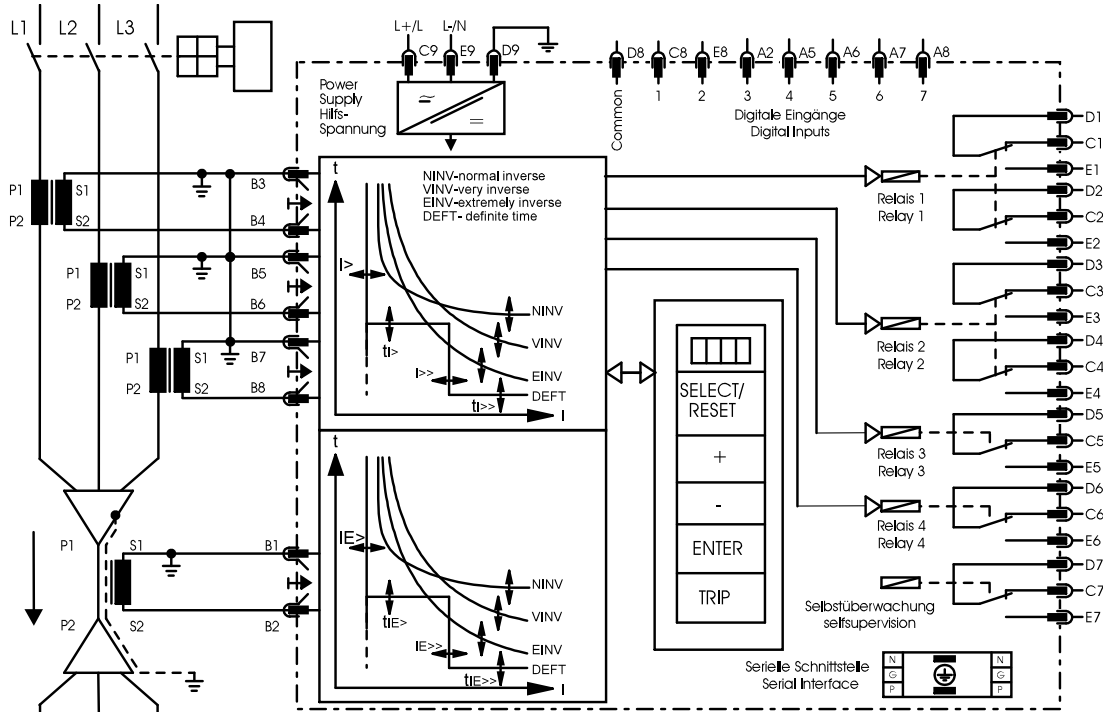


Figure 4.1: Connection diagram `MRIK3-ICE`

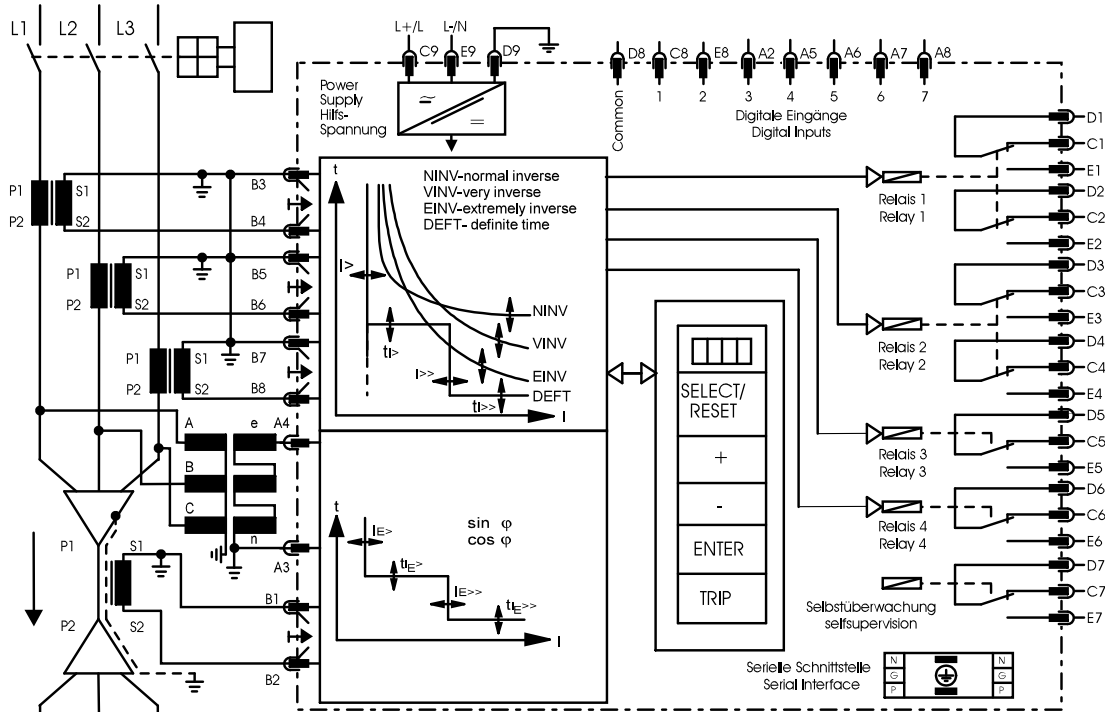


Figure 4.2: Connection diagram MRIK3-ICER/ICXR

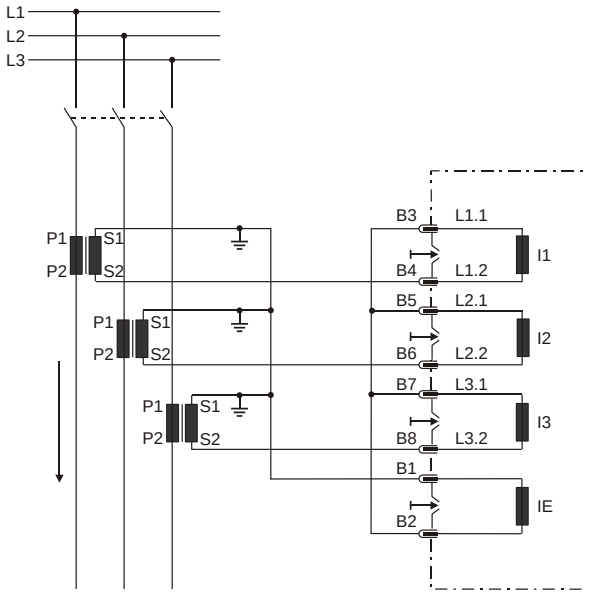


Figure 4.3: Measuring of phase currents and earth current detection in Holmgreen connection (IE)

This kind of connection can be used where three phase CTs are available and a combination of phase and earth current measuring is required.

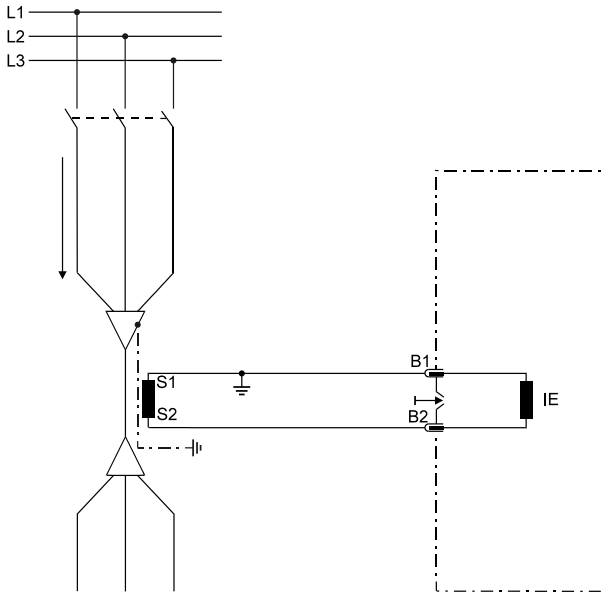


Figure 4.4: Measuring of earth current with core-type CT (IE)

With the combination of phase and earth current measuring, CTs to be connected according to Figure 4.3 or Figure 4.4.

4.1.1 Analog input circuits

The analog input signals of the phase currents I_{L1} (B3 - B4), I_{L2} (B5 - B6), I_{L3} (B7 - B8) and the earth current I_E (B1 - B2) are fed to the protection device via separate input CTs. The current measuring quantities are galvanical decoupled, analogously filtered, and then fed to the analog/digital converter.
For the unit type with earth fault directional features (ER/XR-relay type) the residual voltage from the open delta winding can directly be connected to A3 and A2.

See chapter 5.6 for voltage transformer connections on isolated/compensated systems (direction feature of the earth fault element)

4.1.2 Output relays

The MRIK3-C has 5 output relays. Two of these relays with two change-over contacts and three relays with one change-over contact each are used for signalling. The protective functions can be freely allocated except of those for the self-supervision relay.

- Relay 1: C1, D1, E1 and C2, D2, E2
- Relay 2: C3, D3, E3 and C4, D4, E4
- Relay 3: C5, D5, E5
- Relay 4: C6, D6, E6
- Relay 5: Self-supervision C7, D7, E7

All relays are operating according to the n. o. principle with the exception of the self-supervision relay, which operates acc. to the n. c. principle.

4.1.3 Digital inputs

The MRIK3-C has 7 digital inputs with fixed functions. The input functions can be selected free for each digital input. All inputs have a common reference point: Terminal D8. (See chapter 6.12.4 / 6.12.5) MR – Digital multifunction relays

Terminal	Function	Code jumper
C8	Digital Input 1	X6
E8	Digital Input 2	X7
A2	Digital Input 3	X5
A5	Digital Input 4	X4
A6	Digital Input 5	X1
A7	Digital Input 6	X2
A8	Digital Input 7	X3

4.1.4 Low/High range of the digital Inputs

The MRI(K)3-C is equipped with a wide-range power supply unit and hence the supply voltage is freely selectable. The switching threshold of the digital inputs, however, has to be fixed in compliance with the supply voltage. Two different switching thresholds can be adjusted:

Range	Plug	U_{AB}	U_{AN}
Low	Plugged in	<= 8V	>= 10V
High	Open	<= 60V	>= 80V

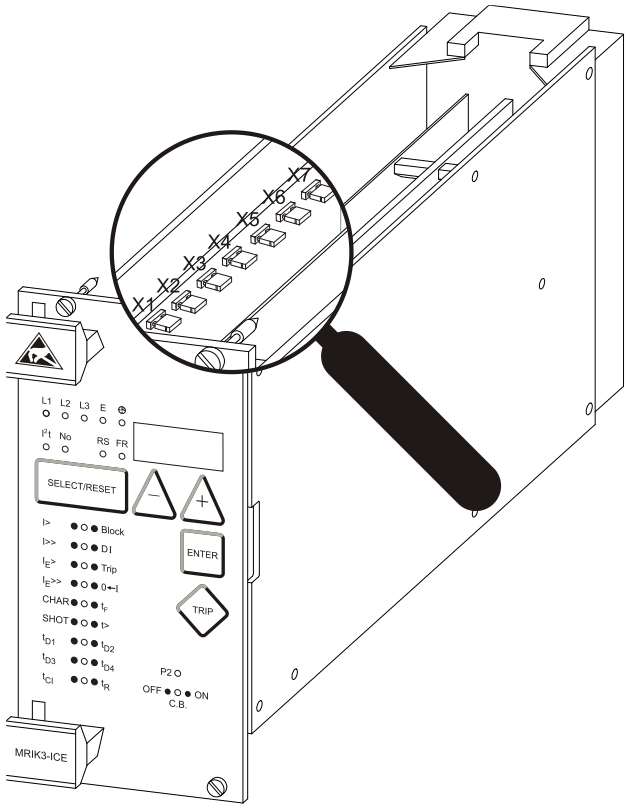


Figure 4.5: Code jumpers

4.2 Password

4.2.1 Code jumpers

Behind the front plate of the MR-relays there are three code jumpers to preset the following functions:

- Password programming
- Output relay functions

The following figure shows the position and designation of the code jumpers:

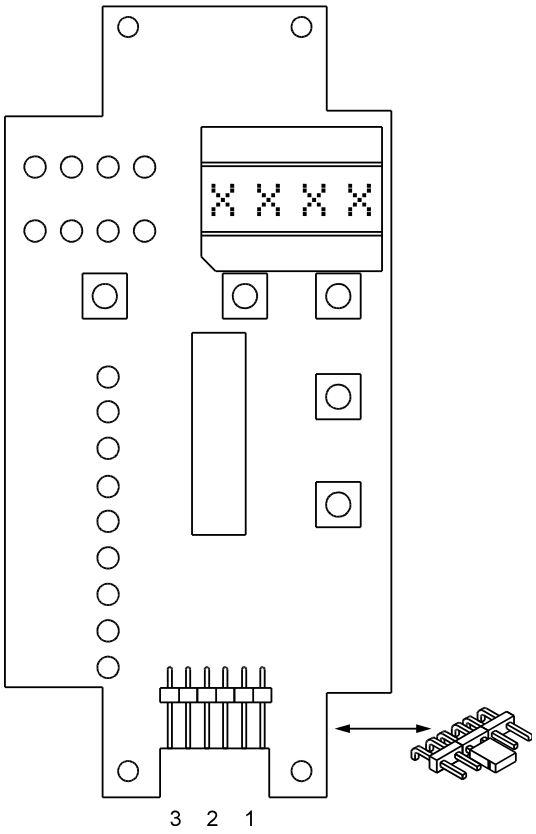


Figure 4.6: Code jumpers

4.2.2 Password programming

The two different passwords are assigned to separate password sections.
Password 1 (Code jumper 1) With this password all protection parameter are changeable.
Password 2 (Code jumper J2) With this password it is allowed to change the mode of the relay from “remote control” to “local control” and also allowed to control the CB. (See Chap. 5.7.8) The procedure for password programming is described in Chapter 4.4 of the description MR – digital multifunction relays.

Code jumper	Function	Code jumper position	Operation mode
J1	Password 1* general	OFF	Normal position
		ON	Password selection (see general description MR chapter 4.4)
J2	Password 2* Control-level	OFF	Normal position
		ON	Password selection (see general description MR chapter 4.4)
J3	Reset	OFF	Output relays will be reset automatically
		ON	no function

Table 4.1: Summary of coding possibilities

*If both code jumpers are set it is not possible to change the password.

4.3 Front plate (for –ICE relay type)

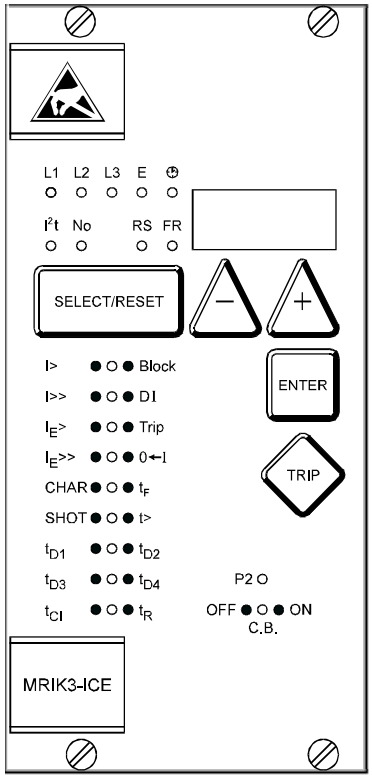


Figure 4.7: Front plate `MRIK3-ICE`

The LEDs No, RS and on the MRIK3-C emit a yellow light, all other LEDs are bi-coloured. The LEDs at the left next to the alphanumerical display give a green light during measuring and a red one when a fault signal occurs.
The LEDs underneath the <SELECT/RESET> - push button emit a green light during adjustment and inquiry of the setting quantities left to the LEDs. They show a red light if the printed setting quantities right to the LEDs are activated.

4.3.1 Indicating LEDs

L1, L2, L3	Indication of the phase currents
E	Indication of the earth current
🕒	Date and time
I^2t	Indication for the composite switch off power of the CB.
No	operation cycle counter
FR	Parameter for the fault recorder
RS	Setting of the relay address

4.3.2 Adjusting LEDs

I>	Overcurrent setting
I>>	Short-circuit setting
IE>	Earth overcurrent setting
IE>>	Earth short circuit setting
CHAR	Selection of characteristics
t>	emits in combination with all time delay settings
DI	Assignment of input functions to the digital inputs.
0←1	AR Autoreclosing unsuccessful
Trip	ext. tripping
Block	Trip/Blockage time
I²t>	Pick up level for the composite switch off power
SHOT	number off AR shots
tF	fault time
tD1	dead time before 1. AR
tD2	dead time before 2. AR
tD3	dead time before 3. AR
tD4	dead time before 4. AR
tCl	close impulse time
tR	reclaim time
P2	Parameter set 2 is active
CB red	CB ist switched on
CB green	CB is switched off
CB blinking	CB has faults

4.4 Front plates (for -ER/-XR-relay types)

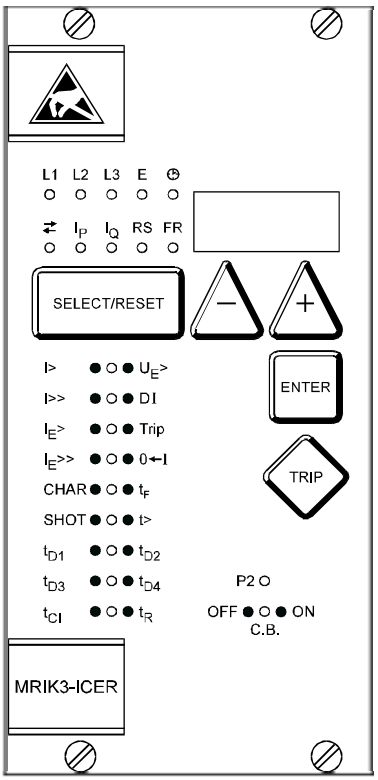


Figure 4.8: Front plate MRIK3-ICER MRIK3-ICXR

The LEDs I_P, I_Q, RS and FR on the MRIK3-ICE and MRI3-ICE emit a yellow light, all other LEDs are bi-coloured. The LEDs at the left next to the alphanumerical display give a green light during measuring and a red one when a fault signal occurs.

The LEDs underneath the <SELECT/RESET> - push button emit a green light during adjustment and inquiry of the setting quantities left to the LEDs. They show a red light if the printed setting quantities right to the LEDs are activated.

4.4.1 Indicating LEDs

L1, L2, L3	Indication of the phase currents
E	Indication of the earth current
🕒	Date and time
⇄	green: forward direction; red: reverse direction
I_P	Indication of the active component of the earth fault current
I_Q	Indication of the reactive component of the earth fault current.
FR	Parameter for the fault recorder
RS	Setting of the relay address

4.4.2 Adjusting LEDs

I>	Overcurrent setting
I>>	Short-circuit setting
IE>	Earth overcurrent setting
IE>>	Earth short circuit setting
CHAR	Selection of characteristics lights in combination with all time delay settings.
DI	Assignment of the input functions to the digital inputs
Trip	ext. tripping
SHOT	Number of AR shots
tF	max. fault time
tD1	dead time before 1. AR
tD2	dead time before 2. AR
tD3	dead time before 3. AR
tD4	dead time before 4. AR
tCl	max close impulse time
tR	reclaim time
FR	Parameter for the fault recorder
RS	Setting of the relay address
P2	Parameter set 2 is active
CB red	CB is switched on
CB green	CB is switched off
CB blinking	CB has faults

5. Working principle

5.1 Analogue circuits

The incoming currents from the main current transformers on the protected object are converted to voltage signals in proportion to the currents via the input transformers and burden. The noise signals caused by inductive and capacitive coupling are suppressed by an analogue R-C filter circuit. The analogue voltage signals are fed to the A/D-converter of the microprocessor and transformed to digital signals through Sample- and Hold-circuits. The analogue signals are sampled at 50 Hz (60 Hz) with a sampling frequency of 800 Hz (960 Hz), namely, a sampling rate of 1.25 ms (1.04 ms) for every measuring quantity.

5.2 Digital circuits

The essential part of the MRIK3-C relay is a powerful microcontroller. All of the operations, from the analogue digital conversion to the relay trip decision, are carried out by the microcontroller digitally. The relay program is located in an EPROM (Electrically-Programmable-Read-Only-Memory). With this program the CPU of the microcontroller calculates the three phase currents and ground current in order to detect a possible fault situation in the protected object.

For the calculation of the current value an efficient digital filter based on the Fourier Transformation (DFFT - Discrete Fast Fourier Transformation) is applied to suppress high frequency harmonics and DC components caused by fault-induced transients or other system disturbances.

The calculated actual current values are compared with the relay settings. If a phase current exceeds the pickup value, an alarm is given and after the set trip delay has elapsed, the corresponding trip relay is activated.
The relay setting values for all parameters are stored in a parameter memory (EEPROM - Electrically Erasable Programmable Read-only Memory), so that the actual relay settings cannot be lost, even if the power supply is interrupted.
The microprocessor is supervised by a built-in "watchdog" timer. In case of a failure the watchdog timer resets the microprocessor and gives an alarm signal, via the output relay "self supervision".

5.3 Status descriptions

Reaction to protection events is possible at any time unless blocking is expressly desired (refer to 6.12.1). In the inactive and blocked state auto reclosing is not possible.

For the explanation of the functional sequence the following six status transitions are defined.

5.3.1 „Inactive“

The relay MRIK3-C is in "inactive" status if one of the following conditions is fulfilled:
- The circuit breaker is in position "OFF",
- the unit is in "blocked" status,
- the unit is not in "starting/cycle" status

5.3.2 „Reclaim time“ tR

The relay MRIK3-C is in "reclaim time" status (tR) when the reclaim time
- has not yet expired or
- not interrupted by other incidents.

5.3.3 „AR-ready“

The relay MRIK3-C is in position "AR-ready" status when the following conditions are fulfilled:

- The circuit breaker is in position "ON",LED CB emit red light
- 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!

5.3.4 „AR-starting“ (dead time)

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

5.3.5 „AR-cycle“ (auto reclosing)

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

5.3.6 „AR-blocked“

Unit *MRIK3-C* changes immediately to "AR-blocked" status when an external or internal blocking signal (A2-A3) exists. (activation via assigned digital input, see Chap. 6.12.4). No auto reclosing is possible in "AR-blocked" status.

5.3.7 „Fast Trip Mode“

By way of the function "Assignment of the AR functions" it is possible to activate or deactivate a Fast Trip function for each AR stage and for each protective function. This is applicable for tripping before the 1st AR up to tripping after the last AR. (see chapter 6.12.3)

5.3.8 „Blocking mode“

By way of the function "Assignment of the AR functions" it is possible to activate or deactivate a protection function for each AR stage. This is applicable for tripping before the 1st AR up to tripping after the last AR. (see chapter 6.12.3)

5.3.9 „Activating of AR“

Prior to every AR it is possible to stipulate which kind of tripping (I> or I>>, etc.) will lead to automatic reclosing. This can be separately fixed for each AR stage. (see chapter 6.12.3)

5.3.10 Description of the status transition

to / from	inactive	reclaim time	ready	starting (dead time)	cycle (auto reclosing)	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					

Table 5.1: AR-status transition matrix

From Table 5.1 you can detect what status transitions of MRIK3-C are possible. When the unit is for instance in "cycle" status (see also para. 4.3) 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.

5.3.11 AR information inputs

By means of the information inputs the MRIK3-C decides whether and when automatic reclosing may take place. The functions are assigned via the function assignment of the digital inputs as far as they are required. (refer to chapter 6.12.5)

If one of the three CB position indicators described in the following is activated, it must also be used because otherwise no correct function indication is possible.

CR = "CB ready" signal (e.g. motor switch or spring power storage)
With this function the CB ready message is signalled.

CI = "CB feedback CB – ON"
With this function the CB position ON is signalled. Signal = 1 = CB is switched on.

CO = "CB feedback CB – OFF
With this function the CB position OFF is signalled. Signal = 1 = CB is switched off.

CAUTION

If both functions are assigned to one digital input, a CB ON position is only recognised if 1 is recognised via the CI function and 0 via the CO function. For the OFF position both signals must indicate a negative signal. All other position indications lead to a CB fault signal. This is visually indicated by the flashing CB LED. (refer to chapter 5.7.11)

AR blocked
With this function an AR can be blocked at any time. If the function has been set, the LED 0←1 lights up.

SY= SY = Synchronisation signal
This function permits an extension of the dead times tD. If this function has been activated, there is a waiting time of 150 s for the synchronisation signal after the dead times have expired. If the input has not been set after this period has expired, the *MRIK3-C* stops the AR cycle. The display shows "S/E?". If the digital input is activated during this period, the ON signal is set without delay.

5.4 Functional sequence

5.4.1 Switching on MRIK3-C

Is the C.B. to be supervised in OFF position while “switching ON” the MRIK3-C, the unit changes into "inactive" status when applying auxiliary voltage. The LED "CB" 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 "CB" signalizes this status.
In case unit MRIK3-C is in "blocked" status before auxiliary voltage failure occurred, this condition remains also after recurrence of auxiliary voltage.
The LED CB shows the position of the C.B.

5.4.2 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 MRIK3-C remains in "inactive" status after protection tripping. By switching the circuit breaker on manually it is possible to choose whether the CB is to switch off with or without delay action in case of connection to a faulty line. Setting is done separately for each protection stage. (refer to chapter 6.5.4; 6.5.9; 6.5.15 and 6.5.19)

5.4.3 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. Auto reclosing is not possible. The LED CB emit green light.

5.4.4 Starting AR

When the information "protection energized" and "protection tripping" is applied, the unit changes from "ready" status to "starting" status. The LED "AR" lights up. The "starting" status begins with the start of a fault timer (tF from 0.1 s to 2.0 s adjustable).

The LED tF lights up red. 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. (C.B. must be tripped within this time). The "start conditions not fulfilled" is evaluated and the MRIK3-C 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". The LED tF flashes red. 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. The LED tF extinguishes. During the switch-off procedure of the circuit breaker the MRIK3-C waits for feedback from the C.B. This feedback must come within 0.2 s. 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 changes to „inactive“ status. The LED CB flashes and the Display shows „CB??“. Tripping timer: Time from the beginning of the trip command until receiving of the C.B. check-back signal.

5.4.5 Unsuccessful reclosing

After the start condition has been fulfilled the unit changes to "starting" status. Now the dead time tD is started. The corresponding LED flashes.

Unit MRIK3-C can be programmed for reclosing of one to four times. For each reclosing a dead time has to be set (t_{D1} to t_{D4}). When the dead time has expired and also the other reclosing conditions have been fulfilled, the reclosing command is given to the circuit breaker. The reclosing conditions are the responsibility of the synchronisation command if the function is configured via the digital inputs. The CB must be ready and in switched-off status. The reclosing command remains either as long as the ON-signal from the circuit breaker appears or the close-impuls-timer (t_{CL}) has expired.

The LED t_{CL} lights up for the duration of the close impulse. When the CB-ON message occurs, the LED t_{CL} extinguishes. After expiration of the ON impulse timer the LED t_{CI} starts flashing and the display shows "CB??"

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 and after the last permissible AR, an unsuccessful reclosing will be detected.
The LED 0→I lights up red and the display shows „OPEN“. Then the unit quits the "cycle" status and changes to the "inactive" status. Simultaneously a relay can be activated which indicates unsuccessful auto reclosing.

5.4.6 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.

During the reclaim time the display shows „CLOS“ and the LED 0←—1 lights up green.
The unit now quits the "cycle" status, changes over into the "ready" status and is ready for the next reclosing. The LED AR extinguishes and the CB LED lights up. The display shows MRIK3.

5.4.7 Repeated reclosing

Is the MRIK3-C programmed for more than single reclosing a further 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.

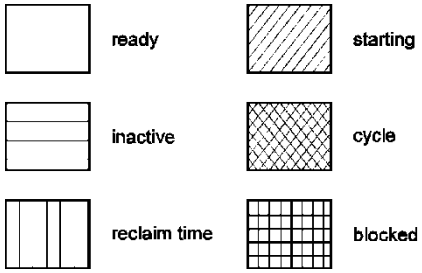
5.4.8 Supervision of the circuit breaker ready information

Because the supervising unit of the circuit breaker energy store operates often after the first fast switch off, 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 for further ARs. There will be a reclosing when the "circuit breaker ready" had been given before the begin of the reclosing cycle. If not, the LED CB flashes and the display shows „S/E?“.

5.4.9 External blocking

The AR-relay is blocked if the external AR-block input is activated. The LED 0←I is alight. When the reclosing shot is set to „EXIT“, the MRIK3 can also be blocked at site. (see chapter 6.12.4)

5.4.10 Time sequence diagrams of MRIK3-C



Legend:

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

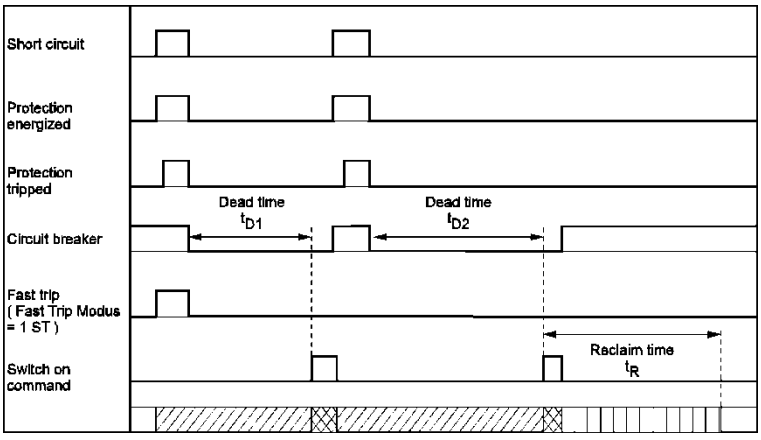


Figure 5.1: Two shots, second AR successful

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 MRIK3-C 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 SHOTs is reached.

5.4.12 The unit is programmed for two shots, unsuccessful AR

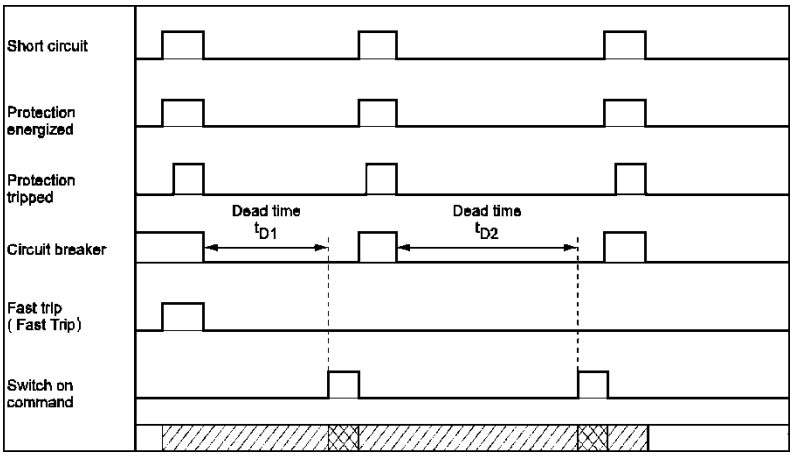


Figure 5.2: Two shots, AR unsuccessful

Here the time sequence as described in para.5.4.11. The second reclosing shot is however unsuccessful.

5.4.13 Manual closing of the circuit breaker to faulty lines

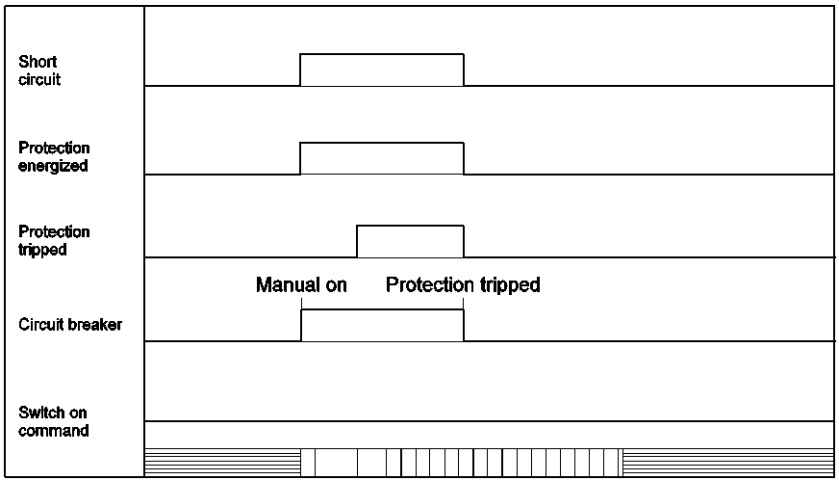


Figure 5.3: Manual closing of the C.B. to faulty lines

Unit MRIK3-C 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 mains protection of the relay. After elapse of the reclaim time unit MRIK3-C changes over to "inactive" status.

5.4.14 Unsuccessful AR

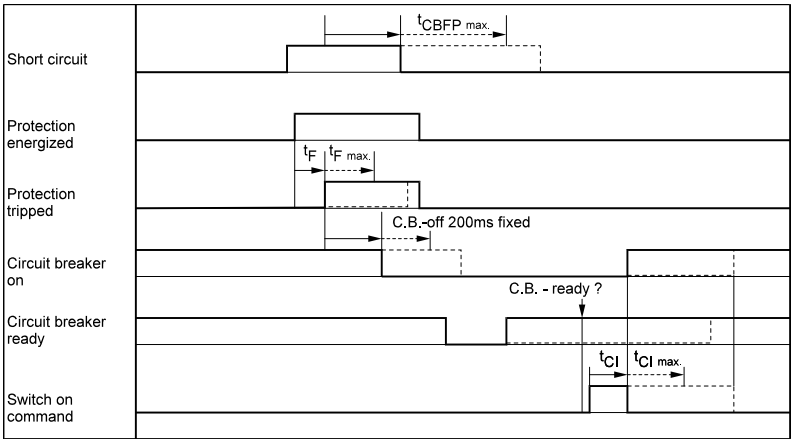


Figure 5.4: Unsuccessful AR

The sequence diagram illustrates the various possibilities of an unsuccessful AR.

5.5 Earth fault protection

5.5.1 Generator stator earth fault protection

With the generator neutral point earthed as shown in Figure 5.5 the MRIK3-C picks up only to phase earth faults between the generator and the location of the current transformers supplying the relay.
Earth faults beyond the current transformers, i.e. on the consumer or line side, will not be detected.

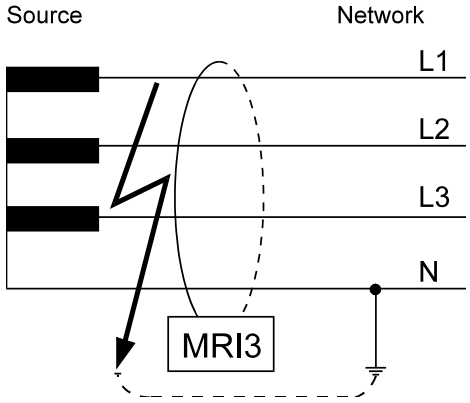


Figure 5.5: Generator stator earth fault protection

5.5.2 System earth fault protection

With the generator neutral point earthed as shown in Figure 5.6, the MRIK3-C picks up only to earth faults in the power system connected to the generator. It does not pick up to earth faults on the generator terminals or in generator stator.

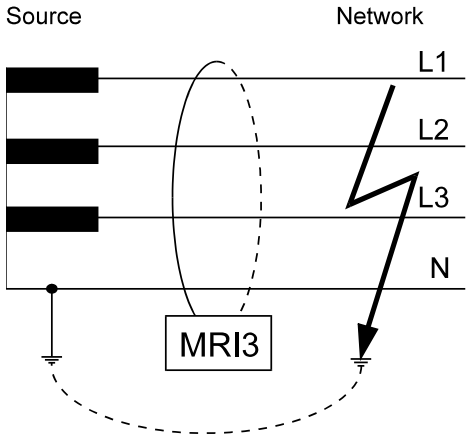


Figure 5.6: System earth fault protection

5.6 Earth-fault directional feature (ER/XR-relay type)

A built-in earth-fault directional element is available for applications to power networks with isolated or with arc suppressing coil compensated neutral point.
For earth-fault direction detection it is mainly the question to evaluate the power flow direction in zero sequence system. Both the residual voltage and neutral (residual) current on the protected line are evaluated to ensure a correct direction decision.
In isolated or compensated systems, measurement of reactive or active power is decisive for earth-fault detection. It is therefore necessary to set the ER/XR-relay type to measure according to sin φ or cos φ methods, depending on the neutral-point connection method.
The residual voltage U_E required for determining earth fault direction can be measured in three different ways, depending on the voltage transformer connections (refer to Table 5.2).
Total current can be measured by connecting the unit either to a ring core C.T. or to current transformers in a Holmgreen circuit. However, maximum sensitivity is achieved if the MRIK3-C protective device is connected to a ring core C. T. See Figure 4.4.
The pick-up values $I_{E>}$ and $I_{E>>}$ (active or reactive current component for cos φ or sin φ method) for MRIK3-ICER-relay types can be adjusted from 0.01 to 0.45 x I_N. For relay type MRIK3-ICXR these pick-up values can be adjusted from 0.1% to 5% I_N.

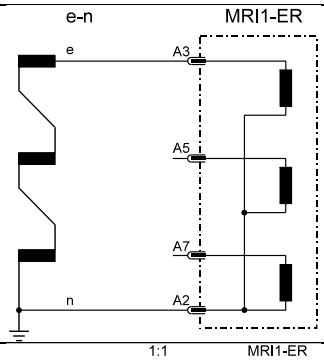
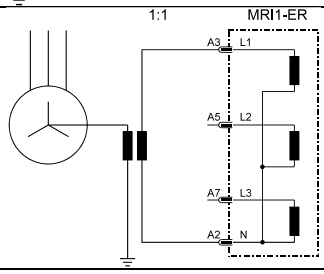
Adjustment possibility	Application	Voltage transformer connections	Measured voltage at earth fault	Correction factor for residual voltage
„e-n“	3-phase voltage transformer connected to terminals A3, A5, A7, A2 (MRIK3-ICER; MRIK3-ICXR)		$U_N = \sqrt{3} \times U_{1N}$	$K = 1/\sqrt{3}$
„1:1“	Neutral-point voltage (= residual voltage) terminals A3, A4 (MRIK3-ICER; MRIK3-ICXR)		$U_{1N} = U_{NE}$	K = 1

Table 5.2: Connection possibility of the voltage transformers

1. Mains with isolated star point (setting: "earthing: SIN", "MTA (fixed): -90°)

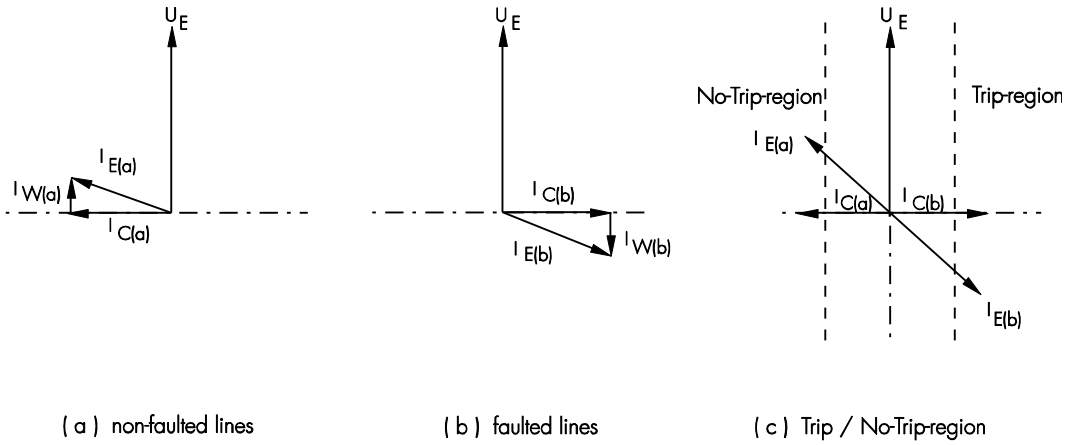


Figure 5.7: Phase position between the residual voltage and zero sequence current for faulted and non-faulted lines in case of isolated systems (sin φ)

U_E - residual voltage
I_E - zero sequence current
I_C - capacitive component of zero sequence current
I_W - resistive component of zero sequence current

By calculating the reactive current component (sin φ adjustment) and then comparing the phase angle in relation to the residual voltage U_E, the ER/XR-relay type determines whether the line to be protected is earth-faulted.
On non-earth-faulted lines, the capacitive component Ic(a) of the total current precedes the residual voltage by an angle of 90°. In case of a faulty line the capacity current $I_{C(b)}$ lags behind the residual voltage at 90°.

2. Compensated mains (setting: "earthing: COS", "MTA (fixed): 180°")

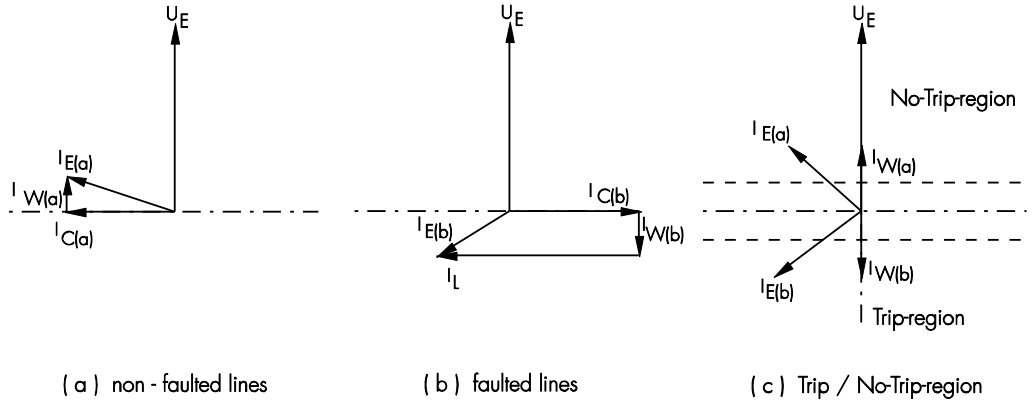


Figure 5.8: Phase position between the residual voltage and zero sequence current for faulted and non-faulted lines in case of compensated systems (*cos φ)*

U_E - residual voltage
I_E - zero sequence current
I_L - inductive component of zero sequence current (caused by Petersen coil)
I_C - capacitive component of zero sequence current
I_W - resistive component of zero sequence current

In compensated mains the earth fault direction cannot be determined from the reactive current components because the reactive part of the earth current depends upon the compensation level of the mains. The ohmic component of the total current (calculated by cos φ adjustment) is used in order to determine the direction. The resistive component in the non-faulted line is in phase with the residual voltage, while the resistive component in the faulted line is opposite in phase with the

residual voltage. By means of an efficient digital filter harmonics and fault transients in the fault current are suppressed. Thus, the uneven harmonics which, for instance, are caused an electric arc fault, do not impair the protective function.
Applikationshinweis: Anwendung ER vs. XR

5.7 Control functions

5.7.1 Introduction

The controlling of the connected circuit breaker take place by the means of the output relays. The CB position as well as the CB ready message are supervise by digital inputs.. The status of the CB and the position are indicated by on LED on the front plate of the relay MRIK3-C. The local operation takes place by means of the push buttons on the front plate. Furthermore the position of the CB are signalize to a SCADA system via the serial interface and Modbus RTU protocol.

5.7.2 Interlocking / Password for control mode

The local operation of the CB is protected via a separate password. The standard setting of this password is four times minus (‘ - - - - ‘).The password can be changed as described in Chapter 4.4 of the of the description "MR – general" and via the jumper J2.
During local operation all remote operation via digital inputs or serial interface are blocked.
To change from local to remote or back are only possible from the front plate of the relay.

5.7.3 Operating assignment of C.B. control

In case of local operation, remote mode via the digital inputs or via the serial interface is no longer possible.
Switching-over between local operation (LCAL on the display) and remote mode (RMOT on the display) can only be done via the front plate.

Display shows “LCAL”
The digital input functions:
t0 = Ext. tripping immediately
t1 = Ext. tripping delayed
ON = Ext. start
t2 = Trip/restore function are blocked (see chapter 6.12.5)
Switching on and off via the serial interface are also blocked.

Display „RMOT“
Switching on and off function via the front panel is blocked.

5.7.4 Changing the operating assignment

Changing the operating assignment requires the following procedure:
Simultaneous operation of the keys <ENTER> and <+> will take you to the control mode. The display shows “LCAL” or “RMOT”. If the function is to be maintained, you can move to the next menu item with the <SELECT/RESET> key. The function can be changed with either the <+> or the <-> key.

5.7.5 Saving the operating assignment

If the changed function is to be saved, the <ENTER> key must be operated. The display shows “SAV?”. If the <ENTER> key is pressed again, you are asked for the password. The display shows ”PSW?”. Pressing the next four keys will enter the password. On the display the entry is accompanied by an “X” for every entered character. The standard password for the control functions is 4x <->. If the password has been entered correctly, the display will show “SAV”. Now the <ENTER> key must be pressed again and kept depressed (3s) until the function to be set reappears in the display. If the entry is incorrect, the password is requested again. The display will show “PSW?” once more. A detailed description of entering and changing the password is provided in the description MR – digital multifunction relays in Chapter 4.4 and in this description in Chapter 3.2.

5.7.6 Remote switching on and off of the C.B.

If the operating assignment of the C.B. control was set to remote (RMOT), the C.B. control via the front panel is blocked. By operating the <SELECT/RESET> key you will leave the operating assignment again. The display will show “MRIK”.

The digital input functions:
t0 = Ext. tripping immediately
t1 = Ext. tripping delayed
ON = Ext. start
t2 = Trip/restore Function are released.
Switching on and off via the serial interface are also released.

5.7.7 Switching on or off the C.B. via the front panel (LCAL)

After having selected the function (LCAL), pressing the <SELECT/RESET> key will take you to the control mode. The display will now show the status of the circuit breaker C.B.

CB??

Position of the C.B. cannot be established as the information from the digital inputs is insufficient. At the same time the LED CB is flashing. At this stage it is important that a digital input which has been activated for a C.B. control function must be used. (see chapter 6.12.4 and 6.12.5). A detailed function assignment for the control signals for the C.B. can be found in Chapter 5.7.9.

ON??

The C.B. is switched off. The LED CB shows a green light. Press the <ENTER> key and enter the password to have ON!! shown on the display.

ON!!

The C.B. can be switched on by pressing the <ENTER> key.

OFF?

The C.B. is switched on. The LED CB shows a red light. Press the <TRIP> key and enter the password to have OFF! shown on the display.

OFF!

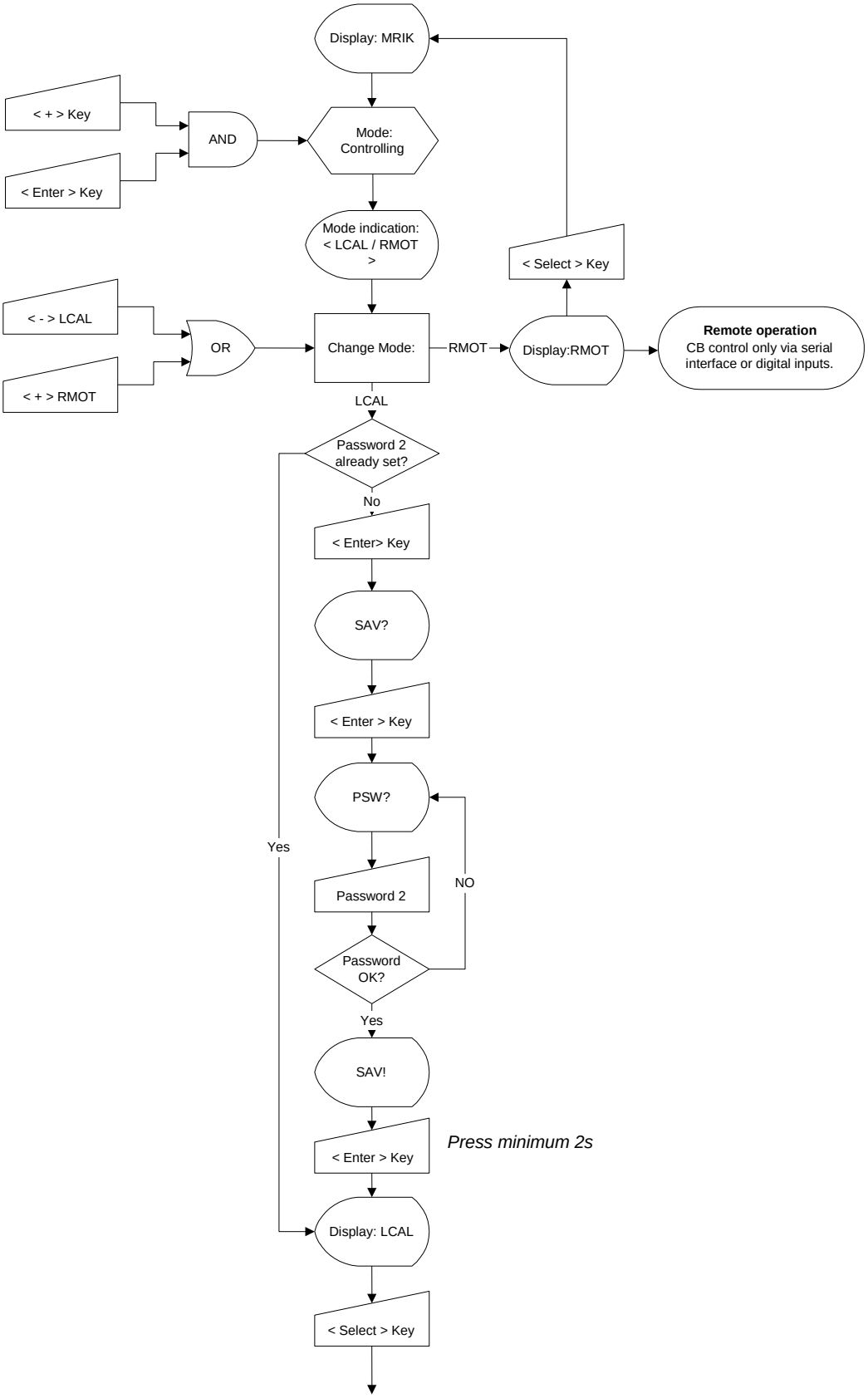
The C.B. can be switched off by pressing the <TRIP> key.

The graph of the procedure of operation assignment and the C.B. control function can be found in the next Chapter 5.7.8.

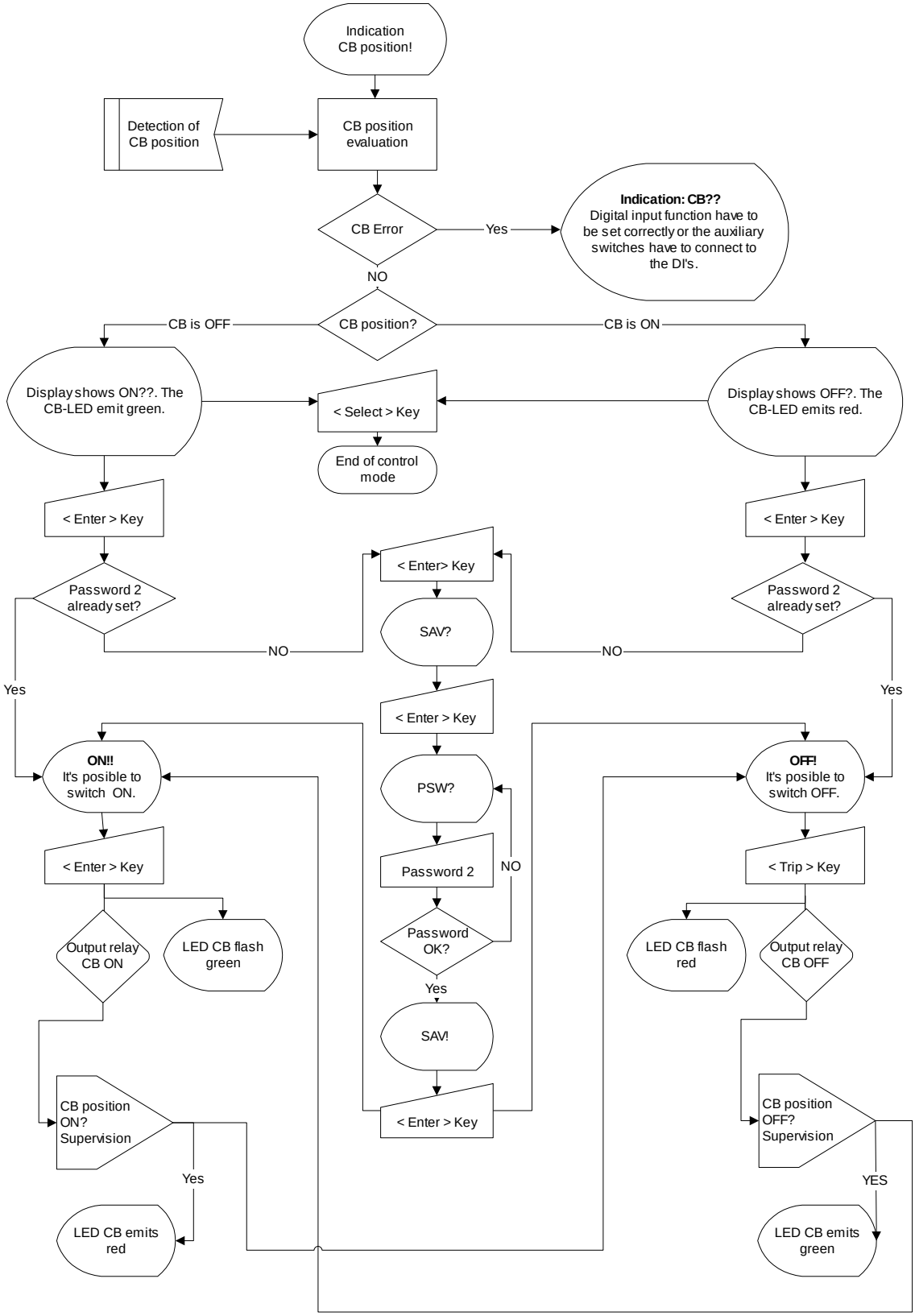
5.7.8 Handling of the control function

The control function of the MRIK3-C are activated by push buttons from the front plate of the relay. In the following flow charts the detail handling is shown.

Control modus activation



Local operation of the CB.



5.7.9 Display for the control functions

The logical independence of the control functions and the digital input functions are shown in the following tables depending of the relay status. Indication from display and LED in the control mode

CB position			LED CB	Display indication	
CB Ready	CB ON	CB OFF		During switching	
0	0	0	Flashed red	CB??	
0	0	1	Flashed red	CB??	
0	1	0	Emits red	OFF?	OFF!
0	1	1	Flashed red	CB??	
1	0	0	Flashed red	CB??	
1	0	1	Emits green	ON??	ON!!
1	1	0	Emits red	OFF?	OFF!
1	1	1	Flashed red	CB??	

CB position			LED CB	Display indication	
CB Ready	CB ON			During switching	
0	0		Flashed red	CB??	
0	1		Emits red	OFF?	OFF!
1	0		Emits green	ON??	ON!!
1	1		Emits red	OFF?	OFF!

CB position			LED CB	Display indication	
CB Ready		CBOFF		During switching	
0		0	Emits red	OFF?	OFF!
0		1	Flashed red	CB??	
1		0	Emits red	OFF?	OFF!
1		1	Emits green	ON??	ON!!

CB position			LED CB	Display indication	
	CB ON	CB OFF		During switching	
	0	0	Flashed red	CB??	
	0	1	Emits green	ON??	ON!!
	1	0	Emits red	OFF?	OFF!
	1	1	Flashed red	CB??	

CB position			LED CB	Display indication
CB Ready				During switching
0			Flashed red	CB??
1			Flashed red	CB??

CB position			LED CB	Display indication	
	CB ON			During switching	
	0		Emits green	ON??	ON!!
	1		Emits red	OFF?	OFF!

CB position			LED CB	Display indication	
		CBOFF		During switching	
		0	Emits red	OFF?	OFF!
		1	Emits green	ON??	ON!!

CB position			LED CB	Display indication
There are no function assign to a digital input			Flashed red	CB??

5.7.10 LED-indication under normal mode

The logical independence of the control functions and the digital input functions are shown in the following tables depending of the relay status.
Indication of display and LED in normal mode.

CB position			CB LED
CB Ready	CB ON	CB OFF	
0	0	0	Flashed red
0	0	1	Emits green
0	1	0	Emits red
0	1	1	Flashed red
1	0	0	Flashed red
1	0	1	Emits green
1	1	0	Emits red
1	1	1	Flashed red

CB position			CB LED
CB Ready	CB ON		
0	0		Emits green
0	1		Emits red
1	0		Emits green
1	1		Emits red

CB position			CB LED
CB Ready		CBOFF	
0		0	Emits red
0		1	Emits green
1		0	Emits red
1		1	Emits green

CB position			CB LED
	CB ON	CB OFF	
	0	0	Flashed red
	0	1	Emits green
	1	0	Emits red
	1	1	Flashed red

CB position			CB LED
CB Ready			
0			Flashed red
1			Flashed red

CB position			CB LED
	CB ON		
	0		Emits green
	1		Emits red

CB position			LED CB
		CBOFF	
		0	Emits red
		1	Emits green

CB position			LED CB
There are no function assign to a digital input			Flashed red

5.7.11 LED-indication auto reclosing conditions (AR)

CB position				
Before switch ON		After switch OFF (after 300ms)		
CB Ready	LED CB	CB ON	CB OFF	LED CB
0	Flashed red	0	0	Flashed red
		0	1	Emits green
		1	0	Emits red
		1	1	Flashed red
1	Emits green	0	0	Flashed red
		0	1	Emits green
		1	0	Emits red
		1	1	Flashed red

CB position				
Before switch ON		After switch OFF (after 300ms)		
CB Ready	LED CB	CB ON	CB OFF	LED CB
0	Flashed red	0	x	Emits green
		1	x	Flashed red
1	Emits green	0	x	Emits green
		1	x	Flashed red

CB position				
Before switch ON		After switch OFF		
CB Ready	LED CB	CB ON	CB OFF	LED CB
0	Flashed red	x	0	Flashed red
		x	1	Emits green
1	Emits green	x	0	Flashed red
		x	1	Emits green

CB position				
Before switch ON		After switch OFF		
CB Ready	LED CB	CB ON	CB OFF	LED CB
x	Emits green	0	0	Flashed red
		0	1	Emits green
		1	0	Flashed red
		1	1	Flashed red

CB position				
Before switch ON		After switch OFF		
CB Ready	LED CB	CB ON	CB OFF	LED CB
0	Flashed red	x	x	Flashed red
1	Emits green	x	x	Flashed red

CB position				
Before switch ON		After switch OFF		
CB Ready	LED CB	CB ON	CB OFF	LED CB
x	Emits green	0	x	Emits green
		1	x	Flashed red

CB position				
Before switch ON		After switch OFF		
CB Ready	LED CB	CB ON	CB OFF	LED CB
x	Emits green	x	0	Flashed red
		x	1	Emits green

CB position				
Before switch ON		After switch OFF		
CB Ready	LED CB	CB ON	CB OFF	LED CB
x	Flashed red	x	x	Flashed red

5.8 Requirement on the Main Current Transformers

The CTs chosen have a considerable influence on the accuracy of the protective system. In order to select the right type of transformer, the requirements and conditions on site have to be considered carefully.

Type of Transformer
Current transformers have to be designed as protection transformers (P).

Overcurrent Factor:
To ensure precise operation of the protection unit even under full short-circuit current, the chosen transformers must not saturate in this current range. This means that the overload factor must be sufficiently large.

Class
For the nominal range or the lower load range it has to be taken into account that not only the basic accuracy of the MRIK3-C has to be considered but also the transformer accuracy. This applies especially for cases where the Holmgreen circuit is used and for low earth fault currents in isolated networks.

Power Rating
The transformer must be rated sufficiently to cover all measuring instruments and protective devices connected as well as the losses on the transformer measuring line without becoming overloaded.

6. Operation and Adjustments

6.1 Displayed text for parameter settings

Function	Displayed Text	Related LED	References
Normal operation	MRIK		
Exceeding the measuring range	max.	ϑ	
Sec. transf. currents indication	SEK	L1, L2, L3, E	Chap. 6.4.1 Chap. 6.4.2
Rated frequency	f = 50 / f = 60		Chap. 6.4.6
LED flashing after activation	FLSH/NOFL		Chap. 6.4.7
Parameter set change-over switch	SET1, SET2,	P2	Chap. 6.4.8
Blocking of a function	EXIT	LED of the blocked parameter	
Characteristics phase current	DEFT,NINV, VINV, EINV, LINV, RINV,	I> + CHAR	Chap. 6.5.2
Characteristics earth current	DEFT, NINV, VINV, EINV, LINV, RINV, RXIDG	IE>> + CHAR	Chap. 6.5.13
Reset mode for phase current	0s / 60s	I> + CHAR + t> tI> + CHAR* I> + t_{RST}**	Chap. 6.5.5
Reset mode for earth current	0s / 60s	I> + CHAR + t> I> + t_{RST}**	Chap. 6.5.16
Warning or Trip at earth fault measuring	TRIP/WARN	IE>	Chap. 6.5.12
Measured method of the residual voltage U_E 1)	E-N; 1:1		Chap. 6.4.3
changeover of isolated (sin φ) or compensated (cos φ) networks	SIN/COS	IE + IE>>	Chap. 6.5.20
CB failure	CB??	CB blinking	Chap. 5.4.7
Auto reclosing successful Auto reclosing unsuccessful	CLOS OPEN	 0→1 rot	Chap. 5.4.6 Chap. 5.4.5
After dead time reclosing condition not fulfilled	S/E?	0→1 rot CB blinking	Chap. 5.4.8
Circuit breaker was manually switched on	MANU	CB rot	Chap. 5.4.2
AR approved	YES/NO	SHOT + I> SHOT + I>> SHOT + IE> SHOT + IE>> running with tD1, tD2, tD3, tD4	Chap. 6.12.3
Protection steps blocked	BLOC	I> I>>	Chap. 6.12.4
Normal trip time	TIME	I_E> I_E>>	
Fast trip	FAST	Together tD1, tD2, tD3, tD4	
CB failure protection	CBFP	CB + t>	Chap. 6.7.4
Control functions	LCAL, RMOT ON??; OFF??; ON!!; OFF!!	CB	Chap. 5.7.3 Chap. 5.7.7

Function	Displayed Text	Related LED	References
Save parameter?	FLT1, FLT2.....	Trip = type depend-ent	Chap. 6.13.4
Erase fault memory!	Wait		Chap. 6.14.1
Software version	TRIP	Trip = type depend-ent	
Manual trip	MRIK		Chap. 6.14
Inquire password	PSW?	LED of the set pa-rameter	Chap. 4.4 “MR-digital multifunc-tion relays” Chap. 7.2
Secret password input	„XXXX“		
Save parameter?	SAV?		
Save parameter!	SAV!		
Manual trip	TRI?		
Blocking of the protection func-tion	BLOC, NO_B, PR_B, TR_B	LED of the blocked protection stage	Chap. 6.12.1
Relay assignment	z. B. _ 2 _ _	LED of the blocked protection stage	Chap. 6.12.2
Trip signal for the fault recorder	P_UP; A_PI; TRIP; TEST	FR	Chap. 6.10.3
Number of fault events	S = 2, S = 4, S = 8	FR	Chap. 6.10.2
Indication of date and time	Y = 01, M = 01, D = 04, h = 12, m = 2, s = 12	🕒	Chap. 6.11
Slave address of the serial inter-face	1-32	RS	Chap. 6.8.1
Baud-Rate	1200-9600	RS	Chap. 6.8.2
Parity-Check	even odd no	RS	Chap. 6.8.3

Table 6.1: Indication Possibilities via the Display

6.2 Setting procedure

<SELECT/RESET>
short advancing the indication
long reset

<ENTER>
Saving of an entry

Before parameters can be set a password is inquired (see chapter 4.4 of description ”MR – Digital Multifunction Relay”).

6.3 Parameter levels

The different levels are entered by press the following key or combination of keys.

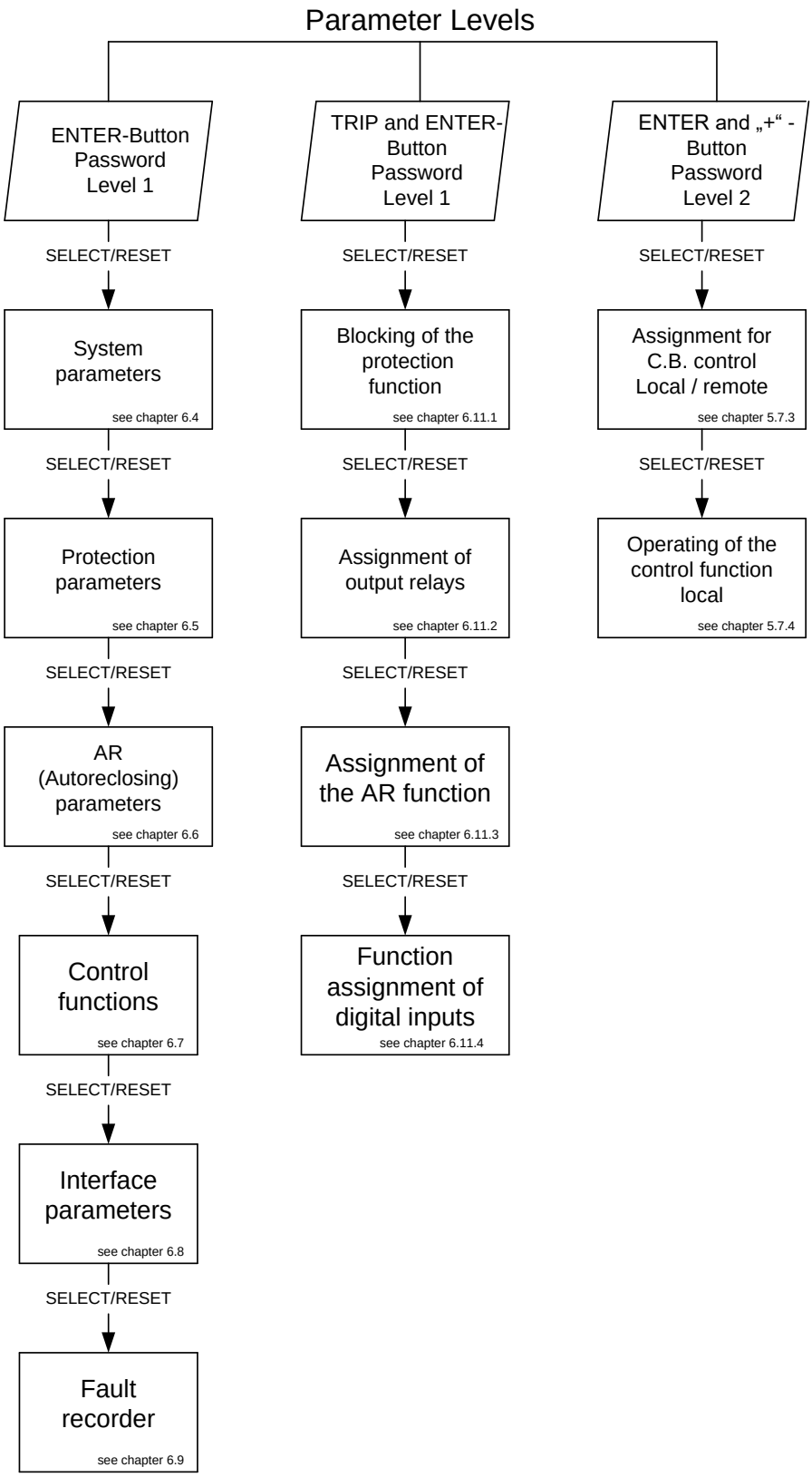


Figure 6.1: Parameter levels

For all levels password 1 is valid.

6.4 System parameters

6.4.1 Presentation of Measuring Values as Primary Quantities on the Display (Iprim Phase)

This parameter makes it possible to present the indications of phase current and earth-fault current separately, i.e. as primary or secondary measuring value. Currents in the kiloampere range are indicated with the symbol of unit of measurement k (kilo) as three-digit point.

Example:
A 1500/5 A CT is used with a primary current of 1380 A. The parameter for the CT primary current is given in kilo Ampere.

- The parameter is set to ”1.50“ (kA). Then ”1K38“ is displayed as I-measurement.
- If the setting is set to ”sec.“, ”0.92“ x I_N. is displayed as I-measurement.

Note:
The settings for the pick-up value are adjusted to a multiple of the secondary rated CT current. The settings for phase and earth current transformers can be done separately.

6.4.2 Display of residual voltage UE as primary quantity (Uprim/Usec)

The residual voltage can be shown as primary measuring value. For this parameter the transformation ratio of the VT has to be set accordingly. If the parameter is set to "SEK", the measuring value is shown as rated secondary voltage.

Example:
The voltage transformer used is of 10 kV/100 V. The transformation ratio is 100 and this value has to be set accordingly. If still the rated secondary voltage should be shown, the parameter is to be set to 1.

6.4.3 Voltage transformer connection for residual voltage measuring (3pha/e-n/1:1)

Depending on the connection of the voltage transformer of ER/XR-relay types three possibilities of the residual voltage measurement can be chosen (see 5.6).

6.4.4 Operation cycle counter

Each switch ON operation increases the counter. It is possible to set the operation cycle counter to a start value.

6.4.5 I2*t Operation cycle counter

The relay MRIK3-C provide a measurement unit to determinate the switch off power of the circuit breaker. They start from the point of set the trip output signal and end until the point of the phase current is lower than <2% of the nominal current. The max. record time for each switch off operation is 2.54s. Each 20ms the value of all three phases is measured. (Measured and calculated in accordance to the HARR algorithm which is used in all MR relay to determine the fundamental wave.). The highest value of the three phase values is stored and added to the composite value. The value of the switch off power can be preset in case of the use of a older CB with preceding load. To indicate that the max. value of the switch off power is reached a alarm output can be set. The indication take place be the means of a LED and / or output relay. The max. possible value is 655,35 kAs

6.4.6 Rated -Frequency

The FFT-Algorithm used for the data acquisition needs the set point of the rated frequency, i.e. 50 Hz or 60 Hz, for correct digital filtering of the earth current.

6.4.7 Indication of pickup

If the momentary current drops below the pickup threshold, e.g. I>, after the relay was activated and there was no tripping, then the activation is signalled by short flashing of LED I>. The LED keeps flashing until the <RESET> push-button is pressed. By setting the parameter to FLSH/NOFL, flashing can be suppressed.

6.4.8 Parameter Set Changeover Switch (P2)

By means of this switch two different parameter sets can be activated. The changeover procedure can be realised either by the software or via the digital input. If the parameter set changeover switch is adjusted to ”SET2“, the active parameter set can be changed to ”SET1“ via the external input. If the changeover switch is set to ”SET1“, then it can be changed to ”SET2“ via the digital input.
The digital input does not change this parameter. The LED P2 on the front cover always indicates which of the parameter sets is active.

6.5 Protection Parameters

6.5.1 Pickup current for phase Overcurrent element

The setting value for this parameter that appears on the display is related to the nominal current (I_N) of the relay. This means: pickup current (Is) = displayed value x nominal current (I_N) e.g. displayed value = 1.25 then, Is = 1.25 x I_N.

6.5.2 Trip Characteristics for the Phase Overcurrent Element (I>)

There are the following standard trip time characteristics available:

DEFT - Definite Time (definite time overcurrent protection)
NINV - Normal inverse
VINV - Very inverse
EINV - Extremely inverse
RINV - RI-Inverse
LINV - Long term Inverse

6.5.3 Tripping Time or Time Factor for the Phase Overcurrent Element

Normally, after change of the trip characteristics, the tripping time or the time factor also has to be changed accordingly. In order to avoid an unsuitable combination between trip characteristics and tripping time or time factor, the following measures are initiated by the MRIK3-C:

The LED for adjustment of the tripping time or time factor starts to flash after the trip characteristics have changed. By this warning signal the operator is reminded to adjust the tripping time or time factor to the changed operational mode or trip time characteristics. This warning signal keeps flashing until the tripping time or time factor are re-adjusted. If re-adjustment has not been done within 5 minutes (the time to enable parameter setting), then the processor sets the tripping time or time factor to the highest sensible value (smallest possible tripping time

When adjusting to the “Definite Time” trip characteristic, the definite tripping time displayed is shown as seconds (e.g. 0.35 = 0.35s). By pressing push-buttons <+><-> this time can be changed step by step in the range 0.04s – 300s
When adjusting to the “Inverse Time” trip characteristics, the time factor (tI>) is displayed. This factor can be changed also by push buttons <+><-> step by step in the range 0.05 – 20.0.
If the tripping time or time factor is set to infinite long (on the display “EXIT” is shown) then trip of the relay overcurrent element is blocked. The WARNING/ ALARM function is still active. During this time LEDs I> and t> are red.

6.5.4 Fast/Time tripping by switch ON of the CB for the overcurrent element

After switch ON the CB a pick up of the I> element happens directly within 200ms, it is possible to switch OFF without time delay when this parameter is already set.

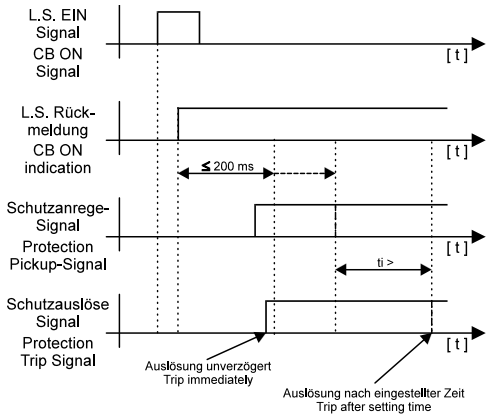


Figure 6.2

6.5.5 Reset Mode for the Trip Characteristics in Phase Current Path

In order to ensure that the trip function is reliable even with repeated error pulses, each of them shorter than the set tripping time, the RESET mode for the trip characteristics can be changed over. With a setting of “60s“ the elapsed tripping time is frozen and is only reset after 60s faultless operation. Should another fault occur within these 60s, the tripping time counter remains in operation. With the setting “_ 0s“ the counter is immediately reset when the fault current is interrupted and it is restarted when the fault current has returned again.

6.5.6 Current setting for high set element

The current setting value of this parameter appearing on the display is related to the rated current of the relay.
This means: I>> = displayed value x I_N.
When the current setting for high set element is set out of range (on display appears "EXIT"), the high set element of the overcurrent relay is blocked.

6.5.7 Trip-Block for all protection elements

If the measured current exceeds the setting value the assigned trip relay for all protection function doesn’t energized. A power contactor is not able to switch electrical current (energy) which is higher than the adjusted value. The setting EXIT disable this function. The current setting value of this parameter appearing on the display is related to the rated current of the relay.
This means: I>>+CB = displayed value x I_N. Setting range: 0.5 – 40 x I_N

6.5.8 Trip delay for high set element

Independent from the chosen tripping characteristic for I>, the high set element I>> has always a definite-time tripping characteristic. An indication value in seconds appears on the display.

6.5.9 Fast/Time tripping by switch ON of the CB for the short circuit element

After switch ON the CB a pick up of the I>> element happens directly within 200 ms, it is possible to switch OFF without time delay when this parameter is already set. (see chapter 6.5.4)

6.5.10 Pickup value for residual voltage (UE) (ER/XR-relay types)

Regardless of the preset earth current, an earth fault is only identified if the residual voltage exceeds the set reference value. This value is indicated in volt.

6.5.11 Pickup current for earth fault element (IE>)

(Similar to chapter 6.5.1)
The pickup value of MRIK3-ICE relates to times I_N
The pickup value of MRIK3-ICER and MRIK3-ICXR relates to % I_N.

6.5.12 WARN/TRIP changeover

A detected earth fault can be parameterized as follows. After delay time.
a) "warn" only the alarm relay trips
b) "trip" the trip relay trips and tripping values are stored.

6.5.13 Time current characteristics for earth fault element (for E/X-relay types)

When adjusting the trip characteristics one of the following 7 abbreviations is displayed:

DEFT	-	Definite Time (definite time overcurrent protection)
NINV	-	Normal inverse (Type A)
VINV	-	Very inverse (Type B)
EINV	-	Extremely inverse (Type C)
RINV	-	RI-Inverse
LINV	-	Long-term inverse
RXID	-	Special purpose characteristics

The displayed text can be changed by push-buttons <+><-> . By pressing <ENTER> the required trip characteristics is selected.

6.5.14 Tripping Time or Time Factor for the Earth Fault Element

The setting procedure outlined in chapter 5.5.3 applies here as well.

6.5.15 Fast/Time tripping by switch ON of the CB for the earth fault low set element

The setting procedure outlined in chapter 5.5.4 applies here as well.

6.5.16 Reset mode for inverse time tripping in earth current path

The setting procedure outlined in chapter 5.5.5 applies here as well.

6.5.17 Current setting for high set element of earth fault supervision (IE>>)

The setting procedure outlined in chapter 5.5.6 applies here as well.
The pickup value of MRIK3-ICE relates to times I_N
The pickup value of MRIK3-ICER and MRIK3-ICXR relates to I_N in %.

6.5.18 Trip delay for high set element of earth fault supervision

The setting procedure outlined in chapter 5.5.7 applies here as well.

6.5.19 Fast/Time tripping by switch ON of the CB for the earth fault high set element

The setting procedure outlined in chapter 6.5.4 applies here as well.

6.5.20 COS/SIN Measurement (ER/XR-relay type)

Depending on the neutral earthing connection of the protected system the directional element of the earth fault relay must be preset to cos φ or sin φ measurement.
By pressing <SELECT> the display shows "COS" resp. "SIN". The desired measuring principle can be selected by <+> or <-> and must be entered with password. (Refer chapter 5.6)

6.6 AR Parameter

6.6.1 Number of AR shots

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

6.6.2 Fault time (tF)

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 MRIK3-C.

6.6.3 Dead time (tD)

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.

6.6.4 Close impulse time (tCl)

During close impulse time t_{Cl} the NO C.B. contact of MRIK3-C 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.

6.6.5 Reclaim time (tR)

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 MRIK3-C 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 after the last permissible AR leads to a final switching-off.

6.6.6 Fault time activation

This parameter can be used to fix whether the supervision of the fault time is active for the first tripping action or for all tripping actions (see 6.6.2)

6.7 Control functions

6.7.1 Block/Trip-time

The block/trip serves for recognising a CB failure protection by rear interlocking. Setting of the blocking input will activate the blocking function and block the configured protection functions. (refer to chapter 5.11.1) If the block/trip time is not set to EXIT but to an adjustable time (0.1 – 2.00s), the blocking function is cancelled again after this time has expired. If trip blocking was set to protection blocking PR_B, protection excitation with subsequent tripping will take place after expiration of the set time when blocking is cancelled on expiration of the block/trip time. If blocking is set to trip blocking TR_B, there will be immediate tripping after blocking has been cancelled following expiration of the block/trip time if the set time of the responding protection step has already expired.

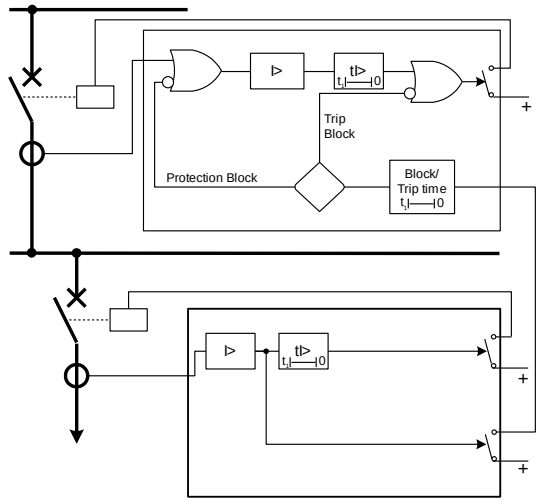


Figure 6.3:

6.7.2 Time delay for ext. Trip

Via a digital input a external trip with settable time is settable. The trip take place by the means of o high voltage level at the input for the set time. It is possible to assign this in out function to the output relay. Also it can assign to the alarm relay.

6.7.3 Dead time for Trip/Restore

This function fulfils the requirements for a manual switch ON operation. When a high level at the assigned digital input take place, the relay trips immediately. When the digital input is reset to low level a counter starts and after the selectable delay time (0,1s – 300s) the relay switch ON the CB.

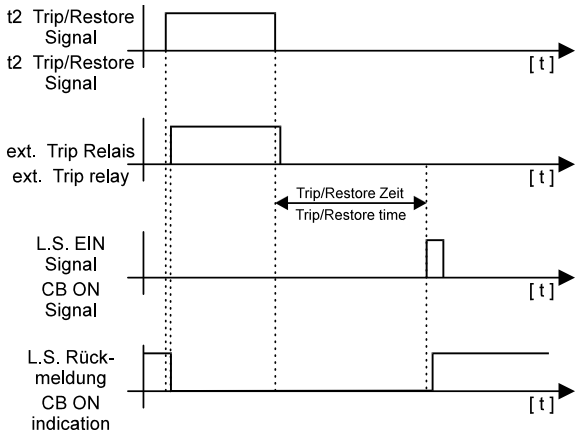


Figure 6.4:

6.7.4 CB failure protection

The CB failure protection is based on supervision of phase currents during tripping events. Only after tripping this protective function becomes active. The test criterion is whether all phase currents are dropped to <1% x I_N within t_{CBFP} (Circuit Breaker Failure Protection - adjustable between 0.1 - 2.0 s). If not all of the phase currents have dropped to <1%xI_N within this time, CB failure is detected and the related relay activated. The CB failure protection function is deactivated again as soon as the phase currents have dropped to 0 within t_{CBFP}.

6.7.5 Release of the pickup relay for CB failure protection

This function is working similar to the Block / Trip function. In the case of a fault the function is activated. The pickup is indicated via a alarm relay to the upstream CB protection unit. At the upstream CB protection unit the blocking input is activated. During the clearing of the fault a CB failure take place, the alarm relay switch off after the settable CB failure time (Chap 6.7.4) and clear the block input of the upstream protection unit and activated the tripping.

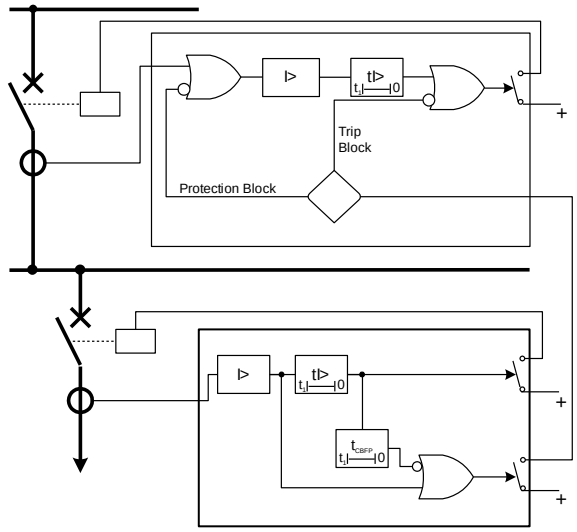


Figure 6.5:

6.8 Interface Parameters

6.8.1 Adjustment of the Slave-Address (RS)

The Slave address can be adjusted in a range from 1-32.

6.8.2 Adjustment of the Baud-Rate

When the Modbus protocol is used for data transmission it is possible to adjust different transmission speeds (Baud rates).

6.8.3 Adjustment of the Parity

For adjustment of the parity there are three options:

- “even“ = even parity
- “odd“ = odd parity
- “no“ = no check of the parity

6.9 Using communication port RS232 or RS485

The MRIK3-C relay provides two possibilities of data exchange communication.
The function is described in the manual MR – digital multifunction relays. See chapter 6 Device communication.

6.10 Fault Recorder (FR)

6.10.1 Fault Recorder

The existing store can be utilised in two ways:

Not to be overwritten
Previous recordings will not be overwritten. When there is no memory space left, further recordings are not possible.

Overwrite
The latest fault incidents can always be called up; the eldest recording is overwritten by a new one.

Parameter Adjustment*	Mode	Time per record (s)	
		50 Hz	60 Hz
S=1	overwrite	8.00	6.66
S=2	Not to be overwritten	8.00	6.66
S=3	overwrite	4.00	3.33
S=4	Not to be overwritten	4.00	3.33
S=7	overwrite	2.00	1.66
S=8	Not to be overwritten	2.00	1.66

* s = total no. of recordings

Table 6.2: Number and size of disturbance records

The storage zone of the fault recorder is designed as ring buffer. In the example shown below storage of 7 fault recordings are possible (overwriting). The 8th segment serves as buffer store.

Memory space 6 to 4 is used.
Memory space 5 is needed for temporary storage of ongoing signals.

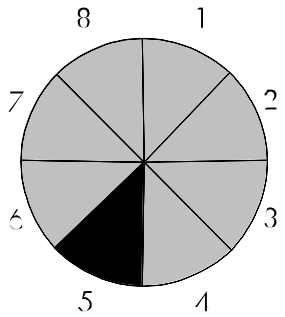


Figure 6.6: Partitioning of the store into 8 segments, for instance

This example shows that the store was used for more than 8 recordings because store spaces 6, 7 and 8 are used. From this it follows that no. 6 was the eldest recording and no. 4 the latest one.

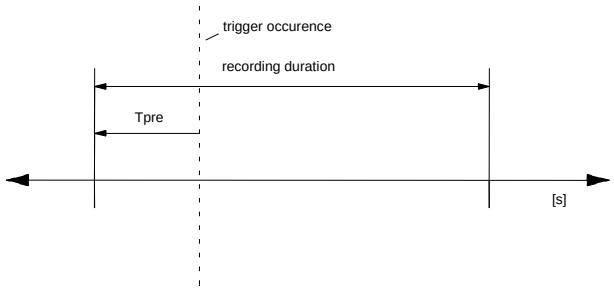


Figure 6.7: General Set-Up of the Fault Recorder

Each of the storage segments have a fixed storage time where the time before the trigger event can be defined.

Via the RS485 interface the data can be read out by means of a PC provided with HTL/PL-Soft4. The data is graphically edited and represented. Binary tracks are recorded additionally, e.g. activation and trip.

6.10.2 Number of fault recordings

The max. recording time is 16 s at 50 Hz or 13.33 s at 60 Hz.
The max. number of recordings to be stored has to be defined beforehand. There is the choice between (1)* 2, (3)* 4 and (7)* 8 recordings. Hence the existing memory space can be used as follows:

(1)* 2 recordings for 8 s at 50 Hz and 6.66 s at 60 Hz.
(3)* 4 recordings for 4 s at 50 Hz and 3.33 s at 60 Hz.
(7)* 8 recordings for 2 s at 50 Hz and 1.66 s at 60 Hz.
* will be overwritten when a new trigger signal occurs.

6.10.3 Adjustment of the Trigger Event

There is the choice between four different trigger events:

P_UP (PickUP)	Data saving begins when a general activation is recognised.
TRIP	Data saving begins when a general trip is recognised.
A_PI (After Pickup)	Data saving begins when the last activation threshold is undershot (recognises, for instance, CB failure protection)
TEST	Data saving is activated when push-buttons <+> and <-> are pressed simultaneously (immediately upon pressing the buttons). For recording time, the mode TEST is displayed.

6.10.4 Pre-Trigger time (T_pre)

The time T_{pre} defines the period to be saved prior to the trip event. This time can be set between 0.05 s and the max. recording time (2, 4 or 8 s). With push-buttons <+> and <-> the values can be changed and with <ENTER> they can be saved.

6.11 Setting of the clock

When date and time are set, the LED „🕒“ is on. The following method is used:

Date:	year	Y=00
	month	M=00
	day	D=00
time:	hour	h=00
	minute	m=00
	second	s=00

Immediately when the supply voltage is applied the clock starts with the respective date and time. The time is buffered against short-term voltage failures (min. 6 minutes).

Note:
The window for setting the clock is behind the measuring value reading. Access to the window is given via push-button <SELECT/RESET>.

6.12 Additional functions

6.12.1 Blocking the protection functions

Blocking of the protective functions:

The MRIK3-C is equipped with a blocking function that can be parameterized arbitrary. Connecting supply voltage to terminals at a assigned digital blocking of those functions which were selected by the user takes place.

It is possible to choose between two types of protective blocking:

1) Blocking of the individual protection stages. The excitation of the blocked protection stage is blocked..
2) Blocking of the individual tripping stages. The individual protection stages are excited and the set tripping time expires. Tripping only takes place when:
   a) the voltage at the blocking input is reduced;
   b) the voltage at the blocking input is applied, the tripping time and the blocking time have expired. (refer to chapter 6.7.1)

Parameter setting is to be carried out as follows:

- After the <ENTER> and <TRIP> keys have been actuated simultaneously, the display shows the text "PR_B" (the protection stages are blocked) or "TR_B" (the tripping stages are blocked).
- The settings can be changed by actuating the keys <+> or <->. In this procedure, the LEDs I>; I>>; IE>; IE>> are simultaneously alight in case of protective blocking "PR_B" and LEDs tI>; tI>>; tIE>, tIE>> simultaneously emit light in case of trip blocking "TR_B".
- Actuation of the <ENTER> key with a one-time entry of the password will store the set function.
- After this actuate the <SELECT/RESET> key to call up the first blockable protection function.
- The display will show the text "BLOC" (the respective function is blocked) or "NO_B" (the respective function is not blocked.
- Actuation of the <ENTER> key will store the set function.
- By pressing the <SELECT/RESET> pushbutton, all further protective function that can be blocked are called one after the other.

After selection of the last blocking function renewed pressing of the <SELECT/RESET> pushbutton switches to the assignment mode of the output relays.

Function		Display	LED/Colour
Blocking of the protection stage		PR_B	I>; I>>; I_E>; I_E>>
Blocking of the trip function		TR_B	t_I>; t_I>>; t_{IE}>; t_{IE}>>
I>	Overcurrent	NO_B	I> green
I>>	Short circuit	BLOC	I>> green
$I_{E>}$	Earth current 1st element	NO_B	$I_{E>}$ green
$I_{E>>}$	Earth current 2nd element	NO_B	$I_{E>>}$ green
t_{CBFP}	Circuit breaker failure protection	NO_B	CB green
DI+Trip	Ext. tripping	NO_B	DI+Trip

Table 6.3: Default settings of both parameter sets

6.12.2 Assignment of the output relays

Unit MRI3 has five output relays. The fifth output relay is provided as permanent alarm relay for self supervision is normally on. Output relays 1 - 4 are normally off and can be assigned as alarm or tripping relays to the current functions which can either be done by using the push buttons on the front plate or via serial interface RS485. The assignment of the output relays is similar to the setting of parameters, however, only in the assignment mode. The assignment mode can be reached only via the blocking mode.
By pressing push button <SELECT/RESET> in blocking mode again, the assignment mode is selected.

The relays are assigned as follows: LEDs I>, I>>, I_E>, I_E>> are two-coloured and light up `green` when the output relays are assigned as `alarm relays` and `red` as `tripping relays`. In case of the MRIK3-C models the LEDs I>; I>>; I_E> and I_E>> always light up in conjunction with t>.
In addition, the LED →← also lights up with each adjustment. Green means forward and red backward direction.

Definition:
Alarm relays are activated at pickup.
Tripping relays are only activated after elapse of the tripping delay.

The adjustment procedure is as follows:
Allocation of one or more of the 4 output relays
to “Alarm” or “Trip” of each of the protective functions. Which of the function is just being processed is signalled by the LEDs. (see Table 6.4 and Table 6.5)

Indication	LED	Allocated relay(s)
_ _ _ _		None
1 _ _ _		1
_ 2 _ _		2
...		...
_ 2 3 4		2, 3 and 4
1 2 3 4		all

By pressing push-buttons <+> and <-> all possible combinations can be realised. The selected allocation can be saved by <ENTER> and subsequent entry of the password.

Any allocation mode can be stopped by pressing the <SELECT/RESET> button for a certain time (about 3s).
Note:

- Coding plugs J3, described in the general description „MR- Digital Multifunctional Relay“ have only one function in the MRIK3-C.
- At the end of this description an Adjustment List can be found in which the customer-specific adjustments can be filled-in.

Relay function		Output relays				Display-indication	Corresponding LEDs
Symbol	Function	1	2	3	4		
I>	Alarm		X			_ 2 _ _	I>
tI>	Tripping	X				1 _ _ _	I>+t>,
I>>	Alarm		X			_ 2 _ _	I>>
tI>>	Tripping	X				1 _ _ _	I>>+t>,
Fast Trip	Fast tripping	X				1 _ _ _	I>+I>>+I_E>+ I_E>>+CB green
IE> (V)	Alarm		X			_ 2 _ _	I_E>+↔ grün
tIE> (V)	Tripping	X				1 _ _ _	I_E>+t>+↔ green
IE> (R)	Alarm		X			_ 2 _ _	I_E>+↔ red
tIE> (R)	Tripping	X				1 _ _ _	I_E>+t>+↔ red
IE>> (V)	Alarm		X			_ 2 _ _	I_E>>+↔ green
tIE>> (V)	Tripping	X				1 _ _ _	I_E>>+t>+↔ green
IE>> (R)	Alarm		X			_ 2 _ _	I_E>>+↔ red
tIE>> (R)	Tripping	X				1 _ _ _	I_E>>+t>+↔ red
tCBFP	Auslösen					_ _ _ _	CB green+t>
AWE	Switch on				X	_ _ _ 4	t_{CI}
AWE	unsuccessfull			X		_ _ 3 _	0←1
Local/Remote	Switch on				X	_ _ _ 4	DI+t_{CL}+CB red
Remote	Switch off immediately	X				1 _ _ _	DI+Trip+CB green
Local/Remote	Switch off delayed	X				1 _ _ _	DI+Trip+CB green +t>
I^2t>	blocked					_·_·_·_	CB grün+0←1

Table 6.4: Example of an Assignment Matrix of the Output Relays MRIK3-ICER/ICXR

Relay function		Output relay				Display-indication	Corresponding LEDs
Symbol	Function	1	2	3	4		
I> tI>	Alarm Tripping	 X	X			_ 2 _ _ 1 _ _ _	I> I>+t>,
I>> tI>>	Alarm Tripping	 X	X			_ 2 _ _ 1 _ _ _	I>> I>>+t>,
Fast Trip	Fast tripping	X				1 _ _ _	I>+I>>+I_E>+ I_E>>+CB green
IE> tIE>	Alarm Tripping	 X	X			_ 2 _ _ 1 _ _ _	I_E> I_E>+t>,
IE>> tIE>>	Alarm Tripping	 X	X			_ 2 _ _ 1 _ _ _	I_E>> I_E>>+t>;
tCBFP	Tripping					_ _ _ _	CB green+t>
AWE	Switched on				X	_ _ _ 4	t_{CI}
AWE	unsuccess-ful			X		_ _ 3 _	0←1
Local/Remote	Switched on				X	_ _ _ 4	DI+t_{CI}+CB red
Remote	Switched off immediately)	X				1 _ _ _	DI+Trip+CB green
Local/Remote	Switched off delayed	X				1 _ _ _	DI+Trip+CB green+t>
I²t>	blocked					_·_·_·_	

Table 6.5: Example of an Allocation Matrix of the Output Relays MRIK3-ICE

6.12.3 Assignment of the AR functions

The last activation of the <SELECT/RESET> key in the relay assignment mode will activate the AR assignment mode.

- The accompanied LEDs indicate which functions will be assigned to the individual protection stages for parameter setting before the 1st AR.
- Actuation of the <+> <-> keys permits switching over between "BLOC", "TIME" or "FAST".

Here the following functions are activated or deactivated one after the other.

1) "BLOC" blocking of the protective functions.
2) "TIME" tripping of the individual protective functions with set delay time.
3) "FAST" tripping with Fast Trip function.

- Actuation of the <ENTER> key with subsequent one-time entry of the pass word will store the altered value.
- Actuation of the <SELECT/RESET> key will assign the tripping function before the 1st AR, one after the other to the individual protection stages.
- After this adjustment the parameters are set for activation of the 1st AR.
- The accompanied LEDs indicate which protective functions are available for parameter setting for the first AR.
- Actuation of the <+> <-> keys permits switching over between "YES" and "NO". "YES" means that the selected protection function will trigger an AR.
- Actuation of the <ENTER> key with subsequent one-time entry of the password will store the altered value.
- Actuation of the <SELECT/RESET> key the protective functions are, one after the other, assigned to the first AR.

The following table shows all parameters that have to be set. After each group the setting changes between parameter set 1 and 2.

Function	Protection step	Display-indication	corresponding LED
Trip cause before the 1st AR	I>	TIME (FAST, BLOC)	I> + tD1
	I>>	TIME (FAST, BLOC)	I>> + tD1
	IE>	TIME (FAST, BLOC)	IE> + tD1
	IE>>	TIME (FAST, BLOC)	IE>> + tD1

Function	Protection step	Display-indication	corresponding LED
Activation of the 1st AR is permitted	I>	NO (YES)	SHOT + I> + tD1
	I>>	YES (NO)	SHOT + I>> + tD1
	IE>	NO (YES)	SHOT + IE> + tD1
	IE>>	NO (YES)	SHOT + EI>> + tD1

Function	Protection step	Display-indication	corresponding LED
Trip cause after the 1st AR	I>	TIME (FAST, BLOC)	I> + tD1
	I>>	TIME (FAST, BLOC)	I>> + tD1
	IE>	TIME (FAST, BLOC)	IE> + tD1
	IE>>	TIME (FAST, BLOC)	IE>> + tD1

Function	Protection step	Display-indication	corresponding LED
Activation of the 2nd AR is permitted	I>	NO (YES)	SHOT + I> + tD2
	I>>	YES (NO)	SHOT + I>> + tD2
	IE>	NO (YES)	SHOT + IE> + tD2
	IE>>	NO (YES)	SHOT + EI>> + tD2

Function	Protection step	Display-indication	corresponding LED
Trip cause after the 2nd AR	I>	TIME (FAST, BLOC)	I> + tD2
	I>>	TIME (FAST, BLOC)	I>> + tD2
	IE>	TIME (FAST, BLOC)	IE> + tD2
	IE>>	TIME (FAST, BLOC)	IE>> + tD2

Function	Protection step	Display-indication	corresponding LED
Activation of the 3rd AR is permitted	I>	NO (YES)	SHOT + I> + tD3
	I>>	YES (NO)	SHOT + I>> + tD3
	IE>	NO (YES)	SHOT + IE> + tD3
	IE>>	NO (YES)	SHOT + EI>> + tD3

Function	Protection step	Display-indication	corresponding LED
Trip cause After the 3rd AR	I>	TIME (FAST, BLOC)	I> + tD3
	I>>	TIME (FAST, BLOC)	I>> + tD3
	IE>	TIME (FAST, BLOC)	IE> + tD3
	IE>>	TIME (FAST, BLOC)	IE>> + tD3

Function	Protection step	Display-indication	corresponding LED
Activation of the 4th AR is permitted	I>	NO (YES)	SHOT + I> + tD4
	I>>	YES (NO)	SHOT + I>> + tD4
	IE>	NO (YES)	SHOT + IE> + tD4
	IE>>	NO (YES)	SHOT + EI>> + tD4

Function	Protection step	Display-indication	corresponding LED
Trip cause After the 4th AR	I>	TIME (FAST, BLOC)	I> + tD4
	I>>	TIME (FAST, BLOC)	I>> + tD4
	IE>	TIME (FAST, BLOC)	IE> + tD4
	IE>>	TIME (FAST, BLOC)	IE>> + tD4

Table 6.6: Assignment of AR functions

AR = Autoreclosing

The assignment mode can be terminated at any time by pressing the <SELECT/RESET> push button for some time (abt. 3 s).
A form is attached to this description where the setting requested by the customer can be filled-in. This form is prepared for telefax transmission and can be used for your own reference as well as for telephone queries.

6.12.4 Function assignment of the digital inputs

After the setting of the AR parameter you enter the allocation of the input function to the 7 digital. With the push-buttons <+> and <->it is possible to assign to each digital input one available logical input function. During the setting procedure the LED “DI” lights. The display shows the number of the DI and the assigned logical function in a short from. „1=RE“. This means that the DI No. 1 is assigned to the function reset. The following functions are available:

NO = No function
RE = Reset (Display and Relay)
BL = Protection block / trip block
P2 = Change parameter set
FR = Ext. Trigger of the disturbance recorder
t0 = Ext. Trip immediately
t1 = Ext. Trip with time delay
ON = Ext. switch ON
t2 = Trip/Restore
CI = CB position supervision CB-ON
CO = CB position supervision CB-OFF
CR = CB ready supervision / CB spring is charged
AB = AWE block
SY = Synchrocheck (only AR relay)

The allocation of the functions can be the same for different digital inputs.

6.12.5 Description of the digital input function

RE = Reset (Display and relay)
With this function the relay and the display indication are reset to normal mode. The relay shows MRIK. Are output relays set to bistabil mode the also reset.

BL = Protection block / Trip block
All active protection function are blocked during pick up conditions.

P2 = Change parameter set
When the input is activated the relay change the active parameter set from Set1 to Set 2.

FR = Ext. Trigger for the disturbance recorder
If this function is allowed it starts the disturbance recorder from a external source. During recording the LED FR lights. If a fault record is being written, the LED FR will be alight.

t0 = Ext. Trip immediately.
This function activates directly the trip relay to switch OFF the CB. Also the alarm relay can be activated. The relays are active as long as the input is active.

t1 = Ext. Trip with time delay.
If this function activated it start a timer with a free setable delay time. After the timer elapsed the output relay for trip will activated. Also the alarm relay can work in the same way. The relays are active as long as the input is active.

ON = Ext. Switch ON
When this input is activated. The output relay to switch ON of the CB is activated immediately. The output relay is activated until the relay indicates via digital input CI that the CB is ON.

t2 = Trip/Restore
This function fulfils the requirements for a manual switch ON operation. When a high level at the assigned digital input takes place, the relay trips immediately. When the digital input is reset to low level a counter starts and after the settable delay time (0,1s – 300s) the relay switches ON the CB

CI = CP position indication. - CB ON
With this function the position of the CB is indicated bay by the relay. Input activated = 1 = CB ON

CO = CB position indication CB OFF
With this function the position of the CB is indicated bay by the relay. Input activated = 1 = CB OFF

Remark:
When both function are assign to a digital input, the position of the CB are indicated only when die CB position is absolute clear. (Exp. CI = 1 and CO = = or CI = 0 and CO) All other indication are wrong and a error message is shown (CB??) and the LED CB flashed)

CR = CB ready supervision / CB spring is charged
This function check the spring of the CB. When the spring is charged the input is activated (CR = 1).
When one of the position function are use this function must use also otherwise a incorrect indication is possible and a malfunction during a AR sequence take place.

AB = AWE block
This function block the AR sequence at each time.

SY = Synchro Check
With this indication function the dead times tD of the AR function extended. If this function active, the relay waiting for 150ms for the Synchro check ready message after the dead time elapsed. When after this time the Synchro Check input is not active, the MRIK3-C interrupt the AR sequence. The display show “S/E?”. If the Synchro Check activated within this time the CB ON signal is activate immediate.

6.13 Measuring Value and Fault Indications

6.13.1 Measuring Value Indications

The following measuring quantities can be indicated on the display during normal service:

- Current in phase 1 (LED L1 green),
- Current in phase 2 (LED L2 green),
- Current in phase 3 (LED L3 green),
- Earth current (LED E green),
- active earth current (LED E and I_P green),*
- reactive earth current (LED E and I_Q green),*
- residual voltage UR (LED U_E),
- angle between I_E and U_E,
  (LED E green, LED $I_{E>}$ yellow and LED $U_{E>}$ yellow).

* only in case that the directional option is built in.

The indicated current measuring values refer to rated current. (For MRIK3-ICXR relays the indicated measuring values refer to % of I_N)

6.13.2 Units of the measuring values displayed

The measuring values can optionally be shown in the display as a multiple of the "sec" rated value (x In) or as primary current (A). According to this the units of the display change as follows:

Phase current:

Indication as	Range	Unit
Secondary current Active portion I_P Reactive portion I_Q	0.0 – 40.0 ±.00 – 40 ±.00 – 40.	x In x In x In
Primary current	.000 – 999. k000 – k999 1k00 – 9k99 10k0 – 99k0 100k – 999k 1M00 – 2M00	A kA* kA kA kA MA
active portion I_P	±.00 – ±999 ±k00 – ±k99 ±1k0 – ±9k9 ±10k – ±99k ±M10 – ±M99 ±1M0 – ±2M0	A kA* kA kA MA MA
Reactive portion I_Q	±.00 – ±999 ±k00 – ±k99 ±1k0 – ±9k9 ±10k – ±99k ±M10 – ±M99 ±1M0 – ±2M0	A kA* kA kA MA MA

**rated current transformer >2kA*

Earth current (sensitive):

Indication as	Range	Unit
Secondary current Active portion I_P Reactive portion I_Q (X/XR types)	.000 – 5.0 ±.00 – 5.0 ±.00 – 5.0	% % %
Primary earth current	00m0 – 99m9 100m – 999m .000 – 999. k000 – k999 1k00 – 9k99	mA* mA* A kA** kA
Active portion I_P	±00m - ±99m ±.10 – ±999 ±k00 – ±k99 ±1k0 – ±9k9	mA* A kA** kA
Reactive portion I_Q	±00m - ±99m ±.00 – ±999 ±k00 – ±k99 ±1k0 – ±9k9	mA* A kA** kA

* rated current transformer 0.019kA
** rated current transformer 20kA

Earth current (normal):

Indication as	Range	Unit
Secondary current Active portion I_P Reactive portion I_Q (E/ER types)	.000 – 15.0 ±.00 – 15 ±.00 – 15.	x In x In x In
Primary earth current	.000 – 999. k000 – k999 1k00 – 9k99 10k0 – 99k0 100k – 999k 1M00 – 2M00	A kA* kA kA kA MA
Active portion I_P	±.00 – ±999 ±k00 – ±k99 ±1k0 – ±9k9 ±10k – ±99k ±M10 – ±M99 ±1M0 – ±2M0	A kA* kA kA MA MA
Reactive portion I_Q	±.00 – ±999 ±k00 – ±k99 ±1k0 – ±9k9 ±10k – ±99k ±M10 – ±M99 ±1M0 – ±2M0	A kA* kA kA MA MA

** rated current transformer >2kA*

Earth voltage:

Indication as	Range	Unit
sec. Voltage	000V – 999V	V
primary voltage	.000 – 999V 1K00 – 9K99 10K0 – 99K9 100K – 999K 1M00 – 3M00	KV KV KV KV MV

6.13.3 Indication of fault data

All faults detected by the relay are indicated on the front plate optically. For this purpose, the four LEDs (L1, L2, L3, E) and the four function LEDs (I>, I>>, IE>, IE>> and →←) are equipped at MRI3. Not only fault messages are transmitted, the display also indicates the tripped protection function. If, for example an overcurrent occurs, first the corresponding LEDs will light up. LED I> lights up at the same time. After tripping the LEDs are lit permanently.

6.13.4 Fault Memory

In case of actuation or tripping of the relay, the fault values and times are stored in a voltage fail-safe way. The MRIK3-C has a fault value memory covering up to 25 fault events. If this number is exceeded, the eldest data set is then overwritten.

Besides the tripping values, the LED states are also saved for fault indication.

Inquiry of the fault memory
When the <-> push-button is pressed during normal measuring value indication, the fault data is displayed.

FLT1 last fault
FLT2 fault before last
etc.
By pressing <+> the respective fault can be selected.

During fault value indication FLT

- it can be changed over to another fault data set by pressing <+> or <->
- it is displayed, which of the parameter sets was active during the event
- the LEDs are flashing according to the stored pick-up values/trip information, i.e. LEDs showing a permanent light when the trip occured, start to flash in order to indicate that is was a past fault condition. Those LEDs, which were flashing when the trip occured, (element was actuated) are flashing briefly
- the individual fault measuring values for the respective fault can be inquired by pressing <SELECT/RESET>

If the relay has not been reset after tripping (TRIP is displayed), measuring values cannot be indicated.

The fault memory can be cleared by pressing the button combination <SELECT/RESET> and <-> for about 3s. In the display „wait“ is shown.

Recorded fault values:

Value displayed	Relevant LED
Phase currents L1, L2, L3 in I/In	L1, L2, L3
Earth current I_E in I/I_En	E
C.B. switching time in s [1)]	C.B.
Expired tripping time of I> in % of $t_{I>}$ [2)]	I>
Expired tripping time of $I_{E>}$ in % of $t_{IE>}$ [2)]	$I_{E>}$
Time stamp	
Date: Y = 99 M = 04 D = 20	🕒 🕒 🕒
time: h = 11 m = 59 s = 13	🕒 🕒 🕒

Table 6.7: Recorded values of fault memory

1) C.B. tripping time:
Time between energizing of the trip output relay and switching of the C.B. (current <1% I_N)).

2) Expired tripping time:
Time between pickup and release of the low set element. This value is only displayed for I> and $I_{E>}$.

6.14 Reset

The MRI(K)3-C offers the following three ways to reset the displayed indications as well as the output relay.

- Manual reset
  By pressing the <SELECT/RESET> push-button for some time (about 3 seconds
- External reset
  By applying aux. voltage to C8/D8
- Reset via interface
  By transmitting the RESET command from the Master PC.

An indication can only be reset if there is no protective function activated. (Otherwise "TRIP" remains in the display).
The set parameters are not changed by the reset procedure.

6.14.1 Erasure of the Fault Memory

For erasure of the fault memory the push-button combination <SELECT/RESET> and <-> has to be pressed for about 3 s. During the erasure procedure „wait“ is displayed.

7. Notes on Relay Tests and Commissioning

7.1 Connection of the auxiliary voltage

To prevent destruction of the relay during tests the following has to be observed:

- The aux. voltage supply of the relay must be within the permissible ranges.
- The test current must not exceed the thermal rating of the measuring circuits.
- The CTs must be connected properly.
- All control and measuring circuits as well as the output relays must be connected properly.
- The voltage ranges of the digital inputs must be adjusted correctly.

For further information please see Technical Data

7.2 Testing of Output Relays and LEDs

Checking of the output relays and of all LEDs can be triggered by the <TRIP>-push-button.

Test procedure

Entry	Display	Note
<TRIP>	Release Version	Display of the relay software version (part 1)* E.g. R2.0
<TRIP>	Device type	Display of the relay software version (part 2)* E.g. ICER
<TRIP>	Handoff ID, part 1	Display of the relay software version (part 3)* E.g. HO_1
<TRIP>	Handoff ID, part 2	Display of the relay software version (part 4)* E.g. 5901
<TRIP>	PSW ?	Call for enter the password
PSW?	**** TRI ?	Password entry Ready for tests
<TRIP>	TRIP	Start the test Release of self-test relay Pick-up of all output relays Test of all LEDs
<Select/ Reset>	MRIK	Finish the test, Output relays return to their current operational state

** If possible please state when writing to us.*

Careful when the relay is installed:
The relay test is not a pure internal test. All the output relays will be energized! The self-supervision relay releases first. Hereby a relay fault could be adopted by a connected control gear.
Thereafter all other existing output relays will pick up one after another. The reaction in the relevant switchboard could be accordingly (e.g. trip of a priority CB).

7.3 Secondary injection test

7.3.1 Test equipment

- Voltmeter, Ammeter with class 1 or better,
- auxiliary power supply with the voltage corresponding to the rated data on the type plate,
- single-phase current supply unit (adjustable from 0 to ≥ 4 x In),
- single-phase voltage supply unit (adjustable from 0 to ≥ 1.2 x Un) (Only for relays with directional feature),
- timer to measure the operating time (Accuracy class ≤ ±10 ms),
- switching device and
- test leads and tools.

7.4 Example of test circuit for *MRIK3-C* relays without directional feature

For testing MRIK3-C relays without directional feature, only current input signals are required. Figure 7.1 shows a simple example of a single phase test circuit with adjustable current energizing the MRIK3-C relay under test.

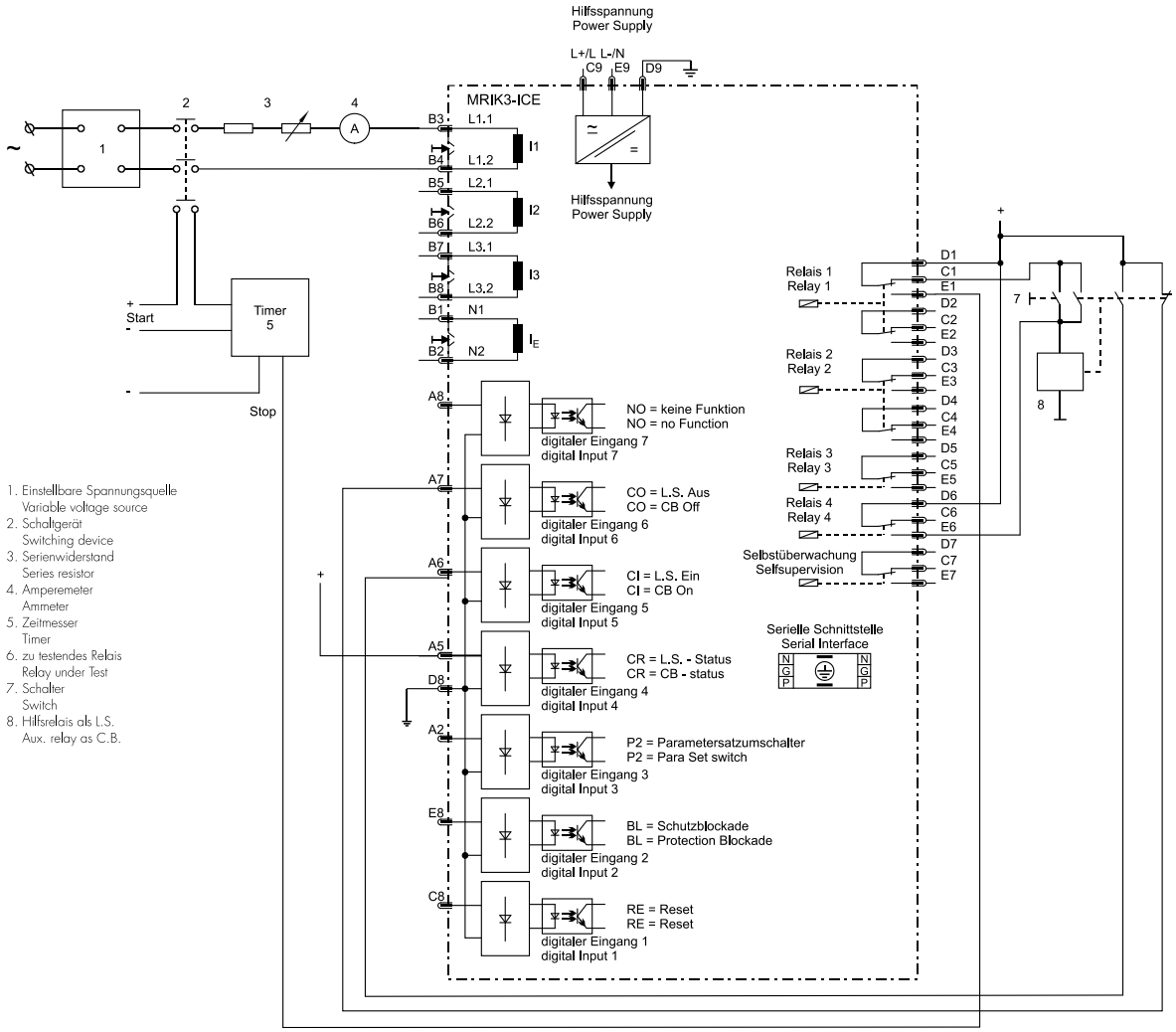


Figure 7.1: Test circuit

7.4.1 Checking the input circuits and measured values

Inject a current, which is less than the relay pickup current set values, in phase 1 (terminals B3-B4), and check the measured current on the display by pressing the push button <SELECT>. For a relay with rated current In = 5A, for example, a secondary current injection of 1A should be indicated on the display with about 0.2 (0.2 x In). When parameter Iprim = „SEK“ is set, the indication is 0.2 x In and at „5“ the indication is 1.00 [A]. The current can be also injected into the other current input circuits (Phase 2: terminals B5-B6, Phase 3: terminals B7-B8. Compare the displayed current value with the reading of the ammeter. The deviation must not exceed 3% or 1% In. By using an RMS-metering instrument, a greater deviation may be observed if the test current contains harmonics. Because the MRIK3-C relay measures only the fundamental component of the input signals, the harmonics will be rejected by the internal DFFT-digital filter. Whereas the RMS-metering instrument measures the RMS-value of the input signals.

7.4.2 Checking the operating and resetting values of the relay

Inject a current which is less than the relay set values in phase 1 of the relay and gradually increase the current until the relay starts, i.e. at the moment when the LED I> and L1 light up or the alarm output relay I> is activated. Read the operating current indicated by the ammeter. The deviation must not exceed 3% of the set operating value or 1% In.
Furthermore, gradually decrease the current until the relay resets, i.e. the alarm output relay I> is disengaged. Check that the resetting current is smaller than 0.97 times the operating current.
Repeat the test on phase 2, phase 3 and earth current input circuits in the same manner.(Accuracy of earth current measuring ±3% of measuring value.

7.4.3 Checking the relay operating time

"For this test the AR function should be deactivated. The number of automatic reclosing attempts "SHOT" should be set to "EXIT".

To check the relay operating time, a timer must be connected to the trip output relay contact. The timer should be started simultaneously with the current injection in the current input circuit and stopped by the trip relay contact. Set the current to a value corresponding to twice the operating value and inject the current instantaneously. The operating time measured by the timer should have a deviation of less than 3% of the set value or ±10 ms (DEFT). Accuracy for inverse time characteristics refer to IEC 255-3.
Repeat the test on the other phases or with the inverse time characteristics in the similar manner. In case of inverse time characteristics the injected current should be selected according to the characteristic curve, e.g. two times I_S. The tripping time may be red from the characteristic curve diagram or calculated with the equations given under "technical data".
Please observe that during the secondary injection test the test current must be very stable, not deviating more than 1%. Otherwise the test results may be wrong.

7.4.4 Checking the high set element of the relay

Set a current above the set operating value of I>>. If required an alarm relay can be tripped if in this moment if it is assigned to this function. Check the tripping time of the high set element according to chapter 7.4.3.

Check the accuracy of the operating current setting by gradually increasing the injected current until the I>> element picks up. Read the current value from the ammeter and compare it with the desired setting.

Repeat the entire test on other phases and earth current input circuits in the same manner.

Note !
Where test currents >4 x I_N are used, the thermal withstand capability of the current paths has to be considered (see technical data, chapter 8.1).

7.4.5 Test circuit for MRIK3 relay with earth-current directional recognition (ER/XR models)

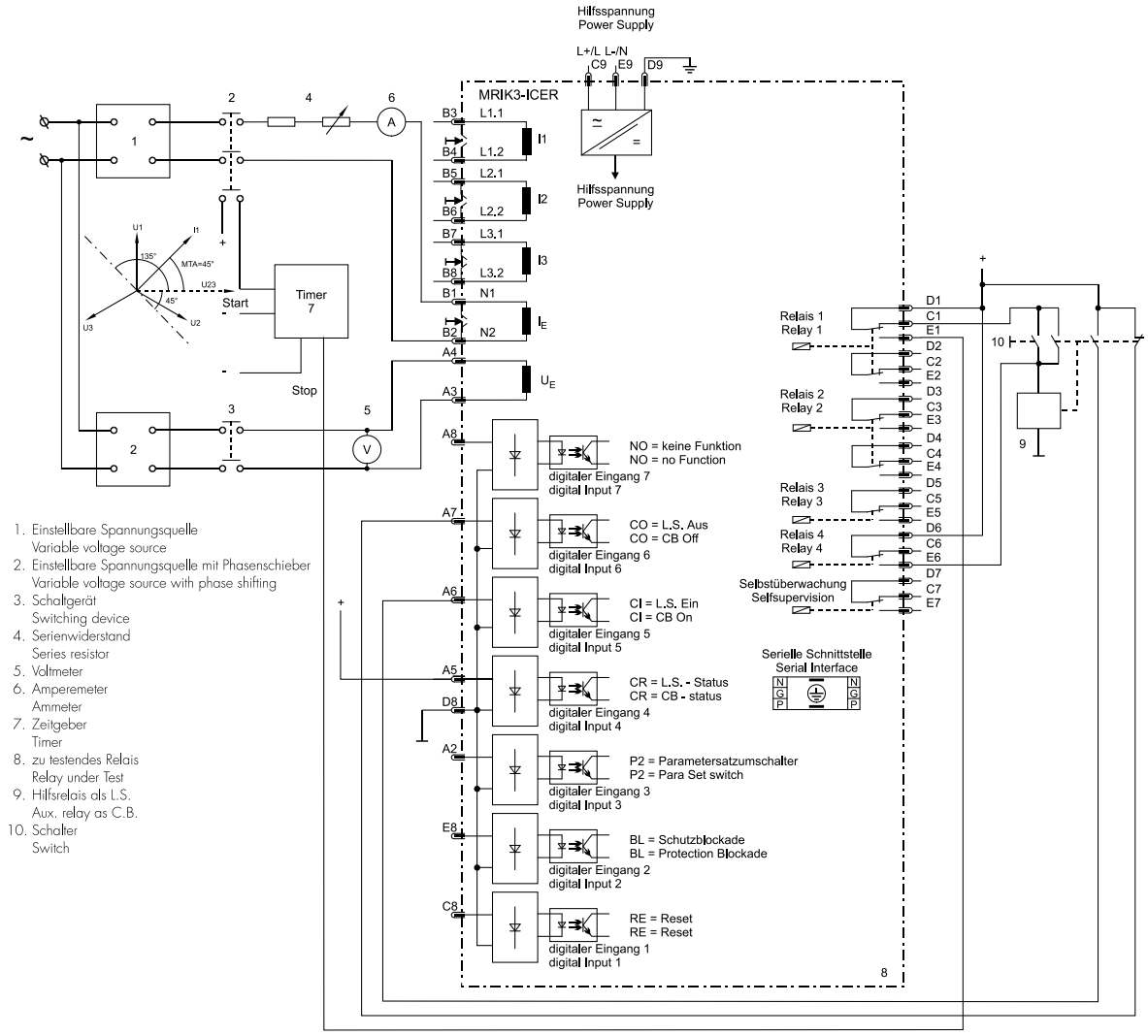


Figure 7.2: Test circuit

For testing relays MRIK3-ICER/XR with earth fault directional feature, current and voltage input signals with adjustable phase shifting are required. Figure 7.2 shows an example of a single phase test circuit with adjustable voltage and current energizing the MRIK3 relay under test.
For testing a relay with earth fault directional feature, one of the input energizing quantity (voltage) shall be applied to the relay with a constant value within its effective range. The other input energizing quantity (current) and phase angle shall be appropriately varied.
With the aid of phase angle indicated on the display the correct function of the relay MRIK3-ICER/XR can be checked (ER-relay type).
Parameters $I_{E>}$ and $I_{E>>}$should be set to EXIT.

The following measured values are shown:

Measured	LED
Earth current	E, $I_{E>}$
Active share	E, I_P
reactive share	E, I_Q
Earth voltage	E, $U_{E>}$
Angel	E, $I_{E>}$, $U_{E>}$

7.4.6 Checking the auto reclosing function

The auto reclosing function can only be tested by means of an auxiliary relay simulating the C.B. and a push button for manual start. In order to simplify testing, the significant settings of the devices and the value of the test current are provided as follows:

I>	= 0,8 x I_N
I> +CHAR	= DEFT
tI>	= 2 s
I>>	= 1,2 x I_N
tI>>	= 0,5 s
SHOT	= 1
tF	= 1,5
tD1	= 5 s
tD2	= 10 s
tCI	= 0,2 s
tR	= 10 s
tF + I>,I>>(IE>,IE>>)	= 1ST
CB (tCBFP)	= 2 s (EXIT)
f_N	= 50 Hz or 60 Hz

Relay assignment:
refer to default settings

AR-assignment:

I>	= YES
I>>	= YES

The test circuit must be set up in accordance with Figure 7.1. First the push button is pressed. The auxiliary relay picks up and the LED CB lights up. With the settings of the devices as shown above, a test current of 1.5 x I_N should be injected on phase L1. When the pickup value is exceeded, tripping takes place at once and the LEDs I>> and L1 light up red.
The auxiliary relay releases again. The device changes into the "Starting" status. Now the dead time is running and the LED tD1 lights up green. After expiration of the dead time the LED tCI briefly lights up and the auxiliary relay trips again.
The display shows "CLOS". The LED tR lights up red. The LED tR signals that the reclaim time is running. Once it has expired, all LEDs extinguish except for the LED CB, and the display shows "MRIK" again. This completes a successful AR simulation.
Note:
After the relay has tripped, the test current should be switched off as quickly as possible. Otherwise, there is the danger that the switch failure protection device CBFP picks up. If switching off quickly is impossible, tCBFP must be set to "EXIT".

7.4.7 Checking the circuit breaker position

First the digital inputs have to be assigned the relevant functions. In order to recognised the circuit breaker position, at least the CB position ON or the CB position OFF must be configured. The correct display of the CB LED can be found in chapter 5.7.10.

Behaviour with AR function
If the circuit breaker is set to position ON, the LED tR will light up for the duration of the set blocking time and the display shows "MANU". The CB LED shows a red light.

Behaviour without AR function
If the circuit breaker is set to position ON, the light of the CB LED will be red.

7.4.8 Checking the AR blocking function

First it must be ensured that the function is assigned to a digital input. If the digital input is activated, the 0←I will light up red.

7.4.9 Checking the external blocking and reset functions

By means of the external blocking input, it is possible to block all protective functions. To give an example, the blocking function of the phase current high set element is described.
This can be tested by first setting the parameter for the phase current high set element to „BLOC“ and then connecting the auxiliary voltage to to the digital input reserved for this purpose.
The phase current low set element I> should be set to EXIT for this test. Inject a test current which could cause a high set (I>>) tripping. Observe that there is no trip of any assigned output relay of the high set or low set element.

Remove the auxiliary supply voltage from the blocking input. Inject a test current to trip the relay (message „TRIP“ on the display). Interrupt the test current and apply auxiliary supply voltage to the external reset input of the relay (terminals C8/D8). The display and LED indications should be reset immediately.

7.4.10 Testing the external blocking with Block/Trip function

In order to simplify things, the short-circuit stage is to be tested here as described in Chapter 7.4.9. For this purpose, the parameter for the Block/Trip function must be set to "TR_B" (first value in the blocking menu of the protection functions Chapter 6.12.1. The appertaining Block/Trip time should be longer than the set tripping time tI>>. Here, too, a current is impressed which should make the short-circuit stage trip. At the same time the blocking input must be activated. The easiest way to do this is to set the alarm relay to the blocking input. After the Block/Trip time has expired, tripping will take place. Tripping takes place when:

- the blocking input has been set
- a tripping stage has been excited
- the appertaining tripping time has expired
- the Block/trip time has expired

If the Block/Trip time is set shorter than the tripping time, tripping will only take place after the tripping time has expired.

7.4.11 Test of the CB failure protection

For testing the tripping time a test current of about two times the rated current to be injected. The timer is started upon tripping of the relay of a protection function (I>, I>>, I_E> or I_E>>) and stopped as soon as the relay for the CB failure protection has picked up. Message "CBFP" is displayed. The tripping time ascertained by the timer should not deviate more than 1% or, at short trip delay, less than ±10 ms from the set tripping time.
Alternatively, the timer can be started when the aux. voltage and the test current are injected simultaneously. The timer stops when the corresponding output relay for circuit breaker failure protection trips.
In this case the previously measured tripping delay has to be subtracted from the total tripping time measured.

7.5 Primary Test

As a rule, tests with currents at the CT primary side (real test) can be performed in the same way as tests with secondary currents. It is recommended to carry out primary tests only as an exception and only if it is absolutely necessary (for very essential protective facilities) because in some cases the costs involved and the strain on the system can be rather high. Many functions of the MRIK3-C can be checked during normal operation of the system due to the efficient fault and measuring value indications. So it is possible, for example, to compare the currents shown on the display with the values shown on the ammeters in the switchboard.

7.6 Maintenance

Normally the relays are checked at regular maintenance intervals at site. From user to user these intervals may vary because among other things they depend on the type of relay, the kind of application, significance of the object to be protected, previous experience of the user etc.

For electro-mechanical or static relays normally an annual check is required. For the MRIK3-C the maintenance intervals can be much longer because:

- The MRIK3-C relays are provided with wide-ranging self-test functions and consequently relay faults are detected and indicated. It is, of course, imperative that the internal self-supervision relay is connected to a central display board.
- The combined measuring functions of the MRIK3-C make monitoring during operation possible.
- The trip test function (TRIP-Test) allows testing of the output relays.

Therefore a maintenance interval of two years is sufficient. When servicing all relay functions incl. setting values, trip characteristics and tripping times ought to be thoroughly checked.

8. Technical Data

8.1 Measuring input

Rated data:	Rated current I_N	1A or 5A	
	Rated frequency f_N	50/60 Hz adjustable	
Power consumption in current path:		at I_N = 1 A	0.2 VA
		at I_N = 5 A	0.1 VA
Power consumption in voltage path:			<1VA
Thermal withstand capability			
Of the current paths:	Current surge		
	(on half-wave)	250 x I_N	
	for 1 s	100 x I_N	
	for 10 s	30 x I_N	
	continuously	4 x I_N	
Thermal withstand in voltage circuit:	continuously	1.5 x U_N	
Fault recorder			
Recorded tracks:		i_{L1}, i_{L2}, i_{L3}, i_E	
Sampling rate:		1.25 ms at 50 Hz	
		1.041 ms at 60 Hz	
Storage capacity:		16 s (at 50 Hz) bzw	
		13.33 s (at 60 Hz)	
Number of events:		1-8	

8.2 Common data

Dropout to pickup ratio:	>97%
Returning time:	40 ms
Boot time (Power-on-time)	< 50 ms
Minimum operating time:	40 ms
Minimum operating time including boot time	<100ms
Transient overreach at instantaneous operation:	≤5%
Permissible interruption of the supply voltage without affecting the relay function:	>50ms

Climatic withstand

Storage:	-25°C ... +70°C
Operation:	-25°C ... +70°C

Influences on the current measurements

Auxiliary voltage:	in the range of 0.8 < U_H / U_{HN} < 1,2 no additional influences can be measured
Frequency:	in the range of 0.9 < f / f_N < 1.1; <0.2%

Measuring errors at higher frequencies: 70Hz – 400Hz < 0.2% / Hz

Influences on delay time: no additional influences can be measured

For further technical data see the general description „*MR*-Multifunctional Relay“.

8.3 Setting ranges and steps

8.3.1 System parameter

	Setting range	Step	Tolerance
I_{prim} IE_{prim}	(SEK) 0,001...50,0KA	0.001; 0.002; 0.005; 0.01; 0.02; 0.05; 0.1; 0.2	
$U_{E>}$ (U_{p-rim}/U_{SEK})	(SEK) 1,01...6500	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1; 2; 5; 10; 20; 50	
$U_{E>}$	U_N = 100 V: e-n: 1 - 70 V 1:1: 1 - 120 V	 1 V 1 V	±5% of the setting value or <0.5% U_N

Operating cycle counter

	Setting range	Step	Tolerance
No	0 - 9999	1	

Presetting for switch off power (I^2t)

	Setting range	Step	Tolerance
I^2t	0 – 655 kAs	0.01; 0.02;0.05; 0.1; 0.2; 0.5; 1; 2; 5	

Date and time

	Setting range	Step	Tolerance
Uhr	Y = 0..99 M = 1..12 D = 1..31 h = 0..23 m = 0..59 s = 0..59	1 year 1 month 1 day 1 hour 1 minute 1 second	

8.3.2 Time overcurrent protection (I-type)

	Setting range	Step	Tolerance
I>	0.2...4.0 x I_N (EXIT)	0.01; 0.02; 0.05; 0.1 x I_N	±3% of the setting value or min. ±2 % In
$t_{I>}$	0.03 - 300 s (EXIT) (definite time)	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10 s; 20 s	±3% or ±10 ms
	0.05 - 10 (EXIT) (inverse time)	0.01; 0.02; 0.05; 0.1; 0.2	±3% of the measuring value of the current or ±20ms (see EN60255-3)
I>>	0,5...40 x I_N (EXIT)	0.02; 0.05; 0.1; 0.2; 0.5; 1.0 x I_N	±3% of the setting value or min. ±2% In
$t_{I>>}$	0,03...10 s (EXIT)	0.01 s; 0.02 s; 0.05 s; 0.1 s; 0.2 s	±3% or ±10 ms
I>>+CB Trip/ Block	0,5...40 x I_N (EXIT)	0.02; 0.05; 0.1; 0.2; 0.5; 1.0 x I_N	±3% of the setting value or min. ±2% In

8.3.3 Earth fault protection (E - type)

	Setting range	Step	Tolerance
$I_{E>}$	0.01...2.0 x I_N (EXIT)(E)	0.001; 0.002; 0.005; 0.01; 0.02; 0.05 x I_N	±5% of the setting value or ±0,3% I_N (E);
$t_{IE>}$	0.03...300 s (EXIT) (definite time)	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10; 20 s	±3% or 15 ms
	0.05...10 (EXIT) (inverse time)	0.01; 0.02; 0.05; 0.1; 0.2	±3% of the measuring value of the current or ±20ms (see EN60255-4)
$I_{E>>}$	0.01...15,0 x I_N (EXIT)(E)	0.001; 0.002; 0.005, 0.01; 0.02; 0.05; 0.1; 0.2; 0.5 x I_N	±5% of the setting value or ±0.3% I_N (E);
$t_{IE>>}$	0.040...10 s (EXIT)	0.01; 0.02; 0.05 s; 0.1 s; 0.2 s	±3% or ±15 ms

8.3.4 Earth fault protection (ER/XR-type)

	Setting range	Step	Tolerance
$I_{E>}$	0.01...0.45 x I_N (EXIT) (ER)	0.001; 0.002; 0.005; 0.01 x I_N	±5% of the setting value or ±0.3% I_N (ER);
	0.1... 5.0% I_N (EXIT) (XR)	0.01%; 0.02%; 0.05%; 0.1% I_N	±0.03% I_N (XR)
$t_{IE>}$	0.04…300s (EXIT)	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10; 20 s	±3% or ±15 ms
$I_{E>>}$	0.01...0.45 x I_N (EXIT) (ER)	0.001; 0.002; 0.005; 0.01 x I_N	±5% of the setting value or ±0.3% I_N (ER);
	0.1...5.0% I_N (EXIT) (XR)	0.01%; 0.02%; 0.05%; 0.1% I_N	±0.03% I_N (XR)
$t_{IE>>}$	0.04...10 s (EXIT)	0.01; 0.02; 0.05 s; 0.1 s; 0.2 s	±3% or ±15 ms

8.3.5 AR Parameter

	Setting range	Step	Tolerance
SHOT	1..4 (EXIT)	1	
t_F	0.1...20 s	0.01; 0.02; 0.05 s; 0.1 s; 0.2 s; 0.5 s; 1 s	±3% or 10 ms
t_{D1}	0.1...20 s	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1 s	
t_{D2}	0.1...100 s	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1; 2; 5 s	
t_{D3}	0.1...100 s	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1; 2; 5 s	
t_{D4}	0.1...100 s	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1; 2; 5 s	
t_{CL}	0.05...2 s	0.01; 0.02; 0.05 s	
t_R	1.0...300 s	0.1; 0.2; 0.5; 1; 2; 5; 10; 20 s	
$t_F$active	1ST/ALL		

AR Assignments

	Setting range	Function
Assignment before or after AR	TIME; FAST; BLOC	TIME Protection stage is tripping with setting time FAST Protection stage is tripping immediately BLOC Protection stage is blocked
Permitted for AR	YES; NO	YES Tripping of the chosen trip stage leads to reclosing NO Tripping of the chosen trip stage blocks the reclosing
t_{D1}	0,1...20 s	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1 s

Fixed Parameter

Fixed parameter	Value	Tolerance	Remarks
Trip delay time	200 ms	<= 20 ms	This time starts with the protection tripping command (before the first AR) 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	<= 20 ms	During this time the C.B. stand-by is supervised before reclosing. It can be deactivated by applying the aux. voltage to connection A5.
Waiting for synchronuous condition	150s	<=20 ms	When one digital input is assign to “synchro check” and one dead time tD elapsed than this timer starts. The timer stopped when the condition is satisfy or the timer elapsed.

8.3.6 Control Function

Block/Trip – time

	Setting range	Step	Tolerance
Trip+Block+t>	0.1...2.0 s; EXIT	0.01; 0.02; 0.05; 0.1 s	±1% or ±10 ms

External trip delay time

	Setting range	Step	Tolerance
DI+Trip+t>	0,1...300,0 s; EXIT	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10 s; 20 s	±1% or ±10 ms

External trip immediate (no parameter setting)

	Setting range	Step	Tolerance
	100ms	fix time	100ms ±10 ms

Trip/Restore - time

	Setting range	Step	Tolerance
DI+t_{CI}+t>	0,1...300,0 s; EXIT	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10 s; 20 s	±1% or ±10 ms

CB failure protection

CBFP	Setting range	Step	Tolerance
CB green + t>	0.1...2.0 s; EXIT	0.01; 0.02; 0.05; 0.1 s	±1% or ±10 ms

8.3.7 Interface parameter

Parameter	LED *	Setting range		Step	Tolerance
	RS	1 - 32	Slave-address	1	
	RS	 2400 4800 9600	Baud-Rate	2400, 4800	
	RS	 even odd no	Parity even odd none		

8.3.8 Parameter for the fault recorder

Parameter	LED	Setting range		Step	Tolerance
Number of recordings*	FR	 1 3 7 2 4 8	Existing recordings to be overwritten * 1 x 8 s (6.66s) 3 x 4 s (3.33s) 7 x 2 s (1.66s) Existing recordings not to be overwritten * 2 x 8 s (6.66s) 4 x 4 s (3.33s) 8 x 2 s (1.66s)		
Saving of the recording at the accurence	FR	P_UP TRIP A_PI TEST	At actuation At trip After actuation Test recording with button <+> and <->		
Pre-Trigger-time	FR	0.05...8.00	Duration of the previous event S		

* All given times refer to 50 Hz (60 Hz in brackets)

8.4 Tripping characteristics

8.4.1 Inverse time overcurrent protection relay

Tripping characteristics according to IEC 255-4 or BS 142

Normal inverse (Typ A)

$$t = \frac{0.14}{\left(\frac{I}{Is}\right)^{0.02} - 1} t_I > [s]$$

Very inverse (Typ B)

$$t = \frac{13.5}{\left(\frac{I}{Is}\right) - 1} t_I > [s]$$

Extremely inverse (Typ C)

$$t = \frac{80}{\left(\frac{I}{Is}\right)^{2} - 1} t_I > [s]$$

Long time inverse

$$t = \frac{120}{\left(\frac{I}{Is}\right) - 1} t_I > [s]$$

RI-inverse

$$t = \frac{1}{0.339 - \frac{0.236}{\left(\frac{I}{I_S}\right)}} t_I > [s]$$

RXIDG – characteristic

$$t = \left(5{,}8 - 1{,}3 \cdot \ell n\left(\frac{I}{Is}\right)\right) \cdot t_{I>}[s]$$

Where:

	t	=	tripping time
	$t_I>$	=	time multiplier
	I	=	fault current
	Is	=	Setting range of the current
	ℓn	=	natural logarithm

8.4.2 Determination of earth fault direction (MRIK3-ER/XR)

Measurement of active current in component for compensated systems:	I_E x cos φ
Measurement of reactive current component for isolated systems:	I_E x sin φ
Angle measuring accuracy:	±3° at I_E x cos φ or I_E x sin φ >5% I_E
Residual voltage sensitivity:	<0.2% U_N at I = 0.1 x I_N

8.5 Tripping characteristics

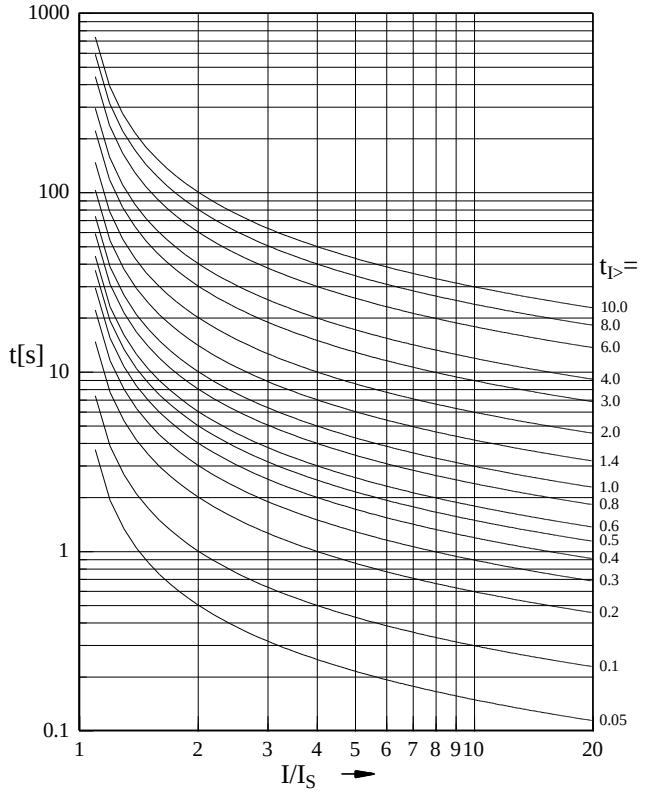


Abbildung 8.1: Normal Inverse

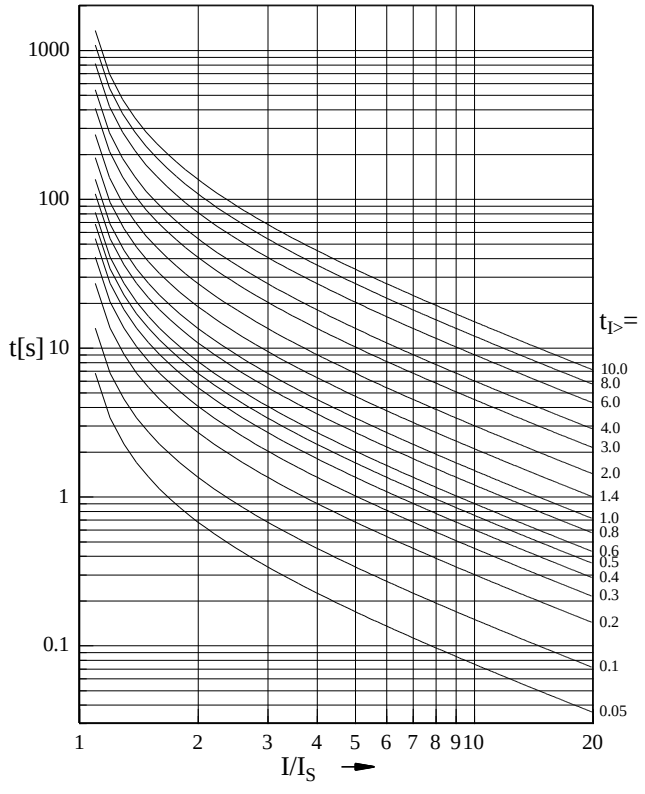


Abbildung 8.2: Very Inverse

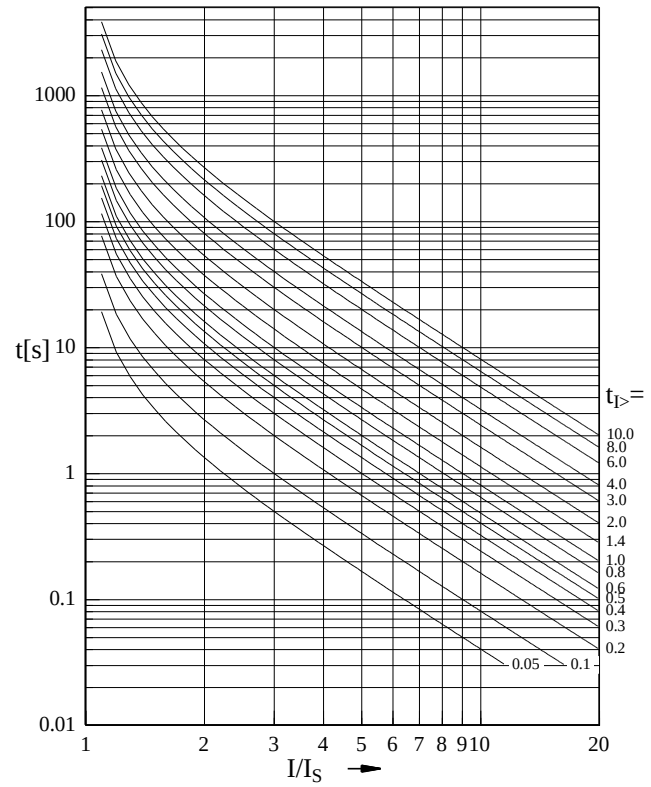


Abbildung 8.3: Extremely Inverse

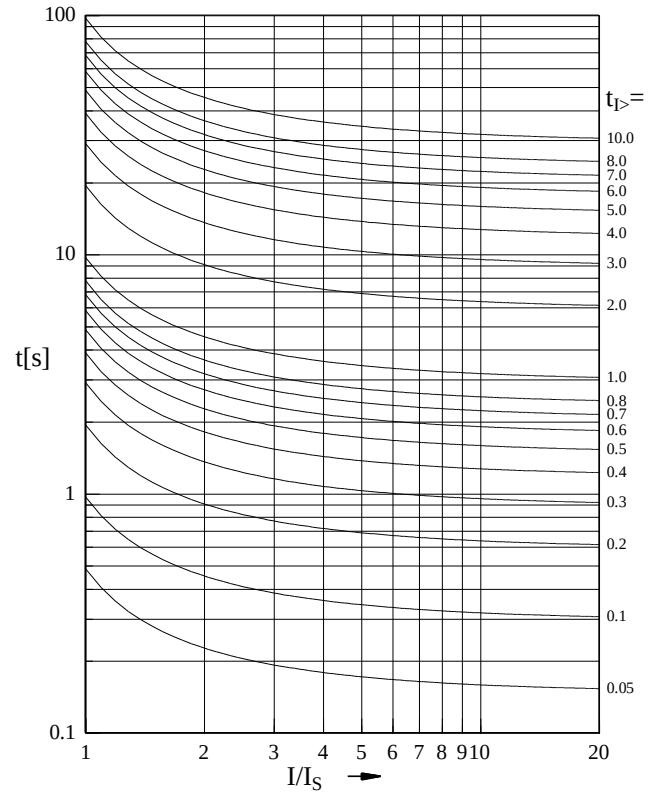


Abbildung 8.4: RI-Inverse

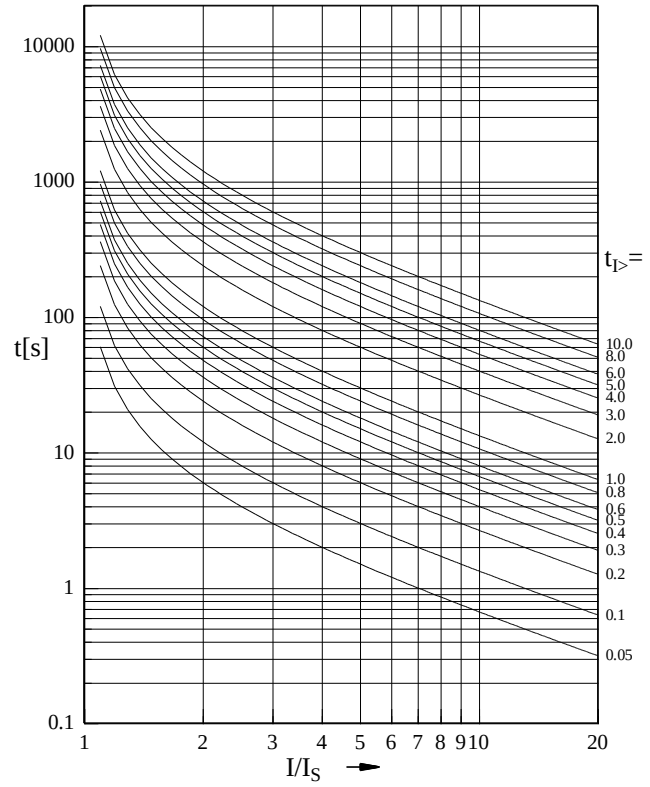


Abbildung 8.5: Long Time Inverse

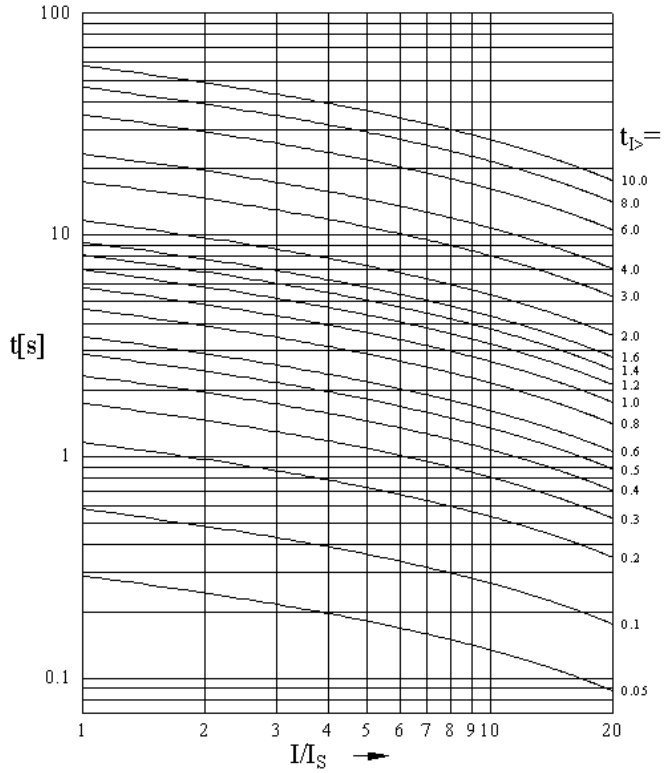


Abbildung 8.6: RXIDG-Kennlinie

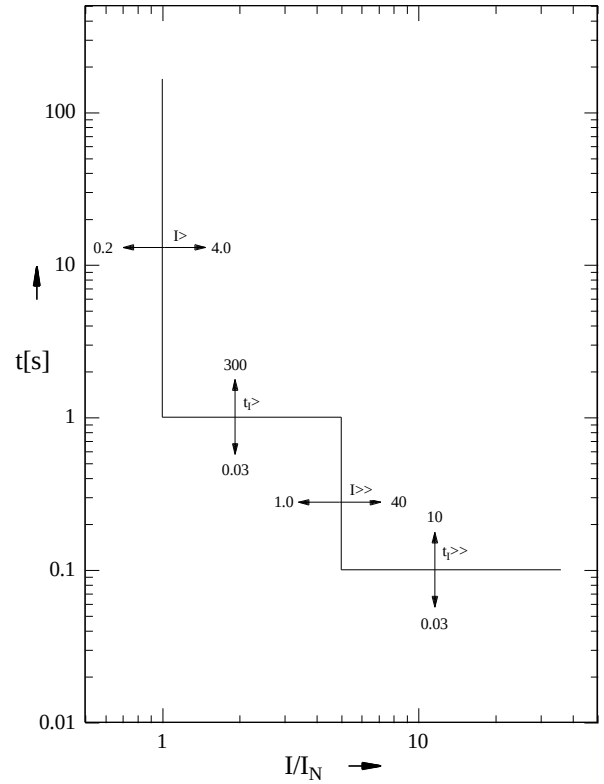


Abbildung 8.7: Unabhängige Auslösekennlinie

8.6 Output relays

Contacts: 2 change-over contacts for relays 1 and 2; 1 change-over contact for relays 3 - 4

9. Order form

Time overcurrent-/earth fault current relay with AR- and control function	*MRIK3-*		C			D	-M
3-phase current I>, I>>							
Rated current	1 A	**I1**					
	5 A	**I5**					
Control and supervision of one circuit breaker							
Earth current	standard						
Rated current	1 A			**E1**			
sensitive**	1 A			****X1**			
Directional feature in earth path					*		
Rated voltage	100 V				**R1**		
Housing (12TE)							
Flush mounting							
Communication protocol Modbus RTU							

* Please leave box empty if option is not desired
** only available with directional feature

Technical data subject to change without notice!

Setting list MRIK3-ICE, MRIK3-ICER, MRIK3-ICXR

Project: _____ Job.-no.: _____

Functional group: =____ Location: +____ Relay code: -_____

Relay functions: _____ Password: _____

Date: _____

All settings have to be checked at site and perhaps adjusted to the object to be protected.

Date and time settings

Function		Unit	Default settings
🕒	Year settings	year	Y = 00
🕒	Month settings	month	M=01
🕒	Day settings	day	D=01
🕒	Setting of the hours	hour	h=00
🕒	Setting of the minutes	minute	m=00
🕒	Setting of the seconds	second	s=00

System parameter

LED	Function	Unit	Default settings	Actual settings
L1+L2+L3 green	$I_{primär}$ (Phase) Display of measuring values as primary quantities	xIn (kA)	sek	
E green	$I_{primär}$ (earth) Display of measuring values as primary quantities	xIn (kA)	sek	
E green+U_E>	U_{prim}/U_{sek} (earth) Display of residual voltage as primary quantities		sek	
U_E>	Setting of the transformer connections for the residual voltage		e-n	
CB green	Operating cycle counter		0001	
L1 L2 L3+ CB green	Pre setting of I^2t measuring	kAs	0k00	
L1 L2 L3 CB red	Threshold value of I^2t measuring	kAs	600k	
	50 / 60 Hz	Hz	f=50	
	Display of the activation storage		FLSH	

Protection parameter

LED	Function	Unit	Default settings	Actual settings	
	Parameter set change-over switch		Set 1/2	Set	
P2	Parameter set change-over switch		SET 1	1	2
I>	Pick-up value of the phase overcurrent element	x I_N	0.2		
I>+CHAR	Trip characteristics for the phase overcurrent element		DEFT		
I>+t>	Tripping time (factor) for the phase overcurrent element	(s)	0.03		
I>+t>	Fast trip at manual switch on at I>		TIME		
I>+CHAR+t>	Reset mode for the tripping characteristics		0s		
I>>	Pick-up value for the phase short-circuit element	x I_N	0.50		
I>>+CB green	Trip-Block for all protection elements	x I_N	EXIT		
I>>+t>	Tripping time of the phase short-circuit element	s	0.03		
I>>+t>	Fast trip at manual switch on at I>>		TIME		
U_E>**	Pick-up value of the residual voltage	V	1V/2V/5V		
I_E>	Pick-up value for earth overcurrent element	xIn(%)***	0.01(0.1)***		
I_E>	Warning/Tripping of the earth current stage		trip		
I_E>+t>+ ↔□green**	Tripping time in forward direction	s	0,04		
I_E>+t>+ ↔□red**	Tripping time in reverse direction	s	0.04		
I_E>+t>*	Tripping delay time for earth overcurrent element	s	0.04		
I_E>+t>	Fast trip at manual switch on at I_E>		TIME		
I_E>>	Pick-up value for the earth short-circuit element	xIn(%)***	0.01(0.1)***		
IE>>+t>+↔□green**	Tripping time in forward direction	s	0.04		
IE>>+t>+ ↔□red**	Tripping time in reverse direction	s	0.04		
IE>>+t>*	Tripping delay time for earth short circuit element	s	0.04		
I_E>>+t>	Fast trip at manual switch on at I_E>>		TIME		
I_E>+I_E>>**	Switch over for SIN/COS		SIN		

* LED-Display at MRIK3-ICE relay type
** LED display at MRIK3-ICER, MRIK3-ICXR relay types
()*** Setting at MRIK3-ICXR relay type

AR Parameter

LED	Function	Unit	Default settings	Actual settings	
	Parameter set change-over switch		Set 1/2	1	2
SHOT	Number of Shots		4		
t_F	Fault time t_F	s	0.10		
t_{D1}	Dead time t_{D1}	s	1.00		
t_{D2}	Dead time t_{D2}	s	2.00		
t_{D3}	Dead time t_{D3}	s	2.00		
t_{D4}	Dead time t_{D4}	s	2.00		
t_{CI}	Close impulse time t_{CI}	s	0.50		
t_R	Reclaim time t_R	s	10.0		
t_f + I>+I>>+I_E>+ I_E>> green	Fault time activation t_F		1ST		

Control functions

LED	Function	Unit	Default	Actual

			settings	settings	
	Parameter set change-over switch		Set 1/2	1	2
Trip+t>+CB green	Block/Trip - time	s	EXIT		
DI+Trip+t>	Trip delay time at ext. Trip	s	0.10		
DI+t_{CI}+t>	Dead time for Trip/Restore	s	EXIT		
CB green+t>	Tripping time for CB failure protection	s	EXIT		
I>+I>>+I_E>+I_E>>+ CB green	Alarm relays drop down at CB failure protection		NO		

Parameters of the fault recorder

LED	Function	Unit	Default setting	Actual setting
FR	Number of recordings		4	
FR	Storage of the recording at the event		TRIP	
FR	Time period prior to the trigger impulse	s	0.05	

Interface parameters

LED	Function	Default setting	Actual setting
RS	Slave Address of the serial interface	1	
RS	Baud rate of the serial interface	9600	
RS	Parity check of the serial interface	even	

Entry via “TRIP” and “ENTER” Button

Assignment of the blocking functions

LED	Function	Default setting*		Actual setting	
		Set 1	Set 2	Set 1	Set 2
I>+I>>+I_E>+I_E>> +(t>**)	Switch over for protection blocking or trip blocking	PR_B	PR_B		
I>	Overcurrent element	NO_B	NO_B		
I>>	Short-circuit element, in operation	BLOC	BLOC		
IE>	Earth current element	NO_B	NO_B		
IE>>	Earth short circuit current element	NO_B	NO_B		
CB green	CB failure protection	NO_B	NO_B		
DI+Trip	External trip	NO_B	NO_B		

*NO_B = not blocked; BLOC = blocked; PR_B = blocking protection pickup function; TR_B = blocking trip function
** t> LED lights up when TR_B function should be set.

Assignment of the Output Relays

LED	Function	Relay 1		Relay 2		Relay 3		Relay 4	
		Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting
I>	I> Alarm			X					
I>+t>	I> trip	X							
I>>	I>> Alarm			X					
I>>+t>	I>> trip	X							
I>+I>>+I_E>+I_E>>+ CB green	Fast trip step	X							
*I_E>	I_E> Alarm			X					
*I_E>+t>	I_E> trip	X							
**I_E>+ ↔green	I_E> Alarm, Forward			X					
**I_E>+t>+↔green	I_E> trip, Forward	X							
**I_E>+ ↔red	I_E> Alarm, Reverse			X					
**I_E>+t>+↔red	I_E> trip, Reverse	X							
*I_E>>	I_E>> Alarm			X					
*I_E>>+t>	I_E>> trip	X							
**I_E>>+ ↔green	I_E>> Alarm			X					
**I_E>>+t> ↔green	I_E>> trip	X							
**I_E>>+ ↔red	I_E>> Alarm			X					
**I_E>>+t> ↔red	I_E>> trip	X							
CB green+t>	Circuit Breaker Failure Protection								
t_{CI}	Switch on impulse							X	
0←1	AR unsuccessful					X			
DI+t_{CI}+CB red	Manual switch on							X	
DI+Trip+CB green	Manual switch off immediately	X							
DI+Trip+CB green+t>	Manual switch off delayed	X							
0←1+CB green	I²t> Alarm								

*LED display at MRIK3-ICE relay type
**LED display at MRIK3-ICER / MRIK3-ICXR relay type

Assignment of the AR functions*

LED	Function	Default settings		Actual settings	
	Parameter set change-over switch	Set 1	Set 2	Set 1	Set 2
	Permitted for tripping before 1st AR				
I>+tD1	For overcurrent stage	TIME	TIME		
I>>+tD1	For short circuit stage	TIME	TIME		
I_E>+tD1	For earth overcurrent stage	TIME	TIME		
I_E>>+tD1	For earth short circuit stage	TIME	TIME		
	Permitted for the 1st AR				
SHOT+I>+tD1	AR is permitted, if the I> stage is the tripping cause	NO	NO		
SHOT+I>>+tD1	AR is permitted, if the I>> stage is the tripping cause	YES	YES		
SHOT+I_E>+tD1	AR is permitted, if the I_E> stage is the tripping cause	NO	NO		
SHOT+I_E>>+tD1	AR is permitted, if the I_E>> stage is the tripping cause	NO	NO		
	Tripping after 1st AR				
I>+tD1	For overcurrent stage	TIME	TIME		
I>>+tD1	For short circuit stage	TIME	TIME		
I_E>+tD1	For earth overcurrent stage	TIME	TIME		
I_E>>+tD1	For earth short circuit stage	TIME	TIME		
	Permitted for the 2nd AR				
SHOT+I>+tD2	AR is permitted, if the I> stage is the tripping cause	NO	NO		
SHOT+I>>+tD2	AR is permitted, if the I>> stage is the tripping cause	YES	YES		
SHOT+I_E>+tD2	AR is permitted, if the I_E> stage is the tripping cause	NO	NO		
SHOT+I_E>>+tD1	AR is permitted, if the I_E>> stage is the tripping cause	NO	NO		
	Tripping after 2nd AR				
I>+tD2	For overcurrent stage	TIME	TIME		
I>>+tD2	For short circuit stage	TIME	TIME		
I_E>+tD2	For earth overcurrent stage	TIME	TIME		
I_E>>+tD2	For earth short circuit stage	TIME	TIME		
	Permitted for the 3rd AR				
SHOT+I>+tD3	AR is permitted, if the I> stage is the tripping cause	NO	NO		
SHOT+I>>+tD3	AR is permitted, if the I>> stage is the tripping cause	YES	YES		
SHOT+I_E>+tD3	AR is permitted, if the I_E> stage is the tripping cause	NO	NO		
SHOT+I_E>>+tD3	AR is permitted, if the I_E>> stage is the tripping cause	NO	NO		
	Tripping after 3rd AR				
I>+tD3	For overcurrent stage	TIME	TIME		
I>>+tD3	For short circuit stage	TIME	TIME		
I_E>+tD3	For earth overcurrent stage	TIME	TIME		
I_E>>+tD3	For earth short circuit stage	TIME	TIME		
	Permitted for the 4th AR				
SHOT+I>+tD4	AR is permitted, if the I> stage is the tripping cause	NO	NO		
SHOT+I>>+tD4	AR is permitted, if the I>> stage is the tripping cause	YES	YES		
SHOT+I_E>+tD4	AR is permitted, if the I_E> stage is the tripping cause	NO	NO		
SHOT+I_E>>+tD4	AR is permitted, if the I_E>> stage is the tripping cause	NO	NO		
	Tripping after 4th AR				
I>+tD4	For overcurrent stage	TIME	TIME		
I>>+tD4	For short circuit stage	TIME	TIME		
I_E>+tD4	For earth overcurrent stage	TIME	TIME		
I_E>>+tD4	For earth short circuit stage	TIME	TIME		

* only MRIK3 – relay types

TIME=tripping with setting time; FAST=trip immediately; BLOC_tripping stage is blocked

Assignment of the digital inputs

LED	Function	Default settings	Actual settings
DI	1. digital input	1=RE	
DI	2. digital input	2=BL	
DI	3. digital input	3=P2	
DI	4. digital input	4=FR	
DI	5. digital input	5=CI	
DI	6. digital input	6=CR	
DI	7. digital input	7=t0	

Setting of the code jumpers

Code jumpers	J1		J2		J3*	
	Default settings	Actual set-tings	Default settings	Actual set-tings	Default settings	Actual set-tings
plugged						
Not plugged	X		X		X	

*not active at MRIK3-C relay types

Digital inputs

Code jumper	Function	Low/High-range for the digital inputs	
Terminal	Low=plugged/High=not plugged	Default settings	Actual settings
D8/C8	1. digital input	plugged	
D8/E8	2. digital input	plugged	
D8/A2	3. digital input	plugged	
D8/A5	4. digital input	plugged	
D8/A6	5. digital input	plugged	
D8/A7	6. digital input	plugged	
D8/A8	7. digital input	plugged	

This technical description applies as from the use of Software Version

MRIK3-ICXR-M: Release 2.0 HO15901
MRIK3-ICER-M: Release 2.0 HO15901
MRIK3-ICE-M: Release 2.0 HO15901

Technical data subject to change without notice!

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