MANUAL

HighTECH Line | PROTECTION TECHNOLOGY MADE SIMPLE

MRI1IU | VOLTAGE CONTROLLED TIME-OVERCURRENT RELAY

VOLTAGE CONTROLLED TIME-OVERCURRENT RELAY

Original document

English

Revision: A

Contents

Important:
For additional common data of all *MR*-relays please refer to manual "*MR* - Digital Multifunctional relays". This technical manual is valid for software version D08-6.00.

1   Introduction and application

The digital multifunctional relay *MRI1-IU* is an universal protection device for alternators and other equipment. It provides the following functions:

- Independent (definite) time overcurrent protection (DMT)
- Inverse time overcurrent protection (IDMT) with the following selectable characteristics:

  Normal Inverse
  Very Inverse
  Extremely Inverse
  Automatic change over characteristic by undervoltage

2   Features and characteristics

- Digital filtering of the measured values by using discrete Fourier analysis to suppress the high frequence harmonics and DC components induced by faults or system operations
- Selectable protective functions between:

  definite time overcurrent relay and
  inverse time overcurrent relay
- Selectable inverse time characteristics according to BS 142 and IEC 255-4:

  Normal Inverse
  Very Inverse
  Extremely Inverse
- Reset setting for inverse time characteristics selectable
- High set overcurrent unit with instantaneous or definite time function.
- Two-element (low and high set) overcurrent relay.
- Voltage controlled characteristic
- Measuring of phase currents in operation without short-circuit storage of tripping values
- Numerical display of setting values and actual measured values.
- Withdrawable modules with automatic short circuit of C.T. inputs when modules are withdrawn.

3   Design

3.1   Connections
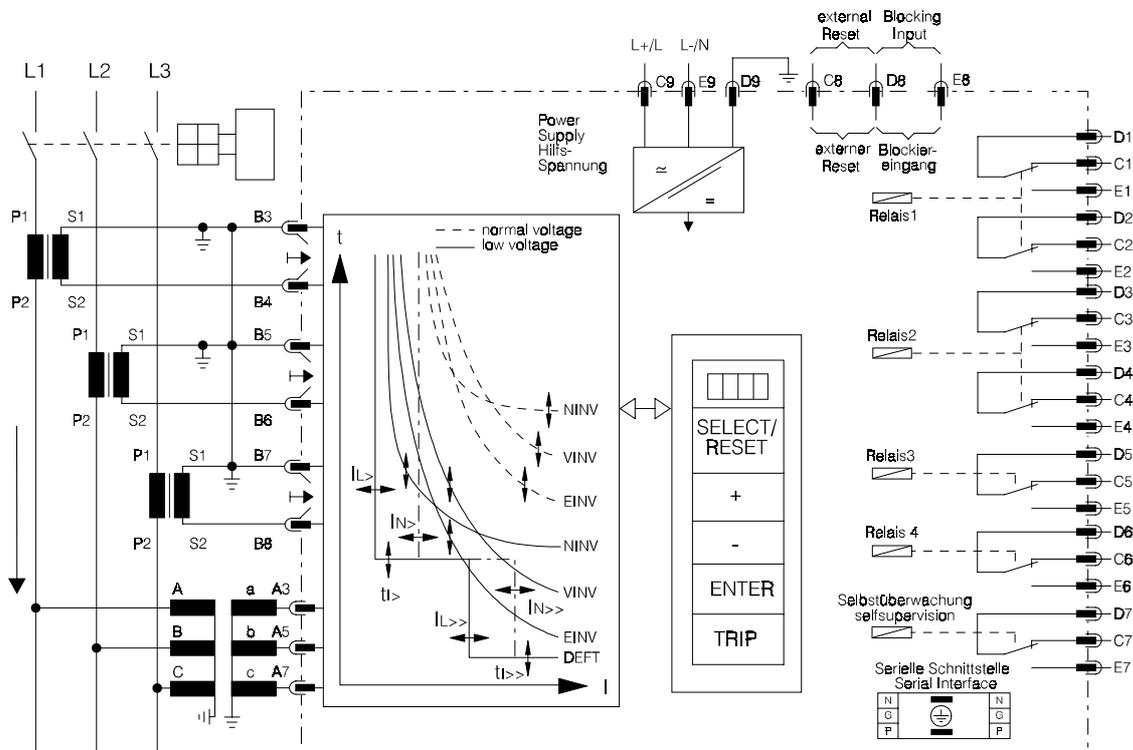
Figure 3.1:   Connection diagram

3.1.1 Analogue input circuits

The protection unit receives the analogue input signals of the phase currents IL1 (B3-B4), IL2 (B5-B6), IL3 B7-B8)), as well as the phase voltages via isolated input transformers in V-connection.

The constantly detected current measuring values are galvanically decoupled, filtered and finally fed to the analogue/digital converter.

3.1.2 Output relays

The *MRI1-IU* has five output relays. Two output relays with two change-over contacts and two with one change-over contacts can be assigned as required.
All relays are working current relays, only the relay for self supervision is an idle current relay. To prevent that the C.B. trip coil circuit is interrupted by the *MRI1-IU* first, i.e. before interruption by the C.B. auxiliary contact, a dwell time is fixed.
This setting ensures that the *MRI1-IU* remains in self holding for 200ms after the fault current is interrupted.

3.1.3 Blocking input

The blocking functions adjusted before will be blocked if an auxiliary voltage is connected to (terminals) D8/E8. (Refer to chapter 5.2.10)

3.1.4 External reset input

Please refer to chapter 5.4.

3.2 LEDs

The LEDs left from the display are partially bi-coloured, the green indicating measuring, and the red fault indication.

The LED marked with letters RS lights up during setting of the slave address of the device for serial data communication.

The 5 LEDs arranged at the characteristic points on the setting curves support the comfortable setting menu selection.
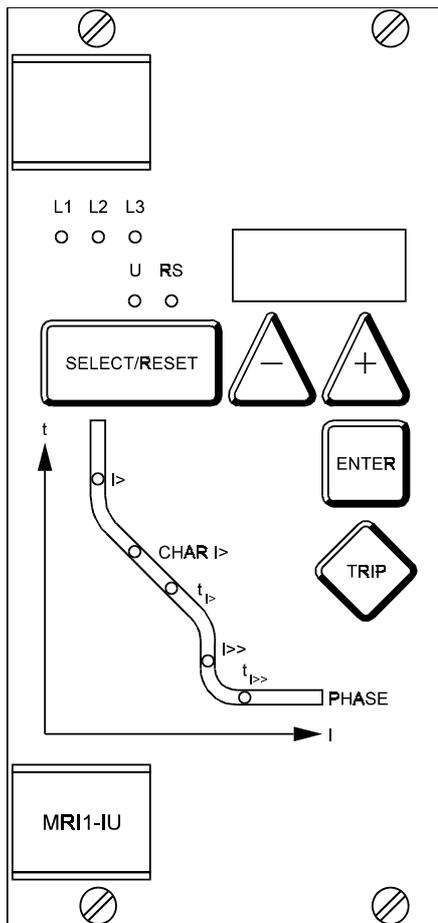
Figure 3.2:   Front panel

4   Working principle

4.1   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. (16 scans per period).

The incoming voltages from the main voltage transformers are led to operational amplifiers through the input transformers and R-C filters.
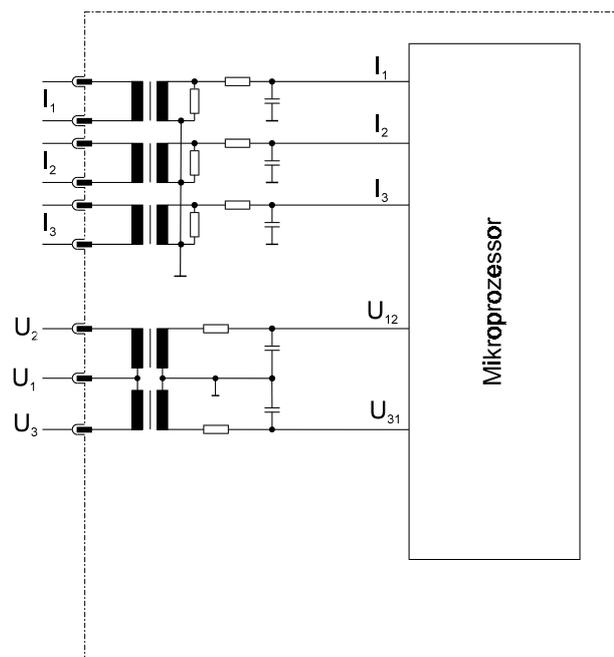
Figure 4.1:   Block diagram

4.2   Digital circuits

The essential part of the *MRI1-IU* 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 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".

selection of current transformers. It implies that, if an electromechanical relay is replaced by *MRI1*, a high accuracy limit factor is automatically obtained by using the same current transformer.

4.3   Voltage controlled tripping characteristic

The voltage controlled time overcurrent relay MRI1-IU is the combination of a time overcurrent relay (basic unit MRI1) and an additional undervoltage supervision unit.

The undervoltage supervision unit has an influence on the tripping delay of the overcurrent and short-circuit steps by switching two setting points. In normal operation (at nominal voltage) the MRI1-IU operates like a normal time overcurrent relay with preselected tripping characteristic (IDMT, DMT) and adjusted pick up value IS.

The following diagram explains the switching-over to another IS value. ISN is the pickup value during normal operation and ISL at undervoltage (low voltage).

Switching-over at undervoltage (Example ISL = 0.5)
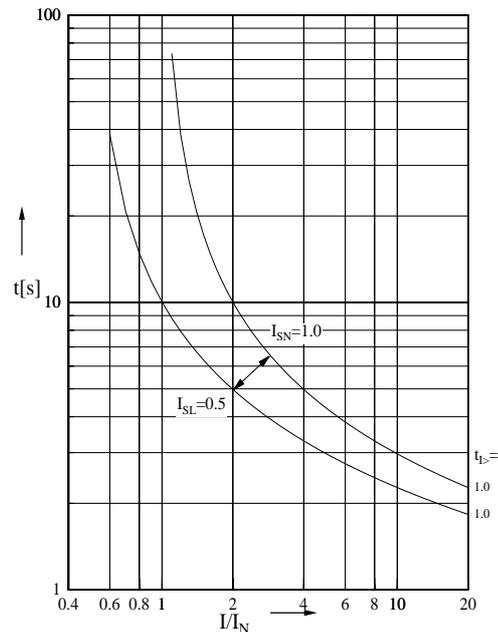
In case of failure (short-circuit of the alternator) the alternator voltage decreases. The *MRI1-IU* will recognise this and then switch over without delay to a lower pickup value IS. The value ISL can be adjusted. As a result, shorter tripping periods of the overcurrent and short-circuit step can be achieved. The adjusted tripping characteristics (normal inverse, very inverse, extremely inverse or DMT is maintained). Setting ranges see in 7.3.

4.4   Demand imposed on the main current transformers

The current transformers have to be rated in such a way, that a saturation should not occur within the following operating current ranges:

Independent time overcurrent function: K1 = 2
Inverse time overcurrent function: K1 = 20
High-set function: K1 = 1.2 - 1.5
K1 = Current factor related to set value

Moreover, the current transformers have to be rated according to the maximum expected short circuit current in the network or in the protected objects.
The low power consumption in the current circuit of *MRI1*, namely <0,2 VA, has a positive effect on the selection of current transformers. It implies that, if an electromechanical relay is replaced by *MRI1*, a high accuracy limit factor is automatically obtained by using the same current transformer.

5   Operation and setting

5.1   Display

Function	Display shows	Pressed push button	Corresponding LED
Normal operation	SEG		
Measured operating values: (I_{L1}, I_{L2}, I_{L3}, U_{12}, U_{23}, U_{31})	Actual measured values,	\<SELECT/RESET\> one time for each	L1, L2, L3, U
Measuring range overflow	max.	\<SELECT/RESET\>	L1, L2, L3, U
Setting values: phase (I\>; CHAR I\>; $t_{I>}$; I\>\>; $t_{I>>}$)	Current settings Trip delay characteristics	\<SELECT/RESET\> one time for each parameter	I \>; CHAR I\>; $t_{I>}$; I\>\>; $t_{I>>}$; LED →←
voltage	Voltage switch value	\<SELECT/RESET\>\<+\>\<-\>	U
Reset setting (only available at inverse time characteristics)	0s / 60s	\<SELECT/RESET\> \<+\>\<-\>	I\>; CHAR I\>; $t_{I>}$
Nominal frequency	f=50 / f=60	\<SELECT/RESET\>\<+\>\<-\>	
Blocking of function	EXIT	\<+\> until max. setting value	LED of blocked parameter
Slave address of serial interface	1 - 32	\<SELECT/RESET\>\<+\>\<-\>	RS
Recorded fault data:	Tripping currents and other fault data	\<SELECT/RESET\> one time for each phase	L1, L2, L3, U I\>, I\>\>
Save parameter?	SAV?	\<ENTER\>	
Save parameter!	SAV!	\<ENTER\> for about 3 s	
Software version	First part (e.g. D01-) Sec. part (e.g. 8.00)	\<TRIP\> one time for each part	
Manual trip	TRI?	\<TRIP\> three times	
Inquire password	PSW?	\<TRIP\>\<ENTER\>	
Relay tripped	TRIP	\<TRIP\>or after fault tripping	
Secret password input	XXXX	\<SELECT/RESET\> \<+\>\<-\>\<ENTER\>	
System reset	SEG	\<SELECT/RESET\> for about 3 s	

Table 5.1:   possible indication messages on the display

The table below shows how the display and LED´s indicate the set values of **MRI1-IU**

Set parameter	LED alight	Colour	Displays shows
Low set current at nominal voltage	I\>; U	I\> yellow, U green	x In
Low set current at low voltage	I\>; U	I\> yellow, U red	x In
Tripping characteristics	CHAR I\>	Yellow	DEFT/NINV/ VINV/EINV
Time delay tI\>	tI\>	Yellow	seconds
Time multiplier at inverse time characteristics	tI\>	Yellow	time multiplier
High set current at nominal voltage	I\>\>; U	I\>\> Yellow, U green	x In
High set current at low voltage	I\>\>; U	I\>\> yellow, U red	x In
Time delay	tI\>\>	Yellow	seconds
Undervoltage setting	U	red	volt
Rated frequency			f = 50 / f = 60
Slave address	RS	yellow	1 -32

Table 5.2: Indicated set values

5.2 Setting procedure

After push button <SELECT/RESET> has been pressed, always the next measuring value is indicated. Firstly the operating measuring values are indicated and then the setting parameters. By pressing the <ENTER> push button the setting values can directly be called up and changed.

5.2.1 Current setting values for overcurrent relay (I_{SN} und I_{SL})

When adjusting the setting values I_{SN} (during normal operation) and ISL (during undervoltage) the values shown on the display are related to the nominal current I_N.

This means:
Pickup current (I_{SN}) = displayed value x rated current (I_N)

e.g. if displayed value = 1.25, then Is = 1.25 x IN.

The pickup of the relay is indicated by the flashing LED I>. LED U flashes red.
The pickup value ISL is also indicated by the flashing LED I>. LED U however flashes red.

5.2.2 Time current characteristics for phase overcurrent element (CHAR I>)

By setting this parameter, one of the following 4 messages appears on the display:

DEFT - Definite Time
NINV - Normal Inverse
VINV - Very Inverse
EINV - Extremely Inverse

Anyone of these four characteristics can be chosen by using <+> <->-push buttons, and can be stored by using <ENTER>-push button.

5.2.3 Trip delay or time multiplier for phase overcurrent element ($t_{I>}$)

Usually, after the characteristic is changed, the time delay or the time multiplier should be changed accordingly. In order to avoid an unsuitable arrangement of relay modes due to carelessness of the operator, the following precautions are taken:

After the characteristic setting, the setting process turns to the time delay setting automatically. The LED tI> is going to flash yellow to remind the operator to change the time delay setting accordingly. After pressing the <SELECT>-push button, the present time delay setting value is shown on the display. The new setting value can then be changed by using <+> <-> -push buttons.

If, through a new setting, another relay characteristic other than the old one has been chosen (e.g. from DEFT to NINV), but the time delay setting has not been changed despite the warning from the flashing LED, the relay will be set to the most sensitive time setting value of the selected characteristics after five minutes warning of flashing LED tI>. The most sensitive time setting value means the fastest tripping for the selected relay characteristic.

5.2.4 Reset setting for inverse time tripping characteristics in the phase current path

To ensure tripping, even with recurring fault pulses shorter than the set trip delay, the reset mode for inverse time tripping characteristics can be switched over. If the adjustment tRST is set at 60s, the tripping time is only reset after 60s faultless condition. This function is not available if tRST is set to 0. With fault current cease the trip delay is reset immediately and started again at recurring fault current.

5.2.5 Current setting for high set element (I>>N und I>>L)

The current setting value of this parameter appearing on the display is related to the nominal current of the relay

This means: I>> = displayed value x I_N.

The response value I>>N is indicated by flashing the LED I>>. LED U flashes green.
The response value I>>L is also indicated by flashing the LED I>>. LED U however flashes red.

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.

The high set element can be blocked via terminals E8/D8 if the corresponding blocking parameter is set to bloc.

5.2.6 Trip delay for high set element ($t_{I>>}$)

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.

5.2.7 Undervoltage set reference value

When adjusting the undervoltage switching point a value in volt is shown on the display.
The LED U flashes red during the setting.

5.2.8 Nominal frequency

The adapted FFT-algorithm requires the nominal frequency as a parameter for correct digital sampling and filtering of the input currents.

By pressing <SELECT> the display shows "f=50" or "f=60". The desired nominal frequency can be adjusted by <+> or <-> and then stored with <ENTER>.

5.2.9 Adjustment of the slave address

Pressing push buttons <+> and <-> the slave address can be set in range of 1-32.

5.2.10 Blocking the protection functions and assignment of the output relays

Blocking the protection functions:

The blocking function of the **MRI1-IU** can be set according to requirement. By applying the aux. voltage to D8/E8, the functions chosen by the user are blocked. Setting of the parameter should be done as follows:

- When pressing push buttons <ENTER> and <TRIP> at the same time, message "BLOC" is displayed (i.e. the respective function is blocked) or "NO_B" (i.e. the respective function is not blocked). The LED allocated to the first protection function I> lights red.
- By pressing push buttons <+> <-> the value displayed can be changed.
- The changed value is stored by pressing <ENTER> and entering the password.
- By pressing the <SELECT/RESET> push button, any further protection function which can be blocked is displayed.
- Thereafter the blocking menu is left by pressing <SELECT/RESET> again.

Function		Display	LED/Colour
I>	Overcurrent (Low set)	NO_B	I> yellow
I>>	Overcurrent (High set)	BLOC	I>> yellow

Table 5.3: Default settings of blocking functions

Assignment of the output relays:

The relay 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>>, are two-coloured and light up **green** when the output relays are assigned as **alarm relays** and **red** as **tripping relays**.

Definition:

Alarm relays are activated at pickup.

Tripping relays are only activated after elapse of the tripping delay.

After the assignment mode has been activated, first LED I> lights up green. Now one or several of the four output relays can be assigned to current element I> as alarm relays. At the same time the selected alarm relays for frequency element 1 are indicated on the display. Indication "1_ _ _" means that output relay 1 is assigned to this current element. When the display shows "_ _ _ _", no alarm relay is assigned to this current element. The assignment of output relays 1 - 4 to the current elements can be changed by pressing <+> and <-> push buttons. The selected assignment can be stored by pressing push button <ENTER> and subsequent input of the password. By pressing push button <SELECT/RESET>, LED I> lights up red. The output relays can now be assigned to this current element as tripping relays.

Relays 1 - 4 are selected in the same way as described before. By repeatedly pressing of the <SELECT/RESET> push button and assignment of the relays all elements can be assigned separately to the relays. The assignment mode can be terminated at any time by pressing the <SELECT/RESET> push button for some time (abt. 3 s).

Note:

- The function of jumper J2 described in general description "MR Digital Multifunctional Relays" has no function. For relays without assignment mode this jumper is used for parameter setting of alarm relays (activation at pickup or tripping).
- 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.

Relay function		Output relays				Display-indication	Lighted LED
		1	2	3	4		
I>	alarm		X			_ 2 _ _	I>: green
	tripping	X				1 _ _ _	$t_{I>}$: red
I>>	alarm			X		_ _ 3 _	I>>: green
	tripping	X				1 _ _ _	$t_{I>>}$: red

Table 5.4: Example of assignment matrix of the output relay (default settings).

5.3 Indication of measuring values and fault data

5.3.1 Indication of measuring values

The following measuring quantities can be indicated on the display during normal service:
- Apparent current in phase 1 (LED L1 green)
- Apparent current in phase 2 (LED L2 green)
- Apparent current in phase 3 (LED L3 green)
- Phase to phase voltage U12 (LED L1, L2, U green)
- Phase to phase voltage U23 (LED L1, L3, U green)
- Phase to phase voltage U31 (LED L1, L3, U green)

5.3.2 Indication of fault data

All of the faults detected by the relay are indicated on the front panel optically. The three phase LEDs L1, L2, L3, the undervoltage LED U and the two function LEDs I>, I>> are used to indicate the fault events.

At the time when a certain relay function is energised by a fault, the corresponding function LED lights up yellow. At the same time, the phase LED(s) is (are) flashing red to indicate the faulty phase(s).

After the time delay is expired, the relay tripps, the LED(s) for faulty phase(s) indication turn(s) to a steady red light.

5.4 Reset

Unit **MRI1-IU** has the following three possibilities to reset the display of the unit as well as the output relay at jumper position J3=ON.

Manual Reset
- Pressing the push button <SELECT/RESET> for some time (about 3 s)

Electrical Reset
- Through applying auxiliary voltage to C8/D8

Software Reset
- The software reset has the same effect as the <SELECT/RESET> push button (see also communication protocol of RS485 interface).

The display can only be reset when the pickup is not present anymore (otherwise "TRIP" remains in display).

During resetting of the display the parameters are not affected.

6 Relay testing and commissioning

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

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

6.1 Power-On

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

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

6.2 Testing the output relays and LEDs

NOTE!
Prior to commencing this test, interrupt the trip circuit to the circuit breaker if tripping is not desired.
By pressing the push button <TRIP> once, the display shows the first part of the software version of the relay (e.g. „D08-"). By pressing the push button <TRIP> twice, the display shows the second part of the software version of the relay (e.g. „4.01"). The software version should be quoted in all correspondence. Pressing the <TRIP> button once more, the display shows "PSW?". Please enter the correct password to proceed with the test. The message "TRI?" will follow. Confirm this message by pressing the push button <TRIP> again. All output relays and LEDs should then be activated and the self supervision alarm relay (watchdog) be deactivated one after another with a time interval of
3 second. Thereafter, reset all output relays back to their normal positions by pressing the push button <SELECT/RESET> (about 3 s).

6.3 Checking the set values

By repeatedly pressing the push button <SELECT>, all relay set values may be checked. Set value modification can be done with the push button <+><-> and <ENTER>. For detailed information about that, please refer to chapter 5.
For a correct relay operation, be sure that the frequency set value (f=50/60) has been selected according to your system frequency (50 or 60 Hz).

6.4 Secondary injection test

6.4.1 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 $\geq 4 \times In$)
- Three-phase voltage supply unit (adjustable from 0 to $\geq 1.2 \times Un$)
- Timer to measure the operating time (Accuracy class $\leq \pm 10$ ms)
- Switching device
- Test leads and tools

6.4.2 Example of test circuit for *MRI1-IU* relays without directional feature

For testing *MRI1-IU* relays current and voltage input signals are required. Figure 6.1 shows an example of a test circuit connected to the *MRI1-IU* relay under test. For testing relays with voltage controlled feature, three phase voltages from a variable voltage source should be applied to the relay with a V-connection as shown in the diagram.

The three phase voltage should be adjustable within the effective operating range of the undervoltage element and have a phase relationship apart from 120°. The current inputs could be single or three phase.


1. Einstellbare Spannungsquelle
   Variable voltage source
2. Einstellbare Spannungsquelle 3-phasig
   Variable three-phase voltage source
3. Schaltgerät
   Switching device
4. Serienwiderstand
   Series resistor
5. Voltmeter
6. Amperemeter
   Ammeter
7. Zeitgeber
   Timer
8. zu testendes Relais
   Relay under test
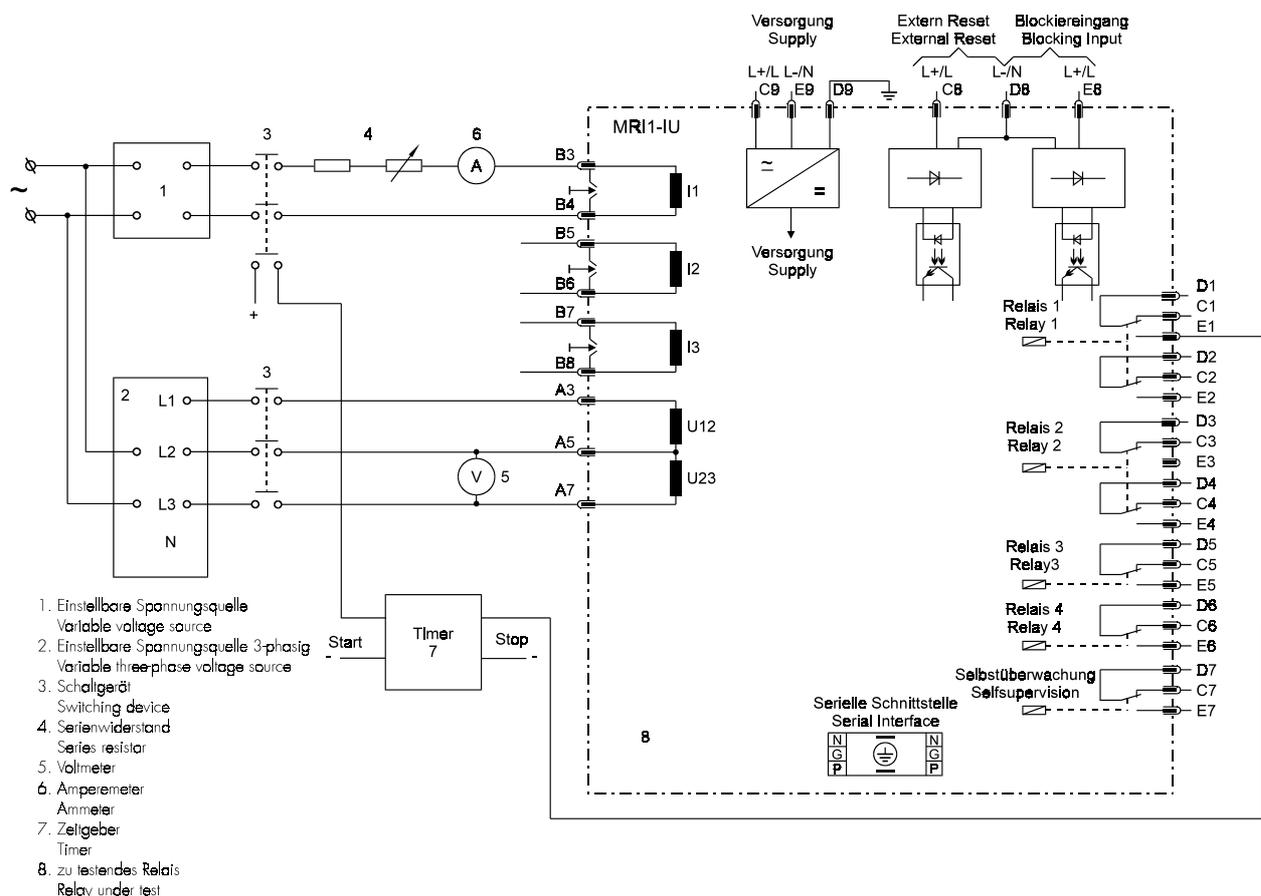
Figure 6.1:   Test curcuit

6.4.3 Checking the input circuits and measured values

Apply three phase rated voltage (e.g. 100 V phase to phase) to the voltage input circuits (terminals A3, A5, A7) and 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/RESET>. 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). The voltage will be indicated on the display in volts. 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 and voltage value with the reading of the ammeter and voltmeter. The deviation must not exceed 3%. By using an RMS-metering instrument, a greater deviation may be observed if the test current contains harmonics. Because the *MRI1-IU* 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.

6.4.4 Checking the operating and resetting values of the relay under normal and low voltage

Apply three phase voltages 5% above the undervoltage set value and inject a current which is less than the relay low set current at low voltage condition in phase 1 of the relay. 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 5% of the pickup current at nominal voltage condition.
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.
Apply three phase voltages 5% below the undervoltage set value. Do the same test as above mentioned and check the relay operating current value and resetting value at low voltage condition.
Repeat the test on phase 2, phase 3 in the same manner.

6.4.5 Checking the relay operating time

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.

6.4.6 Checking the high set element of the relay

Set a current above the set operating value of I>>. Inject the current instantaneously and check that the alarm output relay I>> (contact terminals D5/E5) operates. Check the tripping time of the high set element according chapter 6.4.5.

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

Repeat the entire test on other phases 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 7.1).

6.4.7 Checking the external blocking and reset functions

The external blocking input inhibits e. g. the function of the high set element of the phase current. To test the blocking function apply auxiliary supply voltage to the external blocking input of the relay (terminals E8/D8). The time delay $t_{I>}$ 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 and alarm for the high 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.

6.5   Primary injection test

Generally, a primary injection test could be carried out in the similar manner as the secondary injection test described above. With the difference that the protected power system should be, in this case, connected to the installed relays under test „on line", and the test currents and voltages should be injected to the relay through the current and voltage transformers with the primary side energised. Since the cost and potential hazards are very high for such a test, primary injection tests are usually limited to very important protective relays in the power system.

Because of its powerful combined indicating and measuring functions, the *MRI1-IU* relay may be tested in the manner of a primary injection test without extra expenditure and time consumption.
In actual service, for example, the measured current values on the *MRI1-IU* relay display may be compared phase by phase with the current indications of the ammeter of the switchboard to verify that the relay works and measures correctly.

6.6   Maintenance

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

For electromechanical or static relays, maintenance testing will be performed at least once a year according to the experiences. For digital relays like *MRI1*, this interval can be substantially longer. This is because:

- the *MRI1-IU* relays are equipped with very wide self-supervision functions, so that many faults in the relay can be detected and signalised during service. Important: The self-supervision output relay must be connected to a central alarm panel!
- the combined measuring functions of *MRI1-IU* relays enable supervision the relay functions during service.
- the combined TRIP test function of the *MRI1-IU* relay allows to test the relay output circuits.

A testing interval of two years for maintenance will, therefore, be recommended.
During a maintenance test, the relay functions including the operating values and relay tripping characteristics as well as the operating times should be tested.

7 Technical data

7.1 Measuring input circuits

Rated data:	Nominal current I_N	1A or 5A
	Nominal voltage U_N	100 V, 230 V, 400 V
	Nominal frequency f_N	50 Hz; 60 Hz adjustable
Power consumption in current circuit:	at I_N = 1 A	0.2 VA
	at I_N = 5 A	0.1 VA
Power consumption in voltage circuit:	< 1 VA	
Thermal withstand capability in current circuit:	dynamic current withstand	
	(half-wave)	$250 \times I_N$
	for 1 s	$100 \times I_N$
	for 10 s	$30 \times I_N$
	continuously	$4 \times I_N$
Thermal withstand in voltage circuit:	continuously	$1.5 \times U_N$

7.2 Common data

Dropout to pickup ratio:	> 97 %
Returning time:	30 ms
Time lag error class index E:	± 10 ms
Minimum operating time:	30 ms
Transient overreach at instantaneous operation:	≤ 5 %

7.3 Setting ranges and steps

7.3.1 Definite time overcurrent protection relay

	Setting range	Step	Tolerance
I_{SN}; I_{SL}	0.2...4.0 x I_N	0.05; 0.1 x I_N	±3 % from set value or min. ±1 % In
tI>	0.03 - 260 s	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0 s	±3 % or ±10 ms
$I_{>>N}$ $I_{>>L}$	1...40 x I_N	0.1; 0.2; 0.5; 1.0 x I_N	±3 % from set value or min. ±1 % In
$t_{I>>}$	0.03...2 s	0.01 s; 0.02 s; 0.05 s	±3 % or ±10 ms
U	U_N = 100 V: 10 - 110 V U_N = 230 V: 20 - 250 V U_N = 400 V: 40 - 440 V	5 V 10 V 20 V	±5 % from set value

7.3.2 Inverse time overcurrent protection relay

According to IEC 255-4 or BS 142

Normal Inverse
$$t = \frac{0{,}14}{\left(\dfrac{I}{Is}\right)^{0{,}02} - 1} \, t_{I>} \; [s]$$

Very Inverse
$$t = \frac{13{,}5}{\left(\dfrac{I}{Is}\right) - 1} \, t_{I>} \; [s]$$

Extremely Inverse
$$t = \frac{80}{\left(\dfrac{I}{Is}\right)^{2} - 1} \, t_{I>} \; [s]$$

Where: t = tripping time
$t_{I>}$ = time multiplier
I = fault current
Is = Starting current

	Setting range	Step	Tolerance
I_{SN}; I_{SL}	0.2...4.0 x I_N	0.05; 0.1 x I_N	±3 % from set value or min. ±1 % In
tI>	0.05 - 10	0.01; 0.02	±5 % for NINV and VINV ±7.5 % for NINV and EINV
$I_{>>N}$ $I_{>>L}$	1...40 x I_N	0.1; 0.2; 0.5; 1.0 x I_N	±3 % from set value or min. ±1 % In
$t_{I>>}$	0.03...2 s	0.01 s; 0.02 s; 0.05 s	±3 % or ±10 ms
U	U_N = 100 V: 10 - 110 V U_N = 230 V: 20 - 250 V U_N = 400 V: 40 - 440 V	5 V 10 V 20 V	±5 % from set value

7.4   Inverse time characteristics
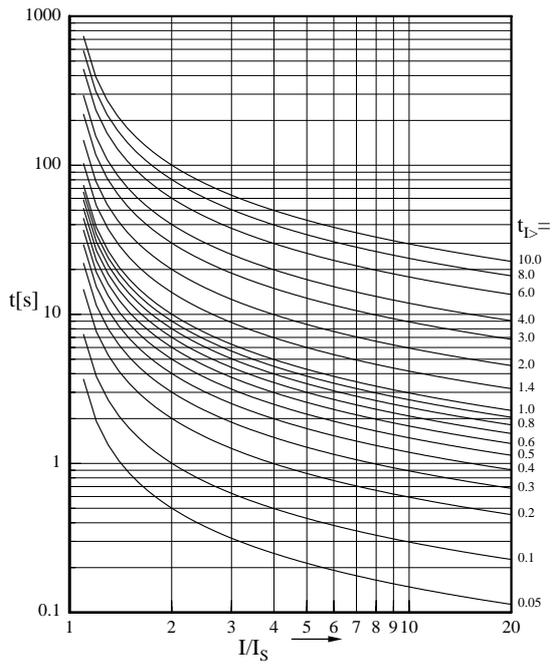
Figure 7.1:   Normal Inverse
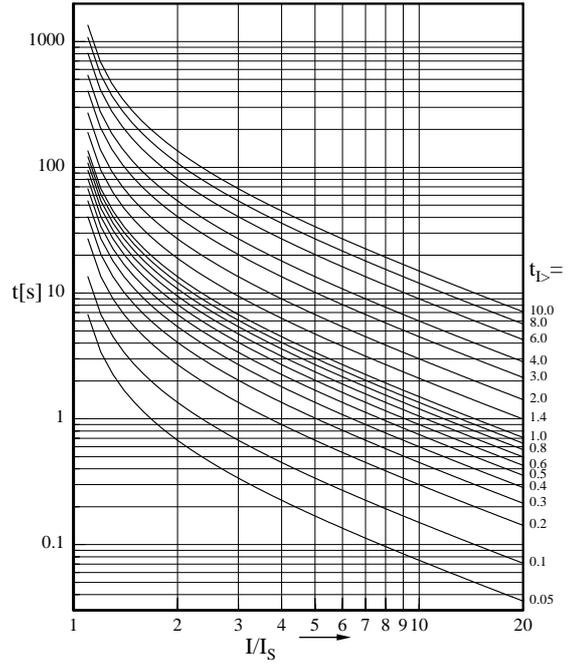
Figure 7.3:   Very Inverse
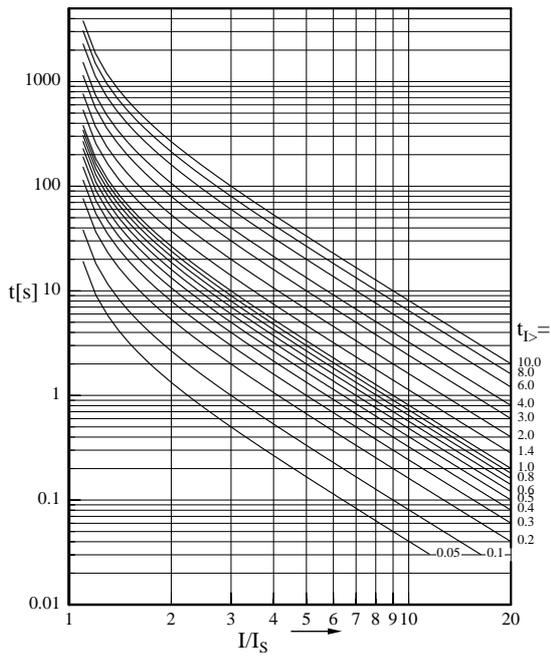
Figure 7.2:   Extremely Inverse
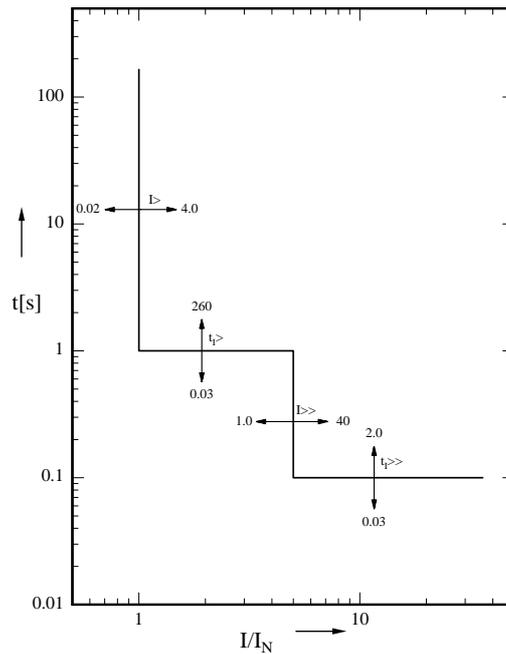
Figure 7.4   Definite time overcurrent relay

7.5   Output contacts

Number of relays: dependent on relay type
Contacts: 2 change-over contacts for trip relay
                                 1 change-over contact for alarm relays

Technical data subject to change without notice!

8 Order form

Voltage controlled time overcurrent relay		*MRI1-*			
3-phase current I>, I>> Rated current	1 A 5 A	**I1** **I5**			
Voltage dependent tripping characteristic Rated voltage	100 V 230 V 400 V		**U1** **U2** **U4**		
Housing (12TE)	19"-rack Flush mounting			**A** **D**	

Setting of code jumpers

Code jumper	J1		J2		J3	
	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting
Plugged			no function			
Not plugged	X				X	

Assignment of the output relays:

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> alarm			X					
I> tripping	X							
I>> alarm					X			
I>> tripping	X							

Assignment of the blocking function:

	Default setting		Actual setting	
Function	Blocking	Not blocking	Blocking	Not blocking
I>		X		
I>>	X			

Setting list *MRI1*

Note !
All settings must be checked at site and should the occasion arise, adjusted to the object/item to be protected.

Project: _____   SEG job.-no.: _____

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

Relay functions: _____ Password: _____

Date: _____

Setting of the parameters

Function		Unit	Default settings	Actual settings
$I>S_{Normal}$	Low set current at nominal voltage	x In	0.2	
$I>S_{Low}$	Low set current at low voltage	x In	0.2	
CHAR I>	Tripping characteristics		DEFT	
tI>	Time delay at independent time	s	0.03	
tI>	Time multiflier at dependent time characteristics			
tI> Reset	Reset Modus for dependent time characteristics			
$I>>S_{Normal}$	High set current at nominal voltage	x In	1.0	
$I>>S_{Low}$	High set current at low voltage	x In	1.0	
tI>>	Time delay	s	0.03	
U	Threshold value for undervoltage setting	V	10V/20V/40V *	
	Rated frequency	Hz	50	
RS	Slave address		1	

All settings must be checked at site and should the occarision arise, adjusted to the object/item to be protected.

* thresholds dependent on rated voltage 100 V / 230 V / 400 V

HighTECH Line

https://docs.SEGelectronics.de/mri1_iu
https://docs.SEGelectronics.de/mr

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