

# Overcurrent and Earth-Fault Relay REJ 525

## Technical Reference Manual





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## **1. About this manual**

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### **1.4. General**

The purpose of this manual is to provide the user with thorough information on the protection relay REJ 525 and its applications, focusing on giving a technical description of the relay.

Refer to the Operator's Manual for instructions on how to use the Human-Machine Interface (HMI) of the relay, also known as the Man-Machine Interface (MMI), and to the Installation Manual for installation of the relay.

## 1.5. Use of symbols

This document includes warning, caution, and information icons that point out safety-related conditions or other important information. The corresponding icons should be interpreted as follows:



The electrical warning icon indicates the presence of a hazard which could result in electrical shock.



The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.



The information icon alerts the reader to relevant facts and conditions.

Although warning hazards are related to personal injury, and caution hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

## 1.6. Terminology

The following is a list of terms that you should be familiar with. The list contains terms that are unique to ABB or have a usage or definition that is different from standard industry usage.

Term	Description
IEC_103	IEC 60870-5-103, a communication protocol standardized by the International Electrotechnical Commission
SPA	A data communication protocol developed by ABB



## 1.7. Related documents

Name of the manual	MRS number
REJ 525 Operator's Manual	1MRS752137-MUM
RE_5__ Installation Manual	1MRS750526-MUM

## 1.8. Document revisions

Version	Date	History
C	23.03.2004	
D	14.11.2005	Relay face plate updated. Manual layout updated.

## 2. Safety Information

	Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.
	Non-observance can result in death, personal injury or substantial property damage.
	Only a competent electrician is allowed to carry out the electrical installation.
	National and local electrical safety regulations must always be followed.
	The frame of the device has to be carefully earthed.
	The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.
	Breaking the sealing tape on the rear panel of the device will result in loss of warranty and proper operation will no longer be guaranteed.



## 3. Introduction

### 3.1. Use of the relay

The combined overcurrent and earth-fault relay REJ 525 is intended for selective short-circuit protection and non-directional earth-fault protection in medium voltage distribution networks but can also be used for protection of generators, motors and transformers.

The REJ 525 is based on a microprocessor environment. A self-supervision system continuously monitors the operation of the relay.

The HMI includes a Liquid Crystal Display (LCD) which makes the local use of the relay safe and easy.

Local control of the relay via serial communication can be carried out with a portable computer connected to the front connector and remote control via the rear connector connected to the distribution automation system through the serial interface and the fibre-optic bus.

### 3.2. Features

- Three-phase low-set overcurrent stage with definite-time or inverse definite minimum time (IDMT) characteristic
- Three-phase high-set overcurrent stage with instantaneous or definite-time characteristic
- Phase discontinuity protection
- Low-set non-directional earth-fault stage with definite-time or IDMT characteristic
- High-set non-directional earth-fault stage with instantaneous or definite-time characteristic
- Circuit-breaker failure protection (CBFP)
- Disturbance recorder
  - recording time up to 10 seconds
  - triggering by a start or a trip signal from any protection stage and/or by a binary input signal
  - records four analogue channels and up to eight user-selectable digital channels
  - adjustable sampling rate
- Non-volatile memory for
  - up to 60 event codes
  - setting values
  - disturbance recorder data
  - recorded data of the five last events with time stamp
  - number of starts for each stage
  - alarm indication messages and LEDs showing the status at the moment of power failure
  - maximum pick-up currents

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- Four accurate current inputs
- Galvanically isolated binary input with a wide input voltage range
- All settings can be modified with a personal computer
- HMI with an alphanumeric LCD and manoeuvring buttons
- IEC 60870-5-103 and SPA bus communication protocols
- Two normally open power output contacts
- Two change-over signal output contacts
- Output contact functions freely configurable for desired operation
- Optical PC-connector for two-way data communication (front)
- RS-485 connector (rear) for system communication
- Continuous self-supervision of electronics and software. At an internal relay fault (IRF), all protection stages and outputs are blocked.
- User-selectable rated frequency 50/60 Hz
- User-selectable password protection for the HMI
- Display of primary current values
- Demand values
- Multi-language support

## 4. Instructions

### 4.1. Application

The combined overcurrent and earth-fault relay REJ 525 is a secondary relay which is connected to the current transformers of the object to be protected. The overcurrent and the earth-fault unit continuously measure the phase currents and the neutral current of the object. On detection of a fault, the relay will start, trip the circuit breaker, provide alarms, record fault data, etc., in accordance with the application and the configured relay functions.

The overcurrent unit includes low-set stage  $I_{>}$  and high-set stage  $I_{>>}$  and the earth-fault unit low-set stage  $I_{0>}$  and high-set stage  $I_{0>>}$ . If the high-set stage is given a setting value within the lower part of the setting range, the relay module will have two nearly identical stages. In this case, the relay can be used in two-stage load shedding applications.

The protection functions are independent of each other and have their own setting groups and data recordings. The overcurrent and earth-fault protection functions use conventional current transformer measurement.

An output contact matrix allows start or trip signals from the protection stages to be routed to the desired output contact.

### 4.2. Requirements

When the REJ 525 is operating under the conditions specified below (see also Technical data), it will be practically maintenance-free. The relay includes no parts or components subject to abnormal physical or electrical wear under normal operating conditions.

#### Environmental conditions

- |  |             |
|--|-------------|
| • Specified ambient service temperature range  | -10...+55°C |
| • Temperature influence on the operation accuracy of the protection relay within the specified ambient service temperature range | 0.1% / °C   |
| • Transport and storage temperature range  | -40...+70°C |

### 4.3. Configuration

#### Setting and connection examples

The appropriate configuration of the output contact matrix enables the use of the signals from the overcurrent and the earth-fault unit as contact functions. The start signals can be used for blocking co-operating protection relays, signalling and initiating autoreclosing.

Fig. 4.3.-1 and Fig. 4.3.-2 represent the REJ 525 with the default configuration: all trips are routed to trip the circuit breaker.





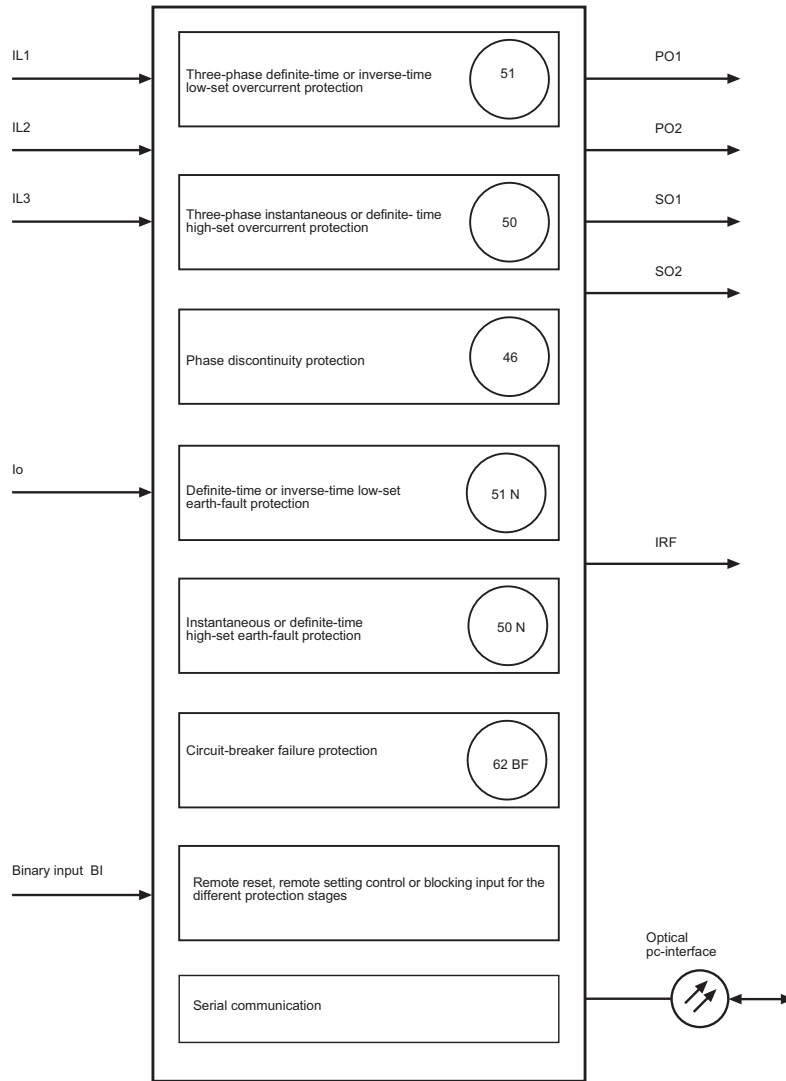


## 5. Technical description

### 5.1. Functional description

#### 5.1.1. Product functions

##### 5.1.1.1. Schema of product functions



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Fig. 5.1.1.1.-1 Product functions

#### 5.1.1.2. Overcurrent, phase discontinuity and earth-fault

Refer to sections:

- 5.1.4.1. “Overcurrent unit”
- 5.1.4.3. “Phase discontinuity protection unit”
- 5.1.4.4. “Earth-fault unit”

**5.1.1.3.****Inputs**

The REJ 525 includes four energizing inputs and one external binary input controlled by an external voltage. Three of the energizing inputs are for the phase currents and one for the earth-fault current. For details, refer to Section 5.2.1. Input/output connections and tables 5.1.4.6-7, 5.2.1-1 and 5.2.1-5. The function of the binary input is determined with the SGB switches.

**5.1.1.4.****Outputs**

The REJ 525 is provided with two power outputs (PO1 and PO2) and two signal outputs (SO1 and SO2). Switchgroups SGR1...10 are used for routing start and trip signals from the protection stages to the desired signal or power output. PO1 and PO2 can be configured to be latched and the minimum pulse length to 40 or 80 ms.

**5.1.1.5.****Circuit-breaker failure protection unit**

The REJ 525 features a circuit-breaker failure protection (CBFP) unit. The CBFP unit will generate a trip signal via output PO2 if the fault has not been cleared on expiration of the set operate time 0.10 s...1.00 s.

Normally, the CBFP unit controls the upstream circuit breaker. It can also be used for tripping via redundant trip circuits of the same circuit breaker. The CBFP unit is activated with a switch of switchgroup SGF1.

**5.1.1.6.****Disturbance recorder**

The REJ 525 includes an internal disturbance recorder which records the momentary measured values, or the RMS curves of the measured signals, and up to eight user-selectable digital signals: the external binary input signal and the states of the internal protection stages. The disturbance recorder can be set to be triggered by a start or a trip signal from any protection stage and/or by an external binary input signal, and either on the falling or rising triggering edge.

**5.1.1.7.****HMI module**

The HMI of the REJ 525 is equipped with six push-buttons and an alphanumeric 2x16 characters' LCD. The push-buttons are used for navigating in the menu structure and for adjusting set values.

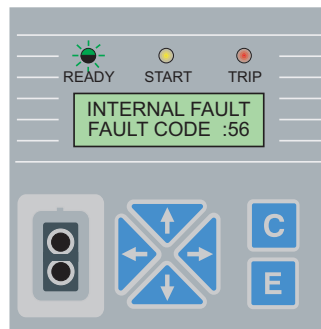
An HMI password can be set to protect all user-changeable values from being changed by an unauthorised person. The HMI password will remain inactive and will thus not be required for altering parameter values until the default HMI password has been replaced. Entering the HMI password successfully can be selected to generate an event code. This feature can be used to indicate interaction activities via the local HMI. For further information on the HMI, refer to the Operator's Manual.

### 5.1.1.8. Non-volatile memory

The REJ 525 can be configured to store various data in a non-volatile memory, which will retain its data also in case of loss of auxiliary voltage. Alarm indication messages and LEDs, the number of starts, disturbance recorder data, event codes and recorded data can all be configured to be stored in the non-volatile memory whereas setting values will always be stored.

### 5.1.1.9. Self-supervision

The self-supervision system of the REJ 525 manages run-time fault situations and informs the user about an existing fault. When the self-supervision system detects a permanent internal relay fault, the READY indicator LED will start to blink. At the same time the self-supervision alarm relay (also referred to as the IRF relay), which is normally picked up, will drop off and a fault code will appear on the LCD. The fault code is numerical and identifies the fault type. For fault codes, refer to section Internal fault in the Operator's Manual.



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Fig. 5.1.1.9.-1 Internal fault

Fault codes can indicate:

- no response on the output contact test
- faulty program, work or parameter memory
- internal reference voltage error

5.1.2. Measurements

The table below presents the measured values which can be accessed through the HMI, expressed as multiples of the rated voltage,  $I_n$ , of the energizing input.

Table 5.1.2-1 Measured values

Indicator	Measured data
L1	Phase current L1
L2	Phase current L2
L3	Phase current L3
$I_0$	Earth-fault current
$\Delta I$	Phase discontinuity value
$I_{1\_min}$	Average current of all three phases during one minute
$I_{n\_min}$	Average current during an adjustable time range
max I	Highest one-minute average current value during the previous time range

5.1.3. Configuration

The figure below illustrates how the start, trip and binary input signals can be configured to obtain the required protection functionality.

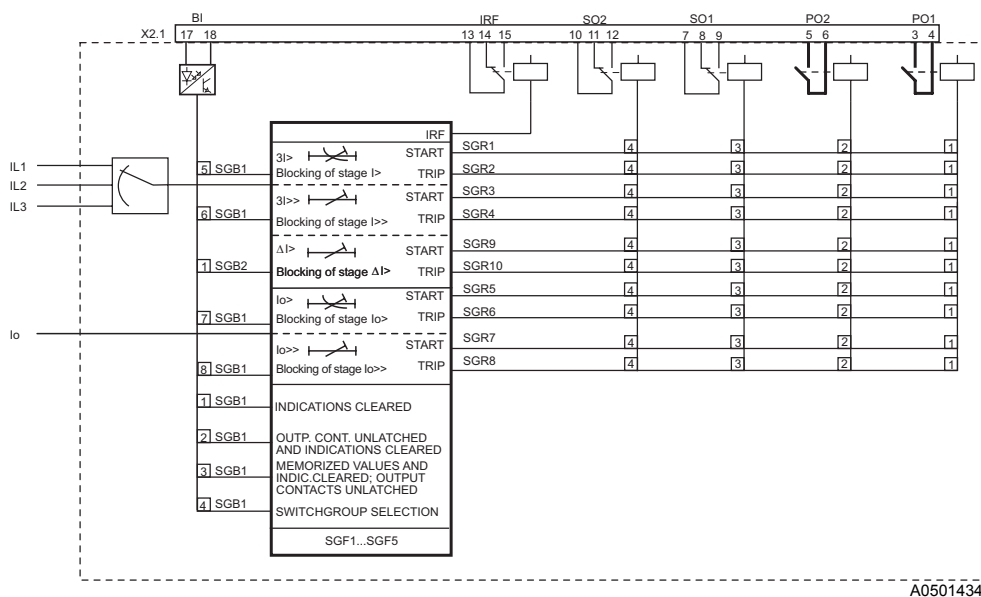
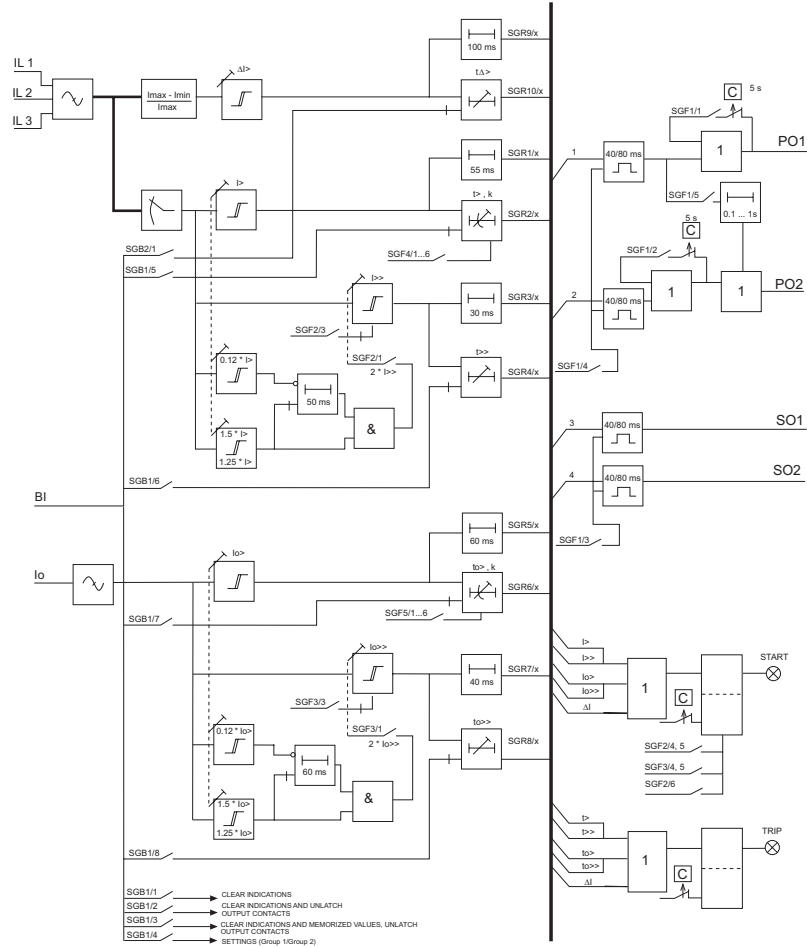


Fig. 5.1.3.-1 Signal diagram

The functions of the blocking and start signals are selected with the switches of switchgroups SGF, SGB and SGR. The checksums of the switchgroups are found under "SETTINGS" in the HMI menu. The functions of these switches are explained in detail in the corresponding SG\_-tables.

5.1.4. Protection

5.1.4.1. Block diagram



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Fig. 5.1.4.1.-1 Block diagram

5.1.4.2. Overcurrent unit

When the phase currents exceed the set start value of low-set stage  $I>$ , the overcurrent unit will start to deliver a start signal after a  $\sim 55$  ms' start time. When the set operate time at definite-time characteristic or the calculated operate time at IDMT characteristic elapses, the overcurrent unit will deliver a trip signal.

When the phase currents exceed the set start value of high-set stage  $I>>$ , the overcurrent unit will start to deliver a start signal after a  $\sim 30$  ms' start time. When the set operate time elapses, the overcurrent unit will deliver a trip signal.

It is possible to block the start and the tripping of an overcurrent stage by applying an external binary input signal to the relay.

The inverse-time function of stage  $I>$  can be set to be inhibited when stage  $I>>$  starts with a switch of switchgroup SGF2. In this case the operate time will be determined by stage  $I>>$ .

The high-set stage can be set out of operation. This state will be indicated by dashes on the LCD and by “999” when the set start value is read via serial communication.

The set start value of stage  $I_{>>}$ ,  $I_{>>}/I_n$ , can be automatically doubled in a start situation, e.g. when the object to be protected is connected to a distribution network. Thus a set start value below the connection inrush current level can be selected for stage  $I_{>>}$ . A start situation is defined as a situation where the phase current rises from a value below  $0.12 \times I_{>}$  to a value above  $1.5 \times I_{>}$  in less than 60 ms. The start situation ends when the current falls below  $1.25 \times I_{>}$ .

#### 5.1.4.3.

### Phase discontinuity protection unit

The phase discontinuity protection function monitors the minimum and maximum phase currents and calculates the difference between them. The difference between these currents is calculated as follows:

$$\Delta I = \frac{(I_{max} - I_{min})}{I_{max}} \times 100\%$$

The phase discontinuity protection stage will start when the current difference exceeds the start value,  $\Delta I$ , of the protection stage. Should the phase discontinuity situation last longer than the set operate time, the protection stage will deliver a trip signal which can be routed to the desired output contact. It is possible to block the start and the tripping of the protection stage by applying an external binary input signal to the relay. When the values of the measured currents fall below  $0.1 \times I_n$ , the function will no longer be in use.

The phase discontinuity function can be set out of operation. This state will be indicated by dashes on the LCD and “999” when the set start value is read via serial communication.

#### 5.1.4.4.

### Earth-fault unit

When the earth-fault current exceeds the set start value of low-set stage  $I_{0>}$ , the earth-fault unit will start to deliver a start signal after a  $\sim 60$  ms' start time. When the set operate time at definite-time characteristic or the calculated operate time at IDMT characteristic elapses, the earth-fault unit will deliver a trip signal.

When the earth fault current exceeds the set start value of high-set stage  $I_{0>>}$ , the earth-fault unit will start to deliver a start signal after a  $\sim 40$  ms' start time. When the set operate time elapses, the earth-fault unit will deliver a trip signal.

It is possible to block the start and the tripping of an earth-fault stage by applying an external binary input signal to the relay.

The inverse-time function of stage  $I_{0>}$  can be set to be inhibited when stage  $I_{0>>}$  starts with a switch of switchgroup SGF2. In this case the operate time will be determined by stage  $I_{0>>}$ .

The high-set stage can be set out of operation. This state will be indicated by dashes on the LCD and by “999” when the set start value is read via serial communication.

The set start value of stage  $I_{0>>}$ ,  $I_{0>>}/I_n$ , can be automatically doubled in a start situation, e.g. when the object to be protected is connected to a distribution network. Thus a set start value below the connection inrush current level can be selected for stage  $I_{0>>}$ . A start situation is defined as a situation where the earth-fault current rises from a value below  $0.12 \times I_{0>}$  to a value above  $1.5 \times I_{0>}$  in less than 60 ms. The start situation ends when the current falls below  $1.25 \times I_{0>}$ .

#### 5.1.4.5.

#### Time/current characteristics

The low-set overcurrent and earth-fault stages can be given a definite-time or an inverse definite minimum time (IDMT) characteristic whereas the high-set overcurrent and earth-fault stages feature the definite-time characteristic alone. The settings of switches SGF4/1...6 determine the operation mode of stage  $I_{>}$  whereas those of switches SGF5/1...6 determine that of stage  $I_{0>}$ . Refer to section Settings for additional information.

At IDMT characteristic, the operate time of the stage is dependent on the current value: the higher the current value, the shorter the operate time. Six time/current curve groups are available, of which four comply with the IEC 60255 standard: the normal inverse, very inverse, extremely inverse and long-time inverse. The two additional inverse-time curve groups, referred to as RI and RD, are special curve groups according to ABB praxis.

#### Characteristics according to the IEC 60255 standard

The relay module incorporates four internationally standardized time/current curve groups called extremely inverse, very inverse, normal inverse and long-time inverse. The relationship between time and current is in accordance with the IEC 60255-3 standard and can be expressed as follows:

$$t[s] = \frac{k \times \beta}{\left(\frac{I}{I_{>}}\right)^{\alpha} - 1}$$

where

t = operate time

k = time multiplier

I = phase current value

$I_{>}$  = set start value

**Table 5.1.4.5-1 The values of constants  $\alpha$  and  $\beta$**

Time/current curve group	$\alpha$	$\beta$
Normal inverse	0.02	0.14
Very inverse	1.0	13.5
Extremely inverse	2.0	80.0
Long-time inverse	1.0	120

According to the standard, the normal current range is 2...20 times the setting value at normal inverse, very inverse or extremely inverse characteristic. The relay is to start before the current exceeds the setting value by 1.3 times. At long-time inverse

characteristic, the normal current range is specified to be 2...7 times the setting value, and the relay is to start before the current exceeds the setting value by 1.1 times.

**Table 5.1.4.5-2 The operate time tolerances specified by the standard**

I/I>	Normal	Very	Extremely	Long time
2	2,22E	2,34E	2,44E	2,34E
5	1,13E	1,26E	1,48E	1,26E
7	-	-	-	1,00E
10	1,01E	1,01E	1,02E	-
20	1,00E	1,00E	1,00E	-

E = accuracy in percent; - = not specified

Within the normal current range the inverse-time stage fulfils the tolerance requirements of class 5 at all degrees of inversivity.

The time/current characteristics according to the IEC and BS standards are illustrated in Fig. 5.1.4.5.-1...Fig. 5.1.4.5.-4.



If the ratio between the current and the set start value is higher than 20, the operate time will be the same as when the ratio is 20.

### RI-type characteristic

The RI-type characteristic is a special characteristic which is principally used for obtaining time grading with mechanical relays. The characteristic can be expressed mathematically as follows:

$$t[s] = \frac{k}{0.339 - 0.236 \times \frac{I>}{I}}$$

where

t = operate time

k = time multiplier

I = phase current value

I> = set start value

The RI-type characteristic is illustrated in Fig. 5.1.4.5.-5.

**RD-type characteristic**

The RD-type characteristic is a special characteristic which is principally used in earth-fault protection and which requires a high degree of selectivity even at high resistance faults. The protection can operate in a selective way even if it is not directional. Mathematically, the time/current characteristic can be expressed as follows:

$$t[s] = 5.8 - 1.35 \times \log_e \left( \frac{I}{k \times I>} \right)$$

where

t = operate time

k = time multiplier

I = phase current value

I> = set start value

The RD-type characteristic is illustrated in Fig. 5.1.4.5.-6.

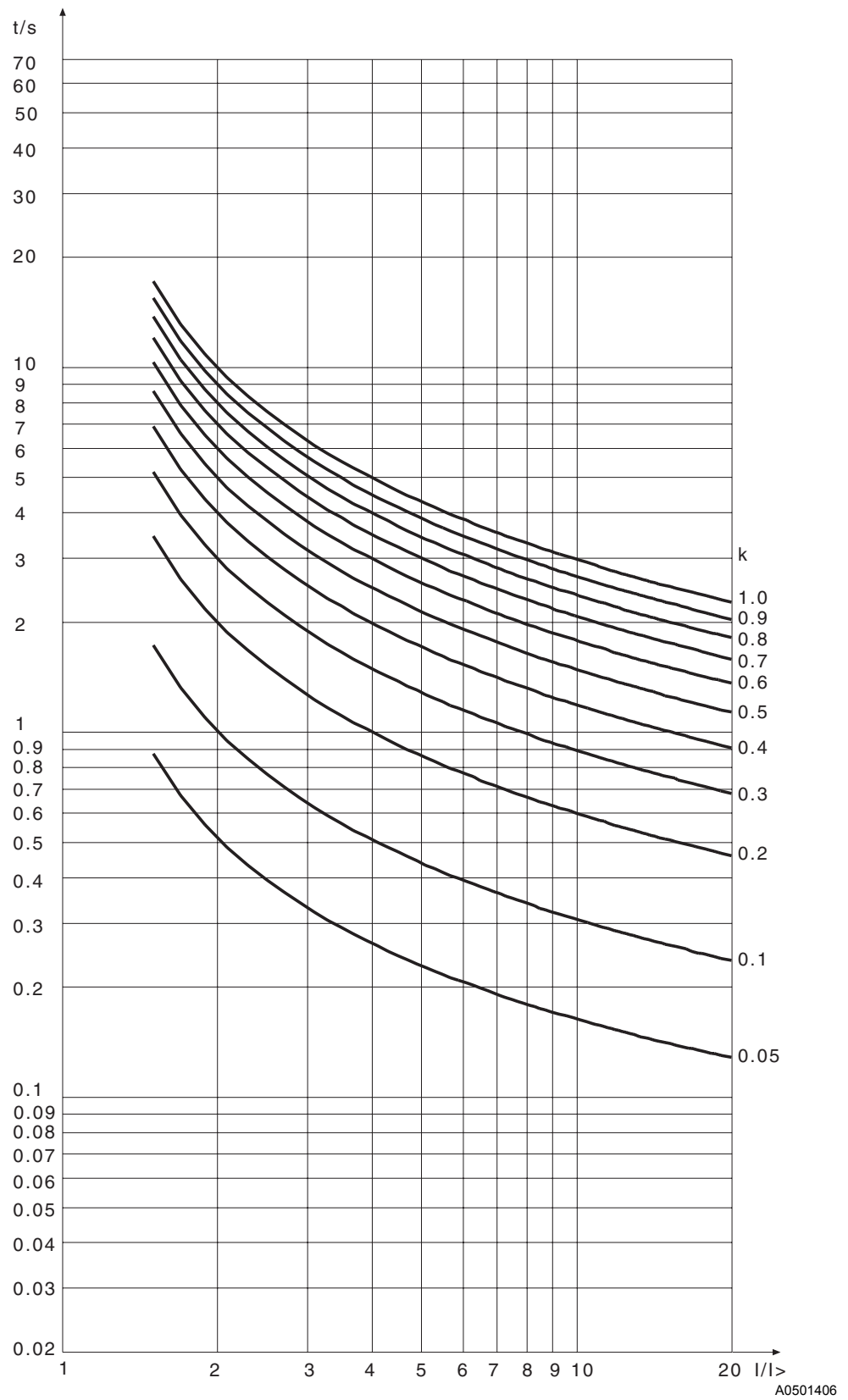
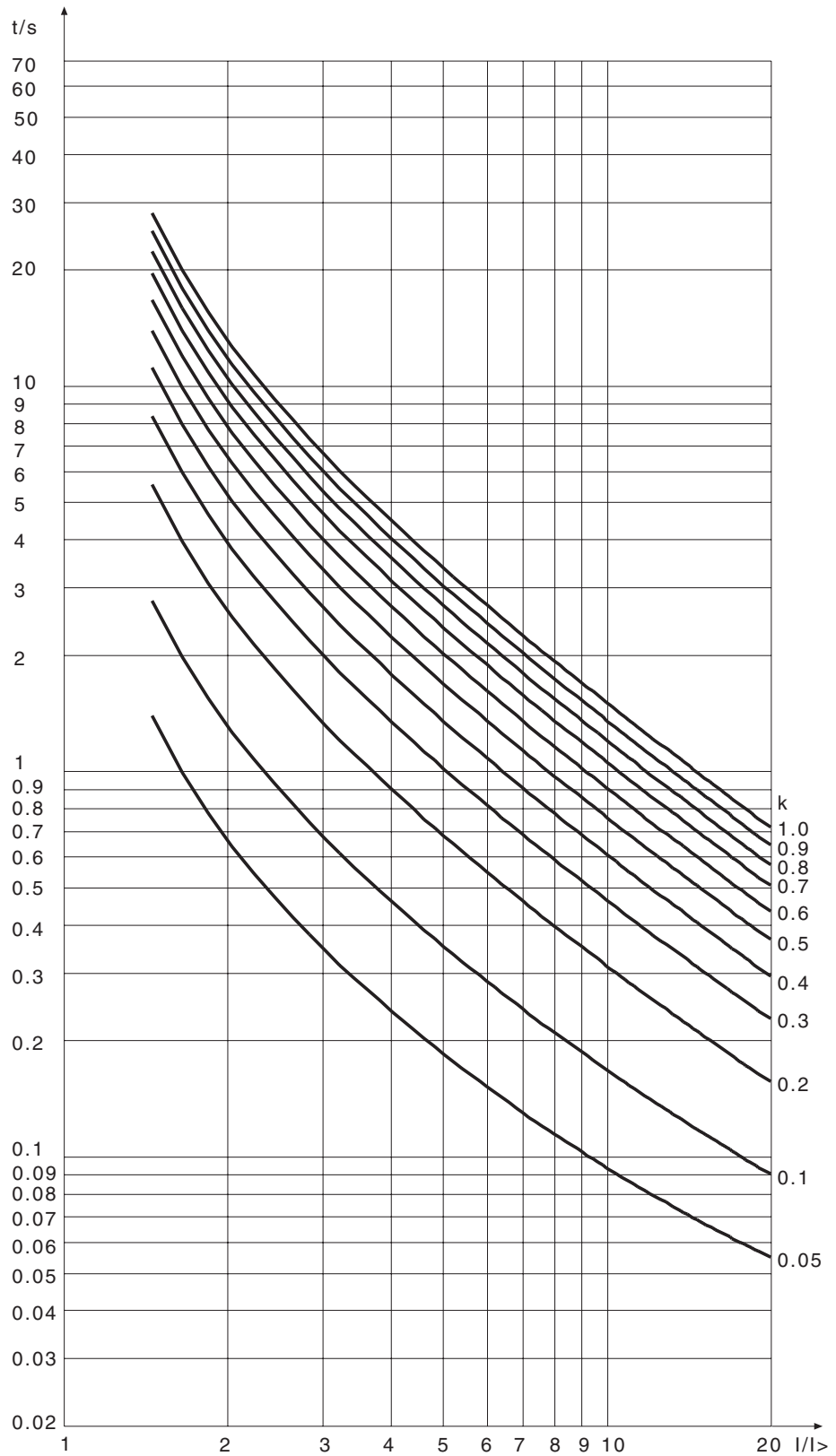


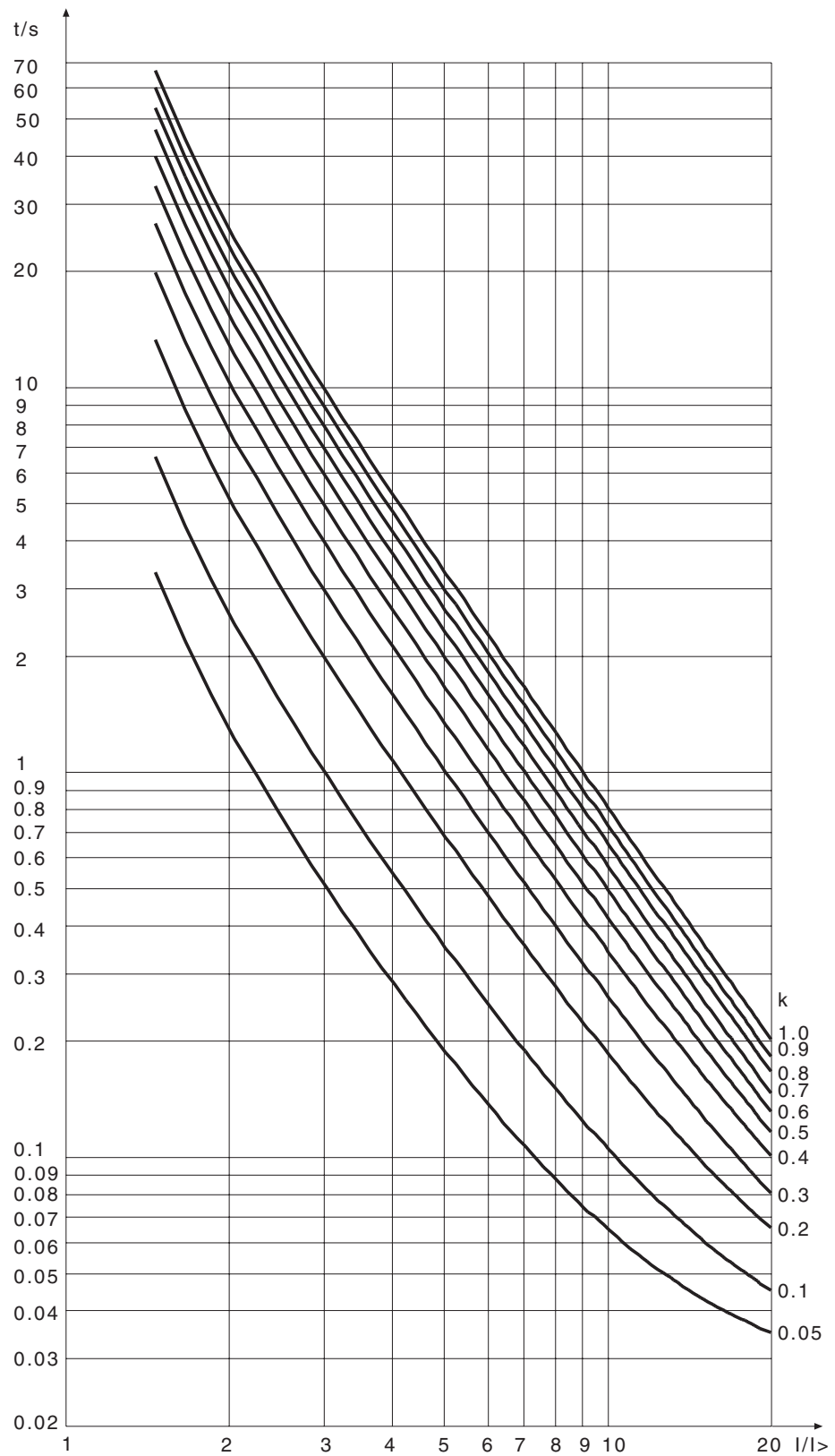
Fig. 5.1.4.5.-1 Normal inverse-time characteristic

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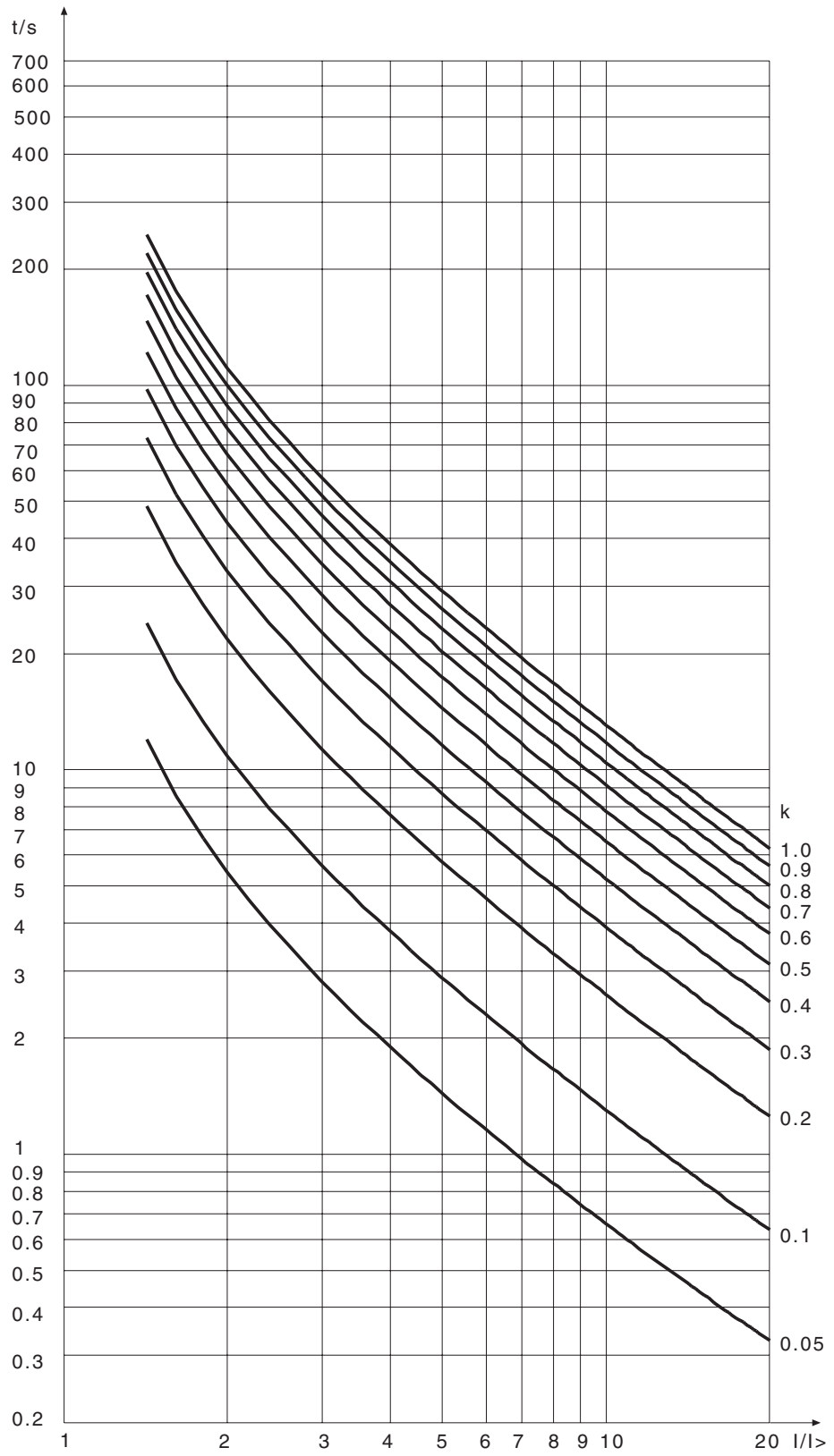
Fig. 5.1.4.5.-2 Very inverse-time characteristic



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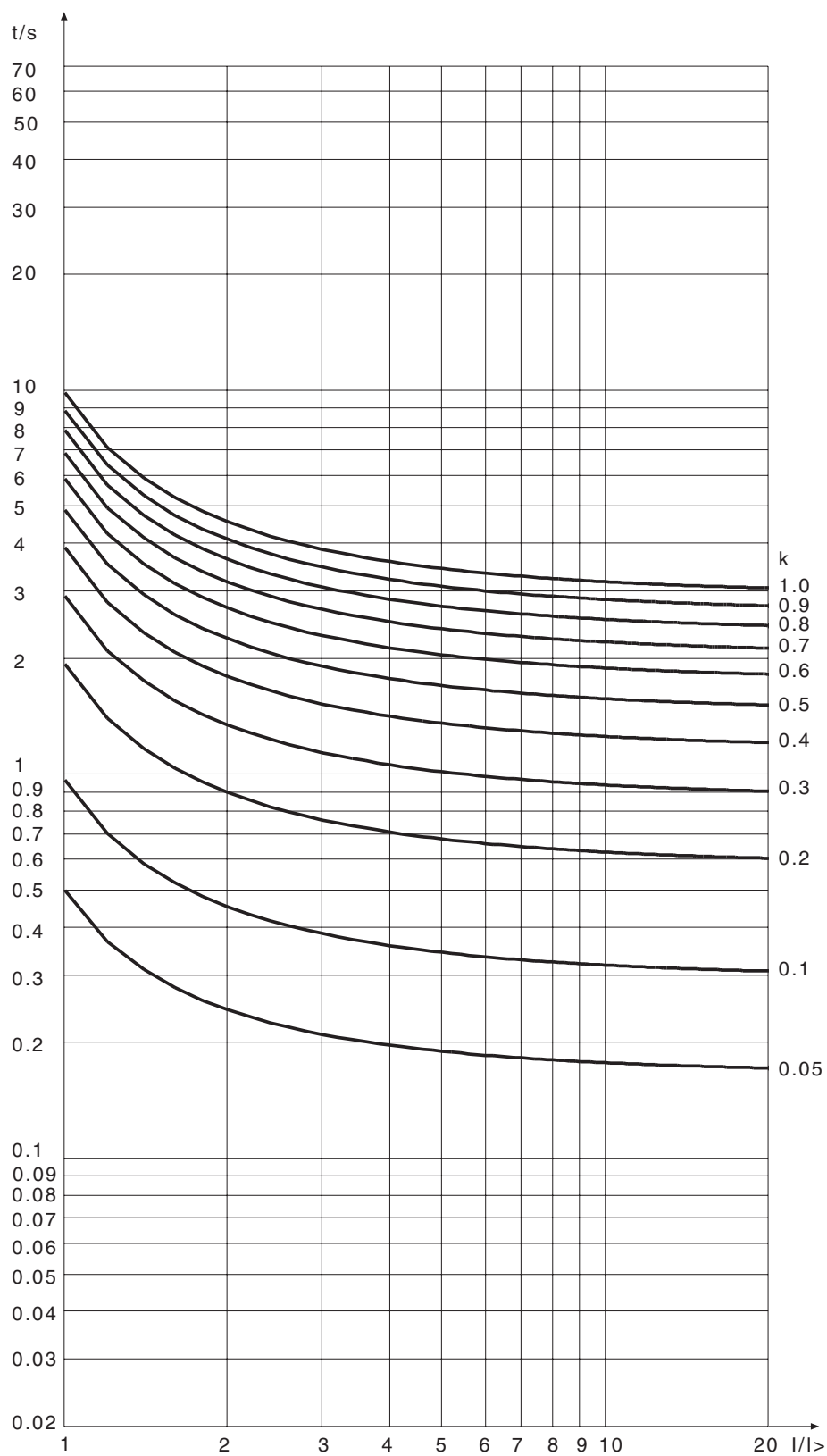
Fig. 5.1.4.5.-3 Extremely inverse-time characteristic

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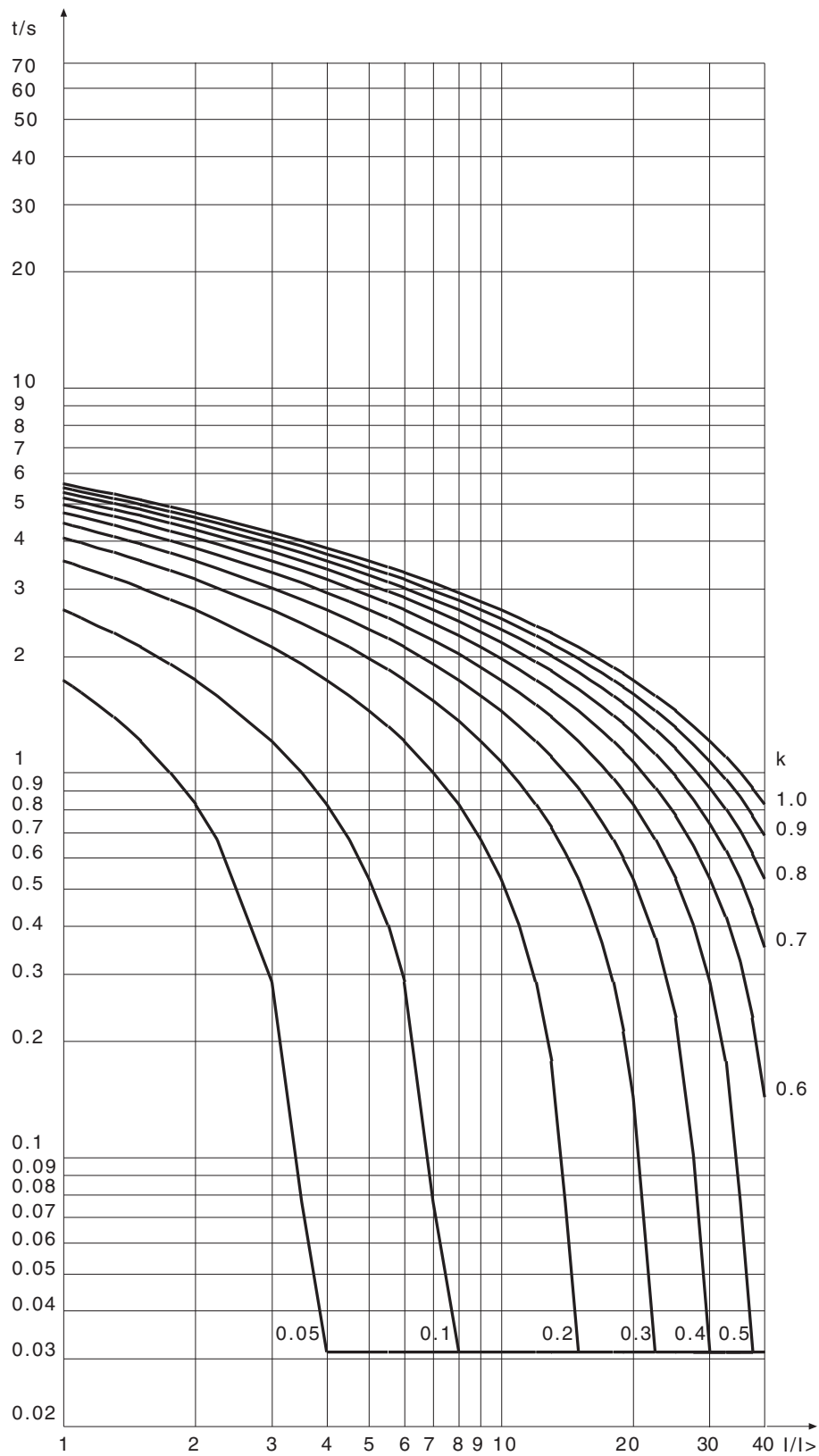
Fig. 5.1.4.5.-4 Long-time inverse-time characteristic



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Fig. 5.1.4.5.-5 RI-type inverse-time characteristic

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Fig. 5.1.4.5.-6 RD-type inverse-time characteristic

## 5.1.4.6.

**Settings**

There are two alternative setting groups available, setting groups 1 and 2. Either of these setting groups can be used as the actual settings, one at a time. Both groups have their related registers. By switching between the setting groups a whole group of settings can be changed at the same time. This can be done in any of the following ways:

Group configuration:

- via the HMI
- entering parameter V150 via serial communication

Group selection:

- switching between Group1 and Group2 is accomplished by means of the external binary input

The setting values can be altered via the HMI or with a personal computer provided with the Relay Setting Tool.

Before the relay is connected to a system it must be assured that the relay has been given the correct settings. If there is any doubt, the setting values should be read with the relay trip circuits disconnected or tested with current injection; refer to section Check lists for additional information.

**Table 5.1.4.6-1 Setting values**

Setting	Description	Setting range	Default setting
$I>/I_n$	Set start value of stage $I>$ as a multiple of the energizing input used <ul style="list-style-type: none"> <li>• definite-time</li> <li>• inverse-time</li> </ul>	0.30...5.00 x $I_n$ 0.30...2.50 x $I_n$ <sup>1)</sup>	0.30 x $I_n$ 0.30 x $I_n$
$t>$	Operate time of stage $I>$ in seconds at definite-time characteristic	0.05...300 s	0.05 s
$k$	Time multiplier $k$ of stage $I>$ at IDMT characteristic	0.05...1.00	0.05
$I>>/I_n$	Set start value of stage $I>>$ as a multiple of the energizing input used	0.30...35.0 x $I_n$ <sup>2)</sup>	0.30 x $I_n$
$t>>$	Operate time of stage $I>>$ in seconds	0.04...300 s	0.04 s
$\Delta I>$	Setting $\Delta I$ for the phase discontinuity protection as a percentage of the highest phase current	10...100%	100%
$\Delta t>$	Operate time of $\Delta I>$ in seconds	1...300 s	60 s
$I_0>/I_n$	Set start value of stage $I_0>$ as a multiple of the energizing input used <ul style="list-style-type: none"> <li>• definite-time</li> <li>• inverse-time</li> </ul>	0.01...0.80 x $I_n$ 0.01...0.40 x $I_n$ <sup>3)</sup>	0.01 x $I_n$ 0.01 x $I_n$
$t_0>$	Operate time of stage $I_0>$ in seconds at definite-time characteristic	0.05...300 s	0.05 s
$k_0$	Time multiplier $k_0$ of stage $I_0>$ at IDMT characteristic	0.05...1.00	0.05

**Table 5.1.4.6-1 Setting values (Continued)**

Setting	Description	Setting range	Default setting
$I_{0>>}/I_n$	Set start value of stage $I_{0>>}$ as a multiple of the energizing input used	0.05...4.00 x $I_n$ <sup>2)</sup>	0.05 x $I_n$
$t_{0>>}$	Operate time of stage $I_{0>>}$ in seconds	0.04...300 s	0.04 s
CBFP	Circuit-breaker failure protection	0.10...1.00 s	0.10 s

- 1) At IDMT characteristic, the REJ 525 allows settings above  $2.5 \times I_n$  for stage  $I_{>}$ , but regards any setting  $> 2.5 \times I_n$  as equal to  $2.5 \times I_n$ .
- 2) The stage can be set out of operation in SGF. This state will be indicated by dashes on the LCD and by "999" when parameters are read via the SPA bus.
- 3) At IDMT characteristic, the REJ 525 allows settings above  $0.4 \times I_n$  for stage  $I_{0>}$ , but regards any setting  $> 0.4 \times I_n$  as equal to  $0.4 \times I_n$ .



The continuous current carrying capacity of the energizing inputs is  $4.0 \times I_n$ .

### Switchgroups and parameter masks

The settings can be altered and the operation characteristics of the relay in various applications selected in the SG\_ selector switchgroups. The switchgroups are software based and thus not physical switches to be found in the hardware of the relay. The switches can be set one by one.

A checksum is used for verifying that the switches have been properly set. The figure below shows an example of manual checksum calculation.

Switch number	Position		Weighting factor		Value
1	1	x	1	=	1
2	0	x	2	=	0
3	1	x	4	=	4
4	0	x	8	=	0
5	1	x	16	=	16
6	0	x	32	=	0
7	1	x	64	=	64
8	0	x	128	=	0
checksum			$SG_{\Sigma}$	=	85

*Fig. 5.1.4.6.-1 An example of calculating the checksum of a SG\_ selector switchgroup*

When the checksum, calculated according to the example above, equals the checksum of the relay, the switches in the switchgroup have been properly set.

The factory default settings of the switches and the corresponding checksums are presented in the tables below.

**SGF1...SGF5**

Switchgroups SGF1...SGF5 are used for configuring the desired function as follows:

**Table 5.1.4.6-2 SGF1**

Switch	Function	Default setting
SGF1/1	Selection of the latching feature for power output PO1	0
SGF1/2	Selection of the latching feature for power output PO2 <ul style="list-style-type: none"> <li>• When the switch is in position 0 and the measuring signal which caused the trip falls below the set start value, the output contact will return to its initial state.</li> <li>• When the switch is in position 1, the output contact will remain active although the measuring signal which caused the trip falls below the set start value.</li> </ul> A latched output contact can be unlatched either via the HMI, the external binary input or the serial bus.	0
SGF1/3	Minimum pulse length for signal outputs SO1 and SO2 <ul style="list-style-type: none"> <li>• 0=80 ms</li> <li>• 1=40 ms</li> </ul>	0
SGF1/4	Minimum pulse length for power outputs PO1 and PO2 <ul style="list-style-type: none"> <li>• 0=80 ms</li> <li>• 1=40 ms</li> </ul> Note! The latching function of PO1 and PO2 will overrun this function.	0
SGF1/5	CBFP <ul style="list-style-type: none"> <li>• When the switch is in position 0, the CBFP is not in use.</li> <li>• When the switch is in position 1, the signal to output PO1 will start a timer which will generate a delayed signal to output PO2, provided that the fault is not cleared before the CBFP operate time has elapsed.</li> </ul>	0
SGF1/6	Not in use	0
SGF1/7	Not in use	0
SGF1/8	Not in use	0
Σ SGF1		0

**Table 5.1.4.6-3 SGF2**

Switch	Function	Default setting
SGF2/1	Automatic doubling of the set start value of stage I>> <ul style="list-style-type: none"> <li>• When the switch is in position 1, the set start value of the stage will automatically be doubled at high inrush situations.</li> </ul>	0
SGF2/2	Inverse-time operation of stage I> inhibited by the start of stage I>> <ul style="list-style-type: none"> <li>• When the switch is in position 1, inverse-time operation is inhibited.</li> </ul>	0
SGF2/3	Inhibition of stage I>> <ul style="list-style-type: none"> <li>• When the switch is in position 1, stage I&gt;&gt; is inhibited.</li> </ul>	0
SGF2/4	The operation mode of the start indication of stage I> <ul style="list-style-type: none"> <li>• 0 = the start indication will automatically be cleared once the fault has disappeared</li> <li>• 1 = latching. The start indication will remain active although the fault has disappeared and the phase(s) which caused the start will be shown on the LCD.</li> </ul>	0

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**Table 5.1.4.6-3 SGF2 (Continued)**

Switch	Function	Default setting
SGF2/5	The operation mode of the start indication of stage I>> <ul style="list-style-type: none"> <li>• 0 = the start indication will automatically be cleared once the fault has disappeared</li> <li>• 1 = latching. The start indication will remain active although the fault has disappeared and the phase(s) which caused the start will be shown on the LCD.</li> </ul>	0
SGF2/6	The operation mode of the start indication of stage ΔI> <ul style="list-style-type: none"> <li>• 0 = the start indication will automatically be cleared once the fault has disappeared</li> <li>• 1 = latching. The start indication will remain active although the fault has disappeared.</li> </ul>	0
SGF2/7	Inhibition of stage ΔI> <ul style="list-style-type: none"> <li>• When the switch is in position 1, stage ΔI&gt; is inhibited.</li> </ul>	1
SGF2/8	Not in use	0
Σ SGF2		64

**Table 5.1.4.6-4 SGF3**

Switch	Function	Default setting
SGF3/1	Automatic doubling of the set start value of stage I <sub>0</sub> >> <ul style="list-style-type: none"> <li>• When the switch is in position 1, the set start value of the stage will automatically be doubled at high inrush situations.</li> </ul>	0
SGF3/2	Inverse-time operation of stage I <sub>0</sub> > inhibited by the start of stage I <sub>0</sub> >> <ul style="list-style-type: none"> <li>• When the switch is in position 1, inverse-time operation is inhibited.</li> </ul>	0
SGF3/3	Inhibition of stage I <sub>0</sub> >> <ul style="list-style-type: none"> <li>• When the switch is in position 1, stage I<sub>0</sub>&gt;&gt; is inhibited.</li> </ul>	0
SGF3/4	The operation mode of the start indication of stage I <sub>0</sub> > <ul style="list-style-type: none"> <li>• 0 = the start indication will automatically be cleared once the fault has disappeared</li> <li>• 1 = latching. The start indication will remain active although the fault has disappeared.</li> </ul>	0
SGF3/5	The operation mode of the start indication of stage I <sub>0</sub> >> <ul style="list-style-type: none"> <li>• 0 = the start indication will automatically be cleared once the fault has disappeared</li> <li>• 1 = latching. The start indication will remain active although the fault has disappeared.</li> </ul>	0
SGF3/6	Not in use	0
SGF3/7	Not in use	0
SGF3/8	Not in use	0
Σ SGF3		0

**Table 5.1.4.6-5** *SGF4: I<sub>p</sub> characteristics*

SGF4/1	SGF4/2	SGF4/3	SGF4/4	SGF4/5	SGF4/6	SGF4/7	SGF4/8	Operation
0	0	0	0	0	0	-	-	Definite-time <sup>1)</sup>
1	0	0	0	0	0	-	-	Extremely inverse
0	1	0	0	0	0	-	-	Very inverse
0	0	1	0	0	0	-	-	Normal inverse
0	0	0	1	0	0	-	-	Long-time inverse
0	0	0	0	1	0	-	-	RI-type characteristic
0	0	0	0	0	1	-	-	RD-type characteristic

<sup>1)</sup> Default setting

**Table 5.1.4.6-6** *SGF5: I<sub>0</sub> characteristic*

SGF5/1	SGF5/2	SGF5/3	SGF5/4	SGF5/5	SGF5/6	SGF5/7	SGF5/8	Operation
0	0	0	0	0	0	-	-	Definite-time <sup>1)</sup>
1	0	0	0	0	0	-	-	Extremely inverse
0	1	0	0	0	0	-	-	Very inverse
0	0	1	0	0	0	-	-	Normal inverse
0	0	0	1	0	0	-	-	Long-time inverse
0	0	0	0	1	0	-	-	RI-type characteristic
0	0	0	0	0	1	-	-	RD-type characteristic

<sup>1)</sup> Default setting



Only one type of characteristic can be selected at a time. If more than one switch is selected, the characteristic with the lowest weighting factor of the selected switches will be activated.

**SGB1****Table 5.1.4.6-7 SGB1 Resetting/blocking with BI**

Switch	Function	Default setting
SGB1/1	<ul style="list-style-type: none"> <li>• 0 = indications are not cleared by the binary input signal</li> <li>• 1 = indications are cleared by the binary input signal</li> </ul>	0
SGB1/2	<ul style="list-style-type: none"> <li>• 0 = indications are not cleared and latched output contacts are not unlatched by the binary input signal</li> <li>• 1 = indications are cleared and latched output contacts are unlatched by the binary input signal</li> </ul>	0
SGB1/3	<ul style="list-style-type: none"> <li>• 0 = indications and memorized values are not cleared and latched output contacts are not unlatched by the binary input signal</li> <li>• 1 = indications and memorized values are cleared and latched output contacts are unlatched by the binary input signal</li> </ul>	0
SGB1/4	Switching between setting groups 1 and 2 using the external binary input <ul style="list-style-type: none"> <li>• 0 = the setting group cannot be changed using the external binary input</li> <li>• 1 = the currently used setting group is determined by the binary input. When the binary input is energized, setting group 2 will be activated.</li> </ul> Note! When SGB1/4 is set to 1, it is important that the switch has the same setting in both setting groups.	0
SGB1/5	Blocking of stage I> by the binary input signal	0
SGB1/6	Blocking of stage I>> by the binary input signal	0
SGB1/7	Blocking of stage I <sub>0</sub> > by the binary input signal	0
SGB1/8	Blocking of stage I <sub>0</sub> >> by the binary input signal <ul style="list-style-type: none"> <li>• When SGB1/5...8=1, tripping of the stage will be blocked by the external binary input signal.</li> </ul>	0
∑ SGB1		0

**SGB2****Table 5.1.4.6-8 SGB2**

Switch	Function	Default setting
SGB2/1	Blocking of stage ΔI> by the binary input signal	0
∑ SGB2		0

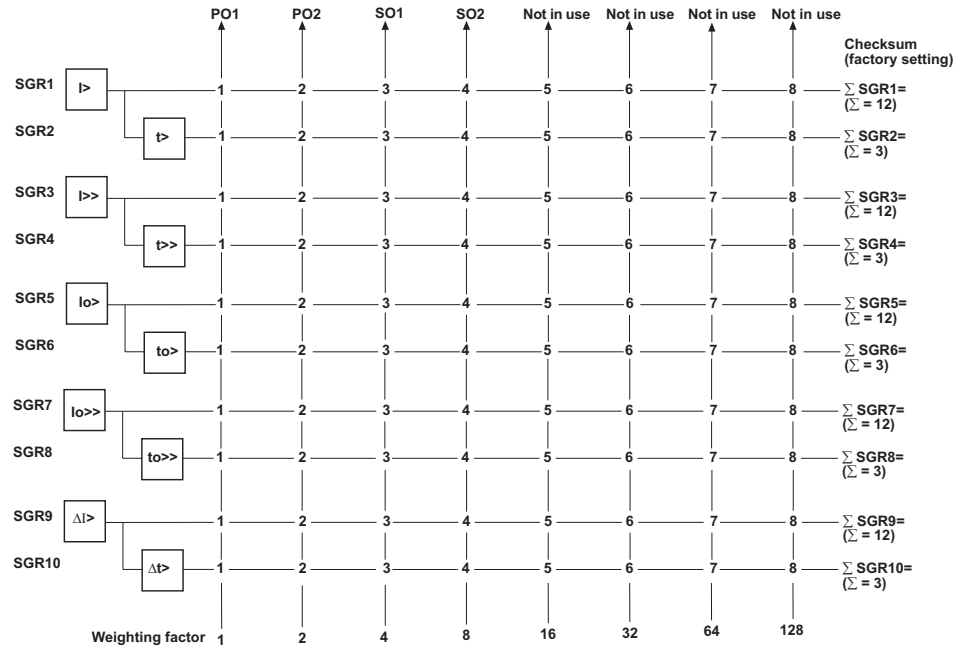
**SGR1...SGR10**

The start and trip signals from the protection stages are connected to the output contacts with the switches of switchgroups SGR1...SGR10.

The matrix below can be of help when making the desired selections. The start and trip signals from the different protection stages are combined with the output contacts by encircling the desired intersection point. Each intersection point is marked with a switch number, and the corresponding weighting factor of the switch

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is shown on the bottom line of the matrix. The switchgroup checksum is obtained by horizontally adding the weighting factors of all the selected switches of the switchgroup.



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Fig. 5.1.4.6.-2 Output signal matrix

Table 5.1.4.6-9 SGR1...SGR10

Switch	Function	Default setting
SGR1/1...4	l> signal to output contacts PO1, PO2, SO1 and SO2	12
SGR2/1...4	t> signal to output contacts PO1, PO2, SO1 and SO2	3
SGR3/1...4	l>> signal to output contacts PO1, PO2, SO1 and SO2	12
SGR4/1...4	t>> signal to output contacts PO1, PO2, SO1 and SO2	3
SGR5/1...4	l <sub>0</sub> > signal to output contacts PO1, PO2, SO1 and SO2	12
SGR6/1...4	t <sub>0</sub> > signal to output contacts PO1, PO2, SO1 and SO2	3
SGR7/1...4	l <sub>0</sub> >> signal to output contacts PO1, PO2, SO1 and SO2	12
SGR8/1...4	t <sub>0</sub> >> signal to output contacts PO1, PO2, SO1 and SO2	3
SGR9/1...4	Δl> signal to output contacts PO1, PO2, SO1 and SO2	12
SGR10/1...4	Δt> signal to output contacts PO1, PO2, SO1 and SO2	3

### New trip indication timer

The new trip indication timer can be configured to allow a second trip indication on the LCD. When several protection stages trip, the first trip indication will be displayed until the time, as specified by the “NEW TRIP IND.” setting value, has expired. After this, a new trip indication can displace the old one. The basic protection functions are not affected by the “NEW TRIP IND.” setting.

**Table 5.1.4.6-10 New trip indication timer**

Setting	Description	Setting range	Default setting
New trip indication	New trip indication timer in minutes No new trip indication allowed until the previous one has been manually cleared	0...998 999	60

### Non-volatile memory settings

The table below presents data which can be configured to be stored in the non-volatile memory. All of the functions mentioned below can be selected separately with switches 1...5 in “MEMORY SETTINGS”.

**Table 5.1.4.6-11 Memory settings**

Switch	Function	Default setting
1	• 0 = alarm indication messages and LEDs will be cleared • 1 = alarm indication messages and LEDs will be retained	1
2	• 1 = information on the “NUMBER OF STARTS” of the protection stages will be retained	1
3	• 1 = disturbance recorder data will be retained	1
4	• 1 = event codes will be retained	1
5	• 1 = recorded data will be retained	1
6	Not in use	0
7	Not in use	0
8	Not in use	0
checksum		31

## 5.1.4.7.

## Technical data on protection functions

Table 5.1.4.7-1 Stages I&gt;, I&gt;&gt; and ΔI&gt;

Feature	Stage I> <sup>1)</sup>	Stage I>> <sup>1)</sup>	Stage ΔI>
Set start value			
• at definite-time characteristic	$0.30...5.00 \times I_n$	$0.30...35.0 \times I_n$ <sup>4)</sup>	$10...100\%$ <sup>4)</sup>
• at IDMT characteristic <sup>2)</sup>	$0.30...2.50 \times I_n$		
Start time, typical	55 ms	30 ms	100 ms
Time/current characteristics			
• definite time operate time t>	0.05...300 s	0.04...300 s	1...300
• IDMT as per IEC 60255-3	Extremely inverse Very inverse Normal inverse Long-time inverse		
• special type of IDMT characteristic	RI-type inverse RD-type inverse		
time multiplier k	0.05 ... 1.00		
Resetting time, typical	40 ms	40 ms	70 ms
Drop-off/pick-up ratio, typical	0.96	0.96	0.90
Operate time accuracy at definite-time characteristic	±2% of the set start value or ±25 ms	±2% of the set start value or ±25 ms	±2% of the set start value or ±25 ms
Accuracy class index E at IDMT characteristic	5		
Operation accuracy			
• $0.3...5.0 \times I_n$	±3% of the set start value +0.05% $\times I_n$	±3% of the set start value +0.05% $\times I_n$	
• $5.0...35.0 \times I_n$		±3% of the set start value	
• 10...100%			±3% of the set start value and ±1 unit

**Table 5.1.4.7-2 Stages  $I_{0>}$  and  $I_{0>>}$** 

Feature	Stage $I_{0>}$ <sup>1)</sup>	Stage $I_{0>>}$ <sup>1)</sup>
Set start value		
• at definite-time characteristic	$0.01 \dots 0.80 \times I_n$	$0.05 \dots 4.00 \times I_n$ <sup>4)</sup>
• at IDMT characteristic <sup>3)</sup>	$0.01 \dots 0.40 \times I_n$	
Start time, typical	60 ms	40 ms
Time/current characteristics		
• definite time	$0.05 \dots 300$ s	$0.04 \dots 300$ s
operate time $t_{0>}$		
• IDMT as per IEC 60255-3	Extremely inverse Very inverse Normal inverse Long-time inverse	
• special type of inverse-time characteristic	RI-type inverse RD-type inverse	
time multiplier k	$0.05 \dots 1.00$	
Resetting time, typical	40 ms	40 ms
Drop-off/pick-up ratio, typical	0.96	0.96
Operate time accuracy at definite-time characteristic	$\pm 2\%$ of the set start value or $\pm 25$ ms	$\pm 2\%$ of the set start value or $\pm 25$ ms
Accuracy class index E at IDMT characteristic	5	
Operation accuracy		
• $0.01 \dots 0.8 \times I_n$	$\pm 3\%$ of the set start value $+0.05\% \times I_n$	$\pm 3\%$ of the set start value $+0.05\% \times I_n$
• $0.8 \dots 4.0 \times I_n$		$\pm 3\%$ of the set start value

<sup>1)</sup> The start and the tripping of the low-set stage at IDMT characteristic can be blocked by the starting of the high-set stage, provided that this function has been selected in SGF. If set in SGF, the operate time will be determined by the set operate time of the high-set stage at heavy fault currents. In order to obtain a trip signal, the high-set stage must be routed to PO1 or PO2.

<sup>2)</sup> At IDMT characteristic, the relay allows settings above  $2.5 \times I_n$  for stage  $I_{>}$ , but regards any setting  $> 2.5 \times I_n$  as equal to  $2.5 \times I_n$ .

<sup>3)</sup> At IDMT characteristic, the relay allows settings above  $0.4 \times I_n$  for stage  $I_{0>}$ , but regards any setting  $> 0.4 \times I_n$  as equal to  $0.4 \times I_n$ .

<sup>4)</sup> The stage can be set out of operation in SGF. This state will be indicated by dashes on the LCD and by "999" when parameters are read via the SPA bus.

### 5.1.5.

#### Indicator LEDs and alarm indication messages

The operation of the REJ 525 can be monitored by means of three indicators on the front panel of the relay: a green READY indicator LED, a yellow START indicator LED and a red TRIP indicator LED (refer to the Operator's Manual for a more thorough presentation).

In addition, in case of an alarm from a protection stage, a text message will appear on the LCD.

The messages on the LCD have a certain priority order. If different types of indications are activated simultaneously, the message with the highest priority will appear on the LCD.

The priority order of the messages:

1. CBFP
2. TRIP
3. START

### **5.1.6. Monitoring of demand values**

The REJ 525 provides three different kinds of demand values. The first value shows the average current of all three phases measured during one minute. The value is updated once a minute. The second value shows the average current during an adjustable time range, ranging from 0 to 999 minutes, with an accuracy of one minute. This value is updated at the expiration of each time range. The third value shows the highest one-minute average current value measured during the previous time range. However, if the time range is set to zero, only the one-minute and the maximum demand value will be shown. The maximum value is the highest one-minute mean value since the last reset.

The demand values can be set to zero by resetting the relay or through communication using a V parameter. The demand values will also be reset if V135, M80 or M83 is changed.

### **5.1.7. Commissioning test**

The function test is used for testing the configuration as well as the connections to and from the relay. By selecting this test the ten internal signals from the protection stages and the IRF function can be activated and tested one by one. Provided that the internal signals from the protection stages have been set to be routed to the output contacts (PO1, PO2, SO1 and SO2) with the switches of SGR1...10, the output contacts will be activated and the corresponding event codes generated when the test is run. The test will not generate protection function event codes. Additionally, if the CBFP function is in use and PO1 is activated, PO2 will be activated, too.

The state of the binary input can be monitored by selecting the binary input test, and the LEDs can be turned on by selecting the LED test. Refer to the Operator's Manual for more detailed instructions on how to perform the tests.

### **5.1.8. Disturbance recorder**

#### **5.1.8.1. Function**

The REJ 525 features an integrated disturbance recorder for recording monitored quantities. The recorder continuously captures the curve forms of the currents as well as the status of both the internal signals and the external binary input signal and stores these in the memory.

Triggering of the recorder will generate an event code. After the recorder has been triggered, it will continue to record data for a pre-defined post-triggering time. An asterisk will be shown on the LCD on completion of the recording. The status of the recording can also be viewed using a SPA parameter.

As soon as the recorder has been triggered and the recording has finished, the recording can be uploaded and analyzed by means of a PC provided with a special program.

### 5.1.8.2.

#### Disturbance recorder data

One recording contains data from the four analogue channels and up to eight digital channels for a preselected time. The analogue channels, whose data is stored either as RMS curves or as momentary measured values, are the currents measured by the relay. The digital channels, referred to as digital signals, are the start and trip signals from the protection stages and the external binary input signal linked to the relay.

The user can select up to eight digital signals to be recorded. The start or trip signal from any protection stage and/or the external binary input signal can be selected. If more than eight signals are selected, the first eight signals will be stored, starting with the internal signals followed by the external signal. The digital signals to be stored are selected with parameters V238 and V239; see tables 5.1.10.4-5 and 5.1.10.4-6.

The recording length varies according to the selected sampling frequency. The RMS curve is recorded by selecting the sampling frequency to be the same as the nominal frequency of the relay. The sampling frequency is selected with parameter M15; see the table below for details.

**Table 5.1.8.2-1 Sampling frequency**

Nominal frequency Hz	Sampling frequency Hz	Cycles
50	800	32
	400	64
	50 <sup>1)</sup>	512
60	960	32
	480	64
	60 <sup>1)</sup>	512

<sup>1)</sup> RMS curve.

Recording length:

$$[s] = \frac{\text{Cycles}}{\text{Nominal frequency}[Hz]}$$

Changing the setting values of parameters M15, V238 and V239 is allowed only when the recorder is not triggered.

The post-triggering recording length defines the time during which the recorder continues to store data after it has been triggered. The length can be changed with parameter V240. If the post-triggering recording length has been defined to be the

same as the total recording length, no data stored prior to the triggering will be retained in the memory. By the time the post-triggering recording finishes, a complete recording will have been created.

Triggering of the recorder immediately after it has been cleared or the auxiliary voltage connected may result in a shortened total recording length. Disconnection of the auxiliary voltage after the recorder has been triggered but before the recording has finished, on the other hand, may result in a shortened post-triggering recording length. This, however, will not affect the total recording length.

At a power reset, triggered recorder data will be retained in the memory provided that it has been defined non-volatile.

#### **5.1.8.3. Control and indication of disturbance recorder status**

It is possible to control and monitor the recording status of the disturbance recorder by writing to and reading parameters M1, M2 and V246. Reading parameter V246 will return either the value 0 or 1, indicating whether the recorder has not been triggered or triggered and ready to be uploaded. Event code E31 will be generated the moment the disturbance recorder is triggered. If the recorder is ready to be uploaded, this will also be indicated by an asterisk shown in the lower right-hand corner of the LCD when it is in the idle mode.

Writing the value 1 to parameter M2 will clear the recorder memory, restart the storing of new data and enable the triggering of the recorder. Recorder data can be cleared by performing a master reset. Writing the value 2 to parameter V246 will restart the unloading process by setting the time stamp and the first data ready to be read.

#### **5.1.8.4. Triggering**

The user can select the start or trip signal from any protection stage and/or the external binary input signal to trigger the disturbance recorder, either on the rising or falling edge of the signal(s). Triggering on the rising edge means that the post-triggering recording sequence will start when the signal is activated. Correspondingly, triggering on the falling edge means that the post-triggering recording sequence will start when the active signal is reset. The trigger signal(s) and the edge are selected with parameters V241...V244; see tables 5.1.10.4-5 and 5.1.10.4-6. The recorder can also be triggered manually using parameter M1.

Triggering of the disturbance recorder is only possible if the recorder has not already been triggered.

#### **5.1.8.5. Settings and unloading**

The setting parameters for the disturbance recorder are V parameters V238...V244 and V246, and M parameters M15, M18, M20 and M80...M83.

Unloading the recorder requires that M80 and M83 have been set. Unloading is done using a PC application. The uploaded recorder data is stored in separate files defined by the comtrade<sup>®</sup> format.

**5.1.8.6.****Event code of the disturbance recorder**

The disturbance recorder generates an event code (E31) on triggering of the recorder by default. The event mask is defined using serial parameter V158.

**5.1.9.****Recorded data of the last events**

The REJ 525 records up to five events. This enables the user to analyze the last five fault situations in the electrical power network. Each event includes the measured currents, the phase discontinuity value, start durations, and the time stamp. Additionally, information on the number of starts is provided.

Recorded data and the number of starts are non-volatile by default. A master reset will erase the contents of the recorded events and the number of starts.

The REJ 525 will start to collect data from all the stages when a protection function starts. When each stage has dropped off, the collected data and the time stamp will be stored in the first event register and the four previously stored events will move one step forward. When a sixth event is stored, the oldest event will be cleared.

**Table 5.1.9-1 Recorded data**

REGISTER	Recorded data
EVENT1	<ul style="list-style-type: none"> <li>Phase current L1 measured as a multiple of the rated current, <math>I_n</math>, is displayed in two registers: the main register and the sub register. When the stage starts but does not trip, the maximum fault current during the pick-up period will be stored in both the main register and the sub register. When the stage trips, the fault current at the time of the trip will be stored in the main register and the maximum fault current during the pick-up period in the sub register. The same applies to phase currents L2, L3 and <math>I_0</math>.</li> <li>The phase discontinuity, <math>\Delta I</math>, as a percentage of the maximum phase current value. When the stage starts but does not trip, the maximum phase discontinuity value during the pick-up period will be stored. When the stage trips, the fault unbalance at the time of the trip will be stored.</li> <li>Duration of the last starts of stages <math>t&gt;</math>, <math>t&gt;&gt;</math>, <math>t_0&gt;</math>, <math>t_0&gt;&gt;</math> and <math>\Delta t&gt;</math>, expressed as a percentage of the set operate time, or of the calculated operate time at IDMT characteristic. The timing will start when a stage starts. A value other than zero means that the corresponding stage has started whereas a value which is 100% of the set or calculated operate time means that the stage has tripped. If the operate time for a stage has elapsed but the stage is blocked, the value will be 99% of the set or calculated operate time.</li> <li>Time stamp for the event. The time when the last stage drops off will be stored. The time stamp is displayed in two registers, one including the date expressed as yy-mm-dd, and the other including the time expressed as HH.MM; SS.sss.</li> </ul>
EVENT 2	Same as EVENT 1.
EVENT 3	Same as EVENT 1.
EVENT 4	Same as EVENT 1.
EVENT 5	Same as EVENT 1.
Number of starts	<ul style="list-style-type: none"> <li>The number of times each protection stage, i.e. <math>I&gt;</math>, <math>I&gt;&gt;</math>, <math>I_0&gt;</math>, <math>I_0&gt;&gt;</math> and <math>\Delta I&gt;</math>, has started, counting up to 999.</li> </ul>

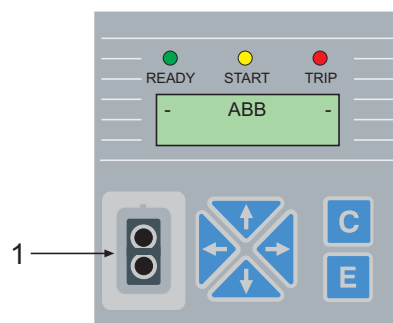
## 5.1.10. External serial communication

### 5.1.10.1. Communication ports

The REJ 525 is provided with two serial communication ports: an optical PC-connection on the front panel and an RS-485 connection on the rear panel.

The D9S-type RS-485 connector is used to connect the relay to the distribution automation system. This connection enables the use of either the SPA bus communication protocol or the IEC 60870-5-103 communication protocol. The fibre-optic interface module RER 103 is used to connect the relay to the fibre-optic communication bus.

Although the RER 103 supports LON bus communication, the REJ 525 does not support the LON protocol. LON communication requires a separate LSG device.



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Fig. 5.1.10.1.-1 Front connector (1) for local communication

The relay is connected to a PC used for setting via the optical PC-connector on the front panel. The front interface uses the SPA bus protocol.

The optical PC-connector galvanically isolates the PC from the relay. The connection consists of a transmitter stage and a receiver stage. The front connector is standardized for ABB relay products and requires a specific opto-cable (ABB art. no 1MKC950001-2). The cable is connected to the serial RS-232C port of the PC. The optical stage of the cable is powered by RS-232C control signals.

The following serial communication parameters are to be used for RS-232C:

- Number of data bits      7
- Number of stop bits      1
- Parity                      even
- Baud rate                  9.6 kbps as default

Relay data such as events, setting values and all input data and memorized values can be read via the optical PC-interface.

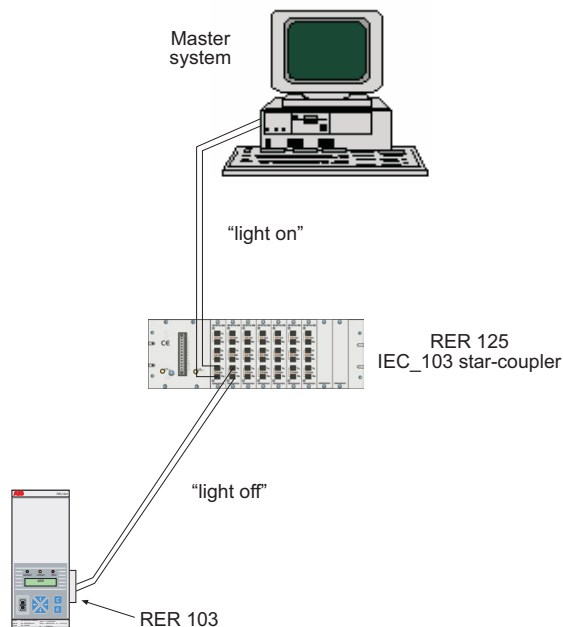
When setting values are altered via the optical PC-interface, the relay will check that the entered parameter values are within the permitted setting range. If an entered value is too high or too low, the setting value will remain unchanged.

The REJ 525 has a counter which can be accessed via “COMMUNICATION” under “CONFIGURATION” in the HMI menu. The counter value is set to 0 when the relay receives a valid message.

**5.1.10.2.****IEC 60870-5-103 remote communication protocol**

The REJ 525 supports the IEC 60870-5-103 remote communication protocol (henceforward referred to as the IEC\_103) in the unbalanced transmission mode. The IEC\_103 protocol is used to transfer measurand and status data from the slave to the master. However, the IEC\_103 protocol cannot be used to transfer disturbance recorder data.

The IEC\_103 protocol can be used only through the RS-485 connection on the rear panel. Connecting the REJ 525 to the fibre-optic communication bus requires the use of the fibre-optic interface module RER 103. The line-idle state of the RER 103 is “light off” whereas it is “light on” according to the IEC\_103 standard. Therefore, to achieve full compatibility in the physical layer between the relay and the master, the IEC 60870-5-103 star coupler RER 125 is required. The RER 125 is used to set the line-idle state “light off” to the relay and “light on” to the master. However, the RER 125 is not required if the master is compatible with the line-idle state “light off”.



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*Fig. 5.1.10.2.-1 REJ 525 communication using the IEC\_103 protocol*

The REJ 525 will use the SPA bus protocol as default when the rear connection is in use. The IEC\_103 protocol can be selected through the HMI of the relay. The selection is memorized and will therefore always be activated when the rear connection is in use. The use of the IEC\_103 protocol in the REJ 525 requires a baud rate of 9.6 kbps. When the IEC\_103 protocol has been selected, event masks are not in use. Therefore, all events in the configuration set are included in the event reporting.

The REJ 525 is provided with two different selectable configuration sets, of which configuration set 1 is used by default. Configuration set 1 provides full compatibility according to the IEC\_103 standard. Configuration set 2 provides all applicable information of the protection equipment. However, some information elements have been mapped to a private range. Configuration set 255 is reserved for future use.

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The tables below indicate the information mapping of the corresponding configuration sets. The column GI indicates whether the status of the specified information object is transmitted within the general interrogation cycle. The relative time in messages with the type identification 2 is calculated as a time difference between the occurred event and the event specified in the column Relative time. The measurand multiplied by the normalize factor is proportional to the rated value. Therefore, the maximum value of each measurand is the normalize factor multiplied by the rated value.

**Table 5.1.10.2-1 Information mapping of configuration set 1**

Event reason	Event code	Function type	Information number	Standard description of the information number (IEC 60870-5-103)	GI	Relative time	Type identification
I> Start Activated/Reset	E1/ E2	160	84	general start/pick-up	X	E1	2
t> Trip Activated/Reset	E3/ E4	160	90	trip I>	-	E1	2
t>> Trip Activated/Reset	E7/ E8	160	91	trip I>>	-	E1	2
I <sub>0</sub> > Start Activated/Reset	E9/ E10	160	67	start/pick-up N	X	E9	2
t <sub>0</sub> > Trip Activated/Reset	E11/ E12	160	92	trip IN>	-	E9	2
t <sub>0</sub> >> Trip Activated/Reset	E15/ E16	160	93	trip IN>>	-	E9	2
PO1 Activated/Reset	E17/ E18	160	27	auxiliary input 1	X	-	1
PO2 Activated/Reset	E19/ E20	160	28	auxiliary input 2	X	-	1
SO1 Activated/Reset	E21/ E22	160	29	auxiliary input 3	X	-	1
SO2 Activated/Reset	E23/ E24	160	30	auxiliary input 4	X	-	1

**Table 5.1.10.2-2 Information mapping of configuration set 1**

Measurand	Normalize factor	Rated value	Function type	Information number	Standard description of the information number (IEC 60870-5-103)	Type identification
Current I <sub>L2</sub>	2.40	I <sub>n</sub>	160	144	measurand I	3.1

**Table 5.1.10.2-3 Information mapping of configuration set 2**

Event reason	Event code	Function type	Information number	Standard description of the information number (IEC 80870-5-103)	GI	Relative time	Type identification
I> Start Activated/Reset	E1/ E2	160	84	general start/pick-up	X	E1	2
t> Trip Activated/Reset	E3/ E4	160	90	trip I>	-	E1	2
I>> Start Activated/Reset	E5/ E6	162	94	-	X	E5	2
t>> Trip Activated/Reset	E7/ E8	160	91	trip I>>	-	E5	2
I <sub>0</sub> > Start Activated/Reset	E9/ E10	160	67	start/pick-up N	X	E9	2
t <sub>0</sub> > Trip Activated/Reset	E11/ E12	160	92	trip IN>	-	E9	2
I <sub>0</sub> >> Start Activated/Reset	E13/ E14	162	95	-	X	E13	2
t <sub>0</sub> >> Trip Activated/Reset	E15/ E16	160	93	trip IN>>	-	E13	2
PO1 Activated/Reset	E17/ E18	160	27	auxiliary input 1	X	-	1
PO2 Activated/Reset	E19/ E20	160	28	auxiliary input 2	X	-	1
SO1 Activated/Reset	E21/ E22	160	29	auxiliary input 3	X	-	1
SO2 Activated/Reset	E23/ E24	160	30	auxiliary input 4	X	-	1
Disturbance recorder triggered	E31	162	100	-	-	-	1
HMI Password Opened/Closed	E32/ E33	162	101	-	-	-	1
ΔI> Start Activated/Reset	E41/ E42	173	84	general start/pick-up	X	E41	2
tΔ> Trip Activated/Reset	E43/ E44	173	90	trip I>	-	E41	2

**Table 5.1.10.2-4 Information mapping of configuration set 2**

Measurand	Normalize factor	Rated value	Function type	Information number	Standard description of the information number (IEC 60870-5-103)	Type identification
Current $I_{L1}$	2.40	$I_n$	135	140	-	9
Current $I_{L2}$	2.40	$I_n$				
Current $I_{L3}$	2.40	$I_n$				
Current $I_0$	2.40	$I_n$				

**5.1.10.3.****Event codes**

Special codes have been determined to represent certain events, such as start and tripping of protection stages and different states of output signals.

Events E1...E51 are stored in the event register of the relay. The maximum capacity of the register is 60 events. Under normal conditions the register is empty.

The contents of the register can be read using the L command, five events at a time. Using the L command erases the previously read events from the register, with the exception of events E50 and E51 which have to be reset using the C command. Should a fault occur, for example in data communication, these events can be re-read using the B command. If needed, the B command can also be repeated.

Events to be included in the event reporting are marked with multiplier 1. The event mask is formed by the sum of the weighting factors of all those events which are to be included in the event reporting.

**Table 5.1.10.3-1 Event masks**

Event mask	Code	Setting range	Default setting
V155	E1...E8	0...255	85
V156	E9...E16	0...255	85
V157	E17...E24	0...255	3
V158	E31...E33	0...7	1
V159	E41...E44	0...15	5

**Table 5.1.10.3-2 Event codes E1...E8**

Code	Event	Weighting factor	Default value
E1	Start of stage I>	1	1
E2	Start of stage I> reset	2	0
E3	Trip of stage I>	4	1
E4	Trip of stage I> reset	8	0
E5	Start of stage I>>	16	1
E6	Start of stage I>> reset	32	0
E7	Trip of stage I>>	64	1
E8	Trip of stage I>> reset	128	0
Default value of event mask V155			85

**Table 5.1.10.3-3 Event codes E9...E16**

Code	Event	Weighting factor	Default value
E9	Start of stage $I_0>$	1	1
E10	Start of stage $I_0>$ reset	2	0
E11	Trip of stage $I_0>$	4	1
E12	Trip of stage $I_0>$ reset	8	0
E13	Start of stage $I_0>>$	16	1
E14	Start of stage $I_0>>$ reset	32	0
E15	Trip of stage $I_0>>$	64	1
E16	Trip of stage $I_0>>$ reset	128	0
Default value of event mask V156			85

**Table 5.1.10.3-4 Event codes E17...E24**

Code	Event	Weighting factor	Default value
E17	PO1 activated	1	1
E18	PO1 reset	2	1
E19	PO2 activated	4	0
E20	PO2 reset	8	0
E21	SO1 activated	16	0
E22	SO1 reset	32	0
E23	SO2 activated	64	0
E24	SO2 reset	128	0
Default value of event mask V157			3

**Table 5.1.10.3-5 Event codes E31...33**

Code	Event	Weighting factor	Default value
E31	Disturbance recorder triggered	1	1
E32	HMI password opened	2	0
E33	HMI password reclosed	4	0
Default value of event mask V158			1

**Table 5.1.10.3-6 Event codes E41...E44**

Code	Event	Weighting factor	Default value
E41	Start of stage $\Delta I>$	1	1
E42	Start of stage $\Delta I>$ reset	2	0
E43	Trip of stage $\Delta I>$	4	1
E44	Trip of stage $\Delta I>$ reset	8	0
Default value of event mask V159			5

Explanations of the default values:

0 = not included in the event reporting

1 = included in the event reporting

Events E50 and E51 are always included in the event reporting.

**Table 5.1.10.3-7 Event codes E50 and E51**

Code	Event
E50	Restart of relay
E51	Overflow of event register

**5.1.10.4.****SPA bus communication protocol parameters**

In some cases, altering parameter values via serial communication requires the use of the SPA password. The password is a number within the range 1...999, the default value being 1.

To enter the setting mode, enter the password into parameter V160. To quit the setting mode, enter the same password into parameter V161. The password protection is also reactivated in case of loss of auxiliary voltage.

The HMI password can be changed via parameter V162, but it is not possible to read the password via this parameter.

Abbreviations used in the following tables:

- R = readable data
- W = writeable data
- P = password protected writeable data
- I = input data
- S = setting value
- V = recorded data/parameter
- M = disturbance recorder parameter
- O = output data

## Settings

**Table 5.1.10.4-1 Settings**

Variable	Actual settings (R)	Group 1 (R, W, P)	Group 2 (R, W, P)	Setting range
Set start value of stage I>	S1	S41	S81	0.30...5.00 x I <sub>n</sub>
Operate time or time multiplier k of stage I>	S2	S42	S82	0.05...300 s or 0.05...1.00 <sup>1)</sup>
Set start value of stage I>>	S3 <sup>2)</sup>	S43	S83	0.30...35.0 x I <sub>n</sub>
Operate time of stage I>>	S4	S44	S84	0.04...300 s
Set start value of stage ΔI>	S25	S65	S105	10...100%
Operate time of stage ΔI>	S26	S66	S106	1...300 s
Set start value of stage I <sub>0</sub> >	S5	S45	S85	0.01...0.80 x I <sub>n</sub>
Operate time or time multiplier k of stage I <sub>0</sub> >	S6	S46	S86	0.05...300 s or 0.05...1.00 <sup>1)</sup>
Set start value of stage I <sub>0</sub> >>	S7 <sup>2)</sup>	S47	S87	0.05...4.00 x I <sub>n</sub>
Operate time of stage I <sub>0</sub> >>	S8	S48	S88	0.04...300 s
checksum, SGF1	S9	S49	S89	0...31
checksum, SGF2	S10	S50	S90	0...127
checksum, SGF3	S11	S51	S91	0...31
checksum, SGF4	S12	S52	S92	0...32
checksum, SGF5	S13	S53	S93	0...32
checksum, SGB1	S14	S54	S94	0...255
checksum, SGB2	S27	S67	S107	0...1
checksum, SGR1	S15	S55	S95	0...15
checksum, SGR2	S16	S56	S96	0...15
checksum, SGR3	S17	S57	S97	0...15
checksum, SGR4	S18	S58	S98	0...15
checksum, SGR5	S19	S59	S99	0...15
checksum, SGR6	S20	S60	S100	0...15
checksum, SGR7	S21	S61	S101	0...15
checksum, SGR8	S22	S62	S102	0...15
checksum, SGR9	S23	S63	S103	0...15
checksum, SGR10	S24	S64	S104	0...15
Operate time of CBFP	-	S121	S121	0.10...1.00 s
Time setting for disabling new trip indications on the LCD	-	S122	S122	0...999 min

<sup>1)</sup> Values above 1 equal 1.

<sup>2)</sup> If the protection stage has been set out of operation, the number indicating the currently used value will be displaced by "999" when parameters are read via the SPA bus and by dashes on the LCD.

### Recorded data

Parameters V1...V4 and V7 show the number of starts of the protection stages, parameter V5 the stage which has caused the trip and parameter V6 the trip indication code.

**Table 5.1.10.4-2 Recorded data: Parameters V1...V7**

Recorded data	Parameter	R, W	Value
Number of starts of stage I>	V1	R	0...999
Number of starts of stage I>>	V2	R	0...999
Number of starts of stage I <sub>0</sub> >	V3	R	0...999
Number of starts of stage I <sub>0</sub> >>	V4	R	0...999
Number of starts of stage ΔI>	V7	R	0...999
Stage/phase which caused the trip; the value may also be a combination of two or more of the individual values, e.g. 24 (=8 + 16)	V5	R	1=I <sub>L3</sub> > 2=I <sub>L2</sub> > 4=I <sub>L1</sub> > 8=I <sub>0</sub> > 16=I <sub>L3</sub> >> 32=I <sub>L2</sub> >> 64=I <sub>L1</sub> >> 128=I <sub>0</sub> >>
Trip indication code	V6	R	0 =--- 1 = start of stage I> 2 = trip of stage I> 3 = start of stage I>> 4 = trip of stage I>> 5 = start of stage I <sub>0</sub> > 6 = trip of stage I <sub>0</sub> > 7 = start of stage I <sub>0</sub> >> 8 = trip of stage I <sub>0</sub> >> 9 = trip of the CBFP unit 10 = start of stage ΔI> 11 = trip of stage ΔI>

The last five recorded values can be read with parameters V11...V108. Event n denotes the last recorded value, n-1 the next one, and so forth.

**Table 5.1.10.4-3 Recorded data**

Recorded data	Event (R)					Value
	n	n-1	n-2	n-3	n-4	
Phase current $I_{L1}$	V11	V31	V51	V71	V91	0...50 x $I_n$
Phase current $I_{L2}$	V12	V32	V52	V72	V92	0...50 x $I_n$
Phase current $I_{L3}$	V13	V33	V53	V73	V93	0...50 x $I_n$
Earth-fault current, $I_0$	V14	V34	V54	V74	V94	0...8 x $I_n$
Start duration, stage I>	V15	V35	V55	V75	V95	0...100%
Start duration, stage I>>	V16	V36	V56	V76	V96	0...100%
Start duration, stage $I_0$ >	V17	V37	V57	V77	V97	0...100%
Start duration, stage $I_0$ >>	V18	V38	V58	V78	V98	0...100%
Time stamp of the registered value, date	V19	V39	V59	V79	V99	YY-MM-DD
Time stamp of the registered value, time	V20	V40	V60	V80	V100	HH.MM; SS.sss
Phase discontinuity, $\Delta I$	V23	V43	V63	V83	V103	0...100%
Start duration, stage $\Delta I$ >	V24	V44	V64	V84	V104	0...100%
Phase L1 maximum pick-up current	V25	V45	V65	V85	V105	0...50 x $I_n$
Phase L2 maximum pick-up current	V26	V46	V66	V86	V106	0...50 x $I_n$
Phase L3 maximum pick-up current	V27	V47	V67	V87	V107	0...50 x $I_n$
$I_0$ maximum pick-up current	V28	V48	V68	V88	V108	0...8 x $I_n$

## Disturbance recorder

**Table 5.1.10.4-4 Parameters for the disturbance recorder**

Description	Parameter	R, W	Value/Note
Manual triggering	M1 <sup>2)</sup>	W	1
Clear recorder memory	M2	W	1
Sampling rate	M15 <sup>3)</sup>	R, W	800/960 Hz 400/480 Hz 50/60 Hz
Station identification/unit number	M18	R, W	0...9999
Rated frequency	M19	R	50 or 60 Hz
Station name	M20	R, W	Max 16 characters
Digital channel texts	M40...47	R	
Analogue channel texts	M60...63	R	
Analogue channel conversion factor and unit, phases $I_{L1}$ , $I_{L2}$ and $I_{L3}$	M80 <sup>1) 4)</sup> M81...82	R, W R	Factor 0...65535, unit (A, kA), e.g. 10.0,kA
Analogue channel conversion factor and unit, $I_0$	M83 <sup>1)</sup>	R, W	Factor 0...65535, unit (A, kA), e.g. 10.0,kA
Post-triggering recording length	V240	R, W	0...100%
Checksum of internal signal storing mask	V238 <sup>3)</sup>	R, W	0...1023

**Table 5.1.10.4-4 Parameters for the disturbance recorder (Continued)**

Description	Parameter	R, W	Value/Note
Internal trigger signals' checksum	V241	R, W	0...1023, see table 5.1.10.4-5
Internal trigger signal's edge	V242	R, W	0...1023, 0 = rising, 1 = falling
Checksum of external signal storing mask	V239 <sup>3)</sup>	R, W	0/1
External trigger signal (BI)	V243	R, W	0/1, see table 5.1.10.4-6
External trigger signal's edge	V244	R, W	0/1, 0 = rising, 1 = falling
Triggering state, clearing and restart	V246	R, W	R: 0 = recorder not triggered 1 = recorder triggered and recording stored in the memory W: 0 = clear recorder memory 2 = download restart; sets the first information and the time stamp for triggering ready to be read 4 = manual triggering

<sup>1)</sup> The disturbance recorder requires this parameter to be set. The conversion factor is the transformation ratio multiplied by the rated current of the relay. If this parameter has been given the default value 0, dashes will be shown on the LCD instead of the primary values and the recorded data will be redundant.

<sup>2)</sup> M1 can be used for broadcast triggering by using the unit address "900".

<sup>3)</sup> Parameters can be written if the recorder has not been triggered.

<sup>4)</sup> This value is copied to parameters M81 and M82.

**Table 5.1.10.4-5 Disturbance recorder internal triggering and storing**

Event	Weighting factor	Default value of triggering mask, V241	Default value of triggering edge, V242	Default value of storing mask, V238
Start of stage I>	1	0	0	1
Trip of stage I>	2	0	0	1
Start of stage I>>	4	0	0	1
Trip of stage I>>	8	1	0	1
Start of stage I <sub>0</sub> >	16	0	0	1
Trip of stage I <sub>0</sub> >	32	0	0	1
Start of stage I <sub>0</sub> >>	64	0	0	0
Trip of stage I <sub>0</sub> >>	128	0	0	1
Start of stage ΔI>	256	0	0	0
Trip of stage ΔI>	512	0	0	0
checksum		8	0	191

**Table 5.1.10.4-6 Disturbance recorder external triggering and storing**

Event	Weighting factor	Default value of triggering mask, V243	Default value of triggering edge, V244	Default value of storing mask, V239
External BI <sup>*)</sup>	1	1	0	1
Not in use	-	0	0	0
Not in use	-	0	0	0
Not in use	-	0	0	0
Not in use	-	0	0	0
Not in use	-	0	0	0
Not in use	-	0	0	0
Not in use	-	0	0	0
checksum		1	0	1

<sup>\*)</sup> Note that the value of SGB1/3 has to be 0 (indications, output contacts and memorized values will not be reset by the binary input signal).

## Control parameters

**Table 5.1.10.4-7 Control parameters**

Description	Parameter	R, W	Value
Unlatching output contacts	V101	W	1 = unlatch
Clearing registers and unlatching output contacts	V102	W	1 = clear and unlatch
One-minute demand value	V111	R	
Demand value during the specified time range	V112	R	
Maximum one-minute demand value	V113	R	
Rated frequency	V133	R, W (P)	50=50 Hz 60=60 Hz
Time setting range for demand values in minutes	V135	R, W	0...999 min, 0 = highest demand value after reset
Remote control of settings	V150	R, W	0 = setting group 1 1 = setting group 2
Non-volatile memory settings	V152	R, W	0...31
Event mask for I> and I>>	V155	R, W	0...255, see Event codes
Event mask for I <sub>0</sub> > and I <sub>0</sub> >>	V156	R, W	0...255, see Event codes
Event mask for output contacts' events	V157	R, W	0...255, see Event codes
Event mask for the disturbance recorder and the HMI password	V158	R, W	0...7, see Event codes
Event mask for ΔI>	V159	R, W	0...15, see Event codes
Entering the SPA password for settings	V160	W	1...999
Changing the SPA password or reinstating the password protection	V161	W (P)	1...999
Changing the HMI password	V162	W	1...999

**Table 5.1.10.4-7 Control parameters (Continued)**

Description	Parameter	R, W	Value
Activating the self-supervision	V165	W	1 = the self-supervision output contact is activated and the READY indicator LED starts to blink 0 = normal operation
LED test for start and trip indicators	V166	W (P)	0 = start and trip LEDs off 1 = trip LED on, start LED off 2 = start LED on, trip LED off 3 = start and trip LEDs on
Default settings	V167	W (P)	2 = restore factory settings
Internal fault code	V169	R	0...255
Unit address of the relay	V200	R, W	1...254
Data transfer rate, kbps	V201	R, W	4.8 or 9.6
Rear communication	V202	W	1 = rear connector activated
Relay serial number	V230	R	ERxxxxxx
CPU serial number	V231	R	MRxxxxxx
Article number	V232	R	1MRS091412(/5)-BAA
Test date	V233	R	YYYYMMDD
Software number	V234	R	1MRS118011
Software revision	V235	R	A...Z
Software build number	V236	R	
Date reading and setting (RED 500 format)	V250	R, W	YY-MM-DD
Time reading and setting (RED 500 format)	V251	R, W	HH.MM; SS.sss
Reading of an event register	L	R	Time, channel number and event code
Re-reading of an event register	B	R	Time, channel number and event code
Type designation of the relay	F	R	REJ 525
Reading of relay state data	C	R	0 = normal state 1 = the relay has been subject to an automatic reset 2 = overflow of an event register 3 = both events 1 and 2
Resetting of relay state data	C	W	0 = resetting E 50 and E51 1 = reset only E50 2 = reset only E51 4 = reset all events including E51 except for E50
Time reading and setting	T	R, W	00.000... 59.999 s
Date and time reading and setting	D	R, W	YY-MM-DD HH.MM;SS.sss

## Input and output signals

The measured currents and the status of the binary input signal can be read (R) with parameters I1...I5. When the value of parameter I5 is 1, the binary input will be energized. I6 is the calculated value of the phase discontinuity.

**Table 5.1.10.4-8 Inputs**

Description	Parameter (R)	Value
Current measured on phase L <sub>1</sub>	I1	0...50 x I <sub>n</sub>
Current measured on phase L <sub>2</sub>	I2	0...50 x I <sub>n</sub>
Current measured on phase L <sub>3</sub>	I3	0...50 x I <sub>n</sub>
Measured earth-fault current	I4	0...8.0 x I <sub>n</sub>
Binary input signal	I5	0 or 1
Calculated phase discontinuity value, ΔI	I6	0...100%

Each protection stage has its internal output signal. These signals can be read (R) with parameters O1...O8, O15 and O16. The state of the output contacts can be read (R) or changed (W) with parameters O9...O12. Functions indicated by parameters O1...O12, O15 and O16 are recorded and can be read with parameters O21...O32, O35 and O36.

**Table 5.1.10.4-9 Output signals**

Status of the protection stages	State of stage (R)	Recorded functions (R)	Value
Start of stage I>	O1	O21	0 or 1
Trip of stage I>	O2	O22	0 or 1
Start of stage I>>	O3	O23	0 or 1
Trip of stage I>>	O4	O24	0 or 1
Start of stage I <sub>0</sub> >	O5	O25	0 or 1
Trip of stage I <sub>0</sub> >	O6	O26	0 or 1
Start of stage I <sub>0</sub> >>	O7	O27	0 or 1
Trip of stage I <sub>0</sub> >>	O8	O28	0 or 1
Start of stage ΔI>	O15	O35	0 or 1
Trip of stage ΔI>	O16	O36	0 or 1

**Table 5.1.10.4-10Outputs**

Operation of output contacts	State of output (R, W, P)	Recorded functions (R)	Value
Output PO1	O9	O29	0 or 1
Output PO2	O10	O30	0 or 1
Output SO1	O11	O31	0 or 1
Output SO2	O12	O32	0 or 1
Enabling output contacts PO1, PO2, SO1 and SO2	O41	-	0 or 1



Only one type of characteristic can be selected at a time. If more than one switch is selected, the characteristic with the lowest weighting factor of the selected switches will be activated.

**5.1.11. Self-supervision (IRF) system**

The REJ 525 is provided with an extensive self-supervision system which continuously supervises the software and the electronics of the relay. It handles run-time fault situations and informs the user about an existing fault via a LED on the HMI and a text message on the LCD.

When a fault is detected, the relay will first try to eliminate it by restarting. Only after the fault has been found to be permanent, the green READY indicator LED will start to blink and the self-supervision output contact will be activated. All other output contacts are blocked during an internal fault. Further, a fault indication message will appear on the LCD.

Fault indications have the highest priority on the HMI. None of the other HMI indications can override the IRF indication. As long as the READY indicator LED is blinking, the fault indication can not be cleared. In case an internal fault disappears, the READY indicator LED will stop blinking and the IRF relay will be returned to the normal service state, but the fault indication message will remain on the LCD.

The IRF code is the code of the last internal fault detected by the self-supervision system and describes the type of fault. When a fault appears, the code is to be recorded and given to an authorised repair shop when overhaul is ordered. For fault codes, refer to the Operator's Manual.

**5.1.12. Relay parameterization****Local parameterization**

The parameters of the relay can be set either locally via the HMI or externally via serial communication with the Relay Setting Tool. When the parameters are set locally, the setting parameters can be chosen via the hierarchical menu structure. The desired language can be selected for parameter descriptions. Refer to the Operator's Manual for further information.

**External parameterization**

The Relay Setting Tool is used for parameterizing the relay units. Adjusting the parameter values using the Relay Setting Tool is done off-line, after which the parameters can be downloaded to the relay via a communication port.

**5.2. Design description****5.2.1. Input/output connections**

All external circuits are connected to the terminals on the rear panel of the relay. Terminals X1.1- are dimensioned for one 0.5...6.0 mm<sup>2</sup> wire or for two max 2.5 mm<sup>2</sup> wires and terminals X2.1- for one 0.08...2.5 mm<sup>2</sup> wire or for two max 1.5 mm<sup>2</sup> wires.

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The energizing currents of the overcurrent unit are connected to terminals X1.1/4-5, X1.1/7-8 and X1.1/10-11 when the rated current of the CT secondary circuits is  $I_n = 5$  A and to terminals X1.1/4-6, X1.1/7-9 and X1.1/10-12 when it is  $I_n = 1$  A. The relay can also be used in single or two-phase applications by leaving one or two energizing inputs unoccupied.

The energizing current of the earth-fault unit is connected to terminals X1.1/1-3 (see table 5.2.1-1).

The binary input X2.1/17-18 can be used to generate an external blocking signal, to unlatch the output contacts or for remote control of relay settings. The requested function is selected in SGB. The binary input can also be used as a trigger signal for the disturbance recorder; this function is selected with SPA parameter V243.

The auxiliary voltage of the relay is connected to terminals X2.1/1-2. At DC supply, the positive lead is connected to terminal X2.1/1. For details, refer to the description of the auxiliary voltage. The permitted auxiliary voltage range of the relay is marked on the front panel of the relay.

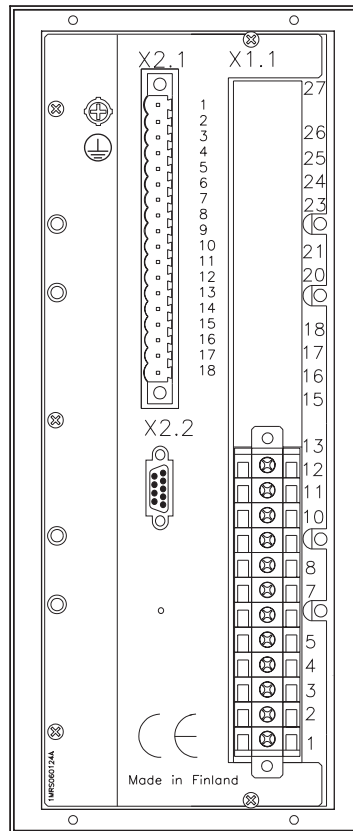
Output contacts PO1 and PO2 are heavy-duty trip contacts capable of controlling most circuit breakers. The trip signals from the different protection stages are routed to the output contacts with switches 1 and 2 of SGR1...SGR10. On delivery from the factory, the trip signals from all the protection stages are routed to both PO1 and PO2.

Output contacts SO1 and SO2 can be used for signalling on start and tripping of the relay. The signals to be routed to output contacts SO1 and SO2 are selected with switches 3 and 4 of SGR1...SGR10. On delivery from the factory, the start signals from all the protection stages are routed to both SO1 and SO2.

Output contact IRF functions as an output contact for the self-supervision system of the protection relay. The IRF relay is energized under normal operating conditions and contact gap X2.1/13-15 is closed. When a fault is detected by the self-supervision system or the auxiliary voltage is disconnected, the output contact will drop off and contact X2.1/13-14 will close.

The following picture presents a rear view of the REJ 525, showing three connecting sockets: one for measuring transformers, one for power supply and one for serial communication.

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Fig. 5.2.1.-1 Rear view of the relay

Table 5.2.1-1 Inputs for phase and earth-fault currents

Terminal	Function	
	REJ 525B 412BAA	REJ 525B 415BAA
X1.1-1	Common	Common
X1.1-2	$I_0$ 1 A	$I_0$ 5 A
X1.1-3	$I_0$ 0.2 A	$I_0$ 1 A
X1.1-4	$I_{L1}$ Common	$I_{L1}$ Common
X1.1-5	$I_{L1}$ 5 A	$I_{L1}$ 5 A
X1.1-6	$I_{L1}$ 1 A	$I_{L1}$ 1 A
X1.1-7	$I_{L2}$ Common	$I_{L2}$ Common
X1.1-8	$I_{L2}$ 5 A	$I_{L2}$ 5 A
X1.1-9	$I_{L2}$ 1 A	$I_{L2}$ 1 A
X1.1-10	$I_{L3}$ Common	$I_{L3}$ Common
X1.1-11	$I_{L3}$ 5 A	$I_{L3}$ 5 A
X1.1-12	$I_{L3}$ 1 A	$I_{L3}$ 1 A

Table 5.2.1-2 Auxiliary supply voltage

Terminal	Function
X2.1-1	Input+
X2.1-2	Input-

**Table 5.2.1-3 Output contacts**

Terminal	Function
X2.1-3	PO1, closing contact
X2.1-4	
X2.1-5	PO2, closing contact
X2.1-6	
X2.1-7	SO1, common
X2.1-8	SO1, NC
X2.1-9	SO1, NO
X2.1-10	SO2, common
X2.1-11	SO2, NC
X2.1-12	SO2, NO

**Table 5.2.1-4 IRF contact**

Terminal	Function
X2.1-13	Internal relay fault, common
X2.1-14	Closed; IRF, or $U_{aux}$ disconnected
X2.1-15	Closed; no IRF, and $U_{aux}$ connected

**Table 5.2.1-5 Binary input**

Terminal	Function
X2.1-17	Input+
X2.1-18	Input-

**5.2.2.****Serial communication connections**

The REJ 525 is interfaced with a fibre-optic bus by means of the bus connection module RER 103 via the D9S-type connector X2 located on the rear panel of the device. The terminals of the fibre-optic cables are connected to the counter terminals Rx (Receiver) and Tx (Transmitter) of the bus connection module. The fibre-optic cables are linked from one protection relay to another and to the substation level communication unit, e.g. SRIO 1000M and the RER 125.

The optical PC-connection on the front panel of the relay is used to connect the relay to a fibre-optic SPA bus via opto-cable 1MKC950001-2.

**Table 5.2.2-1 RS-485 connector X2 for the RER 103**

Terminal	Function
X.2.2-1	Data A (data signal +)
X.2.2-2	Data B (data signal -)
X.2.2-3	RTS A (request to send +)
X.2.2-4	RTS B (request to send -)
X.2.2-5	COL A (2.8 V on relay)
X.2.2-6	COL B (2.2 V on relay)
X.2.2-7	GND
X.2.2-8	NC
X.2.2-9	+5 V DC, auxiliary voltage (max. 200 mA)

## 5.2.3.

**Technical data****Table 5.2.3-1 Dimensions <sup>1)</sup>**

Width, frame 111.4 mm, box 94 mm
Height, frame 265.9 mm (6U), box 249.8 mm
Depth 235 mm (245.1 mm with a protective rear cover, available as an option)
Enclosure size 1/4 (x 19")
Weight of the relay ~3.3 kg

<sup>1)</sup> For dimension drawings, refer to the Installation Manual (1MRS 750526-MUM).

**Table 5.2.3-2 Power supply**

$U_{aux}$ rated	$U_r=10/120/220/240$ V AC $U_r=48/60/110/125/220$ V DC
$U_{aux}$ variation	80...265 V AC 38...265 V DC
Relay power start-up time, typical	300 ms
Burden of auxiliary voltage supply under quiescent/ operating condition	~5 W/~10 W
Ripple in the DC auxiliary voltage	Max 12% of the DC value
Interruption time in the auxiliary DC voltage without resetting the relay	< 30 ms at 48 V DC < 100 ms at 110 V DC < 500 ms at 220 V DC

**Table 5.2.3-3 Energizing inputs**

Rated frequency	50/60 Hz $\pm$ 5 Hz		
Rated current, $I_n$	0.2 A	1 A	5 A
Thermal withstand capability			
• continuously	1.5 A	4 A	20 A
• for 1 s	20 A	100 A	500 A
Dynamic current withstand			
• half-wave value	50 A	250 A	1250 A
Input impedance	< 750 m $\Omega$	< 100 m $\Omega$	< 20 m $\Omega$

**Table 5.2.3-4 Measuring range**

Measured currents on phases L1, L2 and L3 as multiples of the rated currents of the energizing inputs	0...50 x $I_n$
Earth-fault current as a multiple of the rated current of the energizing input	0...8 x $I_n$

**Table 5.2.3-5 Binary input**

Operating range	18...265 V DC
Rated voltage	24/48/60/110/220 V DC
Current drain	~ 2...25 mA
Power consumption	< 0.8 W

**Table 5.2.3-6 Signal outputs (SO1, SO2) and self-supervision (IRF) output**

Rated voltage	250 V AC/DC
Continuous carry	5 A
Make and carry for 3.0 s	8 A
Make and carry for 0.5 s	10 A
Breaking capacity when the control circuit time-constant L/R < 40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

**Table 5.2.3-7 Power outputs (PO1, PO2)**

Rated voltage	250 V AC/DC
Continuous carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control circuit time-constant L/R < 40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC

**Table 5.2.3-8 Enclosure class**

Front side	IP 54 (flush-mounted)
Rear side, connection terminals	IP 20
Note! A rear protective cover (accessory part) can be used to protect and shield the rear of the case.	

**Table 5.2.3-9 Environmental tests**

Specified service temperature range	-10...+55 °C
Transport and storage temperature range	-40...+70 °C according to the IEC 60068-2-48
Dry heat test	According to the IEC 60068-2-2
Dry cold test	According to the IEC 60068-2-1
Damp heat test, cyclic	According to the IEC 60068-2-30

**Table 5.2.3-10 Electromagnetic compatibility tests**

EMC immunity test level requirements consider the demands in the generic standard EN 50082-2.	
1 MHz burst disturbance test, class III • Common mode • Differential mode	According to the IEC 60255-22-1 2.5 kV 1.0 kV
Electrostatic discharge test, class III  • For contact discharge • For air discharge	According to the IEC 61000-4-2 and IEC 60255-22-2  6 kV 8 kV

**Table 5.2.3-10 Electromagnetic compatibility tests (Continued)**

Radio frequency interference tests	
• Conducted, common mode	According to the IEC 61000-4-6 and IEC 60255-22-6 (2000) 10 V (rms), f=150 kHz...80 MHz
• Radiated, amplitude-modulated	According to the IEC 61000-4-3 and IEC 60255-22-3 (2000) 10 V/m (rms), f=80...1000 MHz
• Radiated, pulse-modulated	According to the ENV 50204 and IEC 60255-22-3 (2000) 10 V/m, f=900 MHz
• Radiated, test with a portable transmitter	According to the IEC 60255-22-3 (1989), method C; f=77.2 MHz, P=6 W; f=172.25 MHz, P=5W
Fast transient disturbance tests	According to the IEC 60255-22- and IEC 61000-4-4
• Other terminals	4 kV
• Binary input	2 kV
Surge immunity test	According to the IEC 61000-4-5
• Power supply	4 kV, line-to-earth 2 kV, line-to-line
• I/O ports	2 kV, line-to-earth 1 kV, line-to-line
Power frequency (50 Hz) magnetic field	According to the IEC 61000-4-8 100 A/m continuous
Voltage dips and short interruptions	According to the IEC 61000-4-11 30%/10 ms 60%/100 ms 60%/1000 ms > 95%/5000 ms
Electromagnetic emission tests	According to the EN 55011 and EN 50081-2
• Conducted, RF-emission (Mains terminal)	EN 55011, class A, IEC 60255-25
• Radiated RF-emission	EN 55011, class A, IEC 60255-25
CE approval	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC

**Table 5.2.3-11 Standard tests**

<b>Insulation tests</b>	
Dielectric tests	According to the IEC 60255-5
• Test voltage	2 kV, 50 Hz, 1 min
Impulse voltage test	According to the IEC 60255-5
• Test voltage	5 kV, unipolar impulses, waveform 1.2/50 $\mu$ s, source energy 0.5 J
Insulation resistance measurements	According to the IEC 60255-5
• Isolation resistance	> 100 M $\Omega$ , 500 V DC
<b>Mechanical tests</b>	
Vibration tests (sinusoidal)	According to the IEC 60255-21-1, class I
Shock and bump test	According to the IEC 60255-21-2, class I

**Table 5.2.3-12 Data communication**

Rear interface, connector X2.2 <ul style="list-style-type: none"> <li>• RS-485 connection for the fibre-optic interface module RER 103</li> <li>• SPA bus or IEC 60870-5-103 protocol</li> <li>• 4.8 or 9.6 kbps</li> </ul>
Front interface <ul style="list-style-type: none"> <li>• Optical RS-232 connection for the opto-cable</li> <li>• SPA bus protocol</li> <li>• 4.8 or 9.6 kbps</li> </ul>

### Auxiliary voltage

The REJ 525 requires a secured auxiliary voltage supply to operate. The internal power supply of the relay forms the voltages required by the relay electronics. The power supply is a galvanically isolated (flyback-type) DC/DC converter. When the auxiliary voltage is connected, the READY indicator LED on the front panel will be on. For detailed information on power supply, refer to table 5.2.3-2.

The primary side of the power supply is protected with a fuse located on the PCB of the relay. The fuse size is 3.15 A (slow).



## 6. Ordering information

Order number (I <sub>0</sub> inputs 0.2 A/1 A)	REJ525B 412BAA (Article nr:1MRS091412-BAA)
Order number (I <sub>0</sub> inputs 1 A/5 A)	REJ525B 415BAA (Article nr:1MRS091415-BAA)
Protective cover for rear connectors	1MRS060132
Flush mounting kit	1MRS050209
Semi-flush mounting kit	1MRS050253
Wall mounting kit	1MRS050240
Side-by-side mounting kit	1MRS050241
19" Rack mounting kit	1MRS050257
Optic bus connection module	1MRS090701 (RER 103)
Opto-cable	1MKC950001-2



**7.****Abbreviations**

BI	Binary input
CBFP	Circuit-breaker failure protection
CPU	Central processing unit
CT	Current transformer
IDMT	Inverse definite minimum time characteristic
IEC_103	Standard IEC 60870-5-103
IRF	Internal relay fault
LCD	Liquid Crystal Display
LED	Light-emitting diode
LSG	LON <sup>®</sup> /SPA Gateway, SPA-ZC 102
HMI	Human-Machine Interface
PCB	Printed Circuit Board
PO1, PO2	Power outputs
SGB	Switchgroups for binary input
SGF	Switchgroups for functions
SGR	Switchgroups for output contacts
SO1, SO2	Signal outputs



## 8.

## Check lists

Table 8.-1 Setting group 1

Variable	Group 1 (R, W, P)	Setting range	Default setting	Customer's setting
Set start value of stage I>	S41	0.30...5.00 x I <sub>n</sub>	0.30 x I <sub>n</sub>	
Operate time or time multiplier k of stage I>	S42	0.05...300 s	0.05 s/ 0.05	
Set start value of stage I>>	S43	0.30...35.0 x I <sub>n</sub>	0.30 x I <sub>n</sub>	
Operate time of stage I>>	S44	0.04...300 s	0.04 s	
Set start value of stage ΔI>	S65	10...100%	100%	
Operate time of stage ΔI>	S66	1...300 s	60 s	
Set start value of stage I <sub>0</sub> >	S45	0.01...0.80 x I <sub>n</sub>	0.01 x I <sub>n</sub>	
Operate time or time multiplier k of stage I <sub>0</sub> >	S46	0.05...300 s	0.05 s/ 0.05	
Set start value of stage I <sub>0</sub> >>	S47	0.05...4.00 x I <sub>n</sub>	0.05 x I <sub>n</sub>	
Operate time of stage I <sub>0</sub> >>	S48	0.04...300 s	0.04 s	
Checksum, SGF1	S49	0...31	0	
Checksum, SGF2	S50	0...127	64	
Checksum, SGF3	S51	0...31	0	
Checksum, SGF4	S52	0...32	0	
Checksum, SGF5	S53	0...32	0	
Checksum, SGB1	S54	0...255	0	
Checksum, SGB2	S67	0...1	0	
Checksum, SGR1	S55	0...15	12	
Checksum, SGR2	S56	0...15	3	
Checksum, SGR3	S57	0...15	12	
Checksum, SGR4	S58	0...15	3	
Checksum, SGR5	S59	0...15	12	
Checksum, SGR6	S60	0...15	3	
Checksum, SGR7	S61	0...15	12	
Checksum, SGR8	S62	0...15	3	
Checksum, SGR9	S63	0...15	12	
Checksum, SGR10	S64	0...15	3	

Table 8.-2 Setting group 2

Variable	Group 2 (R, W, P)	Setting range	Default setting	Customer's setting
Set start value of stage I>	S81	0.30...5.00 x I <sub>n</sub>	0.30 x I <sub>n</sub>	
Operate time or time multiplier k of stage I>	S82	0.05...300 s	0.05 s/ 0.05	
Set start value of stage I>>	S83	0.30...35.0 x I <sub>n</sub>	0.30 x I <sub>n</sub>	
Operate time of stage I>>	S84	0.04...300 s	0.04 s	
Set start value of stage ΔI>	S105	10...100%	100%	
Operate time of stage ΔI>	S106	1...300 s	60 s	
Set start value of stage I <sub>0</sub> >	S85	0.01...0.80 x I <sub>n</sub>	0.01 x I <sub>n</sub>	
Operate time or time multiplier k of stage I <sub>0</sub> >	S86	0.05...300 s	0.05 s/ 0.05	

**Table 8.-2 Setting group 2 (Continued)**

Variable	Group 2 (R, W, P)	Setting range	Default setting	Customer's setting
Set start value of stage $I_0>>$	S87	0.05...4.00 x $I_n$	0.05 x $I_n$	
Operate time of stage $I_0>>$	S88	0.04...300 s	0.04 s	
Checksum, SGF1	S89	0...31	0	
Checksum, SGF2	S90	0...127	0	
Checksum, SGF3	S91	0...31	0	
Checksum, SGF4	S92	0...32	0	
Checksum, SGF5	S93	0...32	0	
Checksum, SGB1	S94	0...255	0	
Checksum, SGB2	S107	0...1	0	
Checksum, SGR1	S95	0...15	12	
Checksum, SGR2	S96	0...15	3	
Checksum, SGR3	S97	0...15	12	
Checksum, SGR4	S98	0...15	3	
Checksum, SGR5	S99	0...15	12	
Checksum, SGR6	S100	0...15	3	
Checksum, SGR7	S101	0...15	12	
Checksum, SGR8	S102	0...15	3	
Checksum, SGR9	S103	0...15	12	
Checksum, SGR10	S104	0...15	3	

**Table 8.-3 Control parameters**

Variable	Parameter	Setting range	Default setting	Customer's setting
Rated frequency	V133	50/60	50	
Demand values	V135	0...999	10	
Remote control of settings	V150	0/1	0	
Non-volatile memory settings	V152	0...31	31	
Event mask for $I>$ and $I>>$	V155	0...255	85	
Event mask for $I_0>$ and $I_0>>$	V156	0...255	85	
Event mask for output contacts' events	V157	0...255	3	
Event mask for the disturbance recorder and the HMI password	V158	0...7	1	
Event mask for $\Delta I$	V159	0...31		
Unit address of the relay	V200	1...254	1	
Data transfer rate	V201	4.8 or 9.6	9.6	
Operate time of the CFBP	S121	0.10...1.00 s	0.10 s	
Time setting for disabling new trip indications on the LCD	S122	0...999 min	60	

**Table 8.-4 Parameters for the disturbance recorder**

Information	Parameter	Setting range	Default setting	Customer's setting
Post-triggering recording length in percent	V240	0...100%	50%	
Checksum of internal signal storing mask	V238	0...1023	191	
Internal trigger signals' checksum	V241	0...1023	8	
Internal trigger signal's edge	V242	0...1023	0	
Checksum of external signal storing mask	V239	0/1	1	
External trigger signal (BI)	V243	0/1	1	
External trigger signal's edge	V244	0/1	0	
Sampling rate	M15	800/960 Hz 400/480 Hz 50/60 Hz	800/960 Hz	
Station identification/ unit number	M18	0...9999	0000	
Station name	M20	Max 16 characters	- ABB -	
Analogue channel conversion factor and unit, phases $I_{L1}$ , $I_{L2}$ and $I_{L3}$	M80...82	Factor 0...65535, unit (A, kA)	00000, A	
Analogue channel conversion factor and unit, $I_0$	M83	Factor 0...65535, unit (A, kA)	00000, A	



## 9. Service

When the protection relay is used under the conditions specified in Section 5.2.3. Technical data, it is practically maintenance-free. The protection relay electronics include no parts or components subject to abnormal physical or electrical wear under normal operating conditions.

If the relay fails in operation or if the operating values considerably differ from those mentioned in the protection relay specifications, the relay should be overhauled. All repairs are to be taken by the manufacturer. Please contact the manufacturer or its nearest representative for further information about checking, overhaul and recalibration of the relay.



To achieve the best possible operation accuracy, all parts of the protection relay have been calibrated together. In the event of malfunction, please consult your relay supplier.

If the protection relay is sent to the manufacturer, it has to be carefully packed to prevent further damage to the device.



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