Jacobsen Elektro

Protection and Control

refleX 201

Overcurrent protection
Communication IEC 60870-5-103

User Manual

1 Content

2 Hardware Description

2.1 Hardware Design

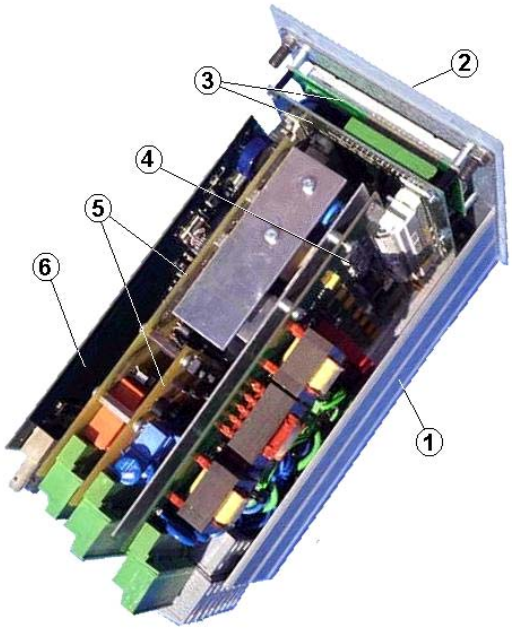
1 Housing

The extruded aluminium housing is maintenance free, and is grooved on the outside to ensure a secure grip during handling.

The circuit board guides are integrated in the housing and symmetrically located to enable the housing to be turned in any direction before mounting the circuit boards.

2 Front panel frame

The front panel frame has standard 4U height (177 mm). If mounted in 19" cubicles a special mounting frame containing up to 4 RefleX units is available. The relay may of course also be mounted into an traditional protection panel.



3 Front panel module

This module forms the base of each system unit when mounted. The multilayer front cover with the 16-key keypad is attached to a galvanised steel-plate. The mother board, the LCD-display and the D-sub connector are permanently attached to the steel plate.

Disassembly is not recommended.

4 Measuring module

This module is plugged directly into the front panel module. At the measuring module a dedicated microprocessor is used for signal conditioning and pre-filtering. The module handles up to seven input channels like currents and/or voltages. The resulting values are streamed through the front panel module to the processor module (6).

5 I/O and power module

This module consists of 1 1/2 circuit boards including all digital input/output insulation circuits (optical isolators and output relays), as well as the unit's power supply. The module is plugged into the front panel module. The smaller input board is "piggy-back" mounted on top of the output/power board.

Both circuit boards are permanently assembled, and should be handled as a single module. Disassembly is not recommended.

6 Processor module

This module contains the main digital circuits including the main microprocessor, permanent FLASH memory and random access memory (RAM) as well as the communication functions and interface.

Three complete sets of full-duplex optical fibre connectors are located here to allow for undisturbed internal and external communication.

2.2 Hardware Replacement

If panel-mounted with rear access, some RefleX parts may be replaced on site. The front module can only be replaced after dismounting the system unit from the panel.

Removal procedure

Before removing any circuit board all connections to the rear terminals must be removed.

SAFETY NOTICE !

Before working on any current measuring circuit - be absolutely sure that all circuits are shorted and disconnected !

Disconnect:

Remove the following components:

- Grounding screw located in the lower right corner of the rear panel.
- Four 5mm unbraco screws fixing the rear panel.
  One screw in each corner of the rear panel.
- Lift off the rear panel

Now the circuit boards may be removed in the following sequence:

1. Measuring module (terminals A1..A14)

2. I/O module (terminals B1..B18)
3. Processor board (terminals D1..D6)

Be sure never to remove the I/O module before the measuring module has been safely removed, to avoid damaging from the grounding strip between the two modules. In any case the processor module may be removed separately if needed.

Replacement procedure

Install each circuit board using the following procedure :

Insert circuit boards:

- Insert the measuring module to the extreme right in the relay casing (when observing the relay from the rear end). The component side of the module must point to the right.
- Then insert the I/O module.
- Finally insert the processor module into the relay casing.

Mount the rear panel:

- Replace the rear panel
- Insert and tighten the four unbraco screws
- Replace the external ground wire and fasten the ground wire fastener screw on the lower right side of the rear panel.

Reconnect all connections to the rear terminals :

- Voltage inputs at terminals A1..A6
- Current inputs at terminals A7..A14
- Binary inputs at terminals B1..B18
- Contact outputs at terminals C1..C18
- Optical fibre links at terminals D1..D6

2.3 Front panel

The RefleX front panel is designed to give the operator easy and efficient access to the system functions.

Display

The display has four lines, each with 16 characters. The backlight is on a few seconds after activating any of the 16 front panel keys.

When the unit is ready to receive changes in settings or functions this is indicated by a cursor (flashing underline) that appears in the display at the "open" location.

LED signal lamps

The three LED's are usually operated like this :

- Green "on": the unit is in normal operation
- Green "off": watchdog signal or supply error
- Yellow "on": unit activated (start) but no trip
- Red "on": unit trip relay is (was) activated

Numerical Keyboard

The three-by-four numerical keyboard enables easy input of numerical values. A dedicated "blocking" or "disable" key is also included.

Navigation keys

The four grey navigation keys are mainly self-explanatory, but application examples are found in the menu-navigation section. In this document the graphic key-symbols are named:

- ESC Key with text "Esc"
- UP Arrow pointing up
- DOWN Arrow pointing down
- ENTER Arrow pointing down and left

ID pocket

To the right of the RS232 plug, there is a "pocket". Here a label is inserted from the right side of the front panel to allow the user to identify each unit.

Front-panel computer connection

The RS232 plug is used to download the main operational software. Readout of data or changing of settings is done through the rear optical I/O.

2.4 Remote operation and readout

Settings can be changed and measured values and trip records are viewed or downloaded via a modem connection or through a local optical fibre ring-bus. All communication is based on the IEC 60870-5-103 standard. "RefCom" is an extremely user-friendly software developed by Jacobsen elektro. RefCom is used for quick and easy access to RefleX relays by mirroring the display and keyboard functions into the computer. Because the user-interface on the computer is identical to the way the relay front panel is operated, no further training is needed.

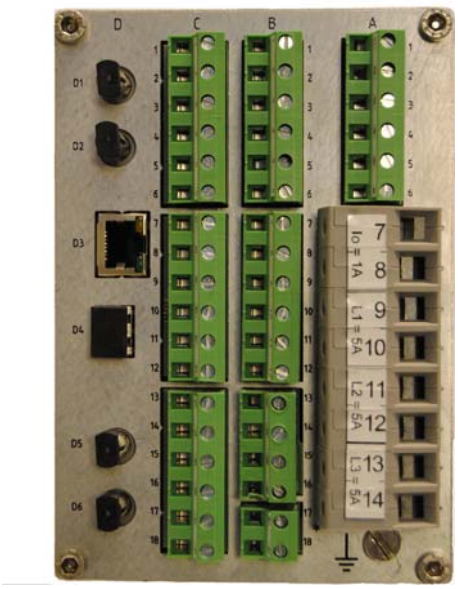
2.5 Rear Connections

The RefleX system is based on a few interchangeable and highly standardised hardware modules. Three measuring configurations are available :

- 3 phase current inputs, 1 sensitive earth fault current input and 3 voltage inputs.
- 4 current inputs, 3 voltage inputs.
- 4 current inputs, 3 voltage inputs (for measurements).

The I/O terminals may be configured to perform a number of functions, and are labeled like this :

- Column "A" : **A**nalogue inputs (measuring)
- Column "B" : 8 **B**inary inputs and power supply
- Column "C" : 8 **C**ontact outputs (relays)
- Column "D" : **D**igital communication. D1 and 2 is ST fiber internal protocol. D3 is RJ45 for LAN, D4 is LC for LAN, and D5-6 is ST fiber for serial protocol.
- All labels are numbered with the lowest value on top of each row, and both RefleX cabinet and plug is labeled.
- The function for each connection is shown in schematic in section 4.



SAFETY NOTICE !
Before working on any current measuring circuit - be absolutely sure that all circuits are shorted and disconnected !

Changing the rated currents

It is possible to change the rated currents after removing the measuring board from the relay. Instructions on how to remove the measuring board are found in the "Hardware Replacement" section 2.2.
The rated current wired in measuring board must be set in the menu.
It is recommended to send the RefleX to the factory for changing rated current.

3 Menu

3.1 Navigation

RefleX have 4 buttons for navigating in the menu. They are all marked with grey colour.

"Up and Down" buttons are used for moving to next menu picture. After entering Password, the up and down arrow is used for moving between items in the actual picture

"Enter" button is used to start a session. If enter is used on the In-service menu, then the next in-service picture will be displayed. When changes should be made in a menu, then also enter is used to start a change session. Password will be prompted. After entering password, you use the up/down arrow to move to the changeable item in the menu

"Esc" button is used to end the session you have entered. If you use "esc" twice, you always end in the normal menu.

3.2 Change a setting

- **Find.** Use the "up/down" buttons to find the menu you want to change.

- **Select.** Use the "enter" button to select the desired menu. Password will be prompted. By means of the keyboard, enter password (factory setting 1111) followed by "enter". First menu item will start flashing.

- **Change.** Use the up/down button to navigate to the menu item you want to change. The flashing item can be changed. Use keyboard to write new item. If item is alphanumerical, use "enter" to select next legal value.

When a value is changed use the "up/down" buttons to move away from the item before saving setting.

- **Save.** Use the "esc" button to leave the setting menu. A question if you want to save new setting will appear.

If settings is OK, then **save** with "enter" button.
If you want to **abort** settings use "esc", and no parameters will be changed.

3.3 Show RefleX software version

Press "1" in normal operation to display the software version in any RefleX module.
Reset the display by pressing ESC.

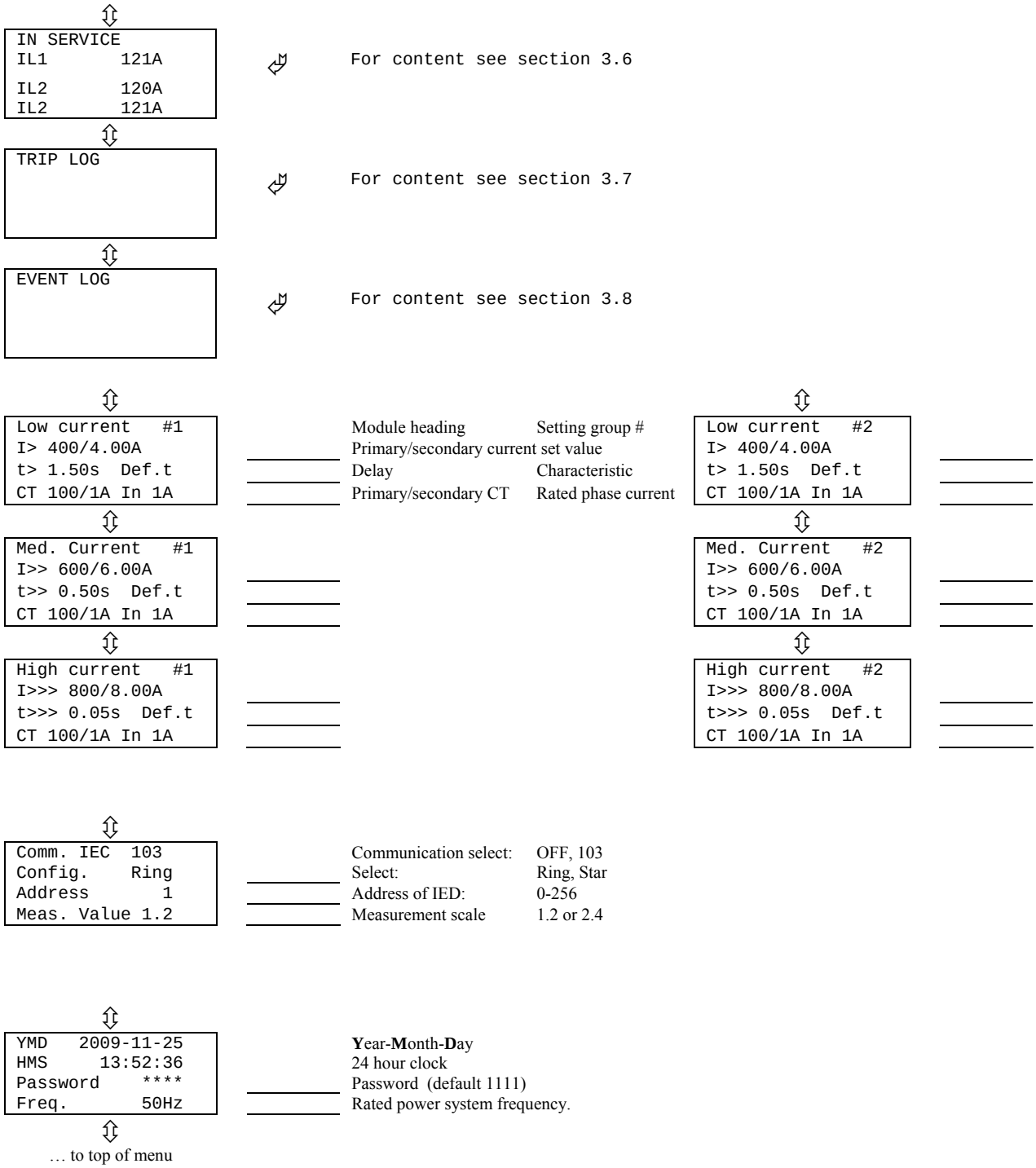
3.4 Change Password

Password is by factory default set to 1111. It can be selected any combination of four digits from the menu. To disable the password, enter password 0000.

To change the password, move to the "Date/Time picture".
Press enter to select. (Year starts blinking)
Press down arrow until the four **** for password is blinking.
Press new password (1234)
Confirm new password (1234)
Save changes by pressing ESC and confirm by pressing enter.

Also please refer to section 5.5.

3.5 Main Menu (Setting Menu)

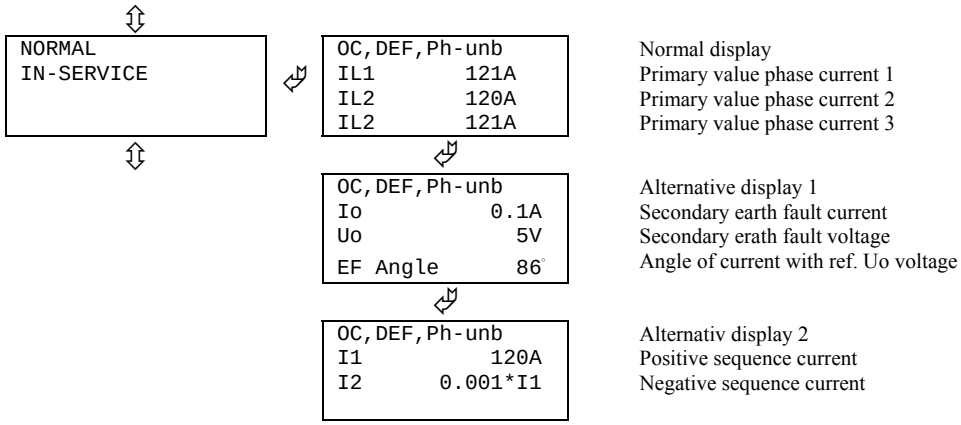


3.6 In-service Menu (Online measurement Menu)

Display shows actual analogue values.

Press “enter” to change between displays.

Chosen display will automatic be the default display. Heading shows the protection functions.

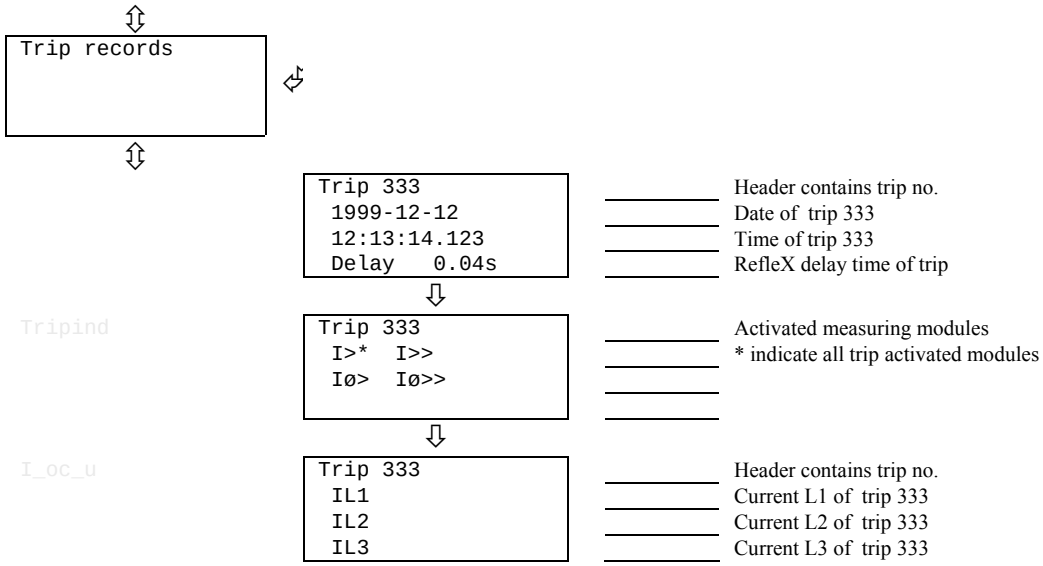


Normal display
Primary value phase current 1
Primary value phase current 2
Primary value phase current 3

Alternative display 1
Secondary earth fault current
Secondary erath fault voltage
Angle of current with ref. Uo voltage

Alternativ display 2
Positive sequence current
Negative sequence current

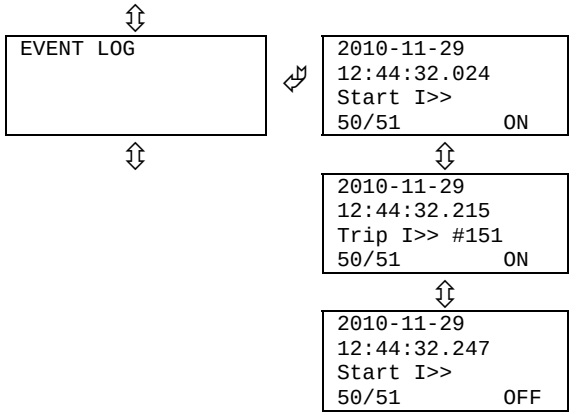
3.7 Trip Records (History Menu)



3.8 Event Log (History Menu)

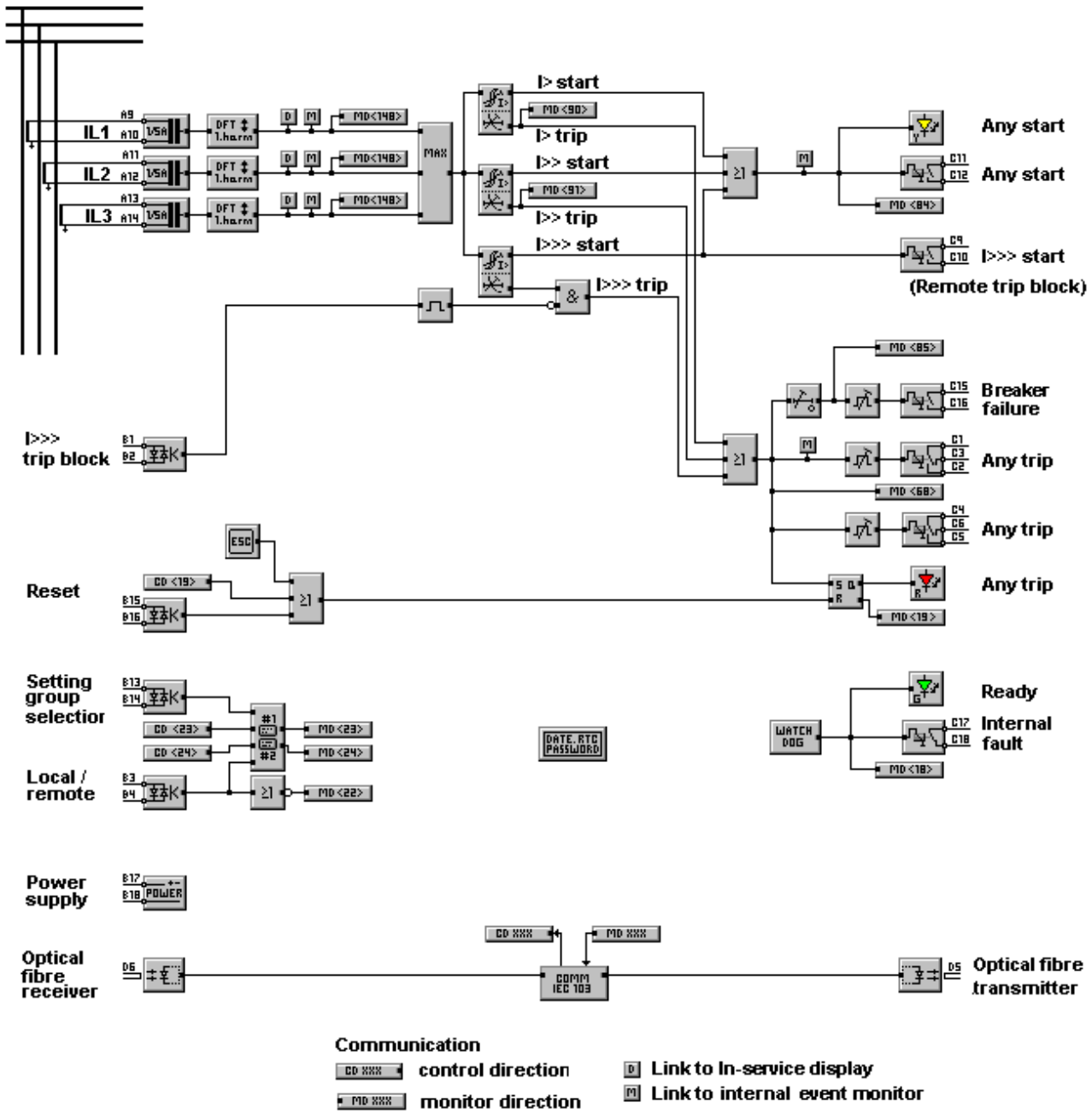
Press “enter” in the picture EVENT LOG to move from main menu to the event list.

Automatic the most resent Event is displayed. By help of the up and down arrow you navigate in the list. The display shows one event at the time.



Module heading	Setting group #
Primary/secondary current set value	
Delay	Characteristic
Primary/secondary CT	Rated phase current

4 Schematic I/O and Logic



5 Module Descriptions

5.1 Overcurrent Description (IEEE C37.2 50, 51)

The overcurrent module contains instantaneous and time overcurrent functions with possibility of 3 independent setting levels. It has 3 phase current measuring inputs and output for start and trip. In the menu the user can define overcurrent level and time delay. The overcurrent module can by menu selection change between the following time delays:

Instantaneous (def.t with t=0)
Definite time
Normal inverse
Very inverse
Extreme inverse
Long time inverse

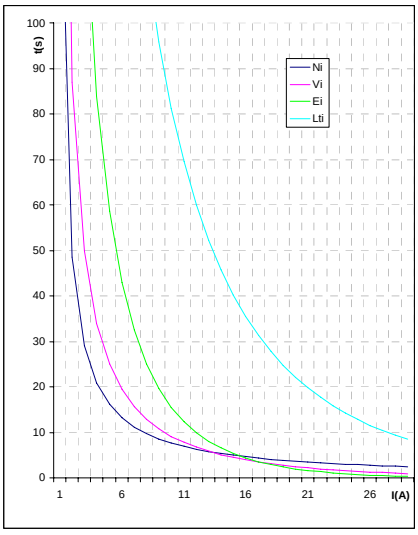
In the menu the CT ratio can be set, and the In factor can be selected according to hardware type.

The overcurrent module uses DFT (Discret Fourier Transformation) with 24 samples pr. cycle from which the amplitude and angle are calculated and output as a value of the respective currents.

5.1.1 Trip time delay

The table below shows formulas for calculating exact trip times with the different inverse characteristics available in the RefleX protective relays. The characteristics are all according to IEC 60255-3 norm.

Definite time (Def.t)	Trip time =	t		
Normal inverse (Ni)	Trip time =	$\frac{k * 0{,}14}{I0^{0{,}02} - 1}$	I0 =	$\frac{\text{Imeasure}}{\text{Isetting}}$
Very inverse (Vi)	Trip time =	$\frac{k * 13{,}5}{I0 - 1}$		
Extreme inverse (Ei)	Trip time =	$\frac{k * 80}{I0^{2} - 1}$		
Long time inverse (Lti)	Trip time =	$\frac{k * 120}{I0^{0{,}02} - 1}$		



5.2 Communication/ Events

Protection active	<18>
LED reset	<19>
Local parameter setting	<22>
Characteristic (setting group) 1	<23>
Characteristic (setting group) 2	<24>
General Trip	<68>
General start/pick –up	<84>
Breaker failure	<85>
Trip I>	<90>
Trip I>>	<91>
Measurands IL-1,-2,-3, VL-1,-2,-3, f	<148>

LED reset	<19>
Activate Characteristic (setting group) 1	<23>
Activate Characteristic (setting group) 2	<24>

5.3 Setting group

RefleX has 2 independent setting groups. The Setting Group module reads status from the input terminals or from communication ports, and changes all displayed settings to group 1 if input is low, and group 2 if input is high.

Selecting setting group from local is possible only when the input local/remote is off (low).

Selecting setting group from remote is possible only when the input local/remote is on (high).

Have in mind when selecting from remote to local control that setting group will change depending of local setting on RefleX inputs!

The SetGroup module always remembers last selected group, but these is overruled by local setting group when changing from remote to local.

5.4 Breaker failure (IEEE C37.2: 50BF)

If the fault is still present 200ms after the trip is given, the Breaker Failure function will give Breaker Failure Trip. The function is used for supervision of the circuit breaker, and breaker failure signal should be routed to the backup circuit breaker.

5.5 Password

RefleX is provided with a 4 digit password protection. The factory default password is 1111, but is easy for the user to change. By changing the password to 0000, the password function is disabled. To disable password is not recommended.

RefleX will always ask for password if user want to enter a menu that can change settings. The password is never asked for information menus like reading In service picture, reading Trip events, reading of settings etc.

Refer section 3.4 for changing password.

6 Settings

6.1 Overcurrent protection (IEEE C32.2: 50, 51)

Measurement		Three phases
Current settings (1A rated input)	I>, I>>, I>>>	0,200 - 75,0 A and ∞
Current settings (5A rated input)	I>, I>>, I>>>	1,00 - 375 A and ∞
Time characteristics		Ni, Vi, Ei, Lti and Def.t
Time multiplier for inverse time characteristics	k>, k>>, k>>>	0,10 – 1,20 and ∞
Definit time settings	t>, t>>, t>>>	0,01 – 9.99 s and ∞
Reset ratio		>0,97
Harmonic measurement		1st harmonic

6.2 Communication (IEC 60870-5-103)

System configuration		Ring/Star
Address		1 to 254*
Resolution of measurement (x In)		1.2 or 2.4
Tx		Input D5
Rx		Output D6
Transmission speed (CD and MD)	Kbit/s	19,2

*) Setting address 0, will make RefleX to act as slave on address 1, and in addition it will act as time master using the internal clock.

6.3 Setting Group

Setting Group 1 is active when input is low, or when selected from communication (remote)	Input	B13-14
Setting Group 2 is active when input is high, or when selected from communication (remote)	Input	B13-14
Setting group is selectable from communication when remote input is high	Input	B3-4

6.4 Breaker failure protection (IEEE C32.2: 50BF)

Delay before transfer of trip (fixed value)	ms	200

6.5 System data

Factory password		1111
Pulse extension on trip outputs (contacts)	ms	200 pulse
Pulse extension on block inputs	ms	50 pulse
Frequency	Hz	16⅔, 25, 50, 60

7 Technical data

7.1 Electrical data

7.1.1 AC Current inputs

Type		Phase current	(max 3 inputs)	Io current	(single input)
Rated current - In	(A rms)	1	5	1	5
Max continuos current	(A rms)	10	30	10	30
Max 3 sec current	(A rms)	100	500	100	500
Measuring range [1]	(A rms)	0.1 – 75	0.5 – 375	0.005 - 2	0.075 – 30
A/D saturation	(A peak)	± 106	± 530	± 2.82	± 42.4
Max input impedance	(mΩ)	10	2	30	2
Measuring E/F [2]	(Terminals)	-	-	A7 – A8	A7 – A8
Measuring phase L1 [2]	(Terminals)	A9 – A10	A9 – A10	-	-
Measuring phase L2 [2]	(Terminals)	A11 – A12	A11 – A12	-	-
Measuring phase L3 [2]	(Terminals)	A13 – A14	A13 – A14	-	-

[1] Max current is stated for true sine wave with no DC offset. For extreme DC offset conditions divide max values by two.
[2] Change between 1A and 5A rated current at internal connections on measuring module

7.1.2 AC Voltage inputs

Type		Voltage (max 3 inputs)
Rated voltage – Un	(V rms)	100 / 110
Max continuos voltage	(V rms)	300
Max 3 sec voltage	(V rms)	500
Measuring range [1]	(V rms)	1 – 170
A/D saturation	(V peak)	± 240
Max burden – ref. Un	(VA)	0.15
Measuring U1	(Terminals)	A1 – A2
Measuring U2	(Terminals)	A3 – A4
Measuring U3	(Terminals)	A5 – A6

[1] Max value is stated for true sine wave with no DC offset.

7.1.3 General AC current and voltage inputs

Rated frequencies – fn (three phase)	(Hz)	60 / 50
Rated frequencies – fn (single phase)	(Hz)	$25 / 16^{2/3}$
Filter cut-off frequency	(Hz)	6 * fn
Available harmonics after DFT filter	(* fn)	1 / 2 / 3 / 4 / 5
A/D conversion (parallel processing) [1]	(bit)	14 + 4
Apparent sampling rate [2]	(samples/cycle)	24
Pre-filter sampling rate [2]	(samples/cycle)	288
Apparent sampling rate ref. 60 Hz	(samples/s)	1440
Pre-filter sampling rate ref. 60 Hz	(samples/s)	17280

[1] Two parallel measuring paths with 1/16 difference in max range
[2] Sampling is automatically synchronised to system frequency

7.1.4 Power supply

Power supply	Supply voltage Input is located at I/O module	(VAC / VDC) (Terminal)	24 – 240 B17 – B18
	Permissible infeed interrupt time	(ms)	100
	Power consumption approximately	(W)	7 – 11

7.1.5 Digital inputs and

HV isolated digital inputs	Operating voltage	(Bipolar VDC)	24 – 240
(8 separate inputs)	Inputs are located at I/O module	(Terminal)	B1-B2 .. B15-B16

7.1.6 Output relays

Relay 1 [1)]	Single make / single break contact	(Terminal)	C1-C2 / C1-C3
Relay 2 [1)]	Single make / single break contact	(Terminal)	C4-C5 / C4-C6
Relay 3 [1)]	Single make-contact (NO contact)	(Terminal)	C7 – C8
Relay 4 [1)]	Single make-contact (NO contact)	(Terminal)	C9 – C10
Relay 5 [1)]	Single make-contact (NO contact)	(Terminal)	C11 – C12
Relay 6 [1)]	Single make-contact (NO contact)	(Terminal)	C13 – C14
Relay 7 [1)]	Single make-contact (NO contact)	(Terminal)	C15 – C16
Relay 8 (watchdog) [1)]	Single break-contact (NC contact)	(Terminal)	C17 – C18
Contact ratings	Rated voltage / max breaking voltage	(V)	250 / 440
	Rated current	(A)	8
	Make current (max 4s at duty cycle<10%)	(A)	30
	Rated breaking capacity (L/R = 20ms)	(W)	20
	Rated breaking capacity	(VA)	2000

[1)] All terminals are located at the I/O module

7.1.7 Data interface

Internal unit to unit bus [1)]	Location	(Terminals)	D1 (Tx) – D2 (Rx)
Serial	Connector type		2x Optical ST 50/125
	Wavelength	(nm)	850
	Max signal-rate	(Mbit/sec)	1
	Idle state		1 ”Light ON”
Communication protocoll	Location	(Terminal)	D3
LAN Ethernet connection	Connector type		RJ45
	Max signal-rate	(Mbit/sec)	10
Comunication protocoll	Location	(Terminal)	D4
LAN Ethernet connection	Connector type		Optical LC 9/125
	Wavelength	(nm)	1300
	Max signal-rate	(Mbit/sec)	100
	Idle state		0 ”Light OFF”
Communication protocoll	Location	(Terminals)	D1 (Tx) – D2 (Rx)
Serial	Connector type		2x Optical ST 50/125
	Wavelength	(nm)	850
	Max signal-rate	(Mbit/sec)	1
	Idle state		1 ”Light ON”
Offline configuration plug	Connection type at relay		9-pin RS232, female
	Located at front panel		Lower left corner
	Adapter cable (unit to pc)		Standard strigth extension cable
	Max cable-length	(m)	10

[1)] This channel is used when two ore more units are interconnected to form one single functional unit.

7.2 Environmental conditions

Insulation			Standard
Dielectric (rated insulation voltage 500V)	(kV DC)	3.6	IEC 60255-5-6 IEC 60255-5 section 4 (draft)
Min insulation resistance (test voltage 500V)	(MΩ)	100	IEC 60255-5-7
Impulse voltage (1.2/50 µs)	(kV)	5	IEC 60255-5-8

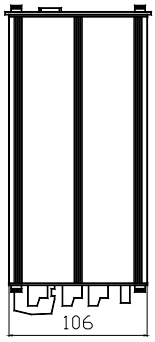
Disturbance and immunity (EMC)			Standard
1 MHz burst, class III, Common Mode	(kV)	2.5	IEC 60255-22-1
1 MHz burst, class III, Differential Mode	(kV)	1	IEC 60255-22-1
Fast transients (EFT/burst), Class IV Common Mode (line-ground)	(kV)	4	IEC 60255-22-4 / EN 61000-4-4 / EN 50082-2 clause 2.2, 3.2, 4.2
Fast transients (EFT/burst), Class IV Differential Mode (line-line)	(kV)	2	IEC 60255-22-4 / EN 61000-4-4 / EN 50082-2 clause 2.2, 3.2, 4.2
ESD, Class 3, Discharge voltage, Contact	(kV)	6	IEC 60255-22-2 / EN 61000-4-2
ESD, Class 3, Discharge voltage, Air	(kV)	8	IEC 60255-22-2 / EN 61000-4-2

Conducted RF immunity (0.15 – 80MHz)	(V EMK, CM)	10	EN 61000-4-6 EN 50082-2, Clauses 2.1, 3.1, 4.1
Radiated EM immunity, Class III (80-1000MHz and 900MHz)	(V/m)	10	IEC 60255-22-3 / EN 61000-4-3
Conducted emissions, Class A ref EN 55022 (0.15 - 0.5 MHz) (0.5 – 30 MHz)	 (µV) (µV)	 79 73	EN 50081-1(2) / EN 55022 IEC 60255-25 (draft)
Radiated emissions, Class A (Test distance 10m) (30 – 230 MHz) (230 - 1000 MHz)	 (µV/m) (µV/m)	 40 47	EN 50081-1(2) / EN 55022 IEC and 60255-25 (draft)
Power supply maximum interruption time	(ms)	100	IEC 60255-11
Power supply maximum input ripple	(%)	100	IEC 60255-11

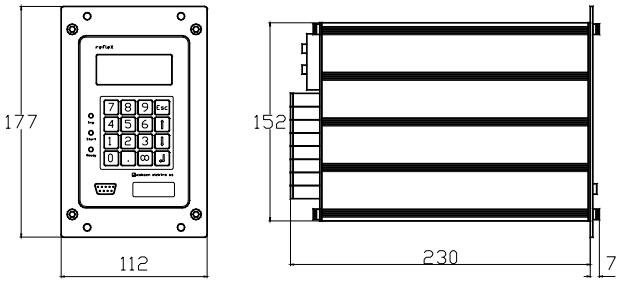
Climate and temperature			Standard
Dry heat, Operation	(°C)	+55	IEC 60255-6 IEC 60068-2-2, test B
Dry heat, Storage	(°C)	+70	IEC 60255-6 IEC 60068-2-2, test B
Cold, Operation	(°C)	-10	IEC 60255-6 IEC 60068-2-1, test A
Cold, Storage	(°C)	-40	IEC 60255-6 IEC 60068-2-1, test A
Damp heat, Storage 56 days at 40°C	(%)	90-95	IEC 60068-2-3, test C
Protection provided by enclosure (complete unit)		IP41	IEC 60529
Protection provided by enclosure (front panel)		IP53	IEC 60529

Mechanical, operation			Standard
Vibration response, Class 2 (10-150 Hz)	(g)	1	IEC 60255-21-1 / IEC 60068-2-6
Vibration endurance, Class 2 (10-150 Hz)	(g)	2	IEC 60255-21-1 / IEC 60068-2-6
Shock response, Class 2	(g)	10	IEC 60255-21-2
Seismic, Horizontal, Class 2 (2-35 Hz)	(g)	2	IEC 60255-21-3
Seismic, Vertical, Class 2 (2-35 Hz)	(g)	1	IEC 60255-21-3

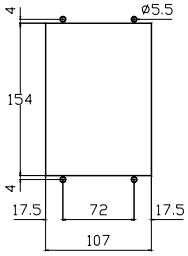
7.3 Dimensions and weight



RefleX base-unit. Weight 3.5 kg.



7.3.1 Panel Cut-out



RefleX base-unit panel-mounting cut-out

Jacobsen Elektro AS
Ringeriksveien 16, 3400 Lier, Norway
Tlf: +47 32 22 93 00 Fax: +47 32 22 93 01
www.jel.no