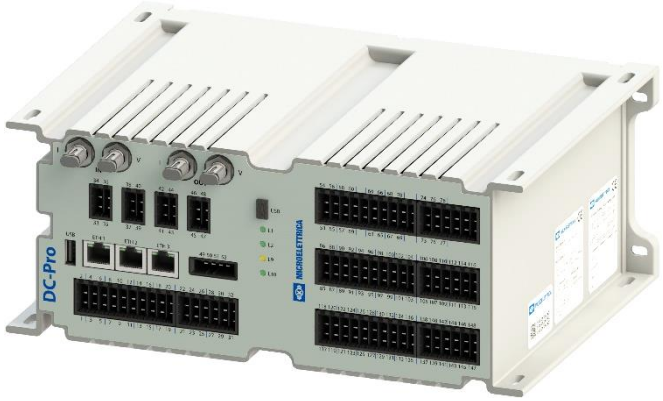
D.C. SUBSTATION PROTECTIVE RELAY

TYPE

DC-PRO

"PRO-LINE"

OPERATION MANUAL



CE

1. General Utilization and Commissioning Directions

Always make reference to the specific description of the product and to the Manufacturer's instruction.
Carefully observe the following warnings.

1.1 - Storage and Transportation

Must comply with the environmental conditions stated in the product's specification or by the applicable IEC standards.

1.2 - Installation

Must be properly made and in compliance with the operational ambient conditions stated by the Manufacturer.

1.3 - Electrical Connection

Must be made strictly according to the wiring diagram supplied with the Product, to its electrical characteristics and in compliance with the applicable standards particularly with reference to human safety.

1.4 - Measuring Inputs and Power Supply

Carefully check that the value of input quantities and power supply voltage are proper and within the permissible variation limits.

1.5 - Outputs Loading

Must be compatible with their declared performance.

1.6 - Protection Earthing

When earthing is required, carefully check its effectiveness.

1.7 - Setting and Calibration

Carefully check the proper setting of the different functions according to the configuration of the protected system, the safety regulations and the co-ordination with other equipment.

1.8 - Safety Protection

Carefully check that all safety means are correctly mounted, apply proper seals where required and periodically check their integrity.

1.9 - Handling

Notwithstanding the highest practicable protection means used in designing M.S. electronic circuits, the electronic components and semiconductor devices mounted on the modules can be seriously damaged by electrostatic voltage discharge which can be experienced when handling the modules.
The damage caused by electrostatic discharge may not be immediately apparent, but the design reliability and the long life of the product will have been reduced. The electronic circuits produced by M.S. are completely safe from electrostatic discharge (8 kV IEC 255.22.2) when housed in their case; withdrawing the modules without proper cautions expose them to the risk of damage.

1.10 - Maintenance

Make reference to the instruction manual of the Manufacturer; maintenance must be carried-out by specially trained people and in strict conformity with the safety regulations.

1.11 - Waste Disposal of Electrical & Electronic Equipment

(Applicable throughout the European Union and other European countries with separate collection program).
This product should not be treated as household waste when you wish dispose of it. Instead, it should be handed over to an applicable collection point for the recycling of electrical and electronic equipment.
By ensuring this product is disposed of correctly, you will help prevent potential negative consequence to the environment and human health, which could otherwise be caused by inappropriate disposal of this product. The recycling of materials will help to conserve natural resource.

1.12 - Fault Detection and Repair

Internal calibrations and components should not be altered or replaced.
For repair please ask the Manufacturer or its authorized Dealers.

Misapplication of the above warnings and instruction relieves the Manufacturer of any liability.

2. General

Input quantities are supplied via isolated converters with (0–20mA / 4-20mA / 12-20mA) output (overload 25mA).

It is also available two optical inputs for current (IL) and voltage (VL) for direct connection to Microelettrica MHIT converters series, without receivers.

For best accuracy and reliability, we recommend to use MHCO – MHIT measuring converters for supply of input.

2.1 - Current measurement

1 Input 0 - 20mA ≡ 0 - 1In
1 Input 0 - 20(25)mA ≡ 0 - 10(12.5)In
Measuring range 0 - 12,5 times the rated input current (12,5In)
Resolution 16 bits

Current analog input can be selectable:
- 0-20mA
- 4-20mA
- 12-20mA

The ratio from first and second current channel is programmable from 2 to 10.

2.2 - Line voltage measurement

1 Input 0 - 40mA ≡ 0 - 2Un
Measuring range 0 - 2 times the rated input voltage (2xUn)
Resolution 12 bits

2.3 - Frame earth fault current measurement

1 Input 0 - 20mA (25mA) ≡ 0 - 1In (0 – 1,25In)
Measuring range 0 - 1 times the rated input current
Resolution 12 bits

2.4 - Frame voltage measurement

1 Input 0 - 40mA ≡ 0 - 2Un
Measuring range 0 - 2 times the rated input voltage (2xUn)
Resolution 12 bits

Make electric connection in conformity with the diagram reported on relay's enclosure.
Check that input currents and voltages are same as reported on the diagram and on the test certificate.
The auxiliary power is supplied by a built-in fully isolated a self-protected unit.

2.5 – Main Unit - Power Supply

The relay can be fitted with two different types of **power supply**:

Type 1	24V(-20%) / 110V(+15%) a.c.	24V(-20%) / 125V(+20%) d.c.
Type 2	80V(-20%) / 220V(+15%) a.c.	90V(-20%) / 250V(+20%) d.c.

Before energizing the unit check that supply voltage is within the allowed limits.

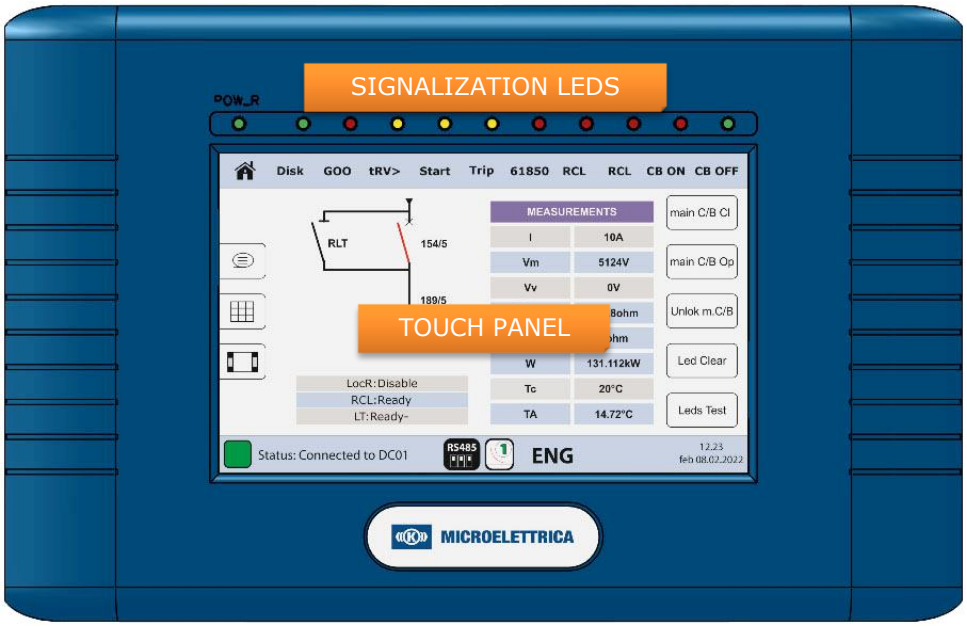
2.6 – Remote Unit - Power Supply

Type	15 ÷ 30 Vdc

The supply for remote MMI unit is available on the main relay (24Vdc – 30W max)
on terminals **73 (-) and 74 (+)** .

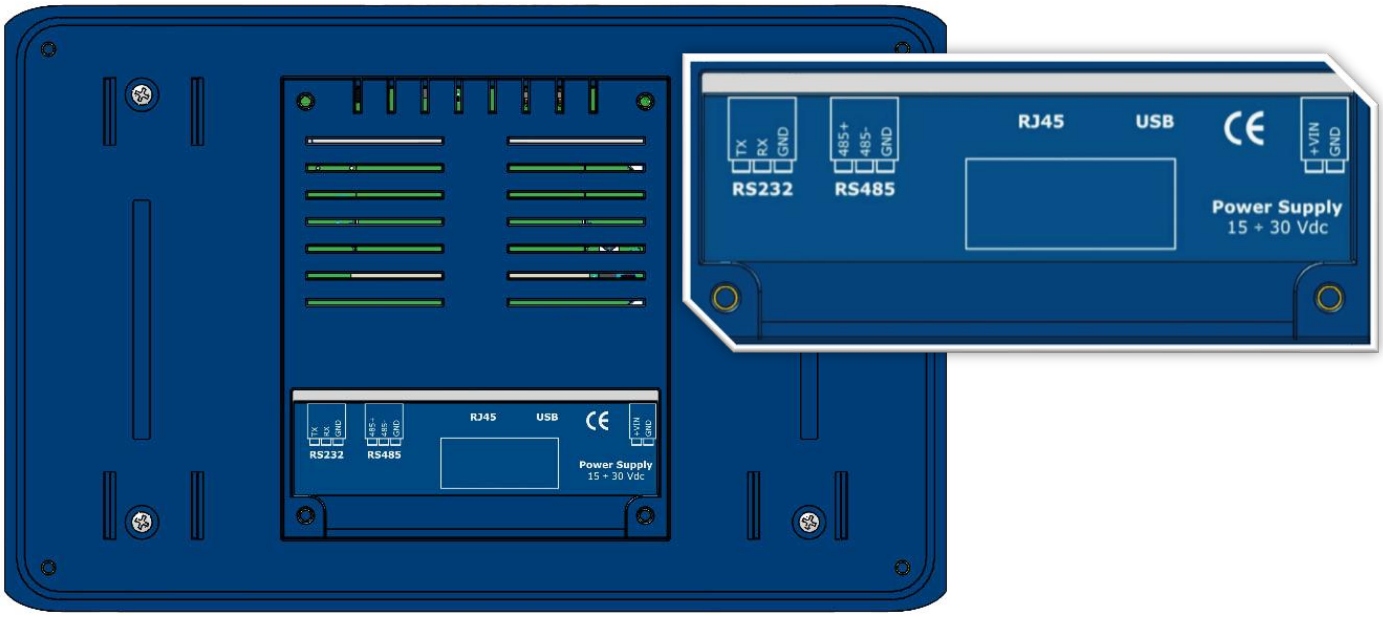
3. Remote Unit

3.1 – Front View



3.2 – Rear View

RS232	Not Used
RS485	Connection to Main Unit
RJ45	Connection to Main Unit
USB	Update Software - Remote Unit
Power Supply	Power Supply



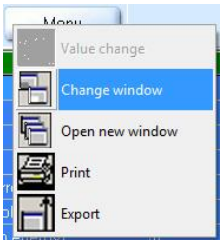
3.3 – Touch home measures settings (available only via MSCom2)

Through this menu is possible to set the order of parameters (maximum 29) shows in the home page

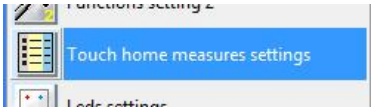
3.3.1 – Example

Open "**MSCOM2**" program and connect to the relay.

Select "Change Windows" from "Menu" button



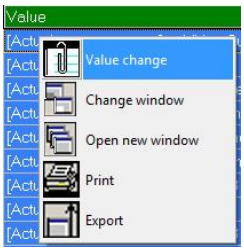
Select "Touch home measures settings".



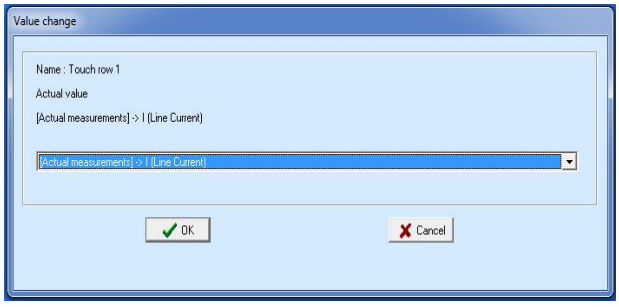
The window configuration will show:

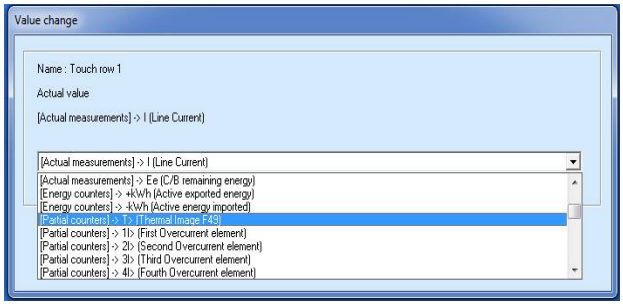
ID	Name	Value
1	Touch row 1	[Actual measurements] -> I (Line Current)
2	Touch row 2	[Actual measurements] -> U (Line Voltage)
3	Touch row 3	[Actual measurements] -> W (Power)
4	Touch row 4	[Actual measurements] -> Tem (Thermal Status %Tn)
5	Touch row 5	[Actual measurements] -> Ig (Frame to Ground fault current)
6	Touch row 6	[Actual measurements] -> Ug (Frame to Ground fault voltage)
7	Touch row 7	[Actual measurements] -> Wir (C/B residual interruption energy)
8	Touch row 8	[Actual measurements] -> RS-G (Resistance Screen/Ground)
9	Touch row 9	[Actual measurements] -> A/ms (Current rate of rise)
10	Touch row 10	[Actual measurements] -> Rapp (Impedance monitoring)

Select "**Value**" related to "Touch row 1" and press right button on mouse, select "Value change":



Select "**T>**" from combo box and press "OK" (if Password is request, see § Password):





Now on the relay display on line 1 will appear T>.

3.3.2 - Available parameters

Actual Measurements	**Stop**	*End Wiev List*	
	Empty	*Empty line*	
	I	*Line Current*	*default*
	U	*Line Voltage*	
	W	*Power*	
	Tem	*Thermal status*	
	Ig	*Frame to Ground fault current*	
	Ug	*Frame to Ground fault voltage*	
	RS-G	*Resistance Screen/Ground*	
	A/ms	*Current rate of rise*	
	Rapp	*Impedance monitoring*	
	Wir	*C/B residual interruption energy*	
	+kWh	*Active Exported energy*	
	-kWh	*Active Imported energy*	
	Vv	*C/B Downstream voltage*	
	Vm	*C/B Upstream voltage*	
	Ei	*C/B remaining energy*	
	Ee	*C/B remaining energy*	
	RLin	*Line resistance*	
	T>	*Thermal image*	
	1I>	*First overcurrent element*	
	2I>	*Second overcurrent element*	
	3I>	*Third overcurrent element*	
	4I>	*Fourth overcurrent element*	
	Iis>	*Instantaneous current element*	
	1dI	*First current step element*	
	2dI	*Second current step element*	
	1di/dt	*First current rate of rise element*	
	2di/dt	*Second current rate of rise element*	
	Rapp	*Impedance monitoring di/dt dependence*	
	Iapp	*Current monitoring with di/dt dependence*	
	1Ig	*First frame fault element*	
	2Ig	*Second frame fault element*	
	RCL	*Recloser*	
	1U>	*First Overvoltage element*	
	2U<	*Second Overvoltage element*	
	1U<	*First Undervoltage element*	
	2U<	*Second Undervoltage element*	
	Ni	*Trip number arcs interrupts operations*	
	Ne	*Trip number electrical contact operations*	
	Nm	*Trip number mechanical operations of circuit breacker*	
	RT	*Remote Trip*	
	TCS	*Trip circuit supervision*	
	IRF	*Internal Relay Fault*	
	BrkF	*Breaker Failure*	
	SelfTrip	*Spontaneous protection trip*	
	AutOp	*Automatic C/B open*	
	AutCl	*Automatic C/B close*	
	ManOp	*Manual / Intentional C/B open*	
	ManCl	*Manual / Intentional C/B close*	
	OvrOp	*Overall C/B open (automatic + Intentional)*	
	OvrCl	*Overall C/B close (automatic + Intentional)*	
	LT	*Line Test*	
	RTX	*Remote Trip*	

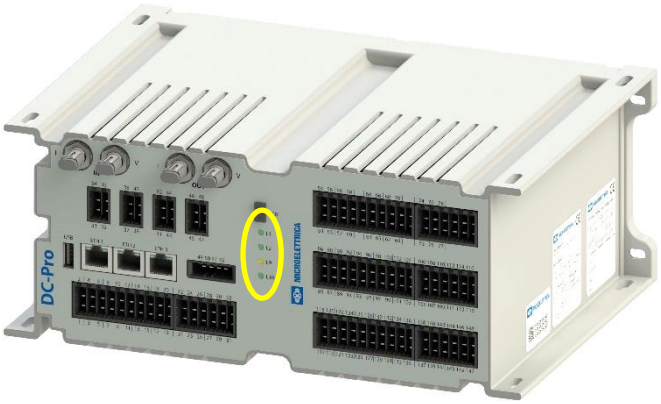
Partial Counters	**DiaCB1**	*Input position discremancy*
	AnCB1	*Operation Failure*
	OpCB1	*Opening operation*
	ClCB1	*Closures operation*
	OPrCB1	*Overall operation (close + open)*
	DiaCB2	*Input position discremancy*
	AnCB2	*Operation Failure*
	OpCB2	*Opening operation*
	ClCB2	*Closures operation*
	OPrCB2	*Overall operation (close + open)*
	DiaCB3	*Input position discremancy*
	AnCB3	*Operation Failure*
	OpCB3	*Opening operation*
	ClCB3	*Closures operation*
	OPrCB3	*Overall operation (close + open)*
	DiaCB4	*Input position discremancy*
	AnCB4	*Operation Failure*
	OpCB4	*Opening operation*
	ClCB4	*Closures operation*
	OPrCB4	*Overall operation (close + open)*
	DiaCB5	*Input position discremancy*
	AnCB5	*Operation Failure*
	OpCB5	*Opening operation*
	ClCB5	*Closures operation*
	OPrCB5	*Overall operation (close + open)*

4. Signalization

4.1 – Leds on Main Unit

4 signal leds are provided:

N°	Colour	Default Status
Led 1	Green	Not Assigned
Led 2	Yellow	Not Assigned
Led 9	Red	Not Assigned
Led 10	Green	Not Assigned

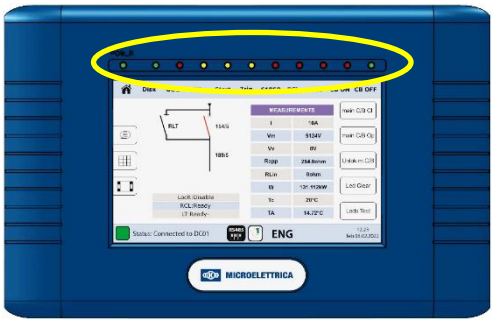


Local leds settings corresponding at remote leds 1,2 and 9,10.

4.2 – Leds on Remote Unit

11 signal leds are provided:

N°	Colour	Default Status
Led Power	Green	Power ON
Led 1	Green	Not Assigned
Led 2	Green	Not Assigned
Led 3	Green	Not Assigned
Led 4	Yellow	Not Assigned
Led 5	Red	Not Assigned
Led 6	Red	Not Assigned
Led 7	Red	Not Assigned
Led 8	Yellow	Not Assigned
Led 9	Red	Not Assigned
Led 10	Green	Not Assigned



In case of auxiliary power supply failure, the status of the leds is recorded and reproduced when power supply is restored.

Reset from Illuminated status is manual or automatic (see § Commands and § led configuration)

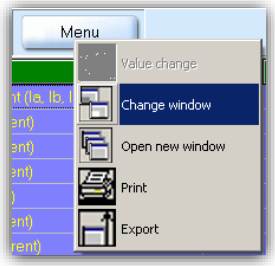
4.3 - Leds Configuration

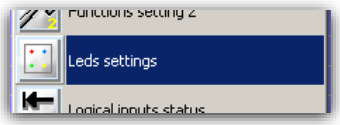
For Leds' programming (only via MSCom2) operate as follows:

Open "**MSCOM2**" program and connect to the relay.

Select "Change Windows" from "Menu" button

Select "Led Setting"





The window for led configuration will show:

ID	Name	Link enable	Status	Light prog.	Funct. Mode	Functions
1	Led 1 (Read only)	Not linked	Light off	Light on	Volatile	1I>
2	Led 2 (Read only)	Not linked	Light off	Light on	Volatile	1I>

4.3.1 - Name

Led name – for leds position see picture

4.3.2 - Link enable

Linked	=	Enable to operate
No Linked	=	Disable

4.3.3 - Status

Light-OFF	=	Normal condition	
Light-ON	=	When cause appear led is illuminated	See "Light Prog"
Flashing	=	When cause appear led is flashing	

4.3.4 - Light Prog.

Light-ON	=	When cause appear led is illuminated
Flashing	=	When cause appear led is flashing

4.3.5 - Funct. Mode

Volatile	=	When cause disappear led turn-off (Not memorized)
Latched	=	When cause disappear led remain illuminated (memorized)

4.3.6 - Functions

Select the function assigned to specific led (see table 1).
It's possible to configure only one function for each led.
For configuration multiple functions use "UserVar" function.

4.3.7 - Table 1

T>	Tal T>	(alarm) (trip)	*Thermal element*
1I>	1I> t1I>	(Start) (Trip)	*First overcurrent element*
2I>	2I> t2I>	(Start) (Trip)	*Second overcurrent element*
3I>	3I> t3I>	(Start) (Trip)	*Third overcurrent element*
4I>	4I> t4I>	(Start) (Trip)	*Fourth overcurrent element*
Iis	tIis>		*Instantaneous current*
1dI	1dI t1dI	(Start) (Trip)	*First Current step element*
2dI	2dI t2dI	(Start) (Trip)	*Second Current step element*
1di/dt	1di/dt t1di/dt	(Start) (Trip)	*First Current rate of rise element*
2di/dt	2di/dt t2di/dt	(Start) (Trip)	*Second Current rate of rise element*
Rapp	Rapp	(Trip)	*Impedance monitoring – di/dt dependance*
Iapp	Iapp		*Current monitoring with di/dt dependence*
1Ig	1Ig t1Ig	(Start) (Trip)	*First instantaneous Frame Fault element* *First time delayed Frame Fault element*
2Ig	2Ig t2Ig	(Start) (Trip)	*Second Frame Fault element*
RCL	RCL cmd ARP ARF ARL ARok ARE ARD	(Trip)	*Reclosure Shot command* *Autoreclosure in progress* *Autoreclosure Failure* *Autoreclosure Lock-out* *Autoreclosure Ok* *Autoreclosure Enable* *Autoreclosure Disable*
1U>	1U> t1U>	(Start) (Trip)	*First overvoltage element*
2U>	2U> t2U>	(Start) (Trip)	*Second overvoltage element*
1U<	1U< t1U<	(Start) (Trip)	*First undervoltage element*
2U<	2U< t2U<	(Start) (Trip)	*Second undervoltage element*
UL<	UL<		*Line Voltage Presence*
RT	RT tRT	(Trip) (Start)	*First Instantaneous Remote Trip* *First Time delayed Remote Trip*
Wi	tWi> Ni alNi Ne alNe Nm alNm		*Circuit breaker maintenance level* *Maximum number of arc chute operation at nominal values* *Alarm maintenance level of arc chute operation* *Maximum number of arc contact operation at nominal values* *Alarm maintenance level of arc contact operation* *Maximum number of mechanical operation* *Alarm maintenance level of mechanical operation*
TCS	tTCS	(Trip)	*Time delayed Trip Circuit Supervision*
IRF	IRF tIRF	(Start) (Trip)	*Time delayed Internal relay Fault* *Instantaneous Internal relay Fault*
RTX	RTX tRTX	(Trip) (Start)	*Second Instantaneous Remote Trip* *Second Time delayed Remote Trip*
CB-L	CB-L		*C/B reclose Lock-out*
BF	BF		*Breaker Failure*
Wh	+ Wh - Wh		*Imported Energy counter Pulse* *Exported Energy counter Pulse*
L/R CB Cmds	cmdOpCB cmdClCB LocRemInc missCBOpe		*Open C/B command* *Close C/B command* *Local / Remote Inconsistency* *Missed C/B opening (Digital input missing)*
LT	LTPb LTP LTF LTOK LTB LT cmd		*Output to operate an external flashing lamp signalling line test in progress* *Line Test in progress* *Line Test Failed* *Line Test OK* *Line Test Blocked* *Line Test Command*

Gen.Start	*Start Generic*	
Gen.Trip	*Trip Generic*	
UserTriggerOscillo	*User Variable for Oscillographic Recording*	
Gate<0> to Gate<98>	*User Variable*	
MasterOp1	*Modbus Master CB1 Open request*	
MasterCl1	*Modbus Master CB1 Close request*	
MasterOp2	*Modbus Master CB2 Open request*	
MasterCl2	*Modbus Master CB2 Close request*	
MasterOp3	*Modbus Master CB3 Open request*	
MasterCl3	*Modbus Master CB3 Close request*	
MasterOp4	*Modbus Master CB4 Open request*	
MasterCl4	*Modbus Master CB4 Close request*	
MasterOp5	*Modbus Master CB5 Open request*	
MasterCl5	*Modbus Master CB5 Close request*	
CB1Fail	*CB1 Failure*	
CB2Fail	*CB2 Failure*	
CB3Fail	*CB3 Failure*	
CB4Fail	*CB4 Failure*	
CB5Fail	*CB5 Failure*	
CB1missedOp	*CB1 Missed Operation*	
CB2missedOp	*CB2 Missed Operation*	
CB3missedOp	*CB3 Missed Operation*	
CB4missedOp	*CB4 Missed Operation*	
CB5missedOp	*CB5 Missed Operation*	
SelfTrip	Spontaneous protection	
t-SelfTrip	Self-Trip time delay	
Vcc	*Reserved*	
Gnd	*Reserved*	
ResLog	*Reset signal logic*	
P1	*Push-button Open*	
P2	*Push-button Close*	
0.D1	*Digital Input "0.D1"*	*activated*
0.D1Not	*Digital Input "0.D1"*	*deactivated*
to		
0.D4	*Digital Input "0.D4"*	*activated*
0.D4Not	*Digital Input "0.D4"*	*deactivated*
1.D1	*Digital Input "1.D1"*	*activated*
1.D1Not	*Digital Input "1.D1"*	*deactivated*
to		
1.D15	*Digital Input "1.D15"*	*activated*
1.D15Not	*Digital Input "1.D15"*	*deactivated*
2.D1	*Digital Input "2.D1"*	*activated*
2.D1Not	*Digital Input "2.D1"*	*deactivated*
to		
2.D15	*Digital Input "2.D15"*	*activated*
2.D15Not	*Digital Input "2.D15"*	*deactivated*
0.R1 to 0.R6	*Output relays*	
1.R1 to 1.R14	*Output relays*	
2.R1 to 2.R14	*Output relays*	
DskClean	*Internal Disk Clean (disk near to full, clean operation is required)*	
DskFull	*Internal Disk Full (disk full, write should be locked)*	
DskWR	*Internal Disk Write (active during internal disk access)*	
DskFRMT	*Internal Disk Format (active during internal disk format)*	
DskChk	*Internal Disk Check (active during internal disk check procedure)*	
rDskAttach	*Remote disk inserted (USB Key)*	
rDskDetach	*Remote disk not inserted (USB Key)*	
rDskDtchable	*Remote disk removible (USB Key)*	
rDskClean	*External Disk Clean (disk near to full, clean operation is required)*	
rDskFull	*External Disk Full (disk full, write should be locked)*	
rDskWR	*External Disk Write (active during internal disk access)*	
rDskFRMT	*External Disk Format (active during internal disk format)*	
rDskCHK	*External Disk Check (active during internal disk check procedure)*	
Sync	*Date – time syncronization event (active during clock syncronization) .*	
SNTP-DIA	*SNTP health status.*	
SNTP-KOD	*Syncro lost by server, Kiss of death. Date-Time need syncro from another server.*	
Dial	*External analog transducer fail (if different from 0-20mA) istantaneous element.*	
tDial	*External analog transducer fail (if different from 0-20mA) time delayed element.*	
I850Ready	*IEC61850 ready to work.*	
Charat1	*Characteristics 1 active*	
Charat2	*Characteristics 2 active*	
Charat3	*Characteristics 3 active*	
Charat4	*Characteristics 4 active*	

4.4 - Example: Change settings for "Led5"

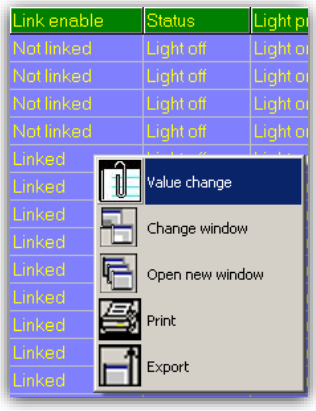
Change settings for "**LED5**" : "Enable", "Flashing", "Latched", "1I>".

Main Windows:

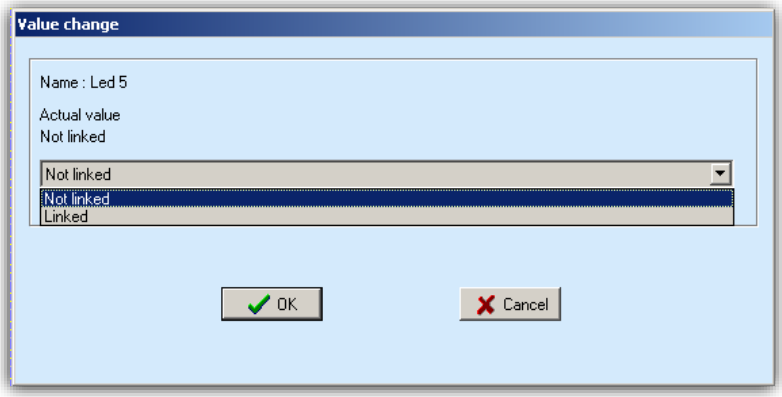
ID	Name	Link enable	Status	Light prog.	Funct. Mode	Functions
1	Led 1 (Read only)	Not linked (0)	Light off (0)	Light on (0)	Volatile (0)	1I> (0)
2	Led 2 (Read only)	Not linked (0)	Light off (0)	Light on (0)	Volatile (0)	1I> (0)
3	Led 3 (Read only)	Not linked (0)	Light off (0)	Light on (0)	Volatile (0)	1I> (0)
4	Led 4 (Read only)	Not linked (0)	Light off (0)	Light on (0)	Volatile (0)	1I> (0)
5	Led 5	Not linked (0)	Light off (0)	Light on (0)	Volatile (0)	1.D1

4.4.1 - "Enable"

Select "**Link enable**" related to "Led 5" and press right button on mouse, select "Value change":

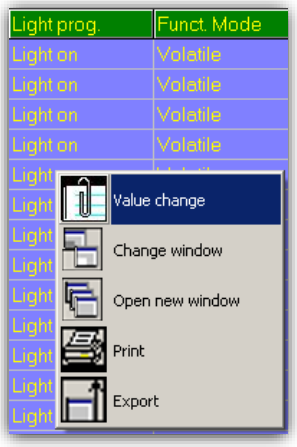


Select "**Linked**" from combo box and press "OK" (if Password is request, see § Password):

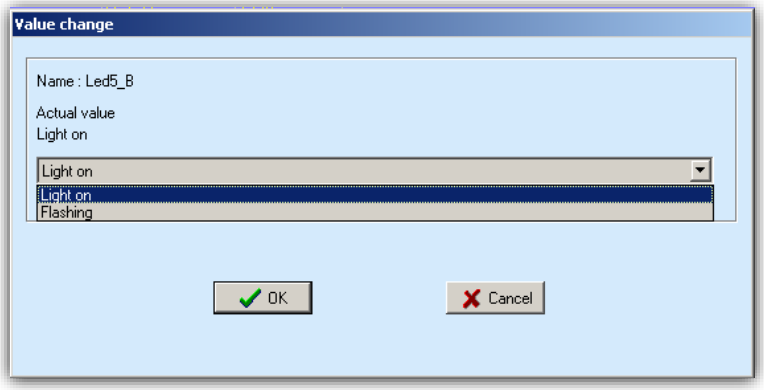


4.4.2 - "Flashing"

Select "**Light prog**" related to Led 5 and press right button on mouse, select "Value change":

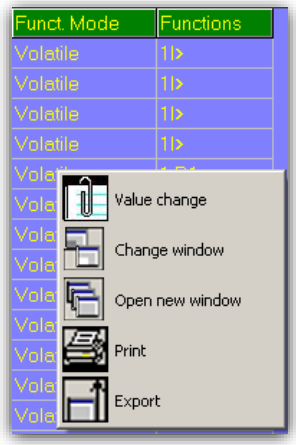


Select "**Flashing**" from combo box and press "OK" (if Password is request, see § Password):

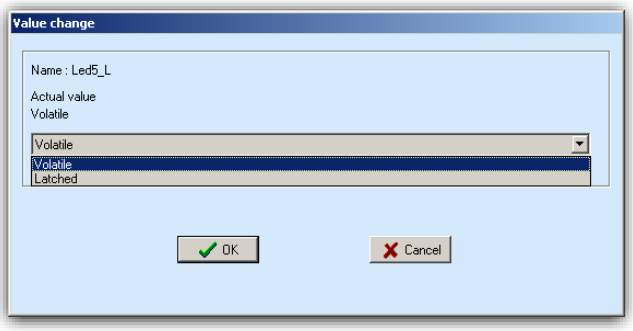


4.4.3 - "Latched"

Select "**Latched**" related to Led 5 and press right button on mouse, select "Value change":

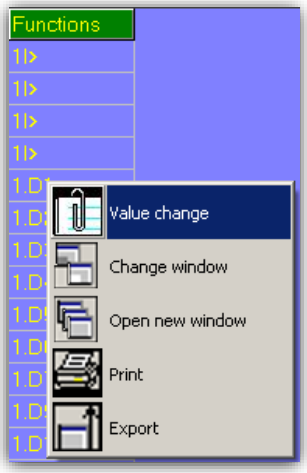


Select "**Latched**" from combo box and press "OK" (if Password is request, see § Password):

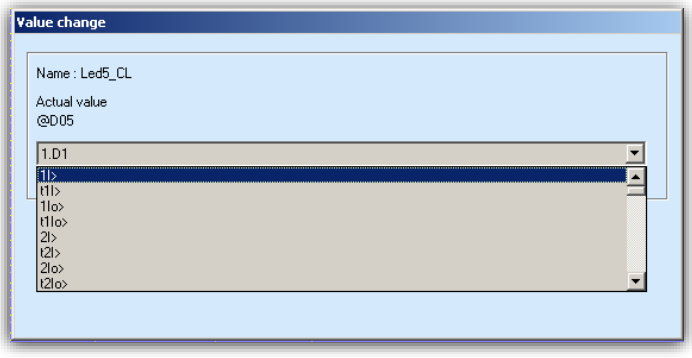


4.4.4 - "Functions"

Select "**Functions**" related to Led 5 and press right button on mouse, select "Value change":



Select "**1I>**" from combo box and press "OK" (if Password is request, see § Password):



5. User Variables

The "**USER VARIABLE**" is a result of a logical operation (Or, AND, ecc...), it can be used like other logical output. This operation is possible only via "MSCom2" software.

Name	User descr.	Linked functions	OpLogic	Timer	Timer type	Logical status

5.1 - Name

Internal progressive name

5.2 - User Descr.

Custom identification label for user variable

5.3 - Linked functions

Selection functions

5.4 - OpLogic

Operation Logic = [None, OR, AND, XOR, NOR, NAND, NOT, Ff-SR, Counter, Rise-Up, Fall-Down]

5.5 - Timer

Time delay (0-10)s, step 0.01s

5.6 - Timer type

Delay	=	Add a delay on output activation. The "Timer" is edge triggered on rise edge.
Monostable P	=	Monostable Positive , the positive length of set signal is determinate by the timer
Monostable N	=	Monostable Negative , the negative length of set signal is determinate by the timer
Blinking	=	The output blink at the specify period
Delay-Fall-Down	=	Delay to change edge

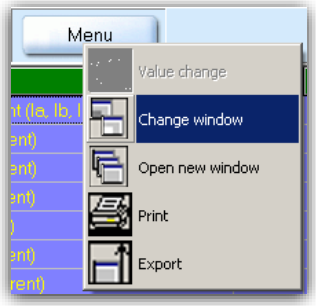
5.7 - Logical status

"User Variable" Logical status

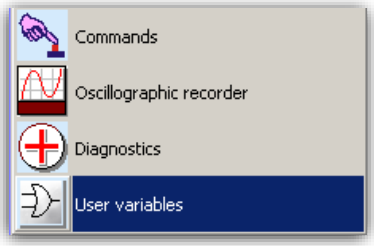
5.8 - Example: Setting "User Variable"

Open "**MSCOM2**" program and connect to the relay.

Select "Change Windows" from "Menu" button



Select "**USER VARIABLE**"

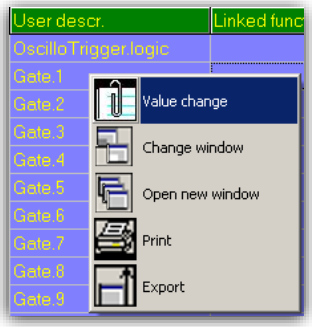


Setting for "**USERVAR<0>**" : "**Current Trip**", "**1I>,2I>,3I>**", "**OR**", "**1**", "**Monostable**".

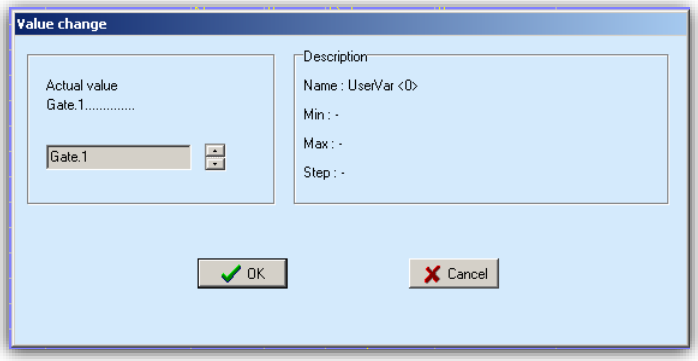
ID	Name	User descr.	Linked functions	OpLogic	Timer	Timer type	Logical status
1	User Trigger Oscillo	User Trigger Oscillo		None	0	Delay	0
2	UserVar <0>	Current trip	1I>,2I>,3I>,	OR	1	Monostable	0

5.8.1 - "User description" (User descr.)

Select "**User descr**" related to "UserVar<0>" and press right button on mouse, select "Value change":

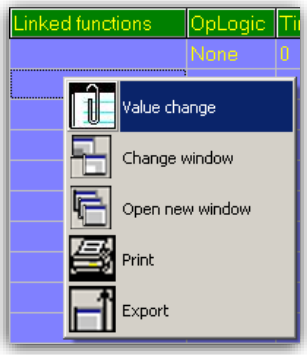


Insert "**Current Trip**" into box and press "OK":

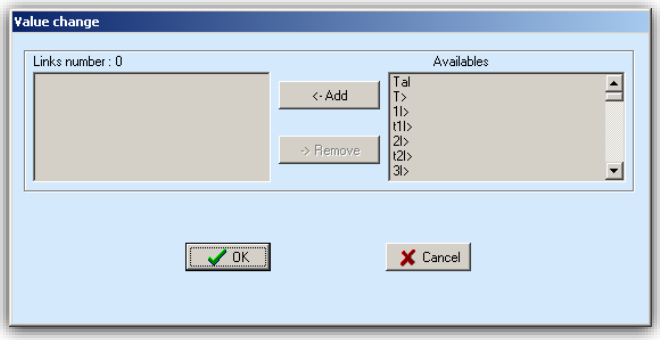


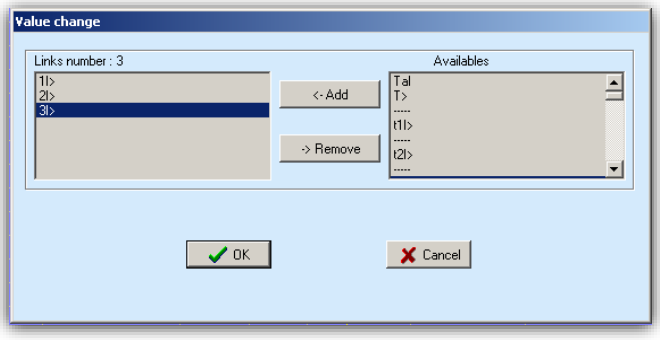
5.8.2 - "Linked Functions"

Select "**Linked Functions**" related to "UserVar<0>" and press right button on mouse,
select "Value change":



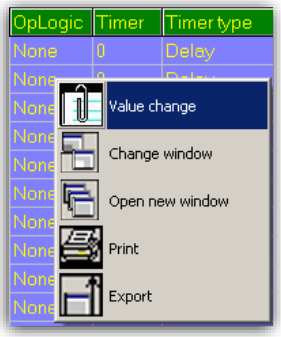
Select "**1I>, 2I>, 3I>**" from "Available" box via push-button "<Add", and press "OK".
For remove functions, use push-button ">Remove".



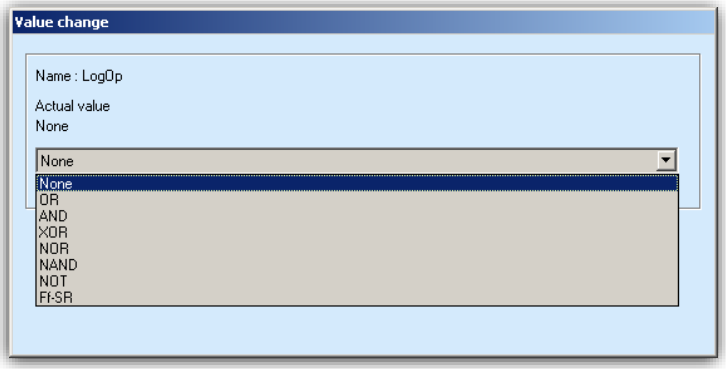


5.8.3 - "Operation Logic" (Oplogic)

Select "**Oper Logic**" related to "UserVar<0>" and press right button on mouse, select "Value change":

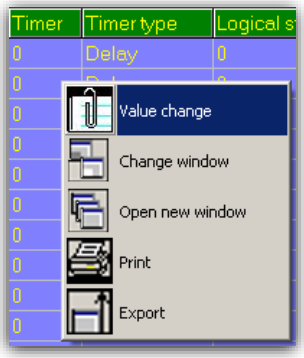


Insert "**OR**" into box and press "OK":

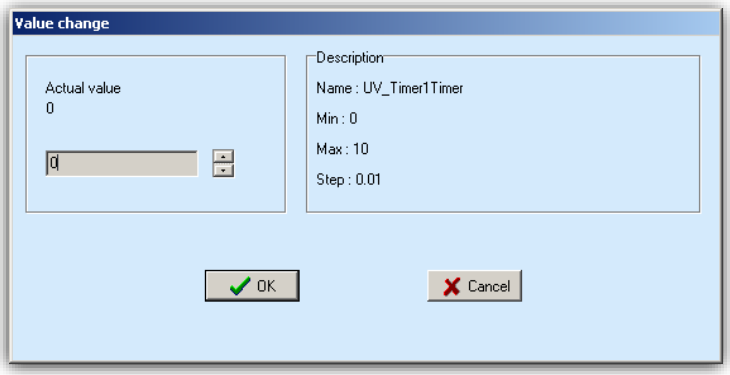


5.8.4 - "Timer"

Select "**Timer**" related to "UserVar<0>" and press right button on mouse, select "Value change":

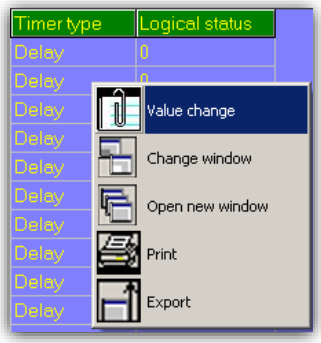


Select "**1**" into box and press "OK":

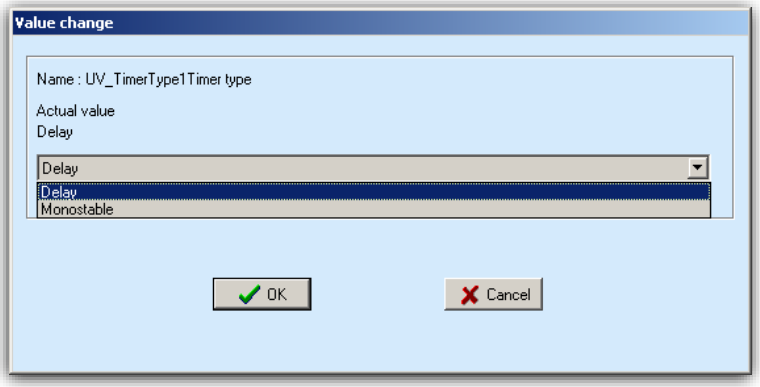


5.8.5 - "Timer type"

Select "**Timer**" related to "UserVar<0>" and press right button on mouse, select "Value change":



Select "**Monostable**" into box and press "OK":



6. Commands

Menu		Description	Password
Reset	Leds	Reset of signal Leds	Yes
Reset	Relays	Manual reset of output relays	Yes
Main breaker	Close	Manual C/B closing	Yes
Main breaker	Open	Manu al C/B opening	Yes
Main breaker	Unlock	Unlock the C/B reclosure	Yes
Reset	Event	Manual reset of Events	Yes
Reset	Last Trip	Manual reset of Last Trips	Yes
Reset	Counters	Manual reset of Counters	Yes
Reset	Energy Counters	Manual reset of Energy	Yes
Reset	Historical Fails	Reset of Internal Failure Historic records	Yes
Reset	Ei	Reset of arc chute energy register.	
Reset	Ee	Reset of arc contact energy register.	
Offset On field		External analog transducer offset calibration	
Reset	Term	Reset to zero of the accumulations relevant to Thermal Image and Interruption Energy.	Yes
Test	Leds	Signal Leds test	*No*
Closure	Breaker C/B1	Closure Breaker CB1	Yes
Opening	Breaker C/B1	Opening Breaker CB1	Yes
Closure	Breaker C/B2	Closure Breaker CB2	Yes
Opening	Breaker C/B2	Opening Breaker CB2	Yes
Closure	Breaker C/B3	Closure Breaker CB3	Yes
Opening	Breaker C/B3	Opening Breaker CB3	Yes
Closure	Breaker C/B4	Closure Breaker CB4	Yes
Opening	Breaker C/B4	Opening Breaker CB4	Yes
Closure	Breaker C/B5	Closure Breaker CB5	Yes
Opening	Breaker C/B5	Opening Breaker CB5	Yes
Force Oscillo recording		Asynchronous command for oscillographic recording	Yes
RS-G	Zero Set	Not used	Yes

7. Maximum Values (available only via MSCom2)

Maximum demand values recorded starting from 100ms after closing of main Circuit Breaker (updated any time the breaker closes).

I	A	Line current
RLin	ohm	Line resistance
W	kW	Power
Tem	%T	Thermal status as % of the full load continuous operation temperature Tn
Ig	A	Frame to ground fault current
Ug	V	Frame to ground fault voltage
Vm	V	C/B upstream voltage
A/ms		Current rate of rise
Rapp	ohm	Impedance monitoring
Ei	%	C/B arc chute remaining energy
Ee	%	C/B arc contact remaining energy

8. Energy

Real time energy measurements

Display	→	**+ kWh**	(0 – 9999999)	Exported Energy
	→	**- kWh**	(0 – 9999999)	Imported Energy

9. Last Trip

Function which caused the tripping of the relay plus values of the measurement at the moment of tripping.
The last 50 are always available on local – remote MMI interface (display or remote communication).
The memory buffer is refreshed at each new relay tripping (FIFO logic).
Each last trip record is also stored on internal / external disk without limits (except the disk capacity).

I	A	Line current
RLin	ohm	Line resistance
W	kW	Power
Tem	%T	Thermal status as % of the full load continuous operation temperature Tn
Ig	A	Frame to ground fault current
Ug	V	Frame to ground fault voltage
Vm	V	C/B upstream voltage
A/ms		Current rate of rise
Rapp	ohm	Impedance monitoring
Ei	%	C/B arc chute remaining energy
Ee	%	C/B arc contact remaining energy
DI-1	A	First current step element
DI-2	A	Second current step element

10. Partial Counters

Partial counters of the number of operations for each of the relay functions.

T>	Thermal Image
1I>	First overcurrent element
2I>	Second overcurrent element
3I>	Third overcurrent element
4I>	Fourth overcurrent element
Iis	Instantaneous overcurrent
1dI	First current step element
2dI	Second current step element
1di/dt	First current rate of rise element
2di/dt	Second current rate of rise element
Rapp	Impedance monitoring (di/dt dependence)
Iapp	Current monitoring with di/dt dependence
1Ig	First Frame Fault element
2Ig	Second Frame Fault element
RS-G	Cable insulation (Screen-Ground)
RCL	Automatic Reclosure
1U>	First Overvoltage element
2U>	Second Overvoltage element
1U<	First Undervoltage element
2U<	Second Undervoltage element
Ni	Trip number arcs interrupts operations
Ne	Trip number electrical contact operations
Nm	Trip number mechanical operations of circuit breacker
Wi	Circuit Breaker maintenance alarm
TCS	Trip Circuit Supervision
IRF	Internal Relay Fault
RT	First Remote Trip
RTX	Second Remote Trip
BrkF	Breaker failure to open
SelfTrip	Spontaneous protection
AutOp	Automatic C/B Open
AutCL	Automatic C/B Close
ManOp	Manual C/B Open
ManCL	Manual C/B Close
OvrOp	Overall C/B Open (Automatic + Manual)
OvrCL	Overall C/B Close (Automatic + Manual)
LT	Automatic Line Test
DiaCB1	CB1 Input position discrepancy
AnCB1	CB1 Operation failure
OpCB1	CB1 Openings operation
ClCB1	CB1 Closures operation
OprCB1	CB1 Overall operation (Close + Open)
DiaCB2	CB2 Input position discrepancy
AnCB2	CB2 Operation failure
OpCB2	CB2 Openings operation
ClCB2	CB2 Closures operation
OprCB2	CB2 Overall operation (Close + Open)
DiaCB3	CB3 Input position discrepancy
AnCB3	CB3 Operation failure
OpCB3	CB3 Openings operation
ClCB3	CB3 Closures operation
OprCB3	CB3 Overall operation (Close + Open)
DiaCB4	CB4 Input position discrepancy
AnCB4	CB4 Operation failure
OpCB4	CB4 Openings operation
ClCB4	CB4 Closures operation
OprCB4	CB4 Overall operation (Close + Open)
DiaCB5	CB5 Input position discrepancy
AnCB5	CB5 Operation failure
OpCB5	CB5 Openings operation
ClCB5	CB5 Closures operation
OprCB5	CB5 Overall operation (Close + Open)

Erase See § Commands
(By the interface program "MSCom2" it is possible to individually reset the counters and set an initial starting number)

11. Total Counters

Counters of the total number of operation of each individual function. These counters cannot be reset

T>	Thermal Image
1I>	First overcurrent element
2I>	Second overcurrent element
3I>	Third overcurrent element
4I>	Fourth overcurrent element
Iis	Instantaneous overcurrent
1dI	First current step element
2dI	Second current step element
1di/dt	First current rate of rise element
2di/dt	Second current rate of rise element
Rapp	Impedance monitoring (di/dt dependence)
Iapp	Current monitoring with di/dt dependence
1Ig	First Frame Fault element
2Ig	Second Frame Fault element
RS-G	Cable insulation (Screen-Ground)
RCL	Automatic Reclosure
1U>	First Overvoltage element
2U>	Second Overvoltage element
1U<	First Undervoltage element
2U<	Second Undervoltage element
Ni	Trip number arcs interrupts operations
Ne	Trip number electrical contact operations
Nm	Trip number mechanical operations of circuit breacker
Wi	Circuit Breaker maintenance alarm
TCS	Trip Circuit Supervision
IRF	Internal Relay Fault
RT	First Remote Trip
RTX	Second Remote Trip
BrkF	Breaker failure to open
SelfTrip	Spontaneous protection
AutOp	Automatic C/B Open
AutCL	Automatic C/B Close
ManOp	Manual C/B Open
ManCL	Manual C/B Close
OvrOp	Overall C/B Open (Automatic + Manual)
OvrCL	Overall C/B Close (Automatic + Manual)
LT	Automatic Line Test
DiaCB1	CB1 Input position discrepancy
AnCB1	CB1 Operation failure
OpCB1	CB1 Openings operation
ClCB1	CB1 Closures operation
OprCB1	CB1 Overall operation (Close + Open)
DiaCB2	CB2 Input position discrepancy
AnCB2	CB2 Operation failure
OpCB2	CB2 Openings operation
ClCB2	CB2 Closures operation
OprCB2	CB2 Overall operation (Close + Open)
DiaCB3	CB3 Input position discrepancy
AnCB3	CB3 Operation failure
OpCB3	CB3 Openings operation
ClCB3	CB3 Closures operation
OprCB3	CB3 Overall operation (Close + Open)
DiaCB4	CB4 Input position discrepancy
AnCB4	CB4 Operation failure
OpCB4	CB4 Openings operation
ClCB4	CB4 Closures operation
OprCB4	CB4 Overall operation (Close + Open)
DiaCB5	CB5 Input position discrepancy
AnCB5	CB5 Operation failure
OpCB5	CB5 Openings operation
ClCB5	CB5 Closures operation
OprCB5	CB5 Overall operation (Close + Open)

Erase See § Commands
(By the interface program "MSCom2" it is possible to individually reset the counters and set an initial starting number)

12. Events

Function which caused any of the following events: - *Status change of digital Inputs/Outputs. - Start of protection functions – Trip of protection function – Function reset – system information.*

The last 500 events are always available on local – remote MMI interface (display or remote communication).
The memory buffer is refreshed at each new relay event (FIFO logic).
Each event is also stored on internal / external disk without limits (except the disk capacity)

Erase	→	See § Commands

12.1 – Events

Functions	Events Displayed	Events Description MScom2	Status	
T>	Tal	*Tal (Alarm – Thermal Image T>)*	Rise	
	T>	*T> (Trip – Thermal Image T>)*	Rise	Fall
1I>	1I>	*1I> (Start - Fist overcurrent element F50-51)*	Rise	
	t1I>	*1I> (Trip - Fist overcurrent element F50-51)*	Rise	Fall
2I>	2I>	*2I> (Start – Second overcurrent element F50-51)*	Rise	
	t2I>	*2I> (Trip – Second overcurrent element F50-51)*	Rise	Fall
3I>	3I>	*3I> (Start – Third overcurrent element F50-51)*	Rise	
	t3I>	*3I> (Trip - Third overcurrent element F50-51)*	Rise	Fall
4I>	4I>	*4I> (Start - Fourth overcurrent element F50-51)*	Rise	
	t4I>	*4I> (Trip - Fourth overcurrent element F50-51)*	Rise	Fall
Iis	Iis	*Iis (Trip – Instantaneous overcurrent)*		
1dI	1dI	*1dI (Start - First Current Step Element)*	Rise	Fall
	t1dI	*1dI (Trip - First Current Step Element)*	Rise	Fall
2dI	2dI	*2dI (Start - Second Current Step Element)*	Rise	Fall
	t2dI	*2dI (Trip - Second Current. Step Element)*	Rise	Fall
1di/dt	1di/dt	*1di/dt (Start - First Current Rate of Rise Element)*	Rise	Fall
	t1di/dt	*1di/dt Trip - (First Current Rate of Rise Element)*	Rise	Fall
2di/dt	2di/dt	*2di/dt (Start - Second Current Rate of Rise Element)*	Rise	Fall
	t2di/dt	*2di/dt (Trip - Second Current Rate of Rise Element)*	Rise	Fall
Rapp	Rapp	*Rapp (Trip - Impedance monitoring-di/dt dependence)*	Rise	Fall
Iapp	Iapp	*Iapp (Trip - Current monitoring-di/dt dependence)*	Rise	Fall
1Ig	1Ig	*1Ig (Start - First Frame Fault Element)*	Rise	Fall
	t1Ig	*t1Ig (Trip - First Frame Fault Element)*	Rise	Fall
2Ig	2Ig	*2Ig (Start - Second Frame Fault Element)*	Rise	Fall
	t2Ig	*t2Ig (Trip - Second Frame Fault Element)*	Rise	Fall
RCL	RCLcmd	*RCL (Autoreclosure shot)*	Rise	
	ARP	*ARP (Autoreclosure in Progress)*	Rise	
	ARF	*ARF (Autoreclosure Failed)*	Rise	
	ARL	*ARL (Autoreclosure Lockout)*	Rise	
LT	LTcmd	*LT (Line Test Command)*	Rise	
1U>	1U>	*1U> (Start - First Overvoltage Element F59)*	Rise	
	t1U>	*1U> (Trip - First Overvoltage Element F59)*	Rise	
2U>	2U>	*2U> (Start - Second Overvoltage Element F59)*	Rise	
	t2U>	*2U> (Trip - Second Overvoltage Element F59)*	Rise	
1U<	1U<	*1U< (Start - First Undervoltage Element F59)*	Rise	
	t1U<	*t1U< (Trip - First Undervoltage Element F59)*	Rise	
2U<	2U<	*2U< (Start - Second Undervoltage Element F59)*	Rise	
	t2U<	*t2U< (Trip - Second Undervoltage Element F59)*	Rise	
Wi	tWi>	*Circuit breaker maintenance level*	Rise	
	Ni	*Maximum number of arc chute operation at nominal values*		
	alNi	*Alarm maintenance level of arc chute operation*		
	Ne	*Maximum number of arc contact operation at nominal values*		
	alNe	*Alarm maintenance level of arc contact operation*		
	Nm	*Maximum number of mechanical operation*		
	alNm	*Alarm maintenance level of mechanical operation*		
TCS	TCS	*TCS (Start - trip coil supervision)*	Rise	
	tTCS	*tTCS (trip coil supervision)*	Rise	Fall
IRF	IRF	*IRF (Start - Internal Relay Failure)*	Rise	
	tIRF	*tIRF (Trip - Internal Relay Failure)*	Rise	
RT	Start RT	*RT (Start - First element Remote Trip)*	Rise	
	Trip RT	*tRT (Trip - First element Remote Trip)*	Rise	
RTX	Start RTX	*RTX (Second element Remote Trip)*	Rise	
	Trip RTX	*tRTX (Trip - Second element Remote Trip)*	Rise	
BF	BF	*BF (Breaker Failure)*	Rise	Fall
SelfTrip	SelfTrip	Spontaneous trip		
	t-SelfTr.	Self-Trip time delay		
L/R CB Hdl	cmdOpC/B	*Circuit Breaker (CB) intentional open*	Rise	
	cmdClC/B	*Circuit Breaker (CB) intentional close*	Rise	
	LocRemInc	*Local Remote inconsistent*	Rise	
LT	LTPb	Output to operate an external flashing lamp signalling line test in progress	*Rise*	
	LTP	Line Test in progress	*Rise*	
	LTF	Line Test Failed	*Rise*	
	LTOK	Line Test OK	*Rise*	
	LTB	Line Test Blocked	*Rise*	
	LT cmd	Line Test command	*Rise*	

13. Systems (System Parameters)

Setting of system parameters.

13.1 – System Parameters

System Rated Current	**In**	4000	A	(1 ÷9999)	step	1	A
System Rated Voltage	**Un**	1000	V	(100 ÷10000)	step	10	V
System Rated Ground Current	**Ign**	1000	A	(1÷9999)	step	1	A
System Rated Ground Voltage	**Ugn**	1000	V	(100÷10000)	step	10	V
Line Test resistance	**Rtest**	1	ohm	(1÷500)	step	1	ohm

13.2 – Configuration Espansions

UX-10-4 Input modules Number	2	(0 -2)
14DI Input modules Number	0	(0 -2)
14DO Input modules Number	0	(0 -2)

13.3 – General Comunication parameters

Node Address	1	(1÷250)	step	1
Password	1111	(1111÷9999)	step	1
SetUp Group	1	(1/2/3/4)		
Date				

13.4 – Ethernet Comunication parameters

IP Address Mode	0.0.0.0	Static IP / Dynamic IP / DHCP
IPv4 address	0.0.0.0	STD Ethernet
IPv4 Subnet Mask Address	0.0.0.0	STD Ethernet
IPv4 Gateway Address	0.0.0.0	STD Ethernet
IPv4 NTP server1 Address	0.0.0.0	-
IPv4 NTP server2 Address	0.0.0.0	-
IPv4 NTP server3 Address	0.0.0.0	-
Host Name	xxxxxx	-

13.6 – Information parameters

Protection Description
IPU version
IAU version
Serial Number

13.7 – Input channel characteristics

DSPiChFact	10		(2÷10)	step	1
currR	0÷20	mA	(0÷20 / 4÷20 / 12÷20)		
currC	single		(single / dual)		
ADSEL	Analog		(Analog / Digital)		
pwmCard	1		(0 / 1)		
fibIP	Direct		(Direct / Invert)		
fibVP	Direct		(Direct / Invert)		
stI>ifBlk	Signal Disable		(Enable / Disable)		

13.7.1 – Description of variables

DSPiChFact	:	Ratio from first current analog channel and second analog channel (external transducer properties).
currR	:	Input characteristic of first and second current analog channel (external transducer properties).
currC	:	Single or dual channel external analog transducer (if single the second channel is not activated).
AdSel	:	Analog or digital source for Current (I) and voltage (Vm), digital source is provided directly on fiber optic inputs from MHIT Microelettrica transducers; The others channels (Vv, Ig, Ug) continue to work in analog mode.
fibIP	:	Digital current (I) measure direct or inverted (polarity).
fibVP	:	Digital voltage (Vm) measure direct or inverted (polarity).
stI>ifBlk	:	If enable Overcurrent instantaneous element are permanently locked when programmed block input is activated; If disable Overcurrent instantaneous element are delayed for [tBF] seconds when programmed block input is activated;

14. Settings

Four complete banks of settings of the programmable variables are available in the "***SETTING***" menu.
Both "Characteristic-1" and "-2; -3; -4" include the hereunder listed variables.

HMI	Visualization parameters
USB	USB properties.
IP Protocols	Internet protocol properties.
IEC850 Protocol	IEC61850 protocol settings.
Modbus TCP Protocol	Modbus on TCP protocol properties.
NTP	Time date synchronization settings
Time Zone/DayLight	Time zone settings.
File system and Disk management	File system an disk management.
T>	Thermal Image
1I>	First overcurrent Element
2I>	Second overcurrent Element
3I>	Third overcurrent Element
4I>	Fourth overcurrent Element
Iis	Instantaneous overcurrent
1dI	First current step element
2dI	Second current step element
1di/dt	First current rate of rise element
2di/dt	Second current rate of rise element
Rapp	Impedance monitoring - di/dt dependence
Iapp	Current monitoring with di/dt dependence
1Ig	First Frame Fault element
2Ig	Second Frame Fault element
RCL	Automatic Reclosure
1U>	First Overvoltage Element
2U>	Second Overvoltage Element
1U<	First Undervoltage Element
2U<	Second Undervoltage Element
UL<	Line voltage presence
Wi	Amount of Energy to reach the C/B maintenance level
TCS	Setting variables for Trip Circuit Supervision
IRF	Internal Relay Fault
RT	First Remote Trip
RTX	Second Remote Trip
BrkFail	Setting variables for Breaker Failure detection
Dia-I	Diagnostic analog input currents
Wh	Energy counter Pulse
SelfTrip	Spontaneous trip
Oscillo	Setting variables for Oscillographic recording
L/R CB Cmds	C/B command Local / Remote setting
CB-L	Locks C/B reclosure
LT	Line Test
ExtResCfg	Configuration for external reset input
Dia C/B	Diagnostic C/B, switches position and statistic
Auxiliary C/B	Auxiliary C/B remote commands

14.1 - Password

The password is requested any time the user wishes to modify any password protected parameter (example "1I>" menu "Setting").

The factory default password is "**1111**".

The password is only modifiable with "MSCom2" software (see Manual "MSCom2").

14.2 – Menu: **Comm.** (Serial Communication protocols options)

Options	→	**BRRem**	19200	[9600 / 19200 / 38400]
	→	**PRRem**	Modbus	[Modbus / IEC103]

14.2.1 – Description of variables

BRRem	:	RS485 remote (Rear terminal block) serial communication speed
PRRem	:	Remote communication protocol:
		Modbus = Modbus RTU
		IEC103 = IEC 103

14.2.2 –USB port (mini-USB port on main unit)

A Mini-USB socket is available on Relay's main unit for composite connection.

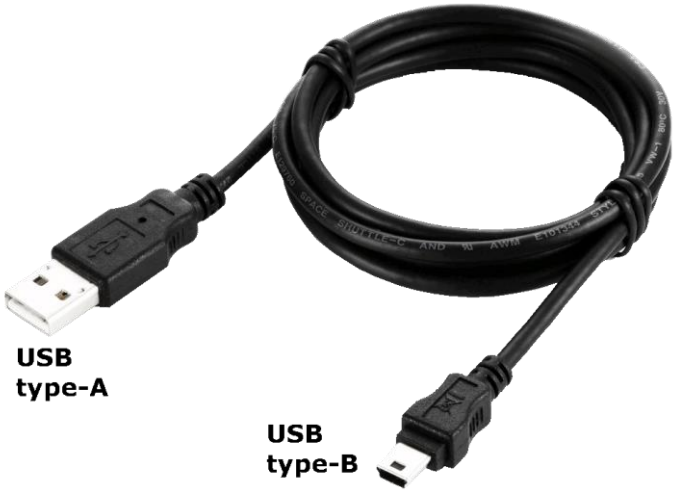
CDC service serial interface connection:
Program available from Microelettrica Scientifica S.p.A. (MSCom2 for Windows XP/Vista/7) – it is possible connect a Personal Computer to download all available information's, operate any control and program the relay; the protocol used is "**MODBUS RTU**".

MSD service interface connection:
Direct access on internal and external disk of the unit to manage files and records.

This port is also used for FW upgrade of the main unit.

14.2.3 – Cable for connection from Relay to Personal Computer

The connection cable is a standard **USB-A** /mini **USB-B**



14.2.4 – Rear serial communication port (RS485)

On the Relay's back terminal board, a RS485 ports is available for communication with SCADA system with Protocol Modbus RTU or IEC60870-5-103.
The communication interface allows programming all settings, operating all commands and downloading all information and records.
The physical connection can be via a normal pair of wires (RS485) or, on request, via fiber optic.

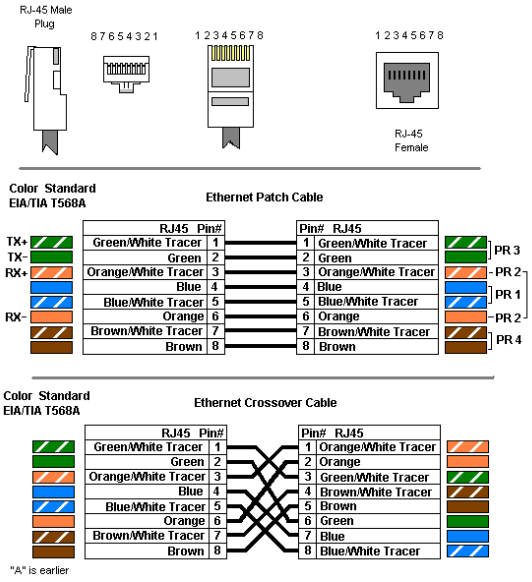
14.2.5 – Rear communication port (Ethernet)

Three Ethernet connection is available for communication on the Relay's back.
The Ethernet connector is a standard RJ45 and can be connected to a PC with a Ethernet "Cross" cable, or it can be connected to a switch with a Ethernet "Patch" cable.

These ports have simultaneous multi-protocol functionality (each communication protocol is always available on each port).

- Modbus On TCP
- IEC61850
- Internet protocol IPV4
- UDP (Network device discover Service server).
- TELNET (Remote protection Monitor server).
- FTP Protocol (File transfer server).
- NTP protocol (Network time protocol client).
- HTTP protocol (web server).

14.2.6 – Wiring the Ethernet Communication



The back Ethernet connector is a standard RJ45 connector and can be wired with a normal Ethernet UTP cable in class 5 minimum.
The relay can be connected directly to a PC with a Ethernet "Cross" cable, or it can be connected to a switch with a Ethernet "Patch" cable.

14.3 - Menu: **HMI** (Human Machine Interface)

14.3.1 – Leds (Number)

In this configuration, you can select the number of led (10 led STD on remote MMI).

Leds	→	10	*[10 / 17 / 24 / 31 / 38 / 45 / 52 / 59]*

Leds : Configuration Leds number

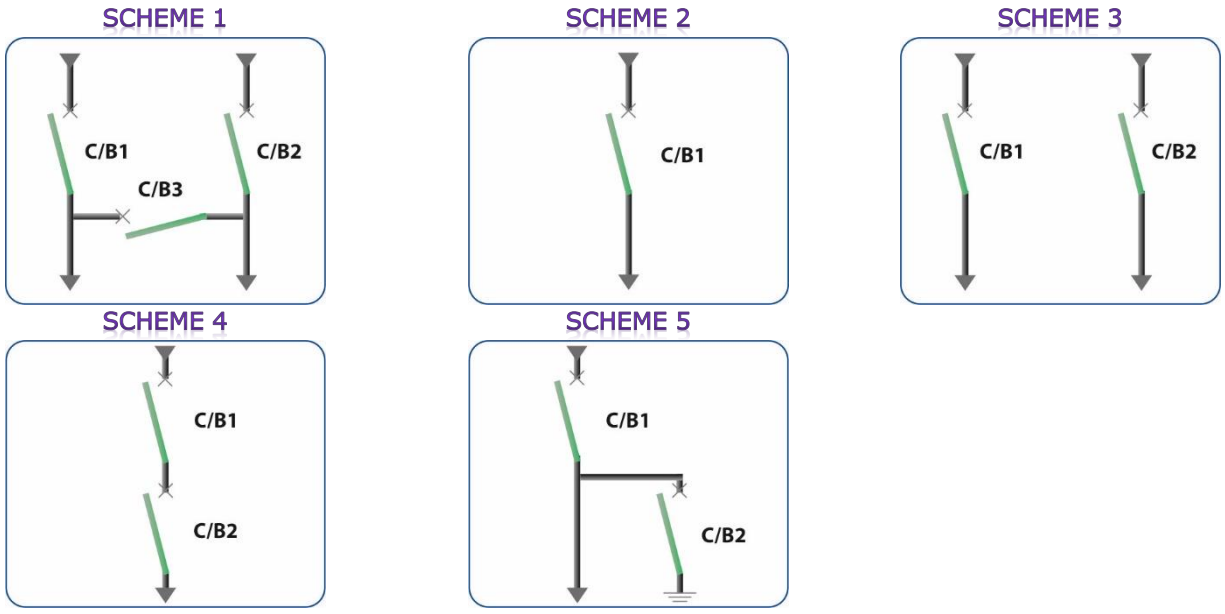
14.3.2 – WirCB scheme – Scheme configuration

In this configuration, you can select the scheme that appears on the Home page (Remote Unit).

Wir	→	*Scheme 1*	*[Scheme 1 / Scheme 2 / Scheme 3 / Scheme 4 / Scheme 5]*

Wir : Circuit Breaker wiring selector

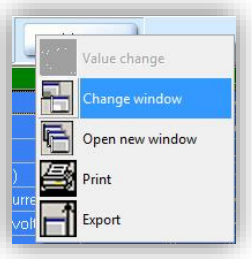
14.3.2.1 - Scheme types



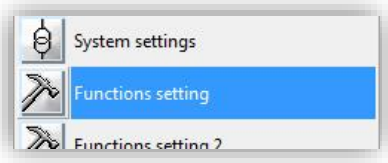
14.3.3 – Example – Configuration with MScom2 software

Open "MSCom2" program and connect to the relay.

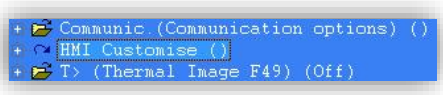
Select "**CHANGE WINDOWS**" from "Menu" button



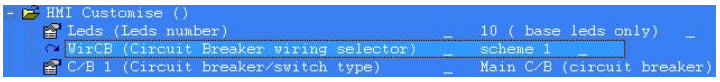
Select "**FUNCTION SETTING**"



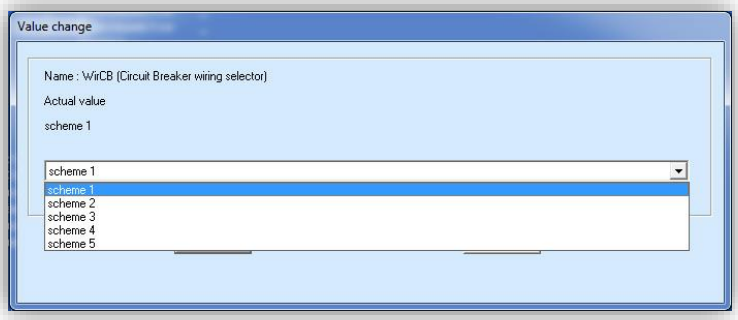
Select "**HMI**" function



Select "**CIRCUIT BREAKER WIRING SELECTOR**"



And select scheme



14.3.4 – Configuration – Close Braker

In this configuration, you can select the Main (C/B) in the sheme selected

C/B		
→	**C/B1**	Main C/B
→	**C/B2**	Disconnector
→	**C/B3**	Disconnector
→	**C/B4**	Absent
→	**C/B5**	Absent

Load Break / Disconnector / Earthing switch
High speed Earthing switch /
Main C/B (Circuit breaker) / Absent

14.4 - USB

USB	→	**USB-Device**	CDC/MSD (Composite)
	→	**USB-Host**	Stick disk 4GB (or less)

14.5 - IP Protocols

IP	→	**IPV4**	Mode/address
	→	**UPD**	Srv port: xxxx
	→	**TELNET Protocol**	Srv port: xxxx
	→	**FTP Ptotocol**	Srv port: xxxx
	→	**NTP Protocol**	Max server x
	→	**HTTP Protocol**	Port: xx

IPV4	:	Internet Protocol
UPD	:	Network Device Discover Service Server
TELNET Protocol	:	Remote Protection Monitor Server
FTP Ptotocol	:	File Transfer Server
NTP Protocol	:	Network Time Protocol Client
HTTP Protocol	:	Web Server

14.6 - IEC61850 Protocol

IEC61850	→	**IEC61850**	Protocol Disable
	→	**IEC61850**	Warnings + Error

IEC61850	:	Type: *Protocol Disable* (acquired at start-up) *Protocol Enable* (acquired at start-up)
IEC61850	:	Log Level (info class stored on internal HD): *Only info* *Only warnings* *Only errors* *Warnings + errors* *Info + Warnings + errors* *Disable*

14.7 - Modbus TCP Protocol

Modbus-TCP	→	**Modbus-TCP (Server)**	Srv port: xxx ; max connection: x

14.8 – NTP (Time/Date synchronization parameters)

NTP	→	**Enab**	Enable		[Enable/Disable]			
	→	**tSNTP**	60	**min**	[1 ÷ 3600]	step	1	min

Enab	:	Enable date and time synchronization
tSNTP	:	Periodic synchronization time

14.9 – Time Zone/DayLight (Options)

NTP	→	**GMT**	GMT+1.00h					
	→	**SumT**	Europe					
	→	**toffs**	0	**min**	[0 ÷ 600]	step	1	min

GMT	:	Time Zone
SumT	:	Isummer Time
toffs	:	Synchronizing time offset, added if summer time is disable

14.10 – File system and disks management

File System	→	**updIAU**	External disk
	→	**Log**	Protection log file on internal disk
	→	**OniDF**	Write Disable
	→	**OneDF**	Write Disable
	→	**FTPvo**	Internal disk

updIAU	:	IAU (Intelligent acquisition unit) FW update source: *Disabled : No IAU FW update procedure activated on PWR ON.* *External disk (USB stick): FW update enabled from USB stick* *Internal disk:): FW update enabled from USB stick*
Log	:	Enable log files: *Protection log file disabled* *Protection log file on internal disk* *Protection log file on external disk*
OniDF	:	Write policy on internal full disk condition: *Write disable* *Delate older folder and write*
OneDF	:	Write policy on external full disk condition: *Write disable*
FTPvo	:	FTP exported volume: *Internal disk* *External disk (USB stick)* *Both disks*

14.11 - Function: **T>** (Thermal Image F49)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Levels	→	**Tal**	50	**%Tn**	[10 ÷ 100]	step	1	%Tn
	→	**Tres**	50	**%Tb**	[10 ÷ 100]	step	1	%Tb
	→	**Is**	1	**In**	[0.5 ÷ 1.5]	step	0.01	In
	→	**Kt**	300	**min**	[1 ÷ 600]	step	0.01	min

14.11.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
Tal	:	Temperature prealarm level
Tres	:	Temperature reset (drop-off temperature)
Is	:	Continuous admissible current
Kt	:	Warming-up Time Constant of the load

14.11.2 - Trip and Alarm

The algorithm compares the amount of heat accumulated "T" (≡ $i^2 \bullet t$) to the steady state amount of heat "Ts" corresponding to continuous operation at the continuously admissible current "Is".
When the ratio "T/Ts" reaches the level set for Thermal Alarm "Tal" of the max allowed heating, the relay trips accordingly, and remain in trip condition until the temperature "T" is over the reset temperature "Tres".

14.11.1.1 – Trip time of the Thermal Image Element

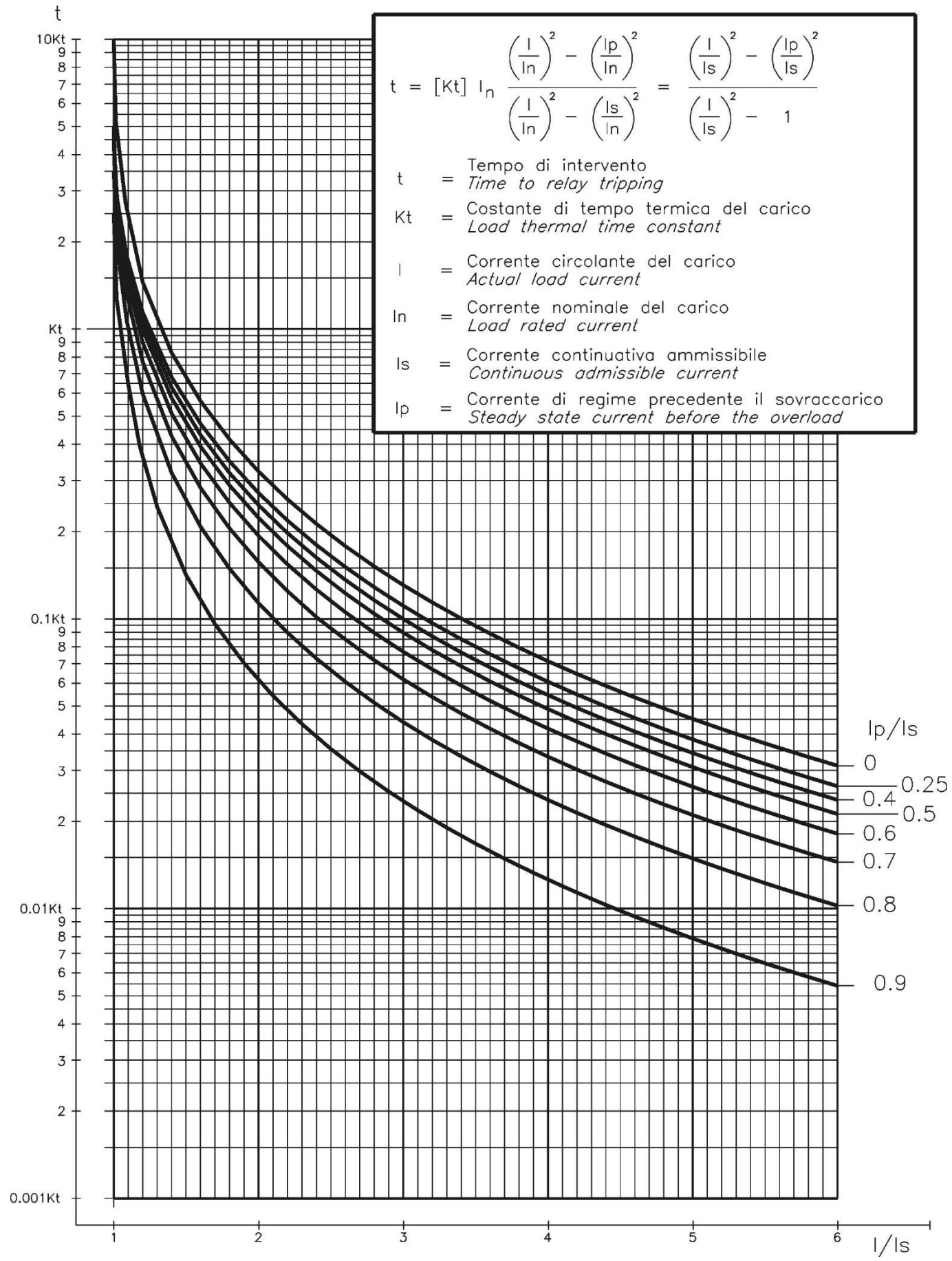
The trip time of the Thermal Image Element is a function of the current "I" flowing into the load and depends on its warming-up Time Constant "Kt", on the previous thermal status "Ip" and on the maximum admissible continuous current "Is" according to the equation:

t	=	Time to relay tripping
Kt	=	Load thermal time constant
I	=	Actual load current
In	=	Load rated current
Is	=	Continuous admissible current
Ip	=	Steady state current before the overload
ℓn	=	Natural Logarithm

$$t = Kt \cdot \ell_n \frac{\left(\frac{I}{In}\right)^2 - \left(\frac{Ip}{In}\right)^2}{\left(\frac{I}{In}\right)^2 - \left(\frac{Is}{In}\right)^2}$$

When the heating exceeds the set alarm level "Tal" or the max. allowed level ("I" > "Is" for the time "t") the output relays programmed for these function will be operated. Reset will take place when the heating will drop below 95% of the trip level.

14.11.1.2 – Thermal Image Curves (TU1024 Rev.1)



14.12 - Function: **1I>** (First Overcurrent Element F50/51)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**f(t)**	Type - D		[D / A / B / C]			
	→	**tBI**	Disable		[Disable / 2tBO]			
	→	**f(a)**	Fw		[Disable / Fw / Rev]			
	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	1	**In**	(0.1÷4)	step	0.01	In
Timers	→	**ts**	100	**s**	(0.01÷100)	step	0.01	s
	→	**tBO**	0.75	**s**	(0.05÷0.75)	step	0.01	s

14.12.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
f(t)	:	Operation characteristic (Time/Current curve): *(D)* = Independent definite time *(A)* = IEC Inverse Curve type A *(B)* = IEC Very Inverse Curve type B *(C)* = IEC Extremely Inverse Curve type C
tBI	:	Blocking input reset time: *Disable* = Permanent block *2tBO* = Set 2xtBO.
f(a)	:	Operation mode: *Disable* = Non Directional *Fw* = Directional Forward *Rev* = Directional Reverse
RCL	:	If "RCL = Yes", after tripping of the element "1I>" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Is	:	Minimum operation level
ts	:	Trip time delay
tBO	:	Time to reset of the Blocking Output after expiring of the Trip time delay. "tBO" is also the trip time delay of the Breaker Failure function.

14.12.2 - Algorithm of the time current curves

The Time Current Curves are generally calculated with the following equation

(1) $t(I)\left[\frac{A}{\left(\frac{I}{Is}\right)^{a}-1}+B\right]\cdot K\cdot T_S\cdot+T_r$ where

t(I) = Actual trip time delay when the input current equals "I"
Is = Set minimum pick-up level

$K = \left(\frac{A}{10^{a}-1}+B\right)^{-1}$

T_s = Set time delay: $t(I) = T_s$ when $\frac{I}{I_s}=10$

tr = Operation time of the output relay on pick-up.

The parameters A, B and a have different values for the different Time Current Curves.

Curve Name	Curve Identifier	A	B	a
IEC A Inverse	A	0.14	0	0.02
IEC B Very Inverse	B	13.5	0	1
IEC C Extremely Inverse	C	80	0	2

For the IEC curves, being B = 0, the Time/Current equation (1), becomes:

$(1')\quad t(I)=\frac{(10^{a}-1)Ts}{\left(\frac{I}{Is}\right)^{a}-1}+tr=\frac{Kt}{\left(\frac{I}{Is}\right)^{a}-1}+tr$

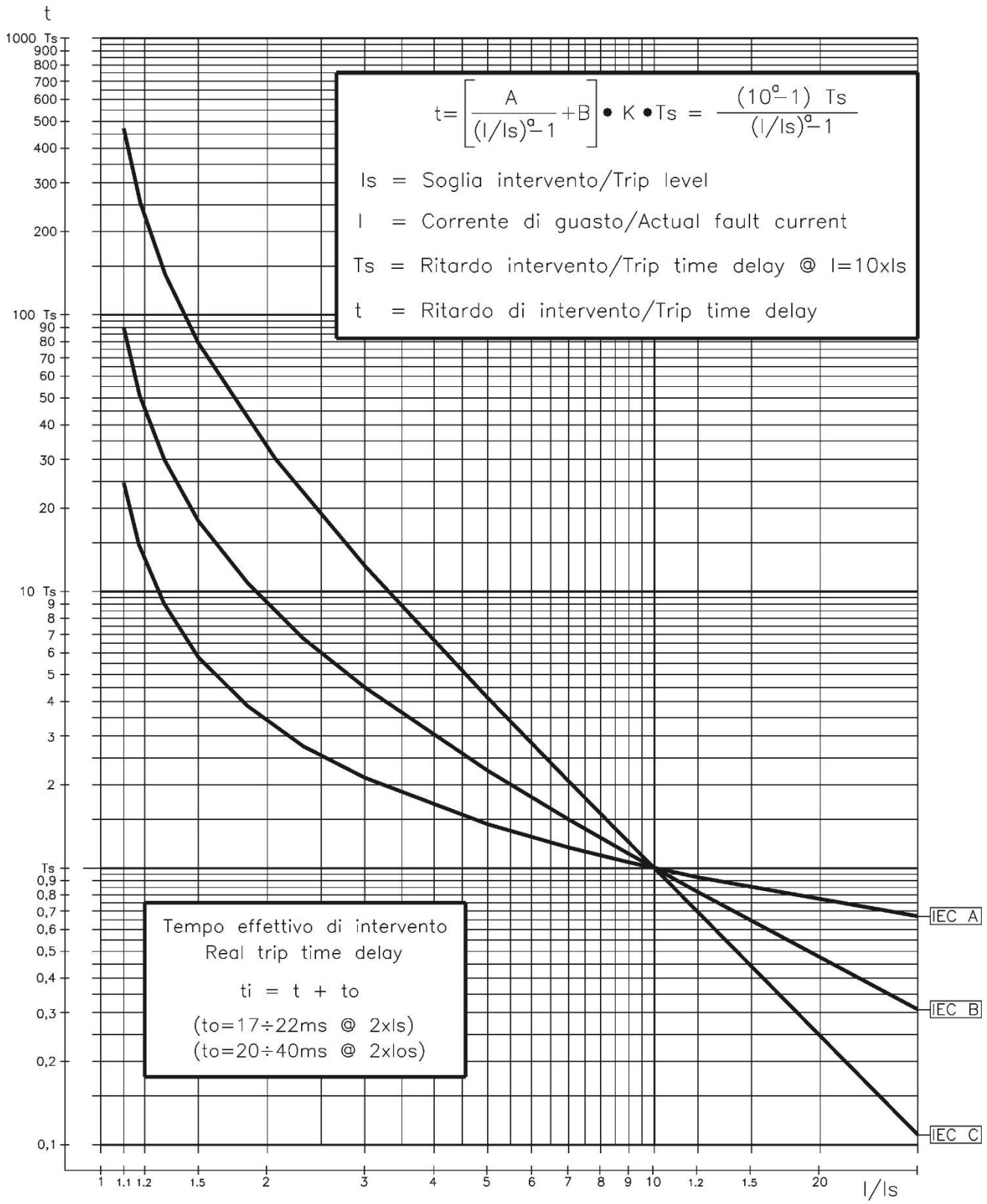
Where $Kt = (10^{a}-1)Ts$ is the time multiplier

When "f(t) = D" is programmed, the trip time delay is Definite and independent from the current: excess "t = ts".

The maximum measuring current is "40xIn" for phase elements and "10xOn" for the neutral elements.

Trip takes place when the current measured exceeds (no matter how much) the set level "Is" for the set time "ts".

14.12.3 - IEC Curves



Curve Type	A	B	K	a
IEC A	0.14	0	0.336632	0.02
IEC B	13.5	0	0.666667	1
IEC C	80	0	1.2375	2

Max. "I" Phase = 40xIn
Max. "I" Neutral = 10xOn

14.12.4 – Blocking Logic (BO-BI)

For each Protection Function it is possible to activate a Blocking Logic allowing for inhibiting their operation by external signals supplied to the Digital Input.

14.12.4.1 – Output Blocking signal "BO"

All the protection functions that can be programmed to operate in the blocking logic mode, element, have an instantaneous element (beside the time delayed) which is operated as soon as the controlled quantity exceeds the set trip level (I > [Is] for current, etc..) and is instantaneously reset when the input quantity drops below the reset level (normally 0.95Is).
The instantaneous element can control one of the user programmable output relays that, by its contacts, makes the signal available for blocking an external element (BO = Blocking Output).
In case, "tBO" sec after the set trip time "ts" has expired, the Protection function is still in operation (current above trip level), the Blocking Output relay (instantaneous element) is anyhow reset to eventually remove the Blocking signal from a back-up protection.

18.6.4.2 – Blocking Input "BI"

For all the functions controllable by the Blocking Logic, it is possible to inhibit the time delayed tripping by an external signal that activates a Digital Input programmed for this functionality.
The programmed Digital Input gets activated by an external cold contact closing across its terminals.
With the variable "tBI" set to "OFF" (tBI=OFF), the tripping of the delayed function is blocked as long as the Blocking Input signal is present at the terminals of the Digital Input.
With the variable "tBI" set to "2xtBI" (tBI=2xtBI), 2xtBI seconds after the set trip time delay of the function has expired the blocking input is anyhow ignored and the function enabled to trip.

14.12.5 - Automatic doubling of Overcurrent thresholds on current inrush

For some of the phase Overcurrent functions it is possible to have the set trip level [Is] automatically doubled when strong inrush current is detected.
If at circuit Breaker switch-on (i.e. when the input current rises from zero to a minimum measurable value) the current increases from 0 to 1.5 times the rated value [In] in less than 60ms, the set minimum pick-up level [Is] is dynamically doubled ([Is]→[2Is]) and keeps this value until the input current drops below 1.25xIn or the set time [t2xI] has elapsed.
This functionality is very useful to avoid spurious tripping of the instantaneous, or short-time delayed Overcurrent elements, that could be experienced at switch-on when energizing the feeder.

14.13 – Function: **2I>** (Second Overcurrent Element F50/51)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**f(t)**	Type - D		[D / A / B / C]			
	→	**tBI**	Disable		[Disable / 2tBO]			
	→	**f(a)**	Disable		[Disable / Fw / Rev]			
	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	1	**In**	(0.1÷4)	step	0.01	In
Timers	→	**ts**	100	**s**	(0.01÷100)	step	0.01	s
	→	**tBO**	0.75	**s**	(0.05÷0.75)	step	0.01	s

14.13.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
f(t)	:	Operation characteristic (Time/Current curve): *(D)* = Independent definite time *(A)* = IEC Inverse Curve type A *(B)* = IEC Very Inverse Curve type B *(C)* = IEC Extremely Inverse Curve type C
tBI	:	Blocking input reset time *Disable* = Permanent block *2tBO* = Set 2xtBO.
f(a)	:	Operation mode: *Disable* = Non Directional *Fw* = Directional Forward *Rev* = Directional Reverse
RCL	:	If "RCL = Yes", after tripping of the element "2I>" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Is	:	Minimum operation level
ts	:	Trip time delay
tBO	:	Time to reset of the Blocking Output after expiring of the Trip time delay. "tBO" is also the trip time delay of the Breaker Failure function.

14.14 - Function: **3I>** (Third Overcurrent Element F50/51)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**tBI**	Disable		[Disable / 2tBO]			
	→	**f(a)**	Disable		[Disable / Fw / Rev]			
	→	**CoF**	Disable		[Disable / Enable]			
	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	1	**In**	(0.1÷10)	step	0.01	In
Timers	→	**ts**	100	**s**	(0.01÷100)	step	0.01	s
	→	**tCoF**	0.05	**s**	(0.02÷0.2)	step	0.01	s
	→	**tBO**	0.75	**s**	(0.05÷0.75)	step	0.01	s

14.14.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
tBI	:	Blocking input reset time *Disable* = Permanent block *2tBO* = Set 2xtBO.
f(a)	:	Operation mode: *Disable* = Non Directional *Fw* = Directional Forward *Rev* = Directional Reverse
CoF	:	If "CoF = Enable", any time the circuit breakers status changes from open to close the "3I>" element is enabled to trip instantaneously if the current exceeds the set value "Is" within the time "tCoF". (Close On Fault Function)
RCL	:	If "RCL = Yes", after tripping of the element "3I>" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Is	:	Minimum operation level.
ts	:	Trip time delay
tCoF	:	Maximum duration of the Close on Fault function.
tBO	:	Time to reset of the Blocking Output after expiring of the Trip time delay. "tBO" is also the trip time delay of the Breaker Failure function.

14.15 - Function: **4I>** (Fourth Overcurrent Element F50/51)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**tBI**	Disable		[Disable / 2tBO]			
	→	**f(a)**	Disable		[Disable / Fw / Rev]			
	→	**CoF**	Disable		[Disable / Enable]			
	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	10	**In**	(0.1÷10)	step	0.01	In
Timers	→	**ts**	100	**s**	(0.01÷100)	step	0.01	s
	→	**tCoF**	0.05	**s**	(0.02÷0.2)	step	0.01	s
	→	**tBO**	0.75	**s**	(0.02÷0.2)	step	0.01	s

14.15.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
tBI	:	Blocking input reset time *Disable* = Permanent block *2tBO* = Set 2xtBO.
f(a)	:	Operation mode: *Disable* = Non Directional *Fw* = Directional Forward *Rev* = Directional Reverse
CoF	:	If "CoF = Enable", any time the circuit breakers status changes from open to close the "4I>" element is enabled to trip instantaneously if the current exceeds the set value "Is" within the time "tCoF". (Close On Fault Function)
RCL	:	If "RCL = Yes", after tripping of the element "4I>" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Is	:	Minimum operation level.
ts	:	Trip time delay
tCoF	:	Maximum duration of the Close on Fault function.
tBO	:	Time to reset of the Blocking Output after expiring of the Trip time delay. "tBO" is also the trip time delay of the Breaker Failure function.

14.16 - Function: ***Iis*** *(*Instantaneous Current Element)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	1	**In**	(1÷10)	step	0.1	In

14.16.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "Iis" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
f(a)	:	Operation mode: *Disable* = Non Directional *Fw* = Directional Forward *Rev* = Directional Reverse
Is	:	Minimum operation level.

14.17 - Function: ***1delta-I*** (First Current Step Element)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Levels	→	**DI**	1000	**A**	(100÷9990)	step	10	A
	→	**di**	200	**A/ms**	(4÷400)	step	1	A/ms
Timers	→	**tDI**	100	**ms**	(0÷500)	step	1	ms
	→	**tdi**	20	**ms**	(0÷100)	step	1	ms

14.17.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "1dI" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
DI	:	Current step trip level
di	:	Minimum di/dt level to start "ΔI" evaluation and detection reset level
tDI	:	Trip time delay
tdi	:	Detection reset time delay

14.17.2 - Operation of the Current step monitoring element

The timely detection of a current step allow to clear a near short circuit long before the current can reach the prospective peak value.

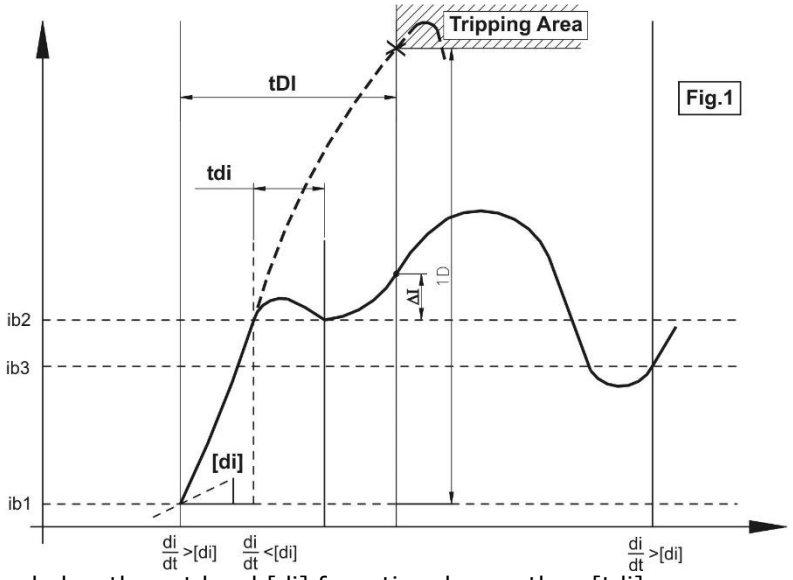


Fig.1

Protection Function Operation (see Fig. 1):

- Any time a current rate of rise exceeding the set value [di] is detected the value of the current "i_{1b}" is recorded as reference basic value to evaluate the current step "$\Delta I = i - i_{1b}$" and the timer "tDI" is started. "ΔI" is evaluated every 1ms.
- If during [tDI] the rate of rise "di/dt" never goes below the set level [di] for a time longer than [tdi], when [tDI] expires, the difference $\Delta I = i - i_{1b}$ is measured and if "$\Delta I \geq$[DI]" the protection function trips.
- If during [tDI] the rate of rise "di/dt" goes below the set level [di] for a time longer than [tdi], a new value of the current i_{2b} is recorded and, when [tDI] expires. If the difference $\Delta I = i - i_{2b}$ measured is greater than [DI], the protection function trips.

In terms of equation the protection function operation is as follow:

$$\text{If } \frac{di}{dt} \geq [di] \Rightarrow \left\{ \begin{array}{l} \text{Value of Current } i_{1b} \text{ is recorded} \\ \text{Timer tDI is Started} \end{array} \right\} \Rightarrow \text{If During tDI} \Rightarrow$$

$$\Rightarrow \left\{ \begin{array}{l} \frac{di}{dt} \geq [di] \text{ during tdi} \Rightarrow \text{Trip if } \Delta = i - i_{1b} \geq [DI] \text{ after tDI} \\ \frac{di}{dt} < [di] \text{ during tdi} \Rightarrow \text{New Value of Current } i_{2b} \text{ is recorded} \Rightarrow \text{Trip if } \Delta = i - i_{2b} \geq [DI] \text{ after tDI} \end{array} \right.$$

If, at the end of [tDI] no trip occurs "ΔI " evaluation is stopped and will restart when the set "di/dt" level is exceeded.

14.18 - Function: ***2delta-I*** (Second Current Step Element)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Levels	→	**DI**	1000	**A**	(100÷9990)	step	10	A
	→	**di**	200	**A/ms**	(4÷400)	step	1	A/ms
Timers	→	**tDI**	100	**ms**	(0÷500)	step	1	ms
	→	**tdi**	20	**ms**	(0÷100)	step	1	ms

14.18.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "2dI" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
DI	:	Current step trip level
di	:	Minimum di/dt level to start "ΔI" evaluation and detection reset level
tDI	:	Trip time delay
tdi	:	Detection reset time delay

14.19 - Function: **1di/dt** (First Current Rate of Rise Element)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Levels	→	**G**	20	**A/ms**	(4÷400)	step	1	A/ms
Timers	→	**tG**	20	**ms**	(2÷500)	step	1	ms
	→	**tRes**	0	**ms**	(0÷500)	step	1	ms

14.19.1 - Description parameters

Disable	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "1di/dt" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
G	:	di/dt trip level
tG	:	Trip time delay
tRes	:	Reset time delay

14.19.2 - Operation of the current rate of rise monitoring element

This function is used to detect remote faults
Current is sampled at 5kHz, is measured as the average of 15 samples are stored in a buffer from which every 1ms the relay computes the average rate of rise in the set time delay:

$$\frac{di}{dt} = \frac{I_{(t+[tG])} - I_{(t)}}{tG}$$

if $\frac{di}{dt} \geq [G]$ the relay trip

14.20 - Function: **2di/dt** (Second Current Rate of Rise Element)

Status	→	**Disable**			[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Levels	→	**G**	20	**A/ms**	(4÷400)	step	1	A/ms
Timers	→	**tG**	20	**ms**	(2÷500)	step	1	ms
	→	**tRes**	0	**ms**	(0÷500)	step	1	ms

14.20.1 - Description parameters

Status	:	Function enabling (No = Disable / Yes = Enable)
RCL	:	If "RCL = Yes", after tripping of the element "1di/dt" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
G	:	di/dt trip level
tG	:	Trip time delay
tRes	:	Reset time delay

14.20.2 - Operation of the current rate of rise monitoring element

This function is used to detect remote faults
Current is sampled at 5kHz, is measured as the average of 15 samples and stored in a buffer from which every 1ms the relay computes the average rate of rise in the set time delay:

$$\frac{di}{dt} = \frac{I_{(t+[tG])} - I_{(t)}}{tG}$$

if $\frac{di}{dt} \geq [G]$ the relay trip

14.21 - Function: **Rapp** (Impedance monitoring - di/dt dependence)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Levels	→	**Va**	400	**V**	(0÷800)	step	1	V
	→	**Ri**	0.1	**Ω**	(0÷0.25)	step	0.001	Ω
	→	**Rt**	1	**Ω**	(0.001÷2.5)	step	0.001	Ω
	→	**Li**	0.005	**H**	(0.001÷0.01)	step	0.001	H
	→	**Lt**	0.01	**H**	(0.002÷0.05)	step	0.001	H
	→	**R***	50	**Ω**	(0÷100)	step	0.01	Ω
	→	**g**	50	**A/ms**	(10÷500)	step	1	A/ms
Timers	→	**tr**	50	**ms**	(0÷100)	step	1	ms

14.21.1 - Description of variables

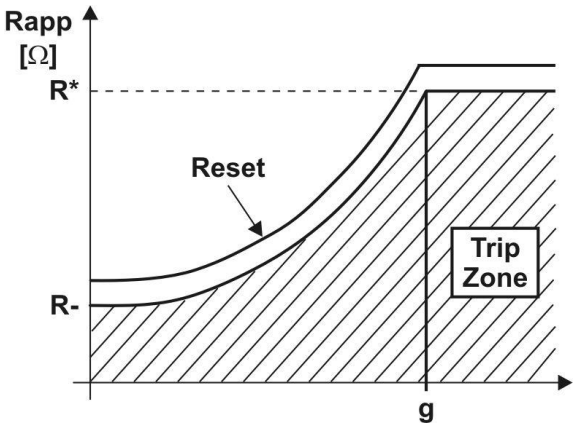
Status	:	Function enabling (Disable / Enable)
RCL	:	I If "RCL = Yes", after tripping of the element "Rapp" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Va	:	Arc voltage.
Ri	:	Internal Resistance = Resistance of the circuit upstream the Circuit Breaker.
Rt	:	Total resistance of the circuit including the Contact Line.
Li	:	Internal Inductance = Inductance of the circuit upstream the Circuit Breaker.
Lt	:	Total Inductance of the circuit including the Contact Line.
R*	:	Resistance trip level if di/dt ≥ g.
g	:	Limit value of di/dt.
tr	:	Trip time delay.

14.21.2 - Operation the Impedance monitoring element

The protection element shall trip if the impedance "Rapp" calculated as the ratio of the line voltage to the line current drops below the calculated value with the current rate of rise exceeding the level as reported on the trip characteristics. Trip takes place if the situation lasts longer than the set time delay "tr".

$$Rapp = \left[V - \frac{Ri(V - Va)}{Rt} + \left(\frac{Lt}{Rt} \cdot Ri - Li \right) g \right] : \left(\frac{V - Va}{Rt} - \frac{Lt}{Rt} \cdot g \right)$$

Reset takes place when "Rapp" is 10% higher than the trip value.



14.22 - Function: **Iapp** (Current monitoring with di/dt dependence)

Status	→ **Enab.**	Disable		[Disable / Enable]			
Options	→ **RCL**	No		[No / Yes]			
Levels	→ **IA**	1500	**A**	(500÷5000)	step	10	A
	→ **I***	500	**A**	(400÷1500)	step	10	A
	→ **g**	50	**A/ms**	(30÷500)	step	1	A/ms
	→ **Res**	90	**%**	(80÷100)	step	1	%Iapp
Timers	→ **tr**	0.1	**s**	(0÷5)	step	0.01	s

14.22.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "Iapp" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
IA	:	Current trip level when di/dt = 0
I*	:	Current trip level when di/dt ≥ [g]
g	:	Limit value of di/dt
Res	:	Drop-out percentage (operation reset)
tr	:	Trip time delay.

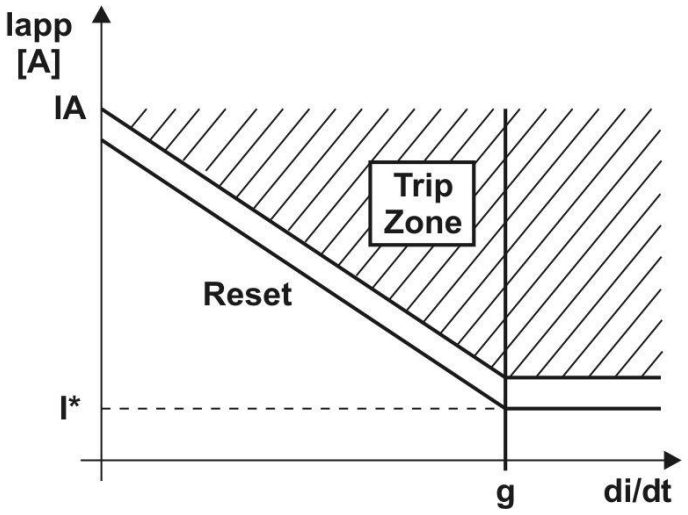
14.22.2 - Operation of the "Iapp" element

The protection shall trip if current measured exceeds the value [Iapp] calculated as hereunder showed for longher than the set time "tr" reset takes place as soon as the current drops below

$$[\text{Iapp}] \cdot \frac{\text{Res}}{100}$$

$$\text{Iapp} = -\left[\frac{\text{IA} - \text{I}^*}{\text{g}}\right] \cdot \frac{\text{di}}{\text{dt}} - [\text{IA}] \quad \text{if} \quad 0 \le \frac{\text{di}}{\text{dt}} \le \text{g}$$

$$\text{Iapp} = \text{I}^* \ \text{if} \ \frac{\text{di}}{\text{dt}} > \text{g}$$



14.23 - Function: **1Ig** (First Frame Fault Element)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**f(t)**	Type - D		[D / A / B / C]			
	→	**V(t)**	Type - D		[D / EN]			
	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	1	**Ign**	(0.00÷2)	step	0.01	Ign
	→	**Us**	0.2	**Ugn**	(0.00÷1)	step	0.01	Ugn
Timers	→	**ts**	20	**s**	(0.02÷100)	step	0.01	s

14.23.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
f(t)	:	Operation characteristic (Time/Current curve): *(D)* = Independent definite time *(A)* = IEC Inverse Curve type A *(B)* = IEC Very Inverse Curve type B *(C)* = IEC Extremely Inverse Curve type C
V(t)	:	Operation characteristic (Time/Current curve): *(D)* = Independent definite time *(EN50122-1)* = Inverse Curve
RCL	:	If "RCL = Yes", after tripping of the element "1Ig" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Is	:	Minimum operation level of frame to earth current.
Us	:	Minimum operation level of frame to earth voltage.
ts	:	Trip time delay

14.23.2 - Operation

Trip takes places if, for larger than the set time delay [ts], both the ground fault current "Ig" and the Voltage to ground "Ug" exceed the set values [Is] and [Us].
If "Is = 0" the relay shall consider "Ug" only, viceversa if "Ug = 0" the relay shall consider "Ig" only.

Setting		Tripping condition
Is	**Us**	
≠0	≠0	Ig>[Is] & Ug>[Us]
≠0	=0	Ig>[Is]
=0	≠0	Ug>[Us]

14.24 - Function: **2Ig** (Second Frame Fault Element)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**f(t)**	Type - D		[D / A / B / C]			
	→	**V(t)**	Type - D		[D / EN]			
	→	**RCL**	No		[No / Yes]			
Levels	→	**Is**	1	**Ign**	(0.00÷2)	step	0.01	Ign
	→	**Us**	0.2	**Ugn**	(0.00÷1)	step	0.01	Ugn
Timers	→	**ts**	20	**s**	(0.02÷100)	step	0.01	s

14.24.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
f(t)	:	Operation characteristic (Time/Current curve): *(D)* = Independent definite time *(A)* = IEC Inverse Curve type A *(B)* = IEC Very Inverse Curve type B *(C)* = IEC Extremely Inverse Curve type C
V(t)	:	Operation characteristic (Time/Current curve): *(D)* = Independent definite time *(EN50122-1)* = Inverse Curve
RCL	:	If "RCL = Yes", after tripping of the element "2Ig" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
Is	:	Minimum operation level of frame to earth current.
Us	:	Minimum operation level of frame to earth voltage.
ts	:	Trip time delay

14.24.2 - Operation

Trip take place if, for larger than the set time delay [ts], both the ground fault current "Ig" and the Voltage to ground "Ug" exceed the set values [Is] and [Us].
If "Is = 0" the relay shall consider "Ug" only viceversa if "Ug = 0" the relay shall consider "Ig" only.

Setting		Tripping condition
Is	**Us**	
≠0	≠0	Ig>[Is] & Ug>[Us]
≠0	=0	Ig>[Is]
=0	≠0	Ug>[Us]

14.25 - Function: **RCL** (Automatic Reclosure)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**ShNum**	2		[1 / 2 / 3 / 4]			
	→	**Test**	Yes		[No / Yes]			
Timers	→	**tr**	10	**s**	(1÷200)	step	1	s
	→	**t1**	0.3	**s**	(0.1÷1000)	step	0.1	s
	→	**t2**	1	**s**	(0.1÷1000)	step	0.1	s
	→	**t3**	3	**s**	(0.1÷1000)	step	0.1	s
	→	**t4**	10	**s**	(0.1÷1000)	step	0.1	s
	→	**tCHK**	0.4	**s**	(0.2÷3)	step	0.1	s
	→	**tCHRT**	100	**s**	(1÷600)	step	1	s

14.25.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
ShNum	:	Number of reclosure shots to Lock-out
Test	:	"Yes" - Before any reclosure the Line Test is started and the reclosure is operated only after a successful Line Test is carried-out. "No" - Reclosure is operated without Line-Test.
tr	:	Reclaim time. Any new trip during "tr" after a successful reclosure shot starts the next shot of the cycle. Any new trip after "tr" restarts a complete cycle.
tCHK	:	Time check C/B operation if any protection function trip except RT/RTX; if one or more protection elements doesn't reset before "tCHK" expire the RCL goes into Lock status.
tCHRT	:	Time check C/B operation if RT/RTX Trip; If RT/RTX doesn't reset before "tCHRT" expire the RCL goes into Lock status.

14.25.2 - Operation

The status of the Circuit Breaker (C/B) is indicated by one normally open contact of the C/B itself and is detected by a digital input of the relay.

A reclose shot is started after a C/B's opening operated by one of the relay's protection functions programmed to control this reclose shot; C/B's opening operated by one element not programmed to control the reclosure shot activates the Lock-out status of the Reclosure function.

Any time the Circuit Breaker (C/B) is closed either manually or automatically the Reclaim time "tr" is started.

After a manual closure of the C/B, operation time start or tripping of any of the relay protection elements during "tr", makes the relay enter into the Lock-Out status (L.O.). In the L.O. status the relay, after breaker opening, does not produce any command for automatic reclose ; the lock-out status is shows on the display.

Reset from the L.O. status takes place when the C/B is opened and then manually reclosed or by operating the external reset command.

If none of the relay protection elements is started during "tr" after a manual closure of the C/B, the relay is ready to start the Automatic Reclose Sequence.

If "tr" is started by an automatic reclosure, the operation time start during "tr" and the tripping of any element programmed for the operation of the next reclosure makes the relay proceed with the reclosing cycle.

After "tr" is expired the reclosing cycle restarts from the first reclosure (1C).

Pick-up of the time start of any protection element, stops the counting down of "tr"; counting is restarted as soon as the element resets.

As soon as the C/B is opened due to tripping of one of the relay's elements programmed to initiate the next automatic reclose shot, the relevant reclose time delay (t1, t2, t3, t4) is started and at the end of this tx time the reclose command is issued by the relay. The C/B is then automatically reclosed and the reclaim time "tr" is started again. If during "tr" the C/B is again opened by a relay's element programmed to initiate the next automatic reclose, the next reclose takes place after the relevant time tx; the C/B is reclosed and "tr" restarted. When the last Automatic Reclose shot of the sequence has been done, any further tripping during "tr" produces a relay's lock-out status. If after any reclose shot no tripping takes peace during "tr", the Reclose Sequence is restarted from the beginning (starting from the first reclose shot 1C)

14.26 - Function: **1U>** (First OverVoltage Element F59)

Status → **Enab.**	Disable		[Disable / Enable]			
Levels → **Us**	1.10	**Un**	(0.5÷1.50)	step	0.01	Un
Timers → **ts**	10	**s**	(0÷650)	step	1	s

14.26.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
Us	:	Minimum operation level
ts	:	Trip time delay

14.27 - Function: **2U>** (Second OverVoltage Element F59)

Status → **Enab.**	Disable		[Disable / Enable]			
Levels → **Us**	1.10	**Un**	(0.5÷1.50)	step	0.01	Un
Timers → **ts**	10	**s**	(0÷650)	step	1	s

14.27.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
Us	:	Minimum operation level
ts	:	Trip time delay

14.28 - Function: **1U<** (First UnderVoltage Element F27)

Status → **Enab.**	Disable		[Disable / Enable]			
Levels → **Us**	0.70	**Un**	(0.05÷1)	step	0.01	Un
Timers → **ts**	10	**s**	(0÷650)	step	1	s

14.28.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
Us	:	Minimum operation level
ts	:	Trip time delay

14.29 - Function: **2U<** (Second UnderVoltage Element F27)

Status → **Enab.**	Disable		[Disable / Enable]			
Levels → **Us**	0.70	**Un**	(0.05÷1)	step	0.01	Un
Timers → **ts**	10	**s**	(0÷650)	step	1	s

14.29.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
Us	:	Minimum operation level
ts	:	Trip time delay

14.30 - Function: **UL<** (Line Voltage Presence)

Status → **Enab.**	Disable		[Disable / Enable]			
Levels → **UL<int**	0.9	**Un**	(0.05÷1.50)	step	0.01	Un
→ **UL<Ric**	1.1	**Un**	(0.05÷1.50)	step	0.01	Un
Timers → **tUL<**	0.2	**s**	(0.2÷200)	step	1	s

14.30.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
UL<int	:	Minimum operation pickup level
UL<Ric	:	Minimum operation dropoff level
tUL<	:	Trip time delay

14.31 - Function: **Wi** (Circuit Breaker maintenance level)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Levels	→	**Ni**	1.000		(10÷1000)	step	1	
	→	**alNi**	80	**%**	(5÷95)	step	1	
	→	**Ne**	1.000		(10÷99999)	step	1	
	→	**alNe**	80	**%**	(5÷95)	step	1	
	→	**Nm**	1.000		(10÷99999)	step	1	
	→	**alNm**	900		(10÷99999)	step	1	
	→	**Ii**	3.000	**A**	(100÷9999)	step	1	A
Timers	→	**ti**	20	**ms**	(10÷40)	step	1	**ms**
	→	**tr**	8	**ms**	(0÷50)	step	1	**ms**

14.31.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
Ni	:	Maximum number of arc chute operation at nominal values
alNi	:	Alarm maintenance level of arc chute operation
Ne	:	Maximum number of arc contact operation at nominal values
alNe	:	Alarm maintenance level of arc contact operation
Nm	:	Maximum number of mechanical operation
alNm	:	Alarm maintenance level of mechanical operation
Ii	:	Circuit Breaker Rated Current primary amps.
ti	:	HSCB open time
tr	:	HSCB auxiliary contact delay

14.31.2 - Operation (Accumulation of the interruption Energy)

The relay computes the Circuit Breaker interruption Energy.
On the relay is possible to set the total level of energy that the breaker is able to interrupt.
During each C/B operation the remain energy is calculated.
The operation of this function is based on the following principle:

Arc chute:

Any time the Circuit Breaker opens, the relay accumulate the square value of the current measured from the instance of the circuit breaker opening to the instant when the current expire.
The opening instant is detected by the change of status from closed to open of digital input connected to normally open contact of the C/B; it is compensated by the parameter "tr":

$$\mathbf{Ei} = \sum_{0}^{n} [i^2]$$

The value calculated is subtracted from the amount total energy available calculated with the following formula:

$$\mathbf{Ei}_{(total)} = \mathbf{Ii^2 * ti * Ni}$$

"Ni" is the number of operation that the arc chute can done at the nominal values of C/B (current, and interrupting time).

On the measures menu is available the remaining energy value calculated as follow:

$$Ei\% = \frac{Ei(total) - Ei}{Ei\ (total)} * 100$$

When the remaining energy value goes below the **AlNi** threshold an alarm is generated .

When the remaining energy value decreased to **zero** another alarm is generated.

The generated alarm can be "linked" to digital outputs (relays) or used in programmable logic functions.

Reset to **100%** of the Energy accumulation is available in the menu "***Command***" (Reset Ei).

Arc contact:

Any time the Circuit Breaker opens, the relay record the value of the current measured at the instance of the circuit breaker opening.
The opening instant is detected by the change of status from closed to open of digital input connected to normally open contact of the C/B; it is compensated by the parameter "tr":

$$Ee = [i^2]$$

The value calculated is subtracted from the amount total energy available calculated with the following formula:

$$Ee(total) = Ii^2 * Ne$$

"Ne" is the number of operation that the arc contact can done at the nominal values of C/B (current).

On the measures menu is available the remaining energy value calculated as follow:

$$Ee\% = \frac{Ee(total) - Ee}{Ee\ (total)} * 100$$

When the remaining energy value goes below the **AlNe** threshold an alarm is generated .

When the remaining energy value decreased to **zero** another alarm is generated.

The generated alarm can be "linked" to digital outputs (relays) or used in programmable logic functions.

Reset to **100%** of the Energy accumulation is available in the menu "***Command***" (Reset Ee).

Mechanical operations:

Any time the Circuit Breaker opens, the relay compute the mechanical operation (opening and closing).

When the mechanical operations counter [**OVrOP**] value exceed the **AlNm** threshold an alarm is generated .

When the mechanical operations counter [**OVrOP**] value exceed the **Nm** threshold another alarm is generated .

The generated alarm can be "linked" to digital outputs (relays) or used in programmable logic functions.

Reset of the mechanical operation is available in the menu "***Command***" (Reset Counters).

14.32 - Function: **TCS** (Trip Circuit Supervision)

Status	→ **Enab.**	Disable		[Disable / Enable]			
Timers	→ **ts**	0.1	**s**	(0.1÷100)	step	0.01	s

14.32.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
ts	:	Trip time delay

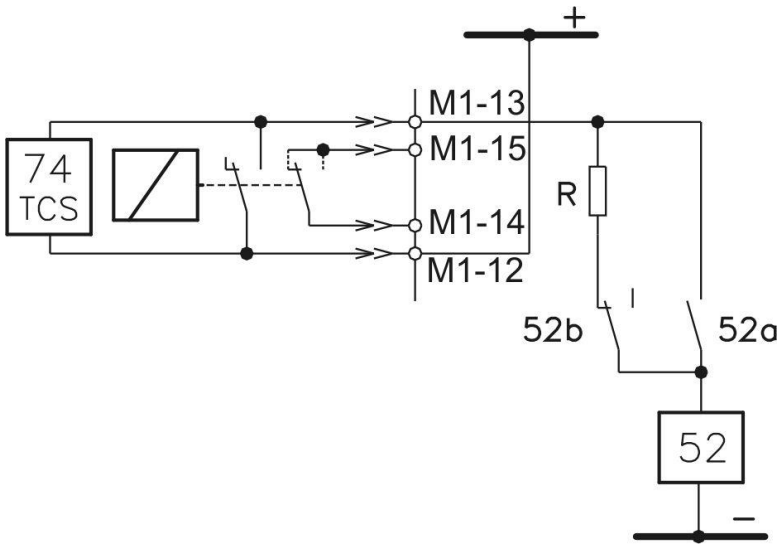
14.32.2 - Operation

The relay includes a complete Circuit Breaker Trip Circuit Supervision unit that is associated to the Contact "19-20" of the "R1" Output Relay.
The contact of "R1" is used to trip the C/B as reported in the drawing here below.
The supervision works when the C/B is closed and recognizes the Trip Circuit as sound as far as the current flowing exceeds "1mA".
In case of Trip Circuit Fault detection, the diagnostic relay is operated and the Led starts flashing (see § Signalization).
To have Supervision also with the C/B open one N/C contact (52b) from the C/B and an external resistor "R" are needed.

$$R[k\Omega] \le \frac{V}{1mA} - R_{52}$$ where **R_{52}**= Trip Coil internal resistance [kΩ]

V = Trip Circuit Voltage

$$P_R \ge 2 \cdot \frac{V^2}{R}[W]$$ Designed power of external resistance "R"



Tripping of the function operates a user programmable output relay.

14.33 - Function: **IRF** (Internal Relay Fault)

In this menu it is possible to configurate the operation of the Relay Internal Fault detection element

Status	→	**Enab.**	Disable		[Disable / Enable]			
Timers	→	**tIRF**	5.00	**s**	(5÷200)	step	0.01	s

14.33.1 - Description of variables

Status	:	Function enabling (No = Disable / Yes = Enable)
tIRF	:	Trip time delay

14.33.2 - Operation

Tripping of the function operates a user programmable output relay.

14.34 - Function: **RT** (First Element Remote Trip)

In this menu it is possible to configurate the Remote Trip Element.

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
	→	**RTon**	FallEdge		[RiseEdge – FallEdge]			
Timers	→	**ts**	5	**s**	(0 ÷ 10)	step	0.01	s

14.34.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "RT" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
RTon	:	Remote trip Edge selector
ts	:	Trip time delay

14.34.2 - Operation

Tripping of the function operates a user programmable output relay.
When Remote Trip is enabled to initiate a reclosure shot, the relevant input signal must be cleared within the time-out "to1" (1000ms); if the signal stays for longer than "to1" the reclosure function goes into the lock-out status giving an External Fail signal.

14.35 - Function: **RTX** (Second Element Remote Trip)

In this menu it is possible to configurate the Remote Trip Element.

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
	→	**RTon**	FallEdge		[RiseEdge – FallEdge]			
Timers	→	**ts**	5	**s**	(0 ÷ 10)	step	0.01	s

14.35.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
RCL	:	If "RCL = Yes", after tripping of the element "RTX" and Opening of the Circuit Breaker, the relay starts an automatic Line Test and a reclosure cycle. If "RCL = No" no test and no reclosure is started.
RTon	:	Remote trip Edge selector
ts	:	Trip time delay

14.35.2 - Operation

Tripping of the function operates a user programmable output relay.
When Remote Trip is enabled to initiate a reclosure shot, the relevant input signal must be cleared within the time-out "to1" (1000ms); if the signal stays for longer than "to1" the reclosure function goes into the lock-out status giving an External Fail signal.

14.36 - Function: **BrKFail** (Breaker Failure)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Timers	→	**tBF**	0.75	**s**	(0.05÷0.75)	step	0.01	s

14.36.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
tBF	:	Trip time delay

14.36.2 - Operation

The Breaker Failure detection is started by the operation of the output relay "R1"
(programmed to be controlled by the Protection Functions that trip the C/B).
If after [tBF] seconds from operation of the relay "R1", any input current flow is still detected (>10% In), the function "BF" trips and operate one user programmable output relay,

14.37 - Function: **Dia-I** (Diagnostic analog inputs current)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Timers	→	**tDiaI**	60	**s**	(1÷180)	step	1	s

14.37.1 - Description of variables

Status	:	Function enabling (Disable / Enable)
tDiaI	:	Time delay current measurement channel failure

14.37.2 - Operation

Tripping of the function operates a user programmable output relay.
Function dedicated to transducers with zero live (4-20mA , 12-20mA); if the reading current value goes to zero .

- If the reading current goes to zero for a time longer than [tDiaI], the protection function trips.

14.38 - Function: **Wh** (Energy counter Pulse)

In this menu it is possible to configurate the Energy counter Pulse.

Status	→	**Enab.**	Disable		[Disable / Enable]			
Levels	→	**WpP**	100	**kW**	(10 ÷ 1000)	step	10	kW
Timers	→	**Pulse**	1	**s**	(0.1 ÷ 2)	step	0.01	s

14.38.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
WpP	:	Energy counter Pulse Level
Pulse	:	Pulse duration

14.38.2 - Operation

One selected output relay issued a pulse from an external energy counter, each pulse corresponds to the programmed Energy unit "WpP" and its duration is the set time "Pulse".

14.39 - Function: **Self Trip** (Spontaneous trip)

In this menu it is possible to configure the Self Trip function.

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**RCL**	No		[No / Yes]			
Timers	→	**ts**	5	**s**	(0 ÷ 10)	step	0.01	s

14.39.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
RCL	:	Reclosure
ts	:	Self-Trip time delay

14.39.2 - Operation

This function is use to individuate the "CB self-trip" without make any complex logic with "user variables". The function check only the "Main HSCB", and if it pass from close status to open, without a command issued by the relay, the "self-trip" variable is set.

14.40 - Function: **Oscillo** (Oscillographic Recording)

Status	→	**Enab.**	Disable		[Disable / Enable]			
Options	→	**Trig**	Start		[Start / Trip / OnCmd / REUserLg / FEUserLG]			
Timers	→	**tPre**	0.50	**s**	(0.01÷2)	step	0.01	s
	→	**tPost**	0.50	**s**	(0.01÷8)	step	0.01	s

14.40.1 - Description of variables

Disable	:	Function enabling (Disable / Enable)
Trig	:	Selection of the Trigger command source (start recording): *Start* = Trigger on time start of protection functions *Trip* = Trigger on trip (time delay end) of protection functions *OnCmd* = On Asynchronous Force trigger command *REUserLg* = On rising edge of "User Logic" *FEUserLg* = On falling edge of "User Logic" (see § "OscilloTriggerLogic")
tPre	:	Recording time before Trigger
tPost	:	Recording time after Trigger

14.40.2 - Operation

In the options: "Trig = Start" and "Trig = Trip", the oscillographic recording starts respectively when any protection function starts operating or trip (provided the function was programmed "TrigEnab").

T>	**1I>**	**1dI**	**Rapp**	**Wi**	**1U>**
	2I>	**2dI**	**Iapp**	**RT**	**2U>**
	3I>	**1di/dt**	**1Ig**	**RTX**	**1U<**
	4I>	**2di/dt**	**2Ig**		**2U<**

In the option "ExtInp", the oscillographic record starts when the Digital Input is activated (terminals shorted)

The "Osc" Function includes the wave Form Capture of the input quantities (I, U, Ig, Ug).
The waveforms of the oscillographic recording are always available for direct access (communication) on the memory of the relay, the maximum record time available for direct access is 40 seconds.

The number of events recorded depends on the duration of each individual recording (tPre + tPost).
In any case the number of event stored can not exceed ten (10 x 0.6 sec).
Any new event beyond the 40 sec capacity of the memory, cancels and overwrites the former records (FIFO Memory).
Example: "10x4s" or "5x8s" .... etc.

Each oscillographic record is also stored in COMTRADE format on internal/external disk;
There is no limit to the records stored on disk (except the disk space), the length of each event, in any case, is maximum 10 seconds.

14.40.3 – Available on MSCom2

T>	Tal T>	(alarm) (trip)	*Thermal element*
1I>	1I> t1I>	(Start) (Trip)	*First overcurrent element*
2I>	2I> t2I>	(Start) (Trip)	*Second overcurrent element*
3I>	3I> t3I>	(Start) (Trip)	*Third overcurrent element*
4I>	4I> t4I>	(Start) (Trip)	*Fourth overcurrent element*
Iis	tIis>	(Start)	Instantaneous Current Element
1dI	1dI t1dI	(Start) (Trip)	*First Current step element*
2dI	2dI t2dI	(Start) (Trip)	*Second Current step element*
1di/dt	1di/dt t1di/dt	(Start) (Trip)	*First Current rate of rise element*
2di/dt	2di/dt t2di/dt	(Start) (Trip)	*Second Current rate of rise element*
Rapp	Rapp	(Trip)	*Impedance monitoring – di/dt dependence*
Iapp	Iapp		*Current monitoring with di/dt dependence*
1Ig	1Ig t1Ig	(Start) (Trip)	*First instantaneous Frame Fault element* *First time delayed Frame Fault element*
2Ig	2Ig t2Ig	(Start) (Trip)	*Second Frame Fault element*
RCL	RCL cmd ARP ARF ARL AROk ARE ARD	(Trip)	*Reclosure Shot command* *Autoreclosure in progress* *Autoreclosure Failure* *Autoreclosure Lock-out* *Autoreclosure Ok* *Autoreclosure Enable* *Autoreclosure Disable*
1U>	1U> t1U>	(Start) (Trip)	*First overvoltage element*
2U>	2U> t2U>	(Start) (Trip)	*Second overvoltage element*
1U<	1U< t1U<	(Start) (Trip)	*First undervoltage element*
2U<	2U< t2U<	(Start) (Trip)	*Second undervoltage element*
UL<	UL<		*Line Voltage presence*
Wi	Ni alNi Ne alNe Nm alNm		*Maximum number of arc chute operation at nominal values* *Alarm maintenance level of arc chute operation* *Maximum number of arc contact operation at nominal values* *Alarm maintenance level of arc contact operation* *Maximum number of mechanical operation* *Alarm maintenance level of mechanical operation*
TCS	tTCS	(Trip)	*Time delayed Trip Circuit Supervision*
IRF	IRF tIRF	(Start) (Trip)	*Time delayed Internal relay Fault* *Instantaneous Internal relay Fault*
RT	RT tRT	(Trip) (Start)	*First Instantaneous Remote Trip* *First Time delayed Remote Trip*
RTX	RTX tRTX	(Trip) (Start)	*Second Instantaneous Remote Trip* *Second Time delayed Remote Trip*
Dia-I	DiaI tDiaI	(Trip) (Start)	*Diagnostic analog inputs current* *Delay current measurement channel failure*
CB-L	CB-L		*C/B reclose Lock-out*
BF	BF		*Breaker Failure*
Wh	+ Wh - Wh		*Exported Energy counter Pulse* *Imported Energy counter Pulse*
SelfTrip	SelfTrip t-SelfTr.		Spontaneous trip Self-Trip time delay
L/R CB Hdl	cmdOpCB cmdClCB LocRemInc missCBOpe		*Open C/B command* *Close C/B command* *Local / Remote Inconsistency* *Missed C/B opening (Digital input missing)*
Characteristiscs	Charat 1 Charat 2 Charat 3 Charat 4		Characteristic 1 Characteristic 2 Characteristic 3 Characteristic 4
LT	LTPb LTP LTF LTOK LTB LT cmd	 (Trip)	*Output to operate an external flashing lamp signalling line test in progress* *Line Test in progress* *Line Test Failed* *Line Test OK* *Line Test Blocked* *Line Test command*

	I850Ready	*IEC61850 ready to work.*
	Sync	*Date – time syncronization event (active during clock syncronization).*
	SNTP-Dia	*SNTP health status.*
	SNTP-Kod	*Syncro lost by server, Kiss of death. Date-Time need syncro from another server.*
	DskClean	*External Disk Clean (disk near to full, clean operation is required)*
	DskFull	*External Disk Full (disk full, write should be locked)*
	DskWr	*External Disk Write (active during internal disk access)*
	DskFRMT	*External Disk Format (active during internal disk format)*
	DskCHK	*External Disk Check (active during internal disk check procedure)*
	rDskAttach	*Remote disk inserted (USB Key)*
	rDskDetach	*Remote disk not inserted (USB Key)*
	rDskDtchable	*Remote disk removible (USB Key)*
	rDskClean	*External Disk Clean (disk near to full, clean operation is required)*
	rDskFull	*External Disk Full (disk full, write should be locked)*
	rDskWr	*External Disk Write (active during internal disk access)*
	rDskFRMT	*External Disk Format (active during internal disk format)*
	rDskCHK	*External Disk Check (active during internal disk check procedure)*
	CB1Fail	*CB1 Failure*
	CB2Fail	*CB2 Failure*
	CB3Fail	*CB3 Failure*
	CB4Fail	*CB4 Failure*
	CB5Fail	*CB5 Failure*
	CB1missedOp	*CB1 Failure*
	CB2missedOp	*CB2 Failure*
	CB3missedOp	*CB3 Failure*
	CB4missedOp	*CB4 Failure*
	CB5missedOp	*CB5 Failure*
	MasterOp1	*Modbus Master CB1 Open request*
	MasterCL1	*Modbus Master CB1 Close request*
	MasterOp2	*Modbus Master CB2 Open request*
	MasterCL2	*Modbus Master CB2 Close request*
	MasterOp3	*Modbus Master CB3 Open request*
	MasterCL3	*Modbus Master CB3 Close request*
	MasterOp4	*Modbus Master CB4 Open request*
	MasterCL4	*Modbus Master CB4 Close request*
	MasterOp5	*Modbus Master CB5 Open request*
	MasterCL5	*Modbus Master CB5 Close request*
	Gen.Start	*General start*
	Gen.Trip	*General Trip*
	Vcc	*Reserved*
	Gnd	*Reserved*
	ResLog	*Reset signal logic*
	P1	*Push-button Open (Not used with remote MMI)*
	P2	*Push-button Close (Not used with remote MMI)*
	P3	*Push-button Reset (Not used with remote MMI)*
	UserTriggerOscillo	*User Variable for Oscillographic Recording*
	UserVar<0> to UserVar<98>	*User Variable*

Only for "**DIGITAL INPUT**"

	0.D1	*Digital Input "0.D1"*	*activated*
	0.D1Not	*Digital Input "0.D1"*	*deactivated*
	to		
	0.D4	*Digital Input "0.D4"*	*activated*
	0.D4Not	*Digital Input "0.D4"*	*deactivated*
	1.D1	*Digital Input "1.D1"*	*activated*
	1.D1Not	*Digital Input "1.D1"*	*deactivated*
	to		
	1.D15	*Digital Input "1.D15"*	*activated*
	1.D15Not	*Digital Input "1.D15"*	*deactivated*
	2.D1	*Digital Input "2.D1"*	*activated*
	2.D1Not	*Digital Input "2.D1"*	*deactivated*
	to		
	2.D15	*Digital Input "2.D15"*	*activated*
	2.D15Not	*Digital Input "2.D15"*	*deactivated*

14.40.4 – Setting "Oscillo Trigger Logic"

The "**OSCILLO TRIGGER LOGIC**" is a result of a logical operation (Or, AND, ecc...), it can be used like other logical output. This operation is possible only via "MSCom2" software.

14.40.4.1 - Name

Internal name

14.40.4.2 - User descr.

Fixed

14.40.4.3 - Linked functions

Selection functions

14.40.4.4 - OpLogic

Operation Logic = [None, OR, AND, XOR, NOR, NAND, NOT, Ff-SR]

14.40.4.5 - Timer

Time delay (0-10)s, step 0.01s

14.40.4.6 - Timer type

Timer =	*Delay*	:	Add a delay on output activation. The "Timer" is edge triggered on rise edge.
	Monostable P	:	Monostable Positive pulse time
	Monostable N	:	Monostable Negative pulse time
	Blinking	:	When selected output is a 50% duty cycle square wave
	Delay Fall-Down	:	Time added on falling output edge

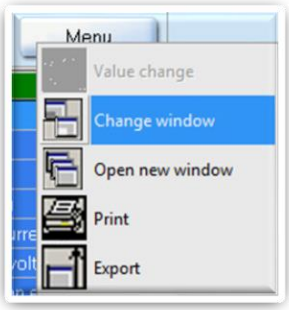
14.40.4.7 - Logical status

"OscilloTriggerLogic" Logical status

14.40.4.8 - Example: Setting "User Variable"

Open "MSCom2" program and connect to the relay.

Select "Change Windows" from "Menu" button



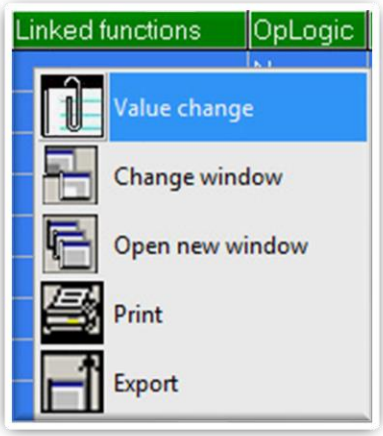
Select "User Variable"

Setting for "User Trigger Oscillo" : "**1I>/2I>/3I>**", "**AND**", "**1**", "**Monostable P**".

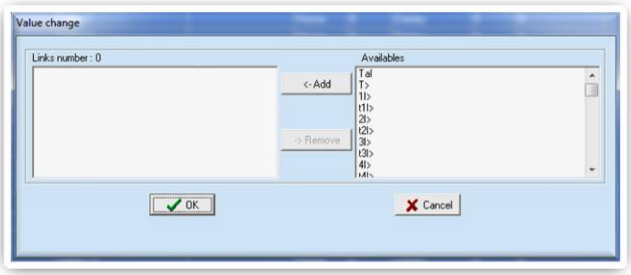
ID	Name	User descr.	Linked functions	OpLogic	Timer	Timer type	Logical status
1	UserTrigger Oscillo	OscilloTrigger.logic		None	0	Delay	0
2	UserVar <0>	Gate.1.....		None	0	Delay	0

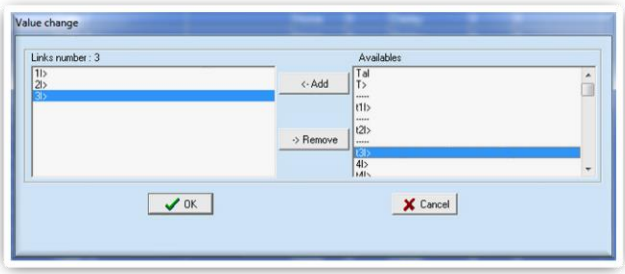
14.40.4.9 - "Linked Functions"

Select "**Linked Functions**" related to "User Trigger Oscillo" and press right button on mouse, select "Value change":



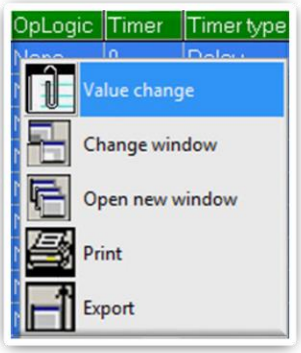
Select "**1I>, 2I>, 3I>**" from "Available" box via push-button "<Add", and press "OK".
For remove functions, use push-button ">Remove".



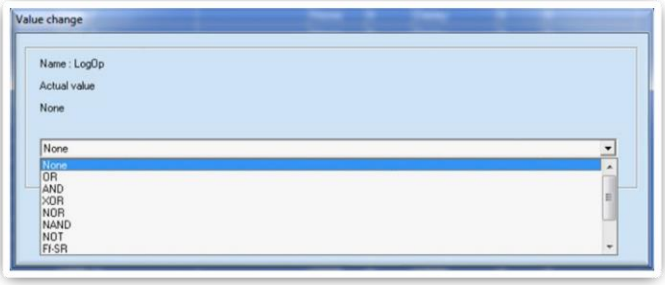


14.40.4.10 - "Operation Logic" (Oplogic)

Select "**Oper Logic**" related to "User Trigger Oscillo" and press right button on mouse, select "Value change":

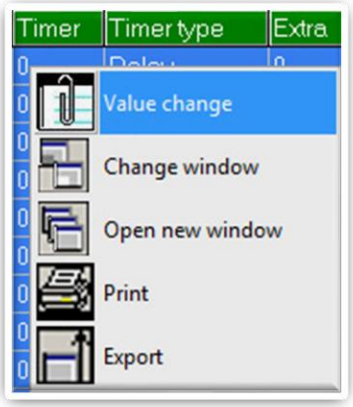


Insert "**AND**" into box and press "OK":

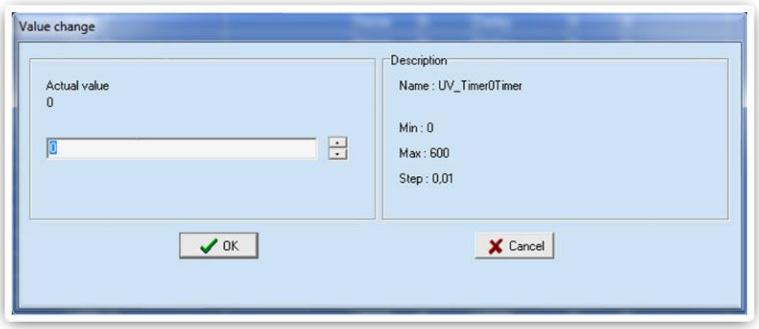


14.40.4.11 - "Timer"

Select "**Timer**" related to "User Trigger Oscillo" and press right button on mouse, select "Value change":

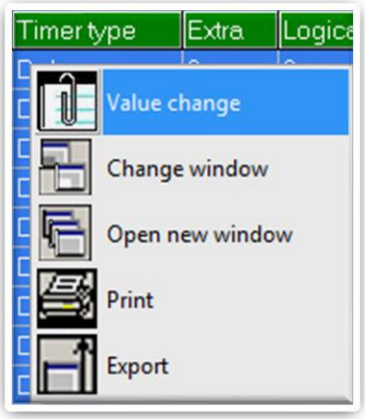


Select "**1**" into box and press "OK":

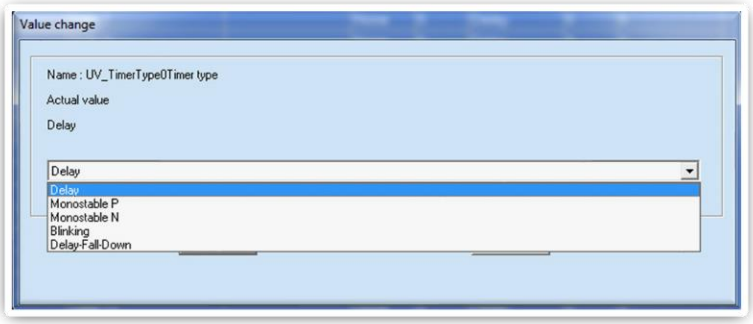


14.40.4.12 - "Timer type"

Select "**Timer**" related to "User Trigger Oscillo" and press right button on mouse, select "Value change":



Select "**Monostable P**" into box and press "OK":



14.41 - Function: **L/R CB Cmds** (Local Remote Close Breaker Command)

This menu allows to configurate the command for C/B operation.

Options	→	**LocRm**	Disable		[Enable / Disable]			
	→	**DI_M**	Remote		[Remote / Local]			
	→	**LineT**	Disable		[Enable / Disable]			
	→	**Key**	Enable		[Enable / Disable]			
Timers	→	**tLRIn**	0.05	s	(0.05 ÷ 1)	step	0.05	s
	→	**tOpen**	1	s	(0.05 ÷ 10)	step	0.01	s

14.41.1 - Description of variables

LocRm	:	Enable/Disable [Local/Remote] Digital input.
LineT	:	Line Test Enable/Disable If Enabled = Line Test will by started any time C/B Close control is activated.
DI_M	:	Local/Remote digital input management
Key	:	*Enable* = The C/B can be controlled by the pushbuttons available on Relay's Front Face as well as by commands sent via the serial communication bus. *Disable* = The pushbuttons on Front Panel are disabled; the operation of the C/B can be controlled either by the serial bus commands or by (password protected) commands available in the menu "***Commands***".
tLRIn	:	Local/Remote inconsistent time.
tOpen	:	C/B operation time-out.

11.42 - Function: **CB-L** (CB Lock)

This menu allows to configurate the command lock for C/B.

Options	→	**Lock**	Enable		[Enable / Disable]			
Timers	→	**tLTBk**	1	s	(0.1 ÷ 10)	step	0.1	s

14.42.1 - Description of variables

Lock	:	*Enable* = Enabling of the close command lock-out. *Disable* = Disabling of the close command lock-out.
tLTBk	:	Line Test progress blink time

14.42.2 - Operation

If the variable "Lock" is set to "Enable", reclosing of the C/B is inhibited after a "Failed reclosure" or after a "Failed Line Test" The reset from the Lock-out status can be operated either by the keyboard via the "CB Unlock" command available in the menu "Commands" (§ Commands) or by an external command via the Digital Input programmed for "Ext.Reset".

14.43 - Function: **LT** (Automatic Line Test)

Options	→	**TNum**	1		[0 / 1 / 2 / 3]			
	→	**Fast**	No		[No / Yes]			
	→	**Rem**	No		[No / Yes]			
Levels	→	**V/I**	Voltage		(Voltage / Current)			
	→	**Vv<**	0.5	**Vn**	(0÷1)	step	0.001	Vn
	→	**Vm<**	0.5	**Vn**	(0÷1)	step	0.001	Vn
	→	**Vlock**	0.05	**Vn**	(0.05÷1)	step	0.01	Vn
	→	**Rr<**	100	**Ω**	(0÷500)	step	0.1	Ω
	→	**VFast**	0.5	**Vn**	(0.5÷1)	step	0.1	Vn
Timers	→	**tp**	3	**s**	(0÷30)	step	0.1	s
	→	**tt**	3	**s**	(0.1÷10)	step	0.1	s
	→	**tcy**	10	**s**	(1÷180)	step	1	s
	→	**t**	3	**s**	(0÷10)	step	0.1	s

14.43.1 - Description of variables

TNum : Number of tests after an unsuccessful test.

Fast :
- *Yes* : When set to "YES" if the voltage measured during the set pre-closing time [tp] exceeds the set level [VFast], the C/B is closed immediately without the Line Test; If the voltage measured doesn't exceeds the [Vfast] level and exceeds the set level [Vlock] the line test fail output and the C/B lock-out was performed; Finally if the line voltage drops below the set level [Vlock] normal line test with check of line resistance value is normally carried out.
- *STD* : When set to "STD" if the voltage measured during the set pre-closing time [tp] exceeds the set level [VFast], the C/B is closed immediately without the Line Test.
- *MIN* : When set to "MIN" if the voltage measured during the set pre-closing time [tp] drops below the set level [VFast] the line test fail output and the C/B lock-out was performed. Otherwise normal line test with check of line resistance value is normally carried out.
- *No* : If set "No" test is normally carried out.

Rem : Remote line test; if "Yes" Line Test can be started by the logical output RCL

V/I :
- *Current* : Line resistance is calculated using Line Current and Line Voltage, in this case the algorithm don't use [Vv] measure.
- *Voltage* : Line resistance is calculated using the difference from [Vm] and [Vv] ant the rated value "Rtest" (line test resistor value).

Vv< : Minimum downstream voltage level to allow C/B close

Vm< : Minimum upstream voltage level to allow C/B close

Vlock : Maximun line voltage to allow Line Test in Yes mode

Rr< : Minimum Residual Resistance level to allow C/B closing.

VFast : Minimum Line Voltage level to allow C/B closing without Line Test.

tp : Waiting time after C/B closing command request to start the line test cycle.

tt : Duration of the Line Test.

tcy : Wait time between two consecutive tests.

t : Wait time to start reclosing after success fine test.

14.43.2 - Operation

The Line Test is started by a request of Automatic Reclosure or Manual Closure of the C/B (see § "RCL" and § "L/R C/B Cmds").
It is also possible to start the Line Test by activating a Digital Input programmed for this purpose (see § Remote Line Test control).

Voltage working:

Test is considered successful depending on "Vv<", "Vm<"and "Rr<" measurement according to programming.

Setting			Test condition
Vm<	Vv<	Rr<	
≠0	≠0	≠0	Vv ≥ [Vv<] & Vm ≥ [Vm<] & Rr≥ [Rr<]
≠0	≠0	=0	Vv ≥ [Vv<] & Vm ≥ [Vm<]
=0	=0	≠0	Rr≥ [Rr<]

If the test was unsuccessful:

If "Test N°=0"	C/B reclosing blocked
If "Test N°=1,2,3"	The timer "tcy" is started and, at the end of "tcy" the test is repeated only 1 or 2 or three times before the C/B reclosing is blocked (if one of the tests is successful, "tw" is started and then the C/B closed).

Current working:

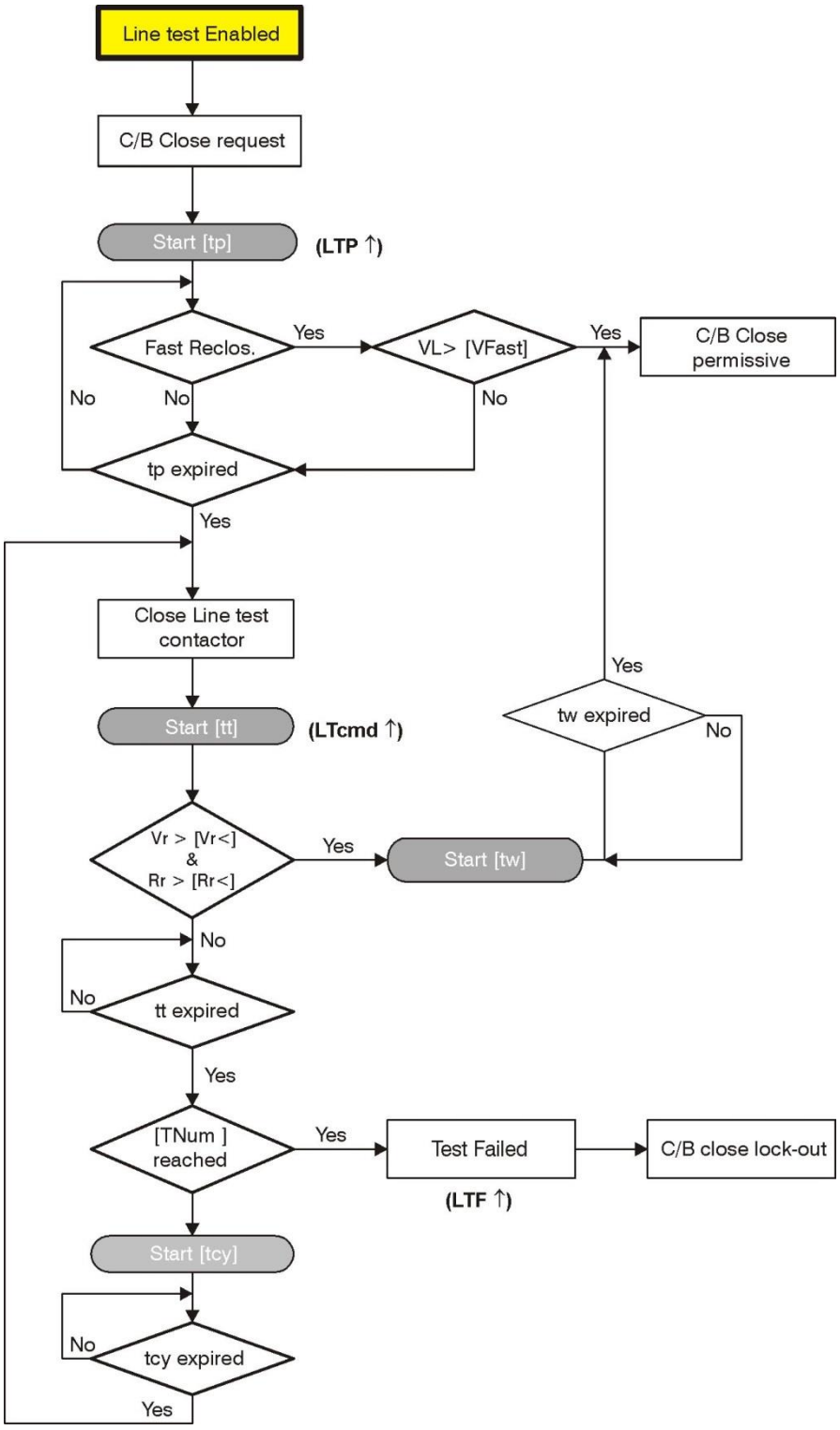
Test is considered successful depending on "Vr<" and "Rr<" measurement according to programming.

Setting		Test condition
Vm<	Rr<	
≠0	≠0	Vr ≥ [Vr<] & Rr≥ [Rr<]
≠0	=0	Vr ≥ [Vr<]
=0	≠0	Rr≥ [Rr<]

If the test was unsuccessful:

If "Test N°=0"	C/B reclosing blocked
If "Test N°=1,2,3"	The timer "tcy" is started and, at the end of "tcy" the test is repeated only 1 or 2 three times before the C/B reclosing is blocked (if one of the tests is successful, " is started and then the C/B closed).

14.43.3 - Flow chart



14.44 - Function: **ExtResCfg** (External Reset Configuration)

This menu allows to select the edge polarity of the signal on the digital input configured to reset the relay after a trip.
The reset input will reset all the output relays configured as manual reset (latched), the signalisation of the trip on the display and the indication of the LED are cleared also.

Options	→	**ActOn**	RiseEdge	[RiseEdge / FallEdge]

14.44.1 - Description of variables

ActOn	:	*RiseEdge*	Active on Rise Edge (Digital Input close).
		FallEdge	Active on Fall Edge (Digital Input open).

14.45 - Function: **Dia C/B** (Diagnostic C/B position)

In this menu it is possible to configure the CB incongruence function.

Status	→	**Enab.**	Disable		[Disable / Enable]			
Timers	→	**tCB1f**	3	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB1A**	2	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB2f**	3	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB2A**	2	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB3f**	3	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB3A**	2	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB4f**	3	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB4A**	2	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB5f**	3	**s**	(0 ÷ 10)	step	0.1	s
	→	**tCB5A**	2	**s**	(0 ÷ 10)	step	0.1	s

14.45.1 - Description of variables

tCB1f	:	C/B1 Diagnostic position discrepancy filter time
tCB1A	:	C/B1 operation control time
tCB2f	:	C/B2 Diagnostic position discrepancy filter time
tCB2A	:	C/B2 operation control time
tCB3f	:	C/B3 Diagnostic position discrepancy filter time
tCB3A	:	C/B3 operation control time
tCB4f	:	C/B4 Diagnostic position discrepancy filter time
tCB4A	:	C/B4 operation control time
tCB5f	:	C/B5 Diagnostic position discrepancy filter time
tCB5A	:	C/B5 operation control time

14.45.2 - Operation

For each auxiliary CB is possible set the incongruence status of its auxiliary contact (1NO e 1 NC). In case the two contacts are in the same status (open are close) for a time longer then tCBxf, a variable (linkable) is set.

14.46 - Function: **auxRCmds** (Auxiliary Remote Commands)

In this menu it is possible to configurate timer for duration of command.

Timers	→	**tCl1**	1	**s**	(0÷10)	step	0.1	s
	→	**tOp1**	1	**s**	(0÷10)	step	0.1	s
	→	**tCl2**	1	**s**	(0÷10)	step	0.1	s
	→	**tOp2**	1	**s**	(0÷10)	step	0.1	s
	→	**tCl3**	1	**s**	(0÷10)	step	0.1	s
	→	**tOp3**	1	**s**	(0÷10)	step	0.1	s
	→	**tCl4**	1	**s**	(0÷10)	step	0.1	s
	→	**tOp4**	1	**s**	(0÷10)	step	0.1	s
	→	**tCl5**	1	**s**	(0÷10)	step	0.1	s
	→	**tOp5**	1	**s**	(0÷10)	step	0.1	s

14.46.1 - Description of variables

tCl1	:	Master close breaker 1 command duration
tOp1	:	Master open breaker 1 command duration
tCl2	:	Master close breaker 2 command duration
tOp2	:	Master open breaker 2 command duration
tCl3	:	Master close breaker 3 command duration
tOp3	:	Master open breaker 3 command duration
tCl4	:	Master close breaker 4 command duration
tOp4	:	Master open breaker 4 command duration
tCl5	:	Master close breaker 5 command duration
tOp5	:	Master open breaker 5 command duration

15. Input – Output (via software MSCom2)

The firmware can manage up to 28 digital inputs and 24 output relays; among these, 4 digital inputs and 6 output relays are available on the relay module, the remaining are available on additional expansion modules controlled via the CAN-Bus communication channel:

14DI	Module	(Board 1)	=	14 Digital Inputs
14DO	Module	(Board 2)	=	14 Outputs Relay
UX10-4	Module	(Board 3)	=	10 Digital Inputs - 4 Outputs Relay

The interfacing software "MSCom2" also allows to program the operation of the output relays (Physical Output), and Digital Inputs (see MSCom2 Manual).

15.1 – Digital Input

→ **0.D1** → **0.D2** → **0.D3** → **0.D4**	Programmable (D1) Programmable (D2) Programmable (D3) Programmable (D4)	When the relevant terminals are open and get activated when the relevant terminals are shorted by an external cold contact.	*Available in the relay* ***This are self-powered.***
→ **1.D1** → **1.D--** → **1.D15**	Inputs "D8", "D16" not available	*Digital input on Expansion Board 1*	Any digital input of the expansion modules is active when the relevant terminals (see wiring diagram) are shorted.
→ **2.D1** → **2.D--** → **2.D15**	Inputs "D8", "D16" not available	*Digital input on Expansion Board 2*	

Three of them (0.D1, 0.D2, 0.D3) are deactivated, when the relevant terminals are open and get activated when the relevant terminals are shorted by an external cold contact.

The operation of the Input "0.D4" is dependent on the value "R" of resistance of the external circuit connected to its terminals (24-25/26):

- Activated if "R < 50Ω" or "R > 3000Ω". - Deactivated if "50Ω ≤ R ≤ 3000Ω".

Therefore, if the terminals "24-25/26" are open-circuited, the input "0.D4" is activated; for using "0.D4" as A normal Digital Input simply controlled by an external cold contact, it is necessary to permanently connect across the terminal's "24-25/26" (in parallel to the external contact) a load resistor of value between 50 and 3000Ω (example 1000Ω - 0.5W).

15.2 – "DI" Configuration paremeter available (via keyboard or MSCom2 software)

Any of the Digital Inputs can be programmed to control one or more of the following functions.

C/B1-Close	Close position status
C/B1-Open	Open position status
C/B1-I/D	Insertion status
C/B2-Close	Close position status
C/B2-Open	Open position status
C/B2-I/D	Insertion status
C/B3-Close	Close position status
C/B3-Open	Open position status
C/B3-I/D	Insertion status
C/B4-Close	Close position status
C/B4-Open	Open position status
C/B4-I/D	Insertion status
C/B5-Close	Close position status
C/B5-Open	Open position status
C/B5-I/D	Insertion status
Bi1I>	Blocking input to the 1I>
Bi2I>	Blocking input to the 2I>
Bi3I>	Blocking input to the 3I>
Bi4I>	Blocking input to the 4I>
BiRCL	Reclosure lock-out RCL
Bypass-LT	Line test bypass

Bi1U<	Blocking input to the 1U<
Bi2U<	Blocking input to the 2U<
Main C/B CL.Status	Circuit breaker status
RT	Remote Trip input
RTX	Second Remote Trip input
BiLT	Line Test blocking inputs
Bi1didt	Blocking input 1di/dt
Bi2didt	Blocking input 2di/dt
Local	Local mode operation
Remote	Remote mode operation
Open CB	Open C/B Command
Close CB	Close C/B Command
RemLT	Remote line test input
Ext Reset	External Reset input
BOpCB	Blocking input open CB
BClCB	Blocking input close CB
Group1	Setting Group 1
Group2	Setting Group 2
Group3	Setting Group 3
Group4	Setting Group 4

15.3 – Function available

In this list are show the functions that can be associated with digital inputs or output relay.

T>	Tal T>	(alarm) (trip)	*Thermal element*
1I>	1I> t1I>	(Start) (Trip)	*First overcurrent element*
2I>	2I> t2I>	(Start) (Trip)	*Second overcurrent element*
3I>	3I> t3I>	(Start) (Trip)	*Third overcurrent element*
4I>	4I> t4I>	(Start) (Trip)	*Fourth overcurrent element*
Iis	tIis>	(Start)	Instantaneous Current Element
1dI	1dI t1dI	(Start) (Trip)	*First Current step element*
2dI	2dI t2dI	(Start) (Trip)	*Second Current step element*
1di/dt	1di/dt t1di/dt	(Start) (Trip)	*First Current rate of rise element*
2di/dt	2di/dt t2di/dt	(Start) (Trip)	*Second Current rate of rise element*
Rapp	Rapp	(Trip)	*Impedance monitoring – di/dt dependence*
Iapp	Iapp		*Current monitoring with di/dt dependence*
1Ig	1Ig t1Ig	(Start) (Trip)	*First instantaneous Frame Fault element* *First time delayed Frame Fault element*
2Ig	2Ig t2Ig	(Start) (Trip)	*Second Frame Fault element*
RCL	RCL cmd ARP ARF ARL AROk ARE ARD	(Trip)	*Reclosure Shot command* *Autoreclosure in progress* *Autoreclosure Failure* *Autoreclosure Lock-out* *Autoreclosure Ok* *Autoreclosure Enable* *Autoreclosure Disable*
1U>	1U> t1U>	(Start) (Trip)	*First overvoltage element*
2U>	2U> t2U>	(Start) (Trip)	*Second overvoltage element*
1U<	1U< t1U<	(Start) (Trip)	*First undervoltage element*
2U<	2U< t2U<	(Start) (Trip)	*Second undervoltage element*
UL<	UL<		*Line Voltage presence*
Wi	Ni alNi Ne alNe Nm alNm		*Maximum number of arc chute operation at nominal values* *Alarm maintenance level of arc chute operation* *Maximum number of arc contact operation at nominal values* *Alarm maintenance level of arc contact operation* *Maximum number of mechanical operation* *Alarm maintenance level of mechanical operation*
TCS	tTCS	(Trip)	*Time delayed Trip Circuit Supervision*
IRF	IRF tIRF	(Start) (Trip)	*Time delayed Internal relay Fault* *Instantaneous Internal relay Fault*
RT	RT tRT	(Trip) (Start)	*First Instantaneous Remote Trip* *First Time delayed Remote Trip*
RTX	RTX tRTX	(Trip) (Start)	*Second Instantaneous Remote Trip* *Second Time delayed Remote Trip*
Dia-I	Dial tDial	(Trip) (Start)	*Diagnostic analog inputs current* *Delay current measurement channel failure*
CB-L	CB-L		*C/B reclose Lock-out*
BF	BF		*Breaker Failure*
Wh	+ Wh - Wh		*Exported Energy counter Pulse* *Imported Energy counter Pulse*
SelfTrip	SelfTrip t-SelfTr.		Spontaneous trip Self-Trip time delay
L/R CB Hdl	cmdOpCB cmdClCB LocRemInc missCBOpe		*Open C/B command* *Close C/B command* *Local / Remote Inconsistency* *Missed C/B opening (Digital input missing)*
Characteristiscs	Charat 1 Charat 2 Charat 3 Charat 4		Characteristic 1 Characteristic 2 Characteristic 3 Characteristic 4
LT	LTPb LTP LTF LTOK LTB LT cmd	(Trip)	*Output to operate an external flashing lamp signalling line test in progress* *Line Test in progress* *Line Test Failed* *Line Test OK* *Line Test Blocked* *Line Test command*

	I850Ready	*IEC61850 ready to work.*
	Sync	*Date – time syncronization event (active during clock syncronization).*
	SNTP-Dia	*SNTP health status.*
	SNTP-Kod	*Syncro lost by server, Kiss of death. Date-Time need syncro from another server.*
	DskClean	*External Disk Clean (disk near to full, clean operation is required)*
	DskFull	*External Disk Full (disk full, write should be locked)*
	DskWr	*External Disk Write (active during internal disk access)*
	DskFRMT	*External Disk Format (active during internal disk format)*
	DskCHK	*External Disk Check (active during internal disk check procedure)*
	rDskAttach	*Remote disk inserted (USB Key)*
	rDskDetach	*Remote disk not inserted (USB Key)*
	rDskDtchable	*Remote disk removible (USB Key)*
	rDskClean	*External Disk Clean (disk near to full, clean operation is required)*
	rDskFull	*External Disk Full (disk full, write should be locked)*
	rDskWr	*External Disk Write (active during internal disk access)*
	rDskFRMT	*External Disk Format (active during internal disk format)*
	rDskCHK	*External Disk Check (active during internal disk check procedure)*
	CB1Fail	*CB1 Failure*
	CB2Fail	*CB2 Failure*
	CB3Fail	*CB3 Failure*
	CB4Fail	*CB4 Failure*
	CB5Fail	*CB5 Failure*
	CB1missedOp	*CB1 Failure*
	CB2missedOp	*CB2 Failure*
	CB3missedOp	*CB3 Failure*
	CB4missedOp	*CB4 Failure*
	CB5missedOp	*CB5 Failure*
	MasterOp1	*Modbus Master CB1 Open request*
	MasterCL1	*Modbus Master CB1 Close request*
	MasterOp2	*Modbus Master CB2 Open request*
	MasterCL2	*Modbus Master CB2 Close request*
	MasterOp3	*Modbus Master CB3 Open request*
	MasterCL3	*Modbus Master CB3 Close request*
	MasterOp4	*Modbus Master CB4 Open request*
	MasterCL4	*Modbus Master CB4 Close request*
	MasterOp5	*Modbus Master CB5 Open request*
	MasterCL5	*Modbus Master CB5 Close request*
	Gen.Start	*General start*
	Gen.Trip	*General Trip*
	Vcc	*Reserved*
	Gnd	*Reserved*
	ResLog	*Reset signal logic*
	P1	*Push-button Open (Not used with remote MMI)*
	P2	*Push-button Close (Not used with remote MMI)*
	P3	*Push-button Reset (Not used with remote MMI)*
	UserTriggerOscillo	*User Variable for Oscillographic Recording*
	UserVar<0> to UserVar<98>	*User Variable*

Only for "**DIGITAL INPUT**"

	0.D1	*Digital Input "0.D1"*	*activated*
	0.D1Not	*Digital Input "0.D1"*	*deactivated*
	to		
	0.D4	*Digital Input "0.D4"*	*activated*
	0.D4Not	*Digital Input "0.D4"*	*deactivated*
	1.D1	*Digital Input "1.D1"*	*activated*
	1.D1Not	*Digital Input "1.D1"*	*deactivated*
	to		
	1.D15	*Digital Input "1.D15"*	*activated*
	1.D15Not	*Digital Input "1.D15"*	*deactivated*
	2.D1	*Digital Input "2.D1"*	*activated*
	2.D1Not	*Digital Input "2.D1"*	*deactivated*
	to		
	2.D15	*Digital Input "2.D15"*	*activated*
	2.D15Not	*Digital Input "2.D15"*	*deactivated*

15.4 – "DI" Configuration - via MSCom2 software

15.4.1 – Example

Name	Status	Functions

15.4.2 - Name

Logical Input name

15.4.3 - Status

Logical Input status

15.4.4 - Functions

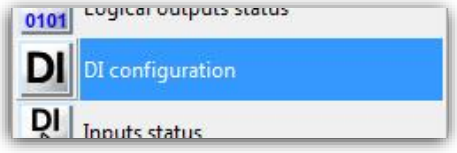
Function available. (for multiple association use "User Variable")

15.4.5 - Example: Setting "Digital Input"

Open "MSCom2" program and connect to the relay.

Select "Change Windows" from "Menu" button

Select "**DI CONFIGURATION**"



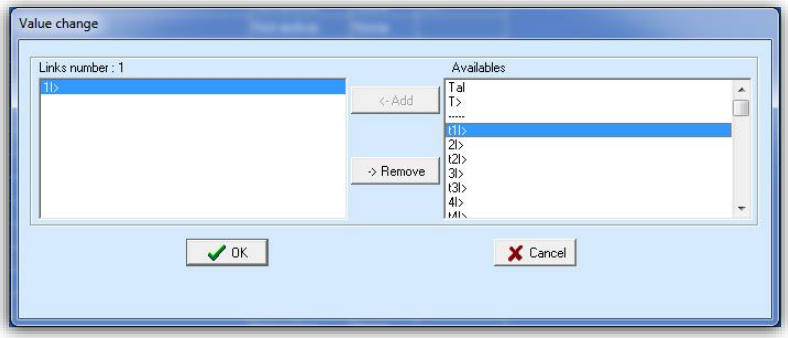
Setting for "**BI1I>**" : "**1I>**".

Name	Status	Functions
Bi1I> (Blocking Input 1I>)	Not active	1I>

15.4.6 - "Functions"

Select "**Functions**" related to "Bi1I>" and press right button on mouse, select "Value change":

From box "Available", select "1I>" and press "Add".
Press "OK" for confirmation. (if Password is request, see § Password)



15.5 – Outputs Relay

The output relay are fully user programmable and controlled by any protection functions and by any digital inputs.

→	**0.R1**	Programmable (R1)
→	**0.R2**	Programmable (R2)
→	**0.R3**	Programmable (R3)
→	**0.R4**	Programmable (R4)
→	**0.R5**	Programmable (R5)
→	**0.R6**	Programmable (R6)
→	**1.R1**	
	to	Programmable
→	**1.R14**	
→	**2.R1**	
	to	Programmable
→	**2.R14**	

Any Output Relay can be programmed to be controlled (energized) by one or more of the following functions or Digital Inputs, see § Function available

15.6 – Analog output

Four analogue output are available to transmit input quantities to external instruments.

→	**AN1-A**	Current monitoring (I)
→	**AN2-A**	Voltage monitoring (V)
→	**AN3-A**	Available
→	**AN4-A**	Available

Output range :

Current [I] : 0-20mA / 0 –In (Full scale 1.2 In) .

Voltage [Vm] : 0-20mA / 0 –Vn (Full scale 1.2 Vn) .

Response time of analog output = 100ms.

15.7 – "OutCfg" Outputs Configuration - via MSCom2 software

15.7.1 – "Example"

Relay	Linked functions	Logical status	Output config	Function	tON	Relay status

15.7.2 – "Relay"

Relay internal name

15.7.3 – "Linked function"

Select the function for tripping the output relay (for multiple association use "User Variable")

15.7.5 – "Logical Status"

Relay Logical status

15.7.6 – "Output Configuration"

Normally Deenergized	The output relay is deenergized in normal conditions and gets energized on activation of the controlling Functional Output; reset means deenergizing.
Normally Energized	The output relay is energized in normal conditions and gets deenergized on activation of the controlling Functional Output; reset means energizing.

15.7.7 – "tON - Operation Time"

This timer controls the duration of the activation of the output relay.

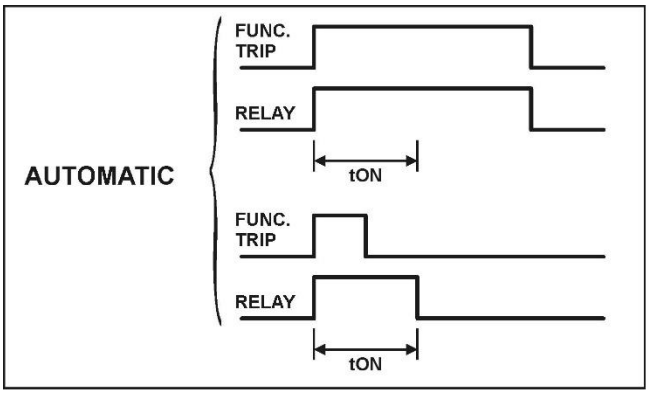
tON : 0 (0.01-10)s, step 0.01s

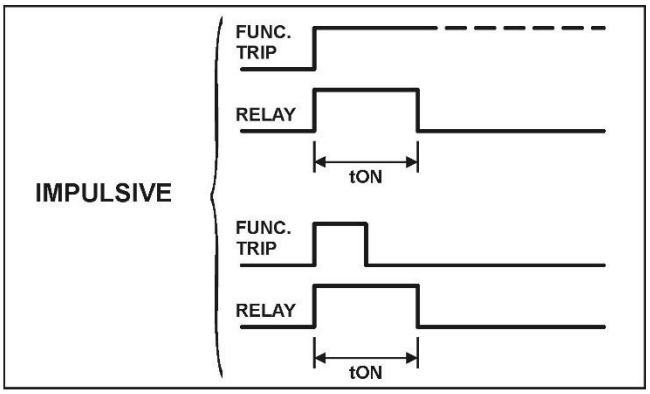
15.7.8 – "Relay Status"

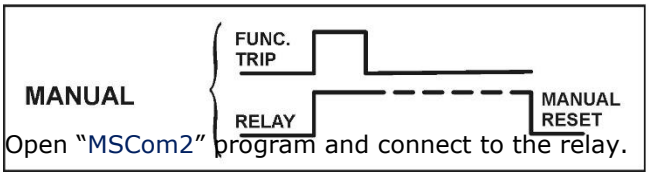
Relay – Physical status

15.7.9 - Functions - Operation Mode

Automatic	:	In this mode the output relay is "operated" (energized if "**N.D.**", deenergized if "**N.E.**") when the controlling Functional Output is activated and it is reset to the "non operated" condition when the Functional Output gets disactivated but, anyhow, not before the time "**TON**" has elapsed (minimum duration of the operation time)
Manual	:	In this mode the output relay is "operated" when the controlling Functional Output is activated and remains in the operated condition until a manual reset command is issued by the relay keyboard (local commands menu) or via the serial communication. In this mode the timer "**TON**" has no effect.
Impulsive	:	In this mode the output relay is "operated" when the controlling Functional Output is activated and it remains in the "operated" condition (energized if "**N.D.**", deenergized if "**N.E.**") for the set time "**TON**" independently from the status of the controlling Functional Output.

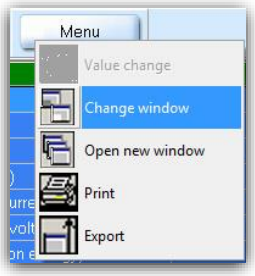




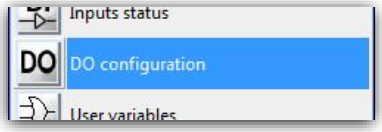


Open "MSCom2" program and connect to the relay.

Select "Change Windows" from "Menu" button



Select "**DO CONFIGURATION**"



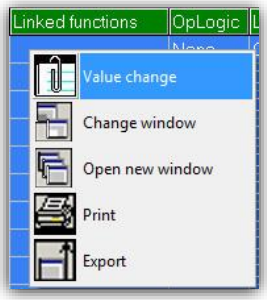
15.7.10 - Example: Change settings for "0.R1"

Change settings for "**0.R1**" : "1I>", "Normally Energized", "Pulse", "0.5".

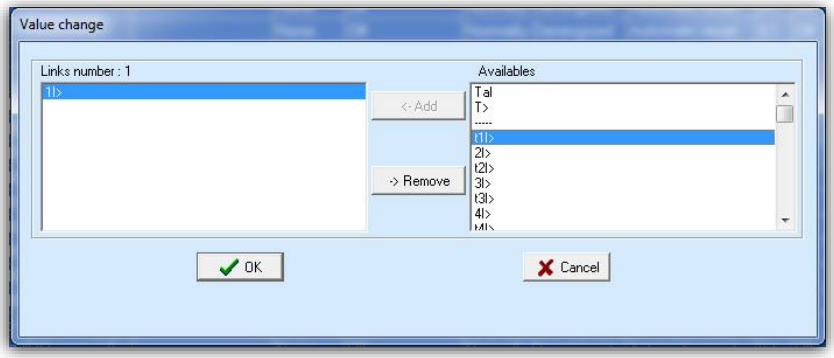
Relay	Linked functions	Logical status	Output config	Function	tON	Relay status
0.R1 [Master board, R:1]	1I>,	Off	Normally Energized	Pulse	0,5	Off

15.7.10.1 - "Linked Functions"

Select "**Linked Functions**" related to "0.R1" and press right button on mouse, select "Value change":

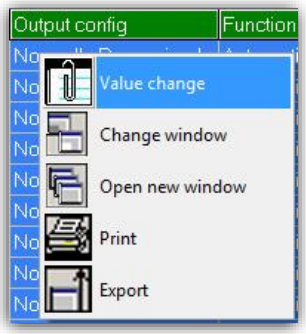


From box "Available", select "1I>" and press "Add".
Press "OK" for confirmation. (if Password is request, see § Password)

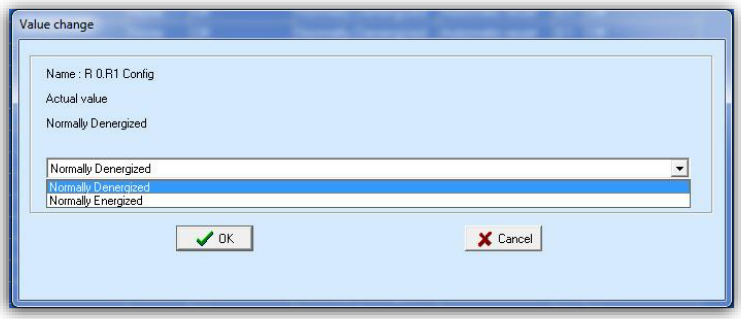


15.7.10.2 - "Output Config"

Select "**Output Config**" related to "0.R1" and press right button on mouse, select "Value change":



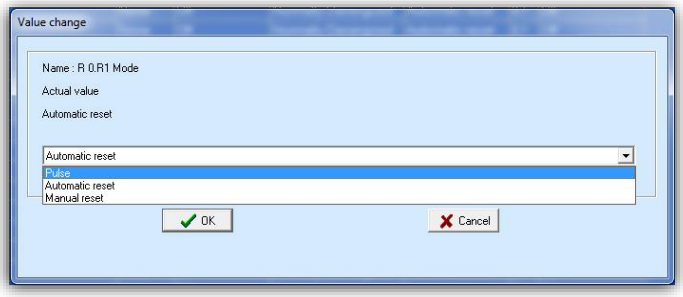
Select "**Normally Energized**" from combo box and press "OK" (if Password is request, see § Password)



15.7.10.3 - "Function"

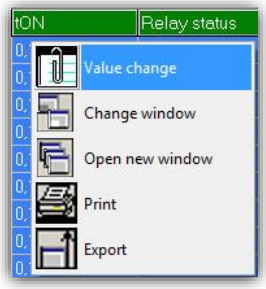
Select "**Function**" related to "0.R1" and press right button on mouse, select "Value change":

Select "**Pulse**" from combo box and press "OK" (if Password is request, see § Password):

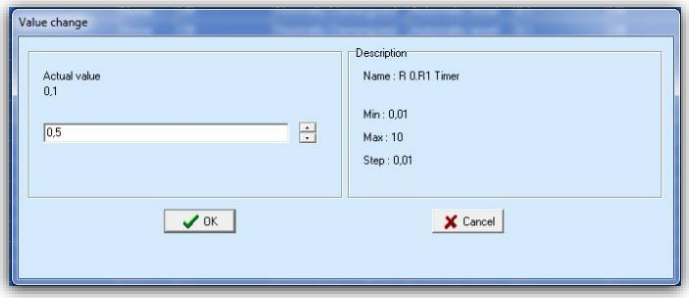


15.7.10.4 - "tON"

Select "**tON**" related to "0.R1" and press right button on mouse, select "Value change":



Select "**0.5**" from combo box and press "OK" (if Password is request, see § Password):



16. UserVar

The "User Variable" is a result of a logical operation (OR, AND, ecc...), it can be used like other logical output.

16.1 – Configuration – via MSCom2 software

Name	User descr.	Linked functions	OpLogic	Timer	Timer type	Extra	Logical status

16.1.1 - Name

Internal progressive name

16.1.2 - User Descr.

Custom identification label for user variable

16.1.3 - Linked functions

Selection functions

16.1.4 - OpLogic

Operation Logic	=	[None, OR, AND, XOR, NOR, NAND, NOT, Ff-SR, Counter, Rise-Up, Fall-Down]

16.1.5 - Timer

Time delay (0-600)s, step 0.01s

16.1.6 - Timer type

Delay	:	Add a delay on output activation. The "Timer" is edge triggered on rise edge.
Impulse P	:	Monostable Positive pulse time
Impulse N	:	Monostable Negative pulse time
Blink	:	When selected output is a 50% duty cycle square wave
Fall-Down	:	Time added on falling output edge

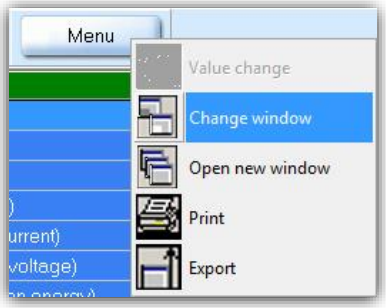
16.1.7 - Logical status

"User Variable" Logical status

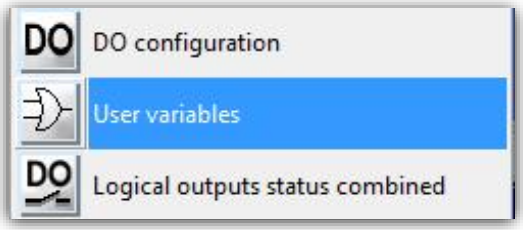
16.1.8 - Example: Setting "User Variable"

Open "MSCom2" program and connect to the relay.

Select "Change Windows" from "Menu" button



Select "**USER VARIABLE**"



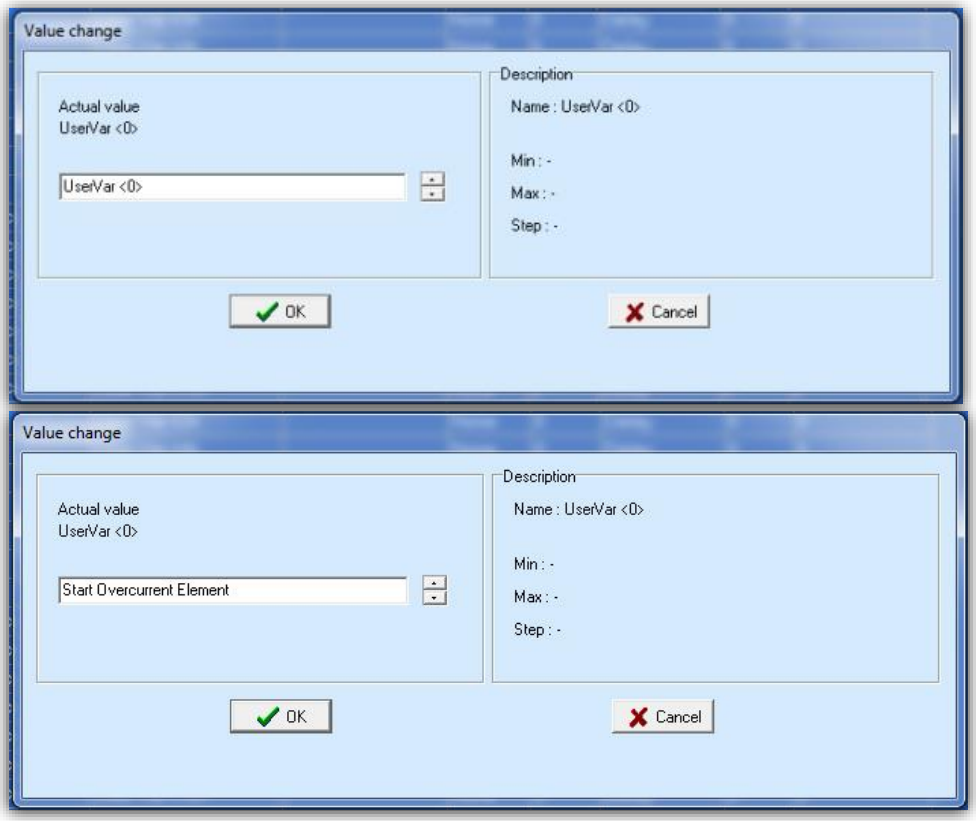
Setting for "**UserVar<0>**" :
"**Start Overcurrent Element**", "**1I>, 2I>, 3I>**", "**OR**", "**1**", "**Monostable P**".

Name	User descr.	Linked functions	OpLogic	Timer	Timer type	Extra	Logical status
UserTrigger Oscillo	UserTrigger Oscillo		None	0	Delay	0	0
UserVar <0>	UserVar <0>		None	0	Delay	0	0

16.1.8.1 - "User description" (User descr.)

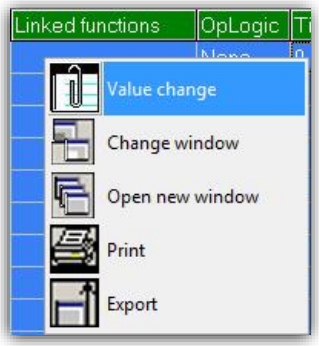
Select "**User descr**" related to "UserVar<0>" and press right button on mouse, select "Value change":

Insert "**Start Overcurrent Element**" into box and press "OK":

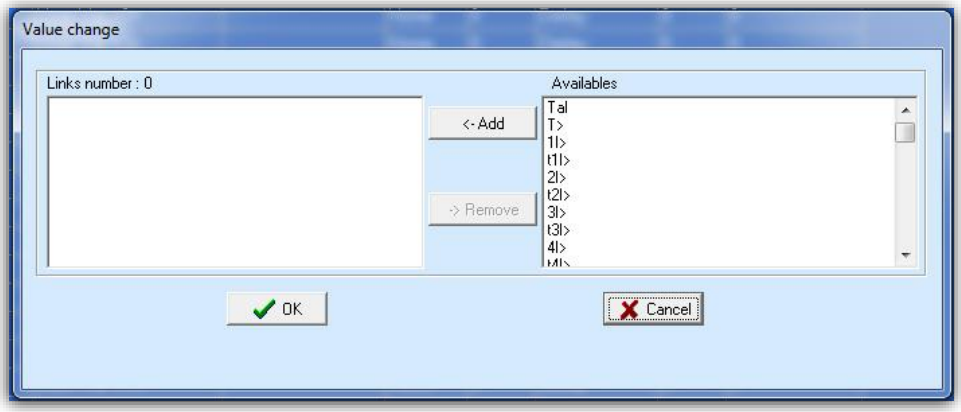


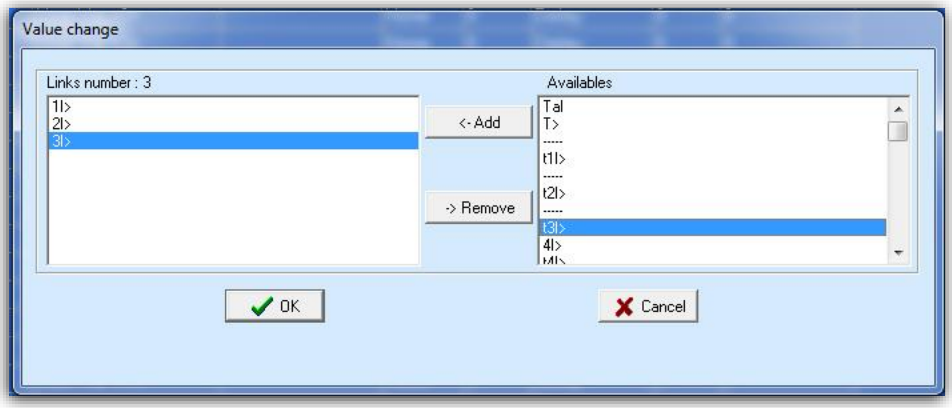
16.1.8.2 - "Linked Functions"

Select "**Linked Functions**" related to "UserVar<0> ("**Start Overcurrent Element**")" and press right button on mouse, select "Value change":



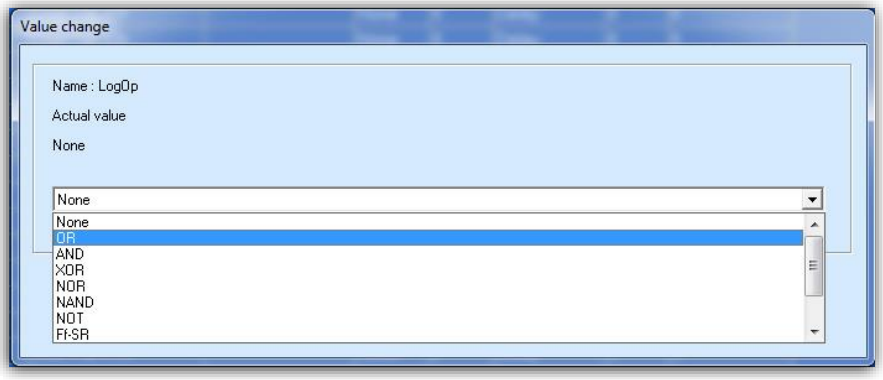
Select "**1I>, 2I>, 3I>**" from "Available" box via push-button "<Add", and press "OK".
For remove functions, use push-button ">Remove".





16.1.8.3 - "Operation Logic" (Oplogic)

Select "**Oper Logic**" related to "UserVar<0> ("**Start Overcurrent Element**")" and press right button on mouse, select "Value change":

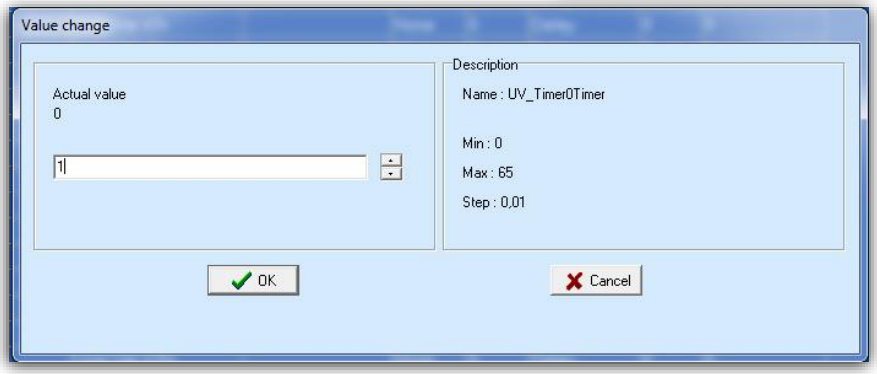


Insert "**OR**" into box and press "OK":

19.1.8.4 - "Timer"

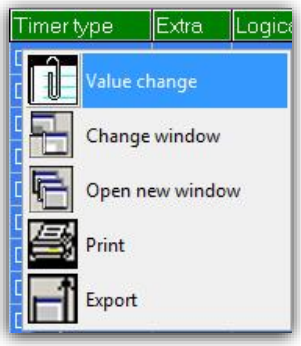
Select "**Timer**" related to "UserVar<0> ("**Start Overcurrent Element**")" and press right button on mouse, select "Value change":

Select "**1**" into box and press "OK":

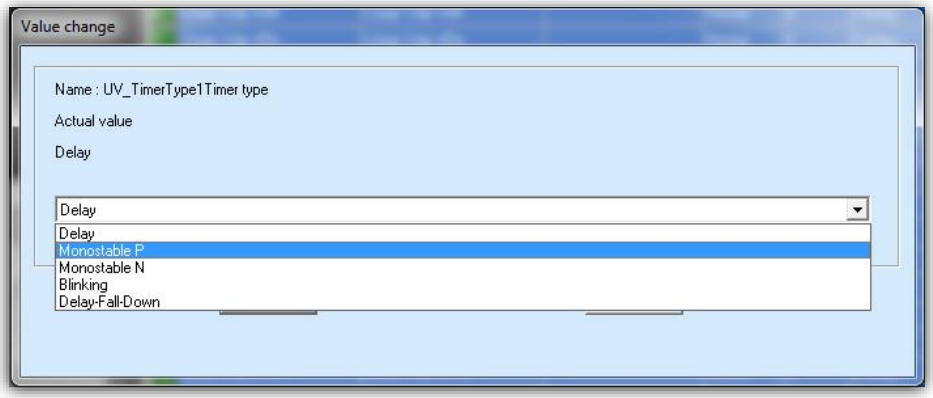


16.1.8.5 - "Timer type"

Select "**Timer**" related to "UserVar<0> ("**Start Overcurrent Element**")" and press right button on mouse, select "Value change":



Select "**Monostable**" into box and press "OK":



17. Date and Time

17.1- Clock synchronization

The internal clock has 1ms resolution and a stability of ±35ppm in the operational temperature range.

It can be synchronized with an external time reference in the following ways:

- Using the "MSCom2" software or from the DCS with the Modbus RTU protocol.

- Through the NTP protocol, maximum 3 SNTP servers;
  The relay synchronize the clock to first server available on the list "IPV4 NP server address ".

Note: On power supply failure an internal battery supports the internal clock for over two years.

18. Battery

The relay is equipped with a lithium battery type "**CR2032 3V**", to support the internal clock and the oscillographic recording memory in case of programmed lack of power.
The expected minimum duration without power exceed 2 years.

ATTENTION!! Use only battery specified.

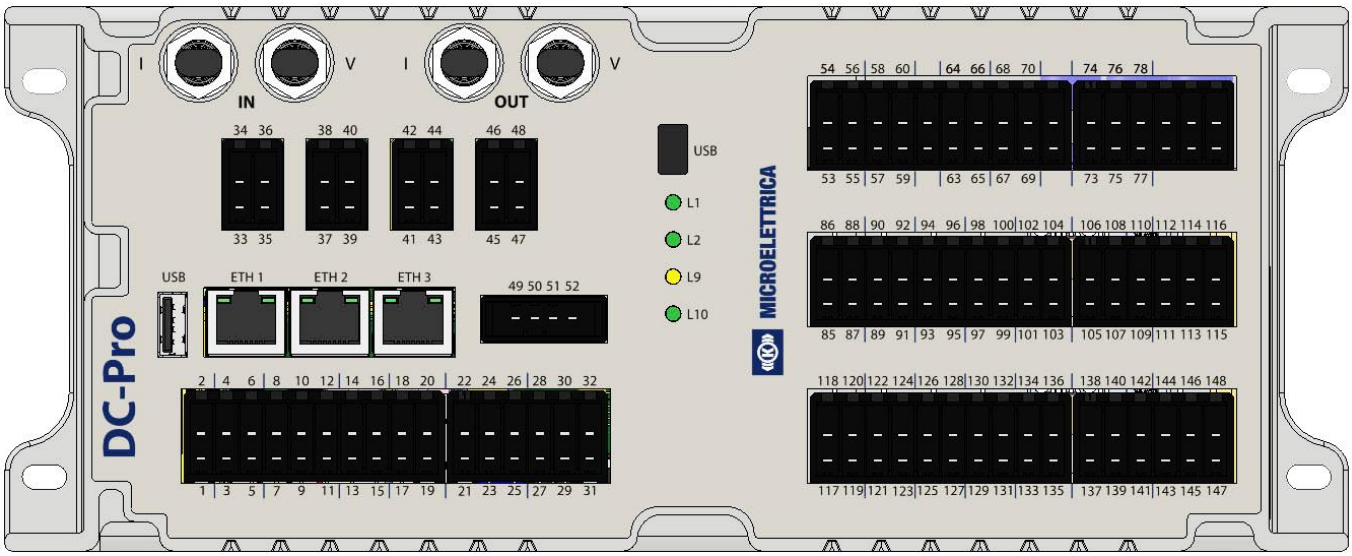
19. Maintenance

No maintenance is required. In case of malfunctioning please contact Microelettrica Scientifica Service or the local Authorized Dealer mentioning the relay's Serial No reported in the label on relays enclosure.

20. Power Frequency Insulation Test

Every relay individually undergoes a factory insulation test according to IEC255-5 standard at
2 kV, 50 Hz 1min. Insulation test should not be repeated as it unusefully stresses the dielectrics.
When doing the insulation test, the terminals relevant to serial output, digital inputs and RTD input must always be short circuited to ground. When relays are mounted in switchboards or relay boards that have to undergo the insulation tests, the relay should be isolated. This is extremely important as discharges eventually tacking place in other parts or components of the board can severely damage the relays or cause damages not immediately evident to the electronic components.

21. Terminal Blocks (Wiring Diagram)



21.1 – Power Supply

21.1.1 – Main Unit power supply input

A 1 **A** 2 **Earth** 3

21.1.2 – Dedicated Remote Unit supply output (24V)

A 74 (+) **A** 73 (-)

21.2 – Measurement Inputs

21.2.1 - Fiber Optic

In I, V (input from MHIT transducers) **Out** I, V (output = input on fiber repeated)

21.2.2 - Voltage Tranducer

VL 37 (+), 38 (-) **VV** 39 (+), 40 (-)

21.2.3 - Current Tranducer

In 33 (+), 34 (-) **10In** 35 (+), 36 (-)

21.2.4 - Frame-to-Ground Monitoring Input

Vg 43 (+), 44 (-) **Ig** 41 (+), 42 (-)

21.3 – Digital Inputs

Type (Self–Powered)		
0.D1	25/26	21
0.D2	25/26	22
0.D3	25/26	23
0.D4	25/26	24

Type	(-)	(+)
2.D1	85	86
2.D2	87	88
2.D3	89	90
2.D4	91	92
2.D5	93	94
2.D6	95	96
2.D7	97	98
2.D8	99	100
2.D9	101	102
2.D10	103	104

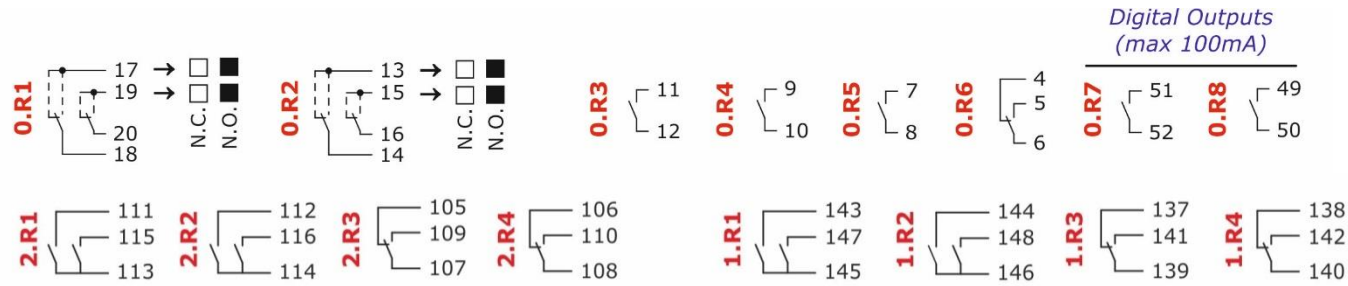
Type	(-)	(+)
1.D1	117	118
1.D2	119	120
1.D3	121	122
1.D4	123	124
1.D5	125	126
1.D6	127	128
1.D7	129	130
1.D8	131	132
1.D9	133	134
1.D10	135	136

21.4 – Analogic Outputs

Type	(-)	(+)
AN1-A	53	54
AN2-A	55	56
AN3-A	57	58
AN4-A	59	60

Type	(-)	(+)
reserved	63	64
reserved	65	66
reserved	67	68
reserved	69	70

21.5 – Output Relays



21.6 – Comunications terminals

21.6.1 – Main Unit

RS485	
A (S+)	27
B (S-)	28
C	29

Canbus	
H	31
L	32
C	29

Connection to Remote Unit	
A	75
B	76
(Z)	77
(Y)	78

21.6.2 – Remote Unit

RS485
485+
485-
GND

21.6.3 – Ethernet port

ETH 1	RJ45

ETH 2	RJ45

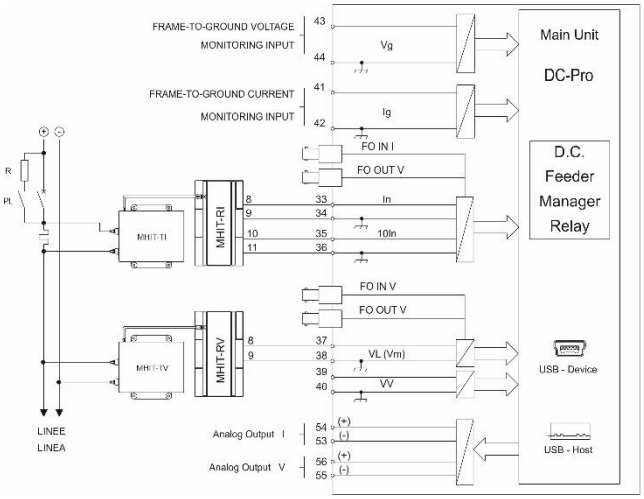
ETH 3	RJ45

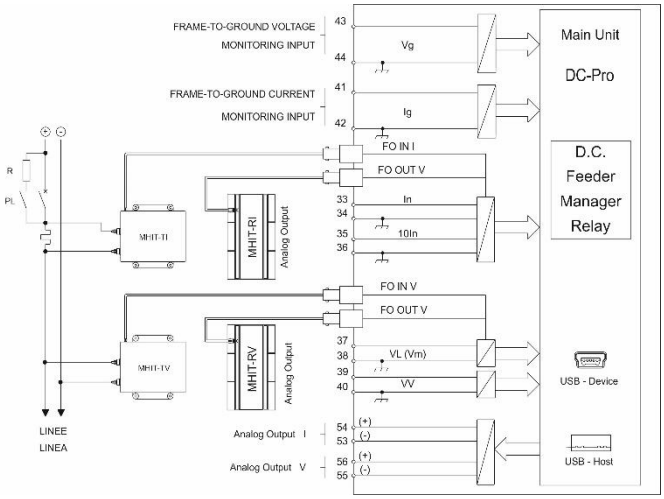
21.6.4 – USB

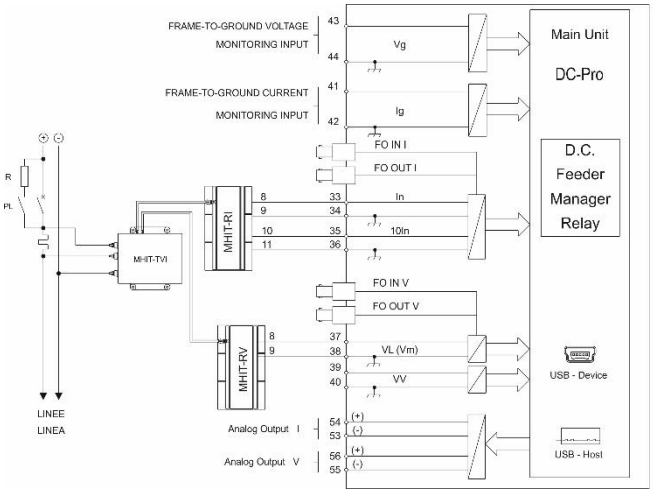
Type	A

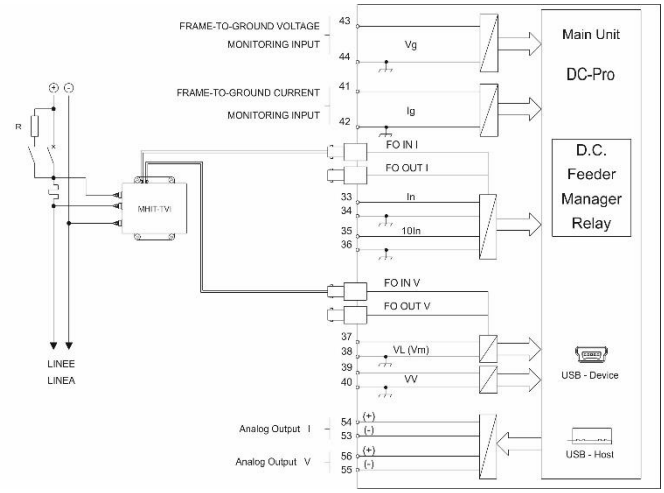
Type	Mini

21.6.5 – Insertion Diagram (Example)

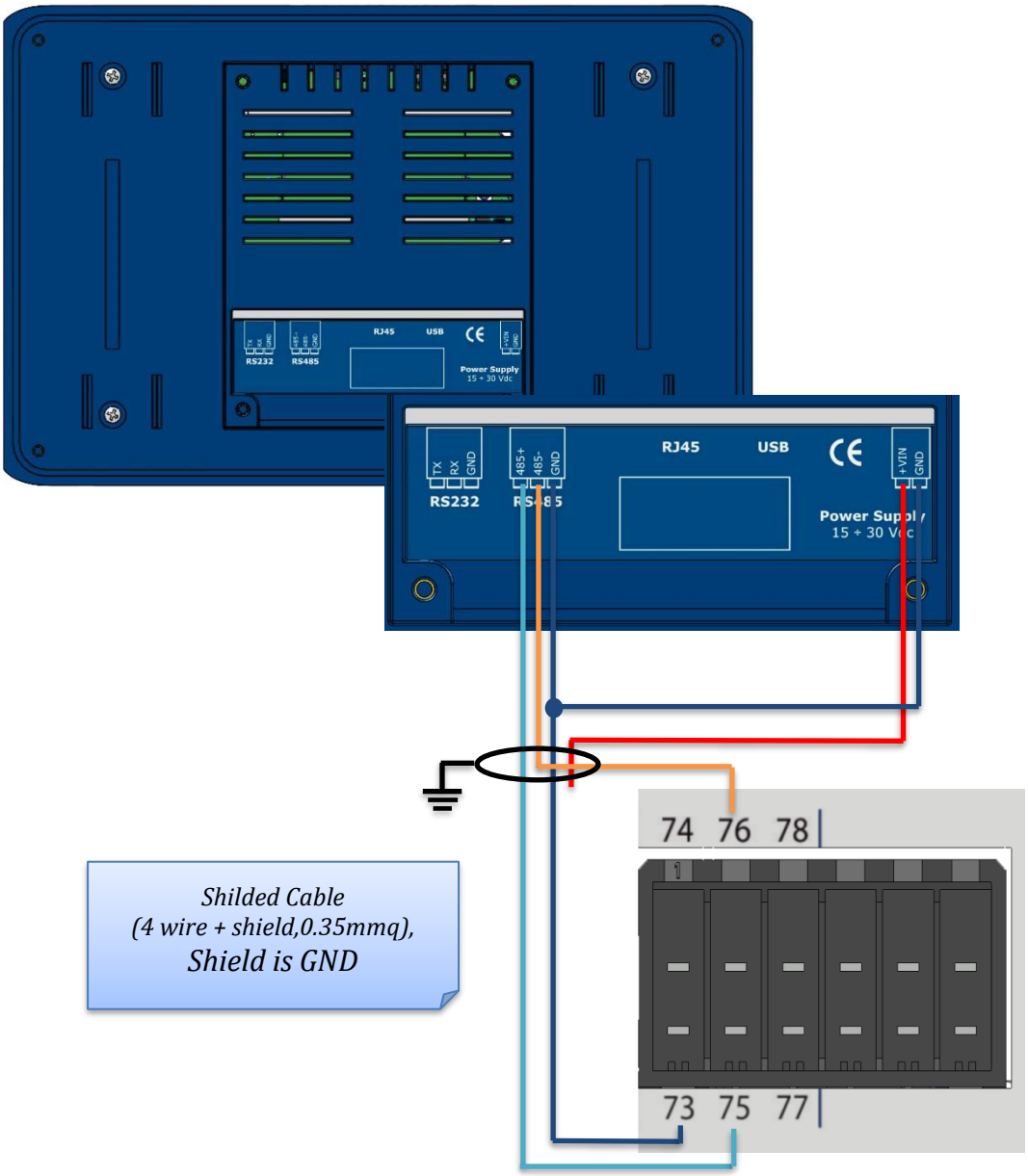


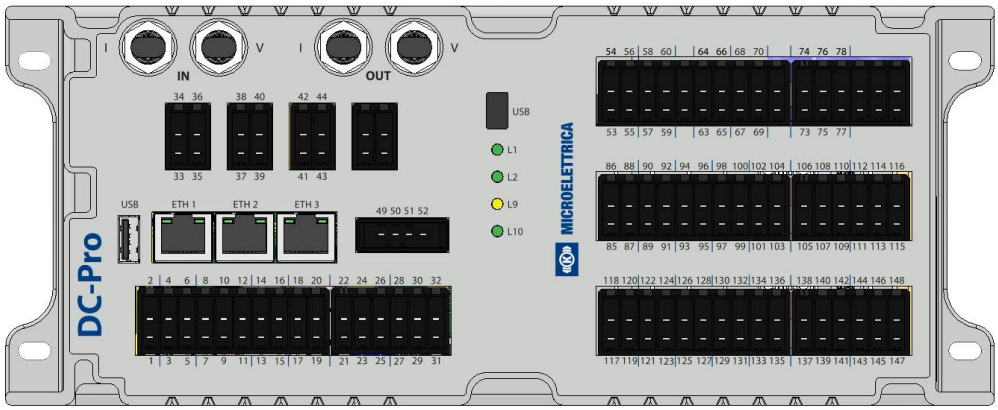






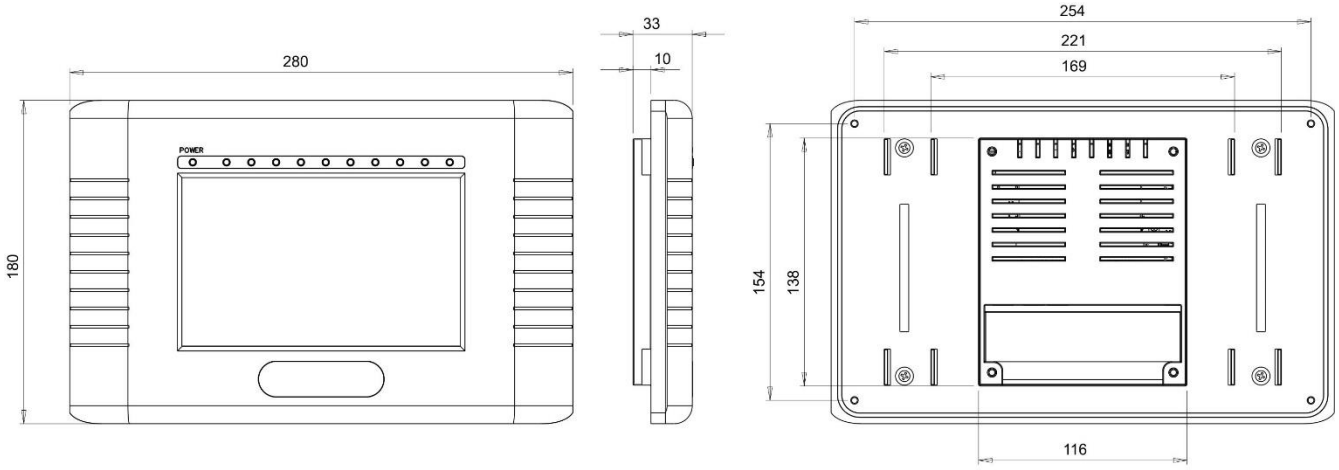
21.6.6 – Main Unit – Remote Unit connection detail

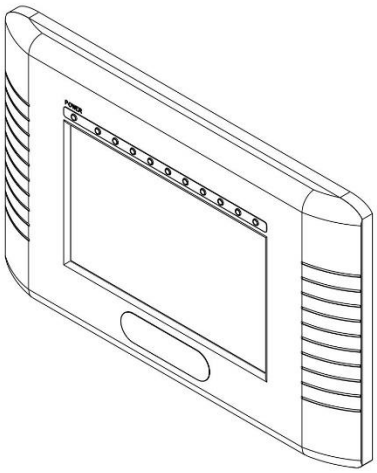


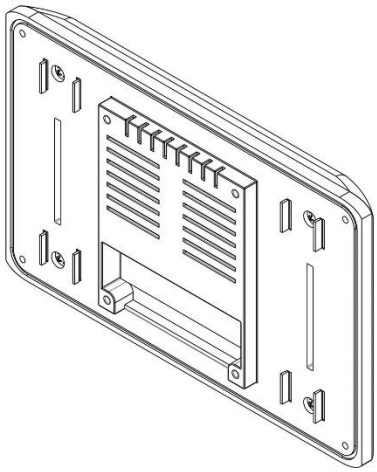


22. Overall Dimensions

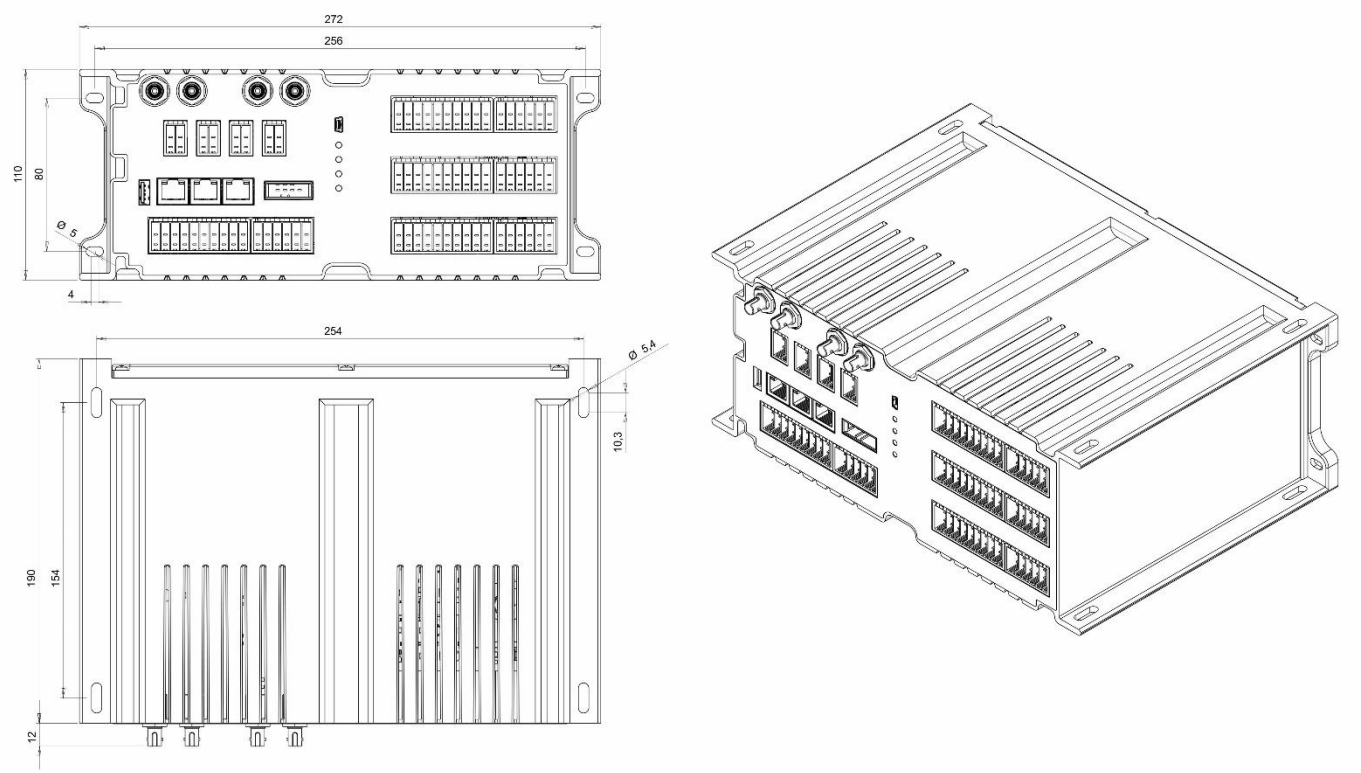
22.1 – Remote Unit





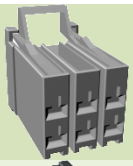
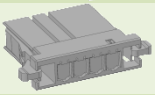


22.2 – Main Unit

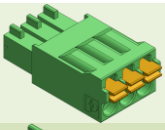
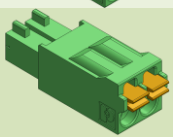


23. Spare Parts

23.1 – Main Unit

	DYNAMIC D-3500 REC HSG 6P	1318095-1
	DYNAMIC D-3500 REC HSG 4P	175363-2
	DYNAMIC D-3500 REC HSG 2P	175362-1
	DYNAMIC 3100 REC HSG 4P	1-178288-4
	DYNAMIC D-3 REC CONT 3L 16-14	1-353715-5

23.1 – Remote Unit

	FMC 1,5 3-ST-3,5	1952270
	FMC 1,5 2-ST-3,5	1952267

24. Tools

	MINI SAHT D3000-3L	2255149-1
	EXTRACTION TOOL (DYNAMIC D-3)	234168-1

25. Electrical Characteristics

APPROVAL: CE
REFERENCE STANDARDS IEC 60255 - EN50263 - CE Directive - EN/IEC61000 - IEEE C37

Dielectric test voltage		IEC 60255-5	2kV, 50/60Hz, 1 min.
Impulse test voltage		IEC 60255-5	5kV (c.m.), 2kV (d.m.) – 1,2/50μs
Insulation resistance		> 100MΩ	

Environmental Std. Ref. (IEC 60068)

Operation ambient temperature		-10°C / +55°C	
Storage temperature		-25°C / +70°C	
Environmental testing	(Cold)	IEC60068-2-1	
	(Dry heat)	IEC60068-2-2	
	(Change of temperature)	IEC60068-2-14	
	(Damp heat, steady state)	IEC60068-2-78	RH 93% Without Condensing AT 40°C

CE EMC Compatibility (EN50081-2 - EN50082-2 - EN50263)

Electromagnetic emission	EN55022	industrial environment		
Radiated electromagnetic field immunity test	IEC61000-4-3	level 3	80-2000MHz	10V/m
	ENV50204		900MHz/200Hz	10V/m
Conducted disturbances immunity test	IEC61000-4-6	level 3	0.15-80MHz	10V
Electrostatic discharge test	IEC61000-4-2	level 4	6kV contact / 8kV air	
Power frequency magnetic test	IEC61000-4-8		1000A/m	50/60Hz
Pulse magnetic field	IEC61000-4-9		1000A/m, 8/20μs	
Damped oscillatory magnetic field	IEC61000-4-10		100A/m, 0.1-1MHz	
Immunity to conducted common mode disturbance 0Hz-150KHz	IEC61000-4-16	level 4		
Electrical fast transient/burst	IEC61000-4-4	level 3	2kV, 5kHz	
HF disturbance test with damped oscillatory wave (1MHz burst test)	IEC60255-22-1	class 3	400pps, 2,5kV (m.c.), 1kV (d.m.)	
Oscillatory waves (Ring waves)	IEC61000-4-12	level 4	4kV(c.m.), 2kV(d.m.)	
Surge immunity test	IEC61000-4-5	level 4	2kV(c.m.), 1kV(d.m.)	
Voltage interruptions	IEC60255-4-11			
Resistance to vibration and shocks	IEC60255-21-1 - IEC60255-21-2 10-500Hz 1g			

Electric Rated Value

Accuracy at reference value of influencing factors	1% In for measure 2% + to (to=20÷30ms @ 2xIs) for times
Rated Current	0 - ±20mA (±40) ≡ 0 – In (2In)
Rated Voltage	0 - 20mA (40) ≡ 0 – Vn (2Vn)
Average power supply consumption	< 20 VA
Output relays	rating 5 A; Vn = 380 V A.C. resistive switching = 1100W (380V max) make = 30 A (peak) 0,5 sec. break = 0.3 A, 110 Vcc, L/R = 40 ms (100.000 op.)

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