Installation and Operating Instructions

Power^IT
Power Factor Controllers
RVT

Industrial^IT enabled

ABB

Table of contents

Read this first

About this Instruction Manual

This Instruction Manual is designed to help you quickly install and operate the RVT Controller.
Before installation and operation of the RVT Controller, read this notice carefully.
Keep it at the disposal of people in charge of installation, maintenance and operation.

Safety

Installation, maintenance and operation of the RVT Controller must be performed by qualified electricians.
Do not work under voltage.
For cleaning, remove the dust with a dry cloth. Do not use abrasives, solvents or alcohol. Before cleaning please turn off the power supply and voltage measurement circuit.
Do not open the RVT Controller's housing. There are no user serviceable parts inside.
Disconnect the voltage before replacing the fuse.
The RVT Controller is connected to a current transformer. Do not unplug the current transformer connections before making
sure it is short-circuited or connected to another parallel load of sufficiently low impedance. Failure to do so can create dangerous over voltages.
Do not use this product for any other purpose than its original aim.

Electromagnetic Compatibility

This RVT Controller has been verified for compliance with EU (European Union) directives for EMC (electromagnetic compatibility) for operation at 50 Hz and bears the CE marking to this effect.

When an apparatus is used in a system, EU directives may require that the system be verified for EMC compliance.
The following guidelines are helpful in improving the EMC performance of a system:

Metallic enclosures generally improve EMC performance.
1. Run cables away from apertures in the enclosure.
2. Run cables close to grounded metallic structures.
3. Use multiple ground straps for doors or other panels parts as required.
4. Avoid common ground impedances.

UL recognition and CSA certification

The RVT Controller is UL Recognized.

The RVT Controller is CSA certified for use in 120Vac system voltage.

1. Description

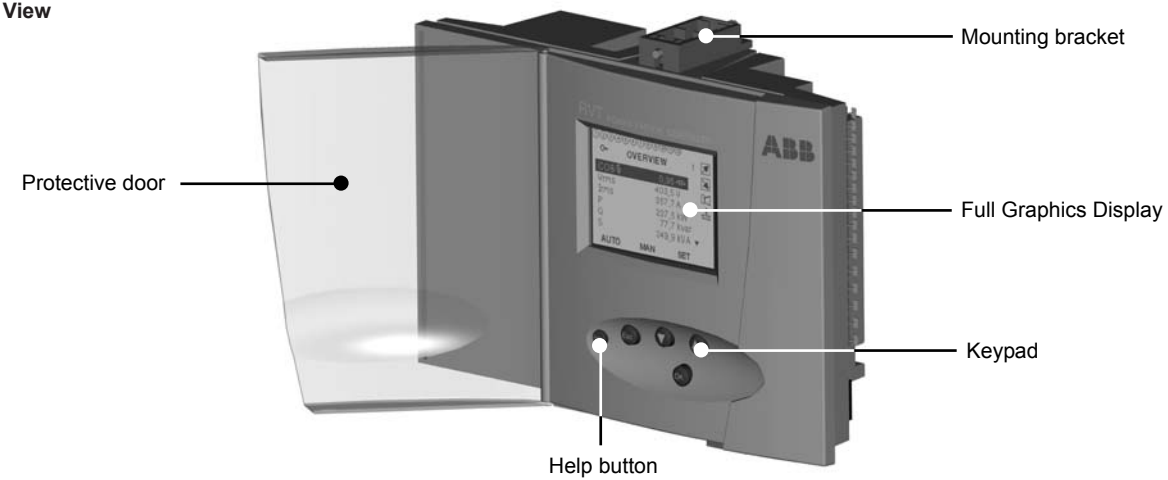
1.1. RVT Features

The RVT Power Factor Controller is the control unit of an automatic capacitor bank.
It performs the switching of capacitors with a view to reaching a user-defined target cos φ.
• All the switching parameters may be programmed automatically or manually (description in paragraphs 6.2 and 6.3)
• In addition to the target cos φ, night target cos φ and target cos φ in regenerative mode may be programmed (description in paragraph 6.3.4).

Additionally the RVT Controller provides useful functions:
• **Measurements** (description in paragraph 5.1).
• **Protection** against unexpected phenomena and/or unauthorized use (description in paragraphs 6.1.1, 6.1.4 and 6.3.2).
• **Logging of data and alarm messages** (description in paragraphs 5.4 and 7).
• **Checking and testing of relays status** (description in paragraphs 6.5 and 7).

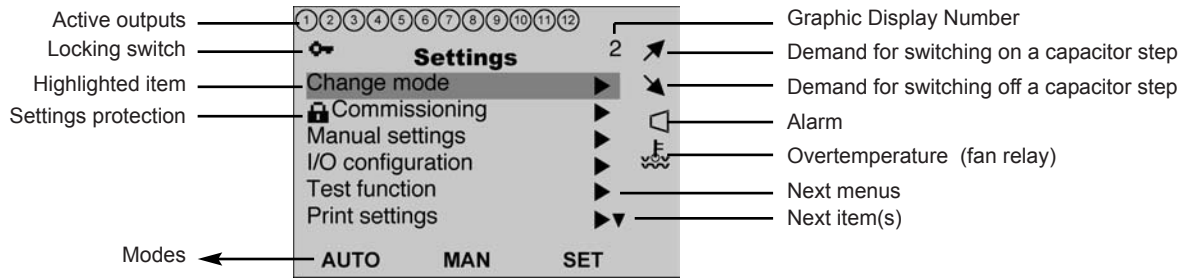
Moreover with the addition of optional accessories, the RVT provides:
• Printout of measurements and parameters.
• Temperature measurements.
Each accessory is delivered with its own Instruction Manual.

1.2. Front View

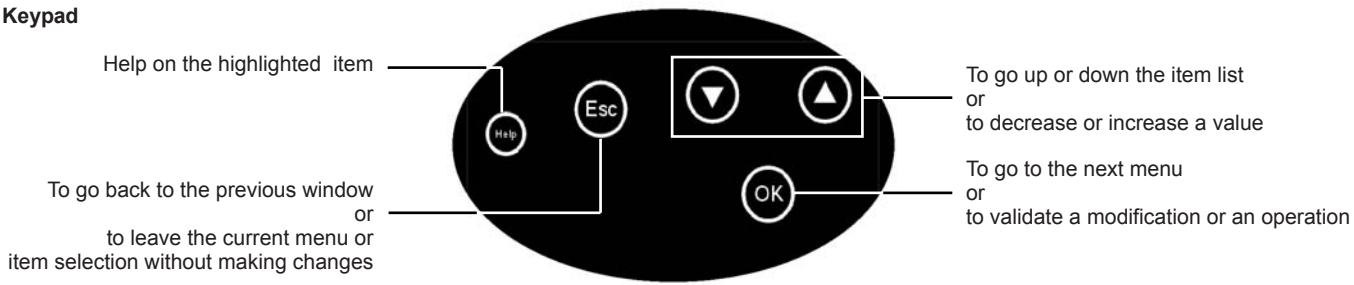


1.3. Full Graphics Display and Keypad

Full Graphics Display



Keypad

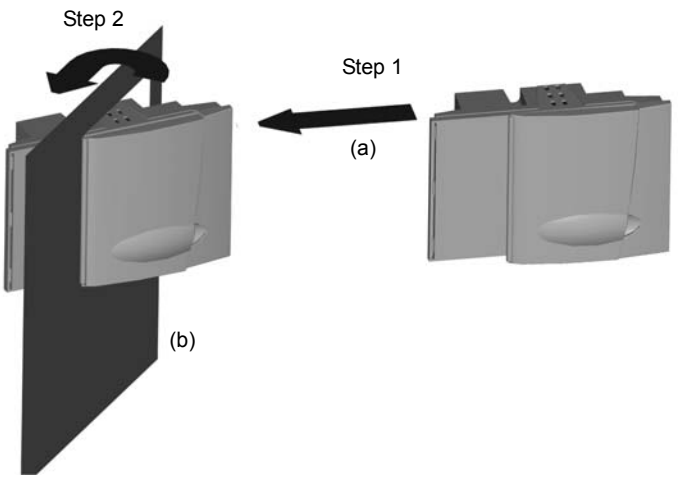


2. Installation

2.1. Mounting

Step 1 : Slide the RVT (a) perpendicularly to the Capacitor Bank Cubicle (b).

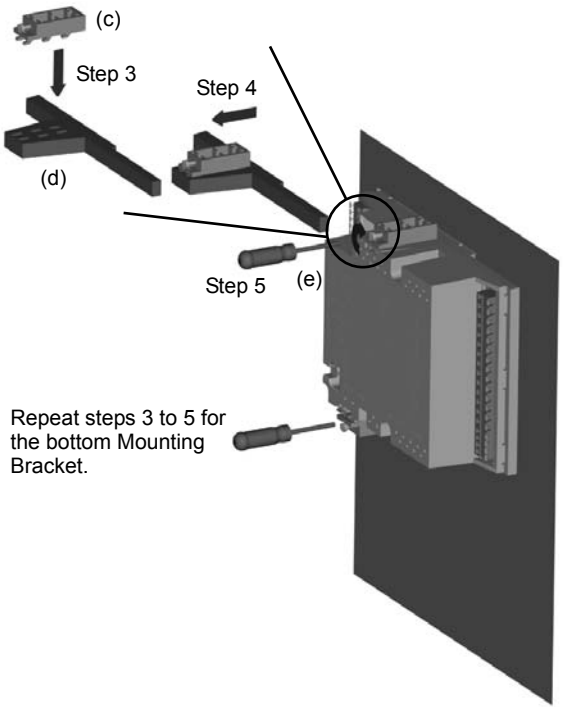
Step 2 : Rotate the RVT to insert it into the Capacitor Bank Cubicle.



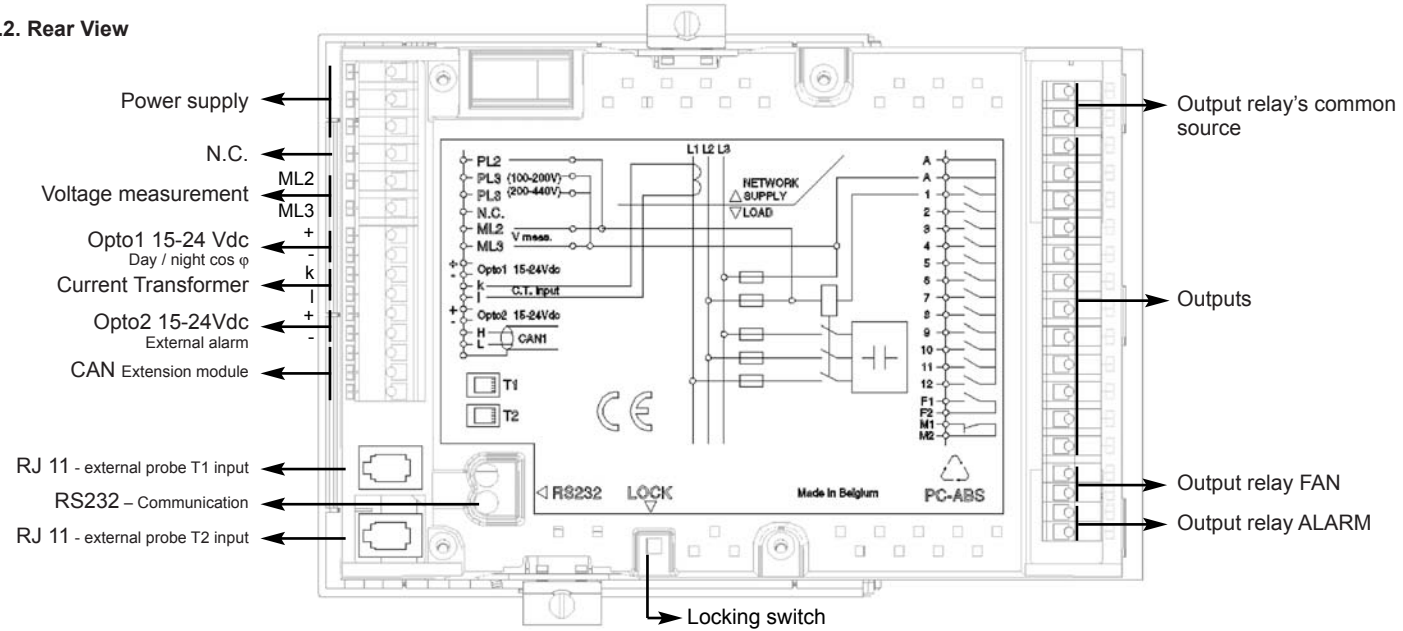
Step 3 : Insert the Mounting Bracket (c) in the corresponding Fixation Holes (d) of the RVT.

Step 4 : Pull the Mounting Bracket backwards.

Step 5 : Turn the Screw (e) into the Mounting Bracket and tighten until the RVT is secured in place.

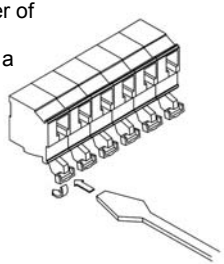


2.2. Rear View

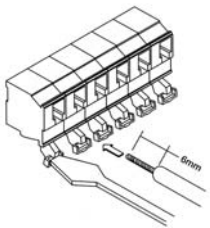


2.3. Lead Connections

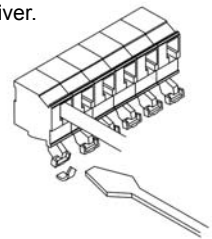
1. Push the lever of the connector backwards with a screwdriver.



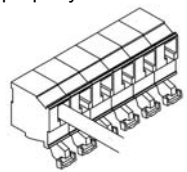
2. Insert the wire (up to 2.5 mm² /single core) in the corresponding connection hole while keeping the pressure on the lever.



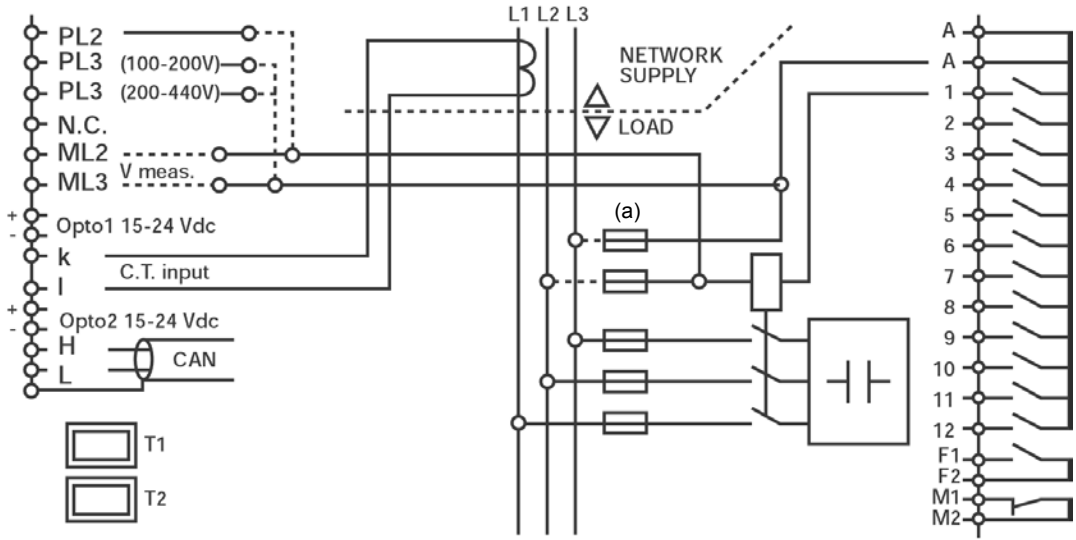
3. Release the screwdriver.



4.The wire is properly connected.



2.4. Wiring diagram



PL2, PL3 :	power supply
ML2, ML3 :	measurement (Category III)
OPTO1 :	day/night input
k, l :	curent transformer
OPTO2 :	external alarm imput
T1, T2 :	temperature probe inputs

H, L :	CAN(b) : extension module
A, A :	output relay's common source
1-12 :	outputs
F1, F2 :	output relay FAN
M1, M2 :	output relay ALARM

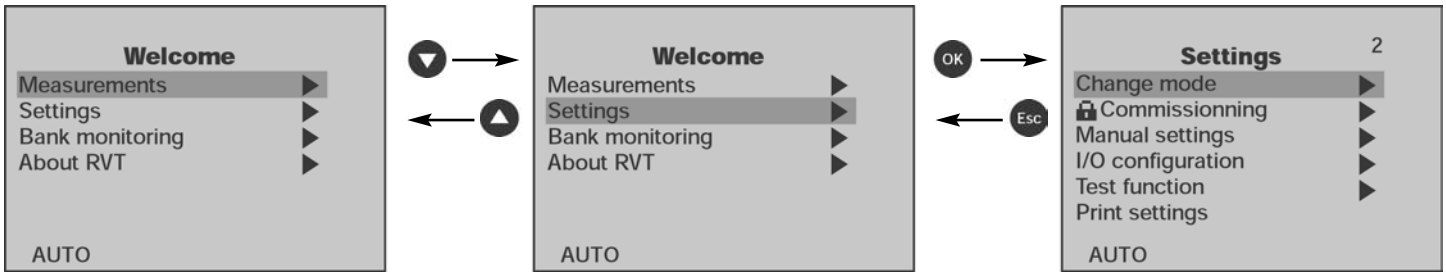
Remarks:

(a) The protective device allowing the disconnection of the RVT supply and measurement circuit must be put inside the same cubicle as the RVT and accessible by maintenance people only.

(b) The CAN connections do not have the isolation Class II. In addition to this, the CAN bus cannot be used by the customer for connecting the RVT to the external world. It is dedicated for interconnecting one or more devices manufactured by ABB Jumet and located in the same cubicle.

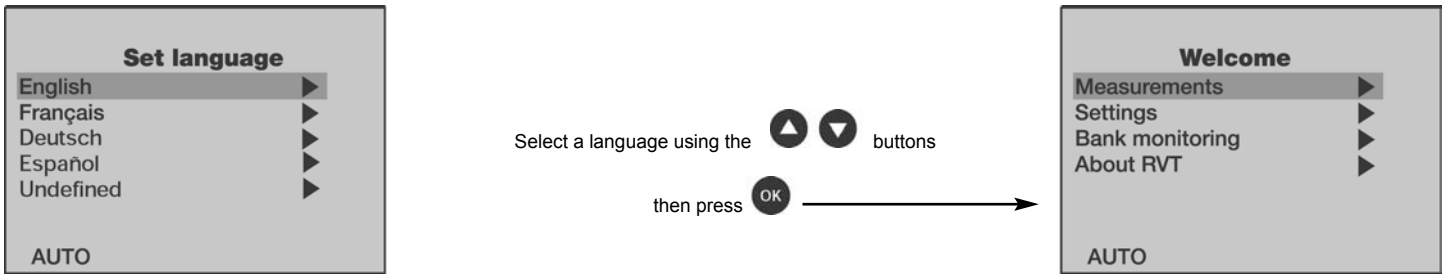
3. Easy start

3.1. Menu navigation



3.2. Starting the RVT

When the RVT is powered-up for the first time, the **Set language** menu is displayed.
1°) Select one of the languages from the list.
2°) Once a language has been selected, the **Welcome** menu appears.



Comment:
- When the RVT has been previously programmed, the Welcome menu appears directly, except when “Undefined” has been previously selected, in which case the Set language menu will appear first.
- The language can be always modified through the **I/O Configuration** menu (description in paragraph 6.4).

3.3. Easy commissioning

3.3.1. Description

The RVT performs automatic commissioning including:

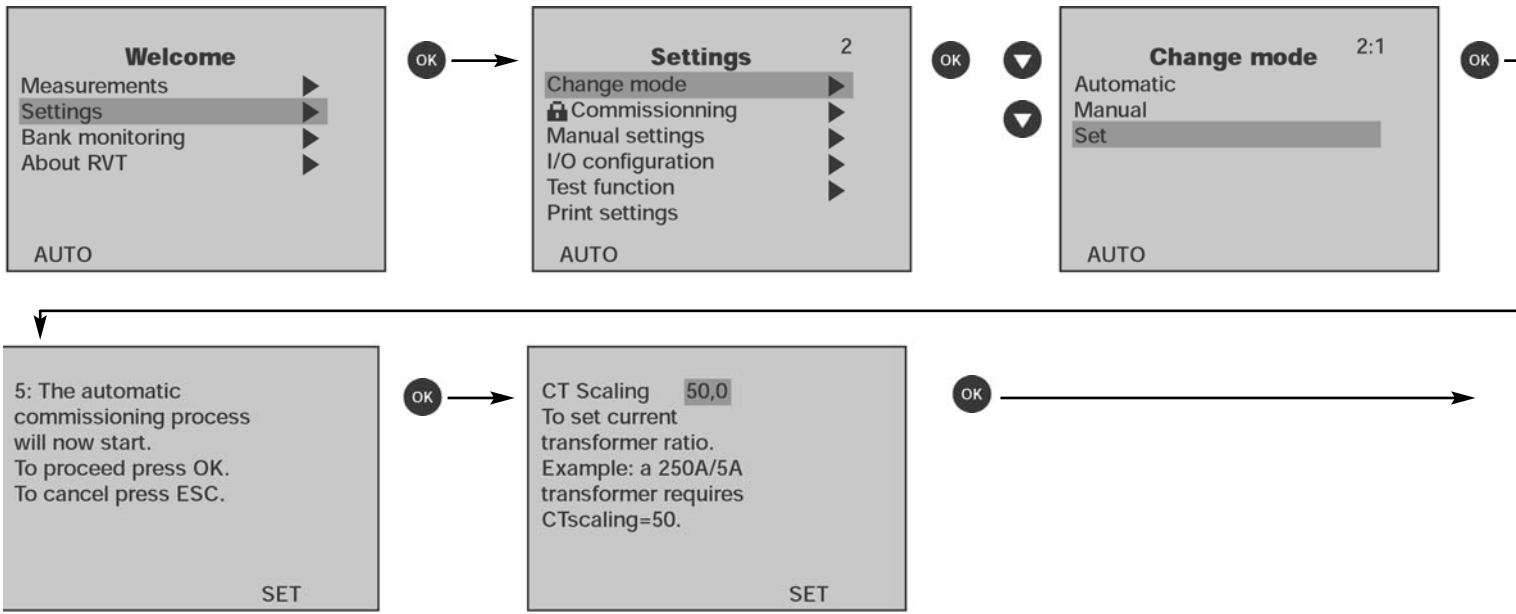
- automatic recognition of :
  - special connection (single phase – C.T. leads)
  - number of outputs
  - type of switching sequence
- automatic setting of : C/k.

3.3.2. Parameters

Requested parameters during the easy commissioning process are:

CT Scaling : **C**urrent **T**ransformer ratio (for instance a 250A / 5A CT has a CT Scaling of 50).

Target cos φ



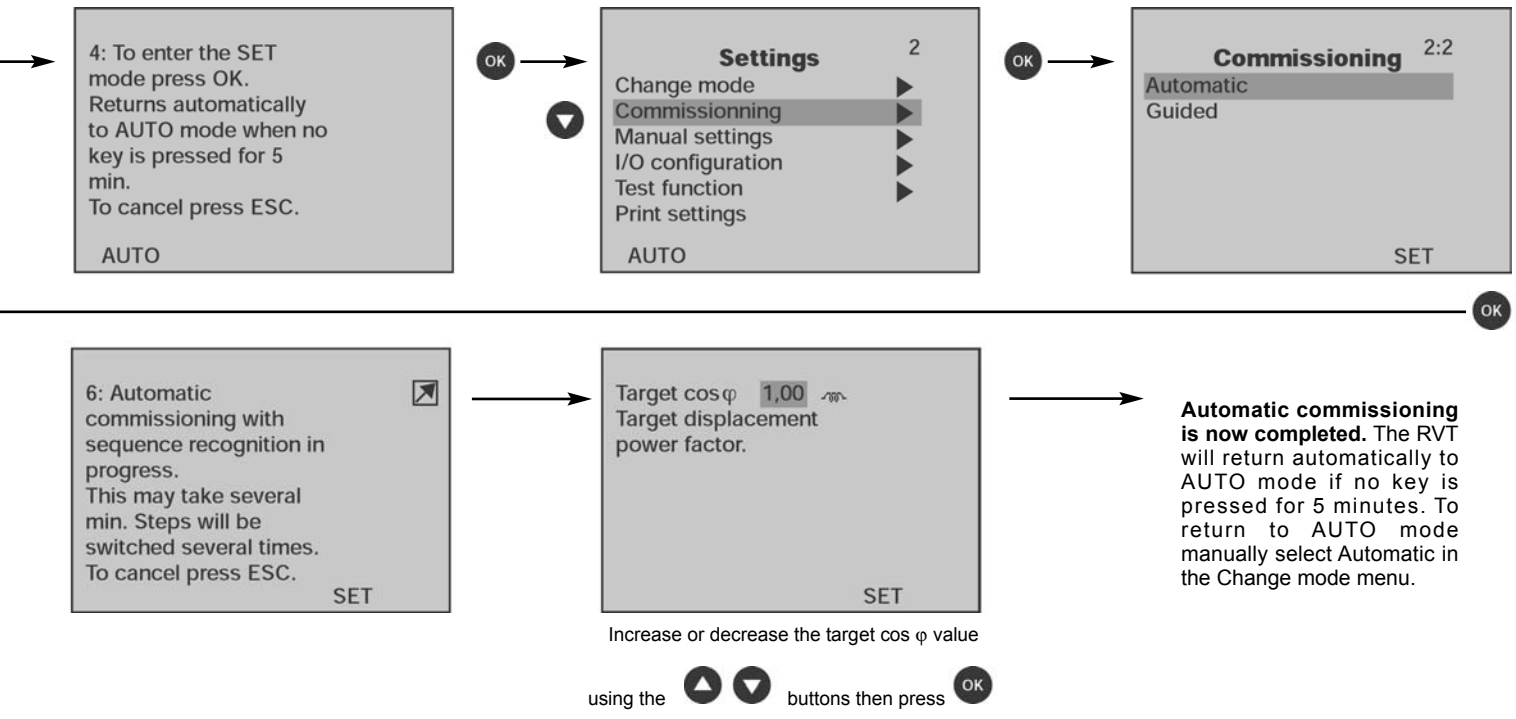
Increase or decrease the CT Scaling value

using the buttons

3.3.3. Automatic commissioning

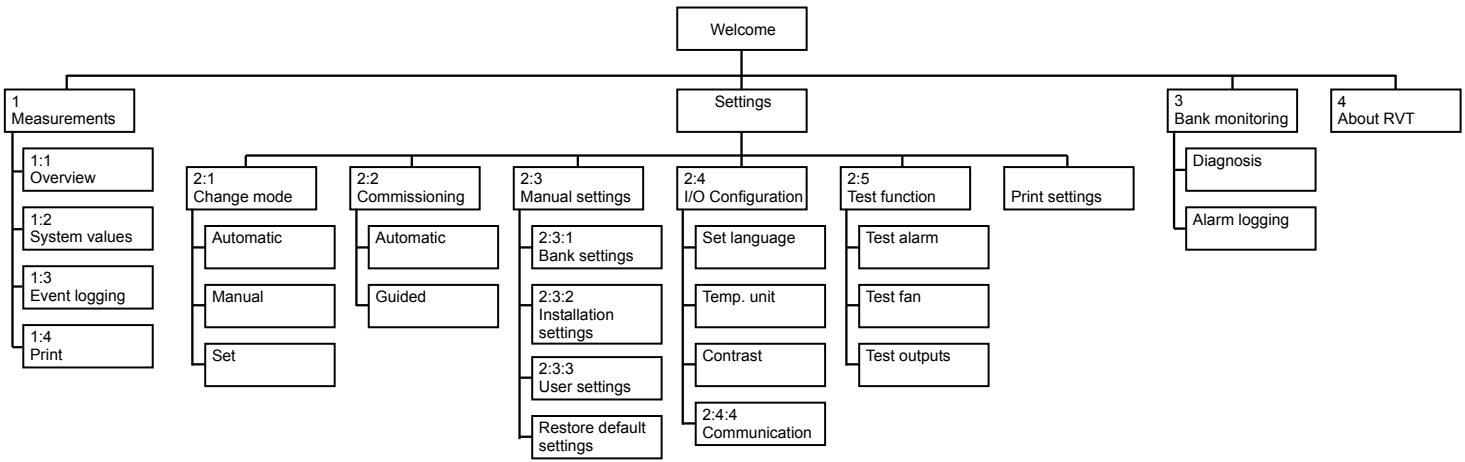
Note: 1°) if you have a short-circuit on the CT's secondary winding do not forget to open it after having connected the current input of the PF Controller
2°) if a transformer is used for the voltage measurement, the Vscaling value has to be changed accordingly (see paragraph 6.3.).

Comment: when the icon appears in the upper left-hand corner of the display, this means that the RVT is locked. SET Mode access is denied and commissioning cannot be performed until the RVT is unlocked (see description in paragraph 6.1.1)



Automatic commissioning is now completed. The RVT will return automatically to AUTO mode if no key is pressed for 5 minutes. To return to AUTO mode manually select Automatic in the Change mode menu.

4. Menus chart



5. Measurements

5.1. Measurements Description

Designation	Unit	Description			
Voltage			**Range (1)**	**Accuracy**	**Maximum Value Displayed**
Vrms	V	Rms Voltage	Up to 690Vac	± 1 %	100 kV
V1	V	Rms voltage at the fundamental frequency	Up to 690Vac	± 1 %	100 kV
Frequency	Hz	Fundamental voltage frequency	45Hz - 65Hz	± 0.5%	40Hz - 70 Hz
THDV	%	Total harmonic voltage distortion on voltage	0 - 300%	± 1 %	300 %
V harm. table		Voltage harmonics displayed in a table	2^{nd}-49^{th}	See later in this paragraph	
V harm. chart		Voltage harmonics displayed in a bar graph	2^{nd}-49^{th}	See later in this paragraph	
Current					
Irms	A	Rms Current	0 - 5 A	± 1 %	100 kA
I1	A	Rms current at the fundamental frequency	0 - 5 A	± 1 %	100 kA
THDI	%	Total harmonic current distortion on current	0 - 300%	± 1 %	300 %
I harm. table		Current harmonics displayed in a table	2^{nd}-49^{th}	See later in this paragraph	
I harm. chart		Current harmonics displayed in a bar graph	2^{nd}-49^{th}	See later in this paragraph	
Power					
Cos φ (2)		Displacement power factor (2)	-1 - +1	± 0.02	-1 - +1
PF (3)		Power factor (3)	-1 - +1	± 0.02	-1 - +1
P	W	Active power	0 - 10 kW	± 2%	0 - 100 MW
Q	var	Reactive power	0 - 10 kvar	± 2%	0 - 100 Mvar
S	VA	Apparent power	0 - 10 kVA	± 2%	0 - 100 MVA
△Q	var	Missing power to reach the pre-set alarm cos φ	0 - 10 kvar	± 2%	0 - 100 Mvar
△N		Missing capacitor steps to reach the pre-set alarm cos φ			
Temperature (optional)					
T1	°C or °F	Temperature T1 (optional external probe 1)	-40°C → + 105°C	± 2°C	-40°C → + 150°C
T2	°C or °F	Temperature T2 (optional external probe 2)	-40°C → + 105°C	± 2°C	-40°C → + 150°C

- All the measurements are averaged over one second

Comments:

(1) the range values have to be multiplied by the CT ratio (Irms - I1 – P – Q – S – △Q) and the PT ratio (Vrms - V1 - P - Q – S - △Q).

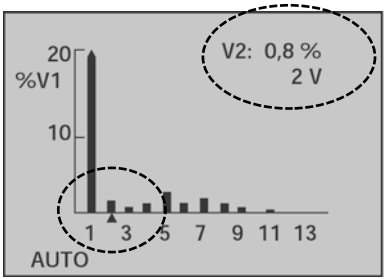
- If a transformer is used for the voltage measurement, the harmonic voltage measurements may be erroneous due to the filter behaviour of the transformer.
  The use of a high quality transformer should minimise the error.

Explanatory note : Power factor – Displacement power factor

(2) Displacement power factor or cos φ : calculation based on the fundamental value of the measurements. This value is used as the reference value by Electricity Supplies Companies.

(3) Power factor : calculation based on the fundamental and harmonic values of the measurements.The power factor is always lower than or equal to the displacement power factor.

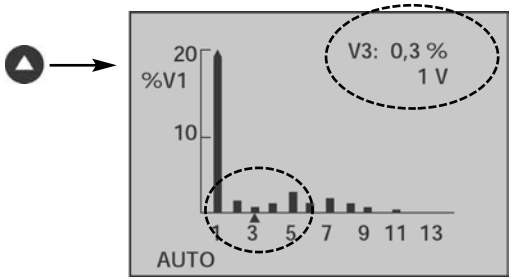
Voltage (current) harmonic chart



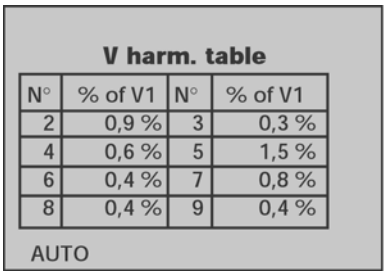
Go left or right in the chart

using the buttons

(measurements up to the 49th harmonic)



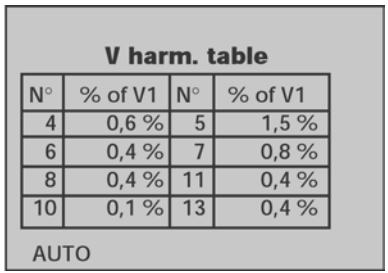
Voltage (current) harmonic table



Go down or up in the table

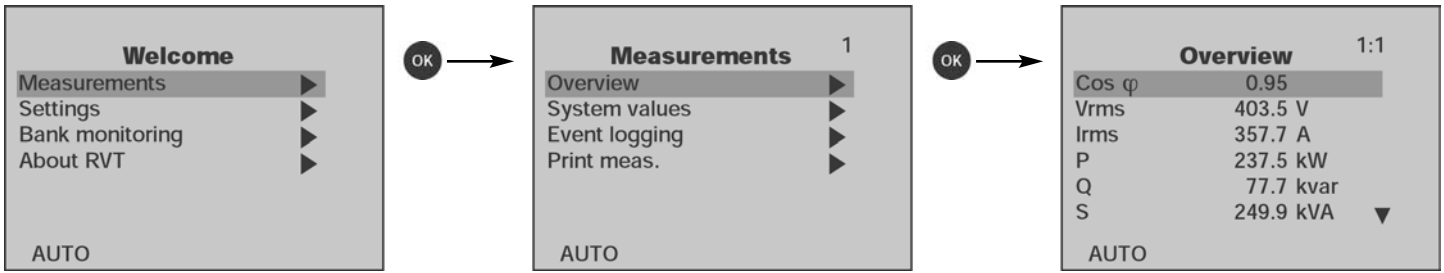
using the buttons

(measurements up to the 49th harmonic)



Comment: accuracy on voltage (current) harmonic measurements: ± 1 % of Vrms (Irms)

5.2. Overview

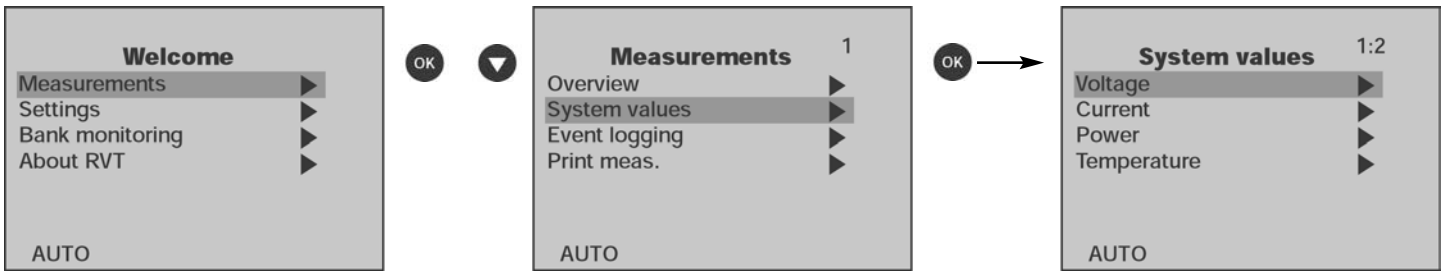


The **Overview** menu displays all measured items in a list. The user may customize the display of the measurement values to his particular needs.

Customization process :
- select the measured parameter that you want to move.
- press OK. The selected parameter starts flashing.
- press ▲ or ▼ to move the selected parameter up or down the list.

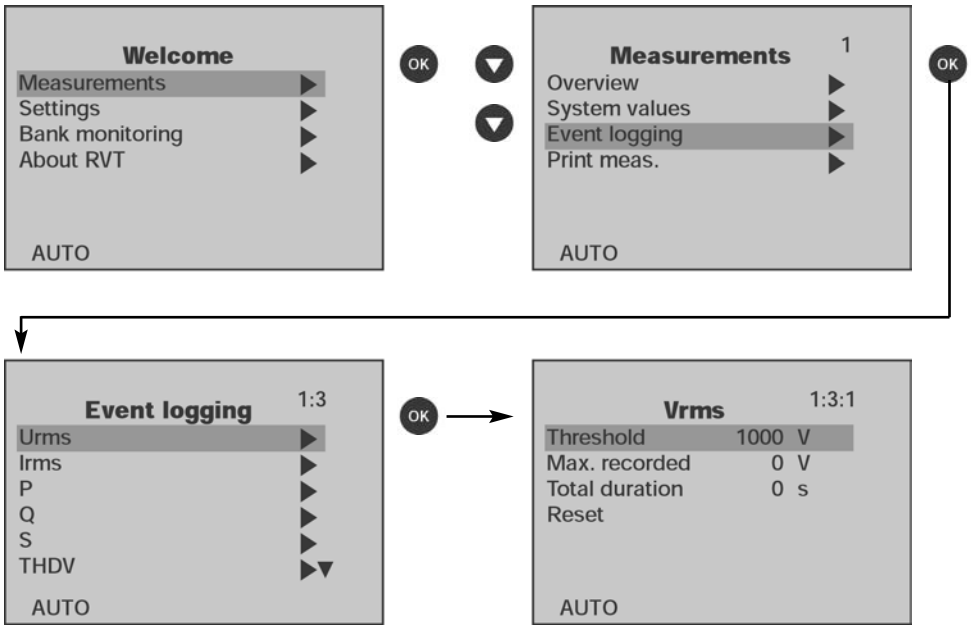
Once the selected parameter is located in the desired position in the list, press OK

5.3. System values



The System Values menu displays all measured system values sorted by type.

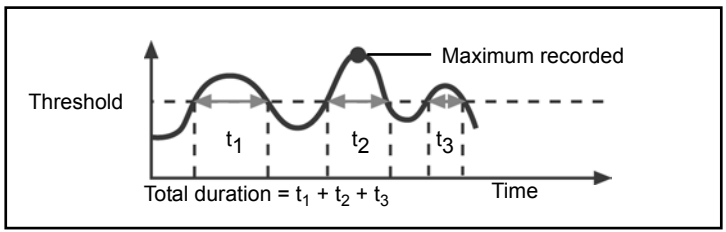
5.4. Event logging



5.4.1 Description

The event logging function allows the user to log, for each significant measured item (see list here below) and since the last clearance:
- the maximum (or minimum) value
- the duration above (or below) the threshold.

Once a threshold has been set (see example in paragraph 5.4.2.), the RVT starts recording the maximum (or minimum) value automatically as well as the total duration until a reset is performed.



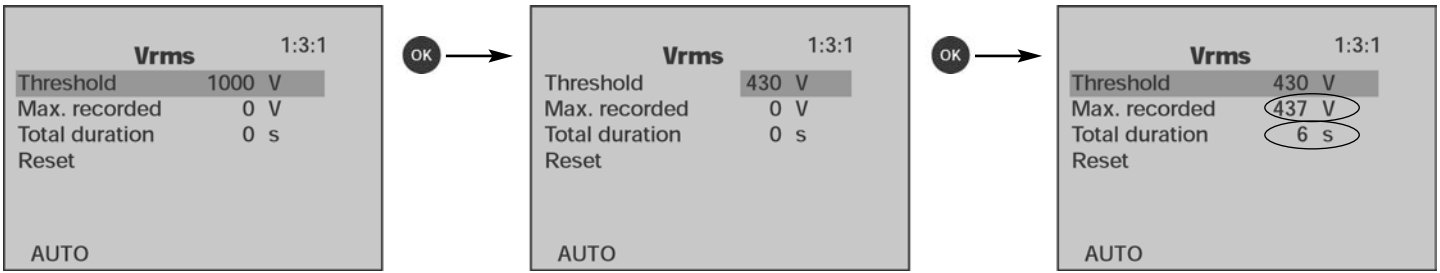
5.4.2. Recorded values

The event logging function allows the user to record the time during which a measured value exceeds a threshold and its maximum value for the following parameters : **Vrms [V], Irms [A], P [W], Q [var], S [VA], THDV [%], THDI [%], △Q [var], frequency(1) [Hz], T1(1) [°C or °F] and T2(1) [°C or °F].**

(1) Minimum values and duration below a threshold are also recorded for the frequency and the temperatures.

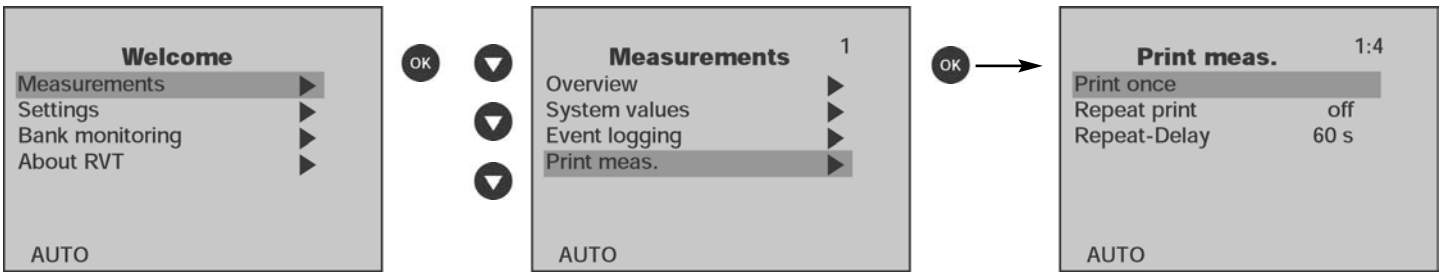
5.4.3. Example

Recording of information on Vrms.
Voltage network : 400V.



The recorded information (maximum value and total duration) may be cleared by selecting and validating the “Reset” item.

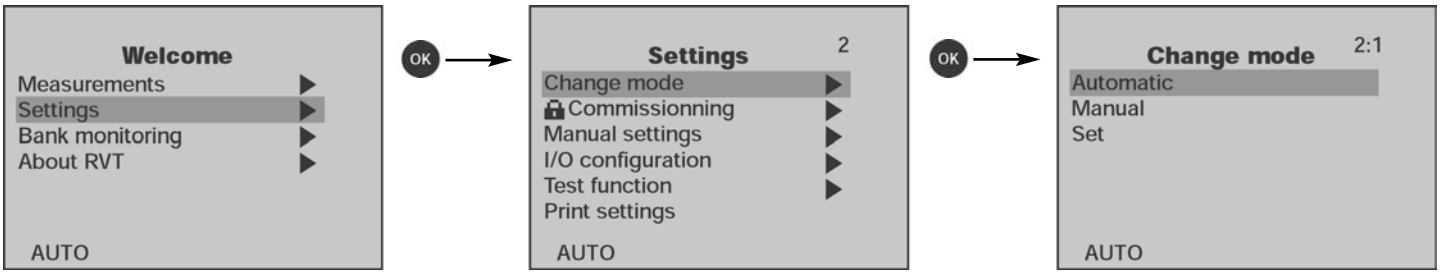
5.5. Measurements printing



Print once: when selected and validated, all the measurements are printed once.
Repeat printing: when set “on”, all the measurements are repeatedly printed according to the Repeat-Delay.
Repeat-Delay: time between two successive measurement printings.

6. Settings

6.1 Change Mode (AUTO – MAN – SET)



The **Change Mode** menu allows the operating mode of the RVT to be selected.

Comment: after a power outage, once the power returns the RVT starts in the Mode previously selected, except for the SET Mode. In this case, the RVT will start in AUTO mode and changes previously made in SET Mode that have not been validated are saved.

Select the mode

with the ▲ ▼ buttons then press OK

6.1.1. Settings Protection

Unauthorised modification of all or some of the parameters can be prevented in a number of ways.

Locking switch:

A locking switch, located at the back of the RVT (see RVT rear view in paragraph 2.2), allows the RVT to be locked in AUTO mode or in MAN mode.

When the lock is set:
- a 🔑 will appear in the upper left-hand corner of the graphics display.
- a 🔒 will appear beside the Change mode menu, Commissioning menu and all the settings.
- access to the Change mode and Commissioning menus will be denied.
- no modification can be made to the settings (including the Event logging settings).
- the setting values may be consulted.

AUTO/MAN mode:

The RVT has three functional modes which are described in the following paragraphs.

When the AUTO or the MAN mode is set:
- a 🔒 will appear beside all the settings.
- access to the Commissioning menu will be denied.
- access to the Change mode menu will be allowed.
- the setting values may be consulted.
- no modification can be made to the settings (except to the Event logging settings).

Bank settings item:

The bank settings item, available at the bottom of the bank settings list, can be either locked or unlocked.

When the bank settings item is set as locked (whatever the Mode used):
- a 🔒 will appear beside all the **bank** settings.
- no modification can be made to the bank settings
- the bank settings values may be consulted.
- the installation and user settings can be modified, if the locking switch is unlocked.

Once locked, the bank set item can be unlocked by entering the following key sequence (in SET mode) : ▲ ▼ ▲ OK

6.1.2. Automatic Mode (AUTO)

Steps are automatically switched on and off to reach the target cos φ according to the measured value of the reactive current, the C/k setting, the switching delay times, the switching strategy, the number of outputs, and the type of sequence.

In Auto Mode:
- settings and measurements can be consulted.
- the measurements list (Overview menu) can be customized.
- the event logging function can be used.

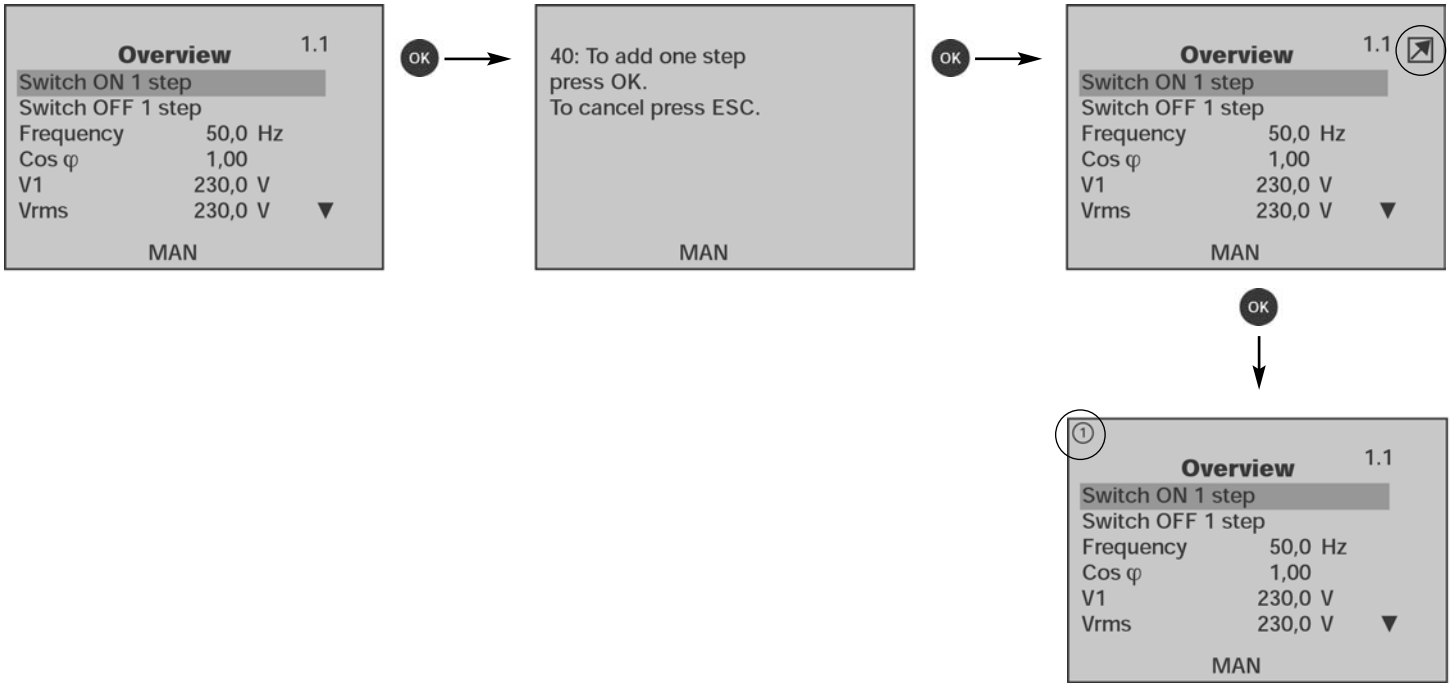
6.1.3. Manual Mode (MAN)

Steps may be switched on and off manually by pressing the ▼ or ▲ buttons.

Switching is performed according to the switching delay times, the switching strategy and type of sequence.

Once the MAN Mode is selected, a message informs the user that he can go directly to the overview menu where the “switch ON 1 step” and “switch OFF 1 step” items are available.

↗ and ↘ respectively indicate that the demand to switch on or off one step is being processed.



The step will be switched ON,
after the switching ON delay time.

6.1.4. Set Mode (SET)

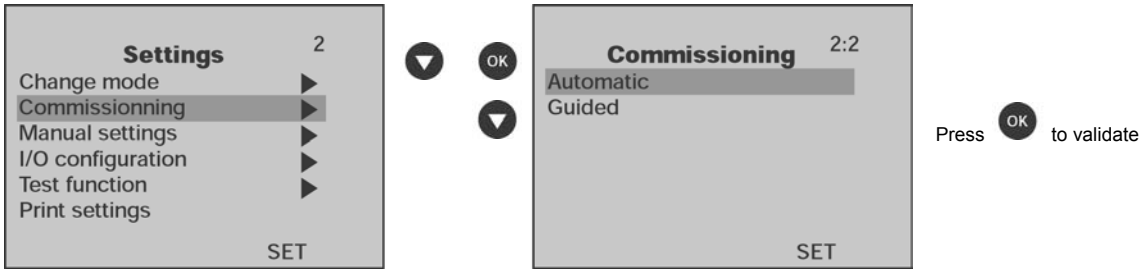
In Set Mode, the RVT parameters can be set manually and automatic or guided commissioning can be performed.

Comment:
- SET Mode access is denied when the RVT is locked (see paragraph 6.1.1).
- the RVT returns automatically to AUTO mode when no key is pressed for more than 5 minutes.

6.2. Commissioning (SET mode)

6.2.1. Easy Commissioning: please refer to the complete description in paragraph 3.3.

6.2.2. Guided Commissioning



The RVT performs a guided commissioning process. The following parameters (see table below) must be entered.

Comment:
1°) before performing guided commissioning, please make sure that:
- the RVT is unlocked (description in paragraph 6.1.1.)
- the RVT is in SET Mode (description in paragraph 6.1.3.)
2°) if you have a short-circuit on the CT's secondary winding do not forget to open it after having connected the current input of the PF Controller.

Guided Commissioning Parameters

Parameter	Description
C.T. scaling	Current Transformer ratio.
1Ph / 3Ph	Bank connection type and RVT measurement connection
V scaling	External voltage transformer ratio.
V nom	Nominal bank voltage.
ON-Delay	Switching ON delay time.
Sequence	Relative reactive power value of each output.
Q step	Smallest reactive power difference between steps.
Phase shift	Phase shift between voltage and current introduced by the measurement connections. The phase shift is 90° (default setting) when the RVT is connected as shown on wiring diagram (see paragraph 2.4). For other connections, please see appendix A.5.
Target cos φ	Target displacement power factor.

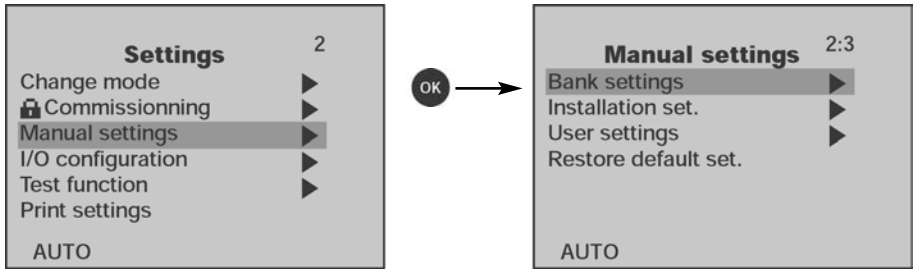
For more information regarding these parameters, a complete description is available in the following paragraph.

6.3. Manual settings (SET Mode)

6.3.1. Description of Parameters

The Settings menu gives access to all the RVT parameters that are grouped in 3 categories:
- **Bank settings**: gathers all configuration parameters related to the automatic bank
- **Installation settings**: gathers installation parameters of the RVT
- **User settings**: gathers additional installation parameters which can be modified by the installer or the user.

Before setting parameters, please make sure that access is allowed : see paragraph 6.1.1.



6.3.2 Bank Settings

The Bank Settings menu includes all configuration parameters related to the bank.

V nom : nominal bank voltage.

When a Vnom value is entered, undervoltage and overvoltage protection levels are automatically set at 80% and 120% of Vnom.
These level values can be changed manually.

V scaling : external voltage transformer ratio.
Examples: for a 15kV/100V voltage transformer, Vscaling = 150.
if no external voltage transformer is used, Vscaling = 1.

1Ph / 3Ph : number of phases of the bank and voltage measurement connection:

3Ph - Ph: 3 phases bank connection – Voltage measurement connection between phases
3Ph - N: 3 phases bank connection – Voltage measurement connection between phase and neutral
1Phase: 1 phase bank connection – Voltage measurement connection between phase and neutral

Qstep : smallest reactive power difference between steps.

For example: Sequence: **1** (25kvar) **1** (25kvar) **1** (25kvar) **1** (25kvar) … -> Q step = 25 kvar
Sequence: **1** (10kvar) **2** (20kvar) **2** (20kvar) **2** (20kvar) … -> Q step = 10 kvar
Sequence: **2** (15kvar) **4** (30kvar) **5** (37.5kvar) **5** (37.5kvar) … -> Q step = 7.5 kvar

Sequence : relative reactive power value of the capacitors connected to the RVT outputs.
These relative values are included between 0 and 8.

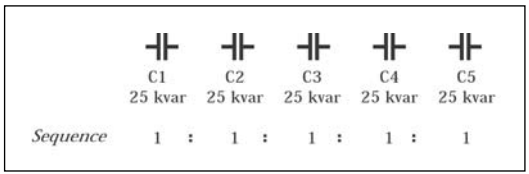
RVT preloaded switching sequences are:

1 : 1 : 1 : 1 : 1 : ... : 1	1 : 1 : 2 : 4 : 4 : ... : 4	1 : 1 : 2 : 3 : 3 : ... : 3
1 : 2 : 2 : 2 : 2 : ... : 2	1 : 2 : 4 : 8 : 8 : ... : 8	1 : 2 : 3 : 6 : 6 : ... : 6
1 : 1 : 2 : 2 : 2 : ... : 2	1 : 1 : 2 : 4 : 8 : ... : 8	1 : 1 : 2 : 3 : 6 : ... : 6
1 : 2 : 4 : 4 : 4 : ... : 4	1 : 2 : 3 : 3 : 3 : ... : 3	

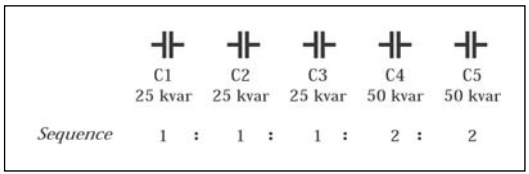
Customised sequence may be introduced manually.

Examples:

Preloaded sequence:



Customized sequence:



Outputs : to configure each output as enabled, fixed ON or fixed OFF.

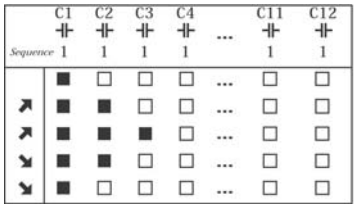
Linear / Circular

Linear switching follows the "first in, last out" switchings principle.
Circular switching follows the “first in, first out” switchings principle.

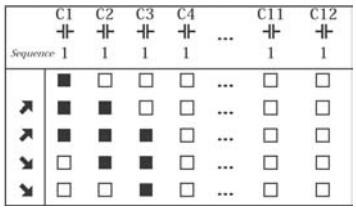
Both operations are described in the following table.

Circular switching increases the lifetime of capacitors and contactors by balancing the stress among all the outputs.
In case of “double first step” (1:1:2:2:…, 1:1:2:4:4.,…), the circularity applies to the first two outputs and also on the outputs of higher value.

Linear



Circular



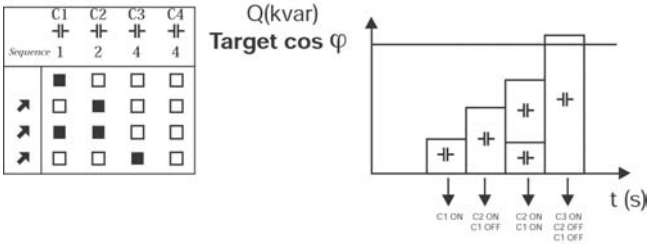
↗ Demand for adding a step
↘ Demand for removing a step
■ Output closed
□ Output open

Progressive / Direct

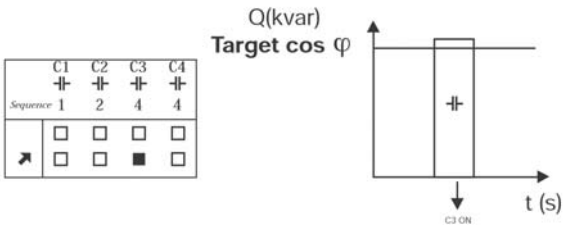
Progressive operation switches the steps sequentially one by one.

Direct operation switches the biggest steps first to reach the target cos φ faster.
The direct mode allows to avoid many useless intermediary switchings.

Progressive



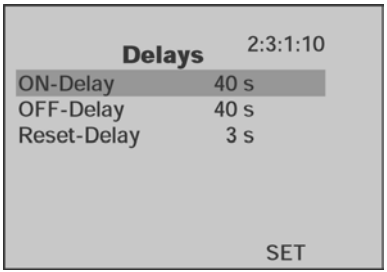
Direct



Normal / Integral

Normal operation: switches the steps when the demand is continuously present for the whole switching delay time.

Integral operation: switches the steps according to averaged value of the requested reactive power.
Integral operation is useful for applications where the load is varying rapidly.



Delays

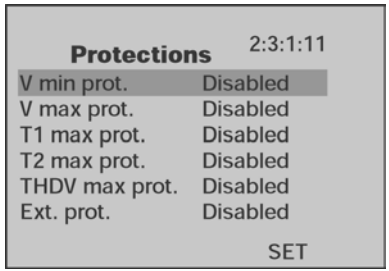
ON-Delay : - in normal operation, it is the time between the demand to switch ON a step and the actual switching.
- in integral operation, it is the integration time between two switching decisions.
The ON-delay is needed to allow the capacitor to discharge before switching it ON.

Warning: a too short delay time could cause damage to the bank.

OFF Delay: - in normal operation, it is the time between the demand to switch OFF a step and the actual switching OFF.
- in integral operation, OFF-Delay is not used.

Reset Delay: time the RVT waits before restarting bank operation after a power outage.

Protection levels : To set the levels of protection against undervoltage, overvoltage, prohibitive harmonics, overtemperature and to enable an external protection.



Once a protection level is reached, the following actions occurs:
- all the capacitor steps are switched off
- an alarm message appears on the display
- the alarm relay closes.
- the fan relay closes (valid for temperature protection level only)

After the event has disappeared, the RVT will restart its regulation after a certain delay time.
This delay time depends on the type of events. RVT post alarm restarting procedure is described in detail in Appendix A4.

Comment 1: when enabled, the external protection (Ext. Prot.) may be activated by applying an external signal through the RVT input OPTO2 (see paragraph 2.2).

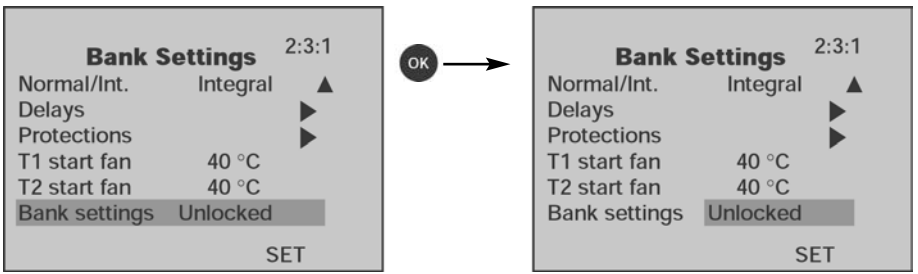
Comment 2: the RVT is self-protected against an internal overtemperature of 85°C. The actions described above will occur.
The RVT will restart automatically when the intemal temperature falls back below 80°C.

Comment 3: the temperature protection levels are disabled by default. When a level is entered, the RVT checks the probe connection. If a defective probe connection is detected, the RVT will close the alarm relay and the fan relay but the capacitor steps will not be switched OFF.

T1 start fan : temperature above which the fan relay closes. This function is inactive when the (optional) external probe 1 is absent.

T2 start fan : temperature above which the fan relay closes. This function is inactive when the (optional) external probe 2 is absent.

Bank settings : the Bank settings item allows to lock all the bank setings. 🔒 will appear beside the parameters locked.
The bank settings can not be modified until the bank settings item is locked (see also paragraph 6.1.1.).



Press ▲ or ▼ to set the bank settings item as locked.

Unlocked is flashing.

To unlock the bank setting item, the following key sequence has to be entered: ▲ ▼ OK Esc

6.3.3 Installation Settings

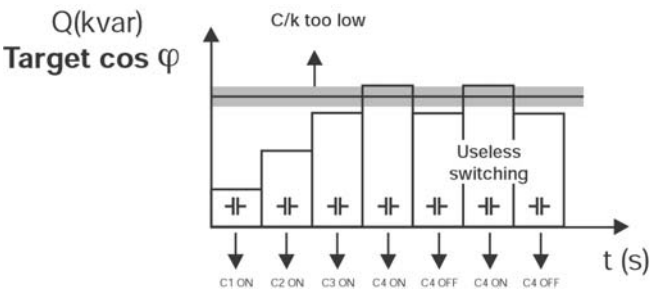
CT scaling : current transformer ratio.

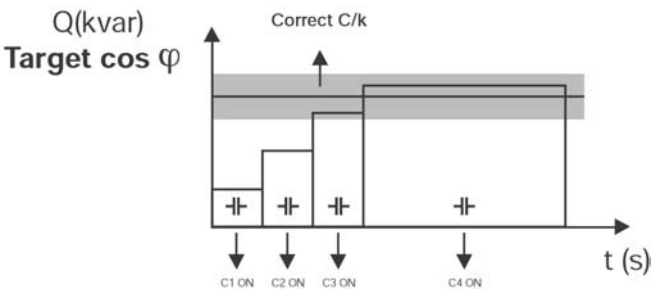
Example: a 250A / 5A CT has a CT Scaling of 50.

C/k : starting current of the RVT Controller. It is usually set equal to 2/3 of the current of the capacitor step (Qstep).

It represents the threshold current value for the RVT to switch ON or OFF a capacitor step.
The C/k can be programmed from 0.01 to 5.

The following example shows the effect of a too low C/k value and how it can lead to useless switching:





A too high C/k value will lead to insufficient capacitor steps being switched ON in order to reach the target cos φ.

The recommended setting of C/k can be calculated by the following formula or can be read directly in the table below.

Formula

Three-phase network

$$C/k = 0.67 \times \frac{Qstep \times 1000}{\sqrt{3} \times Vnom \times CTscaling}$$

Single phase network

$$C/k = 0.67 \times \frac{Qstep \times 1000}{Vnom \times CTscaling}$$

C/k table for a 3-phase / 400V system

CT Ratio		k	Capacitor step rating (kvar)											
			5	10	15	20	30	40	50	60	70	90	100	120
10/1	50/5	10	0.48	0.97	1.45	1.93	2.90	3.87	4.84					
20/1	100/5	20	0.24	0.48	0.73	0.97	1.45	1.93	2.42	2.90	3.38	4.35	4.84	
30/1	150/5	30	0.16	0.32	0.48	0.64	0.97	1.29	1.61	1.93	2.26	2.90	3.22	3.87
40/1	200/5	40	0.12	0.24	0.36	0.48	0.73	0.97	1.21	1.45	1.69	2.18	2.42	2.90
60/1	300/5	60	0.08	0.16	0.24	0.32	0.48	0.64	0.81	0.97	1.13	1.45	1.61	1.93
80/1	400/5	80	0.06	0.12	0.18	0.24	0.36	0.48	0.60	0.73	0.85	1.09	1.21	1.45
100/1	500/5	100	0.05	0.10	0.15	0.19	0.29	0.39	0.48	0.58	0.68	0.87	0.97	1.16
120/1	600/5	120	0.04	0.08	0.12	0.16	0.24	0.32	0.40	0.48	0.56	0.73	0.81	0.97
160/1	800/5	160	0.03	0.06	0.09	0.12	0.18	0.24	0.30	0.36	0.42	0.54	0.60	0.73
200/1	1000/5	200	0.02	0.05	0.07	0.10	0.15	0.19	0.24	0.29	0.34	0.44	0.48	0.58
300/1	1500/5	300	0.02	0.03	0.05	0.06	0.10	0.13	0.16	0.19	0.23	0.29	0.30	0.39
400/1	2000/5	400	0.01	0.02	0.04	0.05	0.07	0.10	0.12	0.15	0.17	0.22	0.23	0.29
600/1	3000/5	600	0.01	0.02	0.02	0.03	0.05	0.06	0.08	0.10	0.11	0.15	0.15	0.19

Phase shift : phase shift between voltage and current introduced by the measurement connection.

If the RVT is connected as shown on the connection diagram described in paragraph 2.4, the phase shift value is 90° (default setting).
For other connection, the phase shift to be programmed can be selected from the tables in the appendix A5.
Please note that the RVT can adapt automatically the phase shift during automatic commissioning.

6.3.4. User Settings

Target cos φ: target displacement power factor.

The target cos φ: value can be set between 0.70 inductive and 0.70 capacitive. indicates an inductive cos φ and indicates a capacitive cos φ.

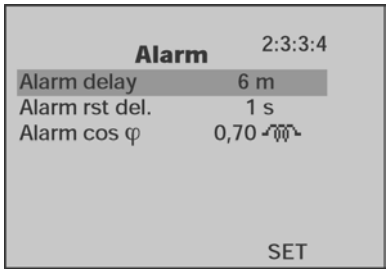
Night cos φ: alternative displacement power factor (disabled by default).

Switching from the target cos φ to the target night cos φ is performed with an external signal applied on the external input Opto1 (description in paragraph 2.2). Once a value has been set, to disable this function set “Night cos φ” value below 0.7.

Reg. cos φ: alternative target displacement power factor. Activated when power flow is reversed : P < 0. (disabled by default).

Once a value has been set, to disable this function set “Reg. cos φ” value below 0.7.

Alarm : alarm relay parameters can be set for the Alarm cos φ condition:
The Alarm cos φ condition is fulfilled when: all the capacitor steps are ON and the actual cos φ value is below the alarm cos φ threshold value such that at least one step is needed.



Alarm delay: duration of alarm cos φ condition before the relay closes.

Alarm reset delay: delay time before the relay opens after the alarm condition has disappeared

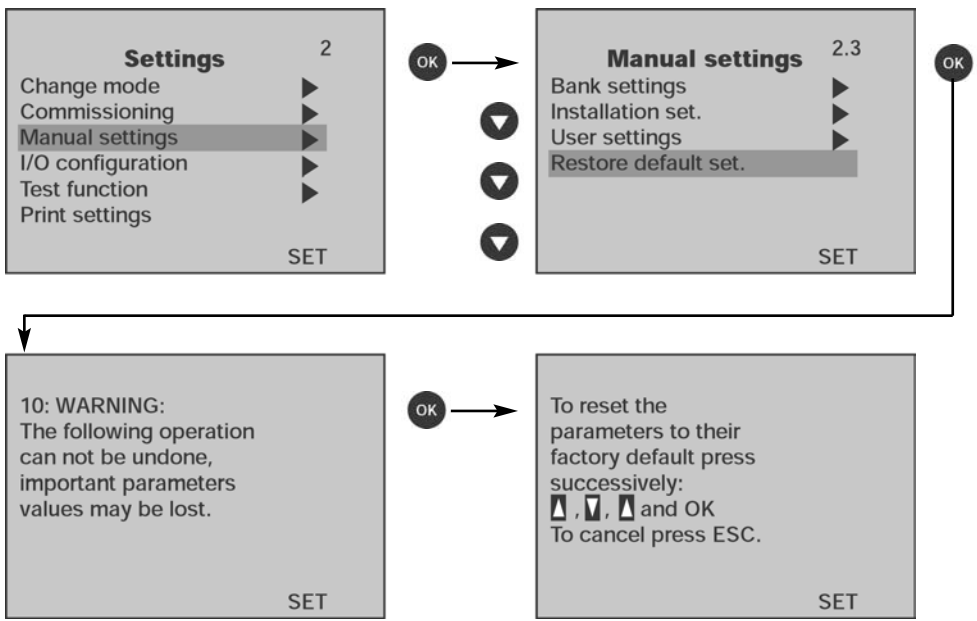
Alarm cos φ: threshold value

6.3.5. Restore Default Settings

By selecting and validating the “Restore default set.” item, all the values of the RVT parameters are reset to their default values (see separate document joined with the RVT), except if the bank settings item is locked, in which case the bank settings are not changed.

Warning: important parameters may be lost.

Comment: before restoring default settings, please make sure that:
- the RVT is unlocked (description in paragraph 6.1.2.)
- the RVT is in SET mode (description in paragraph 6.1.4.)



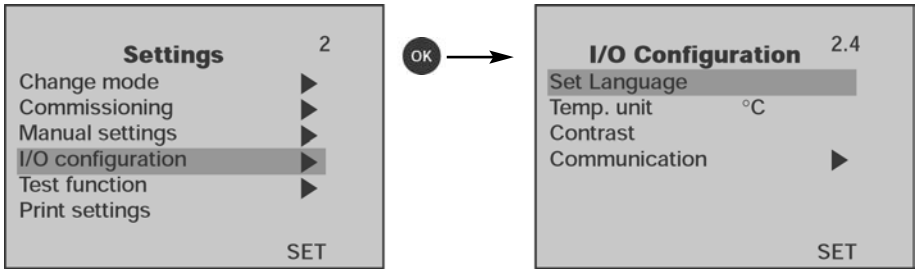
To reset the parameters, press successively

6.4. Input / Output Configuration

The I/O Configuration menu gives access to RVT parameters related to external communication and the graphic display.

Comment: Set language item may be modified in SET Mode only. Other items from I/O configuration menu may be modified in AUTO Mode.

Before performing a parameter setting, please make sure that the RVT is unlocked (description in paragraph 6.1.1).



Set language: to select one of the language from the list or “Undefined”.

Please note that if “Undefined” is selected, the Set Language menu will appear next time the RVT is powered up.

Temp unit: to select the temperature unit between degrees Celsius (°C) and degrees Farenheit (°F).

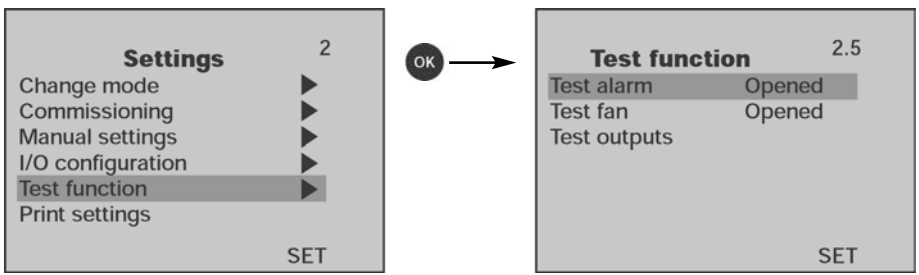
Contrast: to adjust the contrast of the display (by +1 or –1 from the value indicated on the graphic display).

Communication: to set the parameters relating to the serial communication link.

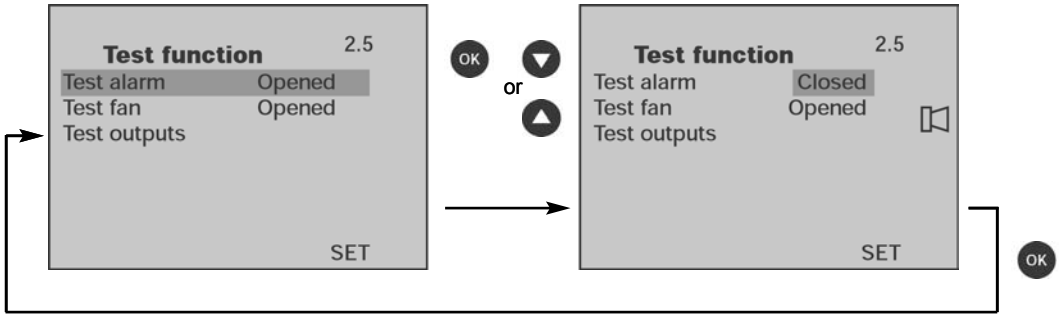
6.5. Test function

The Test function menu allows the user to test each relay of the RVT.

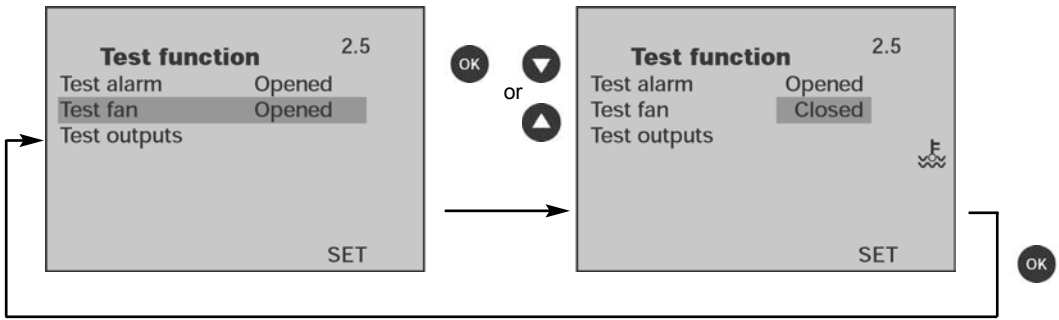
Before proceeding the test functions, please make sure that:
- the RVT is unlocked (description in paragraph 6.1.1.)
- the RVT is in SET Mode (description in paragraph 6.1.4.)



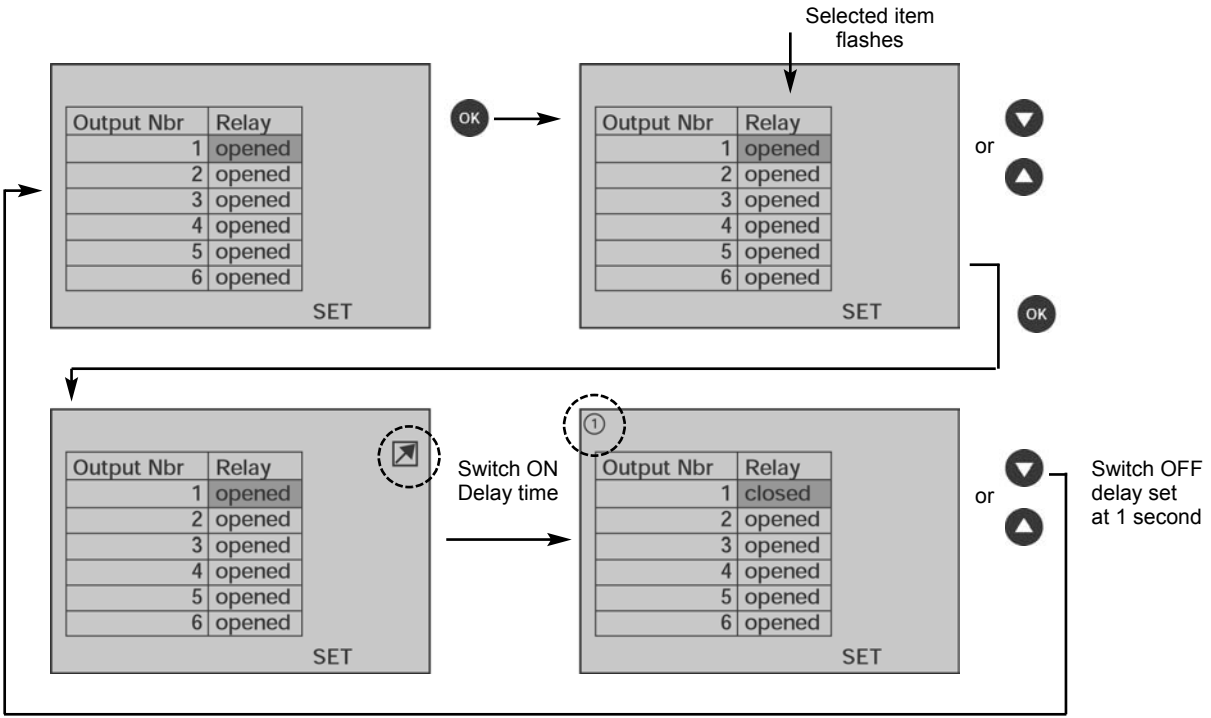
Test alarm: allows testing of the alarm relay



Test fan: allows testing of the fan relay

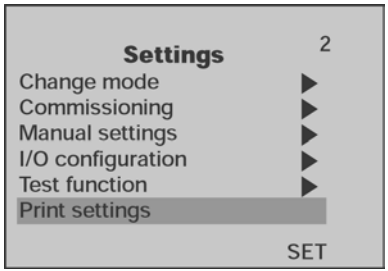


Test outputs: allows testing of each output capacitor relays.



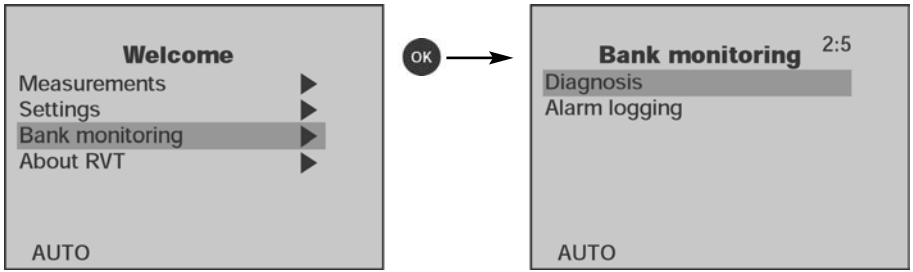
6.6. Settings printing

Print settings: all the settings are printed once.



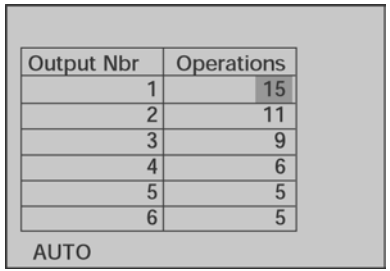
7. Bank Monitoring

The Bank Monitoring function allows
- the number of operations of each output capacitor relay to be checked.
- the last five recorded alarm messages to be listed.



Diagnosis: lists the number of operations of each output capacitor relay since the RVT was manufactured.

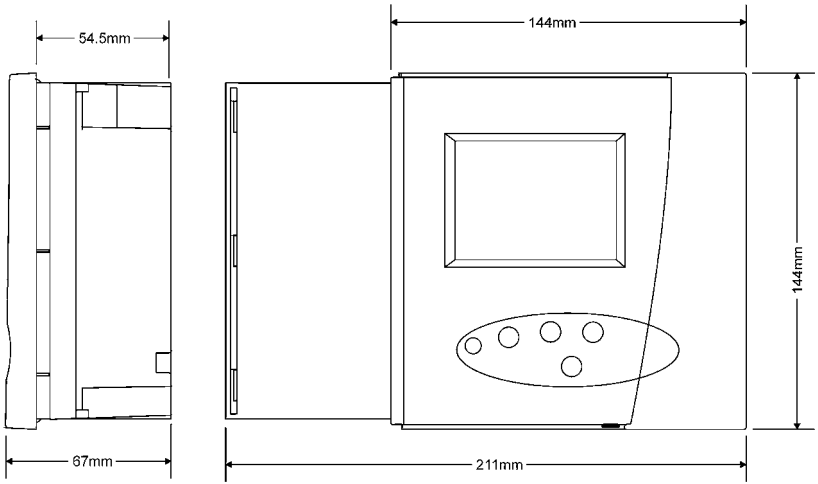
Move up or down the table using the or buttons



Alarm logging: displays the last five alarm messages and the time elapsed since their occurences. Time elapsed is not available after a power outage.

Appendices

A1. Dimensions



A2. Technical specifications

Measuring system:
Micro-processor system for balanced three-phase networks or single-phase networks.

Supply voltage:
From 100Vac up to 440Vac.

Consumption:
15 VA max.

Connection type:
Phase-phase or phase-neutral

Voltage tolerance:
+/- 10% on indicated supply voltages.

Voltage measurement:
Up to 690Vac or higher with a voltage transformer.
Accuracy: 1% full scale

Frequency range:
50 or 60 Hz +/- 5% (automatic adjustments to network frequency).

Current input:
5A or 1A (RMS) (class1 C.T.).

Current input impedance:
<0.1 Ohm.

Power outage release:
Automatic disconnection of all capacitors in case of a power outage longer than 20ms.

Number of outputs:
RVT 6: programmable up to 6 outputs
RVT 12: programmable up to 12 outputs

Output contact rating:
-Max. continuous current: 1.5A (ac) – 0.3A (110V dc).
-Max. peak current: 8A.
-Max. voltage: 440 Vac.
-Terminal A-A are rated for a continuous current of 18A (9A/terminal).

Alarm contact rating: (voltage free contact)
- Normally closed contact.
- Max. continuous current: 1.5A (ac).
- Rated voltage: 250Vac (max. breaking voltage: 440Vac).

Fan contact rating: (voltage free contact)
- Normally open contact.
- Max. continuous current: 1.5A (ac).
- Rated voltage: 250Vac (max. breaking voltage: 440Vac).

Power factor setting:
From 0.7 inductive to 0.7 capacitive.

Starting current setting (C/k):
- 0.01 to 5A.
- automatic measurement of C/k.

Switching sequences:
1:1:1:1:1:..:1 - 1:2:2:2:2:..:2 - 1:2:4:4:4:..:4
1:2:4:8:8:..:8 - 1:1:2:2:2:..:2 - 1:1:2:4:4:..:4
1:1:2:4:8:..:8 - 1:2:3:3:3:..:3 - 1:2:3:6:6:..:6
1:1:2:3:3:..:3 - 1:1:2:3:6:..:6
and any other customer programmable sequence.

Step configuration:
Auto, fixed, disabled.

Display:
64 x 132 pixels with extra symbols

Display contrast automatically compensated with temperature.

Switching time between steps:
programmable from 1s to 18h.

Saving-function:
All programmed parameters and modes are saved in a non-volatile memory.

Autoadaptation to the phase-rotation of the network and the CT-terminals.

Power Factor correction operation is insensitive to the presence of harmonics.

Working with passive and regenerative loads (four-quadrant operation).

Operating temperature:
-20° C to 70° C.

Storage temperature:
- 30° C to 85° C.

Mounting position:
Vertical panel mounting.

Dimensions:
Front plate: 144 x 144 mm (hxw)
Overall dimension: 144 x 211 x 67 mm (hxwxd).

Weight:
1.0 kg (unpacked).

Connector:
Cage clamp type (2.5mm² single core cable).

Front plate protection:
IP 43 (IP54 on request).

Relative humidity:
Maximum 95%; non-condensing.

CE Marked.

UL (file n° NKCR2.E163424).

CSA certified for use in 120Vac system voltage.

A.3. Testing and troubleshooting

Testing

After installation of the automatic capacitor bank and programming of the switching parameters,
the following tests can be performed depending on load situation.

A. No load or cos φ = 1 or capacitive load (set desired cos φ to 0.95 ind.)

1. Select manual mode
2. Add two or more steps.
3. Select automatic mode.
   All capacitor steps must be switched off with the programmed delay time between each switching operation.
   If all steps are not switched off, check the following:
   - Has an inductive load been connected?
   - Have the correct C/k ratio and/or step size been programmed?
     (it is recommended that the C/k value be set to a value slightly higher than the calculated value)

B. Inductive load

1. Set desired cos φ =1
2. Select automatic mode.
   Capacitor steps will now be automatically switched on to compensate the inductive load (the controller will not switch steps if the inductive current is lower than the preset C/k value. In such a case, test according to A. above).

   If all steps are switched on and there is still a demand for additional steps, then check the setting of C/k.
   If it is correct, then the bank is too small to compensate the cos φ = 1. Select a lower value for cos φ.
   When one stage repeatedly switches on and off, it means the C/k is set too low (unless the load actually fluctuates periodically with a time period equal to or close to the switching delay time).

Troubleshooting

Fault	Recommended actions
The controller is connected but does not work (nothing on display)	Check the voltage setting and the fuses.
The controller does not switch on or off steps although there is a considerable variable inductive load.	Check that the controller is in automatic Mode. Check setting of phase shift and C/k. Check that the CT short-circuit bridge is removed.
The controller does not seem to activate any steps.	Wait for the delay time between switching and/or the power outage delay time.
The preset power factor is not achieved.	At low or no load, a low power factor can correspond to a very small inductive current. The corresponding capacitor steps are too large for compensation. If the average cos φ over a period of time is too low, the preset cos φ may be increased.
All capacitors are switched on although the required reactive power is relatively low.	Check setting of phase and C/k values.

The automatic commissioning stops and the controller displays one of the following messages.

Messages during an automatic commissioning process	Recommended actions
98: Current too small	Check that the CT short-circuit bridge is removed and start the Autoset again
99: The load is varying too quickly.	Re-start the Autoset procedure under more stable conditions Or set the parameters manually.
100: Phase error.	The controller could not find a known configuration.
102: C/k too small (< 0.01).	Adapt the step size or the CT ratio.
103: Relative weight too big	Check sequence and reactive power value per output.

A4. Post Alarm Restarting Procedure

Once a protection level is reached (see paragraph 6.3.2) or when the internal temperature is higher than 85°C :

• all the capacitor steps are switched off,
• an alarm message appears on the LCD display,
• the alarm relay closes,
• the fan relay closes (valid for temperature protection only).

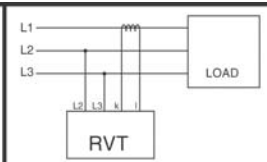
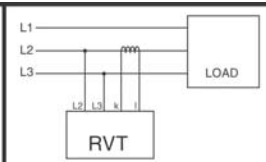
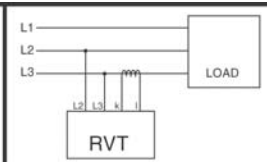
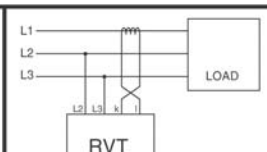
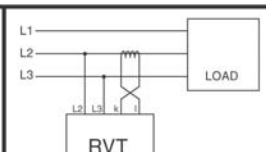
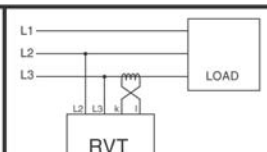
When the alarm condition disappears, the RVT will automatically restart.
The restarting procedure will depend on the type of event that caused the alarm, as indicated in the following table:

Event having occured	RVT restart behaviour after event has disappeared
Urms < Umin prot. Power outage	- Opens alarm relay immediately - Resumes normal behaviour after a time equal to Reset-delay(*)
Urms > U max prot.	- Opens alarm relay immediately - Resumes normal behaviour after a time equal to ON-Delay(*)
Tinternal > 85°C	- Event considered as disappeared, when Tinternal < 80°C - Opens alarm relay immediately - Resumes normal behaviour after a time equal to ON-Delay(*) (opens fan relay, except if another temp. protection level is exceeded)
T1 > T1 max. prot. (external optional probe T1)	- Opens alarm relay immediately - Resumes normal behaviour after a time equal to ON-Delay(*) (opens fan relay, except if another temp. protection level is exceeded)
T2 > T2 max. prot. (external optional probe T2)	- Opens alarm relay immediately. - Resumes normal behaviour after a time equal to ON-Delay(*) (opens fan relay, except if another temp. protection level is exceeded).
THDV > THDV max prot.	- Opens alarm relay immediately. - Resumes normal behaviour after a time equal to ON-Delay(*). Anti-hunting protection: If the same event occurs within one hour, the RVT will resume normal operation after a time equal to 2x ON-Delay. If the same event occurs again within one hour, the restart time will be doubled to 4 x ON-Delay, and so on up to a maximum of one hour. This rule allows a hunting effect due to resonance phenomena to be avoided.
External input activated	- Opens alarm relay immediately. - Restart normal behaviour after a time equal to ON-Delay(*).

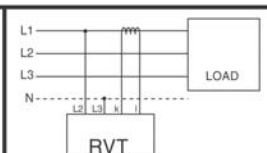
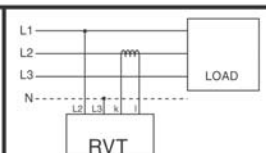
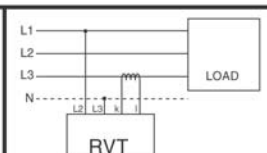
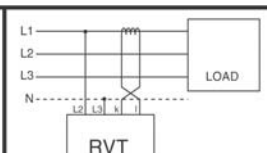
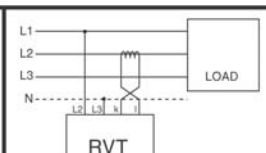
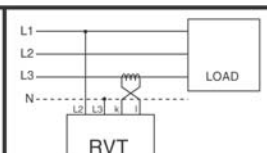
(*) For more information regarding the Reset-Delay and ON-delay parameters, a complete description is available in paragraph 6.3.2.

A5. Phase shift table

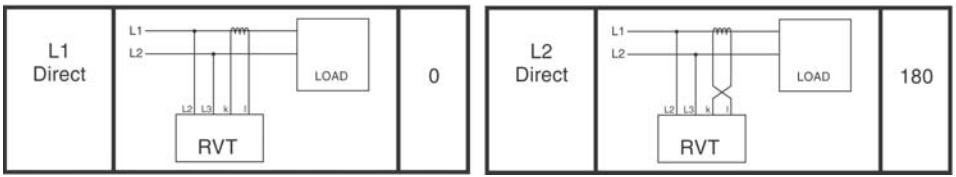
Three-phase connection (Phase to Phase)
Voltage is measured between L2 and L3

L1 Direct		90
L2 Direct		-30
L3 Direct		-150
L1 Inverted		-90
L2 Inverted		150
L3 Inverted		30

Three-phase connection (Phase to Neutral)
Voltage is measured between L1 and Neutral

L1 Direct		0
L2 Direct		-120
L3 Direct		120
L1 Inverted		180
L2 Inverted		60
L3 Inverted		-60

Single-Phase connection



A6. Voltage measurement and power supply connection

This appendix provides a practical way to connect voltage measurement to the RVT when it is the same as the RVT voltage supply.

Description

As shown on figure 1, the RVT has three terminals for its power supply and two other terminals for its voltage measurement input.
The RVT does not use its power supply voltage to perform the voltage measurement. Voltage measurement is performed only through the dedicated voltage measurement input terminals.
If the RVT auxiliary power supply and the voltage measurement signal are from the same source, a bridge between the corresponding terminals can be done (fig.2):

Figure 1

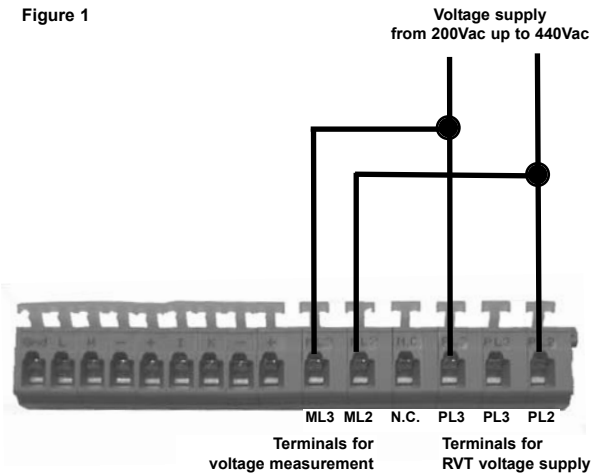
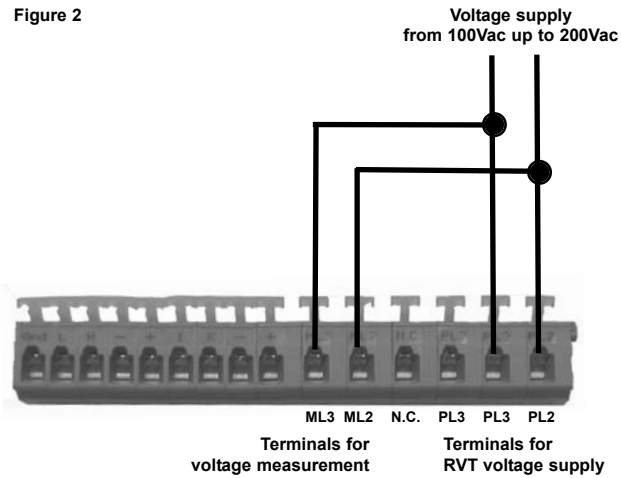


Figure 2



Bridge connection (practical proposal)

Due to limited space, it is not possible to insert two cables in a single slot. Hence alternate methods may be used to connect two wires to a common terminal.

Several pratical ways exist to perform this connection properly. One of these solutions is described on figure 3.
On each voltage supply cable, a double entry terminal has to be used to insert a second cable needed to make the bridge.

These terminals (fig. 4) and the corresponding crimping tool are usually available worldwide.

Please note that with these terminals, cables of same diameter have to be used.
Two terminals have obviously to be used and the result is shown here below (fig. 3).

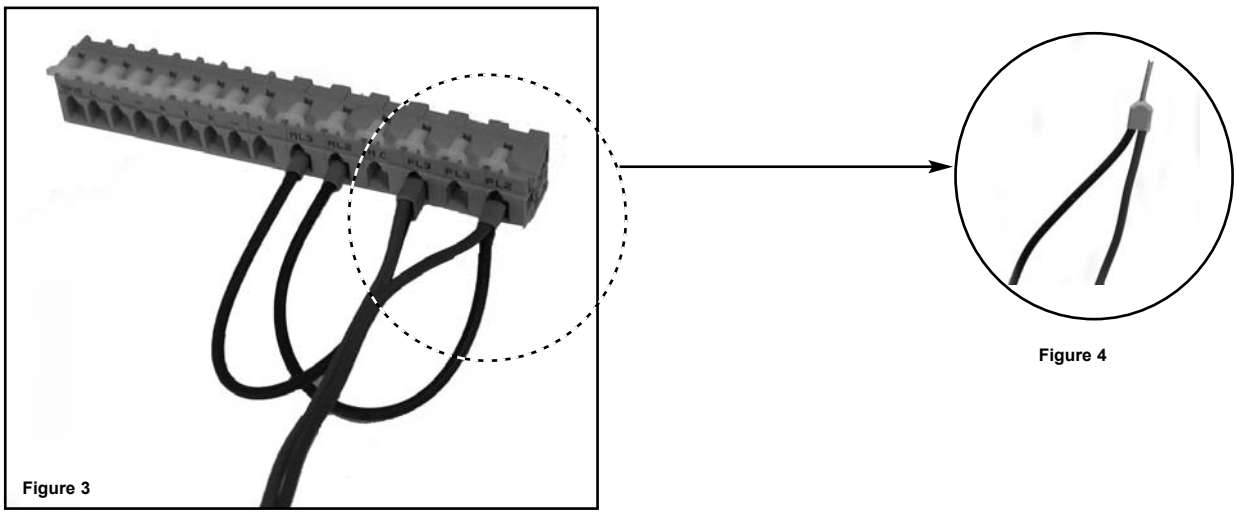


Figure 3

Figure 4

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