Power Factor Controller RVT-D
Installation and operating instructions
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Read this first

About this Instruction Manual
This Instruction Manual is designed to help you quickly install and operate the RVT-D Controller. Before installation and operation of the RVT-D 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-D 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-D Controller’s housing. There are no user serviceable parts inside.
Disconnect the voltage before replacing the fuse.
The RVT-D Controller is connected to two current transformers. Do not unplug the current transformers connections before making sure they are 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-D 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.

The RVT-D Controller is UL Recognized.

The RVT-D Controller is CSA certified for use in 120Vac system voltage.
1. Description

1.1. RVT-D features
The RVT-D Controller is the control unit of an automatic capacitor bank equipped with static switches (dynamic compensation).

It performs the switching of capacitors with a view to reaching a user-defined target $\cos \varphi$ and/or to reducing voltage drops.

- All the switching parameters may be programmed automatically or manually (description in paragraphs 6.2 and 6.3).
- The target $\cos \varphi$ and the control mode (open loop / closed loop / external trigger) may be programmed (description in paragraph 6.3).

Additionally the RVT-D 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, 6.3.2.1, 6.3.3.1 and 6.3.4.1).
- Logging of data and alarm messages (description in paragraphs 5.4 and 7).
- Checking and testing of outputs status (description in paragraphs 6.5 and 7).

Moreover with the addition of optional accessories, the RVT-D provides:
- Printout of measurements and parameters.
- Temperature measurements.
Each accessory is delivered with its own Instruction Manual.
1.3. Full graphics display and keypad

Full graphics display

- Active outputs
- Locking switch
- Highlighted item
- Settings protection
- Modes

Keypad

- To go back to the previous window or to leave the current menu or item selection without making changes
- To go up or down the item list or to decrease or increase a value
- To go to the next menu or to validate a modification or an operation
2. Installation

2.1. Mounting
Step 1: Slide the RVT-D (a) perpendicularly to the capacitor bank cubicle (b).
Step 2: Rotate the RVT-D to insert it into the capacitor bank cubicle.

Step 3: Insert the mounting bracket (c) in the corresponding fixation holes (d) of the RVT-D.
Step 4: Pull the mounting bracket backwards.
Step 5: Turn the screw (e) into the mounting bracket and tighten until the RVT-D is secured in place.

Repeat steps 3 to 5 for the bottom mounting bracket.
2.2. Rear view

![Diagram of RVT-D rear view](image)

- **Power supply**
- **N.C.**
- **Voltage measurement**
- **Opto1 15-24 Vdc**
- **External trigger input1**
- **Current Transformer**
- **Opto2 15-24 Vdc**
- **External trigger input2**
- **CAN**
- **ML2**
- **ML3**
- **ML4**
- **RJ 11 - external probe T1 input**
- **RS485 Modbus adapter or RS232 (Printer connection)**
- **RJ 11 - external probe T2 input**
- **Locking switch**
- **Output connection common**
- **Outputs (open collector type)**
- **Capacitor bank current transformer x/1A CT**
- **Output relay ALARM**

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.
2.2. Wiring diagram

PL2, PL3: power supply
ML2, ML3: measurement
OPTO1: external trigger input1
k, l: network current transformer
OPTO2: external trigger input2/Dynaswitch status input
T1, T2: temperature probe inputs

H, L: CAN: for controlling up to 32 Dynaswitches
A, A: output connection common
1-12: outputs (open collector type)
F1, F2: capacitor bank current transformer (1A)
M1, M2: output relay ALARM

Important comment: please note that the network CT must be placed in the same phase as the capacitor bank CT
3. Easy start

3.1. Menu navigation

3.2. Starting the RVT-D
When the RVT-D is powered-up, the Welcome menu is displayed. The RVT-D is in MAN mode and needs to be set in SET mode in order to commission it or to modify its parameters (see paragraph 6.1)
3.3. Easy commissioning

3.3.1. Description
The RVT-D performs automatic commissioning including:
- automatic recognition of:
  - special connection (C.T. leads)
  - number of outputs
  - type of switching sequence
- automatic setting of:
  - Qstep
  - Istep
  - Invert Icap

3.3.2. Parameters
Requested parameters during the easy commissioning process are:
- **CT scale-net**: Current Transformer ratio (for instance a 250A / 5A CT has a CT scale-net of 50).
- **Target cos \( \phi \)**: Target displacement power factor
- **CT scale-cap**: Capacitor bank current transformer ratio.
- **V scaling**: external voltage transformer ratio.
- **Control**: regulation type: open loop, closed loop and external trigger

![Diagram with buttons and options for configuration settings and commissioning process]

- **V scaling**: To set V scaling when an external voltage transformer is used. Example: A 150V/100V transformer requires V scaling=150.
- **CAN control**: When enabled, both synchronisation and control of each steps are performed through CAN bus. Otherwise, only the On/Off control is possible.
- **Node type**: For characterising the type for load to be switched by the DYNASWITCH. This allows to switch 1Ph/3Ph loads as well as phase and capacitance loads.
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-D is locked. SET Mode access is denied and commissioning cannot be performed until the RVT-D is unlocked (see description in paragraph 6.1.1)

Automatic commissioning is now completed.
The RVT-D 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

1. Measurements
   1.1 Overview
   1.2 System values
   1.3 Event logging
   1.4 Print

2. Settings
   2.1 Change mode
      - Automatic
      - Manual
      - Set
   2.2 Commissioning
      - Automatic
      - Guided
   2.3 Manual settings
      - Control
      - CAN
      - Bank settings
      - Installation settings
      - User settings
      - Restore default settings
   2.4 I/O Configuration
      - Temp. unit
      - Contrast
   2.5 Test function
      - Test alarm
      - Test outputs

3. Bank monitoring
   3.1 Diagnosis
   3.2 Alarm logging
   3.3 Nodes overview

4. About RVT-D
## 5. Measurements

### 5.1. Measurements description

<table>
<thead>
<tr>
<th>Designation</th>
<th>Unit</th>
<th>Description</th>
<th>Range(^{(1)})</th>
<th>Accuracy</th>
<th>Maximum value displayed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voltage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{\text{rms}})</td>
<td>V</td>
<td>Rms voltage</td>
<td>Up to 690 Vac</td>
<td>± 1%</td>
<td>100 kV</td>
</tr>
<tr>
<td>(V_1)</td>
<td>V</td>
<td>Rms voltage at the fundamental frequency</td>
<td>Up to 690 Vac</td>
<td>± 1%</td>
<td>100 kV</td>
</tr>
<tr>
<td>Frequency</td>
<td>Hz</td>
<td>Fundamental voltage frequency</td>
<td>45 Hz - 65 Hz</td>
<td>± 0.5%</td>
<td>40 Hz - 70 Hz</td>
</tr>
<tr>
<td>THDV</td>
<td>%</td>
<td>Total harmonic voltage distortion on voltage</td>
<td>0 - 300 %</td>
<td>± 1%</td>
<td>300 %</td>
</tr>
<tr>
<td>(V_{\text{harm. table}})</td>
<td></td>
<td>Voltage harmonics displayed in a table</td>
<td>2(^{\text{nd}}) - 49(^{\text{th}})</td>
<td>See later in this paragraph</td>
<td></td>
</tr>
<tr>
<td>(V_{\text{harm. chart}})</td>
<td></td>
<td>Voltage harmonics displayed in a bar graph</td>
<td>2(^{\text{nd}}) - 49(^{\text{th}})</td>
<td>See later in this paragraph</td>
<td></td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_{\text{rms}})</td>
<td>A</td>
<td>Rms current</td>
<td>0 - 5 A</td>
<td>± 1%</td>
<td></td>
</tr>
<tr>
<td>(I_1)</td>
<td>A</td>
<td>Rms current at the fundamental frequency</td>
<td>0 - 5 A</td>
<td>± 1%</td>
<td></td>
</tr>
<tr>
<td>THD(I)</td>
<td>%</td>
<td>Total harmonic voltage distortion on current</td>
<td>0 - 300 %</td>
<td>± 1%</td>
<td></td>
</tr>
<tr>
<td>(I_{\text{harm. table}})</td>
<td></td>
<td>Current harmonics displayed in a table</td>
<td>2(^{\text{nd}}) - 49(^{\text{th}})</td>
<td>See later in this paragraph</td>
<td></td>
</tr>
<tr>
<td>(I_{\text{harm. chart}})</td>
<td></td>
<td>Current harmonics displayed in a bar graph</td>
<td>2(^{\text{nd}}) - 49(^{\text{th}})</td>
<td>See later in this paragraph</td>
<td></td>
</tr>
<tr>
<td>(I_{1\text{-cap}})</td>
<td>A</td>
<td>Rms capacitor current at the fundamental frequency</td>
<td>0 - 1 A</td>
<td>± 3%</td>
<td>100 kA</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\cos \varphi^{(2)})</td>
<td></td>
<td>Displacement power factor(^{(3)})</td>
<td>-1 - +1</td>
<td>± 0.02</td>
<td>-1 - +1</td>
</tr>
<tr>
<td>(PF^{(3)})</td>
<td></td>
<td>Power factor(^{(2)})</td>
<td>-1 - +1</td>
<td>± 0.02</td>
<td>-1 - +1</td>
</tr>
<tr>
<td>(P)</td>
<td></td>
<td>Active power</td>
<td>0 - 10 kW</td>
<td>± 2%</td>
<td>0 - 100 MW</td>
</tr>
<tr>
<td>(Q)</td>
<td>W</td>
<td>Reactive power</td>
<td>0 - 10 kvar</td>
<td>± 2%</td>
<td>0 - 100 Mvar</td>
</tr>
<tr>
<td>(S)</td>
<td>var</td>
<td>Apparent power</td>
<td>0 - 10 kVA</td>
<td>± 2%</td>
<td>0 - 100 MVA</td>
</tr>
<tr>
<td>(\Delta Q)</td>
<td>VA</td>
<td>Missing power to reach the pre-set alarm (\cos \varphi)</td>
<td>0 - 10 kvar</td>
<td>± 2%</td>
<td>0 - 100 Mvar</td>
</tr>
<tr>
<td>(\Delta N)</td>
<td>var</td>
<td>Missing capacitor steps to reach the pre-set alarm (\cos \varphi)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Designation Unit Description Range(1) Accuracy Maximum value displayed

<table>
<thead>
<tr>
<th>Temperature (optional)</th>
<th>°C or °F</th>
<th>Temperature T1 (optional external probe 1)</th>
<th>-40°C / + 105°C</th>
<th>± 2°C</th>
<th>-40°C / + 150°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td></td>
<td>Temperature T1 (optional external probe 1)</td>
<td>-40°C / + 105°C</td>
<td>± 2°C</td>
<td>-40°C / + 150°C</td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td>Temperature T2 (optional external probe 2)</td>
<td>-40°C / + 105°C</td>
<td>± 2°C</td>
<td>-40°C / + 150°C</td>
</tr>
</tbody>
</table>

- All the measurements are averaged over one second, except ΔQ and ΔN for which the maximum values are given every second.
- Comments:
  1. the range values have to be multiplied by the CT ratio (Irms - I1 – I1-cap – P – Q – S – ΔQ) and the PT ratio (Vrms - V1 - P - Q – S - ΔQ).
  2. 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.

### 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)

---

Explanatory note: Power factor – Displacement power factor

(1) 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.

(2) 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.
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-D 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: \( \text{Vrms \ [V]} \), \( \text{Irms \ [A]} \), \( \text{P \ [W]} \), \( \text{Q \ [var]} \), \( \text{S \ [VA]} \), \( \text{THDV \ [%]} \), \( \text{THDI \ [%]} \), \( \Delta \text{Q \ [var]} \), frequency\(^{(1)} \) [Hz], \( \text{T1(1) \ [°C or °F]} \) and \( \text{T2(1) \ [°C or °F]} \).
\(^{(1)}\) 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

\textbf{Print once}: when selected and validated, all the measurements are printed once.
\textbf{Repeat printing}: when set “on”, all the measurements are repeatedly printed according to the Repeat-Delay.
\textbf{Repeat-Delay}: time between two successive measurement printings the duration above (or below) the threshold.
6. Settings

6.1 Change Mode (AUTO – MAN – SET)

The Change Mode menu allows the operating mode of the RVT-D to be selected. Comment: after a power outage, once the power returns the RVT-D starts in the Mode previously selected, except for the SET Mode. In this case, the RVT-D will start in AUTO mode and changes previously made in SET Mode that have not been validated are not saved.

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-D (see RVT-D rear view in paragraph 2.2), allows the RVT-D 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-D 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):

6.1.2. Automatic Mode (AUTO)
Steps are automatically switched on and off to reach the target cos $\varphi$ (and/or to reduce voltage drop) according to the parameter settings related to the selected control type.

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 time, 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.
6.1.4. Set Mode (SET)

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

Comment:
- SET Mode access is denied when the RVT-D is locked (see paragraph 6.1.1).
- the RVT-D 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

Press OK to validate

The RVT-D performs a guided commissioning process. The following parameters (see table below) must be entered. Some of them are not asked when the parameter “Bank settings” has been locked (see in table below).

Comment:
1°) before performing guided commissioning, please make sure that:
- the RVT-D is unlocked (description in paragraph 6.1.1)
- the RVT-D 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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT scale-net</td>
<td>Current transformer ratio.</td>
</tr>
<tr>
<td>Phase shift</td>
<td>Phase shift between voltage and current introduced by the measurement connections. The phase shift is 90° (default setting) when the RVT-D is connected as shown on wiring diagram (see paragraph 2.4). For other connections, please see appendix A.5.</td>
</tr>
<tr>
<td>CT scale-cap (*)</td>
<td>Capacitor bank current transformer ratio. x/1A CT</td>
</tr>
<tr>
<td>Invert Icap</td>
<td>To invert the capacitor bank current transformer measurement, if required by the polarity of the network CT.</td>
</tr>
<tr>
<td>1Ph/3Ph (*)</td>
<td>Bank connection type and RVT-D measurement connection.</td>
</tr>
<tr>
<td>V scaling (*)</td>
<td>External voltage transformer ratio.</td>
</tr>
<tr>
<td>V nominal (*)</td>
<td>Nominal bank voltage.</td>
</tr>
<tr>
<td>CAN control (*)</td>
<td>Flag allowing the DYNASWITCHES to be controlled through CAN Bus.</td>
</tr>
<tr>
<td>Node type (*)</td>
<td>When using CAN, specify what type of step is switched (1Ph/3 Ph or Cap/Reactor).</td>
</tr>
<tr>
<td>Sequence (*)</td>
<td>Relative reactive power value of each output.</td>
</tr>
<tr>
<td>Q step (*)</td>
<td>Smallest reactive power difference between steps.</td>
</tr>
<tr>
<td>Control</td>
<td>Regulation type: open loop, closed loop or external trigger.</td>
</tr>
<tr>
<td>Target cos $\phi$</td>
<td>Target displacement power factor.</td>
</tr>
<tr>
<td>Bank settings (*)</td>
<td>To lock the access to the bank settings (see paragraph 6.1.1, 6.3.2.1, 6.3.3.1 and 6.3.4.1 depending on control mode selected).</td>
</tr>
</tbody>
</table>

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

(*) These parameters are not asked when the parameter bank settings has been previously set locked.
6.3. Manual settings (SET mode)

6.3.1. Description of Parameters

The Settings menu gives access to all the RVT-D 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-D
- **User settings**: gathers additional installation parameters which can be modified by the installer or the user.

These parameters are related to the control item. The control item allows to set the RVT-D regulation type:

- **open loop**: the load current is measured. The RVT-D computes the required compensating current and switches steps accordingly.
- **closed loop**: the resulting current (load current + compensating current) is measured. The RVT-D switches steps in order to minimize this resulting current.
- **external trigger**: the RVT-D switches steps based on an external signal provided by the load that must be compensated.

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

6.3.2.1 CAN

The CAN menu allows to set and read the parameters related to the control of steps through CAN bus.

**CAN control:** when enabled, both synchronisation and control of each steps are performed through CAN bus. Otherwise, only the On/Off control is performed through output transistors. When enabled, if any step declared valid in the sequence reports a non-ready status, an error message is displayed.

**Any uncontrolled change of these parameters can cause erratic behavior or even destroy parts of the DYNASWITCH. The settings must be applied by experienced users.**

**Node type:** for characterising the type for load to be switched by the DYNASWITCH. This allows to switch 1Ph/3Ph loads as well as Capacitor/Reactor loads. For proper operation when switching reactors, please invert the CT measurement physically or by setting the “phase shift” accordingly. In this condition, the power (P & Q) measurements will be displayed with the opposite polarity than they are actually.

**Synchro advance:** for tuning the phase advance of the synchronising signal compared with the zero-crossing rising edge of the voltage measured by RVT-D. It is expressed in PE/4, which means that 128 represent a whole fundamental period.

**Dead time:** for tuning the duration while no Thyristor is fired between Thyristor transitions. It is expressed in degree.

**Nodes overview:** gives for all declared nodes in the RVT-D the status.

The below lists the different status reported by RVT-D about DYNASWITCH (one status per node Id):

<table>
<thead>
<tr>
<th>Reporting “Missing”</th>
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<tbody>
<tr>
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<td>Node ready to switch</td>
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<td>Thyristor over temperature</td>
</tr>
<tr>
<td></td>
<td>Protistor opening</td>
</tr>
<tr>
<td>Reporting &quot;Sync. err.&quot;</td>
<td>RVT-D sends inconsistent synchronizing signal</td>
</tr>
<tr>
<td>Reporting “Wire err.”</td>
<td>When the AC voltage sensed across one of the switch is not compliant with type of load compared with the top synchro received from RVT-D. This protects against wrong cabling of Gates / Power / RVT-D.</td>
</tr>
<tr>
<td>Reporting “Rst del.”</td>
<td>The DYNASWITCH is in the reset phase after an initialisation.</td>
</tr>
<tr>
<td>Reporting “Discharg.”</td>
<td>If the DC voltage sensed on the switch after the reset delay is still higher than 100V, then the switch waits until it is below 100V before switching ON. In case of total failure of the discharge resistors, then it will prevent the DYNASWITCH to switch.</td>
</tr>
<tr>
<td>Reporting “Disc. War.”</td>
<td>When the DC voltage sensed across one of the switch depicts a problem in the discharge resistors, it reports a warning, but the switching goes on (but starting with proper phase).</td>
</tr>
<tr>
<td>Reporting “Multiple”</td>
<td>When at least two nodes have the same Id and it is not allowed (“Two nodes/Id” disabled).</td>
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</tbody>
</table>
Node status: When the node status is used, each step not OK is not considered for steps switching. When ignored, then even the nodes not OK are used in steps switching.

Two nodes/Id: (disabled/enabled), for allowing or not several nodes on the same Id. In case it is disabled, double nodes on the same Id’s are detected and reported by RVT-D.

It should be noted that for single phase steps, each DYNASWITCH can drive two steps, the hardware Id set on the DYNASWITCH must be an even value otherwise unexpected behaviour may happen.

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

CT scale-cap: capacitor bank current transformer ratio.
Example: a 50A/1A CT has a CT scale-cap of 50.

Invert Icap: to invert the capacitor bank CT measurement when required by the polarity of the installed network CT.

V nominal: 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 (50kvar) 1 (50kvar) 1 (50kvar) 1 (50kvar) ... --> Q step = 50 kvar
Sequence: 1 (25kvar) 2 (50kvar) 2 (50kvar) 2 (50kvar) ... --> Q step = 25 kvar
Sequence: 2 (100kvar) 4 (200kvar) 5 (250kvar) 5 (250kvar) ... --> Q step = 50 kvar

Sequence: relative reactive power value of the capacitors connected to the RVT-D outputs.
These relative values are included between 0 and 8.
The customised sequence must be introduced manually.
Examples:

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

Linear / Circular
- Linear switching follows the “first in, last out” switching principle.
- Circular switching follows the “first in, first out” switching principle.

Both operations are described in the following table.

Circular switching increases the lifetime of capacitors 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.
Progressive / Direct

- Progressive operation switches the steps sequentially one by one (waiting for “Switch delay” between two switchings).
- Direct operation switches immediately the needed steps to reach the target \( \cos \varphi \). The direct mode allows to avoid many useless intermediary switchings.

**Progressive**

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Direct**

Switch delay: time between the demand to switch ON a step and the actual switching (expressed in 1/32 of the network frequency period).

Reset-Delay: time the RVT-D waits before restarting bank operation after a power outage (expressed in second).

**Protection levels**: To set the levels of protection against undervoltage, overvoltage, prohibitive harmonics and overtemperature.

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.

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

Comment 1: the RVT-D is self-protected against an internal overtemperature of 85°C. The actions described above will occur. The RVT-D will restart automatically when the internal temperature falls back below 80°C.

Comment 2: the temperature protection levels are disabled by default. When a level is entered, the RVT-D checks the probe connection. If a defective probe connection is detected, the RVT-D will close the alarm relay and the fan relay but the capacitor steps will not be switched OFF.
Bank settings: the Bank settings item allows to lock all the bank settings.  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.).

To unlock the bank setting item, the following key sequence has to be entered:

6.3.2.3 Installation settings

CT scale-net: network current transformer ratio.

Istep: current of the smallest step size (see figure).

ΔIstep: percentage value of Istep above which a step will be switched ON taking into account the hysteresis value (see figure).

Hysteresis: percentage value of Istep above and below ΔIstep which determine the sensitivity of the switching process. The lower the ΔI, the higher the sensitivity (see figure below).
**Qspeed:** to optimize the speed of RVT-D calculation.
This parameter needs to be set “slow” if even harmonic currents (I₂-I₄…) are present on the network.

**Sequence strategy:** to set the step transition strategy.
- Under: steps are switched ON/OFF simultaneously
- Over: steps are switched ON/OFF with a slight overlapping giving a temporary overcompensation that may help to reduce the flicker phenomena in some cases.

**Phase shift:** phase shift between voltage and current introduced by the measurement connection.
If the RVT-D 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-D can adapt automatically the phase shift during automatic commissioning.

### 6.3.2.4 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. 

**V drop R/X:** to set R/X value of the power transformer and above network if it is significant (low short circuit power). Once a non zero value is set, the RVT-D takes this value into account instead of target cos φ for capacitor switching in order to reduce voltage drop.

**Alarm:** alarm relay parameters can be set for the Alarm cos φ condition:
In AUTO mode, 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
6.3.3 Control: open loop

6.3.3.1 CAN

The CAN menu allows to set and read the parameters related to the control of steps through CAN bus. **CAN control:** when enabled, both synchronisation and control of each steps are performed through CAN bus. Otherwise, the On/Off control is performed only through output transistors. When enabled, if any step declared valid in the sequence reports a non-ready status, an error message is displayed.

*Any uncontrolled change of these parameters can cause erratic behavior or even destroy parts of the DYNASWITCH. The settings must be applied by experienced users.*

**Node type:** for characterising the type for load to be switched by the DYNASWITCH. This allows to switch 1Ph/3Ph loads as well as Capacitor/Reactor loads. For proper operation when switching reactors, please invert the CT measurement physically or by setting the “phase shift” accordingly. In this condition, the power (P & Q) measurements will be displayed with the opposite polarity than they are actually.

**Synchro advance:** for tuning the phase advance of the synchronising signal compared with the zero-crossing rising edge of the voltage measured by RVT-D. It is expressed in PE/4, which means that 128 represent a whole fundamental period.

**Dead time:** for tuning the duration while no Thyristor is fired between Thyristor transitions. It is expressed in degree.

**Nodes overview:** gives for all declared nodes in the RVT-D the status. The below lists the different status reported by RVT-D about DYNASWITCH (one status per node Id):

<table>
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<tr>
<th>Reporting Status</th>
<th>Description</th>
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<tr>
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<td>&quot;Wire err.&quot;</td>
<td>When the AC voltage sensed across one of the switch is not compliant with type of load compared with the top synchro received from RVT-D. This protects against wrong cabling of Gates / Power / RVT-D.</td>
</tr>
<tr>
<td>&quot;Rst del.&quot;</td>
<td>The DYNASWITCH is in the reset phase after an initialisation.</td>
</tr>
<tr>
<td>&quot;Discharg.&quot;</td>
<td>If the DC voltage sensed on the switch after the reset delay is still higher than 100V, then the switch waits until it is below 100V before switching ON. In case of total failure of the discharge resistors, then it will prevent the DYNASWITCH to switch.</td>
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<td>&quot;Disc. War.&quot;</td>
<td>When the DC voltage sensed across one of the switch depicts a problem in the discharge resistors, it reports a warning, but the switching goes on (but starting with proper phase).</td>
</tr>
<tr>
<td>&quot;Multiple&quot;</td>
<td>When at least two nodes have the same Id and it is not allowed (&quot;Two nodes/Id&quot; disabled).</td>
</tr>
</tbody>
</table>
**Node status**: When the node status is used, each step not OK is not considered for steps switching. When ignored, then even the nodes not OK are used in steps switching.

**Two nodes/Id**: (disabled/enabled), for allowing or not several nodes on the same Id. In case it is disabled, double nodes on the same Id’s are detected and reported by RVT-D.

It should be noted that for single phase steps, each DYNASWITCH can drive two steps, the hardware Id set on the DYNASWITCH must be an even value otherwise unexpected behaviour may happen.

### 6.3.3.2 Bank settings

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

**CT scale-cap**: capacitor bank current transformer ratio.

Example: a 50A/1A CT has a CT scale-cap of 50.

**Invert Icap**: to invert the capacitor bank CT measurement when required by the polarity of the installed network CT.

**V nominal**: 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 (50kvar)  1 (50kvar)  1 (50kvar)  1 (50kvar)   … --> Q step = 50 kvar
Sequence: 1 (25kvar)  2 (50kvar)  2 (50kvar)  2 (50kvar)   … --> Q step = 25 kvar
Sequence: 2 (100kvar)  4 (200kvar)  5 (250kvar)  5 (250kvar) …--> Q step = 50 kvar

**Sequence**: relative reactive power value of the capacitors connected to the RVT-D outputs.

These relative values are included between 0 and 8.

The customised sequence must be introduced manually.
Examples:

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 kvar</td>
<td>25 kvar</td>
<td>25 kvar</td>
<td>25 kvar</td>
<td>25 kvar</td>
</tr>
</tbody>
</table>

Sequence: 1 : 1 : 1 : 1 : 1

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

Linear / Circular

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

Both operations are described in the following table. Circular switching increases the lifetime of capacitors 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.
**Progressive / Direct**

- Progressive operation switches the steps sequentially one by one (waiting for “Switch delay” between two switchings).
- Direct operation switches immediately the needed steps to reach the target \( \cos \varphi \). The direct mode allows to avoid many useless intermediary switchings.

**Progressive**

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
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<tbody>
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</tbody>
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**Direct**

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</tr>
</tbody>
</table>

**Switch delay:** only used when progressive operation is selected. Time between the demand to switch ON a step and the actual switching (expressed in 1/32 of the network frequency period).

**Reset-Delay:** time the RVT-D waits before restarting bank operation after a power outage (expressed in second).

**Protection levels:** To set the levels of protection against undervoltage, overvoltage, prohibitive harmonics and overtemperature.

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.

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

Comment 1: the RVT-D is self-protected against an internal overtemperature of 85°C. The actions described above will occur. The RVT-D will restart automatically when the internal temperature falls back below 80°C.

Comment 2: the temperature protection levels are disabled by default. When a level is entered, the RVT-D checks the probe connection. If a defective probe connection is detected, the RVT-D will close the alarm relay and the fan relay but the capacitor steps will not be switched OFF.
**Bank settings**: the Bank settings item allows to lock all the bank settings. 🔒 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.).

To unlock the bank setting item, the following key sequence has to be entered:

![Unlock Bank Settings](image)

**6.3.3.3 Installation settings**

**CT scale-net**: network current transformer ratio.

**Istep**: current of the smallest step size (see figure here below).

**ΔIstep**: percentage value of Istep above which a step will be switched ON taking into account the hysteresis value (see figure).

**Hysteresis**: percentage value of Istep above and below ΔIstep which determine the sensitivity of the switching process. The lower the ΔI, the higher the sensitivity (see figure below).
**Qspeed**: to optimize the speed of RVT-D calculation. This parameter needs to be set “slow” if even harmonic currents ($I_2-I_4$...) are present on the network.

**Sequence strategy**: to set the step transition strategy.
- Under: steps are switched ON/OFF simultaneously
- Over: steps are switched ON/OFF with a slight overlapping giving a temporary overcompensation that may help to reduce the flicker phenomena in some cases.

**Phase shift**: phase shift between voltage and current introduced by the measurement connection. If the RVT-D 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-D can adapt automatically the phase shift during automatic commissioning.

**CT-net**: to set CT location.
- Line: used in usual applications open loop, closed loop or external trigger regulation mode.
- Load: used in particular applications (*) in open loop mode. RVT-D displays then load measurements.

(*) For example:
- previous version Dynacomp controller retrofitting
- compensation of a three phases welder by three single phase Dynacomp.

### 6.3.3.4 User settings

**Target cos $\phi$**: target displacement power factor.
The target cos $\phi$ value can be set between 0.70 inductive and 0.70 capacitive. $\bigcirc$ indicates an inductive cos $\phi$ and $\square$ indicates a capacitive cos $\phi$.

**V drop R/X**: to set R/X value of the power transformer and above network if it is significant (low short circuit power). Once a nonzero value is set, the RVT-D takes this value into account instead of target cos $\phi$ for capacitor switching in order to reduce voltage drop.
**Alarm**: alarm relay parameters can be set for the Alarm cos \( \phi \) condition:

- The Alarm cos \( \phi \) condition is fulfilled when: all the capacitor steps are ON and the actual cos \( \phi \) value is below the alarm cos \( \phi \) threshold value such that at least one step is needed.
- **Alarm delay**: duration of alarm cos \( \phi \) condition before the relay closes.
- **Alarm reset delay**: delay time before the relay opens after the alarm condition has disappeared.
- **Alarm cos \( \phi \)**: threshold value

### 6.3.4 Control: external trigger

#### 6.3.4.1 CAN

The CAN menu allows to set and read the parameters related to the control of steps through CAN bus.

- **CAN control**: when enabled, both synchronisation and control of each steps are performed through CAN bus. Otherwise, only the On/Off control is performed through output transistors. When enabled, if any step declared valid in the sequence reports a non-ready status, an error message is displayed.

---

**Any uncontrolled change of these parameters can cause erratic behavior or even destroy parts of the DYNASWITCH. The settings must be applied by experienced users.**

- **Node type**: for characterising the type for load to be switched by the DYNASWITCH. This allows to switch 1Ph/3Ph loads as well as Capacitor/Reactor loads. For proper operation when switching reactors, please invert the CT measurement physically or by setting the “phase shift” accordingly. In this condition, the power (P & Q) measurements will be displayed with the opposite polarity than they actually do.

- **Synchro advance**: for tuning the phase advance of the synchronising signal compared with the zero-crossing rising edge of the voltage measured by RVT-D. It is expressed in PE/4, which means that 128 represent a whole fundamental period.

- **Dead time**: for tuning the duration while no Thyristor is fired between Thyristor transitions. It is expressed in degree.
### Nodes overview

**Nodes overview**: gives for all declared nodes in the RVT-D the status. The below lists the different status reported by RVT-D about DYNASWITCH (one status per node Id):

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</tr>
<tr>
<td>Reporting “Rst del.”</td>
<td>The DYNASWITCH is in the reset phase after an initialisation.</td>
</tr>
<tr>
<td>Reporting “Discharg.”</td>
<td>If the DC voltage sensed on the switch after the reset delay is still higher than 100V, then the switch waits until it is below 100V before switching ON. In case of total failure of the discharge resistors, then it will prevent the DYNASWITCH to switch.</td>
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<td>Reporting “Disc. War.”</td>
<td>When the DC voltage sensed across one of the switch depicts a problem in the discharge resistors, it reports a warning, but the switching goes on (but starting with proper phase).</td>
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</tr>
</tbody>
</table>

### Node status

**Node status**: When the node status is used, each step not OK is not considered for steps switching. When ignored, then even the nodes not OK are used in steps switching.

**Two nodes/Id**: (disabled/enabled), for allowing or not several nodes on the same Id. In case it is disabled, double nodes on the same Id’s are detected and reported by RVT-D.

It should be noted that for single phase steps, each DYNASWITCH can drive two steps, the hardware Id set on the DYNASWITCH must be an even value otherwise unexpected behaviour may happen.

### 6.3.4.2 Bank settings

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

**CT scale-cap**: capacitor bank current transformer ratio.

Example: a 50A/1A CT has a CT scale-cap of 50.

**Invert Icap**: to invert the capacitor bank CT measurement when required by the polarity of the installed network CT.

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

**Qstep:** smallest reactive power difference between steps.
For example:
- Sequence: 1 (50kvar)  1 (50kvar)  1 (50kvar)  1 (50kvar)   … --> Q step = 50 kvar
- Sequence: 1 (25kvar)  2 (50kvar)  2 (50kvar)  2 (50kvar)   … --> Q step = 25 kvar
- Sequence: 2 (100kvar)  4 (200kvar)  5 (250kvar)  5 (250kvar) …--> Q step = 50 kvar

**Sequence:** relative reactive power value of the capacitors connected to the RVT-D outputs.
These relative values are included between 0 and 8.
The customised sequence must be introduced manually.
Examples:

```
\[\begin{array}{cccc}
C1 & C2 & \text{25 kvar} & \text{25 kvar} \\
C3 & C4 & \text{25 kvar} & \text{25 kvar} \\
C5 & \text{25 kvar} & \text{25 kvar} & \text{25 kvar} \\
\end{array}\]
```

```
\[\begin{array}{cccc}
C1 & C2 & \text{25 kvar} & \text{50 kvar} \\
C3 & C4 & \text{25 kvar} & \text{50 kvar} \\
C5 & \text{50 kvar} & \text{50 kvar} & \text{50 kvar} \\
\end{array}\]
```

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

**Linear / Circular**
- Linear switching follows the “first in, last out” switching principle.
- Circular switching follows the “first in, first out” switching principle.
Both operations are described in the following table.
Circular switching increases the lifetime of capacitors 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.
Progressive / Direct

- Progressive operation switches the steps sequentially one by one (waiting for “Switch delay” between two switchings).
- Direct operation switches immediately the needed steps to reach the target $\cos \varphi$. The direct mode allows to avoid many useless intermediary switchings.

**Switch delay**: only used when progressive operation is selected. Time between the demand to switch ON a step and the actual switching (expressed in 1/32 of the network frequency period).

**Reset-Delay**: time the RVT-D waits before restarting bank operation after a power outage (expressed in second).
**Protection levels**: To set the levels of protection against undervoltage, overvoltage, prohibitive harmonics and overtemperature.

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.

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

Comment 1: the RVT-D is self-protected against an internal overtemperature of 85°C. The actions described above will occur. The RVT-D will restart automatically when the internal temperature falls back below 80°C.

Comment 2: the temperature protection levels are disabled by default. When a level is entered, the RVT-D checks the probe connection. If a defective probe connection is detected, the RVT-D will close the alarm relay and the fan relay but the capacitor steps will not be switched OFF.

**Bank settings**: the Bank settings item allows to lock all the bank settings.-lock 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.).

To unlock the bank setting item, the following key sequence has to be entered:

Press ▲ or ◀ to set the bank-settings item as locked.
6.3.4.3 Installation settings

CT scale-net: network current transformer ratio.

**Trigger ON:**
- Trigger ON: to set the trigger ON mode and input type:
  + IN1: input 1 - rising edge
  - IN1: input 1 - falling edge
  + IN2: input 2 - rising edge
  - IN2: input 2 - falling edge
  I_{load}: switching ON when I_{load} > StartCurrent \times I_{step}
  - StartCurrent: when I_{load} is the trigger ON mode, to set the percentage value of I_{step} above which the trigger ON condition is detected.
  - Time In: delay time between external trigger condition and switching ON (expressed in 32nd of period).

**Trigger OFF:**
- Trigger OFF: to set the trigger OFF mode and input type:
  + IN1: input 1 - rising edge
  - IN1: input 1 - falling edge
  + IN2: input 2 - rising edge
  - IN2: input 2 - falling edge
  I_{load}: switching ON when I_{load} < I_{step} \times (\Delta step - hysteresis)
  Time Out: delay time between external trigger condition and switching OFF (expressed in 32nd of period).
  - Step Control:
    If set as enabled, the RVT-D continues in open loop mode after Inrush \Delta t. Open loop parameters need to be set (see description in paragraph 6.3.3).
    If set as disabled, steps (Inrush size) remain ON until the trigger OFF condition is true.
  - Total duration: total duration of the external trigger cycle (expressed in periods). It starts at the actual switching ON. When elapsed, the RVT-D disconnects all the steps and waits for the next trigger ON condition.
**Sequence strategy**: to set the step transition strategy.
- **Under**: steps are switched ON/OFF simultaneously
- **Over**: steps are switched ON/OFF with a slight overlapping giving a temporary overcompensation that may help to reduce the flicker phenomena in some cases.

**Phase shift**: phase shift between voltage and current introduced by the measurement connection.
If the RVT-D 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-D can adapt automatically the phase shift during automatic commissioning.

**CT-net**: to set CT location.
- **Line**: used in usual applications open loop, closed loop or external trigger regulation mode.
- **Load**: used in particular applications (*) in open loop mode. RVT-D displays then load measurements.
  
  (*)For example:
  - previous version Dynacomp controller retrofitting
  - compensation of a three phases welder by three single phase Dynacomp.

### 6.3.4.4 User settings

**Inrush size**: number of step switched ON.

**Inrush \( \Delta t \)**: duration during which step(s) remains ON (expressed in 32nd of period).

(1): Total duration is to be considered as a safety duration which ensures the steps to be switched OFF. For example: trigger OFF signal not available or defective.
(2): If step control is set as enabled, the RVT-D continues in open loop mode after Inrush \( \Delta t \).

**Target cos \( \varphi \)**: target displacement power factor.
The target cos \( \varphi \) value can be set between 0.70 inductive and 0.70 capacitive. \( \varphi \) indicates an inductive cos \( \varphi \) and \( \varphi \) indicates a capacitive cos \( \varphi \).

**V drop R/X**: to set R/X value of the power transformer and above network if it is significant (low short circuit power). Once a value is set, the RVT-D takes this value into account for capacitor switching in order to reduce voltage drop.
**Alarm**: alarm relay parameters can be set for the Alarm $\cos \varphi$ condition:
The Alarm $\cos \varphi$ condition is fulfilled when: all the capacitor steps are ON and the actual $\cos \varphi$ value is below the alarm $\cos \varphi$ threshold value such that at least one step is needed.
- **Alarm delay**: duration of alarm $\cos \varphi$ condition before the relay closes.
- **Alarm reset delay**: delay time before the relay opens after the alarm condition has disappeared.
- **Alarm $\cos \varphi$**: threshold value

<table>
<thead>
<tr>
<th>Alarm</th>
<th>2:3:5:3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm delay</td>
<td>6 m</td>
</tr>
<tr>
<td>Alarm reset del.</td>
<td>1 s</td>
</tr>
<tr>
<td>Alarm $\cos \varphi$</td>
<td>0,70</td>
</tr>
</tbody>
</table>

**External trigger**
Global overview of external trigger parameters

- **Standby**
  - **TriggerON cond.**
    - **Y** ➔ **Switch ON - Inrush size**
    - **N** ➔ **TriggerON expired**
  - **TriggerON expired**
    - **Y** ➔ **Inrush \( \Delta t \) expired**
    - **N** ➔ **Step control enabled**
  - **Step control enabled**
    - **Y** ➔ **Start open loop operation**
    - **N** ➔ **TriggerOFF cond.**
  - **TriggerOFF cond.**
    - **Y** ➔ **TriggerOFF expired**
    - **N** ➔ **Standby**

- **All steps disconnected**
- **TriggerON (by ext. trigger or current)**
  - **StartCurrent**
  - **Time In**
  - **Inrush size**
  - **Inrush \( \Delta t \)**
  - **StepControl**
  - **TriggerOFF**
  - **Time Out**
  - **All steps disconnected**
6.3.5. Restore Default Settings

By selecting and validating the “Restore default set.” item, all the values of the RVT-D parameters are reset to their default values (see separate document joined with the RVT-D), 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-D is unlocked (description in paragraph 6.1.2.)
- the RVT-D is in SET mode (description in paragraph 6.1.4.)
6.4. Input / Output Configuration

6.4.1. Various configuration
The I/O Configuration menu gives access to RVT-D parameters related to external communication and the graphic display. Before performing a parameter setting, please make sure that the RVT-D is unlocked (description in paragraph 6.1.1).

**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 (this RVT-D version can be linked with a printer. For more information, please consult your ABB representative).

6.4.2. Communication (Printer or Modbus)
The Communication menu gives access to RVT-D communication protocol (“Printer” or “Modbus”) and related parameters.
**Printer protocol**: by selecting and validating the “Printer” protocol item, the RVT-D can communicate with a printer (DPU414 type - Seiko) by means of the ABB printer cable (optional). Parameters settings or measurements can be printed (description in paragraph 4.1.5 and 4.2.6).

**Modbus protocol**: by selecting and validating the “Modbus” protocol item, the RVT-D can communicate in a Modbus supervision system. All RVT-D parameters as well as the RVT-D measurements are accessible (a comprehensive RVT-D Modbus instruction manual is provided separately).

- **Baud rate**: to adjust the communication speed (bits/second).
- **Parity**: to set the parity checking.
- **Stop bit**: to set the number of stop bit(s).
- **Slave address**: to adjust the address of the Modbus/RTU slave. The Modbus master will refer to this address for each query / answer transaction with this RVT-D.
- **Modbus lock**: the “Modbus lock” item allows to lock the parameters access through the RVT-D padlock. Parameters then can only be modified with the Modbus communication.
6.5. Test function

The Test function menu allows the user to test each output of the RVT-D. Before proceeding the test functions, please make sure that:

- the RVT-D is unlocked (description in paragraph 6.1.1.)
- the RVT-D is in SET Mode (description in paragraph 6.1.4.)

**Test alarm**: allows testing of the alarm relay
**Test outputs**: allows testing of each output capacitor relays

Selected item flashes

Switch ON or Switch OFF

It appears very fast as it is linked to the switching ON delay
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 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-D 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 occurrences. Time elapsed is not available after a power outage.
Appendices

A1. Dimensions
A2. Technical specifications

Language: English


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. minimum).

Current input 2 (capacitor bank): 1A (RMS) (class1 C.T. minimum).

Current input impedance: <0.1 Ohm.

Power outage release: Automatic disconnection of all capacitors in case of a power outage.

Number of outputs: RVT-D: programmable up to 12 physical outputs. If CAN control is enabled, up to 32 steps may be controlled.

Output transistor (open collector type):
  - Max. continuous current: 25mA (dc).
  - Max. voltage: 24 Vdc +10%.

Alarm contact rating: (voltage free contact)
  - Normally closed 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.

Switching sequences: customer programmable sequence.

Step configuration: Auto, fixed, disabled.

Display: 64 x 132 pixels with extra symbols

Display contrast automatically compensated with temperature.
Saving-function: All programmed parameters and modes are saved in a non-volatile memory.

Autoadaptation to the CT-terminals polarity.

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).
- Panel cutout: 138 x 138 mm (hxw).

Weight: 1.0 kg (unpacked).

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

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

Relative humidity: Maximum 95%; non-condensing.

CE Marked.
CSA certified for use in 120Vac system voltage.
UL Recognized.

Related standards:
- EN 55022 class B: radiated emission
- IEC 61000-4-4: fast transients
- IEC 61000-4-2: ESD
- IEC 61000-4-5: Surge immunity test
- IEC 61000-4-3: radiated immunity
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 \( \cos \phi = 1 \) or capacitive load (set desired \( \cos \phi \) to 0.95 ind.)
1. Select manual mode
2. Add two or more steps.
3. Select automatic mode and make sure that the control mode is either in closed loop mode or in open loop mode.
   All capacitor steps must be switched off.
   If all steps are not switched off, check the following:
   • Has an inductive load been connected?
   • Have the correct Istep, \( \Delta I_{\text{step}} \) and hysteresis been programmed?

B. Inductive load
1. Set desired \( \cos \phi = 1 \)
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 \( \Delta I_{\text{step}} \) (+ hysteresis). 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 Istep, \( \Delta I_{\text{step}} \) and hysteresis in open or closed loop mode or check trigger ON in external trigger mode.
   If it is correct, then the bank is too small to compensate the \( \cos \phi = 1 \). Select a lower value for \( \cos \phi \).
   When one stage repeatedly switches on and off, it means the hysteresis is set too low (unless the load actually fluctuates periodically with a time period equal to or close to the switching delay time).
### Problems that may occur during normal operation of the bank

<table>
<thead>
<tr>
<th>Error</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>62: Insufficient reactive power caused an alarm cos $\phi$ condition. To clear this message press OK.</td>
<td>The measured DPF is still below the “Alarm Cos phi” even if all steps have been switched ON and it lasted for more than the “Alarm delay”.</td>
</tr>
<tr>
<td>63: At least one DYNASWITCH reports an error status. To clear this message press OK.</td>
<td>Digital input n°2 is high depicting that one DYNASWITCH not controlled by CAN is in error.</td>
</tr>
<tr>
<td>64: At least one DYNASWITCH reports an error status. Check in Bank monitoring / Nodes overview. To clear this message press OK.</td>
<td>One or several CAN controled DYNASWITCHES, declared valid in the sequence, are not ready for operation.</td>
</tr>
<tr>
<td>65: T probe: No signal. To clear this message press OK.</td>
<td>An external temperature probe was enabled, but not reporting any measurement.</td>
</tr>
<tr>
<td>66: Maximum Vrms protection threshold reached! All capacitors are disconnected. To clear this message press OK.</td>
<td>Occurs when the measured voltage is above “V max prot.”.</td>
</tr>
<tr>
<td>67: Internal temperature protection threshold reached! All capacitors are disconnected. To clear this message press OK.</td>
<td>Occurs when the RVT-D internal temperature is above 85°C.</td>
</tr>
<tr>
<td>68: T1 protection threshold reached! All capacitors are disconnected. To clear this message press OK.</td>
<td>Occurs when the external temperature probe T1 reports a temperature above “T1 max prot.”.</td>
</tr>
<tr>
<td>69: T2 protection threshold reached! All capacitors are disconnected. To clear this message press OK.</td>
<td>Occurs when the external temperature probe T2 reports a temperature above “T2 max prot.”.</td>
</tr>
<tr>
<td>70: THDV protection threshold reached! All capacitors are disconnected. To clear this message press OK.</td>
<td>Occurs when the measured THDV is above “THDV max prot.”.</td>
</tr>
<tr>
<td>71: Minimum Vrms protection threshold reached! All capacitors are disconnected. To clear this message press OK.</td>
<td>Occurs when the measured voltage is below “V min prot.”.</td>
</tr>
<tr>
<td>72: Protection threshold no longer exceeded. Operation will restart automatically after the preset delay time. To restart now press $\bigcirc$. To clear this message press OK.</td>
<td>Message displayed when the error condition has disappeared.</td>
</tr>
</tbody>
</table>
## Troubleshooting during commissioning

The automatic bank commissining requires that all the ID’s starting from 0 be used (no “holes” supported).

<table>
<thead>
<tr>
<th>Fault</th>
<th>Recommended actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The controller is connected but does not work (nothing on display)</td>
<td>Check the voltage setting and the fuses.</td>
</tr>
<tr>
<td>The controller does not switch on or off steps although there is a</td>
<td>Check that the controller is in automatic Mode.</td>
</tr>
<tr>
<td>considerable variable inductive load.</td>
<td>Check if settings are set correctly and according to the selected control mode.</td>
</tr>
<tr>
<td></td>
<td>Check that the CT short-circuit bridge is removed.</td>
</tr>
<tr>
<td>The preset power factor is not achieved.</td>
<td>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 $\phi$ over a period of time is too low, the preset cos $\phi$ may be increased.</td>
</tr>
<tr>
<td>All capacitors are switched ON although the required reactive power</td>
<td>Check setting of phase and settings:</td>
</tr>
<tr>
<td>is relatively low.</td>
<td>• $I_{\text{step}}$, $\Delta I_{\text{step}}$ and hysteresis in open and closed loop mode.</td>
</tr>
<tr>
<td></td>
<td>• Trigger OFF, time out and total duration in external trigger mode.</td>
</tr>
</tbody>
</table>

### Messages during an automatic commissioning process

<table>
<thead>
<tr>
<th>Message</th>
<th>Recommended actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>98: Current too small on first step.</td>
<td>Check CT short circuit.</td>
</tr>
<tr>
<td>99: Zero step size declared on first location of sequence.</td>
<td>Set a non zero size.</td>
</tr>
<tr>
<td>100: Phase error.</td>
<td>The controller could not find a known configuration. Try again or set the parameters manually.</td>
</tr>
<tr>
<td>101: The automatic commissioning failed while recognizing the switching</td>
<td>Try again or set the parameters manually.</td>
</tr>
<tr>
<td>sequence and adapting the sensitivity ($I_{\text{step}}$).</td>
<td></td>
</tr>
<tr>
<td>102: $I_{\text{step}}$ too small ($&lt; 0.01$).</td>
<td>Check the CT ratio.</td>
</tr>
<tr>
<td>103: Relative weight too big.</td>
<td>Check sequence and reactive power value per output.</td>
</tr>
<tr>
<td>137: At least one non capacitive step has been found.</td>
<td>Check steps.</td>
</tr>
</tbody>
</table>

### The automatic commissioning gives a warning but finalises the automatic commissioning.

<table>
<thead>
<tr>
<th>Warning</th>
<th>Recommended actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>138: No current detected in line CT during auto set-up.</td>
<td>Check line CT.</td>
</tr>
<tr>
<td>139: Line CT in open loop.</td>
<td>Check if it is requested by the application.</td>
</tr>
<tr>
<td>140: Line CT in the wrong phase.</td>
<td>Put line CT and capacitor bank CT in the same phase.</td>
</tr>
</tbody>
</table>
### 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.

When the alarm condition disappears, the RVT-D will automatically restart.

The restarting procedure will depend on the type of event that caused the alarm, as indicated in the following table:

<table>
<thead>
<tr>
<th>Event having occurred</th>
<th>RVT-D restart behaviour after event has disappeared</th>
</tr>
</thead>
</table>
| \( \text{Urms} < \text{Umin prot.} \)  
  Power outage         | • Opens alarm relay immediately  
                       | • Resumes normal behaviour after a time equal to Reset-delay(\*) |
| \( \text{Urms} > \text{U max prot.} \) | • Opens alarm relay immediately  
                       | • Resumes normal behaviour after a time equal to Reset-Delay(\*) |
| \( \text{Tinternal} > 85°C \)           | • Event considered as disappeared, when \( \text{Tinternal} < 80°C \)  
                       | • Opens alarm relay immediately  
                       | • Resumes normal behaviour after a time equal to Reset-Delay(\*) |
| \( \text{T1} > \text{T1 max. prot.} \)  
  (external optional probe T1) | • Opens alarm relay immediately  
                       | • Resumes normal behaviour after a time equal to Reset-Delay(\*) |
| \( \text{T2} > \text{T2 max. prot.} \)  
  (external optional probe T2) | • Opens alarm relay immediately.  
                       | • Resumes normal behaviour after a time equal to Rese-Delay(\*) |
| \( \text{THDV} > \text{THDV max prot.} \) | • Opens alarm relay immediately.  
                       | • Resumes normal behaviour after a time equal to Reset-Delay(\*).  
                       | Anti-hunting protection:  
                       | If the same event occurs within one hour, the RVT-D will resume normal operation after a time equal to 2x Reset-Delay.  
                       | If the same event occurs again within one hour, the restart time will be doubled to 4 x Reset-Delay, and so on up to a maximum of one hour.  
                       | This rule allows a hunting effect due to resonance phenomena to be avoided. |

(*) For more information regarding the Reset-Delay parameter, a complete description is available in paragraph 6.3.2.
### A5. Check in case of maloperation of RVT-D

Since no parts are serviceable in the RVT-D, it is important to know when it must be replaced. This is the purpose of this appendix.

#### Connection check

Before incriminating the RVT-D, some connection checks must be conducted. If one of the following requirements fails then the Dynacomp® problem does not come from the RVT-D (please refer to the Dynacomp® troubleshooting manual.)

**Input**

Power supply: is there at least 200Vac between pin PL2 and PL3 (200V-440V) or at least 100Vac between PL2 and PL3 (100V-200V)?

Voltage measurement: is the voltage applied between ML2 and ML3 a proper image of the line voltage (the same or with the proper scaling factor)?

Current measurement: is the current applied between k and l a proper image of the line current (with the proper scaling factor)?

External trigger: when used, with an oscilloscope, check that the voltage waveform applied on the corresponding input (Optol or/and Opto2) has the proper polarity and level. If one voltage is in the range of zero, please disconnect the wire from the RVT-D.

**Output**

When all outputs are off (in MAN mode), the DC voltage between terminal A and the outputs used must be in the range of 15Vdc. If one voltage is in the range of zero, please disconnect the corresponding output from the RVT-D connector and check the voltage on the wire. **If the voltage is OK then this RVT-D output is dead**, otherwise refer to the Dynacomp® troubleshooting manual.

#### RVT-D check

If all the above checks are OK, the RVT-D must be step by step checked as follows:

<table>
<thead>
<tr>
<th>Step</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>LCD display running?</td>
</tr>
<tr>
<td>Measurement channels</td>
<td>The measurements of Urms, frequency, I Line/Load and cos ϕ by RVT-D and on the line are similar?</td>
</tr>
<tr>
<td>I capa measurement</td>
<td>In MAN mode, switch ON one step. Does the I capa indication on the RVT-D follow the I capa measured?</td>
</tr>
<tr>
<td>Output transistors</td>
<td>With the test function in SET mode, switch each output successively and check if the voltage between the output pin and terminal A follows this switching (from about 15Vdc to about 0Vdc).</td>
</tr>
</tbody>
</table>
| External trigger input        | If the external trigger is used (Control = Trigger) then set the parameters as follows:  
  • Trigger ON = rising edge of the external trigger input to be tested  
  • Trigger OFF = time  
  • Inrush Δt = 2000Pe  
  • Inrush size = 1  
  • Total duration = 100 cycles  
  Then check on the LCD that at each rising edge of the external trigger, a step is switched. |
| Settings                      | The settings are wrong, so the RVT-D does not have to be replaced, but a parameters setup must be conducted. |
A6. Phase shift table

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

Important comment: please note that the capacitor bank CT and the network CT MUST be placed in the same phase.

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

Important comment: please note that the capacitor bank CT and the network CT MUST be placed in the same phase.
**Single-Phase connection**

Important comment: please note that the capacitor bank CT and the network CT MUST be placed in the same phase.

![Diagram](image)

**A7. RVT-D cabling possibilities**

Since the RVT-D can have two CT connections, which is more, one of the CT can be on the line or load side, the following table describes all the situations allowed, how some parameters must be set and the performances that can be expected. The preferred situation is cabling 1 and the cabling compliant with the DYNACOMP controller is cabling 2 in CLOSED loop and cabling 4 in OPEN loop.

<table>
<thead>
<tr>
<th>Cabling 1</th>
<th>Cabling 2</th>
<th>Cabling 3</th>
<th>Cabling 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main CT</strong></td>
<td>Line side</td>
<td>Line side</td>
<td>Load side</td>
</tr>
<tr>
<td><strong>CT-cap</strong></td>
<td>Connected</td>
<td>Not connected</td>
<td>Connected</td>
</tr>
<tr>
<td><strong>CT-net parameter</strong></td>
<td>Line</td>
<td>Line</td>
<td>Load</td>
</tr>
<tr>
<td><strong>Measurement displayed</strong></td>
<td>Shows line values</td>
<td>Shows line values</td>
<td>Shows load values</td>
</tr>
<tr>
<td><strong>Missing Q</strong></td>
<td>Detected on line currents</td>
<td>Detected on line currents</td>
<td>Detected on load currents (false)</td>
</tr>
<tr>
<td><strong>Open loop operation</strong></td>
<td>Based on load current</td>
<td>Not allowed</td>
<td>Based on load current</td>
</tr>
<tr>
<td><strong>Closed loop operation</strong></td>
<td>Based on line current</td>
<td>Based on line current</td>
<td>Not allowed</td>
</tr>
<tr>
<td><strong>Bank recognition</strong></td>
<td>OK</td>
<td>NOK</td>
<td>OK</td>
</tr>
<tr>
<td><strong>CT-line rotation check</strong></td>
<td>OK</td>
<td>NOK</td>
<td>NOK</td>
</tr>
</tbody>
</table>
A8. Voltage measurement and power supply connection
This appendix provides a practical way to connect voltage measurement to the RVT-D when it is the same as the RVT-D voltage supply.

Description
As shown on figure 1, the RVT-D has three terminals for its power supply and two other terminals for its voltage measurement input.
The RVT-D 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-D auxiliary power supply and the voltage measurement signal are from the same source, a bridge between the corresponding terminals can be done (fig.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 practical 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).