APCQ Capacitor Banks
Installation, operation and maintenance instructions
# Table of contents

1 Introduction ............................................................................................................. 3

2 Safety instructions .................................................................................................. 3

3 Upon reception ........................................................................................................ 4
   3.1 Lifting and transportation guidelines ............................................................... 4
   3.2 Identification tag .............................................................................................. 5
   3.3 Storage .............................................................................................................. 5
   3.4 Packing & unpacking ....................................................................................... 6

4 Products overview and description ........................................................................ 7
   4.1 APCQ capacitor bank serie ........................................................................... 7
   4.2 APCQ capacitor bank layout ........................................................................... 7
   4.3 APCQ capacitor banks internal layout ............................................................. 8
   4.4 Power Factor Controllers .............................................................................. 10
   4.5 QCap Power module ....................................................................................... 10
   4.6 Ventilation system .......................................................................................... 11
   4.7 Thermal cutoff switch ..................................................................................... 11

5 Installation .............................................................................................................. 13
   5.1 Working conditions: dust, moisture and temperature ...................................... 13
   5.2 Harmonics pollution ....................................................................................... 13
   5.3 Mechanical installation .................................................................................. 13
      5.3.1 APCQ-L capacitor banks ....................................................................... 13
      5.3.2 APCQ-M and APCQ-R capacitor banks ............................................... 14
   5.4 Electrical installation .................................................................................... 14
      5.4.1 Electrical insulation test ........................................................................ 14
      5.4.2 Electrical connections overview ............................................................. 14
      5.4.3 Earth connection .................................................................................... 15
      5.4.4 Power cables selection ......................................................................... 16
      5.4.5 APCQ-L capacitor bank electrical connections ..................................... 16
      5.4.6 APCQ-M and APCQ-R electrical connections – Bottom entry ............ 17
      5.4.7 APCQ-M and APCQ-R electrical connections – Top entry (option on request) ................................................................. 18
      5.4.8 Auxiliary power supply ........................................................................ 19
      5.4.9 Current transformer selection ................................................................. 19
      5.4.10 Current transformer connection ............................................................ 20
      5.4.11 Multi ratio CT and summation transformer .......................................... 21
      5.4.12 Connection of several banks in parallel .............................................. 22
      5.4.13 Optional Circuit breaker connections .................................................. 22
      5.4.14 Cable entry cubicle .............................................................................. 24

6 Easy commissioning .............................................................................................. 27

7 Troubleshooting .................................................................................................... 30

8 Maintenance .......................................................................................................... 31

9 Dimensions and weight ........................................................................................ 33

10 Technical Specifications ....................................................................................... 34

11 Contact us ............................................................................................................ 35
1 Introduction

This manual is intended for qualified electricians that are involved in integrating, installing, operating and/or maintaining an APCQ automatic capacitor bank. They are supposed to know the general electrical wiring practices, electronic components and electrical schematic symbols.

The present manual applies to all types of APCQ capacitor banks.

2 Safety instructions

These safety instructions are intended for all work on all APCQ capacitor banks. Neglecting these instructions can cause physical injuries and death.

All electrical installation and maintenance work on the APCQ capacitor banks should be carried out by qualified electricians.

Do not attempt to work on a powered APCQ capacitor bank.

After switching off the power supply to the APCQ capacitor bank, always wait at least 5 minutes before working on the unit (i.e. time for the power capacitors to be discharged). Always verify by measurement that capacitors are discharged.

Note: AC capacitor may be charged at higher voltage than network nominal value.

Before manipulating current transformers (CT), make sure that the secondary is short-circuited. Never open the secondary connections of a loaded CT.

You must always wear isolating gloves and eye-protection when working on electrical installations. Also make sure that all local safety regulations are followed.

DANGER:

To ensure safe access, the power supply of each individual enclosure must be isolated before entry / opening.

This equipment contains capacitors. Check for residual voltage before working inside the equipment.
3 Upon reception

APCQ capacitor bank is delivered in carton box as per Figure 3.

Make sure that the packing is in good conditions.

After removal of the packing (see § 3.4), check visually the exterior and interior of your APCQ capacitor bank.

Any loss or damage should be immediately notified to your ABB representative.

Please also check the presence of following documentation:

- Instruction manual,
- Wiring diagram,
- RVC or RVT quick start.

3.1 Lifting and transportation guidelines

Please note that APCQ capacitor bank may weigh up to hundreds of kilograms. Care should be taken to ensure that correct handling facilities are used.

During handling and transportation, no shock is allowed.

In their packing, APCQ-L capacitor bank must be handled by their pallet. APCQ-M and APCQ-R must be handled with a forklift truck as per Figure 1.

When unpacked:

- APCQ-M and APCQ-R capacitor banks must be lifted by their lifting lugs as per Figure 2,
- APCQ-M and APCQ-R capacitor banks must be transported vertically without any shock,
- APCQ-L must be transported horizontally.

Figure 1: APCQ-M and APCQ-R transportation
3.2 Identification tag

The APCQ capacitor bank nameplate is located on the front door, at the outside. A second similar nameplate is present inside the cubicle.

The nameplate information should always remain readable to ensure proper identification during the whole life of the APCQ capacitor bank. The bank nameplate includes key data like the type, the nominal voltage and frequency as well as an ABB internal article code and data as per international regulations.

3.3 Storage

The APCQ capacitor bank must be stored indoors, in a dry, dust free, non-corrosive atmosphere and protected from vibrations or shocks.

The storage temperature must be between -20°C (or -4°F) and +60°C (or +140°F).
3.4 Packing & unpacking

APCQ-L, APCQ-M and APCQ-R capacitor banks are delivered in carton box.

![APCQ-L, APCQ-M and APCQ-R](image)

Figure 3: APCQ box

<table>
<thead>
<tr>
<th></th>
<th>APCQ-L</th>
<th>APCQ-M &amp; APCQ-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box dimensions (including pallet) (LxWxH)</td>
<td>800<em>610</em>480 (mm)</td>
<td>720<em>720</em>2390 (mm)</td>
</tr>
<tr>
<td>Packing + APCQ Weight</td>
<td>&lt; 40 kg</td>
<td>Max. 550 kg</td>
</tr>
<tr>
<td>Transportation</td>
<td>Horizontal only</td>
<td>Vertical only</td>
</tr>
</tbody>
</table>

To unpack APCQ-L capacitor bank:
- Remove the nails between the carton box and the pallet and remove the carton,
- Remove fixation screws.

To unpack APCQ-M and APCQ-R capacitor banks:
- Remove the carton box.
- Remove fixation screws.
4 Products overview and description

4.1 APCQ capacitor bank series

There are 3 types of APCQ capacitor banks:

- APCQ-L: wall-mounted cubicles without reactor,
- APCQ-M: free floor-standing cubicles without reactor,
- APCQ-R: free floor-standing cubicles with reactors.

All APCQ capacitor banks are available in master execution only, equipped by default with a RVC controller (RVT as an option).

4.2 APCQ capacitor bank layout

Note: external layouts of APCQ-M and APCQ-R capacitor banks are identical.
### 4.3 APCQ capacitor banks internal layout

<table>
<thead>
<tr>
<th>Number</th>
<th>APCQ-L Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fan (air outlet)</td>
</tr>
<tr>
<td>2</td>
<td>Auxiliary transformer</td>
</tr>
<tr>
<td>3</td>
<td>Auxiliary connections (current transducer)</td>
</tr>
<tr>
<td>4</td>
<td>Power Factor Controller (RVC by default or RVT as an option)</td>
</tr>
<tr>
<td>5</td>
<td>UA contactors</td>
</tr>
<tr>
<td>6</td>
<td>Busbar point of connection (3-Phase)</td>
</tr>
<tr>
<td>7</td>
<td>QCap capacitors</td>
</tr>
<tr>
<td>8</td>
<td>Internal protection Plexiglas (option)</td>
</tr>
<tr>
<td>9</td>
<td>Air inlet</td>
</tr>
<tr>
<td>10</td>
<td>Circuit breaker (optional)</td>
</tr>
<tr>
<td>11</td>
<td>Thermal cutoff switch</td>
</tr>
<tr>
<td>12</td>
<td>Cable knock-out</td>
</tr>
</tbody>
</table>

*Figure 5: APCQ-L internal layout*
<table>
<thead>
<tr>
<th>Number</th>
<th>APCQ-M &amp; APCQ-R Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fans (air outlet)</td>
</tr>
<tr>
<td>2</td>
<td>Auxiliary transformer (optional)</td>
</tr>
<tr>
<td>3</td>
<td>Auxiliary connections (current transducer)</td>
</tr>
<tr>
<td>4</td>
<td>Power Factor Controller (RVC by default or RVT as an option)</td>
</tr>
<tr>
<td>5</td>
<td>UA contactors</td>
</tr>
<tr>
<td>6</td>
<td>Air inlet</td>
</tr>
<tr>
<td>7</td>
<td>Main busbar (3-Phase)</td>
</tr>
<tr>
<td>8</td>
<td>QCap Power Module</td>
</tr>
<tr>
<td>9</td>
<td>Circuit breaker (optional)</td>
</tr>
<tr>
<td>10</td>
<td>HRC fuses</td>
</tr>
<tr>
<td>11</td>
<td>Internal protection grid</td>
</tr>
</tbody>
</table>

*Figure 6: APCQ-M & APCQ-R internal layout*
4.4 Power Factor Controllers

- RVC controller (by default if V<440V),
- RVT (optional if V<440V, otherwise provided by default).

**Note**: the quick start of the power factor controller is provided within the capacitor bank.

![Figure 7: RVC and RVT Power Factor controllers](image)

4.5 QCap Power module

Power modules are all-in-one pre-wired modules, which include capacitor, contactor, fuses and discharge resistors.

![Figure 8: 100 kvar APCQ-M Power module](image)

![Figure 9: 50 kvar APCQ-R Power module](image)
4.6 Ventilation system

All APCQ capacitor banks are air forced ventilated.

<table>
<thead>
<tr>
<th>Fan quantity</th>
<th>APCQ-L</th>
<th>APCQ-M &amp; APCQ-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan location</td>
<td>Door</td>
<td>Top</td>
</tr>
</tbody>
</table>

As a matter of protection, the bank does not operate as long as the ventilation circuit is not fed or when thermal cutoff switch trips.

**Important note:** auxiliary power supply is included by default in the APCQ capacitor bank.

4.7 Thermal cutoff switch

Each APCQ capacitor bank cubicle includes a temperature-sensitive switch that trips the controller power supply (hence RVC/RVT controller will be off) in case of over temperature above 60°C (or 140°F) inside the enclosure. In such event, all the capacitors are switched off while fans keep running. Thermal cutoff switch automatically closes when temperature goes down to normal conditions.

**DANGER**

When the thermal protection switches on, RVC/RVT controller is off but the capacitor bank is still connected to the power supplies. See safety instructions and wait 5 minutes before the opening.
Figure 11: Location of thermal cutoff switch in APCQ-L

Figure 12: Location of thermal cutoff switch in APCQ-M and APCQ-R
5 Installation

5.1 Working conditions: dust, moisture and temperature

The APCQ capacitor banks are for indoor installation only. Protect your APCQ capacitor banks against dust and moisture and place it in a well-ventilated area where the ambient temperature doesn’t exceed the following values:

- 40°C (or 104°F) maximum,
- 35°C (or 95°F) average over 24h,
- 25°C (or 77°F) average over one year.

5.2 Harmonics pollution

The installation of an APCQ capacitor bank on networks polluted by harmonics requires special precautions to avoid any risk of resonance.

In such case, consult your ABB Power Quality specialist.

5.3 Mechanical installation

5.3.1 APCQ-L capacitor banks

- To be fixed on a wall with 3 fixation points located as per below drawing.

![Figure 13: APCQ-L fixing points](image)

- APCQ-L weight: max 30 kg,
- At least M8 screw must be used. The anchors should enable a 5 mm fixture thickness.
5.3.2 APCQ-M and APCQ-R capacitor banks
- Free floor standing cubicles - minimum clearance distance at the back: 50 mm,
- Can be placed immediately side by side with other cubicles,
- Lateral panels CANNOT be removed, even if cubicles are side by side (excepted if cable entry cubicle option is ordered).

5.4 Electrical installation

5.4.1 Dielectric test
All APCQ capacitor banks are fully factory tested including a dielectric test between power terminals and earth (2500V 50Hz 10s).

If additional dielectric test is required on site, the following procedure should be followed:
- Short-circuit the three busbars,
- Apply between earth and short-circuited busbars 2000V 50Hz 10s.

Any damage resulting of this test should be notified immediately to your local ABB agent. Remove short circuit after the test.

5.4.2 Electrical connections overview
Each APCQ capacitor bank cubicle requires individual:
- Earth connection,
- Power connection,
- Current transformer (CT) connection.
5.4.3 Earth connection

- APCQ-L capacitor bank earth connection: one M6 stud located inside the bank plate next to the lower left corner.

![Figure 15: Earth connection in APCQ-L](image)

- APCQ-M and APCQ-R capacitor bank earth connections: two M8 screws located on an earthing bar (either located on top or bottom according to top or bottom cable entry).

![Figure 16: Earth connection in APCQ-M and APCQ-R for bottom cable entry](image)

![Figure 17: Earth connection in APCQ-M and APCQ-R for top cable entry](image)
5.4.4 Power cables selection

Cables and isolating switchgear should be rated at 1.5 times the nominal capacitor bank current rating and it should always be coordinated with the current rating of the backup fuses.

Note: when selecting the appropriate cable, please also consider possible future extension of the equipment.

Cross section of supply cables

The standards in force in the concerned country have to be taken into consideration keeping in mind that the current must be considered as a minimum 1.5 times the nominal current.

Master switch, fuses and circuit breaker

At the location of the APCQ bank installation, the power of the network short-circuit must be taken into consideration to define the main connection fuses, or rating of the circuit breaker.

To disconnect the unit from the network, ABB suggests preferably a circuit breaker. A 3-phase disconnecting fuse or a 3-phase switch with fuses may nevertheless be used.

The circuit breaker should be chosen with a nominal current rating of minimum 1.5 times the rating of the APCQ capacitor bank.

However, the fuses must be calibrated at least at 1.6 times the rating current of the capacitor bank.

5.4.5 APCQ-L capacitor bank electrical connections

- Electrical connection from bottom only,

![Figure 18: APCQ-L bottom entry](image)

- Remove the knock out and pass the power cable in (no grommet provided),
- Connect earth (see 5.4.3),
- Connect the power cables to busbars.

Bar dimensions: 60x3 mm (see Figure 19).

Hole diameter: 9 mm.
5.4.6 APCQ-M and APCQ-R electrical connections – Bottom entry

- The APCQ-M and APCQ-R cubicles are bottom cable entry by default (for optional top entry, refer to 5.4.7).

- Connect earth (see 5.4.3),
- Connect the power cables to busbars,
- Thickness: $L = 30 / T = 10$ mm.
18 Installation

Hole diameter: 13 mm.

Figure 22: APCQ-M and APCQ-R power cables connection to busbars

- Connect CT cable.

Figure 23: APCQ-M and APCQ-R CT connection

5.4.7 APCQ-M and APCQ-R electrical connections – Top entry (optional)

- Unscrew aluminum cover (3 mm thickness) of the cubicle and pass all cables through,
- Connect earth (see 5.4.3),
- Connect power cables to busbar,
- For all other connections: please refer to previous sections.
5.4.8 Auxiliary power supply
Each APCQ cubicle is provided with its own and built-in auxiliary power supply connection (230V 50Hz). Then there is no need to provide external auxiliary power supply.

5.4.9 Current transformer selection
Current transformer (CT) has to be provided locally (not provided with APCQ capacitor bank).

A range of ring and split core CTs exists on the market to ease installation.
CT connection must be in closed loop. It means that the CT should monitor the total current (i.e. both the load current and APCQ capacitor bank current).

CT specification:
- 1 or 5A secondary current rating,
- 15 VA burden for up to 30 meters with 2.5 mm² cable. For longer cables lengths refer to Figure 25 here below. In case of the CT is shared with other loads, the VA burden shall be adapted accordingly,
- Class 1 resolution or better,
- Primary side current rating should be sufficient to monitor the total line current (including transient phenomena such as drive/motor starts).

The APCQ capacitor bank is provided with ABB RVC/RVT controller with automatic adaptation to network phase-rotation.
Maximum rms current of the downstream loads (including starting current of DC drives):

\[ X_1 = \ldots \text{ Arms} \]

Multiply \( X_1 \) by 1.6:

\[ X_2 = \ldots \text{ Arms} \]

Select the CT such that:
- rating at primary \( \geq X_2 \)
- rating at secondary \( : 5A \)
- burden \( \leq 15VA \)
- class 1 accuracy or better

\[ X_3 = (L \times 0.007 \times 26) + 10 \]

\[ X_3 = \ldots \text{ VA} \]

Select the CT such that:
- rating at primary \( \geq X_2 \)
- rating at secondary \( : 5A \)
- burden \( \leq X_3 \) VA
- class 1 accuracy or better

\[ X_4 = (L \times R \times 25) + 10 \]

\[ X_4 = \ldots \text{ VA} \]

Select the CT such that:
- rating at primary \( \geq X_2 \)
- rating at secondary \( : 5A \)
- burden \( \leq X_4 \) VA
- class 1 accuracy or better

5.4.10 Current transformer connection

**WARNING:** When connecting the CT(s), the secondary terminals of each CT have to be shortened. Failure to do so may result in CT destruction and consequent damage to the installation. Once the connections to the APCO capacitor banks have been made, remove the short circuit.

**WARNING:** CT can be connected to several equipment BUT must be in series.

CT must be connected to CT’s terminals as per 5.4.5 and 5.4.6.

The CT terminal block can handle control cable wiring with sections from 0.75 mm² to 10 mm².

Run CT cables inside the cubicle. The cables can be installed in the cable duct fixed on the left of the cubicle.

CT’s are normally marked P1/P2 and S1/S2 and should face the supply transformer while P2 the load side.

S1 control wires terminal goes to terminal marked k and S2 to terminal marked l.
Note: A gray jumper is provided with the bank in a small plastic bag. Use this gray jumper in case shorting of the CT secondary winding is required (e.g. RVC/RVT controller removal). As long as the RVC/RVT controller remains wired to the capacitor bank, the gray jumper must be removed for proper operation of the bank.

5.4.11 Multi ratio CT and summation transformer

When a multi ratio split core CT is used the appropriate ratio is selected by connecting either S2 or S3 or S4 to terminal marked I. The CT ratio should be selected as close as possible to the requested CT specification.

Summation transformer

For more complex situation (i.e.: two or more power source connections) the current has to be measured in different points in order the APCQ capacitor bank receives correct measurement in any circumstances.

Then, when several CT’s are requested, one or several summing transformer should to be used.

When a summation current transformer is used the terminal markings will usually be P1, P2, P3, P4 and S1, S2. The secondary connections S1 and S2 should be connected to K and I respectively as before.

The first CT should be connected to P1 and P2 while the second CT should be connected to P3 and P4 on the summation CT. It is important that all CT’s monitor current in the same direction.
5.4.12 Connection of several banks in parallel

Several APCQ capacitor banks can be connected in parallel.

All APCQ capacitor banks are master units (i.e. fitted with a RVC or RVT controller) for better availability. If two units or more are connected, they must be connected as per Figure 28.

![Figure 28: Connection of several APCQ capacitor banks in parallel](image)

The parameter “switching delay” of each RVC/RVT Controller must be set differently.

If the RVC/RVT controllers are set to normal mode, we recommend using a switching time delay difference of 1 sec. (e.g. 40s, 41s, 42s …).

If the controllers are set to integral mode, we recommend using a switching time delay difference of 21 sec. (e.g. 120s, 141s, 162s …).

5.4.13 Optional Circuit breaker connections

If circuit breaker is ordered, power terminals should be connected to the circuit breaker directly as per figure here below:

![Figure 29: Optional circuit breaker connection – APCQ-M and APCQ-R](image)
Figure 30: Busbar connection – APCQ-M and APCQ-R

Figure 31: Connection for bottom entry – APCQ-L

Figure 32: External layout with circuit breaker – APCQ-L
Front terminals - F
Allow connection of busbars or cables terminated with cable terminal.

<table>
<thead>
<tr>
<th>Type</th>
<th>Version</th>
<th>Pieces</th>
<th>Busbars/cable terminal [mm]</th>
<th>Tightening [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>W</td>
<td>H</td>
</tr>
<tr>
<td>T2</td>
<td>F-P</td>
<td>1</td>
<td>20</td>
<td>7.5</td>
</tr>
<tr>
<td>T3</td>
<td>F-P</td>
<td>1</td>
<td>24</td>
<td>9.5</td>
</tr>
<tr>
<td>T4</td>
<td>F</td>
<td>1</td>
<td>25</td>
<td>9.5</td>
</tr>
<tr>
<td>T5</td>
<td>F</td>
<td>1</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>T6 630</td>
<td>F</td>
<td>2</td>
<td>40</td>
<td>12</td>
</tr>
<tr>
<td>T6 800</td>
<td>F</td>
<td>2</td>
<td>40</td>
<td>12</td>
</tr>
<tr>
<td>T7 1250 (2)</td>
<td>F</td>
<td>2</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>T7 1600</td>
<td>F</td>
<td>2</td>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

(1) minimum 5 mm
(2) up to 1250 A

5.4.14 Cable entry cubicle
The cable entry cubicle can be used with one or two APCQ cubicle(s). It can be located left or right of the APCQ cubicle according to the needs.

In case of two APCQ cubicles, the cable entry cubicle MUST be located in between as per Figure 34 below.

![Figure 33: Connection terminals](image1)

![Figure 34: Cable entry cubicle layout with two APCQ-R cubicles](image2)
If a cable entry cubicle is ordered, interconnection between cubicles must be realized on site according to the following steps:

- Remove lateral panels that are in contact with cable entry cubicle (included those of cable entry cubicle)
- Place the seal between the cubicles, place the cubicles side by side, assemble the 8 pins and interconnect them mechanically with the 4 brackets as per Figure 35.

![Figure 35: Interconnection of cubicles](image)

- Realize electrical connection between cubicles thanks to copper bars provided. These connections are realized by screwing

![Figure 36: Electrical interconnections](image)
- Customer cables are connected on busbar of cable entry cubicle

Figure 37: Customer electrical connections
6 Easy commissioning

1. General check of the capacitor bank: tightness of all connections, earth, fuses, contactors, etc.

   **Note:** the APCQ capacitor bank should be isolated from all power supplies (power and auxiliary).

2. Check cable cross sections and fuses: they should be compliant to the capacitor bank rating.

3. Check that the CT(‘s) is (are) properly installed (closed loop) and connected.

4. Remove the CT short circuit.

   **Note:** If your APCQ capacitor bank is equipped with an optional RVT, refer to RVT instruction manual and don’t follow the points below.

5. Switch on main supplies.

   **Note:** after a power outage, there’s a reset time. During this period of time, the disconnection icons will be blinking and the alarm contact will remain closed. After, the APCQ capacitor bank will resume its normal operation.

   **Check that the fan(s) are working properly.**

   **If not working properly, refer to Chapter 1.**

6. RVC Power Factor Controller auto setting.

   **WARNING:** if several units are connected in parallel, please refer to 5.4.12.

   **WARNING:** The parameter “switching delay” of the RVC should be higher than 40 s. Lower value may damage your capacitor bank.

   Activate the AUTO SET Mode by pressing twice the Mode button. “” appears on the LCD display.

   **Figure 38: View of the AUTO SET mode in RVC**

   Press the + button once: Phase, C/k, and Delay parameters will appear. Steps have been already set in factory.

   Press the + and – buttons simultaneously to start the automatic setting.

   “” starts flashing. Phase, C/k and Delay parameters are automatically set. Note that the delay value remains unchanged if it is set above or equal to 40 sec. before commissioning.

   If an error is detected, the AUTO SET procedure is stopped and an error message is displayed.

   For more details, please refer to RVC manual.

7. Setting target cos ϕ.
Press the Mode button once to activate manual setting of target cos φ.

The previous value will appear. If the RVC has never been programmed before, “  ” appears on the LCD display.

![Figure 39: View of target cos φ setting]

Set your target cos φ by pressing either the – or + button.

- indicates an inductive PF and - indicates a capacitive cos φ.

8. Reactivate the AUTO Mode by pressing the mode button repeatedly.

During this procedure, the parameters previously set will be displayed first: Phase, C/k, Delay and Steps.

![Figure 40: View of programmable parameters]

Then, select: Feature 1 (linear / circular) and Feature 2 (generative / regenerative target cos φ).

![Figure 41: View of the “Feature” parameters]

Finally, set the protections: Protection 1 (overvoltage - Max Vrms), Protection 2 (undervoltage - Min Vrms) and Protection 3 (over THDV - Max THDV).
Once back in AUTO Mode, the RVC automatically switches on the necessary steps to reach the programmed target cos $\varphi$.

The actual cos $\varphi$ appears on the LCD display.

**Note:** a negative cos $\varphi$ indicates that the load is re-injecting reactive power on the network. The RVC continues to work normally.

For RVT, please refer to RVT manual provided within the capacitor bank.
7 Troubleshooting

Most of the APCQ capacitor bank operating problems may be identified with the help of error messages or icons display on the RVC/RVT controller. Refer to the troubleshooting paragraph of the RVC/RVT controller instruction manual.

**APCQ capacitor bank troubleshooting:**
At first, in case of problem, strictly respect the safety instructions.
At first check if the capacitor bank rating is in line with network nominal voltage. If not, you cannot connect the capacitor bank.

**Step 1: is the RVC/T working or not?**
If working, please check the error message and refer to RVC/T manual to understand the problem.
Call ABB if you cannot fix the problem by yourself.

If not working: open the capacitor bank and make a visual inspection:
- Is the capacitor bank clean and fan working properly? (if not clean and/or replace the fan),
  Note: Fans must be replaced after about 40000 hours (check working hours on RVC/RVT).
- Are cables properly connected and yellow marks on terminal OK (if not re-screw them).

Note: at minimum, a yearly maintenance (more frequent if polluted environment).
Note: the capacitors must be checked yearly - replace them if 90% of initial capacitance (phase current).

**Step 2: RVC/T is not working:**

a. Do we have 230V power supply at L2/L3 (RVC) or PS1/PS2 (RVT) terminals?
   o Check if terminal are properly connected and reconnect them if not the case

b. If properly connected, check if 230V is available (disconnect the cables and measure the voltage, after reconnect them)
   o If 230V is present, then RVC/T is faulty, replace it and check if problem if fixed,
   o If no 230V present, and if the thermal switch is open => Then, there is an over-temperature issue:
     ▪ check if fan(s) are OK, replace them if not working,
     ▪ Check if the bank is clean and clean it if necessary,
     ▪ Check if the air inlet & outlet are clean, clean them if necessary,
     ▪ Check if the room is properly ventilated (max temp < 40°C and average temp over 24h < 35°C).
   o If no 230V and thermal switch is OK but there is no power supply:
     ▪ Check the auxiliary transformer, if damaged replace it,
     ▪ Are the auxiliary fuses OK or not. If not replace the fuses,
     ▪ Is the auxiliary tap of the transformer properly set - if not change it to network real value.
8 Maintenance

All maintenance operations should be carried on by qualified electrician. Please refer to Chapter 2.

The interval between two maintenances will depend on working conditions but should not be longer than one year.
**APCQ - Maintenance check list**

<table>
<thead>
<tr>
<th>Regular maintenance procedure</th>
<th>Issued by:</th>
<th>Date:</th>
<th>OK/NOK</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Check ambient temperature and equipment ventilation (should be within specification).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Isolate the APCQ capacitor bank from power supplies.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Open the front door panel.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Clear air inlet and outlet.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Clean all parts from dust and dirt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Check fuses (shouldn’t be brown).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Switch on each power step manually with RVC/RVT Controller.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Check contactors and their good operation – replace them if necessary.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Check operation of RVC/RVT Controller.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Measure capacitors currents (in the three phases) for every power step and record the measurements.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QCap</th>
<th>I Phase A</th>
<th>I Phase B</th>
<th>I Phase C</th>
<th>I Nominal</th>
<th>OK/NOK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fan replacement**

• Fans have to be replaced every 5 years (40 000 hours)

1 current measurements should be compared to previous measurements. If current is 10% lower than first measurement, capacitors have to be replaced.

Nominal current is normally given by: \( I_n = \frac{Q_x}{U_n\sqrt{3}} \)

Where: \( I_n \) = current in one phase - \( Q_x \) = Reactive power (kvar) on the power step - \( \sqrt{3} \) = square root of three - \( U_n \) = RMS value of phase to phase voltage
9 Dimensions and weight

<table>
<thead>
<tr>
<th>Type</th>
<th>H (mm)</th>
<th>W (mm)</th>
<th>D (mm)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>APCQ-L</td>
<td>820</td>
<td>500</td>
<td>290</td>
<td>Max 30 kg</td>
</tr>
<tr>
<td>APCQ-M</td>
<td>2185</td>
<td>610</td>
<td>650</td>
<td>Max 260 kg</td>
</tr>
<tr>
<td>APCQ-R</td>
<td>2185</td>
<td>610</td>
<td>650</td>
<td>Max 550 kg</td>
</tr>
<tr>
<td>Cable entry cubicle</td>
<td>2185</td>
<td>410</td>
<td>650</td>
<td>Max 180 kg</td>
</tr>
</tbody>
</table>

Figure 43: APCQ series dimensions
### Technical Specifications

<table>
<thead>
<tr>
<th><strong>Voltage range</strong></th>
<th>400V 50Hz. For other voltages, please consult us.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working ambient temperature</strong></td>
<td>-5°C (23°F) to +40°C (104°F) according to EN 61921</td>
</tr>
</tbody>
</table>
| **Installation** | - APCQ-L: wall mounted, bottom cable entry  
Clearance lateral: not necessary  
- top and bottom: 200 mm  
- APCQ-M and APCQ-R cubicles: free floor standing, bottom cable entry (top cable entry optional)  
Clearance lateral & back: 50 mm (but no clearance required between two APCQ cubicles) |
| **Connection** | three-phase, balanced network. |
| **Protection** | - IP23 (closed door) - optional IP54  
- Protected against direct and accidental contact (open door) - optional |
| **Execution** | Indoor |
| **Color** | Beige RAL 7035 |
| **Ventilation** | Forced air cooling |
| **Noise** | - APCQ-L: About 55 dBA (1m)  
- APCQ-M/R: About 70 dBA (1m) |
| **Power factor setting** | From 0.7 inductive to 0.7 capacitive |
| **Starting current setting (C/k)** | From 0.01A to 3A for the RVC controller  
From 0.01A to 5A for the RVT controller (optional) |
| **Operation** | During operation, RVC (RVT) controller displays:  
- the number of active outputs  
- the inductive or capacitive power factor  
- the alarm conditions: target cos φ, over/undervoltage, THDV, overtemperature  
- the demand for switching on/off a capacitor step |
| **Losses at 400V 50Hz** | Without reactors: less than 1.5 Watt/kvar  
With reactors: less than 5.5 Watt/kvar |
| **Capacitors – QCap type** | - Dry type self-healing according to IEC 60831-1&2  
- Dielectric: 2.15 Un between terminals during 10 sec at rated frequency  
- Acceptable overvoltage: +10% max. (maximum 8h/day) as per IEC 60831-1  
- Acceptable overcurrent: +30% permanently  
- Temperature range: -25°C (-13°F) / class D according to IEC 60831-1&2 |
| **Reactors (APCQ-R only)** | - Dry type resin embedded according to IEC 289, IEC 76  
- Maximum harmonic pollution: 8% THDV with specific spectrum |
| **Standards** | EN 61921 - IEC 60831-1&2 (capacitors)  
CE marked |
| **Options** | RVT controller (if V<440V, otherwise provided by default)  
Circuit breaker  
Temperature probe (with RVT only)  
Internal Plexiglas protection for APCQ-L  
Internal grid (IP20 open door) for APCQ-M/R  
IP54 enclosure  
Base frame: 200 mm  
Top cable entry cubicle for APCQ-M/R  
Cable entry cubicle and cubicle for interconnection bars for APCQ-M/R |
11 Contact us

s.a. ABB n.v.
Power Quality Products
Allée Centrale 10
Z.I. Jumet
B-6040 Charleroi (Jumet), Belgium
Phone: +32(0) 71 250 811
Fax: +32 (0) 71 344 007
E-Mail: power.quality@be.abb.com

http://new.abb.com/high-voltage/capacitors/lv