Just That Easy: Reactive Power Compensation using the Controller CR4.0

Installation:

Attach 230V AC to the power supply U_B pins 5/6 (in any order) of the 24-pin long connector strip. At three-phase systems with 400V AC you may bridge the star (wye) voltage 230V AC (L-N) to the measurement voltage U_M pins 1/3 (in any order) with the supply voltage. Attach the current transducer to the measurement current I_M pins 8/9 (in any order); remove the current transducer short (if any). Now half the work is done - the controller CR4.0 is empowered to gauge the net configuration.

One after another attach the branch lines to the capacitor bank to the outputs K1 to K8, pins 11 to 18 of the connector strip (in any order). Attach the phase pole of the 230V AC supply for the contactors of the capacitor bank to the common output COM, pin 10 (or COM2, pin19) and the corresponding neutral to the return pathes from the contactors within the capacitor bank. Now the Reactive Power Controller CR4.0 is enabled to compensate the reactive currents in your system by smart activating the capacitors of the bank.

Commissioning:

For check all lamps of the Reactive Power Controller CR4.0 light for a few seconds when powering up (turn in the controller fuse resp. switch on the circuit breaker). Then the controller is ready for commissioning. The green LED **"U (V)"** lights and the numerical 7-segment display shows the voltage actually measured. By the **"↓"** key you may proceed to the next LED **"I (A)"** while the actual current through the current loop transducer <--> controller (0..5A) is displayed. The numerical display is blinking because the current transducer ratio (ctr) is still unknown (the shown value bases on 5A:5A).

Start the Automatic Self Commissioning process by a long keytroke (3 seconds) on both green arrow keys **"↓"** and **"→"** (=reset) or by selecting menu item **"In. 2"** followed by **"SET".** While the commissioning process is running the CR4.0 controller switches several times steps of the capacitor bank. It determines from the changes in strength and phasing of current and voltage the net configuration as well as the capacitors reactive powers. That process may take about 5 to 15 minutes. In the meantime the controller displays clocked in sequnece **"SELF"** / **"InIt"** / **"... "**.

Commissioning is finished when the displayed sequence changes to **"SELF"** / **"InIt"** / **"donE"** followed by lighting all lamps during change to the Automatic Regulation Mode by reset.

If not turned off the sequence "SELF" / "InIt" / "… " is two or three times intercepted by displaying the results of the commissioning process starting with **"APPr"** (for "approve !"; for details refer to respective chapters in the verbose operations manual.

If you want to speed up the commissioning process or if you want to track each action you may select special settings prior to start of commissioning. Refer to the folowing verbose detailed operating instructions. It also comprises the statements necessary for non-standard commissioning.

Automatic Regulation Mode Operation:

Whilest compensating the reactive power in automatic mode operation your controller CR4.0 shows the obtained power factor cos phi at the numerical 7-segment display indicated by the green LED **"cosphi"** as far as it works nice. The more cos phi approaches 1.00 the less your mains is stressed by reactive current. But note that at low active load the power factor cos phi may achieve any value whithout relevance because the reactive power is low, too; low load conditions are indicated by no or only one capacitor being switched on.

The green "Steps" LEDs show which steps of the capacitor bank are actually switched on.

During automatic mode operation the mains conditions and the system utilization are tracked by the controller. That gives an extensive collection of actually measured values with their minimum and maximum to be obtained by using the menu tree "Info". The menu tree "Set" offers a multiplicity of settings due to adapt operation, error detection and alarming to your requirements.

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Installation Manual Reactive Power Controller CR4.0

0 Bibliography

0.1 Disclaimer

0.2 Scope

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0.3 Version History

Edition 1 2018/10/26 First Publication

0.4 File

Name of the original file: CR40_EN_Installation_0101_A1 as .doc and .pdf

1 Installation

1.1 Safety Instructions

Skilled technical staff only is permitted to mount, connect and commission this reactive power controller. Consider all relevant regulations.

In case of visible or assumable damages this controller must not be operated. Only the manufacturer is allowed to repair.

This controller is energized by mains voltage and must not be opened. Please note that the clamps can be energized although the regulator is off.

1.2 Installation Diagram

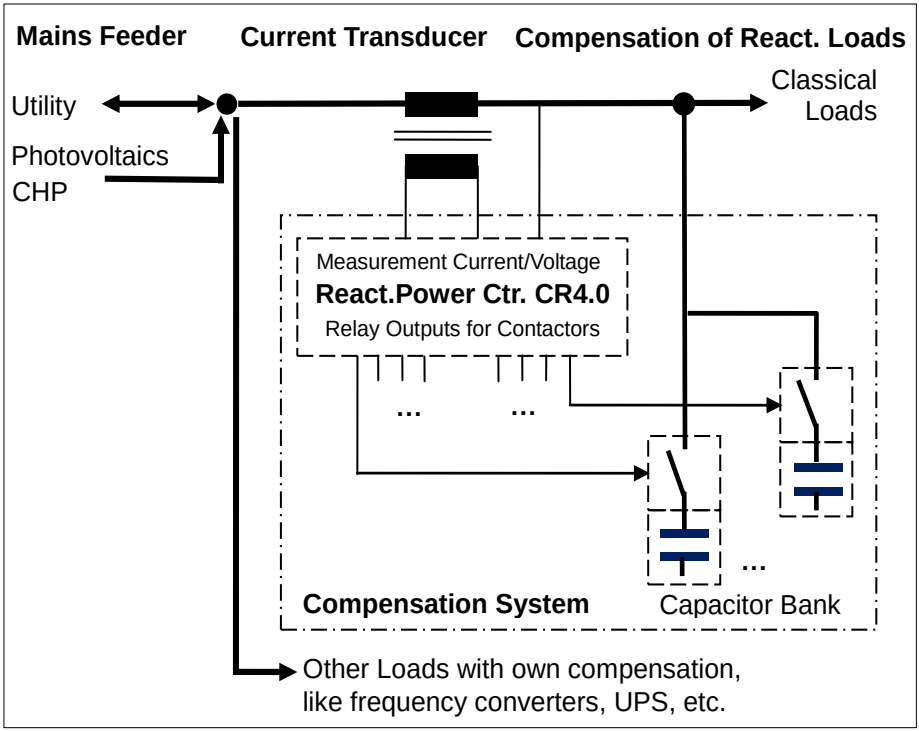

Figure 1 Installation Diagram: Compensation oif Classical Loads, only

1.3 Connection Diagram

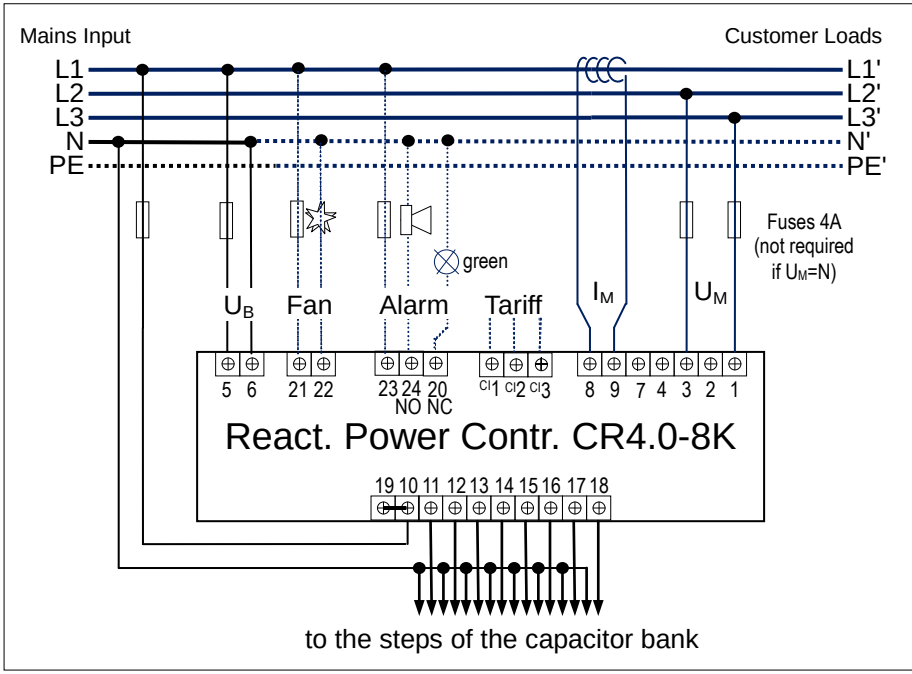

Figure 2 Connections to the Reactive Power Controller CR4.0
Please note that pin numbering corresponds to the markings at controller and connector strip rather than to the marking in the connector datasheet !

Figure 2 shows the L-L standard connection diagram. Despite of single-phase current measurement it provides detection of short break at every phase. Short break in phase L1 results in outage of the controller itself by loss of supply. On short break in phase L2 or L3 the controller detects loss of measuring voltage. In every case all steps of the capacitor bank will be immediately switched off due to protect the capacitors from re-connection in phase opposition. Before re-connection the capacitors are discharged during the idle period. Furthermore the response sensitivity of the CR4.0 with L-L measurement is higher by square root of 3 resp. the smallest step power is reduced by that factor.

Please do not feel disencouraged to use the simple L-N connection method. Lacking the quoted L-L advantages will be compensated by simplified wiring using bridges for any single phase and for the Null directly at the connector strip. The common pin COM for the contactors should not be included in bridging because of the impacts on measured voltage at contactor switching; experience says that no negative effect results on compensation but harmonics may be recognized slightly increased.

1.4 Mechanical Installation

The Reactive Power Controller CR4.0 houses in a panel-mounting case acc. DIN IEC 61554 with a nominal size of 144mm x 144mm.

Usually it is installed into an opening 138mm x 138mm within the door of an electrical cabinet or a compact enclosure. An installation depth of 60mm results using a 90° sideways cabled terminal block connector strip. The housing is locked in the opening by screwed brackets at the left and at the right side.

For DIN-rail installation use the housing variant with the "-H" part identifier. On request you may order gasket rings, or transparent covers with or w/o door lock.

1.5 Hints

- The **current transducer** must be placed in-between all left sided feeding equipment and all right sided load equipment including the compensation system itself, see Figure 1 Installation Diagram on page 4. Loads comprising their own compensation (e.g. frequency converters, uninterruptible power supply UPS, etc.) should not be included in the reactive power compensation.
- **Short bridge unconnected secondary current transducer terminals** when primarily loaded due to protect transducer and service staff from overvoltage harm. Remember to remove the short before controller (re-) activation. General technical regulations suggest single-sided earthing of current transducers at low voltage.
- Low voltage systems with **two or more feeder systems:**

  With all feeder and the section switches at the left of the current transducer ans all loads to be compensated and the compensation system itself at its right side, see Figure 1 Installation Diagram a standard compensation system fits.

  The 6-tranducer-method allows every reactive power controller to handle separate systems using an own reactive power compensation system per transformer but with a section switch in-between. Install each an current transducer at the transformer and at the section switch and use a summarizing transducer for charging the controller. For 2 transformers this sums to 6 transducers. Use different response times for the compensation systems to avoid mutual oscillations.

  With two identical transformers and with the status of the section switch as tariff input to the Control Interface (CI) programming the CI allows the CR4.0 to handle that system with only one current transducer per subsystem. Assuming the current is equally distributed in the system the CR4.0 handles two different transducer ratios as a function of the section switch state.

  Please ask SYSTEM ELECTRIC for (alternative) solutions.
- The Reactive Power Controller CR4.0 is designed to compensate the reactive current of **classical passive loads**.

Loads with their own reactive power compensation (e.g. UPS, frequency converters) can incur mismeasurement on monitoring the steps powers of the own capacitor bank leading to their switch-off. Monitoring the steps powers by the fault analysis is detachable, but you must adopt this task by yourself !

If you have **power generators** (e.g. a photovoltaic plant) installed with the loads **on the right side** of the current transducer (see Figure 1 Installation Diagram) the Reactive Power Controller CR4.0 is not able to see the current between the loads-sided generators and the loads resp. the capacitor bank. Misregulation and particularly switch-off of steps after wrong steps powers measurement may result. Please correct your installation (it would anyway not be accepted by your utility company nor by the subvention authority).

If the correct installation is not possible or not desired use a second current transducer in front of the generators and a summarizing transducer to charge the difference current into the CR4.0. That avoids misregulation but you must try out whether fault analysis / steps powers measurement has to be detached. In special cases when the generator feeds only active power without reactive contributes you may try the EEA mode in CI menu of the Reactive Power Controller CR4.0.

- When using a **summarizing transducer** the transducer ratio to be programmed in the CR4.0 has to be calculated from the sum of all primary nominal current values divided by the secondary nominal current value of the summarizing transducer. E.g. using two current transducers 1200A:5A and a summarizing transducer 5A+5A:5A gives a setting of 1200A+1200A:5A= 2400A:5A resp. the ratio 480.

- Consider to use the **adequate output power and the adequate c able cross-section** for the current transducer

  At current measurement the Reactive Power Controller CR4.0 consumes 0.3VA at 5A from an internal resistance (burden) of 12mOhms (at the -1A variant 90mVA at 1A, 90mOhms). With a maximum of 2.1m cable of 1.0 mm² inside the SYSTEM ELECTRIC cabinet the cable from the current transducer must not exceed (values in brackets for the -1A variant):

cable cross-section	2,5VA-transducer	5VA-transducer	7,5VA-transducer	10VA-transducer
1,5 mm^2	- (100 m)	4,0 m (210 m)	9 m (320m)	13 m (420 m)
2,5 mm^2	- (170 m)	7,5 m (350 m)	15 m	21 m
4 mm^2	-	12 m	24 m	35 m
6 mm^2	-	19 m	36 m	53 m

Table 1 Maximum cable length betwenn current transducer and cabinet including 2,1m 1.0mm^2 (values in brackets for the -1A variant)

The Reactive Power Controller CR4.0 itself is able to handle **secondary-sided transducer overload**, when the system ran for a while with correct load and the overload is creepingly incurred, e.g. by added small machines.

- Measurement bases on analyzing the current and voltage curves versus time. Therefore the accuracy suffers from EMC crosstalk particularly if the common phase for the contactors in the capacitor bank is bridged at the connector strip with the measurement voltage pins. Please **use separate cables for voltage measurement** up to the power bus bar.
- When using **phase shifting components** in the measurement circuits (e.g. old mechanical amperemeter, summarizing current transducer, standard transformer instead of voltage transducer) the resulting measurement fault may be partly corrected by adjusting the parameter "phase error", which at standard is preset for an 1% accuracy current transducer an no voltage transducer.

  Note! A transformer to facilitate 230V AC for the contactors must never be used also as voltage transducer because the fluctuating load results in measurement errors by phase and amplitude shifts. Please connect the voltage measurement directly to the power bus bar, use a dedicated voltage transducer, or at least use a separate transformer.
- The measurement circuits as well as the controller's power suply cope with small overvoltages / overcurrents. Due to increase the robustness against heavily fluctuating or high slew rate signals you may attach filtering circuits. The attenuating and phase shifting qualities of that filters must be considered (adjust transducer ratios and phase error parameters). When adding a filter into an operational system please perform new commissioning afterwards.
- **Reaktive Power Compensation and Emergency Power Supply:** Usualy it is recommended that a stationary emergency power plant should not be stressed by a reactive power compensation. The diesel generator itself is able to provide any reactive power needed. For this the emergency power plant has to be connected at the right side of the current transducer, see Figure 1 Installation Diagram. Then the reactive power compensation plant automatically idles when the emergency power plant takes over from the utility feeder.

  Emergency power supply from the public utility is accomplished using an increased frequency (51Hz / 61Hz). Here it is not intended to switch off the reactive power compensation plant. If your utility company claims switch-off the SYSTEM ELECTRIC service staff can change the internal alarm parameters for frequency accordingly.
- The Reactive Power Controller CR4.0 is not especially designed for use in **isolated networks**, in particular not for networks with a regulation strategy differing from that of the public utility. Usage for that cases is at own risk resp. works on agreement with SYSTEM ELECTRIC (e.g. fishing ships, oil rigs).

