

## General Considerations about the Controller CR2020

The Controller CR2020 is self commissioning. In AUTOMATIC control mode the controller adjusts the mains  $\cos\phi$  using the capacitive condenser (or inductive reactor) steps of the compensation system. Additionally it cuts switching operations and protects the system from harmful net conditions by switch-off all steps of the system according to the alarm thresholds. Also this controller sets the benchmark on maintenance and service.

This controller comprises a key-word guided menu navigation with plain assistance. Thus this controller can be operated without written instructions. The menu navigation starts from the main manu as root that is immediately available from almost everywhere using the 0 key. When password protected all values may be read but may be changed only after pwd. entry. Changes will not get effective unless confirmed by the set key.

## CR2020 Front Side



Standard window 1, enlarged  $\cos\phi$  view

Connection by a 24-pin female screw-type terminal block at the bottom side  
4 lines LCD display with 20 x 4 characters  
15 numerical and functional keys

- 0 - 9: for menu navigation // for numerical entry // direct entry from the standardwindow into main menu (0) or into its numbered sub menus (1 - 9)
- ▲, ▼ for scrolling among the windows // increment / decrement a value // direct entry from standardwindow into readings/survey (major readings or settings):  $U_{rms}$ ,  $I_{rms}$ ,  $f$ ,  $S$  //  $Q_{miss}$ ,  $Q_p$ ,  $Q_{on}$  // THDU /U/I harmonics U3, 5, 7, 11, 13 and I3, 5, 7, 11, 13 // target / alarm- $\cos\phi$ -settings for tariff 1 / 2
- ESC Return to the superior menu level // Leave a special main menu (e.g. experts menu) to the superior menu tree // Abort an action or numerical entry
- SET Start or confirm a numerical entry // enter the info menu from the standard-window (cf. figure: set:Info): 1: standardwindow 1 or 2 toggles between both window types; 2: general instructions; set: legend of symbols; 0: main menu

Short-cut keys: together press for 3 sec.: ESC + SET: Emergency shut-off; ▲ + ▼: Restart; 1 + 7: Software reset

## CR2020 Variants

- CR2020-10K: 10 relay outputs for contactor switching
- CR2020-5T5K resp. -10T: (mixed relay and) transistor outputs for (half) dynamically (mixed contactor and) thyristor switching; without the E option thyristor control voltage is delivered by the controller itself

## CR2020 Modifications

- S: integrated interface RS485; mutually exclusive with the alarm relay (see the Wiring Diagram)
- H: case with DIN-rail support
- 100V:  $U_m$ : 50 - 250 V AC: resolution of smallest gaugeable step power  $Q_{min}$  increased by factor 2.7
- 1A:  $I_m$ : 0 to 1,2 A: resolution of smallest gaugeable step power  $Q_{min}$  increased by factor 5
- Al: Inverted external alarm signal; relay with make contact "a"
- Fm /-Fh: frequency metering uses measuring voltage rather than supply voltage; for  $U_m$ : 190 - 520 V / 420 - 700 V
- E: use external power supply for thyristor control voltage; CR2020 variants -5T5K or -10T

## Power Resolution of the System acc. C/k oder $Q_{min}$ (=smallest gaugeable step power)

$$C/k = Q_c [\text{var}] / ki \geq \alpha \quad \text{with: } Q_c: \text{smallest step power in use}$$

$$Q_{min} [\text{var}] = \alpha \times ki \quad \text{ki / ku: current (ki) / voltage (ku) transducer ratio}$$

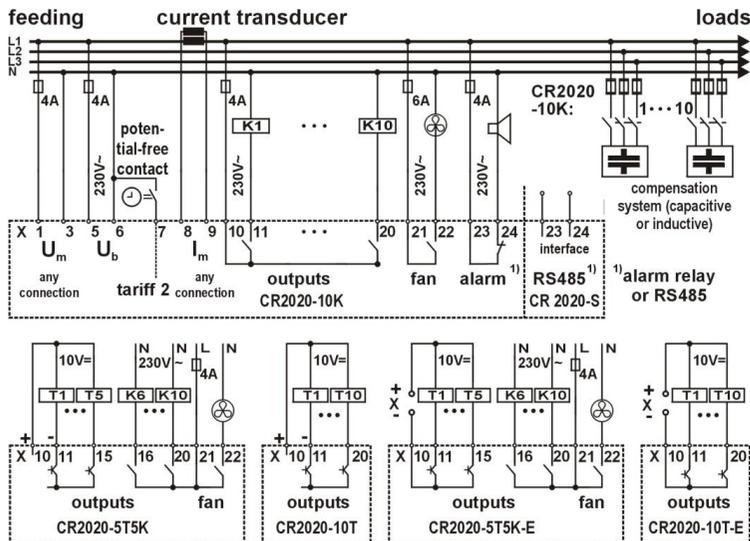
Table of proportionality factor  $\alpha$  considering different controller modifications (L: Phase; N: Neutral Wire)

Controller Modification	Standard	-100V	-1A	-100V plus -1A
L-N	11,58	4,24	2,32	0,85
L-L	6,69	2,50	1,34	0,49
Single-Phase AC	3,86	1,41	0,77	0,28

**Total Steps Power:**  $Q_{max} = 6 \text{ kvar} \times ki @ 400/230V$ ;  $8 \text{ kvar} \times ki @ 690/400V$  (L-L/L-N) (Rule of Thumbs)  
**Operating Current:** Connection L-L:  $\Delta I_{min} = 5 / 4 / 3 \text{ mA} \times ki @ 400/525/690 \text{ V}$ ; Connection L-N:  $\Delta I_{min} = 9 / 7 / 5 \text{ mA} \times ki$   
**For strongly perturbed networks the controller may require up to 5 times the smallest step power !**

**With voltage transducer** ( $U_{transducer \text{ primary}} : U_{transducer \text{ secondary}}$ ) **apply** (for details refer to the complete instructions):  
 $C/k = Q_c [\text{var}] / (ki \times ku) \geq \alpha \times U_{transducer \text{ primary}} [\text{V}] / \text{mains voltage } U_{mains} [\text{V}]$   
 $Q_{min} [\text{var}] = \alpha \times ki \times ku \times U_{transducer \text{ primary}} [\text{V}] / \text{mains voltage } U_{mains} [\text{V}]$

## Wiring Diagram (also check the controller's rear panel)



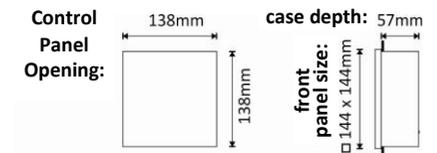
## Issues regarding the Wiring Diagram (contactors (K) or thyristor switches (T) for steps operation)

- tariff 2: Enter signal by floating contact between terminals X6 / X7 (as to 230V AC from terminal X5, load resistance 150 kOhm)
- CR2020-10K: 10 relay outputs for switching by contactors (X11 - X20: switching outputs; X10: common pin)
- 5T5K: 5 outputs each for switching by thyristors (X11 - X15, common pin X10) and contactors (X16 - X20, common pin X21 combined with fan)
- 10T: 10 transistor outputs for switching by thyristor switches (X11 - X20: switching outputs; X10: common pin)
- CR2020-5T5K or -10T: Controller itself supplies the thyristor control voltage +10V DC at the common pin X10, - comes from the switching outputs
- E: Thyristor control voltage from external power supply (10 ... 20 V DC; + wired to all thyristor switches, - goes to common pin X10); Protective Resistor per Output: 47Ω; Maximum Output Current: 150 mA per output, 1.5 A in total
- S: Connector pins X23 / X24 are used by the interface RS485 rather than by the alarm relay

## Mounting Information (Panel-mounting case acc. IEC 61554, nominal size 144mm x 144mm, screwed fasteners at right/left sides)

**Current Transducer** class 1 or better, preferred .../5A. Transducer output power  $\geq 5 \text{ VA}$  according to cable length and cable cross-section.

- **Attention:** Mount the current transducer in front of the switchgear connecting point of all the load to be compensated and in front the compensation cabinet itself
- **Attention:** Short circuit an unconnected current transducer; remove short for operation



## Safety Instructions

Skilled technical staff is only permitted to mount, connect and commission the reactive power controller CR2020 considering all relevant regulations. In case of visible or assumable damages the regulator must not be operated. Only the manufacturer is allowed to repair. The regulator is energized and must not be opened. Please note that the clamps can be energized although the regulator is off.

## Commissioning – Autostart and Experts Menu

During auto-commissioning the reactive power controller CR2020 determines by switching the steps of the compensation system both the net-configuration and the power of the steps. A **factory pre-programmed controller knows the step sizes in kvar and therefore is able to size the transducer without any user input.** For auto-commissioning at standard conditions the user should enter the current transducer data, and the detuning factor. All alarms with switch-off work also during commissioning when ever possible.

### Tips Facilitating Commissioning

- Menu Item 0-3:readings  $U_m/I_m/f$  "at contact bank": Check the current transducer short if  $I_m < 0.04A$ .
- Check the current transducer short if net-configuration could not be gauged or if steps powers could not be sized
- Gauging the net-configuration results in a connection statement for measuring voltage  $U_m$  and measuring current  $I_m$ . But since the controller cannot determine the absolute phase labels the result may be cyclically permuted.
- Due to show the real values for voltage, current, and power the controller must know the transducers data. For regulation only transducer data is negligible.
- Entering the detuning factor(s) is important for resonance supervision and for the harmonics alarm thresholds.

### Commissioning Summary - observe the messages on display

1. Installation, Wiring, and Commissioning requires skilled technical staff and must be done observing all relevant regulations and safety instructions.

#### 2.a Commissioning a factory pre-programmed (SE) controller

**1:autostart:** press the "1" key to start auto-commissioning.

**Await timed commissioning to finish** (ca. 4 .. 12Min.). **Plausibility check the results shown meanwhile. - Ready.**

#### 2.b Commissioning a controller by autocommissioning at standard conditions (refer to 3. for changing the standard)

**1:autostart:** press the "1" key to start auto-commissioning. Observe the messages shown in display.

In **valuable entries** you are encouraged to enter **1:transducer** and **3:detuning factor**, and if desired **2:password**.

Return to auto-commissioning by the **set**-key. (**Tip:** Password 4444 enables detailed info during commissioning.)

**Await timed commissioning to finish** (ca. 7 .. 15Min.). **Plausibility check the results shown meanwhile. - Ready.**

**2. Tip on plausibility checks:** The net-configuration result, page 2 shows the nominal mains and measuring voltages; a pre-programmed controller shows with the transducer ratio the actual current to be compared by multimeter.

**3.** If desired please change the standard conditions prior to commissioning by **set:change standard. 1:config. data** allows to change frequently used parameters, **2:setup** all of them, and **3:infos + tests** provides useful aids and pre-commissioning test equipment. Return to auto-commissioning by **0-1** or by pressing the **esc**-key several times.

**4.** If troubled rerun the commissioning process or enter the net-configuration and the steps sizes manually using **commissioning menu - 2:experts menu**. There you also can execute commissioning step by step.

## Commissioning Menu

**1:autocommissioning:** either **factory pre-programmed (SE)** or **autocommissioning** (at standard conditions)

**2:experts menu:** net-configuration and steps sizes may be entered manually (see below)

**3:readings  $U_m/I_m/f$ :** raw values of measuring current  $I_m$ , measuring voltage  $U_m$  and frequency  $f$  at contact bank without transducer. (**Tip:** If  $I_m < 0,04 A$  then check whether the current transducer short circuit is open.)

**4:menu preprgrSE:** at least enter the steps sizes and their detuning factors. Then the controller requires no further entry when **1:autostart SE: factory pre-programmed** is executed

**5:config. data:** enter **target cosφ; target- and alarm range cosφ; transducers; password; detuning factor(s); basic load** (=fixed compensation power); **special conditions** regarding system configuration or control.

**Attention:** configure inductive steps **prior** to commissioning start using **8:inductive steps**.

**6:setup:** change any parameter; menu tree equals to **8:setup** from the **main menu** within the **automatic mode (AUTO)**

**7: test outputs:** verify system wiring within the compensation cabinet(s)

**Attention:** remove the module fuses prior to test start - idling is not guaranteed!

**8:alarm signal test:** toggle the alarm relay for test

**9:fan test:** toggle the fan relay for test

**set:general instructions:** show instructions for controller usage and wiring; get the version and serial numbers

**Experts Menu** (e.g. for manual entry of net-configuration and steps sizes)

**1:valuable entries: 1:transducer; 2:password; 3:detuning factor**

**2:gauge net-config.:** Gauge the net-configuration induced phasing of measurement voltage  $U_m$  and current  $I_m$ ; also fix the nominal mains voltage and nominal frequency. **Check: are cosφ and mains voltage** (page 2 of result) **plausible?**

**3:enter net-config.:** Manually enter the net configuration; fix nominal mains voltage / frequency on acceptance.

**4:size step power:** Size the powers of all steps by switching and extrapolate them to nominal mains voltage / frequency **Check: control steps powers with system design**

**5:enter step power:** Start manual entry with the 1-key. Prerequisites: transducer and net-configuration exist.

**Related to 4/5:** Remember to enter / check the detuning factors and the alarm thresholds for harmonics THDU / 1U

**6:automatic mode:** Enter / return to the automatic regulation (AUTO). Prerequisites: transducer, net-config., and steps powers exist.

**7:config. data; 8:setup:** see **Commissioning Menu; 9:info + tests:** general instructions, reading at contact bank, connection info, test outputs/alarm relay/fan; **set:factory defaults:** Define new customer specific default parameters

### Start up after Commissioning into Automatic Regulation Mode

When auto-commissioning is finished the display informs you about mode change. Here and after successfully pressing the **6**-key in experts menu the controller restarts with the initialization into the **Automatic Regulation Mode (AUTO)**.

After the contactor idling period (std: 45sec) even for thyristors the controller starts compensating reactive net power.

## Automatic Mode (AUTO): cosφ Standardwindows (ST) 1 & 2

During regulation in automatic mode the steps are switched according to the reactive power in mains. Thereby the loss of steps powers are supervised. Also the controller supervises the mains network for harmful conditions that are treated by switching all steps off (Operating Sub-Mode **Alarm Switchoff Mode AL**, refer to chapter **Alarms**).

### Legend of Symbols: Diverse

**T1 / T2** = actual Tariff 1 or 2

**F\* (L\*)** = fan is active (german: Lüfter)

**C+/C-** = Tendency of switch on/off steps; **not displayed in dynamic systems!**

**B** = Base load (fixed compensation power) programmed, symbol is blinking

**A!** = External alarm signal activated, symbol is blinking

### Legend of Symbols: Switching Status of Steps (A)

**ST1:** - = Step off

+ = Step on

**ST2:** ⌋ = Step off

⌋ = Capacitor step on

⊞ = Reactor step on

= No step connected

t = Step under Test

d = Step defective

R = Step off because of resonance condition

■ = Step idling; the idle period of capacitor is still running.

### Legend of Symbols: Operating Mode (B)

**AUTO** = Automatic Regulation Mode; Note: no regulation when cosφ inside target range

**AL** = System switchoff because on alarms: at least one alarm with switchoff is active.

**MAN** = Manual Switching Mode; allows to switch all outputs plus alarm and fan relays

**HALT** = System Halted, Out of Service; ALL steps are switched off.



### Legend of Symbols: cosφ (C)

**Displayed cosφ:** **c0.99** = capacitive 0,99 **i0.99** = inductive 0,99; **G** = Generator mode

### Further Issues

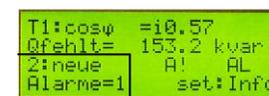
- **set:info** within the **cosφ-standardwindow** opens an Info Menu with: **1:standardwindow 2/1** change between ST1 and ST2 and **2:gen.instructions** (Infos on controller, operation, and technical data)
- When **Qfehlt** value in **ST 2** is shown in brackets then the **cosφ** resides within the **target range cosφ**.

### Standardwindow indicating New Alarms with Alarm Count

When new alarms are present the standardwindows 1 and 2 show at the left of lines 3 and 4: **2:new alarms=** (german 2: neue Alarme=) and then the alarms count. Operation Mode Alarm Switchoff **AL** indicates that at least one alarm with switchoff is still active. The back light flashes twice a period. If the still active alarm is new then also the beeper sound twice a period. The external alarm signal from the alarm relay is active, if indicator **A!** blinks.



ST1



ST2

The system is switched off due to an alarm with switchoff (operation mode **AL**). In the right figure only the external alarm signal is active, too (**A!** blinks).

## Main Menu = root level of the menu navigation

The main menu facilitates quick, and intuitive access to readings, programming, alarms as well as to service applications like maintenance and repair by means of keyword guided paths. Such a path can be characterized by a sequence of key strokes (e.g. **0-3-3:readings/basics**).

The displayed menu or action window drops into the selected standardwindow ST1 or ST2 **after 3 Minutes without keystroke**. As drop target outside the *automatic regulation mode* there exist different standardwindows showing how to leave that mode or how to (re-) enter the *automatic mode*.

**Navigation Aids:** **0:main menu:** Direct return into the main menu (except **0** is used for another purpose)  
**esc:** Return to the manu level just one above / abort an entry

## The Main Menu – intuitive and self-explanatory (in AUTO, MAN, HALT)

**1:standardwindow 1/2:** Actual standwindow of the *automatic regulation mode* (toggle 1/2 by **set-1**)

**Tip:** Quick path to the standardwindow of the actual operation mode: **0-esc**, to standardwindow ST1, ST2: **0-1**

**2:new alarms:** shows only the new, yet unacknowledged alarms (show actually active alarms: **0-6-1**)

**Tip:** **1:Info** provides further information usually the actual settings of the alarm threshold and the alarm delay

**3:readings:** **Hint:** Submenus **1** to **3** comprise *actual* readings as well as *quarterly averaged* readings

**1:cosφ, lambda // 2:power Q, P, S** also  $Q_{miss}$ ,  $Q_{on}$  // **3:basics U, I, f // 4:U harmonics** (up to 31<sup>th</sup>) // **5:1 harmonics** (up to 31<sup>th</sup>) // **6:I at step:** calculated current through steps (re. resonance) // **7:temperature** (also daily mean) // **8:survey:** the same presentation of major readings and settings you get from the standardwindow by the arrow keys // **9:long term means:** averaged over periods from ¼ h up to 1 year for  $cosφ$ ,  $Q$ , and  $Q_{miss}$

**4:min/max-readings:** **Hint:** **7:clear readings** resets the min/max readings shown in submenu **1** to **7** respectively. Submenus **1** to **7** same quantities like at **3:Messwerte // 8:reset min/max** applies to all min/max readings

**5:step information:** **Hint:** **1:alarm info** in submenus **1** to **3** shows the actual alarm thresholds.

**1:step power Qc // 2:cycles on/off // 3:operation time // 4:I at step:** calculated current through steps (re. resonance) // **5:detuning factor:** (relevant for harmonics alarms, resonance) // **6:info per step:** re-sorted view

**6:alarme (AL):** **Hint:** **1:Info** provides further information usually alarm threshold and alarm delay.

**1:actual alarms:** all actually active alarms // **2:accumulated AL:** gives the number of occurrences for all alarms one after another (number=0 may be skipped from SW 1605xx73 on), **7** particularly resets the number; but **total** number remains preserved // **3:AL thresholds** (see table **AL Thresholds**) // **4:alarm signal at...:** you can suppress the external alarm signal for particular alarm groups // **5:alarm signal test:** toggle alarm relay // **6:acoust. alarm:** alarm beeper off / on (keyboard click always on!)

**7:manual mode (MAN):** You are encouraged to switch steps / fan / alarm signal while regulation is stopped

**Hint:** Display permanently shows readings of  $cosφ$  and  $Q$ , from SW 1605xx73 on  $Q_{miss}$  missing to target  $cosφ$ . Blinking background light and beeper remind that the actual operation mode is without regulation. Beeper turns off by **1** in the MAN standardwindow. **Attention:** **Manual Mode** must be left by **6** in the MAN standardwindow.

**8:setup:** **Hint:** When offered **1:Info** provides further information.

**1:for metering:** configure transducers and other metering settings // **2:für Regelung:**  $cosφ$  target / range, alarm range; **for contactors:** response time, idle period, and contactors operate subsequently / all together; **for thyristor switches:** response time, idle period, and **Fast Mode;** special settings for **-5T5K; kap.cosφ limit:** do not regulate more capacitive than the cap. limit of the  $cosφ$  target range // **3:system setup:** base load / fixed compensation power, detuning factor, alarm thresholds for steps, rush-in current dead time, and **special conditions:** i.a. stop fault analysis for steps powers, multi-detuning // **4:for temperature:** setting regarding temperature shut-off and fan control // **5:for alarms:** alarm thresholds and alarms configuration, **alarm signal at...** // **6:back-up/reset:** hold a copy of the actual settings, return to the default settings / factory defaults, show changed settings // **7:Programm spezial (SE):** password protected area, for authorized staff only // **8:interface:** This menu is not visible unless at a CR2020 controller with interface RS485 modification **S**

**9:service menu: 1:shutdown system / restart system // 2:maintenance: executed** restart period for maintenance reminder, **non-standard setup:** show changed settings with respect to standard settings // **3:reparation:** (in AUTO only) allows to configure some single steps while the regulation continues in the background: **check steps' Qc, info per step, parts replaced** (contactor only, capacitor only, both, and fuses only), **add steps;**

**Attention:** **reparation** must be left by **6** in the reparation standardwindow.

**4:connection info:** shows the net-configuration: connection of measuring current  $I_m$  and -voltage  $U_m$ , phase angle, nominal mains voltage and nominal measuring voltage, catenation, transducers and total current, and raw values of measuring current  $I_m$ , measuring voltage  $U_m$  and frequency  $f$  at *contact bank* without transducers //

**5: test outputs:** verify system wiring within the compensation cabinet(s); **Attention:** capacitor idling is not guaranteed // **6:initiation:** re-enter commissioning; existing settings are preserved until new net-config. / steps sizes are evaluated // **7:password:** change pwd.; **Hint:** in order to open the controller without password change **immediately** abort *change password* after entry of old one and **set // 8:general instructions:** infos on controller, operation, wiring, and technical data (version and serial numbers); contact to SYSTEM ELECTRIC // **9fan off for 10Min.:** useful for service on the cabinet; **Tip:** the key sequence **0-9-9** initiates fan off for 10Min. from almost anywhere in the menu trees.

## Special Features of the CR2020 Controller

- A response time, tailored to suit the reactive power needs together with the adjustable **target range  $cosφ$  (0-8-2-2)** extends the system's life span and reduces unwanted circuit feedback by reducing the switching cycles on/off. **Tip:** Use for load tariff: **target  $cosφ$ =least  $cosφ$  and a wide target range  $cosφ$  from least  $cosφ$  to 1.00 oder  $i0.99$ .**
- Target range  $cosφ$  (0-8-2-2):** While the  $cosφ$  stays inside the **target range  $cosφ$**  no regulation will happen. **Tip:** If you are required to always reach a specified target  $cosφ$ , both limits of the **target range  $cosφ$**  must be set equal to the **target  $cosφ$**  itself. That way for monthly energy invoice without permanent power measurement you can equalise low-compensation on heavy load by just a better compensation on medium load.
- The **alarm range  $cosφ$  (0-8-2-3)** like the **target range  $cosφ$**  comprise both inductive- and capacitive-sided limits.
- Prevent from capacitive  $cosφ$ :**
  - When **cap. $cosφ$  limit (0-8-2-7)** is on the compensated  $cosφ$  persists to be more inductive than the **capacitive-sided target range  $cosφ$  limit**.
  - By programming an **inductive fixed compensation power / base load (0-8-3-2)** of the size of the smallest step power the regulation volume is deferred in parallel to keep outside the capacitive area.
- The **long term means (0-3-9)** with the quantities  $cosφ$ ,  $Q$  and missing reactive power  $Q_{miss}$  permits evaluation of compensation grade within the average periods ¼ h, 1 h, 4 h, 1 day, 1 week, 1 month, and 1 year.
- The harmonics alarm **#37:I at step** is calculated from the actual harmonics  $U$ , the actual step power (power loss), the detuning factor, and from the actual voltage / frequency ratio to their nominal values. It is used to protect the capacitors from destructive overcurrent and resonance conditions.
- All system settings changed with respect to the defaults** are shown in the maintenance menu at menu item **non-standard setup (0-9-2-2 or 0-8-6-3)**. A very helpful quality of service.
- While regulation continues in the background the menu **reparation (0-9-3)** enables you for some single steps to check their power, to change the settings for replaced contactors, condensators, both, or fuses while preserving not-involved data. Also you can add new steps that were unassigned before. **Hint:** Due to **remove a step** from regulation manually enter a step power of 0.00 kvar in **reparation/parts replaced / contactor+capacitor**.
- fault analysis:** Fast switching loads, an overcharged current transducer, or loads with their own compensation, like frequency converter or UPS, may trouble the power measurement for steps resulting in erroneously alarmed steps as defective. Then you can switch off the fault analysis for some time by **0-8-3-7-2** until the reason is resolved.
- An **overcharged current transducer** feeds load-dependant less current into the controller. After a long period of undisturbed operation the controller detects that situation and prevents from defect alarms.
- The compensation system is shut-off on **excess temperature** or at quick temperature rise. Stop fan at >15°C over the excess temperature threshold due to prevent from **fire acceleration**.
- When **password protected (0-9-7)** all settings can still be read but changing them may require the password.

## Informations on mains: analysis from the 0:main menu

**0-3-9:long term means:** shows the mean grade of compensation with  $cosφ$ ,  $Q$ ,  $Q_{miss}$  during ¼ h up to 1 year

**0-4:min/max readings:** shows the min./max. readings e.g. of occurred voltages / currents / harmonics

**0-5:step information:** shows power loss, switching cycles, operation times, or current load of the steps

**0-6:alarms (AL):** look at the actual and accumulated alarms to detect problems; adjust alarm thresholds

**0-9-2:maintenance:** inform the controller about executed maintenance; show changed settings

**0-9-3:reparation:** use this item to check some single steps, to inform the controller about replaced parts (contactors, capacitors, both, fuses), or to add new steps

**0-9-4:connection info:** shows the net-configuration of measuring current  $I_m$  and -voltage  $U_m$ , nominal mains and measuring voltage, transducers, and raw values of  $I_m$ ,  $U_m$  and  $f$  at *contact bank* without transducers

**0-9-8-2:connector pins:** infos on connecting and fusing the controller

**0-9-8-3:technical info:** variant / modification, hardware- (HW) and software versions (SW), serial number

## Special Methods of Regulation

- Algorithms for **absorption circuit** und **multi-detuning (0-8-3-7-5:multi-detuning)**: The absorption circuit uses at first **all** steps with the higher detuning factor not till then the steps with lower detuning. Multi-detuning uses every time a little more step power from the higher detuning factor than from the lower detuning
- Instead of a **fixed step** the CR2020 uses a programmed fixed compensation power / **0-8-3-2:base load** (e.g. for low voltage (LV) transformer compensation when the electric supply company bills at the medium voltage (MV)). The display reminds by a blinking **B!** to the corrected **cosφ.B;** quantity  $B / T = \text{at MV / LV (transducer) side}$
- With **dynamic Compensation (CR2020-10T / -5T5K)** the controller responds after 15msec to a step in power needs; compensation using the thyristor switch **CONDENSOTRONIC CT2000** happens within 25/35 msec (on/off).
- The half-dynamical controller **CR2020-5T5K** allows to build reasonably priced, energy efficient compensation systems with super fast response. While quick fluctuating loads are dynamically compensated using thyristor switches the contactor steps hold the long term quasi-constant reactive power needs.

## Service

Service tasks are handled by the **0-9:service menu**, see chapter **The Main Menu**. Additionally you can infer the state of the compensation system from menu tree **0-5:step information**, the state of mains from menu tree **0-4:min/max readings**, and the grade of compensation from the menu item **0-3-9:long term means**.

**Shortcuts** (can be used from almost everywhere within the menu tree depth):

**0:** main menu (operation mode OP dependent), **0-esc:** standardwindow OP, **0-1:** std.window AUTOMATIC mode, **0-9-1-1:** emergency shutdown, **0-9-1-2:** restart, **1 + 7:** software reset, **0-9-4:connection info:** net-config. at mains, **0-9-9:** stop fan for 10 Min., **0-9-3:reparation** menu, +=jointly press keys for 3s until beep off, -=subsequently strike keys.

**Contact points:** X5-X6=Supply voltage, 230V AC; X9=Contactor common, 230V AC (phase); X1-X3=Measuring voltage 58V..700V AC; X8-X9=Measuring current 0..5A / 0..1A AC

**Cuurent:** each phase in any module is loaded by: 50kvar=72A AC, 25kvar=36A AC, 12,5kvar=18A AC, 4,3kvar=6,2A AC

## Alarms (AL)

When the controller CR2020 is supplied to the customer no alarm is switched off. The standard alarm thresholds are configured for standard compensation systems in order to protect them against destructive mains stresses. Special systems or mains networks may require adjusted alarm thresholds (see table **AL Thresholds**). Use **1:info** to show for every alarm additional information usually the actual threshold and actual delay.

**Alarm Notices** (without switch-off of steps or with switch-off of affected steps only)

- **AL #1:over.. / AL#2:low-compensation:**  $\cos\phi$  longer than the delay outside the **alarm range  $\cos\phi$** ;
- **AL #3:fault analysis off:** (as reminder only) monitoring power loss of steps is switched-off; the user himself is obliged to periodically perform maintenance on steps; re-activate fault analysis by **0-8-3-7-2**.
- **AL #4:step 1 to AL #13:step 10:** step power loss > alarm threshold (standard= 20%); the defective step is permanently switched-off while regulation continues with the other steps. Using reparation this step may be tested.
- **AL #14:cycles on/off 1 to #23:cycles on/off 10:** the count of switching cycles exceeds the alarm threshold.
- **AL #24:operation time 1 to #33:operation time 10:** the elapsed operation time exceeds the alarm threshold.
- **AL #34:maintenance:** (as reminder only) about every 2 years the controller reminds for maintenance
- **AL #36:temperature!:** (warning in advance) alarm notice w/o delay at 3°C below excess temperature switch-off
- **AL #37:I at step:** the calculated current through the capacitor exceeds its limits because of harmonics. This step is switched-off while regulation continues with the other steps. Reparation also cannot switch on that step.

(Alarms #35 and #38 are internal counters of the software and are not visible to the user)

**Alarms with Switch-off** (operation mode enters sub-mode Alarm-switch-off **AL**)

- **AL #39:U<U<sub>min</sub> and #40:U>U<sub>max</sub>:** voltage U<sub>M</sub> is under (min) / above (max) the alarm threshold in [%] of the nominal voltage U<sub>netz</sub>
- **AL #41:|>working range, #42:U<working range und #43:U>working range:** voltage (U) / current (I) is beyond the working range of the measuring platform - no reading for that
- **AL #44:single harmonics Un and AL #45:harmonics THDU:** harmonics reading exceeded the alarm threshold (detuning factor dependent) for longer than the alarm delay (std= 5Min.); note that the alarm switch-off will last at least three times the delay even if harmonics are lower for more than one delay period
- **AL #46:zero-voltage:** that alarm occurs if a short break with fast switch-off lasts more than 5sec. (std.)
- **AL #47:Frequency:** frequency increased by more than 7% (std.) over nominal frequency, or measuring problem
- **AL #48:excess temperature:** the temperature exceeded the limit (std= 48°C) for more than the delay (std= 1h / 0,25h acc. SW version); hysteresis (std= 13°C) for alarm end; permanent **HALT** at excess temperature + 15°C
- **AL #49:supply voltage:** supply voltage U<sub>b</sub> to low for microprocessor and measuring platform
- **AL #50:service!:** a software or system error had been solved by a software reset. Use **1:Info** to get the error number and the hexadecimal error information. If this alarm occurs repeatedly please call the service !
- **AL #51:AL cluster:** permanently **HALT**s the controller due to avoid pendulous alarms. Alarm occurs after 20 not acknowledged alarms, but with 2 grace alarms per day for those people who don't daily care about the controller
- **AL #52:** (for information only) shows the first alarm leading to the last (possibly still lasting) alarm switch-off

## AL Thresholds

Threshold / parameter for AL #	Menu path	range of values	standard setting
#1/2 Over / low compensation ( $\cos\phi$ )	<b>0-8-5-1</b>	i0.70 - c0.80	i0.90 - c0.98
alarm delay: #1+2	<b>0-8-5-2</b>	0.00h - 24.00h	1.00h
#4-13 step power loss (to initial) <sup>5/555</sup>	<b>0-8-5-4-2-1</b>	5% - 30%	20%
#14-23 contactor operating cycles <sup>55</sup>	<b>0-8-4-2-2</b>	0; 10000 - 300000	100000
#24-33 step's operating time <sup>55</sup>	<b>0-8-4-2-3</b>	0h; 10000h - 150000h	80000h
#34 maintenance period <sup>55</sup>	<b>0-8-5-4-6</b>	0h; 8000h - 150000h	16000h (=ca. 2 years)
#36 temperature warning		fixed value	excess temperature -3°C
#37 I at step (I <sub>eff</sub> / I <sub>l</sub> ) <sup>55</sup>	<b>0-8-5-4-2-4</b>	0%; 105% - 200%	130%
#39 alarm U <sub>min</sub> (/ U <sub>nominal</sub> ) <sup>55</sup>	<b>0-8-5-4-4-2</b>	0%; 85% - 95%	88%
#40 alarm U <sub>max</sub> (/ U <sub>nominal</sub> ) <sup>55</sup>	<b>0-8-5-4-4-1</b>	0%; 105% - 115%	112%
#41 alarm I > working range		fixed value	ca. I > 6.0A x ki
alarm delay: #39+41 (I-surge dead time)	<b>0-8-5-1-3</b>	0sec - 20sec	5sec
#42 alarm U < working range		fixed value	ca. U < 50V x ku
#43 alarm U > working range		fixed value	ca. U > 780V x ku
alarm delay: #40+42+43		fixed value	60ms
#44 single harmonics Un <sup>55</sup>	<b>0-8-5-4-3-2</b>	0%; 2% - 20%	3%. 6%*. 8%**
#45 harmonics THDU <sup>55</sup>	<b>0-8-5-4-3-1</b>	0%; 2% - 20%	3%. 7%*. 9%**
alarm delay: #37+44+45	<b>0-8-5-4-3-4</b>	2Min. - 20Min.	5Min., min. 15Min. AL
#46 zero-voltage		fixed value	75% (U / U <sub>nominal</sub> )
#47 frequency f (/ f <sub>nominal</sub> )		fixed value	f > 1.07 x f <sub>nominal</sub>
#48 excess temperature <sup>***</sup>	<b>0-8-5-4-5-1</b>	35°C - 65°C	48°C
alarm delay: #48	<b>0-8-5-4-5-2</b>	0.00h - 4.00h	1.00h / 0.25h (from SW 1605xx73)
#51 AL cluster <sup>55</sup>	<b>0-8-5-4-7</b>	0; 10 - 999 / fixed value	20; from SW1605xx73 fixed

c0,98:= capacitive  $\cos\phi$  of 0,98

i0,98 = inductive  $\cos\phi$  of 0,98

\*: for detuning factor of 2% .. 10%

\*\*: for detuning factor > 10%

\*\*\*: HALT at T > excess temperature +15°C or at quick temperature rise

ku / ki: voltage / current transducer ratio <sup>5</sup>; extrapolated to the nominal voltage / frequency

<sup>55</sup>: 0% switches this alarm

<sup>555</sup>: switch off by **0-8-3-7-2:fault analysis**

alarm with switch-off (usually violating threshold must last longer than the alarm delay)

alarm with single step switch-off (regulation continues with the other steps)

## Technical Data

Measuring System:

single phase, electronic

Measuring Voltage U<sub>m</sub>, working range:

58 - 700 V AC / for modification **-100 V**: 50 - 250 V AC

excess voltage measurable upto:

ca. 780V AC / **-100 V**: ca. 285V AC

fusing:

max. 4 A

Measuring Current I<sub>m</sub>, working range:

0,007 - 5 A AC / for modification **-1 A**: 0,004 - 1 A AC

excess current measurable upto:

ca. 6,0A AC / **-1 A**: ca. 1,2A AC

input power (burden):

0,65 VA @ 5 A (26 mΩ) / **-1 A**: 85 mVA @ 1A (85 mΩ)

frequency f:

50 / 60 Hz (PLL lock-in range 45 - 65 Hz, hold-in range 61 - 69 Hz)

Supply Voltage U<sub>b</sub> (fusing):

230 V AC; 15 VA (max. 4 A)

Alarm Relay (fusing):

230 V AC (max. 4 A)

Fan Relay (fusing):

230 V AC (max. 6 A; max. 4 A at CR2020 variant **CR2020-5T5K**)

Ambient Air Temperature:

-10 .. +60°C

Voltage / Current Harmonics:

2<sup>nd</sup> to 31<sup>th</sup> harmonic component

Case, Size:

panel mounting case IEC 61554, 144 x 144 x 65 mm; opening 138 x 138

Protection Class / Category:

Class-II (double insulated) / front IP42 (IP54 on request), rear IP20

Connector:

24-pin Terminal Block Header / screwed female Terminal Strip

(included in delivery), protected against direct contact



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