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Reactive Power Regulator CONDENSOMATIC CR2020

Operation Instructions
February, 2014
software version 73

The innovative solution convinces by the clear operation, control, and safety concept plus by the easy menu driven operation.

- Keyword-guided, menu-driven, and self-explanatory operation
- Storage of all relevant data, also as min/max- and ¼h-values
- Integrated temperature control with fan regulation and overheating protection
- Large measuring voltage range from 58V up to 700V without transformer
- Optimized Fast Mode for dynamic power factor correction
- Simple commissioning by self-adaption and the possibility of optimized factory pre-programming of a system (SE).

Commissioning could be so easy:
For mounting and connection follow instructions on pages 5 to 9.
- ☐ **In case of factory pre-programmed (SE) setup has already been done.**
- ☐ **In case of autocommissioning at standard conditions you are asked to enter valuable entries at commissioning start (refer to page 14).**

Press the "1" key. (1) Follow the display indications. Check shown values for plausibility. Wait until time-controlled commissioning is finished. – Ready!

key combination with plus sign: Press both keys approx. 1s simultaneously.

esc + set: (emergency) shutdown ▲ **+** ▼**: restart after shutdown**

(1) + (7): re-boot system (reset)

(0) :Action: Press key 0 for executing the described action.

(0) ▶ (6): key sequence with ▶: Press key 0 and afterwards key 6.

AUTO: Green shaded texts appear just so in the regulator display.

Operation Instructions – Table of Contents

Display and Operation Elements

4-lines LCD display and overall 15 numerical buttons or function keys

0 – 9 Keys for menu navigation // numerical entry

▲, ▼ Keys scroll between menu windows // show important set values and readings when called up from the **standardwindow**

esc Key allows returning into the next higher menu level // aborts the commissioning or an input

set Key starts or confirms data input // opens the **info** menu when called up from the **standardwindow**

◑ Key for **contrast adjustment** of the LCD-display

Rapid Commissioning – follow advices in the display

1. **For mounting and connection follow instructions on pages 5 to 9.**
2. **Commisioning: 1:autostart**: **Press the "1" key** 1. In case of

- **factory pre-programmed (SE)** proceed with item 3.
- **autocommissioning at standard conditions**: You will be asked to enter some parameters that the regulator cannot determine itself (not required at rerun **commissioning**, the regulator remembers your last entry): Enter **1:transducer** 1, **3:detuning factor** 3, and as desired **2:password** 2. Back to **commissioning** using set.

➢ If standard parameters do not match system requirements, use first **set:change standard** set. By **1:config. data** 1 frequently used and by **2:setup** 2 all parameters can be changed (refer to pages 28 - 30). For **help** or **tests** use **3:info + tests** 3. Go back to **autostart** by pressing esc several times. **1:autostart** 1 starts **autocommissioning**.

3. **Wait until finishing time-controlled commissioning. Check shown values for plausibility. – Ready.**
4. On troubles repeat **autocommissioning** or use **2:experts menu** 2 for entering **net-configuration** and **step power** (refer to pages 17 - 18).

Warning: After completion of the **autocommissioning** the regulator changes into the **Automatic Control Mode** (**AUTO**).

1. What does the CR2020 distinguish?

Commissioning:

- **net-configuration**: **automatic detection** of the **phase-to-pin connection** for **measuring voltage** and **measuring current**
- Both capacitive and inductive **step powers** are **automatically sized**. Only inductive steps have to be labelled before **autostart**.
- **Autocommissioning** is possible, even if none load is in use.
- **factory pre-programmed (SE)**: straightforward **commissioning**. **Step powers** and **detuning factor**(s) have been pre-programmed by the manufacturer; **net-configuration**, **mains voltage**, and **current transducer ratio** are determined. Pre-programmed step power values are checked. None additional input is necessary.
- **experts menu**: System data such as **net-configuration** and **step powers** (also inductive ones) can be entered as values.
- Reporting problems regarding the **current transducer** and facing the raw readings **U_m**, **I_m**, and **f** at the **contact bank** for control.

Innovative operation-, control- and safety-concepts:

- **Optimized load-dependent control modes** and the **target range cosφ extend the longevity of the system and reduce the number of switching cycles as well as the net repercussions**.
- Pressing ▲, ▼ in the **standardwindow 1** or **2** provides **quick information** about all important **parameters** and **readings**.
- **alarm notice**: service information or shut-down of single steps
- **alarm switchoff**: for special net- or system-disturbances
- **fault analysis**: switchoff of steps for critical power loss (**default setting** ≥ 20%). An incorrect **fault analysis** is avoided for unsuccessfully determinable **step power** under disturbed net-conditions.
- **password**: security against unauthorized access
- All changes done on parameters with respect to their **standard values** are tabulated within the **maintenance menu**.
- The **fast algorithm for dynamic compensation** reacts on reactive power changes in network **within 13ms** (control signal to thyristor).

Forward-looking operation control and information concept:

Starting from **0:main menu** ⓪ all parameters and readings are quickly available or adjustable using the **keyword-guided menu structure** and the **comfortable keyboard – comparable to the usage of mobiles**.

- To all relevant **net-** and **system-readings** there also exist **quarterly averaged** as well as **min/max readings**.
- **long term means** show actual **¼ h**, **1 h**, **4 h**, **daily**, **weekly**, **monthly**, and **yearly means** for **cosφ**, **reactive power** (**Q**), and the **missing reactive power** ($\mathbf{Q_{miss}}$ calculated to **target cosφ**).
- display actual and maximum harmonic content of the **2^{nd} - 31^{th} harmonics** for **voltage U** in [**%**] and **current I** in [**A**].
- calculated **effective current per step** (**I at step**) and do a **security shutdown of discrete steps** at unallowable harmonic **overcurrents**
- **maintenance** / **reparation menu**s simplify purposeful servicing
- **Regulator settings** can be **stored** or **recalled** as well as **reset to default values** (system data are preserved) or **factory defaults**.
- programmable **basic load** e.g. for **fix compensation** of a **transformer**
- **operation contactors**: Either several steps operate **all together** at a single blow for fast net-unloading or **subsequently** in a **cascade** for soft-switching repercussions (default setting).
- huge range for **measuring voltage 58 - 700V AC** without transducer
- fan switch-off on fast temperature rise or exceeding 15°C beyond **excess temperature**

2. Mounting and Connection

Safety Instructions

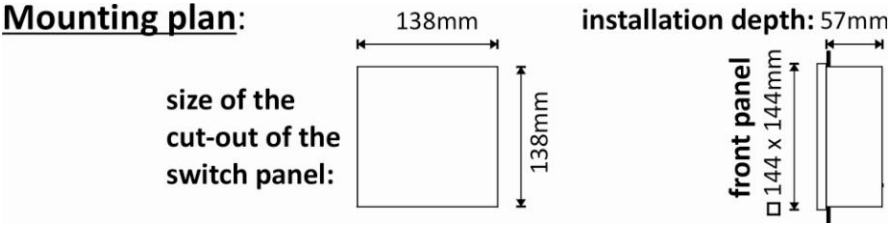
Skilled technical staff is only permitted to mount, connect and commission the reactive power regulator considering all relevant regulations. In case of visible or assumable damages the regulator must not be operated. Only the manufacturer is allowed to repair.

The regulator is energized and must not be opened. Please note that the clamps can be energized although the regulator is off.

Mounting

- Mount a **class 1 transducer**, preferentially … / 5A. For its efficiency analysis (VA), cable length, its cross section, and other in series connected measuring instruments have to be considered.
- **Warning**: The **current transducer** has to be mounted in the supply line of that part, which should be compensated, and **in front of all loads and the connection point of the compensation system**!
- The **temperature sensor** sticks approx. 1mm out of the rear side of the regulator. It must not be depressed or covered.
- Switchgear enclosure case to **DIN 43700**. Fixation in the switchboard cut-out sideways with fixture clips and screws, optionally connection on DIN hat rail (modification **-H**)
- Electrical connection from the bottom by a **24-pin cable connector**
- **Please note**: **After connection of the regulator open the transducer bypass and connect the supply voltage.**

Mounting plan:



Technical Data:

(refer to page 9 for a **Wiring Diagram** within a compensation system)

Kind of measurement:	single phased, electronically
Terminals U_m (measure):	58V - 700V AC
U_m for modification **-100V**:	50 - 250V AC; **Note**: For $U_m \leq$ 100V the modification **-100V** reaches a smaller Q_{min} concerning the **C/k formula** (see page 8).
fuse protection U_m:	max. 4A
Terminals I_m (measure):	0.007A - 5A (0.007A - 1A for modific. **-1A**)
power input (burden):	0.65VA at 5A (26mΩ); 85mVA at 1A (85mΩ)
Frequency **f**:	50 / 60 Hz (45 - 65Hz)
Supply voltage U_b:	230V AC, 15VA
fuse protection U_b:	max. 4A
Alarm relay; fuse protection:	230V AC, max. 4A
Fan relay; fuse protection:	230V AC, max. 6A; max. 4A for modific. **-5T5K**
Ambient temperature:	from -10°C up to +60°C
Voltage harmonics:	2^{nd} - 31^{th}

Current harmonics:	2^{nd} - 31^{th}
Housing, dimensions:	protective insulation, 144x144x65mm
Ingress protection class:	front side IP42 (IP54), rear side IP20
Terminal (24-pin):	screw-in connector, protection against direct contact

Variants: **n**: number of steps (n = 5 or 10)
-K: for contactor switching **-T**: for thyristor switching

-nK:	relay output:	230V (+/- 10%) AC, max. 4A
-nT:	transistor output:	DC 20V at 0mA …5.5V at 150mA
	max. 150mA per output,	max. 300mA in total

The regulators **CONDENSOMATIC CR2020-10T** or **-5T-5K** facilitate the thyristor switches by an internal control voltage. Using **CONDENSOTRONIC CT2000** (thyristor switches from **SYSTEM ELECTRIC**), the regulator's internal mains transformer can only supply a limited number of those thyristor switches:

CR2020	CT2000 per step	CT2000 in total
-5T-5K	**up to 8**	**up to 20**
-10T	**up to 8**	**up to 26**

If more current should be needed, the regulator variants **CR2020-10T-E** or **CR2020-5T5K-E** have to be connected to an external power supply at the terminals **X+** and **X-** (see the **wiring diagram** on page 9).

For dynamic compensation in **Fast-Mode**, a control signal is created in **13ms** after a **fast load change of more than least capacitor power**. Using the **CONDENSOTRONIC CT2000** thyristor that fact facilitates the compensation capacitor to be effective within 20 – 25msec when prior unloaded. The **Fast-Mode** can also be switched off. Control signals can already change after only 40msec tracking the network compensation needs.

Smaller or slower load changes are compensated by another algorithm, which can be slowed down correspondingly to an adjustable **response time** in the range **40 - 10000msec**. It defaults to **0ms =off** (minimal response time, estimated to be 35msec).

Modifications:

-E: thyristor switch control for use with an external power supply
max. output current: 150mA per output and 1.5A in total
nominal supply voltage: 12V … 20V DC
internal protection resistor: 47Ω (transistor switched)

-S: Interface:RS485, only instead of the alarm relay (see page 33), available for contactor or thyristor driven systems

-H: housing with DIN rail adapter

-100V: For a voltage transformer …/100V the regulator improves its resolution of the smallest step power $\mathbf{Q_{min}}$ by a factor of 2.7; $\mathbf{U_m}$: 50 - 250V AC

-1A: For a current transformer …/1A the regulator improves its resolution of the smallest step power $\mathbf{Q_{min}}$ by a factor of 5; $\mathbf{I_m}$: up to 1,3A

-Ai: The alarm relay is now working as an opened potential-free contact.

-Fm /-Fh: Frequency from measuring voltage U_m 190 - 520 V / 420 - 700 V

Resolution of the System by C/k or Q_{min}

C/k = $\mathbf{Q_C}$ [var] / (**ki** x **ku**) $\geq \alpha$ x $\mathbf{U_{transducer,\ primary}}$ [V] / **mains voltage** $\mathbf{U_{mains}}$ [V]

$\mathbf{Q_{min}}$ [var] = α x **ki** x **ku** x $\mathbf{U_{transducer,\ primary}}$ [V] / **mains voltage** $\mathbf{U_{mains}}$ [V]

- $\mathbf{Q_C}$ = smallest used step power
- $\mathbf{Q_{min}}$: minimal usable step power
- **ki** resp. **ku**: transducer ratio for current (**i**) and for voltage (**u**)

  Note: If none voltage transducer is used, there is:
  ku = 1 and $\mathbf{U_{transducer,\ primary}}$ / **Mains voltage** $\mathbf{U_{mains}}$ = 1.

α [var]		**-100V**	**-1A**	**-100V-1A**
L-N	11.58	4.24	2.32	0.85
L-L	6.69	2.50	1.34	0.49
single phase system	3.86	1.41	0.77	0.28

L: phase; **N**: neutral conductor

Example 1: $\mathbf{Q_c}$ = 25kvar; **ki** = 2500A/5A = 500; **ku** = 1; $\mathbf{U_{mains}}$ = 400V
connection of measuring voltage $\mathbf{U_m}$: **L-N** ($\mathbf{U_m}$ = 231V)

C/k = 25000var / (500 x 1) = 50 $\geq$ 11.58var ✓

$\mathbf{Q_{min}}$ = 11.58var x 500 x 1 = 5.79kvar

Example 2: $\mathbf{Q_c}$ = 100kvar; **ki** = 100A/1A = 100; **ku** = 11kV/100V = 110; $\mathbf{U_{mains}}$ = 10kV
$\mathbf{U_{transducer,\ primary}}$ = 11kV; connection of measuring voltage $\mathbf{U_m}$: **L-L**

C/k = = 100000var / (100 x 110) = 9.1var $\geq$ 6.69var x 11kV / 10kV = 7.36var ✓

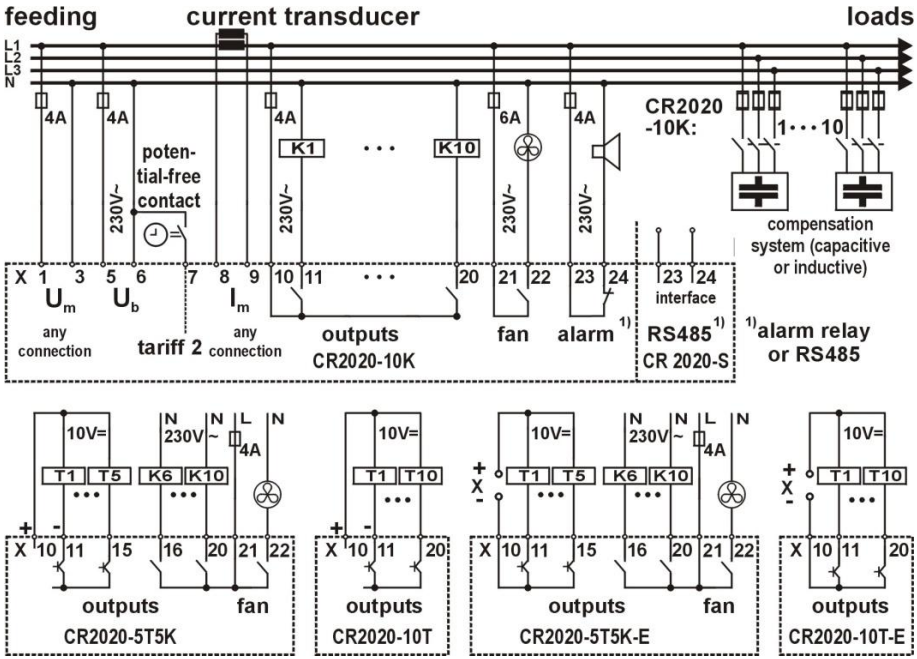
for **-100V**: $\geq$ 2.7var ✓ for **-100V-1A**: $\geq$ 0.539var ✓

$\mathbf{Q_{min}}$ = 6.69var x 100 x 110 x 11kV / 10kV = 81kvar

for **-100V**: $\mathbf{Q_{min}}$ = 30.25kvar; for **-100V-1A**: $\mathbf{Q_{min}}$ = 5.93kvar

Attention: The table items are shown for calm networks only. Expect to have threefold higher $\mathbf{Q_{min}}$ thresholds for networks with fast switching loads or for thyristor driven steps.

Wiring Diagram: (drawing also on the regulator's rear side)



[1] **CONDENSOMATIC CR2020-… -S:** The **RS485 interface** takes in turn with the **alarm relay** the terminals **X23** / **X24** for connection.

fan control at terminals **X21** / **X22**; fuse protection max. 6A, only for **CR2020-5T5K** max. 4A (protection together with the output relays)

tariff T2 – toggle via potential-free contact at terminals **X6** / **X7**

Regulator Variants:

CONDENSOMATIC CR2020-10K: 10 outputs for contactor-switching (**K**); joint terminal: **X10**; switching outputs: terminals from **X11** to **X20**

CONDENSOMATIC CR2020-5T5K or **-10T**: for dynamic compensation; outputs for thyristor switching (**T**) at terminals **X11** to **X15** respectively **X20**; common +10V= at **X10**; for **CR2020-5T5K** switching outputs (**K**) at terminals **X16** to **X20** and joint terminal **X21** for outputs (**K**) and **fan**

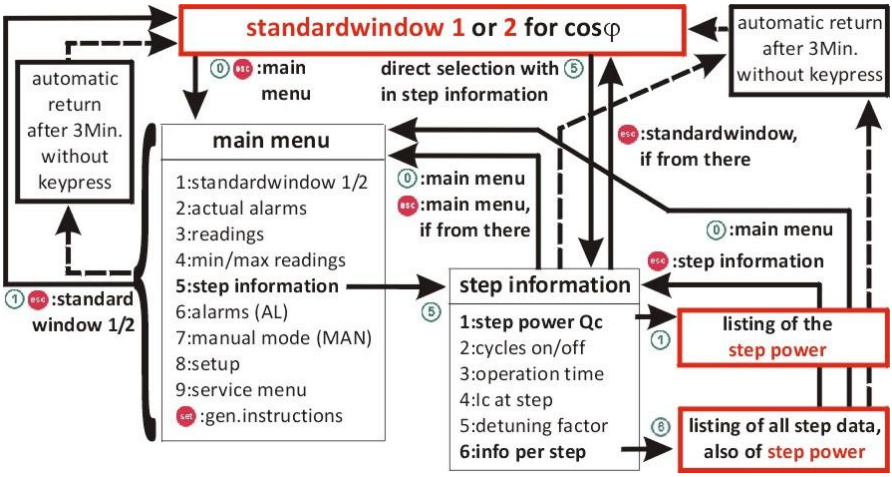
CONDENSOMATIC CR2020-5T5K-E or **-10T-E**: The outputs for thyristor switching (**T**) are energized by an external power supply at **X-** and **X+**.

3. Menu Navigation – comparable to usage of mobiles

The reactive power regulator has **keyword-guided menu navigation**. Thus it is capable to be operated without the operation instructions.

Use **0:main menu** ⓪ to change from any window into the **main menu** that forms the **top layer of the menu branching structure**.

From the **main menu** you can access any information or setup any parameter via a **submenu tree structure**. Intuitively follow the appropriate topic. The **keyword-guided path** can span several **submenu levels**.



*Example showing the paths beginning at the **standardwindow 1** / **2** due to read the stored **step powers** by entering the appropriate key input. Arrows indicate possible transits from one window to another as initiated by key entry or by timeout. The taken action is denoted besides the arrows and described in the menus (also refer to page 19).*

The **windows of a particular submenu** are arranged in a ring. The first line of the actual window contains the path to it or its headline. Use the arrow keys to scroll among the windows. Slowly alternating text blocks within a single window form correspondingly joined texts lines.

During **automatic mode** (**AUTO**) the selected **standardwindow** shows the actual switching and control statuses, too. After **3 minutes without key stroke**, the menu automatically changes to the current **standard-window** (for info on **standardwindow 1** or **2** refer to pages 19 - 20).

Beyond commissioning, for **operating mode**s other than **automatic mode** (**AUTO**): **After 3min. without keystroke** the menu automatically changes to a window that shows how to re-enter the **automatic mode** or how to leave that menu.

Action structure with ":": **(or what happens after key press)**

An **action** describes that, what will happen for a special key press. One keystroke is normally enough for one **action**. **Actions** are explained at the bottom of a submenu or resp. in an input or output window. However, **actions** may typically be executed in any window of a submenu as well.

Each **action** relies on the common **action structure** with "**:**".

Keystroke:Action, e.g.: **0:main menu**; action: return to **main menu**.

Explanation structure with "=": **(as legend or introducing a reading)**

Explanations of symbols or abbreviations in the display are given right down at the bottom of a submenu or respectively direct in an input or output window itself.

Each **explanation** relies on the common **explanation structure** with "**=**".

Sign(s)=Explanation, e.g.: **MAN=manual mode**; abbreviation **MAN** represents the **operating mode manual mode**.

Some submenus may be achieved by several menu paths:
e.g. **AL thresholds** from the **main menu** via 2 paths:
⓪ ▶ **6:alarms (AL)** ⑥ or ⓪ ▶ **8:setup** ⑧ ▶ **5:for alarms** ⑤.

general instructions (help menu as a part of the software)

- ▶ **1:menu navigation** ①**:** explains keyword-guided menu structure.
- ▶ **2:connection pins** ②**:** informs about the **wiring diagram** at rear side of the regulator.
- ▶ **3:technical info** ③**:** Shows hardware type (**HW**), serial number (**serialNo.**), software version (**SW**), and the performance characteristics of the particular regulator.
- ▶ **4:contact data** ④**:** to **SYSTEM ELECTRIC Power Quality GmbH**

international physical abbreviations with [physical units]**:**

U [V] = voltage; **I** [A] = current; **f** [Hz] = frequency

S [kVA] = apparent power; **P** [kW] = active power

Q [kvar] = reactive power

THDU [%] = percentage of harmonics power in relation to the fundamental (THD: Total Harmonic Distortion)

combined designators:

Urms, **Irms** = rms-values **U** resp. **I**; **Umains** = mains voltage

Im = measuring current, **Um** = measuring voltage (**both without transducer**)

U1, **I1**, **P**, **Q** = fundamentals share of **U** [**%**], **I** [A], **P**, **Q**

U2 - **U31**; **I2** - **I31** = 2^{nd} - 31^{th} harmonics share **U** [**%**], and **I** [A]

Qon = step power switched on – capacitive (+), inductive (-)

Qmiss = reactive power missing to **target cosφ**

Add-on: **.B** = **b**asic load-corrected magnitude; then also:
.T = reading measured at the current **t**ransducer

Alarm designators are listed separately on pages 24 – 26.

4. Test Outputs (functional check of the system configuration)

- Functional check of the **system control** without system load
  Attention: **Remove the power fuses prior to test!**
- **1st part:** readings for control: U_m, I_m, and **f at** the contact bank.
- **2nd part:** The **steps** will be switched on and off one after another **without regard to the idle period**. Cycle number (default: 5 cycles) and cycle period (default: 2s on, 2s. off) are configurable.
- **3rd part: temperature** and **alarm test:** Blow with hot air against the temperature sensor until the condition for switching on the fan will be reached. Then **F*** is shown and the fan output is switched on. Reaching the system excess temperature, the display shows **A!** and the **alarm relay** is switched on. Then an **alarm** (**AL**) may occur, too.

Start test outputs while in commissioning:

▶ **0:commissioning menu** ⓪ ▶ **7:test outputs** ⑦

Start test outputs while in the automatic mode (AUTO):

▶ **9:service menu** ⑨ ▶ **5:test outputs** ⑤

5. Autostart and Commissioning Menu

Hint: During gauging the net-configuration and sizing the steps powers you display the raw readings **U_m**, **I_m**, and **f at** the **contact bank** by typing the arrow down key ▼. Leave window with ▲ or with ▼ pressing twice. While this feature is used the progress of commissioning holds.
Hint: At the end of commissioning **valuable entries** are shown again toggling with the final entries. It is still possible that the items can be changed.

1:autostart:

During autocommissioning watch the display.

For factory pre-programmed (SE), Press the „1“ key. (1):
Steps powers, **detuning factors**, and possibly **transducers** were pre-programmed. **Net-configuration** and **transducer** will be gauged and pre-programmed data will be checked. More options:

- **4:menu pre-progrSE** (4)**:** Use this menu item to verify or to change the setup; for more information see chapter 6 on page 16.
- **0:commissioning menu** (0)**:** See on page 15.

For autocommissioning at standard conditions:

a) For a non-standard system: (for example in case of inductive steps) change parameters before starting **autocommissioning**:

- **set:change standard** (set)
  - **1:config. data** (1): fast access to the major parameters concerning **commissioning**; For submenus see on pages 17 and 18.
  - **2:setup** (2): keyword-guided access to all parameters; For submenus see on pages 28 - 31.
  - **3:info + tests** (3): For submenus see on page 18.
- **0:commissioning menu** (0): See on page 15.

b) autocommissioning. Press the „1“ key. (1):
First, the menu **valuable entries** are shown.
Hint: It is strongly recommended to enter **transducer** and **detuning factor** even though these values aren't necessary for the correct compensation.

Gauging the **net-configuration** and sizing the **step powers** follow.

valuable entries:

- **1:transducer** ①: In order to get readings of the right calibration, enter transducer data for **current I**, e.g. 200 / 5A, and, if required, for **voltage U**. Please, check also the automatically distinguished **mains voltage Umains**.
- **2:password** ②: Due to secure sensible settings from manipulation, service staff may use **password** protection.
- **3:detuning factor** ③: Required for calculating **current I at step**; afterwards harmonic thresholds are show.

Special functions after autocommissioning failed:

⓪ ▶**2:experts menu** ②: for performing **net-configuration** or **steps** by **gauging/sizing** or by data input; see chapter 7 on pages 17 – 18.

Automatic Mode (AUTO):

After successful **commissioning**, the regulator compensates reactive power in **automatic mode** (**AUTO**) according to **target cosφ** and **target cosφ range**. In the **standardwindow** (see on pages 19 and 20) **cosφ** and information on the mains and on actual switching mode is shown. Use the **arrow keys** for an abstract of the major set and measuring values.

What to do after autocommissioning failed?

a) **Retry autocommissioning**. If it is possible, shut down fast fluctuating loads during gauging **net-configuration** or sizing **step power**.

b) **Enter net-configuration** and **step power** as values using **2:experts menu** ②; see more in chapter 7 on pages 17 and 18.

Attention: Changing from **2:experts menu** into **automatic mode** (**AUTO**) via **6:automatic mode** ⑥ is not possible until commissioning is finished.

Hint: If failed, try transition/return to **AUTO** a second time.

What to consider for commissioning?

- **Inductive steps** have to be entered using the submenu **config. data before commissioning** of the **net-configuration** or the **step power**.
- For **existing installations** (**regulator replacement**) use the **2:experts menu** for **commissioning**. Especially enter the **nominal steps powers**

by ▶ **5:enter step power** ⑤, due to let the **fault analysis** calculate the **step power loss** with respect to the **nominal step power**.

- Gauged/sized values should be checked for **plausibility** because inappropriate net conditions may cause faulty gauging/sizing.
  1. Are the values shown for **cosφ**, **current** and **voltage** plausible?
  2. Are the **step powers** comparable with the system's data? Small differences result from measuring errors or component tolerances.

0:Commissioning Menu:

▶ **1:autocommissioning** ①: time-controlled (see on pages 13 - 15). **Net-configuration** and **step power** are measured during **autocommissioning** by switching the steps a number of times. Only for a **factory pre-programmed SE**-regulator the **current transducer ratio** is also measured automatically during **autocommissioning**.

▶ **2:experts menu** ②: All functions of the **commissioning** can separately be started (see chapter 7 on pages 17 and 18); additionally the **net-configuration** and the **steps powers** can be entered by value.

▶ **3:readings Um/Im/f** ③: readings of **measuring current** / **measuring voltage** at the regulator's connector bank without **transducer** scaling.
Hint: If Im < 40mA, check whether the **transducer bypass** is open.

▶ **4:menu preprogr.SE** ④: for **factory pre-programming** of the regulator (see chapter 6 on page 16).

▶ **5:config. data** ⑤: frequently used parameters; See on pages 17 - 18.
Hint: Use **8:ind ⋐ <->cap ╪ steps** ⑧ to toggle between steps with **capacitive / inductive reactive power**; ╪ = capacitive, ⋐ = inductive.

▶ **6:set-up** ⑥: For the submenus of this item see on pages 28 -31.

▶ **7:test outputs** ⑦: **Pay attention**: Find advices in chapter 4 on page 12.

▶ **8:alarm signal test** ⑧: **alarm relay on** / **off**.

▶ **9:fan test** ⑨: **fan relay on** / **off**.
Hint: Use key "9" to switch off an annoying fan for 10 minutes. From almost every menu the key sequence "0 ▶ 9 ▶ 9" does that.

▶ **set:general instructions** set: For the submenus of this item see **general instructions** on page 11.

6. Menu Preprogramming SE

A **factory pre-programmed (SE)** regulator simplifies commissioning, saves time at installation site and prevents from failures. At installation site simply press "1" and monitor the regulator acting – **Quite so easy!**

Steps of pre-programming (SE):

On data entry observe the menu hints (:) and explanations (=) in display.

1. Attach **supply voltage U_b** at terminals X5 and X6 to the **230V mains**.
2. Select **0:commissioning menu** ⓪ ▶ **4:menu pre-progr.SE** ④ and confirm with set, if requested.
3. Enter the system configuration. (Mode changes from **autocommissioning at standard conditions** to **factory pre-programmed (SE)** at the next reset, if at least one step power had been entered.)
4. Leave the menu **preprogr.SE** by several esc until reset ("**please wait: initialization**"), not till then remove the 230V supply voltage.
5. Further power on events start the regulator software with **1:autocommissioning factory pre-programmed (SE) Press the „1“ key.**

List of submenus of 4:menu preprogr.SE:

- ▶ **1:ind ⋐ <->cap ⫪ steps** ①: free choice of inductive step powers
- ▶ **2:enter steps (SE)** ②: enter step powers. (Required by mode change)
- ▶ **3:detuning factor** ③: See on page 18.
- ▶ **4:target cosφ** ④, ▶ **5:target range cosφ** ⑤, ▶ **6:alarm range cosφ** ⑥: cosφ settings for **▲:T1** (tariff 1) resp. **▼:T2** (tariff 2)
- ▶ **7:transducer** ⑦: enter transducers of current (**I**) and voltage (**U**)
- ▶ **8:setup** ⑧: For the submenus see on pages 28 - 31.
- ▶ **9:catenation** ⑨: preselect measuring voltage: **L**:phase; **N**:neutral**:**

  1:1-phase AC ①: **(Plain AC)** cannot be measured, but must be entered for a single-phase application before **commissioning**.

  2:3-phase L-L ②: **(phase-phase)**, **3:3-phase L-N** ③: **(phase-neutral)**

  4:3-phase catenation automatically set by gauging net-config. ④.
- ▶ **set:factory defaults** set: store all changes as new **factory defaults**

7. Resolving Problems during commissioning – 2:experts menu

By the **experts menu** you are able to successively perform the particular **commissioning** steps by gauging / sizing or by data input.

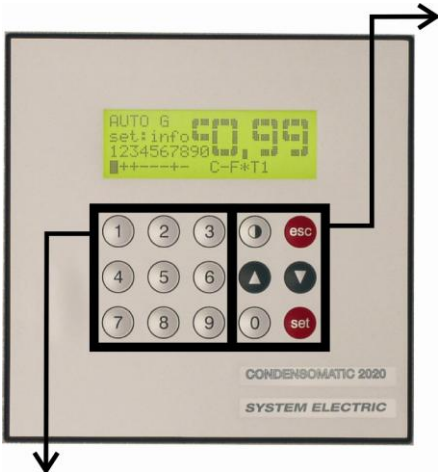
Attention: **Please observe the instructions shown in the display. The experts menu cancels the factory pre-programmed mode (SE).**

- ▶ **1:valuable entries** ①: ▶ **1:transducer** ①; ▶ **2:password** ②; ▶ **3:detuning factor** ③; see explanations on page 13.
- ▶ **2:gauge net-config.** ②: gauging phase angles of **measuring voltage** U_m, e.g. **L1-N**, and of **measuring current** I_m, e.g. **L1, k-l**, like in auto-commissioning; also rates **mains voltage** and **mains frequency**
  Please check: Are the **cosφ** value and the **mains voltage** plausible?
- ▶ **3:enter net-config.** ③: enter **net-configuration** by value, such as described above for **2:gauge net-config.**; Checks are the same.
- ▶ **4:size step power** ④: sizing the **steps powers** like in autocommissioning. The step power is extrapolated to **mains voltage** due to eliminate effects from fluctuating actual voltages. If the **transducer data** have not been entered, result values are shown without scaling.
  Please, check the sized **steps powers**. Then enter/check the **detuning factor**(s). Control the thresholds of **THDU / single harmonics alarms**, but do not change them unless an expert has cleared the net facts.
- ▶ **5:enter step power** ⑤: enter the steps powers by value, start with ▶ **1:start input** ①. **Note**: **transducer data**, **net-configuration**, and (mostly automatically assigned) **mains voltage Umains** are required. **Important**: Also enter the **detuning factor**(s). Checks: see item 4.
  Hint: Use ▶ **2:ind ⋐ <->cap ⫪ steps** ② to toggle between steps with **capacitive / inductive power**; ⫪ = **capacitor** step; ⋐ = **reactor** step.
- ▶ **6:automatic mode** ⑥: transition / return to the **automatic mode** (**AUTO**). **Preconditions**: sized / entered **net-configuration**, **mains voltage** and **step power**. It is recommended to enter **transducer data** and **detuning factor**(s) before **commissioning** is left.
  Hint: If transition to **AUTO** failed, try once more.

- **7:config. data** (7): repertoire of frequently-used system parameters
  - **1:target cosφ** (1), ▶ **2:target range cosφ** (2), ▶ **3:alarm range cosφ** (3): for **▲:T1** (tariff 1) resp. **▼:T2** (tariff 2)
  - **4:transducer** (4): transducer data for **current** (**I**) and **voltage** (**U**)
  - **5:password** (5): enter / change password
  - **6:detuning factor** (6): **equal setting** or separate values per step; for **multi-detuning** select **absorption circuit** / **combi-detuning**
  - **7:basic load** (7): inductive or capacitive fixed compensation (B!)
  - **8:ind ⋐ <->cap ⫪ steps** (8): toggle between capacitive and inductive steps; ⫪ = **capacitor** step; ⋐ = **reactor** step
  - **9:special conditions** (9): For explanation see on pages 29 and 30.
    - **1:operation contact.** (1)
    - **2:fault analysis** (2)
    - **3:detailed info** (3)
    - **4:fan control** (4)
    - **5:multi-detuning** (5)
    - **6:maintenance rate** (6)
    - **7:Fast Mode** (7)
    - **8:opti-var** (8)
- **8:setup** (8): For explanation see on page 28 - 31.
  - **1:for metering** (1)
  - **2:for control** (2)
  - **3:system setup** (3)
  - **4:for temperature** (4)
  - **5:for alarms** (5)
  - **6:back-up/reset** (6)
  - **7:spec.setup (SE)** (7)
  - (▶ **8:interface IF** (8))
- **9:info + tests** (9):
  - **1:gen.instructions** (1): regulator / software; see on page 11.
  - **2:readings Um/Im/f** (2): measured directly at the connector bank.
  - **3:connection info** (3): all about **net-configuration**
  - **4:test outputs** (4): special test; see chapter 3 on page 12.
  - **5:alarm signal test** (5) and ▶ **6:fan test** (6): **relay on** / **off**
  - **7:LCD contrast** (7): for adjusting the LCD display contrast
  - **9:fan off for 10Min.** (9): switch off an annoying fan for 10 minutes.
- **set:factory defaults** (set): store changes as new **factory defaults**

8. Automatic Mode (AUTO): standardwindow 1 / 2

standardwindow 1:



keypress functions such as in the main menu:

1:standardwindow 1 (1)
2:actual alarms (2)
3:readings (3)
4:min/max readings (4)
5:step information (5)
6:alarms (AL) (6)
7:manual mode (MAN) (7)
8:setup (8)
9:service menu (9)

Action for each key press:

(◑): **contrast** for LCD-display
esc: **main menu**
0: **main menu**
▲ ▼: **U,I,f,Q,P,harm.**: **actual readings**: **Urms** , **Irms** , **f**, **S**; **Qmiss**, **Q**, **P**, **Qon**; **THDU**, U_3 [%], I_3 [A]; overview of harmonics: U_5, I_5; U_7, I_7; U_{11}, I_{11}; U_{13}, I_{13}; (**U** [%] and **I** [A]); **target cosφ**, **target range cosφ**, and **alarm range cosφ** are shown in separated pages for **tariff T1** and **tariff T2**.
set: **info**
▶ 1: **gen.instructions**
▶ 2: **change standard**: **1 / 2**
▶ set: **legend**

Key combinations; press both keys at the same time for approx. 1s:

set + esc: **emergency shutdown**
▲ + ▼: **restart after shutdown**
1 + 7: **re-boot system**

Legend of the Display: (with: set ▶ set)

c0,99 = capacitive **cosφ** at 0,99 **i0,99** = inductive **cosφ** at 0,99
G = **generator mode**
tendency for turn on/off: **C+**/**C-** = switch on / off capacitors resp. switch off / on reactors **(no tendency is shown for dynamic compensation)**

B! = **b**asic load (fixed compensation step) is active (signs flash)
T1 / **T2** = the valid **tariff** is shown **F*** = **fan relay** is switched on
A! = **alarm relay** is switched on (signs flash)

Switching status of the outputs:

The figures from 1 to 0 represent the outputs from 1 to 10. If a sign is absent under it, the output is unused. Otherwise the sign means:

- = step power off **+** = step power on
_ = step not wired **R** = step blocked due to **R**esonance
d = step **d**efective **t** = step blocked for **t**est switching
▉ = step blocked due to capacitor idling (reverse switching protection)

Standardwindow 2:

Use **set:info** (set) ▶ **1:standardwindow 1/2** (1) to toggle between **standardwindow 1** and **2**.

Additional info to standardwindow 1:

Qmiss shows the difference between actual reactive power in network and its taget value. When in **brackets ()** the reactive power is well compensated, i.e. the actualcosφ resides in the (extended) target range cosφ. Thus no regulation action is required. (see page 34)

Switching status of the outputs: (in addition to standardwindow 1)

╪ / ≋ = step power on (capacitive / inductive loaded step)
╵ = step power off

Operating mode:

AUTO = **automatic mode**; control value is **target cosφ**, but no control will happen, if **cosφ** is inside of the **target range cosφ**.
AL = **alarm shutoff**; an **AL switchoff** is active.
MAN = **manual mode**; all **output relays** including the **alarm relay** and **fan relay** can be switched by hand (**MAN**).
HALT = **out of order**; all steps are permanently switched off.
(esc) + (set) = (0) ▶ (9) ▶ **1:shutdown controller** (1) ▶ (1): **emergency shutdown**; outputs switched off. You see **HALT**.
(▲) + (▼) = (0) ▶ (9) ▶ **1:system on** (1) ▶ **2:on** (2): **restart** of the system into the previous **operating mode**

9. 0:main menu – keyword-guided, self-explaining

The main menu forms the highest level of the keyword-guided menu, and self-explanatory menu structure

Common Key Entries:

0:main menu (0): **returns to the main menu** // for numerical entry
esc: **jumps one submenu level up** // aborts an input
set:info set ▶ **1: gen.instructions** (1): **for handling** (see on page 11)
1:info (1): additional info to that window (e.g. alarmthresholds)

- ▶ **1:standardwindow 1 / 1:standardwindow 2**: **show the actual cosφ** and other information on regulator's state such as: state of steps, **fan**, **alarm relay**, operational mode, **basic load**, **tariff**, and regulation tendency (10K only). **Standardwindow 1: cosφ in enlarged size. Standardwindow 2: Qmiss** shows the uncompensated reactive power with respect to the **target cosφ**. When in **brackets "()"** the actual **cosφ** resides within the (extended) **target range cosφ**. No regulation action is required (see page 34).

- ▶ **2:new alarms**: re-activates the pop-up windows of all alarms that have not been noticed/acknowledged yet. All alarm windows inform about the number of alarms and offer **1:Info** for further information.

- ▶ **3:readings**: **(actual and 0.25h based values)**

  At first, the regulator enquires the **transducer data** in case of missing.
  For **basic load** the texts in brackets are valid for **cosφ**, **Q**, **lambda**:
  B = converted to **b**asic load and **T** = measured at the **t**ransducer-I
  bold type: **part of the name**; e.g. **cosφ.T**: **cosφ** as measured at **T**.
  italic writing: **only a hint**; e.g. **Qmiss**(*B*) is (always) calculated at **B**.

  - ▶ **1:cosφ,lambda** (1): **cosφ**.(**cosφ.B**; **cosφ.T**), **lambda**(*T*)
  - ▶ **2:power Q,P,S** (2): **Q** (**Q.B**; **Q.T**); **Qmiss**(*B*), **Qon**; **P**; **S**
  - ▶ **3:basics U,I,f** (3): **Urms**, **Irms**, **f**
  - ▶ **4:U harmonics** (4), ▶ **5:I harmonics** (5): actual values of the **2nd - 31th harmonics** for **voltage U** and **THDU** in [%], and for **current harmonics** in [A], presented both in figures and graphically

- ▶ **6:I at step** ⑥: calculated real **current Irms** per step in [A]
- ▶ **7:temperature** ⑦: **actual temperature** and **daily mean**
- ▶ **8:survey** ⑧: all important set and measuring values
- ▶ **9:long term means** ⑨: **cosφ** (**cosφ.B**), **Q** (**Q.B**), **Qmiss**(*B*) (see p.34)

▶ **4:min/max readings**: **(peak and 0.25h based values)**

- ▶ ① to ▶ ⑦ like submenus 1 to 7 in **3:readings**; within each submenu **7:clear readings:** clear only that min/max readings.
- ▶ **8:reset min/max** ⑧: reset of **all min/max readings**

▶ **5:step information**: **(please notice 1:info when offered)**

- ▶ **1:step power Qc** ①: Left/right value: initially gauged or entered / actual **step power Qc** in [kvar] resp. **step power loss** in [%]. (step powers are converted to mains voltage/mains frequency)
- ▶ **2:cycles on/off** ②, ▶ **3:operation time** ③: usage information, important for the life time of the contactor / capacitor
- ▶ **4:I at step** ④: calculated real **current I_{rms}** per step in [A]
- ▶ **5:detuning factor** ⑤: values shown per step (also if **equal setting**); shows **absorption circuit** / **combi-detuning** on **multi-detuning**.
- ▶ **6:info per step** ⑥: all values from ① to ④ but listed per step

▶ **6:alarms (AL)**:

- ▶ **1:actual alarms** ①: all actual **alarms** (also acknowledged ones)
- ▶ **2:accumulated AL** ②: List **all alarm types** (scroll with the arrow keys) with their **number** of occurrence since last reset / **total** number in life. **1:info**: explanation, **7:*->0** reset that number only.
- ▶ **3:AL thresholds** ③: see page 26 for a list of types and values of the **AL thresholds**.
  - ▶ **1:AL cosφ** ①: ▶ **1:alarm cosφ T1/T2** ①; ▶ **2:alarm delay** ②; ▶ **3:low load** ③: behavior when all steps are switched off
  - ▶ **2:steps** ②: ▶ **1:cycles on/off** ①; ▶ **2:operation time** ②; ▶ **3:step power Qc** ③; ▶ **4:I at step** ④: calculated value; ▶ **5:fault analysis** ⑤: monitoring of the **step power**
  - ▶ **3:harmonics** ③: ▶ **1:harmon. THDU** ①; ▶ **2: single harm. Un** ②; ▶ **3: I at step** ③: calculated **current I_{rms}** [A] per step

- ▶ **4:voltage** ④: ▶**1:Umax** ①, and ▶**2:Umin** ② in [%] of $\mathbf{U_{mains}}$
- ▶ **5:temperature** ⑤: ▶ **1:excess temperat.** ①, ▶ **2:delay** ②, and ▶ **3:hysteresis** ③: AL switchoff for temp. > excess temp.
- ▶ **6:maintenance rate** ⑥, ▶ **7:AL cluster** ⑦: very special items.

▶ **4:alarm signal at…** ④: defines, which **alarm** releases an **external alarm signal**. Thus, unwanted external alarms can be avoided.

▶ **5:alarm signal test** ⑤: **external alarm signal** on / off

▶ **6:acoust. alarm** ⑥: acoustic **alarm beeper** on / off

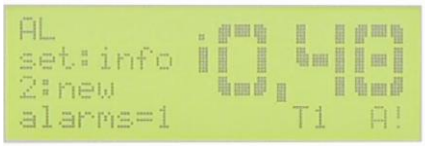
Explanations to Alarms (AL): (Insert into **0:main menu**)

- All **alarm**s are active with the **thresholds** of the **default setting**.
- **alarm switchoff** (**operating mode AL**): All outputs are switched off while the reason for the alarm continues.
- **Alarms with switchoff** (e.g. excess temperature) can also get active during commissioning thereby pausing gauging/seizing.
- **Alarms with switchoff** are delayed in most cases (see on page 26).
- After 20-times alarm switchoff or reset occurred without acknowledge by the user, the regulator changes into **operating mode HALT** and switches off all steps, until **HALT** is manually left (see on page 20).
- **alarm notice without switchoff** (possibly with **single step off**): Shows need for action. Anyhow, the compensation algorithm continues.
- Use **0:main menu** ⓪ ▶ **6:alarms (AL)** ⑥ ▶ **4:alarm signal at…** ④: to particularly configure, which **alarms** should releases an **external alarm signal** (alarm relay closed). By default all alarms go external.
- All **AL thresholds** can be **password-protected** except **alarm-cosφ T1/T2** with the **alarm delay** and **low load**.
- If the software is not able to monitor the **step powers**, the regulator by itself may turn off **fault analysis**, issuing **AL3** (see page 37).

AL Display Indication: (after the alarm pop-up windows disappeared)

Any new **alarm** is displayed for 3 minutes in an **alarm window** with an AL description. After that the display returns to the standardwindow with the indication in lines 3/4: **2:new alarms= quantity**. Key ② re-activates that alarm windows. Enter ⓪ ▶ ⑥ ▶ ① due to get all alarms still actual.

AL indicates, that a general **alarm switchoff** is currently active thus pausing regulation. **A!** reports an external alarm signal. As long as any alarm is actual the back-ground light is rhythmically blinking. The beeper sounds for an unacknowledged **alarm notice** or an **alarm switchoff**.



AL-indication standardwindow 1

AL-indication standardwindow 2

Use **2:new alarms** (2) to re-activate the alarm windows for the new, unacknowledged alarms. Scroll among them with ▼. Use esc to acknowledge each alarm window separately.

For **alarms with switchoff** and **cosφ-AL** their current status is shown as **ALxy is lasting** resp. **ALxy terminated**, and for other alarms **ALxy is new** resp. **ALxy acknowledged**. Additionally, the **number=** and the **total=** inform how often the **alarm** occurred since last alarm reset / in life-time.

Hint: Use **1:info** (1) to get a **detailed description** on the alarm and its thresholds; leave the info window with the esc-key esc.

0:main menu (0) ▶ **6:alarms (AL)** (6) ▶ **1:actual alarms** (1): shows all alarms currently being actual, equal whether acknowledged or not.

Alarm Notices:

- **AL#1:overcompensation** and **AL#2:undercompensation**: **cosφ** resides above / below the **alarm range cosφ** for more than the **alarm delay**.

  For little load situations the alarm range is extended in same manner as the target range thus generating no **cosφ** alarms. If desired getting **low load alarms** which result from the network (i.e. the system is entirely off) these alarms have to be activated. In these cases low load **undercompensation** argues for a lack of fine-stepping while low load **overcompensation** indicates that mains are capacitive itself.
- **AL#3:fault analysis**: monitoring **Qc**; fault analysis is switched off by software or by user: (0) ▶ (8) ▶ (3) ▶ (7) ▶ **2:fault analysis** (2).
- **AL#4:step 1** to **AL#13:step 10**: loss of step power exceeds **AL-threshold** (default**: 20%**): **Check capacitor and contactor!** Prior to

issuing this alarm, the step is tested (**t**) once more. Not before the test failed, the step is declared defective (**d**) and becomes disabled.

- **AL#14:cycles on/off 1** to **AL#23:cycles on/off 10**: Number of cycles of the step exceeded **threshold: Check contactor and capacitor!**
- **AL#24:operation time 1** to **AL#33:operation time 10**: Operational time of the step exceeded **threshold**: **Check contactor and capacitor!**
- **AL#34:maintenance**: **maintenance threshold** exceeded: **Check system, contactors, and capacitors!** Acknowledge with 0 ▶ 9 ▶ **2:maintenance** 2. ▶ **1:executed** 1 to start a new period or change the maintenance period by 0 ▶ 6 ▶ 3 ▶ **6:maintenance rate** 6.
- **AL#36:temperature !!**: **temperature alarm in advance**, 3°C below **temperature switchoff**; An **alarm notice** without switchoff is issued.
- **AL#37:I at step**: overcurrent at steps, perhaps a resonance condition; **Check harmonics and run maybe a net-analysis!**

Alarms (with switchoff):

- **AL#39:U < Umin** and **AL#40:U > Umax**: Voltage **U** is measured below **Umin** resp. above **Umax** in [%] of the **mains voltage Umains**.
- **AL#41:I > working range**, **AL#42:U < w.r.**, and **AL#43:U > w.r.**: **measured voltage** (**U**) resp. **current** (**I**) is beyond the working range
- **AL#44:single harm.Un**, and **AL#45:harmonics THDU**: At least 1 of the single harmonics $\mathbf{U_2}$ to $\mathbf{U_{31}}$ resp. the **THDU** exceeds the **AL threshold**.
- **AL#46:no-voltage**: quick switchoff after voltage drop (only if lasting).
- **AL#47:frequency**: Actual frequency exceeds **mains frequency** (rated at commissioning) by more than 7%, or is smaller than 45Hz.
- **AL#48:excess temperat.**: switchoff because exceeding **excess temperature** for more than the alarm delay time.
- **AL#49:supply voltage**: The microprocessor lacks supply voltage.
- **AL#50:service !!**: The regulator had been re-booted after a software error or system error. Call service, if error appears frequently.
- **AL#51:AL cluster**: After some (default: 20) non-acknowledged alarms with switchoff or re-starts with AL#50 the regulator itself shuts off into **HALT** to prevent periodic system outage without knowledge to the customer. No AL#51, if less than 2 events occur per day.
- **AL#52**: indicates the first appeared alarm of the last switchoff

AL-Thresholds: ⓪ ▶ 6:alarms (AL) ⑥ ▶ 3:AL thresholds ③

Threshold for AL #	Setting Range	Default Setting (SE)
#1/2 over-/undercompens.T1/T2	i0.70 - c0.80	i0.90 - c0.98
delay time for #1+#2	0.00h – 24.00h	1h
#4-#13 loss of power §, §§§	5% - 30%	20% (from initial Qc)
#14-#23 contactor cycles on/off §§	0; 10000 - 300000	100000
#24-#33 operation time §§	0h; 10000h - 150000h	80000h
#34 maintenance period §§	0h; 8000h - 150000h	16000h
#36 temperature warning	constant value	excess temperat. – 3°C
#37 I at step (I_{eff} / I_1) §§	0%; 105% - 200%	130%
#39 Urms < Umin (/ Umains) §§	0%; 85% - 95%	88%
#40 Urms > Umax (/ Umains) §§	0%; 105% - 115%	112%
#41 Irms > working range	constant value	I > 6,6A x ki
AL delay period for #39+#41	0s - 20s	5s
#42 Urms < working range	constant value	U < 50V x ku
#43 Urms > working range	constant value	U > 780V x ku
AL delay period for #40+#42+#43	constant value	60ms
#44 single harmonics Un §§	0%; 2% - 20%	3%, 6%*, 8%**
#45 harmonics THDU §§	0%; 2% - 20%	3%, 7%*, 9%**
AL delay period for #37+#44+#45	2Min. - 20Min.	5Min.to come/ 15Min.to go
#46 no-voltage	constant value	75% (U / Umains)
#47 frequency f	constant value	f > 1.07 x fmains
#48 excess temperature ***	35°C - 65°C	48°C
AL delay period for #48	0Min. - 240Min.	60Min.
#51 AL cluster §§	0; 10 - 999	20

c0.98: capacitive **cosφ** at 0.98 **i0.98**: inductive **cosφ** at 0.98

*: detuning factor between ≥ 2% and < 10% **: detuning factor ≥ 10%

***: system switchoff (**HALT**) at excess temp. +15°C or at fast temperature rise

ku resp. **ki**: transducers ratios for **voltage U** resp. **current I**

§: extrapolated to **mains voltage U_{mains}** and **mains frequency f_{mains}**

§§: The alarm will be deactivated, if the threshold is set to 0%.

§§§: The alarm will be deactivated, if the **fault analysis** is off (refer to **AL #3** on page 24).

(red) **alarms with general switchoff of all steps, mostly delayed**

(green) **alarms with switchoff per step (regulation continues using the other steps)**

▶ 7:manual mode (MAN) (can be password protected)

From the **standardwindow** the **manual mode** can be started by ▶ **set: start MAN** (set) changing the **operating mode** into **MAN**. In the **action window** of the **manual mode** the current state on/off of the steps remains at first unchanged. The background light blinks as warning that the **automatic mode** (**AUTO**) is deactivated and the beeper sounds. The beeper may be deactivated by (esc) ▶ (1) ▶ (set).

Attention! Because the **automatic mode** (**AUTO**) regulation is deactivated, the service staffs themselves are responsible for **over-** or **under-compensation**. However, alarms are active in the **manual mode (MAN)**.

In the **action window** of the **manual mode** you can toggle the **step relays** by the their numbers (1) to (9) and (0), the **alarm relay** by (▼), and the **fan relay** by (▲).Also defective or unused steps can be switched. Note that any **alarm with switch-off** or the **blocking time** of a contactor-switched step prohibit the manual switching of steps.

The output switching status in the lower left area of the display uses the same symbols as in the **standardwindow 2**. For explanation see in the **legend set:info** (set) ▶ **set:legend** (set) or on page 20 here-in.

In line 1 and 2 of the window the **cos**φ (**cosφ.T**) and the reactive power **Q** (**Q.T**) in network is shown (The red quantities apply under **basic load** condition). When **Q** is on the display in **brackets ()**, the reactive power is well compensated, i.e. the actual **cosφ** resides in the (extended) **target cosφ range**, thus no regulation action is required (see page 34).

Use **set: info** (set) ▶ **▲/▼: U,I,f,Q,P,harm.** (▲)(▼) for displaying an assembly of often used measuring values, which is identical to those obtained from the **standardwindow 1** or **2** by (▲)(▼) (see on page 19).

After 3 Min. without keystroke or by **esc:stop** (esc) from the **action window** the **standardwindow** of the **manual mode** is shown. From that **standard-window** all functions (without **reparation**) can be used via the **0:main menu** (0). By (0) ▶**7:manual mode (MAN)** (7) the regulator returns to the **manual mode**. Only from the **standardwindow** you can end **manual mode** and return to the **automatic mode (AUTO)** by **6:automatic mode** (6) or respectively to **HALT** by **6:manual mode off** (6).

▶ 8:setup

- **Attention!** The **factory defaults** comprise reasonable settings. Only qualified staff may change settings. Respect the performance data of the system's components!
- The input menus show the actual setting of the parameter to be changed. During input also its setting range is shown.

▶ 1:for metering ①

Setting Quantity	Setting Range	Factory Default
▶ 1:transducer I ①	5 - 30000A / 1 or 5A	5 / 5A
▶ 2:transducer U ②	100 - 30000V / 100 - 700V	700 / 700V

- ▶ **3:I-surge dead time** ③: **Surge peaks of current I_{rms}** beyond the **measuring range** are suppressed **for 5s by default**; range: 0 - 20s. **Note**: This is the alarm delay period for AL#39+#41, too.
- ▶ **4:transd.overcharge** ④: If **I_{rms}** is greater than the **overcharge current**, fault analysis / monitoring Q_c will be suspended. If 0A (= auto) the regulator did yet not find any transducer overcharge.
- ▶ **5:phase error** ⑤: balance the phase error of the **transducers**
- (▶ **6:catenation** ⑥: visible only at **commissioning**; see on page 16.)

▶ 2:for control ②

Setting Quantity	Range	Factory Default
▶ 1:target cosφ ①	i0.70 - c0.80	*T1:* 1.00 / *T2:* i0.95
▶ 2:target range cosφ ②	i0.70 - c0.80	*T1:* i0.95 - 1.00 *T2:*i0.90 - i0.95
▶ 3: alarm range cosφ ③	i0.70 - c0.80	*T1, T2:* i0.90 - c0.98

T1/T1 = tariff 1/2; ***change value by 0.01 using*** ▲, ▼; ***Follow the displayed menus!***

- ▶ **4:for contactors** ④: special settings only for **contactors**
  - ▶ **1:response time** ①: **10K**: range: 4 - 3600s, **default**: **15s**; the response time is extended up to 10-times for low demand
    5T5K: *range:* 0; 0.10 - 120s, **default**: **0s=off** (as fast as can be).
  - ▶ **2:operation contact.** ②: switch **subsequently** or **all together**
  - ▶ **3:idle period** ③: range: 3 - 300s, **default**: **45s**. **Observe the capacitor discharging time** preventing connection in antiphase.

- ▶ **5:for thyristors** ⑤: special settings only for **thyristors**
  - ▶ **1:response time** ①: range: 0; 40 - 10000ms; **default**: **0ms** (=**no lag)**; controls the slow thyristor regulation.
  - ▶ **2:Fast-Mode** ②: extremely fast thyristor regulation **on** / off
  - ▶ **3:idle period** ③: range: 0; 0,02 - 300s, **default**: **0s (=off)** (as fast as can be). For thyristors with long re-connection delay.
- ▶ **6:for 5T5K** ⑥: special settings only valid for the **CR2020-5T5K**.
  - ▶ **1:switching lag 5T5K** ①: range: 0 - 3600s; **default 0s**. Delays switching on after off and vice versa to avoid fidgetting.
  - ▶ **2:threshold 5T5K** ②: range: 0 - 50%; **default**: **0%.** Reserve some margin from the thyristor volume to allow next regulation for the same direction by thyristor rather than by contactor
- ▶ **7:cap.cosφ limit** ⑦: on/**off** (**default**), there is no **extended target range cos**φ beyond its capacitive limit, also for **low load**.

▶ **3:system setup** ③:

Setting Quantity	Setting Range	Factory Default
▶ **1:idle period** ①	3 - 300s *(only contactor)*	45s
▶ **3:detuning factor** ③	0.00 - 21.00%	0.00%
▶ **5:fixed frequency** ⑤	0Hz=auto; 45 - 65Hz	0Hz *(standard)*

- ▶ **2:basic load** ②: for inductive or capacitive fixed compensation
- ▶ **4:steps** ④: **alarm thresholds** (see page 26); = ⓪ ▶ ⑥ ▶ ③ ▶ ②
  - ▶ **1:step power Qc** ①: Qc power loss > AL threshold [%]
  - ▶ **2:cycles on/off** ②: > threshold; ▶ **4:I at step** ④: > threshold [%]
  - ▶ **3:operation time** ③: > threshold; ▶ **5:fault analysis** ⑤**:** on/off
- ▶ **6:I-surge dead time** ⑥: **Surge peaks of current I_{rms}** beyond the **measuring range** are suppressed **for 5s by default**; range: 0 - 20s. Note: This is the alarm delay period for AL#39+#41, too.
- ▶ **7:special conditions** ⑦: diverse system settings
  - ▶ **1: operation contact** ①: switch **subsequently** or **all together**
  - ▶ **2:fault analysis** ②: **on**/off: monitoring of steps powers Qc
  - ▶ **3:detailed info** ③: on/**off**: shows step power after switching
  - ▶ **4:fan control** ④: fan is **temp. controlled** / **on if one step is on**
  - ▶ **5:multi-detuning** ⑤: **absorption circuit** / combi-detuning
  - ▶ **6:maintenance rate** ⑥: range: 8000 - 150000h; **16000h**

- ▶ **7:Fast Mode** ⑦: extremely fast thyristor regulation **on** / off
- (▶ **8:opti-var** ⑧: number of steps assigned to special **opti-var modules** from **SYSTEM ELECTRIC**;(visible only at commissioning))

(▶ **8: inductive steps** ⑧: see page 18 (visible only at commissioning))

▶ **4:for temperature** ④: *(also see on page 33)*

Setting Quantity	Range	Factory Default
▶ **1:temp. fan on** ①	25 - 40°C	30°C *(fan off at 5°C below)*
▶ **2:excess temperat.** ②	35 - 65°C	48°C
▶ **3:delay** ③	0 - 240Min.	60Min.*(at excess temperature)*
▶ **7:hysteresis** ⑦	5 – 20°C	13°C *(end AL switchoff after > delay with temperature < (excess temperat – **hysteresis**))*

- ▶ **4:temp.-calibration** ④: range -10°C – +10°C; **default 0°C**; subtractive offset between the regulator's sensor temperature and the capacitor bank in the cabinet; change value by ▲, ▼.
- ▶ **5:fan test** ⑤: toggle fan relay on / off for test.
- ▶ **6:fan control** ⑥: fan is **temp.controlled** / **on if one step is on**

▶ **5:for alarms** ⑤: (for details of the submenus see pages 22 - 23)

- ▶ **1:alarm cosφ T1/T2** ①
- ▶ **2:alarm delay** ②
- ▶ **3:low load** ③
- ▶ **4:AL thresholds** ④
- ▶ **5:alarm signal at...** ⑤
- ▶ **6:acoust. alarm** ⑥

▶ **6:back-up/reset** ⑥: (parameters saved in the EEPROM)

- ▶ **1:factory defaults** ①: **reset all settings to their factory defaults**. The regulator takes the delivery state, ready for commissioning.
- ▶ **2:default values** ②: reset non-system specific settings to their factory defaults. Data from commissioning remains unchanged.
- ▶ **3:non-standard setup** ③: show settings that have changed
- ▶ **4:store setup** ④ ▶ **5:restore setup** ⑤: non-system specific sett.
- (▶ **6:SE fact.defaults** ⑥: like ① but with original SE-set of settings)

▶ **7:spec.setup (SE)** ⑦: A **special SE password** is necessary, which allows access onto regulator's internal software and which must not be used by others than **SYSTEM ELECTRIC** (**SE**) authorized experts.

(▶ **8:interface IF** ⑧: visible only for modification **-S**, see on page 33)

▶ **9:service menu**

The service menu comprises all functions for **service**, **reparation**, and **maintenance**.

▶ **1:shutdown system** ① ▶ **1:shutdown system** ①, identical to **key combination** esc + set **emergency shutdown**: The **operating mode** changes to **out of order** (**HALT**). All power steps switch off.

Use ▶ **1:system on** ① ▶ **2:on** ② or the **key combination** ▲ + ▼: **restart** to return to the prior **operating mode**, mostly **AUTO**. While in **HALT** all submenus of the **0:main menu** and all functions are usable – also the **manual mode**, which allows to switch all relays.

▶ **2:maintenance** ②:

- ▶ **1:reset period** ①: to acknowledge maintenance done.
- ▶ **2:non-standard setup** ②: show settings that have changed

▶ **3:reparation** ③: Background light blinks due to regulation affected.

At the beginning of the submenus 2, 4, and 5 comments windows inform, which actions will take place, proceed with ▼. By ① to ⓪, the step number toggle selection "**!**" (**note**: absurd selections are not possible). Start repair of the selected steps with the set key.

Regulation continues with the not-affected steps.

- ▶ **1:beep off** / **1:beep on** ①: beeper **off** / **on**.
- ▶ **2:check steps' Qc** ②: temporarily sizes steps powers.
  Hint: Returns defective steps for regulation, if problem solved.
- ▶ **3:info per step** ③: shows step information per step; same as ⓪ ▶ **5:step information** ⑤ ▶ **6:info per step** ⑥.
- ▶ **4:parts replaced** ④: acts only on selected steps.
  - ▶ **1:contactor only** ①, and ▶ **2:capacitor only** ②: part replaced.
  - ▶ **3:contact./capacitor** ③: contactor and capacitor replaced.
    Hint: Enter a power of 0.00kvar clears that step to "**not wired**".
  - ▶ **4:fuses only** ④: particular fuse are replaced
    Hint: Returns defective steps for regulation without any check.

With **contactor** replaced also its **cycles on/off** count is reset; with **capacitor** its **operation time**. The capacitor's step power Qc can be seized or entered as desired. Defective mark is removed.

- ▶ **5:add steps** ⑤: The capacitor's **step power Qc** can be seized or entered as desired; the **detuning factor** is inquired afterwards.
- ▶ **6:ends reparation** ⑥: return to the prior **operating mode**.

After 3 Min. without keypress the reparation standardwindow informs how to leave reparation by menu item 6.

- ▶ **4:connection info** ④: net-configuration, mains/measuring voltage, transducer data, and U_m/I_m/f measured at the connector bank
- ▶ **5:test outputs** ⑤: functional check of the system configuration. For more explanation see chapter **4:test outputs** on page 12.
- ▶ **6:initiation** ⑥: changes the operation mode into **commissioning** (see chapter 5. on pages 13 et sqq.) and enters the **commissioning menu** (see on page 15). From there, start **1:autocommissioning** or only parts via the **2:experts menu**.

  Warning: Any **new commissioning result** may also **clear other stored data**, e.g. new net-configurations determine new mains voltage or new step powers reset stored cycles on/off and operation time.

  For maintenance, reparation, or system extension we strictly recommend to use ⓪ ▶ **9:service menu** ⑨ ▶ **3:reparation** ②, where you can act on all (but not on net-configurations) like in commissioning
- ▶ **7:password** ⑦: change password; max. 9 digits; 0 = no password.
- ▶ **8:gen.instructions** ⑧: General instructions; see on page 11.
- ▶ **9:fan off for 10Min.** ⑨: switch off an annoying fan for 10 minutes.

Password / Data Integrity

The **service staff** may limit access to the regulator by setting a **password**. Then, all **AL-thresholds** (except for **cosφ**) or **settings** by **8:setup** can only be changed with that **password**. However, the **readings** or **settings** can always be read. Without that password no change of the operating mode like into/from **manual mode** is possible.

The password is a number with up to 9 digits. "0"= no password.

If you forgot your password, **SYSTEM ELECTRIC** can send you a special password, which can reset the service password to "0".

When a password protected system had been opened by password it remains opened until the display falls back into the standardwindow (or remains in it) after 3 Min. without keystroke. Due to lock the system at once invoke "change password" without password entry.

Change password:

+) autocommissioning at **valuable entries** ▶ ②

+) commissioning menu ▶ **5:config. data** ⑤ ▶ ⑤

+) experts menu ▶ **7:config. data** ⑦ ▶ ⑤

+) standardwindow ⓪ ▶ **9:service** ⑨ ▶ ⑦

10. Hardware

Temperature Sensor (temperature monitoring and fan control)

The **temperature sensor** sticks approx. 1mm out of the rear side of the regulator. It must not be depressed or covered.

Readings:

⓪ ▶ **3:readings** ③ ▶ **7:temperature** ⑦: for actual **temperature** and its **daily mean** as well as for the **min/max values**

⓪ ▶ **4:min/max readings** ④ ▶ **7:temperature** ⑦

All parameters concerning the temperature can be set at:

⓪ ▶ **8:setup** ⑧ ▶ **4:for temperature** ④ (see on page 30).

The cabinet fan is switched on for temperatures above the **temp. fan on** (**default** 35°C) until temperature falls again below 5°C under the on-temperature (i.e.: 30°C).

At temperatures above the **excess temperature** (48°C) the regulator enters after a delay (1h) the AL-switchoff mode due to let the compensation system cool down. When for the delay time the temperature falls below the excess temperature-**hysteresis** (i.e.: 48°C - 13°C = 35°C) regulation restarts.

At a temperature **15°C above the excess temp.** or a **fast temp. rise** the fan is stopped to prevent accelerating fire and the regulator enters the shutdown mode (**HALT**). User intervention is required for restart.

Alarm Relay

The **alarm relay** comprises a normally closed potential-free contact. The contact is closed (=**alarm**), if an **active alarm switchoff** or an unacknowledged **alarm notice** should be signalled or **when regulation is stopped** (e.g. not powered during **commissioning**, **shutdown** (**HALT**), or **manual mode** (**MAN**); due to allow manual mode to persist beeper off withdraws that **alarm**). For further description refer to pages 23 - 27. On request **SYSTEM ELECTRIC** can provide regulators with inverted relay contact.

Interface RS485 (optional, modification identifier **-S**)

Via the **RS485 interface** read **readings** and **alarms**, or write **settings**. Configure the interface by menu (only visible, if implemented):

⓪ ▶ **8:setup** ⑧ ▶ **8:interface IF** ⑧: (IF= Interface)

Further information on the **interface** is covered in a special instructions manual for the interface regulator.

11. Special Features

Aids for Net Analysis: (starting from the **standardwindow**)

⓪ ▶ **3:readings** ③: **actual-** and **0.25h-based values** of all **readings**: **harmonics U** and **I**; **actual temperature** with **daily mean**; **actual** ▶ **9:long term means** for **cosφ**, **Q** and $\mathbf{Q_{miss}}$ of following periods: **0.25h-**, **1h-**, **4h-**, **daily-**, **weakly-**, **monthly-** and **yearly-means**

⓪ ▶ **4:min/max readings** ④: extreme values of the same quantities as in **3:readings** enclosing **0.25h mean min/max values**.

⓪ ▶ **5:step information** ⑤: see on page 22.

⓪ ▶ **6:alarms (AL)** ⑥ ▶ **2:accumulated AL** ②: list of all **alarms**; the number shows, how often each **alarm** appeared in the past.

⓪ ▶ **9:service menu** ⑨ ▶ **4:connection info** ④: shows **net-configuration**, mains/measuring voltage, transducer data, and $\mathbf{U_m/I_m/f}$ measured at the connector bank

Target Range cosφ: (Detailed how to setup on page 28)
There is no regulation while the **cosφ** resides inside the **target range cosφ**. The **target range cosφ** can cover the whole **cosφ range**, which is free of cost, and will clearly reduce the **number of switching operations**.

If **target cosφ=1.00** is required, also the **target range cosφ** has to be set to **1.00 - 1.00**. For stability reasons around the **target cosφ** there is always at least an (extended) **target range cosφ**, covering in total **4/3 of the smallest step power Qc,min**. Thus, a fast switching back and forth can be avoided. With **cap. cosφ limit** =on extension is one sided inductive.

Low Load: (Detailed how to setup on page 22)
During **low load** (= all steps are switched off) an **undercompensation** indicates a lack of fine-stepping, while an **overcompensation** indicates a capacitive net. **By default low load alarms are disabled**.

Harmonics Alarms: (also read texts on alarms on pages 23 - 27)
High **harmonic current** can damage the capacitor banks. Therefore, percental **alarm thresholds** are defined for the **THDU** (**T**otal **H**armonic **D**istortion of voltage **U**), for **single harm. U_n**, and for the **current I at step** (as calculated from **detuning factor**, **actual step power** (converted to standard conditions), and **voltage harmonics**). By default the **alarm thresholds** had been set according to the **detuning factor** (see page 26).

Warning! Resonant currents can damage the capacitors. Do not change any alarm threshold unless an expert has cleared the net facts.

Combi Detuning: (**multi detuning modes**: ⓪ ▶ ⑧ ▶ ③ ▶ ⑦ ▶ ⑤)
The compensation power at the higher **detuning factor** always exceeds the compensation power at the lower **detuning factor** a little.
No combi detuning at the **CR2020-5T5K** and with **opti-var switching**.

Absorption Circuit: (**multi detuning modes**: ⓪ ▶ ⑧ ▶ ③ ▶ ⑦ ▶ ⑤)
Steps with lower **detuning factors** will not be switched on unless all steps with higher **detuning factors** have already been switched on.
Steps with the lower **detuning factor** will at first be switched off.
If one step of a higher **detuning factor** is defective, all steps of smaller **detuning factors** remain switched off.

Dynamical Systems: Thyristor Switched Compensation: CR2020-10T
Thyristors switch capacitors wearlessly, gently, and fast. Capacitors do not need an idle period because switching on with no voltage difference and off at current zero crossing. Preferably, thyristors are used where very fast or frequently cycling is required. Using the **thyristor CT2000**, the **CR2020-10T** is able to compensate a load change **within about 25msec** in **Fast Mode**; sufficient to keep track on the reactive power of e.g. spot welders.

Half-Dynamical Systems: CR2020-5T5K
The **CR2020-5T5K** combines the advantages of both thyristor- and contactor-switched steps. While the contactor steps cover the compensation of slowly alternating loads, the thyristor steps compensate the fast and frequently fluctuating loads promptly with the **Fast Mode**. With the right design competitive low compensation systems can be offered.

Contactor Operation: (⓪ ▶ ⑧ ▶ ② ▶ ④ ▶ ②)
Contactors switching **subsequently** (**cascade operation**) do not issue abrupt load changes in the net; contactors switching **all together** make fast compensation.

Programmed Basic Load B!: (Fixed Compensation)
An additive **basic load** can be programmed. Due to compensate reactive power at the HV line entry including the mains transformer but still using measurement at the low voltage side program a capacitive basic load compensating the transformers inductive power loss

The **standardwindow 1 / 2** show a flashing **B!** and the **cosφ*.B*** value. **cosφ** and **Q** quantities are suffixed by "**.B**", when they are related to the extrapolated **b**asic load corrected reference point, and by "**.T**", when they are related to the real measuring point at the current **t**ransducer. Enter capacitive / inductive **basic load** by ⓪ ▶ ⑧ ▶ ③ ▶ ②.

Fault Analysis / Monitoring Qc: (Use ⓪ ▶ ⑧ ▶ ③ ▶ ⑦.▶ ②) for on/off) Fault analysis / monitoring Q_c check the step powers when they are switched on / off due to recognize the power loss of ageing capacitors. Alarm notices AL#4 to AL#13 will appear, if power loss

exceeds a certain AL threshold (default: 20%) and that step is excluded from regulation.

If power measurement is not possible, typically because of fast fluctuating loads, the regulator itself can switch off the **fault analysis** as well as the customer. The **alarm notice AL#03** reminds you that fault analysis if off and that you yourself is responsible for system maintenance.

Inductive Steps: (see on pages 18 and 31)

The regulator is able to size and to handle inductive steps for compensation of capacitive loads or nets. Enter the **inductive steps** types before **commissioning** as well as before **repair/add steps**.

Overloaded Current Transducer: (see on page 28)

A **current transducer** transforms the current properly, until the secondary overload limits the output current. In that way the regulator is no longer able to determine the **step power** accurately. A more powerful **transducer** has to be used or the diameter of the connection line between transducer and regulator must be enlarged. The same behaviour results from other devices connected in series.

Nevertheless, the regulator itself is able to identify such a **transducer overload** automatically by a special algorithm and suspends the **fault analysis** for currents greater than an **overcharge current**. An **overcharge current** can also be entered by the customer via 0 ▶ 8 ▶ 1 ▶ 4.

Maintenance:

Maintenance Period: (change the rate via 0 ▶ 8 ▶ 3 ▶ 7 ▶ 6)
After some operation period (default: 16000h= ca.2 years) the regulator reminds by **alarm notice AL#34** that you should **spend maintenance** onto the compensation system (e.g. cleaning from dust, changing fan filters, controlling steps powers, retightening screws, etc.). Acknowledge maintenance by 0 ▶ 9 ▶ 2 ▶ 1 ▶ set (restarts maintenance period).
Non-Standard Setup: (0 ▶ 9 ▶ 2) Shows settings that have changed with respect to the factory defaults.
fan off for 10Min.: (0 ▶ 9 ▶ 9) Switch off an annoying cabinet fan for about 10 minutes.

Reparation: (0 ▶ 9 ▶ 3)
Using **reparation** all defective markings can be analyzed and repaired. Also actions typically done during commissioning on all steps can be done on single steps while regulation continues in the background. Actions comprise: **2:check steps' Q_c**: temporarily sizes steps powers, **4:parts replaced**: ▶ **1:contactor only**, ▶ **2:capacitor only**, ▶ **3:contact. /capacitor**, ▶ **4:fuses only**; and **5:add steps**. (see on page 32)

12. Troubleshooting

Problem 1: **Autocommissioning was not successful showing a wrong net-configuration or wrong step powers.**

Possible Reasons: **a) Current transducer** short circuit still closed (most likely, if the **measuring current I_m at contact bank** (from **commissioning menu** ▶ **3:readings Um/Im/f** 3) is smaller than 70mA;
b) Current transducer incorrectly connected / overloaded showing less current (see page 37);
c) Unsatisfactory **net conditions** by fast fluctuating loads.

Removal: **a)** Open **current transducer** short circuit and check the terminal for contact; **b)** Use a **current transducer** with increased power rating or increase cable cross-section considering other equipment in series. Restart **commissioning**; **c)** Switch off fast fluctuating loads during **commissioning** or input **net-configuration** resp. **step powers** as values.

Problem 2: **cosφ is temporarily / always wrong.**

Possible Reasons: **a) net-configuration** falsely gauged / entered;
b) current transducer overloaded during heavy load, showing less current.

Removal: **a)** From **AUTO** use 0 ▶ 9 ▶ **4: connection info** 4 to show the **net-configuration**. It can only be changed by **commissioning** (re-enter from the **automatic mode** by 0 ▶ **9:service** 9 ▶ **6:initiation** 6 ▶ set) via **2:experts menu** 2 ▶ **2:gauge net-config.** 2 or ▶ **3:enter net-config.** 3. (Return via ▶ **6:automatic mode** 6 ; repeat on error);
b) solve problem with current transducer. Then re-do commissioning.

Problem 3: **Steps are not switched on despite of demand.**

Possible Reasons: **a)** you calculated false; **b) step power** falsely sized; **c)** Step defective ("**t**" or "**d**": shown in the **standardwindow 1/2** or in the **step power Q_c**).

Removal: **a)** Verify that Q_{miss} in standardwindow 2 is not in brackets; **b)** Verify steps powers by ⓪ ▶ ⑤ ▶ **1: step power** ①. **Note**: By standard the actual correct value is used for regulation.
c) Replace defective part and use reparation ⓪ ▶ ⑨ ▶ ③ ▶ **4:parts replaced** ④ for resizing step or inputting **step power** as a value.

Problem 4: **Fault analysis switches steps off apparently without cause.**

Possible Reasons: **a) Current transducer** overloaded during heavy load thus showing less current; **b)** Fast fluctuating load impedes correct measurement of **step powers** during normal operation.

Removal: **a)** solve problem with current transducer (see Problem 1b); **b)** Switch off fault analysis / monitoring of **step power Qc** by ⓪ ▶ ⑧ ▶ ③ ▶ **8:special conditions** ⑧ ▶ **2:fault analysis** ②.

Note: **Remember to periodically control the step powers and check the step status, too!**

Problem 5: **AL-switchoff caused by harmonics alarms AL#36, #44, #45.**

Possible Reasons: **a) Detuning factor** is not set; **b)** Harmonic distortions in the mains are higher than considered by the **alarm thresholds**.

Removal: **a)** By ⓪ ▶ ⑤ ▶ **5:detuning factor** ⑤ verify the **detuning factors**; **b)** Check the maximum harmonics contributions occurred via ⓪ ▶ **4:min/max readings** ④ ▶ **4:U harmonics** ④. **Do not adjust the alarm thresholds** for alarm **AL#45:harmonics THDU** via ⓪ ▶ ⑥ ▶ ③ ▶ ③ ▶ **1:harmon.THDU** ① resp. via ▶ **2:single harm.Un** ② for **AL#44: single harm. Un unless the system components are designed for higher harmonics currents.** (Alarms can be disabled by an alarm threshold=0%.)

Problem 6: **Over- or undercompensation alarm (AL#01, AL#02)**

Possible Reasons: **a) net-configuration** falsely gauged / inputted; **b) step powers** falsely sized / inputted; **c) Steps** defective;

d) On low load (i.e. all steps off): The regulator cannot reach the **target cosφ range** due to a lack of fine stepping, a capacitive net or other capacitive loads.

Removal: **a)** - **c)**: Like for **problems 3 and 4**

d) Upgrade system due to improve fine stepping; switch off **alarm range cosφ** of **low load** via 0 ▶ 8 ▶ 5 ▶ **3:low load** 3 (default setting); compensate a capacitive net or load by **inductive step power**.

Problem 7: **No display content is visible**.

Possible Reasons: **a) Power supply** missing; **b)** Software crashed.
Removal: **a)** Verify connections; **b)** Reset software via 1 + 7.

Problem 8: **Alarm switchoff by AL#47:frequency without cause.**

Possible Reason: Automatic frequency tracking is disturbed.
Removal: Set value by 0 ▶ 8 ▶ 3 ▶ **5:fixed frequency** 5.

Problem 9: **An alarm switchoff is active.**

Possible Reason: The corresponding **alarm threshold** is exceeded.

Removal: Use **1:Info** 1 to get a description to the **alarm** as well as the **AL-threshold**. By 0 ▶ **4:min/max readings** 4 the corresponding extremes and the **net-conditions** can be checked. Defective components should be replaced. The **AL-thresholds** may be adjusted **with respect to the system parameters and the system components' ratings**.

The regulator still works improperly.

Removal: Contact your service staff or us at **SYSTEM ELECTRIC**.

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