FCR 06, FCR 12

Power factor correction controller

User and service manual

version 2.3

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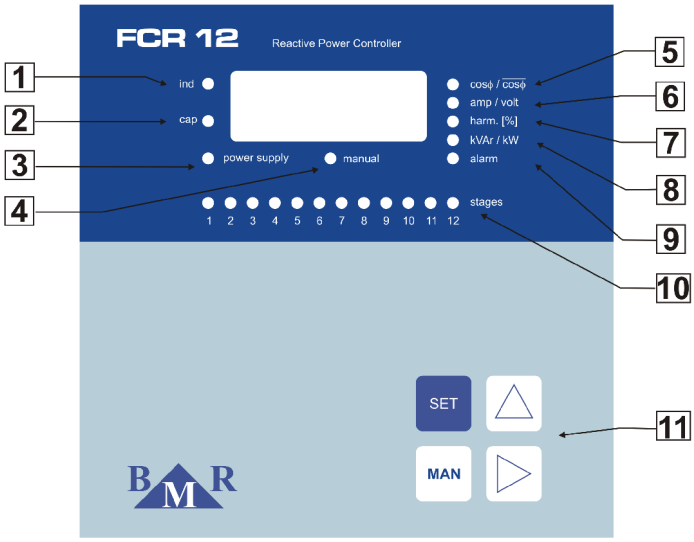
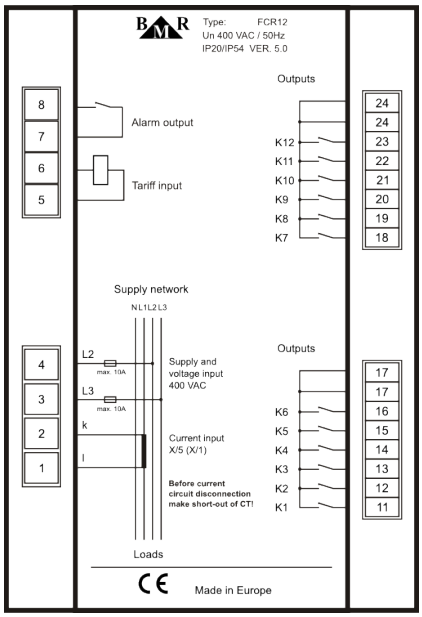
1. Control and signal elements



Picture 1. Description of front control panel

1. **LED ind** – it is ON in the case of inductive cosφ
2. **LED cap** – it is ON in the case of capacitive cosφ
3. **LED power supply** – it is ON when there is power supply to electrical network
4. **LED manual** – it is ON at manual operation of capacitor stages
5. **LED cosφ** – it is ON when instantaneous or average value of cosφ is shown on the display
6. **LED amp/volt** – it is ON when value of measured current / voltage is shown on the display
7. **LED harm.** – it is ON when total harmonic distortion of current / voltage is shown on the display
8. **LED kvar/kW** – it is ON when powers are shown on the display
9. **LED alarm** – it is ON when alarm is present
10. **LED STAGES** – dichromatic LEDs indicate status of each stage individually
11. Buttons for regulator control



Picture 2. Device terminal connection

2. Device description

Power factor correction regulator FCR06 and FCR12 are designed for power factor control in low and medium voltage system networks 50/60 Hz. FCR06 and FCR12 regulator belong to the group of fast regulators and allow to make regulation up to 25 times per second. This feature allows to FCR regulator to control mechanical contactors and also fast semiconductor stages.

FCR06 and FCR12 regulators measure and display also following parameters:

Parameter	Display	Maximum
Instantaneous cosφ, average cosφ (capacitive, inductive)	•	
Line voltage between measured phases	•	•
Current in the measured phase	•	•
System frequency	•	•
Apparent three-phase power	•	•
Active three-phase power	•	•
Reactive three-phase power	•	•
Allowed reactive power	•	•
Odd current harmonics (1 ... 19) in %	•	•
Total harmonic distortion of current THDI	•	•
Odd voltage harmonics (1 ... 19) in %	•	•
Total harmonic distortion of voltage THDU	•	•
Number of connections of each stage	•	
Temperature	•	

Table 1. Measured and displayed parameters

Regulator is available with 6 and 12 stages design. Regulator FCR06 has available 1 x 6 outputs and regulator FCR12 has available 2 x 6 outputs. Outputs for mechanical contactors are with relays and outputs for semiconductor contactors are realized by OPTO-MOSFET transistors, which are able to operate under 24 V DC / 100 mA or 230 V AC / 100 mA (maximum) according to regulator variant.

Regulator variant	Total number of all stages	Number of dynamic stages	Control voltage
FCR 06	6	0	230 VAC
FCR 06-01	6	1	230 VAC
FCR 06-02	6	2	230 VAC
FCR 06-03	6	3	230 VAC
FCR 06-06	6	6	24 VDC
FCR 12	12	0	230 VAC
FCR 12-01	12	1	230 VAC
FCR 12-02	12	2	230 VAC
FCR 12-03	12	3	230 VAC
FCR 12-06	12	6	24 VDC
FCR 12-12	12	12	24 VDC

Table 2. Controller variants for contactor and semiconductor stages

Regulators FCR06 and FCR12 are available in several variants of supplying and measuring voltage. In case that auxiliary power supply is used (measuring voltage is different than supply voltage) the alarm output is not available.

Regulator variant	Power supply voltage	Measuring voltage	Alarm output
FCR 06	400 VAC	400 VAC	yes
FCR 12	400 VAC	400 VAC	yes
FCR 06 V100	100 VAC	100 VAC	yes
FCR 06 V230	230 VAC	100 ... 690 VAC	no
FCR 12 V100	100 VAC	100 VAC	yes
FCR 12 V230	230 VAC	100 ... 690 VAC	no

Table 3. Controller variants according to power supply and measuring voltage

3. Instruction manual for connection and operation

Default parameters are set to the device in production, according to the table 4. Supply voltage has to be taken from regulated network, because it is used also for voltage measuring circuit. Value of this supply voltage is on the product label. Current for current measuring circuit is taken from the remaining phase. By default, in the case of 3 x 400 V, voltage is being measured between phases L2 and L3, and the current is being measured in the phase L1. The connection of measuring circuits is shown at picture 3.

Commissioning procedure:

1. Make connection according to connection diagram at picture 5.
2. Connect supply voltage. In the case that the value of current is lower than 10 mA, the display will show "----". If not, the display will show instantaneous value of power factor.
3. Press button **SET** for the time longer than 5 seconds. After that device will switch to the service menu and on the display will appear parameter **CoS1**.
4. By pressing the button **SET** once again display will show target cosφ. Setting the targeting values of cosφ is done via buttons ▲ (+) and ► (-) .
5. Confirmation of the set value **CoS1** is done by pressing the button **SET**.
6. Press the button ▲ until the parameter **Itr** will appear on the display. It means ratio of current transformer.
7. Press the button **SET** and on the display will appear set value of transformer ratio (default value is 1).
8. Using the buttons ▲, ► set known value of transformer ratio.
9. By pressing button **SET** confirm set value. On the display will appear again the parameter **Itr**.
10. In the case that measuring / supplying voltage is taken from voltage transformer, move to the parameter **U_tr** by pressing button ▲. For example, if the ratio is 22000 / 100, then it should be set like 220.
11. Now again, by using the buttons ▲, ► move to the parameter **Auto** and by pressing button **SET** confirm it. Via button ▲ switch to the value **on** and via button **SET** confirm set value. Device automatically perform phasing of measured voltage, current and detection of connected compensation stages. All parameters will be saved to the internal memory. When the detection is finished, parameter **Auto** will be automatically changed to the value **oFF**.
12. Verify if detection of power of all stages was done correctly. Press button **SET** for time of 8 seconds. On display will appear **CoS1**, via pressing button ▲ move to the parameter **St_P**. Press again button **SET** and **LED1** of first stage will be turned **on**. Another pressing the button **SET** will make the value of the power of the first stage be shown on the display. If the value is not correct, it should be changed by pressing buttons ▲, ► until the correct value. In the case of capacitor stage **LED cap**, placed at the left side of display, has to light. If the power is correct press again button **SET** and on the display will appear again parameter **St_P**. Via button ▲ move to another stage and **LED2** will turn ON. Repeat the same procedure the same way like for the first stage. Following the same control or setting of all stages should be done. At the end press button **SET** until value of power factor will appear on the display.
13. If everything is set correctly, on the display is shown real instantaneous value of power factor. Regulator FCR06 or FCR12 is ready for operation.

Other parameters may remain on having the default values, that were made by the manufacturer. In the case that further changes are necessary, the user should follow detailed manual given in chapter 6.

4. Description of the function

Device digitizes measured phase to phase voltage between two phases and current in the measured phase. Then, from those values, parameters like: power factor, effective values of voltage and current, harmonic distortion of voltage and current, are being counted. Calculation of the needed compensation power is done by using the value of allowed reactive power, which is set in the device in the form of requested power factor. According to its size, regulator will switch on or switch off appropriate capacitor stages.

In preference, regulator compensates via semiconductor stages. When it gets to the point when it's not possible anymore, the regulator will use contactor stages.

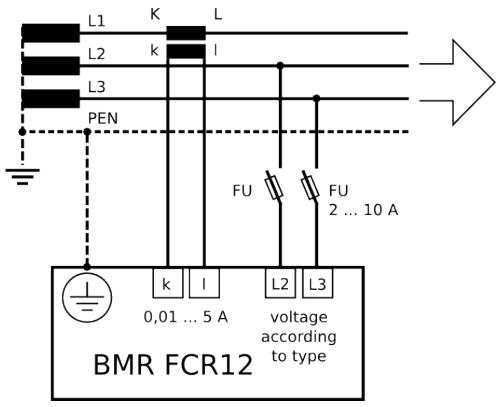
Within the scope of each power level, regulator uses method of circle switching. All the time connects this stage at appropriate power level which was switched off for longest time. Everything is made so that regulator will reach optimal compensation in one regulation cycle with minimum number of switched stages.

The regulator makes harmonics analysis of current and voltage up to 19th harmonics and counts THD factor of voltage and current. If the limit value of TDHI (current) is set, in the case that this value has been overpassed, the regulator will disconnect all capacitor stages and switch on the alarm relay.

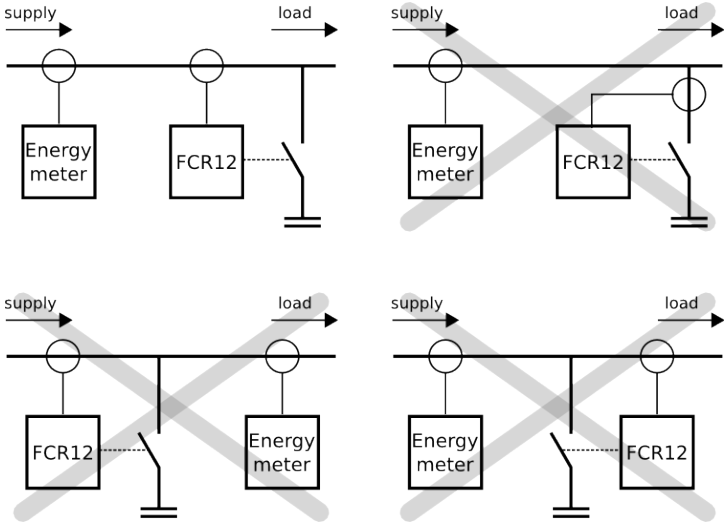
The regulator can operate not just with compensation capacitor stages, but also with de-compensation reactor stages as well, at the same time. The power of these reactor stages will be registered with the negative numerical sign. De compensation reactors has to be connected after last capacitor stage. If the automatic detection of the powers is not possible, these values could be also set manually. For more details, follow the manual in chapter 6.

5. Installation of the device

Regulator FCR is designed in metal box, which provides perfect EMC shielding. Regulator's design also provides panel mounting, into the hole 138 x 138 mm. The connection of the wires is from the back side of regulator, to the terminals box. Measuring and auxiliary voltages are being taken from supply voltage, which must be protected by fuse 6 A.



Picture 3: Connection of measuring circuits



Picture 4: Position of FCR12 controller in the compensation system

Location of the current transformer has to allow both current of the load and the current of the capacitor to be measured together. Correct location is shown on the picture 4 as well as examples of wrong location.

The complete connection is shown at the picture 5. There is only one rule that should be considered. Stages with the same power have to be connected side by side. For example:

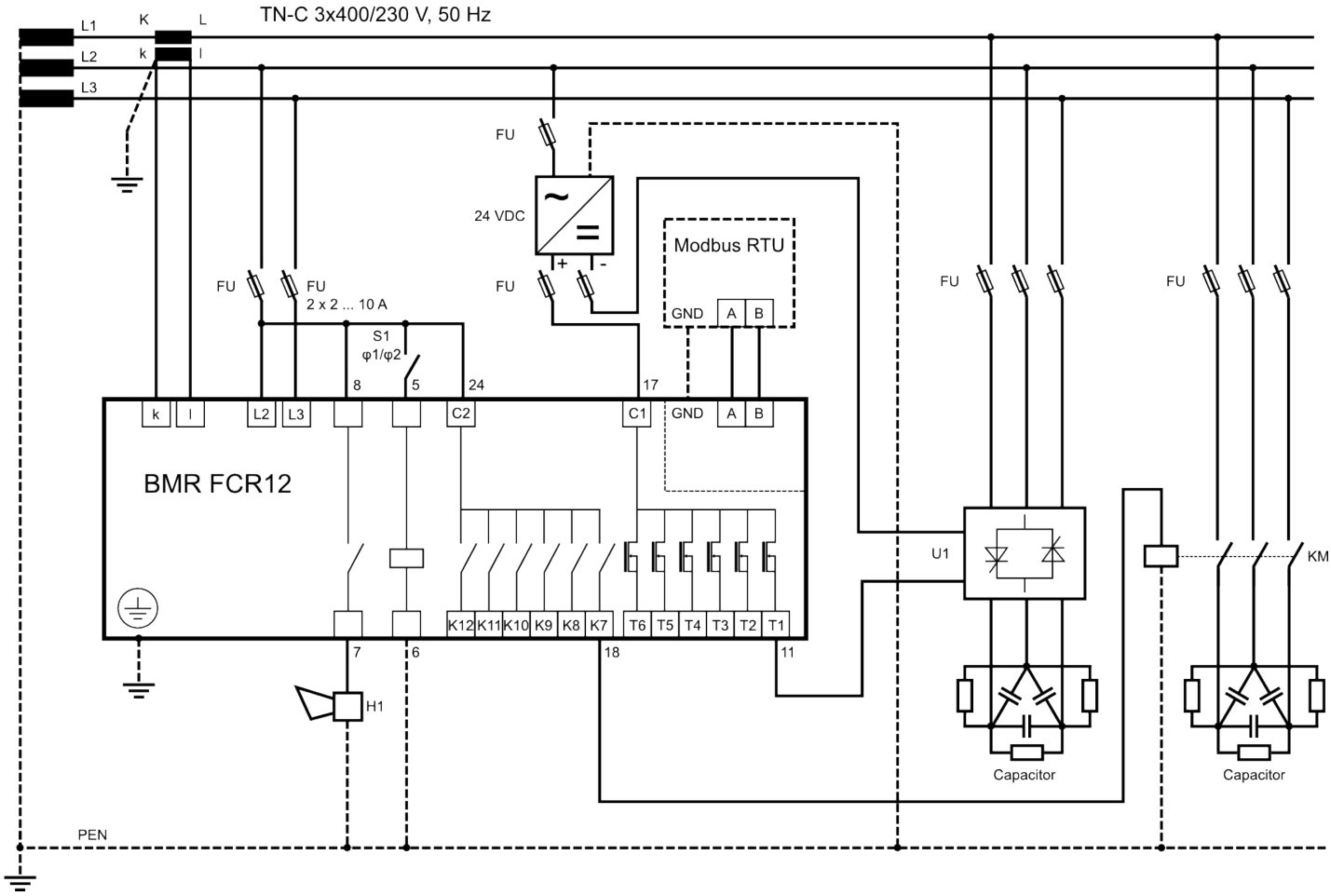
1st stage	2nd stage	3rd stage	4th stage	5th stage	6th stage
6,25 kVAr	6,25 kVAr	12,5 kVAr	-	25 kVAr	25 kVAr

However, ranging the powers in accordance is not necessary. There could be even gaps between particular power levels. For example, stages 1 and 2 could be connected, then stage 3 disconnected, stages 4 and 5 connected and so on.

Important

Fast thyristor stages have to be placed from the first stage of regulator outputs. De-compensation reactors is useful to connect behind the capacitors.

Connection diagrams depend according to the fact if the regulator controls only contactor stages, combination of contactor and semiconductor stages in one set of six stages, or it controls only semiconductor stages in the set of 6 stages.



Picture 5. Connection of the FCR 12 controller for contactor and thyristor stages for standard supply voltage 400 VAC

6. Regulator parameter setting

Considering various usage of regulators FCR06 or FCR12, there is a number of programmable parameters. For easy start, regulator is set to default parameters, made by manufacturer. Set parameters are stated in the following table.

For fast start, the parameters that should necessary be set are cosφ and transformer ratio of current transformer. Eventually, transformer ratio of voltage transformer could also be set. Further more, there are also other parameters that could be set, in accordance to the customer request.

In order to avoid any unwanted reprogramming of the device, it is possible to protect access to service mode by setting the four digits password. By default, new regulator doesn't have any password protection activated. It is recommended to activate password protection after setting all parameters. After the protection has been activated, it is possible to see all set parameters, but not to change any of them.

For checking respective setting set parameters follow those instructions:

1. Press the button **SET** for 5 seconds. Device switches to the service mode and parameter **CoS1** will appear on the display. This is a symbol of parameter whose currently set value will appear after another pressing of button **SET**.
2. Via buttons ▲, ► is possible to set the requested value of specified parameter.

3. By pressing the button **SET** again, regulator will save changed value to the internal memory and on display symbol of the set parameter will appear again. Via buttons ▲, ► it is possible to move to another parameter (see the table 4).
4. If the offered parameter is not the one, which is requested to be modified, follow via buttons ▲, ► to the requested parameter.
5. Regulator turns back automatically from service mode after 1 minute without any keyboard action, or by repeated pressing of buttons **SET** during returning from parameter value setting.

Important

While service mode is activated, device is not regulating. Regulator will not react to the power factor changes, neither to the changes of other monitored variables. Alarm output will not operate as well.

Parameter	Description	Factory setting	Setting range
CoS1	target cosφ	ind 0,98	0,80 cap. ... 0,80 ind. in steps of 0,01
CoS2	target cosφ for second tariff	ind 0,90	0,80 cap. ... 0,80 ind. in steps of 0,01
I_tr	current transformer ratio	1	1 ... 6000 in steps of 1
U_tr	voltage transformer ratio	1	1 ... 300 in steps of 1
Auto	automatic detection of compensation stages	oFF	on / oFF
SHtd	deceleration of regulation in the case of over-compensation	60	0 ... 9999 s in steps of 1 s
St_P	manual setting of compensation stages	0	999,9 kVAr cap. ... 999,9 kVAr ind. in steps of 0,1 or overdrive of 1
dItI	discharging time for thyristor / contactor stage	0/60	5 ... 900 s in steps of 5 s or overdrive of 50 s
dIPA	delay for disconnection of thyristor / contactor stage	0/15	5 ... 900 s in steps of 5 s or overdrive of 50 s
rSSt	number of circuit closing of thyristor / contactor stage	0/99.99	up to 99990
FISt	fixed capacitor stages	Auto	Auto / oFF / on
CoCo	connection configuration	90	0° ... 330° in steps of 30°
H03t	level of 3rd harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H05t	level of 5th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H07t	level of 7th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H09t	level of 9th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H11t	level of 11th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H13t	level of 13th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H15t	level of 15th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H17t	level of 17th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
H19t	level of 19th harmonic of voltage	0	0 ... 20 % in steps of 0,1%
tHdI	total harmonic distortion of current	0	0 ... 300 % in steps of 1%
UL.AL	under-voltage alarm	oFF	on / oFF – off alarm does not operate
UH.AL	over-voltage alarm	oFF	on / oFF – off alarm does not operate
IL.AL	under-current alarm	oFF	on / oFF – off alarm does not operate
IH.AL	over-current alarm	oFF	on / oFF – off alarm does not operate
Co.AL	alarm for cosφ, that is permanently over set limits	oFF	on / oFF – off alarm does not operate
Ht.AL	alarm for harmonic distortion of U and I	oFF	on / oFF – off alarm does not operate
ot.AL	alarm for high ambient temperature	oFF	on / oFF – off alarm does not operate
rS.AL	alarm for exceeding of maximum number of stage circuit closing	oFF	on / oFF – off alarm does not operate
¯CoS	regulation to the average power factor	on	on / oFF / Auto – off device regulates to instantaneous cosφ
Id	device id number in RS485 network	1	1 ... 255
bAUd	communication speed for data transmission	0	0 ... 9600 Bd
PAr	communication control by parity checking	oFF	oFF / on /on_o
CodE	password for access to SET mode	0000	any four digits number 0001 ... 9999
rES	reset to the factory setting	-	

Table 4. Service menu parameters

6.1. Target cosF setting (CoS1, CoS2)

Press the button **SET** at least for 5 second for entering service mode. On the display will appear parameter symbol **CoS1**. After another pressing of button **SET** display will show set value. Via buttons ▲, ► set new requested value in the limits from 0,8 inductive to 0,8 capacitive. Another pressing of button **SET** saves new value to the memory and on display it will appear again symbol **CoS1**.

For programming **CoS2** follow the same instructions as previous case. For changing from **CoS1** to **CoS2** it is necessary to connect auxiliary supply of 230 V AC to the terminal marked as **2nd Tariff** on the connection diagram.

6.2. Setting of current or voltage transformer ratio (I_tr, U_tr)

If **SET** mode is activated, move by buttons ▲, ► to the parameter **I_tr**. After pressing button **SET**, the set value will appear on the display. Via buttons ▲, ► is possible to change value of transformer ratio. Another press of button **SET** saves new value to the memory and on display, symbol **I_tr** will appear again.

It is important to have in mind that the value which is set, is ratio itself. It means that, for example, if primary nominal current of transformer is 50 A and secondary is 5 A then set parameter value is **I_tr** = 10.

In case of voltage transformer usage, parameter **U_tr** should also be set the same way.

Caution

Measurement range of the current inputs is from 10 mA to 6 A. Maximum of the current transformer ratio is 30000 / 5 A. If the current value is over 5,3 A, alarm will be started, in the case it is enabled.

6.3. Automatic detection of compensation stages (Auto)

Another parameter in the menu is function **Auto**. After pressing of button **SET**, the display will show **oFF**. Via buttons ▲, ► change to the value **on**. After double pressing of button **SET** automatic detection will start to detect connected stages. The symbol **CoCo** will appear on the display, and first capacitor stage will be switched on and off 6 times in the cycle of 20 seconds.

Detection of regulator connection to the network is followed by detection of power of connected capacitor stages. During detection, the measured values of each stage are shown on the display. Measured values are being rounded on 0,5 kvar. After the detection is finished, the regulator will switch parameter **Auto** back to **oFF**.

Important

*In some cases regulator is not able to make automatic detection and in place of measured power shows zeros. It can happen in places with very fast changes of network parameters, where measured values will not be correct. In this case regulator shows **Err1** and it is necessary to set parameters manually, after detailed network measurements.*

6.4. Deceleration of regulation at over compensation (SHtd)

This parameter is represented by symbol **SHtd**. This function is used for slowing down the regulation during over-compensation. At under-compensation regulation is slowed down according to average power factor. This function assures reduction of switch on/off operation of contactor stages. After pressing the button **SET**, display will show set value of deceleration. By buttons ▲, ► it is possible to change value and button **SET** saves this into the memory. Current situation of regulation deceleration during over-compensation is shown under parameter **SHtd**, in the menu of measured values.

Important

This function does not affect semiconductor stages. Semiconductor stages react immediately.

6.5. Manual setting of compensation stages (St_P)

After parameter **Shtd**, the parameter that follows in the menu is **St_P**. Pressing the button **SET** will enter the sub menu, where it is necessary to select the stage, which has to be set, via buttons ▲, ►. Selected stage will be signalized by green LED. By pressing button **SET** on display will appear set value of stage that is signalized by relevant green LED. Via buttons ▲, ► it is possible to change the value and by pressing button **SET** to save this into memory. Via buttons ▲, ► select another stage, which must be set and follow the same procedure as before. After

setting of all stages, keep pressing button **SET** until display will show **St_P** and all LED's will be off.

6.6. Discharging time (dItI)

For setting the absorption of stages, parameter **dItI** is available in the menu. By this parameter, it is possible to set, for each stage separately, suitable time for capacitor discharge. This time can be set from 5 to 900 seconds. Default factory setting value is 60 seconds. Setting procedure is according to the same rules as another parameters explained before.

Important

For semiconductor stages the time is set on 0 seconds, and it is not possible to change it.

6.7. Delay for disconnection (dIPA)

This parameter is represented on the display by symbol **dIPA**. It is the minimum time for contactor stage circuit closing. It is possible to be set from 5 to 900 seconds. Setting procedure is according to the same rules as another parameters explained before.

Important

For semiconductor stages the time is set on 0 seconds, and it is not possible to change it.

6.8. Number of stage circuit closing (rSSt)

On the display, it is represented by symbol **rSSt**. It is possible to set allowed number of circuit closing for each contactor stage. For semiconductor stages, this feature doesn't have any reason. Maximum set value is 99.99, which means 99990 closings. Number that appears on display has to be multiplied by 1000.

6.9. Fixed capacitor stages (FISt)

On the display it is represented by symbol **FISt**. This parameter allows to set stages as a fixed ones. The regulator is not counting those stages for regulation cycle. Each stage can stay in three working regimes.

- **Auto** – stage is normally regulated by controller
- **oFF** – always off (status indication LED blinks red)
- **on** – always on (status indication LED blinks green)
- **tAr2** – stage is always on when second tariff is activated at tariff input

Setting procedure is according the same rules as another parameters explained before.

6.10. Connection configuration (CoCo)

If the regulator is connected according the connection diagram on the picture 3 correction angle is 90°. That is default value set by manufacturer. If the regulator is not connected according to this connection diagram, then it is necessary to make angle correction by displacement of measuring current and voltage. This parameter allows to set angle movement from 0° to 330° in steps of 30°. On the display symbol **CoCo** will be shown. After pressing the button **SET**, the display will show set value. Via buttons ▲, ► it is possible to change the value. Another press of button **SET** will save new value into the memory.

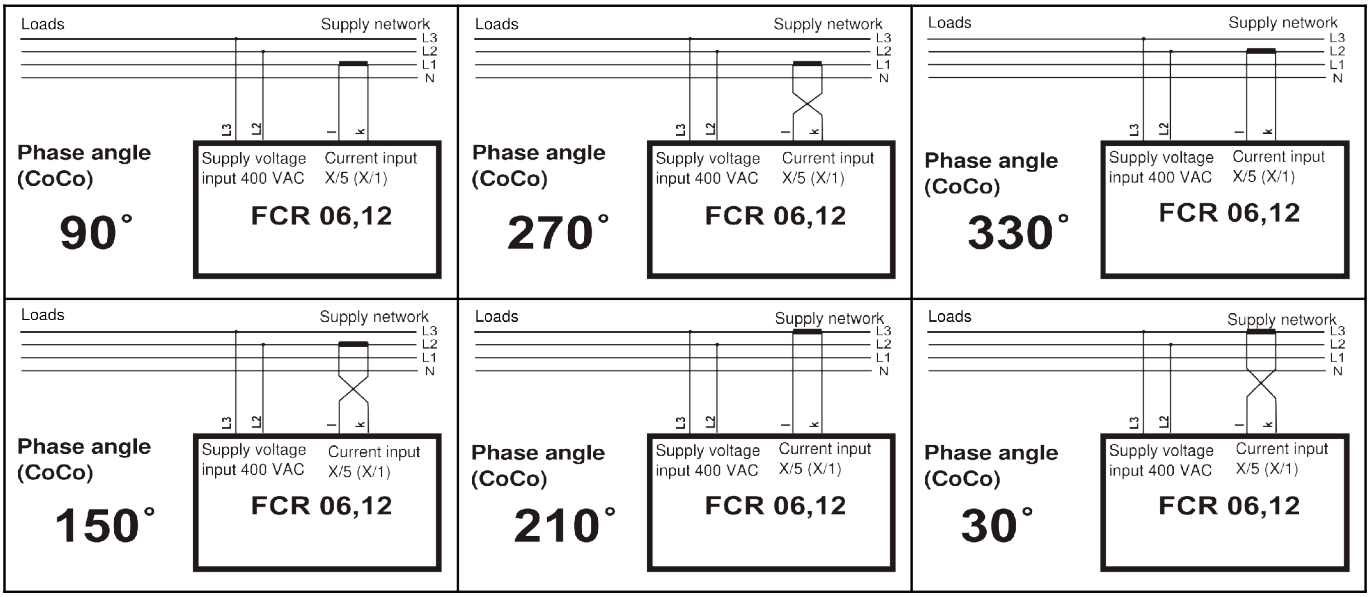


Table 4. Phase shift setting for supply and measuring voltage 400 VAC

6.11. Level of harmonic voltages (H03t – H19t)

Regulator makes harmonic analysis of currents and voltages, up to 19th harmonic. It is possible to set limit values from 3rd till 19th harmonic of measured voltage. Setting procedure is according to the same rules as another parameters explained before. In service mode, via buttons ▲, ►, move to the parameter **H03t**. After the button **SET** being pressed, the display will show set value. The set value can be changed via buttons ▲, ►. By another pressing of button **SET** save changes into the internal memory and on the display the symbol **H03t** will appear again. Via button ▲ move to another harmonic and repeat the same procedure. If it is not necessary to change some limit, move to another harmonic by pressing button ▲. If the value is set to 0 ,then voltage harmonic control is disabled.

6.12. Current harmonic distortion (tHdI)

Regulator doesn't make harmonic control of the current, which is measured, for each particular harmonic, but evaluates total harmonic distortion **THdI**. This symbol is shown on the display when this parameter is active in service mode. Parameter setting should be done according to the same procedure as other parameters. After pressing the button **SET**, display will show set value of **THdI**. Via buttons ▲, ► this value is possible to be changed. By pressing button **SET** this new value will be confirmed and on the display will appear again symbol **THdI**. If the set value is exceeded, regulator automatically disconnect all capacitor stages and starts the alarm, in the case it is previously activated. If the value 0 is set, then harmonic distortion control is disabled.

6.13. Alarms

During normal operation alarm output is opened. In the case of any disturbance the alarm output will close. There are lot of events, that can be enabled to activate alarm.

Individual events, which activate alarms are possible to be defined by following: in service mode move to the first item of alarm event, which is alarm at under-voltage. On the display symbol **UL.AL** will appear. After pressing the button **SET**, display will show if alarm is enabled or disabled. Value **oFF** means that alarm is disabled. Value **on** means that alarm is enabled. Via buttons ▲, ► it is possible to change **on** / **oFF**. By pressing button **SET** new value is saved into the regulator memory. Following the same procedure sets other alarm events.

For alarm **Co.AL** is also possible to set if alarm should be activated at power factor failure during consumption and distribution (**on**), only during consumption (**on_o**) or only during distribution (**on_d**).

Alarm	Condition of activation
UL.AL	measuring voltage < Unominal - 20%
UH.AL	measuring voltage > Unominal + 14%
IL.AL	measuring current on regulator terminals < 10 mA
IH.AL	measuring current on regulator terminals > 5,3 A
Co.AL	it is permanently not possible to reach set power factor for 1 hour
Ht.AL	threshold value of at least one of harmonics over-passed set level or set THDI over-passed set level
ot.AL	ambient temperature for regulator location 35°C switch on alarm output – ventilator (30°C switch of the alarm output – ventilator) 50°C disconnect all stages (40°C will turn back to normal regulation)
rS.AL	if any of contactor stage overpasses maximum allowed circuit closing = 99.999

Temperature alarm is a special alarm which behaves in two levels. When **ot.AL** is enabled then alarm output is supposed to control cabinet ventilation by fan. In first level it starts fan for ventilation at 35°C. Second level which disconnects all compensation stages and gives alarm event on display is at 45°C. Both temperature values are preset in device by manufacturer and cannot be changed by user.

Caution

For harmonic alarm Ht.AL it is necessary to define the level of harmonic. If the harmonic distortion is higher than set level, all compensation stages are disconnected.

6.14. Regulation to average or instantaneous power factor (¯CoS)

This setting defines if regulator will regulate slow contactor stages to average or instantaneous power factor. If the set value is **on** then usage of contactor stages is affected by average power factor. If the set value is **off** then regulation is performed only according to instantaneous power factor. In service mode move via button ▲, ► to the item **¯CoS**. After pressing of button **SET** display will show set value **on** / **oFF** / **Auto**. Via buttons ▲, ► it is possible to change this value. Another pressing of button **SET** saves new value into the regulator memory.

Caution

*Option **auto** is a modification for Lithuanian market where there is not defined any area for cos φ (for example 0,96 ... 1) but strict limit cosφ = 1. With enabled option **Auto**, controller is regulating symmetrically according to parameter **SHtd**.*

6.15. Configuration of RS485 communication port

Following parameters relate to configuration of serial communication for RS485 port (MODBUS communication protocol).

- **Id** – defines the number of device in the RS485 network and can be set from 1 ... 255
- **bAUd** – defines communication speed between the FCR controller and PC. Default value is 0
- **PAr** – by default it is set to **oFF** and it can be changed to even (**on**) or odd (**on_o**)

6.16. Password for entering service mode (CodE)

Thanks to password is possible to protect regulator against unauthorized configuration. Without proper password knowledge it is possible only see set parameters but not to change them. Password is set as four digit number. In service mode move via buttons ▲, ► to the parameter **CodE**. After pressing of button **SET** display will show ‘’- - - -‘’. First dash from left side is blinking. Via button ▲ set number from 0 - 9 and confirm by button ►. Now second dash is blinking and first set number lights on the display. Keep the same procedure until last number is set. By pressing of button **SET**, password for entering service mode is saved into the memory. From this moment it is necessary, for each change, type password in order to enter service mode. Otherwise any change will not be accepted.

6.17. Restart (rES)

This function restores default configuration. It is last item in the menu and it is represented on the display by symbol **rES**. Press the button **SET** and keep it. At the same time press the button **MAN**. LED of capacitor stages will turn on and then slowly will start to go down. This cycle will repeat two times. After that, the display will show instantaneous value of power factor. Factory setting will be restored.

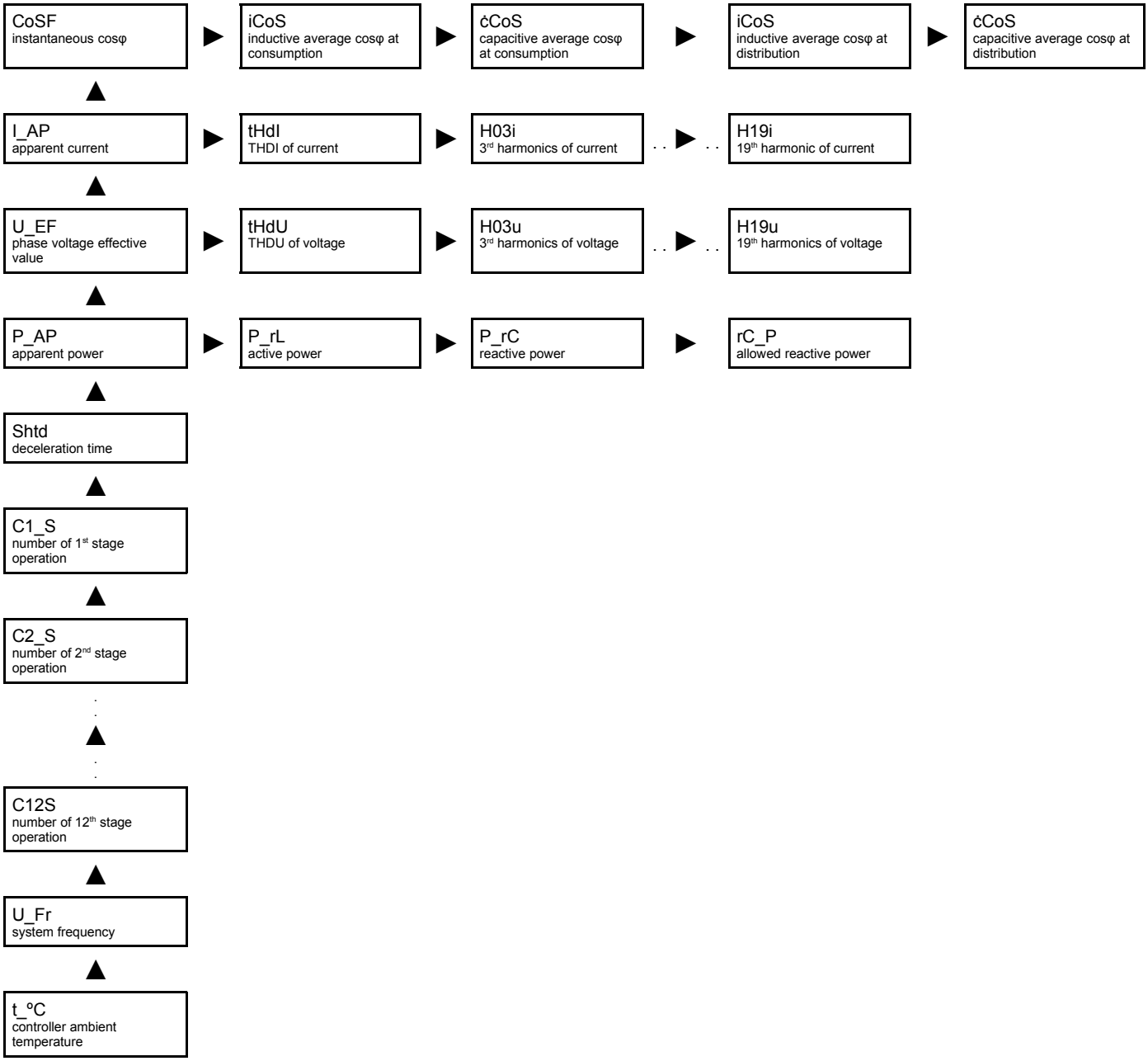
Important

After restart, it is necessary to set device again as well as make auto detection.

7. Displayed values

Monitoring features do not affect regulation process which is invisibly working all the time. Displayed value is possible to be changed at any time and LEDs on the right side of display identify type of shown value.

Shown values are divided to levels so that values in one level are closely related. For switching between particular levels press button ▲ and for changing screens in one level press button ►. Splitting of shown values to the levels is clear from following list. For returning to the instantaneous **CoSF** press button **SET**.



7.1. Maximums

FCR06 and FCR12 controllers record maximums of several measured parameters to volatile memory for information purposes only. Registered maximum values are reset when the power supply is lost.

For getting information about maximum of the measured value, press button **MAN** and the max value will be shown for a while. Keeping the button pressed, the display will show maximum of the measured value.

To erase this maximum value, press together button **MAN** and button **SET**.

7.2. Cosφ

Displaying the cosφ is default indication. This value will appear on display after supply voltage connection and if in current input the current flow is higher than 10 mA. Red LED on the left side of display marked as **ind** and **cap** indicates if measured power factor is in inductive or capacitive area.

If measuring current drops below 10 mA, controller disconnects all stages and on the display will appear " - - - - ". By button ► it is possible move to average inductive power factor indication. At first, the display will show symbol **i_CoS** and then after 1 second numeric value will be shown. After pressing the button ►, the display will show symbol **ċCoS** and after 1 second it will show numeric value. Another pressing of button ► will show **iCOS** during distribution (power supply LED is on), followed by **cCOS** during distribution, and then will return back to instantaneous value of cosφ.

7.3. Apparent current

Pressing of button ▲ will move to another level - apparent current. Symbol **I_AP** will appear on the display for 1 second. After that, the display will show effective value of apparent current on primary side of current transformer, assuming that correct transformer ratio is set in service mode, under the parameter **I_tr**.

Another value in this level is current harmonic distortion factor. After pressing the button ►, the display will show symbol **THDI**, which will be replaced after 1 second by actual measured value. For getting information about maximum value or erasing it, follow the same procedure as described above.

7.4. Voltage

This level has exactly the same structure as previous level for apparent current, but this time it is for network voltage.

7.5. Powers

Another level offers values of four powers. At the first position there is apparent power **P_AP** , following by active power **P_rL** and reactive power **P_rC**, respectively and the last but not least there is allowed reactive power **rC_P**. For all powers actual measured value is available and of course also maximum measured value. Procedure of showing or erasing of all values is the same as for previous levels.

7.6. De-compensation delay

This information shows actual remaining time (seconds) to regulation action during over-compensation. Displayed value is decreased each second by square of true control deviation and requested power factor value.

7.7. Number of stage circuit closings

Number of stage circuit closings is divided to the 6 for FCR06 (12 for FCR12) independent levels. For the first stage, the display will show symbol **C1_S** and after it disappears the number of first stage circuit closings will be displayed. By simultaneous pressing of buttons **SET** and **MAN** this information can be erased. To another level, where information about second stage is, move by pressing the button ▲. The rest of procedure is the same as for the first stage.

Note

For semiconductor stages number of circuit closings is not recorded.

7.8. System frequency

Next to the last level is system frequency **U_Fr**. Also at this level, actual value of system voltage frequency, maximum value and minimum value are available. Showing of actual and maximum values is the same as for previous levels.

7.9. Temperature

Last level shows regulator ambient temperature **t_°C**. Both actual and maximum value are possible to be seen. Showing or erasing these values is the same as for previous levels.

8. Manual operation

Switching the regulator to the service mode and by subsequent press of button **MAN**, manual regulation of compensation stages will be activated. The status is indicated by LED with label **manual**. On the display, symbol **St_1** will be shown for 1 second. After that, it will be replaced by actual value, which blinking (manual mode indication). Button ▲ allows to change stage status with respecting the set discharging time and delay for stage disconnection. It means that if the stage was disconnected, pressing the button ▲ will switch the stage on. If the stage was connected, the same button will switch the stage off. For another stage selection press button ►. After pressing this button, the display will show for 1 second symbol **St_2**, representing another stage. The whole procedure is the same like for the previous stage. By pressing the button **MAN**, manual mode can be deactivated.

9. Alarm notification

If at least one of enabled alarm events appeared, then alarm output relay will be switched on for 1 min and LED with label **alarm** will blink on the display. This LED will also blink after the alarm event disappears, until it gets canceled by button **SET.** Alarm notification does not have any influence to regulator behaviour, except in the case when alarm is activated by high harmonic disturbance.

The symbol of alarm sort is shown on the display after pressing of button **SET**. Symbol of the event that caused the alarm will appear on the display. Another pressing the button **SET** will cancel shown alarm. If more alarm events happened, another event symbol will appear on the display. By keeping the same procedure, it is possible to follow till last alarm event is canceled. In the displayed values mode it is possible to find out which values of alarm events activated alarm (chapter 7.1). Alarm event symbols are the same as symbols used during alarm setting in service mode.

10. Technical features

Parameter	Value
Supply voltage = measuring voltage	400 V AC 50 Hz (+10%,-15%)
Frequency	50 / 60 Hz
Current range	0,01 ... 6 A
Measurement accuracy of 1st current harmonic (I > 200mA)	±1 mA (class 2)
Power consumption	10 VA
Output channels number	6 or 12
Switching power of alarm output	250 VAC / 5 A
Switching power of relay contacts	250 VAC / 5 A
Switching power of semiconductor contacts	24 VDC / 100 mA or 230 VAC / 100 mA
Switching speed of semiconductor stages	25 operations per second
Range of requested power factor	0,8 ind. ... 0,8 cap.
Re-connection delay: semiconductor / contactor stages	0 s / 5 ... 900 s
Switching off delay: semiconductor / contactor stages	0 s / 5 ... 900 s
Compensation stages value setting	manually / automatically
Communication port	RS485 (optional)
Communication protocol	MODBUS RTU
Communication speed	up to 9600 Bd
Temperature limit	-40°C ... +70°C
Front panel	144 mm x 144 mm
Panel cutout	138 mm x 138 mm
Site depth	55 mm
Weight	1 kg (including packaging)
Protection degree	IP20 rear cover / IP54 front panel
Standards	EN 61010-1, EN50081-1, EN50082-1

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