BMR ICR 12

Impulse power factor controller

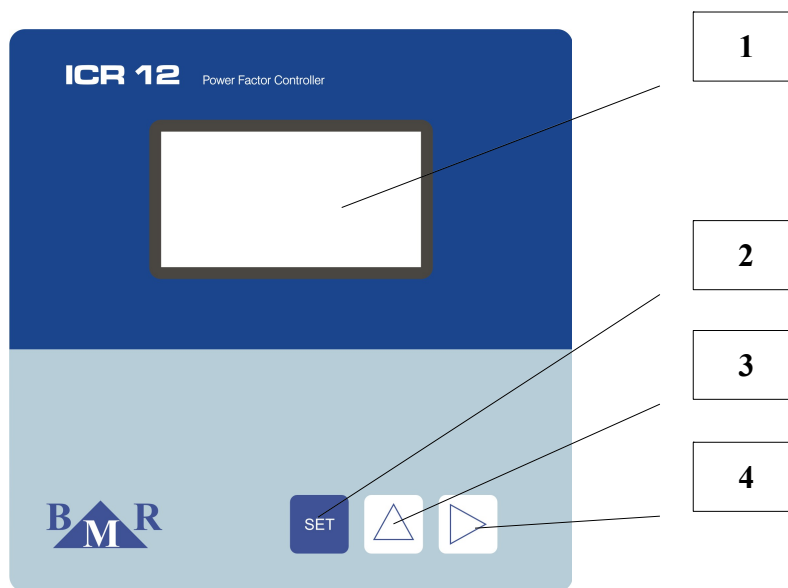## User and service manual

version 1.2

Content

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1. Front control panel and back terminal

Picture 1: Front panel description

1. **Display** – full graphic OLED display
2. Button for menu entrance and saving set parameters
3. Cursor button for moving up in menu and parameter change to higher value
4. Cursor button for moving down in menu and parameter change to lower value
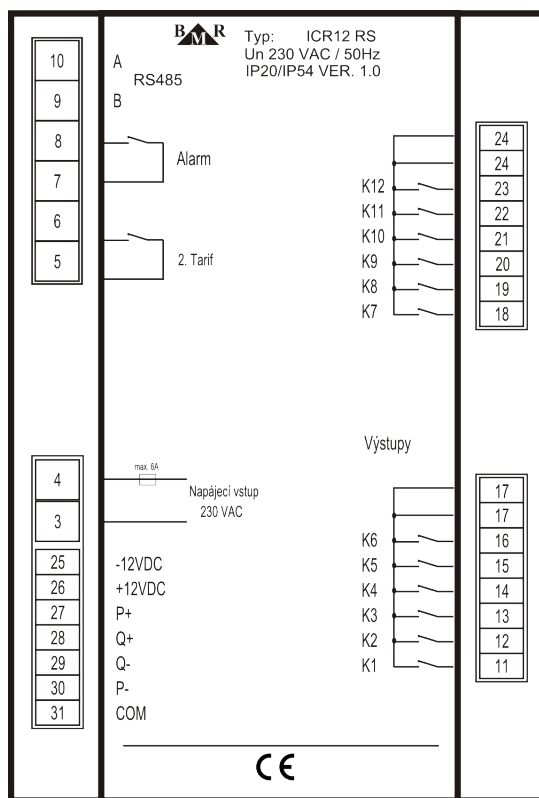
Picture 2: Back panel with terminal connection

2. Device description

Power factor controllers ICR06 and ICR12 are impulse power factor controllers designed for usage together with static four quadrant energy meters equipped with digital pulse outputs.

ICR controller measures, records and shows following variables:

Parameter	Display	Maximum	Minimum
Instantaneous cosφ	●		
Average cosφ (capacitive, inductive)	●		
Active three-phase power	●	●	
Reactive three-phase power	●	●	●
Number of operation of particular outputs	●		
Ambient temperature	●	●	

Device is offered with 6 and 12 outputs design. Controller ICR 06 has available 1 x 6 outputs and controller ICR 12 has available 2 x 6 outputs. Outputs for mechanical contactors are with relays for maximum load of 250 V AC, 5A.

3. Connection

Default parameters are set to the device in production, according to the table 3 and 4. Connection of the device should be done according to picture 3.
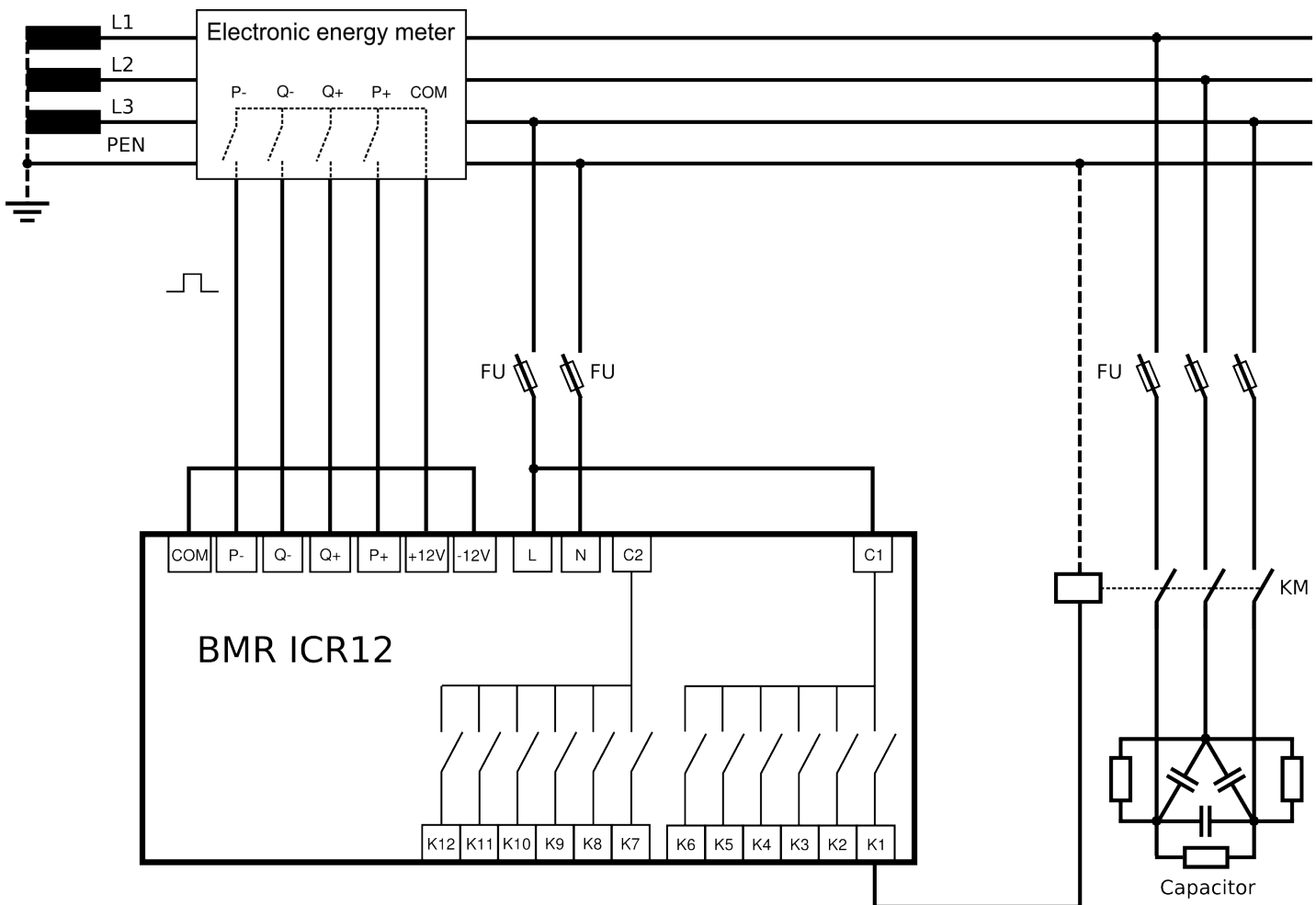
Picture 3: Connection of ICR controller

4. Setting in operation – fast start

For fast setting of the ICR controller in to the operation follow following instructions.

1. Make connection in accordance to connection diagram at picture 3.

2. Connect power supply voltage.

3. Press key **SET** for time at least 5 seconds to enter the **Main menu**.

4. Cursor stays at the parameter **Target CosΦ**. By pressing the button **SET** once again, device will enter to setting of targeted value of cosφ. Setting the desired value of cosφ is done via buttons ▲ (+) and ► (-).

5. Confirmation of the set value **Target CosΦ** is done by pressing the button **SET**. Regulator will also return back to the **Main menu**.

6. Move to the parameter **P pulse weight**.

7. After pressing the button **SET** the value of active power pulse weight will appear (factory setting of pulse weight is 0). Using the buttons ▲, ► set correct value of active power pulse weight in accordance to energy meter label.

8. Pressing the button **SET** confirm set value. On display the **Main menu** will appear again.

9. Move to the parameter **Q pulse weight** now.

10. After pressing the button **SET** the value of active power pulse weight will appear (factory setting of pulse weight is 0). Using the buttons ▲, ► set correct value of active power pulse weight in accordance to energy meter label.

11. Pressing the button **SET** confirm set value. On display the **Main menu** will appear again.

12. Enter the **Advance menu** and open the parameter **Pavg imp. No.**. Set the number impulses used for average active power. The value is defined by weight of pulse / time between two pulses.

13. Move to the parameter **Pavg max. time** and set maximum time [s] for calculation of average instantaneous active power. Factory setting is "0". Setting the time longer than 0 force controller to wait for this time until pulse come. If If till the **Pavg max. time** elapses there is no new pulse or pulses according to parameter **Pavg imp. No.** the time which was measured until that moment is used for average power calculation.

14. Now enter the parameter **Stage powers** and set powers of particular steps. Set the correct type of step orientation (inductive or capacitive). After this setting is done confirm all changes and move back to Monitoring mode by pressing button **SET** until the main screen appears.

Other parameters may remain the same as factory settings. In case of tuning the controller to specific needs of of application study the chapter 7.

Once the setting is done move to second monitoring screen and check if pulses from energy meter are read. Controller has available 4 pulse inputs where the each line on the screen is dedicated for each input. Presence of coming pulses is indicated by flashing dot on the left side of the line.

If the pulses are read by controller and setting is correct than after discharging time expiration controller will start connect compensation steps.

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5. Device function

Device reads pulses from energy meter digital outputs. Base on pulse weight and time between pulses it calculates instantaneous active and reactive powers. According to its size and configuration settings, regulator will switch on or switch off appropriate capacitor stages. Speed and accuracy of reaction depends on pulse weight and pulse count of particular energies. As bigger count of pulses and lower pulse weight as better accuracy and regulation speed. At smaller pulse count controller tune all power values in time. This feature improves significantly the regulation result at small powers and low pulse count.

Within the scope of steps with the same power, regulator uses method of circle switching. At appropriate power level it connects the step, which was switched off for longest time. Everything is made to manage regulator reaching optimal compensation in one regulation cycle with minimum number of switched stages.

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.

6. Installation of the device

Regulator ICR 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 terminal box. Pulse inputs and auxiliary voltages are available from back side of device.

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 = 6,25 kvar, 2nd stage = 6,25 kvar, 3rd stage = 30 kvar, 4th stage = 25 kvar, 5th stage = 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.

7. Device parameters setting

Considering various usage of regulators ICR, there is a number of programmable parameters. For easy start, regulator is set to default parameters, made by manufacturer. Set main parameters available in the **Main menu** are stated in the following table.

Parameter	Description	Factory setting	Setting range
Target CosΦ1	Targeted cosφ for first tariff	ind 0,98	0,80 cap. ... 0,80 ind. In steps of 0,01
P pulse weight	Active pulse weight according to energy meter label	0000.00 Wh	0 ... 9999.99 Wh
Q pulse weight	Reactive pulse weight according to energy meter label	0000.00 Wh	0 ... 9999.99 Wh
Advanced menu	Submenu with additional settings	►	►

Table 3. Main menu

Further more, there are also other parameters that could be set, in accordance to the customer request. Those parameters are available in the **Advanced menu** and are listed in following table. All configurable parameters are described at chapter 7.

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

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Parameter	Description	Factory setting	Setting range
Target CosΦ2	Target cosφ for second tariff	ind 0,90	0,80 cap. … 0,80 ind. In steps of 0,01
COSΦ1 / COSΦ2	Activation method between COSΦ1 and COSΦ2	External input	External input / Current direction
Pavg imp. No.	Number of impulses for average power calculation	3	1 ... 20 in steps of 1
Pavg max. time	Maximum time for average power calculation	0s	0 ... 900s in steps of 10s (0s - disabled)
Stage powers	Manual setting of power of compensation stages	0	999,9 kvar cap. … 999,9 kvar ind.
Delay at Qc	Deceleration of regulation at over-compensation	60	0 … 9999s in steps of 1s
Discharging time	Discharging time for capacitor stages	60	5 … 900s in steps of 5s / overdrive of 50s
Min. closing time	Minimum operation time of capacitor stages	15	5 … 900s in steps of 5s / overdrive of 50s
Stage operation No	Number of operation of capacitor stages	999999	till 999 999
Fix stages	Behaviour of particular capacitor stages	Auto	Auto / Off / On
Alarms	Alarm events menu	►	►
Average COSΦ	Regulation on average or instantaneous cosφ	On	On / Off
COSΦ avg. time	Half period time for average cosφ calculation	15	15, 30, 45, 60 minutes
Max. temperature	Temperature for disconnection of all stages	55	30 ... 80 °C
Fan temperature	Temperature for ventilation start	35	30 ... 80 °C
Maximum saving	Saving the maximums of measured values	Off	On / Off
COSΦ 1/4h days	Number of days for storing the 15 min cosφ	0	0 ... 40 days
Serial port	Serial port RS485 configuration menu	►	►
Password	Protection password against unauthorized setting	0	any four digits number 0001 ... 9999
Manual mode	Manual operation of capacitor stages	Off	On / Off
Reset	Reset to default factory configuration	-	-

Table 4. Advanced menu

For checking respective setting parameters of configuration menu, follow those instructions:

1. Press the button **SET** for 5 seconds. Device switches to the **Main menu** and list of parameter will appear on the display. Via buttons ▲, ► move to requested parameter and by pressing button **SET** enter the configuration or submenu.

2. It is possible to set the requested value of entered parameter by using the buttons ▲, ►.

3. By pressing the button **SET** again, regulator will save changed value to the internal memory and return back to the previous menus.

4. For returning from submenu to previous menu use key **SET**. Every submenu is identified by symbol ► at the right side of the menu name.

5. Regulator turns back automatically from service mode after 1 minute without any keyboard action, or by repeated pressing of the button **SET** during returning from the 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.

☞ **Note**

Overdrive is activated by permanent pressing of button ▲ or ►.

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7.1. Main menu

Main menu of configuration mode is activated from the normal operation mode by pressing the button **SET** for at least 5 seconds. Moving in the menu is done via buttons, where button ► is for moving down and button ▲ for moving up. Entering the parameter setting or **Advanced menu** is by pressing the button **SET**.

7.1.1. Target CosΦ1

The first parameter in the menu is **Target CosΦ1** for setting the requested cosφ. Via buttons ▲, ► set the new requested value in the limits from 0,8 inductive to 0,8 capacitive. Inductive or capacitive character is symbolized by capacitor or inductor icon on the display. Pressing of button **SET** saves new value to the memory and turns back to **Main menu** screen.

7.1.2. P pulse weight – weight of active pulse in Wh

Weight of active energy pulse is fundamental setting for correct controller operation. Refer to the energy meter label for information about the active energy pulse weight and set the appropriate value in this parameter.

7.1.3. Q pulse weight – weight of reactive pulse in Wh

Weight of reactive energy pulse is another fundamental setting for correct controller operation. Refer to the energy meter label for information about the reactive energy pulse weight and set the appropriate value in this parameter.

7.2. Advanced menu – configuration submenu

7.2.1. Advanced menu

Selecting the parameter **Advanced menu** in the list of **Main menu** and pressing the button **SET** will enter the **Advanced menu**. For moving in the menu follow the same procedure as for **Main menu**.

Return from **Advanced menu** to **Main menu** is possible after pressing button **SET** where the first press enters the parameter, second press confirms the set value and turn back to **Advanced menu** and third press escapes to the **Main menu**.

7.2.2. Target CosΦ2 – requested cosφ for second tariff

First parameter in the Advanced menu is **Target CosΦ2** for setting the requested cosφ for second tariff. Via buttons ▲, ► set new requested value in the limits from 0,8 inductive to 0,8 capacitive. Inductive or capacitive character is symbolized by capacitor or inductor icon on the display. Pressing of button **SET** saves new value to the memory and turns back to **Advanced menu** screen.

7.2.3. "COSΦ1 / COSΦ2" – second tariff activation

Defines the way of activation of second tariff of cosφ. Tariff change can be activated by external input or load direction.

7.2.4. "Pavg imp. No." – number of impulses for average power calculation

This parameter defines the array of pulses used for average power calculation. This is important mostly for applications where the load is changing a lot and where there is a lot of impulses in short time. It eliminates power peaks which can appear in such applications. Factory setting is 3 and it is possible adjust it in range 1 ... 20.

7.2.5. Pavg max. time – maximum time for average power calculation

This parameter is important for application where the load is very various. If the time between two pulses is too long then controller does not wait until the number of pulses is reached (parameter **Pavg imp. No.**) but it use time between pulses for calculation of average power. If the parameter **Pavg max. time** is set on 0 then time limitation is disabled. Controller will wait for the defined number of pulses without consideration of the time. Factory setting is 0 and it is possible set time in range 0 ... 900 seconds.

7.2.6. Stage powers – particular stage power setting

Power of every controlled stage of ICR controller can be set independently within the range of values from 999,9 kVAr inductive to 999,9 kVAr capacitive. Inductive or capacitive character is symbolized by capacitor or inductor icon on the display. Pressing of button **SET** saves new value to the memory and turns back to **Advanced menu** screen.

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After entering the the submenu **Stage powers**, select requested stage represented by parameters **ST1** – **ST12** and confirm by pressing the button **SET**. By usage of buttons ▲, ► define the stage power and confirm by pressing the button **SET**. Follow the same procedure for another stages.

7.2.7. Delay at Qc – deceleration of regulation at over compensation

This parameter defines initial time for slowing down the regulation during over-compensation. Default value set by the manufacturer is 60 seconds and it is suitable for most applications. Deceleration is calculated at every second, while there is over-compensation, from initial time and deviation square of real cosφ from targeted cosφ. In the case of need of faster or slower reaction at over-compensation change the value down or up.

By buttons ▲, ► it is possible to change value and button **SET** saves this into the memory.

⚠ **Important**

Changes of this parameter should be done only by authorized and experienced person.

7.2.8. Discharging time

For setting the absorption of stages, parameter **Discharging time** is available in the **Advanced 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.

After entering the the submenu **Discharging time**, select requested stage represented by parameters **ST1** – **ST12** and confirm by pressing the button **SET**. By usage of buttons ▲, ► define the stage discharging time and confirm by pressing the button **SET**. Follow the same procedure for another stages.

⚠ **Important**

Changes of this parameter should be done only by authorized and experienced person.

7.2.9. Min. closing time – delay for disconnection

This parameter is represented on the display by symbol **Min. closing time**. It is the minimum time for contactor stage circuit closing. It is possible to be set from 5 to 900 seconds. Default factory setting value is 15 seconds.

After entering the the submenu **Min. closing time**, select requested stage represented by parameters **ST1** – **ST12** and confirm by pressing the button **SET**. By usage of buttons ▲, ► define the stage minimum connection time and confirm by pressing the button **SET**. Follow the same procedure for another stages.

⚠ **Important**

Changes of this parameter should be done only by authorized and experienced person.

7.2.10. Stage operation No – number of stage circuit closing

This parameters defines number of contactor stage operation until alarm information will appear on the display. On the display. Every stage can be set independently in range from 0 – 999999 operations in step of 1000 operation.

After entering the the submenu **Stage operation No** select requested stage represented by parameters **ST1** – **ST12**. By usage of buttons ▲, ► define maximum number of contactor stage operations and confirm by pressing the button **SET**. Follow the same procedure for another stages.

7.2.11. Fix stages – behaviour of particular stages

This parameter allows to define behaviour of every stage. This parameter allows to set stages as a fixed ones. Te regulator is not counting those stages for regulation cycle. Each stage can stay in three working regimes.

• Auto – normally regulated stage

• Off – permanently off (stage number indication blinks and it is less bright)

• On – permanently on (stage number indication blinks and it is bright)

Setting procedure is according the same rules as another parameters explained before. After entering the submenu **Fix stages** select requested stage represented by parameters **ST1** – **ST12**. By usage of buttons ▲, ► define status

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(Auto / Off / On) of the stage and confirm it by pressing the button **SET**. Follow the same procedure for another stages.

7.2.12. Alarms – setting of alarm event activation

During normal operation alarm output contact is opened. In the case of any alarm event the alarm output contact will close for 1 minute time. There are lot of events, that can be enabled to activate alarm.

After entering the **Alarm** parameter, list of available alarm events will appear on the display. Selecting the requested event and confirming by pressing the button **SET** will open window for alarm event activation. Via buttons ▲, ► it is possible to enable or disable alarm event (**on / off**). By pressing button **SET** new value is saved into the regulator memory. Following the same procedure sets other alarm events.

Parameter (shorter)	Description	Factory setting	Setting range
Power factor COAL	permanently not possible to reach set power factor for 1 hour	Off	On / / Off
Temperature OTAL	Ambient temperature for regulator location > **Max. temperature**	Off	On / Off
Stage operation RSAL	If any of contactor stage overpasses maximum allowed switching operation	Off	On / Off

Table 6: Alarms table

The alarm event **Temperature** has a special significance. If this alarm is activated, alarm output contact is used for ventilator control and cannot be used for any other alarm event indication. Output contact closes when temperature measured by controller ICR goes over level set in parameter **Fan temperature**. In this case, all alarm events are only shown on the display without output contact action.

If there is more alarm events at the same time, the last one is shown on the display together with the value which caused alarm event. After pressing the button **SET**, alarm is erased and another alarm event will appear. Follow the same procedure till the last alarm is erased.

7.2.13. Average COSΦ – regulation to average or instantaneous cosφ

This setting defines if regulator will regulate stages to average or instantaneous power factor. If the set value is **On** then regulation method for under compensation is according average power factor. If the set value is **Off** then regulation is performed only according to instantaneous power factor. After entering the parameter **Average COSΦ** by pressing the button **SET**, display will show set value **On** / **Off**. Via buttons ▲, ► it is possible to change this value. Another pressing of button **SET** saves new value into the regulator memory.

7.2.14. COSΦ avg. time – time period for calculation of average power factor

This setting defines half-period of average cosφ calculation. There are available four half-periods for average cosφ calculation (15, 30 45 and 60 minutes). Default value of period for average cosφ calculation is 15 minutes. It is suitable for most of applications.

7.2.15. Max. temperature – temperature for capacitor stages disconnection

This parameters defines the maximum level of ambient temperature at which regulator will disconnect all capacitor stages and will signalize temperature alarm event in case it is activated. Default temperature is set on 55°C by the manufacturer and can be set in the range from 30°C to 80°C.

7.2.16. Fan temperature – temperature level for ventilator start

This parameters defines the level of ambient temperature at which regulator will close alarm output contact in order to start ventilator. Default temperature is set by the manufacturer on 35°C and can be set in the range from 30°C to 80°C.

7.2.17. Maximum saving – recording of measured values maximum

Activation of this parameters allows the controller to save maximums (the minimum value of frequency is being recorded as well) of measured values into to internal EEPROM memory.

Monitoring of measured parameters is being done in real time but recording to non volatile memory is done in one hour period. Before recording the maximum (minimum) into the memory, this value is kept in standard operating memory. In the case that power supply is lost before one hour recording the maximum (minimum) value will be lost.

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7.2.18.   Serial port – configuration of RS485 communication port

This parameters contains submenu with specification of serial communication for RS485 port (MODBUS communication protocol). Submenu, with parameters according to table no. 7, is available under the parameter **Serial port**.

Parameter	Description	Factory setting	Setting range
ID NUMBER	Device id number in RS485 network	1	1 ... 255
BAUD RATE	Communication speed for data transmission	0	0 / 2400 / 4800 / 9600 Bd
PARITY	Communication control by parity checking	Off	On _O / On_E / Off

Table 7: Serial port menu

ID NUMBER defines the number of device in the RS485 network and can be set from 1 – 255. BAUD RATE is by default set to 0 and it defines communication speed between the ICR controller and PC. PARITY is by default set to Off and it can be changed to even (On_E) or odd (On_O).

7.2.19.   Password – service mode access control

Thanks to the password, it is possible to protect regulator against unauthorized configuration. Without knowing an adequate password it is only possible to see set parameters, but not to change them. Password is set as four digit number.

After entering the **Password** parameter, display will show screen with text "Enter code" and symbols " * * * * ". First dash from left side is blinking. Via button ▲ set number from 0 – 9 and move to another number 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 the button **SET**, password will be saved into the memory. From this moment it is necessary, for each change, to type the password when entering configuration. Otherwise, none of the changes will be accepted.

7.2.20.   Manual ON – manual mode

Parameter **Manual ON** allows to turn controller into the mode where it is possible to operate all stages manually. After entering this mode on the display will appear following screen.

Via buttons ▲, ► particular stages are getting selected and by pressing the button **SET**, the stage turns On or Off. Change of stage status is possible only with respecting the set discharging time and delay for stage disconnection. Information about remaining time is shown on the display.

Returning from the **Manual ON** mode is possible by pressing the button **SET** for at least 5 seconds to enter the **Main menu.** Moving to the **Advanced menu** and choosing the parameter **Manual OFF** will turn the controller to the normal operation.

> **Important**
>
> *Fix stages cannot be controlled in the manual mode.*

7.2.21.   Reset – return back to factory setting

This function restores default configuration. It is the last parameter in **Advanced menu** and it is represented by parameter **Reset**. By pressing the button **SET** enter the **Reset** parameter. New screen will ask for confirmation of reset. If yes, move the cursor to option OK via buttons ▲, ► and confirm by pressing the button **SET**. Controller will turn to the factory setting and switch to the normal operating mode.

> **Important**
>
> *After reset, it is necessary to set device again as well as to make auto detection.*

8. Monitoring screens

Power factor controller ICR12 is displaying many information on the front display at the same moment. In order to provide as much information as possible in the logical way, there are 3 main screens available at the normal operating mode. For movement between single screens use button ►. Screens can be opened and seen just in one

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direction according to the order described below.

8.1. First screen

First screen shows information about instantaneous value of cosφ, average cosφ, active power, reactive power and status of compensation steps.

8.2. Second screen

Second screen provides information about pulse presence on particular measured powers and time between last two pulses. Pulse presents is indicated by flashing dot before the power label.

8.3. Third screen

Third screen shows list of actual values of all measured parameters.

Parameter "**Avg day cosΦ**" allows to see list of day averages of cosφ for last *N* days. *N* value is adjustable in parameter "**COSΦ 1/4h days**".

9. Technical features

Parameter	Value
Supply voltage	230 V AC 50 Hz (+10%,-15%)
System frequency	50/60 Hz
Maximum frequency of incoming pulses	10Hz
Minimum pulse length	50ms
Power consumption	10 VA
Output channels number ICR06 / ICR12	6/12
Switching power of alarm output	250 VAC / 5 A
Switching power of relay contacts	250 VAC / 5 A
Range of requested power factor	0,8 ind. ... 0,8 cap.
Reconnection delay of controlled stages	5 ... 900 s
Switching off delay of controlled stages	5 ... 900 s
Compensation stages value setting	manually
Communication interface	RS485 (optional)
Communication protocol / speed	MODBUS RTU / 9600 Bd
Temperature limit	-25°C ... +70°C
Front panel dimensions	144 mm x 144 mm
Panel cutout	138 mm x 138 mm
Site depth	55 mm
Weight	1 kg
Protection degree	IP20 terminals / IP54 front panel
Related standards	EN61010-1, IEC61557-12, EN61000-6-2, EN61000-2-4, EN61000-6-3

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