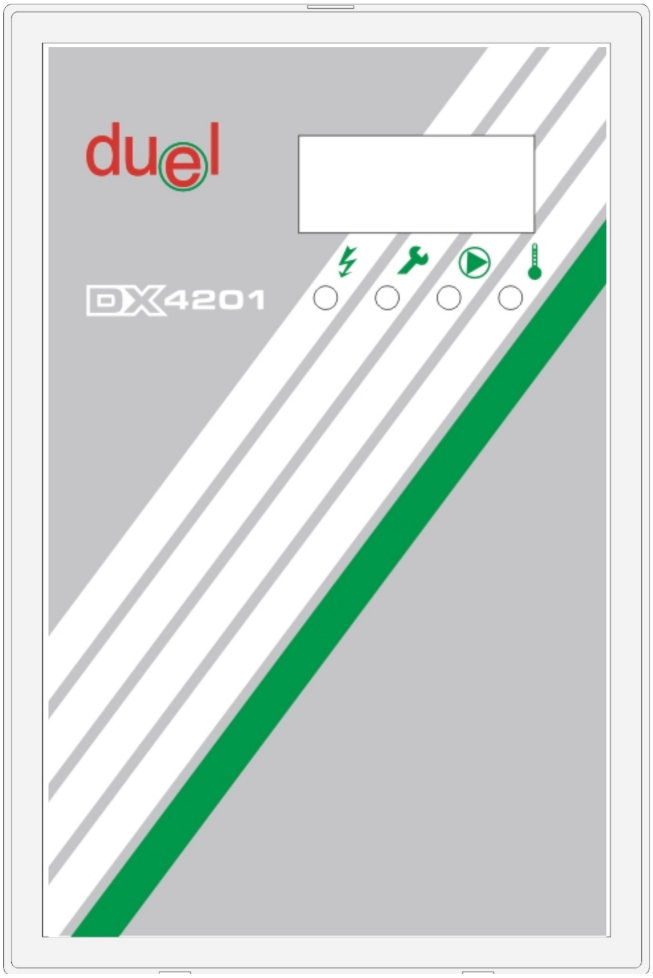
SOLAR SYSTEM REGULATOR

DX 4201D



User guide

version v 1.1

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Content

Abbreviations used in text:

AC	Alternating Current
ADC	Analog to Digital Converter
BCD	Binary Coded Decimal, special way of coding numbers: 127 = 0001 0010 0111
DC	Direct Current
DIP	Dual In line Package
ERR	ERroR
LCD	Liquid Crystal Display
LED	Light Emitting Diode
N	Null wire of power supply ~230V
PE	Protected Earth – the safety guard to prevent human contact with a dangerous voltage
PWM	Pulse Width Modulation
PWR	PoWeR

1 INTRODUCTION

Regulator DX 4201D (in next text regulator or device) is an electronic device, which has implemented many features to utilize solar energy in the most optimal way. The device cooperate with miscellaneous components of hydraulic scheme (circuit) e. g. electric or gas devices in accordance to the component specifications of their manufacturer. The other using of the regulator is **PROHIBITED!**. The most part of the device parameters (so called service parameters) are accessible by opening the front panel and they may be changed only an AUTHORIZED person, who has taken a training and have COMPETENCE for assembling solar thermal systems. The user can change operational parameters (main menu) ACCORDING to this manual.

The power supply of device is **~230V / 50 Hz**. Inexpert installation or inexpert tries of repairing let us say - any inexpert interference may cause serious high voltage injury. Installation and implementation of the device at field must be executed by authorized person with competence in electrical engineering for the country where these activities take place. Dismantling the device or its parts is strictly prohibited. The repair (warranty and post warranty) may be carried out by the manufacturer only.

Device is determined to regulation system consists of solar collectors and a warm exchanger to gain warm energy and propagate it to the other systems through actuator – pump according to values from temperature sensors.

Implemented algorithm controls regulation according to system parameters - “programming”, which is resolved with a quad of DIP (Dual In-line Package) switches and two rotating switches localized under the cover of the device. Status of the device is presented by LEDs (Light Emitting Diode) indicators to show power supply presence, failure, propagating of warm fluid a warm exchanger status.

All important data can also be displayed on the LCD(Liquid Display Crystal) device.

2 CONTROL FUNDAMENTALS

2.1 Regulation fundamentals

Regulator in a forever cycle watches temperature at the exchanger and compares it with the requested value. To pump warm liquid to exchanger the two conditions must be fulfilled (in next text abbreviated *pumping conditions – they define when the pump runs and stops*):

1. *Insufficient warm exchanger temperature - measured exchanger temperature must be lower than requested temperature (set with T switch), with 1 K hysteresis.*
2. *Sufficient collector energy - collector temperature must be higher over minimum difference "Delta ON" (set with ΔT switch) than exchanger temperature to run the pump. The pump stops if difference falls below "Delta OFF" (set together with Delta ON). The "Delta" parameters are necessary because of thermal loss in piping between collector and exchanger.*

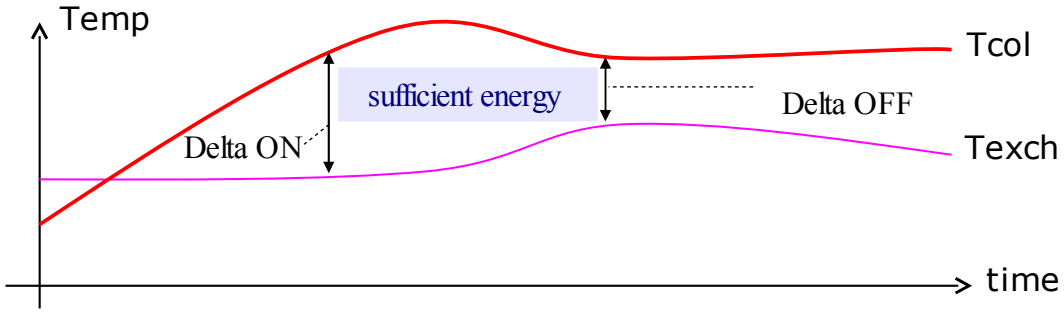


Fig. 1 Pumping condition - sufficient collector energy

In case the pumping conditions are fulfilled (exchanger has insufficient temperature and collector has sufficient energy), the pump start running e. g. warm liquid will be propagated. In case the conditions are not fulfilled for loading warmth, the pump will be stopped.

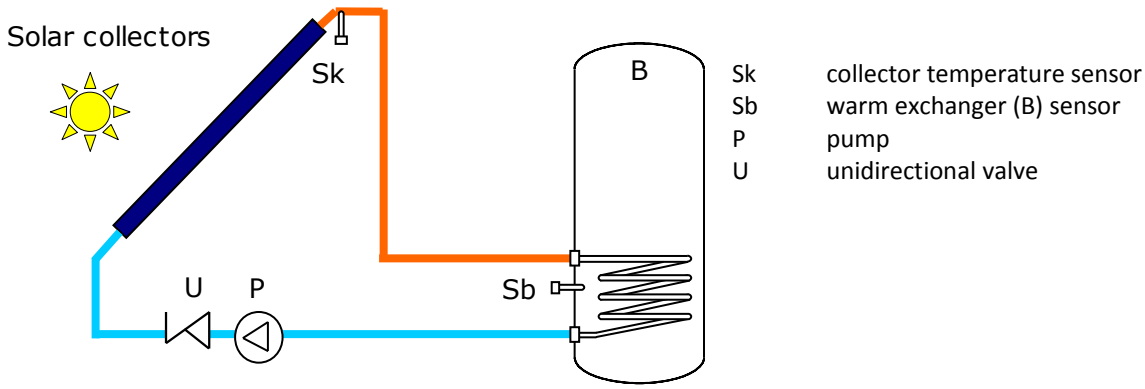


Fig. 2 Hydraulic scheme of regulated system

2.2 Drain-Back system

When system of regulation is "DRAIN - BACK" type (switch menu DRN=ON), it is necessary to fill up the collector with warm carrying liquid. This assures the **flood** and **stabilize** mode of regulation.

Drain-back system – the collector loop of the system is filled up and consequently drained back with warm carrying liquid. After the start condition (1. insufficient warm exchanger temperature, 2. collector temperature is higher over "Delta S" to warm exchanger temperature) is met, the pump start running for fixed time "Time A" with maximal pump capacity (to fill up collector with liquid). Then the pump performance is decreased (to the value Pmin – to keep the defined flow) for the time "Time B" – to stabilize flow and normal process keeps place - see next figure). After stopping propagation the warm liquid is drained back (flows out) from collector loop to additional exchanger. Parameters „Delta S, Time A and Time B“ are set up according to position of T switch.

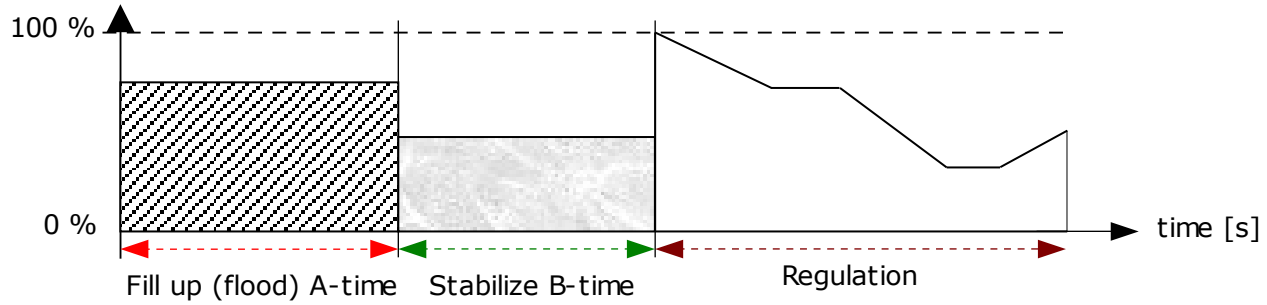
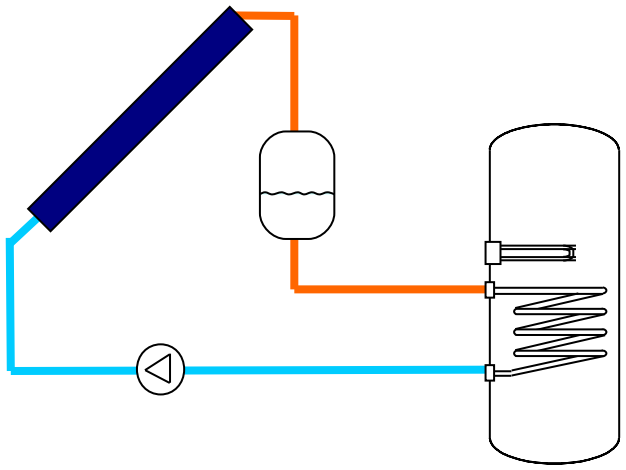


Fig. 3 Regulation modes of drain back operation

If the DRAIN – BACK operation is active there exist a warning of flooding the hot collector by the cold liquid. That is why a stated limitations take place and the liquid is not propagated to the collector (power failure). Regulator assures an additional information about the cause of not propagating the warm liquid in that case (because the pumping condition are true).



Sk	collector temperature sensor
Sb	warm exchanger (B) sensor
B	boiler
T	collector fluid tank
P	pump

Fig. 4 Drain-Back system

2.3 Pump performance regulation

Device can control the pump performance with pulse - width modulation – to decrease performance - the pump is switched off for some tens of milliseconds. Performance regulation is automated and its performance is controlled (see next figure Pmax [100%] to Pmin[50%]) if temperature difference (collector to exchanger) sinks below DeltaON level. The performance is decreased to Pmin till an average value of DeltaON and DeltaOFF is reached, then it stays at Pmin till difference falls below DeltaOFF. Pmin value is set to 50%.

PWM can permanently be disabled by switching DIP switch MAN to ON position and then switch setting temperature difference ΔT in position 0. In the end both switches should be moved back to its original position. The same procedure applies for re-inclusion into the PWM operation. This procedure does not apply to Drain-back system (DRN DIP switch = ON).

If PWM is disabled, the PWM control signal (10VDC) is present on the connector (VC,OT). Pmin value is set to 20%.

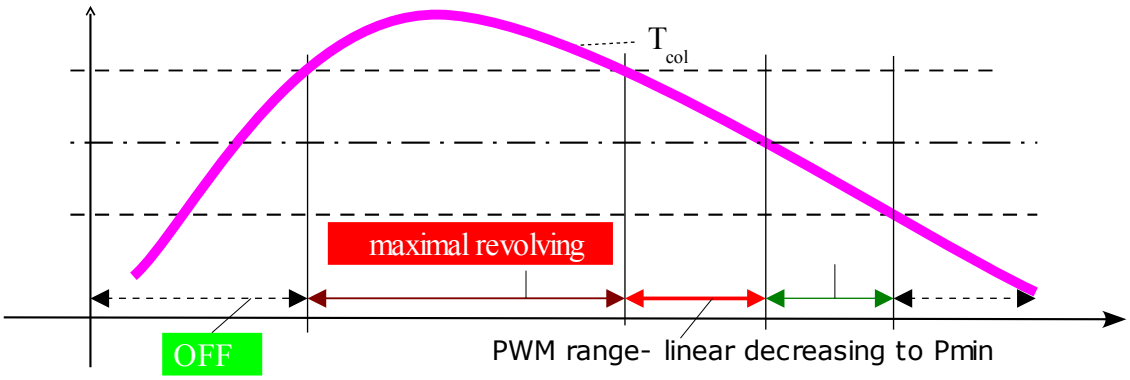


Fig. 5 Pulse - Width - Modulation regulation bandwidth

2.4 Collector temperature sensing

There is only one way for sensing temperature – fixing collector sensor directly to collector field.

2.5 Collector overheating

If exchanger is full loaded (has enough energy) or power supply breakdown happen and the Sun still shines a collector overheating might happen. That is why regulator is equipped with „overheating protection“ which can be activated by DIP switch PROT=YES.

As the collector temperature increases over 120 °C the pumping stops till collector temperature sinks below 100 °C (90 °C in DRAIN – BACK mode) when it starts again.

2.6 Sensor failures

If the sensor failure appears - regulator behaves in a following way:

- Collector sensor failure (S1) – warm liquid pump stops - till the fault removing
- Exchanger sensor failure (S2) – the pump stops till sensor malfunction is removed

2.7 Records

Device updates four registers, which record time of warm propagation and exceptional states during regulation process:

- PWD – power down (burn out) number counter (power absence)
- PMP – total time of pump running during regulation (hours)
- ERR – total number of failure states (sensor failures)
- OVH – total number of collector overheating

These registers can be seen by subsequent pressing the FUN key (under the front panel).

3 SERVICE MANUAL

3.1 Device description

Regulator consists of (seen from the front panel) LCD (Liquid Crystal Device) display (two rows per 8 characters) and four LED indicators to show solar system regulator status.

Under the front cover (easy removable) there are setting tools to define parameters and the mode of regulation. The regulator parameters setting (installation) may change only authorized person, who has taken a training and have competence for solar thermal systems. Installation should be made only once, no service is necessary later.

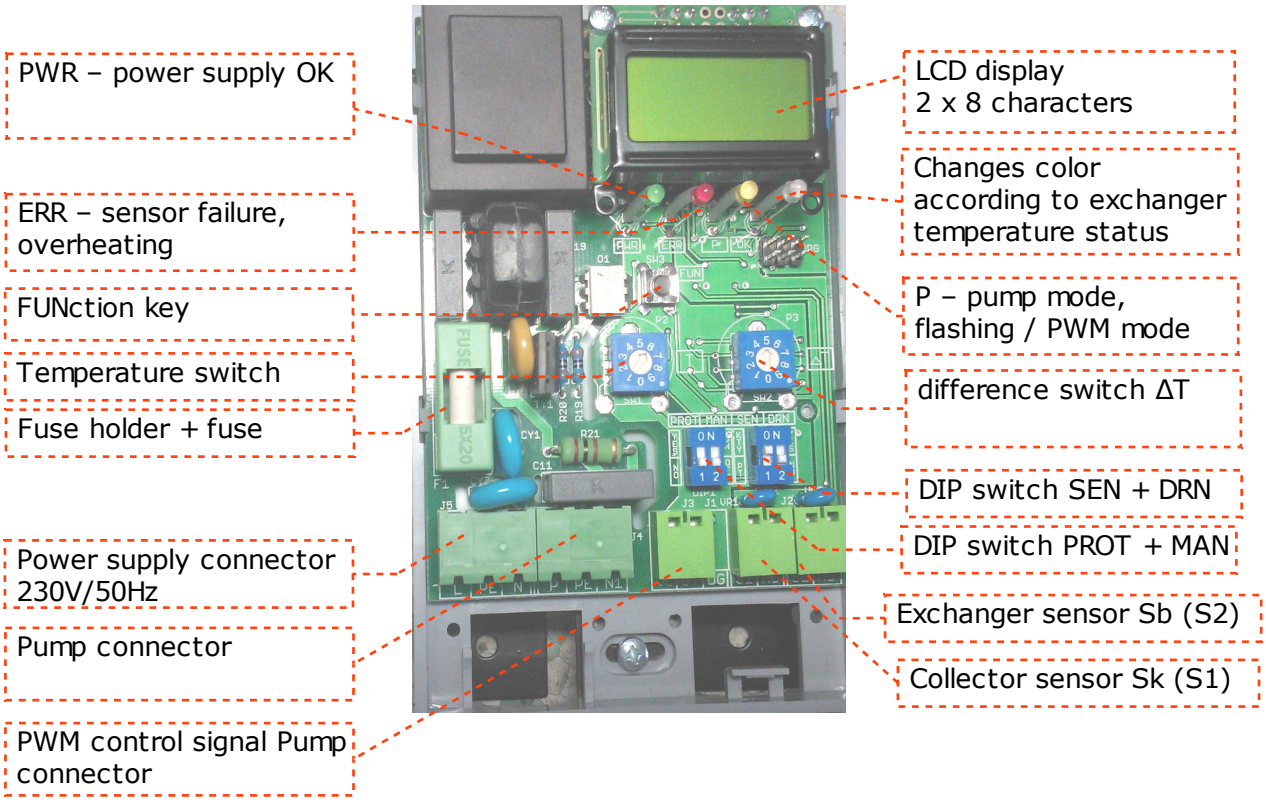


Fig. 6 Set tools and status indicators

3.2 Indicators

Solar system regulator status can be checked trough LED indicators and LCD display.
LED indicate:

- PWR (green) – power supply presence
- ERR (red) – system failure - slow flashing: sensor failure or internal regulator malfunction. Fast flashing: collector overheating (if it was enabled PROT=YES)
- P (orange) – pump function indicator (flashes if PWM mode is active)
- OK (green / red) – exchanger temperature status (green – exchanger is cold, red – exchanger is loaded, the color changes from green to red according to difference between requested exchanger temperature and measured one)

The upper line of LCD keeps collector temperature (K) and exchanger (B) [°C].

The lower one displays pump status, OFF – stopped, ON – runs, or if PWM is active the performance number [%]. (Especially during Drain-Back mode replaced by phase indicators flooding- ONz and stabilization phase ONs). In the middle of the line can be seen the letter:

- **C** – if collector protection function is active and
- **D –** for drain/back mode).

The right side displays requested warm exchanger temperature (P) [°C].

LCD enables showing some statistical data using FUN key (under the front panel). By its pressing the registers: PWD – power down number and PMP – hours of running the pump can be seen, another pressing revolves next two set of registers: ERR – sensor malfunction number and OVH – collector overheating number (collector temperature was over 120°C). The last pressing keeps information of software version (SW), status of PWM mode (↑) and device unique number (N). Statistical data can be cleared by pressing the FUN button and holding it for about 3 seconds.

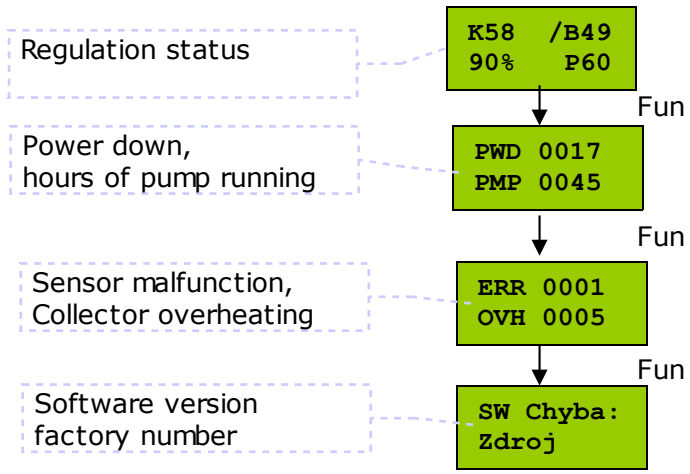


Fig. 7 Regulation status / statistical data

3.3 Setting tools

To set requested configuration of regulator four DIP switches and two switches are assembled. They enable these additional functions:

- ✗ PROT – collector protection mode (NO – protection disabled, YES - enabled, which means stop running the pump if collector temperature overshoots 120°C and its new restart when temperature sinks to under 100°C. Information of this exception – red ERR flashes in fast tempo and LCD shows „OVH“. (Factory set: PROT=NO)
- ✗ MAN – switch to enable start pump in manual mode (the position ON). If it is true, LCD shows letter **M**. If position OFF is chosen – regulation according to algorithm. (Factory: MAN=OFF)
- ✗ SEN – temperature sensor type selection. Position PT means sensors DX 1112 (basis Pt1000), position KTY means DX1083 (semiconductor type KTY). (Factory: SEN=KTY)
- ✗ DRN – switch to choose normal (NO) or Drain - Back system (YES). (Factory: DRN=NO)
- ✗ Switches labeled T a ΔT were designated to set requested temperature in warm exchanger (T) and so called Delta (temperature difference) to start and stop circular pump.

Next tables keeps relations switch position / requested value (pump can be stopped by setting the T switch to position „0“).

T	position	0	1	2	3	4	5	6	7	8	9
	°C	OFF	10	20	30	40	50	60	70	80	90

ΔT	position	0	1	2	3	4	5	6	7	8	9
	ΔON	1	2	4	6	8	10	12	14	16	18
	ΔOFF	0	1	2	3	4	5	6	7	8	9
	ΔDRN	2	3	6	9	12	15	18	21	24	27

Switch ΔT is used to set up the difference temperature collector / exchanger. Regulator distinguishes start (ΔON) difference and stop (ΔOFF) one.

Example: If position „5“ is chosen, ON difference is 10 K a OFF is fixed to 5 K. Other words pump will start if difference collector / exchanger is over 10K a stop if difference falls under 5K.

Providing Drain-Back is active (DRN=YES) next difference takes place (ΔDRN), that initiates start mode, but it is higher to eliminate initial phenomena, when the fluid flows to the collector field (flooding phase) a stabilizes itself (stabilize phase). Then only ΔON a ΔOFF are used as usual.

3.4 Regulation status display

The upper line of LCD keeps collector temperature, rotating icon of running pump and warm exchanger temperature. The lower line informs about: pump status, switches PROT, MAN, DRN positions and requested warm exchanger temperature.

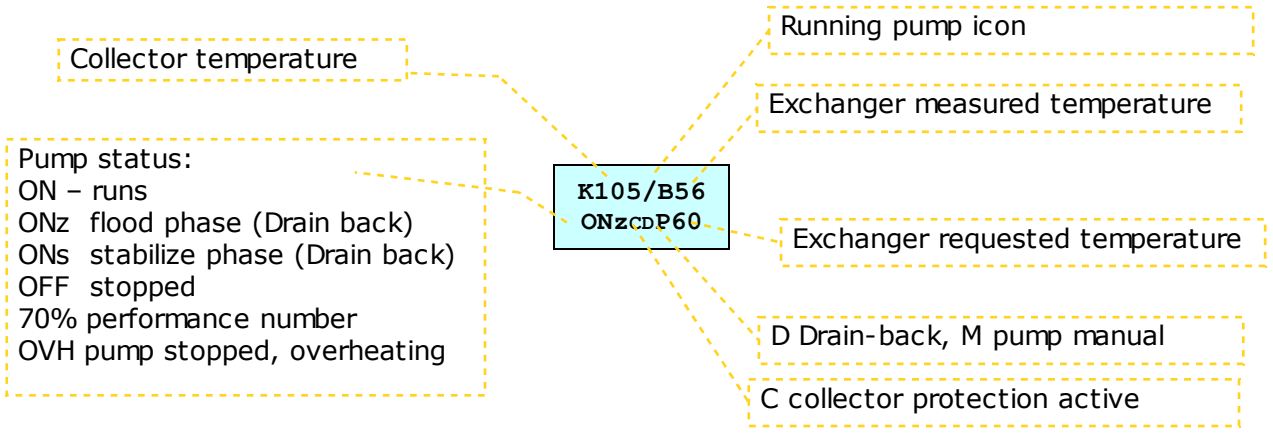


Fig. 8 Compact regulation status

3.5 Failures – information and activity

In case of any failure, the ERR light start to flash. The regulator distinguish these failures:

- **Sensor** failure: instead of temperature value the "–" (open circuit sensor), "x" (short circuit sensor). The pump stops running immediately.
- **System** failure: ADC (Analog Digital Converter) failure instead of temperature "?" flashes. The pump stops.
- **Manual** mode: display shows „M“ letter , pump is manually switched ON or OFF.
-

Special exception – collector overheating (providing PROT=YES) causes fast ERR indicator flashing, together with **OVH** warning in display. Pump is not running.

4 INSTALLATION DIRECTIONS

4.1 Device dimensions

Device is fixed at wall through metal console, that must be first installed. Regulator is delivered in form of plastic box: 125[height] x 83[width] x 35[deep] mm. Dimension follows:

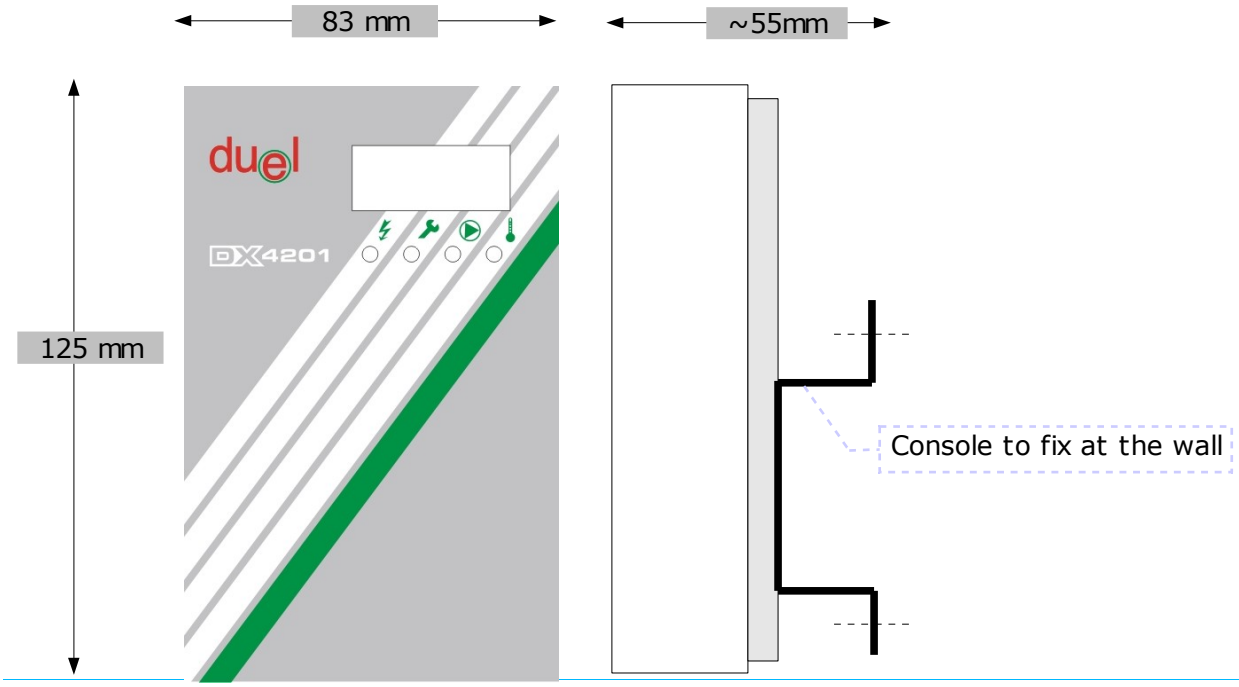


Fig. 9 Device dimensions

4.2 Wire connections

Regulating system consists of: regulator, sensors and actuators (pumps). Sensors and actuators are connected to installation bracket, localized under the cover of the device.

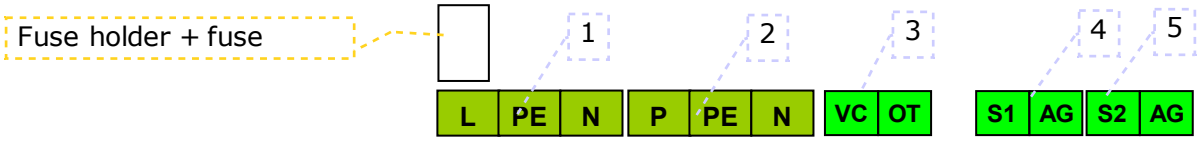


Fig. 10 Wire socket

1. L, PE, N power supply ~230V/50 -60 Hz (~110V at special order) [a)]
2. P, PE, N pump connection [b)]
3. VC,OT PWM control signal for electronic pump (10V, max. 20mA, 1kHz)
4. S1,AG collector sensor (Sk)
5. S2,AG warm exchanger sensor (Sb)

Notes:

a) Warning - current value is limited by fuse 2A.

b) Switching element - triac (semiconductor switch - because of PWM) maximal 1A.

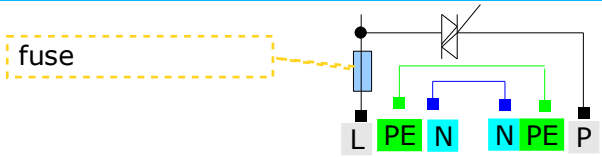


Fig. 11 Power output schematics

4.3 Installation instructions

An installation should be made according to recommended application scheme keeping following rules:

- An installation must be executed by authorized person only – who have a competence in electrical engineering according to the laws of the country where the installation takes place!
- The device must have an independent fuse breaker rated maximal 2A
- Before screwing wires to terminal, put the sleeve endings to the end of the wires
- Firstly sensors (2 x 0.5 mm^2), then actuators (0.75 mm^2) and in the end power line (0.75 mm^2 cross section). For sensors is recommended twisted pair line, keeping distance from power wires (min. 30 cm) and the shield connect to PE wire (see next figure).
- Just before power supply connection check all input and output wires (sensors, actuating terms) for disconnection or short-circuit
- Turn on the safety fuse (breaker) and test function of actuators in manual mode
- Check measured temperature values at collector, then in the loop and set initial system parameters.

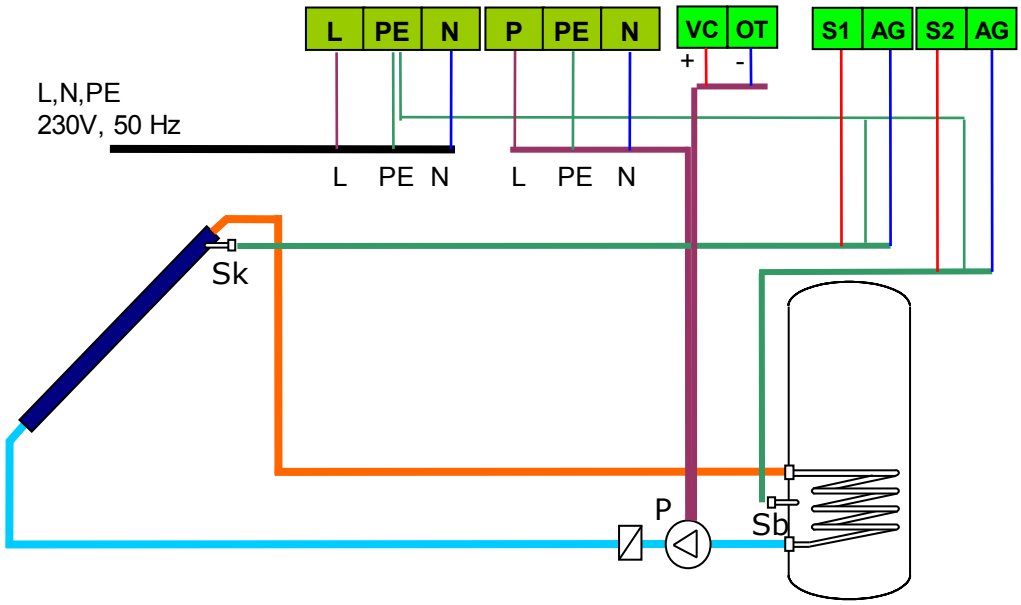


Fig. 12 An example of recommended regulator wiring

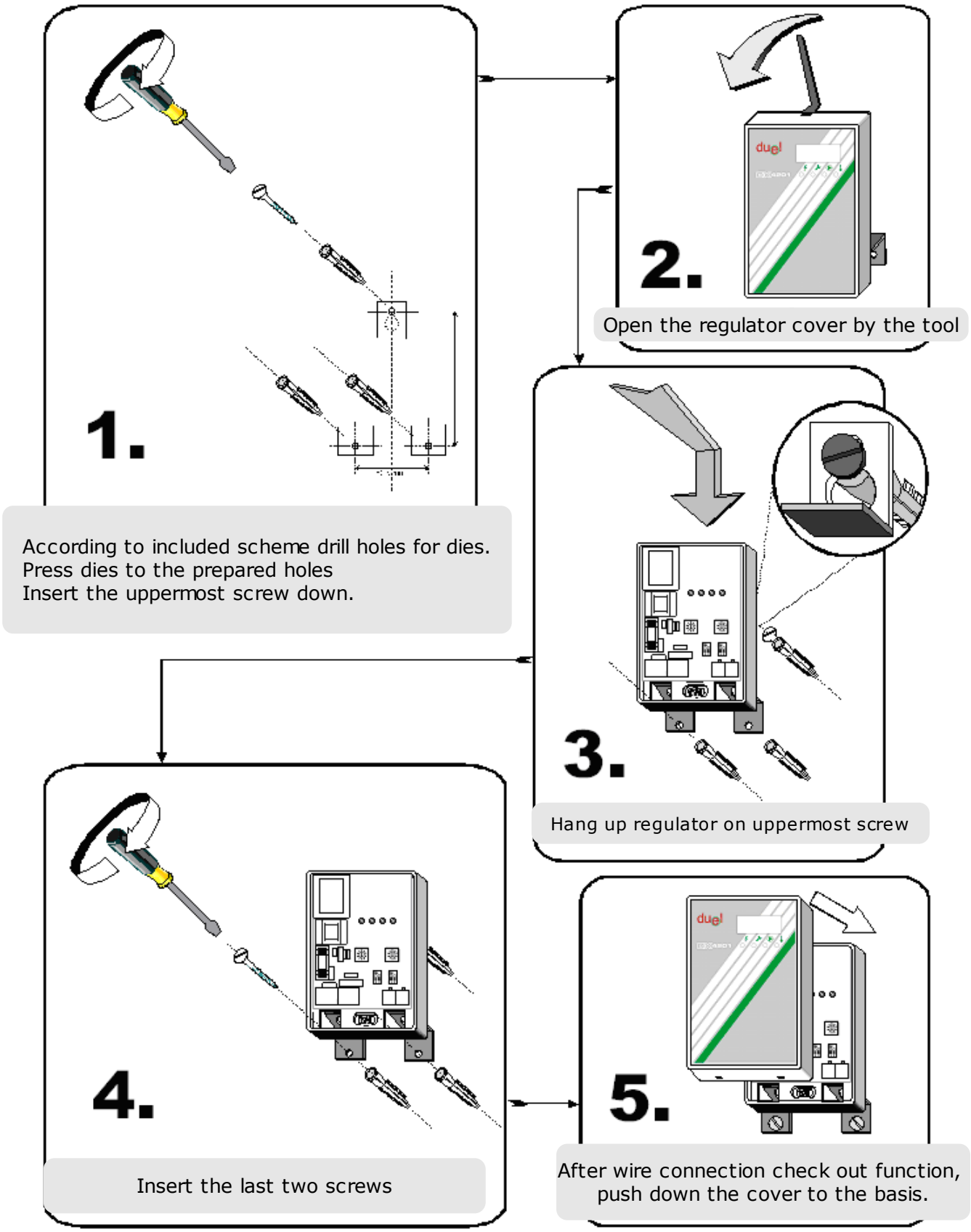
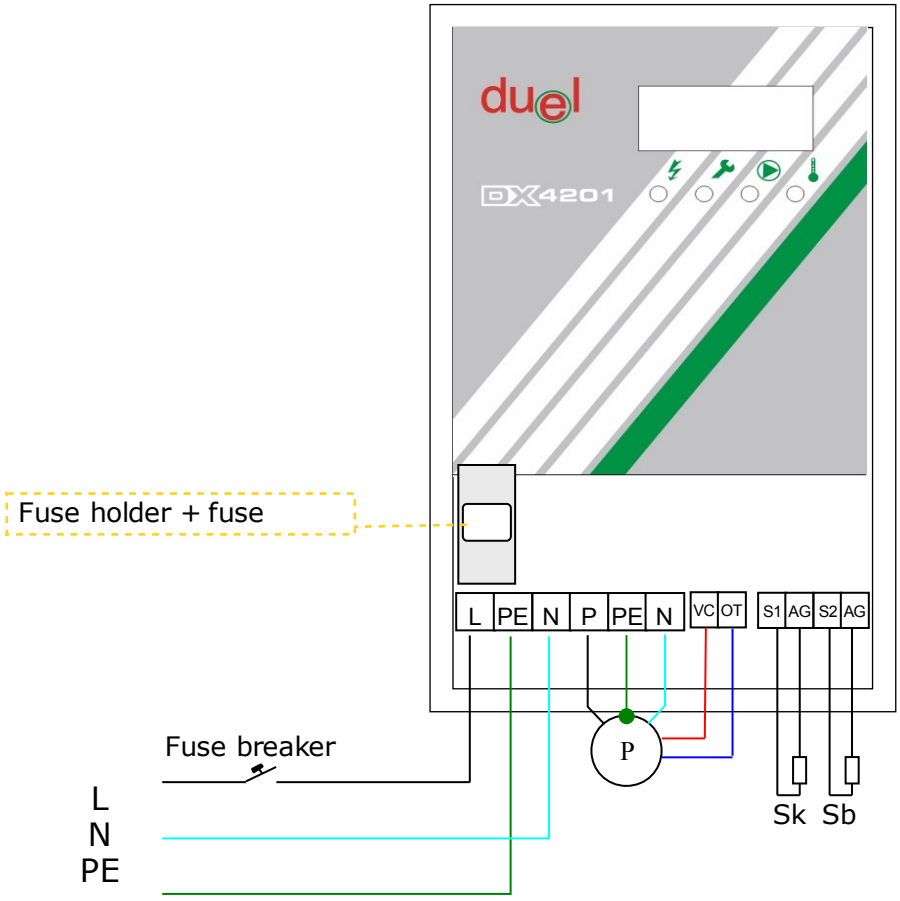


Fig. 13 Device assembling



Sk collector temperature sensor, Sb warm exchanger (B) sensor
P pump
Note: wiring socket and fuse holder are accessible after removing of the front panel

Fig. 14 An example of connections to wiring socket

5 TECHNICAL DATA

Datasheet

Power supply:	230V / 50Hz, other power supplies upon a request
Power rating:	230VA
Device consumption:	0.5 VA
Output voltage:	230V / 50Hz
Output current limitation:	1 A
Output PWM control signal:	10V, max. 20mA, 1kHz
Fuse rating:	2 A, type T (slow reaction)
Sensor temperature range:	-25 ÷ +170 °C
Sensors:	a) DX 1083, base KTY83 producer DUEL Námestovo Ltd., scope -25 .. 170°C, 1000 Ohm @ 25°C, 1670 Ohm @ 100°C) included in delivery (default) b) DX 1112, base PT1000 producer DUEL Námestovo Ltd., scope -30 .. 200°C, 1000 Ohm @ 0°C, 1385 Ohm @ 100°C)
Temperature accuracy:	± 1.0 K
Insulation protection:	IP20
Weight:	~300g (400g including 2 sensors)
Dimensions:	125[height] x 83[width] x 35[deep] mm

Operating ambient conditions

Ambient temperature:	5 ÷ 50 °C
Air humidity:	max 80% @ 30°C
Air pressure:	70 ÷ 106 kPa

Warranty:

- Manufacturer provides guarantee 36 month from the day of delivery
- The price of the device covers guard period, which applies during assembly operations, disassemble operations and transport the device to the producer in spy of repair operations (transport, assembling, disassembling are not producer duties within warranty).
- Warranty and after-warranty service guards manufacturer (during warranty - for nothing)
- Warranty refers only to the fault, which come into being by normal operation. Warranty does not refer to fault, which arises by inexpert service, incorrect storage, unsuitable storage environment and high power activity (spontaneous disaster, flood, fire, atmospheric discharge and so on)
- User looses claim to warranty at the dismantling devices.

Notes:

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