# UI415 Solar irradiation integrator

**Summary**

**UI415 calculates cumulated energy on an area unit based on actual irradiation value. The cumulated energy is used for long-term efficiency calculations of a PV plant operation. The energy may be read at the pulse output to be processed in an external pulse counter, or may be directly read out over a bus - the communication protocol is Modbus RTU / RS485.**

**Application**

- **PV monitoring systems**
- **Integration of any analogue value represented by a 0..10 V signal**

**Function**

The solar radiation integrator acquires input voltage which is proportional to the solar radiation intensity from an external sensor with 0..10 V output (must be ordered separately). The actual intensity in $kW/m^2$ is displayed at the LCD display. This value is integrated in time once per second and available at the potential free output as pulses which are proportional to the energy corresponding to $1\ m^2$ of the measured area. The output pulses may be brought to any counting device which cumulates the resulting energy. The cumulated values are used for comparison to the real plant production to determine both short-term and long-term efficiency of the plant.

All actual and cumulated values are available at the open RS485 bus. The protocol used is Modbus RTU and therefore the UI415 integrator may be connected to most of the PLC and SCADA systems on the market. See table below for register description. The most important available values are:

**Daily cumulated energy**
The integration starts at midnight (00:00) and its value increases throughout the day. At next midnight (24:00) it is copied to the *Last day cumulated energy* and then reset to zero.

**Last day cumulated energy**
For the next 24 hours it contains the accumulated energy of yesterday. This is for comfortable readout of the daily cumulated energy.

**Total energy**
This value integrates the total cumulated energy since commissioning of the device. The value is backupped by a battery.

In the registers, another set of values is calculated:

**Cumulated energy above the irradiation limit**
This register integrates only if the actual irradiation exceeds a predefined limit (settable over the bus as an analogue value, default 300 W/m$^2$). This cumulated value is useful because the inverters start operation only above certain irradiation level, and the measuring errors caused by night residual light cumulation are avoided.

**Cumulated energy when inverters active**
This register integrates only if the integration is enabled by a binary value written over the bus from a PLC or another Modbus master. The binary value indicates operating inverters and thus the comparison of the real produced energy (read at the inverters or at the main meter) and this value gives an image of efficiency of the inverters and distribution components.

The integrator contains real time clock backupped by a battery. There is also integrated thermometer on the PCB, the value of which is available on the bus. The temperature may be used as informative value for monitoring of enviromental conditions at the installation place (switchboard, transformer room etc.).

The constant of Wh/m$^2$ is changeable and therefore the integrator may be used with various sensor types and even for integration of another values than solar irradiation.

| **Technical data** | | |
|---|---|---|
| Power | 24 V AC/DC +/- 10% |
| Consumption | 1,5 W |
| Vstup pro čidlo osvitu | 1x AI 0...10 V ss, Rin = 40 kOhm |
| Input for irradiation sensor | 1x AI 0...10 V DC, Rin = 40 kOhm, common ground with power |
| Measuring range | definable, 10 V represents 1...65 000 W/m$^2$ default value is 0...10 V = 0...1300 W/m$^2$ |
| Output | 1x DO SSR, max. load 60 V / 550 mA AC / DC |
| Output pulses | 1 or 10 Wh/m$^2$ (set by DIP switch), fixed pulse length 100 ms |
| Measuring principle | Integration of actual irradiation value 1/s, complies with EN 61724 - Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis |
| Protection degree | IP20 |
| Configuration | over Modbus RTU / RS485, e.g. with ModComTool |
| Communication | RS485 - Modbus RTU, slave 1200...115200 bit/s |
| Display | LCD, 60 x 60 mm |

| Cover | ABS, similar to white RAL9010, other colours |
| --- | --- |
| Dimensions | see below |
| CE marking | CE |
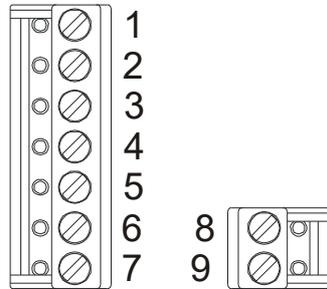
**Terminals**



1: K-          RS485 -
2: K+          RS485 +
3: DO1 A       pulse output (SSR relay)
4: DO1 B       pulse output (SSR relay)
5: G0          power (-), input – reference point
6: G0          power (-), input – reference point
7: G           power (+)

8: AI1         input 0...10 V for irradiation sensor
9: G0          power (-), input – reference point

Terminals 5, 6 (power, common) and 9 (input reference point) are galvanically connected inside of the device. It is recommended to supply the UI415 from the same power source as the irradiation sensor.

**DIP Switches**



0... 10 Wh/m2 / imp.
1... 1 Wh/m2 / imp.
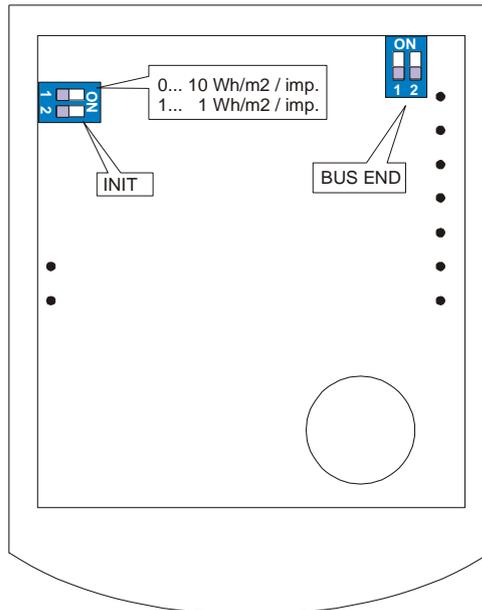
INIT

BUS END

**BUS END:**
both switches at ON terminate the bus (use if the device is the last on the bus)

**USR:** set to 0, the output gives 10 Wh/m2 per pulse (default settings). Set to 1, the output gives 1 Wh/m2 per pulse (mostly for commissioning and tests)

**INIT:** sets the device to default communication parameters: Modbus address 1, communication speed 9600 bps, 8, N, 1.

**Dimensions**
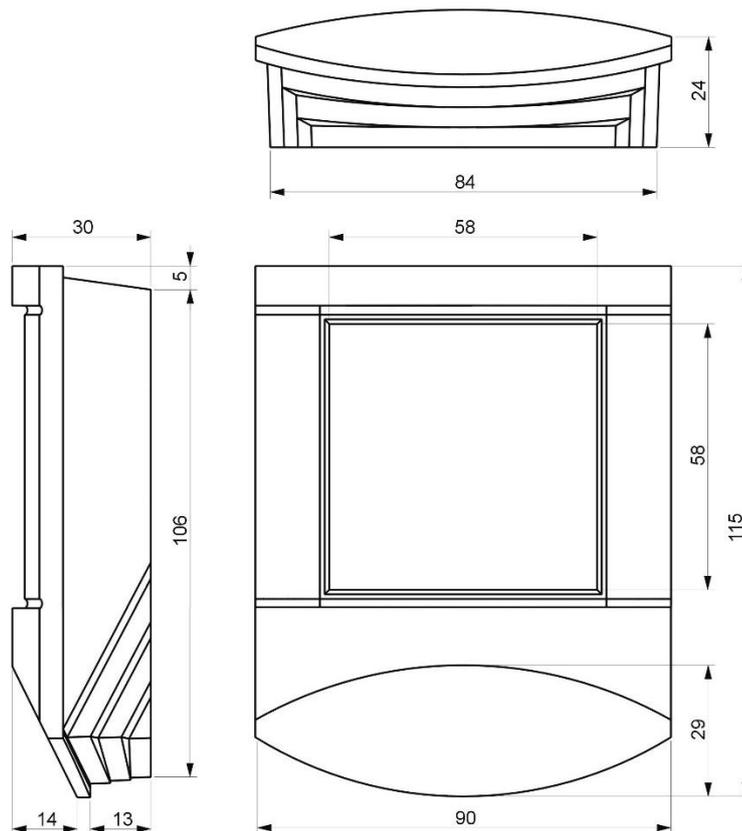


All dimensions in *mm.*

**Installation**   Install the device on a flush-mounting box on a wall or to a subpanel in a switchboard, vertically.

If the internal temperature sensor has to be used, install the device so as to provide relevant measurements.

**Opening the cover**   When removing the display part, proceed as follows:

- press gently the side parts of the unit and pull the right of the display part by several milimeters
- pull the left of the display part
- pull the display part and remove it from the bottom.

Do not bend the display part too much, the connector pins could be damaged. The locks are only at the sides of the display part, not at the top nor bottom.

**Connection**
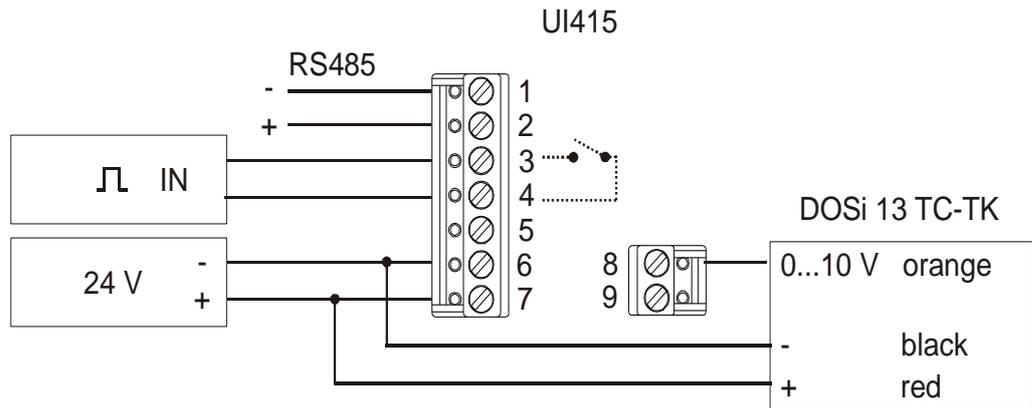


Pulses IN: input module for pulse counting. May be part of a 3$^{rd}$ party monitoring system.

The wire from Terminal 9 to the sensor signal ground may not be connected for the Domat irradiation sensors. Consult the respective data sheets for other sensor manufacturers. The solar integrator may be also connected in parallel to the existing irradiation sensor monitor: maximum input current of the UI415 is 0.25 mA, which does not represent any excessive load for the sensor output.

The analogue input at terminals 8 and 9 is **galvanically not separated**. Please check that the ground terminals (6 and 9) have no difference of potentials between each other before power-up, otherwise the device may be damaged!

The devices may be addressed in the range of 1 to 250 at the RS485 bus. When designing the bus please comply with common RS485 standards, such as maximum bus length of 1000 m, parraller run to power wiring etc. The bus may be connected to the following systems:

- a Domat MiniPLC controller (3 row LCD display and buttons as local HMI, web access, alarms per e-mail and SMS, connectivity to RcWare Vision or another SCADA over Ethernet)
- over a RS485 / RS232 converter (e.g. M012) to a touch screen process station IPCT.1 (8" LCD touchscreen for local operation, web access, alarms per e-mail and SMS, connectivity to RcWare Vision or another SCADA over Ethernet)
- over the converter M012 to a PC with RcWare Vision (SCADA, trends, SMS alarms, web access...)
- any PLC or SCADA system communicating as a Modbus RTU master.

Recommended cable types are LAM DATATWIN 2x2x0.8 (diameter in mm), Draka DATAX PAR 2x2x0.5 (cross section in mm$^2$), etc.

**Startup sequence**

After power reset, the following sequence is displayed:

- display test (all segments and symbols active)
- 1: firmware version (e.g. **1.00**)
- 2: Modbus address (e.g. **0 01 A** for address 1)
- 3: baudrate (see table below for coding, **br 13** = 9600 bps)
- 4: number of EEPROM writing cycles (e.g. **00 04**; for service purposes only)
- 5: pulse weight (1 imp = 1 Wh/m$^2$ or **10** Wh/m$^2$)

After this sequence is completed, the device starts normal operation.

**RoHS notice**    The device contains a non-rechargeable battery which backups the real-time clock and part of the memory. After the device is not operable, please return it to the manufacturer or dispose of it in compliance with local regulations.

**Safety note**    The device is designed for monitoring and control of heating, ventilation, and air conditioning systems. It must not be used for protection of persons against health risks or death, as a safety element, or in applications where its failure could lead to physical or property damage or environmental damage. All risks related to device operation must be considered together with design, installation, and operation of the entire control system which the device is part of.

**Changes in versions**

09/2016 — Changed the format.
02/2017 — Added section Opening the cover and link on the datasheet with other colours.
10/2017 — Added Safety note.
05/2018 – Change technical data.