



# ST2 2422Nx\SR ST2 2422Nx\DR



## DATA SHEET

rev. 2.4  
31 August 2023

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### Attention

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and always download the latest version available.*


# 1 SAFETY

This product is a String Monitoring System (SMU) and its application is the monitoring of photovoltaic systems. From an electrical point of view, by their nature, photovoltaic systems operate in direct current and with very high voltage and current values.





## Safety : General Conditions

	<p><b>DANGER</b></p>	<ul style="list-style-type: none"> <li>- This product is therefore designed to operate with direct current voltage values up to 1500 VDC. This voltage value is potentially fatal. Voltage values between 24 VDC and 1500 VDC are therefore present on this product.</li> <li>- All transducers connected to the auxiliary input connectors must be isolated at 1500 VDC.</li> </ul> <p>These transducers are PT100 and, in the case of the ST2N and ST2 series, also transducers with 0/10 VDC and 0/20 mA output (typically anemometers)</p>
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## Safety : Installation and replacement precautions

	<p><b>DANGER</b></p>	<ul style="list-style-type: none"> <li>- The installation and / or replacement of this product must take place in absolute safety, therefore it is necessary to proceed with the installation and / or replacement of this product which is housed inside the field panel after disconnecting the power and dangerous voltages from solar panels.</li> <li>- In any case, any intervention involving the handling of the SMU must be carried out by skilled and trained technicians equipped with insulation gloves designed for voltage values up to 1500 VDC and after disconnecting any voltage and current from the solar panels.</li> </ul>
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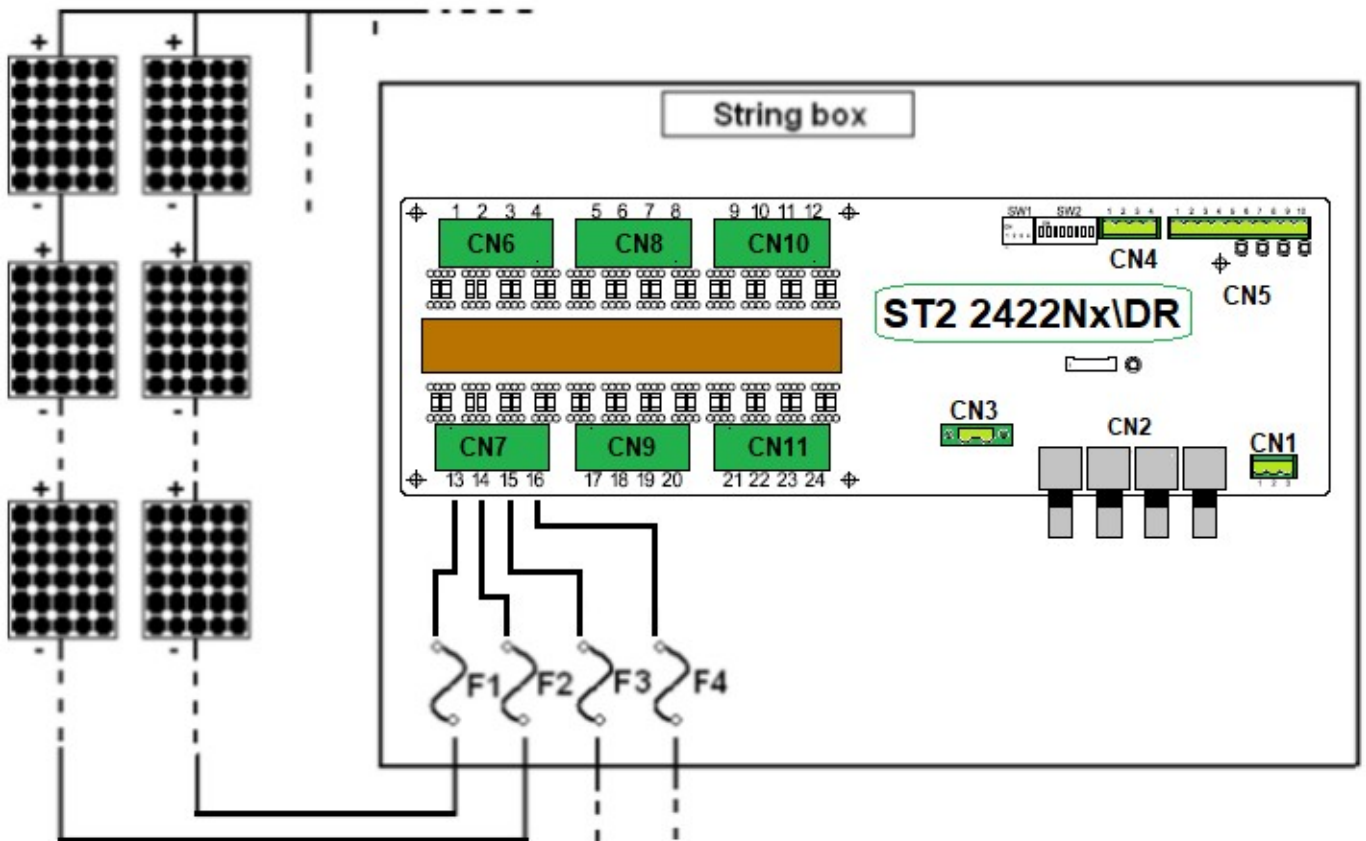
## Important Safety Instructions

	<p><b>DANGER</b></p>	<ul style="list-style-type: none"> <li>- Contact with wiring terminals inside the device can cause death by electric shock!</li> <li>- Before to operate inside cards with tester, or with other measurement equipment, it is mandatory TO OPEN fuses and other components that can bring high level voltage inside cards.</li> </ul>
	<p><b>WARNING</b></p>	<ul style="list-style-type: none"> <li>- Please check all input and output wire terminals in case of high DC voltage and make sure there is no voltage before electrical connection to avoid electric shock!</li> <li>- Do not touch the live parts of the input and output sides to avoid electric shock when checking or maintaining the device.</li> <li>- All installation and wiring connections must be made by qualified technical personnel only.</li> </ul>
	<p><b>CAUTION</b></p>	<ul style="list-style-type: none"> <li>- All wiring and operation must comply with the requirements of the relevant local standards of the device.</li> <li>- Check the device and make sure there are no problems with the installation before putting it into operation!</li> <li>- Connect the wires to the positive and negative marked positions of the device to avoid the risk of short circuit, ensure personal safety and keep the device in normal operation.</li> </ul>
	<p><b>IMPORTANT</b></p>	<p style="text-align: center;"><b>Reference to current standards</b></p> <p>For any other consideration, safety precaution, it is absolutely necessary, before carrying out any installation and / or replacement of the SMU, to refer to the regulations in force regarding the construction of combiner boxes.</p>

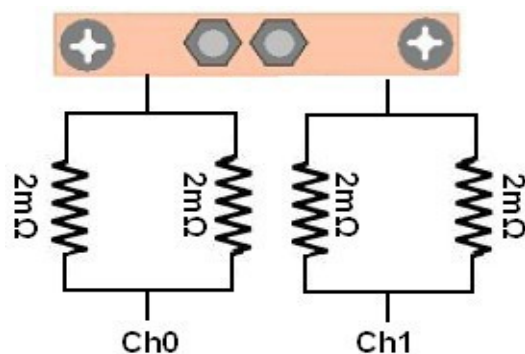
## 2 GENERAL NOTES

### 2.1 Introduction

The ST2 module to string control, allow to monitoring current and voltage generated by photovoltaic panels strings. For example is possible connect each other 32 PV panels at 36 V to each string channel, with positive pole connected each other. The negative pole of each string is brought to the dedicated input, like in the following picture :



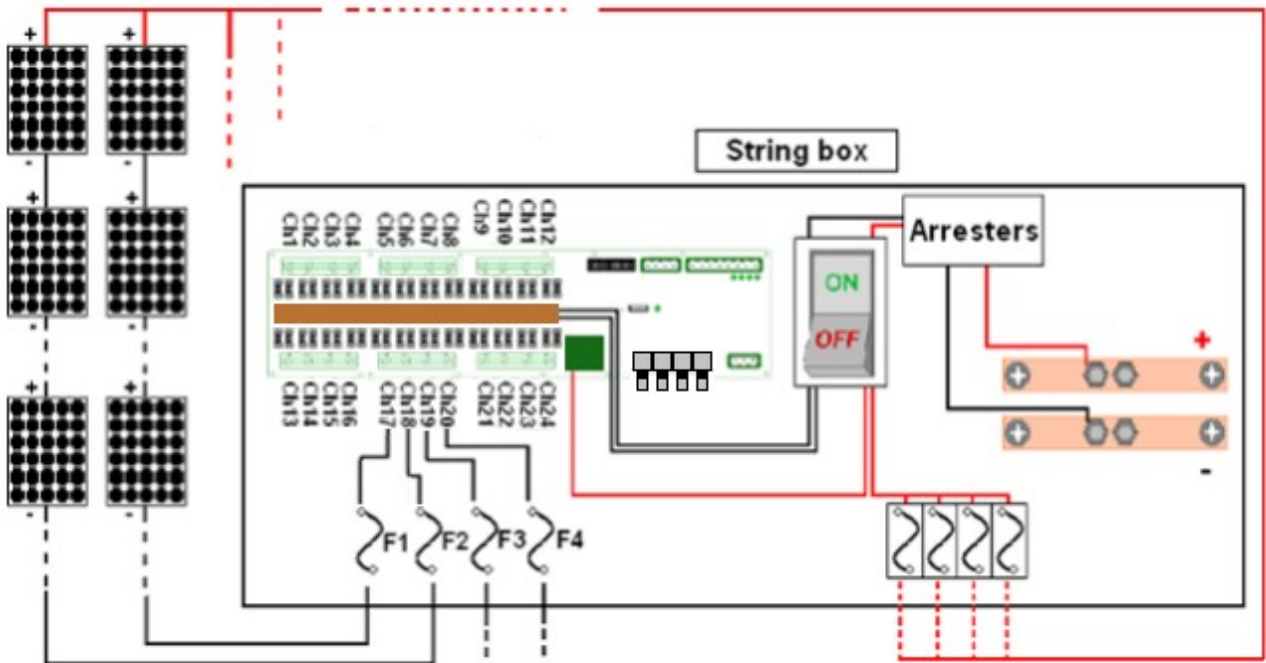
After the strings input connector, on the ST2 board there are two resistors in parallel, they are necessary to detect the current follow :



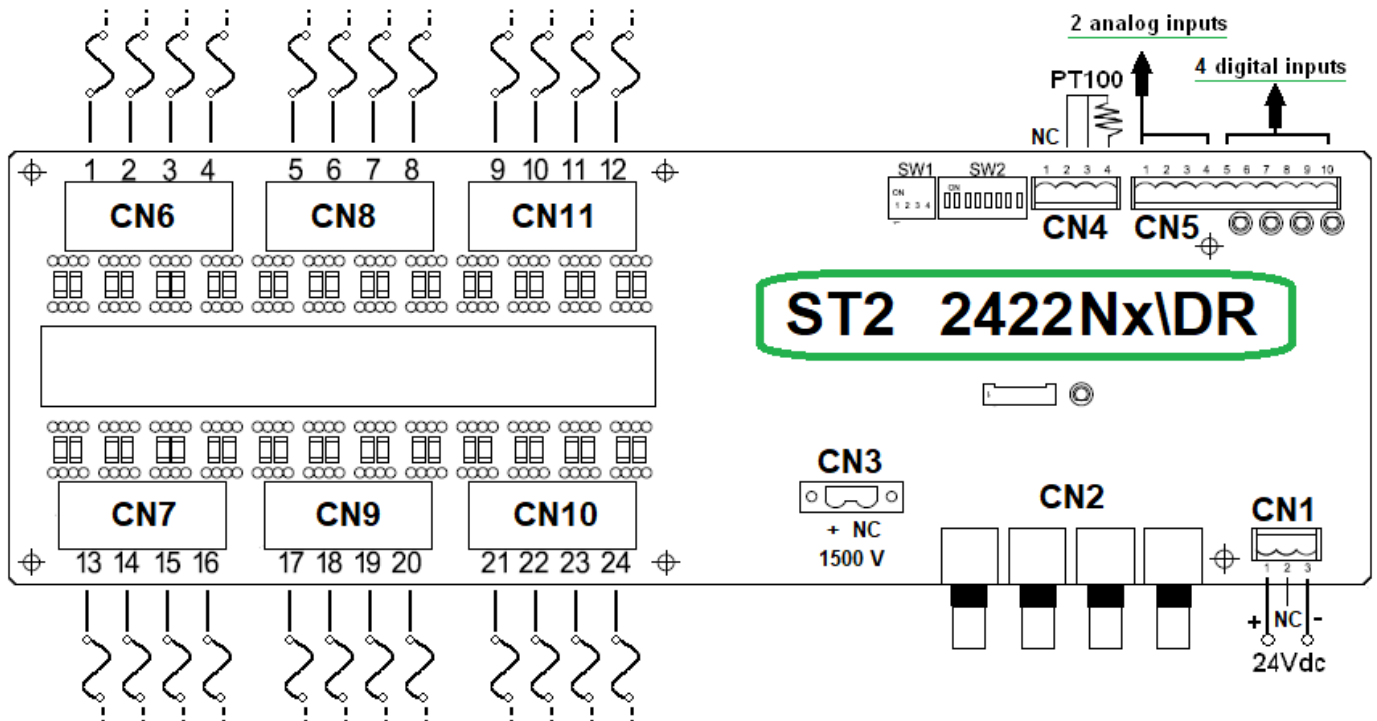
and finally a copper bar connect all the negative poles, thus creating a common 0 V.

The ST2 board also provides four digital inputs and three analog inputs. One analog inputs is for PT100 connection, another one for solarimeter connection and the last analog input is 0 ... 20 mA with precision better than 1,5 %. The digital inputs allows to detect the arrester state, another input is usually used for a sensor connected to string box panel's closing door and other switches in general, and an auxiliary fourth PNP digital input.

Is possible communicate with the ST2 board with a Fiber Optic connection. Using **Modbus RTU protocol**, or with **IEC 60870-5-101 protocol**, is possible monitoring all the physical quantities measured (temperature, solar intensity, current, digital inputs state ecc...). Moreover is possible keep monitored the fuses status on the string box, through the reading of an internal register on memory map (30034).



In the following image there are the “ST2 string controller” with all the wiring. Obviously isn't necessary connect all the specified devices, they are indicated to give a connection general idea.



## 3 HARDWARE CHARACTERISTICS

### 3.1 Hardware Characteristics

ELECTRIC CHARACTERISTICS	
Microprocessor	STM32F303
Power supply	24 Vdc
Power consumption (W)	< 3 W
Maximum number of monitored strings	24
Maximum common voltage	1500 V with precision better than 0,5 %
Max. current for each string	22 A
Range of measurement	0 ... 528 A
Current reading accuracy	Better than 0,15 %
Current reading precision	Typical 0,5 %
Communication	Fiber Optic
Digital Inputs	4 digital inputs 24 Vdc PNP
Analog inputs	1 input PT100, 1 current input (0 ... 20mA) and 1 voltage input (0 ... 10 V) for solarimeter + one on board temperature sensor to know the temperature inside the string box panel
Working temperature's range	From -20 to +80 °C
Working atmosphere	Without corrosive gas
ID Address	Defined by dip-switches
Size	338 x 108 mm
Size (with support for din rail bar)	342 x 128 mm
Working humidity	Lower 95 % without condensation
MTBF	> 500000 hours
Maximum Operating Altitude	4000 meters
Minimum Current	1 A (programmable)
Minimum Voltage	100 V (programmable)
from Firmware Version : 1.31 forward	

N°	Type of resources	Symbol	Terminal Block
1	PT100 input (from -20 to +120 °C) to temperature reading, with precision better than 1,5 %	T1	CN4
1	Sensor on board to switch board's temperature reading (precision better than 1,5 %)	T2	On board
1	Analog input from 0 to 10 V for solarimeter connection	ADC2	CN5
1	Analog input from 0 to 20 mA with precision better 1,5 %	ADC1	CN5
4	PNP digital inputs 24 Vdc, typically used to arrester connection, switches or other devices	INP0, INP1 INP2, INP3	CN5
1	Fiber Optic connection : is used to connect many "ST2 string controllers" into a network or to a PC. Is possible select the communication characteristics with a dip-switches on board (node address, baud rate, parity, and communication protocol, that may be <b>Modbus RTU</b> or <b>IEC 60870-5-101</b> ). It's divided in 2 connectors (Single Ring) or 4 connectors (Double Ring)	FIBER OPTIC	CN2
24	This board can manage the current reading of 24 strings until 22 A with typical precision of 0,5 % and a temperature between -20 and +80 °C	Ch01 ... Ch24	CN6, CN7 CN8, CN9 CN10, CN11



### 3.2 Power Dissipation

First of all we have to distinguish from “power dissipation” to “power consumption” : power dissipation is the total amount of power dissipated by the SMU, that is splitted in two parts : the part needed to supply the electronics and the part dissipated by the shunts used to measure the string currents. Only the part needed by the electronic (the power consumption) is to be supplied by the external 24 V power supply, this part is fixed and is typically less then **3 W** (125 mA) for all models of SMU.

The part dissipated by the shunt is variable and depends by the number of shunts and by the current that flows into them. To calculate the dissipation of each channel you can use the following formula, valid for all the SMU model :

$$\text{Shunt\_Power} = \text{current} * \text{current} * 0.001 \text{ (where 0.001 is the ohmic resistance of the shunt)}$$

than you have to multiply for the number of channels (shunts)

- Example : ST01625 you have  $25 * 25 * 0.001 * 16 = 10.0 \text{ W}$

Otherwise if you consider a current of 12 A the power dissipated onto the shunt drops to **2.3 W**

- Example : ST22422 you have  $22 * 22 * 0.001 * 24 = 11.6 \text{ W}$

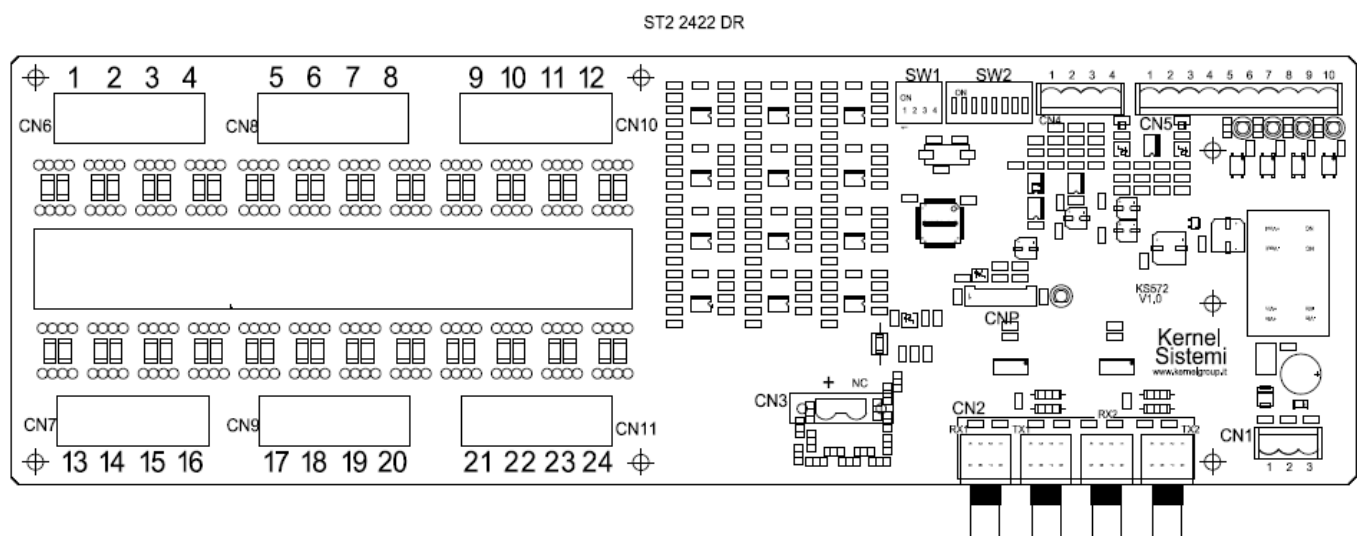
Otherwise if you consider a current of 20 A the power dissipated onto the shunt drops to **9.6 W**

This part of power is not to be supplied by the 24 V external power supply because it is directly generated by the current from PV strings.

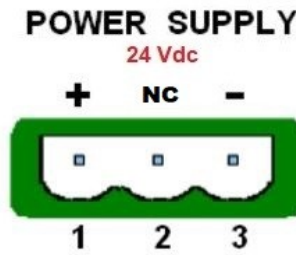
#### IMPORTANT

It is possible to power the board directly from PV panels using an insulated DC/DC power supply for PV usage. Of course keep in mind that before the sunrise and after the sunset the voltage from the PV is zero, so the DC/DC converter does not work and the board is not powered.

### 3.3 Board dimensions (without supporting box)

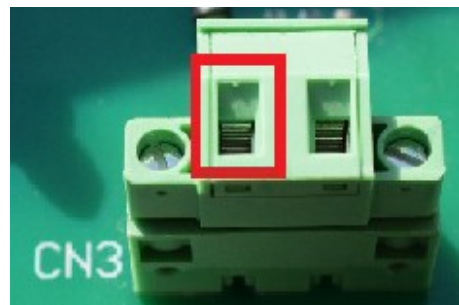
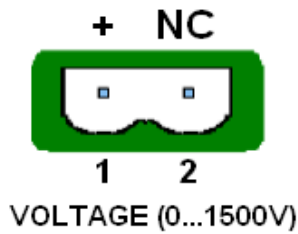


### 3.4 Connector : CN1



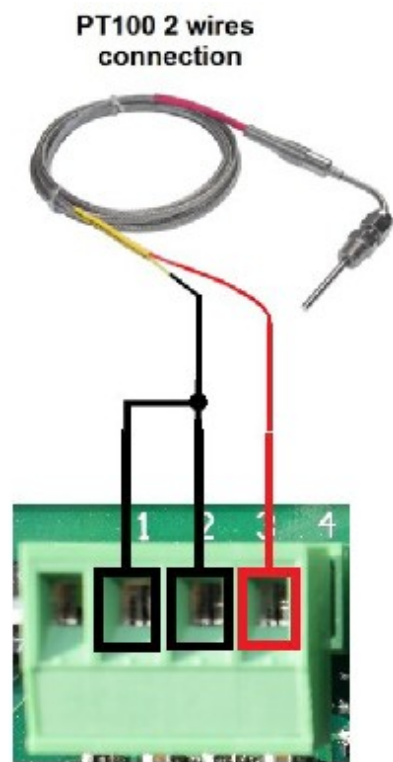
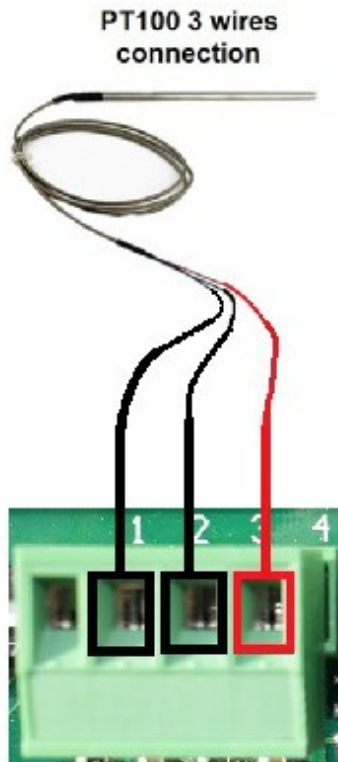
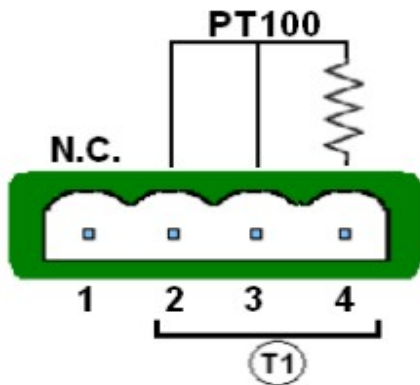
### 3.5 Connector : CN3

To read the voltages, is necessary connect the negative of the panel's string to one channel and the positive to the positive pin of connector CN3. You'll find the voltage value on 30040.



### 3.6 Connector : CN4

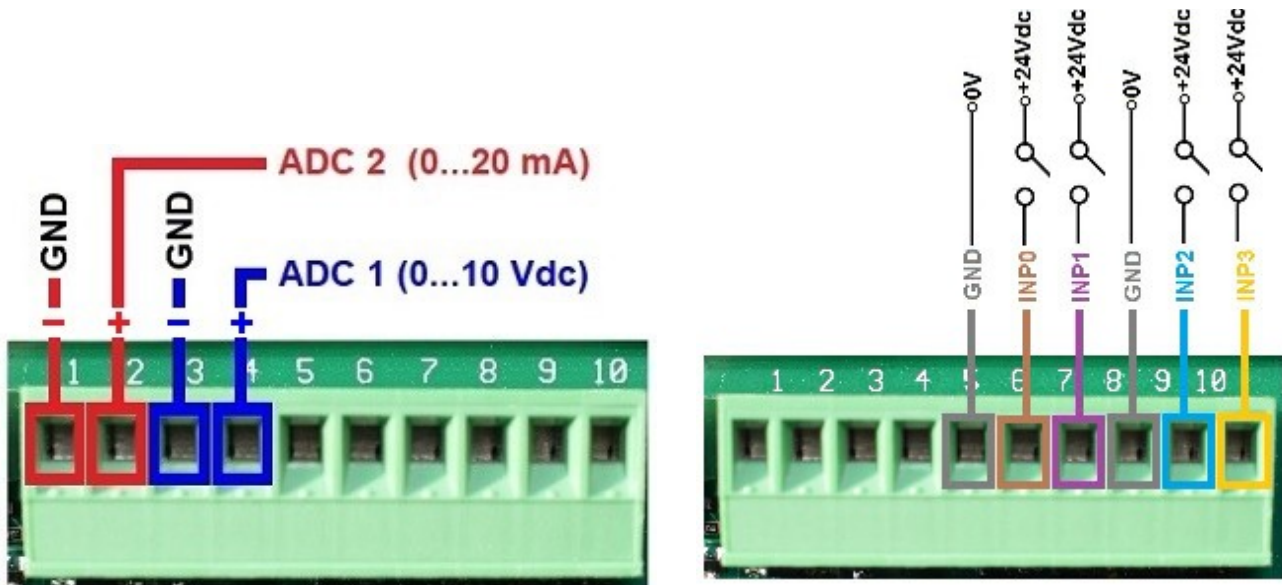
Is possible connect one PT100 to read the external temperature. The PT100 could be 2 or 3 wires, it will be connected in the following way to terminal block CN4. You can find this temperature on register 30044.



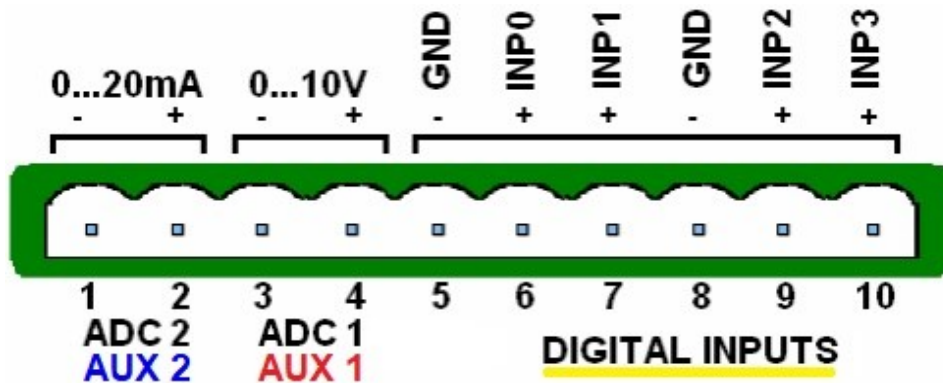


### 3.7 Connector : CN5

To know when a switch (for example the general one) is ON or OFF, there are four digital inputs PNP 24 Vdc on terminal block CN5. Each digital input status is indicated also by a led status on board. You need to use the pins 5, 6, 7, 8, 9 and 10. Inside the memory map the bits from 0 to 3 of register 30001 are the digital input status.



May be necessary connect a probe to a junction box, for example a pyrometer (to know the solar irradiation). To this purpose there are two analog inputs: one which allow to connect a signal which can be from 0 to 20 mA and the other one which allow to connect a signal from 0 to 10 Vdc. The connection is to pin 1, 2, 3 and 4 of terminal block CN5. On register 30042 and 30043 you can find a value between 0...1000 in order to the signal value (20 mA or 10 Vdc = 1000; 10 mA or 5 Vdc = 500; 0 mA or 0 Vdc = 0 etc...)



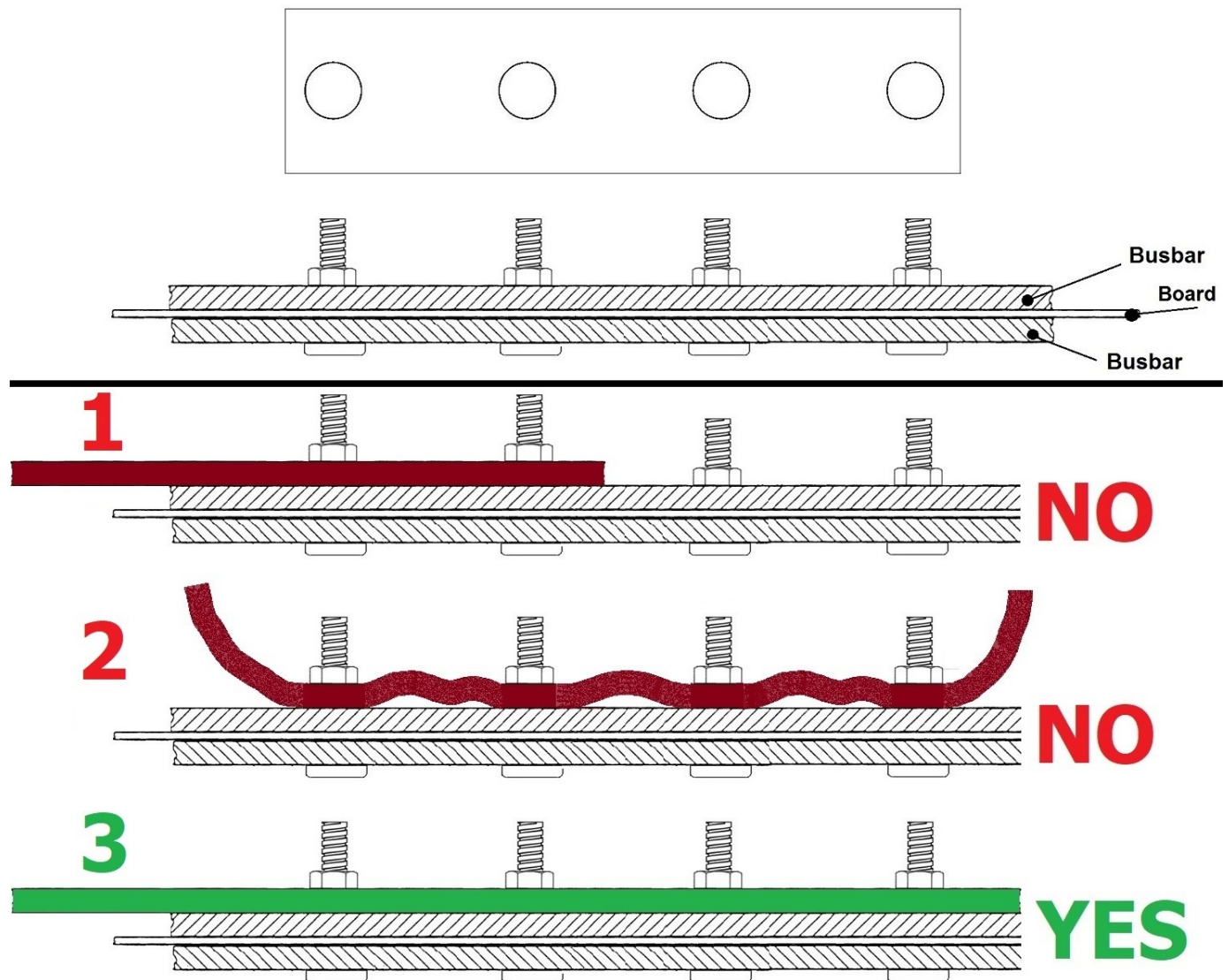
### 3.8 Memory Protection

Memory is always protected by writing! In order to enable writing for a limited time (10 minutes), you have to write :

**Value : 0x5555 Hex**  
**Modbus Address : 40100**

### 3.9 Busbar

Examples of busbar connection :



If it is necessary to "extend" the busbar, the following fundamental rules must be followed :

1. The added bar must take the whole bar and be connected to all the bolts (with the correct tightening torque).
2. It must not have curves or irregularities.
3. It must be absolutely flat so as to be perfectly in contact on the whole surface of the bar.

This connection busbar **MUST** be perfectly planar.

It is therefore necessary to check that these busbars are perfectly planar **BEFORE** fixing them to the busbar of the board.

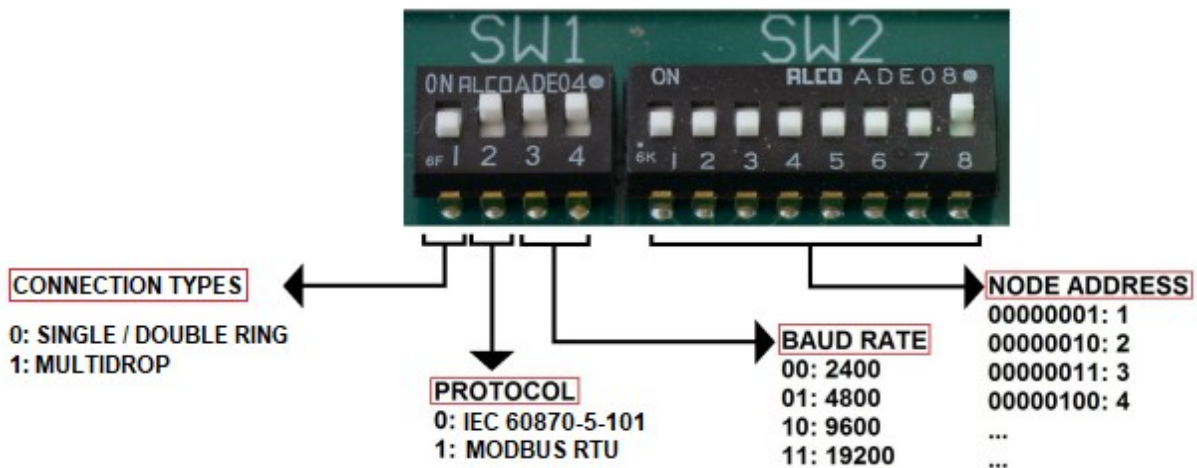
It is necessary **FIRST** to fix the "busbar connection to the Switch Disconnecter" to the BOARD, then perform the fastening of this busbar to the Switch Disconnecter. In doing so, the perfect contact between the "busbar connection to the S.D." and the busbar on the board is guaranteed.

#### **ATTENTION**

The dimensions of the bar must be calculated according to the value of the **MAXIMUM CURRENT**  
(follow the appropriate regulatory tables)

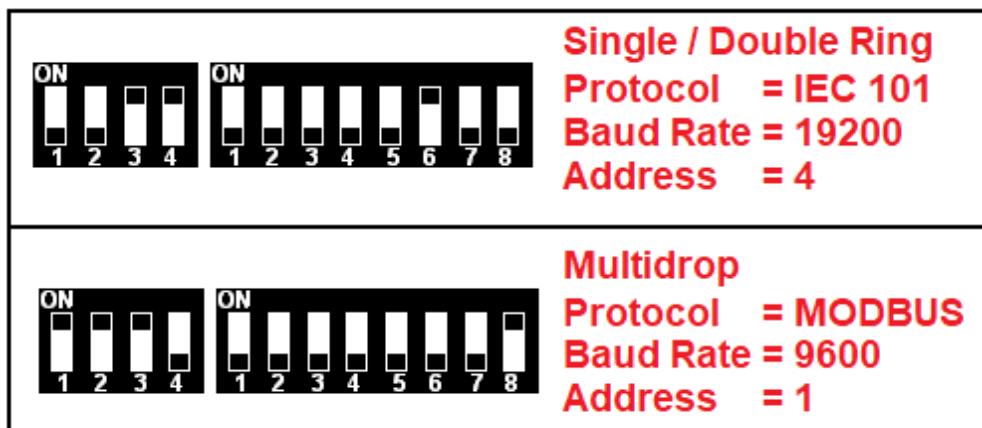
As an alternative to the bar, it is possible to connect more CABLES to the busbar on the board : also in this case the cables must be appropriately sized according to the value of the **MAXIMUM CURRENT**  
(follow the appropriate regulatory tables).

### 3.10 Dip-switches



Note : Parity = NO\_PARITY ; Bit = 8 ; Stop = 1

Some dip-switches examples :



### 3.11 Fixing system of the naked board (without supporting box)

To fix the naked board (without case) is necessary use plastic spacers with dual clutch. The plastic spacers must be 4x20 mm or 4x25 mm (4 mm is the hole diameter on the board). Look the below picture.



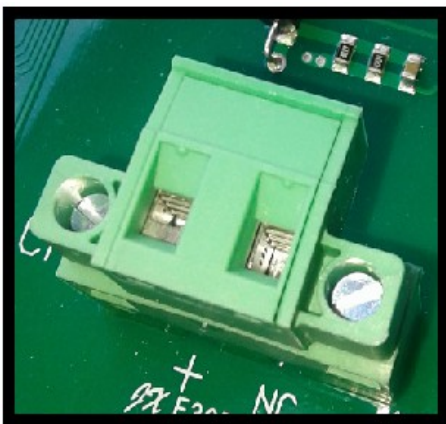
### 3.12 Status led

On the board there is a status led which with its blinking show the board status. There are two possible different blinking ways : blinking each 0,5 sec, or blinking faster. If the blinking is 0,5 sec ON and 0,5 sec OFF, it means that the board is ready to communicate with an external device, instead if the blinking is faster than 0,5 sec, it means that the board is in test mode with all the dip-switch OFF. In this way the board isn't ready to communicate with an external device.

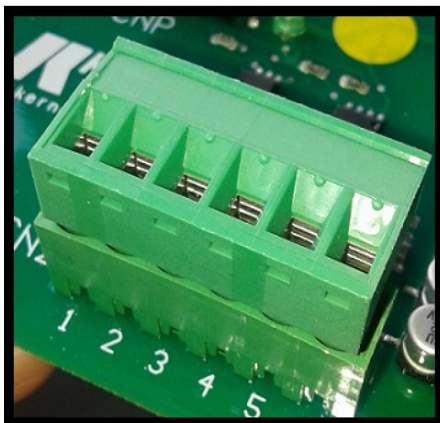
### 3.13 Informations about wires and connectors



CHANNEL CONNECTOR	
Nominal Cross Section	6 mm <sup>2</sup>
Stripping length	8 mm
Conductor cross section AWG/kcmil	24 to 10
Screw	M3
Min / Max Torque	0.50 Nm / 0.60 Nm [4.4 Lbf-In / 5.3 Lbf-In]
Operating temperature	-40°C ÷ (depends on the derating curve)



VOLTAGE CONNECTOR	
Wire Section	2.5 mm <sup>2</sup> / 0.20-2.5 mm <sup>2</sup>
Stripping length	7 mm
Conductor cross section AWG/kcmil	24 to 12
Screw	M3
Min / Max Torque	0.50 Nm / 0.60 Nm [4.4 Lbf-In / 5.3 Lbf-In]
Operating temperature	-40°C ÷ (depends on the derating curve)



OTHER CONNECTORS (Power Supply, Serial ...)	
Wire Section	2.5 mm <sup>2</sup> / 0.34-2.5 mm <sup>2</sup>
Stripping length	7 - 8 mm
Solid Wire (AWG)	12-24 / 14-22
Screw	M3
Max Torque	0.56 Nm [5.0 Lbf-In]
Operating temperature	-40°C ÷ +115°C



Copper Bar	
Min / Max Torque	2.2 Nm / 2.5 Nm [19.5 Lbf-In / 22.1 Lbf-In]



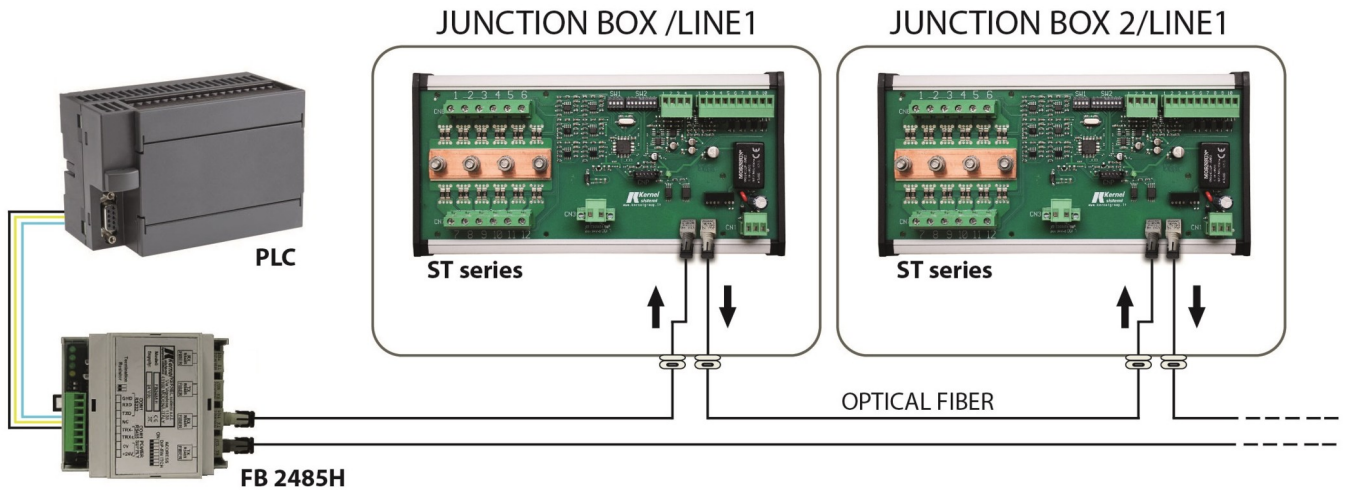
### 3.14 Connection Types

Is possible connect ST2 with 3 different configurations as below! The 3 types are the following :

1. "Single Ring or Single Connection"
2. "Double Ring or Double Connection" [Redundant]
3. "Multidrop Connection" [Redundant]

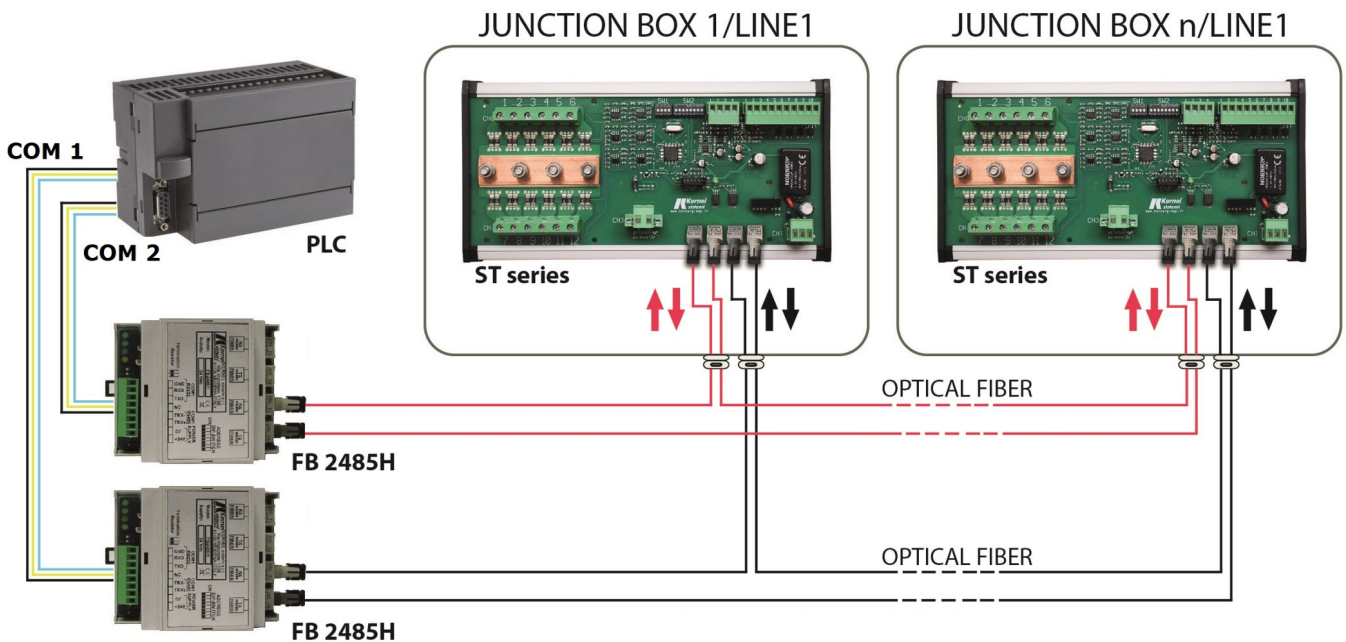
The final result is as schematized here below :

#### SINGLE RING / SINGLE CONNECTION



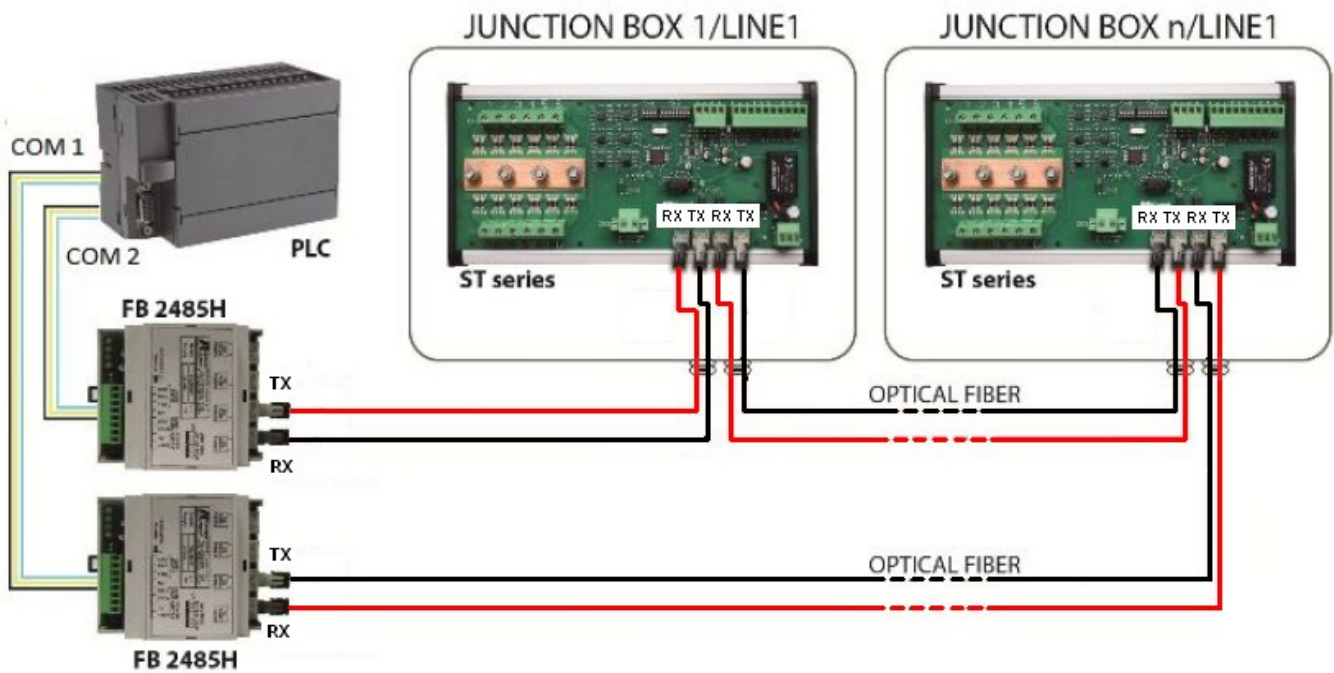
Protocol = MODBUS or IEC 60870-5-101

#### DOUBLE RING / DOUBLE CONNECTION [REDUNDANT]



Protocol = MODBUS or IEC 60870-5-101

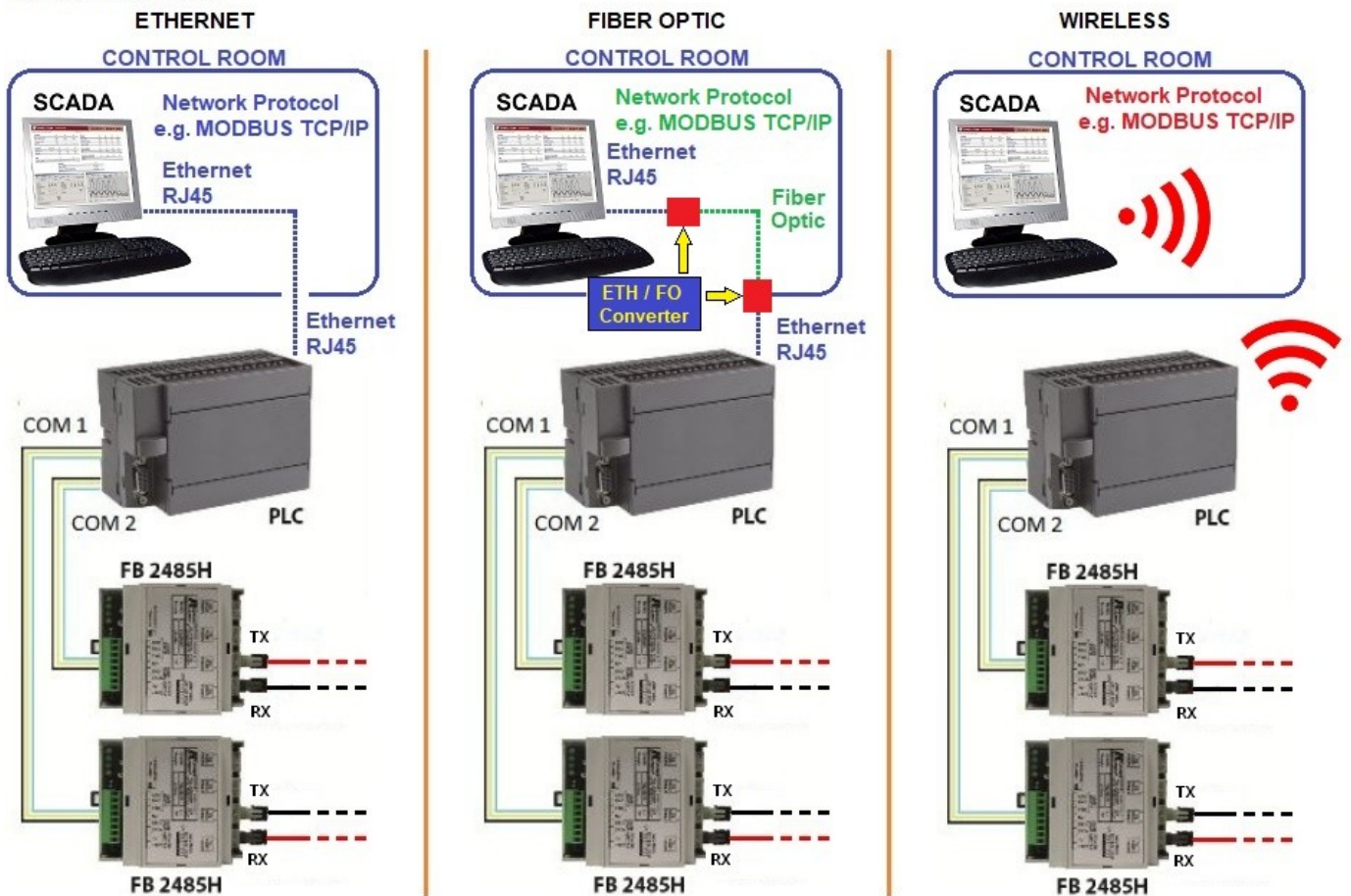
MULTIDROP CONNECTION [REDUNDANT]



Protocol = MODBUS or IEC 60870-5-101

3.15 Scada - PLC

Typically the PLC communicates via Modbus TCP / IP protocol with the SCADA in the control room with Ethernet or fiber optic or wireless connection.





## 4 MEMORY MAP

The ST2 has the following memory map, it's made of 16 bits locations (1 word) called "REGISTERS". Because each REGISTER is composed by 16 bits, its maximum value will be 65535.

MODBUS Register	TYPE	DESCRIPTION
30001	RO	Inputs
30002	RO	Inst Curr Str_01 (mA [0...22000])
30003	RO	Inst Curr Str_02 (mA [0...22000])
30004	RO	Inst Curr Str_03 (mA [0...22000])
30005	RO	Inst Curr Str_04 (mA [0...22000])
30006	RO	Inst Curr Str_05 (mA [0...22000])
30007	RO	Inst Curr Str_06 (mA [0...22000])
30008	RO	Inst Curr Str_07 (mA [0...22000])
30009	RO	Inst Curr Str_08 (mA [0...22000])
30010	RO	Inst Curr Str_09 (mA [0...22000])
30011	RO	Inst Curr Str_10 (mA [0...22000])
30012	RO	Inst Curr Str_11 (mA [0...22000])
30013	RO	Inst Curr Str_12 (mA [0...22000])
30014	RO	Inst Curr Str_13 (mA [0...22000])
30015	RO	Inst Curr Str_14 (mA [0...22000])
30016	RO	Inst Curr Str_15 (mA [0...22000])
30017	RO	Inst Curr Str_16 (mA [0...22000])
30018	RO	Inst Curr Str_17 (mA [0...22000])
30019	RO	Inst Curr Str_18 (mA [0...22000])
30020	RO	Inst Curr Str_19 (mA [0...22000])
30021	RO	Inst Curr Str_20 (mA [0...22000])
30022	RO	Inst Curr Str_21 (mA [0...22000])
30023	RO	Inst Curr Str_22 (mA [0...22000])
30024	RO	Inst Curr Str_23 (mA [0...22000])
30025	RO	Inst Curr Str_24 (mA [0...22000])
...		
30034	RO	Fuse status (Ch01...Ch16)
30035	RO	Fuse status (Ch17...Ch24)
...		
30040	RO	Inst V_1 (V [0...1500])
30041	RO	Not used
30042	RO	Inst Aux 1 (0 ... 10 V) [0...1000]
30043	RO	Inst Aux 2 (0 ... 20 mA) [0...1000]
30044	RO	Inst T_1 ( °C [-20...+120]) - PT100
30045	RO	Inst T_2 ( °C [-22,0...+83,0]) - on board
...		
30047	RO	Sum of all currents (A / 10)
30048	RO	Power (W) - LSW
30049	RO	Power (W) - MSW

...			
30052	RO	RMS Curr Str_01 (average value on last 6 seconds)	
30053	RO	RMS Curr Str_02 (average value on last 6 seconds)	
30054	RO	RMS Curr Str_03 (average value on last 6 seconds)	
30055	RO	RMS Curr Str_04 (average value on last 6 seconds)	
30056	RO	RMS Curr Str_05 (average value on last 6 seconds)	
30057	RO	RMS Curr Str_06 (average value on last 6 seconds)	
30058	RO	RMS Curr Str_07 (average value on last 6 seconds)	
30059	RO	RMS Curr Str_08 (average value on last 6 seconds)	
30060	RO	RMS Curr Str_09 (average value on last 6 seconds)	
30061	RO	RMS Curr Str_10 (average value on last 6 seconds)	
30062	RO	RMS Curr Str_11 (average value on last 6 seconds)	
30063	RO	RMS Curr Str_12 (average value on last 6 seconds)	
30064	RO	RMS Curr Str_13 (average value on last 6 seconds)	
30065	RO	RMS Curr Str_14 (average value on last 6 seconds)	
30066	RO	RMS Curr Str_15 (average value on last 6 seconds)	
30067	RO	RMS Curr Str_16 (average value on last 6 seconds)	
30068	RO	RMS Curr Str_17 (average value on last 6 seconds)	
30069	RO	RMS Curr Str_18 (average value on last 6 seconds)	
30070	RO	RMS Curr Str_19 (average value on last 6 seconds)	
30071	RO	RMS Curr Str_20 (average value on last 6 seconds)	
30072	RO	RMS Curr Str_21 (average value on last 6 seconds)	
30073	RO	RMS Curr Str_22 (average value on last 6 seconds)	
30074	RO	RMS Curr Str_23 (average value on last 6 seconds)	
30075	RO	RMS Curr Str_24 (average value on last 6 seconds)	
...			
30084	RO	RMS V_1 (V [0...1500]) (average value on last 6 seconds)	
30085	RO	Not used	
30086	RO	RMS Aux 1 (0 ... 10 V) [0...1000] (average value on last 6 seconds)	
30087	RO	RMS Aux 2 (0 ... 20 mA) [0...1000] (average value on last 6 seconds)	
30088	RO	RMS T_1 ( °C [-20...+120]) (average value on last 6 seconds)	
30089	RO	RMS T_2 ( °C [-22,0...+83,0]) (average value on last 6 seconds)	
...			
30091	RO	RMS Sum of all currents (A / 10) (average value on last 6 seconds)	
30092	RO	RMS Power (W) - LSW (average value on last 6 seconds)	
30093	RO	RMS Power (W) - MSW (average value on last 6 seconds)	
...			
30201	RO	Firmware Version	READ ONLY
30202	RO	SMU Model	READ ONLY
30203	RO	Channels Number	READ ONLY
30204	RO	Shunt Type	READ ONLY
30205	RO	End Scale	READ ONLY
30206	RO	Reserved for Future Use	RFU
30207	RO	Reserved for Future Use	RFU

30208	RO	Reserved for Future Use	RFU
30209	RO	Reserved for Future Use	RFU
30210	RO	Reserved for Future Use	RFU
30211	RO	Unique ID code [0]	READ ONLY
30212	RO	Unique ID code [1]	READ ONLY
30213	RO	Unique ID code [2]	READ ONLY
30214	RO	Unique ID code [3]	READ ONLY
30215	RO	Unique ID code [4]	READ ONLY
30216	RO	Unique ID code [5]	READ ONLY

...

40001	RW	Set up PARITY mode : 1 = None ; 2 = Even ; 3 = Odd	
40002	RW	Offset Curr Str_01	
40003	RW	Offset Curr Str_02	
40004	RW	Offset Curr Str_03	
40005	RW	Offset Curr Str_04	
40006	RW	Offset Curr Str_05	
40007	RW	Offset Curr Str_06	
40008	RW	Offset Curr Str_07	
40009	RW	Offset Curr Str_08	
40010	RW	Offset Curr Str_09	
40011	RW	Offset Curr Str_10	
40012	RW	Offset Curr Str_11	
40013	RW	Offset Curr Str_12	
40014	RW	Offset Curr Str_13	
40015	RW	Offset Curr Str_14	
40016	RW	Offset Curr Str_15	
40017	RW	Offset Curr Str_16	
40018	RW	Offset Curr Str_17	
40019	RW	Offset Curr Str_18	
40020	RW	Offset Curr Str_19	
40021	RW	Offset Curr Str_20	
40022	RW	Offset Curr Str_21	
40023	RW	Offset Curr Str_22	
40024	RW	Offset Curr Str_23	
40025	RW	Offset Curr Str_24	

...

40034	RW	Answer Delay (msec)	
40035	RW	Time Com Active (1/10 sec.)	
40036	RW	Parity (1 = None, 2 = Even, 3 = Odd) = 40001	
40037	RW	Fuse Threshold	

...

40040	RW	Offset V_1	
40041	RW	Not used	
40042	RW	Offset Aux_1	

40043	RW	Offset Aux_2
40044	RW	Offset T_1
40045	RW	Offset T_2
...		
40047	RW	Minimum Current (Default = 1 A)
40048	RW	Minimum Voltage (Default = 100 V)

...		
40052	RW	Gain Curr Str_1
40053	RW	Gain Curr Str_2
40054	RW	Gain Curr Str_3
40055	RW	Gain Curr Str_4
40056	RW	Gain Curr Str_5
40057	RW	Gain Curr Str_6
40058	RW	Gain Curr Str_7
40059	RW	Gain Curr Str_8
40060	RW	Gain Curr Str_9
40061	RW	Gain Curr Str_10
40062	RW	Gain Curr Str_11
40063	RW	Gain Curr Str_12
40064	RW	Gain Curr Str_13
40065	RW	Gain Curr Str_14
40066	RW	Gain Curr Str_15
40067	RW	Gain Curr Str_16
40068	RW	Gain Curr Str_17
40069	RW	Gain Curr Str_18
40070	RW	Gain Curr Str_19
40071	RW	Gain Curr Str_20
40072	RW	Gain Curr Str_21
40073	RW	Gain Curr Str_22
40074	RW	Gain Curr Str_23
40075	RW	Gain Curr Str_24

...		
40090	RW	Gain V_1
40091	RW	Not used
40092	RW	Gain Aux_1
40093	RW	Gain Aux_2
40094	RW	Gain T_1
40095	RW	Gain T_2

...		
40101	RW	User Memory 01
40102	RW	User Memory 02
40103	RW	User Memory 03
40104	RW	User Memory 04
40105	RW	User Memory 05

40106	RW	User Memory 06
40107	RW	User Memory 07
40108	RW	User Memory 08

...

40201	RO	Shunt Type (= 30204)	READ ONLY
40202	RO	SMU Model (= 30202)	READ ONLY
40203	RO	Firmware Version (= 30201)	READ ONLY
40204	RO	Channels Number (= 30203)	READ ONLY
40205	RO	End Scale (= 30205)	READ ONLY
40206	RO	Reserved for Future Use	RFU
40207	RO	Reserved for Future Use	RFU
40208	RO	Reserved for Future Use	RFU
40209	RO	Reserved for Future Use	RFU
40210	RO	Unique ID code [0] (= 30211)	READ ONLY
40211	RO	Unique ID code [1] (= 30212)	READ ONLY
40212	RO	Unique ID code [2] (= 30213)	READ ONLY
40213	RO	Unique ID code [3] (= 30214)	READ ONLY
40214	RO	Unique ID code [4] (= 30215)	READ ONLY
40215	RO	Unique ID code [5] (= 30216)	READ ONLY

#### NOTES

Each “Offset Register” has 0 as default value. Each “Gain Register” has 1000 as default value. *The value 1000 means x1*, in this way, for example, is possible write 500 and make the value **x0,5**.

### 4.1 Memory Map Description

**30001** : the first four bits of these register are the mirror status of the four digital inputs on the board (INP0 ... INP3 on CN5). So if 30001 = 0000000000001111 [bin] = 15 [dec], it means that all the four digital inputs are ON.

**30002 ... 30025** : these registers contains the current value of the current reading on each channel. It is in mA

**30034, 30035** : the sixteen bits of 30034 and the first eight bits of 30035 show if each channel current reading is under 200 mA or not. This threshold represent the fuse status.

**30040 ... 30049** : these registers show the value of some readings as the temperatures (T1 and T2), voltage reading (on connector CN3) etc...

**30052 ... 30075** : these registers contains the average value on last 6 seconds of the current reading. Obviously these values are more stable than the instantaneous values show in registers 30002 ... 30025

**40001** : through this register is possible set the communication parity. The default value is zero, so “no parity”

**40002 ... 40025** : these are the offset registers. These registers (whose default value is 0) allow to add a constant value to the current reading. This allow to adjust a possible reading error. For example if 30002 show 2300 (it means that channel CH1 read 2,3A), writing 40002 = 200 the new value of the reading will be 30002 = 2500 (it means that channel CH1 read 2,5A).

**40052 ... 40075** : these are the gain registers. These registers (whose default value is 1000) allow to multiply a constant value to the current reading. This allow to adjust a possible reading error. For example if 30002 show 2300 (it means that channel CH1 read 2,3A), writing 40052 = 1500 the new value of the reading will be 30002 = 3450 (it means that channel CH1 read 3,45A, 2300 x 1,5 =3450).

**40101 ... 40108** : these are 8 registers available to the user. They can contain data useful to the customer, for example a different progressive number for each board.

40201 : Shunt Type (= 30204) - READ ONLY

40202 : SMU Model (= 30202) - READ ONLY

40203 : Firmware Version (= 30201) - READ ONLY

40204 : Channels Number (= 30203) - READ ONLY

40205 : End Scale (= 30205) - READ ONLY

40206 ... 40209 : Not Used - Reserved for Future Use (RFU)

40210 ... 40215 : **Unique device ID register (96 bits)** (organized in six 16 bit words) that is unique for any board.  
(= 30211 ... 30216) - READ ONLY

The unique device identifier is ideally suited :

- for use as serial numbers (for example string serial numbers or other end applications).
- for use as part of the security keys in order to increase the security.

The 96-bit unique device identifier provides a reference number which is unique for any device and in any context. These bits cannot be altered by the user. The code is composed of the following parts :

UID [31:00] : X and Y coordinates on the wafer expressed in BCD format

UID [39:32] : WAF\_NUM [07:00] > Wafer number (8-bit unsigned number)

UID [63:40] : LOT\_NUM [23:00] > Lot number (ASCII encoded)

UID [95:64] : LOT\_NUM [55:24] > Lot number (ASCII encoded)

## 4.2 Reading speed

The analogic values of the currents, the voltage and the temperature are read simultaneously 10 times per second (100 msec scan time), then are inserted in it's own FIFO (a FIFO for each analogic value), 16 values deep. The value read from the board is the mobile mean of the FIFO, so it is the mean of the last 16 read values (1.6 sec), updated every 100 msec. This is done to make the analogic readout more stable and it is a good compromise between speed and readout stability.

The instant values of the analogic are temporary stored into a hidden memory area, not accessible to the COM port.

The update time depend on the speed polling time of the SCADA and the communication baud rate.

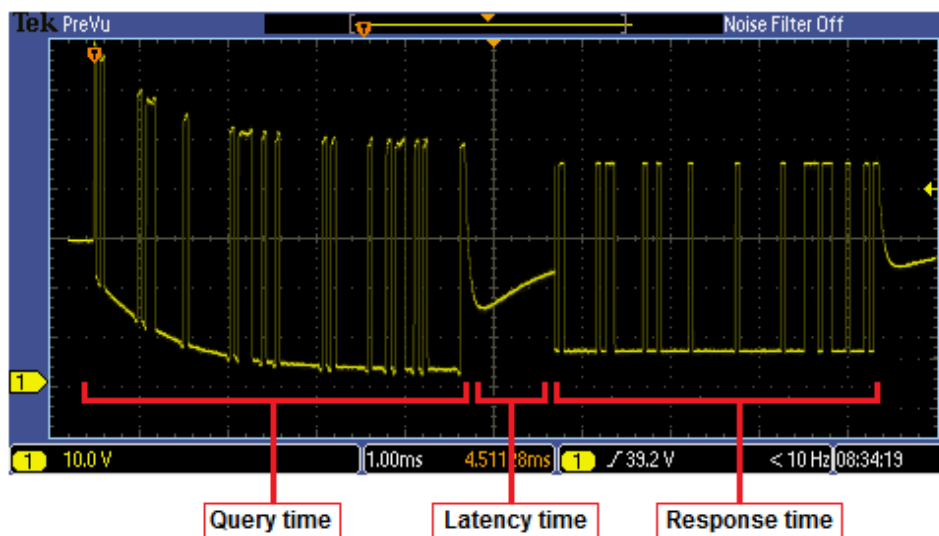
The total time requested to read the board via com port is splitted into three times: *the query time, the latency time and the response time.*

The query time is the time needed by the SCADA to send the MODBUS query packet and depends on the baud rate (about 4 msec at 19200 baud rate).

The latency time is the time need by the board to process the query and prepare the answer, it is between 1 and 2 msec and it is independent on the baud rate.

The response time is the time needed byte the board to send the MODBUS answer packet, it's depend on the baud rate and on the number of registers read at a time, for a single register read at 19200 baud it is about 4 msec.

So at 19200 baud rate the total time needed to read a single register is about 10 msec., you have to add 1 msec every other register read, for example to read 16 registers with a single query will take  $10 \text{ msec} + 15 * 1 \text{ msec} = 25 \text{ msec}$ .





## 5 OPTICAL FIBER

### 5.1 OFC Network features

The characteristics of the fiber optic network achievable with the KERNEL SMUs with OFC interface on board are the following :

Max number of SMU that it's possible to connect in one network	256
Maximum distance between 2 consecutive SMUs	2 - 3 KM if the "fiber / connector" connections are correct
Recommended fiber optic features	Multimode OM2 class or higher 50/125 $\mu\text{m}$ or 62.5/125 $\mu\text{m}$
Connectors features	ST

#### IMPORTANT

The optical signal is regenerated internally to each SMU so that, each SMU retransmits the optical signal at the maximum power.

So the first SMU, connected to the FB2485H converter, receives the same level of optical signal that receives the last SMU of the network.

#### IMPORTANT

### 5.2 Optical Fiber Cable

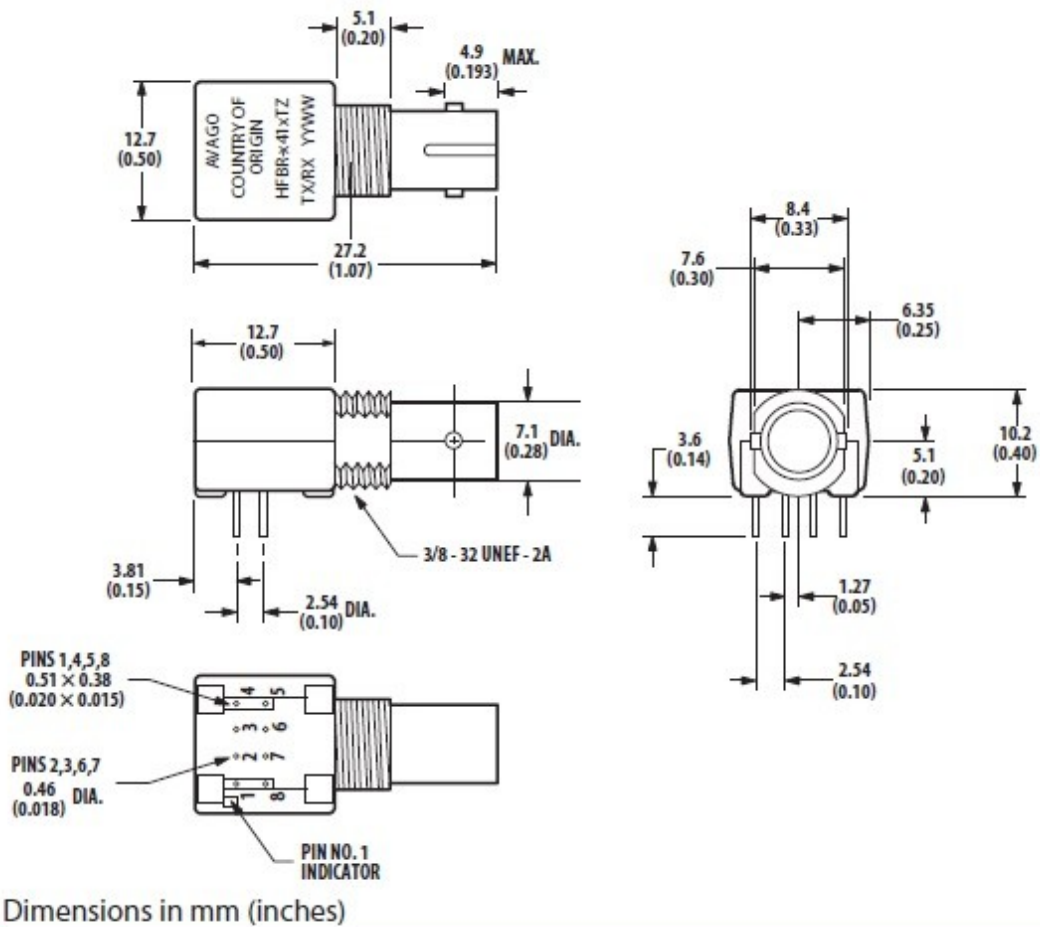
The optical fiber cable which is necessary to the connection, must be a compatible cable :

Optical Fiber	Compatible with : 50/125 $\mu\text{m}$ 62.5/125 $\mu\text{m}$ 100/140 $\mu\text{m}$ 200 $\mu\text{m}$ Plastic-Clad Silica (PCS) Fiber
In Compliance with standard	OM1, OM2, OM3, OM4



### 5.3 Optical Fiber Connector

Here are indicated the characteristics of the optical fiber connector on the board :



## 6 ORDER CODES

Here below the order codes :

CODE	DESCRIPTION
ST2 2422NC\SR	Device with support for din rail bar + 2 Fiber Optic Connectors
ST2 2422NK\SR	Device without support for din rail bar + 2 Fiber Optic Connectors
ST2 2422NC\DR	Device with support for din rail bar + 4 Fiber Optic Connectors
ST2 2422NK\DR	Device without support for din rail bar + 4 Fiber Optic Connectors

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