ERO ELECTRONIC

USER MANUAL

RFS
DIN Rail Mounting Temperature Controller

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HVS.

PRÉCONISATEUR DE SOLUTIONS DEPUIS 1985

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MOUNTING REQUIREMENTS

Select a mounting location having the following characteristics:
1) it should be easy accessible
2) there is no vibrations or impact
3) there are no corrosive gases (sulphuric gas, ammonia, etc.).
4) there are no water or other fluid (i.e. condense)
5) the ambient temperature is in accordance with the operative temperature of the instrument (from 0 to 50 °C).
6) the relative humidity is in accordance with the instrument specifications (20% to 85 % non condensing).
The instrument can be mounted on OMEGA DIN rail in accordance with EN 50 022 (35 x 7.5 mm or 35 x 15 mm) regulations.
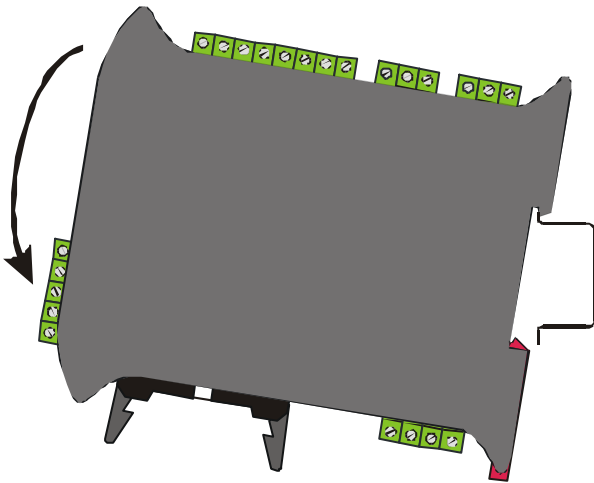For outline dimensions refer to Fig. 2.
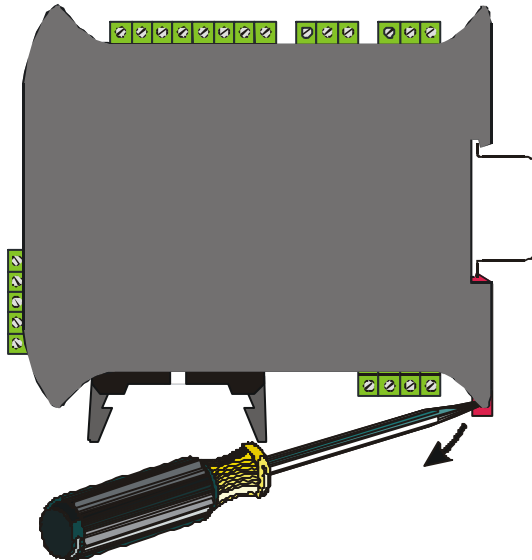
MOUNTING

Fig. 1.A

REMOVING

Fig. 1.B
OUTLINE DIMENSIONS
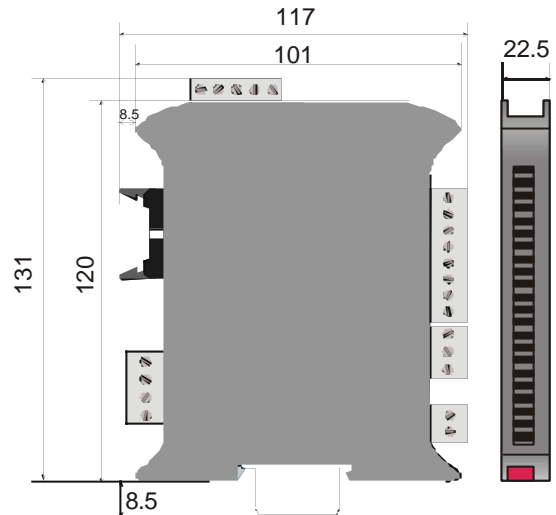
Fig. 2   OUTLINE DIMENSIONS

CONNECTION DIAGRAMS
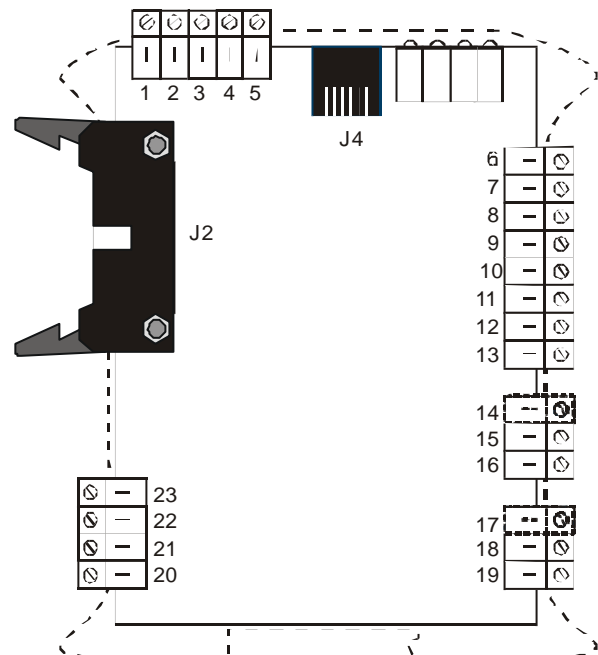
Fig. 3 TERMINAL BLOCK

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1) Don't run input wires together with power cables.
2) Pay attention to the line resistance; a high line resistance (higher than 20 Ω/wire) may cause measurement errors.
3) If shielded cable is used, it should be grounded at one point only.
4) The resistance of the 3 wires must be the same.

MEASURING INPUTS
NOTE: Any external component (like zener barriers etc.) connected between sensor and input terminals may cause errors in measurement due to excessive and/or not balanced line resistance or possible leakage currents.

TC INPUT

LINEAR INPUT

Fig. 6.A   mA INPUT WIRING

Fig. 4 THERMOCOUPLE INPUT WIRING

NOTE:
1) Don't run input wires together with power cables.
2) For TC wiring use proper compensating cable preferable shielded.
3) When a shielded cable is used, it should be connected at one point only.

RTD INPUT
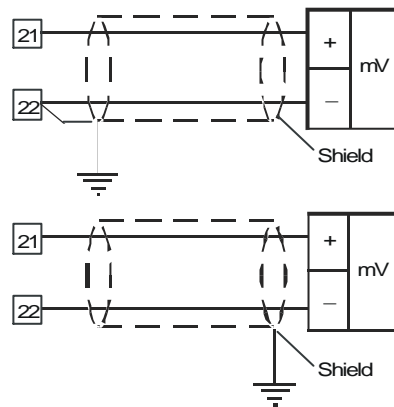
Fig. 6.B   60mV INPUT WIRING

NOTE:
1) Don't run input wires together with power cables.
2) When shielded cable is used, it should be grounded at one side only to avoid ground loop currents.
3) For mV input, pay attention to the line resistance; a high line resistance may cause measurement errors.
4) The input impedance is equal to:
   < 5 Ω for 20 mA input.
   > 1 MΩ for 60 mV input.

Fig. 5   RTD INPUT WIRING

NOTE:

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LOGIC INPUT

Safety note:
1) Do not run logic input wiring together with power cables.
2) Use an external dry contact capable of switching 5 mA, 7.5 V DC.
3) The instrument needs 100 ms to recognize a contact status variation.
4) The logic inputs is isolated by the measuring input.
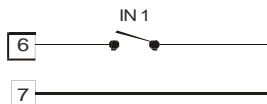
Fig. 7 - LOGIC INPUT WIRING

This logic input can be programmed in order to perform the following functions:
a) to switch from main set point to auxiliary set point and viceversa.

logic input	op. set point
open	main SP
close	auxiliary SP (SP2)

b) to hold the set point ramp execution.

logic input	Ramp
open	RUN
close	HOLD

CURRENT TRANSFORMER INPUT
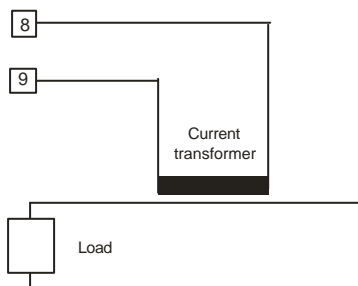
Fig. 8   CURRENT TRANSFORMER INPUT WIRING

Note:
1) The input impedance is equal to 12 Ω.
2) The maximum input current is equal to 50 mA rms (50 / 60 Hz).

RELAY OUTPUTS
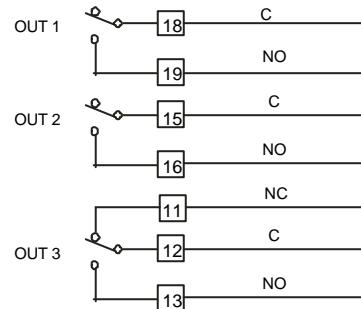
Fig. 9 RELAY OUTPUTS WIRING

The contact rating of the OUT 1, 2 and 3 is 3A/250V AC on resistive load.

The number of operations is 3×10^5 at specified rating.

NOTES
1) To avoid electrical shock, connect power line at the end of the wiring procedure.
2) For power connections use No 16 AWG or larger wires rated for at last 75 °C.
3) Use copper conductors only.
4) Don't run input wires together with power cables.

All relay contacts are protected by varistor against inductive load with inductive component up to 0.5 A.

The following recommendations avoid serious problems which may occur, when using relay output for driving inductive loads.

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INDUCTIVE LOADS
High voltage transients may occur switching inductive loads.
Through the internal contacts these transients may introduce disturbances which can affect the performance of the instrument.
For all the outputs, the internal protection (varistor) assures a correct protection up to 0.5 A of inductive component.

The same problem may occur when a switch is used in series with the internal contacts as shown in Fig. 10.
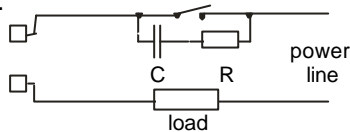
Fig. 10 EXTERNAL SWITCH IN SERIES WITH THE INTERNAL CONTACT

In this case it is recommended to install an additional RC network across the external contact as show in Fig. 10
The value of capacitor (C) and resistor (R) are shown in the following table.

LOAD (mA)	C (µF)	R (Ω)	P. (W)	OPERATING VOLTAGE
<40 mA	0.047	100	1/2	260 V AC
<150 mA	0.1	22	2	260 V AC
<0.5 A	0.33	47	2	260 V AC

The cable involved in relay output wiring must be as far away as possible from input or communication cables.

VOLTAGE OUTPUTS FOR SSR DRIVE
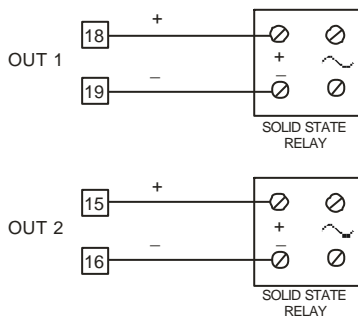
Fig. 11   SSR DRIVE OUTPUT WIRING

It is a time proportioning output.
Logic level 0: Vout < 0.5 V DC.
Logic level 1:
- 14 V $\pm$ 20 % @ 20 mA
- 24 V $\pm$ 20 % @ 1 mA.

Maximum current = 20 mA.
NOTE: This output is not isolated. A double or reinforced isolation between instrument output and power supply must be assured by the external solid state relay.

SERIAL INTERFACE
RS-485 interface allows you to connect slave
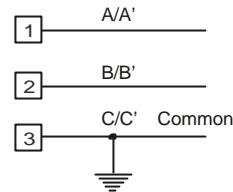
devices with one remote master unit.

Fig. 12 - RS-485 WIRING

NOTES:
1) The RFS is equipped with an RS-485 driver with an input impedance fore time higher than a standard one. For this reason it is possible to connect 120 RFS units to the same master (instead of 30).
1) The cable length must not exceed 1.5 km at 19200 BAUD.
2) This serial interface is isolated.
3) The following report describes the signal sense of the voltage appearing across the interconnection cable as defined by EIA for RS-485.
    a) The " A " terminal of the generator shall be negative with respect to the " B " terminal for a binary 1 (MARK or OFF) state.
    b) The " A " terminal of the generator shall be positive with respect to the " B " terminal for a binary 0 (SPACE or ON).
4) The EIA standard establishes that by RS-485 interface it is possible to connect up to 30 devices with one remote master unit.
The serial interface of these instruments is based on "High input impedance" transceivers; this solution allows you to connect up to 120 devices (based on the same transceiver type) with one remote master unit.

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POWER LINE WIRING

5	
POWER LINE 24 V A.C/DC	
4	
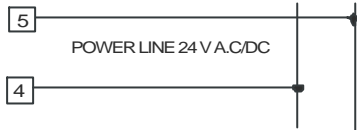
Fig. 13 POWER LINE WIRING

NOTES:
1) Before connecting the instrument to the power line, make sure that line voltage corresponds to the description on the identification label.
2) Use copper conductors only.
3) Don't run input wires together with power cables.
4) The power supply input is **NOT** fuse protected. Please, provide it externally.
   For <u>one unit only</u>, the fuse must be rated as follows:

Power supply	Type	Current	Voltage
24 V AC/DC	T	315mA	250 V

When fuse is damaged, it is advisable to verify the power supply circuit, so that it is necessary to send back the instrument to your supplier.
5) The maximum power consumption is equal to 6 VA (4 W) maximum.

ACCESSORIES

BUS cable
It is possible to use a screw connector instead of the flat cable, allowing the normal wiring of a single controller.
This flat cable allows the simultaneous connection of the power supply, the serial interface, the common alarm output (out 4) and the common logic input of up to 12 instruments plus one Common I/O unit or up to 13 instruments.
NOTE:
1) the logic inputs of each instrument can be driven:
-   by its own connector (terminals 6 and 7), without affecting the working of the other elements
-   by the common logic input (terminals 24 and 25) present on the common I/O unit. In this case, all instruments connected with the BUS cable will detect the same logic input condition.
2) The local logic input (terminals 6 and 7), and the common logic input (terminals 24 and 25), are in OR condition.
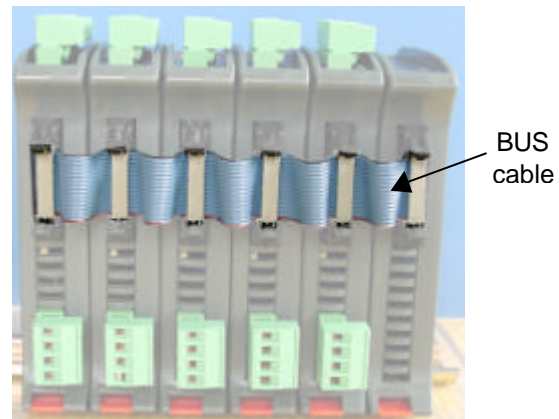
Fig. 14 – BUS CABLE

The connector used is a MOLEX Europe with 16 circuits Part number 39512163
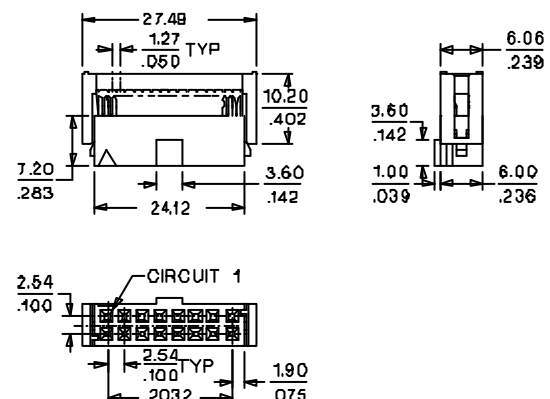
Fig. 15 – CONNECTOR 8 x 2 FOR BUS CABLE
COMMON I/O UNIT
This unit can perform 3 different functions:
1) It is the relay output of all the common alarm connected by the BUS cable.
2) It performs the connection of the common logic input of all the units connected by the BUS cable.
3) It is the natural connection of the power supply and of the serial link for all the units connected by the BUS cable.
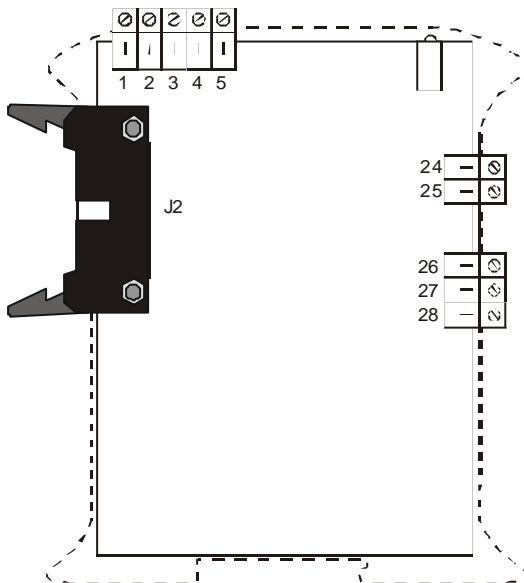
Fig. 16 - COMMON I/O UNIT TERMINAL BLOCK

For serial interface and power supply connection see fig. 12 and 13 and relative notes.

Common logic input
Safety note:
1) Do not run logic input wiring together with power cables.
2) Use an external dry contact capable of switching 100 mA, 7.5 V DC minimum.
3) The instrument needs 100 ms to recognize a contact status variation.
4) The logic input is isolated by the measuring input.
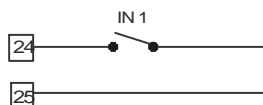
Fig. 17 – COMMON LOGIC INPUT WIRING
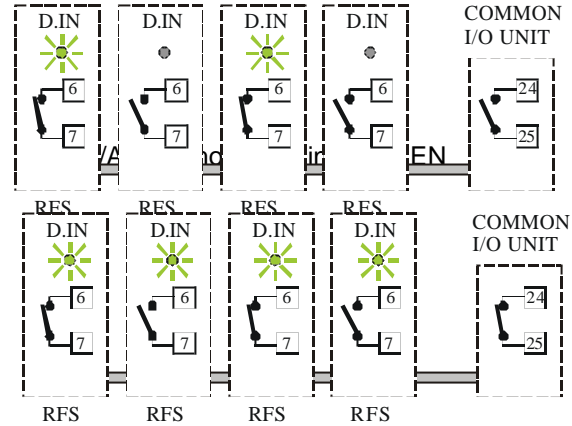
Fig. 18/B Common logic input CLOSE

NOTE: As shown in Fig 18, the logic input of a group of RFS can be driven singularly (using terminals 6 and 7 of the specific instrument) or collectively (using terminals 24 and 25 of the Common I/O unit).

This logic input can be programmed in order to perform the following functions:
a) to switch from main set point to auxiliary set point and viceversa.

logic input	selected set point
open	main SP
close	auxiliary SP (SP2)

b) to hold, the set point ramp execution.

logic input	Ramp
open	RUN
close	HOLD

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Common alarm output
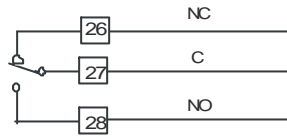
Fig. 19 COMMON ALARM OUTPUT WIRING
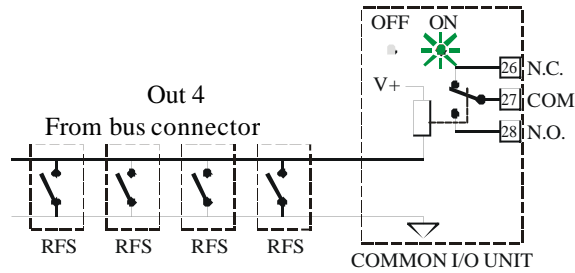
Fig. 20/A Relay de-energized, beacon ON lit.
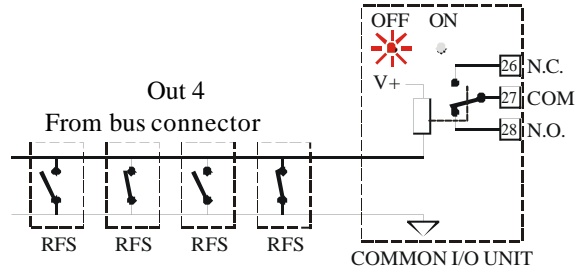
Fig. 20/B Relay energized, beacon OFF lit.

The contact rating of this output is 8A/250V AC on resistive load.

The number of operations is 3×10^5 at specified rating.

NOTE

Don't run input wires together with power cables. The relay contacts are protected by varistor against inductive load with inductive component up to 0.5 A.

CONNECTOR KIT

The unit can be supplied with or without the connector kit.

The quantity of each connector is related with the specific options selected.
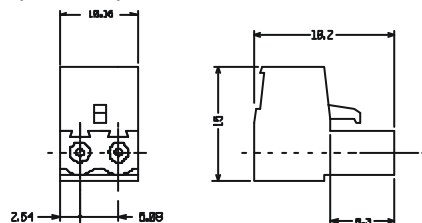
Fig 21 – 2 wires connector

Phoenix model MSTB 2.5/2-ST-5.08
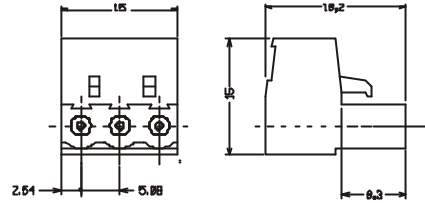
Fig. 22 - 3 wires connector

Phoenix model MSTB 2.5/3-ST-5.08
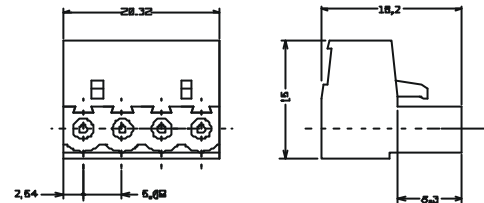
Fig. 23 - 4 wires connector

NOTE: this connector is a gold plated connector and it is shipped with the instrument and it is not included in the connector kit.

Phoenix model MSTB 2.5/4-ST-5.08
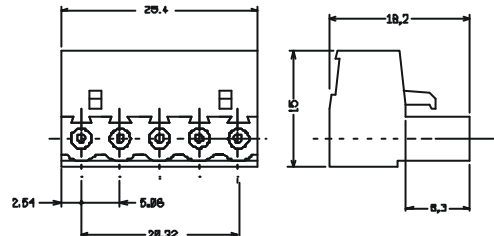
Fig. 24 - 5 wires connector

Phoenix model MSTB 2.5/5-ST-5.08
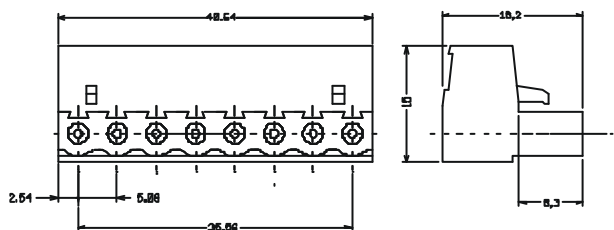
Fig. 25 - 8 wires connector

Phoenix model MSTB 2.5/8-ST-5.08

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FUNCTIONALITY

Operating modes description

The device foresees three different operating modes named:
- Calibration mode
- Configuration mode
- Operative mode

The calibration mode
This operating mode is detailed in a specific manual named "RFS Calibration manual".

The configuration mode
During configuration mode the instrument does not perform the process control and the alarms functions.

During configuration it is possible to read and write all the parameters of the instrument.
The instrument configuration can be made by RS-485 or by a specific tool named CPI.
NOTE the standard RS-485 and the CPI are mutually exclusive and the CPI have the priority with respect of the RS-485.
The CPI is shipped with a special software aimed to made the configuration procedure very easy.
The CPI and the RFS configuration program are described in a specific manual.
In the chapter "RFS Modbus protocol" you will find all the information related with the various parameters (when it can be write or read, limits, and so on).

The operative mode
During operative mode the instrument performs the process control and the alarms management and all the other special functions (SMART, soft start, etc.).

During Operative mode it is possible to read and write a subset of parameters.

SPECIAL FUNCTIONS DURING OPERATIVE MODE

Follows a list of the special functions perform by this instrument. It aims to help you during configuration and operative mode in order to obtain the best performance from this instrument.
NOTE: in the following descriptions two square brackets are used to define the Modbus address of a parameter.

Indicators
1	Lit when OUT 1 is ON.
2	Lit when OUT 2 is ON.
3	Lit when OUT 3 is ON.
4	Lit when OUT 4 is ON.
PV FAIL	Lit when a failure is detected on the measuring input.
COM	Lit during transmission.
SYS	Flashing during operative mode Lit during configuration and calibration mode.
D.IN	lit when the logic input is closed

Enable/disable the control output
When the instrument is in operative mode, it is possible to disable the control outputs [1504]. In this open loop mode the device will function as an indicator, the instrument will perform the measure but all control outputs will be forced to 0.
When the control outputs are disabled the alarms are also in no alarm condition.
If a power down occurs when the control output is disabled, at instrument power up the control output will be automatically disabled.
When the control is restored the instrument operates as in presence of a power up and the alarm mask function, if configured, will be activated.

MANUAL function
The MANUAL mode function [1503] allows to set directly the power output of the instrument.
The transfer from AUTO to MANUAL and viceversa is bumpless (this function is not provided if integral action is excluded).
If transfer from AUTO to MANUAL is performed during the first part of SMART algorithm (TUNE) when returning in AUTO the device will be forced automatically in the second part of the SMART algorithm (ADAPTIVE).
At power up the device will be in the AUTO mode or as it was left prior to power shut down depending on [1521] configuration selection.
Note: When start up occurs in Manual mode the power output (OUT1 - OUT2) is set to 0.

SMART function
It is used to automatically optimize the control action.
When the SMART function is enabled, it is possible to read but not to write the control parameters (Pb, Ti, Td).

Disabling the SMART function, the instrument maintains the actual set of control parameters and it enables parameter modification.
NOTES: When ON/OFF control is programmed (Pb=0), the SMART function is disabled.

Synchronous pre-heating
This function eliminates differential heating during machine start up due to differing heating rates of individual heaters.

This function operate as follows:
At instrument start up all controllers use the first measured value as initial set point and than they start a ramp from this set point to the final set point previously programmed.
All common alarms are set as band alarms and are connected with the common logic input.
In this way if the measure of one loop goes out of the tracking band, the common alarm will close the common logic input and the ramp execution of all the loops will be hold.
The ramp execution will restart when all measures come back in the tracking band.

In order to obtain this function, set the instruments as follows:
1) The alarm 3 is a band alarm ([1903] = 2, [1904] = 0, [1905] = 0, [1906] = 0 and [1907] = 0)
2) The "operative set point at start up" must be set equal to "aligned to the measured value" ([1410] = 1)
3) The logic input is used for ramp hold ([1301] = 2)
4) The "rate of change for positive set point variation" [1408] and the "rate of change for negative set point variation" [1409] must be set between 1 and 100 digit per minute according with the desired rate of change.
5) The common alarm output is connected with the common logic input.

Sequential address (Modbus) for frequently accessed parameter.
To maximize the data transfer rates between the RFS and the host supervisory system important operating parameters are grouped with sequential address (see operative group [900]).
To further increase data transfer efficiency, all digital status information are transferred as one data word.
The system enables the RFS to communicate relevant parameter information with a single data request, not a series of separate address operations.

Energy management at start up
When you turn ON a multi-loops machine where all loops have the soft start function, at power up the ON and OFF period of the control output of all loops will be (more or less) synchronous. This fact produces high current peaks.
These instruments will use their Modbus address (all addresses are different) in order to displace the ON and OFF period of the control output(s).
This facility significantly reduces maximum machine start-up current requirements and offers potential savings in electrical installation capacity and cable requirements.

Availability of the not used I/O by serial link
All RFS I/O may be read directly over the Modbus communication interface by the host supervisory system. Additionally, the communication host may write to RFS outputs that are not assigned as alarm or output functions.
This facility expands available PLC and host supervisory system I/O, simplifies machine troubleshooting and provides the possibility to perform remote diagnostics.

OFD function – Output failure detection (optional)
Using the CT input the output failure detection function monitors the current in the load driven by the output 1.
Load and actuator protection is provided in the following way:
- During the ON period of the output, the instrument measures the current through the load and it generates an alarm condition if this current is lower than a pre-programmed threshold [1206]. A low current shows a partial or total break down of the load or actuator SSR.
- During the OFF period of the output, the instrument measures the leakage current through the load and it generates an alarm condition when this current is higher than a pre-programmed threshold value[1205]. A high leakage current shows a short circuit of the actuator.

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"Soft start" function

This function allows to gradually warm up the machine during start up in order to delete thermal strength and to protect the raw material.

The energy applied is restricted (by [1514]) for a programmable time [1515].

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GENERAL NOTES ON THE MODBUS RTU PROTOCOL

This half duplex protocol accepts one master and one or more slaves.
The physical interface should be of the RS-485 type.
A single multidrop link can take up to 120 devices having the same "High input impedance" as the transceiver used.

The computer must be programmed to serve as a master controlling which slave has access to the link. All other slaves are in waiting state. Each slave has a unique address ranging from 1 to 254.
Address "0" is a broadcast one. When the master sends a message with address "0", all slaves receive it and no one replies.

NOTE: The numerical value present in this text are expressed as:
- binary value if they are followed by b
- decimal value if they are not followed by any letter
- hexadecimal value if they are followed by h

TRANSMISSION FORMAT

The protocol uses the RTU (Remote terminal unit) mode of transmission.
RTU is a binary method with byte format composed as follows:

1 start bit, 8 data bit, 1 parity bit (optional), 1 stop bit.

The communication speed is selectable among 600, 1200, 2400, 4800, 9600 and 19200 baud.

NOTE: If CPI (Configuration Port Interface) is used the transmission format is fixed
        (19200 - 8 bits – No parity) and the address is fixed at 255
        The broadcast address (0) is not admitted

COMMUNICATION PROCEDURE

The communication can be initiated only by the master unit; the slave units can transmit only after a query has been received from the master.
The general format for the transmission from master to slave is the following:

RANGE	BYTE
Slave address	1
Function code	1
Data	n
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

The slave detects the start of a query frame when the delay time between two characters is greater than 3.5 T.U. (Time Unit = Time necessary to transmit one character).

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ERROR CHECK (CRC-16 Cyclical Redundancy Check)

The CRC-16 value is calculated by the transmitting device. This value is appended to the message. The receiving device recalculates a CRC-16 and compares the calculated value to the received value. The two values must be equal.
The CRC-16 is started by first pre-loading a 16-bit register to all 1's. Then a process begins of applying successive the bytes of the message to the current contents of the register.
Only the eight bits of data in each character are used for generating the CRC-16. Start and stop bits, and the parity bit if one is used, do not apply to the CRC-16.
During generation of the CRC-16, each byte is exclusive ORed with the register contents. Then the result is shifted to the right , with a zero filled into the most significant bit (MSB) position. If the LSB was a 1, the register is then exclusive ORed with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place.
This process is repeated until eight shifts have been performed. After the last shift, the next byte is exclusive ORed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the characters of the message have been applied, is the CRC-16 value.

A procedure for generating a CRC-16 is:

1) Load a 16-bit register (CRC-16 register) with FFFFh (all 1's).

2) Exclusive OR the first byte of the message with the low byte of the CRC-16 register. Put the result in the CRC-16 register.

3) Shift the CRC-16 register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.

4) (If the LSB was 0): Repeat Step 3 (another shift).
   (If the LSB was 1): Exclusive OR the CRC-16 register with the polynomial value A001h (1010 0000 0000 0001b).

5) Repeat Steps 3 and 4 until 8 shifts have been performed. When this is done, a complete byte will have been processed.

6) Repeat Steps 2 through 5 for the next byte of the message. Continue doing this until all bytes have been processed.

7) The final contents of the CRC-16 register is the CRC-16 value.

When the CRC-16 (16 bytes) is transmitted in the message, the low byte will be transmitted first, followed by the high byte.

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An example of a C language function performing CRC generation is shown below.

```
/* ----------------------------------------------------------------
crc_16          calculate the crc_16 error check field

Input parameters:
  buffer: string to calculate CRC
  length: bytes number of the string

This function returns the CRC value.
---------------------------------------------------------------- */
unsigned int crc_16 (unsigned char *buffer, unsigned int length)
{
    unsigned int i, j, temp_bit, temp_int, crc;

    crc = 0xFFFF;

    for ( i = 0; i < length; i++ ) {
        temp_int = (unsigned char) *buffer++;

        crc ^= temp_int;

        for ( j = 0; j < 8; j++ ) {
            temp_bit = crc & 0x0001;

            crc >>= 1;

            if ( temp_bit != 0 )
                crc ^= 0xA001;
        }
    }
    return (crc);
}
```

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Function code 1 and 2: Bits reading

These function codes are used by the master unit to request the value of a consecutive group of bits (max 24) which are representing the status of the slave unit.

Request from master to slave	
Range	Byte
Slave address (1-255)	1
Function code (01-02)	1
Bit starting address (high byte)	1
Bit starting address (low byte)	1
Number of bits (high byte)	1
Number of bits (low byte)	1
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

Reply from slave to master	
Range	Byte
Slave address (1-255)	1
Function code (01-02)	1
Byte counter (n)	1
Data	n
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

The "Data" field indicates the bits requested: the bit with lower address is in the bit 0 of the first byte, the next is in the bit 1, and so on.
The eventual don't care bits necessary to complete the last byte are equal to 0.

Example:
Ask to slave at address 3 (3h) the status of 4 (4h) bits starting from bit 2000 (7D0h) "Digital outputs group".

Request from master to slave	
Range	Byte
Slave address	03h
Function code	01h
Bit starting address (high byte)	07h
Bit starting address (low byte)	D0h
Number of bits (high byte)	00h
Number of bits (low byte)	04h
Error check (CRC-16) (low byte)	3Ch
Error check (CRC-16) (high byte)	A6h

Reply from slave to master	
Range	Byte
Slave address	03h
Function code	01h
Byte counter	01h
Data	0Ah
Error check (CRC-16) (low byte)	D0h
Error check (CRC-16) (high byte)	37h

The byte in "Data" field (0Ah=000001010b) means:

Bit 2000 status	= 0	Status of output 1, output not energized
Bit 2001 status	= 1	Status of output 2, output energized
Bit 2002 status	= 0	Status of output 3, output not energized
Bit 2003 status	= 1	Status of output 4, output energized
Don't care	= 0	
Don't care	= 0	
Don't care	= 0	
Don't care	= 0	

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Function code 3 and 4: Words reading

These function codes are used by the master unit to read a consecutive group of words (16 bit) which contain the value of the variable of the slave unit.
The master can require a maximum of 20 words at a time.

Request from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address (1-255)	1	Slave address (1-255)	1
Function code (03-04)	1	Function code (03-04)	1
Word starting address (high byte)	1	Byte counter (n)	1
Word starting address (low byte)	1	Data	n
Number of word (high byte)	1	Error check (CRC-16) (low byte)	1
Number of word (low byte)	1	Error check (CRC-16) (high byte)	1
Error check (CRC-16) (low byte)	1		
Error check (CRC-16) (high byte)	1		

The "Data" field contains the requested words in the following format: high byte of the first word, low byte of the first word, high byte of the second word, and so on.
The "Data" field contains 8000h for not implemented addresses or for information not relevant in the actual device configuration.

Example:
Ask to slave at address 1 (1h) the value of 3 (3h) words starting from word 1100 (44Ch) "Process variable input group".

Request from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address	01h	Slave address	01h
Function code	03h	Function code	03h
Word starting address (high byte)	04h	Byte counter	06h
Word starting address (low byte)	4Ch	Data	00h
Number of words (high byte)	00h	Data	1Dh
Number of words (low byte)	03h	Data	00h
Error check (CRC-16) (low byte)	C5h	Data	1Dh
Error check (CRC-16) (high byte)	2Ch	Data	00h
		Data	03h
		Error check (CRC-16) (low byte)	1Dh
		Error check (CRC-16) (high byte)	70h

The 6 bytes in "Data" field (00h, 1Dh, 00h, 1Dh, 00h, 03h) are 3 words whose meaning is:

Word 1100 value = 29 (1Dh)	Input variable without filter, 29 °C
Word 1101 value = 29 (1Dh)	Filtered input variable, 29 °C
Word 1102 value = 3 (3h)	Input type and range value for main input, Tc J −100 ÷ 1000°C

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Function code 5: Single bit writing

By using this command, the master unit can change the state of one bit of the slave unit.

Command from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address (0*-255)	1	Slave address (1-255)	1
Function code (05)	1	Function code (05)	1
Bit address (high byte)	1	Bit address (high byte)	1
Bit address (low byte)	1	Bit address (low byte)	1
Data	2	Data	2
Error check (CRC-16) (low byte)	1	Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1	Error check (CRC-16) (high byte)	1

* To use the address 0, see note 1 ("Broadcast" address) in the "Notes" section.

"Data" field $=$ 0h to reset the bit
$=$ FF00h to set the bit

Example:
Set bit 1003 (3EBh) of slave at address 35 (23h), "Manual reset of an alarm condition" in "Device management group".

Command from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address	23h	Slave address	23h
Function code	05h	Function code	05h
Bit address (high byte)	03h	Bit address (high byte)	03h
Bit address (low byte)	EBh	Bit address (low byte)	EBh
Data	FFh	Data	FFh
Data	00h	Data	00h
Error check (CRC-16) (low byte)	FAh	Error check (CRC-16) (low byte)	FAh
Error check (CRC-16) (high byte)	C8h	Error check (CRC-16) (high byte)	C8h

Function code 6: Single word writing

By using this command, the master unit can change the value of one word (16 bit) of the slave unit.

Command from master to slave	
Range	Byte
Slave address (0*-255)	1
Function code (06)	1
Word address (high byte)	1
Word address (low byte)	1
Data	2
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

Reply from slave to master	
Range	Byte
Slave address (1-255)	1
Function code (06)	1
Word address (high byte)	1
Word address (low byte)	1
Data	2
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

* To use the address 0, see note 1 ("Broadcast" address) in the "Notes" section.

The 8000h value, present in the "Data" field, should be considered as a don't care value, that is, the value present in the device at this address will not be modified.

Example:
Set word 1403 (57Bh) of slave at address 1 (1h) with value 240 (F0h), "Main set point" in "Setpoint group".

Command from master to slave	
Range	Byte
Slave address	01h
Function code	06h
Word address (high byte)	05h
Word address (low byte)	7Bh
Data	00h
Data	F0h
Error check (CRC-16) (low byte)	F9h
Error check (CRC-16) (high byte)	5Bh

Reply from slave to master	
Range	Byte
Slave address	01h
Function code	06h
Word address (high byte)	05h
Word address (low byte)	7Bh
Data	00h
Data	F0h
Error check (CRC-16) (low byte)	F9h
Error check (CRC-16) (high byte)	5Bh

Function code 8: Diagnostic

By using this command, the master unit can check the communication system to Slaves.

Request from master to slave	
Range	Byte
Slave address (1-255)	1
Function code (08)	1
Sub-function (high byte)	1
Sub-function (low byte)	1
Data	2
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

Reply from slave to master	
Range	Byte
Slave address (1-255)	1
Function code (08)	1
Sub-function (high byte)	1
Sub-function (low byte)	1
Data	2
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

The Sub-function code will not be processed by Slave, any code is accept.
The Sub-function code and data passed in the request is returned (looped back) in the slave replay. The entire replay message is identical to the request

Example:

Request from master to slave	
Range	Byte
Slave address	01h
Function code	08h
Sub-function (high byte)	00h
Sub-function (low byte)	00h
Data	55h
Data	AAh
Error check (CRC-16) (low byte)	5Fh
Error check (CRC-16) (high byte)	24h

Reply from slave to master	
Range	Byte
Slave address	01h
Function code	08h
Sub-function (high byte)	00h
Sub-function (low byte)	00h
Data	55h
Data	AAh
Error check (CRC-16) (low byte)	5Fh
Error check (CRC-16) (high byte)	24h

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Function code 15: Multiple bits writing

This function code is used by master unit to set/reset a consecutive group of bits (Max 24).

Command from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address (0*-255)	1	Slave address (1-255)	1
Function code (15)	1	Function code (15)	1
Bit starting address (high byte)	1	Bit starting address (high byte)	1
Bit starting address (low byte)	1	Bit starting address (low byte)	1
Number of bits (high byte)	1	Number of bits (high byte)	1
Number of bits (low byte)	1	Number of bits (low byte)	1
Byte counter (n)	1	Error check (CRC-16) (low byte)	1
Data	n	Error check (CRC-16) (high byte)	1
Error check (CRC-16) (low byte)	1		
Error check (CRC-16) (high byte)	1		

* To use the address 0, see note 1 ("Broadcast" address) in the "Notes" section.
The desired status of each bit is packed in the "Data" field (1 = ON, 0 = OFF).
The status imposed for read only bits will be ignored.
The command will be processed starting from the first bit and it will be executed or not executed depending on the actual device status.
At the first error found, the command will be aborted and the slave will answer with an error.

Example:
Send to slave, at address 2 (2h), the following set of 2 bits:

Bit 2002 (7D2h) status	= 0	(bit 0)	Status of output 3, output not energized
Bit 2003 (7D3h) status	= 1	(bit 1)	Status of output 4, output energized
Filler	= 0	(bit 2)	
Filler	= 0	(bit 3)	
Filler	= 0	(bit 4)	
Filler	= 0	(bit 5)	
Filler	= 0	(bit 6)	
Filler	= 0	(bit 7)	

NOTE: 1 byte with 2 bits and 6 filler bits must be sent

Command from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address	02h	Slave address	02h
Function code	0Fh	Function code	0Fh
Bit starting address (high byte)	07h	Bit starting address (high byte)	07h
Bit starting address (low byte)	D2h	Bit starting address (low byte)	D2h
Number of bits (high byte)	00h	Number of bits (high byte)	00h
Number of bits (low byte)	02h	Number of bits (low byte)	02h
Byte counter	01h	Error check (CRC-16) (low byte)	75h
Data	02h	Error check (CRC-16) (high byte)	74h
Error check (CRC-16) (low byte)	A6h		
Error check (CRC-16) (high byte)	E6h		

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Function code 16: Multiple words writing

This function code is used by the master unit to write a consecutive group of words .
The master unit can change a maximum of 20 words at a time.

Command from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address (0*-255)	1	Slave address (1-255)	1
Function code (16)	1	Function code (16)	1
Word starting address (high byte)	1	Word starting address (high byte)	1
Word starting address (low byte)	1	Word starting address (low byte)	1
Number of words (high byte)	1	Number of words (high byte)	1
Number of words (low byte)	1	Number of words (low byte)	1
Byte counter (n)	1	Error check (CRC-16) (low byte)	1
Data	n	Error check (CRC-16) (high byte)	1
Error check (CRC-16) (low byte)	1		
Error check (CRC-16) (high byte)	1		

* To use the address 0, see note 1 ("Broadcast" address) in the "Notes" section.
The data imposed for read only words will be ignored.
The command will be processed starting from the first word and it will be executed or not executed depending on the actual device status.
At the first error found, the command will be aborted and the slave will answer with an error.
The 8000h value, present in the "data" field, should be considered as a don't care value, this is, the value present in the device at this address will not be modified.

Example:
Set words 1505 (5E1h), 1506 (5E2h), 1507 (5E3h) of slave at address 10 (Ah) with 40 (28h), don't care (8000h) and 300 (12Ch) values; "Proportional band", "Hysteresis" and "Integral time" in "Control group".

Command from master to slave		Reply from slave to master	
Range	Byte	Range	Byte
Slave address	0Ah	Slave address	0Ah
Function code	10h	Function code	10h
Word starting address(high byte)	05h	Word starting address (high byte)	05h
Word starting address (low byte)	E1h	Word starting address (low byte)	E1h
Number of words (high byte)	00h	Number of words (high byte)	00h
Number of words (low byte)	03h	Number of words (low byte)	03h
Byte counter	06h	Error check (CRC-16) (low byte)	D1h
Data	00h	Error check (CRC-16) (high byte)	89h
Data	28h		
Data	80h		
Data	00h		
Data	01h		
Data	2Ch		
Error check (CRC-16) (low byte)	F1h		
Error check (CRC-16) (high byte)	DFh		

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NOTES

1. "Broadcast" address
When using the writing codes (5, 6, 15 and 16) the slave address 0 is permitted: in this case all the slaves connected accept the command but do not give any reply.

2. Words format
Every time the information transfer is performed by using 2 bytes (1 word of 16 bits), the first byte transmitted is the most significant one. For the negative numbers the "two complement" format is used.

3. Reply time
The slave will start to send a reply from 2 ms to 700 ms after the end of the request detected by counting the received bytes.

4. Decimal digits
The decimal point that may be present in the value is ignored.
Example:
The value 204.6 is transmitted as   2046
        (07FEh)
The value -12.50 is transmitted as -1250
        (FB1Eh)

The number of decimal digits, if significant, is stated for each parameter (see the DEC column in the parameters tables).
Some parameters have a variable number of decimal digits according to the configuration, as described below:
PV   number of decimal digits apply on
     process variable [1105]
CT   number of decimal digits apply on
     current transformer read-out [1211]
OP   number of decimal digits apply on
     output power [1524]

5. Local/remote status
In this controller, unlike other Ero Electronic devices, the "Local/remote status" setting isn't required. This means that the master unit can modify any parameters without set any local/remote status bit, moreover no "3 seconds timeout" will be applied.

6. Operative mode
"Operative mode" indicates the normal functioning status of the device (controller). In operative mode the master can read the whole parameters; the device returns 8000h for the meaningless one (for example: the threshold of a not configured alarm).
The write operation is allowed only for a restricted number of parameters (for example: isn't permitted to change the input configuration). In operative mode the controller checks the write data to be within the allowable limits (for example: the main set point must be inside the set point low and high limits).

7. Configuration mode
"Configuration mode" is intended to set-up the device, then the controller doesn't work. In configuration mode the master can read and write the whole parameters.
In configuration mode, unlike the operative mode, the device returns always a value for each parameters, even for the meaningless one; this is intended to clone exactly the unit. Moreover, no check is done by the device receiving parameters; it's under the responsibility of the master to send a valid set of parameters. If the master fails to follow the above rule, it will be impossible to switch the controller in operative mode until the whole set of parameters will be valid.

8. Read / write access permissions
The access permissions are stated for each parameter in the description tables by means of two columns named "read" and "write" according the following meaning:
O   access allowed in operative mode
C   access allowed in configuration mode
L   access allowed in calibration mode
F   access allowed in factory test mode

9. Software key for lock/unlock control parameters

Due to the lack of frontal panel, no one protection scheme is available for this device.

10. Address space

The whole variables are addressable as word as well as bit; the user may choose the better way according to the condition. Although we suggest to manage analog variables as words and boolean variables as bits, below is described the behavior to access analog variables (example: alarm threshold) as bits and boolean variables (example: alarm status) as words.

- Reading analog variables as bits: if the variable is not relevant in the actual device configuration (word value 8000h) or if the value is zero the bit is reset, otherwise the bit is set.
- Writing analog variables as bits: the reset bit means 0000h, the set bit means 0001h.
- Reading boolean variables as words: a reset variable is reported as 0000h, a set one is reported as 0001h.
- Writing boolean variables as words: send 0000h to reset the variable, send a value different from 0000h and 8000h to set the variable.

11. Communication parameters at start up.

When it is desired to regain the control of an instrument with an unknown set of communication parameter, you can operate in two different way:

11.1. Make use of the CPI adapter. The instrument automatically recognizes the CPI adapter and it will use the following communication parameter set:
- Address = 255
- Baud rate = 19200
- Bite format = 8 bit without parity

NOTE: this is a fixed parameters set and it is not configurable.

11.2. At power up the instrument will start using the same communication parameter set used in presence of the CPI adapter.
- If the instrument receives a correct Modbus request within the first 3 seconds, it will continue to operate with the same communication parameters.
- If, during the 3 seconds time-out, the instrument doesn't receive a correct request, it will set-up the communication interface with the parameter values previously programmed.

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ERROR REPLY

If the "error check" is wrong or the function code is not implemented or a buffer overflow has been received, the slave does not send any reply to the master.
If other errors are detected in the request or command frame, or the slave cannot reply with the requested values or it cannot accept the requested sets because it is in error condition, the slave replies by forcing at "1" the bit 7 of the received "Function code" byte followed by an error code.

Error reply (from slave to master)

RANGE	BYTE
Slave address	1
Function code (+80h)	1
Error code	1
Error check (CRC-16) (low byte)	1
Error check (CRC-16) (high byte)	1

List of error codes

ERROR CODE	DESCRIPTION
2	Illegal data address
3	Illegal data value
9	Illegal number of data required
10	The parameter indicated cannot be modified or command cannot be executed

Error 2 is issued only when the whole addresses involved in a read or write operation are not implemented on the device.

DEVICE IDENTIFICATION GROUP (117)

Modbus Address	DESCRIPTION	READ	WRITE	DEC
117	FIRMWARE DEVICE CLASS <u>Availability</u>: Always <u>Value</u>: 413 for RFS	OCL F		
118	FIRMWARE DEVICE LETTER <u>Availability</u>: Always <u>Value</u>: 'A' (41h)	OCL F		
119	FIRMWARE REVISION <u>Availability</u>: Always <u>Value</u>: Nr. of firmware revision	OCL F		
120	Manufactured trade mark 50 (32h)	OCL F		
121	Device identification code Note: Number of software revision x 100 + identification code 54 (36h)	OCL F		
122	Serial firmware identification code <u>Availability</u>: Always <u>Value</u>: 0	OCL F		

OPERATIVE GROUP (900)

Note: On this group are repeated some information present in other groups.
The purpose of this is to have these information at consecutive address.
This solution allows to maximize the data transfer rates between the RFS and the host supervisory system.

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
900	OUT 1 Leakage current measure value (in Ampere) **(Same as address 1201)**		O		CT	
901	OUT 1 Load current measure value (in Ampere) **(Same as address 1203)**		O		CT	
902	OUT 2 value (in %) **(Same as address 1501)**	0 / 100	O	O	OP	
903	OUT 1 value (in %) **(Same as address 1500)**	0 / 100	O	O	OP	

904	STATUS
	D15 = OUT 1 Leakage current measure updating
	    (See address 1202)
	        (0 = Measure updated)
	        (1 = Measure not updated)
	D14 = 0 (Reserved)
	D13 = Status alarm 3 (0 = No alarm 1 = Alarm)
	D12 = Status alarm 2 (0 = No alarm 1 = Alarm)
	D11 = Status alarm 1 (0 = No alarm 1 = Alarm)
	D10 = Status CT alarm (0 = No alarm 1 = Alarm)
	D 9 = OUT 1 Load current measure updating
	    (See address 1204)
	        (0 = Measure updated)
	        (1 = Measure not updated)
	D 8 = 0 (Reserved)
	D 7 = Status of Out 4 (0 = Out not energized
	        1 = Out energized)
	D 6 = Status of Out 3 (0 = Out not energized
	        1 = Out energized)
	D 5 = Status of Out 2 (0 = Out not energized
	        1 = Out energized)
	D 4 = Status of Out 1 (0 = Out not energized
	        1 = Out energized)
	D 3 = Digital input status (0 = Contact open
	        1 = Contact closed)
	D 2 = Auto / Manual (0 = Auto 1 = Manual)
	D 1 = control output Enabled or disabled
	        (0 = Enabled 1 = Disabled)
	D 0 = SMART Enable or Disable
	        (0 = Disabled 1 = Enabled)
			O			

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
905	Filtered Input variable (in engineering units) Notes: When a measure error is detected, the "Data field" contains one of these error codes: 30004 (7534h) = Under-range 30005 (7535h) = Over-range (or open input) 30014 (753Eh) = Error on reference junction temperature (<-25 °C or >75 °C) 30050 (7562h) = Error on internal auto-zero **(Same as address 1101)**		O		PV	
906	Input variable without filter (in engineering units) Notes: When a measure error is detected, the "Data field" contains one of these error codes: 30004 (7534h) = Under-range 30005 (7535h) = Over-range (or open input) 30014 (753Eh) = Error on reference junction temperature (<-25 °C or >75 °C) 30050 (7562h) = Error on internal auto-zero **(Same as address 1100)**		O		PV	
907	Working set point (in engineering units) **(Same as address 1402)**		O		PV	
908	Main set point (in engineering units) **(Same as address 1403)**	SP L. SP H.	OCL F	OCL F	PV	
909	Auxiliary set point (in engineering units) **(Same as address 1405)**	SP L. SP H.	OCL F	OCL F	PV	
910	Target set point (in engineering units) **(Same as address 1401)**		O		PV	
911	Main volatile set point (in engineering units) **(Same as address 1404)**	SP L. SP H.	O	O	PV	

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DEVICE MANAGEMENT GROUP (1000)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC
1000	Device mode Range: 　0 = Operative mode 　1 = Configuration mode 2 = Calibration mode 　3 = reserved Note: 　When operative mode is set a "Parameter Check Operation" is automatically performed 　If an error is found the device answers with error code 10 and doesn't enable the new status. 　Otherwise the device stops any other address test, answers immediately, resets and restarts in operative mode 　The set in "Calibration" mode 　is allowed only from configuration mode		OCLF	OCLF	
1001	Execute the PCO (Parameter Check Operation). It returns 0 if no error was found, otherwise it returns the Modbus address of the first wrong parameter.		OCLF		
1002	Load default parameter values Range: 0 = No operation 　1 = Load default European table (TB1) 　2 = Load default American table (TB2) Note: 　Using this command, the parameters related with the serial link will change immediately but the new values will become operative only when the instrument comes back to the operative mode.			C	
1003	Manual reset of the alarm conditions Range: 　0 = No operation 　1 = Alarm Reset			O	
1004	Data Management in Operative Mode Range: 　0 = Only valid data are transmitted 　1 = All the data are transmitted		O	O	

PROCESS VARIABLE INPUT GROUP (1100)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1100	Measured value without filter (in engineering units) Notes: When an measure error is detected, the "Data field" contains one of these error codes: 30004 (7534h) = Under-range 30005 (7535h) = Over-range (or input open) 30014 (753Eh) = Error on reference junction temperature (<-25 °C or >75 °C) 30050 (7562h) = Error on internal auto-zero		O		PV	
1101	Filtered measured value (in engineering units) Note: See "Measured value without filter" [1100]		O		PV	
1102	Input type and range value for main input Range: 0 = Tc L (0 ÷ 400.0 °C) 1 = Tc L (0 ÷ 900 °C) 2 = Tc J (-100.0 ÷ 400.0 °C) 3 = Tc J (-100 ÷ 1000 °C) 4 = Tc K (-100.0 ÷ 400.0 °C) 5 = Tc K (-100 ÷ 1370 °C) 6 = Tc N (-100 ÷ 1400 °C) 7 = Tc R (0 ÷ 1760 °C) 8 = Tc S (0 ÷ 1760 °C) 9 = RTD Pt100 (-200.0 ÷ 400.0 °C) 10 = RTD Pt100 (-200 ÷ 800 °C) 11 = Linear (0 ÷ 60 mV) 12 = Linear (12 ÷ 60 mv) 13 = Linear (0 ÷ 20 mA) 14 = Linear (4 ÷ 20 mA) 15 = (reserved) 16 = (reserved) 17 = (reserved) 18 = (reserved) 19 = Tc L (0 ÷ 1650 °F) 20 = Tc J (-150 ÷ 1830 °F) 21 = Tc K (-150 ÷ 2500 °F) 22 = Tc N (-150 ÷ 2550 °F) 23 = Tc R (0 ÷ 3200 °F) 24 = Tc S (0 ÷ 3200 °F) 25 = RTD Pt100 (-200.0 ÷ 400.0 °F) 26 = RTD Pt100 (- 330 ÷ 1470 °F) 27 = Tc T (-200.0 ÷ 400.0 °C) 28 = Tc T (- 330 ÷ 750 °F)		OC L F	C L F		TB1= 3 TB2= 20

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1103	Initial scale value (*)	-2000/4000 (for linear) Range limits (for Tc/Rtd)	OC L F	C L F	PV	TB1=0 TB2=0
1104	Full scale value (*)	-2000/4000 (for linear) Range limits (for Tc/Rtd)	OC L F	C L F	PV	TB1=400 TB2=1000
1105	Decimal point position PV (Process variable). Range: 0 = No decimal figure 1 = One decimal figure 2 = Two decimal figures 3 = Three decimal figures Note: The write command is enabled only for linear input.		OC L F	C L F		TB1 = 0 TB2 = 0
1106	Offset adjustment (in engineering units) Note: Not available for linear ranges	-199 / 199	OC L F	C L F	PV	TB1 = 0 TB2 = 0

(*) Note: The minimum input span ([Full scale value] – [Initial scale value]), in absolute value, must
be greater than:
100 digits for linear input ranges
300 °C (550 °F) for Tc input ranges
100 °C (200 °F) for Rtd input ranges.

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CURRENT TRANSFORMER INPUT AND ALARM GROUP (1200)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1200	CT alarm status
	("Load" and "Leakage" alarms)
	Range:
	   0 = No alarm
	   1 = Alarm
	Note: Available only when the option is programmed
			O			

1201	OUT 1 Leakage current measured value (in Ampere) Note: Available only when the option is programmed		O		CT	

1202	OUT 1 Leakage current measure updating flag
	Range:
	   0 = Measure updated
	   1 = Measure not updated
	Notes:
	1) Available only when the option is programmed.
	2) If the OFF period is lower than 150 ms, the
	   instrument is not able to perform this measure.
	   This flag shows the status of the measure
			O			

1203	OUT 1 Load current measured value (in Ampere) Note: Available only when the option is programmed		O		CT	

1204	OUT 1 Load current measure updating flag
	Range:
	   0 = Measure updated
	   1 = Measure not updated
	Notes:
	1) Available only when the option is programmed.
	2) If the ON period is lower than 150 ms, the
	   instrument is not able to perform this measure.
	   This flag shows the status of the measure
			O			

1205	Threshold for alarm on Leakage current (in Ampere) Note: Available only when the option is programmed	0 / H. Scale	OCLF	OCLF	CT	TB1 = 50 TB2 = 50
1206	Threshold for alarm on Load current (in Ampere) Note: Available only when the option is programmed	0 / H. Scale	OCLF	OCLF	CT	TB1 = 100 TB2 = 100

1207	Active period of the load (for the current transformer)
	Range:
	   0 = Option not provided
	   1 = The load is energized when Out1 is
	     active (Relay "ON" or SSR=1)
	   2 = The load is energized when Out1 is not
	     active (Relay "OFF" or SSR=0)
			OCLF	CLF		TB1 = 0
						TB2 = 0

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1208	CT Alarm reset type
	Range:
	  0 = Automatic reset
	  1 = Manual reset
	Note: Available only when the option is programmed
			OCL F	C L F		TB1 = 0
						TB2 = 0

1209	CT Alarm action
	Range:
	  0 = Direct action (relay energized in alarm condition)
	  1 = Reverse action (relay de-energized in alarm condition)
	Note: Available only when the option is programmed
	    This configuration is the same made by address 1806.
			OCL F	C L F		TB1 = 1
						TB2 = 1

1210	CT range (in Ampere) It is the nominal primary current of the current transformer used. Note: Available only when the option is programmed	10 / 100	OCL F	C L F	0	TB1 = 10 TB2 = 10
1211	Number of decimal figures for the CT measurement The resolution of the CT measurement is as follow: - 0.1 A for CT range lower than 20 A - 1 A for CT range higher than 20 A So that: - When [1210] parameter is lower than 20 (A), the [1211] parameter will be equal to 1 - When [1210] parameter is higher than 20 (A), the [1211] parameter will be equal to 0		OCL F			TB1 = 1 TB2 = 1

Note: CT alarm and Alarm 2 are in OR condition driving the output 3.

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DIGITAL INPUT GROUP (1300)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1300	Digital input status
	Range
	   0 = Input not active (contact open)
	   1 = Input active (contact closed)
			OC L F			

1301	Digital input function
	Range
	   0 = Option not used
	   1 = Digital input used for "main set point"/"auxiliary set point" selection (Input active means Auxiliary set point).
	   2 = Digital input used to hold the set point ramp execution (Input active means ramp hold).
			OC L F	C L F		TB1 = 0
						TB2 = 0

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SETPOINT GROUP (1400)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1400	Selected set point Range: 0 = Main set point 1 = Auxiliary set point		O			
1401	Target set point (in engineering units)		O		PV	
1402	Working set point (in engineering units)		O		PV	
1403	Main set point (in engineering units)	SP L. Limit / SP H. Limit	OC L F	OC L F	PV	TB1 = 0 TB2 = 0
1404	Volatile set point (in engineering units)	SP L. Limit / SP H. Limit	O	O	PV	TB1 = 0 TB2 = 0
1405	Auxiliary set point (in engineering units) Note: Available only if selectable	SP L. Limit / SP H. Limit	OC L F	OC L F	PV	TB1 = 0 TB2 = 0
1406	Set point high limit (in engineering units)	SP L. Limit / H. Scale	OC L F	OC L F	PV	TB1 = 400 TB2 = 1000
1407	Set point low limit (in engineering units)	L. Scale / SP H. Limit	OC L F	OC L F	PV	TB1 = 0 TB2 = 0
1408	Rate of change for positive set point variation (gradient in engineering units per minute)	1 / 100 32767 (7FFFh) for step change	OC L F	OC L F	PV	TB1 = 7FFFh TB2 = 7FFFh
1409	Rate of change for negative set point variation (gradient in engineering units per minute)	1 / 100 32767 (7FFFh) for step change	OC L F	OC L F	PV	TB1 = 7FFFh TB2 = 7FFFh

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1410	Operative set point alignment at start-up Range: 0 = The operative set point will be aligned to the set point selected by digital input or by the serial link 1 = The operative set point will be aligned to the actual measured value and then it will reach the selected set point with the programmed ramp (Address 1408 / 1409). NOTE: if the instrument detect an out of range or an error condition on the measured value, it will operate as described for [1410] = 0		OC L F	C L F		TB1 = 0 TB2 = 0
1411	Set point selection source Range: 0 = Set point selected by digital input. 1 = Set point selected by serial link (address 1412)		OC L F	OC L F		TB1 = 0 TB2 = 0
1412	Set point selected by serial link Range: 0 = Main set point 1 = Auxiliary set point		OC L F	OC L F		TB1 = 0 TB2 = 0
1413	Delta applied to the Main set point (in engineering units) This value will be algebraically added to the main set point (address 1403) and then limited.	-6000 / 6000		O		
1414	Delta applied to the volatile set point (in engineering units) This value will be algebraically added to main set point (address 1404) and then limited.	-6000 / 6000		O		
1415	Delta applied to the Auxiliary set point (in engineering units) This value will be algebraically added to auxiliary set point (address 1405) and then limited.	-6000 / 6000		O		

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Notes about set point management

NOTE 1

In order to make clear the result of different set of the various parameter, we have added the following diagram.
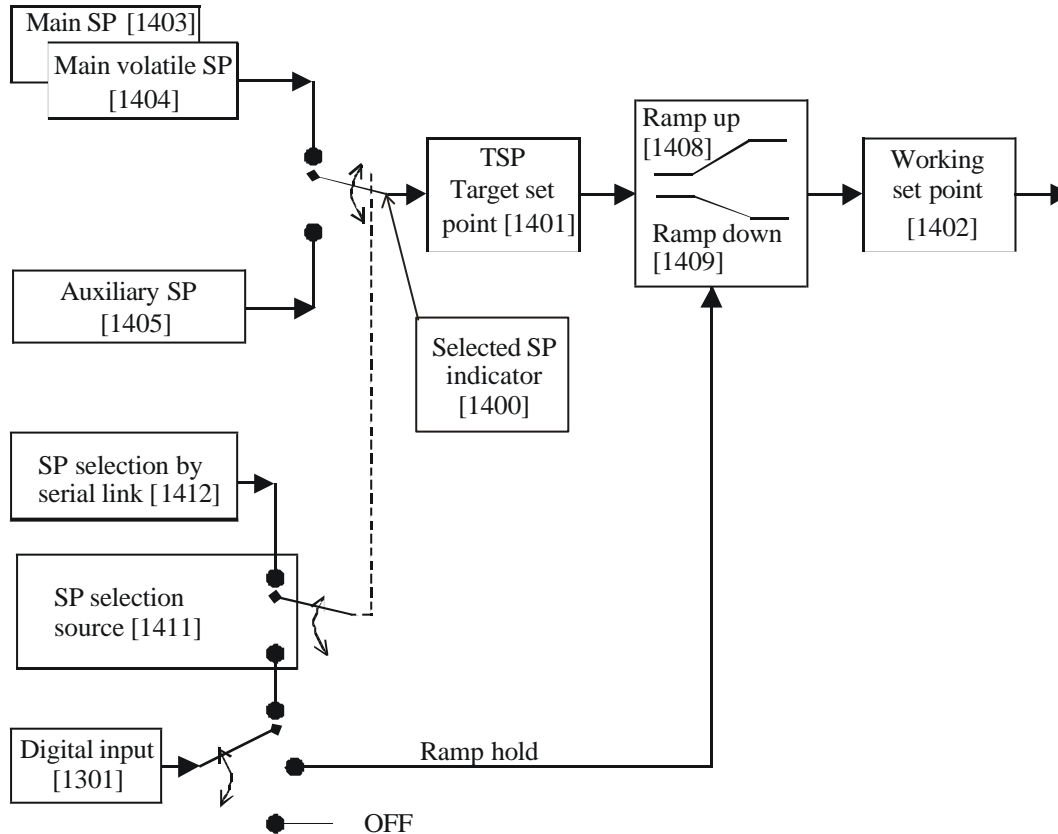
NOTE: the main SP (1403) is a value memorized in EEPROM while the main volatile SP (1404) is a value memorized in RAM. For this reason, when you make a profile setting the set point value by serial link (e.g. with a supervisory system), it is advisable to use the main volatile SP, instead of the main SP (the EEPROM has a limited number of write actions allowed while the RAM has no limit).

NOTE 2

Parameters [1413], [1414] and [1415] allow you to increase or decrease a set point without knowing the current set point value.
This solution allows you to modify of the same quantity the set point (Main set point, volatile set point or auxiliary set point respectively) of different instruments at the same time.

CONTROL (OUTPUT 1) GROUP (1500)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1500	OUT 1 value (in %)	0 / 100	O	O	OP	
1501	OUT 2 value (in %)	0 / 100	O	O	OP	
1502	Pid out value	-32767 / 32767	O	O	OP	

1503	Auto/manual function
	Range:
	  0 = Auto
	  1 = Manual
			OCLF	OCLF		TB1 = 0
						TB2 = 0

1504	Enable/disable control output
	Range:
	  0 = Control enabled
	  1 = Control disabled
			OCLF	OCLF		TB1 = 0
						TB2 = 0

1505	Proportional band (in % of the input span)	10 / 1000 (for H only) 15 / 1000 (for H/C) 0 (for ON/OFF)	OCLF	OCLF	1	TB1 = 40 TB2 = 40
1506	Hysteresis for ON / OFF control mode (in % of the input span) Note: Available only when Proportional band is set to zero.	1 / 100	OCLF	OCLF	1	TB1 = 5 TB2 = 5
1507	Integral time (in seconds) Note: The value 32767 (7FFFh) means that the integral action is excluded	1 / 1200	OCLF	OCLF	0	TB1 = 240 TB2 = 240
1508	Integral pre-load (in % of the output span) Default value for Heating action 30% Default value for Heating/cooling action 0%	0 / 100 (for H only) -100 / 100 (for H/C)	OCLF	OCLF	0	TB1 = 30 TB2 = 30
1509	Derivative time (in seconds)	0 / 600	OCLF	OCLF	0	TB1 = 60 TB2 = 60
1510	Out 1 Cycle time (in seconds)	1 / 200	OCLF	OCLF	0	TB1 = 15 TB2 = 15
1511	Relative cooling gain Note: Available only for HC control	20 / 100	OCLF	OCLF	2	TB1 = 100 TB2 = 100

1512	Dead band/overlap between H/C outputs (in % of the proportional band)
	  Notes:
	  1) Available only for HC control
	  2) A negative value produces an dead band while a positive value produces an overlap
		-20 / 50	OCLF	OCLF	0	TB1 = 0
						TB2 = 0

1513	Out 2 Cycle time (in seconds) Note: Available only for HC control	1 / 200	OCLF	OCLF	0	TB1 = 10 TB2 = 10

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1514	Output high limiter (in %) (**)	0 / 100 (for H only) -100 / 100 (for H/C)	OC L F	OC L F	0P	TB1 = 100 TB2 = 100
1515	Time duration of the output power limiter (soft start) (in minutes) (**) Note:The value 32767 (7FFFh) means that the limiting action is always on	1 / 540	OC L F	OC L F	0	TB1 = 7FFFh TB2 = 7FFFh
1516	Control output max rate of rise (in percent of the output per second) Note:The value 32767 (7FFFh) means that no ramp limitation is imposed.	1 / 25	OC L F	OC L F	OP	TB1 = 7FFFh TB2 = 7FFFh
1517	Out 1 action Range: 0 = Direct 1 = Reverse		OC L F	C L F		TB1 = 1 TB2 = 1
1518	Control action type Range: 0 = The process is controlled by PID actions 1 = The process is controlled by PI actions		OC L F	C L F		TB1 = 0 TB2 = 0
1519	Threshold to enable the soft start (output power limiting) (in engineering units)	L. Scale / H. Scale	OC L F	C L F	PV	TB1 = 0 TB2 = 0
1520	Inhibit reset band extension A positive value increases the high limit of the Anti-reset-wind up (over set point) A negative value decreases the low limit of the Anti-reset-wind up (under set point)	-30 / +30 (in % of the proportional band)	OC L F	C L F	0	TB1 = 10 TB2 = 10
1521	Device status at instrument start up Range: 0 = It starts always in auto mode 1 = It starts in the same way it was left prior to the power shut down. If in manual mode the power output is set to 0 2 = It starts in the same way it was left prior to the power shut down. If in manual mode the power output will be equal to the last value used left prior to the power shut down. 3 = It starts always in manual mode with power output set to 0		OC L F	C L F		TB1 = 2 TB2 = 2

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1522	Condition for output safety value
	Range:
	  0 = No safety value (Standard setting)
	  1 = Safety value applied when over range or under range condition is detected
	  2 = Safety value applied when over range condition is detected
	  3 = Safety value applied when under range condition is detected
			OC L F	C L F		TB1 = 0
						TB2 = 0

1523	Output safety value (in %) When the controller detects an out range condition. Note: Available only if used	0 / 100 (for H only) -100 / 100 (for H/C)	OC L F	C L F	OP	TB1 = 0 TB2 = 0
1524	Number of decimal figures of parameters with DEC attribute set in OP		OC L F			

(**) NOTE: the parameters [1514] and [1515] allow to set the soft start function.
At power up the instrument limits the power output (using [1514]) for a programmed time (set by [1515].
This function allows to gradually warm up the machine during start up in order to delete thermal strength and to protect the raw material.

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SMART GROUP (1600)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1600	Tune status
	Range:
	   0 = No tune
	   1 = Tune
			O			

1601	Adaptive status
	Range:
	   0 = No adaptive
	   1 = Adaptive
			O			

1602	Smart enable/disable
	Range:
	   0 = Disable
	   1 = Enable
	Note: Reading, this bit is logical "or" between Tune and Adaptive status
			OC L F	OC L F		TB1 = 0
						TB2 = 0

1603	Relative cooling gain calculated by the smart algorithm
	Range:
	   0 = Smart does not calculate R.C.G.
	   1 = Smart calculates R.C.G.
	Note: Available only for HC control
			OC L F	C L F		TB1 = 0
						TB2 = 0

1604	Type of cooling media
	Range
	
	   0 = Air is used as cooling media
	   1 = Oil is used as cooling media
	   2 = Direct water is used as cooling media
	Changing [1604], the instrument forces the cycle time and relative cooling gain parameter to the default value related with the chosen cooling media
	When [1604] = AIr - Cy2 = 10 s and rC = 1.00
	        [1604] = OIL - Cy2 = 4 s and rC = 0.80
	        [1604] = H2O - Cy2 = 2 and rC = 0.40
	Note: Available only for HC control
			OC L F	C L F		TB1 = 0
						TB2 = 0

1605	Max value of proportional band calculated by the smart algorithm	Min. Value / 1000	OC L F	C L F	1	TB1 = 300 TB2 = 300
1606	Min value of proportional band calculated by the smart algorithm Note: Not available for HC control	10 / Max. value	OC L F	C L F	1	TB1 = 15 TB2 = 15
1607	Min value of proportional band calculated by the smart algorithm Note: Available only for HC control	15 / Max. value	OC L F	C L F	1	TB1 = 10 TB2 = 10
1608	Min value of integral time calculated by the smart algorithm (in seconds)	1 / 120	OC L F	C L F	0	TB1 = 50 TB2 = 50

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ALARM 1 (OUTPUT 2) GROUP (1700)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
1700	Alarm 1 status Range: 　0 = No alarm 　1 = Alarm Note: 　Available only if AL1 is configured		O			
1701	Alarm 1 threshold Note: 　Available only if AL1 is configured	L. Scale / H. Scale (for Process alarm) 0 / 500 (for Band alarm) -500 / 500 (for deviation alarm)	OC L F	OC L F	PV	TB1 = 0 TB2 = 0
1702	Alarm 1 hysteresis (Range: from 0.1% to 10.0 % of the range selected with [1103] and [1104] parameters or 1 LSD). Note: 　Available only if AL1 is configured	1 / 100	OC L F	OC L F	1	TB1 = 1 TB2 = 1
1703	Out 2 function Range: 　0 = Output not used 　1 = Output used as alarm 1 output 　　(Process alarm) 　2 = Output used as alarm 1 output 　　(Band alarm) 　3 = Output used as alarm 1 output 　　(Deviation alarm) 　4 = Output used as cooling output		OC L F	C L F		TB1 = 1 TB2 = 1
1704	Alarm 1 operating mode Range: 　0 = High alarm (outside for band alarm) 　1 = Low alarm (inside for band alarm) Note: 　Available only if AL1 is configured		OC L F	C L F		TB1 = 0 TB2 = 0
1705	Alarm 1 reset type Range: 　0 = Automatic reset 　1 = Manual reset Note: 　Available only if AL1 is configured		OC L F	C L F		TB1 = 0 TB2 = 0

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Modbus Address	DESCRIPTION	R A N G E	R E A D	W R I T E	D E C	Default Value

1706	Alarm 1 action
	Range:
	   0 = Direct action (relay energized in alarm condition)
	   1 = Reverse action (relay de-energized in alarm condition)
	Note:
	     Available only if AL1 is configured
			OC L F	C L F		TB1 = 1
						TB2 = 1

1707	Alarm 1 stand-by (mask) function
	Range:
	   0 = No standby function
	   1 = Standby function
	Notes:
	1) Available only if AL1 is configured
	2) If the alarm is programmed as band or deviation alarm, this function masks the alarm condition after a set point change or at the instrument start-up until the process variable reaches the alarm threshold plus or minus hysteresis.
	If the alarm is programmed as a process alarm, this function masks the alarm condition at instrument start-up until process variable reaches the alarm threshold plus or minus hysteresis.
			OC L F	C L F		TB1 = 0
						TB2 = 0

ALARM 2 (OUTPUT 3) GROUP (1800)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1800	Alarm 2 status
	Range:
	  0 = No alarm
	  1 = Alarm
	Note:
	    Available only if AL2 is configured
			O			

1801	Alarm 2 threshold Note: Available only if AL2 is configured	L. Scale / H. Scale (for process alarm) 0 / 500 (for band alarm) -500 / 500 (for deviation alarm)	OC L F	OC L F	PV	TB1 = 0 TB2 = 0
1802	Alarm 2 hysteresis (Range: from 0.1% to 10.0 % of the range selected with [1103] and [1104] parameters or 1 LSD). Note: Available only if AL2 is configured	1 / 100	OC L F	OC L F	1	TB1 = 1 TB2 = 1

1803	Out 3 function
	Range:
	  0 = Output not used for alarm 2
	  1 = Output used as alarm 2 output (Process alarm)
	  2 = Output used as alarm 2 output (Band alarm)
	  3 = Output used as alarm 2 output (Deviation alarm)
	Note:
	  Alarm 2 and CT alarm outputs are in OR condition.
			OC L F	C L F		TB1 = 0
						TB2 = 0

1804	Alarm 2 operating mode
	Range:
	  0 = High alarm (outside for band alarm)
	  1 = Low alarm (inside for band alarm)
	Note:
	    Available only if AL2 is configured
			OC L F	C L F		TB1 = 0
						TB2 = 0

1805	Alarm 2 reset type
	Range:
	  0 = Automatic reset
	  1 = Manual reset
	Note:
	    Available only if AL2 is configured
			OC L F	C L F		TB1 = 0
						TB2 = 0

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1806	Alarm 2 action
	Range:
	    0 = Direct action (relay energized in alarm condition)
	    1 = Reverse action (relay de-energized in alarm condition)
	Note: This configuration is the same of that at address 1209
	        Available only if AL2 is configured
			OC L F	C L F		TB1 = 1
						TB2 = 1

1807	Alarm 2 stand-by (mask) function
	Range:
	    0 = No standby function
	    1 = Standby function
	Notes:
	1) Available only if AL2 is configured
	2) If the alarm is programmed as band or deviation alarm, this function masks the alarm condition after a set point change or at the instrument start-up until the process variable reaches the alarm threshold plus or minus hysteresis.
	    If the alarm is programmed as a process alarm, this function masks the alarm condition at instrument start-up until process variable reaches the alarm threshold plus or minus hysteresis.
			OC L F	C L F		TB1 = 0
						TB2 = 0

ALARM 3 (OUTPUT 4) GROUP (1900)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1900	Alarm 3 status
	Range:
	    0 = No alarm
	    1 = Alarm
	Note:
	        Available only if AL3 is configured
			O			

1901	Alarm 3 threshold Note: Available only if AL3 is configured	L. Scale / H. Scale (for Process alarm) 0 / 500 (for Band alarm) -500 / 500 (for deviation alarm)	OC L F	OC L F	PV	TB1 = 0 TB2 = 0
1902	Alarm 3 hysteresis (Range: from 0.1% to 10.0 % of the range selected with [1103] and [1104] parameters or 1 LSD). Note: Available only if AL3 is configured	1 / 100	OC L F	OC L F	1	TB1 = 1 TB2 = 1

1903	Out 4 function
	Physically available only through bus connector J2
	Range:
	    0 = Output not used for alarm 3
	    1 = Output used as alarm 3 output
	        (Process alarm)
	    2 = Output used as alarm 3 output
	        (Band alarm)
	    3 = Output used as alarm 3 output
	        (Deviation alarm)
			OC L F	C L F		TB1 = 0
						TB2 = 0

1904	Alarm 3 operating mode
	Range:
	    0 = High alarm (outside for band
	        alarm)
	    1 = Low alarm (inside for band
	        alarm)
	Note:
	        Available only if AL3 is configured
			OC L F	C L F		TB1 = 0
						TB2 = 0

1905	Alarm 3 reset type
	Range:
	    0 = Automatic reset
	    1 = Manual reset
	Note:
	        Available only if AL3 is configured
			OC L F	C L F		TB1 = 0
						TB2 = 0

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Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value

1906	Alarm 3 action
	Range:
	  0 = Direct action (relay energized in alarm condition)
	  1 = Reverse action (relay de-energized in alarm condition)
	Note:
	    Available only if AL3 is configured
			OC L F	C L F		TB1 = 1
						TB2 = 1

1907	Alarm 3 stand-by (mask) function
	Range:
	  0 = No standby function
	  1 = Standby function
	Notes:
	1) Available only if AL3 is configured
	2) If the alarm is programmed as band or deviation alarm, this function masks the alarm condition after a set point change or at the instrument start-up until the process variable reaches the alarm threshold plus or minus hysteresis.
	If the alarm is programmed as a process alarm, this function masks the alarm condition at instrument start-up until process variable reaches the alarm threshold plus or minus hysteresis.
			OC L F	C L F		TB1 = 0
						TB2 = 0

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DIGITAL OUTPUTS GROUP (2000)

Modbus Address	DESCRIPTION	READ	WRITE	DEC

2000	Output 1 status
	Range
	    0 = Output not energized
	    1 = Output energized
		OC L F	C L F	

2001	Output 2 status
	Range
	    0 = Output not energized
	    1 = Output energized
	Note:
	    Writing to this parameter is allowed in
	    operative mode only if the output is not driven
	    by an internal function (like alarm).
		OC L F	OC L F	

2002	Output 3 status Range and note: see "Status of output 2"	OC L F	OC L F	
2003	Output 4 status Range and note: see "Status of output 2"	OC L F	OC L F	

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COMMUNICATION GROUP (2100)

Modbus Address	DESCRIPTION	RANGE	READ	WRITE	DEC	Default Value
2100	Serial link device address Note: 　When you set a new value, it will become operative after an instrument resets or removing the CPI. If you made a request before the reset the device will reply the new value but it continue to use the old one. 　Keep attention to the data set because at the instrument start-up, if incompatible data are found, the serial line will be set with fixed parameters: 　　Address　　255 　　Baud rate　19200 　　Byte format　　8 bits without parity	1 / 254	OCL F	OCL F		TB1 = 1 TB2 = 1
2101	Baud rate for serial link Range: 　0 =　　600 Baud 　1 =　1200 Baud 　2 =　2400 Baud 　3 =　4800 Baud 　4 =　9600 Baud 　5 = 19200 Baud Note: 　See note on "Serial link device address" parameter.		OCL F	OCL F		TB1 = 5 TB2 = 5
2102	Byte format for serial link Range: 　0 = 8 bits + even parity 　1 = 8 bits + odd parity 　2 = 8 bits without parity Note: 　See note on "Serial link device address" parameter.		OCL F	OCL F		TB1 = 2 TB2 = 2

HVS.
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TITLE: RFS – User Manual

GENERAL SPECIFICATIONS

Case: Polycarbonate dark grey color self-extinguishing degree: V2 according to UL 746C.
Protection: IP20
Terminals: 23 screw terminals (screw M3, for cables from 0.25 to 2.5 mm^2 or from AWG 22 to AWG 14) with connections diagram.
Dimensions: DIN 43700 120 x 101 x 22.5 mm.
Weight: - of the RFS = 140 g.
        - of the common I/O unit = 110 g.
Power supply: 24 V AC/DC ($\pm$ 10 % of the nominal value).
Power consumption: 6 VA max (4 W).
Sampling time: 250 ms for linear inputs
            500 ms for TC and RTD inputs.
Accuracy: $\pm$ 0,2% f.s.v.. $\pm$ 1 digit @ 25 °C ambient temperature.
Common mode rejection: >120 dB @ 50/60 Hz.
Normal mode rejection: >60 dB @ 50/60 Hz.
Electromagnetic compatibility and safety requirements: This instrument is marked CE. Therefore, it is conforming to council directives 89/336/EEC and to council directives 73/23/EEC and 93/68/EEC (reference harmonized standard EN 61010-1).
Installation category (over-voltage category): CAT II / 50V
Pollution degree: 2
Operative temperature: from 0 to 50 °C (+32 to 122 °F).
Storage temperature: -20 to +70 °C (-4 to 158 °F)
Humidity: from 20 % to 85% RH, non condensing.
Operating altitude:up to 2000mt

INPUTS

A) THERMOCOUPLE

Type : L -J -K -N -R -S -T. °C/°F selectable.
External resistance: 100 Ω max.
Burn out: It is shown as an overrange (standard) or an underrange condition (selectable by cut and short)
TC sensor current: 150 nA.
Cold junction: automatic compensation from 0 to 50 °C.
Cold junction accuracy : 0.1 °C/°C
Input impedance: > 1 MΩ

	Type	STD	Eng unit	Range		Temperature drift (PPM)
TC	J	IEC 584-1	°C	-100.0	400.0	400
			°C	-100	1000	200
			°F	-150	1830	200
	K	IEC 584-1	°C	-100.0	400.0	400
			°C	-100	1370	200
			°F	-150	2500	200
	L	DIN 43710 - 1977	°C	0.0	400.0	400
			°C	0	900	200
			°F	0	1650	200
	N	IEC 584-1	°C	-100	1400	200
			°F	-150	2550	200
	R	IEC 584-1	°C	0	1760	500
			°F	0	3200	500
	S	IEC 584-1	°C	0	1760	500
			°F	0	3200	500
	T	IEC 584-1	°C	-200.0	400.0	400
			°F	-330	750	400

B) RTD (**R**esistance **T**emperature **D**etector)
Type: Pt 100 3 wires connection.
Line resistance: automatic compensation up to 20 Ω/wire with not measurable error.
Engineering units: °C or °F programmable.
RTD sensor current: 130 μA
Burnout: up scale. **NOTE**: a special test is provided to signal OVERRANGE when input resistance is less than 12 Ω.

	Type	STD	Eng unit	Range		Temperature drift (PPM)
RTD	Pt100	DIN 43760	°C	-200.0	400.0	500
			°C	-200	800	400
			°F	-200.0	400.0	800
			°F	-330	1470	400

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C) LINEAR INPUTS

Read-out: programmable from -2000 to +4000.
Decimal point: programmable in any position
Burn out: the instrument shows the burn out condition as an underrange condition for 4-20 mA, 0-60 mV and 12-60 mV input types.

Sensor	Type	Input impedance	Temperature drift (ppm/°C of full span)
Current	0/20 mA	< 5 Ω	300
	4/20 mA	< 5 Ω	
Voltage	0/60 mV	> 1MΩ	300
	12/60 mV	> 1MΩ	

D) LOGIC INPUT

The instrument is equipped with one programmable input from contact (voltage free)
NOTES:
1) Use an external dry contact capable of switching 5 mA, 7.5 V DC.
2) The instrument needs 100 ms to recognize a contact status variation.
3) The logic input is isolated by the measuring input.

C) CURRENT TRANSFORMER INPUT

Input current: 50 mA rms 50/60 Hz.
Read-out: selectable between 10 and 100 A.
Resolution:
 - 0.1 A for 20 A range.
 - 1 A for all the other ranges.
Active period:
 - for relay output: NO or NC programmable
 - for SSR drive output: logic level 1 or 0 programmable.
Minimum time duration of the active period: 50 ms.

SET POINTS

This instrument allows to use 2 set points: main SP and auxiliary SP (SP2).
Set point transfer:
The transfer between one set point to another (or between two different set point values) may be realized by a step transfer or by a ramp with two different programmable rate of change (ramp up and ramp down).
Slope value: 1 - 100 eng. unit/min or step.
Set points limiter: programmable.

CONTROL ACTIONS

Control action: PID + SMART
Type: One (heating or cooling) or two (heating and cooling) control outputs.
Proportional Band (Pb):
Range: - from 1.0 to 100.0 % of the input span for process with one control output.
 - from 1.5 to 100.0 % of the input span for process with two control outputs.
When Pb=0, the control action becomes ON/OFF.
Hysteresis (for ON/OFF control action):
 from 0.1% to 10.0% of the input span.
Integral time (Ti): from 1s to 20 min. or excluded.
Derivative time (Td): from 0 s to 10 min.
If zero value is selected, the derivative action is excluded.
Integral pre-load:
- from 0 to 100 % for one control output
- from -100 (cooling) to +100 % (heating) for two control outputs.
SMART: enabling/disabling
Auto/Manual mode: selectable.
Manual/Auto transfer: bumpless method type

OUTPUTS

Control output updating time :
- 250 ms when a linear input is selected
- 500 ms when a TC or RTD input is selected.
Action: direct/reverse programmable.
Output status indication: four indicators (OUT 1, 2, 3 and 4) are lit when the respective outputs are in ON condition.
Output level limiter:
- For one control medium: from 0 to 100 % .
- For two control mediums: from -100 to +100 % .
Cycle times:
- For out 1 it is programmable from 1 to 200 s.
- For out 2 it is programmable from 1 to 200 s.
Relative cooling gain: programmable from 0.20 to 1.00.
Overlap/dead band: programmable from - 20 % to + 50 % of the proportional band

ERO ELECTRONIC

TITLE: RFS – User Manual

OUTPUT 1

Function: programmable as heating or cooling output.

Type:

a) Relay output with SPST contact;
   contact rating 3A / 250 V AC on resistive load.

b) Logic voltage for SSR drive.
   Logic status 1:   24 V $\pm$20% @ 1 mA.
                     14 V $\pm$20% @ 20 mA
   Logic status 0:   <0.5 V

OUTPUT 2

Function: programmable as:

- control output (cooling)
- Alarm 1 output

Type:

a) Relay output with SPST contact;
   contact rating 3A / 250 V AC on resistive load.

b) Logic voltage for SSR drive.
   Logic status 1:   24 V $\pm$20% @ 1 mA.
                     14 V $\pm$20% @ 20 mA
   Logic status 0:   <0.5 V

OUTPUT 3

Function: Alarm 2 output.
Type: relay with SPDT contact
Contact rated: 3 A at 250 V AC on resistive load.

OUTPUT 4

Output type: open collector, optically isolated with respect to the other circuits.
Rating: max 10 mA at 48 V

ALARMS

Actions: Direct or reverse acting.
Alarm functions: each alarm can be configured as process alarm, band alarm or deviation alarm.
Alarm reset: automatic or manual reset programmable on each alarm.
Stand by (mask) alarm: each alarm can be configured with or without stand by (mask) function.
This function allows to delete false indication at instrument start up and/or after a set point change.

Process alarm:
Operative mode : High or low programmable.
Threshold : programmable in engineering unit within the input span.
Hysteresis: programmable from 0.1 % to 10.0 % of the input span ([1104] – [1103]).

Band alarm
Operative mode: Inside or outside programmable.
Threshold : programmable from 0 to 500 units.
Hysteresis : programmable from 0.1 % to 10.0 % of the input span.

Deviation alarm:
Operative mode : High or low programmable.
Threshold : programmable from - 500 to +500 units.
Hysteresis : programmable from 0.1 % to 10.0 % of the input span.

Communication interface

Type: RS-485, opto-isolated
Protocol: Modbus RTU, device acts as slave
Baud-rate: 600, 1200, 2400, 4800, 9600 or
               19200 baud
Data format: 8 bit without parity, 8 bit even parity
               or 8 bit odd parity
Slave number: up to 120 RFS unit could be
               connected to the same RS-485
               network without using repeaters

MAINTENANCE

1) REMOVE POWER FROM THE POWER SUPPLY TERMINALS AND FROM RELAY OUTPUT TERMINALS
2) Using a vacuum cleaner or a compressed air jet (max. 3 kg/cm^2) remove all deposit of dust and dirt which may be present on the louvers and on the internal circuits trying to be careful for not damage the electronic components.
3) To clean external plastic or rubber parts use only a cloth moistened with:
   - Ethyl Alcohol (pure or denatured) [C_2H_5OH] -
   Isopropyl Alcohol (pure or denatured) [$(CH_3)_2CHOH$] or
   - Water (H_2O)
4) Verify that there are no loose terminals.
5) Before re-power the instrument be sure that it is perfectly dry.
6) Turn the instrument ON.