MV Electrical network management

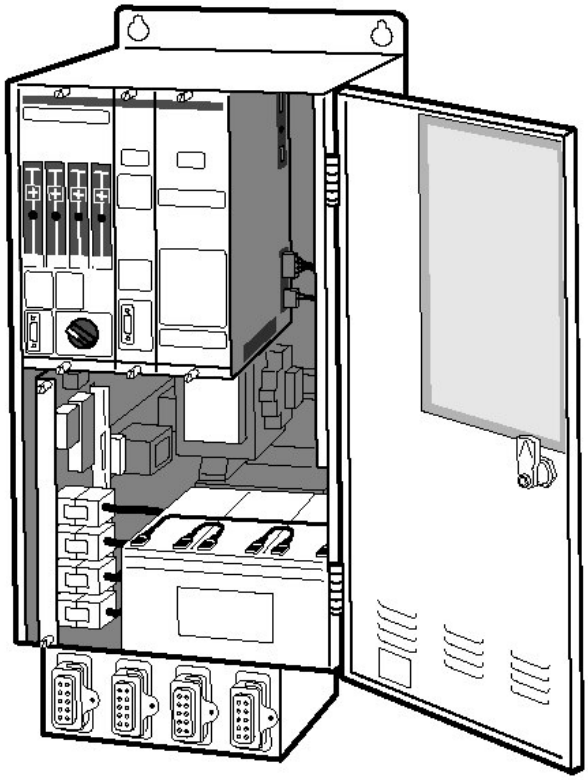
MV substation control unit

Merlin Gerin **Easergy** Range

T200

Modbus II Communication

User's manual



a brand of Schneider Electric

Merlin Gerin

Contents

General

The T200-MOD2 communication board allows the connection of T200 to a telecontrol system by using a MODBUS protocol . It includes advanced telecommunication function and manages PSTN type of transmission modems.

Application

Permanent and non permanent serial link with a telecontrol center by using MODBUS protocol.

Advantages

- type of transmission modem : PSTN, Radio, GSM, etc .
- Advanced telecommunication functions
- Configuration by PC computer
- Built-in protocol analyser

Functions

Select before execute

- All control order needs a double transmission:
- A Select then an Execute order
- A control order is executed after reception of a healthy double transmission
- Delay between select and execute is limited to 20s

Report by exception

Each alarm may be configured to be sent spontaneously to the telecontrol centre when it changes of state.
The modem is activated through HAYES frames and after PSTN link is established with the telecontrol centre, a MODBUS protocol is initiated.
In case of use with a permanent link transmission(private line, optical fibre) or radio, a special MODBUS message is sent to the telecontrol centre which then initiates a Master/Slave MODBUS protocol exchange. The T200-MOD2 board manages the collision detection.

Protocol analyser

The communication board includes a protocol analyser functionality (including a MODBUS frame translation) available from the PC computer connected to the communication board
This analyser allows the display of the frames which are exchanged with the telecontrol system.

Events

The communication board memorises up to the last 200 events. Each change of states is time tagged with an accuracy of 20ms.

Accessible data

■ **Writing of digital data**

■ Transmission of remote control commands to MV switches.

■ Transmission of the remote control command to reset fault currents stored.

■ **Reading of digital data**

■ Position of switches (SW1 to SW16),

■ Remote indications:

□ Status of SW1 to 16,

□ Phase and earth fault currents of ways 1 to 16,

□ Digital inputs 1 to 24,

□ Local / Remote control operating mode,

□ Immediate AC supply OFF

□ Delayed AC supply OFF

□ Equipment fault,

□ Charger fault

□ Battery fault

□ Switchgear supply OFF.

■ **Reading of measurements**

■ 16 phase currents (1 per way).

■ **Diagnosis**

■ reading of MODBUS diagnostic counters.

■ **Other functions**

■ time synchronization function,

■ identification / configuration function.

■ managment of up to 16 ways (4 ways by CPU)

■ possibility to add an other MODBUS equipment (SEPAM, PM300/600)

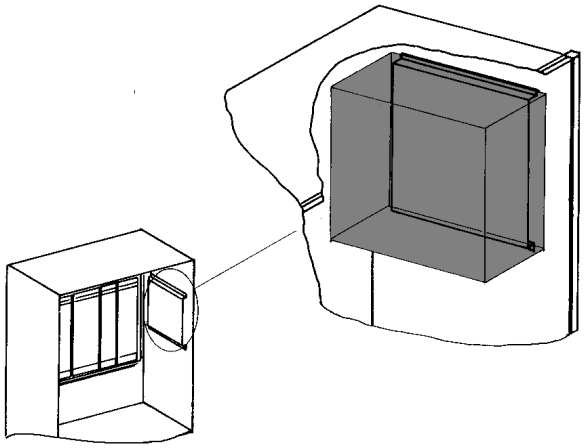
Characteristics

type of transmission	asynchronous serial
protocol	MODBUS slave
speed	300, 600, 1200, 2400, 4800, 9600, 19200 bauds
data format	1 start bit, 8 data bits with no parity, 1 stop bit
electrical interface	RS232
type of connector	9 pin SUB-D, female
T200 amount on a line	4080

Connection to a transmission network

Space available for a transmission interface

The top right section of the equipment contains a space available for a transmission interface (Modem, optical fibre, ...). A support structure mounted on sliding rails offers multiple possibilities for adding such a unit.



Connection to a transmission interface

Power supply :

The interface may be connected to the ''Telecomms supply'' terminals.

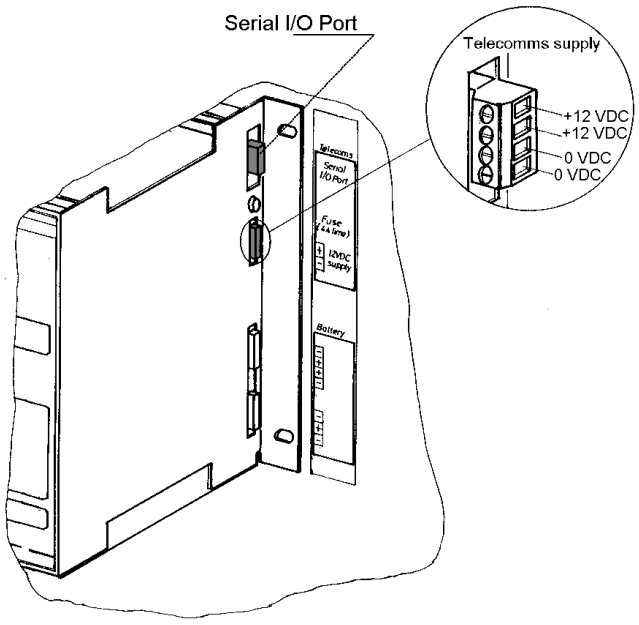
■ Output Voltage :

12 Vdc (10.8 to 14.8 Vdc)

■ Output Current :

See T200 user's manual.

The output is protected by a 4A time lag fuse located on the right side of the rack.



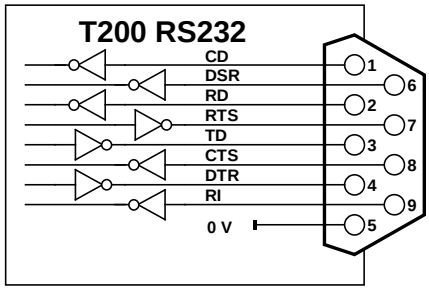
Connection to a transmission network

Serial I\O Port

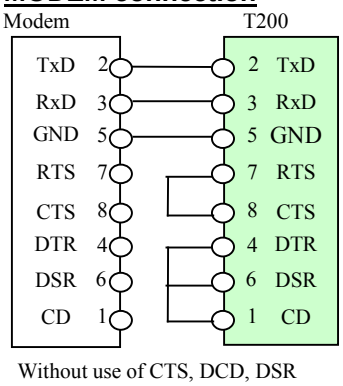
The RS232 serial line is available on a 9 pins SUB-D female plug, located on the right side of the rack. (only with using a RS232 modem on card "Comms").

■ **Signals :**

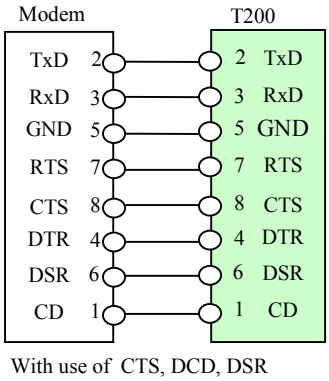
- □ CD : Carrier Detect
- □ RD : Receive Data.
- □ TD : Transmit Data.
- □ DTR : Data Terminal Ready
- □ DSR : Data Set Ready
- □ RTS : Request To Send.
- □ CTS : Clear To Send
- □ RI : Ring Indicator



MODEM connection



Without use of CTS, DCD, DSR



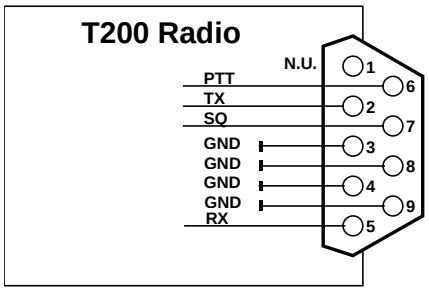
With use of CTS, DCD, DSR

Radio Port

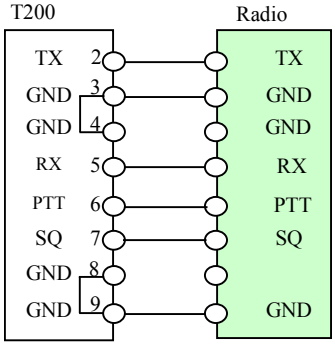
The RADIO connection is available on a 9 pins SUB-D female plug, located on the right side of the rack. (only with using a Radio modem on card "Comms") :

■ **Signals :**

- □ PTT : Press To Talk.
- □ TX : Transmission signal.
- □ SQ : Squelch.
- □ RX : Reception signal.
- □ N.U. : Not used.



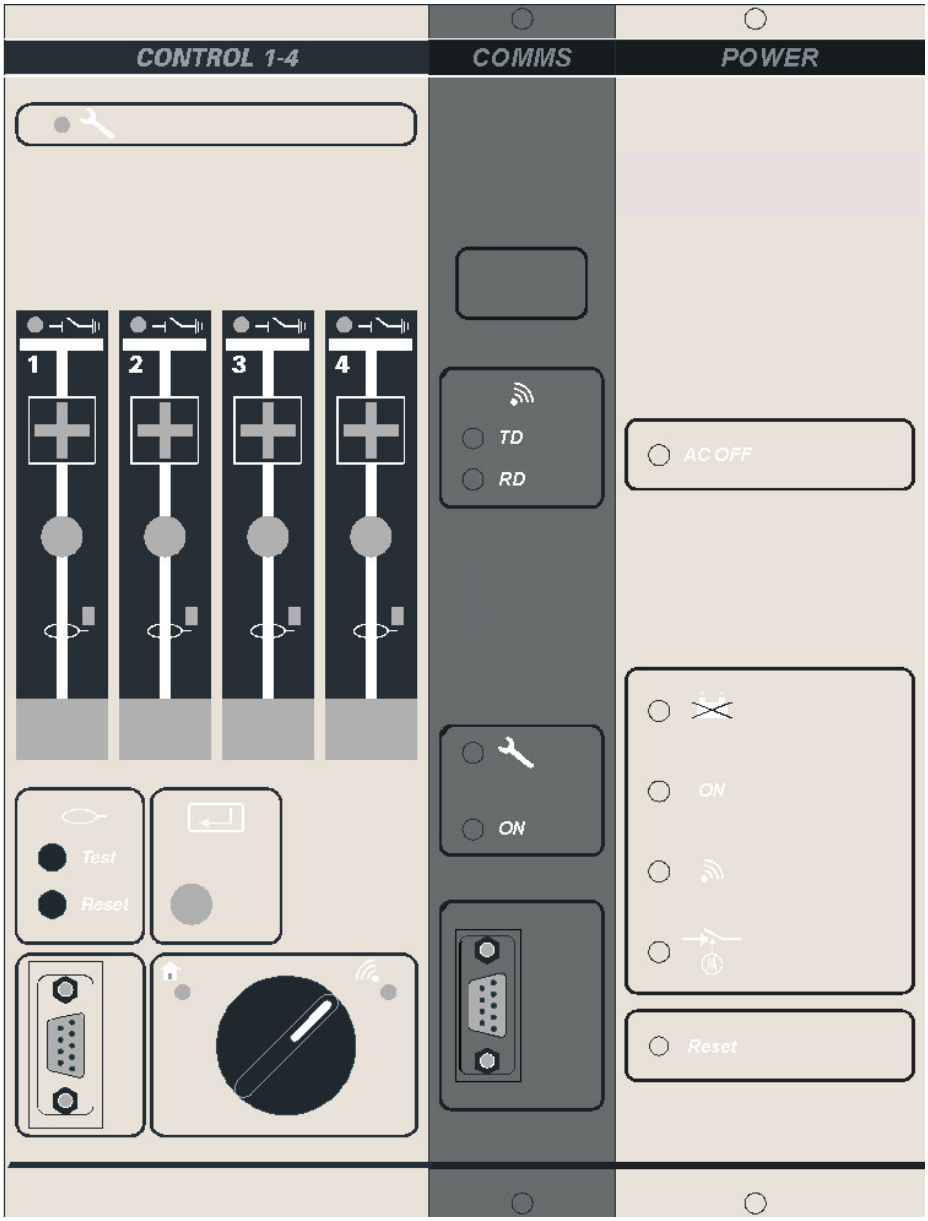
RADIO connection



Communication module

Communication using MODBUS protocol takes place via a "COMMS" module.

The module is installed in the rack (position 3) of a "standard" T200 enclosure (on the left side of the Power supply module).



Communication module

Communication module configuration

The communication parameters are configured by using the ‘’**T200 Configuration and diagnostic’’** software.

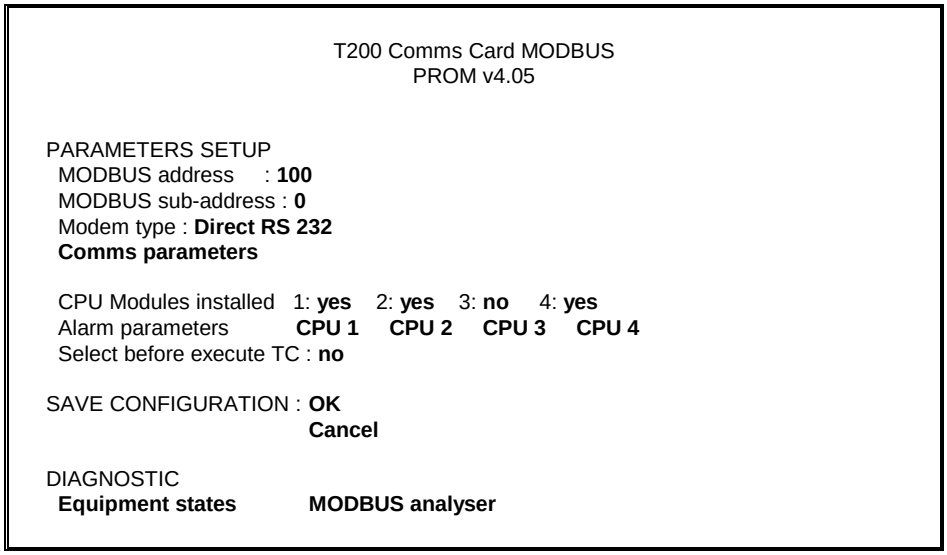
- Plug a computer to the **COMMS** module.
- The computer being under DOS control, insert the the ‘’**T200 Configuration and diagnostic’’** disquette and enter **A:MG** then **ENTER.** The main menu is displayed.

The use of the software is described into the T200 user’s manual.

The main menu configures the protocol, the RTU address and the type of transmission.

It allows also the access to:

- Communication parameters
- Alarmes configuration
- MODBUS frame analyser
- Modem status



- **MODBUS address :**
  from **1 to 255**

- **MODBUS sub-address :**
  This sub address allows a number of T200 on a MODBUS line greater than 255 by addressing several T200 on the same MODBUS address.

  from **0 to 15**

- **CPU Modules installed:**
  Yes : indicate that CPU1 (..CPU4) is present
  No : indicate that CPU1 (..CPU4) is not present

- **Modem type :**
  Hayes : use of a HAYES compatible modem.
  Direct RS 232: permanent link
  GSM : use of a GSM with AT commands.
  Radio : use of a radio with analog input.

- **Select before execute :**
  Yes : Controls are received with the ‘’Select Before excetute’’ mode
  No : Controls are received with the standard mode.

Comms parameters

1- Modem : Hayes

Comms parameters

Modem : Hayes

Host baud rate : **9600** baud
Dialing type : **Pulse**
Host telephone number (main) : **????????**
Host telephone number (standby) : **????????**

Dial-up delay time - first attempt : **1s**
(0s = random value) - second attempt : **1 mn**
- third attempt : **2 mn**

Modem init : **&B1E0Q0V1&C1&D2X4S0=2S2=255**
Factory modem init

ESCAPE=Exit

■ **Host baud rate :**

Transmission speed with the telecontrol center.

200, 300, 600, 1200, 2400, 4800, 9600 or 19200 baud.

■ **Dialing type :**

Dialling up system.

Tone or **Pulse**.

■ **Host tel number (main) :**

Telephone number of the host computer system, used to send the alarms to the telecontrol center.

15 figures maximum.

The telephone number can generaly include the following dialling options (Depend on external modem):

, (coma) : wait 2 seconds

/ (slash) : wait 125 milliseconds

W : Wait a second tone before carry on the dialling. Only for a modem that need to to dial a number to get an external line.

@ : Wait a 5s silence on the line before dialling the remaining part of the number.

■ **Host tel number (standby) :**

Backup telephone number used in case of trouble with the main telephone number.

15 figures maximum.

The dialing option are the same as as for the main phone number.

■ **Dial up delay time :**

Delay to transmit an alarm configured with "delayed" option.

- **first attempt** : configurable from **0 to 1 mn, by step of 1 s**. A **‘’0’’** value configures a random delay between 0 and 1 mn, which is compulsory to avoid that all equipments call at the same time the telecontrol center.
- **second attempt** : configurable from **0 to 5 mn, by step of 1 mn**. A **‘’0’’** value configures a random dely between 0 and 5 mn.
- **third attempt** : configurable from **0 to 10 mn, by step of 1 mn**. A **‘’0’’** value configures a random dely between 0 and 10 mn.

Nota : The 2nd and 3rd emission are only used by the equipment if the preceding emission didn’t success in sending the frame.

■ **Modem init :**

Hayes modem initialisation frame.

40 characters maximum.

Nota : **NEVER PLACE the AT frame at the beginning of initialisation frame.** T200 will send it automatically to the modem, before the configured frame.

■ **Factory modem init :**

This option allows the configuration of the **‘’modem init’’** frame with U.S. Robotics type(Plant configuration). This frame is valid for most of the modems.

Plant initialised frame :

&B1 : Serial port speed constant (compulsory). The modem communicates with T200 at the configured speed (menu ‘’comms parameter’’).

E0 : Echo disabled

Q0 : Display the resulting codes (Compulsory).

V1 : resulting code as word format (Compulsory).

&C1 : Normal use of DCD

&D2: Normal use of DTR

X4 : Activation of resulting code X4

S0=2 Automatic answer after two rings (Compulsory for European norm).

S2=255 Disable escape code +++ (Compulsory because the transmission frame is binary coded).

2- Modem : GSM

Comms parameters

Modem : GSM
Host baud rate : **9600** baud
PIN code : **0000**
Modbus parameters
Alarm message enabled **: no**
Host telephone number (main) : **????????**
Host telephone number (standby) : **????????**

Dial-up delay time - first attempt : **1s**
(0s = random value) - second attempt : **1 mn**
- third attempt : **2 mn**

Short message system : SMS
Short message system enabled **: no**
SMS service center phone number **: +33689004000**
SMS user phone number **: ????????**

ESCAPE=Exit

■ **Host baud rate :**

Transmission speed with the telecontrol center.

Must be fixed at 9600 baud with GSM modem.

■ **PIN code :**

Setting of the PIN code into the SIM card (default value is 000).
In case of wrong PIN code, **"GSM SIM card failure"** appears in the screen **"Equipment states".**

Be care : After 3 wrong settings of the PIN code, the SIM cardis unavaible. To return to available status, a mobile phone must be use (T200 can not do it).

Please, consult the user guide of the SIM Card to return to an available status.

■ **Alarm message enabled :**

Yes : If a change of state of alarms and switch position occurs, a special MODBUS message is send to the telecontrol centre which then initiates a Master/Slave MODBUS protocol exchange.

No : T200 do not send an alarm message.

Nota : Please note that it is possible to have either an alarm on the control center and with a short message on a mobile . The short message is send at first.

■ **Host tel number (main) :**

Telephone number of the host computer system, used to send the alarms to the telecontrol center.

15 figures maximum.

■ **Host tel number (standby) :**

Backup telephone number used in case of trouble with the main telephone number.

15 figures maximum.

■ Dial up delay time :

Delay to transmit an alarm configured with "delayed" option.

- **first attempt** : configurable from **0 to 1 mn, by step of 1 s**. A **‘’0’’** value configures a random delay between 0 and 1 mn, which is compulsory to avoid that all equipments call at the same time the telecontrol center.
- **second attempt** : configurable from **0 to 5 mn, by step of 1 mn**. A **‘’0’’** value configures a random dely between 0 and 5 mn.
- **third attempt** : configurable from **0 to 10 mn, by step of 1 mn**. A **‘’0’’** value configures a random dely between 0 and 10 mn.

Nota : The 2nd and 3rd emission are only used by the equipment if the preceding emission didn’t success in sending the frame.

■ Short message system enabled :

Yes : When an alarm is detected, a short message is send to a mobile.

No : The short message system is disabled.

Nota : Please note that it is possible to have either an alarm on the control center and with a short message on a mobile . The short message is send at first.

■ SMS service center phone number:

Setting of the phone number of the server of the SMS.

Please consult the user guide of the SIM card in which this phone number is given.

Nota : Please note that is is possible to set the phone number in internationnal format. The following format +33 6 ….can be used in all countries**.**

■ SMS user phone number:

Setting the phone number of the mobile in wich you wish to receive the short message.

Nota : Please note that is is possible to set the phone number in internationnal format. The following format +33 6 ….can be used in all countries.

3- Modem : Radio

Comms parameters

Modem : Radio 600/1200 baud

Host baud rate : **1200** baud

RTS to message delay : **10ms**

Handle CTS (Squelch) : **no**

Alarm message enabled : **no**
Alarm delay time - first attempt : **1s**
(0s = random value) - second attempt : **1 mn**
- third attempt : **2 mn**

ESCAPE=Exit

■ **Host baud rate :**

Transmission speed with the telecontrol center.

600 or 1200 baud.

■ **RTS to message delay :**

It's the delay T200 will wait after RTS before sending the message value – depend of the radio..

Value is from **0** to **500ms** default value is 100ms.

■ **Handle CTS (Squelch) :**

Squelch, if it exist on the radio, allows T200 to have information about the status of the network (busy or not busy).

If the radio network is very noisy, it can be better to unabled this option.

■ **Alarm message enabled :**

Yes : if a the change of state of alarms and switch position occurs, a special MODBUS message is sent to the telecontrol centre which then initiates a Master/Slave MODBUS protocol exchange

No : T200 do not send an alarm message.

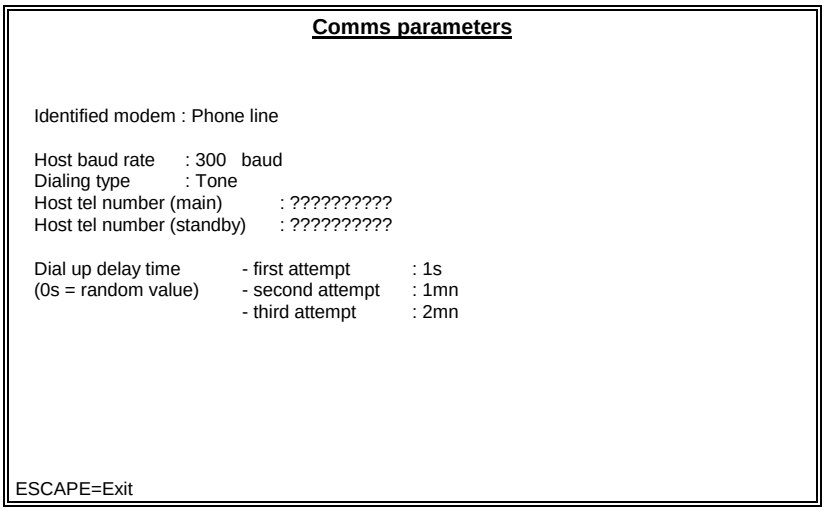
■ **Alarm delay time :**

Delay to transmit an alarm configured with "delayed" option.

- **first attempt** : configurable from **0 to 1 mn, by step of 1 s**. A **‘’0’’** value configures a random delay between 0 and 1 mn, which is compulsory to avoid that all equipments call at the same time the telecontrol center.
- **second attempt** : configurable from **0 to 5 mn, by step of 1 mn**. A **‘’0’’** value configures a random dely between 0 and 5 mn.
- **third attempt** : configurable from **0 to 10 mn, by step of 1 mn**. A **‘’0’’** value configures a random dely between 0 and 10 mn.

Nota : The 2nd and 3rd emission are only used by the equipment if the preceding emission didn’t success in sending the frame.

4- Modem : Phone line



■ Host baud rate :

Transmission speed with the telecontrol center.

Configurable with **300, 600 or 1200 baud.**

■ Dialing type :

Type of dialing using for alarm transmission to telecontrol center.

Configurable with **Tone** or **Pulse** (default value : Tone).

■ Host tel number (main) :

Telephone number of the host computer system, used to send the alarms to the telecontrol center.

15 figures maximum.

■ Host tel number (standby) :

Backup telephone number used in case of trouble with the main telephone number.

15 figures maximum.

■ Dial up delay time :

Delay to transmit an alarm configured with "delayed" option.

- **first attempt** : configurable from **0 to 1 mn, by step of 1 s**. (Default value : 1s).

  A **''0''** value configures a random delay between 0 and 1 mn, which is compulsory to avoid that all equipments call at the same time the telecontrol center.

- **second attempt** : configurable from **0 to 5 mn, by step of 1 mn**. (Default value : 1mn).

  A **''0''** value configures a random dely between 0 and 5 mn.

- **third attempt** : configurable from **0 to 10 mn, by step of 1 mn**. (Default value : 2mn).

  A **''0''** value configures a random dely between 0 and 10 mn.

Nota : The 2nd and 3rd emission are only used by the equipment if the preceding emission didn't success in sending the frame.

5- Modem : Direct RS 232

Comms parameters

Modem : Direct RS232

Host baud rate : **9600** baud

RTS delay : **20 ms** (Only if handle CTS = no)
Handle CTS : **yes**
Handle DCD : **yes**
Handle DSR : **yes**

Alarm message enabled : **no**

ESCAPE=Exit

■ **Host baud rate :**

Transmission speed with the telecontrol center.

200, 300, 600, 1200, 2400, 4800, 9600 ou 19200 bauds.

■ **RTS delay :**

Waiting time between RTS activation and frame emission. This parameter is to be used only if Handle CTS = 0.

Configurable from **0 to 500ms by step of 10 ms**

■ **Handle CTS :**

Yes : T200 uses a normal RST/CTS handshake: The RTS delay is not taken into account.

No : T200 uses the RTS delay

■ **Handle DCD :**

Yes : T200 uses DCD signal.

No : T200 do not use DCD signal.

■ **Handle DSR :**

Yes : T200 uses DSR signal.

No : T200 do not use DSR signal.

■ **Alarm message enabled :**

Yes : if a the change of state of alarms and switch position occurs, a special MODBUS message is sent to the telecontrol centre which then initiates a Master/Slave MODBUS protocol exchange

No : T200 do not send an alarm message.

Alarm parameters

The ''Alarm Parameters'' menu allows the configuration of each status to be in alarm mode for each CPU.

```
                          Alarm Parameters CPU1
SWITCH ALARM              -------------------------------------
  Switch 1 : no                       Switch 2 : yes
  Switch 3 : yes                      Switch 4 : no

 SINGLE STATE REMOTE INDICATION ALARM
  Status SW1      : no                Presence HT SW1  : yes
  Status SW2      : no                Presence HT SW2  : yes
  Status SW3      : no                Presence HT SW3  : yes
  Status SW4      : no                Presence HT SW4  : yes
  Phase fault SW1  : no               Local            : no
  Earth fault SW1 A : no              Immediate AC supply OFF : no
  Earth fault SW1 B : no              Delayed AC supply OFF   : no
  Phase fault SW2  : no               Digital input 1  : yes
  Earth fault SW2 A : no              Digital input 2  : yes
  Earth fault SW2 B : no              Digital input 3  : yes
  Phase fault SW3  : no               Digital input 4  : yes
  Earth fault SW3 A : no              Digital input 5  : yes
  Earth fault SW3 B : no              Digital input 6  : yes
  Phase fault SW4  : no               Charger/FPI fault : no
  Earth fault SW4 A : no              Battery fault    : no
  Earth fault SW4 B : no              SW supply OFF    : no

ESCAPE=Exit
```

Each status could be configure as:

no : The T200 do not send an alarm in case of change of state of this status.

Yes : T200 send a message to the telecontrol center, after the ''dial up delay time'' at each change of state of the status.

Remark :

The above screen shows all the available status in the T200.
Depending on the T200 type (1 or 4 ways , internal FPI or external FPI), some status should not exist and consequently are not displayed on the screen.

```
                          Alarm Parameters CPU2
 SWITCH ALARM             -------------------------------------
  Switch 5 : no                       Switch 6 : yes
  Switch 7 : yes                      Switch 8 : no

 SINGLE STATE REMOTE INDICATION ALARM
  Status SW5      : no                Presence HT SW5  : yes
  Status SW6      : no                Presence HT SW6  : yes
  Status SW7      : no                Presence HT SW7  : yes
  Status SW8      : no                Presence HT SW8  : yes
  Phase fault SW5  : no
  Earth fault SW5 A : no
  Earth fault SW5 B : no
  Phase fault SW6  : no               Digital input 7  : yes
  Earth fault SW6 A : no              Digital input 8  : yes
  Earth fault SW6 B : no              Digital input 9  : yes
  Phase fault SW7  : no               Digital input 10 : yes
  Earth fault SW7 A : no              Digital input 11 : yes
  Earth fault SW7 B : no              Digital input 12 : yes
  Phase fault SW8  : no
  Earth fault SW8 A : no
  Earth fault SW8 B : no
 ESCAPE=Exit
```

The alarm parameters menus of CPU2, CPU3 and CPU4 allow the same configuration as CPU1 except the parameters which are global to the equipment.

MODBUS analyser

The equipment includes a protocol analyser function(with a modbus frame specific decoding) . This function is accessible from the MODBUS analyser'' menu on the PC connected to the COMMS card configuration plug.

Warning : The CPU includes also a MODBUS analyser allowing the display of MODBUS internal exchange between CPU and COMMS modules.

MODBUS analyser

```
ESCAPE=Exit, SPACE=Pause, C=Clear, F=Toggle filtering
34:56.67   read ts      <    01 03 00 34 00 08 05 C2
34:56.67   READ TS      >>   01 03 10 00 08 00 00 00 04 00 00 00 00 00 80 00 00 00
                             00 F8 B1
34:57.05   read tm      <    01 03 00 40 00 05 84 1D
34:57.05   READ TM      >>   01 03 0A 00 00 00 00 00 00 00 00 00 00 24 B6
34:57.27   read date    <    01 03 00 02 00 04 E5 C9
34:57.27   READ DATE    >>   01 03 08 00 60 0A 19 10 22 DF B6 95 F5
Pause...
```

Use:

■ The "SPACE" key is used to stop scrolling, thereby facilitating analysis of the frames received.

■ The "C" key clears the screen.

■ The ''F'' key changes the filtering method.

- ☐ Display all received frames
- ☐ Display only frames destinated to this T200.

■ The "ESCAPE" key is used to exit the analyser function.

Display:

■ The first column gives the time of the message in minutes, seconds and 100ths of seconds.

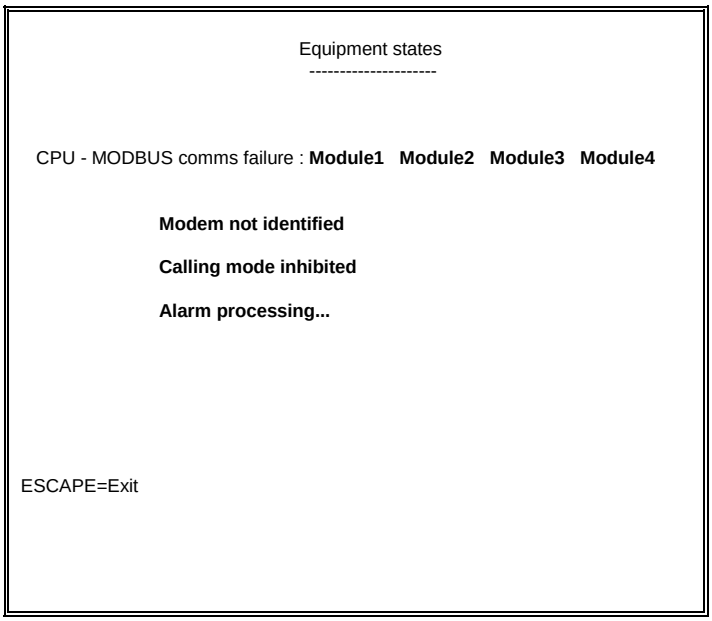
■ The second column indicates the type of frame. Upper case characters are used for frames transmitted by the T200. This is confirmed by the double chevron '>>' in column 3. On the other hand, all the lower case characters pertain to frames received by the remote control station (confirmed by a single chevron '<' in column 3).

■ The last column displays the frame in hexadecimal form. The "+" and ' * ' signs may precede the display of the frame:

□ The '+' sign indicates frames not intended for the equipment,

□ The ' * ' sign indicates an erroneous frame (incomplete frame, faulty construction, ...).

Equipment states



This menu shows the modem status (A selected information is displayed as bold)

■ **CPU-MODBUS comms failure:**

T200 doesn't recognise the CPU1 or CPU2 or CPU3 or CPU4; It is either not connected either the CPU is not valid.

■ **Modem not identified :**

T200 doesn't recognise the modem; It is either not connected either the initialisation frame is not valid.

■ **Number blacklisted :**

(Only with Hayes modem).

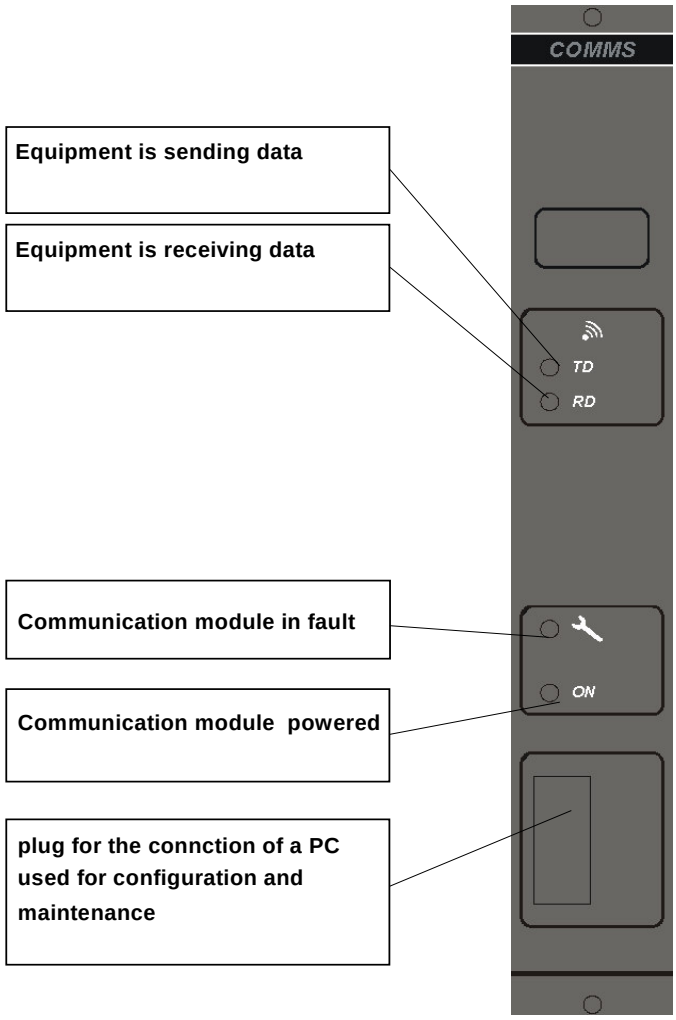
At least one of the telephone number doesn't work after some trials. (Generaly 6; this function is managed by the modem itself).

■ **Alarm processing ...**

An alarm is in processing or in repeat mode.

Communication module

Front panel indications



Normal operation

During normal operation the COMMS card display is as follow:

☐ TD and RD communication LEDs OFF

☐ ON is energized

☐ Fault LED is OFF

Diagnosis using front panel indicators and time-stamped events

T200 includes time stamped facilities in order to help in the diagnostic. The events are memorized into the CPU module.

The Time stamped events can be read locally from a lap top PC computer connected to the CPU configuration plug and equiped with the software : **‘’T200 Configuration and Diagnostic’’.**

- Connect the Lap top to the CPU card.
- The PC being powered, and under Dos control, insert the disquette **‘’T200 Configuration and Diagnostic’’** into the driver and press **A:MG** then **ENTER** (Capital letter either not). The main menu is displayed.

For information on the use of the configuration software package, refer to the chapter entitled "Commissioning" in the T200 user's manual.

Event	Possible cause	Solution
The "ON" LED on the COMMS card is OFF.	Equipment is not powered	Power the equipment
	Control unit supply fuse is burnt	Change the fuse on the Power supply unit. Fuse : 5x20mm, 0.8A semi time lag.
	Comms card failure.	Change the Comms card.
The "FAULT" LED on the COMMS card is steady ON.	The modem connected to the T200 is not recognised or doesn’t work properly	Connect a correct modem
	At least one of the telephone number doesn’t answer.	Check: - The phone numbers - The complete chain of use - The modem standard options (generaly setup by switches on the modem). Reset the Hayes modem and the T200.
The "FAULT" LED on the COMMS card is flashing ON.	The comms card software is in fault	Press ‘’General RESET’’ button on the Power supply unit. If the led doesn’t turn OFF some seconds later, change the comms card.
The "Equipment fault" LED on the "Control panel" module is ON. and presence of MODBUS comms failure event	Comms card failure.	Change the Comms card.

Replacing the Serial line module

Removing the module

a) switch off the control unit,
- Switch Off the AC supply
- Disconnect the batteries

b) unscrew the two module locking screws and extract it from its location.

Installing the module

a) install the new board and lock it to its slot,

b) switch the control unit on again.

IMPORTANT: Do not forget to configure the module; refer to the sections entitled "configuration of access mode" and "configuration of communication parameters"

MODBUS data addresses and encoding

General

Addressing

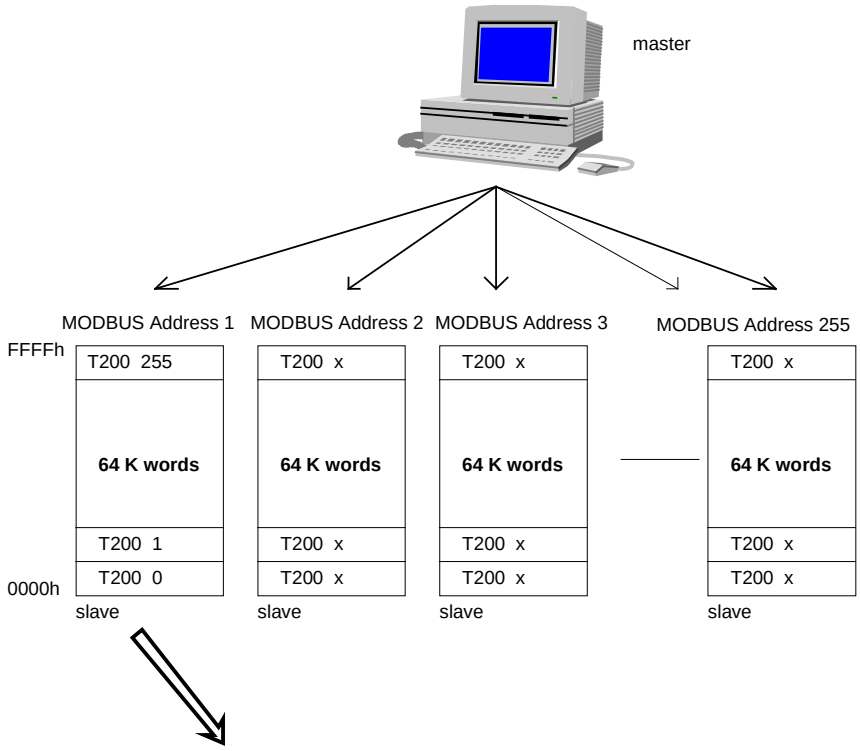
A MODBUS master can access 255 storage spaces of 64K words (255 MODBUS addresses).

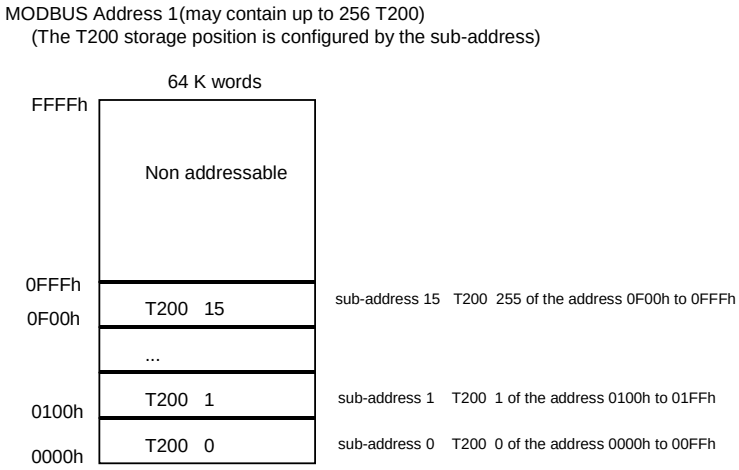
To increase the addressing capability, each storage space is divided into 16 parts (256 words each).

Each part represents the storage space of a T200.

This makes it possible to dialogue with 16 T200s, with the same MODBUS address which increase the addressing capability to 4 080 T200 (255 x 16) in the same MODBUS network.

In the documentation which follows, the term "**sub-address**" (0 to 15) is used to refer to the storage position of the T200 in a MODBUS address.





Transmission

■ asynchronous, 300 to 19200 bauds

■ 1 start bit, 8 data bits, 1 stop bit, no parity

■ maximum response time < 30ms.

Reply messages

■ Upon receipt of a request recognized by the equipment (read or write), transmission of the data corresponding to the MODBUS specifications.

■ Upon receipt of a request not recognized by the equipment, transmission of an exception message (type 1, 2 or 3 only).

Read zone

■ The number of words read may not exceed the size of the checked zone.

■ Some zones may only be accessed as a whole.

Remarks

■ The bit by bit write and read functions are not used in the T200 application.

■ Values followed by the letter "h" are in hexadecimal form (e.g. 0003h).

■ In the charts describing the data exchanged between the master and the T200, the hatched strips in the "authorized function" columns indicate the zones that are accessible as a whole.

Terminology

■ TCD: remote control (encoded in 2 bits)

■ TSD: two-state remote indication (encoded in 2 bits)

■ TSS: single-state remote indication (encoded in 1 bit)

■ TM: telemetering (encoded in 16 bits)

Control orders

The control orders could be received with the ‘’Select Before Execute’’ mode. This mode is configurable from the main configuration menu of communication card.

MODBUS data addresses and encoding

Identification / configuration zone

	word address 0000h to 0001h	access mode	authorized function
Software version	0000h	read	3,4
Status	0001h	read/write	3,4,6

■ **Bit 0 of status indicates:**

- 0 = "Scale conversion" telemetering mode.
- 1 = "Raw data" telemetering mode.

The T200 preset mode is "Scale conversion".

■ **Bit 15 of status indicates:**

- 0 = No events loss
- 1 = Loss of events

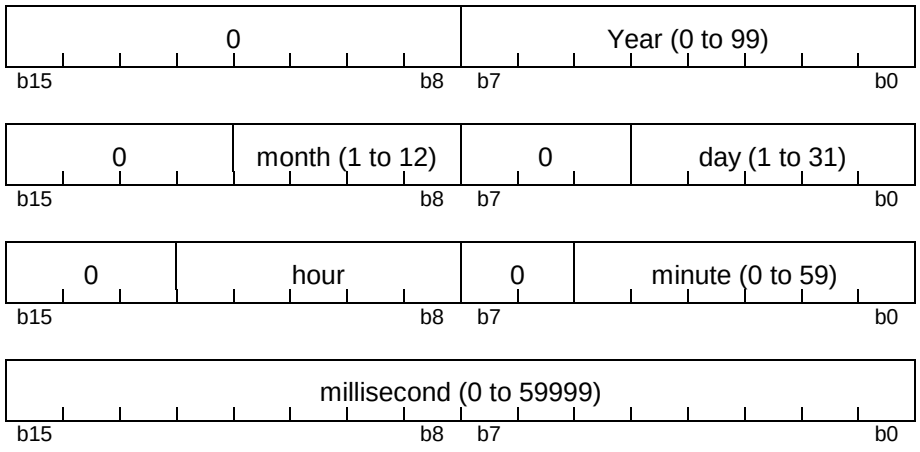
This bit is set when the event file is full. The event ‘’event loss’’ is then placed in the file. As long as this event is in the file, no other event can be memorized. This bit is reset when the file is empty. This chenge of state doesn’t initiate an event.

Time synchronization zone

This zone contains the internal date and time of the equipment for time-stamping of events.

The zone may only be read or written as a whole.

binary date	word address 0002h to 0005h	access mode	authorized function
year	0002h	read/write	3,4,16
month+day	0003h	read/write	3,4
hours+minutes	0004h	read/write	3,4
milliseconds	0005h	read/write	3,4



MODBUS data addresses and encoding

Test zone

The test zone contains 9 words that can be read or written. It is preset to zero status and is available to users to facilitate final adjustment tests.

The contents of the zone do not have any effect on the T200 functions.

Test zone	word address	access mode	authorized function
9 words	0006h to 000Eh	read/write	1,2,3,4,5,6,16

Event zone

This zone contains the time stamp events.

Event zone	word address	access mode	authorized function
exchange word	000Fh	read/write	3,4,6,16
event 1	0010h to 0017h	read	3,4
event 2	0018h to 001Fh	read	3,4
event 3	0020h to 0027h	read	3,4
event 4	0028h to 002Fh	read	3,4

Only the exchange word may be written.
It is possible to read the exchange zone as a whole or the exchange word only.

The exchange word is used to manage a specific protocol to be sure not to lose events as a result of a MODBUS communication problem; the event table is numbered for that purpose.

The exchange word comprises 2 bytes:

- Most significant byte = exchange number which identifies each event frame. It is preset to zero when the T200 is switched on; when it reaches its maximum value (FFh), it automatically goes back to 0. The T200 numbers the exchanges and the master acknowledges the numbering.

- Least significant byte = number of valid events in the event zone (maximum 4).

Encoding of events

Each event is encoded with 4 words related to the event, followed by 4 words containing the event time-stamping data:

■ word1: 0800h /2048

■ word2: event bit address

□ 001Fh /31:
Event loss bit (set only on appearance)

□ 0340h to 036Fh / 832 to 879:
TSD 1 to 24

□ 0370h to 0375h /880 to 885 :
code CR

□ 0380h to 03BFh / 896 to 959:
TSS 1 to 64

■ word3: 0

■ word4: 0 = 0 to 1 change of state
1 = 1 to 0 change of state

■ words 5 to 8: time-stamping with same format as date zone.

Acknowledgment of events

To inform the T200 that it has correctly received the frame it has read, the master must :

☐ writes the number of the last exchange it has received in the "exchange number" byte

☐ resets the "number of events" byte of the exchange word to zero.

After acknowledgment, the T200 erases the events that have already been transmitted and replaces them by new ones when applicable.

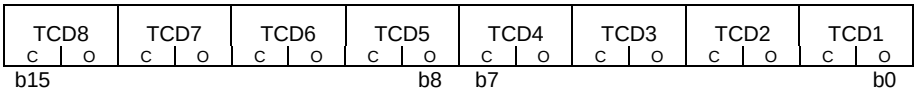
Remark: until the exchange word written by the master becomes "X,0" (with X = number of the previous exchange that the master wishes to acknowledge), the exchange word in the table remains at "X, number of previous events".

If the number is equal to zero, the master is not required to acknowledge a message with no event.

TC / TSD / TSS zone

TCD / TSD / TSS	word adddress	access mode	function authorized
TCD 1-8	0030h	write	1,2,3,4,5,6
TCD 9-16	0031h	write	1,2,3,4,5,6
TCD 17-24	0032h	write	1,2,3,4,5,6
reserved	0033h	write	1,2
TSD 1-8	0034h	read	1,2,3,4
TSD 9-16	0035h	read	1,2,3,4
TSD 17-24	0036h	read	1,2,3,4
CR	0037h	read	1,2,3,4,5,6
TSS 1-16	0038h	read	1,2,3,4
TSS 17-32	0039h	read	1,2,3,4
TSS 33-48	003Ah	read	1,2,3,4
TSS 49-64	003Bh	read	1,2,3,4
TSS 65-80	003Ch	read	1,2,3,4
TSS 81-96	003Dh	read	1,2,3,4
TSS 97-112	003^{E}h	read	1,2,3,4
TSS 113-128	003Fh	read	1,2,3,4

Each TCD word is encoded as follows:



A remote control TCD is encoded in 2 bits:

- 01 = open order
- 10 = closing order

The TCDs are assigned as follows:

- TCD1..16 : Switch 1..16.

- TCD18: reset of fault current detectors by a closing order.

- TCD21..24: Automatism ON/OFF of CPU1, CPU2, CPU3, CPU4

Remote control orders are performed by writing a TCD word. Only one remote control order at a time may be requested. The order type is the status complementary to the TSD status (only one bit should be included in the word written). It is only accepted if the T200 is not already processing a remote control order.

The control order zone (TCD) may be read with bit and word read function code. As it contains no information the data is 0.

The CR code (result code) gives information on the processing of the remote control order carried out by the T200:

- bit 0: Remote control in progress.

- bit 1: Fault concerning the initial remote control order

- bit 2: Serious fault detected during internal check.

- bit 3: External fault; the switch has not reached the desired status within the time allotted.

- bit 4: Remote control not executed due to Station in Local mode or other disabling condition.

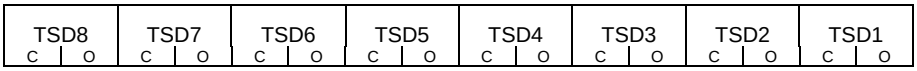
- bit 5: Failure to execute for an unknown reason.

Each chane of state of one of this bit will produce a MODBUS event.

The telecontrol center system may reset this codes by writing a 0 to the relevant address.

MODBUS data addresses and encoding

Each TSD word is encoded as follows:



A TSD is encoded in 2 bits, F,O

- 01 = switch open.
- 10 = switch closed.
- 00 or 11 = undetermined.

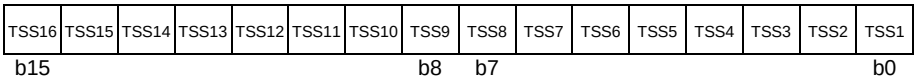
For automatism only :

- 11 = automatism locked by internal problem
- 00 = automatism locked by external TSS

The TSDs are assigned as follows:

- TSD1: Switch 1.
- TSD2: Switch 2.
- TSD3: Switch 3.
- TSD4: Switch 4.
- TSD18: Corresponds to fault current detector reset order. The status is set to 01.

Each TSS word is encoded as follows:



CPU 1 (4 ways)

Single remote indications	Word	bit
TSS1 : Phase fault SW 1.	38h	0
TSS2 : Earth fault A SW 1.	38h	1
TSS3 : Phase fault SW 2.	38h	2
TSS4 : Earth fault A SW 2.	38h	3
TSS5 : Phase fault SW 3.	38h	4
TSS6 : Earth fault A SW 3.	38h	5
TSS7 : Phase fault SW 4.	38h	6
TSS8 : Earth fault A SW 4.	38h	7
TSS9 : Earth switch SW 1.	38h	8
TSS10 :Earth switch SW 2.	38h	9
TSS11 :Earth switch SW 3.	38h	10
TSS12 :Earth switch SW 4.	38h	11
TSS13 :Earth fault B SW 1.	38h	12
TSS14 :Earth fault B SW 2.	38h	13
TSS15 :Earth fault B SW 3.	38h	14
TSS16 :Earth fault B SW 4.	38h	15
TSS17 :Digital input 1.	39h	0
TSS18 :Digital input 2.	39h	1
TSS19 :Volt. presence SW1	39h	2
TSS20 :Volt. presence SW2	39h	3
TSS21 :Volt. presence SW3	39h	4
TSS22 :Volt. presence SW4	39h	5
TSS23 :Local.	39h	6
TSS24 :Im. AC sup OFF.	39h	7
TSS25 :Digital input 3.	39h	8
TSS26 :Charger fault.	39h	9
TSS27 :Battery fault.	39h	10
TSS28 :SW. supply OFF.	39h	11
TSS29 :Del. AC sup. OFF.	39h	12
TSS30 :Digital input 4.	39h	13
TSS31 :Digital input 5.	39h	14
TSS32 :Digital input 6.	39h	15

optionnal CPU2 (8 ways)

Single remote indications	Word	bit
TSS33 :Phase fault SW 5	3Ah	0
TSS34 :Earth fault A SW 5	3Ah	1
TSS35 :Phase fault SW 6	3Ah	2
TSS36 :Earth fault A SW 6	3Ah	3
TSS37: Phase fault SW 7	3Ah	4
TSS38: Earth fault A SW 7	3Ah	5
TSS39: Phase fault SW 8	3Ah	6
TSS40: Earth fault A SW 8	3Ah	7
TSS41: Earth switch SW 5	3Ah	8
TSS42 :Earth switch SW 6	3Ah	9
TSS43 :Earth switch SW 7	3Ah	10
TSS44 :Earth switch SW 8	3Ah	11
TSS45 :Earth fault B SW 5	3Ah	12
TSS46 :Earth fault B SW 6	3Ah	13
TSS47 :Earth fault B SW 7	3Ah	14
TSS48 :Earth fault B SW 8	3Ah	15
TSS49 :Digital input 7	3Bh	0
TSS50 :Digital input 8	3Bh	1
TSS51 :Volt. Presence SW5	3Bh	2
TSS52 :Volt. Presence SW6	3Bh	3
TSS53 :Volt. Presence SW7	3Bh	4
TSS54 :Volt. Presence SW8	3Bh	5
TSS55 :Reserved	3Bh	6
TSS56 :Reserved	3Bh	7
TSS57 :Digital input 9	3Bh	8
TSS58 :Reserved	3Bh	9
TSS59 :Reserved	3Bh	10
TSS60 :Reserved	3Bh	11
TSS61 :Reserved	3Bh	12
TSS62 :Digital input 10	3Bh	13
TSS63 :Digital input 11	3Bh	14
TSS64 :Digital input 12	3Bh	15

optionnal CPU3 (12 ways)

Single remote indications	Word	bit
TSS65 :Phase fault SW 9	3Ch	0
TSS66 :Earth fault A SW 9	3Ch	1
TSS67 :Phase fault SW 10	3Ch	2
TSS68 :Earth fault A SW 10	3Ch	3
TSS69: Phase fault SW 11	3Ch	4
TSS70: Earth fault A SW 11	3Ch	5
TSS71: Phase fault SW 12	3Ch	6
TSS72: Earth fault A SW 12	3Ch	7
TSS73: Earth switch SW 9	3Ch	8
TSS74 :Earth switch SW 10	3Ch	9
TSS75 :Earth switch SW 11	3Ch	10
TSS76 :Earth switch SW 12	3Ch	11
TSS77 :Earth fault B SW 10	3Ch	12
TSS78 :Earth fault B SW 11	3Ch	13
TSS79 :Earth fault B SW 12	3Ch	14
TSS80 :Earth fault B SW 13	3Ch	15
TSS81 :Digital input 13	3Dh	0
TSS82 :Digital input 14	3Dh	1
TSS83 :Volt. presence SW9	3Dh	2
TSS84 :Volt. presence SW10	3Dh	3
TSS85 :Volt. presence SW11	3Dh	4
TSS86 :Volt. presence SW12	3Dh	5
TSS87 :Reserved	3Dh	6
TSS88 :Reserved	3Dh	7
TSS89 :Digital input 15	3Dh	8
TSS90 :Reserved	3Dh	9
TSS91 :Reserved	3Dh	10
TSS92 :Reserved	3Dh	11
TSS93 :Reserved	3Dh	12
TSS94 :Digital input 16	3Dh	13
TSS95 :Digital input 17	3Dh	14
TSS96 :Digital input 18	3Dh	15

optionnal CPU4 (16 ways)

Single remote indications	Word	bit
TSS97 :Phase fault SW 13	3Eh	0
TSS98 :Earth fault A SW 13	3Eh	1
TSS99 :Phase fault SW 14	3Eh	2
TSS100:Earth fault A SW 14	3Eh	3
TSS101: Phase fault SW 15	3Eh	4
TSS102: Earth fault A SW 15	3Eh	5
TSS103: Phase fault SW 16	3Eh	6
TSS104: Earth fault A SW 16	3Eh	7
TSS105: Earth switch SW 13	3Eh	8
TSS106:Earth switch SW 14	3Eh	9
TSS107:Earth switch SW 15	3Eh	10
TSS108:Earth switch SW 16	3Eh	11
TSS109:Earth fault B SW 13	3Eh	12
TSS110:Earth fault B SW 14	3Eh	13
TSS111:Earth fault B SW 15	3Eh	14
TSS112:Earth fault B SW 15	3Eh	15
TSS113:Digital input 19	3Fh	0
TSS114:Digital input 20	3Fh	1
TSS115:Volt.presence SW13	3Fh	2
TSS116:Volt.presence SW14	3Fh	3
TSS117:Volt.presence SW15	3Fh	4
TSS118:Volt.presence SW16	3Fh	5
TSS119:Reserved	3Fh	6
TSS120:Reserved	3Fh	7
TSS121:Digital input 21	3Fh	8
TSS122:Reserved	3Fh	9
TSS123:Reserved	3Fh	10
TSS124:Reserved	3Fh	11
TSS125:Reserved	3Fh	12
TSS126:Digital input 22	3Fh	13
TSS127:Digital input 23	3Fh	14
TSS128:Digital input 24	3Fh	15

Telemetering zone

32 TM	Word address		access	function
	Hexa.	decimal	mode	authorized
Phase current way 1	0040h	64	read	3,4
Phase current way 2	0041h	65	read	3,4
Phase current way 3	0042h	66	read	3,4
Phase current way 4	0043h	67	read	3,4
Phase current way 5	0044h	68	read	3,4
Phase current way 6	0045h	69	read	3,4
Phase current way 7	0046h	70	read	3,4
Phase current way 8	0047h	71	read	3,4
Phase current way 9	0048h	72	read	3,4
Phase current way 10	0049h	73	read	3,4
Phase current way 11	004Ah	74	read	3,4
Phase current way 12	004Bh	75	read	3,4
Phase current way 13	004Ch	76	read	3,4
Phase current way 14	004Dh	77	read	3,4
Phase current way 15	004Eh	78	read	3,4
Phase current way 16	004Fh	79	read	3,4
TM reserved	0050h à 005Fh	80 à 95	read	3,4

Each TM value is a signed value encoded in 2's complement 16-bit word.

Depending on the calibration mode configured (in the identification zone), the value should be interpreted as follows:

"Raw data" mode: This is a value over +/-32767. For current metering, it is always positive and reaches +32767 as the maximum value. To find out the current value, it is necessary to convert :
I = A * val + B.

Example: for a full scale at 400 Amps, a TM value read as 8192 (2000h) corresponds to 8192 * 400 / 32767 + 0 = 100 A.

"Scale conversion" mode: This is the direct value of what is measured. Example: if the equipment measures 387 Amps, the value of the TM read will be +387.

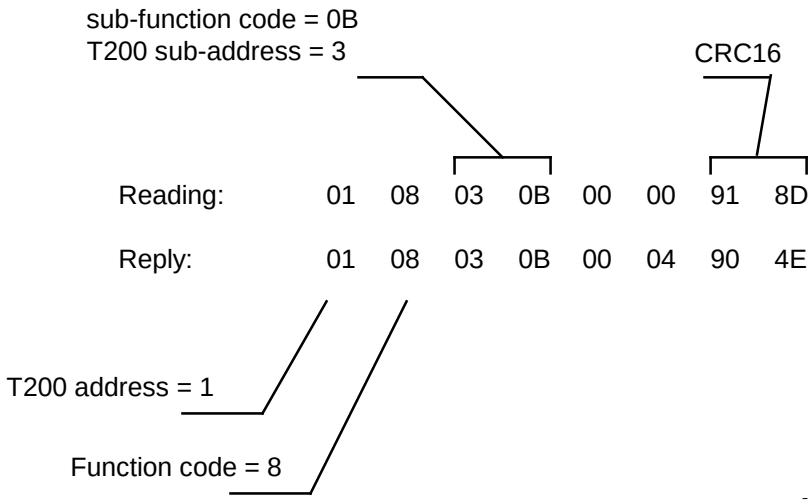
In both operating modes, invalid or non-declared measurements are encoded with the value 8000h (-32768).

Diagnostic counter reading

The sub-function codes recognized by the T200 are:

- 0000h: T200 returns an echo of the request.
- 000Ah: diagnostic count reset.
- 000Bh: reading of the number of frames received with no CRC errors (CPT1).
- 000Ch: reading of the number frames received with CRC errors (CPT2).
- 000Dh: reading of the number of exception replies (CPT3).
- 000Eh: reading of the number of frames addressed to the station (CPT4).
- 000Fh: reading of broadcast requests received (CPT5).

The most significant bit of the sub-function code should be assigned with the sub-address of the T200 to be accessed.



Example of exchanges with MODBUS

Reading of TSs followed by reading of TMs (Address=1, sub-address=0)

```
07:56.29 read  ts    <  01 03 00 34 00 08 05 C2
07:56.30 READ  TS    >> 01 03 10 00 6A 00 00 00 04 00 00 00 00 00 00 00 00 00
                        00 1B 46
07:56.52 read  tm    <  01 03 00 40 00 04 45 DD
07:56.52 READ  TM    >> 01 03 08 00 00 80 00 80 00 80 00 C2 17
```

Reading of TSs followed by reading of TMs (Address=1, sub-address =4)

```
07:56.29 read  ts    <  01 03 04 34 00 08 04 F2
07:56.30 READ  TS    >> 01 03 10 00 6A 00 00 00 04 00 00 00 00 00 00 00 00 00
                        00 1B 46
07:56.52 read  tm    <  01 03 04 40 00 04 44 ED
07:56.52 READ  TM    >> 01 03 08 00 00 80 00 80 00 80 00 C2 17
```

Writing of the broadcast date followed by a reread

```
08:25.48 write date  <  00 10 00 02 00 04 08 00 60 09 1E 0A 05 A0 32 AC 2C
07:56.74 read  date  <  01 03 00 02 00 04 E5 C9
07:56.74 READ  DATE  >> 01 03 08 00 60 09 1E 0A 07 DD A4 B7 B8
```

Opening of TC n°1 followed by reading of TSs (and code CR=01)

```
08:12.21 write tc    <  01 06 00 30 00 01 48 05
08:12.21 WRITE TC    >> 01 06 00 30 00 01 48 05
08:14.69 read  ts    <  01 03 00 34 00 08 05 C2
08:14.69 READ  TS    >> 01 03 10 00 69 00 00 00 04 00 01 00 00 00 00 00 00 00
                        00 55 D7
```

Resetting of diagnostic counters

```
29:04.89 diag.cpt    <  01 08 FA 0A 00 00 F0 D1
29:04.90 DIAG.CPT    >> 01 08 FA 0A 00 00 F0 D1
```

Event reading :

Request :	**01**	**03**	**00**	**0F**	**00 01**	**B4 C9**
				Event addres	*1 word*	*CRC16*
Reply in case of no event :	**01**	**03**	**02**	**XX**	**00**	**XX XX**
			2 bytes	*event tag*	*no event*	*CRC16*

Reply in case of events:

In case of events, the frame contains 4 events. The frame structure is:

Header	Event 1	Event 2	Event 3	Event 4	CRC16
5 bytes	16 bytes	16 bytes	16 bytes	16 bytes	2 bytes

Header :

01	03	42	XX	04
Slave address		*Bytes nb (66 bytes)*	*Event tag*	*Event number In the frame*

If the event is an internal event (local/remote, fault):

Event 1 is the event itself
Event 2 and Event 3 are only 00
Event 4 is a result code (@ 37h)

If the event is a control order from the control centre :

Event 1 is a result code (@37h) with bit 0 set to 1 (telecontrol in progress)
Event 2 and Event 3 are the change of state of close and open position of the switch.
Event 4 is a result code (@37h) with bit 0 reset to 0

Event :

08 00	XX XX	00 00	00 0X	00 63 08 0C OE 12 91 DC
Always 08 00	Bit address 03 97 (word 39h bit 7)	Always 00 00	X=new value 0 : bit is reset 1 : bit is set	YY MM DD HH MM millisec 99 / 08 / 12 14:18 44252 ms (44s 252ms)

Example of reply on SW1 close control order at 12th August 1999 10:39:09 510

```
01 03 42 13 04
08 00 03 70 00 00 00 01 00 63 08 0C OE 27 0C 58  Control in progress
08 00 03 41 00 00 00 01 00 63 08 0C OE 27 0C B2  SW1 close = 1
08 00 03 40 00 00 00 00 00 63 08 0C OE 27 0C B2  SW1 open = 0
08 00 03 70 00 00 00 00 00 63 08 0C OE 27 18 74  End of control
C2 78
```

Report by exception with a modem

When an indication configured as an alarm changes of state, T200 initiates an alarm cycle by dialling-up the main phone number after the ‘’dial-up delay time / first attempt’’.

Two cases can occure:

1 - The telecontrol center system doesn’t answer:

T200 dial-up again the ‘’main’’ phone number after the ‘’dial-up delay time / second attempt’’ and eventually try again after the ‘’dial-up delay time / third attempt’’.

If the 3 attempts fail, T200 starts agin a new sequence with the ‘’standby’’ phone number.

2 - The telecontrol center system answer :

The telecontrol center system send a broadcast message (Slave address = 0) and the function code = 0.

T200 send back an exception message with its address, function code 0 with most significant bit set to 1 and the exception code filled with the sub-address.

The telecontrol center system can then initiate a standard MODBUS Master/Slave communuication.

Example of an alarm followed by TS reading (Address=1, sub-address=4)
(Frame displayed with the MODBUS analyser function of the COMMS card)

```
98/06/12 11:17:06.20 Alarm 1, delay = 1s...
98/06/12 11:17:07.22 Call in progress... "122"
98/06/12 11:17:30.48 Connected, calling mode "CONNECT 9600"
98/06/12 11:17:33.80 address     <  00 00 01 B0
98/06/12 11:17:33.80 ADDRESS     >> 01 80 04 40 03
98/06/12 11:17:44.74 read  ts    <  01 03 04 34 00 08 04 F2
98/06/12 11:17:44.74 READ  TS    >> 01 03 10 00 9A 00 00 00 04 00
                                    00 00 00 00 40 00 00 00 00 EA CD
```

Report by exception without any modem

This function allows T200 to report an alarm to the master when :

- The link between T200 / Master is multipoint (permanent link, radio, optical fiber ...).
- The Master doesn't pool T200 all the time.

In this case configuration of T200 in the comms parameter menu is :

Modem : **Direct**

Alarm message enabled : **yes**

Then T200 can report an alarm by exception (modification of status, fault detection …)

- T200 transmits spontaneously an exception.

Slave number	00h	Sub-address	CRC16
1 byte	1 byte	1 byte	2 byte

- The master then must read tables and events from the T200 which transmits spontaneously an exception.
- If the master doesn't reply by a reading of table, T200 has no transmits again the exception message after 1, 2, 5, 10, 10, ... minutes.
- T200 transmits this exception with a collision avoidance mechanism .

Select before execute

This function allows to send first a select message before the control message.

- First writing message : Select.
- Second writting message :' "Execute.

Case of "Writting bit" (function n°5) :

- Message "Select" : bit = "0".
- Message "Execute " : bit = "1".

Case of "Writting word" (function n°6) :

- Message "Select" : the word consists of all the bit = "1". Except the bit of the control which is set to "0".
- Message "Execute " : normal control proceedings : the word consists of all the bit = "0". Except the bit of the control which is set to "1".

The control is operate by the equipment only after reception of Select and Execute.

The Execute must be received less than 20 seconds after the Select.

In case of failure, an exception reply (03 = incorrect data) is replied to the master.

Appendix

MODBUS protocol

MODBUS is a master - slave protocol.

It is used to read or write one or more words (16 bits), as well as diagnostic counters.

Functions available:

- **1**: read n output bits.
- **2**: read n input bits.
- **3**: read n output words.
- **4**: read n input words.
- **5**: write a bit.
- **6**: write a word.
- **8**: read diagnostic counters.
- **16**: write several words.

Exchanges are carried out at the master's initiative and comprise a request from the master followed by the reply from the slave. The master's requests are addressed to a slave identified by its number in the first byte of the frame or else addressed to all the slaves (broadcast).

Broadcast commands are necessarily write commands. No reply is transmitted by the slaves.

Structure of frames exchanged

All the frames exchanged (request and reply) have the same structure:

Slave number	function code	data zone	check zone CRC16

Each message or frame contains 4 types of information:

- slave number (1 byte): it specifies the receiving equipment (0 to FFh). If it is equal to zero, the request concerns all the slaves (broadcast) and there is no reply message.
- function code (1 byte): it is used to select a command (read, write...) and check that the reply is correct.
- data zone (n bytes): it contains the parameters linked to the function.
- check zone (2 bytes): it is used to detect transmission errors.

Please note that words (2 bytes = 16 bits) are always written as high-order bits to low-order bits, with the exception of the CRC16 which is written as least significant bit, most significant bit.

Synchronization of exchanges

Any character that is received after a silence of more than 3 characters is considered as the beginning of a frame. A silence in the line equal to at least 3 characters should be respected between two frames.

Example: at 9600 bauds, the time is equal to approximately 3 milliseconds.

Checking of messages received by the slave

When the slave receives a frame, it checks the following, in order: CRC16, slave number, function code and function parameters.

■ If the CRC16 or the slave number are incorrect, the slave does not reply.

■ If the CRC16 and the slave number are correct, but the function code or parameters are not valid, the slave transmits an exception reply.

■ If the CRC16, slave number, function code and parameters are correct, the slave replies to the master's request.

Exception reply transmitted by the slave

Slave number	function code received with MSB set to 1	Exception code 01 unknown function code 02 incorrect address 03 incorrect data	CRC16
1 byte	1 byte	1 byte	2 bytes

Appendix

Read N bits: functions n°1 and 2

Function 1: read output bits.
Function 2: read input bits.

Request

Slave number	1 or 2	address of 1st bit (MSB+LSB)	number of bits	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Reply

Slave number	1 or 2	number of bytes read	1st byte read		last byte read	CRC16
1 byte	1 byte	1 byte	2 bytes	N bytes	2 bytes	2 bytes

Example

Reading of 16 bits, bit address 300h of slave n°1, sub-address 2
Request: `01 01 23 00 00 10 36 42`
Reply:`01 01 02 00 00 B9 FC`

Read N words: functions n°3 and 4

The number of words to be read should be less than or equal to 125.

Function 3: read output words.
Function 4: read input words.

Request

Slave number	3 or 4	address of 1st word (MSB+LSB)	number of words (MSB+LSB)	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Reply

Slave number	3 or 4	number of bytes read	1st word read (MSB+LSB)		last word read (MSB+LSB)	CRC16
1 byte	1 byte	2 bytes	2 bytes		2 bytes	2 bytes

Example

Reading of words 40h to 43h of slave n°1, offset 0
Request: `01 03 00 40 00 04 45 DD`
Reply:`01 03 08 00 00 80 00 80 00 80 00 C2 17`

Appendix

Write a bit: function n°5

Request

Slave number	5	address of bit (MSB+LSB)	bit value	0	CRC16
1 byte	1 byte	2 bytes	1 byte	1 byte	2 bytes

Reply

The reply is an echo of the request indicating that the slave has acknowledged the value contained in the request.

Slave number	5	address of bit (MSB+LSB)	bit value	0	CRC16
1 byte	1 byte	2 bytes	1 byte	1 byte	2 bytes

Example

Writing of bit to 1, bit address 301h of slave n°1, sub-addresst n°2
Request: `01 05 23 01 FF 00 D6 7E`
Reply:`01 05 23 01 FF 00 D6 7E`

Write a word: function n°6

Request

Slave number	6	address of word (MSB+LSB)	value of word (MSB+LSB)	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Reply

The reply is an echo of the request indicating that the slave has acknowledged the value contained in the request.

Slave number	6	address of word (MSB+LSB)	value of word (MSB+LSB)	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Example

Writing of word 30h of slave n°1, offset 0 at the value 0001h
Request: `01 06 00 30 00 01 48 05`
Reply:`01 06 00 30 00 01 48 05`

Read diagnostic counters: function n°8

Each slave is assigned diagnostic counters. There are 5 counters in all per slave. The counters are 16-bit words. When they reach FFFFh, they go back to 0000h.
When a request is sent by the master, the most significant byte in the sub-function code is assigned by the T200 equipment offset to access and the data are at 0000h.
When the slave sends a reply, the data contain the value of the counter concerned.

Request / reply

Slave number	8	sub-function code (MSB+LSB)	data (MSB+LSB)	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

	sub-function code	data
the slave should send the echo of the request	xx00	XXXX
resetting of diagnostic counters	xx0A	0000
reading of total number:		
of frames received with no CRC errors (CPT1)	xx0B	XXXX
of frames received with CRC errors (CPT2)	xx0C	XXXX
of the number of exception replies (CPT3)	xx0D	XXXX
of frames addressed to the station (CPT4) (excluding broadcast)	xx0E	XXXX
of broadcast requests received and correctly executed (CPT5)	xx0F	XXXX

Sub-function n°0 is used to test transmission. The slave sends back the echo of the data received.

Examples

Resetting of counters for slave n°1, offset 0
Request: `01 08 00 0A 00 00 C0 09`
Reply:`01 08 00 0A 00 00 C0 09`

Reading of broadcast requests received (CPT5) for slave n°1, offset 3 (300h in storage space)
Request: `01 08 03 0F 00 00 D0 4C`
Reply:`01 08 03 0F 00 05 10 4F`

Write N consecutive words: function n°16

The number of words to be written is between 1 and 123 and the number of bytes is between 2 and 246.
Words are written in increasing order of addresses.

Request

Slave number	10h	address of 1st word to write	number of words to write	number of bytes to write	values of words to write	CRC16
1 byte	1 byte	2 bytes	2 bytes	1 byte	N bytes	2 bytes

Reply

Slave number	10h	address of 1st word written (MSB+LSB)	number of words written (MSB+LSB)	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

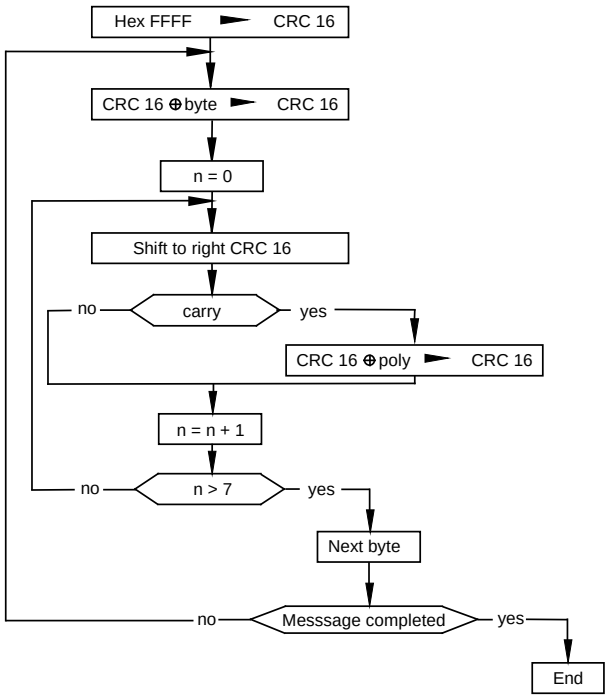
Example

Writing of words 0302h to 0305h of slave n°1, sub-address 3 (addresses 02h to 05h) with the values 0060h, 0A10h, 0B33h, 1662h

Request: `01 10 03 02 00 04 08 00 60 0A 10 0B 33 16 62 96 B3`
Reply: `01 10 03 02 00 04 60 4E`

Appendix

CRC 16 calculation algorithm



n = number of bits of data
poly= CRC16=1010 0000 0000 0001 calculation polynomial

Write CRC 16 calculation in C language

Calculates and gives the CRC16 in the "buf" zone with length "len".

- *buf: pointer of buffer on which the calculations are performed.
- len: length of buffer.

```
unsigned crc16(char *buf, int len)
    {
    #define POLY  0xA001
    char i;
    unsigned crc;

    for (crc = 0xFFFF; len != 0; len --)
        {
        crc ^= *buf ++;
        for (i = 0; i < 8; i ++)
            {
            if (crc & 0x0001)
                crc = (crc >> 1) ^ POLY;
            else
                crc >>= 1;
            }
        }
    return (crc);
    }
```

Communication exchange table T200 - 16 ways

Single remote indications	Word	bit
TSS1 : Phase fault SW 1.	38h	0
TSS2 : Earth fault A SW 1.	38h	1
TSS3 : Phase fault SW 2.	38h	2
TSS4 : Earth fault A SW 2.	38h	3
TSS5 : Phase fault SW 3.	38h	4
TSS6 : Earth fault A SW 3.	38h	5
TSS7 : Phase fault SW 4.	38h	6
TSS8 : Earth fault A SW 4.	38h	7
TSS9 : Earth switch SW 1.	38h	8
TSS10 :Earth switch SW 2.	38h	9
TSS11 :Earth switch SW 3.	38h	10
TSS12 :Earth switch SW 4.	38h	11
TSS13 :Earth fault B SW 1.	38h	12
TSS14 :Earth fault B SW 2.	38h	13
TSS15 :Earth fault B SW 3.	38h	14
TSS16 :Earth fault B SW 4.	38h	15
TSS17 :Digital input 1.	39h	0
TSS18 :Digital input 2.	39h	1
TSS19 :Volt. presence SW1	39h	2
TSS20 :Volt. presence SW2	39h	3
TSS21 :Volt. presence SW3	39h	4
TSS22 :Volt. presence SW4	39h	5
TSS23 :Local.	39h	6
TSS24 :Im. AC sup OFF.	39h	7
TSS25 :Digital input 3.	39h	8
TSS26 :Charger fault.	39h	9
TSS27 :Battery fault.	39h	10
TSS28 :SW. supply OFF.	39h	11
TSS29 :Del. AC sup. OFF.	39h	12
TSS30 :Digital input 4.	39h	13
TSS31 :Digital input 5.	39h	14
TSS32 :Digital input 6.	39h	15

Single remote indications	Word	bit
TSS33 :Phase fault SW 5	3Ah	0
TSS34 :Earth fault A SW 5	3Ah	1
TSS35 :Phase fault SW 6	3Ah	2
TSS36 :Earth fault A SW 6	3Ah	3
TSS37: Phase fault SW 7	3Ah	4
TSS38: Earth fault A SW 7	3Ah	5
TSS39: Phase fault SW 8	3Ah	6
TSS40: Earth fault A SW 8	3Ah	7
TSS41: Earth switch SW 5	3Ah	8
TSS42 :Earth switch SW 6	3Ah	9
TSS43 :Earth switch SW 7	3Ah	10
TSS44 :Earth switch SW 8	3Ah	11
TSS45 :Earth fault B SW 5	3Ah	12
TSS46 :Earth fault B SW 6	3Ah	13
TSS47 :Earth fault B SW 7	3Ah	14
TSS48 :Earth fault B SW 8	3Ah	15
TSS49 :Digital input 7	3Bh	0
TSS50 :Digital input 8	3Bh	1
TSS51 :Volt. Presence SW5	3Bh	2
TSS52 :Volt. Presence SW6	3Bh	3
TSS53 :Volt. Presence SW7	3Bh	4
TSS54 :Volt. Presence SW8	3Bh	5
TSS55 :Reserved	3Bh	6
TSS56 :Reserved	3Bh	7
TSS57 :Digital input 9	3Bh	8
TSS58 :Reserved	3Bh	9
TSS59 :Reserved	3Bh	10
TSS60 :Reserved	3Bh	11
TSS61 :Reserved	3Bh	12
TSS62 :Digital input 10	3Bh	13
TSS63 :Digital input 11	3Bh	14
TSS64 :Digital input 12	3Bh	15

Single remote indications	Word	bit
TSS65 :Phase fault SW 9	3Ch	0
TSS66 :Earth fault A SW 9	3Ch	1
TSS67 :Phase fault SW 10	3Ch	2
TSS68 :Earth fault A SW 10	3Ch	3
TSS69: Phase fault SW 11	3Ch	4
TSS70: Earth fault A SW 11	3Ch	5
TSS71: Phase fault SW 12	3Ch	6
TSS72: Earth fault A SW 12	3Ch	7
TSS73: Earth switch SW 9	3Ch	8
TSS74 :Earth switch SW 10	3Ch	9
TSS75 :Earth switch SW 11	3Ch	10
TSS76 :Earth switch SW 12	3Ch	11
TSS77 :Earth fault B SW 10	3Ch	12
TSS78 :Earth fault B SW 11	3Ch	13
TSS79 :Earth fault B SW 12	3Ch	14
TSS80 :Earth fault B SW 13	3Ch	15
TSS81 :Digital input 13	3Dh	0
TSS82 :Digital input 14	3Dh	1
TSS83 :Volt. presence SW9	3Dh	2
TSS84 :Volt. presence SW10	3Dh	3
TSS85 :Volt. presence SW11	3Dh	4
TSS86 :Volt. presence SW12	3Dh	5
TSS87 :Reserved	3Dh	6
TSS88 :Reserved	3Dh	7
TSS89 :Digital input 15	3Dh	8
TSS90 :Reserved	3Dh	9
TSS91 :Reserved	3Dh	10
TSS92 :Reserved	3Dh	11
TSS93 :Reserved	3Dh	12
TSS94 :Digital input 16	3Dh	13
TSS95 :Digital input 17	3Dh	14
TSS96 :Digital input 18	3Dh	15

Single remote indications	Word	bit
TSS97 :Phase fault SW 13	3Eh	0
TSS98 :Earth fault A SW 13	3Eh	1
TSS99 :Phase fault SW 14	3Eh	2
TSS100:Earth fault A SW 14	3Eh	3
TSS101: Phase fault SW 15	3Eh	4
TSS102: Earth fault A SW 15	3Eh	5
TSS103: Phase fault SW 16	3Eh	6
TSS104: Earth fault A SW 16	3Eh	7
TSS105: Earth switch SW 13	3Eh	8
TSS106:Earth switch SW 14	3Eh	9
TSS107:Earth switch SW 15	3Eh	10
TSS108:Earth switch SW 16	3Eh	11
TSS109:Earth fault B SW 13	3Eh	12
TSS110:Earth fault B SW 14	3Eh	13
TSS111:Earth fault B SW 15	3Eh	14
TSS112:Earth fault B SW 15	3Eh	15
TSS113:Digital input 19	3Fh	0
TSS114:Digital input 20	3Fh	1
TSS115:Volt.presence SW13	3Fh	2
TSS116:Volt.presence SW14	3Fh	3
TSS117:Volt.presence SW15	3Fh	4
TSS118:Volt.presence SW16	3Fh	5
TSS119:Reserved	3Fh	6
TSS120:Reserved	3Fh	7
TSS121:Digital input 21	3Fh	8
TSS122:Reserved	3Fh	9
TSS123:Reserved	3Fh	10
TSS124:Reserved	3Fh	11
TSS125:Reserved	3Fh	12
TSS126:Digital input 22	3Fh	13
TSS127:Digital input 23	3Fh	14
TSS128:Digital input 24	3Fh	15

Single remote indications	Word	bit
CR0Remote ctrl in progress	37h	0
CR1Remote control fault	37h	1
CR2Internal fault (serious)	37h	2
CR3SW posit. not reached	37h	3
CR4T200 in Local	37h	4
CR5Fail for unknown reason	37h	5

Measure	Word
Phase current switch 1	40h
Phase current switch 2	41h
Phase current switch 3	42h
Phase current switch 4	43h
Phase current switch 5	44h
Phase current switch 6	45h
Phase current switch 7	46h
Phase current switch 8	47h
Phase current switch 9	48h
Phase current switch 10	49h
Phase current switch 11	4Ah
Phase current switch 12	4Bh
Phase current switch 13	4Ch
Phase current switch 14	4Dh
Phase current switch 15	4Eh
Phase current switch 16	4Fh

Events (*)	Word
Exchange word	0Fh
Event 1	10h-17h
Event 2	18h-1Fh
Event 3	20h-27h
Event 4	28h-2Fh

Double remote indications	Word	bit
TSD1 :Switch 1 open	34h	0
Switch 1 close	34h	1
TSD2 :Switch 2 open	34h	2
Switch 2 close	34h	3
TSD3 :Switch 3 open	34h	4
Switch 3 close	34h	5
TSD4 :Switch 4 open	34h	6
Switch 4 close	34h	7
TSD5 :Switch 5 open	34h	8
Switch 5 close	34h	9
TSD6 :Switch 6 open	34h	10
Switch 6 close	34h	11
TSD7 :Switch 7 open	34h	12
Switch 7 close	34h	13
TSD8 :Switch 8 open	34h	14
Switch 8 close	34h	15
TSD9 :Switch 9 open	35h	0
Switch 9 close	35h	1
TSD10:Switch 10 open	35h	2
Switch 10 close	35h	3
TSD11:Switch 11 open	35h	4
Switch 11 close	35h	5
TSD12:Switch 12open	35h	6
Switch 12 close	35h	7
TSD13:Switch 13 open	35h	8
Switch 13 close	35h	9
TSD14:Switch 14 open	35h	10
Switch 14 close	35h	11
TSD15:Switch 15 open	35h	12
Switch 15 close	35h	13
TSD16:Switch 16 open	35h	14
Switch 16 close	35h	15
TSD 18 : Reserved (1)	36h	2
Reserved (0)	36h	3

Double remote control	word	
TCD1 :Switch 1 open	30h	0
Switch 1 close	30h	1
TCD2 :Switch 2 open	30h	2
Switch 2 close	30h	3
TCD3 :Switch 3 open	30h	4
Switch 3 close	30h	5
TCD4 :Switch 4 open	30h	6
Switch 4 close	30h	7
TCD5 :Switch 5 open	30h	8
Switch 5 close	30h	9
TCD6 :Switch 6 open	30h	10
Switch 6 close	30h	11
TCD7 :Switch 7 open	30h	12
Switch 7 close	30h	13
TCD8 :Switch 8 open	30h	14
Switch 8 close	30h	15
TCD9 :Switch 9 open	31h	0
Switch 9 close	31h	1
TCD10:Switch 10 open	31h	2
Switch 10 close	31h	3
TCD11:Switch 11 open	31h	4
Switch 11 close	31h	5
TCD12:Switch 12open	31h	6
Switch 12 close	31h	7
TCD13:Switch 13 open	31h	8
Switch 13 close	31h	9
TCD14:Switch 14 open	31h	10
Switch 14 close	31h	11
TCD15:Switch 15 open	31h	12
Switch 15 close	31h	13
TCD16:Switch 16 open	31h	14
Switch 16 close	31h	15
TCD 18 : Reset FPI	32h	2
Reserved	32h	3

Other	word
Version	00h
Status	01h
Clock synchronisation	02h-05h
Test area	06h-0Eh

Automatism (TSD)	Word	bit
TSD21 :Auto CPU1 OFF	36h	8
:Auto CPU1 ON	36h	9
TSD22 :Auto CPU2 OFF	36h	10
:Auto CPU2 ON	36h	11
TSD23 :Auto CPU3 OFF	36h	12
:Auto CPU3 ON	36h	13
TSD24 :Auto CPU4 OFF	36h	14
:Auto CPU4 ON	36h	15

Automatism (TCD)	Word	bit
TCD21 :Auto CPU1 OFF	32h	8
:Auto CPU1 ON	32h	9
TCD22 :Auto CPU2 OFF	32h	10
:Auto CPU2 ON	32h	11
TCD23 :Auto CPU3 OFF	32h	12
:Auto CPU3 ON	32h	13
TCD24 :Auto CPU4 OFF	32h	14
:Auto CPU4 ON	32h	15

(*) The 200 events stored in memory are read through a 4 events buffer

Communication exchange table T200 - 4 ways

Double remote indications		wor	bit
TSD1 :	Switch 1 open	34h	0
	Switch 1 closed	34h	1
TSD2 :	Switch 2 open	34h	2
	Switch 2 closed	34h	3
TSD3 :	Switch 3 open	34h	4
	Switch 3 closed	34h	5
TSD4 :	Switch 4 open	34h	6
	Switch 4 closed	34h	7
TSD 18 :	Reserved: value = 1	36h	2
	Reserved: value = 0	36h	3

Single remote indications			
CR0 :	Remote control in progress	37h	0
CR1 :	Remote control fault	37h	1
CR2 :	Internal fault (serious)	37h	2
CR3 :	Switch position not reached	37h	3
CR4 :	Failure due to T200 in local	37h	4
CR5 :	Failure due to unknown reason	37h	5
TSS1 :	Phase fault SW 1.	38h	0
TSS2 :	Earth fault A SW 1.	38h	1
TSS3 :	Phase fault SW 2.	38h	2
TSS4 :	Earth fault A SW 2.	38h	3
TSS5 :	Phase fault SW 3.	38h	4
TSS6 :	Earth fault A SW 3.	38h	5
TSS7 :	Phase fault SW 4.	38h	6
TSS8 :	Earth fault A SW 4.	38h	7
TSS9 :	Earth switch SW 1.	38h	8
TSS10 :	Earth switch SW 2.	38h	9
TSS11 :	Earth switch SW 3.	38h	10
TSS12 :	Earth switch SW 4.	38h	11
TSS13 :	Earth fault B SW 1.	38h	12
TSS14 :	Earth fault B SW 2.	38h	13
TSS15 :	Earth fault B SW 3.	38h	14
TSS16 :	Earth fault B SW 4.	38h	15
TSS17 :	Digital input 1.	39h	0
TSS18 :	Digital input 2.	39h	1
TSS19 :	Volt. Presence SW1	39h	2
TSS20 :	Volt. Presence SW2	39h	3
TSS21 :	Volt. Presence SW3	39h	4
TSS22 :	Volt. Presence SW4	39h	5
TSS23 :	Local.	39h	6
TSS24 :	Immediate AC supply OFF.	39h	7
TSS25 :	Digital input 3.	39h	8
TSS26 :	Charger fault.	39h	9
TSS27 :	Battery fault.	39h	10
TSS28 :	Switchgear supply OFF.	39h	11
TSS29 :	Delayed AC supply OFF.	39h	12
TSS30 :	Digital input 4.	39h	13
TSS31 :	Digital input 5.	39h	14
TSS32 :	Digital input 6.	39h	15

Double remote control		word	bit
TCD1 :	opening Switch 1	30h	0
	closing Switch 1	30h	1
TCD2 :	opening Switch 2	30h	2
	closing Switch 2	30h	3
TCD3 :	opening Switch 3	30h	4
	closing Switch 3	30h	5
TCD4 :	opening Switch 4	30h	6
	closing Switch 4	30h	7
TCD18 :	Fault detector reset (value = 0)	32h	2
	Fault detector reset (value = 1)	32h	3

Remote measurements	
Phase current channel 1	40h
Phase current channel 2	41h
Phase current channel 3	42h
Phase current channel 4	43h

Events	
Exchange word	0Fh
Event 1	10h to 17h
Event 2	18h to 1Fh
Event 3	20h to 27h
Event 4	28h to 2Fh

Miscellaneous	
Version	00h
Status	01h
Clock synchronisation	02h to 05h
Test zone	06h to 0Eh

Automatism (TSD)			
TSD21 :	Auto CPU1 OFF	36h	8
	Auto CPU1 ON	36h	9

Automatism (TCD)			
TCD21 :	Auto CPU1 OFF	32h	8
	Auto CPU1 ON	32h	9

Communication exchange table T200 P

Double remote indications		wor	bit
TSD1 :	Switch open	34h	0
	Switch closed	34h	1
		34h	2
		34h	3
		34h	4
		34h	5
TSD4 :	automatism OFF	34h	6
	Automatism ON	34h	7
TSD 18 :	Reserved: value = 1	36h	2
	Reserved: value = 0	36h	3

Single remote indications			
CR0 :	Remote control in progress	37h	0
CR1 :	Remote control fault	37h	1
CR2 :	Internal fault (serious)	37h	2
CR3 :	Switch position not reached	37h	3
CR4 :	Failure due to T200 in local	37h	4
CR5 :	Failure due to unknown reason	37h	5
TSS1 :	Phase fault SW 1.	38h	0
TSS2 :	Earth fault A SW 1.	38h	1
		38h	2
		38h	3
		38h	4
		38h	5
		38h	6
		38h	7
		38h	8
		38h	9
		38h	10
		38h	11
		38h	12
		38h	13
		38h	14
		38h	15
TSS17 :	Digital input 1.	39h	0
TSS18 :	Digital input 2.	39h	1
TSS19 :	Digital input 3.	39h	2
		39h	3
		39h	4
		39h	5
TSS23 :	Local.	39h	6
TSS24 :	Immediate AC supply OFF.	39h	7
		39h	8
TSS26 :	Charger fault.	39h	9
TSS27 :	Battery fault.	39h	10
TSS28 :	Switchgear supply OFF.	39h	11
TSS29 :	Delayed AC supply OFF.	39h	12
TSS30 :	Operated	39h	13
		39h	14
		39h	15

Double remote control		word	bit
TCD1 :	opening Switch 1	30h	0
	closing Switch 1	30h	1
		30h	2
		30h	3
		30h	4
		30h	5
TCD4 :	automatism OFF	30h	6
	Automatism ON	30h	7
TCD18 :	Fault detector reset (value = 0)	32h	2
	Fault detector reset (value = 1)	32h	3

Remote measurements	
Phase current	40h
Measurement of voltage	41h
	42h
	43h

Events	
Exchange word	0Fh
Event 1	10h to 17h
Event 2	18h to 1Fh
Event 3	20h to 27h
Event 4	28h to 2Fh

Miscellaneous	
Version	00h
Status	01h
Clock synchronisation	02h to 05h
Test zone	06h to 0Eh

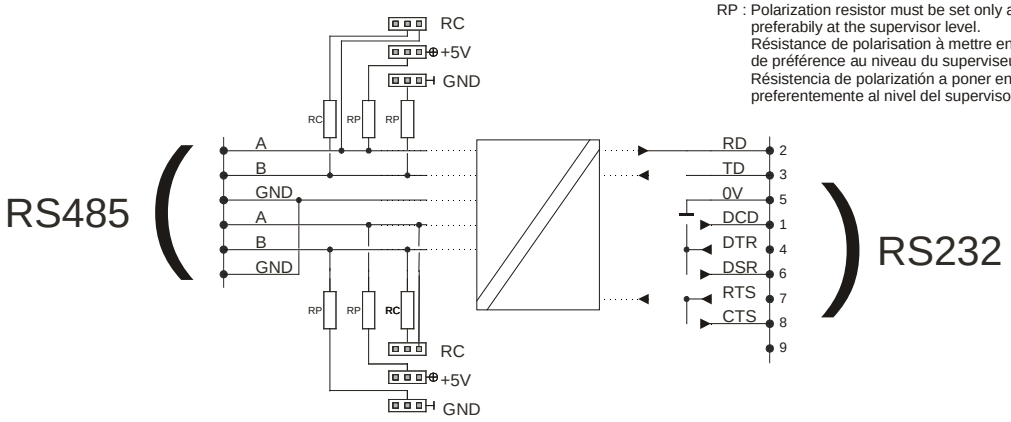
RS 485 network

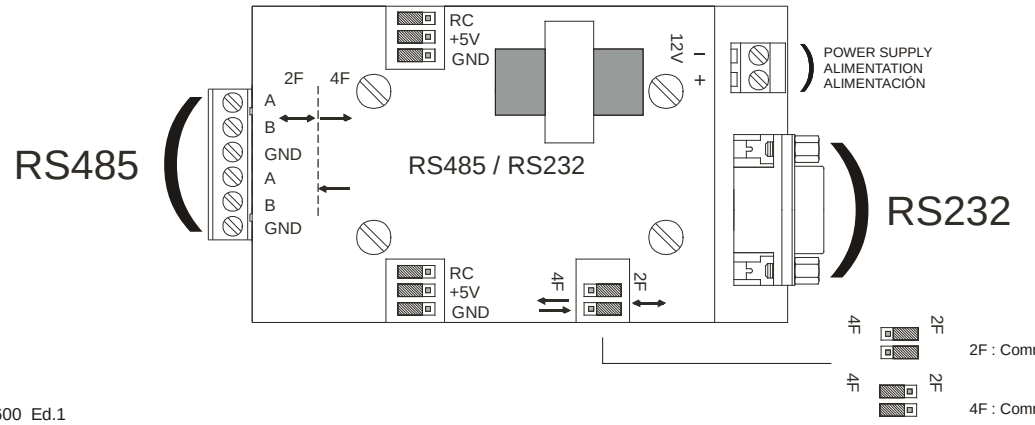
A optinal board (Réf 0600) is availaible with RS 485 type in compliabce with the EIA RS 485 standard.

Connexion to RS485 transmission network
Connection au réseau de transmission RS485
Conexión a una red de transmisión RS485

RC : Impedance matching resistor is compulsory one at each end of the network.
Résistance de boucle à mettre en service à chaque extrémité du réseau.
Résistencia de bucle a poner en servicio a cada extremidad de la red.

RP : Polarization resistor must be set only at one point of the network, preferabily at the supervisor level.
Résistance de polarisation à mettre en service en un seul point du réseau, de préférence au niveau du superviseur.
Résistencia de polarizatión a poner en servicio en un solo punto de la red, preferentemente al nivel del supervisor.





2F : Communication 2 wires, 2 fils, 2 hilos (standard)

4F : Communication 4 wires, 4 fils, 4 hilos

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Operating problems

In case of problems, it is advisable to connect the devices to the RS 485 network one by one.
Make sure that the master sends frames to the equipment concerned.

Points to be checked

Check:
- the distributed voltage V+ (12V),
– the polarization is in one location only,
- the impedance matching is set up at the ends and only at the ends of the RS 485 network,
- the cable use is the one advised,
- the L+ or L- lines are not earthed,
- the earthing of all the cabled shielding.

Use an oscilloscope to check the forum of the signals:
Transmit voltage
Level 0 +1.5V to +5V
Level 1 -1.5V to –5V
reception voltage threshold
Level 0 >+0.2V
Level 1 <-0.2V

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