REMOTE INPUT OUTPUT INTERFACE

TES

TESIS 32 User's Manual

P DOC TES 002 E Version 1.0

Thank you for purchasing a Remote I/O Terminal of our TES product line
This equipment has been developed and manufactured by using the most advanced methods and techniques and we are confident that it will work to your entire satisfaction.

This TES complies with the following standards:

NFC 63 850
IEC 801 2/3/4
Military: GAM EG 13 Book 63

This manual details the product parameters settings with Tesis32 software.
Please read it carefully before you operate the equipment for the first time.

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CONTENTS

1 General overview

This manual contains all the necessary information for.

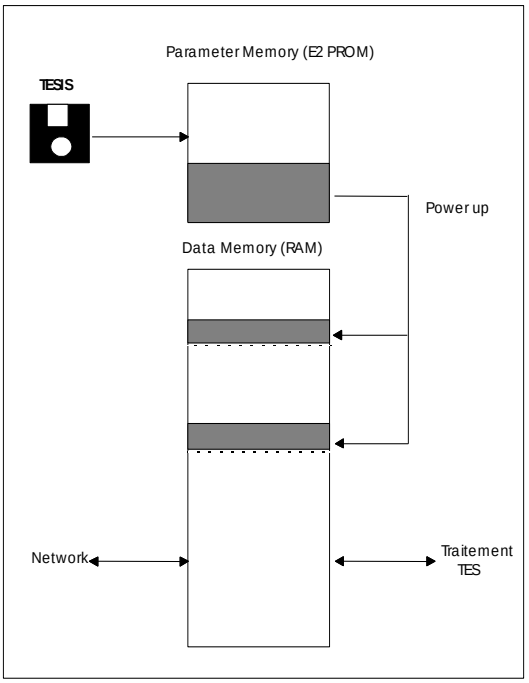
- the use of TESIS32 workbench software
- all pre-programmed TES functions: how to set all parameters.
- the TES Modbus slave memory map.

Note: The implementation manual is detailed in P DOC TES 002 E manual available on our web site: http://www.leroy-automation.fr

In the Modbus/Jbus network, the TES acts as a slave under the control of a master, which can be either a PC or a PLC.
The TES acts as a remote shared memory address, which can be accessed by the master by writing or reading commands.

The memory structure is shared into two parts.
One local data memory that is not saved at power loss, and an E2PROM, which contains configuration parameters. This E2PROM is not accessible by the network; the TESIS software may only modify the data contained.

At power-up parts of these parameters are loaded from E2PROM to the shared working memory (RAM).
This way the parameters can be modified on line (debouncing time, home position, etc...), but if the TES is powered on again it resumes working with the E2PROM parameters instead of those modified on line.



2 TESIS set up

Minimal informatics Configuration: Tesis32 is compatible:
- with Win32 software: Windows 95, 98, 98SE, Me, NT 4.0+, 2000, XP.
- with PC with Intel hardware and processors Pentium or ulterior.

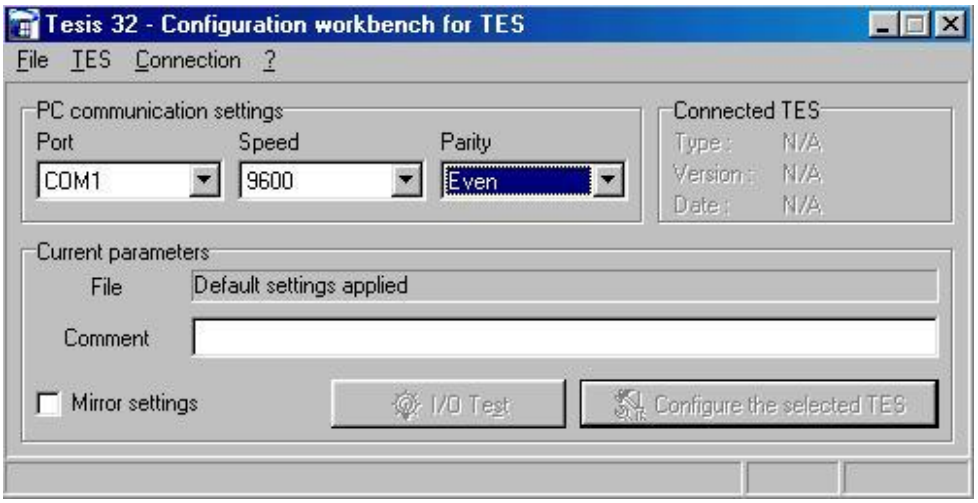
Run **Tesis32setup** and follow instructions.

3 Use of TESIS Workbench

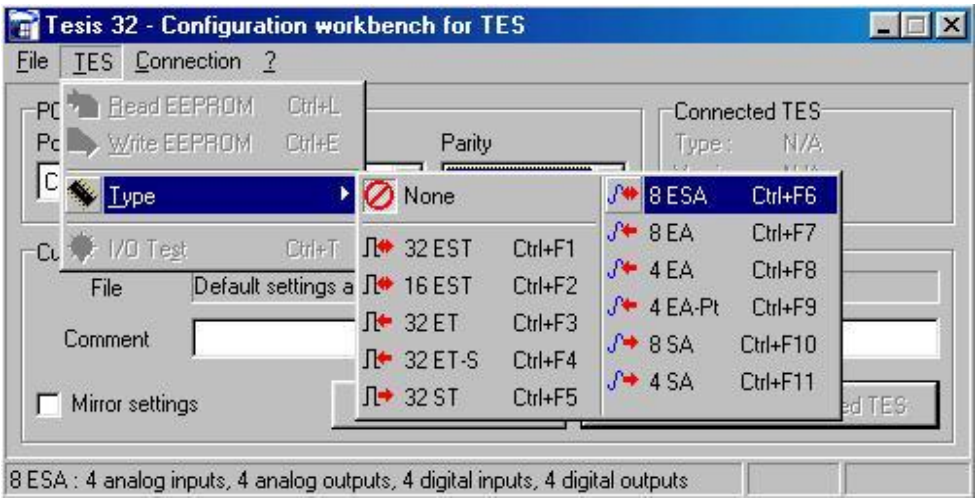
3.1 Common implementation to all TES

3.1.1 Running TESIS alone

Run TESIS32 with the Windows command « Start/ Program/ Leroy Automation/ Tesis / Tesis 32 »



To create a TES configuration, choose the menu TES / Type / « TES to parameter »



3.1.2 Running TESIS with a connected TES–PRM terminal

Connect the TES to a PC with the following cable:

PC SubD	RS232	TES SubD 9 points
3	-------->	9
2	<--------	4
5	---------	5

Do a bridge between Prm (Parameter) terminal and terminal 0V
Power on the TES with 24V.
Green leds Pwr, Run and Prm are on.
Led Wdg (red) is down.

Run TESIS32 with « Start/ Program/ Leroy Automation/ Tesis / Tesis 32 »

To connect you to TES, execute the command « Connection / Connected ».
Several options are available in menu « Connection »:

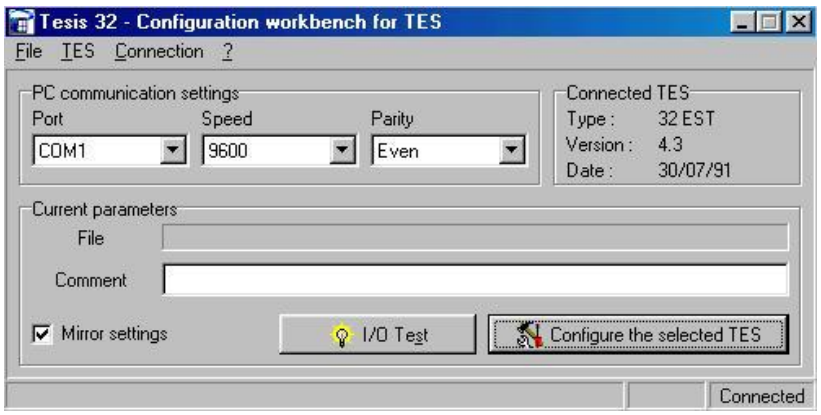
- « Connected »: connected to TES without downloading parameters from connected TES.
- « Refresh »: that command will download settings parameters of connected TES: box « **Mirror settings** » will be checked; this command read TES EEPROM and copy it in your PC RAM memory.
- « Auto-detect »: active the automatic search of TES communication parameters on the port of PC chosen.
- « Auto-connect »: same command than « Refresh » but automatically run at Tesis start up.
- « Default connection »: restore the default RS232 settings (TES in Prm mode)

Prm terminal:
It must be let unconnected in normally running: User settings will be activated.

By connecting Prm terminal to 0V, TES use the default factory settings describe therefore. This operation allows always connecting TESIS workbench to TES.

- RS 232 link: Modbus/Jbus, slave 1, 9600 bauds, 8 bits data, parity even, 1 bit stop.
- RS 422/485 link: Modbus/Jbus, slave 1; 38400 Bauds, 8 bits data, parity even, 1 bit stop, delay time: 100ms
- Outputs fallback position: all outputs at 0.
- Digital Inputs: filtering time: 5 ms.
- Digital Outputs: blinking frequency 1: 1 Hz; blinking frequency 2: 10 Hz
- Analog Inputs: scaling deactivation (values in points between 0 and 1023) and any other thresholds
- Analog Outputs: scaling deactivation (values in points between 0 and 32735) and no fallback positions.

Note 1: When PC communicates with TES, RX 232 and TX 232 leds (reception and transmission) are blinking. If TX 232 doesn't blink, that means that TES don't respond to PC request. Verify the link connection.
Note 2: It can happen that RX 485 led is blinking at the same frequency of exchanges on RS 232 line. Don't worry: RS 485 link is at high impedance in this case, exchanges on RS 232 line lead voltage levels on RS 485 line, but without any effect on TES running.

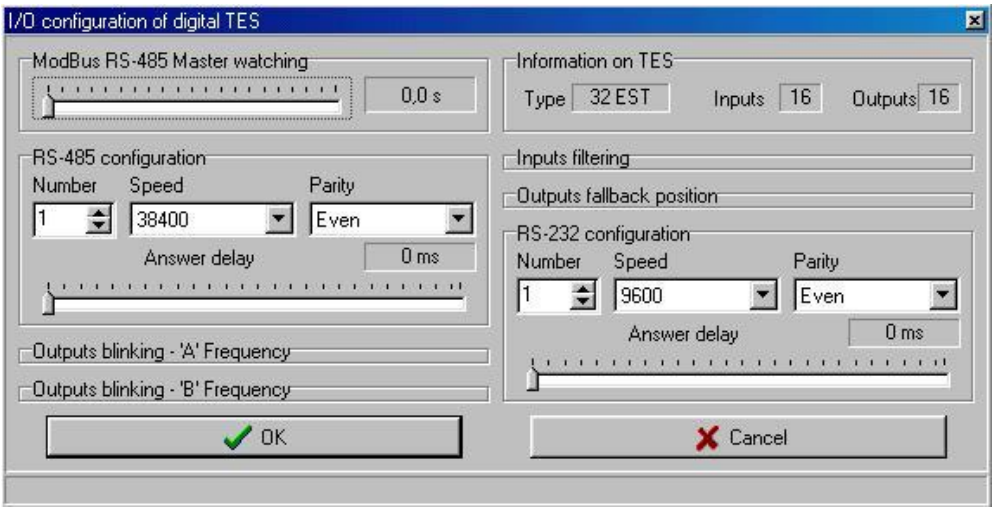


3.1.3 RS485 configuration

After choosing TES type, you can configure

- « RS485 configuration »:
  - TES slave number
  - Transmissions parameters: Speed and parity are parameters; the number of data bits is set at 8 and the number of stop bits is set to 1.
  - Answer delay: it's sometimes necessary to adjust the TES answer delay (typically 1.5ms) when it's connected to PLC that take some time to validate their reception buffer: that bring about Time Out errors on master that "miss" the beginning of TES response frame. In this case, increase « Answer delay » that is by default to 0.

- Time « Modbus RS485 master watching » (Unit: 100ms)
  - If at end of this time (>0), the slave doesn't receive a request, it'll put its outputs in fallback position and led Wdg will blinking.
  - If a watching time other than 0 is set, the « Output fallback position » parameters appear.



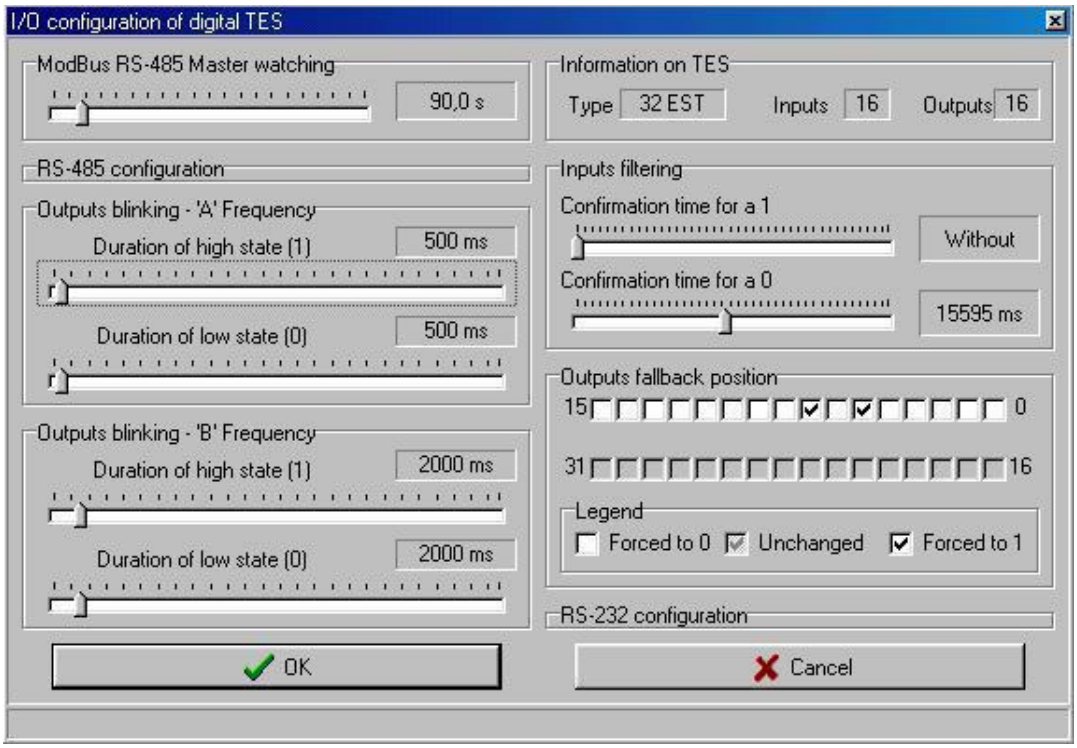
3.1.4 RS232 configuration

You can configure too the RS232 parameters in the«RS232 configuration» window: we advise you to modify this parameters only if TES must communicate via the RS232 with a modbus master; in this case to establish the connection with Tesis Workbench, a bridge between Prm terminal and 0V will be necessary. Parameters modifiable are:

- slave number
- Transmissions parameters: Speed and parity are parameters; the number of data bits is set at 8 and the number of stop bits is set to 1.
- Answer delay: like for the RS485? it's sometimes necessary to adjust the TES answer delay (typically 1.5ms) when it's connected to PLC that take some time to validate their reception buffer: that bring about Time Out errors on master that "miss" the beginning of TES response frame. In this case, increase « Answer delay » that is by default to 0.

4 TES Functions: setting and use

4.1 Digital Input/ Output



4.1.1 Inputs filtering

From directs inputs, TES create filtered inputs bits.
Filtered inputs bits are bits that are changing in a new state if the last state has been confirmed during at least X ms.
Settings: X duration is a parameter between 0 and 32765 ms by steps of 5 ms
Use: See TES modbus memory mapping.

4.1.2 Memorized Inputs

Function: For each input, at each state change, TES increase an internal counter.
Following a reading master request, if the counter is >0, TES reverse the bit « memorized input » and decrease the counter. If the counter =0, TES don't reverse the bit. TES resituate at each master request (and above all at master speed) the state change succession that happens during the eventually communication break.
Parameters: any. Function always active.
Use: See TES memory map.

4.1.3 Rising edge and falling edge inputs counters

TES count the rising edge and falling edge for each input in a 32 bits counter and put those counters in the memory map. Modbus master can reset counters with a Modbus writing function.
Parameters: any. Function always active.
Use: See TES memory map.

4.1.4 States inputs durations

For each input, TES chronometer the states duration in 1/10s on 32 bits data.
TES furnished:

- duration of last state at 1 or state at 1 in progress.
- duration of last state at 0 or of state at 0 in progress.
- duration cumulated of states at 1 since the last master reset to 0 or the last power on.
- duration cumulated of states at 0 since the last master reset to 0 or the last power on.

Parameters: any. Function always active.

Use: See TES memory map.

4.1.5 Safety Inputs

TES 32EST-S allows the wiring broken or short circuit detection between sensor and terminal input.
Wiring: see TES User's manual P DOC TES 001 E
TES furnish for each wiring control input, one bit state and one bit default; it allows to detect 4 states: Normally open, Normally close, short circuit, open circuit.

Parameters: it's possible to use one safety input as a normal input.
Use: see memory map

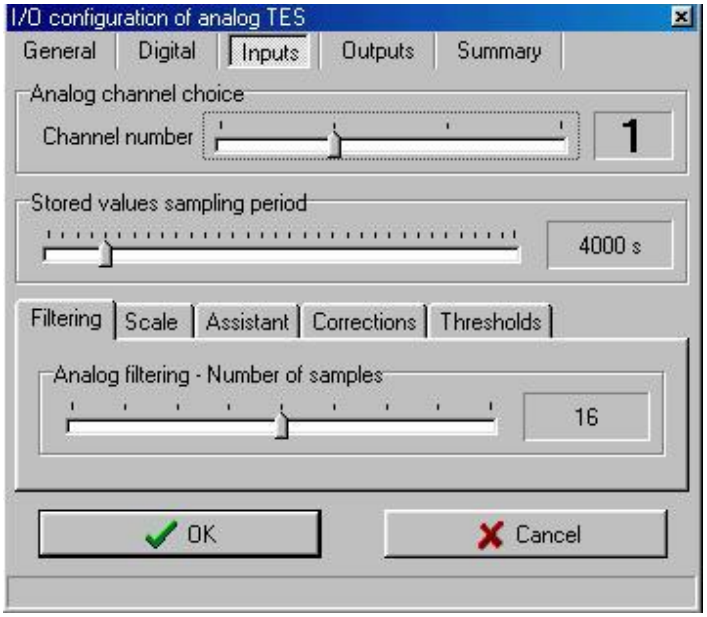
4.1.6 Output blinking

Digital outputs can be set in blinking mode: 2 frequencies are available: frequency A and frequency B.
Parameters: For each frequency, you can parameter the duration to 1 and the duration to 0 of period per step of 5ms.
Use: Function always active. The choice between « not blinking », « blinking to frequency A », and «blinking to frequency B» is made by the Modbus master with the command of 2 bits in the Modbus memory mapping.

4.1.7 Outputs fallback

- This function depends on the supervising of the master activity.
    - If at end of the programmed duration (>0), the slave don't see any line activity, it set its outputs fallback mode and the Wdg led will be blinking.
    - If a supervising duration other than 0, is set, the« outputs fallback position » window appears.
    - Fallback position: forced to 0 (OFF), forced to 1 (ON), unchanged.

4.2 Analog inputs



TES analog parameters screen propose:

- To choose among 4 or 8 channels depending on model
- To choose the sampling period of the 120 last values.
- To filter inputs « Filtering »
- To do the scaling operation « scale »
- To help you how to find the right scale values
- To correct the input values « corrections »
- To set the thresholds values « Thresholds » and to associate digital outputs.

4.2.1 Sampling period

TES acquire a new analog input every 8ms. Then for one input, a new sample is available every 32ms on a 4 analog channels TES and every 64 ms for an 8 analog inputs channels.

4.2.2 Measuring storage

TES store in a FIFO structure the last 120 filtered and scaled values for each input. This storage isn't saved in case of power down.

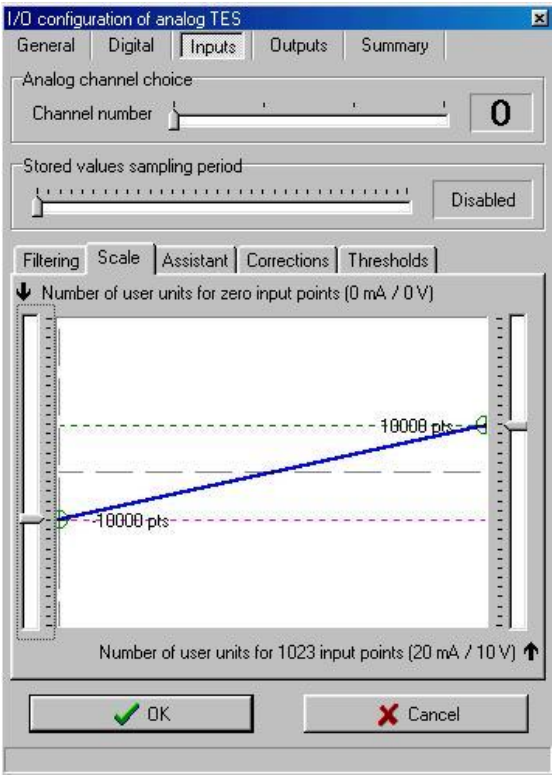
Parameters: channel sampling period (1 per channel) per step of 5ms
Use: Function always active. See TES analog.

4.2.3 Inputs filtering

One filtered input is an average on the last N values.
If EA is the instantaneous analog input, i the number of samples, the value of an analog filtered input is calculated as follow:
X = (EAi + EA(i+1) + ... + EA(i+N-1)) / N
Parameters: the number N can take the values 2,4,8,16,32,64,128 or 256 (high filtration)

4.2.4 Scaling – Conversion

Scaling allows to convert points values of inputs (between 0 and 1023 points: initial value) in an other final value (between - 32768 and +32767).
More exactly, TES propose in its memory map the hexadecimal corresponding value.

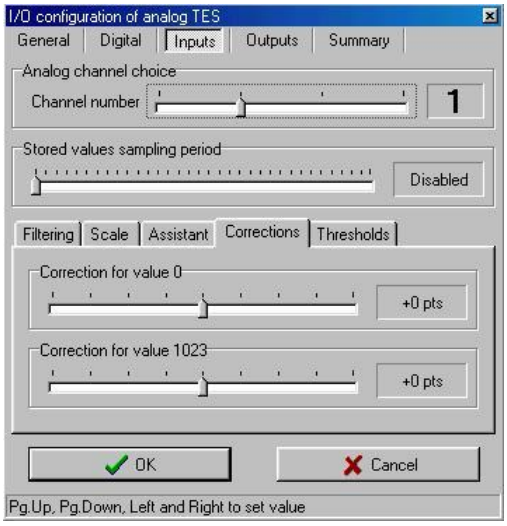


4.2.5 Measure correction

The function « activate scaling » allows to have an access to the screen Corrections.

Those parameters allow to correct in number of points uncertainty due to components (0,5% max) of inputs and outputs.

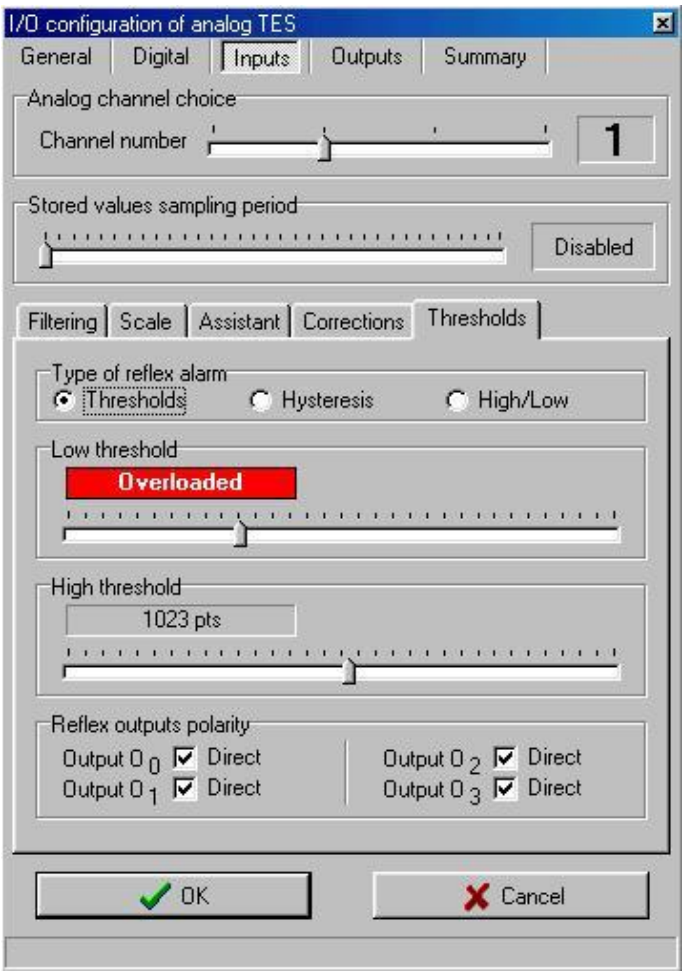
Note: every new analog TES has been calibrating in our factory: corrections parameters have then been set in EEPROM: before doing and transmit a new configuration, backup the actual configuration done in factory (menu TESIS/Read EEPROM) and save it: your new parameters will put out the factory calibration.



4.2.6 Thresholds and digital outputs associated

Thresholds are used after scaling, on the final value. If thresholds are put on an incorrect value for the final value, the message « overloaded » appears.
Example: After a conversion fixing a final value between –100 and + 15000 points, a high threshold to 12602 points will be accepted, but a low threshold to –200 will be over limits.

Three types of thresholds are proposed: Thresholds simple, Hysteresis, Thresholds high / low.



4.2.6.1 Thresholds

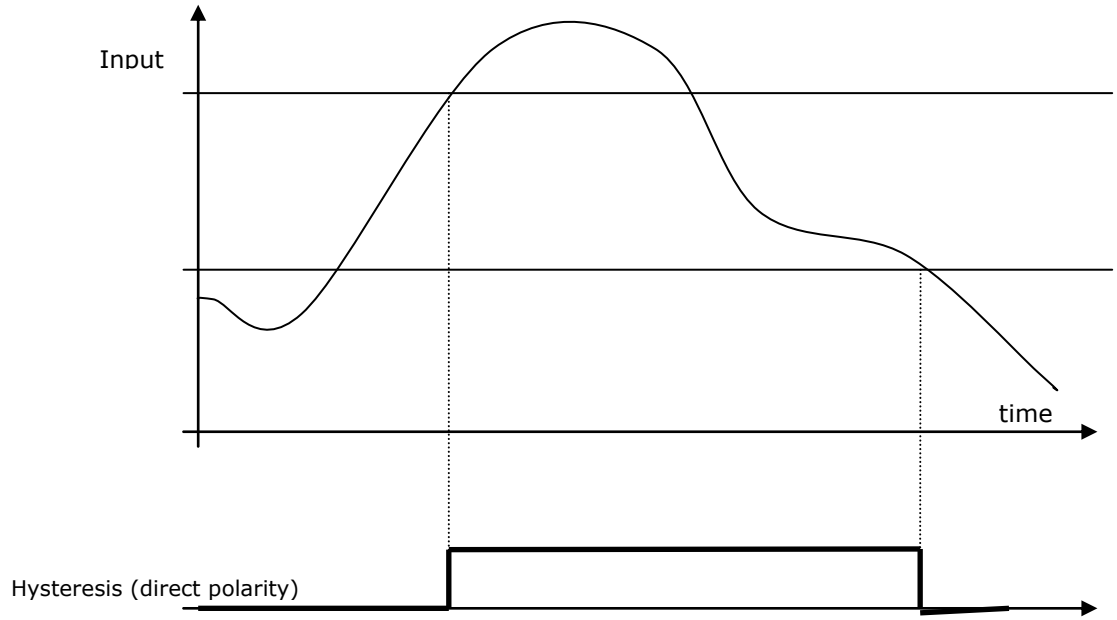
Parameters: choose the value low threshold and the value high threshold

Use:

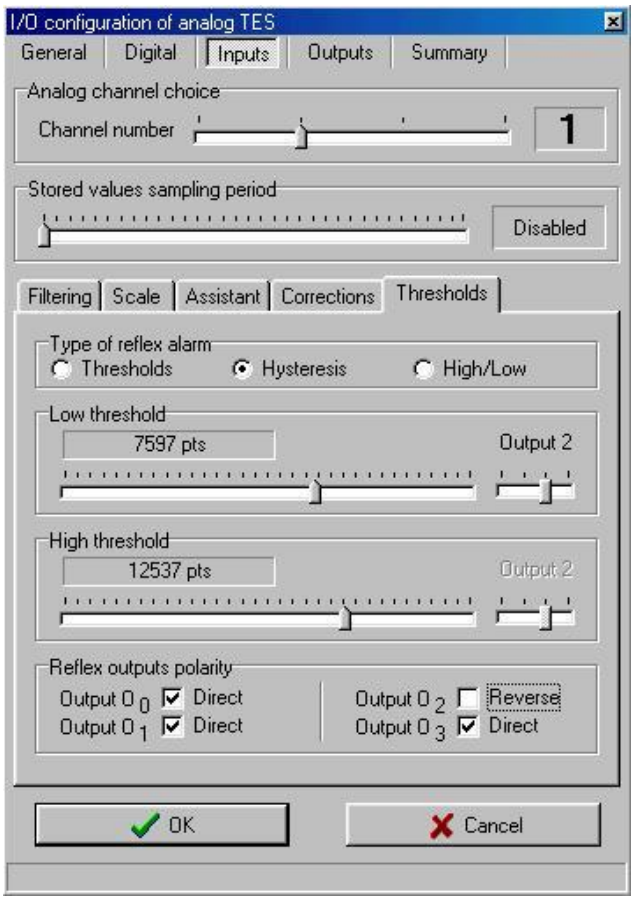
If input > high threshold
Then
Set to 1 of bit 5 of state word of the channel (address Modbus 0B to 12h).
Led associate to analog input will blink
Any digital output associate.

If input < low threshold
Then
Set to 1 of bit 4 of state word of the channel (address Modbus 0B to 12h).
Led associate to analog input will blink
Any digital output associate.

4.2.6.2 Hysteresis



Parameters: set the high and low threshold. Choose **the** digital associated output.



Use:

Bits Modbus:

If input > high threshold
Then
Set to 1 of bit 5 of state word of the channel (address Modbus 0B to 12h).
Led associate to analog input will blink

If input < low threshold
Then
Set to 1 of bit 4 of state word of the channel (address Modbus 0B to 12h).
Led associate to analog input will blink

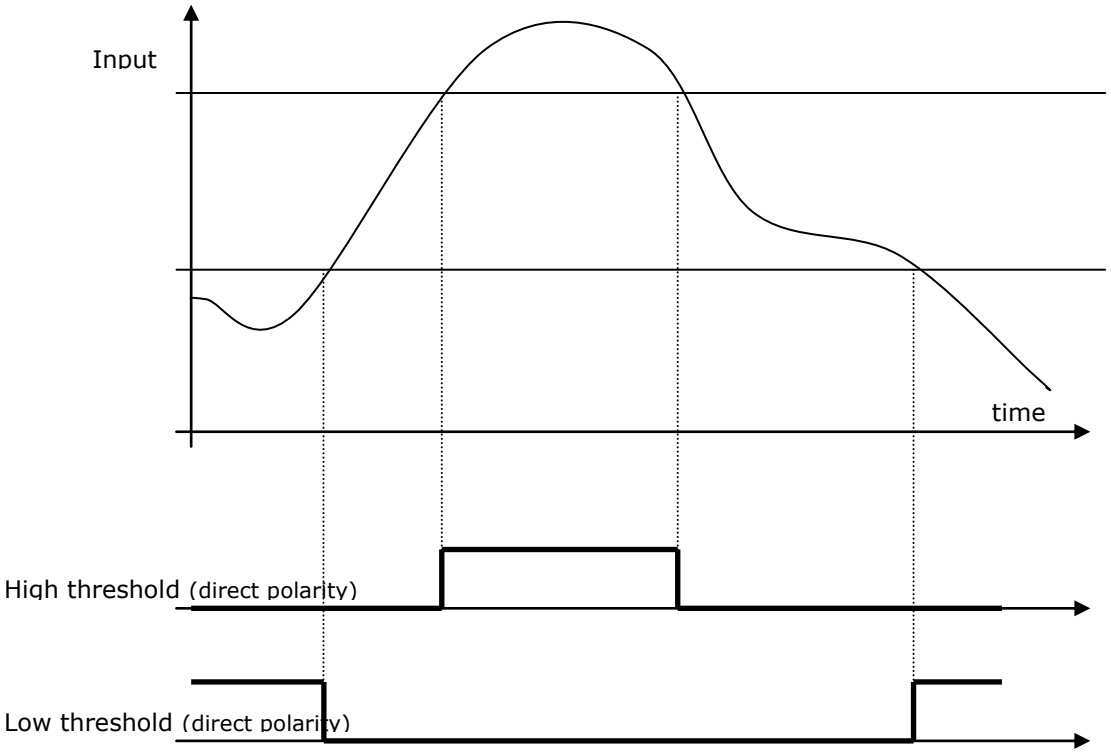
NOTE: the 2 bits are then at 0 if input is « normally » between the 2 thresholds.
To obtain the hysteresis bit, use the bit of the digital reflex output, as describe below.

Digital reflex output:

If input > high threshold then the digital output chosen is set to 1. It'll be reset to 0 when analog input will be under the low threshold.
NOTE: the output polarity associated to the threshold can be reversed.

WARNING: Don't choose the same digital output for 2 different analog inputs!

4.2.6.3 Thresholds high / low



Parameters: set the high threshold value and its digital output associated. Set the low threshold and its digital output associated. The 2 outputs must be different.

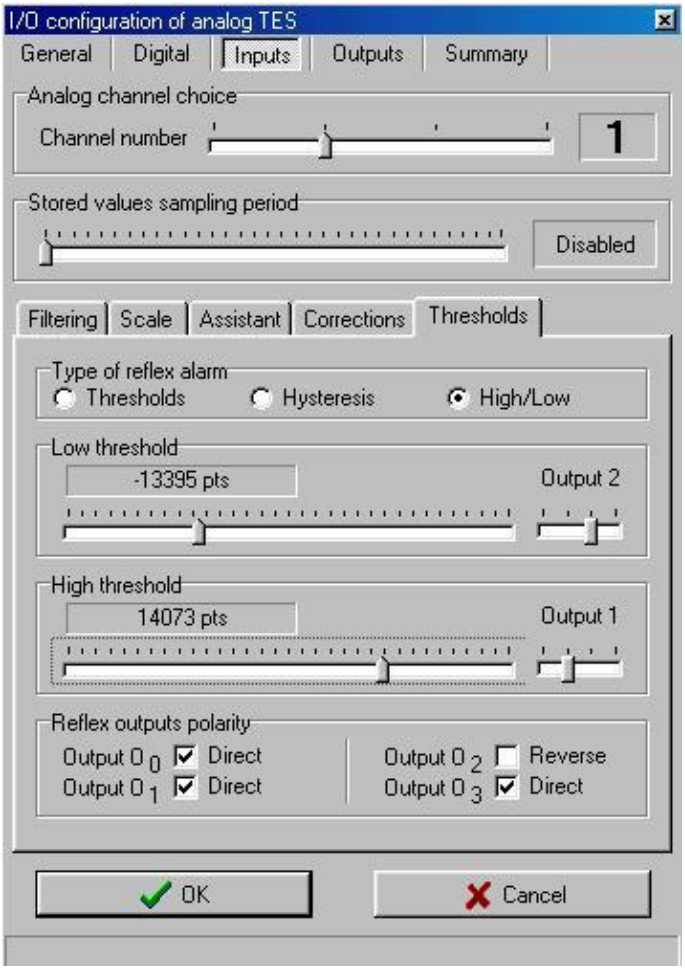
Use:

Bits Modbus:

If input > high threshold
Then
Set to 1 of bit 5 of state word of the channel (address Modbus 0B to 12h).
Led associate to analog input will blink
Set to 1 digital output associated

If input < low threshold
Then
Set to 1 of bit 4 of state word of the channel (address Modbus 0B to 12h).
Led associate to analog input will blink
Set to 1 digital output associated

WARNING: Don't choose the same digital output for 2 different analog inputs!

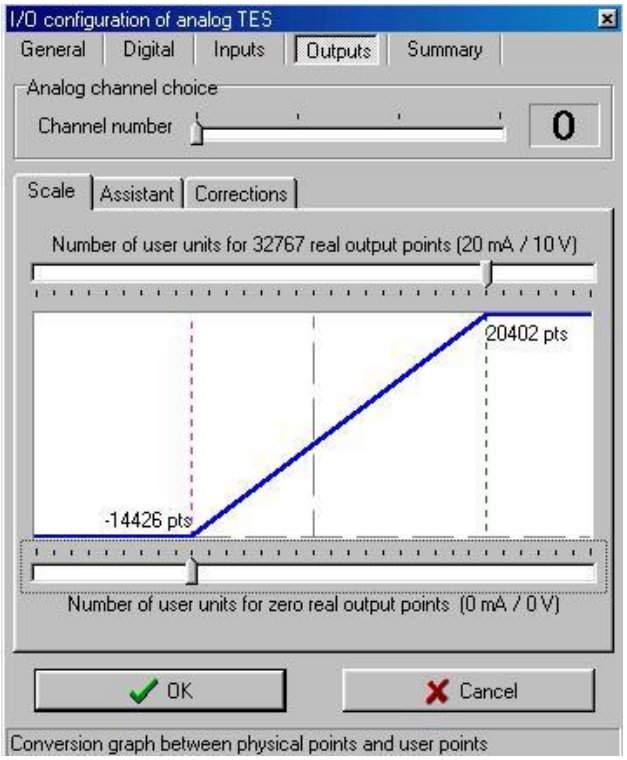


4.3 Analog outputs

4.3.1 Scaling

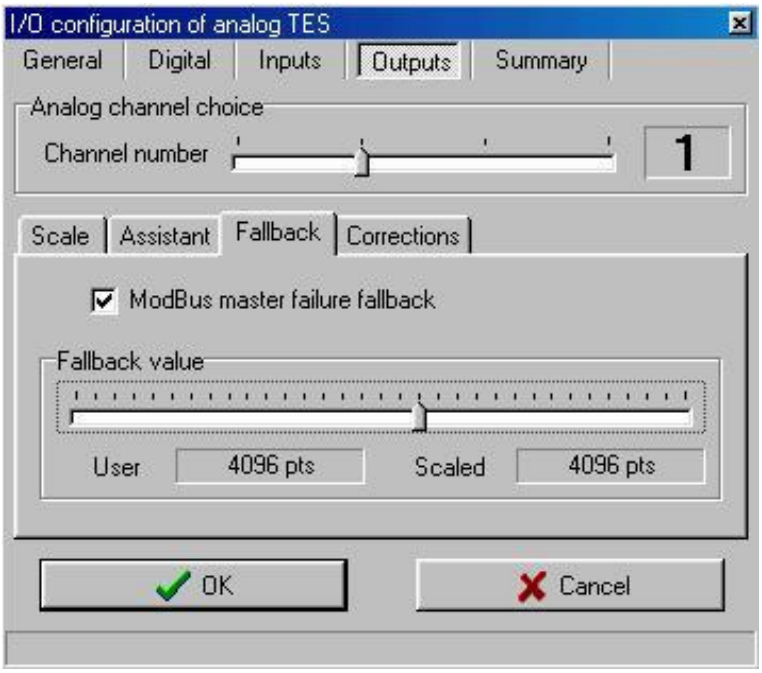
The converter numeric analog (CNA) converts a value between 0 and 32767 pts in a voltage between 0 and 10V or in a current between 0 and 20mA.

Scaling allow to convert a user value (between –32767 and +32768) in the CNA interval between 0 and 32767.



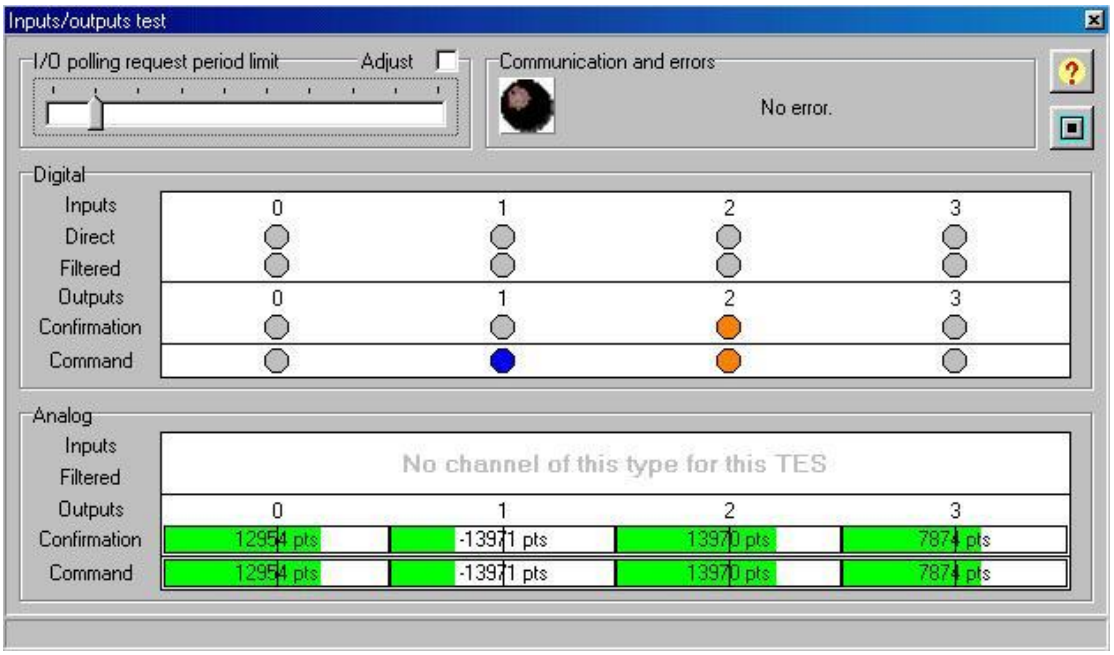
4.3.2 Fallback position

The fallback position is a forcing operation to an analog security value in case of communication break with the modbus master (network wire breakage, modbus master device failure...).



5 I/O testing

Once connected to TES, you can watch all digital and analog inputs and outputs states and force the digital and analog outputs: the button « I/O Test » is then activate and allow to open the following screen.



A button « ■ » allow you to close this window.

A button « ? » allow you to know the leds signification.

Digital outputs forcing is done when you click on corresponding outputs command buttons.
Analog outputs forcing is done when you move the cursor on command bar associated to each analog output.

6 TES Memory map

6.1 Introduction

All values exchanged with the modbus master are coded in hexadecimal: the protocol used is Modbus RTU.

Analog values:

- Analog input between:
  0000 and 03FF (1023) if any scaling has been set
  8000/FFFF (-32768/-1) and 0/7FFF (0/+32767) depending on the scaling settings in the opposite case.

- Analog output between:
  0000 and 7FFF (32787) if any scaling has been set
  8000/FFFF (-32768/-1) and 0/7FFF (0/+32767) depending on the scaling settings in the opposite case

Glossary

MP	Memory Parameters: Those registers are initialised with parameters from EEPROM (loaded with TESIS) at every 24 V power on.
Tb	Time base

1st column indicates address in hexadecimal.
2d column indicates address in decimal.

6.2 TES 16 EST, 32 EST, 32 ET, 32 ET-S Memory Map

6.2.1 General state word

000h	000d	TES general word

The 8 bits from 0 to 7 of this state word are accessible with the Jbus function « 8 bits quick reading »

bit 0: 24v power on; TES that use parameters loaded with TESIS.
Set to 1 by TES, reset to 0 by master

bit 1: TES is in fallback position because the master doesn't ask it anymore.
Set to 1 by TES, reset to 0 by master

bit 2: **For TES32EST-S only**, one (at least) of security input between sensors and one of inputs -S (declared) of TES is in short circuit or broken. Set to 1 by TES, reset to 0 by the master

bit 3: TES stored at least 1 state change on one digital input. The master must read (or reread) the memorized input registers (words 1 & 2)
Reset to 0 by TES as soon as the master has read all the memorized state changes.

6.2.2 **Digital Input and output state words**

	001h	001d	memorized inputs [15..00]
	002h	002d	memorized inputs [31..16]
	003h	003d	filtered inputs [15..00]
	004h	004d	filtered inputs [31..16]
	005h	005d	directs inputs [15..00]
	006h	006d	directs inputs [31..16]
	007h	007d	outputs instantaneous state [15..00]
	008h	008d	Reserved
	009h	009d	Reserved
MP	00Ah	010d	filters duration for inputs state 0 (Tb=5ms)
MP	0Bh	011d	filters duration for inputs state 1 (Tb=5ms)
	00Ch	012d	word 0 of output command: choice of blinking outputs
	00Dh	013d	word 1 of output command: choice of fixed states 0/1 in C0/C1
MP	00Eh	014d	duration of state 1 blinking mode 0 (Tb=5ms)
MP	00Fh	015d	duration of state 0 blinking mode 0 (Tb=5ms)
MP	010h	016d	duration of state 1 blinking mode 1 (Tb=5ms)
MP	011h	017d	duration of state 0 blinking mode 1 (Tb=5ms)

6.2.3 Words used to supervise the RS 422/485 link with the master.

6.2.3.1 Control of master activity and fallback position

MP	012h	018d	OR mask of word 0 of output command
MP	013h	019d	OR mask of word 1 of output command
MP	014h	020d	AND mask of word 0 of output command
MP	015h	021d	AND mask of word 1 of output command
MP	016h	022d	maximum duration time separating 2 masters request (Tb=100ms)

6.2.3.2 Control of quality of serial links

6.2.3.2.1 Diagnosis counters for RS 485 link

017h	023d	number of exception replies returned by TES
018h	024d	number of replies « slave not ready » returned by TES
019h	025d	number of frames correctly executed by TES
01Ah	026d	number of received frames with CRC16 errors
01Bh	027d	number of wrong characters received by TES
01Ch	028d	number of received frames without errors
01Dh	029d	bus double pair : not analysed frames by default of silent time
		bus single pair : idem or replies sends by others slaves

6.2.3.2.2 Diagnosis counters for RS 232 link

01Eh	030d	number of exception replies returned by TES
01Fh	031d	number of replies « slave not ready » returned by TES
020h	032d	number of frames correctly executed by TES
021h	033d	number of received frames with CRC16 errors
022h	034d	number of wrong characters received by TES
023h	035d	number of received frames without errors
024h	036d	not analysed frames by default of silent time

From that address, read (or write) master request can be sometimes refused by TES that reply "slave not ready" ; this allows to keep information coherence (coded on 32 bits) that TES calculate the periodic gap in memory buffers.

6.2.4 Digital channels counters

6.2.4.1 Counter of rising edge (after filtration) : high part / low part

	025h / 026h	037d / 038d	counter of rising edge input No 0
	027h / 028h	039d / 040d	counter of rising edge input No 1
	...	.	...
TES 16 EST	033h / 034h	051d / 052d	counter of rising edge input No 7
	035h / 036h	053d / 054d	counter of rising edge input No 8
	...	...	...
TES 32 EST	043h / 044h	067d / 068d	counter of rising edge input No 15
	045h / 046h	069d / 070d	counter of rising edge input No 16
	...	...	...
TES 32 ET	063h / 064h	099d / 100d	counter of rising edge input No 31

6.2.4.2 Counter of falling edge (after filtration) : high part / low part

	065h / 066h	101d / 102d	counter of falling edge input No 0
	067h / 068h	103d / 104d	counter of falling edge input No 1
	..	...	...
TES 16 EST	073h / 074h	115d / 116d	counter of falling edge input No 7
	075h / 076h	117d / 118d	counter of falling edge input No 8
	...	...	...
TES 32 EST	083h / 084h	131d / 132d	counter of falling edge input No 15
	085h / 086h	133d / 134d	counter of falling edge input No 16
	...	...	...
TES 32 ET	0A3h / 0A4h	163d / 164d	counter of falling edge input No 31

6.2.5 Chronometers

Addresses are arranged in « High part / low part ». **Time base is of 100 ms** .

6.2.5.1 chronometers of states 1

	0A5h / 0A6h	165d / 166d	duration of state 1 for input No 0
	0A7h / 0A8h	167d / 168d	duration of state 1 for input No 1
	..	...	...
TES 16 EST	0B3h / 0B4h	179d / 180d	duration of state 1 for input No 7
	0B5h / 0B6h	181d / 182d	duration of state 1 for input No 8
	..	...	...
TES 32 EST	0C3h / 0C4h	195d / 196d	duration of state 1 for input No 15
	0C5h / 0C6h	197d / 198d	Duration of state 1 for input No 16
	..	...	...
TES 32 ET	0E3h / 0E4h	227d / 228d	duration of state 1 for input No 31

6.2.5.2 **chronometers of states 0**

	0E5h / 0E6h	229d / 230d	duration of state 0 for input No 0
	0E7h / 0E8h	231d / 232d	duration of state 0 for input No 1
	...	...	...
TES 16 EST	0F3h / 0F4h	243d / 244d	duration of state 0 for input No 7
	0F5h / 0F6h	245d / 246d	duration of state 0 for input No 8
	...	...	...
TES 32 EST	103h / 104h	259d / 260d	duration of state 0 for input No 15
	105h / 106h	261d / 262d	duration of state 0 for input No 16
	...	...	...
TES 32 ET	123h / 124h	291d / 292d	duration of state 0 for input No 31

6.2.6 Adding up chronometers for digital inputs

Time base is 100ms

6.2.6.1 Cumulated durations of states at 1

125h / 126h	293d / 294d	cumulated duration of states 1 for input No 0
127h / 128h	295d / 296d	cumulated duration of states 1 for input No 1
...	...	...
163h / 164h	355d / 356d	cumulated duration of states 1 for input No 31

6.2.6.2 Cumulated durations of states at 0

165h / 166h	357d / 358d	cumulated duration of states 0 for input No 0
167h / 168h	359d / 360d	cumulated duration of states 0 for input No 1
...	...	for input No X a1 = 357 + 2 x a2 = 358 + 2 x
1A3h / 1A4h	419d / 420d	cumulated duration of states 0 for input No 31

6.2.7 TES 32ET-S specifics registers : broken wires and short circuit detection

SC = Short Circuit between sensor wired securely(R+r) and terminal TES
OC = Open Circuit between sensor wired securely (R+r) and terminal TES

	1A5h	421d	Word of 16 bits SC inputs E1 to E16 Bit i=1-> short circuit for Ei
	1A6h	422d	Word of 16 bits SC inputs E17 to E32
	1A7h	423d	Word of 16 bits OC inputs E1 to E16 Bit i=1-> Open circuit for Ei
	1A8h	424d	Word of 16 bits OC inputs E17 to E32
	1A9h	425d	Word of 16 bits defaults OC or SC E1 to E16
	1AAh	426d	Word of 16 bits defaults OC or SC E17 to E32
MP	**1ABh**	427d	Connection Bits : allow to set inputs Ei that are wired in security mode
MP	**1ACh**	428d	bit i = 1 : Ei is wired in security mode (r + R) bit i = 0 : Ei isn't wired in security mode : direct input

6.3 TES 32 ST memory map

6.3.1 State Word

000h	000d	TES status

Bit 0: Set to 1 by TES at initialisation. Can be reset to 0 by the master after watching.
Bit 1: Reset to 0 by TES when in reply after over passing of the master inters request max. time.

6.3.2 States and outputs commands

	001h	001d	instantaneous outputs state [15..OO]
	002h	002d	instantaneous outputs state [31..16]
	003h	**003d**	**Select Fix or Blinking for outputs 0 to 15 (*)**
	004h	**004d**	**Select Fix or Blinking for outputs 16 to 31 (*)**
	005h	**005d**	**Command state or outputs frequency 0 to 15**(*)
	006h	**006d**	**Command state or outputs frequency 16 to 31**(*)
MP	007h	007d	duration of state 1 of blinking frequency 0 (Tb=5ms)
MP	008h	008d	duration of state 0 of blinking frequency 0 (Tb=5ms)
MP	009h	009d	duration of state 1 of blinking frequency 1 (Tb=5ms)
MP	00Ah	010d	duration of state 0 of blinking frequency 1 (Tb=5ms)

(*) see next page

Bit no i of word 3	Bit no i of word 5	Output no i between 0 and 15

0	0	Command to 0
0	1	Command to 1
1	0	Blinking frequency 0
1	1	Blinking frequency 1

Bit no i of word 4	Bit no i of word 6	Output no i between 16 and 31
0	0	Command to 0
0	1	Command to 1
1	0	Blinking frequency 0
1	1	Blinking frequency 1

00Bh	00011d	not used
00Ch	00012d	not used
00Dh	00013d	not used

6.3.3 Words used for supervise RS 485 communication

MP	00Eh	014d	OR mask of word 0 of output command [15..00]
MP	00Fh	015d	OR mask of word 0 of output command[31..16]
MP	010h	016d	OR mask of word 1 of output command [15..00]
MP	011h	017d	OR mask of word 1 of output command[31..16]
MP	012h	018d	AND mask of word 0 of output command[15..00]
MP	013h	019d	AND mask of word 0 of output command[31..16]
MP	014h	020d	AND mask of word 1 of output command[15..00]
MP	015h	021d	AND mask of word 1 of output command[31..16]
MP	016h	022d	maximum duration time separating 2 masters request (Tb=100ms)

6.3.4 serial link RS422/485 diagnosis counters

017h	023d	number of exception replies returned by TES
018h	024d	number of replies « slave not ready » returned by TES
019h	025d	number of frames correctly executed by TES
01Ah	026d	number of received frames with CRC16 errors
01Bh	027d	number of wrong characters received by TES
01Ch	028d	number of received frames without errors
01Dh	029d	bus double pair : not analysed frames by default of silent time bus single pair : idem or replies sends by others slaves

6.3.5 serial link RS232 diagnosis counters

01Eh	030d	number of exception replies returned by TES
01Fh	031d	number of replies « slave not ready » returned by TES
020h	032d	number of frames correctly executed by TES
021h	033d	number of received frames with CRC16 errors
022h	034d	number of wrong characters received by TES
023h	035d	number of received frames without errors
024h	036d	not analysed frames by default of silent time

6.4 Memory map of TES 4EA, 4SA, 8EA, 8ESA, 8SA-U

6.4.1 Word state of analog TES

8 bits 0 to 7 are accessible in Jbus with function « 8 bits quick read »

000h	000d	TES status

TES status resume the general TES state at the time of the master read request.

bit 0 to 1 TES has been reinitialised (power on).
bit 1 to 1 TES is in reply position as a result of the communication stop on RS 485 serial link.
bits 0 and 1 are reset to 0 at the first exchange with the Modbus/Jbus master.

bit 3 to 1: TES store at least 1 state change on one digital inputs. The master must then reread the stored register inputs (words 2).
bit 3 to 0: reset to 0 by TES as soon as the master read all stored state changes.

bit 6 One of analog input s is in low alarm
the "OR" of bits 4 of analog channels status.
bit 7 One of analog input s is in high alarm
the "OR" of bits 5 of analog channels status.

bits 6 and 7 will be reset to 0 by master that will then read the registers 11d to 18d to have more information on each analog input .

6.4.2 Digital inputs

001h	001d	digital filtered inputs [3..0]
002h	002d	digital stored inputs [3..0]

6.4.3 Analog inputs

003h	003d	analog input No 0
004h	004d	analog input No 1
005h	005d	analog input No 2
006h	006d	analog input No 3
007h	007d	analog input No 4
008h	008d	analog input No 5
009h	009d	analog input No 6
00Ah	010d	analog input No 7

6.4.4 state words of analog channels

bit 1 to 1 Output in fallback position
bit 4 to 1 Input < low threshold
bit 5 to 1 Input > high threshold

00Bh	011d	State of channel No 0 (can be one input or one output depending on model)
00Ch	012d	State of channel No 1
00Dh	013d	State of channel No 2
00Eh	014d	State of channel No 3
00Fh	015d	State of channel No 4
010h	016d	State of channel No 5
011h	017d	State of channel No 6
012h	018d	State of channel No 7

6.4.5 Digital outputs command

013h	019d	Digital outputs command [3..0]

choice output fixed or blinking : bits 11-08
command of states outputs : bits 03-00

Note : the master can't supervise one digital output connected to an alarm input threshold.

6.4.6 Analog outputs command

014h	020d	Analog output No 0
015h	021d	Analog output No 1
016h	022d	Analog output No 2
017h	023d	Analog output No 3
018h	024d	Analog output No 4
019h	025d	Analog output No 5
01Ah	026d	Analog output No 6
01Bh	027d	analog output No 7

Warning : the 4 analog outputs of a TES 8 ESA are the outputs N° 4, 5, 6 and 7.

6.4.7 Digital variables

	01Ch	028d	Bits 0 to 3: direct inputs (not filtered) Bits 8 to B: direct outputs
MP	01Dh	029d	filtered time of levels 0 digital inputs (Tb=5ms)
MP	01Eh	030d	filtered time of levels 1 digital inputs (Tb=5ms)
MP	01Fh	031d	duration of state 1 of blinking mode° 0 (Tb=5ms)
MP	020h	032d	duration of state 0 of blinking mode° 0 (Tb=5ms)
MP	021h	033d	duration of state 1 of blinking mode° 1 (Tb=5ms)
MP	022h	034d	duration of state 0 of blinking mode° 1 (Tb=5ms)

6.4.8 values thresholds for analog input s

MP	023h	035d	low threshold of analog input No 0
MP	024h	036d	low threshold of analog input No 1
MP	025h	037d	low threshold of analog input No 2
MP	026h	038d	low threshold of analog input No 3
MP	027h	039d	low threshold of analog input No 4
MP	028h	040d	low threshold of analog input No 5
MP	029h	041d	low threshold of analog input No 6
MP	02Ah	042d	low threshold of analog input No 7

MP	02Bh	043d	high threshold of analog input No 0
MP	02Ch	044d	high threshold of analog input No 1
MP	02Dh	045d	high threshold of analog input No 2
MP	02Eh	046d	high threshold of analog input No 3
MP	02Fh	047d	high threshold of analog input No 4
MP	030h	048d	high threshold of analog input No 5
MP	031h	049d	high threshold of analog input No 6
MP	032h	050d	high threshold of analog input No 7

6.4.9 digital outputs associated to thresholds

Each word below contain in one byte each no (between 0 and 3) of the 2 digital outputs associate to high and low threshold of each analog input. Apart from those limits any output is commanded.

MP	033h	051d	Outputs associated to analog input No 0
MP	034h	052d	Outputs associated to analog input No 1
MP	035h	053d	Outputs associated to analog input No 2
MP	036h	054d	Outputs associated to analog input No 3
MP	037h	055d	Outputs associated to analog input No 4
MP	038h	056d	Outputs associated to analog input No 5
MP	039h	057d	Outputs associated to analog input No 6
MP	03Ah	058d	Outputs associated to analog input No 7

6.4.10 digital outputs polarity associated to thresholds

03Bh	059d	digital outputs polarity commanded by low and high thresholds of analog inputs

6.4.11 outputs fallback position

6.4.11.1 Time .

MP	03Ch	060d	maximum time (in 1/10 seconds) separating two master requests on RS485 serial link.

6.4.11.2 Digital outputs

MP	03Dh	061d	Fallback position ; command word for 4 digital outputs

The repartition of bits in the fallback digital outputs command word is the same than in the digital output command word.
Note : If one digital output is associated to an alarm threshold, it won't fall back.

6.4.11.3 Analog outputs

MP	03Eh	062d	analog output fallback value No 0
MP	03Fh	063d	analog output fallback value No 1
MP	040h	064d	analog output fallback value No 2
MP	041h	065d	analog output fallback value No 3
MP	042h	066d	analog output fallback value No 4
MP	043h	067d	analog output fallback value No 5
MP	044h	068d	analog output fallback value No 6
MP	045h	069d	analog output fallback value No 7

Rappel : TES 8 ESA : the first of the 4 analog outputs is the output No° 4

MP	046h	070d	Fallback authorisation for analog outputs : one bit per output

6.4.12 Supervising networks

6.4.12.1 Serial link RS 485 diagnosis counters

047h	071d	number of exception replies returned by TES
048h	072d	number of replies « slave not ready » returned by TES
049h	073d	number of frames correctly executed by TES
04Ah	074d	number of received frames with CRC16 errors
04Bh	075d	number of wrong characters received by TES
04Ch	076d	number of received frames without errors
04Dh	077d	bus double pair : not analysed frames by default of silent time bus single pair : idem or replies sends by others slaves

6.4.12.2 Serial link RS 232 diagnosis counters

04Eh	078d	number of exception replies returned by TES
04Fh	079d	number of replies « slave not ready » returned by TES
050h	080d	number of frames correctly executed by TES
051h	081d	number of received frames with CRC16 errors
052h	082d	number of wrong characters received by TES
053h	083d	number of received frames without errors
054h	084d	not analysed frames by default of silent time

6.4.13 analog inputs storage

MP	055h	085d	storage period: analog inputs (Tb= 1s)

From that address, master read request (or writing) can be sometimes refused by TES that reply " slave not ready " ; this allows to keep information coherence (coded on 32 bits) that TES calculate the periodic gap in memory buffers.

056h	*086d*	*Reserved*
057h 0CEh	087d 206d	120 last values of analog input No 0
0CFh	*207h*	*Reserved*
0D0h 147h	208d 327d	120 last values of analog input No 1
148h	*328d*	*Reserved*
149h 1C0h	329d 448d	120 last values of analog input No 2
1C1h	*449d*	*Reserved*
1C2h 239h	450d 569d	120 last values of analog input No 3
23Ah	*570d*	*Reserved*
23Bh 262h	571d 690d	120 last values of analog input No 4
263h	*691d*	*Reserved*
264h 32Bh	692d 811d	120 last values of analog input No 5
32Ch	*812d*	*Reserved*
32Dh 3A4h	813d 932d	120 last values of analog input No 6
3A5h	*933d*	*Reserved*
3A6h 41Dh	934d 1053d	120 last values of analog input No 7
41Eh	*1054d*	*Reserved*

6.4.14 Counters of state change on digital inputs

counters store state changes for each filtered inputs. high part / low part

41Fh 420h	1055d 1056d	counter of rising edge input No 0
421h 422h	1057d 1058d	counter of rising edge input No 1
423h 424h	1059d 1060d	counter of rising edge input No 2
425h 426h	1061d 1062d	counter of rising edge input No 3
427h 428h	1063d 1064d	counter des falling edge input No 0
429h 42Ah	1065d 1066d	counter des falling edge input No 1
42Bh 42Ch	1067d 1068d	counter des falling edge input No 2
42Dh 42Eh	1069d 1070d	counter des falling edge input No 3

6.4.15 Chronometers of digital inputs

Variables are arranged on 32 bits : high part/low part. Time base is of 100 milliseconds.
Inputs measured are filtered inputs.

6.4.15.1 Duration of actual state for the filtered digital inputs

42Fh 430h	1071d 1072d	duration of state 1 for input No° 0 (Tb=100ms)
431h 432h	1073d 1074d	duration of state 1 for input No° 1 (Tb=100ms)
433h 434h	1075d 1076d	duration of state 1 for input No° 2 (Tb=100ms)
435h 436h	1077d 1078d	duration of state 1 for input No° 3 (Tb=100ms)
437h 438h	1079d 1080d	duration of state 0 for input No° 0 (Tb=100ms)
439h 43Ah	1081d 1082d	duration of state 0 for input No° 1 (Tb=100ms)
43Bh 43Ch	1083d 1084d	duration of state 0 for input No° 2 (Tb=100ms)
43Dh 43Eh	1085d 1086d	duration of state 0 for input No° 3 (Tb=100ms)

6.4.15.2 Cumulated durations of states for the filtered digital inputs

43Fh 440h	1087d 1088h	duration of states 1 for input No 0 (Tb=100ms)
441h 442h	1089d 1090d	duration of states 1 for input No 1
443h 444h	1091d 1092d	duration of states 1 for input No 2
445h 446h	1093d 1094d	duration of states 1 for input No 3
447h 448h	1095d 1096d	duration of states 0 for input No 0
449h 44Ah	1097d 1098d	duration of states 0 for input No 1
44Bh 44Ch	1099d 1100d	duration of states 0 for input No 2
44Dh 44Eh	1101d 1102d	duration of states 0 for input No 3

7 Modbus protocol

7.1 Generalities

The MODBUS protocol (RTU mode : binary) is a protocol of type master / slave (only 1 master per network). The JBUS protocol is compatible, for TES range, with the MODBUS protocol.

7.1.1 Functions codes

Function	**Code**
Reading n bits	**01 and 02**
Writing 1 bit	**05**
Writing n bits	**0F**
Reading n words	**03**
Writing n words	**10**
Writing 1 word	**06**
Reading quick of 8 bits	**07**

TES accept writing in diffusion mode: writing in slave No 0

7.1.2 Addresses

Addressing mode: type word

TES memory is a suite of words of 16 bits from address 0.
The address in frame is equal to the digital address.

Note: The addresses used by MODBUS devices are added to 1 compared to addresses really used on the line.
Example: program address if MODBUS device: 0002 / real address in frame :0001

Addressing mode: type bit

Address of bit i (between 0 and F) in a word j = j x 10h + i
Example: address of bit D in word 7A is 7AD (use with bits reading and writing functions)

7.1.3 Exchanges description

The master manages exchanges: it sends a request; when the addressee slave had decoded it, it sends its reply.

Each message or frame contains 4 information:

- number of slave (1 byte): addressee slave of master request or sender of reply.
- function code (1 byte): indicate the direction (reading or writing) and data type used (words or bits).
- data to transmit (p bytes).
- control word CRC16 (2 bytes): to detect transmission errors. It is calculate on 16 bits, from all bytes of the transmitted or received frame, except the 2 bytes of control.

All information is coded in hexadecimal.

7.2 Frames structure

7.2.1 Function reading n words

frames structure used on Modbus/Jbus network:

Frame request **Nq = 8**

01 to FF	03 or 04	[2 bytes] PF pf	[2 bytes] PF pf	[2 bytes] pf PF
slave number	function code	address of 1st word	number of words to read	CRC 16

Frame reply **Nr = 5 + 2n**

01 to FF	03 or 04	[1 byte]	[2 bytes] PF pf	---------- -	[2 bytes] PF pf	[2 bytes] pf PF
slave number	function code	Byte number	value of 1st read word	<----------n words or 2n bytes---------->	value of last word read	CRC 16

7.2.2 Writing function n words

Frame request **Nq = 9 + 2n**

01 to FF	10	[2 bytes] PF pf	[2 bytes] PF pf	[1 byte] pf	[2 bytes] PF pf	-----	[2 bytes] PF pf	[2 bytes] pf PF
slave number	function code	address 1st word	number words to write	number of bytes to write (1)	value of 1st word		value of last word	CRC 16

(1) = 2x number of words to write

Frame de reply **Nr = 8**

01 to FF	10	[2 bytes] PF pf	[2 bytes] PF pf	[2 bytes] pf PF
slave number	function code	address 1st word	number words to write	CRC 16

7.2.3 Writing function 1 word

Frame request **Nq = 8**

01 to FF	6	[2 bytes] PF pf	[2 bytes] PF pf	[2 bytes] pf PF
slave number	function code	address 1st word	number words to write	CRC 16

Frame reply **Nr = 8**

01 to FF	6	[2 bytes] PF pf	[2 bytes] PF pf	[2 bytes] pf PF
slave number	function code	address word	value word to write	CRC 16

7.2.4 Read function n Bits

Frame request **Nq = 8**

[1 byte] 01 to FF	[1 byte] 1 or 2	[2 bytes] PF pf	[2 bytes] 1 to 2000	[2 bytes] pf PF
Slave number	Function	Address of 1st bit	Number of bits	CRC 16

Frame reply **Nr = 5 + n/8**

[1 byte] 01 to FF	[1 byte] 1 or 2	[1 byte]	...	[n bytes]	...	[2 bytes]

Slave number	Function	Number of read bytes	1st read byte	CRC 16	Last read byte	CRC 16

7.2.5 Writing function n bits

Frame request **Nq = 9 + n/8**

[1 byte] Number slave	[1 byte] 0F	[2 bytes] address 1st bit to force	[2 bytes] number of bits to force	[1 byte] number bytes to force	[n bytes] value of bits to force	[2 bytes] CRC 16 pf PF

Frame reply **Nr = 8**

[1 byte] Number slave	[1 byte] 0F	[2 bytes] address 1st bit force	[2 bytes] number of bits forced	[2 bytes] CRC 16 pf PF

7.2.6 Quick reading 8 bits function

TES reply the 8 bits of word status (low part) that resume TES state (address bit : from 0000 to 0007).

Frame request **Nq = 4**

[1 byte] No slave	[1 byte] 07	[2 bytes] CRC 16

Frame reply **Nr = 5**

[1 byte] No slave	[1 byte] 07	[1 byte] xxxxxxxxx	[2 bytes] CRC 16

All TES reply to writing frames words/bits sends in DIFFUSION MODE (address to slave 0 = to all slaves). In this case TES return any frame and execute simultaneously the master command (synchronisation of commands, counters reset,...).

7.2.7 Transmission time

the duration is calculate from 5 data
- number Nb de bits (from 8 to 11) on which are coded the transmitted bytes
- transmission speed (Vt), in Bauds
- number of bytes transmitted in a request (Nq) and in a reply (Nr)
- numbers Sq and Sr of characters (3 defined in Modbus norm) : define silent time after any question frame or reply
- time tr of calculation in TES to rebuild and transmit its reply

Typically tr is equal to 1,5 ms. TES version 4.1 and more has a parameter answer delay : from 0 to 2570 ms.
- answer delay of master tq (evaluated to 1.5ms in calculations below).
Exchange duration request/reply between an API and a TES is given by the formula:

T = [Nbx1000/Vt x (Nq + Sq + Nr + Sr)]+ tq + tr (en ms)

Example : 38400 Bds, transmission format : 8 bits data, 1 bit parity, 1 bit start, 1 bit stop : writing one word in TES will take (except internal calculation time in master) :
T = ((8+1+1+1)1000/38.400) x (8 + 3+ 8 + 3) + 1,5 + 1,5 # 9,3 ms

Note : the low time between end of transmission of master last byte and reception of first bytes of TES reply (between 1 and 2ms) can, when master don't validate quickly its reception buffer, involve Time Out errors on master : it "miss" the frame beginning of TES reply.
In that case, TES answer delay can be increased by parameter in Tesis32 software for the RS485 line.

TES can return following errors codes:
1 = function code used by master is unknown.
2 = address TES used isn't correct.
4 = TES not ready.