REMOTE INPUT OUTPUT INTERFACE

TES range

Implementation Manual

www.leroy-automation.com

P DOC TES 001 E V 4.5

Thank you for purchasing a Remote I/O Terminal of our TES product line.

This manual details the product characteristics and all information necessary for its operation.

TECHNICAL SUPPORT:

Phone: +33 562 240 546
e-mail: support@leroy-autom.com

Leroy Automation is constantly developing and improving its products. The information contained herein is subject to change without notice and is in no way legally binding upon the company.

LEROY AUTOMATION
250 rue Max Planck
31670 LABEGE
FRANCE
Tel: +33 562 240 550
Fax: +33 562 240 555

Web site: http://www.leroy-automation.com

CONTENTS

1 General overview

This manual contains all the necessary information for the installation, cabling and powering up. The software implementation with TESIS32 workbench is detailed in P DOC TES 002 E manual available on our web site : http://www.leroy-automation.com

Intelligent I/O terminals TES are housed in rugged aluminium enclosures with a polycarbonate face. Screw terminal connectors allow easy connection. TES are fitted with universal DIN-Rail feet. Power supply, communication traffic and either RS-232 or RS-485 are indicated by LED.

TES provide a serial interface between the process and the host, which can be either a PC or a PLC. The TES accepts parallel input from the process and converts it into serial for input to the CPU, conversely it accepts serial data commands from the CPU and converts them into parallel for output to the process. The EIA RS-422/485 standard serial link on 2 or 3 pairs uses **Modbus/Jbus protocol**.
These characteristics allow highly reliable transmission.

The TES concept provides a lot of advantages:

- Reducing field wiring, associated costs and maintenance: TES are located near the process I/O's.
- Low wiring and hardware costs
- Easy mounting on universal DIN-Rail
- Compact and easy hardware integration
- Quick set-up: using PC software to set internal parameters in Modbus/Jbus protocol allows direct connection with most of PLC's or PC's.
- Centralized (host) and decentralized (TES) installation diagnoses in case of problems.

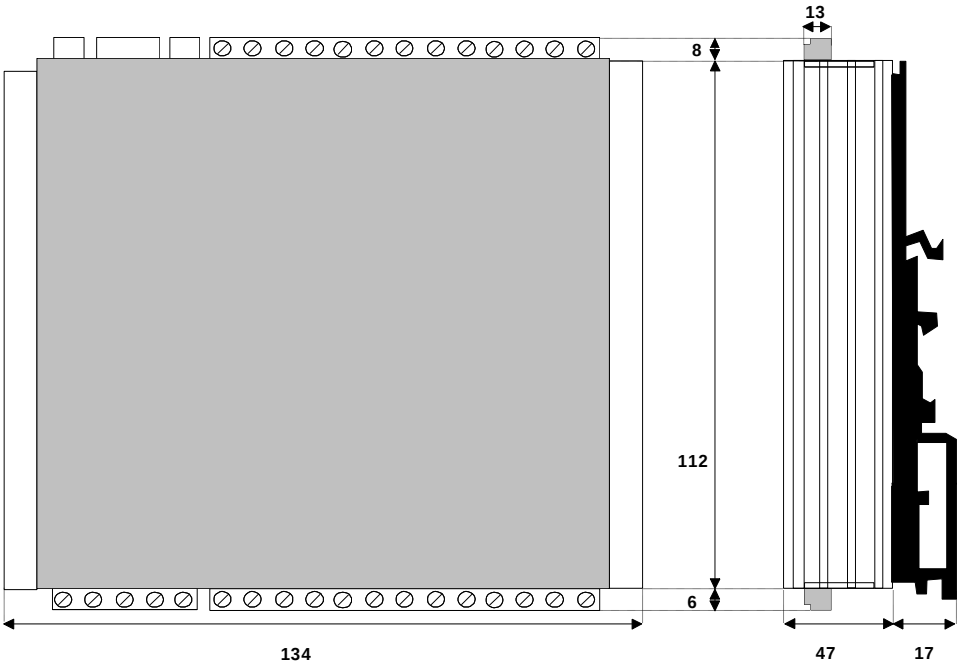
1.1 Mechanical characteristics

The TES is housed in a rugged aluminium enclosure.

Weight: 650 g
Protection: IP 205
Storage temperature: 20 to +70 degrees C
Operating temperature: 0 to +60 degrees C
Hygrometry: to 90% without condensation
Tropicalisation option on request

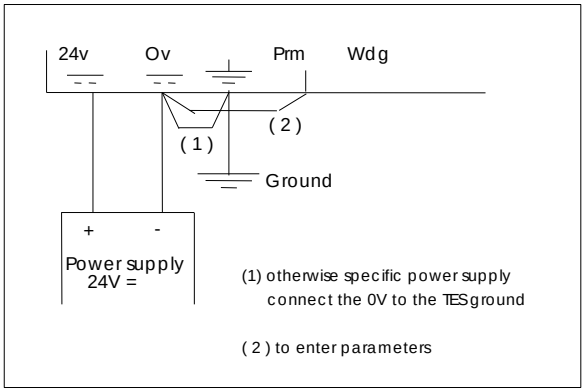
1.2 Dimensions and fixing

Dimensions are in millimetres. Connections are made by removable screw terminals and a SubD 9 pin female connector with 2 locking devices. The fixing of the TES uses asymmetric (G) 32 mm DIN Rail mountings or symmetrical DIN Rail mountings.



2 Connections

2.1 Power supply, Watch dog and parameters



2.1.1 Power supply 24V=

The TES power supply provides different voltages, power protection (transil) and filtration (capacitor). It also provides protection against permanent over voltage or reverse polarity (fuse, peak limiter and diode).

Specification	Units	Comments
Voltage		+/- 10%
Nominal value	24 Vdc	Direct current (redressed filtered)
Permitted range	21,6... 26,4	50 Hz ripple included
Current request	2 A	At start-up for 5 ms
Non detected micro-cut	10 ms	TES at full load
Isolation		Power supply, inputs and outputs have the same 0V reference
Power supply/ I/O	NO	
Power supply/CPU	2,5 KV RMS	
Power supply/serial links	2,5 KV RMS	

Consumptions

TES	Nominal consumption in mA at 24V
With 16 logic channels	70
With 32 logic channels s	105
With 4 analog channels	110
With 8 analog channels	170

2.1.2 Watchdog output: Wdg

The **watchdog output** power section is the same as the one of a logic output, and it is activated in normal operation (positive security). The watchdog command section is independent from the CPU, so that, in case of problem, it can be activated. The logic output then gets deactivated, a red L.E.D. lights up while the CPU is reset.
NOTE: At TES power up and down, the WDG L.E.D. lights up briefly.

2.1.3 Signalisations

0: switched off L.E.D. 1: switched on L.E.D. C: blinking L.E.D. x: indifferent state

Pwr	Run	Wdg	Prm	Meaning of the different L.E.D.'s
0	X	x	x	Power supply problem: source, connection, fuse...
1	0	1	x	Functional TES problem detected at self-test. All the outputs are not activated.
1	1	0	x	Normal operation
1	1	C	x	Wdg blinking indicate that communication with the master has been lost
x	x	x	1	Indicate that the TES runs with the default parameters (independents of those programmed with TESIS). All the previous cases are available.

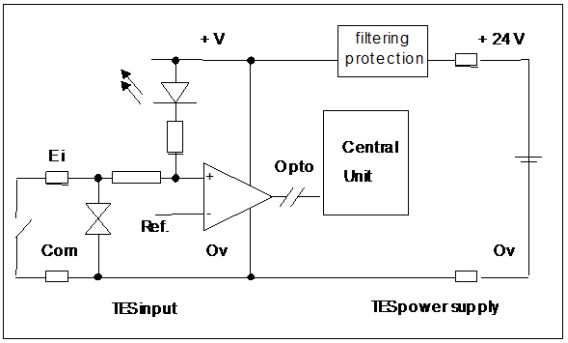
2.2 TES range

DESIGNATION	LOGIC INPUTS	LOGIC OUTPUTS	ANALOGIC INPUTS	ANALOGIC OUTPUTS
P TES 16EST	8 type N	8 type P		
P TES 32EST	16 type N	16 type P		
P TES 32ET	32 type N			
P TES 32ET-S **(1)**	32 type P safety (wiring control)			
P TES 32ST		32 type P		
P TES 16ESR	8 type P	8 relay		
P TES 16 rem **(1)**		16 relay		
P TES 4EA I	4 type N	4 type P	4 input 0-20mA	
P TES 4EA U	4 type N	4 type P	4 input 0-10V	
P TES 8EA I	4 type N	4 type P	8 input 0-20mA	
P TES 8EA U	4 type N	4 type P	8 input 0-10V	
P TES 8ESA I	4 type N	4 type P	4 input 0-20mA	4 output 0-20mA
P TES 8ESA U	4 type N	4 type P	4 input 0-10V	4 output 0-10V
P TES 4SA I	4 type N	4 type P		4 output 0-20mA
P TES 4SA U	4 type N	4 type P		4 output 0-10V
P TES 8SA U	4 type N	4 type P		8 output 0-10V
P TES Mirror 32EST	16 type P **(2)**	16 type P		
P TES Mirror 32ET	32 type P **(2)**			
P TES Mirror 4SA I	4 type N	4 type P		4 output 0-20mA
P TES Mirror 4SA U	4 type N	4 type P		4 output 0-10V
P TES Mirror 8ESA I	4 type N	4 type P	4 input 0-20mA	4 output 0-20mA
P TES Mirror 8ESA U	4 type N	4 type P	4 input 0-10V	4 output 0-10V
P TES Mirror 8SA U	4 type N	4 type P		8 output 0-10V

(1) LEROY AUTOMATION hasn't sold any more this reference since 1st January 2009
(2) The inputs of this reference have been N type since 1st January 2009.

2.3 Logical input type N, Common = 0V

Input power supply is furnished by the terminal: the max current is 10 mA max per activated input (contact closed).



The logic signal is processed before entering the TES's CPU. The input section is powered by the 24 VDC supply through the filtration and protection circuit of the TES. A transil protects each TES input against transient over voltages.
Software debouncing on each input is configurable.

Number of logical input	Logic TES 8 16 32	Analog TES 4	Comments
Number of commons	1* 1 2	1	* 0 on TES 16 EST-REM
Isolation			
- between inputs	NO	NO	
- between input and CPU	YES	YES	2500 V RMS
Output current			
- open contact	0	0	impedance of contact infinite
- closed contact	10 10 5	10	impedance of contact null
Debouncing delay			Time base 5 ms
- "0" to "1" transition	0 to 32755 ms	0 to 32755 ms	"1" : closed contact
- "1" to "0" transition	0 to 32755 ms	0 to 32755 ms	"0" : opened contact
Minimal duration			
- a level 1 (ms)	0,5 1 2	0,5	
- a level 0 (ms)	0,5 1 2	0,5	
Maximum input commutation frequency	1000 500 250	500	Counters guaranties at 40 Hz
Visualisation	orange LED	orange LED	per input

particular case of sensors with various impedance (Type NPN)

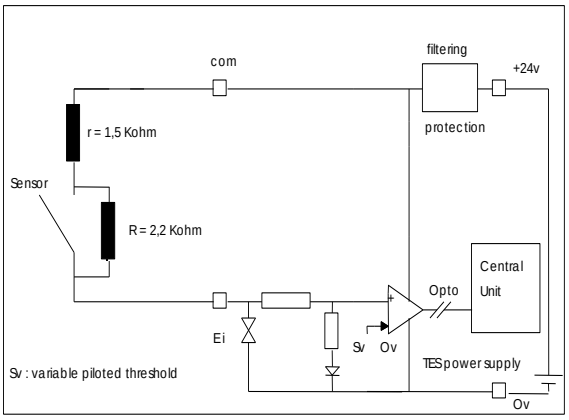
Contact opened "0" impedance min current absorbed max.	 4 kohm 3.5 mA
Contact closed "1" impedance max current absorbed min Max voltage	 2.4kohm 5 mA 7 V

2.4 Logical input type P ,Common = 24V

Wiring identical to type N except connect the COM to 24V.
LEROY AUTOMATION hasn't sold any more this reference since 1st January 2009.

2.5 Logical safety input type P : wiring control

LEROY AUTOMATION hasn't sold any more this reference since 1st January 2009.



Safety input on TES 32ET-S are of type "P" (common to +24v).

Associate to sensor 2 resistances R and r, connected as near as possible to sensor.
parallel resistance : R = 2,2 Kohms +/- 5%
serial resistance : r = 1,5 Kohms +/- 5%

Those 2 resistances allows to detect 4 states :
1 – Short circuit between the sensor and the TES input
2 – Sensor normally closed
3 – Sensor normally opened
4 – Circuit broken between the sensor and the TES input

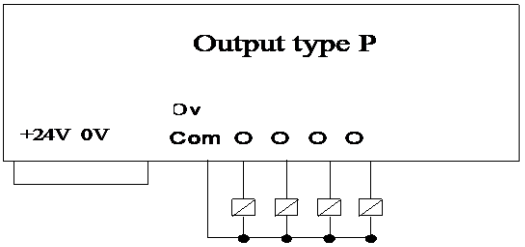
TES is doing a wiring control between the sensor and the input : it allows to detect if the circuit open is due to the sensor open or to a wiring break between input and sensor.
TES 32ET-S use TES 32ET memories registers and 8 specifics words at addresses 01A5 to 01AC to visualise the state of links with the sensor.

It's possible to parameter an input in wiring control or not.
Registers 01ABh and 01ACh define the input really cabled in security mode.

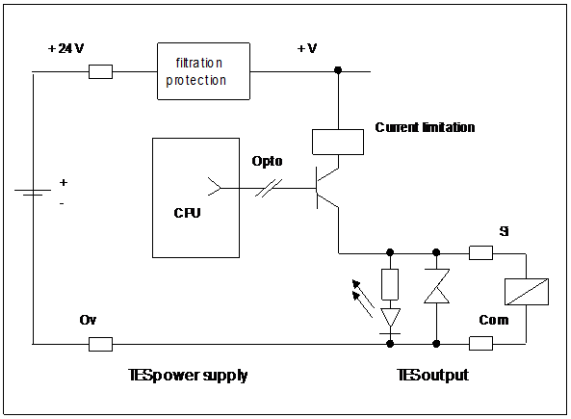
Number of input	32	
Number of commons	2	common at + 24 V
Isolation		
- between inputs	NO	
- between input and CPU	2500 V RMS	
Line Impedance		
- contact open	3,5 Kohm < Z < 3,9 Kohm	In particular case of sensors with various
- contact close	1,4 Kohm < Z < 1,6 Kohm	impedance you have to adjust the
- short circuit	< 270 ohm	resistances r and R to be compatible with
- circuit break	> 7,9 Kohm	those limit values
Debouncing delay		Time base 5 ms
- "0" to "1" transition	0 to 32755 ms	"1" : closed contact
- "1" to "0" transition	0 to 32755 ms	"0" : opened contact
Minimal duration		
- a level 1 (ms)	8	
- a level 0 (ms)	8	
Maximum input commutation frequency	60 Hz	Counters guaranties at 20 Hz
Visualisation	1 orange LED	per input

2.6 Static Output type P , Common = 0v

Output power supply is furnished by terminal from his 24 V power supply : the max current per output is 100 mA.



The logic outputs interface converts logic levels from CPU, to process compatible levels.
Output sections are powered by the 24 VDC supply, through the filtration and protection circuit of the TES. A transil protects each TES output against transient over voltages (for example those caused by inductive loads).

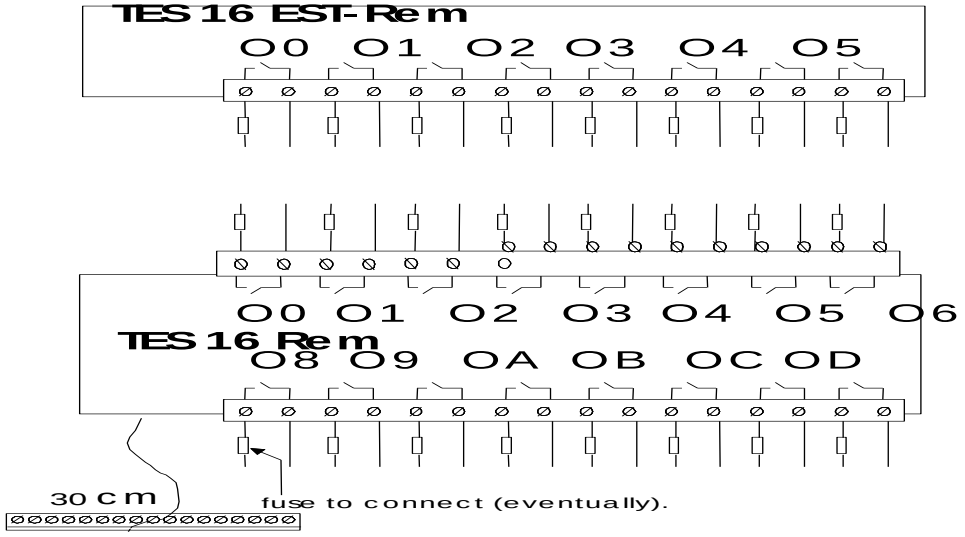


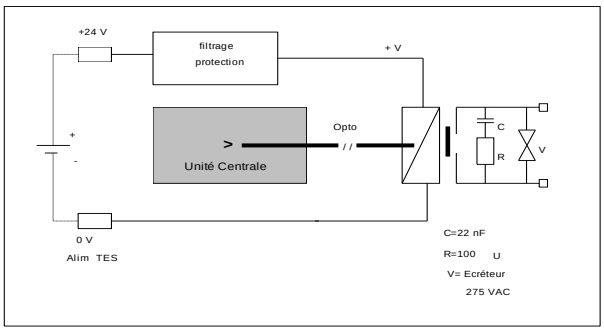
Schema of a digital output

	TES logic	TES analog	Comments
Number of output	8 16 32	4	
Number of commons	1 1 2	1	for TES 16 EST-REM see characteristics p 10
Isolation			
- between outputs	NO	NO	
- between output and CPU	YES	YES	2500 V RMS
Output max current			
- signal "1" in mA	100 100 50	100	Depends on load and under 24 Vdc power supply
- signal "0" in mA	< 0,5	< 0,5	Note : several outputs can be put in parallel to command a load over 100 mA
Protection against short-circuits	YES	YES	Activate from 120 mA
Output level			
- "0" signal (max)	1V 2V 2V	1V	With no load
- "1" signal (min)	Ua - 2,5 V	Ua - 2,5 V	Ua : TES power supply voltage : 24V +/- 10% and output under full load.
Rise time(max)	0,1 5 2	0,1	Full Load and in ms
Fall time (max)	2 5 2	2	No load and in ms
Visualisation	Red LED	red LED	For each output

2.7 Logic relay output

The output interface is made from relays with a free potential contact.
2 components protect every output section: one RC filter and one transil.
It's recommended to attenuate over voltage due to inductive elements: near of load, with an RC filter in case of an alternative current, or with a diode in case of DC current.

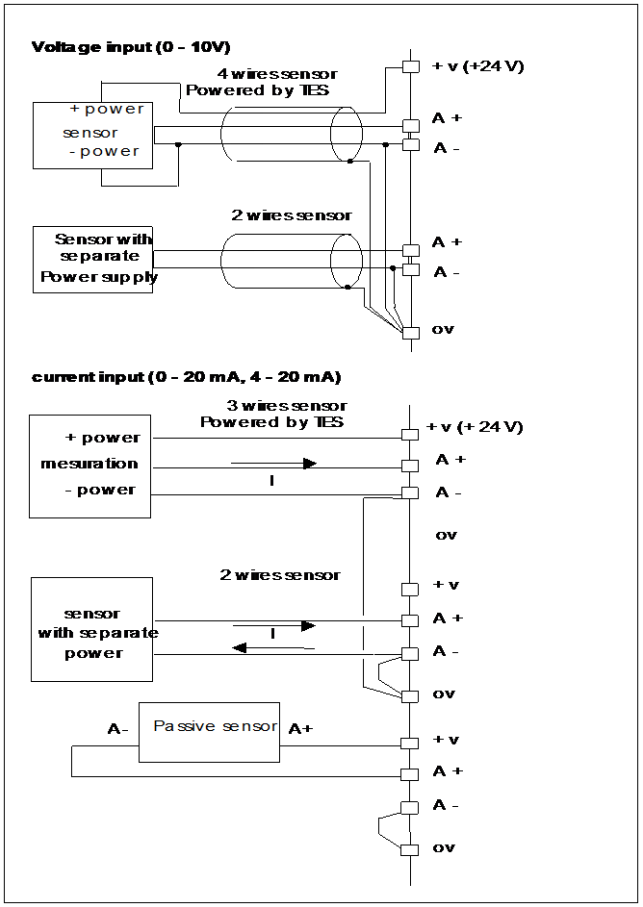


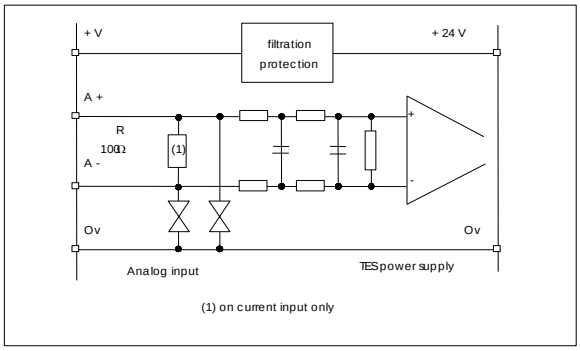


	TES 16EST-REM	Comments
Number of outputs	8	
output consumption at 1	10 mA	
Number of commons	0	Contacts with potential free
Isolation		
between outputs	YES	1500 RMS
between output and CPU	YES	2500 RMS
Max current per channel		
On resistive load	5A / 250 V AC 5A / 30 V DC	
On inductive load	1A / 250 V AC 0,5A / 30 V DC 0,25A / 60 V DC	
Residual current		
At opened state (AC current)	2 mA max	under 250 V AC
Expected life		
Number of switches	20.000.000	
Electric	100.000	
Contact resistance	100 m Ohms	Initial value
Max response time		
closed	10 ms	
opened	10 ms	

2.8 Analog Input 0 - 20 mA and 0-10 V

Input power supply is too available on +V screw terminal: it's furnished by TES from it's own 24 V DC power supply. The connection of 2 wires or 3 wires sensors, or more powered by TES (4 wires), is possible, as shown therefore.
Note: To ameliorate the measuring stability, it's recommended to connect A- screw to 0v screw and too the ground of TES to the 0v of Power supply.





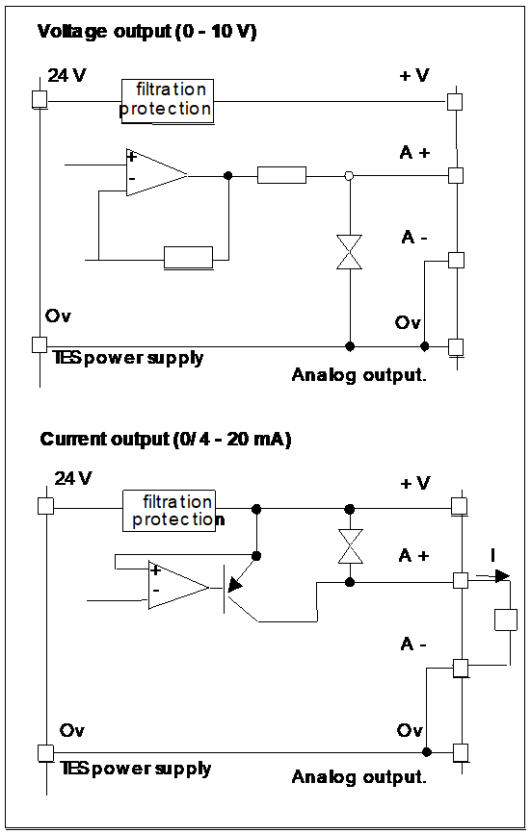
Simplified diagram of an analog input

Input section is protected against over voltage with two transils and a filter stop the 50 Hz.

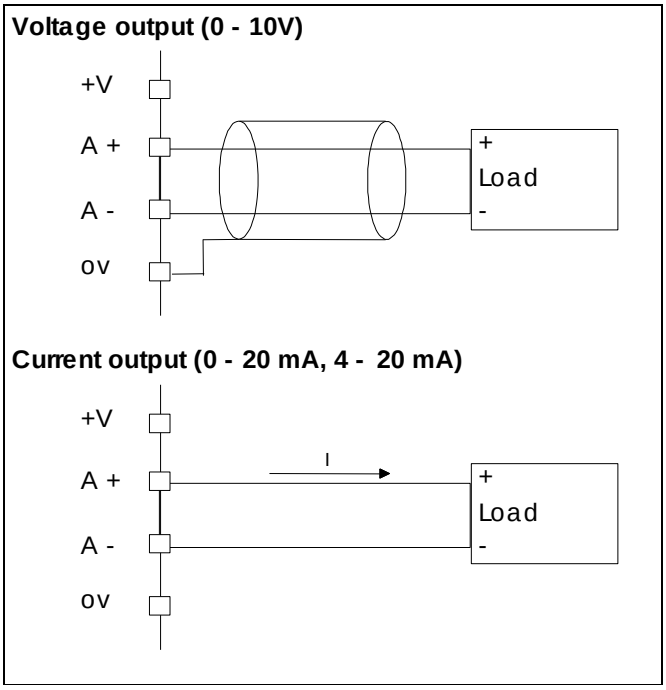
specification	4 EA	8 EA	8 ESA	Comments
Nb of analog inputs	4	8	4	Real differentials input
Input signals	0-10 v or 0/4-20 ma			
Input impedance				
- voltage input	1 M ohms			
- current input	100 ohms			
Digital resolution	10 bits			1024 points, de 0 to full scale
Precision	1/1000			After soft correction
Conversion time	250 micro seconds			
Acquisition time	8 ms/channel			
Attenuation 50 and 60 Hz	60 dB			
Admissible voltage on each input	10 V			Over this, transils are activated
Maximum error from 0 to + 55° C	0,3 %			Before soft correction
Isolation				
- between inputs	NO			OV common to all channels
- between inputs and UC	2500 V RMS			
- between inputs and serial links	2500 V RMS			
Power supply +V	24V+/- 10% - 1v			Protected with quick fuse 2A.

2.9 Analog output 0-20 mA and 0-10 V

Analog outputs convert numeric values calculated by TES CPU in voltage or in current depending on interfaces chosen.
A quick component protects each input section against over voltage.
Like for inputs, output sections are powered by TES, from it's own 24V, with filtration and protection circuits.



Simplified diagram of an analog output



	TES 8 ESA- I/U M 8ESA M 4SA	8 SA-U M 8SA-U	Comments
Nb of analog outputs	4	8	
Output signals	0-10 v or 0/4-20 ma	0 - 10 v	TES 8SA are only in voltage output.
Max load impedance	1K ohms	/	
Output current			
- max.	10 mA	/	
- short-circuit	20 mA	/	permanent short-circuit isn't destructive
Resolution	15 bits	15 bits	32.767 points from 0 to full scale
Conversion time	1 ms	1ms	
Calculation duration	64 ms	64 ms	refresh the 8 analog channels.
Max error	0,5 %	0,5 %	Of full scale.
- from 0 to + 55° C			
Isolation			
- between channels	NO	NO	Ov common to all channels
- between channels and CPU	YES	YES	2500 V RMS
- between channels and serial links	YES	YES	2500 V RMS
Power supply + V	Ua-1v	Ua - 1v	Ua TES voltage power supply, 24 V +/-± 10 %. Protected by quick fuse 2A.

2.10 RS232 and RS485 serial links

The TES has 2 independent asynchronous serial links. They use Modbus/Jbus RTU protocol with 2 different physical layers: serial link 0 uses RS422/485 and serial link 1 uses RS232.

The **RS232** serial link 1 allows direct connection to a PC. But it's not a multi-point connection. This port is more used "off-line" to configure or test the TES.

The **RS485/422** serial link 0 must be used to connect the TES through a Modbus network. More care must be taken to connect this type of serial link correctly. On the other hand, this serial link is more reliable and efficient than the RS232. It provides more noise immunity, higher speed and longer distances. It allows up to 30 devices to be connected in multipoint. The electrical standard used is the EIA RS485, which is compatible with the EIA RS422.

Terminal of SubD	RS232	RS422/RS485
1		Transmission +
2		Transmission -
3		OV
4	TES transmission	
5	0 V	
6		Reception +
7		Reception -
8		5V
9	TES reception	

2.11 Connection to RS485 network

2.11.1 Network connections

The TES's are connected in parallel on the RS-422/485 network through a 1 or 2 pair cable and ground screen. Transmission is half-duplex, multipoint and bi-directional. The protocol used is Modbus/Jbus master/slave. Disconnection or loss of power to a slave station doesn't affect the functioning of the network.

Cable type: telephonic cable with 2 or 3 twisted pairs, individual or general ground screen. SYT 1 type.

Maximum length of the connections to TES: They should be as short as possible l<=1m.
Ground screen: Only connect the 0V point of the master serial link to ground. You must assume there is continuity through the line.

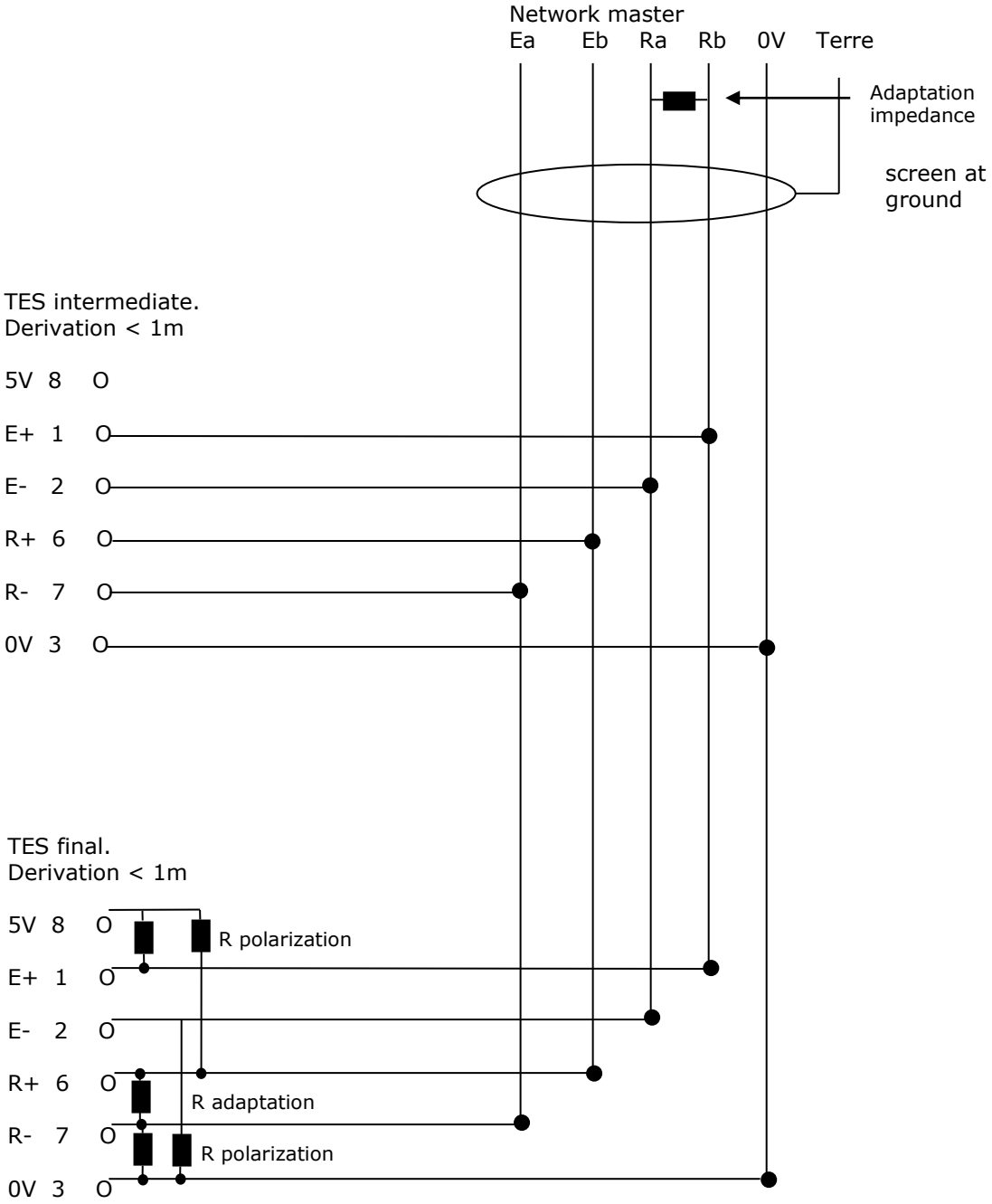
OV reference point of the master serial link must be connected to the external 0V point of each TES by a wire of the cable. This connection eliminates common mode voltage, which can be harmful for the transmission.

Line adaptation: an adaptation resistor must be connected on the reception side of each station on the 2 extremities of the serial link in order to improve communication. Use a 150 to 250 ohm 1/8W resistor. Sometimes this resistor is provided by the PLC communication controller and must be used when it is placed at the extremity of the network.

Line polarization: Line polarization is absolutely necessary to dictate the electrical level of the line when not activated. Otherwise the line could be in high impedance state, which is not functionally correct. You should place two or four 4.7 kohms resistors, if they are not already present, preferably near the master board. If necessary, this polarization can also be made on the TES.

NOTE: Be careful for the signals furnished by the master:
RS 422: every time double pair.
RS 485: can be on one or a double pair depending on constructor implementation.
TES communication module manages those 2 types of signals.

2.11.2 Connections in double pair RS422



R polarization between 4.7 and 10 kohm
R adaptation between 120 and 150 ohm

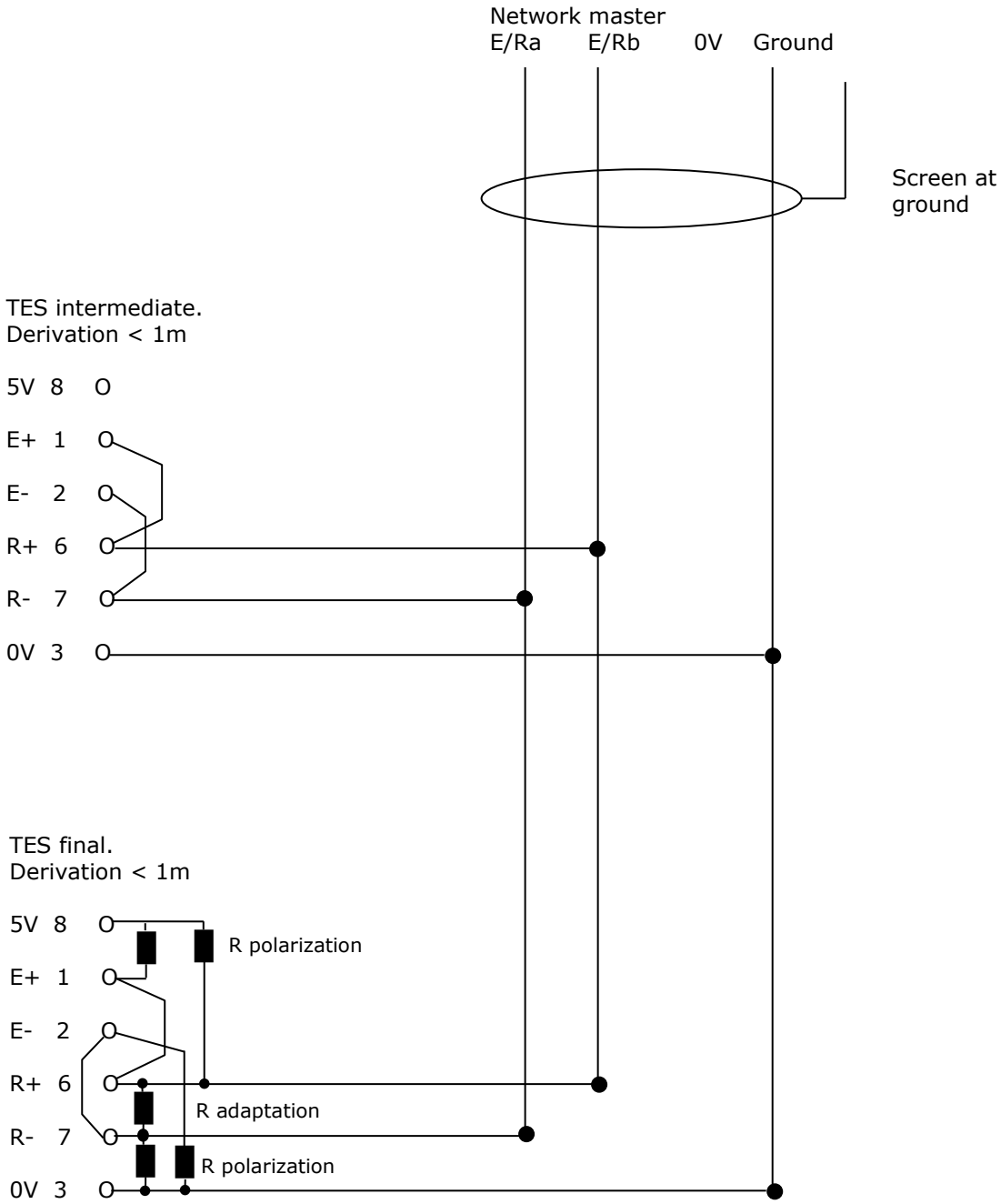
DETERMINATION OF CONNECTION SENSE:

Terminal a and b are concept as a:

- "0" logic (bit Start for ex) transmitted by the master will be traduce by Vb -Va < 200 mV.
- "1" logic (state low for ex) will be traduce by Vb -Va->= 200 mV.

But this sense of connection depends on implementation chosen by the master RS 422/485 constructor: isolation sections between terminals E/R and UART can invert logic sense: you have to try!

2.11.3 Connection in RS485 single pair



R polarization between 4.7 and 10 kohm
R adaptation between 120 and 150 ohm

DETERMINATION OF CONNECTION SENSE:

Terminal a and b are concept as a:

- "0" logic (bit Start for ex) transmitted by the master will be traduce by Vb -Va < 200 mV.
- "1" logic (state low for ex) will be traduce by Vb -Va->= 200 mV.

But this sense of connection depends on implementation chosen by the master RS 422/485 constructor: isolation sections between terminals E/R and UART can invert logic sense: you have to try!

2.11.4 Leroy Automation "CF" cable

Leroy Automation can provide the final connection (CF) cable. It is equipped with

- a subD at one extremity
- free wires at other extremity for a connection on screw terminals
- an adaptation resistor of 120 ohm between terminal 6 and 7
- polarization resistors.

Function	SubD terminal	Wire colour
E+	1	WHITE with BLUE line
R+	6	WHITE with BROWN line
E-	2	GREEN with WHITE line
R-	7	BLUE with WHITE line
0V	3	WHITE with GREEN line

3 SPECIAL TES

3.1 MIRROR TES

It is a MODBUS/JBUS master which is able to duplicate very rapidly (less than 15 ms at 38400 baud) and on a long distance (a few kms) its inputs (outputs) on the outputs (inputs) of a standard TES. The numbers on its inputs (outputs) are the same as the numbers on the outputs (inputs) of the standard TES, that is mirrored with.

3.1.1 Wiring

On RS485, mirror TES and TES standard slave are wired in front to front.
Terminals R- on terminals E-, terminals R+ on terminals E+ .
0 V of serial links are connected to eliminate common mode potentials.
Mirror TES assure in internal pre polarizations (+ and -) of network; wire adaptation resistor Ra at each side of network must be set.

Connection length:
The length of the link may be up to 4500 meters at a baud rate of 38 400. Longer distances can be used with the same speed or less, but testing is necessary.

3.1.2 Parameters

- **IMPORTANT**: 2 parameters are imperative for the standard TES. It must have
- - slave no 1
- - transmission format: 8 bits of data, even parity, 1 bit stop
- - enough waiting time depending on communication speed

TES MIRROR set up is then automatically made

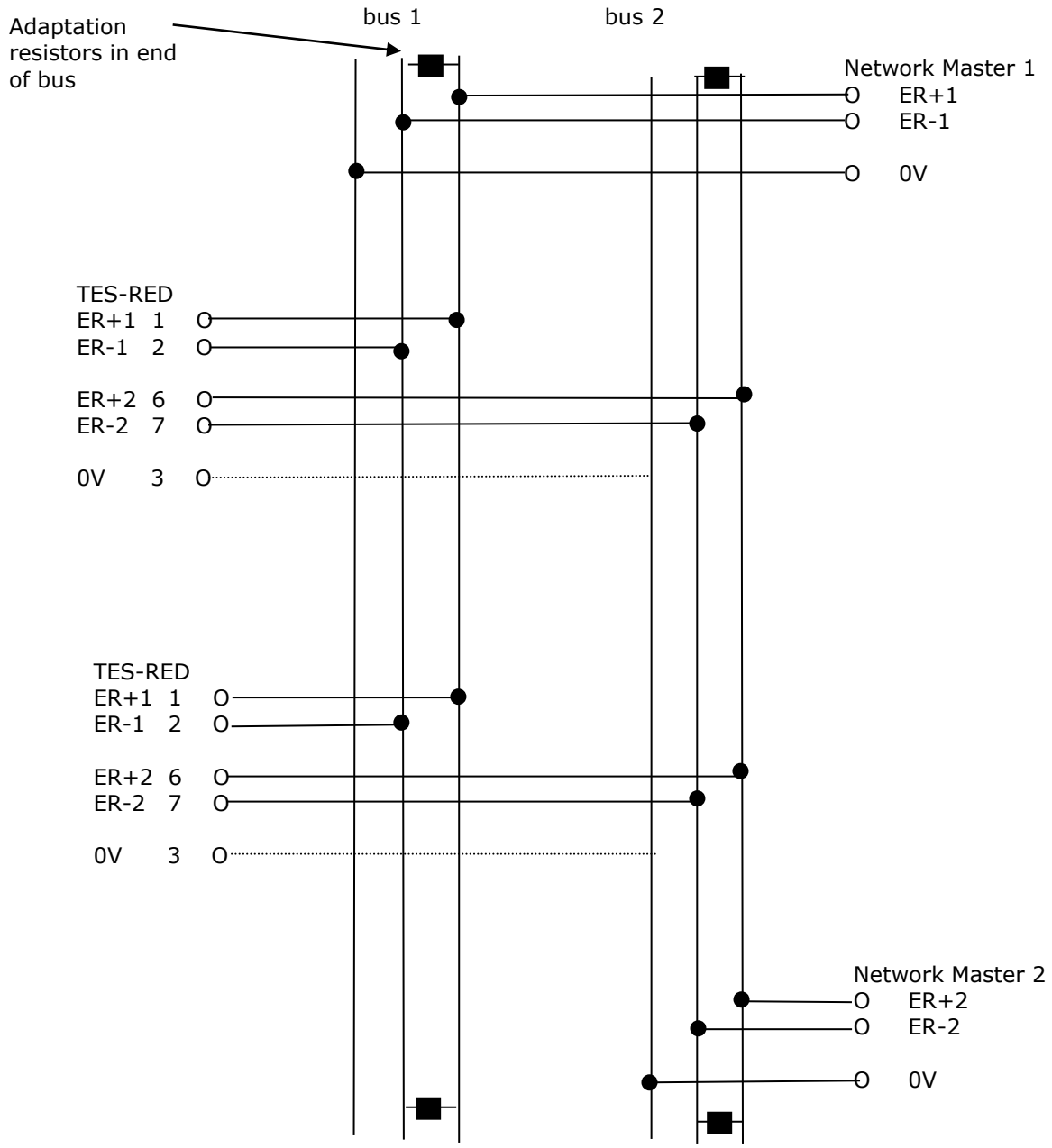
It tests the different baud rates until it can communicate with the standard TES on the 2 serial links (RS232 and RS422): RS422/485: 1200 to 38400 ; RS232 : 150 to 9600

As soon as the connection is made, the mirror TES imports the following parameters:
- Time out delay to monitor the serial link. Make sure that the delay of the standard TES is programmed accordingly to the delay between 2 queries in case of a small baud rate (4800 and less).
- Debouncing time of the logic inputs: mirror TES will use the same delay as the standard TES it is connected to.
Analog channels: on analog standard slave TES let the default parameters.

3.2 TES - RED: twin bus RS485

TES-RED may be used where the application requires a high degree of reliability. The twin bus minimizes the risk of serial link break down. It allows two Modbus/Jbus masters, not active at the same time, to have remote I/O through two independent buses. The two buses may have different routes through the factory.

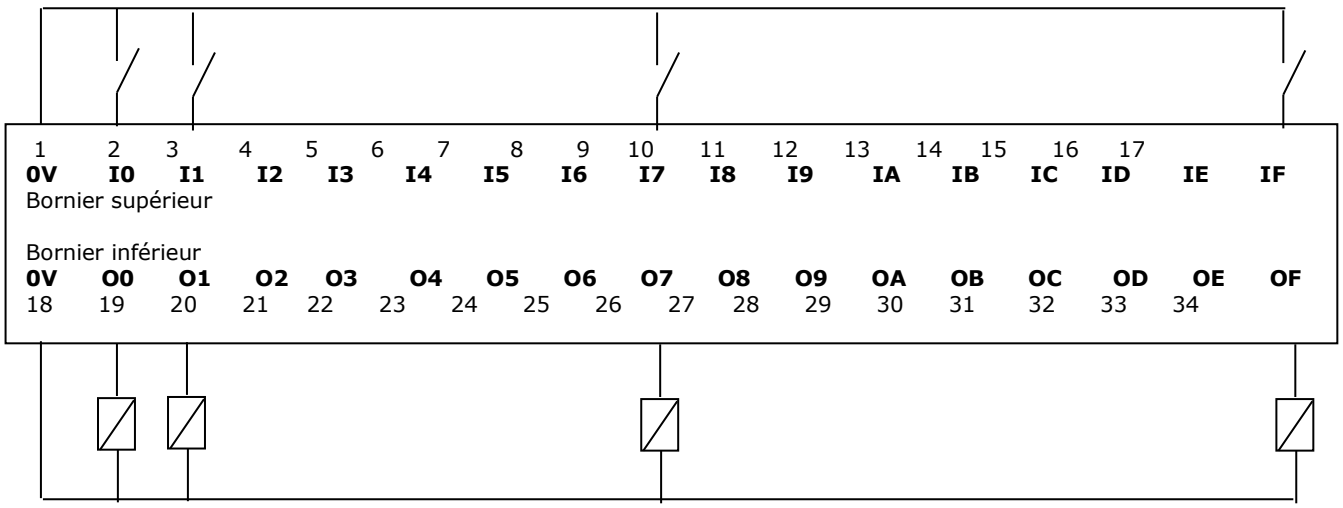
These TES's are software configurable and have the same memory mapping as standard TES's.
Only the serial link connection (RS-422/485 one pair) is special.


Adaptation
resistors in end
of bus
bus 1
bus 2
Network Master 1
O ER+1
O ER-1
O 0V
TES-RED
ER+1 1 O
ER-1 2 O
ER+2 6 O
ER-2 7 O
0V 3 O
TES-RED
ER+1 1 O
ER-1 2 O
ER+2 6 O
ER-2 7 O
0V 3 O
Network Master 2
O ER+2
O ER-2
O 0V

4 Wiring

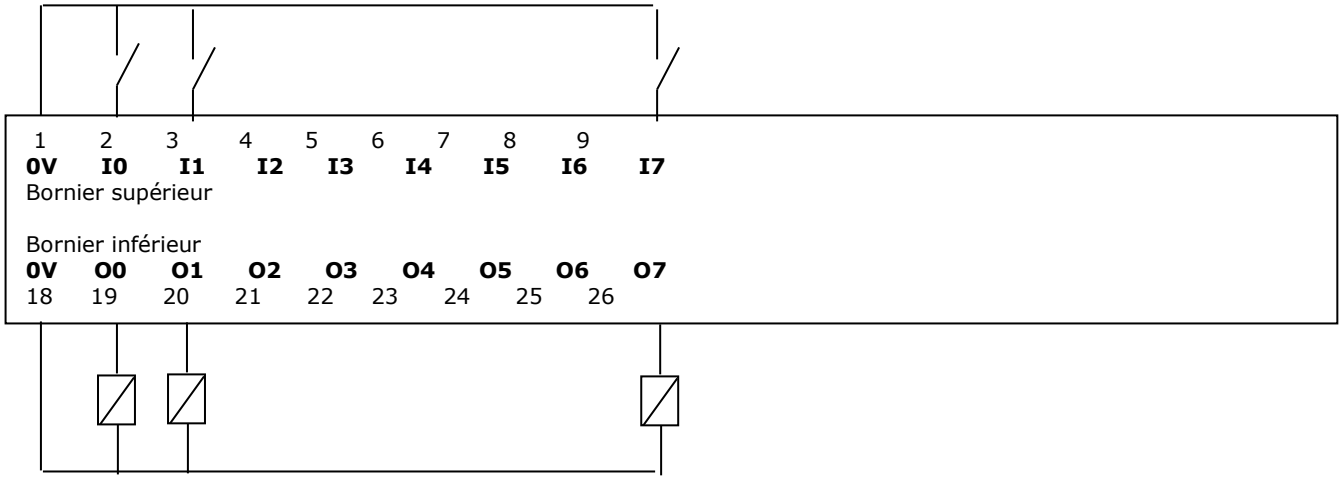
4.1 TES 32EST : 16 digital inputs, 16 digital outputs

16 digital inputs type N, Common = 0V . 16 digital outputs, Common = 0V



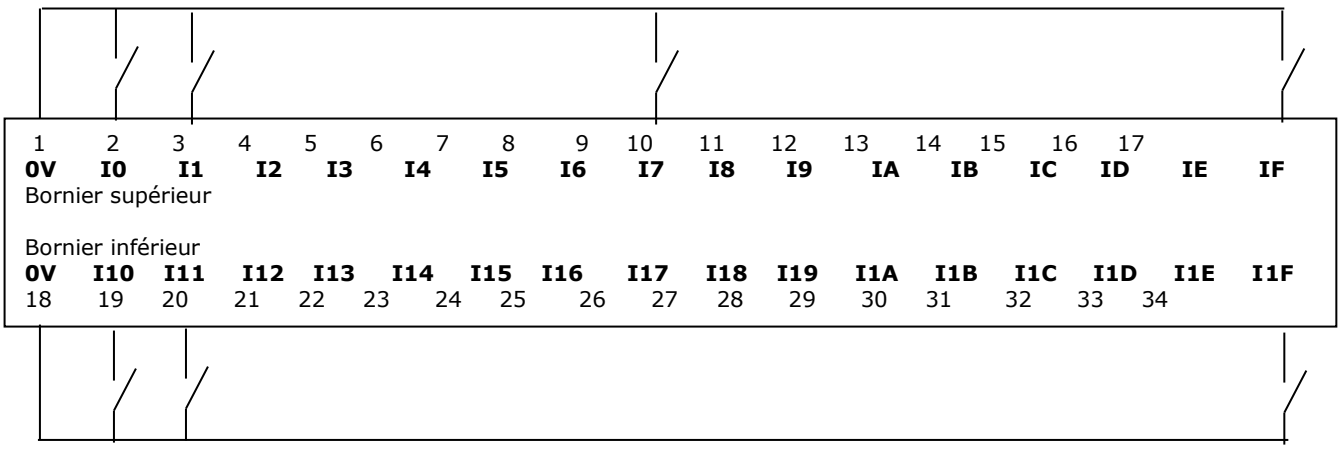
4.2 TES 16EST : 8 digital inputs, 8 digital outputs

8 digital inputs type N, Common = 0V . 8 digital outputs, Common = 0V



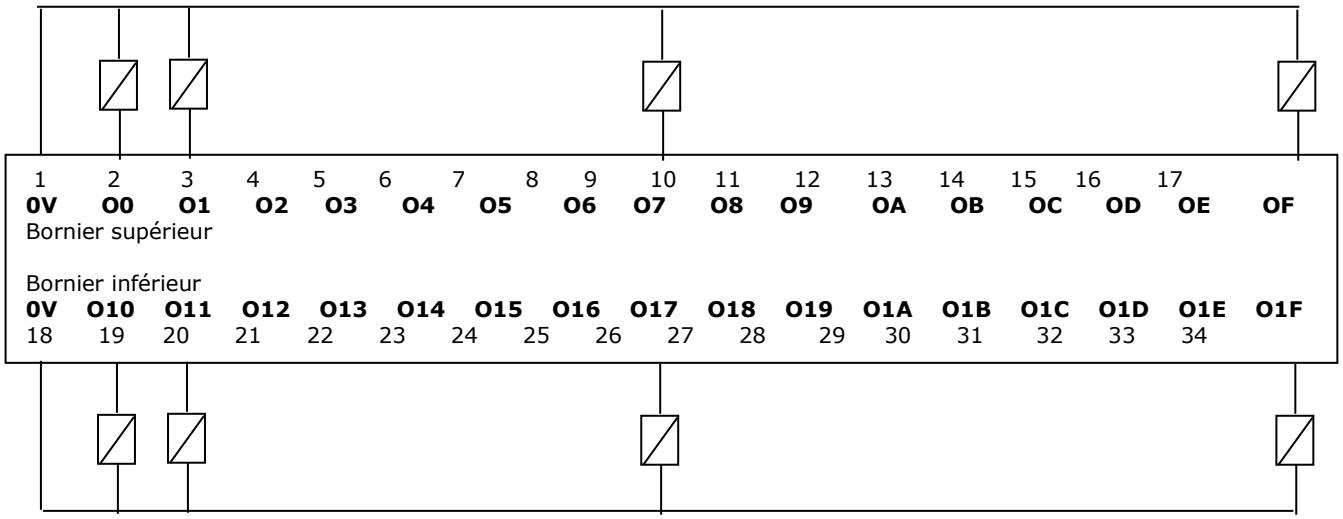
4.3 TES 32ET : 32 digital inputs

32 digital inputs type N, Common = 0V . V



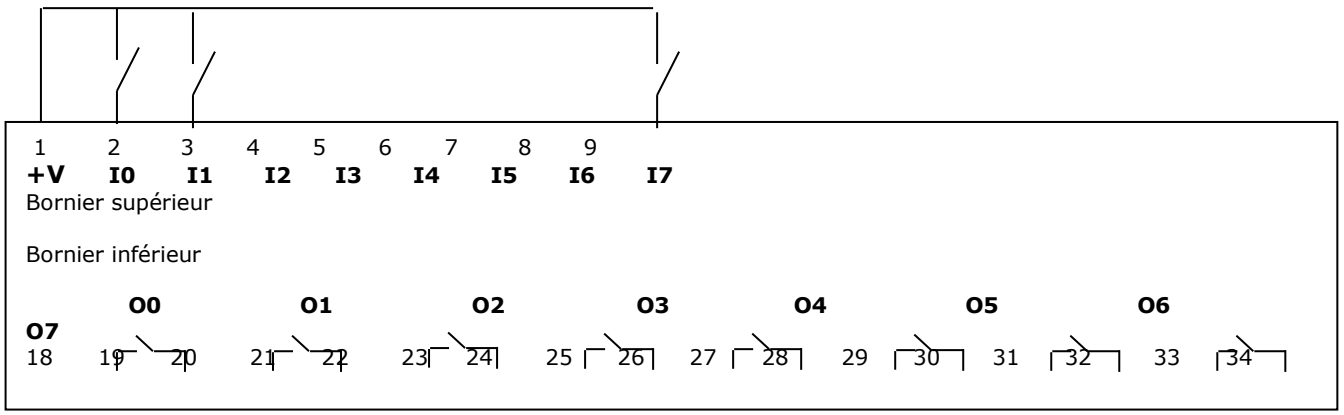
4.4 TES 32ST : 32 digital outputs

32 digital outputs, Common = 0V



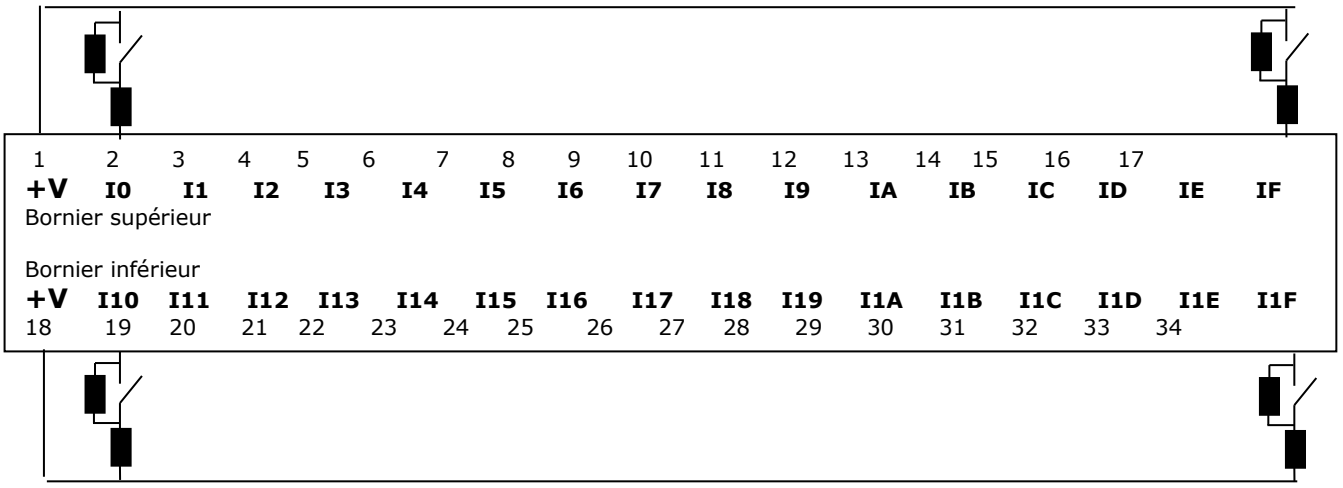
4.5 TES 16EST REM : 8 digital inputs, 8 relay digital outputs

8 digital inputs type P, Common = +V

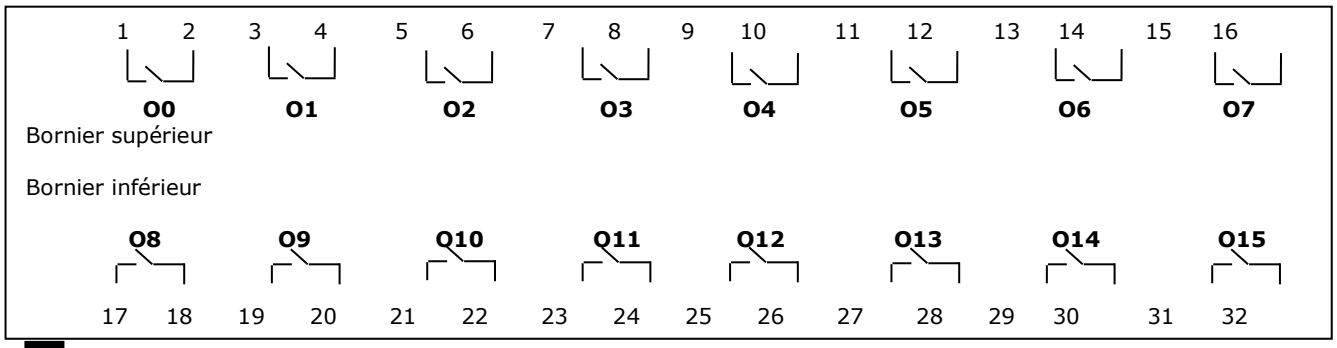


4.6 TES 32ET-S : 32 digital inputs with sensor wire checking

LEROY AUTOMATION hasn't sold any more this reference since 1st January 2009



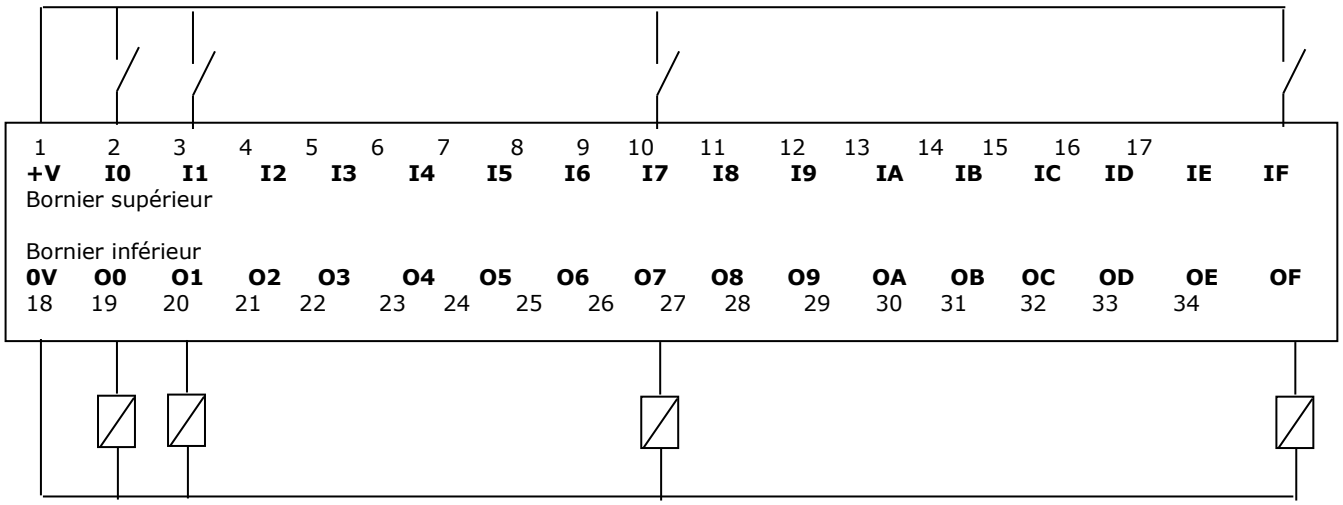
4.7 TES 16 REM : 16 relays (passive extension) with TES32EST or 32ST



Câble de liaison venant du TES associé

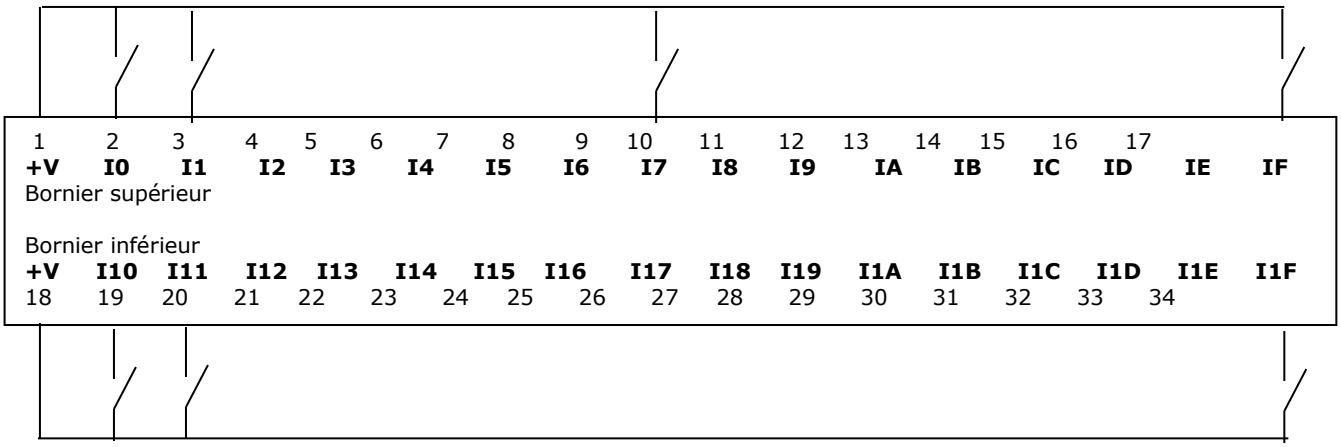
4.8 TES M 32EST : Mirror TES with basic TES 32EST

The inputs of this reference have been N type since 1st January 2009. Cf chapter 4.1.
16 digital inputs type P, Common = +V . 16 digital outputs, Common = 0V



4.9 TES M 32ET : Mirror TES with Basic TES 32ST

The inputs of this reference have been N type since 1st January 2009. Cf chapter 4.3.
32 digital inputs type P, Common = +V



4.10 Analog TES

4.10.1 Digital inputs/outputs

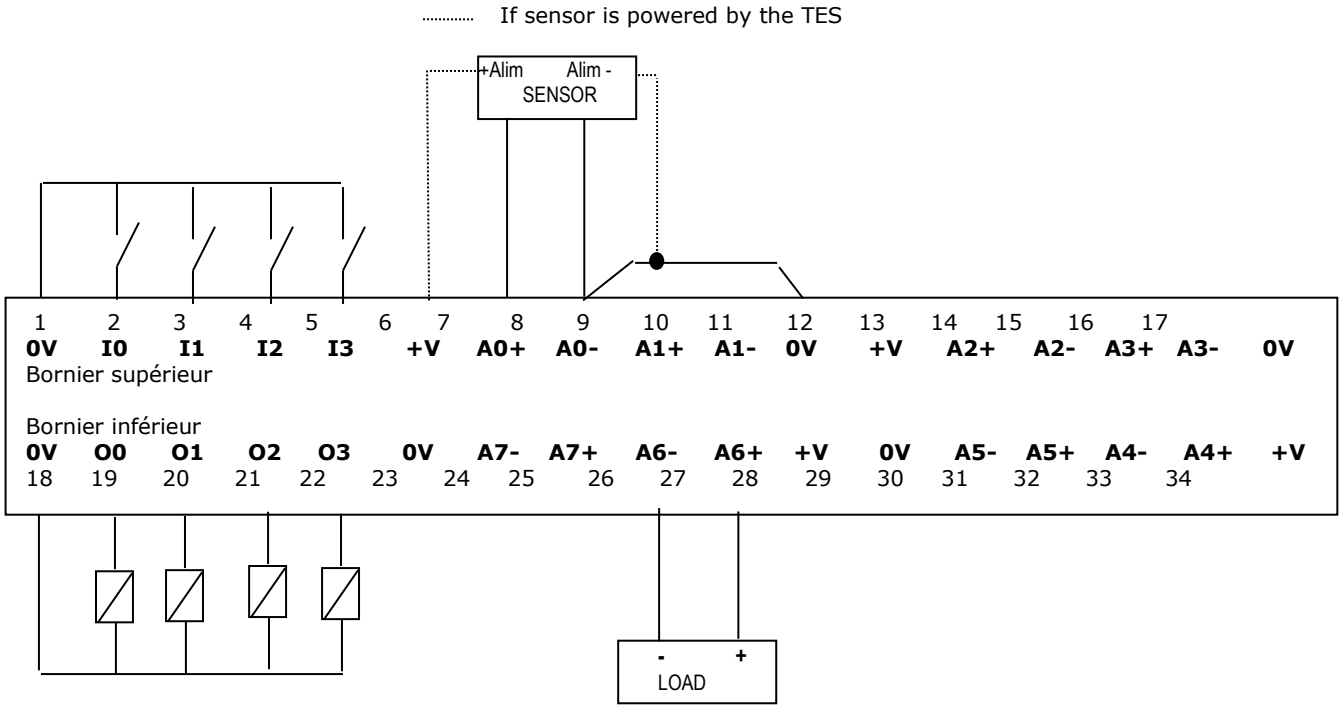
4 digital inputs I0 à I3 and 4 digital outputs O0 à O3

NOTA : on Mirror Analog TES, 0V terminal is marked « Com »

4.10.2 Analog inputs

Voltage Input : if U (A+) > U(A-) then the measure is positive.

Current input : if the current come out from A+ terminal and come in the A- terminal then the measure is positive.



4.10.3 Analog outputs

Voltage output 0-10V : U (A+) > U (A-)
Current output 0-20mA : Current OUT = A+ ; Current IN = A-