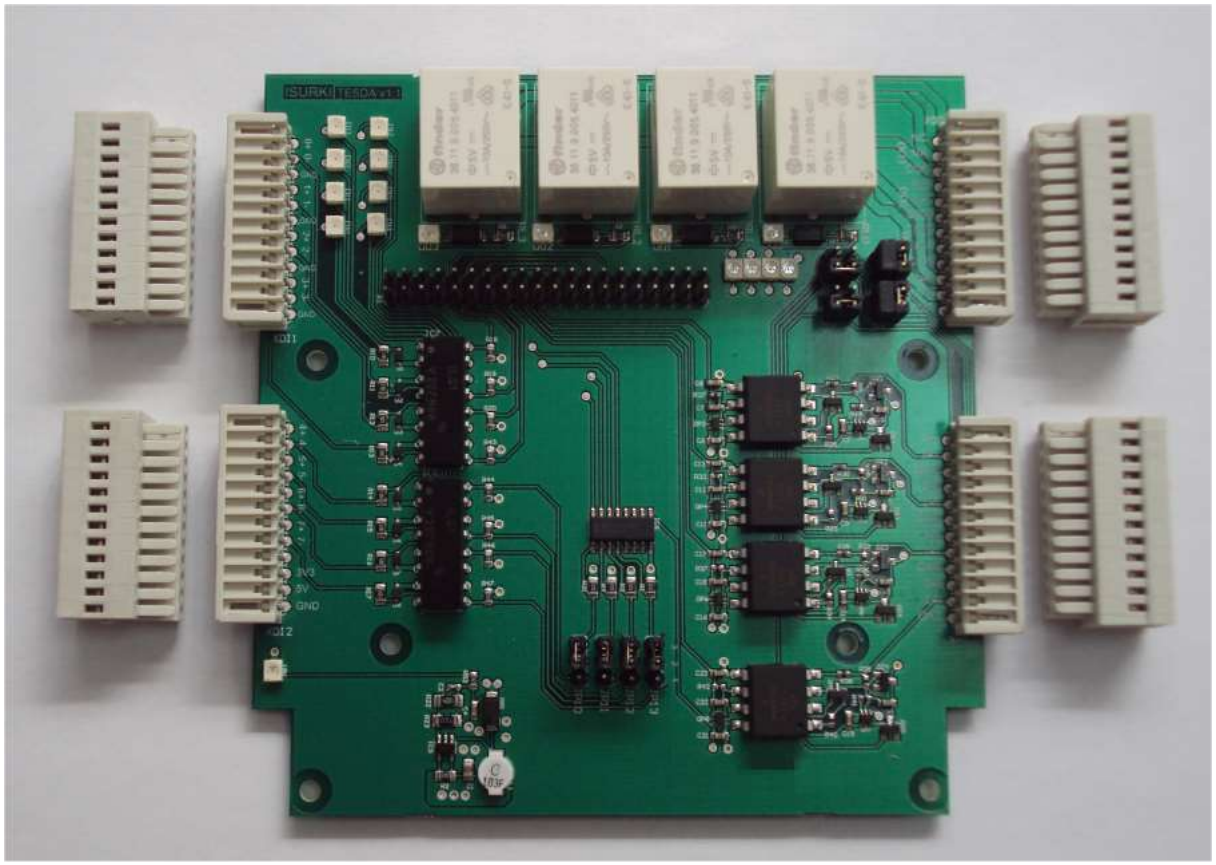
TESDA v1.1



DIGITAL AND ANALOG

INDUSTRIAL INPUT & OUTPUTS BOARD

FOR *IRIS BOX PC* EMBEDDED COMPUTER

USER MANUAL

SUMMARY

1 INTRODUCTION

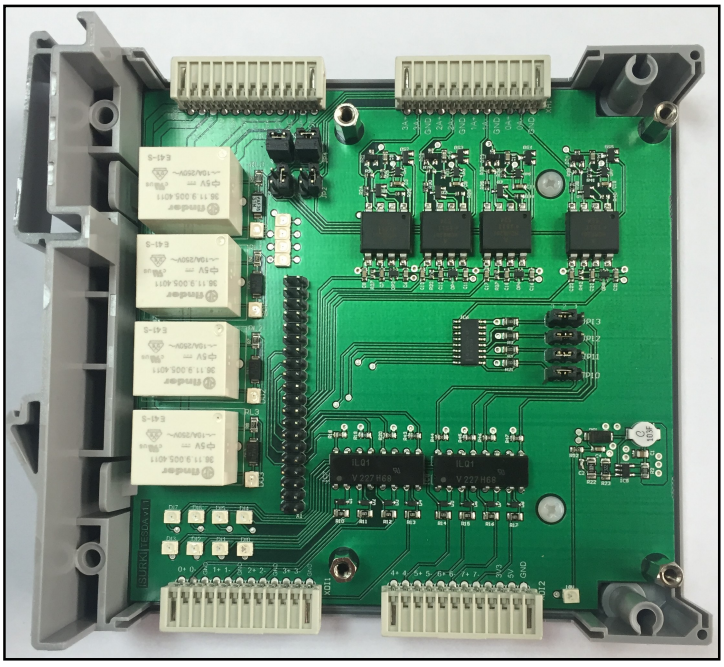
This User Manual concerns the ISURKI's developed and manufactured TESDA digital & analog input/output board designed for interfacing the IRIS BOX PC embedded computer (hereinafter referred as IRIS BOX PC) with a harsh industrial environment of devices, such as sensors, detectors, actuators, valves, drives,....

1.1 FEATURES

The TESDA card directly interfaces with the X16 EXTENSION CONNECTOR of the inner IRIS carrier board, providing:

- Auxiliary power of 3.3 and 5.0 volts dc.
- 8 digital inputs, for voltage free contacts or passive detectors (i.e., proximity inductive detectors) with included 18 Vdc auxiliary supply.
- 4 pin to pin configurable digital input/outputs. Digital outputs are relays with 1 SPDT contact with 6 A switching power.
- 4 x 4-20 mA analogue inputs, 12 or 16 bits resolution (SoM dependant), one by one configurable as active or passive signals, with included 18 Vdc auxiliary supply.

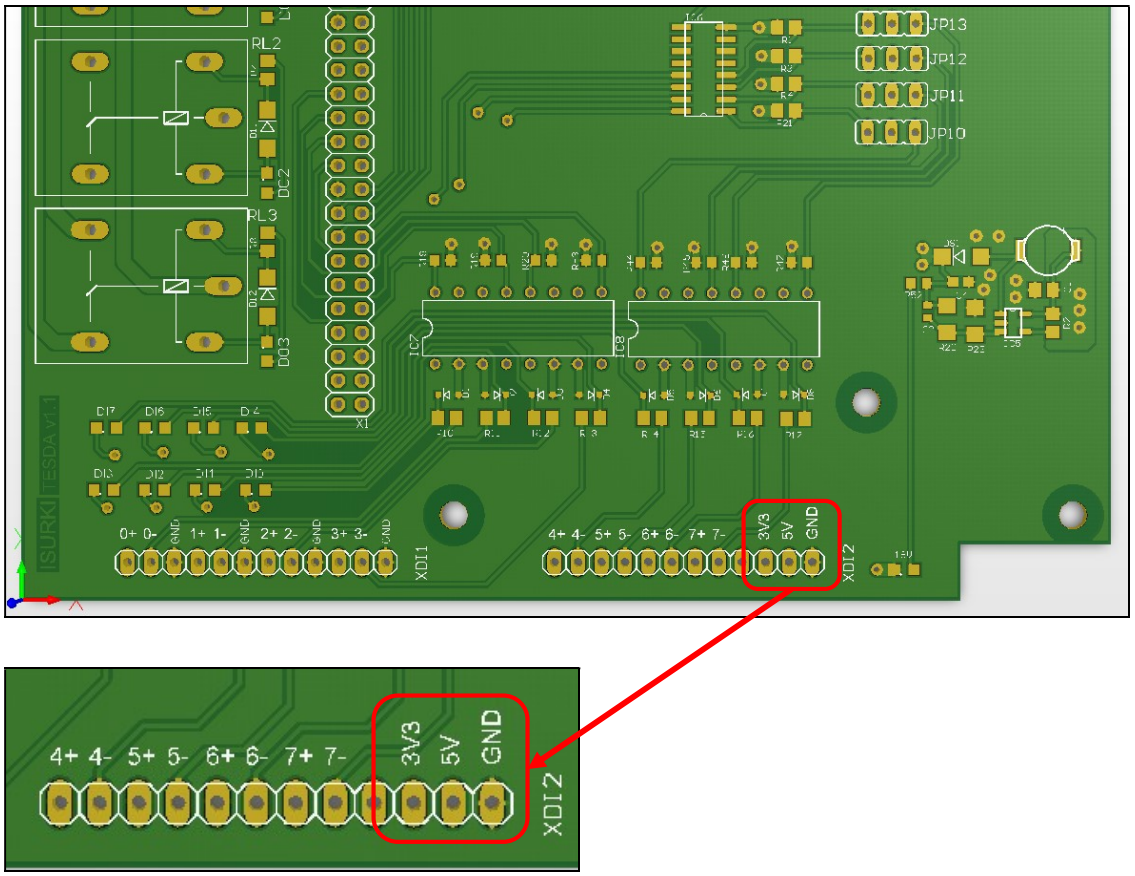
1.2 UPPER VIEW LAY OUT



2 AUXILIARY POWER SUPPLIES

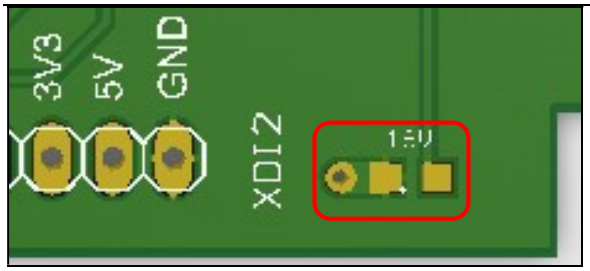
TESDA provides the user with two auxiliary power supplies for his/her use with the next output ratings: 3.3V/2A and 5V/2.5A. Exceeding this limits may cause card misfunction or permanent damages.

Detachable connection terminals are located at the bottom left corner of the card:



In case of using both auxiliary sources at the same time, the ground (GND) terminal should be shared..

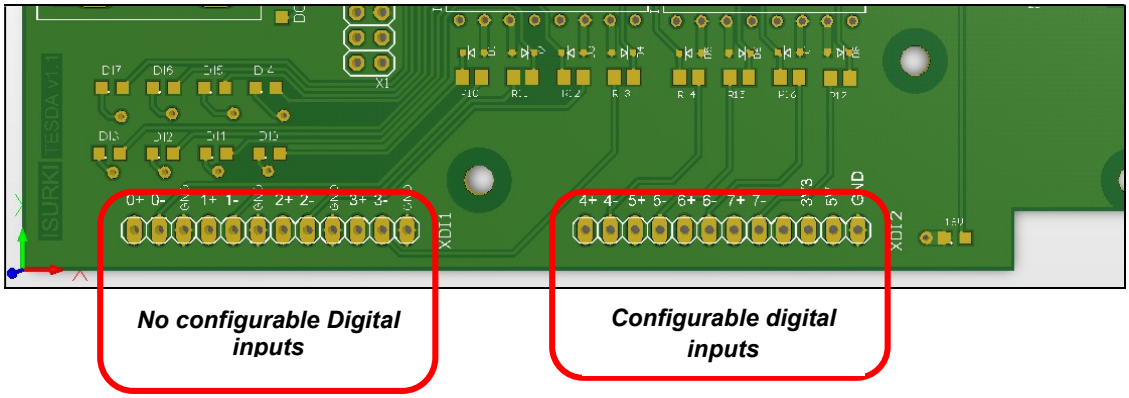
TESDA also includes an 18 Vdc power supply for energizing passive detectors and sensors. The state of service of this 18 Vdc auxiliary power supply can be monitored throughout the led located at the botton right corner of the board.


3V3
5V
GND
XDI2
1-Wire

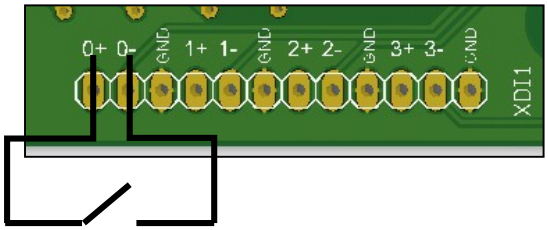
3 DIGITAL INPUTS

The TESDA board provides 4 digital inputs which connection detachable terminal **XDI1** is located at the bottom left of the card.

These digital inputs allow the connection of industrial field devices such as voltage free contacts, passive and active detectors (photocells, inductive detectors, …), ….

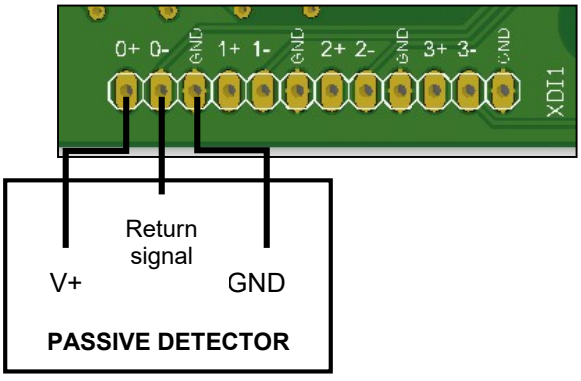


- The connection of voltage free (dry) contacts is as follows:



In the above mentioned case, the connection can be done without any polarity consideration.

- When connecting detectors that require supply from an external source, the next connection diagram applies:



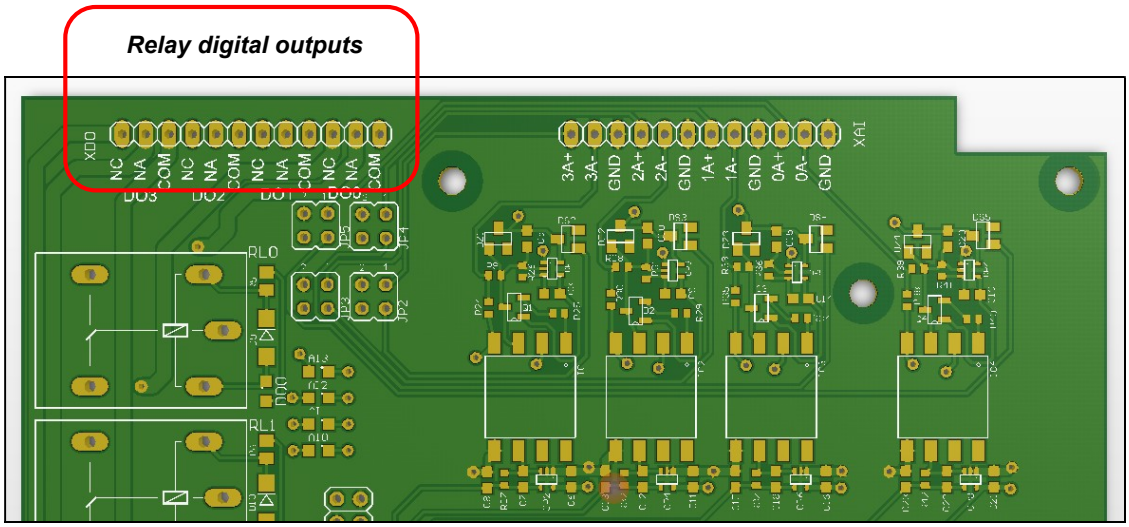
In the above mentioned example, the 18 Vdc excitation to the detector is given through the 0+ and GND pins of the board. The output signal of the detector inputs the board through the 0- pin. For the rest of digital inputs, the diagram is equivalent.

The 4 digital inputs operation is according to a *positive logical* criteria, which means that Return signal = V+ corresponds to a high logic level.

4 USER CONFIGURABLE DIGITAL INPUTS AND OUTPUTS

Additionally, the TESDA board provides 4 jumper configurable digital input/output points.

For the input configuration, the detachable **XDI2** connector is located at the bottom right corner of the board (as explained in the previous topic) and, when used as relay digital outputs, at the top left corner with **XDO**, as shown in the below picture.

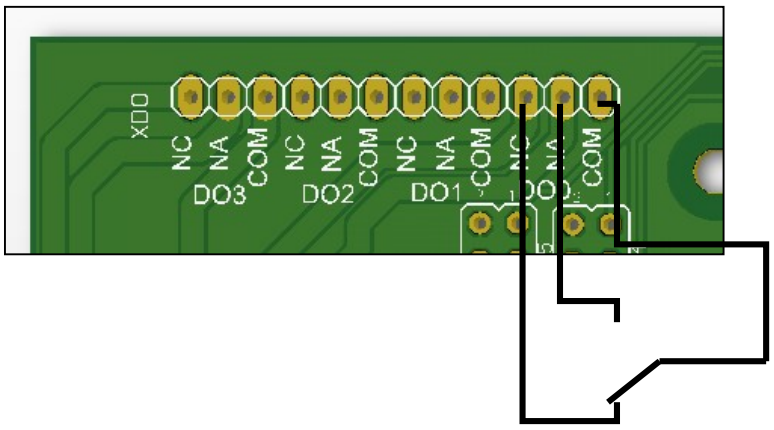


4.1 DIGITAL INPUTS

The four configurable digital inputs only can be connected to voltage free (dry) contacts, therefor, with no polarity considerations to be taken in account and with the same connection criteria as the stated in the case of the fixed digital inputs:.

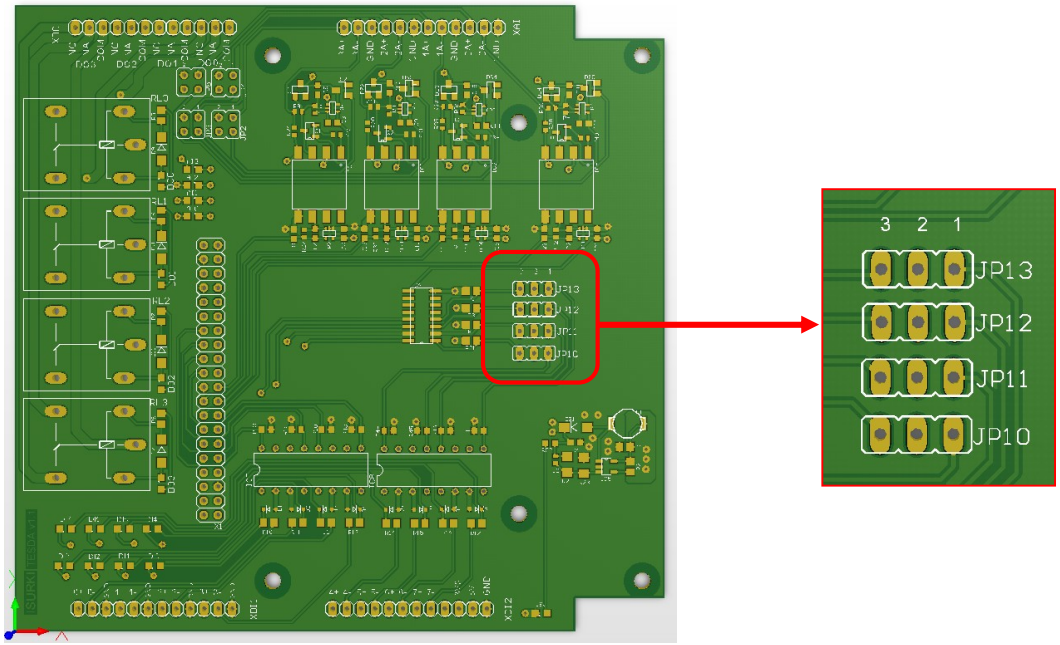
4.2 RELAY OUTPUTS

The relay outputs provide one dry switched contact (Normally open + normally closed) with one pin for the NO contact (marked as NA in the board), another pin for the NC contact (marked as NC in the board) and a third pin for the common terminal of the contact (COM in the board), according to the next schematics:



4.3 CONFIGURATION AS INPUTS OR OUTPUTS

The set up of the configurable digital inputs/outputs is done with the jumpers 10, 11, 12 and 13 located at the right side of the board.



Jumpers 10, 11, 12 and 13 allow to select if four configurable digital points will work as input or output. Shortcircuiting the pins 1 and 2 of the jumper configure the point as input. On the other hand, connecting the pins 2 and 3 will configure the point as an output. To summarize:

- **JP10** selects the first configurable point as DI4 or DO0.
- **JP11** selects the second configurable point as DI5 or DO1.
- **JP12** selects the third configurable point as DI6 or DO2.
- **JP13** selects the forth configurable point as DI7 or DO3.

4.4 CONSIDERATIONS REGARDING DIGITAL OUTPUT #3 (DO3)

The relay output #3 is linked to the Colibri SODIMM pin **CLK12M_OUT** signal, which holds by default a high logic value with the processsor start up, leading to the relay activation when powering up the system and possibly causing, if not properly controlled, undesired or even risky situations on field actuators.

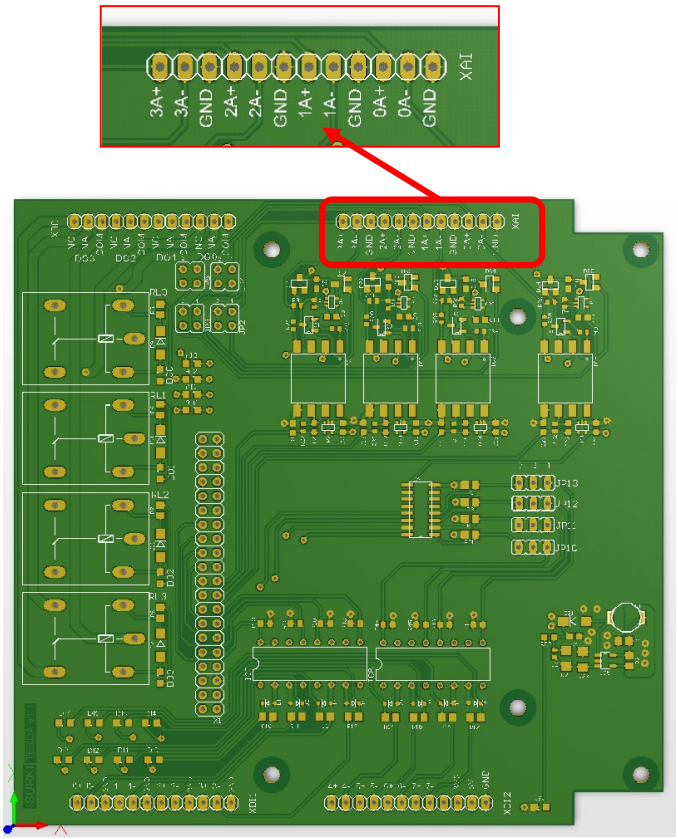
The default start up value of the GPIOs when booting the module can be consulted in the nex Toradex web page link: http://developer.toradex.com/knowledge-base/bootloader-customizer-kit

5 ANALOG INPUTS

5.1 CONNECTION

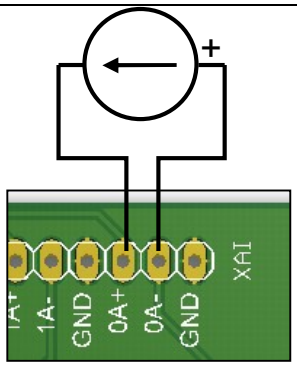
The TESDA analogue inputs allow the user the connection of both active and passive 4-20 mA transducer with a simple on board set up.

The detachable analogue input **XAI** connector is located at the right top of the TESDA board:

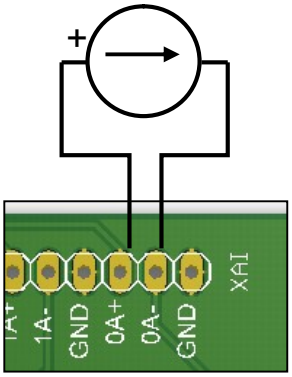


The connection procedure of a 4-20 mA current loop sensor is different depending on if it requires external excitation (passive sensor) or not (active). For the first case, the TESDA board provides a high quality industrial 18 Vdc auxiliary supply. The next drawings illustrate this concern, based on the first analogue channel marked as AI0:

- Passive sensor connection example: The positive terminal of the sensor is connected to the **0+P/0-A** board terminal and the negative to the **0-P/0+A**.

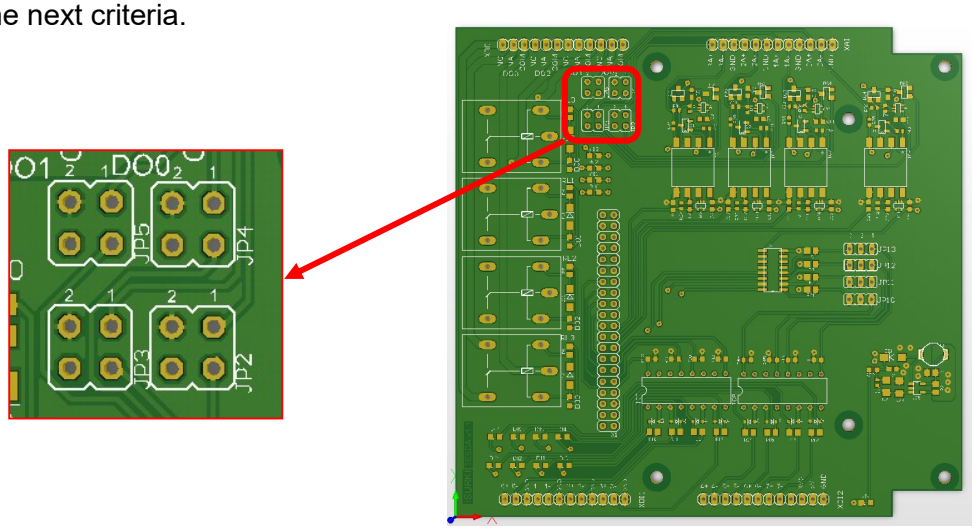


- Active sensor connection example: The positive terminal of the sensor is connected to the **0+A/0-P** board terminal and the negative to the **0-A/0+P**.



In both cases, the cable shield should be connected to the GND board terminal.

The set up between active or passive mode is done with the **JP2**, **JP3**, **JP4** y **JP5** jumpers, located just below the connection **XAI** terminal, as shown in the next picture and according to the next criteria.



- Set up as passive sensor: connect pin 1 to pin 2; connect pin 3 to pin 4.
- Set up as active sensor: connect pin 1 to pin 3.

The correspondence between analogue channels and jumpers is as follows:

- **JP2** for analogue input 3 set up.
- **JP3** for analogue input 2 set up.
- **JP4** for analogue input 1 set up.
- **JP5** for analogue input 0 set up.

 https://youtu.be/KaBh4xRarmk Introductory video

 https://youtu.be/rOiRODY-2c4 Hardware and connectivity

5.2 ANALOG INPUTS CALIBRATION

ISURKI provides the TESDA user with free software tools and libraries for the real time automatic read out and calibration of the ADC converters of the four analog channels, featuring:

- Continuous acquisition and read out in resolution points (0 to 4096) and eletric units (0 to 3000 mV or 4 to 20 mA, depending on the mounted processor).
- Conversion to user defined engineering units.
- Configurable filtering for smooth acquisition.
- Board calibration generating a text file report.

All TESDA boards are supplied from factory with a high accuracy personalized calibration report of the four analog channels in a text file format.

 For using the free software tools provided by ISURKI, the TESDA board should be connected to an IRIS board or IRIS BOX PC with a Tegra or Vybrid TORADEX processor with Windows CE installed.

If required, the user can perform his/her own calibration, getting the ADC resolution points in the range 0 to 4096 (12 bits), corresponding to the zero (4 mA) and full scale sensor signal (20 mA) of each channel. The next tools would be required:

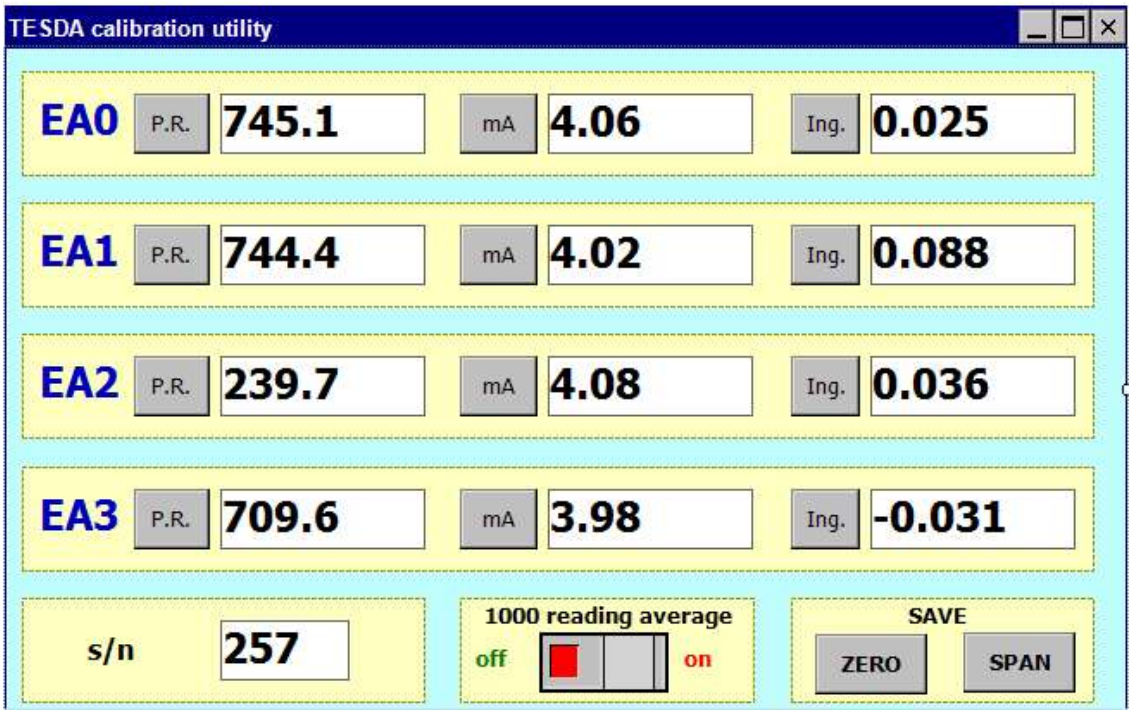
- A laboratory 4 to 20 mA current loop accurate generator.
- The free software tool provided by ISURKI.

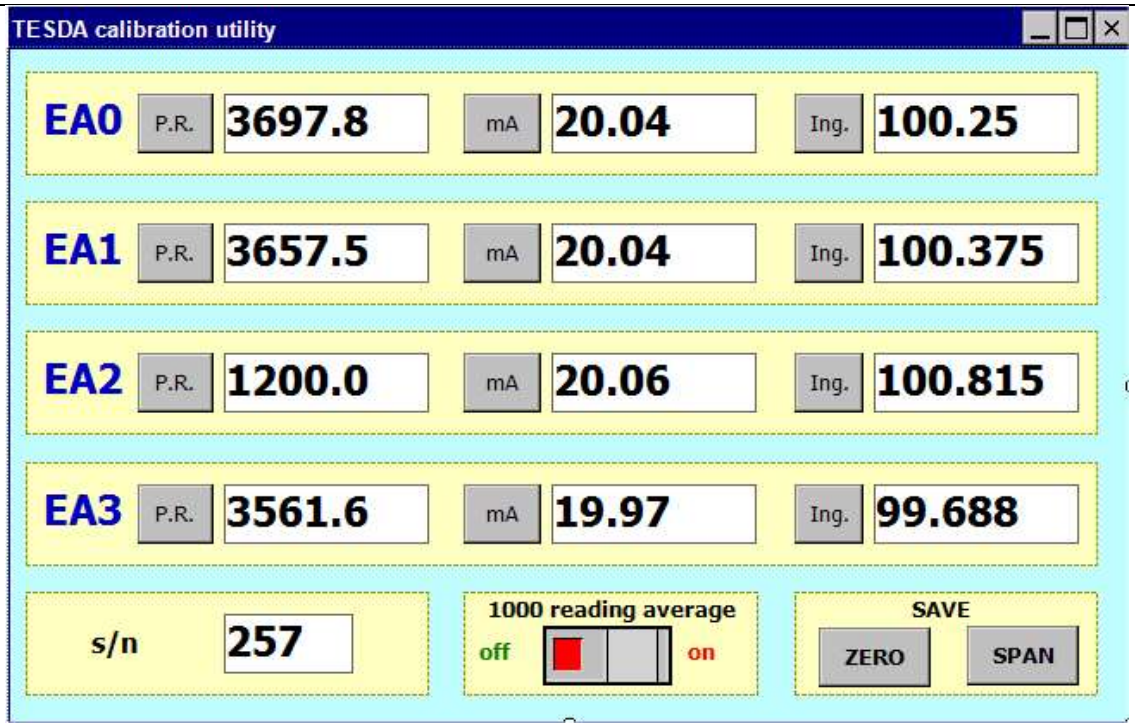
video tutorial: https://youtu.be/eQ-MO9GU0mU

There are two different calibration software tools depending on the type of processor used.

5.2.1 Analog inputs calibration utility for TEGRA processor based units

Attached below you can see a couple of screenshots of this tool, showing respectively the resolutions points obtained for the offset and span calibration.

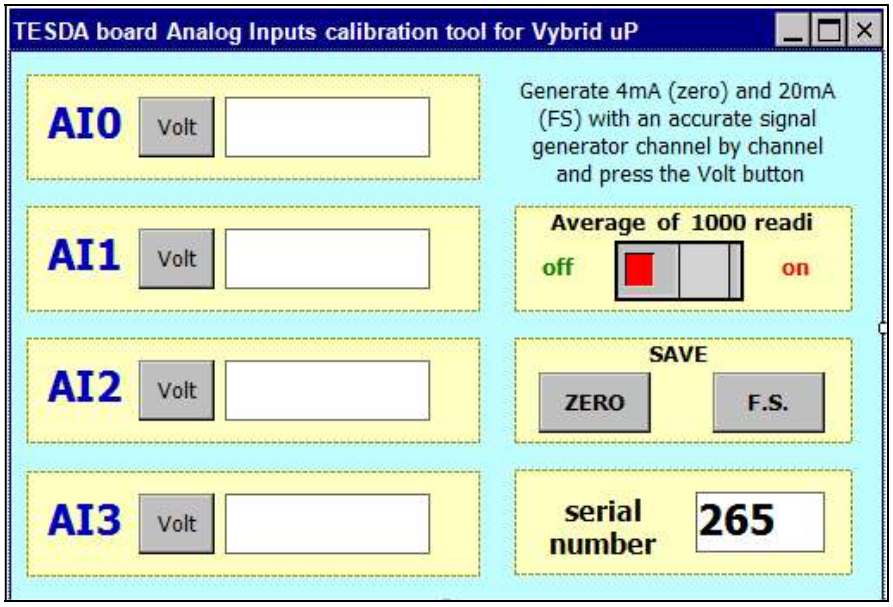




Using the ZERO and SPAN buttons located at the bottom right corner of the window the user can save the calibration results into a text format file.

video tutorial: https://youtu.be/dL_RkQIQQ_c

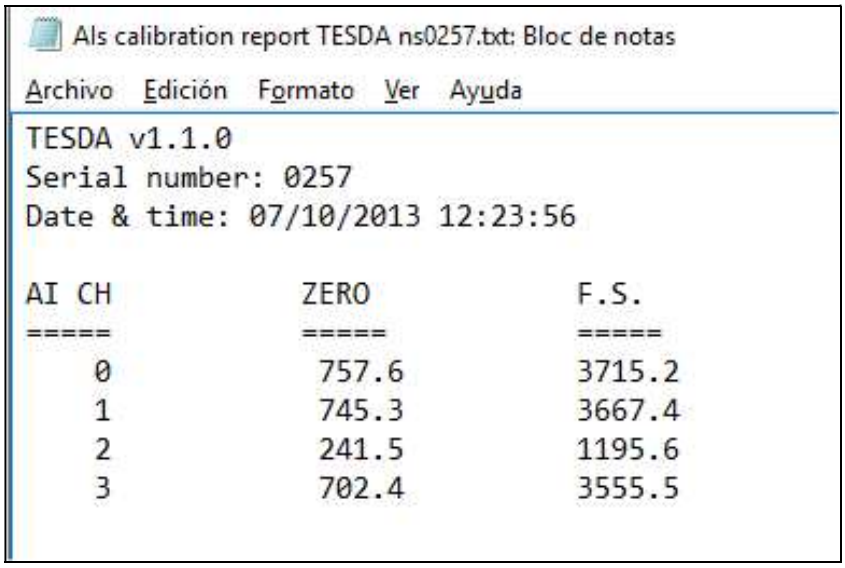
5.2.2 Analog inputs calibration utility for VYBRID processor based units



video tutorial: https://youtu.be/NYq4iT8rXzE

5.2.3 Calibration report

In both of the above mentioned cases, the utility automatically creates a .txt file based calibration report with the obtained values after pressing the ZERO and F.S. save buttons as explained in the tutorials, for future use with the analog input acquisition library. The next picture shows one example of this report.



5.3 ANALOG INPUTS READ OUT

There are different libraries available depending on the the kind of processor used, but either it is a Tegra Txx or a Vybrid VFxx, they clearly simplify the acquisition and control tasks.

5.3.1 Analog input library for Tegra processors

Let's see the case of the library provided for Tegra processors. The estructure or sintax of the read-out function is defined as follows:

TESDA_ea.TESDAea.EAX_mA(ByVal *NumMuestras* as Integer, *EAX_PR_Cero* as Double, *EAX_PR_FE* as Double) as Double

Where:

- *X*: corresponds to the analog channel (from 0 to 3) which reading is sought.
- *NumMuestras*: It is the number of the necessary acquisitions values to calculate an averaged value as raw data before proceeding with its conversion. The higher this value is, the smoother and more representative the calculated value is and the refresh time is.
- *EAX_PR_Cero*: Number of points of resolution of the ADC converter for the X selected analog channel, ranging from 0 to 4096, for a zero input signal of 4 mA.
- *EAX_PR_FE*: Number of points of resolution of the ADC converter for the X selected analog channel, ranging from 0 to 4096, for a full scale input signal of 20 mA.
- *ReturnValue*: analog input channel read out in mA.

***TESDA_EA.DLL* LIBRARY FOR TEGRA PROCESSORS LIST OF AVAILABLE FUNCTIONS**						
Sintax of the function	**Parameters**					**Result**
	Par1	**Par2**	**Par3**	**Par4**	**Par5**	**Return Value**
TESDA_ea.TESDAea.**init**()	-	-	-	-	-	Success / Failed (*boolean*)
TESDA_ea.TESDAea.EAX_**PunRes**(Par1)	Number of samples (*integer*)	-	-	-	-	AI read out in points res. (*double*)
TESDA_ea.TESDAea.EAX_**mA**(Par1, Par2, Par3)	Number of samples (*integer*)	Points of resolution for 4 mA (*double*)	Points of resolution for 20 mA (*double*)	-	-	AI read out in mA (*double*)
TESDA_ea.TESDAea.EAX_**Ing** (Par1, Par2, Par3,Par4, Par5)	Number of samples (*integer*)	Points of resolution for 4 mA (*double*)	Points of resolution for 20 mA (*double*)	User offset in eng. Units (*double*)	User full scale in eng.Units (*double*)	AI read out in user def. Units (*double*)
TESDA_ea.TESDAea.**DeInit**()	-	-	-	-	-	Success / Failed (*boolean*)
TESDA_ea.TESDAea.**Lib_Info**()	-	-	-	-	-	Version / author (*string*)

Where X is the number of the analog input channel, from 0 to 3.

5.3.2 Analog input library for Vybrid processors

In the case of Vybrid processors, the analog input library read out function estructure is as follows:

EAmVX = TESDA_ea_VFxx.TESDAea_vyb.EA_mV(HandlePuertoADCY)

Where:

- *X*: corresponds to the analog channel (from 0 to 3) which reading is sought.
- *HandlePuertoADCY*: ADC port address. *Y* corresponds to the ADC port (from 1 to 4) which addressing is sought
- *ReturnValue*: analog input channel read out in mV.

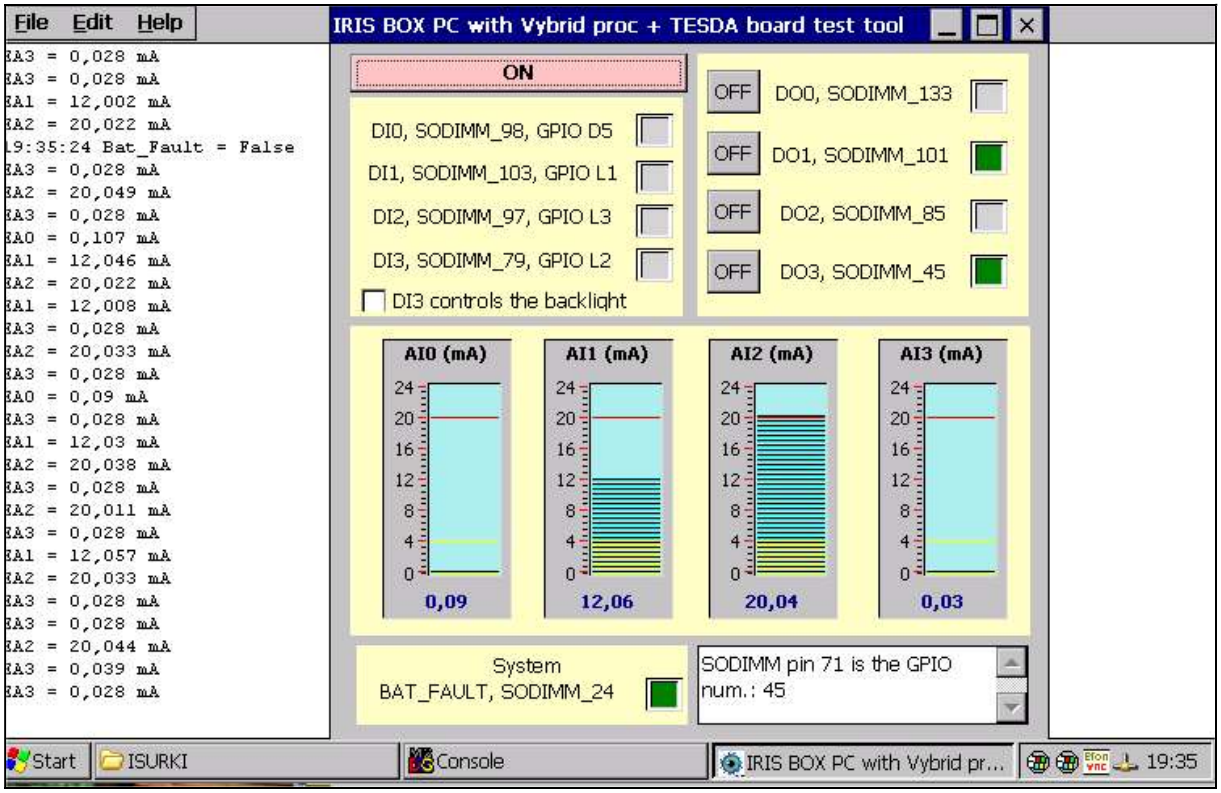
***TESDAea_vyb.DLL* LIBRARY FOR VYBRID PROCESSORS LIST OF AVAILABLE FUNCTIONS**						
Sintax of the function	**Parameters**					**Result**
	Par1	**Par2**	**Par3**	**Par4**	**Par5**	**Return Value**
HandlePuertoADCY = TESDA_ea_VFxx.TESDAea_vyb.**Init**(Par1)	"ADCY" (*String*)	-	-	-	-	HandlePuertoADCY (*IntPtr*)
SuccessOrFailed = TESDA_ea_VFxx.TESDAea_vyb.**Open**(Par1)	HandlePuertoADCY (*IntPtr*)	-	-	-	-	Success / Failed (*boolean*)
TESDA_ea_VFxx.TESDAea_vyb.EA_**GetConfi**(Par1, Par2, Par3, Par4)	HandlePuertoADCY (*IntPtr*)	Parameter to be read (*string*)	Read data (*integer*)	-	-	Number of bytes read (*integer*)
TESDA_ea_VFxx.TESDAea_vyb.EA_**SetConfi**(Par1, Par2, Par3, Par4)	HandlePuertoADCY (*IntPtr*)	Parameter to be set up (*string*)	Value to configure (*integer*)	Save setup (*ParamStorageType*)	-	Success / Failed (*boolean*)
EAmV0 = TESDA_ea_VFxx.TESDAea_vyb.EA_**mV**(Par1)	HandlePuertoADCY (*IntPtr*)	-	-	-	-	AI read out in mV (*integer*)
SuccessOrFailed = TESDA_ea_VFxx.TESDAea_vyb.**Close**(Par1)	HandlePuertoADCY (*IntPtr*)	-	-	-	-	Success / Failed (*boolean*)
SuccessOrFailed = TESDA_ea_VFxx.TESDAea_vyb.**Deinit**(Par1)	HandlePuertoADCY (*IntPtr*)	-	-	-	-	Success / Failed (*boolean*)
SuccessOrFailed = TESDA_ea_VFxx.TESDAea_vyb.**Lib_Info**()	-	-	-	-	-	Library info (*string*)

Where X is the number of the analog input channel, from 0 to 3, and Y the number of the addressed ADC, from 1 to 4.

5.4 FUNCTIONAL TEST TOOL

To check the functional operation of the TESDA board, ISURKI provides the user with a free software tool which includes:

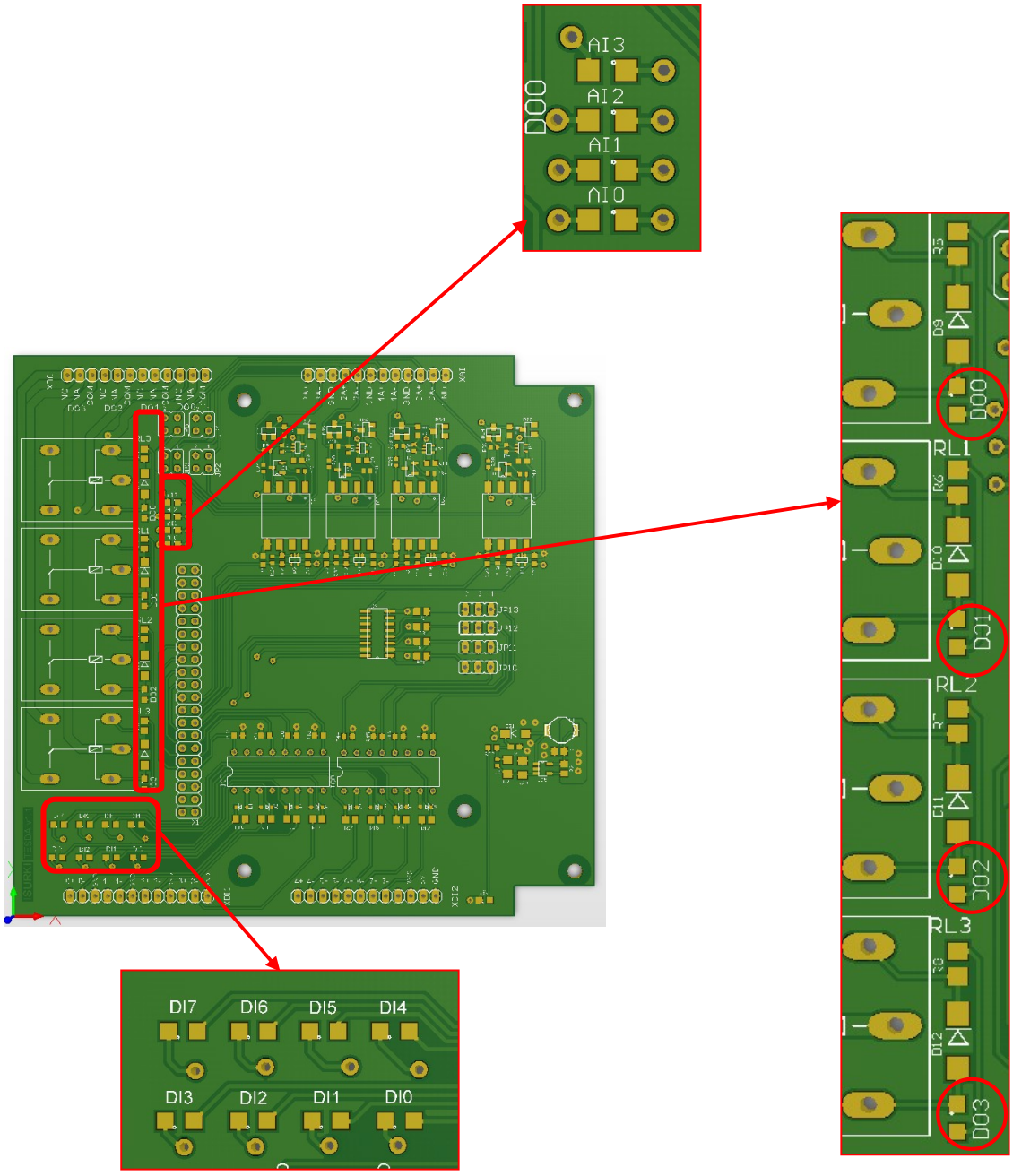
- Continuous automatic monitoring of the state of the 4 digital inputs.
- Continuous automatic monitoring of the current value of the 4x4-20 mA analog inputs.
- Push buttons for the four relay digital outputs activation & deactivation.
- State of the BAT_FAULT_PIN of the SODIMM connector of the Colibri MCU board.
- Toradex and Isurki's used libraries information messages by the Windows Console.



Test utility screen capture

6 MONITORING LEDS

TESDA card provides on board visual led indication of the state of both digital inputs and outputs. Green leds locations are shown in the below attached picture.



The led marking on the board is as follows:

AI (Analog Inputs):

AI0 – Analog input 0

AI1 – Analog input 1

AI2 – Analog input 2

AI3 – Analog input 3

In the referred analogue inputs leds, the light intensity is proporcional to the mA input value, lighting the weakest with the 4 mA input signal and the maximum with the 20 mA.

DI (Digital Inputs):

DI0 – Digital input 0

DI1 – Digital input 1

DI2 – Digital input 2

DI3 – Digital input 3

DI4 – Digital input 4

DI5 – Digital input 5

DI6 – Digital input 6

DI7 – Digital input 7

DO (Digital outputs):

DO0 – Digital output 0

DO1 – Digital output 1

DO2 – Digital output 2

DO3 – Digital output 3

7 FACTORY DEFAULT SETUP

0 means no jumper

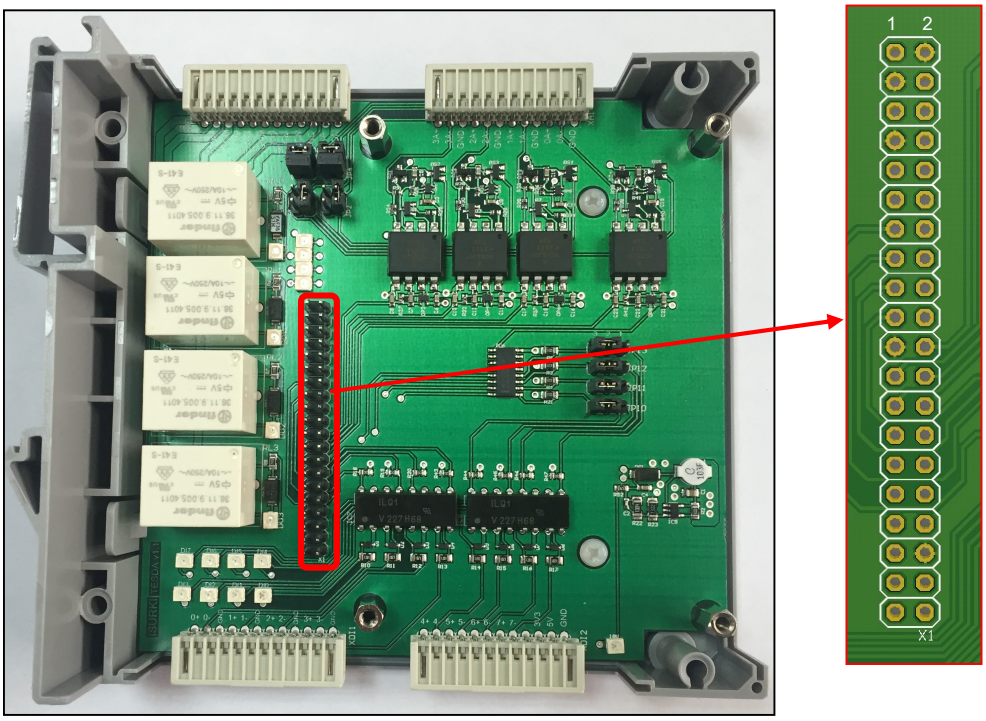
I means jumper installed

JUMPER	IDEN	SET UP DESCRIPTION	1-2	2-3	3-4	1-3
JP2	AI3	Analog input 3 in active mode	**0**	**0**	**0**	**I**
JP3	AI2	Analog input 2 in active mode	**0**	**0**	**0**	**I**
JP4	AI1	Analog input 1 in passive mode	**I**	**0**	**I**	**0**
JP5	AI0	Analog input 0 in passive mode	**I**	**0**	**I**	**0**
JP10	DO0	DI/O0 configured as relay output	**0**	**I**	**0**	**0**
JP11	DO1	DI/O1 configured as relay output	**0**	**I**	**0**	**0**
JP12	DO2	DI/O2 configured as relay output	**0**	**I**	**0**	**0**
JP13	DO3	DI/O3 configured as relay output	**0**	**I**	**0**	**0**

8 CONNECTION

8.1 CONNECTING WITH TORADEX IRIS CARRIER BOARD

The 2 x 20 pin IDE **X1** male connector of the TESDA board (see picture below) directly interfaces with the **X16** EXTENSION CONNECTOR of the IRIS carrier board, through a 40 pole flat ribbon cable with two IDE female connectors at both sides. This flat cable, with a length of 20 cm., is included together with the board.



To connect the ribbon cable properly it is very important to assure a correct correspondance between the on board male connector and the aerial connector of the ribbon cable. The orientation is provided with the pin number 1 marked over the board as shown in the above attached picture.

Wrong connection of the ribbon cable may cause permanent hardware damages!!!

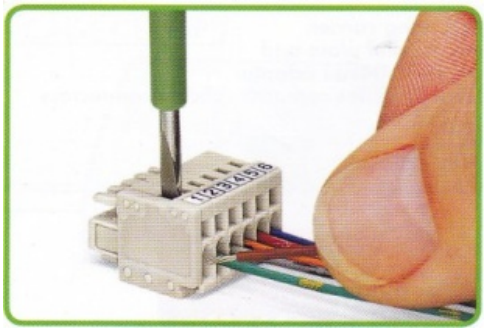
8.2 I/O CONNECTION

Detachable cage clamps provide an easy and quick connection of the different field signals coming from devices, sensors and actuators, allowing the connection of the different wires even in the absence of the TESDA board, thus considerably reducing the on field unit replacement time in case of maintenance operations.

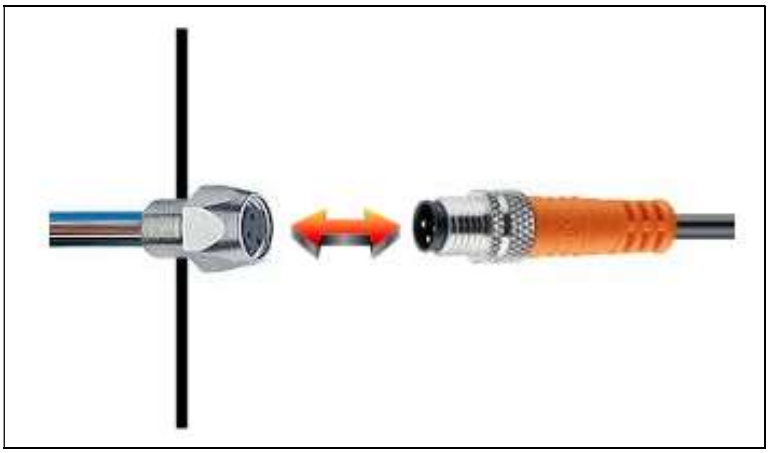
The TESDA unit supply from factory includes all the power and I/O detachable aerial connectors including 50 cm (20”) of cable. The I/O connectors characterististics are:

- Commercial reference: WAGO, item number 733-372.
- Type: cage clamp
- pitch: 2’5 mm
- 250V/2’5kV/2
- Nominal current: 4 A.
- Wire section: 0’08 a 0’5 mm^2.
- Required tool: 2’5 x 0’4 mm. screwdriver

The wire insertion procedure is shown in the below picture.



8.3 POWER CONNECTION (PWR)



The power supply connector is a Lumberg M8 industrial connector with ¼ turn blocking system to assure a proper connection despite of vibrations, involuntary handling, thermal drifts, etc...

The external aerial connector is supplied with a 2 metres length cable.

9 TECHNICAL SPECIFICATIONS

CONCEPT	NUM / REMARKS	CHARACTERISTICS
Power supply input	1 x	• 6 – 27 Vdc, • shortcircuit and polarity inversion protected
Auxiliary power supply outputs	1 x 1 x 1 x	• 18 Vdc (for AIs & DIs), software managed. • 5 Vdc-3'5 A • 3'3 Vdc-2'5 A
Digital inputs	4 x (fixed) 4 x (configurable)	• voltage free / voltage active • optoisolated (V_{AIS}=5300 V_{RMS}) • maximum input current: 60 mA • maximun reverse voltage: 6V. • pull-down. • Led for status indication.
Digital relay outputs	4 x (configurable)	• 1 SPDT contact 0'12A@250Vac, 4A@12Vdc • Led for status indication.
Analog inputs	4 x	• Electric range: 4 to 20 mA • Optoisolated (V_{AIS}=1414 V_{RMS}) • Jumper configurable passive or active mode. • Led indication, with progressing luminosity according to input signal value.
Housing	Policarbonate	• 137'5 (depth) x 118 (high) x 45 (wide) mm. • Policarbonate • Working temperatura range: -40 to +125 ºC
Mounting		DIN rail

10 VIDEO TUTORIALS

IRIS BOX PC (BASIC UNIT)		
Description	**Link**	**Contents**
1.- Introductory video	https://youtu.be/28R5CDcZsZI	The basic ideas in which IRIS BOX PC concept is based
2.- Outer view and connectivity	https://youtu.be/7vcTDXAEHps	External view, format and connectivity
3.- Inner view and composition	https://youtu.be/kO_MTS0vqUc	Inner view and different boards lay out
4.- Connectivity with peripherals and field devices	https://youtu.be/Bs_rVip8h50	plug & play connectivity to external peripherals and field devices

INPUT & OUTPUTS *TESDA* BOARD		
Description	**Link**	**Contents**
1.- Introductory video	https://youtu.be/KaBh4xRarmk	Main features and characteristics
2.- Hardware and connectivity	https://youtu.be/rOiRODY-2c4	main hardware features and connectivity options to field devices and peripherals
3.- Test software tool	https://youtu.be/6-CjZogcXxA	test software tool for the input & outputs TESDA board
4.- AIs calibration (Part 1)	https://youtu.be/eQ-MO9GU0mU	Analog inputs calibration procedure: previous preparations
5.- AIs calibration (Part 2A)	https://youtu.be/dL_RkQIQQ_c	Analog inputs calibration procedure: software tool for TEGRA processors
6.- AIs calibration (Part 2B)	https://youtu.be/NYq4iT8rXzE	Analog inputs calibration procedure: software tool for VYBRID processors
7.- AIs library (Tegra µP)	https://youtu.be/ku0ShZcKGJ8	Analog inputs library for TEGRA processors
8.- AIs library (Vybrid µP)	https://youtu.be/t4rc7r-TliE	Analog inputs library for VYBRID processors

ON FIELD RUNNING APPLICATIONS		
Description	**Link**	**Contents**
1.- Hydrology telecontrol	https://youtu.be/-sW_kGjiiYI	Monitoring boreholes underground water evolution telecontrol

11 TECHNICAL SUPPORT

(34) 943-635437

tecnica@isurki.com

www.isurki.com/pc-embebido