Technion Control Unit
TEC122
Technical manual

Table of contest

1 Overview

This document specifies Technion Control Unit (TEC122) electrical and mechanical details and gives brief functional overview of the controller.

2 Abbreviations and terminology

CAN	Controller Area Network
TBD	To Be Defined
CLAMP-15, cl15	Automotive power rail which is supplied when ignition switch is closed
CLAMP-30, cl30	Automotive power rail that has permanent power supply regardless of ignition switch state.
AI	Analog input
DI	Digital input
DO	Digital output
FI	Frequency input
PWM	Pulse width modulation. In this document this refers to digital output with pulse width modulation capability.
EMC	Electromagnetic compatibility
I/O	Input / Output
SW	Software
System SW	Software preprogrammed to device by Technion Oy
Application SW	Software customized by/for customer - a C language program or IEC-61131 program
Wetting current	Minimum current flow through switch to break any oxidation on the switch contacts

3 General

TEC122 is a general purpose controller for mobile vehicles. Mobile vehicles consist of but not limited to following utility, forest, construction, mining, load and container handling machinery. TEC122 is intended to be a part of the control system in vehicle. The control unit will control lights, valves and other actuator, read different kind of sensors and communicate with other control units forming a complete control system. The TEC122 is intended for mounting directly to vehicle body or inside the cabin.

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4 Product data

4.1 Mechanics

Material(s): Glass Fiber Reinforced PA, electroplated steel
Protection Class: IP67
Weight: 0,7 kg
Dimensions: 152 mm x 152 mm x 59 mm (W x L x H) excluding mating connectors
Mounting: 2 holes at module edges for M6 bolts.
Connectors: Straight mount, located at top side of the casing

Mechanical drawing is presented in Chapter 9.

4.2 Electrical connection

Module has three connectors. Connector types and usage is presented in Table 1. Connector orientation and location is presented in mechanical drawing (see Chapter 9).

Table 1- TEC122 connectors

Ref	Pins	Module connector	Contact plating	Mating connector	Usage
X1	14	AMPSEAL 1-776262-1 BLACK	Gold	AMPSEAL 776273-1 BLACK	Power input, CAN, RS-232, DI
X2	35	AMPSEAL 776231-1 BLACK	Tin	AMPSEAL 776164-1 BLACK	DO, DI, AI, sensor reference

Note: Mating of tin coated contacts to gold coated contacts is not recommended. Tin-to-gold contacts are susceptible to fretting corrosion related failures. Lubrication of contacts improves reliability and prevents fretting corrosion for both tin-to-tin and gold-to-gold contacts. See references [1] – [2] for more details.

4.3 Marking

Product is marked with the Technion part number and serial number.

4.4 Order options

TEC122 product family has several product variants. This documents covers following products.

Table 2- TEC122 order codes covered by this manual

Order code	Application development environment
TEC122-001	C-programming language
TEC122-002	CODESYS V2.3
TEC122-003	Pre-programmed application (CANopen CiA 401 profile SW)

5 Electrical data

5.1 System block diagram

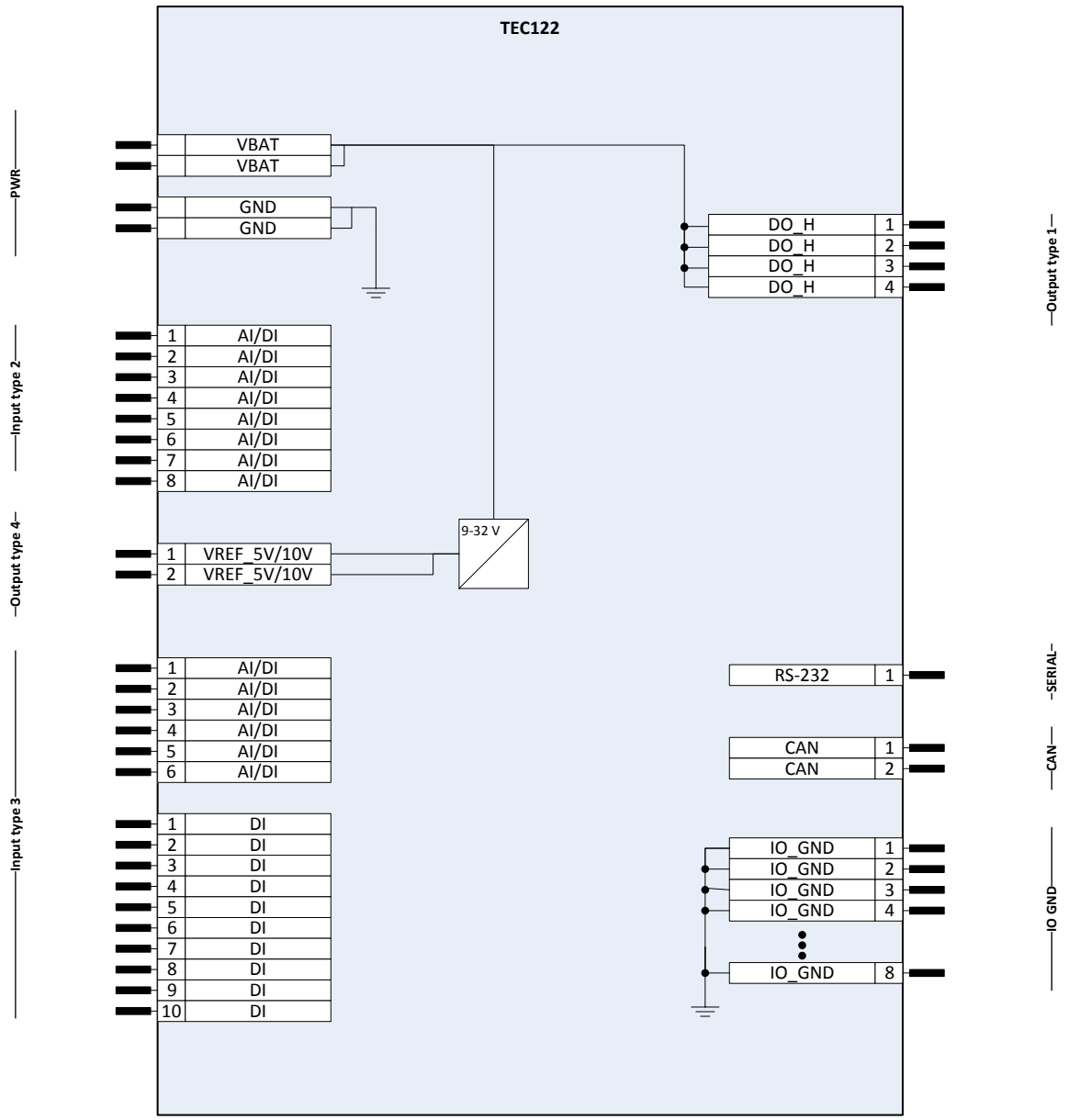


Figure 1 - TEC122 I/O block diagram

5.2 System properties

TEC122 has 32-bit CPU architecture that is capable to handle common machine control tasks. TEC122 application can be developed either using CODESYS V2.3 or C-language with readymade board support package. Memory resources are presented below.

Memory	Size
RAM (total)	96 KiB
RAM (CODESYS application)	16 KiB
Program Flash (total)	512 KiB
Program Flash (application)	224 KiB
Data EEPROM	63 KiB

IEC-61131 (i.e. CODEYS) application is executed and located in "program flash (application)" memory. EEPROM memory can be used to store for example application parameters and/or failure / diagnostics log.

Module start-up time

Parameter	Time (typical)	Notes
Start-up time from power-up to application software start[1]	1000 ms	CODESYS application

TEC122 CPU has integrated watch-dog that monitors program execution. If watch-dog is not refreshed for 4 seconds module is re-started. During re-start all I/O is set to default state (described in chapter 6). Behavior after restart depends on product variant. TEC122 with CODESYS module execution is halted after restart and program execution can be restarted only by reconnection module power input somehow.

Controller internal temperature can measured in application using internal temperature sensor. If temperature is out of operational range application software should switch off all outputs to prevent unexpected behavior.

Item		Min	Typ	Max	Unit	Notes
Internal temperature measurement range		-45		125	°C	
Accuracy			±5		°C	

[1] Application software is located and executed from flash memory (simple application toggling digital output).

5.3 Power supply

TEC122 module can operate either in 12V or 24V electrical system. 24V system allows using all TEC122 I/O functions. In 12V system some of the I/O functions are not available see Table 3 for more details.

Item		Min	Nom	Max	Unit	Notes
Supply voltage (12V system) [2]		9	12	32	V	Extended voltage range compared to ISO 16750-2 code C
Supply voltage (24V system)		16	24	32	V	Voltage range according to ISO 16750-2 code F
Overvoltage 1				36	V	Controller operates normally during overvoltage (32 V – 36 V). Maximum overvoltage 1 duration that module withstands is 60 minutes.[3]
Reverse voltage		-28			V	MAX 20A external fuse is mandatory. Module has internal connection from GND to POWER. Module is damaged without fuse.
Under voltage shutdown			5,7		V	
Under voltage detection (12V system)			7,9		V	Automatic module shutdown after 30 seconds
Under voltage detection (24V system)			14		V	Automatic module shutdown after 30 seconds
Supply current: module/logic			0,15		A	VBAT= 24V, all outputs OFF
Supply current: outputs				14	A	
External FUSE				20	A	Mandatory for reverse polarity protection

Table 3 – 12V & 24V system I/O availability differences

I/O	12V system	24V system
VREF	5 V outputs only	5 V and 10 V outputs

5.3.1 Power supply input

Supply voltage must be within in the module operating range. Module has common power input for both logic and outputs. Input is protected against polarity reversal with internal diode. External fuse (max. 20A) must be used. TEC122 will damage without external fuse.

[2] All I/O functions are not available in 12V system (AO 0-10V and VREF 10V)
[3] Some I/O functions do not tolerate overvoltage during short circuit to battery conditions. See detailed I/O specifications.

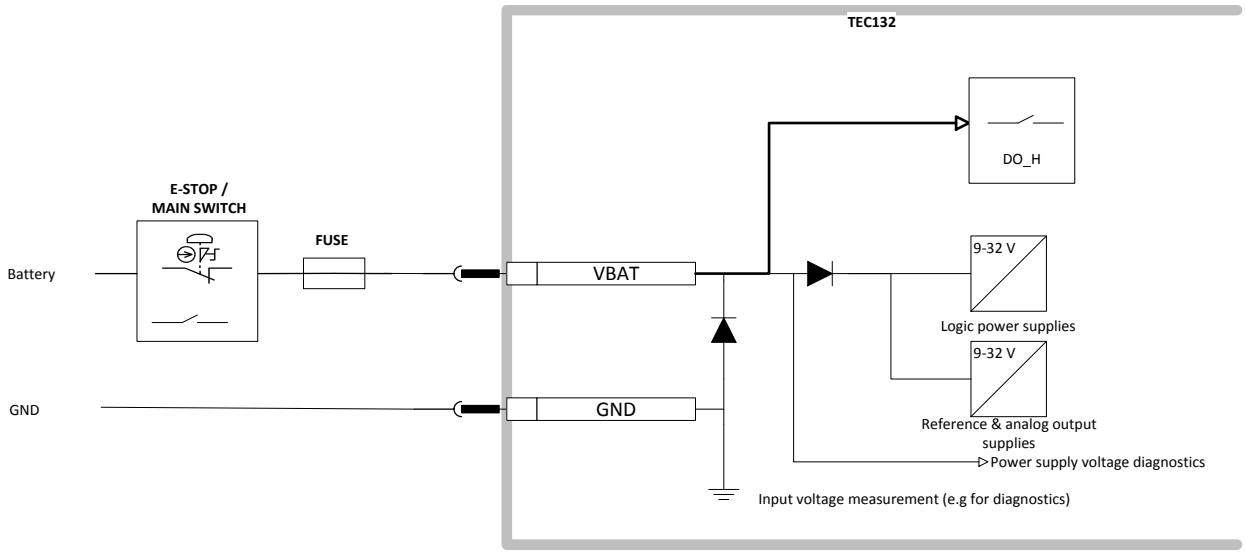


Figure 2 – VBAT power input topology

Module VBAT power input voltage (i.e. system/battery voltage) can be measured in application level.

Table 4 – VBAT input diagnostics

Item		Min	Nom	Max	Unit	Notes
VBAT voltage measure-ment range		0		48	V	
Measurement accuracy % FS				±1	%FS	

Reverse feed

Note! If module is not powered by power supply pins and there is external voltage in output pin(s). As a consequence the module is powered through the output pin! There is also voltage in power supply pins at this time. Module does not withstand reverse feed from outputs. Electrical system must be designed so that reverse feed is not possible.

Note! This applies also to inputs that are shared with output pins.

Table 5 - Power input signals

Signal	Type	Description
VBAT	PWR	Power supply input for module logic functions, sensors and outputs
GND	-	Ground for logic and output power supply

6 General I/O functionality

All I/O functions (every connector pin) have short circuit protection against ground (GND) short circuit. Most I/O pins are protected against short circuit to system supply voltage (max 32V). I/O pins that share output and input functionality cannot withstand voltage higher than current supply voltage.

Sensor ground pins are able to break 10 A fuse during short circuit to battery.

6.1 I/O List

TEC122 controller has versatile set of I/O types. Different I/O types/functions are presented in Table 6. Detailed description of the I/O types is provided in Chapters 6.2 and 6.3. TEC122 I/O pins can be configured to several I/O functions. I/O configuration is presented in Table 7. Configuration is selected in SW.

Table 6 - TEC122 I/O types

I/O Type	Abbreviation
Digital output high-side, PWM or ON/OFF 3.5A	DO_{H3A5}
Digital input PNP (high active)	DI_{H}
Analog input - voltage measurement 0-5V Analog input - voltage measurement 0-10V Analog input - voltage measurement 0-32V	AI_{5V} AI_{10V} AI_{32V}
Actuator or sensor ground	IO GND
Voltage reference output for analog input (output voltage)	$VREF_{5V/10V}$
CAN	CAN
RS-232	RS232

Note 1: Each input/output can have several subtypes. Subtype number is shown after I/O-type e.g. $DI_{H.1}$ (i.e. Digital input, high-active, type 1)

Table 7 - TEC122 I/O configuration

I/O Group	Pcs	I/O Types	Notes
HIGH SIDE DIGITAL OUTPUTS (Output #1)	4	$DO_{H\_3A5.1}$	Digital output 3,5A, high side
PRECISION INPUTS (Configurable input / #2)	8	$DI_{H.3}$ $AI_{5V.2}$ $AI_{10V.2}$	Digital input (PNP / active high) Analog input 0-5 V Analog input 0-10 V
INPUTS (Configurable input / #3)	6	$DI_{H.4}$ $AI_{10V.4}$ $AI_{32V.4}$	Digital input (PNP / active high) Analog input 0-10 V Analog input 0-32 V
	10	$DI_{H.5}$	Digital input (PNP / active high)
REFERENCE OUTPUTS (Configurable output #4)	2	$VREF_{5V.1}$ $VREF_{10V.1}$	Voltage reference output 5 V Voltage reference output 10 V
GND	8	GND	Ground for sensors and actuators
Module power supply	2 2	VBAT GND	Power supply module logic and outputs VBATT ground
CAN	2	CAN	
RS-232	1	RS232	CODESYS programming interface

6.2 I/O definition

Every configurable I/O type has its own specification.

I/O functions presented in following chapters have several protection and diagnostics functions to detect failures either in module, wiring or sensor/actuator. Failure mode diagnostic capability depends on I/O type. Failure types are presented in table below.

Table 8 - I/O protection and failure diagnostic features

Failure	
Open load	OL
Short circuit to ground	SC_G
Short circuit to battery	SC_B
Over Current	OC

Each IO-type is named according to Figure 3. TEC122 has several IO types that have same functionality and subtype but different electrical specification. Extra care has to be taken on electrical specification when selecting IO-type / pin for application.

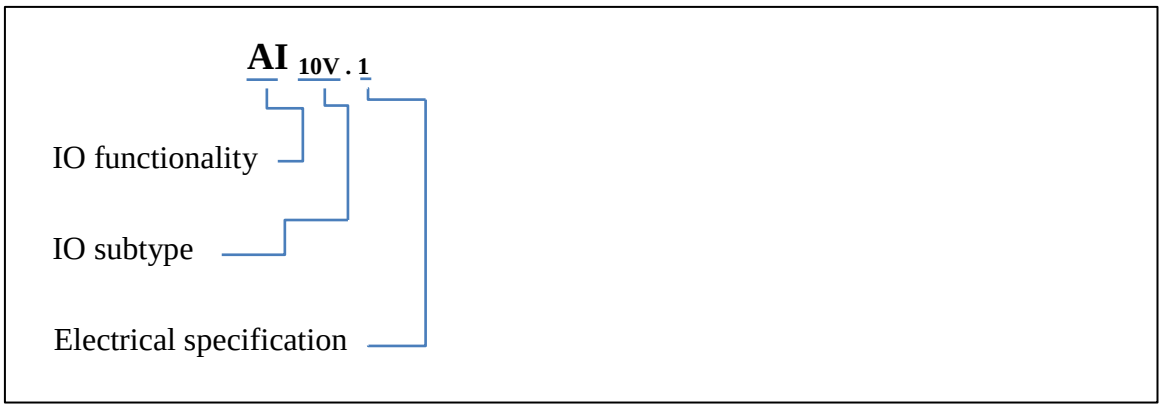


Figure 3 - IO-type naming

6.2.1 Input, DI PNP ($DI_{H.3}$)

Active high i.e PNP digital input is used to interface sensors / switches powered from TEC122 output or directly from battery.

- Mechanical on/off switches
- Semiconductor switches
- Inductive sensors

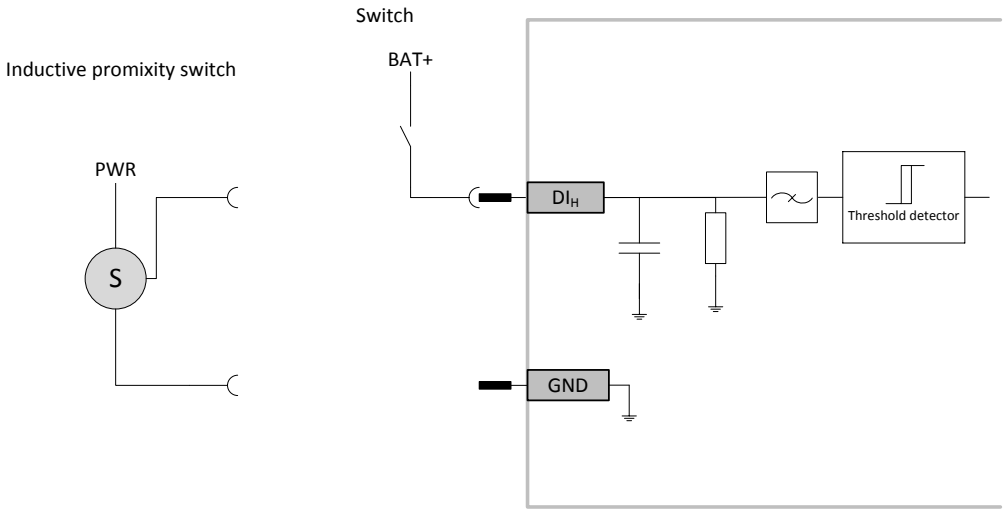


Figure 4- $DI_{H.3}$ usage

Table 9 - Electrical specification

Item		Min	Nom	Max	Unit	Description	ID
Type	**$DI_{H.3}$** Digital input PNP, Active high						
Voltage range	U_{in}	0		32	V		
Over voltage				36	V		
Threshold low	U_{low}	2			V		
Threshold high	U_{high}			7	V		
Hysteresis	U_{hyst}		3		V		
Cutoff frequency (HW)	f_{-3dB}		1,15		kHz		
Input capacitance			5		nF		
Pull-down resistance	R_{PD}		22,5		kΩ	U_{in} < 10V	
Protection		SC_G, SC_B					

Table 10 - DI signals

Signal	Dir	Description
DI_H	In	Digital input

6.2.2 Input, DI PNP ($DI_{H.4}$ & $DI_{H.5}$)

Active high i.e PNP digital input is used to interface sensors / switches powered from TEC122 output or directly from battery.

- Mechanical on/off switches
- Semiconductor switches
- Inductive sensors

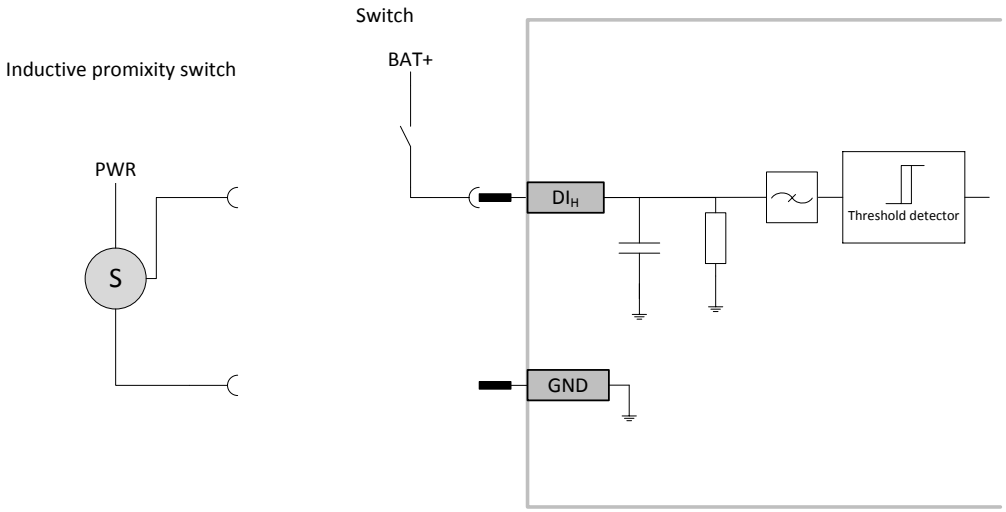


Figure 5- $DI_{H.4}$ & $DI_{H.5}$ usage

Table 11 - Electrical specification

Item		Min	Nom	Max	Unit	Description	ID
Type	**$DI_{H.4}$** Digital input PNP, Active high						
Voltage range	U_{in}	0		32	V	Input voltage must be ≤ VBAT in all conditions	
Over voltage				VBAT	V		
Threshold low	U_{low}	2			V		
Threshold high	U_{high}			7	V		
Hysteresis	U_{hyst}		3		V		
Cutoff frequency	f_{-3dB}		1,15		kHz	HW filter	
Input capacitance			22		nF		
Pull-down resistance	R_{PD}		7		kΩ	U_{in} ≤ 27 V	
Protection		SC_G, SC_B					

Table 12 - Electrical specification

Item		Min	Nom	Max	Unit	Description	ID
Type	**$DI_{H.5}$** Digital input PNP, Active high						
Voltage range	U_{in}	0		32	V	Input voltage must be ≤ VBAT in all conditions	
Over voltage				VBAT	V		
Threshold low	U_{low}	2			V		
Threshold high	U_{high}			7,5	V		
Hysteresis	U_{hyst}	1			V		
Cutoff frequency	f_{-3dB}		10		kHz	HW filter	
Input capacitance			22		nF		
Pull-down resistance	R_{PD}		6		kΩ	U_{in} ≤ 12 V	
Protection		SC_G, SC_B					

Table 13 - DI signals

Signal	Dir	Description
DI_H	In	Digital input

6.2.3 Input, Analog input, 0-5V / 0-10V ($AI_{5V.2}$ & $AI_{10V.2}$)

Analog input type is software configurable. For example following sensors can be connected to input.

- Potentiometer (3-wire) / joysticks
- Temperature transduces
- Pressure sensors
- Voltage output sensors

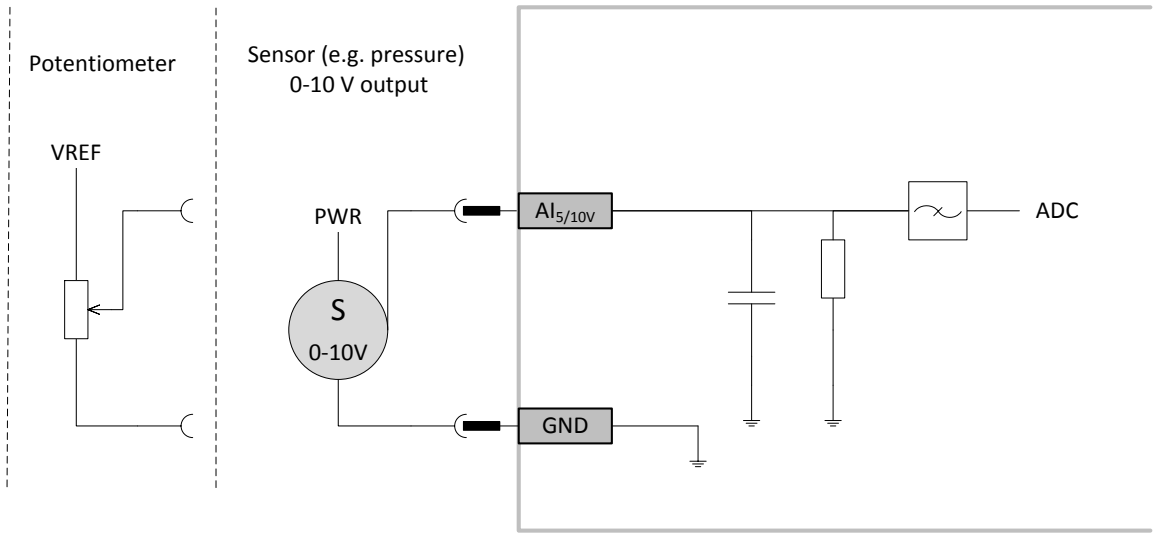


Figure 6 - $AI_{5V.2}$ / $AI_{10V.2}$ usage

Table 14 - Analog input electrical specification

Parameter		Min	Nom	Max	Unit	Description	ID
Resolution			12		bits		
Protection		SC_G, SC_B					
Type	**$AI_{5V.2}$ 0-5V Voltage input**						
Input voltage range		0		5	V	Voltage input	
Over voltage				32	V		
Accuracy % FS				±1,5	%FS		
Accuracy, typical			0,6+0,2		%	±(% of reading + % FS)	
Input resistance			44,1		kΩ	*Uin < 5V*	
Input capacitance			4,7		nF		
Input cut-off frequency	f_{-3dB}		0,6		kHz	HW filter	
Type	**$AI_{10V.2}$ 0-10V Voltage input**						
Voltage range		0		10	V	Voltage input	
Over voltage				32	V		
Accuracy % FS				±1,5	%FS		
Accuracy, typical			0,6+0,2		%	±(% of reading + % FS)	
Input resistance			22,8		kΩ	*Uin < 10V*	
Input capacitance			4,7		nF		
Input cut-off frequency	f_{-3dB}		1,15		kHz	HW filter	

Table 15 - AI signals

Signal	Dir	Description
$AI_{V.2}$	In	Configurable analog input
IO_GND		Ground pin for sensor return signal

6.2.4 Input, Analog input, 0-10V / 0-32V ($AI_{10V.4}$ & $AI_{32V.4}$)

Analog input type is software configurable. For example following sensors can be connected to input.

- Temperature sensors
- Pressure sensors
- Voltage output sensors

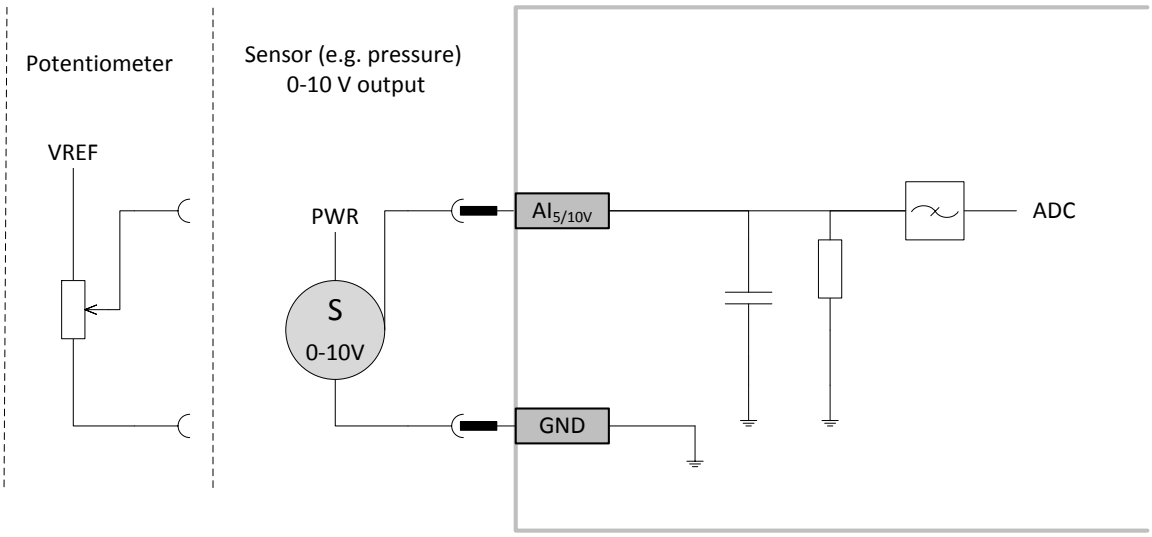


Figure 7 - $AI_{10V.4}$ / $AI_{32V.4}$ usage

Table 16 - Analog input electrical specification

Parameter		Min	Nom	Max	Unit	Description	ID
Resolution			10		bits		
Protection		SC_G, SC_B				Input voltage ≤VBAT	
Type	**$AI_{10V.4}$ 0-10V Voltage input**						
Input voltage range		0		10	V	Voltage input	
Over voltage				32	V		
Accuracy % FS				±4	%FS		
Input resistance			7,6		kΩ	*Uin ≤ 10V*	
Input capacitance			22		nF		
Input cut-off frequency			0,6		kHz	HW filter	
Type	**$AI_{32V.4}$ 0-32V Voltage input**						
Voltage range		0		32	V	Voltage input	
Over voltage				32	V		
Accuracy % FS				±4	%FS		
Input resistance			7,1		kΩ	*Uin ≤ 32V*	
Input capacitance			22		nF		
Input cut-off frequency			1,3		kHz	HW filter	

Table 17 - AI signals

Signal	Dir	Description
$AI_{V.4}$	In	Configurable analog input
IO_GND		Ground pin for sensor return signal

6.2.5 Output, Voltage reference output 5 V / 10V ($VREF_{5V.1}$, $VREF_{10V.1}$)

Output can be used as reference voltage output for sensors (i.e. ratiometric measurement) or supply voltage source for external sensors.
Output voltage can be configured in application software.

Note! 10 V reference output voltage cannot be used if system nominal voltage is 12V.

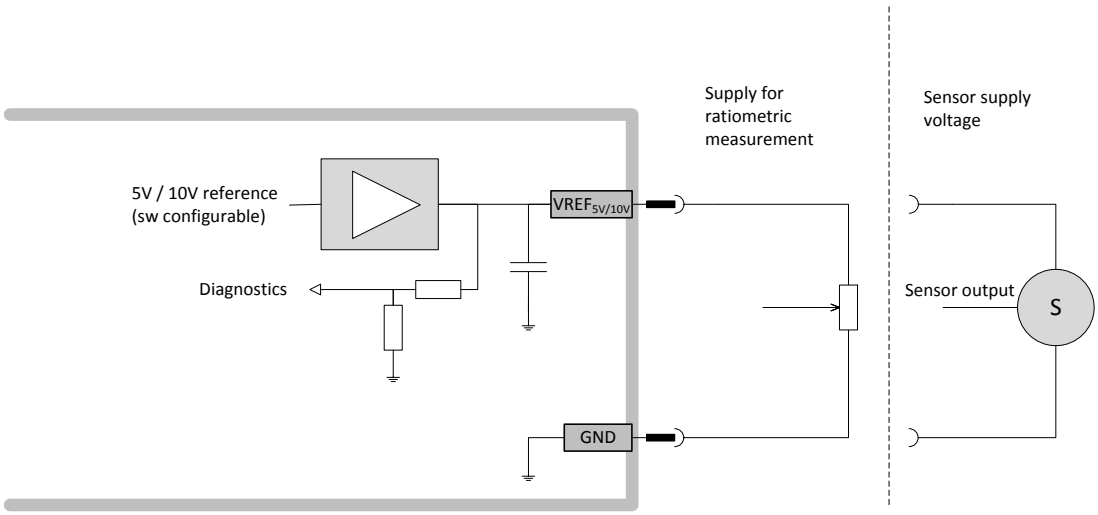


Figure 8- VREF usage

Table 18 - Voltage reference output electrical specification

Parameter		Min	Nom	Max	Unit	Description	ID
Type	$VREF_{5V.1}$, $VREF_{10V.1}$						
Default state		OFF					
Output voltage	U_{out}		5 10		V V	10V mode is available on in 24V system	
Output accuracy % FS				±0,5	%FS		
Output over voltage		-3		32	V	Output short circuit to battery	
Output current				50	mA		
Protection		SC_G, SC_B					
Output voltage feedback measurement range		0		10,5	V		
Output voltage feedback measurement accuracy % FS				±1	%FS		

Table 19 - VREF signals

Signal	Dir	Description
$VREF_{V.1}$	OUT	Configurable reference output
IO_GND		Ground pin for sensor return signal

6.2.6 Output, high side PWM or ON/OFF ($DO_{H\_3A5.}$)

TEC122 high-side outputs can be used either in ON/OFF or open-loop PWM mode. External free-wheeling diode is mandatory with inductive loads.

TEC122 high-side output load examples:
- ON/OFF hydraulic valve
- Solenoid
- Proportional valve (open-loop control)
- Bulb lamp
- Led lamp (with external led driver)
- Heaters (and other resistive loads)
- Relay

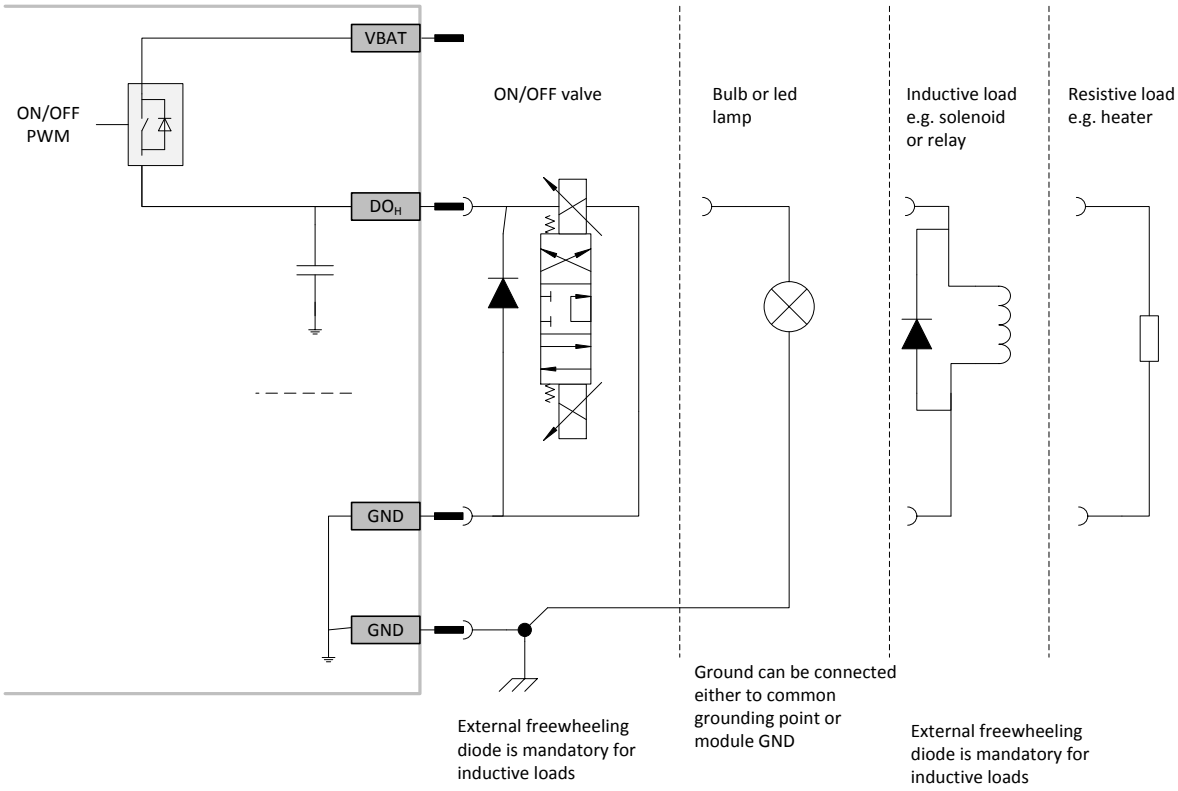


Figure 9 – DO_{H_3A5} usage

Table 20- DO_{H3A5} Electrical specification

Parameter		Min	Nom	Max	Unit	Description	ID
Type		**$DO_{H\_3A5.1}$** High-side output					
Default state		OFF					
Voltage range		9		32	V		
Over voltage				36	V		
Output current				3.5	A	Parallel connection of the channels is allowed for higher output current in ON/OFF mode only with dedicated CODESYS block	
Voltage drop load 1 A load 3.5 A				 0.1 0.3	 V V	U(VBAT) – U(DO_H)	
Output current				3.5	A		
Short circuit current limit			7		A		
Leakage current in off state		-350		100	uA	Leakage current from DO_H (positive value outgoing from DO_H)	
PWM frequency		20		1000	Hz		
PWM duty cycle resolution			0,1		%		
Protection	SC_G, SC_B						

Inductive loads (e.g. relays or valves) Free-wheeling diode

Note!
TEC122 module has not internal free-wheeling diode. Inductive load (relay or valve coil) turn-off generates voltage spike that will **damage** TEC122 module.

External free-wheeling diode must be used always with inductive loads!

Free-wheeling diode must be either regular (pn) diode or schottky diode. Varistor and/or TVS diode usage is forbidden. Free-wheeling diode shall have adequate voltage and current rating for the application. Diode voltage rating should be >100 V (>600 V is recommended).

Table 21 - DO_H signals

Signal	Dir	Description
DO_{H_3A5}	OUT	High-side output
IO_GND		Ground pin for load return signal

6.2.7 IO GND (actuator / sensor return signal)

TEC122 module has several IO GND pins that can be used to connect load / actuators / sensor return signals. IO GND is internally connected to module GND pins. It is essential to use strictly controlled grounding principle e.g. for analog signals to prevent measurements errors caused be ground currents. Sensors and loads shall be grounded only in module side to prevent ground loops (IO_GND pin or star-grounding near module GND pin).

Table 22 – IO GND electrical specification

Parameter		Min	Nom	Max	Unit	Description	ID
Type	IO_GND, Ground signal for sensors and actuators						
Input current				10	A		

6.3 Communication definition

6.3.1 CAN

Module has two CAN 2.0 A/B communication interfaces. CAN physical layer is according to ISO 11898-2.

Parameter		Value	Description
Physical layer		ISO 11898-2	High speed CAN
Termination resistor		no internal termination	
Communication speed		10 kbps – 1 Mbps	
Common mode voltage		-25 V …+25 V	
Short circuit protection		-28 V … +36 V	
CAN_H / CAN_L leakage current		5µA	Max leakage current during power-off, $U_{CAN\_H/CAN\_L} < 5$ V

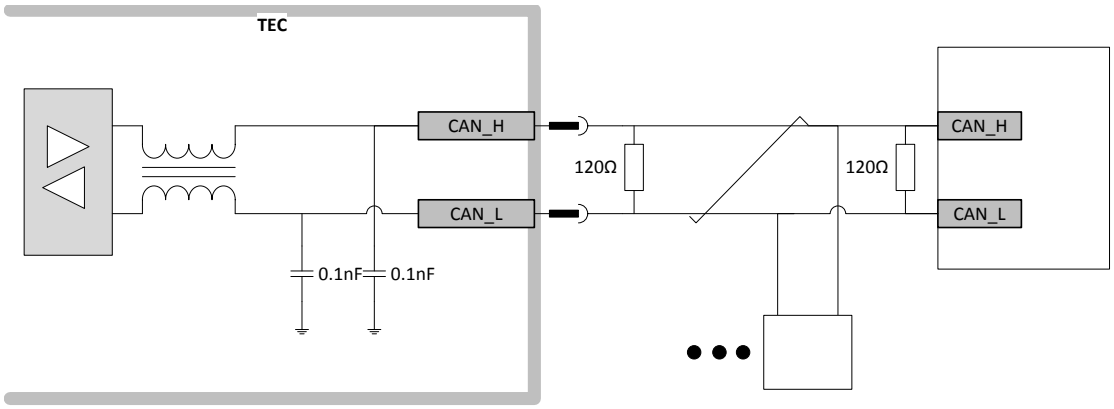


Figure 10 – CAN usage

Table 23 - CAN interface signals

Signal	Dir	Description
CAN_H	In / Out	CAN transmit / receive high
CAN_L	In / Out	CAN transmit / receive low

6.3.2 RS-232

RS-232 interface has two operation modes that depend on used TEC122 product variant. In TEC122 models that include CODESYS application development environment RS-232 port can only be used as CODESYS V2.3 development port. TEC122 models with C-libraries have full support for RS-232 in application level.

Parameter		Value	Description
Communication speed		max. 115200 bps	
Input capacitance		typ. 1,5 nF	

Table 24 – RS-232 interface signals

Signal	Dir	Description
RS-232_TXD	Out	Transmit data
RS-232_RXD	In	Receive data
IO_GND		Reference ground signal

7 Environmental specification

7.1 General

Electrical and environmental requirements are based on standard ISO 16750.

7.2 Ambient temperature

The TEC122 is to be designed to operate directly in vehicle body or inside the cabin. The function of the TEC122 will not deteriorate in an unacceptable manner, throughout the environmental extremes, for normal life time of the product.

Item		Min	Nom	Max	Unit	Notes
Operating temperature		-40	-	75	°C	
Storage temperature		-40	-	85	°C	

7.3 Technical conformity

E/ECE Regulation No. 10	Automotive EMC Directive (E^{17} type approval pending)
EN 13309:2010	Construction machinery - Electromagnetic compatibility of machines with internal power supply
EN ISO 14982:2009	Agricultural and forestry machinery. Electromagnetic compatibility. Test methods and acceptance criteria (ISO 14982:1998)
ISO 13766:2006	Earth-moving machinery -- Electromagnetic compatibility

7.4 Functional safety

TEC122 is not a safety component according to the machine directive 2006/42/EC. TEC122 is not SIL classified.

8 Connector pin mapping

8.1 Connector locations

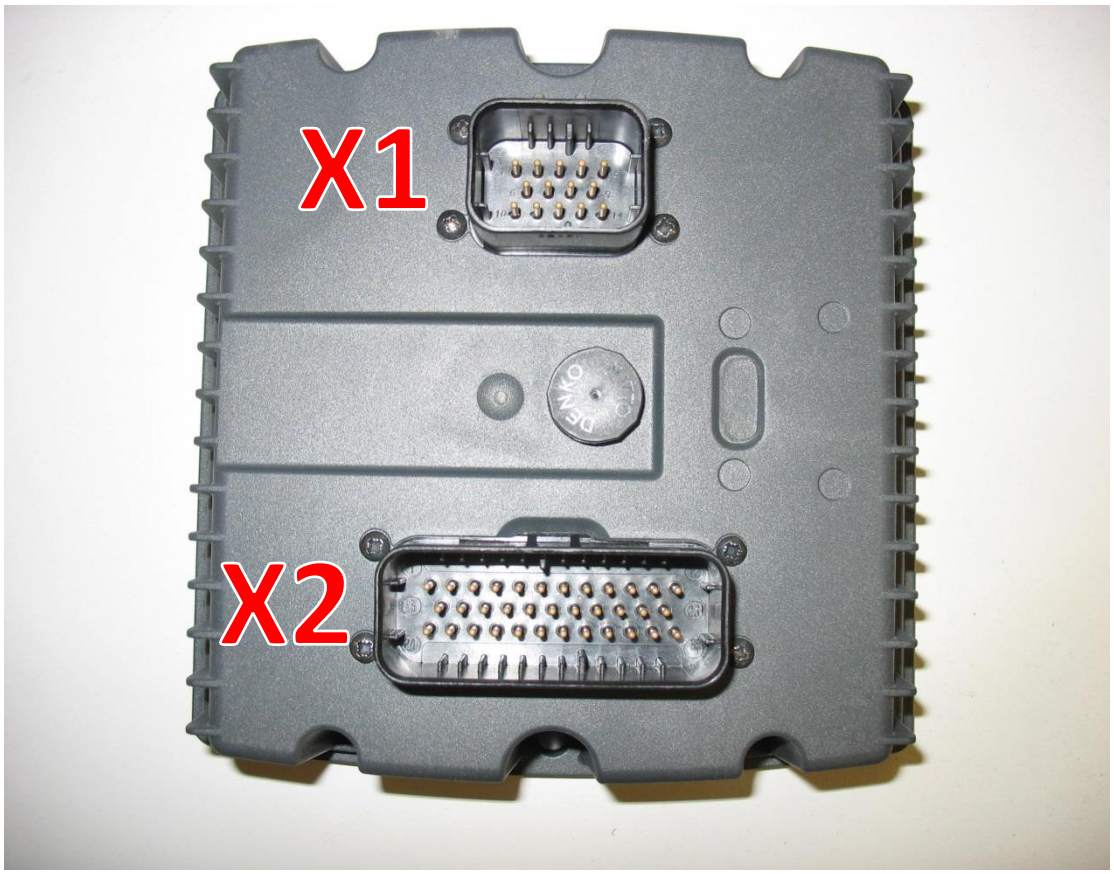


Figure 11 - Connector locations

8.2 Main connectors pin map

Table 25 – Connector X1 pinout

Connector A – TYCO AMPSEAL 1-776262-1 BLACK					
Pin		**Dir**	**Function(s)**	**Group**	**Notes**
X1	1	PWR[1)]	VBAT		Power input, both X1-1 and X1-10 shall be connected
X1	2	I/O	CAN1_H		
X1	3	I/O	CAN1_L		
X1	4	O	RS232_TXD		
X1	5	GND[1)]	GND		System ground
X1	6	I/O	CAN2_H		
X1	7	I/O	CAN2_L		
X1	8	I	RS232_RXD		
X1	9	GND[1)]	GND		System ground
X1	10	PWR[1)]	VBAT		Power input, both X1-1 and X1-10 shall be connected
X1	11	I	$DI_{H.5}$	I#3	
X1	12	GND	IO GND		
X1	13	I	$DI_{H.5}$	I#3	
X1	14	GND	IO GND		

1) *Several parallel pins are needed for output current rating*

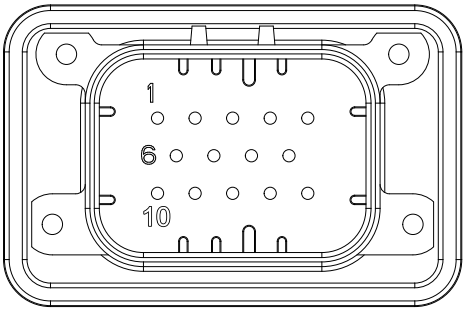


Figure 12 – X1 connector pin numbering

Table 26 – Connector X2 pinout

Connector A – TYCO AMPSEAL 776231-1 BLACK					
Pin		Dir	Function(s)	Group	Notes
X2	1	I	$DI_{H.4}$,$AI_{10V.4}$,$AI_{32V.4}$	I#3	
X2	2	I	$DI_{H.4}$,$AI_{10V.4}$,$AI_{32V.4}$	I#3	
X2	3	I	$DI_{H.4}$,$AI_{10V.4}$,$AI_{32V.4}$	I#3	
X2	4	O	$DO_{H\_3A5.1}$	O#1	
X2	5	O	$DO_{H\_3A5.1}$	O#1	
X2	6	O	$DO_{H\_3A5.1}$	O#1	
X2	7	O	$DO_{H\_3A5.1}$	O#1	
X2	8	I	$DI_{H.5}$	I#3	
X2	9	I	$DI_{H.5}$	I#3	
X2	10	I	$DI_{H.5}$	I#3	
X2	11	I	$DI_{H.5}$	I#3	
X2	12	I	$DI_{H.5}$	I#3	
X2	13	GND	IO GND		
X2	14	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	15	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	16	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	17	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	18	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	19	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	20	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	21	I	$AI_{5V.2}$,$AI_{10V.2}$,$DI_{H.3}$	I#3	
X2	22	O	$VREF_{5V.1}$,$VREF_{10V.1}$	O#4	
X2	23	O	$VREF_{5V.1}$,$VREF_{10V.1}$	O#4	
X2	24	I	$DI_{H.4}$,$AI_{10V.4}$,$AI_{32V.4}$	I#3	
X2	25	I	$DI_{H.4}$,$AI_{10V.4}$,$AI_{32V.4}$	I#3	
X2	26	I	$DI_{H.4}$,$AI_{10V.4}$,$AI_{32V.4}$	I#3	
X2	27		NC		
X2	28	GND	IO GND		
X2	29	GND	IO GND		
X2	30	GND	IO GND		
X2	31	GND	IO GND		
X2	32	GND	IO GND		
X2	33	I	$DI_{H.5}$	I#3	
X2	34	I	$DI_{H.5}$	I#3	
X2	35	I	$DI_{H.5}$	I#3	

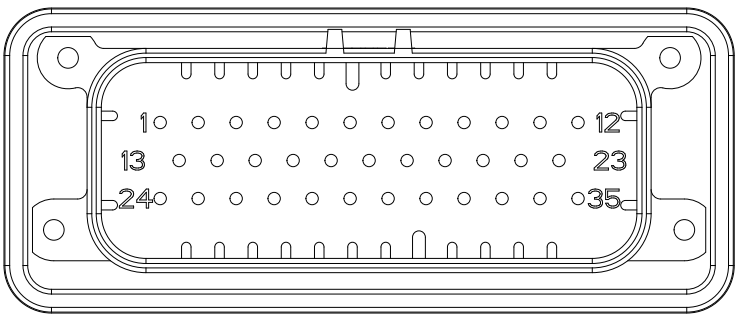
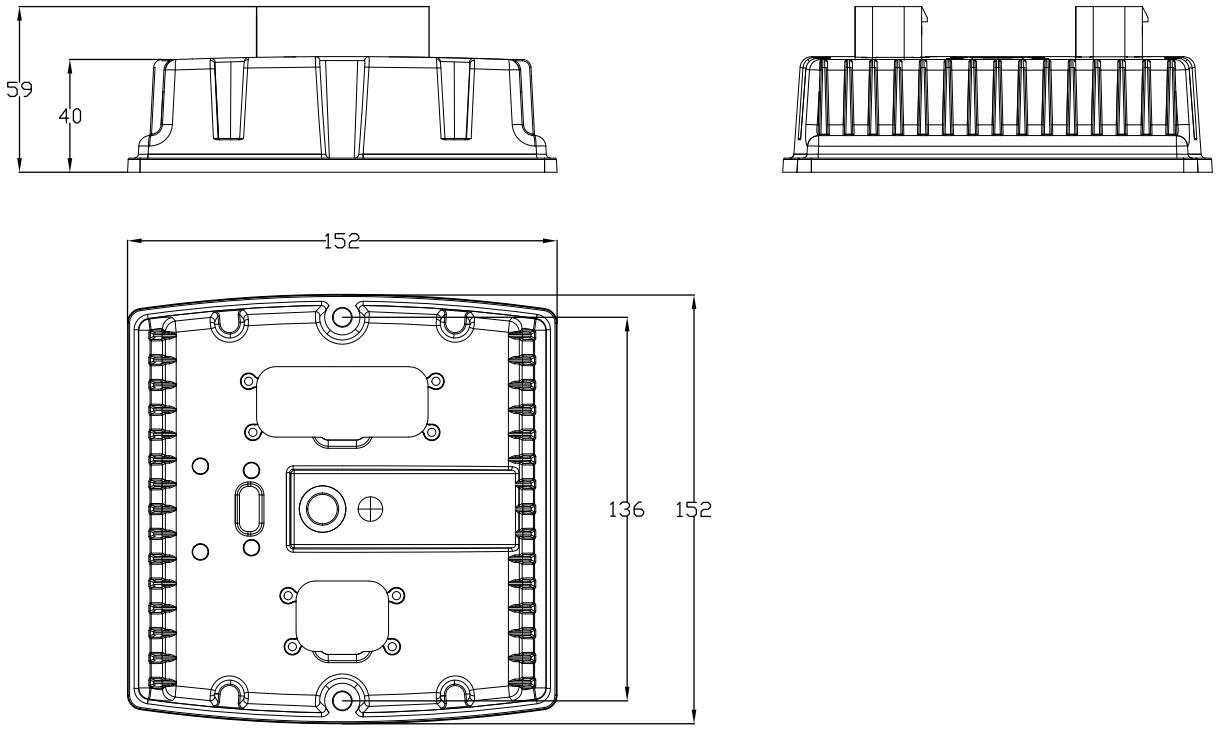


Figure 13 – X2 connector pin numbering

9 Mechanical drawings



10 Reference documents

Item	Document name	Description	Rev.
[1]	Technical Report: The Tin Command-ments:Guidelines For The Use Of Tin On Connector Contacts, AMP Incorporated	http://www.te.com/documentation/whitepapers/pdf/sncomrep.pdf	7/31/96
[2]	Technical Report: Golden Rules: Guide-lines For The Use Of Gold On Connector Contacts, AMP Incorporated	http://www.te.com/documentation/whitepapers/pdf/aurulrep.pdf	7/29/96

11 Version History

Version	Date	Description	Author	Approval
1.0	16.03.2015	Initial version (new documentation layout)		
1.1	14.04.2016	Ch. 6.1, 6.2.4 & 8.2 IO type change $AI_{27V.4}$ → $AI_{32V.4}$ Ch. 6.2.3 AI $AI_{5V.2}$ & $AI_{10V.2}$ accuracy specification improved		