Advanced Mini Module

Data Sheet

Document: 2038C01.doc
Updated: 24.3.2006

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DOCUMENT VERSION HISTORY

Date	Notes
8.3.2006	First released version
24.3.2006	Specifications for I/O pins XM1.11 and XM1.12 updated to chapter "3.7 I/O / IEC Map", chapter "3.8 Specification for Internal Diagnostics" updated

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1 GENERAL

1.1 Purpose of This Document

This technical document is meant to be used in system development. This document contains necessary data concerning the module in question which system designer needs in system development work.

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1.2 About Manufacturer

Epec Oy helps its customers to manufacture efficient, safe and environmental friendly mobile working machines which helps their customers to maximise their productivity.

Epec is a solution provider specialized in embedded control systems, information logistics systems for mobile machines and information systems communicating with machines. We believe that we know control systems for challenging conditions and we are able to offer a total solution from control units to project services and designing.

1.3 Epec CAN Module Family

Epec CAN Module Family is designed to operate in extreme environments, where vibration, wide temperature changes and moisture are normal conditions. The requirements for the system's reliability and safety have been the key words in module family development. A small and protective module casing keeps inside high performance microcontroller with lots of control capabilities.

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2 ADVANCED MINI MODULE GENERAL DESCRIPTION

Advanced Mini Module is part of the Epec CAN Module Family. Module is equipped with several input and output pins such as PWM outputs for proportional controls and some feedback inputs for better accuracy of proportional controls. Versatile analog inputs can be used for example for joystick connection and pulse inputs for frequency measuring or for pulse counting. In addition, the module has some digital inputs and outputs for digital controlling. Digital outputs can be used as digital inputs and counterwise by the means of user application program. The module is used in CAN bus based control systems as a multifunction controller with different kinds of sensors and actuators. This PLCopen programmable (with CoDeSys tool) module can also be used as an independent controller because of digital and analog I/O capabilities. Module has two CAN busses.

Features

- ISO High Speed CAN1 interface, CANopen compatible
- ISO High Speed CAN2 interface, user programmable
- Operating voltage 9…30 VDC
- Recommended operating voltage 24 VDC
- 248 16-bit parameters
- Operating temperature -40ºC…+70ºC
- Storage temperature -50ºC…+85ºC
- Protection IP67 (classification according to IEC 60529)
- Overload protection for outputs
- Gold plated, locked and sealed connectors:
  8-pin AMPSEAL for module connection
  23-pin AMPSEAL for I/O
- Small outline dimensions: 147,5 x 63 x 53 mm
- Weight 0.5 kg

Applications

- Forest Machines
- Road Maintenance
- Construction Machines
- Crushing Stations
- Industrial Machines
- Agricultural applications
- Automation applications
- Mining Machines

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3 INPUT / OUTPUT SPECIFICATIONS

Advanced Mini Module contains inputs and outputs or, in other words, I/O pins of different types. There are, for example, outputs which source current and outputs which sink current. Furthermore, there are I/O pins which can be used as inputs or as outputs at the control of the application programmer.

3.1 Configurable I/Os

	DI	**PI**	**AI**	**AI**	**PWM**	**DO**	**DO**
Amount	***Digital Input***	***Pulse Input***	***Current Measuring Feedback***	***Analog Input***	***Pulse Width Modulation Capability***	***Digital Output (sourcing)***	***Digital Output (sinking)***
6	X				X	X	
4	X	X					
3			X				
6	X			X			
1	X						X
20	*Total I/O amount*						

The usage of each I/O pin is determined by the application.

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3.2 Digital Input / PWM Output / Digital Output

Pins XM1.1, XM1.3, XM1.4, and XM1.7…XM1.9 are current sourcing outputs. In other words, pin connects the load to positive supply voltage. The application program can also simultaneously monitor the actual state of the pin. This feature makes it possible to detect short circuits to the ground. Open loads can not be detected because the internal load resistor is connected to the ground.

This kind of outputs are also capable to generate pulse width modulated (PWM) output signals. This feature is useful when driving proportionally controlled loads, e.g. proportional hydraulic valves. Monitoring the state of the pin is generally not possible when the pin is used as a PWM signal output.

PWM frequencies can be configured under software control in groups of outputs. The frequency is set by ***HW_SET_PWM_FREQ*** function call. The setting is done by a PWM channel but setting the frequency of one channel sets also the frequencies of all the other channels in the same groups.

In very carefully selected applications a pin of this type can also be used as an input by using the output state monitoring feature. In those cases the output functionality of the pin must of course be kept in off state. It must be taken care in system design that the output unintentionally switching to on state causes no harm to the system.

PWM Frequency Control Groups (PFCG)

Group	*Channel*	*Output pin*
A	0	XM1.8
	1	XM1.9
	2	-
	3	-
B	4	XM1.1
C	5	XM1.3
D	6	XM1.4
E	7	XM1.7

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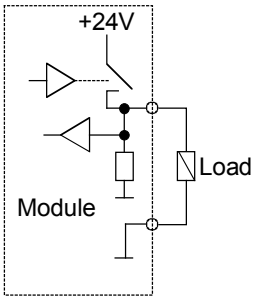
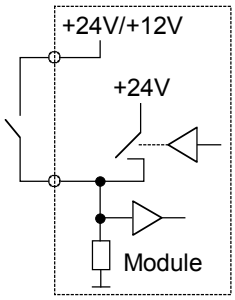
Electrical Characteristics

Symbol	*Parameter*	*Conditions*	*Min*	*Max*	*Units*
R_O	Output Resistance	Output On		0.2	Ω
I_O	Output Current	Output On		3	A
f_{PWM}	PWM Frequency	(Note 1)	40	2550	Hz
	PWM Resolution	Group A	2.5MHz/ f_{PWM}		
		Group B, C, D and E (Note 1)	312.5kHz/ f_{PWM}		
		Group A; f_{PWM}=100Hz (Note 1)	25000		
		Group B, C, D, and E; f_{PWM}=100Hz (Note 1)	3125		
R_I	Input Resistance	Output Off	2.8	7.5	KΩ
V_{IH}	Input High Voltage		4.8	V_{SUPPLY}	V
V_{IL}	Input Low Voltage	Output Off	-0.5	4.2	V
f_I	Input frequency	t_C=10ms (Note 2, 3, 4)		12	Hz
		Variable t_C (Note 2, 4)		$1/8t_C$	
t_I	Input Pulse Width	t_C=10ms (Note 2, 3, 4)	40		ms
		Variable t_C (Note 2, 4)	$4t_C$		

Connection Principle



Connection Principle (when used as input)



Note 1: PWM capable outputs are divided into five groups. All outputs in same group share the same PWM frequency (default value 140 Hz)

Note 2: Violating this rating may lead to system not recognizing all input state transitions

Note 3: These parameters depend on software cycle time

Note 4: t_C denotes software cycle time.

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3.3 Digital Input / Pulse Input

3.3.1 Pins XM1.11 and XM1.12

Pins XM1.11 and XM1.12 are ground referenced inputs (***DI***) including pulse counting (***PI***) feature. This kind of pins have 2.2kΩ resistor connected to +5V.

The application program is provided with the number of the pulses seen in the input in addition to the normal input state.

There are three variables associated with each pin of this type in PLCopen programming environment. The first is a bit variable in the ***IX*** area just in the same way as with the pins without the ***PI*** features. The other two are word variables in the ***IW*** memory area which hold the frequency value and the number of pulses.

After starting up the module measures only the pulse frequency. Pulse counting, if needed, must be enabled explicitly by the application program.

The counting of the pulses competes with the application program and other processes for the CPU time. This makes it rather hard to estimate the actual maximum frequency of the pulses that the module is able to count reliably. The maximum frequencies given in the table below are such frequencies which make the module to freeze in practice if all inputs are connected to their maximum frequencies. It means that to be able to reach the maximum frequencies, there is no room for application program or any other processes like CAN traffic. So, the practical limits are lower but the maximum values of the table still give the basis for the estimation.

Inputs of this type are also suitable for quadrature sensor position counting. These inputs can be logically paired with another similar input. The result is a two channel pulse counter which is capable of detecting the direction of the movement of the sensor. The pairing is done in the application program.

Electrical Characteristics

Symbol	*Parameter*	*Conditions*	*Min*	*Max*	*Units*
R_I	Input Resistance	Referenced to +5V	2.1	2.3	kΩ
V_{IH}	Input High Voltage		4.8	30	V
V_{IL}	Input Low Voltage		-0.5	4.2	V
f_I	Input Frequency (frequency measurement and pulse counting)	(Note 1, 4)		2.5	kHz
	Input Frequency (normal input)	t_C=10ms (Note 1, 2, 3, 5)		12	Hz
		Variable t_C (Note 1, 3, 5)		$1/8t_C$	
t_I	Input Pulse Width	Note 1, 4	50		µs
		t_C=10ms (Note 1, 2, 3, 5)	40		ms
		Variable t_C (Note 1, 3, 5)	$4t_C$		
C_I	Input Capacitance		0.8	12	nF

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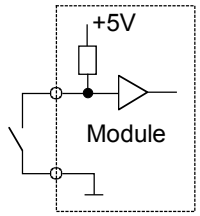
Connection Principle



Note 1: Violating this rating may lead to system not recognizing all input state transitions

Note 2: These parameters depend on software cycle time

Note 3: t_C denotes software cycle time

Note 4: Applies to inputs used for pulse counting. Violating this rating may lead to incorrect measurement or counting

Note 5: Applies to inputs used as normal digital input. Violating this rating may lead to application program not noticing all input state transitions

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3.3.2 Pins XM1.13 and XM1.14

Pins XM1.13 and XM1.14 are ground referenced inputs (***DI***) including pulse counting (***PI***) feature. These pins have 10kΩ resistor connected to GND.

The application program is provided with frequency and number of the pulses seen in the input in addition to the normal input state.

There are three variables associated with each pin of this type in PLCopen programming environment. The first is a bit variable in the ***IX*** area just in the same way as with the pins without the ***PI*** features. The other two are word variables in the ***IW*** memory area which hold the frequency value and the number of pulses.

After starting up the module measures only the pulse frequency. Pulse counting, if needed, must be enabled explicitly by the application program.

The pulse counting competes with the application program and other processes for the CPU time. This makes it rather hard to estimate the actual maximum frequency of the pulses that the module is able to count reliably. The maximum frequencies given in the table below are such frequencies which make the module to freeze in practice if all inputs are connected to their maximum frequencies. It means that to be able to reach the maximum frequencies, there is no room for application program or any other processes like CAN traffic. So, the practical limits are lower but the maximum values of the table still give the basis for the estimation.

Inputs of this type are also suitable for quadrature sensor position counting. Any of these inputs can be logically paired with another similar input. The result is a two channel pulse counter which is capable of detecting the direction of the movement of the sensor. The pairing is done in application program.

Electrical Characteristics

Symbol	*Parameter*	*Conditions*	*Min*	*Max*	*Units*
R_I	Input Resistance	V_I greater than 4.3V (Note 1)	9.0	11	kΩ
		Referenced to 1.3V; V_I less than 4.3V (Note 1)	6.2	7.6	kΩ
V_{IH}	Input High Voltage		4.8	30	V
V_{IL}	Input Low Voltage		-0.5	4.2	V
f_I	Input Frequency (frequency measurement and pulse counting)	(Note 2, 3, 6)		2.5	kHz
	Input Frequency (normal inputs)	t_C=10ms (Note 3, 4, 5, 7)		12	Hz
		Variable t_C (Note 3, 5, 7)		$1/8t_C$	
t_I	Input Pulse Width	(Note 3, 6)	50		µs
		t_C=10ms (Note 3, 4, 5, 7)	40		ms
		Variable t_C (Note 3, 5, 7)	$4t_C$		
C_I	Input Capacitance		0.8	12	nF

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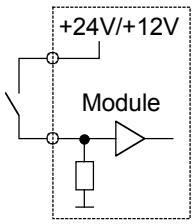
Connection Principle



Note 1: With input voltages below 4.3V it seems like the internal input resistance was connected to a 1.3V voltage source

Note 2: All conditions must be respected. Even if some of the inputs were not used for frequency measurement or pulse counting, these conditions must nevertheless be respected regarding those inputs too. Otherwise operation of other inputs may be interfered

Note 3: Violating this rating may lead to system not recognizing all input state transitions

Note 4: These parameters depend on software cycle time

Note 5: t_C denotes software cycle time

Note 6: Applies to inputs used for frequency measurement and pulse counting. Violating this rating may lead to incorrect measurement or counting

Note 7: Applies to inputs used as normal digital inputs. Violating this rating may lead to application program not noticing all input state transitions

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3.4 Current Measuring Feedback

Pins XM1.2, XM1.5, and XM1.6 are normally used as a return path for the loads of PWM outputs. These kind of pins have a small shunt resistor connected to ground. The shunt resistor is used to measure the current flowing through the load. Nothing prevents using these pins to measure currents from other sources as well.

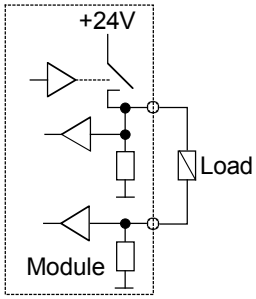
In PLCopen programming environment, there is a word variable in ***IW*** area associated with each pin from where the software can read the actual current flowing into the pin.

Electrical Characteristics

Symbol	*Parameter*	*Conditions*	*Min*	*Max*	*Units*
R_I	Input Resistance		0.21	0.23	Ω
I_I	Input Current	Analog measuring range	0.0	1.0	A
		(Note 1)		1.7	A
TIRE	Total Input Referred Error			50	mA

Note 1: Exceeding the max value might cause damage to input.

Connection Principle



A pin where the upper wire of the load is connected is PWM output / digital output. This illustrates the normal way to connect loads when load current measurement is desired.

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3.5 Digital Input / Analog Input

Pins XM1.10, XM1.17, XM1.20…XM1.23 are analog inputs. Each pin can be configured either as a current input or as a voltage input.

Pins of this kind are used to measure analog signals. They can be used as high impedance voltage inputs for signals from 0 to 5 volts or low impedance current inputs for signals from 0 to 22.7 milliamperes.

The input impedance of each pin is controlled by a bit in an *Input Impedance Configuration Register* (IICR). This register is invisible to the programmer but it can be written by ***HW_SET_AI_TYPE*** function call.

NOTE: When an input like this is configured as a low impedance current input, it can't withstand the normal maximum input voltage rating. The maximum rating is lowered in this case to 15 volts.

In PLCopen programming environment, there is a word variable in ***IW*** area associated with each pin from where the software can read the actual signal magnitude at the pin.

In carefully selected applications these pins can also be used as digital inputs. Generally, it is not recommended. In high impedance voltage input configuration they have low threshold voltage which is quite sensitive to interference signals. In low impedance current input configuration they are subject to damage if they are connected to for example 24 volt system voltage. There are bits in ***IX*** area associated with these inputs to support the DI functionality.

Input Impedance Configuration Register (IICR)

Bit	*Input pin*
IICR.0	X1.10
IICR.1	X1.17
IICR.2	X1.20
IICR.3	X1.21
IICR.4	X1.22
IICR.5	X1.23

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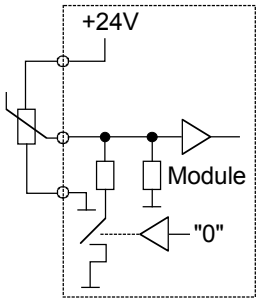
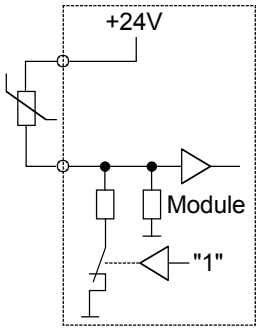
Electrical Characteristics

Symbol	*Parameter*	*Conditions*	*Min*	*Max*	*Units*
V_I	Input Voltage	Analog measuring range	0.0	5.0	V
I_I	Input Current	Analog measuring range	0.0	22.7	mA
V_{IH}	Input High Voltage	(Note 1)	2.0	30	V
		(Note 2)	2.0	15	V
V_{IL}	Input Low Voltage		-0.5	1.0	V
I_{IH}	Input High Current	(Note 2)	9.0	27	mA
I_{IL}	Input Low Current	(Note 2)	-2.3	4.5	mA
R_I	Input Resistance	(Note 1)	81	83	kΩ
		(Note 2)	219	225	Ω
TIRE	Total Input Referred Error	(Note 1)		0.12	V
		(Note 2)		0.7	mA
π_I	Time Constant of Input Low Pass Filter	(Note 1)	3.1	4.7	ms

Connection Principle; High Impedance Voltage Input



Connection Principle; Low Impedance Current Input



Note 1: Input Configured for Voltage Measurement (220Ω Input Resistor Disconnected)

Note 2: Input Configured for Current Measurement (220Ω Input Resistor Connected)

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3.6 Digital Input / Digital Output (sinking)

Pin XM1.18 is current sinking output. In other words, pin connects the load to ground. The application program can also simultaneously monitor the actual state of the pin. This feature makes it possible to detect open load and short circuit to the supply voltage.

In very carefully selected applications a pin of this type can also be used as an input by using the output state monitoring feature. In those cases the output functionality of the pin must of course be kept in off state. It must be taken care in system design that the output unintentionally switching to on state causes no harm to the system.

There are two bit variables associated with each pin of this type in PLCopen programming environment. The first is one of the ***QX*** output bits for controlling the pin as an output. The second is one of the ***IX*** input bits for monitoring the actual state of the output or reading the pin as an input.

Electrical Characteristics

Symbol	*Parameter*	*Conditions*	*Min*	*Max*	*Units*
R_O	Output Resistance	Output On		0.12	Ω
I_O	Output Current	Output On		3	A
R_I	Input Resistance	Output Off	9	11	kΩ
V_{IH}	Input High Voltage	Output Off	4.8	30	V
V_{IL}	Input Low Voltage		-0.5	4.2	V
f_I	Input frequency	t_C=10ms (Note 1, 2, 3)		12	Hz
		Variable t_C (Note 1, 3)		$1/8t_C$	
t_I	Input Pulse Width	t_C=10ms (Note 1, 2, 3)	40		ms
		Variable t_C (Note 1, 3)	$4t_C$		

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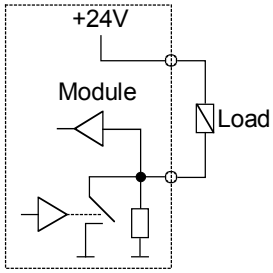
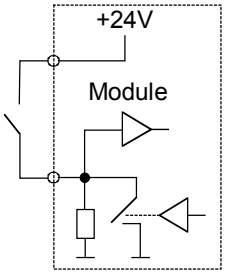
Connection Principle



Connection Principle (when used as input)



Note 1: Violating this rating may lead to system not recognizing all input state transitions

Note 2: These parameters depend on software cycle time

Note 3: t_C denotes software cycle time

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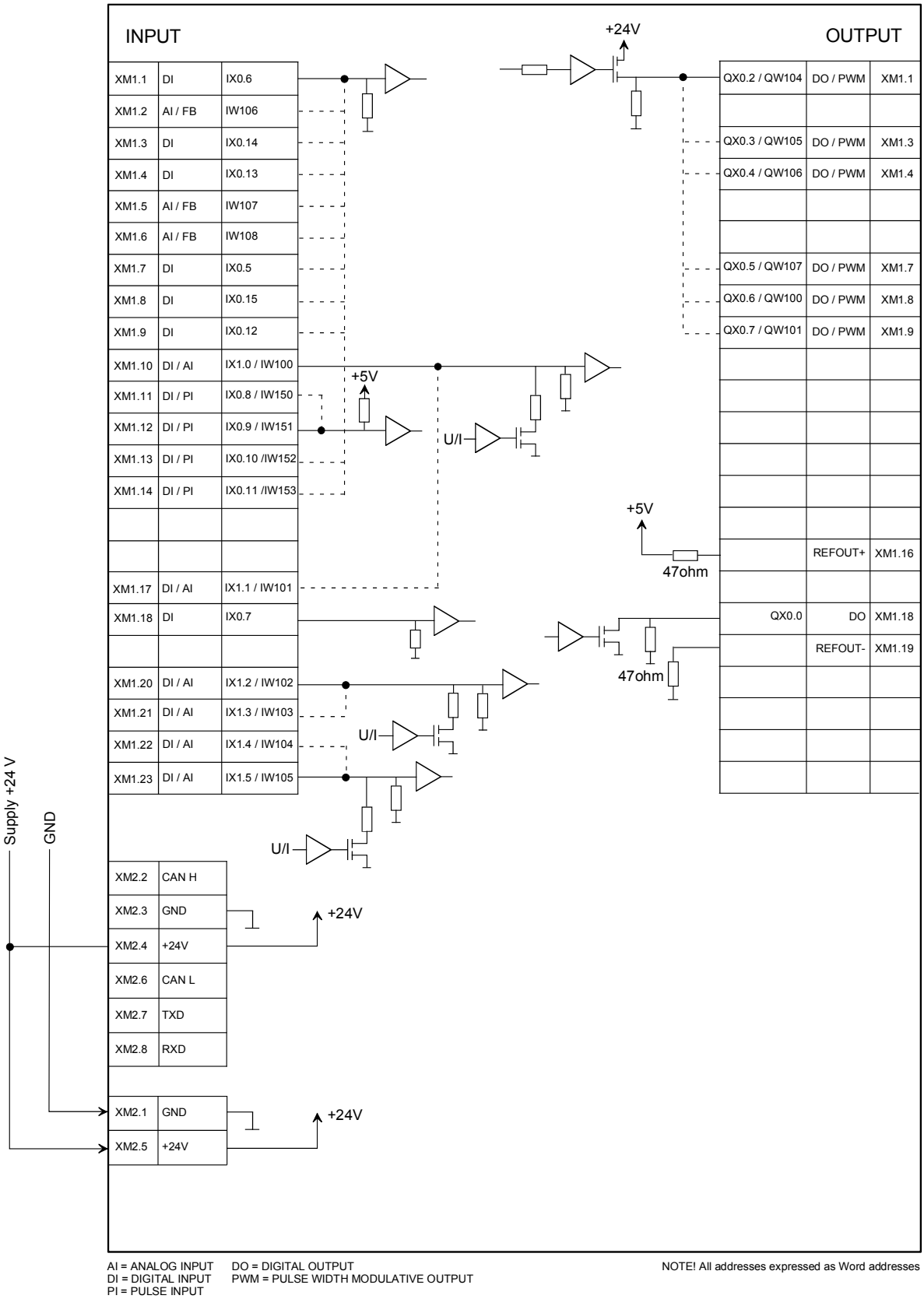
3.7 I/O / IEC Map



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3.8 Specification for Internal Diagnostics

Type	*IEC address*	*Precision FS*	*Resolution bits*	*Full reading*	*Notes*
AI(TEMP)	IW109	≤ ±5.0%	10	5 V	V_{TEMP} = 395 mV + (6.2 mV / ºC x Temp ºC)
AI(+24V)	IW110	≤ ±5.0%	10	46 V	

3.9 Connectors

Epec uses gold plated, locked and sealed AMPSEAL heavy duty connectors for all CAN Module Family products to ensure the endurance of extreme conditions.

- 8-pin AMPSEAL for power and system CAN connections
- 23-pin AMPSEAL for I/Os
- All connectors are mechanically keyed to mate only with identical colours

3.10 AMPSEAL Cable Dimensions

Size		***Insulation diameter range***	***Strip length ±0,4***	***Wire crimp height***	***Wire crimp width (nom)***	***Insulation crimp height max.***	***Insulation crimp width ±0,1***
mm^2	***AWG***						
0.5	20	1.7	5.1	1.17 ± 0.08	2.03	3.2	3.1
0.8	18	to	5.1	1.27 ± 0.05	2.03	3.2	3.1
1.4	16	2.7	5.1	1.40 ± 0.05	2.03	3.2	3.1
Typical hand crimping tools			AMP Procrimper 58440-1 (408-9592) AMP Procrimper 58529-1 (408-9999)				

- All applied cables should be properly shielded, bundled and grounded
- See the General Mounting and Cabling Instructions for Epec Modules for more detailed information about the cabling

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4 POWER SUPPLY

- Nominal supply voltage 24 VDC
- Full operating range 9…30 VDC

NOTE! *No saving operations (program flashing or parameter storing) into permanent memory can be done under 11,5 VDC.*

4.1 Power Supply Pins

Designation	***Connector / pin number***	***Potential***
Supply voltage (V_{SUPPLY})	XM2.4 XM2.5	+24 VDC (+9…30 VDC)
Ground	XM2.1 XM2.3	GND
Ref+ 47Ω	XM1.16	+5 VDC
Ref- 47Ω	XM1.19	GND

4.2 Overvoltage

- Max. 34 VDC (stresses above this value may cause permanent damage to the module)
- Module can handle only short period transients of greater voltages than 34V. The complete protection can be achieved with Hub Module (EPEC 2021). The Hub Module is designed to protect the system against power line transients.

4.3 Power Consumption

- Approximately 1 W (+24 VDC, no external load)
- Supply Voltage (V_{SUPPLY}) maximum continuous current 10 A (with full external load)

4.4 Closed Loops Wiring

It is strongly recommended to use closed loops for connecting all sensors, actuators etc. devices to I/O modules. Closed loops wiring can be achieved by connecting the GND wire from the sensor, actuator etc. device into the GND pin of module connector.

4.5 Undervoltage Reset

- $V_{SUPPLY} < 9.0$ VDC

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5 BUS CONNECTIONS

5.1 Bus Connection Pins

Designation	*Connector / pin number*
CAN1 interface, system interface	XM2.2 (CAN H) XM2.6 (CAN L) XM2.3 (GND)
CAN2 interface, user programmable communication	XM2.7 (CAN H) XM2.8 (CAN L)
(this pin must be left open)	XM1.15

5.2 CAN Interface

- CANopen compatible
- Physical interface ISO 11898
- Protocol CAN 2.0B
- Higher layer protocol user programmable (CAN2)
- There is no internal terminal resistor in Advanced Mini Module. For detailed information concerning the use of terminal resistors, see the General Mounting and Cabling Instructions for Epec Modules

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6 ENVIRONMENTAL CHARACTERS

- Operating temperature -40°C…+70°C
- Storage temperature -50°C…+85°C

6.1 Protection

- IP67 (classification according to IEC 60529)
- Module is equipped with Oil Rating 7 (according to test method AATCC 118-1997ASTM) hydrophobic and oleophobic Gore HPM Membrane Vent
- Protection for plugs depends on cable processing
- All cables, connectors and tools must be of correct type and sufficiently high quality. Also the environmental suitability of equipment should be checked (protection for moisture, mechanical stability, power durability, coupling resistance, etc.)
- Additional module cover for wires and connectors is also available (E10801109)

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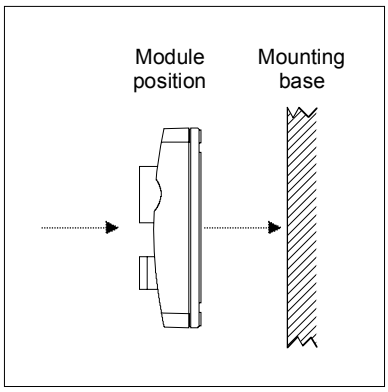
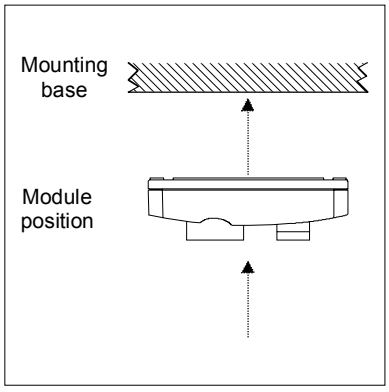
7 HOUSING

- Closed light cast aluminium housing
- Powder-painted, yellow surface passivation
- Puncture hole fastening

7.1 Mounting

- 2 pieces of M6 screws to DIN 912
- If a separate Epec module shock protection cover (E10801109) is mounted, it is recommended to use Epec E10701038 fastening bolts
- Recommended mounting position horizontal or vertical to allow water etc. flowing away from connectors:





- See the General Mounting and Cabling Instructions for Epec Modules for more detailed information about the module mounting

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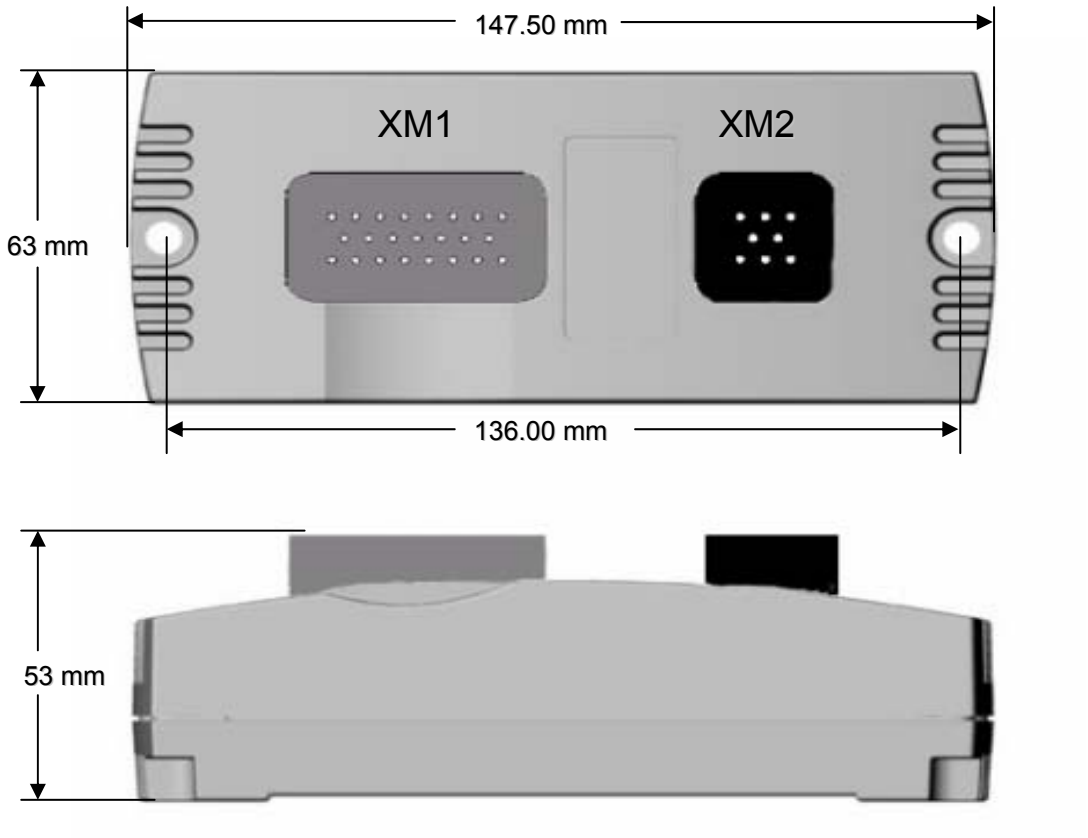
7.2 Unit Dimensions



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8 ADDITIONAL DOCUMENTS

Document name	***Document description***
MountingInstructions	General mounting and cabling instructions for Epec modules

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