CrossFire™ MX1B

User Manual and Reference Handbook
CrossFire™ MX1B CANopen slave

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Table of Contents

CrossFire™ MX1B

Introduction

The CrossFire™ MX1B is a general, flexible I/O module and controller for rough environments. It fits in distributed and decentralized systems where you want to be able to put electronics close to the I/O that will be managed. The module is highly configurable, and has its I/O distributed over a number of M12 connectors.

The CrossFire™ MX1B is a CAN bus node, and by configuring the node properties, the module can be set up to automatically send and receive I/O to and from the CAN bus network.

The CrossFire™ MX1B supports the CANopen protocol which is one of the leading protocols used for CAN bus networks.

This document describes how the CrossFire™ MX1B CANopen slave should be used. The reader should be familiar with the CANopen standard in order to fully understand the manual.

Functions and Features

- The CrossFire™ MX1B is a CiA DS-401 I/O (Input/output) module, designed for automotive products equipped with hydraulic components. It has 20 individually configurable I/O ports to provide various types of I/O. The CrossFire™ MX1B can therefore be configured to have:
  - Up to 12 Digital ON/OFF Outputs (PNP Open-Emitter)
  - Up to 12 Digital Inputs
  - Up to 12 Analog Inputs
  - 8 of which have two software-selectable ranges, 0–5 V or 0–32 V
  - Up to 8 Regulated PWM (Pulse Width Modulated) Outputs
  - Up to 4 Non-Regulated PWM Outputs
  - Up to 2 Pulse Counter Inputs or 1 pair of Shaft Encoder Inputs
  - Up to 2 Frequency Measurement inputs
- Configurable using SDO's (Service Data Object)
- 8 dynamically-mapped PDO's (Process Data Objects) compliant to DS-401
- Supports use of synch object
- Support for both heartbeat and node guarding
- The CrossFire™ MX1B is an EMCY (Emergency) object producer. The COB ID (Communication Object Identifier) of the EMCY object can be configured
- Storage for up to 127 Error codes
- Status bits for output drivers ("Ok", "short circuit", "open load" or "over current") are sent directly with TPDO1, (i.e. there is no need to request them with an SDO)
- Reset function restores settings back to their factory default values
- CANopen Node ID is hardware-configurable by means of a dongle, or may be configured using SDO's

Technical data

Processor	Infineon C167
Physical Housing Dimensions Weight	 Plastic enclosure filled with silicon compound, metal base plate L x W x H: 212 x 116 x 37 mm (H = 67 mm with connectors) 1.0 kg.
Environment Operating Temperature Range Protection rating Protection Class EMC Conformity	 -40 ˚C to +85 ˚C IP67 (IEC 60529) III ISO 14982 for Emissions, ISO 11452-2 for Immunity
Power Supply Operating voltage Current consumption	 10 to 36 VDC <100 mA at 24 V without external load
Indicators	PS: Power, ST: CAN status, CAN: CANopen status
CAN interface Communication profile Device Profile Drivers Baud Rate Node ID	ISO 11898-2 (High Speed CAN) CANopen I/O module to CiA DS401 Phillips 82C251 or 82C252 10, 20, 50, 100, 125, 250, 500, 800 and 1000 kbit/s 1 to 16 hardware set, or 1 to 127 set with SDO's
Serial Interface	RS-232 (Only for firmware loading, not for application)
Connectors	I/O: DIN M12 CAN: DIN M12 Power: DIN M23
Digital Inputs Input Voltage Pulse Shaft Encoder Inputs	 0 – 5 V, 0 – 24 V Frequency up to 60 kHz. Full quadrature decoding
Analog Inputs* Input Voltage Input impedance Resolution Total Unadjusted Error	 0 – 5 V, 0 – 32 V or 0 – 20 mA 1 MΩ (0 – 5 V), 11.5 kΩ (0 – 32 V) 10 bits ±2 LSB's
Digital Outputs Max Voltage Max Current Total Current Protection	 30 V 3 A 18 A (external fuse not included) Ground Fault, Over Current, Open Load, with Status Feedback
PWM (Analog) Outputs Max Voltage Max Current Resolution Protection	 30 V 3 A 0.1 % Ground Fault, Over Current, Open Load, with Status Feedback
Certifications / Compliance	CE ISO IEC CiA

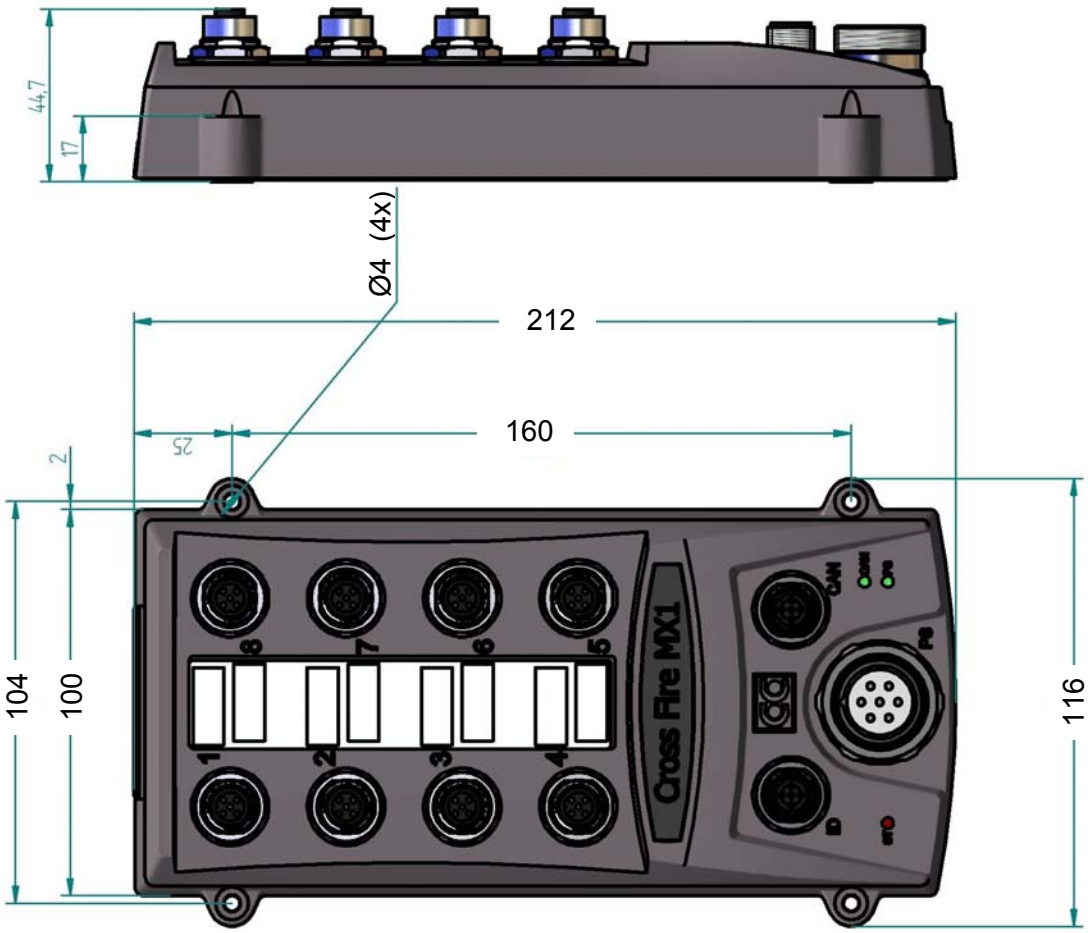
*The analog inputs that are combined with on/off outputs shall only be used as feedback for the outputs. Because of the open-load detection feature there will be a low current flowing to these outputs. This makes the inputs not useful as ordinary analog inputs

References

CAN in Automation - CANopen standard:	http://www.can-cia.org
CE Marking:	http://ec.europa.eu/
International Standards Organisation:	http://www.iso.org/
International Electrotechnical Commission	http://www.iec.ch/

Weight and dimensions

The CrossFire™ MX1B dimensions and placement of the four mounting holes is illustrated below. The four mounting lugs have clearance for 4 mm bolts. The module weighs 1.0 kg.



Identification

There is a label on the back of the CrossFire™ MX1B. On the label there are numbers which identify your unique module. Take note of them. During service and other contact with the supplier it is important to be able to provide these numbers.

Environmental Tolerance

The CrossFire™ MX1B has been designed to cope with tough environmental demands. Strict tests have been conducted on the unit in order to ensure that it fulfils the expectations of a rugged unit. Much work has been performed to choose and design integral components so that they, in the best possible way and under all circumstances, provide you with a dependable working instrument. In Appendix 1, a list of standards can be found according to which the CrossFire™ MX1B has been tested and approved.

Despite thorough design requirements and testing specifications, it is always best to install and handle the CrossFire™ MX1B with care.

Installation

Your CrossFire™ MX1B should be installed in such a way that the module is not exposed to any unnecessary stress, heat, vibration or moisture. In this section, some recommendations are made regarding methods for how the unit should be installed.

If the unit is opened by non-authorised personnel, the warranty becomes invalid.

Cooling

Although the CrossFire™ MX1B can operate in relatively high temperatures, cooling should still be considered when installing the CrossFire™ MX1B. If the unit becomes too warm, it may not perform to its full capacity and, with high temperature, cease to function. Common sense should be used to select an appropriate location where adequate cooling is achievable. It is not recommended to install the module near a vehicle's exhaust system, for example.

Inadequate cooling may lead to overheating, causing permanent damage to the unit.

Vibration

We recommend installing the CrossFire™ MX1B in such a way that it is not unnecessarily exposed to vibration or other stress.

Rain / Moisture

The CrossFire™ MX1B shall preferably be placed under a roof in order to prevent direct exposure to water.

CrossFire™ MX1B

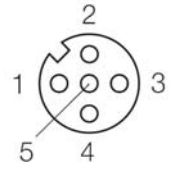
Electrical Interface

Connectors

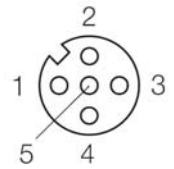
Every I/O pin on the CrossFire™ MX1B is assigned a unique port. The ports are numbered from 1 to 20. Every port may be configured individually in software to one of 6 different I/O types. Not all I/O types are available on all ports.

In some cases, a port is associated with more than one pin. This occurs when two or more pins work together to perform a certain function.

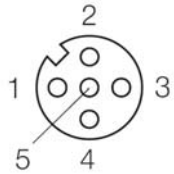
Connector 1

Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X1.1	2	Regulated PWM Output	Digital ON/OFF Output Type 1	
X1.2	1	Current Feedback		
X1.3	2	Current Feedback		
X1.4	1	Regulated PWM Output	Digital ON/OFF Output Type 1	
X1.5	-	GND	GND	

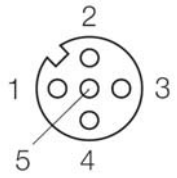
Connector 2

Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X2.1	4	Regulated PWM Output	Digital ON/OFF Output Type 1	
X2.2	3	Current Feedback		
X2.3	4	Current Feedback		
X2.4	3	Regulated PWM Output	Digital ON/OFF Output Type 1	
X2.5	-	GND	GND	

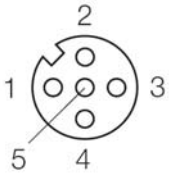
Connector 3

Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X3.1	-	+5V ref		
X3.2	9	Analog Input Type 1	Digital Input Type 1 (0-5/0-32 V)	
X3.3	-	Analog GND		
X3.4	13	Analog Input Type 2*	Digital ON/OFF Output Type 2 Digital Input Type 2 (0-5/0-32 V) PWM Output (non-regulated) Pulse Counter / Encoder A Input Frequency Measurement	
X3.5	-	GND	GND	

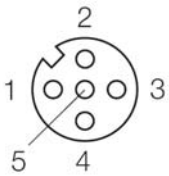
Connector 4

Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X4.1	-	+5V ref		
X4.2	10	Analog Input Type 1	Digital Input Type 1 (0-5/0-32 V)	
X4.3	-	Analog GND		
X4.4	14	Analog Input Type 2*	Digital ON/OFF Output Type 2 Digital Input Type 2 (0-5/0-32 V) PWM Output (non-regulated) Pulse Counter / Encoder B Input Frequency Measurement	
X4.5	-	GND	GND	

Connector 5

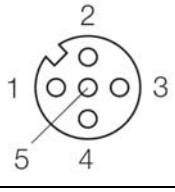
Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X5.1	-	+5V ref		
X5.2	12	Analog Input Type 1	Digital Input Type 1 (0-5/0-32 V)	
X5.3	-	Analog GND		
X5.4	16	Analog Input Type 2*	Digital ON/OFF Output Type 2 Digital Input Type 2 (0-5/0-32 V) PWM Output (non-regulated)	
X5.5	-	GND	GND	

Connector 6

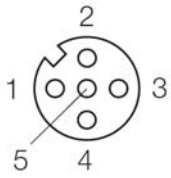
Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X6.1	-	+5V ref		
X6.2	11	Analog Input Type 1	Digital Input Type 1 (0-5/0-32 V)	
X6.3	-	Analog GND		
X6.4	15	Analog Input Type 2*	Digital ON/OFF Output Type 2 Digital Input Type 2 (0-5/0-32 V) PWM Output (non-regulated)	
X6.5	-	GND	GND	

*The analog inputs that are combined with on/off outputs shall only be used as feedback for the outputs. Because of the open-load detection feature there will be a low current flowing to these outputs. This makes the inputs not useful as ordinary analog inputs.

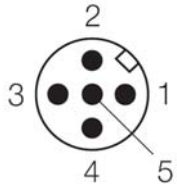
Connector 7

Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X7.1	6	Regulated PWM Output	Digital ON/OFF Output Type 1	
X7.2	5	Current Feedback		
X7.3	6	Current Feedback		
X7.4	5	Regulated PWM Output	Digital ON/OFF Output Type 1	
X7.5	-	GND	GND	

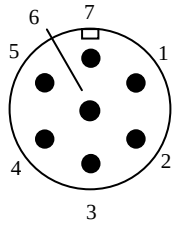
Connector 8

Pin	Port	Default Signal	Other Configurations	DIN M12 female, 5-pole
X8.1	8	Regulated PWM Output	Digital ON/OFF Output Type 1	
X8.2	7	Current Feedback		
X8.3	8	Current Feedback		
X8.4	7	Regulated PWM Output	Digital ON/OFF Output Type 1	
X8.5	-	GND	GND	

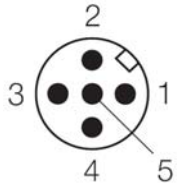
CAN Connector

Pin	Port	Default Signal	Comments	DIN M12 male, 5-pole
CAN.1	-	No Connection		
CAN.2	-	No Connection		
CAN.3	-	CANGND		
CAN.4	-	CANH		
CAN.5	-	CANL		

Power Supply (PS) Connector

Pin	Port	Default Signal	Comments	DIN M23 male, 7-pole
PS.1	-	+24 V	10 V-36 V supply (V_{batt}) Load-dump protection.	
PS.2	-	+24 V		
PS.3	-	GND	Battery ground	
PS.4	-	GND		
PS.5	-	TxD	Standard RS-232 levels (±10 V)	
PS.6	-	RxD	Standard RS-232 levels (±10 V)	
PS.7	-	Debug	Used for program loading	

ID Connector

Pin	Port	Default Signal	Other Configurations	DIN M12 x 1 male, 5-pole
ID.1	19	ID2	Digital Input Type 3 (0-5 V) Analog Input Type 3	
ID.2	18	ID1	Digital Input Type 3 (0-5 V) Analog Input Type 3	
ID.3	-	GND	-	
ID.4	17	ID0	Digital Input Type 3 (0-5 V) Analog Input Type 3	
ID.5	20	ID3	Digital Input Type 3 (0-5 V) Analog Input Type 3	

ID Interface Lookup Table

CANopen Node ID	ID3	ID2	ID1	ID0
1	0	0	0	0
2	0	0	0	1
3	0	0	1	0
4	0	0	1	1
….				
16	1	1	1	1

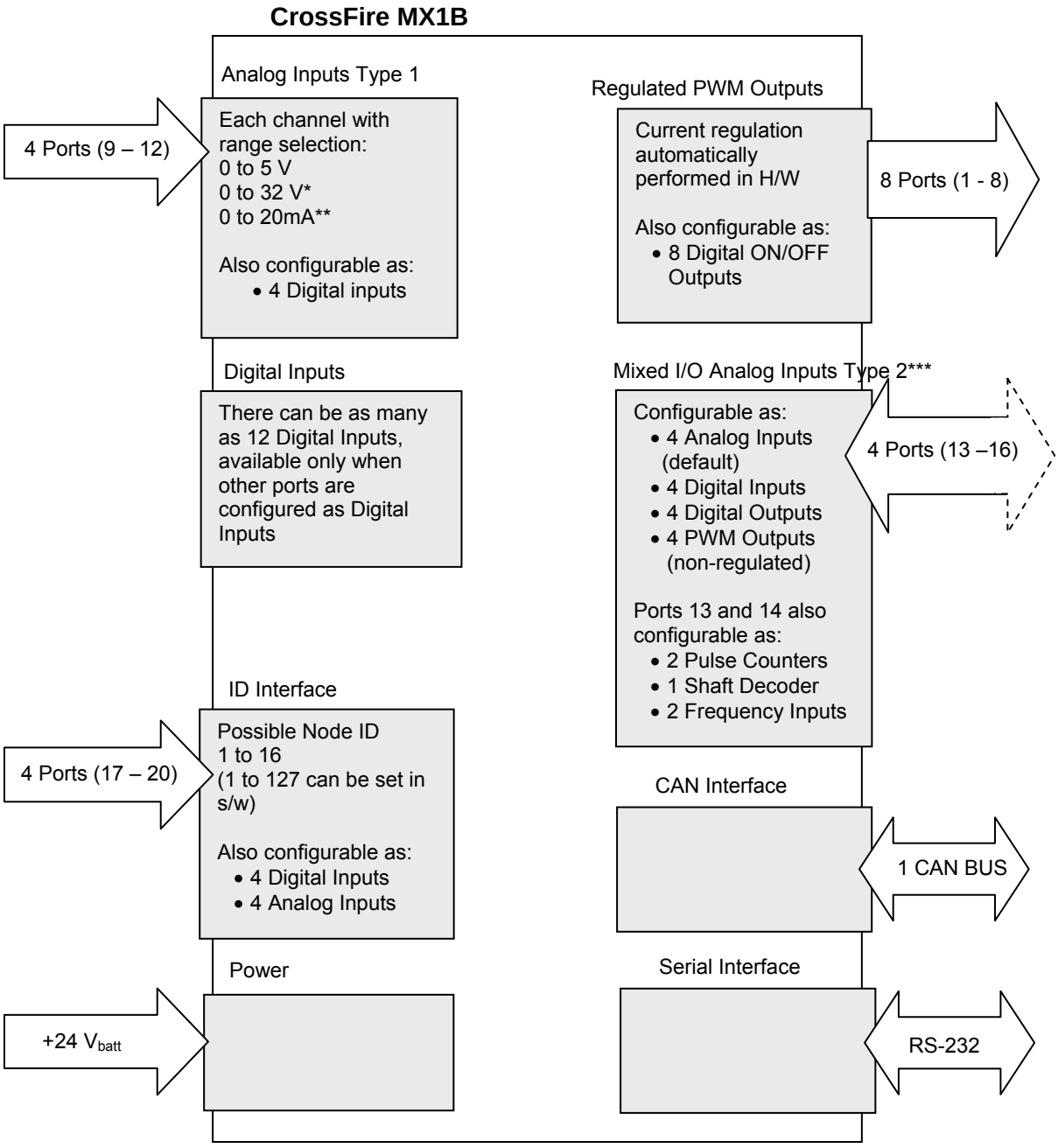
- State 0 is reached by wiring corresponding ID pin to pin 3 (GND)
- State 1 is reached by leaving corresponding ID pin disconnected.

⚠ Notice that the connector descriptions are those which are located on the unit, not those that the attached cables shall have in order to mate with them.

⚠ Use caution when plugging/unplugging connectors. If the pins become bent or damaged they may not function correctly, or in the worst case, the CrossFire™ MX1B or other equipment may be damaged.

Electrical Interface Overview

The CrossFire™ MX1B is highly configurable. The following illustration consists of several boxes which represent the main functional groups on the CrossFire™ MX1B. The arrows leading to and from the functional groups represent I/O, power or communication busses. The configuration can be changed by writing to the object dictionary in the Manufacturer-Specific Profile Area (0x2000 to 0x5FFF).



* not available on Analog Input Ports 17, 18, 19 or 20
**with external 250 Ω resistor
*** The analog inputs that are combined with on/off outputs shall only be used as feedback for the outputs. Because of the open-load detection feature there will be a low current flowing to these outputs. This makes the inputs not useful as ordinary analog inputs.

Electrical Interface Characteristics

Analog Inputs

There are three types of Analog Inputs available on the CrossFire™ MX1B. Only ports 9 through 16 are configured by default. Ports 17 through 20 must be reconfigured in the object dictionary (index 0x2000) in order to be used as Analog Inputs. The port allocations and characteristics of all Analog Inputs are described in the tables below.

Analog Inputs

Port	Signal Type	Comment
9	Analog Input Type 1	Functional Group: Analog Inputs
10		
11		
12		
13	Analog Input Type 2	Functional Group: Mixed I/O
14		
15		
16		
17	Analog Input Type 3	Functional Group: ID Interface
18		
19		
20		

Electrical Characteristics for Analog Inputs

Signal Name	Parameter	Value			Unit	Comment
		Min	Typ	Max		
Analog Input Type 1	Input Voltage	0	-	5/32	V	Each port has a software-selectable range
Analog Input Type 2*		0	-	5/32 or V_{batt}	V	Each port has a software-selectable range ⚠ Damage Occurs if Input Voltage exceeds V_{batt}
Analog Input Type 3		0	-	5	V	10 kΩ pull-up to +5 V
Analog Input Type 1 and 2	Input Impedance 0 – 32 volt range		11.5		kΩ	pull down*
	Input Impedance 0 – 5 volt range		1		MΩ	pull down
Analog Input Type 3			10		kΩ	pull up
Analog Inputs Types 1, 2 & 3	Resolution		10		bits	
	Total Unadj.Error		±2		LSB	0 – 5 volt range*
	Input Capacitance		100		nF	
	Protection	Diode-Clamp protected against over- and under voltage.				

*Use of 0 – 32 Volt range adversely affects input impedance and error.
*The analog inputs that are combined with on/off outputs shall only be used as feedback for the outputs. Because of the open-load detection feature there will be a low current flowing to these outputs. This makes the inputs not useful as ordinary analog inputs.

Digital Inputs

There are three types of Digital Inputs available on the CrossFire™ MX1B. Only ports 17 to 20, however, are available by default. The desired ports must therefore be reconfigured as Digital Inputs in order to be used (See object dictionary, index 0x2000). The port allocations and characteristics of all Digital Inputs are described in the tables below.

Digital Inputs

Port	Signal Name	Comment
9	Digital Input Type 1	Functional Group: Analog Inputs
10		
11		
12		
13	Digital Input Type 2	Functional Group: Mixed I/O
14		
15		
16		
17	Digital Input Type 3	Functional Group: ID Interface
18		
19		
20		

Digital Input Types 1 and 2 have a software selectable voltage range, and a 1-MΩ pull down resistor. All inputs are diode clamp protected against over- and under voltage.

Electrical Characteristics for Digital Inputs

Signal Name	Parameter	Value			Unit	Comment
		Min	Typ	Max		
Digital Input Type 1	Input Voltage	0	-	5/32	V	Each port has a software-selectable range
Digital Input Type 2		0	-	5/32 or V_{batt}	V	Each port has a software-selectable range ⚠ Damage Occurs if Input Voltage exceeds V_{batt}
Digital Input Type 3		0		5	V	10 kΩ pull-up to +5 V
Digital Input Types 1 and 2	Input Impedance 0 – 32 volt range		11.5		kΩ	pull down
	Input Impedance 0 - 5 volt range		1		MΩ	pull down
Digital Input Type 3			10		kΩ	pull up

Digital ON/OFF Outputs
There are two types of Digital ON/OFF Outputs, both of which can drive currents up to 3.0 Amps at 24 volts. None of the ports are configured as Digital Outputs by default, and must therefore be configured in the object dictionary (index 0x2000) in order to be used. The port allocation and characteristics are described in the following tables.

Digital ON/OFF Outputs

Port	Signal Name	Comment
1	Digital ON/OFF Output Type 1	Functional Group: Regulated PWM Outputs
2		
3		
4		
5		
6		
7		
8		
13	Digital ON/OFF Output Type 2	Functional Group: Mixed I/O
14		
15		
16		

Electrical Characteristics for Digital ON/OFF Outputs

Signal Name	Parameter	Value			Unit	Comment
		Min	Typ	Max		
Digital ON/OFF Output Type 1 and Type 2	Output Voltage	0	24	30	V	Outputs shut down @ 30 V
	Output Current			3.0	A	Protected against short circuit to gnd, open load and overload (3.0 A) Status can be read in software

Open load and short circuit detection
The open load detection is active during the first 250 ms after start up of the MX1B unit. An open load state can only be detected if the output is turned off, which is the default state at start up. According to the configuration possibilities for port 13-16 the open load detection might not be reliable. Therefore it is not recommended to use the open load detection feature for port 13-16.

The short circuit detection is active when an output is turned on. If a short circuit state is detected then the corresponding port will be disabled and prevented to be turned on again. The port will be disabled until the problem is solved and the power supply of MX1B is reset.

PWM Outputs (Regulated & Non-Regulated)
There are two types of PWM outputs, namely Regulated and Non-Regulated PWM Outputs. The Non-regulated PWM Outputs are not enabled by default. In order to enable them, the corresponding ports must be configured as Analog Outputs by writing an SDO to the object dictionary (address 0x2000). The following tables show the port allocations and characteristics of the PWM Outputs.

PWM Outputs

Port	Signal Name	Comment
1	Regulated PWM Output	Current Regulation is performed automatically in hardware. ⚠ Must have inductive load
2		
3		
4		
5		
6		
7		
8		
9	(Non-Regulated) PWM Output	No current regulation
10		
11		
12		

Electrical Characteristics for PWM Outputs

Signal Name	Parameter	Value			Unit	Comment
		Min	Typ	Max		
Regulated and Non-Regulated PWM Output	Output Voltage	0	24	30	V	Outputs shut down @ 30 V
	Output Current			3.0	A	Protected against short circuit to GND, open load and overcurrent (3.0 A) Status can be read in software
	Output Frequency		10		kHz	
	Duty Cycle Range	0	-	100	%	Corresponds to 0 – 1023 in Software.

Open load and short circuit detection
The open load detection is active during the first 250 ms after start up of the MX1B unit. An open load state can only be detected if the output is turned off, which is the default state at start up.

The short circuit detection is active when an output is turned on. If a short circuit state is detected then the corresponding port will be disabled and prevented to be turned on again. The port will be disabled until the problem is solved and the power supply of MX1B is reset.

Pulse Counter / Shaft Encoder Inputs / Frequency Measurement
The Pulse Counter, Frequency Measurement and Shaft Encoder characteristics are electrically identical – the only difference being how the signals are interpreted in software – so they are grouped together here for simplicity.

By default, these Inputs are not available. In order to use these inputs, reconfigure the ports in the object dictionary at index 0x2000. The following tables describe the port allocations and characteristics of the PWM Outputs. Note that both ports are required to read a single Shaft Encoder.

Pulse Counter / Shaft Encoder Inputs / Frequency Measurement

Port	Signal Name	Comment
13	Pulse Counter Shaft Encoder A Frequency Measurement	Functional Group: Mixed I/O
14	Pulse Counter Shaft Encoder B Frequency Measurement	

Electrical Characteristics for Pulse Counter / Shaft Encoder Inputs / Frequency Measurement

Signal Name	Parameter	Value			Unit	Comment
		Min	Typ	Max		
Pulse Counter Frequency-Measurement Shaft Encoder	Input Voltage	0		5/24	V	Software selectable input voltage range.
	Frequency	0	-	60	kHz	Interrupt driven.

Power Interface

Power Interface Electrical Characteristics

Parameter	Value			Unit	Comment
	Min	Typ	Max		
Supply Voltage, V_{batt}	10	24	36	V	Outputs disabled @ 30 V Load-dump protected @ 40 V
Supply Current	0.1	-	18	A	External 18-A fuse required.

CAN Interface

CAN Interface Electrical Characteristics

Parameter	Value			Unit	Comment
	Min	Typ	Max		
Input Voltage	±10	±24	±36	V	
Output Voltage	$0.8V_{batt}$	-	V_{batt}	V	
Baud rate	10	-	1000	kbit/s	See Object Dictionary index 0x2011 for default baud rate.

LED indicators

LED indicators

LED Description	Blink Pattern	Meaning
ST (Red) "CAN Status"	Off	Communication OK
	Single flash	CAN error state
	Double flash	Guarding of other node failed
	On	Bus off
CAN (Green) CANopen status	Off	No power to unit
	Blinking	Preoperational mode
	Single flash	Stopped mode
	On	Operational mode
PS (Red) Power	On	CrossFire™ MX1b power OK
	Off	No CrossFire™ MX1b power, or power too low

Appendix 1 – Environmental Tolerances

Environmental Tolerances

Environmental Test	Level			Standard
High temperature	Functional During test +75 °C, 16 hours			IEC 60068-2-2 Ab
Low temperature	Functional During test -40 °C, 16 hours			IEC 60068-2-1 Bb
Change of temperature	Functional During test -40 °C – +30 °C, 5 °C/min 3 hour hold time, 2 cycles			IEC 60068-2-14 Nb
Damp heat	Functional During test +25 °C / +55 °C, Rel. Humidity > 95% 6 x 24 hours			IEC 60068-2-30 Db
Shock	Functional During test 50 g / 6 ms 3 impulses in 6 directions			IEC 60068-2-27
Vibration	ASD-level 5 m^2/s^3 10 – 200 Hz ASD-level 1 m^2/s^3 200 – 500 Hz 60 min in 3 directions			IEC 60068-2-6
Electrical Transients	Conducted transients Pulse 1: -50 V 2: +25 V 3a: -220 V 3b: +220 V 4: -5 V 5: +70 V			ISO 7637-2
EMC Susceptibility (Component)	RF electromagnetic field 200 – 1000 MHz 30 V/m 1 kHz sine			ISO 11452-2
	Bulk Current Injection 20 – 200 MHz 60 mA 1 kHz sine			ISO 11452-4
EMC Emissions (Component)	Frequency MHz	Narrowb. dBμV/m	Broadb. dBμV/m	ISO 14982
	30-75 75-400 400-1000	54-44 44-55 55	64-54 54-65 65	
Electrostatic Discharge	+/- 4 kV air/contact			ISO/TR 10605
Enclosure	IP67			IEC 60529

Technical Support

Contact your reseller or supplier for help with possible problems with your CrossFire™ MX1B. In order to get the best help, you should have access to your CrossFire™ MX1B and be prepared with the following information before you contact support.

- Part number and serial number of the unit, which you find on the brand label
- Date of purchase, which is found on the invoice
- The conditions and circumstances under which the problem arises
- LED indicator colours and blink patterns.
- EMCY object error codes (if possible)
- Description of external equipment which is connected to the CrossFire™ MX1B

Trade Mark, etc.

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CrossFire™ MX1

Index