

# FMC-MOTDRV22

## FMC Dual-Channel Stepper Motor Driver



### User's Manual



FMC - FPCA MEZZANINE CARD

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## Document Revisions

Document Revision	Date	Comment
1.0	June 26 <sup>th</sup> 2018	First Release
1.1	December 11 <sup>th</sup> , 2019	Correction of errors
2	August 8 <sup>th</sup> 2024	Updated address and revision numbering



## Safety information - Warnings

CAEN ELS will repair or replace any product within the guarantee period if the Guarantor declares that the product is defective due to workmanship or materials and has not been caused by mishandling, negligence on behalf of the User, accident or any abnormal conditions or operations.

**Please read carefully the manual before operating any part of the instrument**



### **Do NOT open the boxes**

**CAEN ELS s.r.l. declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly this User's Manual before any kind of operation.**

CAEN ELS s.r.l. reserves the right to change partially or entirely the contents of this Manual at any time and without giving any notice.

### **Disposal of the Product**

The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.



Read over the instruction manual carefully before using the instrument.  
The following precautions should be strictly observed before using the device:

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**WARNING**

- Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in this manual.
- Do not use the device if it is damaged. Before you use the device, inspect the instrument for possible cracks or breaks before each use.
- Do not operate the device around explosives gas, vapor or dust.
- Always use the device with the cables provided.
- Turn off the device before establishing any connection.
- Do not operate the device with the cover removed or loosened.
- Do not install substitute parts or perform any unauthorized modification to the product.
- Return the product to the manufacturer for service and repair to ensure that safety features are maintained

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**CAUTION**

- This instrument is designed for indoor use and in area with low condensation.

The following table shows the general environmental requirements for a correct operation of the instrument:

<b>Environmental Conditions</b>	<b>Requirements</b>
Operating Temperature	0°C to 70°C
Operating Humidity	30% to 85% RH (non-condensing)
Storage Temperature	-10°C to 60°C
Storage Humidity	5% to 90% RH (non-condensing)

# 1. Introduction

This chapter describes the general characteristics and main features of FMC-MOTDRV22 mezzanine cards.

## 1.1 FMC-MOTDRV22 Overview

The FMC-MOTDRV22 is a cost-efficient two-channel stepper motor driver compliant to the ANSI/VITA57.1 specification. Each channel can provide up to 12 V/ 1.8 A per coil for bipolar stepper motors.

The chopper slope is programmable within three different modes. Each driver provides motor load detection without external sensors and a load dependent current control. It offers diagnostics and protection against overcurrent, short-to-ground, undervoltage and overtemperature.

For safety reasons and measurement purposes a power monitor is implemented for each channel. This monitor can measure the power delivered to the motor and switch off the motor driver if the power exceeds a user-defined limit.

According to ANSI/VITA 57.1, the FMC-MOTDRV22 provides an I2C EEPROM with unique number and additionally an I2C temperature sensor. These devices are usually handled by the MMC on the Carrier-Board.

The below table resumes the main specifications of the FMC-MOTDRV22:

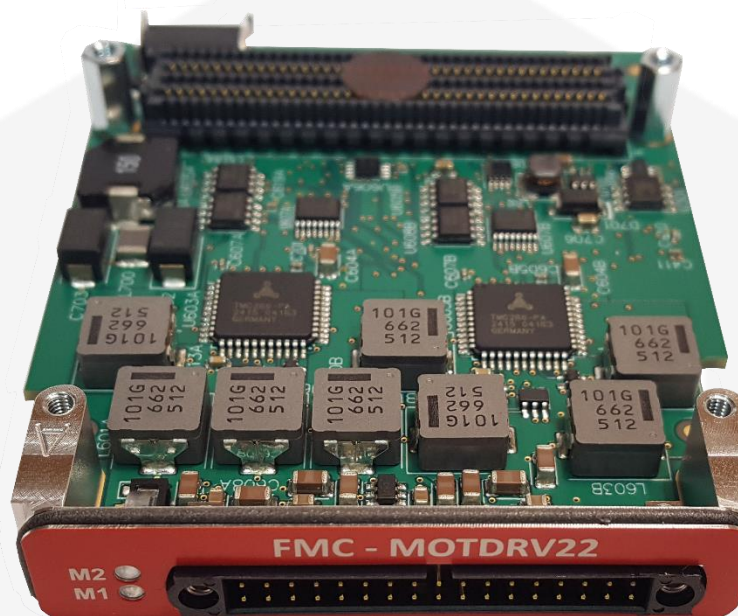
<i>Interface</i>	
Mechanical Interface Front panel connectors	ANSI/VITA 57.1 (LPC) HARWIN M80-5403405
<i>IPMI</i>	
IPMI Version	2.0
<i>Motor Driver Channels</i>	
Number of Channels	2
Max. Motor load	1.8 A
Motor voltage	12 V
Stepper motor type	Two-phase bipolar
Encoder Interface	EnDat 2.2 or Incremental ABN



Physical Data	
Power Requirements	max power: 4 A @ 12 V DC (with max load) max power 1.5 A @ 3.3 V DC (with max load)
Operating Temperature Range	0°C to 70°C

## 1.2 Device Description

A picture of the FMC-MOTDRV22 board can be seen below in **Figure 1**.

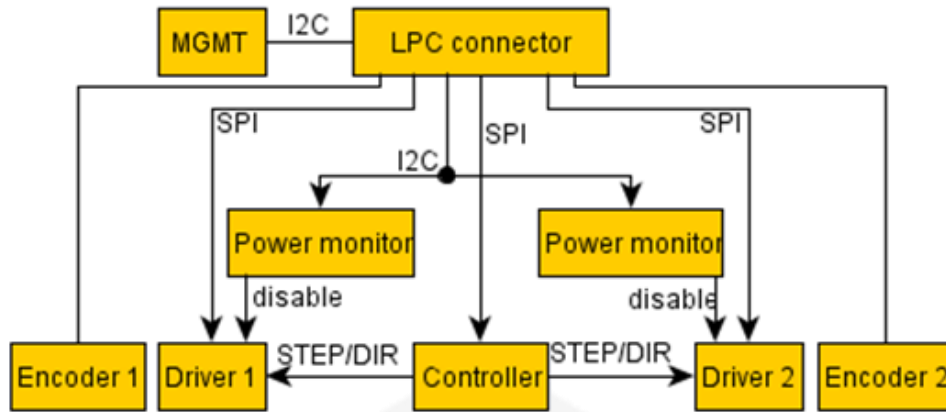


**Figure 1:** FMC-MOTDRV22 front view

The FMC-MOTDRV22 device is composed of the following building blocks:

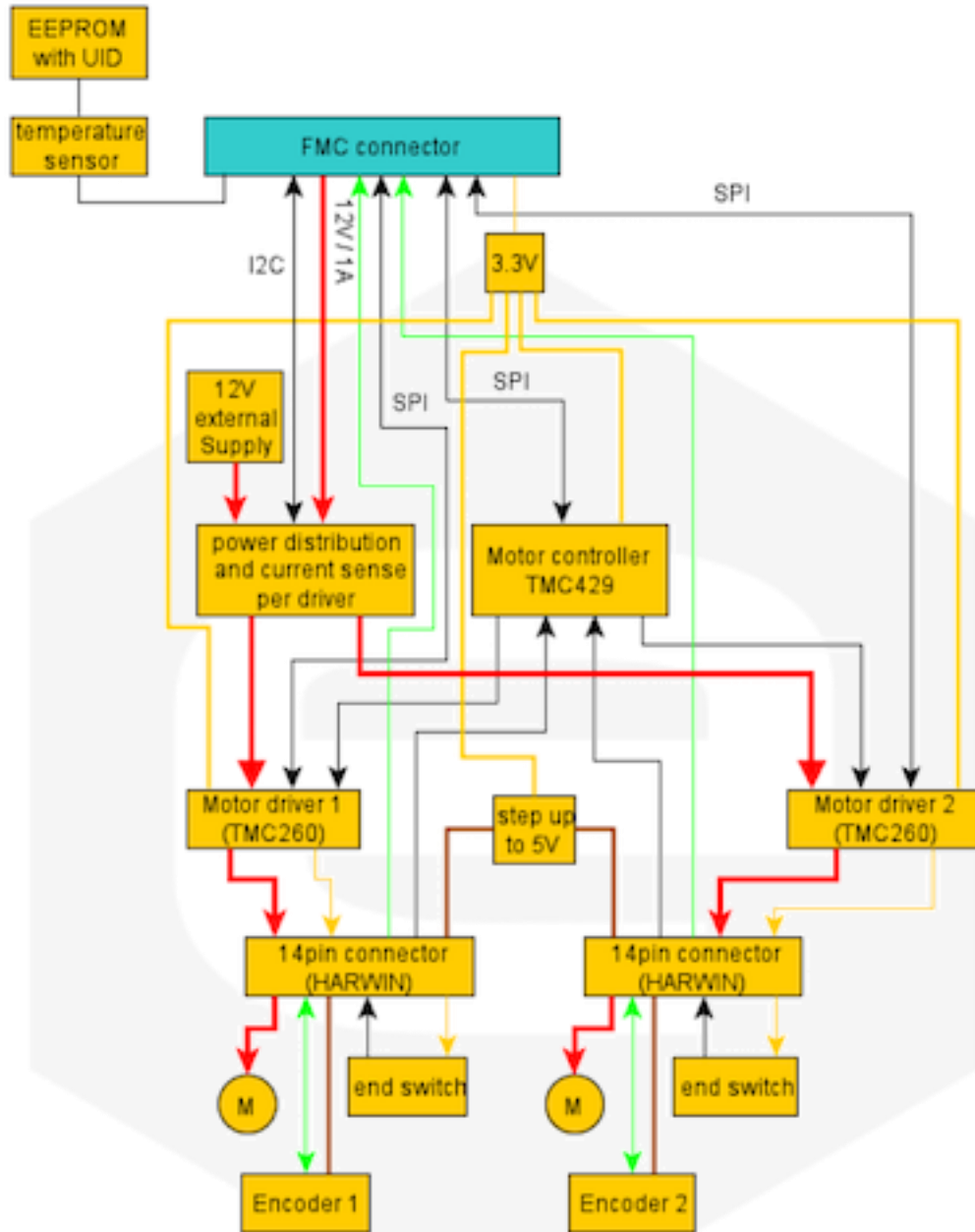
- the encoders (for stepper motors M1, M2);
- the motor driver section;
- the encoder interface section;
- the power monitor part.

The building blocks are schematically represented hereafter in **Figure 2**:



**Figure 2:** FMC-MOTDRV22 building blocks

The block diagram of the whole device can be seen on the **Figure 3**.



**Figure 3:** FMC-Pico-1M4 block diagram

### 1.3 Device Details

The following main components have been selected (schematically represented in **Figure 3**):

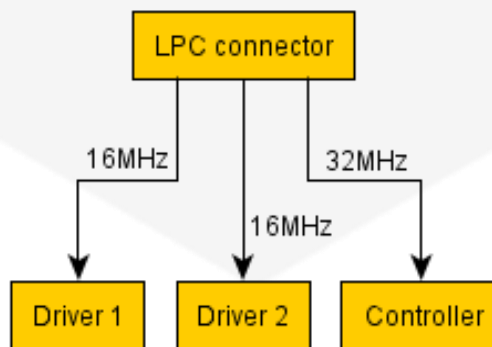
- Motor controller: Trinamic TMC429;
- Motor driver: Trinamic TMC260;
- RS-485 Transceiver: MAX14841EASA+.

The **TMC260 motor driver** chip with built-in MOSFETs is the linking component between the motion controller and the two-phase stepper motor.

Following power-up, an embedded MCU/CPU/FPGA on the carrier initializes the driver by sending commands over an SPI bus to write control parameters and mode bits to the TMC260 and the **dedicated motion controller TMC429**.

With reference to **Figure 2**, the motion controller controls the motor position by sending pulses on the STEP signal while indicating the direction on the DIR signal; the TMC260 embeds a micro-step counter and sine table to convert these signals into the coil currents which in turn are responsible for the position of the motor.

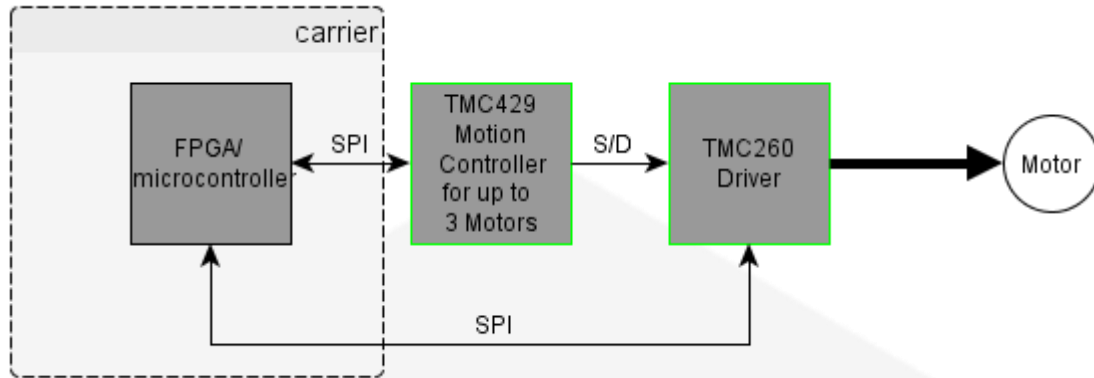
To control the module, the carrier has to provide three clock inputs. The drivers (CLK\_M1 and CLK\_M2) can be clocked with 16MHz and the controller clock (CLK\_CTRL) is clocked with 32 MHz (as shown in **Figure 4**):



**Figure 4:** Required Clocks

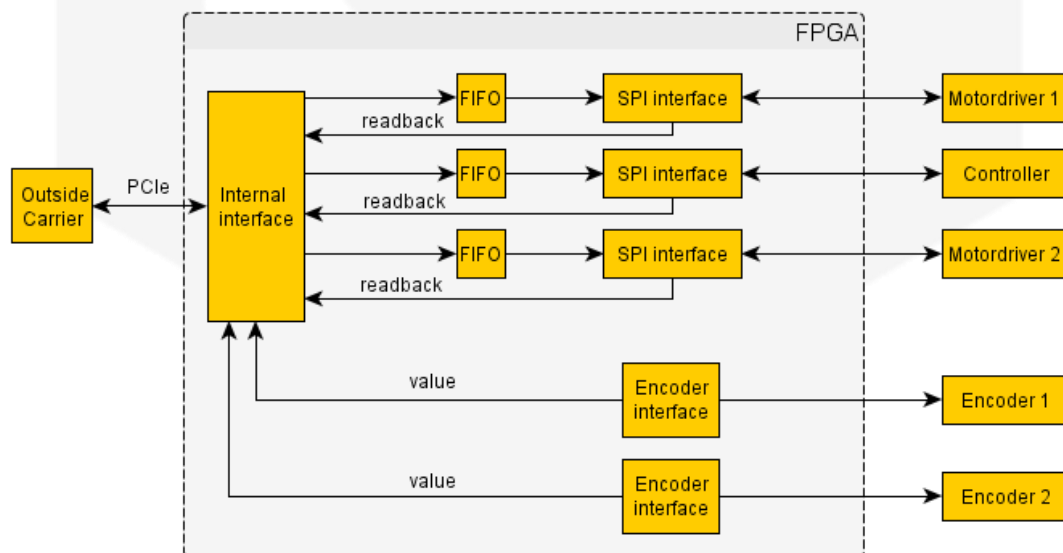
## 1.4 Controlling Firmware

It is intended that the CPU/MCU/FPGA on the FMC carrier controls the functions of the FMC via independent SPI interfaces:



**Figure 5:** Control Architecture

The controlling firmware should use a PCI express core to provide motor control functions to the main CPU board in the system. In such firmware, FIFOs are used to write data from PCI express to the SPI interfaces controlling the components on the FMC module. The proposed firmware architecture is shown below:



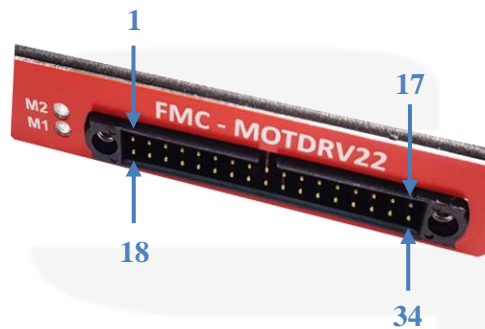
**Figure 6:** Firmware Architecture

## 2. Installation and Operation

The FMC-MOTDRV22 board can be installed on the FMC carrier board which is compliant to the FMC standard. The FMC-MOTDRV22, being a LPC FMC, can be mounted on both low-pin count (LPC - 160 pins) and high-pin count (HPC - 400 pins) carrier boards. Only the LPC pins are connected on the mezzanine module.

### 2.1 Front Panel Connections

For connection of the stepper motors, a 34-pin male connector is available at the front panel:



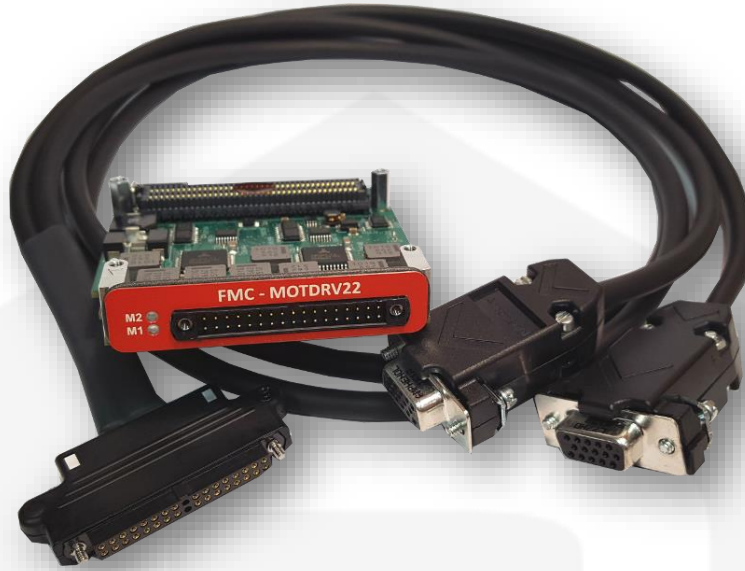
The pinout is listed in **Table 1**:

34	GND	SHIELD	33	Driver 1
32	Coil A neg	Coil A	31	
30	Coil B neg	Coil B	29	
28	GND	GND	27	
26	End right	End left	25	
24	3.3V_LIM	5.5V_LIM	23	
22	A/DAT_P	B/DAT_N	21	
20	CLK_N	N/CLK_P	19	
18	GND	GND	17	
16	GND	SHIELD	15	Driver 2
14	Coil A neg	Coil A	13	
12	Coil B neg	Coil B	11	
10	GND	GND	9	
8	End right	End left	7	
6	3.3V_LIM	5.5V_LIM	5	
4	A/DAT_P	B/DAT_N	3	
2	CLK_N	N/CLK_P	1	

**Table 1:** 34-pin connector pinout

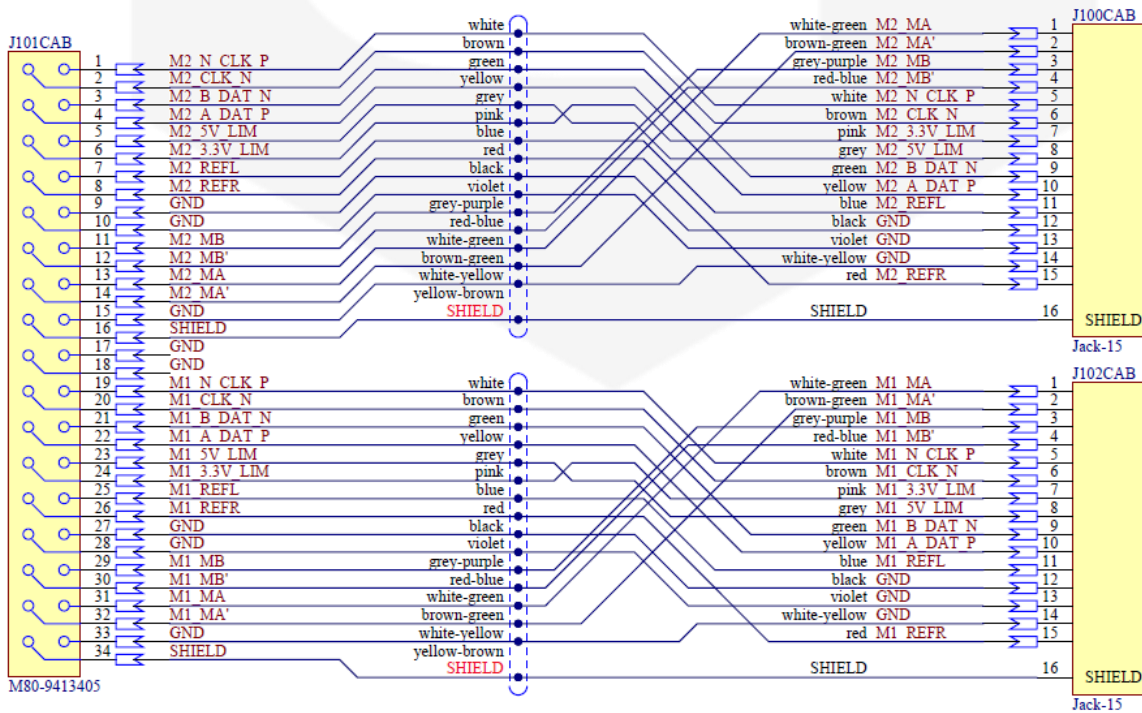
## 2.2 Cable Connections

The FMC-MOTDRV22 can be provided with a proper cable (34-pin male connector to 2 D-SUB HD 15 connectors). Three different cable lengths are available (see description in the “Ordering Options” section):



**Figure 7:** FMC-MOTDRV22 and its cable

The pinout on the D-SUB HD 15 connectors is presented below (refer to **Table 1**):



**Figure 8:** Cable Connections

## 2.3 On-Board Connectors

Hereafter the pin assignment on the LPC connector is listed:

	<i>C</i>	<i>D</i>	<i>G</i>	<i>H</i>
1	GND	NC	GND	NC
2	NC	GND	NC	PRSNT_M2C#
3	NC	GND	NC	GND
4	GND	NC	GND	NC
5	GND	NC	GND	NC
6	NC	GND	Enable_MD2	GND
7	NC	GND	ALERT_MD2#	Clock Motordriver 2
8	GND	I2C_SDA_User	GND	SPI_CS_MD2#
9	GND	I2C_SCL_User	SPI_SCK_MD2	GND
10	Clock Motordriver 1	GND	SPI_MOSI_MD2	SPI_MISO_MD2
11	SPI_MOSI_MD1	SPI_CS_MD1#	GND	Stallguard Motordriver 2
12	GND	SPI_SCL_MD1	MUX_Encoder_Ch2	GND
13	GND	GND	Inc.-Encoder Ch2 B	Inc.-Encoder Ch2 N
14	EnDat2.2 Ch1 Direction	SPI_MISO_MD1	GND	Inc.-Encoder Ch2 A
15	Stallguard Motordriver 1	EnDat2.2 Ch1 Data	EnDat2.2 Ch2 Data	GND
16	GND	GND	EnDat2.2 Ch2 Direction	EnDat2.2 Ch2 Clock
17	GND	SPI_MOSI_Controller	GND	ALERT_MD1#
18	SPI_MISO_Controller	Interrupt Controller	PosComp	GND
19	Enable MD1	GND	Clock Controller	SPI_CS_CTRL#
20	GND	MUX_Encoder_Ch1	GND	SPI_SCL_CTRL
21	GND	Inc.-Encoder Ch1 N	LED Ch1_2	GND
22	Inc.-Encoder Ch1 A	GND	LED Ch1_1	Inc.-Encoder Ch1 B
23	EnDat2.2 Ch1 Clock	#FAULT_LIM_M2	GND	LED Ch2_2
24	GND	EN_5V_LIM_M2	EN_3V3_LIM_M2	GND
25	GND	GND	EN_3V3_LIM_M1	LED Ch2_1
26	NC	NC	GND	EN_5V_LIM_M1
27	NC	NC	NC	GND
28	GND	GND	NC	NC
29	GND	NC	GND	#FAULT_LIM_M1
30	I2C_SCL_Managment	TDI	NC	GND
31	I2C_SDA_Managment	TDO	NC	NC
32	GND	PWR_3.3V_Managment	GND	NC
33	GND	NC	NC	GND
34	GA0	NC	NC	NC
35	PWR 12V	GA1	GND	NC
36	GND	PWR 3.3V	NC	GND
37	PWR 12V	GND	NC	NC
38	GND	PWR 3.3V	GND	NC
39	PWR 3.3V	GND	NC	GND
40	GND	PWR 3.3V	GND	NC



## 3. Ordering Options

The three main ordering codes for the **FMC-MOTDRV22** are the following:

*Standard Code*

M	O	T	D	R	V	2	2	I	N	1	2
---	---	---	---	---	---	---	---	---	---	---	---

*2-Channel Stepper Motor Driver with 12 V Internal Power*

M	O	T	D	R	V	2	2	E	X	1	2
---	---	---	---	---	---	---	---	---	---	---	---

*2-Channel Stepper Motor Driver with 12 V External Power*

M	O	T	D	R	V	2	2	E	X	2	4
---	---	---	---	---	---	---	---	---	---	---	---

*2-Channel Stepper Motor Driver with 24 V External Power*

These units differ by the power supply that is fed to the FMC card: the standard ordering code MOTDRV22IN12 receives the power directly from the +12 V on the FMC connector while the MOTDRV22EX12 and the MOTDRV22EX24 from an external 12 V or 24 V power source respectively.

### 3.1 Optional Codes

The FMC-MOTDRV22 boards can be provided with the corresponding cable.

Three different cables are available (with different lengths of 1 meter, 20 meters and 91 meters):

C	A	B	L	-	F	M	T	0	0	0	1
---	---	---	---	---	---	---	---	---	---	---	---

*Cable for FMC-MOTDRV 1m*

C	A	B	L	-	F	M	T	0	0	0	2
---	---	---	---	---	---	---	---	---	---	---	---

*Cable for FMC-MOTDRV 20m*

C	A	B	L	-	F	M	T	0	0	0	3
---	---	---	---	---	---	---	---	---	---	---	---

*Cable for FMC-MOTDRV 91m*



## 4. Technical Specifications

Technical Specifications for the FMC-MOTDRV22 mezzanine cards are hereafter presented:

Interface	
Mechanical Interface	ANSI/VITA 57.1 (LPC)
Front panel connectors	HARWIN M80-5403405
IPMI	
IPMI Version	2.0
Motor Driver Channels	
Number of Channels	2
Max. Motor load	1.8 A
Motor voltage	12 V
Stepper motor type	Two-phase bipolar
Encoder Interface	EnDat 2.2 or Incremental ABN
Physical Data	
Power Requirements	max power: 4 A @ 12 V DC (with max load) max power 1.5 A @ 3.3 V DC (with max load)
Operating Temperature Range	0°C to 70°C

**Table 2:** General information for the FMC-MOTDRV22