UDMpc

EtherCAT® Universal Drive Module

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About this Document

This guide specifies the UDMpc EtherCAT Universal Drive Module's hardware features (electrical, mechanical and thermal) and provides design guidelines for the PCB designer. The guidelines include interface schematics, recommended interface circuitry, and board layout instructions. The guide also contains the UDMpc-2-048/BoB (combined module and a breakout connector board, termed BoB) specifications regarding connectors used and the required mating connectors, jumper settings and other needed information.

Contents

Product Overview

UDMpc Module

The UDMpc EtherCAT Universal Drive Module (shown in Figure 1) product line is a low footprint, PCB mounted (chip like) module. The UDMpc functions as a slave with any of ACS EtherCAT master controllers. It drives 2 motors at 24V to 48V bus voltages, with the following ordering configurations: 2.5/5A (average and peak sine peak-to-peak currents), 5/10A and 10/20A.

According to the installation instructions, the system is installed in a metal enclosure; therefore, the unit accessibility is limited.

Figure 1: UDMpc

The primary goal of the UDMpc is to support Original Equipment Manufacturer (OEM) applications that prefer designing their own interface to meet specific needs and integrative system requirements within limited space.

Breakout Board (BoB)

UDMpc-2-048-BOB Breakout Carrier Board (shown in Figure 2) includes the UDMpc module and a connected Breakout Board as a single product

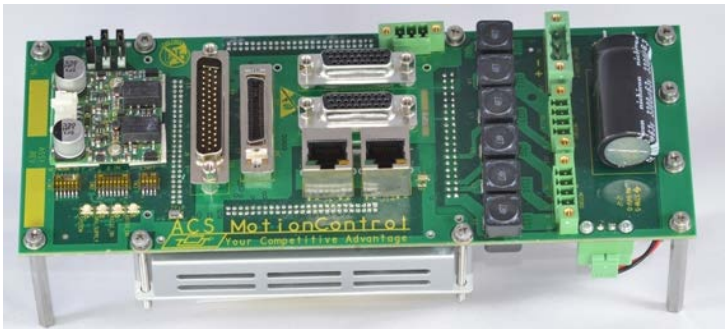


Figure 2: UDMpc-2-048/Breakout Board (Combined Module and Breakout Board)

Combined with the carrier board, the two components serve as a stand-alone, 2-axes slave drive. This configuration enables the user to evaluate the module's performance and develop user applications prior to the completion of the PCB design. The product serves as a reference for any future developments. The carrier board contains an STO module, which can be purchased from ACS as an optional add-on, and integrated into the user's PCB. Detailed design information and design recommendations are provided in this guide.

The BoB, along with the UDMpc-2 module, is used for product evaluation, prior to designing a custom PCB into which the module is being inserted. The BoB is based on industry standard connectors and their mating connectors. The BoB is mostly passive; however some interface circuitry and jumper settings have been added, as explained below. This circuitry should be considered when designing a custom PCB.

An optional STO Cable Mating kit (PN STO-ACC1), provides a cable with flying leads used to connect the optional STO module.

Motor Connectivity

The built-in universal drives support 2- and 3-phase AC synchronous, AC Induction, 2- and 3-phase step, and DC brush motors. Selection of motor and parameter settings is done using the **Adjuster Wizard** of the SPiiPlus MMI Application Studio.

A 3-phase motor connection for 2.5A and 5A is depicted in Figure 3, and for 10A and 20A in Figure 4. Note that the inductors depicted in the diagrams are not part of the module, and must be added as external circuitry.

Refer to subsequent sections for grounding and shielding considerations.

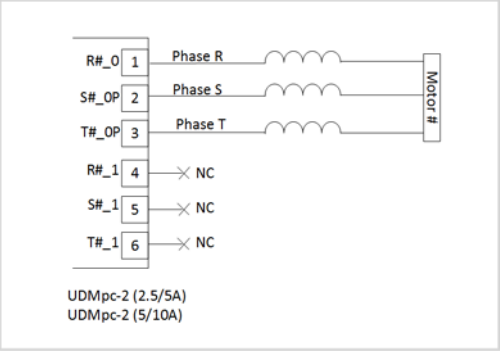


Figure 3: 3-Phase Motor Connection for the 2.5A/5A Version

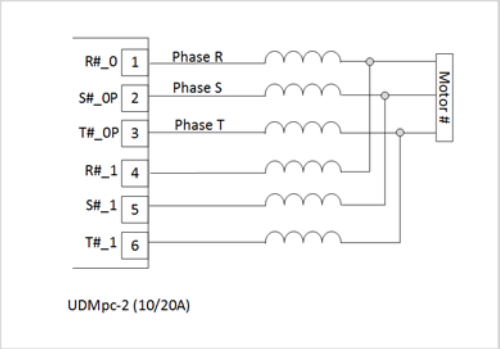


Figure 4: 3-Phase Motor Connection for the 10A/20A Version

The diagrams above relate to brushless motor connections. For DC brush motor connections do not connect phase T.

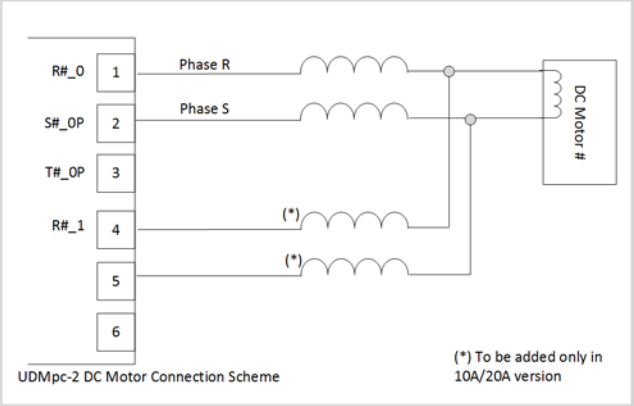


Figure 5: DC Motor Connections

For 2-phase step motors connect the motor phases between S-R and between T-R as shown in Figure 6 below.

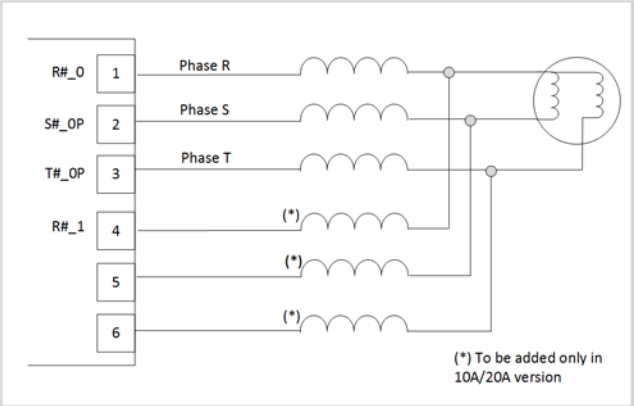


Figure 6: Step Motor Connections

The designer has to provide a 3300µF/80V capacitor on the bus voltage to supply the return energy during braking. An over voltage protection of 55V is provided by the module.

Feedback

Encoder Assignment

The UDMpc-2-048 supports the following feedback devices per each axis:

- ❑ Two AqB Incremental digital encoders
- ❑ One Sin-Cos analog encoder
- ❑ One absolute encoder (its type must be pre-ordered and setup by the factory)
- ❑ One set of Hall sensors. Dual feedback (dual loop) is supported.

Encoder Power Supply

The unit includes a built-in 5V/400mA encoder power supply for all available encoders.

Incremental Digital AqB Encoder

Each internal drive has two AqB encoders.

The interface of each of the encoder's A, B and Index signals is depicted in Figure 7.

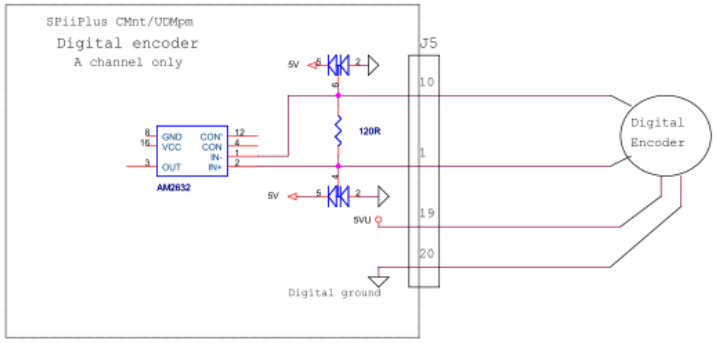


Figure 7: Incremental Digital AqB Encoder Connections

The connection is a protected RS-422 differential line with 120Ω termination. Maximal rate: 12.5MHz which equals to 50 million Quadrature counts/sec. Fault detection: 'Encoder Error' (due to noise), and 'Encoder Not Connected'.

Encoders are fed by a 5V±5% 400mA supply (the total available current to all encoders) referenced to a digital ground.

A, B, I and Clk/Dir modes of operation are supported.

Note that the module includes 120Ω terminations for all A, B, I signals.

Sin-Cos Encoders

The interface for the Sin, Cos and Index signals is differential, 1Vptp±10% with 52dBm SNR. The maximal input frequency is 250 kHz.

Sin and Cos inputs are sampled in 20 kHz at 12 bit resolution. A multiplication factor of x4 to x4,096 is supported. A software based Offset, Gain and Phase compensation can be set using the SPiiPlus MMI Application **Studio Sin Cos Encoder Compensation** tool which optimizes and sets the compensation values, stores the optimized values and displays the results graphically.

'Encoder Error' and 'Encoder Not Connected' are reported as faults.

The module includes 120Ω terminations for all sin-cos signals.

Absolute Encoder Interface

Absolute encoder's interfaces (pins and electrical circuitry) are shared with Digital Incremental (AqB) and with Sin-Cos encoder's interfaces, according to the table below:

Table 1: Absolute Encoder Reference

Absolute encoder type	Encoder's Interface	Controller's interface
Endat 2.2	RS485 bidirectional Data	CHA
	RS422 Clock (encoder input)	CHB (controller's output)
SmartABS/ Panasonic	RS485 bidirectional Data	CHA
BiSS C/ SSI	RS485 bidirectional Data	CHA
	RS422 Clock (encoder input)	CHB (controller's output)
Hiperface	RS485 bidirectional Data	CHA
	Sin output	Cos input
	Cos output	Sin input

The digital bidirectional communication data channel is shared with CHA (data).

The Clock line interfaces to the controller's CHB.

Hiperface uses in addition to the digital bidirectional data channel the analog Sin and Cos interfaces, see Figure 8 below.

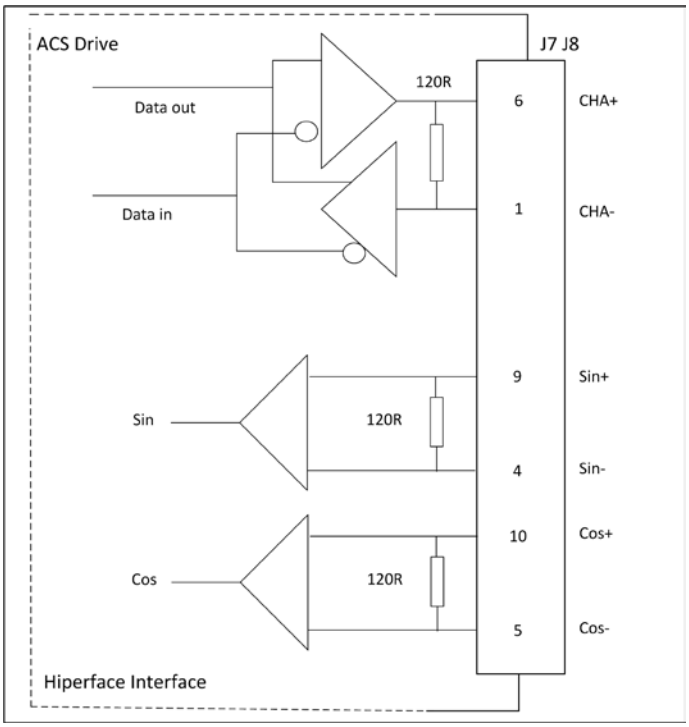


Figure 8: Absolute Encoder hiperface schematic diagram

Bi-directional RS485 data channels uses CHA of the digital incremental encoder, and when clock is provided to the encoder, then CHB of the corresponding digital incremental encoder is used, see Figure 9 and Figure 10 on page 7.

The setting is performed by software.

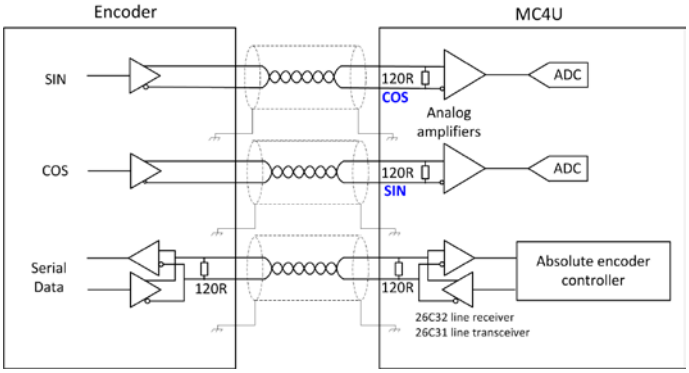
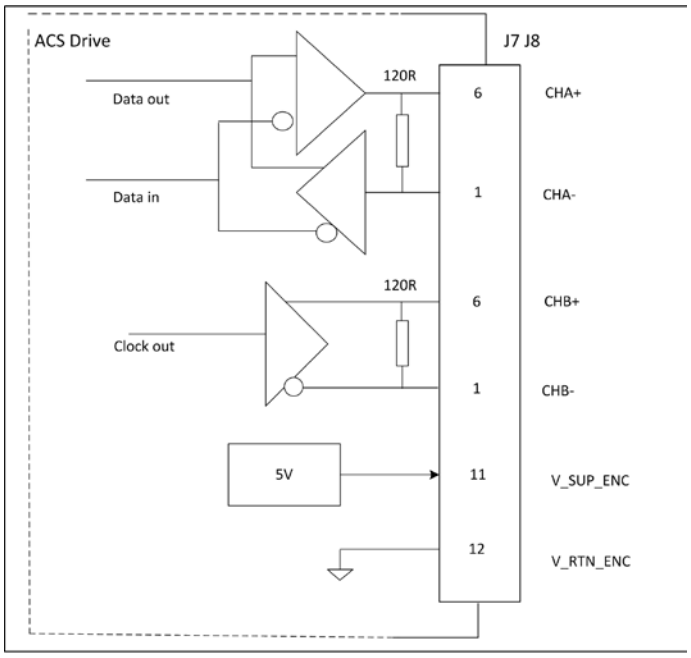


Figure 9: Absolute Encoder schematic diagram



Absolute Encoder Interface: biderectional data and clock

Figure 10: Absolute Encoder biderctional schematic diagram

Hall Sensor Encoders

One Hall sensor per drive (a set of 3 single-ended, current driving lines) is available. The lines are opto-isolated with a current sensitivity of 7mA. The connection for a Hall sensor is shown in Figure 11.

Design should either provide 5V to 5VU from an external, customer supplied source, or one can shorten the signal to the module's supplied encoder supply line (5V_ENC_SUP)

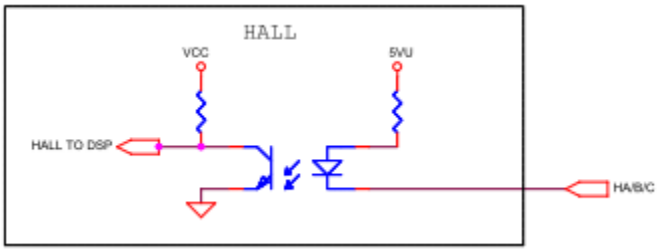


Figure 11: Hall Sensor Encoders Connection

Inputs and Outputs

Digital Inputs

UDMpc-2-048 provides 8 opto-isolated, sink or source (refer to Figure 12) digital inputs.

Sink mode: connect VCC (5V) to DIN_COM.

Source mode: connect GND to DIN_COM).

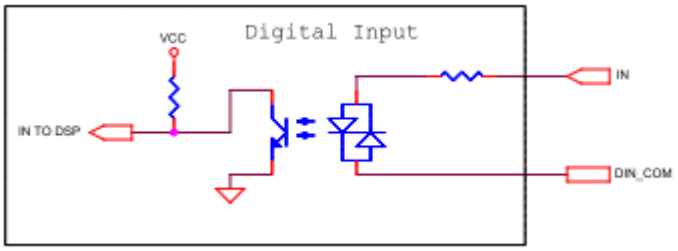


Figure 12: Digital Input Connection

The user should ensure that the analog input's signal range does not exceed 20% of specified range of ±10 V.

Higher signals may cause abnormal behavior of the drive and affect its performance.

Digital Outputs

Four digital outputs are available. The signals are differential, driving 15 mA (refer to Figure 13).

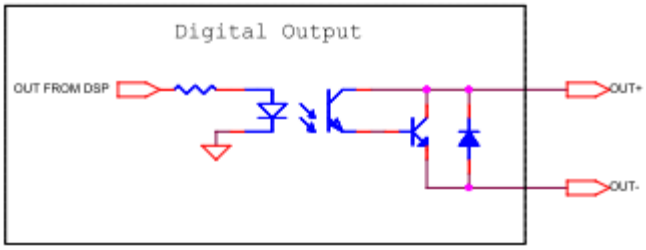


Figure 13: Digital Output Connections

General Purpose Analog Inputs

UDMpc-2-048 provides four differential, filtered, ±10 V ±5%, 12 bit accuracy, up to 100mV offset, with a bandwidth of 10 kHz . The General Purpose Analog Input connections are shown in Figure 14.

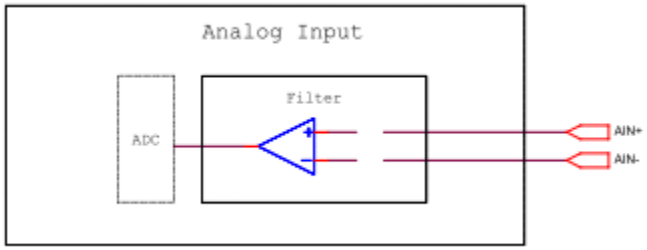


Figure 14: Analog Input Connection

General Purpose Analog Outputs

UDMpc-2-048 provides two General Purpose Analog Outputs. The outputs are characterized by 10 bit resolution filtered PWM, differential ±10V±10%, 50mV maximal offset, with 50mVp_p maximal ripple, and linearity better than 1%. Minimal 10KΩ load is required. The outputs can be used for external drive control being updated at the 20kHz servo rate.

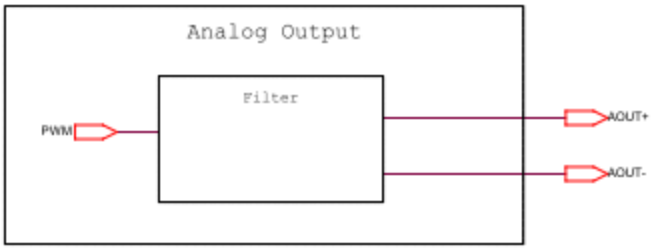


Figure 15: Analog Output Connection

Safety

Limit Input

UDMpc-2-048 provides two limit inputs per axis, The signals are opto-isolated, sink or source inputs (refer to Figure 16).

Sink mode: connect VCC (5V) to SAF_COM.

Source mode: connect GND to SAF_COM.

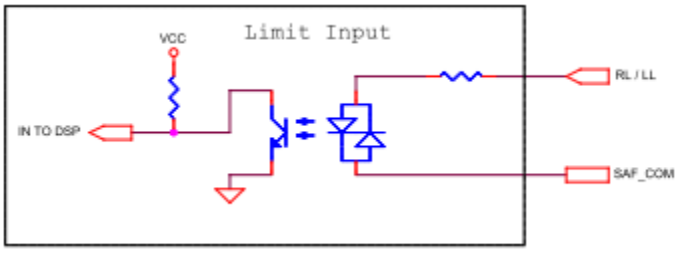


Figure 16: Limit Input Connection

Emergency Stop Input

Emergency Stop input is a two line, opto-isolated signal, fed from a 24V supply and activated when current rises above 14mA (refer to Figure 17).

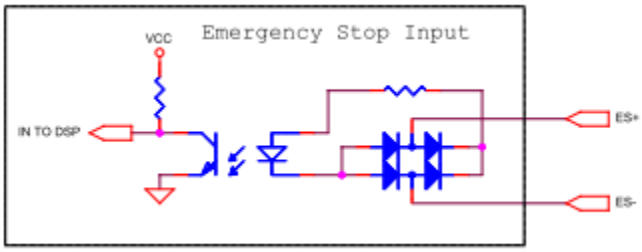


Figure 17: Emergency Stop Interface

Safe Torque Off (STO)

STO is an optional feature. The STO circuit functionality is designed and tested by ACS to comply with the requirements of EN ISO 13849-1, EN 62061, and IEC 61800-5-2 standards.

STO (The Safe Torque Off) is the fundamental safety capability needed in order to prevent moving of motors upon a safety event.

STO capability prevents the moving of the motor using two hardware inputs, STO1 and STO2 that block the PWM signals to the power stage of the drive. A 24V (18Vdc to 33Vdc) must be connected to both inputs to enable the drive's regular operation. When the 24V is removed from one or both STO inputs, the PWM signals are blocked at least 50msec afterwards but not more than 200msec afterwards. In addition, the controller is informed about this event. This delay (between informing the controller and blocking of the PWM signals of the drive) provides the controller the ability to bring all axes to a complete stop (or low velocity movement) in an orderly manner.

The implementation of the STO guarantees that under any foreseen circumstances, failure or damage, any of following types of motors will not move:

- ❑ AC synchronous (DC brushless)
- ❑ Step motor
- ❑ AC asynchronous (AC induction)

For DC brush motor, removing the 24V from both STO inputs, guarantees that under any foreseen circumstances, failure or damage, the motor will not move.

Usually, STO1 and STO2 are connected to a 24V source via industry standard safety switch. This device disconnects the

24V upon opening a door, a light current tripping or other safety related event.

Figure 18 below describes a wiring scheme of a safety relay, controlled in this example by a PLC safety device.

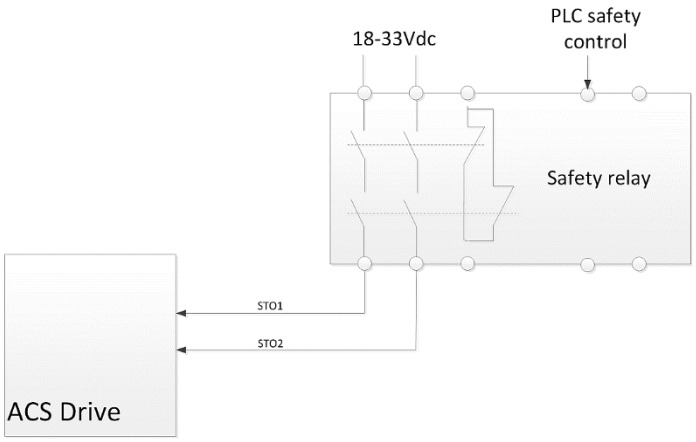


Figure 18: STO Wiring Scheme

The STO inputs can be also fed from a door switch, a light-curtain or any other safety related controller.

Figure 19 below describes a schematic STO implementation: The STO inputs feed the power (through additional circuitry which is not shown in the figure) to the upper and lower PWM drivers of the corresponding transistors

The STO circuit is implemented on a dedicated module that plugs into all ACS products that support this functionality.

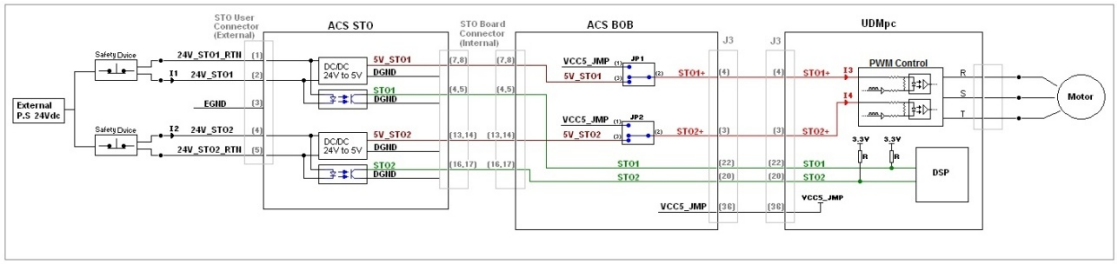


Figure 19: STO Implementation

STO Module Connector Type and Pinout

Table 2: STO Connector Type

Connector Name	STO Input
Connector type	JST 5 PIN 2mm male SM05B-PASS-1
Mating connector type	JST 5 PIN 2mm female PAP-05V-S Pin: SPHD-001T-P0.5

Table 3: STO Pinout

Pin	Name	Description
1	STO1-	Safety torque input 1 inverted input
2	STO1+	Safety torque input 1 non inverted input
3	EGND	Electrical ground
4	STO2+	Safety torque input 2 non inverted input
5	STO2-	Safety torque input 2 inverted input

Position Event Generation (PEG)

The UDMpc-2-048 supports advanced Position Event Generator (also referred to as Output Compare) output signals for synchronous random and incremental timing generation. The two PEG pulses and two PEG STATE signals can be associated with any of the digital incremental (AqB) or Sin-Cos encoders, to be used by any of the two axes, and can be programmed for polarity and width. Note that using a Sin-Cos encoder as reference, the maximal PEG rate is determined by the encoder's zero crossing rate. The product supports three independent PEG engines, each of which can be assigned to any of the product's encoders.

The Incremental PEG mode provides the ability to generate a fixed width pulse whenever a fixed position interval has elapsed, starting at a predefined start point and ending at a predefined end point.

The Random PEG mode provides the ability to control a PEG pulse and a two-bit STATE vector at predefined positions, which are stored as a 256 member user-defined array.

Refer to the *PEG and MARK Operations Application Notes* for more details.

Communication

Being an EtherCAT slave unit, the UDMpc interfaces through EtherCAT lines only. The RJ45 connectors (IN and OUT) along with appropriate termination circuitry are provided by the designer, and should include two LEDs which are controlled by the unit.

Thermal Considerations

UDMpc-2-048 (all power ratings) operates with forced air of 23 CFM in ambient temperatures of up to 50°C. Airflow should be directed through the ventilation opening in the unit and in parallel to the surface.

Custom PCB Implementation

The PCB design has to address the following considerations:

1. Mechanical dimensions. Make sure that the module's mating connectors are accessible to the user (see Figure 24).
2. Layout considerations

   Design the PCB according to connector's DXF. Make sure any components placed between the module and PCB do not exceed the allowed height.
3. STO PCB connector

   Refer to the module's dimensions and connector's specification. The STO is almost flush with the designer's PCB, thus only low profile components can be place underneath it.

   It is recommended adding switches or jumpers to allow bypassing the STO operation, and/or for providing a constant feed to the module, when the module is not in use. This is useful during debugging and integration, since it saves the need to feed the module (through its connector) with 24Vdc. For periodical activation to verify correct operation, activate the STO and observe Drive Alarm or Over Current fault indications.

   Refer to BoB's STO guidelines in this guide for further information.

This section provides guidelines for the PCB design around the UDMpc-2-048. The evaluation board, detailed in this document, should serve as the reference product to evaluate performance and implement similar interfacing circuitry.

UDMpc is available as a component for incorporation into a schematic diagram and into industry-standard layout CAD tools, refer to UDMpc Design Reference Files available for download at ACS Website at: www.acsmotioncontrol.com

The following topics have to be addressed:

- ❑ Implementation of interfacing circuitry: motor phases' inductors, termination resistors, LED supporting circuits
- ❑ Special care should be allocated to the EtherCAT traces' layout and grounding, in the path from the RJ45 connectors to the module's input and output pins, as detailed below.

Motor Connections

The design should include the inductors referred to in this guide (or their equivalent). Include 3 inductors (1 per phase) per motor for 2.5/5A and 5/10A modules, and 6 inductors (2 per phase) per motor for the 10/20A module . Use inductors of 4.7µH/10A (TRIO EB-47AM25G09 or equivalent). The connectivity scheme for both product types is depicted in Figure 3 and Figure 4.

EtherCAT Layout Guidelines

In order to ensure signal quality in the EtherCAT In and EtherCAT Out paths between the RJ45 connectors and the EtherCAT connector, the following layout guidelines should be followed (refer to Figure 20).

- ❑ Include a virtual ground plate, upon which the ECAT RJ45 connectors reside, which contains the traces and required termination circuitry as depicted in Figure 20.
- ❑ Add a 1MΩ/10nF-500V filter to all other plates/surfaces to the product's protective ground plate. Note that the above values may change between the designs and have to be adjusted to the product's operating environment
- ❑ Add shielding around the connectors

The EtherCAT communication pins (in J14 and J15) and both RJ45 connectors and their interconnecting traces are positioned on a separate ground plate. An 0R resistor is placed between the ground plate and module's DGND.

Traces must be kept to minimal lengths, each pair should be twisted and separated from others, and the structure must be kept as symmetrical as possible. Termination circuitry, as shown in Figure 20, should be placed as close to the RJ45 connectors as possible. Ensure minimal 1mm separation between the shield plate to Virtual ground plate, and between the Virtual ground plate to the digital ground.

Observe industry standard practices for circuit layout. ACS recommendations are as follows: Trace to trace spacing 5mil, and trace thickness 5mil.

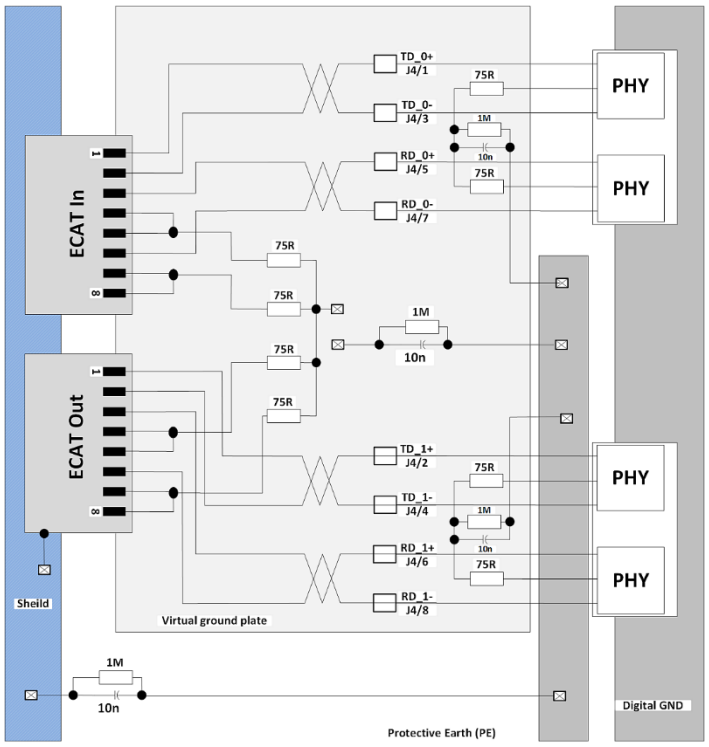


Figure 20: EtherCAT Layout Guideline

Grounding and Shielding

Figure 21 depicts the UDMpc-2-048's scheme for shielding, cable connections and method of grounding.

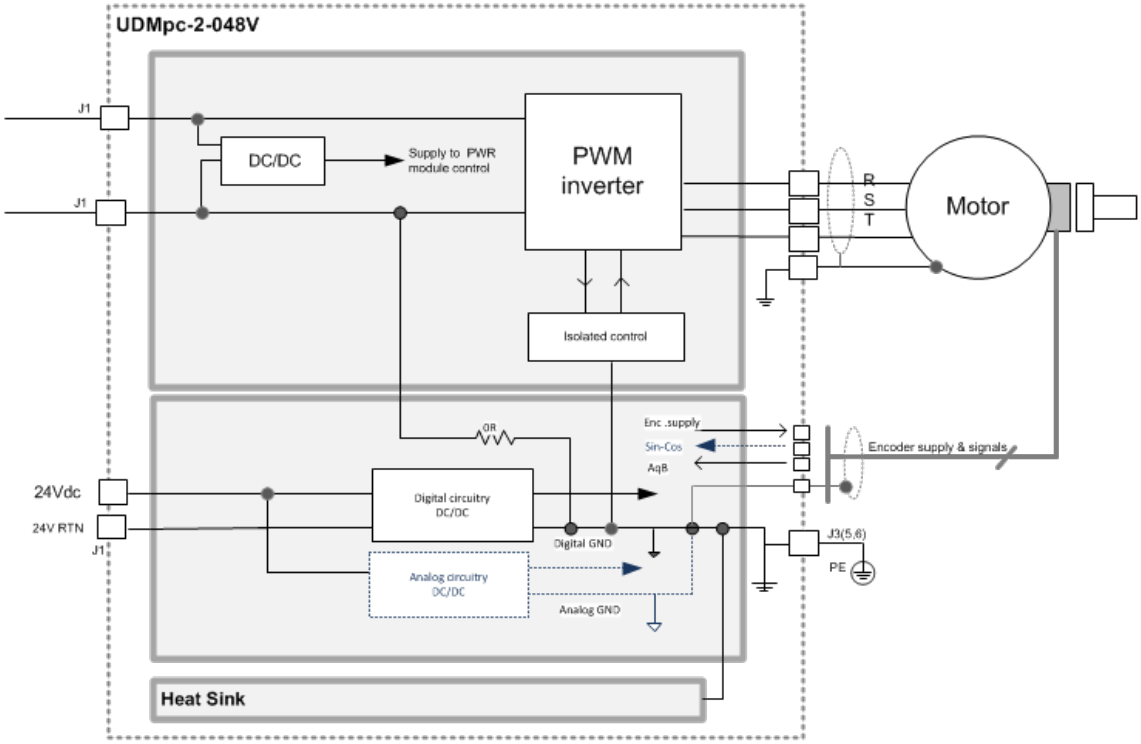


Figure 21: Grounding and Shielding

Personnel Safety Guidelines

Make sure that the following guidelines and procedures are addressed and observed prior to powering and while handling any of the network elements. Observing these procedures is crucial in order to achieve safe and optimal operation of ACS networking provisions.

The UDMpc is not authorized for use in safety-critical applications (such as life support) where a failure of the product would reasonably be expected to cause severe personal injury or death.

The UDMpc surface warms up during operation to temperatures that may cause injuries when touched by a person. The operator has to ensure that the guidelines in this manual in terms of air flow are followed, and that adequate means are taken to prevent personnel exposure to hot surfaces around the product.

Installation and maintenance must be performed by qualified personnel only. Such a person must be trained and certified to install and maintain high power electrical and electro-mechanical equipment, servo systems, power conversion equipment and distributed networks. Prior to powering up the system, ensure that all network components are properly installed mechanically, properly grounded and that all attached power and signal cables are in good operating conditions. Maintenance should be performed only after the relevant network element has been powered down, and all associated and surrounding moving parts have settled in their safe mode of operation. Certain drives require longer times in order to fully discharge.

Follow the hardware guide of each element and observe the residual discharge time specified. Avoid contact with electrostatic-sensitive components and take the required precautions.

The UDMpc-2-048 is powered up as long as an ACS inlet is connected to it. Therefore it is the responsibility of the user to provide an in-series switch or circuit breaker that disconnects all power-carrying signals which is readily and rapidly accessible to the operator. The disconnecting device must meet the requirements of IEC60947-1 or IEC60947-3 and the current rating must be not more than 20A. The disconnecting device must be in close proximity to the equipment and within easy reach of the operator and be clearly marked as the disconnecting device for the UDMpc-2-048. A power cord with conductor area of not less than 0.75mm², with a voltage rating of not less than 300V, rated to 105ºC or more, and complying with IEC60227 or IEC60245 must be used for the AC drive supply input. Only the Green–Yellow wire of the cable is to be used for connection to the protective conductor terminal.

UDMpc Specifications

This section presents the specifications for the UDMpc product line.

General

Part Number X – number of axes YY – special options	UDMpc-X-048D-002-YY	UDMpc-X-048D-005-YY	UDMpc-X-048D-010-YY
Number of internal axes	1 or 2		
Input voltage range	24 to 48 Vdc		
Phase Current Continuous/Peak, sine amplitude	2.5/5 A	5/10 A	10/20 A
Phase Current Continuous/Peak, RMS	1.8/3.6 A	3.6 / 7.1 A	7.2/14.2 A
Peak current time	1 second		
Maximum output voltage	Vdc x 99%		
Max. input continuous power per axis at 48Vdc	105 W	210 W	420 W
Max. continuous /peak output power per drive @ 48Vdc	100/200 W	200/400 W	400/800 W
Minimum load Inductance, at maximum motor voltage.	0.05 mH (note that With a lower voltage the minimum inductance value can be reduced proportionally)		
Maximum Heat dissipation per axis	2 W	5 W	12 W
Over voltage protection	55 Vdc (Note that applying voltage above 55 Vdc even for a short time can cause damage to the product.)		
Over temperature protection	95º C		

Input Power

Control DC Power	Range: 24Vdc ± 10% Maximum input power: 15 W Input current: < 0.6 A
Motor Supply	Range: 24 Vdc to 48 Vdc Current rating should be calculated based on actual load.

Plugging the 48V supply cable while the supply is on will damage the unit. The power cord must be connected when the supply is off.

Drives

Control	▪ Type: digital current control with field-oriented control and space vector modulation. ▪ Current ripple frequency: 40 kHz. Current loop sampling rate: 20 kHz ▪ Programmable current loop bandwidth: up to 5 kHz ▪ Commutation type: sinusoidal. Initiation with and without hall sensors ▪ Switching method: advanced unipolar PWM
Protection	▪ Over voltage, Phase-to-phase short, Short-to-ground, Over current, Over temperature
Motor types	▪ Single phase motors: DC Brush, ▪ Voice coil 2- or 3-phase AC synchronous motor: Step motor, open & closed loop, always using high resolution micro-stepping control.

Communication

Two EtherCAT ports: In and Out

Feedback

Incremental Digital Encoder	Four, two per axis, A&B,I; Clk/Dir,I Type: RS-422. Max. rate: 50 million encoder counts/sec. Protection: Encoder error, not connected
Sin-Cos Analog Encoder (optional)	Two, one per axis. Type: 1Vptp, differential. Programmable multiplication factor: x4 to x4,096. Maximum frequency: 250kHz Automatic compensation of Offset, Phase and Amplitude Maximum acceleration with Sin-Cos encoder: 10^8 sine periods/second^2. Protection: Encoder error, not connected
Absolute Encoders (optional)	EnDat 2.1/2.2, Smart-Abs, Panasonic, BiSS-C, Hiperface.
HALL	Two sets of three per axis. Type: single-ended, 5V, source, opto-isolated. Input current: < 7 mA
5V feedback supply	The total current available for feedback devices is 400mA.

Digital Inputs/Outputs

Safety Inputs	Left and Right Limit inputs per axis. Type: 5Vdc, single-ended, selectable sink / source, opto-isolated. Input circuit current: 14 mA E-Stop: Opto-isolated, floating two-terminal STO: Two pairs of inputs. The STO module is sold separately, and must be designed into the designer's PCB according to this guide's instructions.
General Purpose Digital Inputs	Eight, 5V, single-ended, selectable sink/source, opto-isolated. Input current: 14mA.
Registration MARK Inputs	Two, RS422. Both inputs can be assigned to one axis or each can be assigned to a different axis. Can be used as GP inputs. Two GP opto-isolated inputs can be programmed to be used as the MARK inputs. For further information, see *PEG and MARK Operations Application Notes*.
General Purpose Digital Outputs	Four, opto-isolated, floating two-terminal, 15 mA per output.

Analog Inputs/Outputs

Inputs	Four inputs, ±10V, differential, 12 bit resolution. 20kHz sampling rate. Can be used as feedback to the servo loops.
Outputs	Two outputs, ±10V, differential, 12-bit resolution. 20kHz update rate.

PEG Outputs

Position Event Generator (PEG) Outputs	Two differential RS-422 outputs (PEG0 and PEG1), and two PEG state TTL signals. Supports incremental and random (256 events per burst) modes.
GP Outputs	Two GP opto-isolated outputs can be programmed to be used as the PEG Pulse outputs. Pulse width with RS422 outputs: 26 nSec to 1.75 mSec Maximum rate with RS422 outputs: 10 MHz. Pulse width with GP outputs: 0.75 mSec to 1.75 mSec Maximum rate with GP outputs: 1 kHz For further information, see PEG and MARK Operations Application Notes.

Dimensions

Refer to UDMpc-2-048 Mechanical Dimensions and UDMpc-2-048 BoB Dimensions.

If using version A of the UDMpc, the dimensions are as given in *UDMpc EtherCAT Universal Drive Module Evaluation Kit Version NT2.10, 06 February 2012.*

Environment

Operating	0 to + 40°C. Refer to operating condition section.
Storage	-25 to +70°C
Humidity	5% to 90% non-condensing

Applicable Standards

The following standards are pending approval for the UDMpc module.

EN 61326-1:2006	Industrial locations equipment, class A standard, under article 6(2) of EMC Directive 2004/108/EC (ACSEMC_EN.22513C)
IEC 61010-1:2001	Safety conformance, 2nd edition.
SEMI F42-0999:1999 **SEMI F47-0200:2000**	Voltage sag immunity
IEC 60068-2-6 Class 4M4 **IEC 60068-2-29 Class 4M4** **IEC 60068-2-56 Class 4K3**	Sine vibration during operation (5-150 Hz, 3 axes, 10 m/s^2) 600 shocks, 150m/s^2, 6ms 93%, 30C

Product Connectors

UDMpc Connectors

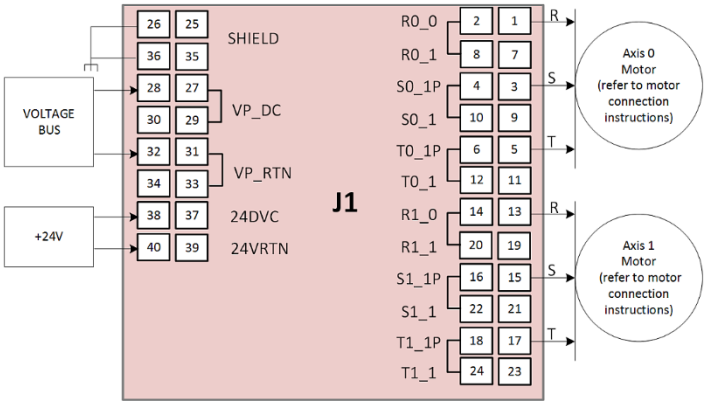
This section details the UDMpc EtherCAT Universal Drive Module connectors and connectivity. A summary of the connectors is given in Table 4.

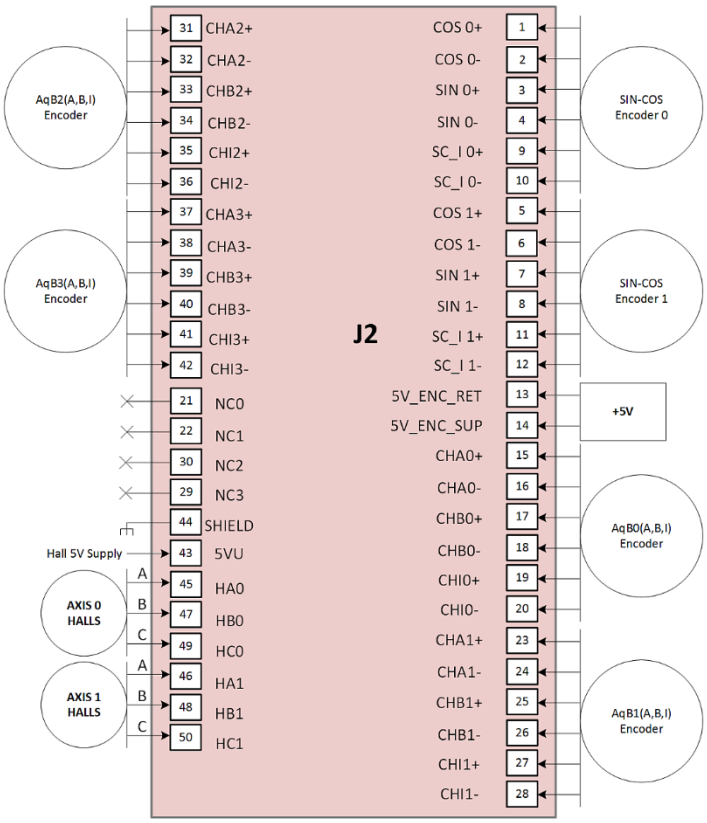
Table 4: UDMpc Connectors

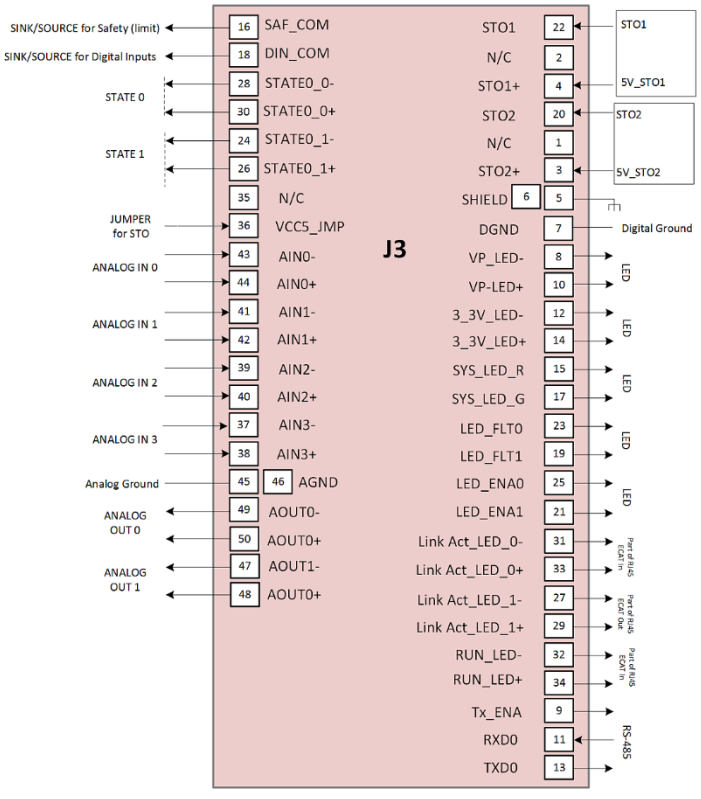
	Label	Connector Type	Mating Connector
J1	DRIVE	SAMTEC DW-20-10-G-D-260	SAMTEC CES-120-01-L-D
J2	FEEDBACK	SAMTEC TW-25-03-G-D-135-255	SAMTEC SQT-125-01-L-D
J3	IO AND LEDS	SAMTEC TW-25-03-G-D-135-255	SAMTEC SQT-125-01-L-D
J4	IO AND ETHERCAT	SAMTEC TW-25-03-G-D-135-255	SAMTEC SQT-125-01-L-D

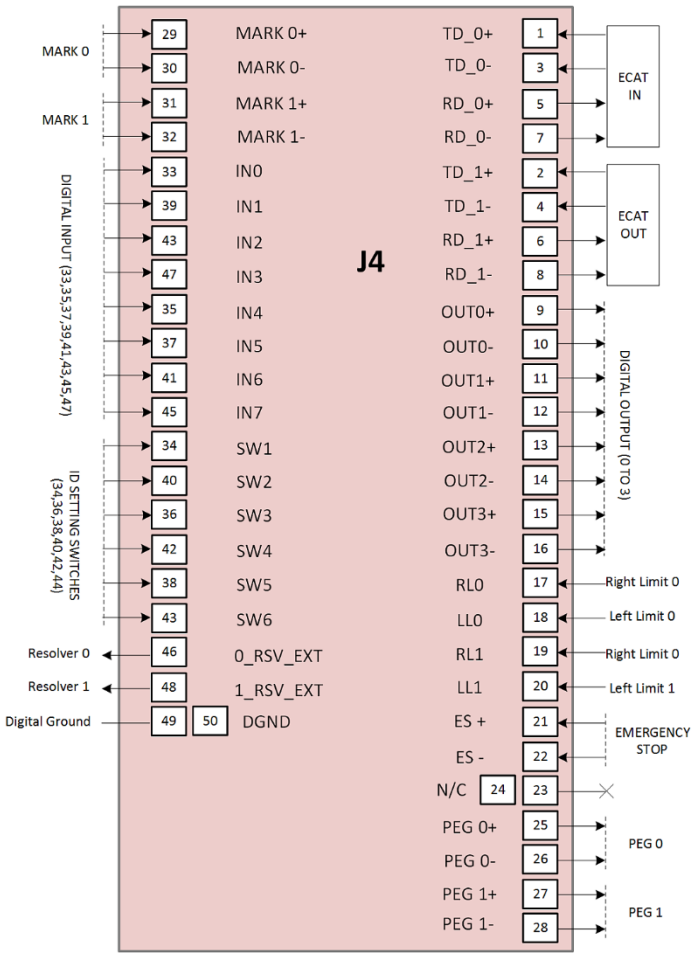
UDMpc-2-048 Functional Pin Allocation

The following diagrams detail the four connectors' signals, grouped by functionality.

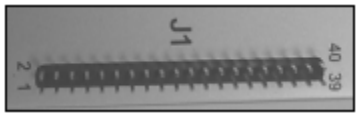








J1 – Drive Connector



Label: J1 - DRIVE

Table 5: J1 - Drive Connector Pinout

Pin	Name	Desc.	Pin	Name	Desc.
1	R0_0	PhR0	21	S1_1	Ph. – S1
2	R0_0	PhR0	22	S1_1	Ph. – S1
3	S0_1P	PhS0	23	T1_1	Ph. – T1
4	S0_1P	PhS0	24	T1_1	Ph. – T1
5	T0_1P	PhT0	25	SHIELD	Shield
6	T0_1P	PhT0	26	SHIELD	Shield
8	R0_1	PhR0	28	VP_DC	Drive Sup.

Pin	Name	Desc.	Pin	Name	Desc.
9	S0_1	PhS0	29	VP_DC	Drive Sup.
10	S0_1	PhS0	30	VP_DC	Drive Sup.
11	T0_1	PhT0	31	VP_RTN	Drive RTN
12	T0_1	PhT0	32	VP_RTN	Drive RTN
13	R1_0	PhR1	33	VP_RTN	Drive RTN
14	R1_0	PhR1	34	VP_RTN	Drive RTN
15	S1_1P	PhS1	35	SHIELD	RTN
16	S1_1P	PhS1	36	SHIELD	Shield
17	T1_1P	PhT1	37	24VDC	+24 Vdc
18	T1_1P	PhT1	38	24VDC	+24 Vdc
19	R1_1	PhR1	39	24VRTN	24 Vdc RTN
20	R1_1	PhR1	40	24VRTN	24 Vdc RTN

J2 – Feedback Connector

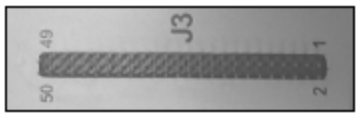
Label: J2 - FEEDBACK

Table 6: J2 – Feedback Connector Pinout

Pin	Name	Desc.	Pin	Name	Desc.
1	COS0+	Enc.	26	CHB1-	Enc.
2	COS0-	Enc.	27	CHI1+	Enc.
3	SIN0+	Enc.	28	CHI1-	Enc.
4	SIN0-	Enc.	29	NC3	Enc.
5	COS1+	Enc.	30	NC4	NA
6	COS1-	Enc.	31	CHA2+	Enc.
7	SIN1+	Enc.	32	CHA2-	Enc.
8	SIN1-	Enc.	33	CHB2+	Enc.
9	SC_I 0+	Enc.	34	CHB2-	Enc.
10	SC_I 0-	Enc.	35	CHI2+	Enc.
11	SC_I 1+	Enc.	36	CHI2-	Enc.
12	SC_I 1-	Enc.	37	CHA3+	Enc.
13	5V_ENC_RET	Supply	38	CHA3-	Enc.
14	5V_ENC_SUP	Supply	39	CHB3+	Enc.
15	CHA0+	Enc.	40	CHB3-	Enc.
16	CHA0-	Enc.	41	CHI3+	Enc.
17	CHB0+	Enc.	42	CHI3-	Enc.
18	CHB0-	Enc.	43	5VU	HALL 5V Supply
19	CHI0+	Enc.	44	SHIELD	Shield
20	CHI0-	Enc.	45	HA0	Hall
21	NC0	NA	46	HA1	Hall
22	NC1	NA	47	HB0	Hall
23	CHA1+	Enc.	48	HB1	Hall
24	CHA1-	Enc.	49	HC0	Hall
25	CHB1+	Enc.	50	HC1	Hall

For the single axis product (UDMpc-1-048), short the Sine and Cosine pairs of encoder 1(Y) as follows: J2-5 to J2-6 and J2-7 to J2-8.

J3 – I/O and LEDs Connector



Label: J3 - IO AND LEDS

Table 7: J3 - I/O and LEDs Connector Pinout

Pin	Name	Desc.	Pin	Name	Desc.
1	N/C	Not used	26	STATE0_1+	State
2	N/C	Not used	27	Link Act_LED_1	Link Active LED
3	STO2+	STO	28	STATE0_0-	State
4	STO1+	STO	29	Link Act_LED_1+	Link Active LED
5	SHIELD	Shield	30	STATE0_0+	State
6	SHIELD	Shield	31	Link Act_LED_0-	Link Active LED
7	DGND	Dig.GND	32	Run_LED-	Run LED
8	VP_LED-	VP LED	33	Link Act_LED_0+	Link Active LED
9	Tx_ENA	RS485 Enabled LED	34	Run_LED+	Run LED
10	VP_LED+	VP LED	35	N/C	Not used

Pin	Name	Desc.	Pin	Name	Desc.
11	RXD0	RS485 Rec. LED	36	VCC5_JMP	Jumper for STO
12	3_3V_LED-	3.3V LED	37	AIN3-	Analog Input
13	TXD0	RS485 Transmit LED	38	AIN3+	Analog Input
14	3_3V_LED+	3.3V LED	39	AIN2-	Analog Input
15	SYS_LED_R	System LED	40	AIN2+	Analog Input
16	SAF_COM	Select Sink or Source	41	AIN1-	Analog Input
17	SYS_LED_G	System LED GND	42	AIN1+	Analog Input
18	DIN_COM	Select Sink or Source	43	AIN0-	Analog Input
19	LED_FLT1	Drive Status LED	44	AIN0+	Analog Input
20	STO2	Safe Torque Off function	45	AGND	Analog Ground
21	LED_ENA1	Drive Enabled LED	46	AGND	Analog Ground
22	STO1	Safe Torque Off function	47	AOUT1-	Analog Output
23	LED_FLT0	Drive Status LED	48	AOUT1+	Analog Output
24	STATE0_1-	State	49	AOUT0-	Analog Output
25	LED_ENA0	Drive Enabled LED	50	AOUT0+	Analog Output

J4 – I/O and EtherCAT Connector

Label: J4 - IO AND ETHERCAT

Table 8: J4 - I/O and EtherCAT Connector Pinout

Pin	Name	Description	Pin	Name	Description
1	TD_0+	Tx 0	26	PEG0-	PEG
2	TD_1+	Tx 1	27	PEG1+	PEG
3	TD_0-	Tx 0	28	PEG1-	PEG
4	TD_1-	Tx 1	29	MARK0+	MARK
5	RD_0+	Rx 0	30	MARK0-	MARK
6	RD_1+	Rx 1	31	MARK1+	MARK
7	RD_0-	Rx 0	32	MARK1-	MARK
8	RD_1-	Rx 1	33	IN0	Digital Input
9	OUT0+	Dig. Out	34	SW1	DIP Switch 1
10	OUT0-	Dig. Out	35	IN4	Digital Input
11	OUT1+	Dig. Out	36	SW3	DIP Switch 3
12	OUT1-	Dig. Out	37	IN5	Digital Input
13	OUT2+	Dig. Out	38	SW5	DIP Switch 5
14	OUT2-	Dig. Out	39	IN1	Digital Input
15	OUT3+	Dig. Out	40	SW2	DIP Switch 2
16	OUT3-	Dig. Out	41	IN6	Digital Input
17	RL0	Right Limit	42	SW4	DIP Switch 4
18	LL0	Left Limit	43	IN2	Digital Input
19	RL1	Right Limit	44	SW6	DIP Switch 6
20	LL1	Left Limit	45	IN7	Digital Input
21	ES+	E. Stop	46	0_RSV_EXT	Resolver
22	ES-	E. Stop	47	IN3	Digital Input
23	N/C	Not used	48	1_RSV_EXT	Resolver
24	N/C	Not used	49	DGND	Digital Ground
25	PEG0+	PEG	50	DGND	Digital Ground

UDMpc-2-048 Mechanical Dimensions

Refer to following drawings for the module's dimensions.

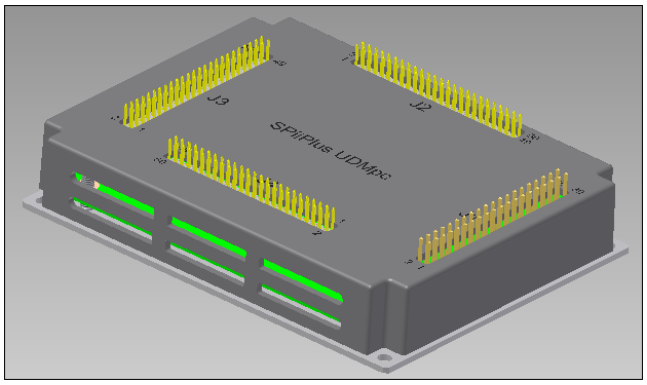


Figure 22: UDMpc-2-048

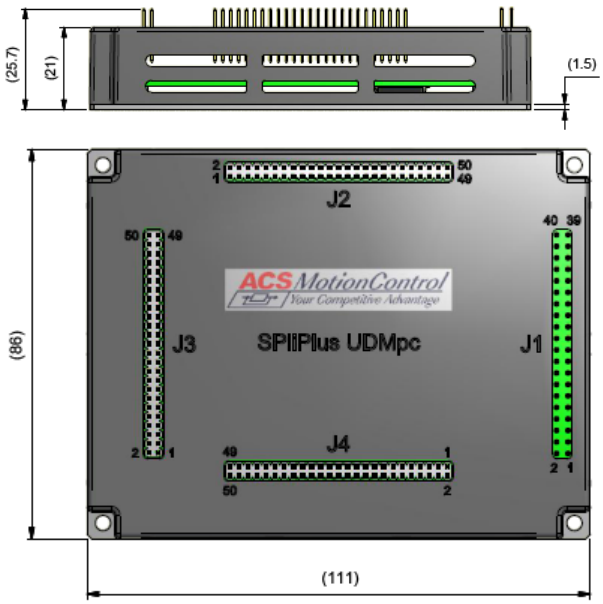


Figure 23: UDMpc Dimensions

For planning purposes Figure 24 provides the UDMpc dimensions for mounting PCB components on the module.

Dimensions are in mm, with a tolerance of 0.2 for linear, and 0.3 for angular dimensions.

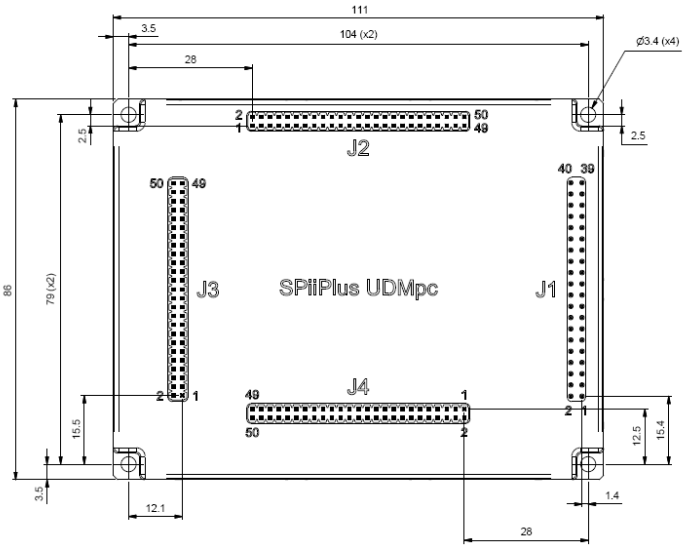


Figure 24: UDMpc Dimensions

UDMpc-2-048/BoB Evaluation Module

This chapter describes the functionality of the BoB and its circuitry. For each function, reference to the customer's design is made, detailing whether the implementation is mandatory or optional, along with additional design recommendations and references.

The BoB is designed so the module UDMpc plugs into its bottom (print side) as shown in Figure 25.

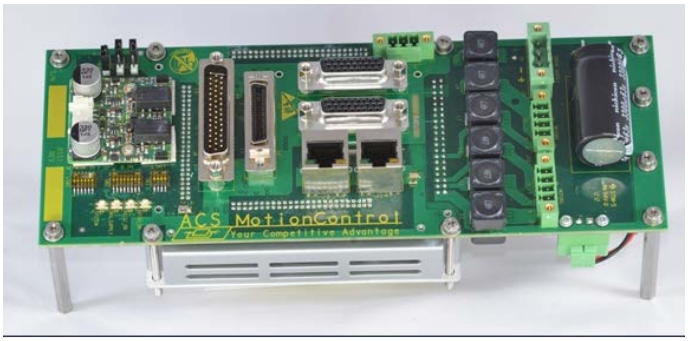


Figure 25: Combined UDMpc and BoB

Industry standard connectors for both the UDMpc and BoB are used for direct cable interfacing. Refer to connector type and pin-out details in Table 9 and **BoB Connectors**.

Motor Connections

BoB contains motor phases' inductors, as detailed in **An optional** STO Cable Mating kit (PN STO-ACC1), provides a

cable with flying leads used to connect the optional STO module.

Motor Connectivity above.

Emergency Stop

Emergency stop signal is available in the BoB's J4 connector.

Digital Outputs

BoB allows using the digital outputs as either 'sink' or 'source', by jumper JP-3 settings:

Position 1-2: 'sink', On state is represented by V_RTN.

Position 2-3: 'source', On state is represented by V_SUP.

V_SUP is supplied by the user, and can be in the range of 5 to 24Vdc.

Sin Cos Encoder Interface

Since the module contains 120Ω termination for all sin-cos signals, no additional external termination is added to the BoB.

For the single axis product (UDMpc-1-048), leave the non-active encoder 1(Y) connector J9 unconnected.

Digital Encoder interface (A,B,I)

Since the module contains 120Ω termination for all signals, no additional external termination is added to the BoB.

Hall Encoders

Hall supply (5VU) is provided by the BoB

Digital Inputs

IN0 to IN7 can be either 5V or 24V, as selected by DIP switch SW2.

Right Limit, Left Limit

RL0, RL1, LL0, LL1 can be either 5V or 24V, as selected by DIP switch SW3.

DIP switch settings are as follows:

SW3 Position OFF = 24V (Default)

SW3 Position ON = 5V

SW3/1 – RL0

SW3/2 – LL0

SW3/3 – RL1

SW3/4 – LL1

SW2 Position OFF = 24V (Default)

SW2 Position ON = 5V

SW2/1 – IN0

SW2/2 – IN1

SW2/3 – IN2

SW2/4 – IN3

SW2/5 – IN4

SW2/6 – IN5

SW2/7 – IN6

SW2/8 – IN7

See Figure 27 for the location of the DIP switches.

LED Indicators

The BoB uses a buffer/driver for the following LED signals:

LED_ENA0, LED_ENA1, LED_FLT0, LED_FLT1, SYS_LED_G, SYS_LED_R.

The following signal pair, after buffering, are used along with a bi-color LED component: LED_FLT0 and LED_ENA0. LED_FLT1 and LED_ENA1.

VP_LED+ and VP_LED- , SYS_LED_G and SYS_LED_R. are used along with a bi-color LED component as well.

For PCB designers:

Use the above implementation as an optional guideline for the PCB design.

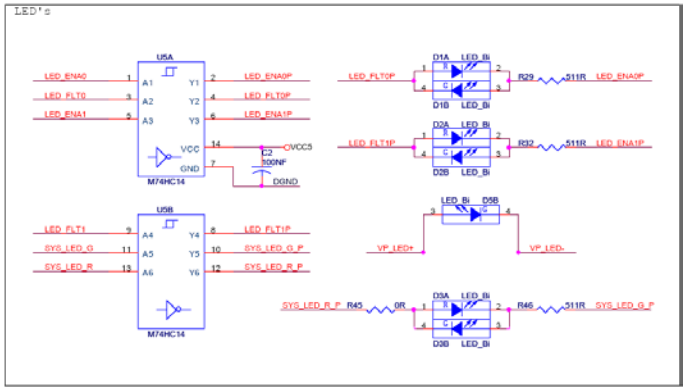


Figure 26: LED Electrical Connections

BoB DIP Switches

There are three DIP switches, SW1, SW2 and SW3, located on the BoB.

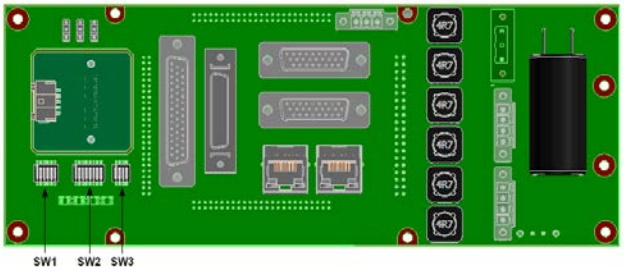


Figure 27: BoB DIP Switches

SW1 is used for setting the EtherCAT ID of the BoB.

SW2 and SW3 are used for setting the digital inputs (see **Digital Inputs**)

STO (Safe Torque Off Activation for Both Axes)

When using the combined UDMpc and BoB, there is an option for including a STO module as part of the BoB.

For regular operation, 24Vdc voltage has to be present at pins 2 and 5 of the STO connector. The removal of any of these signals causes the STO to trip, thus disabling both axes.

Refer to jumper setting below. By factory setup, the jumper is set to "2-3" position. The location of the jumpers is shown in Figure 28.

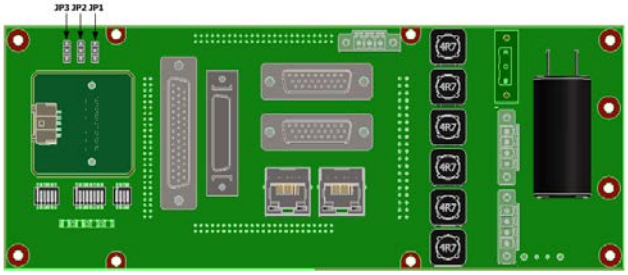


Figure 28: BoB Jumper Locations

Jumper settings:

- ❑ In order to use STO: Set JP1 and JP2 to position "2-3"
- ❑ In order to bypass the STO functionality, or when the module is not mounted: Set JP1 and JP2 to position "1-2"
- ❑ In order to bypass the STO functionality without the BoB, you have to short pin 3 (STO2+) and pin 36 (VCC5_JMP) of J3, and short pin 4 (STO1+) and pin 36 (VCC5_JMP) of J3.

BoB Connectors

This section details the UDMpc BoB connectors and connectivity. The BoB connectors locations are shown in Figure 29. A summary of the connectors is given in Table 9.

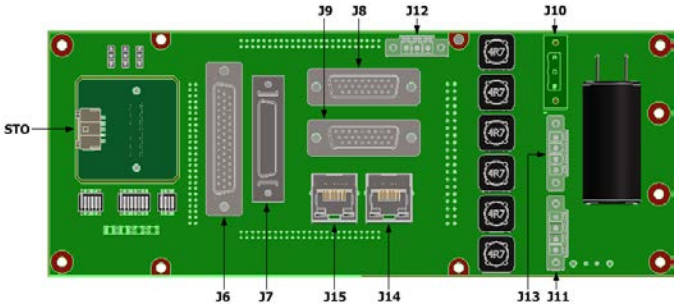


Figure 29: BoB Connectors

Table 9: BoB Connectors

	Label	Connector Type	Mating Connector
J6	I/O	D-Type	NELTRON [5508-44S-02-F1]
J7	GENERAL PURPOSE	SCSI	AMTEK [HPCENS-MM36SAB-A1-L]
J8	ENCODER0	D-Type	NELTRON [5508-26P-01-F1]
J9	ENCODER1	D-Type	NELTRON [5508-26P-01-F1]
J10	DRIVE SUPPLY 48V	Power 2EDGVM-5	DEGSON [2EDGKFM-5.0-03P-14]
J11	MOTOR0	Power MCV 1,5	PHOENIX [MC1,5/4-STF3,81]
J12	CONTROL SUPPLY 24V	Power MCV 1,5	PHOENIX [MC1,5/3-STF3,81]
J13	MOTOR1	Power MCV 1,5	PHOENIX [MC1,5/4-STF3,81]
J14	ETHERCAT IN	RJ45 with 2 LEDs [Manufacturer WE 615 008 138 321]	Ethernet plug
J15	ETHERCAT OUT	RJ45 with 2 LEDs [Manufacturer WE 615 008 138 321]	Ethernet plug
STO	STO	JST 5 pin 2mm male	JST 5 pin 2mm
		SM05B-PASS-1	female PAP-05V-S Pin: SPHD-001T-P0.5

J6 – I/O Connector

Table 10: J6 – Connector Pinout

Pin	Name	Pin	Name
1	OUT1	23	RL1
2	OUT3	24	ES
3	DATA+	25	AIN0+
4	N/C	26	AIN1+
5	IN3	27	AOUT0-
6	IN7	28	MARK1-
7	LL0	29	PEG0-
8	LL1	30	PEG1-
9	ES+	31	V_SUP_IO
10	AIN0-	32	V_RTN_IO
11	AOUT0+	33	IN1
12	MARK1+	34	IN2
13	PEG0+	35	IN4
14	PEG1+	36	IN6
15	DGND	37	DIN_COM
16	OUT0	38	SAF_COM
17	OUT2	39	AGND
18	N/C	40	AIN1-
19	DATA	41	AOUT1+
20	IN0	42	AOUT1-
21	IN5	43	MARK0+
22	RL0	44	MARK0-

J7 – General Purpose Connector

Table 11: J7 - Connector Pinout

Pin	Name	Pin	Name
1	CHA2+	19	CHA3+
2	CHA2-	20	CHA3-
3	CHB2+	21	CHB3+
4	CHB2-	22	CHB3-
5	CHI2+	23	CHI3+
6	CHI2-	24	CHI3-
7	5VU	25	DGND
8	State0_0+	26	State0_1+
9	State0_0-	27	State0_1-
10	AGND	28	SHIELD
11	AIN2+	29	AIN3+
12	AIN2-	30	AIN3-
13	0_RSV_SIN+	31	1_RSV_SIN+
14	0_RSV_SIN-	32	1_RSV_SIN-
15	0_RSV_COS+	33	1_RSV_COS+
16	0_RSV_COS-	34	1_RSV_COS-
17	0_RSV_EXT	35	1_RSV_EXT
18	AGND	36	AGND

J8 – Encoder 0 Connector

Table 12: J8 - Connector Pinout

Pin	Name	Pin	Name
1	CHA0-	14	HC0
2	CHB0-	15	LL0
3	CHI0-	16	SIN0+
4	HB0	17	COS0+
5	SAF_COM	18	SC_I0+
6	RL0	19	5V_ENC_SUP
7	SIN0-	20	5V_ENC_RET
8	COS0-	21	SHIELD
9	SC_I0-	22	N/C
10	CHA0+	23	N/C
11	CHB0+	24	N/C
12	CHI0+	25	5V_ENC_SUP
13	HA0	26	5V_ENC_RET

J9 – Encoder 1 Connector

Table 13: J9 - Connector Pinout

Pin	Name	Pin	Name
1	CHA1-	14	HC1
2	CHB1-	15	LL1
3	CHI1-	16	SIN1+
4	HB1	17	COS1+
5	SAF_COM	18	SC_I1+
6	RL1	19	5V_ENC_SUP
7	SIN1-	20	5V_ENC_RET
8	COS1-	21	SHIELD
9	SC_I1-	22	N/C
10	CHA1+	23	N/C
11	CHB1+	24	N/C
12	CHI1+	25	5V_ENC_SUP
13	HA1	26	5V_ENC_RET

J10 – DRIVE SUPPLY 48V Connector

Table 14: J10 - Connector Pinout

Pin	Name	Description
1	VP_DC	Cable: 12AWG
2	VP_RTN	
3	SHIELD	

The maximum bus fuse rating is 15A.

Fuse blow speed must be less than 300msec.

J11 – MOTOR 0Connector

Table 15: J11 - Connector Pinout

Pin	Name	Description
1	R0	Phase R
2	S0	Phase S
3	T0	Phase T
4	SHIELD	

J12 – CONTROL SUPPLY 24V Connector

Table 16: J12 - Connector Pinout

Pin	Name	Description
1	24VDC	Cable: 18AWG
2	24VRTN	
3	SHIELD	

Connect a 1.5A fuse to the 24V feeding cable.

J13 – Motor 1 Connector

Table 17: J13 - Connector Pinout

Pin	Name	Description
1	R1	Phase R
2	S1	Phase S
3	T1	Phase T
4	SHIELD	

J14 – EtherCAT in Connector

Table 18: J14 - Connector Pinout

Pin	Name	Description
1	TD+	Positive transmit signal
2	TD-	Negative transmit signal
3	RD+	Positive receive signal
4	N/C	Not connected
5	N/C	Not connected
6	RD-	Negative receive signal
7	N/C	Not connected
8	N/C	Not connected

J15 – EtherCAT Out Connector

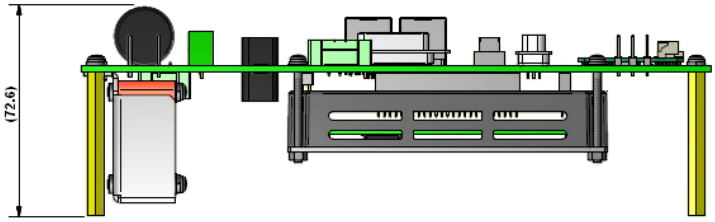
Table 19: J15 - Connector Pinout

Pin	Name	Description
1	TD+	Positive transmit signal
2	TD-	Negative transmit signal
3	RD+	Positive receive signal
4	N/C	Not connected

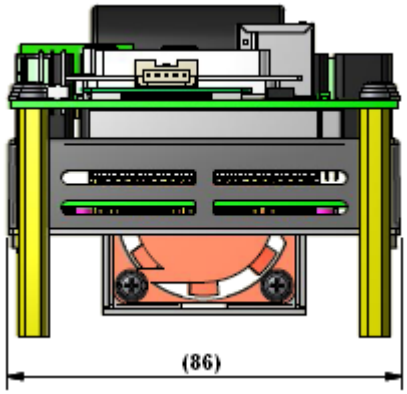
Pin	Name	Description
5	N/C	Not connected
6	RD-	Negative receive signal
7	N/C	Not connected
8	N/C	Not connected

UDMpc-2-048 BoB Dimensions

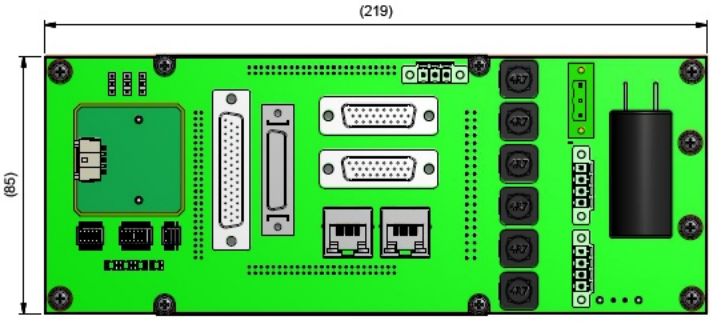
Refer to drawings below. Note that they indicate dimensions of the module as well as the BoB:



UDMpc-2-048/BoB – combined module and BoB dimensions:



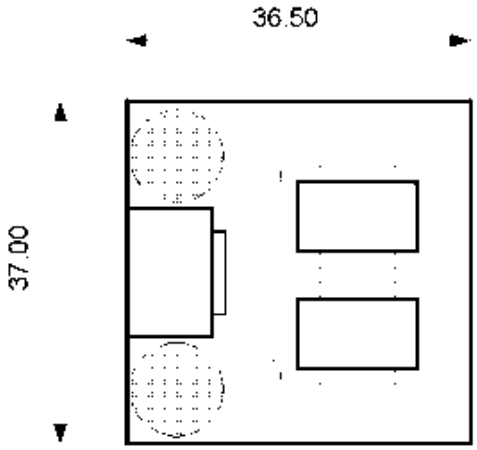
BoB top view and dimensions:



STO Dimension (included as part of BoB)

The STO module is provided as part of the BoB, and can be L × W × H = 36.5 × 37 × 11.5 mm

Board thickness T = 1 mm



The STO module has 2 connectors:

- A user connector, accessible to the outside world, detailed in **STO User Connector**.
- A PCB connector, used to connect the STO module to the designer's PCB. This connector is detailed in **STO Board Connector (PCB Mount)**.

STO User Connector

Connector type	JST 5 PIN 2mm male SM05B-PASS-1
Mating connector type	JST 5 PIN 2mm female PAP-05V-S Pin type: SPHD-001T-P0.5

Table 20: STO User Connector Pinout

Pin	Name	Description
1	24V_STO1_RTN	Safety torque input 1 inverted input
2	24V_STO1	Safety torque input 1 non-inverted input
3	EGND	Electrical ground
4	24V_STO2	Safety torque input 2 non-inverted input
5	24V_STO2_RTN	Safety torque input 2 inverted input

STO Board Connector (PCB Mount)

Connector type	PCB layout contacts for Samtec 20-pin one piece interface connector
Mating connector type (on PCB)	Samtec 20-pin, pitch 1mm, ONE PIECE INTERFACE, SEI-120-02-GF-S-M-AB

Table 21: STO Board Connector Pinout

Pin	Name	Description
1	24V_STO1_RTN	Safety torque input 1 inverted (24V return)
2	24V_STO1	Safety torque input 1 non-inverted (24V)
3	EGND	Electrical ground
4	STO1	STO1 status – output control signal
5	STO1	STO1 status – output control signal
6	EGND	Electrical ground
7	5V_STO1	Safety torque output 1 non-inverted (5V)
8	5V_STO1	Safety torque output 1 non-inverted (5V)
9	DGND	Safety torque output 1 inverted (Digital ground)
10	DGND	Safety torque output 1 inverted (Digital ground)
11	DGND	Safety torque output 2 inverted (Digital ground)
12	DGND	Safety torque output 2 inverted (Digital ground)
13	5V_STO2	Safety torque output 2 non-inverted (5V)
14	5V_STO2	Safety torque output 2 non-inverted (5V)
15	EGND	Electrical ground
16	STO2	STO2 status – output control signal
17	STO2	STO2 status – output control signal
18	EGND	Electrical ground
19	24V_STO2	Safety torque input 2 non-inverted (24V)
20	24V_STO2_RTN	Safety torque input 2 inverted (24V return)

UDMpc Design Reference Files

UDMpc design reference files are available in several industry-standard formats for insertion as a component (refer to Figure 30) into a PCB design.

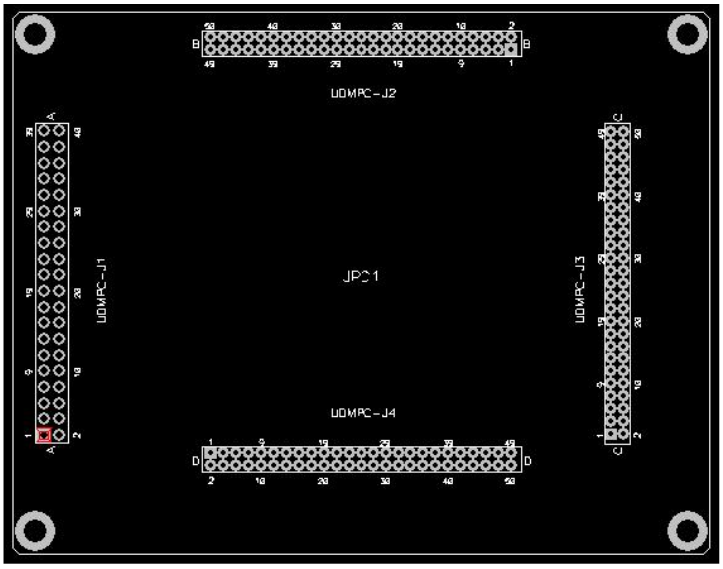


Figure 30: UDMpc JPC Connector

The files available for download from the ACS web page are:

- Allegro format: ACS-UDMPC-Allegro.dra
- Altium format: ACS-UDMPC-Altium09.PcbLib
- Orcad format: ACS-UDMPC-ORCAD.OLB
- PCAD format: ACS-UDMPC-PCAD.lib

NOTICE

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Changes in Version NT2.20

Page	Date	Change
		Preliminary Release, February 2012
20	12/02/12	Figure 24 showing mounting dimensions added.
Error! Bookmark not defined.	07/05/12	Expanded explanation of Absolute Encoder support.
27	19/07/12	Added section on UDMpc Design Files
12	26/07/12	Added warnings
10	31/1/13	Thermal considerations
6	12/8/13	Absolute Encoder Interface

Related Documents

The following documents provide additional details relevant to this guide:

Document	Description
SPiiPlus Setup Guide	A guide providing step-by-step instructions for setting up a SPiiPlus system.
SPiiPlus Command & Variable Reference Guide	Complete description of all variables and commands in the ACSPL+ programming language.
SPiiPlus C Library Reference	C++ and Visual Basic® libraries for host PC applications. This guide is applicable for all the SPiiPlus motion control products.
SPiiPlus COM Library Reference	COM Methods, Properties, and Events for Communication with the Controller.
SPiiPlus MMI Application Studio User Guide	A complete guide for using the SPiiPlus MMI Application Studio.
SPiiPlus Utilities User Guide	A guide for using the SPiiPlus User Mode Driver (UMD) for setting up communication with the SPiiPlus motion controller.
MC4U Control Module Hardware Guide	Technical description of the MC4U Control Module integrated motion control product line.
PEG and MARK Operations Application Notes	Provides details on using the PEG commands in NT systems.
Safe Torque Off Function Application Notes	Provides details of the implementation of the STO function in SPiiPlus products.


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