2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
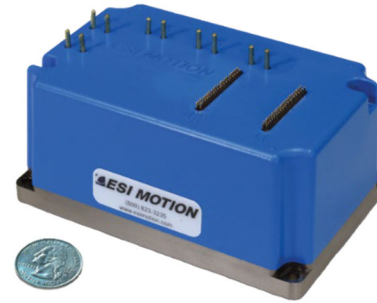www.esimotion.com   Product of USA

SCORPION
Servo Drive Module

Compact, Versatile, Powerful
High Power Density

Scorpion is an exceptionally lightweight, efficient controller with one of the highest power densities on the market today. At 24kW, the Scorpion is capable of performing in very demanding applications. It incorporates our rugged, high-density DSP controller and power drive, and is packaged in a rock-solid potted plastic case.

The Scorpion Servo Module Series is offered in many configurations to meet a wide spectrum of applications. This versatile servo drive module is ideal for high-performance applications operating at high temperatures, in high vibration (+/-20g), or other extreme environmental conditions. It comes with an industry benchmark user interface, allowing the most flexible and precise system integration and control.

Features

- Nominal Bus Voltage range 24V to 600V
- Nominal input current up to 40A (transient: 80A)
- Maximum output power 24 kW
- Maximum motor speed 75,000 RPM
- Torque, velocity or position control
- Lightweight and efficient
- Single axis configuration
- Commands: Brakes, Inrush (Precharge), Regeneration, and Voltage Discharge
  (external circuits required)
- Includes configurable, user-friendly GUI with enhanced data collection capability and integrated oscilloscope feature.
- DC brushless, brushed, and induction motor types
- Feedback:
  - BiSS-C (Unidirectional)
  - Encoder
  - Hall
  - Resolver
  - Sensorless
- I/O Board option for rapid initial integration
- Chassis-cooled
- Robust potted plastic case with integrated heat sink.

Specifications

- Operating temperature -40ºC to +71ºC
  - Extended -55°C to 71°C (optional)

- Weight: 1 lb.
- Size: 2.6" L x 4.0" W x 1.8" H
- Efficiency >95% (full load)

Compliance

- The safety-critical **Scorpion** is based on DO-178C Baselined Software, which can be tailored to your requirements.
- Compliant to IPC-610 Class II (Class III and higher also available)
- Designed to ruggedization standards:
  - MIL-STD-810
  - MIL-STD-1275
  - MIL-STD-704
  - MIL-STD-461*

Customization Available

ESI Motion has the expertise to customize a solution for your project's needs – contact us to see how we can tailor a solution for you.
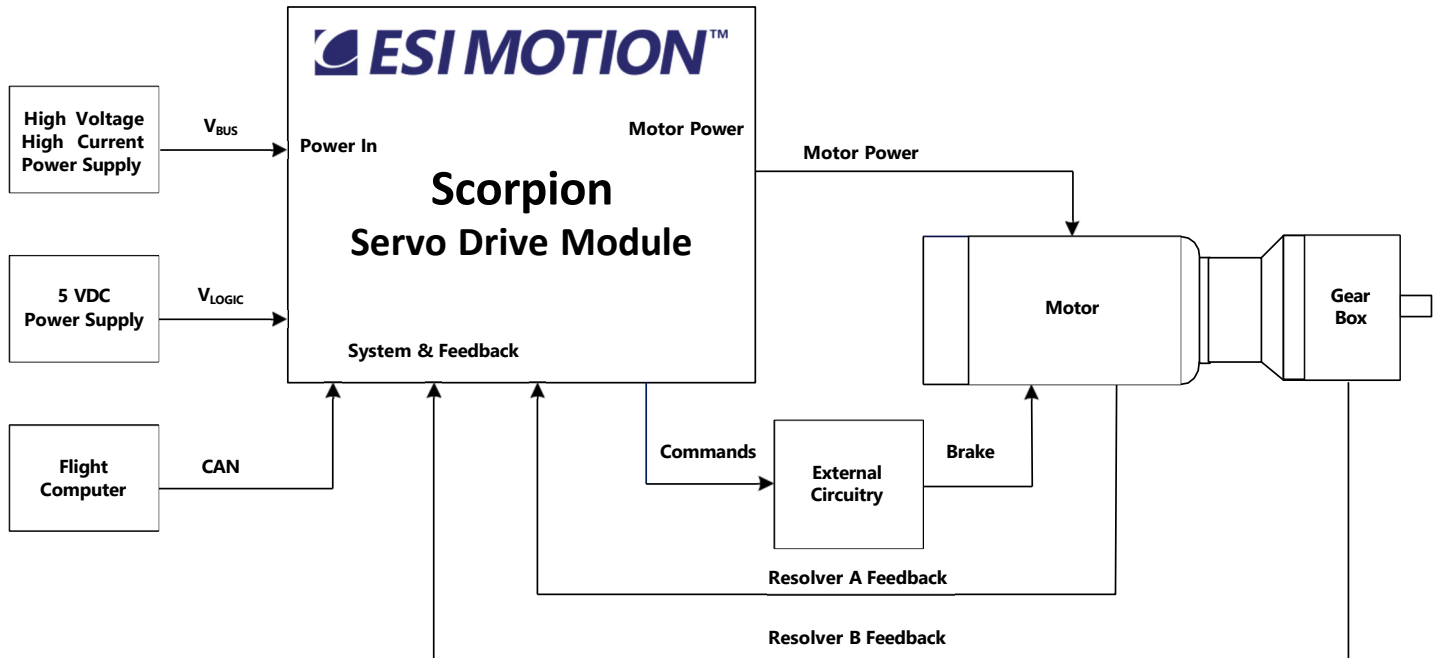
*The EMI features on ESI's Draco drive are being sold AS-IS, without warrantee. EMI compliance is a complex requirement involving the controller, cabling, and the motor. All parts in the system will require special consideration in order to fully comply with EMI features. Due to this complexity, ESI does not warrantee system level EMI compliance.

ESI offers EMI certification services. Certification services can be customized to your needs and typically include a system EMI review, formal compliance testing, and a compliance report. Please contact ESI for details on how to get your system certified to MIL-STD-461.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Typical Scorpion Application:

Scorpion Block Diagram:

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA
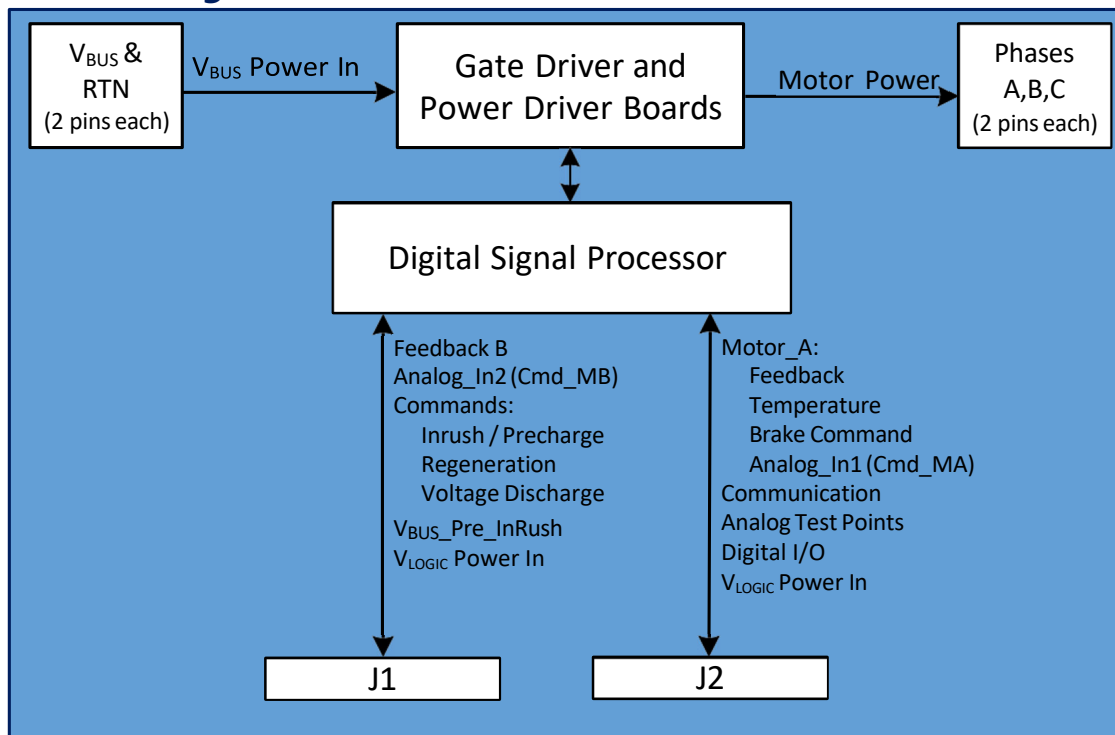
ELECTRICAL SPECIFICATIONS

Absolute Maximum Values

The values in the table below should never be exceeded as permanent damage to the controller may result.

PARAMETER	ABSOLUTE MAX	UNIT
Bus Voltage (V_{BUS}), 600V Model	720	VDC
Bus Voltage (V_{BUS}), 300V Model	450	VDC
Digital Logic Voltage (V_{LOGIC})	6.5	VDC
Analog Inputs	$\pm$22	V
Resolver Inputs	$\pm$22	V
Hall Inputs	$\pm$22	V
Encoder Inputs [1]	7.6	V
BiSS-C Inputs [1]	7.6	V
Temperature Sensor Input	+7	V
Digital I/O (Input value)	4.6	V
Operating Case Temperature: Standard Temperature Model Extended Temperature Model	-40 to +85 -55 to +85	ºC
Storage Temperature	-55 to +100	ºC

Notes:
1. For Encoder and BiSS-C Inputs, 7.6V is the maximum differential voltage (assumes 50% duty cycle) and common mode voltage maximum is +/-7V.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Recommended Operating Conditions

DC INPUT CHARACTERISTICS			
PARAMETER	MIN	MAX	UNIT
V_{BUS} Bus Voltage, 600V Model	24	600	VDC
V_{BUS} Bus Voltage, 300V Model	24	300	VDC
V_{LOGIC} Digital I/O Logic Voltage Input (nominal 3.3V)	3.14	3.47	V
V_{LOGIC} Current		0.45	A

OUTPUT CHARACTERISTICS (PER AXIS)		
PARAMETER	MAX	UNIT
Continuous Output Current, 60A Model [1]	60	A
Continuous Output Current, 40A Model [1]	40	A
Continuous Output Current, 20A Model [1]	20	A
Continuous Output Current, 10A Model [1]	10	A
Continuous Output Current, 5A Model [1]	5	A
Transient Output Current, 60A Model [1] [2]	120	A
Transient Output Current, 40A Model [1] [2]	80	A
Transient Output Current, 20A Model [1] [2]	40	A
Transient Output Current, 10A Model [1] [2]	20	A
Transient Output Current, 5A Model [1] [2]	10	A
Continuous Output Power [3]	24	kW
Motor Speed	75,000	RPM

Notes:
1. Peak Sine Wave.
2. Transient Output Current Duration: 2 Seconds
3. Output Power may be limited by the maximum input current at low input voltages.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Recommended Operating Conditions, cont.

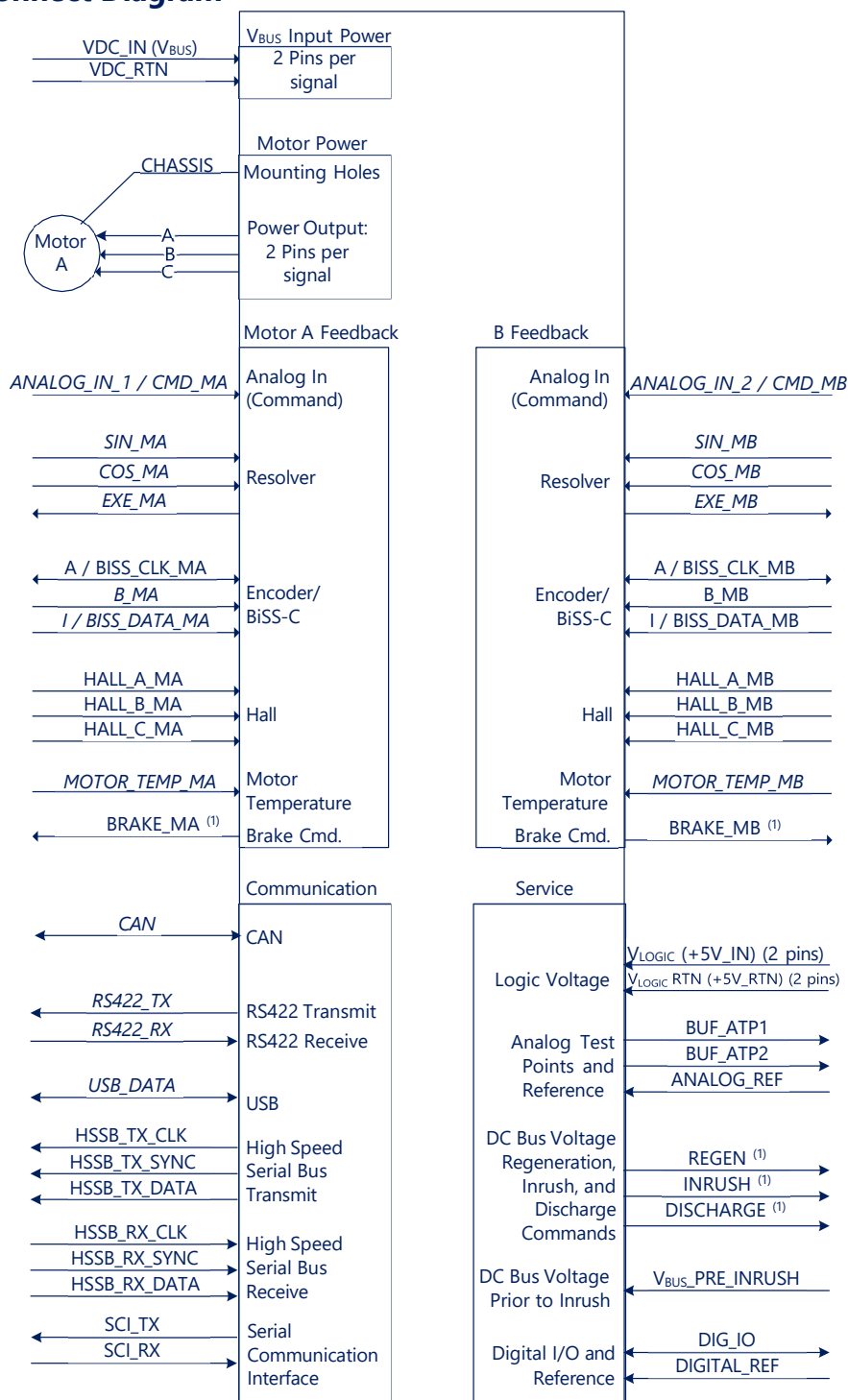| I/O CHARACTERISTICS				
PARAMETER	MIN	NOM	MAX	UNIT
Analog Input Range [1]	-10		10	V
Analog Input Impedance		20		KΩ
Analog Test Point (TP) Output Range [1]	-3		+3	V
Analog Test Point Output Load		50		Ω
Thermistor Resistance at 25°C [1] [2]	1	5	10	KΩ
Resolver Excitation Output [1]	3.8	4	4.2	V_{RMS}
Resolver Excitation Output Frequency [3]		5		kHz
Resolver SIN, COS Input Differential Range [1]	2		4.2	V_{RMS}
Resolver SIN, COS Input Differential Impedance		20		KΩ
Hall Inputs [1]	0		5	V
Digital Encoder Inputs Voltage [1]	0		5	V
Digital Encoder Inputs Impedance		120		Ω
BiSS-C Clock Inputs [1] [4]	3		3.5	V
BiSS-C Data Inputs Voltage [1] [4]	0		5	V
BiSS-C Inputs Impedance		120		Ω
Digital Input / Output Voltage [1]		3.3		V
Digital Input / Output Current	9		54	mA
CAN [1] [5] [6]			1,000	Kbps
RS-422 [1] [6] [7]			1,000	Kbps
USB 2.0 [1]			12	Mbps
Commands: Regeneration, Brakes, Inrush, Discharge	0		3.3	V
V_{BUS} Monitor Pre-Inrush (analog voltage)	0		5	V
HSSB, SCI	0		3.3	V

Notes:
1. ESD Protected
2. Recommended: NTC 5k thermistor, Vishay Dale part #NTCS0603E3502FLT
3. Default Resolver Frequency is 5 kHz. Contact Factory for custom frequencies.
4. Physical Interface compliant to EIA-422-B
5. Compliant to ISO 11898-2 specification
6. Short circuit protection from -7 V to +12 V
7. Compliant to EIA-422-B

Mechanical & Connectors

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

MECHANICAL CHARACTERISTICS

PARAMETER	VALUE	UNIT
Weight	1.0	lb.
Size	2.6 L x 4.0 W x 1.8 H	inches

CONNECTORS

Ref. No.	FUNCTION	INSERT ARRANGEMENT	#, TYPE CONTACTS	CONTACTS SIZE	SCORPION CONNECTOR (CONTACTS)	MATING CONNECTOR (CONTACTS)
J8, J9, J13, J14	V$_{BUS}$ Input Power & Return	single pins	V$_{BUS}$: 2 pins RTN: 2 pins	0.06" dia. 0.28" length	(nail pins)	Plated holes – or – Mill Max 9372-0-15-15-23-27-10-0 Pin Receptacle
J2, J3, J4, J5, J6, J7	Motor Phase Power Out	single pins	Phase A: 2 pins Phase B: 2 pins Phase C: 2 pins	0.06" dia. 0.28" length	(nail pins)	Plated holes – or – Mill Max 9372-0-15-15-23-27-10-0 Pin Receptacle
J1	Feedback B, Commands	2 x 20 0.05" pitch	40 pins	0.016" dia. Square Pins	FCI 20021121-00040T4LF, (pins)	Samtec CLP-120-02-F-D-TR (sockets)
J2	Motor A Feedback, Communication	2 x 20 0.05" pitch	40 pins	0.016" dia. Square Pins	FCI 20021121-00040T4LF, (pins)	Samtec CLP-120-02-F-D-TR (sockets)

Scorpion Interconnect Diagram

V_{BUS} Input Power
2 Pins per signal
- VDC_IN (V_{BUS})
- VDC_RTN

Motor Power
- CHASSIS
- Mounting Holes
- Power Output: 2 Pins per signal — A, B, C → Motor A

Motor A Feedback
- Analog In (Command): ANALOG_IN_1 / CMD_MA
- Resolver: SIN_MA, COS_MA, EXE_MA
- Encoder/BiSS-C: A / BISS_CLK_MA, B_MA, I / BISS_DATA_MA
- Hall: HALL_A_MA, HALL_B_MA, HALL_C_MA
- Motor Temperature: MOTOR_TEMP_MA
- Brake Cmd.: BRAKE_MA [1]

B Feedback
- Analog In (Command): ANALOG_IN_2 / CMD_MB
- Resolver: SIN_MB, COS_MB, EXE_MB
- Encoder/BiSS-C: A / BISS_CLK_MB, B_MB, I / BISS_DATA_MB
- Hall: HALL_A_MB, HALL_B_MB, HALL_C_MB
- Motor Temperature: MOTOR_TEMP_MB
- Brake Cmd.: BRAKE_MB [1]

Communication
- CAN: CAN
- RS422 Transmit: RS422_TX
- RS422 Receive: RS422_RX
- USB: USB_DATA
- High Speed Serial Bus Transmit: HSSB_TX_CLK, HSSB_TX_SYNC, HSSB_TX_DATA
- High Speed Serial Bus Receive: HSSB_RX_CLK, HSSB_RX_SYNC, HSSB_RX_DATA
- Serial Communication Interface: SCI_TX, SCI_RX

Service
- Logic Voltage: V_{LOGIC} (+5V_IN) (2 pins), V_{LOGIC} RTN (+5V_RTN) (2 pins)
- Analog Test Points and Reference: BUF_ATP1, BUF_ATP2, ANALOG_REF
- DC Bus Voltage Regeneration, Inrush, and Discharge Commands: REGEN [1], INRUSH [1], DISCHARGE [1]
- DC Bus Voltage Prior to Inrush: V_{BUS}_PRE_INRUSH
- Digital I/O and Reference: DIG_IO, DIGITAL_REF

NOTES:

Signals shown in italics indicates differential (high and low) signal pair

1. Logic level only, external circuit required.

This document does not contain Technical Data or Technology as defined the ITAR Part 120.10 or EAR Part 772

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Interfaces Description

Overview
This section describes application interfaces for the Scorpion Servo Module by functional group. The groups are:
Power Input, Motor Power Output, Motor Feedback, Communications and System (Service) Interface.

Power Input
Voltage DC In (with Return) is the high voltage / high current input, referred to as V_{BUS}. (For V_{LOGIC}, see System Interface). The power signals are isolated from control circuitry.

Motor Power
Motor Power outputs three-phase power to the motor.

The Power Input and Motor Power Output pins are designed to be soldered to a carrier printed circuit board, and use pairs of pins, to handle high current.

Motor Feedback
The Motor Feedback connections consists of feedback options and motor temperature inputs.

The Scorpion Servo Module supports the following motor feedback devices:
- Resolver
- Quadrature Encoder
- Hall
- BiSS-C
- Sensorless.

Feedback options are software configurable via ESI Motion's servo motor controller software tool, Host Interface for Drive/Servo Controller (HiDS, see page 10). External feedback interfaces are 5V tolerant, and feedback sensors should be powered from the same 5VDC V_{LOGIC} supply used to power the Scorpion.

The temperature input is an active circuit that measures a negative temperature coefficient (NTC) thermistor, which is directly proportional to motor temperature. The temperature vs. resistance polynomial can be configured through HiDS.

Communications Interface
Communication busses, or networks, are the main User Interface with the Scorpion in an end application. Networking has been emphasized in the communication interface to the Scorpion, which uses CAN Bus for motor control. CAN Bus is ideal for real-time embedded networking – it has been proven to be stable and robust, as well as flexible. (For RS-422 motor control, please contact ESI.)

The Scorpion Servo Module can easily be modified through software to accept commands and report feedback, without hardware modification, using HiDS. These interfaces have a defined software protocol, and provide the user with complete flexibility in controller configuration, commands, and feedback.

The CAN physical interface is compliant to the ISO 11898-2 specification, with a maximum data rate of 1 Mbps for a bus length of up to 40 meters, and meets the extended common mode range of -7 to +12 V.

Note: for maximum system flexibility, no internal CAN bus 120 ohm-termination is provided (so the User must provide them, as required – refer to the Typical Scorpion Application diagram on page 1). This can be added in the wire harness. (During development, a DB9 connector version is available from Gridconnect as Part Number GC-CAN-TERM-GC) The RS-422 physical interface is compliant to the TAI/EIA-422-B specification, is capable of a 1 Mbps data rate, and is short circuit protected from -7 V to +12V.
USB is compliant to USB 2.0 and can be also used to reprogram internal flash memory (a Flash update program is provided).

HiDS Software Tool
Host Interface for Drive/Servo Controller (HiDS) is ESI Motion's motor controller software tool which features a configurable, user-friendly GUI, with integrated oscilloscope feature and enhanced data collection capability. The HiDS functions can be accessed via the CAN interface, or in an analog fashion, for legacy systems.
For more on HiDS, please see page 10. HiDS and its related User's Manual can be downloaded from ESI Motion's website at:
https://www.esimotion.com/support/downloads/

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

System (Service) Interface

The System / Service interface includes low-level voltage input (V_{LOGIC}), and several discrete I/O signals.

The V_{LOGIC} 5VDC Input is required to power the internal electronics.

The Scorpion provides the following software-controlled, LVTTL (3.3V-level) output "Command" signals, which are used in conjunction with external hardware:

- Brakes Command
- Regeneration Command
- Inrush (Precharge) Command
- Discharge Command

See the Signal and Voltages Descriptions Table (page 12) for details.

Analog input signal V_{BUS}_Pre-inrush is an analog voltage input for monitoring the DC Bus Voltage, measured prior to the Inrush hardware. This analog input needs to be scaled between 0 to 5V.

Digital I/O, Analog Inputs, and Analog Test Point Output signals can be configured by ESI Motion's "HiDS" motor controller software tool for test control, test inputs or status functions (see page 10). In Control Mode, the signal may be used to give the Scorpion Servo Module a torque or velocity command. In Test Mode, the signal may be used to inject a test signal into the system.

The Digital I/O is a LVTTL (3.3V-level) discrete that can be configured via the HiDS software and is ESD protected to 2kV.

The two analog inputs can be mapped to various control parameters, and have a differential voltage input range of
$\pm$ 10 V. One use of an analog input is the Command for Motor, which is mapped and scaled through software configuration, to the motor current or velocity control loop. This analog input is provided to support legacy analog systems – ESI recommends the use of a serial command (CAN strongly preferred) on new implementations.

The user may use HiDS to setup the four analog test points for monitoring. The voltage range on the analog test points is from -3V to +3V (buffered with a 50 Ohm series resistor.)

Mechanical Interface

The Scorpion Servo Module is designed to be mated to a carrier printed circuit board (PCB). Connectors J1 and J2 are designed to be mated with connectors on the PCB, and the Power Input and Motor Power Output pins are designed to be soldered to the PCB

The Scorpion module has an integrated heat sink, which is located opposite to the motor pins and connectors. The integrated heat sink is designed to be used alone, without any external heat sink mass, for motor currents, up to 5A. Care must be taken when using the Scorpion module for high-power applications. Motor currents greater than 5A will require an external heat sink. Proper heat sinking practices should be followed.

See page 23 for drawings representing Scorpion installation on customer boards.
Headers J1 and J2 can be soldered directly to the PCBA or mated with Samtec part number CLP-120-02-F-D-TR. The mating height for J1 and J2 to the Samtec mate is 0.14". The length of the "spade" pins will accommodate either configuration. If PCBA area is at a premium, the use of mating connectors for J1 and J2 will allow the user to place low-profile components underneath the Scorpion Module.

Scorpion I/O Board Option

The Scorpion Servo Drive Module is designed to mount to a PCBA. The Scorpion Servo Drive Module can be purchased with an ESI-furnished I/O Board, designed to be used for initial system development and software integration. Please refer to ESI Document 101578-00, *I/O Board for the Scorpion Servo Module* for more information (available from ESI Motion's website at: https://www.esimotion.com/support/downloads/).
To specify inclusion of the I/O Board, add the "-I" to the part number, as explained in Ordering Information on page 24. An image of the I/O Board, mounted on the Scorpion, is included in the Mechanical Diagrams section.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

ESI Motion's HiDS Application

The Host Interface for Drive/Servo Controller (HiDS) is ESI Motion's servo motor controller software tool.

This innovative application allows users to configure a servo motor control system quickly, and with a great deal of flexibility. It's based upon a configurable, user-friendly GUI, with an integrated oscilloscope feature. Extensive data collection and control allows system tuning and troubleshooting.

On Scorpion, the HiDS functions can be accessed via a CAN (strongly recommended) or USB. HiDS and the Controller User's Manual can be downloaded from ESI Motion's website at: https://www.esimotion.com/support/downloads/

ESI's motion control products employ industry-standard current-loop, velocity-loop, and in some applications, a position-loop. Each of these control loops utilizes proportional, integral, and derivative (PID) error correction to achieve the desired performance. The Controller User's Manual includes a procedure for tuning each control loop to match the intended application. After the tuning is completed, additional initial configuration using feedback is described in detail.

The Controller User's Manual walks you through the steps to set up limits, enter motor parameters, and tune the motor using the desired loop configuration. An excerpt from the summary tab shown below is an example view of key device configuration parameters:
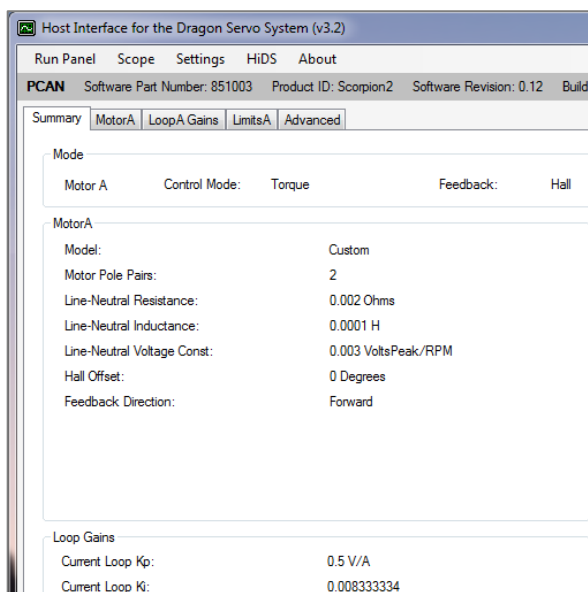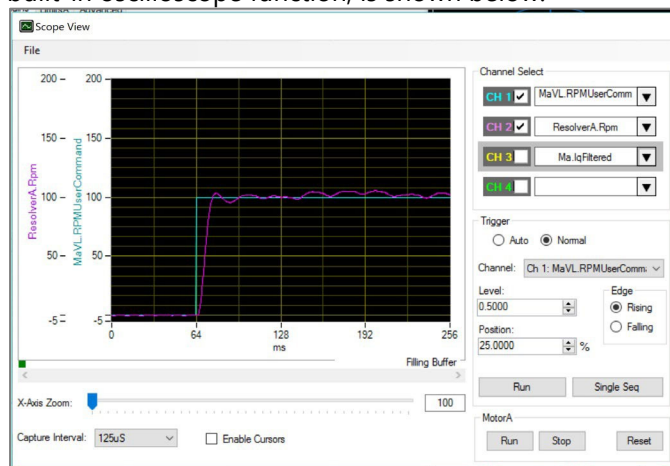

HiDS allows extreme flexibility via simply changing parameters, without the need to reload custom software.

The HiDS Run Panel facilitates control commands and monitoring of parameters such as motor speed and current:

A typical velocity-loop step response, displayed on the built-in oscilloscope function, is shown below:

The design of the ESI Motion Scorpion Servo Module and HiDS tool allow for tremendous flexibility and capabilities in motor control and monitoring, to ensure success of the most challenging motion control applications.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Built-In Protection

The Scorpion Servo Drive Module includes the following protection. For details, please refer to the ESI Motion Controller User's Manual.

Over Current

The Scorpion Servo Drive Module's motor phase current is continuously monitored and when the current on any phase exceeds the over current limit, (typically set at 1.25 * peak current), the servo drive module will disable itself. The servo drive module can only be re-enabled when the fault is removed and the fault state cleared.

Over Voltage

The Scorpion Servo Drive Module's bus voltage is continuously monitored and when the V_{BUS} exceeds the over-voltage limit for motor or the servo drive module, (whichever is lower), the servo drive module will disable itself. The servo drive module can only be re-enabled when the fault is removed and the fault state cleared.

Over Temperature

The Scorpion Servo Drive Module has sensors that monitor the processor temperature, as well as the motor power driver sections. Software will alert the User with a warning, if the temperature nears the critical level, and is programmed to shut itself off, or shut down the power driver section, if the temperature reaches the critical level. The servo drive module can only be re-enabled when the fault is removed and the fault state cleared.

ESD and Short Circuit Protection

As described in I/O Characteristics on page 4, the Scorpion I/O signals are ESD protected, and communications busses are short circuit protected.

Other Built-In Protection

The Scorpion Servo Drive Module has other protection including Built-In Test (BIT), Motor Over-Temperature sensing from a user-provided thermistor, Motor Over-Speed, Bus Under-Voltage, Motor Loss of Feedback, and I-squared-T (I^2T) protection, which is an estimate of the energy content in current transient conditions, used to protect against motor overheating. The servo drive module can only be re-enabled when the fault is removed and the fault state cleared.

Powering Up

The Scorpion Servo Drive Module has two voltage sources, Bus Voltage (V_{BUS}) and Controller Voltage (V_{LOGIC}). The bus voltage should be set to a voltage below the V_{BUS} level shown on page 4. If the Absolute Maximum Voltage (page 3) is exceeded, software will trigger a bus over-voltage fault, and disable the servo drive.

V_{LOGIC} should be set to +5V +/- 10%. V_{BUS} and V_{LOGIC} voltages can be applied to the servo drive in either order. When the controller voltage is applied to the servo drive, the configuration of the module is read and voltage and current limits are set to their default values.

Initializing the System

The Scorpion Servo Drive Module will remain disabled until it receives a command to enable and no system faults are active. If the servo drive module is disabled, due to a system fault, the system fault or faults must be resolved and a reset command sent to servo drive module prior to another enable command. The ESI Motion Controller User's Manual provides the additional information necessary to successfully configure and run the Scorpion Servo Drive Module.

Signal and Voltage Descriptions

For further details using Digital and Analog I/O, please refer to the Controller User's Manual, downloadable from ESI Motion's website at: https://www.esimotion.com/support/downloads/

For electrical characteristics, see the Recommending Operating Conditions and Absolute Maximum Values Tables.

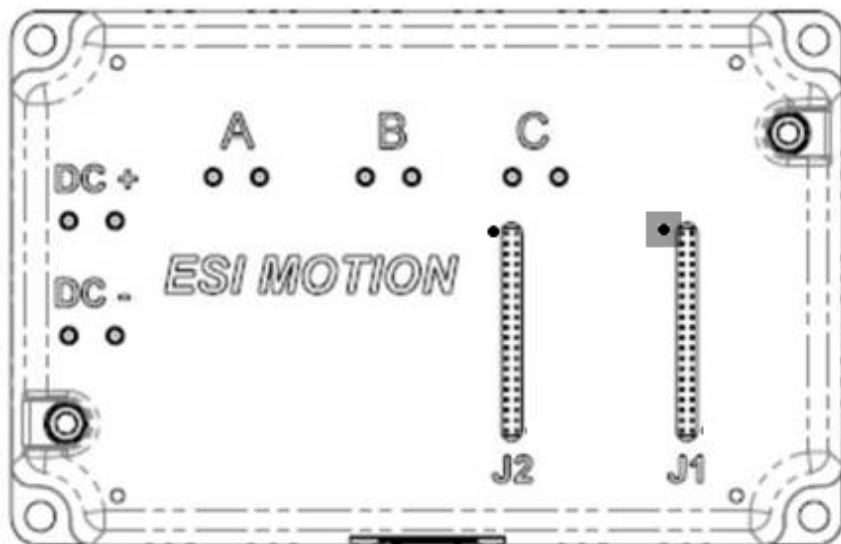| Name	I/O	Description
V_{BUS}	I	V Bus Input power, potentially High Voltage and/or High Current, which is converted to Motor Power.
V_{LOGIC}	I	Logic Voltage inputs (nominal 5VDC), required to run internal electronics. The feedback power source (for Encoder, Hall or BiSS-C sensors) can be either the same 5V for the controller, or another supply, however they must share a common ground.
Motor Phase A/B/C	O	3-phase output power to the motor.
Brake Command	O	3.3V-level (LVTTL) output which can be used to engage or disengage an external brake circuit. The user is required to implement the external brake circuit (e.g., using a MOSFET switch). When the logic level is high, the brake is assumed to be engaged -- the MOSFET switch is open and no current is flowing through the brake coil.
Regeneration Command	O	3.3V-level (LVTTL) output which commands external circuitry to switch V_{BUS} to a load resistor, when the bus voltage exceeds a software configurable limit, to avoid an over-voltage condition. The duty cycle and duration of the Regeneration discrete is also configurable through software.
Inrush (Precharge) Command	O	3.3V-level (LVTTL) output can be used to control an external switch that will slow the RC rise time of the bus voltage as it charges the capacitor bank during power up, thus protecting from damage due to an abrupt voltage change when connecting Motor Power to a motor. When the bus voltage reaches a software configurable limit, the Inrush discrete will switch off.
Discharge Command	O	3.3V-level (LVTTL) output used, with an external circuit, to discharge the bus voltage capacitor bank, during power down, safely removing power from the system in a timely fashion.
V_{BUS}_Pre-inrush	I	Analog voltage input for monitoring the DC Bus Voltage, measured prior to the Inrush switch hardware. This analog input needs to be scaled between 0 to 5V.
CAN +/-	I/O	CAN Bus main communication: commands and status (highly recommended for motor control)
USB D+/-	I/O	Universal Serial Bus Data main communication: commands and status (For USB motor control, please contact ESI.)
RS-422 TX/RX+/-	I/O	Serial bus main communication: commands and status (For RS-422 motor control, please contact ESI.)
HSSB	I/O	High-Speed Serial Bus: reserved for customer-specific applications
SCI	I/O	Serial Communication Interface: reserved for customer-specific applications
Analog In X+/-	I	Differential Analog Input. These flexible signals are typically used as the input command source (current command, velocity command, or position command). Note that ESI recommends using one of the digital main communication interfaces for commands whenever possible. The analog input is provided for backwards combability with legacy systems.
Analog Test Point X	O	Analog Test Point Output. Used with HiDS, these flexible signals are used to output status for many possible selections, including for display on the HiDS oscilloscope feature. Referenced to Analog Reference.
Digital Input / Output	I/O	The Digital I/O are 3.3V-level (LVTTL), software-configurable input or output pins and can be mapped to various system events. Depending on configuration, several other Digital I/O signals may be available (contact ESI Motion for further information). See the HiDS Controller User's Manual for more information.

Name	I/O	Description
Motor Temp. +/-	I	Two-wire interface for a PTC thermistor.
Resolver X Excitation+/-	O	Resolver Excitation outputs (reference signal to a resolver)
Resolver X Sin/Cos+/-	I	Resolver inputs provide motor position information
Encoder X A/B/I	I	Encoder inputs provide motor position information. **NOTE:** When Encoder feedback is not used, these six digital signals may be used as additional differential digital inputs. Refer to the ESI Controller User's Manual for further information.
Hall X A/B/C	I	Hall Effect Encoder inputs provide motor position information. **NOTE:** When Hall feedback is not used, these signals may be used as Open Collector inputs. Refer to the ESI Controller User's Manual for further information.

Notes:
1. For signals with multiple instances (including Feedback A and B), "X" is used in this table.
2. Suffix "+/-" indicates differential pair

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Connection Locations

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

ELECTRICAL INTERFACES

Connector Pinouts

V$_{BUS}$ Power In Pin Assignments

V$_{BUS}$ Power and Return are provided by "nail" pins (2 each). Chassis Ground is provided by the mounting holes.
For part numbers, see connector chart on page 6
For locations, see diagrams on page 14. See also Mechanical Drawings, for physical details.

NAME	I/O	DESCRIPTION	TYPE
V$_{BUS}$_IN [1]	IN	Bus Voltage, (V$_{BUS}$), Voltage DC In	DC Bus Voltage Input
V$_{BUS}$_RTN [1]	IN	Bus Voltage Return	DC Bus Return

Notes:
1. Two V$_{BUS}$_IN and two V$_{BUS}$_RTN pins are provided.
2. Chassis Ground connections provided via the four mounting holes.

Motor Phase Power Out Pin Assignments

Motor Phase Power Outputs are provided by "nail" pins (2 per phase, for a total of six).
For part numbers, see connector chart on page 6
For locations, see diagrams on page 14. See also Mechanical Drawings, for physical details.

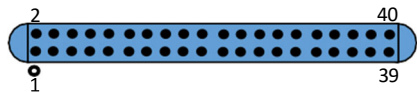| NAME	I/O	DESCRIPTION	TYPE
A_MA [1]	OUT	Motor A Phase A	Motor Power
B_MA [1]	OUT	Motor A Phase B	Motor Power
C_MA [1]	OUT	Motor A Phase C	Motor Power

Notes:
1. Two pins are provided for each phase.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

J1 Pin Assignments

View looking into chassis pins (dot indicates Pin1)

J1 Connector is a 40-pin connector, with pin assignments are shown below.
For part numbers, see connector chart on page 6
For location, see diagrams on page 14. See also Mechanical Drawings.

J1 PIN	NAME	I/O	DESCRIPTION	TYPE
1	ANALOG_IN_2+ (CMD+_MB)	IN	Analog In 2 (+), *can be used as* Command Positive Motor B	Analog Input
2	ANALOG_IN_2- (CMD-_MB)	IN	Analog In 2 (-), *can be used as* Command Negative Motor B	Analog Input
3	SIN+_MB	IN	Resolver Sin Positive Motor B	Resolver
4	SIN-_MB	IN	Resolver Sin Negative Motor B	Resolver
5	COS+_MB	IN	Resolver Cos Positive Motor B	Resolver
6	COS-_MB	IN	Resolver Cos Negative Motor B	Resolver
7	EXE+_MB	OUT	Resolver Excitation Positive Motor B	Resolver
8	EXE-_MB	OUT	Resolver Excitation Negative Motor B	Resolver
9	A+_MB *or* BISS_CLK+_MB	IN/ OUT	Digital Encoder B Positive / BiSS-C Clock Positive Motor B	Encoder / RS-422
10	A-_MB *or* BISS_CLK-_MB	IN/ OUT	Digital Encoder B Negative / BiSS-C Clock Negative Motor B	Encoder / RS-422
11	B+_MB	IN	Digital Encoder B Positive Motor B	Encoder
12	B-_MB	IN	Digital Encoder B Negative Motor B	Encoder
13	I+_MB *or* BISS_DATA+_MB	IN/ IN	Digital Encoder I Positive / BiSS-C Data Positive Motor B	Encoder / RS-422
14	I-_MB *or* BISS_DATA-_MB	IN/ IN	Digital Encoder I Negative / BiSS-C Data Negative Motor B	Encoder / RS-422
15	HALL_A_MB	IN	Hall A Motor B	Hall Encoder
16	HALL_B_MB	IN	Hall B Motor B	Hall Encoder
17	HALL_C_MB	IN	Hall C Motor B	Hall Encoder
18	DIGITAL_REF	---	Digital Reference	Digital Ref.
19	MOTOR_TEMP+_MB	IN	Temperature Positive Motor B	Temp. Sensor
20	MOTOR_TEMP-_MB	IN	Temperature Negative Motor B	Temp. Sensor
21	V_{LOGIC}	IN	V_{LOGIC} (+5V) Input	Low Voltage In
22	V_{LOGIC}_RTN	IN	V_{LOGIC} Return	Low Voltage Rtn
23	Reserved	---	Reserved	No Connect
24	Reserved	---	Reserved	No Connect
25	Reserved	---	Reserved	No Connect
26	Reserved	---	Reserved	No Connect
27	Reserved	---	Reserved	No Connect

This document does not contain Technical Data or Technology as defined the ITAR Part 120.10 or EAR Part 772

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

J1 PIN	NAME	I/O	DESCRIPTION	TYPE
28	Reserved	---	Reserved	No Connect
29	Reserved	---	Reserved	No Connect
30	Reserved	---	Reserved	No Connect
31	BRAKE_MA	OUT	Brake Command Motor A	Digital Out
32	Reserved	---	Reserved	No Connect
33	REGEN	OUT	DC Bus Voltage Regeneration Command	Digital Out
34	INRUSH	OUT	DC Bus Voltage Inrush (Precharge) Command	Digital Out
35	DISCHARGE	OUT	DC Bus Voltage Discharge Command	Digital Out
36	VBUS_PRE_INRUSH	IN	DC Bus Voltage Monitor Prior to Inrush	Analog In
37	SCI_TX	OUT	Serial Communication Interface (SCI) Transmit	SCI
38	SCI_RX	IN	Serial Communication Interface (SCI) Receive	SCI
39	Reserved	---	Reserved	No Connect
40	Reserved	---	Reserved	No Connect

Notes:
1. Differential pairs are indicated by "+/-". Twisted pairs should be used in wire harness.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

J2 Pin Assignments (see also Connector Chart on page 5)
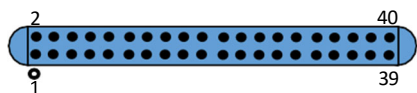
View looking into chassis pins (dot indicates Pin1)

J2 Connector is a 40-pin connector, with pin assignments are shown below.
For part numbers, see connector chart on page 6
For location, see diagrams on page 14. See also Mechanical Drawings.

J2 PIN	NAME	I/O	DESCRIPTION	TYPE
1	ANALOG_IN_1+ (CMD+_MA)	IN	Analog In 1 (+), *can be used as* Command Positive Motor A	Analog Input
2	ANALOG_IN_1- (CMD-_MA)	IN	Analog In 1 (-), *can be used as* Command Negative Motor A	Analog Input
3	SIN+_MA	IN	Resolver Sin Positive Motor A	Resolver
4	SIN-_MA	IN	Resolver Sin Negative Motor A	Resolver
5	COS+_MA	IN	Resolver Cos Positive Motor A	Resolver
6	COS-_MA	IN	Resolver Cos Negative Motor A	Resolver
7	EXE+_MA	OUT	Resolver Excitation Positive Motor A	Resolver
8	EXE-_MA	OUT	Resolver Excitation Negative Motor A	Resolver
9	A+_MA *or* BISS_CLK+_MA	IN/ OUT	Digital Encoder A Positive / BiSS-C Clock Positive Motor A	Encoder / RS-422
10	A-_MA *or* BISS_CLK-_MA	IN/ OUT	Digital Encoder A Negative / BiSS-C Clock Negative Motor A	Encoder / RS-422
11	B+_MA	IN	Digital Encoder B Positive Motor A	Encoder
12	B-_MA	IN	Digital Encoder B Negative Motor A	Encoder
13	I+_MA *or* BISS_DATA+_MA	IN/ IN	Digital Encoder I Positive / BiSS-C Data Positive Motor A	Encoder / RS-422
14	I-_MA *or* BISS_DATA-_MA	IN/ IN	Digital Encoder I Negative / BiSS-C Data Negative Motor A	Encoder / RS-422
15	HALL_A_MA	IN	Hall A Motor A	Hall Encoder
16	HALL_B_MA	IN	Hall B Motor A	Hall Encoder
17	HALL_C_MA	IN	Hall C Motor A	Hall Encoder
18	DIGITAL_REF	---	Digital Reference	Digital Ref.
19	MOTOR_TEMP+_MA	IN	Temperature Positive Motor A	Temp. Sensor
20	MOTOR_TEMP-_MA	IN	Temperature Negative Motor A	Temp. Sensor
21	V_{LOGIC}	IN	V_{LOGIC} (+5V) Input	Low Voltage In
22	V_{LOGIC}_RTN	IN	V_{LOGIC} Return	Low Voltage Rtn
23	RS422_TX+	OUT	RS422 Transmit Positive	RS-422
24	RS422_TX-	OUT	RS422 Transmit Negative	RS-422
25	RS422_RX+	IN	RS422 Receive Positive	RS-422
26	RS422_RX-	IN	RS422 Receive Negative	RS-422
27	CAN+	I/O	CAN High	CAN
28	CAN-	I/O	CAN Low	CAN
29	USB_D+	I/O	USB Data Positive	USB 2.0
30	USB_D-	I/O	USB Data Negative	USB 2.0

J2 PIN	NAME	I/O	DESCRIPTION	TYPE
31	ANALOG_REF	---	Analog Reference	Analog Ref.
32	DIG_IO	I/O	Digital Input / Output	Digital In / Out
33	HSSB_TX_CLK	OUT	High Speed Serial Bus Transmit Clock	HSSB
34	HSSB_RX_CLK	IN	High Speed Serial Bus Receive Clock	HSSB
35	HSSB_TX_SYNC	OUT	High Speed Serial Bus Transmit Sync	HSSB
36	HSSB_RX_SYNC	IN	High Speed Serial Bus Receive Sync	HSSB
37	HSSB_TX_DATA	OUT	High Speed Serial Bus Transmit Data	HSSB
38	HSSB_RX_DATA	IN	High Speed Serial Bus Receive Data	HSSB
39	BUF_ATP1	OUT	Analog Test Point 1	Analog Out
40	BUF_ATP2	OUT	Analog Test Point 2	Analog Out

Notes:
1. Differential pairs are indicated by "+" and "-". Twisted pairs should be used in wire harness.
2. Depending on configuration, several other Digital I/O signals may be available (contact ESI Motion for further information.

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Thermal

Max. Case Temperature

The maximum operating case temperature is +71°C.

Thermal Conductivity Data

The Scorpion Servo Drive Module thermal resistance was measured from component junction to the heat sink base plate. Refer to Thermal Resistance Table below.

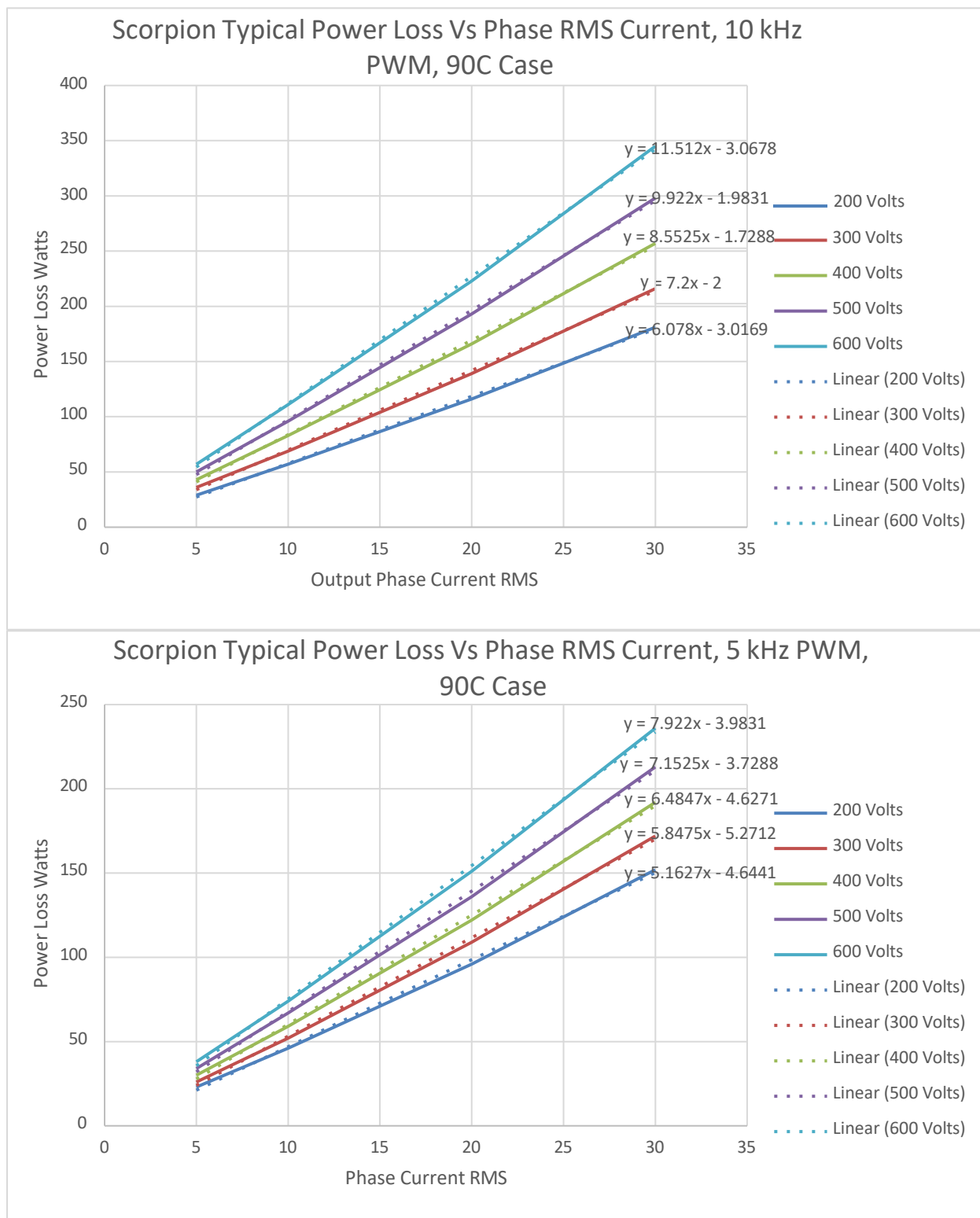| Symbol	Description	°C/W
Tjb	Theta Junction to Base Plate	TBD

Thermal Resistance

Heat Sink Interface Materials

If a heat sink is needed, effective coupling of the Scorpion base plate to the heat sink is essential for optimum heat transfer. Depending on the operating current and the amount of heat dissipated, various methods are available to achieve a good thermal bond. The Thermal Interface Compounds table below shows examples of thermal interface compounds which can be used with the Scorpion Servo Drive Module.

Thermal Interface Compound	Supplier	Part Number	Thermal Conductivity	Operating Temperature
Phase Change	Aavid Thermalloy	100300F00000G	0.79 W/(m-°C)	-40°C to 200°C
Gap Pad	Bergquist	GP1500	1.5 W/(m-°C)	-60°C to 200°C
Thermal Grease	Aavid Thermalloy	100100F00000G	0.73 W/(m-°C)	-40°C to 200°C

Thermal Interface Compounds

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Power Loss Curves

Scorpion Typical Power Loss Vs Phase RMS Current, 10 kHz PWM, 90C Case

y = 11.512x - 3.0678
y = 9.922x - 1.9831
y = 8.5525x - 1.7288
y = 7.2x - 2
y = 6.078x - 3.0169

Scorpion Typical Power Loss Vs Phase RMS Current, 5 kHz PWM, 90C Case

y = 7.922x - 3.9831
y = 7.1525x - 3.7288
y = 6.4847x - 4.6271
y = 5.8475x - 5.2712
y = 5.1627x - 4.6441

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Mechanical Diagrams

All dimensions are in inches.

Scorpion

0.062

0.010

(1.68)

RECOMMENDED MOUNTING HARDWARE
⌀ .250" OD X 1.70" LONG SPACER

3.75

⌀ 0.105 TYP.

2.30

CUSTOMER FURNISHED PCB

⌀ 0.024 MIN.TYP.

0.50 Typ.

4x ⌀ 0.144
PCB ONLY

0.50 Typ.

CUSTOMER FURNISHED
⌀ 0.250 OD X 1.70 LG
AL OR SS SPACERS OR EQUIV
& MOUNTING FASTENERS (4 PLS)
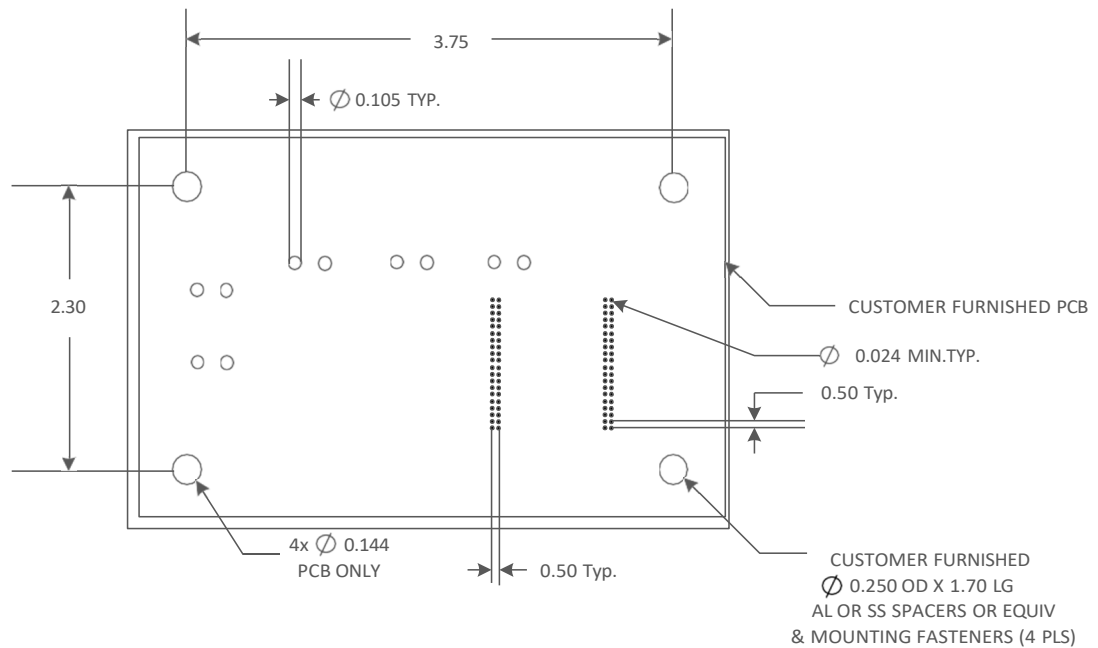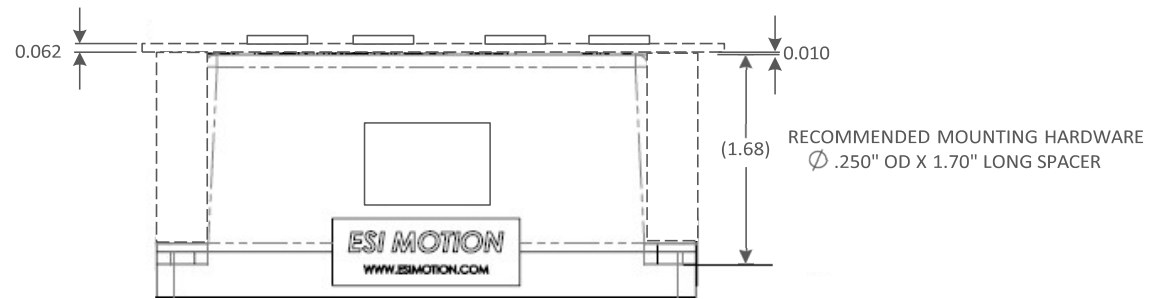
All dimensions are in inches.

Scorpion with typical customer-furnished PCB & Hardware Installed

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

Mechanical Diagrams: Scorpion with Optional I/O Board Installed

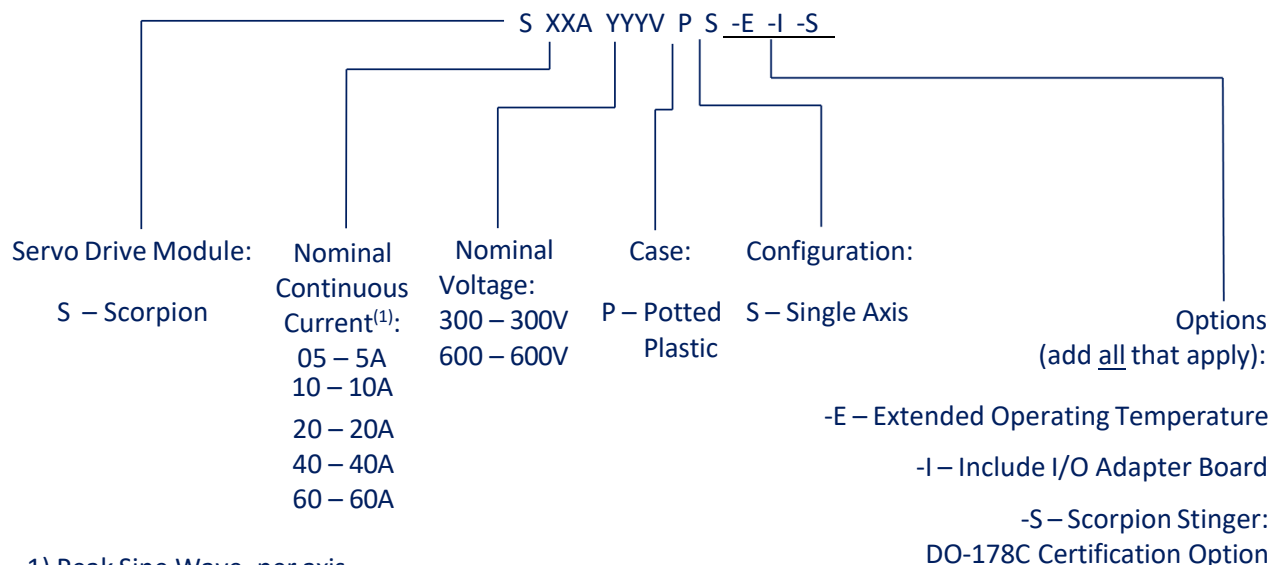The figures below depict the Scorpion with the optional Scorpion I/O Board mounted on it, with connectors indicated.

All dimensions are in inches.
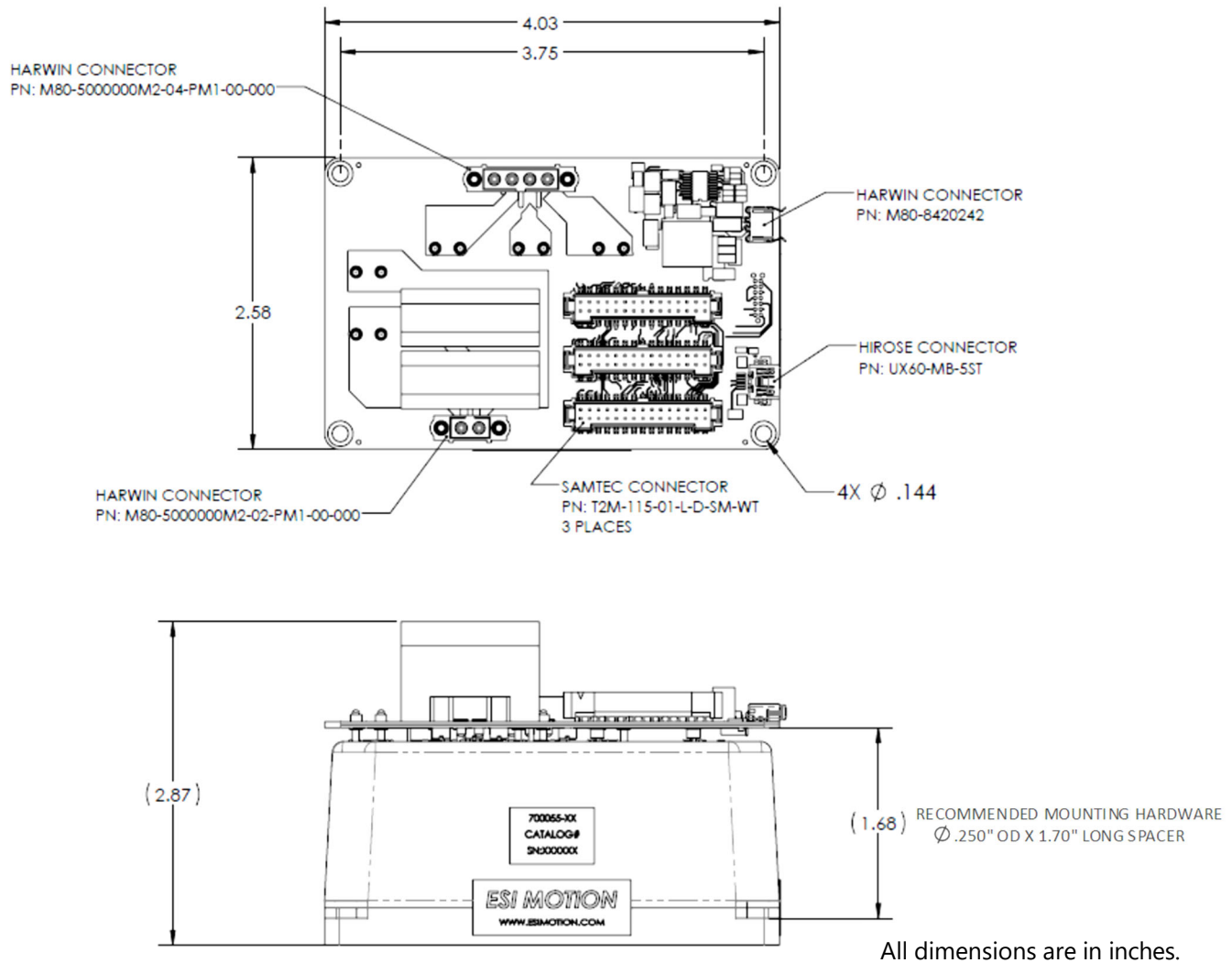
Scorpion with I/O Board Installed

2250-A Union Place, Simi Valley, CA 93065
Tel: 800.823.3235 – sales@esimotion.com
www.esimotion.com   Product of USA

ESI MOTION™

Ordering Information

S XXA YYYV P S -E -I -S

Servo Drive Module:

S – Scorpion

Nominal Continuous Current[1]:
05 – 5A
10 – 10A
20 – 20A
40 – 40A
60 – 60A

Nominal Voltage:
300 – 300V
600 – 600V

Case:

P – Potted Plastic

Configuration:

S – Single Axis

Options (add all that apply):

-E – Extended Operating Temperature

-I – Include I/O Adapter Board

-S – Scorpion Stinger: DO-178C Certification Option

1) Peak Sine Wave, per axis

Example:
Part Number   S40A300VPS-E-I-S
Servo Drive Module: Scorpion
Continuous Current: 40A
Nominal Voltage: 300VDC
Case: Potted Plastic
Configuration: Single-Axis

Options:
Extended Operating Temperature
Include I/O Adapter
Scorpion Stinger: DO-178C Certification

Model Availability List
The following tables lists available models (options available on all models):

Single Axis:

Continuous Current	300V	600V
60A	**S60A300VPS**	**S60A600VPS**
40A	**S40A300VPS**	**S40A600VPS**
20A	S20A300VPS	**S20A600VPS**
10A	**S10A300VPS**	S10A600VPS
5A	S05A300VPS	**S05A600VPS**
	300V	600V

Voltage

Notes:
1. Standard Products are shown in bold, and have expedited lead times.