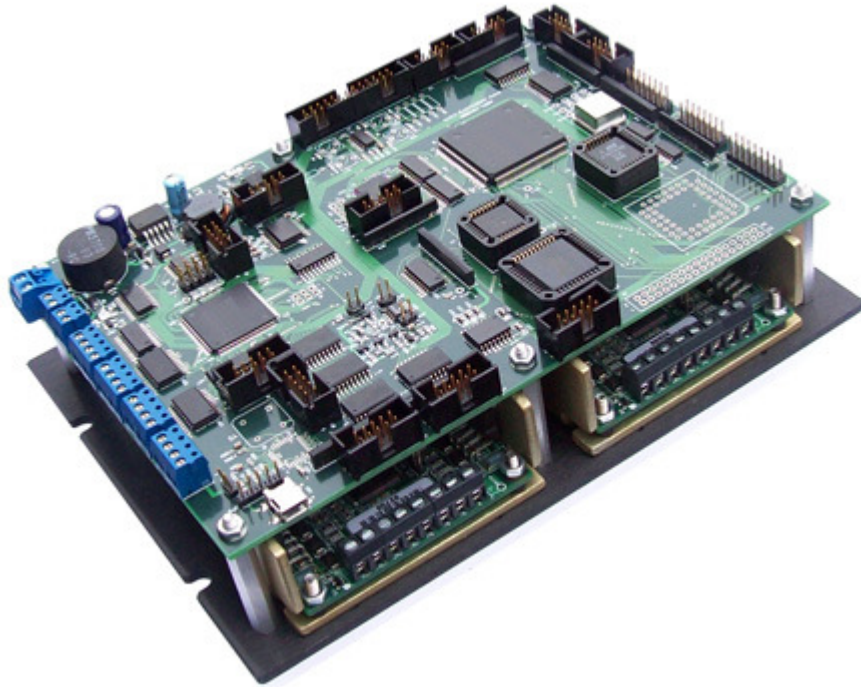


ICAD Series Reference Manual



Integrated Motion Controller and Driver



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The **programmable ICAD** series of motion controllers is **stand-alone or externally controlled, easy-to-use** and **cost effective** solutions for motion control applications.

Each module includes the **stepper motor controller**, and the **micro-stepper** and/or **servo motor drivers**.

This series supports up to 4 axes of motion, 16 CMOS / TTL inputs, 16 CMOS / TTL outputs, 3 analog inputs, and up to five optical encoder inputs. The command port is provided for stand-alone operation.

The module may be controlled in different ways;

1) **Stand-alone**

In this mode, the controller does not need an external device such as a PC to operate. The controller is programmed in a simple programming language. The code is developed, downloaded to the controller, run and saved in the controller's non-volatile memory using the supplied Integrated Development Environment (IDE) software.

2) **Externally Controlled**

In this mode, the external host such as a PC, micro-controller or PLC sends a series of commands to the controller via the RS-232 serial port. The controller processes and performs the incoming commands and responds with proper messages.

3) **Control Panel**

The supplied user friendly Control Panel software allows the user to set-up the system quickly. The operator is able to move the mechanism to different positions by pressing the corresponding buttons of the Control Panel or by using the joystick and/or trackball.

The system can also be operated using an analog joystick or a trackball. The speed of the motor is proportional to the tilt angle of the joystick or the rotational speed of the trackball.

Features

- Compact
- Plug-and-Play
- Quick and Easy to Install
- Very Compact and Easy to Use
- Low Power Consumption, High Torque Motors, High Speed Capability
- Easy Programming Language, No Compiler or Assembler Required
- Programmable, Teachable or Manual Control
- Different Modes of Operation:
 - 1) Host Controlled
 - 2) Stand-alone, No PC Required to Operate
 - 3) Joystick / Trackball Controlled
- Optical Encoder Feedback
- Optional Keypad and LCD Display

DC and Three Phase Brushless Motor Driver

- Up to 15 Amps Phase Current
- +18 VDC to up to +80 VDC Power Supply
- LED Fault Indicator

Stepper Motor Driver

- Up to 7A Phase Current
- +12 VDC to +80 VDC Power Supply
- 2 to 256 Micro-steps per Step Resolution
- Size 11 To 42 Motors
- Auto Current Reduction
- LED Power Indicator

Typical Applications

- Automated Assembly Systems
- CNC Machines
- Inspection Systems
- Linear and Rotary Stages
- Machine Tools
- Medical Devices
- Pan-Tilt Gimbals
- PCB Assembly or Inspection
- Pick and Place
- Positioning Tables
- Scanner
- Time-lapse Photography

TECHNICAL DATA

Modes of Motion

- Point-to-Point Positioning
- Jogging

Supported No. Of Axes

- Up to 4 Axes

Range of Motion Parameters

- Position: +/- 2147483648 Steps
- Velocity: 200 - 200 KHz Step Rate
- Acceleration: 40,000 - 40 Million Steps / sec²

Communication Interface

- RS-232 Interface

Software

- Easy System Setup and Evaluation
- Menu Driven

Power Requirement

- +5 VDC **or** +7.5 to +40 VDC
- 2 Watts Power Consumption

Dedicated Inputs

- Positive and Negative Limit Switches per Axis
- Home Switch per Axis
- CONTINUE, END, RUN, STOP, and UPLOAD-and-RUN for Stand-alone Mode Operation

Dedicated Outputs

- Status LED Output

General Purpose Digital Input / Output

- Up to 32 TTL / CMOS Inputs
- Up to 16 TTL / CMOS Outputs
- Up to Four Optical Encoder Inputs

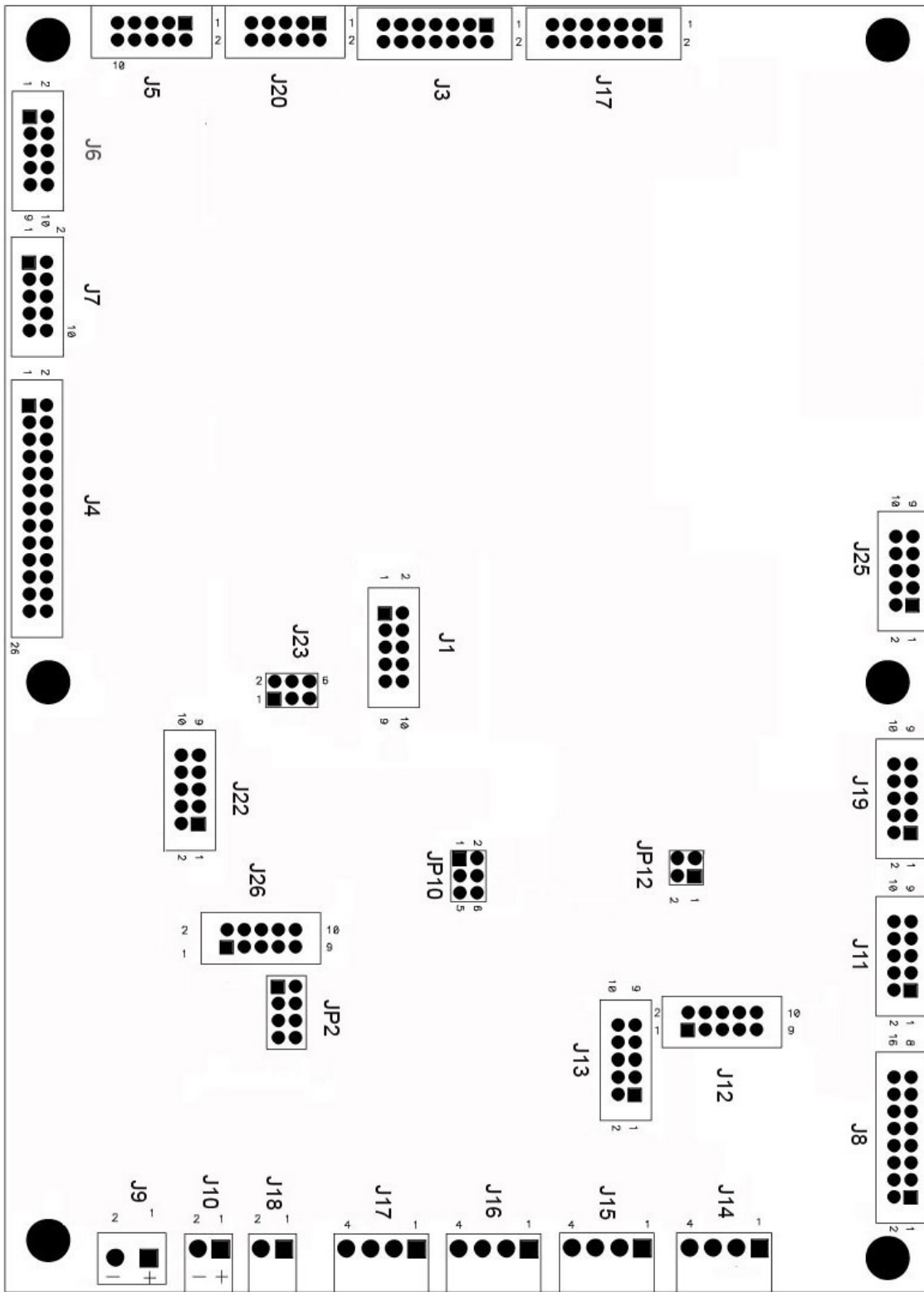
General Purpose Analog Input

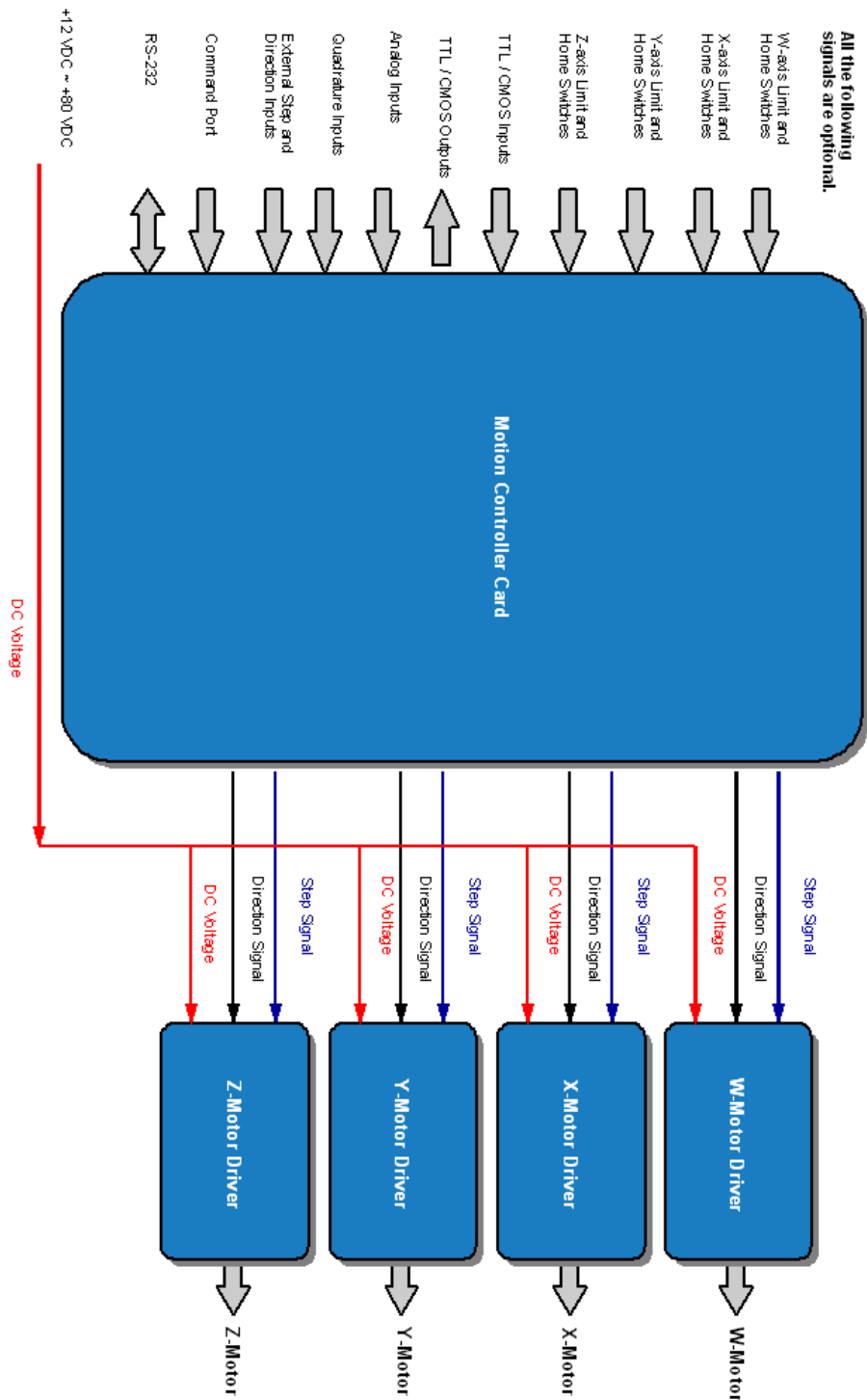
- 4 Inputs
- 10 Bits of Resolution
- Adjustable Gain

Memory

- 22 General Purpose Variables, 32 Bits of Resolution

Connections

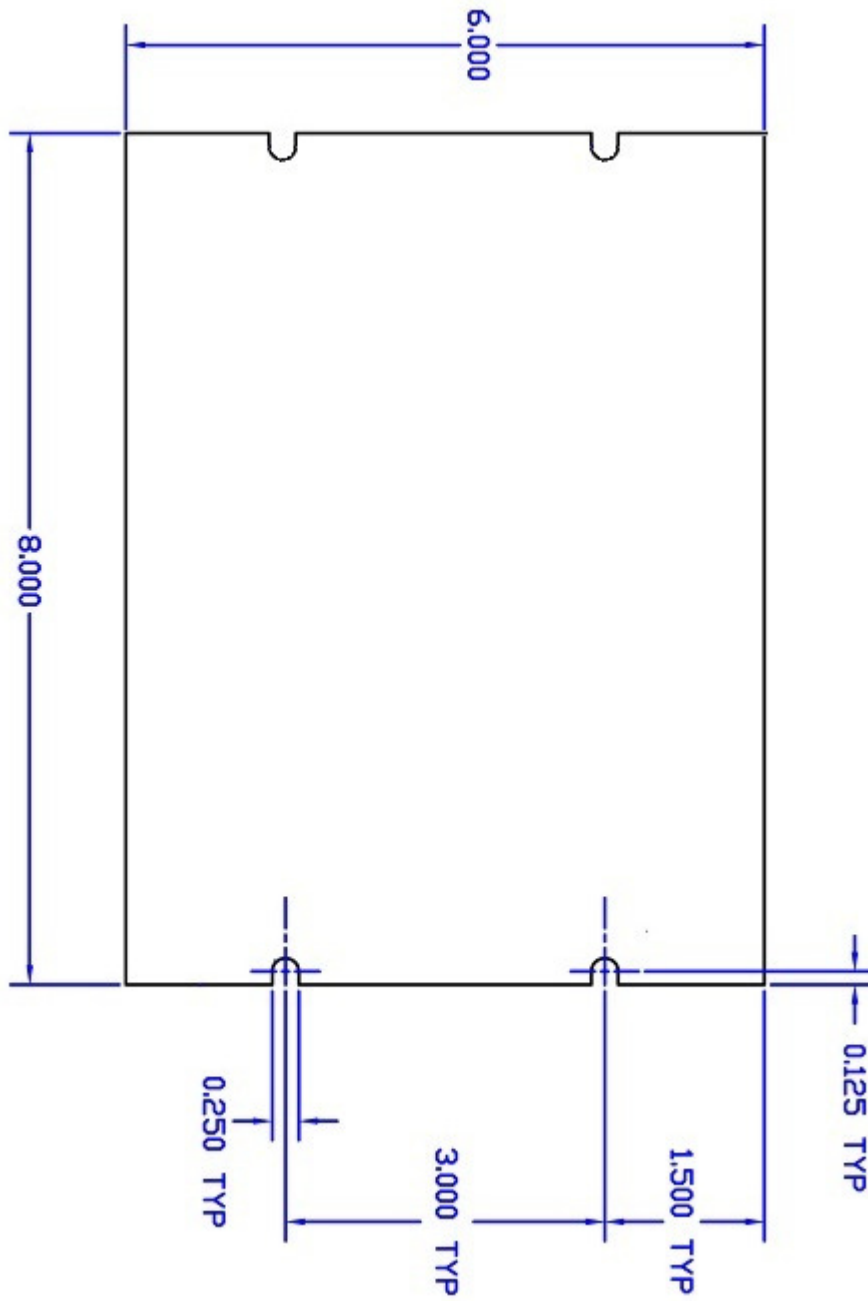




ICAD Series of Motion Controllers Block Diagram

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Mechanical Specifications



Pin Assignment and Description

J10, +5 VDC Input / Output

Screw Terminal Type

PIN	NAME	DESCRIPTION
1	+5 VDC	+5 VDC Input @ 400 ma
2	GND	+5 VDC Return

J9, +7.5 to +40 VDC Input (Optional)

Screw Terminal Type

PIN	NAME	DESCRIPTION
1	HIGHVOLT	+7.5 to +40 VDC Input
2	HIGHVOLT-RTN	+7.5 to +40 VDC Return

Please note that that only one of the above voltages is required for operation of the module.

J18, Status LED Output

Screw Terminal Type

PIN	NAME	DESCRIPTION
1	+5 VDC	+5 VDC Output
2	STATUS-LED	Status LED Output Open Collector

J5, X-Axis Limit and Home Switch Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	POS-LIMIT-X *	Positive Limit Switch Input, Active High
2	+5 VDC	+5 VDC
3	GND	+5 VDC Return
4	HOME-X **	Home Switch Input, Active High
5	+5 VDC	+5 VDC
6	GND	+5 VDC Return
7	NEG-LIMIT-X *	Negative Limit Switch Input, Active High
8	+5 VDC	+5 VDC
9	GND	+5 VDC Return
10	NC	No Connection

* A normally closed switch should be placed between this pin and GND.

** A normally closed switch should be placed between this pin and GND, if necessary.
A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J6, Y-Axis Limit and Home Switch Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	POS-LIMIT-Y *	Positive Limit Switch Input, Active High
2	+5 VDC	+5 VDC
3	GND	+5 VDC Return
4	HOME-Y **	Home Switch Input, Active High
5	+5 VDC	+5 VDC
6	GND	+5 VDC Return
7	NEG-LIMIT-Y *	Negative Limit Switch Input, Active High
8	+5 VDC	+5 VDC
9	GND	+5 VDC Return
10	NC	No Connection

* A normally closed switch should be placed between this pin and GND.

** A normally closed switch should be placed between this pin and GND, if necessary.
A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J7, Z-Axis Limit and Home Switch Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	POS-LIMIT-Z *	Positive Limit Switch Input, Active High
2	+5 VDC	+5 VDC
3	GND	+5 VDC Return
4	HOME-Z **	Home Switch Input, Active High
5	+5 VDC	+5 VDC
6	GND	+5 VDC Return
7	NEG-LIMIT-Z *	Negative Limit Switch Input, Active High
8	+5 VDC	+5 VDC
9	GND	+5 VDC Return
10	NC	No Connection

* A normally closed switch should be placed between this pin and GND.

** A normally closed switch should be placed between this pin and GND, if necessary.
A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J20, W-Axis Limit and Home Switch Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	POS-LIMIT-W *	Positive Limit Switch Input, Active High
2	+5 VDC	+5 VDC
3	GND	+5 VDC Return
4	HOME-W **	Home Switch Input, Active High
5	+5 VDC	+5 VDC
6	GND	+5 VDC Return
7	NEG-LIMIT-W *	Negative Limit Switch Input, Active High
8	+5 VDC	+5 VDC
9	GND	+5 VDC Return
10	NC	No Connection

* A normally closed switch should be placed between this pin and GND.

** A normally closed switch should be placed between this pin and GND, if necessary.
A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J4, Analog Joystick Interface (Optional)

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	ANALOG-X	Analog-X Input
2	ANALOG-W	Analog-W Input
3	ANALOG-Y	Analog-Y Input
4	ANALOG-Z	Analog-Z Input
5	HIGH-SPEED	High Speed Selection Input
6	GND	+5 VDC Return
7	MEDIUM-SPEED	Medium Speed Selection Input
8	GND	+5 VDC Return
9	LOW-SPEED	Low Speed Selection Input
10	GND	+5 VDC Return
11	SPARE	SPARE key of Joystick
12	+5 VDC	+5 VDC
13	NC	No Connection
14	+5 VDC	+5 VDC
15	NC	No Connection
16	+5 VDC	+5 VDC
17	NC	No Connection
18	NC	No Connection
19	NC	No Connection
20	NC	No Connection
21	NC	No Connection
22	NC	No Connection
23	NC	No Connection
24	NC	No Connection
25	NC	No Connection
26	NC	No Connection

J13, Discrete Output Connection (Optional)

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	OUTBIT9	Discrete Output 9
2	OUTBIT10	Discrete Output 10
3	OUTBIT11	Discrete Output 11
4	OUTBIT12	Discrete Output 12
5	OUTBIT13	Discrete Output 13
6	OUTBIT14	Discrete Output 14
7	OUTBIT15	Discrete Output 15
8	OUTBIT16	Discrete Output 16
9	GND	+5 VDC Return
10	+5 VDC	+5 VDC

All outputs are CMOS level signals, 10 mA sink and source capability, +5 VDC.

J11, Discrete Input Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	INBIT1	Discrete Input 1
2	INBIT2	Discrete Input 2
3	INBIT3	Discrete Input 3
4	INBIT4	Discrete Input 4
5	INBIT5	Discrete Input 5
6	INBIT6	Discrete Input 6
7	INBIT7	Discrete Input 7
8	INBIT8	Discrete Input 8
9	GND	+5 VDC Return
10	+5 VDC	+5 VDC

A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J12, Discrete Output Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	OUTBIT1	Discrete Output 1
2	OUTBIT2	Discrete Output 2
3	OUTBIT3	Discrete Output 3
4	OUTBIT4	Discrete Output 4
5	OUTBIT5	Discrete Output 5
6	OUTBIT6	Discrete Output 6
7	OUTBIT7	Discrete Output 7
8	OUTBIT8	Discrete Output 8
9	GND	+5 VDC Return
10	+5 VDC	+5 VDC

All outputs are CMOS level signals, 10 mA sink and source capability, +5 VDC.

J19, Command Port Connection

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	STOP *	STOP Motion on all axes
2	END *	END the running program
3	RECALL-and-RUN *	RECALL and RUN the code
4	RUN *	RUN the code
5	CONT *	CONTInue execution of the code
6	TERMINAL	Start the terminal mode on power-up
7	HI / LO *	Select the states of the outputs on power-up
8	JON / JOFF *	Select the state of joystick on power-up
9	GND	+5 VDC Return
10	+5 VDC	+5 VDC

* A normally open switch should be placed between this pin and GND, if necessary.
A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J3, Quadrature Encoder Interface (Optional)

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	+5 VDC	+5 VDC
2	GND	+5 VDC Return
3	+5 VDC	+5 VDC
4	GND	+5 VDC Return
5	+5 VDC	+5 VDC
6	GND	+5 VDC Return
7	WA	Phase-WA Quadrature Input
8	ZA	Phase-ZA Quadrature Input
9	WB	Phase-WB Quadrature Input
10	ZB	Phase-ZB Quadrature Input
11	XA	Phase-XA Quadrature Input
12	YA	Phase-YA Quadrature Input
13	XB	Phase-XB Quadrature Input
14	YB	Phase-YB Quadrature Input

A 470 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J1, External Step and Direction Inputs (Optional)

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	ESTEPX	External Step Signal – X Discrete Input 9
2	EDIRX	External Direction Signal - X
3	ESTEPY	External Step Signal – Y
4	EDIRY	External Direction Signal – Y
5	ESTEPZ	External Step Signal – Z
6	EDIRZ	External Direction Signal – Z
7	ESTEPW	External Step Signal – W
8	EDIRW	External Direction Signal – W
9	GND	+5 VDC Return
10	SELECT	Select Input

A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J26, SPI Port, LCD Interface (Optional)

0.1" (2.54 mm) Pitch Header

PIN	NAME	DESCRIPTION
1	DATA	Serial Data Out
2	NC	Not Connected
3	CS1	Chip Select 1
4	NC	Not Connected
5	CLK	Serial Clock
6	+5 VDC	+5 VDC
7	CS2	Chip Select 1
8	+5 VDC	+5 VDC
9	GND	+5 VDC Return
10	NC	Not Connected

A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

J25, RS232 Interface

0.1" (2.54 mm) Pitch Header









PIN	NAME	DESCRIPTION
3	DATA-XMT	Data Transmit to PC
4	RESET	RESET Signal from PC to Controller
5	DATA-RCV	Data Receive from PC
9	GND	+5 VDC Return

JP2, Joystick Speed Selection (Optional)

JP2 1 - 2	JP2 3 - 4	JP2 5 - 6	JP2 7 - 8	Micro- Stepper Resolution	Maximum Slow Speed (RPS) *	Maximum Medium Speed (RPS) *	Maximum Fast Speed (RPS) *
IN	IN	IN	IN	10	0.44	1.33	4.00
OUT	IN	IN	IN	10	0.56	1.67	5.00
IN	OUT	IN	IN	10	0.67	2.00	6.00
OUT	OUT	IN	IN	10	0.78	2.33	7.00
IN	IN	OUT	IN	50	0.02	0.30	6.00
OUT	IN	OUT	IN	50	0.02	0.30	7.00
IN	OUT	OUT	IN	50	0.02	0.30	8.00
OUT	OUT	OUT	IN	50	0.02	0.30	9.00
IN	IN	IN	OUT	125	0.03	0.50	1.00
OUT	IN	IN	OUT	125	0.03	0.50	2.00
IN	OUT	IN	OUT	125	0.03	0.50	3.00
OUT	OUT	IN	OUT	125	0.03	0.50	4.00
IN	IN	OUT	OUT	250	0.03	0.50	2.50
OUT	IN	OUT	OUT	250	0.03	0.50	4.00
IN	OUT	OUT	OUT	250	0.03	0.50	5.50
OUT	OUT	OUT	OUT	250	0.78	2.33	7.00

* 200 Steps per Revolution Motor

Mating Pin and Housings

	Mfr. Part #	DESCRIPTION
	86016-5	AMPMODU MOD. IV Receptacle Contact, 24-20 AWG, gold
	87456-6	AMPMODU MOD. IV Connectors Non-Polarized Housing, 5x2
	1-87456-0	AMPMODU MOD. IV Connectors Non-Polarized Housing, 7x2
	1-87456-2	AMPMODU MOD. IV Connectors Non-Polarized Housing, 8x2
	102387-1	AMPMODU MOD. IV Connectors Center Polarized Housing, 5x2
	102387-2	AMPMODU MOD. IV Connectors Center Polarized Housing, 7x2
	102387-3	AMPMODU MOD. IV Connectors Center Polarized Housing, 8x2
	102387-6	AMPMODU MOD. IV Connectors Center Polarized Housing, 13x2

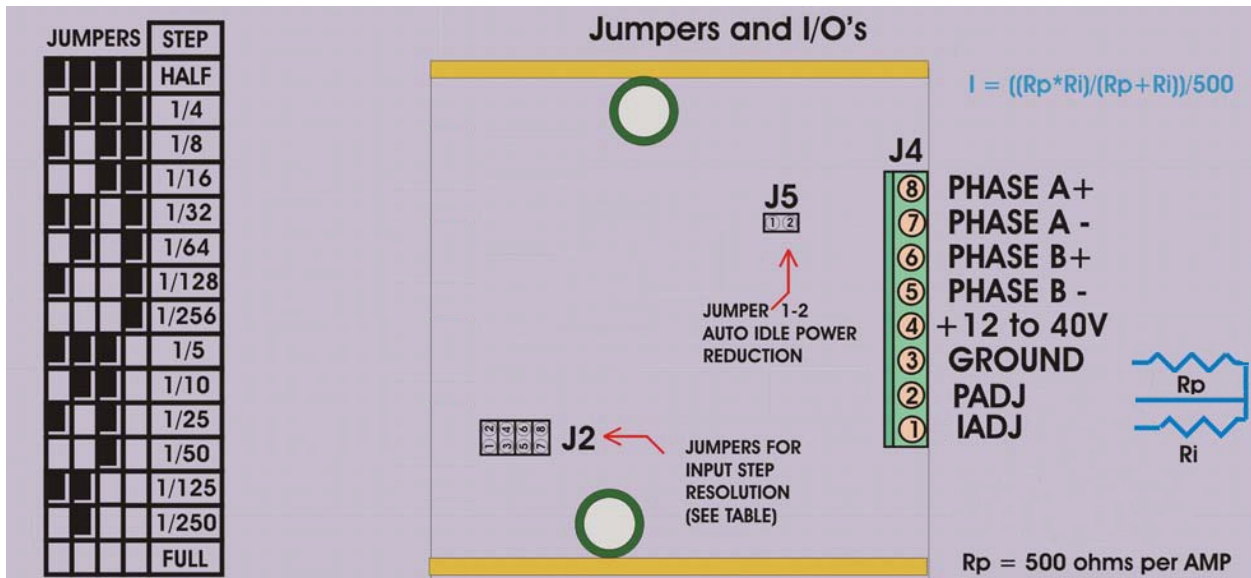
Mfr: Tyco Electronics / AMP

Specifications are subject to change without notice.

Stepper Motor Connection, -250-01 Version



STPMDRV-404



Current Set Resistor Value Table

Peak Output Current (Amp)	Resistor Value (Ohm)
0.66	330
0.94	470
1.12	560
1.36	680
1.64	820
2.00	1000
2.40	1200
3.00	1500
3.60	1800
4.00	2000

Stepper Motor Connection

Screw Terminal Type

PIN	NAME	DESCRIPTION
1	IADJ	This pin is used for connection to the idle current reduction programming resistor, the other end of which is connected to IADJ (J4-2). Idle Current (Amp) = $((R_i * R_p) / (R_i + R_p)) / 500$ where R_i is the idle current resistor and R_p is the programmed current resistor.
2	PADJ	
3	PGND	This pin is used for programming the current of the driver. The return pin for the resistor should be connected to the GND (J4-3) pin. Current (Amp) = $R_p / 500$ where R_p is the programmed current resistor. Power Ground
4	POWER	+12 VDC to +40 VDC
5	PHB-	Motor Phase B-
6	PHB+	Motor Phase B+
7	PHA-	Motor Phase A-
8	PHA+	Motor Phase A+

Stepper Motor Connection, -10-01 Version



(TERM. 1) POWER GROUND Connect the power supply ground to this terminal

(TERM. 2) +24 TO 80 VDC Connect the power supply "+" to this terminal

The power supply voltage must be between 24 VDC and 80 VDC. The maximum power supply current required is 67% of the motor's rated phase current. An unregulated power supply may be used as long as the voltage stays between the limits; keep the ripple voltage to 10% or less for best results. The drive has a 2 second power-on reset time before the motor is energized.

CAUTION! Power supply voltage in excess of 80 VDC will damage the STPMDRV-807.

If the power supply is more than 1 foot (300 mm) away from the STPMDRV-807, a 470 uF capacitor must be connected across the STPMDRV-807's power supply terminals. Keep the capacitor lead length to 1 inch (25 mm) or less.

The choice of power supply voltage depends on the high speed performance required of the motor; doubling the voltage doubles the motor's high speed power. In all cases the power supply voltage should be no less than 4 times or no more than 25 times the motor's rated voltage. The motor may not run as smoothly as possible if the power supply voltage is less than 4 times the motor's rated voltage. A power supply voltage greater than 25 times the motor's rated voltage will overheat and damage the motor, even if it is not turning. Motor winding inductance should be 500 uH or greater.

(TERM. 3) PHASE A Connect one motor winding to this terminal

(TERM. 4) PHASE B Connect the other end of the winding to this terminal

(TERM. 5) PHASE C Connect the other motor winding to this terminal

(TERM. 6) PHASE D Connect the other end of the winding to this terminal

Connect one motor winding to terminals 3 and 4. Connect the other winding to terminals 5 and 6. Turn the power supply off when connecting or disconnecting the motor. If the motor turns in the wrong direction, reverse the motor winding connections to terminals 3 and 4.

CAUTION! Do not short the motor leads to each other or to ground; damage will result to the STPMDRV-807.

4-wire, 6-wire and 8-wire motor may be used. When 6-wire motors are used, they may be connected in half winding or full winding. This is equivalent to an 8-wire motor connected in parallel or series. If a motor is connected in series or full winding, the motor's phase current rating is half of its parallel or unipolar rating. The choice depends on the high-speed performance required; a parallel-connected motor will provide twice the power of a series-connected motor at the same power supply voltage.

(TERM. 11) CURRENT SET Connect the current set resistor to this terminal

(TERM. 12) CURRENT SET Connect the other end of the current set resistor to this terminal

This input programs the STPMDRV-807A's current output to the motor windings. The STPMDRV-807 will accommodate motor winding currents from 1 to 7A. Use the following equation to calculate the value, (in kilo-ohms) of the current set resistor:

$$R \text{ (in kilo-ohms)} = 47 * I / (7 - I)$$

AUTO CURRENT REDUCTION: The STPMDRV-807 reduces motor phase current to 33% of the set value when the motor is stopped. This reduction occurs 1 second after the last step pulse is sent to the drive.

Current Set Resistor Value Table (-10-01 Version)

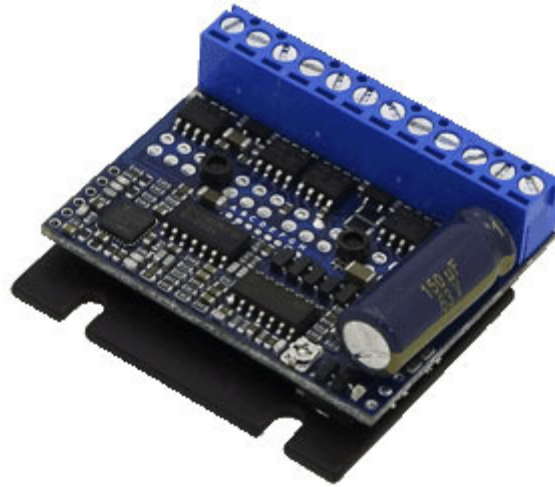
Motor Peak Current	Resistor Value
1 Amp	8.2 KOhm
2 Amp	18 KOhm
3 Amp	36 KOhm
4 Amp	62 KOhm
5 Amp	120 KOhm
6 Amp	270 KOhm
7 Amp	OPEN

Stepper Motor Connection (-10-01 Version)

Screw Terminal Type

PIN	NAME	DESCRIPTION
1	PGND	Power Ground
2	POWER	+24 VDC to +80 VDC
3	PHA+	Motor Phase A+
4	PHA-	Motor Phase A-
5	PHB+	Motor Phase B+
6	PHB-	Motor Phase B-
7		Not Used
8	DIR	Direction Signal
9	STEP	Step Signal
10	+5 VDC	+5 VDC
11	CSR+	Current Set Resistor
12	CSR-	Current Set Resistor

Stepper Motor Connection, -10-02 Version



STPMDRV-504

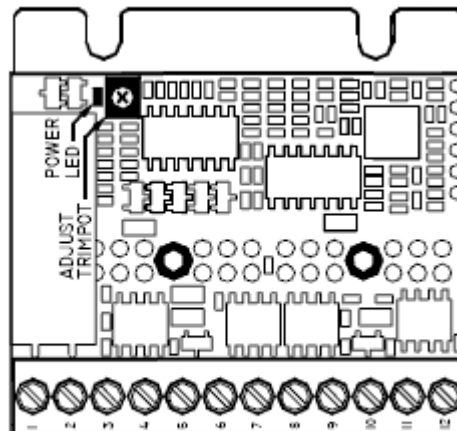
- (TERM. 1) **POWER GROUND** Connect the power supply ground to this terminal
(TERM. 2) **+15 TO 50 VDC** Connect the power supply “+” to this terminal
(TERM. 3) **CURRENT SET** Connect the current set resistor to this terminal
(TERM. 4) **CURRENT SET** Connect the other end of the current set resistor to this terminal
(TERM. 5) **PHASE A+** Connect one motor winding to this terminal
(TERM. 6) **PHASE A-** Connect the other end of the winding to this terminal
(TERM. 7) **PHASE B+** Connect the other motor winding to this terminal
(TERM. 8) **PHASE B-** Connect the other end of the winding to this terminal
Motor winding inductance should be 500 UH or greater.

MAIN CONNECTOR:

- 1 GND
- 2 +VDC
- 3 I-SET
- 4 I-SET
- 5 PHASE A
- 6 PHASE /A
- 7 PHASE B
- 8 PHASE /B

CURRENT SET RESISTOR:

CONNECT 1/4W RESISTOR FROM
"I-SET" (TERM. 3) TO "I-SET" (TERM. 4).
MOTOR PHASE CURRENT = 1 AMP
PER 1,000 OHMS.



Specifications are subject to change without notice.

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