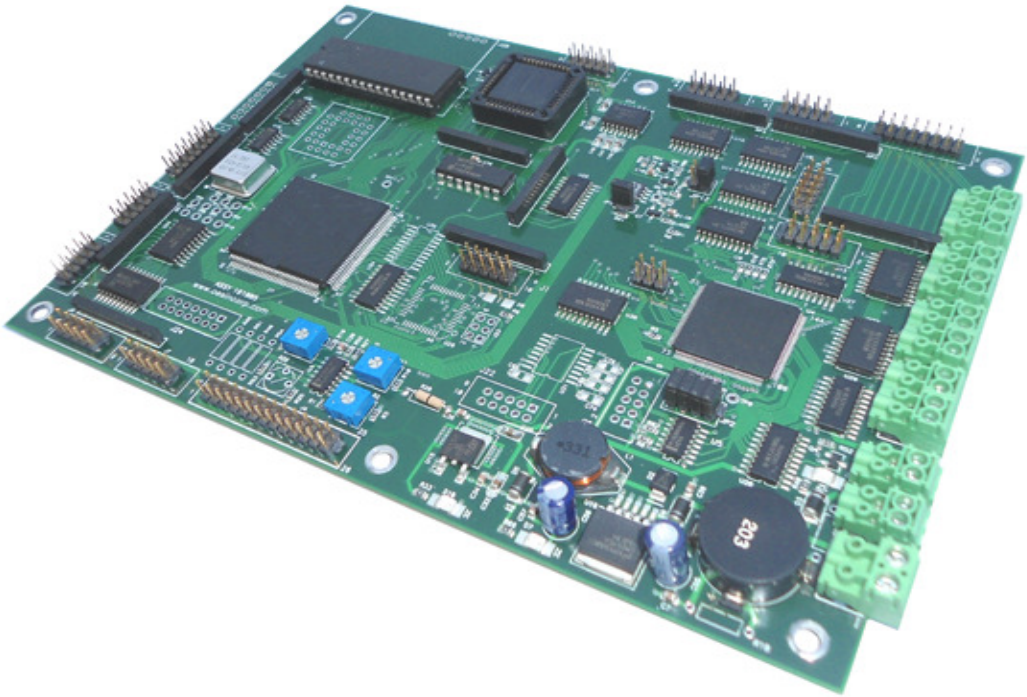
# *PSMC Series Hardware Reference Manual*



*Motion Controller Card*

***Optimal Engineering Systems, Inc.***
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This card is an easy-to-use, plug-and-play and cost effective solution for single and multi-axis motion control applications. It may be used as a stand-alone unit or may be commanded by an external device.

These series supports up to 4 axes of motion, up to 32 TTL / CMOS compatible inputs, 16 TTL / CMOS compatible outputs, 4 analog inputs, and up to four optical encoder inputs. The command port is provided for stand-alone operation.

The powerful programming instructions with more than 120 commands include motion control, system configuration, data flow, program flow commands, 32-bit logical and mathematical operations, and other miscellaneous instructions.

These cards can also be operated using an analog joystick or a trackball with quadrature outputs. The speed of the motor is proportional to the tilt angle of the joystick or the rotational speed of the trackball. The joystick has three speed selection keys; fast, medium and slow speed.

The card 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 module 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.

## 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

## Software

- Easy System Setup and Evaluation
- Menu Driven
- Free Software Included

## 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 / $sec^2$

### Communication Interface

- RS-232 Interface

### Software

- Easy System Setup and Evaluation
- Menu Driven

### Power Requirement

- +5 VDC **or** +7.5 to +40 VDC
- Max. 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
- Optional External Step and Direction Input Signals per Axis

### Dedicated Outputs

- Step, Direction, and Driver Enable Outputs per Axis
- Status LED Output

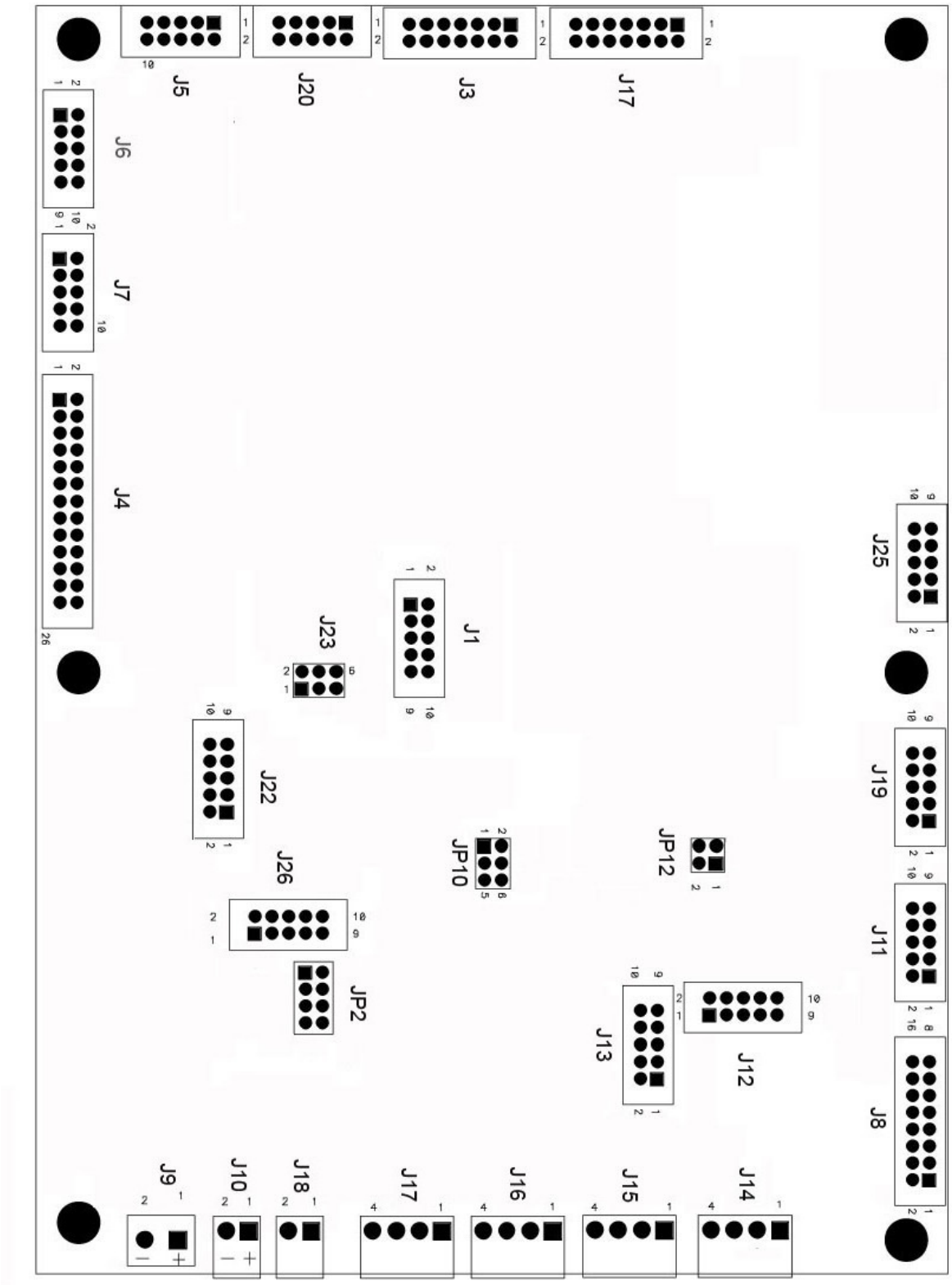
### General Purpose Digital Input / Output

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

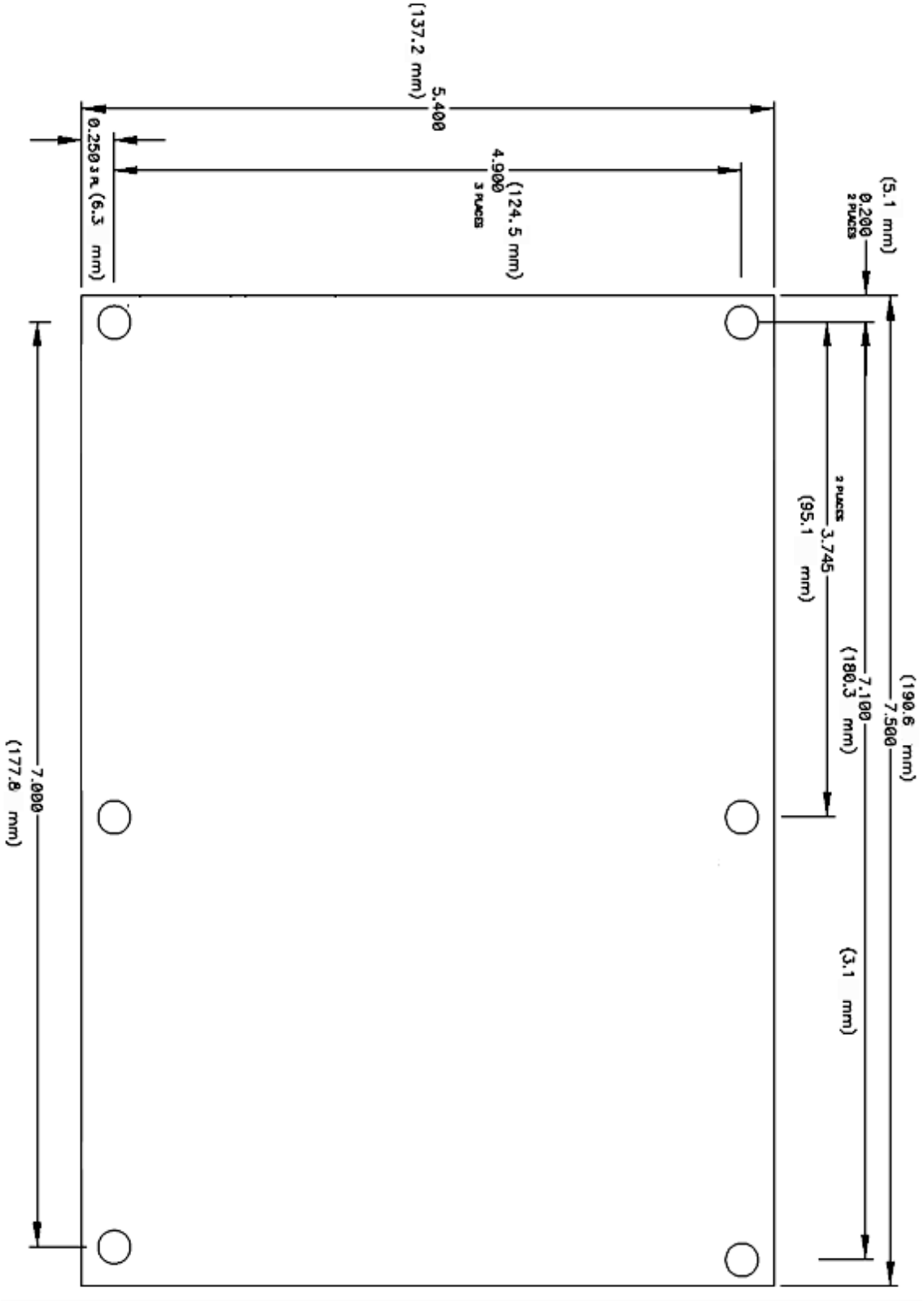
### General Purpose Analog Input

- Up to 4 Inputs
- 10 Bits of Resolution
- Adjustable Gain

## Connections



## 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<br>Open Collector |

## J14, X-Axis Motor Driver Connection

Screw Terminal Type

| PIN | NAME | DESCRIPTION |
|---|---|---|
| 1 | **+5 VDC** | +5 VDC Output |
| 2 | **STEP-X** | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 3 | **DIR-X** | Direction Output<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 4 | **DIS-X** | Disable Output, Active Low<br>CMOS level signals, 40 mA sink and source capability, +5 VDC |

## 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.

## J15, Y-Axis Motor Driver Connection

Screw Terminal Type

| PIN | NAME | DESCRIPTION |
|---|---|---|
| 1 | **+5 VDC** | +5 VDC Output |
| 2 | **STEP-Y** | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 3 | **DIR-Y** | Direction Output<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 4 | **DIS-Y** | Disable Output, Active Low<br>CMOS level signals, 40 mA sink and source capability, +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.

## J16, Z-Axis Motor Driver Connection

Screw Terminal Type

| PIN | NAME | DESCRIPTION |
|---|---|---|
| **1** | **+5 VDC** | +5 VDC Output |
| **2** | **STEP-Z** | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| **3** | **DIR-Z** | Direction Output<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| **4** | **DIS-Z** | Disable Output, Active Low<br>CMOS level signals, 40 mA sink and source capability, +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.

## J21, W-Axis Motor Driver Connection

Screw Terminal Type

| PIN | NAME | DESCRIPTION |
|---|---|---|
| **1** | **+5 VDC** | +5 VDC Output |
| **2** | **STEP-W** | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| **3** | **DIR-W** | Direction Output<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| **4** | **DIS-W** | Disable Output, Active Low<br>CMOS level signals, 40 mA sink and source capability, +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.

## J8, All Axes Motor Driver Connection (Optional)

0.1” (2.54 mm) Pitch Header

| PIN | NAME | DESCRIPTION |
|---|---|---|
| 1 | +5 VDC | +5 VDC Output |
| 2 | STEP-X | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 3 | DIS-X | Disable Output, Active Low<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 4 | DIR-X | Direction Output<br>CMOS level signals, 40 mA sink and source capability, +5 VDC |
| 5 | +5 VDC | +5 VDC Output |
| 6 | STEP-Y | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 7 | DIS-Y | Disable Output, Active Low<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 8 | DIR-Y | Direction Output<br>CMOS level signals, 40 mA sink and source capability, +5 VDC |
| 9 | +5 VDC | +5 VDC Output |
| 10 | STEP-Z | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 11 | DIS-Z | Disable Output, Active Low<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 12 | DIR-Z | Direction Output<br>CMOS level signals, 40 mA sink and source capability, +5 VDC |
| 13 | +5 VDC | +5 VDC Output |
| 14 | STEP-W | Step Pulse Output, 50 % Duty Cycle<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 15 | DIS-W | Disable Output, Active Low<br>CMOS level signals, 20 mA sink and source capability, +5 VDC |
| 16 | DIR-W | Direction Output<br>CMOS level signals, 40 mA sink and source capability, +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 |

## 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.

## 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.

## 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.

## 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 |

## J1, External Step and Direction Inputs (Optional)

0.1” (2.54 mm) Pitch Header

| PIN | NAME | DESCRIPTION |
|---|---|---|
| 1 | ESTEPX | External Step Signal – X<br>Discrete Input 17 |
| 2 | EDIRX | External Direction Signal - X<br>Discrete Input 18 |
| 3 | ESTEPY | External Step Signal – Y<br>Discrete Input 19 |
| 4 | EDIRY | External Direction Signal – Y<br>Discrete Input 20 |
| 5 | ESTEPZ | External Step Signal – Z<br>Discrete Input 21 |
| 6 | EDIRZ | External Direction Signal – Z<br>Discrete Input 22 |
| 7 | ESTEPW | External Step Signal – W<br>Discrete Input 23 |
| 8 | EDIRW | External Direction Signal – W<br>Discrete Input 24 |
| 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 |

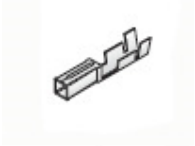
A 10 KOHM pull-up resistor is placed between all inputs and +5 VDC.

## JP2, Joystick Speed Selection

| 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.

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