

7154 MANUAL

Six channel 40V 3A Servo motor drive

V1.1

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GENERAL

DESCRIPTION

The 7154 is a low cost 6 Axis H-bridge card for use with Mesa motion control cards. The 7154 has a maximum per axis current rating of 3 Amps and a voltage rating of 40V. Current limits of 1 Amp and 3 Amp are user selectable, as are voltage and current (torque) modes. All motor power circuitry is galvanically isolated from the controller interface

The H-bridge chips (Allegro A3959) use DMOS transistors and synchronous rectification for high efficiency and low power dissipation. PWM rates up to 50 KHz are supported.

The 7154 also conditions and multiplexes the encoder input signals and supports both TTL and differential encoder inputs.

The controller connection is a 50 pin header that matches the pinout of the Mesa 50 pin FPGA based motion controllers. The 7154 uses Phoenix compatible 3.5 mm headers and is supplied with pluggable terminal blocks.

HARDWARE CONFIGURATION

GENERAL

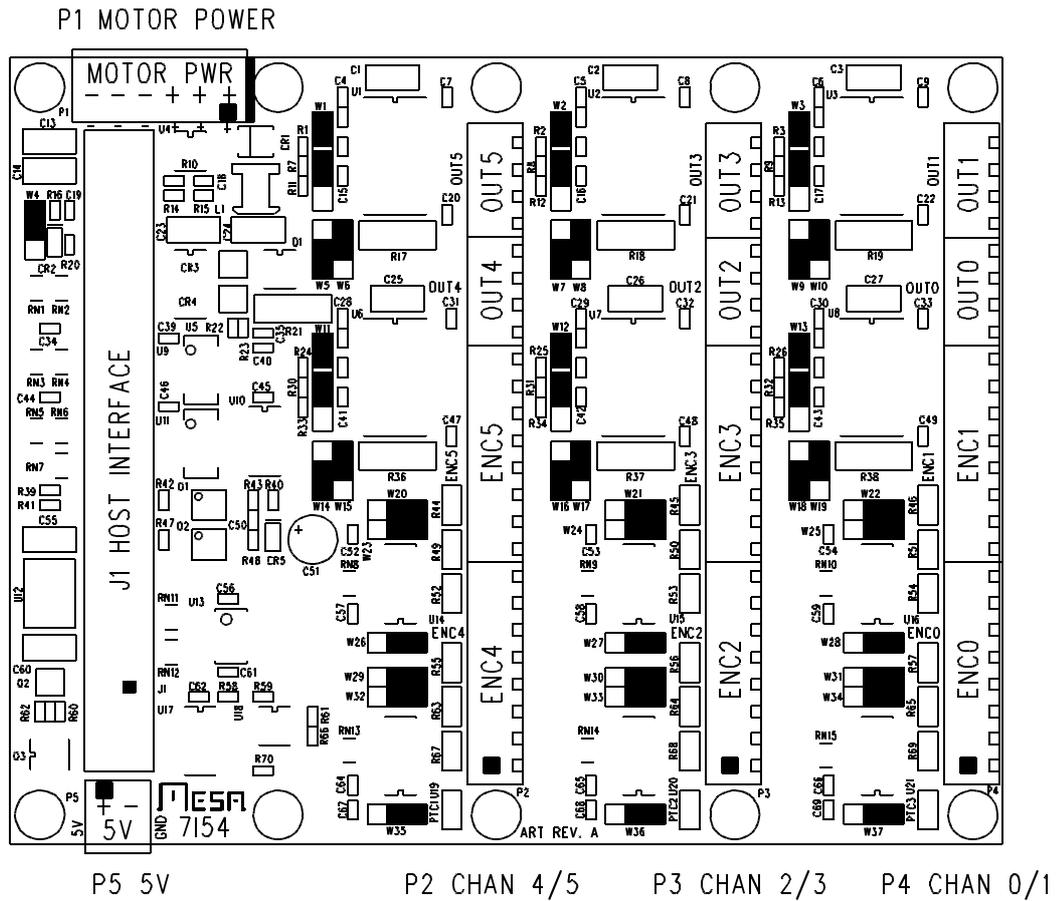
Hardware setup jumper positions assume that the 7154 card is oriented in an upright position, that is, with the 50 pin controller connector is on the left hand side,

DEFAULT CONFIGURATION

| JUMPER | FUNCTION | DEFAULT SETTING |
|---------------|-------------------|------------------------|
| W4 | CABLE POWER | NO POWER |
| W1,W6 | HBRIDGE MODE CH0 | CURRENT = UP-UP,UP |
| W2,W8 | HBRIDGE MODE CH1 | CURRENT = UP-UP,UP |
| W3,W10 | HBRIDGE MODE CH2 | CURRENT = UP-UP,UP |
| W11,W15 | HBRIDGE MODE CH3 | CURRENT = UP-UP,UP |
| W12,W17 | HBRIDGE MODE CH4 | CURRENT = UP-UP,UP |
| W13,W19 | HBRIDGE MODE CH4 | CURRENT = UP-UP,UP |
| W5 | CURRENT RANGE CH0 | 1 AMP = DOWN |
| W7 | CURRENT RANGE CH1 | 1 AMP = DOWN |
| W9 | CURRENT RANGE CH2 | 1 AMP = DOWN |
| W14 | CURRENT RANGE CH3 | 1 AMP = DOWN |
| W16 | CURRENT RANGE CH4 | 1 AMP = DOWN |
| W18 | CURRENT RANGE CH5 | 1 AMP = DOWN |
| W37,W34,W31 | ENCODER MODE CH0 | DIFFERENTIAL = RIGHT |
| W28,W25,W22 | ENCODER MODE CH1 | DIFFERENTIAL = RIGHT |
| W36,W33,W30 | ENCODER MODE CH2 | DIFFERENTIAL = RIGHT |
| W27,W24,W21 | ENCODER MODE CH3 | DIFFERENTIAL = RIGHT |
| W35,W32,W29 | ENCODER MODE CH4 | DIFFERENTIAL = RIGHT |
| W26,W23,W20 | ENCODER MODE CH5 | DIFFERENTIAL = RIGHT |

HARDWARE CONFIGURATION

DEFAULT CONFIGURATION AND CONNECTOR LOCATIONS

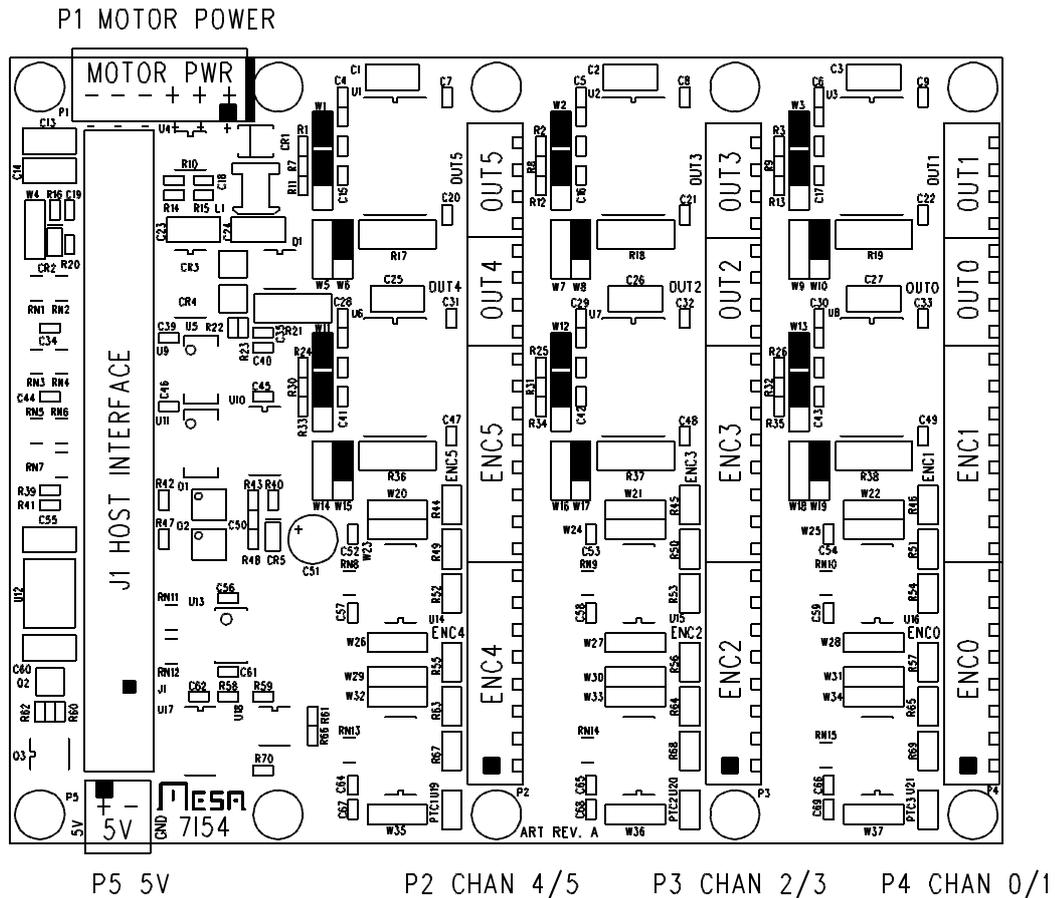


HARDWARE CONFIGURATION

HBRIDGE MODE

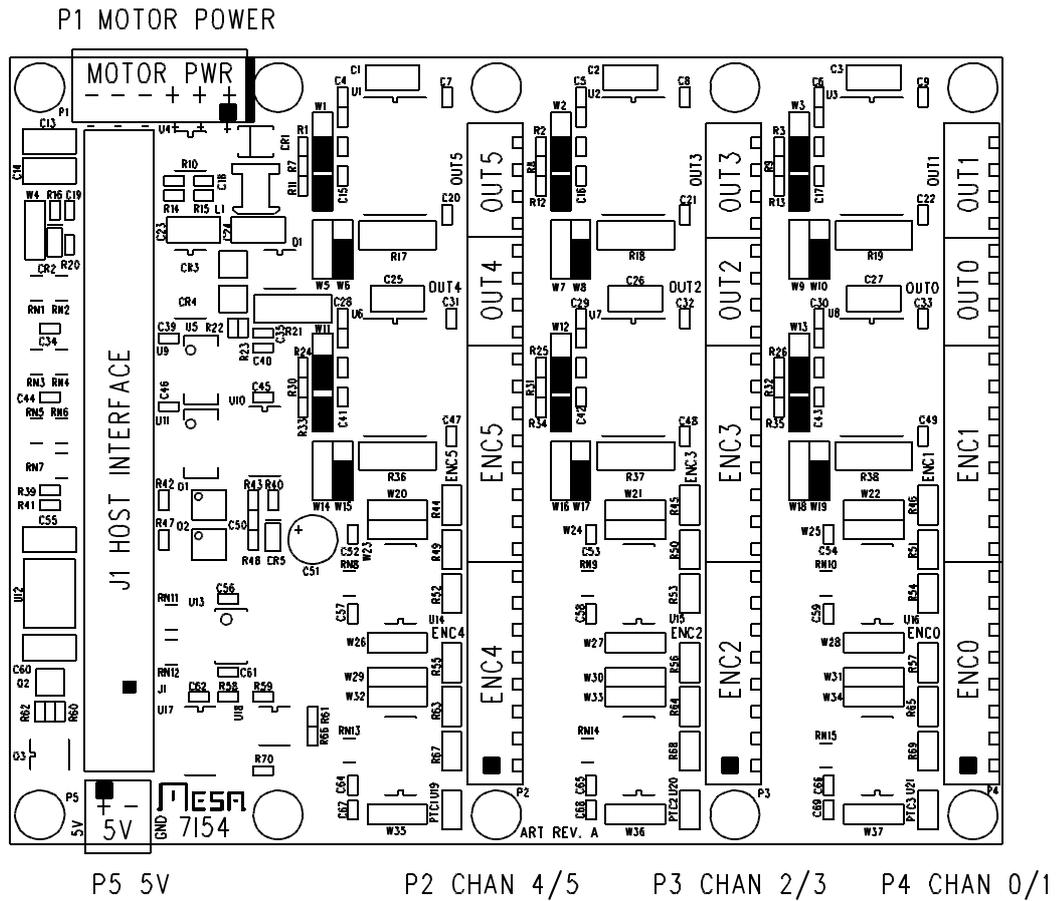
The Hbridge's on the 7154 can be operated in voltage mode or current mode. Three jumpers per channel must be moved to select the mode. One jumper block has 5 pins and two shorting jumpers. These two jumpers must be in the top two locations or bottom two locations of the 5 pin header depending on mode. The remaining jumper uses a standard 3 pin header. All three jumpers must be in the "UP" position to select current mode, and in the "DOWN" position to select voltage mode.

JUMPER SETTINGS FOR CURRENT MODE



HARDWARE CONFIGURATION

JUMPER SETTINGS FOR VOLTAGE MODE

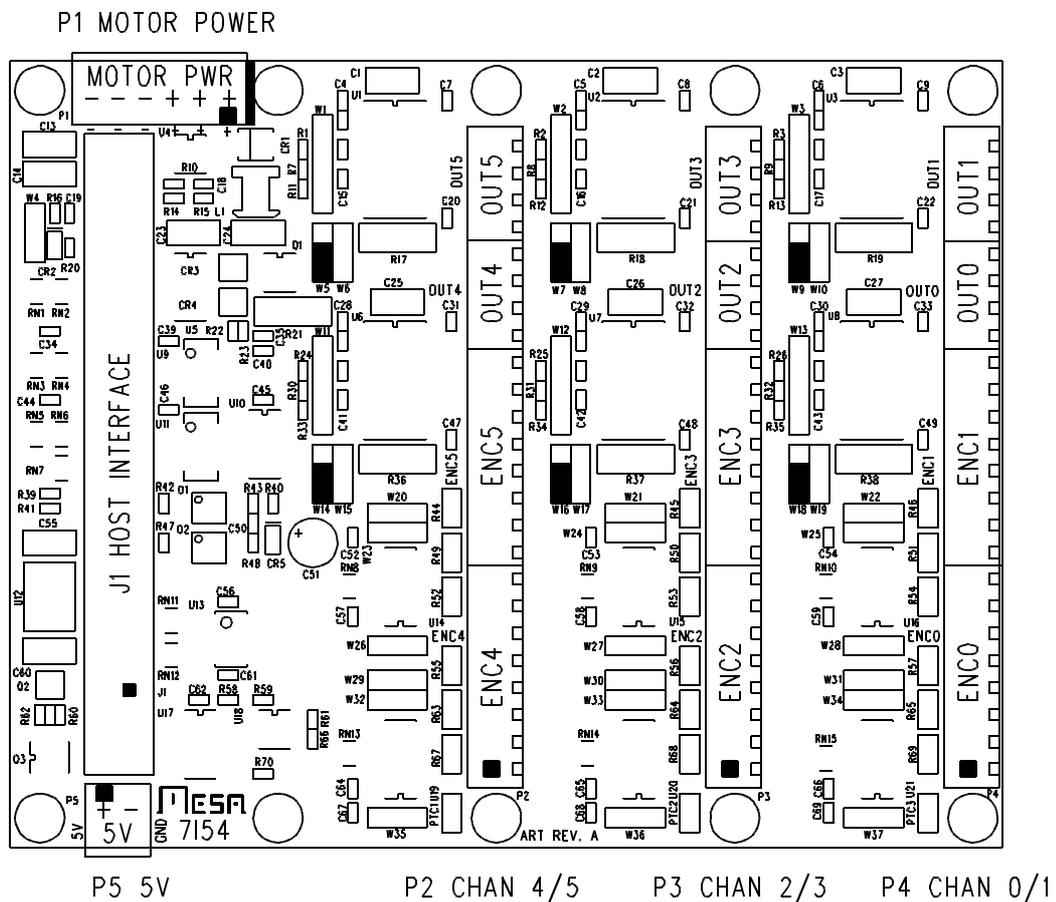


HARDWARE CONFIGURATION

MAXIMUM CURRENT

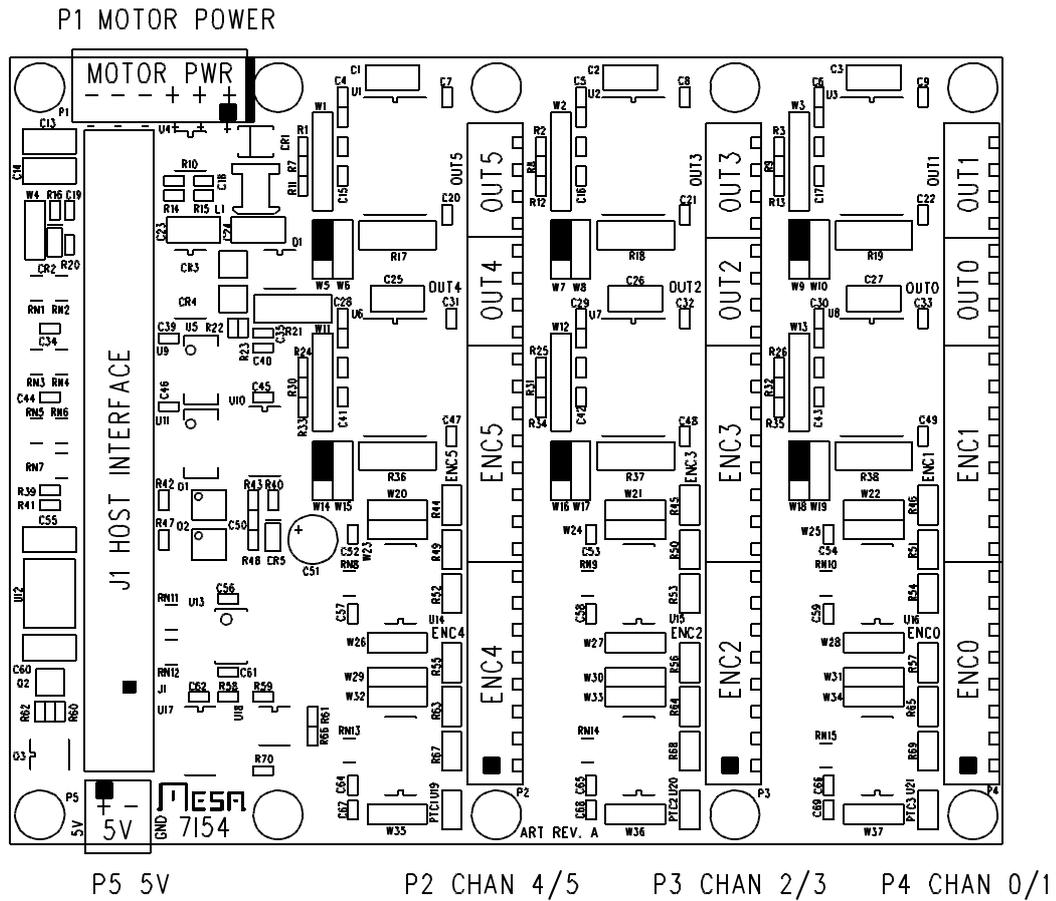
The 7154 can have a maximum current setting of 1 Amp or 3 Amp selectable on a per channel basis. When in current mode this set the full scale current, when in voltage mode this selects the current limit.

JUMPER SETTINGS FOR 1 AMP MAXIMUM CURRENT



HARDWARE CONFIGURATION

JUMPER SETTINGS FOR 3 AMP MAXIMUM CURRENT

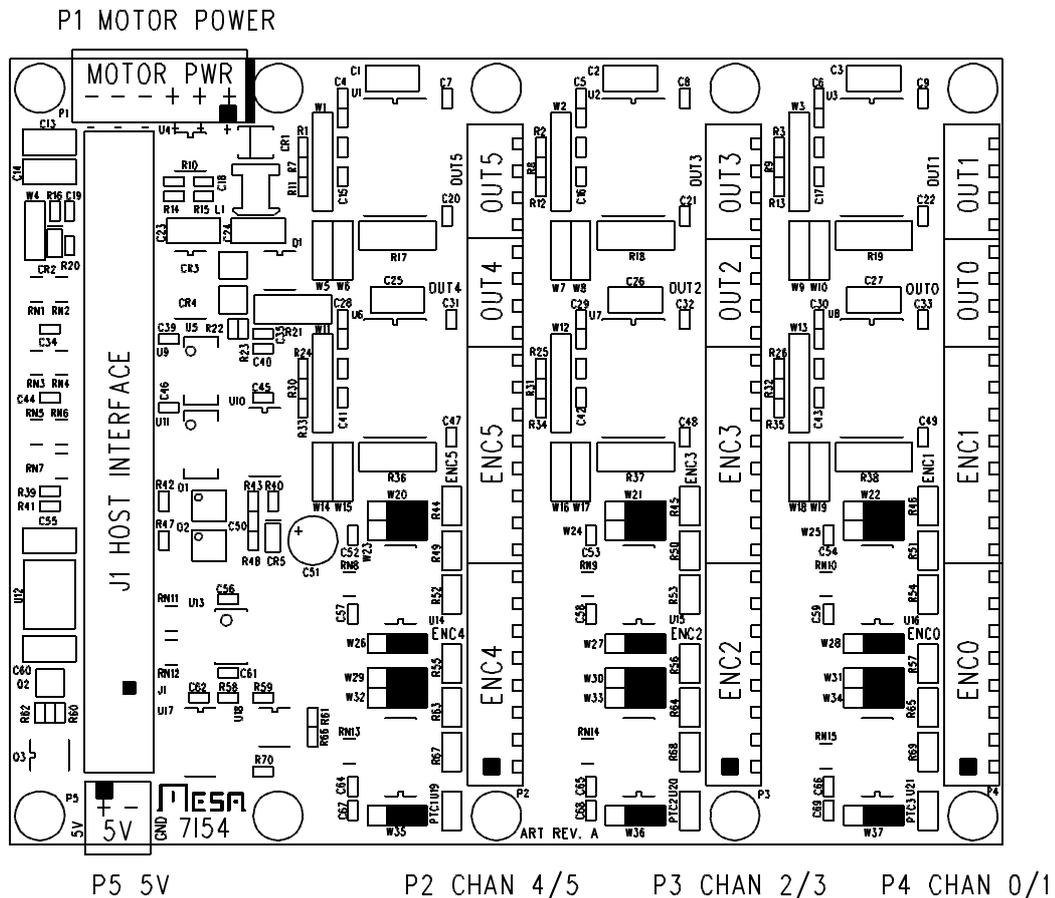


HARDWARE CONFIGURATION

ENCODER INPUT MODE

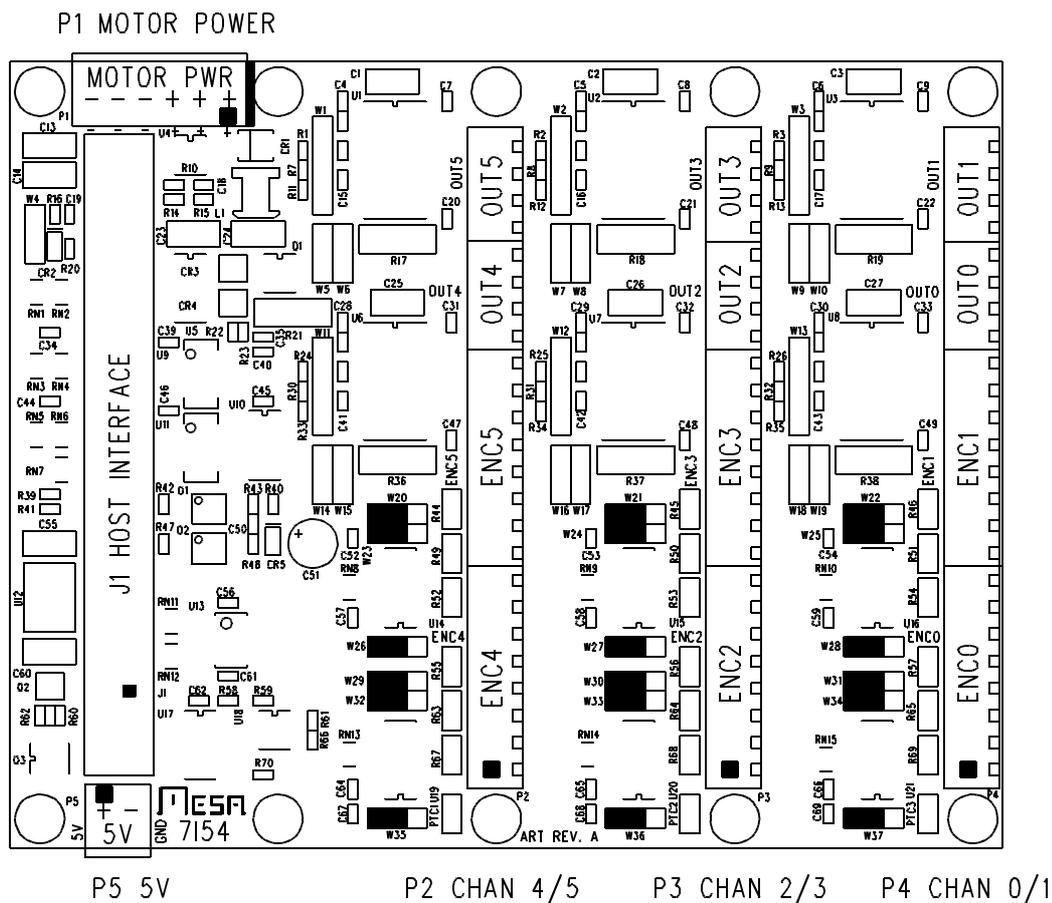
Each 7154 channel has a selectable TTL or differential encoder input conditioning. Conditioning type is determined by setting groups of 3 jumpers to the left or right position. When the jumpers are in the "LEFT" position, TTL inputs are selected, When the jumpers are in the "RIGHT" position, differential inputs are selected. Note these sets of three jumpers are in physical proximity to the terminal block encoder connections.

JUMPER SETTINGS FOR DIFFERENTIAL MODE ENCODERS



HARDWARE CONFIGURATION

JUMPER SETTINGS FOR TTL MODE ENCODERS



CABLE POWER/P5 POWER SELECTION

The 7154 can get its operating power from the flat FPGA cable or from P5. For testing and with low power encoders, cable power can be used. W4 selects whether cable power connects to the 7154s 5V supply. If W4 is in the "UP" position, cable power is selected. If W4 is in the "DOWN" position, external 5V power must be supplied via P5.

CONNECTORS

CONTROLLER CONNECTOR

50 pin header connector J1 connects to the anything I/O card/motion controller. This can be a male 50 pin header on the top of the 7I54 card or a female 50 conductor header on the bottom side of the 7I54 depending on 7I54 model. Controller connector pin-out is as follows:

| PIN | FUNCTION | DIRECTION | PIN | FUNCTION | DIRECTION |
|------------|-----------------|------------------|------------|-----------------|------------------|
| 1 | /ENA0 | TO 7I54 | 25 | DIR0 | TO 7I54 |
| 3 | MUXQA0 | FROM 7I54 | 27 | PWM1 | TO 7I54 |
| 5 | MUXQB0 | FROM 7I54 | 29 | DIR1 | TO 7I54 |
| 7 | MUXIDX0 | FROM 7I54 | 31 | PWM2 | TO 7I54 |
| 9 | MUXQA1 | FROM 7I54 | 33 | DIR2 | TO 7I54 |
| 11 | MUXQB1 | FROM 7I54 | 35 | PWM3 | TO 7I54 |
| 13 | MUXIDX1 | FROM 7I54 | 37 | DIR3 | TO 7I54 |
| 15 | MUXQA2 | FROM 7I54 | 39 | PWM4 | TO 7I54 |
| 17 | MUXQB2 | FROM 7I54 | 41 | DIR4 | TO 7I54 |
| 19 | MUXIDX2 | FROM 7I54 | 43 | PWM5 | TO 7I54 |
| 21 | MUXSEL0 | TO 7I54 | 45 | DIR5 | TO 7I54 |
| 23 | PWM0 | TO 7I54 | 47 | /ENA1 | TO 7I54 |
| | | | 49 | +5V PWR | TO 7I54 |

Note: all even pins are grounded.

CONNECTORS

AUX 5V POWER

The 7I54 can get its 5V power from the FPGA cable or connector P5. Normally P5 should be used for power as the 5V current draw from 6 encoders will exceed what the FPGA flat cable can deliver. Note that the 7I54 will only connect to P5 power if the cable 5V is present.

| PIN | FUNCTION |
|------------|-----------------|
|------------|-----------------|

| | |
|---|----------------------------|
| 1 | 5V (Square pad on drawing) |
| 2 | GND |

MOTOR POWER

Motor power is supplied to six pin connector P1

| PIN | FUNCTION |
|------------|-----------------|
|------------|-----------------|

| | |
|---|---------------------------------------|
| 1 | + MOTOR POWER (Square pad on drawing) |
| 2 | + MOTOR POWER |
| 3 | + MOTOR POWER |
| 4 | - MOTOR POWER |
| 5 | - MOTOR POWER |
| 6 | - MOTOR POWER |

CONNECTORS

ENCODER / MOTOR CONNECTORS

The 7I54's servo amplifier / encoder connectors (P2,P3, and P4) are 3.5MM 24 pin headers compatible with Phoenix style screw terminal blocks (supplied). Connector P4 has the I/O signals for channels 0 and 1:

| P4 PIN | FUNCTION | DIR |
|---------------|-----------------|------------|
| 1 | ENCA0 | TO 7I54 |
| 2 | /ENCA0 | TO 7I54 |
| 3 | GND | FROM 7I54 |
| 4 | ENCB0 | TO 7I54 |
| 5 | /ENCB0 | TO 7I54 |
| 6 | +5V | FROM 7I54 |
| 7 | IDX0 | TO 7I54 |
| 8 | /IDX0 | TO 7I54 |
| 9 | ENCA1 | TO 7I54 |
| 10 | /ENCA1 | TO 7I54 |
| 11 | GND | FROM 7I54 |
| 12 | ENCB1 | TO 7I54 |
| 13 | /ENCB1 | TO 7I54 |
| 14 | +5V | FROM 7I54 |
| 15 | IDX1 | TO 7I54 |
| 16 | /IDX1 | TO 7I54 |
| 17 | MGND | FROM 7I54 |
| 18 | MOTOR0+ | FROM 7I54 |
| 19 | MOTOR0- | FROM 7I54 |
| 20 | MGND | FROM 7I54 |
| 21 | MGND | FROM 7I54 |
| 22 | MOTOR1+ | FROM 7I54 |
| 23 | MOTOR1- | FROM 7I54 |
| 24 | MGND | FROM 7I54 |

CONNECTORS

SERVO AMP/ENCODER CONNECTORS

Connector P3 has the I/O signals for channels 2 and 3:

| P3 PIN | FUNCTION | DIR |
|---------------|-----------------|------------|
| 1 | ENCA2 | TO 7I54 |
| 2 | /ENCA2 | TO 7I54 |
| 3 | GND | FROM 7I54 |
| 4 | ENCB2 | TO 7I54 |
| 5 | /ENCB2 | TO 7I54 |
| 6 | +5V | FROM 7I54 |
| 7 | IDX2 | TO 7I54 |
| 8 | /IDX2 | TO 7I54 |
| 9 | ENCA3 | TO 7I54 |
| 10 | /ENCA3 | TO 7I54 |
| 11 | GND | FROM 7I54 |
| 12 | ENCB3 | TO 7I54 |
| 13 | /ENCB3 | TO 7I54 |
| 14 | +5V | FROM 7I54 |
| 15 | IDX3 | TO 7I54 |
| 16 | /IDX3 | TO 7I54 |
| 17 | MGND | FROM 7I54 |
| 18 | MOTOR2+ | FROM 7I54 |
| 19 | MOTOR2- | FROM 7I54 |
| 20 | MGND | FROM 7I54 |
| 21 | MGND | FROM 7I54 |
| 22 | MOTOR3+ | FROM 7I54 |
| 23 | MOTOR3- | FROM 7I54 |
| 24 | MGND | FROM 7I54 |

CONNECTORS

SERVO AMP/ENCODER CONNECTORS

Connector P2 has the I/O signals for channels 4 and 5:

| P2 PIN | FUNCTION | DIR |
|---------------|-----------------|------------|
| 1 | ENCA4 | TO 7I54 |
| 2 | /ENCA4 | TO 7I54 |
| 3 | GND | FROM 7I54 |
| 4 | ENCB4 | TO 7I54 |
| 5 | /ENCB4 | TO 7I54 |
| 6 | +5V | FROM 7I54 |
| 7 | IDX4 | TO 7I54 |
| 8 | /IDX4 | TO 7I54 |
| 9 | ENCA5 | TO 7I54 |
| 10 | /ENCA5 | TO 7I54 |
| 11 | GND | FROM 7I54 |
| 12 | ENCB5 | TO 7I54 |
| 13 | /ENCB5 | TO 7I54 |
| 14 | +5V | FROM 7I54 |
| 15 | IDX5 | TO 7I54 |
| 16 | /IDX5 | TO 7I54 |
| 17 | MGND | FROM 7I54 |
| 18 | MOTOR0+ | FROM 7I54 |
| 19 | MOTOR0- | FROM 7I54 |
| 20 | MGND | FROM 7I54 |
| 21 | MGND | FROM 7I54 |
| 22 | MOTOR1+ | FROM 7I54 |
| 23 | MOTOR1- | FROM 7I54 |
| 24 | MGND | FROM 7I54 |

OPERATION

HBRIDGE MODE

Each of the 7154s Hbridges can be programmed for current (torque) or voltage mode. Each mode has advantages and disadvantages.

CURRENT MODE

In current mode, the PWM signal sets the motor current, with 100% duty cycle being maximum current (1A or 3A). Current mode has the advantage that the current setting is largely unaffected by the motor power supply voltage or motor back EMF, so allows the controller to set the motors torque directly. One disadvantage of current mode is that it provides no inherent damping and may require fast servo loop rates for good performance.

VOLTAGE MODE

In voltage mode, the PWM signal directly controls the motor voltage. This has the advantage that the low output impedance of the Hbridge provides some high frequency damping to the motor. The main disadvantage of voltage mode operation is that the loop tuning now depends on the motor power supply voltage so if this is not well regulated, performance will be compromised.

PWM RATE

The desired PWM rate depends on the operating mode. In voltage mode, where the PWM signal directly drives the motor, the 7154 can operate with PWM rates from 1 KHz to 50 KHz. Higher PWM rates will result in slightly higher switching losses and a larger dead zone. PWM rates in voltage mode are normally set above 20 KHz to avoid audible noise from the motor. In current mode, the PWM is filtered to generate a reference current setting so the highest practical PWM rate should be used to minimize ripple, with 100 KHz as a suggested minimum frequency.

MAXIMUM CURRENT

Each 7154 output channel can have its maximum current set to 1A +-20% or 3A +-10%. In voltage mode this current setting sets the current limit. When the current limit is reached the 7154 will start operating in a constant current mode, modulating the drive to maintain the current at the preset limit. In current mode the maximum current setting selects the full scale current at 100% PWM duty cycle.

OPERATION

VOLTAGE MODE PRECAUTIONS

In voltage mode, the motor is shorted in the off PWM cycle. This results in the slowest decay of load current and best linearity of PWM versus motor speed. This results in motor braking when PWM drive is removed, since the motor is shorted by the Hbridge chips when no drive is present.

It is important to note that the current limit circuit does not operate when the load is shorted, so if PWM drive to a motor is suddenly removed when moving at high speed, a large fault current can flow in the Hbridge circuit - potentially destroying it. To prevent a possible overcurrent, The controller should disable the /ENA lines to the Hbridges in the event of an excessive position error or drive limit, to avoid this problem.

OPERATION

ENCODER INPUT CIRCUIT

The 7I54 input circuit is different depending on whether TTL or RS-422 encoder types have been selected. In TTL mode the input circuit on the encoder A,B, and index inputs drive one input of the RS-422 differential receiver, and the other receiver input is terminated to a 1.6V (TTL threshold) reference voltage. In RS-422 mode, the input consists of a 132 Ohm termination resistor and a RS-422 differential receiver.

When TTL encoders are used, they connect to the 'True' input of the differential pair, for example a TTL encoder for channel 2 would connect to ENCA2, ENCB2 and IDX2, while the /ENCA2,/ENCB2, and /IDX2 terminals would be left open.

Fine print: normally the input mode jumpers would always be moved as a sets of three to select TTL or RS-422 mode for individual encoders, however it is possible to select TTL or RS-422 mode for each encoder signal, for example if a encoder had a differential A,B but TTL index, the input circuit can accommodate this. The three input mode select jumpers are in bottom to top order: A,B,INDEX.

MAXIMUM COUNT RATE

The 7I54 uses multiplexed encoder signals to save interface pins. The multiplexing rate will determine the maximum encoder count rate. Default multiplexing rate with HostMot2 firmware is approximately 4 or 6 MHz, giving a resolvable count rate of 2 to 3 MHz. Multiplexing rate can be increased if desired but high multiplex rates will require short cables between the FPGA controller card and the 7I54 due to signal integrity and time-of-flight considerations. Maximum practical multiplex rate is approximately 12 MHz (and 6 MHz count rates). Encoder count rate is further limited by HostMot2s input filtering to ~5 to ~8 million counts per second (encoder filtering off) and ~1 to ~1.6 million counts per second (encoder filtering on).

OPERATION

5V POWER

The 7I54 requires ~400 mA of 5V power for operation. Encoder power can also be supplied from the 7I54's 5V source. Power for the 7I54 is normally supplied from P5 but can also be supplied via pin 49 of the 50 conductor controller cable when testing or when low power encoders are used.

MOTOR POWER

The 7I54s motor power supply must be in the range of 10VDC to 40VDC. Motor power should be externally fused with a 20A fuse. To prevent damage in load dump situations (such as disconnecting motor power when operating), the 7I54 has a snubber circuit that applies a large load to the motor power bus if the motor voltage exceeds 46 VDC. This snubber is only intended to protect the 7I54 in load dump situations and should not be used for braking as it will overheat and damage the 7I54.

Motor power is galvanically isolated from the controller and encoder circuitry to help prevent ground loops and EMI.

MOTOR CONNECTIONS

The motor connections provide a MGND signal for motor wire shielding. This MGND signal is connected to -MOTOR POWER.

ENABLE INPUTS

There are two active low enable inputs on the 7I54 from the FPGA card, /ENA0 and /ENA1. These enable inputs enable the Hbridges when low. /ENA0 controls Hbridge channels 0,2, and 4. /ENA1 controls Hbridges 1,3, and 5. When disabled, all Hbridge outputs are disabled, regardless of the state of the PWM or DIR inputs.

SPECIFICATIONS

| | MIN | MAX | UNITS |
|------------------------------|------|------|----------|
| 5V POWER SUPPLY | 4.75 | 5.25 | VDC |
| 5V POWER CONSUMPTION | --- | 500 | mA |
| MOTOR VOLTAGE | 10 | 40 | VDC |
| SNUBBER CLAMP VOLTAGE | 44 | 48 | VDC |
| OPERATING TEMP. | 0 | +70 | °C |
| OPERATING TEMP. (-I version) | -40 | +85 | °C |
| OPERATION HUMIDITY | 0 | 95% | NON-COND |

DRAWINGS

