

7140 MANUAL

Dual 400W HBridge

V1.1 Preliminary

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GENERAL

DESCRIPTION

The 7I40 is a low cost two axis H-bridge card for use with Mesa motion control cards and brush type motors. The 7I40 is available in 2 models, the 7I40L and the 7I40H. The 7I40L has a maximum per axis current rating of 10 Amps continuous and a voltage rating of 40V. Current limits of 7.5 Amps and 15 Amps are user selectable. The 7I40H has a maximum per axis current rating of 7 Amps continuous and a voltage rating of 80V. Current limits of 5 Amps and 10 Amps are user selectable.

The 7I40 is protected against excessive current, excessive voltage and over temperature conditions. Low dead time (320 nS) allows PWM rates up to 100 KHz to be supported. All cross conduction blanking and overcurrent protection is handled locally on the 7I40 card. The 7I40 can operate in in fast or slow decay mode. When operated in fast decay mode, synchronous rectification is used to reduce power loss. Encoder and index inputs can be TTL or differential. TTL inputs are conditioned with RC filters and Schmitt triggers for high noise rejection.

The controller connection is a 50 pin header that matches the pinout of the Mesa 4I27, 4I34M, 4I65, 4I68, 5I20, 5I22 and 7I60 motion controllers.

The 7I40 uses a four axis compatible controller pinout to allow two 7I40 cards to share a single four axis controller connector.

HARDWARE CONFIGURATION

GENERAL

Hardware setup jumper positions assume that the 7140 card is oriented in an upright position, that is, with the 50 pin controller connector is on the left hand side, and the 5 pin motor and and 10 pin encoder connectors are on the right side.

DEFAULT CONFIGURATION

JUMPER	FUNCTION	DEFAULT SETTING
W1	ENCODER 1 TTL/DIFF	RIGHT = TTL
W2	CABLE SEL 0,1 or 2,3	RIGHT = 0,1
W3	DECAY MODE	RIGHT = SLOW
W4	CURRENT LIMIT 1	RIGHT = LOW
W5	CURRENT LIMIT 0	RIGHT = LOW
W6	ENCODER 0 TTL/DIFF	RIGHT = TTL

CURRENT LIMIT

Each 7140 Hbridge channel has a selectable current limit. The current limit is selected with jumper W5 for channel 0 and W4 for channel 1. When W4 or W5 are in the right hand position, the low current limit is selected. When W4 or W5 are in the left hand position, the high current limit is selected. Current limits differ depending on 7140 model:

	LOW CURRENT LIMIT	HIGH CURRENT LIMIT
7140L	7.5 AMP	15 AMP
7140H	5 AMP	10 AMP

For more information on current limit, see the OPERATION section of the manual.

HARDWARE CONFIGURATION

CABLE SELECT

W2 determines whether the 7I40 connects to the motor 0,1 or motor 2,3 signals on the controller connector. When jumper W2 is in the right hand position, the 7I40 connects to the motor 0 and 1 signals on the controller connector. When jumper W2 is in the left hand position, the 7I40 connects to the motor 2,3 signals. For two axis controllers (like the 4I27), W2 must be left on the right hand position. For four axis controllers, two 7I40s may share a single 50 pin controller cable, one 7I40 jumpered to connect to motor 0,1 signals and the other 7I40 jumpered to connect to the motor 2,3 signals.

TTL/DIFFERENTIAL ENCODER SELECT

The 7I40 can operate with either single ended (TTL) or differential (RS-422) encoders. W1 selects the encoder mode for channel 1 and W6 selects the encoder mode for channel 0. When W1 or W6 is on the right hand position, TTL mode is selected. When W1 or W6 are on the left hand position, differential mode is selected.

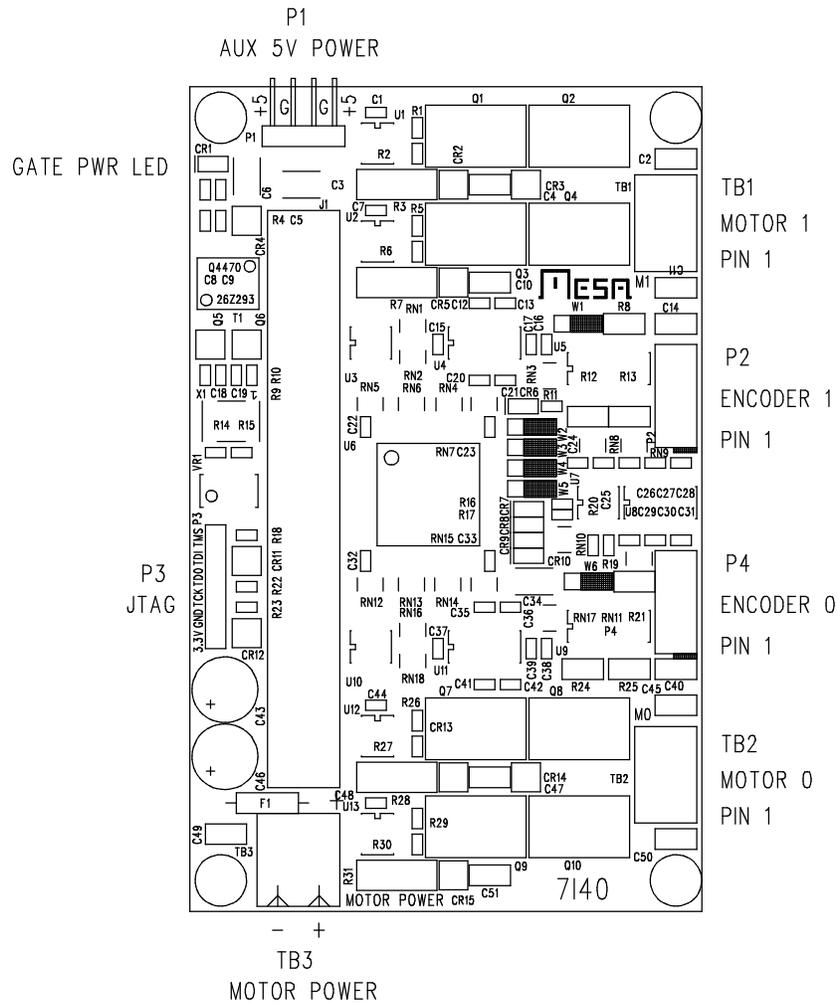
DECAY MODE SELECT

The 7I40 HBridge can operate in two basic modes, fast decay and slow decay. These modes determine the behavior of the Hbridge switches during the off time of the PWM cycle. The word decay refers to the decay of the inductive energy in the load during the off time. In slow decay mode the load is shorted by turning on both lower MOSFETS during the off time of the PWM cycle. This results in a minimum voltage across the load and therefore a slow decay of the inductive energy. In fast decay mode, the stored inductive energy is discharged back into the power supply, resulting in the fastest possible current decay. When jumper W3 is in the right hand position, slow decay mode is selected. When jumper W3 is in the left hand position, fast decay mode is selected.

For more information on DECAY MODE, see the OPERATION section of the manual.

CONNECTORS

CONNECTOR LOCATIONS AND DEFAULT JUMPER POSITIONS



CONNECTORS

CONTROLLER CONNECTOR

50 pin header connector J1 connects to the motion controller. This can be a male 50 pin header on the top of the 7I40 card or a female 50 conductor header on the bottom side of the 7I40 depending on 7I40 model. The controller connector pinout matches the 4I34M, 4I65, 4I68, 7I60, 5I20 pinouts. Controller connector pinout is as follows:

PIN	FUNCTION	DIRECTION	PIN	FUNCTION	DIRECTION
1	QB1	FROM 7I40	25	QB3	FROM 7I40
3	QA1	FROM 7I40	27	QA3	FROM 7I40
5	QB0	FROM 7I40	29	QB2	FROM 7I40
7	QA0	FROM 7I40	31	QA2	FROM 7I40
9	IDX1	FROM 7I40	33	IDX3	FROM 7I40
11	IDX0	FROM 7I40	35	IDX2	FROM 7I40
13	PWM1	TO 7I40	37	PWM3	TO 7I40
15	PWM0	TO 7I40	39	PWM2	TO 7I40
17	DIR1	TO 7I40	41	DIR3	TO 7I40
19	DIR0	TO 7I40	43	DIR2	TO 7I40
21	/ENA1	TO 7I40	45	/ENA3	TO 7I40
23	/ENA0	TO 7I40	47	/ENA2	TO 7I40
			49	+5V PWR	TO 7I40

Notes: 1. All even pins are grounded.

2. When W2 is in the right hand position, only signals on odd pins 1 through 23 are used, other inputs being ignored and outputs tri-stated conversely, when W2 is in the left hand position, only signals on odd pins 25 through 47 are used.

AUX 5V POWER

Four pin header P1 can be used to supply 5V power to the 7I40 if the controller cable is too long and +5V voltage drop too high. P1 has the following pinout:

PIN	FUNCTION
1	5V
2	GND
3	GND
4	5V

CONNECTORS

MOTOR CONNECTORS

The two 3 pin motor connector are 3.5 MM inline, Phoenix Contact 1843635. The suggested mating part is 1863181, This is a pluggable screw terminal type connector.

PIN	FUNCTION
1	MOTOR +
2	GND
3	MOTOR -

ENCODER CONNECTORS

The two encoder connectors are standard 10 pin male headers. Suggested female receptacle is AMP 1658622-1. This is an IDC type connector for flat cable. Encoder connector pinout is as follows:

PIN	FUNCTION	NOTE
1	ENC_+5V	
2	/ENC_QA	DIFFERENTIAL -
3	/ENC_QB	DIFFERENTIAL -
4	/ENC_QIDX	DIFFERENTIAL -
5	ENC_GND	
6	ENC_+5V	
7	ENC_QA	TTL/DIFFERENTIAL +
8	ENC_QB	TTL/DIFFERENTIAL +
9	ENC_QIDX	TTL/DIFFERENTIAL +
10	ENC_GND	

OPERATION

PWM RATE

The 7I40 can operate with PWM rates from 1 KHz to 100 KHz. Higher PWM rates will result in slightly higher switching losses and a larger dead zone. PWM rates are normally set above 20 KHz to avoid audible noise from the load.

DECAY MODE

The 7I40 can operate in slow decay and fast decay modes. Slow decay mode is a better choice for most applications as it results in a more linear ratio of output drive to PWM duty cycle and lower current ripple in the load. Slow decay mode also improves motor damping as the motor sees the Hbridge as a low impedance load.

Fast decay mode usually requires that a large offset be added to the PWM value since at reasonable PWM frequencies, no appreciable motor current will be generated until the PWM duty cycle gets above 50%. Fast decay mode has an advantage that the MOSFETs share the load more equally, while slow decay mode dissipates more energy in the low side MOSFETs. In fast decay mode the 7I40 uses synchronous rectification to reduce power dissipation in the MOSFETs. Synchronous rectification is not required in slow decay mode.

LOCKED-ANTIPHASE MODE

The 7I40 has equal blanking time for PWM and DIR changes. This means the 7I40 will operate efficiently in locked-antiphase mode if desired. In locked-antiphase mode, PWM is held high and DIR driven by the PWM signal. In locked-antiphase mode, a 50 % duty cycle PWM signal means 0 output drive. Decay mode has no effect when running in locked-antiphase mode, as there is no time (other than blanking time during switching) when all MOSFETS are off.

CURRENT LIMIT

Each 7I40H output channel can have its preset current limit set to 5A +-10% or 10A +- 10%. Each 7I40L output channel can have its preset current limit set to 7.5A +-10% or 15A +- 10%. When the current limit is reached the 7I40 will start operating in a fixed off time constant current mode, modulating the drive to maintain the current at the preset limit. Because the off time is long (200 uSec), Current limiting will result in reduced average output current (current foldback) so should be avoided for best performance.

OPERATION

OVER VOLTAGE PROTECTION

The 7140 has built in over voltage protection on motor power. This protects the 7140 from load dump type faults (for example disconnecting the motor power when current flows in the motor) without requiring large capacitors on the 7140 card. The over voltage protection functions by turning on all driver MOSFETS when motor power exceeds 48 VDC (7140L) or 92 VDC (7140H), thus shorting out the motor power. Once an overvoltage is detected the MOSFETS are all driven for a minimum of 20 uSec to prevent high frequency oscillations. If the 7140 is run at a motor power near the overvoltage threshold, an external capacitor may be needed to prevent voltage surges from inadvertently tripping the protection circuit. This capacitor is usually needed only if the power supply does not have a output capacitor.

OVER TEMPERATURE PROTECTION

The 7140 has 2 independent over temperature detection circuits, one per axis. These circuits will disable the output MOSFETS on the affected side when the card temperature reaches approximately 120°C. Once disabled, the output MOSFETS will be kept off for 5 seconds at which point the temperature is re-sampled, and the MOSFETS either enabled or disabled for another 5 seconds depending on whether the temperature is above or below 120°C.

TTL INPUT CIRCUIT

The TTL input circuit on the encoder A,B, and index inputs consists of a RC filter followed by a Schmitt trigger. This helps to reject spike noise on the encoder lines. The input circuit inverts the signals, so, for example, an active high index signal will be active low at the controller interface.

MAXIMUM TTL COUNT RATE

The input RC filter limits the maximum encoder input frequency to approximately 1 MHz. This corresponds to 4 million counts per second with most quadrature counters (4X mode). The maximum input frequency may be lower with encoders that have high value (>1K Ohm) pullup resistors on open collector outputs.

OPERATION

DIFFERENTIAL INPUT CIRCUIT

The 7140 can interface to differential encoders. Differential encoder signals have better noise immunity and are a good choice when cable lengths are long or a noisy electrical environment is present. The differential encoder inputs are enabled when W6 (channel 0) or W1 (channel 1) are in the right hand position.

MAXIMUM DIFFERENTIAL COUNT RATE

The differential receivers used on the 7140 limit the maximum input frequency to 10 MHz resulting in a maximum count rate of 40 MHz.

5V POWER

The 7140 requires ~150 mA of 5V power for operation. Encoder power is also supplied from the 7140's 5V source. Power for the 7140 is normally supplied from pin 49 of the 50 conductor controller cable, but can also be supplied via P1. If external 5V power is supplied via P1, make sure that controller the pin 49 power is disconnected. This is done via a jumper on Mesa's FPGA cards.

OPERATION

MOTOR POWER

Motor power is supplied via terminal block TB3. Positive motor power is on the right hand side of the terminal block, negative power on the left. The negative motor power is connected to ground on the 7I40 card. Because the 7I40 control signals are not isolated from motor power, some precautions need to be followed:

1. The motor power supply needs to be isolated from system ground (floating).
2. The negative motor power lead should connect to ground only at the 7I40 card.
3. If multiple 7I40 cards are used, their negative motor power leads should be connected together first with a minimum length of heavy wire, 6 inches maximum of 18 GA wire or heavier.

Maximum motor voltage for the 7I40L is 40VDC. Maximum motor voltage for the 7I40H is 80V. Note that the absolute maximum motor voltage is 45 VDC for the 7I40L and 85V for the 7I40H. Gate power on the 7I40 is derived from 5V power, which allows the 7I40 to function properly all the way down to 0V motor power supply voltage. This can be useful for safe first time setup and testing by using low motor power supply voltages.

The total motor current supplied to both axis should be limited to 15 Amps continuous to prevent thermal overload. A 15A replaceable fuse is located next to the motor power terminal block.

LED FUNCTIONS

CR1	GATE POWER	YELLOW
CR6	3.3V OK	GREEN
CR7	FAULT ON AXIS 1	RED
CR8	PWM1 and /ENA1	YELLOW
CR9	PWM0 and /ENA0	YELLOW
CR10	FAULT ON AXIS 0	RED

Fault indication can be over voltage, current limit, or over temperature.

OPERATION

ENABLE INPUT

Each Hbridge circuit has an active low enable input. When this input is high, the Hbridge is disabled regardless of the state of the PWM inputs. A pullup resistor keeps the enable input high if the controller connection is lost.

MOTOR/ENCODER WIRING

The motor wires carry high voltage signals with fast rise times. These signals can easily couple into the low voltage encoder inputs, causing position counting errors. One or more of the following methods should be used to reduce this coupling:

1. Twist motor leads
2. Shield motor leads
3. Route motor leads away from encoder leads (do not bundle together)
4. Shield encoder leads.
5. Use differential encoder signals

Longer wiring runs may require all of these methods to be used together.

SPECIFICATIONS

	MIN	MAX	UNITS
5V POWER SUPPLY	4.5V	5.5V	VDC
5V POWER CONSUMPTION	---	150	mA
MOTOR SUPPLY VOLTAGE -- 7140L	0	40	V (1)
MOTOR SUPPLY VOLTAGE - 7140H	0	80	V (2)
IDLE MOTOR SUPPLY CURRENT	---	5	mA
CONTINUOUS PER MOTOR CUR. -- 7140L	---	10	A (3)
CONTINUOUS PER MOTOR CUR -- 7140H	---	7	A (3)
TOTAL CONTINUOUS CURRENT -- 7140L	—	15	A
TOTAL CONTINUOUS CURRENT -- 7140H	---	10	A
ENCODER FREQUENCY (TTL)	DC	1	MHz
ENCODER FREQUENCY (DIFF)	DC	10	MHz
OPERATING TEMP.	0	+70	°C
OPERATING TEMP. (-I version)	-40	+85	°C
OPERATION HUMIDITY	0	95%	NON-COND

Notes:

1. 45V is absolute maximum rating due to 47V 3% over voltage clamp
1. 85V is absolute maximum rating due to 91V 3% over voltage clamp
3. Motor current rating is at 55°C ambient.