Simple Bridge
Stand Alone H-Bridge Data Sheet

Revision 1
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1.0 Revision Log

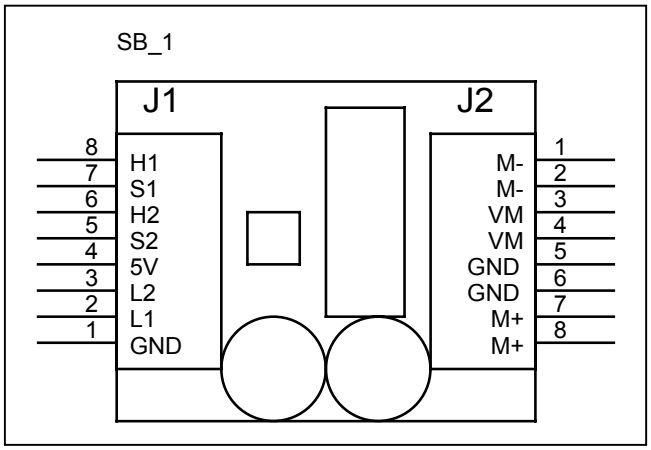
Date	Rev	Description	By
08-05	1	Original Implementation	L. Glazner

2.0 Introduction

Simple Bridge
Stand Alone H-Bridge Module

FEATURES

- Up to 6A continuous current (25A peak)
- 6-24VDC brush motors or other 2 terminal load (lamp, heater, etc)
- Tiny 1.7" x 1.6" packaging
- Two 8-pin 0.1" locking headers
- Under-voltage, over-temperature, over-current protection built in
- 14mΩ low-side, 26mΩ high side MOSFETS
- Dual status flag outputs



2.1 Description

The Simple Bridge is capable of bi-directional control of one brushed DC motor or other two-terminal DC load (such as a lamp or thermoelectric module). The small footprint, low cost, and ease of use allow the Simple Bridge to fit many design needs. Control of the on-board H-bridge is accomplished with 4 i/o lines, each controlling a switch of the H-bridge (2 high-side, and 2 low-side). Using a microcontroller, and pulse width modulating the low-side switches allows for speed control. Individual control of the H-bridge switches also allows for dynamic braking.

The Simple Bridge H-bridge is rated for 25A peak, but due to the small package and thermal issues 6A is about the highest continuous current it will pass before on-board thermal protection causes it to cut-out. The high peak and moderate continuous current rating meets the needs of many motor control applications where large start-up currents are common.

The low-side switches are low rdson MOSFETS (14milliohm) and are controlled by a MOSFET driver IC for more efficient turn-on/off times when pulse width modulated. The high-side switches are smart MOSFETs (26milliohm) with over-current, over-temperature, and under voltage protection built in.

The board measures 1.7" x 1.6" x 0.6", and comes with two 8-pin locking headers (0.1" spacing).

Note: In this datasheet hexadecimal values are represented by a prefix of "0x". For example decimal 10 is represented as 0x0A.

3.0 Electrical – Mechanical – Functional Descriptions

3.1 Absolute Maximum Ratings

These are stress ratings only. Stresses above those listed below may cause permanent damage and/or affect device reliability. The electrical characteristics should be used to determine applicable ranges of operation.

Storage Temperature	-50°C to +150°C
Operating Temperature	-40°C to +125°C
Motor Voltage (VM pins)	+6V to +36.0V
MOSFET Driver Voltage (5V pin)	+4.5V to +22.0V
Voltage on pins L1, L2, H1, H2	-5.0 V to 5V pin + 0.3V
Voltage on VM, M+, M-	40V transient spike
Motor Current Load	25A peak / 6.0A continuous

3.2 Electrical Characteristics

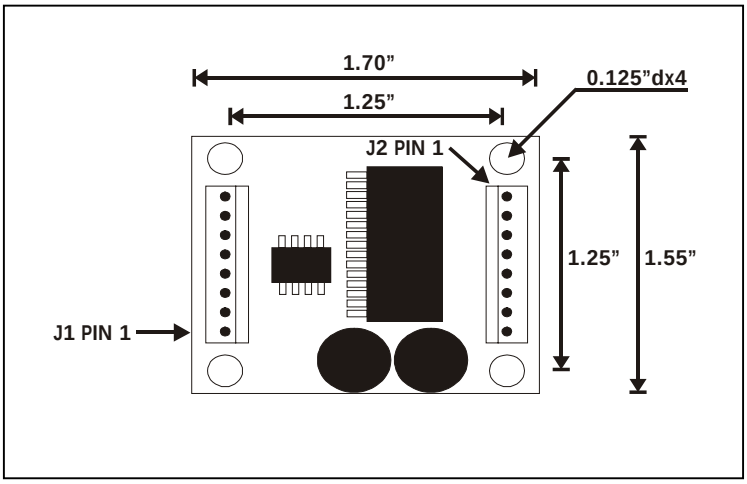
Characteristic	Min	Typ	Max	Unit	Notes
Motor Supply Voltage	6		24	V	VM pins
MOSFET Driver Voltage (5V pin)	4.5		18	V	5V pin
Over-current trip point	25	32	42	A	The higher the temperature the lower the trip point
Peak load current			25	A	<100ms pulsed at a period of 1S
Max continuous motor current	5.0		6.0	A	Continuous current rating at room temp. 90% duty-cycle, resistive load.
Under-voltage shutdown VM pin	1.8		4.5	V	VM voltage that causes under-voltage fault
Under-voltage turn-on VM pin			5	V	VM voltage that allows H-bridge to turn on
Over-temperature shutdown	155	180	190	°C	Hysteresis is 10C (if shutoff occurs at 175°C then fault clears at 165C)
Low Level Input L1, L2, H1, H2 pins		1.0		V	Pins pulled to ground with 10kΩ resistor
High Level Input L1, L2, H1, H2 pins		2.5		V	Pins pulled to ground with 10kΩ resistor
Low Level Output S1, S2 pins		0.2	0.6	V	Pins pulled to 5V pin voltage with 10kΩ and limited to 5.4V with internal zener diode.
High Level Output S1, S2 pins	5.4			V	Pins pulled to 5V pin voltage with 10kΩ and limited to 5.4V with internal zener diode.
Low Level Output TM pin			0.6	V	TM pin has a 270Ω resistor in series on the PCB
Low side MOSFET turn-on time			210	ns	
Low side MOSFET turn-off time			300	ns	
High side MOSFET turn-on time			220	us	
High side MOSFET turn-off time			250	us	

note: “Typ” values are for design guidance only and are not guaranteed

3.3 Mechanical Dimensions

The following diagram may be used to develop PCB carrying boards or enclosures used to fit the controller into custom designs. The mounting holes may be used with 4-40 machine screws and nuts

Figure 1: Mechanical Dimensions



Mechanical Landmark Descriptions

Landmark	Type	Description
J1	1x8 0.1” locking straight header	Control lines connect to this headers
J2	1x8 0.1” locking straight header	Motor connections are made to this header

3.4 Connectivity Overview

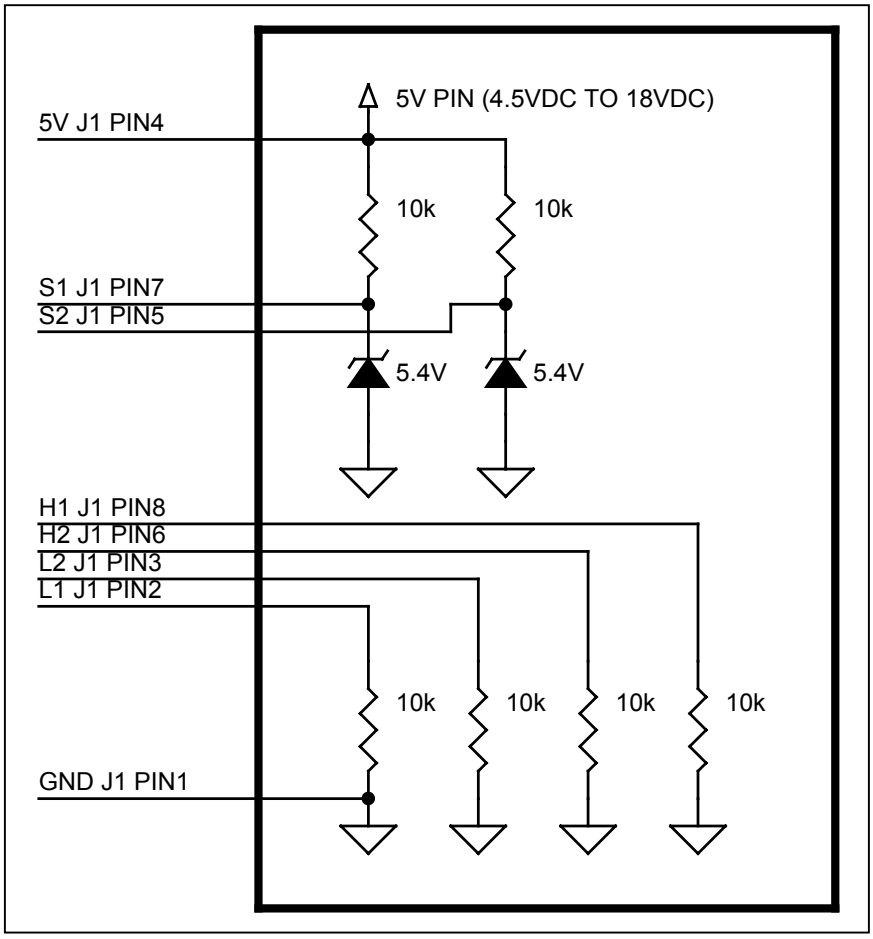
J1 Control Input Pin Descriptions

Pin	Name	Type	Description
1	*GND*	POWER	Control line connection ground return (common to J2 GND)
2	*L1*	POWER	Low side 1 MOSFET control line, pulled to ground with 10kΩ resistor. Logic high turns on MOSFET
3	*L2*	OUTPUT	Low side 2 MOSFET control line, pulled to ground with 10kΩ resistor. Logic high turns on MOSFET
4	*5V*	INPUT	MOSFET driver IC power supply. While named 5V this pin will accept voltages from +4.5VDC to +18VDC.
5	*S2*	INPUT	Status of high side 2 MOSFET, pulled to 5V pin internally with 10kΩ resistor, and limited to 5.4V by internal Zener diode. If connected to anything other than a high-impedance (input) pin a series resistor should be included.
6	*H2*	INPUT	High side 2 MOSFET control line, pulled to ground with 10kΩ resistor. Logic high turns on MOSFET
7	*S1*	POWER	Status of high side 1 MOSFET, pulled to 5V pin internally with 10kΩ resistor, and limited to 5.4V by internal Zener diode. If connected to anything other than a high-impedance (input) pin a series resistor should be included.
8	*H1*	POWER	High side 1 MOSFET control line, pulled to ground with 10kΩ resistor. Logic high turns on MOSFET

J2 Motor Connection Pin Descriptions

Pin	Name	Type	Description
1	*M-*	OUTPUT	Negative motor lead connection
2	*M-*	OUTPUT	Negative motor lead connection
3	*VM*	POWER	Motor power supply connection
4	*VM*	POWER	Motor power supply connection
5	*GND*	POWER	Motor power supply ground return (common to J1 GND)
6	*GND*	POWER	Motor power supply ground return (common to J1 GND)
7	*M+*	OUTPUT	Positive motor lead connection
8	*M+*	OUTPUT	Positive motor lead connection

Figure 2: Internal Electrical Components



3.5 Controlling the H-bridge

The Simple Bridge is controlled via four control lines L1, L2, H1, and H2. Each line controls a switch in the H-bridge with "L" designating the low side and "H" the high side switches. Each switch is turned on with a logic high signal and turned off with a logic low signal. For variable speed control the low side switches can be turned off-and-on at a high rate of speed (such as with a pulse-width modulated signal). But the high side switches should be turned on and left in that state.

Shoot through conditions can occur and should be avoided. Always disable the low side switch associated with a particular high side switch (example L1 and H1 or L2 and H2) before enabling the high side switch.

Truth Table for H-Bridge Control

TRUTH TABLE	H2	L1	H1	L2
FORWARD	1	1	0	0
REVERSE	0	0	1	1
FORWARD – SPEED CONTROL	1	PWM	0	0
REVERSE – SPEED CONTROL	0	0	1	PWM
BRAKE TO GROUND	0	1	0	1
BRAKE TO SUPPLY	1	0	1	0
SHOOT THROUGH – DON'T DO THIS	1	X	X	1
SHOOT THROUGH – DON'T DO THIS	X	1	1	X

1 = LOGIC HIGH
0 = LOGIC LOW
X = DON'T CARE
PWM = PULSE WIDTH MODULATED

Figure 3: Switch Control Diagram

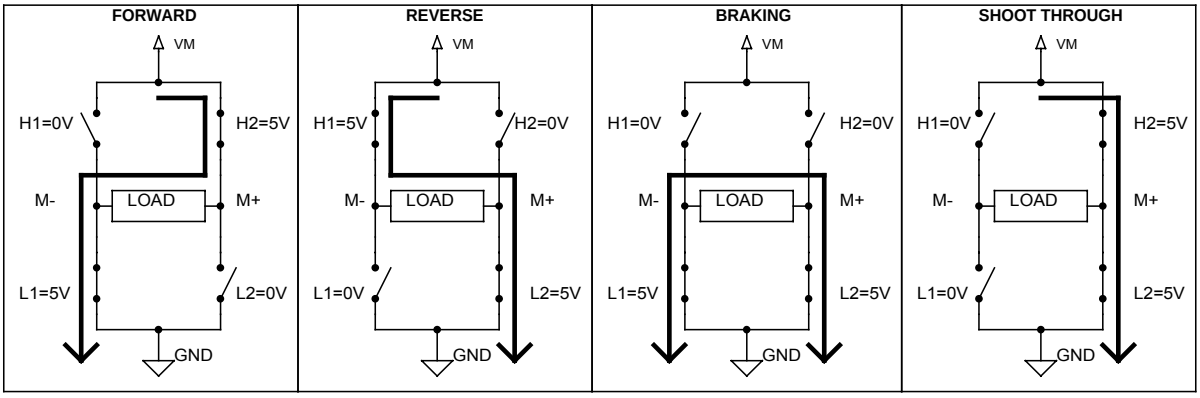
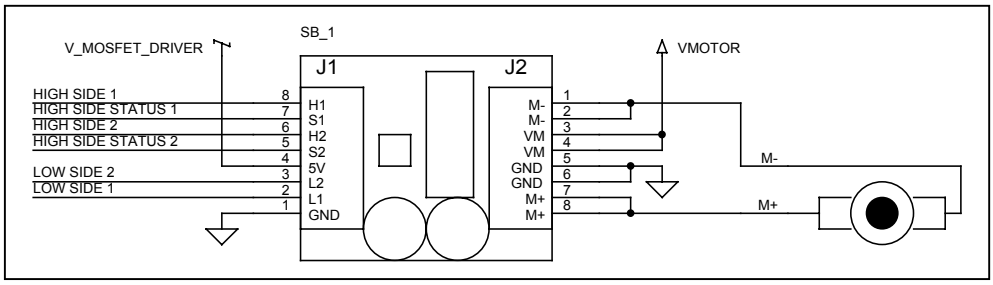


Figure 4: Standard Connections



3.6 Status Lines

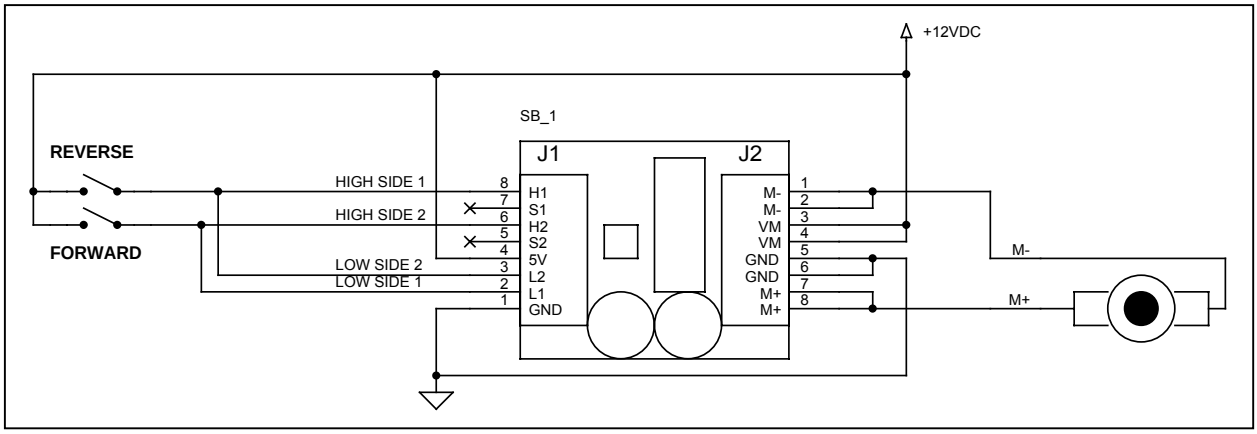
The Simple Bridge has 2 output lines used to monitor faults associated with the high side smart MOSFETs used on the module. These outputs are connected internally to 5.4V Zener diodes and pulled to the voltage at the 5V pin (+4.5VDC to +18VDC). When using voltages greater than 5V at the 5V pin a series resistor (1kΩ) should be attached between the fault lines and the controlling unit. If a fault condition occurs the Simple Bridge will pull the line low. The control lines must be in a specific state in order for the fault condition to be detected. Simply monitoring the status lines for a logic low will not provide good fault indications.

STATUS FLAG TABLE	H1	H2	M-	M+	S1	S2
OPEN LOAD AT M-	0	X	Z	X	0	1
OPEN LOAD AT M+	X	0	X	Z	1	0
OVER-TEMPERATURE H1 SWITCH	1	X	L	X	0	1
OVER-TEMPERATURE H2 SWITCH	X	1	X	L	1	0

1 = LOGIC HIGH
0 = LOGIC LOW
X = DON'T CARE
Z = HI IMPEDANCE STATE
L = SINKING CURRENT

3.7 Example Circuits

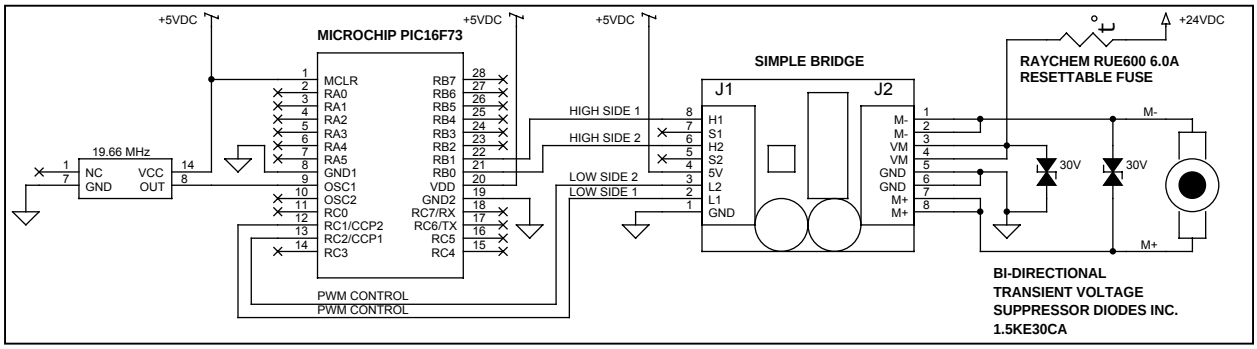
Figure 5: Button Drive 12VDC Motor Control



In figure 5 pressing the REVERSE button pulls H1 and L2 to +12V running the motor full-speed in reverse. Releasing the button allows the internal pull-down resistors to turn off H1 and L2. Pressing the FORWARD button pulls H2 and L1 to +12V causing the Simple Bridge to run the motor full-speed forward.

Pressing both buttons would result in a shoot-through condition (current running from the power bus straight through the H-bridge to ground). Additionally, there is no ability to create proportional speed control without some dedicated controlling unit. The next example describes a more robust system.

Figure 6: PIC16F73 Transient Protected 24VDC Motor Controller



In figure 6 a Microchip PIC16F73 is used to provide high and low side control. The high side switches are controlled with logic level signals (on or off), while the low side switches are controlled with the PWM capable CCPx hardware available in Microchips PIC16x7x series of controllers.

Additional protective circuitry is included with two bi-directional transient voltage suppressors (TVS). These parts act like very fast Zener diodes and short to ground when their turn on voltage is exceeded. In the case of transient voltages (short duration voltage spikes) the TVS will often turn-on (short to ground) and turn off (open) very quickly thus protecting the Simple Bridge. A resettable fuse is also shown as a means to limit the current flowing through the turned on TVS and motor system. The fuse selected will turn on at 12A and stay on until the load current drops below 6.0A.

```
‘ Note:  This code is not complete.  Additional configuration of the microcontroller registers would be required
‘ to have a fully-functional application.

SETUP_CCP_AND_PORTS
        clrf    CCPR1L          ;Set L2 PWM output to 0
        clrf    CCPR2L          ;Set L1 PWM output to 0
        movlw   H'0C'           ;Set CCP hardware for PWM mode
        movwf   CCP1CON         ;Load LSBs for on h-bridge
        movwf   CCP2CON         ;Load LSBs for on h-bridge
        bcf     PORTB,1;Set H1 PWM output to 0
        bcf     PORTB,0;Set H2 PWM output to 0
        bcf     TRISB,1         ;Set H1 control pin to an output
        bcf     TRISB,0         ;Set H2 control pin to an output

START
PWM_FORWARD                     ;Update PWM for forward
        clrf    CCPR1L          ;Set L2 PWM output to 0V
        bcf     PORTB,1;Set H1 PWM output to 0V
        bsf     PORTB,0;Set H2 output to 5V
        movlw   H’40’           ;Load 25% duty cycle into working register
        movwf   CCPR2L          ;Load PWM register associated with L1
        call    DELAY_30S       ;Dummy 30S delay, not really coded here

PWM_REVERSE                     ;Update PWM for reverse
        clrf    CCPR2L          ;Set L1 PWM output to 0V
        bcf     PORTB,0;Set H2 PWM output to 0V
        bsf     PORTB,1;Set H1 output to 5V
        movlw   H’40’           ;Load 25% duty cycle into working register
        movwf   CCPR1L          ;Load PWM register associated with L2
        call    DELAY_30S       ;Dummy 30S delay, not really coded here
        goto    START
```

4.0 Disclaimer / Warrantee

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