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1X3 Hex Switch Manual

High current, high side switching

Logos Electromechanical

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Introduction

The Logos Electromechanical hex switch is designed to enable users to switch DC loads up to 5A at up to 30V with no heat-sinking. It uses International Rectifier IPS6041 fully-protected high side MOSFET switches, which includes over-temp, over-current, and under-voltage protection on each switch. The high-side topology is safer in many applications than the more common low-side topology because a short to ground cannot energize the circuit while the switch is turned off, as it can with a low-side switch. Each channel has a protection diode to absorb the kick from switching off large inductive loads.

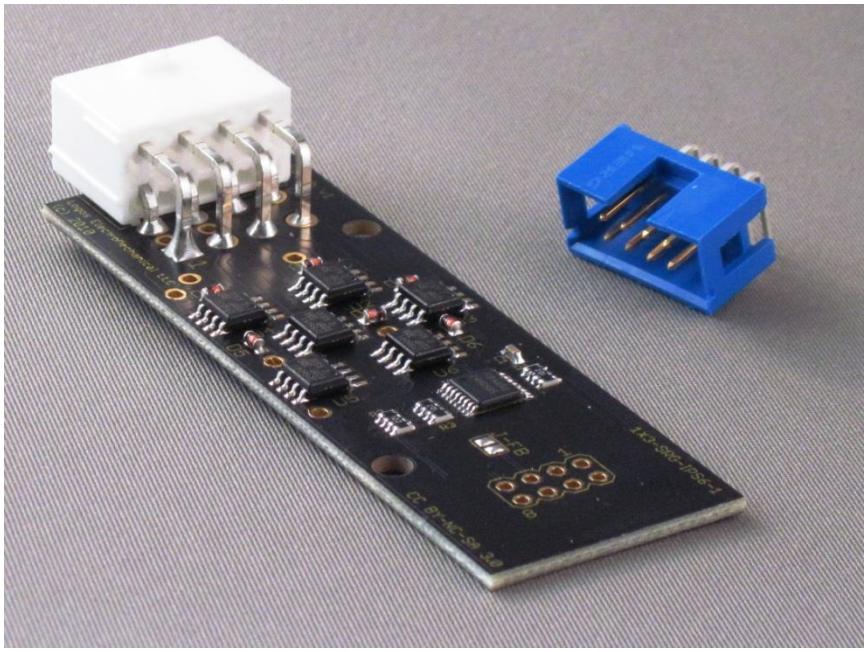

Figure 1: Kit Contents

The board is built with generous traces to handle the current with minimal voltage loss and heating on the board. A 74HC595 8-bit shift registers allow the control of six high current channels from only four logic inputs, and make it possible to daisy-chain as many as 50 boards together, for a total of 300 high current channels. In addition, it can be daisy-

chained with all other Logos output boards with a shift register input, i.e. those with a part number of the form *-SRG-*.

Board Overview

Board Layout

This board is divided into two sections – the logic section and the power section. The logic section, on the right side of Figure 2, carries the shift register that provides control of the switches. The power section on the left carries six IPS6041GPBF high side high current switches. Each can switch a 5A current at up to 30V. An anti-parallel diode protects each switch, enabling this board to be used for fast switching of inductive loads such as motors or solenoids.

All of the power for all six switches comes in through a single pin on the power connector. The Molex Mini-Fit Jr connector is rated to handle up to 12A per channel. Therefore, the continuous current draw from all switches must not be allowed to exceed 12A in order to avoid overloading the connector.

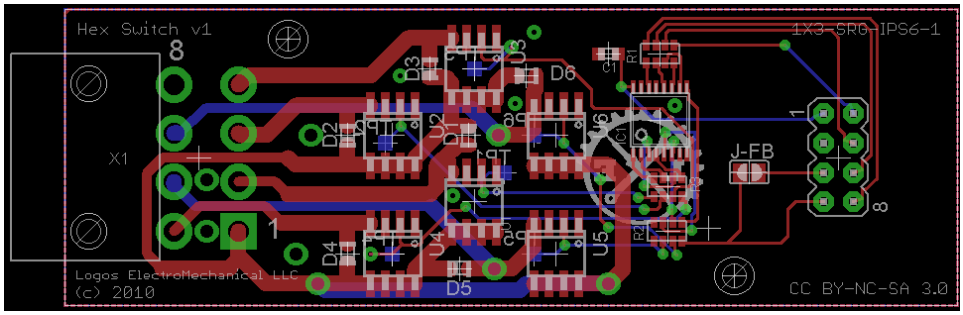

Figure 2: Board Layout

Like all 1X3 series boards, this board is designed for convenient mounting. The mounting holes and connectors are arranged to facilitate mounting the board inside an enclosure with the connectors projecting out on each side. Files for 3D printing a suitable enclosure will be coming soon to Thingiverse.

Pin Descriptions

Table 1: Input Connector Pinout

Input Pin	Name	Function
1	+5V	+5V power for shift registers
2	SCK	Serial Clock (positive edge)
3	GND	Ground
4	MR	Master Reset (active low)
5	DAT	Data Return
6	LAT	Register Clock (positive edge)
7	SOUT	Serial Data Out (to next board)
8	SIN	Serial Data In (from last board/host)

- **DAT:** Data return. This allows boards on a daisy chain to return data to the host. Each shift register compatible board has a jumper (J-FB) that allows this pin to be connected to the SOUT pin. The last board in a chain must have this pin jumpered to SOUT in order to enable data return.
- **LAT:** A positive edge on this pin latches the current contents of all of the the shift register to the outputs.
- **MR:** Pulling the Master Reset low clears all of the shift registers.
- **SCK:** A positive edge on this pin move the current value of the SIN pin to the least significant bit of the first shift register (IC1), and shifts every current bit in each shift register one bit up.
- **SIN:** The value of this pin is shifted in to the least significant bit of the first shift register
- **SOUT:** When a bit is shifted past the end of the second shift register (IC2) it appears on this pin. This is what allows multiple shields to be daisy chained.

Table 2: Power Connector Pinout

Power Pin	Name	Function
1	PWR	Power input for all switches
2	OUT1	Output for Switch 1 (bit 1)
3	OUT2	Output for Switch 2 (bit 2)
4	OUT3	Output for Switch 3 (bit 3)
5	OUT4	Output for Switch 4 (bit 4)
6	OUT5	Output for Switch 5 (bit 5)
7	OUT6	Output for Switch 6 (bit 6)
8	GND	Circuit ground (shorted to GND on input)

Pin 1 is marked by a square hole. Pin numbers count up down the same row as pin 1 and then up the other row from the same end as pin 1.

Electrical Characteristics

Table 3: Switch Electrical Characteristics

Symbol	Parameter	Max	Typ	Min	Units
R_{ds}(on)	Resistance, on state	0.13	0.12	0.11	Ω
V_{clamp}	Clamping Voltage	39	39	37	V
I_{lim}	Current Limit	10	7	4	A
V_{cc}Op	Recommended Operating Voltage Range	28	-	6	V
Td_{on}	Turn-on Delay Time	-	5	15	µs
T_r(90%)	Rise Time to 90% of V_{cc}	-	4	20	

Board Usage

Electrical Connection

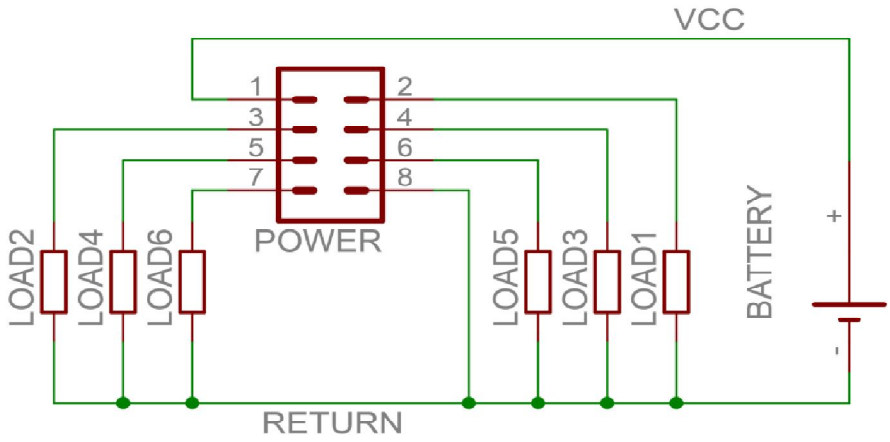

Figure 3: Typical Connection

The power connection to this board is through an eight-pin Molex Minifit Jr connector. This is the same family of connectors as is used for power supplies on most desktop computers. The connector body and crimp contacts are sold separately.

Figure 3 shows a schematic of a typical connection.

Software Interface

The switches are controlled by a 74HC595 shift register. The switches are wired to bits 1-6 of the shift register. Bits 0 and 7 are unconnected.

If you are using an Arduino as a host, the `shiftOut()` function provides a convenient method for controlling the shift register. The following code will write the contents of `switchByte` to the hex switch outputs. The pin names are as seen in Table 1.

```
digitalWrite(LAT, LOW); // Prepares latch
digitalWrite(MR, HIGH); // Deactivates master reset
shiftOut(SCK, SIN, MSBFIRST, switchByte); // shift data for S1-S6
digitalWrite(LAT, HIGH);      // latch data
```

Daisy Chaining

This board is designed to be daisy-chained in order to get greatly expanded numbers of high current outputs off a fixed number of digital output pins. This requires a cable of the type shown in Figure 4. All of the pins are carried over, with the exception of SIN & SOUT (pins 8 & 7, respectively). SOUT of the source board must be connected to SIN of the next board, and so on down the chain.

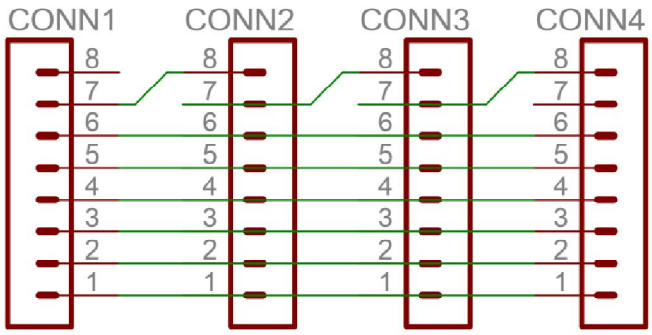

Figure 4: Daisy Chain Cable Schematic

If you're using IDC connectors with ribbon cable to make your daisy chain cable, this is straightforward. Assemble the first connector normally. At the second connector, separate and swap conductors seven and eight. After assembling the connector, cut conductor seven (now plugged into pin eight of the second connector) downstream of the second connector and conductor eight (now plugged into pin seven of the second connector) upstream of the connector. Assemble the third connector normally, but after you have assembled it, trim conductor eight downstream and conductor seven upstream. Assemble the fourth connector as you did the second and the fifth as you did the third, alternating for any additional connectors. See Figure 5 for how it should look.

The first connector is on the left hand side of the image.

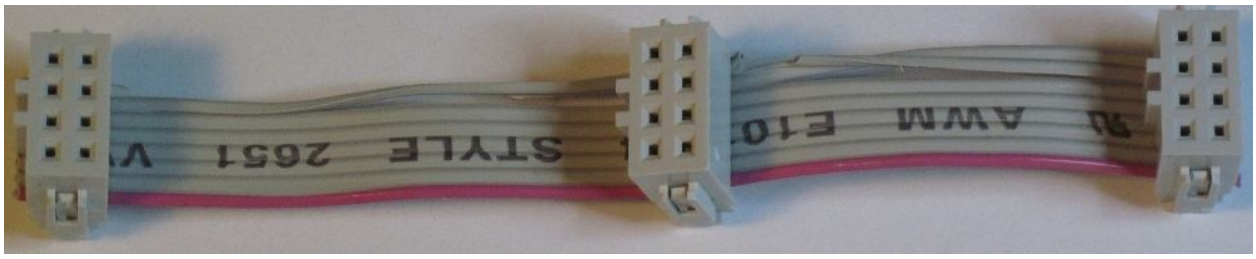

Figure 5: Daisy Chain Cable

Certain other Logos Electromechanical boards also use shift registers compatible with this shield – see the product page for which ones. They will have expansion connectors compatible with the eight pin connector on this shield.

References

Datasheet for 74HC595 shift registers http://datasheet.octopart.com/MM74HC595MTC-Fairchild-datasheet-12735.pdf

Datasheet for IPS6041GPBF http://www.irf.com/product-info/datasheets/data/ips6041pbf.pdf

Arduino Language Reference http://arduino.cc/en/Reference/HomePage