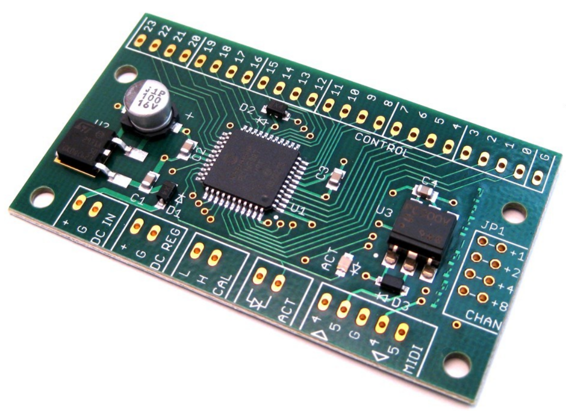
MIDI CPU

Hardware Revision K

User Manual



Updated 2010-09-08

Additional documentation available at:

http://highlyliquid.com/support/

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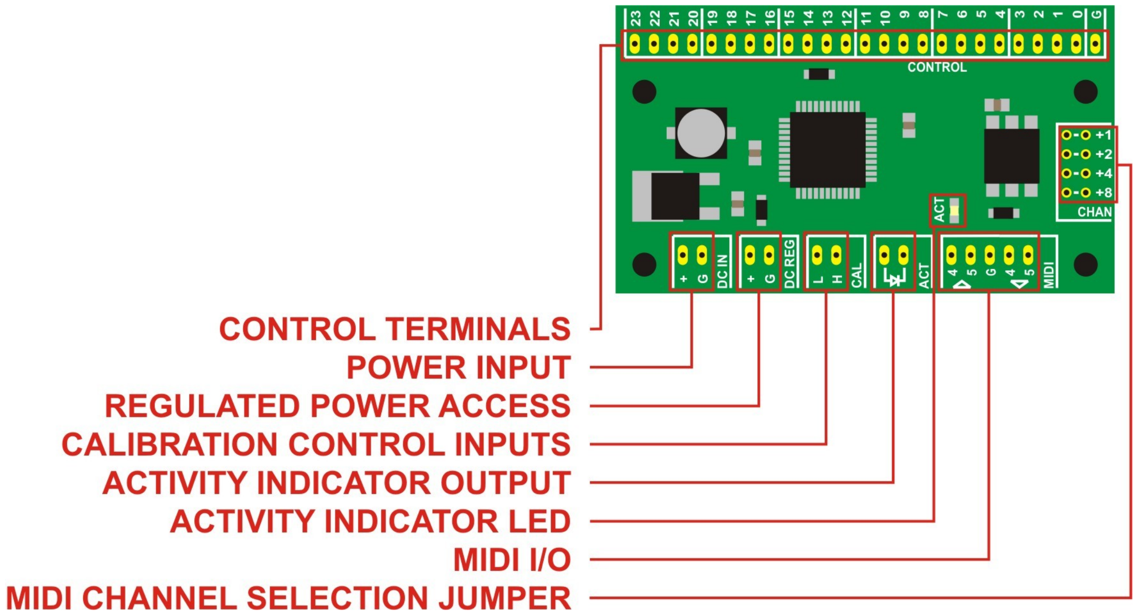
1.0 Important Safety Information

To prevent damage to the MIDI CPU and connected devices, and to prevent personal injury:

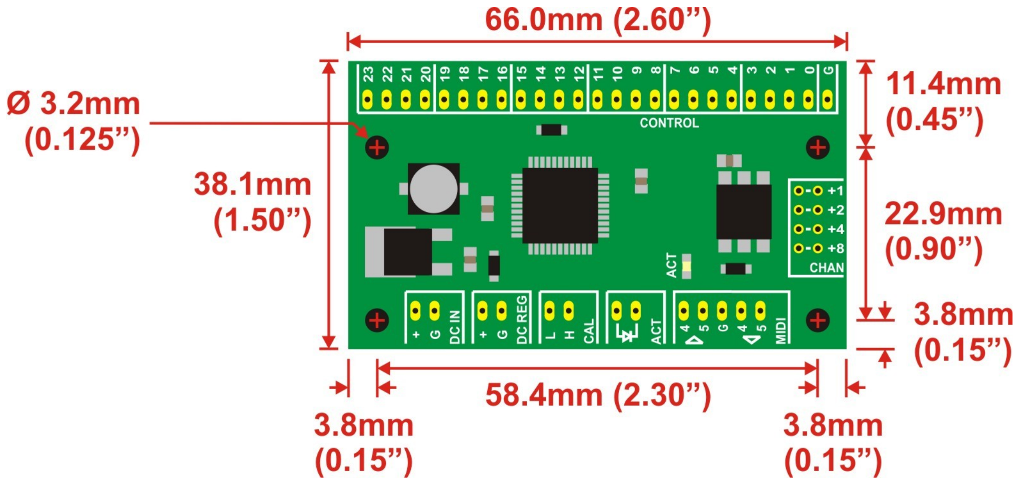
- Use an appropriate power source. Incorrect supply voltage could cause the MIDI CPU to overheat and/or cause the on-board electrolytic capacitor to explode.
- Do not connect signals which exceed the specified electrical maximums of the MIDI CPU.
- Do not exceed the specified maximum current load of MIDI CPU outputs. Overloading may damage the MIDI CPU and cause excess power consumption from the power supply.
- Take reasonable static control precautions when handling. The MIDI CPU contains ESD-sensitive parts.

2.0 Feature Diagram



- **Control Terminals:** Switches, potentiometers, encoders, control signals or indicator LEDs are connected here. See *Control Wiring*.
- **Power Input**: DC power input. See *Power Supply*.
- **Regulated Power Access:** Output from on-board voltage regulator. See *Voltage Regulation*.
- **Calibration Control Inputs:** See *MIDI CPU Firmware User Manual.*
- **Activity Indicator Output:** Can be used to control a remote activity indicator LED. See *Remote Power & Activity LED Wiring*.
- **Activity Indicator LED:** See *MIDI CPU Firmware User Manual.*
- **MIDI I/O:** Standard MIDI IN and MIDI OUT ports. See *MIDI Wiring*.
- **MIDI CHANNEL SELECTION JUMPER:** Optionally specifies the channel for MIDI input and output. See *MIDI Channel Selection Jumper.*

3.0 Mechanical Drawing



4.0 Power Supply

To operate, the MIDI CPU must be connected to a battery or other DC power supply. A "wall adapter" supply with appropriate specifications may be used. V_{SUPPLY} refers to the output voltage of the power supply.

4.1 Specifications

- V_{SUPPLY} **maximum**: 12VDC
- V_{SUPPLY} **minimum**: 3.3VDC*
- Power supply current capacity: 150mA or greater

*Note**:** If V_{SUPPLY} is less than 5.3V, the MIDI OUT signal generated by the MIDI CPU may not be strong enough to trigger some receiving devices.

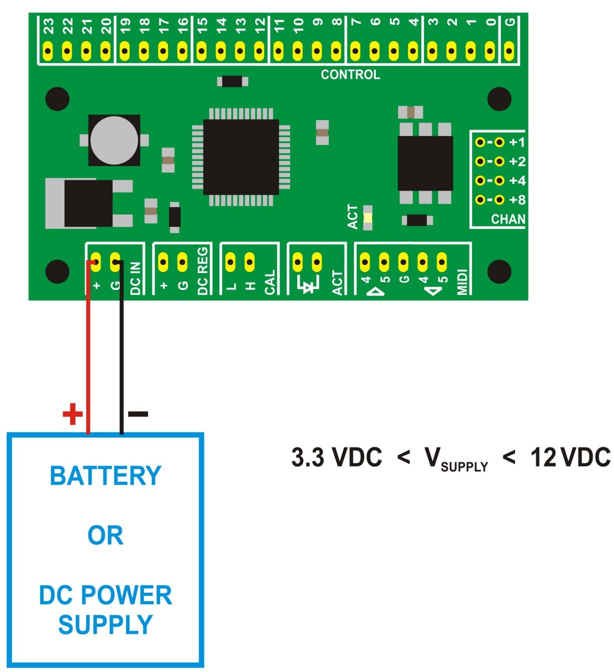
4.2 Wiring

Wire the battery or power supply to the MIDI CPU as shown in Figure 4.1. All MIDI CPU terminals marked "G" are MIDI CPU ground.

4.3 Voltage Regulation

The MIDI CPU has an on-board voltage regulator. The output of the regulator powers the on-board components and is accessible via the "DC REG" terminals. Regulator output voltage (V_{REG}) is the lesser of 5V or (V_{SUPPLY} − 0.3V).

Figure 4.1: Power Supply Wiring



5.0 MIDI Wiring

The MIDI CPU features both a MIDI IN and MIDI OUT port. Figure 5.1 shows the typical connection to other MIDI devices.

The MIDI standard specifies a 5-position DIN connector. Figure 5.2 shows MIDI receptacle pin numbering. The MIDI signal is carried by pins 4 & 5. Pin 2 is connected to ground at the OUT or THRU side of the MIDI link, and is left unconnected at the IN side of the link. Pins 1 & 3 are unused. Connector pin numbers are marked on the MIDI CPU. See Figure 5.3.

Multiple MIDI CPU units can be chained together. For this purpose, MIDI connectors can be bypassed: the OUT port of one unit can be wired directly to the IN port of the next device in the chain. See Figure 5.4.

Figure 5.1: MIDI IN/OUT

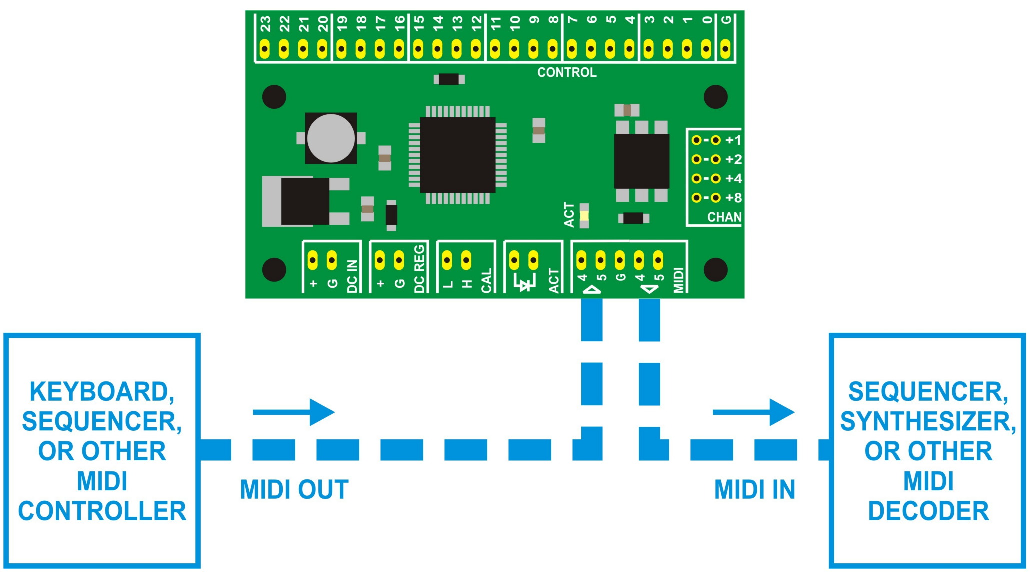


Figure 5.2: MIDI Receptacle Pin Numbering

Figure 5.3: MIDI Receptacle Wiring

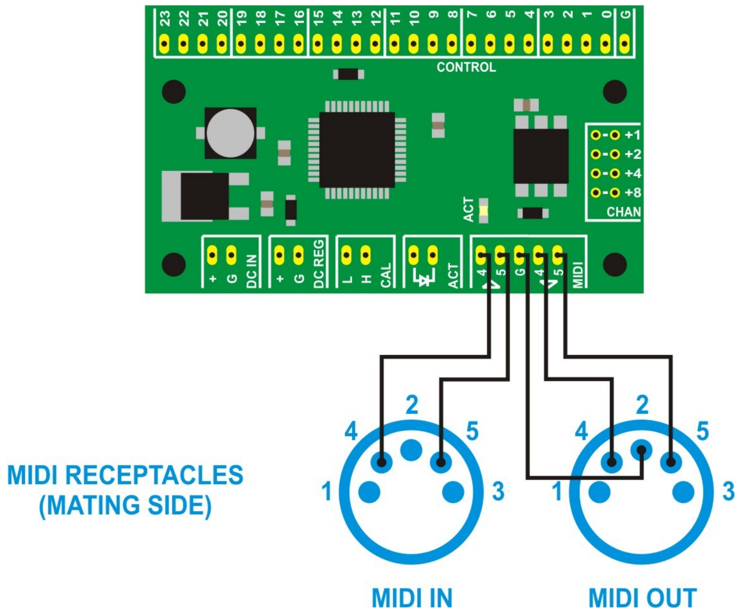
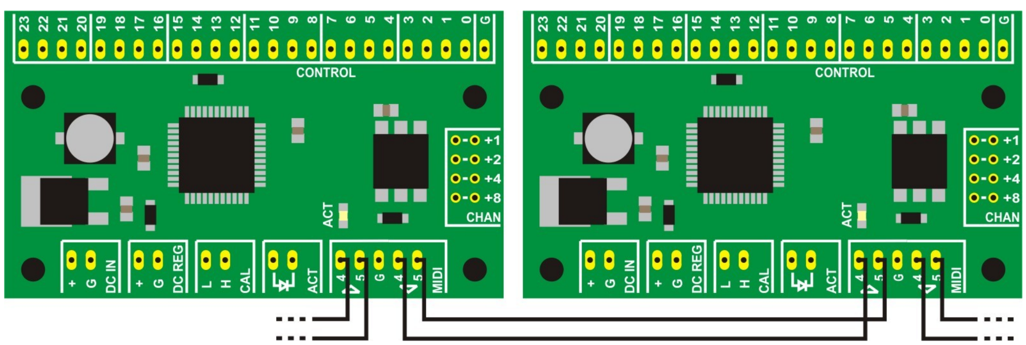


Figure 5.4: Multiple-Device Chain



6.0 Remote Power & Activity LED Wiring

The MIDI CPU includes an on-board activity indicator LED. If desired, user-supplied power & activity LEDs can be connected. Remote activity LED wiring is via the “ACT” terminals, and can be accomplished via one of two methods.

6.1 Power LED Wiring

A power indicator LED can be wired to the MIDI CPU as shown in figure Figure 6.1. Select a value for R_{LED} such that the ACT cathode terminal does not sink more than 20mA. R_{LED} = 1.0kΩ will work with most standard-brightness LEDs.

6.2 Remote Activity LED Wiring, Method A

The two leads of an LED can be wired directly to the ACT terminals of the MIDI CPU. This method will work with most standard-brightness LEDs. See Figure 6.2. The ACT anode terminal is connected internally to V_{REG} via a series 1.0kΩ current-limiting resistor.

6.3 Remote Activity LED Wiring, Method B

A user-supplied resistor can be used to limit the current through the remote LED. See Figure 6.3. Select a value for R_{LED} such that the ACT cathode terminal does not sink more than 20mA.

The ACT cathode terminal is a standard logic output capable of driving external circuitry.

Figure 6.1: Power LED Wiring

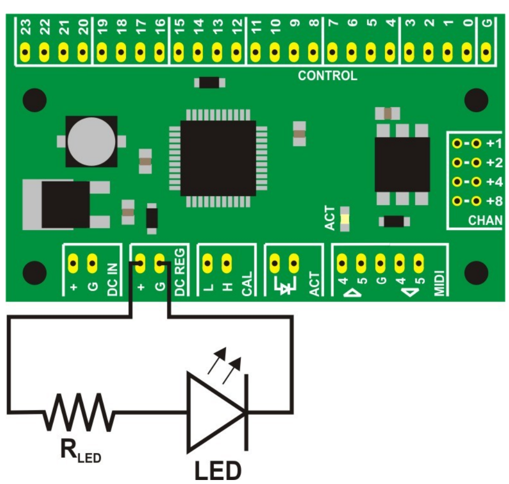


Figure 6.2: Remote Activity LED Wiring, Method A

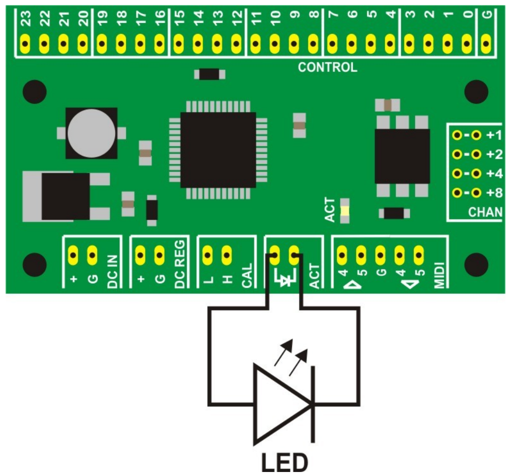
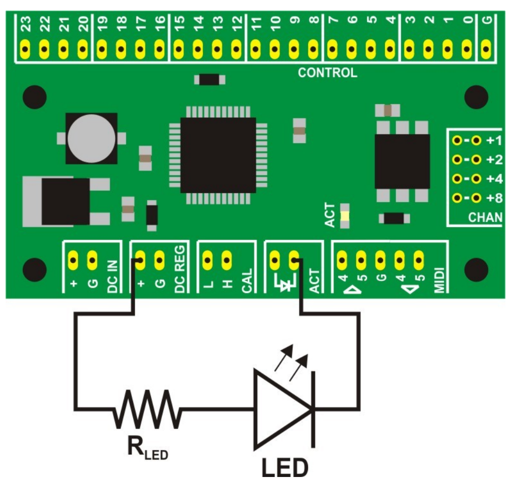


Figure 6.3: Remote Activity LED Wiring, Method B

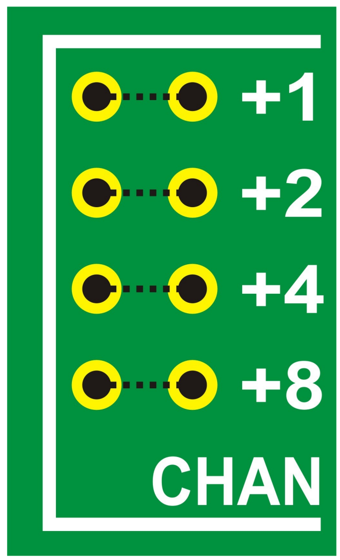


7.0 MIDI Channel Selection Jumper

The MIDI Channel Selection Jumper can be used to select the channel for MIDI input or output. See *MIDI CPU Firmware User Manual* for more information.

The channel selection jumper consists of 4 pairs of terminals. To specify a channel, connect zero or more terminal pairs as indicated by the dotted lines in Figure 7.1. A shorting block or piece of wire can be used.

Figure 7.1: MIDI Channel Selection Jumper Wiring



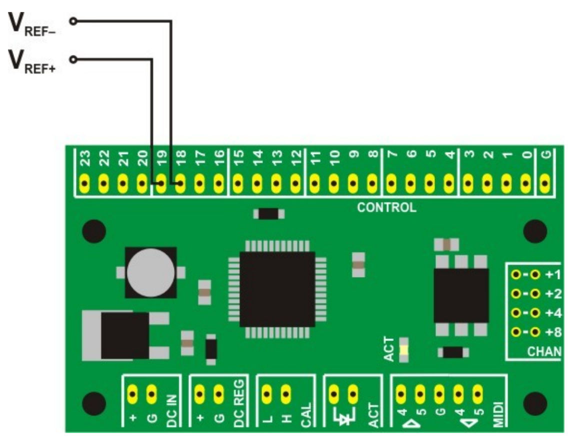
8.0 Reference Voltage Wiring

The MIDI CPU can optionally use external reference voltages for analog-to-digital conversion. See *MIDI CPU Firmware User Manual* for more information.

External reference voltages are connected to MIDI CPU control terminals 18 and 19 as shown in Figure 8.1. Only control terminals 18 and 19 can be used for this purpose.

When configured for reference voltage input, control terminals 18 and 19 are subject to minimum and maximum input voltages as described in *Absolute Maximum Ratings*.

Figure 8.1: External Reference Voltage Wiring



9.0 Control Wiring

Each MIDI CPU control terminal can be configured for one of up to three control functions:

- **Logic Input.** A logic input can be connected to a switch, switch matrix, or an externally generated logic signal. All control terminals are pulled up to V_{REG} via internal pull-up resistors.
- **Analog Input.** An analog input converts an incoming analog signal to a digital value. The analog signal can be generated by a potentiometer, variable resistor, or other circuitry.
- **Logic Output.** A logic output generates a signal which is used together with logic inputs to monitor a switch matrix or drive an LED matrix.

Not every control terminal can perform every function. See Table 9-1. For more information about reference voltage, see *Reference Voltage Wiring*.

Table 9-1: Control Terminal Function Summary

Control Terminal	Logic Input	Analog Input	Logic Output	Reference Voltage
0	√		√	
1	√		√	
2	√		√	
3	√		√	
4	√		√	
5	√		√	
6	√		√	
7	√		√	
8	√	√	√	
9	√	√	√	
10	√	√	√	
11	√	√	√	
12	√	√	√	
13	√	√	√	
14	√		√	
15	√		√	
16	√	√	√	
17	√	√	√	
18	√	√	√	V_{REF-}
19	√	√		V_{REF+}
20	√	√	√	
21	√	√	√	
22	√	√	√	
23	√	√	√	

Different types of control wiring are described below. Any wiring scheme requires proper configuration of the MIDI CPU control terminals as described in *MIDI CPU Firmware User Manual.*

All terminals marked “G” are MIDI CPU ground and are internally connected to each other.

9.1 Basic Switch Input

Any logic input can be connected to an SPST switch. MIDI CPU ground is used as the common. See Figure 9.1. If a larger number of switch inputs are desired, a switch matrix may be used.

Because of the internal pull-up resistor connected to each control terminal, the terminal will be held V_{REG} when the connected switch is open.

9.2 Switch Matrix Input

In order to conserve control terminals, or to connect a large number of input switches, a switch matrix can be employed.

A switch matrix is a $d \times s$ array of switches where d is the number of data lines, and s is the number of select lines. Data lines are connected to MIDI CPU control terminals configured as logic inputs. Select lines are connected to MIDI CPU control terminals configured as logic outputs. Unneeded switches are omitted and replaced with an open circuit.

Figure 9.2 & Figure 9.3 each show an 8 x 4 matrix with 32 total switches.

The matrix in Figure 9.2 is suitable for applications where multiple simultaneous switch closures are not expected. Certain combinations of simultaneous switch closures will cause "aliasing" to occur, and may generate unexpected results.

The matrix in Figure 9.3 includes a diode connected in series with each switch. Common small-signal diodes such as 1N914 or 1N4148 are suitable. The MIDI CPU will accurately detect all switch states, regardless of the number or combination of closed switches. Use this approach when creating a polyphonic keyboard.

9.3 Potentiometer Input

Potentiometers (knobs, sliders, etc.) can be connected directly to MIDI CPU analog inputs as shown in Figure 9.4 and Figure 9.5. For best results, use potentiometer values between 1.0kΩ and 10kΩ. If larger potentiometer values are used, extra circuitry is required to reduce the impedance of the analog signal.

9.4 Rotary Encoder Input

2-bit rotary (quadrature) encoders can be connected to MIDI CPU inputs as shown in Figure 9.6.

9.5 Externally Generated Signal Input

Any MIDI CPU input can be connected directly to a signal generated by external circuitry. See Figure 9.7. Any input signal must meet the specifications described in *Absolute Maximum Ratings*.

9.6 Mixed Input

Any of the above control wiring schemes can be combined. Figure 9.8 shows a MIDI CPU connected to 4 basic switch inputs, a 4 x 4 switch matrix, 8 externally generated signals, and 4 potentiometers.

9.7 Indicator LED Matrix Output

Indicator LED, LED 7-segment display, and LED bar graph wiring diagrams are included in *MIDI CPU Firmware User Manual.*

Figure 9.1: Basic Switch Input

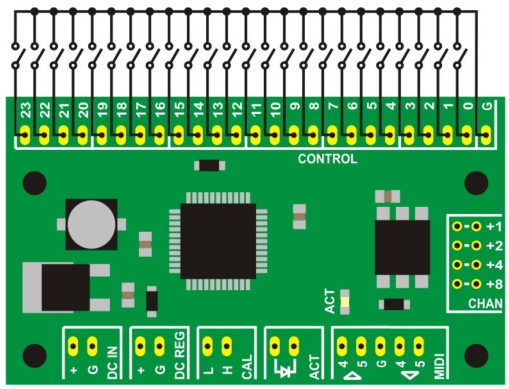


Figure 9.2: Switch Matrix Input, Without Diodes

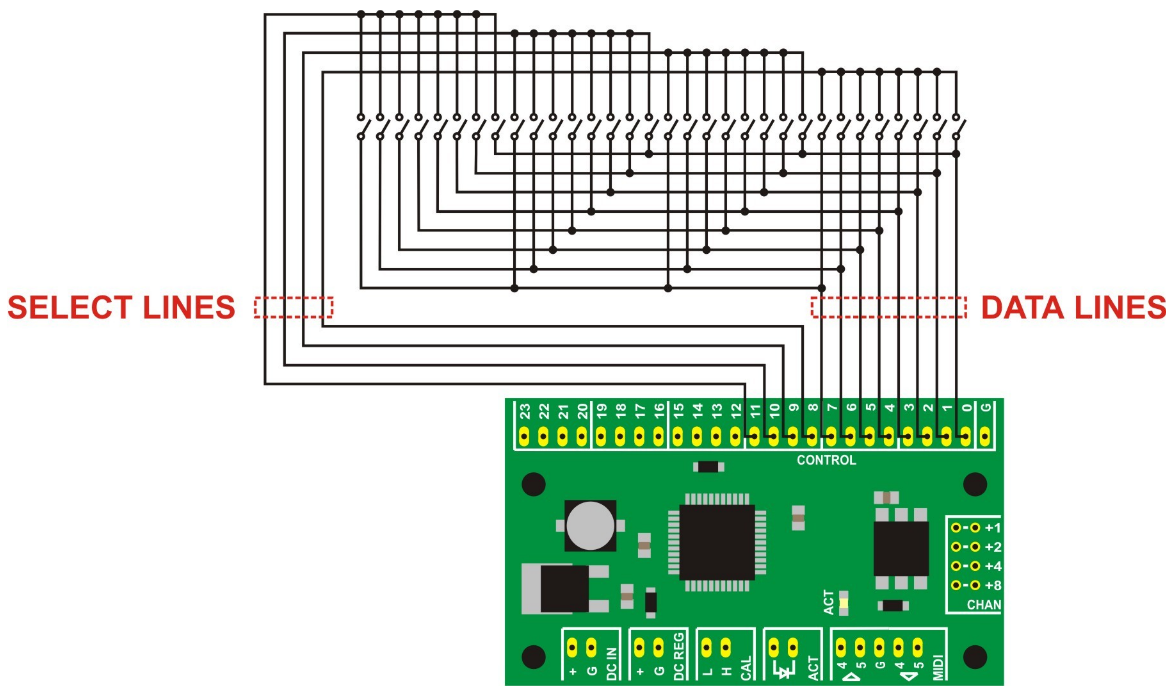


Figure 9.3: Switch Matrix Input, With Diodes

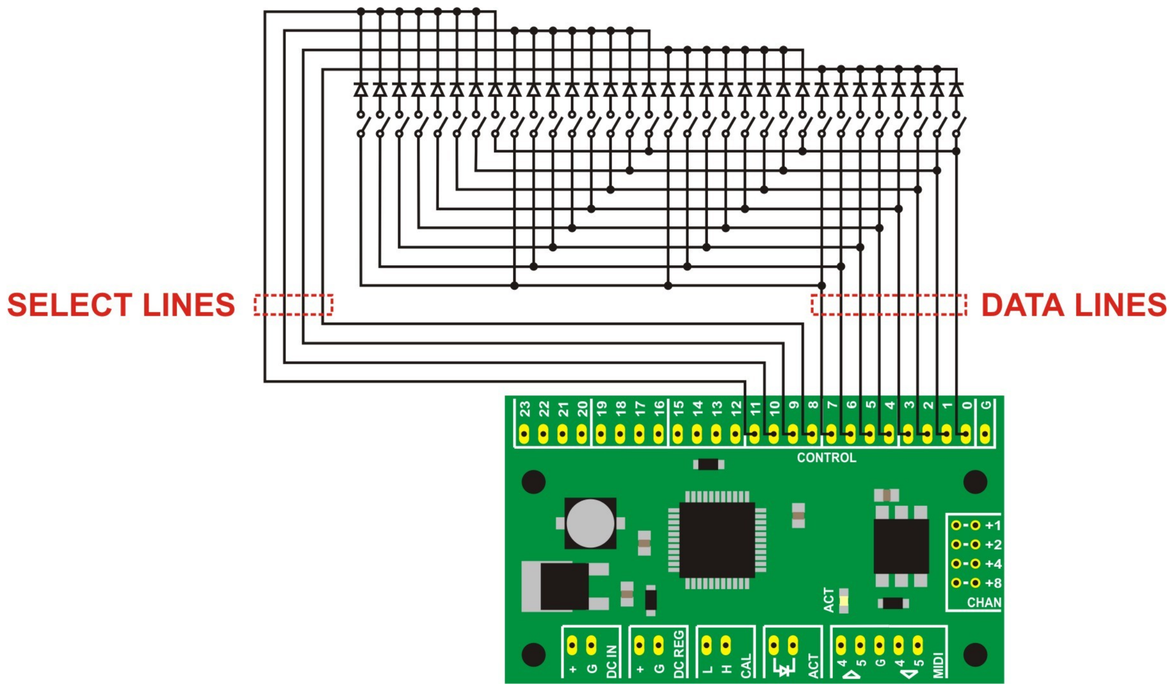


Figure 9.4: Potentiometer Input with On-Board Reference Voltages

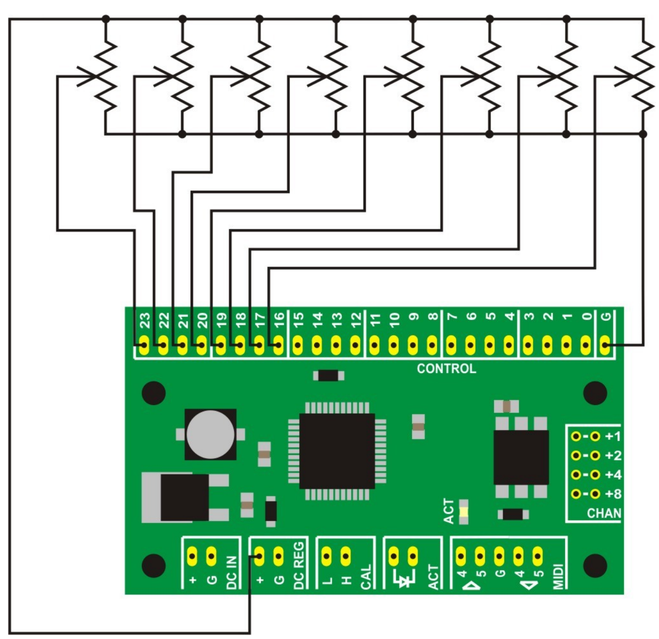


Figure 9.5: Potentiometer Input with External Reference Voltages

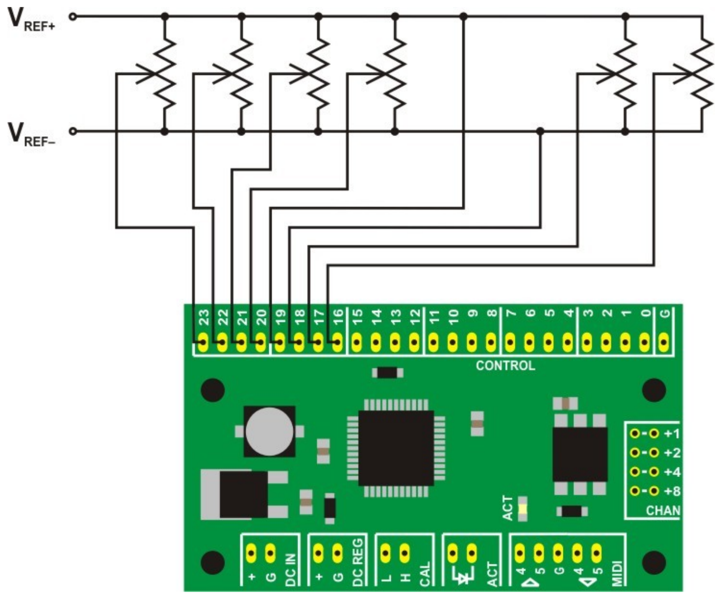


Figure 9.6: Rotary Encoder Input

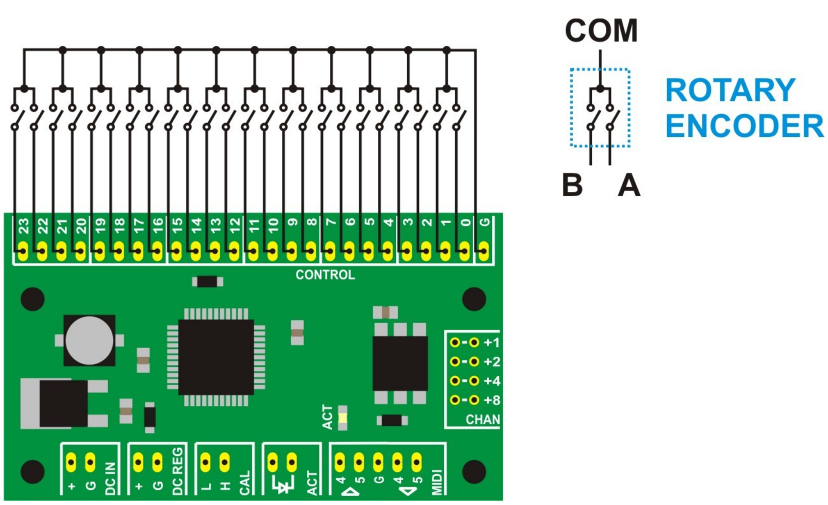


Figure 9.7: Externally Generated Signal Input

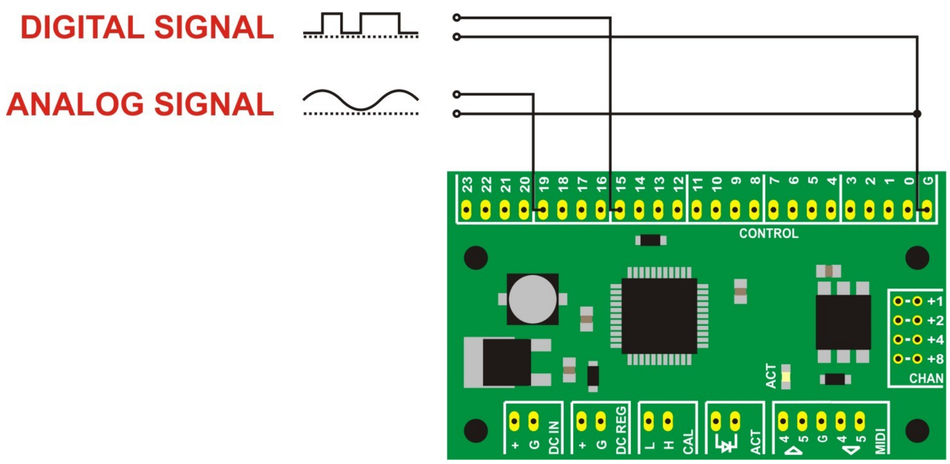
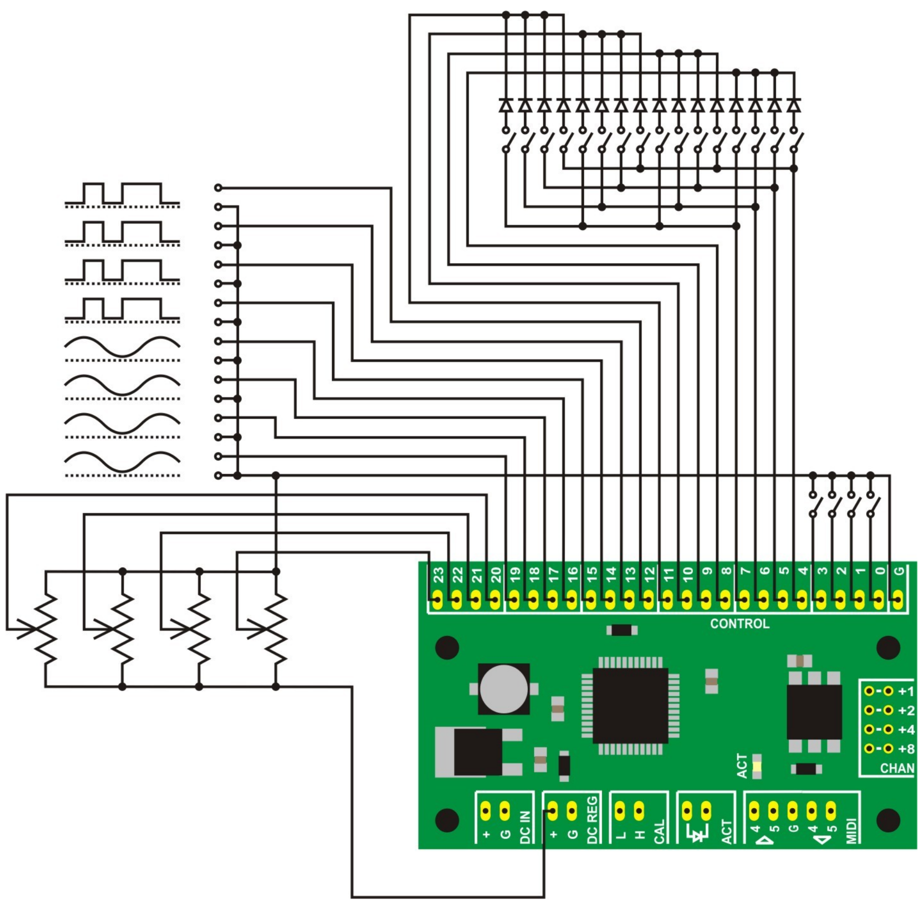


Figure 9.8: Mixed Input Wiring Example



10.0 Electrical Specifications

10.1 Absolute Maximum Ratings

- Maximum control terminal input voltage: V_{REG} (see *Voltage Regulation*)
- Minimum control terminal input voltage: MIDI CPU ground
- Maximum sink/source current per I/O terminal (includes "CONTROL" & "ACT" terminals): 20mA
- Maximum aggregate I/O sink/source current per MIDI CPU (includes all "CONTROL" terminals & "ACT" cathode terminal): 70mA
- Voltage regulator maximum output current (including load from on-board circuitry): 100mA