Curiosity Collective MIDI Controller Board (CC01-01)

Brief notes on the design of the MIDI Interface board.

The board is quite simple. At its heart is a PIC microcontroller (U2), a PICF873A. This is a flash device (meaning it can be reprogrammed many times). I chose it because it has a reasonable number of I/O pins, a fair size program memory (8K words), and an internal UART (Universal Asynchronous Receiver Transmitter) which is used for receiving and transmitting the MIDI data.

MIDI

The MIDI circuit is composed of connectors J8, J9, J10, an optocoupler (U4) and a hex Schmitt inverter chip (U3). The input current drives the LED in the optocoupler. (The optocoupler is there to provide isolation between the source of the MIDI and our circuit: this was originally intended as a way of avoiding ground loops between different musical instruments.) The output of the optocoupler is an open collector which is active (pulls low) when the internal LED illuminates. It needs a pull-up resistor (R3) in order to generate a voltage output. The output of the optocoupler is fed to the UART receive input and to the buffer that drives the 'MIDI Through' output. There is also a connection from the transmit output of the PIC, through a buffer, to the 'MIDI Out' connector. Currently, the firmware doesn't drive the MIDI Out - it could be used to make a MIDI input device of some kind with the board (i.e. sensor in, MIDI out).

Inputs

There are 8 inputs (other than the UART receive). Four of these connect to the 4-way bitswitch and the other 4 to the link header J7. All of them have a 10k pull-up resistor. The bitswitch is used to set the MIDI channel address. I intended the header J7 to take links (the push-on kind you use on computer motherboards). Alternatively, it could be used to interface to external switches or other devices.

Outputs

The main output is an octal darlington driver chip U1. This buffers the outputs from the PIC allowing them to drive higher currents and voltages. The outputs from the PIC are limited to the voltage range of the device (0-5V in this case) and could only drive about 15mA. The octal driver increases the voltage range up to about 50V and the current to several hundred milliamps; suitable for a relay coil, small solenoid, or small motor. The octal driver has internal diodes which, if tied to the power rail for the output parts, will catch the back emf generated by any inductive devices, so saving the drivers from damage. There are also placements for two power MOSFET transistors (Q1 and Q2) - depending which devices you fit here, these would be capable of much higher currents than the darlington driver chip (note: you might need a heatsink on these at high currents).

Crystal

The oscillator in the PIC uses an external crystal X1. The 16MHz frequency divides nicely to give the baud rate for the MIDI whilst running the PIC at a reasonable speed. Don't substitute a ceramic resonator for the crystal as we need the better accuracy of the crystal.

Power

Power to the board comes in on J6. The circuit requires +5V at ??mA. U5 is a voltage regulator that can be used to run the board from a higher voltage. If you already have a regulated source of +5V then you can leave off the regulator and link across from pin 1 to pin 3. If you do use the regulator, bear in mind that the power dissipated by the regulator depends on the difference between the input voltage and the regulated voltage. The higher the input voltage, the greater the power that will be dissipated (as heat). Ahead of the regulator is a bulk decoupling capacitor (C4). If you are going to regulate down from a higher voltage you need to consider the voltage rating of the device. As a general rule of thumb, for capacitors like this the device voltage should be more than twice the voltage that it actually sees – so if you have 24V going in, don't use a 25V rating tantalum bead capacitor for C4.

I've fed the +5V from the regulator back out of the power terminal block so that it can be used for other things (such as powering any 5V device on the output of the board). A standard 7805 regulator will limit at about 1A. Bear in mind that using the regulator in this way will increase the power dissipated.

Miscellaneous

There are two I/O pins on the PIC that aren't connected. These could be used simply by wiring them to the prototyping area at the top of the board. As well as working as ordinary inputs or outputs, they can also be set to operate as an I^2C bus for controlling other chips.

R6 and C8 form a simple reset circuit. The values aren't all that critical – the PIC will happily work with just a pull-up resistor to the +5V rail, though Microchip do now recommend that you use both components.

On the original circuit I show the hex inverter as a 74HCT04 device. When I ordered the bits from Rapid I discovered that the 74HCT14 hex Schmitt inverter was much cheaper so bought those instead. (What I'm saying is don't worry that the parts list seems to disagree with the circuit – it doesn't matter!)

Oh, and in case it's not obvious, the PIC has to be programmed in order to do anything. I chose not to use in-circuit programming (because it make for a messy circuit design around the PIC) so the device will have to be programmed out of circuit (which is why it's sitting in an IC socket).

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