Drum Pad MIDI Controller

Hardware Description
This percussive MIDI controller has three units: a 5-volt DC power supply, a modified practice drum pad, and a control unit. The power supply is a common wall plug type with a +5VDC regulated output. The maximum current output is rated at 3A, and it terminates in a 2.5mm coaxial plug.

The drum pad is a Remo tunable practice pad modified with a six-inch piezoelectric film transducer manufactured by Measurement Specialties Inc. The transducer signal is transmitted over a shielded twisted pair terminating in a 3.5mm stereo audio plug. The cable’s shield is connected at the plug side only to avoid a ground loop. The remainder of the hardware is contained in the control / interface.

The MIDI message is an asynchronous, serial bit stream composed of a status byte and one or two data bytes. The most significant bit is always 1 for a status byte, and 0 for a data byte. The scope of the project is limited to three types of messages. Program change allows the user to select a bank of related sounds. The sole data byte represents one of 128 \(2^7\) program numbers. The program number stays the same until a new program change message is received.

Note on and note off messages contain data bytes for note number and velocity information. For keyboard instruments, the program number typically refers to the type of instrument, such as piano, and the note number refers to the pitch, such as middle C. In drum controllers, the program numbers frequently represent drum sets with associated note numbers for various drum and cymbal sounds. While indirectly related, velocity information is more immediately related to the force with which a note is triggered (or released). As with program numbers, the MIDI standard allows for 128 note numbers and velocity values. The piezoelectric transducer generates an AC signal proportional to the mechanical stress of the film. This makes it an ideal “velocity” sensor.
The control / interface is designed around the MC68HC912B32 MCU (U5). +5VDC is connected at 2.5mm coaxial jack J1, and to the rest of the unit through ON / OFF switch SW1. 0.1µF decoupling capacitors are used at the several VDD inputs on the microcontroller, as well as the power inputs of the remaining integrated circuits.

Normally-open pushbutton switch SW2 initiates a note off message when ground is detected at Port P pin 5. Note off messages end a note currently being played. Most percussion sounds dampen out very quickly on their own. Therefore, the most predictable context for the note off is that of a choked cymbal. For this reason, the input is labeled “CHOKE_L”.

SW3 and SW4 are three-position momentary rocker switches that change the note and program numbers, respectively, by triggering up / down counter functions implemented by software. User feedback is provided through the display outputs at Port A via the ICM7218C (U3). The ICM7218C is designed to interface with a microprocessor. Four-bit data is written to locations for eight digits with a three-bit addressing scheme. The ICM7218C then decodes the data to seven-segment display format, and multiplexes the display codes to a set of common anode LED displays.

Since the maximum note and program numbers are 128 each, DSP1 and DSP2 are three-digit seven-segment LED displays. For this reason, DIG1 and DIG5 from the ICM7218C are not connected. Similarly, the decimal points are not used, and the active low decimal point input to the 7218, ID7_L, is tied high. MODE input pin 9 is a three level input. It is tied to mid-supply (+2.5VDC) for “code B” decoding. The +2.5VDC level is derived from voltage divider R4 and R5 via buffer U1D.

The main purpose of 2.5V buffer U1D is to provide a reference analog signal conditioning. The transducer signal enters the control / interface at 3.5mm stereo audio jack J2.
The shield is grounded on the control / interface end only to avoid a ground loop. The transducer signal is fed to the precision rectifier formed by U1B, U1C, R9, R10, D1 and D2. Ideally, this circuit’s output should be a full-wave rectified version of the transducer input with negative peaks traversing from +5VDC. The limitations of the LM324 require a reduced voltage level at this point (+3.9VDC approximately). This negative full-wave rectified signal is then summed at U2A with a threshold level determined by sensitivity resistor R7 and buffered by U1D. Since the summer is an inverting configuration, the negative peaks of the transducer signal will be converted to positive peaks, and, the lower the DC sensitivity level, the smaller the resultant signal peaks. The summed signal is also amplified in accordance with the setting of gain resistor R11. The signal is next fed to a two-pole low-pass filter at U2B before it is input to the HC12’s A-to-D converter at ANALOG IN.

The DIGITAL OUT signal is generated by the serial communications interface (SCI) of the HC12. The MIDI electrical specification calls for the interface circuit shown. J3 is a five-pin DIN connector with pin 2 grounded. Again, the specification calls for the cable shield connected to pin 2 to be grounded only at the MIDI OUT side. R23 and R24, connected to pins 4 and 5, respectively, form a current loop. The current loop drives an opto-isolator at the MIDI IN side, in accordance with the electrical specification. Switching inverters Q1 and Q2 allow current sourcing without loading the output of the SCI.