Fiber optic MIDI extender

Looking for a way to connect a distant MIDI device but don't have the cash for a wireless interface? Maybe this fiber optic extender is for you. MIDI cables are limited in length to about 50 feet by both the MIDI specifications and by cable capacitance and other practical considerations. Exactly how far you can go depends on the exact type of cable, the MIDI devices you use and the electrical noise environment around the setup. Some users will find a need to go much further than 50 feet especially as MIDI becomes more common in stage productions, theater lighting and other new applications. A simple extender can be built with the circuit described in this article. The extender uses fiber optic cable instead of wire in order to obtain good noise immunity, long distances and low cost. Two types of fiber optic cable may be used interchangeably. For lengths up to 160 feet, plastic optical fiber (POF) may be used. For lengths up to 1600 feet, hard-clad silica fiber (HCS) may be used.

OPERATION

Figure 1 is a photo of the MIDI extender. Short MIDI cables from a MIDI device such as a synthesizer connect to the standard MIDI IN and OUT connectors on the back of the extender. No changes need to be made to the MIDI devices on either end. Wherever a standard MIDI cable is used now, it may be unplugged and replaced with a pair of these extender boxes and a fiber optic cable. On the front panel, the snap-in, snap-out fiber optic connectors plug into the optical transmitter and receiver which send the MIDI data as pulses of red light to an identical extender on the other end of the fiber optic cable.

HOW IT WORKS

Referring to schematic Figure 2, data arrives at MIDI IN connector J1 and the current signal is converted to a TTL signal by optocoupler U5 and its 1K ohm pullup resistor. This signal drives U4A which turns the
Light Emitting Diode (LED) in U2 on and off as the MIDI data changes. The 47 ohm resistor sets the current in U2 to about 60mA while on. The 2.2K ohm resistor is part of the recommended circuit for U2 and reduces the pulse width distortion of U2 to less than a few nanoseconds. Since quite large currents are turned on and off rapidly in U2, C5 and C6 are needed to keep the supply voltage constant.

At this point red light leaves U2 and enters the fiber optic cable, traveling to a second MIDI extender. U1 converts the incoming optical signal to a TTL compatible logic signal. U4B and the 220 ohm resistors are then used to generate a current signal to drive the MIDI OUT signal of J2.

The AC to DC adapter provides power for project. Diodes D1-D4 are used so that either polarity of adapter will work. Select an adapter with 9VDC or 12VDC output. Capacitor C1 smoothes any residual ripple which may exist at the AC to DC adapter output. If you can only find an AC adapter with AC output in the 9 to 12VAC range, you can still use it, but you will need to increase C1 to 1000uF. The 7805 regulator (U3) provides an accurate source of 5V for the ICs. LED D5 and its 1K ohm drive resistor verify that power really is on when switch S1 is closed. Capacitors C2,C3,C7 and C4 act as bypass capacitors for U3,U1, U5 and the MIDI output reference respectively.

The fiber optic components and optocoupler are suitable for high-speed use so together they add less than 0.085 microseconds of pulse width distortion. Clearly no degradation occurs to the MIDI signals which are sent at 31,250 bits per second. For those concerned with delay time that might occur with long cables, even a 1600 foot version of this extender adds about 4 microseconds of delay. This won't be perceived as it's less than 1% of the time needed to send a MIDI note-on command.

HOW TO BUILD IT

Figure 3 shows the printed circuit board pattern. To assist in making your own PC board, a printer file version of the figures (in HP Laserjet format) which you can print on your laser printer is available from the Hewlett-Packard Optical Communications Division computer bulletin board at (408) 435-6733 under the filename MIDI1.ZIP. Figure 4 shows the placement of components on the PC board. No special requirements exist, just solder the components to the PC board in the orientation shown in Figure 4. U1 and U2 need to be sanpped together before they will fit on the PC board. The switch and LED should be soldered to the PC board via 6" long wires so they can be attached to the front panel. Be sure to observe the polarity markings on C1 since electrolytic capacitors can get VERY hot if reverse biased.

The AC adapter cable should be run through the rear panel of the enclosure and have a knot tied in it for strain relief before soldering the leads to the PC board in the place indicated in Figure 4. The PC board is
designed to fit inside the PacTec CM3-150K-BK enclosure. The rear panel should be punched or drilled to make room for J1, J2 and the AC adapter's cable and the front panel drilled to mount the LED, power switch and allow clearance for U1 and U2.

CABLE SELECTION

Two types of cable may be used for this MIDI extender. Plastic optical fiber (POF) with 1mm diameter is cheaper and may be used for lengths of 0 to at least 50m (about 160'). This cable is available in a few lengths with connectors already installed from Hewlett-Packard (HP) Components Distributors such as Arrow/Schweber Industrial Division, Hamilton/Hallmark, etc. It is also available as bulk cable with separate connectors and connectoring kits if you want just the right length and want to put on your own connectors. For example HP part number HFBR-EMD020 is a 20m (~65') duplex (like zip cord) POF cable with connectors on both ends and has a list price of $37.50.

Hard Clad Silica fiber (HCS) with 0.2mm diameter is slightly more expensive but has less loss so it can be used in longer runs - 0 to at least 500m (about 1600'). An example preconnectored HCS cable is HP part number HFBR-HND100 which is a 100m (~330') duplex cable assembly and has a list price of $189.00. Bulk cable and separate connectors are also available for HCS cable. The connectors are still easy to put on, but a fairly expensive ($999 list) toolkit (HP part number HFBR-4594) is needed.

If you push the cable distances you'll find that POF usually works to about 300' and HCS to about 3000' but you may not have any safety margin for the extender to keep working over time and temperature variations. Ask an HP distributor for data sheet HFBR-RXXYYY to find more detail on cable options and instructions for installing the connectors.

PARTS LIST

Capacitors
C1 ....100uF/16Velectrolytic RS 272-1044
C2,3,4,5,7 ....0.1uF ceramic RS 272-109
C6 ....1.0uF ceramic

Diodes
D1-D4 ....1N4001 1A 50V PIV RS 276-1101
D5 ....Red LED RS 276-044

Integrated Circuits
U1 ....fiber optic receiver HP HFBR-2528
U2 ....fiber optic transmitter HP HFBR-1528
U3 ....7805 5 V regulator RS 276-1170
U4 ....peripheral driver IC TI SN75451A
U5 ....optocoupler HP 6N137

Connectors
J1,J2 ....5PIN DIN 180deg sockets PP DIN-5500-5

Resistors (1/4W 5%)
R1,7 ....1K ohm RS 271-1321
R2 ....2.7 ohm
R3,4,6 ....220 ohm RS 271-1313
R5 ....47 ohm RS 271-009
R8 ....2.2K ohm RS 271-1325

Other Components
AC to DC adapter 9V or 12VDC   RS 273-1652
Enclosure 1.75Hx3.33Wx5.25"L   PC CM3-150K-BK
Printed Circuit Board
Fiber optic cable with connectors (see text).

HP=Hewlett-Packard Components (800) 752-0900 to find nearest distributor.
PC=Pac Tec (800) 220-9800 to find nearest distributor.
PP=Pan Pacific Enterprises (714) 540-4021 if your local stores can't help.
RS=Radio Shack

BIOGRAPHIES

Mike Brosnan is a design engineer at Hewlett-Packard in San Jose CA. His hobbies include computer music, computer graphics and amateur radio. If you have any questions about this article, Mike may be reached by FAX at (510) 713-2476 or internet email at mike_brosnan@sj.hp.com.

Brett Frymire is a electronics technician at Hewlett-Packard in San Jose CA. When he's not designing printed circuit boards he enjoys perfecting his salsa recipe and providing coworkers with tortilla chips to enjoy it with.

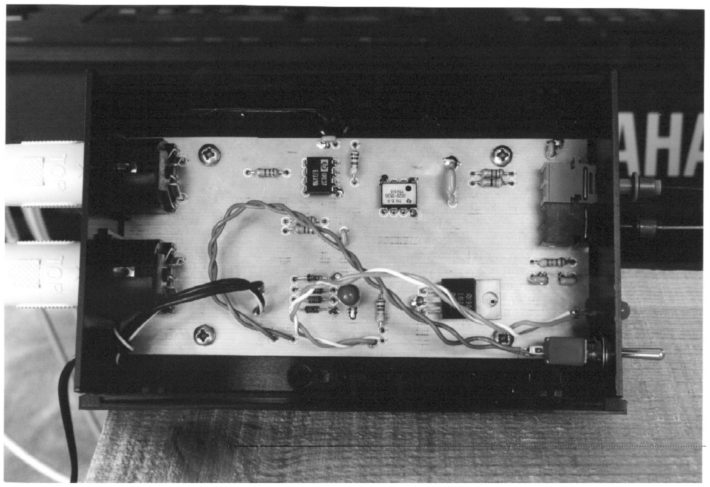

FIGURE 1

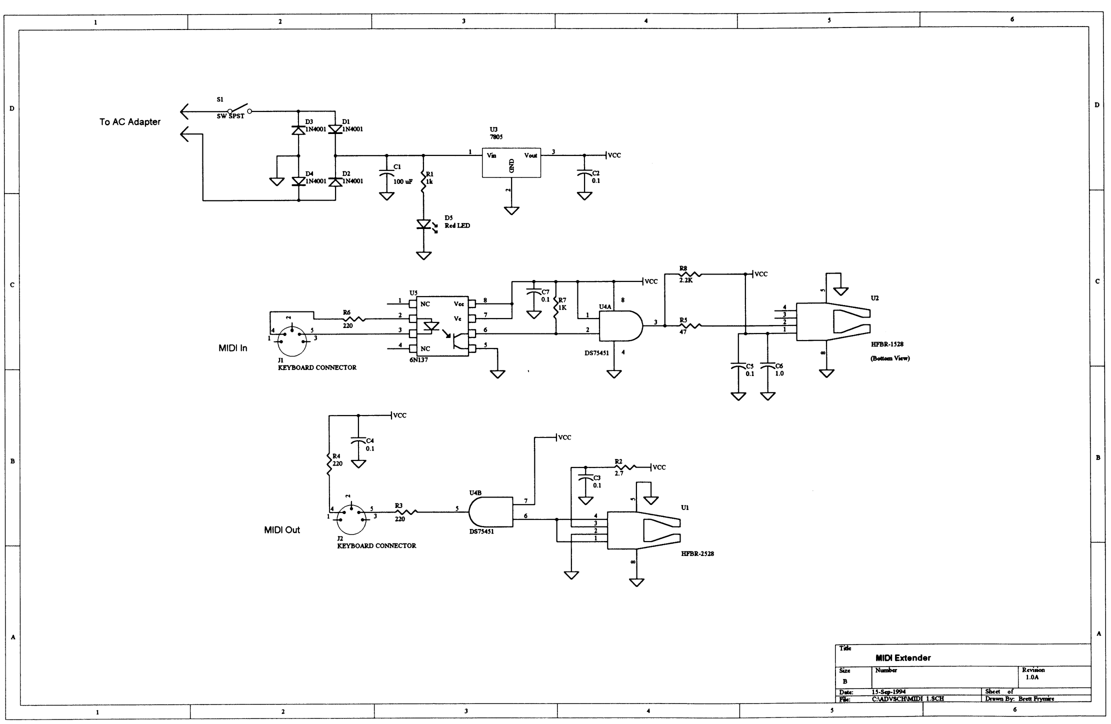

FIGURE 2

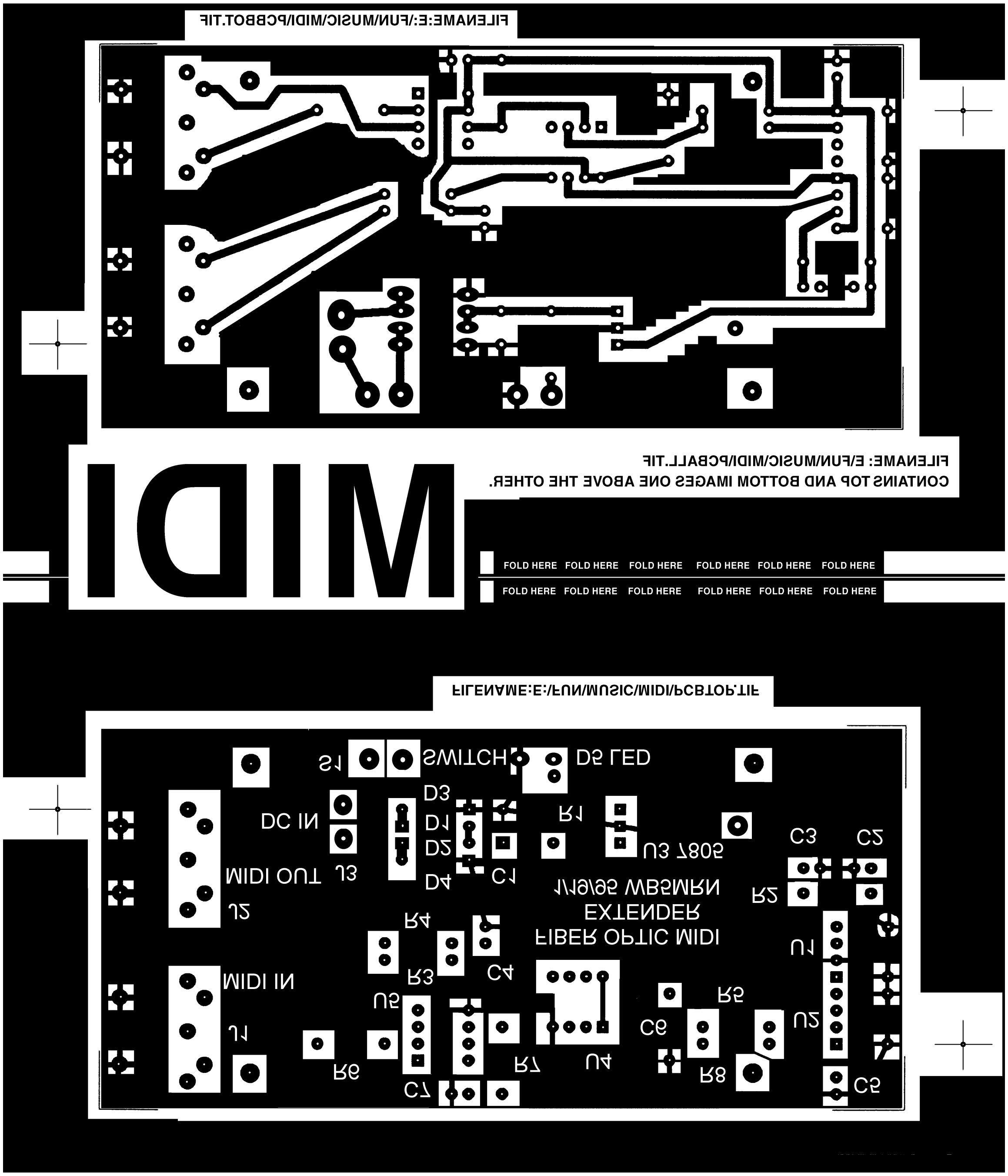
FILENAME:E:/FUN/MUSIC/MIDI/PCBBOT.TIF
FILENAME: E/FUN/MUSIC/MIDI/PCBALL.TIF
CONTAINS TOP AND BOTTOM IMAGES ONE ABOVE THE OTHER.
MIDI
FOLD HERE FOLD HERE FOLD HERE FOLD HERE FOLD HERE FOLD HERE
FOLD HERE FOLD HERE FOLD HERE FOLD HERE FOLD HERE FOLD HERE
FILENAME:E:/FUN/MUSIC/MIDI/PCBTOP.TIF
S1
SWITCH
D5 LED
D3
DC IN
D1
D2
D4
C1
R1
U3 7805
C3
C2
MIDI OUT
J3
J2
1/16/95 WB5MRN
EXTENDER
FIBER OPTIC MIDI
R2
R4
R3
C4
U1
MIDI IN
U5
R5
C6
U2
J1
R6
C7
R7
U4
R8
C5

FIGURE3

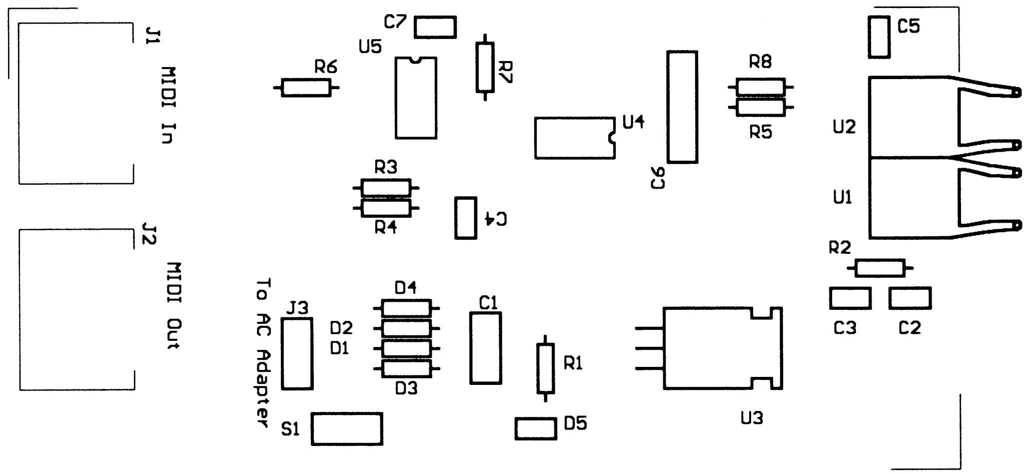
J1 MIDI In
J2 MIDI Out
To AC Adapter
J3
S1
R6
U5
C7
R7
R3
R4
C4
D4
D2
D1
D3
C1
R1
D5
U4
C6
R8
R5
U3
C5
U2
U1
R2
C3
C2

FIGURE 4