GUITARISTS: Build a Fiber-Optic Cord ■ Taming the Wild Algorithm

Electronic Musician

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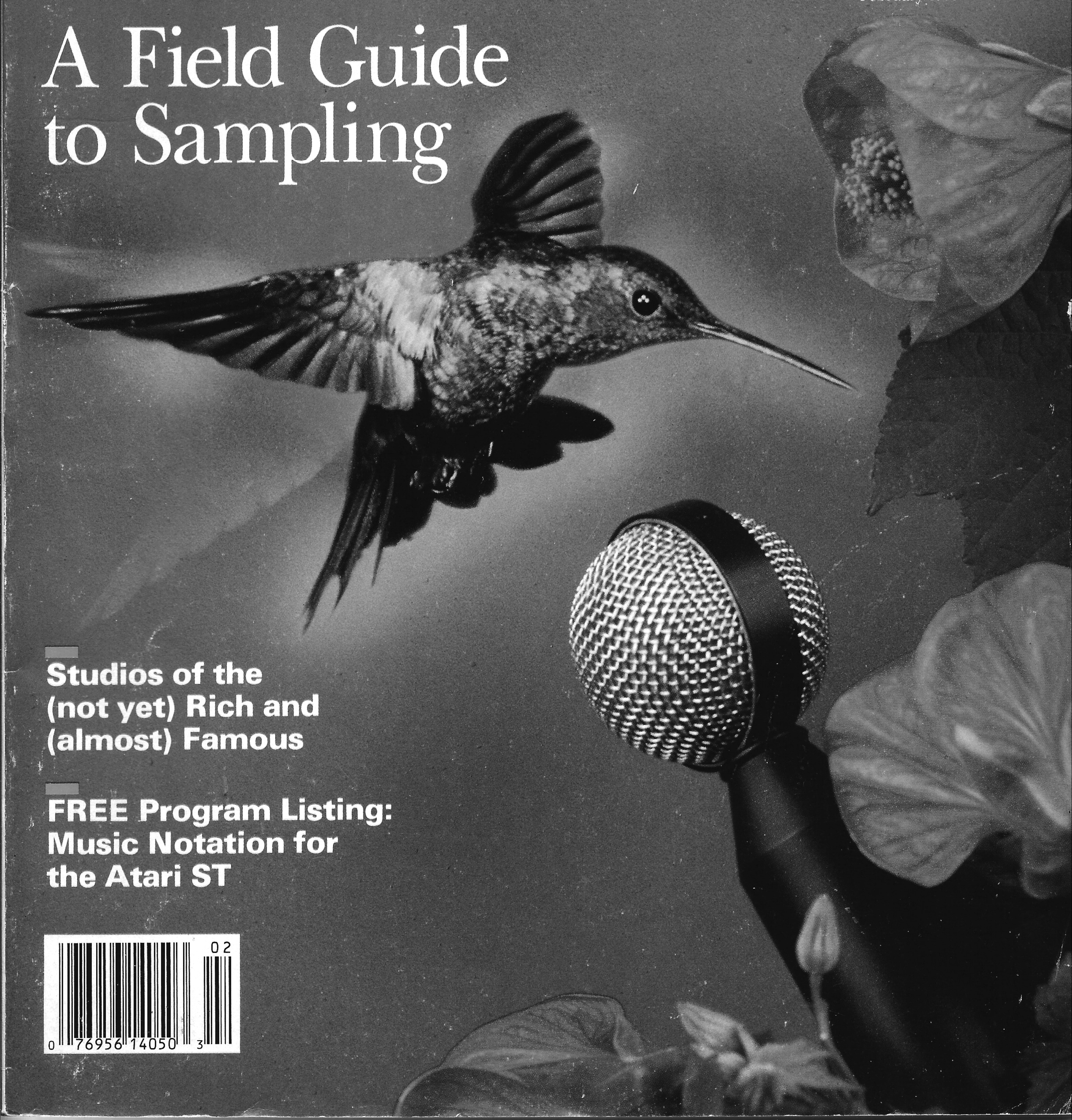
A Field Guide to Sampling



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BUILD A FIBER-OPTIC GUITAR CABLE

Now guitarists can see the light, lose their hum, and put a little fiber in their diets.

By William Pirkle

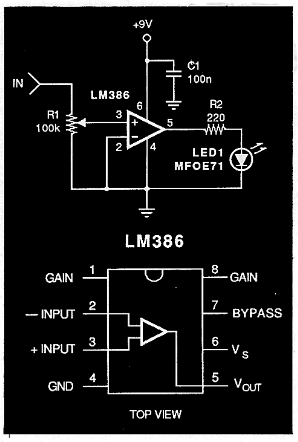

FIG. 1: Transmitter circuit schematic and LM386 pinout.

Until now, guitar players have had only two ways to get the guitar's signal to the amp: the standard, coaxial guitar cable and the wireless transmitter. The wireless system allows more freedom of movement and rejects electromagnetic interference (EMI), but it costs a lot, and it's susceptible to both hum and the radio-frequency interference (RFI) often found under intense fluorescent lighting. This adds noise to any signal it transmits. Hum is also a problem with standard cables; since the amount of hum is proportional to the amount of wire present, the longer the cable, the more noise it picks up. This limits guitar cables to a maximum length of about 20 feet.

Now, from a technology that has been around for some time, yet has at least as high-tech a gloss as the wireless approach, comes a solution: the fiber-optic guitar cable system.

OPERATION

The principle of operation is simple. A transmitter modulates light in proportion to the input signal from the guitar. This light beam travels down a thin fiber-optic cable, which consists of a silica (glass) or plastic core surrounded by a flexible plastic sheath. The glass transmits the light beam, so it is always focused towards the center of the core. The result is a very accurate, low-loss transmission of data. The cable couples to a receiver that responds to the incoming light and creates an electrical output.

Since the signal passing through the fiber is in the form of a light beam, it is not susceptible to EMI, RFI, or any kind of electrical interference at all. It also greatly reduces the chance of shock, because there is no electrical or ground connection between you and your amp. Besides these benefits, the fiber is extremely small and lightweight, very rugged, inexpensive, and getting cheaper all the time (Radio Shack sells pre-cut, five-meter pieces for about six dollars). It also looks cool.

The icing on the cake is that both the transmitter and receiver circuits are not only inexpensive, but also extremely easy to build. They don't even require circuit boards.

THE SCHEMATICS

The heart of the transmitter circuit (**Fig. 1**) is an LM386 audio power amplifier (IC1), which is ideally suited for our purposes. It comes with its gain preset to 20 and runs from a single power supply, consuming very little power itself and leaving enough current to drive the LED. The parts count is minimal since the transmitter is built in or around the guitar.

R1 is an optional input attenuator. With guitar, I keep it turned all the way up (i.e., creating no resistance). If you're building the project for a synth or you have on-board preamps or other effects that send out very hot signals, you might overload the LM386 and cause distortion. If you decide to include R1, adjust it so that your heaviest strumming is not distorted at the output. If you need even more gain, connect pins 1 and 8 for an additional 40 dB.

D1 is an infrared LED whose light intensity changes in proportion to the current through R2. C1 is the power supply filter. Be sure to attach it as close to the LM386's power and ground pins as possible.

The receiver (**Fig. 2**) is a basic electronic circuit that uses phototransistor Q1 to receive the LED's signal. As photons from the transmitter strike Q1's base, current flows through R3 proportional to the amount of transmitted light. Since the current is proportional to the incoming light, the voltage appearing at the base of Q2 is proportional to R3, which sets the sensitivity (larger values of R3 reduce the output voltage, thus sending less signal to Q2). Q2 is a common-collector emitter-follower that conducts current through R4 in proportion to the changing voltage at Q1's collector. R4 also sets the output

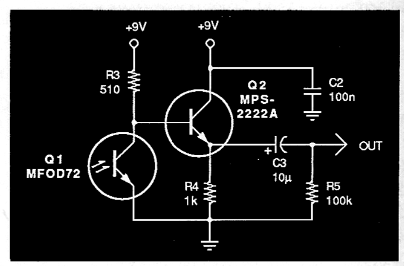

FIG. 2: Receiver circuit schematic.

impedance. C3 couples the output to the load and blocks the DC offset present at Q2's emitter. C2 provides power-supply filtering.

HANDLING THE FIBER

The fiber is very easy to work with, but a few simple rules will make life much easier. Make as few cuts as possible. When you must cut, use a heavy razor or art knife. *Never* cut the fiber at an angle, since this will cause poor coupling. Prepare the fiber by stripping back about 0.1

inch of the protective sheath with 18-gauge wire strippers. This helps collect the light into the fiber. The fiber is very rugged and can withstand twisting, stretching, being stepped on, and just about anything we guitarists can do, but you *should* try to keep it away from sharp corners or excessive pressure (closing it in a door, for example). Remember, your signal is moving through a piece of *glass*.

THE TRANSMITTER/RECEIVER PAIR

D1 and Q1 are specialty parts you can buy as a matched pair at any Radio Shack (part no. 276-0225). D1 (Motorola MFOE-71) is an infrared diode mounted in a plastic case that allows the fiber to be inserted and locked into place with a special nut. Q1 (Motorola MFOD72) is a phototransistor packaged in the same type of case and is easy to use, designed to respond to the infrared light frequency that D1 emits. Both of these parts are sensitive to heat, so solder quickly to avoid damage. If you buy the parts at Radio Shack, some technical data should be stapled to the package. In case it's not, **Fig. 3** shows the basics.

CONSTRUCTION

Housing both units is easy since their circuits are so small. I opted to mount the transmitter in a small plastic box with a quarter-inch plug mounted directly to it. This compact unit plugs into the output jack of the guitar and is held in place by the jack itself. An even better alternative is to build the unit inside the guitar or

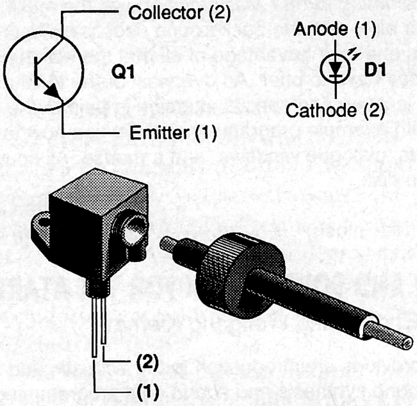

FIG. 3: The connector housing (which looks identical for both transmitter and receiver) for the MFOE71 and MFOD72.

synth. If you have active electronics in the guitar, you may be able to tap the power from the existing battery *if* the battery is not hooked up in a bipolar configuration (i.e., as a ±4.5V supply). Inside a synth, you can tap directly from an internal supply. This should be close to 9V, but if it's not, you can go up to 15V if you change R2 such that R2=V/(10 mA). Don't go under 5V or the signal in the fiber may not be bright enough. I also put a power switch on the unit, but you may want to rig it up to a stereo or switching jack so that plugging into the guitar's jack turns on the battery. This battery-switching trick is explained in Craig Anderton's *Electronic Projects for Musicians*. I strongly recommend this book if you haven't had much experience soldering or packaging projects like this one; it contains a wealth of information on basic electronics assembly. (*Available from EM Bookshelf; see FYI page for details.*)

For lack of a better case, I mounted the receiver in a plastic pill bottle and mounted a quarter-inch plug on it as well. The optical fiber plugs into Q1 at one end of the bottle. The output is at the other end

PARTS LIST

RESISTORS (¼W, 10% tolerance)	
R1	100k audio taper potentiometer
R2	220Ω
R3	510Ω
R4	1k
R5	100k
CAPACITORS	
C1,C2	100n (0.1μF; ceramic or mylar)
C3	10μ (electrolytic)
SEMICONDUCTORS	
IC1	LM386 power amp
D1/Q1	MFOE71/ MFOD72 (R.S. P/N 276-0225)
Q2	MPS2222A (R.S. P/N 276-2009)
MECHANICAL PARTS	
	FIBER 1000 Micron (R.S. P/N 276-0228)
P1,P2	open circuit ¼-inch mono phone plugs
	Note: R.S. P/N = Radio Shack Part Number
MISCELLANEOUS	
	Case, circuit board, solder, wire, etc.

and plugs directly into the guitar amp's input. The receiver uses a power supply for the required +9V. It's a little unorthodox, but it's small and it works.

MODIFICATIONS

The receiver's output impedance is functionally identical to that of a guitar, so you can also run the output through some signal processing—a power amp, tone controls, or other effects—before you plug it into your amp. Fiber optic circuits are also applicable to digital data (such as MIDI, SMPTE time code, RS-232, video, and digital audio) and to analog signals for applications such as fiber-optic patch bays or snakes. With your imagination at the helm, the sky's the limit once you've seen the light.

William Pirkle *is a music engineering technology student at the University of Miami. He's been playing guitar for eight years and is looking for a career that will combine all his talents.*