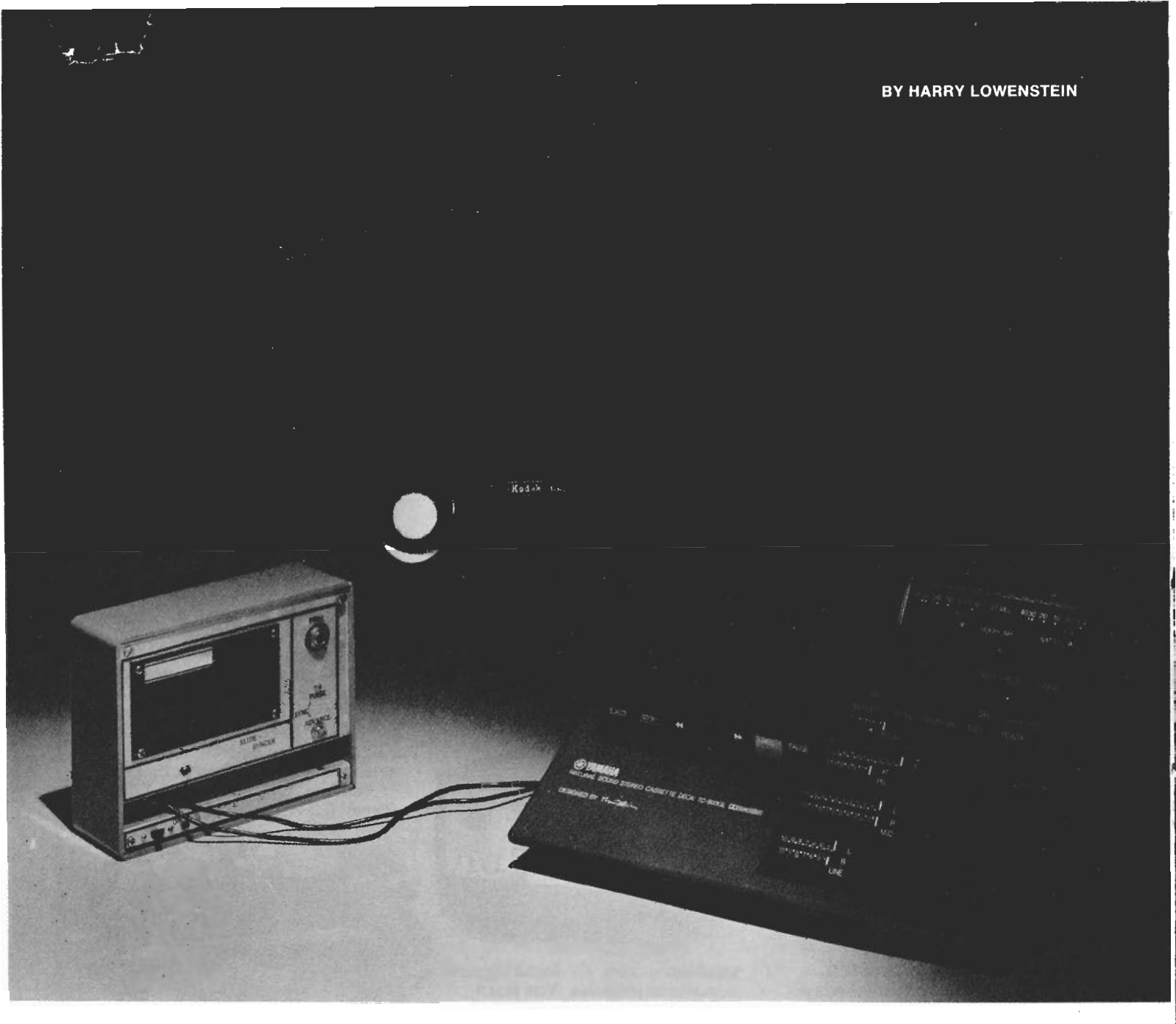
BY HARRY LOWENSTEIN



BUILD THE 35-mm Slide Syncer

A low-cost programmer for audio-visual presentations.

THE Slide Syncer is a programming device which enables you to record musical or talking material and a slide projector advance signal on the same tape track. It can be built using readily available, inexpensive parts, and will provide reliable and quiet performance. Incorporated into the Slide Syncer is a speaker for use with the external speaker jack on a cassette or open-reel tape recorder. The self-contained power source consists of four "AA" cells which should last for one year with moderate use.

About the Circuit. As shown in Fig. 1, *IC1*, a 567 tone decoder phase-locked loop, is the heart of the Slide Syncer. This eight-pin DIP contains a

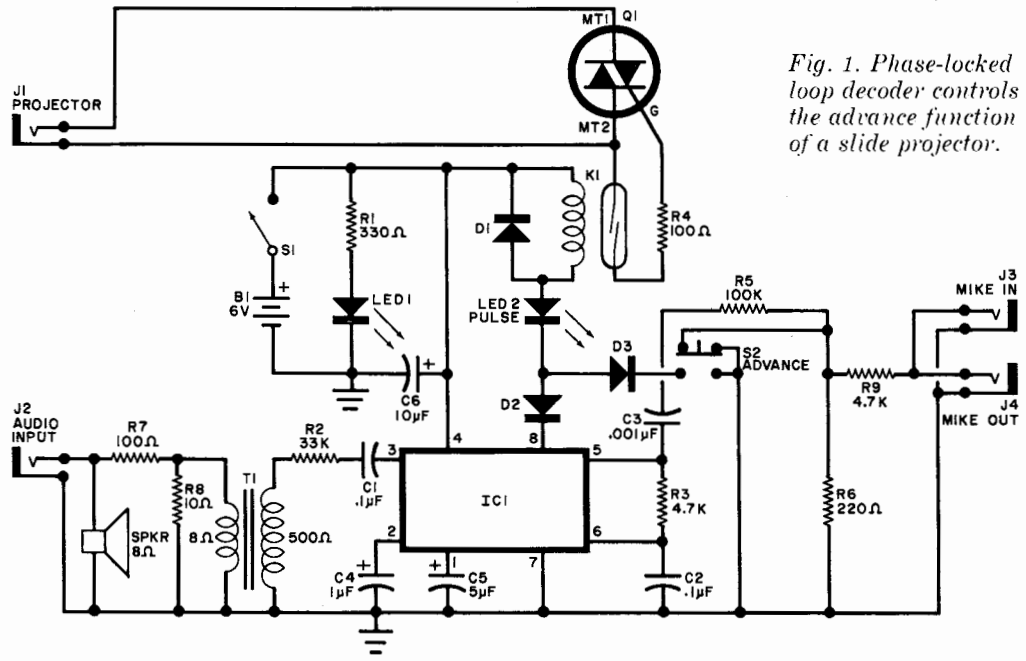


Fig. 1. Phase-locked loop decoder controls the advance function of a slide projector.

PARTS LIST

C1, C2—0.1-μF Mylar or disc ceramic capacitor
C3—0.001-μF disc ceramic capacitor
C4—1-μF, 10-volt electrolytic capacitor
C5—5-μF, 10-volt electrolytic capacitor
C6—10-μF, 10-volt electrolytic capacitor
D1, D2, D3—1N4001 diode
IC1—567 tone decoder PLL IC
J1—¼" insulated phone jack
J2, J3, J4—miniature two-conductor open-circuit phone jacks
K1—4.8-volt reed relay with SPST contacts
LED1, LED2—20-mA light emitting diode
Q1—200-volt, 6-ampere triac (Radio Shack 276-1001 or equivalent)
The following resistors are ¼-watt, 10% tolerance components.
R1—330 ohms
R2—33,000 ohms
R3, R9—4700 ohms
R4, R7—100 ohms
R5—100,000 ohms
R6—220 ohms
R8—10 ohms
S1—Spst switch (see text)
S2—Spdt pushbutton switch
SPKR—8-ohm, 4" × 2⅝" (10.2 × 6.7 cm) oval speaker — Sanyo R-S6367A or equivalent
T1—8-ohm/500-ohm audio transformer (Radio Shack 273-1381 or equivalent)
Misc.—Suitable enclosure, shielded cable, hookup wire, dry transfer lettering, printed circuit or perforated board, IC socket or Molex Soldercons, hookup wire, solder, machine hardware, etc.

control oscillator, phase-locked circuitry, and an output stage that can sink up to 100 mA of direct current.

It is customary to use an external tone generator to trigger the 567. However, the output of an external oscillator would have to be very close to the response frequency of the tone decoder for proper triggering to occur. This means that high-tolerance, low-drift components would have to be used. Fortunately, the output of the internal oscillator of the 567 can be picked off at pin 5 so the tone generated can be coupled from pin 5 to the microphone input of the tape recorder. Then it will be recorded on the same track as the commentary. The frequency at pin 5, determined by *R3* and *C2*, is exactly that which is required as an input signal to trigger the phase-locked loop.

When *S2*, a spring-loaded SPDT pushbutton switch, is tapped, the "beep" at pin 5 is coupled onto the microphone line (the hot side of *J3* and *J4)* through *C3* and the attenuating network *R5R6R9*. This switch also allows current to flow through the coil of reed relay *K1*, *LED2*, and *D3*. When the relay contacts close, gate current is provided for triac *Q1* if a low-voltage source is connected to jack *J1*. This triac is used to control the slide advancing mechanism in the projector, which is most often an ac-actuated circuit.

However, there is no need to have the projector set up when you are recording a program. When *LED2*, the PULSE indicator, is lit, the command tone is being recorded on the audio track at about 10 dB down from the commentary level. The Slide Syncer eliminates the need for a two-track recorder (one track for the commentary, the other for the advance tone). But you will find that the tone is not loud enough to be distracting.

On playback, the audio output of the recorder is taken from the external speaker jack and applied to the Slide Syncer's internal speaker and transformer *T1* through *J2*, the audio input jack. Resistors *R7* and *R8* attenuate the audio to a level that *IC1* can handle. The drive signal for the phase-locked loop is coupled from the secondary of *T1* through *R2* and *C1*. When the tone that was taken from pin 5 and recorded on the tape appears at pin 3, pin 8 is grounded and sinks current for the coil of *K1* and *LED2* through *D2*. Then the contacts of *K1* close, and *Q1* turns on and activates the advance mechanism in the projector. The 567 will not sink current unless a sustained tone of the proper frequency appears at pin 3, so normal speech and music will not cause the projector to advance to the next slide.

Most inexpensive cassette recorders have better audio sections than their small speakers would lead you to believe. For this reason, the 8-ohm speaker is included in the Slide Syncer circuit. It is a 4" × 2⅝" (10.2 × 6.7 cm) oval speaker, and should improve the sound quality of your audio-visual presentations.

The Slide Syncer requires +6 volts dc at about 25 mA quiescent current, which increases to 47 mA when *S2* is depressed. At these low current levels, four AA penlight cells mounted in a battery holder form an inexpensive power source.

Construction. The circuit is not too complex, so you can use perforated board or printed circuit construction techniques. Be sure to observe polarities on the electrolytic capacitors and the semiconductors. It is suggested that an IC socket or Molex Soldercons be used in mounting the 567 IC on the board. This will avoid heat damage to the chip. All LED's, jacks, and switches are mounted off the board. Use shielded cable for all audio lines.

The Slide Syncer should be mounted in an enclosure about 6½" × 5½" × 2" (16.5 × 14 × 5.1 cm). The speaker cutout can be made with a nibbling tool. Current limiting resistor *R1* is mounted on the lugs of *S1*. (The author used a DPDT slide switch wired as an SPST, with the unused contact lugs for tie points to the power leads and *R1* and *LED1*.) Jack *J1* should be insulated from the front panel if a metallic enclosure is used. Rubber or fiber washers can be used for insulation and mechanical support. A small bracket can be fashioned from a piece of scrap aluminum stock to secure the battery holder to the enclosure. Dry transfer lettering can be used to label all jacks, LED's, and switches. Spray the lettering with clear Krylon spray after it has been transferred to the panel.

Prepare shielded jumper cables for the audio inputs and outputs (external speaker jack to *J2*, microphone jack to *J4*) and terminate them with plugs compatible with your cassette recorder. Connect a ¼" phone plug to the advance control cable from your projector.

Checkout and Use. Insert all plugs into their corresponding jacks, and plug the recorder microphone into jack *J3*. Record a short test program on the cassette recording, pushing *S2* each time you want the projector to advance to the next slide. Then turn the projector on and play back the tape. The projector should advance each time the control "beep" is heard.

The 567 tone decoder requires an input level of 100 to 500 μV for reliable operation. The Slide Syncer is designed so that normal audio levels from a small cassette recorder placed in an average-sized living room will consistently advance the projector. Resistors *R8*, *R7*, and *R2* attenuate the audio to the working level of the IC. For high-volume audio-visual use — say, in a classroom — *R2* should be increased to a value between 68 and 82 kilohms. For low-level use, *R2* can be reduced to 10,000 ohms or so. If you prefer, you can mount these three attenuating resistors on the foil side of the printed circuit board so they can be easily changed (if necessary) to prevent false triggering.

The tone output from the Slide Syncer is very low, but is sufficient to trigger the tone decoder. However, if you have a recorder with automatic gain control, the advance tone will be loud on playback. If possible, use a recorder with a manual gain control to keep the tone almost inaudible. But the Slide Syncer will work with either type of tape recorder. The advance tone, using the values given for *R3* and *C2*, is about 2200 Hz. You can change it to any other frequency simply by using different values for these two components. You can also build two decoders sharing a common audio input and output to trigger two projectors. In that case, the two tones should be somewhat removed from each other—say, 1000 and 2200 Hz—so that each projector will advance only on its proper tone command. ◈

SLIDE SYNCER STEERS MOTORBOAT

I enjoyed building "The 35-mm Slide Syncer" (November 1976). Found the circuit to be so stable that I plan to use two of them in a programmable steering system for my motorboat. The only "bug" in the system is that it will trigger from some momentary signals other than its center-frequency signal. This problem can be eliminated by increasing the value of *C6* to 20 or 30 μF.

I also found that the circuit refused to trigger at low signal levels. I discovered that by paralleling *R2* with a 50,000-ohm potentiometer, this second problem could be eliminated. These modifications ensure excellent circuit operation.—*Mark Irgang, New York, NY.*