Improving TIMEX/SINCLAIR Tape Loading

Reduce troublesome dropouts and noise problems

By Tim Stoner

THE Sinclair/Timex ZX81/1000 is an excellent computer for its price. However, as a result of design compromises made to keep the price low, there are some shortcomings. The most annoying of these is the delicate nature of the tape loading process. Frequently, a cassette has to be run several times before a good load occurs.

Although the tape SAVE/LOAD function within the computer is designed well, tape hiss, dropouts, and other forms of noise from low-cost tape can cause problems. The use of high-quality tapes may not solve the problem either since distortion produced by inexpensive cassette recorders can also make tape loading a frustrating experience. The purpose of the "Z-Dubber" described in this article is to improve tape loading and also allow the user to reliably copy a tape.

The Tape Signals. An idealized pulse train that drives the input of the cassette is shown in Fig. 1A. A sync pulse, or clock burst, consists of four pulses. If the data is a "one," the four pulses are followed by a "silent period" of approximately the same width as the series of four pulses. A "zero" consists of eight pulses, rather than four.

The purpose of this specialized waveform can be seen in Fig. 1B. When the pulses are played back into the computer, they are applied to a one-shot multivibrator within the multipurpose chip. This circuit modifies the input (as shown in Fig. 1B) by creating an "envelope" of the pulse train. The four pulses become one clock pulse, which is used to synchronize the loading sequence. A gap after the clock pulse represents a "one." However, when eight pulses occur, the period following the clock stays at the same level as the clock and represents a "zero."

This scheme is said to be self-clocking, and is very tolerant of playback speeds that are faster or slower than the original recording speed. The data stream provides a series of evenly spaced clock pulses, each of which is followed by a data pulse. The synchronization circuit in the computer waits until the arrival of a clock pulse, then starts looking for a "one" or a "zero."

It would appear that missing or misinterpreted data bits are eliminated by the conservative save/load design. However, the preceding explanation gave no consideration to the distortion introduced by the cassette recorder.

One of the principal reasons for tape-loading difficulties is that Sinclair/Timex does not supply or recommend a particular cassette recorder for use in conjunction with its computer. As a result, virtually every conceivable make and type of cassette recorder is being used to save and load Sinclair/Timex program tapes.

The pulses shown in Fig. 1A are those applied to the cassette recorder. The ideal waveform from the earphone jack of the cassette shown in Fig. 2A was generated from the waveform shown in Fig. 2B, the one that was used to make the recording. Unfortunately, these ideal waveforms are seldom seen. Inadequate high-frequency response can produce a distorted waveform such as that shown in Fig. 3A. Notice that the area where the one-zero information resides is predominantly positive. Depending at what level the computer makes its decision, the gap can become either a "one" or a "zero." If one single bit is wrong, a checksum error will occur at the end of the tape, and it's rewind time again.

Poor transient and high-frequency response combined can make the ideal waveform look like Fig. 3B. This is a very common type of distortion created by cassette recorders with a slow acting automatic volume control circuit.

Another form of distortion commonly encountered is poor low-frequency response that results in the tilt of the gap in Fig. 3C. This improper waveform can cause the circuit to make an improper one-zero decision.

The Mystery Buzz. Just before the computer starts to SAVE to a cassette, a 60-Hz "buzz" occurs for a few seconds. Some users have blamed this on "motor noise" from the cassette. Actually, this is the sound of vertical sync pulses leaking out of the computer into the tape recorder. The Z-Dubber circuit will filter this noise below the level where it is troublesome. However, when making copies of existing tapes, it is a good idea to fast-forward the tape past the point where the buzz ceases.

Circuit Operation. As shown in the schematic diagram on page 86, the circuit is designed around *IC1*, a quad operational amplifier. Only three sections of the device are used. This particular op amp was selected since it is able to operate efficiently when powered by ±1.5 volts.

The input at *P1*, connects to the earphone jack of the cassette recorder. Resistor *R1* provides a load for the recorder audio, while *R2* couples the signal

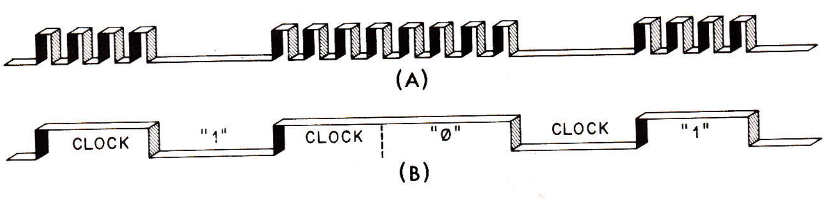

Fig. 1. Idealized pulse train representing zeros and ones.

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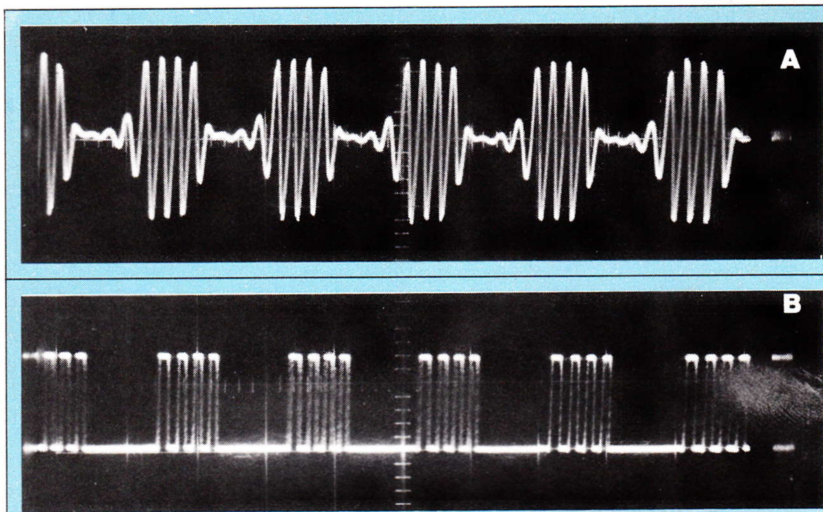


Fig. 2. Output of IC1A is shown at (A), which is amplified in IC1B, whose output is at (B).

into an active filter formed by *IC1A* and its associated components. This type of circuit passes and amplifies the resonant frequency, and attenuates all others. The center frequency of the *IC1A* filter is approximately 3000 Hz, which appears to be the approximate frequency of the recorded pulse bursts. This responds only to sine waves and ignores distortion which appears between the pulse bursts. The output of *IC1A* is nearly ideal and is shown in Fig. 2A. This is the signal that would have been produced if there were no distortion generated by the cassette recorder.

The output of *IC1A*, feeds the inverting input of *IC1B* and appears greatly amplified at the output of *IC1B*. A small amount of the output is fed back to the noninverting input through *R8*. The feedback provides a small amount of hysteresis, which causes the circuit to switch states slightly above and below the centerline. The hysteresis prevents this stage from switching at zero crossings and thus ignores "glitches" and noise pulses which might get through the active filter.

The output consists of a series of four or eight square waves (depending on whether a one or zero is present). The signal is shown in Fig. 2B and is an exact reproduction of the waveform which originally made the recording. This output is coupled to the computer input jack via *C5* and *P2*.

Since the original waveform has been reproduced, it can be used to feed the microphone input (via *PL3*) of a second, or "slave," cassette recorder. This can be extremely useful for making backup copies of machine-language programs and other difficult-to-copy tapes. The signal is fed to the "slave" recorder through *R10* and *C6*, with *R11* acting as a voltage divider to reduce the signal level. This is necessary to prevent overloading the microphone input of the slave recorder. The value of resistor *R11* can be increased or decreased if the recording level for your cassette proves to be too low or too high.

The noninverting input of *IC1C* is pulled high by *R12*. Since the inverting input is grounded, the output on pin 14 is also high. Thus, no current flows through *LED1*. However, when pulses appear at the output of *IC1B*, the cathode of *D2* is brought low. This causes the output of *IC1C* to go low and allows current to flow through the LED, thus causing it to glow. When the pulses make the cathode of *D2* go high, the relatively slow discharge of *C4* keeps the noninverting input of *IC1C* low between data pulses. Thus, the output remains low as long as data is passing through and *LED1* steadily glows. This is useful for setting the correct level of the playback cassette.

Testing and Using. The circuit can be wired point-to-point on perforated board, or a pc board using the foil pattern shown in Fig. 4 and the component installation of Fig. 5 can be used.

Before installing the two AAA cells, set switch *S1* to the ON position. Connect one lead of an ohmmeter to the shielded braid of one of the cables (ground). Measure the resistance to the plus and minus battery terminals. The reading should be in excess of 1000 ohms. If it is not, look for solder splashes, semiconductors inserted backwards, and so on. Don't insert the batteries until the condition is corrected.

With the LED, *B1* and *B2* correctly

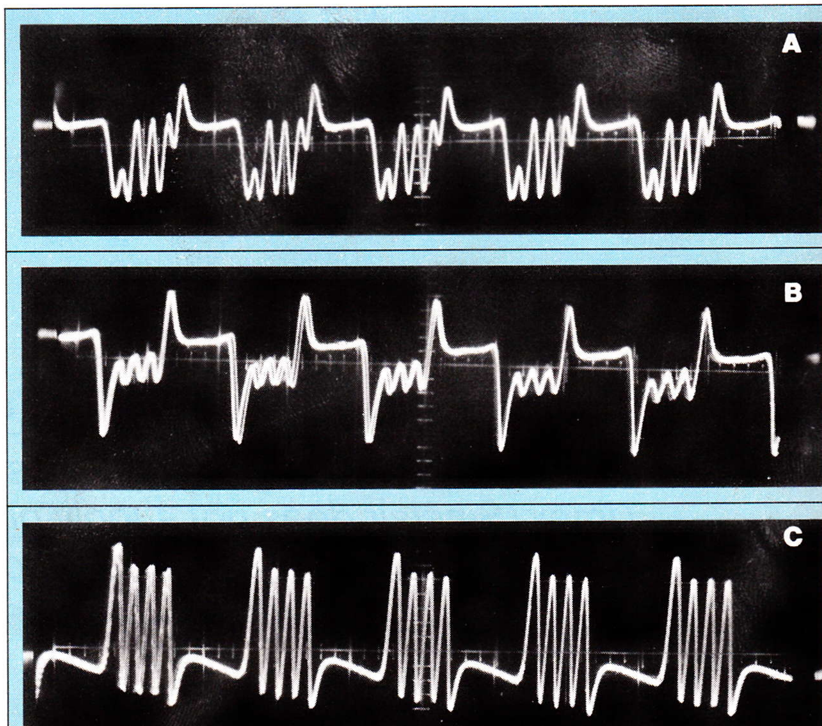


Fig. 3. Three forms of distortion involving poor transient and low- and high-frequency response.

inserted, the LED should glow when pins 1 and 11 of *IC1* are temporarily jumpered.

Insert *P1* into the earphone jack of the cassette with the tape to be loaded. Insert cable with *P2* into the jack labled EAR on the side of the computer. One half of the cable supplied with the computer can be used to connect the MIC jack to the microphone input of the cassette recorder for saving programs, if desired. It is not necessary to use this cable to simply load tapes. The remaining cable from the Z-Dubber *(P3)* can be left hanging until a second recorder is connected for copying.

Before attempting to load a tape, get the "feel" of the volume control. Even though the computer is not yet turned on, the LED should glow at some point as the cassette recorder volume is increased. Notice that as the volume is

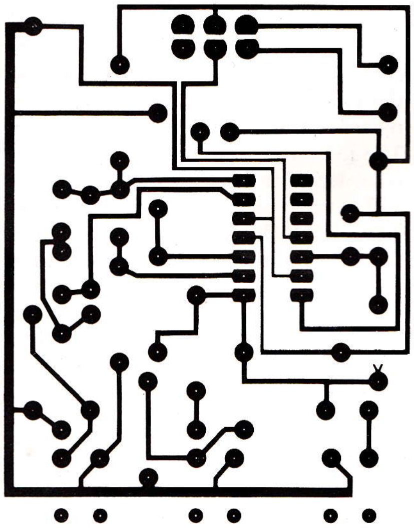


Fig. 4. Actual-size foil pattern for the circuit board.

raised and lowered, the LED goes on and off. The correct setting is 10-20 degrees past where the LED first illuminates. This will ensure that "weak spots" on the tape do not drop below the threshold level. If the volume level is advanced too far, the signal may overload the Z-Dubber.

Once you feel you have the correct setting, rewind the tape to the start of the program (where the musical buzz starts), power up the computer and follow the vendor's instructions for loading the tape.

Normally the LED should remain lit. If it flickers off and on, the volume is set too close to the threshold and should be slightly advanced. As the tape is load-

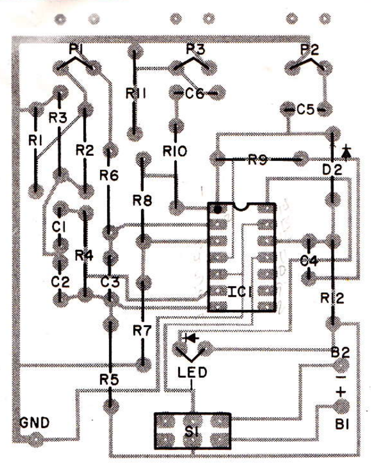


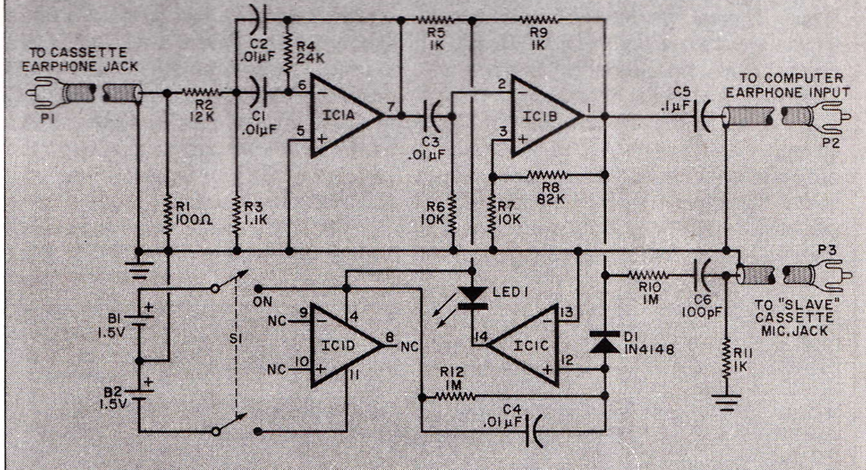
Fig. 5. Component layout diagram.

ing, evenly spaced black-and-white bars should be noted on the TV screen.

It should be possible to get a good load the first time the Z-Dubber is used. However, this may not occur until the user becomes familiar with the relationship between the volume control and the LED. Once the correct setting is found, note the amount of rotation beyond the point where the LED first glows. The correct setting depends on the volume level at which the program was recorded and will vary from tape-to-tape. One will find that different tapes may require different settings of the volume control. Always add the few degrees of volume advance to that required to illuminate the LED.

Making Copies. The procedure for making tape copies is almost exactly the same as for loading tapes. In fact, to ensure a perfect reproduction, the tape should be loaded at the same time the copy is made. When the tape is loaded properly, the user can be assured that the copy is perfect. The signal to the "slave" recorder is essentially the same (except for a much lower level) as is fed to the input of the computer.

As mentioned earlier, the tape being copied should be advanced to just before the point where the buzz sound starts. This way, one can "edit out" the vertical sync noise that appears on some tapes. Always use good quality tape in the slave" recorder and don't forget to leave a 10-second leader at the beginning of the new tape. This will eliminate plastic leaders, wrinkles, and so on. ◇



Schematic diagram of the circuit.

PARTS LIST

B1,B2—1.5-V AAA cell
C1,C2,C3,C4—0.01-μF monolythic capacitor
C5—0.1-μF, 50-V disc ceramic capacitor
C6—100-pF silver mica capacitor
D1—1N4148
IC1—LM324 quad operational amplifier
LED1—MV50 or similar light emitting diode
P1,P2,P3—12″ shielded cable, terminated in miniplug
R1—100-ohm, ¼-W, 5% carbon resistor
R2—12-kilohm, ¼-W, 5% carbon resistor
R3—1.1-kilohm, ¼-W, 5% carbon resistor
R4—24-kilohm, ¼-W, 5% carbon resistor
R5,R9,R11-1-kilohm, ¼-W, 5% carbon resistor
R6,R7—10-kilohm, ¼-W, 5% carbon resistor
R8—82-kilohm, ¼-W, 5% carbon resistor — 100K ohm
R10,R12—1-megohm, ¼-W, 5% carbon resistor
S1—Dpdt slide switch
Misc.—Suitable enclosure, perforated or printed circuit board, battery holder, for two AAA cells, tie wraps (3), double-sided "sticky" tape for securing pc board.

Note: The following is available from Bytesize Micro Technology, PO Box 12309, Seattle, WA 98111: kit of all parts and materials at $22.95. Also available separately: pc board at $8.50 punched and silk-screened cabinet at $6.50. Postage and handling prepaid.