MorseKOB Loop Interface

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The *MorseKOB Tutorial* shows how a telegraph key can be connected directly to the serial port of a computer for use with the KOB program. The tutorial also describes a simple interface circuit for driving a sounder by connecting it to the same serial port. This arrangement works fine if you have separate access to the key and sounder. There are situations, however, in which you may want to tie a computer into an existing telegraph loop where the keys and sounders are all wired in series. This paper describes an interface circuit that makes that possible.

Figure 1 shows an example of how this interface can be used. The picture shows a prototype of the circuit in the lower left, a serial cable (with USB adapter) going to a laptop computer, and a pair of wires with alligator clips tied into the telegraph loop. A 12 volt "wall wart" power supply is out of view to the right of the picture, and a 50 ohm current-limiting resistor is connected to one of the binding posts on the telegraph instrument.

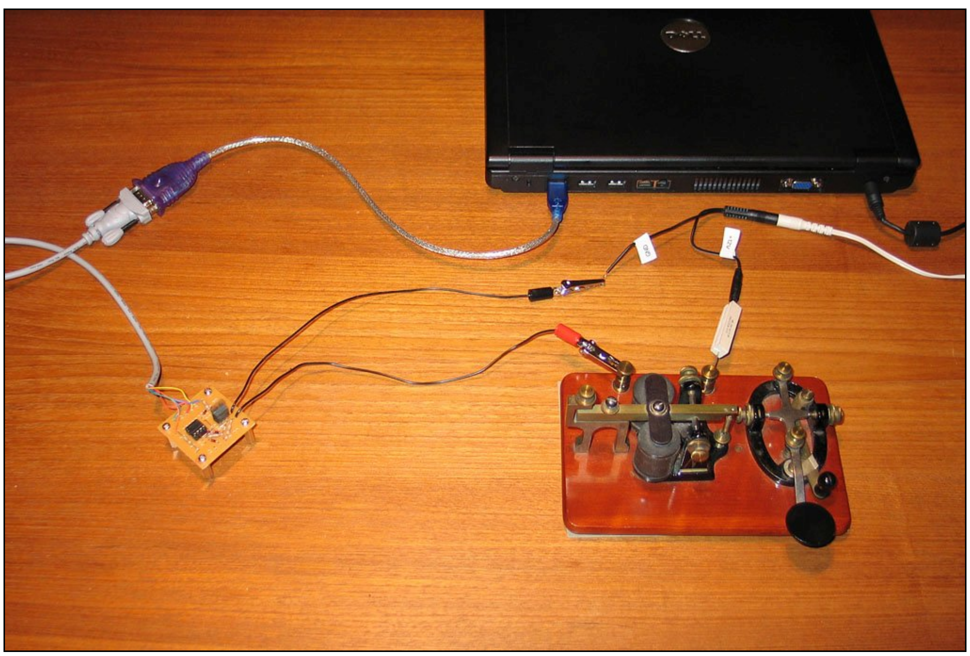


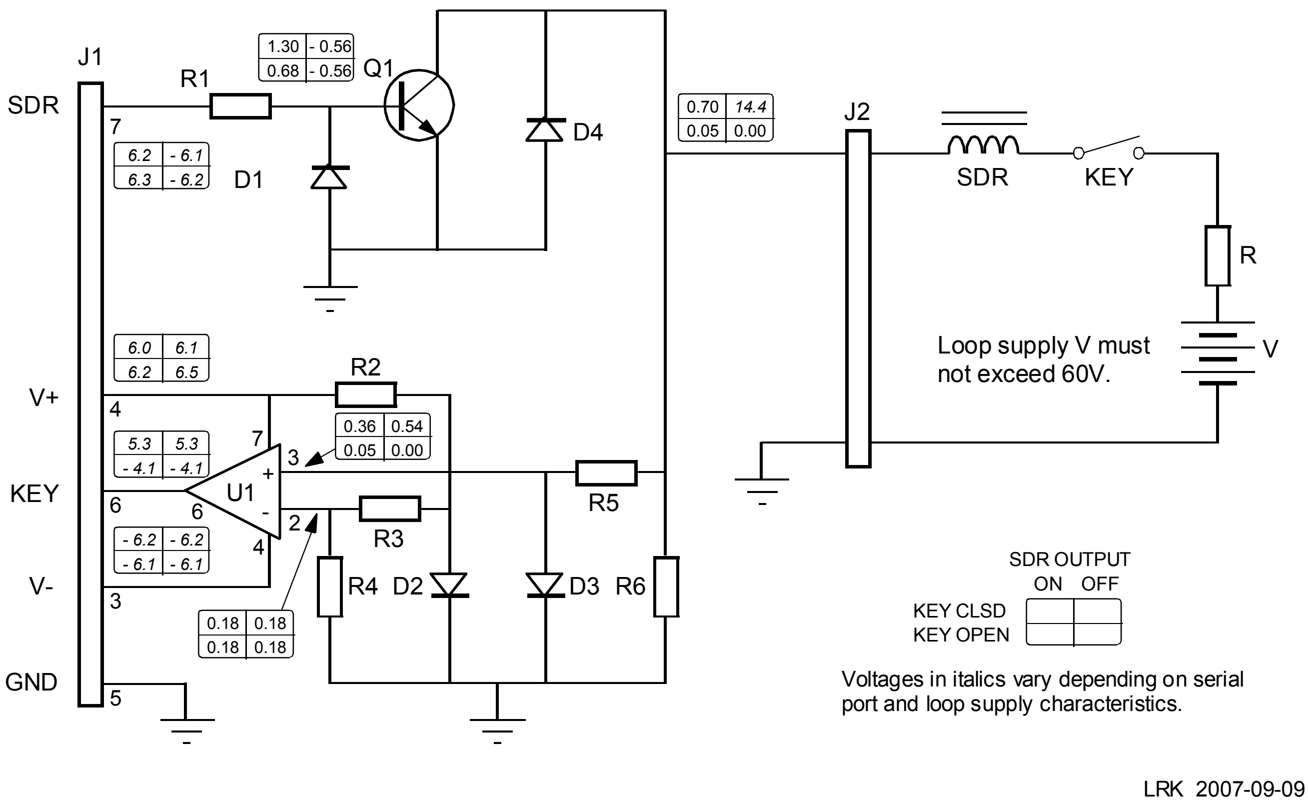
Figure 1. Loop interface circuit in operation

Because the key and sounder are wired internally in series and only two binding posts are provided for external connections, without the loop interface circuit it would be difficult to connect this telegraph instrument to a computer.

Circuit design

A schematic diagram of the interface circuit is shown in Figure 2.

MorseKOB Loop Interface



Note: crossing lines do not connect; i.e. R2 does not connect to pin 3 of U1.

		Radio Shack cat. no.
Q1	TIP120 Darlington switching transistor	276-2068
U1	741 op amp	276-007
R1-R3	10K, ¼W resistors	271-1335
R4	4.7K, ¼W resistor	271-1330
R5-R6	47K, ¼W resistors	271-1342
D1-D3	1N914 or 1N4148 signal diodes	276-1122
D4	1N4001 or 1N4005 rectifier diode	276-1101 or 276-1104
J1	“DB9” connector	
J2	jack or binding posts for telegraph loop	
	circuit board	276-159
	IC socket	276-1995
	standoffs (4)	276-1381 or 276-195

Figure 2. Schematic diagram and parts list

The circuit consists of a transistor, an op amp, 6 resistors, and 4 diodes. Figure 3 shows the parts mounted on a standard Radio Shack printed circuit board, but perfboard or stripboard could be used instead. The entire assembly can be enclosed in a project box as small as 2”×2”×1”. The total cost of all parts, including the circuit board, connectors, and box, is around $10.

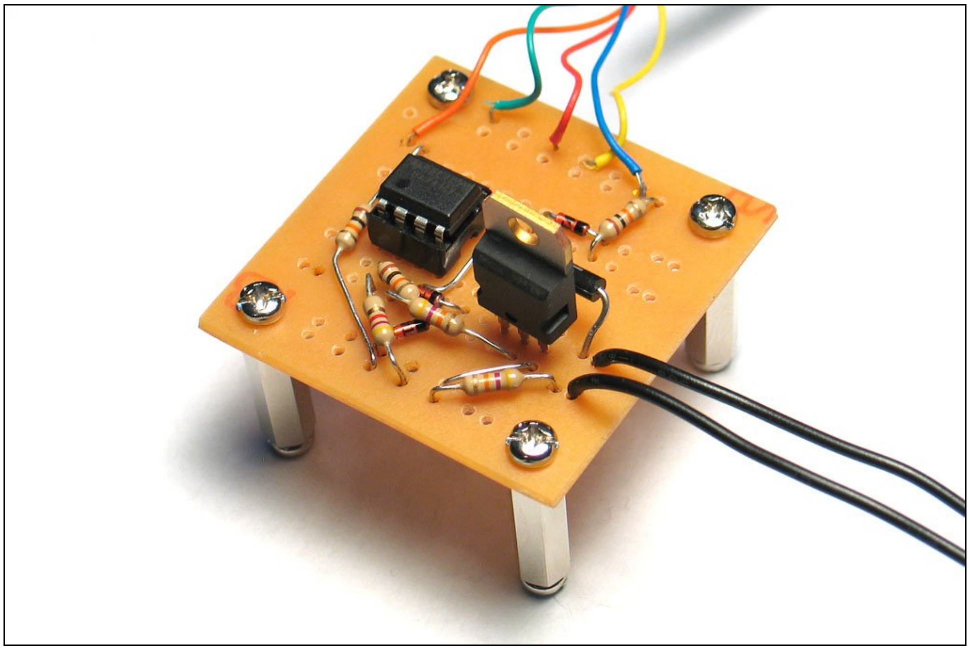


Figure 3. Interface circuit assembly

Caution: this circuit hasn’t been tested yet with high inductance loops or high voltage loop supplies. To reduce the risk of damaging your computer’s serial port, I recommend you use a USB-to-serial adapter cable. It’s much cheaper to replace a damaged adapter cable than to have your computer repaired.

Operation

Before I describe how the circuit works, I should mention that this is the first circuit I’ve ever designed. It’s been a great learning experience! I’ve designed the circuit with great care, but my knowledge is limited so there’s a definite possibility that I didn’t get it quite right. Therefore, please read the following explanation with a critical eye, and if you spot anything that seems amiss, by all means let me know so I can improve the circuit and/or this document.

The inspiration for the design comes from Ed Trump’s “KOB-loop repeater” concept, which uses traditional electromechanical relays instead of electronic components. I’m grateful to Ed for his help in getting my circuit to work properly.

The loop interface circuit has two distinct functions. One is to allow the computer to open and close the loop circuit. The second is to sense whether the key in the loop is open or closed.

The first function is relatively straightforward, and this part of the circuit is identical to the sounder driver described in the *MorseKOB Tutorial*. When pin 7 of the serial port (the RTS line) goes low (somewhere in the range of −5 to −15V, depending on the serial port), then the switching transistor Q1 stops conducting, and no current flows through the loop. If the key in the loop is closed, then the collector voltage will be the same as the loop supply voltage V; if the key is open, then the collector voltage will be zero. The pull-down resistor R6 ensures that the collector is brought down to ground level reliably when the key is open.

When pin 7 of the serial port goes high (+5 to +15V), current flows into the base of Q1, causing the transistor to go into "saturation". When Q1 is in saturation, there is very little resistance between its collector and emitter, and the collector voltage will be close to zero. This allows current to flow through the telegraph loop – as long as the key is closed, of course.

In fact, when Q1 is in saturation, the collector voltage is not actually zero. If the key is closed and current is flowing through the loop, the collector voltage will be in the range of 0.6 to 0.7V (assuming a loop current between 20 and 400mA). If the key is open, then the collector voltage will be about 0.05V. These characteristics become important when we look at the second function of the interface: determining the state of the key.

The heart of the circuit that detects the state of the key is the op amp U1, a device capable of magnifying small voltage differences into RS-232 signal levels. As mentioned above, if the key is closed, then Q1's collector voltage will be 0.6V or greater. The collector voltage is sampled through resistor R5 and fed to the non-inverting input of the op amp. Diode D3 limits the voltage to less than a volt, thereby protecting the op amp from damage in case the loop supply V exceeds the op amp's maximum rating.

If the collector voltage is 0.6V, the combination of R5 and D3 has the effect of reducing that to 0.35V at the input of the op amp. On the other hand, if the collector voltage is 0.05V, the op amp input will also be 0.05V since at this voltage level no current flows through the diode. This means the op amp must discriminate between a voltage of 0.05V or less when the key is open and a voltage of 0.35V or greater when the key is closed.

The subcircuit consisting of diode D2 and resistors R2, R3, and R4 provides a constant reference voltage of 0.20V to the inverting input of the op amp. Therefore, if the key is closed, then the output of the op amp goes to its maximum positive voltage. Similarly, if the key is open, the op amp's output goes to its maximum negative voltage. These signals are passed to pin 6 of the serial port (the DSR line) for input to the KOB program.

A final point worth mentioning is where the op amp gets its positive and negative supply voltages. These are conveniently obtained "free of charge" from the serial port itself. Pin 4 (the DTR line) is set by the KOB program to go positive, and the +5 to +15V provided by the serial port is just what the op amp needs for its positive supply.

The negative supply is taken from pin 3 of the serial port. This is the TxD line, which would otherwise be used by the serial port for transmitted data but in this case is left in a marking state, which corresponds to a voltage level of −5 to −15V.