

## Kit 13. VOICE-ACTIVATED TAPE RECORDER SWITCH

This is a very sensitive, sound or voice activated switch (VOX) which plugs into the REMOTE plug of a tape recorder and turns it on when it detects a preselected level of sound. If the sound continues then the switch will self-trigger and remain on. Once the sound goes away then a delay in the circuit will turn off the tape recorder after about 6 seconds.

It is ideal for hands-free operation of a tape recorder, eg, for taking notes. The Kit can be calibrated to turn on at the slightest sound or at a much high sound level.

Note that this Kit does not improve the sensitivity of the tape recorder itself. It is just a switch which turns the recorder on. So that the sound which turns ON the tape recorder may not be picked up by the tape recorder if the microphone in the tape recorder is not sensitive enough.

The kit is constructed on a single-sided printed circuit board (PCB). Protel Autotrax and Schematic were used to design the board.

### ASSEMBLY INSTRUCTIONS

Assembly is straight forward and components may be added to the PCB in any order. Note that the electret microphone should be inserted with the pin connected to the metal case connected to the negative rail (that is, to the ground or zero voltage side of the circuit). This is marked by the minus sign on the overlay of the PCB. It is generally best to add the lowest height components first for ease of soldering. Be sure to put the electrolytic capacitors and the diodes in the correct way as indicated.

The two PCB-mounted switches may go in either way. Note the two links required next to the DPDT switch (the larger of the two switches.) Use some wire cut off from the leads from the other components. Note that T3 is different to T1 and T2. T3 can handle the higher current which flows through the REMOTE switch when the it is turned ON. The 10" of two strand wire goes into the 'TO TAPE REMOTE' pads. Attach the 2.5mm plug to the other end. Be sure the two wires within the plug do not short-circuit when you screw on the cover.

Use the two 1% metal film 1M resistors (the two resistors with the extra band- they are a different colour to the 5% carbon film resistors) for the voltage divided input to pin 1 of the IC. The purpose of the pad marked 'A' will be explained in the next section.

### CIRCUIT DESCRIPTION

At the start of the circuit is an electret microphone. An electret is a permanently charged dielectric. It is made by heating a ceramic material, placing it in a magnetic field then allowing it to cool while still in the magnetic field. It is the electrostatic equivalent of a permanent magnet. In the electret microphone a slice of this material is used as part of the dielectric of a capacitor in which the diaphragm of the microphone forms one plate. Sound pressure moves one of its plates. The movement of the plate changes the capacitance. The electret capacitor is connected to an FET

amplifier. These microphones are small, have excellent sensitivity, a wide frequency response and a very low cost.

The electret microphone is followed by two standard audio amplification stages. A good quality 5K pot provides sensitivity control for the level at which the following digital part of the circuit will be activated. The 22nF capacitor isolates the microphone from the base voltage of the transistor and only allows alternating current (AC) signals to pass. The 100nF acts similarly after the second and third stages.

The input to the digital section is biased at mid-way between the supply voltage to the Kit by the two 1M (1% metal film) resistors. Before we look at the digital section let us review the operation of the 74HC14, the Inverting Schmidt Trigger IC. At the maximum operating voltage (6V) there is a 1V hysteresis gap between 2.2V and 3.2V. This means that as the input voltage increases from zero to six volts the Schmidt circuit will not trigger until it gets to 3.2V. But as the voltage falls from six volts to zero the circuit must fall to 2.2V before it changes state.

Assume that pin 1 of the IC is taken HIGH by sound input to the microphone. This means that pin 2 is LOW. C5, the 22uF electrolytic capacitor will charge very quickly via the diode D2. The low on pin 2 will make pin 4 HIGH. This will turn ON transistor T3 and the tape recorder will turn ON.

Now the LOW on pin 3 will also go to pin 11 and to pin 8. This LOW will pull pin 1 LOW in the absence of any sound input signal from the microphone. This in turn makes pin 2 HIGH. The diode D2 now blocks discharge via the path it was charged up. C5 will start to discharge via the 470K resistor R9 with a time constant of R9.C5 or about 10.3 seconds. The turn off time is determined by the relative switch on voltage which is about 50% on the rail voltage, or about 6 seconds. Pin 3 will then move through 3.2V and pin 4 will go LOW thus turning OFF the tape recorder.

It can be seen that continuous noise input to pin 1 will keep pin 4 HIGH but that as soon as there is an absence of noise input the time-out process automatically begins.

The LED is connected so that it lights up when there is power to the Kit. However, it may easily be reconnected to light up when the tape recorder is switched ON. That is the purpose of the pad marked A next to the IC. Pad A is connected to the unused sixth Schmidt trigger circuit. Pin 4 is connected to pin 5 so pin 6 goes LOW when the tape recorder is ON. Pin 6 is connected to the pad marked A. Cut the connection from the 1K resistor in series with the LED between the resistor and the ground track. Solder in a jumper wire between the 1K and pad A/pin 6 of the IC. Now the LED will light up when the tape recorder is turned ON.

### CIRCUIT CALIBRATION

The Kit can be adjusted to switch on at the slightest sound. However, at these levels of sensitivity there are

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several points to remember. Firstly, the switching level is sensitive to the supply voltage. So that a battery is not a good power source for this method of operation over a long period of time. A plug in pack or a mains operated power supply would be better. If you do use a battery pack for extended periods then disconnect the LED as it will just consume power for no purpose.

Note that the electret microphone of the sound switch may be more sensitive than the microphone in the tape recorder itself! This could result in the recorder switching on but nothing being recorded.

The PCB mounted switch is to allow for the polarity of the tape recorder. In one position the tape recorder will be ON and the Kit will have no effect. In the other position the Kit should work and the 5K pot will control the sound level at which the tape recorder turns ON.

If the Kit is too sensitive: we have chosen a good quality 5K pot to give fine adjustment at low levels of sound. If this is too low for your purpose then replace it by a good quality 50K or 100K pot. Also you can change the 47K load resistor R1 on the microphone to alter its sensitivity.

To change the delay: Lower R9 to say 100K to get an approximate 2 second delay. Increasing R9 will increase the delay up to point. For long 1 minute delays or more it would probably be best to incorporate a delay circuit on the base of T3. The 470R could be increased to 10K say with an electrolytic of around 47uF from it (on the other side to the connection to the base) and ground.

### WHAT TO DO IF IT DOES NOT WORK

Poor soldering is the most likely reason that the circuit does not work. Check all solder joints carefully under a good light. Next check that all components are in their correct position on the PCB. Thirdly, follow the track with a voltmeter to check the potential differences at various parts of the circuit particularly across the base, collector and emitter of the transistors and the integrated circuit.

A check list of other items:

- are the transistors and IC in the correct way.
- are the electrolytic capacitors and diodes in the correct way.
- are the 2 wires in the REMOTE socket shorting out inside the plug.

For the circuit before the IC check that the collector-ground voltage for T1 is about 2V. For T2 it should be 4V. There should be about 1V across the electret microphone.

At the IC pin 3 taken to ground by a jumper wire should turn ON the recorder. So should pin 1 taken HIGH to the 6V track. If this does not happen the the IC or its attachment to the PCB is at fault.

After the IC short out the collector and emitter of T3. The recorder should turn ON. If not then the fault lies in the plug or switch.

It is possible that due to variations in tolerance the 47K load resistor of the microphone may have to be increased or decreased to get the best response. Reducing the value will increase the sensitivity but if you decrease it too much you will get an oscillation.

If the tape recorder does not turn OFF completely but very slowly turns then there is a dry solder joint or hair-line crack in a track somewhere. This type of fault can be hard to find. Resolder everything and inspect all trackwork.

### WHAT TO LEARN FROM THIS KIT

Many VOX use an op-amp at the front end instead of cmos logic as we have done. An op-amp provides the amplification and comparator operations all in one. However, the total component count is almost the same. (We have in fact built up two other commercial Kits using op-amps and we found them to be surprisingly insensitive at lower noise levels. This lower tech. cmos circuit we have developed is the most sensitive circuit of all three.) It is quite easy to modify the output of the PCB to attach a relay to T3 instead of the tape recorder.

### COMPONENTS

Resistors(1/4W, 5% carbon):	
470R yellow violet brown	1
1K brown black red	1
3K9 orange white red	1
10K brown black orange	1
47K yellow violet orange	1
470K yellow violet yellow	2
1M brown black green	1
2M2 red red green	1
Resistors(1/4W, 1% metal):	
1M brown black black yellow	2
Capacitors:	
22nF mylar	2
100nF monoblock	2
22uF electrolytic	1
47uF electrolytic	1
5K potentiometer	1
1N4148 diode	2
74HC14 IC	1
14 pin IC socket	1
BC338 transistor	1
BC547 transistor	2
5mm LED	1
Electret Microphone	1
Two strand wire	10"
2.5mm plug	1
6V battery snap	1
Kit 13 PCB	1
PCB mounted switches SPDT	1
DPDT	1

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