

GLOLAB

Universal Telephone Hold

UNIVERSAL HOLD CIRCUIT

If you have touch tone telephone service, you can now put a call on hold from any phone in the house, even from cordless phones and phones without a hold button by plugging this device into any telephone jack, anywhere in the house. Just one of these UNIVERSAL HOLD circuits adds the call hold feature to every phone that has a keypad with a # (pound) key. To put a call on hold, you press the # key and hang the phone up. The # key function remains activated for five seconds after the key is pressed and released so you can hang up phones that have a keypad in the handset.

WHAT IT DOES

The UNIVERSAL HOLD circuit detects the dual tone, multi frequency (DTMF) tone that is generated when the # key is pressed and then activates a circuit that partially loads the telephone line so that the central office thinks a phone is still off hook even after it is hung up. When any phone is again picked up, the hold function is canceled.

HOW IT WORKS

Figure 1 shows the schematic diagram of the UNIVERSAL HOLD circuit. The telephone line is connected to the hold components through bridge rectifier BR so the input is not polarity sensitive and the input lines may be connected either way. BR always connects the positive side of the line to zener diode D2 and the negative side of the line to IC2. If L1 is positive, current flows into the circuit through bridge diode A and back out through diode D into L2. If L2 is positive, current flows in through diode C and out through diode B into L1. The telephone line also connects to tone decoder IC4 through C4 and T1.

Optoisolator IC1 contains a silicon controlled rectifier (SCR) having a characteristic that makes it continue to conduct current, or latch on, once turned on by current flowing through an optically coupled LED within the IC. The SCR conduction continues even after the LED current is removed, providing enough anode current is available to sustain it. When the SCR anode voltage is removed and conduction stops, it will not resume when voltage is re-applied until again triggered by LED current. This characteristic makes the SCR optoisolator ideal for a line hold application.

When all phones are hung up (on-hook) the voltage across the telephone line is about 48 volts. When a phone is picked up (off-hook) it places a load on the line and a current of about 20 milliamps flows through the phone which causes the line voltage to drop to about 3 to 8 volts, depending on the telephone unit. Current also flows through circuits in the central office, indicating that the phone has been picked up.

A call is put on hold when all phones are hung up and the SCR in IC1 is triggered on by circuits driving its LED (we'll tell you more about this later). When The SCR conducts, current flows through BR, D2, D1, IC1, IC2 and back through BR, placing a load on the line that keeps the central office circuits active. A 15 volt drop across D2, a 2 volt drop across D1, a 1.5 volt drop across the LED in IC2 and about a 1.5 volt drop across the diodes in BR results in the normal 48 volt open circuit line voltage across L1, L2 being clamped to about 20 volts which allows line current to flow but is a higher voltage than when a telephone loads the line. Now when a phone is picked up and the line voltage drops to about 8 volts or less, there is no longer enough voltage to produce conduction through D2, D1 IC1, IC2 and BR and the hold function is canceled. LED D1 is provided to indicate that a call is on hold.

The telephone line also connects through C4 and transformer T1 to capacitor C8 which couples the DTMF signal to the input of IC4, a Motorola MC145436 or Harris CD22204 dual tone, multi frequency tone decoder integrated circuit used to detect the # key tone. The 3.57 Mhz crystal XTAL

GLOLAB

Universal Telephone Hold

generates a clock required by the decoder. Zener diode D6 clamps its input to prevent damage from transients. The decoder has four outputs that produce a hexadecimal code corresponding to the tones it

receives when a key is pressed as shown in table 1. When these outputs are further decoded, the "1" or "0" status of all four outputs usually must be considered to get a unique hexadecimal number for each DTMF tone. Notice, however, that a "1" occurs simultaneously in both the pins 13 and 14 outputs only when the # key is pressed. This makes using the outputs easier since only two hexadecimal bits must be considered to decode the # key.

The binary decoding is done by a logical AND circuit consisting of two diodes, D4 and D5 whose cathode terminals must both be at an up level or logical "1" for their anodes, which are connected together, to be pulled up by R5. This up level discharges C1 through R4 into the positive supply. When the # key is released the DTMF signal stops, pins 13 and 14 go down again and a down level pulse is produced by time constant C1, R4 at the pin 2 trigger input of timer IC3. Since the IC3 trigger input must receive a negative transition to start a timing cycle, the cycle does not start until the # key is released. When the timing cycle starts, IC3 output pin 3 goes up for five seconds and drives current through R3 into the LED within IC1 which places its SCR in a potentially conducting state where it needs only to have sufficient voltage applied to its anode terminal to make it heavily conduct and latch on, a condition that occurs when the phone is hung up. The five second output from IC3 keeps IC1 LED current flowing long enough to hang up the phone and have the required anode voltage applied to maintain conduction. The time duration is controlled by R7 and C7 and may be altered by changing the value of R7.

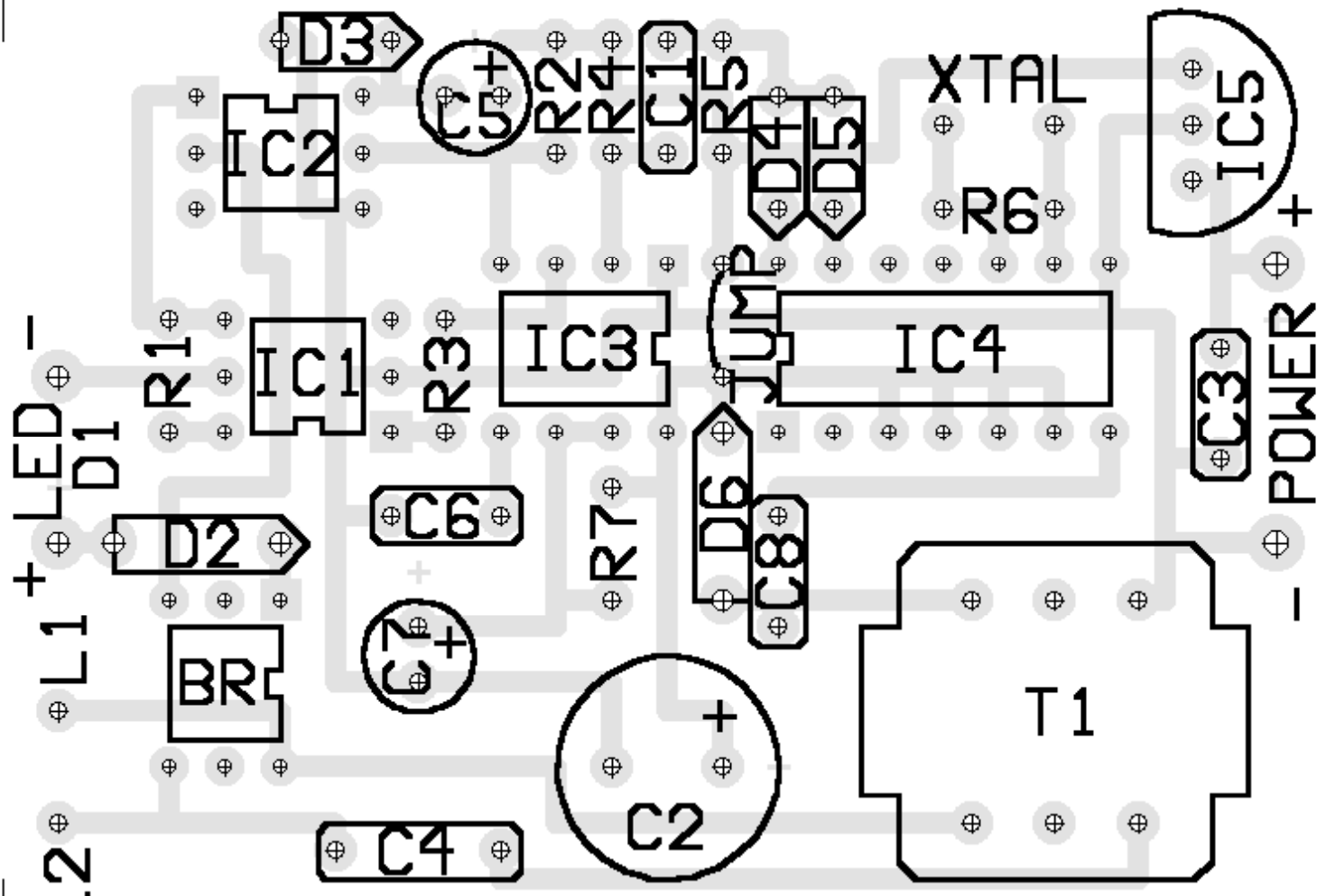
IC2 is an optoisolator with a transistor output. After the # key is pressed and the phone is hung up, telephone line current flowing through the led in IC2 turns its transistor on which resets timer IC3 and terminates its timing cycle. This reset function removes current from the LED in IC1 and allows a hold to be canceled immediately after initiating it without having to wait for the five second cycle to complete. The transistor within IC2 also performs a power-on reset by having its base coupled through C5 to the positive supply. When power is turned off C5 discharges through D3. Power is supplied by a 12 volt DC wall transformer and by IC5, a 78L05 5 volt regulator, and is filtered by C2 and C3. The power supply, DTMF decoder and timing circuits are isolated from the telephone line by the optoisolators and transformer T1.

TESTING

Connect the hold circuit to the telephone line and plug the wall transformer into an AC outlet. Pick a phone up, press the # key and hang it up within five seconds. D1 should light. Pick a phone up and D1 should go out. Press the # key, wait about eight seconds and hang the phone up. D1 should not light.

OPERATION

The five second timing cycle that starts after the # key is released gives ample time to hang up a phone with a keypad on the handset. If the keypad is on the telephone base the # key can be pressed while the phone is being hung up. If the # key is pressed for reasons other than to place a call on hold, such as to signal the end of a number entry after using a fax back service, the timing cycle will end after five seconds and will probably not be active when the phone is hung up, but to be sure that the line is not on hold after using the # key just pick the phone up and hang up again.



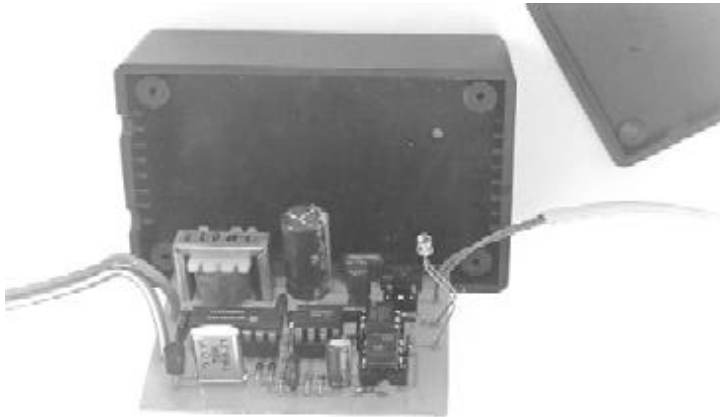
AMERICAN ELECTROMECHANICAL INC.

HEX DATA OUT CODE

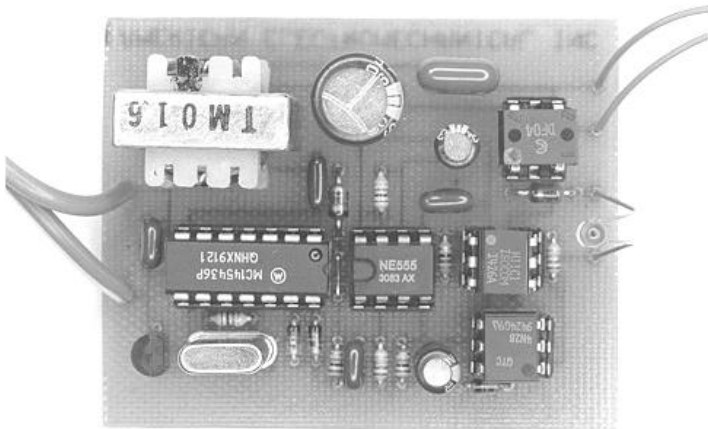
IC PIN 1	KEY	D8		D4		D2		D1	
		IC PIN 13	IC PIN 2			IC PIN 14			
	1	0		0		0		1	
	2	0		0		1		0	
	3	0		0		1		1	
	4	0		1		0		0	
	5	0		1		0		1	
	6	0		1		1		0	
	7	0		1		1		1	
	8	1		0		0		0	
	9	1		0		0		1	
	0	1		0		1		0	
	*	1		0		1		1	
	#	1		1		0		0	

TABLE 1

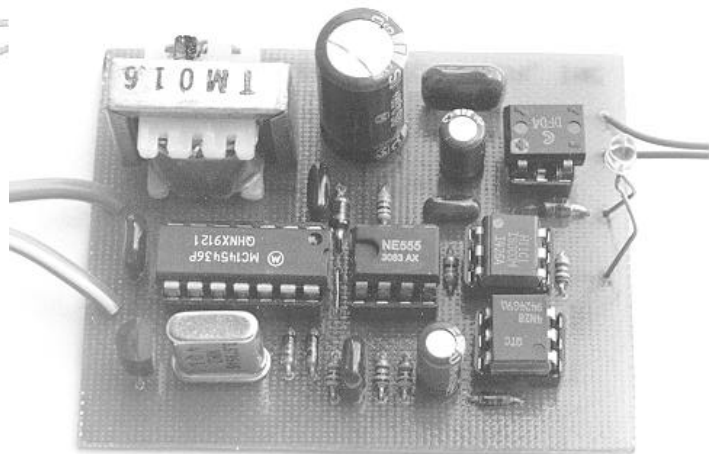
BOARD IS HELD IN PLACE BY BOTTOM COVER



ASSEMBLED UNIT



TOP VIEW OF BOARD



SIDE VIEW OF BOARD
note LED mounted on right side

UNIVERSAL HOLD PARTS LIST

R1, R4 - 56K 1/8 watt 5 %	Digi-Key
R2, R5 - 10K 1/8 watt 5%	Digi-key
R3 - 0.056K 1/8 watt 5%	Digi-Key
R6, R7 - 1 MEG 1/8 watt 5%	Digi-Key
C1, C3 - .1 MFD 50 volt metalized film	Digi-Key P4525
C2 - 1000 MFD 16 volt electrolytic	Digi-Key P6231
C4 .1 MFD 250 volt polyester	Digi-Key EF2104
C5 - 1 MFD 50 volt electrolytic	Digi-Key P6260
C6, C8 - .01 MFD 50 volt metalized film	Digi-Key P4513
C7 - 4.7 MFD 35 volt electrolytic	Digi-Key P6247
D1 - light emitting diode	Digi-Key LT1083
D2 - 1N4744 15 volt 1 watt zener diode	Jameco 36185
D3, D4, D5 - 1N914 silicon diode	DC Electronics
D6 - 1N4739 9.1 volt 1 watt zener diode	DC Electronics
BR - DF04 1 AMP 400 volt DIP bridge rectifier	DC Electronics
IC1 - H11C1 SCR optoisolator	Jameco 114016
IC2 - 4N28 transistor optoisolator	Jameco 41013
IC3 - 555 timer	DC Electronics
IC4 - MC145436 or CD22204 DTMF decoder	DC Electronics or Circuit Specialists
IC5 - 78L05 voltage regulator	DC Electronics
XTAL - 3.579545 MHZ crystal	Hosfelt 23-108
T1 - 600 OHM primary, 600 OHM secondary transformer	Jameco 105902
IC sockets - 3 six pin, 1 eight pin, 1 fourteen pin	Digi-Key
XFMR - 12 volt DC 100 MA wall transformer	Hosfelt 56-309
6 foot telephone wire with RJ11 plug	DC Electronics
plastic box - 2 X 3 X 1	Jameco 18921
two 4" cable ties	Digi-Key
printed circuit board	American Electromechanical

UNIVERSAL HOLD ASSEMBLY INSTRUCTIONS

1. Insert and solder a bare jumper wire in the holes between IC3 and IC4 as shown in figure 2. A piece of lead from a resistor or capacitor may be used as a jumper.
2. Bend the resistor leads close to the resistor body. Insert and solder all resistors.
3. Bend diode D3, D4 and D5 leads close to the diode body. Insert and solder D3, D4 and D5 with the cathode band in the direction shown in figure 2.
4. Bend D2 and D6 leads. These leads are heavy and should be bent carefully if glass diodes are supplied. Insert and solder D2 and D6 with the cathode band in the direction shown in figure 2.
5. Insert and solder all .1 mfd and .01 mfd capacitors.
6. Insert and solder each IC socket with its alignment notch facing as shown in figure 2.
7. Insert and solder crystal XTAL.
8. Insert and solder voltage regulator 78L05 with its flat side facing XTAL.
9. Insert and solder electrolytic capacitors C2, C5 and C7 with their long positive leads connected to + as shown in figure 2. A + symbol is also marked on the PC board to indicate polarity.
10. Insert and solder transformer T1. Both the primary and secondary of T1 are 600 ohms so it may be connected in either direction.
11. Insert and solder LED D1 with its long positive lead connected to + as shown in figure 2. Leave the leads long and bend them in an S shape as shown in figure 3 to adjust the height of the LED so it fits through the hole in the box.
12. Insert and solder the wall transformer leads. The positive lead has a white tracer stripe and should be connected to the positive terminal as shown in figure 2. A + symbol is also marked on the board to indicate polarity.
13. Strip about ¼ inch of insulation from the red and green wires in the telephone cable. Tin the wires to make insertion easier. Insert and solder these wires in either direction since the circuit is not polarity sensitive. The telephone cable has 4 wires but only the red and green are used.
14. Place a cable tie around the telephone cable and another around the power cable. Adjust their position to leave sufficient slack in the cables to prevent strain on the PC board. Pull the ties very tight so they cannot slide on the wires and cut the tails off.
15. Plug each IC into its socket with the pin 1 indicator in the same direction as the socket notch.
16. Place the PC board in the box with the cable ties inside and the LED going through the hole. Screw the cover in place.