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CES 410 Personal Patch Installation and Programming Instructions

Obsolete Product - No Longer Supported

The Model 410 Personal Patch (obsolete) is designed to provide reliable telephone interconnect operation at an exceptionally affordable cost. Complicated microprocessor programming steps (as with other interconnect models) have been replaced with simple jumper configuration. Level adjustments and radio connections are kept to an absolute minimum, in order to allow the installation process to be accomplished in the easiest possible manner. Further, user operation is simple and straightforward.

The Personal Patch provides DTMF equipped two-way mobile and handheld radios with the ability to make and receive telephone calls. The patch is fully compatible with both half-duplex (repeater installation) and simplex (base station installation) radio systems. It offers either of two popular methods of operation when used in simplex applications: VOX control or sampling control. The unit provides simple "*" up and "#" down operation, and either pulse or DTMF dialing. Inputs are provided for external CTCSS decode and COR. A mobile activity timer provides an automatic disconnect feature for those occasions when the mobile abandons the connection without properly disconnecting the call.

CES has a full line of DTMF encoding microphones compatible with many popular radio models, from low-cost basic to memory dialing types. Contact your sales representative for more information.

INSTALLATION

Telephone Line Connection A standard RJ-11 modular phone jack is provided on the rear panel of the unit for connection to the telephone line. **Base Station or Repeater Connections** Make the following connections to the base station or repeater station equipment. Connections are made to terminal block J2 located on the rear of the Personal Patch. A minimum of five (5) connections are required (Transmit Audio, Receive Audio, PTT, Power, and Ground). Two additional connections (CTCSS and COR) are optional. For assistance in determining the connection points in the radio equipment, see the illustration Figure "B" in the Appendix of this manual. It is also helpful to refer to the radio or repeater schematic diagram and service manual for additional information on where to make the physical connection.

Function	J2	Procedure
Transmit Audio	1	Connect to the microphone audio input, or an alternate voice-range (300-3000 Hz) transmitter input that incorporates pre-emphasis.

Receive Audio	2	Connect to discriminator or detector audio (preferred method). Verify that jumpers JP2 & JP10 are both installed (IN).
Receive Audio	2	<i>(Alternate Method)</i> Connect to speaker audio or the high side of receiver volume control. Remove both jumpers JP2 and JP10. If using this method, the External COR input from the receiver <i>must</i> be utilized.
PTT	3	Connect this active logic low function to the microphone PTT input, or an alternate transmitter PTT
Power	4	Connect to the base station power supply, one that is reasonably well-regulated and filtered. An acceptable voltage range is 10-15 VDC (+12 VDC nominal).
Ground	5	Connect to a good ground/common point in the radio.
COR	6	<i>Not required if the preferred discriminator/detector audio method is used.</i> If using Speaker audio, connect this input to the receiver's squelch logic, either an active logic high or low on received carrier. If an active logic high, set jumper JP7 to the 1 & 2 position. If an active logic low, set JP7 to the 2 & 3 position. For more information on COR, see the applicable Appendix section.
CTCSS	7	This input may be used as an input (active high) from the receiver CTCSS (or DCS) decoder to allow only certain authorized use of the patch. If this input is grounded (kept at a logic low), the Personal Patch will not allow a connection from a mobile, only manually from the front panel.

Function	Jumper Setting	Factory Default
Sampling Controlled Simplex Mode	JP5 OUT, JP6 OUT	X
VOX Controlled Simplex Mode	JP5 OUT, JP6 IN	
Half-Duplex Mode	JP5 IN, JP6 OUT	
DTMF Dialing	JP4 OUT	X

U.S. Pulse Dialing (39/61 make/break ratio)	JP4 IN, JP3 OUT	
Foreign Pulse Dialing (33/67 make/break ratio)	JP4 IN, JP3 IN	
Discriminator/Detector Audio (<i>preferred method</i>)	JP2 IN, JP10 IN	X
Speaker Audio used (<i>must use External COR</i>)	JP2 OUT, JP10 OUT	
No External COR (discriminator audio used)	JP7 between 2 & 3	X
External COR Active High input from receiver	JP7 between 1 & 2	
External COR Active Low input from receiver	JP7 between 2 & 4	
Mobile Activity Timer enabled (1-minute)	JP9 IN	X
Mobile Activity Timer disabled	JP9 OUT	
Mobile enabled to receive calls	JP8 OUT	X
Mobile not enabled to receive calls	JP8 IN	
Transmitter Audio High Impedance Input	JP1 IN	X
Transmitter Audio Low Impedance Input	JP1 OUT	

Jumper Functional Descriptions:

JP1 Output Impedance: Remove jumper to drive low impedance inputs to transmitter. Leave jumper IN for high impedance inputs. See Transmit Audio Level Adjustment for more information.

JP2 De-emphasis Select: Used to enable or disable the de-emphasis circuit. De-emphasis is required when using discriminator or detector audio (leave jumper IN). Remove jumper when using speaker audio (this receiver audio is already de-emphasized).

JP3 Pulse Dialing Make/Break Ratio: Changes the make/break ratio for the particular telephone pulse dialing requirement. For the foreign 33/67 ratio, commonly used outside the U.S., place the jumper IN. For use within the U.S. or compatible pulse dialing systems, remove the jumper. If DTMF dialing is selected, this jumper function is not used.

JP4 Dialing Select: Remove jumper to select DTMF dialing. Leave jumper IN to select Pulse Dialing.

JP5 Mode Select: Leave jumper IN for half-duplex (repeater) installation. Remove the jumper if installing with a simplex base station.

JP6 Simplex Control: This jumper is only functional if JP5 is set for simplex operation. Remove the jumper for Sampling control. Leave the jumper in for VOX control. See the Operation section for more information about these modes.

JP7 Mobile Detect Mode

Jumper between Pins 1 & 2	Patch detects mobile carrier using an active high logic input from the receiver to the External COR Input.
Jumper between Pins 2 & 4	Patch detects mobile carrier using an active low logic input from the receiver to the External COR Input.
Jumper between Pins 2 & 3 (default-preferred method)	Patch detects mobile carrier using internal circuitry using the discriminator or detector audio connected to Receiver Audio input.

INSTALLATION

Adjustments:

Internal COR Mobile Detector (RV4) (not required if External COR is used)

- (1) Apply power to the Personal Patch and base station or repeater.
- (2) Beginning with RV4 fully clockwise, rotate it slowly until the "Noise" LED DS2 illuminates.
- (3) Connect a service monitor to the receiver and generate an on-channel carrier. Vary the generator output and verify that the Noise LED goes out with a received carrier of approximately 12 dB SINAD, or the same point where the receiver becomes unscelched. Repeat the readjustment of RV4 as necessary so that it illuminates when no carrier is present, and goes out when a useable carrier signal is received.

Transmit Audio (RV2)

- (1) Set the service monitor to receive on the transmitter frequency.
- (2) With the telephone line plugged into the rear panel connector, press the front panel switch to manually connect. A dial tone will be transmitted.
- (3) Set RV2 for 4.0 KHz deviation as observed on the service monitor. The modulation should not be clipped or distorted. If the level can not be reached, or if the range is inadequate, remove jumper JP1.
- (4) Press the front panel switch to disconnect the telephone line.

Receive Audio (RV3) (Jumper JP8 must be removed for this adjustment)

- (1) Call the patch telephone line from another telephone.
- (2) Manually answer the line by pressing the front panel switch.
- (3) Have a mobile unit make a test transmission and adjust RV3 for a normal telephone line level as heard on the telephone. If an AC voltmeter is available, monitor the telephone line and set RV3 for approximately 500 mV (-4 dBm) on voice peaks from the mobile.
- (4) Verify that the mobile can disconnect the call with a "#" from the DTMF microphone or encoder, and connect with a "*". If not, then adjust RV3 slightly CW or CCW until the mobile is able to reliably connect and disconnect.
- (5) Reinstall jumper JP8, if desired (disables Reverse Patch Enable).

VOX Sensitivity (RV1) (Not required for half-duplex installation)

- (1) Jumpers JP5, JP8, and JP9 must be removed.
- (2) Jumper JP6 must be installed.
- (3) Rotate RV5 fully clockwise.
- (4) Call the patch from another telephone.
- (5) Press the front panel switch to manually connect the call. Wait 20 seconds.
- (6) Adjust RV1 so that the PTT LED illuminates when you speak into the telephone, and goes out after not speaking. Further adjust RV1 so that this procedure responds reliably and for lower level voice audio.

(7) Reinstall jumper JP9 if desired (enables Mobile Activity Timer).

Sampling Rate (RV5) (Not required for half-duplex installation)

(1) Jumpers JP5, JP6, and JP9 must be removed.

(2) Remove the telephone line from the rear panel of the Personal Patch.

(3) Connect the patch manually by pressing the front panel switch, or connect from mobile.

(4) Observe the periodic sampling indications (PTT LED momentarily goes off) and adjust RV5 for the shortest period of time that it is on, while periodically having the mobile transmit for a short period to confirm that both the PTT and Noise LED's will stay off during the period the mobile is transmitting.

(5) Reinstall jumper JP9 if desired (enables Mobile Activity Timer).

Verify that all jumpers are configured in accordance with the manner selected for the Personal Patch to operate in this installation.

The installation procedure has been completed.

Refer to the OPERATION section that follows in this manual for instructions on how to use the 410 Personal Patch.

Should the Personal Patch not operate correctly, please refer to the "In Case of Difficulty" section of this manual.

OPERATION

In a half-duplex radio system, that incorporates the use of different transmit and receive frequencies, and allows the base station or repeater to simultaneously transmit and receive at the same time. When the Personal Patch is used in this manner, the mobile can transmit at any time to reply to the telephone line caller, or to disconnect the patch. This mode of operation affords the best approach to telephone interconnection for conventional simplex/half-duplex mobiles.

In simplex systems where a single-frequency is used, the base station radio must be unkeyed before it can detect the presence of a transmitting mobile. Therefore, there are some restrictions on when the mobile can dial or speak. Two different modes of control are available for the Personal Patch when configured for simplex systems. In the Sampling mode, it will cause a periodic interruption, or receive "window", while transmitting. These "samples" cause the patch to unkey the transmitter in order to determine if the mobile is transmitting. If it sees mobile carrier, it then will remain in a receive mode - routing the mobile audio to the telephone line for the duration that the mobile transmits. When the mobile unkeys, the patch reverts back to the transmit mode and continues with sampling the receiver for subsequent mobile activity. In this mode, each time the mobile wants to talk or dial, it first has to transmit long enough for the next sample to occur. This takes approximately 1/2 second when there is no audio from the telephone line, or approximately 8-seconds when audio is present. The advantage of the Sampling mode is that the mobile will always have the ability to interrupt the conversation or to disconnect.

In VOX mode, the base station will transmit whenever the landline party speaks. After a pause in telephone line audio, the base station will revert back to the receive mode - allowing the mobile to transmit. When using the VOX mode, the operation is susceptible to telephone line noise or perhaps music from the telephone line keeping the connection in a continual transmit mode and not permitting the mobile to transmit. Similarly, the mobile unit may not be able to disconnect the call connection and the transmitter may "hang" for an indefinite period of time, unless the Mobile Activity Timer is enabled and the call will disconnect after one minute of not seeing. It is recommended to use the Mobile Activity Timer when using the VOX mode.

The above description of the VOX mode does not apply to the first 20-seconds after the patch is activated. During this period, the patch always defaults to the Sampling mode. This assures the

activated. During this period, the patch always defaults to the sampling mode. This assures the mobile the ability to disconnect a call in the event of a busy signal or other telephone line audio that may occur on the onset of the call.

Making a Mobile to Landline Call Generally, dialing is easiest if you dial the telephone number immediately following the "*" command to connect. If you prefer to hear dial tone after connecting, and using the simplex Sampling mode, then hold the first digit of phone number for a couple of seconds to capture the patch before proceeding. In simplex VOX mode, if you need to hear dial tone you will have to hold the first digit for up to 8-seconds, or make a minor modification that will shorten this time (see Sampling Time in Appendix B).

Receiving a Landline to Mobile Call If reverse patch mode is enabled, you may receive an incoming call from the mobile(s). Each time the incoming call rings, it will cause Personal Patch to transmit a tone to the mobile. To answer the call: Press the "*" key on the microphone or encoder.

Conversing During a Call In the half-duplex mode, the mobile may transmit at any time and be heard by the landline party.

In simplex systems that are using the Sampling mode control, the mobile must key up and wait for the next sample period to occur before speaking. If there is no audio from the phone line this will only take a brief period - about 1-second. If you need to break into an ongoing period of voice from the landline party (or dial tone, busy signal, music, etc) then you will have to wait a maximum of 8-seconds before speaking or disconnecting. The reason sampling occurs less frequently during landline to mobile audio periods is so that the sampling interrupts (that can be heard by the landline party as short bursts of noise) are minimally distracting to the telephone conversation.

In simplex systems that are using VOX mode control you must wait for the telephone line party to stop speaking before the mobile can transmit and be heard.

Disconnecting a Call

To disconnect a call dial the "#" digit. In half-duplex mode, this can be done at any time during the call. In simplex Sampling mode you can accomplish this at any time, but the "#" digit must be keyed for at least 1-second when no telephone line audio is present, or up to 8-seconds if continuous audio is occurring. In the simplex VOX mode you may send the "#" digit only when the base station is not transmitting. If continual audio becomes present, keeping the transmitter on the air, simply wait one minute for the mobile activity timer to automatically disconnect the call (Mobile Activity Timer enabled).

Manual Operation

The "Connect" switch on the front panel provides a means to manually connect the phone line to any mobile, even one without DTMF capability. To invoke an outbound call, dial the desired telephone number from an extension telephone (connected to the Personal Patch line) and at an appropriate time, press the Connect switch. On an inbound call, press the Connect switch at any time. To disconnect the patch, press the Power switch OFF and then press again to turn the Personal Patch back on.

Automatic Mobile Activity Timer

The Personal Patch is designed with a timer that will disconnect a call in progress after 1-minute if the mobile has not been received for that period of time. This is a feature that prevents the patch from keeping the base station from being continually kept in transmit in the event that a mobile moves out of range or fails to disconnect for any other reason. You may disable this feature by removing jumper JP9, but is not recommended, and in particular when using the simplex VOX mode.

In Case of Difficulty

Unit appears dead or non-functional

(1) Remove the top cover and check fuse F1. Replace with 1.0 Ampere fast-blow type.

(2) Verify that approximately 112 VDC is present at J2, 4

(2) Verify that approximately +12 VDC is present at J2-4.

(3) Verify that the ground connection is properly made at the base station and J2-5.

Mobile cannot connect ("*") or disconnect ("#")

(1) Verify that the mobile DTMF encoding is working properly (3.0 KHz deviation).

(2) Recheck the setting of RV3 (Installation section).

(3) Verify that the Noise LED is off when the mobile is transmitting and illuminated with not transmitting. Readjust RV4 as necessary.

(4) Verify that jumper JP7 is set correctly for the receive audio and COR method used.

Mobile is unable to transmit - base station always transmitting (Simplex VOX mode)

(1) Recheck the adjustment of RV1 (see Installation section).

(2) Verify that the telephone line is free of hum or other residual noise.

(3) Verify that the patch is set for the proper jumper configurations for this mode.

(4) Verify that jumper JP7 is set correctly for the receive audio and COR method used.

Mobile is unable to transmit - base station always transmitting (Simplex Sampling mode)

(1) Verify that the patch is set for the proper jumper configurations for this mode.

(2) Verify that the Sampling Rate is set correctly (RV5).

(3) Verify that jumper JP7 is set correctly for the receive audio and COR method used.

Noise LED does not function (Discriminator or Detector Audio used)

(1) Ensure that jumper JP7 is set correctly for this method (across Pins 2 & 3).

(2) Readjust RV4 in accordance with the procedure in the Installation section.

(3) Using an oscilloscope, verify that detector noise is present at J2-2 and that noise disappears when a mobile is transmitting (voice audio only).

Transmitter audio or modulation too low or too high

(1) Recheck the adjustment of RV2.

(2) Change the position of jumper JP1, and readjust RV2 for the correct deviation.

(3) Locate another connection point to the transmitter, and repeat steps 1 & 2.

Transmitter does not key

(1) Check the connection at J2-3 and the base station point of connection for PTT.

(2) Verify that the base station requires a logic low (ground) to transmit.

One or more functions are not operational

(1) Return all jumper settings to the factory defaults (see Summary of Jumper Configurations).

(2) Review the Installation section and compare with the radio or repeater schematic diagram and service manual.

(3) If installing for CTCSS, bypass this function for the time being and accomplish a 'basic' installation first with only the 'five connections', confirm proper operation with carrier squelch, and then proceed with the interface with the CTCSS decoder.

If difficulty is still experienced after addressing the above suggestions and the technical information contained in the Appendices of this manual, contact CES Customer Service Department for assistance.

Appendix A

How To Locate Discriminator or FM Detector Audio

Most receivers used in conjunction with CES Simplex Interconnects will likely have an integrated circuit FM detector, where the detected audio will appear on one pin of the IC. This pin will normally exit to the receiver's squelch circuit (sometimes part of the same IC) and to an audio amplifier incorporating de-emphasis (removes the high-frequency noise components) and/or and audio switch controlled by the squelch circuitry. In interfacing to an interconnect, several factors should be considered: (1) That connecting any external circuit to the IC does not load or affect it's operating characteristics, and (2) that any other external noise or RF is not permitted to be coupled back into the receiver. Locate the IF/Detector or Detector IC in the radio schematic. Verify with an oscilloscope that the pin contains both unsquelched high frequency noise (300 mV to 2 V typical) and only detected audio when receiving a modulated carrier. Connect the CES interconnect's Receiver Audio input to this point and note if the level is affected. If it becomes reduced by more than 20%, try placing a 10K to 20K resistor in series to minimize any loading. If necessary, use a higher value resistor. Place heatshrink tubing over the resistor and the connections to prevent any chance of shorting to surrounding components. If unusual noise is observed either in the radio speaker or interconnect when either is used, then an RF choke of perhaps 1 mH in series and at this point of connection may be needed.

The table later in this appendix lists several types of applicable detector IC's. If the IC type is not listed, and you are unable to determine the proper pin on the detector IC on the radio schematic:

Use an oscilloscope to locate the detected audio output. With no carrier being received, look for a pin that has high frequency noise (up to approx. 10 KHz or greater), and that has detected audio when receiving a modulated carrier. The audio level at the correct pin will not be affected by the receiver squelch control or the volume control. The correct pin will not normally be connected to a tunable coil, crystal filter, or ceramic resonator.

If the detector IC output pin cannot be determined, then proceed with the following suggestions:

(1) In no case will true FM detector audio be available at the speaker output connection of the receiver. Similarly, it is unlikely that the desired FM detector audio will be available at the 'top' of the receiver volume control. The recovered audio at these points will normally already be de-emphasized and will not include the high-frequency noise components necessary for most simplex interconnects to operate in this mode.

(2) The correct point will be somewhere between the 'top' of the front panel volume control and the detector IC. Looking at the radio schematic diagram, an FET audio gate may be seen with its gate connected to the squelch circuitry. Verify with an oscilloscope that audio is always present at this point, even when the squelch control is set to squelched (no audio is heard from the speaker). With an RF signal generator or communications service monitor, generate a full-quieting on-channel carrier modulated with a 1 KHz tone.

After verifying the presence of the 1 KHz tone, vary the modulated tone upward to 10 KHz. If the recovered audio signal observed stays at approximately the same level, then make the discriminator audio connection to this point. If the level drops to a substantial level below that observed at 1 KHz, such as 30% or less, then move to a point in the schematic diagram toward the FM detector where the level of noise and recovered audio, including the 10 KHz test, are approximately the same.

Common FM Receiver IC's:

Manufacturer	Part Number	Detector Output Pin
Motorola	MC3357, MC3361 MC3359 MC3362 MC3363 MC3367	9 11 13 16 10
National Semiconductor	LM1865*, LM1965*, LM2065* LM3089*, LM3189* LM3361 TBA120S	15 6 9 5
Plessey	SL8837 SL8852 SL8853 SL8854 SL8855	1 3, 4 3 4 17, 18
RCA	CA3089*, CA3189*, CA3209 CA3215	6 7
SGS-Thomson	TDA7359, TDA7361 TDA3089*	9 6
Sharp	IR3N06, IR3N37	9
Siemens	TBA120S, TBB1469 TBA120T, TBA120U TBB469, TBB2469G, S041P	5 8 or 12 8

Note: Some of the IC's listed above, in particular those marked with an "", may have the detected audio pin squelched when a carrier is not being received. If this is the case, then the receiver must be left unsquelched at all times, or the External COR function must be used.

Appendix B

Customizing Timing Parameters Although the Personal Patch is designed with operating characteristics that meet most requirements and for optimum performance, many of the timing parameters can be easily changed by replacing a resistor or capacitor with a different value. To change a given timing parameter simply use a new resistor or capacitor value that is proportional

to the change in time duration desired. For example, to decrease the mobile activity time from 60 seconds to 30 seconds, replace the applicable resistor or capacitor with a value that is one-half of the existing value.

The following is a list of timing parameters that can be changed:

Function	Normal	Components	Description
Mobile Activity Timer	1-min	R47, C23	Time for patch to automatically disconnect if mobile stops transmitting.
Sampling Rate	1/2 sec.	R58, C24	Time between samples when audio is not present from telephone line.
Enhanced Sampling	8-sec	R42, C28	Time between samples when audio remains present on telephone line. Faster sampling requires less time to dial or "break-in" from mobile but may become more intrusive to person's speech. Also, shortening this time makes dialing easier in the VOX mode when hearing dial tone is preferred after connecting.
Initial Sampling Time	20-sec	R75, C48	Period of time after dialing the unit will initially sample (VOX mode). A shorter period will allow the mobile to go into the VOX mode sooner, but increases the chance that mobile may not be able to hang up when a busy signal is obtained. <i>(Note: C48 also affects dialing mode below)</i>
Dialing Mode	5-sec	R74, C48	Period of time in Sampling mode that patch will ignore phone audio (usually dial tone) and sample at the normal faster rate. <i>(Note: C48 also affects Initial Sampling time above)</i>

Appendix C

Understanding Carrier Operated Relay (COR)

Although the preferred method for interfacing a simplex interconnect is using Discriminator or Detector Audio, where internal COR mobile detection is used, it may not be possible in cases where this audio is only available as squelched-controlled audio in the receiver.

If this is the case, then External COR must be used as an input to the CES Interconnect you are installing. Using the receiver schematic diagram, determine the circuit that derives the squelch logic and verify that the signal is a DC level change of 0 to 5 or more volts from a no-signal to a received signal condition. This can also be simulated by operating the squelch control. It is not important whether this active state is high or low, since all CES simplex interconnects can be configured for either one. Note the logic level (an active high or an active low) when the receiver squelch is "open" (unsquelched or receiving a carrier). This is the active logic level that will be used in configuring or programming the interconnect. Note: This logic signal must change very quickly in conjunction with receiving a carrier and when the carrier drops. In some receivers there are similar functions that may be used as a signal strength indicator, and are DC levels that

change too slowly, or that change proportional to the received signal level, and are not suitable to serve properly as COR logic. Do not use this type of logic. Often, these outputs are labeled on the radio schematic as "S-Meter," or similar descriptions.

If you are not able to determine a direct source for squelch logic, and if the radio has a "busy" LED indicator, then the logic signal applied to the LED may be suitable for COR. In some circuits, the LED may be turned on with an open collector transistor to ground. If this is the case, the interconnects COR connection would be made to the collector and would be an active 'LOW' logic state. In other cases, the LED may be illuminated by a transistor switching a source current path

to the LED. In this case, connect the COR lead from the interconnect to the high side of the LED and is a 'HIGH' active state when carrier is received.

Do not get discouraged, the receiver connection of a simplex telephone interconnect is the most complex aspect of the installation. You can call CES Technical Support during business hours (Telephone: 407-679-9440 M-F 9 AM to 5PM EST) and we will assist you as much as possible.

If you do not feel comfortable working on your radio or looking for connection points inside of the radio, we offer installation of our equipment to most radio models. Please contact the CES Sales Department for current rates and instructions.

Model 410 Personal Patch Parts List

Ref	Description	CES Part #	Reference	Description	CES Part #
C1 C2	Capacitor .01 uf 630V	CP103	R3 R56	Resistor 220K 1/4w	R220K
C3 C20 C21	Capacitor .1 uf 50V	CM.1	R6 R28 R53	Resistor 2.2K 1/4w	R2.2K
C4 C5 C19 C47	Capacitor .22 uf 50V	CM.22	R7 R18 R23	Resistor 22K 1/4w	R22K
C6	Capacitor 1000 pf 100V	CM.001	R103	Resistor 22K 1/4w	R22K
C7	Capacitor 1 uf NP	CE105NP	R9	Resistor 15K 1/4w	R15K
C8 C9 C10	Capacitor .01 uf 50V	CM.01	R10	Resistor 120K 1/4w	R120K
C11	Capacitor .0047 uf	CM.0047	R11	Resistor 470 1/4w	R470R
C12 C14	Capacitor 100 pf 100V	CM101	R12 R19 R21	Resistor 100K 1/4w	R100K
C26 C27	Capacitor 100 pf 100V	CM101	R30 R35 R72	Resistor 100K 1/4w	R100K
C15 C22 C28	Capacitor .01 uf	CM.01	R100	Resistor 100K 1/4w	R100K
C18 C30 C31	Capacitor 33 uf 16V	CT33	R15-17 R24 R38	Resistor 47K 1/4w	R47K
C16	Capacitor .47 uf	CM.47	R71 R102 R104	Resistor 47K 1/4w	R47K
C24 C45 C46	Capacitor 2.2 uf 20V	CT2.2	R14 R26	Resistor 47K 1/4w	R47K
C17 C25	Capacitor 22 uf 16V	CT22	R22 R66	Resistor 27K 1/4w	R27K
C23	Capacitor 4.7 uf 35V	CT475	R25 R27	Resistor 100 1/4w	R100R
C29	Capacitor 1 uf	CE105	R29	Resistor 330K 1/4w	R330K
C32-C42	Capacitor .01 uf 50V	CM.01	R33 R34	Resistor 68K 1/4w	R68K
C43	Capacitor .47 uf 250V	CP474	R39 R50	Resistor 3.3K 1w	RD3.3K
C44 C101	Capacitor 22 uf	CT22	R57 R58	Resistor 1K 1/4w	R1K
C48	Capacitor 100 uf 25V	CE107	R41	Resistor 1K 1/4w	R1K
C100	Capacitor 10 uf 16V	CT10	R42	Resistor 4.7K 1/4w	R4.7K
CR1 CR8	Diode 1N4004	D4004	R43-44 R75	Resistor 4.7M 1/4w	R4.7M
CR2 CR3	Zener 1N746 3.3V	D746	R47	Resistor 470K 1/4w	R470K
CR4-CR7	Diode 100PIV 1N914	D914	R54	Resistor 10M 1/4w	R10M
CR9	Zener 1N5231A 5.1V	D5231	R55 R109	Resistor 3.9K 1/4w	R3.9K
DS1	LED	LED4	R74	Resistor 5.6K 1/4w	R5.6K
DS2	LED Red	LED1	R105 R107	Resistor 150K 1/4w	R150K
DS3	LED Red	LED1	RV1 RV2	Resistor 330 1/4w	R330R
F1	Fuse 1-Ampere 3AG	FUSE1	RV3 RV4	Potentiometer 10K	RV103
JP1-JP10	Jumper Plug 2-pos	CON13	RV5	Potentiometer 100K	RV100K
J1	Connector Jack RJ-11	CON80	S1	Potentiometer 50K	RV503
J2	Connector 9-position	TB01	S2	Switch, Momentary	SW6-A
K1	Relay DPDT 12VDC	RELAY1	T1	Switch, push-on/off	SW6
Q1-Q3, Q6 Q7	Transistor 2N2222	Q2222	U1 U3 U5	Transformer, Audio	TRAN1
Q10 Q11 Q12	Transistor 2N2222	Q2222	U2 U6 U14	IC TLC274CN	UC274
Q4 Q8 Q9	FET VN10KM	QV10	U4	IC SN74LS123BE	U74LS123
Q5	IC Regulator 7805	U7805	U7	IC Analog 4066BE	U4066
			U8 U11	IC Optocoupler	U4N25
			U8	4N25A	U556
R1-2, R4-5, R8			U10 U12 U16	IC Timer NE556N	U8870
R13 R20, R31-32 R36-37, R40			U13	IC Decoder MT8870	U16L8
R45-46, R48-49			U15	IC TIBPAL16L8	U40982
R51-52, R59-65			Y1	IC LR40982	U20L8

R07-R10, R13 R76 R101 R106 R108	Resistor 10K 1/4w	R10K	TZ Z1 Z2	IC 11BPALZ0L8 Crystal 3.579 Mhz Crystal 480 Khz Surge Absorber 220V	XTAL5 XTAL6 SURAB03
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