## FUNCTIONAL DESCRIPTION.

The Autopatch Module is used with the DTMF Decoder/Controller Module to provide the following functions: repeater autopatch, reverse autopatch, primary phone line remote control of repeater, phone line monitor of repeater receiver, and secondary remote control through repeater receiver.

The Autopatch Module can be interfaced directly with any touchtone telephone line. It is registered with the FCC under part 68.

## HOW IT WORKS.

Refer to the schematic diagram and the repeater block diagram during the following discussions.

### Phone Line Interface.

The phone line is connected to E1-E2. Relay K1 completes a path to dc load resistors R6/R7 and to isolation transformer T1 via high voltage capacitor C5. When the phone patch relay is activated, the dc current drawn by R6/R7 "seizes" the phone line, and T1 couples audio in and out of the line. When the phone line is "on-hook", any incoming ac ringing voltage is coupled through capacitors C6 and C99 to opto-coupler U2. When the opto-coupler senses a ringing voltage on the line, it trips timer U3.

### Audio Paths.

When the autopatch is enabled, relay K1 connects the telephone line to isolation transformer T1 through dc blocking capacitor C5. Phone line audio is amplified in two successive op-amp stages. The repeat phone line level is set by potentiometer R8. U1-D also acts as a switch: audio passes only when the autopatch is enabled and the receiver squelch is closed. Therefore, the radio station using the repeater has control over what parts of the incoming telephone conversation goes out over the air: any time the radio operator keys his microphone, the receiver squelch cuts off the telephone audio at U1-D. C10 prevents switching clicks from occurring when a dc signal is applied through R12 or R13. The 220 pf capacitors at various input and output terminals of the board are to bypass vhf/uhf rf energy.

Audio from the repeater receiver enters at E7. Some of this audio is applied through R16 and mixer U1-C and E9 to the transmit audio input circuit on the COR board. Because of the squelch action in the receiver, audio is present only when a station is heard on the receiver. Thus, receiver audio does not interfere with audio coming from the telephone line.

Q5 acts as a switch to mute the audio at the input of U1-C whenever the DTMF Decoder/Controller Board applies a signal indicating that tones are being received. This prevents tones from being repeated on the transmitter. Capacitor C15 works in conjunction with a diode on the TD-2 DTMF Decoder/Controller Board to provide a fast-attack/slow-release time constant for the mute switch.

Receiver audio is applied through potentiometer R1 to line driver Q4, which amplifies the signal and drives the telephone line through isolation transformer T1. Bias for the stage is switched on by Q2 only when the receiver squelch is open. Because U1-D is off during this condition, the amplified audio from Q4 is blocked from the input of U1-C through this second path. (The high gain needed in U1-D for the weak phone audio would cause distortion of the receiver audio if allowed to take the same path as the phone audio.)

VR1/VR2 is a pair of back-to-back zener diodes to absorb the inductive surge when Q4 is switched off, thus preventing transistor damage. C8 is a bypass for low frequency rf which may be present on the telephone line. DTMF tones from either the phone line or the receiver are applied to the DTMF Decoder/Controller Module through E8.

### Logic Circuits.

When the DTMF Decoder/Controller Board applies a ground signal to E13, two things happen. First, switch Q1 turns on, thereby applying a positive signal to the COR input on the COR Board. This turns on the repeater transmitter. Second, the ground signal at E13 is applied to or-gate U1-A, which energizes relay K1 through switch U1-B. R32, CR3, and C26 in the line to U1-A provide a time delay of about one second between the time the DTMF Board commands the autopatch to turn on and the time the relay actually energizes. This prevents the tail end of the last digit in the sequence which energizes the autopatch from being applied to the telephone line and thereby being construed by the telephone exchange as the first digit in the telephone number.

The phone patch relay also can be activated by timer U3. If someone calls in on the phone line, opto-coupler U2 detects the ringing voltage, and U3 activates the relay for about 60 seconds. This is sufficient time to give a tone command or listen to the repeater receiver to hear what is on the input frequency. During the 60 seconds, a tone command may be given to turn the repeater or the autopatch on or off or to perform any other function which the DTMF Board is programmed to do. If the autopatch is turned on, of course, then it stays on even after the 60 second period elapses.

The COR Module keying output at E12 is activated by Q1 whenever the autopatch is turned on, as previously described. It also is activated by Q2 and Q3 via or-gate CR2 whenever the

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receiver squelch is open. This is the manner in which the COR line is activated when the autopatch is off, during basic repeater operation. Q2 also switches bias to Q4, and Q3 switches bias to mute U1-D, whenever the receiver squelch is open. (COS = carrier operated switch).

## CONSTRUCTION.

Assembly is fairly simple. Refer to the parts list and the component location diagram during construction. *Caution: The pc board uses plated-through holes for easy construction. Soldering need be done only on underside of board. However, because it is more difficult to unsolder plated-through boards, be sure parts are in the correct place before soldering. Be careful not to interchange parts which look similar, e.g., resistors with similar color codes. Be sure to observe polarity on transistors, diodes, electrolytic capacitors, and ic's.*

*Note that the pc board was designed for a relay which is no longer available. Therefore, some adaptations are necessary to use another style of relay.*

a. Orient board as shown in the component location diagram. Be sure the proper side is up.

b. Locate relay K1, which is blue and has four leads. Cut four one inch lengths of #22 bus wire, and wrap the ends around the relay leads as shown. Tack solder bus wires to relay leads. Be careful not to stress the relay leads and break them.

c. Lay the relay down on the pc board, and solder the bus wires to the pads on the board as shown. Note that the old relay had two rows of five large pads for its connections. The bus wires from the new relay connect to four of those pads. Make sure you use the correct ones.

d. Find R33 and C99 from the parts list and install them on the board as follows. Note that the board was originally designed for R33 to be installed horizontally between two pads, as you might surmise from the original parts location drawing. However, it is necessary to connect C99 in series with R33 in order to use the new relay. Therefore, the lead of R33 closest to the relay no longer connects directly to the board. See the detail to the left of the drawing. The leads of C99 are bent so that one goes down into the board where R33 originally connected. Do not trim the lead off. Instead, bend the C99 lead under the board and use it as a jumper to connect to the second pad from the right of the row of five original relay pads, as shown in the drawing. Solder the lead at both pads. Install R33 on an angle as shown, with one lead tack soldered to the top lead of C99, as shown in the detail.

e. Install R28, and solder to the board. Then, install C27, tack soldering its leads to the leads of R28. Observe polarity.

f. Install zener diodes VR1 and VR2 vertically with cathode bands up, as shown in the detail. Tack solder the upper leads together.

g. Install the ic socket for U1 as shown. The socket has a prominent notch in one end. Install the socket to match the notch shown on the diagram. Plug the 3301 ic into the socket, being careful that no pins bend over.

h. Solder ic's U2 and U3 directly to the board, orienting as shown.

i. Install transformer T1, and solder leads.

j. Install potentiometers R1 and R8, checking parts list for proper values.

k. Install all other resistors and diodes according to diagram and parts list. Bodies of vertical parts are indicated as circles on the diagram. Observe polarity on diodes. Note that switching diodes may not be marked except with a band. The zener diodes are marked with their part number, and they should be installed as shown in the detail with the cathode bands up and the cathode leads tack soldered together.

l. Install all other capacitors, observing polarity on electrolytic types.

m. Install transistors, orienting as shown.

**TABLE 1. CONNECTIONS BETWEEN MODULES WHEN AP-3 IS USED WITH COR-4.**

| SIGNAL | RCVR | TD-2 | AP-3 | COR |
|---|---|---|---|---|
| Rcvr Audio | E2* | | E7 | |
| AP Audio Out | | | E9 | E12 |
| Rcvr COS | E4* | | E11 | |
| AP COR Out | | | E12 | E14 |
| DTMF Rpt Inhibit | | "H" | | E16 |
| DTMF Tones | | "1" | E8 | |
| DTMF Mute | | "3" | E10 | |
| AP-ON Command | | "4" | E13 | |

*Note: Inside receiver enclosure, E2 and E4 on the receiver module are connected to feedthru capacitors C2 and C1, respectively.

**TABLE 2. CONNECTIONS BETWEEN MODULES WHEN AP-3 IS USED WITH COR-3.**

| SIGNAL | RCVR | TD-2 | AP-3 | COR |
|---|---|---|---|---|
| Rcvr Audio | E2* | | E7 | |
| AP Audio Out | | | E9 | E6 |
| Rcvr COS | E4* | | E11 | |
| AP COR Out | | "H" | E12 | E7 |
| DTMF Tones | | "1" | E8 | |
| DTMF Mute | | "3" | E10 | |
| AP-ON Command | | "4" | E13 | |

n. Check over construction to be sure all parts are installed in proper places and with correct polarity on diodes and electrolytic capacitors. Check all solder connections for bad joints, solder splashes, etc.

## OPTION FOR NO REVERSE AUTOPATCH.

If you wish to prevent any reverse autopatch or calling into the Autopatch for control purposes, for example, because you are using the family telephone line and you need to have normal telephone operation, disconnect R33 to disable the ring detector. If you want to selectively disable this function only at certain times, use a front panel switch in series with the resistor.

## INSTALLATION.

To simplify matters, we will discuss the normal installation in a Hamtronics repeater system first; then we will go into variations when using other equipment and options.

It is assumed that you are using our COR-4 module. An interconnection block diagram and wiring table are supplied for use with that module. If you are using our

earlier COR-2 or COR-3 modules, a table is also supplied for those interconnections.

a. Attach the Autopatch module with standoffs in the four corner holes. It is recommended that the module be shielded from high level rf; however, in a repeater, the transmitter already is shielded, so this requires no extra attention.

b. Use hookup wire for all connections, and neatly bundle with other cabling. Table 1 lists the connections between modules to add the Autopatch and DTMF Decoder/Controller Modules to the basic repeater configuration using the COR-4 board.

**Note**: If you are connecting the Autopatch in an existing repeater, be sure that you disconnect the original audio and cos connections to the COR board before connecting the Autopatch. We have had some customers mistakenly leave the old connections direct from the receiver to the COR board, and this causes incorrect operation which is difficult to diagnose. The audio and COS signals from the receiver to the COR Board are processed through the Autopatch Board; so they would not be connected directly to the COR Board when an Autopatch is in the system.

c. Connect E1 and E2 with a twisted pair to two spare terminals on rear of repeater. These will be used for connection to the phone line when wiring is completed. Tip and ring polarity may be interchanged; the Autopatch phone line input is non-polarized.

d. The ground plane on the pc board is already grounded if mounted to metal chassis. If not, be sure to connect power and signal ground to a solder lug added under one of the mounting screws.

e. Connect E3 to source of filtered and regulated +13.6Vdc. If you are using the COR-4 module, the B+ should be obtained from E4. Do not apply power yet.

f. Solder pads E5 and E6 at the left side of the relay provide normally-open relay contacts to operate the motor of a tape recorder for logging, to activate the AP-2 Timing Board in a simplex autopatch system, or to perform any other auxiliary switching function you may wish to have. They normally are not connected in a basic repeater setup.

g. E7 should be connected to the audio output feedthru capacitor on the repeater receiver enclosure, which is connected to the E2 "speaker" output of the receiver board. E9 should be connected to audio input: terminal E12 on the COR-4 module (or terminal E6 on the COR-2 or COR-3 module). The receiver would normally connect directly to the COR module if the Autopatch was not used.

h. Connect E8 to terminal 1 of the TD-2 DTMF Decoder/Controller Module. This provides DTMF tones to the TD-2 Board.

i. Connect E10 to terminal 3 of the TD-2 DTMF Decoder/Controller Module. This is the mute output of the TD-2 Board, which mutes the repeater when tones are present.

j. Connect E11 to the COS output feedthru capacitor of the receiver enclosure. Inside the enclosure, this feedthru capacitor is connected to E4 on the receiver. (The COS output of the receiver would normally be connected directly to the COR Board if the Autopatch was not installed.)

k. Connect E12 to COS input E14 on the COR-4 module (or E7 on the COR-2 or COR-3 Module).

l. Connect terminal "H" of the TD-2 DTMF Decoder/Controller Module to E16 on the COR-4 module (or E7 on the COR-2 or COR-3 Module). Terminal "H" inhibits the COR Board from keying the transmitter when the repeater is turned off by tone command.

m. Connect E13 to terminal 4 of the TD-2 DTMF Decoder/Controller Module.

## OPTIONS.

a. If you would like to have a front panel control to inhibit phone patch operation at times while leaving other functions intact, connect a SPST switch in series with the AP-ON line from the DTMF Decoder/Controller Module to E13 on the Autopatch Module. When the switch is open, the patch cannot be brought up by anyone on the air or on the phone.

b. If a DTMF Module other than our model TD-2 is used, it is unlikely that a tone mute signal will be available for pin E10. In that case, just leave E10 disconnected.

c. If another receiver is used, it must provide 1.5V p-p audio (the equivalent of 50 mW of audio into an 8 ohm speaker). It must also provide a COS signal of at least +4Vdc when the receiver squelch is open and ground (less than 1V) when the squelch is closed.

d. If a different COR Module is used, it must have a high impedance (greater than 10K audio input impedance) and operate with 1.5V p-p audio level at full modulation. The COR control input should be the equivalent of a transistor base-emitter junction or a CMOS input, with hi = COR-on and lo = COR-off.

e. If a different DTMF Decoder/Controller Module is used, it must operate with 2V p-p max. tone input level; and the autopatch control output must be ground = on and open = off. If it is also to inhibit the repeater COR as a second function, it must have ground = off and open = on for that function.

**CAUTION**: Phone lines are notorious collectors of static charges from lightning, etc., and high enough charges can damage any electronic circuitry. The phone company normally puts lightning arrestors on the service line at the house, but these are primarily carbon fuses to prevent fires. If you are in an area with frequent lightning strikes, you may need to install a gas discharge device or similar protector on the phone line and connect to a good ground. These are available from telephone supply companies. In any case, be sure to have a good safety ground for the chassis.

## SYSTEM ADJUSTMENTS.

Following is a first-time, fire up and system audio level adjustment procedure. It is assumed that all the other modules, including the DTMF Decoder/Controller, have already been aligned or tested and programmed and that the system was working before the Autopatch was installed. Otherwise, troubleshooting can be complicated.

*When Autopatch is used in a repeater, the repeater audio is adjusted differently. Therefore, the following audio setup instructions take precedence over any in manuals for other modules.*

It is assumed that the AP-3 is installed in a Hamtronics repeater or used with Hamtronics modules to make a repeater. If not, the instructions below can be adapted for your particular system.

Note that when power is first applied, the circuit which answers a phone call for reverse autopatch may latch up and require a one minute wait for it to turn off the telephone line relay. This is normal and should not be a concern.

a. Obtain a 1000 Hz test signal on the receiver with 3 kHz deviation. Set the RPT VOL control (receiver volume control) for midrange to get a moderately strong audio signal for the transmitter. On the exciter, set the mic. gain control fully clockwise, and adjust the deviation limiter control to limit at about 5.5 kHz deviation so it isn't quite limiting in normal operation. This sets up the limiter to be used with telephone audio only.

b. Connect an oscilloscope or ac voltmeter to the audio output feedthru capacitor (center ft cap) on the rear of the receiver enclosure, and adjust the RPT VOL control (receiver volume control) for 1.5 V peak-to-peak (p-p).

Set the exciter mic. gain control for 3 kHz deviation out of the transmitter (3 kHz at receiver and 3 kHz on transmitter). This sets up the deviation for normal repeater operation without autopatch.

c. Temporarily connect a ground to E13 to bring up the patch and get a dial tone. (This should provide audio which normally would be the maximum level ever to be applied to the transmitter.) With dial tone present, adjust phone repeat level control R8 on the Autopatch Module for 5 kHz deviation. This sets up the audio gain for telephone audio going out over the transmitter. If the dial tone times out at the central office, release and remake the ground connection to E13 to get a fresh dial tone.

d. Disconnect the phone line from the input terminals, and connect a scope or ac voltmeter across the phone line terminals of the Autopatch. Set the input to the receiver for a 1000 Hz tone at 5 kHz deviation. With E13 still grounded, adjust line drive level control R1 for 2V p-p across the Autopatch phone line terminals. This sets the audio applied to the phone line to about -3 dBm with full receiver audio. Remove ground from E13.

*This completes the adjustments. Following is a discussion of what the affects are of each adjustment in case you prefer different settings.*

The repeater receiver has crystal filters which limit the input deviation to the receiver; so it is not necessary to use the transmitter limiter for normal repeat operation. However, the limiter is needed to prevent high deviation levels on telephone audio, since the level on phone lines varies so much. Indeed, it is desirable to run into limiting occasionally with telephone audio in order to get some compression to compensate for some weaker telephone connections, thereby bringing up the average telephone audio level. So, a good compromise is to run the limiter for hard limiting at about 5.5 kHz deviation so that no limiting occurs with a normal 5 kHz receiver input.

You may want to experiment a little with the setting of phone repeat level control R8. You want to be able to comfortably hear weaker phone audio but not have the ordinary local calls be so strong that they are too loud. The limiter in the transmitter will prevent over-deviation on the louder phone calls, but if the gain is set too high, the audio on the louder calls may be running into limiting most of the time and sound too loud. After using the autopatch for a time, you may want to turn R8 up or down a little. Since R8 does not affect the setting of the limiter in the transmitter, you can tweak it easily without needing test equipment.

The phone company normally does not like to have a level higher than about -3 dBm applied to their lines in order to prevent crosstalk to other phone lines. This translates to about 2 V p-p.

In order to measure the phone line level with a scope, it is necessary to disconnect the phone line and measure across the terminals of the Autopatch because you don't want to ground one side of the phone line. This may cause a small inaccuracy due to the removal of the load impedance from the Autopatch terminals, but not enough to worry about. If you have a battery operated ac voltmeter, it may be connected across the phone line, but since it measures rms voltage instead of true peak-to-peak, you must use a single-tone sine wave for the test and calculate p-p voltage by multiplying the rms voltage by 2.8.

If the line level is set too high, cross talk results. If too low, your DTMF tones may not be strong enough to break the dial tone or dial reliably.

Another factor to consider is that the DTMF Decoder/Controller Board may not decode some or all the digits properly if the level applied to it is too high or too low. This level is affected by the setting of the line drive level with R1 on the Autopatch Board. The decoder chip has a fairly wide dynamic range of tone level acceptance; however, tones from the receiver will be relatively strong compared to the weaker telephone tones, so you don't want to crowd either end of the dynamic range. It

may be necessary to readjust R1 slightly if a problem occurs operating reliably with either the phone company central office tone decoders or the DTMF Decoder/Controller Board.

Another factor affecting reliable operation of tone decoders is twist, which is the relative levels of the high and low tones in any digit. Modern tone decoder chips used in the DTMF Board and the telco central office tolerate about 10 dB of twist. (It is common practice to run the high tones just a little stronger than the low tones in driving the phone line to compensate for the greater attenuation of high tones on long phone lines.)

## SYSTEM CHECKOUT.

After alignment, you may want to perform the following procedure to verify that everything functions properly.

a. Try operating the repeater with the autopatch turned off, and verify that the transmitter deviation is about the same as the receiver input deviation.

b. Try the various tone codes to ensure that the DTMF Decoder/Controller responds normally to control codes transmitted over the air. Refer to instruction manual for that module for operating procedure.

c. Dial up phone line from an outside phone. Listen on the phone to hear the repeater receiver. Try turning the repeater on and off with the proper DTMF digits sent from the telephone. Do not turn on the autopatch function; just listen to the receiver, and verify that the one-minute timer disconnects the phone line in about one minute.

d. Dial up phone line again from an outside phone. Enable the autopatch with the proper tone code sent from the telephone. Talk into the phone and verify that the audio sounds good through the repeater. The transmitter deviation should be no greater than 5.5 kHz with full audio (shouting into the phone).

e. Bring up the patch through the repeater receiver, and try dialing an outside call from a mobile station. See Operating Instructions for complete procedure.

## OPERATION.

**Note**: Before reading this section, refer to DTMF Decoder/Controller Instruction Manual Operating Procedures.

Also note that when power is first applied, the circuit which answers a phone call for reverse autopatch may latch up and require a one minute wait for it to turn off the telephone line relay. This is normal and should not be a concern.

### How to Make an Autopatch Call from a Mobile Station.

Key the transmitter, and send the digits on the tone pad required to activate the autopatch. Be careful not to hold the last digit too long, because any tones present when the phone line is connected will be counted by the phone exchange as a digit entered as a phone number. There is a one-second delay before the phone line is connected to minimize this possibility.

The repeater audio is muted for a few seconds each time a DTMF digit is received; so there is a short delay after the last digit of the command sequence before you will hear audio again if you unkey your microphone. The complete sequence of digits required to bring up the patch must be sent within 5 seconds, or the decoder circuit resets and you must start over.

After bringing up the patch, release the transmitter keyline, and listen for dial tone. If you don't hear it, try again. If you hear the phone line noise but no dial tone, knock down the patch and bring it up again to get a dial tone. After you get a dial tone, key the transmitter and dial the desired phone number. Then, release transmitter and listen for ringing.

When the called party answers, you can talk to him merely by pressing push-to-talk button when it is your turn to speak. Be sure to inform the party you call that he is on the air, and explain any rules you think he should understand. Note that you can block anything the party on the phone says over the air merely by keying your transmitter. Although the repeater carrier stays on the air, the audio is muted anytime the receiver squelch is open. This allows you to censor the other party.

The Autopatch will stay up until you release it by sending the required digit sequence. When the repeater carrier drops, you know you have successfully knocked down the patch.

The repeater time-out timer will shut down the carrier if the patch is held too long. To reset repeater time-out timer, someone must send required tone sequence to turn off the autopatch. Then, normal operation can resume.

### How to Control the Repeater.

The repeater may be enabled or disabled by sending the required repeater control digit sequence, either through the repeater receiver or via telephone call into the autopatch line from a touch-tone phone. If power to the repeater is turned off for any reason, when power is resumed, the DTMF Decoder/Controller Module automatically enables the repeater and turns off the autopatch.

Anyone with the proper phone number and codes can call into the autopatch line from any telephone and receive access for one minute, during which time he can listen to the repeater receiver (whether the transmitter is enabled or not). This is handy for a controlling ham to check on interference before bringing up the repeater transmitter after a shut-down. During the one minute period, the person on the phone also has access to the tone decoders so he can punch in tones to turn the repeater on or off or bring up the autopatch.

### Reverse Autopatch.

A party calling in to the autopatch

line can access the patch, just as the mobile radio operator can, if he/she knows the control code sequence to bring up the autopatch. He has 60 seconds to monitor the repeater, and if not busy, to dial the required digit sequence for autopatch access. He can then call the party he wishes to speak to by call letters just as if he was using a radio. If the party addressed on the air does not respond, the calling party must knock down the patch by sending the required digit sequence to turn it off.

Note that the repeater trustee is responsible to see that current FCC requirements regarding licensing of such reverse autopatch users is observed. Since the calling party has control of the repeater carrier, legally, he may be required to hold a valid license.

### Other Rules and Regulations.

It is beyond the scope of this discussion to address all the legal problems involved in autopatch systems. The repeater trustee must be aware of current regulations.

For example, any business use of the autopatch is prohibited for any reason by the "amateur" status of the repeater. Repeater trustees should investigate and list all such requirements for users before the autopatch is made accessible for general use.

### FCC Registration.

This device has been granted a registration number by the Federal Communications Commission, under part 68 rules and regulations for direct connection to the telephone lines. In order to comply with these FCC rules, the following instructions must be carefully read and applicable portions followed completely. By law, these instructions must be provided to you.

1. This equipment complies with part 68 of the FCC rules. A label is provided below, which must be cut out and attached to the outside of the equipment in which this module is installed. This label contains the FCC registration number and ringer equivalence number (REN). If requested, this information must be provided to the telephone company.

2. The ringer equivalence code (REN) is used to determine the quantity of devices which may be connected to the telephone line may result in the device not ringing in response to an incoming call. In most, but not all areas, the sum of the REN's should not exceed five (5.0). To be certain of the number of devices that may be connected to the line, as determined by the total REN's, contact the telephone company to determine the maximum REN for the calling area.

3. If this equipment, causes harm to the telephone network, the telephone company will notify you in advance. But if advance notice is not practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

4. The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications in order to maintain uninterrupted service.

5. If trouble is experienced with this module, it must be repaired promptly. If the trouble is causing harm to the telephone network, the telephone company may request you remove the equipment from the network until the problem is resolved. If any questions on how to repair the module, please consult factory for any additional troubleshooting information you may need or to make arrangements for factory service .

6. This equipment must not be used on telephone company provided public coin service. Connection to party lines is subject to state tariffs; contact your state public utility commission for information.

## TROUBLESHOOTING.

If you have trouble, check each stage, and trace signals through the circuit path. Following are charts of dc voltages and audio signal levels at key points. Voltages are typical but may vary considerably without necessarily indicating a problem.

When troubleshooting a unit which has just been built, be sure to check for solder splashes, bad solder joints, parts mixed up, etc. It is easy to have something like that happen during construction.

Note that the sensitivity of the ring detector circuit has been set to operate reliably with most telephone central offices. If you have a problem with the autopatch relay turning on due to transient pulses on the phone line when no ringing signal actually occurred, the sensitivity may be reduced by reducing the value of R25. Likewise, if the ring detector doesn't answer the phone quickly enough, you may need to increase the value of R25.

The time delay of timer U3 may be adjusted by changing the value of R27. Larger values make the delay longer, and smaller values make the delay shorter.

**DC TEST VOLTAGES REFERENCED TO GROUND.**

| XSTR | CONDITION | EM | BASE | COLL |
|---|---|---|---|---|
| Q1 | AP on | 13.6 | 12.4 | 13.2 |
| | AP off | 13.6 | 13.6 | 0.03 |
| Q2 | Squelch Open | | 0 | 0.65 |
| | 0.13 | | | |
| | Sq Closed | 0 | 0 | 13.6 |
| Q3 | Squelch Open | | 13.6 | 12.6 |
| | Sq Closed | 13.6 | 13.4 | 0.05 |
| Q4 | Squelch Open | | 8.3 | 7.5 |
| | Sq Closed | 13.6 | 13.6 | 0 |
| Q5 | Tones Present | | 0 | 0.65 |
| | 0.06 | | | |
| | Tones Absent | | 0 | 0* |

* Indicates voltage charge may be held by capacitor and discharge slowly.

COMPLIES WITH PART 68, FCC RULES
FCC Registration # 2T7USA-75643-OT-E
MFR Model AP-3 AUTOPATCH MODULE
Ringer Equivalence 1.6A, 4.7B
Made In USA

| U1 pin | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| U3 off | 0.03 | 0 | - | 0.09 | 13.0 | 0.12 |
| U3 running | 0.07 | 0.7 | - | 12.2 | 2.3 | 0.9 |
| AP off | 0.03 | - | 0.55 | 0.09 | 13.0 | 0.12 |
| AP on | 0.07 | - | 0* | 12.2 | 2.3 | 0.9 |

* Indicates voltage charge may be held by capacitor and discharge slowly.

| U1 pin | 7 | 13 | 14 |
|---|---|---|---|
| All conditions | 0 | 0 | 13.6 |

| U1 pin | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|
| Tones present | 0.06 | 12.2 | - | - | - |
| Tones absent | 0.55 | 6.2 | - | - | - |
| Sq open or AP off | - | - | 12.2 | 0.05 | 0.55 |
| Sq closed & AP on | - | - | 7.4 | 0.55 | 0.07 |

| U3 Pin | Running | Off |
|---|---|---|
| 2 | 0(momentary) | 13.0 |
| 3 | 13.0 | 0 |
| 4 | 13.6 | 13.6 |
| 5 | 9.0 | 9.0 |
| 6 | 0 to 9 | 0 |
| 7 | 0 to 9 | 0 |
| 8 | 13.6 | 13.6 |

**TYPICAL AUDIO LEVELS WITH STANDARD SETUP & FULL DEVIATION INPUT ON RECEIVER (SQUELCH OPEN, AUTOPATCH ON.**

| Test Point | Typical |
|---|---|
| Signal Level | |
| E7 (Audio in from Rcvr) | 1.5 V p-p |
| E8 (Tones to DTMF Board) | 2.2 V p-p |
| E9/U1-9 (Xmit AF to COR Board) | 1.5 V p-p |
| Q4 Base | 50 mV p-p |
| Across Phone Line Terminals (Phone Line Disconnected) | 2 V p-p |

**TYPICAL AUDIO LEVELS WITH LOUD 1 KHZ TEST TONE COMING IN ON PHONE LINE (SQUELCH CLOSED, AUTOPATCH ON).**

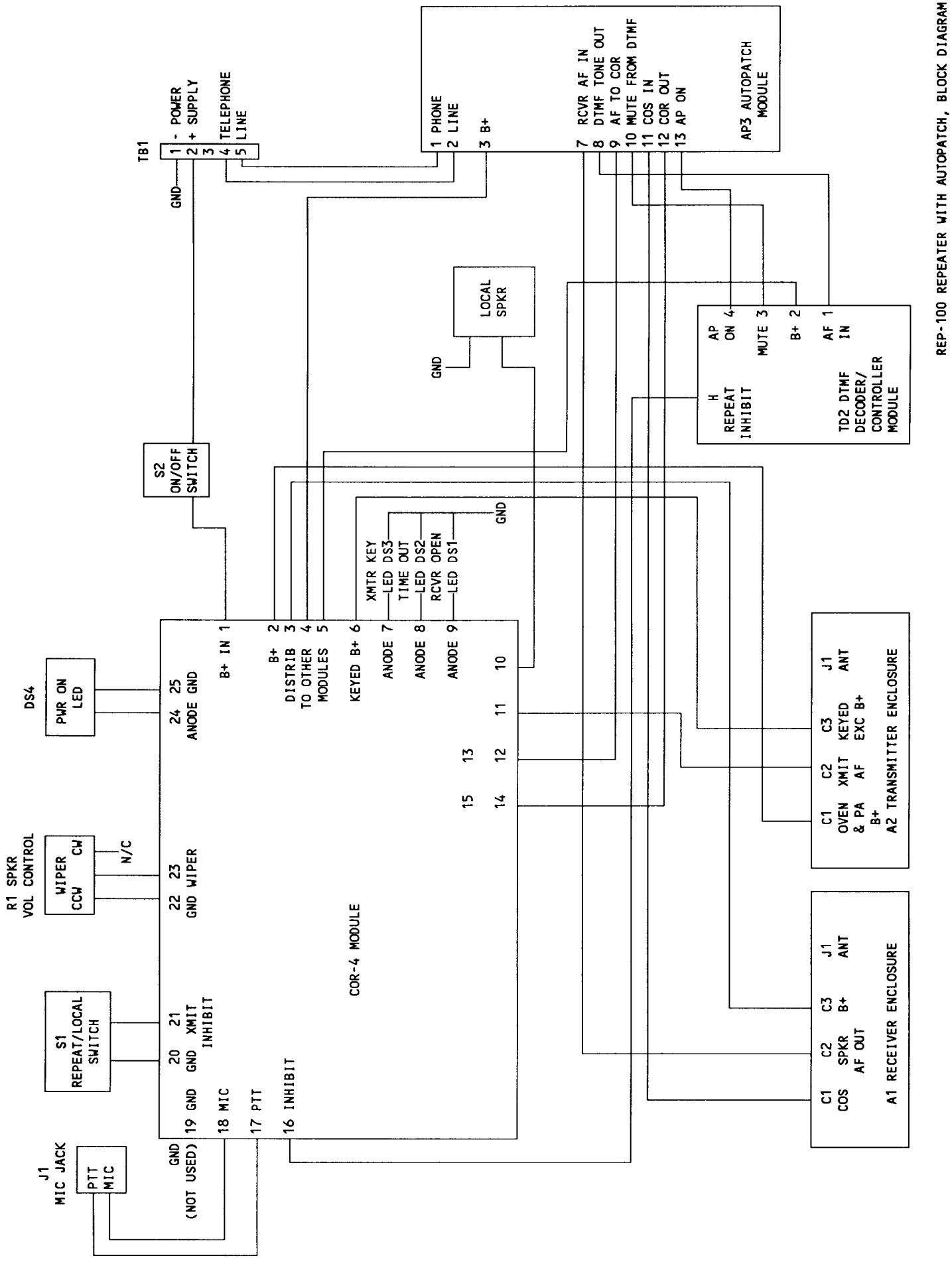
| Test Point | Typical |
|---|---|
| Signal Level | |
| E8 (Across T1 Secondary) | 1 V p-p |
| U1-11 | 50 mV p-p |
| U1-10 | 2 V p-p* |
| U1-9/E9 | 6 V p-p* |

* Varies with setting of Phone Repeat Level Control R8

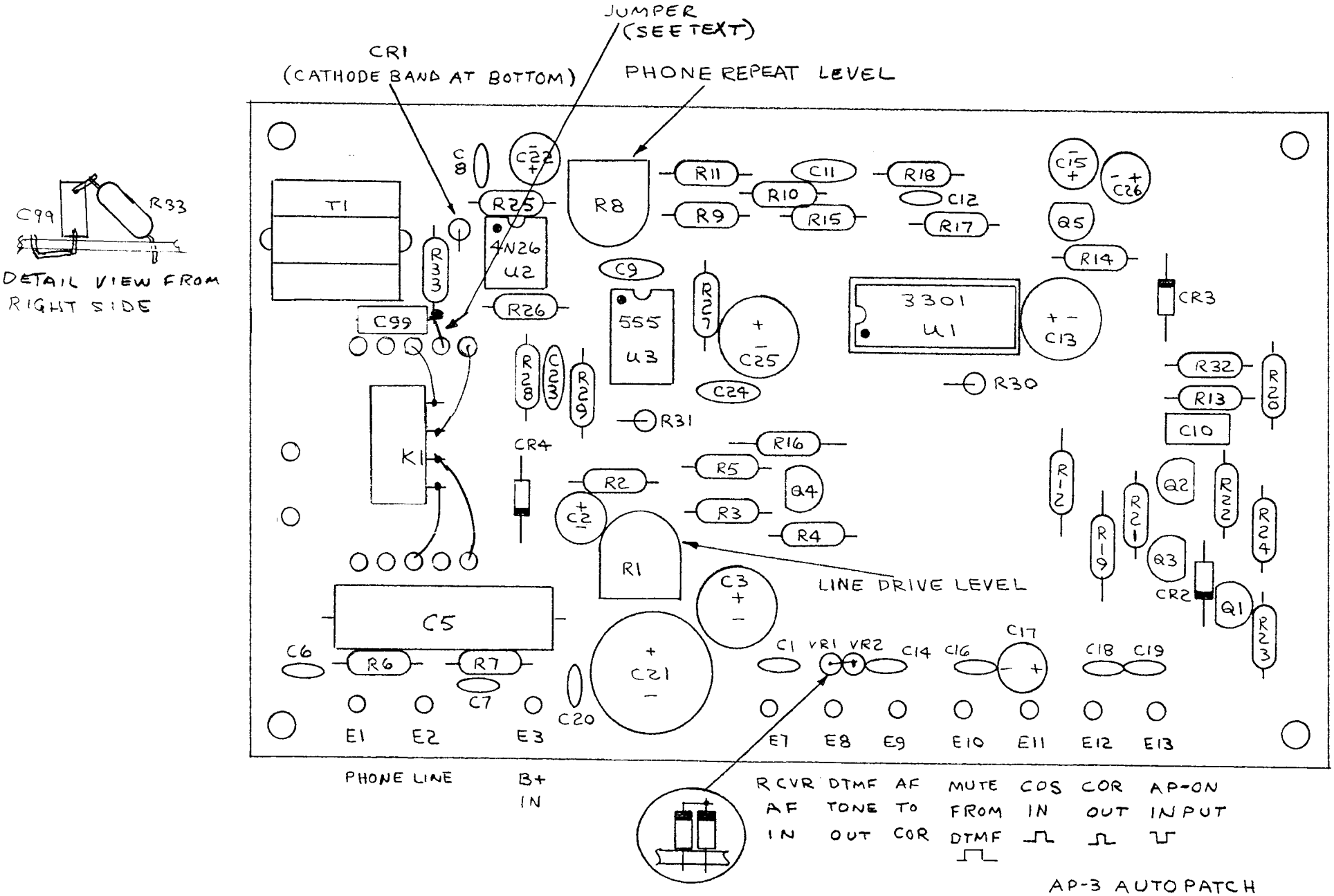
## PARTS LIST.

| Ref # | Value (marking) |
|---|---|
| C1 | .001 uf (102, 1nM, or 1nK) |
| C2 | 1 uf electrolytic |
| C3 | 47 uF electrolytic |
| C4 | Not used |
| C5 | 1 uF, 250V metalized polyester capacitor |
| C6-C7 | .001 uf (102, 1nM, or 1nK) |
| C8-C9 | .01 uf disc (103) |
| C10 | 0.15 uf mylar (red) |
| C11 | .01 uf disc (103) |
| C12 | 33 pf |
| C13 | 47 uF electrolytic |
| C14 | .001 uf (102, 1nM, or 1nK) |
| C15 | 2.2 uF electrolytic |
| C16 | .001 uf (102, 1nM, or 1nK) |
| C17 | 1 uF electrolytic |
| C18-C20 | .001 uf (102, 1nM, or 1nK) |
| C21 | 47 uF electrolytic |
| C22 | not used |
| C23-C24 | .01 uf disc (103) |
| C25 | 47 uF electrolytic |
| C26 | 1 uF electrolytic |
| C99 | 0.15uF mylar (red) |
| CR1-CR4 | 1N4148 switching diode |
| K1 | Reed relay (blue) |
| Q1 | 2N3906 or 2N4126 |
| Q2 | 2N3904 or 2N4124 |
| Q3-Q4 | 2N3906 or 2N4126 |
| Q5 | 2N3904 or 2N4124 |
| R1 | 1k pot (102) |
| R2 | 10k |
| R3-R4 | 15k |
| R5 | 180 ohms |
| R6-R7 | 470 ohms |
| R8 | 1k pot (102) |
| R9 | 330k |
| R10 | 2 meg |
| R11 | 150k |
| R12 | 100K |
| R13 | 1 meg |
| R14 | 47k |
| R15 | 150k |
| R16-R17 | 1 meg |
| R18 | 100k |
| R19 | 150k |
| R20 | 47k |
| R21 | 150k |
| R22 | 100k |
| R23 | 27k |
| R24 | 10k |
| R25 | 1 meg |
| R26 | 270 ohms |
| R27 | 1 meg |
| R28 | 47k |
| R29 | 510k |
| R30 | 150k |
| R31 | 180 ohms |
| R32 | 1 meg |
| R33 | 3.3k |
| T1 | 600 ohm transformer #56118-005 |
| U1 | 3301 quad norton op-amp (can substitute 3401) |
| U2 | 4N33 optocoupler |
| U3 | 555 timer |
| VR1-VR2 | 1N5239B zener diode, 9.1V |






AP-3 AUTOPATCH

 Revised: 11/27/01