Vega® a MARK IV company
Signaling Products

Instruction Manual

098-0301

Model C-550 Dial-up Tone-Remote Console

Model RP-250 Dial-up Tone-Remote Adapter

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Introduction

The Vega C-550/RP-250 dial-up tone remote system provides a reliable and inexpensive means of remotely controlling two-way radio base stations over standard Public Switched Telephone Network (PSTN) lines. The system consists of the Model C-550 console and the Model RP-250 remote station panel. Unlisted and dedicated telephone numbers are recommended at both the console and the base station to maintain near 100% line availability; this is not a requirement because the system is very secure against unauthorized use of the base-station transmitter. A three-part tone burst is required to initiate and maintain the base station in transmit. As shipped, anyone dialing the base-station number may listen to any audio present for about 40 seconds, but cannot transmit. If security against unauthorized listening is also desired, the base-station unit may be solder-bridge programmed to connect receiver audio to the telephone line only after decoding a PTT or MONITOR tone burst from a C-550 console.

The system is also secure against unauthorized use of the base-station telephone line by mobile operators, because the only telephone number that a mobile operator can reach is the C-550 console number.

Multiple C-550 consoles may be used with a single telephone line and a single RP-250 panel. However, like extension telephones, transmit and receive audio is attenuated when more than one console is off-hook at the same time. A maximum of two C-550 consoles per system is recommended, unless a switchboard or some other type of telephone line switching is used. The C-550 consoles are prepared for simultaneous parallel station operation by the inclusion of notch filters, which greatly attenuate PTT tone audio from one console, which would otherwise appear in the receive audio of the other console.

Auxiliary audio input and PTT control terminals are provided in the C-550 console, in order that audio from paging or other auxiliary equipment may be transmitted by the base station in the same manner as voice communications.

Console Originate

Upon lifting the C-550 console handset, the telephone number of the base station is automatically dialed about two seconds after dialtone is detected. The RP-250 at the base station automatically goes off-hook upon ring detection and answers with a beep after a 2-second billing delay. As shipped, monitor audio (CTCSS-disabled audio) is connected to the telephone line as soon as the beep tone is completed. The console operator may then listen to all base-station audio for as long as desired from the handset earpiece or, if the speaker switch is pressed, from the loudspeaker. If the base station has multiple users, the operator may momentarily depress the PTT switch on the handset, which will switch the base station to CTCSS (Continuous Tone Coded Squelch System) reception, and only the audio having the proper CTCSS frequency will be heard. PTT switch operation automatically resets the console for handset-only operation. This prevents speaker-to-microphone feedback. After releasing the PTT switch, the speaker may be enabled again at any time by pressing the speaker switch.

Monitoring of the base station for long periods is possible due to a "refresh base station timer" tone burst, which is automatically generated about every 25 seconds after off-hook or after the last PTT activity by the console operator.

When the console operator wishes to call a mobile station, operation is the same as with standard tone remote systems over a leased line, except for the delay between off-hook and the answer-back beep. Depressing the PTT switch generates a tone burst followed by a low-level PTT tone which switches the base station to transmit. The low-level PTT tone is notched out of the audio that is transmitted to the mobile stations. When the console operator releases the PTT switch, the base-station panel connects CTCSS audio from the mobile operator to the telephone line.

When communications between the console and mobile operators are completed and the console operator does not wish to monitor mobile-to-mobile transmissions, the base-station to telephone-line connection can be broken (i.e., the base-station telephone can be caused to go on-hook) in three different ways. The console operator can just hang up the handset and the base station will automatically go on hook in 15 to 40 seconds; or the console operator can press the monitor switch twice within a 1-second period before hanging up; or the mobile operator may transmit the "reset" code. In the last two cases, the base station will go on-hook immediately.

If the C-550 telephone line is not dedicated to base-station operation or if the C-550 rings from a wrong-number call, audio from any ordinary telephone can be heard, and simplex communications can take place, but a tone burst followed by an annoying low-level high-pitched (2174 Hz) sound will be heard by the caller upon PTT switch operation by the C-550 operator.

The C-550 wall power supply requires only 8 watts or less and should be plugged into a non-wallswitch-controlled outlet. If the C-550 is unpowered and the handset is off-hook, the telephone line is seized but no audio, including dialtone, telephone-company recordings, and howler sounds, can be heard. The C-550 handset should therefore

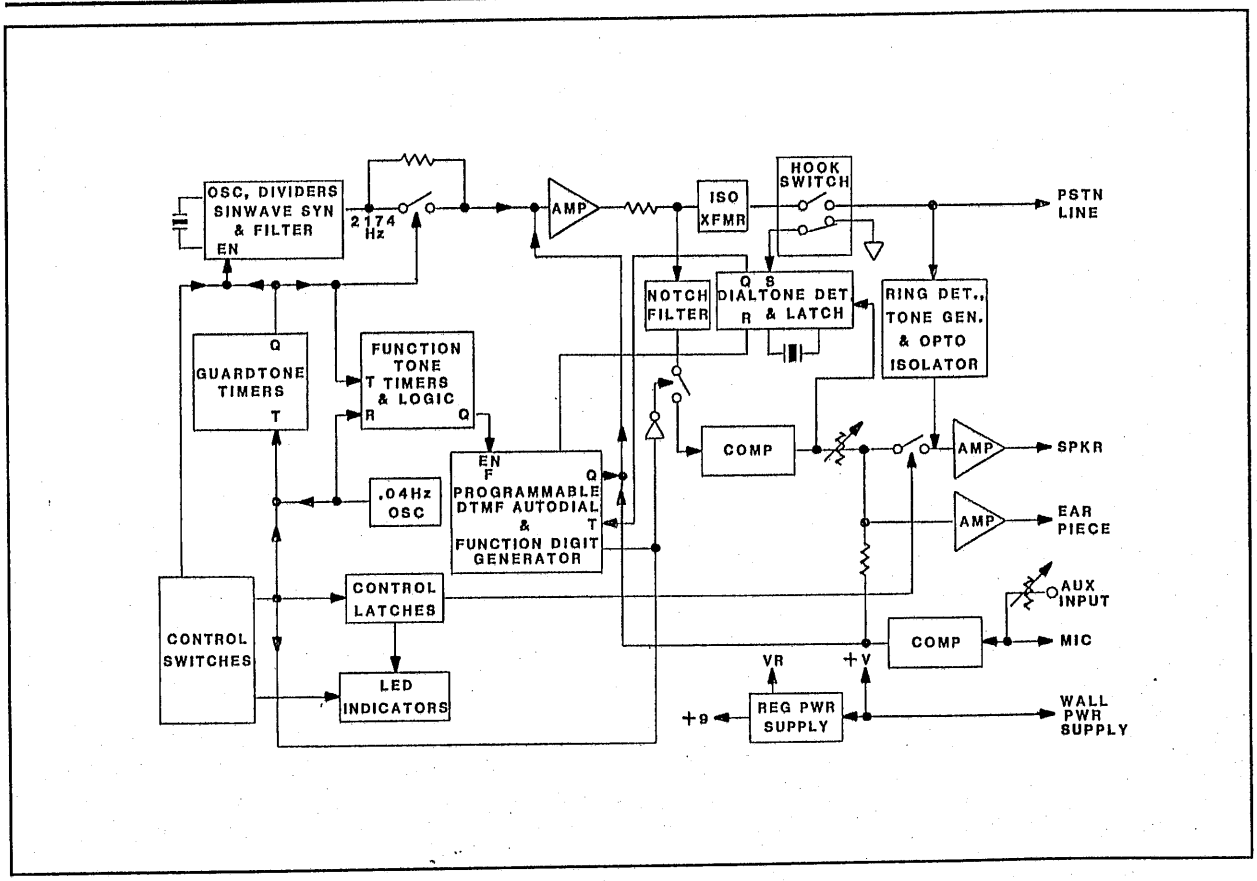

Figure 1. C-550 console block diagram.

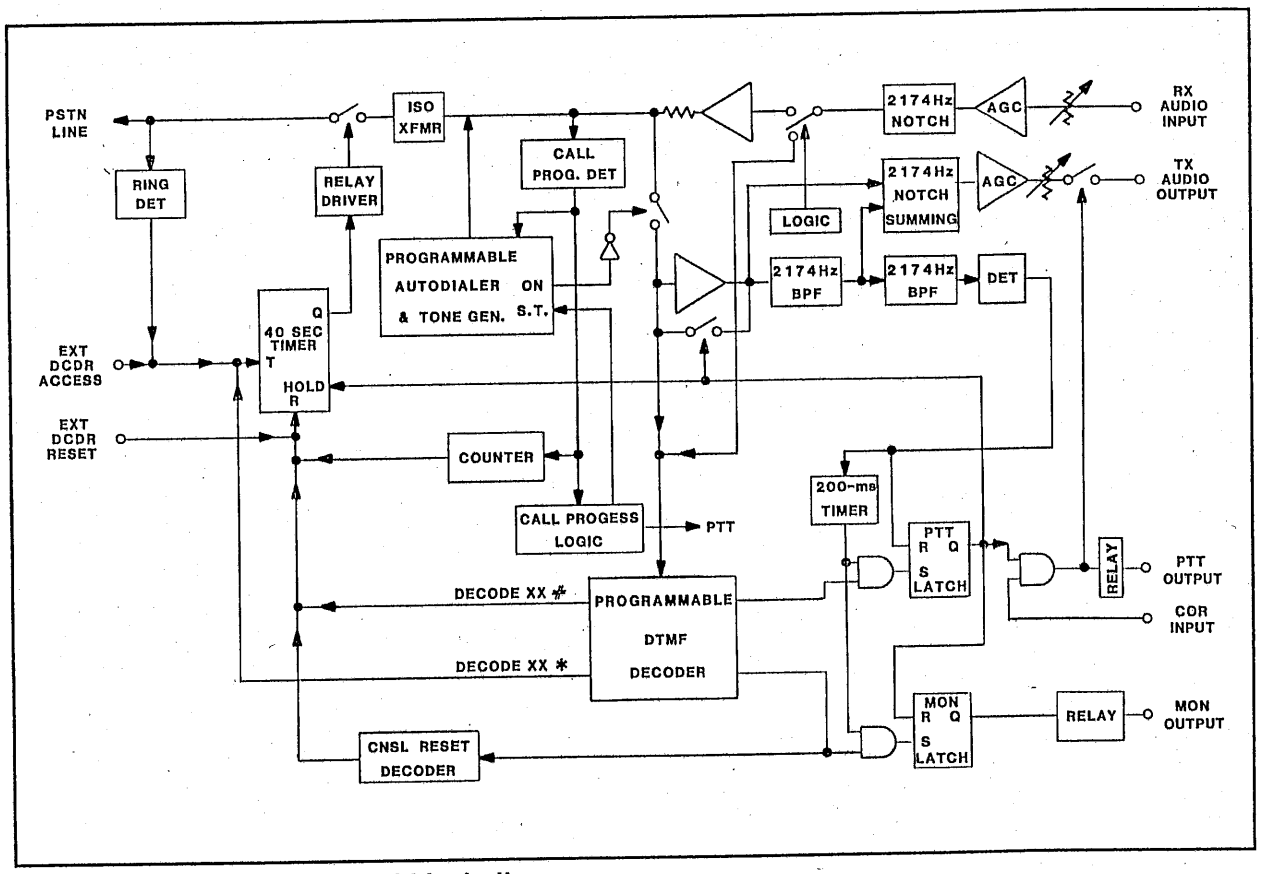

Figure 2. RP-250 station panel block diagram.

be placed on-hook when unattended and during power failures.

Mobile Originate—General

The RP-250 remote station panel provides internal programmable DTMF PSTN access/reset decoders and input terminals for external access/reset logic.

Use of the internal DTMF access/reset decoders requires the mobile stations to have means to transmit a three-digit DTMF access or reset message. A DTMF microphone is usually the most available and least expensive way to provide this capability.

The external decoder input terminals are operated by grounding or by a logic low from 8 to 28 V_{dc} logic. The external decoders may be extra CTCSS frequency decoders. In this case, the mobile stations are required to have radios with an operator-accessible switch for changing CTCSS frequencies, and the base station is required to have the additional CTCSS decoders.

If mobile-to-mobile communications are seldom, if ever, used, logic from the existing CTCSS decoder can often be used to operate the access decode input of the RP-250. In this case, no added equipment is required. However, if mobile-to-mobile transmissions are used with this method of operation, the panel will go off-hook and dial the console telephone number upon the termination of any first transmission. In addition, during "dead air" time (assuming proper input to the panel's COR input), ringback or other call-progress tones will be transmitted. Also, at the end of additional mobile transmissions, a short "off-hook" beep will be transmitted. The mobile operator has no means to terminate the call except by waiting for automatic reset after six rings or 40 seconds.

Mobile Originate

Using the DTMF microphone method as an example, the mobile-originate sequence is as follows. The mobile operator monitors the radio channel, and, if idle, transmits a three-digit DTMF access code (two programmable digits, last digit "*"). The three-digit DTMF message is decoded by the RP-250 panel at the base station, which triggers a 40-second timer and seizes the telephone line. The telephone company (telco) detects the off-hook and connects a dialtone generator to the line. The RP-250 panel detects the dialtone and triggers the autodialer which has been programmed to dial the telephone number at the C-550 console. Telco decodes the autodialed number, connects a ringback tone generator to the base-station line, and connects a ringer-voltage generator to the console line.

The ringback tone on the base-station line is detected by the RP-250 panel, which switches the base station to transmit and supplies a tone signal to the modulator for the duration of the ringback signal. The mobile operator hears the transmitted tone signal, which has the same duration characteristics (2 seconds on, 4 seconds off) as the telco's ringback signal. In the meantime, the C-550 console is ringing.

When the C-550 console operator goes off-hook, ringing at the console and ringback at the base station stops. If, as recommended, the telco line at the console is dedicated to base-station operation, the console operator knows that a mobile station is calling, presses the PTT switch, and answers the mobile's call. Operation from now on is the same as a console-operator originate call.

When the mobile operator dials the access code, the console operator may be monitoring the channel and the telco line is already in use. In this case, the RP-250 panel will briefly switch the base station to transmit and generate a beep tone which will be heard by both the mobile and console operators.

If the C-550 console's line is busy when autodialed by the RP-250 panel at the base station, the base station will transmit a tone having the same duration characteristics as the telco's busy signal (1/2 second on, 1/2 second off). After six or seven on-off cycles of the busy signal, transmission stops and the RP-250 panel goes on-hook (releases the telco line).

If no dialtone is detected after access decode and line seize (all of the telco's lines are busy), the RP-250 panel will wait for dialtone to appear before autodialing. If all of the telco's lines remain busy for some period of time, the telco will connect a busy signal to the line. This will not be detected by the RP-250 panel which at the moment is programmed to detect dialtone, and the unit will remain off-hook for about 40 seconds from the initial line seize. The mobile operator will hear nothing if no dialtone occurs, and may think that he is out of range and may retransmit the access code. Anytime the access message is decoded and the RP-250 panel is already off-hook (for more than 2 seconds), an "off-hook" beep tone will be transmitted to the mobile operator.

When a wrong number is reached due to telco or programmer's error, voice from the wrong number may cause short tone-modulated transmissions (corresponding to words or syllables over 150 ms in length), but no voice will be transmitted. If transmission does occur, the RP-250 panel will terminate the call by going on-hook after six on-off transmitted tone transitions. If less than six tone-modulation transitions occurred during the wrong number, the RP-250 panel will go on-hook in

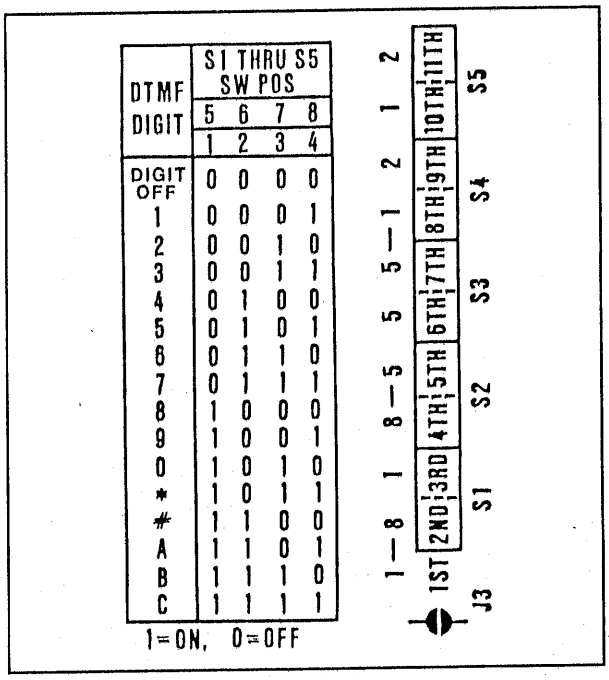

Chart 1. Autodial programming

about 40 seconds from the time of access decode.

The mobile operator may terminate the call at any time by transmitting the reset code ("#" third digit), except during an automatic tone transmission from the base station. (If the base station is a repeater type with the ability to transmit and receive simultaneously and with proper RP-250-to-radio interconnections, a mobile reset is possible at any time.)

Setup, Adjustments, and Programming

C-550 Disassembly

Access to autodial programming switches and auxiliary input terminals is obtained by loosening two screws on the bottom of the console and "folding" the case forward. This opens up the entire unit for setup. Make sure that the wall power supply is unplugged during disassembly and assembly to prevent accidental short circuits.

C-550 Autodial Programming

Any PSTN telephone number up to 11 digits may be programmed, except that the first digit of an 11-digit number must be the DTMF digit "1".

To program a standard seven-digit telephone number, refer to Chart 1 or to the programming label on the bottom of the unit; move all switches on S1 and the first four switches on S2 to their off positions and program the seven desired digits on the last four switches of S2 and on S3, S4, and S5. To program a standard 10-digit long-distance telephone number, use all programming switches starting with the first four switches of S1 and, if in your area the digit "1" must precede a long-distance number, close J3.

Dialing takes place at about seven digits per second with one digit pausing after the first and fourth digits of an 11-digit programming field.

Because this 11-digit field is scanned for programming, dialing requires about 2 seconds regardless of the number of digits.

C-550 Console Adjustments

Other than the volume control on the front panel and the auxiliary input level control on the PC board, no customer adjustments are required, and, with the exception of the factory-preset 2174-Hz notch potentiometers R6 and R12, no others are present.

If the auxiliary audio input terminals TB1-3 and TB1-2 are used, input a normal auxiliary audio level and adjust R53 for about 1 V_{p-p} or 350 mV_{rms} at TP1. This is about 3.5 dB above the threshold of compression. Increased level at TP1 does not increase line output level and may cause excessive noise or distortion.

RP-250 Autodial Programming

Refer to Chart 1 or the programming label inside the RP-250 cover and to the C-550 programming instructions. Program the C-550 telephone number using S1 through S5 and, if long distance, J3.

RP-250 DTMF Access/Reset Code Programming

The first two digits of the three-digit access/reset code are programmed by S6. The third digit is a fixed "*" for access and "#" for reset. Refer to Chart 1 or to the programming label for the switch positions for the desired DTMF digits. Program the first DTMF digit on the first four switches of S6 and the second DTMF digit on the last four switches of S6. The only difference between autodial programming and access/reset programming is that 0000 programming on S6 is DTMF character "D" while 0000 programming on

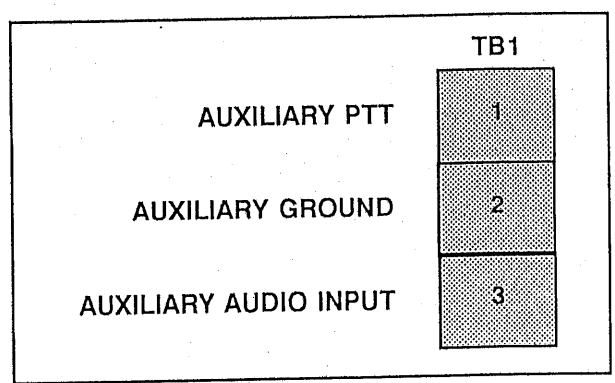

Figure 3. C-550 console terminals for auxiliary connections.

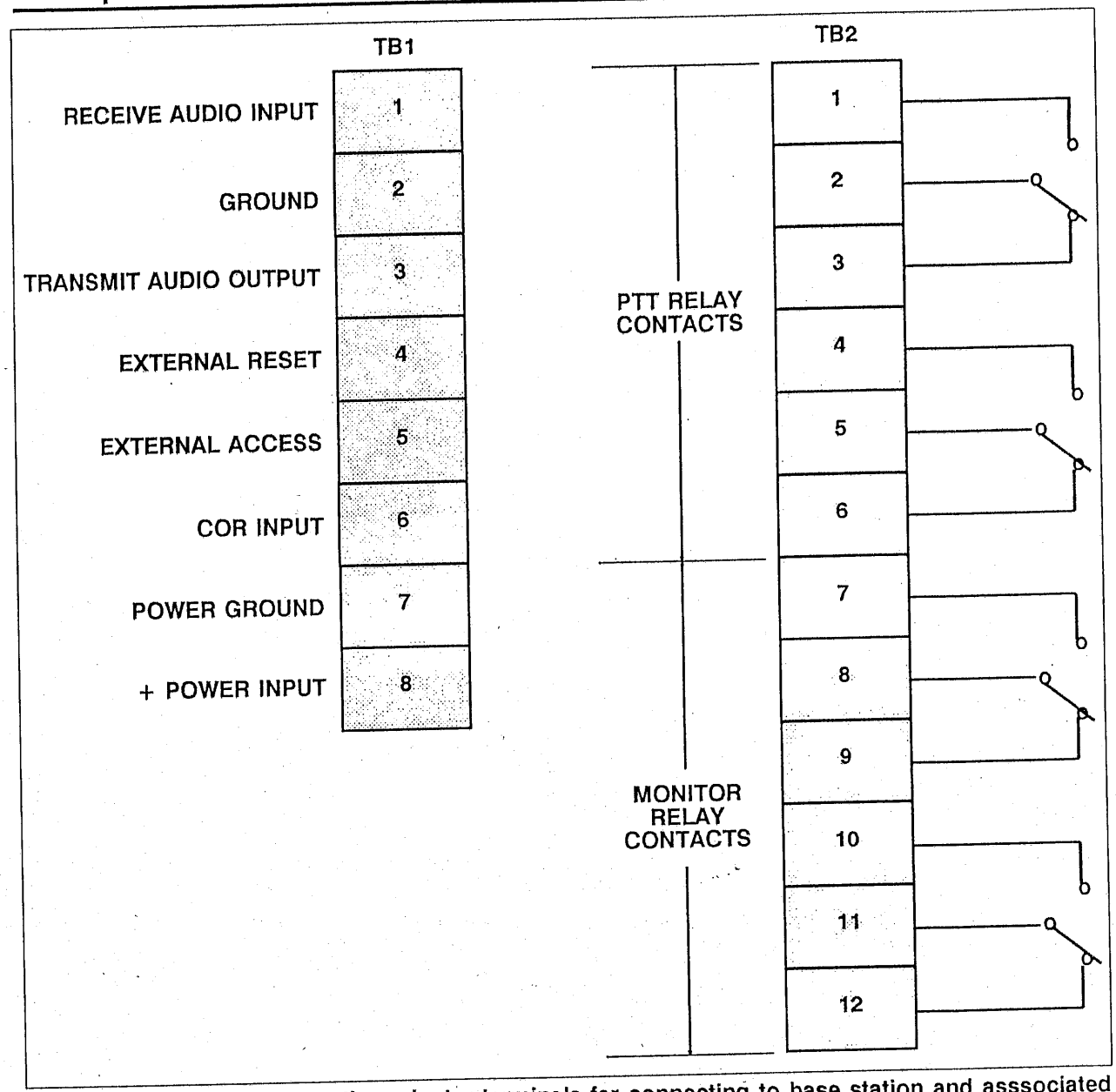

Figure 4. RP-250 remote-station-adapter terminals for connecting to base station and asssociated equipment.

S1 through S5 is DTMF off. The three-digit access and/or reset codes may be part of a longer string of DTMF digits if desired. For example, the access code may be added to a DTMF ANI message and still be decoded. If automatic DTMF message generators are used instead of a manual DTMF microphone, the digit rate must be 10 digits/s or less.

RP-250 Adjustments

Only the RX audio input and the TX audio output require adjustment upon installation. These controls may be adjusted from the front of the panel by removing only the top cover, but must be turned counter-clockwise to increase level when adjusted from this direction. A nonmetallic or insulated screwdriver should be used to avoid accidental short circuits. The TX output control R53 should be adjusted for proper transmitter deviation with voice audio rather than a sinewave, because the TX compressor maintains its output at an average power level and, for a given power level, typical voice peak-to-peak is 2.4 times that of a sinewave. The compressor between the RX input and the telephone line is of the same type as the TX compressor, and RX level should also be adjusted using typical voice audio. Adjust R51 for about 1 V_{p-p} of typical voice audio at TP1.

RP-250 Solder-Bridge Programming

As shipped, upon ring detection, the RP-250 panel connects base-station audio, if any, to the telephone line immediately after the answer beep.

The C-550 console operator therefore is not required to operate any controls to monitor base-station audio for activity. However, if the base-station telephone number is listed or has become common knowledge, anyone dialing the base-station number from anywhere can listen to base-station audio, if any, for up to 40 seconds and tie up the base-station telephone line. To change RP-250 operation so that a monitor or PTT tone burst from a C-550 console is required before base-station audio is connected to the telephone line, open J1 and J8 and close J2.

Sensitivity of the RP-250 as shipped is for typical C-550 to RP-250 telephone-line losses of from 7 to 17 dB. If higher telephone-line losses are typical, close J6. Do not close J6 unnecessarily, because the increased sensitivity also increases sensitivity to line noise.

J4 has been provided to defeat the auto-answer function, which is necessary only on certain multiple RP-250 installations on a PSTN line.

C-550 Console Theory of Operation

C-550 Autodialer—General

Upon lifting the handset from the cradle (going off-hook), telephone-company (telco) line is connected to transformer T1 by the hookswitch, causing direct-current flow (loop current) through the telco line. Telco senses the loop current and switches a dial-tone generator to the line.

The enabled dial-tone detector U20 detects the dial-tone signal and, after about two seconds of delay, enables the autodial circuit and disables the dial-tone detector by resetting the dial-tone latch. The autodial circuit scans the programming field, and, when programming is detected at any digit position, the programmed DTMF digit is generated by U18 and outputed to the telco line. Telco detects DTMF, disconnects the dial-tone generator, decodes the autodialed number, and applies a ringing voltage to the dialed number at the base station and a ringback signal to the C-550 console. Upon detecting loop current at the base station (the RP-250 has gone "off hook"), telco disconnects the ringing voltage and the ringback signal generator and provides a two-way audio signal path between the RP-250 and the C-550.

Autodial Logic

The dial-tone latch U19-3,4,9,8 is set through C48 and CR9 from one set of hookswitch contacts at J7,8 whenever the handset is placed on hook. Upon going off hook to originate a call to the base station, the dial-tone detector is enabled at U20-3 by the set dial-tone latch. Dial-tone audio signal is conducted to the dial-tone detector audio input at U20-5 through J2-2, J10, J9, T1, R35, U5-14, R8, U1-14, C29, C20, R22, U2-10, R76, and C53.

U20 detects the dial-tone signal and V20-4 goes high and, in about two seconds, charges C50 to the threshold of U19-1, which causes U19-6 to go high and enable the autodial sequence.

At idle, the autodial counter U17 is latched at the last autodial position plus one, causing U17-9 to be high. When the autodial circuit is enabled by a high at U19-1, both U16 and U17 counters are reset to their zero count positions, causing U17-9 to go low. The low at U17-9 resets the autodial latch through CR8, which then disables the dial-tone detector at U20-3. Capacitor C50 is quickly discharged through CR10 by the low at U20-4, which then removes the reset logic at U16-15 and U17-15 through U19-1,2,5,6.

When U17-9 went low at the start of the autodial sequence, U14-13 went high through R69 and U19-11,10, enabling the clock-pulse generator U14-11, R63, and C47. The high at U14-13 causes U14-11 to go low because U14-12 is high from a fully charged C47. U14-11 remains low for about 150 ms until C47 is discharged by R63 to the threshold of U14-12. U14-11 then goes high and, due to the Schmitt input hysteresis characteristics, now oscillates at about 7 Hz. The first low-to-high transition at U14-11 clocks the high at U16-3 to U16-2, which, if J3 is closed, causes U18-9 to go high through CR5.

A high at U18-9,10,11 or 12 (data inputs) also causes a high at U14-1 through U15-13, and, if U14-2 is also high from the clock being high, U14-3 goes low, U13-4 goes high, and U18-2 goes high, enabling DTMF output at U18-14. The DTMF digit generated is determined by the data at U18-9,10,11,12. In the above case where only U18-9 is high, DTMF "1" is generated.

The clock output at U14-11 remains high for about 70 ms and then goes low for about 70 ms, disabling U18 at pin 2 through U14-3 and U13-3,4. U14-11 goes high again, clocking U16 from pin 2 to pin 4. Pin 4 has no circuit connections and is a 140-ms "pause" position of the counter. The low-to-high transition at U14-11 clocks U16 from pin 4 to pin 7, which provides data to U18 if any of the S1-1,2,3,4 switches are on, and enables DTMF output for the 70-ms period when the clock is high.

The process continues, with another pause at counter position 6, until the counter is clocked to position 7 (pin 6). A high at U16-6 is directly connected to U16-13, which inhibits U16's clock input. U16 is now latched at position 7 (pin 6), but the U16-6 high has also enabled U17 counting at U17-13 through U14-8,10. The clock-line high and the high-to-low transition at U17-13 clocks U17 from pin 3 to pin 2, enabling DTMF if any of S3-1,2,3,4 switches are on.

The sequence continues until U17 is clocked to pin 9 (position 8), which disables the clock at U14-13 through R69 and U19-11,10. Autodialing stops and the counter is latched as it was before autodial trigger.

The U18 to line audio path is from U18-14 through R67, C38, U8-2, U8-1, R39, T1, and the hookswitch contacts.

When U18 is enabled, the average DC level at U18-14 would normally step from 0 to 4.5 volts, but reverse DC logic and R68 maintains a near-constant DC average voltage at the junction of R67 and R68.

C-550 Transmit Logic and Tone Bursts

The 3.58-Mhz crystal at U20-1,2 is oscillating continuously. This frequency is applied to U11-9 through U19-13,12. U11 is a programmable divider wired to divide by 206, causing the output at U11-1 to be 17.376 kHz. U7 is another programmable divider used as a 16-step-per-cycle sinewave synthesizer. U7 also divides by 8 in the process, causing output at C36 to be 2172 Hz if the preset enable at U7-10 is low. (At idle, U7-10 is high, presetting U7-6 high and U7-4 low, so that the bias applied to U5-6 is 4.5 V). C37, U5-6,7, and associated components comprise an active low-pass filter which attenuates the steps on the synthesized waveform to a low-distortion sinewave at the U5-7 filter output.

Depression of the PTT switch triggers timer U6A at U6-5 through the debounce network R44 and C35, and U10-12,11. Once triggered, the timer output at U6-7 will go low for about 75 ms, enabling the sinewave synthesizer at U7-10 through U10-1,3,6,4. The analog gate U3-3,4 is enabled to conduct at U3-5 through U10-1,3 and U13-11,10. The 75-ms 2172-Hz audio signal path is from U5-7, through U3-3,4, through R33, U8-2,1, and through R39 and T1 to the line at a level of about –4 dBm.

Upon timeout of U6A, U6-7 goes high, disabling analog gate U3-3,4 and triggering timer U6B at U6-12. U6-10 goes high for about 47 ms, enabling DTMF character "C" generation from U18 through DN1. Upon U6B timeout and for as long as the PTT switch remains depressed, the sinewave synthesizer remains enabled at U7-10 through U10-5,4. The 2172-Hz sinewave path is now through R19, which causes the line output level to be –29 dBm.

Tone-burst generation from monitor-switch operation is the same as from PTT operation, except that U9A and U9B are used for the timers and U9B enables the DTMF character "B" through DN2.

U12 is used to trigger a –4-dBm, 75-ms, 2172-Hz tone burst every 25 seconds after off-hook or after PTT-switch operation. During on-hook, U14-4 is high due to the low at U14-6. Likewise, during PTT, U14-4 is high due to the low at U14-5. The high at U14-4 causes a low at U12-3,13 through U13-13,12, holding the timers in a reset condition. Upon off-hook or termination of PTT, U14-4 goes low, causing U12-3,13 to go high, removing timer reset, and U10-9 to go high, which causes U10-10 to go high, because U10-8 is also high from the untriggered Q of U12B at U12-9. The high at U10-10 triggers the 25-second timer U12A at U12-4 through R54, which pulse-discharges C41 and causes timer Q output at U12-7 to go low. C41 slowly charges through R58, reaching the threshold point in about 25 seconds, causing timer timeout.

Upon U12A timeout, U12-7 goes high, triggering timer U12B at U12-12, causing U12-9, U10-8, U9-3,13, U6-13, and U10-13 to go low for 100 ms. Timers U9A, U9B, and U6B are held in reset for 100 ms, but timer U6A is triggered by the high-to-low transition at U10-13. A 75-ms pulse from U6A causes –4-dBm, 2172-Hz line output in the same manner as from PTT operation, but U6B is held in reset upon U6A timeout and, therefore, is not triggered. U12A is triggered again upon timeout of the U12B 100-ms timer through U10-8,10 and R54. The net result is a 75-ms, –4-dBm, 2172-Hz line output every 25 seconds. This tone burst is used by the RP-250 at the base station to refresh its 40-second timer and thereby prevent timeout up to indefinitely.

C-550 Transmit Voice and Auxiliary Audio

Voice signals from the handset microphone and auxiliary audio from TB1-3 are applied to audio buffer U5-3,2,1, which drives the transmit compressor at U2-6 through C21, C16, and R10. The maximum gain of this compressor is set by R11, which causes C17 to become slightly charged, which then controls the amount of internal inverse feedback. Audio signal present at U2-2 is internally full-wave rectified and applied to C17 whenever the rectified signal voltage exceeds the existing bias caused by R11. Any increase in voltage at C17 causes a decrease in the compressor gain and therefore maintains a near-constant output at U2-7 for input levels above threshold. RN1-1,2,3,4 and C11 provide a DC but not audio-frequency feedback path which maintains the average DC voltage at U2-7.

During PTT, U3-1,2 is enabled at U3-13 by the lows at U10-12,11 through R64, U13-5,6, and R61. The audio signal path is then from U2-7 through C12, U3-1,2, R32, U5-9,8, R38, U8-2,1, R39, T1, and the hookswitch contacts to the line at a level of about –10 dBm.

Another transmit audio signal path exists from U5-8 through R40 to the junction of C7 and R50. This path provides transmit audio at attenuated volume-control-adjustable level to the handset earpiece through R50, U8-6,7, C23, and R24. This

sidetone in the earpiece makes talking into the handset microphone seem more natural (because standard telephones have sidetone, and lack of sidetone might appear that power is off and no transmission is occurring).

Receive Audio

The incoming audio path is through the hookswitch contacts, T1, R35, to U5-13,14. From U5-14, two signal paths exist to U1-13—a direct path through R8 and another path through R9 to the U1 tunable 2172-Hz bandpass filter, R6, and R7. R12 and R6 are factory-adjusted to cause 180° and equal-amplitude 2172-Hz audio at U1-14. The result is a 45-dB or greater notch at 2172 Hz in the audio at U1-14. This eliminates the annoying low-level 2172-Hz PTT tone that would otherwise be present when a parallel C-550 console is transmitting.

U3-6,9 and R18 shunts R16 in the U1-13,14 feedback loop. This shunt greatly attenuates the receive audio path during PTT, autodial, and tone-burst generation. PTT enables U3-6 (which almost disables the receive audio path) through R44, U10-12,11, R31, and Q1. U3-6 is also enabled by a high at U15-1, caused by guard tone, autodial enable, 100-ms timer U12B, and function-tone DTMF enable.

Audio signals from U1-14 are applied to the receive compressor at U2-11 through C29, C20, and R22. Operation of the receive compressor is identical to that of the transmit compressor, and a near-constant audio output signal is developed at U2-10 at all input signal levels above threshold.

The audio signal path from U2-10 is through C8, the front-panel volume control R101, C7, R50, U8-6,7, C23, and R24 to the handset earpiece.

U3-10,11 blocks the audio path to the speaker unless the speaker latch U13-1,2,9,8 has been set by speaker-switch operation, which enables the U3-10,11 path at U3-12. The speaker latch is reset by PTT or on-hook through U14-5,6,4, U13-13,12, and CR-1.

When the speaker latch is set, the audio path to the speaker is through R17, U3-10,11, C6, U4-2,8, C26, and E1.

Ring Detector

Ringing voltage from the telco line is applied to ringer IC U23, which, upon ringing-voltage detection, outputs ringing audio through C55 and R79 to the optical isolator at U22-1,2. Ringing audio signals are coupled to U22-5, through R84, C62, and C6 to the input of power-amplifier U4, and then to the speaker. Ringing tone to the speaker path is unaffected by the volume control.

Power Supply

The external wall power supply connects to J5, supplying unregulated voltage through CR13 and R81 to power-amplifier U4. Regulated 9-V power for everything else appears at the output of regulator U21. The 4.5-V reference voltage derived from the regulated 9 V appears at C3, to bias most of the opamps.

RP-250 Adapter Theory of Operation

General—Autodialer and Call Progress

Upon DTMF ACCESS decode or upon a logic-low input to the external access terminal, the telco line is connected to transformer T1 by relay contacts, causing direct current flow (loop current) through the telco line. Telco senses the direct current flow and switches a dial-tone generator to the line.

The enabled call-progress detector U27 detects the dial-tone signal and, after about 2 seconds of delay, triggers the autodial circuit, which then disables the call-progress detector. The autodial circuit scans the programming field and, when programming is detected at any digit position, the programmed DTMF digit is generated by U19 and applied to the telco line. Telco detects the DTMF and disconnects the dial-tone generator, decodes the autodialed number, applies a ringing voltage to the dialed number at the C-550 console, and applies a ringback signal to the RP-250 line.

The RP-250 call-progress detector, which was enabled at autodial completion, detects the ringback signal, and switches the base station to transmit, modulated by a tone signal which lasts for the duration of the ringback signal on the telco line.

When the C-550 operator goes off-hook, telco detects the loop current, disconnects the ringing voltage and ringback signal, and provides a two-way audio signal path between the C-550 and the RP-250.

RP-250 Autodialer and Call-Progress Logic

Upon DTMF ACCESS decode or upon external access input at TB1-5, the 40-second timer U17 is triggered at U17-5, and the MOBILE ACCESS latch U6 is set at U6-15. U17-6 goes high, energizing line-relay K1 through U12-5,12, which connects the telco line to transformer T1. Setting ACCESS latch U6 causes U6-1 to go high, which disables RX audio at U24-5 through U33-8,9 and U32-6,4. The high at U6-1 also enables the call-progress detector at U27-3 through U35-12,11, U28-5,6, and R84. Dial-tone audio signal is applied to U27 through T1, R82, and C58.

Detection of the dial-tone signal causes U27-4 to go high, Q4-D to go low, Q3 to go open-circuit, and C44 to charge through R73. C44 charges to

the threshold voltage of U26-9 in about 2 seconds, causing a low at U26-8 and U16-13,11. The high-to-low transition at U16-11 applies a 10-μs clock pulse to counter U29 at pin 14 through C59 and U18-9,10.

Counter U29 is clocked from position 0 (pin 3) to position 1 (pin 2), causing U29-3 to go low, which disables the call-progress detector at U27-3 through U35-13,11 and U28-5,6, and enables the DTMF-rate generator at U36-12. The high at U36-12 causes U36-11 to go low because U36-13 is high from a fully charged C63. U36-11 remains low for about 150 ms until C63 is discharged by R76 to the threshold of U13-13. U36-11 goes high and, due to the Schmitt input hysteresis characteristics, now oscillates at about 7 Hz. The first low-to-high transition at U36-11 clocks counter U29 from position 1 (pin 2) to position 2 (pin 4), which, if J3 is closed, causes U19-9 to go high through CR17.

A high at U19-9,10,11,12 (data inputs) also causes a high at U36-1 from U9-13. If U36-2 is also high from the clock being high, U36-3 goes low, and U28-12 and U19-2 go high, DTMF output is enabled at U19-14. The DTMF digit generated is determined by the data at U19-9,10,11,12. In the present case, where only U19-9 is high, a DTMF "1" is generated.

The clock output at U36-11 remains high for about 70 ms and then goes low for about 70 ms, disabling U19 at pin 2 through U36-2,3 and U28-13,12. U36-11 goes high again, clocking U29 from position 2 (pin 4) to position 3 (pin 7). Pin 7 has no circuit connections and therefore produces a 140-ms pause in the "dialing" sequence. The next low-to-high transition clocks counter U29 to position 4 (pin 10), which provides data to U19 if any of the S1-1,2,3,4 DIP switches are on, and enables DTMF output during the clock-high period.

The scanning process continues, with another pause at position 7 (after the three-digit long-distance numbers), until the counter is clocked to position 8 (pin 9). The high at U29-9 is connected to U29-13, which inhibits U29's clock input. U29 is now latched at position 8 (pin 9), but the U29-9 high has also enabled the U37 counter clock input at U37-13 through U28-9,8. U37 is clocked from position 0 (pin 3) to position 1 (pin 2). This enables DTMF if any of S2-1,2,3,4 switches are on.

The scanning sequence continues until U37 is clocked to position 8 (pin 9), which sets the autodial-completed latch at U6-11 through U28-1,2. U6-10 goes high, resetting counters U29 and U37 to position 0 through U16-8,10. The high at U29-3 (position 0) disables the clock oscillator at U36-12 through U28-11,10, returning the autodial circuit to the idle state; however, the input trigger circuit is disabled at U16-12 by the set autodial-completed latch.

The DTMF audio signal path is from U19-14, through C5, R63, U24-8,9, U24-11,10, U22-2,1, R40, T1, and the K1 relay contacts.

The call-progress detector U27 was reenabled by autodial completion through U35-13,11 and U28-5,6. Therefore, when a ringback signal is detected, U27-4 goes high. The set autodial latch decreases the time constant of the network R73, C44 from U6-10 through U31-10,11,12, and C44 charges in less than 200 ms.

U26-8 goes low, U33-13 goes low, and U26-10 goes high. The high at U26-10 energizes the PTT relay through U36-6,4, U26-13,12, U33-5,6, U25-8,10, U32-1,3, and U12-6,11. The lows at U33-11,12,13 cause a high at U33-10, U9-5,1, and U28-3, and a low at U28-4 and U19-3,4. This disables DTMF generation by U19. The high at U19-9 from U9-5 through CR7 causes a 697-Hz sinewave to be generated and the transmitter to be modulated. This audio path is from U19-14 through C5, R64, U22-9,8, U23-10, and U24-2,1 to TB1-3. The audio path to the telco line is disabled at U24-6 from U9-5 through U26-3,4.

Upon termination of the telco ringback signal, tone modulation stops. After an 800-ms delay, the PTT relay deenergizes.

In the event that telco generates a busy signal instead of ringback, each low-to-high transition of U26-8 clocks counter U8 (a busy signal is 1/2 s on, 1/2 s off). After six U26-8 transitions, U8 is clocked to pin 6, which resets the 40-second timer at U17-3 through U35-1,3 and U7-4,6. This causes relay K1 to deenergizes and the RP-250 to go on-hook.

DTMF Access/Reset Decoder

As shipped, the DTMF audio path from the radio receiver to the DTMF decoder U10 is from TB1-1 through U24-4,3, U22-2,1, R40, U31-2,1, U22-6,7, R58, and C6 to U10-2. Upon digit decode, date is translated from 5-V to 9-V logic by U11 and applied to the 4-bit comparator U1. At idle, counter U2 is held at position 0 (pin 3) by a high at the reset input pin 15. Upon the decode of any valid DTMF digit by U10, U11-12 goes high, charging C2 (interdigit timer capacitor) through U12-1,16. This releases the reset at U2-15 through U4-3,4 and U3-1,3. The 4-bit data applied to U1-10,12,13,15 is compared to the 4-bit programming of S6-1,2,3,4, which, if identical, causes U1-6 and U25-5 to go high. U25-6 is high from the VALID DTMF digit at U11-12. Therefore, U25-4 goes low.

Upon termination of this first DTMF digit, U25-4 goes high, clocking counter U2 from position 0 (pin 3) to position 1 (pin 2), which enables digit 2 programming at S6-5,6,7,8. Upon the decode of a second DTMF digit and a second comparison with programming, the counter either will be reset if the digit is wrong (through U4-5,6, U3-5,4, and U3-2,3)

or will be clocked to position 2 (pin 4) on the trailing edge of VALID if the decoded digit is per programming. The high at position 2 (pin 4) enables the fixed "*" (star) programming of DN3. If DTMF "*" is decoded on the third digit, the counter will be clocked to position 3 (pin 7). The high at U2-7 through U3-9,10 and CR25 causes a low at U15-9, a high at U15-8 and U36-9, and a low at U36-10 on the trailing edge of VALID. From the low at U15-9, logic is the same as from an external access input.

DTMF reset decode is the same as access decode up to the third digit. If the third digit is a "#" (or DTMF "A", "B", or "C"), data from U11-6 and U11-10 is applied to U5-1 and U5-6 milliseconds before VALID at U11-12 goes high. The highs from U11-6,10 and from U2-4 cause a high at U5-4, which holds U4-5 high, disabling the wrong-digit reset which would otherwise occur. U3-12 is high from U5-4 and, when VALID at U3-13 goes high, U3-11 goes low, resetting the 40-second timer U17. Reset occurs on the leading edge of VALID. On the trailing edge of VALID, counter U2 is clocked to position 4. Because wrong-digit reset is enabled by the low at U5-4 and data from U11 is latched for DTMF "#", counter reset occurs in less than 1 μs.

Ring Detector

The incoming AC ringing voltage is applied to the optical coupler U30 through C37 and R46. U30-16 conducts to ground on both the positive and negative peaks of the ringing voltage charging C68. C41 charges through R26 and, after about two and one-half rings, reaches the threshold of U15-13. U15-12 goes high and triggers the 40-second timer at U17-4, which energizes line relay K1. Telco senses current through transformer T1 and disconnects the ringing voltage. The high at U15-12 disables RX audio at U24-5 through U16-5,4, U33-1,9, and U32-6,4.

After about 2.2 seconds (billing delay), C41 discharges through R26 and R44 to the threshold of U15-13, causing U15-12 to go low, charging C43 through R27, causing a low at U15-1 and a high at U15-2. The high at U15-2 maintains RX disable with a high at U16-6, and enables U19 through CR8, U9-10,13, U36-1,3, and U28-13,12, and enables single-tone generation at U19-3,4 through U9-3,1 and U28-3,4. The audio signal path from U19-14 to the line is through C5, R63, U24-8,9, R61, U22-2,1, R40, T1, and the K1 relay contacts.

After about 500 ms of beep tone to the C-550 operator, C43 charges to the threshold of U15-1, and U15-2 goes low, enabling RX audio to the line.

Tone-Burst and PTT-Tone Detection

The 2174-Hz guard-tone signal generated by the C-550 upon PTT switch operation is applied to U22-6 through the K1 relay contacts, T1, U31-2,1, and R57. U31-3,4 is conducting, causing a signal loss of 8.5 dB at U22-7. The signal at U22-7 is applied to the unity-gain 2174-Hz bandpass filter at U21-12 through RN3-6,5. Output from the unity-gain bandpass filter is applied to the high-Q, 10-dB-gain, 2174-Hz bandpass filter at U21-3 through R34. Output of the high-Q filter at U13-1 is about at line level, because a loss occurs in T1. The 2174-Hz signal at U13-1 is amplified 31 dB by U13-12,13,14, and is normally into clipping at U13-14. Negative-going signal peaks at U13-14 discharge C30 through R23 and CR3, causing U13-8 to go high. The high at U13-8 disables RX audio at U24-5 through U25-12,11 and U32-5,4, and applies a low to U31-5 through U25-12,11 which increases the line-to-2174-Hz-detector and the line-to-DTMF-decoder signal-path gain by 25 dB. The high at U13-8 also causes U6-3 to go high through U32-13,11, releasing the CLEAR on U6-3,4,13 PTT latch. The low-to-high transition at U13-8 also triggers a 180-ms timer at U17-12, which enables the function-tone DTMF decoder at U14-2 for the timed period.

The DTMF function tone is decoded by U10 about 25 ms after initiation into 4-bit binary, translated from 5-V to 9-V logic by U11 and applied to U14-1 through DN5. (DN5 and R2 are equivalent to a four-input AND gate.) When pins 1, 2, and 9 of U14 are all high (enabled, VALID, and correct 4 bits), U14-9 goes low, causing a low at U6-4, presetting U6-13 (Q) low which energizes the PTT relay K2 through U25-9,10, U32-1,3, and U12-6,11. The TX audio path to TB-1 is also completed through U24-2,1 by a high at U24-13.

The low-level 2174-Hz PTT tone is initiated on the trailing edge of the function tone and, due to the 25-dB increase of 2174-Hz-signal-path gain, U13-8 remains high and the PTT relay remains energized.

Upon release of the C-550 PTT switch, low-level 2174-Hz tone stops and C30 charges through R16 in about 200 ms to the threshold of U13-9. U13-8 then goes low and U6-3 goes low through U32-13,11, clearing U6-13 to high, causing the PTT relay to deenergize.

Monitor Tone-Burst Detection

The monitor tone burst differs from the PTT tone burst only in the function-tone DTMF character used and the lack of PTT tone after the function tone.

2174-Hz guard-tone detection causes U13-8 to go high, disabling RX audio, increasing line-to-detectors gain by 25 dB, and triggering the U17 180-ms timer, which enables the monitor-function tone decoder at U14-3. When the VALID monitor function tone is decoded, pins 3, 4, and 5 of U14 are all high, causing a low at U14-6, which is applied

to U6-7 through U5-9,10, setting the monitor latch and energizing the monitor relay from U6-9 through U12-7,10.

The monitor latch is reset at U6-6 upon PTT function-tone decode from U14-9 through U5-13,11.

RP-250 Reset to On-Hook by Double Monitor Tone Burst

The first monitor function tone decode at U14-9 quickly discharges C40 through CR13 and causes a high at U35-6 through U26-1,2. The low at U15-5 causes a high at U15-6, but C55 does not charge through R71 enough to reach the threshold of U35-5 during the first monitor decode period.

If a second monitor decode occurs before C40 has charged to the threshold of U15-5, U35-5 will be high at the same time that U35-6 goes high and, therefore, U35-4 will go low. The low at U35-4 resets the 40-second timer at U17-3 through U7-1,9 and U7-5,6, causing the line relay K1 to deenergize.

RP-250 Line to TX Audio Signal Path

The TX audio signal path is from the telco line through K1 relay contacts, T1, U31-2,1, and R57 to U22-7. U31-3,4 is open circuit and the gain of U22-6,7 is high. Audio signal from U22-7 is applied to U22-9 through RN2-7,8. A second audio signal path from U22-7 to U22-9 is through RN3-6,5, U21-12,14, R37, U21-9,8, R42, and R43. R39 and R42 have been factory adjusted to apply 2174-Hz signals to U22-9 that are at a 180° phase relationship and at equal amplitude to the first audio signal path. This results in a deep narrow notch at 2174 Hz in the passband seen at U22-8. This removes the PTT tone from the TX audio.

TX audio from U22-8 is applied to TB1-3 through the ALC (automatic level control) stage U23, C34, R53, U24-2,1, and C35.

RP-250 TX and RX Automatic Level Control (ALC)

U23 contains two independent variable-gain stages which may be connected to operate as a two-to-one compressor, a two-to-one expander, or an automatic level control. Only ALC and the TX section will be explained.

U23-15 is the input to a full-wave rectifier which charges C31 at U23-16. The voltage at U23-16 controls the variable-impedance section (G) in the feedback path from U23-10 to U23-12. The external feedback path from U23-10 through RN5-6,5,4,3 and bypassed by C33 at RN5-4,5 represents 44-k-ohm feedback resistance at DC and near infinite impedance at audio frequencies. At no signal input and with no DC return to ground at the U23-15 rectifier input, the voltage at C31 is near zero and the internal feedback impedance is near infinity. Stage gain would be extremely high under these circumstances.

To set the maximum stage gain to a reasonable level, R49 pulls a steady direct current from U23-15 to ground. This charges C31 to low voltage, which causes the internal feedback impedance to become a reasonable value, and the desired maximum gain has been achieved.

When an audio signal is applied to U23-15 through C21, stage gain is unchanged until the rectified signal level exceeds the bias derived from R49. Any signal input level above the bias threshold causes the voltage on C31 to increase and the internal feedback impedance to decrease in almost direct proportion to the above-threshold signal. This decrease in stage gain with increased input maintains an almost constant output at U23-10.

The output level that is maintained is determined by R50 and an internal resistor.

RP-250 RX Input to Line Audio Path

When the RP-250 is off-hook in the receive mode, RX audio signals must be applied to the line so that the C-550 operator can hear. Line audio signals must be applied to the 2174-Hz detector circuits so that the RP-250 may be switched to TX and so that the refresh-timer tone burst from the C-550 will be detected.

Under high-line-loss conditions, RX signal level at the line transformer may exceed an incoming guard or function tone signal by as much as 27 dB. To allow function-tone decoding under these circumstances, guard-tone detection must disable RX audio to the line. This occurs at U24-3,4 and is explained under "Tone-Burst Detection."

Warranty

Vega signaling products are guaranteed to be free from defects in material and workmanship for a period of three years from the date of shipment. Warranty is for factory repair or replacement only.

In the event repairs are ever needed on your C-550 console or RP-250 station panel, they should be performed by Vega or an authorized representative of Vega. For information contact:

Vega, a Mark IV company
9900 Baldwin Place
El Monte, California 91731-2204
(818) 442-0782

Information Required To Be Supplied to the Customer

User's Responsibility

The user is required to notify the telephone company of the connection or disconnection of the device, the make, model number, FCC registration number, and ringer equivalence and the particular line to which it is to be made. If the proper jack(s) are not available, the user must order the type of jack(s) to be used from the telephone company.

Information for the Remote Console

Manufacturer: VEGA, A MARK IV COMPANY
Model Number: C-550
Registration Number: BFD9EG-19272-OT-E
Ringer Equivalence: 1.0 B
Jack(s) Which May Be Used: RJ11C or RJ11W

Information for the Station Panel

Manufacturer: VEGA, A MARK IV COMPANY
Model Number: RP-250
Registration Number: BFD9EG-19271-OT-E
Ringer Equivalence: 0.41 B
Jack(s) Which May Be Used: RJ11C or RJ11W

It is prohibited to connect this equipment to pay-telephone or party lines.

Telephone Company Rights and Responsibilities

Under certain circumstances, the telephone company may discontinue service if the device causes harm to the telephone network. In this case, the telephone company shall:

1. Promptly notify the customer of discontinuance.
2. Afford the customer the opportunity to correct the situation which caused discontinuance.
3. Inform the customer of his rights to bring a complaint to the FCC concerning the discontinuance.

The telephone company may make changes in its facilities and services which may affect the operation of the user's equipment. However, the user shall be given adequate notice in writing to allow the user to maintain uninterrupted service.

In case of trouble with this unit, return the unit to the manufacturer (Vega) for repair, or have the manufacturer or his representative repair it in place. Do not attempt to repair the unit as this will violate the FCC Rules and may cause danger to persons or to the telephone network.

FCC Requirements

This equipment complies with Part 68 of the FCC Rules. On the bottom of the C-550 console and on the back of the RP-250 station panel is a label that contains, among other information, the FCC Registration Number and Ringer Equivalence Number (REN) for this equipment. If requested, this information must be given to the telephone company.

The REN is useful to determine the quantity of devices you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most, but not all, areas, the sum of the RENs of all devices connected to one line should not exceed 5.0. To be certain of the number of devices you may connect to your line, as determined by the REN, you should contact your local telephone company to determine the maximum REN for your calling area.

If your telephone equipment causes harm to the telephone network, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance. But if advance notice isn't practical, you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC.

Your telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the proper functioning of your equipment. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If you experience trouble with this telephone equipment, please contact your telephone company for information on obtaining service or repairs. The telephone company may ask that you disconnect this equipment from the network until the problem has been corrected or until you are sure that the equipment is not malfunctioning.

This equipment may not be used on coin service provided by the telephone company. Connection to party lines is subject to state tariffs.

C-550 CONSOLE SPECIFICATIONS

Input and Output Impedance: 600 Ω nominal

Line Output Level: Less than –9 dBm average in any 3-s time interval

PTT Tone-Burst Format

Guard Tone: 75 ms ± 20%, 2174 Hz ± 0.02%, –4 dBm ± 1 dB

Function Tone: 47 ms ± 20%, –4 dBm ± 1 dB

PTT Tone: Continuous 2174 Hz ± 0.02%, –29 dBm ± 1 dB

Monitor Tone-Burst Format

Guard Tone: 75 ms ± 20%, 2174 Hz ± 0.02%, –4 dBm ± 1 dB

Function Tone: 47 ms ± 20%, –4 dBm ± 1 dB

Line Output Level from Handset Microphone or Auxiliary Input: –10.3 dBm ± 1 dB (about 2.2 V_{p-p} from typical voice)

Autodial

Digits: 1 to 11, 10 DIP-switch programmable

Digit Rate: 7 digits/s nominal

DTMF Duty Factor: 50% nominal

DTMF Output Level: –4 dBm ± 1 dB

Audio Compression, Receive, and Transmit Audio: Less than 3 dB change in output for 20 dB change in input above threshold

Distortion: 2% THD maximum at full compression

Audio Frequency Response: ±1.5 dB, 300 to 3000 Hz, except at transmit notch frequency

Hum and Noise: 50 dB below operating signal levels, minimum

Speaker: 4 in, 8 Ω, heavy-duty

Amplifier Power: 800 mW at 10% THD

Handset Earpiece Level: Volume-control adjustable

Sidetone Level: About 25 dB below receive level

Telephone Line Interface: Modular cord

Power Requirements: 105 to 130 V_{ac}, 60 Hz, 8 W

Operating Temperature Range: 0 to +50°C

Notch Filter: 45 dB typical attenuation of a parallel console's PTT tone

Miscellaneous: Crystal-controlled tone frequencies; electret handset microphone element; auxiliary audio and PTT input terminals; speaker mute upon PTT

RP-250 PANEL SPECIFICATIONS

Line Input and Output Impedance: 600 Ω nominal

Receive Audio Input Impedance: 15 kΩ nominal

Transmit Audio Output Impedance

Receive or Idle: 22 kΩ typical

During Transmit: 250 to 500 Ω

Receive Input Sensitivity at Threshold of Compression: 280 mV_{rms} to 6 V_{rms}, adjustable

Transmit Output Level: –40 to –6 dBm (50 mV_{p-p} to 2.6 V_{p-p} typical voice) into a 600-Ω load, adjustable. Tone output levels are 6 dB below voice

Telephone Line Loss

Low Sensitivity: 7 dB minimum to 17 dB maximum (as shipped)

High Sensitivity: 17 dB minimum to 27 dB maximum, solder-bridge programmable

S/N Tolerance

DTMF Access, Reset, Function Tone Decode: 10 dB

Line-Noise Tolerance, PTT or Monitor Decode: –22 dBm at 7 dB line loss to –42 dBm at 27 dB line loss

Line-Noise Tolerance, False TX Hold of 800 ms or Longer, 1 in 10,000 Probability

Low Sensitivity: –36 dBm, 3 kHz bandwidth white noise

High Sensitivity: –46 dBm, 3 kHz bandwidth white noise

RX Input Noise Tolerance

False DTMF Access or Reset Decode: Less than one false in 1000 hours of typical radio audio estimated

False TX Initiate: 0 dBm, 3 kHz white noise, 1 in 10,000 probability with properly adjusted RX input control

Receive and Transmit Audio Compression: Less than 3 dB change in output for 20 dB change in input above threshold

Distortion: 2% THD maximum at full compression

Audio Frequency Response: ±1.5 dB, 300 to 3000 Hz except at transmit tone notch frequency

Hum and Noise: 60 dB below operating levels, minimum

Autodial

Digits: 1 to 11, 10 DIP-switch programmable

Digit Rate: 7 digits/s nominal

DTMF Duty Factor: 50% nominal

DTMF Output Level: –4 dBm ± 1 dB

Line Output Level

Voice: –10 dBm ± 1 dB (about 2.2 V_{p-p} typical voice)

Tones to Line: –16 dBm ± 1 dB

Autodial DTMF: –4 dBm ± 1 dB

Logic Hold after Power Loss: 200 ms minimum

Telephone Line Interface: Modular cord

Power Requirements: 11.5 to 16.5 V_{dc}, semi-regulated; 140 mA maximum at 12 V_{dc} input; 100 mA maximum at idle and 12 V_{dc} input, factory programming; 70 mA maximum at idle, 12 V_{dc} input and alternate-mode programming; provision for optional 105 to 130 V_{ac}, 8 W wall power supply

Operating Temperature Range: –30 to +60°C

Size: 16.6 W, 6.56 D, 1.72 H inches; 42.2 W, 16.7 D, 4.37 H centimeters

Miscellaneous: Crystal-controlled tone frequencies and decoders; inhibit PTT/COR input terminals; external access/reset decoder input terminals

C-550 Parts List

Part No.	Description	Ckt Sym
011-0039	TOP ASSY C-550	
012-0007	SUB ASSY PHONE BASE	
024-0003	PANEL FRT C-550 CONSOLE	
065-0383	PCB MAIN C-550	
065-0384	PCB SWITCH C-550	
102-0430	CAP CER 47OP S2L 5% 50V	C31
104-0748	CAP TANT 10MF 10V	C27
		C30
		C34
		C42
		C43
104-0762	CAP TANT 100 UF 10V RAD	C41
105-1001	CAP MYLAR .001MF 10% 100V	C13
		C14
		C32
		C40
		C45
		C60
105-1009	CAP MYLAR .022MF 10% 100V	C63
105-1011	CAP MYLAR .047MF 10% 100V	C51
105-1095	CAP MYLAR .47UF 250V AX	C54
105-1099	CAP MYLAR .01MF 10% 100V	C36
		C62
110-1340	CAP CER .1MF SMALL	C6
		C12
		C16
		C20
		C22
		C24
		C25
		C28
		C33
		C35
		C37
		C38
		C39
		C44
		C46
		C48
		C49
		C52
		C53
		C55
		C64
110-1345	CAP CER .0022MF 5% NPO	C1
		C4
112-1606	CAP ELEC 10MF 25V	C2
		C5
		C9
		C10
		C11
		C58
112-1608	CAP ELEC 1.0MF 20% 25V	C 7
		C 8
		C15
		C19
		C21
		C23
		C29
		C56
112-1609	CAP ELEC 100MF 20% 25V	C3
112-1645	CAP ELEC 4.7UF 25V MINI	C57
112-1671	CAP ELEC 22MF 16V 10%RD	C50
112-1673	CAP ELEC 2.2MF 20% RAD	C17
		C18
		C47
112-1691	CAP ELEC 220UF 25V	C26
		C59
		C61
130-0673	RES VAR 10K 20T 3/8SQ	R12
130-0724	RES VAR 10K LOG V-ADJ	R53
130-0731	POT PCB 10K V-ADJ CER	R6
130-0739	RES VAR PL 1K LG 7/16SHFT	R101
132-0004	RES RN55C 32.4K 1% 1/4W	R1
		R2
		R3
		R4
		R8
		R9
		R14
		R16
		R48
		R49
134-0212	RES RN55D 10.0K 1% 1/4W	R32
134-0241	RES RN55D 11.3K 1% 1/4W	R33
134-2840	RES RN55D 5.62K 1% 1/4W	R67
134-2842	RES RN55D 22.1K 1% 1/4W	R10
		R34
		R36
134-2864	RES RN55D 536 1% 1/4W	R39
134-2887	RES RN55D 27.4K 1% 1/4W	R7
		R38
134-2947	RES RN55D 249K 1% 1/4W	R58
134-3018	RES RN55D 866.K 1% 1/4W	R46
		R47
134-3020	RES RN55D 1.69K 1% 1/4W	R5
134-3027	RES RN55D 191K 1% 1/4W	R19
136-0001	RES COMP 2.7 5% 1/4W	R18
		R28
		R81
136-0030	RES COMP 680 5% 1/4W	R24
136-0032	RES COMP 1K 5% 1/4W	R13
		R15
		R23
		R30
		R102
136-0035	RES COMP 1.8K 5% 1/4W	R80
136-0037	RES COMP 2.7K 5% 1/4W	R78
		R79
136-0040	RES COMP 4.7K 5% 1/4W	R17
		R43
		R45
		R55
		R56

136-0044	RES COMP 10K 5% 1/4W	R21	162-0001	DNET CMNA QUAD DIODE SIP	DN1
		R25			DN2
		R26			DN3
		R50			DN4
		R52			DN5
		R54			DN6
		R57			DN7
		R59			DN8
		R60			DN9
		R61			DN10
		R70			DN1
		R71			DN12
		R73			
		R74	165-1212	XTAL HC-18 3.579545 MHZ	Y1
		R76			
		R77	249-0119	SPEAKER 4"SQ 3W	
		R83	249-0121	HANDSET ELECTRET PTT	
136-0048	RES COMP 22K 5% 1/4W	R22	286-1768	PIN TEST POINT	TP1
		R29			TP2
		R31			TP3
		R35			TP4
		R37	286-1784	PWR JACK PC BD 2.5MM	J5
		R40	286-1786	TERM STRIPPC BD 3 WIRE	TB1
		R51	286-1830	CONN PCB MODULAR HANDSET	J1
		R62	286-1831	CONN PCB MODULAR LINE	J2
		R64	286-1833	TERM QUICK CONNECT	
		R66	286-1851	RECPT PCB SPADE LUG DUAL	J7
		R69			J8
		R72			J9
136-0051	RES COMP 39K 5% 1/4W	R68			J10
			296-0589	SWITCH PCB PUSH MOM	S101
136-0056	RES COMP 100K 5% 1/4W	R41			S102
		R44			
		R63	299-0315	SWITCH 8 POSITION DIP	S1
		R75			S2
136-0059	RES COMP 180K 5% 1/4W	R82			S3
136-0062	RES COMP 330K 5% 1/4W	R84			S4
					S5
136-0064	RES COMP 470K 5% 1/4W	R20			
136-0095	RES COMP 7.5K 5% 1/4W	R27	318-0261	XFORMER 600-600 FCC	T1
		R42			
136-0284	RES COMP 75K 5% 1/4W	R11	395-0036	SOCKET 7 PIN INLINE IC	J6
138-0013	RNET ISO 4X22K SIP	RN1	425-0105	IC OPAMP 4558 DUAL	U8
138-0027	RNET CMN 5X10K SIP	RN2	425-0132	IC CMOS 4017 CNTR-DCDR	U16
					U17
141-0001	XSTR PNP MPS4126 TO92 GP	Q1	425-0156	IC PWRAMP LM380 2.5W	U4
			425-0171	IC CMOS 4081 QUAD 2AND	U10
161-0366	DIODE 1N4003	CR13	425-0173	IC CMOS 4072 DUAL 40R	U15
161-0426	DIODE 1N4148	CR1	425-0178	INT CKT NE570N	U2
		CR2	425-0181	IC OPAMP TL084 QUAD BFET	U1
		CR3			U5
		CR4	425-0186	IC CMOS 4018 PROG CNTR	U7
		CR5	425-0203	IC CMOS 4569 PROG CNTR	U11
		CR6	425-0206	IC CMOS 4584 HEX TRIG	U13
		CR7			U19
		CR8	425-0250	INT CKT 4N25	U22
		CR9	425-0255	IC CMOS 4093 QUAD TRIG	U14
		CR10	425-0285	IC CMOS 4066 QUAD SW	U3
		CR11	425-0411	IC 4538 DUAL MONO	U6
		CR12			U9
161-0573	DIODE LED T1 3/4 RED DIF	DS101			U12

425-0448	IC REG-P 78L09 9V .1A	U21
425-0455	IC ENCDR TP5088 DTMF	U18
425-0456	IC DCDR M980 CALL PROG	U20
425-0459	IC RINGER MC34012-3P	U23
450-0016	PWR SUPPLY 12DC .5A UNREG	
484-0102	STANDOFF 4-40 X 1/8 ROUN	
528-0003	SCREW PH 4-40X1/4	
528-0259	SCREW PH 3-28X1/4 TYPE B	
536-0358	NUT TINNERMAN .187ID PERM	
538-1157	NUT PEM 4-40X3/16	
550-0243	KNOB BLACK1/2OD 1/8I	
674-0226	CORD PWR 2C 24 GA	
674-0239	CORD TEL MDULR 7'PLG-PLG	
674-0247	CABLE RBN 7 COND .15 6"L	
869-0024	CASE TELEPHONE BEIGE	

RP-250 Parts List

Part No.	Description	Ckt Sym
011-0042	TOP ASSY RP-250	
012-0027	PCB ASSY RP-250	
021-6584	COVER BTTM P-218/RP-250	
021-6585	COVER TOP P-218/RP-250	
021-6587	PANEL REAR RP-250	
527-0003	SCREW FH 4-40X1/4 100DE	
533-0064	SCREW PH 6-20X 1/4 TYPE B	
065-0385	PCB RP250	
104-0408	CAP TANT 1MF 35V	C68
104-0748	CAP TANT 10MF 10V	C2
		C4
		C39
		C40
		C41
		C43
		C44
		C53
		C65
104-0751	CAP TANT 2.2. MF 16V	C23
		C30
		C31
		C63
104-0762	CAP TANT 100 UF 10V RAD	C51
105-1001	CAP MYLAR .001MF 10% 100V	C13
		C25
		C28
		C42
		C45
		C59
		C64
		C67
105-1011	CAP MYLAR .047MF 10% 100V	C12
105-1013	CAP MYLAR .1MF 10% 100V	C7
105-1091	CAP MYLAR .33MF 10% 250V	C37
105-1116	CAP MYLAR .0047 UF 1%	C69
		C70
		C71
		C72
110-1320	CAP CER .001MF 20% 50V	C26
110-1340	CAP CER .1MF SMALL	C1
		C3
		C5
		C6
		C14
		C18
		C20
		C24
		C27
		C29
		C38
		C47
		C54
		C57
		C58
		C60
		C62
		C66
110-1345	CAP CER .0022MF 5% NPO	C9
		C10
		C15
		C16
112-1553	CAP ELEC 1000MF 25V	C46
112-1606	CAP ELEC 10MF 25V	C8
		C11
		C22
		C33
		C52
		C61
		C74
112-1608	CAP ELEC 1.0MF 20% 25V	C17
		C19
		C21
		C32
		C36
		C55
		C56
		C73
112-1609	CAP ELEC 100MF 20% 25V	C49
		C50
112-1659	CAP ELEC 4.7MF NP 10V	C34
		C35
112-1695	CAP ELEC 2200UF 16V TWSS	C48
130-0673	RES VAR 10K 20T 3/8SQ	R15
		R39
		R42
130-0674	RES VAR 2K	R87
		R90
		R94
130-0725	RES VAR 10K LOG PC HADJ	R51
130-0734	RES VAR 1K LOG H-ADJ	R53
132-0004	RES RN55C 32.4K 1% 1/4W	R13
		R14
		R36
		R37
		R41
134-0212	RES RN55D 10.0K 1% 1/4W	R34
134-0250	RES RN55D 178K 1% 1/4W	R55
134-2864	RES RN55D 536 1% 1/4W	R40
134-2873	RES RN55D 133K 1% 1/4W	R48
134-2875	RES RN55D 18.2K 1% 1/4W	R62

134-2901	RES RN55D 26.7K 1% 1/4W	R43
		R57
134-2945	RES RN55D 267 1% 1/4W	R35
134-2948	RES RN55D 6.98K 1% 1/4W	R63
		R92
134-2987	RES RN55D 11.8K 1% 1/4W	R56
134-2989	RES RN55D 14.7K 1% 1/4W	R88
		R89
134-2991	RES RN55D 10.5K 1% 1/4W	R54
134-3020	RES RN55D 1.69K 1% 1/4W	R38
134-3031	RES RN55D 66.5K 1% 1/4W	R22
136-0020	RES COMP 100 5% 1/4W	R98
136-0032	RES COMP 1K 5% 1/4W	R18
		R23
		R75
		R77
		R80
		R81
		R86
		R93
136-0035	RES COMP 1.8K 5% 1/4W	R47
136-0040	RES COMP 4.7K 5% 1/4W	R5
		R20
		R66
		R67
		R74
		R82
136-0044	RES COMP 10K 5% 1/4W	R32
		R33
		R46
		R50
		R52
		R97
136-0048	RES COMP 22K 5% 1/4W	R1
		R2
		R6
		R7
		R8
		R31
		R60
		R69
		R70
		R79
		R83
		R84
		R85
		R95
		R96
136-0055	RES COMP 82K 5% 1/4W	R64
136-0056	RES COMP 100K 5% 1/4W	R4
		R10
		R19
		R21
		R27
		R58
		R59
		R65
		R68
		R71
		R76
		R99

136-0059	RES COMP 180K 5% 1/4W	R29
136-0060	RES COMP 220K 5% 1/4W	R9
		R24
136-0061	RES COMP 270K 5% 1/4W	R26
		R73
136-0062	RES COMP 330K 5% 1/4W	R30
136-0063	RES COMP 390K 5% 1/4W	R11
136-0086	RES COMP 51 5% 1/4W	R 28
		R 91
		R100
136-0090	RES COMP 620 5% 1/4W	R45
136-0282	RES COMP 51K 5% 1/4W	R16
		R78
136-0287	RES COMP 130K 5% 1/4W	R49
		R72
136-0288	RES COMP 160K 5% 1/4W	R25
136-0297	RES COMP 910K 5% 1/4W	R44
136-1952	RES COMP 240K 5% 1/4W	R3
136-1955	RES COMP 5.1K 5% 1/4W	R12
136-1962	RES COMP 36K 5% 1/4W	R17
136-1965	RES COMP 11K 5% 1/4W	R61
138-0013	RNET ISO 4X22K SIP	RN4
		RN5
138-0027	RNET CMN 5X10K SIP	RN6
138-0032	RNET CMN 5X22K SIP	RN1
138-0045	RNET ISO 5X33K SIP	RN2
		RN3
141-0002	XSTR PNP 2N5087 TO92 HB	Q6
144-0001	XSTR NDMOS2N7000 TO92 SW	Q1
		Q3
		Q4
		Q5
		Q7
161-0366	DIODE 1N4003	CR11
		CR12
		CR18
		CR20
		CR21
		CR22
161-0426	DIODE 1N4148	CR1
		CR3
		CR4
		CR5
		CR6
		CR7
		CR8
		CR9
		CR10
		CR13
		CR14
		CR15
		CR16
		CR17
		CR19
		CR23
		CR24
		CR25
		CR26
		CR27

162-0001	DNET CMNA QUAD DIODE SIP	DN1	425-0166	IC REG-P 78L05 5V .1A	U20
		DN2			U38
		DN3	425-0171	IC CMOS 4081 QUAD 2AND	U5
		DN4			U18
		DN5			U32
		DN6	425-0173	IC CMOS 4072 DUAL 40R	U9
		DN7	425-0178	INT CKT NE570N	U23
		DN8	425-0181	IC OPAMP TL084 QUAD BFET	U13
		DN9			U21
		DN10			U22
		DN11	425-0193	IC CMOS 4023 TRIP 3NAND	U14
		DN12	425-0204	IC CMOS 4025 TRIP 3NOR	U33
		DN13	425-0206	IC CMOS 4584 HEX TRIG	U 4
		DN14			U15
		DN15			U26
165-1212	XTAL HC-18 3.579545 MHZ	Y1			U28
		Y2	425-0215	INT CKT ULN2004A	U12
180-0321	RELAY DPDT PCB 12V	K2	425-0221	IC CMOS 4071 QUAD 20R	U16
		K3	425-0227	IC CMOS 4504 6-L/SHIFT	U11
180-0326	RELAY FCC DPDT PCB 12V	K1	425-0255	IC CMOS 4093 QUAD TRIG	U 3
286-1719	TERM STRIP12 PIN MINI	TB2			U25
286-1768	PIN TEST POINT	TP1			U35
286-1770	TERM STRIP 8 PIN MINI	TB1			U36
286-1784	PWR JACK PC BD 2.5MM	J7	425-0262	IC CMOS 4044 QUAD LATCH	U6
286-1831	CONN PCB MODULAR LINE	J5	425-0266	IC OPTO H11AA1 MOT 2LED	U30
299-0315	SWITCH 8 POSITION DIP	S1	425-0273	INT CKT CD4073B	U7
		S2	425-0285	IC CMOS 4066 QUAD SW	U24
		S3			U31
		S4	425-0295	INT CKT MT8870 DTMF DCR	U10
		S5	425-0296	IC CMOS 4063B MAG COMP	U1
		S6	425-0411	IC 4538 DUAL MONO	U17
318-0261	XFORMER 600-600 FCC	T1	425-0448	IC REG-P 78L09 9V .1A	U34
425-0132	IC CMOS 4017 CNTR-DCDR	U2	425-0455	IC ENCDR TP5088 DTMF	U19
		U8	425-0456	IC DCDR M980 CALL PROG	U27
		U29	484-0102	STANDOFF 4-40 X 1/8 ROUN	
		U37	674-0239	CORD TEL MDULR 7'PLG-PLG	

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NOT USED	LAST USED
C 16	C 63
R 65	R 84
R 100	CR 13
E 11	DN 12
	E 9
	U 23
	J 5

ASSY 011-0039
P.C.B 065-0383
P.C.B 065-0384

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C74 TP1	Q2
J9 U38	R82
K3 TB2	
CR27 S6	
Q7 DN15	

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