

# HAMTRONICS® REP-200 REPEATER: INSTALLATION, MAINTENANCE, & OPERATION

## TABLE OF CONTENTS

**PLEASE READ THIS NOW!** ..... 1

*Before you unpack the repeater*..... 1

*Before you turn on power*..... 1

*If you have any questions*..... 2

*Cover Screws*..... 2

*Notes about Synthesized Modules*..... 2

**GENERAL DESCRIPTION**..... 2

**PACKING TO RESHIP**..... 2

**INSTALLATION**..... 2

*General*..... 2

*Mounting*..... 2

*Antenna System*..... 2

*Transmit/receive Isolation*..... 3

*Connections To Terminals*..... 3

*Power Supply*..... 3

*RAM Backup Battery Power*..... 3

*Autopatch Connections*..... 4

*Monitor Speaker*..... 4

*Auxiliary Receiver*..... 4

*Local Touch Tone Pad*..... 4

*Auxiliary Control Circuits*..... 4

*Alarm Circuit*..... 4

*Linking 2 Repeaters*..... 5

**SYSTEM CHECKOUT**..... 5

**THEORY OF OPERATION**..... 5

*General*..... 5

*Microcomputer and DTMF Circuits*..... 5

*Watchdog Timer Circuit*..... 6

*Audio Circuits*..... 6

*COS Circuits*..... 6

*Autopatch Circuits*..... 6

*Switching and LED Circuits*..... 7

*Power Supply Circuits*..... 7

**TROUBLESHOOTING**..... 7

*General*..... 7

*Desense*..... 7

*Checking Repeater for Desense*..... 7

*Intermod*..... 8

*Coax Cables*..... 8

*Frequency Stability*..... 8

*COR-5 Controller Module*..... 8

*Test Points*..... 8

*Current Drain*..... 9

*Fuse Circuit*..... 9

**MAINTENANCE**..... 9

*Handling IC's*..... 9

*Replacement EPROM*..... 9

*Yearly Checkup*..... 9

*Exciter & PA Tuning*..... 9

*Power Level*..... 9

*COR and CWID Adjustments*..... 9

*Audio Adjustments*..... 10

**FCC INFORMATION**..... 10

**OPERATION**..... 10

*GENERAL*..... 10

*TURN ON*..... 10

*FRONT PANEL CONTROLS AND INDICATORS*..... 11

**REPEAT MODE**..... 11

*COR Operation*..... 11

*Time-out Timer*..... 11

*CWID Operation*..... 11

*Changing Settings*..... 11

**USING DTMF COMMANDS**..... 11

*General*..... 11

*How to Enter Commands*..... 12

*What The Computer Does After Each Command*..... 12

*Owner Password*..... 12

*User Commands*..... 13

**AUTOPATCH OPERATION**..... 13

*Autopatch Modes*..... 13

*Making Phone Calls*..... 13

*Pulse-Dial Option*..... 13

*Time-out Timer*..... 13

*Toll Call Restrictor*..... 14

**REVERSE AUTOPATCH**..... 14

*Telephone Remote Control*..... 14

*Ringtone Option*..... 14

**USER ACCESS CONTROLS**..... 14

*Transmit Inhibit*..... 14

*Kerchunk Filter*..... 14

*Touch Tone Repeater Access*..... 15

*User TT Control Inhibit*..... 15

**DIGITAL VOICE RECORDER**..... 15

*Making a Recording*..... 15

*Enabling Voice ID Operation*..... 15

*Playback by DTMF Request*..... 15

**AUXILIARY RECEIVER**..... 15

**ALARM FEATURE**..... 15

**ADJUSTING PARAMETERS**..... 16

*General*..... 16

*Cw Speed*..... 16

*Cw Tone*..... 16

*Beep Delay*..... 16

*Tail Length*..... 16

*Courtesy Beep Type*..... 16

*Time Out Timer*..... 17

**TEST FEATURES**..... 17

**REBOOTING COMPUTER**..... 17

**AUXILIARY CONTROL OF EXTERNAL CIRCUITS**..... 17

**REGISTRATION**..... 17

**COPYRIGHTS**..... 17

**OBTAINING A NEW EPROM**..... 18

**COR-5 BOARD PARTS LIST**..... 18

**PARTS LOCATION & SCHEMATIC DIAGRAMS**..... 18

## PLEASE READ THIS NOW!

**Before you unpack the repeater...**

Take a minute to note how the unit is packed. If you should ever need to return the unit for service at some time in the future, you must be able to pack it properly. Should you ever reship your repeater, you will need all the packing material which came with the unit. We recommend you find a safe spot in your attic to store the carton and padding.

**Before you turn on power...**

Don't change any control settings. Don't adjust anything until you read the rest of this instruction manual and the OPERATION manual.

Note that shock and vibration in shipping can cause problems when any unit is first powered up. Intermittent problems which may not have been evident at the factory can easily show up after bouncing around for thousands of miles. If you encounter any problems with your unit, please call and we will get you squared away promptly.

One problem which can happen is that the compression mica variable capacitors in the pa may change settings due to vibration. We seal the screws, but you may have to repeak the capacitors for maximum output if the power level is low.

Please check the VSWR of the antenna system and the power output of the transmitter before operating the unit for any length of time. The pa can be damaged if operated in a detuned or misloaded condition for very long.

Note that it often is necessary to retune the output capacitors (big mica variables on vhf units) on the repeater PA module to match the antenna system you have. Repeaters are fussy about being tuned properly to avoid desense. **We highly recommend you repeak just the two output capacitors, using a good wattmeter in line with the transmitter output cable. This is especially necessary with the 25-30 output option on two meter units because the PA transistor has a lot of gain and can oscillate if mistuned.** If you notice desense, it often helps to change the length of the coax between the output of the repeater and the duplexer.

There is no special length, but just changing the length can affect the load impedance the PA sees at other than the operating frequency.

If you notice that the power level is less than 90% of what it should be (assuming meter is accurate and full 13.6V power), or the power level drops more than 10% as the unit heats up, check your duplexer and antenna, check the pa tuning, and check your B+ voltage.

**CAUTION!** Do not operate the transmitter without a 50 ohm load or antenna connected. PA damage may result. The transmitter is keyed whenever the receiver squelch is open.

### If you have any questions...

First read all the instructions which are packed with the unit. Then, if any questions still remain, please call us for assistance. Repeaters are complex systems, which interact with power supplies, antennas, duplexers, phone lines, etc. It may take a little time and patience before you get your complete system up and running. However, once you do, it probably will operate for years with very little attention.

### Cover Screws...

In order to save you time installing the repeater, we only install a few cover screws for shipment. The other screws are supplied in a plastic bag with the instruction manuals. **Make sure you install all the cover screws before you place the repeater in operation.** This is especially important for the new synthesized exciter module because rf feedback will degrade performance if rf from the pa leaks back into the exciter compartment. Sometimes, we install an additional thin metal shield near the center of the exciter. This shield is clamped in place by the cover and cover screws, and it is important that any such shields remain in place and that the cover screws be installed to clamp the shield and provide its ground connection.

### Notes about Synthesized Modules. Key Up Delay...

The T301 or T304 Exciter can be keyed two ways. There are two power input pads on the pc board: E1 and E4. E1 is the main power input for the whole board. E4 is a separate input pad for just the synthesizer and modulator stages. Normally, E1 and E4 are connected by a trace on the pc board. The trace can be cut to allow

E4 to be powered separately. This allows the synthesizer to run all the time and E1 can be keyed when necessary by the COR board.

Our normal method of building repeaters is to key both power terminals. This avoids having any low level signal get out on the antenna when the repeater is not keyed. However, it does cause about 1/2 second delay when the repeater is first keyed. After that, there is no delay until you let the carrier completely drop.

If this delay on first key up is objectionable, you can split the B+ as described above. However, even though the carrier is attenuated over 100 dB, some may hear the carrier on the air all the time if they are close to the repeater. We originally thought we would supply repeaters this way all the time, but it quickly became evident that many users objected to the weak carrier on the air when the repeater was not in use; so we stopped making repeaters this way as the default keying option.

### Shielding...

It is important, with frequency synthesizers, to avoid getting even small amounts of rf from output stages of a transmitter back into the vco or synthesizer chip. Such unwanted feedback can prevent the synthesizer from properly locking and may result in spurious signals. In the repeater, the pa is in a separate shielded compartment, but we have seen cases where rf from the output stage of the exciter (it has a nice little heatsink antenna!) gets back into the synthesizer and causes it to unlock.

To prevent such problems, a metal shield strip has been installed on the exciter, between the output stages and the vco and buffer stages. But you should be aware that such feedback can cause problems with synthesizer locking. It is necessary to keep the cover on the repeater whenever transmitting to avoid this feedback. Also, two meter units have a shield over the vco area. It is important to keep this shield in place as installed at the factory.

## GENERAL DESCRIPTION.

The REP-200 Repeater consists of a receiver, exciter, power amplifier, and a COR-5 computerized controller module, which is a combination of a cor/ cwid/autopatch/dtmf decoder. The transmitter and receiver modules are enclosed in rf-tight enclosures to

prevent desense.

Connections for dc power, telephone line, monitor speaker, auxiliary receiver, and alarm circuit are made with convenient push-on terminals on the controller board. In addition, two solder pads are provided for control of accessories, such as subaudible tone decoder which are mounted in the repeater or even control of external devices.

## PACKING TO RESHIP.

Repeaters returned for alignment or repair often arrive with panel corners bent because the repeater was not blocked properly. Packages are handled on conveyors and often dropped from as high as arm level onto any edge or corner of the box.

Be sure to pad the whole perimeter of the repeater with foam or peanuts or crumpled newspaper, especially in the corners. Don't allow any surface of the equipment to come within 2 inches of the carton.

## INSTALLATION.

### General.

The REP-200 is designed to provide the ultimate in sensitivity and selectivity; however, any repeater is only as good as its installation. Much care should be taken in selecting a quality duplexer, antenna, coaxial cable, site, etc.

### Mounting.

The Repeater is built on a standard 19 inch rack panel. A matching cabinet is available from Hamtronics, or you can rack mount the repeater or set it on a desk.

### Antenna System.

Selecting a good antenna is critical for proper operation. Any good quality antenna can be used for repeater service, such as four pole, coaxial, and ground plane antennas.

The use of long, flexible antennas, such as a Ringo Ranger, is not recommended, since the mechanical joints of the antenna can loosen in the wind and cause problems when slight changes in impedance are magnified by the duplexer.

Antennas without a ground plane or dipole type construction are not recommended because rf on the shield of the coax can cause desense. The Cushcraft Four-Pole antennas are particularly good for repeaters because they are mechanically rigid and will take a lot of wind without

**TABLE 1. MINIMUM ANTENNA SEPARATION.**

Band	50MHz	144MHz	220MHz	440MHz
Vertical Separation	200'	50'	30'	20'
Horizontal Separation	2500'	800'	500'	250'

changing tuning or becoming intermittent.

Grounding is an important part of the antenna installation. In repeater service, an excellent grounding system is required, both for safety and for good performance.

Coaxial cable should be low-loss type, both to prevent loss of transmit power and to prevent degradation of the receive sensitivity. If a duplexer is used, double shielded coax, such as type RG-214/u, should be used between the repeater and the duplexer to prevent leakage to the receiver cable. From the duplexer to the antenna, standard cable can be used. If separate antennas are used, double shielded coax or hard line should be used, and the transmit and receive cables should be separated — routed up separate legs of the tower and separated in the drop to the building.

### Transmit/receive Isolation.

The minimum transmit to receive antenna isolation required by any repeater is 80 to 85 dB. This isolation can be obtained by using either separate antennas or a good bandpass/bandreject duplexer and a single antenna.

Many duplexers are not of sufficient quality; so choose one with care. To be avoided are the old-fashioned bandpass only or bandreject only type duplexers and the miniature mobile type duplexers used for car telephones. They just don't do the job well enough for repeaters.

When using a duplexer, be sure that the antenna VSWR is as low as possible. Any reflected power can cause desense in the repeater system. Duplexers are also sensitive to changes in VSWR, even when tuned properly. VSWR changes due to humidity, temperature, and wind damage are common problems with certain antennas. Such changes will cause the duplexer to become less effective during this temporary change. This explains why some repeater installations have random periods of desense while operating well other times.

Repeaters may also be operated using separate antennas for transmitter and receiver. In this way,

isolation is provided by vertical or horizontal separation.

Typical antenna separations for a 1/2 wave antenna are shown in Table 1. In

the case of vertically separated antennas, the distance should be measured from the top of the lower antenna to the bottom of the higher antenna. The ARRL Repeater Handbook should be consulted for further information.

Obviously, vertical separation is the easiest to obtain. Vertical separation takes advantage of the fact that a null occurs at the ends of the antennas. It is very important to mount the antennas directly in line with one another. For maximum range, the top one should be connected to the receiver.

### Connections To Terminals.

There are two types of terminals on the controller board for external connections.

The primary connections are made with push-on terminals. Checking the parts location diagram, you will note that there are pairs of terminals for the monitor speaker (J1-J2), dc power input (J3-J4), auxiliary receiver COS and audio (J5-J6), and phone line (J7-J8). There also is a single terminal for the alarm input (J9). The mating plugs for these terminals are supplied. They are installed on the wires by crimping the lugs over the stripped end of the wire.

Other connections for auxiliary control wires "CTCSS Defeat" and "Voice ID Trip" (E7 & E8) and RAM backup power (E12) are made by soldering wires directly to pads on the pc board. Since the holes are plated through the board, soldering can be done on the top of the board.

Wires for connections to the controller board should enter the repeater through the hole in the rear panel. The transmitter/controller compartment cover should be removed to expose the controller board. Route the wires neatly along the rear of the controller board and out through the channel provided between compartment shields for the transmitter and receiver.

### Power Supply.

Any good quality 13.6 Vdc power supply can be used with the REP-200. The power supply should be able to supply at least 6 Amp, regulated and free from ripple. An excellent DC

power supply is a car or boat battery with a floating battery charger. Not only is this a clean supply; it provides emergency power and backup power for the computer memory.

The power supply must provide the full 13.6 Vdc at the input of the repeater to obtain full rf output power. Any less voltage will cause a significant decrease in rf power. For this reason, heavy wires should be used to the power supply: at least #18 wire for short runs of a few feet, or heavier wire for longer runs.

Both negative and positive leads should be connected from the power supply to J3 and J4 on the Controller Board. Be sure to observe polarity.

Although the controller board has a transient suppression diode, care should be taken that the power supply has no transients, for instance, at turn on. Be careful on battery-operated systems that the charger does not put transients or heavy ripple on the power line. Also be sure that any inductive devices, such as relays, that operate on the same power source have transient-suppression reverse diodes connected directly across the coil.

A 6Amp or 7Amp fuse should be installed in line with the positive power lead unless you are using a power supply with current and short circuit limiting.

### RAM Backup Battery Power.

The microcomputer has variables in RAM memory which store various control parameters. When the computer boots, your default choices, which are burned into the EPROM, are transferred to RAM to be used during operation. Cw speed, cw tone, beep delay, tail time, and courtesy beep type can be changed by touch tone command, and the new settings are used as long as power is applied to RAM. All of the on-off functions operated by touch tone command are also controlled by flags stored in this memory.

There are provisions for you to supply an external 5V battery to backup the RAM power source, or you can provide uninterrupted dc power to the entire repeater or no backup power at all. If there is no backup power and power is lost to the RAM, then the microcomputer will reload the original default settings from EPROM when power is restored, and any settings made by touch tone to these five parameters will be lost. Any features which were turned on or off

by touch tone command will revert to your default settings in EPROM according to the questionnaire choices you make.

If you wish to power the backup RAM section of the microcomputer from a separate battery source, break the pc trace as indicated by "X" on the parts location diagram, and solder a wire for the backup battery to pc pad E12. The negative lead of the battery should be connected to ground at J1 or some other suitable place on the ground plane of the controller board. The RAM section of the microcomputer requires +5Vdc +/-5% (4.75 to 5.25V). The amount of current required is approximately 6 mA for the regular (NMOS) MC-6803P microcomputer.

Since 5V batteries are hard to find, you can use a 6V battery with a 1N4148 diode in series to drop the voltage to within the required 5.25V limit. If you do so, be sure to put a 0.1  $\mu$ F disc capacitor from the backup battery pad (E12) to ground to bypass any high frequency transients which may be generated by the microcomputer.

Note that the above backup arrangement is only good for the 6803 (NMOS) version of the microcontroller. In the 6303 (CMOS) version of the chip, which is provided if you order the low standby current option, the pin on the chip normally used for RAM backup power is used for another function instead. Therefore, if you wish to provide backup power for the RAM in a repeater with a 6303 microcontroller, it is necessary to do so for the entire chip instead of just the RAM section. Because the chip draws so little current to begin with, it is no problem to back up the entire chip with a battery.

To connect a battery to the 6303 chip, disconnect pin 7 of the chip from the 5V bus and reconnect it to your backup battery circuit instead. It is necessary to have an electrolytic capacitor of about 100  $\mu$ F from the power input (pin 7) of the microcontroller chip to ground.

### Autopatch Connections.

The autopatch circuits can be interfaced directly with any touch tone telephone line or, where required, can be interfaced through a protective interface device specified by phone company. For safety, the autopatch circuits are electrically isolated from any source of power on the board by a transformer and an optocoupler.

For lightning protection, the phone line should have a protector block where the phone line enters the building. This normally is provided by the phone company as a normal termination practice.

### Monitor Speaker.

To conserve space and allow a low profile chassis and panel design, the REP-200 has provision to drive a local 8-ohm speaker but has no built-in speaker. We do offer a low cost 3 x 5 oval speaker as an option if you want one, or you may use any speaker you happen to have with an impedance of 8 ohms or higher. Connect speaker at push-on terminals J1 and J2.

### Auxiliary Receiver.

Push-on terminals J5 and J6 provide COS and audio connections for an auxiliary receiver, either as a second input receiver or to cross-link two repeaters. Touch tone commands control when the receiver is active in the repeater.

The aux. receiver may also be used simply as a control link, a secondary channel on which to send touch tone commands for control of the repeater; in which case, the COS input is not required. This feature is always available if an aux. rcvr is connected.

The audio should be taken directly from the speaker output of the receiver at a nominal level of 1.5 V p-p for a signal with full deviation. The COS signal should be taken from the squelch circuit of the receiver, at a point which provides a positive dc voltage greater than 3V with the squelch open and close to ground with the squelch closed. The receiver ground should be connected to J1 on the controller board.

### Local Touch Tone Pad.

If you don't need to use auxiliary audio input J6 for an aux. receiver and you want to have a touch tone pad for local operation of the repeater or for testing, you can connect the output of a pad to J6 and ground (J1). Set the output level for about 1.5 V p-p or advance the output level just past the point at which the front panel TONES led illuminates for every digit of the pad.

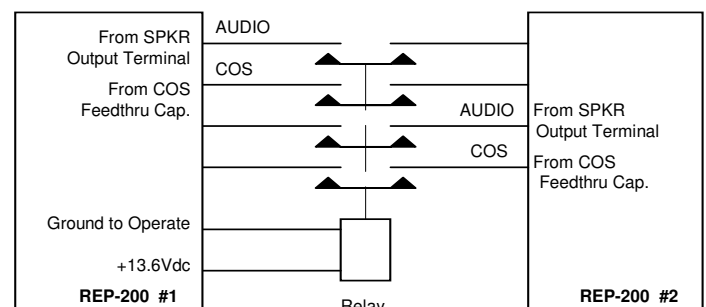
### Auxiliary Control Circuits.

Two control circuits are provided for interface with accessories. E7 and E8 provide open collector outputs which can sink up to 200 mA of positive dc current with a voltage up to 15Vdc. E7 can be turned on and off by touch tone command. It normally is used to defeat or enable the CTCSS (subaudible tone) decoder accessory (TD-3). It may also be used to turn any external circuit on and off if not dedicated to the CTCSS accessory. E8 is used for tripping the voice id module option (DVR-2). It applies a ground pulse to the DVR-2 whenever the controller determines that it is time to id. E8 may not be used for any other application.

### Alarm Circuit.

There are provisions to connect an external alarm circuit to the repeater at push-on terminal J9. This allows an external circuit to sound an alarm on the air if activated. The alarm circuit requires an external switch of some sort to momentarily pull the input down to ground to trip the alarm. If tripped in this way and the alarm is turned on, a wailing sound will be transmitted for a period of time. Thereafter, the courtesy beep is changed to a short wailing sound until the alarm circuit is reset by touch tone command.

The alarm function might be used to indicate a break in at the building or cabinet where the repeater is located. Another use might be to indicate when battery power is low in a solar powered installation or when a standby power system has taken over in place of a failed main power line from the power company. Any circuit which can pull a microprocessor input low can be used. For instance, a small signal transistor with an open collector output is suitable. It only needs to sink a few mA. Still another use would be to have a weather alert radio trip the alarm circuit whenever the NWS issues a severe weather warning.



## Linking 2 Repeaters.

The easiest way to link two repeaters is with the auxiliary receiver input feature. Connect the speaker audio output of the first repeater to the auxiliary receiver audio input of the second repeater and the cos output of the first repeater to the aux receiver cos input on the 2nd repeater. Then, to activate the connection between the repeaters, turn on the auxiliary receiver feature of both repeaters.

To allow a simple hookup like this requires that each repeater must be given the command to turn on the aux receiver feature. You may be able to turn them both on at once if the same command code is used for both repeaters and the audio with the touch tones is applied to both repeaters at once. The aux receiver audio is always connected to the dtmf decoder in the control board; it is disconnected by the aux receiver command only in regards to connection to the transmitter. Therefore, if the command tones to turn on the aux receiver appears on the audio line to the aux receiver input, it will activate the touch tone decoder even if the aux receiver feature is turned off.

If you want to be able to connect both directions of the link at once by a means other than the aux receiver command, the circuit shown below can be used with a small four pole relay controlled by a switch of some sort. For instance, if the auxiliary (CTCSS Defeat) output function is not needed to control a CTCSS (sub-audible tone) decoder module, then it may be used to control the relay. If control from either of two repeaters is required, the control lines of both repeaters can be tied in parallel so that if either one applies a ground, the link will be established.

## SYSTEM CHECKOUT.

After installation, you should 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. Check the transmitter power output and vswr into the antenna and into the duplexer.

b. Try the various tone codes to ensure that the repeater responds normally to control codes transmitted over the air. Refer to separate OPERATION instruction manual for operating procedures.

c. With telephone remote control function active, dial up phone line from an outside phone. Listen on the phone to hear the repeater receiver. Try various control functions, including transmit inhibit, with the proper DTMF digits sent from the telephone.

d. 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 OPERATION instruction manual for complete procedure.

## THEORY OF OPERATION.

### General.

Theory of operation of the transmitter and receiver modules is covered in their own separate instruction manuals. Following is a discussion of the COR-5 Controller Module organized by function.

Microcomputer controllers always look like there isn't much to them because most of the complexity is in the firmware inside the EPROM instead of in the hardware. For instance, even though the COR-5 Controller does much more than our earlier modules in terms of functions, it is only one board, yet it takes the place of four individual pc boards: cor, cwid, touch tone controller, and autopatch boards. In addition, it provides all the connections which were done by cable harness in our original REP-100 Repeater and adds refinements, such as fusing, reverse polarity protection, and much more.

Another factor which masks the true composition of the controller is the modern use of many surface mount capacitors under the board; if these were disc capacitors, the board would be 25% larger and there would be 21 additional components on the top of the board.

To give you a sense of the true value of the COR-5 Controller, consider the following facts. It took over a year of design and programming time to develop the controller. The firmware in the EPROM, in addition to holding your call letters, the default settings for various cor, tone generator, and touch tone functions, and the touch tone codes, holds over 1200 lines of

assembly language code, which takes up 29 printed pages. There are 14 I/O ports controlled by the microcomputer chip. There are 53 touch tone commands, each requiring its own programming. Over all, there are 84 major programming routines and there are well over 100 sub-routines. The simplicity of the hardware conceals the true complexity of the system and what it costs to develop. By far, the most costly part of such modern controllers is the software development and debugging.

### Microcomputer and DTMF Circuits.

Sheet 1 of the schematic illustrates the basic microcomputer and the various support circuits which are responsible for running the repeater.

The microcomputer chip is an MC-6803P (or with CMOS option, the HD-6303RP), which has four ports. Two of the ports, shown on the right hand side, are dedicated to the 16-bit address bus and the 8-bit data bus.

The 8-bit bus connected to pins 30-37 are multiplexed through U5 to allow operation as an address bus on part of the machine cycle and as a data bus on the other part of the cycle. When the microcomputer chip (hereinafter referred to as "the 6803") wants to present an address to the EPROM, it sets the address strobe on pin 39 high so that U5 accepts the address byte on its input lines and latches the address byte presented to the EPROM as bits A0-A7.

The EPROM uses 4K of addresses, 32K divided by 8 bits. Therefore, only 4 more address lines are needed for a total of a 12 bit address. These additional address lines, A8-A11 are connected directly from the lower port on the right side of the diagram to the EPROM. However, the actual addresses used in the 6803 for instructions in the EPROM are in the high end of the 64K range which the 6803 can address; so the A15 address bit is used through inverter U3 pins 4-6 to operate the chip enable of the EPROM. Thus, the EPROM responds only to addresses in the 4K range from hex F000 to FFFF.

In order to prevent bus contention, data from the EPROM to the 6803 is presented to the multiplexed 8-bit bus of the 6803 only when both the "chip enable" and "output enable" of the EPROM are activated. The output enable is activated only during that part of the 6803 machine cycle when the read/write line (pin 38) and the "e" line (pin 40) are high.

U2 notifies the 6803 whenever a valid touch tone code is present by pulsing the non-maskable interrupt on pin 4 of the 6803. When this happens, the 6803 stops whatever it is doing and captures the touch tone data before it ceases. Touch tone decoder chip U2 has a hexadecimal output, requiring four lines, which are multiplexed into the lower four bits of the 6803 data bus. This is done by using address line A14 of the 6803 to address the touch tone decoder when a reading is needed of the touch tone digit data. Gate U3/8-10 provides address decoding in conjunction with address lines A14 and A15, and gate U4/1-3 allows the touch tone decoder to be enabled only during the correct part of the 6803 machine cycle.

The touch tone decoder chip uses a standard 3.57595 MHz color burst crystal for timing. This oscillator signal is also used to operate the 6803, which has a divide by four circuit to provide the 6803 clock rate of 3.57595/4 or 0.89399 MHz.

There is a difference in the internal circuitry of the HD-6303RP CMOS version of the 6803 in the way that the oscillator/buffer for the clock is handled. This requires that pin 2 of the microcomputer be floating instead of grounded when the CMOS 6303 chip is used in place of the NMOS 6803. To do this, simply break off pin 2 on the 6303 before plugging the ic into the socket.

### Watchdog Timer Circuit.

The watchdog timer circuit is shown at the bottom of schematic sheet 2. The 6803 is initialized (booted) at turn-on by a ground pulse to reset line pin 6, and pin 6 is held high during normal operation. Any good microcomputer controller has a watchdog timer which automatically reboots the computer should it get out of sync for some reason and stop following the normal program. In this case, we perform this function simply with a few nor-gates.

U4/4-6 operates as a nor-gate, which allows either of two circuits to boot the 6803. The input at pin 5 is from a simple R-C network which gives a pulse when power is first applied. This is the circuit which boots the computer initially.

The leg of the circuit which feeds pin 6 is a watchdog circuit, which generates a reset pulse should the computer fail to cycle through the main program routine at least once every ten seconds. The 6803 applies

a ground pulse each time it cycles through the trigger routine in the program. This pulse stream is amplified by inverter U4/8-10 and used to charge capacitor C27, which keeps the signal at U4/11-12 high. Should the ground pulses from the 6803 cease, indicating that the computer has crashed, R29 slowly discharges C27.

After 10 seconds, the voltage crosses the threshold required to keep U4/11-12 turned on. U4 pin 13 then applies a +5V pulse to U4 pin 6, which acts as a one shot multivibrator to apply a ground pulse to the reset line on the 6803, thereby restarting it. CR5 is feedback for the multivibrator to completely discharge C27 once U4 pin 4 goes low, so the timer is reset to zero.

### Audio Circuits.

The circuitry at the top of schematic sheet 2 involves cos and audio input signals from the main and auxiliary receiver processed to provide audio outputs to the exciter and touch tone decoder chip and a COS signal to a port on the 6803.

The circuitry at the center of sheet 2 is the autopatch circuitry, including the ring detector, and the output circuitry for the tone synthesizer.

Although it make look confusing, all the audio circuits simply involve either LM-324 op amps or 4066 CMOS analog switches. One of the op amps and all of the 4066 switches are controlled by output ports of the 6803 to switch signals on and off at appropriate times as determined by the program.

At the upper right-hand corner of the diagram is shown the audio part of the touch tone decoder chip. The audio input basically is an op amp, with an internally generated reference voltage applied to the non-inverting input. This reference voltage also is used for some of the LM-324 op amp sections. R1 is a feedback resistor, and R3 and R4 are input resistors for two mixer input paths, one from the aux. receiver, and the second from the telephone line transformer. This second input leg also carries touch tones from the main receiver, since they are applied to the transformer through line driver U7/12-14. C8 and C9 are simple bypass capacitors. C34 and R40 form a timing circuit which establishes both the minimum length of a dtmf signal to be considered valid and the interdigit timing between valid digits.

The audio for the transmitter is processed through mixer U7/8-10 and applied to the exciter through R7, which works as a voltage divider in conjunction with the input resistance of the mic input on the exciter.

Audio for inverting mixer input U7 pin 9 can originate at any of four sources. The main receiver audio is switched on at appropriate times through a 4066 analog switch section. Repeat audio level pot R10 allows this level to be adjusted. The auxiliary receiver audio is switched by another analog switch section. The autopatch audio from the telephone is switched by yet another analog switch section.

The fourth source is the tone synthesizer in the 6803. Bit one on port 2 is used to synthesize the various tones which the 6803 generates. It is controlled by the firmware program and by an internal timer run from the microcomputer clock. When a tone is required, the 6803 generates a square wave of a particular frequency. This square wave signal is rounded to provide a quasi-sinewave signal by two section low pass filter R22/C23/R21/C22. Since the tone is synthesized only as required, no analog switch is required between this circuitry and the input of the audio mixer.

### COS Circuits.

The COS signals from the receivers must be near ground when the squelch is closed and between +3V and 15Vdc when the squelch is open. The COS signal is applied to the non-inverting input of op amp U7/1-3, which acts as a threshold detector so that a wide range of COS voltages can be accommodated, not necessarily compatible with microcomputer input port levels. The output of this op amp drives an input port of the 6803 and a driver to illuminate the RCV led on the front panel.

To allow for two isolated sources, diode or-gate CR1-CR2 is used in the input path to the op amp. The COS signal from the main receiver is applied directly to CR2, since the main receiver is always active. The COS from the aux. receiver is processed by another threshold detector, U7/5-7, the output of which is passed by analog switch U8/10-12 to CR1 only when the aux. receiver function is enabled by the owner.

### Autopatch Circuits.

The heart of the autopatch is its interface with the phone line. This is

done in separate circuits for ac and dc, with complete isolation between any operating voltages on the controller and the phone line for safety purposes. When the autopatch relay is enabled by the 6803, the phone line connection is completed. R18 provides a dc path to draw current and thereby seize the phone line. C18 couples the audio to isolation transformer T1. C19 and C20 are rf bypasses.

The audio path to and from the phone line is switched through op amp U7/12-14 and analog switch U8/3-5, respectively. During any condition except when the autopatch is turned on and the receiver squelch is open, audio is applied to T1 through line driver U7/12-14. This may be audio either from the receiver or audio from the tone synthesizer circuit, which is routed through the mixer. When the autopatch is activated and there is no COS signal from the receiver, then the line driver is muted and analog switch U8/3-5 routes the phone line audio to the transmitter through the audio mixer.

When the phone rings, the ac ringing voltage is detected by optocoupler U9, which provides phone line isolation. R25 and C25 at the collector of the optocoupler provides a time delay to filter out any transients on the phone line, which might otherwise trip the circuit, and requires the completion of one full ring cycle to activate. The collector voltage is applied to one port of the 6803, which polls this port pin each program cycle to check for ringing.

### Switching and LED Circuits.

Refer to the top of schematic sheet 3. Peripheral driver ic U10 contains 7 drivers, each one the equivalent of darlington pair of transistors with an open collector output. Each output also has a protection diode clamp referenced to the +13.6Vdc power bus.

The first section drives the TONES led as a function of the valid digit signal from the touch tone decoder ic. The second section keys the exciter as a function of a port bit of the 6803; with the output of the driver operating both the front panel XMIT led and a

power transistor which switches the operating power for the exciter when it is to be keyed. The third driver operates the autopatch relay and the PATCH led on the panel. CR6 is an additional transient protection diode. The fourth and fifth drivers operate the front panel RCV and TIME OUT led's.

The remaining two drivers switch external accessories and are called "CTCSS Defeat" and "Voice ID Trip". These outputs can sink up to 200 mA at voltages up to 15Vdc.

The alarm input is applied to an input port of the 6803, with pullup resistor R42 providing the current and C31 acting as an rf bypass.

### Power Supply Circuits.

Refer to the bottom of schematic sheet 3. Operating power for the repeater enters the controller board at J3-J4. A fuse in this path provides protection mainly for the traces on the pc board and fire protection. CR7 provides protection against reverse voltage transients. In the event that the actual power supply is connected to the repeater with reversed polarity, the diode may burn out before the fuse; so it should not be relied on in place of careful checking before power is applied.

Switched B+ is distributed to the receiver, exciter, pa, and crystal ovens through traces on the controller board terminating at E3 and E10. Switched B+ for the exciter is provided through transistor switch Q1, as discussed earlier. Voltage regulator U11 provides +5Vdc for the various ic's on the controller board. Each area of the board has its own decoupling beads and bypass capacitors.

## TROUBLESHOOTING.

### General.

Individual module instruction manuals provide much troubleshooting information in great detail. Once you suspect a particular function, refer to the manual for that module. Following is supplemental information for repeater system problems.

### Desense.

One of the problems which occurs frequently with repeater operation is desensitization. This is caused by the repeater transmitter interfering with the receiver and blocking it. Either excessive amounts of

transmitter carrier are getting into the front end of the receiver and overloading it, or sideband noise generated by the transmitter is getting into the receiver passband.

The most severe cases of desense will cause a cyclical chopping (continuous keying and unkeying) of the repeater. Less severe desense is indicated by a noisy receive signal only when the transmitter is turned on.

Desense is cured by increasing the amount of isolation between transmitter and receiver rf connectors. There are several different methods for increasing isolation: increasing antenna separation, using double shielded coax, adding band pass cavities, piezo-electric filters, or good duplexers. (To review requirements for antenna systems, refer to INSTALLATION section.)

In our experience in talking with customers, the most common problem seems to be use of inadequate duplexers. There are duplexers on the market which give 60-70 dB of isolation. This clearly is insufficient. The small "mobile" duplexers used in car telephones fall into this category. The old-fashioned bandpass-only or bandreject-only type duplexers are also inadequate for solid state repeaters. The receivers are so much more sensitive now that good bandpass/bandreject duplexers are required to allow the full potential to be realized.

The analysis in table 2 makes the need for a good duplexer obvious. It is clear from the calculations that any less than 80 dB isolation in a duplexer or dual antenna system will result in desense because the transmitter noise will be greater than the received signal. Actually, more than 80 dB isolation is needed because the noise must be below the received signal strength by a margin great enough so it won't be heard at all.

The above calculations assume that everything remains perfectly tuned. In actual practice, the antenna system and duplexer are certain to drift a bit from optimum tuning; so a little safety margin should be added. Also note that an additional dB of isolation will be required for each dB you increase the transmitter output if you add a high power amplifier to the repeater.

### Checking Repeater for Desense.

To ensure that the repeater has no

**Table 2. ANALYSIS OF REQUIRED DUPLEXER ISOLATION.**

Xmtr Power (approx. 15W)	+ 42 dBm
Typ. Xmtr Sideband Noise Suppression	- 85 dB
Noise Level at Rcvr Freq	= - 43 dBm
Subtract Rcvr Sensitivity Threshold (0.15uV)	-123 dBm
Minimum T/R Duplexer Isolation Required	= 80 dB

intrinsic desense, welded rf tight compartment shields are used, and feedthrough capacitors and ferrite beads are in line with all signal lines which could carry rf between compartments.

It is fairly easy to check out the Repeater so that, in your own mind, you know that any desense problem is external to the repeater.

With double-shielded coax, connect the receiver to a good signal generator, and connect the transmitter to a shielded dummy load. You can simulate a received signal with the signal generator and verify that there is no cross-talk in the repeater itself by checking the repeater sensitivity with the transmitter both on and off, using the transmit inhibit touch tone command. There should be no noticeable change in sensitivity with transmitter on or off.

### Intermod.

Intermodulation is indicated by the reception of an unwanted signal on the repeater receiver, one that clearly did not originate on the repeater frequency. Intermod can usually be identified by the type of conversations taking place. The intermod signal sometimes sounds distorted or off frequency. Another intermod characteristic is the presence of some signal which periodically causes the repeater to latch up. Intermod interference can be weak or strong, even to the point of covering up local wanted signals.

Intermod is caused by two strong signals mixing in a non-linear circuit producing a third interfering signal. The non-linear circuit could be a corroded antenna connector, the transmitter output stage, or the receiver front end.

The most common form of intermod is a strong signal doubling in the repeater receiver's mixer and mixing with a second signal to produce a product that is on or near the repeater receive frequency.

This interference is called third-order intermod. The relationship between its frequency and that of the unwanted signals forming it is  $F_{IM} = 2F_1 - F_2$  where  $F_1$  and  $F_2$  are the frequencies of the two signals.

Since the repeater transmitter usually is the strongest signal, it is more likely to double in the receiver mixer and cause a 3rd order intermod product with another strong in-band signal. This type of intermod is characterized by a signal on the

receiver after repeater key-up locks repeater up and stopping when transmitter is turned off. Note this intermod never keys repeater itself but only occurs after someone keys up the repeater.

Cure for this type of intermod can be increasing isolation between the transmitter and receiver. This could be accomplished by further separation of transmit and receive antennas, installing a better duplexer, or additional filtering in the receive line with a front-end crystal filter or a cavity.

Intermod also can be caused by two strong signals from nearby transmitters mixing in the repeater receiver mixer. With this type of interference, the signal will key up the repeater. The cure for this is adding a helical resonator, a bandpass cavity, or a crystal filter; or by using a bandpass/bandreject duplexer.

Intermod also can occur in a transmitter output stage. The output stage may be that of the repeater transmitter or a nearby transmitter. Usually, the frequency doubled is the transmitter's output frequency, which, together with an external signal picked up by the transmitter antenna, forms a 3rd order intermod product. The local signals causing the intermod need to be quite strong due to the lack of gain in the transmitter's output stage.

Since this intermod product is formed outside the receiver and is within the receive bandpass, it can't be filtered out in the receive antenna line. This type of interference can be eliminated by installing a circulator in the interfering transmitter's antenna line. A circulator allows power to pass in only one direction. This will prevent signals external to the transmitter from reaching its output stage.

Finding the cause of intermod can be a confusing, frustrating, and difficult job. The fact that intermod occurs is not necessarily the fault of the repeater. Every consideration has been given in design of the REP-200 Repeater for intermod and desense, e.g., helical resonators, 8-pole crystal filter, rf-tight compartment shields, feedthrough capacitors, etc. Remember, intermod is the result of two signals present in some non-linear device. The cure is simply to remove one of the interfering signals.

Other sources of information on repeaters and repeater problems is available from several ARRL

publications.

### Coax Cables.

High quality coaxial cable is an absolute requirement for proper repeater operation. For short runs, a good quality RG-8/u is suitable. Low-loss hardline is preferred for long runs or uhf frequencies. All antenna connections must be thoroughly waterproofed.

In installations with a duplexer, double shielded coax, such as RG-214/u, must be used between the repeater and the duplexer. Regular single shielded coax can be used from duplexer to antenna.

If separate antennas are used for receive and transmit, the cables should be separated throughout their run by 6 to 12 inches. Double shielded coax or hard line is required to prevent leakage from the transmit cable into the receive cable.

### Frequency Stability.

Because even at room temperature, the transmitter compartment changes temperature with use, we recommend the crystal oven option for any crystal controlled transmitter, especially on uhf or 900 MHz

### COR-5 Controller Module.

Having read the Theory of Operation, you have a good understanding of how the circuits work. The best way to troubleshoot is to trace signals from stage to stage to check the operation of each circuit, starting with the function you believe is not working properly.

Digital circuits have signal levels near ground for a lo logic level and near +5V for a hi logic level. On the schematic diagram, a bar over the function name at an ic indicates the active logic level is lo; if no bar, the active level is hi (majority of signals are active-hi).

Relative audio signal levels for full modulation are shown for the mixer circuit on the schematic diagram.

### Test Points.

There are a couple of handy test points which may not be obvious.

The long top lead of R25 is connected to the collector of the optocoupler in the autopatch circuits. You can connect a meter to that point to check if the ring detector is working, and you can short that point to ground to simulate a phone ring condition. However, note that a timer



in the computer prevents the phone ring signal from activating the corresponding reverse autopatch responses more than once within a few minutes; so it may be necessary to reboot the computer to repeatedly test the reverse autopatch functions.

Alarm input J9 can be simply shorted to ground to test the alarm circuit.

With a good scope, you can observe the addressing action of the computer by connecting a probe to pin 37 of the 6803, which is the least significant bit of the address bus. Be careful not to short to adjacent pins. The clock speed is close to 1 MHz; so you need to set the scope time base accordingly. You can observe changes in the addressing pattern with changes in operating conditions, such as opening the squelch. If the pattern doesn't change regardless of stimulus, the computer may not have booted properly or may have crashed for some reason.

Another method of checking to see if the computer is running properly is to check the watchdog timer circuit. Observe either the pulse train at bit 2 of port 2, on pin 10, of the 6803 or the dc timer voltage at pins 11-12 of J4 to see if the watchdog timer is being constantly reset by the microcomputer.

If the computer doesn't seem to be running, and the front panel TONES led doesn't respond to touch tone inputs, check the crystal oscillator with a scope at pin 3 of the 6803 to be sure it is running.

### **Current Drain.**

Current drain is relatively low in idle condition. With the transmitter off, the current drain for the receiver and controller, which are the only modules drawing current, should be about 260 mA (about 88 mA with the low power CMOS microcomputer and EPROM option). If you have a crystal oven(s), they require an additional 25-50 mA at idle and up to 400 mA when cold. With the transmitter on, current drain will be 3 to 4 Amp, depending on power level.

### **Fuse Circuit.**

Fuse F1 and crowbar diode CR7 provide limited protection against short circuits and negative transients. If a power supply with current foldback is used, the diode may even prevent damage if the power supply is connected backwards. And the diode can absorb many reverse voltage transients. It is always a risk, but if a

short circuit occurs, hopefully, the fuse will blow before any damage to the wiring or pc board occurs.

If it is necessary to change the fuse, unsolder the old one from the top of the board, and replace it with a new 7 amp type GJV pigtail fuse. If you can't find one, you can solder your own leads to the end of a regular type AGC plug-in fuse.

## **MAINTENANCE.**

**CAUTION!** Do not operate the transmitter without a 50 ohm load or antenna connected. PA damage may result. The transmitter is keyed whenever the receiver squelch is open.

### **Handling IC's.**

Note that most of the ic's are static sensitive. The warranty does not cover static damage; so handle them with care. A grounded wrist strap should be worn whenever cmos parts are handled. Even after assembly, it is possible to damage cmos parts if static builds up from walking or sliding a chair on a carpet, etc. Always use precautions when handling a board with cmos parts.

### **Replacement EPROM.**

The EPROM is light sensitive. Excessive exposure to sunlight or even strong room light eventually may erase the chip. Normally it is not necessary because of the cover on the compartment; but if you expect the chip to be exposed to strong light for many days, cover the window on the EPROM with a sticker of some sort.

If you want to change call letters, touch tone codes, or default parameters, we can burn a new EPROM for you. The cost is \$20, plus shipping. Please enclose a completed questionnaire like the one you filled out when you ordered your repeater. Also, please specify the name and zip code used when you ordered the repeater, since we only support registered owners and we need to find your original records on the computer. Should you transfer ownership of the repeater at any time, please contact us to change registration to the new owner.

### **Yearly Checkup.**

About once each year, you should check several things on the repeater.

The transmit and receive frequencies should be recalibrated, since all crystals age a little. Refer to receiver and exciter manuals for procedures. Use an accurate service monitor or

signal generator and frequency counter.

The vswr and power output should be checked both at the input to the duplexer and at the antenna to be sure that the antenna system is in good condition. Since antennas typically are subjected to weather conditions and flexing from wind, it is a good idea to inspect the antenna and tighten any loose joints. Also inspect any weatherproofing on coax connections.

### **Exciter & PA Tuning.**

The exciter and power amplifier both must be aligned properly both to prevent desense and to protect the transistors from damage. (See "Before you turn on power..." section on page 1.)

The exciter and pa should each be carefully tuned into a 50 ohm dummy load, using exact procedure defined in manuals for those modules.

### **Power Level.**

Rf output level must be set according to the procedure in the power amplifier module manual. It is important not to overdrive the pa, but to operate at the level recommended in the instructions so you can operate continuously without overheating.

On the other hand, it is not necessarily better to underdrive the pa by a substantial amount, because class C amplifiers always run cleanest when driven to full power. If you reduce drive too much, the base-emitter junction of the pa transistor is not fully turned on, and spurious outputs can result. The optimum drive level usually is about 10% less than full saturation; stress is considerably reduced while the transistor is turned on well enough to run clean.

When properly adjusted, the power output should not sag appreciably after the transmitter has been on for a few minutes. Power sag of more than about 2 Watts indicates overdrive, improper heatsinking, or a bad antenna system.

### **COR and CWID Adjustments.**

Various timers and tone frequencies for the COR and CWID and courtesy beep functions are may be set by touch tone command, with defaults established by data burned into the EPROM at the factory. Refer to the separate OPERATION instruction manual for details.

## Audio Adjustments.

There are only two adjustment pots on the COR-5 Controller Board: repeat audio pot R10 and tone level pot R20. The repeater has been designed to minimize the number of adjustments, and all audio adjustments are done simply with the mic gain and deviation limiter controls on the exciter and the two pots on the controller.

a. Use a service monitor or some other method of monitoring transmitter deviation.

b. Set repeat audio pot R10 on the controller fully clockwise, and set mic gain pot in exciter fully clockwise. With loud modulation on the receiver, adjust the deviation limiter pot in the exciter for hard limiting at about 5.5 kHz deviation. The result of this procedure is to set up the deviation limiter so that it doesn't limit on normal receiver audio but it will limit if telephone audio exceeds 5 kHz deviation.

c. Activate the autopatch. Adjust the mic gain pot in the exciter for full deviation with dial tone audio. Then, call someone and have the person speak first softly and then very loudly into the telephone. The deviation limiter should clip the audio at not much more than 5 kHz deviation with the loud audio, and the soft audio should be easy to hear. If necessary, turn up the mic gain pot to make the telephone audio louder, but check again to be sure the limiter clips the audio at about 5.5 kHz deviation with dial tone or very loud audio from the phone line. Turn off autopatch.

d. Apply a signal to the receiver with 1000 Hz tone at 3 kHz deviation, and adjust repeat audio pot R10 on the controller for 3 kHz deviation on the transmitter. This establishes the repeat audio level relative to the settings already done for the autopatch.

e. Set the deviation of the cwid and courtesy beep tones to 3 kHz, or whatever level you prefer, by setting tone level pot R20 on the controller. The Test Tone 1000 Hz touch tone command is handy for this operation; it provides a ten second tone for alignment purposes.

f. This completes the adjustments. If any future changes are made, remember that the deviation limiter pot in the exciter is set to limit loud audio from the autopatch, the mic gain pot in the exciter is used to set the autopatch gain, and the repeat audio and tone level pots on the controller

are used to set normal repeat audio levels. Any change to the pots in the exciter require that the pots on the controller be reset afterwards.

## FCC INFORMATION.

This device has also 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.

1. This equipment complies with part 68 of the FCC rules. A label is provided on the rear of the repeater chassis. This label contains the FCC registration number and ringer equivalence number (REN). If requested, this information must be provided to 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. 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 the telephone interface circuits, 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.

## OPERATION.

### GENERAL.

Operation of the REP-200 Repeater is fairly typical of what you would expect. However, because of the number of control functions, there is a considerable amount of material to be read in order to understand the whole system. In order to make it easier to visualize what is involved and to find information later for reference, information is presented in small sections in the order in which you would be likely to need it. First, simple repeat operation is explained, followed by how to perform touch tone commands, autopatch operation, and finally, descriptions of each of the other operating functions available to the owner.

If you have any difficulty, please re-read the section(s) which describe the mode of operation involved. There may be things about using that mode which you don't fully understand yet. Also, refer to the computer-generated Repeater Programming sheet we sent with your repeater to list parameters and command codes you specified when you ordered your repeater. If you still have problems, please give our engineering department a call, and we'll try to explain it further or see if there is a problem.

At the end of this manual, there are discussions of owner registration, obtaining a reprogrammed EPROM, and what to do if you have ideas on future features and refinements.

### TURN ON.

Be sure to read the entire Installation And Maintenance manual before attempting to power up the repeater. Otherwise, damage may occur. When you first turn on the POWER switch, the repeater will initialize the computer to use all of the default parameters for the cor, cwid, and courtesy beep, and all the default feature settings you selected on your Programming Questionnaire. The POWER led should illuminate.

Before operating for any extended length of time, be sure to check the power output of the transmitter and the vswr going into the duplexer and the antenna system. If the power

output is less than it should be, check the tuning of the power amplifier in the repeater to be sure it is properly peaked with the load impedance your antenna system presents. Refer to the instruction manual for the power amplifier for proper procedure. Operation with a detuned amplifier or a mistuned duplexer could cause damage to the pa.

## **FRONT PANEL CONTROLS AND INDICATORS.**

The front panel is fairly simple.

The POWER switch turns on the +13.6Vdc operating power, and the led indicates when power is applied.

The RCV led indicates when the squelch is open.

The XMIT led indicates when the transmitter is on the air.

The TONES led indicates when a valid touch tone signal is being received and decoded.

The PATCH led indicates when the autopatch is activated to make a phone call (not reverse autopatch).

The TIMEOUT led illuminates when the transmitter cannot be keyed because the receiver squelch was on longer than the limit and the time-out timer has inhibited further transmission. The TIMEOUT led blinks if the transmitter is inhibited intentionally by the owner with the transmit inhibit touch tone command.

The SQUELCH control sets the level of carrier which will activate the repeater. Note that the squelch circuit has hysteresis, which means that the squelch requires greater signal strength to open than to close. This minimizes cycling of the repeater due to fluttering mobile stations or desense. For this reason, you will notice a significant difference in SQUELCH control settings to open and close the squelch. Because the squelch is so sensitive, the actual amount of hysteresis in signal strength is only a few dB, not as much of a difference as you would guess from the amount of rotation of the knob. The further clockwise you set it, the tighter the squelch will be and the shorter the noise burst will be when the squelch closes.

The MONITOR VOLUME control sets the level of audio to the external monitor speaker if one is used. To conserve space and allow a low profile chassis and panel design, the REP-200 has provision to drive a local 8-ohm speaker but has no built-in speaker. We offer a low cost 3 x 5 oval speaker as an option if you don't

already have one. There are push-on terminals on the controller board for connection of this speaker. Refer to the Installation and Maintenance manual for more information.

There are many features which can be turned on and off and many parameter settings which can be done by touch tone command and require no front panel controls. These will be explained later. Note that it is possible to connect an external touch tone pad to the repeater for local control if you find it easier than using your mobile or portable radio to make settings. Refer to the Installation and Maintenance manual for more information.

## **REPEAT MODE.**

### **COR Operation.**

When the receiver squelch opens, the transmitter is keyed. When the squelch closes, the cor circuit waits for a short period to see if anyone wants to break in; if not, the courtesy beep sounds, and the time-out timer is reset. If no user captures the receiver after the courtesy beep, the cor circuit waits for a predetermined time (tail), and then it shuts off the transmitter.

### **Time-out Timer.**

If the squelch remains open for more than 3 minutes (or whatever other time-out period you chose in the Questionnaire), or if users do not wait for the courtesy beep to announce that the timer is reset (at least once in three minutes), the time-out timer shuts the transmitter down until the squelch closes, and then the timer is reset. This is to prevent a runaway transmitter condition in the presence of interference of some sort.

Just before the transmitter shuts down, the cwid sends one long warning tone followed by "T O" in morse code.

To reset the time-out timer, the squelch must close for at least 3 seconds. When the time-out condition is cleared, the computer turns the carrier back on and sends an "OK" in cw to let you know the repeater is back in service.

### **CWID Operation.**

The cwid is polite; so it is heard only after the squelch closes and the courtesy beep delay occurs to allow for break-ins. It is triggered in this way the first time there is repeater activity after an extended period and every 9 minutes after that (or

whatever period was selected on the Questionnaire) as long as there is repeater activity.

If the DVR-2 Digital Voice Recorder Module has been installed, the repeater can id either in cw or with a recorded voice message. The Voice ID on/off setting done by touch tone command and the corresponding default setting in the eeprom programmed at the factory determines whether the id will be in voice or cw when it occurs. Consult separate manual for the DVR-2 for details of operation of the voice id option.

## **Changing Settings.**

The various cor, cwid, and courtesy beep time, speed, and tone settings were initialized according to selections you made on your Programming Questionnaire. Refer to computer-generated Repeater Programming sheet we sent with your repeater for any questions you may have about these parameters. Many of the settings can be changed by touch tone commands. This will be covered in detail later.

## **USING DTMF COMMANDS.**

### **General.**

Refer to your copy of the computer-generated Repeater Programming sheet we sent with your repeater during the following discussions. It will help to visualize all the functions and what your codes are.

The control parameters tell you which functions are programmed to default in the "on" condition when power is turned on. The micro-computer has variables in RAM memory which store these control parameters. When the computer boots, the default choices you make, which are burned into the EPROM, are transferred to RAM to be used during operation. Cw speed, cw tone, beep delay, tail time, and courtesy beep type can be changed by touch tone command, and the new settings are used as long as power is applied to RAM. All of the on/off functions can also be operated by touch tone command. (Note that cwid interval and transmit timeout period are fixed constants which cannot be changed by touch tone control.)

There are provisions for you to supply an external 5V battery to backup the RAM power source, or you can provide uninterrupted dc power to the entire repeater or no backup power at all.

If there is no backup power and power is lost to the RAM, then the microcomputer will reload the original default settings from EPROM when power is restored. Any settings made by touch tone to these five parameters will be lost, and any features which were turned on or off by touch tone command will revert to your default settings in EPROM according to the questionnaire choices you made.

### How to Enter Commands.

At present, there are 58 touch tone commands which may be used to operate the repeater remotely. These are listed on computer-generated Repeater Programming sheet.

Each command consists of four digits. The first three digits may be any combination of numbers or letters on a 16-digit touch tone pad, but not "\*" or "#". The last digit must be a "\*" or "#".

The commands are usually in pairs, with the first three digits indicating the type of function, and the fourth digit, a "\*" or "#", specifying one of two decisions: on or off, enable or disable, higher or lower, or some other such binary decision. No function can be performed without ending with either "\*" or "#", which acts as a sort of an "ENTER" key.

You have chosen the first three digits of some of the commands to make them unique. All commands must have four digits, counting the "\*" or "#".

The TONES led indicates when a valid touch tone signal is being received and decoded. If someone sends a touch tone command and the TONES led does not illuminate, it may be due to insufficient tone level, distortion due to clipping or over deviation in his transmitter, off-frequency tone encoder, or excessive twist (difference in level between high and low tones).

When you transmit a touch tone command to the repeater, the digits are immediately stored in memory in the microcomputer. Then, as soon as the computer has time available, it analyzes the digits you sent.

Note that the computer will not accept any new commands until it finishes analyzing the previous one you sent and finishes the rest of a complete program cycle which involves many other aspects of repeater operation. This normally takes 2 to 3 seconds. If you try to send a command before then, the computer will ignore it because the

input buffer is still loaded with the prior command. If this happens, simply wait a few seconds and resend the command.

The computer automatically mutes the audio from the main receiver whenever it detects the presence of a touch tone signal. Only a few milliseconds of the first digit can be heard on the repeater, and the receiver remains muted until the computer checks out the digits received and clears its memory buffer. This can sometimes give you an audible clue as to when the computer is ready for another command; since the background noise may change slightly when the receiver audio input is unmuted at the end of the touch tone command analysis.

This touch tone muting may be defeated, however, either by manual command of the owner or by the default setting of the TT Mute feature programmed into the eeprom at the factory.

Users should get in a habit of releasing their push to talk switch immediately after sending a touch tone command. The repeater will send a cw "R" (di-dah-dit) to acknowledge (roger) a valid command, and the user will hear the acknowledgment only if his transceiver is in receive mode at the time. It only takes the computer about a second to analyze a command and acknowledge; so you won't hear the "R" if you hold the mic button very long after the last touch tone digit is sent.

### What The Computer Does After Each Command.

First, the computer stores the command in a four-digit buffer in memory. If you send more than four digits, it truncates (disregards) any extra digits and accepts only the first four. If you send fewer than four digits, it does not process the command unless there is a "\*" or "#". If the computer does not receive a complete command within three seconds, it clears the buffer and goes on about its business doing other things until another command is received.

When the fourth digit of a series or a "\*" or "#" is recorded, the computer decides that this may be a valid command; so it compares the digits in the buffer with a look-up table to see if it is a valid command and if the command is allowed by the owner at this time. This table is burned into the EPROM from the codes you put on the Questionnaire, and it appears in

the same order as on the Questionnaire. (The reason for the order used in the Questionnaire is that frequently-used commands appear first and therefore are found quicker by the computer when it checks each command.)

If the computer finds that the command matches one in the table, and that command is currently allowed by the owner, the repeater generates an acknowledgment on the air in the form of a cwid "R" (for "roger"). It then performs whatever routine is programmed for that command, depending on whether the last digit was "\*" or "#". If no matches are found or the command is not currently allowed by the owner, then the computer simply clears the input buffer and goes on about its business.

### Owner Password.

The owner command is the password required before owner-only commands may be executed, which is all commands listed from owner command down. (Refer to computer-generated Repeater Programming sheet we sent with your repeater.) To perform any one of those functions, the owner must enable owner control mode by sending the owner command password, which is three digits plus "\*".

If someone tries to send one of owner-only commands without having the password, the repeater won't even acknowledge that it is a valid code, even though it is listed in the look-up table. When the computer analyzes commands received by looking up codes in the table, it quits after comparing the third listing in the table unless the password is in effect.

Don't even trust your mother with this secret password! Secrets have a way of getting around, and the only way to rectify the situation is to have us make a new EPROM for you.

Before you decide it is a good idea for someone else in your repeater group to have the password just in case, decide if you think he/she will still be a trusted friend a year or two from now.

Once you send the owner password, you have access to all the commands normally used to turn features on and off, change cor/cwid parameters, or do testing. Access to these functions remains in effect until you disable access by sending the corresponding command, which ends with "#", or the cwid occurs, at which time the computer automatically dis-

ables owner access in case you forget. You don't need to keep resending the password before each command; you only need to repeat it if the cwid occurs during your session.

### **User Commands.**

The full four-digit (closed-access) Autopatch code, Touch Tone Repeater Access code, and Record Voice Message code should be codes you give out only to users you select. These and Playback Voice Message are the only user commands. ("\*" and "#" as single digit codes are also valid user commands if you enable open-access autopatch mode). The Autopatch function allows a user to bring up or knock down the autopatch. The Touch Tone Repeater Access function allows a user to access or close down the repeater by touch tone command if you turn on this "closed access repeater" feature. More details are given later on voice messages.

## **AUTOPATCH OPERATION.**

### **Autopatch Modes.**

This section of the manual deals with making telephone calls from a mobile or portable transceiver. It is assumed that the radio has a touch tone microphone or a touch tone pad on the radio.

There are two basic modes of operation for outgoing autopatch activation. The normal (closed access) mode of operation requires that the user know a four-digit code to bring up the autopatch. This code consists of three digits and a star (\*). To turn off the autopatch, the user sends the same three digits, but ends with a pound sign (#).

The second mode (open access) may be used only if the owner activates it. This requires only a star to bring up the patch and a pound sign to knock it down. To use this mode, the owner must enter his password and then the code to turn on open access autopatch.

### **Making Phone Calls.**

To make a phone call from a mobile or portable transceiver, 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.

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 3 seconds, or the decoder circuit resets and you must start over.

After bringing up the patch, release the transmitter keyline immediately, 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 her merely by pressing push-to-talk button when it is your turn to speak. Be sure to inform the party you call that s/he is on the air, and explain any rules you think s/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 repeater carrier remains on for the duration of the phone call. When the repeater squelch is open, the repeater transmits audio from the mobile or portable station. When the squelch is closed, the repeater transmits audio from the phone line.

The Autopatch will stay up until you release it by sending the required command. When you hear a courtesy beep and then the repeater carrier drops, you know you have successfully knocked down the patch.

### **Pulse-Dial Option.**

In addition to the two basic modes of autopatch operation, the REP-200 Repeater allows a third mode of autopatch operation, which redials the phone number you enter by pulsing the phone line (rotary dialing). You may wish to use the pulse-dial option because you do not have touch-tone service on your telephone line, or because some mobiles have dtmf tones which are not of sufficient quality to work on the public telephone system, or because the user prefers to bring up the autopatch and dial the desired number all in one step without stopping to wait for the dial

tone.

To place a call with pulse dialing, activate the autopatch by entering the normal four digit command, except enter the telephone number to be called before entering the "\*" at the end of the command.

For example, if the command to bring up the autopatch is "001\*", enter "001", followed by the phone number, and finally enter the "\*". It is important to remember to enter the "\*" last, since it is a special character which tells the repeater controller to carry out the command. Enter only the first three digits of the normal command before entering the phone number, and don't forget to enter the "\*" at the end.

Note that pulse-dial option will not operate with a simple "\*" command to bring up the patch, even if the open-access autopatch option is activated. It will only work with the full autopatch command code.

The buffer memory area which records the phone number in the micro-controller allows up to 12 digits in the phone number in addition to the three digits and the "\*" required to bring up the autopatch.

In order for the user to be able to use pulse dialing, the Pulse Dial option must be enabled, either as a default in the eeprom burned at the factory, or as a separate touch tone command entered by the owner. If the Pulse Dial option is turned on, the user may use either tone or pulse dialing as s/he wishes for any given phone call. If the Pulse Dial option is turned off, the repeater will not allow the user to make calls in that manner.

### **Time-out Timer.**

The repeater time-out timer is reset to 3 minutes (whatever time-out period you chose in the Questionnaire), each time the squelch opens. Therefore, there is no danger of timing out as long as the repeater user continues to key and unkey his transceiver periodically during the phone call.

Should the user drive out of range or forget to turn off the patch, the computer will know that the phone line is out of control by the lack of squelch activity, and so it will shut down the carrier and turn off the autopatch. Just before the transmitter shuts down, the cwid sends one long warning tone followed by "T O" in morse code.

The repeater will reset the time-out timer automatically after the phone

line is disconnected if the squelch is closed for longer than 3 seconds. Then, normal operation can resume. When the time-out condition is cleared, the computer turns the carrier back on and sends an "OK" in cw to let you know the repeater is back in service.

Note that the repeater touch tone decoder will not respond to valid touch tone commands if there is a loud tone on the telephone. It has circuitry which prevents falsing, one aspect of which is to ignore inputs if other tones are present other than touch tone frequencies or if more than two valid frequencies are present. Therefore, if you should happen to dial up a phone line which has a loud tone on it, you may lose control of the phone line and not be able to turn off the patch.

For example, most phone companies have test lines with a 1000 Hz tone at a standard level used to test telephone circuits in the field. If you should happen to dial this line (as we do to test repeaters), you will not be able to turn off the patch again.

The solution to this is simple. Just don't key your microphone for three minutes and let the time-out timer kill the patch automatically. Be sure not to key your microphone at all during this time-out period because any squelch activity on the repeater receiver resets the time-out timer for another three minutes.

### **Toll Call Restrictor.**

The owner also has the ability to determine whether or not to allow toll calls on the repeater. Unless he specifically activates the toll call allow function with a touch tone command using his password or had the repeater programmed when made to default in the toll call allow mode, then the computer in the repeater automatically disconnects the phone line if a user dials a "0" or "1" or any other restricted digit as the first digit of a phone call.

The autopatch can be programmed, when we burn the eprom, to restrict certain up to four different numbers from being used as the first digit of a phone number. The default is to restrict 0 and 1 to prevent long distance calls from being made. These cannot be changed by touch tone command, but the owner can turn toll restrict on and off.

Another common type of phone call which costs money is "411" information calls. Our microcontroller

is programmed such that if you specify "4" as a restricted digit, the autopatch only prevents calls starting with "411". Any exchange with different second or third digits would be allowed, for example "425", so that you don't need to exclude all exchanges starting with "4" just to exclude "411" calls.

### **REVERSE AUTOPATCH.**

#### **Telephone Remote Control.**

If this feature is turned on by the owner, anyone with the proper phone number and touch tone codes can call into the autopatch line from any telephone and receive access for two minutes, 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 shutdown.

During the two minute period, the person on the phone also has access to the touch tone decoder in the controller; so he can punch in tones to turn the transmit inhibit on or off, bring up the autopatch if desired, or perform any of the other touch tone functions. When he is done, he can send the touch tone command for autopatch off to disconnect the phone line or simply wait until the repeater automatically disconnects in two minutes.

Note that the two minute timer also prevents a recurring ring from reactivating the auto-answer function within two minutes of the original phone call. This prevents someone who may have called accidentally from getting repeated access to the repeater. If you want to test the ring detector for some reason and don't want to wait two minutes between each test, you can reboot the computer to reset the timer. This can be done by touch tone command or simply by turning power off and on.

Note that the telephone remote control command and the ringtone option command toggle each other. Since they cannot both be active, if you turn one on, the other is automatically turned off by the computer.

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, s/he may be required to hold a valid license.

### **Ringtone Option.**

This option may be activated by the owner instead of the telephone remote control option. If so, any incoming telephone call will cause a ringing signal on the repeater for up to ten ring cycles. This is not the same ringing tone you would hear on the phone; it is a ringing signal synthesized by the computer.

If a repeater user wishes to answer the call, s/he should key the transceiver and send the normal autopatch on command. S/he can then talk to the calling party the same as if s/he had initiated the phone call.

If no one answers the incoming phone call, the ringing on the air will cease after ten ring cycles, no matter how long the calling party lets the phone ring.

Note that the repeater computer prevents a recurring ring from reactivating the ringtone function within two minutes of the original phone call. This prevents someone who may have called accidentally from repeatedly generating a ringing signal on the air.

Note that the telephone remote control command and the ringtone option command toggle each other. Since they cannot both be active, if you turn one on, the other is automatically turned off by the computer.

### **USER ACCESS CONTROLS.**

#### **Transmit Inhibit.**

Transmit inhibit disables the transmitter so no one can use the repeater. When this is turned on, the TIMEOUT led on the front panel flashes. This function is useful if someone has been abusing the repeater or you have had interference of some type and you want to temporarily prevent anyone from transmitting through the repeater. It also is handy during maintenance if you want to work on the receiver and prevent the transmitter from keying.

#### **Kerchunk Filter.**

The kerchunk filter may be used if you have had trouble with some lid continually keying his radio to see if the repeater will key up.

If you turn on this function, the repeater transmitter will not key up the first time after a period of inactivity unless the user holds his mic keyed for at least one full second. From then on, the repeater will respond normally until the repeater has not been used for several minutes, at

which point it again requires a one second carrier for the repeater transmitter to respond.

Note that the kerchunk filter option and the Touch Tone Repeater Access option cannot both be on at the same time. For this reason, if you turn one on, the other is automatically turned off by the computer.

### **Touch Tone Repeater Access.**

The touch tone repeater access option is similar to the kerchunk filter except that a touch tone command is required to break the silence of the repeater after a period of inactivity. It is used in circumstances where you want a totally closed repeater, with the access codes given only to desired users. You can think of it as a "closed access" repeater mode.

To put this mode into effect, the owner must use his password and then send the Touch Tone Repeater Access Mode on command. Thereafter, users must send a four-digit Touch Tone Repeater Access Open command to initiate a repeater session. Then, operation is similar to that described for the kerchunk filter option. If the repeater is not used for several minutes, it once again closes until the Touch Tone Repeater Access Open command is sent again. Or, if preferred, the user can send the Touch Tone Repeater Access Close command to close access immediately.

### **User TT Control Inhibit.**

The user controls INHIBIT function allows the owner to prevent users from using commands they normally are allowed: i.e., autopatch on/off and Touch Tone Repeater Access open/close, which are the only commands allowed to general users. The user controls ALLOW command restores normal control. Both commands require the owner enable command (password) to have been sent first.

The user controls INHIBIT function still allows normal repeater operation but disables touch tone control for the user, including use of the autopatch. If you want to deny complete use of the repeater, use this command in conjunction with the transmit inhibit command, in effect turning off the repeater by remote control without physically turning off the POWER switch.

Note: When you send the user controls inhibit command, the computer immediately disables the owner enable function (password) as

well, since it is assumed you want this feature to go into effect immediately. Otherwise, users would still be able to access features until you (or the computer at cwid time) happened to disable access to all the owner commands. Therefore, if you decide to do other owner-only commands after you give a user controls inhibit command, you must enable the owner password again and remember to disable it when you end your control session.

### **DIGITAL VOICE RECORDER.**

The following information applies only to the REP-200T Repeater, which has a DVR-3 Digital Voice Recorder Module. With this option, you can record voice messages and have them playback either as a periodical voice id, as an announcement which users can request, or both.

Any user can record or playback messages. Owner's password is not required; so do not give out the record command code to anyone you don't trust.

### **Making a Recording.**

The audio for the recording is taken from the receiver; so the microphone on a mobile radio or handie talkie is used to make the recording. To record a message, send the dtmf command for the Record Voice Msg function, which usually is "099\*". Allow time for the command to be acknowledged. Then, key the microphone and recite the message. Allow about a second of silence after the message, and then unkey your microphone. It is that simple.

You can unkey the mic as soon as you send the Record Voice Msg command, in order to hear the 'R' acknowledgment, and then rekey the mic to make the recording. Or you can simply keep the mic keyed and allow enough time for the controller to recognize and carry out your command. The former method is preferred, because it allows you to know for sure that the command was received and allows you to know precisely when the recording begins — when you rekey.

Be sure to allow a second or two after pressing ptt switch before speaking, and allow about 1 second after the end of your message before releasing the switch. This will allow for smooth transition between carrier turn on and playback of the actual message. Total recording time is 20 seconds.

When you send the Record Voice Msg command, the yellow TimeOut led will illuminate to indicate the DVR-3 is ready to record. This led is used for convenience; it does not mean the time out timer had been triggered.

### **Enabling Voice ID Operation.**

To allow automatic voice id to occur, the Voice ID option must be enabled on the COR-5 control board, either by sending the appropriate dtmf command (usually "302\*") or by having that option default on by eeprom programming.

### **Playback by DTMF Request.**

Any repeater user can request message playback by sending the Playback Voice Msg command, usually "003\*". You can use the command for testing, as well. You can make prerecorded messages available for call up by club members, for instance.

### **AUXILIARY RECEIVER.**

The controller board has provisions to connect an auxiliary receiver, which can be used simply as a control receiver to allow touch tone commands to be applied to the controller on an alternate frequency, perhaps on another band.

The aux. receiver can also be used as a second input for the repeater itself, either as a link from another receive site or to link two repeaters together. In such a case, the receiver remains simply a control receiver, always having access to the touch tone decoder, unless the auxiliary receiver ON command is sent, at which time the receiver is connected to the main repeater audio and COS circuits. The aux. receiver will then perform generally the same as the main receiver, except that touch tones are not muted on the transmitter as they are when received on the main receiver.

To disable the repeater audio and COS link with the aux. receiver, send the auxiliary receiver OFF command. Then, the aux. receiver reverts to being simply a control receiver, having access to the touch tone decoder in the controller but not the transmitter.

### **ALARM FEATURE.**

There are provisions to connect an external alarm circuit to the repeater. (See Installation and Maintenance Manual for details.) This allows an external circuit to sound an alarm on

the air if activated. The alarm function might be used to indicate a break in at the building or cabinet where the repeater is located. Another use might be to indicate when battery power is low in a solar powered installation. And some repeater owners connect the alarm circuit to a weather radio so the alarm is heard on the air if the NWS has issued a severe weather warning.

If tripped in this way and the alarm is turned on, a wailing sound will be transmitted for about ten seconds. Thereafter, the courtesy beep is changed to a short wailing sound until the alarm circuit is reset by touch tone command.

To activate the alarm feature, you must send the owner enable command (password) followed by the alarm ON command. To disable the alarm completely, use the alarm OFF command. If the alarm has been tripped, you can restore the normal courtesy beep with the alarm RESET command. If you want to be sure the alarm is definitely set, you can use the alarm TEST command to trip it remotely. All these commands require the owner password.

It is recommended that you not be tempted to reveal your owner password to someone just to let them reset the alarm in case it is tripped. There is no harm done in leaving the courtesy beep in the alarm condition until you have a chance to discover that the alarm has been tripped and reset it yourself.

The alarm circuit has a memory of sorts. Once the alarm has sounded, it will not sound again until after it is reset. However, if the alarm is tripped more than once, it will sound again immediately after you reset it. If this occurs, simply reset it again. The second reset will restore the normal courtesy beep, indicating that the alarm is indeed reset.

If the alarm continues to sound after reset the second time, it means that the alarm circuit is constantly tripped, i.e., a constant ground is applied to the alarm input. The condition causing the alarm was not just a temporary event. In such a case, you can either leave it tripped until the condition is cleared or you can turn off the alarm altogether with the alarm off command.

## **ADJUSTING PARAMETERS.**

### **General.**

The following five functions allow you to change cor/cwid parameters by

touch tone command, providing that you have sent the owner password. Changes to these parameters are saved for as long as power remains applied to the RAM memory in the repeater.

If power to the memory is interrupted or if you send the reboot microprocessor (reset-to-defaults) command, these parameters will be reset to the default values programmed into the EPROM at the factory from your Questionnaire.

To adjust a setting, send the appropriate command, which consists of three digits to identify the parameter to be changed, and a fourth digit, either "\*" or "#", to make a parameter slower/faster, lower/higher, longer/shorter, etc. Settings are made in steps; so to increment more than one step, it is necessary to send the command as many times as is necessary to reach the setting you want. For instance, if your present Courtesy Beep Type is "3" and you want to use type "5", send the command to "go higher" twice, i.e., once to go to "4" and again to go to "5".

There are predetermined limits to how much you can change each parameter. You can't harm anything by asking for a change beyond a limit; the computer simply refuses to change beyond limits. If you request a change and the present setting is already at a limit, the computer sends a long series of dits as a warning that you can't go any further in the requested direction. You may then opt either to keep the present setting or try changing in the opposite direction.

Note that CWID interval and transmit time-out period are fixed constants which are burned into the EPROM from settings you selected on your Questionnaire. They are not changeable.

### **Cw Speed.**

Use the cw speed - slower/faster pair of commands to adjust the speed of the station id and cw status messages. The speed is adjustable over a range of 5 to 22 words per minute in small increments. Each time you make a change, it will be evident in the "R" roger acknowledgment of the next command you send.

You can also try it out by forcing the cwid with the test cw command; however, since the owner command (password) is disabled whenever the

cwid runs, you will need to re-send the owner command enable password again before you can make further changes requiring the password.

### **Cw Tone.**

The cw tone - lower/higher pair of commands allows adjustment of the tone used for cw id and cw status messages to one of the following frequencies: 400, 500, 667, 1000, or 2000 Hz.

### **Beep Delay.**

The length of time between squelch dropping and the courtesy beep, which provides a time for someone to break in after a user drops his carrier, is adjustable with the beep delay - longer/shorter pair of commands. The allowable range is 0 to 5.0 seconds in half-second increments.

### **Tail Length.**

The period between the courtesy beep and when the repeater carrier drops if no one is transmitting is adjustable with the tail length - longer/shorter pair of commands. The allowable range is 0 to 10.0 seconds, and the increment of adjustment is one second.

(Fractional values are allowed in the value originally specified on the Questionnaire for the default in the EPROM to allow for fractional amounts; however, it would take a large number of incremental changes to make much difference for touch tone settings if the program used such small increments for touch tone alteration of the value.)

Normally, you want the tail to be long enough so that the repeater carrier only drops at the end of a qso, allowing plenty of time for a user to key his mike if he wants to continue using the repeater.

### **Courtesy Beep Type.**

The courtesy beep type - higher/lower command pair allows selection of the type of courtesy beep normally used as follows. Types are numbered from 0 to 6. (Actually, there is another type which sounds like a siren; but this type is only used if the alarm circuit is tripped.) Otherwise, the courtesy beep will be one of the normal 7 types (0-6) as follows.

0 is no courtesy beep tone (disabled).

1 is a 500 Hz tone.

2 is a 666 Hz tone.

3 is a 1000 Hz tone.



4 is a 2000 Hz tone.

5 is a pleasant musical burst sequence of tones ranging from 2000 Hz down to 333 Hz. The whole burst is only 300 milliseconds long, so it is similar to a beep except that the frequency sweeps during the beep.

6 is a similar burst of tones ranging from 333 up to 2000 Hz.

You can compare types 5 and 6 by using the test pretty tones command.

### **Time Out Timer.**

The time-out timer is not adjustable in the field, as such, but several customers have asked for a way to disable the timer to allow extended transmissions without a break to reset the timer. Although you should avoid leaving it set in this mode during normal operation, you can accomplish this by using the Set Long Timeout command (normally "701#"). This sets the length of the time-out timer to 25.5 minutes. In order to reset it to the normal time (usually 3 minutes), use the Reboot Microprocessor - Reset to Defaults command (normally "702#").

### **TEST FEATURES.**

The following five pairs of commands allow testing of the repeater. You may not find applications where these help you, but we use them at the factory and thought they might be helpful.

The test cw command forces the cwid. When you use this command, remember that since the owner command (password) is disabled whenever the cwid runs, you will need to re-send the owner command enable password again before you can make further changes requiring the password

The test carrier command locks the transmitter on the air for a period of 10 seconds with no modulation.

The test xxx-Hz commands lock the transmitter on the air for a period of 10 seconds and provide tone modulation at tone frequencies of 250, 500, 1000, and 2000 Hz. The 1000 Hz tone is especially useful to allow setting the deviation of the transmitter for id, beep, and other tones the computer transmits during operation.

The ringtone command forces the ringtone generator, which normally is heard only if the phone rings while the reverse autopatch option is active.

The test pretty tones command forces both types of multi-tone courtesy beeps with a pause between them. If you have a service monitor, it

is handy to trigger this service function and observe the change in deviation level over the entire range of audio tones from 333 to 2000 Hz.

The test watchdog function tests the watchdog timer in the computer. Any computer can get out of sync due to a transient of some sort or even due to a bug in programming triggered by some obscure sequence of events. This is called "crashing". When this happens, the computer wanders off into some uncharted sequence, no longer following the program as written. If you have a computer, you know what crashing is. To restore operation, the repeater has a "watchdog timer", which is a circuit which must be triggered periodically by a procedure in the main program of the computer. If the computer fails to trigger this hardware circuit at least every 10 seconds, the timer reboots the computer. The test watchdog function tests the watchdog timer circuit by deliberately putting the computer in an endless loop, which locks it up. After 10 seconds, the computer should automatically reboot and allow normal operation to resume.

### **REBOOTING COMPUTER.**

The reboot microprocessor pair of functions forces the computer to reboot. If done with a "\*" as the fourth digit, any parameter changes which you have made by touch tone are saved. If you reboot with the "#" version of the command, the computer is forced to forget your changes and read in your specified default settings programmed into the EPROM at the factory. This is a way to restore all the default settings after you try all sorts of changes and forget where you left things.

### **AUXILIARY CONTROL OF EXTERNAL CIRCUITS.**

The two drivers are provided on the COR-5 board to switch external accessories and are called "CTCSS Defeat" (E7) and "Voice ID Trip" (E8). These outputs can sink up to 200 mA at voltages up to 15Vdc.

E7 can be used to switch any accessory, although it is usually dedicated to defeating a TD-3 Sub-audible Tone Decoder if one is installed. This output is controlled by the CTCSS Defeat command. The "on" command defeats the CTCSS Decoder (allows the repeater to be used without any sub-audible tone on the received signal. "Off" allows the

CTCSS Decoder to block the repeater if the received signal does not have the proper tone. It is important to remember that "on" means ctcss is defeated and "off" allows ctcss to restrict access to the repeater; so don't get confused.

E8 is used only in conjunction with the DVR-2 Digital Voice Recorder Module for doing voice id's. Details are given in a separate instruction manual. If the Module is installed, turning the Voice ID command on allows the Digital Voice Recorder to provide the id at the appropriate times. If turned off, the regular cw id occurs whenever an id is called for.

### **REGISTRATION.**

In order to protect you, limiting the number of people who know how all the control codes operate, we only provide logistics support, including replacement EPROMS and documentation, to registered owners.

We maintain a computerized record of the control parameters for each repeater manufactured. Should you contact us, please identify yourself with the name, call letters, and zip code used on your original repeater order and the serial number on the rear of your unit. If you transfer ownership to someone else, please either contact us yourself or advise the new owner to contact us to change the registration.

The registration data base also will be used to notify you should improvements or new features be added in the form of new firmware and documentation. In such a case, we will notify you by mail and offer you a chance to upgrade at nominal cost.

### **COPYRIGHTS.**

Note that the firmware in the EPROM for the COR-5 and the documentation supplied with the repeater are copyrighted, and Hamtronics, Inc. reserves all rights. Neither the EPROM nor the documentation may be legally copied or distributed in any way. They are supplied to you under license which provides for your use in the original repeater.

Schools, computer hackers, and hams are noted for thinking that they can help themselves to anything they can get ahold of as long as they don't sell it. This is not in accord with copyright law, nor is it moral. As with any computer software, you have to remind yourself at times that some organization invested a lot of man hours to develop the product you

enjoy. Continued availability depends on the manufacturer being properly compensated for its efforts. Our employees thank you for your cooperation.

### OBTAINING A NEW EPROM.

Despite the effort you put into making selections for the parameters to be burned into your EPROM, you may find that you would like to make some changes at some time. We would like to make it as easy as possible for you to order a new EPROM, and although it is very time consuming for us to do, we try to charge as little as possible, knowing that we don't need to necessarily cover all of our cost on support for a product such as the REP-200. We also know that you don't want to take the repeater off the air in order to be able to return the original EPROM to us, and really, the labor costs are substantially more than the cost of the part. So here's the deal.

To order a new EPROM, simply mark up the computer-generated repeater Repeater Programming sheet we sent with your repeater with whatever changes you want to make. Send us a copy with a check or credit card authorization for \$30 plus shipping (usually \$7.00 in the U.S.). We will try to burn you a new prom within a day or two and send it right out to you by first class mail.

Don't bother to return the old EPROM. Even though we could reuse it, it has more value to you as a back up in case you ever need it. The cost of the new one is basically to cover some of the time required to program and test it. Remember that EPROM's are static sensitive; so be careful in handling them. Be sure to observe proper orientation when you plug the new one into the socket. You can use the static protection material the new one was packed in to store the old one.

## COR-5 BOARD PARTS LIST.

\* Note: Reference designators marked with \* are parts located on the bottom of the pc board. "SMT" means "surface mount".

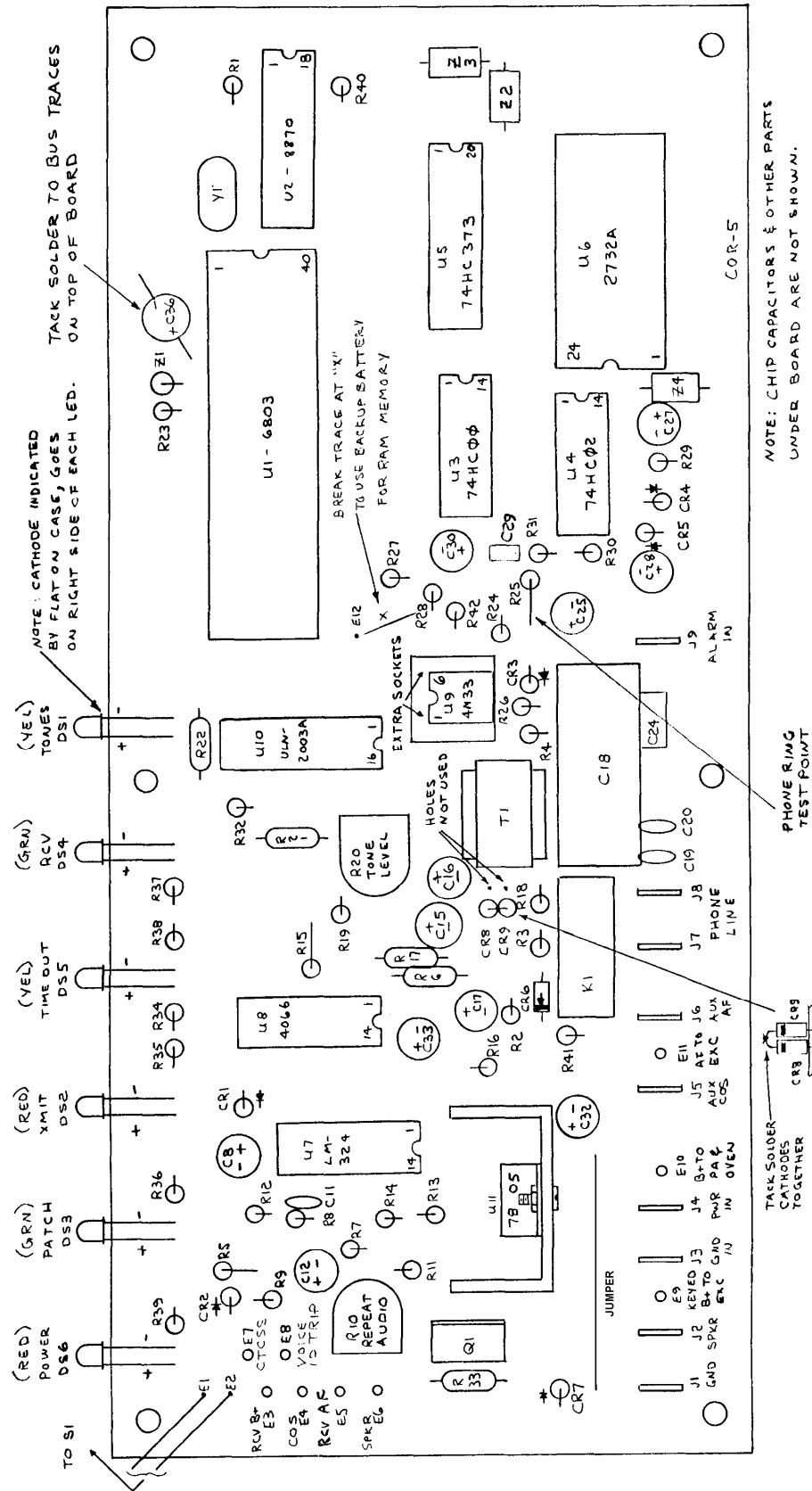
Ref #	Value ----- (marking)
C1-C4*	0.1 uF 805 Chip Cap
C5-C7*	.01 uF SMT Chip Cap
C8	10 uf electrolytic
C9*	0.1 uF 805 Chip Cap
C10*	.01 uF SMT Chip Cap
C11	470 pf disc cap (471)
C12	10 uf electrolytic
C13*	0.1 uF 805 chip cap
C14*	0.1 uF 805 Chip Cap
C15	47 uF electrolytic
C16-C17	10 uf electrolytic
C18	1 uf, 200V PMU cap (grn)
C19-C20	.001 uf disc cap (102)
C21-C23*	.01 uF SMT Chip Cap
C24	0.15 uF mylar cap (red)
C25	47 uF electrolytic
C26*	.01 uF SMT Chip Cap
C27	47 uf electrolytic
C28	47 uf electrolytic
C29*	0.1 uF 805 chip cap
C30	1 uf electrolytic
C31*	.01 uF SMT Chip Cap
C32	47 uF electrolytic
C33	470 uF electrolytic
C34*	0.1 uF 805 chip cap
C35*	.01 uF SMT Chip Cap
C36	470 uF electrolytic
C37*	.001 uF SMT Chip Cap
CR1-CR4	1N4148 (unmarked)
CR5	not used
CR6	1N4148 (unmarked)
CR7	1N4003 rectifier
CR8-CR9	1N5239B 9.1V zener diode
DS1	Jumbo Yellow LED
DS2	Jumbo Red LED
DS3-DS4	Jumbo Green LED
DS5	Jumbo Yellow LED
DS6	Jumbo Red LED
J1-J9	Push-on blade jacks
K1	Reed Relay, spst
Q1	D45C1 or TIP-30 PNP, 1A
R1	100K
R2	1K
R3	330K
R4	68K
R5	27K
R6	150K
R7	27K
R8	100K
R9	4.7K
R10	20K or 22K Pot.
R11	4.7K
R12	47K
R13	180 ohms

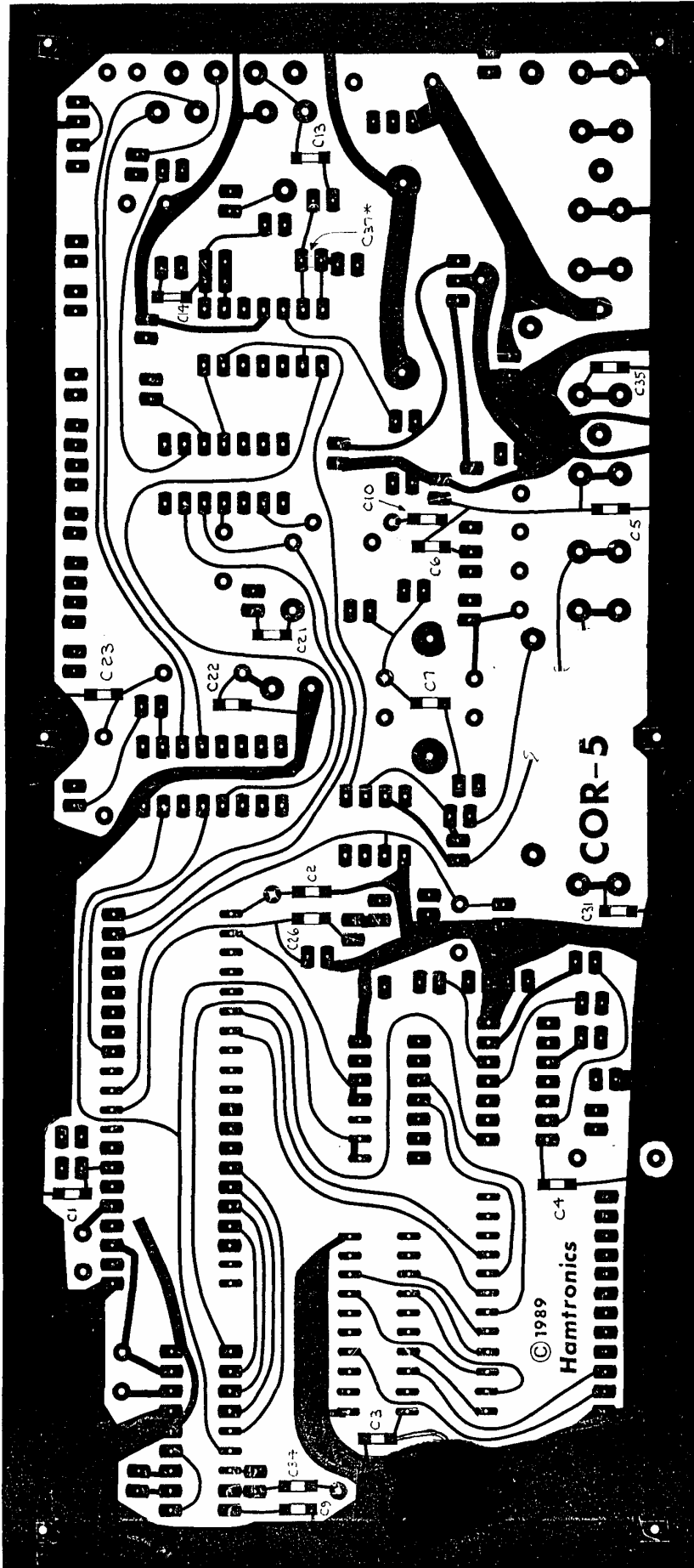
R14	100K
R15	10.1K (3.3K & 6.8K in series)
R16	15K smt
R17	10.1K (3.3K & 6.8K in series)
R18	2ea 470 ohms in series
R19	150K
R20	20K or 22K Pot.
R21-R22	10.1K (3.3K & 6.8K in series)
R23	27K
R24	22 Meg.
R25	47K
R26	3.3K
R27	27K
R28	1 Meg smt
R29	510K
R30	10K smt
R31	510K
R32	680 ohms
R33	27K
R34-R35	680 ohms
R36	470 ohms
R37-R39	680 ohms
R40	680K
R41	100K
R42	27K
S1	SPST toggle switch
T1	600:600 ohm transformer

*Caution: Most of the IC's are static sensitive. Use suitable precautions.*

U1	MC-6803P microcontroller (or HD-6303RP CMOS)
U2	G8870P DTMF Decoder
U3	74HC00 quad NAND gate
U4	74HC02 quad NOR gate
U5	74HC373 Multiplexer
U6	2732A or 27C32 EPROM
U7	LM-324 quad op amp
U8	4066B quad analog switch
U9	4N33 or 4N26 optocoupler
U10	ULN2003A/MC-1413 peripheral driver array
U11	7805 voltage regulator
Y1	3.57595 MHz crystal
Z1-Z4	Ferrite beads

# PARTS LOCATION & SCHEMATIC DIAGRAMS.

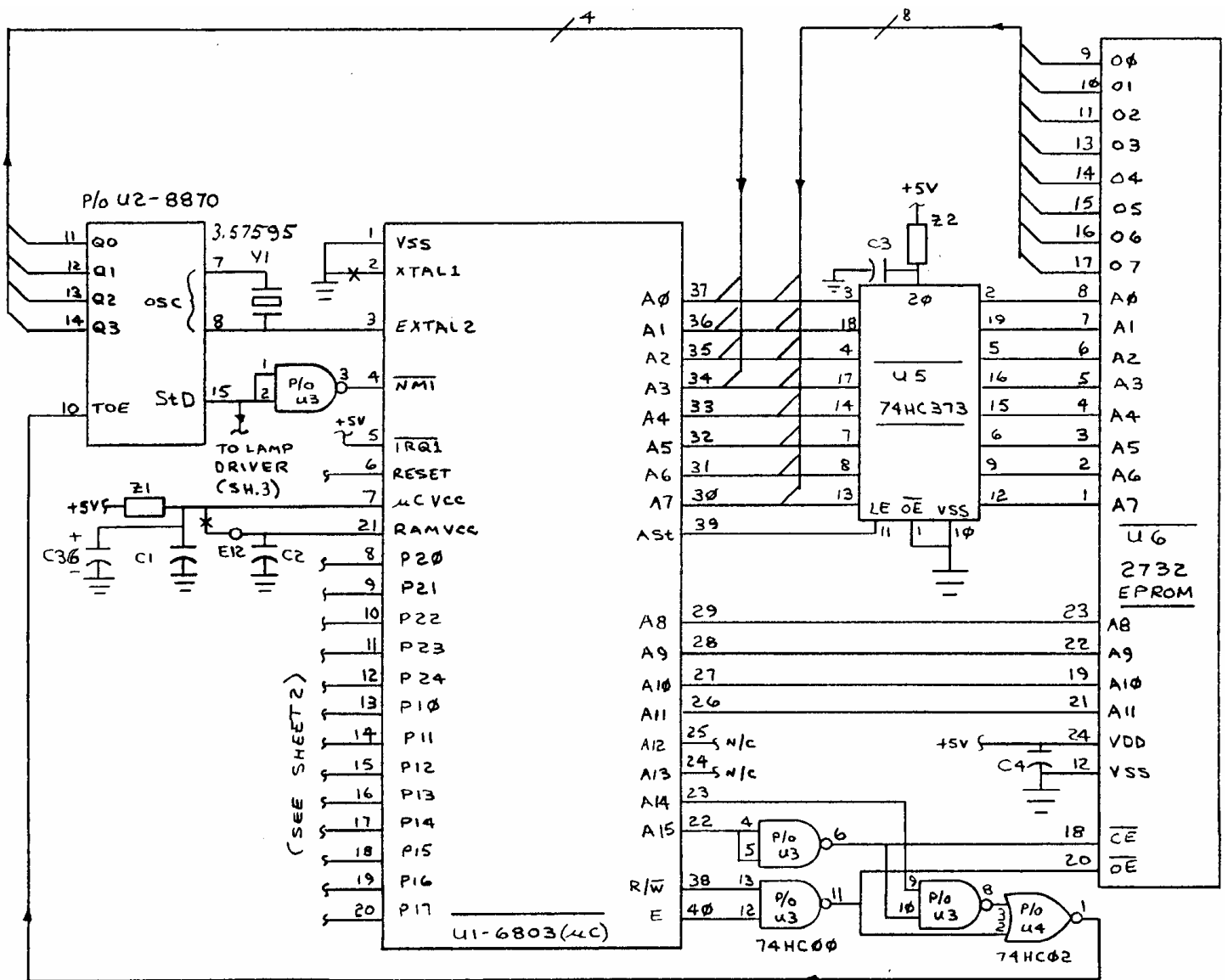




COR-5 BOTTOM SIDE CAPACITORS

**NOTE:**

\* INSTALL C37 AFTER R14 HAS BEEN  
SOLDERED. THEY SHARE SAME PADS.



COR-5 SHEET 1

