HAMTRONICS® COR-6 REPEATER CONTROLLER WITH VOICE ID: ASSEMBLY, INSTALLATION, OPERATION, AND MAINTENANCE

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FUNCTIONAL DESCRIPTION.

The COR-6 module is an all-in-one COR and voice id unit designed for operation with Hamtronics® fm exciters and receivers to provide repeater operation. As such, it is the controller unit for the new, low-cost REP-200C Repeater. The unit may also be used with other makes of transmitters and receivers if the required interface signals are available.

The COR-6 offers many advantages. It uses very low current consumption CMOS logic; idling current is only 50mA. It is designed to simplify wiring, with many on-board traces replacing earlier harness wiring for front panel controls and indicators. Using a digital voice recorder circuit also eliminates having to program call letters in a cwid circuit with diodes or an eprom; the id message is simply recorded off the air with a microphone. Many adjustments have been eliminated and replaced by preset digital circuits to simplify installation, while still allowing customizing if needed. An on-board fuse provides limited protection against pc board damage from short circuits.

The COR-6 module features a courtesy beep tone, which helps to prevent talk-over by encouraging users to wait a short time before picking up the repeater. After the waiting period, a beep sounds on the repeater and the time-out timer is reset. Waiting this short period allows any new party to break in and identify himself.

ASSEMBLY.

Construction Methods.

Assembly is relatively straight forward. Use the parts list and component location drawing as guides.

During construction, orient the board right side up as shown in the component location diagram.

The top is the side with the terminal numbers. Numbered holes around the perimeter of the board are for wires connecting to the outside world, which are connected during installation.

Be careful not to confuse parts marked similarly, such as 150K and 510K resistors. Double check each part as installed. When done, if parts are short and others are left over, go back and check each part to be sure a wrong value didn't get installed somewhere.

The pc board uses plated-through holes; so only the bottom of the board needs to be soldered. Because it is more difficult to remove parts from plated-through holes, be sure parts are correct before soldering. Traces are close together; so use a fine tip on the soldering iron.

All components, especially capacitors, should be installed with leads as short as possible.

Caution the ic's are static sensitive. The warranty does not cover static damage; so handle them with care. Leave them in their protective carriers until assembly is done; and then plug them in, using suitable static handling precautions. 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.

Assembly Procedure.

Refer to component location diagram, figure 4.

a. Install fuse on board, and solder leads with fuse spaced about 1/16 inch above traces on top of board.

b. Install ic sockets with notch pointing as shown in the component location diagram. U2 and U3 face the bottom and U4 faces the top. Solder leads carefully to prevent solder shorts.

c. Install transistors and voltage regulator U1, orienting as shown. Note tab position on power transistor Q4.

d. Install pots R13 and R23.

e. Install all capacitors, observing polarity on electrolytics.

f. Install all resistors. On vertically-mounted parts, the body of the part is indicated by a circle on the diagram.

g. Install ferrite bead Z1 in the upper left-hand corner.

h. Install the diodes, observing polarity. The banded (cathode) ends must be oriented as shown. For convenience, install them all with the banded end at the bottom of the body, and just make sure the body is oriented as shown.

i. Install led's as shown, observing both proper colors and polarity. The long lead is the anode. It is necessary to leave as much of the lead as possible; so install all the led's on the board with the shorter (cathode) lead just protruding through on the bottom side of the board. The easiest way to do this is to put both leads through the board until about 1/16 inch of the shorter one protrudes on the bottom of the board, which leaves a little more than that of the longer anode lead. Bend the anode lead over on the end to keep the led from falling out of the board while soldering. Then, trim the bent over part of that lead off. The shorter cathode lead should not need trimming if done properly. See insert below component location diagram for lead forming, which is done after the led's are soldered to the board. Bend the leads at a 90° angle about 1/4 inch above the board so the led's can go through holes in the front panel.

j. Using a lead clipping, solder a bus wire jumper between pads E13 and E14 near the lower left corner.

k. If you want to add a switch to turn the power on and off, when building an REP-200C for instance, skip this step; otherwise, solder a bus wire jumper between pads E4 and E5 near the lower right corner.

l. Check over construction to be sure all parts are installed in proper places, with proper polarities, and check solder connections for any cold solder joints, solder splashes, etc.

m. Using suitable static protection described earlier, carefully unpack the ic's and install them in the sockets. Be sure to orient them with notches pointing as shown on the diagram. Be careful that all the pins actually go into the sockets. It is easy for some to bend underneath or extend over the outside of the socket. Note that ic's made by Motorola have one extra digit in the part number, e.g., MC14584 instead of 4584.

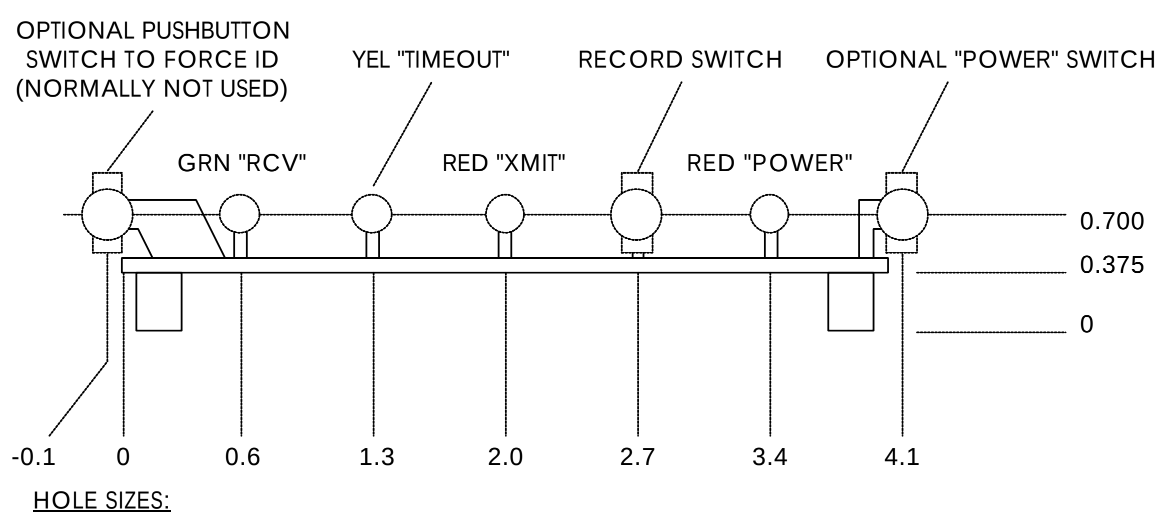

FIGURE 1. FRONT PANEL HOLE TEMPLATE

INSTALLATION.

General.

Interconnection diagram, figure 3, shows normal wiring for use with a basic repeater. The REP-200C Repeater configuration is used as an example. If you build your own repeater, the locations of the feed-through capacitors may differ, but the basic functions will be the same.

Note that the led's are provided with the kit, but some panel mounted components, such as switches, are not provided with the COR-6 module; however, those which are needed are supplied with the REP-200C Repeater Kit chassis components. Because there are many options in the way the switches are wired or whether they are even used, you can provide whatever switches you may wish to use.

Along the right-hand side and the rear of the pc board in the illustration are the receiver and transmitter compartment shields, respectively, along with the four feedthrough capacitors normally used with each. The two pairs of wires shown with arrow heads at the upper-right are external connections for power and monitor speaker (if used). Because all the external connections may be soldered at pads on the top of the board, it should be mounted in the chassis before any wiring is done.

Mounting.

The COR-6 board normally is mounted just behind the front panel of the repeater, using 3/8" 4-40 standoffs in the four corners. The front set of mounting holes normally are 5/16" from the inside front wall of the chassis.

If you purchased the REP-200C in kit form, the chassis and panel are already punched for the mounting holes and led's. You need only enlarge two holes in the panel which originally were used for "TONES" and "PATCH" led's in the full-blown REP-200 Repeater, which uses the COR-5 module. In this configuration, those led's are not used, and their holes can be used for optional switches with the COR-6 if enlarged to the proper size and relabeled. Refer to figure 1.

If you purchased the COR-6 to use in your own chassis, you can drill out the mounting holes in the chassis (0.125" dia for 4-40 screws) and holes in the panel for led's and switches per figure 1. The easiest way to do this is to first lay the board in the chassis, before standoffs are assembled to the board, and mark the four mounting holes in the chassis. Also mark the approximate positions of the holes in the front panel for the led's and switches. Then, remove the board, and carefully mark exact positions of front panel holes, using dimensions in front panel hole template, figure 1. You may want to read ahead about the various switches to see if you want to provide any or all of them before drilling those holes.

After the chassis is prepared, bend the led leads as shown in figure 4 (about 1/4" above the board) so they can protrude through the panel. Slide the board in place after standoffs are attached, and secure to chassis. You will need to guide the led's through the holes in the panel.

Switches for power and other options (see text which follows) can be installed in the panel and wired to the board after the board is installed in the chassis.

Making Connections to the Board.

The COR-6 board uses plated through holes, and the numbered terminal pads around the edge of the board are specially designed to allow easy solder connection of cable harness wires going to the rest of the repeater. The holes are large enough so the wires can be easily inserted even after the holes are filled with solder.

The easiest way to attach wires is to strip them about 1/4 inch. Then, bend a small "Z" in the end of the wire so that it stays in the hole until soldered. In this way, you can install many wires and solder them all at once.

An alternate method is to preload all the terminal pads with solder. Then, melt the solder at each pad when the wire is inserted. This latter method requires care that solder and flux remains in good condition until the wire is bonded.

Power Source.

Terminal E3 is the input terminal for +13.6Vdc from the power supply. **E2** is the negative power supply input (ground) terminal. Heavy wire should be used because the COR-6 board provides power distribution to all the other modules in the repeater, including the power amplifier. Therefore, the wire should be able to carry 5 or 6 Amp with little resistance.

Power for the repeater should be obtained from a voltage regulated power supply, rated for +13.6Vdc at 4 Amp. 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.

Power Switch.

B+ from E3 goes through the fuse to E4. E5 provides the power to the circuitry on the COR-6 and the other modules in the repeater. If you want to use a power switch to turn the repeater on and off, you can connect one between terminals **E4** and **E5**. If you have no reason to turn the repeater off, simply connect a jumper wire between **E4** and **E5.**

Power Distribution to Other Modules.

The COR-6 board provides fan-out of fused +13.6Vdc power for the other modules in the repeater, as shown in figure 3. Because the wires are only a few inches long if the repeater is laid out as shown, #22 solid hook up wire is good to use. It is nice to use various colors, and figure 3 shows wire colors we use for the REP-200C Repeater. Assuming you use a metal chassis, all grounds for other modules pick up the B- supply return through the mounting hardware.

Note that the power amplifier and crystal oven option in the transmitter compartment operate from this source of constant B+ and not from the switched B+. The oven must be powered up all the time if used, not keyed, and the pa should be powered all the time too, since class C amplifiers draw current only when driven with rf.

Terminal **E6** provides B+ for the receiver. Terminal **E17** provides B+ for a crystal oven on the exciter, when used. Terminal **E16** provides B+ for a 10-30W power amplifier module, and it can supply up to 6 Amp.

Terminal **E19** provides switched B+ for the exciter. All power for the exciter other than the crystal oven, is obtained from this terminal. The switching transistor is rated to switch up to 700 mA, which more than the 500-600 mA which Hamtronics® exciters draw. *Do not exceed that limit if another exciter is used.* We recommend that all the exciter stages be keyed on and off and that the class-C pa, which draws no current when undriven, be powered up all the time.

Audio Connections.

Terminal **E18** provides the audio to the microphone input of the exciter. The output of the mixer circuit has dropping resistors, which work in conjunction with the input resistance of the exciter to drop the relatively high level of audio in the mixer down to the level required for the microphone input of the exciter. The resistor values used work in conjunction with the 2K input resistance of Hamtronics® exciters to provide the proper 30 mV p-p which they need.

For other than Hamtronics® exciters, the audio level may be too high if the input impedance of the microphone input is higher than 2K or the sensitivity of the audio input is different. You may have to experiment to find an appropriate value of external resistor to use in series with the audio line from E18 to the mic input on the exciter. The easiest way to do this is to connect it as is and try it. If the level is too high, try adding an external resistor and adjust the value of resistor until proper level can be achieved at about midrange on the exciter gain control so you have some adjustment range later with the pot.

Refer to *ADJUSTMENTS* section for details of audio level setup, which must be done exactly as specified for tone levels to be correct.

Terminal **E15** is the audio input from the receiver. Audio normally should be taken from the top of the volume control, a point which is squelched and de-emphasized, but not affected by volume control setting. The nominal audio level required is 200-300 mV p-p at full deviation, which is what Hamtronics® receivers put out.

☹*Note: This input is not intended for connection to the discriminator output of receivers, which normally is not de-emphasized audio, nor is it squelched.*

COS Input.

Terminal **E7** is the COS input from the receiver. This is a dc signal which is taken from the squelch circuit to indicate when the squelch is open so the controller knows when to key the transmitter. The input resistance is fairly high (about 50K) so that it doesn't load down the receiver. The threshold is set at about +3V; so that any level above that keys the repeater transmitter and any level near ground unkeys it.

When a CTCSS (subaudible tone decoder) module is used, it can be connected to short this line to ground (usually in the receiver compartment) to prevent transmission.

If you want to inhibit the transmitter from being keyed, you can connect a switch to ground the COS input. You can use either a conventional toggle switch or the output of one of our DTMF controllers: TD-2 or TD-4. When the switch is closed, the ground blocks the keying circuit to prevent transmission.

The COS inputs are set up for an active high (over +3V) when the squelch is open and ground when the squelch is closed. If you need an input of inverted sense, i.e., squelch open = ground instead of high, you can add an inverter transistor off the board. Call for details if you need help.

Record Switch.

Terminal **E10** must be grounded in order to record a message. See figure 3. There are several ways to do this.

If you only need to record your call letters once and don't expect to change the message under normal circumstances, it is only necessary to ground E10 manually while the message is being recorded. This can be done by temporarily touching a clip lead to E10. The other end of the clip lead can be clipped to the chassis.

If you are going to record a message often, you will find it handy to install a mini-toggle switch or some other form of switch on the front panel to activate record mode when you need to record a message.

Terminal **E8** is a hard ground. If you connect a switch between **E8** and **E10**, the COR-6 will record whenever the switch is turned on. This is adequate for many situations. However, there is a way to control recording with the push-to-talk switch on the microphone of the handie talkie or mobile radio used to provide the audio for the recording.

By connecting a toggle switch between **E9**, which is activated by the COS circuit, and **E10**, turning the switch on will *allow* recording to occur whenever the handie talkie or mobile radio is keyed up; but the recording occurs only when the ptt switch on the radio is keyed. When you use this method, you must be sure to turn off the toggle switch on the repeater after the recording is made.

It is also possible to record completely by remote control, using a modified TD-4 DTMF Controller board. See information in OPTIONS section.

OPTIONS.

Switch to Force ID Message Playback for Testing.

It may be handy to have a front panel switch to force the id message to play for testing after you record. To install one, connect a push button switch between **E11** and **E12** on the COR-6.

Switch to Select From Two Messages.

The recorder ic on the COR-6 has a capacity of 20 seconds. Normally, this is used all in one message area. However, it can be broken up into segments by using addressing to tell the ic where in memory to begin each message. If you look at the schematic, you will notice many address pins on the ic. Theoretically, you can use a binary scheme to set the starting address in one-second increments for up to 20 segments. For simplicity, we decided that you probably would not want to have more than two messages, and so we brought one of the address lines out to terminal E13 and provided a pull-up resistor for this line. A jumper is provided on the board to ground E13 under normal circumstances so the starting address is always zero.

If you want to be able to record two different messages, you can connect a toggle switch between **E13** and **E14**. When the switch is closed, the starting address is zero; when open, the starting address is 8 seconds. The switch therefore sets the starting address for any message recorded or played back until the switch setting is changed. If the switch is closed, any message recorded or played back starts at the beginning of memory and runs as long as you recorded. With the switch open, recording or playback starts at 8 seconds.

☹ *Note that you must keep track of how long a message you record in either case: if you run over the allocated time, you will overwrite the upper memory area if starting at zero or run over the 20 second limit if starting in the high area and recording more than 12 seconds.*

It is also possible to select the message segment by remote control using DTMF commands. To do so, use our TD-2 DTMF Controller instead of the TD-4 so you have more than one function available. One latch can be modified as described for the TD-4 to record remotely. A second one can be used to provide the ground for the address line at E13.

Remote Control of Message Recording.

By adding a modified version of our TD-4 DTMF Controller, you can provide remote control of message recording by touch-tone command.

Figure 2 shows how to modify the TD-4. First, break the trace on the pc board from U3-B to U4-B as shown. Then, change R8 on the TD-4 to 100K, and add a 47µF electrolytic capacitor from the base of Q1 to ground, as shown.

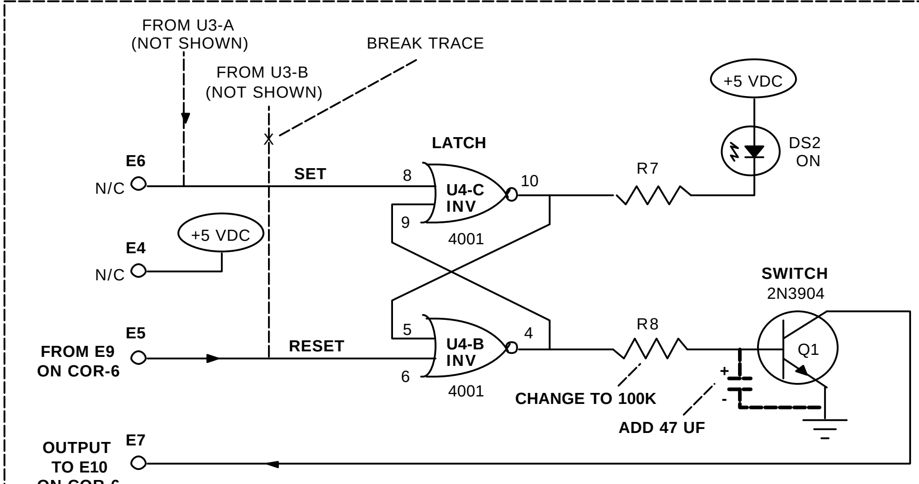

FIGURE 2. MODS TO TD-4 DTMF CONTROLLER FOR REMOTE MESSAGE RECORDING.

Connections to the TD-4 board are as follows:

- B+ supply to TD-4 term E3.
- Audio from receiver audio ft cap (same place audio for COR-6 comes from) to E1 on TD-4.
- Reset signal from E9 on COR-6 to E5 on TD-4.
- Control output from TD-4 E7 to COR-6 term E10.

Here is a quick rundown on how the remote control works. The TD-4 is modified so that there is a short time delay after the touch-tone sequence is received and the output transistor turns on. This prevents recording the tail end of the touch tone signal. When the proper four-digit command is received, U4-B&C latches and Q1 grounds the record circuit in the COR-6. The normal reset circuit of the TD-4 is modified so that reset occurs when the COS signal drops on the receiver.

To record a message, key the handie talkie or mobile radio and send the proper four-digit touch tone command. Keep the microphone keyed. Wait one second to allow the recorder to activate, and then say the message to be recorded. Wait about a second after you stop speaking to release the ptt button. When the squelch drops on the repeater receiver, the recorder circuit will be turned off. Be sure not to unkey the transceiver before recording the message, because that would immediately reset the latch in the TD-4.

Disable Courtesy Beep.

If you do not want a courtesy beep tone, simply turn beep level control R13 all the way down.

ADJUSTMENTS.

General Information.

There are only two adjustment pots on the COR-6 board: BEEP LEVEL R13 and ID LEVEL R23. The repeat audio level is set with the mic gain control on the exciter. All other parameters are preset by fixed component values, but there are provisions to change all of the parameters if the default conditions are not suitable for your application.

Audio Level Setting.

Refer to schematic figure 5B during this discussion.

The receiver audio is a fixed level, which is applied through buffer Q2 to the microphone input of the exciter. This is the reference level to which other levels are later matched; so it is necessary to adjust this first. The deviation of the transmitter is set with the exciter mic gain control for the desired repeat level. The proper way to set this is to adjust the mic gain control on the exciter for transmitter deviation equal to incoming deviation on the receiver. Normally, this is done at about full 5 kHz deviation. Ideally, you should have a service monitor to measure the deviation, but if you can't find one to use, you can simply adjust for best sounding audio, being careful not to over deviate.

When the receiver input signal deviation is increased much beyond 5 kHz, you should notice the deviation being compressed on the transmitter output; this is due to bandwidth limit of the crystal filter in the receiver. (We assume you have a receiver with a sharp filter as on our receivers.)

The level of audio from the receiver with full modulation like this should be about 200-300 mVp-p. If you are not using one of our receivers and you notice distortion even with normal receiver input signal deviation, you may need to check the level of audio coming into E15 on the COR-6 board. If it is much higher than 300 mVp-p, you may need to use a resistor in series with the audio input to E15 to reduce the level to what the buffer on the COR-6 needs. You can try starting with 100K and increasing it as necessary.

If you are using an exciter which is very sensitive, and the mic gain control must be set very close to minimum, the top lead of resistor R14 on the COR-6 module can be clipped out of the circuit to reduce the level of audio applied to the exciter. That will allow the mic gain control to be set more easily.

We normally recommend that the deviation limiter control in the exciter be set fully cw unless an autopatch is in the system. The mic gain control sets the required gain, and the maximum deviation levels are limited automatically by the crystal filters in the receiver. This eliminates any distortion which might result from clipping in the limiter.

If you are not using a Hamtronics® exciter, it is possible that you may need to compensate for a difference in exciter mic input impedance or sensitivity in order to be able to adjust the exciter mic gain control to a proper level. If so, you may have to experiment to find an appropriate value of external resistor to use in series with the audio line from E18 to the mic input of the exciter.

Once the repeat audio is set up properly, you can set the beep level and id message level as follows.

First, record a message on the id recorder. Then, to make adjustments, momentarily ground E12 to force the id message to be played back. A pushbutton switch connected between E11 and E12 is handy for this. Simply adjust ID LEVEL control R23 for desired id message level.

In similar fashion, BEEP LEVEL control R13 can be adjusted for a comfortable courtesy beep level. Momentarily key the repeater with an HT or by cracking open the squelch control to initiate a courtesy beep for testing.

Beep Delay.

The delay before the courtesy beep is preset to about 1 second by the time constant of R1/C17 (figure 5A). This gives someone a chance to break in before the next person keys his mic. However, the beep delay length is affected by the COS voltage your particular receiver uses. The one-second time is based on the COS level from Hamtronics® receivers. If you want to change it, you can increase/decrease the value of R1 to increase/decrease the delay.

Tail Length.

The length of tail after the courtesy beep is preset to about 5 seconds by the time constant of R4//C18 (figure 5A). If you want to change it, you can increase/decrease the value of R4 to increase/decrease the tail length.

Beep Tone.

The courtesy beep pitch is preset to about 2000 Hz by the time constant of R12/C21 (figure 5B). To change the pitch, you can increase the value of R12 to lower the tone or decrease it to raise the tone.

ID Interval.

The length of time between id's is determined by cwid interval timer U3-F (figure 5B). The id message should occur only after the receiver squelch is dropped (polite id'er) and the interval timer says it's time to id. The interval is set by the time constant of R31/C16. To increase the time, increase the value of R31, and vice versa.

Time-out Time.

The time-out timer length is preset close to 3 minutes with the time constant of R10/C19 (figure 5A). To increase time-out length, increase the value of R10, and vice versa.

Audio Tone.

The mixer circuit on the COR-6 is transparent, and assuming the transmitter and receiver are designed with the normal EIA response curve, the audio through the repeater should be transparent with regard to tone response. However, there may be installations where alteration of tone coloring is desired to compensate for some component in the system or to suit individual taste. Some degree of tone control can be achieved by adding capacitance from E18 to ground. This will decrease high-frequency response. If the audio is too bassy, then the only solution is to change some values of capacitors in the audio circuits of the exciter or receiver.

OPERATION.

Operation of the COR-6 module is fairly typical of what you would expect in a repeater controller. When the receiver squelch opens, the transmitter is keyed. When the squelch closes, the cor circuit waits for 1 second 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 about 5 seconds (tail), and then it shuts off the transmitter.

If the squelch remains open for more than 3 minutes, 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.

The voice id is polite; so it is heard only after the squelch closes and the one-second delay to allow for break-ins. It is triggered in this way the first time there is repeater activity after an extended period and every 8 minutes after that as long as there is repeater activity.

LED's on the front panel indicate when the power is on, when the transmitter is on, when the receiver squelch is open, and when the time-out timer has shut down the transmitter.

Note that if forced to id before you record a message, you will hear a buzz, which is a digital signal the factory uses to test the ic. This is normal.

The voice id message is recorded off the air, using the microphone on a handie talkie or mobile transceiver. There are several ways to activate the record mode, depending on how the front panel switch was configured. (See Record Switch section under INSTALLATION).

In any of these optional configurations, the front panel record switch must be activated and then the HT or mobile radio must be keyed with the operator saying the message over the air. The repeater receiver applies this audio message to the recording circuit in the COR-6.

Once the ptt switch on the transceiver is keyed, wait about one second, say the message slowly and distinctly, and then pause one more second at the end before unkeying the radio. This will allow a short pause at the beginning and end of the message to provide a smooth transition. It may take a little practice to find a voice technique which sounds good over the air when the message is played back.

The recorder ic in the COR-6 automatically keeps track of how long the message is. Maximum length is 20 seconds. On playback, the repeater will stay keyed up until the end of the message you recorded.

THEORY OF OPERATION.

Power Supply Circuits.

Refer to figure 5A. +13.6Vdc to operate the entire repeater is applied to E3. This power is supplied through fuse F1 and optional POWER switch S1 to the various other modules in the repeater. 13.6Vdc is switched by power transistor Q4 to key the exciter. The receiver and power amplifier modules and the crystal oven in the exciter are powered constantly. 13.6Vdc is reduced by regulator U1 to provide 5Vdc for the other ic's in the COR-6.

Basic COR Circuit.

An electronic carrier-operated relay provides operating power to the exciter in the transmitter enclosure whenever the receiver squelch is open. Many of the timing circuits in the COR-6 employ the schmitt trigger inverters of U3, which rapidly change state when a predetermined schmitt trigger voltage is reached on their input gates. Capacitors connected to the input gates either charge or discharge under circumstances when the timer is to run.

U3-A is a threshold detector and beep delay timer, which senses the presence of a COS signal from the receiver and provides a courtesy wait period after the COS signal is removed (receiver squelch closed). CR1 allows a fast attack, slow release of the R1/C17 network which discharges slowly after the COS signal from the receiver goes low.

That, in turn, trips tail timer U3-C, which provides the silent repeater tail after the courtesy beep. The delay is provided by C18 charging slowly through R4. That timer, in turn, keys Q3/Q4, which switches the actual B+ to the exciter.

Time-out Timer.

If the receiver should be held on for longer than 3 minutes, time-out timer U3-B automatically shuts down the transmitter until the receiver is released. While the transmitter is keyed, the ground from U3-A pin 2 is released, which allows the voltage on C19 to slowly discharge. When it drops below the schmitt trigger voltage, U3-B output applies a logic high through CR5 to U3-C, thereby forcing U3-C to turn off. When the receiver squelch finally closes, the time-out timer automatically resets.

LED Drivers.

Four LED's normally are provided on the front panel of the repeater. The red POWER led is driven by resistor R9 connected to the output of the fuse in the power supply circuits. The red XMIT led is driven from keyed B+ switch Q4 through R8. The yellow TIMEOUT and green RCV led's are driven by inverters U2-B and U2-D. Inverter U2-A provides a logic low signal to tell the recorder circuit when to record.

Courtesy Beep.

The courtesy beep forces operators to wait 1 second after the previous user releases the receiver squelch before picking up the repeater or else run the risk that the time-out timer may shut them down. This provides a psychological incentive to be courteous.

Each time the receiver squelch closes, U3-A times for 1 second; then, one-shot U3-E is triggered, which produces a 100 mSec ground pulse. This pulse keys tone oscillator U3-D (figure

5B), which generates a short 2000 Hz tone burst. R14/C22 forms a low-pass filter to round off the square wave signal.

Audio Mixer.

Squelched and de-emphasized audio from the top of the volume control in the receiver enters the COR-6 at terminal E15. This audio is amplified by a class-A buffer stage, Q2. The low-impedance output signal is mixed with audio from the digital recorder ic and from the courtesy beep oscillator at the output of the COR-6 at terminal E18. The mixer circuit actually consists of resistors R15, R17, and R24, in series with each audio leg, and load resistor R16 working in parallel with the input resistance of the exciter. R16 is included to provide at least some load resistance on the board for testing and for cases where the exciter input resistance may be higher than the 2K on the Hamtronics® exciters. The level at the output of the COR-6 is reduced to the relatively low level (about 30mV p-p) required at the input of the exciter.

ID Message Recording Circuit.

Recorder ic U4 is a complete analog sampled data system, with on-chip audio input preamp, agc, anti-aliasing and smoothing filters, storage array, control interface, and internal precision reference clock. This system uses eeprom technology to directly record analog signals so no d-a and a-d converters are required.

U4 uses a sampling rate of 6.4 kHz for 20 seconds of storage time, and it has an anti-aliasing filter which cuts off at 2700 Hz. If the frequency response was higher, the recording time would be less, because at least two samples per cycle are required to reproduce any frequency.

Refer to figure 5B. The COR-6 records audio from the receiver audio signal taken from the feedthrough capacitor which feeds the audio to the COR-6 board for repeater audio. R21/R22 is a voltage divider to provide the proper level to recorder ic U4 at pin 17. Pin 18 of the ic provides an reference input to the input op-amp. This is connected to the ground plane of the board to cancel any hum or noise pickup. The analog preamp output at pin 21 is coupled through blocking capacitor C8, which also serves to tailor the frequency response and level to match the repeater audio input.

During recording, U4 performs several stages of signal conditioning before the actual storage operation takes place. The first stage is the amplification of the input signal to a level optimized for the dynamic range of the storage circuits. This is done by the preamplifier, amplifier, and agc circuits in the chip. Amplification is done in two steps — initially by the input preamplifier and then by a fixed gain amplifier. The preamplifier has automatic gain control, with the attack/release time constants set by R34/C13. The 20 dB or so of gain compression range on the preamp compensates for variations in voice characteristics and levels of speech volume.

The next stage of signal conditioning is done by an internal low-pass filter. Although analog storage of the instantaneous voice level does not require an a-d converter, digital sampling is done in the time domain; so an anti-aliasing filter is required to limit any speech components to frequencies less than one-half the sampling rate. This is a primary requirement of any digital audio processing technology.

The processed waveform is then passed into the analog transceivers to be written into the analog storage array. Because the storage process takes longer than the sampling period, several samples are written at one time, and then another group of samples is written, and so on. The eeprom cells work similar to digital eeproms you are familiar with, but these eeprom cells actually store an analog voltage and not a digital signal (0's and 1's). The recording is non-volatile; it has a useful life of at least ten years even if no power is applied during part or all of that time.

During playback, the recorded analog voltages are sequentially read from the storage array, thereby reconstructing the sampled waveform. A smoothing filter on the output path removes the sampling frequency component, and the original waveform is restored. The output of the smoothing filter is connected through an analog multiplexer into an output power amplifier. Although not normally used in the COR-6, two output pins (14 & 15) can drive a small loudspeaker. Audio for the repeater is derived from one line of the speaker driver. This audio is coupled through dc blocking capacitor C11 and ID LEVEL control R23.

Recording Control Circuits.

There are four control lines used on the ic.

The PD (power down) line at pin 24, which is normally held low during record or playback, does two things when raised high. First, it resets the internal address pointer to the starting address. Second, it puts the ic in a power down state in which it draws very little current (for idling).

The P/R line puts the chip in a playback mode when high and record mode when low.

The CE (chip enable) line is what actually starts each record or playback cycle. It is held low to make the chip run.

The EOM (end of message) line puts out a low signal under two conditions. First, when the playback mode reaches the end of a recording on the chip, the EOM line puts out a ground pulse of about 25 mSec length. Second, if the chip runs until the very end of its 20 second recording time, the EOM line goes low and stays low until the chip receives a PD signal to reset it.

In order to record a message, a ground must be applied to terminal **E10**. This ground works in conjunction with pull-up resistor R29 to apply either +5Vdc or ground to playback/record pin 27 on the U4 chip. If ground is not applied to E10, R29 pulls the P/R line high and the U4 is held in the playback mode. When recording is necessary, ground is applied to E10, and pin 27 is held low, in the record mode. At the same time, the ground is applied through CR7 to the PD and CE control lines at pins 24 and 23.

At the end of the recorded message, releasing the ground from E10 stops the record cycle and causes the chip's internal control circuitry to put an "end of message" marker at the point in memory where the message ends. On playback, this marker controls where playback stops.

Depending on the configuration you chose to implement, the ground at E10 may come from a switch connected between ground terminal E8 and E10, or it may come from through a switch from E9, which is driven by inverter U2-A from the COS input signal in the COR circuits (on figure 5A). It may even come from a modified TD-4 DTMF Decoder/Controller, which would allow remote control by touch tone command.

Playback Control Circuits.

In order for U4 to play back a message, P/R line at pin 27 is held high by R29. With the id circuit at rest, pullup resistor R28 normally holds the PD and CE lines high. To play back a message, Q1 pulls these lines low. This action is initiated by a logic high from and-gate U2-C through R30. Once activated, a dc voltage is applied from pins 14 and 15 of U4 through R26 and R25 to the base of Q1 to keep it latched. At the end of the message, a ground pulse on EOM pin 25 momentarily removes the latching voltage from the base, and Q1 turns off. The playback action stops, and the high on PD pin 24 makes the ic reset all its circuits for the start of a new cycle; in particular, this is what sets the address back to the starting address.

U3-F and the time constant of C16 charging through R31 provides an 8-minute timer. When the id message plays back, ground from the collector of Q1 is applied through CR3 (figure 5A) to key the transmitter for the duration of the message. This ground also discharges C16 through CR9 and R32, which provides a short delay to avoid glitches. When the message ends, C16 slowly charges until it trips U3-F 8 minutes later. The timer output is combined in and-gate U2-C with a pulse from the one-shot circuit which drives the courtesy beep oscillator. When the timer times out, the and-gate waits until the next time the courtesy beep occurs. Then, it applies a logic high pulse to the base of Q1 to initiate another id playback.

Message Selection.

Refer to figure 5B. Address lines A0-A9 shown at the upper left corner of the digital recorder ic set the starting address of the message in a binary format. Whenever a message is recorded or played back, it starts at the memory position set by these lines. Normally, all the lines are grounded; so the starting address is zero. In order to allow more than one message to be used but still keep the circuit simple, we brought the 8 second address line out on the pc board and connected it with a pull-up resistor and jumper at E13-E14. If you want to use two separate messages, a toggle switch can be used in place of the jumper to select the two address ranges: 0-8 seconds, and 8-20 seconds. Selecting other addresses is possible but gets involved in multiple pull-up resistors and a diode matrix to allow combinations of lines to be switched. If you need to do three or more messages, call for details on how to modify the board.

TROUBLESHOOTING.

Procedures.

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 small symbol indicates if the signal at that point is an active high or low. This helps to keep the sense of the signal clear in your mind as you glance through from one circuit to the next. Function names in the digital recorder ic on the schematic have a bar over the function abbreviation if the function has an active low state; otherwise, it is an active high function.

The most common troubles in all kits are interchanged components, cold solder joints, and solder splashes. Another common trouble is blown transistors and ic's due to reverse polarity or power line transients. Remember if you encounter problems during initial testing that it is easy to install parts in the wrong place. Don't take anything for granted. Double check everything in the event of trouble.

Relative audio signal levels measurements taken with an oscilloscope, for full modulation, are as follows. Output levels are based on use with a Hamtronics® exciter connected (2K load). If you make measurements without an exciter connected, the level will be somewhat higher.

Test Point	Normal P-P Voltage
Rcvr af input at E15	300 mV
Rcvr af at Q2 emitter	300 mV
Rcvr af at E18 output to exc.	100 mV
Beep osc at U3 pin 8	5 V
Beep osc at E18	50 mV
Recorder output U4 pin 15	1.6V
Recorder input U4 pin 17	50 mV
Recorder ANA out pin 21	100mV

Current Drain.

Current drain is relatively low at idle; and even with the recorder ic running, which is the maximum current condition, the current drawn by the circuitry on the COR-6 module is much less than the current drawn by the exciter through the B+ switch on the COR-6 module. I.e., the current drain normally is 6 times higher with the exciter connected to the COR-6.

The following current drain conditions are typical for a COR-6 board with the exciter disconnected for troubleshooting. Current drain depends on the mode the module is in at any given time.

Idle	50 mA
Keyed	100 mA
ID Message Cycle	110 mA

Fuse Circuit.

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 MGP 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.

PARTS LIST.

Ref Desig	Description	(marking)
C1	10 µf electrolytic	
C2	47µf electrolytic	
C3	.01µ disc	(103)
C4	47µf electrolytic	
C5-C6	0.1µf monolithic	(104)
C7	.001µf	(102, 1nM, or 1nK)
C8-C10	0.1µf monolithic	(104)
C11	10µf electrolytic	
C12	0.47µf electrolytic	
C13	4.7µf electrolytic	
C14-C15	0.1µf monolithic	(104)
C16	470µf electrolytic	
C17-C18	4.7µf electrolytic	
C19	470µf electrolytic	
C20	4.7µf electrolytic	
C21	.0022µf	(2.2nK or 2n2K)
C22	.01µ disc	(103)
CR1-CR9	1N4148 switching diode	
DS1	T1¾ Green LED	
DS2	T1¾ Yellow LED	
DS3-DS4	T1¾ Red LED	
F1	7A Pigtail Fuse, type GJV	
Q1-Q3	2N3904 NPN xstr	
Q4	TIP-30 PNP 1A pwr xstr	
R1	150K	
R2-R3	100K	
R4	1 meg	
R5	4.7K	
R6	330Ω, ½W	
R7	27K	
R8-R9	1.2K	
R10	510K (be careful not to use 150K, which looks similar)	
R11	27K	
R12	680K	
R13	20K or 22K Pot.	
R14	27K	
R15	6.8K	
R16-R17	2.2K	
R18	150K (be careful not to use 510K, which looks similar)	
R19-R20	100K	
R21	150K	
R22	27K	
R23	1K Pot.	
R24	3.9K	
R25-R30	47K	
R31	1 Meg	
R32	1.2K	
R33	100K	
R34	510K	
S1	SPST Toggle Switch (optional, not supplied)	
U1	78L05 5V Regulator	
U2	4001B quad nor gate	
U3	4584B hex schmitt trigger inverting buffer	
U4	ISD-1020AP or ISD-1420P recorder ic	
Z1	Ferrite Bead, prestrung	

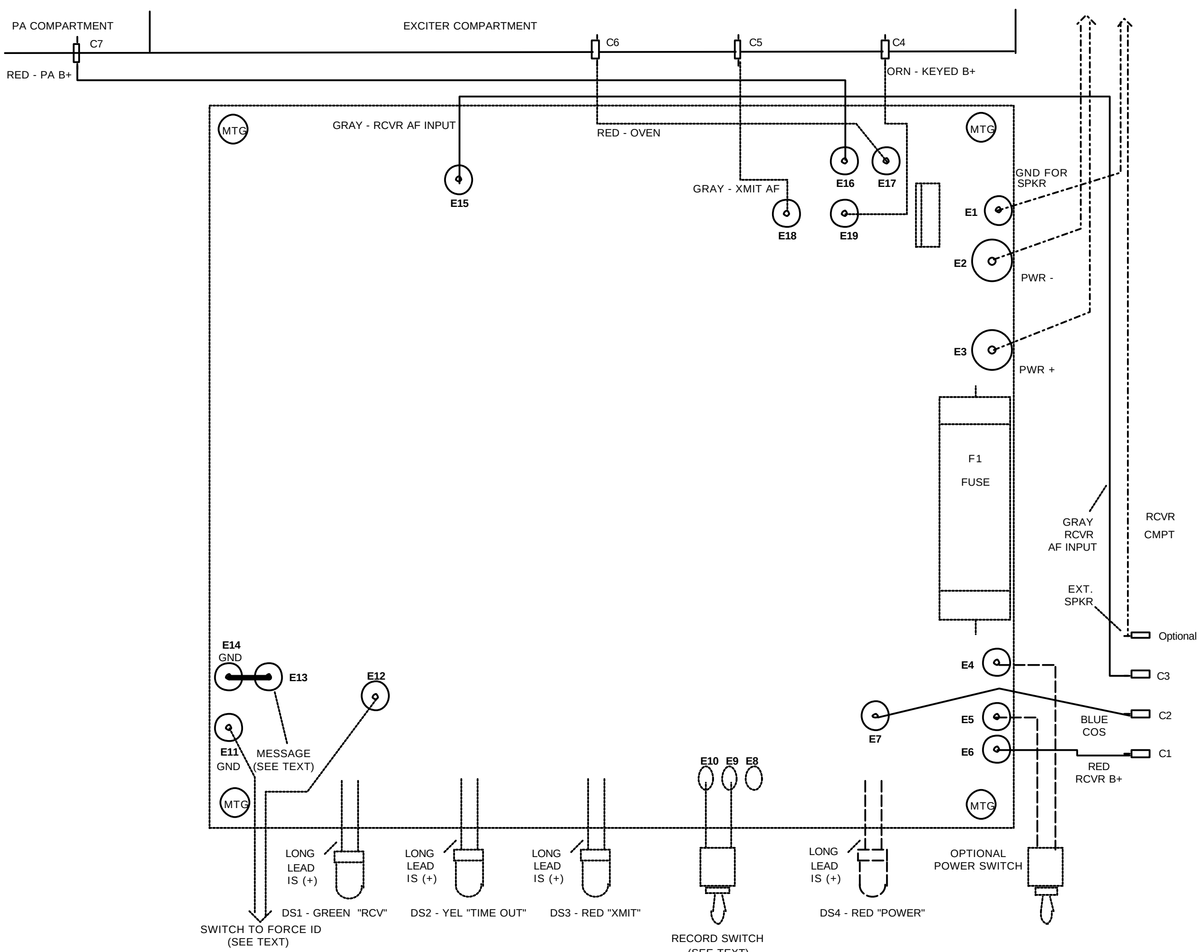

FIGURE 3. COR-6 REPEATER CONTROLLER MODULE
REP-200C REPEATER INTERCONNECTIONS DIAGRAM

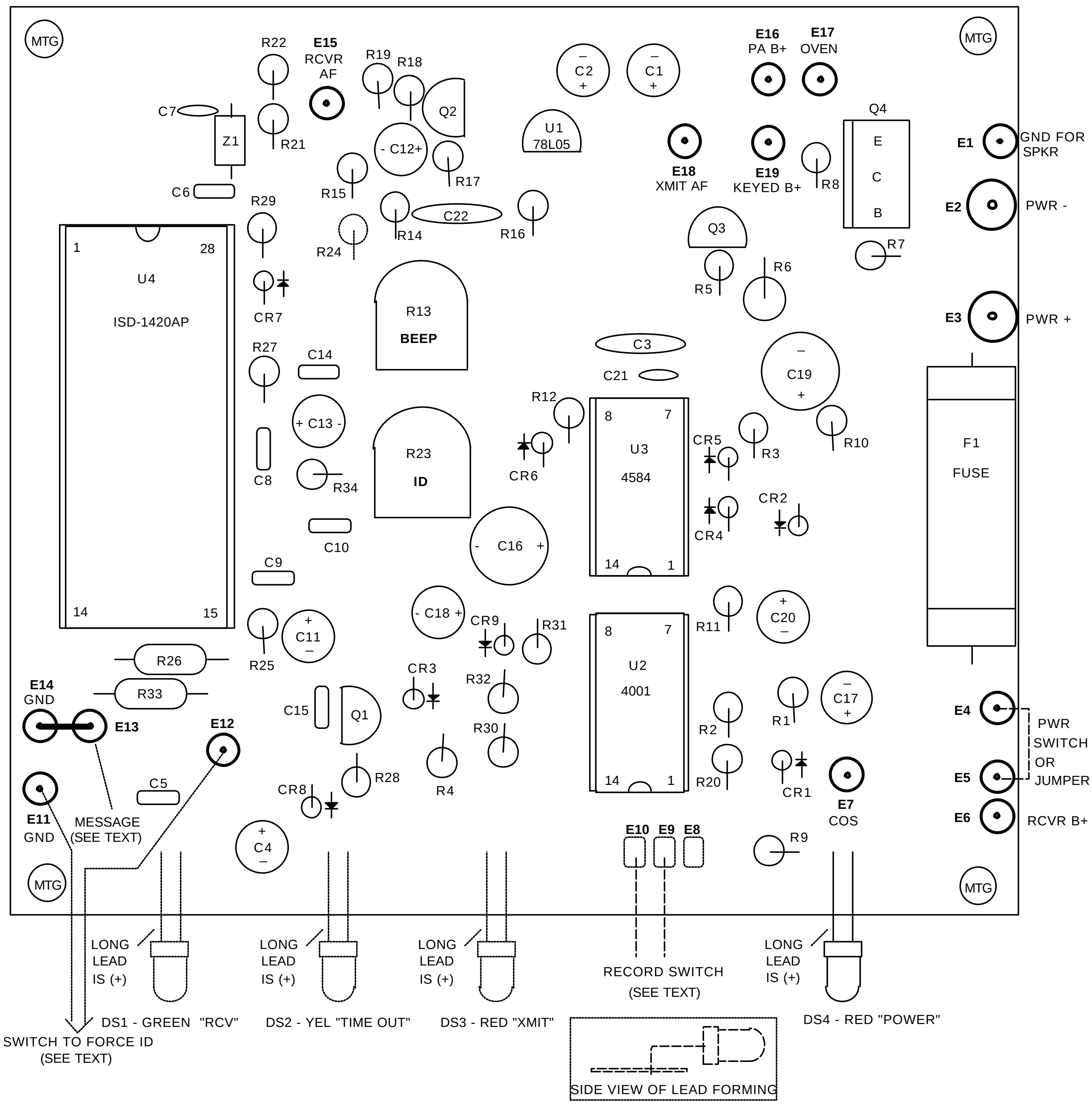

FIGURE 4. COR-6 REPEATER CONTROLLER MODULE, COMPONENT LOCATION DIAGRAM

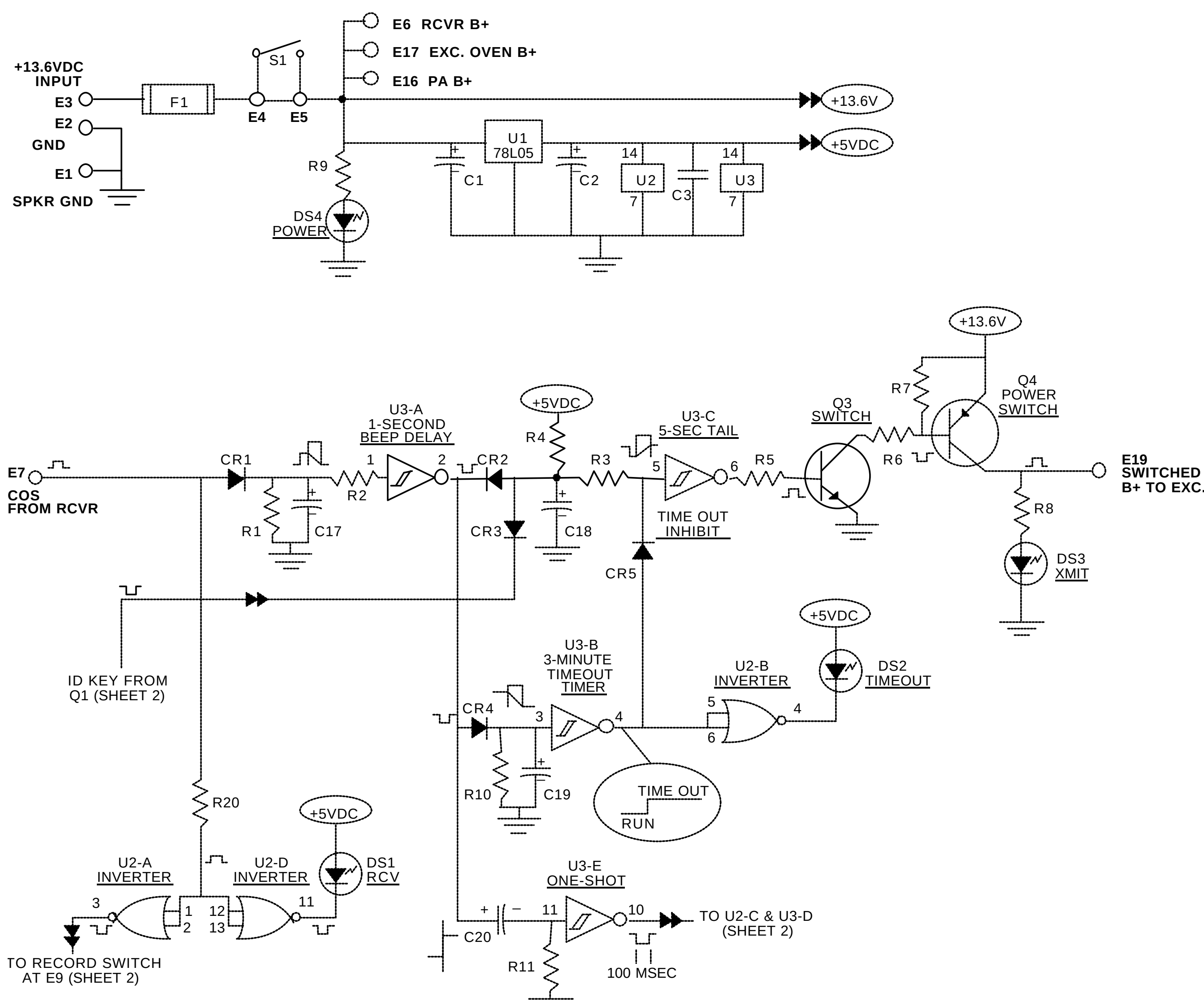

FIGURE 5A. COR-6 REPEATER CONTROLLER MODULE, SCHEMATIC DIAGRAM (SHEET 1)

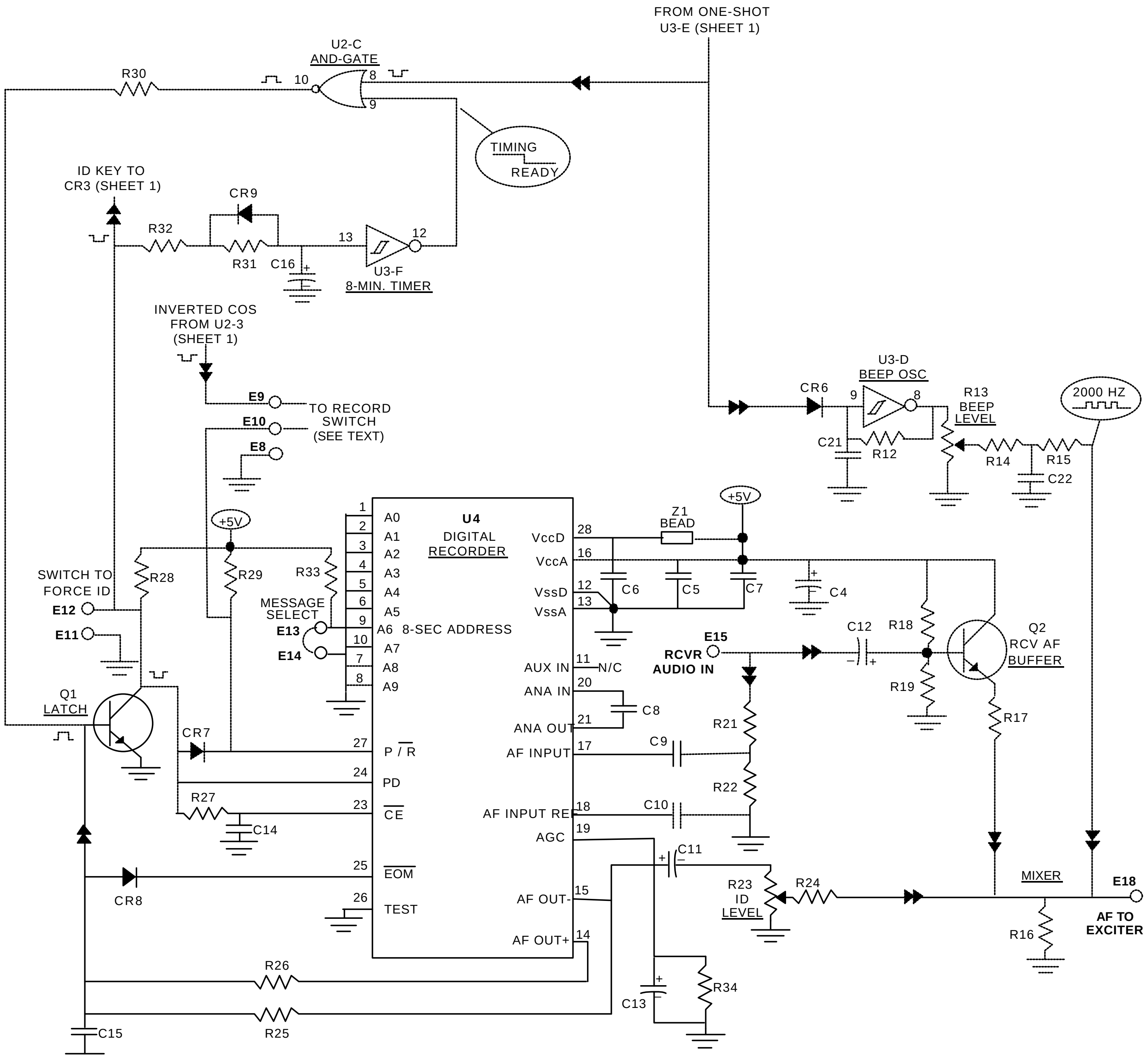

FIGURE 5B. COR-6 REPEATER CONTROLLER MODULE, SCHEMATIC DIAGRAM (SHEET 2)