HAMTRONICS® DVR-3 DIGITAL VOICE RECORDER, REV. C: INSTALLATION, OPERATION, AND MAINTENANCE

GENERAL INFORMATION.

Functional Description.

The DVR-3 is a versatile pc board module, which is designed primarily as a voice id'er and message recorder for the REP-200T Repeater. It is a special version of the general purpose DVR-1 module. The difference is that the DVR-3 substitutes direct control interfaces with the COR-5 Control Board for the general purpose timer and logic circuits on the DVR-1, and the DVR-3 uses audio off the air for recording instead of a microphone.

The DVR-3 module is based on the ISD-1420P chip, using direct analog eeprom technology. The recording is good speech quality, equivalent to what you would expect using a cassette tape recorder. The solid-state recording lasts ten years or more and requires no battery backup.

Use of the DVR-3 requires firmware version 2.06 or later in the REP-200 Repeater. This includes all repeaters manufactured after December 1993. Older repeaters can be retrofitted by replacing the eprom; no hardware changes to the control board are required.

The COR-5 Controller provides the means to enable either the voice id or conventional cw id, and it provides the triggering signal for the DVR-3 module and the necessary timing to ensure that the id occurs at the proper time and that the transmitter is keyed each time that the id message is played back. It also allows the message to be recorded and played back through dtmf commands.

Enhancements.

The 20 seconds of recording time normally is accessed all as one unit. However, with the addition of some external addressing switches, the 20 second capacity can be broken up, any way you like, into multiple messages. Although, switching circuitry to do this is not provided, the address line connections are provided, and information on how to add switches to do your own enhancements is given later in the manual.

Other enhancements may be added to suit your application. With a few changes, you can make the message repeat periodically or loop continuously.

Recording Quality.

The ISD-1420P is an amazing ic which implements an entire digital voice recording and playback system in one chip. This brings real voice to the radio community at a previously unheard-of low price. However, we don't want you to expect a one-chip system to sound like a music CD.

Limitations imposed by the restraints of putting everything on one chip result in good communications quality sound, but not hi-fi. There is a little noticeable hiss and a little distortion because of the digitizing and the limited sampling rate imposed by the number of eeprom cells which will fit on a chip. It is definitely real voice, though, and not a synthesized, artificial-sounding voice.

If you want to enjoy the benefits of digital recording technology at an attractive price and are willing to live with less than perfect audio, you will be pleased. We tell you this now because expectations have a lot to do with satisfaction.

INSTALLATION.

Mounting.

Four mounting holes should have been drilled in the repeater chassis before assembling the DVR-3 pc board. Now, set the board in place as shown below, and secure with four 4-40 x ¼ inch screws.

Caution: The digital recorder ic is static sensitive. Use suitable handling precautions, including grounding yourself, to avoid damage.

Wiring.

Dress the wire leads away from the DVR-3 board, as shown in the diagram below, along the front edge of the COR-5 board, and under the LED leads. Dress individual lead ends and solder as follows.

a. Connect the gray "audio output" wire to the loop at the top of R8 on the COR-5 board. Check that the resistor is oriented as shown, because the loop at the top of the resistor would be connected to the wrong point if the resistor was inadvertently reversed when the COR-5 board was assembled. Wrap the wire around the resistor lead, and tack solder.

b. Connect the brown "playback control" wire to the Voice ID Trip output pad at the right-front corner of the COR-5 board. (This is the pad which used to be called "Aux. #2" before the DVR-3 was available.) Insert the stripped end of the lead into the hole just enough to hold it, and solder from the top of the board.

c. Connect the blue "key carrier" wire to the top lead of R34, as shown in the diagram. Check that the resistor is oriented as shown, because the loop at the top of the resistor would be connected to the wrong point if the resistor was inadvertently reversed when the COR-5 board was assembled. Wrap the wire around the resistor lead, and tack solder.

d. Connect the yellow "record control" wire to the top lead of R38, as shown in the diagram. Check that the resistor is oriented as shown, because the loop at the top of the resistor would be connected to the wrong point if the resistor was inadvertently reversed when the COR-5 board was assembled. Wrap the wire around the resistor lead, and tack solder.

e. Connect the green "rcvr audio" wire to the third feedthrough capacitor from the front along the receiver compartment shield. This feedthrough has an existing gray wire connected to the audio input of the COR-5 board. Leave the original wire and add the new green wire.

f. The DVR-3 board gets its +5Vdc power directly from the 5V trace on the top of the COR-5 board. Bring the bus wire lead previous installed on the DVR-3 board from the +5V input pad on that board across to lay on top of the +5V bus trace on the COR-5 board as shown, and trim the length. Tack solder to the foil. Check to be sure that there is no

Table 1. Interconnecting Wires.

Wire Color	Length	Terminal
Blue	8 in	E3 KEY
Brown	12 in	Pad by R11
Gray	12 in	E1 AUDIO
Green	15 in	Top of R6
Yellow	7 in	E2 TRIP
Violet	3 in	Between 2 Pads As Shown

short circuit to any other foil traces.

OPERATION.

General.

Use of the DVR-3 requires firmware version 2.06 or later in the REP-200 Repeater. This includes all repeaters manufactured after December 1993. Older repeaters can be retrofitted by replacing the eprom; no hardware changes to the control board are required.

Recording a Message.

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*". Unkey the mic, and allow time for the command to be acknowledged. Then, key the microphone and say the message. Allow about a second of silence after the message, and then unkey your microphone.

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 and then key the mic, the yellow TimeOut led will illuminate to indicate the DVR-3 is recording. This led is used for convenience; it does not mean the time out timer had been triggered.

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 eprom programming.

Message Playback.

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.

THEORY OF OPERATION.

General.

Following is a thorough discussion of the operation, first of the digital voice recorder ic, and then of the support circuitry. You will need a background in digital electronics to understand some of it, although it isn't too complicated.

Recording Technology.

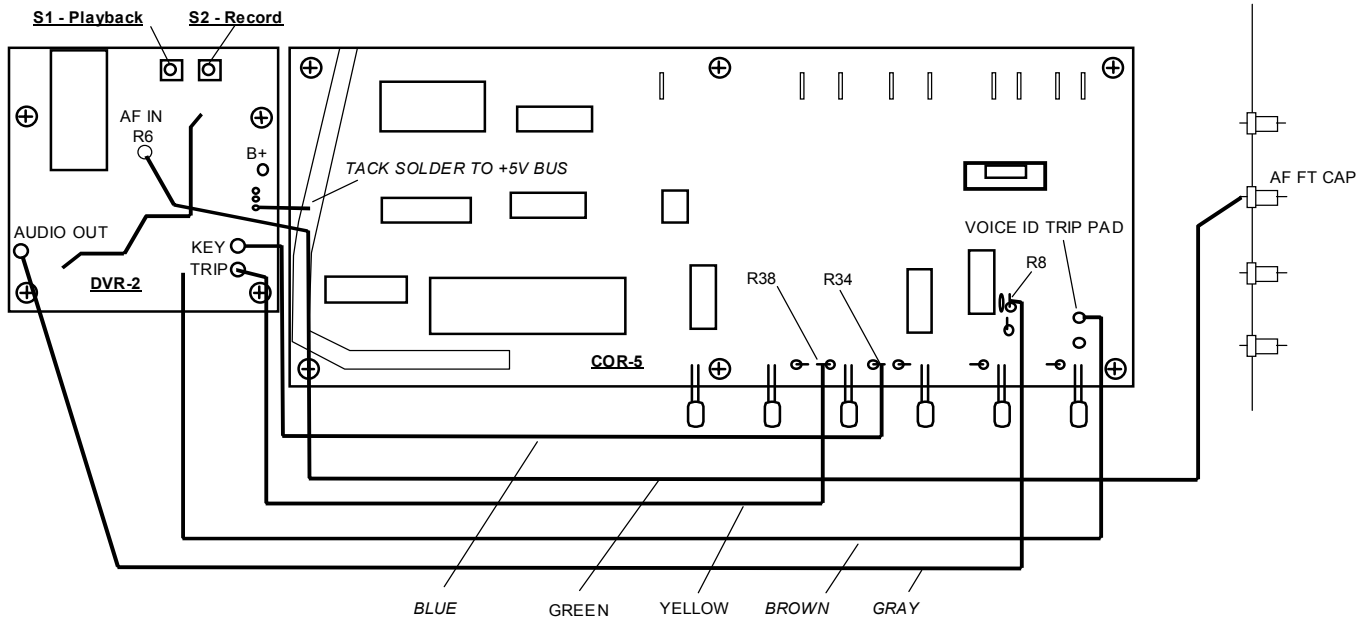
The ISD-1420P ic is an analog sampled data system, with on-chip microphone preamp, agc, anti-aliasing and smoothing filters, storage array, speaker driver, control interface, and internal precision reference clock. This system uses eeprom technology to directly record analog signals so no d-a and a-d converters are required.

The ISD-1420P ic 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.

Audio Recording Circuits.

Refer to schematic diagram at the rear of the manual and the block diagram of the ic below. The DVR-3 records audio from the receiver audio signal taken from the feedthrough capacitor which feeds the audio to the COR-5 board for repeater audio. R6 and R7 is a voltage divider to provide the proper level to recorder ic U1 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 C6, which also serves to tailor the frequency response and level to match the repeater audio input.

During recording, the 1420P chip 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.



View of Installation in REP-200 Repeater

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 signal path between the preamplifier and the fixed gain amplifier is completed by a blocking capacitor, which allows the fixed amplifier to be connected to a line input instead in some applications.

The preamplifier has automatic gain control, with the attack/release time constants set by R10/C12. 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 the input 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.

Audio Playback Circuits.

During playback, the recorded analog voltages are sequentially read from the storage array, thereby reconstructing the sampled waveform. The 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 the output power amplifier.

Although not normally used in the DVR-3, two output pins (14 & 15) can provide direct speaker drive capability of about 50 mW rms (100 mW peak) into a 16Ω speaker — enough to be clearly heard from the other side of a normal sized room. An external audio signal can also be applied to the speaker driver through the AUX IN at pin 11.

Audio for the repeater is derived from one line of the speaker driver. This audio is coupled through potentiometer R8, which allows for level adjustment, and R9/C10, which provides the proper output impedance and dc blocking.

U1 Control Circuits.

There are several control lines on the ic, of which we only use two.

The PLAY E (edge triggered playback) line, does two things when taken low momentarily. First, it resets the internal address pointer to zero. Second, it puts the ic in a power down state in which it draws very little current (for idling).

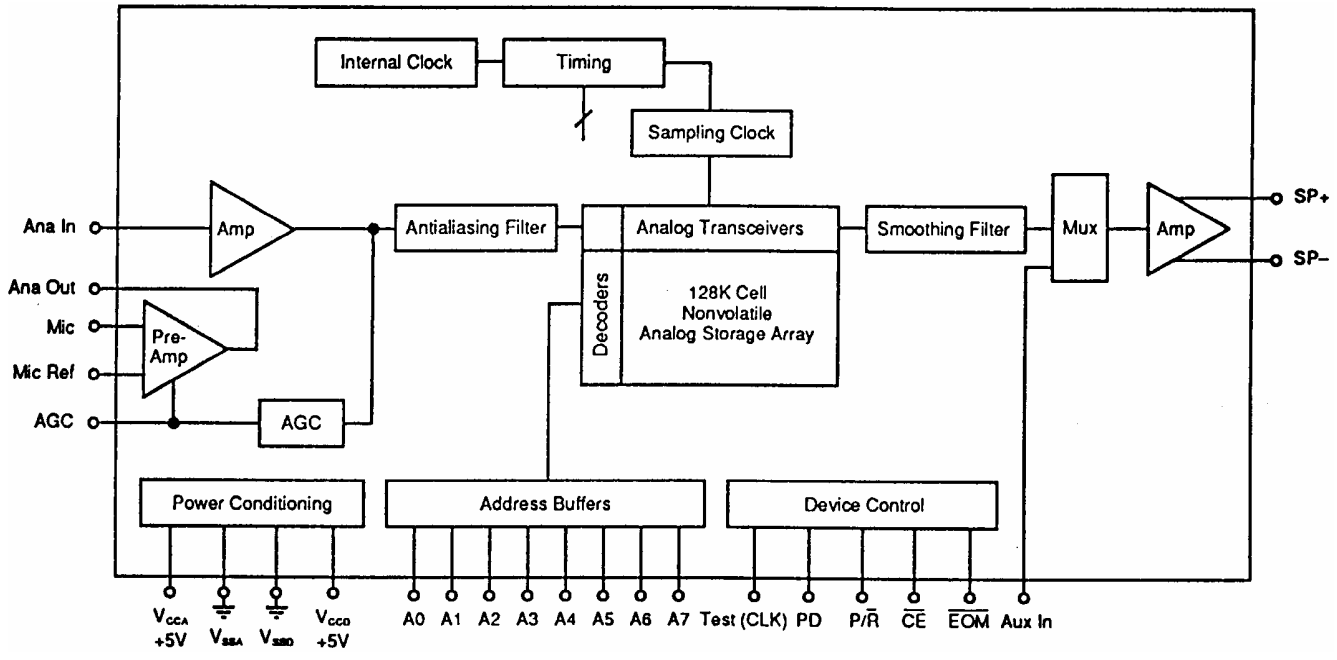
The REC line records a message up for as long as it is held low, but not exceeding 20 seconds.

Record Circuit.

Now that you know the functions of the control pins on the U1 chip, we can discuss how the external control circuits operate. *Refer to the schematic diagram.*

In order to record a message, a ground is applied from the repeater controller. This works in conjunction with pull-up resistor R2 to apply either +5Vdc or ground to playback/record pin 27 on the U1 chip. When recording is necessary, ground is applied, and pin 27 is held low, in the record mode. This causes the ic to be in record mode and to run, i.e., for the clock circuits to step through a message.

At the end of the recorded message, releasing the ground input stops the record cycle and causes the chip's internal control circuitry to



Block Diagram of ISD-1420P Voice Record/Playback IC

put an "end of message" marker at the point in memory where the message ends. On playback, this marker controls where playback stops.

In order for the ic to play back, a momentary ground is applied to the playback line from the repeater controller. This works in conjunction with pull-up resistor R1 to apply either +5Vdc or ground to the PLAY E line on the U1 chip. This is an edge triggered command line, which means only a momentary ground is required to start the palyback operation.

Remote Control Circuits.

In order for the COR-5 Control Board to control the record and playback cycles of the DVR-3, two control lines are connected to the COR board.

Playback control is connected through the brown wire to a dedicated port on the microcontroller chip on the COR-5. When the controller decides playback is required, it applies a ground pulse of approximately 100 milliseconds duration to the Playback Control input on the DVR-3. This starts the playback cycle, which continues until the end of message marker is reached inside the ic.

To record, the controller board grounds the Record Control line continuously while also holding the Playback Control line low. The Record Control line is connected to the circuit on the COR-5 board which operates the Time Out led. Since no more microprocessor ports were available, the port which operates the led also is used for Record Control. In order to prevent recording during a time-out condition in the repeater, when the Time Out led comes on, Q1 inhibits the operation of Q5 unless the playback line is also activated.

Q2/Q3 ID Key Circuit.

The base of Q2 is biased on or off by current from R1 in the Q1 latch circuit. When that circuit is in a playback cycle, Q2 is turned on, which applies bias to turn on Q3. That transistor, in turn, applies a ground to the exciter keying circuit on the COR-5 board. This action holds the transmitter on while an ID message is played back and operates independently from the microcontroller on the COR-5 board which normally keys the transmitter.

Addressing.

There are two types of addresses used in the U1 chip. The first is an internal address pointer, which at any given time, keeps track of which memory cell is next to be read or written. At the beginning of a record or playback cycle, it starts at a starting location and cycles through until the end of the message and remains there until the PD line is brought high, which resets it to the starting address again.

The starting address normally is set by the address control lines on the upper left side of the pc board. As the board comes from the factory, these lines are all strapped to ground by pc board traces; so the starting address is zero. If one or more of these lines is raised to +5Vdc, the starting address for a given record or playback cycle is changed to some other location in memory. This feature normally is not used in the DVR-3.

Power Distribution.

In the DVR-3, the +5Vdc operating voltage for the board is derived from the regulated +5Vdc power bus on the COR-5 board. Electrolytic capacitor C13 provides a low ac impedance for the 5V bus on the DVR-3 board.

There are two separate +5Vdc busses on the DVR-3 board and separate sets of Vcc and Vss pins on the recorder ic for digital and analog power supplies. Because noise from the switching and clock circuits in the chip could affect the quality of the recording and playback audio, these two power paths are carefully separated and filtered from each other at various frequencies from audio up through the vhf range. This is also the reason a special microphone reference line is used to carefully establish the reference point used for the op-amp microphone preamp to suppress any noise from affecting the recording. It is important to maintain these features if you make any modifications to the circuits.

TROUBLESHOOTING.

General.

Tracking down trouble is fairly straightforward. The *Theory of Operation* section describes the signal path and what each circuit does.

Remember that the ic's are static sensitive. You don't want to further damage the board while troubleshooting. A ground wrist strap should be worn when handling the ic's.

Significant logic voltages are high's (near +5V) and low's (near ground) as marked on the schematic by the little pulse symbols. Following is a stage-by-stage description of other voltages which should be present under various conditions.

A logical troubleshooting procedure would be to start by checking for expected operation with the proper ground inputs applied to record or playback. If you can't hear any audio or the transmitter does not key when playback ground is applied momentarily, then check various voltages and logic levels. An oscilloscope may be necessary to check audio levels. If the unit works manually but the timer and external trip circuits do not respond as expected, then trace those signals through the circuit, referring to the schematic diagram and information in the *Theory of Operation* section of the manual.

Digital Recorder U1.

All analog circuits in 1420P ic U1 are referenced to an internally generated bias of approximately 1.5Vdc. This voltage can be measured at the mic input (pin 17), mic ref (pin 18), ana input (pin 20), and ana output (pin 21), but only in the record mode. In playback mode, these pins measure near ground. The audio output pins (14 and 15) should each measure about 1.5 Vdc to ground in playback mode.

The agc line at U1 pin 19 rests at about 1.5Vdc in record and peaks up just a little bit if you apply loud audio to the audio input to make the agc take action.

Here are some typical ac voltage measurements. In record mode, the mic input voltage at pin 17 should be about 20 mVp-p. The analog input voltage at pin 20 should be about 50 mVp-p. In playback mode, the audio output between pins 14 and 15 should be about 3Vp-p (1.5Vp-p ref ground).

The control signal pins on U1 are at logic levels noted on the schematic.

Switching Transistors.

Q3 provides a ground to the key output at E3 whenever a message is played back. The base of Q2 is turned on by the playback ground pulse input and R1, and remains on

for the duration of the playback. Q2, in turn, biases Q3 on.

Q1 initially is turned on by a ground pulse from the Playback Control line. It is held on by voltage applied through R4 and R5 from the audio output of U1, which has dc bias only during playback. At the end of the message, the EOM ground pulse from U1 pin 25 turns off Q1.

During record, the record ground input from the repeater controller grounds the P/R pin 27, which puts U1 in record mode instead of playback. The Playback Control line must hold the record circuit at ground to make the ic run during record. Because their is no output on the audio output pins (14 & 15) during record, Q1 does not latch on as it does in playback mode.

Switching transistors Q4 and Q5 act as a buffer for the Record Control input from the Time Out led circuit on the COR-5 board. When the COR-5 requests a record session, Q5 grounds the record circuit.

Power Supply Circuit.

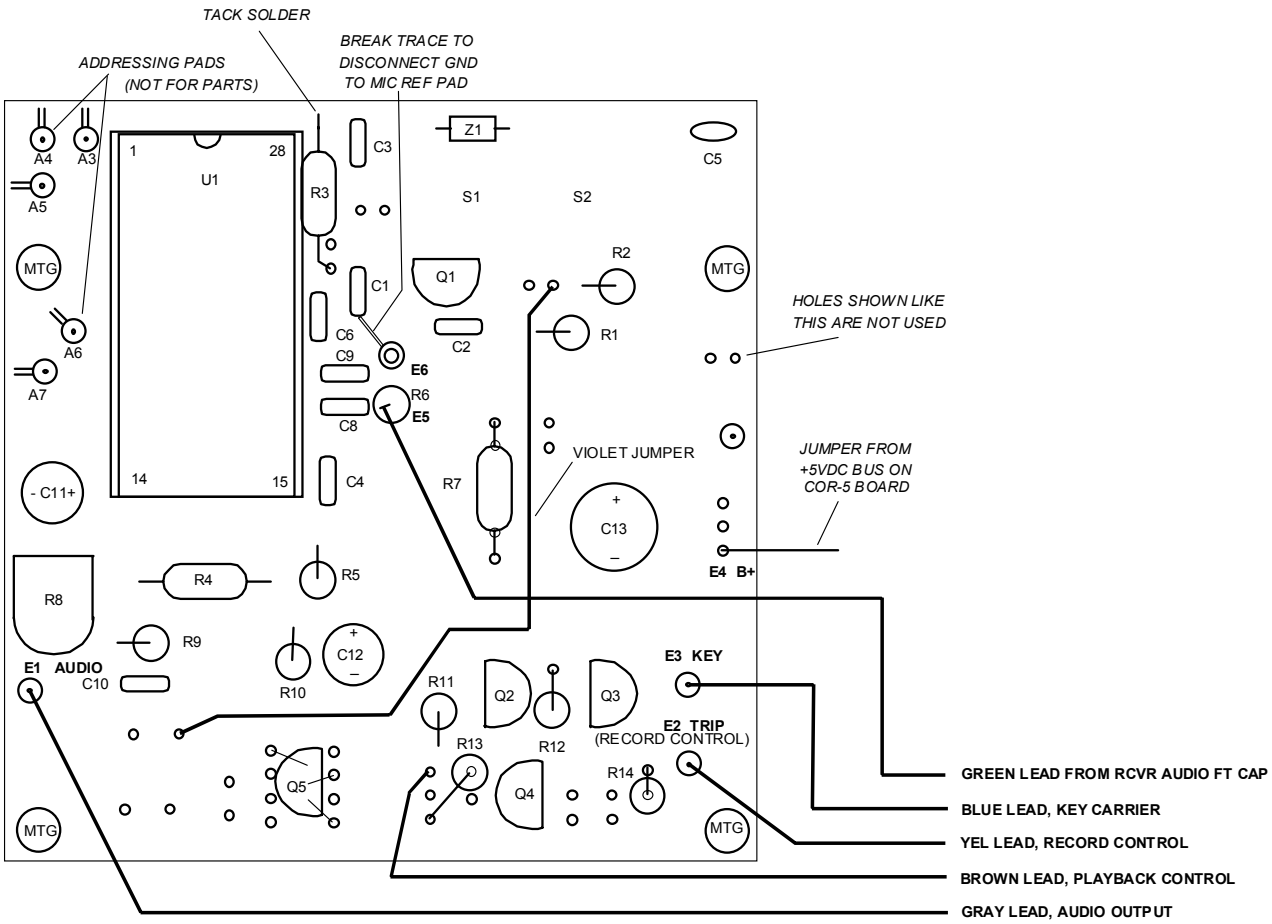
The acceptable range of operating voltages is +4.75 to +5.25 Vdc. Current drain normally is about 4 mA at idle and 22 mA in playback mode.

It is very important, though, to protect the entire board from voltage transients and reverse polarity, which will cause damage. If the DVR-3 is powered from the COR-5, as is normal, then you don't need to worry about transients. But if you use a separate power source, be careful, especially if any relays are powered from the same line. Any relay coils or other inductive devices must have diodes connected across them to absorb transients generated when current to the coil is switched off.

PARTS LIST.

* Indicates component surface mounted under pcb.

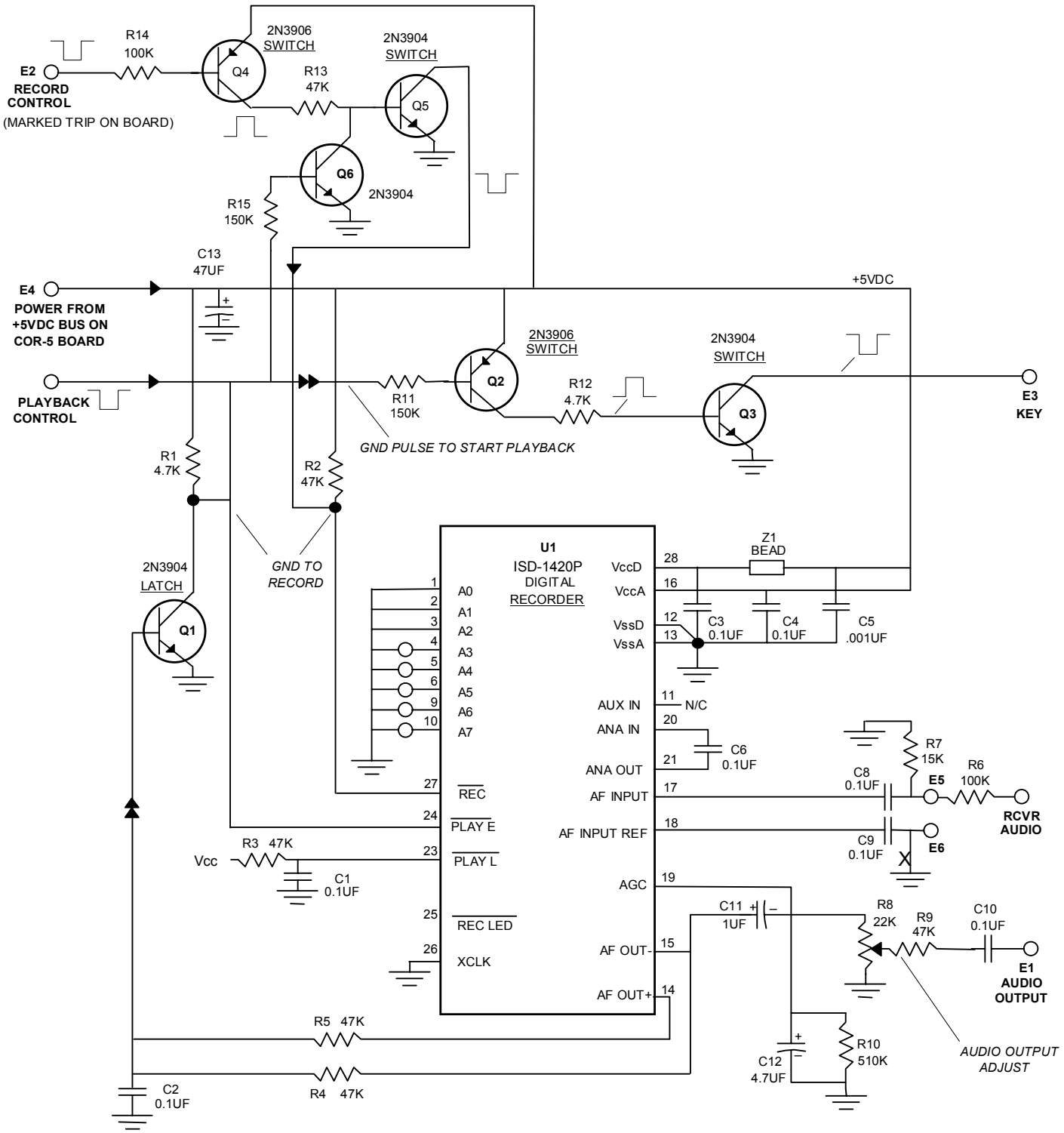
Ref Desig	Description (marking)
C1-C4*	0.1µf
C5*	.001µf
C6*	0.1µf
C7	not assigned
C8-C10*	0.1µf
C11	1µf electrolytic
C12	4.7µf electrolytic
C13	47µf electrolytic
Q1	2N3904
Q2	2N3906
Q3	2N3904
Q4	2N3906
Q5-Q6	2N3904
R1*	4.7k
R2*	47k
R3-R4	47k
R5*	47k
R6	100k
R7	15k
R8	22k or 20k pot
R9*	47k
R10*	510k
R11*	150k
R12*	4.7k
R13	47k
R14*	100k
R15	150k
U1	ISD-1420P recorder ic
Z1	ferrite bead, prestrung



Note: Q6 and R15 are located under board and are not shown here.

DVR-3 DIGITAL VOICE RECORDER MODULE, REV. C, COMPONENT LOCATION DIAGRAM

 Revised: 4/27/05



DVR-3 DIGITAL VOICE RECORDER MODULE, REV. C

