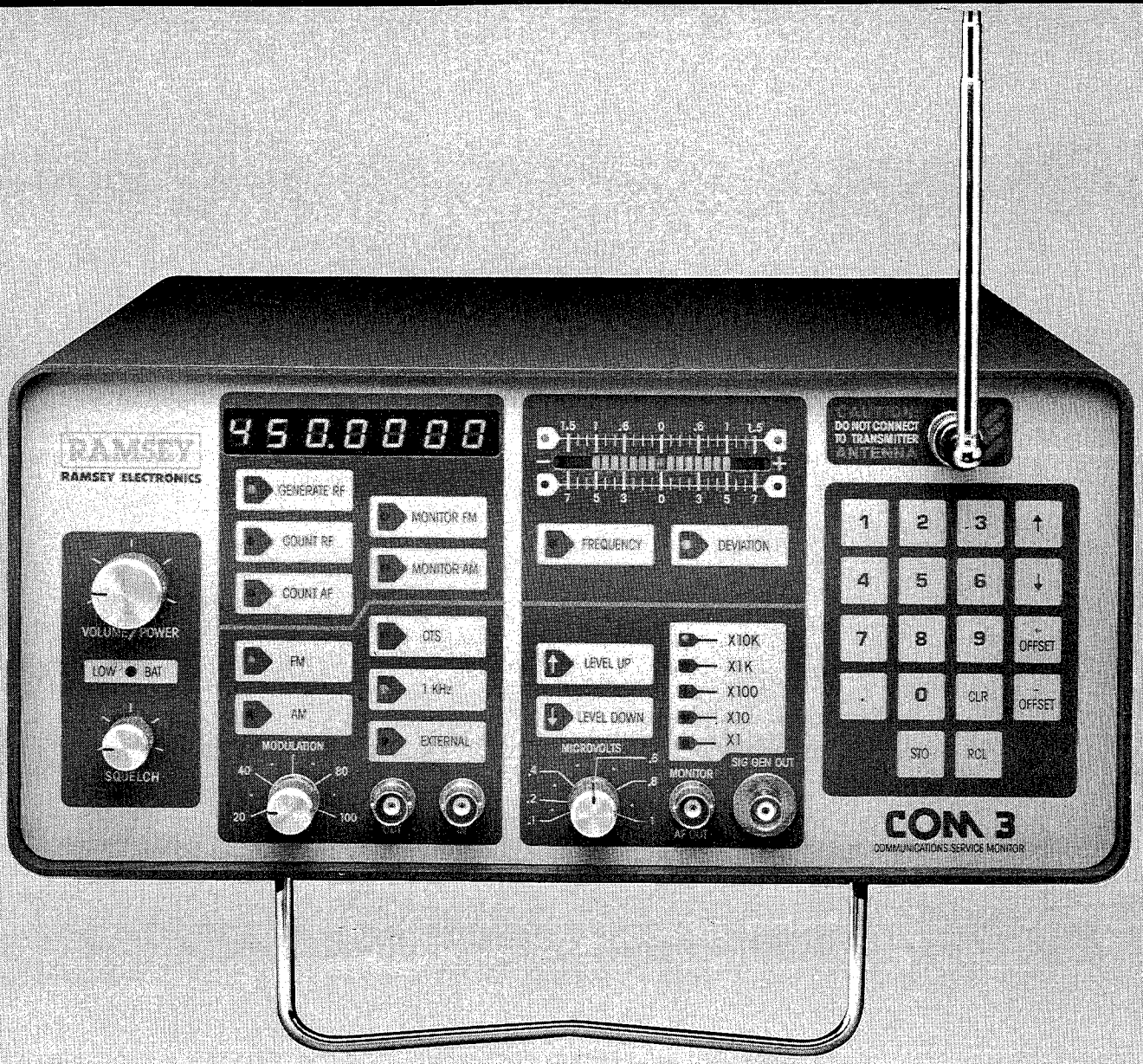
COM 3

COMMUNICATIONS SERVICE MONITOR



Owner's Manual

RAMSEY

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COM 3 Service Monitor Owner's Manual

Version 1.7

RAMSEY

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SECTION 1
GENERAL INFORMATION

The Com 3 is a lightweight, compact service monitor for testing AM and FM transceivers. The internal battery, which is a standard feature of the Com 3, combined with the optional carrying case and low weight (13 lbs), make it ideal for field use. Utilizing specially designed micro powered oven circuits, warm -up time is minimal, providing maximum use of the battery.

The frequency range is 100 KHz to 999.999 MHz in 500 Hz steps. Standard CTS tones as well as a 1 KHz tone can be generated. RF power is continuosly variable in five ranges from 0.1 µv to 10,000 µv. The display is a seven digit LED type which will display frequencies generated or received, CTS off air, as well as being an audio and RF frequency counter. Deviation and frequency error are displayed on a 20 segment LED bargraph, which is easily visible from across the shop.

An internal RF relay switches transmitted power greater than 500 mW to a rear panel mounted BNC connector. This protects the Com 3 from accidental keying and allows easy connection of an antenna, power meter, or dummy load.

1.2 Specifications

1.2.1 Generate Mode

1.2.1.1 Frequency

Range	100 KHz to 999.999 MHz
Resolution	500 Hz
Display	7 digit LED
Accuracy	see time base

1.2.1.2 Rf Output

Range	0.1 µv to 10,0000 µv in 5 ranges
Accuracy	±2.0 dB (10 MHz to 900 MHz)
Attenuctor	20 dB / step

1.2.1.3 Spectral Purity

Non-Harmonic	<-50 dBc within 10 KHz of carrier (all land mobile bands)
Other	2 signals, f1 and f2 For f1 = (fc + Fine Loop) 10 dB below maximum RF output range selected For f2 = (fc + 2(Fine Loop) MHz, same level as fc Fine Loop: 5 to 7 MHz, depending upon selected frequency

1.2.1.4 Reverse Power Protection

Type	Automatically switches to external load at inputs > 500 mw
Power	Up to 100 watts (10 seconds)

1.2.1.5 Modulawion

	FM
Deviation	0 to 15 KHz peak (displays to 7 KHz only)
Ranges	±1.5 , ±7.0 KHz

Bandwidth,3dB	10 Hz to 10KHz
Accuracy	±5% of full scale (1 KHz frequency)
External Input	1 vpp for 3 KHz peak
	AM
Depth	0 to 99%
Bandwith, 3dB	10 Hz to 10 KHz
Accuracy at 30 % mod.	± 5% of full scale (1 KHz frequency)
External Input	1 vpp for 50 %

1.2.2 Receive Mode

1.2.2.1 Frequency

Range	100 KHz to 999.9999 MHz
Resolution	500 Hz
Display	7 digit LED
Accuracy	see time base
Sensitivity	5.0 µv for 10 dB quieting (10 MHz to 900 MHz)
Bandwidth	3 dB / 7 KHz

1.2.2.2 Modulation Measurement Mode

FM Mode

Deviation	0 to 7 KHz
Ranges	±1.5 , ± 7.0 KHz
Bandwidth, 3 dB	10 Hz to 10 KHz (display limited to < 7 KHz)
Accuracy	±5% of full scale (1 KHz frequency)
Display	20 segment LED bargraph

AM Mode		(Carrier frequency error only)
Ranges		± 1.5 , ± 7.0 KHz
Accuracy		± 5% of full scale
Display		20 segment LED bargraph

1.2.3 Time Base Characteristics

	STANDARD OCXO	HIGH STABILITY OCXO
Accuracy	± 1.0 ppm	± 0.5 ppm, ± 0.25 ppm, or ± 0.10 ppm
Aging rate	± 2.5 ppm / year	± 1.0 ppm / year
Oper. range	0 to 50 ° C	0 to 50 ° C
Stability	± 1.0 ppm after 5 minutes at 25 ° C	± 0.5 ppm after 10 minutes at 25 ° C

1.2.5 Frequency Counter Mode

Ranges	10 Hz to 1.0 KHz, 0.1 Hz resolution 10 MHz to 999.999 MHz, 1 KHz resolution

1.2.6 GENERAL

Operating temperature	0 to 50 ° C
Power requirements	117 VAC, or 12 VDC
Dimensions	12" W x 5.5" H x 14" D
Weight	13 lbs

1.2.7 OPTIONS

High stability timebase	An oven controlled oscillator which increases the accuracy to 0.5 ppm, 0.25 ppm, or 0.10 ppm depending on which model is selected.
12 VDC cigarette plug	Allows the Com 3 to operate from a car's battery
Cordura travel case	A rugged carrying case made from black Cordura nylon, with a convenient zipper pouch for holding schematics, probes etc.
Protective front cover	Vacuum formed plastic cover for protecting the Com 3's front panel.
Side Handle	A side mounted handle for easy transportation of the Com 3.

1.2.8 SPECIAL MODIFICATIONS

Due to the constant advancements in the two way communications field, customer needs may require a special modification, either at the time of purchase, or some time in the future. Contact the customer service department at 716-586-3950. We will do our best to meet your needs, please note that modifications will require a service charge, and some may not be possible.

SECTION 2
INSTALLATION

2.1 INTRODUCTION

The Com 3 is a rugged, portable service monitor that is equally at home in the field or on the bench. Refer to the following sections when unpacking your service monitor.

2.2 UNPACKING AND INSPECTION

When unpacking your service monitor check, the shipping container and the monitor for shipping damage. Save the container for future use, or in the event of an insurance claim.

Your Com 3 was thoroughly tested and inspected , then carefully packaged prior to shipment and should operate according to section 3 of this manual.

If your monitor was damage in transit, contact the carrier immediately. Save all shipping and packing materials for inspection by the carrier. Contact the carrier to report the incident.

2.3 POWER REQUIREMENTS

The Com 3 operates on 117 VAC 60 HZ . The three conductor power cord provides a ground connection when it is connected to a properly grounded outlet. Using the optional 12 VDC power cord, the Com 3 can be operated from a car's battery. The Com 3's internal battery **cannot** be charged from an external DC source.

NOTE: Do not start the engine while the Com 3 is plugged into the cigarette lighter. This could result in damage to the Com 3.

A 240 VAC 50 Hz version of the unit is available by special order. There is an addtional charge for this option.

2.4 ENVIRONMENTAL CONSIDERATIONS

The Com 3 comes equipped with bottom and rear panel feet (the rear panel feet act as cord wraps), and a tilt bail . These features allow the unit to be used in almost any situation.

The Com 3 is designed to operate between 0° C and 50° C. Care should be taken to keep the unit clean and dry.

SECTION 3
OPERATION

3.1 INTRODUCTION

Use of the Com 3 is as straight forward as the front panel layout, you can begin using the Com 3 without even reading this manual. We suggest you do read it though, to take advantage of all the features available.

3.2 FRONT PANEL DESCRIPTION

The Com 3's front panel is a flat, fully sealed membrane switch designed for years of reliable service. All numeric data is entered through the keypad located on the right front side. An audible tone will sound when a key is depressed to indicate positive contact.

Note, related keys that control the various functions of the Com 3 are logically grouped together. Refer to figure 3.1 and the following section for an explanation of each control and its function.

(1) **POWER:** applies AC power when the Com 3 is plugged into a standard 117 VAC outlet, or supplies 12 VDC from the internal battery in areas where there is no 117 VAC source available.

(2) **LOW BAT:** indicator lights when the internal battery needs recharging.

(3) **VOLUME:** controls the audio level of the internal speaker.

(4) **DISPLAY:** A 0.4" 7 segment LED display shows the generate or receive frequency, AF frequency, or RF count frequency depending on mode selected.
Note; that the display is calibrated in KHz for the Count AF mode and in MHz for all other modes.

(5) **GENERATE RF:** selects the GENERATE RF mode. The display will indicate the frequency being generated.

(6) **COUNT RF:** enables the Com 3's RF frequency counter. The display will show the frequency being measured. Display indicates in MHz.

(7) **COUNT AF:** enables the Com 3's audio frequency counter, the display indicates in KHz.

(8) **MONITOR FM:** enables the monitor FM mode, the display indicates the frequency selected for monitoring.

(9) **MONITOR AM:** enables the monitor AM mode, the display indicates the frequency selected for monitoring.

(10) **FM:** enables the FM modulation mode. Only operates in the GENERATE RF mode.

(11) **AM:** enables the AM modulation mode. Only operates in the GENERATE RF mode.

(12) **CTS:** enables the CTS mode Generates all standard EIA CTS tones from 50 Hz to 300 Hz (see table 3.1) Only operates in the GENERATE RF mode.

(13) **1 KHz:** enables the internal 1 KHz tone source. Only operates in the GENERATE RF mode.

(14) **EXTERNAL:** allows an external modulation source to be connected to the Com 3's external input. Signal can be looped through using the **IN** and **OUT** jacks (numbers 15 and 16 respectively). Only operates in the GENERATE RF mode.

(15) **IN:** jack is for the input of an external modulation source. Approximately 1v p-p required for 3 KHz deviation.

(16) **OUT:** jack allows the external source to be looped through the Com 3. Also will source CTS and 1 KHz if so selected.

(17) **MODULATION KNOB:** controls the percent modulation in AM mode,and the deviation in FM mode. In the FM mode,the bargraph will indicate the amount of FM deviation.

(18) **BAR GRAPH DISPLAY:** a 20 segment LED bar graph display which shows deviation in one mode and frequency error in the other mode.

(19) **FREQUENCY:** sets the bargraph into frequency error mode, touching the key again changes the frequency range. 2 LED's light up, one on each side of the range selected.

(20) **DEVIATION:** sets the bargraph into deviation mode, touching the key again will change the deviation range. 2 LED's light up, one on each side of the range selected.

(21) **LEVEL UP:** increases the output level in 1 dB. steps.

(22) **LEVEL DOWN:** reduces the output level in 1 dB. steps.

(23) **ATTENUATOR DISPLAY:** indicates the attenuator range selected.

(24) **MICROVOLTS:** control knob varies the output within the range selected.

(25) **MONITOR AF OUT:** jack allows deviation to be monitored by using an oscilloscope.

(26) **RF OUT:** output jack thru which the generate RF signal is available, and also the input **for a transmitter.**

(27) **RF IN:** input jack for the Com 3's RF frequency counter and Frequency / Deviation receive monitor.

WARNING : Do not connect a transmitter to this jack or serious **damage will result!**

(28) **0-9:** used for numeric data entry into the Com 3.

(29)  step the Com 3 in 500 HZ increments up or down. Useful for checking a receiver's discriminator zeroing.

(30) **+OFFSET/-OFFSET:** programmable offset keys for repeater service, or channel stepping.

(31) **CLR:** clears the current entry in the display

(32) **RCL:** recalls a previously stored test setup.

(33) **STO:** stores the current test setup into one of the Com 3's **ten** memories (0 - 9).

3.3 INITIAL TURN ON

Connect the rear panel AC line cord to a suitable power outlet and turn the power switch on. The front panel display will light indicating power on. When first turned on The Com 3 should always start out with these settings.

Display : 450.0000 MHz
Generate RF: on
FM: on
1 KHz: on **CTS:** off **Ext.tone:** off
Deviation: on, 1.5 Khz range selected
X10K: on

If these conditions do not exist refer to the trouble shooting section.

Com 3's equipped with the **standard OCXO** will generate 1ppm precision signals within10 minutes. Units equipped with the **high stability OCXO** will produce 0.5ppm accuracy after 10 minutes. When using the Com 3 in cold environments longer warm-up times may be required.

DETAILED OPERATION OF THE COM 3

3.4 GENERATE RF

To generate an RF frequency, type in the desired frequency then touch the **GENERATE RF** key. **NOTE:** the display always reads the frequency in Mhz, therefore an entry of 10 would generate 10 Mhz, an entry of 0.1 would generate 100Khz. For frequencies above 100 MHz, it is not necessary to enter the decimal point.

3.5 RF OUTPUT LEVEL

The output level is controlled by a five step attenuator and a variable attenuator. The ranges available are;

0.1 to 1.0µv ,1.0 to 10.0 µv ,10.0 to 100µv.
100 to1,000 µv,1,000 to10,000 µv.

To select the desired range, touch the **LEVEL UP** or **LEVEL DOWN** key to select the desired range. An LED will light next to the range selected. The output can be controlled within the range by the control knob labeled **MICROVOLTS.**

3.6 FM MODULATION

To FM modulate the RF frequency selected, touch the **FM** key. The deviation is adjustable by the **MODULATION** control knob. The indications on the knob have no reference to the FM deviation, they are used for AM modulation. The deviation will be displayed automatically on the LED bargraph.

3.7 AM MODULATION

To AM modulate the RF frequency selected, touch the **AM** key. The percentage of modulation is adjustable by the **MODULATION** control knob and is variable from 10 to 100 percent.

3.8 CTS TONE GENERATION

The Com 3 will generate all the standard CTS tones (see table 3.1). CTS can be generated in either the AM or FM modulation modes, and in conjunction with the internal 1Khz tone source, or an external tone source. To generate a CTS tone touch the **CTS** key, enter the desired frequency, then press the **CTS** key again. The display will show the current CTS tone being generated.Power up default tone is (100.0 Hz). If an improper tone is entered, it will not be accepted. To return the display to the generated RF display, just touch the **GENERATE RF** key, to display the CTS tone touch the **CTS** key. The **MODULATION** knob will control the deviation of the CTS tone when in the CTS mode.

STANDARD EIA CTS TONES (Hz)			
67.0	97.4	136.5	192.8
71.9	100.0	141.3	203.5
74.4	103.5	146.2	210.7
77.0	107.2	151.4	218.1
79.7	110.9	156.7	225.7
82.5	114.8	162.2	233.6
85.4	118.8	167.9	241.8
88.5	123.0	173.8	250.3
91.5	127.3	179.9	
94.8	131.8	186.2	

Table 3.1

3.9 1 KHz INTERNAL TONE

Touching the **1 KHz** key will enable the internal 1 KHz tone. In **AM** mode, the **MODULATION** knob will control the percent modulation, in **FM** mode it will control the deviation.

3.10 EXTERNAL SOURCE INPUT

Touching the **EXTERNAL** key will allow the connection of an external tone source. (see specifications Chapter 1 for limitations on this input) The source is looped through the Com 3 using the **IN** and **OUT** jacks located under the **EXTERNAL** key. The percentage of modulation in **AM** mode is adjusted using the **MODULATION** knob, in **FM** mode it will control the deviation.

3.11 COMBINING CTS AND INTERNAL / EXTERNAL TONE SOURCES

Select the **CTS** frequency desired and adjust for the desired deviation (for example 0.6 KHz). Then select the **1 KHz** mode. The 1 KHz tone will now have a deviation of 3 KHz, and will vary in a 5/1 ratio with the CTS tone. (0.6 KHz CTS deviation will produce 3 KHz deviation of the 1 KHz tone).This ratio was chosen since the most common deviation for CTS is 0.6 KHz and 3 KHz for voice. Having the two signals in this ratio allows for CTS testing in the presence of voice.

Use of the **CTS** and **EXTERNAL** tone sources work in a similiar manner as the **CTS** and **1 kHz**. The CTS tone sets the same 5/1 ratio as in the above example. An external input of 1 vp-p will produce 3 KHz of deviation. Therefore a setting of 0.6 KHz CTS, with 1 vp-p external input will produce 3 KHz of deviation of the external tone.

3.12 OFFSET + / OFFSET -

The Com 3 allows you to select any offset frequency you desire. Enter in the desired offset using the keyboard, then touch the **STO** key and then touch the **OFFSET+** key. This will store the desired offset into the Com 3's memory. Pressing **OFFSET+** or **OFFSET-** will increment or decrement the display by the offset amount.

3.13 500Hz STEP

The two arrow keys are the 500Hz up or down keys. Touching either of these keys will allow you to step 500Hz at a time.

3.14 STORING/RECALLING TEST SETUPS

The Com 3 has the capability of storing up to 10 different test setups in its memory. Stored is the current set-up selected on the Com 3's front panel, including all frequencies being generated, CTS, offsets, etc. To store a test setup touch the **STO** key, then the number of where you want it stored (0-9). To recall a setup, touch **CLR**, then **RCL**, then the number of the memory you wish to recall (0-9).

3.15 SPURIOUS SIGNALS

In any wideband, receiver spurious signals sometimes present problems. We would like to bring to your attention the existance of a non-problematic spur within the Com 3.

Refer to the block diagram (fig. 4.1) and the main board schematic during the following explanation.

The Com 3 has a reference oscillator of 4 Mhz, the fourth harmonic of this is 16 MHz. The first IF is from 14.5 to 16.5 MHz, and the second IF is 9.5 MHZ. As you can see, if an incoming signal is at such a frequency as to hit the first IF at 16 MHz, there would be a possibility of interference or a heterodyne due to the Com 3 receiving the forth harmonic of its own reference oscillator. This will

occur every 1 MHz throughout the range of the Com 3, for example, 450.0000,451.0000, 452.0000, 453.0000 etc. This does not present a problem however, as the level of the fourth harmonic is only approximately 10 µv. An incoming signal of 20-30 µv will easily over come this. If you have selected a frequency under these conditions please be aware that the squelch will open up and a weak carrier will be heard. This should be of no concern and is considered normal.

3.16 Leakage

Leakage from the Com 3 is virtually unmeasurable. If you are using the Com 3 with a coax cable connecting your transceiver to the **RF OUT** jack, you will probably never have to be concerned with leakage.Most mobile and base tranceivers have plenty of shielding in their front ends, they will not normally receive any minute radiated emissions. However, in the event that you are making a sensitivity measurement on a handheld unit or a pager utilizing a direct cable connection, shielding caps should be placed on all unused connectors and the test set-up should be positioned away from the com 3. Handheld units and pagers are designed to pick up radiated emissions directly through antennas mounted either on them or in them,thus they have little use for expensive front end shielding.True radiated emission (µv/cm*) testing of a pager or a handheld tranceiver can only be accomplished using an RF shielded test box .This is especially true in RF congested areas.Keep in mind that <u>all</u> generators even the most expensive models radiate some amount of RF especially at UHF. You may be able to sniff out some RF from your Com 3 using a handheld or a pager but this is normal. RF shielded boxes and rooms are widely available although expensive.

3.17 Audio Count Off Air

To measure audio frequencies off the air, set the Com 3 up for receive on the channel frequency desired, then touch the **COUNT AF** key. Select the approximate deviation range of the tone by touching the **DEVIATION** key (ranges are ± 1.5, ± 7.0 KHz). High deviation tones, ±1.5 KHz or greater, should be read in while in the ± 7 KHz range, while low deviation tones, such as CTS, in the ± 1.5 KHz range. The display will now indicate the audio frequency.

3.18 Audio Count External

Connect the audio source to the external **IN** jack, then touch the **GENERATE RF** key and the **COUNTAF** key in that order. The external light will automatically come on, and the display will indicate the audio frequency. The input level must be at least 50 mv, but should not exceed 5 v.

3.19 RF Count

To count RF frequencies connect the whip antenna to the **RF IN** jack, then touch the **COUNT RF** key, the display will indicate the frequency in MHz. The range is 10 MHz to 999.999 MHz, resolution is 1 KHz.

WARNING: Do not transmit into the RF IN jack, this will cause serious damage to your Com 3. This jack is for whip antenna connections only. Transceivers should be connected to the RF OUT jack, inputs over500 mW will be switched to the rear panel mounted BNC connector.

Section 4
Typical Test Setups

4.1 INTRODUCTION

This chapter outlines typical measurements that can be made with the Com 3. For our example we will use a FM transceiver with a receive frequency of 469.150 MHz, a transmit frequency of 464.150 MHz, with a CTS tone of 82.5 Hz.

NOTE

The COM 3 **DOES NOT** have an enter key. After entering in the desired frequency a function must be selected to complete the entry, or nothing will happen. (ie enter in 464.150 then touch the **GENERATE FM** key) The function keys are **(GENERATE-FM , MONITOR-FM** and **MONITOR-AM).** If you change the frequency within a mode, you must touch the same function key again to complete the function, or you will select a different operating mode. This does not apply to the frequency storage or increment modes.

4.2 FREQUENCY COUNTER OFF AIR

This test allows you to count the frequency of a transmitter off air, this is especially useful for identifying the frequency of unmarked radios that come in for repair.

1) Connect the whip antenna to the Com 3's **RF INPUT.**

2) Push the **COUNT RF** key, then key the transmitter, the display will indicate the transmitted frequency (in MHz).

NOTE

You may have to bring the transmitter within a few inches of the Com 3's whip antenna in order to achieve a stable count. This is due to the fact that the Com 3 is less sensitive as a frequency counter (typically 25 millivolts) in this mode.

4.3 FREQUENCY COUNTER DIRECT CONNECTION

The Com 3 can be used as an RF frequency counter by connecting a 50 Ω probe or sniffer loop to the RF input. This is useful for the alignment of crystal oscillators.

1) Connect a 50Ω probe or sniffer loop to the **RF INPUT.**

2) Bring the loop close to the oscillator, or connect the probe to an appropriate test point. The Com 3 will display the frequency in MHz.

4.4 FREQUENCY/DEVIATION MEASUREMENTS

The following series of tests will allow the measurement of the frequency and deviation, of the transmitter, and the PL tone. NOTE: We will assume that the transmitter is 300 Hz low in frequency, has deviation of 7.4KHz, the PL tone deviation is 1KHz, and the frequency of the tone is high by 5.0 Hz.

4.4.1 TRANSMITTER FREQUENCY MEASUREMENT

1) Connect the whip antenna to the **RF INPUT** jack.

2) Enter in 464.15, then touch the **MONITOR FM** key.

3) Connect the tranceiver to be tested to an antenna or dummy load.(**DO NOT** under any circumstances connect a transmitter to the **RF INPUT** of the Com 3, serious damage will result.)

4) Touch the **FREQUENCY** key, and two red lights will light, one on each side of the (1.5KHz)bargraph display. Touch the **FREQUENCY** key again and the (7.0 KHz) range is selected. Key the transmitter, note that only the center LED is lit.

5) Touch the **FREQUENCY** key to select the (1.5 KHz range). The first two LEDs from center on the minus side of the scale should be lit, indicating that the transmitter frequency is 300 Hz low. Adjust the transmitter until only the center LED is lit. The transmitter is now exactly on 464.150 MHz.

4.4.2 CTS TONE FREQUENCY MEASUREMENT

1) Connect the whip antenna to the **RF INPUT** jack.

2) Enter in 464.15, then touch the **MONITOR FM** key and the deviation key.

3) Connect the tranceiver to be tested to an antenna or dummy load. (**DO NOT** under any circumstances connect a transmitter to the **RF INPUT** of the Com 3, serious damage will result.)

4) Key the transmitter, (mute the microphone so no voice or background noise will disturb the measurement). If too much background noise or voice is present, the frequency display will say (**Error**).The amount of background noise can be observed on the deviation bargraph display (1.5KHZ.range). Touch the **AF COUNT** key, the display should indicate the CTS tone frequency immediatly. For our example our tone should be 82.5 Hz, since it is high by 5.0 Hz the display will read 87.5 Hz. Adjust the CTS tone frequency until 82.5 Hz is displayed.

NOTE

If the transmitter is turned on after entering the **AF COUNT** mode, you may notice an 8 to 10 second wait before the frequency display can stabilize. De-select and re-select the **AF COUNT** mode by touching the **AF COUNT** key twice.The display should stabilize,unless the signal is too weak or noisy.

4.4.3 CTS TONE DEVIATION MEASUREMENT

1) Connect the whip antenna to the **RF INPUT** jack.

2) Enter in 464.15, then touch the **MONITOR FM** key.

3) Connect the tranceiver to be tested to an antenna or dummy load. (**DO NOT** under any circumstances connect a transmitter to the **RF INPUT** of the Com- 3, serious damage will result.)

4) Touch the **AF COUNT** key to select the **AF COUNT** mode.

5) Touch the **DEVIATION** key, and two red lights will light, one on each side of the (1.5KHz) bargraph display. Turn on the transmitter, mute the microphone so no voice or background noise is transmitted. The bargraph display should be indicating ±1 KHz. of CTS tone deviation.

NOTE

Typical CTS tones have a deviation of 0.6 KHz, therefore, we should adjust the deviation for a reading of 0.6 KHz.deviation. Four LEDs on each side of the center LED should be lit, indicating that 0.6 KHz of CTS deviation is seen.

4.4.4 TRANSMITTER DEVEATION MEASUREMENT

1) Connect the whip antenna to the **RF INPUT** jack.

2) Enter in 464.15, then touch the **MONITOR FM** key.

3) Connect the tranceiver to be tested to an antenna or dummy load. (**DO NOT** under any circumstances connect a transmitter to the **RF INPUT** of the Com 3, serious damage will result.)

4) Touch the **DEVIATION** key, and two red lights will light, one on each side of the (±1.5KHz) bargraph display. Key the transmitter, mute the microphone so no voice or background noise is transmitted. Four LEDs on each side of the center LED should be lit, indicating that 0.6KHz. of CTS tone deviation is seen.

5) Touch the **DEVIATION** key, and two red lights will light, one on each side of the (±7.0KHz) bargraph display. Voice test the transmitter, all ten LEDs on each side of the center LED should light up with voice, indicating (±7.0 KHz) of deviation.

NOTE

It is important to adjust the CTS tone deviation first, before adjusting the voice deviation.Since the CTS tone will be added to the voice and will increase it's overall deviation.

6) Perform the voice test again and adust the transmitter for (±5.0 KHz) deviation. Six LEDs on each side of the center should light indicating a total deviation of (±5.0 KHz) including CTS tones.

4.5 20 dB QUIETING MEASUREMENT

This test allows you to measure the sensitivity of a receiver.

1) Connect an AC voltmeter to the speaker terminals of the transceiver.

2) Open the transceiver's squelch and adjust the volume control for a nominal reading on the AC voltmeter (for this example; 1 volt).

3) Connect a cable between the tranceiver's antenna input and the Com 3's **RF OUTPUT**.

4) Enter in 469.15, then touch the **GENERATE RF**,the **FM**, and **1 KHz** keys. The red light should be "on" next to the **GENERATE RF** and **FM** keys, and "off" next to the **1 KHz** key.

5) Select the **X1** range on the attenuator by touching the **LEVEL UP** or **LEVEL DOWN** keys until the red light next to the **X1** is lit. (the output range is now 0.1 to 1.0 μV).

6) Increase the output level until the AC voltmeter reading drops 20 dB, or to 0.1 volts. The setting of the **MICROVOLTS** knob will be the 20 dB quieting measurement.

NOTE

If the receiver is not sensitive, you may have to change the attenuation scale to the next higher range. Touch the **X10** key and repeat step (6) until 0.1 volts is read on the AC voltmeter (the output range is now 1.0 to 10.0 μv).Keep going up until 20 dB of quieting is achieved.

4.6 12dB SINAD MEASUREMENT

1) Connect a Sinad meter to the speaker terminals of the transceiver.

2) Open the transceiver's squelch and adjust the volume control for a nominal reading on the Sinad meter (in the black zone).

3) Connect a cable between the tranceiver's antenna input and the Com 3's **RF OUTPUT**.

4) Enter in 469.15, then touch the **GENERATE RF** and **FM** keys. The red light should be "on" next to the **GENERATE RF** , **FM** and **1 KHz** keys.

5) Select the **X1** range on the attenuator by touching the **LEVEL UP** or **LEVEL DOWN** keys until the red light next to the **X1** is lit. (the output range is now 0.1 to 1.0 µV).

6) Increase the output level until the sinad meter reading drops to 12 dB. The setting of the **MICROVOLTS** knob will be the 12 dB Sinad measurement.

NOTE

If the receiver is not sensitive, you may have to change the attenuation scale to the next higher range. Touch the **X10** key and repeat step (6) until 12dB is read on the Sinad meter. (The output range is now 1.0 to 10.0 µv).Keep going up until 12 dB of Sinad is achieved.

SECTION 5
THEORY OF OPERATION

5.1 GENERAL

The Com 3 is composed basically of three phase locked loops, whose outputs are combined through various mixers and amplifiers to give a final output frequency range of 100 KHz to 999.9999 MHz in 500 Hz steps. The main VCO or PLL tunes from 506 MHz to 1017 Mhz in 2 MHz steps, we'll call that loop the coarse loop, since its frequency steps coarsely tune the service monitor's RFgenerator. The fine loop, which tunes in 500 Hz steps, runs from 5 Mhz to 7 Mhz. The output of the fine loop is mixed with the 506 to 1017 Mhz loop in mixer X2, which produces an output of 505 to 1011 Mhz in 500 Hz steps. The coarse loop steps every 2 Mhz and the 5 to 7 Mhz loop, which has a tuning range of 2 Mhz, mixes with the coarse loop to give the finer resolution steps across the entire band.

Using general numbers we see that one loop tunes from 500 to 1000 Mhz in 2 Mhz steps, and the other loop tunes from 5 to 7 MHz in 500 Hz steps. To obtain 0 to 500 Mhz from the Com 3, the output of the coarse loop is mixed with another oscillator that runs at about 1000 MHz (actually 1024 Mhz). Taking the 500 to 1000 MHz subtracted from 1000 you will see that the result is 0 to 500 MHz.

Of the three loops, the fine loop, and the coarse loop run continually, and the offset oscillator or loop (1024 MHz) is only switched in for the lower band of 0 to 500 MHz. The final output of all these PLLs is the channel frequency.

Some form of attenuation is required to give a variable range from 0.1 µv to 10,000 µv. This attenuation is performed in two sections, one being a continously variable 20 dB, and the other a switchable step, 0-80 dB. The variable attenuator is part of the AM modulator section and uses a double balanced modulator IC. Its output, variable over a 20 dB range, is then applied to the step attenuator.The step attenuator is controlled in 20 dB steps utilizing pin diodes . The signal is then directed to the output jack.

In the receive mode the same PLLs are utilized. However, the input frequency of 100 KHz to 999.9999 MHz is applied to mixer X3, and mixed with the output of the coarse loop (506 to 1017 Mhz in 2 MHz steps). This will allow the Com 3 to receive frequencies from 505 -999.9999 MHz. For

the lower band of 0.1 to 505 Mhz, the coarse loop (506-1017 MHz) signal is mixed with the offset loop (1024 MHz) at mixer X5. This output is then mixed with the incoming signal at mixer X3. This allows reception of signals from 0.1 - 505 MHz.

When the service monitor is in the receive mode, the microprocessor directs the synthesizers to output a frequency which is 9.5 MHz higher than what is desired to be received, therefore we use a 9.5 Mhz IF. The RF input to the first mixer, X3, is combined with the output of the coarse loop. This produces an output of 14.5 to 16.5 MHz. This output is bandpass filtered, then amplified by a low noise microwave transistor which sets the noise figure, and thus, the sensitivity of the service monitor.

The output of this low noise amplifier is directed into an additional mixer X4 where it is combined wth the output of the fine loop (5 to 7 MHz). The final output of mixer X4 is at 9.5 MHz. This output is then sent through a 2 pole bandpass filter before arriving at the AM and FM receiver portion of the service montior. All these individual circuits will be discussed in detail in the following sections.

5.2 506-1017 MHz COARSE LOOP PLL

The Coarse Loop tunes from 506 - 1017 MHz in 2 MHz steps. The coarse loop uses what is known as dual-modulus prescaling , using a varable division divider. If you notice on the circuit diagram you see that U13 is a divide by 10 or divide by 11. The division ratio can be controlled by the synthesizer chip. The reason dual-modulus is used, is that it makes it appear to the phase detector that a much higher reference frequency is used . The higher the reference frequency, the faster the loop will respond, and the cleaner the loop will be.

The synthesizer IC used, U14, is a Motorola MC145156P1. The MC145156P1, receives its division instructions from the microprocessor by way of three lines. The three lines are; clock, data, and enable. The clock and data signals are ignored by the MC145156P1 except for when the enable input is high. When this happens, the synthesizer looks at the data and controls the programable dividers accordingly.

Also, internal to the MC145156P1, is a reference divider. Since the input frequency to the MC145156P1 is 4 MHz, and the reference frequency desired is 500 KHz, the reference divider is preset inside the MC145156P1 to divide by 8.

The phase detector outputs of the MC145156P1 appear on pins 4 and 3. The outputs are a charge up and a charge down, which are used to control the loop filter which is composed of U16 and its associated components. U16 also performs the function of a level shifter. U14 (MC145156P1) runs on 6.2 volts, and the VCO requires a tuning range of 1.5 to 27 volts, therefore U16 runs on a 30 volt supply and also has the proper amount of gain to shift the 6.2 volt level from the MC145156P1 up to the 1.5 to 27 volt level required by the VCO.

The VCO consists of transistor Q5 , along with varactor diodes D21, D22, D23. The oscillator is very unique in that it will tune approximately one octave. In order to tune the oscillator over one octave, variable feedback must be used. Most VCOs use just a pair of diodes in the tuned circuit, however this VCO uses an additional diode which comes off the emitter of the VCO transistor . This varactor diode, provides the effect of bypassing the emitter more at the lower end of the tuning range, and at the higher end of the tuning range leaving the emitter floating above ground.

To provide stability of the VCO over the entire tuning range, a constant current bias source is used, which keeps the emitter current constant throughout the entire tuning range. That circuitry is composed of transistor Q9, R94, R95, and R96. The voltage divider R94, R95 produces 10.7 volts at the base of Q9, the emitter therefore has to follow 0.7 volts above that at 11.4 volts. R96 therefore, has 12 volts on one side and 11.4 volts on the other for a net voltage difference of 0.6 volts. This 0.6 volts with 51 ohms produces approximately 12 ma of emitter current on transistor Q5. The output of transistor Q5 is lightly coupled into a MMIC, a buffer / amplifier and from there into a wide band amplifier MAR-8, which produces approximately +10 dBm of power output. Also coupled to the VCO at the output of MIC amplifier Q6 is U12, which is a divide by 4, 1 GHz prescaler. This divides the output of the VCO by 4, and from there it is fed into U13 , the divide by 10/11 dual-modulus prescaler. For more information on dual-modulus prescaling see appendix A. The output of the divide by 10/11

prescaler goes back into the synthesizer chip, where it is compared to the 500 KHz reference.

5.3 5 - 7 MHz Fine Loop PLL

The fine loop runs from 5 - 7 MHz in 500 Hz steps, it consist of frquency synthesizer IC U6 which is a MC5155. Similiar in operation to the MC5156P1 that is found in the coarse loop, it receives its input data through the same three lines; clock , data, and enable. The clock and data lines are ignored except when the enable input is high. The data line tells the programmable dividers within the MC51555 what to divide by. The data input, clock, and enable come from the microprocessor on the front panel board.

IC U23 which is a divide by two, takes the 16 KHz reference which is available within the Com 3, divides it by two to produce a 8 KHz reference signal to U6. Internal to U6 is a divide by 16 counter, which divides the 8 KHz signal to provide the 500 Hz reference which is used inside the MC5155. The output of the MC5155 is available on pin 6, which is a three-state output. Being a three-state output it can be high, low, or open circuit, that output is smoothed out to a constant DC voltage by U5 and its associated circuitry.

U5 also performs the function of a level shifter, in that the VCO requires more than 0-5 volts to tune it, so the level is shifted to the 5 to 7 volts required by the VCO.

The VCO consists of transistor Q3, coil L12 and varactor diodes D19, D20. You'll note that all the components within the fine loop run off their own 5 volt regulator, the reason for that is to keep the various reference frequencies used within the Com 3 which may be present on the power supply bus from modulating the oscillator. The VCO oscillator which is used within the fine loop has to be very clean, since that is where the FM modulation takes place. The loop filter used in the fine loop is designed to be fairly slow, so that modulation can be simply added to the control voltage which goes to the varactor diodes. Since the loop is so slow, any modulation appearing on the VCO's output frequency is not taken out by the loop . If the loop was faster it would in effect, vary the control voltage to take the modulation back out of the loop. However, this is not the case. You'll note that the FM modulation is applied through the resistor R69, and modulation sensitivity adjust control R70.

5.4 1024 MHz Offset PLL

The 1024 MHz oscillator consists of transistor Q8 and associated components which form a VCO that runs at a frequency of 1024 MHz with an output level of approximately 0 dBm. The output of the oscillator drives mixer X4, through a pad, and is also coupled to U10, which is a 1.25 GHz divide by 256 ECL prescaler. Since it is ECL, the output level is only 600 mv p-p. Transistor Q10 is used to raise the 600 mv p-p to a TTL level of approximately 0-4 vpp. The amplified output then goes into one stage of U11, which is a buffer/amplifier, and then fed into the phase detector portion of U11.

U11 is an exclusive OR circuit , this will provide a high output whenever the two inputs are different from each other. When the two inputs are out of phase, the output goes high forcing the oscillator to move in frequency. The other input, the phase comparator portion of U11, comes from another buffer /amplifier stage of U11 which is driven by the 4 MHz crystal standard. The output of U11 will be a series of pulses when the loop is in lock. These pulses are filtered, then sent on to the VCO as a dc voltage representing the error voltage needed to maintain a locked loop condition. In a locked loop condition the average VCO output would be 1024 MHz. Therefore U-11's output is run through a lowpass filter, consisting of components C98, C99, R157, and R158. These components form a two pole filter which filters the pulses coming from U11 into a constant DC voltage to control a varactor diode, CR28. Since the 1024 MHz oscillator uses a reference of 4 MHz, its output spectrum is very clean. A clean spectrum is absolutely required when mixing down to another whole band of frequencies.

Notice that a separate five volt supply is used to run all the components in the 1024 MHz offset loop. This is done for two reasons; one is to provide a clean five volt signal to the VCO and phase detector so that they are not modulated by any of the other frequencies found on the power

supply bus of the Com 3, and the other is to prevent any references that are used within the 1024 MHz loop from leaking back out onto the power supply line bus.

The 1024 MHz Offset oscillator is switched in and out of the circuit using PIN diodes CR24 through CR27. When these diodes are turned on, the output frequency from the coarse loop (506 - 1017 MHz) is applied to mixer X4 along with the 1024 MHz oscillator. The difference frequency goes into a 600 MHz low pass filter and a hybrid broadband amplifier which provides approximately 25 dB of gain. There its output is applied to another 600 MHz low pass filter and then switched back to the output through the PIN diodes. When the pin diodes are turned off, the signal simply bypasses around the mixer X4, and the 25 dB amplifier.

To prevent spurrious signals from being generated, the 1024 MHz oscillator is simply switched off when it is not needed. This is acomplished by diode D29, and resistor R208 which simply supply a negative 10 volt bias to the base of the 1024 MHz VCO transistor Q5. Op-amp U 17 drives the PIN diode switches and the on/off control for the VCO transistor Q5. This device is driven by one of the extra available data outputs on the synthesizer chip U14.

5.5 Output Step Attenuator

The output step attenuator goes from 0 - 80 dB in 20 dB steps. It consists of two 20 dB sections, and one 40 dB section. Each section can be switched in or out of the circuit through the use of PIN diodes. For 0 dB attenuation all attenuators are bypassed, for 20 dB attenuation only one 20 dB attenuator is in the circuit, for 40 dB attenuation the 40 dB attenuator is switched in, for 60 dB a 20 and the 40 dB attenuator is switched in, for 80 dB all attenuators are switched in.

The PIN diodes are driven off of op-amp U2 which is a 4 section device. The attenuator is turned on by a high level, and turned off by a low level. In this circuit a high level is +12 volts, and a low level is -10 volts. The attenuator operates over the frequency range of 10 MHz to 1 GHz, and flat to within approximately ±1.5 dB. The attenuator is composed of surface mounted capacitors and surface mounted resistors.

U2, the driver for the attenuators, is controlled by the additional outputs of the synthesizer ICs . The synthiszer ICs have available extra outputs that are not in use within the synthesizer, but which are decoded . In this case the attenuators are controlled by the output of the microprocessor, the data is fed along the same line to the synthesizer chip, the synthesizer simply ignores that data and controls the output pins which drive the comparators of U2.

5.6 4 MHz Reference Standard

The 4 Mhz crystal that is used in the crystal oscillator is a small HC-18U type. Each individual crystal has been tested and data has been taken to plot out its charateristic curve with respect to temperature. Then appropriate temperature compensating capacitors are matched with the crystal. After that has been acomplished the crystal is encased in a very small micropowered oven . The crystal is wound with several turns of nichrome wire, and a darlington power transistor and thermistor are put in contact with the crystal. The entire assembly is then potted with thermally conductive epoxy and enclosed in a styrofoam shell to insulate it from external temperature changes. The crystal, with the nichrome wire wrapped around it, and the transistor all in close proximity makes for a very small micropower oven which has very low temperature inertia. This allows it to warm up quickly, and not be affected by external temperature variations. The crystal oscillator is composed of transitor Q15, and related parts with buffer stage Q14 following it . The output of the crystal oscillator is 4 MHz with a level of approximately 0-4 vpp. The 4 Mhz is used throughout the service monitor and all frequencies generated and received within the service monitor are referenced back to the 4 MHz standard. The high stability timebase option utilizes similiar circuitry. The crystal used in the high stability timebase is much more closely tested, and tolerances on the temperature compensating components and the oven components are much more closely held which allows an increase in stabilty (0.5 ppm).

5.7 FM MODULATOR

FM modulation takes place in the fine loop VCO circuit (5 - 7 MHz). Analog switches U 15 route the external modulation signal, or the internal modulation signal to either the AM or FM modulator. In the FM modulator, the modulation is applied directly to the control voltage of the VCO, along with the phase detector output. The phase detector loop filter in the fine loop has a very long time constant, therefore any modulation applied to the VCO is effectively not seen within the loop. If the loop had a faster response, then the phase locked loop would attempt to take the modulation out, however this is not the case. Therefore the FM is a true FM signal which is generated directly on the fine loop signal. Modulation sensitivity control, R70, is also contained in this circuit which is used to calibrate the proper amount of FM deviation.

5.8 AM MODULATOR

The AM modulator consists of a double balanced modulator/mixer constructed on a monolythic silicon chip contained within IC U3, MC1496. The 5 -7 Mhz output frequency from the fine loop is applied to one input of the double balanced mixer. Applied to the other input is the output of IC U7 which is a DC voltage. The double balanced mixer does nothing more than a multiplication process . The DC voltage which is a constant, is multiplied by the 5-7 Mhz from the fine loop. The constant can be 1, 1.5, 2.5 etc., therefore you can see how it controls the level by multiplying it up or down. The output level is controlled by the front panel potentiometer called OUTPUT LEVEL, and is also controlled by the AC coupled input signal through capacitor C75. The output of the double-balanced mixer U3 is coupled through capacitor C20 to emitter follower transitor Q2. The output impedance of the double-balanced mixer is fairly high, and must go through the emitter follower in order to match the 50 Ω 7 Mhz low pass filter that follows.

The 7 MHz low pass filter is composed of L9 - L11, and capacitors C14 - C17. The 7 MHz low pass filter is used to filter out any higher order harmonics which come from the 5 - 7 MHz loop. Any higher order harmonics would be mixed in the output and would produce an output spectrum with many undesirable spurrious signals. After the lowpass filter, the signal is run through a small pad composed of resistors R32 - R34 where it continues to mixer X1. The output level at this point is approximately -20 to -40 dBm, variable, controlled by the front panel RF output control.

5.9 1 KHz SOURCE

The 1 KHz oscillator is formed by a section of U7, it is a standard Wein-bridge oscillator which uses an incandescent bulb for feed back bias stabilization. The output is a very low distortion 1 KHz tone which can be used to modulate the internal oscillator in the AM and FM signal generation modes, or switched to the output jack to be used for other purposes within the shop.

5.10 RECEIVER

The input to the receiver portion of the Com 3 is coupled to the RF input jack to mixer X2. Mixer X2 takes the coarse loop output frequency which has two ranges 0.1-505 MHz or 505-1018 Mhz in 2 MHz steps, mixes it wth the input from the front panel jack. The output frequency is in the range of 14.5 to 16.5 MHz. The output of mixer X2 is applied to a bandpass filter and then to a low noise microwave transistor which is used to set the noise figure of the entire receiver.

The output of that amplifier is applied to a resistive pad to provide proper impedence matching to mixer X3. Mixer X3 is driven by the 5-7 MHz loop, which has 500Hz steps. The output of mixer X3 is the final 9.5 MHz final IF frequency. The 9.5 MHz IF frequency is amplified by transistor Q12 and applied to a double pole tuned filter and into AGC amplifier U 19.

The AM/FM receiver portion consists of two receivers, an AM receiver and a FM receiver. The FM receiver uses a standard MC3359 FM IF IC. Inside this IC is another oscillator which operates at 9.045 MHz, which converts the 9.5 MHz down to the 455 KHz IF. The 455 KHz IF goes through a ceramic IF filter which is approximately ±8 KHz wide, then into a transistor gain stage which drives another gain stage as well as the AM detector. The

reason for the external transistor stages is that the mixer within the 3359 is contained within the AGC loop. This means that the mixer must be operated over a linear region in order that the AGC loop and AM detector operate properly. After the AM detector is driven, the IF signal can be limited and applied back into the 3359 chip for quadrature detection and processing. Audio output from the MC3359 is amplified by op-amp U20 and applied to analog switch U21. Squelch action is also provided in the MC3359, the amount of squelch is set by resistor R134. Note that the squelch output, on pin 16, controls the analog switch U 21.

Even when the receiver is in the AM mode, the squelch in the FM receiver MC3359 is used. In a FM detector, even though it is receiving AM, the signal still quiets and therefore the squelch still works properly whether an AM or FM signal is being received.

The AM detector consists of diode D 31 and op-amp U 20. The 455 KHz filtered signal is envelope detected by D 31 and amplified by U 20 where the demodulated signal is available at pin 8. Another section of U 20 amplifies the filtered DC component of the demodulated signal and drives the AGC amplifier U 19, which provides an AGC range of over 60 dB. Appropriate switching of the audio signal between the AM and FM sections and the squelch action, is provided by analog switch U20.

When the Com 3 is in the receive mode, the microprocessor is instructed to offset the oscillators by 9.5 MHz, which is the IF. It does this by offsetting the coarse loop and the fine loop at the same time.

5.11 16 KHz REFERENCE GENERATOR

The 16 KHz reference which is used throughout the Com 3 is derived from counter U9. U9 takes the 4 MHz signal from the crystal oscillator and divides by 250. U 9 is run on 12 volts because its specifications do not allow it to divide properly on a 5 volt supply at a frequency as high as 4.0 MHz.

5.12 FREQUENCY ERROR DETECTOR

The frequency error detector is novel in that it is completely temperature stable, not relying upon a quadrature detector, pulse counter, or other analog system, it is a true digital counting system which indicates the frequency error.

The converted 455 KHz signal from the receiver section of the Com 3 is amplified and applied to an eight bit binary counter whose output goes to an R-2R resistor ladder network. The output of the resistor ladder network goes into a sample and hold gate/buffer, then to an operational amplifier stage. The op-amp is used to properly center the output voltage and provide a gain factor to give a precise voltage/KHz output for frequency error input. The eight bit counter is clocked by the 455 KHz signal from the IF and is gated with another counter. This counter takes the 16 KHz input used within the service monitor, and divides it by 64. The output is a 250 Hz square wave which gates the counter for a period of 4 milliseconds. At the end of that 4 millisecond period, the sample and hold gate is closed, sending the output of the resistor ladder network to the op-amp, and then on to the bargraph display. After the sample and hold gate is closed, both the counters are reset again and the same process is allowed to continue. In this way, if the 455 KHz signal is a contstant frequency, there will be a constant voltage at the output of the resistor ladder network at the end of each count period, and therefore, a constant output voltage as frequency error. However, if the 455 KHz signal is somewhat higher in frequency, the eight bit counter will count up to a higher output number and the resistor ladder network will produce a higher output voltage. This will reflect in the frequency error meter output. If the 455 KHz signal is lower in frequency, the eight bit counter will produce a lower number and the resistor ladder network will produce a lower voltage. Thus, a lower output voltage for the frequency meter error output. Note that in this circuit there is nothing dependent upon temperature or component tolerances, it is a completely digital system.

5.13 AUDIO AMPLIFIER

The audio amplifier is a standard LM 380/2 watt audio amplifier, it performs basic audio amplifiication functions such as speaker driver for receiver mode, and speaker driver for modulation mode to enable you to hear what modulation is taking place.

5.14 +30 VOLT AND -10 VOLT SUPPLIES

The +30 V and -10 V supplies within the Com 3 use the 16 KHz which is available throughout the Com 3, as a reference frequency. Looking at the -10 volt supply, the 16 KHz signal is applied to transistors Q18 and Q19. Q18 forms a simple inverter which drives transistor Q17. Q17's emitter is tied to the collector of Q19, and at that point forms a 12 volt square wave. C166, C167 and diodes D41 and D42 comprise a voltage doubler which takes the square wave and after suitable filtering and the doubling comes out with a minus 10 volts supply under load.

The +30 volt supply works in a similiar manner in which the 16 KHz wave is coupled to transistors Q20 and Q22 which again forms the phase inverter and then to Q21. The emitter of Q21 is tied to the collector of Q22 where once again we get the 12 volt square wave and diodes D43 through D46 along with capacitors C169 through C172 form a voltage tripler which produce approximately +30 volts under a light loading. The -10 volt supply is somewhat heavily loaded in that it drives the op-amp comparator U2, and the PIN diode attenuator.

5.15 TRANSMIT PROTECTION CIRCUIT

The Com 3 is protected from transmitter inputs up to 100 watts. If a transmitter signal appears on the RF input jack of the Com 3, the signal is detected by diodes D1 and D2. The resultant DC output voltage is applied to one section of U1 which is configured as a simple comparator which drives Q1. You'll note that the relay K1 is kept normally closed whenever the Com 3 is in use. When an Rf signal is present, it turns off Q1 which opens relay K1. The reason for this is if the Com 3 is not turned on, yet is transmitted into, you do not want the RF power going into the attenuator, so the unit is connected with the normally closed contacts of the relay going to the output load jack on the rear of the Com 3.

5.16 DC SUPPLY AND BATTERY

The power supply within the Com 3 is derived from a +12 volt source. The reason +12 volts was chosen was that a standard +12 volt gel cell battery can be used, which is internal to the Com 3, or an external power supply. The transformer used goes into a standard bridge rectifier composed of diodes D32 through D35 which is filtered by capacitor C149. That output voltage which is approximately 20 volts DC under load is applied to a rear panel mounted 5 volt regulator, which produces 5 volts at 1 amp which is used through out the circuits of the Com 3. It is also applied to VR1 a 7812 +12 volt regulator whose ground tab is pulled above ground through a variable resistor R176. This causes the output voltage of VR1 (7812) to be somewhat greater than +12 volts , and is adjusted for +13.8 volts. The +12 V gel cell battery is connected at this point. The +13.8 V floats the battery to maintain full charge at all times. After passing through diode D37, and the front panel switch we come up with a +12 volt source which is used throughout the Com 3. A seperate 5 volt regulator VR5 is used to power the microprocessor located on the front panel board. VR5 is connected directly to the +12 volt gel cell battery, so it will draw current all of the time, although it will be a small amount of only 5 ma. This 5 volt voltage is used to power the microprocessor ,and keep its memory alive in the event AC power fails. In that case, the battery will keep the microprocessor alive in a low power mode to remember any previosly stored front panel settings. Series protection is provided in diode D39 in the event that a reverse polarity power supply is connected to the Com 3.

5.17 MEMBRANE SWITCH

The membrane switch is an eight by four X-Y array. The microprocessor scans each column and watches the rows for a contact closure.When a key closure is detected, the closure is timed for 30 milliseconds before it is considered valid.

5.18 MICROPROCESSOR

The microprocessor is a Hitachi HD63705VOP 8 bit unit with 4k ROM. The microprocessor does the general housekeeping functions of the Com 3, such as display driving, keyboard scanning and debouncing, audio and RF, CTS tone encoding, and synthesizer loading.

5.19 DISPLAY DRIVERS

The display drivers are 40 pin devices (MM5451) that take a 35 bit serial word from the microprocessor and from this produce a constant current output. The microprocessor loads each one of these serially and at the end of the 36 th data pulse, the display drivers store the data and output it in a parallel form to control the various LEDs of the display.

5.20 AUDIO FREQUENCY COUNTER

The audio frequency counter function is performed within the microprocessor. It measures the period of the audio signal, then averages it over 4 count cycles and displays the result. U 7 (a cmos quad nand gate) suitably amplifies the signal and low pass filters it, then applies it to U13 (a dual D flip flop), which divides the signal by two to provide a clean waveform, insensitive to edge jitter. This square wave then goes to the gating circuitry of U 5, then to the microprocessor through pin 37. The microprocessor internally counts the signal and then displays it.

5.21 RF FREQUENCY COUNTER

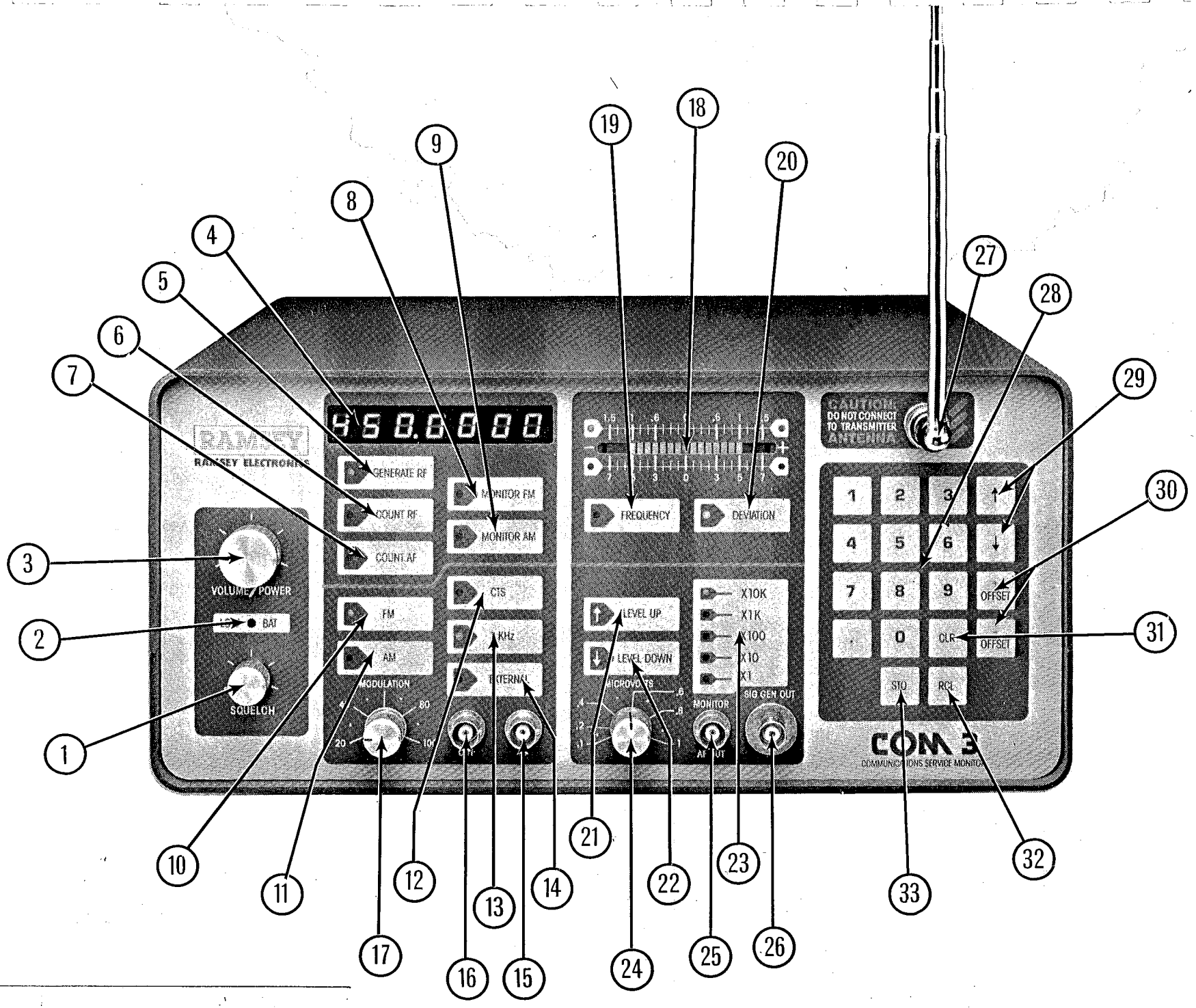
The RF frequency counter also draws upon the frequency counting capabilities of the microprocessor, but has two external prescalers. The first prescaler U 6 is a 1 GHz divide by 256 (SP4550) unit . After passing through this prescaler the signal is amplified by Q1, applied to gate U 5 , and then continues to the second prescaler, which is an 8 bit device (74HC393). The output of those 8 bits are applied to one of the ports of the microprocessor so that it can read the counter and also look at the count of its internal counter. Between the two readings the frequency can be determined. The output is sent in serial form to the display drivers and seven segment frequency display.

5.22 CTS TONE GENERATION

The CTS tone generator uses an R-2R ladder network on the output of three of the microprocessor ports. The microprosser directs a variable duty cycle wave form to these three output ports. When applied to the R-2R ladder network, a stepped approximation of a sine wave appears at the network's output. Active filter op-amp U 10, takes the digital approximation of a sine wave, low pass filters it and produces a low distortion sine wave at its output. That output is then available for modulation within the Com-3 or available for external uses.

5.23 FREQUENCY ERROR/DEVIATION DISPLAY

The frequency Error / Deviation Display uses a 20 segment LED bargraph. Each side, plus and minus is relatively the same and uses a LM3914 LED Bargraph driver. Internally, the bargraph driver is nothing more than 10 comparators which have a resistor divider array connected to them. Increasing the voltage that is applied to it, increases the number of lit LED segments. The input to each of these LED bargraph driver ICs comes from a pair of ideal diode circuits which are constructed of a diode and op-amp. An ideal diode circuit performs as an ideal diode with no DC forward drop at all, and having a high input impedance. Ideal diodes are used to eliminate the DC offset problem associated with regular diodes. Since one display has to indicate in the negative direction and one in the positive direction, signals are appropriately routed to each of these ideal diodes so the displays read in the proper directions. The display will truly indicate positive and negative excursions of the deviation signal so that you can actually read the amount of positive and negative deviation. Another section of the op-amp is used as a scaling unit which scales the display appropriately for 1.5 or 7KHz full scale indication. The gain of this op-amp is controlled with an analog switch and a pair of different feedback resistors. This portion of the Com 3's circuitry also has some blanking circuitry so that the display is blanked when no signal is received, and in certain modes where the display is not calibrated or required.


RAMSEY ELECTRONICS
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SQUELCH
GENERATE RF
COUNT RF
COUNT AF
FM
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MODULATION
MONITOR FM
MONITOR AM
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KHZ
EXTERNAL
CTS
KHZ
FREQUENCY
DEVIATION
LEVEL UP
LEVEL DOWN
MICROVOLTS
MONITOR
AF OUT
X10K
X1K
X100
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X1
SIG GEN OUT
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COM 3
COMMUNICATIONS SERVICE MONITOR
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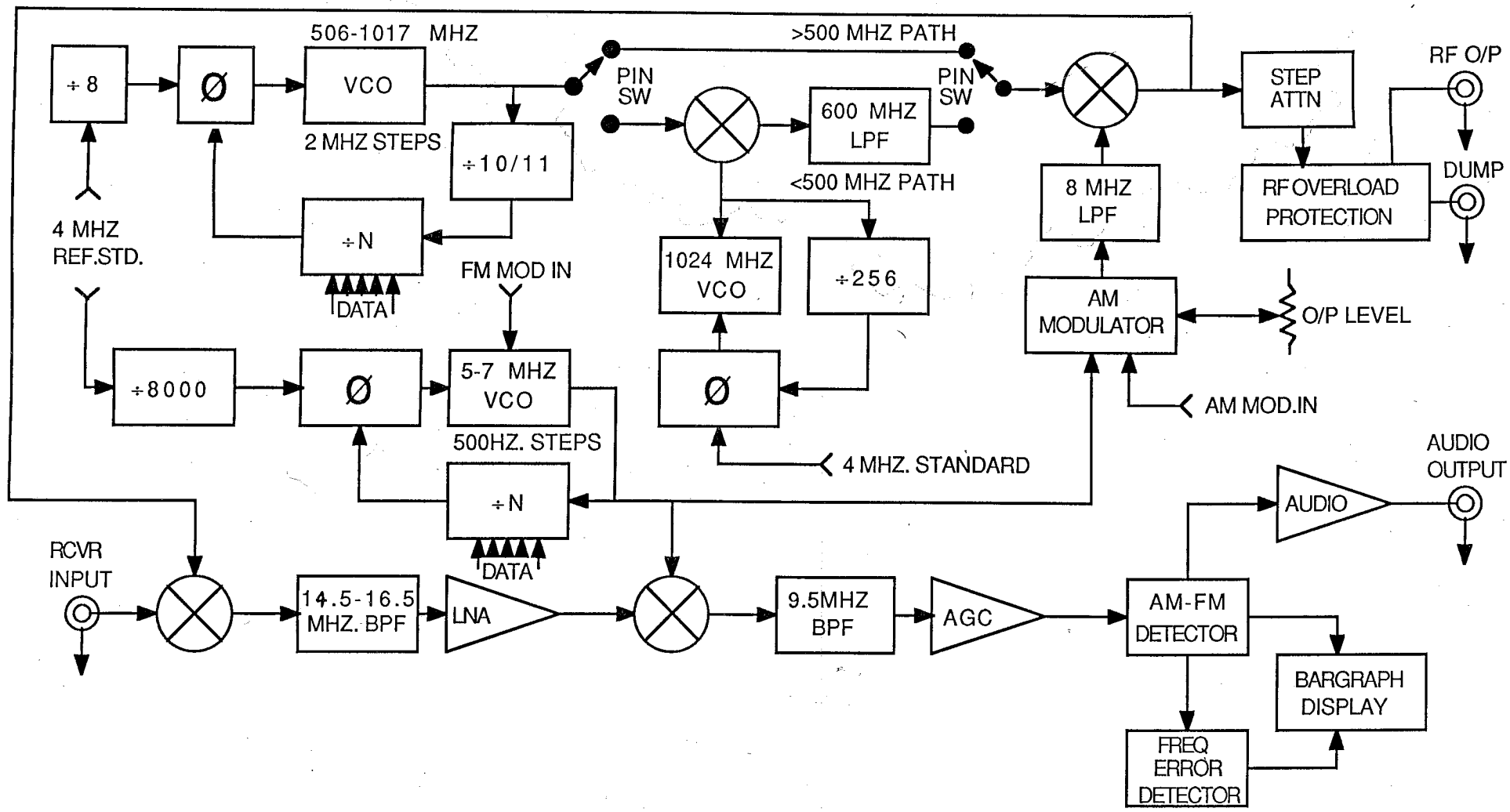
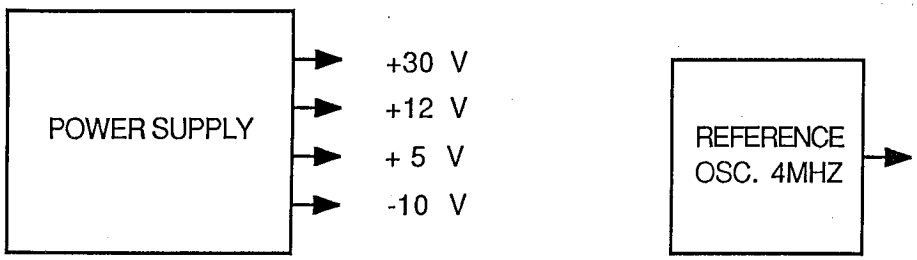
FIGURE 3–1





RAMSEY ELECTRONICS INC.	
TITLE	COM-3 BLOCK DIAGRAM REV. 0
DATE 10-21-87	DRAWING NUMBER FIG. 4.1

Certification

Ramsey Electronics Corporation certifies that this product meets it's published specifications at the time of manufacture and that the calibration measurements are traceable to the United States National Bureau of Standards .

Warranty

Ramsey Electronics, Inc. warrants this product against defects in materials and workmanship for a period of one year from the original manufacture date. Ramsey Electronics, Inc., at it's option, will repair or replace this product at no cost to the original owner during the warranty period, provided the product is proved to be defective.

Warranty Service

To obtain warranty service, the purchaser shall first obtain a return authorization number by calling ~~(716)~~ 585 924-4560 or by writing to Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564. Include, with the product, a note showing the name, address, phone number, return authorization number and a brief description of why the product is being returned. All returns must be sent postage and duty paid to Ramsey Electronics, Inc.,793 Canning Parkway, Victor, NY 14564 Attn: Service Dept. International customers must pay, in advance, the duty and shipping in both directions .

Limitations

This warranty shall not apply to products that have been improperly cared for, abused, or used outside the operating specifications of the product. This warranty shall not apply to products repaired or altered by persons not authorized by Ramsey Electronics, Inc. This warranty shall not apply to products containing sealed or epoxied assemblies that have been opened. This warranty is in lieu of all other warranties, expressed or implied, and is solely for the use of the original product purchaser.

RAMSEY

COM 3 FINAL TEST DATA

A) Sensitivity and Output Level Flatness

1) Enter 5.15 MHz,Monitor FM ,50 MHz offset
2) Turn output attenuator full CW,examine RF output on spectrum analyzer.

FREQ (MHz)	SENSITIVITY (-100 dBm)	OUTPUT LEVEL FLATNESS (± 2dB)
5.15	☑	☑
55.15	☑	☑
105.15	☑	☑
155.15	☑	☑
205.15	☑	☑
255.15	☑	☑
305.15	☑	☑
355.15	☑	☑
405.15	☑	☑
455.15	☑	☑
505.15	☑	☑
555.15	☑	☑
605.15	☑	☑
655.15	☑	☑
705.15	☑	☑
755.15	☑	☑
805.15	☑	☑
855.15	☑	☑
905.15	☑	☑
955.15	☑	☑

B) Monitor Functions

1) Enter 464.150, Monitor FM

☑	(±5 KHz)	Deviation check
☑	(±1 KHz)	Deviation check
☑	(+5 KHz)	Center frequency check
☑	(- 5 KHz)	Center frequency check
☑	(- 1 KHz)	Center frequency check

Digital Input and Demod Output Options Installed

C) Generate RF

1) **Enter 464.150, Generate RF, FM**

☑ 1 KHz tone level and frequency OK
☑ CTS tone level and frequency OK
☑ Ext. Mod input OK
☑ Int. 1 KHz, CTS outputs OK
☑ Step attn OK
☑ Variable attn OK
☑ Internal Xmit changeover relay OK

2) **Enter 10.25 MHz, Generate RF, AM**

☑ AM mod OK, variable up to 100%

D) Counter Functions

1) **Enter 464.150 Monitor FM, Dev. (1.5 KHz)**

2) **Press Count AF**

☑ Count AF OK

3) **Press Count RF**

☑ Count RF OK

E) Battery Charge

☑ Charge rate OK
☑ Charge held ≥ 1.5 hrs

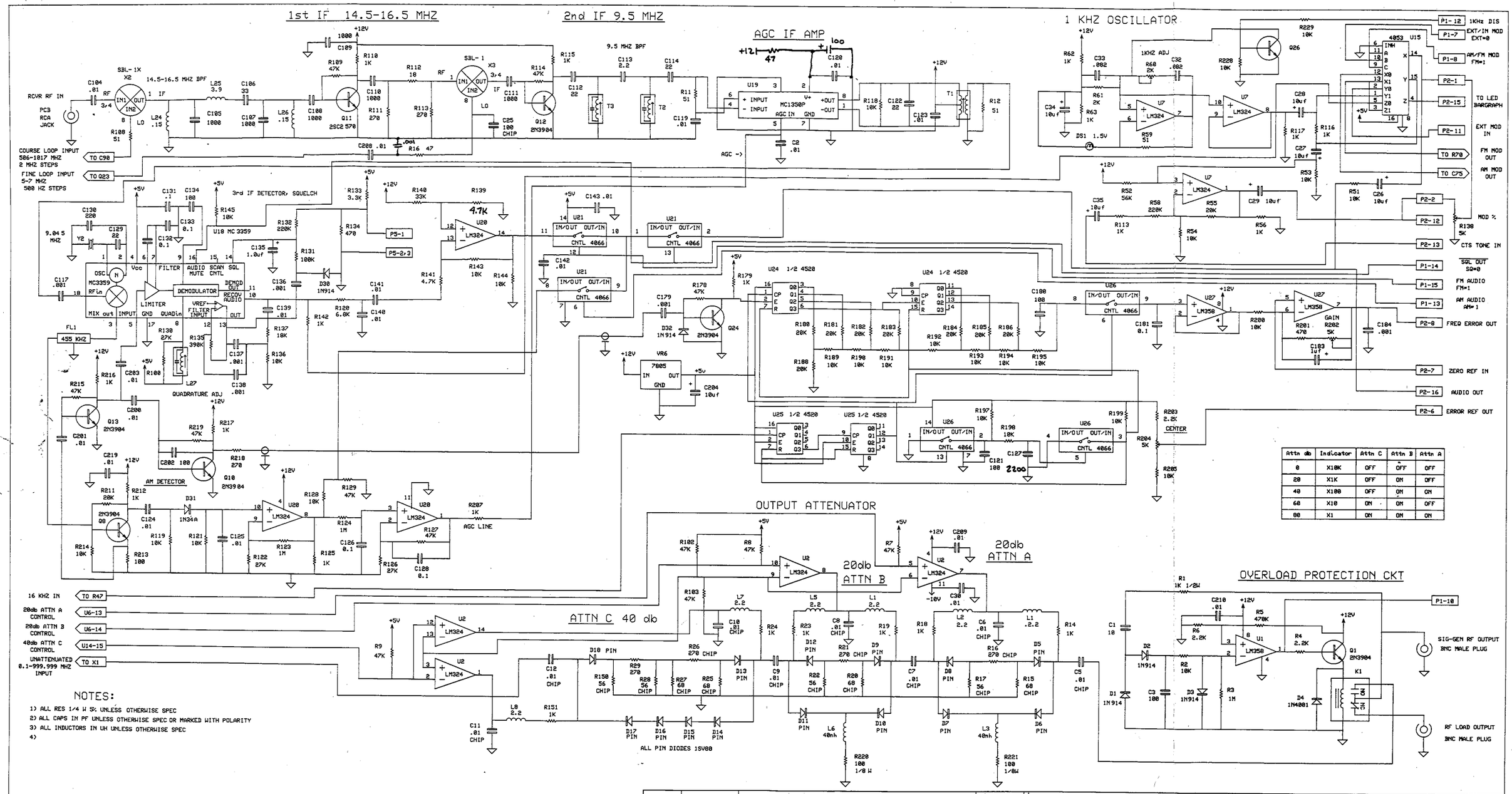
F) Cosmetics

☑ All hardware on case OK
☑ All PCB hardware
☑ Loose wire tape trap installed
☑ Lead dress
☑ Knob attachment
☑ All LEDs operating

Technician: Edwin Knight

Date: 10-19-90

Serial #: 5541



Attn db	Indicator	Attn C	Attn B	Attn A
0	X10K	OFF	OFF	OFF
20	X1K	OFF	ON	OFF
40	X100	OFF	ON	ON
60	X10	ON	ON	OFF
80	X1	ON	ON	ON

NOTES:

1) ALL RES 1/4 W 5% UNLESS OTHERWISE SPEC
2) ALL CAPS IN PF UNLESS OTHERWISE SPEC OR MARKED WITH POLARITY
3) ALL INDUCTORS IN UH UNLESS OTHERWISE SPEC
4)

REV	DATE	REVISION RECORD	AUTH
A	10-6-87		

RAMSEY ELECTRONICS INC.

RECEIVER 1 KHZ OSC — FREQUENCY ERROR DETECTOR OUTPUT ATTENUATOR

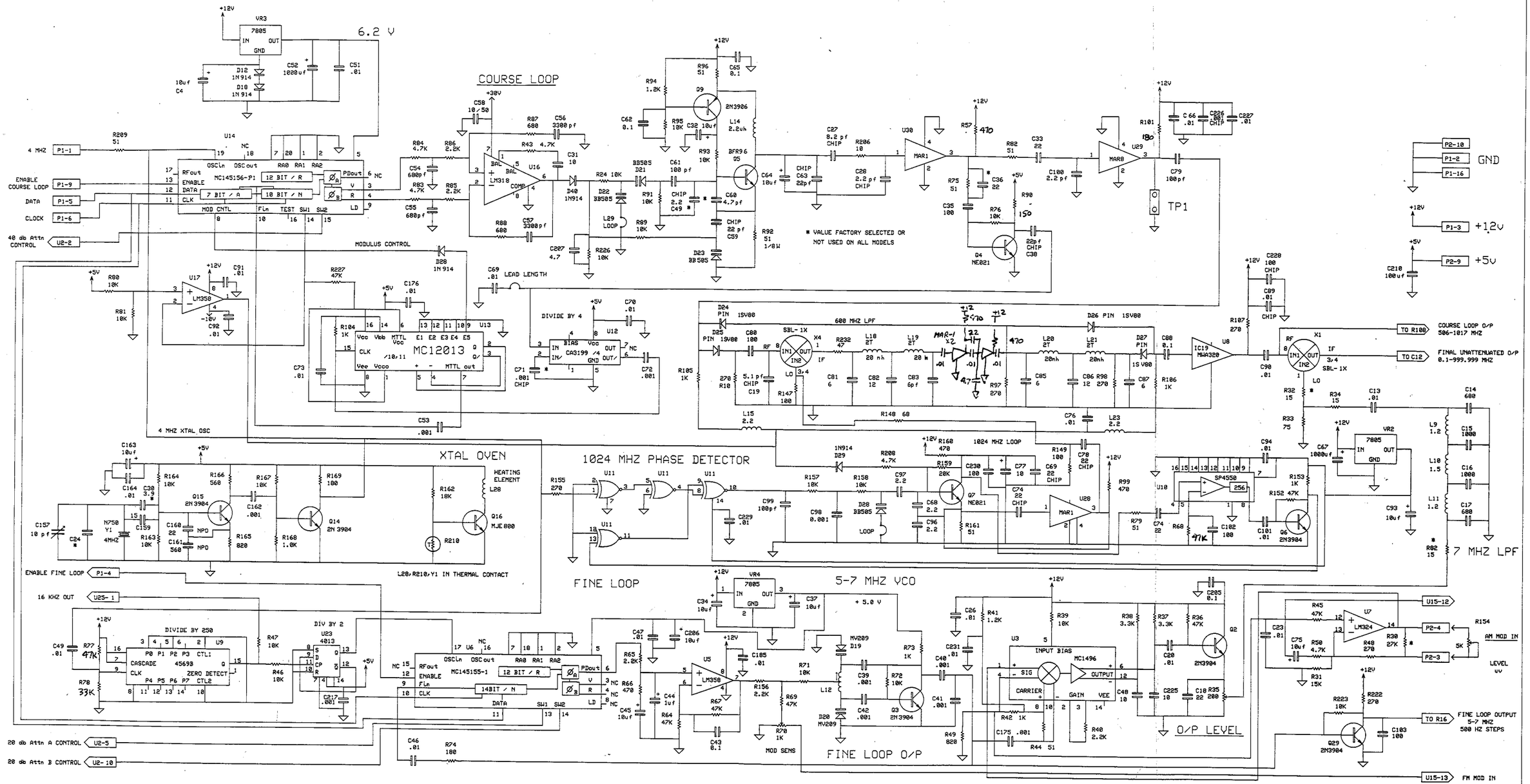
DRAWN BY ROBERT YOST

APPROVED BY

TITLE: COM-3 REV G MAIN BOARD

DATE: 9-1-87

DRAWING NUMBER: COM3-103 a



NOTES:

1) * VALUE FACTORY SELECTED OR NOT USED ON ALL MODELS
2) ALL RES 1/4W 5% UNLESS OTHERWISE SPEC
3) ALL CAPS IN PF UNLESS SPEC OR MKD WITH POLARITY
4) ALL INDUCTORS IN UH UNLESS OTHERWISE SPEC

REV	DATE	REVISION RECORD	AUTH
A	10-8-87		

RAMSEY ELECTRONICS INC.

COURSE LOOP
OFFSET LOOP
FINE LOOP

4 MHZ CRYSTAL OSC
AM MODULATOR/LEVEL CONTROL

DRAWN BY ROBERT YOST

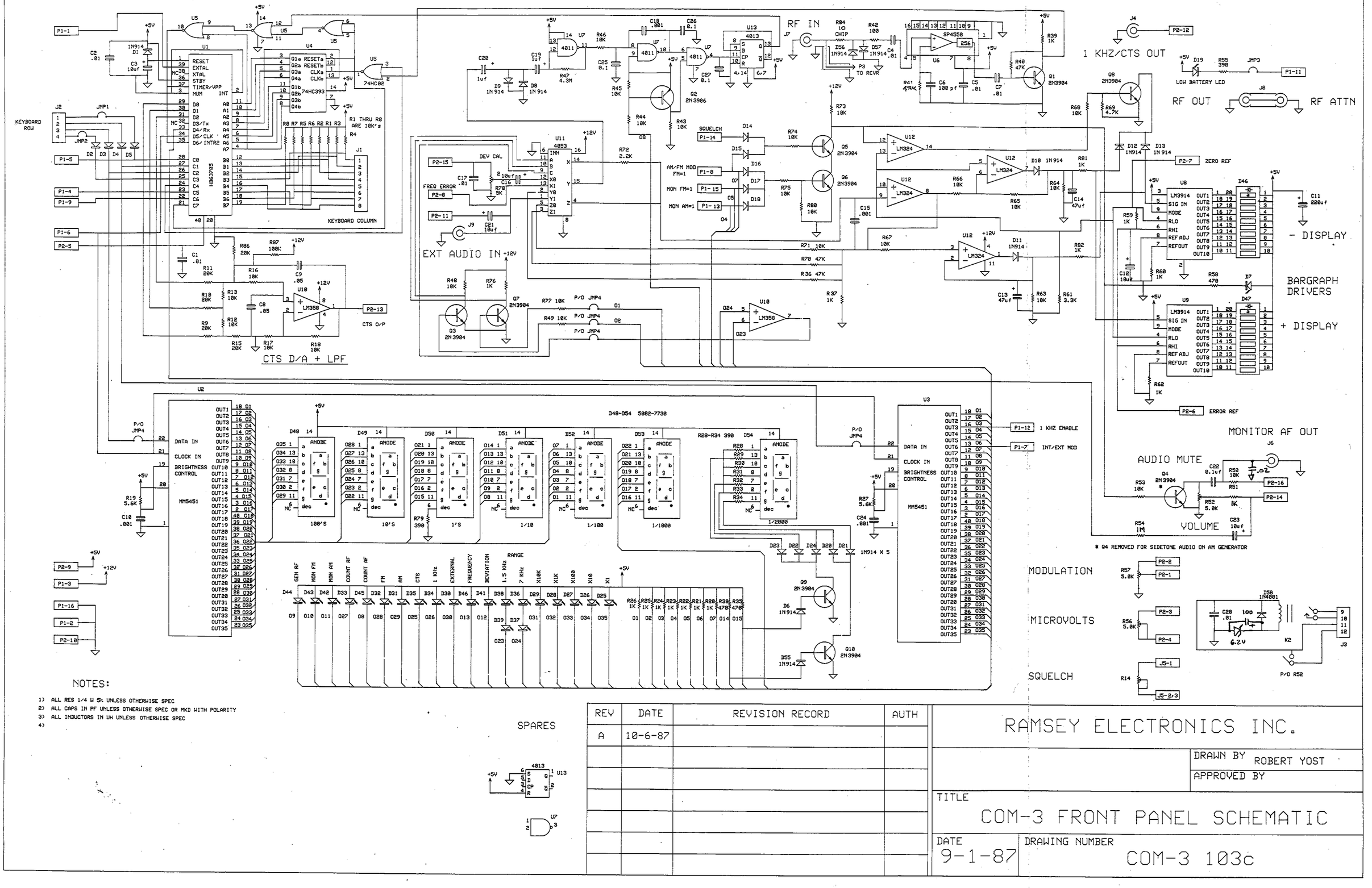
APPROVED BY

TITLE

COM-3 REV G MAIN BOARD

DATE 9-2-87

DRAWING NUMBER COM3-103b



NOTES:

1) ALL RES 1/4 W 5% UNLESS OTHERWISE SPEC
2) ALL CAPS IN PF UNLESS OTHERWISE SPEC OR MKD WITH POLARITY
3) ALL INDUCTORS IN UH UNLESS OTHERWISE SPEC
4)

REV	DATE	REVISION RECORD	AUTH
A	10-6-87		

RAMSEY ELECTRONICS INC.

DRAWN BY ROBERT YOST

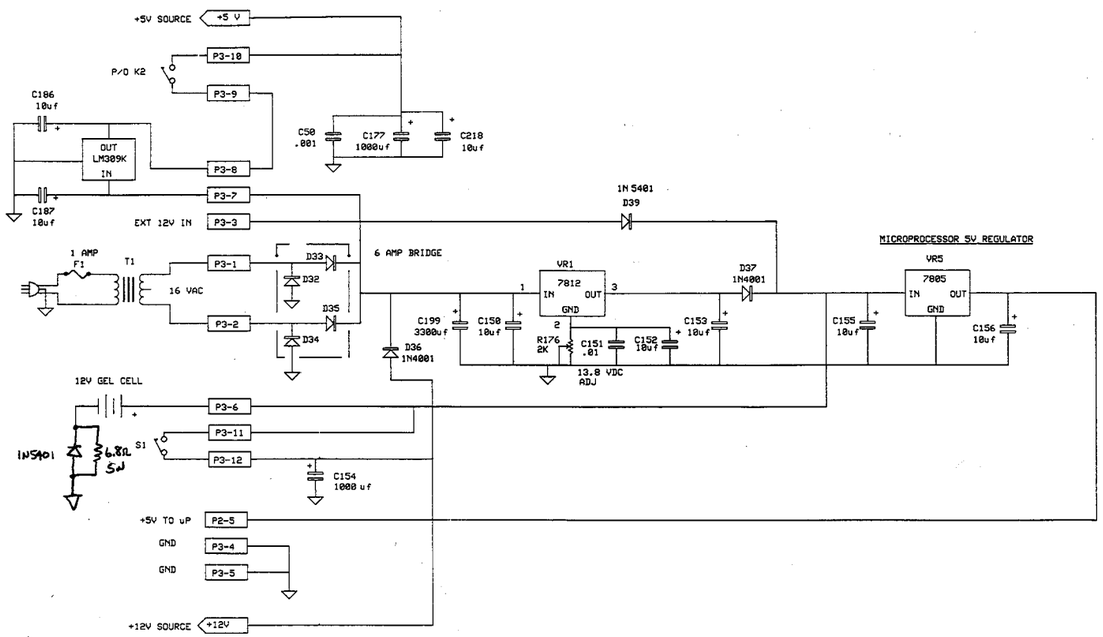
APPROVED BY

TITLE

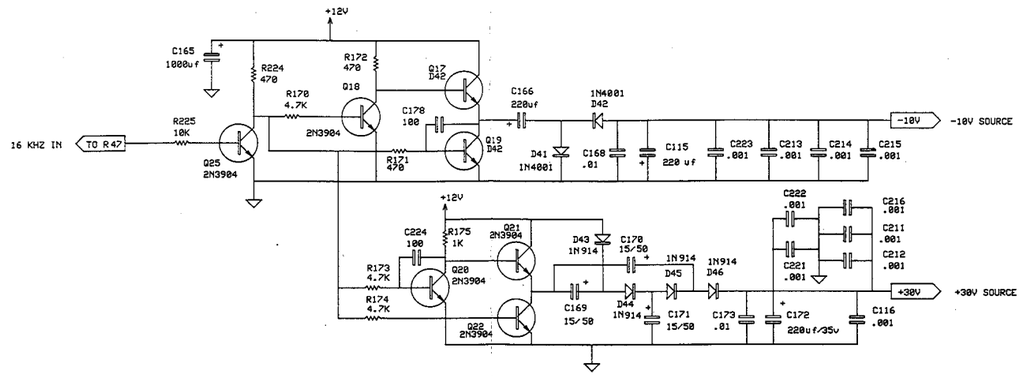
COM-3 FRONT PANEL SCHEMATIC

DATE 9-1-87

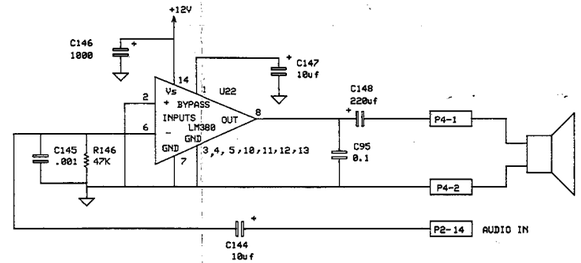
DRAWING NUMBER COM-3 103c



-10V/+30V DC-DC CONVERTER



AUDIO POWER AMP



NOTES:

1) ALL RES 1/4W 5% UNLESS OTHERWISE SPEC
2) ALL CAPS IN PF UNLESS OTHERWISE SPEC OR IF MKD WITH POLARITY
3) ALL INDUCTORS IN UH UNLESS OTHERWISE SPEC

REV	DATE	REVISION RECORD	AUTH
A	10-7-87		

RAMSEY ELECTRONICS INC.

POWER SUPPLY
AUDIO AMPLIFIER

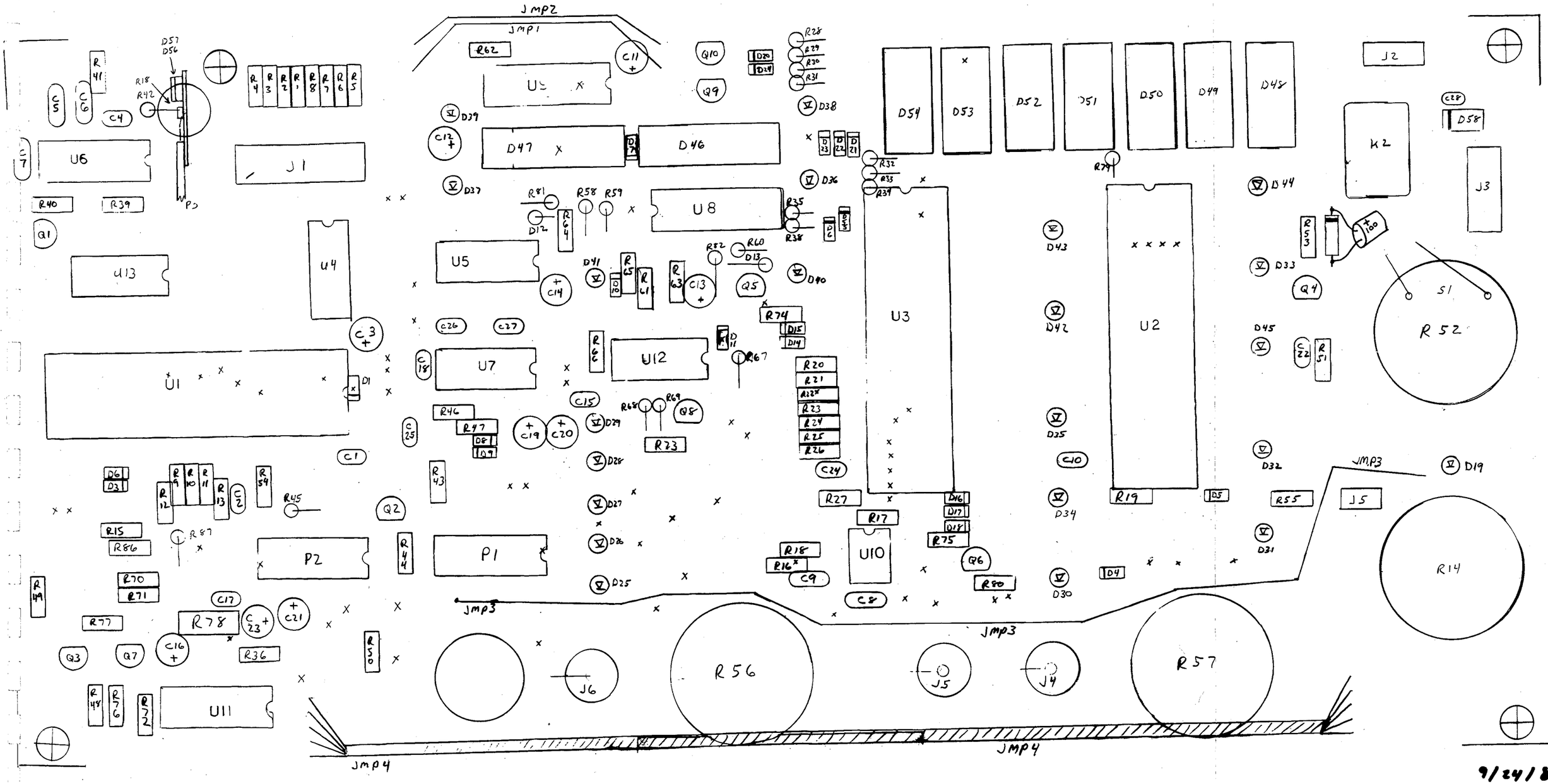
DRAWN BY ROBERT YOST

APPROVED BY

TITLE
COM-3 REV G

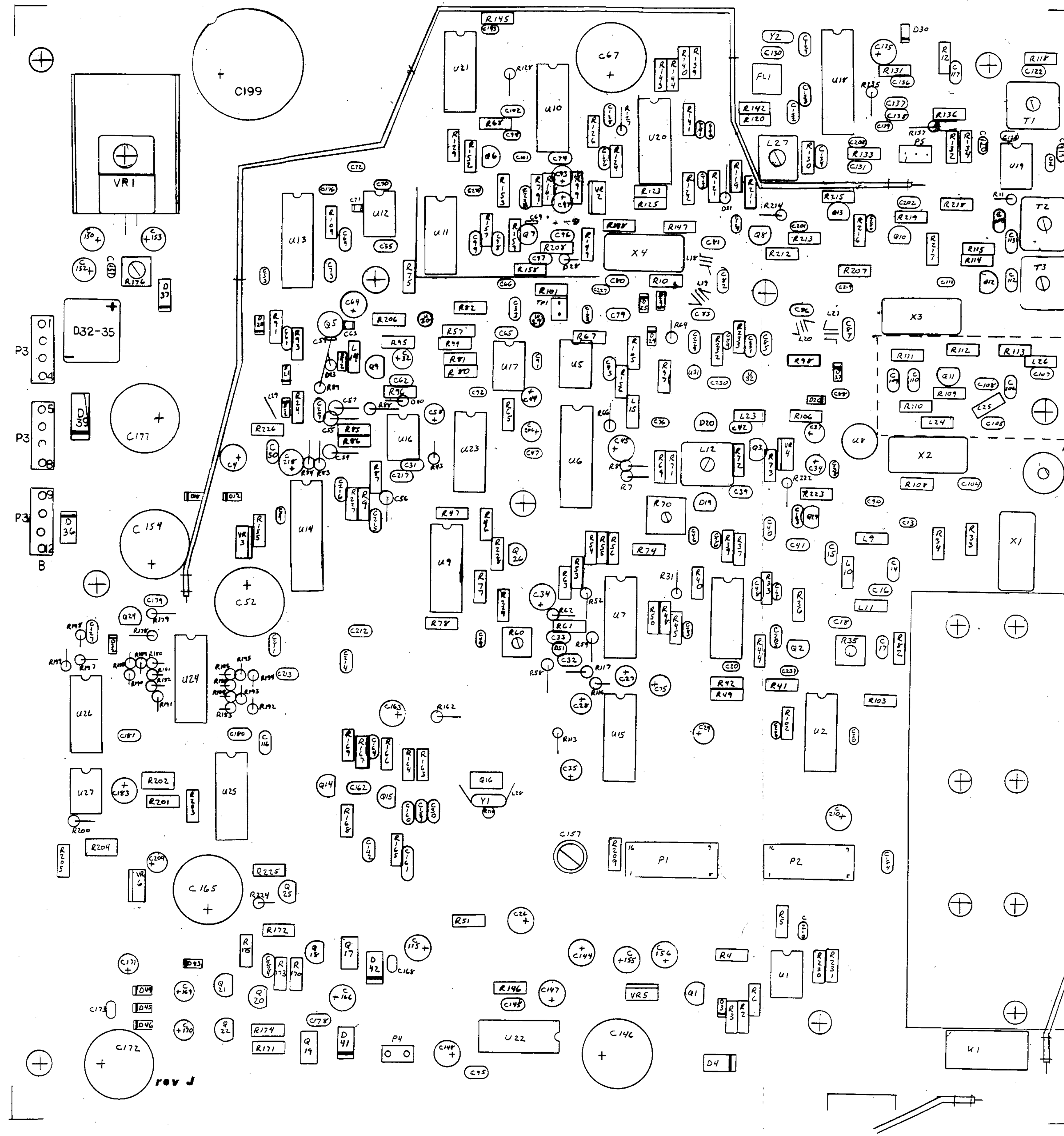
DATE
9-2-87

DRAWING NUMBER
COM3-103d



DISPLAY BOARD

RF
BOARD


C199
VR1
P3
D32-35
C177
C154
C52
C165
C172
C67
C146
X4
X3
X2
X1
T1
T2
T3
P1
P2
P4
U22
rev J
RCVR RF IN