

Serial No. _____

NSN 6625-01-286-3566

WAVETEK

**SIGNAL GENERATOR
MODEL 2407
OPERATING MANUAL**

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USE OF THIS MANUAL

This is the Instruction Manual for the Wavetek Model 2407 RF Signal Generator. It contains ten sections.

Section 1 provides general information about the unit, including specifications.

Section 2 contains detailed installation instructions. Instructions proceed from the initial inspection (after unpacking a unit) to the instrument checkout procedure after installation is completed.

Section 3 provides detailed operating instructions for the unit.

Section 4 contains performance tests that may be used to verify the unit is operating at the limits of its specifications.

Section 5 provides maintenance procedures, including user diagnostics and the almost completely automatic calibration (AUTOCAL™) procedure for this unit.

Section 6 contains documentation for the GPIB interface.

Section 7 contains Theory of Operation for the unit.

Section 8 provides generalized Troubleshooting information.

Section 9 has the Reference Drawings (schematics, part layout, and assembly drawings) for the 2407. Schematics and their associated parts layout drawings are grouped together.

Section 10 contains the Replaceable Parts Lists for the unit.

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1.1 INTRODUCTION

The Wavetek Model 2407 is a dual micro-processor controlled, single-loop synthesized signal generator that covers the frequency range of 10 kHz to 550 MHz. It has an output power level continuously adjustable from +13 dBm to -127 dBm. In addition to CW operation, it is capable of AM/FM operation from an internal or external source. The 2407 has a very broad 500 kHz to 1 MHz peak FM deviation over the majority of its operating range. Standard features include an exclusive AutoCal® selfcalibration function for frequency and amplitude, extensive user diagnostics, an automatic power up test sequence, and 15 nonvolatile memory locations to store front panel settings. A 10 MHz sine wave reference output is available at the rear panel.

A talk/listen GPIB fully conforming to the IEEE-488 standard is standard for the Model 2407. Because it utilizes the minimum uniqueness concept, the 2407 is easily conformed to any ATE system. It is fully compatible with the entire Wavetek 2500 family of instruments.

The Model 2407 also has an FM deviation meter that will measure FM deviation on externally applied input signals from 30 MHz to 500 MHz.

All operational controls are located on the front panel. Controls include keypad switches for entry of all RF output numeric parameters. A 4-key cursor provides increment/decrement entry of numeric data in digit steps, with any displayed digit selectable as the digit

around which changes occur. Instrument settings and operational status are indicated on a two-line LCD display.

The 2407 is a space-saving 3/4-rack size. (Two optional rack mount adaptor kits are available.)

1.1.1 FREQUENCY CHARACTERISTICS

The carrier frequency may be set from 10 kHz to 550 MHz with 10 Hz resolution and .0005% (5 ppm) accuracy. Frequency aging is <2 ppm/year.

1.1.2 MODULATION CHARACTERISTICS

The instrument features both internal and external AM and FM capabilities. The internal modulation source may be set at a 400 or 1000 Hz rate. AM depth is specified from 0 to 99%. FM deviation can be set at peak values from 10 kHz to 1 MHz, depending upon the output frequency (see section 1.2.7.2). A TTL compatible sine or square wave at 10 MHz may be used as an external reference input.

Internal and external sources may be used simultaneously to produce complex modulation.

1.1.3 OUTPUT LEVEL CHARACTERISTICS

The Model 2407 has an RF output range of +13 dBm to -127 dBm with an accuracy of ± 1.5 dB of the actual measured level. Level resolution is .1 dB.

Output level may be read in dBm, mV, or μ V. Reverse power protection to 50 watts is standard.

1.1.4 AutoCal®/DIAGNOSTICS

The Model 2407 utilizes a unique Auto-Cal® routine to perform a quick and easy almost completely automatic self-calibration. The routine is software controlled, menu driven, and activated from the front panel. A variety of other menu driven diagnostic/control programming aids are standard with the 2407.

1.1.5 STORED SETTINGS

Nonvolatile memory locations allow up to 15 complete front panel settings to be stored and recalled in any order. This storage permits fast and accurate recall of frequently used settings.

1.2 SPECIFICATIONS

1.2.1 FREQUENCY

Range	10 kHz to 550 MHz
Resolution	10 Hz; digital readout
Stability, 0-50° C	.0005% (5 ppm)
Stability, Aging	<2 ppm/year
Switching Time	200 ms (\pm 100 Hz of final value in CW and for changes >10 kHz in FM); typically 100 ms
Reference	
Internal	10 MHz
External	Accepts 10 MHz or 5 MHz TTL compatible

1.2.2 RF OUTPUT

Level Range	+13 to -127 dBm (1 volt to 0.1 microvolt)
Level Resolution	0.1 dB
Level Accuracy	\pm 1.5 dB of set output level
Impedance	50 Ω
Output Connector	Type "N", female
SWR	<1.3:1 at RF outputs below -7 dBm

The 2407 powers up with the same settings present when power was removed, except the RF output will be off.

1.1.6 ERROR INDICATORS

The 2407 front panel display indicates the following error conditions:

- A control microprocessor communication failure
- An unlocked condition in the phase locked loop circuitry
- An unlevelled condition in the RF output leveler circuitry
- A tripped RF circuit breaker
- Deviation meter errors

EMI/RFI Leakage	<1 μ V into a 2-turn 1 inch diameter loop held one inch from any surface at 550 MHz
1.2.3 SPECTRAL PURITY	
Harmonics	<-30 dBc for frequencies >10 MHz <-26 dBc for frequencies <10 MHz
Nonharmonics Spurious(>5 kHz from carrier)	<-35 dBc
1.2.4 PHASE NOISE @ 500 MHz	10 kHz offset ; <-100 dBc/Hz guaranteed
1.2.5 RESIDUAL AM	<-60 dBc (50 Hz to 15 kHz post detection bandwidth)
1.2.6 RESIDUAL FM	<30 Hz rms (50 Hz to 15 kHz post detection bandwidth)
1.2.7 MODULATION	
Modes	AM, FM, COMPLEX (EXT AM and INT FM; EXT FM and INT AM)
Internal Source	400 Hz, 1 kHz; derived from frequency standard
External Source	
AM Mode	10 Hz to 50 kHz, 600 Ω input Input Level 1 volt peak-to-peak into 600 ohms for full scale modulation
FM Mode	50 Hz to 100 kHz, 600 Ω input
Ranges	0 to 1 MHz (3-137.49999 and >275 MHz); 0 to 500 kHz (137.5-275 MHz); 0-100 kHz (1-3 MHz); 0-10 kHz (.2-1 MHz)
Deviation Error	\pm 5% of deviation at 1 kHz, excluding residual FM
Distortion	<2%
1.2.7.1 AM CHARACTERISTICS	
AM Frequency Response	10 Hz to 50 kHz, (3 dB BW, 50% modulation)
AM Resolution	.1%
AM Range	0 - 99%
Modulation Accuracy, AM (0 - 90%)	\pm 1% + (\pm 5% of indicated setting) at internal rates
AM Distortion	<1.5%, below 30% modulation <3%, 30% to 70% modulation <5%, 70% to 90% modulation

1.2.7.2 FM CHARACTERISTICS

FM Resolution	100 Hz (deviations <100 kHz) 1 kHz (deviations <1 MHz)
FM Rate	50 Hz - 100 kHz (3 dB BW)
FM Deviation Range (1 kHz Rate)	1 MHz peak (3-137.49999 & >275 MHz) 500 kHz peak (137.5 - 275 MHz) 100 kHz peak (1 - 3 MHz) 50 kHz peak (0.1 - 1 MHz)
Modulation Accuracy, FM	At internal rates, $\pm 5\%$ of indicated setting, excluding residual FM
FM Distortion	<2% at internal rates for deviation <100 kHz, excluding residual FM <0.5% at external rates for deviation <100 kHz, excluding residual FM

1.2.8 FM DEVIATION METER CHARACTERISTICS

Frequency Input	30 to 500 MHz
Input Signal Level	15 millivolts to 5 volts rms
Input Impedance	50 ohms
Measurement Range	0 to 500 kHz
Polarity	Selectable positive or negative
Modulation Rate	100 Hz to 8 kHz
Accuracy	6% of full scale from 100 Hz to 8 kHz

1.2.9 FRONT PANEL CONTROLS

Type	Push-button
------	-------------

1.2.10 REVERSE POWER PROTECTION

Max RF Power	50 W
Trip Level	~ .7 W
Trip Time	Typically <2 mSec
RF Circuit Breaker	Resettable from front panel

1.2.11 STORED SETTINGS

15 Total, non-volatile Complete front panel settings stored

1.2.12 EXTERNAL REFERENCE INPUT (REAR PANEL)

Frequency 10 MHz or 5 MHz
Required Input Level TTL compatible
Required Input Impedance 50 Ω
Waveform Sine or Square Wave

1.2.13 INTERNAL REFERENCE OUTPUT (REAR PANEL)

Frequency 10 MHz
Voltage Out/Impedance $>.5 V_{p-p}$, into 50 Ω

1.2.14 GENERAL

Dimensions 14 cm (5.2 in.) High; 31.75 cm (12.5 in.) Wide;
54.36 cm (21 in.) Deep
Weight 11.79 kg (26 lbs.) net; 13.61 kg (30 lbs.)
shipping
Power Requirements 100, 115, 215, or 230 VAC $\pm 10\%$; single phase;
50, 60, or 400 Hz; 100 watts, maximum
Calibration Interval After calibration, the Model 2407 will meet each
performance requirement within the tolerance
specified for a period of at least 12 months

1.2.15 Remote (GPIB) Operation

The GPIB permits remote programming of front panel
functions. Command codes conform to TEK codes and
formats, Tektronix Standard 80009, Rev. C, 1979.

Interface GPIB IEEE-488.1, IEEE-488.2

Control All functions except On/Off

Functions T6, L4, SH1, AH1, RL1, DC1, DT1, E2, SR1, TE0,
LE0, PP0, C0

1.3 OPTIONS

Rack Mount Kits Wavetek manufactures two rack mount adaptor kits,
one without slides and one with slides. The rack
mount adaptor kit without slides provides a fixed,

immovable unit mount. The rack mount adaptor kit with slides allows the unit to be pulled out from the rack. Complete installation instructions are supplied with the hardware for either kit.

INSTALLATION INSTRUCTIONS

2.1 INTRODUCTION

This section provides complete installation instructions for the Wavetek Model 2407 RF Signal Generator. These instructions include the initial inspection required for the unit and contain information on mechanical installation, electrical installation, and the initial installation checks.

2.2 INITIAL INSPECTION

After unpacking the instrument, visually inspect external parts for damage to connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

2.2.1 DAMAGE CLAIMS

If the instrument received has been damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana. Retain the shipping carton and packing material for the carrier's inspection. The local representative or the factory will immediately arrange for either replacement or repair of your instrument without waiting for damage claim settlements.

2.3 MECHANICAL INSTALLATION

2.3.1 Mechanical installation instructions are limited to those steps required to install the 2407 into a rack using the optional rack mount adaptor kits available from Wavetek.

2.3.2 Wavetek manufactures two rack mount adaptor kits, one without slides and one with slides. The rack mount adaptor kit without slides provides a fixed, immovable unit mount. The rack mount adaptor kit with slides allows the unit to be pulled out from the rack.

2.3.3 Complete installation instructions are supplied with the hardware for either kit.

2.4 ELECTRICAL INSTALLATION

The instrument can operate from 100, 115, 215, or 230 VAC supply mains, over an AC supply frequency range from 50 to 400 Hz. The rear-panel AC power connector module is set for the operating voltage being used, and adjusts the Power Supplies accordingly. The AC power connector module connects to an AC supply via a line cord with a 3-prong plug. The module contains a time-delay

line fuse: 1 A for 100/115 VAC operation; 0.5 A for 215/230 VAC operation. The fuse and a clearly marked voltage selector are accessed when the fuse/voltage select compartment door is open (see Figure 2-1).

Instruments are shipped from the factory set up for 115 VAC operation unless otherwise specified.

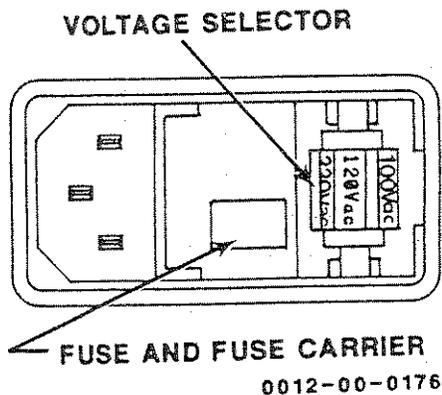


Figure 2-1. AC Power Connector Module

NOTE

Before operating the instrument, check that the rear-panel AC fuse is the correct value for the supply voltage.

2.5 INSTALLATION CHECKS

Wavetek performs a rigorous and complete test/calibration of each 2407 before it leaves the factory. Because accidents can occur during shipment, the user may elect to perform any or none of the following functional checks to further verify proper operation. It is the user's responsibility to determine the degree to which the unit will be tested initially (upon receipt).

Any time power is applied to the Model 2407, it automatically performs a test sequence to verify various subsystems and subsystem circuitry are functional.

That power up test sequence is described in Section 5.5 of this manual.

The following installation check procedures provide a quick functional test to verify that the instrument (total system) is operating properly. If the user desires to verify operation at specification limits, the performance test procedures in Section 4 of this manual must be used.

The functional test procedures involve use of the front panel controls and displays. Controls and displays are described in detail in Section 3 of this manual. Please read Section 3 before initiating operation.

AutoCal®, the almost completely automatic self-calibration procedure for the instrument, is contained in Section 5.4 of this manual. If it is determined that the unit is not operating properly, perform the AutoCal® procedure, then retest.

2.5.1 REQUIRED TEST EQUIPMENT

The test equipment required to perform the following installation checks will depend upon the degree to which the user wants to verify the instrument. If the desire is to verify to specification, the user should proceed to Section 4 and complete the performance tests detailed there. The installation checks described in the next few paragraphs are intended to provide a functional test of the unit. The operator will verify the output frequency, modulation, and power levels are accurate to the limits of the test equipment used and that the output characteristics change when programmed to change. The following tests are general in nature because the operator may use the test equipment on hand (spectrum analyzer, modulation analyzer, oscilloscope, power meter, etc.) to perform them. Wavetek does not recommend specific test equipment to use for these initial functional tests.

2.5.2 TURN ON

Verify that the voltage selector is set to select the available line voltage, and that the proper fuse is installed (see Section 2.4). Verify that the EXTERNAL/INTERNAL REFERENCE has been selected properly. Selection is made using the diagnostic and control programming procedures (see section 3.8.2). If the internal reference source is used, the INT source must be selected. (If the INT source is not the selected source when the internal reference is used, the power up self test will give an error message and the unit will not operate.) Depress the POWER switch. The display will indicate operation, with the RF OFF. Press the RF ON/OFF key to turn on the RF.

2.5.3 TEST PROCEDURE

The following paragraphs briefly outline a general functional test procedure for the 2407. Verify measurements to the limits of the test equipment used, if desired.

2.5.3.1 FREQUENCY

Use the keyboard (Section 3.5.2.1) to set the output frequency to 550 MHz at a 0 dBm power level, with no modulation. Measure the output frequency. Change the output frequency to 250 MHz. Measure the output frequency. Use the keyboard to set the frequency to 0.01 MHz. Measure the frequency.

2.5.3.2 OUTPUT POWER

Set the output frequency at 1 MHz with no modulation. Use the keyboard to set the output power level at +13 dBm. Measure the output power. Set the output power to -7 dBm. Measure the output power. Set the output frequency to 200 MHz. Measure the output power. Use the keyboard to change the output power to +13 dBm. Measure the output power. Set the output frequency to 550 MHz. Measure the output power. Change the output to -7 dBm. Measure the output power.

2.5.3.3 AM

Set the output frequency at 1 MHz and power level at -7 dBm. Select INT AM and the 1000 Hz internal source. Set internal AM at 90%. Measure AM. Change the output frequency to 550 MHz. Measure AM. Select the 400 Hz internal source. Measure AM.

2.5.3.4 FM

Set the output frequency to 275 MHz and the power level at 0 dBm. Select INT FM and the 1000 Hz internal source. Set internal FM deviation at 99.9 kHz. Measure the deviation. Change the output frequency to 500 MHz. Measure deviation. Select the 400 Hz internal source. Measure FM deviation.

2.5.3.5 EXTERNAL AM/FM

The user may elect to insert an external modulation source at the "Mod In" connector on the front panel and repeat steps 2.5.3.3 and 2.5.3.4 for EXT AM and EXT FM outputs. Select EXT AM and EXT FM by pressing the appropriate keyboard switch.

2.5.3.6 DEVIATION METER

Press the "Pos Dev" key on the front panel. Set the output frequency of the Model 2407 to 250 MHz.

Connect the RF output from an external signal generator to the 2407 front panel Mod In connector. Set the external generator to 250 MHz, 0dBm, FM modulation 500kHz peak, internal rate of 1 kHz.

The external generator's positive FM deviation to ± 30 kHz will be shown in the 2407's LCD display.

Press the "Neg Dev" key on the front panel. The external generator's negative FM deviation to ± 30 kHz will be shown in the 2407's LCD display.

Decrease the external generator's output frequency by 200 kHz. When the de-

viation measurement is used, the 2407 display will show the message "TUNE -". This indicates the 2407 output frequency must be adjusted down to make the measurement.

The display will show "TUNE +" or "TUNE -" when the external source frequency is within approximately ± 1 MHz of the 2407 frequency.

3.1 INTRODUCTION

This section provides complete operating instructions for the Wavetek Model 2407 RF Signal Generator. No preparation for operation is required. The optional initial installation checks contained in Section 2 of this manual may be performed at this time.

The 2407 may be operated locally using the front panel controls or remotely through the General Purpose Interface Bus (GPIB) interface on the rear panel, under computer/controller instructions. The GPIB conforms to proposed IEEE 488.1 and is described in section 6 of this manual.

3.2 AIR FILTER CAUTION

Regularly check the air flow filter installed over the intake vents on the bottom of the unit. Clean or change as necessary. Air filter maintenance is described in the Maintenance Section of this manual.

3.3 FRONT PANEL DESCRIPTION

Front panel operating controls, displays, and connectors are shown in Figure 3-1. All controls necessary for local (manual) operation of the unit are located on the front panel. Front panel features are identified by number in Figure 3-1. Each numbered feature is briefly described in the following paragraph with the same number.

1. POWER

The power switch turns on/off the 2407.

CAUTION

Allow a 2-second time interval between turning power off and on to prevent current surges.

2. FUNCTION CONTROL KEYPAD

The function control keys are grouped together into a keypad for operator convenience. Each key is described in the following section.

The "Int AM" key selects the internal amplitude modulation mode of operation and is associated with the Rate key.

The "Int FM" key selects the internal frequency modulation mode of operation and is associated with the Rate key.

The "Ext AM" key selects the external amplitude modulation mode. Connect the external amplitude modulation source at the "Mod In" connector (feature 7).

The "Ext FM" key selects the external frequency modulation mode. Connect the external frequency modulation source at the "Mod In" connector (feature 7).

The "Rate" key determines which internal source, 400 or 1000 Hz, provides the internal modulation rate (AM or FM, selected by the "Int AM" key or the "Int FM" key, respectively).

The "Mod Off" key turns off all modulation of the carrier wave, selecting an unmodulated CW RF output. This key also turns off the deviation meter.

The "Pos Dev" (Positive Deviation) key

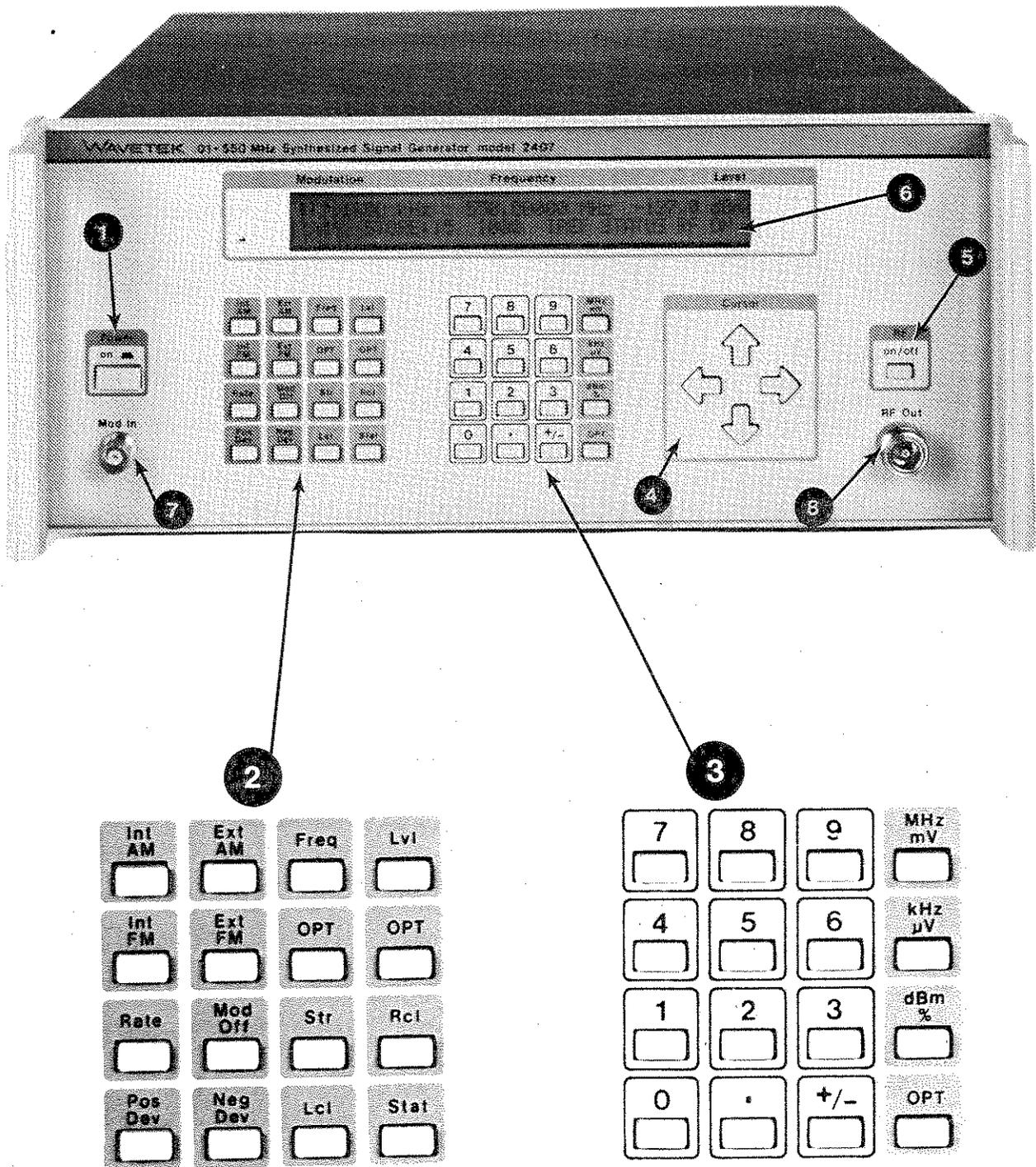


Figure 3-1. Wavetek Model 2407 Front Panel

deviation meter option.

The "Neg Dev" key is used with the FM deviation meter option.

The "Freq" key initiates the procedure to set the RF output carrier frequency.

The "Lvl" key initiates the procedure to establish the RF output power level.

The two (2) "OPT" keys that are present but nonfunctional on the standard Model 2407 provide potential operator interfaces for future 2407 options. If an option is installed, its associated key will be relabeled. Documentation for future options will be supplied separate to this manual.

The "Str" key initiates the procedure to store front panel settings in non-volatile RAM (Random Access Memory). There are 15 locations available for stored settings.

The "Rcl" key initiates the procedure to recall front panel settings from storage locations in non-volatile RAM.

The "Lcl" key is used to reestablish front panel control of the 2407 from the remote control source when the unit is in the remote control mode of operation (GPIB). Note that documentation for the GPIB is provided in section 6 of this manual.

The "Stat" key initiates LCD menus associated with error messages, diagnostics, options, calibration, and control switch setting operations

3. NUMERIC ENTRY/TERMINATOR KEYPAD

Numeric data is entered using 12 of the 16 keys grouped in this keypad. The digits (0-9) and a decimal point (.) are represented by individual keys. The "+/-" key establishes the sign of an entry (positive or negative) and is the "exit" key for various status key operations described later in this manual.

The "MHz/mV" key terminates an output frequency (MHz) or output level (mV) entry.

The "kHz/ μ V" key terminates output frequency and FM deviation (kHz) and output level (μ V) entries.

The "dBm/%" key terminates output level (dBm) and AM modulation depth (%) entries .

The "OPT" key that is present but nonfunctional on this keypad provides an additional operator interface for future 2407 options. If an option is installed, this key will be relabeled to indicate the option it controls. Option documentation will be supplied separate to this manual.

4. CURSOR

The four cursor keys work together to provide fine and coarse control of output frequency, output level, AM depth (%), and FM deviation (kHz). The keys work in pairs. The left/right arrow keys (resolution digit keys) form one pair. The up/down arrow keys form the other pair. The operation of each pair is described in the following sections.

The left and right arrow keys act as cursor keys to establish the "resolution" digit in the numeric portion of a displayed function (see item 6). The "resolution" digit is controlled by the up/down keys (see the paragraph immediately following this one). The digits to the left of the resolution digit also are controlled by the up/down keys. The resolution digit is underlined on the display. Pressing the up/down keys will not change digits to the right of the resolution digit.

The up/down keys increase or decrease the numeric value displayed, with the resolution digit as the point around which the change occurs. Pressing the up key will increase the value. The down key will decrease the value.

5. RF ON/OFF

The "RF on/off" key is used to switch the RF signal on and off at the "RF out" connector (feature 8). Also it is used to reset the reverse power protection circuit breaker when it trips.

6. LCD DISPLAY

The front panel display is a two line by forty character, dot matrix, liquid crystal display (LCD). The display provides information about RF output characteristics, indicates operational status of the instrument, and shows deviation meter readings. The display is divided into various information fields described in the following sections. The top line includes modulation information, frequency information, and level information. The bottom line includes additional modulation information, front panel setting storage/recall information (memory), GPIB and external reference indicators, status information, and the RF on/off indicator. Both lines carry deviation meter information. Many of the numeric values shown on the display will contain the underlined resolution digit used with the cursor (see item 4 of Figure 3-1 and see section 3.3).

The modulation field is the left most twelve characters of the first line of the display. It is identified by the "Modulation" label above the display. It is separated from the next field by two blank characters. (Additional modulation information is shown on the second display line).

The first three characters of the modulation field form a mnemonic that indicates the current modulation input or the last modulation input. Identical mnemonics are used for front panel and remote (GPIB) operation. Mnemonics for normal operating conditions are:

IAM Internal AM
IFM Internal FM
XAM External AM
XFM External FM

After a blank space, the next four characters of the modulation field indicate the numeric portion, including decimal point, of the modulation value. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to control these digits. After another blank space, the last three characters show the modulation units (% or kHz). When no modulation (internal or external) is in effect, MOD OFF is displayed in this field.

Note that when the deviation meter is in use, it replaces all internal and external modulation functions. The display will show the positive or negative FM deviation values with the POS or NEG mnemonic, the numerical deviation value, cursor, and the Hz unit. (The first field of the second line on the display will show the characters DEV).

The frequency field is on the first line of the display, below the "Frequency" label. It consists of characters 15 through 28 on the line and is separated from the modulation field by two blank spaces. The numeric value of the frequency, including decimal point, is shown in the first ten characters. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to control these digits. After a blank space, "MHz" units are shown.

The level field is composed of the last ten characters on the first line of the display. These characters are located under the "Level" label. Two blank spaces separate this field from the frequency field. The first character in the level field is the plus or minus sign for level in dBm. The next five characters show the numeric value of the level, including decimal point. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to control these digits. After a space, the last characters are dedicated to the level units (dBm or mV or μ V).

When external and internal modulation are in use, the first line of the dis-

play shows the modulation type last entered. The first three characters of the second line of the display show the additional modulation. These characters are the same as those shown on line one (IAM, IFM, XAM, or XFM) and have the same meaning. The next five characters give the internal rate in Hz (either 1000 or 400). When no internal modulation is used, no internal rate is displayed.

When the deviation meter is in use, the characters DEV will replace the modulation status shown in this field.

When instrument settings are loaded into (stored) or recalled from memory locations, the location for storage or recall is shown under the Frequency label on line two of the display. Typical store/recall indications are STORE 11 and RECALL 11, for example. When a setting is changed and no longer represents the contents of a particular location, the location information is removed. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to increment or decrement the recall operation.

When the instrument is controlled across the GPIB bus (remote operation), this field will show the indication REMOTE.

The third field on the second line displays XREF when an external reference is used. IREF is shown when the internal reference (default condition) is used.

The fourth field on the second line contains the STATUS message that will flash on and off when an instrument error condition occurs. The STATUS error message will continue to flash on and off until the Status (Stat) key (item 2 of Figure 3-1; section 3.3) is pressed.

After the STATUS request is acknowledged by pressing the "Stat" key, the second display line will show the following message:

1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT

This is the status key operation select menu. It shows the available status key operations. The status key is used to initiate error reporting, diagnostics, options, calibration, and control switch setting operations. ERROR represents error reporting operations. DIAG stands for diagnostic test procedures. OPTN is the option review and programming procedures. CAL stands for calibration procedures. SET is the control switch setting operations. To initiate the status key operation shown, enter its associated number. The appropriate menu will be called up. The cursor is initially located under the "E" in "ERROR", as shown above. Pressing the STATUS key is like pressing the "1" key in this instance. The first in the series of Error Reporting menus will be generated (see section 3.6.1).

Pressing the "+/-" key from the status key operation select menu will restore the normal operating display. If the error condition is still present after returning to the normal display, the "STATUS" indicator will be on but will not be blinking on/off. If a new error condition occurs, the "STATUS" indication will begin flashing again. If the error condition disappears, the "STATUS" message will turn off.

Status key operation incorporates user friendly LCD menus that guide the operator through the procedures associated with the status key. CAL (Calibration) operations are described in Section 5.3 of this manual. The remaining status key operations are described in sections 3.6.1 through 3.6.5.

The last field in the second line shows the status of the RF output. It will indicate RF ON or RF OFF. This information is always present on the display.

7. Modulation In Connector

The "Mod In" connector is a BNC connector to which an external modulation source or the deviation meter input will be applied.

8. RF Output Connector

The "RF Out" connector is a type N connector at which the RF output signal is obtained.

3.4 REAR PANEL DESCRIPTION

Rear panel connectors are shown in Figure 3-2. Each numbered feature is briefly described in the following paragraph with the same number.

1. INTERNAL REFERENCE OUT CONNECTOR

This is the connector at which the 10 MHz sine wave internal reference signal may be obtained.

2. EXTERNAL REFERENCE IN

This is the connector at which an external 10 MHz signal or 5 MHz (TTL compatible, sine or square wave) is applied.

3. GPIB CONNECTOR

This is the connector for GPIB communication. It permits instrument operation

from a remote controller (GPIB documentation is in Section 6 of this manual).

4. FAN

The fan removes instrument heat. Air inlet vents are located on the bottom cover near the front of the unit.

5. AC POWER CONNECTOR MODULE

The voltage selector in this module is removable. It must be inserted in the correct AC line voltage position to adjust the unit's power supply correctly. (See Section 2.4 and Figure 2-1 of this manual for greater detail.)

6. OPTION PLUGS

These four (4) plugs cover openings for installation of options. Options may be installed at the factory when a unit is ordered or in the field by the customer.

7. WARNING LABELS

The electrical shock and fuse replacement warnings are on the rear panel.

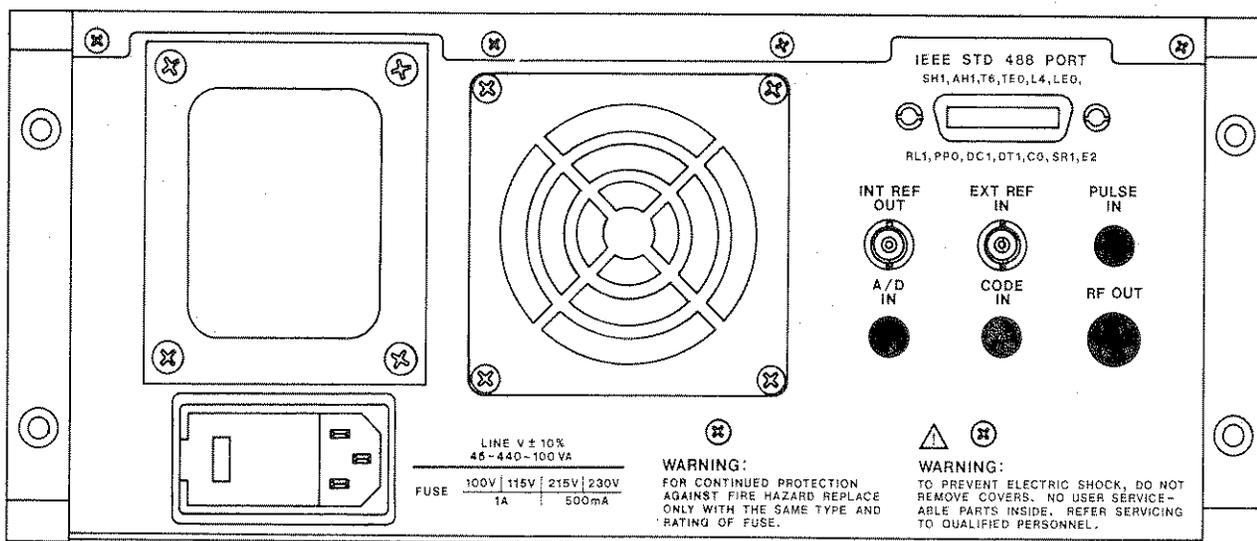


Figure 3-2. Wavetek Model 2407 Rear Panel

Note that there are no user serviceable parts inside this unit. Service must be performed by qualified personnel.

3.5 LOCAL MODE OF OPERATION

In the local mode of operation the instrument is completely controlled from the front panel. Front panel control involves interaction of the display, function keys, and termination keys.

3.5.1 TURN ON

Depress the power switch to turn on the unit. The unit will power up with the RF output off. The front panel settings that were active when the unit was last turned off will be active when the unit is turned on again. The power up test sequence described in Section 5.5 will be performed each time power is applied to the unit. See section 5.5 for the displays associated with power up.

3.5.2 NUMERIC ENTRIES (KEYBOARD AND CURSOR KEYS)

The following front panel operations require numeric entry that can be made using the keyboard and/or the cursor arrow keys:

- Setting the output frequency (FREQ)
- Setting the output level (LVL)
- Setting the source and type of modulation (INT AM, INT FM, EXT AM, EXT FM), and its value (% AM or kHz Deviation FM)
- Setting deviation meter frequency

3.5.2.1 SEQUENCE OF OPERATIONS

The keyboard/cursor key sequence and the instrument response for a numeric entry are:

a. Press the function key (FREQ, LVL, INT AM, INT FM, EXT AM, EXT FM, POS DEV, NEG DEV). After the function is selected, the resolution digit for the cursor keys will be indicated on the appropriate display field for the function selected.

b. If the arrow cursor keys are going to be used to determine the numeric value for the selected function, they must be used before the numeric keypad (numbers 0-9, decimal point, and +/- key) is used to enter a number. (Cursor key operation is described in detail in Section 3.5.2.2, immediately following this section.

c. Either use the cursor keys to establish the numeric value to be entered (Section 3.5.2.2) or use the numeric keypad to enter the value for the function. The first keypad number entry will appear in the most significant digit (MSD) of the display for the selected function. The cursor will appear under the digit immediately following the MSD. Blank spaces will appear in the remaining digit locations and the decimal point will not appear in the display field. Any suffix will be blanked out.

d. Enter the numbers to the left of the decimal point (see e, below). As further numbers are entered, they will be placed to the right of the previously entered digit until the last digit position has been reached. When the last position has been reached, further number entries may be accepted (up to a maximum of fifteen significant places), but will not be displayed.

e. Enter the decimal, as required. When the decimal key is depressed, the decimal point will be placed to the right of the previously entered digit. The decimal point key can be pressed more than once during a single entry, moving the location of the decimal point. Enter the remaining digits.

f. After the complete number has been entered, enter a terminator. When the correct terminator key has been pressed, the entered number will be adjusted as required to put it into the standard format. If an insufficient number of digits have been entered, for example, then the display will be filled with zeroes and these will be used for the data entry. The correct suffix will also

be enabled. The function will be executed with the new data.

g. The following responses will occur for illegal key entries:

- Inadvertently pressing another function key during a numeric entry will enable that function. The function for which the numeric entry was being made will be restored to its previous value.
- If a non-numeric function key (discussed in Section 3.5.4) is depressed, the function will be executed without affecting the numeric entry process. After the non-numeric process has been executed, the numeric entry process can be completed.
- If the entered data is out of the range of the function, the previous function value will be restored and displayed.

3.5.2.2 CURSOR KEY OPERATION

The up and down arrow and left and right arrow cursor keys are used to increase or decrease the numeric value of a function. Pressing the up arrow cursor key increases the value; pressing the down arrow key decreases the value. Values for output frequency, power level, internal and external amplitude modulation, and internal and external frequency modulation may be controlled.

a. The left and right arrow cursor controls are used to select a given digit, the resolution digit, on the chosen function's display field. The resolution digit for a particular function can be changed by using the left and right arrow cursor keys. The line under the resolution digit will be moved to the left or right to indicate the selected digit. When the LSD (Least significant digit) is reached using the right arrow key, the next depression of the right arrow key will

be ignored. Likewise, when the MSD (Most significant digit) is reached using the left arrow key, the next depression of the left arrow key will be ignored. No wrap-around occurs in either "direction." The resolution digit selected for each function will be retained during operation of the 2407 Signal Generator.

b. When the up/down arrow keys are pressed, the value for the selected resolution digit will increase or decrease. The digits to the left of the resolution digit will be affected by either a carry or a borrow operation and will also increase or decrease, respectively. The digits to the right of the resolution digit will not be affected by cursor key operation. These digits will maintain their previous values during cursor key operation.

The cursor keys permit very coarse control when used with the most significant digit, and very fine control when used with the least significant digit. When the upper or lower range limit of a function is reached, the display and the function parameter will stop at that value. Once the limit is reached, further use of the cursor key will not cause a further change in the displayed value.

c. CAUTION: When the cursor keys are used to set the output level, care should be exercised not to overdrive a device being tested.

3.5.3 NUMERIC ENTRY (KEYBOARD ONLY)

The 2407 contains fifteen (15) locations in memory for storage of 15 different sets of front panel settings. These locations are identified by a two digit number (01-15). The function keys "Str" and "Rcl" (items 13 and 14 of Figure 3-1) are used to initiate storage or recall, respectively, of the front panel settings at a given location. The numeric keyboard is used to specify the two digit location. Refer to Section 3.5.6.1 for a detailed dis-

cussion of the STORED SETTINGS feature.

3.5.4 NON-NUMERIC ENTRY

Five functions do not require a numeric entry. These functions are direct action functions. The desired operation will be executed when the key is depressed. The functions are:

- Selection between 400 and 1000 Hz internal modulation source (Rate)
- Selection of the CW unmodulated output (Mod Off)
- Local mode selection (Lcl)
- Switching the RF output on and off (RF on/off)
- Status key operations (Stat)

Toggle switches control the 400/1000 Hz Rate and RF on/off functions. When either key is depressed, its function toggles between the two possibilities shown.

The "Mod Off", "Lcl", and "Stat" keys select particular functions. When one of these keys is depressed, the function is executed and the appropriate annunciators are displayed. The "Stat" key is a multifunction key (see Section 3.8 for a detailed description).

3.5.5 SETTING RF OUTPUT CHARACTERISTICS (FREQUENCY, LEVEL, MODULATION)

The three basic RF output characteristics are frequency, level, and modulation. Each can be set from the front panel. This section describes the procedures to set each characteristic when the unit is in the Local Mode of operation. Remote Mode (GPIB) operation is described in Section 6.

3.5.5.1 FREQUENCY

The output RF frequency of the 2407 is set using the keyboard/cursor key sequence described in Section 3.5.2.

Press the "Freq" function key to initiate a change in frequency. Then enter the numeric value using the keyboard or

cursor keys as described in Section 3.5.2.

The "kHz" and "MHz" keys are terminators for numeric entry of frequency. Output frequency is shown on the frequency field of the display.

When FM (Frequency Modulation) is selected and a frequency change ≥ 10 kHz is to be made, the 2407 will be momentarily set to the CW mode. After the frequency change has been made and the generator has stabilized, the original FM output will be restored. (A frequency change < 10 kHz will not turn off the modulation.)

3.5.5.2 POWER LEVEL

The RF output power level of the 2407 is set using the keyboard/cursor key sequence described in Section 3.5.2.

Press the "Lvl" function key to initiate a change in output level. Enter the numeric value for the required output using the keyboard or cursor keys (Section 3.5.2). Terminate the entry using the "dBm", "mV", or " μ V" key. Output level will be shown on the Level field of the display.

Convert dBm to mV or μ V by pressing the "Lvl" function key, then pressing the "mV" or " μ V" key. The conversion from mV or μ V to dBm is performed by pressing the "Lvl" key followed by pressing the "dBm" key.

CAUTION: When the cursor keys are used to set the output level, be careful not to overdrive a device being tested.

3.5.5.3 MODULATION

The "Mod Off" key selects a CW (unmodulated) output of frequency and level as set in Sections 3.5.5.1 and 3.5.5.2, respectively.

Modulation of the 2407 RF output signal is set using the keyboard/cursor key sequence described in Section 3.5.2.

There are three basic modes of modulation that may be selected using the function keys. They are:

- AM, Internal or External
- FM, Internal or External
- Complex, AM and FM together

Single modulation (AM, internal or external; or FM, internal or external) is established by pressing the function key associated with the desired type of modulation ("Int AM" or "Ext AM"; "Int FM" or "Ext FM"). The numeric value for the modulation depth (AM) or deviation (FM) is then set using the keyboard/cursor key sequence (described in Section 3.5.2). Single modulation is executed by pressing the appropriate terminator key ("% for AM; "kHz" for FM).

Section 1.2.7.1 of this manual lists the Model 2407 specified AM range. Although the unit may be set to an AM depth of 100%, an AM depth greater than 90% is outside the specified range. Section 1.2.7.2 lists the Model 2407 specified deviation range for FM operation. A deviation greater than 50 kHz in the frequency range from 0.1 MHz to 1 MHz, for example, is outside the specified range. AM or FM operation outside specified ranges may produce one or more of the front panel messages described in Sections 3.6 and 3.7.

The following combinations of complex modulation are possible:

- INT AM and EXT FM
- INT FM and EXT AM

The order in which internal and external modulation is entered is not important.

Modulation characteristics will be shown on lines 1 and 2 of the display.

Use the "Rate" function key (item 6 on Figure 3-1) to choose between internal modulation sources of 400 and 1000 Hz.

To obtain a calibrated output, an exter-

nal modulating signal of 1 volt peak-to-peak (0.353 RMS) into a 600 Ω load must be provided.

NOTE

If the external modulating signal is not 1 volt peak-to-peak, the output will not be calibrated.

3.5.6 STORAGE/RECALL OF FRONT PANEL SETTINGS

There are 15 memory locations set aside for storage of 15 complete front panel settings (output frequency, level, and modulation settings). The function keys associated with this dedicated memory are the "Str" (store) and "Rcl" (recall) keys. Each is described below.

3.5.6.1 STORED SETTINGS (STORAGE AND RECALL)

a. Use the following key sequence to store the current front panel settings.

1) Press the "Str" function key. The word "STORE" will appear on the display. The last location into which front panel settings were stored also will be displayed.

2) Enter the two digit number that designates the storage location. Location 3 would be entered as "0" and "3". The "0" is placed in the most significant digit position. The "3" will go into the least significant position.

3) When the final location digit is entered, the current front panel settings are stored at that location.

b. To recall a stored setting:

1) Press the "Rcl" function key. The word "RECALL" will appear on the display. The last location from which front panel settings were recalled will be indicated on the display.

2) Enter the two digit number identifying the location from which recall is

to be performed. After entry of the second digit the display will show the two digit location entered. The front panel settings that were recalled will be executed and the display will be updated to show the recalled settings.

c. The following responses will occur for illegal key entries:

- 1) If a terminator, sign, or decimal point key is depressed, the key will be ignored.
- 2) If any function key associated with a numeric entry is pressed, that function is enabled and the store/recall process is aborted. The store/recall display will be blank.
- 3) If a function key not associated with a numeric entry is pressed, the function will be executed. After the non-numeric process is executed, the storage/recall process will resume.
- 4) If the stored setting number is out of range, the entry is ignored. The display returns to the last storage location that was stored or recalled.

3.5.7 RETURN TO LOCAL MODE OF OPERATION FROM REMOTE

The "Lcl" key will cause the 2407 to exit the Remote Mode (GPIB) of operation and return to full front panel operation (Local Mode). The front panel display will show the message "LOCAL" on the second line.

When the unit is in the Remote Mode, the REMOTE indicator is shown on the display. The front panel keys, except for the "Lcl" key, are disabled. The "Lcl" key is disabled if the local lockout command is received over the GPIB. (GPIB operation is described in Section 6 of this manual.)

3.6 STATUS KEY OPERATION

Pressing the status key (Stat) is the initial step in calling up error report-

ing, diagnostics, option review/programming, calibration, and control switch setting menus. Menu selections are numeric. Each number shown has an associated operation. Entering a number on the keyboard generates the operation shown on the menu. The cursor is automatically placed under the most frequent choice on each menu, allowing the selection of that choice by pressing the status key. The "+/-" key is the exit key for each menu.

3.6.1 ERROR MESSAGES

Several error messages are displayed by this instrument. An instrument malfunction or operation of the instrument outside its specified range may generate the error message sequence described in the following sections.

If an instrument error occurs, the fourth field on the second line of the normal operating display will have a STATUS annunciator that will blink on and off. The STATUS error message will continue to blink on and off until the "Stat" key (item 2 of Figure 3-1; see section 3.3) is pressed. If a new error occurs after the initial response, the STATUS indication will begin blinking again.

After the status key is pressed to acknowledge the STATUS request, the second display line will show the following message:

1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT

This is the menu that shows the paths available through status key operations. When the "Stat" key is pressed in response to an error indication (STATUS blinking on/off), the cursor is initially located under the "E" in "ERROR" as shown above. When ERROR is implemented (press the "Stat" key when the cursor is under the "E" in "ERROR" or press the "1" key), the second line of the display will show the error condition(s) actually present. The locations on the second line for the various error indicators are:

MFREQ TRIP UNLOCK1 UNLOCK2 UNLEV +:Exit
and
CONTROL uP COMMUNICATION FAILURE +:Exit

Individual errors are described in sections 3.6.1.1 through 3.6.1.5. The cursor will be present under the "EXIT" message. Pressing the "+/-" key or the "Stat" key will restore the normal operating display. If the error condition is still present after returning to the normal display, the "STATUS" indicator will be on but will not be blinking. If a new error condition occurs, the STATUS indicator will begin to blink on/off again. If the error condition should disappear, the STATUS message will turn off.

Error reporting will not interfere with the normal operation of the unit.

If the error procedure has been implemented when no errors are in effect, the second line of the display will show:

SYSTEM OPERATIONAL +:Exit

Pressing the "+/-" key or the status key will restore the normal operating display to the LCD.

Note that FM Deviation Meter errors also are shown in the display. They are detailed in the Deviation Meter discussion (section 3.7).

3.6.1.1 MFREQ

The MFREQ error message indicates a problem with the selected reference. If the internal reference has been selected (section 3.6.5.1), the MFREQ error message indicates that the internal modulation reference (400 Hz or 1000 Hz) derived from the frequency reference is not accurate. If the external reference has been selected, the MFREQ error message indicates either there is no external reference input or the input is not within specifications.

3.6.1.2 TRIP

A "TRIP" message on the display indicates an external input has been connected to the 2407 RF output, tripping the RF circuit breaker that provides reverse power protection. If this occurs, remove the external input and then push the "RF on/off" switch, first off then on, to reset the circuit breaker.

3.6.1.3 UNLOCK1 and UNLOCK2

The "UNLOCK1/UNLOCK2" messages on the display may indicate one of the phase locked loops (PLLs) in the output frequency generating circuitry has become unlocked. UNLOCK1 indicates the loop in the Synthesizer circuitry may be unlocked. UNLOCK2 indicates the loop in the LO (Local Oscillator) circuitry may be unlocked. If either UNLOCK message occurs, perform the calibration described in Section 5.4 of this manual. (If this procedure does not erase the UNLOCK indicator, the unit has a problem that will require troubleshooting. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

3.6.1.4 UNLEVEL

The UNLEVEL message also indicates the output amplifier/leveling circuitry may be out of calibration. Perform the calibration described in Section 5.4 of this manual. (If this procedure does not erase the UNLEVEL message, the unit has a problem that will require troubleshooting. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

3.6.1.5 CONTROL UP COMMUNICATION FAILURE

The "CONTROL uP COMMUNICATION FAILURE" message on the display indicates the control microprocessor communication

system has failed during execution of a command. This failure can be due to a component failure of the dual-port RAM or failure of the control microprocessor or any of its associated memory and decoding.

3.6.2 Diagnostic Procedures

Pressing the status key ("Stat") during normal operation will call up the initial screen for status key operations. The first line will contain normal operating information. The second line will look like:

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

To initiate the Diagnostics, press the "2" key. Software will turn off the RF output (RF OFF) and store the current instrument settings. The diagnostic selection display will be called up:

DIAGNOSTIC

```
1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:EXIT
```

Diagnostics are part of 2407 maintenance and are detailed in section 5.3.

3.6.3 Option Review And Programming

The option menus are included in the 2407 for future expansion. Typically these menus allow review or programming of the options installed in a unit. Press the "Stat" key from any normal operating menu to call up the status key operation select menu (second display line shown):

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

Enter a "3" to implement Option review/programming. The initial option display called up offers the alternatives to review or program the status of options installed or to be installed in the unit:

OPTION PROGRAMMING

```
1:REVIEW 2:PROGRAM +:EXIT
```

3.6.3.1 Option Review

To review the options currently installed, enter a "1" or press the "Stat" key, from the initial option review/programming menu. If the option review/programming functions were operational in the 2407, the options installed and their revision levels would be shown in a series of displays. The up/down arrow cursor keys would be used to scroll through the series of option review menus. Because the option menus in the 2407 are not active (for future expansion only), the sole option review menu is:

```
OPTIONS INSTALLED:↑BACK ↓NEXT +:EXIT  
NO OPTIONS INSTALLED
```

3.6.3.2 Option Programming

The Model 2407 option review/programming screens currently in place are for future expansion only and are not truly functional. Therefore no programming screens are shown in this manual. Operational option programming functions require entering a five digit security code for access to programming. This code can be easily changed as security requires. When the five digits are entered in the correct order, the display will show a series of screens that list the options that can be programmed, with instructions for programming them.

3.6.4 Calibration

Pressing the "Stat" key during normal operation will call up the initial screen for status key operations (second display line shown):

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

To initiate calibration procedures, press the "4" key. Calibration is part of 2407 maintenance. Calibration is described in detail in section 5.4 of this manual.

3.6.5 Control Switch Setting

The Control Switches set the reference source (internal or external), load the factory default settings into system memory, set LCD contrast, set the GPIB address and terminator, and initiate a service request. Press the "Stat" key during normal operation to call up the initial status key operations screen (second line shown):

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

Press the "5" key to call up the first of the Control Switch Set menus:

```
*:INT REF 2:XREF10 3:XREF5 4:DEFAULT  
5:CONTRST 6:ADDR 7:TERM 8:SRQ +:EXIT
```

3.6.5.1 Reference Programming

In the initial control switch setting menu, shown immediately above, the asterisk in front of the "INT REF" indicates the internal reference is the current reference source. Enter a "2" from this menu to change from the internal reference to an external 10 MHz reference. When an external source is used, the instrument must be told an external source is being used. The "XREF-5" characters are for future use with the 2407. After a reference change entry, the cursor is automatically placed below the EXIT field because the reference change is the most probable use for this menu. (Internal Reference is the default reference setting). An asterisk beside the entry chosen verifies the new selection. The reference selection with the asterisk (as INT REF, above) will be implemented when the status key ("Stat") is pressed while the cursor is under EXIT.

3.6.5.2 Load Factory Default Settings

The initial Control Switch Set menu is:

```
*:INT REF 2:XREF10 3:XREF5 4:DEFAULT  
5:CONTRST 6:ADDR 7:TERM 8:SRQ +:EXIT
```

Enter a "4" from this menu to load the

factory default settings into the current settings locations in the continuously powered RAM. Calibration values are not affected. This test is primarily a factory test that also may be used to verify RAM loading/storage. The cursor will move to EXIT and an asterisk will be placed in front of the DEFAULT characters to indicate the operation is complete:

```
1:INT REF 2:XREF10 3:XREF5 *:DEFAULT  
5:CONTRST 6:ADDR 7:TERM 8:SRQ +:EXIT
```

The default conditions are shown in following table.

MOD	OFF
FREQ	1 MHz
LEVEL	0 dB
INT AM	50%
EXT AM	50%
INT FM	10 kHz
EXT FM	10 kHz
RF	OFF
INT RATE	1 kHz
DEV METER	OFF

3.6.5.3 LCD contrast

Enter a "5" from the initial control switch setting menu to call up the LCD contrast adjustment screen:

```
DISPLAY CONTRAST PROGRAMMING***** 0  
Adjust using up/down arrows +:Exit
```

LCD contrast can be adjusted using the up and down arrow cursor keys, as indicated by the directions shown on the second line of the LCD. The contrast level is displayed on the right side of the upper display line. There are 16 levels of contrast, from a minimum "0" level to a maximum "15" level. To leave this procedure, press the "+/-" key or the status key.

3.6.5.4 GPIB address

Entry of a "6" from the initial control switch setting menu calls up the GPIB address setting screen:

GPIB ADDRESS SELECTION: 02
ENTER NEW SELECTION(00TO30):** +:EXIT

The GPIB address can be programmed for any value from 00 to 30. The value for the current address is shown on the first line of the display. The second line shows the address range and has asterisks where the new address should be entered. The two asterisks indicate that two digits of programming are required. The cursor will be placed in the EXIT field. Pressing the "+/-" key or the status key will immediately activate the new address. If no new address is entered, the current address displayed will be maintained. The factory default address is 02.

3.6.5.5 GPIB terminator

Entering a "7" from the initial control switch setting menu calls up the GPIB terminator programming menu:

GPIB TERMINATOR SELECTION: 10 LF
ENTER NEW SELECTION(00TO31):** +:EXIT

Any ASCII characters corresponding to a decimal number from 00 to 31 may be used as a GPIB terminator. The terminators LF, EOI, and CR are always accepted as GPIB input terminators, regardless of the terminator chosen using this display menu. This menu provides an additional input terminator, a fourth acceptable terminator. The first line of the display identifies the procedure and indicates the terminator currently chosen. The second line shows the available terminator range and has asterisks to indicate the two digit decimal value to enter to select a different terminator.

The ASCII characters associated with any number from 00 to 31 may be used. The most common terminator/ASCII numbers are:

NC (Null Character)	00
LF (line feed)	10
CR (Carriage Return)	13

The EOI (End or Identify) terminator is

always an output terminator, regardless of the terminator chosen using this display menu. The terminator chosen using this display menu will also be sent as an output terminator. The factory default terminator is LF, because it is specified in IEEE 488.2 and it is the most commonly used terminator. When this programming procedure is entered, the cursor will be under the EXIT field to avoid accidental reprogramming of the terminator. Terminator programming is executed immediately upon pressing the "+/-" key or the status key.

3.6.5.6 SRQ operation

Entering an "8" from the initial control switch setting menu will issue a service request to the GPIB. The cursor will move to the EXIT field and an asterisk will be placed in front of the SRQ characters to indicate the operation has been completed.

1:INT REF 2:XREF10 3:XREF5 4:DEFAULT
5:CONTRST 6:ADDR 7:TERM *:SRQ +:EXIT

3.7 DEVIATION METER OPERATION

3.7.1 Operating Instructions

The 2407 performs an automatic calibration of its deviation meter circuitry anytime the "Pos Dev" or "Neg Dev" key is pressed. Perform the following operations to use the 2407 deviation meter:

1. Press the "Pos Dev" or "Neg Dev" key.
2. Connect the signal to be measured at the "Mod In" connector.
3. Enter the measurement frequency. The measurement frequency may range from 30 MHz to 543 MHz. The frequency entered will be shown on the middle of display line one.
4. Read the measured deviation to the left of the deviation frequency on line one of the display.
5. Press "Mod Off" to exit the deviation meter mode of operation.

The deviation meter mode will be stored

in memory when the unit is turned off. At turn on, the unit will power up with the deviation meter active if it was active when the unit was turned off.

3.7.2 Deviation Meter Error Messages

There are four deviation meter errors that may be shown in characters 29 through 35 on the second line of the display when the unit is in the deviation meter mode. They are "TUNE +" (tune higher), "TUNE -" (tune lower), "TUNE" (tune meter), and "LOLEVEL" (input level too low).

3.7.2.1 TUNE +

The "TUNE +" display indicates the deviation meter is set at too low a frequency and needs to be tuned higher.

3.7.2.2 TUNE -

The "TUNE -" display indicates the deviation meter is set at too high a frequency and needs to be tuned lower.

3.7.2.3 TUNE

The "TUNE" display indicates the deviation meter frequency is not set within the approximate ± 1 MHz window required by the instrument to tell whether the deviation meter frequency is too low or too high. The meter needs to be tuned.

3.7.2.4 LOLEVEL

The "LOLEVEL" display indicates the input level is too low in amplitude, or too far off frequency, for the meter to measure it.

4.1 INTRODUCTION

This section contains the performance tests to verify that the Wavetek Model 2407 RF Signal Generator meets its published specifications (Section 1.2).

These tests will be performed with the unit in the Local Mode of operation as opposed to the remote (GPIB) mode.

Each performance test consists of: the specification to be verified; the method of testing; the test equipment required; and a detailed test procedure.

If a performance test cannot be completed satisfactorily the AutoCal® procedure of Section 5 should be performed and the test repeated. If the test is failed again, after autocalibration, the factory calibration and/or troubleshooting must be performed.

The user may elect to return the unit to the factory for factory recalibration and/or repair, after authorization. The Customer Service Department at the fac-

tory is available for consultation during the regular work week.

Recommended test equipment is listed in Table 4-1. Test equipment required for each procedure is identified in each procedure by number(s) from Table 4-1.

The Model 2407 Signal Generator should have its top cover installed for the performance tests. All of the tests can be performed without access to the internal controls. Before applying power to the Signal Generator, see Section 2 for details of electrical installation. The line voltage should be maintained as specified in Section 2.4 throughout the tests. Allow a one-hour warm up of the Signal Generator before beginning the performance test procedures.

The results of completed performance tests should be filed for future reference. Record the performance of the signal generator during performance tests to maintain a permanent record for incoming inspection, and to use as a guide for routine performance testing.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

	INSTRUMENT RECOMMENDED
(1) Signal Generator	Wavetek Model 2500A or equivalent
(2) Oscilloscope	Tektronix 2465 or equivalent, with matched X10 probes
(3) Frequency Counter	Hewlett-Packard Model 5383A with external reference time base accuracy of ± 5 parts in 10^8 , or equivalent
(4) DVM	Fluke Model 8010A, or equivalent
(5) Spectrum Analyzer	Tektronix 496, 492, or equivalent H-P 8559A, or equivalent
(6) Spectrum Analyzer	Hewlett-Packard 8568, or equivalent
(7) Measuring Receiver	H-P 8902A, with sensor module 11722A, or equivalent
(8) Power Meter	Wavetek 8531, with Power Sensor 85312, or equivalent
(9) Function Generator	Wavetek Model 20 or equivalent
(10) Audio Analyzer	H-P 8903A, or equivalent
(11) VSWR Bridge	Wiltron Model 60N50, or equivalent
(12) Sweep Generator	Wavetek Model 2002A, or equivalent

4.2 FREQUENCY RESOLUTION AND RANGE TEST

SPECIFICATION	MIN FREQ	MAX FREQ	RESOLUTION
	.01 MHz	550 MHz	10 Hz
METHOD	A frequency counter is used to measure frequency resolution and range. The 2407 cursor keys (see Section 3.5.2.2) are used to step through the frequency range to verify cursor operation. Frequency resolution may be varied from 10 Hz to 100 MHz, depending upon which digit is established as the resolution digit.		
EQUIPMENT	(3)		
PROCEDURE	1. Put the unit into the Local Mode of operation. Connect the Model 2407 front-panel RF OUT connector to the appropriate input of the frequency counter. Use the MOD OFF key to select a CW output.		

Turn on the RF output.

2. Use the cursor keys to step through each frequency range shown in the following table. The underlined digit in each range is the resolution digit for that range. The value of the resolution digit will be increased one step (one unit) at a time until the entire range is verified. The Model 2407 resolution per step in each range is indicated below. Read the frequency counter after each step change. Verify the counter shows the same frequency as that set on the Model 2407, to within the specified accuracies of the counter and the 2407. Record the frequency counter values for minimum (.01 MHz) and maximum (550 MHz) frequencies.

FREQUENCY RANGES (MHz)	2407 RESOLUTION
0.01 <u>0</u> 00 - 0.010 <u>1</u> 0	10 Hz
0.010 <u>1</u> 0 - 0.011 <u>0</u> 0	100 Hz
0.01 <u>1</u> 00 - 0.02 <u>0</u> 00	1 kHz
0.0 <u>2</u> 000 - 0.1 <u>0</u> 000	10 kHz
0. <u>3</u> 0000 - 1. <u>0</u> 0000	100 kHz
<u>1</u> .00000 - 1 <u>0</u> .00000	1 MHz
<u>10</u> .00000 - 1 <u>00</u> .00000	10 MHz
<u>100</u> .00000 - <u>500</u> .00000	100 MHz

3. Use the numeric keypad (see Section 3.5.2.1, if necessary) to enter a frequency output of 0.2 MHz. The frequency counter should indicate a value between 199.999 kHz and 200.001 kHz.

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

All modes (CW, AM, and FM): ± 5 ppm ($\pm 0.0005\%$),
0 - 50° C

METHOD

A frequency counter is used to measure frequency accuracy. All carrier frequencies are derived from a single temperature compensated crystal-controlled oscillator (TCXO). The instrument will be tested at 500 MHz (CW) to verify that the crystal-controlled oscillator operates within specified limits. The user may pick a frequency value in each of the three frequency ranges to verify the Model 2407 frequency conversion circuitry.

EQUIPMENT

(3)

PROCEDURE

1. Set the 2407 CW output at 500 MHz. Use the frequency counter to verify the frequency output is between 499,997.500 kHz (499.997500 MHz) and 500,002.500 kHz (500.002500 MHz).

4.4 HARMONICS TEST

SPECIFICATION

< -30 dBc for frequencies >10MHz
< -26 dBc for frequencies <10MHz

METHOD

A spectrum analyzer is used to determine levels for the second and third harmonics associated with the output frequency range of the Model 2407.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2407 output for .01 MHz frequency at a +13 dBm level.

2. Connect the spectrum analyzer. Use the cursor keys (see Section 3.5.2.2, if necessary) to establish the 10 kHz digit (0.01000) as the resolution digit and then increase the frequency from .01 MHz to 10 MHz in 10 kHz steps. Monitor the second and third harmonics on the analyzer at each step. Record the worst case. It should be less than -26 dBc.

3. Set the resolution digit at 1 MHz (10.00000 MHz) and increase the output frequency from 10 MHz to 550 MHz in 1 MHz steps. Monitor the second and third harmonics at each step. Record the worst case. It should be less than -30 dBc.

4. Set the 2407 output level at +3 dBm and repeat steps #2 and #3, described above.

5. Set the 2407 output level at -3 dBm and repeat steps #2 and #3, described above.

4.5 NON-HARMONICS TEST

SPECIFICATION

offset >5 kHz from carrier frequency: <-35 dBc

METHOD

A spectrum analyzer is used to measure non-harmonics.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2407 for a 275 MHz output signal at a 0 dBm level. Set the spectrum analyzer to a 5 MHz span, centered at 275 MHz. Note and record the worst case sideband location and level.

2. Repeat step 1 for 0.5 MHz and 50 kHz spans.

3. Repeat steps 1 and 2 for 389.5 MHz, 390 MHz, and 550 MHz outputs (2407).

4. Set the 2407 for a 50 MHz output signal at a -3 dBm level. Set the spectrum analyzer for a 50 - 550 MHz sweep.

5. Use the cursor keys (Section 3.5.2.2) to increase frequency in 0.1 MHz steps from 50 MHz to 137.5 MHz. Check each step for non-harmonics. Record the location (frequency) and level for the worst case.

4.6 PHASE NOISE TEST

SPECIFICATION

< -100 dBc/Hz at 500 MHz; 10 kHz offset

METHOD

An H-P 8568 (or equivalent) spectrum analyzer is used to measure phase noise at 500 MHz.

EQUIPMENT

(6)

PROCEDURE

1. Set the 2407 output to a frequency of 500 MHz and a 0 dBm level, with no modulation. Connect the H-P 8568 spectrum analyzer (or equivalent). Center the analyzer at 500 MHz.

2. Set the analyzer at the following values:

50 kHz span
1 kHz resolution BW
30 Hz video BW
0 dBm reference level

3. Press the following analyzer key sequence to reference the 2407 output signal to the graticule of the analyzer CRT display:

- a. "Peak search"
- b. "Mkr→Ref level"
- c. "Signal track"
- d. "OFF"

4. Press the following analyzer key sequence to measure phase noise in a 1 Hz BW:

- a. "Shift"
- b. "Normal" (Marker)
- c. "↑"
- d. "↑" (again)

5. Read the phase noise value directly from the analyzer CRT display. It should be more than 100 dB below the reference level (shown at the top of the display).

4.7 SWITCHING TIME TEST

SPECIFICATION	200 mSec
METHOD	An H-P 8568 spectrum analyzer, or equivalent, will be used to measure switching time over two frequency changes.
EQUIPMENT	(6)
PROCEDURE	<ol style="list-style-type: none">1. Set the 2407 for a 274.9 MHz output at a 0 dBm level, with no modulation.2. Set the H-P 8568 spectrum analyzer at the following values, then connect the 2407:<ol style="list-style-type: none">a. 275.0 MHz center frequencyb. 0 dBm reference levelc. 300 kHz resolution BWd. 100 kHz video BWe. 0 Hz spanf. 1 Sec sweep time3. The spectrum analyzer CRT display will be used to indicate switching time as the 2407 changes frequency from 274.9 MHz to 275.0 MHz and back again. The frequency change must begin at the same time as an analyzer trace (sweep) begins (step 4, below). The "VIEW" key on the analyzer must be pushed before the end of the same sweep (step 5, below).4. Use the 2407 numeric keypad sequence (Section 3.5.2.1) to select a frequency change (press "FREQ" key), then enter a frequency value of 275.0 (press the appropriate numeric/decimal keys), and finally enter the terminator (press "MHz" key) at the beginning of a CRT sweep.5. Push the "VIEW" key before the end of the sweep at which the 2407 "MHz" terminator key was pushed (step 4). Performing step 4 and this step requires use of both hands, one for the 2407 and one for the analyzer.6. Note the transient character of the "stored" analyzer sweep. The trace should have settled (returned to reference level) in less than 2 horizontal screen divisions (200 mSec).7. Push the "clear/write" key on the spectrum analyzer to clear the stored CRT display.8. Repeat step 4 above, except enter a 2407 frequency of 274.9 MHz.

9. Repeat steps 5 - 7, above.

10. Set the 2407 for a 389 MHz output. Set the analyzer at a center frequency of 389.1 MHz. (The remaining values are set as shown in steps 1 and 2, above.)

11. Repeat step 4, above, except set the 2407 at a 389.1 MHz output.

12. Repeat steps 5 - 7, above.

13. Repeat step 4, above, except set the 2407 at a 389 MHz output.

14. Repeat steps 5 - 7, above. Disconnect the spectrum analyzer.

4.8 AM PERFORMANCE TESTS

SPECIFICATION

AM Accuracy $\pm 1\%$ of Full Scale + ($\pm 5\%$ of reading)

Distortion
at 70% - 90% AM = < 5%
at 30% - 70% AM = < 3%
at <30% AM = < 1.5%

AM Bandwidth 10 Hz to 50 kHz: < 3 dB change at 50% AM

METHOD

An audio analyzer and a measuring receiver will be used to measure AM accuracy and distortion at three modulation levels for +3 dBm and -3 dBm output levels. A function generator will then be used to help measure frequency response (AM bandwidth) over an external 10 Hz to 50 kHz modulation rate at 50% AM.

EQUIPMENT

(7), (9), (10)

PROCEDURE

1. There are a variety of measuring receivers on the market that measure AM accuracy and distortion. Some audio analyzers also contain an audio generator. The user must modify the following procedure according to the equipment available.

2. Make the following connections, as appropriate. Connect the 2407 output to the measuring receiver. Connect the audio output of the measuring receiver to the audio analyzer input. Connect the function generator output to the external modulation input of the 2407.

3. AM accuracy and distortion will be measured to-

gether at the modulation and power levels identified below. AM frequency response (bandwidth) will be tested later in this procedure (starting with step 15 below).

4. Set the 2407 for an output frequency of 11 MHz, internal AM, and modulation at the 1 kHz rate. Set the output power level at +3 dBm. Set AM for 90%.

5. Press the "+PK and "-PK" control buttons on the measuring receiver and record modulation accuracy. Calculate average accuracy as: $\frac{(+PK) + (-PK)}{2}$

and record this value. This must be within the $\pm 1\%$ of Full Scale + ($\pm 5\%$ of reading) range specified (84.5 - 95.5%).

6. Press the appropriate button(s) on the audio analyzer to measure AM distortion. Record the displayed value. Distortion must be less than 5%.

7. Repeat steps 5 and 6 for each of the following frequencies:

- a. 137 MHz
- b. 138 MHz
- c. 194 MHz
- d. 195 MHz
- e. 274 MHz
- f. 275 MHz
- g. 400 MHz
- h. 550 MHz

8. Set the 2407 AM level to 70% and the output frequency to 11 MHz. Repeat step 5, above. The average accuracy must be within the $\pm 1\%$ of Full Scale + ($\pm 5\%$ of reading) range specified (65.5 - 74.5%).

9. Repeat step 6, above, distortion must be less than 3%.

10. Repeat steps 8 and 9, above, for each of the frequencies listed in step 7, above.

11. Set the 2407 for a 30% AM level and 11 MHz frequency output. Repeat step 5. AM accuracy must be within the $\pm 1\%$ of Full Scale + ($\pm 5\%$ of reading) range specified (27.5 - 32.5%).

12. Repeat step 6. Distortion must be less than 1.5%.

13. Repeat steps 11 and 12 for each frequency listed in step 7, above.

14. Repeat steps 4 - 13, above, with the 2407 power output set at the -3 dBm level.

15. To measure frequency response (AM bandwidth) set the 2407 for external AM at a 50% modulation level. Set the output frequency at 11 MHz and power at +3 dBm. Set the function generator for a 1 volt peak-to-peak signal at 1 kHz (at the "Mod In" connector on the 2407 front panel). Set the measuring receiver as follows:

- a. Push the AM modulation button.
- b. Press the "Ave" button.
- c. Push the ratio button at the 1 kHz modulation rate.

16. Use the function generator to sweep from 1 kHz to 50 kHz while observing the relative dB output change on the measuring receiver. Record the change. It should be less than 3 dB.

17. Repeat steps 15 and 16 for each of the frequencies listed in step 7.

4.9 RESIDUAL AM TEST

SPECIFICATION

<-60 dBc; CW mode with 50 Hz to 15 kHz post detection bandwidth (PDBW)

METHOD

A measuring receiver is used to measure residual AM at a variety of output frequencies.

EQUIPMENT

(7)

PROCEDURE

1. Set the 2407 for a 200 kHz output at the 0 dBm level with 10% AM modulation.

2. Connect the 2407 output to an HP-8902A measuring receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measuring receiver. Put the receiver in the average detection mode.

3. Select AM on the measuring receiver and set a reference using the Ratio and Log/Lin keys. This is the -20dB (10% AM) reference level.

4. Press the "Mod Off" key on the 2407. Determine residual AM by subtracting 20 dB from the measuring receiver's reading. If the measuring receiver indicates a reading of -50 dB, the residual AM is $-50-(20) = -70$ dBc.

5. Record the residual AM measurement. It should

be < -60 dBc, after the 10% AM (-20 dB) correction.

6. Change the 2407 frequency output to each of the frequencies listed below and record the residual AM associated with each. Each should be <-60 dBc.

- | | |
|-----------|------------|
| a. 1 MHz | f. 50 MHz |
| b. 2 MHz | g. 100 MHz |
| c. 5 MHz | h. 200 MHz |
| d. 10 MHz | i. 400 MHz |
| e. 20 MHz | j. 550 MHz |

4.10 RESIDUAL FM TEST

SPECIFICATION

< 60 Hz rms; Post detection bandwidth .05 - 15 kHz

METHOD

A measuring receiver is used to measure residual FM at selected frequencies from 102.401 MHz to 550 MHz.

EQUIPMENT

(7)

PROCEDURE

1. Set the 2407 for a 102.401 MHz output at the 0 dBm level with no modulation.

2. Connect the 2407 output to an HP-8902A measuring receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measuring receiver. Put the receiver in the average detection mode.

3. Record the residual FM measurement. It should be less than 60 Hz rms.

4. Change the 2407 frequency output to each of the frequencies listed below and record the residual FM associated with each. Each should be less than 60 Hz rms.

- | | |
|----------------|------------|
| a. 128.001 MHz | c. 390 MHz |
| b. 275 MHz | d. 550 MHz |

5. The user may elect to choose and then determine residual FM values associated with 2407 frequency outputs in the .01 - 137.5 MHz range and the 137.5 - 275 MHz range, if desired. The residual FM measured should be less than 60 Hz rms for any frequency in these ranges, respectively. The successful performance of steps 1 through 4, above, will automatically verify the .01 - 137.5 MHz and 137.5 - 275 MHz ranges.

4.11 FM PERFORMANCE TESTS

SPECIFICATIONS

FM Accuracy	±5% of setting, at internal rates (excluding residual FM)
Distortion	<2% at internal rates for deviation < 100 kHz (excluding residual FM)
FM Bandwidth	From 50 Hz to 100 kHz with respect to 1 kHz reference: < 3 dB relative change
Deviation Range	For 1 kHz rate: 1 MHz peak for 3 - 137.49999 MHz and > 275 MHz 500 kHz peak for 137.5 - 275 MHz 100 kHz peak for 1 - 3 MHz 50 kHz peak for 0.1 - 1 MHz

METHOD

A measuring receiver is used to measure FM accuracy. An audio analyzer and a measuring receiver are used to measure FM distortion. A function generator and measuring receiver are used to measure the FM bandwidth. The frequency deviation range is measured using a spectrum analyzer.

EQUIPMENT

(5), (7), (9), (10)

PROCEDURE

1. There are a variety of measuring receivers on the market that measure FM accuracy and distortion. Some audio analyzers also contain an audio generator. The user must modify the following procedure according to the equipment available.
2. Make the following connections, as appropriate. Connect the 2407 RF output to the measuring receiver. Connect the audio output of the measuring receiver to the input of the audio analyzer.
3. To determine FM accuracy, set the 2407 for an output frequency of 275 MHz at the 0 dBm power level. Select the internal 1 kHz modulation source. Set internal FM deviation at 99.9 kHz. Read deviation accuracy on the measuring receiver (+PK value) and verify it is between 94.9 kHz and 105.9 kHz.
4. Repeat step 3, increasing the 2407 output frequency from 275 MHz to 550 MHz in 5 MHz steps. Verify FM deviation shown on the measuring receiver is between 94.9 kHz and 105.9 kHz at each frequency. Record the worst case deviation.

5. To further check FM accuracy and to check FM distortion, set the 2407 output frequency to 500 MHz. Record the FM accuracy reading (+PK) on the measuring receiver. It must be between 94.9 and 105.9 kHz ($\pm 5\%$ of setting). Set the measuring receiver to measure FM distortion and record the value shown. Distortion must be less than 2%.

6. Set FM deviation at 100.0 kHz. Measure FM accuracy and distortion. Accuracy as shown on the measuring receiver must be between 95 kHz and 105 kHz. Distortion must be $< 2\%$.

7. Change the 2407 internal modulation source from the 1 kHz to the 400 Hz source. Set FM deviation at 99.9 kHz. Record FM accuracy and distortion. Verify accuracy is between 94.9 kHz and 104.9 kHz and distortion is less than 2%.

8. Set FM deviation at 100.0 kHz. Record accuracy and distortion. Verify accuracy is between 95 kHz and 105 kHz. Verify distortion is less than 2%.

9. To measure FM bandwidth set the 2407 for external FM at 9.9 kHz deviation. Set the output frequency at 330 MHz.

10. Use the function generator to apply a 1 Vpp signal at a 1 kHz rate to the external modulation input of the 2407.

11. Set the measuring receiver for "average" detection. Use the Rel dB function on the receiver to set the modulation reference rate at 1 kHz.

12. Use the function generator to sweep from 50 Hz to 100 kHz while observing the relative dB output change on the receiver. Record the change. It should be ± 3 dB or less.

13. Disconnect the test equipment. To measure deviation range connect the 2407 RF output to a spectrum analyzer. Set the 2407 at the 1 kHz internal rate source, at an FM deviation of 1000 kHz, and an output frequency of 389 MHz. Use the spectrum analyzer to verify a deviation range of 1 MHz $\pm 5\%$ (2 MHz peak to peak).

14. Select an output frequency value between 137 to 275 MHz. Repeat step 13. Verify the 500 kHz peak deviation range on the spectrum analyzer.

15. Disconnect the spectrum analyzer.

4.12 OUTPUT POWER ACCURACY TEST

- SPECIFICATION** ± 1.5 dB
- METHOD** A measuring receiver with power sensor is used to measure output power at 3 representative frequencies.
- EQUIPMENT** (7)
- PROCEDURE**
1. Connect the 2407 RF output to the power sensor for the measuring receiver. Set the 2407 for an output frequency of 5 MHz at a +13 dBm power level.
 2. Read the power measurement on the measuring receiver and verify it is between +14.5 and +11.5 dBm.
 3. Set output power to 0 dBm and verify the measuring receiver reading is between -1.5 and +1.5 dBm.
 4. Use the cursor keys to set the output power resolution digit at the 10 dB incremental position and to decrease output power in 10 dB steps. Observe the output level on the measuring receiver and verify it is within ± 1.5 dB of each output level setting below:

Output (dBm)	Output (dBm)
-10	-70
-20	-80
-30	-90
-40	-100
-50	-110
-60	-120
 5. Set the 2407 output frequency to 400 MHz. Set the power level at +13 dBm. Repeat step 2, above.
 6. Repeat step 3, above.
 7. Repeat step 4, above.
 8. Set the 2407 output frequency to 550 MHz. Set the power level at +13 dBm. Repeat step 2, above.
 9. Repeat step 3, above.
 10. Repeat step 4, above.
 11. Disconnect the test equipment.

4.13 OUTPUT POWER LEVEL FLATNESS TEST

SPECIFICATION	± 1 dB
METHOD	A power meter and an oscilloscope with a 50 Ω input are used to measure representative output levels across the 2407 frequency spectrum.
EQUIPMENT	(2), (8)
PROCEDURE	<ol style="list-style-type: none">1. Connect the power sensor unit of the power meter to the 2407 RF output. Set the 2407 output at the +13 dBm level.2. Use the cursor keys (see Section 3.5.2.2, if necessary) to sweep through the 2407 frequency spectrum (.03 MHz to 550 MHz) while monitoring output power on the power meter. Using an oscilloscope with a 50 Ω input, measure the peak-to-peak amplitudes at 10 kHz, 20 kHz, and 30 kHz. Verify the highest output power is within 2 dB of the lowest output power across the frequency range.3. Set the 2407 output level at +3 dBm. Repeat step 2.4. Set the 2407 output level at -3 dBm. Repeat step 2.5. Disconnect the test equipment.

4.14 OUTPUT IMPEDANCE TEST

SPECIFICATION	50 Ω , with VSWR <1.5:1 at output power <-3 dBm
METHOD	A VSWR bridge, spectrum analyzer, and sweep generator are used to measure output impedance across the frequency range.
EQUIPMENT	(5) (11) (12)
PROCEDURE	<ol style="list-style-type: none">1. Connect the RF input of the VSWR bridge to the sweep generator output. Connect the VSWR reference short across the bridge test port. Connect the bridge RF output port to the spectrum analyzer input.2. Set the sweep generator to sweep from 0 - 550 MHz using a 20 second sweep at a power level of +10 dBm. Store this data in the spectrum analyzer as the reference level.3. Set the 2407 for an output frequency of 50 MHz

at a -3 dBm output power level.

4. Remove the reference short from the test port on the VSWR bridge and connect the 2407 output to the test port.

5. Use the sweep generator to manually sweep the frequency range (.01 MHz to 550 MHz) again. Compare these spectrum analyzer readings to the spectrum analyzer reference level from step 2. Record the worst case frequency and level. The worst case level should be <-14 dBm from the reference level.

4.15 EXTERNAL REFERENCE TEST

SPECIFICATION

External source specification

METHOD

A signal generator is used to verify the 2407 external reference circuitry.

EQUIPMENT

(1)

PROCEDURE

1. Determine the error in the external source.

2. Connect the external source (a Wavetek Model 2500A signal generator, for example) to the external reference input on the rear panel of the 2407. Set the source at 1 volt peak-to-peak and 10 MHz. Set the 2407 external reference selection at 10 MHz.

3. Set the output frequency for the 2407 at 100 MHz and set the power level to 0 dBm.

4. Verify that the 2407 output frequency is within the external source limits.

5. Disconnect the external source and set the 2407 reference at the appropriate value.

Note that the above procedure may be performed using a 5 MHz external reference, with the 2407 external reference selection set at 5 MHz.

4.16 DEVIATION METER TEST

SPECIFICATION

Frequency Range

30 MHz to 500 MHz

Input Level

15 mV to 5 VRMS

Deviation Range

0 to 500 kHz peak deviation

Deviation Accuracy 6% of full scale

Modulation Rate 100 Hz to 8 kHz

METHOD

A signal generator is used as an FM source to verify accuracy of the deviation meter over a level range from -25 dBm to +13 dBm. An audio analyzer or a function generator is used to test the modulation bandwidth.

EQUIPMENT

(1), (9) or (10)

PROCEDURE

1. Set the 2407 to its FM Deviation Meter mode by pressing the POS DEV front panel key.

2. Set the 2407 frequency to 250.000 MHz.

3. Set the signal generator frequency to 250.000 MHz, 500 kHz peak FM deviation. Connect its RF output to the 2407 MOD IN front panel connector.

4. Verify that the 2407 Deviation Meter display (Left section of LCD) indicates 500 kHz \pm 30 kHz.

5. Adjust the signal generator level over the range from -25 dBm to +13 dBm and verify Deviation Meter accuracy at several different input levels.

6. Repeat steps 2 through 5 at frequencies of 30 MHz and 500 MHz.

7. With the test set up of steps 2 and 3, set the signal generator to 250.200 MHz. Verify the Deviation Meter display indicates "TUNE+".

8. Set the signal generator at 249.800 MHz. Verify the Deviation Meter display indicates "TUNE-".

9. Set the signal generator at 250.000 MHz. Connect the Audio Analyzer or Function Generator output to the EXT MOD IN connector on the signal generator.

10. Set the audio source for a 1 kHz, 1 volt peak-to-peak sine wave (measured at the MOD IN connector). Set the signal generator for external FM at 500 kHz peak deviation.

11. Vary the audio source frequency from 100 Hz to 8 kHz and verify that the Deviation Meter reading is 500 kHz \pm 30 kHz.

12. The preceding steps are equally applicable to test the NEG DEV mode of the Deviation Meter.

5.1 INTRODUCTION

This section provides maintenance information for the Wavetek Model 2407 RF Signal Generator. Maintenance consists of service information (fan/air filter maintenance and cover removal instructions), user diagnostics, and calibration procedures. This section also contains a description of the instrument test sequence automatically performed when the power is turned on.

WARNING

High voltages are present in this unit. Do not operate this unit with the cover removed and the power on.

5.2 SERVICE INFORMATION

5.2.1 FAN/AIR FILTER MAINTENANCE

The rear-panel fan reduces operating temperature, and contributes to the long life of the instrument. The air filter installed in the bottom intake vents must be kept clean. Remove the cover and clean the air filter as described below.

5.2.2 COVER REMOVAL

The cover is U-shaped and wraps around and covers the sides of the unit. Remove power from the instrument. Lay it on its top (with the bottom up). Remove the six bottom screws. Place the unit right side up again. Remove the eight rear panel screws. Remove the two screws on top

near the front of the unit. Slide the cover back and remove it. (Reverse this procedure to reinstall the cover.)

5.2.3 AIR FILTER CLEANING

The air filter is glued to the bottom of the unit. Use an air hose to direct a stream of air against the filter to clean it.

5.3 USER DIAGNOSTICS

The user diagnostics allow the user to verify proper operation of 2407 subsystems. When the 2407 is in user diagnostics, any command across the GPIB bus will be ignored.

Press the status key ("Stat") to call up the status key select menu (second line of the display shown):

1:Error 2:Diag 3:Optn 4:Cal 5:Set +:Exit

Press the "2" key to implement the diagnostics (DIAG). Software will turn off the RF output (RF OFF) and store the current instrument settings. The diagnostic selection display will be called up:

DIAGNOSTIC

1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:Exit

The first line indicates the instrument is in the diagnostic mode. The second line displays the available diagnostic functions. To implement a choice,

TESTS NUMBER 3-7: RAM/ROM TESTS

The RAM/ROM tests verify ROM checksums and RAM read/write integrity.

TEST NUMBER 8: RF DATA/ADDRESS BUS TEST

The RF Data/Address Bus test verifies that the RF data and address bus operates correctly.

TEST NUMBER 9: CARD ID CODE TEST

The Card ID (Identification) Code Test verifies that all cards are installed and are installed in their proper slots by reading their ID codes.

TEST NUMBER 10: ADC/DAC TESTS

The ADC used in instrument calibration and deviation meter measurements is tested for accuracy at minimum and maximum input levels. Three of the five DACs are set to minimum and maximum values, and their accuracies are measured by the ADC.

TESTS NUMBER 11-14: FEEDBACK TESTS

The feedback tests check the ability to monitor the hardware error conditions associated with each entry number.

5.3.2 LCD Test

The diagnostic select menu is:

DIAGNOSTIC
1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:Exit

Pressing the "2" key from this menu will call up a two-line display test pattern that shows all printable characters, permitting the visual verification that the display is functional.

5.3.3 Keypad Test

The diagnostic select menu is:

DIAGNOSTIC
1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:Exit

Entering a "3" from this menu will call up the keypad test screen. The second line will be blank until a key is pressed. The first line will be:

KEY TEST: PRESS TO DISPLAY KEY +:Exit

Pressing any key will produce a second line that shows the mnemonic associated with the key. For example, pressing the "Mod Off" key will generate the following display:

KEY TEST: PRESS TO DISPLAY KEY +:Exit
MOD OFF

Pressing the "+/-" key will recall the diagnostics select menu.

5.3.4 DACs Test

There are two basic screens associated with the DACS diagnostics. The A/D Testpoint screen is the first of the two basic screens. The second basic screen is the DAC Entry Selection screen. Both screens are described in the following section. The RF ON/OFF key may be used to toggle between the two screens. The DACS diagnostics may be exited by pressing the STATUS key.

The DACS diagnostics are selected from the diagnostic select menu:

DIAGNOSTIC
1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:Exit

Entering a "4" from this menu will call up the A/D Testpoint screen:

ADC TEST: +: Pos A/D: +x.xx v
00: Ground ref A/D value: xxx

The "xxx" value displays the current A/D value being read for the selected testpoint. The "x.xx" indicates the equivalent voltage for that A/D value. The A/D readings are taken continuously at approximately a 200 msec sampling rate. The key function definitions in this mode are as follows:

"+/-": Toggles between a positive and

Table 5-3 DAC TEST SELECTIONS

<u>Number</u>	<u>Description</u>	<u>Bits</u>
00	Ramp all DACs	N/A
01	AM depth DAC	12
02	FM deviation DAC	12
03	Level DAC	12
04	Coarse tune DAC	8
05	Loop comp DAC	8
06	A aux pll reg	8
07	N aux pll reg	8
08	R aux pll reg	8
09	A main pll reg	8
10	N main pll reg	8
11	R main pll reg	8

The initial DAC Entry Selection screen is:

```
DAC TEST:          Pos A/D: +x.xx v
00: Ramp all DACs      +: Start
```

Press the "INC" (Up arrow) key to call up the screen for DAC test number 01:

```
DAC TEST:          Pos A/D: +x.xx v
01: AM depth DAC     DAC value: xxx
```

This is a typical screen for non-ramp DAC tests. The "xxx" value displays the last DAC value written to the selected DAC (the AM depth DAC, in this case). The "x.xx" indicates the equivalent voltage for that DAC value. Numeric keys may be used to make DAC data entries. The data is entered in hexadecimal (base 16) code format. Code entries terminate automatically after 3 digits for the 12-bit DACs and after 2 digits for the 8-bit DACs and the PLL registers. The numeric keys 0-9 are used for the digit values 0-9. For the hex digit values A-F, the following keys are used:

<u>Hex</u>	<u>Key</u>
A	MHz
B	kHz
C	dBm
D	OPT
E	+/-
F	

The RIGHT and LEFT arrow keys may be used with non-ramp DAC tests:

"RIGHT" (arrow key): If the cursor is currently under the DAC test selection number, the cursor will be moved to the most significant digit of the current DAC value. If the cursor is under a digit of the current DAC value, the cursor will be positioned one digit position to the right, unless it is under the least significant digit of the current DAC value. If it is under the least significant digit of the current DAC value, it will be repositioned under the DAC test selection number.

"LEFT" (arrow key): If the cursor is currently under the DAC test selection number, the cursor will be moved to the least significant digit of the current DAC value. If the cursor is under a digit of the current DAC value, the cursor will be shifted one digit position to the left, unless it is under the most significant digit of the current DAC value. If it is under the most significant digit of the current DAC value, it will be repositioned under the DAC test selection number.

The "INC" and "DEC" (UP and DOWN arrow) keys will increment and decrement the current digit of the DAC value selected when the cursor is positioned under the DAC value.

When the ramp DACs test is performed (Test 00), the internal modulation rate selection is set for 1 kHz with both AM and FM selected (to observe the ramp output of the DACs) and the high range FM mode is selected (for the larger ramp voltage output). One complete cycle of ramping the 12-bit DACs requires approximately one minute. The PLL registers are not affected during the ramping. For the AM and FM DAC test selections, again the internal modulation rate selection is set for one kHz and AM and FM are enabled so that the DAC output is enabled.

When performing DAC test 01 (AM depth DAC), set the DAC value at "000" and verify the corresponding voltage shown is "0.00 v". Then set the DAC value to "FFF" and verify a voltage of "9.99 v".

DAC test 02 (FM deviation DAC), should be performed at the low and high ranges of the DAC. To test the DAC's low range, first return to normal operation (leave the DACS diagnostics mode) and set internal FM to 1 kHz. This sets the high/low FM range bit for a low range output. Return to the DACS diagnostics. Set the DAC value at "000" and verify the corresponding voltage shown is "0.00 v". Then set the DAC value to "FFF" and verify a voltage of "1.00 v". To test the DAC's high range, return to normal operation (leave the DACS diagnostics mode) and set internal FM to 1 MHz. This sets the high/low FM range bit for a high range output. Return to the DACS diagnostics. Set the DAC value at "000" and verify the corresponding voltage shown is "0.00 v". Then set the DAC value to "FFF" and verify a voltage of "9.99 v".

To perform DAC test 03 (Level DAC), first go to DAC test 01 and set the AM depth DAC value at "000". Then return to DAC test 03 (level DAC). Set the DAC value at "000". Verify the corresponding voltage shown is "0.00 v". Then set the DAC value to "FFF" and verify a voltage of "9.99 v".

The remaining DAC tests (04-11) are basically debugging exercises, intended primarily for factory test purposes.

5.3.5 DEBUG DIAGNOSTICS

The DEBUG diagnostics are provided to troubleshoot the instrument hardware. They are entered from the diagnostic select menu:

DIAGNOSTIC

1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:Exit

Press the "5" key to call up the DEBUG diagnostics selection screen:

DEBUG MODE

1:LATCH 2:COMM 3:CTRL +:Exit

Three different debugging screens may be selected.

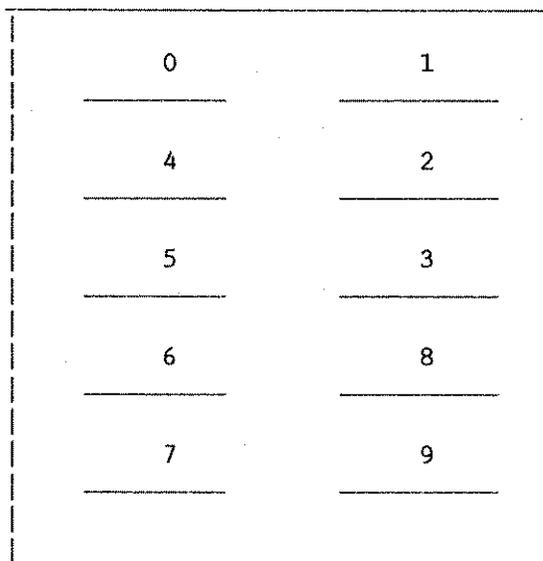
5.3.5.1 Latch Debug Mode

Enter a "1" to select the Latch debug screen. This screen will display the names of all the cards and latches found in the system and will allow access to the data in the latches. The display format is:

```
'Card description'   CARD: 0  LATCH: 0
'Latch description'  READ    DATA: xx
```

The cursor under the digit following "CARD" indicates that the "Card Description" is the active selection parameter. The number stands for the position of the card in the 2407 card cage. Card cage positions are shown in Figure 5-1.

Figure 5-1 CARD CAGE BOARD LOCATIONS (looking into the card cage)



Selection of a card is made by pressing the UP/DOWN arrow keys. As the card cage position number is incremented or decremented, the corresponding card description is updated. Card slot position numbers and the cards that occupy those

positions are listed in Table 5-4. Cards 0-3 are unenclosed cards. Cards 4-9 are enclosed RF cards.

The LEFT/RIGHT arrow keys toggle the

active parameter selection between the CARD selection and the LATCH selection. Latch selection is in terms of the card on which a latch is located. A message corresponding to the selected latch is

Table 5-4 CARD/LATCH DEBUG DESCRIPTIONS

CARD		LATCH		TYPE
NO.	DESCRIPTION	NO.	SELECTION	
0	DDS CARD	0	ID code	R
		1	10 Hz/1 Hz prog	W
		2	1 kHz/100 Hz prog	W
		3	100 kHz/10 kHz prog	W
1	MICROPROCESSOR CARD	0	RF data out port	W
		1	RF data in port	R
		2	RF addr out port	W
		3	Interrupt port	R
2	CONTROL CARD	0	ID code	R
		1	RF card select	W
		2	RF addr select	W
		3	RF data out	W
		4	RF data in	R
		5	Undefined latch	W
		6	Attenuator prog	W
		7	Peak detector ctrl	W
		8	A/D data (8 lsbs)	R
		9	A/D data (4 msbs)	R
		10	Modulator select	W
11	DAC select/ FR range	W		
3	CARD NOT FOUND	0	Undefined latch	R
4	SYNTHESIZER CARD	0	ID code	R
		1	DAC/PLL/tstpt select	W
		2	DAC/PLL data	W
5	CARD NOT FOUND	0	Undefined latch	R
6	AM/DIVIDER CARD	0	ID code	R
		1	Band/tstpt select	W
7	OUTPUT AMP CARD	0	ID code	R
		1	Band/tstpt select	W
8	LO/REF CARD	0	ID code	R
		1	Undefined latch	W
		2	LO enable/ ref select	W
		3	PLL data/ register	W
9	DEF METER CARD	0	ID code	R
		1	Testpt select	W

shown on the lower line of the display. Some of the latches are undefined. Latches and their associated cards are listed in Table 5-4.

Each latch selection is either a read only or a write only latch and is indicated by the READ or WRITE message that follows the latch description on the lower line of the display. The "Latch Type" column entry of Table 5-4 uses "R" (Read) or "W" (Write) to identify the Latch Type. For read only latches, the data display shows the data that is currently being monitored at that latch. No data entry is allowed to a read only latch, so the numeric keys are disabled. For write only latches, the data display indicates the last data written to the selected latch. This data value may be incorrect under certain conditions (e.g., entry into latch debug mode, RF card latches written to through the control card RF bus latches), but will be accurate under most circumstances. Numeric entries are allowed to write only latches. Data entry is in 2 digit hexadecimal format where the data input is automatically terminated after the second digit entry. The numeric keypad is defined identically as for the DACS Diagnostic mode described earlier (Section 5.3.4).

Any changes made to the operation status of the instrument are overwritten when the debug mode is exited and the unit is returned to normal operation. To exit this mode, press the STATUS key.

5.3.5.2 Comm Debug Mode

Enter the communication microprocessor (Comm) debug mode from the debug diagnostics select screen (Section 5.3.5.)

Enter a "2" to call up the initial Comm debug screen:

```
0000: 404142434445464748494A4B4C4D4E4F
PORT   @ A B C D E F G H I J K L M N O
```

The communication debug mode can be used to display the contents of any address-

able location of the communication microprocessor. The starting address is shown in the upper left corner of the display. A cursor is placed under the LSD (least significant digit). The cursor keys may be used to increment and decrement the selected digit and to position the cursor under a selected digit. Addresses are shown in 16 bit hexadecimal format. A title block that indicates the region of memory being displayed is below the address. The region refers to the address of the first byte being displayed (the address above it), and not necessarily that of all the bytes being displayed when region boundaries are crossed. The defined microprocessor regions, address ranges, and memory descriptions are listed in Table 5-5.

Table 5-5 COMM DEBUG DESCRIPTIONS

Region	Addr Range	Description
PORT	0000-001F	6801 μ P int registers
STACK	0080-00FF	μ P int RAM for stack
PIA1	0400-04FF	PIA registers (LCD contrast)
PIA2	0800-08FF	PIA registers (keybd scan)
GPIA	0C00-0CFF	GPIB device
DPRAM	1000-1FFF	global RAM between the 2 μ Ps (1 kbyte)
SRAM	2000-3FFF	local RAM (8K-static)
EPROM	8000-FFFF	code section

Sixteen bytes of data are displayed at a time with the upper line formatted in hexadecimal and the lower line formatted in ascii. The left and right arrows will position the cursor on the starting address being displayed. The INC/DEC keys will increment/decrement the current address digit. Press the STATUS key to exit this mode.

5.3.5.3 Ctrl Debug Mode

The control microprocessor (Ctrl) debug

mode is entered from the debug select screen:

DEBUG MODE
1:LATCH 2:COMM 3:CTRL +:Exit

Enter a "3" to call up the initial Ctrl debug screen. The control microprocessor debug mode functions exactly like the communication microprocessor debug mode (Section 5.3.5.2), except the control microprocessor can be used to display the contents of any addressable location of the control microprocessor.

Defined microprocessor regions, address ranges, and memory descriptions for the control debug mode are listed in Table 5-6.

5.4 AUTOCAL® CALIBRATION

The Wavetek Model 2407 RF Signal Generator uses an almost completely automatic calibration procedure (AutoCal®) to calibrate the circuits that determine output frequency and output power level. The status key is used to implement AutoCal®. The detailed procedure to perform the Model 2407 calibration is described in the following sections.

5.4.1 Turn on the Model 2407 and permit a warm up time of one hour (if necessary).

5.4.2 Press the status key ("Stat") to call up the status key operation select menu:

1:Error 2:Diag 3:Optn 4:Cal 5:Set +:Exit

Note that only the second line of the display is shown above. The second line of the LCD display contains operator selections. The first line of the display shows the current modulation, frequency, and level settings for the unit.

5.4.3 Implement the Calibration Mode of Operation (AutoCal®) by pressing the "4" key. Software will turn off all modulation, turn off the RF output, and store the current instrument settings. The initial calibration screen will be called up:

CALIBRATION SELECTIONS
1:Freq 2:Level 3:Default +:Exit

Output frequency or output level may be calibrated in the AutoCal® mode. The output frequency calibration routine is described in section 5.4.4; the output level calibration routine is described in section 5.4.6.

The frequency calibration must be performed before the output power level calibration.

When either calibration routine is selected, the entire calibration procedure must be completed. No exit or abort will be allowed after this point.

5.4.4 Before performing a frequency calibration, factory default data must be entered from the initial calibration screen:

CALIBRATION SELECTIONS
1:Freq 2:Level 3:Default +:Exit

Table 5-6 CTRL DEBUG DESCRIPTIONS

Region	Addr Range	Description
PORT	0000-001F	6801 μ P int registers
STACK	0080-00FF	μ P int RAM for stack
PIA1	0800-08FF	PIA registers (RF data/addr bus)
PIA2	1000-10FF	PIA registers (err intrp in)
DPRAM	2000-2FFF	global RAM between the 2 μ Ps(1 kbyte)
SRAM	4000-7FFF	local RAM (8K- nonvolatile; expandable)
EPROM	8000-FFFF	code section

Press a "3" from this display to load factory default values for frequency and level calibrations into memory. The following message will be displayed:

LEVEL & FREQUENCY CALIBRATION DATA
RESET TO FACTORY DEFAULT VALUES

This message is displayed for 2-3 seconds while default calibration data is loaded. A generic table of frequency calibration values and a default selection of level flatness calibration frequencies are loaded. The level flatness and linearity calibration factors are reset to 0.0 dB. Then the initial calibration menu is displayed again, ready for another selection.

After entering the default data, press a "1" from the initial calibration menu to call up the menu used to initiate a frequency calibration:

FREQUENCY CAL SELECTIONS
1:FULL 2:VCO1 3:VCO2 4:Date +:Exit

Three separate frequency calibrations may be selected and a calibration date may be entered. Pressing the "1" key will initiate a complete frequency calibration. Pressing the "2" key will calibrate the lower VCO only. Pressing the "3" key will calibrate the upper VCO only. Pressing the "4" key will initiate the procedure to enter a calibration date (described at the end of this section).

Press the appropriate numeric key ("1-3") from the initial calibration menu to select the desired frequency calibration. Each frequency calibration routine is completely automatic and requires no operator input at any step.

Pressing a "1" or a "2" will initiate calibration of the lower VCO and call up the the VCO 1 display:

FREQUENCY 275 MHZ
CALIBRATION VCO 1 DELAY 60

Pressing a "3" will initiate calibration

of the upper VCO and call up the VCO 2 display:

FREQUENCY 390 MHZ
CALIBRATION VCO 2 DELAY 60

The bottom line of either calibration display shows the 60 second countdown delay, with the count decreased by 1 every second, that allows a 60 second warmup time for each VCO to eliminate drift problems. The DELAY message will disappear after reaching "DELAY 1".

During lower VCO calibration, the current frequency being calibrated will be shown. Calibration data will be shown in the right section of the bottom display line, following the characters "DATA". three data values are shown: the coarse tune DAC value, the loop compensation DAC value, and the FM correction value. The A/D error voltage for the associated coarse tune DAC value is shown immediately above the calibration data. A typical display will look like:

FREQUENCY VCO 1 A/D: +0.32 v
CALIBRATION 275 MHZ DATA: 40 2D 5FD

To calibrate the first calibration point (for each VCO) requires about 10 seconds. Calibration is performed at 2 MHz intervals, taking approximately two seconds for each succeeding calibration point. The loop compensation DAC and coarse tune DAC values are determined every 10 MHz. FM correction is sampled every 5 MHz. These measurements are used to interpolate FM correction values at 1 MHz intervals.

When the lower VCO calibration is complete, the unit will automatically begin calibration of the upper VCO if a complete frequency calibration was requested (the "1" key was the initial key pressed). After the last frequency calibration has been performed the following screen will be displayed for approximately 2 seconds:

FREQUENCY
CALIBRATION COMPLETED

The initial calibration screen will then be recalled:

CALIBRATION SELECTIONS

1:Freq 2:Level 3:Default +:Exit

Press a "4" from the initial frequency calibration menu to call up the screen for the calibration date:

FREQ CAL Last call: xx-xx-xx
DATE Enter: MM-DD-YY +:Exit

The last date entry (Last call) is shown on the top line of the display. The date should be updated every time a frequency calibration is performed. Loading default calibration data will reset the date to 00-00-00. The numeric keys are used to modify the date. The cursor is placed under the digit to be changed, and automatically goes to the next digit when an entry is made. Entries are made in the order shown, (month, day, year). There is no internal verification that valid dates are entered. Modifying the frequency calibration date entry does not affect the level calibration date, which is accessed from the level calibration procedure. Date entries are accessible over the GPIB.

5.4.5 Frequency calibration errors typically are due to hardware problems and require some degree of troubleshooting. Wavetek recommends returning the unit to the factory for troubleshooting and repair.

The peak A/D detector is tested before calibration begins because frequency calibration depends upon it functioning properly. If it fails the test, the following screen will be called up:

FREQUENCY 275 MHz FAIL: A/D ERROR
CALIBRATION PRESS STATUS TO EXIT

The A/D error can occur only at the beginning of the frequency calibration. Press the status key ("Stat") to recall the initial calibration display.

During frequency calibration the coarse tune DAC is adjusted to make the synthesizer error voltage equal 0.0v. Two errors can occur. If the coarse tune DAC can not be reduced as far as it needs to be, the coarse low fail error will occur:

FREQUENCY 275 MHz FAIL: COARSE LOW
CALIBRATION PRESS STATUS TO EXIT

If the coarse tune DAC can not be increased as much as it needs to be, the coarse high fail error will occur:

FREQUENCY 275 MHz FAIL: COARSE HIGH
CALIBRATION PRESS STATUS TO EXIT

If either error occurs, press the status key to recall the initial calibration display.

The loop compensation DAC values are derived from the coarse tune values. There are no errors associated with them. The FM correction values are determined by adjusting the FM DAC value until the peak A/D value matches a level corresponding to the desired deviation value. Therefore the FM correction values can have the same errors as the coarse tune DAC. That is, it may not be possible to adjust the DAC value low enough (FM Cal Low error) or high enough (FM Cal High error) to reach the desired voltage level. The associated error messages are:

FREQUENCY 275 MHz FAIL: FM CAL LOW
CALIBRATION PRESS STATUS TO EXIT

FREQUENCY 275 MHz FAIL: FM CAL HIGH
CALIBRATION PRESS STATUS TO EXIT

If either error occurs, press the status key to recall the initial calibration display.

5.4.6 The level calibration routine is semiautomatic when performed using front panel controls. A power meter will be

connected to the RF output and the unit tuned from the front panel, according to the power meter readings.

The frequency calibration described in section 5.4.4 should be performed before the output power level calibration to ensure the frequency points used in the level calibration are accurate. If the frequency and level calibrations have been performed, and only an adjustment in either level flatness or linearity is needed, it is not necessary to perform the frequency calibration again.

The LEVEL calibration routine is selected from the initial calibration menu:

CALIBRATION SELECTIONS

1:Freq 2:Level 3:Default +:Exit

Press the "2" key to initiate level calibration and call up the initial level calibration screen:

LEVEL CAL SELECTIONS

1:Flatness 2:Linearity 3:Date +:Exit

Separate procedures are available to calibrate level flatness and level linearity. Pressing the "3" key will initiate the procedure to enter a calibration date (described at the end of this section).

The level flatness calibration process (section 5.4.6.1) adjusts the level accuracy of the instrument over different frequency settings. This flatness correction is performed at a fixed level output of 0 dBm, and the adjustment corrects for the variations in level across the operating frequencies of the instrument.

The level linearity calibration process (Section 5.4.6.2) adjusts the level accuracy of the instrument over different level settings. Because the level flatness correction is performed at a fixed level output (0 dBm), the linearity adjustment must be performed to correct for the nonlinearities of the

level control circuitry. The linearity calibration is performed at a fixed frequency of 300 MHz, with level settings adjusted from +13 dBm to -7 dBm in 1 dB increments.

If the level calibration data has been reset to the default setting (Section 5.4.4), it doesn't matter whether level flatness or level linearity calibration is performed first. Note that whichever calibration is performed last should have nearly 0.0 dB correction factor at the "crossover" point. The crossover point for the level flatness calibration is the 300 MHz frequency calibration point. The 0.0 dB level calibration point is the crossover point for the level linearity calibration.

5.4.6.1 To begin a level flatness calibration, enter a "1" from the initial level calibration screen to call up the following screen:

LEVEL CALIBRATION CONNECT POWER METER

The message to connect a power meter will be displayed for approximately 4 seconds. Connect an RF power meter with range from .01 MHz to 550 MHz to the 2407 RF output connector.

If cable losses are also to be nulled out so that a flat signal is transmitted at the end of a long cable length, connect the power meter to the end of the cable when making the level flatness adjustments.

The level flatness calibration mode screen will appear after the "CONNECT POWER METER" message:

LEVEL CAL UP/DOWN: xx.x dB <- adjust
FLATNESS LFT/RIT: xxxx MHz +:Exit

The top line of the display indicates the procedure being performed (LEVEL CAL) and shows the UP/DOWN arrow cursor keys control the output RF (xx.x dB). The "<-adjust" identifies the value associated with the UP/DOWN arrow keys

(xx.x dB) as the value to be adjusted. The bottom line indicates the part of the procedure being performed, the "FLATNESS" procedure, and shows the left/right arrow cursor keys advance the level flatness calibration through the frequency points (xxxx MHz) at which calibration occurs. The "+" key will recall the previous display.

During the level flatness calibration, the 2407 output will be tuned so the power meter reads 0 dBm at each frequency calibration point.

The up and down arrow cursor keys increment and decrement the calibration factor (the "xx.x dB" value required to make the power meter reading equal 0 dBm) at each calibration frequency point.

The right and left arrow cursor keys step forward and backward from one frequency calibration point to the next. The right arrow cursor is used to step forward through the level flatness calibration frequencies. Pressing this key at the last calibration point will display the message "DONE" in place of the frequency display, to indicate there are no more calibration points. When this message is displayed, only the left arrow key, the "+" key and the STATUS key are active. The left arrow cursor is used to recall a calibration point for review. The left arrow key has no effect when the first (lowest frequency) calibration point is displayed.

The "+" key and the STATUS key may be used to exit the level flatness calibration mode and recall the initial level calibration menu.

The level flatness calibration factor (in xx.x dB) for the current frequency calibration point is displayed to the left of the UP/DOWN characters. The Up and Down cursor arrow keys will adjust the level flatness calibration factor in 0.1 dB steps. The RF output at each calibration point should be adjusted to

0.0 dBm, using the up/down cursor arrow keys as necessary. The range over which adjustment can occur is from +6 dB to -6 dB. After all calibration points have been adjusted initially, it is usually beneficial to review the calibration points and refine the adjustments.

The calibration factor displayed indicates the amount of adjustment that was necessary at each calibration frequency, but should not to be used as an indicator of how much adjustment to perform.

The following frequencies are points at which level flatness calibration occurs:

10 kHz, 20 kHz, 40 kHz, 60 kHz, 80 kHz, 100 kHz, 200 kHz, 400 kHz, 600 kHz, 800 kHz, 1 MHz, 2 MHz, 4 MHz, 6 MHz, 8 MHz, 10 MHz, 15 MHz, 20 MHz, 40 MHz, 60 MHz, 80 MHz, 100 MHz, 150 MHz, 200 MHz, 250 MHz, 300 MHz, 350 MHz, 400 MHz, 450 MHz, 500 MHz, and 550 MHz

If a point can not be adjusted to 0.0 dBm, a hardware problem is indicated.

When all calibration points have been adjusted to 0.0 dBm, press the "+" key or the STATUS key to exit the level flatness calibration process, and recall the initial level calibration display.

5.4.6.2 To begin a level linearity calibration, enter a "2" from the initial level calibration screen to call up the following screen:

LEVEL CALIBRATION
CONNECT POWER METER

This message will be displayed for approximately 4 seconds. Connect an RF power meter with range from .01 MHz to 550 MHz to the 2407 RF output connector.

The level linearity calibration mode screen will appear after the "CONNECT POWER METER" message:

LEVEL CAL UP/DOWN: xx.x dB <- adjust
LINEARITY LFT/RIT: xx.x dBm +:Exit

The top line of the display indicates the procedure being performed (LEVEL CAL) and shows the UP/DOWN arrow cursor keys control the output RF (xx.x dB). The <-adjust" identifies the value associated with the UP/DOWN arrow keys (xx.x dB) as the value to be adjusted. The bottom line indicates the part of the procedure being performed, the "LINEARITY" procedure, and shows the left/right arrow cursor keys advance the level linearity calibration through the power level points (xx.x dBm) at which calibration occurs. The "+" key will recall the previous display.

During the level linearity calibration, the 2407 output will be tuned at each calibration point to make the power meter read the same value as the level value shown on the bottom line of the display.

The up and down arrow cursor keys increment and decrement the calibration factor (the "xx.x dB" value required to make the power meter reading equal to the value shown on the display's bottom line) at each calibration level point.

The right and left arrow cursor keys step forward and backward from one level calibration point to the next. Calibration is from +13 dB to -7 dB. The right arrow cursor is used to step backward through the level linearity calibration power levels. Pressing this key at the last calibration point will display the message "DONE" in place of the level display, to indicate there are no more calibration points. When this message is displayed, only the left arrow key, the "+" key and the STATUS key are active. The left arrow cursor is used to recall a calibration point for review. The left arrow key has no effect when the beginning (+13 dB) calibration point is displayed.

The "+" key and the STATUS key may be used to exit the level flatness calibration mode and recall the initial level calibration menu.

The level linearity calibration factor (in xx.x dB) for the current power level calibration point is displayed to the left of the UP/DOWN characters. The Up and Down cursor arrow keys will adjust the level linearity calibration factor in 0.1 dB steps. The range over which adjustment can occur is from +6 dB to -6 dB. The RF output at each level calibration point should be adjusted using the up/down cursor arrow keys to make the power meter reading equal the level value shown on the bottom line of the display. After all calibration points have been adjusted initially, it is usually beneficial to review the calibration points and refine the adjustments.

The calibration factor displayed indicates the amount of adjustment that was necessary at each calibration level, but should not to be used as an indicator of how much adjustment to perform.

Level linearity calibration occurs from +13 dB to -7 dB, at 1 dB increments.

If a point can not be adjusted so the 2407 level output and the power meter readings are the same, a hardware problem is indicated.

When all calibration points have been adjusted, press the "+" key or the STATUS key to exit the level linearity calibration process, and recall the initial level calibration display.

LEVEL CAL SELECTIONS

1:Flatness 2:Linearity 3:Date +:Exit

Press a "3" from the initial level calibration menu to call up the screen for the calibration date:

LEVEL CAL Last call: xx-xx-xx
DATE Enter: MM-DD-YY +:Exit

The last date entry (Last call) is shown on the top line of the display. The date should be updated every time a level calibration is performed. Loading default calibration data will reset the

date to 00-00-00. The numeric keys are used to modify the date. The cursor is placed under the digit to be changed, and automatically goes to the next digit when an entry is made. Entries are made in the order shown, (month, day, year). There is no internal verification that valid dates are entered. Modifying the level calibration date entry does not affect the frequency calibration date, which is accessed in the frequency calibration mode. Date entries are accessible over the GPIB.

5.5 POWER UP TESTS

Each time power is applied to the 2407 (the unit is turned on) it performs an automatic sequence of tests to verify various subsystems are functional. The display shows:

```
WAVETEK Model 2407      rev 4.0
POWER UP SELF-TEST
```

The following tests are performed in sequence. As each test is performed, the upper line of the display remains as shown above. The lower line of the display shows the test just completed and the test result. All possible displays for each test are shown. If a test is passed, no fail message will be shown.

1. The communication test detects stuck keys and verifies that the two microprocessors communicate with each other properly. The read/write capability of the both microprocessors dual-port RAM is examined. The communication microprocessor verifies it can read and write to its half of the RAM, and requests that the control microprocessor do the same. Data is then passed to the control microprocessor, checked against the value it expected, echoed back to the communication microprocessor, and checked against the value it originally sent. This is the same test as the diagnostic test for dual-port RAM.

The following messages are displayed on the bottom line to indicate the result of the test:

```
Communication test:      PASSED
Stuck key:  xxxxxxxx    FAIL      +:CONT
Dual-port RAM test:     FAIL      +:CONT
```

If a stuck key is detected, its key code is displayed (represented by the "xxxxxxx"). Key codes basically repeat the legend found on the key and are shown in Table 5-7. The self-test will halt until a stuck key is no longer detected, and will automatically continue when the key is released. If "???????" is displayed as the key code, it means that the keyscan port of the microprocessor has detected a short between at least one column and one row scanned, and there is no corresponding key at this position.

TABLE 5-7 STUCK KEY CODES

UP	DOWN
LEFT	RIGHT
RF	MHZ/MV
KHZ/UV	DBM/%
+/-	LCL
FREQ	LVL
STR	RCL
INT AM	POS DEV
INT FM	NEG DEV
EXT AM	MOD OFF
EXT FM	RATE
The numerals 0-9	
the decimal "."	

Note that a bad cable or a bad microprocessor card component can also cause a stuck key indication.

2. The RAM test verifies the RAM of both microprocessors can be written to and read from correctly. If an error is found, the self-test will stop until the + key or the STATUS key is pressed. The following messages indicate the results of this test:

```
RAM test:                PASSED
Control RAM test:        FAIL      +:CONT
Communication RAM test:  FAIL      +:CONT
```

3. The ROM test verifies that the PROMs of both microprocessors have the correct

checksum. If an error is found, the self-test will stop until the + key or the STATUS key is pressed. The following messages indicate the results of this test:

```
ROM test: PASSED
Control ROM test: FAIL +:CONT
Communication ROM test: FAIL +:CONT
```

4. The non-volatile data test verifies the checksums of the calibration settings and powerup instrument settings match the values that were saved. An error in either or both of these tables may indicate that the non-volatile RAM is failing. (Note that errors may be induced by handling the microprocessor card any time it is removed from the unit). Recurrent failure may dictate replacing the non-volatile memory device. If the calibration data is lost, it must be regenerated by performing both a frequency and a level calibration. A powerup instrument settings data failure will result in the powerup settings being reset to their factory default values. When either failure occurs, any or all of the stored settings may be lost. If either error occurs, the default values are loaded in place of the corrupt data.

An error will cause the self-test to stop until the + key or the STATUS key is pressed. The following messages indicate the results of this test:

```
Non-volatile data test: PASSED
Calibration table: FAIL +:CONT
Instrument setting: FAIL +:CONT
```

5. The hardware test verifies that all necessary cards are installed properly and that the RF data and address bus is operational. This test determines if the cards are in their correct positions in the card cage by reading the ID code latch on each card. Each card has a specific position in the card cage, so the cards' ID code can be used to verify that each card slot contains the correct card. Card ID codes are listed in Table 5-8.

TABLE 5-8 CARD ID CODES

Code	Card
0	DDS Card
2	Control Card
4	Synthesizer Card
6	AM/Divider Card
7	Output Amp Card
8	LO/Reference Card
9	Deviation Meter Card

The Control card and the DDS card are read directly from the Microprocessor card. If these cards are installed properly and an error is indicated for either of these two card positions (ID codes 0 and 2), the problem can be isolated to the RF data/address port of the microprocessor card, or its connections to these cards. Power supply loss to these cards can also cause a misleading hardware error indication.

Because the Control card is required to read the RF cards, the RF cards are skipped if the Control card cannot be read. If one of these cards gives an error indication (ID codes 4,6-9), even though it is installed correctly, the problem can be isolated to the RF data or address bus between the Control card and the RF cards, or to the Control card latches that drive these lines.

The RF data bus test consists of exercising the RF data bus on the Control card to verify that the data written is written properly. A test failure will indicate a problem localized to the RF data bus or the corresponding latch drivers on the Control card. The control card must be properly installed to perform this test.

An error will cause the self-test to stop until the + key or the STATUS key is pressed. The following messages indicate the results of this test:

```
Hardware test: PASSED
Card x not installed: FAIL +:CONT
RF data bus test: FAIL +:CONT
```

5.5.1 After power up tests are completed, the unit is ready for normal

operation as detailed in Section 3 of this manual. The unit powers up with the instrument settings that were active when it was last turned off.

5.5.2 If the front panel display does

not operate (is blank or exhibits nonsense or a garbage message), the Model 2407 is inoperable and needs repair. Wavetek recommends the unit be returned to the factory, after authorization, for any repair work.

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6.1 INTRODUCTION

The general purpose interface bus (GPIB) in the Model 2407 is fully compatible with IEEE Std 488-1978 and 1987. The following interface functions are implemented.

SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T6	Basic talker, serial poll; unaddressed if MLA (my listen address) is active; talk only mode disabled
TE0	Extended talker mode disabled
L4	Basic listener; unaddressed if MTA (my talk address) is active; listen only mode disabled
LE0	Extended listener mode disabled
RL1	Complete Remote/Local capability
PP0	Parallel poll capability disabled
DC1	Complete device clear capability
DT1	Complete device trigger capability
CO	Controller capability disabled
E2	Device dependent code to data line to indicate end of string; bit 2 (of bits 1-8) must be set.
SR1	Complete service request capability

All instrument functions except Power On/Off may be set via the GPIB. The Model 2407 is both a listener and a talker over the GPIB and provides error status and instrument status to its associated computer/controller.

The GPIB command format uses the minimum uniqueness concept to allow considerable flexibility in programming the 2407

functions. Because of this flexibility the Model 2407 with GPIB can be easily conformed to any GPIB based Automated Test Equipment (ATE) system. It also is compatible with Wavetek 2500 family instruments.

6.2 INSTALLATION INSTRUCTIONS

The GPIB circuitry is located on the dual microprocessor card inside the Model 2407. The bus address (My Listen Address; MLA) for the Model 2407 is factory preset at "2", but this may be changed over the GPIB or through the front panel diagnostics procedure if desired. Installation associated with GPIB control of the 2407 consists of using a GPIB cable to connect a GPIB controller to the GPIB connector on the rear panel of the 2407.

A GPIB controller is a digital computer that has I/O interface hardware and an operating system that is compatible with the IEEE-488 standard. The controller sends ASCII command strings over the GPIB to control a GPIB instrument.

Verify GPIB operation by sending the simple carrier frequency command "FRQ 200 MHZ" over the bus. (The complete command entry will depend upon the controller used. See Sections 6.3.5 and 6.3.11 for greater detail.) The 2407 FREQUENCY display will show 200 MHZ and the second line STATUS display will show the REMOTE annunciator if installation is correct.

6.3 OPERATING INSTRUCTIONS

6.3.1 LOCAL/REMOTE MODE SELECTION

When power is first applied to the Model 2407 the instrument will be in the Local Mode of operation. All functions will be controlled from the front panel. The 2407 will enter the Remote Mode of oper-

ation after any valid command has been transferred over the GPIB bus.

When the unit is in the Local Mode with a STATUS menu displayed (Error, Diagnostic, Calibration, or Debug screen), no GPIB activity can occur. GPIB activity can resume when the unit is returned to normal operation.

When the 2407 is in the remote mode, the front panel keypad is inactive with one possible exception. The LCL key may be used to switch operation back to the Local Mode if the Local Lockout bus command has not been sent by the controller. Note that if the GPIB has been used to send Local Lockout, the 2407 front panel is totally inactive (except for the power on/off switch) and the keyboard cannot be used to make changes in operating functions/values.

Three procedures may be used to switch from remote mode to local mode. The operator may cycle power (turn the 2407 off, then on), with power up in the local mode. The operator may press the LCL key on the 2407 front panel (if the Local Lockout Command has not been sent over the GPIB). The operator may send the return to local mode (RTL) command over the GPIB. Either of these three procedures will return control to the 2407 front panel. The unit will not enter the local mode while valid GPIB commands are being sent.

6.3.2 ADDRESS SETTING

The MLA (My Listen Address), the 2407 instrument bus address, is programmable over the GPIB and from the front panel using the diagnostics menus. The power up (default) address is factory preset at "2". The default MLA can be changed by reprogramming through the diagnostic mode or reprogramming over the GPIB bus. SIG (signal generator), MLA (my listen address), and MTA (my talk address) are all methods of changing the programmable instrument address over the GPIB bus. The talk and listen addresses must be the same. Only a decimal address of 0-30

is allowed. An error will be generated if the programmed address is out of range and the current address is not changed. The last valid address set through the diagnostics procedure is the power-up default address. The 2407 allows only primary addressing.

6.3.3 GPIB INPUT COMMAND DEFINITION

A GPIB input command is a statement generated at the controller and communicated to the 2407 by the GPIB that causes the 2407 to execute a particular function or establish a particular setting.

The Wavetek 2407 GPIB recognizes a variety of input commands to provide maximum user friendliness. The majority of GPIB input commands are identical in format to their corresponding manual inputs (using the 2407 front panel keyboard). The remaining GPIB commands are used to obtain system status information or to change system status.

6.3.4 GPIB INPUT COMMAND TYPES

There are four (4) basic types of GPIB input commands: parameter, enumerated, direct, and query. Each type of command and its format are described in the following sections. GPIB commands use the minimum uniqueness concept to enhance user friendliness (see below).

6.3.5 PARAMETER COMMANDS

Parameter commands are commands that change numerical values of the 2407 operational settings (output frequency, output level, etc.) A parameter command specifies a particular numerical value for an instrument setting.

The parameter command format is:

```
<header> space <numeric argument>  
<terminator>
```

6.3.5.1

Parameter command headers are shown and described in Table 6-1. Characters (let-

ters) may be entered in upper or lower case. Each header must contain a minimum number of letters in a specific order. The minimum format is the minimum set of letters in the specific order shown that will identify the operating parameter described. Each header has a maximum length format. The maximum format is the maximum set of characters for identification of the parameter. To specify a parameter command header the operator may use the minimum format, maximum format, or any combination of letters between the minimum and maximum format that includes the minimum format characters in their specified order. This is the minimum uniqueness concept. For example, the header for a command to alter center frequency (or deviation meter frequency) may be entered as "FRQ", "FREQ", or "FREQUENCY". Three parameter commands (MLA, MTA, and SIG) have identical minimum and maximum formats.

6.3.5.2

After the header is entered, a space character must be entered to separate the header from the numeric argument of the parameter command format. Note that after this required space has been entered, spaces may be included anywhere else in the command string at the users' option (to make the user's program more easily readable, for example).

6.3.5.3

The numeric argument consists of a number and the applicable engineering notation for the units associated with the parameter entered. The general form for a numeric argument is: (sign) (9 digits and decimal point) (engineering notation). If no sign is entered the 2407 will assume the numeric value is positive (the sign is positive). The 2407 will accept a number that has a maximum of nine digits and has a decimal point anywhere within the nine digits entered. The operator may enter any number of digits from 1 to 9. The 2407 will ignore any digits entered after the ninth digit.

6.3.5.4

The number may be entered in scientific notation, using a two digit exponent value that is not part of the nine digit maximum. Scientific notation takes the form: (E) (sign) (digit 1) (digit 2). The sign and the second digit are optional. If no sign is entered, the 2407 will assume the sign is positive. The "E" character (for exponent) may be entered in upper or lower case. The general form for the number part of a numeric argument entered in scientific notation is: (overall sign) (9 digits) (decimal point) (E) (exponent sign) (digit 1) (digit 2).

TABLE 6-1. PARAMETER COMMAND HEADERS

<u>MINIMUM FORMAT</u>	<u>MAXIMUM FORMAT</u>	<u>DESCRIPTION</u>
FRQ	FREQUENCY	Output or Deviation Meter Frequency
LVL	LEVEL	Output Level
IAM	INTERNALAM	Internal Amplitude Modulation
IFM	INTERNALFM	Internal Frequency Modulation
XAM	EXTERNALAM	External Amplitude Modulation
XFM	EXTERNALFM	External Frequency Modulation
RTE	RATE	Internal Modulation Rate
STR	STORE	Storage of an Instrument Setting
RCL	RECALL	Recall of an Instrument Setting
MLA	MLA	Programmable Talk and Listen Address
MTA	MTA	Programmable Talk and Listen Address
SIG	SIG	Programmable Talk and Listen Address

The general form for a numeric argument with scientific notation is: (sign) (9 digits) (decimal point) (E) (exponent sign) (digit 1) (digit 2) (engineering notation).

6.3.5.5

The engineering notation for the units associated with the parameter entered may contain additional numeric information. For example, kHz is 1000 Hz. Therefore, an entry of 3.000 kHz is an entry of 3000 Hz. Engineering notation is shown in Table 6-2. Note that GHZ, GZ, MHZ, MZ, KHZ, KZ, MV and UV provide numeric and engineering unit information. Engineering notation may be entered in upper or lower case or any combination of the two.

6.3.5.6

The numeric values for the parameter command arguments have the ranges specified as normal ranges for the 2407 signal generator functions. The internal modulation rate (RTE) argument can have only two values, "400" and "1000" Hz. The RTE argument does not require an engineering notation (HZ) entry.

TABLE 6-2. ENGINEERING NOTATION

NOTATION ASSOCIATED PARAMETER

GHZ	Output or Dev Meter Frequency
GZ	Output or Dev Meter Frequency
MHZ	Output or Dev Meter Frequency
MZ	Output or Dev Meter Frequency
KHZ	Output Frequency, Internal FM, External FM
KZ	Output Frequency, Internal FM, External FM
HZ	Output Frequency, Internal FM, External FM
DB	Output Level
DBM	Output Level
MV	Output Level
UV	Output Level
V	Output Level
%	Internal AM, External AM

6.3.5.7

The arguments for the storage (STR) and recall (RCL) of a complete front panel setting are limited to values between 1 and 15. Extended storage options are available to expand storage limits from 1 to 25 or from 1 to 50. The STR/RCL function is a unitless value requiring no engineering notation as part of its argument. The programmable talk and listen address commands (MLA, MTA, and SIG) are limited to values between 0 and 30 and also are unitless. MLA (my listen address), MTA (my talk address), and SIG (signal generator) are all commands to change the programmable instrument address over the GPIB instead of changing the address from the front panel with the diagnostic procedure. The talk and listen addresses must be the same.

6.3.5.8

The final item in the generalized parameter command format is an end of string (EOS) terminator. A series of parameter commands may be entered at the controller before any single command in the series is executed across the GPIB. The series is called a string of commands. The EOS terminator tells the controller to send the entered command or string of commands to the 2407. The commands in a string of commands are separated from one another by semicolons after each command's engineering notation. The EOS terminator tells the controller that the entered sequence has been concluded.

The EOS terminator is programmable. The EOS terminator sequence is selected from the front panel diagnostic programming mode. Any ASCII data character associated with the decimal numbers 00-31 may be programmed as the EOS terminator. The number 10, for example, selects the LF terminator. The number 13 selects the CR terminator. The operator may establish a different EOS terminator character by performing the GPIB enumerated command identified as TRM in Section 6.3.6, immediately following this section.

Regardless of the EOS terminator selected, EOI is also sent. The EOI message is not an ASCII character, but is a bus control line issued simultaneously with an ASCII data character. The responses generated by the 2407 always will terminate with the programmed terminator character (the ASCII equivalent to decimal 00-31) and EOI. Any of the following, individually or in combination, will terminate a command: CR, LF, EOI.

Upon power up, the EOS terminator is set to LF. These are the default EOS terminators.

6.3.6 ENUMERATED COMMANDS

Enumerated commands, with one exception, are commands that provide distinct choices to change system status. The modulation off command (see Table 6-3) has no alternative choices. Enumerated commands follow the format: <header> space <alphabetic or ASCII control symbol argument> <terminator>.

6.3.6.1

Enumerated command headers and their associated arguments are shown in Table 6-3. The majority of commands require an alphabetic argument. Argument characters may be in upper or lower case or any combination of the two. The EOS terminator command requires use of an ASCII control symbol(s). A brief description of each command function is included in Table 6-3. More information about each command is contained in the following sections, as required.

It is the minimum format for enumerated command headers that is shown in Table 6-3. These headers also employ the minimum uniqueness concept (Section 6.3.5.1) to provide expanded user friendliness. Minimum and maximum formats for enumerated command headers are shown in Table 6-4.

6.3.6.2

A space character must be entered be-

tween an enumerated command header and its argument. Additional spaces may be entered anywhere else in the command string as desired (to aid in reading a program, for example).

6.3.6.3

The final item in an enumerated command is the EOS (end of string) terminator. The discussion of EOS terminators of parameter commands in Section 6.3.5.8 is equally applicable for enumerated commands.

6.3.6.4

When enabled, the RQS (Request for Service) allows the 2407 to signal to the GPIB controller that the 2407 is requesting attention. The service request line will signal the controller if an error condition exists within the 2407 or a message is pending in the GPIB output buffer. This function is disabled at 2407 power up (the default condition). The function is enabled by the GPIB enumerated command "RQS ON". The GPIB command "RQS OFF" will disable the RQS function.

When an error generates a service request, the operator must send the query command "ERR" (discussed in Section 6.3.8) over the GPIB to receive a coded message identifying the source of the error. If the SRQ function is not enabled, the 2407 serial poll buffer will still contain the current status of the 2407.

Note that to utilize the 2407 SRQ capability the controller also must have complete service request (SRI) capability.

6.3.6.5

The GET (Group Execute Trigger) command is used to automatically execute a group of functions within the 2407. There are four (4) types of GET input commands:

TABLE 6-3. ENUMERATED COMMAND LISTINGS

<u>HEADER</u>	<u>ARGUMENT</u>	<u>DESCRIPTION</u>
RF	ON	RF output signal enabled at the RF OUT connector on the 2407 front panel
RF	OFF	RF output signal disabled at the RF OUT connector on the 2407 front panel
MOD	OFF	Disables all modulation: internal and external AM, and internal and external FM also Turns off the deviation meter readings and returns the unit to its normal operation mode
NOTE MOD ON is not a valid command. The specific modulation desired must be entered as a separate parameter command (see Section 6.3.5, ff).		
NOTE The deviation meter is turned on using a query command (see Section 6.3.9).		
RQS	ON	Enable the 2407 to produce service requests
RQS	OFF	Disable all service requests
GET	ON	Execute the previously transmitted group of functions
GET	OFF	Disable the group execution or group input
GET	SS	Execute the next stored setting
TRM	1 ASCII control symbol at user's discretion	Programmable end of string terminator (see Section 6.3.5.8).

TABLE 6-4. ENUMERATED COMMAND HEADERS

<u>MINIMUM FORMAT</u>	<u>MAXIMUM FORMAT</u>	<u>COMMAND NAME</u>
RF	RF	RF Signal Output
MOD	MOD	Modulation
RQS	REQUESTFORSERV	Request for Service
GET	GET	Group Execute Function
TRM	TERMINATORS	Programmable End of String Terminators

1. GET precedes a group of commands which will be executed at one time. The commands following "GET" are stored until "GET ON" is received. At that time, the commands are passed to the 2407 and executed. GET storage is limited to 100 characters. If the length of the GET command string exceeds 100 characters, the excessive characters will write over the earlier GET entries.

2. GET ON sends the stored commands to the 2407 for group execution.

3. GET OFF disables the GET function and clears all stored commands.

4. GET SS calls up the "next" 2407 stored setting and executes that setting. The stored settings calculated as "next settings" will refer only to settings that have been set up through the GPIB. This avoids having the controller query the 2407 to obtain the current stored setting, wait for the 2407 response, and then ask for a recall of the next setting.

The GET command also may be used to simultaneously trigger a group of devices (instruments) on the GPIB.

6.3.6.6

The TRM (programmable terminator) function allows the user to select an end of string termination ASCII control character. Any ASCII data character associated with decimal 00-31 may be used. The terminator command must always be completed with a semicolon. The current EOS terminator is not a valid completion indication for this command because a resetting of the EOS is occurring as the TRM command is given. If the terminator input process is incorrect, an error will be generated and the current termination string will not be changed.

The general format for the TRM command is: TRM (char);.

Only ASCII control characters (decimal 00-31) may be used as a terminator char-

acter. The minimum format header TRM is shown (see Section 6.3.5.1 for a brief discussion of the minimum uniqueness concept, if necessary).

6.3.7 DIRECT COMMANDS

Direct commands make the 2407 perform an immediate action. The format for a direct command is: <header> <terminator>.

6.3.7.1

The header specifies the action to be performed. Minimum and maximum formats for the direct command headers and command name are shown in Table 6-5. The minimum uniqueness concept discussed in Section 6.3.5.1 is equally applicable for direct command headers.

6.3.7.2

The terminator description of Section 6.3.5.8 is equally applicable for the direct command format.

6.3.7.3

The LLO (Local Lock Out) command disables the 2407 front panel controls with the exception of the power on/off switch. The front panel LCL key cannot be used to return the 2407 to local control when the GPIB command LLO has been entered at the controller.

6.3.7.4

The RTL (Return to Local) command will return 2407 control to the 2407 front panel (local mode of operation).

6.3.8 QUERY COMMANDS

The majority of query commands tell the 2407 to send 2407 operating parameters/status information to the controller. (Two query commands turn on the deviation meter; see section 6.3.9.) Using query commands, the 2407 is capable of informing the GPIB controller of: 1) the 2407's identity; 2) its operational status; 3) certain error conditions

which have occurred; 4) the need for immediate attention. The query command format is: <header> <?> <terminator>.

6.3.8.1

The header specifies the type of information to be sent to the controller. The majority of the parameter command headers (Section 6.3.5.1) and enumerated command headers RF and MOD also serve as query command headers. Table 6-6 lists all query command headers (minimum format) and the associated 2407 response to the command. Note that information about 2407 output level (LVL) may be supplied to the controller in units of v, mV, μ V, or dBm. There are nine possible responses to a "MOD" query, and two responses to both "RF" and "RTE" queries. The 2407 responses to commands ID, ERR, and SET are discussed in detail in Sections 6.3.8.4 through 6.3.8.6.

All responses use a fixed message length of 30 characters, not including the terminator character. Blanks are inserted as necessary at the end of the message to complete the message length.

Table 6-6 lists query command headers in minimum format. The minimum uniqueness concept of Section 6.3.5.1 is valid for query commands also. Header formats for all commands but ID, ERR, SET, and the two deviation meter query commands PSM and NGM have been presented earlier in this section. Header formats for these commands are shown in Table 6-7.

6.3.8.2

Because parameter and enumerated command headers can also be query headers, the question mark <?> in the query command format tells the 2407 to send, rather than receive, information. The query command "<FRQ> <?> <terminator>" requests the current operational output frequency setting for the 2407.

6.3.8.3

The terminator characters in a query

command are exactly as described in Section 6.3.5.8 for parameter commands.

6.3.8.4

The response of the 2407 to the query command ID (Identify) will be "ID WVTK/2407,0,Fx.x", where: WVTK/2407 is the Wavetek model number for the 2407, 0 is a place holder, and Fx.x is the firm-ware version number.

6.3.8.5

The 2407 will respond to the query command ERR (Error) with error messages that identify the source of a detected error(s). The general format of an error message is:

XXX-ENGLISH DESCRIPTION OF THE ERROR

where XXX is an identifier which is used to identify the error. To maintain the fixed message length of 30 characters, the total error message will be kept to 30 characters. Error messages are shown in Table 6-8.

When an error is detected, the error bit (bit 5) of the serial poll byte will be set. Bit 6 of the serial poll byte also will be set if RQS (request for service) is enabled. Bit descriptions for the serial poll byte are as follows:

Bit 7	Deviation Meter Updated
	From Last Reading
Bit 6	Service Request
Bit 5	Error
Bit 4	Message Available
Bit 3	Undefined
Bit 2	Undefined
Bit 1	Buffer Empty
Bit 0	Message In Process

The buffer empty flag (bit 1) will be set if the output buffer is empty and no messages are being processed for output. If there is no message to send but a talk request has been made, the 2407 will respond with a terminator character only.

Table 6-5. DIRECT COMMAND HEADERS

LLO	LOCALLOCKOUT	Lockout of Front Panel
RTL	RETURNTOLOCAL	Return Instrument to Local Control

TABLE 6-6. QUERY COMMAND HEADERS/2407 RESPONSE

<u>HEADER</u>	<u>2407 RESPONSE</u>	<u>HEADER</u>	<u>2407 RESPONSE</u>
FRQ	FREQUENCY ffff.ffff MHz	MOD	MODULATION OFF
LVL	AMPLITUDE aaaa Volts		MODULATION INT AM/EXT FM
	AMPLITUDE aaaa mV		MODULATION EXT AM/INT FM
	AMPLITUDE aaaa μV		MODULATION INT AM
	AMPLITUDE aaa.a dBm		MODULATION INT FM
RF	RF OUTPUT ON		MODULATION EXT AM
	RF OUTPUT OFF		MODULATION EXT FM
IAM	INTERNAL AM mm %		MODULATION POS MET
IFM	INTERNAL FM mmmmm kHz		MODULATION NEG MET
XAM	EXTERNAL AM mm %	ID	ID WAVETEK/2407, 0, Fx.x
XFM	EXTERNAL FM mmmmm kHz	ERR	xxx-ENGLISH DESCRIPTION
RTE	MOD RATE 400 Hz	SET	CURRENT 2407 SETTINGS
	MOD RATE 1000 Hz	PSM	See DEVIATION METER
CAL	See CALIBRATION		COMMANDS, section 6.3.9
	COMMANDS, Section 6.3.10	NGM	See DEVIATION METER
OPT	NO OPTIONS INSTALLED		COMMANDS, section 6.3.9

TABLE 6-7. HEADER FORMATS FOR ID, ERR, SET, PSM, AND NGM QUERY COMMANDS

<u>MINIMUM FORMAT</u>	<u>MAXIMUM FORMAT</u>	<u>DESCRIPTION</u>
ID	IDENTIFY	Request for the instrument name and model
ERR	ERROR	Request for the current listing of errors
SET	SET	Request for a listing of the current instrument settings
PSM	POSMETER	Turn on deviation meter, positive dev
NGM	NEGMETER	Turn on deviation meter, negative dev

TABLE 6-8. ERROR MESSAGES

101-COMMAND HEADER	317-EXTERNAL MOD SOURCE UNCAL
103-ARGUMENT	320-DEV METER FREQUENCY HIGH
205-ARGUMENT OUT OF RANGE	321-DEV METER FREQUENCY LOW
302-SYSTEM ERROR	322-DEVIATION INPUT LEVEL LOW
310-LO UNLOCKED	323-FM DEV SIGNAL OUT OF RANGE
311-SYNTHESIZER UNLOCKED	342-OPTION PROGRAMMING ERROR
312-UNIT UNLEVELED	349-POWER UP SETTINGS ERROR
313-CIRCUIT BREAKER TRIPPED	350-STORED SETTING ERROR
315-400 HZ NOT FUNCTIONAL	401-POWER UP
316-UPPER FREQUENCY UNLEVELED	499-SYSTEM OPERATIONAL

The message in process flag (bit 0) will be set if the output buffer is empty, but a message is currently being processed for output. This will indicate that an output buffer message will be available soon.

The message available flag (bit 4) will be set if one or more messages are pending in the output buffer. This will indicate data is ready to be read.

Only the message available condition and the error condition will issue a service request (when RQS is enabled).

6.3.8.6

The 2407 responds to a SET query (SET?) with the the current operating settings of the instrument. Each setting is sent as an individual message. Continuous "READS" must be performed to get all settings. SET also sends the last deviation meter readings and puts the unit into the negative deviation meter mode.

6.3.9 DEVIATION METER COMMANDS

The deviation meter is turned on by either of two query commands. The command <PSM> <?> turns on the meter, if it isn't already on, and sets up the display for a positive deviation meter reading. This command also requests the last positive deviation meter reading made. The command <NGM> <?> turns on the meter, if it isn't already on, and sets up the display for a negative deviation meter reading. This command also requests the last negative deviation meter reading made.

When the deviation meter mode is turned on, the 2407 performs a calibration that takes about 8 seconds to complete. In the meter mode, one reading per second is taken. Therefore when a positive or negative deviation meter reading is requested, a valid response takes about 8 seconds if the meter must be turned on and about 1 second if it is on.

A response is generated every time a

PSM or NGM query command is issued. The response value indicates the last measurement taken, and will be available until the next sample is taken. In order to determine if the reading requested has been updated from the last query, the program used must check the status of bit 7 of the serial poll register. If set, the reading is from a fresh sample. If not, the program must continue requesting a reading until bit 7 is set. Note that the output buffer is loaded with a response whether the setting has been updated or not. Therefore the response must be read for each query performed.

Deviation meter frequency may be set across the GPIB using the Parameter command FRQ, as detailed beginning at section 6.3.5 (see Table 6-2 for header format). The query command ERR (section 6.3.8.5) requests the error status of the instrument if an error message occurs in the deviation meter mode.

The enumerated command MOD OFF (section 6.3.6) turns off the deviation meter mode and returns the unit to its normal operating mode.

Section 6.3.11.5 contains a sample software program using the remote capability of the 2407 deviation meter with a Wavetek Model 6000.

6.3.10 CALIBRATION COMMANDS

The three types of CAL (Calibration Commands) are:

"CAL 0"
"CAL ?"
"CAL + data string"

"CAL 0" is used to load the factory default calibration values into the calibration tables. "CAL ?" is the CAL QUERY, the request for all calibration data. The level and frequency calibration data will be returned as a series of data strings. "CAL + data string" sends change information for specific calibration data as identified and

coded in the data string.

6.3.10.1 CAL Command Data Strings

The data strings shown after a "CAL ?" query or the data string used with a "CAL + data string" entry have the same character definition. A typical string sequence following the "CAL ?" entry might contain lines that look like the following (the dotted lines indicate the entire sequence of data strings is not shown):

```
LF000 510052005300540055005600
LF006 570058005900610062006300
LF00C 640065006600670068006900
... ..
LC000 0001FEFC0406000003020202
LC00C 020000000004040000000001
... ..
FLO00 40404040404040404040404040404040
FLO0C 404040404040
... ..
FC000 324549505357595C666A7177
FC00C 82868F939
... ..
FM000 055505550555055505550555
FM006 055505550555055505550555
... ..
FM10E 055505550555055505550555
```

As indicated above, not all 30 character spaces may be needed in each data string.

A typical data string sent with the "CAL + data string" entry might be:

```
"CAL LF000 510052005300540055005600"
```

The level calibration and frequency calibration date entries produce strings with slightly different formats. They are single line entries of format:

```
"LD000 MMDDYY" and "FD0000 MMDDYY"
```

The characters MMDDYY are replaced by decimal digits representing the date last set.

6.3.10.2 Data String Characters

The argument (characters following CAL)

for the preceding entry and the characters in the data strings resulting from a "CAL ?" entry have identical definitions. Characters 1-2 are the table selection alpha code. The code, listed in the order in which information is supplied following a "CAL ?" query, is:

- LD = the level calibration date.
- LF = the level calibration frequency table, which contains the frequencies at which level calibration is to be performed.
- LC = the level flatness calibration correction table, which contains the level correction in .1dB increments at each calibration point.
- LL = the level linearity calibration correction table, which contains the corrections at 1 dB decrements from +13 dBm to -7 dBm.
- FD = the frequency calibration date.
- FL = the frequency loop compensation DAC table, which contains DAC compensation values for frequencies starting at 275 MHz, with each succeeding entry at a 10 MHz higher frequency.
- FC = the frequency coarse DAC table, which contains coarse DAC values for frequencies starting at 275 MHz, with each succeeding entry at a 10 MHz higher frequency.
- FM = the FM calibration table, which contains FM values starting at 275 MHz, with each succeeding entry at a 1 MHz higher frequency.

The following descriptions apply to the formats for the calibration tables (LF, LC, FL, FC, FM, and LL) listed above. The calibration date formats have been described earlier (Section 6.3.10.1).

Characters 3-5 indicate the entry number of the selected table at which to store the calibration data. Table entry lengths can be one or two bytes. The first byte of each table is "000", with the exception of the level calibration table (LC). The first digit of the LC first byte indicates the attenuator selection (range 0-C; hex for 12, or 120 dB). The last two digits indicate the level calibration entry number for that attenuator.

Character 6 is a data field separator (an ASCII space character).

Characters 7 to the end of the string contain the actual data, which is described in detail in the following sections.

6.3.10.3 Data Characters

Characters 7 to the end of the string in a data string contain data, with each byte of data represented as 2 ASCII characters. All calibration data characters are ASCII characters. In the following descriptions, a data value that has a "signed binary byte" is data that has its two ASCII characters converted into the binary value they represent. The ASCII characters "E2", for example, would be converted into their hexadecimal value \$E2 (a one byte binary value). Therefore, all data characters must be made up of ASCII characters 0-9 and A-F (lower case accepted), unless the data is decimal. If the data is decimal, only the characters 0-9 are allowed.

Each of the level frequency (LF) table data entries are four characters in length. These entries represent the frequencies at which the level calibration data values (LC) are to be used. The number of entries in this table can be increased from the 30 set up in default to a maximum of 255. The range of valid frequencies is from 10 kHz to 550 MHz, the operating range of the instrument. The format of the data

entry is:

- char 1 = exponent of frequency value in .1 Hz units; range from 5 to 9; for example, 10 kHz would be E5 (10 kHz in Hz units is E4, but exponent must increase by 1 when using .1 Hz units = E5)
- char 2 = most significant digit of frequency data; must be a nonzero decimal value
- char 3 = second most significant digit of frequency data; must be a decimal value
- char 4 = third most significant digit of frequency data; must be a decimal value

Each of the level correction (LC) table data entries are two characters in length. These entries represent the level correction values (factors) in .1 dB units to be applied at their corresponding level calibration frequencies. Each correction factor is used over the frequency range extending from the midpoints of the two calibration points on either side of the calibration point that actually corresponds to the correction factor. The lower frequency limit for a correction factor is the frequency halfway between the calibration point that corresponds to the correction factor and the calibration point immediately preceding it. The upper frequency limit for a correction factor is the frequency halfway between the calibration point that corresponds to the correction factor and the calibration point immediately following it. The calibration data is in signed binary notation. A correction value of "FE", for example, corresponds to a correction of -0.2 dB. A value of "12" corresponds to a correction of +1.8 dB.

The number of entries in the LC table must always be the same as the number of entries in the LF table. Therefore, if the LC table is to be extended, the additional frequencies must first be defined in the LF table.

Each of the loop compensation DAC (FL) table data entries are two characters in length. These entries represent the values to be programmed into the loop compensation DAC for the given frequencies. The number of entries in this table is fixed at 28. This corresponds to one entry every 10 MHz, starting at 275 MHz. The values are one byte binary, with a range from 00 to FF.

Each of the coarse tune DAC (FC) table data entries also are two characters in length. These entries represent the values to be programmed into the coarse tune DAC for the given frequencies. The number of entries in this table also is fixed at 28. This corresponds to one entry every 10 MHz, starting at 275 MHz. The values are one byte binary, with a range from 00 to FF.

Each of the FM calibration (FM) table data entries are four characters in length. These entries represent the FM DAC values corresponding to a deviation of 1 MHz at the given frequencies. The number of entries in this table is fixed at 276. This corresponds to one entry every 1 MHz, starting at 275 MHz. The values are twelve bit binary, with a range from 0000 to 0FFF (the first character always must be a "0").

The level linearity calibration table entry produces a 21-byte long string, each byte represented by 2 hexadecimal characters. Because each line displays 12 bytes, the data is shown on 2 lines and is organized as followings. The first byte represents the level linearity correction at +13 dBm. Succeeding values represent corrections at 1 dB decrements up to and including -7 dBm. Correction factor limits are the same as those for the level flatness (LC) data. Those limits are from -60 to +60, (hexadecimal values C4 to 00 for negative values and 00 to 3C for positive values).

6.3.10.4 Checking For Errors

Two methods may be used to verify cor-

rect CAL commands (check for errors). The error query "ERR ?" command may be sent (to look for errors that have occurred) or the "RQS ON" command may be sent (to enable the service request and issue a service request if an error occurs). In either case, an error will generate the appropriate error message shown in Table 6-8.

Argument errors may be generated for the following reasons:

1. The table select code is missing or invalid.
2. The table entry number is missing or invalid (not 3 ASCII hex characters).
3. The data field separator is missing.
4. Data is missing or invalid (not ASCII hex characters).
5. Word-format data is only partially defined (must be four characters each).
6. Byte-format data is only partially defined (must be two characters each).

Range errors may be generated for the following reasons:

1. The entry number exceeds the number of entries for the selected table.
2. Level frequency calibration table data is not in a valid format (exp D1, D2, D3: where exp = \$5 to \$9, D1 = \$1 to \$9, D2 = \$0 to \$9, D3 = \$0 to \$9).

If the data string length exceeds 12 data bytes (24 characters), no error is generated but the string is truncated to 12 bytes.

If the data string length is less than 12 data bytes (24 characters), no error is indicated and only those data bytes read are output. Note that an argument error will result if any non-hex values occur in the data string.

6.3.11 SAMPLE SOFTWARE PROGRAMS

These basic programs can be adapted to any GPIB controller if the appropriate write and address formats are substituted. These programs illustrate the 2407 as a listener. The 2407 is also a talker.

6.3.11.1 FUNCTION: FREQUENCY

Exercise: Program the frequency in 50 MHz steps between 100 and 550 MHz.

```
WAVETEK 6000 BASIC:
100 FOR I=100 TO 550 STEP 50
110 WRITE @ 702:"FRQ "&STR$(I)& "MHZ;"
120 WAIT DELAY.2
130 NEXT I
140 END
```

The 200 millisecond time delay in line 120 permits the Model 2407 frequency to stabilize.

```
HP85 BASIC:
100 FOR I=100 TO 550 STEP 50
110 OUTPUT 702;"FRQ "&VAL$(I)&"MHZ;"
120 WAIT 200
130 NEXT I
140 END
```

```
HP9825 HPL:
0: for I=100 to 550 by 50
1: wrt 702,"FRQ "&str(I)&"MHZ;"
2: wait 200
3: next I
4: end
```

```
IBM PC BASIC:
100 for I=100 to 550 STEP 50
110 I$=RIGHT$(STR$(I),LEN(STR$(I))-1)
120 WRT$="FRQ "+I$+"MHZ;"
130 CALL IBWRT(SIGEN%,WRT$)
140 FOR J=1 to 200
150 NEXT J
160 NEXT I
170 END
```

In line 110 a blank space is removed to prevent an illegal response. In lines 140 and 150 an approximate delay is achieved by using a for-next 1000.

NOTE: The necessary program lines that initialize the PC, set the device number, and clear the 2407 (NAME: SIGEN) are omitted from the above program.

6.3.11.2 FUNCTION: LEVEL

Program the output level in 5 dB steps between +10 and -100 dBm. Initially set the frequency to 500 MHz in CW mode with the RF output on.

```
WAVETEK 6000 BASIC:
100 WRITE@702:"FRQ 500 MHZ; MOD OFF;
RF ON;"
110 WAIT DELAY .2
120 FOR I=10 TO -100 STEP -5
130 WRITE@702:"LVL "&STR$(I)& "DBM;"
140 NEXT I
150 END
```

```
HP 85 BASIC:
100 OUTPUT 702:"FRQ 500MHZ; MOD
OFF; RF ON;"
110 WAIT 200
120 FOR I=10 TO -100 STEP -5
130 OUTPUT702;"LVL "&VAL$(I)& "DBM;"
140 NEXT I
150 END
```

```
HP 9825 HPL:
0: wrt 702,"FRQ 500MHZ;MOD OFF;RF ON;"
1: wait 200
2: for I=10 to -100 by -5
3: wrt702,"LVL "&STR(I)&"DBM;"
4: next I
5: end
```

```
IBM PC BASIC:
100 WRT$-"FRQ 500 MHZ;MOD OFF;RF ON;"
110 FOR I=1 to 200
120 NEXT I
130 FOR I=10 TO -10 STEP -5
140 I$=RIGHT$(STR$(I),LEN(STR$(I))-1)
150 WRT$="LVL "+I$+"DBM;"
160 CALL IBWRT(SIGEN%,WRT$)
170 NEXT I
180 END
```

6.3.11.3 FUNCTION: RF LEVEL (ON/OFF)

Set the Model 2407 to 500 MHz at +13 dBm in CW mode with the RF output off for 400 milliseconds, then on for 200 milli-

seconds, then off again.

WAVETEK 6000 BASIC:

```
100 WRITE@702:"FRQ 500MHZ;
    MOD OFF; RF OFF;"
110 WAIT DELAY .4
120 WRITE@702:"RF ON;"
130 WAIT DELAY .2
140 WRITE@702:"RF OFF;"
150 END
```

HP 85 BASIC:

```
100 OUTPUT 702:"FRQ 500MHZ; MOD OFF;
    RF OFF;"
110 WAIT 400
120 OUTPUT702;"RF ON;"
130 WAIT 200
140 OUTPUT702;"RF OFF;"
150 END
```

HP 9825 HPL:

```
0: wrt702,"FRQ 500MHZ; MOD OFF;
    RF OFF;"
1: wait 400
2: wrt702,"RF ON;"
3: wait 200
4: wrt702,"RF OFF;"
5: end
```

IBM PC BASIC:

```
100 WRT$="FRQ 500MHZ; MOD OFF;
    RF OFF;"
110 CALL IBWRT(SIGEN%,WRT$)
120 FOR I=1 to 400
130 NEXT I
140 WRT$="RF ON;":CALL IBWRT (SIGEN%,
    WRT$)
150 FOR I=1 to 200
160 NEXT I
170 WRT$="RF OFF;":CALL IBWRT
    (SIGEN%,WRT$)
180 END
```

6.3.11.4 FUNCTION: INTERNAL FM

Initially set the Model 2407 to 500 MHz at +10 dBm in CW mode with RF output on. After 1 second, set the internal FM deviation to 500 kHz at 1 kHz modulation rate. After 500 milli-seconds turn the modulation off.

WAVETEK 6000 BASIC:

```
100 WRITE@702:"FRQ 500MHZ;
    LVL 10DBM ; MOD OFF;RF ON;"
110 WAIT 1
120 WRITE@702:"IFM 500KHZ;RTE 1000;"
130 WAIT .5
140 WRITE@702:"MOD OFF;"
150 END
```

HP 85 BASIC:

```
100 OUTPUT 702;"FRQ 500MHZ;
    LVL 10 DBM; MOD OFF; RF ON;"
110 WAIT 1000
120 OUTPUT702;"IFM 500KHZ; RTE 1000;"
130 WAIT 500
140 OUTPUT702;"MOD OFF;"
150 END
```

HP 9825 HPL:

```
0: wrt702,"FRQ 500MHZ; LVL 10DBM;
    MOD OFF; RF ON;"
1: wait 1000
2: wrt702,"IFM 500KHZ; RTE 1000;"
3: wait 500
4: wrt702,"MOD OFF;"
5: end
```

IBM PC BASIC:

```
100 WRT$="FRQ 500MHZ; LVL 10DBM;
    MOD OFF; RF OFF;"
110 CALL IBWRT(SIGEN%,WRT$)
120 FOR I=1 to 1000
130 NEXT I
140 WRT$="IFM 500KHZ; RTE 1000;"
150 CALL IBWRT(SIGEN%,WRT$)
160 FOR I=1 TO 500
170 NEXT I
180 WRT$="MOD OFF;":CALL IBWRT
    (SIGEN%,WRT$)
190 END
```

6.3.11.5 FUNCTION: DEVIATION METER

The following sample program and comments show the 2407 deviation meter used with a Wavetek Model 6000 controller. The program requests a given number of positive and negative deviation meter readings, and displays them only after a new reading is completed. If an error occurs while readings are being taken, the error message is displayed until the error condition disappears.

PROGRAM	COMMENTS
WAVETEK 6000 BASIC:	
100 DIM POS\$*40,NEG\$*40,ERR\$*40	2407 Response strings
110 !	
120 EOI ON	
130 TERM IS CHS\$(10)	TERMINATOR CHAR = LF
140 LET SGEN=702	GPIB ADDR = 02
150 LET DTIME=.3	LOOP DELAY = .3 SEC
160 !	
170 LOOP: PRINT "ENTER # OF READINGS TO TAKE"	
180 INPUT A	
190 !	
200 FOR Y=1 TO A	
210 !	
220 POS: WRITE @SGEN: "PSM ?"	ISSUE POS DEV METER QUERY
230 POSWAIT: WAIT DELAY DTIME	RESPONSE DELAY
240 STATUS @SGEN:S	READ SERIAL POLL REGISTER
250 IF ADB(S,16)=0 THEN GO TO POSWAIT	WAIT FOR RESPONSE AVAILABLE FLAG
260 READ @SGEN: POS\$	READ RESPONSE
270 IF LEN(POS\$)<2 THEN GO TO POSWAIT	CONTINUE WAITING IF NULL MESSAGE
280 IF ADB(S,32)<>0 THEN GO SUB ERROR	CHECK FOR ERROR FLAG
290 IF ADB(S,128)=0 THEN GO TO POS	REPEAT IF NOT NEW READING
300 !	
310 NEG: WRITE @SGEN: "NGM ?"	ISSUE NEG DEV METER QUERY
320 NEGWAIT: WAIT DELAY DTIME	RESPONSE DELAY
330 STATUS @SGEN:S	READ SERIAL POLL REGISTER
340 IF ADB(S,16)=0 THEN GO TO NEGWAIT	WAIT FOR RESPONSE AVAILABLE FLAG
350 READ @SGEN: NEG\$	READ RESPONSE
360 IF LEN(NEG\$)<2 THEN GO TO NEGWAIT	CONTINUE WAITING IF NULL MESSAGE
370 IF ADB(S,128)=0 THEN GO TO NEG	REPEAT IF NOT NEW READING
380 !	
390 PRINT POS\$;NEG\$	PRINT POS AND NEG DEV READINGS
400 NEXT Y	
410 GO TO LOOP	
420 !	
430 ERROR: WRITE @SGRN: "ERR ?"	ISSUE ERROR QUERY
440 ERRWAIT: WAIT DELAY TIME DTIME	RESPONSE DELAY
450 STATUS @SGEN:S	READ SERIAL POLL REGISTER
460 IF ADB(S,2)<>0 THEN GO TO ERREND	BRANCH IF NO MOVE RESPONSES
470 IF ADB(S,16)=0 THEN GO TO ERRWAIT	WAIT FOR RESPONSE AVAILABLE FLAG
480 LET OLDERR\$=ERR\$(1:3)	SAVE LAST ERROR #
490 READ @SGEN: ERR\$	READ ERROR RESPONSE
500 IF ERR\$(1:3)=OLDERR\$ THEN GO TO ERRWAIT	PRINT ERROR IF UPDATED
510 PRINT ERR\$	
520 GO TO ERRWAIT	
530 ERREND: IF ADB(S,32)<>0 THEN GO TO ERROR	REPEAT IF MORE ERRORS
540 RETURN	
550 !	
9999 END	

7.1 INTRODUCTION

This is the theory of operation for the 2407. This section begins with a general overview of the instrument circuitry (Section 7.2) and proceeds to a detailed description of each board used (Sections 7-3 to 7-13). Each circuit board is described in terms of the schematic(s) associated with it. Some have more than one schematic. An overview of each board will be presented, followed by more detailed circuit descriptions where appropriate.

Figure 7-1 is a block diagram of the frequency synthesis circuitry. Figure 7-2 shows card cage location for the boards. The detailed theory of operation makes extensive references to the schematic diagrams (Figures 9-1 through 9-14) bound in Section 9, the reference drawing section, of this manual. Schematics and their associated parts layout diagram(s) are located together in Section 9. Other reference drawings are also located in Section 9.

7.2 GENERAL OVERVIEW

The block diagram for frequency synthesis in the Model 2407 Synthesized Signal Generator is shown in Figure 7-1. The "BD" abbreviation for Board shown on the figure will also be used in this text. The internal/external reference switching circuitry is contained on the LO/REF BD and is select logic that determines whether the internal 10 MHz Temperature Compensated Crystal Oscillator (TCXO) source will be used as the frequency reference (as shown in Figure 7-1) or an external

5 MHz or 10 MHz source will be substituted. The 10 MHz reference is divided by 10 to generate 1 MHz reference signals to the phase detectors on the LO/REF BD and the DDS (Direct Digital Synthesis) BD. The 10 MHz reference also is sent to the SYNTH (Synthesizer) BD.

The NVCO (Narrow VCO) on the LO/REF BD provides a 512 MHz output to the Mixer on the OUTPUT BD. The 512 MHz output from this loop also is fed to a divide-by-512 ($\div 512$) circuit. The resultant 1 MHz signal ($512 \text{ MHz} \div 512 = 1 \text{ MHz}$) is applied to the phase detector to provide an error voltage to lock the loop output at 512 MHz.

The WVCO (Wide VCO) loop on the SYNTH BD is the main loop for frequency synthesis. It contains two VCOs that provide outputs from 275 - 550 MHz to the associated AM/DIV BD circuitry.

The main loop output frequency is the product of several operations. Software selects the appropriate VCO in the WVCO. Software also provides the appropriate input to the coarse tuning circuitry to generate an output frequency within tracking (lock-in) range of the loop. Frequency lock-in is controlled by the feedback circuit from the WVCO output to the phase detector in the WVCO loop. The output from the WVCO loop is fed to a divide-by-10 divider and then to a Single Side Band (SSB) Mixer and then to the Main Loop Frequency Divider (Fractional-N Divider).

The SSB Mixer also receives 115-190 kHz inputs from the DDS BD.

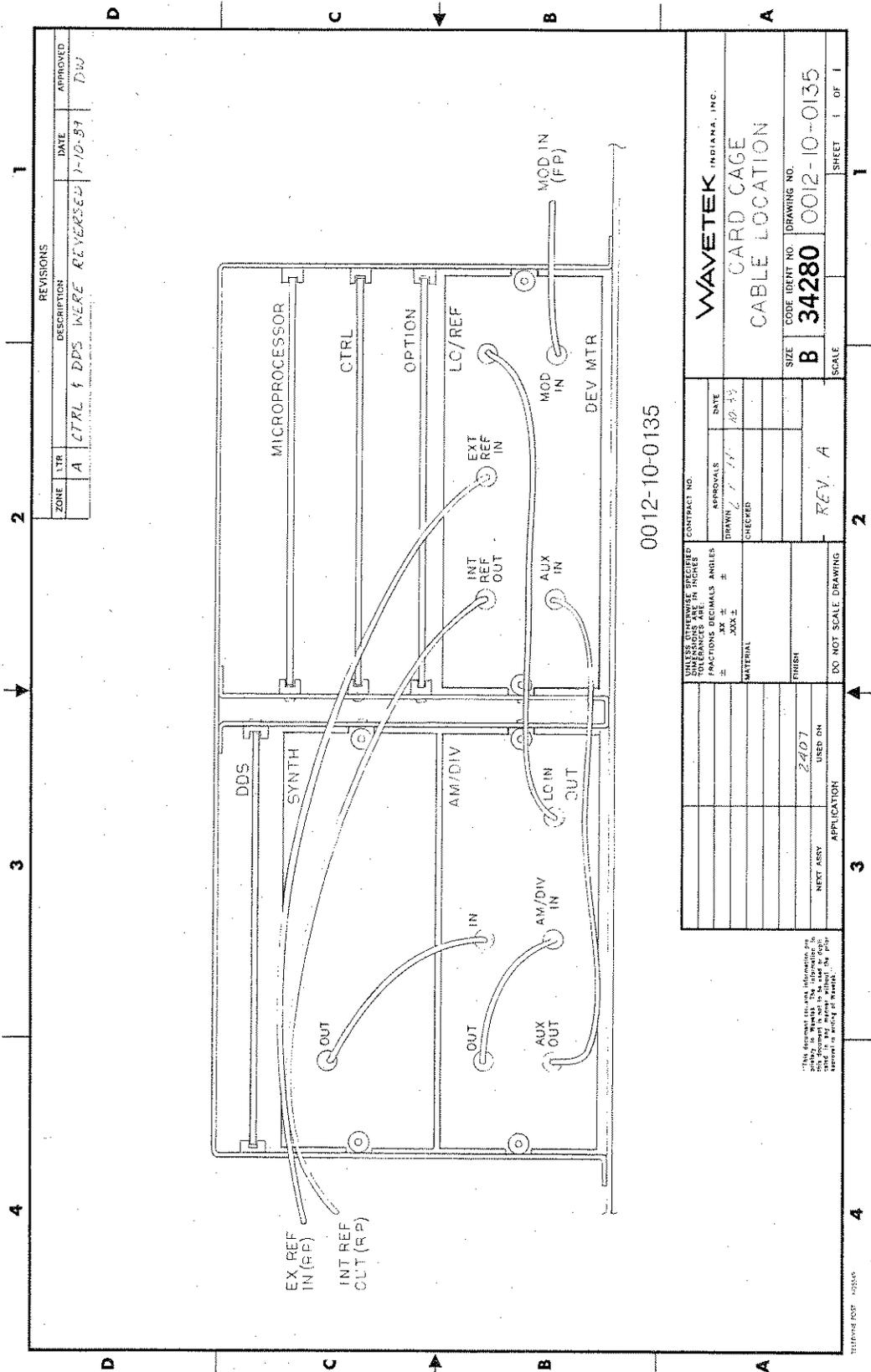


Figure 7-2 Card Cage Board and Cable Locations

Each loop contains filter circuitry as shown. FM is added to the WVCO loop from the CONTROL BD as shown.

The 275-550 MHz output from the WVCO is fed to a straight through or a divide-by-2 frequency conversion circuit in the AM/DIV BD. The top path shown in the AM/DIV BD provides direct coupling of the main loop WVCO output (275 - 500 MHz) to the amplifiers in the Output BD. The bottom path connects the WVCO loop output to the divide by two ($\div 2$) circuitry. The main loop WVCO output will be divided by two, applying 137.5 -275 MHz to the amplifiers in the Output BD.

The AM/DIV BD receives AM from the CONTROL BD as shown.

Both amplification and leveler circuitry are shown by the blocks for the OUTPUT BD on Figure 7-1. Outputs to the power amplifier circuitry (on another part of the OUTPUT BD) and to the DEV MTR (Deviation Meter) BD are shown.

The power output from the OUTPUT BD is applied to the Attenuator Assembly and its Reverse Power Protection circuitry before it is sent to the front panel RF OUT connector.

7.2.1 On Board Voltage Regulation

The majority of the boards described in the following sections have on board voltage regulators. Voltage in and out is clearly identified.

7.2.2 Identification (ID) Codes

For debugging purposes, and to identify options installed and hardware revision levels, each card (except the μ P card) has a fixed 8-bit identification (ID) code that can be accessed by the μ P card. ID codes are shown in Table 7-1.

The two most significant bits (MSBs) indicate the card's functional history. When the bits are "0 0", the card

currently installed in the slot is the one originally located there. A two bit code allows identification for up to four functionally different cards (the original card and up to three replacement cards) being used at any given position. These "function" bits may be used to indicate the options installed in the system.

The next three significant bits indicate the required card slot position of the card. Card slot locations are shown in Table 7-2. The card slot bits verify operation of the RF data and address busses. If a card is placed in an incorrect location, it will generate an RF data/address bus error. Missing cards are also detected when a card slot ID code is read and the position code is an illegal value.

The three least significant bits (LSBs) indicate the revision level of the card. The revision level is updated only for a hardware revision that requires a software modification.

The address decoding of the ID code latch for all cards is \$00. Because the RF cards and the control driver cards are on separate data/address busses, card ID codes only need to be unique for the separate busses. The ID codes currently defined are shown in Table 7-1.

7.3 MICROPROCESSOR BOARD

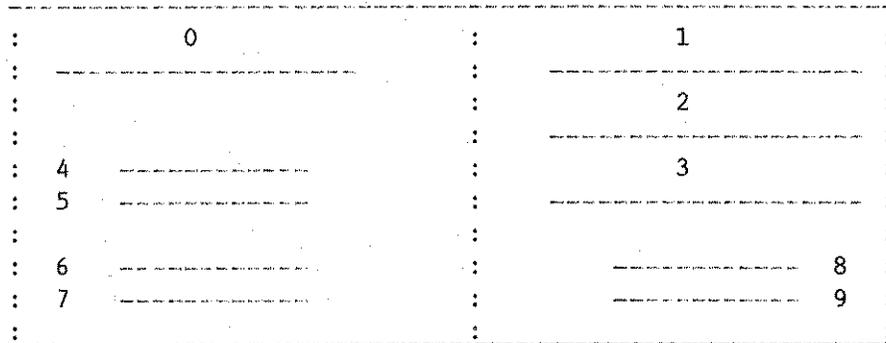
7.3.1 Overview

The Microprocessor (μ P) Board (see Figures 9-1 and 9-2) may be divided into communication and control sections. The control section (Figure 9-1) handles the internal interfacing tasks consisting of RF control data output and RF feedback data input. This section is also the math processor. Essentially, the calculation of the RF latch data are the only math operations performed. The communication section (Figure 9-2) handles

Table 7-1 Identification Codes

Function Hist Code	Position Code			Revision Code			:	Card Position	:	Card Name
	D7 D6	D5 D4 D3	D2 D1 D0							
RF Cards:	0 0	0 0 1	0 0 0	:	4	:	Synthesizer			
	0 0	1 1 0	0 0 0	:	5	:	For future use			
	0 0	0 1 1	0 0 0	:	6	:	AM/Divider			
	0 0	1 0 0	0 0 0	:	7	:	Output Amp			
	0 0	0 1 0	0 0 0	:	8	:	LO			
	0 0	1 0 1	0 0 0	:	9	:	Dev Meter			
	Control Cards	0 0	1 1 0	0 0 0	:	0	:	DDS		
	- -	- - -	- - -	:	1	:	μP (no code)			
	0 0	0 0 0	0 0 0	:	2	:	Control			
0 0	1 0 1	x x x	:	3	:	For future use				

Table 7-2 CARD LOCATION NUMBERING SCHEME:



the external interfacing tasks that include GPIB I/O, keyboard input, and display output. The communication section is a language processor, converting external input into a form usable by the control section, and converting data provided by the control section to a displayable form with meaning for the user. Because the communication μP handles most of the system I/O, and therefore initiates most of the internal communication, it is the master controller of the system. Each section is governed by a separate μP. The two microprocessors communicate with each

other through a shared dual port RAM (shown of Figure 9-1).

The communication μP handles the GPIB and keyboard inputs in solitude until execution of a setting or toggle function is complete. Then the input data is converted to the language of the control μP, and fed to it via the dual port RAM. An interrupt will be issued to "wake" the control μP, if necessary, so that it can perform the necessary calculations to update the data in the RF latches. If return in-

formation is necessary (feedback errors, deviation reading, etc.), the control μ P will perform any necessary mathematical calculations on the data and return it to the dual port RAM. It will then issue an interrupt to the communication μ P to get its attention, so that it can reformat the data for the display. This arrangement minimizes the amount of communication needed between the microprocessors. The dual port RAM provides a method of sharing common information with a minimum of software overhead.

Both sections (control and communication) contain their own μ P, EPROM, local RAM, parallel I/O interface, and reset, decode, and interrupt circuitry. A single dual port RAM is shared by both sections. The control I/O section includes the parallel RF control data interface and the feedback data interface. The communication I/O section includes the GPIB interface, keyboard interface, and LCD data interface.

7.3.2 Microprocessor Board Control Circuitry

The Control Section of the Microprocessor Board is shown on Figure 9-1. IC101 is the control microprocessor. Lines AD0-AD7 (pins 37-30) are the data bus. Lines A8 - A15 (pins 29 - 22) are address lines. The read/ write (R/W) output line is at pin 38. The interrupt request (IRQ) input at pin 5 may be from the communication microprocessor (INTCOM, low) from pin 44 of dual port RAM IC112 to pin 13 of NAND gate IC109 or a system interrupt (INTCTA, low) from pin 41/42 of Peripheral Interface Adaptor (PIA) IC105 to pin 1 of NAND gate IC109. (The INTCTB, low, interrupt line at pin 2 of NAND gate IC109 is not used at this time. It is reserved for future expansion.)

The reset (RST, low) signal at pin 6 is generated from +5V regulator IC137 on power up. This circuit resets the control μ P and the communication μ P (Figure 9-2). The reset provided for

the RF control boards is generated under software control.

Lines P17-P10 and P24-P22 (pins 20-10) are used for factory test purposes only.

The crystal (X101) input at pins 2 and 3 is divided by 4 internally to produce the control microprocessor clock.

Address Latch IC102 demultiplexes the input from data lines D0R-D7R (pins 2-9) to output address lines A0-A7 (pins 19-12). IC102 is enabled at pin 11 by the control microprocessor.

The Microprocessor Board control section memory is in EPROM IC103 (32Kx8), non-volatile RAM IC104 (8Kx8), and Dual Port RAM IC112. The NAND gates in IC111 and Inverters in IC107 that connect to pins 1 and 26 of RAM IC104 are for future bankswitching decode logic. They are not used in the 2407.

Peripheral Interface Adaptor (PIA) IC105 receives system interrupts at pins 3-10 from pins 26A-29C of P102. These are output at pins 37-29 onto data lines D0R-D7R to the control microprocessor to identify the particular interrupt generated. The interrupts at P102 also are fed to NOR gate IC113. Any interrupt will be felt at pin 44 of PIA IC105 and generate the INTCTA, low, interrupt signal at pin 41/42 that is sent to the control microprocessor telling it to interrogate the PIA to determine which system input generated the interrupt.

Contacts AA2 and AA3 of Switch SW101 are reserved for future expansion and are not used in the 2407.

PIA IC106 is an I/O device. Pins 3-10 connect to the data bus (D0-D7) at pins 17A-20C of P102. The data bus is bidirectional. Pins 11 and 13-15 of PIA IC106 provide output to the address bus (A0-A3) at pins 21A-22C of P102. Pins 16-19 are Board Selects 0, 1, and 2, and the R/W signal output to pins 23A-24C of P102. Pins 20, 21, 44, and 43 are for future expansion and are not

used in the 2407. Interrupt INTCTB at pin 41/42 is not used in the 2407.

The port decode logic for PIA chips IC105 and IC106 is the NAND gate (from pins 9-11 to pin 8) in IC110 and the Inverters in IC108.

Dual port RAM IC112 is common to both the control and communication sections of the Microprocessor Board. The microprocessors for each section communicate through IC112. The left side of IC112 communicates with the communication section of the Microprocessor Board. The right side of IC112 communicates with the control section of the Microprocessor Board. Interrupt INTCOM, low, from pin 44 is applied through pin 13 of NAND gate IC109 and inverter IC107 to pin 5 of control microprocessor IC101 to tell it that the communication microprocessor has an execution request. Interrupt INTCTL, low, from pin 4 is applied through pin 2 of NAND gate IC134 and Inverter IC135 to pin 5 of communication microprocessor IC121 (Figure 9-2) to tell it that the control microprocessor has an execution request.

7.3.3 Microprocessor Board Communication Section Circuitry

The Communication Section of the Microprocessor Board is shown on Figure 9-2. IC121 is the communication microprocessor. Lines ADO-AD7 (pins 37-30) are the data bus. Lines A8-A15 (pins 29-22) are address lines. The read/write (R/W) output line is at pin 38. The interrupt request (IRQ) input at pin 5 may be from the control microprocessor (INTCTL, low) from pin 4 of dual port RAM IC112 (Figure 9-1) or from the GPIB (INTGPI, low) from pin 19 of General Peripheral Interface Adaptor (GPIA) IC126, or the Keyboard (INTKEY, low) from pin 3 of NAND gate IC136.

The reset (RST, low) signal at pin 6 is generated from +5V regulator IC137 (Figure 9-1) on power up.

Lines P10-P17 communicate with the LCD Display.

The crystal (X102) input at pins 2 and 3 is counted down internally to produce the control microprocessor clock.

Address Latch IC123 demultiplexes the input from data lines D0R-D7R (pins 2-9) to output address lines A0-A7 (pins 19-12). IC123 is enabled at pin 11 by the communication microprocessor.

The Microprocessor Board communication section memory is in EPROM IC124 (32Kx8), RAM IC125 (8Kx8), and Dual Port RAM IC112. Signals at pins 2, 26, and 27 of EPROM IC124 and contact AA4 of Switch SW101 are for future bankswitching purposes. They are not used in the 2407.

General Peripheral Interface Adaptor (GPIA) IC126 provides the interface to the GPIB. GPIB Drivers IC130, IC131, IC133, and IC133 transfer signals to and from the GPIB at P111. The interrupt at pin 40 (INTGPI, low) of IC126 is applied to the communication microprocessor when the GPIB needs to be serviced.

Contact AA8 of Switch SW101 may be used to break the shield ground to the GPIB circuitry.

Peripheral Interface Adaptor (PIA) IC127 provides the interface between the Keyboard and the communications microprocessor. Pins 3-8 process "row" information (see Section 7.11) from pins 9A-14A of P102. Pins 11 and 13-19 process "column" information from pins 9C-16C of P102. Column information also is fed to NAND gate IC129. Any keypress will put a low into IC129, producing a high at its output (pin 8) which is applied to pin 20 of IC127. A rising edge at pin 20 will generate an interrupt at pin 41/42 which is transferred through the NAND gates in IC136 as the INTKEY (low) interrupt to the communications microprocessor (to pin 5 through IC134).

Programmable Logic Device (PLD) IC128 is a decoder. It decodes lines A15L-A12L into the chip selects and output enables on pins 19-16. Inputs ROMX0, ROMX1, and ROMX2 are for future ROM

bankswitching purposes and are not used in the 2407.

Contacts AA5, AA6, and AA7 of Switch SW101 which provide inputs to pins 4-6 of IC122 are reserved for future expansion and are not used in the 2407. Signals ROMX0, ROMX1, and ROMX2 which provide inputs to pins 8-10 of IC122 are reserved for future expansion and are not used in the 2407.

Pins 16-19 of IC122 are output voltages that are used to set the contrast on the LCD. More than one may be active at a time, placing one or more of the four resistors (R159, R157, R168, or R158) in series with R156. The magnitude of the voltage output at pin 3A of P102 depends upon which resistors are chosen, varying LCD contrast accordingly.

Pins 7, 20, 21, 44, and 43 of IC122 are not used in the 2407. The interrupts at pins 41 and 42 of IC122 are not used in the 2407.

7.3.4 Communication Between Control and Communication Microprocessors

Dual port RAM IC112 (Figure 9-1) is common to both the control and communication sections of the Microprocessor Board. The microprocessors for each section communicate through IC112. The control microprocessor interrupts the communication microprocessor by writing a memory location in the Dual Port RAM, and the communication microprocessor clear it by reading from the same location. The communication microprocessor interrupts the control microprocessor by writing to another memory location also in the Dual Port RAM, and the control microprocessor clears it by reading from the location written to. The data written to these locations is in the form of a flag indicating the type of the data being transferred. The interrupted microprocessor always returns this value to a 0, after accepting the interrupt. The communication microprocessor always initiates the data exchange by first setting up the data

to transfer in the Dual Port RAM, then writing a code to location to the RAM that interrupts the control microprocessor and indicates the type of data to be transferred. The control microprocessor then clears this location, accepts the data transferred (usually by executing a setting), then returns an error code to the communication microprocessor by writing it to the Dual Port RAM. The communication microprocessor will then determine what error has occurred (if any) and take the appropriate display and/or GPIB action. The arbitration registers in the dual port RAM prevent the simultaneous setting and clearing of a microprocessor communication interrupt.

7.4 CONTROL BOARD

Refer to the two schematics associated with the Control Board (Figures 9-3 and 9-4) for the following discussion. The circuitry shown on Figure 9-3 will be described before the circuitry on Figure 9-4 is described, with the following exceptions. The temperature sensing circuitry of IC247 (Figure 9-3) will be described with the analog signals feeding into Multiplexer IC217 of Figure 9-4. The 1 MHz reference input at pin 6B of P200 (Figure 9-3) provides the clock for the clock control logic (IC222 and associated circuitry) shown on Figure 9-4.

7.4.1 Overview

The control board performs the following functions:

- 1) Generates the 400 Hz and 1 kHz modulation rate reference sources
- 2) Generates the FM deviation, AM depth, and level analog drive voltages for the RF modules
- 3) Transfers data between the Microprocessor Board and the RF modules (keeping the data and address busses static on the RF side)

- 4) Multiplexes a variety of analog inputs so that a single A/D convertor can read all the analog feedback lines
- 5) Performs a peak detection of the analog input selected
- 6) Generates the select lines for the attenuator
- 7) Provides RF circuit breaker protection on the RF output
- 8) Provides self-check capabilities for the analog drive outputs, the mod rate frequency, and the RF module data and address busses (including the ability to identify the RF cards currently installed in the system)

7.4.2 Internal Modulation Circuitry

The 4 kHz modulation reference from the Synthesizer Board at pin 7C of P200 (see Figure 9-3, the Control Board Schematic, sheet 1 of 2) is counted down by 2 and counted down by 5 inside Counter chip IC230 to generate a 2 kHz output at pin 3 and an 800 Hz output at pin 7, respectively. Both output signals are applied to Quad NAND GATE IC233. The circuitry in IC233 is enabled by a 400 Hz or a 1 kHz enable signal from Latch IC249. The appropriate switch in Nand Gate chip IC233 is enabled (the 400 Hz enable at pin 5 or the 1 kHz enable at pin 2) to pass either an 800 Hz or a 2 kHz signal through IC223 (output at pin 8) back into Counter IC230 (at pin 15). That input is counted down by 2 again and output as a 400 Hz or 1 kHz signal at pin 13.

The TTLMOD output shown between pin 13 of Counter IC230 and pin 10 of Nand Gate Chip IC233 goes to pin 9 of ID Buffer IC208 (Figure 9-4) and provides the microprocessor input used to verify the 400 Hz signal.

The 400 Hz modulating signal is selected from pin 13 of IC233 through to pin 11 by the 400 Hz enable at pin 12. The 1 kHz modulating signal is selected from pin 10 of IC233 through to pin 8 by the 1 kHz enable at pin 9. Amplifier IC234

and its associated circuitry form a two stage low pass filter with amplification for the 400 Hz signal. The $5V_{p-p}$ TTL signal at pin 11 of IC233 is amplified to a $20V_{p-p}$ signal at pin 7 of IC234. R267 provides the 400 Hz signal output level adjustment. Amplifier IC235 and its associated circuitry form a two stage low pass filter with amplification for the 1 kHz signal. The $5V_{p-p}$ TTL signal at pin 8 of IC233 is amplified to a $20V_{p-p}$ signal at pin 7 of IC235. R281 provides the 1 kHz signal output level adjustment. The selected modulating signal (400 Hz or 1 kHz) is applied to pin 2 of unity gain amplifier IC236, buffered, and output at pin 6 to pin 3 of Quad Switch IC237 and pin 3 of Quad Switch IC238.

Quad Switches IC237 and IC238 (Figure 9-3) are controlled by software through Latch IC249. An internal AM signal at pin 3 of IC238 will be passed through to pin 2 if the control signal at pin 1 is low (to put the switch in the closed position). An external AM signal at pin 6 of IC238 (see section 7.4.3) requires that switch to be closed (low at pin 8) before the signal can pass through to pin 7. The voltage at pin 8 opens or closes the switch. The control voltages at pins 1 and 8 come from pins 14 and 13, respectively, of Latch IC249. The selected AM signal (internal or external modulation) is applied to pin 8 of AM DAC IC244 (see section 7.4.5 for a discussion of the three DACs shown on Figure 9-3). When no AM signal should be present (AM off), a low at pin 9 (AM enable) of IC238 closes the switch from pin 10 to pin 11 and any incidental AM present is shorted to ground through the switch.

FM signals are routed from pin 3 to pin 2 (Internal Modulation) or from pin 6 to pin 7 (External Modulation) of Quad Analog Switch IC237. Control voltages applied to pins 1 and 8 of these switches come from pins 17 and 16, respectively, of Latch IC249. The selected FM signal (internal or external modulation) is applied to pin 8 of FM

DAC IC242 (see section 7.4.5 for a discussion of the three DACs shown on Figure 9-3). When no FM should be present (FM off) pin 9, the FM enable, of IC237 closes the switch from pin 10 to pin 11 and any incidental FM present is shorted to ground through the switch.

Pin 16 of IC238 is associated with the FM deviation range (see Section 7.4.4).

7.4.3 External Modulation

For the Model 2407, the external modulation input to the Control Board is at pin 28 of P200. This input comes from the deviation meter circuitry. Section 7.13 details its routing. (The EXT MOD IN shown at P203 is used for members of the 2400 series family of test instruments that do not include deviation meter circuitry).

The external modulation input is a 1V p-p signal that is amplified by Amplifier IC239 and its associated circuitry into a 20V_{p-p} output at pin 6 of IC239. This output is applied to the external modulation inputs to Quad Switches IC237 (pin 6) and IC238 (pin 6). The action of these switches are described in section 7.4.2. The external modulation signal may be enabled through the appropriate switch into the FM (IC242) or AM DAC (IC244).

7.4.4 Control Board DAC Circuitry

The three DACs (FM DAC, IC242; AM DAC, IC244; and LEVEL DAC, IC245) shown on Figure 9-3 are enabled by signals from Latch IC248 (FMEN, AMEN; LEVEN, respectively; all active low) to pin 1 of the appropriate DAC. Inputs to each DAC are at pin 8. Each is a 12-bit DAC served by an 8-bit data bus (RFDO-RFD7), therefore the 12-bit control word to the DAC must be written in two stages: the first 8 bits, then the last 4 bits. The sequence to write to any DAC is as follows. First, the DAC is enabled by a low at its pin 1. Then the upper and lower bytes are written to the DAC, with the MSB (Most Significant Bit)

written first, followed by the LSB (Least Significant Bit). After the LSB has been written, the entire 12 bits is latched out to the DAC. The bit configuration for the DACs is shown in Table 7-3.

Address bus signals RFA3 and RFA4 from Data Latch IC205 (on Figure 9-4) determine the control word write sequence to the DACs. Each DAC multiplies its input at pin 8 by the control word from the data bus. The output from its associated Dual Buffer/Amplifier (pin 1 of IC243, IC253, or IC246) is fed to a downstream amplifier (the other half of the Buffer/Amplifier) and also fed back to pin 9 of the DAC to provide feedback. A sample of the output from each DAC sent to Multiplexer IC217 shown on Figure 9-4 (see section 7.4.6). The three DACs serve different functions but are identical in performance. The FM DAC (IC242) will be described and compared with the remaining two DACs.

FM DAC IC242, one half of dual op amp IC243, and their associated capacitors (C245, C246, and C250) comprise the FM DAC circuitry shown in Figure 9-3. The FM input at pin 8 of FM DAC IC242 is multiplied by the control word from data bus RFDO-RFD7, when this DAC has been selected by a low at pin 1, the FM DAC enable. The output at pin 1 of IC243 provides DAC feedback to pin 9 and is applied to pin 5 of IC243. The amplified signal goes through pin 4B of P200 to the Synthesizer Board (see section 7.6). A sample of the output is sent to Multiplexer IC217 shown on Figure 9-4 (see section 7.4.6).

The FM DAC circuitry contains an FM range selector not found in the other DAC circuitry. "A" and "B" taps on either side of R297 (located between pin 1 and pin 5 of IC243) connect to pins 15 and 14, respectively, of Switch IC238. The control signal FMRG at pin 16 determines whether the switch is closed (and R297 is shorted out of the circuit) or whether the switch is open (and R297 is in the circuit). Signal

FMRG comes from pin 17 of Latch IC248.

The deviation ranges are:

Range 1: 0 - 99.9 kHz; R297 in the circuit

Range 2: 99.9 kHz - 1 MHz; R297 not in the circuit

When all modulation is turned off, the Modulation DACs are programmed for minimum outputs.

The comparable DAC circuitry output from the AM DAC at pin 1 of IC253 provides feedback for the DAC and is sent to pin 3C of P200 and then to the AM/Divider Board (see section 7.8). A sample of the output is sent to Multiplexer IC217 shown on Figure 9-4 (see section 7.4.6). The output also goes through the other half of the dual amplifier (pins 6 to 7) and provides the input to LEVEL DAC IC245. The LEVEL DAC output at pin 3A of P200 goes to the Output Board (see section 7.9) where it is used with AM in the leveler range from 10 Hz and below. A sample of this output also is sent to Multiplexer

IC217 shown on Figure 9-4 (see section 7.4.6).

7.4.5 Data Transfer

Refer primarily to Figure 9-4 for the following discussion. Data latches IC203, IC205, and IC206 transfer data on buss lines D0-D7 from the microprocessor to the RF modules. IC203 provides device Select Lines SEL0 through SEL5, all active low (pins 23A,B,C and 24A,B,C of P200) to the RF modules. IC205 provides Address Lines RFA0 through RFA4 (pins 29C,B,A and 28C,B of P200). IC206 provides Data Lines RFD0 through RFD7 (pins 27B,A and 26C,B,A and 25C,B,A of P200). Buffer IC207 reads the RF data bus back to the microprocessor from the RF modules. Buffer IC208 is the ID buffer, transferring the board ID information back to the microprocessor when selected. (The ID

Table 7-3. Control DAC Bit Configuration

R/W	DATA NAME	b7	b6	b5	b4	b3	b2	b1	b0
W	DAC data xfer contrl	: x :	x :	x :	/XFR:/WRT:	x :	x :	x :	
W	Selected DAC Hi Data	: D11:	D10:	D9 :	D8 :	D7 :	D6 :	D5 :	D4 :
W	Selected DAC Lo Data	: D3 :	D2 :	D1 :	D0 :	x :	x :	x :	x :
W	DAC select latch	:/LEV:	/AM:	/FM:	x :	x :	x :	x :	x :

Table 7-3 Definitions:

/XFR =High byte/Low byte select and DAC transfer enable lines

1 = Enable /WRT to MSB latch, disable /WRT to DAC transfer latch

0 = Disable /WRT to MSB latch, enable /WRT to DAC transfer latch

(LSB latch always enabled)

/WRT Write MSB latch, LSB latch, and DAC transfer latch

0 = Transfer data from input to latch output

1 = Latch data (disable output from following input)

/LEV Chip select Level DAC (0 = enable, 1 = disable)

/AM Chip select AM DAC (0 = enable, 1 = disable)

/FM Chip select FM DAC (0 = enable, 1 = disable)

Dxx (12) Selected data bits. D11 is MSB and D0 is LSB.

buffer also transfers the 400 Hz test signal TTLMOD described in section 7.4.2 and the reverse power protection signal TRIP described in section 7.4.x back to the microprocessor).

The data latches and both buffers receive device selects from decoders IC204 and IC211, which form a 1:16 decoder, decoding lines IO₀, A3, A2, A1, and A0. The data, address, and card select busses on the RF module side are static in the sense that they change only when new data is written to the RF modules.

7.4.6 Analog Feedback Signal Multiplexing

The FM, AM, and LEVEL DAC output signals and the TEMPSENS signal from temperature sensing device IC247 (shown on Figure 9-3) are multiplexed by Multiplexer IC217 shown on Figure 9-4. The test and calibration signal TPX (pin 1C of P200) from the Synthesizer Board (see section 7.6) and the Deviation Meter Board (see section 7.13) and +10V and ground signals are also multiplexed by IC217. The selected output from pin 12 of the multiplexor is applied to pin 5 of Comparator IC220. IC220 is part of the peak detection circuitry described in section 7.4.x.

Latch IC224 provides select and enable logic (pins 16-19) for the multiplexer (pins 3, 4, 1, and 16). Data lines D0-D7 from the microprocessor control Latch IC224 outputs. The Latch chip select (a low at CE7) comes from Decoder IC204.

7.4.7 Peak Detection Circuitry

The peak detection circuitry includes D/A Converter IC218, Dual Operational Amplifier IC219, Gates IC221, IC222, and IC223, Up/Down Counters IC225, IC226, and IC227, and Buffers IC228 and IC229. The analog inputs to IC217 are multiplexed into the peak detection circuitry and measured. Peak detection is performed digitally, and is implemented by

driving a 12-bit DAC with a 12-bit binary counter, enabling the counter clock as long as the output of the DAC is less than the analog input to which it is compared. Both positive and negative peaks can be detected by inverting the polarity of the enable signal and the direction of the count. The counter is clocked by a 1 MHz reference or the microprocessor. This setup allows the microprocessor to test the peak detector circuit.

The multiplexed analog input from Multiplexer IC217 (pin 12) is applied to pin 5 of Comparator IC220 and compared to the A/D Converter output at pin 4. The difference is applied to pin 1 of Exclusive OR Gate IC221 and is routed through the clock control logic of NAND gates in IC223 and IC222. The 1 MHz signal at pin 4 of IC222 is the clock for the A/D Converter. It comes from the REF/LO Board (see section 7.7) and enters the Control Board at pin 6B of P200 (shown on Figure 9-3).

A high or a low from pin 13 of Latch IC224 will be loaded into Up/Down Counters IC225 through IC227 to set their 12 output bits (pins 3, 2, 6, and 7 on each chip) to the D/A Converter (input at pins 4-15) to produce a +10V or a -10V level at pin 4 of Comparator IC220. For positive peaks, any time the DAC output is lower than the analog input at pin 5 of Comparator IC220, it will generate a low at pin 12. The low will be passed from pin 1 of Exclusive OR gate IC221 through the clock control logic and increment the Up/Down Counter string until the DAC output is identical to the analog input to the Comparator. When this occurs, pin 12 of IC220 will go high, pin 1 of IC221 will go high, and this will turn off the clock. Note that the A/D Converter will require several cycles to match the a sinusoidal input analog signal. The clock will decrement the counter string during those times the input signal is higher than the DAC output. When the peak signal for a positive peak has been determined, the output from pin 12 of

Comparator IC220 will remain high throughout the input signal swing. The output from pin 3 of IC221 will remain low throughout the cycle. No further counter changes will occur. For negative peaks, a DAC output higher than the analog input at pin 5 of Comparator IC220, will result in the clock incrementing the counter string. When the peak signal for a negative peak has been determined, the output from pin 12 of Comparator IC220 will remain low throughout the input signal swing. The output from pin 3 of IC221 will remain high throughout the cycle. No further counter changes will occur. The PEAK signal at pin 3 of IC221 is applied to pin 9 of Buffer IC228 and read back to the microprocessor to indicate the peak value has been obtained. That 12-bit value is on lines 2-9 of Buffer IC229 and lines 2-5 of Buffer IC228 and is read back to the microprocessor on data lines D0-D7 when the buffers are selected (chip selects are lows at CE8 and CE9).

One half of IC219 (at pin 2 of the D/A Converter) serves as a current compensation device, adding the equivalent current of one half a Least Significant Bit to the D/A output current.

The analog multiplexer inputs include a ground and +10 volt reference. These selections allow self calibration of the A/D Converter without adjustments.

7.4.8 Attenuator Control

IC201 is the attenuator Driver. IC202 is the Latch for the attenuator driver. The Latch select at pin 11 of IC202 comes from pin 9 of Decoder IC204. The RESET low at pin 12 of Exclusive OR gate IC221 is a microprocessor signal to enable the Attenuator Latch (at pin 1) after power up has been accomplished.

7.4.9 Reverse Power Protection

Reverse power protection is provided by comparator IC216 and transistors Q203 and Q201 and their associated circuitry.

Transistor Q202 and its associated circuitry provide the reverse power protection reset path. The actuating signal comes from the reverse power detector in the Programmable Attenuator (see Section 7.9) and enters the Control Board at pin 22C of P200. This signal is applied through R208 to pin 2 of comparator IC216. It is compared to the reference voltage at pin 3. When the voltage at pin 2 is greater than the reference voltage at pin 3 it trips the reverse power protection circuit. The output at pin 1 of IC216 goes low (approximately -13 V) and causes transistor Q203 to turn off. The collector (pin 3) of Q203 goes high (+5 V), applying a high (+5 V) to the TRIP output that goes to pin 8 of ID Buffer IC208 (and is read as an Interrupt by the microprocessor). Transistor Q201 normally is turned off when RF power is on. When the collector (pin 3) of Q203 goes high, transistor Q201 is turned on, producing a low at its collector (pin 3) which is applied to pin 8 of Attenuator Driver IC201. The signal at pin 8 drives the RFEN output at pin 11, which controls the drive relay at the Attenuator. A low at pin 8 of IC201 turns off the drive relay, turning the RF off. Until it has been reset, the reverse power protection circuit will continue to output the TRIP interrupt, and hold RF off.

A RFON low at pin 8 of Exclusive OR gate IC221 serves to reset the reverse power protection circuit. The RFON high comes from the microprocessor when the front panel RF ON/OFF switch is toggled. The high is applied to pin 1 (Base) of transistor Q202, turning it on. When Q202 turns on, a negative going AC coupled pulse is applied through diode CR201 to pin 2 of Comparator IC216. Because pin 2 is lower than the reference signal at pin 3, the output at pin 1 becomes high again (as it was before the TRIP occurred). The high at pin 1 is applied to Q203, turning it on. When Q203 conducts, TRIP goes low and the RF power can be turned on again. The reverse power protection

circuit is reset when Q203 conducts and its output from pin 3 goes low.

The next RFON low will turn on the RF again (assuming the condition causing the TRIP interrupt has corrected itself or been corrected). The RFON low comes from the microprocessor when the front panel RF ON/OFF switch is toggled. The low is applied through R202 to the base of Q201 (pin 1), turning it off. When Q201 turns off, pin 3 goes high. The high is applied to pin 8 of Attenuator Driver IC201. The RFEN output at pin 11 turns on the attenuator drive relay and RF is applied to the output.

7.5. DIRECT DIGITAL SYNTHESIZER BOARD

7.5.1 Overview

The Direct Digital Synthesizer (DDS) circuitry shown in Figure 9-5 controls fine frequency resolution of the Synthesizer Board. The DDS output frequency is 115-118 kHz or 140-165 kHz or 168-190 kHz, in 1 Hz increments to maintain the 10 Hz instrument resolution.

The output from the DDS circuit is generated from a look up sine table stored in EPROMs accessed by a phase accumulator network. The output from the phase accumulator network provides the EPROM address from which a 12-bit binary voltage representation is taken. The EPROM address is incremented some number (the phase increment input from software) at each clock pulse to generate (synthesize) the required output frequency. The phase accumulator section processes the phase increment input (frequency control number) from software to increment a series of BCD Adders the required number. The 12-bit binary output from the sine table is converted into an equivalent current by a DAC, amplified, and filtered. The filtered signal is sent to a phase splitter network, with outputs that are identical in voltage level and frequency but 90° out of phase with one another.

7.5.2 Sine Table

The output from the DDS circuit is generated from the look up sine table in EPROMs IC317 and IC 318 as they are accessed by the Phase Accumulator Network. The EPROMs contain 4000 addresses with 12-bit binary numbers which represent the voltage levels at 0.09 degrees of phase angle along a sine wave. Each address in sequence from 0000 to 3999 contains the voltage representation associated with that point on the sine curve. Note there are lines for 16 bits but only 12 are used.

7.5.3 Phase Accumulator Network

The phase accumulator network includes the shift registers (IC304, IC305, and IC306), BCD Adders (IC307, IC308, IC309, IC310, IC311, and IC312), Octal D type flip-flops (IC313, IC314, and IC315), Dual D type flip-flops (IC316), and gates in IC300 and IC301. The output from the phase accumulator network provides the address input (lines A₀-A₁₃ on IC317 and IC318) to the sine table EPROMs from which the 12-bit binary voltage representation is taken. IC317 holds the most significant data byte. IC318 holds the lower significant data byte. The EPROM address "n" is incremented some number "k" (the phase increment input from software) at each clock pulse to generate (synthesize) the required output frequency. The 1 MHz reference (pin 30A from P303 to pin 3 of IC300) clocks all the flip-flops to latch the address (which is the new accumulator value). For example, if k = 1, then at each clock pulse the look-up address "n" is incremented by 1. The phase accumulator network is reset to n = 0 any time frequency is changed; therefore the first frequency control number clocked through the shift registers to the adder series and into the sine table EPROM is n = 0. At the next clock pulse the address is incremented k = 1 to address n = 1. At the next clock pulse the address n = 1 is incremented by k = 1 and becomes n = 2. Flip-flops IC313 - IC315 provide feed-

back as shown to the series of adders. IC316 extends the range of the accumulator by latching overflow at 4×10^6 . The address increment sequence with $k = 1$ is shown below:

```

    for k = 1
0000 first address  $n_1 = 0$  (reset)
0001  $n_2 = n_1 + k = 0 + 1 = 1$ 
0002  $n_3 = n_2 + k = 1 + 1 = 2$ 
0003  $n_4 = n_3 + k = 2 + 1 = 3$ 
.
.
.
0999
1000
1001
.
.
.
3998
3999
0000 rolls over to 0000 again

```

When $k = 1$, each address of the look-up table EPROM is accessed at a rate of 1 address per clock cycle (1 μ sec). It requires 4000 μ sec to get one cycle out at this address increment (frequency control) number. The output frequency at $k = 1$ is therefore

$$f_0 = \frac{1}{4000 \mu\text{sec}} = 250 \text{ Hz}$$

Consider the case when $k = 5$. The phase accumulator is reset to $n = 0$ but each successive increment ($k = 5$) increases the phase angle of the output by $.45^\circ$ ($.09^\circ \times 5$) skipping to every fifth address (rather than every address as when $k = 1$). The address sequence will be:

```

    for k = 5
0000 first address  $n_1 = 0$  (reset)
0005  $n_2 = n_1 + k = 0 + 5 = 5$ 
0010  $n_3 = n_2 + k = 5 + 5 = 10$ 
0015  $n_4 = n_3 + k = 10 + 5 = 15$ 
.
.
.
0995
1000

```

```

1005
.
.
.
3990
3995
0000 rolls over to 0000.

```

When $k = 5$ the complete look-up table is accessed five times as rapidly as when $k = 1$ because every fifth address is accessed at each clock pulse. It requires 800 clock pulses (1 μ sec/pulse) to generate one cycle out. Therefore the output frequency at $k = 5$ is

$$f_0 = \frac{1}{800 \mu\text{sec}} = 1250 \text{ Hz}$$

The general equation for output frequency (f_0) as a function of phase offset (k) is:

$$f_0 = f_{\text{clk}} \times \frac{k}{n_{\text{full scale}}}$$

where $f_{\text{clk}} =$ the frequency of the clock = 1×10^6 Hz and $n_{\text{full scale}}$ is 4000 or the maximum number of EPROM addresses available.

Note that this equation expresses output frequency as a function of the rate at which one complete cycle is synthesized from the look-up table EPROM. That rate is a function of the address increment steps k , used to step through the table.

The 1 MHz reference (pin 30A of P303) for the DDS circuit provides clock pulses at 1 μ sec intervals.

The phase accumulator section processes the frequency programming input (the control number that determines the phase increment) from the microprocessor (through the Control Board) to pins 12C-9A of P303. The frequency programming input is three bytes of information. Registers IC304-IC306 each process one

byte. Decoder IC302 selects the active register. BCD Adder IC312 processes the least significant digit of the frequency control number (phase increment input). Adder IC311 processes the next least significant digit. Adders IC312, IC311, and IC310 do not address the EPROM, therefore these three adders allow k to be a fractional value as low as 0.001, permitting an output frequency resolution of 0.25 Hz. For $k = 0.001$, for example, output frequency (f_o) is:

$$f_o = f_{clk} \times \frac{k}{n_{full\ scale}}$$

$$f_o = 1 \times 10^6 \text{ Hz} \times \frac{.001}{4000}$$

$$f_o = 0.25 \text{ Hz}$$

When the hundreds digit controlled by IC312 is full, the carry (pin 6 of IC312) steps IC311 up one unit (one tenth). When the tenths digit controlled by IC311 is full, the carry (pin 6 of IC311) is fed to IC310 (pin 5) to step the ones place up one unit.

In summary, at each clock pulse the phase accumulator network provides an address that is latched through octal flip-flops (IC313-IC315) into the sine table EPROMs. The address is incremented some value k (the phase increment input; the frequency control number) at each clock pulse. This number k is basically the number of degrees along the sine curve that the address n is incremented at each clock pulse.

7.5.4 DAC IC321

The output from the EPROMs at each clock pulse is a 12 bit binary number representative of the sine wave voltage at the associated sine wave phase angle. This number is latched by flip-flops IC319 and IC320 into 12-bit DAC IC321. The pulse from pin 6 of Exclusive OR gate IC300 clocks the 12-bit binary word through IC319 and IC320 into the DAC (IC321).

DAC IC321 converts the input binary word into the equivalent output current at pin 9. The output is fed to pin 2 of amplifier IC322A. The output at pin 1 of IC322A is applied to a high and low pass filter network (R325, C340 to C342, R304) that also scales the voltage output. The scaled signal is then applied to a two stage low pass filter comprised of IC322B and IC323A and their associated circuitry. This filter eliminates the frequency component introduced as a result of the step nature of the sine table waveform. The cutoff for the low pass filter is 250 kHz.

The filtered signal at pin 1 of IC323A is sent to the phase splitter network of IC325A/B, IC326A/B, and their associated circuitry. The outputs at pins 1 and 7 of IC326A and IC326B, respectively, are identical in voltage level and frequency but 90° out of phase with one another. These are the quadrature DDS outputs supplied to the Synthesizer Board (see Section 7.6).

7.5.5 ID Buffer

ID buffer IC303 provides the ID code (see Section 7.2.2) for the DDS Board.

7.6 SYNTHESIZER BOARD and VCO BOARD

7.6.1 Overview

The synthesizer board (see Figure 9-6) generates a CW or FM-modulated signal in the frequency range of 275-550 MHz, with a 10 Hz resolution. The synthesis is indirect Phase Locked Loop (PLL), with a single loop, fractional division, and DDS (Direct Digital Synthesis) offsetting, using a Single Side Band (SSB) mixer. The VCO board is attached to the synthesizer board. The function of the VCO Board is to produce an RF signal with a frequency range of 275 - 550 MHz.

The digital interface that controls the synthesizer board consists of a data

bus, address bus, and a board select line. Two inputs from the DDS board and a reference input from the REF/LO board are part of the frequency control. An FM input from the Control Board modulates the signal when the unit is in the FM mode. A 4 kHz signal (used for internal modulation), and an analog test and calibration signal (TPX) are output to the Control Board. An interrupt (INT) signal is output to the Microprocessor Board.

7.6.2 Digital Control

The synthesizer board accepts an 8-bit data bus (pins 15-8 of P401; data lines RFD0-RFD7), 2-bits (pins 34 and 33 of P401; RFA0 and RFA1) of a 5-bit address bus, and a card-select signal (pin 27 of P401; SEL 3). When the synthesizer board is selected by a low at SEL 3, there are three options for the data bus:

1. ID buffer IC406 is selected and the ID is transferred to the data bus to be read by the microprocessor.
2. Data latch IC404 is selected and the content of the data bus is transferred to it.
3. Control latch IC405 is selected and the content of the data bus is transferred to it.

The data on the data latch is used for the loop compensation and coarse tuning DACs in dual DAC IC414 and also for programming the PLL chips (IC407 and IC408).

The data on the control latch is used for strobing the main and auxiliary PLL chips (IC408 and IC407, respectively), switching the VCO bands (the BANDSW signal at pin 3 of VCO IC500), selecting CW or FM modes (pins 6 and 9 of Switch IC413), selecting the loop compensation or coarse tuning DAC and enabling writing into the selected DAC (pins 6 and 16 of dual DAC chip IC414), and enabling the analog signal (TPX) to

the control board (pins 1,8 of Switch IC419).

7.6.3 Synthesizer Phase Lock Loop

The Synthesizer Phase Lock Loop (PLL) consists of Main PLL Synthesizer chip IC408, the switchable loop filter network composed of switch IC413 and buffers/op amps IC411 and IC417 and their associated circuitry, dual D/A convertor IC414, VCO IC500, Divide-by-10 Counter IC416, a Single Side Band (SSB) Mixer composed of Mixers MX400 and MX401 and Power Divider PS401 and resistors R448-R450, and the Divider Network of Dual Modulus Counter IC410 and Adder IC409. The frequency dividers in Auxiliary PLL chip IC407 also are used in the PLL.

The 10 MHz reference frequency (pin 3 of P401) from the the REF/LO Board is sent to the Main PLL Chip IC408, where it is counted down to f_R , the PLL reference frequency. The 10 MHz signal into IC408 is counted down by 10 to a f_R of 1MHz or counted down by 200 to a f_R of 50 kHz, depending upon whether the unit is in the CW mode or FM mode, respectively. The 1 MHz or 50 kHz PLL reference frequency, f_R , is applied to the phase detector in IC408. The phase detector in IC408 also receives an input from the Divider Network (described later in this discussion).

The outputs from the phase detector at pins 16 and 17 Of IC408 are applied to the loop filter, which is switched into one of two configurations by Switch IC413. During operation in the CW mode, R406 and R407 are each shorted and C433 is not connected. During operation in the FM mode, R406 is in series with R408, R407 is in series with R409, and C433 is in parallel with C434. A control signal from pin 16 of Control Latch IC405 sets the switch to the CW or FM setting.

The output from the switched loop filter also is applied through diodes CR401 and CR402 to pins 9 and 10 of

IC418. This circuitry forms a window comparator to check the output for saturation, which would mean the loop is unlocked (UNLOCK1). If the signal is outside a ± 10.0 V window, an interrupt signal (INT 3) will be sent to the Microprocessor Board through pin 26 of P401.

The signal from the loop filter network is applied to pin 4 of dual DAC (Digital to Analog Convertor) chip IC414. IC414 contains two DACs and their associated registers and circuitry. This chip performs two functions. It provides loop compensation to maintain constant loop bandwidth and also provides the coarse tuning signal. One of the two registers in IC414 holds the number by which the loop compensation DAC input is multiplied. The other register holds the number by which the coarse tuning DAC input (a constant +15V at pin 18) is multiplied. The DAC multipliers are on data bus lines D0-D7 from Data Latch IC404 and are applied to IC414 pins 14-7, respectively. The registers are controlled by signals at pins 6 and 16 (from Control Latch IC405). One control signal is a write enable, the other selects which buffer is written to. The coarse tuning voltage is output at pin 20, the loop compensation voltage at pin 2. The two voltages are summed and output at pin 1 of Output Amplifier IC417. The output goes through 50 kHz trap (R432, R444, L404, and C476) and has the FM signal (from pin 2 of Switch IC413) added to it. The FM signal enters the board at pin 5 of P401 (FM Return at pin 6), goes through Buffer/amp IC417, and through Switch IC413 (pins 3 and 2 are connected during FM mode operation).

The coarse tune/loop compensated signal, with FM added if appropriate, is sent to pin 12 of amplifier IC418 and also sent to pin 6 of VCO IC500. IC418 circuitry is used as a difference amplifier to compare the summed signal (coarse tune/loop compensated/FM, if present) at pin 12 (of IC418) with the coarse tune output from pin 1 of IC418

through pins 6 and 7 of IC418. The difference signal at pin 7 of IC418 is sent through Switch IC419 (pin 2 to pin 3) to pin 24 of P401. This is error voltage signal TPX, an analog signal sent to the Control Board for test and calibration purposes. Switch IC419 is enabled by a low at pin 1 from Control Latch IC405.

The coarse tune/loop compensated signal, with FM added if appropriate, sent to pin 6 of VCO IC500 is used to tune and modulate the VCO.

VCO IC500 is actually a small board that fits on the Synthesizer Board. The VCO Board contains two VCOs. The BSEL signal at pin 3 selects the VCO to be used. The low band VCO (275-390 MHz) is selected by a low at pin 3. The high band VCO (390-550 MHz) is selected by a high at pin 3. The control signal comes from Control Latch IC405, pin 17.

The VCO Board schematic is shown in Figure 9-7. The function of the VCO Board is to produce an RF signal with a frequency range of 275 - 550 MHz. The frequency is set by a tuning voltage V_{tune} . The frequency range is separated into a low band (275-390 MHz) and a high band (390-550 MHz), each provided by a different oscillator. An analog switch selects the oscillator used. The oscillator outputs go through a common buffer amplifier to the VCO Board's output.

The basic active component in the low band oscillator is Transistor Q501, configured as a modified Clapp oscillator. L502 and Varactors CR501-504 form the main resonator. Feedback is provided through capacitors C502-504, Varactor CR505, and emitter resistors R504 and R505. The output obtained from the collector across R502 goes through a low pass filter (L506, C511 and C512) and a PIN Diode CR506 to the buffer amplifier.

The high band oscillator has the same basic design as the low band oscillator, with Q502 the main active component. The

main resonant tank consists of L508, CR508 and CR509. The feedback network consists of R516, 517, C522, 524 and CR510-513, with C523 a DC blocking capacitor. Output is obtained from the collector across R514, and goes through a low pass filter (L507, C519 and C520) and PIN diode CR507 to the buffer amplifier.

Band switching is performed by IC501. IC501 is a single-pole, double-throw analog switch controlled by the band select line (BSEL). When BSEL is at a logic "HIGH" level, power is supplied to the high band oscillator and CR507 is also turned on. Similarly, when BSEL is at logic "LOW", power is supplied to the low band oscillator and CR506 is turned on.

IC502 is the Buffer Amplifier. Signals from the two oscillators pass through an attenuator formed by R509, 510, and 511 into amplifier IC502. The output of IC502 goes to the OSC Out to be used by the Synthesizer Board.

The VCO output is sent to the RF OUT Jack J501 through a 17 dB attenuator pad (R454, R455, and R456) and a 17 dB amplifier (IC420) to isolate the VCO (from the output load at J501). A sample of the VCO output is applied to pin 2 of amplifier IC421. The output at pin 7 goes through an attenuator pad (R466, R464, and R465) and a high pass filter (C594, L407, and C593) to pin 2 of amplifier IC422. These stages isolate the VCO from the PLL feedback.

The output at pin 7 of IC422 is applied to Divide-by-10 Counter IC416. This device is a Divide-by-10/11 wired as a Divide-by-10. Its counted down output goes through amplifier IC415 to the resistive in-phase power divider (R448-R450) that makes up part of the Single Side Band (SSB) Mixer used in the PLL feedback circuit. The outputs of the power divider drive the LO inputs of the double balanced mixers (MX400 and MX401) in the SSB Mixer. The IF inputs

of the double balanced mixers are driven by quadrature DDS signals, 90° out of phase from one another, from the DDS Board (pins 1 and 2 of P401). The outputs of the two mixers are combined in 90° Power Divider/Combiner PS400. The Upper Side Band (USB) output at pin 6 is terminated (R423). The Lower Side Band (LSB) output at pin 1 is amplified by IC412 and passed through to IC410, a divide-by-5/6 counter. IC410, Adder IC409, Counters N_m and A_m in Main PLL chip IC408, and Counters N_a and A_a in Auxiliary PLL chip IC407 comprise the fractional divider network in the PLL feedback circuit.

The modulus control signal from pin 14 of Main PLL chip IC408 to pin 9 of Divide-by-5/6 Counter IC410 determines the part of the total counting time that IC410 divides by 5 and the part of the total counting time that IC410 divides by 6. This modulus control line is itself controlled by Counters N_m and A_m in Main PLL chip IC408. When fractional division is required, Counter A_m must divide by A_m for the part of the counting time and divide by A_m+1 for the remaining part of the counting time (see section 7.6.4, Frequency Synthesis, for greater detail). The four bits from pins 4, 1, 13, and 10 of Adder IC409 to Main PLL chip IC408 determine whether A_m divides by A_m or by A_m+1 . These four bits are controlled by the modulus control signal from pin 14 of the Auxiliary PLL chip IC407 to pin 6 of Adder IC409. When this signal is low, A_m divides by A_m . When this signal is high, A_m divides by A_m+1 . Counters N_a and A_a in Auxiliary PLL chip IC407 control the signal over the total counting time. (see section 7.6.4, Frequency Synthesis, for greater detail). The data bus (D0-D7) sets the internal conditions for all internal circuitry in the two PLL chips and the Adder chip.

7.6.4 Frequency Synthesis

The synthesizer board output frequency,

fs, is:

$$f_s = 10 \left[\left(N_T + \frac{F}{20} \right) \cdot f_R + f_{DDS} \right]$$

where f_R is the reference frequency of the PLL and is 1 MHz for the CW mode, 50 kHz for the FM mode.

N_T is the integer frequency division in the feedback, excluding the constant divide-by-10.

F is an integer, specifying the fractional frequency division: $F=0$ (no fractional division) for the FM mode; $0 \leq F < 20$ for the CW mode.

f_{DDS} is the DDS frequency (115-118 kHz, 140-165 kHz, 168-190 kHz; $\Delta f_{DDS} = 1$ Hz).

When the internal reference or an external 10 MHz reference is used, the reference divider R_m (a register in the Main PLL chip IC408) is set at 10 for the CW mode and 200 for the FM mode. When an external 5 MHz reference is used, R_m is half these values.

N_T is obtained by the $\pm 5/6$ counter (IC410) and the N_m and A_m counters in the Main PLL chip IC408. The total division is:

$$N_T = 5 \cdot N_m + A_m$$

For fractional division to occur, counter A_m must divide by A_m for part of the counting time and divide by A_m+1 for the remaining part of the counting time. Counters N_a and A_a in the Auxiliary PLL chip IC407 determine the A_m/A_m+1 counting ratio of counter A_m . There are twenty (20) intervals in a complete counting cycle. Counter N_a is set at 20, Counter A_a set at $20-F$. The Modulus Control output of the Auxiliary PLL (pin 14 of IC407) will be low for $20-F$ pulses, high for F pulses. When this signal is high, the output of the 4-bit adder (pins 4, 1, 13, and 10 of IC409) is increased by one. The main PLL IC is set (by the

data bus) so that its A_m divider (register) is controlled by the 4-bit Adder output. Therefore, A_m divides by A_m for $20-F$ pulses and by (A_m+1) for F pulses.

The average division is $\left(A_m + \frac{F}{20} \right)$.

The total division is $\left(N_T + \frac{F}{20} \right)$.

7.7 REFERENCE and LO BOARD

7.7.1 Overview

Figure 9-8 is the schematic for the Reference and LO (Local Oscillator) Board. This board provides the 10 MHz internal reference source and contains the circuitry that processes the 10 MHz or 5 MHz external reference. This board also provides the 5 MHz or 10 MHz reference to the Synthesizer Board, the 1 MHz reference to the DDS Board and Control Board, and the 512 MHz L.O. output to the Output Board.

7.7.2 Internal/External Reference Source

The INT/EXT, low, control signal from pin 12 of Control Latch IC604 determines which Switch of Diode Switch pair CR606 and CR607 is closed (and allows signal flow to pass) at any given time. The internal 10 MHz reference comes from pin 2 of Temperature Compensated Crystal TCX0. The signal is applied through Transistor Q606 and passes through Switch CR606 when it is closed by a high at its anode (the INT/EXT, low, signal from Control Latch IC604 through Switch Driver IC612 is high). Coil L606 provides a high impedance path for the 10 MHz signal when CR606 is open, with any signal leak through the coil shorted to ground by C659. The 10 MHz reference at the emitter of Q606 also passes through an attenuator pad (R647, R646, and R645) and is applied to Amplifier IC614. The amplified signal is the Internal Reference Out signal at J603.

The 5 MHz or 10 MHz external reference input at J604 passes through an attenuator pad (R648, R649, and R650) and is applied to Switch CR607. It passes through Switch CR607 when it is closed by a low at its cathode (the INT/EXT, low, signal from Control Latch IC604 through Switch Driver IC612 is low). Coil L605 provides a high impedance path for the 5 MHz or 10 MHz external reference signal when CR607 is open, with any signal leak through the coil shorted to ground by C659.

The reference source passed through Diode Switch pair CR606/CR607 goes through another attenuator pad (R639, R640, and R641) to Amplifier IC613. The amplified reference is applied to pin 7 of Phase Lock Loop (PLL) Synthesizer IC601 and also to pin 3 of P601 (the reference to the Synthesizer Board; see Section 7.6).

7.7.3 Phase Lock Loop (PLL) Synthesizer IC

The L.O. (Local Oscillator) consists of a VCO, phase-locked to a reference, by the Phase Lock Loop (PLL) Synthesizer IC601. The VCO output frequency (f_o) from the emitter of Transistor Q603 is fed back to pin 2 of divide-by-64 fixed prescaler IC602. The prescaler output frequency (f_d) is then divided by 8 in a divide-by-8 divider in PLL Synthesizer IC601. The output frequency of the divide-by-8 device (f_v) is compared by a PFD (Phase/Frequency Detector) in the PLL Synthesizer Chip to a 1 MHz fixed frequency (f_R) derived by dividing the input 10 MHz TCXO signal (f_x) at pin 7 by 10 (or dividing an external 5 MHz reference input at pin 7 by 5). At phase lock:

$$f_v = f_R = 1 \text{ MHz}$$

$$\text{(because } f_v = \frac{f_o}{64 \times 8} = \frac{f_o}{512} \text{)}$$

then:

$$f_o = 512 f_R = 512 \text{ MHz}$$

Pin 18 of the PLL Synthesizer Chip provides the 1 MHz reference to the DDS Board and the Control Board (see Section 7.5) at pin 5 of P601.

7.7.4 Loop Filter and Comparator Circuits

The PFD outputs at pins 16 and 17 of IC601 are connected to a differential Loop Filter (LF) composed of IC608A and its associated circuitry. The LF output from pin 1 of IC608A drives the VCO tuning circuitry (see Section 7.7.5). The LF output from IC608A also goes to Comparator IC608B. When the Local Oscillator is enabled and the loop is locked, the output at pin 7 will be between 4V and 10V. An unlocked condition will produce an output at pin 7 less than 4V or greater than 10V, and generate the LO UNLOCK (UNLOCK2) signal at pin 26 of P601 (sent to the Control Board; see Section 7.4).

7.7.5 VCO Circuitry

The LF output from pin 1 of IC608A (see Section 7.7.4) is applied through L603 to drive the VCO tuning circuitry. Varactor CR605, C652, the transmission line segment between C652 and R622 (which acts as an inductor), and C653 and C654 form the main resonant tank for the VCO. The tank resonates at 512 MHz, with feedback provided through R624, R625, C653, and C654. Transistor Q603 is the active device for the VCO.

Transistors Q605 and Q604 are controlled by the L.O. enable signal from pin 13 of Control Latch IC604 and provide bias for oscillator Q603.

7.7.6 VCO Output Circuit

The output at the collector of Q603 passes through a low pass filter network (C648, C647, and the inductance in the transmission line segments shown between the two capacitors) and is then applied to pin 1 Amplifier IC605. The output from pin 3 of IC605 is the 512

MHz Local Oscillator output to the Output Board at J602 (see Section 7-9).

The RLC network between the output of IC605 and J602 is a bias decoupling network.

7.7.7 Control and Data Circuitry

Control logic is provided by Control Latch IC604. Data is processed through Data Latch IC603. ID Buffer IC606 contains board identification (see Section 7.2.2). IC607 is the Decoder. Data bus lines RFD7-RFD0 (pins 8-15 of P601) and SEL2 and Address lines RFA0 and RFAL (pins 27, 34, and 33 of P601) provide communication to the Control Board.

7.8 AM/DIVIDER BOARD

7.8.1 Overview

Refer to Figure 9-9 for the following discussion. The AM/DIV board takes the 275-550 MHz RF signal from the Synthesizer Board (see section 7.6) and sends it through frequency conversion circuitry (a bank of switched filters and a frequency divider) to obtain the additional 137.5 to 275 MHz range. This circuitry also reduces harmonic content.

The signal then goes through a chain of variable attenuators, amplifiers and a level detector to set the output power level and to allow amplitude modulation (AM). AM is achieved by comparing the level detector output with the modulation signal at AM REF IN, and using the difference voltage as a negative feedback to control the variable attenuators. This system produces an output amplitude that varies directly with the modulation signal.

Note that the 550-1100 MHz circuitry shown at the top left section of the schematic is not used with Model 2407 Signal Generator.

7.8.2 Frequency Conversion Section

The frequency conversion section con-

sists of five separate paths the RF IN signal at J700 can take, depending upon the desired output frequency, and the microprocessor band switch control network that determines the path the signal will take.

The first of the five pathways the RF In signal can take through the frequency conversion circuitry is the 550-1100 MHz circuit, not used with the Model 2407 Signal Generator. The frequency input at J700 for this circuit comes from doubler circuitry not installed in the 2407, not the Synthesizer Board. When the circuitry is installed, the input 550-1100 MHz signal is passed unchanged through the resistor/diode string from CR700 to C703 and into the variable attenuator PIN diode circuitry of CR729 and CR730 (see section 7.8.1).

The four remaining signal pathways receive a 275-550 MHz input from the Synthesizer Board (or the doubler circuitry, when it is installed) at J700. These paths consist of two straight through, no conversion circuits (one for 390-550 MHz signals, one for 275-390 MHz signals) and two divide-by-two circuits (one for 195-275 MHz signals, one for 137.5-195 MHz signals).

Signal paths 1-3 are non-conversion routes. Signal path 1 (550-1100 MHz) begins through diode CR700 to resistor R700. Path 2 begins through CR701 and CR727. Path 3 begins through diodes CR704 and CR705. Signal paths 4 and 5 begin through diodes CR704 and CR707 and go through C722 to pin 7 of divide-by-two frequency divider IC700. The divided output at pin 2 will then go through the low pass filter string beginning at C729/L710 (path 4; 195-275 MHz) or beginning at C736/L714 (path 5; 137.5-195 MHz).

The RF signal in at J700 is applied simultaneously to each path described above. Only one path will be opened (turned on). The actual path the signal takes will be determined by the band switching control signals from the

microprocessor on data bus lines RFD0-RFD7. These are fed to Data Control Latch IC712 and transferred to Buffer IC711. The buffered signals, H0 and F1-F4, turn on/off the bandswitch diodes and the frequency divider. Output circuitry (transistors Q701 and Q702) further processes the F3 and F4 control signals.

The band switching signals turn on diodes (and other components in paths 4 and 5) to allow signal flow. Band switching signals are positive logic (1 = 5 volts), with all lines active high. The frequencies, control signals, and bandswitch diodes associated with each path are shown in Table 7-4.

All of the the low pass filters used in the frequency conversion pathways are of the same design. They are ninth order Tschebyshev filters, consisting of four series inductors and five shunt capacitors.

The frequency divider is an ECL flip-flop (IC 700) connected as a divide-by-two circuit. The divider converts the input frequency range of 275-550 MHz into an output frequency range of 137.5-275 MHz. Power is applied to the divider through 5V Voltage Regulator IC701 when either F3 or F4 is turned on.

The output from each of the five frequency conversion paths goes through C703 and is applied to variable 7.8.3 Leveler/AM Range Control

The leveler section includes two stages of variable attenuation. The first variable attenuator consists of PIN diodes CR729 and CR730, and their bias attenua-

tor PIN diodes CR729 and CR730. resistors and decoupling capacitors. The second attenuator consists of CR731 and CR732 and their bias network. Two stages of variable attenuation are required to provide leveling and to provide the amplitude modulation (AM) range control.

The PIN diode attenuators are driven through transistors Q700 and Q703 by the output at pin 1 of Comparator IC705B. The Comparator compares the linearized detected output (see the following sections) with the AM drive reference from pin 5 of P700 from the Control Board (see section 7.4). Transistor Q703 functions as a voltage level shifting device that controls the current through PIN diodes CR729 and CR730 to set the coarse RF signal level. (PIN diodes CR731 and CR732 provide fine level control).

A feedback system is used to achieve level control. The RF output to J701 is detected by two Schottky diodes CR722 & CR723 acting as full wave rectifiers. Their outputs are combined in Operational Amplifier IC706A. Diode CR724 provides temperature compensation for the rectifiers. Potentiometer R750 is used to nullify the offset voltage at the output of IC 706A (TP 1).

The detector output is linearized by summing the output of IC706A with the voltage drop across another diode of the same type as the detector. Using the voltage drop from a diode of the same type as the detector corrects for the non-linear behavior of the detector at low RF levels. This voltage drop is provided by CR726, R761 and IC706B. Diode CR725 prevents saturation of IC706B by a positive offset voltage at TP1. The output of IC706A and the volt-

Table 7-4. RF Signal Path Information

PATH	OUTPUT FREQ.	INPUT FREQ.	CONTROL	
			SIGNAL	SW DIODES
1	550-1100 MHz	SAME	H0	CR 700,728,702
2	390-550	"	F1	CR 701,727,703
3	275-390	"	F2	CR 704,705,715,706
4	195-275	390 - 550	F3	CR 704,707,711,712,708
5	137.5-195	275 - 390	F4	CR 704,707,713,714,708

age drop across the diode are summed in Op Amp IC705A. Potentiometer R776 adjusts the offset voltage at TP2 to zero.

Comparator IC705B compares the linearized detector output from IC705A with the AM reference voltage. The difference is integrated in IC705B to form a type-one system where tracking error approaches zero with the increase of time. The resultant error signal at pin 1 of IC705B is applied to the base of transistor Q703, producing a voltage change that controls the current through PIN diodes CR729 and CR730. The error signal at pin 1 of IC705B also is applied to the base of transistor Q700, producing a voltage change that controls the current through PIN diodes CR731 and CR732. Transistors Q700 & Q703 form emitter followers to increase the current drive ability for IC705B to drive the two variable attenuators. R779 (connected to pin 2 of IC705B) determines the nominal RF output level and resistors R773, R770, R765, and R779 determine AM accuracy.

The error signal at pin 1 of IC705B also is fed to pins 10 Switch IC707 to be output to the Control Board as test signal TPX (pin 24 of P700) if that section of the switch is enabled (see section 7.8.4).

Amplitude modulation is achieved by superimposing a modulation signal on top of the DC level reference voltage in the AM drive signal. The amplitude of the RF out signal will track the AM input.

Two types of amplifiers are used to amplify the RF signal. IC715, IC702, and IC703 are small signal amplifiers. Output stage amplifier IC704 is a medium level amplifier.

Roll-off compensation consists of a series tank (L747 and C811) that resonates at 1 GHz across resistor R794 and also the shunt arms of resistors R793 & R795 in series with L745 and L746, respectively. This circuit attenuates the

signal at low frequencies to compensate for roll-off in the amplifier and detector circuits.

7.8.4 Digital Interface and Analog Feedback Circuits

Decoder IC709 decodes the digital interface signals (Address bus lines RFA0-RFA3 and SEL 1) that select the AM/Divider board (SEL 1, low) and then select the various devices on the board. ID Buffer IC710 returns the code for AM/Divider board identification (see section 7.2.2) to the microprocessor. Data Control Latch IC712 latches the control information from data lines RFD0-RFD7. IC 711 shifts the control signals to proper voltage levels for band switching and controls the various switches in Switch IC707. Switch IC707 operation is identical to that described for quad switches IC237 and IC238 in section 7.4.2, with control signals at pins 1, 8, and 9 opening and closing the internal switches. Switch IC707 selects between Test Points 1, 2, and 3 inputs (at pins 2, 7, and 10, respectively) and sends the selected signal to pin 24 of P700 as signal TPX. This signal is then sent to the Control Board for diagnostic and calibration purposes (see section 7.4).

7.8.5 Bypass Capacitors

The capacitor string (C776-C787; lower left corner) are bypass capacitors.

7.9 OUTPUT BOARD

7.9.1 Overview

Figures 9-10 and 9-11 are the schematics for the Output Board. The Output Board provides the main RF output to the attenuator, with vernier level control and DC AM. The Output Board extends the AM/Divider Board's output signal (see Section 7.8) down to 10 kHz by mixing it with the local oscillator input (512 MHz) from the LO/REF Board (see Section 7.7). The Output Board also provides a buffered Auxiliary Output (AUX OUT) for

use with the Deviation Meter (see Section 7.13).

The Output Board contains an input buffer, a straight through path, an auxiliary output path, two heterodyne paths, a leveler, and an output amplifier. The RF signals are switched through these different sections, and through two different variable gain blocks in the leveler section, depending on the desired output frequency.

7.9.2 Input Buffer

The RF signal coming in from the AM/DIV Board at J800 (Figure 9-10) goes through a fixed attenuator (pad R800, R801, and R802) and a buffer amplifier (IC801) for isolation. The buffered signal is switched into different paths depending on the desired output frequency. The three signal paths are shown in Table 7-5, with their associated input/output frequencies, control signals, and control switches.

7.9.3 Straight Through Path and Aux Out Path

When the output frequency is greater than 137.5 MHz (shown as the THRU Band in Table 7-5), the RF signal from buffer/amplifier IC801 is switched through control diodes CR801-CR804 and additional attenuation, and split between two paths after R845. Part of the signal power goes to amplifier (IC804) and the AUX OUT connector at J802 to the Deviation Meter (see Section 7.13). The rest of the signal power goes to the straight through (THRU) path that begins on Figure 9-10 and ends on Figure 9-11. ON Figure 9-10, the signal goes through variable attenuators (PIN diodes CR811 and CR812) and amplifier IC803 and is output as signal AA to Figure 9-11. The GAIN CONTROL input to R864 (and PIN diodes CR811 and CR812) in the THRU path on Figure 9-10 is from the Leveler circuitry (see Section 7.9.5). The THRU path on Figure 9-11 is through variable attenuators (PIN diodes CR815 and CR816) and buffer amplifier

IC805, through PIN diode switch CR821 into amplifier IC809. This amplifier and the circuitry following it are common to all signal paths on the Output Board. The GAIN CONTROL input to R924 (and the PIN diodes) is from the Leveler circuitry (see Section 7.9.5).

7.9.4 The Mixer and Heterodyned Bands

The frequency range below 137.5 MHz is produced by two heterodyned bands, HET1 (10 MHz to 137.5 MHz) and HET2 (10 kHz to 10 MHz). When either of these bands is selected, the input RF signal at J800 (Figure 9-10) passes through amplifier IC801 and is switched by control switch CR800 through a fixed attenuator (pad R808, R809, and R810) into mixer MX800. In the mixer this signal beats against a 512 MHz signal from the LO IN connector (J801) to produce the desired output frequency at the IF (I) port of the mixer. The 512 MHz LO IN signal goes through a fixed attenuator (pad R806, R825, and R807) and a buffer amplifier (IC800) for isolation.

The IF signal from the mixer is passed into a Diplexor (R813, R814, L802, and C808) and a 150 MHz Low Pass Filter (C812, L804, and C814) where all unwanted signals above 150 MHz are blocked without being reflected into the mixer. The signal then goes through Broadband Amplifier IC802 and another Low Pass Filter (C829, L813, and C834).

If the HET1 path (10 MHz to 137.5 MHz output frequency) is selected, the signal passes through PIN diode switch CR810 to R845 and is split between the THRU and AUX OUT paths described in section 7.9.3, earlier. CR810 is controlled by the F67A signal at R816.

If the HET2 path (10 kHz to 10 MHz) is selected, then a portion of the signal power also goes through FET Switch Q800 into a variable gain amplifier composed of Dual Gate FET Q804 and Transistors Q801 and Q803. The GAIN CONTROL input to R839 (and to G2 of Q804) is from the Leveler circuitry (see Section 7.9.5).

TABLE 7-5 RF Signal Path Summary

Band	Output Frequency	Input Frequency	Control Signal Active	Switch Active
THRU	>137.5 MHz	Same	F5, F56	CR801-804, CR821
HET1	10 - 137.5 MHz	502 - 374.5 MHz	F56, F67	CR800, CR821, CR810
HET2	10 kHz - 10 MHz	511.99 - 502 MHz	F67, F7	CR800, CR810, Q800, Q802

The output through FET Switch Q802 is applied as signal BB to Amplifier IC809

(Figure 9-11). Control signal F7 opens and closes the two FET Switches (Q800 and Q802) in the HET2 path.

7.9.5 Leveler

Variable gain for signals with frequency above 10 MHz is provided separate to that for signals with frequency below 10 MHz. PIN diode variable attenuators CR811 and CR812 associated with amplifier IC803 and PIN diode variable attenuators CR815 and CR816 associated with amplifier IC805 provide the variable gain for signals above 10 MHz. The variable gain amplifier composed of Amplifiers Q804, Q801, and Q803 provides the variable gain for signals below 10 MHz.

The signal from the THRU path or the HET1 path or the HET2 path goes through two stages of amplification (Amplifiers IC809 and IC810; Figure 9-11) and then to the detector circuit. Diodes CR817 and CR818 are the detectors. Their outputs go to pins 2 and 3 of Summing Amplifier IC806. The output at pin 1 is applied to the other half of IC806. The circuitry associated with this half (pins 5, 6, and 7) of IC806 forms a linearization circuit for the detected output. Temperature compensation is

provided by CR819. The linearized output at pin 7 is applied to pin 2 of Comparator IC808 and is then compared to the Level Reference Input (LEV REF) at R905 from pin 3 of J804 (Figure 9-10). The difference voltage at pin 1 of IC808 is integrated and used as a negative feedback (GAIN CONTROL signals) to control either the variable gain amplifier or the variable PIN diode attenuators. Vernier level control and DC AM is achieved because the RF power level coming through the detector varies directly with the LEV REF input.

The linearized detector output at pin 7 of IC806 may be applied through Switch IC807 (pin 11) as test signal TPX to pin 24 of J804 (Figure 9-10). The DET TEST low output at pin 12 of Command Code Latch IC900 is applied to pin 9 of Switch IC807 (Figure 9-11) to close the switch. The GAIN CONTROL signal at the emitter of Transistor Q808 (Figure 9-11) may be applied through pin 14 of Switch IC807 as test signal TPX to pin 24 of J804 (Figure 9-10). The PIN TEST low output at pin 13 of Command Code Latch IC900 is applied to pin 16 of Switch IC807 (Figure 9-11) to close the switch.

7.9.6 Output Amplifier

Two stages of output amplification bring the RF power to the required level at the MAIN OUT connector (J805).

Transistor Q900 is the first stage amplifier. Its collector current is controlled by Transistor Q901 and its associated circuitry. Transistor Q902 is the second stage amplifier. Its operating point is maintained by Transistor Q903, which sets the collector voltage, and Transistor Q905 which sets the collector current. Negative feedback is used in both stages to obtain the wide frequency range of operation.

7.9.7 Control Logic Circuitry

Control logic is provided by Command Code Latch IC900 (Figure 9-10) and Buffer IC903. Buffer IC903 provides proper level signals to Control Signal Drivers Q904, Q906-Q909. ID Buffer IC901 contains board identification (see Section 7.2.2). IC902 is the Decoder. Data bus lines RFD7-RFD0 (pins 8-15 of J804) and SEL3(low) and Address lines RFA3-RFA0 (pins 27, 30, and 32-34 of J804) provide communication to the Microprocessor Board through the Control Board.

7.10 MOTHERBOARD

7.10.1 Overview

Figure 9-12 is the schematic for the Motherboard. The various boards used in the 2407 fit into slots identified by board name on the Motherboard schematic. The Motherboard provides bus lines and other interconnections that run between these boards. The Motherboard also contains the LCD backlighting circuitry.

7.10.2 Board Interconnection

The data and address bus lines and other interconnections that run between the boards are clearly labelled on Figure 9-12. The jacks at which connections are made for each board and their associated pins are also clearly identified. Note that there are two slots reserved for option boards.

7.10.3 LCD Backlighting

The EL Inverter E1001 provides the back-

light source for the LCD (Liquid Crystal Display). The +5V IN is converted to a 100VAC, 400 Hz, OUT to pin 1 of J1014 on the Motherboard. The 100VAC drives the display backlighting.

7.11 DISPLAY BOARD AND KEYBOARD

7.11.1 Overview

The Display Board used in the 2407 includes the LCD (Liquid Crystal Display), four LCD drivers and a Controller/Driver. Instruction and Data Registers, Address Counters, and a Display Data RAM are contained inside the Controller/Driver. The RAM stores data in 8-bit character codes.

7.11.2 LCD/Communication Microprocessor Communication

Data and control signals go from the communication microprocessor (IC121 of Figure 9-2) to the LCD through connectors shown on Figure 9-13, the Keyboard schematic. Data lines from the microprocessor pass through pins 1-8 (AD7-AD0) of J1111 to Pins 14-7 of P1112 to the LCD. Control signal RS (pin 12 of J1111) is the register select to the LCD (pin 4 of P1112). Control signal READ (pin 13 of J1111) provides the read/write signal to the LCD (pin 5 of P1112). Control signal STOBE (pin 14 of J1111) is the LCD enable (pin 6 of P1112). Control signal VO (pin 16 of J1111) is the LCD contrast control voltage (pin 3 of P1112).

7.11.3 Keyboard Circuitry

When a keyboard switch is pressed, the keyboard interrupt request (INTKEY, low) is generated and the communication microprocessor (IC121 on Figure 9-2) initiates the data exchange necessary to identify the particular key that generated the request for service. Decode process components are found on two schematics, the Keyboard schematic (Figure 9-13) and Microprocessor Board schematic Figure 9-2.

During operation between keyboard use,

the communication microprocessor sets a logic "0" (low; 0 volts) at the "Row 0" to "Row 5" pins (26, 28, 30, 32, 34, and 36) of J1111 (Figure 9-13). The voltage at the "COL 0" to "COL 7" pins (25, 27, 29, 31, 33, 35, 37, and 39) of J1111 is a logic "1" (high; +5 volts) because these pins connect through pins 9C-16C of P102 (Figure 9-2) to +5 volts at pull-up resistor network R180-R187. Pressing any keyboard switch (key) closes the switch and connects its associated Column (COL, odd numbered pins 25-39 of J1111; Figure 9-13) to the low in the Row (ROW, even numbered pins 26-36 of J1111) in which the pressed switch is located. The low at the column is fed through J1111 to the associated pin input to NAND gate IC129 (Figure 9-2) where it generates a high output at pin 8 of IC129. This signal is the INTKEY low that tells the communication microprocessor (IC121, Figure 9-2) the keyboard requires service.

Following a keyboard interrupt, the communication microprocessor will read the column output to determine which column is low. This is the column in which the pressed key is located. Then the microprocessor will write a low (zero) to that column (the other columns will be high). The closed switch in the column will pass the low from the microprocessor into the row in which the switch is located. The microprocessor will read the row outputs and identify the row with the low output (the rows in which no key has been pressed will have high outputs). Finally, the microprocessor will compare the column/row information with the 8x6 switch matrix (table) stored in memory to determine which key was pressed, and proceed accordingly.

If the STR key (switch SW1123 in column 4) is pressed, the microprocessor will receive the keyboard interrupt and then locate the pressed key in the following manner. The microprocessor will read the column outputs, identifying column 4 (pin 33 of J1111) as low. The microprocessor will then write a low to

column 4 and read the row outputs at J1111. Switch 1123 (STR) will be closed so the low at its pin 1 will be passed to its pin 2 and out to the row 4 output at pin 34 of J1111. The microprocessor will at column 4 and row 4 of the switch matrix, and initiate execution of the STR (store) function.

7.12 POWER SUPPLY

The Model 2407 Power Supply (see Figure 9-14) provides the DC power for the instrument circuitry and fan.

AC input power passes through a line filter and then through either a 1 amp or 0.5 amp fuse, depending upon the input voltage source. Input power is then routed through the power switch to the primary of transformer T1300.

The instrument will operate from a 100 VAC, 115 VAC, 215 VAC, or 230 VAC source. The voltage selection wheel in the rear panel AC power connector module (see Figure 2-1) must be rotated to show the proper input voltage through the small window in the module (the module's full cover must be removed to rotate the selector wheel).

The voltage selector wheel opens and closes the switches associated with the primary of T1300 as shown in the Line Voltage Selector table on the power supply schematic (Figure 9-14) to configure the transformer primary as required. When a 115 VAC source is selected, for example, switches G, I, and J are closed, as shown in the table. Switches H and K are open. Each of the two primary windings are in parallel across the "voltage in" lines (at points F and B). When a 230 VAC source is selected the primary windings are configured in series.

The secondary of T1300 has five taps; the center tap is grounded.

CR1300 is a bridge rectifier providing full wave rectification of the signal across the secondary of T1300. Each half

of the input cycle charges capacitor C1300 to provide a +27 VDC level at the collector of voltage regulator Q1301. Each half of the input cycle also charges C1306 to put a -27 VDC level at the emitter of voltage regulator Q1303.

The +18 VDC at pins 1 and 2 of J1302 is produced by +18 VDC regulator Q1301 which is controlled by its base voltage. Voltage reference IC1300 provides +5 VDC to pin 3 of operational amplifier IC1301. When the +18 volt regulator (Q1301) is at +18 V, voltage divider network R1303 and R1316 feeds a +5 volt level back to pin 2 of IC1301. If the voltage out from the regulator drops, the voltage output at pin 1 of IC1301 increases in response to the decrease in input signal at pin 2. The output at pin 1 of IC1301 is applied to the base of regulator Q1301. When base voltage increases, emitter voltage increases, and the +18 volt supply returns to +18 volts.

FET Q1300 is a current source, supplying current to R1302 to raise the control voltage to the base of Q1301 as needed. This circuit supplies base current to Q1301 to make certain that the regulator will start up when power is applied.

Diode CR1302 provides protection for electrolytic capacitor C1302 (prevents a negative voltage at pin 1 or pin 2 being fed to the capacitor).

The -18 VDC at pins 3 and 4 of J1302 is produced by -18 V regulator Q1303 which is controlled by its base voltage. The output from pin 7 of op amp IC1301 controls transistor Q1302 which controls the -18 V regulator. Op amp IC1301 receives a ground (zero volt) reference input at pin 5. The voltage divider network of R1305 and R1307 (from +18V to -18V) sets the other input (pin 6) to zero (0) volts when the -18 V (and +18 V) levels are accurate. If the -18 volt output goes lower (to -17 volts, for example), the input at pin 6 of IC1301 will go positive, forcing pin 7

negative. The negative will be applied to the base of Q1302 which will turn Q1302 on harder. When Q1302 conducts harder, more base current is drawn from regulator Q1303 and the output voltage goes back to -18 volts.

Diode CR1304 provides protection for electrolytic capacitor C1308, preventing a positive voltage at pin 3 or pin 4 being fed to the capacitor.

The voltages fed through diodes CR1305 and CR1306 to C1309 provide an unregulated +12.4 volts to the collector of Darlington power transistor Q1304. R1312 and CR1307 make up a 12V Zener voltage source applied to the base of Q1304. The two diode voltage drop (approximately 0.6 volts per diode; two diodes in Q1304) of 1.2 volts lowers the +12 volt input to a +10.8 volt level to the fan (J1301, pin 1). The +10.8 volts results in a longer operating life for the fan and quieter operation.

The +8 volt supply at pins 5 and 6 of J1302 is produced by +8 volt three terminal voltage regulator IC1302. The +12.4 volts input (from CR1305 and CR1306) is regulated to an +8 volts output using output feedback through the resistor network of R1313 and R1314 and capacitors C1310 and C1311.

Diode CR1309 protects the regulator from a negative input at pins 5 or 6 of J1302.

7.13 DEVIATION METER

Refer to the Deviation Meter Schematic (Figure 9-15) for the following discussion.

Because the Model 2407 Deviation Meter input connector (J1402) also functions as the External Modulation Input, high pass (C1408, L1400, and C1409) and low pass (L1404, C1419, and L1403) filters are needed to isolate the two inputs. The low pass filter cuts off at 200 kHz, with the signal routed to the modulation control circuits at pin 5 of

P1401. The high pass filter cuts off at 10 MHz, with the signal routed to a 10 dB pad (R1400, R1401, R1402, R1434) and then to on/off PIN switch CR1406. The on/off PIN switch is needed to turn off the modulation input during self calibration. It also is off when the deviation meter is not in use, which decreases the opportunity for leakage out, increasing RFI protection. PIN switch CR1406 is controlled by the output from pin 7 of op amp IC1420. When the output is high, CR1406 is an open (off). When the op amp output is low, CR1406 conducts and the signal passes either straight through to the mixer (MX1400) or through a 20 dB pad (R1403, R1404, and R1405) and then to the mixer. The output from pin 1 of op amp IC1410 determines whether the signal goes through the 20 dB pad or not. When the output is high, CR1401 and CR1402 turn on and CR1403 and CR1404 are off and the signal goes through the 20 dB pad. When op amp IC1410's output is low, CR1401 and CR1402 turn off and CR1403 and CR1404 turn on and the signal goes straight through (0 dB attenuation) to the mixer.

The 20 dB pad reduces the input signal level to the mixer. The maximum input level to the deviation meter is +27 dBm so the maximum level at the mixer RF port will be -3 dBm.

A sample of the signal generator RF output signal (J1401) provides the LO drive for mixer MX1400. The input sample frequency will be the meter receive frequency +7 MHz at -6 dBm. This signal is attenuated by a 12 dB pad (R1406, R1433, and R1407) and then amplified by 12 dB (IC1408) and amplified again by 8 dB (IC1409). The 6 dB pad keeps the first amplifier stage from being overdriven and sets the proper LO drive level. The output signal level to the mixer (pin 8) is +8 dBm.

The mixer 7 MHz IF output (at pin 1) is connected to a 10 dB RF pad (R1415, R1435, and R1416), bandpass filtered (L1408, C1421, C1422, L1409, L1410,

C1423, L1411, and C1424), and amplified (IC1412) before being connected to the input of the MC13055 FSK Receiver (IC 1413). The input level to the MC13055 will range from approximately -3 dBm to -33.5 dBm.

The MC13055 functions as a limiter, and an FM demodulator, and produces a fairly linear signal strength indicator over a 60 dB dynamic range. R1431, L1413, C1439, and C1440 form a quadrature tank circuit to provide a distortion null for the MC13055, with C1440 the centering adjustment.

The demodulated FM is taken differentially from pins 10 and 11 and then amplified by a differential amplifier (1/2 of IC1411, inputs at pins 5 and 6). The demodulated FM is AC coupled to a 20 kHz low pass filter/amp (the other half of IC1411 and its associated circuitry). The output of this filter is approximately ± 8 V for 500 kHz peak deviation and is routed through switch IC1404 and pin 24 of P1401 as signal "TPX" to the Control Board (see Section 7.4).

The demodulated FM from pin 7 of IC1411 is also DC coupled to a 15 Hz low pass filter/amplifier (1/2 of IC1410: input at pin 6) to strip off the AC component of the modulation. The DC output at pin 7 is fed through switch IC1404 to pin 24 of P1401 as signal "TPX" to the Control Board (see Section 7.4). This signal is used as a frequency error indicator, providing the "TUNE" instructions for the unit. The nominal signal output voltage is +2.5 VDC at 7 MHz with approximately a +3.5 V/MHz sensitivity.

The signal from pin 12 of IC1413 is applied to pin 3 of amplifier IC1420 and serves as the Received Signal Strength Indicator (RSSI) signal. It is connected through switch IC1404 and pin 24 of P1401 to the Control Board (see Section 7.4). It indicates when the signal into IC1413 is too low to be read, providing the "LOW LEVEL" indicator. This signal is also used to

indicate when the RF input 20 dB attenuator pad should be switched on and off by the microprocessor.

IC1400, IC1401, and IC1403 provide the interface circuitry between the deviation meter circuitry and the microprocessor. Decode chip IC1400 uses signals RFA2-RFA0 (pins 32-34 of P1401) to select either read only ID Buffer IC1401 or write only Control Latch IC1404 for access to buss lines RFD0-RFD7 (pins

8-15 of P1401). The SEL 5 signal at pin 27 of P1401 is the card select signal, the active low signal that turns the Deviation Meter Board on and off.

ID Buffer IC1401 provides the ID code (see Section 7.2.2) for the Deviation Meter Board. Control Latch IC1403 latches microprocessor signals through to control the various Deviation Meter Board circuitry indicated by LD0-LD7 labels.

8.1 INTRODUCTION

No troubleshooting guide can replace the knowledge and skills of experienced repair personnel. The purpose of this guide is to provide information to help the troubleshooter isolate the cause of an instrument failure, correct the problem, and return the unit to normal service as soon as possible. This guide also provides a general methodology for troubleshooting. Some failures are easily corrected. Others may require a thorough understanding of the circuit descriptions in Section 7 of this manual. Successful troubleshooters understand circuit operation within and between unit subassemblies. The troubleshooter should be familiar with the functional and detailed circuit descriptions and the schematics for this unit.

When the instrument is operating, but out of specifications (Section 1.2), performing the AutoCal® calibration procedure in Section 5.4 of the Manual may correct the problem.

8.1.1 INITIAL PREPARATION

Before attempting to troubleshoot the Model 2407, please read the Theory of Operation in Section 7 of this manual. Signal flow through the unit is traced in detail, with subassembly inputs and outputs clearly identified. The troubleshooter should be familiar with the relevant performance test procedures

and maintenance procedures (especially the user diagnostics) detailed in Sections 4 and 5, respectively, of the manual.

8.1.2 METHODOLOGY

Troubleshooting is, in general, a systematic process of elimination. A thorough understanding of the circuit descriptions located in Section 7 of this manual will enable the trouble symptom to be associated with a particular circuit function. Once this has been accomplished, the problem can be further isolated using the reference schematics in Section 9. Voltage and resistance checks may then be used to locate the defective component.

8.1.3 FACTORY REPAIR

Wavetek maintains an on-site staff of highly skilled, experienced electronic technicians to provide assistance for those customers who lack the necessary test equipment or personnel to troubleshoot/repair the unit. Please obtain factory authorization before returning a unit for repair. If a unit is returned for repair, please include a detailed description of the problem encountered (to minimize turnaround time).

8.1.4 RECOMMENDED TEST EQUIPMENT

Recommended troubleshooting test equipment is listed in Table 8-1.

TABLE 8-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	MODEL RECOMMENDED
Signal Generator	Wavetek Model 2500A or equivalent
Oscilloscope	Tektronix 2465 or equivalent, with matched X10 probes
Frequency Counter	Hewlett-Packard Model 5383A with external reference time base accuracy of ± 5 parts in 10^8 , or equivalent
DVM	Fluke Model 8010A, or equivalent
Spectrum Analyzer	Tektronix 496, 492, or equivalent H-P 8559A, or equivalent
Spectrum Analyzer	Hewlett-Packard 8568, or equivalent
Measuring Receiver	H-P 8902A, with sensor module 11722A, or equivalent
Power Meter	Wavetek 8531, with Power Sensor 85312, or equivalent
Function Generator	Wavetek Model 20 or equivalent
Audio Analyzer	H-P 8903A, or equivalent
VSWR Bridge	Wiltron Model 60N50, or equivalent
Sweep Generator	Wavetek Model 2002A, or equivalent

8.2 PERSONNEL SAFETY CONSIDERATIONS

Maintain the standard safety precautions required when working around 100-240 VAC. Be aware that when the unit's cover is removed, there is 120 VAC at the back of the display board.

8.3 INSTRUMENT SAFETY CONSIDERATIONS

Static sensitive devices are used in this instrument. Use ESD precautions when handling a static sensitive device or a card on which a static sensitive device is mounted. These devices may not fail catastrophically if precautions are not taken, but the life of the device and its performance may be reduced and an early failure may result.

8.4 INITIAL INSPECTION

Instrument problems sometimes have simple, fairly obvious, solutions that are apparent upon visual inspections. Perform the following inspections before proceeding with extensive troubleshooting.

8.4.1 INPUT POWER

Verify the unit is plugged into an appropriate power source and that the unit is turned on. Verify the voltage selector (Section 2.4) is set properly. Verify the fuse in the AC Power Connector Module (Section 2.4) has not opened.

8.4.2 INCORRECT CONTROL SETTINGS

Verify a correct operating procedure has been used. Refer to Section 3 of the manual for a complete description of each front and rear panel control, display, and connector. Section 3 contains operating instructions for the unit.

8.4.3 VISUAL AND MECHANICAL CHECKS

Failures, whether they are continuous or intermittent, may be caused by any item listed in Table 8-2. The entire list may be checked out prior to further troubleshooting.

Note: Units are shipped from the factory in operating condition. Some items on this checklist can occur because of improper handling during shipment and unpacking. Be aware that poor troubleshooting procedures can generate almost any of the items on the list.

TABLE 8-2.
VISUAL/MECHANICAL CHECKLIST

1. Loose RF Cables.
2. Loose cards.
3. Improperly mated connectors.
4. Burned or broken components.
5. Loose or missing screws.
6. RF cables to incorrect connectors.
7. Defective ribbon cables.
8. Solder joints on connectors or PC cards defective.
9. Incorrect power selection and fuse (see 2.4).
10. Defective contacts on cable connectors.
11. Defective wiring harness.
12. Broken wires.

8.5 GENERAL TROUBLESHOOTING NOTES

8.5.1 POWER UP TESTS/DIAGNOSTICS

The power up tests and the user diagnostics described in Section 5 of the manual should be used as troubleshooting aids when possible.

8.6 REPAIR WORK CAUTIONS

8.6.1 CUSTOM COMPONENT REPLACEMENT

Reference schematic components that have a star (*) beside them are custom components. The value for the component, if shown, is its typical value and may or may not be its actual value. The actual values for custom components are determined at the factory during factory calibration. They are the values required to bring an individual unit into specification. Major repair of a subassembly may require a trial and error substitution for the custom components in related circuitry to recalibrate the unit.

8.6.2 ROUTINE REPAIR WORK CAUTIONS

Observe the standard precautions associated with any electronic instrumentation repair. For example:

- Make certain there are no solder shorts on any board.
- Check the pin 1 location of any IC that is removed and reinserted or replaced; make certain that the IC is inserted correctly.
- Make certain electrolytic capacitors are installed properly.

8.7 POWER SUPPLY

8.7.1 If the unit is totally inoperable, check the power supply. If there is no output or low output, check the line fuse and verify that the voltage selector switch is in the proper position.

8.7.2 A power supply problem also may cause many seemingly unrelated symptoms. The power supply should be checked when a symptom(s) does not clearly indicate a specific trouble area.

8.7.3 If the +18V is inaccurate, check Q1301, IC1301, IC1300, and CR1300.

8.7.4 If the -18V is not present, verify

the +18V supply (the -18V supply will not come up without the +18V supply). If the +18V supply is correct, check Q1302, Q1303, IC1301, and CR1300.

8.7.5 If the +8V is inaccurate, check IC1302, CR1305, and CR1306.

8.7.6 If the fan B⁺ is absent, check Q1304, CR1307, CR1305, and CR1306.

8.7.7 Sense ground (pin 7 of J1302) and chassis ground (pins 8/9 of J1302) must be connected together for proper output voltage.

8.7.8 If the power supply voltages are acceptable, verify the microprocessor board is functional (See Sections 7.3 and 8.9).

8.8 ON-BOARD REGULATORS

A voltage level problem on the individual boards in this unit may be the result of a defective regulator or a defective electrolytic capacitor. Voltmeter tests with the power supply turned on will normally reveal any such problem.

8.9 MICROPROCESSOR BOARD

Verify the the power supply voltages are acceptable before working on the microprocessor board. The microprocessor board is very complicated. Carefully read Section 7.3 before troubleshooting this board.

Microprocessor board circuitry controls much of the unit's operation. Proper operation of the board is indicated by the front panel displays during the automatic power up test (described in Section 5.5). Erratic or nonsense operation may result if microprocessor circuitry is bad, or the unit may be totally inoperable.

8.9.1 Basic system timing is derived from the 3.579545 MHz crystals (X101, X102) on the microprocessor board. The microprocessors (IC101, Figure 9-1 and

IC121, Figure 9-2)) provide the 1 MHz system clocks and the clock enables used to generate the various clocks that provide timing for control functions.

8.9.2 There are several control signals and address and bus lines that are required for proper system operation. Usually it is only necessary to verify these signals and lines are switching.

8.9.3 If the display indicates "Dual port RAM test: FAIL" on powerup:

Verify that the control μ P ROM (IC103) is installed correctly (no bent lead).

Check the Enable clock (IC101 pin 40) for a 1MHz clock. If bad, either IC101 or its associated oscillator circuit is bad.

Check the INTCOM low signal (IC112 pin 44) to verify the interrupt request to the control μ P. If that is not the problem, there are two possibilities. Verify the decode selection CS0 line (pin 25) pulses low. A decode selection CS0 line that does not pulse low indicates a problem with IC128. Verify that IC101 pin 5 also pulses low. If IC101 pin 5 does not pulse low, there probably is a problem with IC134 or IC135.

8.9.4 If the display shows "Calibration table: FAIL" on powerup:

A nonvolatile memory (IC104) failure may have occurred. The failure may be caused by inserting a new software version or a battery failure of IC204. Rerun the calibration process using the status menu selection.

8.9.5 If the display indicates "Instrument setting: FAIL" on powerup:

A nonvolatile memory (IC104) failure may have occurred. The failure

may be caused by inserting a new software version or a battery failure of IC204. The default settings will be reloaded automatically.

8.9.6 If the front panel display and keyboard are operational, but there is no RF response:

Check the decode select to IC106 (pin 25) for TTL pulses. If no pulses are present, verify that IC108 and IC110 decoder logic are good. If IC108 and IC110 are good, check IC106 pins 24, 26, 27, 28 for TTL pulses. If pulses are present, check IC106 and its pullup resistors.

8.9.7 If the front panel display is operational, but the keyboard does not function:

Check IC127 pins 3-10 for logic level low. If these pins are low, verify IC127 and its corresponding decode logic (IC128) are functioning properly. Also verify that pins 11-20 in all the ICs are pulled high. If all pins are not high, one or more keys may be stuck.

When a key is pressed, verify that one of the lines on pins 11-19 of IC127 goes low. If this does not happen, suspect a problem with the keyboard. When a key is pressed, line CB1 (IC127, pin 20) should pulse high. If not, suspect IC129. When a key is pressed, pin 41 of IC127 should pulse low. Pin 5 of IC121 also should pulse low. If either does not happen, suspect IC127 or ICs 134-136.

8.10 AM/DIVIDER BOARD

The AM/Divider Board circuitry is described in detail in Sections 7.8 of this manual. Review this section carefully. Troubleshooting the circuitry involved is a straight forward procedure.

8.10.1 Check the input and output of

each band in a frequency conversion network to isolate a problem. Be aware of common problems. For example, if neither the 195-275 MHz nor the 137.5-195 MHz band is operational, the problem is common to both bands (and could be that voltage regulator IC701 or frequency divider IC700 is malfunctioning).

8.10.2 When a failed network has been isolated, the problem will usually be a failed component.

8.10.3 The signal paths through the frequency conversion circuits of the amplifier assembly are controlled by band switching diodes. If the correct diodes are not turned on, the output signal will not be correct. The band switch/diode relationships are shown in Table 8-3.

TABLE 8-3.
BANDSWITCH/DIODE RELATIONSHIPS

<u>Band</u>	<u>Diodes Turned On</u>
1(550-1100 MHz)	CR700,728,702
2(390-550 MHz)	CR701,727,703
3(275-390 MHz)	CR704,705,715,706
4(195-275 MHz)	CR704,707,711,712,708
5(137.5-195 MHz)	CR704,707,713,714,708

8.10.4 Level control is performed by PIN diode pairs CR729/CR730 and CR731/CR732, which are driven through transistors Q700 and Q703 by the output at pin 1 of Comparator IC705B.

8.11 SYNTHESIZER BOARD

The Synthesizer Board is described in detail in section 7.6 of this manual.

8.11.1 For no RF output (at J501) or too low an output, check the amplifier circuitry (IC420 and its associated components) or a VCO problem (IC500 and its associated components).

8.11.2 If output harmonics are too high, Check for a VCO problem (IC500 and its associated components).

8.11.3 If output spurs at 50 kHz are too high, check the 50 kHz trap (L404, C476). If the problem isn't there, check for a loop pole problem (C450, C435, C427, C431).

8.11.4 For no FM or FM too low, check for an FM control problem (IC405, IC413) or an FM path problem (IC413, R424, R433, IC417, and associated components).

8.11.5 If FM is too high, check for an FM attenuator problem (R424, R433) or an FM buffer problem (IC417 and its associated components).

8.11.6 If a false UNLOCK indication occurs, the most likely cause is IC418 or its associated circuitry.

8.11.7 If a false TPX indication occurs, check the TPX control circuitry (IC405, IC419). Check the TPX amplifier/buffer circuitry (IC418 and its associated components).

8.11.8 For no 4 kHz MOD output or an output at the wrong frequency, replace IC407.

8.11.9 If the synthesizer becomes unlocked, there are several possible causes. There may be a problem with:

The VCO circuitry (IC500 and its associated circuitry).

The buffer/divide-by-10 prescaler circuitry (IC421, IC422, IC416, IC415, and their associated circuitry).

The SSB mixer circuitry (MX400, MX401, PS400, IC412, and their associated circuitry).

The divide-by-5/6 prescaler circuitry (IC410 and its associated components).

The PLL (IC407, IC408, IC409, and associated components).

The loop filter (IC411, IC413,

IC414, IC417, and their associated circuitry).

The coarse tuning circuitry (IC414, IC418, and their associated components).

The control/data transfer circuitry (IC400, IC404, IC405).

External signals may be missing or be at an incorrect frequency or an incorrect amplitude.

8.12 CONTROL BOARD

The Control Board is described in detail in section 7.4 of this manual.

8.12.1 Possible modulation problems fall into several categories. Problem areas and circuitry to check for each are:

<u>Problem</u>	<u>Check</u>
Modulation source switching	IC249, IC233, IC223, and IC230
1 kHz source	IC235 and IC236
400 Hz source	IC234 and IC236
Ext Mod	IC239
FM	IC242, IC243, IC237, IC238, IC248, and IC249
AM	IC244, IC253, IC237, IC238, IC248, and IC249
Level	IC245, IC246, IC253, and IC248

8.12.2 For problems with the RF reverse power protection (circuit breaker) circuitry, check IC216, Q201, Q202, and Q203.

8.12.3 For attenuator control problems, check IC201 and IC202.

8.12.4 If RF control circuitry does not work properly, check IC204, IC205, IC211, IC203, IC206, and IC207.

8.12.5 Problems with the peak detector may show up as a frequency calibration or a deviation meter measurement problem. Check IC217-IC229.

8.13 OUTPUT BOARD

The Output Board is described in detail in section 7.9 of this manual. Review this section carefully. Troubleshooting the circuitry involved is a straight forward procedure.

8.13.1 There are three frequency conversion paths for signal flow. Check the input and output of each path to isolate a problem. Be aware of common problems. For example, if Amplifier IC803 opens, no signal will be present at the straight through path or heterodyne 1 path.

8.13.2 When an inoperable path has been isolated, the problem will usually be a failed component.

8.13.3 The signal paths are controlled by switching diodes. If the correct diodes are not turned on, the output signal will not be correct. The switch/diode relationships are shown in Table 8-4.

TABLE 8-4.
PATH/SWITCH RELATIONSHIPS

Path	Switches Turned On
THRU	CR800-804, CR821
HET1	CR800, CR810, CR821
HET2	CR800, CR810, Q800, Q802

8.13.4 Gain control for the THRU path and the HET1 path is performed by PIN diode pairs CR811/CR812 and CR815/CR816, which are driven through transistor Q808 by the output at pin 1 of Comparator IC808.

Gain control for the HET2 path is performed by Dual Gate FET Q804, which are driven through transistor Q808 by the output at pin 1 of Comparator IC808.

8.13.5 Transistors Q900 and Q902 are the output amplifiers.

8.14 DISPLAY/KEYBOARD

The Display/Keyboard is described in detail in section 7.11 of this manual. Verify a keyboard problem is not strictly a physical one (sticking key, damaged area, etc.). The Keyboard and Display interface through the Microprocessor Board. Look at Figure 9-2 for the following hints.

8.14.1 If the front panel display and keyboard are operational, but there is no RF response:

Check the decode select to IC106 (pin 25) for TTL pulses. If no pulses are present, verify that IC108 and IC110 decoder logic are good. If IC108 and IC110 are good, check IC106 pins 24, 26, 27, 28 for TTL pulses. If pulses are present, check IC106 and its pullup resistors.

8.14.2 If the front panel display is operational, but the keyboard does not function:

Check IC127 pins 3-10 for logic level low. If these pins are low, verify IC127 and its corresponding decode logic (IC128) are functioning properly. Also verify that pins 11-20 in all the ICs are pulled high. If all pins are not high, one or more keys may be stuck.

When a key is pressed, verify that one of the lines on pins 11-19 of IC127 goes low. If this does not happen, suspect a problem with the keyboard. When a key is pressed, line CB1 (IC127, pin 20) should pulse high. If not, suspect IC129.

When a key is pressed, pin 41 of IC127 should pulse low. Pin 5 of IC121 also should pulse low. If either does not happen, suspect IC127 or ICs 134-136.

8.15 DDS BOARD

The DDS Board is described in detail in section 7.5 of this manual.

8.15.1 If both 0° and 90° outputs are missing, check:

For the absence of a 1 MHz REF input.

IC302, IC321, IC322, IC323, and their associated circuitry.

For a permanent RST(low); will happen if IC301 bad or the RST line shorted to ground.

8.15.2 For only one output present (0° or 90°), check IC325, IC326, and their associated circuitry.

8.15.3 If the output levels are too low, check IC321, IC322, IC323, and their associated circuitry.

8.15.4 If output spurs or harmonics are too high, check IC317, IC318, IC319, IC320, IC321, IC322, IC323, and their associated circuitry.

8.15.5 If the output frequency is not correct, there are several possible causes:

Verify the 1 MHz REF input frequency is correct.

If bad, almost any digital IC on the board may cause this problem.

Verify there is no problem with the address and data bus input lines.

8.16 REFERENCE/LO BOARD

The Reference and LO Board is described in detail in section 7.7 of this manual.

8.16.1 If there is no LO output at J602, check:

For a disabled LO (IC607, IC694, Q605, Q604, and their associated circuitry).

For a VCO not oscillating (Q603 and its associated circuitry).

For an amplifier problem (IC605 and its associated circuitry).

8.16.2 If the output at J602 is too low, check for an amplifier problem (IC605 and its associated circuitry).

8.16.3 If the LO becomes unlocked, there are several possible causes:

The VCO circuitry (CR601, C652, C653, C654, Q603).

The prescaler circuitry (IC602 and its associated circuitry).

The PLL (IC601 and its associated circuitry).

The loop filter (IC608, IC603, IC607, and their associated circuitry).

A reference problem (IC604, Y601, Q606, CR606, IC613, IC612, and their associated components).

8.16.4 If there is no INT REF output or the output level is too low, check IC614 and its associated circuitry.

8.16.5 If the LO is not locking on EXT REF, check IC604, IC612, CR607, and their associated circuitry.

8.16.6 If a false UNLOCK indication occurs, check IC608, Q601, and their associated circuitry.

8.17 DEVIATION METER BOARD

The Deviation Meter Board is described in detail in section 7.13 of this manual.

8.17.1 Possible Deviation Meter problems fall into several categories. Problem areas and circuitry to check for each are listed in the following sections.

8.17.2 If a general loss of Deviation Meter control is experienced, check IC1400 and IC1403.

8.17.3 For a general loss of meter sensitivity, check CR1401-CR1406, IC1420, IC408, IC409, and J1401.

8.17.4 If FM demodulation distortion occurs, check IC1413.

8.17.5 If there is no TPX (test point output), check IC1404 and IC1403.

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9.1 INTRODUCTION

This section contains the reference drawings for the Model 2407. Reference drawings are schematics, board top assembly drawings (board parts layout drawings), and assembly drawings.

9.1.1 A starred (*) value shown on a schematic indicates the nominal value for the particular part. A component with a slightly different value may be substituted for a starred part during calibration.

9.1.2 Some early versions of the Microprocessor, Control, and Output boards were built with a .047 μF ceramic capacitor instead of the .1 μF tantalum capacitor shown on these schematics.

9.2 REFERENCE DRAWINGS

Schematics are numbered from Figure 9-1 to Figure 9-15. Some boards require two (2) schematics to show circuitry detail. For example, the Microprocessor Board requires two schematics (Figures 9-1 and 9-2). The board top assembly drawing (parts layout drawing) is shown on the

page immediately following its associated schematic. If two schematics are used, the top assembly drawing will be shown following the first schematic. The top assembly drawing for the Microprocessor Board, for example, follows Figure 9-1, the first of the two Microprocessor Board schematics.

A schematic may show components found on several subassemblies. When this occurs, more than one assembly drawing may be required to clearly show detail. For example, the 2407 power supply requires four assembly drawings (Figures 9-14A, 9-14B, 9-14C, and 9-14D). Assembly drawings have the same numeric designator as their associated schematics. They also contain a letter suffix.

Assembly drawings are shown in Figures 9-14A through 9-14D, and 9-16 through 9-26. Each assembly drawing refers to a "Reference BOM" (Bill of Material). Each BOM is included in Section 10 of this manual as a "Parts List".

9.3 ORDER OF REFERENCE DRAWINGS

Reference drawings are located in the following order:

2407 REFERENCE DRAWING LIST

Figure 9-1	SCHEMATIC, MICROPROCESSOR BD (Sheet 1 of 2)(0014-30-0420)
Figure 9-1A	TOP ASSEMBLY DWG, MICROPROCESSOR BD (0012-30-0123)
Figure 9-2	SCHEMATIC, MICROPROCESSOR BD (Sheet 2 of 2)(0014-30-0420)
Figure 9-3	SCHEMATIC, CONTROL BD (Sheet 1 of 2)(0014-30-0415)
Figure 9-3A	TOP ASSEMBLY DWG, CONTROL BD (side 1)(0012-30-0103)
Figure 9-3B	TOP ASSEMBLY DWG, CONTROL BD (side 2)(0012-30-0103)
Figure 9-4	SCHEMATIC, CONTROL BD (Sheet 2 of 2)(0014-30-0415)
Figure 9-5	SCHEMATIC, DIRECT DIGITAL SYNTHESIZER BD (0014-30-0421)
Figure 9-5A	TOP ASSEMBLY DWG, DDS BD (0012-30-0124)
Figure 9-6	SCHEMATIC, SYNTHESIZER BD (0014-30-0428)
Figure 9-6A	TOP ASSEMBLY DWG, SYNTHESIZER BD (0012-30-0122)
Figure 9-7	SCHEMATIC, VCO BD (0014-30-0430)
Figure 9-7A	TOP ASSEMBLY DWG, VCO BD (0012-30-0127)
Figure 9-8	SCHEMATIC, REFERENCE & LO BD (0014-30-0427)
Figure 9-8A	TOP ASSEMBLY DWG, REFERENCE & LO BD (0012-30-0121)
Figure 9-9	SCHEMATIC, AM/DIVIDER BD (0014-30-0426)
Figure 9-9A	TOP ASSEMBLY DWG, AM/DIV BD (0012-30-0120)
Figure 9-10	SCHEMATIC, OUTPUT BD (Sheet 1 of 2)(0014-30-0424)
Figure 9-10A	TOP ASSEMBLY DWG, OUTPUT BD (0012-30-0118)
Figure 9-11	SCHEMATIC, OUTPUT BD (Sheet 2 of 2)(0014-30-0424)
Figure 9-12	SCHEMATIC, MOTHER BD (0014-30-0422)
Figure 9-12A	TOP ASSEMBLY DWG, MOTHER BD (0012-30-0116)
Figure 9-13	SCHEMATIC, KEYBOARD (0014-30-0425)
Figure 9-13A	TOP ASSEMBLY DWG, KEYBOARD (0012-30-0019)
Figure 9-14	SCHEMATIC, POWER SUPPLY (0014-30-0423)
Figure 9-14A	TOP ASSEMBLY DWG, POWER SUPPLY (0012-30-0117)
Figure 9-14B	ASSY DWG, HEATSINK (0012-10-0133)
Figure 9-14C	ASSY DWG, TRANSFORMER (0012-20-0100)
Figure 9-14D	ASSY DWG, FAN (0012-20-0101)
Figure 9-15	SCHEMATIC, DEVIATION METER (0014-30-0416)
Figure 9-15A	TOP ASSEMBLY DWG, DEVIATION METER (0012-30-0104)
Figure 9-16	ASSY DWG, F.P. MECH. (0012-30-0113)
Figure 9-17	ASSY DWG, FRONT PANEL (0012-30-0114)
Figure 9-18	ASSY DWG, CARD CAGE (0012-30-0115)
Figure 9-19	ASSY DWG, CARD CAGE CABLE LOCATION (0012-10-0135)
Figure 9-20	ASSY DWG, ENCLOSURE, AM/DIV AND OUTPUT, 2407 (0012-30-0131)
Figure 9-21	ASSY DWG, ENCLOSURE, DOUBLER AND SYN, 2407 (0012-30-0132)
Figure 9-22	ASSY DWG, ENCLOSURE, LO REF AND DEV METER (0012-30-0133)
Figure 9-23	ASSY DWG, BOTTOM COVER (0012-30-0126)
Figure 9-24A/B	ASSY DWG, REAR PANEL ASSY. (2 sheets) (0012-30-0125)
Figure 9-25A/B	ASSY DWG, CHASSIS ASSY. (2 sheets) (0012-30-0128)
Figure 9-26	ASSY DWG, FINAL ASSY. (0012-30-0129)

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 WAVELETK DESIGN RIGHTS BELONGING TO
 WAVELETK AND MAY NOT BE REPRODUCED FOR ANY
 REASON EXCEPT CALIBRATION, OPERATION, AND
 MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.

REV ECN BY DATE APP

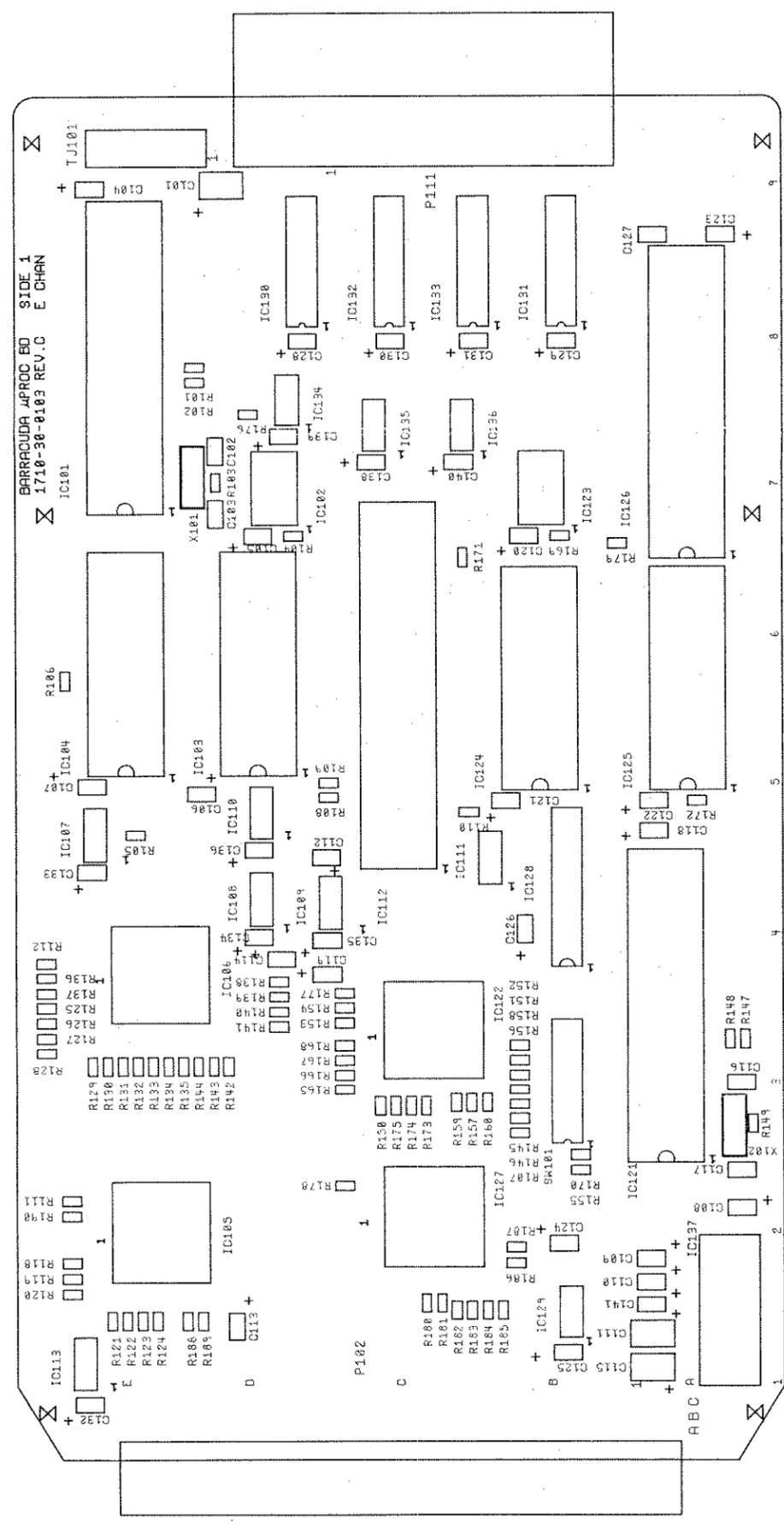


Figure 9-1A

REMOVE ALL BURRS AND BREAK SHARP EDGES MATERIAL		DATE	1. FEB 1988
DRAWN	DATE	DR. LEE	1. FEB 1988
PROJ ENGR	F. CHAN	RELEASE APPROV	S. MISSISSAUGA
FINISH WAVELETK PROCESS		TOLERANCE UNLESS OTHERWISE SPECIFIED ANGLES XXX.X	
DO NOT SCALE DWG		SCALE	2:1
MODEL NO.	2407	DWG NO.	0012-30-0123
CODE	34280	REV	C
DATE	07. FEB 1988	SHEET	3 OF 8

WAVELETK
 MFG / ENGR CHECK SET
 TOP ASSEMBLY DWG
 MICROPROCESSOR BD

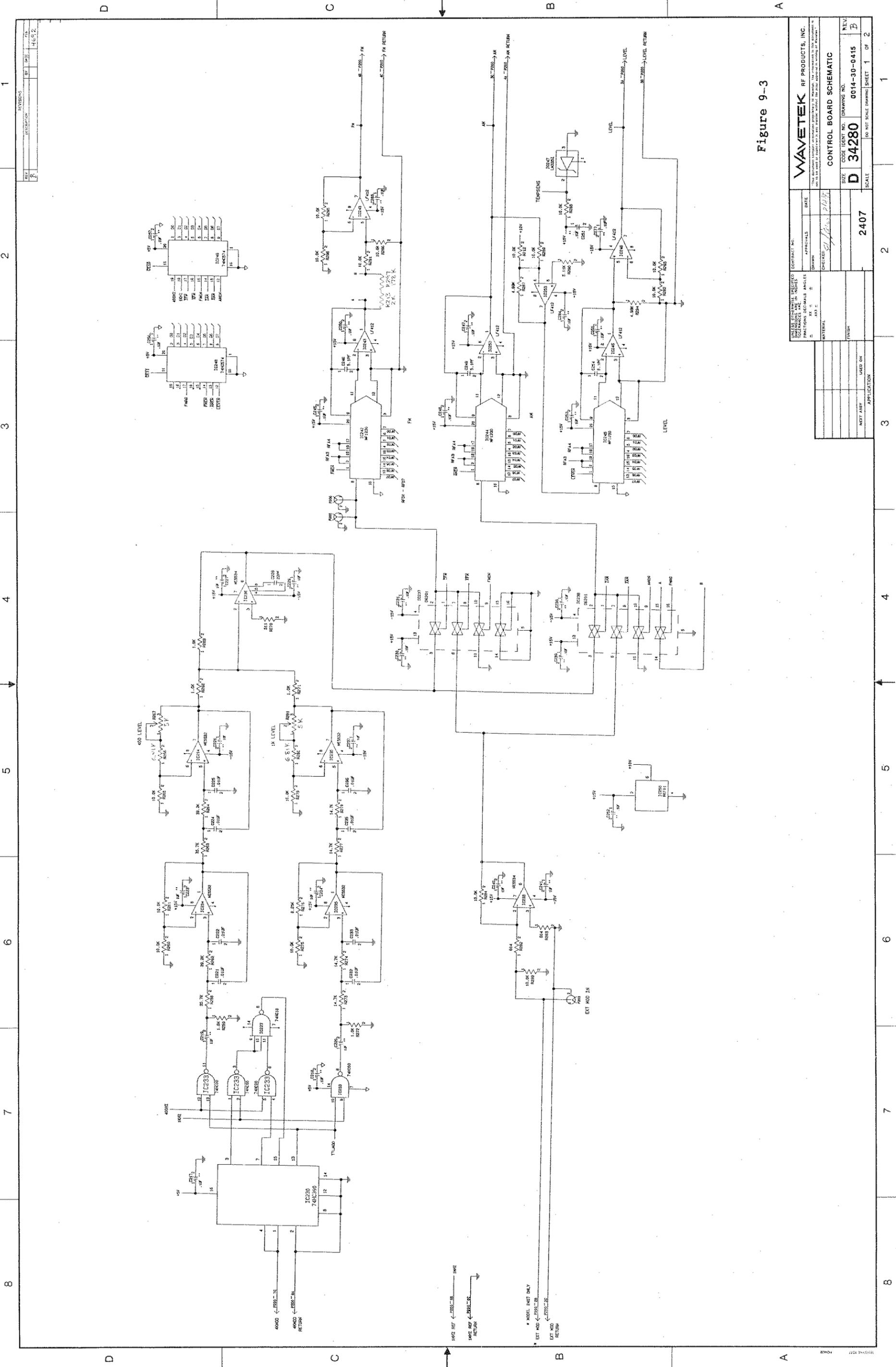


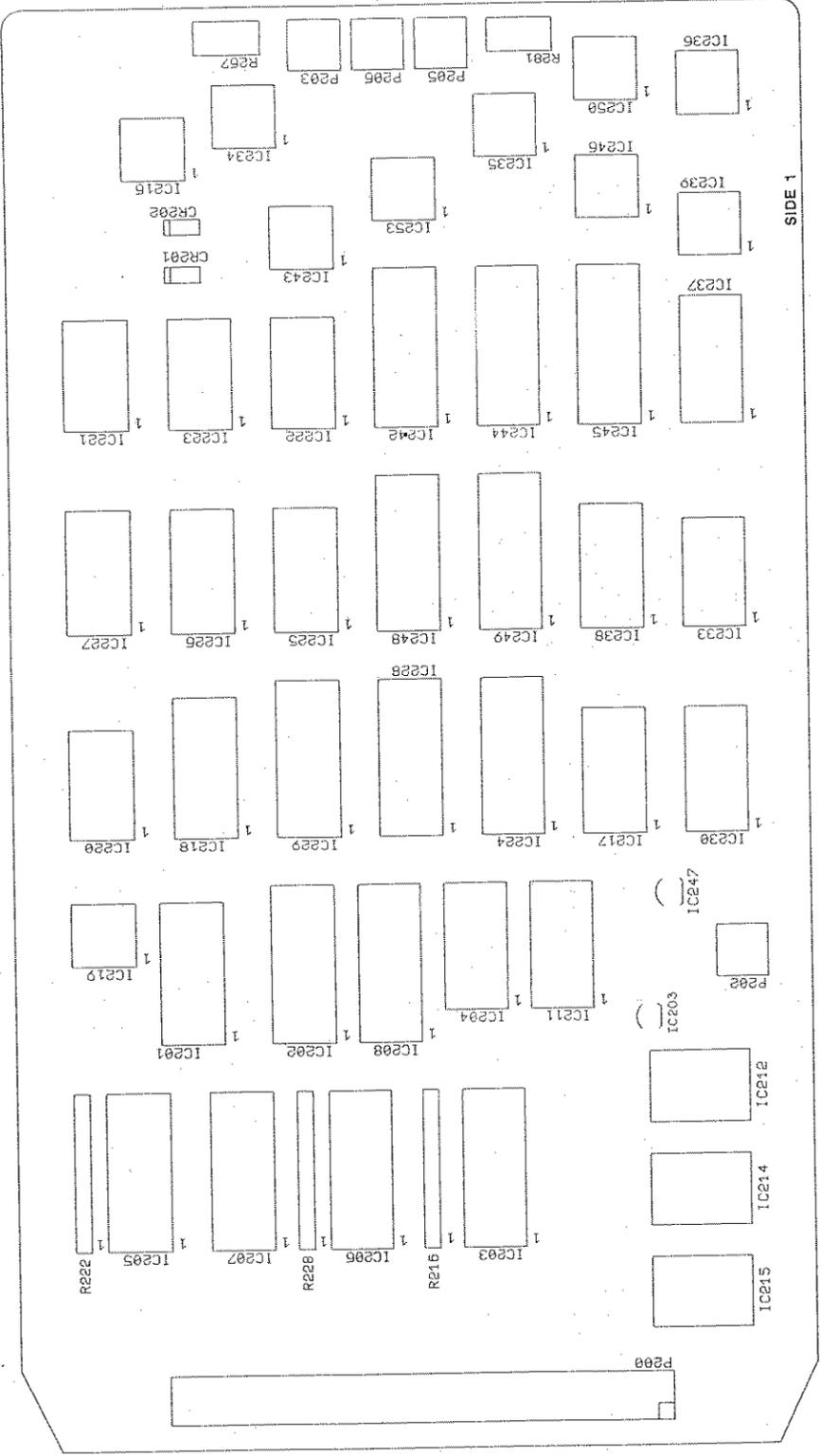
Figure 9-3

WAVETEK RF PRODUCTS, INC. <small>These drawings are the property of Wavetek, Inc. and are to be used only for the specific application for which they were prepared. No other use without the written consent of Wavetek, Inc.</small>	
DATE	APPROVALS
DESIGNED	CHECKED
MATERIAL	
FINISH	
CONTRACT NO.	SCALE
SIZE CODE IDENT NO.	SCALE
D 34280	2407
0014-30-0415	DO NOT SCALE DRAWING
1	2
3	4
5	6
7	8
APPLICATION	
CONTROL BOARD SCHEMATIC	
SHEET 1 OF 2	

1 2 3 4 5 6 7 8

D C B A

REV	DESCRIPTION	BY	DATE
A	PER P/N	DM	5-89
		4602	



REV. A
CONTROL BOARD
PC BOARD # : 1710-30-0094
DWG. # : 0012-30-0103

Figure 9-3A

UNLESS OTHERWISE SPECIFIED: DIMENSIONS IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES		CONTRACT NO.	DATE
±	±	APPROVALS	
±	±	DRAWN	
±	±	CHECKED	
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NEXT ASSY		DRAWING NO.	
USED ON		REV	
APPLICATION		A	
SCALE		D 34280 0012-30-0103	
DO NOT SCALE DRAWING		SHEET 1 OF 2	

1 2 3 4 5 6 7 8

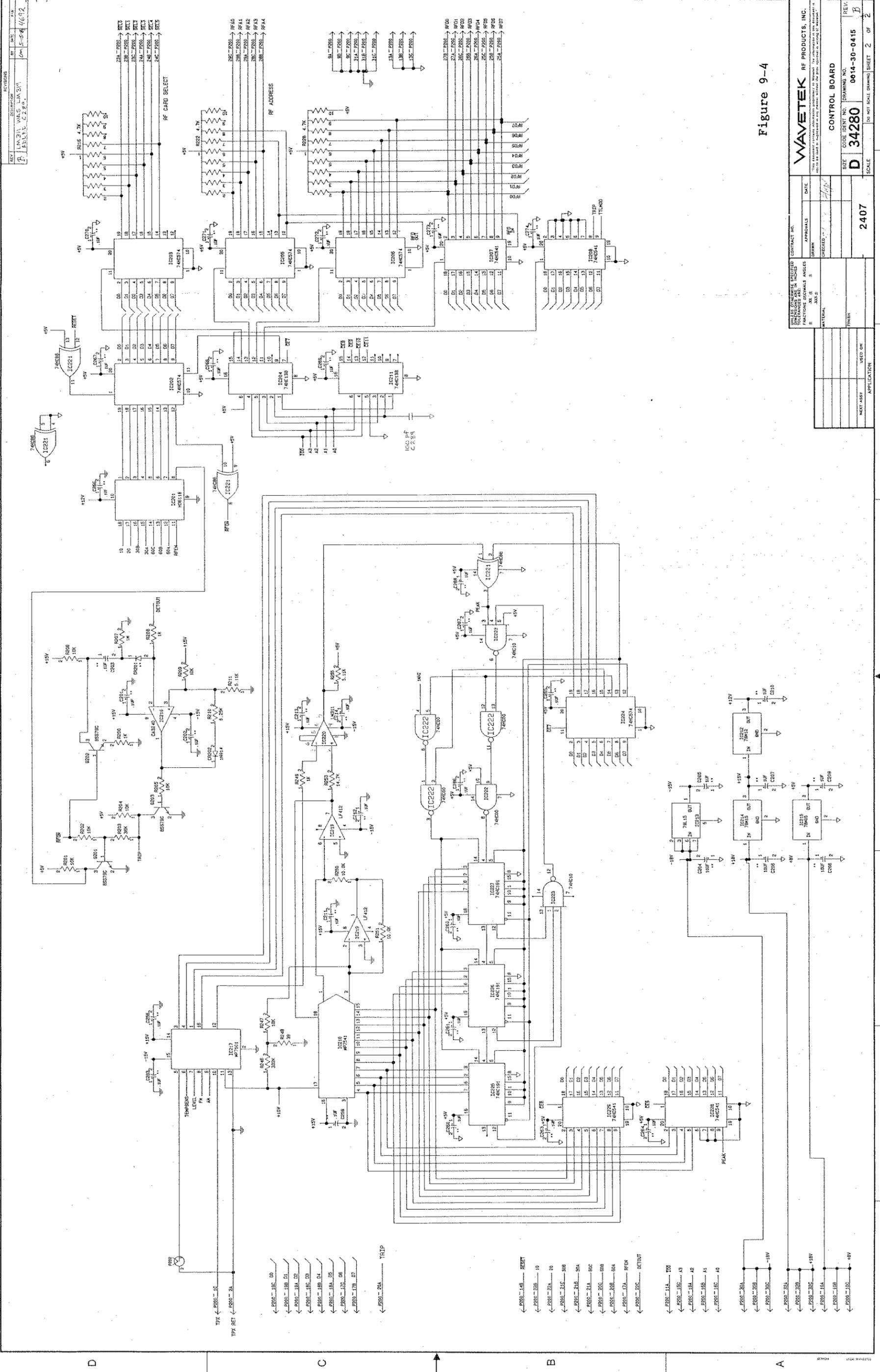


Figure 9-4

WAVETEK RF PRODUCTS, INC. <small>10000 WILSON AVENUE, SUITE 100, CHATTAHOOCHEE, ALABAMA 35952</small>	
DATE	APPROVALS
DRAWN	CHECKED
MATERIAL	FINISH
CONTRACT NO.	2407
SIZE	CODE IDENT NO.
D 34280	0014-30-0415
SCALE	DO NOT SCALE DRAWING SHEET 2 OF 2

UNLESS OTHERWISE SPECIFIED	CONTRACT NO.
TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE
ANGLE DIMENSIONS UNLESS OTHERWISE SPECIFIED	DRAWN
FINISH UNLESS OTHERWISE SPECIFIED	CHECKED
APPROVALS	DATE
DATE	APPROVALS
DRAWN	CHECKED
MATERIAL	FINISH
CONTRACT NO.	2407
SIZE	CODE IDENT NO.
D 34280	0014-30-0415
SCALE	DO NOT SCALE DRAWING SHEET 2 OF 2

1
2
3
4
5
6
7
8

1
2
3
4
5
6
7
8

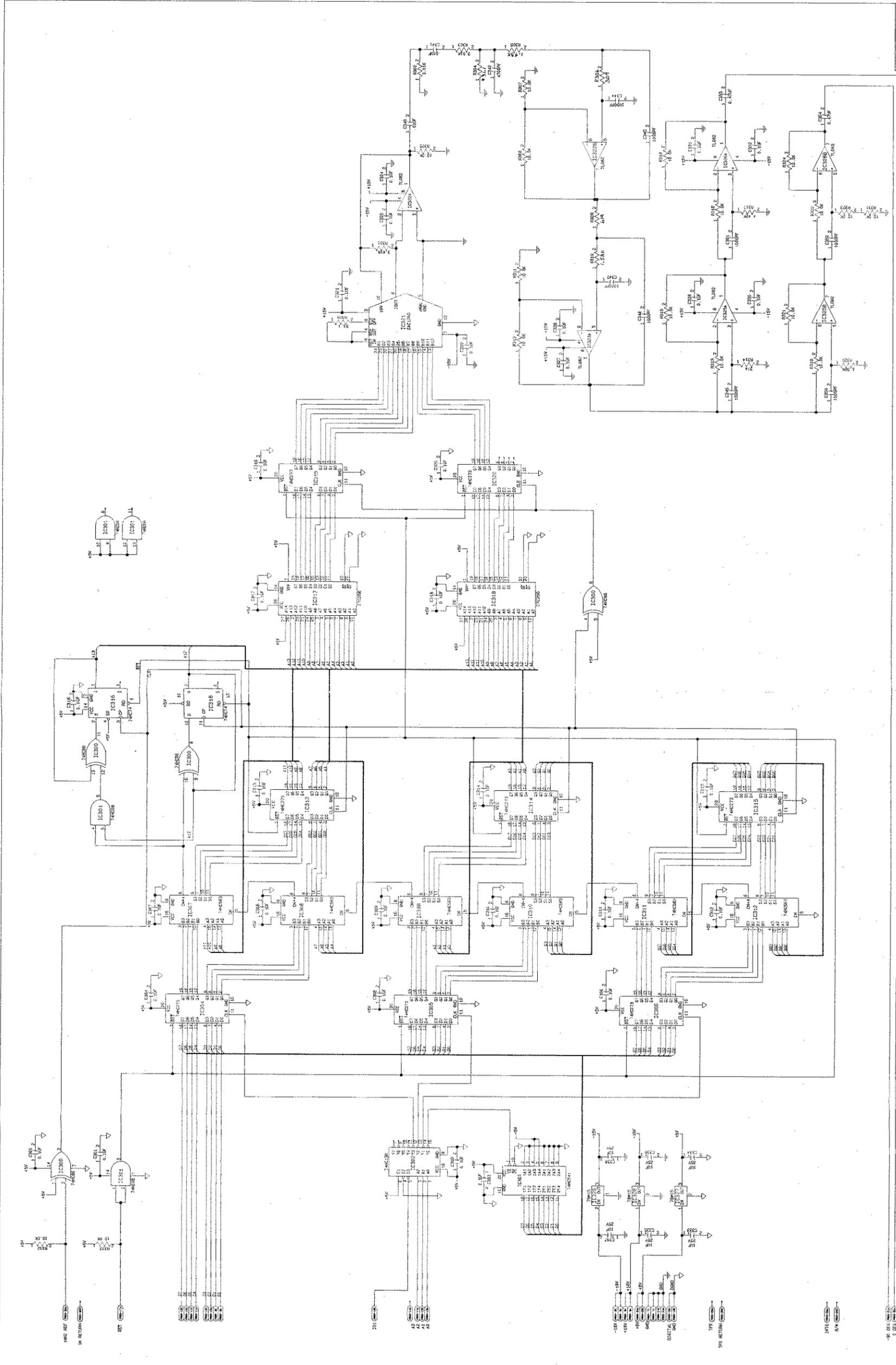
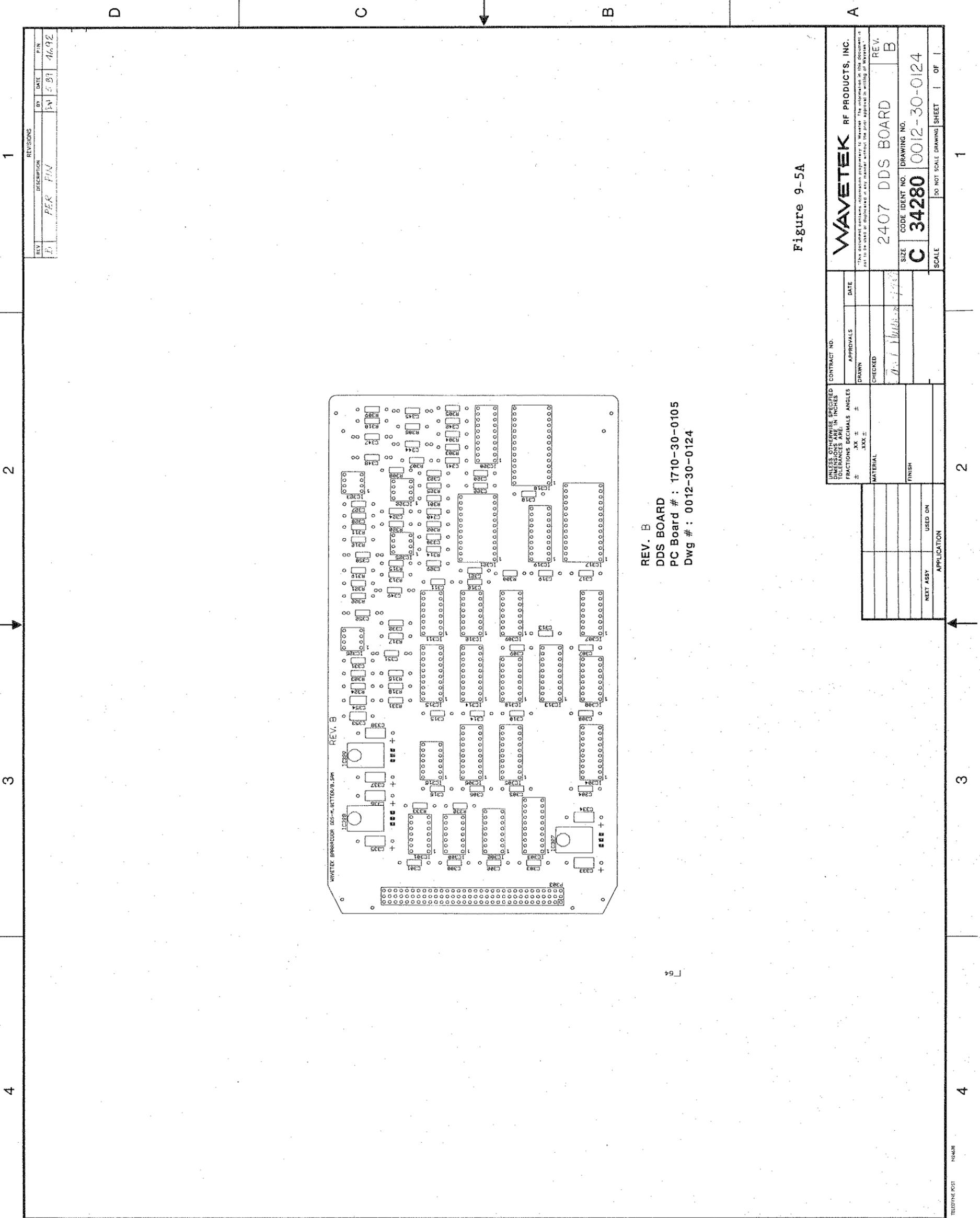


Figure 9-5



REV. B
 DDS BOARD
 PC Board # : 1710-30-0105
 Dwg # : 0012-30-0124

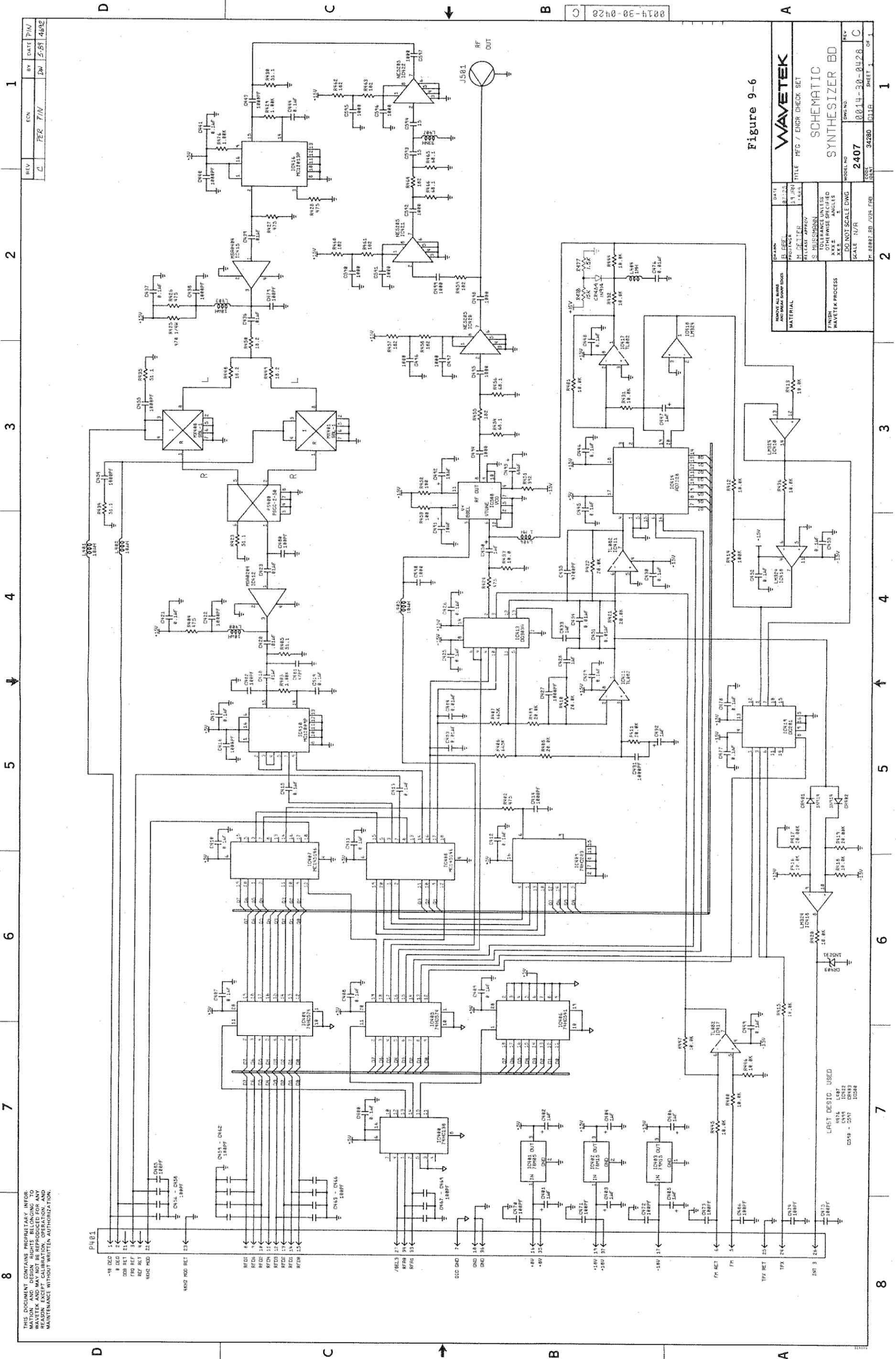
Figure 9-5A

REVISIONS			
REV.	DESCRIPTION	BY	DATE
1	PER FIN	EW	5/81
2			4/92

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES .XX ± .XXX ±		CONTRACT NO.	DATE
MATERIAL		APPROVALS	
FINISH		DRAWN	
NEXT ASSY USED ON		CHECKED	
APPLICATION			
SCALE		DO NOT SCALE DRAWING SHEET	

WAVETEK RF PRODUCTS, INC.	
2407 DDS BOARD	REV. B
SIZE CODE IDENT NO. DRAWING NO.	
C 34280	0012-30-0124

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REV	ECN	BY	DATE	P/I/N
1	PER	T/N	5-89	4892

1	2	3	4	5	6	7	8
---	---	---	---	---	---	---	---

Figure 9-6

WAVETEK

DATE: 07-22-89
 DRAWN: R. ROSE
 CHECKED: M. GILBERT
 RELEASED APPROV: S. MURSBACH
 TOLERANCE UNLESS OTHERWISE SPECIFIED: XXX%
 FINISH: WAVEJETEK PROCESS
 DO NOT SCALE DWG
 SCALE: N/A

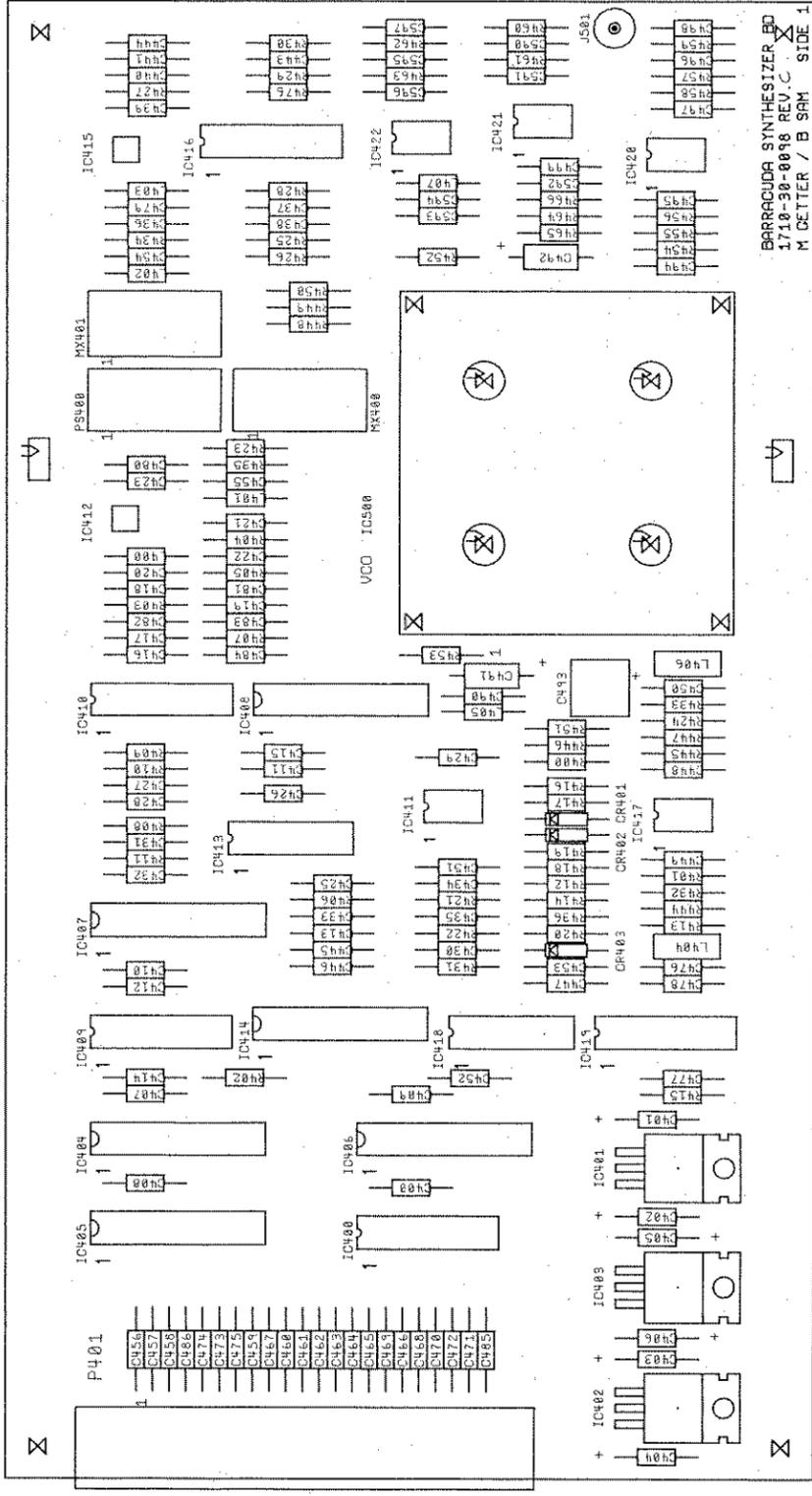
MODEL NO: 2407
 PART NO: 34280
 SHEET 1 OF 1

TITLE: MFC / ENGR CHECK SET
 SYNTHESIZER BD

REMOVE ALL WIRING AND DRAMA SHORTS DURING MATERIAL

LAST DESIG. USED:
 8874
 1497
 10522
 10588
 10588
 10588

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BARRACUDA SYNTHESIZER BOARD
1710-30-0098 REV. C
M. DETTER / B. SMITH SIDE 1

0012-30-0122 C

Figure 9-6A

REV. NO.	2407	DWG. NO.	0012-30-0122	REV.	C
DATE	07.25	DATE	07.25	BY	APP
DESIGNER	M. DETTER	DESIGNER	M. DETTER	BY	APP
RELEASER	S. PRUSSMANN	RELEASER	S. PRUSSMANN	BY	APP
FINISH	WAVE TEK PROCESS	FINISH	WAVE TEK PROCESS	BY	APP
TOLERANCE UNLESS SPECIFIED	XXX ±	TOLERANCE UNLESS SPECIFIED	XXX ±	BY	APP
SCALE	2:1	SCALE	2:1	BY	APP
DO NOT SCALE DWG		DO NOT SCALE DWG		BY	APP
WAVE TEK		WAVE TEK		BY	APP
TOP ASSEMBLY DWG		TOP ASSEMBLY DWG		BY	APP
SYNTHESIZER BOARD		SYNTHESIZER BOARD		BY	APP
34280		34280		BY	APP
SHEET 1		SHEET 1		BY	APP
OF 2		OF 2		BY	APP

REV.	DATE	DESCRIPTION
A		
B		
C		

REV.	ECN	BY	DATE	APP

1 2 3 4 5 6 7 8

1 2 3 4 5 6 7 8

D

C

B

A

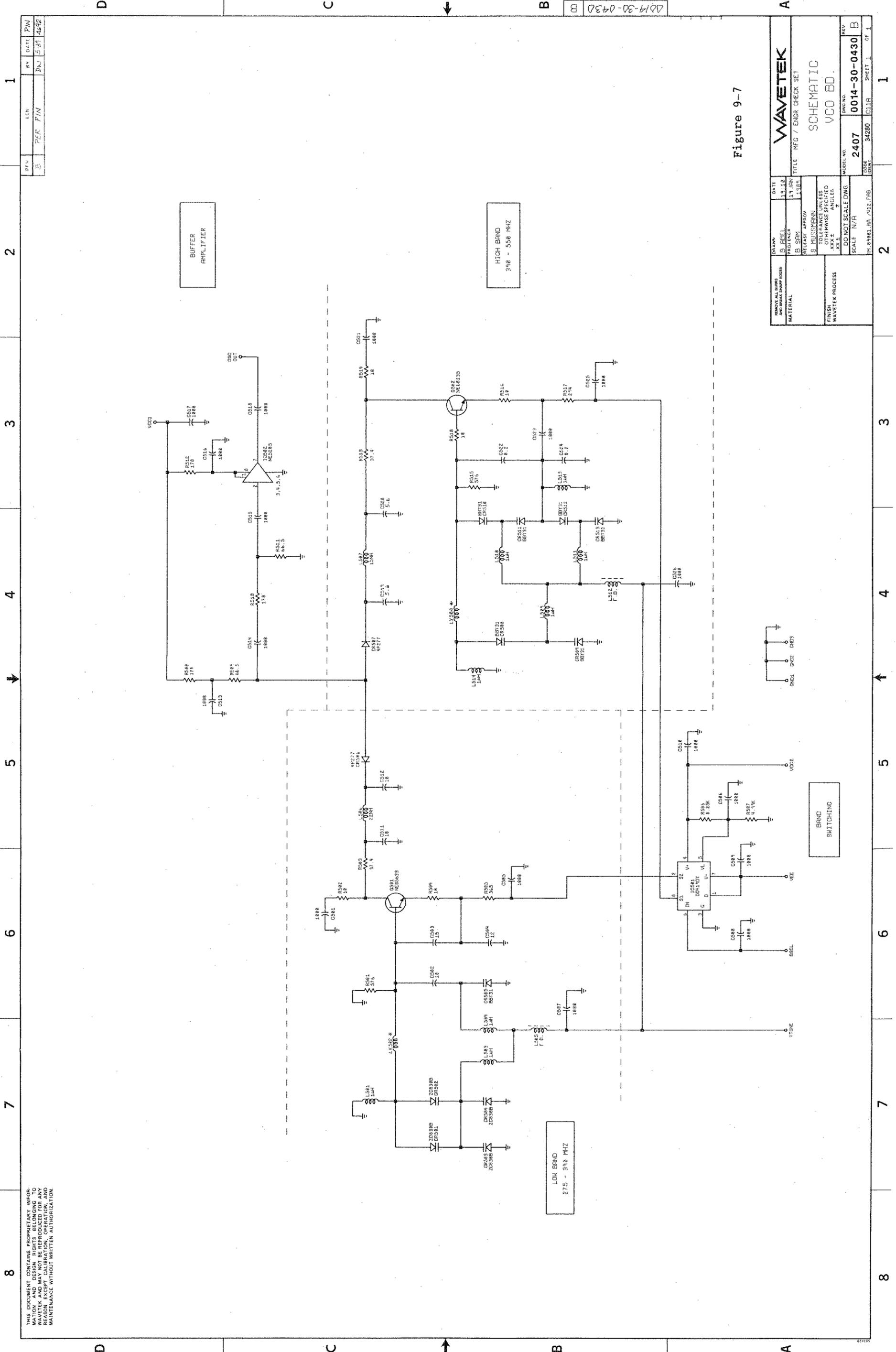
D

C

B

A

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REV	BY	DATE	PIN
1	ELN	5-83	482
2	ELN	5-83	482
3	ELN	5-83	482
4	ELN	5-83	482
5	ELN	5-83	482
6	ELN	5-83	482
7	ELN	5-83	482
8	ELN	5-83	482

REV	BY	DATE	PIN
1	ELN	5-83	482
2	ELN	5-83	482
3	ELN	5-83	482
4	ELN	5-83	482
5	ELN	5-83	482
6	ELN	5-83	482
7	ELN	5-83	482
8	ELN	5-83	482

REV	BY	DATE	PIN
1	ELN	5-83	482
2	ELN	5-83	482
3	ELN	5-83	482
4	ELN	5-83	482
5	ELN	5-83	482
6	ELN	5-83	482
7	ELN	5-83	482
8	ELN	5-83	482

REV	BY	DATE	PIN
1	ELN	5-83	482
2	ELN	5-83	482
3	ELN	5-83	482
4	ELN	5-83	482
5	ELN	5-83	482
6	ELN	5-83	482
7	ELN	5-83	482
8	ELN	5-83	482

REV	BY	DATE	PIN
1	ELN	5-83	482
2	ELN	5-83	482
3	ELN	5-83	482
4	ELN	5-83	482
5	ELN	5-83	482
6	ELN	5-83	482
7	ELN	5-83	482
8	ELN	5-83	482

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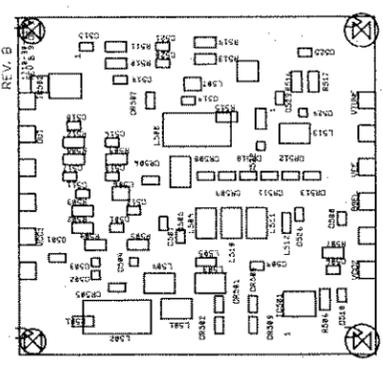
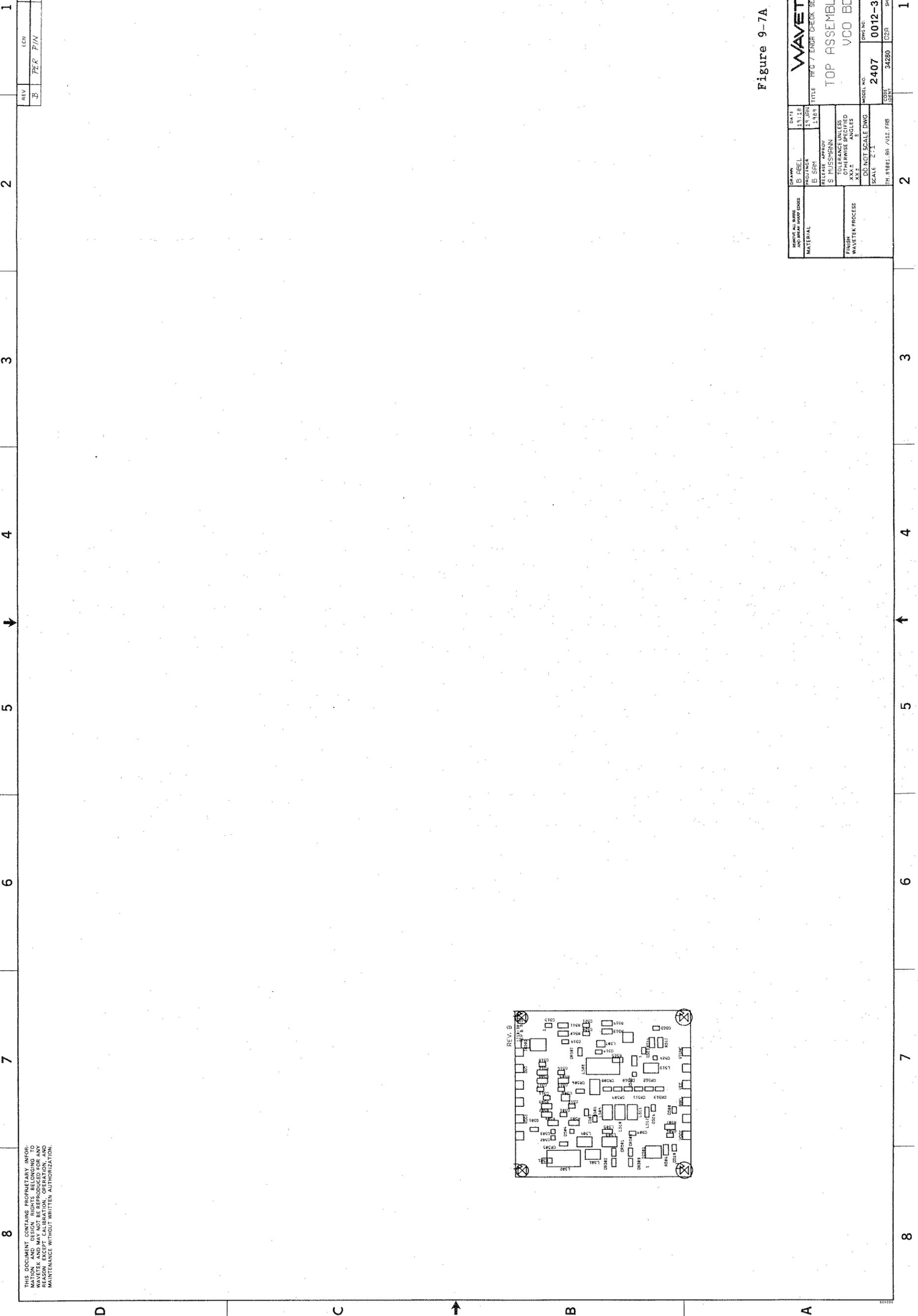


Figure 9-7A

WAVE TEK		DATE	15:18
TOP ASSEMBLY DWG		19 JUN	1989
VCO BD		TITLE RFD 7 ENGR CHECK SET	
FINISH WAVE TEK PROCESS		TOLERANCE UNLESS OTHERWISE SPECIFIED ANGLES	
DO NOT SCALE DWG		SCALE 1"=1"	
MODEL NO. 2407		DWS NO. 0012-30-0127 B	
TM 81881 BR /V12 FRS		CODE SHEET 34280	
SHEET 3		DF 7	

REV	BY	DATE	PIN
B	PER	5-85	4042

0012-30-0127 B



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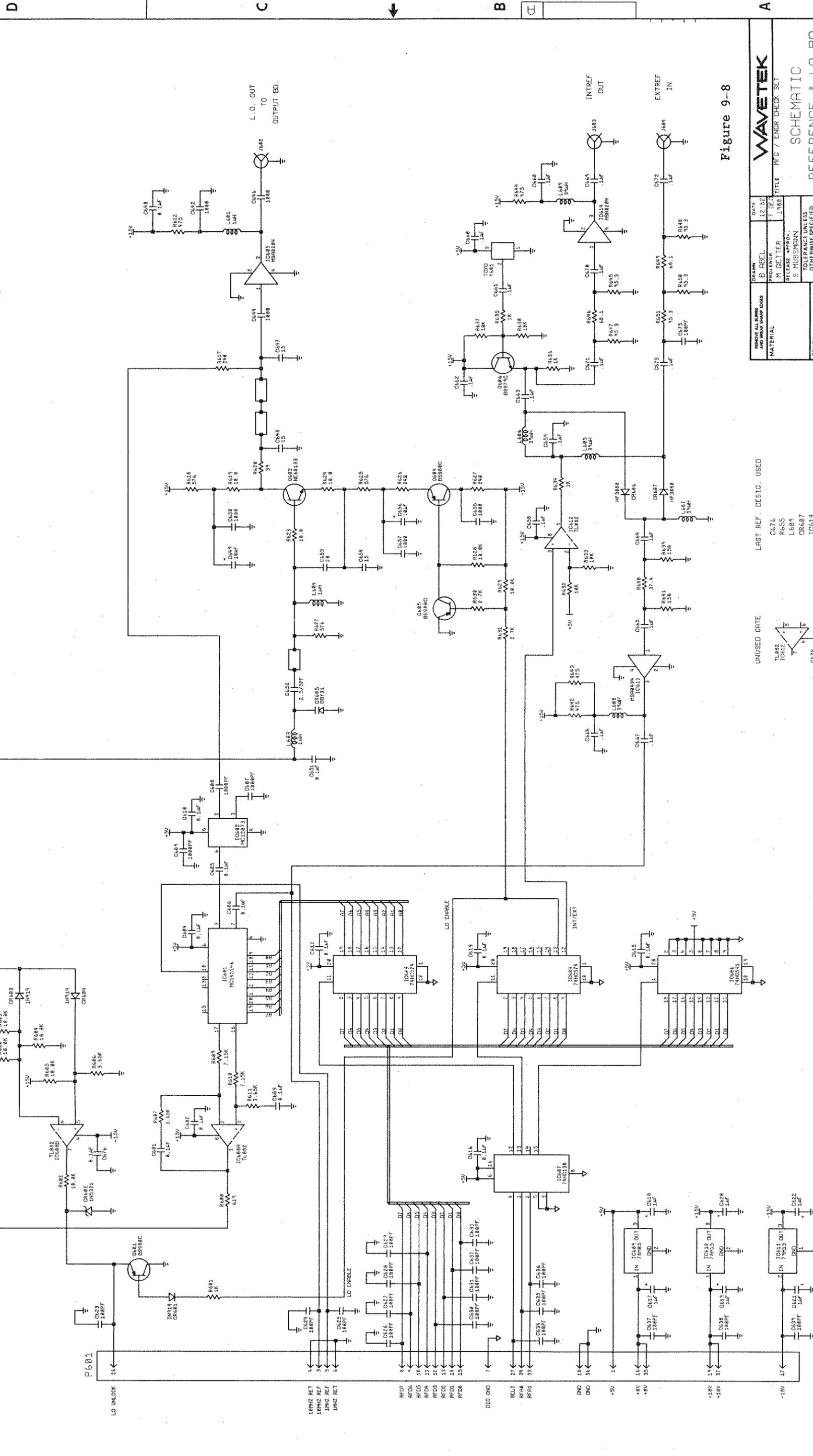


Figure 9-8

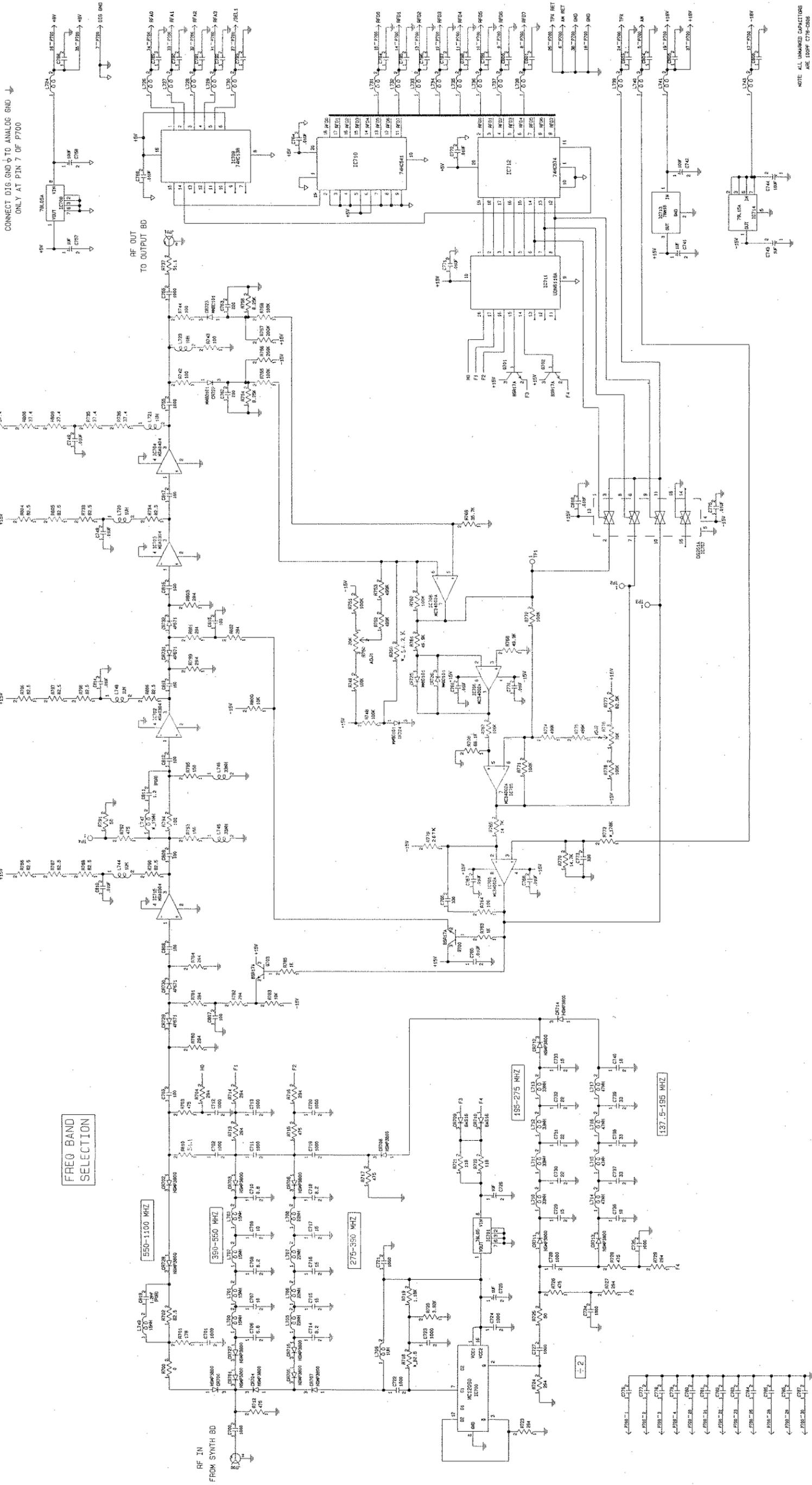
DESIGNER	DATE	REV.	OF
B. REBEL	7 DEC 1988	2407	1
PROJ. NO.	TITLE	SCALE	DATE
7100	RFC / ENGR CHECK SET	N/A	34200
ISSUED BY	APPROVED BY	MODEL NO.	CODE
M. GRIFFIN	S. HUSSMANN	0014-30-0427	D11R
FINISH	WAVETEK PROCESS	DO NOT SCALE DWG.	TH. 97836-RR / USS. FRB
TOLERANCE UNLESS OTHERWISE SPECIFIED	ANGLES XXX	SCALE N/A	SHEET 1 OF 1

LAST REF. DESIG. USED

UNUSED ORTE

IC682
IC683
IC684
IC685
IC686
IC687
IC688
IC689
IC690
IC691
IC692
IC693
IC694
IC695
IC696
IC697
IC698
IC699
IC700

NOTE: UNLESS OTHERWISE SPECIFIED.



CONNECT DIG. GND TO ANALOG GND
ONLY AT PIN 7 OF P700

FREQ BAND
SELECTION

550-1100 MHZ

350-550 MHZ

275-350 MHZ

195-275 MHZ

137.5-195 MHZ

-2

NOTE: ALL UNMARKED CAPACITORS
ARE .001UF 50V

* NOMINAL VALUE INDICATED,
MAY BE ADJUSTED DURING CALIBRATION

Figure 9-9

TITLE		AM/DIVIDER BD		REV. 2	
DESN		2-1-69		APPROV. DATE	
SCALE		NONE		FILE NAME	
BY		SM 1		DATE	
DESCRIPTION		DESCRIPTION		FILE NO.	
PIN NO.		REV. DATE		BY	
4692		A		4/6/72	
B		C		D	
E		F		G	
H		I		J	
K		L		M	
N		O		P	
Q		R		S	
T		U		V	
W		X		Y	
Z		AA		AB	
AC		AD		AE	
AF		AG		AH	
AI		AJ		AK	
AL		AM		AN	
AO		AP		AQ	
AR		AS		AT	
AU		AV		AW	
AX		AY		AZ	
BA		BB		BC	
BD		BE		BF	
BG		BH		BI	
BJ		BK		BL	
BM		BN		BO	
BP		BQ		BR	
BS		BT		BU	
BV		BW		BX	
BY		BZ		CA	
CB		CC		CD	
CE		CF		CG	
CH		CI		CJ	
CK		CL		CM	
CN		CO		CP	
CQ		CR		CS	
CT		CU		CV	
CW		CX		CY	
CZ		DA		DB	
DC		DD		DE	
DF		DG		DH	
DI		DJ		DK	
DL		DM		DN	
DO		DP		DQ	
DR		DS		DT	
DU		DV		DW	
DX		DY		DZ	
EA		EB		EC	
ED		EE		EF	
EG		EH		EI	
EJ		EK		EL	
EM		EN		EO	
EP		EQ		ER	
ES		ET		EU	
EV		EW		EX	
EY		EZ		FA	
FB		FC		FD	
FE		FF		FG	
FH		FI		FJ	
FK		FL		FM	
FN		FO		FP	
FQ		FR		FS	
FT		FU		FV	
FW		FX		FY	
FZ		GA		GB	
GC		GD		GE	
GF		GH		GI	
GJ		GK		GL	
GM		GN		GO	
GP		GQ		GR	
GS		GT		GU	
GV		GW		GX	
GY		GZ		HA	
HB		HC		HD	
HE		HF		HG	
HH		HI		HJ	
HK		HL		HM	
HN		HO		HP	
HQ		HR		HS	
HT		HU		HV	
HW		HX		HY	
HZ		IA		IB	
IC		ID		IE	
IF		IG		IH	
II		IJ		IK	
IL		IM		IN	
IO		IP		IQ	
IR		IS		IT	
IU		IV		IW	
IX		IY		IZ	
JA		JB		JC	
JD		JE		JF	
JG		JH		JI	
JJ		JK		JL	
JM		JN		JO	
JP		JQ		JR	
JS		JT		JU	
JV		JW		JX	
JY		JZ		KA	
KB		KC		KD	
KE		KF		KG	
KH		KI		KJ	
KK		KL		KM	
KN		KO		KP	
KQ		KR		KS	
KT		KU		KV	
KW		KX		KY	
KZ		LA		LB	
LC		LD		LE	
LF		LG		LH	
LI		LJ		LK	
LM		LN		LO	
LP		LQ		LR	
LS		LT		LU	
LV		LW		LX	
LY		LZ		MA	
MB		MC		MD	
ME		MF		MG	
MH		MI		MJ	
MK		ML		MM	
MN		MO		MP	
MQ		MR		MS	
MT		MU		MV	
MW		MX		MY	
MZ		NA		NB	
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NF		NG		NH	
NI		NJ		NK	
NL		NM		NO	
NP		NQ		NR	
NS		NT		NU	
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NY		NZ		OA	
OB		OC		OD	
OE		OF		OG	
OH		OI		OJ	
OK		OL		OM	
ON		OO		OP	
OQ		OR		OS	
OT		OU		OV	
OW		OX		OY	
OZ		PA		PB	
PC		PD		PE	
PF		PG		PH	
PI		PJ		PK	
PL		PM		PN	
PO		PP		PQ	
PR		PS		PT	
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PX		PY		PZ	
QA		QB		QC	
QD		QE		QF	
QG		QH		QI	
QJ		QK		QL	
QM		QN		QO	
QP		QQ		QR	
QS		QT		QU	
QV		QW		QX	
QY		QZ		RA	
RB		RC		RD	
RE		RF		RG	
RH		RI		RJ	
RK		RL		RM	
RN		RO		RP	
RQ		RR		RS	
RT		RU		RV	
RW		RX		RY	
RZ		SA		SB	
SC		SD		SE	
SF		SG		SH	
SI		SJ		SK	
SL		SM		SN	
SO		SP		SQ	
SR		SS		ST	
SU		SV		SW	
SX		SY		SZ	
TA		TB		TC	
TD		TE		TF	
TG		TH		TI	
TJ		TK		TL	
TM		TN		TO	
TP		TQ		TR	
TS		TU		TV	
TW		TX		TY	
TZ		UA		UB	
UC		UD		UE	
UF		UG		UH	
UI		UJ		UK	
UL		UM		UN	
UO		UP		UQ	
UR		US		UT	
UU		UV		UW	
UX		UY		UZ	
VA		VB		VC	
VD		VE		VF	
VG		VH		VI	
VJ		VK		VL	
VM		VN		VO	
VP		VQ		VR	
VS		VT		VU	
VV		VW		VX	
VY		VZ		WA	
WB		WC		WD	
WE		WF		WG	
WH		WI		WJ	
WK		WL		WM	
WN		WO		WP	
WQ		WR		WS	
WT		WU		WV	
WX		WY		WZ	
XA		XB		XC	
XD		XE		XF	
XG		XH		XI	
XJ		XK		XL	
XM		XN		XO	
XP		XQ		XR	
XS		XT		XU	
XV		XW		XZ	
YA		YB		YC	
YD		YE		YF	
YG		YH		YI	
YJ		YK		YL	
YM		YN		YO	
YP		YQ		YR	
YS		YT		YU	
YV		YW		YZ	
ZA		ZB		ZC	
ZD		ZE		ZF	
ZG		ZH		ZI	
ZJ		ZK		ZL	
ZM		ZN		ZO	
ZP		ZQ		ZR	
ZS		ZT		ZU	
ZV		ZW		ZZ	

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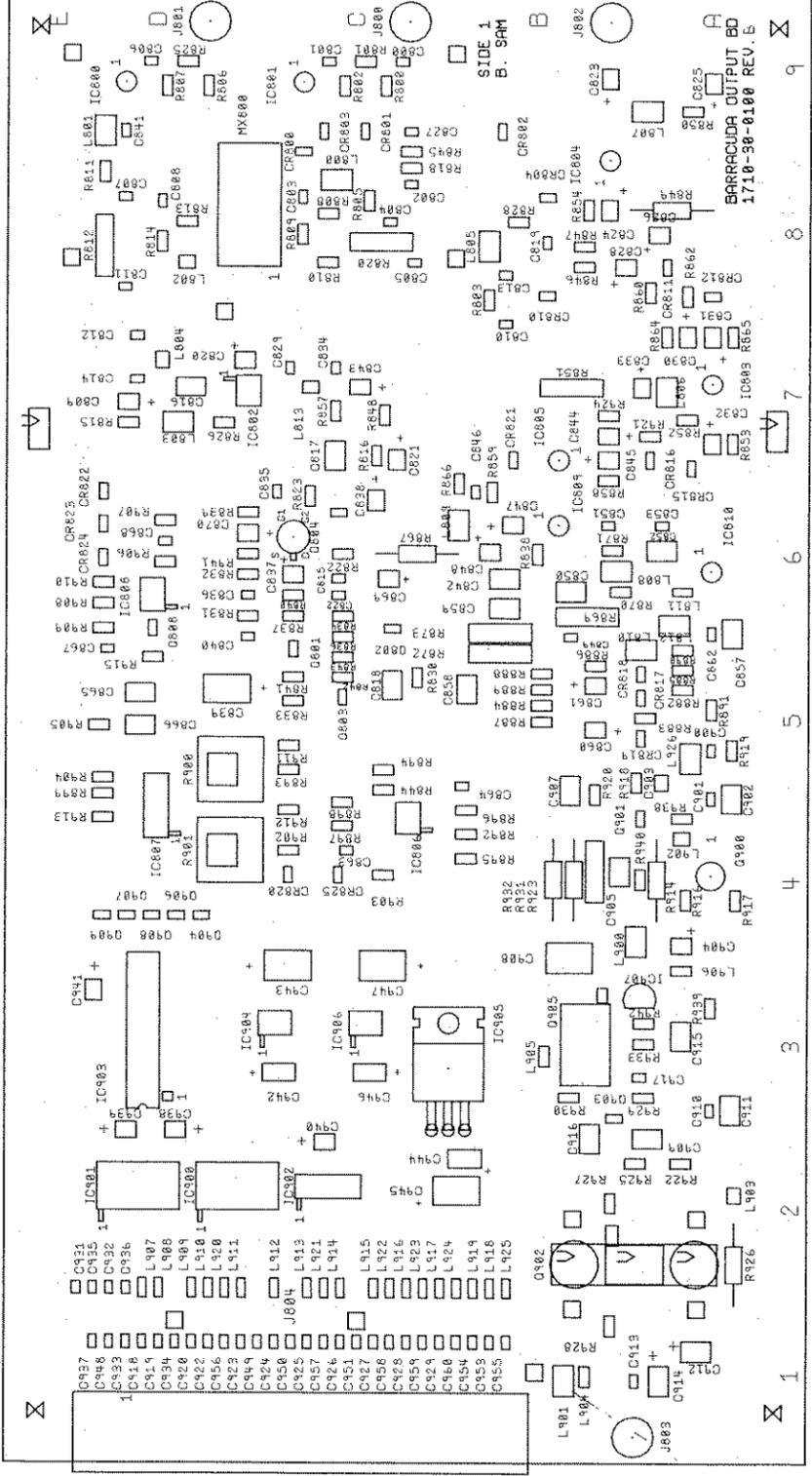


Figure 9-10A

REMOVE ALL SURFACES AND REPAIR DAMAGED MATERIAL	DATE	31 JAN 1983	TITLE	MFG / ENGR CHECK SET
	DRAWN	B. BELL	PROFILING	
FINISH WAVE TEK PROCESS	DATE		MODEL NO.	2407
	SCALE	2:1	DWG NO.	0012-30-0118
TOLERENCE UNLESS OTHERWISE SPECIFIED		XXI ±		REV
DO NOT SCALE DWG		TH. 88818 REV. 4/25, FRB		34280
SCALE		SHEET 3		OF 8

WAVETEK
TOP ASSEMBLY DWG
OUTPUT BO

0012-30-0118

PIN NO.	REV	ECN	DATE	APP
1492	A			
	B			
	C			

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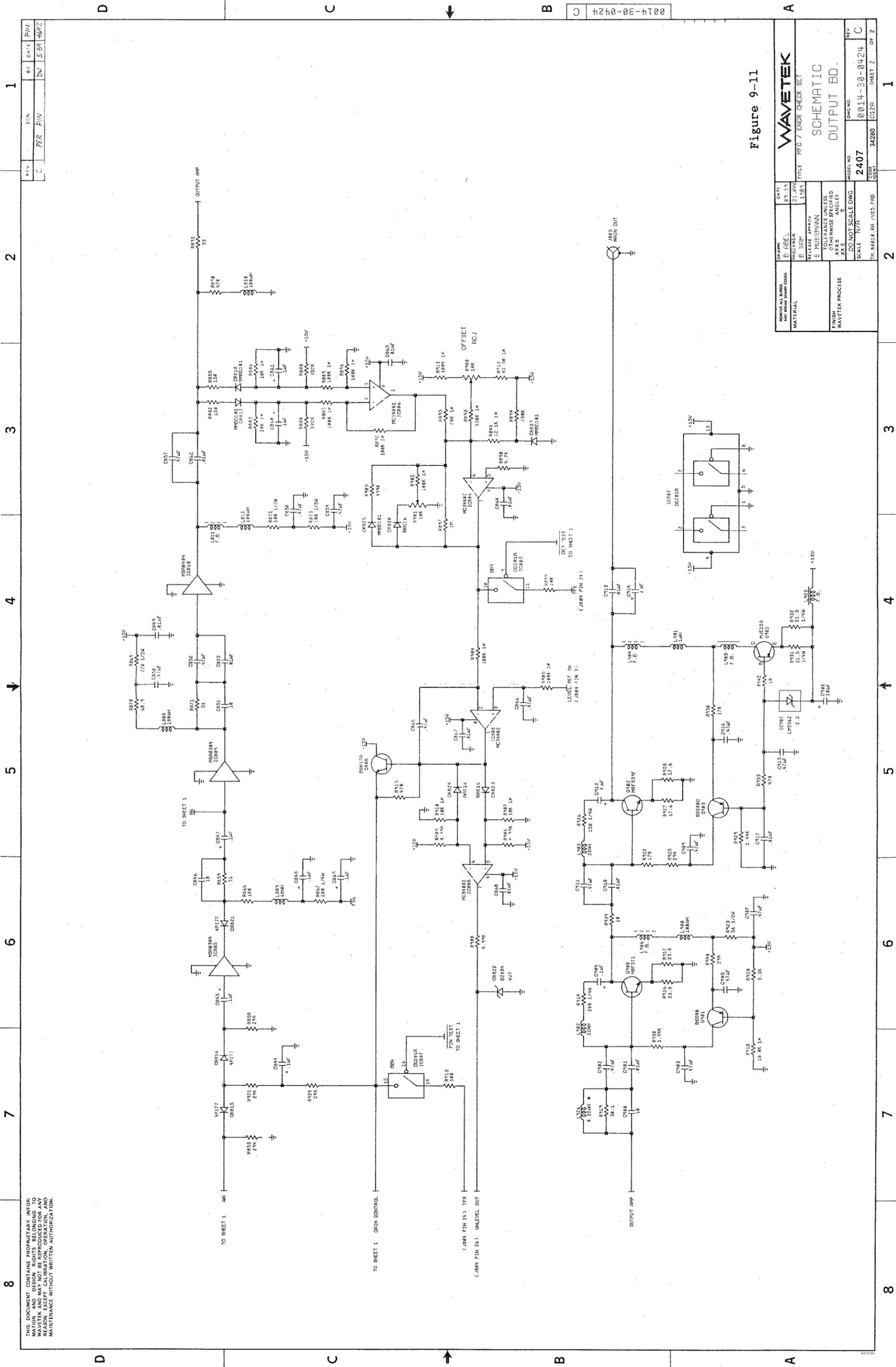


Figure 9-11

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
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DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
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REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY	DATE	BY
8/1/81	JLJ	5/8/81	4492
REV	PER	DATE	BY
C	PER	5/8/81	4492

DATE	BY
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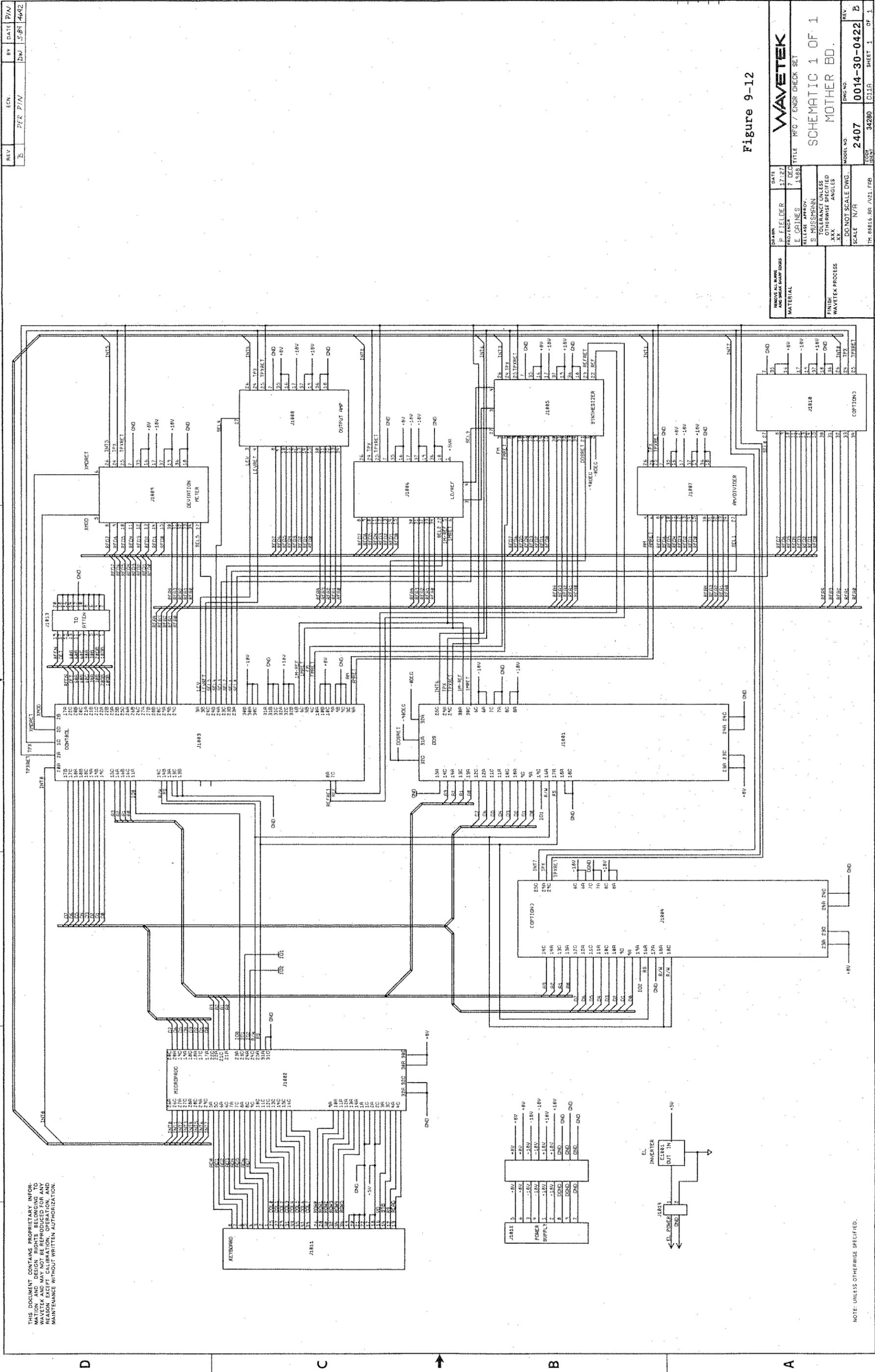


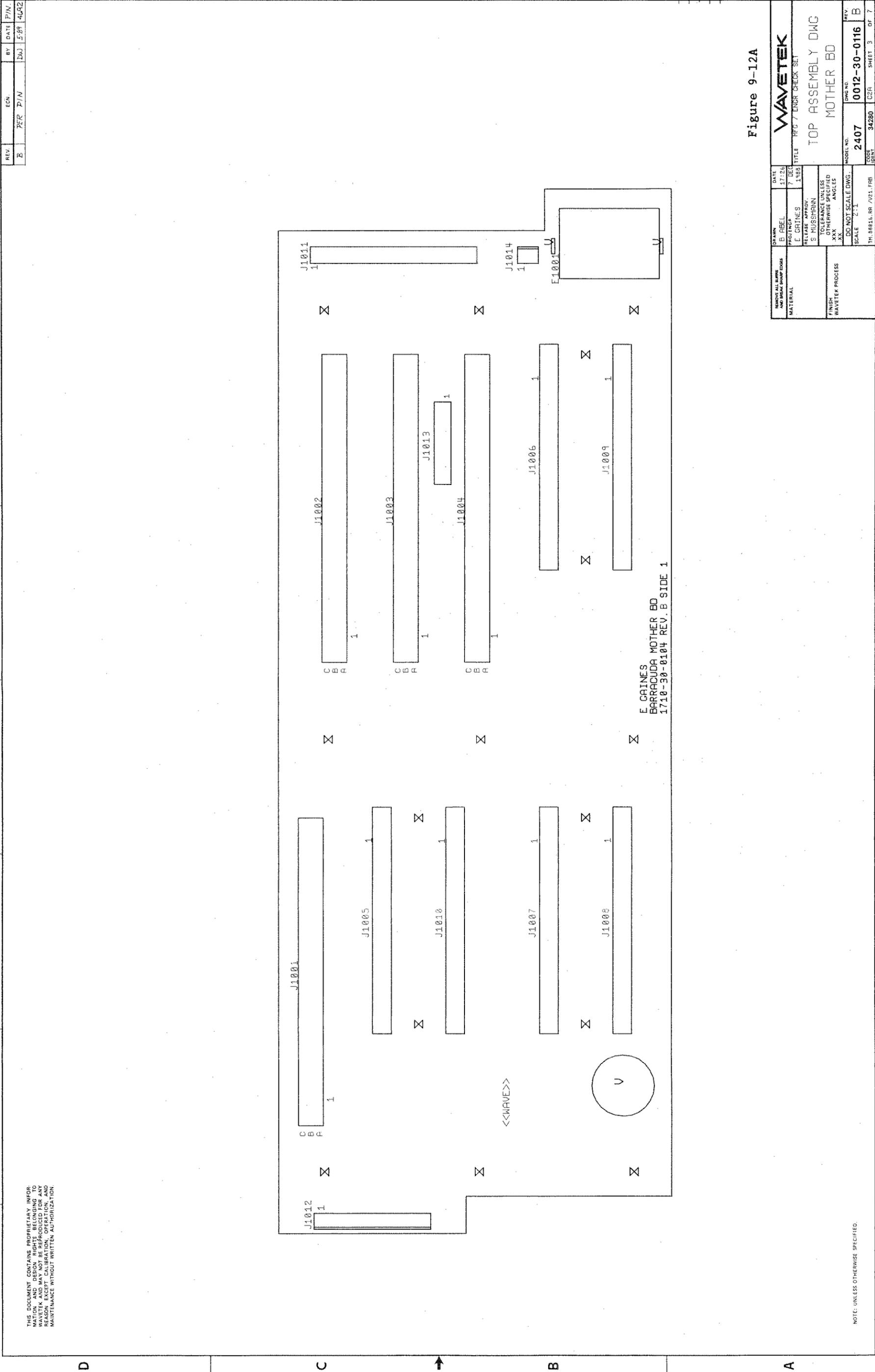
Figure 9-12

DRAWN P. FIELDER		DATE 17-27	7 DEC
PROJ ENGR E. CRINES		4 988	
RELEASE APPROV S. MUSSMANN			
TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ANGLES			
DO NOT SCALE DWG.			
SCALE	N/A	MODEL NO.	2407
TH. P885.6.RS /021.FRB	34280	0014-30-0422	REV. 1
COURT. SHEET 1		OF 1	

REMOVE ALL MARKS AND MASK SHAPED MATERIAL		WAVETEK	
FINISH WAVETEK PROCESS		SCHEMATIC 1 OF 1 MOTHER BD.	
TITLE R/C 7 ENGR CHECK SET		REV. 1	

NOTE: UNLESS OTHERWISE SPECIFIED.

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REMOVE ALL SOLDER AND BREAK SHARP EDGES	DRAWN	DATE	17:26
MATERIAL	B. REBEL	7 DEC	1988
FINISH WAVE TEK PROCESS	E. GRINES	1988	
	S. MUSCHMANN		
	TOLERANCE UNLESS OTHERWISE SPECIFIED		
	XX ANGLES		
	XX DO NOT SCALE DWG.		
	SCALE	2:1	
	TM, 58816, RR / V21, FFB		
	MODEL NO.	2407	REV. B
	DWG NO.	0012-30-0116	
	CODE	34280	SHEET 3 OF 7

Figure 9-12A

WAVE TEK

TOP ASSEMBLY DWG
MOTHER BOARD

1710-30-0116 B

REV	BY	DATE	P/N
B	DUJ	5/88	4L42
ECN	PER	P/N	

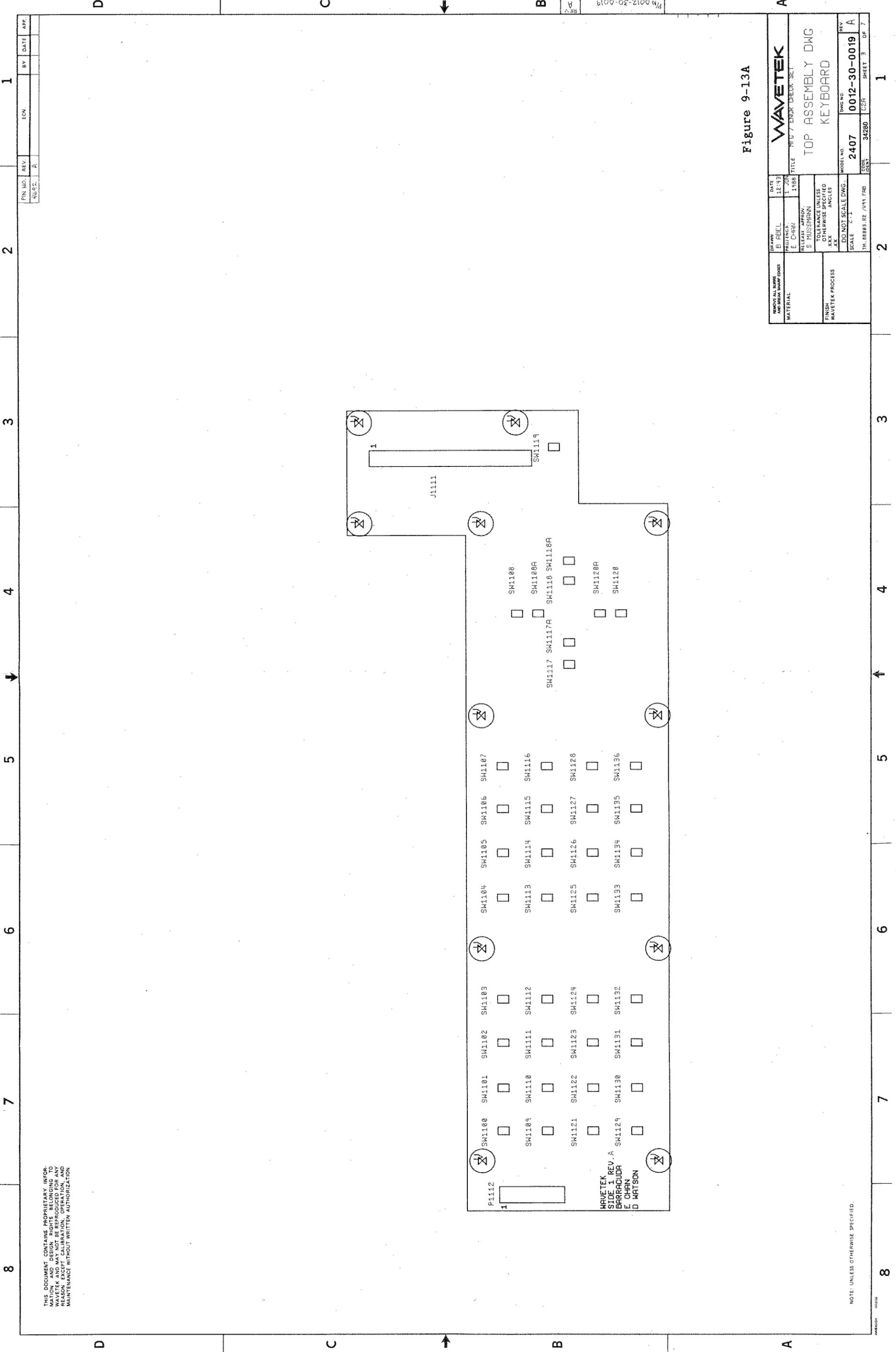


Figure 9-13A

DRAWN B. REEL		DATE 12-4-93	WAVETEK TOP ASSEMBLY DWG KEYBOARD	
PROJECTED E. CHAN		1-2008	REV. 3 OF 7	
RELEASE APPROV. S. MUSSMANN		1988	DRAWING NO. 0012-30-0019	
TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ANGLES XX		SCALE 2:1		
DO NOT SCALE DWG.		MODEL NO. 2407		
MATERIAL		CODE 34280		
FINISH WAVETEK PROCESS		SHEET 3 OF 7		

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NOTE: UNLESS OTHERWISE SPECIFIED.

WAVETEK

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REV	ECN	BY	DATE	APP
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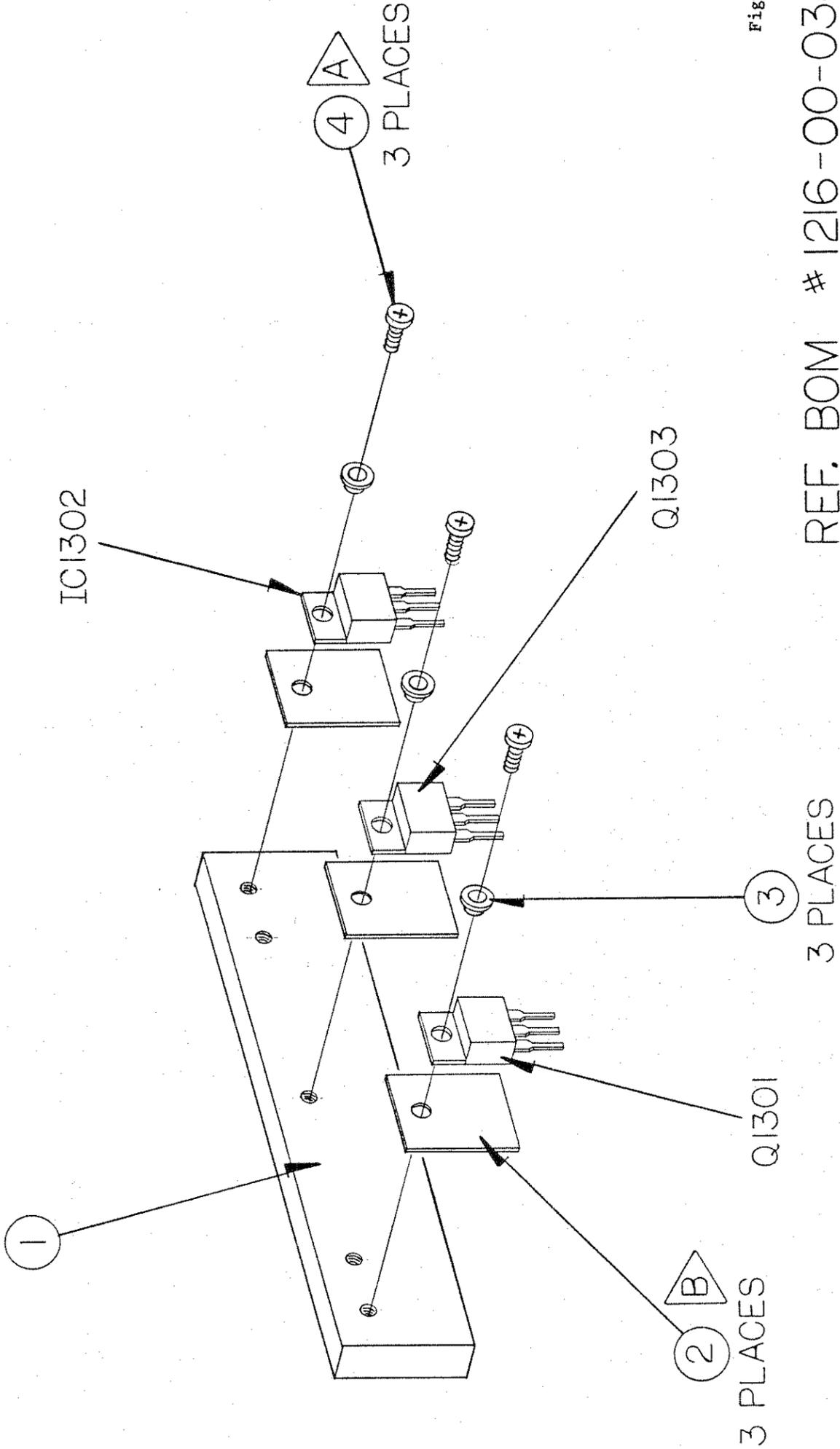


Figure 9-14B

REF. BOM # 1216-00-0349

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN DJ WATSON	DATE 9-88	WAVETEK
MATERIAL	PROJ ENGR		TITLE HEATSINK — ASSY DRAWING —
FINISH WAVETEK PROCESS	RELEASE APPROV <i>[Signature]</i>	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .XX ±	MODEL NO. 2407
	DO NOT SCALE DWG	SCALE NTS	DWG NO. 0012-10-0133
			REV
			CODE IDENT 34280
			SHEET 1 OF 1

- A TORQUE TO 4.7 IN-LBS
- B THERMAL COMPOUND TO BE USED BETWEEN HEATSINK AND INSULATOR AND ALSO Q1301 AND INSULATOR

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-  LEAD LENGTH IS $6 \pm 1/2$ "
STRIP ENDS $3/8$ "
-  LEAD LENGTH IS $6 \pm 1/2$ "
STRIP ENDS $1/8$ "

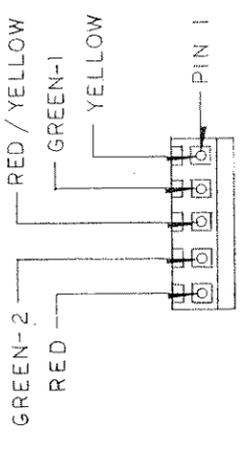
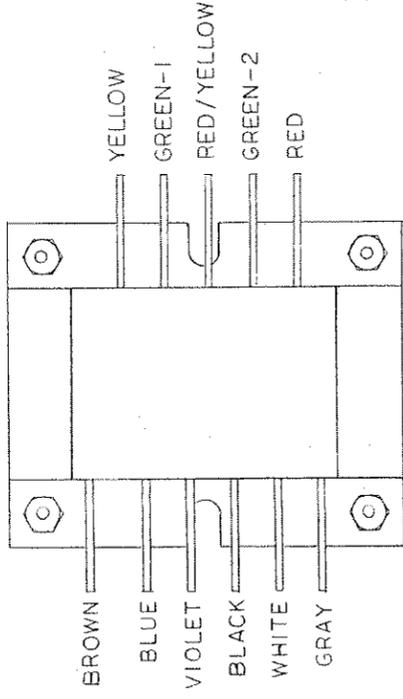
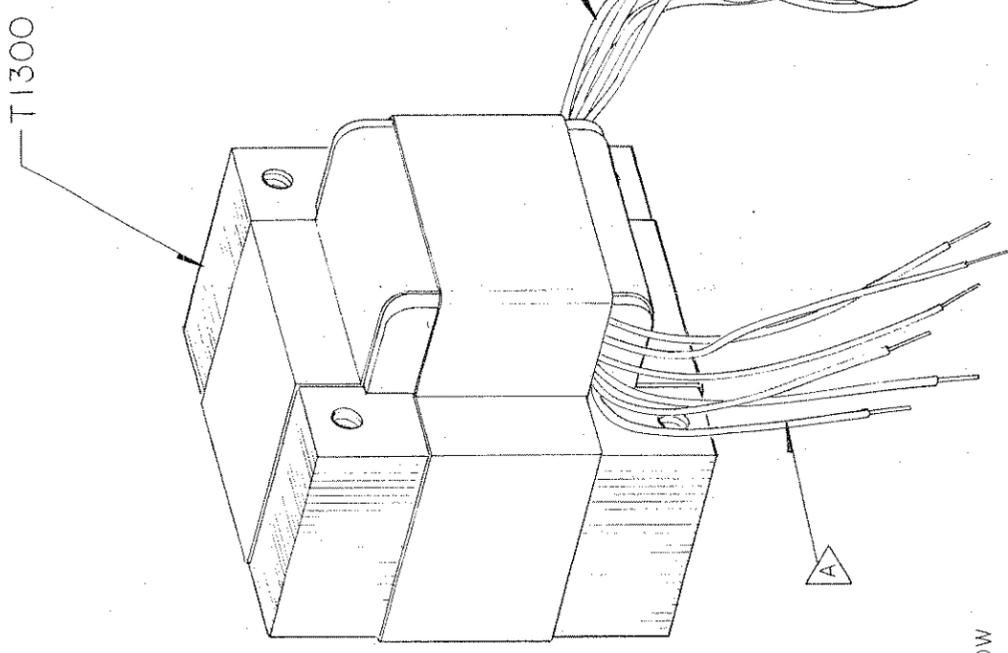
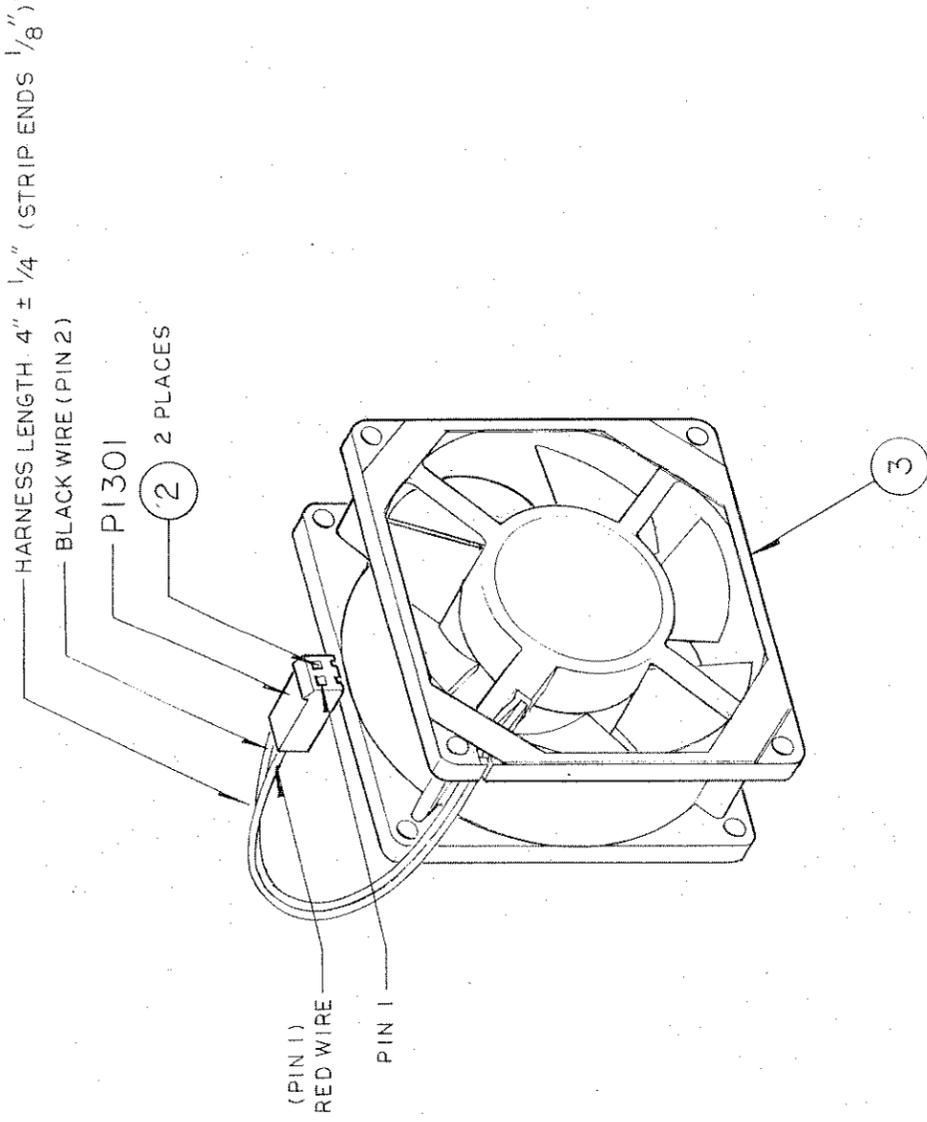


Figure 9-14C

REFERENCE B.O.M. 1219-00-0731

DRAWN <i>Libba</i>		DATE 9/88	WAVETEK	
PROJ ENGR		RELEASE APPROV <i>Shaw H. Haddad</i>	TITLE TRANSFORMER ASSEMBLY	
REMOVE ALL BURRS AND BREAK SHARP EDGES		TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .XX ±		
MATERIAL N/A		DO NOT SCALE DWG SCALE NONE		
FINISH WAVETEK PROCESS		MODEL NO. 2407	DWG NO. 0012-20-0100	REV
		CODE IDENT 34280		
		SHEET 1 OF 1		

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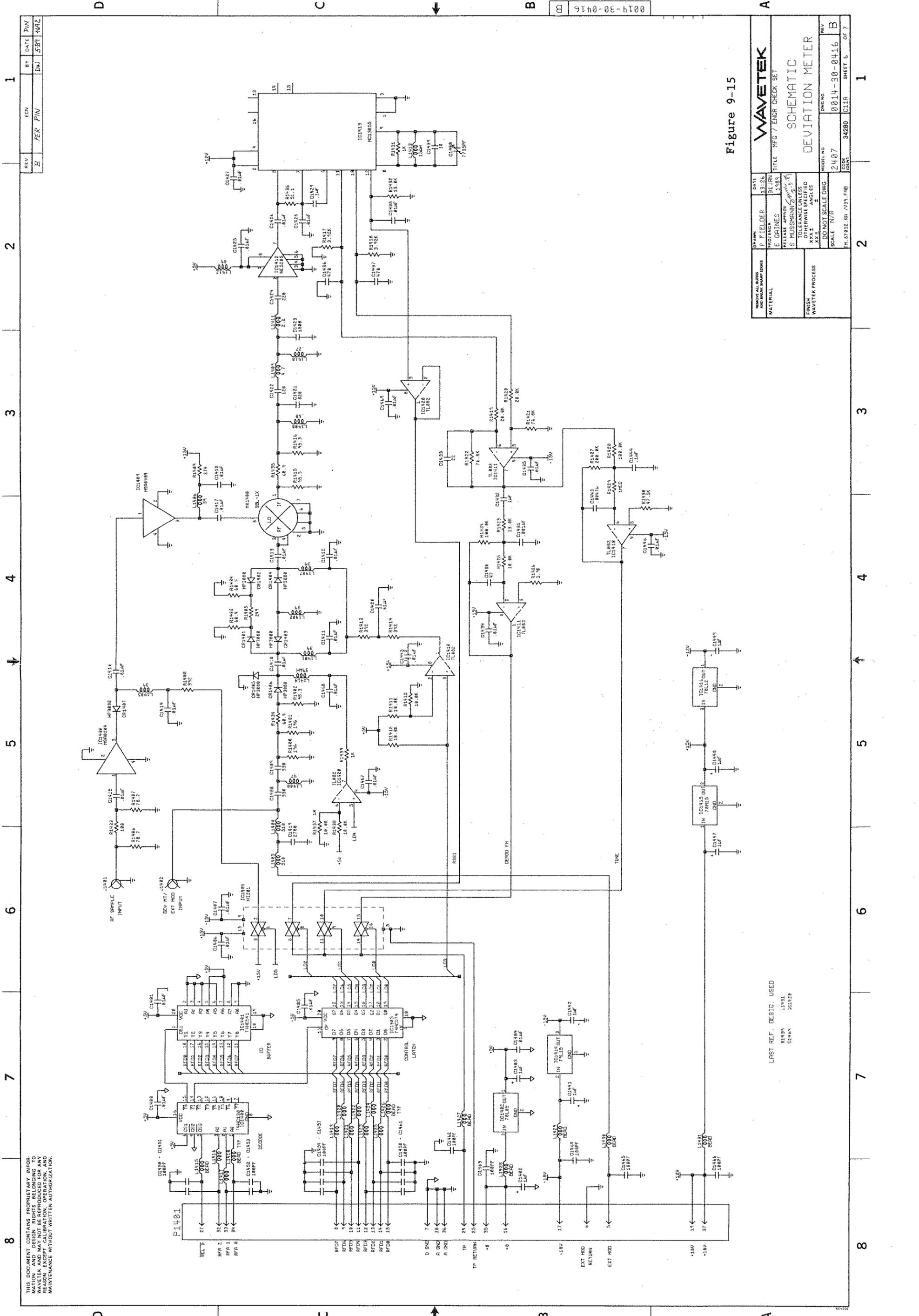


REV	ECN	BY	DATE	APP
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REF: B.O.M. # 1219-00-0732
Figure 9-14D

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN <i>[Signature]</i>	DATE 9/88	WAVETEK	
MATERIAL N/A	PROJ ENGR	RELEASE APPROV <i>[Signature]</i>	TITLE FAN ASSY. DRWG.	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± N/A ANGLES XX ±		MODEL NO. 2407	REV 0012-20-0101
N/A	DO NOT SCALE DWG SCALE		CODE IDENT 34280	SHEET 1 OF 1

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LAST REF. DESIG. USED
R1499 L1931
C1484 IC1426

REV	DATE	BY	ECN	PIN
B	5/81	DW	581	4642

REV	DATE	BY	ECN	PIN
B	5/81	DW	581	4642

DATE	13:26
PROF. DR.	31 JAN 1989
PROF. ENGR.	E. GRINES
RELEASE APPROV.	S. MUSSMANN
TOLERANCE UNLESS OTHERWISE SPECIFIED	XXX.1 ANGLES
DO NOT SCALE DWG	SCALE: N/A
MODEL NO.	2407
CODE	0014-30-0416
ISSUE	1
DATE	11/87
BY	882.SB/039.FMB
NO.	34280
SHEET	5
OF	7

Figure 9-15

WAVETEK	
TITLE	MF07 ENGR CHECK SET
SCHEMATIC	
DEVIATION METER	

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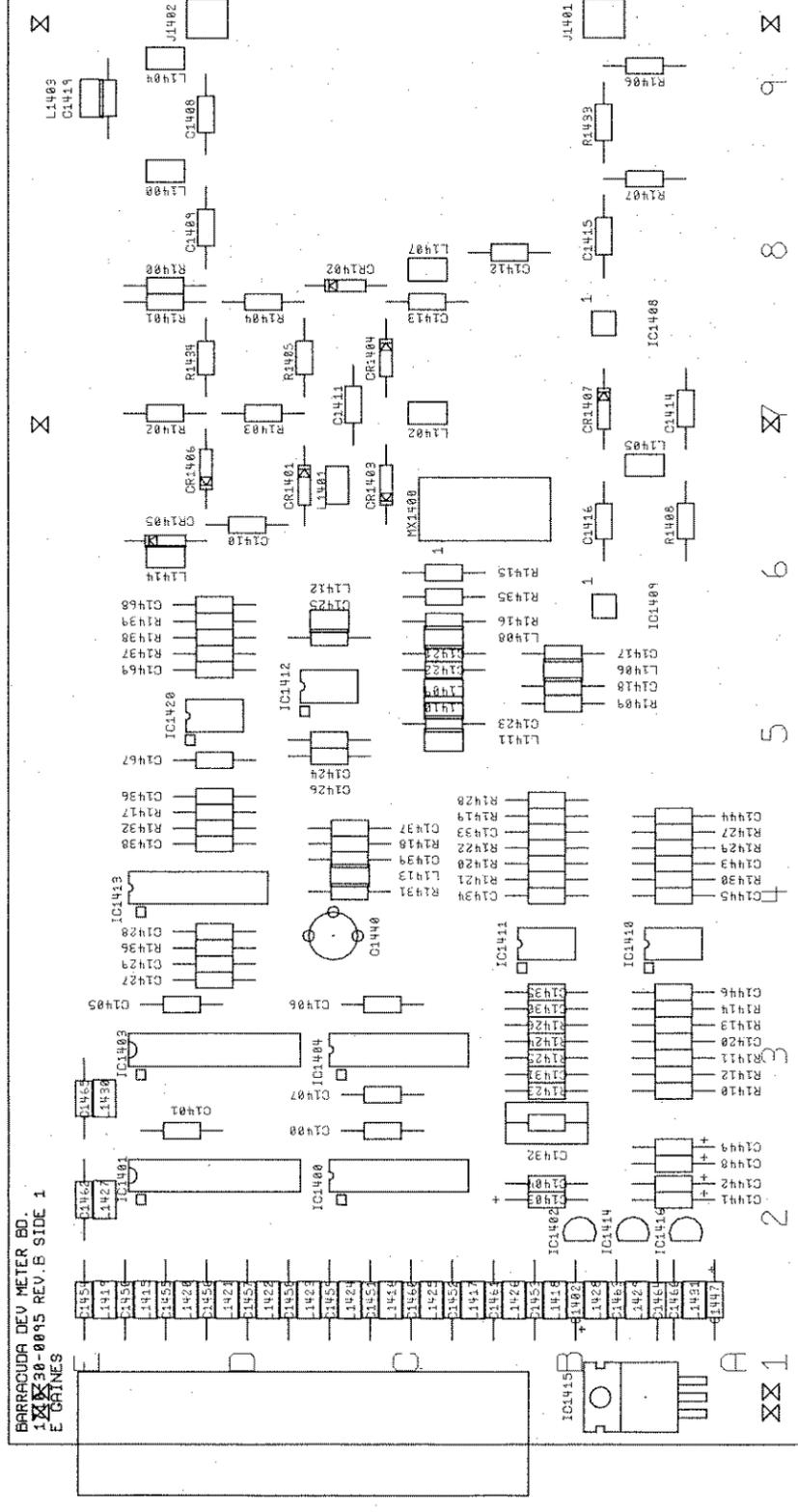


Figure 9-15A

WAVE TEK		DATE: 11-24-83	
DRAWN: [blank]		2. FEE: [blank]	
MATERIAL: [blank]		3. RELEASE APPROV: [blank]	
FINISH: WAVE TEK PROCESS		TOLERANCE UNLESS OTHERWISE SPECIFIED: .005 ±	
DO NOT SCALE DIMS		ANGLES: XXX ±	
SCALE: 2:1		REV: B	
MODEL NO: BARRACUDA		PART NO: 0012-30-0104	
DRAWN: [blank]		SHEET: 3 OF 7	

REV: B	ECN: PER PIAJ	DATE: 5-83	PIA: 4492
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0012-30-0104 B

1 2 3 4 5 6 7 8

A B C D

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-  TORQUE TO 17.8 IN-LBS
-  TORQUE TO 9 IN-LBS
-  TORQUE TO 5 IN-LBS

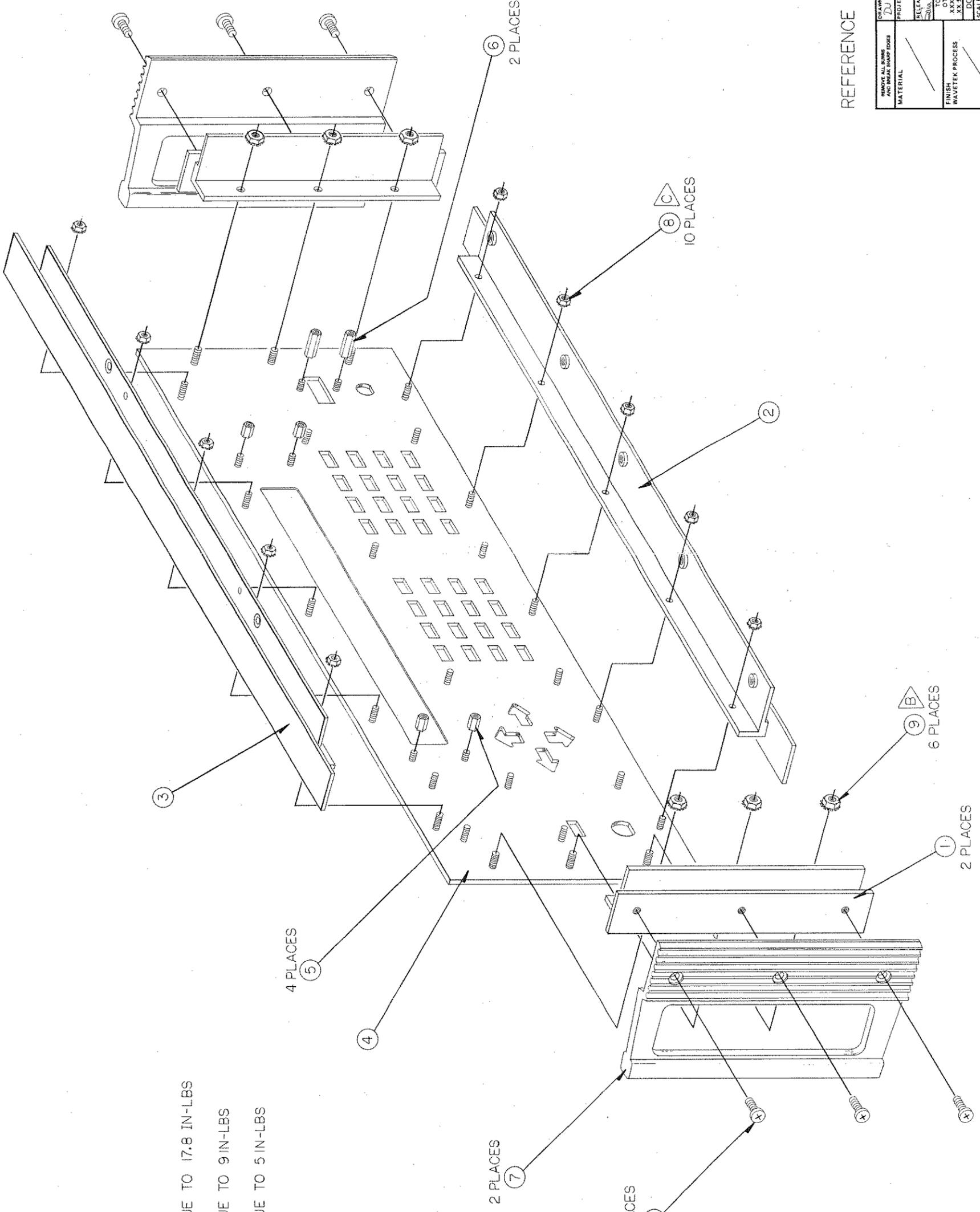


Figure 9-16

REFERENCE BOM # I216-00-0351

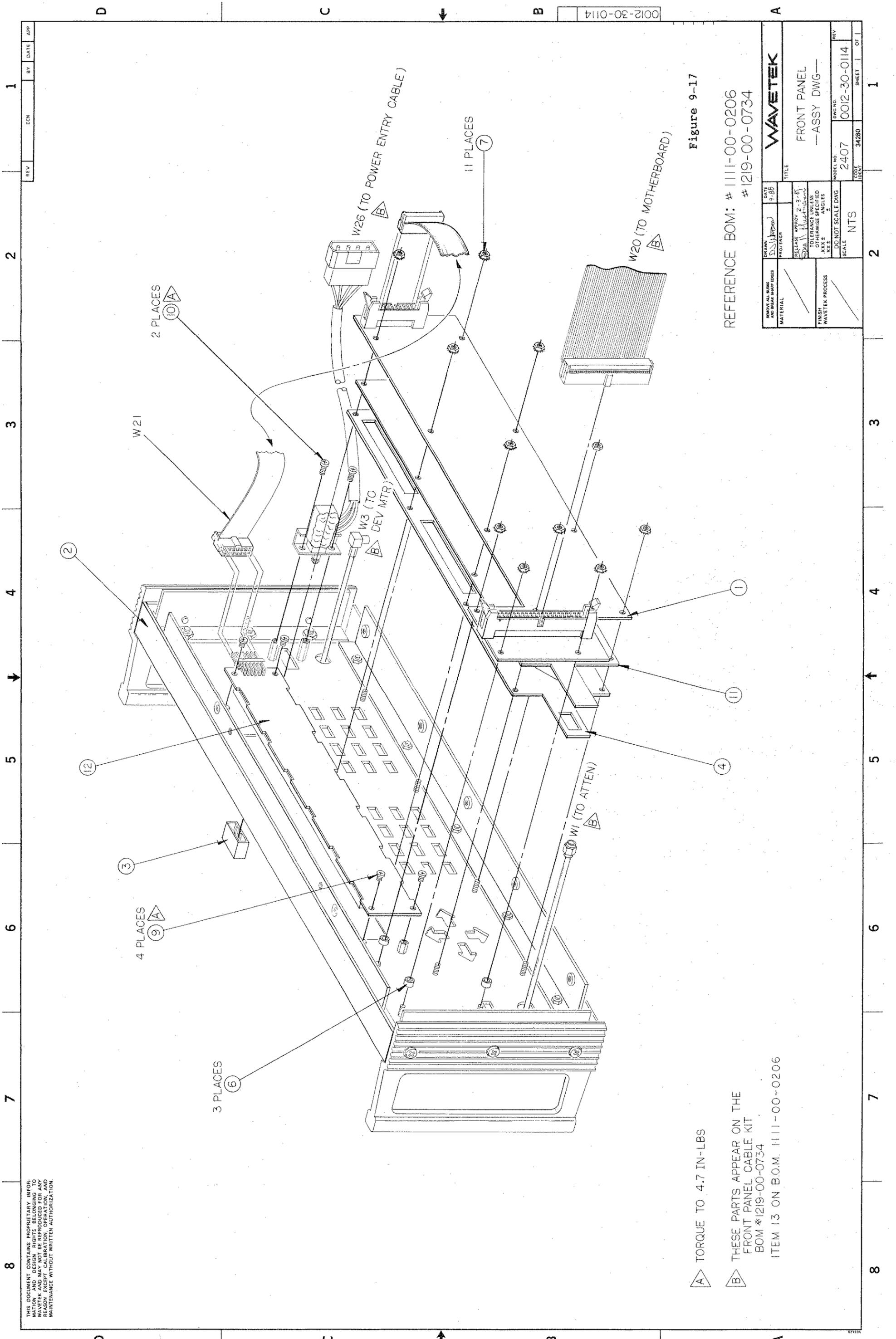
DRAWN D. WATSON		DATE 8-88	TITLE WAVETEK	
PROJ ENGR		RELEASE APPROV D. H. WATSON	F.P. MECH. — ASSY DWG —	
MATERIAL		TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±		
FINISH WAVETEK PROCESS		DO NOT SCALE DWG		
SCALE FULL		MODEL NO 2407	DWG NO 0012-30-0113	REV 1
		CROSS IDENT	34280	SHEET OF

0012-30-0113

D C B A

D C B A

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▲ TORQUE TO 4.7 IN-LBS

▲ THESE PARTS APPEAR ON THE FRONT PANEL CABLE KIT BOM #1219-00-0734 ITEM 13 ON B.O.M. 1111-00-0206

Figure 9-17

REFERENCE BOM: # 1111-00-0206
1219-00-0734

DRAWN		DATE	TITLE	
PROJEN		9-86	FRONT PANEL — ASSY DWG —	
RELEASE APPROV		2-3-87	MODEL NO.	
BY		11-11-86	2407	
OTHERWISE SPECIFIED		ANGLES	DWG NO.	
XXX ±		XX ±	0012-30-0114	
DO NOT SCALE DWG		SCALE	REV	
NTS			0012-30-0114	
MATERIAL		FINISH		WAVEJETEK PROCESS
REMOVE ALL MARKS AND BREAK SHARP EDGES		SCALE		2407
		SHEET		34280
		OF		1

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10 TYP 8-PLCS

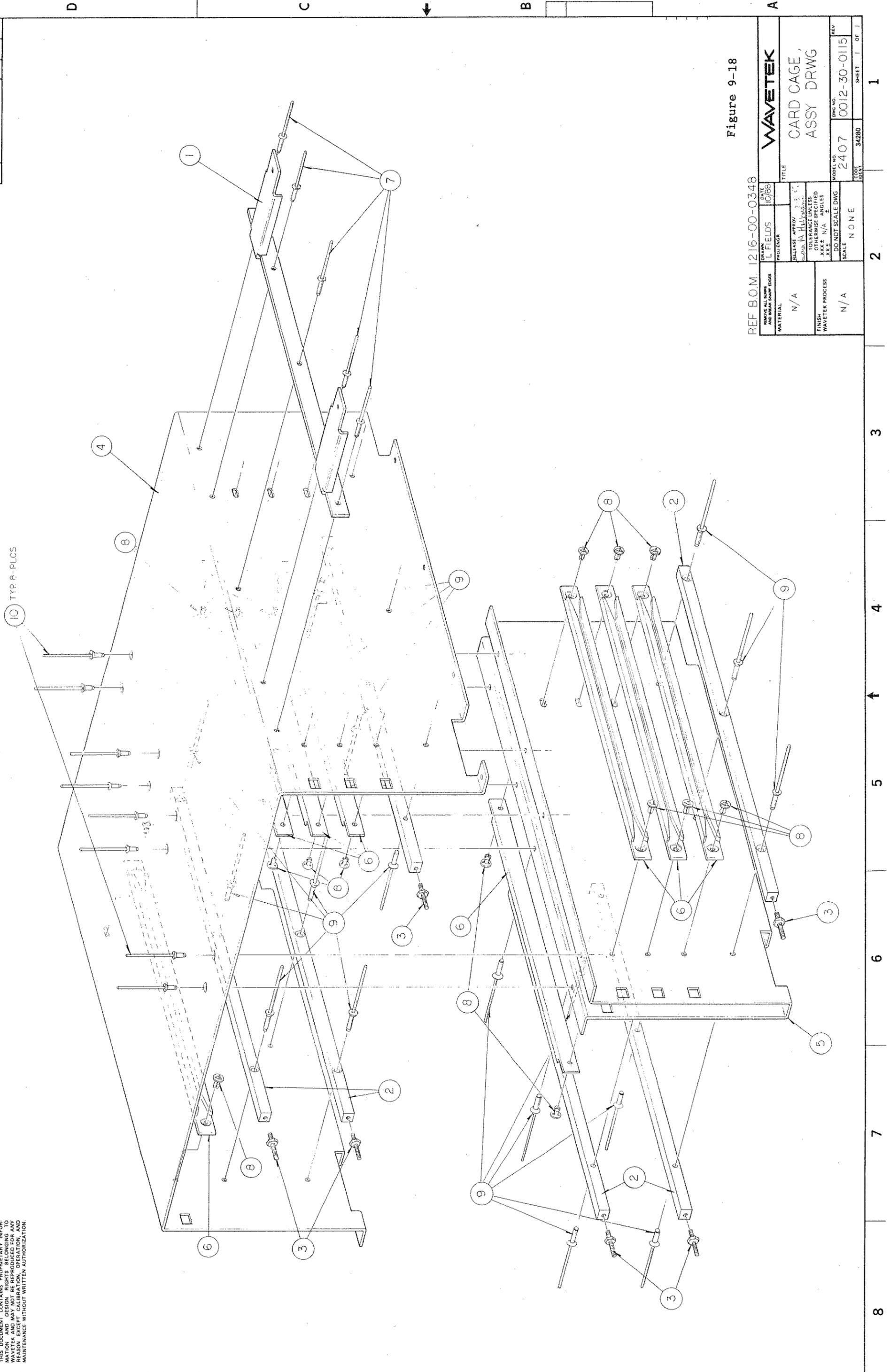


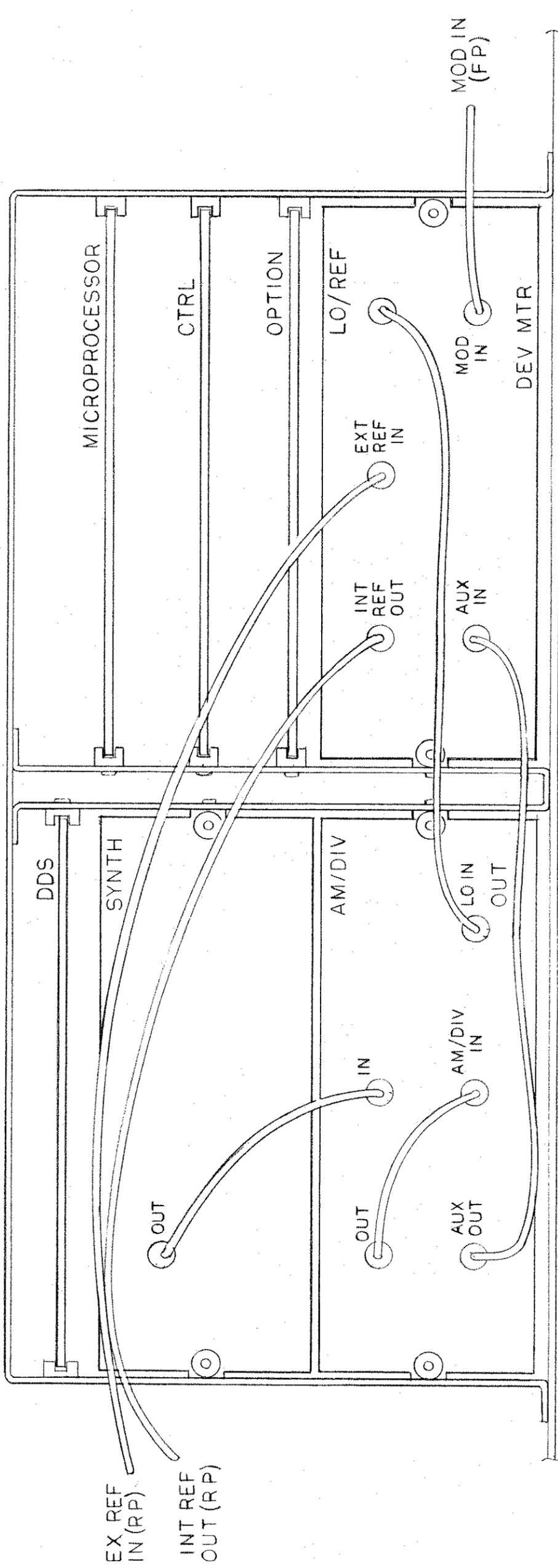
Figure 9-18

REF B.O.M. 1216-00-0348

DRAWN BY L. FIELDS		DATE 10/88	TITLE WAVETEK CARD CAGE, ASSY DRWG	
MATERIAL N/A		PROFESSOR	RELEASE APPROV 3.3.1 N/A	MODEL NO 2407
FINISH WAVETEK PROCESS			TOLEANCE UNLESS OTHERWISE SPECIFIED XXX± N/A	DWG NO 0012-30-0115
N/A			DO NOT SCALE DWG SCALE NONE	REV 1
			CORE IDENT 34280	SHEET 1 OF 1

1 2 3 4 5 6 7 8

REVISIONS		
ZONE	LTR	DESCRIPTION
	A	CTRL & DDS WERE REVERSED
		DATE 1-10-89
		APPROVED DW

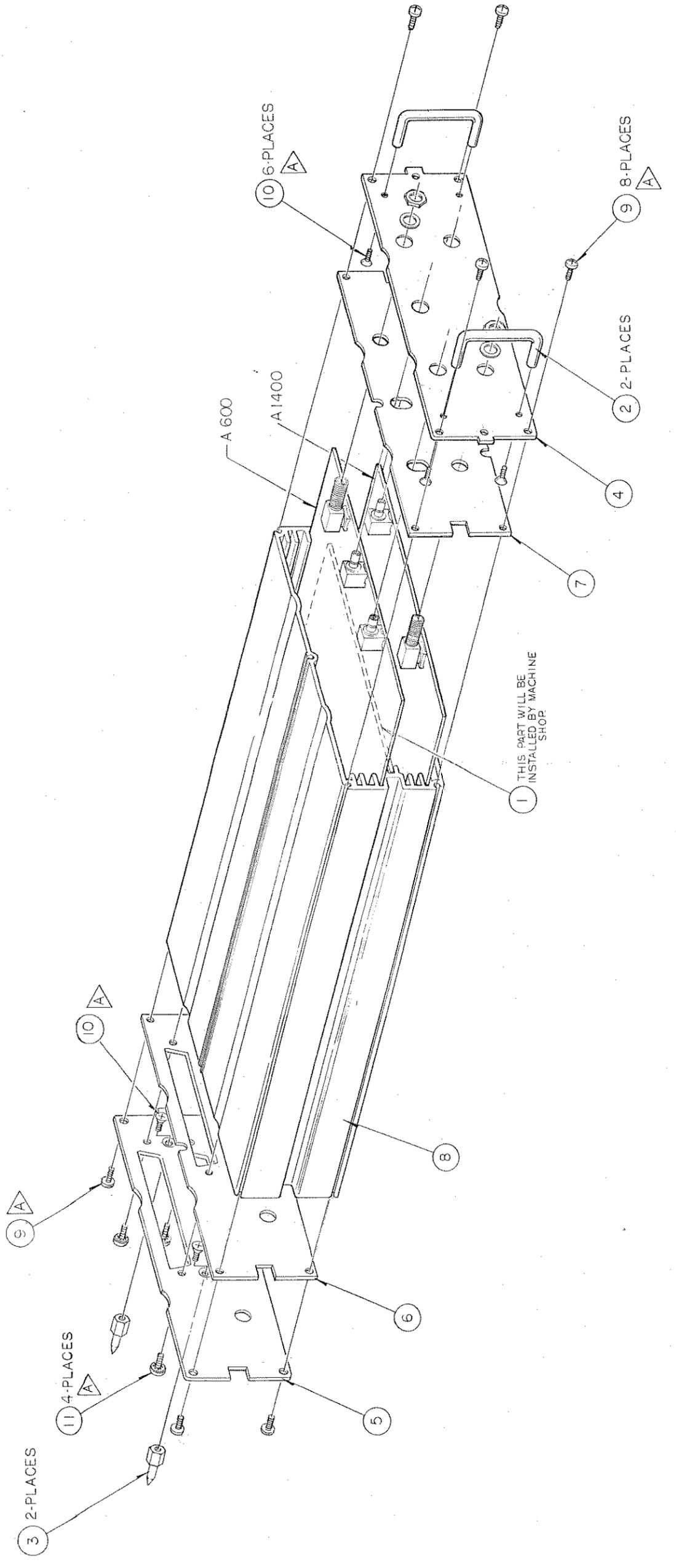


0012-10-0135

Figure 9-19

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:		CONTRACT NO.	
± .XX ±	FRACTIONS DECIMALS ANGLES ±	APPROVALS	DATE
± .XXX ±		DRAWN <i>L Fields</i>	10-88
MATERIAL		CHECKED	
FINISH			
2407	USED ON		
NEXT ASSY	APPLICATION	REV. A	
		SIZE B	CODE IDENT NO. 34280
			DRAWING NO. 0012-10-0135
			WAVETEK INDIANA, INC.
			CARD CAGE
			CABLE LOCATION
			DO NOT SCALE DRAWING

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▲ TORQUE TO 4.7 IN-LBS

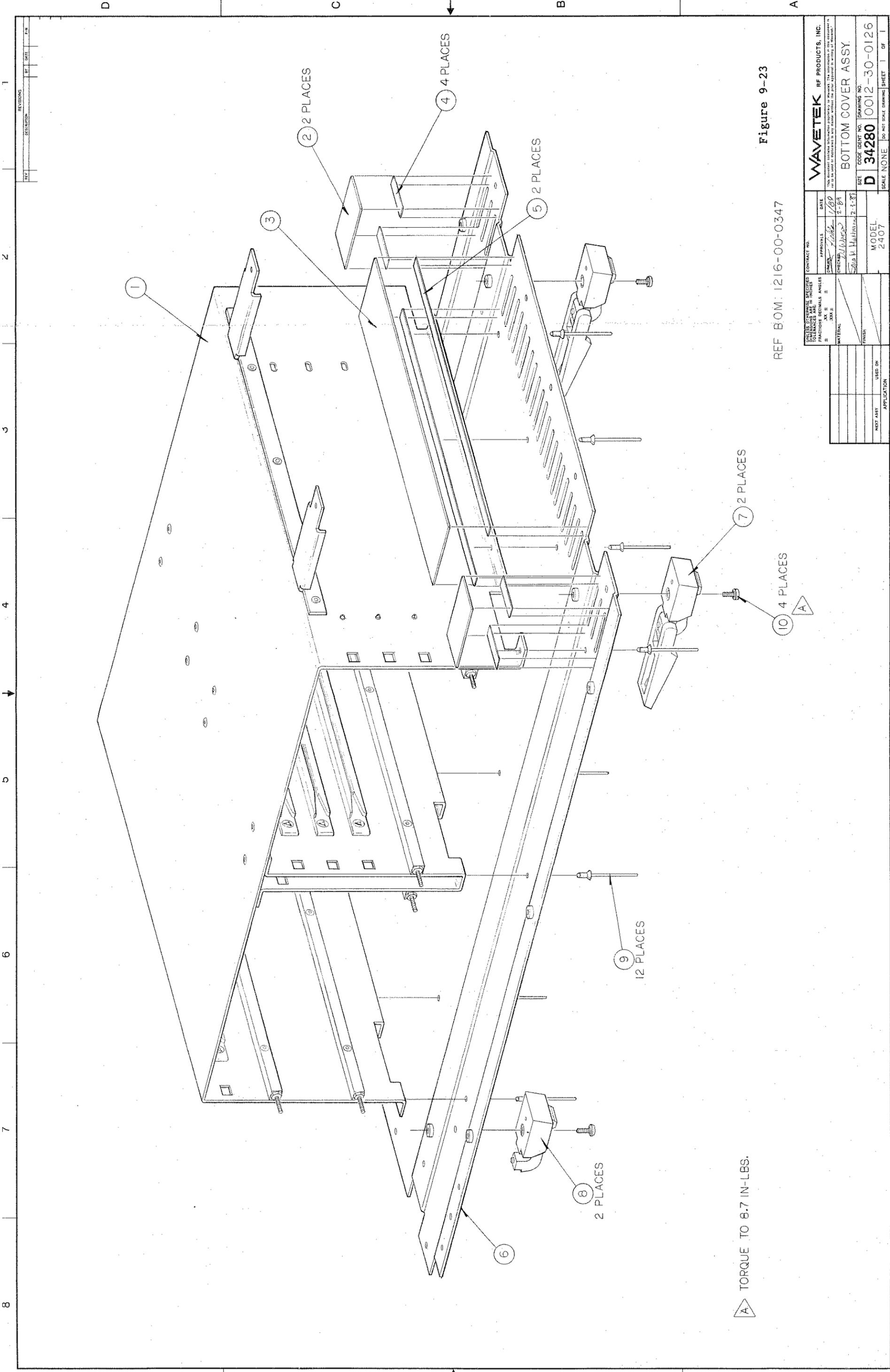
Figure 9-22

REF BOM 1114-00-0536

WAVETEK RF PRODUCTS, INC.	
DATE	1/89
APPROVAL	
DESIGNED BY	J. H. HARRIS
CHECKED BY	J. H. HARRIS
SIZE	D
CODE IDENT NO.	0012-30-013
SCALE	NONE

CONTRACT NO.	
ORDER NO.	
QUANTITY	
UNIT ASY	2407
USED ON	
APPLICATION	

UNITS	
INCHES	
ANGLES	
AXES	
XXX	
MATERIAL	
FINISH	



A TORQUE TO 8.7 IN-LBS.

Figure 9-23

REF BOM: 1216-00-0347

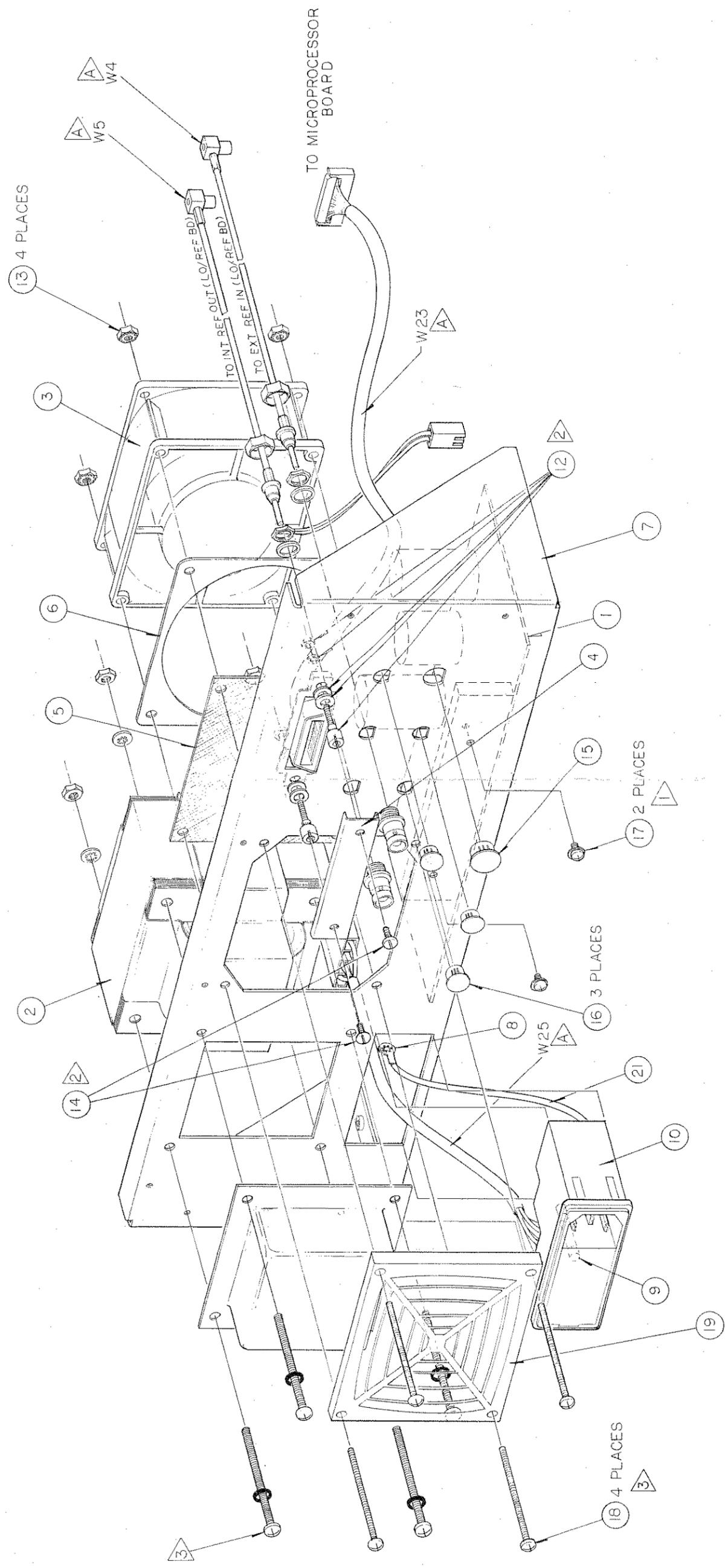
WAVETEK RF PRODUCTS, INC. <small>The following information is provided for reference only. It is not intended to be used as a substitute for the manufacturer's instructions. The user should refer to the manufacturer's literature for complete information.</small>		CONTRACT NO. APPROVALS DATE: 1/80 DRAWN: [Signature] CHECKED: [Signature] ENGINEER: [Signature]	SIZE: 2.5 x 3.0 SCALE: NONE
PARTS LISTED IN INCHES FRACTIONS DECIMALS ANGLES XXXX		MODEL: 2407	DRAWING NO.: 0012-30-0126 SCALE: NONE
MATERIAL:		FINISH:	DRAWING NO.: 0012-30-0126 SCALE: NONE
NOT ANY	USED ON	APPLICATION	SHEET 1 OF 1

REVISIONS: REV. DATE: P.N.

1 2 3 4 5 6 7 8

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REV	BY	DATE	APP



REFERENCE BOM: 1111-00-0205 R.P. ASSY.
1219-00-0733 CABLE KIT

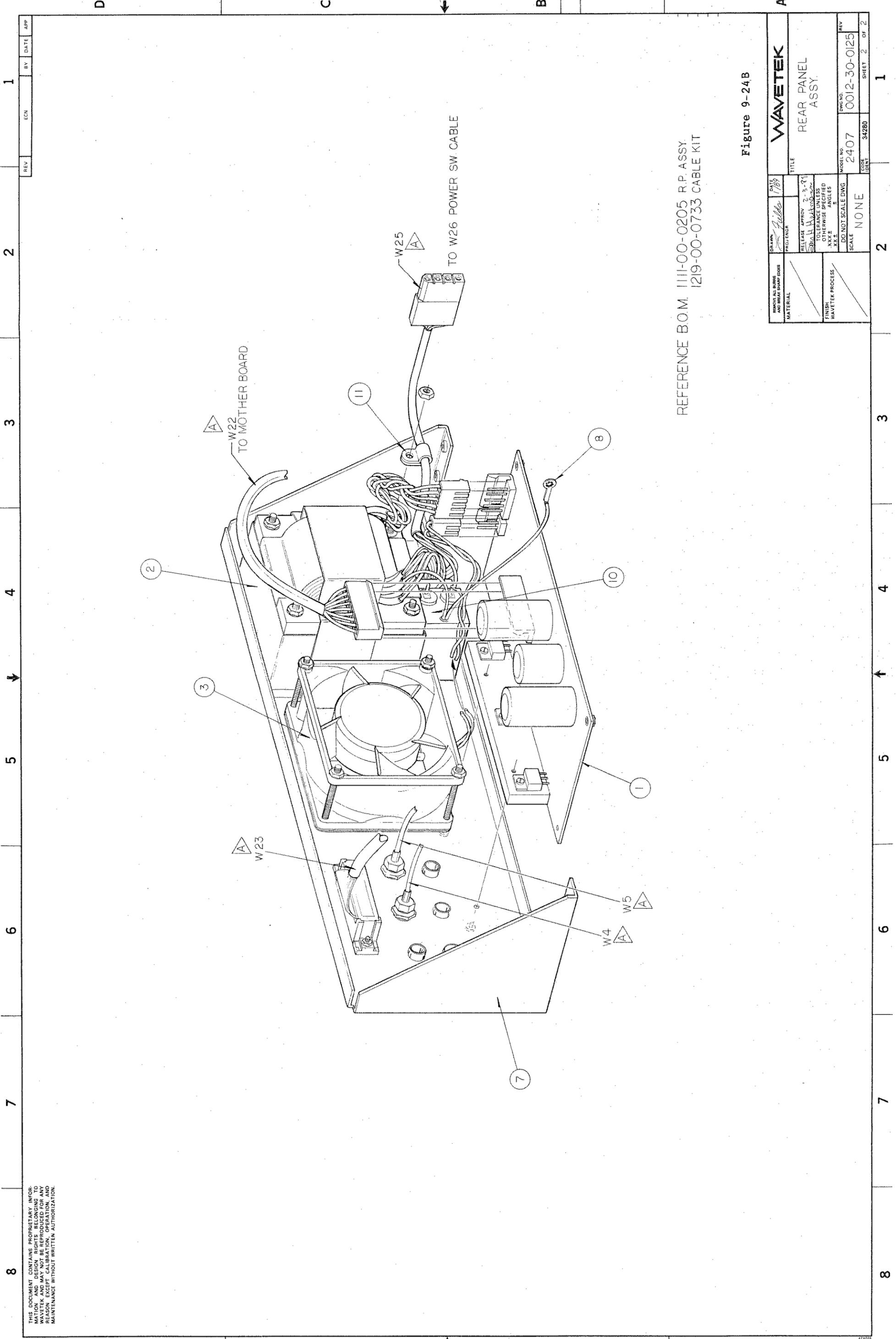
- 1 TORQUE TO 4.7 IN-LBS.
- 2 TORQUE TO 8.7 IN-LBS.
- 3 TORQUE TO 17.8 IN LBS.
- 4 THESE PARTS APPEAR ON THE R.P. CABLE KIT # 1219-00-0733

NOTE:
- LINE CORD NOT SHOWN (ITEM 20)

Figure 9-24A

DRAWN: <i>F. G. ...</i>		DATE: 1/89	REV: 1
CHECKED: <i>F. G. ...</i>		DATE: 1/89	REV: 1
RELEASE APPROV: <i>F. G. ...</i>		DATE: 1/89	REV: 1
TOLERANCE UNLESS OTHERWISE SPECIFIED: XXX ±		DO NOT SCALE DWG	SCALE: NONE
FINISH: WAVETEK PROCESS		MODEL NO: 2407	DWG NO: 0012-30-0125
MATERIAL: <i>(blank)</i>		ISSUE NO: 34280	SHEET 1 OF 2

WAVETEK
REAR PANEL ASSY.



REFERENCE B.O.M. 1111-00-0205 R.P. ASSY.
1219-00-0733 CABLE KIT

Figure 9-24B

		REAR PANEL ASSY.	
DRAWN: <i>J. J. J.</i> DATE: 1/89 PROJECT:	TITLE:	MODEL NO.: 2407	REV: 0012-30-0125
REMOVE ALL BURRS AND BRAG SHARP EDGES MATERIAL:	RELEASE APPROV: 2-3-89 BY: <i>H. H. H.</i> TOLERANCE UNLESS OTHERWISE SPECIFIED: .XX"	DO NOT SCALE DWG	SCALE: NONE
FINISH: WAVETEK PROCESS	CODE IDENT: 34280	SHEET: 2 OF 2	1

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.

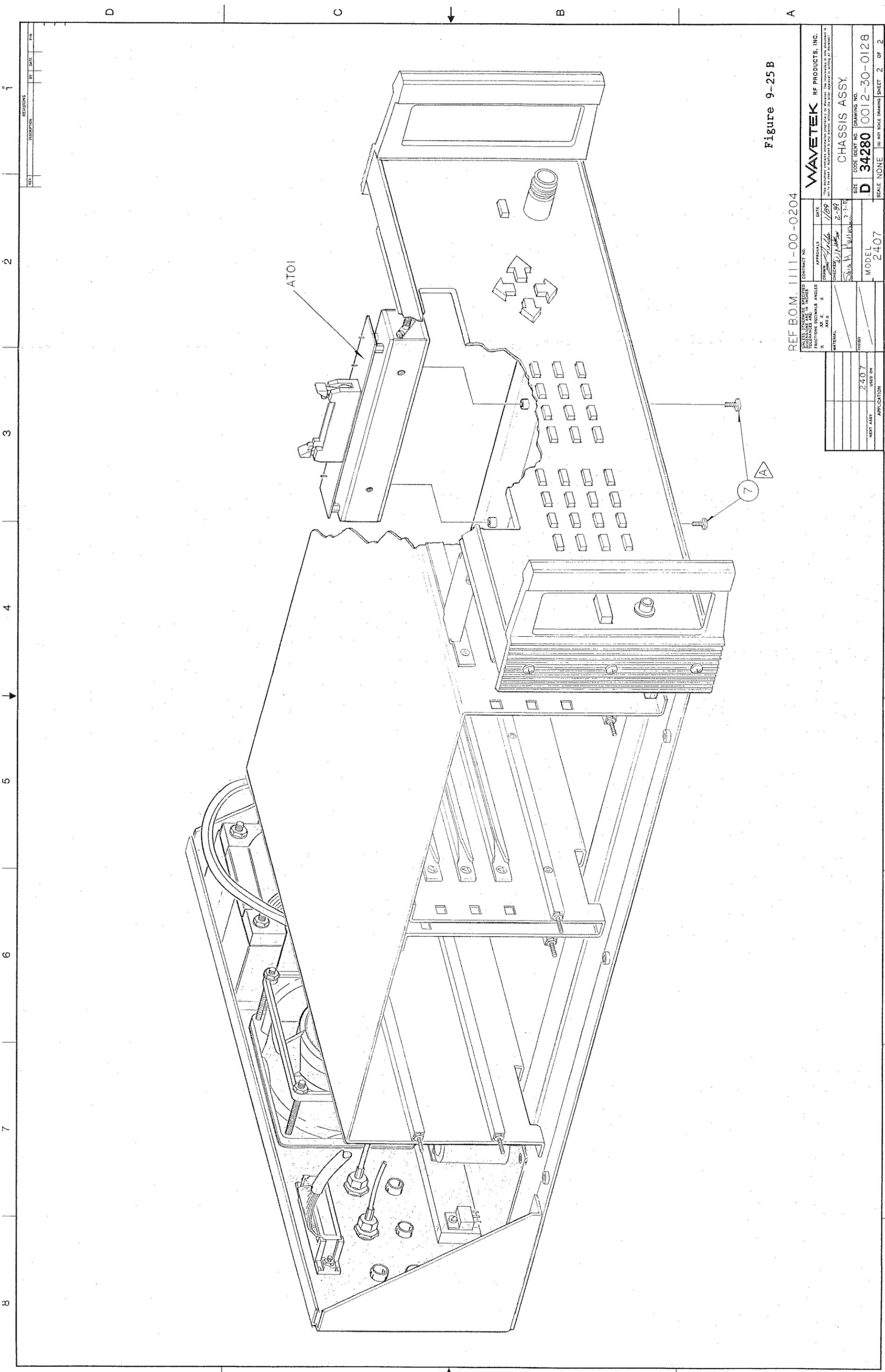


Figure 9-25 B

REF B.O.M. 1111-00-0204

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. FRACTIONS DECIMALS AND ANGLES SHALL BE TO NEAREST 1/16, .001 AND .01 RESPECTIVELY.		CONTRACT NO.	
DATE	APPROVALS	DATE	APPROVALS
1/89	[Signature]	1/89	[Signature]
DESIGNER	CHECKER	DATE	DATE
[Signature]	[Signature]	2-89	2-89
MATERIAL		FINISH	
2407		USED ON	
NEXT ASY		APPLICATION	
2407		2407	
CODE IDENT NO.		DRAWING NO.	
D 34280		0012-30-0128	
SCALE		NONE	
DO NOT SCALE DRAWING		SHEET 2 OF 2	

WAVETEK RF PRODUCTS, INC.
 CHASSIS ASSY.
 SIZE: D 34280
 DRAWING NO.: 0012-30-0128
 SCALE: NONE

1 2 3 4 5 6 7 8 A B C D

10.1 INTRODUCTION

This section contains replaceable parts lists for the Model 2407. A complete parts list may have more than one page.

10.1.1 A part with a starred (*) value indicates that it is the nominal value that is shown for the particular part. A component with a slightly different value may be substituted for a starred part during calibration.

10.1.2 Some early versions of the Micro-processor, Control, and Output boards were built with a .047 μ F ceramic capacitor instead of the .1 μ F tantalum

capacitor shown (part number 1510-27-9104).

10.2 MANUFACTURER CODES

Component manufacturers are identified by abbreviation codes on the Replaceable Parts Lists in this section. Complete manufacturer information (entire name, location, and FSCM number) for each manufacturer are shown immediately after the last of the parts lists.

10.3 ORDER OF PARTS LISTS

The parts lists begin immediately and are located in the following order:

PCB ASSY, Uproc Bd, 2407 (1218-00-2621)
HYBRID PTS KIT, Uproc Bd, 2407 (1219-00-0740)
EPROM KIT, Uproc Bd, 2407 (1219-00-0753)
PCB ASSY, Control Bd, 2407 (1218-00-2620)
HYBRID PTS KIT, Control Bd, 2407 (1219-00-0741)
PCB ASSY, DIRECT DIGITAL SYN, 2407 (1218-00-2622)
PC ASSY, Syn Bd, 2407 (1110-00-2315)
EPROM KIT, DDS, 2407 (1219-00-0752)
PC ASSY, LO/Ref Bd, 2407 (1110-00-2318)
HYBRID PTS KIT, LO/Ref Bd, 2407 (1219-00-0739)
PC ASSY, VCO, 2405/2407/2410/2475 (1218-00-2623)
HYBRID PTS KIT, VCO, 2405/2407/2410/2475 (1219-00-0749)
PC ASSY, AM/Div Bd, 2407 (1110-00-2314)
HYBRID PTS KIT, AM/Div Bd, 2407 (1219-00-0736)
PC ASSY, Output Bd, 2407 (1110-00-2313)
HYBRID PTS KIT, Output Bd, 2407 (1219-00-0735)
PC ASSY, Mother Bd, 2407 (1110-00-2311)
PC ASSY, P/S, 2407 (1110-00-2312)
HEAT'SINK ASSY, 2407 (1216-00-0349)
XFMR ASSY, 2407 (1219-00-0731)
FAN ASSY, 2407 (1219-00-0732)
PC ASSY, Dev Meter Bd, 2407 (1110-00-2317)
FP ASSY, 2407 (1111-00-0206)
FP MECH ASSY, 2407 (1216-00-0351)
LCD ASSY, 2407 (1219-00-0754)
CABLE KIT, FP, 2407 (1219-00-0734)
CD/CAGE ASSY, 2407 (1216-00-0348)
CABLE KIT, RP, 2407 (1219-00-0733)
CABLE KIT, RF, 2407 (1219-00-0728)
CABLE KIT, ATTN, 2407 (1219-00-0742)

ENCLOSURE, AM/DIV & OUTPUT, 2407 (1114-00-0534)
ENCLOSURE, SYNTH, 2407 (1114-00-0535)
ENCLOSURE, LO/REF & DEV METER, 2407 (1114-00-0536)
BOTTOM COVER ASSY, 2407 (1216-00-0347)
RP ASSY, 2407 (1111-00-0205)
CHASSIS ASSY, 2407 (1111-00-0204)
FINAL ASSY, 2407 (1118-00-0183)

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC101 IC121	MPU,CMOS PLAS,DIP-40,*SS*	HD63B03RP	HIT	8000-63-0310	2.000
IC104	8K X8 NON-VOL RAM PLAS,DIP-28,*SS*CMOS	DS1225Y-200	DLLAS	8000-12-2510	1.000
IC112	RAM DUAL PORT,1KX8 PLAS,DIP-48,CMOS*SS*	CY7C130-45PC	CYPRS	8000-71-3010	1.000
IC125	RAM CMOS,8KX8,DIP-28 120nS,*SS*	HM6264LP-12	HIT	8000-62-6400	1.000
IC126	ADPTR,GEN PURP INTFC PLAS,DIP-40,CMOS*SS*	MC68488P	MOT	8006-84-8810	1.000
IC130 IC131 IC132 IC133	XCVR,BIDRCT INST BUS PLAS,DIP-16,*SS*	MC3448AP	MOT	8000-34-4800	4.000
IC137	VOLT REG,5V,*SS* PLAS,TO-220,750MA W/DLYD RESET	LM2925T	NAT	7000-29-2510	1.000
P102	CONN,96 POS,DIN,M,RA 64 PIN,ROW B VOID	10-8457-096-002-026	ELCO	2112-20-0004	1.000
P111	HDR,DBL,RA,26-PIN	842-816-2633-435	APL	2112-08-0055	1.000
SW101	SWITCH,DIP,8 SPST	435802-1	AMP	5112-00-0004	1.000
TJ101	HDR,DBL,STRT,GOLD,16	65610-116	BER	2112-07-0079	1.000
X101 X102	(O)CRYSTAL,3.579545 MHZ	MPC18-3.579545MHZ	NEL	2310-00-1190	2.000
WAVETEK PARTS LIST		PCB ASSY,UPROC BD, 2407		1218-00-2621 PAGE: 1	A REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C101 C111 C115	CAP,TANT,10 UF,25V SURFACE MOUNT,T/R	NRD106M25R12	NEC	1510-27-9106	3.000
C102 C103 C116 C117	(P)CAP,CER,12PF,50V 1%,CHIP,NPO,+/-30PPM 0805,T/R,VALUE MARKD	C2012COG1H120FT	TDK	1510-06-5120	4.000
C104 C105 C106 C107 C110 C112 C113 C114 C118 C119 C120 C121 C122 C123 C124 C125 C126 C128 C129 C130 C131 C132 C133 C134 C135 C136 C138 C139 C140 C141	(P)CAP,TNT,-.1uF,50V +/-20%,CHP,T/R, 1206 CASE	TAJA104M050R	AVX	1510-27-9104	30.000
C108 C109	CAP,TANT,1 UF,35V SURFACE MOUNT	NRB105M35R12	NEC	1510-27-9105	2.000
C127	(P)CAP,CER,180PF,50V 5%,CHIP,NPO,+1-30PPM 0805,T/R,VALUE MARKD	500R15N181JV3P	W-I	1510-06-5181	1.000
IC102 IC123	LATCH 8 BIT 3 STATE SO-20 WIDE PKG,*SS* PLAS,H SPD CMOS	74HC573D	SIG	8007-45-7311	2.000
IC105 IC106 IC122 IC127	PERIPHERAL INTERFACE ADAPTER,PLCC-44,1MHZ *SS*	EF6821FN	THOMN	8000-68-2112	4.000
IC107 IC108 IC135	HEX INVERTER PLAS,SO-14,*SS* H-SPD CMOS	74HC04DH1	SIG	8000-74-0413	3.000
IC109 IC110 IC111 IC134	MAND GT,TRIPLE 3 IN PLAS,SO-14,*SS* H SPD CMOS	74HC10DH1	SIG	8000-74-1012	4.000
IC113	8-INPUT NOR/OR GATE PLAS,SO1C-14,*SS* H SPD CMOS	DM74HC4078M	NAT	8074-40-7810	1.000
IC129	8 INPUT NAND GATE PLAS,SO-14,*SS* L-PWR SCHOTTKY	N74LS30D	SIG	8000-74-3013	1.000
IC136	QUAD 2-INPUT NAND GT PLAS,SO-14,*SS* L-PWR SCHOTTKY	N74LS00D	SIG	8000-74-0015	1.000
R101 R102 R104 R105 R106 R107 R108 R109 R110 R111 R112 R119 R120 R121 R125 R126 R127 R128 R129 R130 R131 R132 R133 R134 R135 R136 R137 R138 R139 R140 R141 R142 R143 R144 R145 R146 R147 R148 R150 R151 R152 R153 R154 R157 R165 R166 R167 R168 R169 R170 R171 R172 R173 R174 R175 R176 R177 R178 R179 R180 R181 R182 R183 R184 R185 R186 R187 R188 R189 R190	(P)RES,CHP,5.11K,1% 1/8W,TC=100ppm,T/R 1206	MCR1206-5.11KOHM,1%T	RCD	4711-03-5111	70.000
WAVETEK PARTS LIST	HYBRID PTS KIT, UPROC BD, 2407	1219-00-0740			C REV
		PAGE: 1			

REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R103 R149	(S)RES,CHP,6.19M,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B6194F	KOA	4711-03-6194	2.000
R118 R122 R123 R124	(P)RES,CHP,100,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810091C	KMYO	4711-03-1000	4.000
R155	RES,CHP,576,1% 1/8W,TC=100ppm,T/R 1206	RMC 1857691C	KMYO	4711-03-5760	1.000
R156 R160	RES,CHP,2.15K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1821511C	KMYO	4711-03-2151	2.000
R158	(P)RES,CHP,1.0K,1% 1/8W,TC=100ppm,T/R 1206	BCK1001FB	A-B	4711-03-1001	1.000
R159	(P)RES,CHP,10.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810021C	KMYO	4711-03-1002	1.000
WAVETEK PARTS LIST	HYBRID PTS KIT, UPROC BD, 2407	1219-00-0740 PAGE: 2		C REV	

REFERENCE DESIGNATORS	PART DESCRIPTION	>< ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
IC103 IC124	32Kx8 ROM CMOS ONE TIME PROGRAMMABLE PLAS,DIP-28, *SS*	TMS27C256-25N	T-I	8002-72-5600	2.000	
IC128	PLD,ONE TIME ONLY PLAS,DIP-20,*SS*HCMOS	EP320PC-2	ALTRA	8000-32-0210	1.000	
WAVETEK PARTS LIST		EPROM KIT,UPROC,2407		1219-00-0753 PAGE: 1		REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
CR201 CR202	DIODE, SIGNAL, GP AXIAL, V=75V, IO=10mA CT=4pF, *SS*	1N914	G-E	4807-01-0914	2.000
IC201	FLOUR DISPLAY DRVR *SS*	UDN-6118A	SPR	8000-61-1800	1.000
IC202 IC203 IC205 IC206 IC224 IC248 IC249	OCT 3-STATE NON-INV D-TYPE FLIP-FLOP*SS* PLASTIC, DIP-20 CMOS	MC74HC574N	MOT	8007-45-7410	7.000
IC204 IC211	DCCR/DEMUX, 1-OF-8 PLAS, DIP-16 H SPD CMOS, *SS*	MC74HC138N	MOT	8007-41-3811	2.000
IC207 IC208 IC228 IC229	BUFFER, OCTAL, 3 STATE PLAS, DIP-20, *SS* HIGH SPEED CMOS	MC74HC541N	MOT	8007-45-4110	4.000
IC212	VOLT REG, +12V, 3-TERM PLAS, TO-220, 35Vdc Io=500mA, *SS*	LM78M12CT	NAT	7000-78-1200	1.000
IC213	VOLT, REG, FIXED, -15V PLAS, TO-226AA, -35Vdc 10%, Io=100mA, *SS*	LM79L15ACZ	NAT	7000-79-1510	1.000
IC214	VOLT REG, FIXED, +15V PLAS, 3 PIN(TO-220) 35Vdc, .1%, 700mA, *SS*	SA78M15CU	SIG	7000-78-1500	1.000
IC215	POS. VOLT REG-3 TERM PLAS, TO-220AB, 5 VOLT 500mA, 7 W, 5%, 3-TERM	S78M05CV	SIG	7000-78-0500	1.000
IC216 IC219 IC243 IC246 IC253	OP AMP, JFET, DUAL PLAS, DIP-8, 22Vdc 10V/uS, LOW OFST, *SS*	LF412CN	NAT	7000-04-1210	5.000
IC217	MULTIPLEXER, 4/8 CHAN PLAS, DIP-16, +-17Vdc CMOS, 30uW, R=170, *SS*	AD7501JN	A-D	7000-75-0110	1.000
IC218	MULTIPLYING, DAC PLAS, DIP-18, 17Vdc CMOS, 12 BIT, *SS*	AD7541AKN	A-D	7000-75-4110	1.000
IC220	VOLT COMPARATOR PLAS, DIP-8, Tr=200ns *SS*	LM311N	NAT	7000-03-1100	1.000
IC221	EXCL-OR G, QUAD 2 INP PLAS, DIP-14, H SP CMOS, *SS*	SN74HC86	T-I	8000-74-8611	1.000
IC222 IC233 IC252	NAND GATE, QUAD 2-INP PLAS, DIP-14, *SS* H-SPD CMOS-LSTTL	MC74HC00N	MOT	8000-74-0012	3.000
IC223	NAND G, TPL 3-INP PLAS, DIP-14, CMOS*SS*	SP74HC10	SPI	8000-74-1001	1.000
WAVETEK PARTS LIST		PCB ASSY, CONTROL BD, 2407		1218-00-2620 PAGE: 1	A REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC225 IC226 IC227	UP/DWN CNTR,4 BIT PLAS,DIP-16,*SS* H-SPD CMOS,PRESETTBL	SN74HC191N	T-I	8007-41-9110	3.000
IC230 IC231 IC232	CNTR,BIN RPL,DUAL PLS,DIP-16 H SPD CMOS,*SS*	MM74HC390N	NAT	8007-43-9011	3.000
IC234 IC235	OP AMP,DUAL,LW NOISE PLAS,DIP-8,18Vdc 140KHz,9V/uS,*SS*	NE5532AM	SIG	7000-55-3201	2.000
IC236 IC239	OP AMP,LOW NOISE PLAS,DIP-8,20Vdc 200KHz,13V/uS,*SS*	NE5534AM	SIG	7000-55-3401	2.000
IC237 IC238	ANLG SW,QUAD,SPST GERM,DIP-16,CMOS*SS*	DG201CJ	SCX	8000-02-0101	2.000
IC242 IC244 IC245	DAC,12BIT,UP,COMPAT PLAS,DIP-20,*SS*CMOS	MP1230KN	MCS	8001-20-3000	3.000
IC247	PREC TEMP SENSOR PLAS,TO-92,I _f =15mA I _r =15mA,+/-2C,*SS*	LM335Z	NAT	7000-03-3500	1.000
IC250	VOLT REF,PREC,10V PLAS,DIP-8,+/-100mV *SS*	REF-01CP	PMI	7000-00-0101	1.000
P200	D-CONN,96 PIN,RA, MALE,ROW A-C FILLED	DIN-96CPC-SRI-TR	R-N	2112-20-0007	1.000
P201A P201B	HEADER,8-PIN STRT REF:2112-07-0000	65501-408	BER	2112-07-0006	2.000
R267 R281	TRM,CM,L,5K,10%,PC 1T,PN,CW,.375H,.200W .375L,SA	3386S-1-502	BOU	4610-00-1502	2.000
RN216 RN222 RN228	RES,NW,4.7K,SIP,2% 1-1/4W,BUSSED,9 RES TC=100PPM	750-101-R4.7K	CTSBR	4770-00-0014	3.000
WAVETEK PARTS LIST	PCB ASSY,CONTROL BD, 2407	1218-00-2620			A REV
		PAGE: 2			

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C201 C202 C203 C211 C212 C213 C214 C217 C218 C230 C231 C238 C239 C245 C247 C248 C250 C251 C252 C253 C255 C256 C257 C258 C259 C260 C261 C262 C263 C264 C265 C266 C267 C268 C269 C270 C271 C272 C273 C274 C277 C283 C284 C285 C286 C287 C288	(P)CAP,TNT,.1uF,50V +/-20%,CHP,T/R, 1206 CASE	TAJA104M050R	AVX	1510-27-9104	47.000
C204 C206 C208	CAP,TANT,10 UF,25V SURFACE MOUNT,T/R	NRD106M25R12	NEC	1510-27-9106	3.000
C205 C207 C209 C210 C219 C220 C223 C226 C227 C229 C234 C237 C240 C241	CAP,TANT,1 UF,35V SURFACE MOUNT	NRB105M35R12	NEC	1510-27-9105	14.000
C221 C222 C224 C225 C232 C233 C235 C236	(P)CAP,CER,.01uF,50V 20%,CHP,X7R,0805,T/R VALUE MARKED	08055C103MAT050M	AVX	1510-06-7103	8.000
C228	(P)CAP,CER,22PF,50V 1%,CHIP,NPO,+/-30PPM 0805,T/R,VALUE MARKD	C2012COG1H220FT	TDK	1510-06-5220	1.000
C246 C249 C254	(C)CAP,POR,5.1pF,50V +/- .25,CHP,NPO .07"x.055"	MA585R1C	MURGA	1510-02-9519	3.000
C289	(P)CAP,CER,100PF,50V 1%,CHIP,NPO,+1-30PPM 0805,T/R,VALUE MARKD	C2012COG1H101FT	TDK	1510-06-5101	1.000
Q201 Q202 Q203	NPN,SOT-23,MED PWR F=250m,V=40,P=310m, hFE=40,*SS*,T/R	BSS79C-SOT-23	SIEM	4902-00-0170	3.000
R200 R208 R249 R259 R268 R269 R271 R272	(P)RES,CHP,1.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810011C	KMYO	4711-03-1001	8.000
R201 R202 R204 R205 R206 R209 R212 R247 R250 R251 R260 R261 R265 R275 R279 R285 R286 R289 R291 R292 R293 R295 R296 R299	(P)RES,CHP,10.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810021C	KMYO	4711-03-1002	24.000
R203 R258 R263	(S)RES,CHP,35.7K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B3572F	KOA	4711-03-3572	3.000
R207	(S)RES,CHP,1.0M,1% 1/8W,1206,TC=100PPM T/R	RK73H2B1004F	KOA	4711-03-1004	1.000
R210 R276	(S)RES,CHP,8.25K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B8251F	KOA	4711-03-8251	2.000
R211 R255 R290	(P)RES,CHP,5.11K,1% 1/8W,TC=100ppm,T/R 1206	RMC1851111C	KMYO	4711-03-5111	3.000
WAVETEK PARTS LIST		HYBRID PTS KIT, CONTROL BD,2407		1219-00-0741 PAGE: 1	B REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
R213	(P)RES,CHP,2.00K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1820011C	KMYO	4711-03-2001	1.000	
R246	(S)RES,CHP,332K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B3323F	KOA	4711-03-3323	1.000	
R248	(C)RES,CHP,39,1% 1/8W,NON-STD VALUE	RMC1839081C	KMYO	4711-03-3909	1.000	
R253 R273 R274 R277 R278	RES,CHP,14.7K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1814721C	KMYO	4711-03-1472	5.000	
R262 R264	(P)RES,CHP,39.2K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B3922F	KOA	4711-03-3922	2.000	
R266 R280	(S)RES,CH,6.81K,1% 1/8W,TC=100ppm,T/R 1206	RK73H2BT6811F	KOA	4711-03-6811	2.000	
R270	(S)RES,CHP,511,1% 1/8W,TC=100ppm,T/R 1206	RMC 1851191C	KMYO	4711-03-5110	1.000	
R282 R283	RES,CHP,604,1% 1/8W,TC=100ppm,T/R 1206	RMC 1/8 604 OHM 1%	KMYO	4711-03-6040	2.000	
R284	(S)RES,CHP,13.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC1/8 13.0K 1%	KMYO	4711-03-1302	1.000	
R287 R294	RES,CHP,4.99K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1849911C	KMYO	4711-03-4991	2.000	
R297	(P)RES,CHP,178K,1% 1/8W,TC=100ppm,T/R 1206	RMC1817831C	KMYO	4711-03-1783	1.000	
WAVETEK PARTS LIST		HYBRID PTS KIT, CONTROL BD,2407		1219-00-0741 PAGE: 2		B REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C300 C301 C302 C303 C304 C305 C306 C307 C308 C309 C310 C311 C312 C313 C314 C315 C316 C317 C318 C319 C320 C321 C322 C323 C324 C327 C328 C329 C330 C331 C332	CAP,CER, .1uF,50V 20%,AXL,Z5U .10"Dx.26"L	SA205E1042AA	AVX	1510-17-1104	31.000
C333 C334 C335 C336 C337 C338	CAP,TNT,1uF,25V 10%,AXL.095"Dx.260"L	1730105X9025U	SPR	1510-21-7010	6.000
C340 C341	CAP,CER, .01uF,50V 10%,AXL,X7R .10"Dx.17"L	SA105C103KAA	AVX	1510-17-1103	2.000
C342	4700 PF 20% 100V X7R AXIAL LEAD,TAPE/REEL	C410C472M1R5CA	KEM	1510-17-1472	1.000
C344 C345 C347 C348 C349 C350 C351 C352	CAP,CER,1000PF,50V 1%,AXL,NPO,T/R .10"D X .17"L	SA105A102FAA	AVX	1510-17-5102	8.000
C353 C354	CAP,CER, .47uF,50V 20%,AXL,Z5U .15"D x .29"L	SA305E474MAA	AVX	1510-17-1474	2.000
IC300	EXCL-OR G,QUAD 2 INP PLAS,DIP-14, H SPD CMOS,*SS*	SN74HC86	T-I	8000-74-8611	1.000
IC301	AND G,QUAD 2-INP PLAS,DIP-14 H-SPD CMOS,*SS*	MC74HC08N	MOT	8000-74-0812	1.000
IC302	DCCR/DEMUX,1-OF-8 PLAS,DIP-16 H SPD CMOS,*SS*	MC74HC138N	MOT	8007-41-3811	1.000
IC303	BUFFER,OCTAL,3 STATE PLAS,DIP-20,*SS* HIGH SPEED CMOS	MC74HC541N	MOT	8007-45-4110	1.000
IC304 IC305 IC306 IC313 IC314 IC315 IC319 IC320	FF,OCT,COM CLK &RST PLAS,DIP-20 H SPD CMOS,*SS*	MC74HC273N	MOT	8007-42-7300	8.000
IC307 IC308 IC309 IC310 IC311 IC312	ADDER,BCD,4 BIT,FULL PLAS,DIP-16,*SS* H SPD CMOS	CD74HC583E	RCA	8007-45-8300	6.000
IC316	FF,DUAL-D,W/SET&RST PLAS,DIP-14, H SPD CMOS,*SS*	MC74HC74	MOT	8000-74-7403	1.000
IC321	HI-SPEED 12-BIT D/A CONVERTER W/REF,*SS* CER,DIP-24	DAC1265LCJ	NAT	8000-12-6510	1.000
IC322 IC323 IC325 IC326	OP AMP,JFET INPUT PLAS,DIP-8,18Vdc 13V/uS,*SS*	TL082CP	T-I	7000-00-8200	4.000
WAVETEK PARTS LIST	PCB ASSY,DIRECT DIGITAL SYN, 2407	1218-00-2622 PAGE: 1		A REV	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC327	POS. VOLT REG-3 TERM PLAS, TO-220AB, 5 VOLT 500mA, 7 W, 5%, 3-TERM	S78M05CV	SIG	7000-78-0500	1.000
IC328	VOLT REG, FIXED, +15V PLAS, 3 PIN(TO-220) 35Vdc, .1%, 700mA, *SS*	SA78M15CU	SIG	7000-78-1500	1.000
IC329	VOLT REG, -15V, 3-TERM PLAS, TO-220, 35Vdc 5%, 1.5W, 1.0A	79MA5CU	SIG	7000-79-1500	1.000
P303	CONN, 96 POS, DIN, M, RA 64 PIN, ROW B VOID	10-8457-096-002-026	ELCO	2112-20-0004	1.000
R300 R304	(S)RES, MF, 51.1, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-51.1-F-T/R	KOA	4701-03-5119	2.000
R301 R302 R303	(P)RES, MF, 3.01K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-3.01K-F-T/R	KOA	4701-03-3011	3.000
R305	(S)RES, MF, 1.43K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-1.43K-F-T/R	KOA	4701-03-1431	1.000
R306	(S)RES, MF, 309, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-309-F-T/R	KOA	4701-03-3090	1.000
R307 R308 R311 R312 R313 R315 R316 R318 R319 R321 R322 R323 R324 R325 R331 R332 R333	(P)RES, MF, 10K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-10K-F-T/R	KOA	4701-03-1002	17.000
R309	(S)RES, MF, 619, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-619-F-T/R	KOA	4701-03-6190	1.000
R310	(S)RES, MF, 1.58K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-1.58K-F-T/R	KOA	4701-03-1581	1.000
R314	(S)RES, MF, 374, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-374-F-T/R	KOA	4701-03-3740	1.000
R317	(S)RES, MF, 4.42K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-4.42K-F-T/R	KOA	4701-03-4421	1.000
R320	(P)RES, MF, 1.50K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-1.50K-F-T/R	KOA	4701-03-1501	1.000
WAVETEK PARTS LIST	PCB ASSY, DIRECT DIGITAL SYN, 2407	1218-00-2622	PAGE: 2	A REV	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C400 C407 C408 C409 C410 C411 C412 C413 C415 C417 C419 C421 C425 C426 C429 C430 C437 C441 C444 C445 C446 C448 C449 C452 C453 C477 C478	CAP,CER,.1uF,50V 20%,AXL,Z5U .10"Dx.26"L	SA205E1042AA	AVX	1510-17-1104	27.000
C401 C402 C403 C404 C405 C406 C432 C447 C450	CAP,TNT,1uF,25V 10%,AXL.095"Dx.260"LL	173D105X9025U	SPR	1510-21-7010	9.000
C414 C416 C422 C427 C431 C438 C440 C443 C454 C455 C490 C494 C495 C496 C497 C498 C499 C590 C591 C592 C595 C596 C597	CAP,CER,1000pF,50V 10%,AXL,X7R .09"Dx.16"L	RPA10X7R102K50VPT	MURGA	1510-16-8102	23.000
C418 C420 C423 C434 C436 C439 C451 C476 C483 C484	CAP,CER,.01uF,50V 10%,AXL,X7R .10"Dx.17"LL	SA105C103KAA	AVX	1510-17-1103	10.000
C428 C433	CAP,CER,1uF,50V 10%,AXL,X7R .25"Dx.50"LL	C202C105K5R5CA	KEM	1510-16-6105	2.000
C435	4700 PF 20% 100V X7R AXIAL LEAD,TAPE/REEL	C410C472M1R5CA	KEM	1510-17-1472	1.000
C456 C457 C458 C459 C460 C461 C462 C463 C464 C465 C466 C467 C468 C469 C470 C471 C472 C473 C474 C475 C479 C480 C482 C485 C486	100 PF 20% 100V NPO AXIAL LEAD,TAPE/REEL	C410C101M1G5CA	KEM	1510-17-1101	25.000
C481	CAP,CER,200V,47PFT/R	C114C470J2G5CA	KEMET	1510-16-8470	1.000
C491 C492	CAP,TNT,10uF,25V, 20%,AXL,D=3% .18"x.345"	173D106X0025W	SPR	1510-21-7100	2.000
C493	CAP,TNT,68uF,25V,10% RAD,DIPPED .35"x.73",.20"LS	T353L686K025AS	UNCAR	1510-22-7680	1.000
C593 C594	CAP,CER,15pF,50V 5%,AXL,NPO.09"Dx.16"LL	NAD 15J 50V NPO	NIC	1510-16-8150	2.000
CR401 CR402 CR404	DIODE,SIGNAL,GP AXIAL,V=75V,IO=10mA CT=4pF,*SS*	1N914	G-E	4807-01-0914	3.000
CR403	DIODE,ZENER,500mW,GP DO-35,V=5.1,IT=20mA IF=89mA,+/-20%,*SS*	1N5231	MOT	4801-01-5231	1.000
IC400	DCCR/DEMUX,1-OF-8 PLAS,DIP-16 H SPD CMOS,*SS*	MC74HC138N	MOT	8007-41-3811	1.000
IC401	POS. VOLT REG-3 TERM PLAS,TO-220AB,5 VOLT 500mA,7 W,5%,3-TERM	S78M05CV	SIG	7000-78-0500	1.000
WAVETEK PARTS LIST	PC ASSY,SYN BD,2407	1110-00-2315			D
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
IC402	VOLT REG, FIXED, +15V PLAS, 3 PIN(TO-220) 35Vdc, .1%, 700mA, *SS*	SA78M15CU	SIG	7000-78-1500	1.000	
IC403	VOLT REG, -15V, 3-TERM PLAS, TO-220, 35Vdc 5%, 1.5W, 1.0A	79MA5CU	SIG	7000-79-1500	1.000	
IC404 IC405	OCT 3-STATE NON-INV D-TYPE FLIP-FLOP*SS* PLASTIC, DIP-20 CMOS	MC74HC574N	MOT	8007-45-7410	2.000	
IC406	BUFFER, OCTAL, 3 STATE PLAS, DIP-20, *SS* HIGH SPEED CMOS	MC74HC541N	MOT	8007-45-4110	1.000	
IC407 IC408	PLL FRQ SYN, D BUS IN PLAS, DIP-20, CMOS*SS*	MC145146P1	MOT	8014-51-4610	2.000	
IC409	ADDER, 4-B BINARY PLAS, DIP-16 H SPD CMOS, *SS*	MC74HC283	MOT	8007-42-8311	1.000	
IC410	PRESC, 2-MOD, DIV 5/6 PLAS, DIP-16, ECL, *SS*	MC12009P	MOT	8001-20-0910	1.000	
IC411 IC417	OP AMP, JFET INPUT PLAS, DIP-8, 18Vdc 13V/us, *SS*	TL082CP	T-I	7000-00-8200	2.000	
IC412	UWAVE WB AMP, 0204*SS*	MSA-0204	AVT	4902-00-2040	1.000	
IC413	ANLG SW, CMOS CERM, DIP-14, *SS*	DG303ACJ	SCX	8000-03-0310	1.000	
IC414	MULTIPLYING DAC, BFRD DUAL, 8-BIT, CMOS PLAS, DIP-20, *SS*	AD7528JN	A-D	8000-75-2810	1.000	
IC415	UWAVE WB AMP, 0404*SS*	MSA-0404	AVT	4902-00-4040	1.000	
IC416	PRESC, 2-MOD, DIV B 10 PLAS, DIP-16, ECL*SS*	MC12013PC	MOT	8001-20-1300	1.000	
IC418	OP AMP, QUAD, LOW PWR PLAS, DIP-14, 30V 1MHz, 45nAdc, *SS*	LM324N	NAT	7000-03-2400	1.000	
IC419	ANLG SW, QUAD, SPST CERM, DIP-16, CMOS*SS*	DG201CJ	SCX	8000-02-0101	1.000	
IC420 IC421 IC422	WIDEBAND HI FREQ AMP PLAS, DIP-8, *SS*	NE5205M	SIG	7000-52-0510	3.000	
J501	CONN, SMA-F, 50, PC MT RT ANG	42-302-1	CNTRS	2110-02-0017	1.000	
L400 L401 L402 L403 L405	CHOKE, COATED, 10UH 10%, D=0.120IN, L=0.300IN, I=130MA	08N100	JEF	1810-03-0100	5.000	
L404 L406	CHOKE, MOLDED, 1MH	15S102K	JEF	1810-02-0102	2.000	
WAVETEK PARTS LIST		PC ASSY, SYN BD, 2407		1110-00-2315 PAGE: 2		D REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
L407	COIL, MOLDED, 33nH, 5% RAD, L=0.38", W=0.23", H=0.26" Q=64Q, F=50MHz	132-02	CLCFT	1810-14-0330	1.000
L502* L508*	(C)SELECTED AIRCOILS	1815-99-9999	W-I	1815-99-9999	2.000
MX400 MX401	MIXER, DBL. BAL.	SBL-1-DBL	MIN-C	3010-54-0004	2.000
P401	D-CONN, 37POS, RIGHT ANGLE, MALE	617L037PAJ201	APL	2112-04-0020	1.000
PS400	SPLITTER, 2WAY 90 DEG 25-50MHz CASE A01	PSCQ-2-50	MIN-C	3010-20-0017	1.000
R400 R401 R412 R413 R415 R416 R418 R420 R431 R432 R436 R444 R445 R446 R447	(P)RES, MF, 10K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-10K-F-T/R	KOA	4701-03-1002	15.000
R402 R404 R424 R425 R426 R427 R428	(S)RES, MF, 475, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-475-F-T/R	KOA	4701-03-4750	7.000
R403 R429 R476	(P)RES, MF, 1K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-1K-F-T/R	KOA	4701-03-1001	3.000
R405 R423 R430 R434 R435	(S)RES, MF, 51.1, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-51.1-F-T/R	KOA	4701-03-5119	5.000
R406 R407	(S)RES, MF, 665K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-665K-F-T/R	KOA	4701-03-6653	2.000
R408 R409 R410 R411 R417 R419 R421 R422	(P)RES, MF, 20K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-20K-F-T/R	KOA	4701-03-2002	8.000
R414	(P)RES, MF, 100K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-100K-F-T/R	KOA	4701-03-1003	1.000
R433	(S)RES, MF, 10, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-10-F-T/R	KOA	4701-03-1009	1.000
R448 R449 R450	(S)RES, MF, 18.2, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-18.2-F-T/R	KOA	4701-03-1829	3.000
R451	(S)RES, MF, 392, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-392-F-T/R	KOA	4701-03-3920	1.000
R452 R453	(P)RES, MF, 100, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-100-F-T/R	KOA	4701-03-1000	2.000
R454 R456 R465 R466	(S)RES, MF, 68.1, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-68.1-F-T/R	KOA	4701-03-6819	4.000
R455 R457 R458 R459 R460 R461 R462 R463 R464	(S)RES, MF, 182, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-182-F-T/R	KOA	4701-03-1820	9.000
R477	(P)RES, MF, 1.50K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-1.50K-F-T/R	KOA	4701-03-1501	1.000
R478	(P)RES, MF, 15K, 1% 18W, AXL, TC=100ppmT/R	MF55D-15K-F-T/R	KOA	4701-03-1502	1.000
WAVETEK PARTS LIST	PC ASSY, SYN BD, 2407	1110-00-2315			D REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC317 IC318	32Kx8 ROM CMOS ONE TIME PROGRAMMABLE PLAS,DIP-28, *SS*	TMS27C256-25N	T-I	8002-72-5600	2.000
WAVETEK PARTS LIST	EPROM KIT,DDS,2407	1219-00-0752		REV	
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REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C601 C602 C603 C604 C605 C606 C610 C612 C613 C615 C616 C640 C651 C658 C659 C660 C661 C662 C663 C664 C665 C666 C667 C668 C669 C670 C671 C672 C673 C674 C676	CAP,CER,.1uF,50V 20%,AXL,25U .10"Dx.26"L	SA205E1042AA	AVX	1510-17-1104	31.000
C607 C608 C609 C642 C646	CAP,CER,1000pF,50V 10%,AXL,X7R .09"Dx.16"L	RPA10X7R102K50VPT	MURGA	1510-16-8102	5.000
C617 C618 C619 C620 C621 C622	CAP,TNT,1uF,25V 10%,AXL.095"Dx.260"L	173D105X9025U	SPR	1510-21-7010	6.000
C652	CAP,VAR,2.5-5PF	302504111	STR	1510-70-8509	1.000
C675	100 PF 20% 100V NPO AXIAL LEAD,TAPE/REEL	C410C101M1G5CA	KEM	1510-17-1101	1.000
CR601 CR603 CR604	DIODE,SIGNAL,GP AXIAL,V=75V,I0=10mA CT=4pF,*SS*	1N914	G-E	4807-01-0914	3.000
CR602	DIODE,ZENER,500mW,GP DO-35,V=5.1,IT=20mA IF=89mA,+/-20%,*SS*	1N5231	MOT	4801-01-5231	1.000
CR606 CR607	DIODE,PIN,GP SWIT AXIAL,V=100V CT=0.4pF,*SS*	5082-3080	H-P	4805-02-0002	2.000
IC601	PLL FRQ SYN,D BUS IN PLAS,DIP-20,CMOS*SS*	MC145146P1	MOT	8014-51-4610	1.000
IC602	LO-PWR PRESCALER DIVIDE BY 64,PLAS DIP-8,MECL *SS*	MC12073P	MOT	8001-20-7310	1.000
IC603 IC604	OCT 3-STATE NON-INV D-TYPE FLIP-FLOP*SS* PLASTIC,DIP-20 CMOS	MC74HC574N	MOT	8007-45-7410	2.000
IC605 IC614	UNWAVE WB AMP,0204*SS*	MSA-0204	AVT	4902-00-2040	2.000
IC606	BUFFER,OCTAL,3 STATE PLAS,DIP-20,*SS* HIGH SPEED CMOS	MC74HC541N	MOT	8007-45-4110	1.000
IC607	DCCR/DEMUX,1-OF-8 PLAS,DIP-16 H SPD CMOS,*SS*	MC74HC138N	MOT	8007-41-3811	1.000
IC608 IC612	OP AMP,JFET INPUT PLAS,DIP-8,18Vdc 13V/uS,*SS*	TL082CP	T-I	7000-00-8200	2.000
IC609	POS. VOLT REG-3 TERM PLAS,TO-220AB,5 VOLT 500mA,7 W,5%,3-TERM	S78M05CV	SIG	7000-78-0500	1.000
IC610	VOLT REG,FIXED,+15V PLAS,3 PIN(TO-220) 35Vdc,.1%,700mA,*SS*	SA78M15CU	SIG	7000-78-1500	1.000
WAVETEK PARTS LIST	PC ASSY,LO/REF BD, 2407	1110-00-2318		PAGE: 1	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC611	VOLT REG, -15V, 3-TERM PLAS, TO-220, 35Vdc 5%, 1.5W, 1.0A	79MA5CU	SIG	7000-79-1500	1.000
IC613	UWAVE WB AMP, 0404*SS*	MSA-0404	AVT	4902-00-4040	1.000
J602	CONN, SMA-F, 50, PC MT RT ANG	088-2080-BRASS	LYNIC	2110-02-0017	1.000
J603 J604	CONN, RF, RT. ANGLEJACK	700214	CBLWV	2110-08-0005	2.000
L601 L603 L604	CHOKE, COATED, 1UH, 10% D=0.120IN, L=0.300IN, I=385MA	08N1R0	JEF	1810-03-0010	3.000
L605 L606 L607 L608 L609	CHOKE, COATED, 39UH 10%, D=0.120IN, L=0.300, I=125MA	09C390K	JEF	1810-03-0390	5.000
P601	D-CONN, 37POS, RIGHT ANGLE, MALE	617L037PAJ201	APL	2112-04-0020	1.000
R600 R602 R603 R604 R605 R632 R633 R637 R638	(P)RES, MF, 10K, 1% 1/8W, AXL, TC=100ppmT/R	4701-03-1002	W-I	4701-03-1002	9.000
R601 R634 R635 R636	(P)RES, MF, 1K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-1K-F-T/R	KOA	4701-03-1001	4.000
R606 R607 R611	(S)RES, MF, 3.65K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-3.65K-F-T/R	KOA	4701-03-3651	3.000
R608	(S)RES, MF, 619, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-619-F-T/R	KOA	4701-03-6190	1.000
R609 R610	(S)RES, MF, 7.15K, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-7.15K-F-T/R	KOA	4701-03-7151	2.000
R612 R642 R643 R644	(S)RES, MF, 475, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-475-F-T/R	KOA	4701-03-4750	4.000
R639 R641	(P)RES, MF, 150, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-150-F-T/R	KOA	4701-03-1500	2.000
R640	(S)RES, MF, 37.4, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-37.4-F-T/R	KOA	4701-03-3749	1.000
R645 R647 R648 R650 R651	(S)RES, MF, 95.3, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-95.3-F-T/R	KOA	4701-03-9539	5.000
R646 R649	(S)RES, MF, 68.1, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-68.1-F-T/R	KOA	4701-03-6819	2.000
Y601	XO, 10 MHZ, 5PPM, DIP	TCO-706AB	TOYO	2311-00-0022	1.000
WAVETEK PARTS LIST	PC ASSY, LO/REF BD, 2407	1110-00-2318		REV	
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C623 C624 C625 C626 C627 C628 C629 C630 C631 C632 C633 C634 C635 C636 C637 C638 C639	(P)CAP, CER, 100PF, 50V 1%, CHIP, NPO, +/-30PPM 0805, T/R, VALUE MARKD	C2012COG1H101FT	TDK	1510-06-5101	17.000
C644 C650 C655 C657	(P)CAP, CER, 1000pF 100V, 20%, CHP, X7R 0805, T/R, VALUE MARKD	101R15W102MV3P	JHSN	1510-06-7102	4.000
C647 C648	(P)CAP, CER, 15PF, 50V 1%, CHIP, NPO, +/-30PPM 0805, T/R, VALUE MARKD	C2012COG1H150F	TDK	1510-06-5150	2.000
C649 C656	CAP, TANT, 10 UF, 25V SURFACE MOUNT, T/R	NRD106M25R12	NEC	1510-27-9106	2.000
C653	(S)CAP, POR, 20 PF 500V, +/- 1%, CHP NPO, 30PPM, 0805, T/R	500R15Q200FW2T	JHSN	1510-06-3200	1.000
C654	(S) CAP, POR, 15 PF, 500V, +/- 1%, CHP, NPO, 30PPM, 0805, T/R	500R15Q150FW2T	JHSN	1510-06-3150	1.000
CR605	DIODE, VAR CAP, *SS* SOT-23, Ct=1.8pF, V=28 T/R	BBY31 (SOT-23) T/R	APX	4807-02-0005	1.000
Q601 Q604 Q605	PNP, SOT-23, MED PWR F=200m, V=40, P=350m, hFE=40, *SS*, T/R	BSR18A T/R	APX	4902-00-0800	3.000
Q603	NPN, SIL, H FRQ, TRAN SOT-23, fT=8GHz, *SS*, T/R	NE68133-T1B	NEC	4902-68-1330	1.000
Q606	NPN, SOT-23, MED PWR F=250m, V=40, P=310m, hFE=40, *SS*, T/R	BSS79C-SOT-23	SIEM	4902-00-0170	1.000
R617 R625 R627	RES, CHP, 243, 1% 1/8W, TC=100ppm, T/R 1206 CASE	RMC1824391C	KMYO	4711-03-2430	3.000
R618 R622 R626	RES, CHP, 576, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1857691C	KMYO	4711-03-5760	3.000
R619 R623 R624	(P)RES, CHP, 10.0, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1810081C	KMYO	4711-03-1009	3.000
R620	RES, CHP, 37.4, 1% 1/8W, TC=100ppm, T/R 1206	RM1837481C	KMYO	4711-03-3749	1.000
R628 R629	(P)RES, CHP, 10.0K, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1810021C	KMYO	4711-03-1002	2.000
R630 R631	(S)RES, CHP, 2.67K, 1% 1/8W, TC=100ppm, T/R 1206 CASE	RMC1826711C	KMYO	4711-03-2671	2.000
WAVETEK PARTS LIST	HYBRID PTS KIT, LO/REF BD, 2407	1219-00-0739			A
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REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
Q502	NPN, TO-35, AMP F=9G, V=10, JCBO=1.0UA P=290mW, HFE=100, *SS*	NE68135	NEC	4902-68-1350	1.000
WAVETEK PARTS LIST	PCB ASSY, VCO, 2405/ 2407/2410/2475	1218-00-2623 PAGE: 1		REV	

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C501 C505 C506 C507 C508 C509 C510 C513 C514 C515 C516 C517 C518 C521 C523 C525 C526	(P)CAP, CER, 1000pF 100V, 20%, CHP, X7R 0805, T/R, VALUE MARKD	08051C102MAT050M	AVX	1510-06-7102	17.000
C502	(S)CAP, HI-Q, 10.0pF 50V, +/- .25pF, CHP, P90 20ppm, 0505, T/R	500R12Q100GV5E	JHSN	1510-06-3100	1.000
C503	(S)CAP, HI-Q, 15pF 50V, +/- 1%, CHP, P90 20ppm, 0505, T/R	500R12Q150FV5E	JHSN	1510-06-3150	1.000
C504	(S)CAP, HI-Q, 12pF 50V, +/- 1%, CHP, P90 20ppm, 0505, T/R	500R12Q120FV5E	JHSN	1510-06-3120	1.000
C511 C512	(P)CAP, CER, 10PF, 50V +/- .5PF, CHIP, NPO 0805, T/R, VALUE MARKD	C2012COG1H100DT	TDK	1510-06-5100	2.000
C519 C520	(P)CAP, CER, 5.6PF, 50V +/- .5PF, CHIP, NPO 0805, T/R, VALUE MARKD	C2012COG1H5R6DT	TDK	1510-06-5569	2.000
C522* C524*	(S)CAP, HI-Q, 8.2pF 50V, +/- .25pF, CHP, P90 20ppm, 0505, T/R	500R12Q8R2CV5E	JHSN	1510-06-3829	2.000
CR501 CR502 CR503 CR504	VARACTOR DIODE SOT23 10PF, +/- 5%, 25V	ZC830B	FRRNT	4803-02-0030	4.000
CR505 CR508 CR509 CR510 CR511 CR512 CR513	DIODE, VAR CAP, *SS* SOT-23, Ct=1.8pF, V=28 T/R	BBY31 (SOT-23) T/R	APX	4807-02-0005	7.000
CR506 CR507	DIODE, PIN, GP, ODS-07 V=100V, CJ=0.4pF *SS*, T/R	AL67226-07	EATON	4805-02-0016	2.000
IC501	ANLG SW SINGLE SPDT, PLAS, SO-8, CMOS, *SS*	DG419DY	SCX	8000-04-1900	1.000
IC502	WIDEBAND AMP, 20 DB 600 MHZ BW, SO-8 PKG	NE5205D	SIG	7000-52-0500	1.000
L501 L503 L504 L509 L510 L511 L513 L514	CHOKE, CHIP, 1 UH, 20% MOLDED, .18"L X .12"W T/R	LEM4532T1ROM	TAIYO	1816-02-0102	8.000
L505 L512	BEAD, SHIELD, SURF MNT TAPE & REEL	2743019447	FRTE	1813-00-0111	2.000
L506	CHOKE, CHIP, 22nH, 5%, .12"L X .10"W, MOLDED, T/R	SM3-022J	GWDA	1816-01-0220	1.000
L507	CHOKE, CHIP, 15nH, 5%, .12"L X .10"W, MOLDED, T/R	SM3-015J	GWDA	1816-01-0150	1.000
Q501	NPN, SOT-23, HI FREQ 7GHz, 12V, 100mA, T/R *SS*	NE85633-T1B	NEC	4902-85-6330	1.000
WAVETEK PARTS LIST	HYBRID PTS KIT, VCO, 2405/2407/2410/2475	1219-00-0749 PAGE: 1		B REV	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
R501* R515*	RES, CHP, 576, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1857691C	KMYO	4711-03-5760	2.000	
R502* R504 R514* R516 R518*	(P)RES, CHP, 10.0, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1810081C	KMYO	4711-03-1009	5.000	
R503* R513*	RES, CHP, 37.4, 1% 1/8W, TC=100ppm, T/R 1206	RM1837481C	KMYO	4711-03-3749	2.000	
R505*	RES, CHP, 365, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1836591C	KMYO	4711-03-3650	1.000	
R506	(S)RES, CHP, 8.25K, 1% 1/8W, 1206, TC=100 PPM T/R	RK73H2B8251F	KOA	4711-03-8251	1.000	
R507	RES, CHP, 4.99K, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1849911C	KMYO	4711-03-4991	1.000	
R508* R510 R512	(S)RES, CHP, 178, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1817891C	KHYO	4711-03-1780	3.000	
R509 R511	RES, CHP, 66.5, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1866581C	KMYO	4711-03-6659	2.000	
R517*	RES, CHP, 294, 1% 1/8W, TC=100ppm, T/R 1206	9C12063A2940FKR	M-E	4711-03-2940	1.000	
WAVETEK PARTS LIST		HYBRID PTS KIT, VCO, 2405/2407/2410/2475		1219-00-0749 PAGE: 2		B REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC700	PRESALER, H-SPD PLAS, DIP-16, *SS* MECL, TYPE D FF	MC12090P	MOT	8001-20-9010	1.000
IC702 IC703 IC715	UWAVE WB AMP, 0304*SS*	MSA-0304	AVT	4902-00-3040	3.000
IC704	UWAVE WB AMP, 0404*SS*	MSA-0404	AVT	4902-00-4040	1.000
IC707	ANLG SW, QUAD, SPST CERM, DIP-16, CMOS*SS*	DG201CJ	SCX	8000-02-0101	1.000
IC709	DCDR/DEMUX, 1-OF-8 PLAS, DIP-16 H SPD CMOS, *SS*	MC74HC138N	MOT	8007-41-3811	1.000
IC710	BUFFER, OCTAL, 3 STATE PLAS, DIP-20, *SS* HIGH SPEED CMOS	MC74HC541N	MOT	8007-45-4110	1.000
IC711	FLOUR DISPLAY DRVR *SS*	UDN-6118A	SPR	8000-61-1800	1.000
IC712	OCT 3-STATE NON-INV D-TYPE FLIP-FLOP*SS* PLASTIC, DIP-20 CMOS	MC74HC574N	MOT	8007-45-7410	1.000
IC713	VOLT REG, FIXED, +15V PLAS, 3 PIN(TO-220) 35Vdc, .1%, 700mA, *SS*	SA78M15CU	SIG	7000-78-1500	1.000
J700 J701	CONN, SMA-F, 50, PC MT RT ANG	088-2080-BRASS	LYNIC	2110-02-0017	2.000
P700	D-CONN, 37POS, RIGHT ANGLE, MALE	617L037PAJ201	APL	2112-04-0020	1.000
R750 R776	TRM, CM, L, 20K, 10%, PC 1T, PN, CW, .19H, .375W .375L, TA	3386R-1-203	BOJ	4610-00-3203	2.000
WAVETEK PARTS LIST		PC ASSY, AM/DIV BD, 2407		1110-00-2314 PAGE: 1	B REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C700 C701 C702 C711 C712 C713 C719 C720 C721 C722 C723 C724 C727 C728 C734 C735 C755 C756	(P)CAP, CER, 1000pF 100V, 20%, CHP, X7R 0805, T/R, VALUE MARKD	08051C102MAT050M	AVX	1510-06-7102	18.000
C703 C776 C777 C778 C779 C780 C781 C782 C783 C784 C785 C786 C787 C788 C789 C790 C791 C792 C793 C794 C795 C796 C797 C798 C799 C800 C801 C803 C804 C805 C806 C807 C808 C809 C812 C813 C815 C816 C817	(P)CAP, CER, 100PF, 50V 1%, CHIP, NPO, +1-30PPM 0805, T/R, VALUE MARKD	C2012COG1H101FT	TDK	1510-06-5101	39.000
C707 C708 C709	(P)CAP, CER, 6.8PF, 50V +/- .5PF, CHIP, NPO 0805, T/R, VALUE MARKD	C2012COG1H6R8DT	TDK	1510-06-5689	3.000
C714 C718	(P)CAP, CER, 8.2PF, 50V +/- .5PF, CHIP, NPO 0805, T/R, VALUE MARKD	C2012COG1H8R2DT	TDK	1510-06-5829	2.000
C715 C716 C717 C729 C733	(P)CAP, CER, 15PF, 50V 1%, CHIP, NPO, +/-30PPM 0805, T/R, VALUE MARKD	C2012COG1H150F	TDK	1510-06-5150	5.000
C725 C726 C741 C743 C757	CAP, TANT, 1 UF, 35V SURFACE MOUNT	NRB105M35R12	NEC	1510-27-9105	5.000
C730 C731 C732	(P)CAP, CER, 22PF, 50V 1%, CHIP, NPO, +/-30PPM 0805, T/R, VALUE MARKD	C2012COG1H220FT	TDK	1510-06-5220	3.000
C736 C740	(P)CAP, CER, 18PF, 50V 1%, CHIP, NPO, +/-30PPM 0805, T/R, VALUE MARKD	C2012COG1H180FT	TDK	1510-06-5180	2.000
C737 C738 C739	(P)CAP, CER, 33PF, 50V 1%, CHIP, NPO, +1-30PPM 0805, T/R, VALUE MARKD	C2012COG1H330FT	TDK	1510-06-5330	3.000
C742 C744 C758	CAP, TANT, 10 UF, 25V SURFACE MOUNT, T/R	NRD106M25R12	NEC	1510-27-9106	3.000
C748 C749 C759 C764 C765 C767 C768 C769 C770 C771 C772 C775 C810 C814 C818	(P)CAP, CER, .01uF, 50V 20%, CHP, X7R, 0805, T/R VALUE MARKED	08055C103MAT050M	AVX	1510-06-7103	15.000
C762 C763	(P)CAP, CER, 2200F, 50V 5%, CHIP, NPO, +1-30PPM 0805, T/R, VALUE MARKD	500R15N221JV3P	JHSN	1510-06-5221	2.000
C766 C773	(P)CAP, CER, 330PF, 50V 5%, CHIP, NPO, +/-30PPM 0805, T/R, VALUE MARKD	500R15N331JV3P	JHSN	1510-06-5331	2.000
C811 C819	CAP, POR, 1.2pF, 50V +/- .1, CHP, P90, 20PPM .07"x.055"	MA181R2B	MURGA	1510-02-8129	2.000
CR700 CR701 CR702 CR703 CR704 CR705 CR706 CR707 CR708 CR711 CR712 CR713 CR714 CR715 CR727 CR728	DIODE, PIN, GP, ODS-07 V=100V, CJ=0.4pF *SS*, T/R	AL67226-07	EATON	4805-02-0016	16.000
WAVETEK PARTS LIST	HYBRID PTS KIT, AM/DIV BD, 2407	1219-00-0736			D
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
CR709 CR710	DIODE, PLANAR, HI SPD SWIT, SOT-23, V=75, IO=250m, SUR, *SS*, T/R	BAS16	SEM	4812-02-0005	2.000
CR722 CR723 CR724 CR725 CR726	DIODE, HOT CAR, SOT-23 SMD, V=4VCT=1pF, SS#1	MMBD101	MOT	4809-02-0015	5.000
CR729 CR730 CR731 CR732	DIODE, PIN, POWER SOT-287, V=100V C=.15pF, *SS*, T/R	MA4P671-T/R	M-A	4805-02-0009	4.000
IC701 IC708	VOLTAGE REG, 3 TERM PLAS, SO-8, 5V, 100MA5%	MC78L05ACD	MOT	7000-78-0511	2.000
IC705 IC706	DUAL JFET INPUT OP AMP, SO-8*SS*	MC34002AD	MOT	7003-40-0210	2.000
IC714	-15V VOLTAGE, REG, PLS PLAS, 20-8, *SS*, Io=100mA	MC79L15ACD	MOT	7000-79-1511	1.000
L700 L703 L747* L749	CHOKE, CHIP, 15nH, 5%, .12" LX .10" W, MOLDED, T/R	SM3-015J	GWDA	1816-01-0150	4.000
L701 L702 L705 L706 L707 L708 L745 L746	CHOKE, CHIP, 22nH, 5%, .12" LX .10" W, MOLDED, T/R	SM3-022J	GWDA	1816-01-0220	8.000
L709 L720 L721 L723 L744 L748	CHOKE, CHIP, 1 UH, 20% MOLDED, .18" L X .12" W T/R	LEM4532T1ROM	TAIYO	1816-02-0102	6.000
L710 L711 L712 L713	CHOKE, CHIP, 33nH, 5%, .12" LX .10" W, MOLDED, T/R	SM3-033J	GWDA	1816-01-0330	4.000
L714 L715 L716 L717	CHOKE, CHIP, 47nH, 5%, .12" LX .10" W, MOLDED, T/R	SM3-047J	GWDA	1816-01-0470	4.000
L724 L726 L727 L728 L729 L730 L731 L732 L733 L734 L735 L736 L737 L738 L739 L740 L741 L743	BEAD, SHIELD, SURF MNT TAPE & REEL	2743019447	FRTE	1813-00-0111	18.000
Q700 Q701 Q702 Q703	NPN, SOT-23, MED PWR F=250m, V=40, P=310m, hFE=40, *SS*, T/R	BSS79C-SOT-23	SIEM	4902-00-0170	4.000
R700	RES, CH, 1/8W, 5%, 0	ERJ-8GCJR00D	PNSNC	4711-05-0000	1.000
R701	(S)RES, CHP, 178, 1% 1/8W, TC=100ppm, T/R 1206	RMC 1817891C	KMYO	4711-03-1780	1.000
R702 R718* R733 R734 R786 R787 R788 R790 R796 R797 R798 R804 R805 R806	(S)RES, CHP, 82.5, 1%, 1/8W, TC=100ppm, T/R, 1206	RMC1882581C	KMYO	4711-03-8259	14.000
R703 R712 R715 R717 R726 R728 R792	(S)RES, CHP, 475, 1% 1/8W, 1206, TC=100 PPM T/R	RK73H2B4750F	KOA	4711-03-4750	7.000
WAVETEK PARTS LIST	HYBRID PTS KIT, AM/DIV BD, 2407	1219-00-0736 PAGE: 2		D REV	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R704 R713 R714 R716 R723 R724 R727 R729 R780 R781 R782 R784 R799 R801 R802 R803	RES,CHP,294,1% 1/8W,TC=100ppm,T/R 1206	9C12063A2940FKR	M-E	4711-03-2940	16.000
R719	RES,CHP,1.18K,1% 1/8W,TC=100ppm,T/R 1206	BCK1181FB	A-B	4711-03-1181	1.000
R720	(S)RES,CHP,3.92K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B3921F	KOA	4711-03-3921	1.000
R721 R722	RES,CHP,118,1% 1/8W,TC=100ppm,T/R 1206	RMC118-118	KMYO	4711-03-1180	2.000
R725 R737 R791	(S)RES,CHP,51.1,1% 1/8W,TC=100ppm,T/R 1206 CASE	RMC1851181C	KMYO	4711-03-5119	3.000
R735 R736 R807 R808 R809	RES,CHP,37.4,1% 1/8W,TC=100ppm,T/R 1206	RM1837481C	KMYO	4711-03-3749	5.000
R742 R743 R744 R764 R794 R810	(P)RES,CHP,100,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810091C	KMYO	4711-03-1000	6.000
R748 R749 R751 R755 R759 R762 R767 R771 R772 R778	(P)RES,CHP,100K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810031C	KMYO	4711-03-1003	10.000
R752 R753 R774 R775	RES,CHP,499K,1% 1/8W,TC=100ppm,T/R 1206	RK73H2B4993F	KOA	4711-03-4993	4.000
R754 R758	(S)RES,CHP,8.25K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B8251F	KOA	4711-03-8251	2.000
R756 R757	(S)RES,CHP,200K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1820031C	KMYO	4711-03-2003	2.000
R760*	(S)RES,CHP,56.2K,1% 1/8W,TC=100ppm,T/R 1206	RK73H2B5622F	KOA	4711-03-5622	1.000
R761 R768	RES,CHP,49.9K,1% 1/8W,TC=100ppm,T/R 1206	RMC1814992	KMYO	4711-03-4992	2.000
R763 R785	(P)RES,CHP,1.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810011C	KMYO	4711-03-1001	2.000
R765 R770	RES,CHP,14.7K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1814721C	KMYO	4711-03-1472	2.000
R766	(S)RES,CHP,68.1K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B6812F	KOA	4711-03-6812	1.000
WAVETEK PARTS LIST	HYBRID PTS KIT, AM/DIV BD,2407	1219-00-0736			D REV
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REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R769	(S)RES,CHP,35.7K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B3572F	KOA	4711-03-3572	1.000
R773*	(P)RES,CHP,178K,1% 1/8W,TC=100ppm,T/R 1206	RMC1817831C	KMYO	4711-03-1783	1.000
R777	(S)RES,CHP,82.5K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B8252F	KOA	4711-03-8252	1.000
R779	(S)RES,CH,267K,1%, 1/8W,TC=100PPM,T/R, 1206 CASE	RMC1826731C	KMYO	4711-03-2673	1.000
R783 R800	(P)RES,CHP,10.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810021C	KMYO	4711-03-1002	2.000
R793 R795	(P)RES,CHP,150,1% 1/8W,TC=100ppm,T/R 1206	RMC 1815091C	KMYO	4711-03-1500	2.000
WAVETEK PARTS LIST		HYBRID PTS KIT, AM/DIV BD,2407		1219-00-0736 PAGE: 4	D REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC800 IC801 IC803 IC804 IC805 IC809	UWAVE WB AMP,0304*SS*	MSA-0304	AVT	4902-00-3040	6.000
IC810	UWAVE WB AMP,0404*SS*	MSA-0404	AVT	4902-00-4040	1.000
IC903	FLOUR DISPLAY DRVR *SS*	UDN-6118A	SPR	8000-61-1800	1.000
IC905	VOLT REG, FIXED, +15V PLAS, 3 PIN(TO-220) 35Vdc, .1%, 700mA, *SS*	SA78M15CU	SIG	7000-78-1500	1.000
IC907	REFERENCE DIODE, 2.5V PLAS, TO-92 I _{max} =10mA, *SS*	LM336Z-2.5	NAT	7000-03-3600	1.000
J800 J801 J802 J803	CONN, SMA-F, 50, PC MT RT ANG	088-2080-BRASS	LYNIC	2110-02-0017	4.000
J804	D-CONN, 37POS, RIGHT ANGLE, MALE	617L037PAJ201	APL	2112-04-0020	1.000
Q804	2IGMOSFET, TO-72, AMP F=500, V=25, I _{gss} =10mA P=360mW, NF=4.5, SS#1	MFE 201	MOT	4903-00-2010	1.000
Q900	NPN, 317-01 HFREQ F=2G, V=8, I _{CES} =70mA P=1W, hFE=50-300, *SS*	MRF571	MOT	4902-00-5710	1.000
Q902	NPN, 319-04, RFPWR F=870M, V=12.5, I _{CEO} =1 mA, P=3W, *SS*	MRF839F	MOT	4902-00-8390	1.000
Q905	PNP, TO-126, POWER F=40, V=80, I _{cbo} = .1uA P=15W, hFE=25, *SS*	MJE252	STI	4902-00-2520	1.000
R812 R820 R851 R869	RES, C, 1/2W, 5%, 220	PR50-220-5	PIC	4700-25-2200	4.000
R849	(O)RES, C, 1/4W, 5%, 300 USE P/N:4701-03-3010	RDO 1403015C	KMYO	4700-15-3000	1.000
R867 R914	(S)RES, MF, 200, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-200-F-T/R	KOA	4701-03-2000	2.000
R872 R873	RES, C, 1/2W, 5%, 100	PR50-100-5	PIC	4700-25-1000	2.000
R900 R901	TRM, CM, L, 10K, 10%, PC 1T, PN, CW, .19H, .375W .375L, TA	3386R-1-103	BOU	4610-00-3103	2.000
R923	RES, C, 1/2W, 5%, 68	PR50-68-5	PIC	4700-25-6809	1.000
R926	(P)RES, MF, 150, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-150-F-T/R	KOA	4701-03-1500	1.000
R931 R932	(S)RES, MF, 21.5, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-21.5-F-T/R	KOA	4701-03-2159	2.000
WAVETEK PARTS LIST	PC ASSY, OUTPUT BD, 2407	1110-00-2313			A REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C800 C801 C802 C803 C804 C805 C806 C807 C810 C811 C813 C815 C819 C822 C835 C836 C840 C841 C849 C853 C862 C863 C864 C867 C868 C901 C910 C913 C917	(P)CAP,CER,.01uF,50V 20%,CHP,X7R,0805,T/R VALUE MARKED	08055C103MATO50M	AVX	1510-06-7103	29.000
C808 C827 C846 C851 C900	(P)CAP,CER,10PF,50V +/- .5PF,CHIP,NPO 0805,T/R,VALUE MARKD	C2012COG1H1000T	TDK	1510-06-5100	5.000
C809 C820 C821 C823 C824 C825 C826 C828 C830 C831 C832 C833 C837 C838 C843 C844 C845 C847 C848 C860 C861 C869 C870 C904 C938 C939 C940 C941	(P)CAP,TNT,.1uF,50V +/-20%,CHP,T/R, 1206 CASE	TAJA104M050R	AVX	1510-27-9104	28.000
C812 C814 C829 C834	(P)CAP,CER,22PF,50V 1%,CHIP,NPO,+/-30PPM 0805,T/R,VALUE MARKD	C2012COG1H220FT	TDK	1510-06-5220	4.000
C816 C817 C818 C842 C850 C852 C857 C858 C859 C865 C866 C902 C903 C905 C907 C909 C911 C915 C916	(S)CAP,CER,.47uF,50V 20%,CHP,Z5U,1812,T/R VALUE MARKED	18125E474MATO50M	AVX	1510-06-7474	19.000
C839 C908 C943 C945 C947	CAP,TANT,10 UF,25V SURFACE MOUNT,T/R	NRD106M25R12	NEC	1510-27-9106	5.000
C912 C914 C942 C944 C946	CAP,TANT,1 UF,35V SURFACE MOUNT	NRB105M35R12	NEC	1510-27-9105	5.000
C918 C919 C920 C922 C923 C924 C925 C926 C927 C928 C929 C931 C932 C933 C934 C935 C936 C937 C948 C949 C950 C951 C953 C954 C955 C956 C957 C958 C959 C960	(P)CAP,CER,100PF,50V 1%,CHIP,NPO,+1-30PPM 0805,T/R,VALUE MARKD	C2012COG1H101FT	TDK	1510-06-5101	30.000
CR800 CR801 CR802 CR803 CR804 CR810 CR811 CR812 CR815 CR816 CR821	DIODE,PIN,GP,ODS-07 V=100V,CJ=0.4pF *SS*,T/R	AL67226-07	EATON	4805-02-0016	11.000
CR817 CR818 CR819 CR825	DIODE,HOT CAR,SOT-23 SMD,V=4VCT=1pF,SS#1	MMBD101	MOT	4809-02-0015	4.000
CR820 CR823 CR824	DIODE,PLANAR,HI SPD SWIT,SOT-23,V=75,I0= 250m,SUR,*SS*,T/R	BAS16	SEM	4812-02-0005	3.000
CR822	DIODE,ZENER,*SS*,T/R 350mW,SOT-23,V=4.7 +/-5%	BZX84C4V7BL	APX	4801-02-0010	1.000
IC802	WIDEBAND AMP,20 DB 600 MHZ BW,SO-8 PKG	NE5205D	SIG	7000-52-0500	1.000
IC806 IC808	DUAL JFET INPUT OP AMP,SO-8*SS*	MC34002AD	MOT	7003-40-0210	2.000
IC807	ANLG SW.,QUAD, SPST, PLAS,SO-16,CMOS	DG201ADY	SCX	8000-02-0102	1.000
WAVETEK PARTS LIST	HYBRID PTS KIT, OUTPUT BD,2407	1219-00-0735			C REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC900	OCT,3-ST D-FLIP FLOP PLAS,SO-20,*SS*,HCMOS	MC74HC574DW	MOT	8007-45-7411	1.000
IC901	BUF,OCT,3 STATE, PLAS,SO-20,*SS*,HCMOS	MC74HC541DW	MOT	8007-45-4111	1.000
IC902	DCCR/DEMUX,1-OF-8, PLAS,SO-16,H-SPD, CMOS,*SS*	MC74HC138D	MOT	8007-41-3812	1.000
IC904	VOLTAGE REG,3 TERM PLAS,SO-8,5V,100MA5%	MC78L05ACD	MOT	7000-78-0511	1.000
IC906	-15V VOLTAGE,REG,PLS PLAS,20-8,*SS*, Io=100mA	MC79L15ACD	MOT	7000-79-1511	1.000
L800 L801 L803 L900 L901 L926*	CHOKE,CHIP,1 UH,20% MOLDED,.18"L X .12"W T/R	LEM4532T1ROM	TAIYO	1816-02-0102	6.000
L802 L804 L813	CHOKE,CHIP,68nH,5%, .12"LX.10"W,MOLDED, T/R	SM3-068J	GWDA	1816-01-0680	3.000
L805 L806 L807 L808 L809 L810 L812	CHOKE,CHIP,100UH,10% MOLDED,.18"L X .12"W T/R	LEM4532T101K	TAIYO	1816-02-0104	7.000
L811 L904 L905 L906 L907 L908 L909 L910 L911 L912 L913 L914 L915 L916 L917 L918 L919 L920 L921 L922 L923 L924 L925	BEAD,SHIELD,SURF MNT TAPE & REEL	2743019447	FRTE	1813-00-0111	23.000
L902 L903	CHOKE,CHIP,22nH,5%, .12"LX.10"W,MOLDED, T/R	SM3-022J	GWDA	1816-01-0220	2.000
MX800	MIXER,SURFACE MOUNT 500 MHZSAM 2000	SCM-1NL	MIN-C	3010-54-0016	1.000
Q800 Q802	FET,SOT-23,UHF/VHF, V=25,ID=60MA,P=350MV TAPE/REEL,*SS*	MMBFJ310T1	MOT	4902-00-3100	2.000
Q801 Q803 Q808 Q904 Q906 Q907 Q908 Q909	NPN,SOT-23,MED PWR F=250m,V=40,P=310m, hFE=40,*SS*,T/R	BSS79C-SOT-23	SIEM	4902-00-0170	8.000
Q901 Q903	PNP,SOT-23,MED PWR F=200m,V=40,P=350m, hFE=40,*SS*,T/R	BSR18A T/R	APX	4902-00-0800	2.000
R800 R802	RES,CHP,78.7,1% 1/8W,TC=100ppm,T/R 1206	RMC 1878781C	KMYO	4711-03-7879	2.000
R801	RES,CHP,107,1% 1/8W,TC=100ppm,T/R 1206	9C12063A1070FKR	M-E	4711-03-1070	1.000
WAVETEK PARTS LIST	HYBRID PTS KIT, OUTPUT BD,2407	1219-00-0735			C REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R803 R916 R917 R942*	(S)RES,CHP,22.1,1% 1/8W,TC=100ppm,T/R 1206	RMC 1822181C	KMYO	4711-03-2219	4.000
R805 R808 R810 R811 R828 R870	RES,CHP,66.5,1% 1/8W,TC=100ppm,T/R 1206	RMC 1866581C	KMYO	4711-03-6659	6.000
R806 R807 R816 R818 R833 R853 R854 R858 R860 R862 R864 R865 R921 R924 R925 R940	RES,CHP,294,1% 1/8W,TC=100ppm,T/R 1206	9C12063A2940FKR	M-E	4711-03-2940	16.000
R809 R922 R930	(S)RES,CHP,178,1% 1/8W,TC=100ppm,T/R 1206	RMC 1817891C	KMYO	4711-03-1780	3.000
R813 R814 R823 R838 R845 R859 R871 R919	(S)RES,CHP,51.1,1% 1/8W,TC=100ppm,T/R 1206 CASE	RMC1851181C	KMYO	4711-03-5119	8.000
R815 R826	RES,CHP,118,1% 1/8W,TC=100ppm,T/R 1206	RMC118-118	KMYO	4711-03-1180	2.000
R822 R834 R903*	RES,CHP,499K,1% 1/8W,TC=100ppm,T/R 1206	RK73H2B4993F	KOA	4711-03-4993	3.000
R825 R846 R939	(P)RES,CHP,10.0,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810081C	KMYO	4711-03-1009	3.000
R830 R848 R890 R915 R933	(S)RES,CHP,475,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B4750F	KOA	4711-03-4750	5.000
R831 R841 R847 R850 R852 R866 R899 R913 R941	(P)RES,CHP,100,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810091C	KMYO	4711-03-1000	9.000
R832 R842	(S)RES,CHP,681,1% 1/8W,TC=100ppm,1%1206	RMC 1868191C	KMYO	4711-03-6810	2.000
R836 R837 R839 R883 R886 R907 R910 R918	(P)RES,CHP,10.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810021C	KMYO	4711-03-1002	8.000
R840 R929 R938	RES,CHP,1.40K,1% 1/8W,TC=100ppm,T/R 1206	IMS-010-2-1401-F	IMS	4711-03-1401	3.000
R843 R898 R906 R908 R909 R920	RES,CHP,4.99K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1849911C	KMYO	4711-03-4991	6.000
R844*	RES,CHP,14.7K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1814721C	KMYO	4711-03-1472	1.000
R857 R882 R885	(P)RES,CHP,150,1% 1/8W,TC=100ppm,T/R 1206	RMC 1815091C	KMYO	4711-03-1500	3.000
WAVETEK PARTS LIST	HYBRID PTS KIT, OUTPUT BD,2407	1219-00-0735			C REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R884 R888 R893 R894	(S)RES,CHP,332K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B3323F	KOA	4711-03-3323	4.000
R887 R889 R892 R896 R902 R904 R905 R911	(P)RES,CHP,100K,1% 1/8W,TC=100ppm,T/R 1206	RMC 1810031C	KMYO	4711-03-1003	8.000
R891	(S)RES,CHP,30.1,1% 1/8W,TC=100ppm,T/R 1206	RMC 1830181C	KMYO	4711-03-3019	1.000
R895	(P)RES,CHP,20.0K,1% 1/8W,TC=100ppm,T/R 1206	RMC1820021C	KMYO	4711-03-2002	1.000
R897*	(S)RES,CHP,1.0M,1% 1/8W,1206,TC=100PPM T/R	RK73H2B1004F	KOA	4711-03-1004	1.000
R912	(S)RES,CHP,68.1K,1% 1/8W,1206,TC=100 PPM T/R	RK73H2B6812F	KOA	4711-03-6812	1.000
R927 R928	RES,CHP,17.4,1% 1/8W,TC=100ppm,T/R 1206	RMC 1817481C	KMYO	4711-03-1749	2.000
WAVETEK PARTS LIST	HYBRID PTS KIT, OUTPUT BD,2407	1219-00-0735	PAGE: 4	C REV	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	PCB, MOTHER, 2407	1710-30-0104	W-I	1710-30-0104	1.000
2	SCREW, STNLS, PPH, 4-40 X 1/4	23022	F-S	2810-23-0064	10.000
3	HEX NUT 4-40 CRES. STNLS.	70202	F-S	2810-16-0023	6.000
4	SHIELD, BACK LIGHT DRIVER	1410-60-4250	W-I	1410-60-4250	1.000
5	SCW, PPH, 4-40X3/8 STAINLESS	23024	F-S	2810-23-0053	6.000
6	WASH, LOCK, SPLIT, 4	1355	F-S	2810-28-0038	16.000
E1001	DC/AC INVERTER FOR EL, 5V TO 100V AC, 400HZ *SS*	D32-43	OPTRX	3010-90-0058	1.000
J1001 J1002	CONN, 96POS, DIN. F, STR 64 PIN, ROW B VOID	20-8457-096-001-026	ELCO	2112-20-0005	2.000
J1003	D-CONN, 96 PIN, ST FEM, ROW A-C FILLED	20-8457-096-001-025	ELCO	2112-20-0006	1.000
J1005 J1006 J1007 J1008 J1009	D CONN, 37POS, STRT F SHIELDED, 4/40 INSERT	H2R37ST28C	HLMBG	2112-04-0019	5.000
J1011	HDR, DBL, 40-PIN SHRD, W/LATCH	80-40-013	WIN	2112-07-0102	1.000
J1012	HEADER, LOCKING, 9-PIN .156"SPACING, RND PIN	09-65-1091	MOL	2112-05-0001	1.000
J1013	HEADER, 20-PIN ST W/ LATCH/SHROUDED	IDH-20PK2-S3-TG	R-N	2112-08-0082	1.000
J1014	HEADER, LOCKING, 2-PIN .156"SPACING, RND PIN	09-65-1021	MOL	2112-05-0010	1.000
WAVETEK PARTS LIST		PC ASSY, MOTHER BD, 2407	1110-00-2311 PAGE: 1		C REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1300	CAP, ALM, 4700uF, 35V 80%, RAD 1.0 "DX1.4 "LX.08"LS	80D472P035JC5	SPR	1510-27-7472	1.000
C1301 C1307	4700 PF 20% 100V X7R AXIAL LEAD, TAPE/REEL	C410C472M1R5CA	KEM	1510-17-1472	2.000
C1302 C1308	CAP, ALM, 100uF, 25V 20%, RAD	RE100MF25V20%	ELNA	1510-23-4101	2.000
C1303 C1304 C1305	CAP, TNT, 1uF, 25V 10%, AXL.095"DX.260"LL	173D105X9025U	SPR	1510-21-7010	3.000
C1306	CAP, ALM, 2700uF, 35V 80%, RAD 1.0 "DX1.0 "LX.08"LS	80D272P035JA5	SPR	1510-27-7272	1.000
C1309	CAP, ALM, 10000uF, 16V + - 20%, RAD 1.0"DX1.38"LX.08"LS	ECES1CV103S	PNSNC	1510-27-3103	1.000
C1310 C1311	CAP, TNT, 10uF, 25V, 20%, AXL, D=3% .18"x.345"	173D106X0025W	SPR	1510-21-7100	2.000
CR1300	DIODE, RECT BRDG, GP V=100V, IO=4A, IS=200A	KBL01	G-I	4806-02-0020	1.000
CR1301 CR1303	DIODE, SIGNAL, GP AXIAL, V=75V, IO=10mA CT=4pF, *SS*	1N914	G-E	4807-01-0914	2.000
CR1302 CR1304 CR1308 CR1309	DIODE, RECT, GP DO-15, V=400V, IO=1.0A *SS*, TAPE&REEL	1N4004	P-C	4806-01-4004	4.000
CR1305 CR1306	DIODE, RECT, GP AXIAL, V=200, IO=5.0A SUR I=225A, *SS*	1N5624	G-E	4806-01-5624	2.000
CR1307	DIODE, ZENER, 1W, GP DO-41, V=12, IT=21mA IF=76mA, +/-5%, *SS*	1N4742A	MOT	4801-02-0003	1.000
IC1300	5V PREC VOLT REF, .3% PLAS, DIP-8, 30Vdc W/TEMP TRANSDR, *SS*	REF02CP	PMI	7000-00-0203	1.000
IC1301	OP AMP, JFET INPUT PLAS, DIP-8, 18Vdc 13V/uS, *SS*	TL082CP	T-I	7000-00-8200	1.000
Q1300	JFET-N, TO-92, AUD AMP VGS=40, IDSS=10mA P=350mW, SS#1	E232	SCX	4902-00-2320	1.000
Q1302	PNP, TO-92, GP AMP/SW F=300, V=40, Icex=50uA P=625mW, hFE=100, *SS*	2N3906	T-I	4901-03-9060	1.000
Q1304	NPN, TO-126, DRLNG PWR F=1M, V=80, Iceo=100uA P=40W, hFE=750, *SS*	MJE803	MOT	4902-00-8030	1.000
WAVETEK PARTS LIST	PC ASSY, P/S, 2407	1110-00-2312		PAGE: 1	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R1300	(P)RES,MF,1K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-1K-F-T/R	KOA	4701-03-1001	1.000
R1301	(P)RES,MF,47.5K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-47.5K-F-T/R	KOA	4701-03-4752	1.000
R1302	(P)RES,MF,3.92K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-3.92K-F-T/R	KOA	4701-03-3921	1.000
R1303	(P)RES,MF,13.0K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-13.0K-F-T/R	KOA	4701-03-1302	1.000
R1305 R1307 R1309	(P)RES,MF,10K,1% 1/8W,AXL,TC=100ppmT/R	4701-03-1002	W-I	4701-03-1002	3.000
R1308 R1311	(S)RES,MF,4.75K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-4.75K-F-T/R	KOA	4701-03-4751	2.000
R1310	(S)RES,MF,1.24K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-1.24K-F-T/R	KOA	4701-03-1241	1.000
R1312	(S)RES,MF,825,1% 1/8W,AXL,TC=100ppmT/R	MF55D-825-F-T/R	KOA	4701-03-8250	1.000
R1313	(P)RES,MF,2.74K,1% 1/8W,AXL,TC=100 PPM T/R	MF55D-2.74K-F-T/R	KOA	4701-03-2741	1.000
R1314	(P)RES,MF,499,1% 1/8W,AXL,TC=100ppmT/R	MF55D-499-F-T/R	KOA	4701-03-4990	1.000
R1316	(P)RES,MF,4.99K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-4.99K-F-T/R	KOA	4701-03-4991	1.000
WAVETEK PARTS LIST		PC ASSY,P/S,2407	1110-00-2312		REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	PS HEATSINK,2407	1410-01-5150	W-I	1410-01-5150	1.000
2	MICA INSULATOR	B08853A001	MOT	2810-11-0004	3.000
3	SHLDR WSHR, T0-220	B51547F019	MOT	2810-11-0031	3.000
4	SCW,PPH,4-40X1/4	19022NP	F-S	2810-55-4104	3.000
IC1302	ADJ REG,1.2V-37V PLAS,T0-220,1.5A=Io 15W,0.1%,*SS*	LM317T	NAT	7000-03-1700	1.000
Q1301 Q1303	PROT PWR DARLINGTON *SS*	LM395T	NAT	4902-00-3950	2.000
WAVETEK PARTS LIST		HEATSINK ASSY,2407		1216-00-0349 PAGE: 1	
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	TERM, LOOP, WIRE CRIMP 18-24GA	08-50-0106	MOL	2113-07-0002	5.000
P1300	JACK, FEMALE, 5-CKT MC000-066	09-50-3051	MOL	2113-06-0008	1.000
T1300	POWER XFMR, 115/230V +12.4 & +/-24.2V SEC PER B/P	BE 23163-001	BASLR	5610-00-0077	1.000
WAVETEK PARTS LIST		XFMR ASSY, 2407	1219-00-0731		REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
2	TERM, LOOP, WIRE CRIMP 18-24GA	08-50-0106	MOL	2113-07-0002	2.000	
3	FAN, 12VDC, 80X80X25MM 25CFM	3110PL-04W-B30-D00	NMB	3010-13-0018	1.000	
P1301	CONN, FEMALE, 2-PIN .156"SPACING, SNAP LK	09-50-3021	MOL	2113-06-0014	1.000	
WAVETEK PARTS LIST		FAN ASSY, 2407		1219-00-0732 PAGE: 1		REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1400 C1401 C1404 C1405 C1406 C1407 C1410 C1411 C1412 C1413 C1414 C1415 C1416 C1417 C1418 C1420 C1425 C1426 C1427 C1428 C1434 C1435 C1438 C1445 C1446 C1467 C1468 C1469	CAP, CER, .01uF, 50V 10%, AXL, X7R .10"Dx.17"L	SA105C103KAA	AVX	1510-17-1103	28.000
C1402 C1403 C1441 C1442 C1447 C1448 C1449	CAP, TNT, 1uF, 25V 10%, AXL, .095"Dx.260"LL	173D105X9025U	SPR	1510-21-7010	7.000
C1408 C1409	330 PF 20% 100V NPO AXIAL LEAD, TAPE/REEL	C410C331M1G5CA	KEM	1510-17-1331	2.000
C1419	CAP, CER, 2700pF, 100V 5%, AXL, NPO, T/R, .15"D X .29"LL	SA301A272JAA	AVX	1510-16-4272	1.000
C1421	CAP, CER, 820pF, 100V, 5%, AXL, NPO, T/R, .10"D X .17"LL	SA101A821JAA	AVX	1510-16-4821	1.000
C1422	CAP, CER, 120pF, 100V 5%, AXL, NPO, .09"Dx.16"LL	C114G121J1G5CA	KEM	1510-17-0121	1.000
C1423	CAP, CER, 1800pF, 100V 5%, AXL, NPO, T/R .1"D X .26"LL	SA301A182JAA	AVX	1510-17-1182	1.000
C1424	CAP, CER, 220pF, 100V, 5%, AXL, NPO, T/R, .1"D X .17"LL	5A101A221JAA	AVX	1510-17-1221	1.000
C1429 C1444	CAP, CER, .1uF, 50V 20%, AXL, Z5U .10"Dx.26"LL	SA205E1042AA	AVX	1510-17-1104	2.000
C1430	CAP, CER, 200V, 47PF/T/R	C114C470J2G5CA	KEMET	1510-16-8470	1.000
C1431	CAP, CER, 1000pF, 50V 10%, AXL, X7R .09"Dx.16"LL	RPA10X7R102K50VPT	MURGA	1510-16-8102	1.000
C1432	CAP, CER, 1uF, 50V 10%, AXL, X7R .25"Dx.50"LL	C202C105K5R5CA	KEM	1510-16-6105	1.000
C1433	22PF 20% 100V NPO AXIAL LEAD, TAPE/REEL	C410C220M1G5CA	KEM	1510-17-1220	1.000
C1436 C1437	CAP, CER, 470pF, 50V 10%, AXL, NPO .09"Dx.16"LL	592CC0G471J050B	SPR	1510-16-4471	2.000
C1439	CAP, CER, 10pF, 100V 5%, AXL, NPO .10"Dx.17"LL, T/R	SA106A100JAA	AVX	1510-17-1100	1.000
C1440	CAP, VARI, 7-35PF, 160V	CV101-035	W-1	1510-70-0350	1.000
C1443	4700 PF 20% 100V X7R AXIAL LEAD, TAPE/REEL	C410C472M1R5CA	KEM	1510-17-1472	1.000
WAVETEK PARTS LIST	PC ASSY, DEV METER BD 2407	1110-00-2317			A REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1450 C1451 C1452 C1453 C1454 C1455 C1456 C1457 C1458 C1459 C1460 C1461 C1462 C1463 C1464 C1465 C1466	100 PF 20% 100V NPO AXIAL LEAD, TAPE/REEL	C410C101M1G5CA	KEM	1510-17-1101	17.000
CR1401 CR1402 CR1403 CR1404 CR1405 CR1406 CR1407	DIODE, PIN, GP SWIT AXIAL, V=100V CT=0.4pF, *SS*	5082-3080	H-P	4805-02-0002	7.000
IC1400	DCCR/DEMUX, 1-OF-8 PLAS, DIP-16 H SPD CMOS, *SS*	MC74HC138N	MOT	8007-41-3811	1.000
IC1401	BUFFER, OCTAL, 3 STATE PLAS, DIP-20, *SS* HIGH SPEED CMOS	MC74HC541N	MOT	8007-45-4110	1.000
IC1402	VOLT REG, +5V, 3-TERM PLAS, TO-92, 35Vdc 5%, I _o =100mA, *SS*	671-045	W-I	7000-78-0501	1.000
IC1403	OCT 3-STATE NON-INV D-TYPE FLIP-FLOP*SS* PLASTIC, DIP-20 CMOS	MC74HC574N	MOT	8007-45-7410	1.000
IC1404	QUAD ANALOG SWITCH *SS*	HI-201-5	HSD	8000-02-0100	1.000
IC1408	UWAVE WB AMP, 0204*SS*	MSA-0204	AVT	4902-00-2040	1.000
IC1409	UWAVE WB AMP, 0404*SS*	MSA-0404	AVT	4902-00-4040	1.000
IC1410 IC1411 IC1420	OP AMP, JFET INPUT PLAS, DIP-8, 18Vdc 13V/uS, *SS*	TL082CP	T-I	7000-00-8200	3.000
IC1412	WIDEBAND HI FREQ AMP PLAS, DIP-8, *SS*	NE5205N	SIG	7000-52-0510	1.000
IC1413	WIDEBAND FSK RCVR PLAS, DIP-16, *SS*	MC13055P	MOT	8001-30-5510	1.000
IC1414	VOLT, REG, FIXED, -15V PLAS, TO-226AA, -35Vdc 10%, I _o =100mA, *SS*	LM79L15ACZ	WAT	7000-79-1510	1.000
IC1415	VOLT REG, FIXED, +15V PLAS, 3 PIN(TO-220) 35Vdc, .1%, 700mA, *SS*	SA78M15CU	SIG	7000-78-1500	1.000
IC1416	VOLT REG, +12V, 3-TERM PLAS, TO-92, 35Vdc 5%, 100mA, *SS*	LM78L12ACZ	WAT	7000-78-1220	1.000
J1401	CONN, SMA-F, 50, PC MT RT ANG	088-2080-BRASS	LYNIC	2110-02-0017	1.000
J1402	CONN, RF, RT. ANGLE JACK	700214	CBLWV	2110-08-0005	1.000
L1400	CHOKE, COATED, 0.47UH 10%, D=0.120IN L=0.300IN, I=650MA	08NR47	JEF	1810-03-0478	1.000
WAVETEK PARTS LIST	PC ASSY, DEV METER BD 2407	1110-00-2317			A REV
		PAGE: 2			

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
L1401 L1402 L1405 L1406 L1407 L1412 L1414	CHOKE, COATED, 39UH 10%, D=0.120IN, L=0.300, I=125MA	09C390K	JEF	1810-03-0390	7.000
L1403 L1404	CHOKE, COATED, 510UH 10%, T/R, NON-STD VAL.	10154-48K	JEF	1810-03-0511	2.000
L1408	CHOKE, COATED, 0.68UH 10%, D=0.120IN L=0.300IN, I=495MA	08NR68	JEF	1810-03-0688	1.000
L1409	CHOKE, COATED, 4.7UH 10%, D=0.120IN L=0.300IN, I=230MA	08N4R7	JEF	1810-03-0479	1.000
L1410	CHOKE, COATED, 0.27UH 10%, D=0.120IN L=0.300IN, I=960MA	08NR27	JEF	1810-03-0278	1.000
L1411	CHOKE, COATED, 2.2UH 10%, D=0.120IN L=0.300IN, I=395MA	08N2R2	JEF	1810-03-0229	1.000
L1413	CHOKE, COATED, 15UH 10%, D=0.120IN, L=.30"	08N150	JEF	1810-03-0150	1.000
L1415 L1416 L1417 L1418 L1419 L1420 L1421 L1422 L1423 L1424 L1425 L1426 L1427 L1428 L1429 L1430 L1431	WIRED FERRITE BEAD .138 DIA X .236 T/R	11424-4A6	FRXC	1813-00-0114	17.000
MX1400	MIXER, DBL. BAL.	SBL-1-DBL	MIN-C	3010-54-0004	1.000
P1401	D-CONN, 37POS, RIGHT ANGLE, MALE	617L037PAJ201	APL	2112-04-0020	1.000
R1400 R1401	RES, L-A, 1/4W, 1%, 196 TAPE AND REEL	SPS-N-347-196	IRC	4741-19-6008	2.000
R1402 R1415 R1416	(S)RES, MF, 95.3, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-95.3-F-T/R	KOA	4701-03-9539	3.000
R1403 R1404 R1434 R1435	(S)RES, MF, 60.4, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-60.4-F-T/R	KOA	4701-03-6049	4.000
R1405	(S)RES, MF, 249, 1% 1/8W, AXL, TC=100 PPM T/R	MF55D-249-F-T/R	KOA	4701-03-2490	1.000
R1406 R1407	(S)RES, MF, 78.7, 1% 1/8W, AXL, TC=100 PPM T/R	MF55D-78.7-F-T/R	KOA	4701-03-7879	2.000
R1408 R1413 R1414	(S)RES, MF, 392, 1% 1/8W, AXL, TC=100ppmT/R	MF55D-392-F-T/R	KOA	4701-03-3920	3.000
R1409	(S)RES, MF, 274, 1% 1/8W, AXL, TC=100 PPM T/R	4701-03-2740	WSD	4701-03-2740	1.000
R1410 R1411 R1412 R1425 R1437 R1438	(P)RES, MF, 10K, 1% 1/8W, AXL, TC=100ppmT/R	4701-03-1002	W-I	4701-03-1002	6.000
WAVETEK PARTS LIST	PC ASSY, DEV METER BD 2407	1110-00-2317			A REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
R1417 R1418 R1426	(P)RES,MF,3.92K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-3.92K-F-T/R	KOA	4701-03-3921	3.000	
R1419 R1420	(P)RES,MF,20K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-20K-F-T/R	KOA	4701-03-2002	2.000	
R1421 R1422	(S)RES,MF,76.8K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-76.8K-F-T/R	KOA	4701-03-7682	2.000	
R1423 R1432	(P)RES,MF,13.0K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-13.0K-F-T/R	KOA	4701-03-1302	2.000	
R1424 R1428	(P)RES,MF,100K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-100K-F-T/R	KOA	4701-03-1003	2.000	
R1427	(P)RES,MF,200K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-200K-F-T/R	KOA	4701-03-2003	1.000	
R1429	(P)RES,MF,1M,1% 1/8W,AXL,TC=100ppmT/R	MF55D-1M-F-T/R	KOA	4701-03-1004	1.000	
R1430	(P)RES,MF,47.5K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-47.5K-F-T/R	KOA	4701-03-4752	1.000	
R1431 R1439	(P)RES,MF,1K,1% 1/8W,AXL,TC=100ppmT/R	MF55D-1K-F-T/R	KOA	4701-03-1001	2.000	
R1433	(P)RES,MF,100,1% 1/8W,AXL,TC=100ppmT/R	MF55D-100-F-T/R	KOA	4701-03-1000	1.000	
R1436	(S)RES,MF,51.1,1% 1/8W,AXL,TC=100ppmT/R	MF55D-51.1-F-T/R	KOA	4701-03-5119	1.000	
WAVETEK PARTS LIST		PC ASSY,DEV METER BD 2407		1110-00-2317 PAGE: 4		A REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	KEYBD ASSY,2407	1216-00-0350	W-I	1216-00-0350	1.000
2	FP MECH ASSY,2407	1216-00-0351	W-I	1216-00-0351	1.000
3	BUTTON,LT GRAY	J52304 30656	C-L	5110-04-0019	1.000
4	KEYBOARD SPACER	1410-30-8790	W-I	1410-30-8790	1.000
6	1/8" SPACER	610-009	W-I	2810-05-0017	3.000
7	NUT,KEPS,4	71500	F-S	2810-16-0026	11.000
9	SEMS-PPH-INT 4-40 X 3/16 NPPER B/P	PER DESC2810-57-4103	F-S	2810-57-4103	4.000
10	SEMS-PPH-INT 4-40 X 1/4 NPPER B/P	PER DESC2810-57-4104	F-S	2810-57-4104	2.000
11	KEYPAD	5108-00-0014	W-I	5108-00-0014	1.000
12	LCD ASSY,2407	1219-00-0754	W-I	1219-00-0754	1.000
13	CABLE KIT,FP,2407	1219-00-0734	W-I	1219-00-0734	1.000
WAVETEK PARTS LIST		FP ASSY,2407	1111-00-0206		A REV
			PAGE: 1		

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
1	RIGHT & LEFT FRONT PANEL BEZEL, 2407 FROM:3210-06-0055	1410-30-8830	W-I	1410-30-8830	2.000	
2	BOTTOM FRONT PANEL BEZEL, 2407 FROM:3210-06-0055	1410-30-8840	W-I	1410-30-8840	1.000	
3	TOP FRONT PANEL BEZEL, 2407 FROM:3210-06-0055	1410-30-8850	W-I	1410-30-8850	1.000	
4	FRONT PANEL, 2407	1410-80-2460	W-I	1410-80-2460	1.000	
5	SPACER, HEX, 4-40X1/4 HD101-404	108301NP	F-S	2810-02-4104	4.000	
6	SPACER, THD, 4-40X1/2 HD101-408	108304NP	F-S	2810-02-4108	2.000	
7	HANDLE, STYLE-Z, 0- FINSH, .187" MOUNT FOR #8SCREW; BATCH/PAINT	15112-187-0	AMATM	2810-07-0020	2.000	
8	NUT, KEPS, 4	71500	F-S	2810-16-0026	10.000	
9	NUT, KEPS, 6	9225	F-S	2810-16-0027	6.000	
10	SCW, PPH, 8-32X5/16	19063NP	F-S	2810-55-8105	6.000	
WAVETEK PARTS LIST		FP MECH ASSY, 2407		1216-00-0351 PAGE: 1		REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
5	LCD,DOT MATRIX,40X2 SUPERTWIST, TOP VIEW EL BACKLIGHT *SS*	DMC40218NEU	OPTRX	2410-03-0025	1.000
W27	CABLE ASSY,DISPLAY TO MOTHER BD,2407	1217-50-0008	W-I	1217-50-0008	1.000
WAVETEK PARTS LIST		LCD ASSY,2407	1219-00-0754		REV
PAGE: 1					

REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
W01	(P)CABLE ASSY,5.5 IN SMA-N,.141" CONFORM REF DWG:0012-10-0084	1217-92-0049	W-I	1217-92-0049	1.000	
W03	CABLE ASSY,6",BNC CABLE JACK TO SMB, RA PLUG	WX2407-W3	W-I	1217-80-0137	1.000	
W20	CABLE ASSY,RIBBON 40-PIN,6 IN	6011-60-0096	W-I	6011-60-0096	1.000	
W21	CABLE ASSY,RIBBON 16-PIN,3.5 IN	6011-60-0095	W-I	6011-60-0095	1.000	
W26	POWER SWITCH/HARN ASSY,2407,26",W26	1212-00-0040	W-I	1212-00-0040	1.000	
WAVETEK PARTS LIST		CABLE KIT,FP,2407		1219-00-0734 PAGE: 1		REV

REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	FRONT PANEL BRACE2407	1410-30-8860	W-I	1410-30-8860	1.000
2	CARD CAGE ENCLOSURE GUIDE, 2407	1410-30-8880	W-I	1410-30-8880	6.000
3	MALE-MALE THREADED ADAPTER #4-40	1410-30-8920	W-I	1410-30-8920	6.000
4	CARD CAGE	1410-80-2480	W-I	1410-80-2480	1.000
5	CARD CAGE CNTR WALL 2407	1410-80-2520	W-I	1410-80-2520	1.000
6	CARD GUIDE, SLOTTED L=6.875, W=.375 MTG .4 CTRS W/O RVTS	PRD-6875	UTK	2112-16-0033	8.000
7	RIVET, AL, 1/8X1/8	AD42ABS	USMFS	2810-30-0015	5.000
8	RIVET, SNAP-IN .060 THK CHASSIS FOR:2112-16-0033	RV4700	UTK	2810-30-0039	16.000
9	RIVET, POP, OPEN-END .125 BODY, CNTR SUNK GRIPRANGE, .251-.312	AK45BS	EMHFG	2810-30-0040	18.000
10	RIVET, POP, OPEN-END .125 BODY, CNTR SUNK, GRIPRANGE, .0635-.125	AK42BS	EMHFG	2810-30-0041	8.000
 WAVETEK PARTS LIST		CD/CAGE ASSY, 2407	1216-00-0348		REV
			PAGE: 1		

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
W4 W5	CABLE ASSY, 16 IN	WX1080A-W1	W-I	1217-80-0082	2.000	
W22	CABLE ASSY, MOTHER BD TO PS BD, 2407	1217-50-0003	W-I	1217-50-0003	1.000	
W23	CABLE ASSY, GPIB, 17", 2407	1217-50-0005	W-I	1217-50-0005	1.000	
W25	CABLE ASSY, 10" POWER ENTRY MODULE, 2407	1217-50-0002	W-I	1217-50-0002	1.000	
WAVETEK PARTS LIST		CABLE KIT, RP, 2407		1219-00-0733 PAGE: 1		REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
W06	(P)CABLE ASSY,4 IN, SMA-SMA,.085"SOFT FM REF DWG:0012-10-0126	1217-91-0007	W-I	1217-91-0007	1.000
W07	(P)CABLE ASSY,3 IN, SMA-SMA,.085"SOFT FM REF DWG:0012-10-0126	1217-91-0005	W-I	1217-91-0005	1.000
W08 W09	(P)CABLE ASSY,7.5 IN SMA-SMA,.085"SOFT FM REF DWG:0012-10-0126	1217-91-0014	W-I	1217-91-0014	2.000
WAVETEK PARTS LIST		CABLE KIT, RF,2407		1219-00-0728 PAGE: 1	
					REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
W02	(P)CABLE ASSY,4 IN SMA-SMA,-141" CONFM REF DWG:0012-10-0126	1217-92-0007	W-I	1217-92-0007	1.000	
W24	RIBBON CABLE ASSY 20-PIN	1217-50-0010	W-I	1217-50-0010	1.000	
WAVETEK PARTS LIST		CABLE KIT,ATTEN,2407		1219-00-0742 PAGE: 1		A REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
2	ENCLOSURE HANDLE,2407	1410-30-8900	W-I	1410-30-8900	2.000
3	GUIDE PIN .150 O.D.	1410-30-8910	W-I	1410-30-8910	2.000
4	FRONT ENCLOSURE END CAP,AM/DIV&OUTPUT2407	1410-60-4090	W-I	1410-60-4090	1.000
5	REAR ENCL END CAP AM/DIV & OUTPUT2407	1410-60-4170	W-I	1410-60-4170	1.000
6	REAR ENCLOSURE GASKET,2407	1410-60-4180	W-I	1410-60-4180	1.000
7	FRONT ENCLOSURE GASKET,2407	1410-60-4190	W-I	1410-60-4190	1.000
8	RF ENCLOSURE WITH CENTER WALL,24XX	1410-80-2590	W-I	1410-80-2590	1.000
9	SCREW 4-40X1/4" PPH THREAD CUTTING,TYPE1 ZINC PLATED	2810-22-0008	ANY	2810-22-0008	8.000
10	SCW,82 PFUCUT, 4-40X3/16	PER DESC2810-23-0091	F-S	2810-23-0091	6.000
11	SEMS-PPH-INT 4-40 X 1/4 NPPER B/P	PER DESC2810-57-4104	F-S	2810-57-4104	4.000
12	NUT 3/8 ACROSS FLATS .250-36 THREAD	2810-16-0030	F-S	2810-16-0030	6.000
13	I,LW,1/4X.408X.018 HW102-000	30-120	F-S	2810-28-0001	6.000
14	WASHER, FLATPER B/P	2810-26-0017	W-I	2810-26-0017	6.000
A700	PC ASSY,AM/DIV BD, 2407	1110-00-2314	W-I	1110-00-2314	1.000
A800	PC ASSY,OUTPUT BD, 2407	1110-00-2313	W-I	1110-00-2313	1.000
WAVETEK PARTS LIST		ENCLOSURE,AM/DIV & OUTPUT,2407		1114-00-0534 PAGE: 1	c REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
2	ENCLOSURE HANDLE,2407	1410-30-8900	W-I	1410-30-8900	2.000
3	GUIDE PIN .150 O.D.	1410-30-8910	W-I	1410-30-8910	2.000
4	FRONT ENCLOSURE END CAP, SYNTH, 2407	1410-60-4110	W-I	1410-60-4110	1.000
5	REAR ENCLOSURE GASKET, 2407	1410-60-4180	W-I	1410-60-4180	1.000
6	FRONT ENCLOSURE GASKET, 2407	1410-60-4190	W-I	1410-60-4190	1.000
7	REAR ENCLOSURE END CAP (TOP D-SUR ONLY), 2407	1410-60-4260	W-I	1410-60-4260	1.000
8	RF ENCLOSURE WITH CENTER WALL, 24XX	1410-80-2590	W-I	1410-80-2590	1.000
9	SCREW 4-40X1/4" PPH THREAD CUTTING, TYPE 1 ZINC PLATED	2810-22-0008	ANY	2810-22-0008	8.000
10	SCW, 82 PFUCUT, 4-40X3/16	PER DESC2810-23-0091	F-S	2810-23-0091	6.000
11	SEMS-PPH-INT 4-40 X 1/4 NPPER B/P	PER DESC2810-57-4104	F-S	2810-57-4104	2.000
12	NUT 3/8 ACROSS FLATS .250-36 THREAD	2810-16-0030	F-S	2810-16-0030	1.000
13	I, LW, 1/4X.408X.018 HW102-000	30-120	F-S	2810-28-0001	1.000
14	WASHER, FLATPER B/P	2810-26-0017	W-I	2810-26-0017	1.000
A400	PC ASSY, SYN BD, 2407	1110-00-2315	W-I	1110-00-2315	1.000
WAVETEK PARTS LIST		ENCLOSURE, SYNTH, 2407		1114-00-0535 PAGE: 1	D REV

REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
2	ENCLOSURE HANDLE,2407	1410-30-8900	W-I	1410-30-8900	2.000
3	GUIDE PIN .150 O.D.	1410-30-8910	W-I	1410-30-8910	2.000
4	FRONT ENCLOSURE END CAP,LO/REF&DEV MTR 2407	1410-60-4100	W-I	1410-60-4100	1.000
5	REAR ENCLOSURE END CAP,2407	1410-60-4120	W-I	1410-60-4120	1.000
6	REAR ENCLOSURE GASKET,2407	1410-60-4180	W-I	1410-60-4180	1.000
7	FRONT ENCLOSURE GASKET,2407	1410-60-4190	W-I	1410-60-4190	1.000
8	RF ENCLOSURE WITH CENTER WALL,24XX	1410-80-2590	W-I	1410-80-2590	1.000
9	SCREW 4-40X1/4" PPH THREAD CUTTING,TYPE1 ZINC PLATED	2810-22-0008	ANY	2810-22-0008	8.000
10	SCW,82 PFUCUT, 4-40X3/16	PER DESC2810-23-0091	F-S	2810-23-0091	6.000
11	SEMS-PPH-INT 4-40 X 1/4 NPPER B/P	PER DESC2810-57-4104	F-S	2810-57-4104	4.000
12	NUT 3/8 ACROSS FLATS .250-36 THREAD	2810-16-0030	F-S	2810-16-0030	2.000
13	I,LW,1/4X.408X.018 HW102-000	30-120	F-S	2810-28-0001	2.000
14	WASHER, FLATPER B/P	2810-26-0017	W-I	2810-26-0017	2.000
A600	PC ASSY,LO/REF BD, 2407	1110-00-2318	W-I	1110-00-2318	1.000
A1400	PC ASSY,DEV METER BD 2407	1110-00-2317	W-I	1110-00-2317	1.000
WAVETEK PARTS LIST		ENCLOSURE,LO/REF & DEV METER, 2407		1114-00-0536 PAGE: 1	c REV

REFERENCE DESIGNATORS	PART DESCRIPTION ><	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY	
1	CD/CAGE ASSY, 2407	1216-00-0348	W-I	1216-00-0348	1.000	
2	FOAM FILTER 1.20 X 1.05 FROM:3210-99-0050	1410-01-5160	W-I	1410-01-5160	2.000	
3	FOAM FILTER, 1.20 X 6.95 FROM:3210-99-0050	1410-01-5170	W-I	1410-01-5170	1.000	
4	ADHESIVE STRIP,2407, .20"X.75"	1410-01-5180	W-I	1410-01-5180	4.000	
5	ADHESIVE STRIP,2407, .20"X6.80"	1410-01-5190	W-I	1410-01-5190	2.000	
6	BOTTOM COVER, 2407	1410-80-2510	W-I	1410-80-2510	1.000	
7	FOOT,W/TIP-UP,BLACK	10603-025	SCHRF	2810-08-0029	2.000	
8	FOOT,L=1.594,W=.748 BLACK W/LOCATOR TAB	10603-026	SCHRF	2810-08-0030	2.000	
9	RIVET,AL,1/8X1/8	AD42ABS	USMFS	2810-30-0015	12.000	
10	SEMS-PPH-INT 6-32 X 3/8 NPPER B/P	PER DESC2810-57-6106	F-S	2810-57-6106	4.000	
WAVETEK PARTS LIST		BOTTOM COVER ASSY, 2407		1216-00-0347 PAGE: 1		A REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	POWER SUPPLY,2407	1115-00-0050	W-I	1115-00-0050	1.000
2	XFMR ASSY, 2407	1219-00-0731	W-I	1219-00-0731	1.000
3	FAN ASSY, 2407	1219-00-0732	W-I	1219-00-0732	1.000
4	GPIB CONN COVER PER B/P	1410-01-4980	W-I	1410-01-4980	1.000
5	FAN SCREEN FROM:3210-02-0571 PER B/P	1410-30-8240	W-I	1410-30-8240	1.000
6	FAN GASKET,2407	1410-30-8930	W-I	1410-30-8930	1.000
7	REAR PANEL, 2407	1410-80-2470	W-I	1410-80-2470	1.000
8	GROUND LUG,#6,INT HG102-600	38-111	F-S	2112-03-0003	1.000
9	FUSE,3AG,SB,1A,250V	MDL-1	BUS	2410-05-0005	1.000
10	FUSEHOLDER/PWR ENTRY MODULE	PE712003	CRTIS	2410-05-0045	1.000
11	CABLE CLAMP,1/4	8957	HHS	2810-00-0004	1.000
12	JACK SOCKET ASSY	3341-3KIT	MMM	2810-09-0035	1.000
13	KEP NUT8-32	9226	F-S	2810-15-0007	4.000
14	SCREW,PH,M3.5X.6X6MM	PER DESC2810-23-0122	S-S	2810-23-0122	2.000
15	HOLE PLUG, 1/2 BLK HB118-000	P500	HEYCO	2810-35-0001	1.000
16	HOLE PLUG,3/8 HB118-001	110-016	W-I	2810-35-0002	3.000
17	SEMS-PPH-INT 4-40 X 1/4 NPPER B/P	PER DESC2810-57-4104	F-S	2810-57-4104	2.000
18	SCW,PPH,8-32X1-3/4BK	19074-BK OXIDE	F-S	2810-65-8128	4.000
19	FAN GUARD	FF-325G	AFP	3010-13-0017	1.000
20	LINE CORD,3-COND,SVT 18 GA,7-1/2 FT,W/REC EUROPEAN COLOR CODE	6011-80-0006	ECMC	6011-80-0006	1.000
21	WIRE,18,UL1015,GN/YL	UL1015-18-GN/YL	ULSP	6013-11-8545	7.000
WAVETEK PARTS LIST		RP ASSY, 2407	1111-00-0205		A
			PAGE: 1		REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	RP ASSY, 2407	2407-RP	W-I	1111-00-0205	1.000
2	FP ASSY, 2407	2407-FP	W-I	1111-00-0206	1.000
3	BOTTOM COVER ASSY, 2407	1216-00-0347	W-I	1216-00-0347	1.000
4	SCW, 82 PFUCUT, 6-32X1/4	PER DESC2810-23-0096	F-S	2810-23-0096	6.000
5	SCW, PPH, 6-32X3/16	19041NP	F-S	2810-55-6103	1.000
6	SEMS-PPH-INT 4-40 X 1/4 NPPER B/P	PER DESC2810-57-4104	F-S	2810-57-4104	9.000
7	SEMS-PPH-INT 4-40 X 1/2 NPPER B/P	PER DESC2810-57-4108	F-S	2810-57-4108	2.000
8	SEMS-PPH-INT 6-32 X 1/4 NPPER B/P	PER DESC2810-57-6104	F-S	2810-57-6104	12.000
A1000	PC ASSY, MOTHER BD, 2407	1110-00-2311	W-I	1110-00-2311	1.000
AT01	P1111, BARRACUDA	P1111	W-I	1113-40-0169	1.000
WAVETEK PARTS LIST		CHASSIS ASSY, 2407		1111-00-0204 PAGE: 1	
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
1	CHASSIS ASSY, 2407	2407-CHAS	W-I	1111-00-0204	1.000
2	ENCLOSURE, AM/DIV & OUTPUT, 2407	1114-00-0534	W-I	1114-00-0534	1.000
3	ENCLOSURE, DOUBLER & SYN, 2407	1114-00-0535	W-I	1114-00-0535	1.000
4	ENCLOSURE, LO/REF & DEV METER, 2407	1114-00-0536	W-I	1114-00-0536	1.000
5	CABLE KIT, RF, 2407	1219-00-0728	W-I	1219-00-0728	1.000
6	CABLE KIT, ATTN, 2407	1219-00-0742	W-I	1219-00-0742	1.000
7	THUMB NUT, #4-40, NICKEL, 3/8"D X 1/4"H	75001-NP	F-S	2810-16-0037	6.000
A100	PC ASSY, UPROC BD, 2407	1110-00-2321	W-I	1110-00-2321	1.000
A200	PC ASSY, CONTROL BD, 2407	1110-00-2320	W-I	1110-00-2320	1.000
A300	PC ASSY, DIRECT DIGITAL SYN, 2407	1110-00-2319	W-I	1110-00-2319	1.000
WAVETEK PARTS LIST		FINAL ASSY, 2407	1118-00-0183		B
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MANUFACTURERS REFERENCE LIST BY ABBREVIATION

ABBR.	NAME.....	CITY.....	ST	FSCM.
A-B	ALLEN-BRADLEY	MILWAUKEE	WI	01121
A-D	ANALOG DEVICES	CAMBRIDGE	MA	24355
A-H	ARROW HART, INC.	KETTERING	OH	07858
A-I	ALAN INDUSTRIES	COLUMBUS	IN	52750
A-M	AMERICAN MAGNETICS	CARTERVILLE	IL	12715
A-P	AMERICAN PLASTICRAFT CO.	CHICAGO	IL	53628
A-Z	AMERICAN ZETTLER, INC.	IRVINE	CA	26806
A.T.	A.T. WALL CO.	WARWICK	RI	
AAVID	AAVID ENGINEERING, INC.	LACONIA	NH	30161
ABAC	ABACUS PACKAGING CO.	CHICAGO	IL	
ABBIN	ABBOTT-INTERFAST CORP.	WHEELING	IL	08928
ABLST	ABLESTIK LABORATORIES	GARDENA	CA	21109
ACEIN	ACE INDUSTRIAL HWYR.	CAMDEN	NJ	
ACI	ADVANCE COMPONENTS, INC.	CENTERBROOK	CT	28102
ACR	AMERICAN CHEMICAL REFINER	VILLA PARK	IL	
ACRIN	ACRIAN	CUPERTINO	CA	58135
ADV	ADVANCE	CHICAGO	IL	
AEG-T	AEG-TELEFUREN CORP.	SOMERVILLE	NJ	24972
AEP	APPLIED ENG PRODUCTS	NEW HAVEN	CT	19505
AER	AUX CERAMICS	MYRTLE BEACH	SC	96095
AERTK	AERTECH INDUSTRIES	SUNNYVALE	CA	21847
AFF	ACCESSORIES FOR ELECTRONICS	BALDWIN	NY	54355
AFP	AIR FILTRATION PRODUCTS, INC	TUCSON	AZ	
AHAM	AHAM COMPANY	AZUSA	CA	53894
AIN	ALPHA INDUSTRIES, INC.	WOBURN	MA	17540
ALASC	ALASCO RUBBER AND PLASTICS CORP	BURLINGAME	CA	13862
ALC	ALCO ELECTRONICS PRODUCTS	NORTH ANDOVER	ME	95146
ALDDV	ALLIED DEVICES CORP.	BALDWIN	NY	29964
ALENG	ALPHA ENG.	GREENWOOD	IN	
ALLAN	ALLAN WOODS AND ASSOC.	DES PLAINES	IL	
ALLPL	ALL PLASTICS, INC.	INDIANAPOLIS	IN	
ALMPT	ALPHA METALS, INC	JERSEY CITY	NJ	96613
ALPHA	ALPHA INDUSTRIES	LAWRENCE	MA	
AMATM	AMATOM ELEC HWYR CO	NEW HAVEN	CT	
AMD	ADVANCED MICRO DEVICES INC.	SUNNYVALE	CA	34335
AMELC	AMERICAN ELECTRIC CORDSETS	BENSENVILLE	IL	0
AMP	AMP, INC.	HARRISBURG	PA	00779
AND	TENNECO CO	PISCATAWAY	NJ	
ANDER	S.W. ANDERSON CO.	DOWNERS GROVE	IL	03018
ANOG	ANOGRAPHICS	BURR RIDGE	IL	
ANSLY	ANSLEY ELECTRONICS LTD	DOWNSVILLE, ONT., CANADA	**	
ANY	ANY SUITABLE SUPPLIER			
ANZAC	ADAMS-RUSSELL, ANZAC DIV	BURLINGTON	MA	
AFL	AMPHENOL CONNECTOR SYSTEMS	BROADVIEW	IL	74868
APP	A-P PRODUCTS	PAINESVILLE	OH	0
APPSP	APPLIED SPECIALTIES INC.	BELTSVILLE	MD	64998
AFX	AMPEREX ELECTRONIC CORP.	SLATERSVILLE	RI	25403
ARC	ARCO ELECTRIC PRODUCTS	SHELBYVILLE	IN	24652
ARE	AMERICAN RESEARCH ENG.	ELGIN	IL	65832
ARELE	ARROW ELEC	INDPLS	IN.	
ARIES	ARIES ELECTRONICS CORP.	FRENCHTOWN	NJ.	51167
ARN	ARNOLD ENGINEERING CO.	MARENGO	IL	95566
AROMT	AROMAT CORP.	ELK GROVE VILLAGE	IL	
ARW-M	ARROW-M CORP	CARSON	CA	
ASBAG	ASSOCIATED BAG CO.	MILWAUKEE	WI	62777
ASC	ASSOCIATED SPRING	BRISTOL	CT	92830
ASE	AIRCO SPEER ELECTRONICS	ST. MARYS	PA	06560
ASM	ACCURATE SCREW MACHINE CO	NUTLEY	NJ	51506
ASTID	ASTRO INDUSTRIES	DAYTON	OH	29365
AT/IN	ATLANTIC INDIA RUBBER CO	CHICAGO	IL	70485
ATC	AMERICAN TECHNICAL CERAMICS	HUNTINGTON STATN	NY	29990

ABBR.	NAME.....	CITY.....	ST	FSCM.
ATLAS	ATLAS WIRE AND CABLE CORP.	MONTERELLO	CA	62277
ATR	ATR COIL CO.	BLOOMINGTON	IN	XXXXXX
AUGAT	AUGAT, INC.	ATTLEBORO	MA	91506
AULT	AULT INC.	MINNEAPOLIS	MN	14310
AUTCN	AUTOMATIC CONNECTOR, INC.	COMMACK	NY	94375
AUTCP	AUTOMATION COMPONENTS	PECKVILLE	PA	33498
AVDEL	AVDEL FASTENER SYS.	PARSIPPANY	NJ	19738
AVT	AVANTEK, INC.	SANTA CLARA	CA	24539
AVTEK	AVTEK INC	AURORA	NE	
AWC	ALPHA WIRE	ELIZABETH	NJ	92194
AWP	ALMEGA WIRE PRODUCTS	BREMEN	IN	
H-B	BURR-BROWN RESEARCH CORP.	TUCSON	AZ	13919
H-D	BECTON, DICKINSON, AND CO.	FARAMUS	NJ	06531
H-T	BEK-TEK, INC.	READING	PA	XXXXXX
H-W	BARKER & WILLIAMSON	BRISTOL	PA	05690
BAHRS	BAHRS DIE AND STAMPING CO. INC.	CINCINNATI	OH	63416
HALL	MICROLITE INC	WESTFIELD	IN	
BEARI	BEARINGS, INC.	CLEVELAND	OH	05469
BEK	BECKMAN INSTRUMENTS, INC.	FULLERTON	CA	73138
BEL	BELDEN CORP.	GENEVA	IL	70903
BELFS	BELFUSE	XXXXX	XX	00000
BELL	BELL INDUSTRIES	RANCHO DOMINGUEZ	CA	
BER	BERG ELECTRONICS	NEW CUMBERLAND	PA	22526
BERQ	BERGQUIST	MINNEAPOLIS	MN	55285
BGH	BEECH GROVE HARDWARE	BEECH GROVE	IN	XXXXXX
BIRT	BIRTCHEK CORP	EL MONTE	CA	93962
BIVAR	BIVAR INC	SANTA ANA	CA	92759
BL-TG	BLONDER-TONGUE LABS, INC.	OLD BRIDGE	NJ	82054
BOKER	BOKER'S INC.	MINNEAPOLIS	MN	85446
BORDIN	BORDEN INC.	COLUMBUS	OH	32283
BOU	BOURNS, INC.	RIVERSIDE	CA	80294
BRAUN	BRAUN MFG CO	CHICAGO	IL	93785
BRIARX	BRIAR-REX CO.	WILLIMANTIC	CT	71124
BREEZ	BREEZE CORPORATIONS, INC.	UNION	NJ	08484
BSCAN	B-SCAN, INC.	PHILADELPHIA	PA	32198
BSHF	BISHOP GRAPHICS, INC.	WESTLAKE VILLAGE	OH	34730
BUCK	BUCKEYE STAMPING CO.	COLUMBUS	OH	31604
BUD	BUD RADIO, INC.	WILLOUGHBY	OH	71218
BURND	BURNIY CORP.	NORWALK	CT	09922
BUS	BUSSMAN MFG.	ST. LOUIS	MO	71400
BUSCM	BUSCOM SYSTEMS, INC.	SANTA CLARA	CA	64623
BWC	BARON WIRE AND CABLE CORP.	CHICAGO	IL	72622
C-A	CIRCUIT ASSEMBLY CORP	COSTA MESA	CA	52072
C-C	COMPOWER CORP.	SAN JOSE	CA	
C-D	CORNELL DUBILIER ELECT DIV	NEWARK	NJ	14655
C-E	CLINTON ELECTRONICS	ROCKFORD	IL	54972
C-H	CUTLER-HAMMER, INC.	MILWAUKEE	WI	55841
C-I	COMPONENTS, INC.	RIDGEBURY	ME	17554
C-J	TRW/CINCH	ELK GROVE VILLAGE	IL	71785
C-K	C & K COMPONENTS, INC.	WATERTOWN	MA	09353
C-L	CENTRALAB DIV.	MILWAUKEE	WI	71590
C-M	C-M			
C-W	C-W INDUSTRIES	WARMINSTER	PA	79727
CAIBN	CADDELL-BURNS MFG.CO., INC	MINEOLA	NY	04213
CAE	CAPAR COMPONENTS CORP	MELVILLE	NY	
CAI	CUSTOM ACCESSORIES, INC.	SKOKIE	IL	XXXXXX
CAM	CAMBION	CAMBRIDGE	MA	71279
CAPL	CADILLAC PLASTICS	INDIANAPOLIS	IN	
CAR	CARLING ELECTRIC, INC.	WEST HARTFORD	CT	73559
CAROL	CAROL CABLE CO.	PAWTUCKET	RI	
CBLWV	CABLEWAVE SYSTEMS, INC.	NORTH HAVEN	CT	16733
CBSDM	CARBORUNDUM INSUL DIV	NIAGARA FALLS	NY	
CCM	CORCOM, INC.	LIBERTYVILLE	IL	05245
CUC	COMPONENT DEVELOPMENT CORP.	CARSON	CA	XXXXXX
CECO	CENTRAL COIL CO.	BRAZIL	IN	XXXXXX
CES	CES ELECTRONICS	WINTER PARK	FL	
CFI	CIRCUIT FUNCTIONS INC.	NEWBURY PK	CA	32499
CGW	CORNING GLASS WORKS	CORNING	NY	24546
CHE	CHERRY ELECTRICAL PRODUCTS	WAUKEGAN	IL	01963

ABBR.	NAME.....	CITY.....	ST	FSCM.
CHEMP	CHEMPLAST, INC.	WAYNE	NJ	0
CHLAR	CHARLES LARSON CO.	STERLING	IL	
CHOM	CHOMERICS INC.	WORURN	MA	18565
CHR	CHR INDUSTRIES	NEW HAVEN	CT	71643
CHRY	CHRYSLER CORP.	DETROIT	MI	12204
CHTFD	CHATFIELD PAPER	CINCINNATI	OH	97361
CIMCO	CIMCO WIRE AND CABLE INC.	ALLENDALE	NJ	XXXXX
CINOX	CINOX CORP	CINCINNATI	OH	58997
CKI	CTS KNIGHTS, INC.	SANDWICH	IL	75378
CLA	CLAIREX CORP.	MT. VERNON	NY	03911
CLAR	CLAROSTAT MFG. CO	DOVER	NH	12697
CLOFT	COILCRAFT	CARY	IL	02113
CLFRM	COILFORM	GENEVA	IL	20254
CLFX	COLE-FLEX CORP.	BABYLON	NY	56352
CLMRK	CALMARK CORP	SAN GABRIEL	CA	52094
CMLC	CAMLOC FASTENER	PARAMUS	NJ	
CMS	CURTIN MATHESON SCIENTIFIC, INC.	INDIANAPOLIS	IN	
CNCRI	CONCORDI ELEX	NEW YORK	NY	18310
CNTRN	CENTURION	*****	**	
COBAR	COBAR RESOURCES, INC.	CARROLLTON	TX	
COL	COLLMER SEMICONDUCTORS INC	DALLAS	TX	
COMM	COMMODORE	WESTCHESTER	PA	
COMPQ	COMPAQ COMPUTER CORP.	HOUSTON	TX	65685
COORS	COORS PORCELAIN CO	GOLDEN	CO	14566
CPKG	CREATIVE PKG DIV	INDIANAPOLIS	IN	46203
CPLRD	COMPLETE-READING ELEC.CO.	DALLAS	TX	02358
CRDWE	CARDWELL CONDENSER CORP	LINDENHURST	NY	88356
CRMGS	CERAMIC MAGNETICS INC.	FAIRFIELD	NJ	28733
CRMLY	CERMALLOY	WEST CONSHOHOCKEN	PA	
CRT	CONDUCTIVE RUBBER TECHNOLOG Y	SANTA BARBARA	CA	
CRTIS	CURTIS INDUSTRIES, INC.	MILWAUKEE	WI	
CRTR	CORE-TRONICS	ORANGE	NJ	29324
CRYLD	CRYSTALOID	HUDSON	OH	
CRYTK	CRYSTEK	FT. MEYERS	FL	
CSIC	CONDITIONING SEMICNITR DIVS	WAYNE	NJ	
CSW	CENTRAL STEEL AND WIRE	CHICAGO	IL	11292
CTC	COMMUNICATIONS XISTOR CORP	SAN CARLOS	CA	
CTS	CHICAGO TELEPHONE SYSTEMS	CHICAGO	IL	71450
CTS-EE	CTS OF ELKHART	ELKHART	IN	71450
CTS-FF	C.T.S. OF FAIRBERRY	FAIRBERRY	IL	71450
CTS-K	CTS OF KEENE	PASO ROBLES	CA	11237
CTSRB	CTS OF KERNE	BERNE	IN	11236
CTSBV	CTS OF BROWNSVILLE	BROWNSVILLE	TX	34263
CTYSP	CENTURY SPRING CO.	LOS ANGELES	CA	56988
CURT	CURTIS ELECTRO DEVICES, INC.	MOUNTAIN VIEW	CA	54719
CURTI	CURTIS INSTRUMENTS, INC.	KISCO	NY	18583
CW/AL	C.W./ALPHA	SOUTHAMPTON	PA	
D-S	DATA SIGNAL INC.	ALBANY	GA	
DABRN	DABURN ELECTRONICS, INC.	NORWOOD	NJ	25706
DAL	DALE TECHNOLOGY CORP.	HARTSDALE	NY	XXXXX
DATL	DATL SYSTEMS, INC.	MANSFIELD	MA	50721
DAV	HARRY DAVIES HOLDING CO.	CHICAGO	IL	72512
DAYTN	DAYTON ELECTRIC CO.	CHICAGO	IL	16327
DEL	DELEVAN DIV.	EAST AURORA	NY	XXXXX
DELKR	DELKER CORPORATION	BRANFORD	CT	
DEN	DENNISON MFG. CO.	FRAMINGHAM	MA	16956
DEW	DEWIRE FABRICATING CORP.	LOWELL	MA	13161
DGTRN	DIGITRAN CO.	PASADENA	CA	
DIASH	DIAMOND SHAMROCK			
DILEC	DIELECTRON	MONROVIA	CA	0
DIO	DIONES, INC.	CHATSWORTH	CA	12060
DIXON	DIXON INDUSTRIES INC.	BRISTOL	RI	04813
DK-WR	DAKO-WARE	CHICAGO	IL	
DLGHT	DIALIGHT	BROOKLYN	NY	72619
DLI	DIELECTRIC LABORATORIES INC	CAZENVIA	NY	55153
DLLAS	DALLAS SEMICONDUCTOR CORP	DALLAS	TX	
DLTEM	DELTA ELECTRONICS MFG CO	BEVERLY	MA	00795
DM-GY	DIMCO-GRAY	CENTERVILLE	OH	80813

▲BBB.	NAME.....	CITY.....	ST	FSCM.
INTCH	IONTECH, INC.	DOYLESTOWN	PA	63009
DOWCG	DOW CORNING CORP.	MILILANI	HI	71984
IRA	IRAKE MANUFACTURING CO.	HARWOOD HEIGHTS	IL	71744
IRBRN	IRARBORN WIRE & CABLE CO.	ROSEMONT	IL	
IRMYR	IRMEYER	ROCKVILLE	IN	73662
IUPNT	E.I.DUPONT DENEMOURS & CO	WILMINGTON	DE	
IYNA	IYNACHEM CORP.			
IYNR	IYNEER CORP.	CHATSWORTH	CA	
E-C	ELECTRONIC CRYSTALS	KANSAS CITY	MO	18953
E-E	E&E NAMEPLATE	GALION	OH	
E-I	ELECTRICAL INDUSTRIES, INC.	MURRAY HILL	NJ	20093
E-L	E-L PRODUCTS CO	EAST AURORA	NY	14550
E-M	ELECTRA/MIDLAND CORP.	MINERAL WELLS	TX	XXXXX
EATON	EATON CORP.	SUNNYVALE	CA	34657
EBM	EBM INDUSTRIES, INC.	UNIONVILLE	CT	62292
EBY	EBY COMPANY	PHILADELPHIA	PA	72825
ECKIT	ECKARDT LABORATORIES	ORANGE	CA	61874
ECMC	ELECTRI-CORD MFG. CO. INC.	WESTFIELD	PA	XXXXX
ECNMT	ECONOMITE (ITW SWITCHES)	CHICAGO	IL	
EDAC	EDAC, INC.	ION MILLS, ONT., CANADA	**	31781
EECO	EECO, INC.	SANTA ANA	CA	97525
ELC-I	ELECTRA	CUMBERLAND	IN	63685
ELCO	ELCO INDUSTRIES	ROCKFORD	IL	83486
ELCPT	ELECTRONIC CONCEPTS INC	EATONTOWN	NJ	50558
ELDRE	ELDRE COMPONENTS, INC	ROCHESTER	NY	19648
ELEXP	ELECT EXPEDITERS	MILWAUKEE	WI	
ELFX	ELECTRO-FLEX HEAT INC.	BLOOMFIELD	CT	02728
ELHIW	ELECTRONIC HARD	FARMINGDALE	NY	23480
ELNA	ELNA	CARSON	CA	64013
ELOCK	ELECTRO CUBE, INC.	SAN GABRIEL	CA	14752
ELSTN	ELSTON ELECTRONICS CORP.	GENEVA	NY	
EM-OM	EMERSON & CUMING, INC	CANTON	MA	
EMHFG	EMHART FASTENER GROUP	SHELTON	CT	
EMH	EMMTRONICS	INDIANAPOLIS	IN	
EMRON			S	0
EMS	EM SCIENCE			
ENTHN	ENTHONE INC.	NEW HAVEN	CT	02258
EPITEK	EPITEK ELECTRONICS	KANATA, ONT, CANADA	**	37907
EPOXT	EPOXY TECHNOLOGY, INC.	BILLERICA	MA	33246
EPSON	EPSON AMERICA, INC.	TORRANCE	CA	61722
ETC	ELECTRONIC TRANSISTOR CORP.	FLUSHING	NY	12045
ETP	ERIE TECHNOLOGICAL PRODUCTS	ERIE	PA	72982
ETROL	ELEC-TROL INC.	SAUGUS	CA	15636
EVRIY	EVEREADY	NEW YORK	NY	
EWG	EWG INC.	KENILWORTH	NJ	
EXAR	EXAR INTEGRATED SYSTEMS	SUNNYVALE	CA	52063
EXCEL	EXCELSIOR HARDWARE CO.	STAMFORD	CT	21192
EZHK	E-Z HOOK DIV.	ARCAHIA	CA	00000
EZLOK	E-Z LOK	GARDENIA	CA	
F-K	THERM WELL PRODUCTS, INC.	FRAMINGHAM	MA	XXXXX
F-S	FEDERAL SCREW	CHICAGO	IL	73734
FAN	FAN COURT & CO.	GREENSBORO	NC	XXXXX
FASTX	FASTEX DIV., ILL. TOOL WORKS	DES PLAINES	IL	0
FCI	FAIRCHILD	MOUNTAIN VIEW	CA	07263
FCI	FILM CAPACITORS, INC.	PAS SALC	NJ	00686
FID	FIDELITY			
FISH	FISHER SCIENTIFIC			
FJTSU	FUJITSU AMERICA, INC.	LAKE BLUFF	IL	
FMC	FMC CORP			
FNWL	FENWAL	FRAMINGHAM	MA	15801
FRIKS	FREDERICKS CO.	HUNTINGDON VALLEY	PA	
FRK	FRAKO	FRANKFORT, GER.	**	XXXXX
FRQSS	FREQUENCY SOURCES INC. SOURCES DIV	CHELMSFORD	MA	26629

ABBR.	NAME.....	CITY.....	ST	FSCM.
FRRNT	FERRANTI ELECTRIC, INC.	COMMACK	NY	22119
FRSCI	FISHER SCIENTIFIC	ST. LOUIS	MO	80011
FRTE	FAIR RITE PRODUCTS CORP.	WALLKILL	NY	34899
FRXC	FERROXCUBE DIVISION	SAUGERTIES	NY	02114
FUT	FUTABA			
G-E	GENERAL ELECTRIC	INDIANAPOLIS	IN	24446
G-H	GRAYHILL, INC.	LA GRANGE	IL	81073
G-I	GEN'L INSTRUMENT SEMICNDTR	HICKSVILLE	NY	14963
G-T	GRAND TRANSFORMERS	GRAND HAVEN	MI	02459
GAL	GALILEO ELECTRO-OPTICS	STURBRIDGE	MD	28719
GARRY	GARRY DIV.	NORTH BRUNSWICK	NJ	
GATES	GATES ENERGY PROD.	DENVER	CO	57053
GRN	GILBERT ENGINEERING CO., INC	PHOENIX	AZ	82316
GCE	GC ELECTRONICS	ROCKFORD	IL	80112
GHZ	GHZ DEVICES, INC.	CHELMSFORD	MA	
GILMN	GILLMAN	INDIPLS	IN	
GLNMC	GLENMARC MFG. CO.	NORTHBROOK	IL	59323
GLOBE	GLOBE	MILWAUKEE	WI	
GM-NP	GM NAMEPLATE, INC.	SEATTLE	WA	22670
GNATR	GENERAL ATRONICS CORP.	PHILADELPHIA	PA	07407
GNBRC	GENERAL BEARING CORP.	WEST NYACK	NY	09721
GNIVC	GENERAL DEVICES CO.	INDIANAPOLIS	IN	06666
GNRAD	GENRAD INC	CONCORD	MA	24655
GOU	GOULD, INC.	ST. PAUL	MN	55257
GRIES	GRIES REPRODUCER	NEW ROCHELLE	NY	05873
GRIF	GRIPMASTER CO.	MARLBORO	NJ	XXXXX
GRVCO	GROVE COMPANY	DAYTON	OH	
GRVFN	GROOV-FIN CORP	RIDGEFIELD	NJ	73957
GUIL	GUDERROD BROS. SILK CO.	CHICAGO	IL	XXXXX
GUWDA	GOWANIA ELEX CORP	GOWANIA	NY	24226
H-H	HANDY & HARMON	NEW YORK	NY	73977
H-P	HEWLETT-PACKARD	INDIANAPOLIS	IN	28480
HARTW	HARTWELL CORP.	PLACENTIA	CA	0
HAYES	HAYES MICROCOMPUTOR PRODUCT S, INC.	NORCROSS	GA	63730
HIMLI	DAVIES H MOLDING	CHICAGO	IL	
HEC	HOPKINS ENGINEERING CO.	SAN FERNANDO	CA	02777
HEL	HELIPOT	ANAHEIM	CA	XXXXX
HEY	HEYMAN MFG. CO.	WAUKESHA	WI	28520
HEYCO	HEYCO MOLDED PRODUCTS	KENILWORTH	NJ	28520
HGHS	HUGHES SOLID-STATE PROD	NEWPORT BEACH	CA	
HHS	HERMAN H. SMITH, INC.	BROOKLYN	NY	83330
HI-G	HI-G INC	WINDSOR LOCKS	CT	02289
HIT	HITACHI AMERICA, LTD.	SAN FRANCISCO	CA	XXXXX
HL-MK	HALL-MARK ELECT.	INDIANAPOLIS	IN	
HMLN	HAMLIN	LAKE MILLS	WI	12617
HNKL	HENKEL ADHESIVES CO.	MINNEAPOLIS	MN	
HOLGW	HOLLINGSWORTH SLIRLS TERM.	POTTSTOWN	PA	14726
HOLUB	HOLUB DISTRIBUTING CO.	NEWPORT	KY	XXXXX
HRMTT	HERMETITE CORP.	AVON	MA	04302
HSI	HARRIS CORP. SEMICDR. DIV.	MELBOURNE	FL	27410
HUD	HUDSON TOOL & DIE CO.	NEWARK	NJ	02875
HWDN	HOWDEN CO.	NEWARK	OH	
HY/PL	HYDRO PLASTICS INC.	GEORGETOWN	KY	XXXXX
HYSOL	HYSOL CORP	INDUSTRY	CA	12405
HYSYS	HYBRID SYSTEMS	REDFORD	MA	33256
HYT	HYTRONICS	PINELLAS PARK	FL	29525
I-S	INSTRUMENT SPECIALTIES CO., INC.	DELAWARE WATER GA F	PA	
IBNCO	INDIANA BOLT AND NUT CO.	INDIANAPOLIS	IN	
ICI	ILLINOIS CAPACITOR INC.	MORTON GROVE	IL	74840
ICO-R	ICO-RALLY	PALO ALTO	CA	51705
IDC	INTL DIODE CORP.	HARRISON	NJ	16068
IEE	INDUSTRIAL ELECTRONIC ENG	NORTH HOLLYWOOD	CA	05464
IERC	INT'L ELEC. RESEARCH CORP.	BURBANK	CA	98978
IMB	IMB ELECTRONICS PRODUCTS. I NC	SANTA FE SPRINGS	CA	27556

ABBR.	NAME.....	CITY.....	ST	FSCM.
IMS	IMS EQUIPMENT, INC.	IRVINE	CA	
INDCP	INDUCTIVE COMPONENTS	HAUPPAUGE	NY	25159
INDEC	INDUSTRIAL ELECTRONIC HIWR.	NEW YORK	NY	97913
INDFS	INDUSTRIAL FASTENERS CORP.	PORT WASHINGTON	NY	84992
INDIGL	INDIANA GENERAL	KEASKEY	NJ	72356
INLOK	INTERLOK/WM J FURDY CO.	BURLINGAME	CA	55951
INSPK	INSTAPAK DIV.	LIANBURY	CT	51614
INT	INTERSIL, INC.	CUPERTINO	CA	32293
INTEL	INTEL CORP	SANTA CLARA	CA	34649
INWEB	INTERNATIONAL WEBBING	WHITEHALL	PA	32860
IRC	INTERNATIONAL RESISTANCE CO	PHILADELPHIA	PA	75042
IREC	INT'L RECTIFIER CORP.	LOS ANGELES	CA	81483
ISC	INLAND SPECIALTY CHEMICAL	COSTA MESA	CA	59987
ISKRA	ISKRA ELECTRONICS, INC.	FARMINGDALE	NY	
ISTMP	ISOTEMP RESEARCH, INC.	CHARLOTTEVILLE	VA	31785
ITRON	ISE ELECTRONICS	ISE, JAPAN	**	0
ITT	INT'L TELEPHONE & TELEGRAPH	W. PALM BEACH	FL	XXXXX
ITT-C	ITT-CANNON	FOUNTAIN VALLEY	CA	71468
ITT-P	ITT POMONA ELECTRONICS	NORTHBROOK	IL	
JAMES	JAMES ELECTRONICS	CHICAGO	IL	12749
JAN	JAN HARDWARE MFG. CO.	LONG ISLAND CITY	NY	99813
JEM	JEM ELECTRONICS, INC.	MANCHESTER	NH	62694
JEF	JEFFERS	DUBOIS	PA	97469
JEFWC	JEFFERSON WIRE AND CABLE	WORCHESTER	MA	07883
JEW	JEWELL ELECTRICAL INST	MANCHESTER	NH	33005
JFI	JFI ELECTRONICS	BROOKLYN	NY	73899
JFW	JFW INDUSTRIES	BEECH GROVE	IN	56332
JHNS	JOHANSON MFG. CORP.	ROONTON	NJ	91293
JON	E.F. JOHNSON CO.	WASECA	MN	74970
JRBT	JACK RABBIT, INC.	SALEM	PA	
JROME	JEROME INDUSTRIES CORP.	KENILWORTH	NJ	00000
JUDD	JUDD WIRE DIV. ECC	TURNERS FALLS	MA	12703
K-L	KERRIGAN LEWIS MFG.	CHICAGO	IL	73920
K-S	K & S ENGINEERING CO.	CHICAGO	IL	22376
KB-D	K B DENVER	FREDRICK	CO	57272
KDI-P	KDI-PYROFILM CORP.	WHIPPANY	NJ	03888
KEENE	KEENE CORP.	NEWARK	DE	52869
KEM	KEMTRON ELECTRON PRODUCTS	NEWBURYPORT	MA	92703
KEY	KEYSTONE ELECTRONIC CORP.	NEW YORK	NY	91833
KID	KIDCO, INC.	MEIFORD	NJ	12126
KIN	KINGS ELECTRONICS	TUCKAHOE	NY	91836
KMYO	KAMAYA OHM	JAPAN	**	
KRYST	KRYSTINEL	PATERSON	NJ	29251
KSTR	KESTER SOLDIER DIV.	CHICAGO	IL	09185
KSW	KSW ELECTRONICS	BURLINGTON	MA	52676
KUL	KULKA ELECTRIC CORP.	MT. VERNON	NY	75382
KULKA	KULKA SMITH	MANASQUAN	NJ	83330
KX	KONEX	CHICAGO	IL	
KYCRA	KYOCERA INTERNATIONAL	SAN DIEGO	CA	59096
L-E	LARSEN ELECTRONICS, INC.	VANCOVER	WA	
L.S	LEWIS SPRING	CHICAGO	IL	
LADU	LADIEAU	LOS ANGELES	CA	
LAMB	LAMB INDUSTRIES, INC.	PORTLAND	OR	
LAURN	LAUREN MFG CO.	NEW PHILADELPHIA	OH	56329
LEYSE	LEYSE ALUMINUM CO.	KEWANEE	WI	20218
LINR	LINEAR TECHNOLOGY	KILPITAS	CA	
LIT	LITTELFUSE, INC.	DES PLAINES	IL	75915
LNMST	LINEMASTER SWITCH CORP.	WOODSTOCK	CT	97918
LOCTT	LOCTITE CORP.	NEWINGTON	CT	05972
LONCH	LONDON CHEMICAL			
LRC	LRC ELECTRONICS, INC.	HORNELL	NY	16157
LSI	LUMINESCENT SYSTEMS, INC	LEBANON	NH	16157
LTRNX	LITRONIX	CUPERTINO	CA	50579
LYNTR	LYN-TRON INC.	BURBANK	CA	05791
M-A	MICROWAVE ASSOCIATES	BURLINGTON	MA	96341
M-D	MILLER DIAL & NAMEPLATE CO.	EL MONTE	CA	74072
M-E	MEPCO ELECTRA. INC.	MORRISTOWN	NJ	19701
M-O	ILLUMINATED PRODUCTS INC.	SANTA ANA	CA	XXXXX

ABBR.	NAME.....	CITY.....	ST	FSCM.
M-P	MICRO PLASTICS INC.	CHATSWORTH	CA	31223
M-P-C	METAL PROCESSING CO.	WOBURN	MA	
M-TRN	M-TRON INDUSTRIES, INC	YANKTON	SD	
MACDC	MACDONALD AND CO.	GLENDALE	CA	13102
MACOM	M/A COM	BURLINGTON	MA	
			SS	
MAG	MAGNUM ELECTRIC CORP.	ERIE	MI	
MAL	MALLORY CONTROLS CO.	FRANKFORT	IN	90201
MAL-C	MALLORY CAPACITOR COMPANY	INDIANAPOLIS	IN	
MALIN	MALINKRODT			
MAND	MANDEX	CHICAGO	IL	98278
MARQ	J. & J. MARQUARDT	TUTTILINGEN, GER.	**	XXXXX
MAX	MAXIM INTEGRATED PRODUCTS			
MAYS	MAYS CHEMICAL			
MCB	MCB MFG CHEMICALS			
MCMTL	MICROMETALS, INC	ANAHEIM	CA	12856
MCREL	MICRO ELEX LTD	HONG KONG	**	
MCS	MICRO POWER SYSTEMS INC.	SANTA CLARA	CA	54186
MD-AM	MID AMERICA	CHICAGO	IL	
MDC	MAIDA DEVELOPMENT CO.	HAMPTON	VA	91984
MDLRS	MIDLAND ROSS	CINCINNATI	OH	57951
MDTC	MODUTEC	NORWALK	CT	32171
METH	METHODE ELECTRONICS, INC.	ROLLING MEADOWS	IL	
MFLCO	MAURICE FRANKLIN LOUVER CO.	PROVIDENCE	RI	
MGNUM	MAGNUM ELECTRIC CORP.	ERIE	MI	52458
MICKL	MICRO LINK	CARMEL	IN	
MICRO	MICRONEL	VISTA	CA	
MILN	MILLEN MFG. CO.	NEW YORK	NY	XXXXX
MILSP	MILITARY SPECIFICATION	WASHINGTON	DC	81349
MILST	MILLER-STEPHENSON CHEM.	MORTON GROVE	IL	
MILT	MILTEX SALES CORP.	ELMHURST	IL	
MIN-C	MINI-CIRCUITS	BROOKLYN	NY	15542
MINIS	MINI SYSTEMS	NORTH ATTLEBORO	MA	50316
MINOR	MINOR RUBBER CO.	BLOOMFIELD	NJ	76385
MIT	MITSUMI	TOKYO		
MITEK	MITEK	LEXINGTON	MA	0
MLRJW	J.W. MILLER	COMPTON	CA	96804
MMC	MAGNUM MICROWAVE CORP.	MOUNTAIN VIEW	CA	
MMI	MONOLITHIC MEMORIES, INC.			
MMM	3M COMPANY	ST. PAUL	MN	
MNO	MONSANTO COMM. PROD. DIV.	PALO ALTO	CA	50522
MNTLN	MANTALINE CORP.	MANTUA	OH	00000
MODPH	MODERN PHOTO			
MOL	MOLEX PRODUCTS	LISLE	IL	27264
MORAD	MORGAN ADHESIVES	STOW	OH	17452
MOSTK	MOSTK CORP.	CARROLLTON	TX	50088
MOT	MOTOROLA SEMI. PROD. DIV.	INDIANAPOLIS	IN	04713
MOUS	MOUSER ELECTRONICS	LAKEVIEW	CA	50811
MFC	MICROWAVE PRINTED CIRCUITRY	LOWELL	MA	
MPI	MICRO PLASTICS, INC.	FLIPPIN	AR	
MRKMD	MARKING METHODS, INC.	ALHAMBRA	CA	18675
MRM	M. ROSS MASON	INDIANAPOLIS	IN	
MRO	MICRO SWITCH DIV.	FREEMONT	IL	91929
MRODV	MICRO DEVICES DIV.	DAYTON	OH	27012
MRRUB	MARION RUBBER PROD.	INDIANAPOLIS	IN	
MRSHL	MARSHALL INDUSTRIES	INDIANAPOLIS	IN	
MSI	MSI ELECTRONICS, INC.	WOODSIDE	NY	
MSN	MICROSONICS DIV.	WEYMOUTH	MA	11869
MSP	MICRO SEMICONDUCTOR CORP.	SANTA ANA	CA	14552
MTSBI	MTSUBISHI ELEC. CORP.	SUNNYVALE	CA	00000
MUELR	MUELLER ELECTRIC CO.	CLEVELAND	OH	76545
MULSO	MULTICORE SOLDERS LTD.	WESTBURY	NY	03051
MURA	MURA	WESTBURY	NY	32539
MURGA	MURATA-GEORGIA	MARIETTA	GA	51406
MWS	MAGNET WIRE SUPPLY CO.	CHATSWORTH	CA	51668
MWS-P	MWS PRECISION WIRE INDUS	WESTLAKE VILLAGE	CA	
MYERS	MYERS SPRING CO.	LOGANSPOET	IN	91956
N-T	NATIONAL TEL-TRONICS	LAREDO	TX	XXXXX

ABBR.	NAME.....	CITY.....	ST	FSCM.
NAT	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	27014
NCC	NATIONAL CERAMIC CO	TRENTON	NJ	76626
NCSVC	NATL COM SERV.	WILLOW GROVE	PA	
NIS	NATIONAL DECORATORS SUPPLY	INDIANAPOLIS	IN	
NEC	NIPPON ELECTRIC CO.	TOKYO, JAPAN	**	18324
NEL	NATIONAL ENGINEERING LABS	INDIANAPOLIS	IN	XXXXX
NEMC	NEW ENGLAND MICROWAVE	HUDSON	NH	
NEMCO	NEMCO METALS, INC	MANVILLE	RI	
NEW	NEWARK ELECTRONICS	INDIANAPOLIS	IN	XXXXX
NHBR	NEW HAMPSHIRE BALL BEARINGS INC	PETERBOROUGH	NH	83086
NHWC	NEW HAVEN WIRE & CABLE	NEW HAVEN	IN	XXXXX
NIC	NIC COMPONENTS CORP	FARMINGDALE	NY	
NICCC	NIC COMPONENTS CORP.	FARMINGDALE	NY	
NICHN	NICHICON (AMERICA) CORP.	SCHAUMBURG	IL	55680
NMB	NMB CORP.	ARLINGTON HEIGHTS	IL	60005
NMC	MAGNUM MICROWAVE CORP.	SUNNYVALE	CA	59277
NORLE	NORLE U.S.A., INC.	ELK GROVE VILLAGE	IL	
NOVA	NOVACAP	RURBANK	CA	
NOVAT	NOVATION	CHATSWORTH	CA	
NPC	NUCLEONIC PRODUCTS CO.	CANOGA PARK	CA	0
NRTLK	NORTHLAKE ENG. INC	ANTIOCH	IL	50638
NTT	NATIONAL TEL-TRONICS	MEADVILLE	PA	
NYGLS	NY-GLASS PLASTICS INC.	PARAMOUNT	CA	11783
NYLO	NYLOMATIC	MORRISVILLE	PA	XXXXX
NYTCG	NYTRONICS COMPONENTS GROUP INC	DARLINGTON	SC	00213
O-G	OPTI-GAGE INC.	DAYTON	OH	XXXXX
O-S	OMNI SPECTRA INC.	FARMINGTON	MI	16179
OAK	OAK INDUSTRIES INC.	CRYSTAL LAKE	IL	76854
OHM	OHMITE MFG. CO.	SKOKIE	IL	44655
OMEGA	OMEGA WIRE & CABLE	HARLEYSVILLE	PA	XXXXX
OPTO	OPTO ELECTRONICS INC	FT LAUDERDALE	FL	
OPTRN	OPTRON INC.	CARROLLTON	TX	XXXXX
OTTIN	OTTINGER	ZIONSVILLE	IN	
P-B	POTTER AND BRUMFIELD	FRINCETON	IN	77342
P-C	POWER COMPONENTS	WOODLAND HILLS	CA	XXXXX
P-E	PAWLS ENGINEERING	XXXXX	XX	00000
P-K	PARKER KALON CORP.	CLIFTON	NJ	XXXXX
P-T	PENN TUBE PLASTICS CO.	CLIFTON HEIGHTS	PA	0
P-U	PROJECTS UNLIMITED INC.	DAYTON	OH	XXXXX
POLPH	POLYPHASE INSTR. CO.	BRIDGEPORT	PA	0
PACTC	PACTEC DIV.	PHILADELPHIA	PA	
PALCO	PALCO CONNECTOR INC	KRISTOL	CT	58167
PAH	PAMOTOR DIV.	BURLINGAME	CA	23936
PAND	PANDUIT CORP.	TINLEY PARK	IL	06383
PARA	PARAMETRIC INDUSTRIES	NORTHFIELD	IL	XXXXX
PARKR	PARKER SEAL GROUP	LEXINGTON	KY	
PCC	PANEL COMPONENTS CORP.	BERKELEY	CA	00000
PHI	POWER DYNAMICS, INC	SOUTH ORANGE	NJ	
PEC	PACIFIC ELECTRICCORD CO.	GARDENA	CA	80126
PEM	PENN ENRG & MANUF CO.	DANBORO	PA	
PFZR	PFIZER, INC.	NEW YORK	NY	86491
PHC	PHILADELPHIA HANDLE CO.	CAMDEN	NJ	XXXXX
PHILP	PHILPOTT RUBBER CO.	CLEVELAND	OH	86510
PHLDG	PHELPS DODGE INDUSTRIES INC	FORT WAYNE	IN	09040
PHRIN	PHREHIER INC	CHICAGO	IL	
PIC	PIHER INTERNATIONAL CORP.	ARLINGTON HEIGHTS	IL	54869
PIEZO	PIEZO TECHNOLOGIES, INC.	ORLANDO	FL	
PLI	PRECISION LAMP, INC.	MT. VIEW	CA	48451
PLSSY	PLESSEY ENG.	SCHILLER PARK	IL	55112
PLSTI	PLASTIC TECHNIQUES, INC	NEW BOSTON	NH	
PLYCL	POLYCLAD LAMINATES	SOUTHFIELD	MI	
PMCL	PERMACEL DIV.	NEW BRUNSWICK	NJ	99742
PHI	PRECISION MONOLITHICS INC.	SANTA CLARA	CA	06665
PNSNC	PANASONIC			
POLPH	POLYPHASE INSTR. CO	BRIDGEPORT	PA	98330
POM	POMONA ELECTRONICS CO., INC	POMONA	CA	05276
PP	PACIFIC POLYCRAFT			

ABBR.	NAME.....	CITY.....	ST	FSCH.
PBACK	POWER BACK INC	CHICAGO	IL	
PREH	PREH VERT, MBH	GERMANY	**	
PREM	PREM MAGNETICS INC.	JOHNSBURG	IL	
PREXT	PRECISION EXTRUSIONS, INC.	BENSENVILLE	IL	
PRMD	PYRAMID INDUSTRIES, INC.	PHOENIX	AZ	XXXXX
PROLG	PRO-LOG	MONTEREY	CA	
PRRES	PRECISION RESISTIVE PRINTS	MEDIAPOLIS	IA	
PRSLK	PRESTO-LOCK	GARFIELD	NJ	77386
PRSN	PRECISION TUBE CO., INC	NORTH WALES	PA	82413
FTN	PENN TRAN CORP.	BELLEFONT	PA	XXXXX
PWRGP	POWER GROUP INTL.	BURNSVILLE	MN	25441
PWRMT	POWER-MATE CORP.	HACKENSACK	NJ	
PYRO	PYROFILM CORP.	WHIPPANY	NY	XXXXX
PYTT	PYTTONICS INDUSTRIES, INC.	MONTGOMERYVILLE	PA	31924
Q-C	QUALITY COMPONENTS	ST. MARYS	PA	95121
QUAM	QUAM-NICHOLS CO.	CHICAGO	IL	
R-B	RED BIRD			
R-E	ROBISON ELECTRONICS	SAN LUIS ORISPO	CA	
R-G	REAGENT GRADE			
R-N	ROBINSON-NUGENT	NEW ALBANY	IN	0
R-OHM	R-OHM	IRVINE	CA	57668
RAF	RAF ELECTRONIC HIWE	STRAFFORD	CT	
RAWST	RAW STOCK	*****	**	
RAY	RAYTHEON	INDIANAPOLIS	IN	49956
RAYVC	RAY-O-VAC/DV	MADISON	WI	
RBRCT	RUBBERCRAFT	*****	**	
RBYCN	RUBYCON	XXXXX	XX	00000
RCA	RCA	CAMDEN	NJ	02735
RCHLK	RICHLOK CORP	CHICAGO	IL	
RCL	RCL ELECTRONICS	HOLLYWOOD	FL	
REL	RELIANCE MICA CO.	BROOKLYN	NY	08530
RGNCY	REGENCY ELECTRONICS, INC.	INDIANAPOLIS	IN	
RGR	ROGERS CORP.	CHANILER	AZ	31745
RICH	RICHCO PLASTIC CO.	CHICAGO	IL	06915
RICHM	RICHARDS METAL PRODUCTS	WOLCOTT	CT	19076
RMC	RADIO MATERIALS CORP.	CHICAGO	IL	82560
RMF	RMF PRODUCTS INC.	BATAVIA	IL	XXXXX
ROBNU	ROBINSON NUGENT, INC.	NEW ALBANY	IN	
ROCKW	ROCKWELL INTL.	ANAHEIM	CA	33085
ROGAN	ROGAN CORP.	NORTHBROOK	IL	86797
ROTRN	ROTRON INC.	WOODSTOCK	NY	82877
RPELC	REPUBLIC ELECTRONICS CORP	PATTERSON	NJ	
RSSLL	RUSSELL	OCEANSIDE	NY	24324
RTNA	ROSENTHAL TECHNIK, N.A.	PROVIDENCE	RI	
S-C	SPECIALTY CONNECTOR	INDIANAPOLIS	IN	24931
S-G	STANDIARD GRIGSBY	AURORA	IL	82104
S-I	SWITCHCRAFT, INC.	CHICAGO	IL	82389
S-S	SERVICE SUPPLY	INDIANAPOLIS	IN	XXXXX
S-T	SARKES TARZIAN	BLOOMINGTON	IN	51589
S-W	SOUTH WALL	FALD ALTO	CA	
SAE	STANFORD APPLIED ENG	SANTA CLARA	CA	
SAGE	SAGE LABORATORIES, INC.	NATIC	MA	
SAMTC	SAMTEC	NEW ALBANY	IN	47150
SANYO	SANYO ELECTRIC, INC.	LITTLE FERRY	NJ	
SAYRO	SAYROSA ENGINEERS LTD.	ALTON, HANTS, U.K	**	04180
SCHE	SCANBE DIVISION	EL MONTE	CA	18677
SCC	STACKPOLE CARBON CO.	ST. MARYS	PA	78488
SOCHM	SOUTHERN CALIFORNIA CHEMICAL CO., INC.	GARLAND	TX	54507
SCHRF	SCHROFF, INC	WARWICK	RI	
SCX	SILICONIX INC.	SANTA CLARA	CA	17856
SEAST	SEASTROM MFG. CO.	GLENDALE	CA	86928
SECR	SECOR INC.	WESTWOOD	NJ	0
SEFITZ	SEITZ SONS, INC.	TORRINGTON	CT	
SEL	SELECTRO CORP.	MAMARONECK	NY	98291
SEM	SEMTECH	NEWBURY PARK	CA	14099
SEMI	SEMICONDUCTORS INC.	RIVIERA BEACH	FL	
SEMIX	SEMTEX	DAYTON	OH	0
SENST	SENSOTEC INC	COLUMBUS	OH	51518
SGM	SIGMA INSTRUMENTS	BRAINTREE	MA	72421
SGS-A	SGS-ATES COMP ELET SPA	AGRATE BRIANZE,	**	

ABBR.	NAME.....	CITY.....	ST	FSCM.
SHAM	SHAMROCK PLASTICS & RUBBER	ITALY		
SHDW	I.T.T. SCHADOW	INDIANAPOLIS	IN	XXXXX
SHIN	SHIN-ETSU POLYMER CO.LTD.	EDEN PRAIRIE	MIN	
SHIP	SHIPLEY	*	*	
SHKMN	SHACKMAN INSTRUMENTS	CHESHAM, ENGLAND	**	0
SHKPF	SHAKEPROOF DIV, ILLINOIS TOO	ELGIN	IL	78189
	L WORKS			
SHURE	SHURE BROS. INC.	EVANSTON	IL	
SIEM	SIEMENS	ISELIN	NJ	25088
SIERR	SIERRACIN POWER SYSTEMS	CHATSWORTH	CA	
SIG	SIGMETICS CORPORATION	SUNNYVALE	CA	18324
SIGNL	SIGNAL TRANSFORMER	INWOOD	NY	
SIGPT	SIGMA PLASTRONICS	DEARBORN	MI	
SIMP	SIMPSON ELECTRIC COMPANY	ELGIN	IL	
SINCR	SINCLAIR & RUSH, INC.	ST. LOUIS	MO	15819
SKIRV	STOCK DRIVE PROD. DIV.	NEW HYDE PARK	NY	
SLOGN	SILICON GENERAL INC	GARDEN GROVE	CA	34333
SLT	SOLITRON/MICROWAVE DIV.	PORT SALERNO	FL	95077
SMOS	S-MOS SYSTEMS, INC.	SAN JOSE	CA	
SMTIC	SAMTEC INC.	NEW ALBANY	IN	55322
SNGMO	SANGAMO CAPACITOR DIV	PICKENS	SC	00853
SNSTK	SENSOR TECHNOLOGY CO	SEATTLE	WA	
SOART	STATE OF THE ART, INC	STATE COLLEGE	PA	56235
SOUCA	SOUTHERN CALIFORNIA			
SOURU	SOURIAU	VAN NUYS	CA	
SOUTH	SOUTHCO FASTENERS	LESTER	PA	94222
SPE	SPECTROL	DAYTON	OH	02111
SPEC	SPECTRUM CONTROL, INC.	FAIRVIEW	PA	33095
SPI	SEMI PROCESSES INC.	SAN JOSE	CA	
SPNPI	SPENDER PRODUCTS	FT. WAYNE	IN	00000
SPPRI	SPECIALTY PRODUCTS	INDIANAPOLIS	IN	
SPR	SPRAGUE ELECTRIC CO.	INDIANAPOLIS	IN	56289
SPRTX	SUPERTEX INC.	CUPERTINO	CA	0
SFS	SFS TECHNOLOGIES (UNBRAKO D	JENKINTOWN	PA	
	IV)			
SPST	SPECTRA-STRIP	GARDEN GROVE	CA	08261
SPY	SPYRAFLO INC	PEACHTREE CITY	GA	
SS	SERVICE SUPPLY	INDIANAPOLIS	IN	
SSS	SOLID STATE SCIENTIFIC	MONTGOMERYVILLE	PA	31019
STAV	STAYER	L. I.	NY	
STC	SILICON TRANSISTOR CORP	CHELMSFORD	MA	
STOPS	STANDARD PRESSED STEEL	JENKINTOWN	PA	03680
STI	SEMICONTR TECHNOLOGY INC	STUART	FL	
STKFS	STAKE FASTENERS	SOUTH EL MONTE	CA	
STNCR	STANCOR PRODUCTS	LOGANSFORD	IN	
STR	STETTNER TRUSH CO.	CAZENOVIA	NY	52763
STRCO	STRANCO PRODUCTS, INC.	ELK GROVE VILLAGE	IL	
STSA	STEEL SALES	INDIANAPOLIS	IN	XXXXX
STSDI	STAR SOUND	JAPAN	**	
SULL	SULLINS ELECTRONICS CORP	SAN MARCOS	CA	
SWMIN	SWIDGET MINIATURE	WARMINSTER	PA	
SXNRG	SAXONBURG CERAMICS	SAXONBURG	PA	
SYL	GTE SYLVANIA	WALTHAM	MA	94131
SYN	SYNTRONIC INSTRUMENTS	ADDISON	IL	99409
SYNRG	SYNERGY MICROWAVE CORP.	JERSEY CITY	NJ	
SYNTC	SYNTAC CORP.	CLEVELAND	OH	
SYNTK	SYNERTEK	**	*	
SYS	SYSCON INTERNATIONAL, INC.	SOUTH BEND	IN	32436
T-B	THOMAS & BETTS	RARITAN	NJ	59730
T-CSF	THOMSON-CSF COMPONENTS CORP	RUTHERFORD	NJ	
T-II	THIOKOL/DYNACHEM CORP			
T-I	TEXAS INSTRUMENTS	DALLAS	TX	01295
TAPP	TAPE PRODUCTS, INC	*****	**	
TCPL	TACONIC PLASTIC	PETERSBURG	NY	59688
TEK	TEKTRONIX	INDIANAPOLIS	IN	80009
TEKA	TEKA PRODUCTS INC.	COLLEGE POINT	NY	58050
TEKMD	TEKMOLD, INC.	MUSKEGON	MI	

ABBR.	NAME.....	CITY.....	ST	FSCM.
TEKNT	TECKNIT	CRANFORD	NJ	
TELE	TELETYPE CORP.	ELK GROVE VILLAGE	IL	XXXXXX
TELEX	TELEX COMMUNICATIONS, INC.	MINNEAPOLIS	MN	
TELRY	TELEDYNE RELAYS	HAWTHORNE	CA	11532
TEMPL	TEMPEL STEEL CO.	CHICAGO	IL	34353
TFI	T&F INDUSTRIES DIV.	ROLLING MEADOWS	IL	58933
THMST	THERMOSET	INDIANAPOLIS	IN	
THOMN	THOMSON INDUSTRIES INC.	PORT WASHINGTON	NY	96281
THR	THERMALLOY CO.	DALLAS	TX	13103
TIMES	TIMES WIRE AND CABLE	CINCINNAI	OH	XXXXXX
TIN	TINNERMAN PRODUCTS, INC.	CLEVELAND	OH	78553
TKN	TECHNICAL WIRE	CRAWFORD	NJ	XXXXXX
TLLAB	TEL LABS, INC	LONDONIERRY	NH	94322
TLNC	TELEVIC ALTAIR	LAGUNA BEACH	CA	04423
TLSRY	TILSBY	*****	**	
TOCOS	TOCOS AMERICA, INC.	ARLINGTON HEIGHTS	IL	
TOKO	TOKO AMERICA	SKOKIE	IL	
TORCO	TOR CORP.	VAN NUYS	CA	XXXXXX
TOWER	TOWER MFG. CORP.	PROVIDENCE	RI	87930
TR-UT	TRIAD-UTRAD DIV.	HUNTINGTON	IN	0
TRIXX	TRIONYX INDUSTRIES	INDIANAPOLIS	IN	
TRMTR	TROMPETER ELECTRONICS INC.	WESTLAKE VILLAGE	CA	14949
TRNSN	TRANSENE CO., INC.	ROWLEY	MA	53796
TRU	WALDES TRUARC	LONG ISLAND CITY	NY	79136
TRW	TRW CAPACITOR DIV.	OGALLALA	NE	84411
TRWLL	TRI-WALL CONTAINERS, INC.	WOODBURY	NY	13351
TSHRA	TOSHIBA AMERICA INC	WAYNE	NJ	00000
TTC	TRAN-TEC CORP.	COLUMBUS	NE	
TUSNX	TUSONIX, INC.	TUCSON	AZ	59660
TVL	TEL-VISION LABS	WAUCONDA	IL	0
TWAY	TWAY COMPANY	INDIANAPOLIS	IN	0
TYTON	TYTON CORP.	MILWAUKEE	WI	
U-C	UNIVERSAL COMPONENTS	LOS ANGELES	CA	82933
UCE	UCE INC	NORWALK	CT	00000
ULSP	UNDERWRITERS LAB. SPEC.	CHICAGO	IL	0
UNCAR	UNION CARBIDE COMPONENTS	GREENVILLE	SC	57185
UNCHM	UNITED CHEMI-CON			
UNIC	UNICORP	ORANGE	NJ	04729
UNIT	UNITRODE CORP.	WATERTOWN	MA	12969
UNIV	UNIVERSAL SEMICONDUCTOR INC	SAN JOSE	CA	
USECO	USECO DIV.	VAN NUYS	CA	88245
USMFS	USM FASTENER DIV.	SHELTON	CT	07707
UTK	UNITRACK DIV.	UPPER DARBY	PA	XXXXXX
VAC	VACTEC INC.	MARYLAND HEIGHTS	MO	18178
VACO	VACO PRODUCTS CO.	NORTHBROOK	IL	79061
VAR	VARADYNE CAPACITOR DIV.	SANTA MONICA	CA	26654
VARIL	VARI-L CO.	DENVER	CO	05375
VARO	VARO SEMICONDUCTOR INC	GARLAND	TX	
VAULT	VAULT CORP	WESTLAKE VILLAGE	CA	
VCTRN	VECTRON LABORATORIES, INC.	NORWALK	CT	27802
VELCR	VELCRO USA INC	NEW YORK	NY	11153
VIC	VICTOREEN INC	CLEVELAND	OH	
VIK	VIKING CONNECTORS	CHATSWORTH	CA	
VIN	VINCENT BRASS AND ALUM. CO.	INDIANAPOLIS	IN	
VISCM	VISUAL COMM	PLAYA DEL REY	CA	56769
VLIER	VLIER ENGINEERING CORP.	BURBANK	CA	01226
VLTRX	VOLTREX	*****	**	
VONGT	VONNEGUT HARDWARE	INDIANAPOLIS	IN	XXXXXX
VRN	VERNITRON CORP.	GREAT NECK	NY	XXXXXX
VRNIN	VRN INTERNATIONAL	ST PETERSBURG	FL	
VRW	VAN WATERS AND ROIGER	INDIANAPOLIS	IN	
VSSNC	VIEWSONICS, INC.	SYOSSET	NY	59108
VTRMN	VITRAMON, INC.	BRIDGEPORT	CT	95275
W-E	WELLS ELECTRONICS	SOUTH BEND	IN	14329
W-I	WAVETEK INDIANA, INC.	BEECH GROVE	IN	34280
W-J	WATKINS-JOHNSON CO.	PALO ALTO	CA	
WAFCO	WAFCO SALES & SERVICE CORP	INDIANAPOLIS	IN	
WAG	WAGNER ELECTRIC CORP.	ST. LOUIS	MO	63477
WALKN	WALBERN DEVICES, INC	LINDEN	NJ	
WESH	WABASH RELAY & ELECT.	WABASH	IN	18542
WECK	WECKESSER CO., INC.	CHICAGO	IL	95987

ABBR.	NAME.....	CITY.....	ST	FSCM.
WESCO	WESCO ELECTRONICS	LOS ANGELES	CA	14551
WHBRY	W.H. BRADY INDL PRDS DIV	MILWAUKEE	WI	
WHTMN	WHITMAN	CINCINNATI	OH	
WILL	WILLIAMS	INDIANAPOLIS	IN	
WIN	WINCHESTER ELECTRONICS	OAKVILLE	CT	
WKFLD	WAKEFIELD ENGINEERING	WAKEFIELD	MA	05820
WLIOM	WALIDOM	CHICAGO	IL	92219
WLG	W.L. GORE	NEWARK	DE	
WMBG	W.M. BERG	ROCKAWAY	NY	
WNSL	WEINSCHEL ENGINEERING	GAITHERSBURG	MD	93459
WNZLR	WINZLER MFG	CHICAGO	IL	09109
WRC	WIRE RESEARCH CORP	SANTA ANA	CA	
WRGPA	W. R. GRACE AND CO. POLYFIB RON DIV.	ROANOKE RAPIDS	NC	53718
WSTI	WAVETEK	SAN DIEGO	CA	23338
WSTLK	WESTLAKE CAPACITORS INC	WESTLAKE VILLAGE	CA	
WSTN	WESTON COMPONENTS	ARCHBALD	PA	94075
X-MRO	X-MICRO			
YORK	YORK INDUSTRIES	GARDEN CITY PARK	NY	
ZEN	ZENITH RADIO CORP.	CHICAGO	IL	67177
ZERO	ZERO MANUFACTURING CO.	BURBANK	CA	98376
ZIE	ZIERICK MFG. CORP.	MOUNT KISCO	NY	79963
ZPT	ZIPPERTURING. CO.	LOS ANGELES	CA	07240

755 records listed.

