

INSTRUCTION MANUAL

SSI-3000

SERVICE MONITOR

WAVETEK[®] INDIANA, INC.

5808 CHURCHMAN, P.O. BOX 190

BEECH GROVE, INDIANA 46107

317-787-3332

(TOLL FREE OUTSIDE INDIANA)

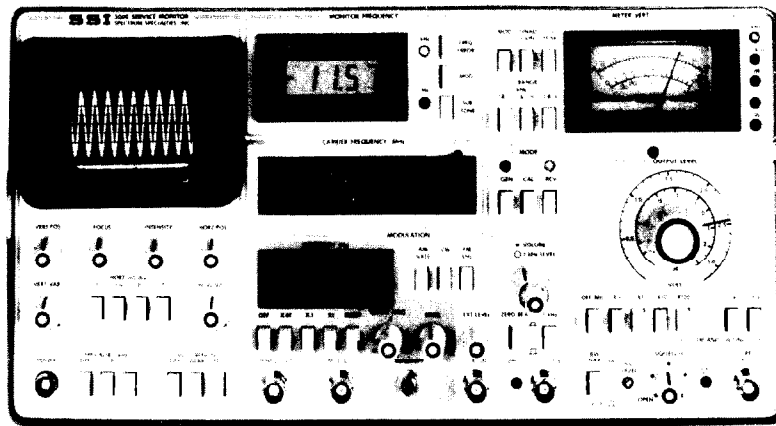
1-800-428-4424

Serial No. _____

INSTRUCTION MANUAL

SSI-3000

SERVICE MONITOR



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All Wavetek instruments are warranted against defects in material and workmanship for a period of one year after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective under normal use during this period. Transfermatic Switch assemblies, manufactured by Wavetek, are unconditionally warranted for the life of the instrument. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which, in Wavetek's sole opinion, proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

This warranty does not apply to any products repaired or altered by persons not authorized by Wavetek, or not in accordance with instructions furnished by Wavetek. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

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SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek/SSI Model 3000 is a compact, lightweight Service Monitor, for testing FM and AM transceivers. Its 25 lb weight and optional Inverter permit use in the field, powered by a car or truck alternator.

The frequency range is 400 kHz to 1000 MHz in 100 Hz steps. An audio synthesizer permits generation of sub-audible tones and timed tone bursts. On receive, a built-in counter displays frequency error, modulation frequency, or received sub-audible tone frequency.

RF voltage level is continuously variable from 0.03 μV to 316 mV.

A built-in scope shows modulation waveform and relative signal strength. A meter reads modulation, SINAD (using the built-in 1 kHz tone source), audio voltage at a front-panel connector, or RF power from 1 to 100 W. The built-in load eliminates the possibility of damage from accidental keying.

The meter and the scope display the same information, including SINAD, noise and distortion, except that only the meter indicates power.

1.2 SPECIFICATIONS

1.2.1 GENERATE MODE

1.2.1.1 FREQUENCY

Range	400 kHz to 999.9999 MHz
Resolution	100 Hz
Display	7 digit switch, individually selectable
Accuracy	See Internal Time Base

1.2.1.2 RF OUTPUT

Range	0.03 μ V to 316 mV
Accuracy, 400 kHz to 1000 MHz, 0.3 μ V	± 1 dB
0.1 μ V to 300 μ V	± 1.5 dB
300 μ V to 300 mV	± 4.5 dB
Spectrum	One signal, typically 5 mV, always 17 to 18 MHz higher in frequency than the desired signal. Second signal always 34 to 37 MHz higher in frequency than the desired and at the same level.
Spurious outputs within ± 30 kHz of desired signal at all Land Mobile frequency bands	50 dB below desired signal
Noise	
Residual FM (0.1 to 3 kHz BW)	
400 kHz to 481 MHz	40 Hz rms
482 MHz to 1000 MHz	80 Hz rms
Residual AM (0.1 to 3 kHz BW)	1%
Output Control	
Continuous	23 dB range
Step Attenuator	6 steps of 20 dB
RF Leakage	Virtually unmeasurable at 0.3 μ V output level

1.2.1.3 MODULATION

AM	
Range	0 to 90%
Frequency Range, 3 dB	10 Hz to 10 kHz

Accuracy	±5%
External Input	100 mV rms for 100%
Impedance	50K ohms, nom.

FM

Deviation Range	0 to 18 kHz, peak
Frequency Range, 3 dB	1 Hz to 10 kHz
Ranges	18, 6, 1.8 kHz, peak
Accuracy	±5%
External Input	100 mV rms for 5 kHz, peak
Impedance	50K ohms, nom.

Display Meter and CRT

1.2.1.4 AUDIO GENERATOR

Frequency Range	10 Hz to 9999 Hz
Frequency Resolution	1 Hz, 0.1 Hz, 0.01 Hz
Frequency Accuracy	See Internal Time Base
Display	4 digit switch, individually selectable
Burst Modes	Continuous and variable, .03 to 1.0 seconds
Interrupt	Miniature phone jack to externally enable audio generator with a switch closure (Ron less than 1000 ohm)
Output	0 to 1 V rms
Output Impedance	600 ohms, nom.

1.2.1.5 DISTORTION ANALYZER (SINAD MEASUREMENTS, "AUDIO IN" CONNECTOR)

Notch Frequency	1 kHz
Range	0 to -30 dB
Accuracy @ -12 dB	±1 dB
Input Impedance	100K ohm, nom.
Display	Meter and CRT

1.2.1.6 VOLTMETER/OSCILLOSCOPE ("AUDIO IN" CONNECTOR)

Frequency Range	10 Hz to 100 kHz
Ranges	6, 1.8, 0.6 volts, peak
Accuracy	±5%
Display	Meter and CRT
Input Impedance	100K ohm, nom.
Internal Speaker maximum power (monitors "Audio In")	2 W

1.2.1.7 POWER METER (Automatically switches to power meter and receive mode when 200 mw or greater is present at "RF" connector)

Meter Range	1 W to 100 W
Accuracy, less than 500 MHz	±10% of full scale
Display	Meter

1.2.2 RECEIVE MODE

1.2.2.1 FREQUENCY SYNTHESIZER

Range	400 kHz to 999.9999 MHz
Resolution	100 Hz
Display	7 digit switch, individually selectable
Accuracy	See Internal Time Base

1.2.2.2 FREQUENCY COUNTER

Display	4 digit, back-lighted LCD
Accuracy	±1 count plus timebase error
Frequency Error	
Range	±(0.01 to 9.99 kHz)
Resolution	10 Hz
Gate Period	1.0 sec

MOD (counts signal that appears on CRT)

Range	50 to 9999 Hz
Resolution	1 Hz
Gate Period	1 sec.

SUBTONE (counts signal that appears on CRT)

Range (built-in 300 Hz low-pass filter)	60 Hz to 270 Hz
Resolution	0.1 Hz
Gate Period	1 sec.

1.2.2.3 RECEIVER

Sensitivity, Typical	3 μ V for 12 dB SINAD
Bandwidth, 3 dB	
Wide	50 kHz
Narrow	7 kHz

1.2.2.4 MODULATION

FM

Range	18, 6, 1.8 kHz, peak
Display	Meter and CRT
Accuracy, 1 kHz	\pm 3% of Full Deflection
Calibrator Accuracy, 5 kHz and 600 Hz	\pm 2%
Frequency Response, 3 dB	1 Hz to 10 kHz

AM

Range	0 to 90%
Display	Meter and CRT
Accuracy, 1 kHz, 30%	\pm 3%
Frequency Response, 3 dB	50 Hz to 10 kHz

1.2.2.6 OSCILLOSCOPE

Vertical

Frequency Range	10 Hz to 100 kHz
Ranges	18, 6, 1.8 volts, peak
Accuracy	\pm 5%
Input Impedance	100K ohm, nom.
Input Connector	"Audio In"

Horizontal

Sweep Range 0.01, 0.1, 1.0, 10 mS/Division

Accuracy ±15%

1.2.3 GENERAL

1.2.3.1 TIME BASE ACCURACY

Aging ±1 ppm/yr.

Temperature Variance, 0° C to 50° C

Standard TCXO ±1 ppm

Optional "Quick Warmup" Oven ±0.1 ppm

Warmup to within 0.1 ppm 10 min.

1.2.3.2 POWER

AC 117 V, 60 VA

12 VDC (optional SSI-110 Inverter) 6 A

1.2.3.3 PHYSICAL SIZE 14" W x 13-3/4" D x 7-1/8" H

1.2.3.4 WEIGHT Approx. 25 lbs.

SECTION 2

INSTALLATION

2.1 INTRODUCTION

The Wavetek/SSI Model 3000 is a rugged piece of precision test equipment designed for portability. Although it is quite commonly used as a laboratory instrument, it is also well suited for field use.

2.2 UNPACKING AND INSPECTION

When unpacking the Model 3000 Service Monitor, inspect the shipping container and instrument for shipping damage. Save the shipping carton and packing material for possible future use.

The instrument was inspected, given final operational and quality control tests, then carefully packaged for shipment and should operate in accordance with Section 3 of this manual.

If instrument received has been damaged in transit, notify carrier and either your Wavetek/SSI representative or the factory in Indiana. The representative or the factory will immediately arrange for either replacement or repair of your instrument without waiting for damage claim settlements.

West of the Rockies, contact

Wavetek/SSI
3555 Ryder
Santa Clara, CA 95051

408 - 737-7374

2.3 PREPARATION FOR USE

Before line power is applied, the meter should read zero. If not, insert a blade screwdriver into the opening below the meter and adjust it to zero.

2.4 POWER REQUIREMENTS

The standard Model 3000 operates from a 117 VAC 60 Hz

primary power source at 60 VA. The three conductor power cord provides a ground connections to the Model 3000 chassis when it is connected to the proper outlet.

The instrument can also be operated with DC power by using the optional inverter. With the inverter, the Model 3000 requires 10.5 VDC to 15.2 VDC.

For use with other primary power sources, please consult the factory.

2.5 ENVIRONMENTAL CONSIDERATIONS

The Model 3000 comes equipped with bottom and rear panel feet, and a combination carrying handle/instrument stand. These features along with its small size and light weight permit easy access to confined working spaces.

The Model 3000 is designed to operate between 0° C and 50° C and should be used in an area where free air flow around the instrument is not restricted. Do not permit the ventilating ports to be blocked or restricted and **never** operate the unit within its protective cloth cover.

Exceeding the upper or lower temperature limits for extended periods may not result in damage to the instrument but may cause degraded performance.

2.6 INSTALLING THE INVERTER

1. Remove the four rear feet of the Model 3000.
2. Position the inverter over the screw holes with the **LOW VOLTAGE** lamp at the top, and secure the inverter with the four screws supplied.
3. Install the rear feet on the back of the inverter.
4. Plug the line cord of the Model 3000 into the receptacle of the inverter, and plug the inverter power cord into a cigarette lighter outlet.

SECTION 3

OPERATION

3.1 INTRODUCTION

This section contains operating instructions for the Wavetek/SSI Model 3000 Service Monitor. Included are descriptions of front and rear panels, and notes on use of features.

3.2 FRONT PANEL DESCRIPTION

Due to the number of controls, the front panel is divided into sections for description.

3.2.1 SCOPE

See Figure 3-1.

1. Display, with scales for ± 1.8 , ± 6 , and ± 18 kHz deviation.
2. Display controls for Vertical Position, Focus, Intensity, and Horizontal Position.
3. Vertical sensitivity. Clockwise detent is calibrated position.
4. Horizontal sweep rate. Pushbuttons select 10, 1.0, 0.1, and 0.01 msec/div.
5. Horizontal variable control. Clockwise detent is push-button calibration; lower setting reduces speed.
6. AC Power. Push-on/push-off. Non-electric indicator shows switch is pushed.
7. FM Calibration. Puts horizontal lines at ± 6 or ± 5 kHz deviation levels.
8. Signal Strength. When WEAK or FULL is pressed, horizontal size of display from left side depends on signal strength. WEAK requires approximately 30 μ V for full width; FULL requires approximately 100 mV. Minimum width to maximum width requires approximately 90 dB change on either range.

3.3.2 FREQUENCY

See Figure 3-2.

1. Monitor Frequency indicator. Displays count of frequency selected by pushbuttons. kHz or Hz lamp indicates units.
2. Frequency Error select. Display reads difference in kHz between frequency on Carrier Frequency switches and input frequency. Negative reading indicates switch frequency is lower than input.
3. Modulation Frequency select. Display reads input modulation frequency, 300-3000 Hz.
4. Sub-tone Frequency select. Display reads input modulation frequency below 300 Hz.
5. Carrier Frequency. Seven lever/indicator switches select output frequency or input reference frequency, with 100 Hz resolution.

3.2.3 MODULATION

See Figure 3-3.

1. Modulation Frequency. Lever/indicator switches set output modulation frequency. Four digits; left-most cannot be zero.
2. Modulation Frequency multiplier. Multiplies switch setting by .01 (for 10.00 to 99.99 Hz range), by .1 (for 100.0 to 999.9 Hz) or 1 (for 1000 to 9999 Hz). OFF turns off variable frequency modulation.
3. DEMOD OUT. BNC connector for receiver's demodulated audio.
4. MOD OUT. BNC connector for output of all audio generation, including synthesizer, 1 kHz, external, and microphone.

5. **BURST.** Generates burst of variable-frequency modulation with duration controlled by **TIME (SEC)** control.

6. **TIME (SEC).** Sets length of modulation burst, from .03 to 1.0 second. Clockwise detent is continuous tone.

7. **INTERRUPT.** Miniature phone jack for interrupting variable-frequency modulation using rotary-dial equipment.

8. **LEVEL.** Sets level of audio synthesizer.

9. **EXT IN.** BNC connector for external modulation.

10. **EXT LEVEL.** Controls level of external modulation.

11. **AUDIO IN.** Input to audio voltmeter and scope. Audio is displayed on scope, voltage is indicated on meter and scope.

12. **ZERO BEAT.** Speaker carries beat between generated frequency and received frequency.

13. **1 kHz.** Turns 1 kHz on or off.

14. **VOLUME.** Inner knob controls speaker volume, outer knob controls 1 kHz.

15. **Modulation mode.** AM (meter reading x 10 equals modulation depth), CW, FM.

3.2.4 METER/MODE

1. **Meter** - indicates modulation level, SINAD, voltage, or transmitter power.

2. **VOLT (PEAK)** pushbutton - causes meter to read peak voltage at **AUDIO IN** connector (Section 3.2.3, number 11.)

3. **SINAD (1 kHz)** pushbutton - for 1 kHz modulation, causes meter to read ratio of (signal + noise + distortion)/(noise + distortion) in dB.

4. **MOD** pushbutton - causes meter to read modulation level in kHz deviation or %AM. AM is read on the upper scale (0-18) and multiplied by 10.

5. **METER RANGE** - sets meter range to 18, 6, or 1.8 kHz (if **MOD** is selected) or 18, 6, or 1.8 volts (if **VOLTS** is selected).

6. **Meter unit indicators** - indicate whether meter is to be read in kHz (for FM), % x 10 (for AM), dB (for SINAD) volts (peak), or watts. All depend on which pushbuttons are pushed, except watts, which comes on automatically when RF is put into the **RF IN/OUT** connector (Section 3.2.5, number 9).

7. **GEN** - sets Generate mode.

8. **CAL** - centers discriminator bias, and invokes self-test features

9. **RCV** - sets Receive mode.

3.2.5 OUTPUT LEVEL/SQUELCH

1. **Output Level Control** - calibrated in volts and dB.

2. **OFF/MIC** pushbutton - when button is depressed, output is off except when push-to-talk switch of accessory microphone is pushed.

3. **Output Range Multiplier** - multiplies Output Level Control setting by .1, 1, 10, or 100.

4. **Output Level Units** - sets Output Level Control to read μ V or mV. See Section 3.4 for interpretation of dB scale.

5. **BW** - sets receiver bandwidth to Narrow (7 kHz) or Wide (50 kHz).

6. **Signal Level indicator** - lights when input signal level is above squelch setting.

7. **SQUELCH** - cuts out background noise when signal level is too weak.

8. **LOAD OVERTEMP** - lamp and audible signal indicate that RF power input has caused internal load to exceed rated temperature.

9. **RF IN/OUT** - output for generated RF, input for signal to be measured. Automatically switches from generate to receive when RF is keyed.

3.3 INITIAL TURN-ON

Connect the power cord from the rear panel of the SSI-3000 to a suitable power outlet and depress the front panel power pushbutton. The power pushbutton indicator will change from black to amber, the meter will become illuminated, and lamps corresponding to whichever pushbuttons are depressed will become illuminated. The display scope will warm up in a few seconds.

SSI-3000 Service Monitors equipped with the **standard TCXO master oscillator** will generate precision signals accurate to 1 ppm within a few seconds.

SSI-3000 Service Monitors equipped with the **optional ovenized master oscillator** will stabilize to ± 1 ppm accuracy within three minutes and to ± 0.1 ppm accuracy within ten minutes in a normal room temperature environment. Cold environments will require longer stabilization times.

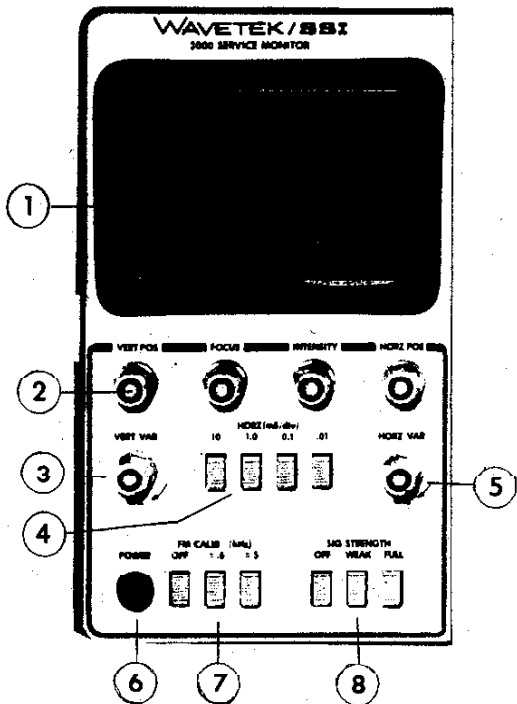


Figure 3-1. Scope front panel.

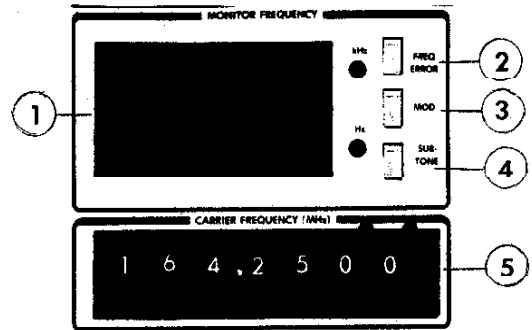


Figure 3-2. Frequency front panel.

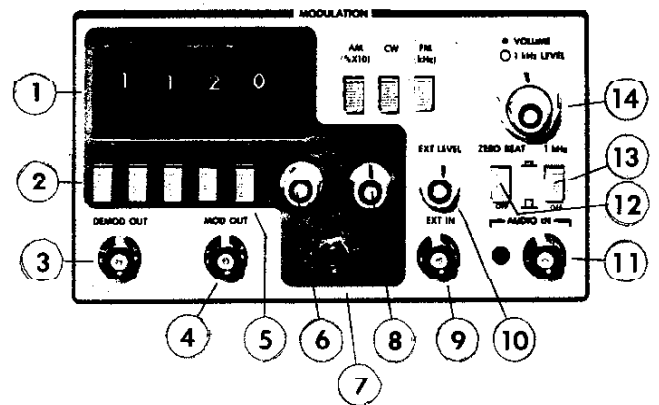


Figure 3-3. Modulation front panel.

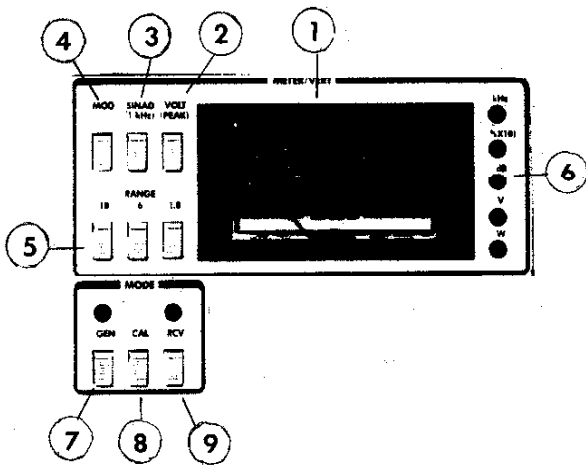


Figure 3-4. Meter/mode front panel.

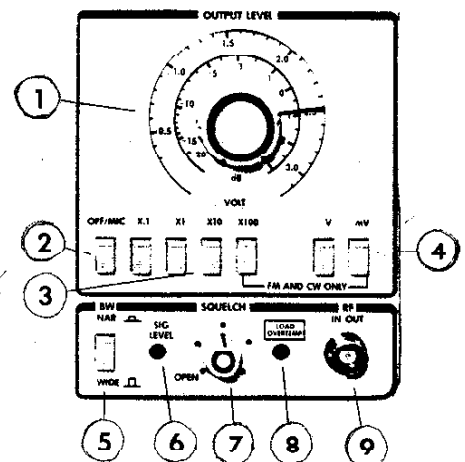


Figure 3-5. Output level front panel.

3.4 RF GENERATOR OPERATION- CONTINUOUS WAVE

Select Generate mode by pressing GEN in the MODE section of the front panel.

Select CW modulation by pressing the CW pushbutton. BE SURE THE OFF/MIC PUSHBUTTON IS RELEASED.

Set the CARRIER FREQUENCY (MHz) lever switches to the desired frequency.

Set RF output level by depressing the desired range and multiplier pushbuttons and adjusting the OUTPUT LEVEL dial. For example, to generate a 152.090 MHz signal at 0.3 μ V, set 152.0900 with the FREQUENCY (MHz) lever switches. Then depress the μ V range and the X 0.1 multiplier pushbuttons and adjust the OUTPUT LEVEL dial to 3.

The Output Level control may be calibrated in dBm according to Table 3-1. The Low and High columns are the limits of the dial calibration for the selected multiplier and range. The 0 dBm column is the dBm calibration for 0 dB on the dial, with the selected multiplier and range. For example, for -85 dBm push X10 μ V and set the dial to -5 dB.

The OFF/MIC pushbutton turns off RF power to the RF output jack when it is depressed. RF power can be restored to the RF output jack while the OFF/MIC pushbutton is depressed by keying a microphone. This is accomplished by connecting a Shure 405K or equivalent microphone to the rear panel MIC jack and depressing the push-to-talk switch of the microphone.

3.5 RF GENERATOR WITH FM MODULATION- SINGLE SOURCE

Release the OFF/MIC pushbutton and depress the FM kHz modulation and meter MOD pushbuttons. The kHz lamp will be illuminated.

Modulating with the internal audio synthesizer is accomplished by setting the desired frequency with the FREQUENCY (Hz) lever switches, selecting the desired multiplier pushbuttons and adjusting the LEVEL control. Turn the TIME (SEC) control clockwise until it clicks, unless tone burst is desired.

For example, if a CTCSS tone of 131.8 Hz at 500 Hz of deviation is desired, set 1318 with the FREQUENCY (Hz) lever switches, and select multiplier pushbutton X 0.1. Select the 1.8 kHz meter RANGE switch and adjust the LEVEL control for a meter reading of 0.5 kHz.

For tone burst, set the TIME (SEC) control to the desired time, and press BURST.

The audio synthesizer may be used to modulate the RF carrier with frequencies up to 9999 Hz at modulation levels up to 18 kHz.

The INTERRUPT jack is closed if no plug is inserted. If a rotary-dial pulser is connected, the audio will be off until the pulser switches it on.

The OFF pushbutton is used to turn off the audio synthesizer without disturbing the frequency or level settings.

External modulation is accomplished by connecting the source, such as a sequential tone generator, to the EXT MOD jack and adjusting the EXT LEVEL control to the desired level of modulation. For a tone deviation of ± 3 kHz, press the 6 kHz meter RANGE pushbutton and adjust the EXT LEVEL control for a meter reading of 3 kHz.

Disconnect the tone generator to remove external modulation signals without disturbing the frequency or level settings.

1 kHz modulation is activated by depressing the 1 kHz ON/OFF pushbutton and adjusting the 1 kHz LEVEL control; the level is displayed on the meter. Release the ON/OFF pushbutton to remove the 1 kHz modulation signal without disturbing the level setting.

Voice modulation of the RF carrier is accomplished by connecting a microphone to the rear panel MIC Jack and talking into it. If the OFF pushbutton is depressed, the push-to-talk switch of the microphone must be depressed to activate the RF output. The modulation level is internally limited to 5 kHz maximum deviation and is not adjustable.

3.6 RF GENERATOR WITH FM MODULATION- MULTIPLE SOURCE

Modulation of the RF carrier by more than one audio signal is accomplished by setting up the parameters for each signal, one at a time, and applying them simultaneously to the modulator. For example, to modulate with a CTCSS tone and a sequential tone generator, set up the desired CTCSS tone on the internal audio synthesizer as discussed in Section 3.4 and press the OFF pushbutton. Next, connect the external tone generator to the EXT MOD jack, set its modulation to the desired level and restore the CTCSS tone by pressing the desired frequency multiplier pushbutton. The RF carrier will then be modulated by two separate signals at two separate preset levels.

Up to three sources can be used to modulate the RF carrier. For example, a CTCSS signal, a tone burst to turn on a receiver, and the internal 1 kHz signal to measure SINAD or audio from a microphone may be simultaneously superimposed upon the RF carrier. To modulate with these three sources, set up the CTCSS signal on the external tone generator, then disconnect the external generator. Set the burst frequency on the internal generator and set TIME (SEC) to the burst time. Next, set up the internal 1 kHz signal for the desired level of modulation as discussed in paragraph 3.4. Reconnect the external tone generator. The RF carrier will then be modulated by the two separate signals at separate preset levels. Press BURST for the timed burst frequency.

3.7 RF GENERATOR WITH AM MODULATION

Depress the AM modulation pushbutton; the % X 10 lamp will be illuminated.

The AM modulation meter has ranges of 18, 60, and 180%. Specifications apply only up to 90%.

AM modulation, single or multisource, is applied in the same manner as FM modulation as discussed in Section 3.4. The microphone, however, is intended for FM modulation, so AM modulation will be limited to approximately 16% peak. Consult the factory for modifications.

3.8 SINAD MEASUREMENTS

Press the SINAD meter mode pushbutton; the dB lamp will light.

Apply an RF signal to the receiver under test; the level of the signal must be sufficient to quiet the receiver.

Modulate the RF carrier to 3 kHz FM or 30% AM, with the internal 1 kHz signal. (See paragraph 3.4.)

Connect the audio-out of the receiver under test to the AUDIO IN jack of the SSI-3000. Adjust the volume control of the receiver to a level sufficient to light the level indicating lamp adjacent to the AUDIO IN jack. Adjust the VOLUME control of the SSI-3000 to a comfortable listening level. The meter should indicate a reading which should vary with the RF level. Adjust the CARRIER FREQUENCY (MHz) for a minimum reading to locate the center of the IF. Adjust the RF output level for a meter reading of -12 dB. This is the 12 dB SINAD sensitivity. Adjust the receiver IF for the best reading.

NOTE: The SINAD reading is the net result of two conflicting requirements on IF alignments: sharp tuning for minimum receiver noise and wide tuning for minimum

receiver distortion. Thus, IF alignment with a SINAD meter quickly optimizes these two requirements simultaneously by displaying a reading that results from both noise and distortion. The composite distortion signal may be viewed on the scope for analysis of the distortion source.

3.9 20 dB QUIETING MEASUREMENT

Press the CW modulation pushbutton and the VOLTS meter mode pushbutton; the V lamp will light.

Apply an RF signal to the receiver under test; the level of the signal must be sufficient to quiet the receiver.

Connect the audio-out of the receiver under test to the AUDIO IN jack of the SSI-3000. Adjust the CARRIER FREQUENCY (MHz) for a minimum reading to locate the center of the IF.

Depress the OFF/MIC pushbutton and adjust the receiver volume control to a convenient reading on the voltmeter, say 10 V. Adjust the VOLUME control of the SSI-3000 to a comfortable listening level.

Release the OFF/MIC pushbutton and increase the RF output level of the SSI-3000 until the voltmeter reading has been reduced 20 dB, to 1.0 V in this case. The RF output level is the 20 dB quieting sensitivity of the receiver.

3.10 AC VOLTMETER

AC signals from 10 Hz to 100 kHz up to 18 V peak can be measured with the AC voltmeter and the scope.

Depress the meter VOLTS pushbutton, connect the signal to be measured to the front panel AUDIO IN jack and select the appropriate meter RANGE switch.

Signals applied to the AUDIO IN jack are also monitored aurally with the speaker.

3.11 RF WATTMETER

RF power up to 100 watts can be measured with the SSI-3000.

Connect the transmitter output to the RF output jack of the SSI-3000. When the transmitter is keyed, the meter will automatically switch to the power mode and the W annunciator will become illuminated.

The internal 50 ohm load temperature alarm, consisting of the front panel LOAD OVERTEMP indicator and the internal speaker aural alarm, will activate if the load overheats, typically after 100 watts has been applied for longer

than 10 seconds. If the warning signals become activated the power applied at the RF output jack must be interrupted (transmitter must be unkeyed) to prevent possible damage to the internal load.

RF power keyed into the SSI-3000 when the AC power is not on will be absorbed by the internal 50 ohm load, but the overtemperature alarms will not be operative.

3.15 MOD SCOPE (FM/AM MODULATION MEASUREMENTS)

Before making modulation measurements with the scope adjust the VERT POS control so that the trace is on the zero reference line. Adjust the HORZ POS so that the dot is in the center of the scope when the horizontal (ms/DIV) switch is in the EXT position. Adjust the INTENSITY and FOCUS controls for a sharp clear trace on the screen.

When the receiver is tuned to a transmitter signal any modulation (FM or AM) can be observed and measured on the scope depending on the setting of the VERT (SENS/VAR) switch and HORZ (ms/DIV) switch.

To measure FM deviation select FM on the MODE switch and set the horizontal switch to 1.0 ms/DIV. Set the SENSITIVITY switch to 1.8 kHz, 6.0 kHz, or 18 kHz depending on the range of deviation being observed. Deviation can be measured directly on the scope graticule.

FM CAL markers at ± 5 kHz or ± 0.6 kHz provide ease of reading of peak deviation. With FM CAL markers ON, the display is time multiplexed, and therefore some decrease in display intensity and audio volume will be experienced

If the received signal is the same frequency as the FREQUENCY switches, the scope trace will be on the zero line of the graticule. If the input frequency is above the switch frequency the trace will be above zero. Calibration is set by the RANGE pushbuttons in the METER/MODE area (see Section 3.2.4). The scope is a convenient indication of frequency error, but the counter (see Section 3.2.2) should be used for accurate measurements.

To zero the trace, press the CAL button and adjust the VERT POS control. (See Section 3.17.)

3.16 RELATIVE SIGNAL STRENGTH

When one of the SIG STRENGTH buttons is pushed (see Figure 3-1, number 8), the length of the trace, starting at the left edge of the screen, will depend on the signal strength. That is, the stronger the signal the farther the trace extends to the right. When OFF is pushed, the trace is full-width.

When the FULL button is pushed, the trace is full-width for a signal of approximately 100 mV; when WEAK is pushed, full-width is about 30 μ V. Dynamic range in the FULL position is about 90 dB.

3.17 AUTO CAL

When the CAL button is pushed (see Figure 3-4, number 8) or when the SIG LEVEL light is off (see Figure 3-5, number 6), the discriminator will be automatically zeroed, removing any long-term drift that has occurred. The Frequency Error display will read zero. The vertical position of the scope trace may be adjusted to zero using the VERT POS control (Figure 3-1, number 2).

Mult	Range	Low	0 dB	High
X.1	μ V	-137	-120	-117
X1	μ V	-117	-100	-97
X10	μ V	-97	-80	-77
X100	μ V	-77	-60	-57
X.1	mV	-77	-60	-57
X1	mV	-57	-40	-37
X10	mV	-37	-20	-17
X100	mV	-17	0	3

Table 3-1. dBm level calibration.

SECTION 4

THEORY OF OPERATION

4.1 OVERALL

Refer to the block diagram, Figure 4-1. The RF phase-locked loop, on the A3 High-Frequency Synthesizer board, generates a frequency from 18 to 1021 MHz in 1 MHz steps. In Generate mode this is mixed with the output of the low-frequency PLL, on board A2, to provide the output frequency. In Generate, the low-frequency PLL goes from 17.0001 to 18.0000 MHz in 100 Hz steps. The result is a frequency that ranges up to 999.9999 MHz in 100 Hz steps.

In Monitor (receive) mode the output of the A3 high-frequency synthesizer is 22 MHz above the MHz digit of the front-panel frequency. This is mixed with the RF input; the difference is sent to the A4 IF board. The output of the low-frequency PLL now steps by 100 Hz from 16.7001 to 17.700 MHz; when this is mixed with the 21 - 22 MHz output of the A1 mixer board, the result is the constant 4.3 MHz second IF.

The second IF is mixed with 3.6 MHz to produce 700 kHz, which drives the FM discriminator, the AM detector, and the AGC. The 700 kHz is divided by 10 to drive the Frequency Error counter on the front-panel.

4.2 A10 FRONT PANEL BOARD

U5 is a one-shot timer for the burst frequency. Grounding pin 2 starts the cycle; the length is controlled by the front-panel Time control. The output pulse is returned via P1 pin 21. U3 sums all the modulation sources (subtone, 1 kHz, external, and microphone). The output goes to U6 pin 11, where it is sent on if \overline{RCV} ("not receive") is high. This signal will be high (true) in Generate mode.

R18, R19, and R24 form the Meter Range attenuator. U1A filters out the chopping frequency when the display is in FM CALIB mode. This is the frequency that alternates the trace between the signal and the calibration lines. U1B amplifies the signal by a factor of 2 in FM CALIB mode to compensate for the losses resulting from the chopping action.

S5A switches the audio signal in AM; S5B mutes the audio in CW mode; and S5C selects the proper LED.

The collector of Q2 controls the RF output of the A3 High-Frequency Synthesizer board by controlling the power supplied to its VCO. When the OFF/MIC switch is in MIC, the base of Q2 is grounded, turning Q2 and the RF on. In OFF the base is held at +15 V by R46, so the RF is off. Grounding the base via the push-to-talk line turns the RF on. In receive mode \overline{GEN} is high, allowing Q3 to turn on. This clamps the base of Q2 low, bypassing the OFF/MIC and PTT switches.

4.3 A11 FREQUENCY CONTROL BOARD

The Frequency Control Board reads the front-panel Frequency switches, adds offsets for transmit or receive, and time-multiplexes the frequency digits to the frequency-synthesizer cards. It also counts the 70 kHz IF, subtone, or modulation frequencies to drive the counter display on the front panel.

Counter circuitry is shown on Sheet 1. Sections of U27, U23, and U28 select the input to be counted. R100 and C36 filter RF from the modulation frequency. U21 and U22 count the 100 Hz from the A5 card to produce a 1 second gate appearing at U26 pin 26. U33 is the four-decade counter chip. D1 to D4 are the bits of the output digit; pins 4 - 7 indicate which digit is being enabled.

U30 is a phase-locked loop which multiplies the subtone frequency by 10, allowing 0.1 Hz resolution with 1 sec gate time. U30 pin 4 is the VCO output; it is divided by 10 in U31 to drive the phase comparator in U30.

When the modulation or subtone frequencies are being counted, U33 counts up. When frequency error is to be counted, a signal on P4 pin 7 causes U19 to set U33 to count down. The 70 kHz signal from the 700 kHz IF is counted. Each time the counter reaches zero (after 10,000 counts) the divide-by-seven counter consisting of U19A, U34, and U27 is advanced by 1. If the one-second gate expires just as U33 reaches zero (70,000 counts), the counter will indicate zero error.

Since the IF is generated by high-side injection, a high input frequency with triple conversion will produce a low IF. Thus if the input is 1 kHz above the switches the counter input will be 69 kHz, and the counter will count only 69,000 counts in one second. The effective starting count is 70,000, so the display will indicate 1.00 kHz, which will be displayed as 1 kHz.

If the input frequency is low the IF will be high. In this case the seventh zero will be reached before the end of the gate time. U27 clocks U19B, switching the counter to up. If the input is 1 kHz low there will be 71,000 IF counts per second, and the counter will count up 1000 counts before the gate closes. U32 causes the minus sign to be lit.

Sections of U24 control decimal points and the minus sign. The back-plane frequency (BP) is applied to both sides of the segment to be turned on. When the data line is low the output of the exclusive-or gate is in phase with the BP frequency, so the segment is off. When the data line is high the output is inverted, producing the alternating potential difference needed to drive the LCD segments.

Sheet 2 of the schematic shows the frequency-setting circuitry. U1 free-runs at about 5 Hz. This low frequency, along with CMOS gates, minimizes switching-frequency interference in RF circuits.

The output of U1 clocks U2 and U3, which form a binary counter. U3 decodes the output of U2 to produce four time slots, one for each of the three phase-locked loop chips in the 3000. (The fourth slot is not used.) Outputs of U4 produce four subintervals, one for each of the four digits a chip can accept. These signals are gated to produce pulses that select sections of the front-panel switches S1. For instance, when the output of U11 pin 4 is low, closure of switches in S1G puts the binary-coded decimal (BCD) representation of the 100 Hz digit on the data bus, which is terminated by R40-R43. Diodes prevent interaction between switches.

U18 is a programmable read-only memory (PROM). The BGD number from the selected switch forms part of the address for the PROM. The count from U2/U3 forms another part of the address, as does the REC signal from the motherboard. Each combination of bits addresses one memory location. The contents of that location represent the input digit to the PLL chip, with offset appropriate for generate or receive.

Outputs of O_0 to O_3 are the BCD bits of the digit. Output O_4 tells whether a carry is necessary to the next digit. If it is, U16B stores the carry flag, which becomes part of the address for the next word.

For example, for a Generate frequency of 396 MHz, an offset of 18 MHz is added for programming the A3 PLL. The MHz digit becomes $6 + 8 = 4$ with a carry. The 100 MHz digit becomes $3 + 1$ (carry) = 4. So the frequency sent to the synthesizers is 414 MHz.

Switches S2 for the audio synthesizer are scanned in similar fashion; no offsetting is required.

U13 is a PROM which selects the appropriate frequency band. (See the description of the A3 High Frequency Synthesizer for band limits.) U14 and U15 latch the 100 MHz and 10 MHz digits respectively. U16A latches the 1000 MHz digit, which can be only 0 or 1. The binary output of U13 is decoded to decimal by U17, which causes one of lines B1 through B6 to go low.

4.4 A3 HIGH-FREQUENCY SYNTHESIZER

The A3 High-Frequency Synthesizer generates a frequency that ranges from 18 MHz to 1021 MHz in 1 MHz steps. The 3.6 MHz reference frequency is generated on this board.

The heart of the high-frequency synthesizer is a voltage-controlled oscillator (VCO) adjustable between 240 and 505.5 MHz. This frequency is divided or multiplied to get the desired output. The VCO consists of Q2 and Q3; emitter coupling is through the series resonance of voltage-variable capacitors CR1 and CR2, and L3. Q4 is a buffer.

There are two phase-locking paths to complete the loop. The divide-by-N loop locks to the required frequency; when it is locked the sampling loop takes over. The sampling loop will lock on any integral MHz frequency, but it is less sensitive to noise than the divide-by-N loop.

The output of Q4 goes to the input of the sampling bridge CR8 CR11. The crosswise corners of the bridge are driven by the output of U14, an ECL device. The input to U14 pin 14 is a 1 MHz square wave from the A6 card. The first two gates of U14 crisp up the edges of the wave. The output of U14 pin 8 goes to pin 24, lowering the output of pin 2 and raising pin 3, which turns the bridge on. The input to pin 1 arrives after one gate delay, restoring the original condition. The result is that the bridge is turned on for a period equal to the gate delay, less than 1 nanosecond.

The current flowing through the bridge charges C42. If an integral number of RF cycles have passed since the last sampling pulse (that is, if the RF frequency is a multiple of 1 MHz) the sample will be taken at the same RF phase and the voltage on C42 will be constant. Thus the VCO frequency will be constant. If the frequency varies the

phase at sample time will vary, and so will the VCO control voltage. The design of the circuit is such that the resulting change in frequency will move the phase back toward lock.

U13 buffers the bridge output and feeds part of the voltage back via R163. This bootstrapping varies the bridge bias as the output voltage changes, preventing the RF from cutting off the diodes and increasing the efficiency of the sampling. U10 further buffers the control voltage; the feedback circuitry linearizes the frequency/voltage characteristic of the VCO. C37 and C38 limit the voltage swing to protect the voltage-variable capacitors.

The output of Q4 also goes to the input of U1, an ECL divide-by-2 chip. U2 and the parts of U3 perform further divisions by 2. The high-frequency synthesizer operates in six bands, as follows:

- 1 18-29 MHz
- 2 30-69 MHz
- 3 60-119 MHz
- 4 120-239 MHz
- 5 240-499 MHz
- 6 500-1021 MHz

Band selection is done automatically on the A11 Frequency Control Board. If band 5 is selected, the VCO output goes directly to amplifiers Q8 and Q9, and to J1. On bands 1 through 4, sections of U4, gated by control lines B1 through B4, select the appropriate subharmonic of the VCO frequency. The selected frequency is fed through PIN diode CR15 to Q8.

When the Frequency Control board selects band 6, PIN diodes CR16 and CR17 are shut off. CR20 and CR25 conduct, sending the VCO output to the doubler, T1 and CR21-CR24. Q12 and Q13 amplify the doubled frequency.

The selected frequency (undoubled) goes to the input of U5, a divide-by-10 prescaler, and U6, a divide-by-2. The divided-by-20 frequency goes to the input of U9. This phase-locked loop chip receives its divisor one byte at a time from the Frequency Control board, on pins 15 - 18; each of pins 2 - 5 loads one of the bytes. The phase detector output on pin 12 is amplified by U10A and U10B.

When a new divisor is loaded into U9 the loop is unlocked, and the LOCK output, pin 13, is low. SPDT switch U12 grounds the junction of R47 and R48, disabling the sampling loop. When the divide-by-N loop locks the LOCK line goes high; U12 switches so as to ground the junction of R41 and R42, disabling the divide-by-N loop and allowing the sampling loop to control the frequency. As long as the

frequency is constant the divide-by-N loop will consider itself locked, even though it is not in control of the frequency.

The 3.6 MHz reference frequency is prescaled by U9, which divides by 36. The 100 kHz result comes from pin 14 to U7. This dual-D flip-flop compares the phase of the 100 kHz output of U9 to the 100 kHz reference from the timebase on the A6 card. The output voltage is differentially amplified by U11 to control the frequency of the VCO consisting of Q16, CR35, and L18. When band 6 is selected U6 divides the 3.6 MHz by 2. This is necessary because the main VCO frequency is doubled, and must change in 0.5 MHz steps.

4.5 A2 LOW FREQUENCY SYNTHESIZER

The Low-Frequency Synthesizer consists of two phase locked loops, going from 6.60 to 7.89 MHz in 10 kHz steps and from 10.1001 to 10.1100 MHz in 100 Hz steps. The outputs are mixed to produce a frequency from 16.7001 to 18.0000 MHz in 100 Hz steps.

Q1 and Q2 form the VCO for the low PLL. Q3 is a buffer, providing the input to PLL chip U3. PIN diodes CR8 and CR9 set the RF output level, which is controlled by the OUTPUT LEVEL control on the front panel and by the AM modulating voltage. The combined level control voltage comes via board pin 2, LVL IN.

Q10 switches in or out of the signal path a 20 dB pad between Q9 and Q11. This is controlled by the front-panel OUTPUT LEVEL range pushbuttons.

The output of the 10.1001 - 10.11 MHz VCO, Q14 and Q15, is mixed by Q6 and Q18 with the 10 MHz output of the timebase generator on the A6 card. The difference, 100.1 - 110.0 kHz, is the input to U6. The 3.6 MHz reference is divided by 100 before being divided by 36 and by 10 in U6, to give the 100 Hz reference frequency.

FM modulating voltage comes in on board pin Z. Thermistor RT1 compensates for the temperature sensitivity of the modulator. The loop is designed to have a narrow bandwidth, so that it will not track out audio-frequency variations.

4.6 A1 MIXER BOARD

The Mixer Board mixes the 18 - 1017 MHz signal from the A3 high-frequency synthesizer with the 17 - 18 MHz signal from the A2 low-frequency synthesizer, to produce the Generate output, 0.4 - 1000 MHz, or the Receive 1st LO,

22 - 1021 MHz. Most of the output level control is on this board, along with the RF dummy load and its over-temperature circuitry.

The 17 - 18 MHz signal from the A2 low-frequency synthesizer comes in J4. In Receive (GEN high) Q21 routes the signal to the Mixer Board to be the 2nd LO injection frequency.

In Generate the signal is switched as necessary through a series of 20 dB pads, controlled by the front-panel LEVEL OUTPUT range pushbuttons. CR21 is turned off, so the signal goes from R103 to the mixer. The 18 - 1021 MHz from the high-frequency synthesizer comes to J3, through Q9 and Q10 as the high level mixer input. The mixer output goes to the left, possibly switched through 20 dB pads along the way. K3 and K4 are normally energized, so the signal goes on to J2, the front-panel RF IN/OUT connector.

In Receive mode the incoming RF is mixed with the 18 - 1021 MHz signal; the difference is sent via CR21 and J1 to the A4 IF board, with CR22 biased off.

R78 and R113 - R114 form a voltage divider for incoming RF. CR2 and CR3 detect the voltage; the DC is buffered by U4B. If the voltage rises above a threshold value (equivalent to about 200 mW) comparator U4 turns Q14 off, de-energizing K3. This connects the RF input to dummy load R88, a 50-ohm 150 W resistor. R89 and C50 hold K4 in for a moment, giving K3 time to dump the RF to R88. This avoids requiring K4 to interrupt what may be a large current.

CR8, CR9, C10 and CR11 form a power limiter to keep the following attenuators from being damaged by the incoming RF during the brief interval before K3 de-energizes.

When the RF input is not excessive, switch U2 sends to the meter whatever is coming in to board pin Z from the meter-select pushbuttons. When Q14 is turned off U2 switches to the output of U4B, the detected RF voltage. Q16 turns on the WATTS annunciator and if in the GENERATE mode, switches the instrument into the RECEIVE mode by grounding the cathode of CR1 on the A12 mother board.

CR12 is physically close to R88. If R88 overheats, the voltage drop across CR12 decreases enough to raise the output of comparator U3. This turns on the front-panel LOAD OVERTEMP annunciator, and turns off CR1. CR23 was turned off when Q14 was turned on by the RF input. These diodes had been disabling U1; it now produces an audio tone through the speaker. When the transmitter is unkeyed Q14 turns on, shutting off the alarm; the LOAD OVERTEMP annunciator continues to be on until R88 cools.

4.7 A4 IF AMPLIFIER

The IF amplifier amplifies the 21 - 22 MHz 1st IF, converts it to the 4.3 MHz 2nd IF and 700 kHz 3rd IF, and demodulates both AM and FM signals. It also produces the calibration lines on the CRT.

The 1st IF signal comes from the mixer board via J1. T1 is a balun which matches the input impedance of Q1. U1 and U2 are AGC'd amplifiers, driving the mixer. The 16.7 - 17.7 MHz 2nd IF injection signal comes in to pin A to be amplified by Q2. Q3 and Q4 drive double-balanced mixer U2, mixing the 4.3 MHz 2nd IF with the 3.6 MHz signal from the high-frequency to get 700 kHz. The output of U2 goes to a four-cascode cascade stage. Transistors Q14 through Q21 control the bandwidth. In the first stage, for example, when WIDE (pin Z) is low (narrow bandwidth) Q15 is off. The tank circuit consisting of L9 and C40 has its maximum Q, hence minimum bandwidth. When WIDE is high Q15 turns on, shunting the tank with R50, lowering the Q and increasing the bandwidth. This also decreases the gain, so Q14 shunts the emitter resistance to compensate.

The output of Q13 goes to CR2 and CR3 for AM detection; the audio is amplified by U8. C68 filters the DC level for AGC amplifier U3. The output of U3 pin 1 controls the gain of U1; the output of pin 7 controls the resistance of PIN diode CR21 on the A1 mixer board. To get the best signal/noise ratio, the attenuation by CR21 is delayed until the gain of U1 has been reduced, thus allowing the maximum possible signal to get to U1.

In Generate mode, the GEN line cuts CR21 off.

The 700 kHz signal also goes via Q22 to U17. If the front-panel CAL pushbutton is not pushed, the signal goes to U4, a one-shot frequency discriminator.

U19 divides the output frequency by 10 to drive the Frequency Error counter.

To reduce temperature effects, the transistors of U7 provide a precision voltage swing out of U4. U8 and the first section of U13 filter out the 700 kHz component.

When the front-panel CAL button is pushed, U21 connects its pins 4 and 6, biasing U15 such that U13 pin 1 is forced to zero, by comparison with U20 pin 3. At the same time, signals of 200 kHz and 500 kHz come from the time base into board pins 6 and 7. These frequencies are mixed in U18, filtered, and amplified by U17 pins 11 - 12. The resulting 700 kHz is fed via U17 pins 1 - 3 to U4. Thus C80 changes to the voltage necessary to hold the discriminator output (U13 pin 1) at zero with 700 kHz into

the discriminator. The charge on C80 leaks off slowly, so that sustained receiver input results in a drift of approximately 20 Hz/minute. The proper charge on C80 is re-established whenever the CAL mode is enabled.

U8 compares the AGC voltage with the voltage from the front-panel SQUELCH control; when the signal is strong enough SIG is brought low. When SIG is high, that is when the receiver is squelched, Q24 gates U12 pin 2 to put the discriminator into CAL mode. U12 pin 1 is gated off when the 3000 is in Generate mode.

Calibration lines on the CRT are developed by U9 and U11. Positive and negative voltages from the A10 Front Panel board, selected by front-panel pushbuttons, come to board pins V and W. When CALIB, pin X, is high U5 free-runs to generate a chopping signal. The output of U15 pin 15 toggles U11 to switch between the + and - voltages. The output of U14 pin 11, half the frequency of pin 15, toggles U9 to switch between the output of U11 and the FM audio. The result is a three stage period: V+, V-, and audio. This is repeated across the CRT. When CALIB is low U9 selects the FM audio, unchopped.

The output of U5 pin 1 blanks the CRT while the display is switched, to avoid having vertical lines on the screen.

4.8 A5 AUDIO BOARD

The Audio Board comprises the distortion analyzer for SINAD measurements, the audio-frequency synthesizer, the meter amplifier, and the circuitry that adjusts output level as frequency changes.

Audio comes in to U1, a gain-controlled amplifier. CR1 rectifies the output, developing a DC voltage which is amplified by U2A to control the resistance of Q1, which in turn controls the gain of U1. This stabilizes the level at the input of U2B, which with U3B forms a 1 kHz notch filter. With the 1 kHz tone filtered out, what remains is distortion; this is amplified by U3A to drive the meter. U3A is quasi-logarithmic, to get a meter range of about 35 dB.

The 100 kHz signal from the timebase on the A6 low-voltage power supply card comes to board pin H. It is divided by 100 to generate the 1 kHz tone, and by 10 to generate a 100 Hz reference, and by 10 again for a 10 Hz reference for the audio phase-locked loop. Digits from the front-panel switches come to board pins V, W, X, and Y and are loaded into latches U35, U36, U16, and U17. These latches load on positive-going edges rather than negative, so the load pulse is the leading edge of the next pulse. U31 through U34 are the divide-by-N counter for the audio phase-locked loop. U28 stretches the zero-count pulse from the divide chain to drive PLL chip U15. The

output of U15 goes to the divide chain, and to U12, U13, and U14. Each chip divides the frequency by 10; the output of one of them is selected in U18 by the front-panel audio-frequency range pushbuttons. The selected audio frequency is used as the reference input to phase-detector U20; the other input is the output of sine-wave VCO U19.

U21 through U27 form the flatness-control circuitry. The AM modulating voltage on board pin 9 is summed with DC reference voltage in U21B. U21A and U25 buffer this voltage. U22 is an SPDT switch which selects either the voltage from U21 pin 7 or the voltage at the junction of R77 and R78, 0.2 dB less. U23, U24, U26 and U27 switch in attenuation of 0.4, 0.8, 1.6, and 3.2 dB respectively. Switch positions are controlled by outputs of PROM U29. This memory, addressed by the 100 MHz frequency switch, was programmed during factory calibration to produce flat RF output across the frequency range.

4.9 A7 DEFLECTION BOARD

The Deflection Board generates the horizontal and vertical deflection signals for the CRT, and separates the subtone from the audio for counting.

Vertical information (including FM calibration lines if the A4 IF board is switching them in) comes in to U1 pin 5. Vertical position and gain control come to pin 6. The output voltage is inverted by U1A and drives push-pull amplifiers Q4 and Q6. Q5 and Q7 reduce the collector dissipation of Q4 and Q7, respectively. The signal also passes through U9 and U10, a low-pass filter cutting off at 270 Hz. The subtone output goes to A11 frequency control board where it is multiplied by 10 and counted.

The meter drive comes in to board pin 17. It is amplified by U6 and squared by Schmitt trigger U3 to become the horizontal sync signal, triggering U4.

Q12 is a current source charging a sweep timing capacitor on the front-panel board. U8A amplifies the 0 to 10 V ramp to -10 to +10 V. When the ramp voltage reaches the level set by the SIG IN line, U8 triggers the auto-reset one-shot U5. The output of U5 has been holding U4 at clear, keeping Q2 off, which allows Q12 to charge the sweep timing capacitor. When U5B is triggered it unclears U4. Q1 is turned on and discharges the capacitor. The output of U8B also triggers the hold-off one-shot U5B. Until this one-shot times out it holds U4 and Q2 at clear, allowing the capacitor to discharge fully and return the trace to the left side of the screen.

When the hold-off times out, the next sync pulse sets U4 and the sweep starts. If there is no input signal U4 will not be triggered; in this case it will be cleared when U5 times out, and the sweep will start regardless.

Q10 and Q11 form the blanking amplifier. If U3 pin 3 is low, Q10 is on, Q11 is off, and the BLANK line is pulled high, cutting off the trace. If U3 pin 3 is high the transistors reverse, and BLANK is grounded. The Q output of U4 or the Z MOD input can activate blanking.

4.10 MISCELLANEOUS BOARDS

This section describes the A6 Low Voltage Power Supply, A8 High Voltage Power Supply, A9 Display Board, and A12 Mother Board.

The A6 Low Voltage Power Supply provides +5 V (from U1), +15 V (from U2), and -15 V (from U3). Each regulator controls a series-regulating transistor, mounted on the rear panel. Q2 and Q3 are NPN; Q1 is PNP, to allow the output voltage to be closer to the supply. R1, R6/R7, and R12/R52 are current limiters; when current is too high, the increased voltage drop across the resistor shuts down the series transistor.

U5 is a separate regulator for the 10 MHz temperature-controlled crystal oscillator (TCXO), which establishes the frequency accuracy of the unit. Q3 buffers the output; U6 divides the frequency by 10 to provide a 1 MHz reference. U7 is connected as a divide-by-five counter followed by a divide-by-two; the output of the first stage provides a 200 kHz reference; the second stage provides 100 kHz.

When band 6 is selected, U8 divides the 1 MHz and 100 kHz frequencies by 2. This allows the synthesizer to take half-steps, which will be full steps when the frequency is doubled.

U4, U9, and U10 encode the front-panel Output Range pushbuttons to activate attenuators on the A1 Mixer Board.

Q1, Q2, and U13 limit and filter the microphone input to limit the deviation to 5 kHz.

The A8 High-Voltage Power Supply provides voltages for the CRT. U1 controls series transistor Q2. The 15.V supply provides a reference on U1 pin 3; R6 and R8 divide the 200 V at U1 pin 2. R3 is a current limiter; if the current becomes too great Q3 conducts, lowering base of Q2 and lowering the current. U1 pin 6 becomes positive, turning off Q1; CR10 clamps the voltage to protect Q1.

CR5 - CR8 supply cathode and focusing voltages to the CRT. The voltage at the top of resistor string R19 - R17 is about -1200 V. This is controlled by shunting current through Q4. The +15 V provides a reference; the voltage at the junction of R28 and R30 will be held at zero.

The A9 Display Board contains the display driver U1, the LCD display, and LEDs indicating Hz or kHz. When P3 pin 8 is low the Hz annunciator CR1 conducts; when the pin is high, CR1 is off; Q1 conducts, turning on CR2, the kHz annunciator.

The A12 Mother Board provides most of the interconnections between boards. Q1 switches the unit between Generate and Receive. When it is in Generate, activation of the WATTS line turns Q1 off, putting the unit into Receive.

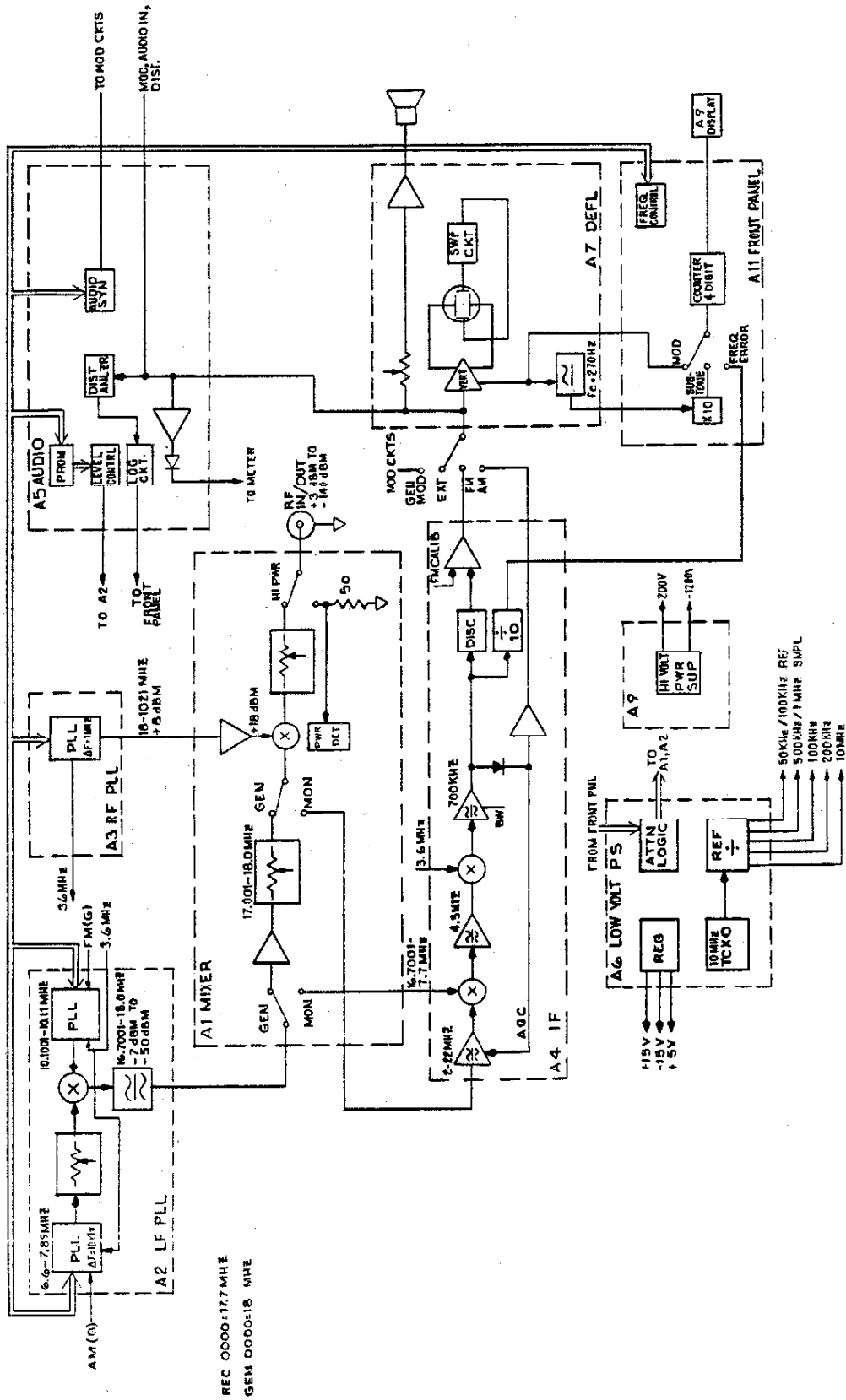


Figure 4-1. Block Diagram

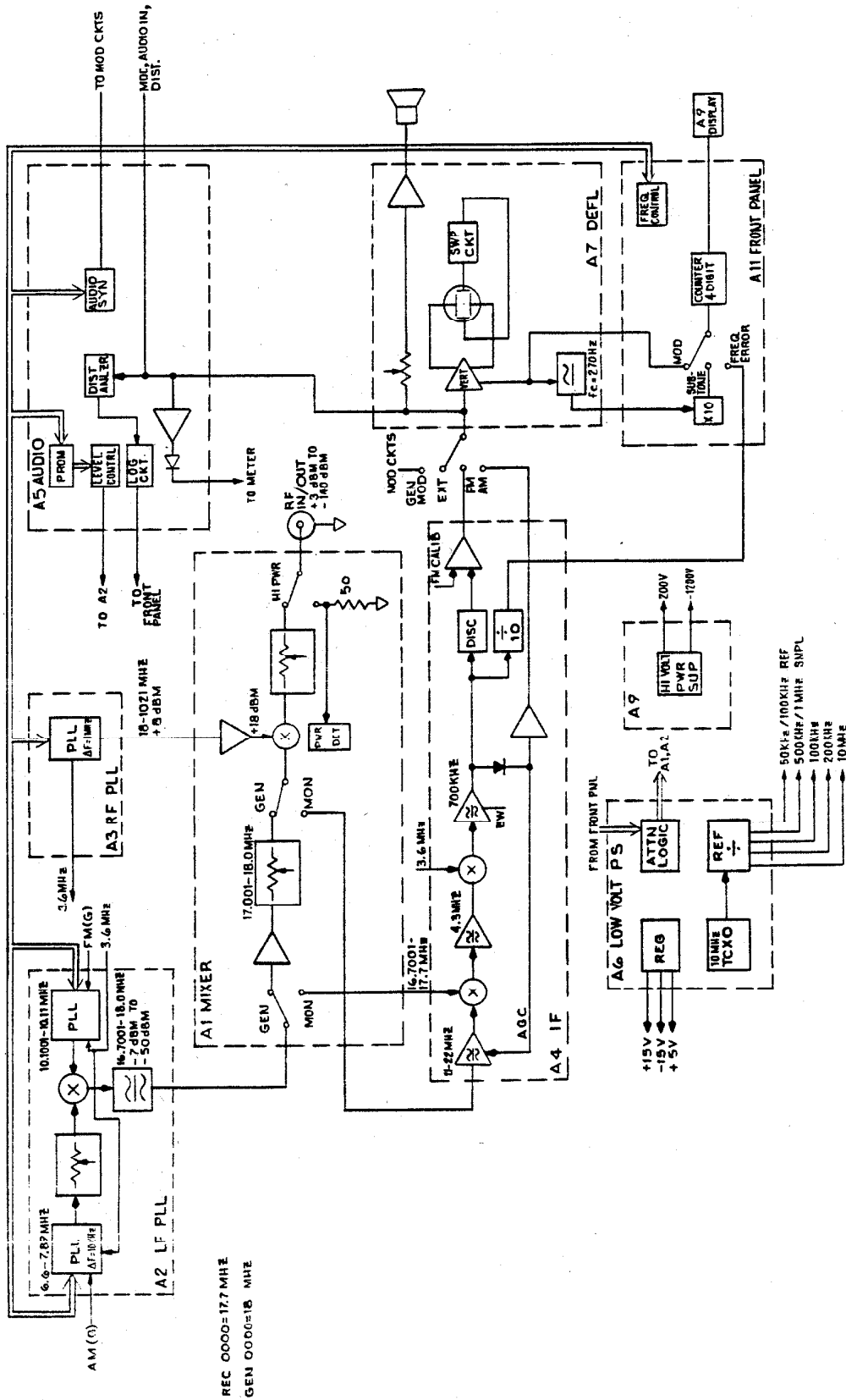


Figure 4-1. Block Diagram