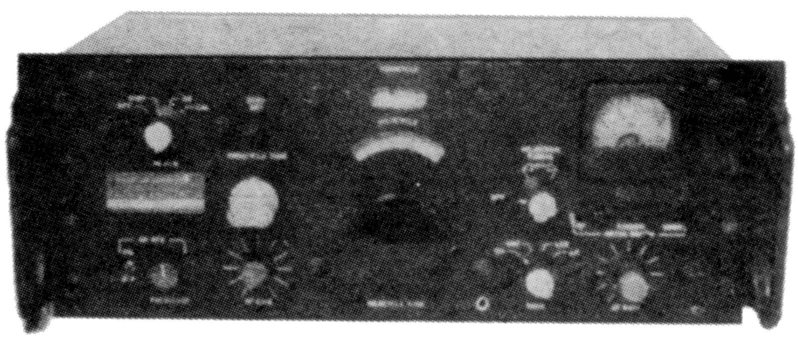
GTM-D-133

TECHNICAL MANUAL

HF RECEIVER

G133 SERIES



PUBLISHED BY LTV TEMCO AEROSYSTEMS DIVISION
GREENVILLE, TEXAS

1 JULY 1964

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G133F HF RECEIVER

(PART NO. G133F00000-1)

Issued 1 July 1964

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G133F HF RECEIVER

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL

The G133F Receiver is a single-channel SSB-AM-CW receiver covering the frequency range between 0.2 mc and 30 mc in 30 bands of 1-megacycle width each. Twenty-eight positions of the turret plus two positions of overtravel provide the 30 bands. Triple conversion is used for the 0.2- to 7-mc bands and double conversion is used for the 7- to 30-mc bands. Audio and i-f outputs are provided.

1-2. EQUIPMENT SUPPLIED

QTY	ITEM	PART NO.
1	Receiver	G133F00000-1
As Reqd	Mount	GM19400000-1

1-3. EQUIPMENT REQUIRED BUT NOT SUPPLIED

QTY	ITEM	PART NO.
1	Connector	DS07-7S059
1	Connector	DS07-7P059
5	Connector	UG21EU

1-4. ELECTRICAL SPECIFICATIONS

Primary power requirements, signal inputs and outputs, frequency range, bandwidths, and overall system electrical specifications are:

Type Reception:	SSB-AM-CW
Frequency Range:	0.2 to 30 mc in 30 one-megacycle bands, continuous coverage
Input Power Required:	115- or 230-volt, single-phase 50- to 400-cps ac, 125 watts (1.09 amps); 28-volt dc, 4.7 watts (168 milliamperes)
R-F Input Impedance:	50 ohms, unbalanced
500-KC I-F Output:	50-mv minimum into 50-ohm load with 5-microvolt input signal
Matching Speaker Impedance:	4 or 600 ohms
Line Output Impedance:	150 ohms unbalanced and 600 ohms balanced.
Matching Phone Patch Impedance (Local):	500 to 600 ohms
Frequency Stability:	During temperature change from 0 to +50°C, after 20-minute warmup, audio output frequency will not vary more than ±885 cps for carrier frequencies from 2 to 7 mc. From 7 mc to 30 mc, stability varies from 36 PPM ±400 cps at 7 mc to 27 PPM ±400 cps at 30 mc. For ±10% line voltage variation, frequency varies not more than ±100 cps.
Calibration Accuracy:	When zeroed to nearest 100-kc calibration point, the frequency will be within ±400 cps.
Audio-Frequency Response:	
SSB	300 to 2700 cps ±3 db
AM	100 to 2500 cps ±6 db
Audio Output Distortion (SSB Test Signal 100-Microvolt Input, 1.0-W Output):	
Local	Not more than 10 percent
Line	Not more than 1.2 percent
Q-Multiplier Rejection Notch Depth:	Not less than 40 db
Receiver Sensitivity (Nominal):	
AM	3 microvolts for not less than 10-db signal + noise/noise (2 to 30 mc) 15 microvolts for not less than 10-db signal + noise/noise (0.5 to 2 mc) 20.2 microvolts for not less than 10-db signal + noise/noise (0.2 to 0.5 mc)
SSB and CW	0.6 microvolts for not less than 10-db carrier on/carrier off (2 to 30 mc) 3.0 microvolts for not less than 10-db carrier on/carrier off (0.5 to 2 mc) 4.0 microvolts for not less

	than 10-db carrier on/carrier off (0.2 to 0.5 mc)
Selectivity:	
CW (at 6-db points)	300-cps bandwidth
SSB (at 3-db points)	2.4-kc bandwidth
AM (at 6-db points)	5.0-kc bandwidth
Spurious Responses:	
Internal Spurious Signals	Less than one microvolt equivalent signal (above 2 mc)
Other Spurious Responses	Not less than 80 db down
Image Response	Not less than 50 db down

1-5. MECHANICAL SPECIFICATIONS

Dimensions and weight of the G133F are:

Dimensions:	
Height	6-1/4 inches
Width	18-5/16 (approx) inches.
Depth	12-7/8 (approx) inches.
Weight:	26 pounds

G133F TUBE AND SEMICONDUCTOR COMPLEMENT

SYMBOL	TYPE	FUNCTION
CR1 THRU CR4	1N128	PRODUCT DEMODULATOR
CR5	IN67A	METER RECTIFIER
CR6 THRU CR13	1N1695	POWER SUPPLY RECTIFIER
CR14	1N482A	AGC RECTIFIER
CR15	1N128	AM DETECTOR
CR16	1N482A	AGC STABILIZER
CR17	1N67A	MUTING TRANSIENT SUPPRESSOR
CR1201	1N100A	MIXER
CR1202	G02	ELECTRONIC SWITCH
CR1203	1N3024B	ZENER REGULATOR
Q1	2N647	SSB/CW A-F AMPLIFIER
Q1201	2N1142	R-F AMPLIFIER
Q1202	2N1142	AMPLIFIER
Q1203	2N1142	AMPLIFIER
Q1204	2N1142	AMPLIFIER
Q1205	2N1142	IMPEDANCE MATCHING AMPLIFIER
V1	6DC6	R-F AMPLIFIER
V2	6EA8	FIRST MIXER AND HF CRYSTAL OSCILLATOR
V3	6EA8	SECOND MIXER AND 17.5-MC OSCILLATOR
V4	6EA8	THIRD MIXER AND REMOTE GAIN GATE
V5, V7, AND V8	6BA6	I-F AMPLIFIERS
V6	12AX7	Q-MULTIPLIER
V9	6BA6	AGC AMPLIFIER
V10	6EA8	L-F MIXER AND L-F CRYSTAL OSCILLATOR
V11	5670	I-F CATHODE FOLLOWER AND AGC CATHODE FOLLOWER
V12	6BF5	SECOND LOCAL A-F AMPLIFIER
V13	6AK6	SECOND LINE A-F AMPLIFIER
V14	12AX7	FIRST LINE A-F AMPLIFIER AND FIRST LOCAL A-F AMPLIFIER
V15 (V501)	6136	VFO
V16	6EA8	L-F MIXER AND CALIBRATION OSCILLATOR
V17	6BA6	BFO
V18(V502)	6136	VFO AMPLIFIER

Table 1-1

G133F CRITICAL DIMENSIONS

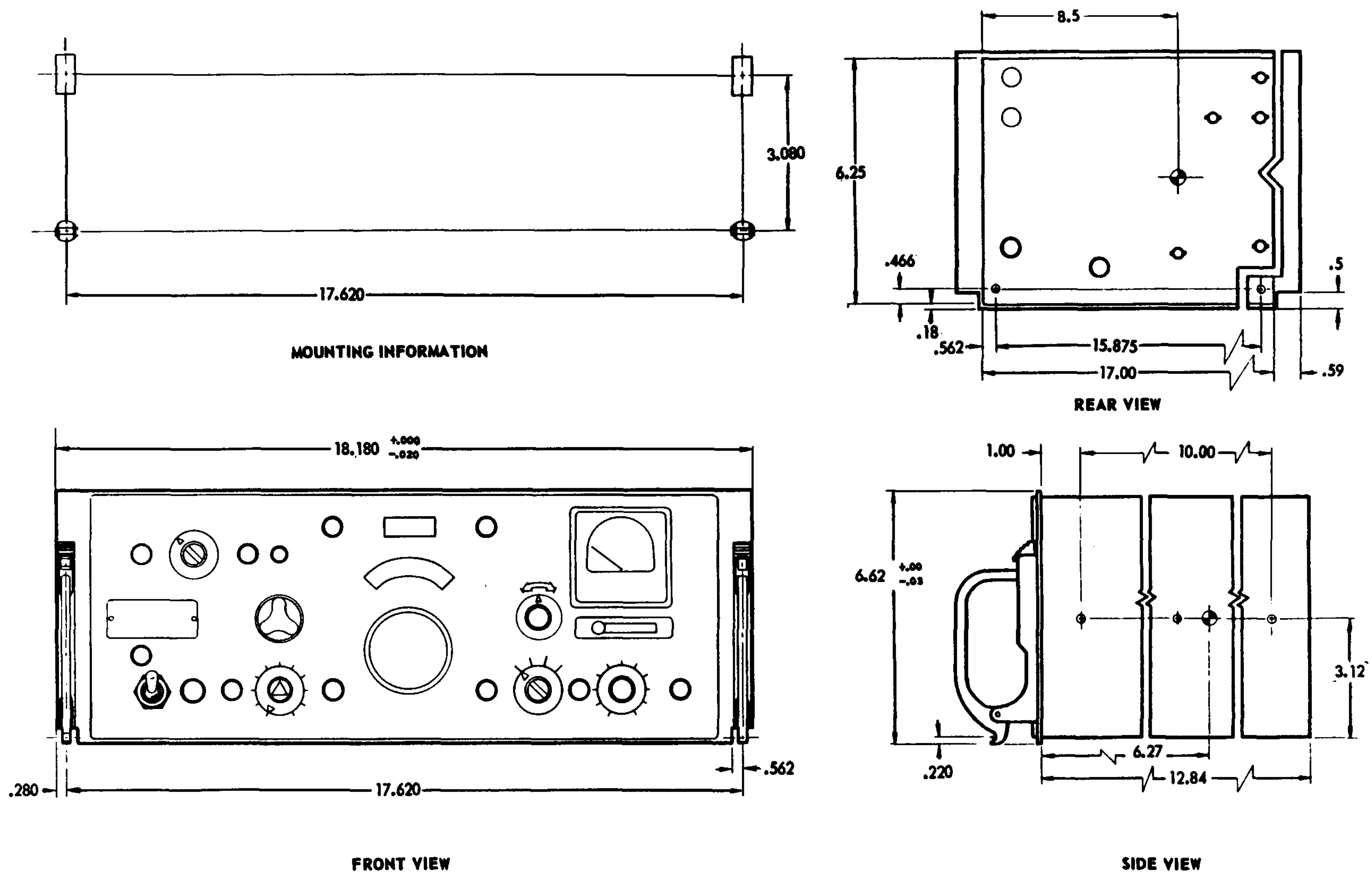


Figure 2-1

SECTION III
OPERATION

3-1. GENERAL

The G133F is a single-channel SSB-AM-CW receiver covering a frequency range of 0.2 to 30 megacycles in 30 bands of 1-megacycle width each. The G133F contains an electronic package which is used to prepare the internal local oscillator signals for processing by external equipment to determine the tuned frequency of the G133F. Both i-f and audio outputs are provided. The audio output level may be visually monitored by a front-panel meter. The meter may also be used to give signal strength indications.

3-2. OPERATING CONTROLS

All of the operating controls of the G133F Receiver are located on its front panel. The function of each of the controls is described in the following paragraphs.

a. POWER -- The POWER switch controls the power to the G133F. The positions of this switch are OFF, STBY, ON, and CAL. With the switch in the OFF position, power is removed from the G133F. With the switch in the STBY position, the receiver is disabled but is capable of immediate operation when the POWER switch is put in the ON position. With the switch in the CAL position, the G133F KILOCYCLE dial may be calibrated as explained in paragraph 3-7.

b. RF GAIN -- The RF GAIN control adjusts the gain of the r-f circuits. This control is normally set for the best signal-to-noise ratio in the audio output.

c. MEGACYCLE TUNE -- The MEGACYCLE TUNE control selects the 1-megacycle band in which the receiver is to operate. The selected frequency band is displayed on the MEGACYCLE counter in the top center of the receiver front panel.

d. KILOCYCLE TUNE -- The KILOCYCLE TUNE control selects the tenth megacycle portion of the operating frequency; the tenth megacycle is displayed on the MEGACYCLE counter. The KILOCYCLE TUNE control is also used for fine frequency selection. Kilocycles are displayed on the KILOCYCLE dial on the receiver's front panel.

e. ZERO SET -- The ZERO SET control moves the hairline on the KILOCYCLE dial. This control is used to set the zero indication of the KILOCYCLE dial during calibration of the receiver.

f. MODE -- The MODE switch selects the mode of operation of the receiver. Four positions are provided: CW, USB, LSB, and AM.

g. REJECTION TUNING -- The REJECTION TUNING control provides for suppression of heterodyne interference during AM operation.

h. METER SWITCH -- The METER switch selects the type of signal indication which is displayed on the meter. Three positions are provided: RF, +10DBM, and 0DBM. With the meter switch in the RF position, the meter indicates relative signal strength. With the switch in the +10DBM or 0DBM position, the meter indicates the level of the audio output signal.

i. AF GAIN -- The AF GAIN control varies the audio output level.

j. AM BFO ON-OFF SWITCH -- The AM BFO ON-OFF switch in the ON position applies operating power to the beat frequency oscillator. The BFO affects the G133F Receiver in the AM mode only.

k. AM BFO FREQUENCY CONTROL -- The AM BFO FREQUENCY dial, when rotated, varies the BFO frequency from 485 kc to 515 kc. The dial is divided into numbered divisions of 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, and each division is subdivided in increments of 50 providing a total of 500 reset points.

3-3. OPERATING PROCEDURES

The following paragraphs outline G133F operation in single-sideband, continuous wave and amplitude-modulated modes. The procedures may vary slightly at the discretion of the operator.

3-4. SINGLE-SIDEBAND RECEPTION

When the receiver is to be operated in the single-sideband mode, the following procedures should be used as a guide.

a. Turn the POWER switch to the ON position.

b. Turn the MEGACYCLE TUNE control to obtain an indication on the MEGACYCLE counter corresponding to the desired frequency band.

c. Turn the RF GAIN control fully clockwise.

d. Move the MODE switch to USB for upper sideband reception or to LSB for lower sideband reception.

e. Tune in the desired signal using the KILOCYCLE TUNE control.

f. Set the AF GAIN control for a comfortable listening level.

g. Adjust the KILOCYCLE TUNE control to obtain the most natural sounding audio output.

h. Adjust the RF GAIN control to the position which gives the best signal-to-noise ratio.

i. Readjust the AF GAIN control if necessary.

3-5. CW RECEPTION

When the receiver is to be operated in the CW mode, the following procedure should be used as a guide.

a. Move the POWER switch to the ON position.
b. Turn the MEGACYCLE TUNE control to obtain an indication on the MEGACYCLE counter corresponding to the desired frequency band.
c. Turn the RF GAIN control fully clockwise.
d. Move the MODE switch to the USB position. If interference is present, move the MODE switch to the CW position for greater selectivity.
e. Tune in the desired signal using the KILOCYCLE TUNE control. If the MODE switch is in the CW position, tune for definite peak in signal strength.
f. Turn the RF GAIN control to approximately midrange, and adjust the AF GAIN control for a comfortable listening level.

3-6. AM RECEPTION

When the receiver is to be operated in the AM mode, the following procedure should be used as a guide.

a. Move the POWER switch to the ON position.
b. Turn the MEGACYCLE TUNE control to obtain an indication on the MEGACYCLE counter corresponding to the desired frequency band.
c. Turn the RF GAIN control fully clockwise.
d. Move the MODE switch to the AM position.
e. Tune in the desired signal using the KILOCYCLE TUNE control.
f. Set the AF GAIN control for a comfortable listening level.
g. Adjust the KILOCYCLE TUNE control to obtain the best reception.
h. Adjust the RF GAIN control to obtain the best signal-to-noise ratio.
i. Readjust the AF GAIN control if necessary.

An interfering heterodyne may be suppressed by adjusting the REJECTION TUNING control for minimum interference.

Note

When an interfering signal is present during AM reception, the resulting heterodyne may be suppressed by either of two settings of the REJECTION TUNING control. Select the REJECTION TUNING setting which gives the better intelligibility. The operating range of rotation for the REJECTION TUNING control is 180 degrees. Do not force the control at the OFF position; no OFF position detent will be detected.

If interference or selective fading is present, better reception of AM signals may be obtained by moving the MODE switch to either the USB or LSB position, zero beating the desired carrier, and proceeding according to steps f, g, and h in paragraph 3-4. Choose the MODE switch position which results in better reception.

3-7. CALIBRATION

When the G133F is being calibrated, the following procedure should be used.

a. Move the POWER switch to the CAL position.
b. Move the MODE switch to the USB or LSB position.
c. Turn the KILOCYCLE TUNE control to obtain an indication of 0 kc on the KILOCYCLE dial. (The MEGACYCLE counter and tenth MEGACYCLE counter reading should approximate the desired frequency of operation.)
d. Tune the KILOCYCLE TUNE control to obtain a zero beat.
e. Using the ZERO set knob, move the hairline to 0 on the KILOCYCLE dial.
f. Return the POWER switch to the ON position.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

The G133F Receiver is shown in block diagram form in figures 4-1 and 4-2. The G133F covers the frequency range from 0.2 to 30 megacycles. Both double-conversion and triple-conversion are used. Triple-conversion is used for the 0.2-mc to 7-mc bands, and double-conversion is used for the 7-mc to 30-mc bands. For 7-mc to 30-mc operation the 14.5-mc to 15.5-mc bandpass network and second mixer are bypassed.

The G133F utilizes a built-in low frequency converter to tune frequencies below 2 mc. The tuning mechanism, counter dials, and turret are arranged so that the two lowest bands, 0.2 to 1 mc and 1 to 2 mc, use the 28-mc to 29-mc and the 29-mc to 30-mc bands of the receiver as a variable i-f (conversion) frequency. As the MEGACYCLE counter is reduced in setting below 2 mc (lowest band on the turret), a segment switch S6 connects the low frequency converter and its low pass filter between the antenna and the turret input, which is now the 29-mc to 30-mc band. When the MEGACYCLE counter setting is reduced below 1 mc, the segment switch S6 maintains the low frequency converter connection, but the turret is changed to the 28-mc to 29-mc band. In this manner, the 28 positions of the turret plus the two positions of overtravel provide 30 frequency bands, each 1-megacycle wide. The 0.2-mc limitation of the lowest band is a function of the frequency rolloff in the low pass filter and low frequency losses in the mixer.

The electronic package of the G133F is shown in block diagram form in figure 4-2. This assembly prepares the local oscillator frequencies of the receiver for processing by external equipment to accurately determine the tuned frequency of the G133F. During receiver operation in the first seven frequency ranges (0.2 - 7 mc), the output of the high frequency crystal-controlled oscillator is mixed with the output of either the 17.5-mc oscillator or the low frequency crystal-controlled oscillator (depending on which one is in use), and the resulting mixed frequency is applied to a notch filter (see figures 4-3 and 4-4). The notch filter attenuates the basic crystal oscillator frequencies of 8.5, 9.5, and 10.5 mc of the receiver which appear in the mixer output. These frequencies closely approximate the desired output frequency during some receiver operating modes and must therefore be suppressed. The notch filter has lumped constant components which attenuate all frequencies above 9.5 mc so that they will be suppressed in the output. During operation in the remaining 23 frequency ranges (7 - 30 mc), the low frequency crystal-controlled oscillator and 17.5-mc oscillator are off, and the output of the high frequency crystal-controlled oscillator goes through the by-pass circuit to the electronic switch. The output of the electronic switch is amplified and applied to output jack J1101 of the electronic package. The output of the variable frequency oscillator, which functions during operation in all 30 bands, is applied through a Darlington amplifier to output jack J1102 of the electronic package. The outputs of J1101 (3 to 32 mc) and J1102 (2.5 to 3.5 mc) are routed to external equipment which accurately determines the G133F tuned frequency. The G133F13000-1 Oscillator Assembly provides BFO operation in the AM mode.

4-2. DARLINGTON AMPLIFIERS

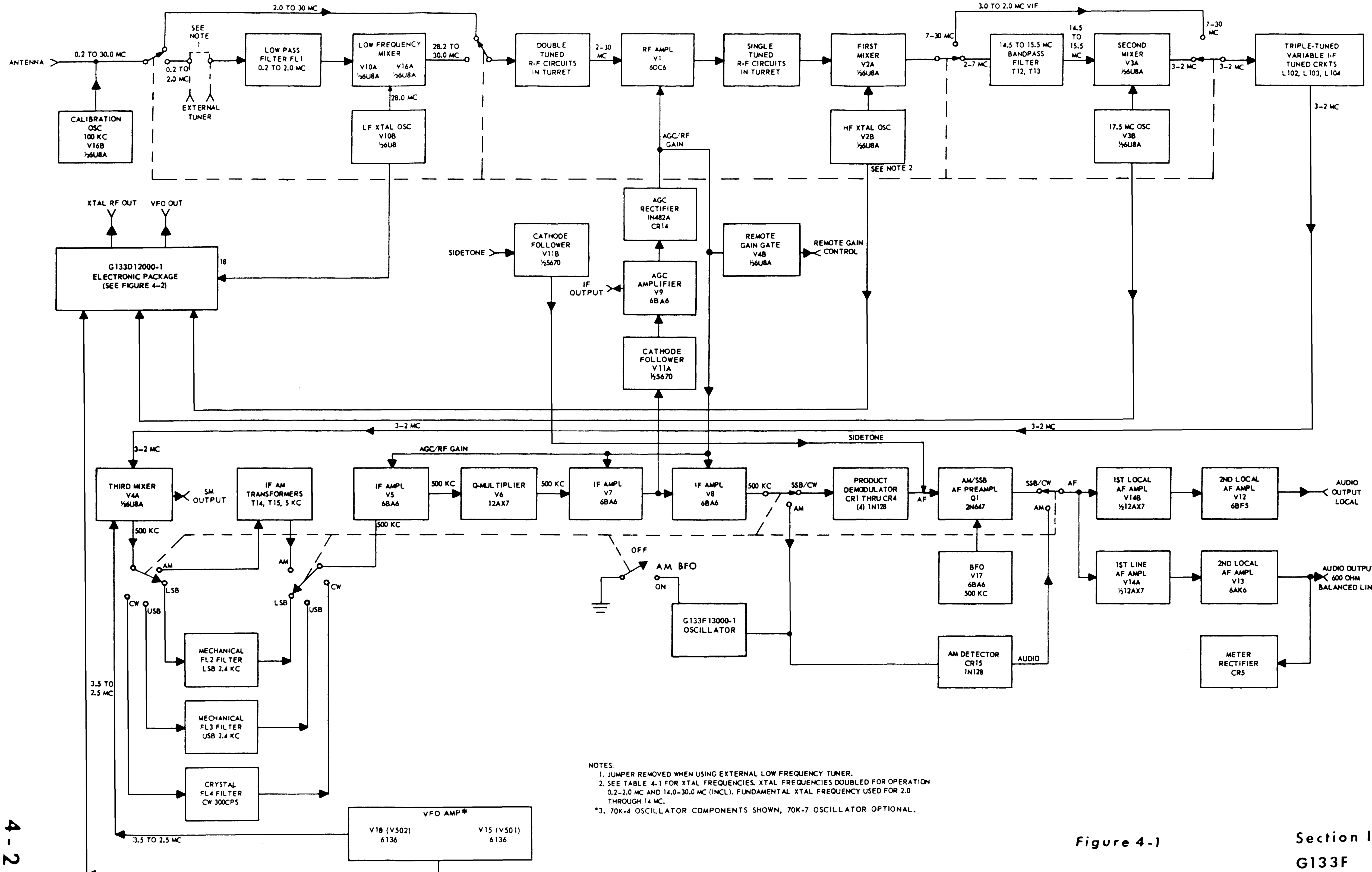
There are four Darlington amplifiers in the electronic package, one for the output of each receiver oscillator. The Darlington amplifier is a two-transistor, cascaded emitter follower (see figure 7-2). Each amplifier provides more than 60-db decoupling between output and input. Because of the amplifier's low output impedance, the output voltage and waveforms are not affected by cable lengths 25 feet or less. The Darlington amplifiers are encapsulated in epoxy resin to provide protection against moisture, heat, and mechanical damage. The encapsulated circuits are shown in enclosures on the schematic of the electronic package, figure 7-2.

4-3. DETAILED THEORY OF OPERATION

A detailed description of the operation of the circuits of the G133F Receiver is given in the following paragraphs. Figure 7-1 is a schematic diagram of the G133F Receiver.

4-4. R-F INPUT TUNING

Signals from the antenna are applied to connector J106 and are routed through switch S6 to impedance-matching transformer L30. The output of L30 is coupled to the first section of the double-tuned input network (see figure 4-6). The double-tuned input circuits are composed of capacitors C40 and C71; chokes L33, L32, L31, L69, L68, L67; and the detailed parts mounted on turret wafers A1 through A5. All r-f section detailed parts and turret wafers



NOTES:
1. JUMPER REMOVED WHEN USING EXTERNAL LOW FREQUENCY TUNER.
2. SEE TABLE 4-1 FOR XTAL FREQUENCIES. XTAL FREQUENCIES DOUBLED FOR OPERATION 0.2–2.0 MC AND 14.0–30.0 MC (INCL). FUNDAMENTAL XTAL FREQUENCY USED FOR 2.0 THROUGH 14 MC.
*3. 70K-4 OSCILLATOR COMPONENTS SHOWN, 70K-7 OSCILLATOR OPTIONAL.

Figure 4-1

G133D12000-1 ELECTRONIC PACKAGE, BLOCK DIAGRAM

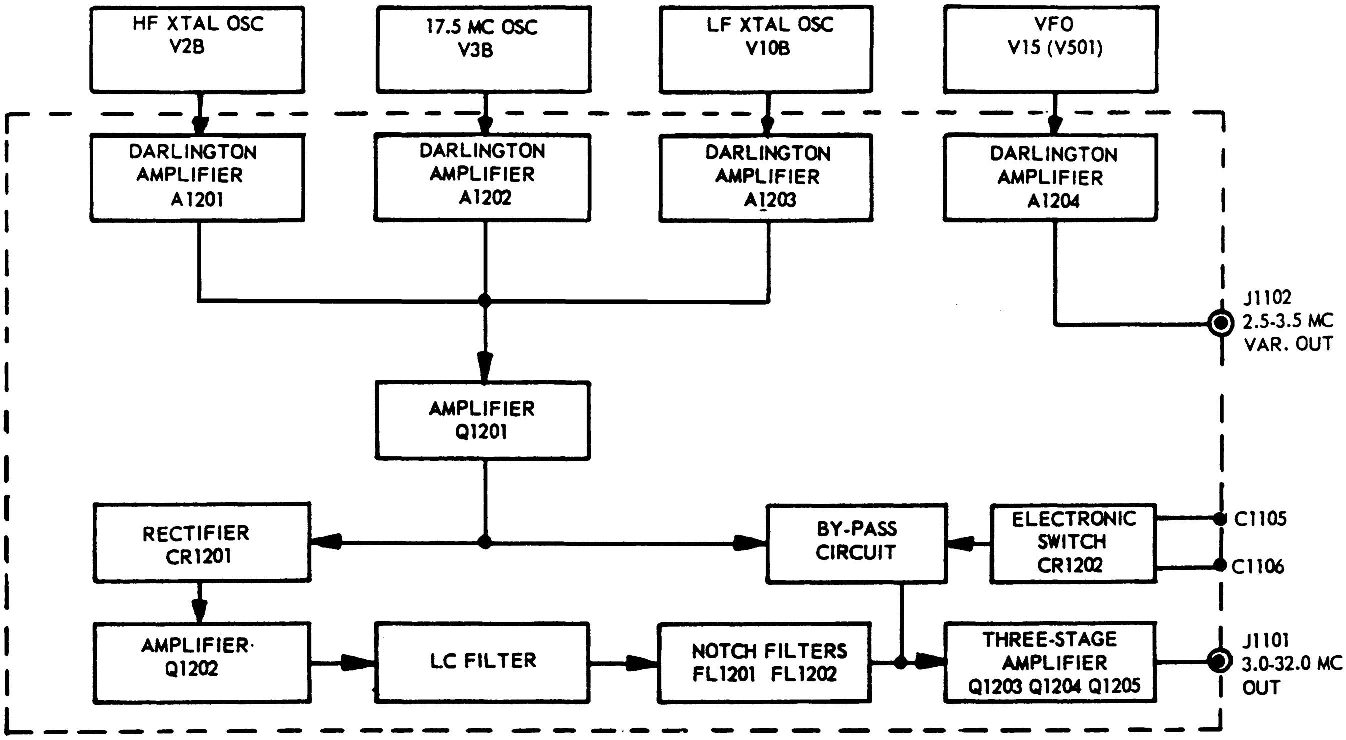
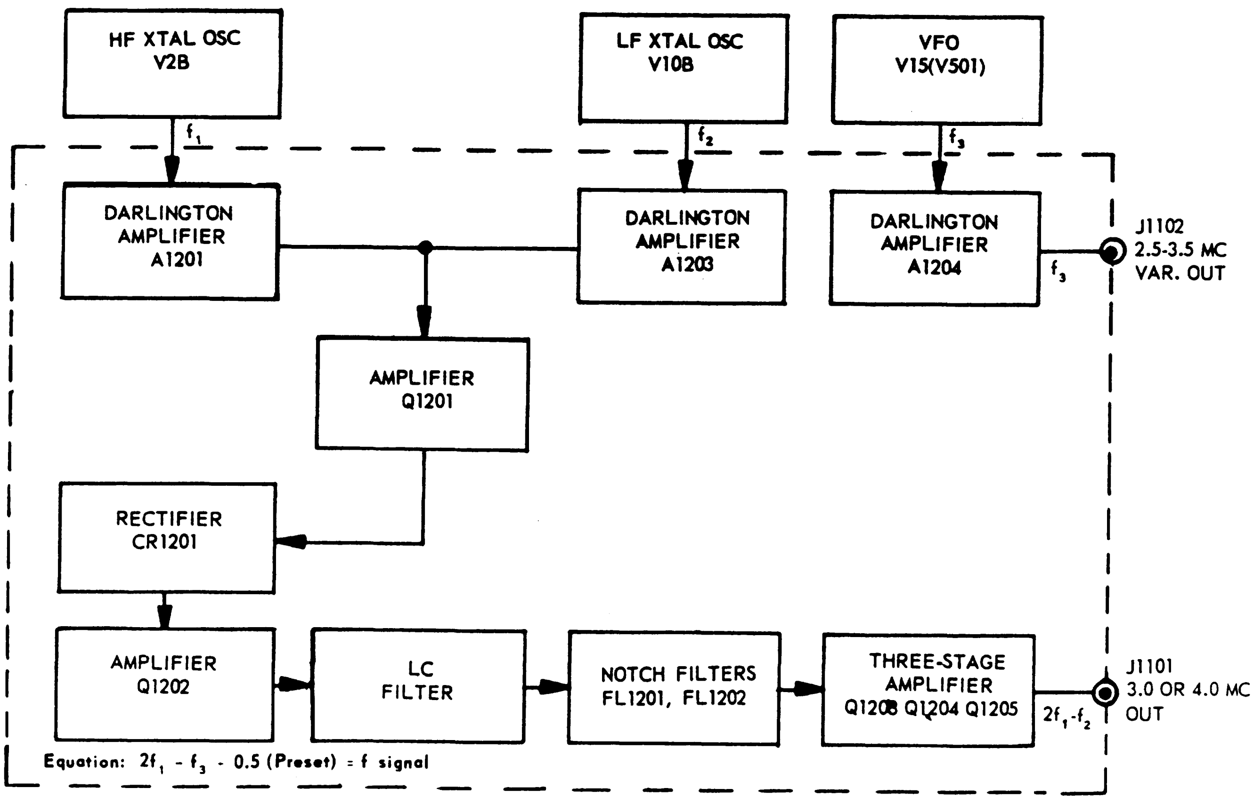


Figure 4-2

G133D12000-1 ELECTRONIC PACKAGE, PARTIAL BLOCK DIAGRAM



G133D12000-1 ELECTRONIC PACKAGE, PARTIAL BLOCK DIAGRAM

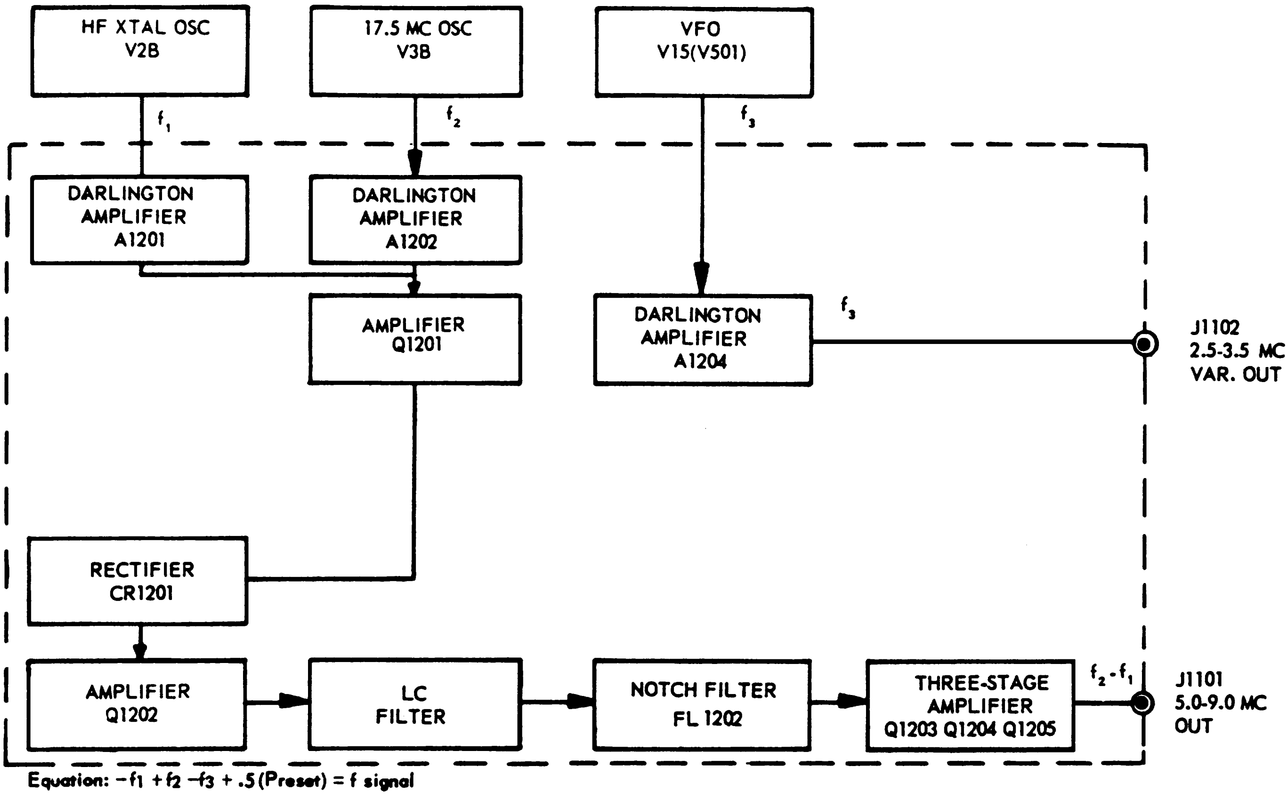


Figure 4-4

G133D12000-1 ELECTRONIC PACKAGE, PARTIAL BLOCK DIAGRAM

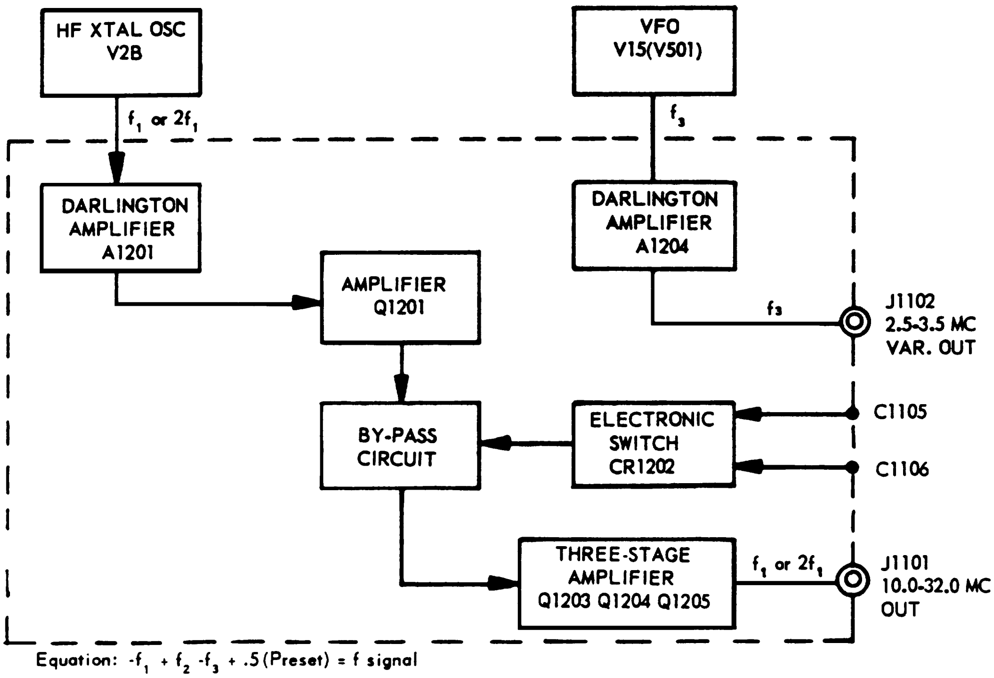


Figure 4-5

R-F INPUT CIRCUITS, SIMPLIFIED SCHEMATIC

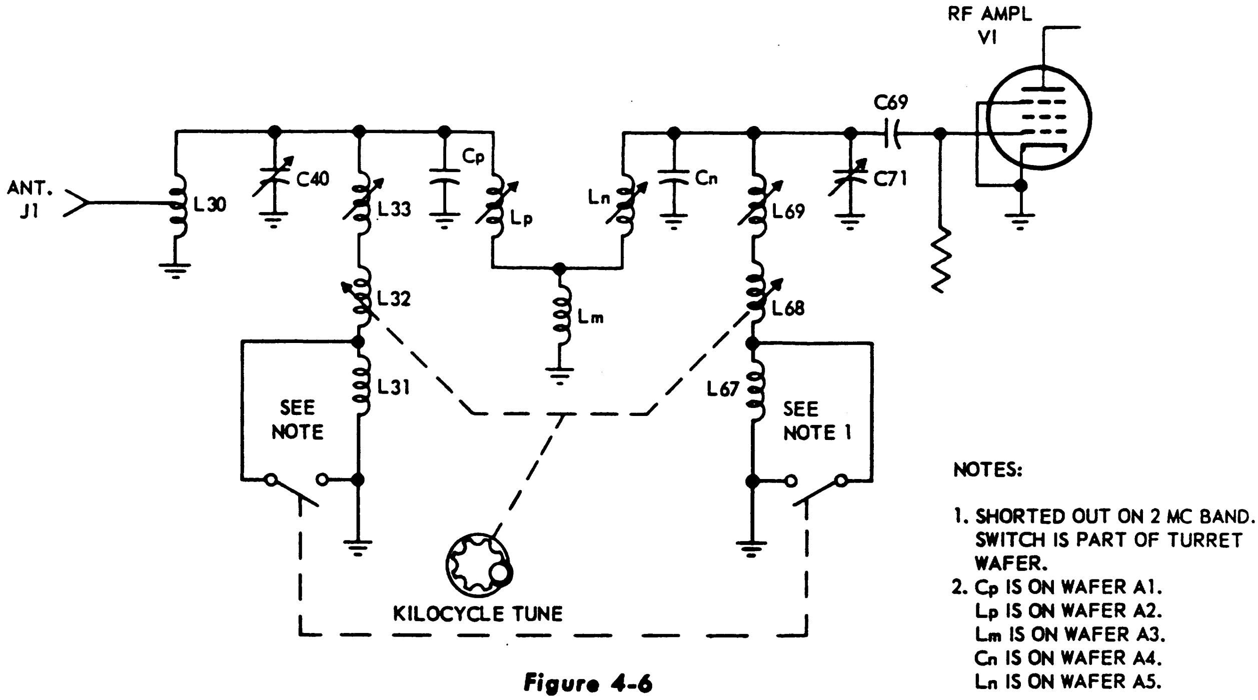


Figure 4-6

are shown in figure 7-3. The first section of this network is tuned by capacitors C40 and Cp and chokes Lp-Lm, L33, L32, and L31. For any position of the turret, L33, L32, L31, and C40 are in the circuit, and the band changing is accomplished by connecting the proper turret-mounted components into the circuit. The tuning slug of L32 is mechanically coupled to the KILOCYCLE TUNE control of the receiver, and the position of the slug is varied to accomplish tuning throughout the megacycle frequency band which is selected by the MEGACYCLE TUNE control. The second section of the network is tuned by capacitors C71 and Cn and chokes Ln-Lm, L69, L68, and L67. The tuning slug of L68 is ganged to the KILOCYCLE TUNE control of the receiver to accomplish tuning in the same manner as that of L32 in the first section of the network. The turret-mounted detailed parts are selected by the MEGACYCLE TUNE control. This control positions the turret wafers so that the proper set of detailed parts is connected into the circuit for the desired 1-mc band. Coupling between the two sections of the input network is provided by mutual inductance Lm. The output network consists of a single-tuned circuit using a band-switching and tuning arrangement similar to that of the input network.

4-5. FIRST MIXER

The output signal of r-f amplifier V1 is applied to the grid of the first mixer V2A, while the h-f crystal-controlled oscillator signal is injected at the cathode. The output network consists of a 14.5-mc to 15.5-mc bandpass filter for 2-mc to 7-mc operation and a 3-mc to 2-mc variable, triple-tuned network for a 7-mc to 30-mc operation. The slugs of the 3-mc to 2-mc variable i-f network inductors are mechanically coupled to the KILOCYCLE TUNE control of the receiver and are tracked with the slug-tuned indicators in the r-f circuits to produce the 1-mc coverage for each band.

4-6. SECOND MIXER

During 2-mc to 7-mc operation, second mixer V3A uses a 3-mc to 2-mc variable i-f circuit for its output network. This is the same output network that is used by the first mixer during 7-mc to 30-mc operation. The signal from the first mixer plate is passed through the 14.5-mc to 15.5-mc bandpass filter network, T12 and T13, to the grid of the second mixer. The 17.5-mc oscillator signal is injected into the cathode circuit of this mixer. The second mixer is inoperative during 7-mc to 30-mc operation.

4-7. THIRD MIXER

The third mixer, V4A, receives its input signal from the 3-mc to 2-mc variable i-f network. The output signal from the first or second mixer is applied to the grid of the third mixer, and the VFO signal is injected into the cathode of the third mixer. An external VFO signal may be injected through connector J6 if external frequency control is desired. The third mixer produces the final fixed i-f of 500 kc. Part of the 500-kc i-f signal is applied from the screen of V4A to connector J107. The signal at J107 is suitable for an input to the spectrum display equipment.

The output network of the third mixer is selected by the MODE switch on the front panel. Filter FL2 is used for LSB operation, and filter FL3 is used for USB operation. These are mechanical filters which provide a 2.4-kc bandwidth. The CW position of the MODE switch selects a crystal filter FL4. This crystal filter provides a 300-cps bandwidth. The AM position of the MODE switch selects a network, composed of two loosely-coupled 500-kc i-f transformers T14 and T15, which provides a bandwidth of 5-kc.

4-8. FIRST I-F AMPLIFIER

The first i-f amplifier V5 receives its input signal from the third mixer through one of the four selective networks described in paragraph 4-7. The output signal is coupled to the Q-multiplier through i-f transformer T1.

4-9. Q-MULTIPLIER

The Q-multiplier V6 uses a twin triode. The first triode section is a cathode follower, the output of which is coupled to the cathode of the second triode section. When REJECTION TUNING is being used, the signal from the plate of the second triode is coupled through a parallel-tuned circuit to the grid of the second i-f amplifier V7. The parallel-tuned circuit consists of choke L108, capacitors C145 and C146, and a small trimmer capacitor. These parts, plus resistors R33 and R34, form a bridged-T rejection notch filter. The output of the parallel-tuned circuit is also coupled to the grid (pin 7) of the second triode. This feedback arrangement forms a Q-multiplier. The Q of L108 is 250. The feedback loop has a gain of 10, resulting in an overall Q of 2500 and a rejection notch depth of not less than 40-db. By turning the REJECTION TUNING control fully counterclockwise, the bridged-T network is shorted, deactivating the rejection filter.

4-10. SECOND I-F AMPLIFIER

The second i-f amplifier V7 receives its input signal from the Q-multiplier network. The output network of the second i-f amplifier is i-f transformer T2. The secondary of T2 is coupled to the third i-f amplifier V8 and cathode follower V11A.

4-11. THIRD I-F AMPLIFIER

The third i-f amplifier V8 receives its input signal from the second i-f amplifier through i-f transformer T2. The third i-f amplifier output is coupled to the product demodulator through i-f transformer T3 and to the AM detector through capacitor C158.

4-12. PRODUCT DEMODULATOR

The product demodulator is composed of CR1, CR2, CR3, and CR4 in a diode-ring configuration. The signal from beat-frequency oscillator, V17, is injected into the product demodulator at the junction of resistors R135 and R136. The BFO supplies a reinserted carrier in the place of the carrier missing from the SSB suppressed carrier signal, but the reinserted carrier is cancelled in the product demodulator, leaving only the recovered audio signal in the output. The audio output of the product demodulator is applied to SSB/CW AF preamplifier Q1.

4-13. SSB/CW AF PREAMPLIFIER

The output impedance of the product demodulator is approximately 600 ohms. Transistor Q1 provides impedance match and gain between the product demodulator and the following audio amplifier grid circuit. The SSB/CW AF preamplifier is an NPN transistor, connected in a common emitter configuration. Audio signals from the product demodulator and sidetone signals from cathode follower V11B are coupled to the base of Q1. The SSB/CW AF preamplifier output signal is coupled from the collector of Q1 through capacitor C165 to switch S2C. During SSB and CW operation, the contacts of S2C connect the audio output signal to the first local a-f amplifier, V14B, and the first line a-f amplifier, V14A.

4-14. AUDIO AMPLIFIER

The audio amplifier of the G133F consists of electron tubes V14A and V13. The first audio amplifier, V14A, receives its input from SSB/CW AF preamplifier Q1 or from AM detector CR15, depending upon the position of MODE switch S2. V14A is a voltage amplifier which drives the second audio amplifier V13. The plate load of V13 is transformer T4, which provides audio output impedances of 150 ohms and 600 ohms. Distortion is reduced by the use of negative feedback from transformer T4 to the cathode of V14A.

4-15. LOW FREQUENCY MIXER

For receiving signals in the 0.2-mc to 2-mc range, the G133F uses low frequency mixer V10A and V16A to convert the signal for reception on the receiver 28-mc and 29-mc bands. The low frequency input to the mixer is passed through a low-pass filter, and the output of the mixer is tuned by the turret and slug-tuned circuits.

4-16. OSCILLATORS

Calibration oscillator V16B is a crystal-controlled oscillator operating at 100 kilocycles. Variable capacitor C227 trims the frequency of the oscillator. The output of the calibration oscillator is coupled to the antenna jack J106. Harmonics of this oscillator will cause beat notes in the audio output at the 100-kc points of the G133F tuning range. These beat notes are used for the calibration of the KILOCYCLE dial as outlined in Section III. The calibration oscillator is able to make this calibration only when POWER switch S1 is in the CAL position.

Low frequency crystal-controlled oscillator V10B uses a 14-mc crystal. The plate circuit of this oscillator is tuned to the second harmonic of the crystal. The low frequency crystal-controlled oscillator operates only when G133F is receiving signals in the 0.2-mc to 2-mc bands. The output of this oscillator is coupled to low frequency mixer V16A. Capacitor C2 trims the crystal to frequency.

High frequency crystal-controlled oscillator V2B operates on all bands. The frequency of oscillator operation is determined by one of 16 crystals mounted on a wafer in the turret (see table 4-1). Crystal selection is automatically performed during setting of the MEGACYCLE TUNE control. Individual turret-mounted piston trimmer capacitors trim each crystal to frequency.

The 17.5-mc oscillator, V3B, is crystal controlled. This oscillator operates only when the G133F is operating in the 2-mc to 7-mc range. Capacitor C233 trims the crystal to frequency.

The variable-frequency oscillator is a Collins 70K-4 permeability-tuned oscillator. The frequency of this unit is varied by changing the inductance of L501. This change of inductance is accomplished by turning the KILOCYCLE TUNE knob, which is coupled mechanically to the slug of L501. The output of oscillator tube V15 (V501) is coupled to isolation amplifier V18 (V502). The isolation amplifier is coupled to the cathode of the third mixer through transformer T501.

The beat frequency oscillator (BFO) V17 is a 500-kc crystal-controlled oscillator which operates only when the MODE switch is in USB, LSB, or CW position. The BFO is not for AM operation. Output of the BFO is coupled to the product demodulator.

4-17. G133F13000-1 BEAT FREQUENCY OSCILLATOR

The G133F13000-1 Oscillator Assembly, with a fundamental center frequency of 500 kc, operates in the AM mode only. An ON-OFF switch mounted on the receiver front panel is used to connect +28-volt, d-c power to the oscillator. A helical potentiometer, also mounted on the receiver front panel, is used to vary the oscillator frequency up to a maximum of ±15 kc from the 500-kc center frequency. The potentiometer dial is divided into 10 divisions numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 0; subdivided into 50 divisions each. Rotating the knob so that the large needle rotates ±five revolutions from the center setting of the potentiometer constitutes the maximum frequency variation of ±15 kc that is possible. When the AM BFO ON-OFF switch is turned on, the +28-volt, d-c power is supplied to the filter section of the BFO through resistor R1301. Resistor R1302 adjusts the working voltage of the BFO frequency potentiometer for the purpose of aligning the center of the potentiometer to coincide with the 500-kc i-f center frequency of the receiver. Variable capacitor C1307 is used to adjust the resonant frequency of the tank circuit to assure that the center frequency of the BFO is at the desired 500-kc setting prior to adjustment of R1302. The potentiometer varies the voltage to the variactors CR1302 and CR1303 that are across the tank circuit comprised of coil L1301, capacitor C1304, and variable capacitor C1307. The capacitance of the variactors varies with the amount of the bias voltage applied to the variactors. Varying the capacitance of the variactors varies the resonant frequency of the tank circuit from the 500-kc center frequency. The output of the tank circuit is applied to the oscillator transistor Q1301. Resistor R1307 decreases the Q of the tank circuit comprised of coil L1304 and capacitor C1309 that is used to develop a feedback voltage to the oscillator through capacitor C1305. The tank circuit comprised of coil L1305 and capacitor C1311 is used as a harmonic suppressor for all harmonics and allows only the fundamental frequency at the BFO output to be applied to the AM detector of the receiver. The tank circuit comprised of coil L1303 and capacitor C1308 forms a decoupling network which is connected to the AM position of the receiver mode switch. When the receiver mode switch is placed in the AM position, the BFO decoupling network is connected to ground. This furnishes a d-c path to the emitter of transistor Q1301 permitting operation of the oscillator. This assures that the BFO operates only in the AM mode.

4-18. SPECIAL CIRCUITS

Cathode follower V11A receives i-f excitation from the second i-f amplifier. The output of this cathode follower is applied to automatic gain control (AGC) amplifier V9. Output of the AGC amplifier is coupled to the AGC rectifier CR14 and through the low-pass filter to the i-f output connector J105.

AGC rectifier CR14 rectifies the i-f signal from the AGC amplifier V9. The d-c output from the AGC rectifier is used for automatic gain control of the r-f and i-f amplifiers.

The sidetone output of an associated system transmitter may be connected to connector J8. This allows audible monitoring of transmission. The sidetone signal is applied to cathode follower V11B. The output of V11B is applied to SSB/CW/AF preamplifier Q1 and then to the audio amplifier.

Diode CR16 in the grid return circuit of r-f amplifier V1 is used to stabilize the AGC circuit by preventing oscillatory action in the AGC loop.

Diode CR17 stabilizes the r-f gain control bus by suppressing transients which occur during mute on-off switching.

Remote gain gate V4B presents a high-impedance isolation between the remote gain line and the AGC circuit. This prevents the low-impedance remote gain circuit and the bias supply from loading the high-impedance AGC circuits.

4-19. G133D12000-1 ELECTRONIC PACKAGE

A detailed description of the operation of the circuits of the electronics package is given in the following paragraphs. Figure 7-2 is a schematic diagram of the electronics package.

4-20. OPERATION IN THE 0.2- TO 2.0-MC TUNING RANGE

During operation in the 0.2- to 2.0-mc range, both the low frequency crystal-controlled oscillator and the high frequency crystal-controlled oscillator are operating (see figures 4-3, 7-1, and 7-2). The output of the low frequency oscillator is applied through J1104 of the electronic package to Darlington amplifier A1203, which provides 60-db decoupling between the oscillator and amplifier Q1201. The high frequency oscillator signal is applied through J1103 of the electronics package to Darlington amplifier A1201, which provides 60-db decoupling between the oscillator and amplifier Q1201. The high frequency output of A1201 and the 28-mc output of A1203 are linearly mixed in the base circuit and then amplified by Q1201.

When the low frequency oscillator is operating, a B+ voltage is applied through C1106 and R1226 to the anode of CR1202. This positive voltage forward biases CR1202, preventing the output of Q1201 from being coupled to Q1203 through C1206, C1207, and R1216; C1209 and R1219, C1211, and C1220. When CR1202 is forward biased, the output of C1207 is shorted to ground.

The output of Q1201 is coupled through C1202 to CR1201 which rectifies the signal. This rectified signal is applied to amplifier Q1202. Q1202 amplifies the signal to help overcome the loss in the following filters. The LC filter (consisting of L1202 through L1204, C1210, and C1212 through C1217), FL1201, and FL1202 prevent the fundamental and sum frequencies of the high frequency and low frequency oscillators from appearing at the base of Q1203. The output of the filter network is the difference frequency signal between the high frequency oscillator and the low frequency oscillator.

During operation in the 0.2- to 1-mc frequency range, the high frequency oscillator operates at 31 mc. The low frequency oscillator frequency is 28 mc; therefore, the difference in frequency is 3 mc.

During operation in the 1- to 2-mc frequency range, the high frequency oscillator operates at 32 mc. The low frequency oscillator frequency is 28 mc; therefore, the difference in frequency is 4 mc.

The output of the filters is applied to voltage amplifiers Q1202, Q1203, and Q1204 which amplify the signal. The signal is then applied to J1101 of the electronic package.

4-21. OPERATION IN THE 2- TO 7-MC TUNING RANGE

During operation in the 2- to 7-mc tuning range, the 17.5-mc oscillator and the high frequency oscillator are operating, with the low frequency oscillator disabled. (See figures 4-4, 7-1, and 7-2.)

The 17.5-mc signal is applied to J1105 of the electronic package and then through Darlington amplifier A1202 to the base of transistor Q1201.

The high frequency output of A1201 and the 17.5-mc output of A1202 are linearly mixed in the base circuit and then amplified by Q1201.

When the 17.5-mc oscillator is operating, a B+ voltage is applied through C1105 and R1225 to the anode of CR1202. This positive voltage forward biases CR1202, shorting the output of C1207 to ground. The signal must therefore go through Q1202 and the filter network.

The output of Q1201 is rectified by CR1201 and applied to Q1202. Transistor Q1202 amplifies the signal to help overcome the loss in the following

G133F HF RECEIVER CRYSTAL UTILIZATION

RECEIVER FREQUENCY RANGE IN MEGACYCLES	TURRET CRYSTAL		17.5-MC OSCILLATOR	L-F CRYSTAL OSCILLATOR (2x14 MC=28 MC)
	FREQUENCY (MC)	SYMBOL		
0.2 - 1.0	15.5	Y20	OFF	ON
1.0 - 2.0	16.0	Y12	OFF	ON
2.0 - 3.0	12.5	Y1	ON	OFF
3.0 - 4.0	11.5	Y2	ON	OFF
4.0 - 5.0	10.5	Y3	ON	OFF
5.0 - 6.0	9.5	Y4	ON	OFF
6.0 - 7.0	8.5	Y5	ON	OFF
7.0 - 8.0	10.0	Y6	OFF	OFF
8.0 - 9.0	11.0	Y7	OFF	OFF
9.0 - 10.0	12.0	Y8	OFF	OFF
10.0 - 11.0	13.0	Y9	OFF	OFF
11.0 - 12.0	14.0	Y10	OFF	OFF
12.0 - 13.0	15.0	Y11	OFF	OFF
13.0 - 14.0	16.0	Y12	OFF	OFF
14.0 - 15.0	8.5	Y5	OFF	OFF
15.0 - 16.0	9.0	Y13	OFF	OFF
16.0 - 17.0	9.5	Y4	OFF	OFF
17.0 - 18.0	10.0	Y6	OFF	OFF
18.0 - 19.0	10.5	Y3	OFF	OFF
19.0 - 20.0	11.0	Y7	OFF	OFF
20.0 - 21.0	11.5	Y2	OFF	OFF
21.0 - 22.0	12.0	Y8	OFF	OFF
22.0 - 23.0	12.5	Y1	OFF	OFF
23.0 - 24.0	13.0	Y9	OFF	OFF
24.0 - 25.0	13.5	Y18	OFF	OFF
25.0 - 26.0	14.0	Y10	OFF	OFF
26.0 - 27.0	14.5	Y19	OFF	OFF
27.0 - 28.0	15.0	Y11	OFF	OFF
28.0 - 29.0	15.5	Y20	OFF	OFF
29.0 - 30.0	16.0	Y12	OFF	OFF

Table 4-1

filters. The LC filters FL1201 and FL1202 prevent the fundamental and sum frequencies of the high frequency oscillator and 17.5-mc oscillator from appearing at the base of Q1203. The output of the filter network is the difference frequency signal between the high frequency oscillator and 17.5 mc.

As the frequency range of the receiver is changed from 2 to 7 mc, the high frequency crystal-controlled oscillator output signal will vary in 1-mc steps from 12.5 to 8.5 mc, and the difference frequency will vary in the same manner from 5 to 9 mc.

FL1201 and FL1202 are notch filters which prevent some of the fundamental frequencies of the high frequency crystal-controlled oscillator (8.5 mc, 9.5 mc, and 10.5 mc) from being passed on to the next stage.

The output of the filters is amplified by Q1203, Q1204, and Q1205, and applied to J1101 of the electronic package.

4-22. OPERATION IN THE 7- TO 30-MC TUNING RANGE

During operation in the 7- to 30-mc tuning range, both the low frequency crystal-controlled oscillator and the 17.5-mc oscillator are disabled, and the high frequency crystal-controlled oscillator is operating. (See figures 4-5, 7-1, and 7-2.)

The output signal from the high frequency oscillator is applied to J1103 on the electronic package and then through Darlington amplifier A1201 to transistor Q1201.

The high frequency oscillator signal is amplified by Q1201 and coupled through C1206, C1207 and R1216, C1209 and R1219, C1211, and C1220 to the base of Q1203.

With the low frequency oscillator and the 17.5-mc oscillator both inoperative, no B+ voltage is applied to C1105 or C1106. A negative voltage is applied to CR1202 back-biasing it, and the high frequency signal is allowed to pass on to Q1203, bypassing the filter network.

The high frequency oscillator signal is amplified by Q1203, Q1204, and Q1205, and applied to J1101 of the electronic package.

4-23. OPERATION OF THE VARIABLE FREQUENCY OSCILLATOR

The variable frequency oscillator is operating during operation of the G133F Receiver in all of its frequency ranges. The signal from the variable frequency oscillator is applied to jack J1106 of the electronic package and then through Darlington amplifier A1204 to J1102. The frequency of the oscillator is continuously variable from 2.5 mc to 3.5 mc.

Note

V501 and V15 are one and the same. V502 and V18 are one and the same.

Figure 7-1. G133F HF Receiver (Sheet 1 of 2)

Figure 7-1. G133F HF Receiver (Sheet 1 of 2)

NOTES:

1. REMOVE JUMPER IF ACCESSORY LOW FREQUENCY TUNER IS USED.
2. TEMPERATURE COMPENSATING CAPACITORS, VALUES SELECTED IN MANUFACTURE.
3. THESE CONTACTS ARE PART OF WAFERS IN TURRET.
4. COMPONENTS SHOWN IN DASHED LINES ARE TO BE ADDED FOR USE WITH ACCESSORY EXTERNAL FREQUENCY STABILIZERS.
5. ONLY REPRESENTATIVE CONPONENTS ARE SHOWN. THE R.F. CIRCUITS SCHEMATIC DIAGRAM SHOWS ALL COMPONENTS IN TURRET. SEE FIGURE 7-3.
6. PART OF TURRET WAFER, CLOSED ONLY FOR 14 TO 30 MC OPERATION.
7. PART OF TURRET WAFER, CLOSED ONLY ON 2-3 MC BAND.
8. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN MICROMICROFARADS AND INDUCTANCES ARE IN MICROHENRYS.
9. NO GROUND ON COAXIAL SHIELDS WITHIN OSCILLATOR SUBASSEMBLY.
10. UNUSED CONNECTOR FACILITIES ARE J2, J3, J4, J9 AND J12.
11. SCHEMATIC ADDENDUM FOR UNITS USING 70K-7 OSCILLATOR.
12. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE ±10%, 1/2 WATT (SEE LEGEND).
13. ALTERNATE METER RECTIFIER INSTALLED IN SOME UNITS.
14. MODIFIED BY SERVICE BULLETIN GTM-D-133-01
15. IN SOME MODELS, C503 MAY BE FIXED VALUE, FACTORY SELECT

RESISTOR LEGEND

- ◘ 5%, ½ WATT
- ✱ 10%, ¼ WATT
- ▲ 10%, 1 WATT
- ▼ 10%, 2 WATT
- ■ 30%, 3/4 WATT

Figure 7-1. G133F HF Receiver (Sheet 2 of 2)

FOR OFFICIAL USE ONLY

NOTES:

1. REMOVE JUMPER IF ACCESSORY LOW FREQUENCY TUNER IS USED.
2. TEMPERATURE COMPENSATING CAPACITORS, VALUES SELECTED IN MANUFACTURE.
3. THESE CONTACTS ARE PART OF WAFERS IN TURRET.
4. COMPONENTS SHOWN IN DASHED LINES ARE TO BE ADDED FOR USE WITH ACCESSORY EXTERNAL FREQUENCY STABILIZERS.
5. ONLY REPRESENTATIVE CONPONENTS ARE SHOWN. THE R.F. CIRCUITS SCHEMATIC DIAGRAM SHOWS ALL COMPONENTS IN TURRET. SEE FIGURE 7-3.
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7. PART OF TURRET WAFER, CLOSED ONLY ON 2-3 MC BAND.
8. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN MICROMICROFARADS AND INDUCTANCES ARE IN MICROHENRYS.
9. NO GROUND ON COAXIAL SHIELDS WITHIN OSCILLATOR SUBASSEMBLY.
10. UNUSED CONNECTOR FACILITIES ARE J2, J3, J4, J9 AND J12.
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RESISTOR LEGEND

- ◻ 5%, ½ WATT
- ✱ 10%, ¼ WATT
- ▲ 10%, 1 WATT
- ▽ 10%, 2 WATT
- ■ 30%, 3/4 WATT

Figure 7-1. G133F HF Receiver (Sheet 2 of 2)

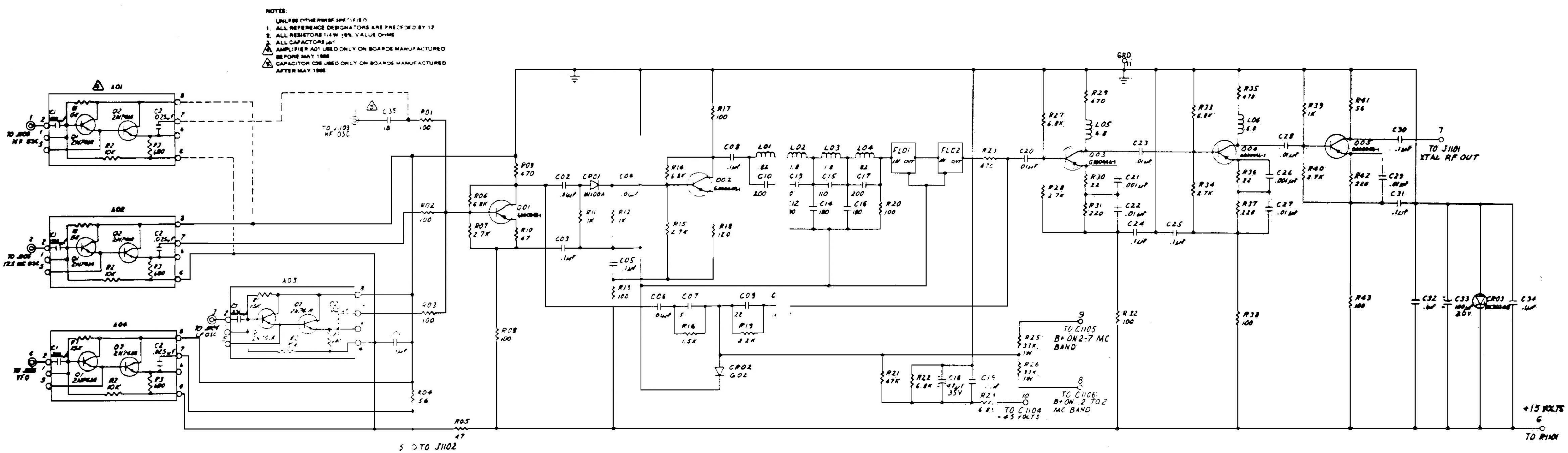

Figure 7-2. G133D12000-1 Mixer Schematic