Application for Type Acceptance Under Part 87 of FCC Rules and Regulations for the DME-900 Distance Measuring Receiver-Transmitter

Collins Part Number: 653-9905-002 Rev -

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Rockwell International

Collins Commercial Avionics Group

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CAGE: 4V792

NOTICES AND SIGNATURES

Notices

Approval Signatures

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REVISION HISTORY

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-001			R. J. Oswalt	Initial Release

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LIST OF FIGURES

1. SCOPE

This document is application for type acceptance to the FCC for the Collins Air Transport Division type DME-900, 822-0329-001 Distance Measuring Equipment. The following information and measurement data is supplied in accordance with paragraphs 2.985 thru 2.997 of Part 2, Subpart J of the FCC rules and regulations. This data is supplied in accordance with requirements for type acceptance for the Rockwell/Collins DME-900,distance measuring equipment, under Part 2, and Part 87 of the FCC rules and regulations.

2. APPLICATION

2.1 Applicant (2.983 (a))

Rockwell Int./Collins Air Transport Division
400 Collins Rd. N.E.
Cedar Rapids, Iowa 52406

2.2 Identification (2.983 (b))

The Rockwell/Collins distance measuring equipment, DME, type number DME-900 is intended to be airborne equipment for use in the national airspace system. Its purpose is to electronically measure the line-of-sight distance in nautical miles from the aircraft to a selected ground station.

FCC identifier AJK 9UR CPN 822-0329-(XXX)

2.3 Production Quantity (2.983 (c))

Production quantity of past DME's have been in excess of 5000 units. The DME-900 is expected to meet or exceed past production quantities.

2.4 Technical Description (2.983 (d))

2.4.1 Type of Emission (2.983 (d) (1))

The carrier of the transmitter is pulse modulated. The transmitter pulses results in an emission type of P0N, per Part 2 Subpart C. The necessary bandwidth as defined in section 2.202 is calculated from the formula:

$$B_n = 2K/t$$

where B_n is the necessary bandwidth, K is a numerical factor which is defined to be 1.6, and t is the pulse duration in seconds. Assuming the minumum allowable pulse duration of 3.2 microseconds, then $B_n = 1$ MHz. Therefore the complete emission designation is 1M00P0N

2.4.2 Frequency Range (2.983 (d) (2))

The frequency range of the transmitter is 1025 MHz TO 1150 MHz. The DME band consists of 126 channels with a channel separation of 1 Mhz. The frequency range of the receiver is 962 MHz to 1213 MHz. These frequencies are within the band of frequencies allocated to airborne electronic aids to air navigation, Part 87 subpart N.

2.4.3 Transmitter Output Power Range (2.983 (d) (3))

Minimum power output is 316 watts. Maximum power output is 800 watts. Typical power output is 600 watts.

2.4.4 Maximum Power Rating (2.983 (d) (4))

The maximum power rating of the DME is 2000 watts as specified by TSO C-66a, Minimum Performance Standards RTCA DO-151A document.

2.4.5 Power Amplifier Supply Voltages (2.983 (d) (5))

The power amplifier final transistor stages are modulated by a 50 volt gaussian pulse. These 50 volt pulses are applied to the transistor's collectors. The final modulation pulses develop a maximum current of 100 amps.

2.4.6 Functional Description (2.983 (d) (6))

2.4.6.1 Transmitter-Receiver

Refer to overall block diagram Figure 2-1. The 3-port circulator provides VSWR protection for the power amplifier and directs the incoming ground station signal from the antenna to the receiver input. The low-pass filter prevents the radiation of high-frequency spurious energy through the antenna.

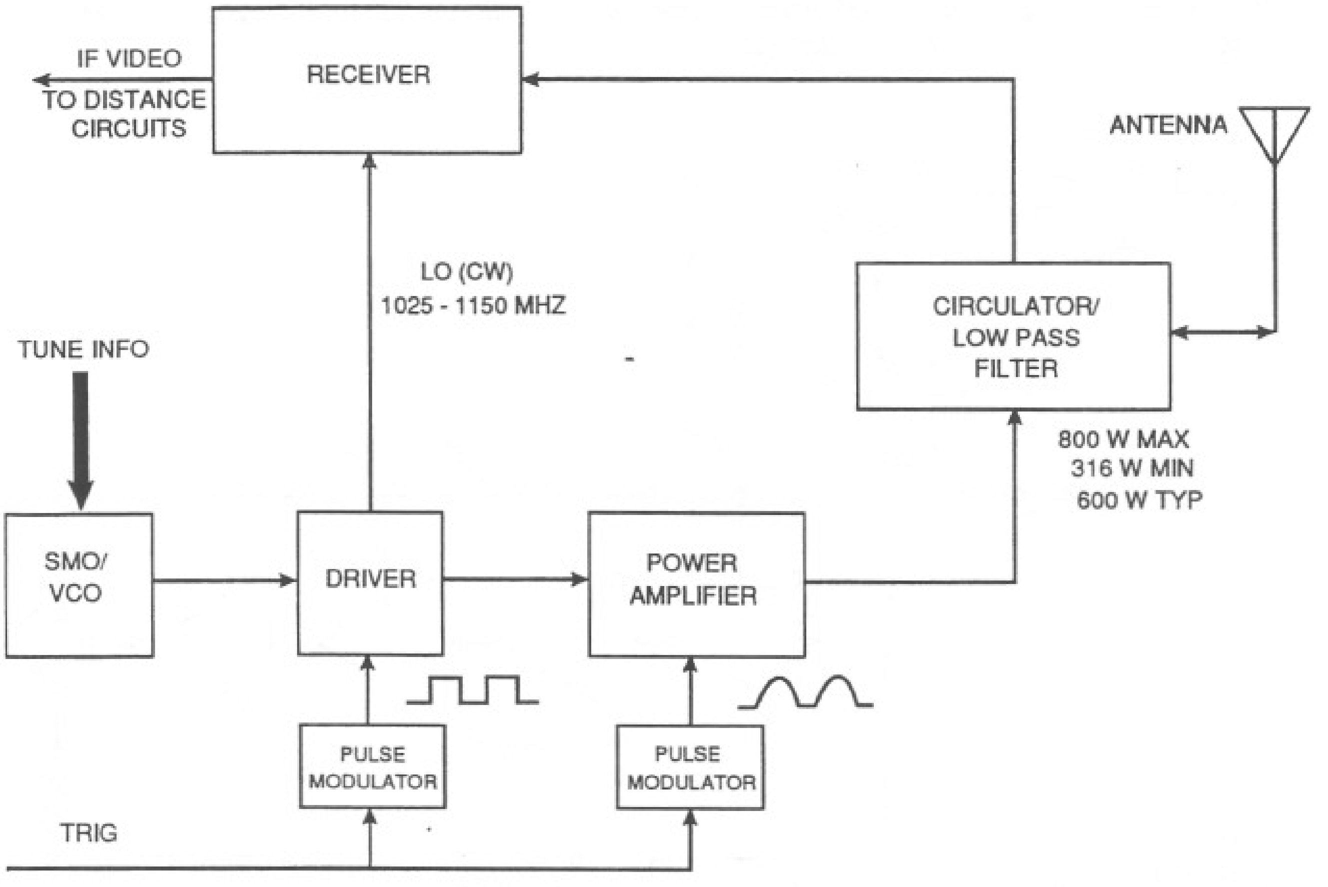


Figure 2-1 Block Diagram Receiver Transmitter

2.4.6.1.1 Transmitter

2.4.6.1.1.1 Detailed Driver Description

Figure 2-2 shows a detailed block diagram of the pulse amplifiers in the driver. The VCO provides +20 dBm of power to the driver input. A pin diode switch is used to direct the VCO output through an 8 db pad to produce the local oscillator (LO) injection for the receiver. During the transmitter pulse interval the pin diode switch directs the VCO output into the first stage of the pulsed amplifier string. Four pulse amplifiers provide a nominal 70 watts of pulse power to the power amplifier.

The collector voltage is a square pulse that is applied to the RF drive at all four pulse amplifiers to provide a pulsed drive signal to the power amplifier.

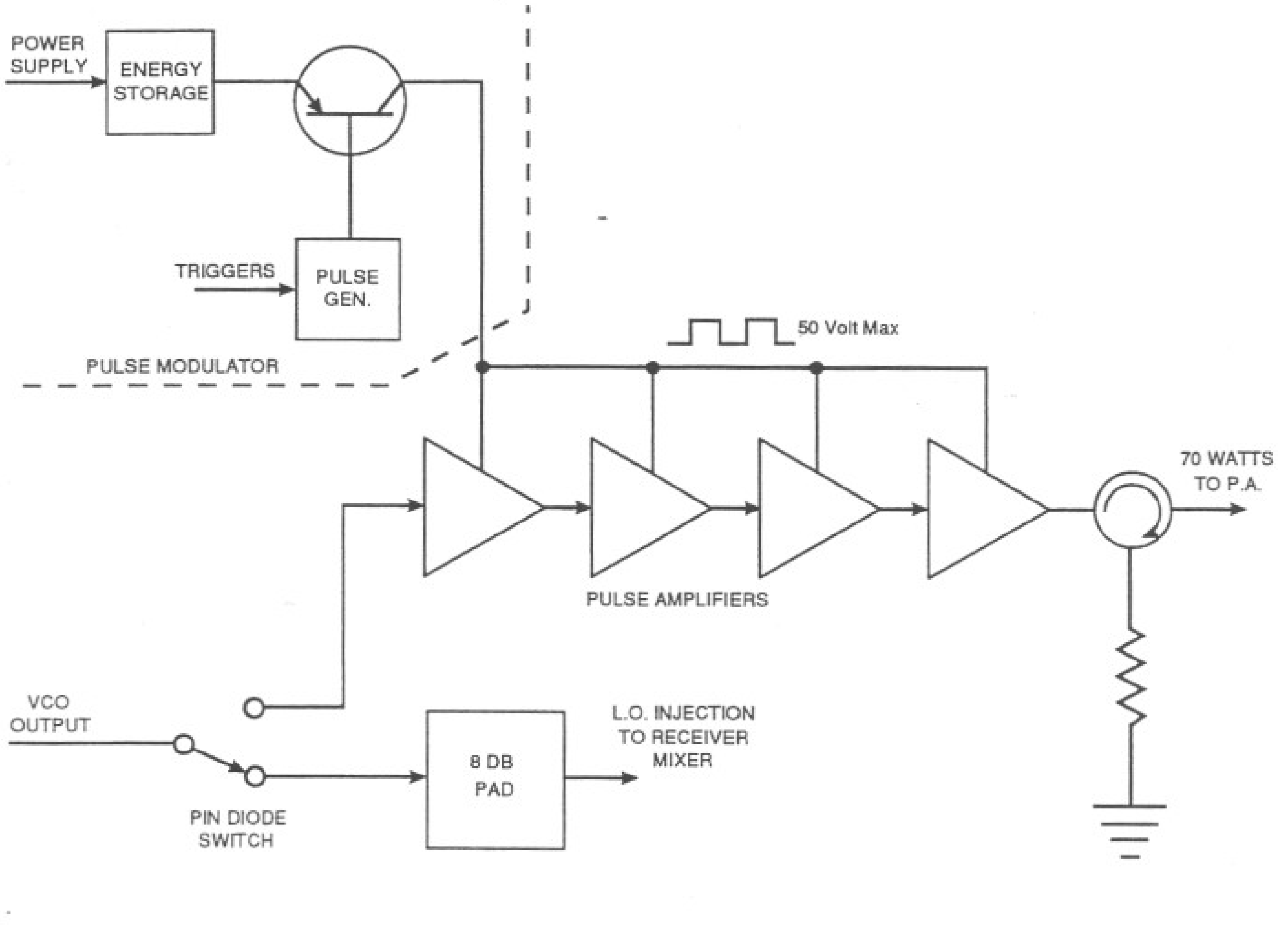
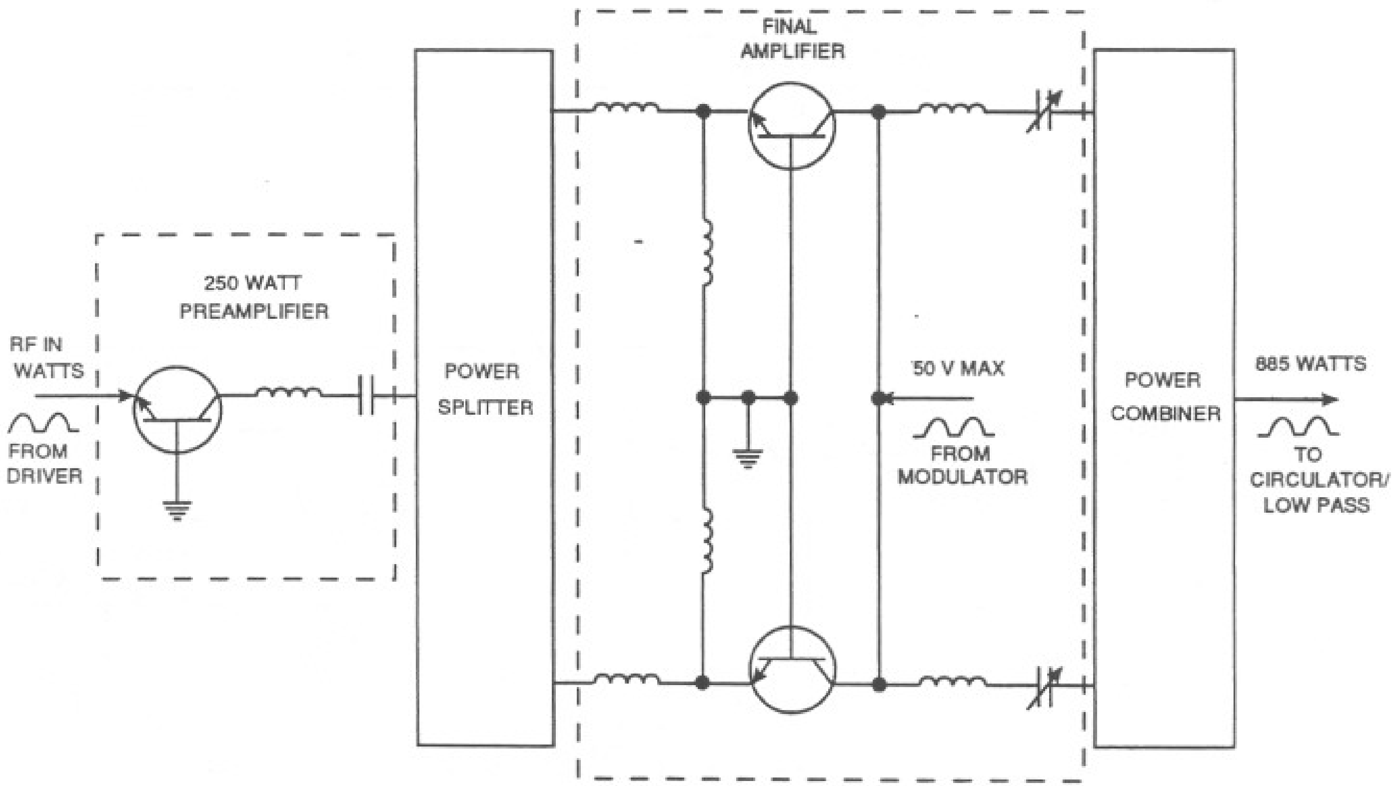


Figure 2-2 Driver Stages

2.4.6.1.1.2 Detailed Power Amplifier Description

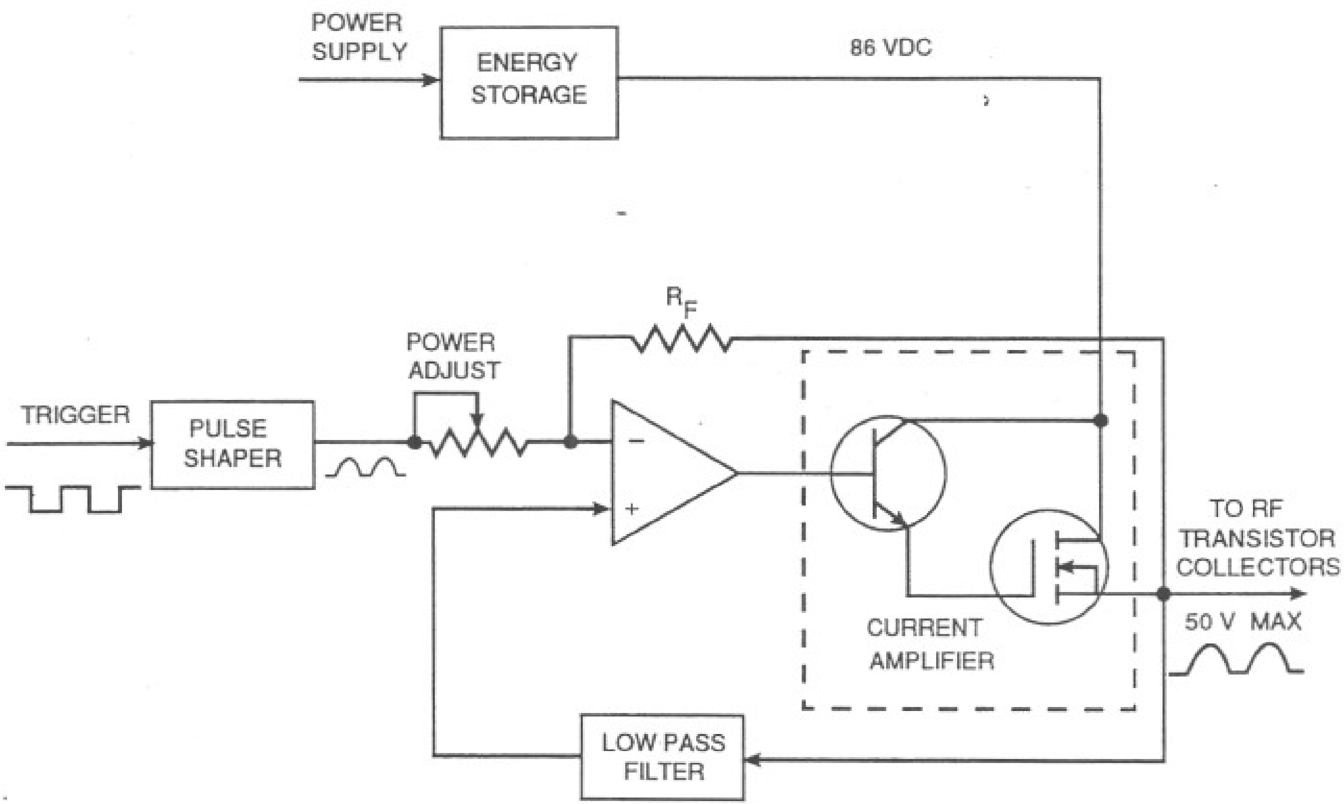
Figure 2-3 shows a detailed block diagram of the power amplifier. The pre-amplifier amplifies and modulates the 70 watt pulsed signal from the driver to generate a shaped pulse with a peak power of 250 watts. The pre-amplifier operates at a soft saturation point of 0.75 db.

The modulated power output from the 250 watt pre-amplifier is evenly divided in the power splitter to drive the final amplifier, which consists of two parallel devices and associated strip-line coupling networks. The outputs of the broadband final amplifiers are pulse shaped by the collector supply voltage which is provided by the modulator. The final amplifier outputs are summed in the power combiner to produce a nominal output of 885 watts of peak power.



The cosine-squared waveform of the output signal is controlled by the power amplifier modulator shown in the block diagram of Figure 2-4. Modulation is controlled by a square pulse transmitter signal applied to the modulator circuits and controlled by a microprocessor. The square-pulse transmitter triggers are connected to an LC pulse shaper network to produce a gaussian waveshape. The pulse shaper output amplified by a differential amplifier and the current amplifier.

The output of the power amplifier modulator is the collector supply voltage for the transistors in the power amplifier. Its waveshape modulates the final amplifier output to produce a cosine-squared signal. The output of the power amplifier passes through the circulator/low-pass to the antenna as shown in Figure 2-1. The losses of the circulator/low-pass results in a nominal output power level of 600 watts.



2.4.6.1.2 Receiver

The receiver input to the pre-selector/RF amplifier is a DME signal on one of the 252 DME channels in the frequency band from 962 to 1213 MHz. The receiver signal may have a level of -93 dbm to -10 dbm. The pre-selector/RF amplifier filters and amplifies the signal to the mixer. The mixer mixes the pre-selector/RF amplifier output with the local oscillator drive signal to produce an output signal at the 63 MHz IF frequency. The IF Amplifier produces amplitude-modulated video output pulses of 1.5 volts nominal amplitude.

2.4.6.1.2.1 Preselector/RF Amplifier

Figure 2-5 is a more detailed block diagram of the receiver. Input RF signals from the circulator/low-pass filter are applied to a 2-pole varactor-tuned filter. The tuned filter output is connected to an RF amplifier. The filter keeps high level out-of-band spurious signals from overloading the RF amplifier. The filter also protects the RF amplifier from antenna-reflected transmitter pulses that might otherwise damage it. In order to provide additional protection for the receiver while ground station interrogations are transmitted by the DME or another on-board DME or transponder is transmitting, an internal suppression pulse is applied to the suppression network. the suppression network detunes the first pole of the filter. The internal suppression pulse is activated by the aircraft suppression pulse line to which all of the on-board DME's and transponders are connected.

The output from the 2-pole filter is amplified by a single-stage bipolar amplifier with a gain of approximately 12 db. The RF amplifier output is connected to a 3-pole varactor-tuned filter, which provides additional filtering of undesired signals such as heterodyne spurious responses, images, and higher-order first mixer responses. Both tuned filters use silicon varactors with Q's of at least 130. Tuning voltage for the varactors is supplied by an Analog to Digital converter on the Video processor board. The preselector/RF amplifier has an overall gain of approximately -3 db and provides image rejection of about 80 db.

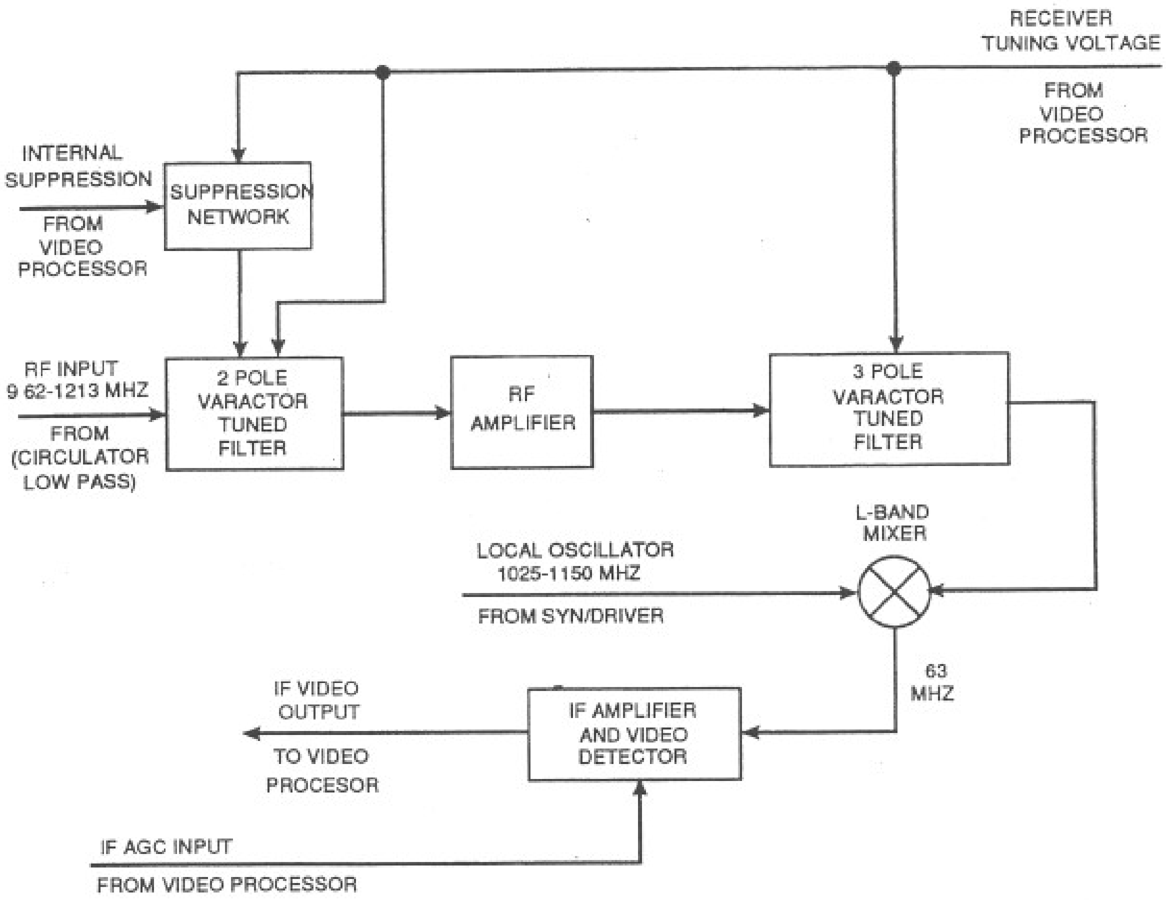


Figure 2-5 Receiver Block Diagram

2.4.6.1.2.2 L-Band mixer

The output of the 3-pole filter in the preselector/RF amplifier is fed to the L-Band mixer, where it is converted to 63 MHz and fed to the IF amplifier. The local oscillator injection signal for the L-Band mixer is the synthesizer output from the L-Band VCO. The L-Band mixer is balanced to remove the am noise from the local oscillator injection signal.

2.4.6.1.2.3 IF Amplifier and Detector

Refer to Figure 2-6. The 63-MHz signal from the L-Band mixer is applied to the IF amplifier. The IF amplifier provides low-noise gain and adjacent channel selectivity. A double-conversion IF is used with a second IF frequency of 10.7 MHz. A 63 MHz LC filter attenuates provides image rejection. The 3 dB bandwidth of this filter is +/- 2 MHz. A 52.3 MHz crystal oscillator provides the injection to the second mixer.

The majority of the gain in the amplifier is obtained at the second IF frequency. Additional selectivity is obtained using two inter-stage 3-pole LC filters at 10.7 MHz to provide greater than 60 dB of rejection to frequencies +/- 1 MHz from the desired frequency.

AGC is applied to the IF as required to provide a constant video amplitude to the range circuitry. The AGC voltage is generated in the video processor. Diode voltage limiters are used to prevent the amplifier from "crushing" under large input signals. AGC occurs on the 10.7 MHz stages first, with delayed AGC applied to the 63 MHz stages at signal levels up to +10 dbm.

A detector follows the second IF amplifier. Its output is buffered and sent to the decoder/signal processor.

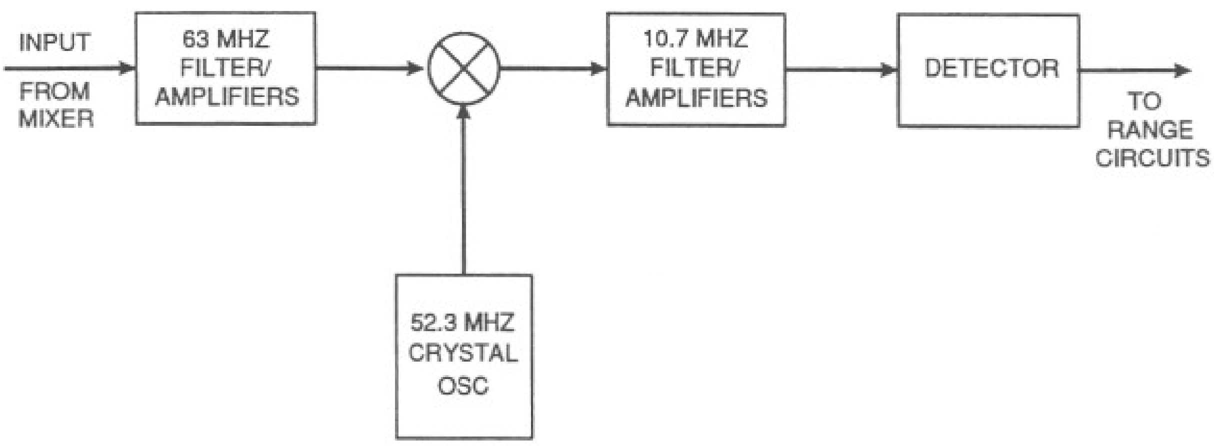


Figure 2-6 IF Amplifier Block Diagram