TYPE N2 CARRIER TELEPHONE SYSTEM
VOICE-FREQUENCY AMPLIFIER UNIT
DESCRIPTION

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1. GENERAL

A. System Functions of the Voice-frequency (VF) Amplifier Unit

1.01 This section describes the VF amplifier unit which is an optional plug-in unit of the N2 carrier telephone system.

1.02 The VF amplifier unit is substituted for the compandor unit normally used in the N2 system when a noncompandored channel is required, and is identical to the compandor unit in size and external connections.

1.03 A VF amplifier consists of two voice-frequency amplifiers, one designated transmit, which replaces the compressor, and the other designated receive, which replaces the expandor in the compandor unit.

1.04 These amplifiers provide the necessary gain and impedance matching facilities that are needed for compandorless operation.

1.05 Noncompandored operation of an N2 channel is provided for certain special service uses, such as transmission of data, VF carrier telegraph, etc. VF amplifier units may be used as thru-channel units.

B. Description and Features

1.06 The VF amplifier (Fig. 1) is a single plug-in module. Both individual amplifiers share a common connecting plug and operate off a common −21 volt source.

1.07 The current drain of the VF amplifier unit is identical to that of a compandor, so that no effect upon regulation of the terminal power supply will be noted.

1.08 Transistors and silicon diodes have been used to improve performance, to increase reliability, and to minimize power requirements. Since long life is anticipated, the transistors and diodes are wired directly into their circuits.

1.09 All components have been reduced to minimum sizes consistent with design objectives.

1.10 Circuit components are mounted on a poured-epoxy board. The epoxy board is surrounded by a die-cast frame attached to the front panel. All interconnecting wiring to and from the VF amplifier is via a 20-pin plug mounted on the rear of the assembly. Four pin-jacks for testing are located on the front panel as are two level adjustment potentiometers and the latch for securing the unit in position. Pro-

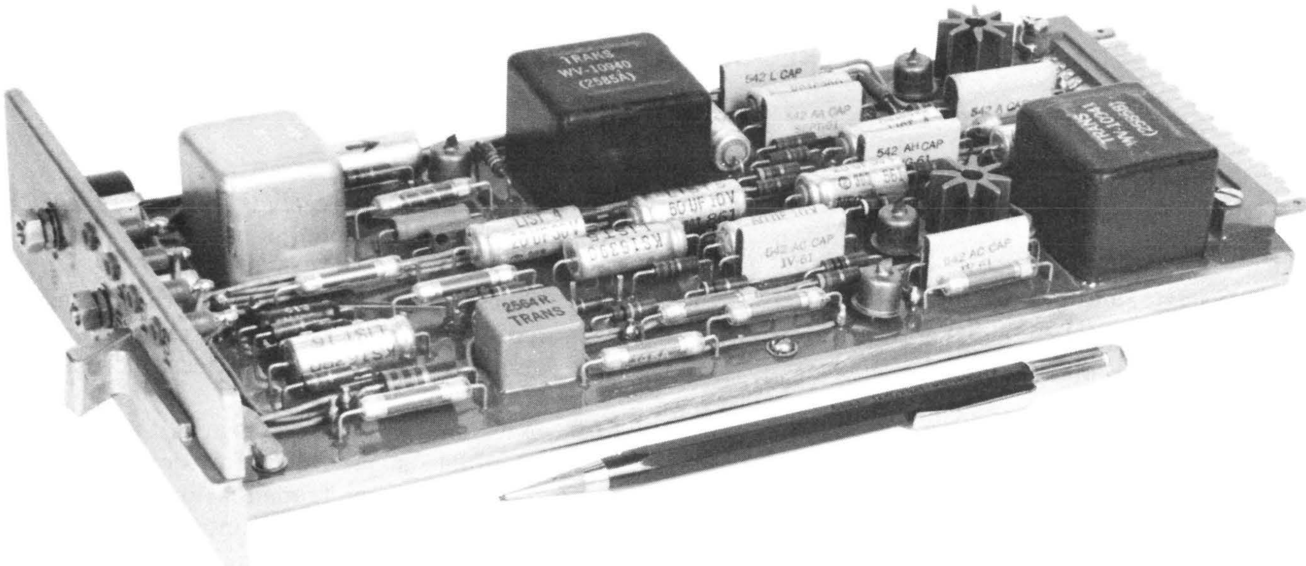


Fig. 1 – Voice-frequency Amplifier

vision is made on the face of the unit for pencil notation under the heading USE.

C. Transmission Characteristics

1.11 Normal input range of the amplifier, which provides the circuitry needed between connected VF circuits and the modulator (transmit amplifier), may be −8 dbm to −74 dbm. The nominal adjustment for noncompandored voice service (thru-channel service) provides a signal of 5.36 volts into the modulator with an input of −16 dbm. The corresponding modulator output is 47 per cent modulation of the channel carrier. The input level control IN ADJ is provided so that if a different circuit application is encountered, the VF amplifier output may still be adjusted to 5.36 volts. The range of this adjustment allows signals from −21 dbm to −8 dbm to modulate the channel carrier 47 per cent.

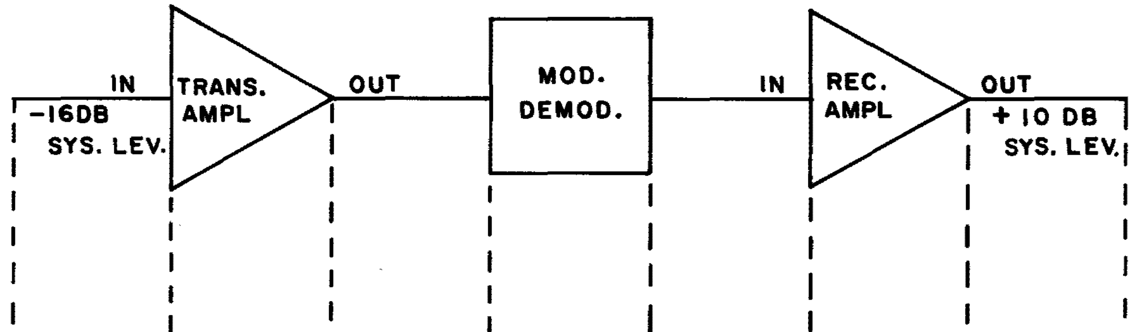
1.12 The amplifier which provides this necessary circuitry from the output of the demodulator to the connecting VF circuitry (receive amplifier) has a normal output range of +18 dbm to −48 dbm. With a normal adjustment for noncompandored voice service, an input from the demodulator of −5 dbm provides an output of +10 (or +7) dbm. The receive amplifier potentiometer OUT ADJ provides a range of gain adjustment such that for this same input the amplifier output may be adjusted to any value between +2 and +14 dbm. Since the VF output of the VF amplifier unit is normally +10 db system level, this means that the VF amplifier unit at each end of the channel provides a net gain of 26 db and maximum carrier modulation obtained for channel inputs ranging from −6 to +8 dbm at 0-db system level.

1.13 Typical levels that can be provided for are shown in Fig. 2.

1.14 The input impedance of the transmit amplifier is 600 ohms and the output impedance of the receive amplifier is 600 ohms. The other input and output impedances match those of the respective N2 modulator and demodulator circuits.

D. General Discussion of the Amplifiers

1.15 Both amplifiers use three transistors each in a common-emitter configuration and are of the negative feedback type.



APPLICATION	IN	IN ADJ.	OUT	% MOD.*	IN	OUT ADJ.	OUT
THRU-CHANNEL	ODB SL -16DBM	NOMINAL	5.36 V	47 %	- 5DBM	NOMINAL	+10DBM
THRU-CHANNEL	+ 4DB SL -12 DBM	NOMINAL	8.5 V	75 %	-1DBM	NOMINAL	+ 14DBM
DATA	ODB SL -16 DBM	+ 4 DB	8.5V	75 %	-1DBM	-4 DB	+10 DBM

* MAX 75%

Fig. 2 – Typical Power Levels

1.16 The voice-band amplifiers are high gain; due to the large amount of negative feedback, the current gain of the transistors may vary from −50 per cent to 200 per cent without affecting the over-all gain. Adequacy of design and stability of components making up the amplifier and its feedback circuit loop are essential. In general, roll off of gain around this loop must be controlled below as well as above the VF band. The low-frequency cutoff is shaped by choosing appropriate capacitors to bypass the emitter and base-bias resistors. The high-frequency cutoff is shaped by the addition of resistance-capacitance networks. The design objectives for margins within the feedback loop are to obtain phase change no greater than 45 degrees at the frequencies where the gain around the loop has changed to zero, and at the frequencies where the phase has changed 180 degrees to have at least 20-db attenuation in the loop.

2. TRANSMIT AMPLIFIER

A. Circuit Description

2.01 The transmit amplifier circuit is shown functionally in Fig. 3.

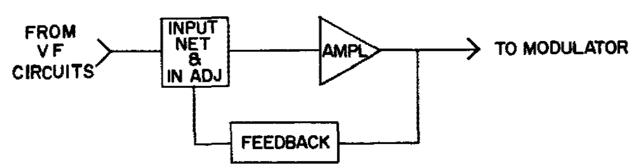


Fig. 3 – Block Diagram — Transmit Amplifier Circuit

2.02 The input network presents a 600-ohm impedance to the connected circuit and allows the level to be changed over a 14-db range without seriously affecting the input impedance.

2.03 A detailed schematic is shown in Fig. 4.

2.04 The input transformer is balanced both transversely and longitudinally, and also has an electrostatic shield between input and output windings to reduce longitudinal coupling. The resistive network maintains a near constant impedance on the transformer secondary independent of the IN-ADJ potentiometer setting.

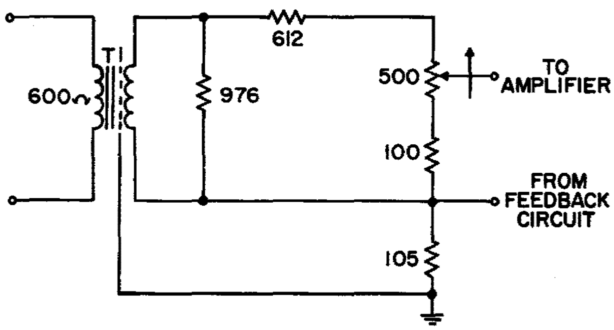


Fig. 4 – Detailed Schematic of the Input Network

2.05 The feedback amplifier, which consists of three common-emitter stages, is shown in Fig. 5.

2.06 Transistors Q1 and Q2 are PNP type and Q3 is an NPN type. The three stages are direct coupled with self-biasing emitter circuits.

2.07 The shunt-type feedback from network Cc and Rc enables the amplifier to have approximately zero output impedance. The modulator impedance matching network, therefore, is located in the modulator.

2.08 The two networks Ra, Ca and Rb, Cb provide the high-frequency shaping to maintain stability at the high end of the frequency range above the voice-band.

2.09 The emitter biasing bypass capacitors provide the necessary low-frequency shaping.

3. RECEIVE AMPLIFIER

A. Circuit Description

3.01 The receive amplifier circuit is shown functionally in Fig. 6.

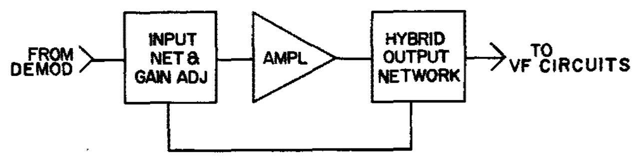


Fig. 6 – Block Diagram — Receive Amplifier Circuit

3.02 In order to present a 600-ohm impedance to the connected VF circuits, hybrid-type feedback is used in the output circuit. A detailed schematic is shown in Fig. 7.

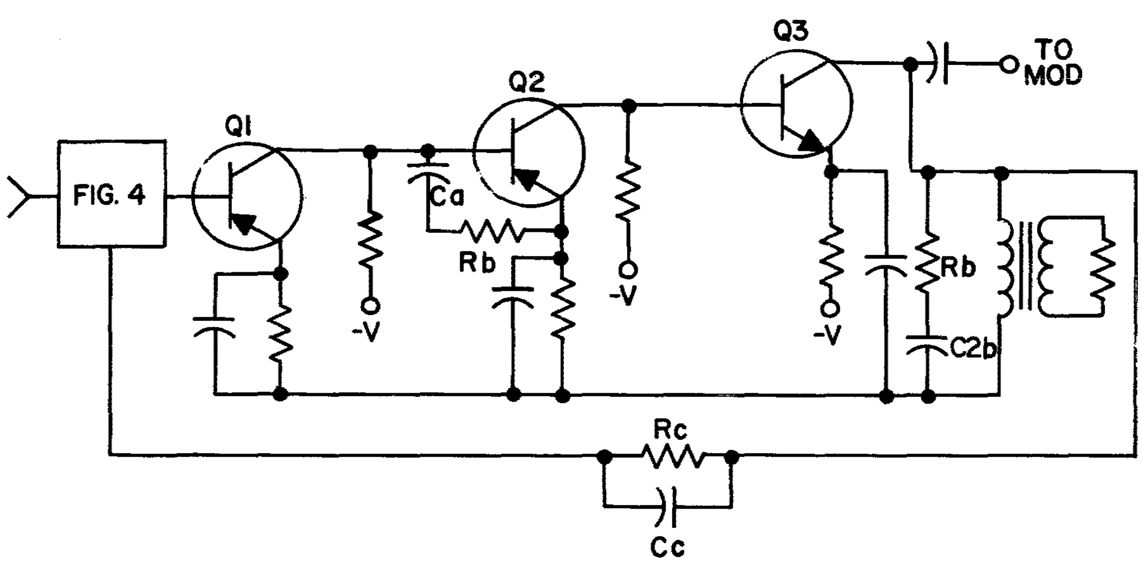


Fig. 5 – Feedback Amplifier Circuit

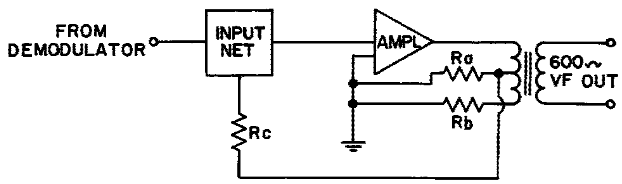


Fig. 7 — Detailed Schematic of the Hybrid Output Circuit

3.03 The hybrid transformer output impedance is controlled predominantly by Rb. The outside legs of the hybrid connection are the amplifier and Rb; the balance is a function of all the elements.

3.04 The input network provides the necessary impedance matching to the demodulator and a means of adjusting the over-all gain of the receive amplifier. A detailed schematic is shown in Fig. 8.

3.05 The amplifier consists of three common-emitter stages. A schematic is shown in Fig. 9.

3.06 Transistors Q4 and Q5 are PNP type and Q3 is an NPN type. The three stages are direct coupled with self-biasing emitter circuits.

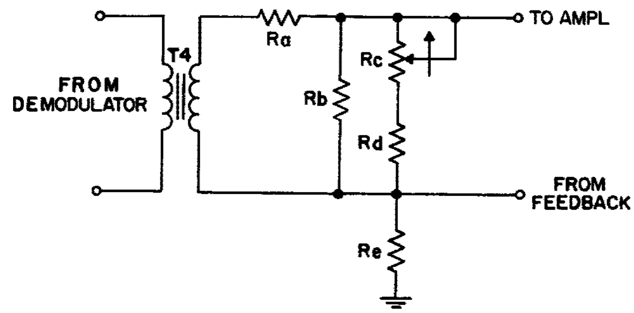


Fig. 8 — Detailed Schematic of the Input Network

3.07 The two networks Ca, Ra and Cb, Rb provide high-frequency shaping to maintain stability at the high end of the frequency range.

3.08 The emitter biasing bypass capacitors provide the necessary low-frequency shaping.

4. TESTING AND MAINTENANCE FEATURES

A. Terminal Mounting

4.01 The terminal mounting is covered in Section 362-801-100.

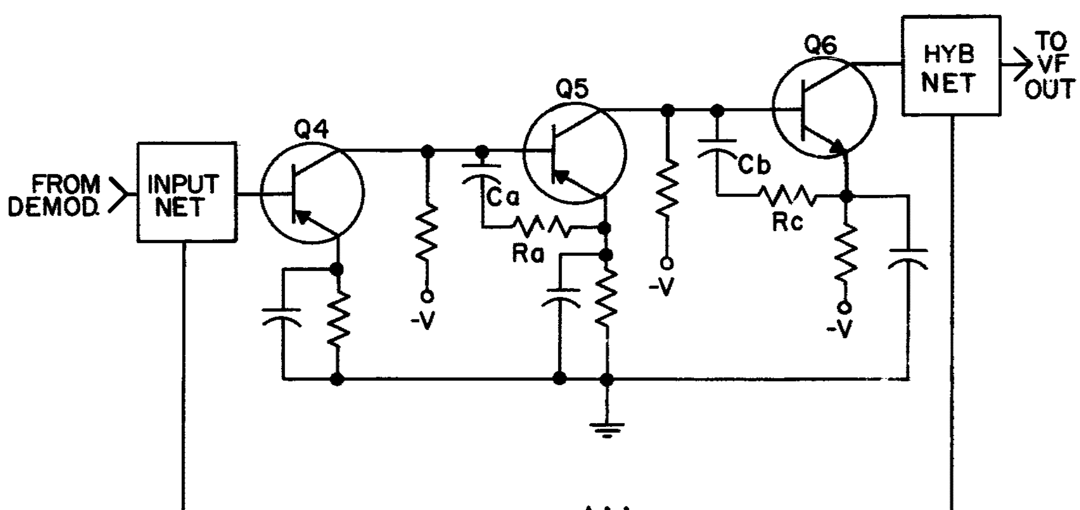


Fig. 9 — Schematic of the Receive Amplifier

4.02 The VF amplifiers are interchangeable plug-in units, all interconnecting wiring being made through a 20-contact plug. The plug pin assignments are:

PIN	ASSIGNMENT
1	Shield ground
2	No connection
3 and 5	Transmit input pair
4	No connection
6	No connection
7	To modulator output
8	Bias test, transmit ampl
9 and 15	Receive ampl output pair
10	No connection
11	−21 volts
12	No connection
13	Circuit ground
14	Bias test, receive ampl
16	No connection
17 and 19	Input from demodulator
18	No connection
20	No connection

B. Test Points and Adjustments

4.03 On the front panel of the VF amplifier are located four test points and two screwdriver adjustments.

4.04 One pair of test points is designated V11 and V12 and allows observation of the transmit amplifier input power. The other pair of test points is designated V01 and V02 and allows observation of the receive amplifier output power.

4.05 The two adjustments are designated IN ADJ for the transmit amplifier and OUT ADJ for the receive amplifier.

4.06 The levels normally encountered in a compandored channel may differ from those used in a noncompandored special service channel; the following levels from the VF amplifier should not be exceeded:

(a) Transmit 8.5 volts as read at the modem unit pin jacks MI and MG.

(b) Receive +18 dbm as read at the VF amplifier pin jacks V01 and V02.

4.07 The adjustment procedure for the VF amplifier is covered in Section 362-808-500.

5. TRANSMISSION PERFORMANCE

A. Frequency Characteristics

5.01 The over-all VF transmission characteristics for an N2 channel are limited by the contributions of several components. The transformers in the VF amplifiers limit the low frequencies below 250 cycles. The upper limit of the VF amplifiers is beyond audibility, but is limited elsewhere in the system beyond 3200 cycles.

B. Limiting Characteristics

5.02 To prevent a strong VF signal from modulating the carrier beyond 100 per cent, it is necessary to provide limiting action. The transmit amplifier is designed to perform this function. The maximum output is limited to approximately 10.0 volts or 2.0 db above normal maximum signal.

6. DRAWINGS

6.01 The following schematic and equipment drawings (not attached) provide detailed information:

DESIGNATION	SUBJECT
SD-99711-01	VF Amplifier Circuit
J99272AA-( )	VF Amplifier Assembly