INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TA-2 FREQUENCY-SHIFT AUDIO TONES

Caution: It is recommened that the user of this equipment become acquainted with the information in this instruction leaflet before connecting the equipment in a relaying system. If the set is mounted in a cabinet, the cabinet must be bolted down to the floor or otherwise secured before swinging out the equipment rack to prevent its tipping over.

APPLICATION

The type TA-2 tones are of the high speed frequency shift type that are used in conjunction with a permissive relaying system. They are applied in either a STU-12 overreaching transfer trip scheme or a SKBU dual-phase comparison scheme for the protection of a transmission line.

The TA-2 equipment may be used directly over a pilot wire pair or may be multiplexed on a microwave or other carrier channel.

CONSTRUCTION

The type TA-2 tone system uses plug-in modules to meet the requirements of a permissive relaying system.

In a typical relaying application, the tone system consists of a transmitter module, a beat frequency oscillator and demodulator module, two receiver modules, (a band pass filter and a frequency shift receiver), an optional AM receiver module for tone deterioration detection, and two noise modules (a band pass filter and an AM receiver module).

Basic construction is shown in Figure 1.

Transmitter Module

The transmitter module consists of a transistor keying circuit, an oscillator, an output amplifier and an output band-pass filter. The band-pass filter and oscillator are the frequency determining components and are contained in a separate plug-in enclosure on the transmitter module.

Beat Frequency Oscillator And Demodulator Module

The beat frequency oscillator and demodulator module consists of an oscillator, a mixing circuit, and an amplifier. The tuned circuits for the beat frequency oscillator are contained in a sealed plug-in assembly. The front panel provides controls for adjustment of the output level frequency, and includes test jacks for monitoring these adjustments.

NEW INFORMATION

EFFECTIVE APRIL 1967

Receiver Filter Module

This module is a band-pass filter which connects the demodulator to the receiver. The sum frequencies of the demodulator and the audio frequency carrier are selected to be passed by the filter.

Frequency Shift Receiver Module

The receiver module consists of a limiting amplifier, a specially tuned discriminator, rectifying and filter circuitry and two d-c amplifiers. A low signal squelch circuit is also included in this module.

AM Receiver Noise Squelch

This module consists of a three-stage amplifier, rectifying and filtering circuitry and an output d-c amplifier. This module is connected to a separate input filter module which is normally tuned for a pass band of 650 to 1050 Hertz.

OPERATION

As shown in Figure 2, the output of a high frequency oscillator in the TA-2 tone set is beat with the output of a lower frequency oscillator. The difference frequency or the translated frequency is applied through a band pass filter to the pilot channel. By keying the transmitter with a voltage, the frequency is shifted from one frequency to a second frequency. At the receiving end of the channel, the incoming audio tone frequency is translated to the higher frequency of the transmitter and is applied to the FS receiver through a band-pass filter. The receiver converts the frequency to a d-c voltage which is applied to the relaying scheme.

In the STU-12 permissive transfer trip scheme, under normal line conditions, a space frequency is obtained from the transmitter terminal. This frequency is lower than the center frequency marked on the unit. At the receiving terminal, this signal is translated to a higher frequency and a spare output is produced from the TA-2 set. When a tripping function is called for, operation of the protective relay shifts the tone transmitter to a higher frequency. This frequency is translated and applied to the pilot wire as a mark frequency which is greater than the center frequency. At the receiving terminal, the reception of the higher frequency produces a mark output from the receiver. Hence, under normal conditions a spare output is obtained and under fault conditions a mark output is obtained. These outputs are applied as inputs to the STU-12 relay which trips the breaker.

In a SKBU phase comparison relaying system, the phase relationship of square wave pulses are compared to determine if a fault is internal or external to the protective transmission line-- a pulse derived from the 60 Hertz current at one line terminal is compared in phase relationship to a pulse received from a remote line terminal. The transmitter is shifted in frequency at a rate equal to the power system frequency. On alternate half cycles, either a mark or space frequency is applied to the pilot channel and is received at the remote terminal. The receiver converts the mark and space frequencies to two d-c pulses which are applied to the SKBU phase comparison relay for comparing to local pulses at the remote terminal.

FS Transmitter - HB-19925-2

The oscillator shown schematically in Figure 3 is tuned to a high frequency relative to the audio tone channel frequency. The output of the oscillator is applied to a balanced modulator circuit which is driven by a beat-frequency oscillator tuned below this oscillator frequency to produce a difference frequency equal to that of the audio tone channel. Both sidebands thus generated are applied to an amplifier having a band-pass filter in the output circuit. The filter rejects the upper sideband and passes the lower sideband to the line. A shift in the frequency of the oscillator when keyed will produce the same amount of shift in cycles of the audio tone output.

The oscillator stage includes transistor Q1 and associated circuit components. The tuned circuit consists of inductance L_o and the capacitor C_M; C_s and C_c are the frequency shifting capacitors. Oscillations from the tuned circuit are coupled to the base of Q1 by capacitor C3. Feedback to the tuned circuit from the collector of Q1 is through resistor R3. The network consisting of C2, R6 and variable resistor R7 allows frequency adjustment by variation of the effective capacity of C2 across a portion of the tuned circuit.

The secondary winding on L_o is center-tapped and serves as a part of the balanced modulator which includes switching transistors Q3 and Q4. The bases of Q3 and Q4 are driven with the beat frequency voltage from a center-tapped winding on the BF Oscillator module. Both sidebands appear across the LEVEL control R10 from which they are coupled to the base of the output amplifier Q2. The band-pass filter in the collector circuit of Q2 rejects the upper sideband and passes the lower sideband to the line.

Capacitors C_c and C_s are strapped in parallel on the circuit board and clamped by Q5, forward biased at the emitter, across L_o to generate a Space frequency. A negative voltage applied to the base of Q5 through divider R17 and R18 will increase the collector-emitter impedance to effectively remove C_s and C_c from L_o. This will leave C_M only across L_o and the carrier frequency will shift to Mark.

BF Oscillator And Demodulator - HB-19905

Three functions are provided in this module.

1. A beat frequency voltage is generated.

2. The received audio tone signal is mixed with the output of the beat frequency oscillator in a balanced modulation circuit for frequency translation.

3. The received audio tone signal is amplified before translation to compensate for losses in the modulator circuit and impedance improving pads.

BF Oscillator

The BF oscillator stage includes transistor Q1 and a tuned LC circuit. Oscillations from the tuned circuit are coupled to the base of Q1 by capacitor C2. Feedback from the collector of Q1 to the tuned circuit is through resistor R1. An RC network consisting of C1, R2 and R3 is connected across a portion of the tuned circuit for frequency trimming purposes; R3 is variable and controls the effective capacity of C1.

Voltage from the tuned circuit is also coupled by capacitor C4 to the base of Q2 which operates as a Class A output amplifier. The tuned transformer in the collector circuit has a center-tapped secondary for applying the switching voltage to the bases of the modulator transistors Q3 and Q4.

Line Amplifier And Demodulator

The audio tone line amplifier consists of transformers T2 and T1, transistors Q5 and Q6 with associated components, a LEVEL control R20, and impedance improving pads R24 through R29. The audio tone signal to the amplifier is applied through a 3-db pad and line isolating transformer T2. The secondary winding of T2 is terminated with R21 and the LEVEL control which applies a base-to-base input signal to Q5 and Q6. Q5 and Q6 are biased to Class A operation. Q5 and Q6 are an emitter-coupled pair with a push-pull output transformer T1 in the collector circuit. The secondary winding of T1 is center-tapped to serve as part of the balanced demodulator circuit which includes switching transistors Q3 and Q4. The load on the secondary winding is a 3-db pad and the receiver band-pass filter. This load is in effect switched across each half of the secondary winding by alternate half cycles of the beat frequency voltage. Thus the amplified audio tone signal from T1 will appear across the load in modulated form as two sideband frequencies; the beat frequency oscillator frequency plus the audio tone frequency, and the beat frequency oscillator frequency minus the audio tone frequency, the beat frequency being suppressed to a low value by balanced modulator action. The lower sideband will be rejected by the receiver band-pass filter, and the upper sideband will be passed to the receiver.

FS Receiver - HB-19915-5

Limiter Amplifier

In the schematic diagram of Figure 3, the limiting amplifier consists of three direct coupled stages. The first stage is an emitter coupled pair of transistors, Q1 and Q2, as a differential amplifier which provides a push-pull signal to the second stage. The second stage includes an emitter-coupled pair, Q3 and Q4, to provide a single-ended output to the third stage Q5. A feedback network from the collector of Q5 to the inverting input of the first stage yields d-c and a-c stability to the amplifier. The signal from the band-pass filter and sensitivity control in parallel is applied to the non-inverting input which has a high impedance characteristic.

Discriminator

The output signal from Q5 is coupled to the base of Q8 by resistors R18 and R21 which also serve to provide a d-c bias voltage to Q8. With full limiting, Q8 is switched on and off at the translated frequency rate, allowing 40 MA peak pulses to energize the tuned discriminator in the collector circuit. The discriminator consists of two parallel tuned circuits resonant at Mark and Space respectively. A secondary winding on each tuned circuit yields a d-c output by means of full wave rectifier diodes. The d-c outputs are connected in series aiding and applied across series resistors R23, R25 and R24, the combination in effect being a bridge circuit. Output from the bridge is taken between the center arm of the BIAS control R25 and the center connections of the secondary windings. As the discriminator is energized with alternate Mark and Space signals, the output will be approximately ± 1.5 volts, and zero volts in the absence of the translated tone signal. C7, L1 and C8 filter the translated tone component from the discriminator output which is applied to the output d-c amplifier.

Low Signal Squelch Circuit

A squelch circuit on the discriminator is provided by Q6, C7 and associated components. In the absence of a carrier signal, Q7 is clamped by a forward base bias through R20; this shunts the base of Q8 the discriminator driver. When the signal from the limiter amplifier is coupled to the rectifier diodes CR1 and CR2 by the emitter follower Q6 a reverse bias voltage is applied through R19 to the base of Q7, causing Q7 to unclamp. The carrier output from Q5 can then drive Q8 to energize the discriminator. The circuit is designed so that the carrier must reach a level high enough to yield a receiver output with very little distortion before Q7 unclamps and permits the discriminator to drive the output d-c amplifier. Hence when the received carrier falls below this level, the discriminator is squelched and receiver output signals cease. This threshold level is determined by the setting of the SENSITIVITY control R2. The value of capacitor C5 determines the speed of operation of the squelching action. Charging is less rapid than discharge in this circuit. As C5 becomes larger, the unclamping action of Q7 is delayed while the clamping time is not increased appreciably. Thus the turn-on time of the receiver can be delayed to make the circuit less vulnerable to noise when the carrier falls below a predetermined level setting of the SENSITIVITY control. The bandwidth, carrier frequency and level of a channel are also determining factors in the speed of operation of the squelch circuit.

Output D-C Amplifier

In the d-c amplifier the output transistors Q14 and Q13 provide push-pull output. They are driven by a two-stage push-pull regenerative circuit consisting of Q10, Q9, Q12 and Q11. The regenerative circuit is monostable due to the unequal resistances in the emitter circuits of Q10 and Q9; Q10 on- Q12 off, and Q9 off- Q11 on. Thus in the absence of discriminator output Q14 is saturated and Q13 is cut off. A Mark signal from the discriminator will maintain the above condition. A Space signal from the discriminator will reverse the conducting states, and Q13 will be saturated while Q14 is cut off. The trigger type of switching action due to regeneration yields fast rise and fall time to the output pulses.

AM Noise Receiver - HB-17840-1

The filter used at the input of the AM receiver is designed to reject the signals of the adjacent channels, to match the receiver input impedance to the line, and to prevent loading of the adjacent channel signals. The filter has approximately 35-db attenuation to the adjacent channel which provides an extra safety margin for operation in case the channel signal levels at the receiver input become unbalanced.

The receiver sensitivity control R1 (see Figure 3) is connected across the output of the filter. This control provides the means by which the receiver sensitivity is adjusted. Two RC coupled stages of amplification using Q1 and Q2 as the active elements follow this control. R3 and R2 set the d-c biasing for the base of Q1 while R5 and R6 provide emitter self-biasing. C3 acts as a bypass for R6. R5 is not bypassed and introduces degeneration into the stage for greater stability of the circuit under varying conditions. R4 is the collector load for the stage. The operation of the second stage involving Q2 is the same. R12 and C4 acts as a decoupling network to prevent self-oscillation in the high-gain receiver.

The third stage acts as an amplifier and driver for the full-wave rectifier stage. T1 is the collector load for Q3 and also matches the impedance of the rectifier circuit to the transistor Q3. The other components of the stage have similar purposes to those described for Q1 or Q2.

With no signal input Q4 is biased to cut-off by means of the voltage divider R19 and R22 and no collector current flows. The rectifier circuit produces a positive voltage output and, if sufficient signal is applied, this voltage overcomes the reverse bias on Q4 and the transistor conducts. C8, C9, and R17 form a low pass RC filter to remove the carrier compoenents.

Carrier Deterioration Detector - HB-17840-10

This is an AM receiver similar to the AM Noise Receiver with the exception of the output circuit. Q4 is removed and the output of the receiver is across two diodes. The output is used to drive a microammeter to determine the signal level of the remote transmitter. It is connected to the output of the wide-band filter of the FS receiver.

CHARACTERISTICS

General

Audio Tone Center Frequencies (Hz): Two terminal line 1500, 2700
Three terminal line 1500, 2180, and 2860

Shift in Frequency: Two terminal line ±300 Hertz
Three terminal line ±170 Hertz

Frequency BF Oscillator: 13.5 kHz

Transmitter Center Frequencies: 15 kHz For 1500 Hz Tone Channel
15.68 kHz For 2180 Hz Tone Channel
16.2 kHz For 2700 Hz Tone Channel
16.36 kHz For 2860 Hz Tone Channel

Operating Temperature: -10°C to +60°C

Storage Temperature: -60°C to +75°C

Operating Time: Two terminal line 2 to 2.5 MS
Three terminal line 3.5 to 4 MS

Energy Requirements: 110 milliamperes at 12 volts d-c

FS Transmitter - HB-19925-2

Output Level: Adjustable from -30 dbm to +2 dbm

Output Impedances: 600 ohms nominal, isolated and balanced

Output Stability: ±1.5 db from -10°C to +60°C

Frequency Stability: ±.25% to +1.5%

Keying Input: -10 volts

FS Receiver - HB-19915-2

Sensitivity: Adjustable from -40 dbm to +6 dbm

Input Impedance: Band-pass filter, 600 ohms nominal

Squelch Circuit: D-C output assumes a mark-hold condition when level falls to the sensitivity setting of receiver.

D-C Output: Push-pull, -10 volt pulses at 5 to 40 MA. Rise and fall times each less than 5 microseconds.

INSTALLATION

The tone assemblies should be mounted on relay racks or in suitable cabinets. The mounting location should be free from dirt, moisture, excessive vibration as well as heat. All electrical connections are made to a connector terminal on the rear of the chassis.

SETTINGS

Transmitter

Only one setting is required on the tone transmitter and that is the output level. This setting is made by using the screwdriver type adjustor marked "level" on transmitter module. In general, the tone transmitters are set to the maximum level allowed by the Telephone Company on the pilot wire or telephone pair.

If zero dbm is the maximum allowance level, a single tone transmitter will be set to that level (0.775 volt into 600 ohms).

The audio output level of the transmitter is measured by connecting a 600-ohm resistor or load across the signal output terminals. No other signal should be present on the line if it is used. The level can be measured at the output terminals using an a-c vacuum-tube voltmeter. The level control is then adjusted for the desired output. After the transmitter is adjusted properly, a VTVM reading should be taken at the "OUT" pin jack on the front panel and recorded for maintenance and check-out purposes. This avoids the necessity of disconnecting the transmitter from the line when levels are to be checked or readjusted.

Demodulator - Level Control

After the remote transmitter has been adjusted, pull out the local transmitter. Check the received signal at top two terminals of the beat frequency oscillator and demodulator module (Hl, Lo). Pull out the local F/S receiver filter and connect a 600-ohm load across demodulator out and Lo (white) terminals. Connect a VTVM across the 600-ohm load, and adjust the level control for 3-dbm above the received signal.

FS Receiver

Plug a d-c voltmeter (at least 20 volt range) into TP norm. and TP comm. of receiver. (The tone transmitters must be previously set to their desired output levels). Connect a VTVM across the tone receiver input terminals (TP Lo and TP Hi) and note the normal received voltage (preferably in db). Now connect a calibrated attenuator (such as the Hewlett-Packard Model 350B Attenuator) between the telephone line and the terminal equipment. Set the attenuator for 12 db attenuation. This value can be checked on the VTVM. If such an attenuator is not available, connect a variable resistor, 500 ohms maximum is adequate, across the incoming line and reduce the resistance until the incoming signal level drops 12 db.

With the level of the incoming tone set 12 db below normal, advance the gain control of the tone receiver by adjusting level control on the receiver module until the receiver output increases suddenly from zero to approximately -12 volts, at this point the squelch has operated to clamp the receiver in a mark state. When the attenuator is removed from the circuit, the tone receiver will have a normal operating point 12 db above the pickup signal level.

AM Receiver Noise Squelch (When Used)

The AM squelch receiver is set in the factory such that an output is obtained across TP out and TP comm. when the noise measured in the 650-1050 band exceeds the FS receiver setting by 5 db (e.g. if frequency shift receiver sensitivity at -32 dbm, AM receiver sensitivity at -27 dbm).

Carrier Level Monitor (When Used)

The following procedure is to be used when an AM receiver is utilized in conjunction with a Weston Model 1082 meter relay to detect a partial deterioration of the tone signal. Since the meter is also calibrated with the AM receiver, these instructions only apply when the meter is used.

a. On AM receiver, set bias control fully counter-clockwise position.

b. Set potentiometer in series with meter to fully counter-clockwise position. (zero resistance)

c. Pull AM receiver module from circuit and adjust zero of meter such that the contacts just close.

d. Push in AM receiver and adjust sensitivity control such that meter is at full-scale deflection with normal received signal. Adjust zero adjustment of meter such that the contacts just close with the normal received signal.

e. Lower incoming signal by 10 db, and adjust sensitivity control of AM receiver such that the meter contacts just make. The meter is now calibrated for a 10 db deterioration of signal.

f. For deterioration levels greater than 10 db, lower the incoming signal to the desired value and adjust the series potentiometer until the meter contacts just make.

ADJUSTMENTS AND MAINTENANCE

(In service procedure to be used in conjunction with SKBU Relay)

1. Beat Frequency Oscillator - frequency control

Check the frequency at bottom two terminals of the BF oscillator and demodulator module (Hl, Lo). Readjust frequency if required to nameplate marking.

2. Transmitter - level and frequency control

   a. Check output of transmitter at terminals of channel equipment. Adjust level control for the desired output.

   b. Check mark and space frequencies at green terminals of F/S transmitter (Hi, Lo). (To key transmitter to mark jumper X_3 to X_{14} of SKBU relay). Readjust transmitter frequency if required so that the space and mark frequencies are approximately correct.

3. Demodulator - level control

   After remote transmitter has been adjusted, pull out local transmitter. Check the received signal at top two terminals (Hi, Lo). Pull out the local F/S receiver filter and connect a 600-ohm load across the demodulator out and Lo (white) terminals. With a VTVM across the 600-ohm load, adjust the level control for 3-dbm above received signal.

4. Frequency Shift Receiver - sensitivity and bias control

   a. Reduce incoming signal by 12-dbm and adjust sensitivity control until the receiver is clamped in a mark state. This can be measured across X_{16} and X_4 of SKBU relay. Also, the dropout of the alarm relay of the SKBU relay can be utilized to determine this point.

   b. Apply sufficient a-c current to pickup the remote fault detector. With oscilloscope across X_9 and X_4 of SKBU relay, adjust bias control of tone set for pulses of approximately 8 milliseconds.

5. Carrier Level Monitor Circuit

   a. On AM receiver, set bias control fully counter-clockwise position.

   b. Set potentiometer in series with meter to full counter-clockwise position. (zero resistance)

   c. Pull AM receiver module from circuit and adjust zero of meter such that the contacts just close.

   d. Push in AM receiver and adjust sensitivity control such that meter is at full-scale deflection with normal received signal. Adjust zero adjustment of meter such that the contacts just close with the normal received signal.

   e. Lower incoming signal by 10 db, and adjust sensitivity control of AM receiver such that the meter contacts just make. The meter is now calibrated for a 10 db deterioration of signal.

   f. For deterioration levels greater than 10 db, lower the incoming signal to the desired value and adjust the series potentiometer until the meter contacts just make.

6. AM Noise Circuit - sensitivity control

a. Set bias control fully counter-clockwise.

b. Pull local and remote transmitters.

c. Apply a 800-cycle signal to channel from external oscillator, and connect d-c voltmeter across X_{17} and X_4 of SKBU relay.

d. Adjust sensitivity control of AM receiver until the d-c voltmeter reads 20 volts when the 800-cycle signal is set at the desired squelch level.

Maintenance

The modules in this equipment use transistors and other components which are conservatively rated for reliability and long life. In normal operation, the monitoring function provides a continuous check on the performance of the equipment. At periodic intervals, it may be desired to check the tripping function. For such a check, the channel may have to be taken out of service to prevent unnecessary breaker operation. The keying circuit may then be closed to check the operation of the tripping relay.

As long as the channel is operating satisfactorily, no maintenance work is necessary other than seeing that the equipment is free of dust or dirt. However, a scheduled routine check will prevent down-time loss, since it may indicate deterioration in the performance of one of the units. If a channel failure occurs because of the terminal equipment, a trouble-shooting procedure should be used similar to that employed for any electronic equipment. First determine where the failure has taken place (transmitter or receiver); then determine the portion of the circuit at fault.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to users who are equipped for doing repair work. When ordering parts, always give the assembly style number and voltage rating, plus the component identification and module in which it is located.

TABLE OF REPLACEABLE PARTS
FS Transmitter HB-19925-2

DIAGRAM SYMBOL	DESCRIPTION	PART NO.
R1-R22	RESISTOR, fixed comp., see Note 5, Fig. 1 and 2.	
R7	RESISTOR, variable, 250K, 0.1 watt, BD taper. CTS Corp., type PE200.	HA-14594
R10	RESISTOR, variable, 500 ohms, 0.125 watt, DB taper. CTS Corp., type PE200.	HA-13573
C1	CAPACITOR, tantalum, 15 uf ± 20%, 25V, Mallory TAM156M025P5C	H-1007-439
C3, C4 C5 and C6	CAPACITOR, tantalum, 33 uf ± 20%, 10V, Mallory TAM336M010P5C.	H-1007-438
C2	CAPACITOR, mica, see Note 4, Fig. 1 and 2 Elmenco Type DM20.	H-1080-X
C7	CAPACITOR, ceramic, 0.47 uf + 80%, -20%, 25V, Sprague 5C11A.	HA-13579
Q1, Q2 Q3 and Q4	TRANSISTOR, germanium, PNP, Texas Inst. 2N1375	HA-17117
Q5, Q6, Q7	TRANSISTOR, silicon, NPN, Texas Inst., 2N706A.	HA-19928
	BP Filter and Osc. Assy. HB-19925 FS Transmitter and Mod.	HB-58200
	Test Jacks, Sealectro Corp., SKT-10.	
	Filter Cable connector, 3-terminal socket, Eby Sales Co.	HA-21091

TABLE OF REPLACEABLE PARTS
BF Oscillator and Demodulator HB-19905

DIAGRAM SYMBOL	DESCRIPTION	RFL PART. NO.
R1-R29	RESISTOR, fixed comp. See Note 6, Fig. 1	
R3	RESISTOR, variable, 250K, 0.1 watt, BD taper. CTS Corp., type PE200.	HA-14594
R20	RESISTOR, variable, 500 ohms ± 20%, .125 watt, BD taper. CTS Corp., type PE200.	HA-13573
C1	CAPACITOR, mica, see Note 5, Fig. 1.	H-1080-#
C2, C3, C4, C5	CAPACITOR, tantalum, 15 uf ± 20%, 25V. Mallory, TAM156M025P5C.	H-1007-439
C6	CAPACITOR, tantalum, 22 uf ± 20%, 15V. Mallory, TAM226M015P5C.	H-1007-494
T1	TRANSFORMER, modulation, 4000 C.T./2400 C.T.	HB-18936
T2	TRANSFORMER, input, 600/600. Microtran, MT1FB.	HA-14791
Q1-Q6	TRANSISTOR, germanium, PNP. Texas Inst., 2N1375.	HA-17117
	BF Oscillator and tuned Transformer assembly, plug-in.	HA-58600
	Test Jacks, Sealectro Corp., SKT10.	

TABLE OF REPLACEABLE PARTS
FS Receiver

DIAGRAM SYMBOL	DESCRIPTION	PART NO.
R1-R35	RESISTOR, fixed comp. See Note 7, Fig. 1	
R2	RESISTOR, variable, 2.8K ± 20%, 0.12 watt, AC taper. CTS Corp., type PE200.	HA-23742
R25	RESISTOR, variable, 1K ± 20%, 0.25 watt, linear taper. CTS Corp., type PE200.	HA-14593
C1, C2, C4	CAPACITOR, tantalum, 22 uf ± 20%, 15V. Mallory, TAM226M015P5C.	H-1007-494
C3, C6	CAPACITOR, tantalum, 56 uf ± 20%, 6V. Mallory, TAM566M006P5C.	H-1007-495
C5, C7, C8	CAPACITOR, tantalum, 0.47 uf ± 10%, 35V. Texas Inst., SCM474FP035D2. See Note 6, Fig. 1	H-1007-511
L1	CHOKE, See Note 6, Fig. 1.	HA-23703
CR1, CR2	DIODE, silicon, 200 PIV., 250 MA Diode, Inc., DI42.	HA-17197
Q1-Q4, Q6-Q14	TRANSISTOR, silicon, NPN. Texas Inst., 2N118	HA-19938
Q5	TRANSISTOR, silicon, PNP. Motorola, MM998.	HA-19751
	DISCRIMINATOR ASSEMBLY, plug-in	HB-58400
	BAND-PASS FILTER module, Channels below 4000 cps.	HB-58300
	TEST JACKS, Sealectro Corp., SKT-10.	

TABLE OF REPLACEABLE PARTS
AM Receiver

DIAGRAM SYMBOL	DESCRIPTION	PART NO.
R2-R19, R22	RESISTOR, fixed comp.: All ±10%, ½ watt, values as shown in Fig. 2. Int. Res. Corp. #GBT-½	H-1009-X
R1	RESISTOR, variable: comp., 5K, .25W, "AC" Taper CTS #PE200.	HA-13572
R20	RESISTOR variable: comp., 2.5K, .25W, "D" Taper CTS #PE200.	HA-13588
C1,C2,C5, C8,C9	CAPACITOR, tantalum: .47 uf, ± 20%, 35V. Tex. Instr. #SCM474FP035A4.	H-1007-433
C3,C6,C7	CAPACITOR, tantalum: 33 uf, ± 20%, 10V., Mallory #TAM336M010P5C.	H-1107-438
C4	CAPACITOR, tantalum: 22 uf, ± 20%, 15V., Mallory #TAM226M015P5C.	H-1107-494
Q1, Q2	TRANSISTOR, PNP: 2N415. G.E. #1415.	HA-21519
Q3	TRANSISTOR, PNP: 2N1414. G.E. #1414.	HA-21514
Q4	TRANSISTOR, NPN: T1493. Tex. Instr. #T1493.	HA-17113
	Jack, Pin: various colors. Sealectro #SKT-10.	
T1	TRANSFORMER: 2000 CT/8000 CT, 150 MW. Berkshire #BTC 5080.	HA-3175
CR1,CR2	DIODE silicon: 200 PIV, 250 MA. Diodes, Inc. #DI42.	HA-17197

N-365513

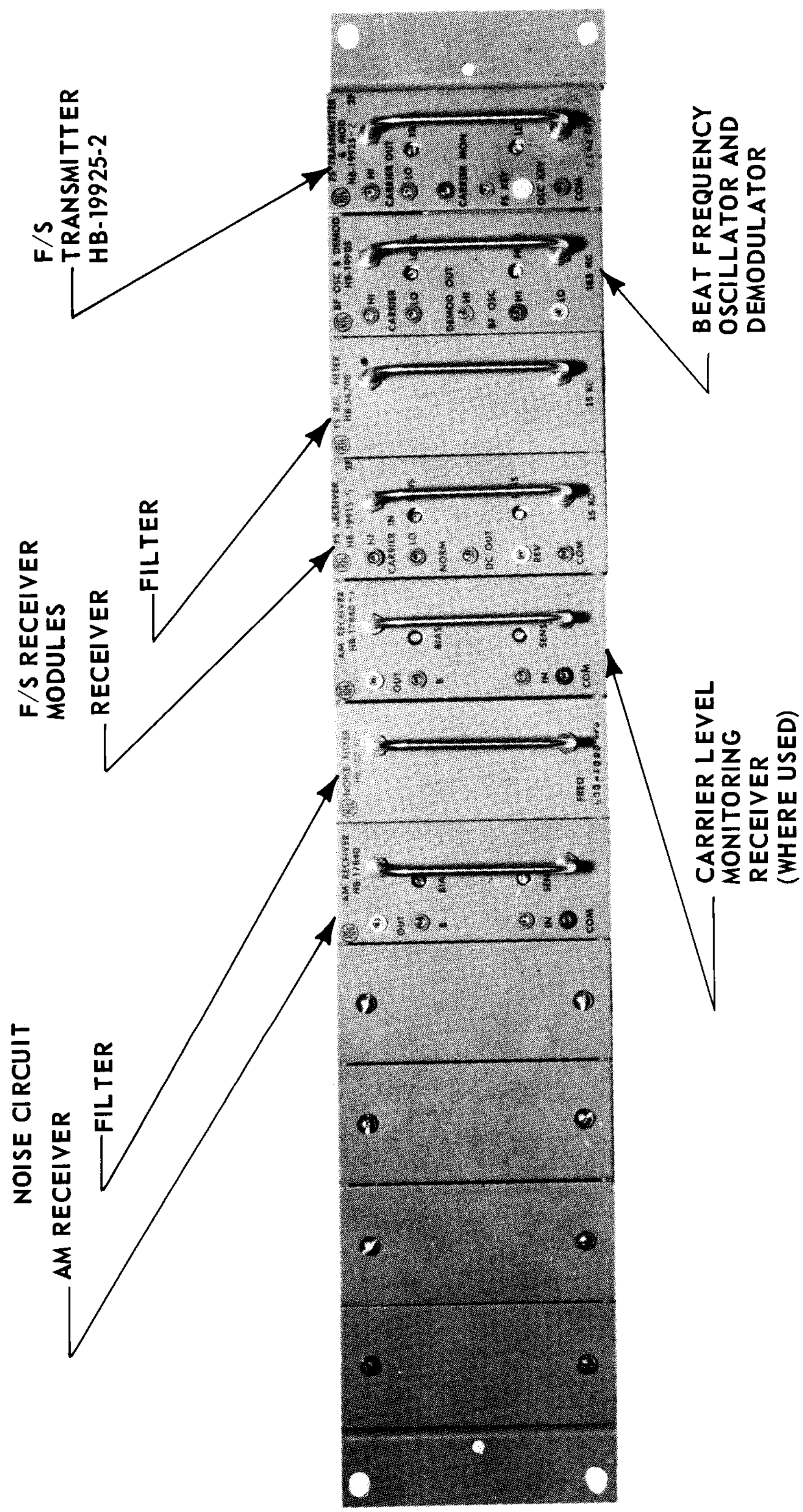
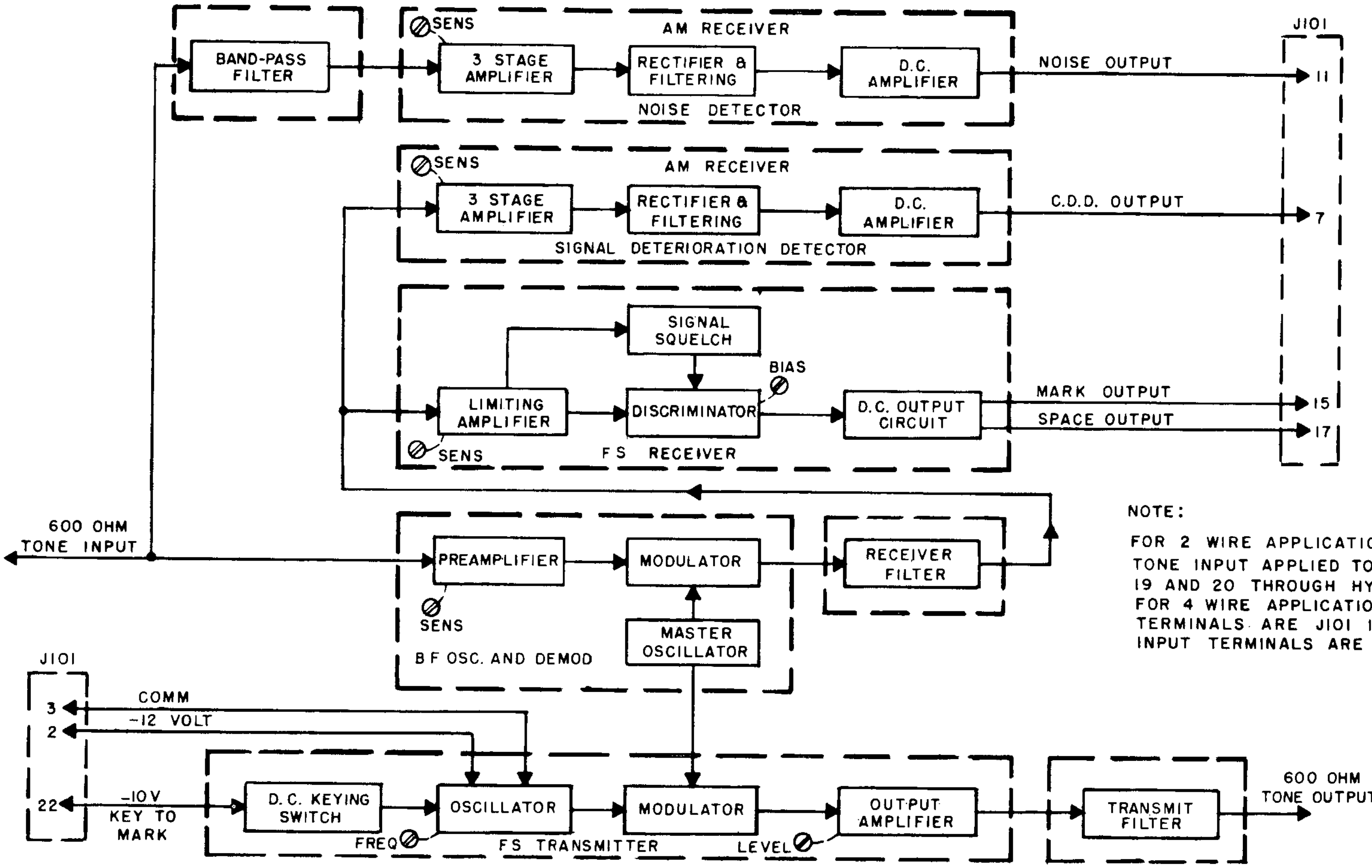


Fig. 1 Front View of Full Chasis.

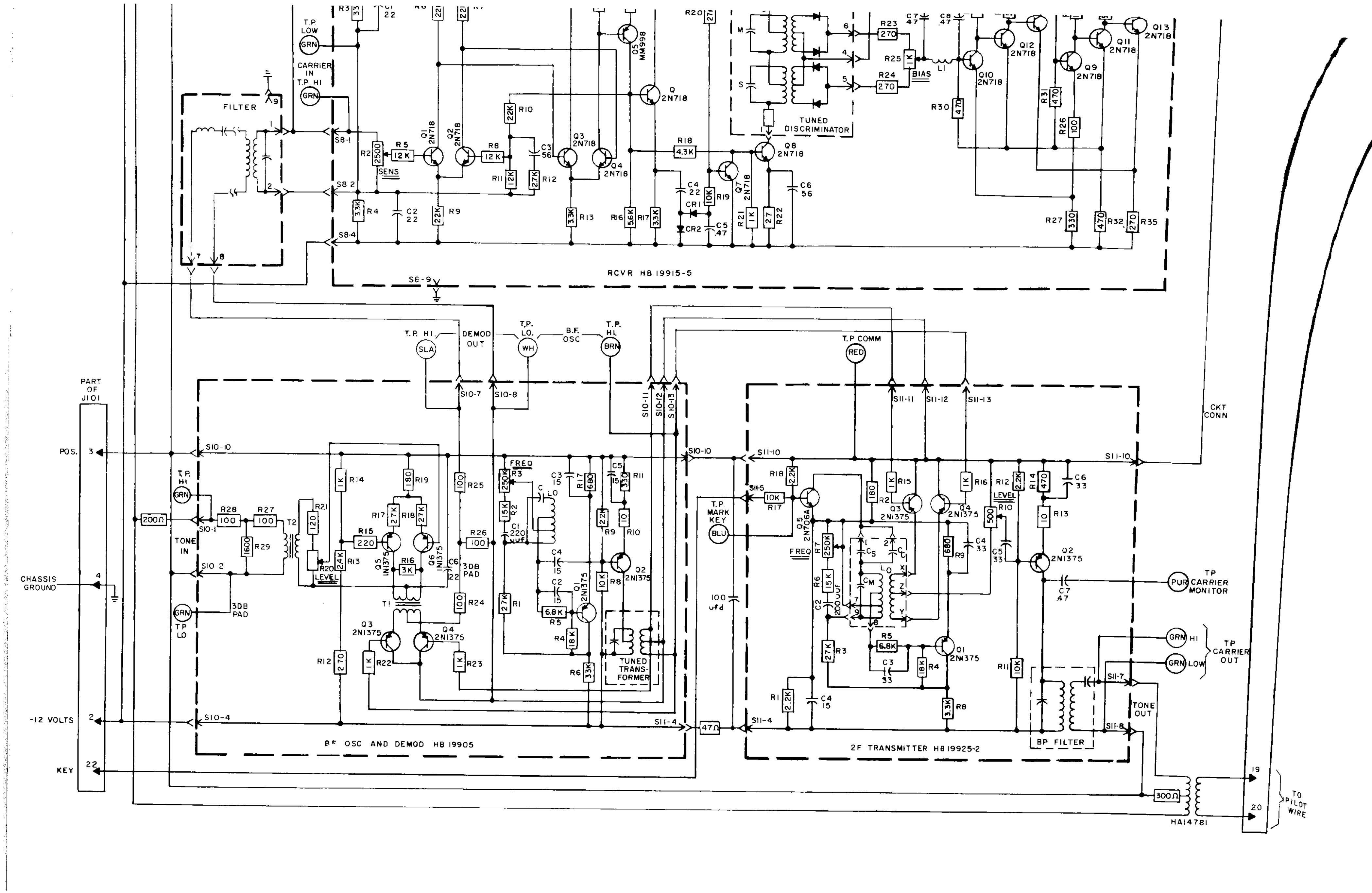


NOTE:

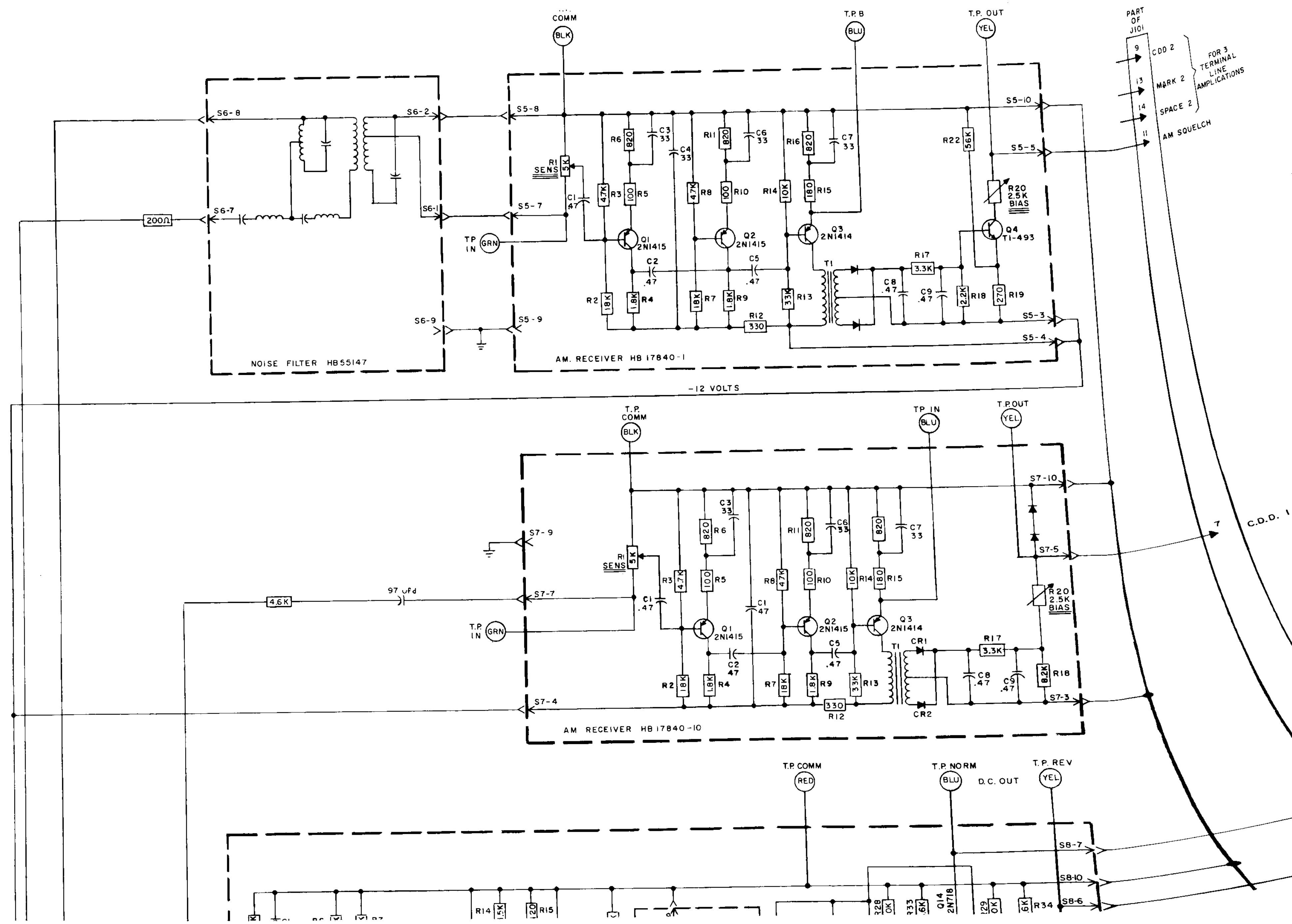
FOR 2 WIRE APPLICATIONS, TONE OUTPUT AND TONE INPUT APPLIED TO PILOT WIRE AT J101 19 AND 20 THROUGH HYBRID UNIT HA-14781. FOR 4 WIRE APPLICATIONS, TONE OUTPUT TERMINALS ARE J101 19 AND 20 AND TONE INPUT TERMINALS ARE J101 5 AND 6.

671B851

Fig. 2 Block Diagram of Type TA-2 Tone Assembly.



PART OF J101
POS. 3
CHASSIS GROUND 4
-12 VOLTS 2
KEY 22
FILTER
RCVR HB 19915-5
TUNED DISCRIMINATOR
T.P. LOW
CARRIER IN T.P. HI
SENS
BIAS
T.P. HI DEMOD OUT
T.P. LO. B.F. OSC
T.P. HI.
T.P COMM
TONE IN
3DB PAD
T.P. HI
T.P. LO
LEVEL
FREQ
TUNED TRANS-FORMER
BF OSC AND DEMOD HB 19905
T.P MARK KEY
2F TRANSMITTER HB19925-2
BP FILTER
TONE OUT
TP CARRIER MONITOR
TP CARRIER OUT
CKT CONN
HA14781
TO PILOT WIRE



NOISE FILTER HB55147
AM. RECEIVER HB 17840-1
AM RECEIVER HB 17840-10
-12 VOLTS
COMM
T.P.B
T.P. OUT
TP IN
T.P. COMM
TP IN
T.P. IN
T.P. COMM
T.P. NORM
D.C. OUT
T.P. REV
200Ω
4.6K
97 ufd
SENS
BIAS
PART OF J101
CDD 2
MARK 2
SPACE 2
AM SQUELCH
FOR 3 TERMINAL LINE AMPLICATIONS
C.D.D. 1

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