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RECEIVER ALIGNMENT (cont'd)

F. **LSB** For SSB alignment use either the transmitter Spot or a signal generator. £n either case make sure the Spot or signal is exactly on center of the channel being used. For LSB set the Receiver dial 1/3 channel below center and adjust C-223 for Zero beat (a null between 2 rising tones). Note the S-Meter reading. Adjust the signal generator level or receiver RF gain so that it is between S-6 and S-9.

G. **USB** Switch the Receiver to USB and tune the dial above the channel until you get the same S-Meter reading as in Step F. Adjust C224 for Zero beat at this point. If USB is now more than 1/2 a channel high go back to F. and set dial 1/4 below center and repeat Steps F and G. If USB is less than 1/4 channel high go back to Step F. and set dial 1/2 channel low then repeat Steps F and G.

LSB and USB may or may not be the same distance from center. It is more important that they be of equal sensitivity as indicated by the S-Meter level.

H. **Overall GAIN CHECK.** Connect a modulated (1000 Hz, 30%) Channel 12 (27.105 MHz) to the receiver antenna terminal. Connect the AC VTVM across the speaker terminals. Adjust the signal generator 0.3 uV. Adjust the receiver volume for a convenient reading on the high end of the VTVM scale. Remove the modulation from the signal generator and the VTVM reading should drop by 10 dB.

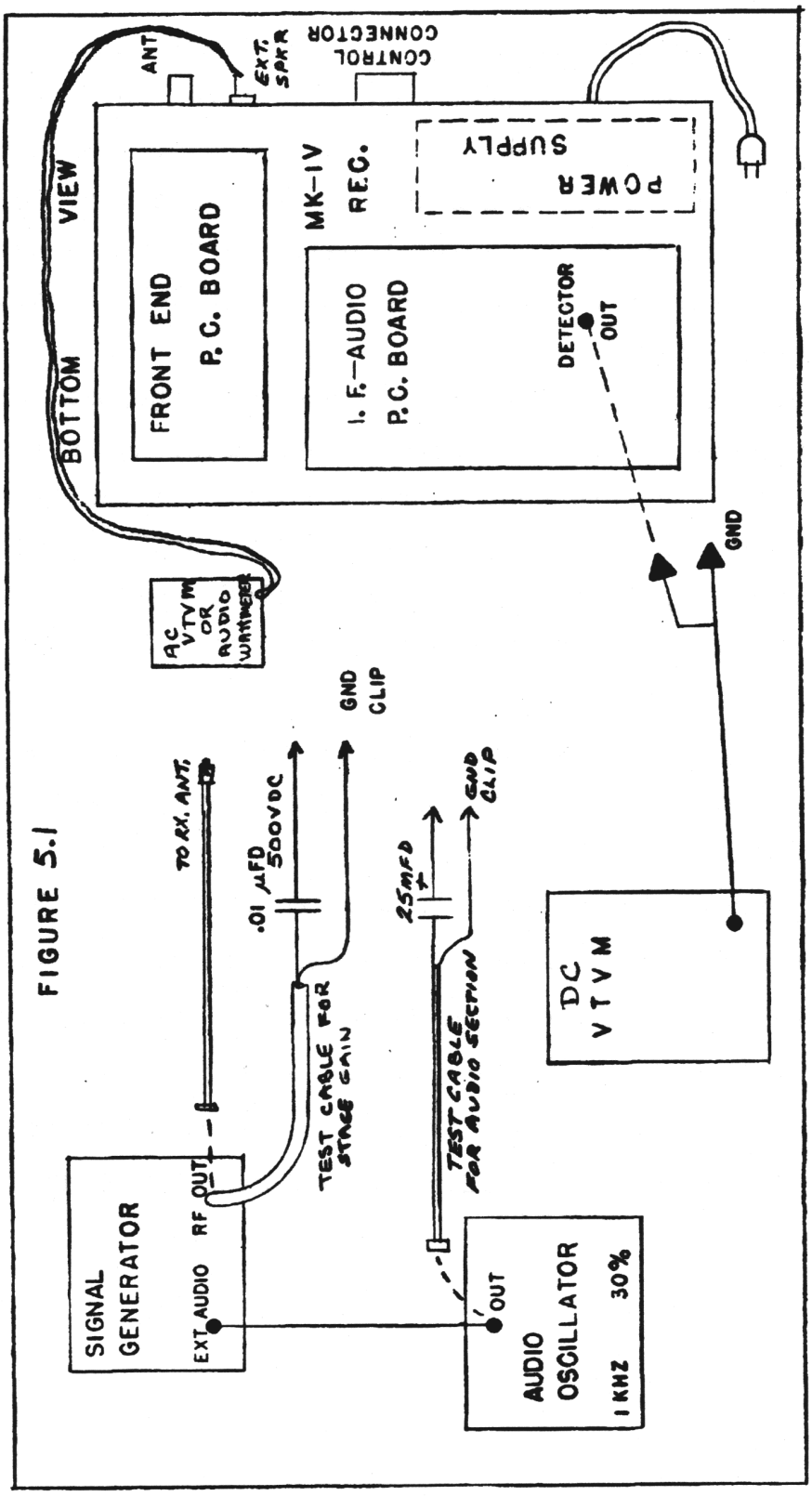


FIGURE 5.1
ANT
EXT. SPKR
CONTROL CONNECTOR
VIEW
BOTTOM
FRONT END P.C. BOARD
MK-IV REC.
POWER SUPPLY
I. F.—AUDIO P.C. BOARD
DETECTOR OUT
GND
AC VTVM OR AUDIO VOLTMETER
GND CLIP
TO RX. ANT.
.01 μFD 500VDC
25MFD
GND CLIP
TEST CABLE FOR STAGE GAIN
TEST CABLE FOR AUDIO SECTION
DC VTVM
SIGNAL GENERATOR
RF OUT
EXT AUDIO
OUT
AUDIO OSCILLATOR
1 KHZ 30%

Figure 5.1

5.3 TRANSMITTER ALIGNMENT

A. EQUIPMENT REQUIRED:

Bird Thruline Model 43 with 25 watt element or equivalent.

50 ohm Dummy Load - Heath Cantenna or equivalent.

Frequency Counter - Frequencies up to 30 MHz with 10HZ accuracy.

DC VTVM.

Monitor Scope Heath SB610 or equivalent
(in line with transmitter output)

AC VTVM. High Frequency (above 27 MHz bandwidth) Scope with low capacity probe.

Audio Oscillator.

Control Box with switch to key transmitter and Audio Cable with switch wired to Amphenol SL-40-4M on one end, other end to Audio Oscillator See Fig. 5-2.

B. PROCEDURE:

1. Preset Controls as follows only for complete Alignment.

A.	Mode SW	LSB
B.	Bias Control:	CCW (rear of chassis)
C.	R219 Mike Gain:	1/2 Turn CW
D.	R318 ALC Control:	CCW
E.	R603 Clipper Control:	CW
F.	Plate Tuning:	1/2 Mesh
G.	Meter Switch:	to MA
H.	C201:	90° Rotation.

2. Connect Cables

   A. Plug Power Cable into Receiver,

   B. Connect SL-40-4M from Control Box to Transmitter (Keying and Audio Switch Off).

   C. Connect RF Wattmeter with Scope and Dummy Load to Antenna.

   D. Connect RX Antenna Cable to Test Receiver.

TRANSMITTER ALIGNMENT (cont'd)

3. Set Bias

   A. Turn Transmitter Power On at Receiver.

   B. Check for Meter Switch in MA Position and Warm up approximately 30 seconds.

   C. Key Transmitter (SW on Keying Box).

   D. Adjust Bias Control so Transmitter Meter Reads to center of Bias Box. (Plate current should equal 29 M.A.)

4. Adjustment for Synthesizer Board

   A. See Fig. 6-1.
   Remove cable with BNC connector from synthesizer output jack.

   B. Connect Counter to synthesizer output jack.

   C. Set Channel Selector to Channel 01.

   D. Connect VTVM to control voltage test point.

   E. Adjust C122 for 1.8V output. Frequency reading should be 21.320 MHz.

   F. Set Channel Selector to Channel 40. Output frequency reading should be 21.760 MHz and control voltage should be 3.0 - 3.4 V.

5. Adjust Carrier Oscillator

   With Transmitter in LSB, connect Frequency Counter to one leg of R204.Tune C201 for 5.645 MHz, exactly.

6. Tune for Output

   A. Turn Audio Switch ON

   B. Set Audio Test Oscillator to 1000 Hz and increase level.

   C. Set Channel Selector to Channel 20.

   D. If you have power reading on the wattmeter go to Step G. If not, connect Scope to input of LSB filter (FL202) and adjust T201 and T202 for Peak.

   E. Connect scope to V302 Pin 2 and adjust T301 and 302 (2 slugs each) for peak.

   F. Connect scope to Antenna Jack (on inside of set. Do not remove Dummy load) and adjust T303 and C602 for peak. If at any point you have power on the wattmeter go to Step G.

   G. RF should be present at Wattmeter, Use Wattmeter for peak from now on.

   H. Set C602 (plate tuning) for Peak on Wattmeter.

   I. Adjust audio level for approx. 3 watts.

   J. Adjust T201 for peak on wattmeter.

TRANSMITTER ALIGNMENT (cont'd)

6. Tune for Output (cont'd)

   K. Adjust T202 for peak on wattmeter

   L. Repeak T301, 2 and 3 for peak on wattmeter. Reduce Audio Input level as needed.

7. SUPPRESS CARRIER

   A. Adjust audio level for 4 watts output.

   B. Remove V203 (12AX7) connect scope to output of T202.

   C. There may be an A.C. ripple with RF riding on it. Adjust R204 and C205 to minimize the RF portion. It should be below 50mv. P-P on both LSB and USE.

   D. Remove scope, install V203, switch back to LSB.

8. CHECK AUDIO CUT OFF FREQUENCY

   A. Set audio level to 4 watts, at 1000 Hz.

   B. On LSB increase AUDIO generator frequency until power drops to 1/10W (at approximately 2900 Hz). Note the exact audio frequency.

   C. Repeat Step B for USB.

   D. Average the two audio frequencies and adjust C201 for 1/10W output at that average frequency. It should now be the same for LSB and USB.

   E. The average audio frequency should be between 2800 - 3000Hz If not, the filter whose frequency in Steps B & C is farthest from 2900 Hz is out of tolerance.

9. CHECK AM POWER

   A. Switch to AM and check for 3.5-4 watts power.

10. CHECK AM MODULATION AND METER FUNCTION

   A. Switch audio on at 1000 Hz and adjust to 100% Modulation. Check for clear audio signal on scope.

   B. Switch meter to Mod and check for full scale reading.

   C. Switch meter to FWD. Adjust SWR calibrate for full scale reading.

   D. D. Switch meter to REF. reading should be under 3 Division.

11. CHECK SSB POWER

   A. Switch to LSB increase audio input until maximum power is obtained. It should be at least 10W (equivalent to 12W PEP with 2 tone test).

TRANSMITTER ALIGNMENT (cont'd)

12. CHECK TRANSMITTER PANEL CONTROL FUNCTIONS

A. Power Cable still in Receiver,
Connect Receiver Antenna cable to Receiver.

B. Key transmitter and check that Receiver cuts off and the "On the Air" light operates.

C. Switch modes to AM, LSB, USE and observe mode indicator lights for operation.

D. Switch Mode to AM with transmitter still keyed.

E. Switch Channel Selector CW and observe Channel numbers counting up 1 - 40 and stop. Transmitter power will shut down when Channel Selector is operated.

F. Switch Channel Selector CCW and observe Channel numbers counting down 40-1 and stop. Transmitter power will shut down when Channel Selector is operated.

G. Switch Test control to LED (CW Position).
All Channel Indicator segments will light up (88)

H. Switch Channel Selector CW and stop at any channel above 1 Switch Test Control to Reset (CCW) Channel Indicator will reset to Channel 1.

I. Set Scan Rate Control full CW.
Switch Channel Selector CW and observe fast scan rate.

J. Set Scan Rate Control full CCW and observe slow scan rate.

K. Channel Selector set on 1 low limit light will operate.

L. Channel Selector set on 40 high limit light will operate.

M. Unkey Transmitter, press spot on AM and LSB, USB (observe Meter on Receiver with transmitter and receiver on same channel). Minimum level on S Meter S6.

N. Install Bottom Plate.

13. FINAL ALIGNMENT
Refer to GEIV Transmitter Test Set Up. Fig. 5-2

Control Settings:

Mode: AM

Close Test Switch 2 (No audio input)

Close Test Switch 1

R219 1/2 Volume

Audio Osc. - 1000 Hz (Check Accuracy)

13. Final Alignment (cont'd)

A. Set transmitter to Ch. 20 and adjust C602 (plate tuning) for peak output.

B. Switch to LSB and readjust bias to center of box. See Sect.3

C. Open Test Switch 2 and adjust audio oscillator level for about 4W output power.

D. Align T301, 302 and 303 for maximum output.

E. Adjust T301 and 302 to obtain approx. equal power on all channels 1-40, should be within 1W at the 3 - 4 W. level. Typical alignment gives 3W. on Ch. 1 and 40 and up to 4W. on channels in between.

F. Increase audio level to obtain max. power, should be 10 W. or better (equivalent to 12W PEP). If you cannot reach approx. 10W repeat Step E. attempting to obtain same 3-4W flat response with less audio input.

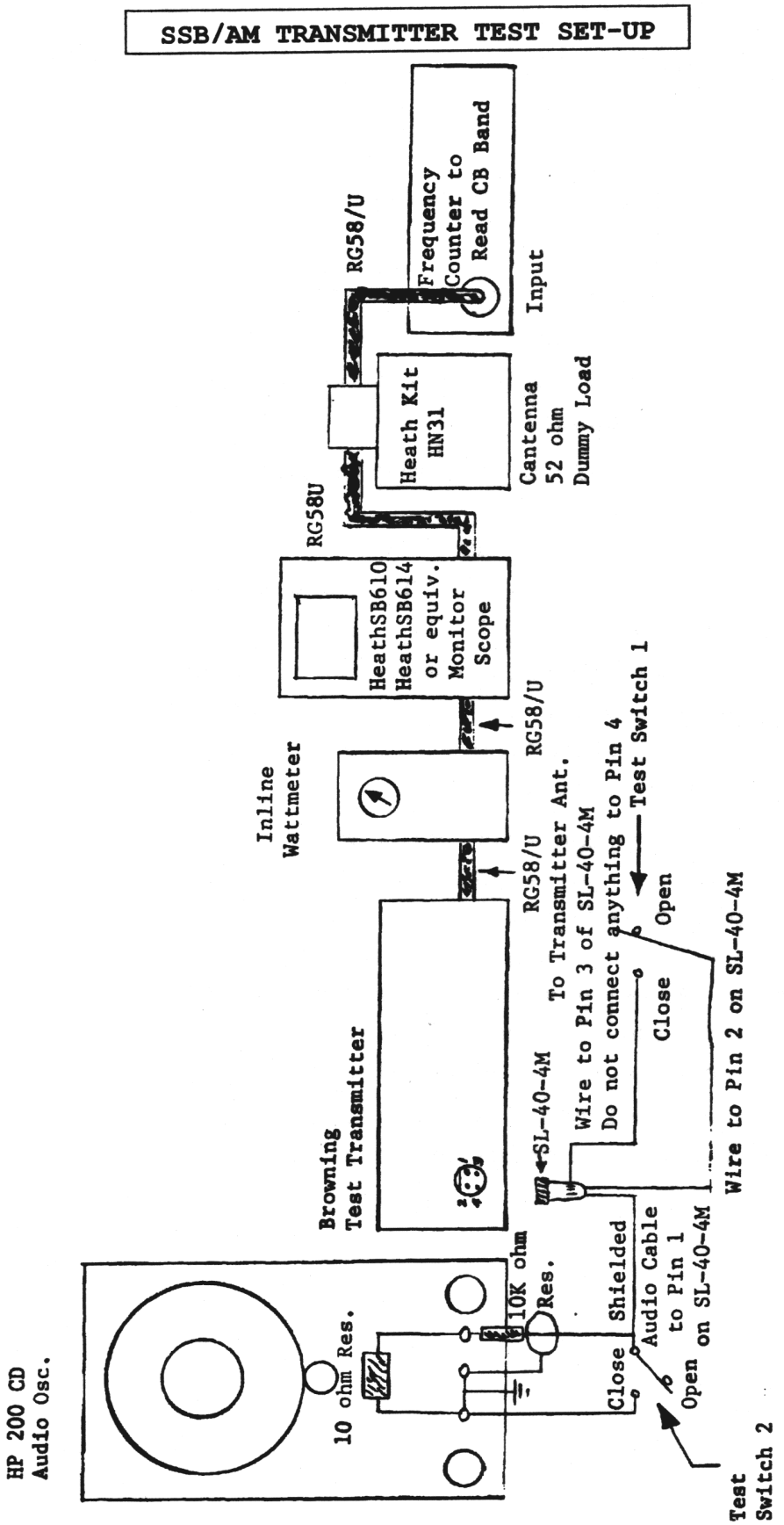
G. Adjust-R318 (SSB ALC control) for 10W.

H. Remove audio and switch to AM. Check for 3.5 W min. from Ch. 1 - 40, should not vary more than .5W.

I. Check output frequency on all 40-channels. +/-.002% tol. Frequency may be adjusted by C101.

J. Disconnect test plug and install microphone. Adjust R219 for 100 modulation on monitor scope with a low voice or Whistle.

K. Adjust R603 (audio clipper) so as not to exceed 100% modulation with a loud voice or whistle.



If other that an HP 200 CD Audio OSC. Is used, it may be necessary to attenuate the signal with a 10 ohm and 10K resistor. Figure 5.2

SECTION 6

SERVICING

6.1 INTEGRATED CIRCUIT TROUBLE SHOOTING

6.1.1 GENERAL

The following information is intended to aid trouble-shooting and isolation of a defective Integrated Circuit (IC). Because an IC can contain as many as 30 or more transistors and more than one function, the input and output conditions are used to qualify a particular IC package.

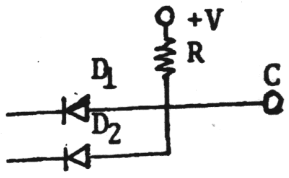
6.1.2 AN OVERVIEW OF LOGIC GATES.

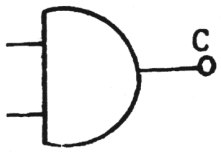
An easy way of understanding Logic Gates is presented below.

6.1.2.A THE AND GATE

A diode-resistor representation is given for ease of understanding. A two input AND gate is shown below:

SCHEMATIC SYMBOL A





The inputs are A and B and the output is C. By subjecting the inputs to all possible combinations, the output and input combinations in a table form make up a Truth Table. Logic has two possible conditions; a Logic 1 represents a +voltage from 2.5V up to 5.0V. A Logic of 0 represents a voltage at or near ground.

6.1.2.A THE AND GATE (continued)

If ground is applied to terminal "A" in the above AND GATE SCHEMATIC, AND TERMINAL "B" is connected to +5V (+V), DIODE D1 will be forward biased and will conduct. Due to its voltage drop, when conducting, Terminal "C" will be one diode drop above ground, (+ .7 volts = Logic "0") This gives us the following portion of the AND GATE TRUTH TABLE:

INPUTS		OUTPUT
A	B	C
0	1	0

If the input conditions are reversed (Ground to "B" and +5v to "A") we see that now D2 conducts and diode D1 will be cutoff and back biased. AGAIN the output AT "C" will be one diode drop above ground and the following portion of the TRUTH TABLE is given:

INPUTS		OUTPUT
A	B	C
1	0	0

If both input terminals are placed to ground, the diode with the lowest diode drop will conduct the heaviest and it will be this diode that sets the output diode drop above ground. This condition gives the following portion to the TRUTH TABLE:

INPUTS		OUTPUT
A	B	C
0	0	0

6.1.2.A THE AND GATE (continued)

Now if both input terminals are tied to +5 (+V) neither of the two diodes will be forward biased and therefore cannot conduct. The output will be +V minus the IR drop across R (Generally between +2.5 and +5V). This gives the final portion of the TRUTH TABLE:

INPUTS		OUTPUT
A	B	C
1	1	1

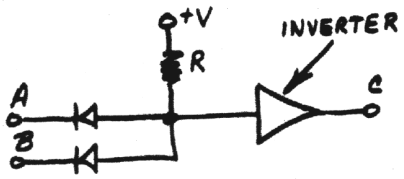
The complete AND GATE TRUTH TABLE is given below

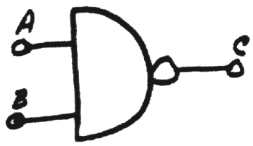
INPUTS		OUTPUT
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

As can be seen from the above TRUTH TABLE the only input conditions that allows a Logic "1" at the Output is when both inputs are at a Logic "1" or +V

6.1.2.B THE NAND GATE

The NAND GATE is a NOT-AND GATE and the only real difference between an AND and a NAND GATE is the NAND GATE contains an AND GATE whose output is passed through an inverter. Using the diode-resistor representation, the schematic and symbol are shown below:





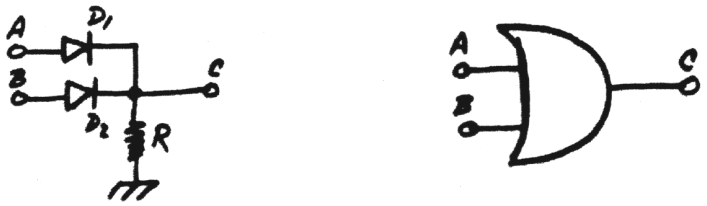
The TRUTH TABLE for a NAND GATE is given below and as can be seen, the only difference from an AND GATE is that all the outputs are "Inverted" (i.e. a "1" becomes a "0" and vice-versa).

INPUTS		OUTPUT
A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

As can be seen the only Input conditions that allow a "0" on the Output, is when both "A" and "B" are at a Logic "1" or +V

6.1.2.C OR GATE

The OR GATE is represented below again in the diode-resistor format for ease of understanding:



A two input OR GATE is shown both in the schematic and symbol form. Again the inputs are terminals A and B and the output is terminal C.

If terminal "A" is connected to +V (+5V) and terminal "B" is grounded; diode D1 will be forward biased and therefore will conduct. Diode D2 will be cutoff. The output at terminal "C" will therefore be +5V - the diode drop or approx. +4.3V, which is a logic "I". This gives the first portion of the OR GATE TRUTH TABLE:

INPUTS		OUTPUT
A	B	C
1	0	1

If the inputs are reversed, (+5V to "B" and ground to "A"), Diode D2 now is forward biased and will conduct and D1 will be reversed biased and cutoff. This again gives an output of +5V - D2 diode drop or approx. +4.3V. The second portion of the TRUTH TABLE becomes:

INPUTS		OUTPUT
A	B	C
0	1	1

If both inputs are connected to +5V, the diode with the lowest drop will conduct the heaviest and its drop will determine the output. This still is approx. +5V - diode drop = +4.3v

AND THE THIRD PORTION OF THE TRUTH TABLE BECOMES:

6.1.2.c OR GATE

INPUTS		OUTPUT
A	B	C
1	1	1

However if both inputs are connected to ground, both diodes will be reversed biased and therefore both will be cut-off. The output then will be the IR drop across R and essentially will be at ground potential the last portion of the TRUTH TABLE IS:

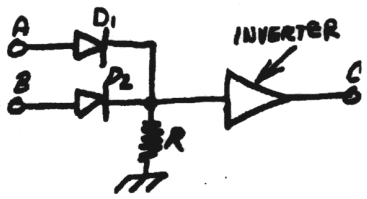
INPUTS		OUTPUT
A	B	C
0	0	0

The complete OR GATE TRUTH TABLE is given below and as can be seen, the only Input condition that will give a Logic "0" on the Output, is when both inputs are also at Logic "0":

INPUTS		OUTPUT
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

6.1.2.D THE NOR GATE

The NOR GATE is a NOT-OR GATE and the only real difference between a NOR and an OR is that the NOR contains an OR GATE whose output is passed through an inverter. Using the diode-resistor representation, the schematic and symbol form are shown below:



The Truth Table for a NOR Gate is given below and as can be seen, the only difference from an OR GATE is that all the outputs are "inverted" (i.e. a "1" becomes a "0" and vice-versa).

INPUTS		OUTPUT
A	B	C
0	0	1
1	0	0
0	1	0
1	1	0

Again note that the only Input condition that allows a "1" on the Output is when both Inputs are at a logical "0"

6.1.2.E DIGITAL LOGIC TROUBLESHOOTING

From the previous discussion on Logic Gates, it can be seen that the input condition must be met in a certain way for a given output--thus the name a "TRUTH" TABLE. Whenever trouble shooting Digital Logic to determine if a particular 1C Logic Gate is functioning properly, check the input conditions and verify the output. Sometimes the Output may seem correct except that its level may be too high or too low. For the devices used in this unit, a Logic "0" output or input should be no higher than +1.0v, and a Logic "1" should be no lower than +2.5v. Because of the small areas between pins on an IC, a short may easily be created and make an input or output appear incorrect--DO NOT assume a bad IC until it has been verified that there are no shorts or opens. A simple VOM may be used to check an IC as long as the Input and Output conditions are stable; in other words, not pulsing. Another key area is to verify that the logic supply voltage is correct. This should be between +4.75 and +5.5v. CATASTROPHIC DAMAGE TO A LARGE NUMBER OF IC's CAN BE DONE IF THE SUPPLY VOLTAGE EXCEEDS +5.5v! When trouble shooting, great care must be taken to prevent shorting any IC pin to another. Several good IC Test Clips are available to aid in trouble shooting. Another word of caution is required in the area of soldering on P.C. boards. Excessive heat may not only damage an IC but may also damage the P.C. board. This may occur in the form of completely removing a "land area" or causing the P.C. board circuit to be completely lifted off the P.C. board material itself! Soldering irons of 30W or less should be used. When soldering, care should be taken not to apply too much solder, the small areas between

6.1.2.E DIGITAL LOGIC TROUBLESHOOTING (continued)

IC pins and the P.C. circuitry may be easily "bridged" and create hard-to-find shorts! The solder used should be 60/40 Resin Core Solder.

6.2 RECEIVER SERVICING

6.2.1 GENERAL

This section covers receiver trouble isolation procedures. A separate TROUBLE-CAUSE section is included for your assistance.

6.2.2 RECEIVER DISASSEMBLY

1. Access to the chassis is gained by removing the four brass screws located on the sides of the dust cover and the three hex-head sheet metal screws located where the lower edge of the dust cover grillwork meets the rear of the chassis.

2. Access to the bottom of the receiver is achieved by removing the three hex-head sheet metal screws located where the lip of the bottom plate extends along the lower edge of the chassis rear and then placing the receiver on its side and removing the four bottom plate screws.

6.2.3 TEST EQUIPMENT REQUIRED

NOTE: EQUIVALENT EQUIPMENT MAY BE SUBSTITUTED

A. VTVM - Heathkit IM-11

B. RF Signal Generator - 0.455 to 54 MHz with attenuated output of 0.1 microvolt to 100 mV and capable of modulationat 1000 Hz at 30%. CLEMENS SG-83C.

C. Oscilloscope - Tektronix 561A

D. Audio Oscillator - H.P. Type 200 CD

E. Frequency Counter - Heath Schlumberger SM-128A

F. A.C. VTVM or Audio Wattmeter - Heath Schlumberger SM-5238

6.2.4. TEST EQUIPMENT CONNECTIONS

SEE FIGURE 5.1 In some instances, the signal generator output maybe placed in series with a 0.01 uF capacitor and this will be indicated where appropriate. Be sure the transmitter control cable is plugged in or the control connector, J2, has Pins #7 and #9 shorted together.

6.2.5 PRELIMINARY RECEIVER TEST

A. Connect the AC - VTVM or Audio wattmeter via a 1/4" phone plug into the external speaker jack. If an AC VTVM is used connect a 4 ohm load of at least 3 watts across its input.

B. Connect the test equipment as illustrated in Figure 5.1.

C. Turn the volume control to minimum (CCW) and the squelch to minimum (CCW).

D. Set the signal generator for 0.3 uV output. Modulate the generator with 1000 Hz at 30%.

E. Short J-2 Pins #7 and 9, if transmitter is not connected to J2.

F. While observing the VTVM, adjust the volume control for a convenient reading - say +15 dB.

G. Now remove the 1000 Hz 30% modulation, and the VTVM should read +5 dB. The other specifications should be met as listed in Section 2.

If these conditions are not met, follow the recommended Receiver checks as outlined in the following text.

6.2.6 AUDIO

A. Connect an audio generator thru a 25uF capacitor to the top of the volume control with an output of 0.8 volts RMS ±10 at 1000 Hz. Be sure the 25uF capacitor is in series with the positive or hot side of the generator. The generator ground lead is connected to the Receiver chassis.

B. Connect the VTVM across the speaker. With the input as in A above, the VTVM should read >+15 dB (4.4V AC). Be sure the squelch is a minimum (CCW) and the Tone Control at Min. (CCW).

6.2.7 SQUELCH

A. Connect the signal generator to the antenna jack (S0239) and set it for .3 uV with 30% modulation then turn the squelch CW just enough to quiet the audio. Then increase the signal generator output until you hear audio again. It should take no more than 4 DB (to .5 uV). If it does change V205. If this does not correct the problem check the voltages on V205 A & B. An incorrect voltage should point to the problem.

B. Set the squelch to MAX. CW and increase the signal generator output by more than 40 DB (above 30 uV.). The squelch should not open with less than 40 DB signal increase. If it does change V205. If this does not correct the problem perform the voltage checks in Sect. C. This should point to the problem.

C. V205	Squelch Full CCW	Squelch Set to Threshold	Squelch Full CW
Pin 1	+45V. DC	+ 35-40V DC	+15V DC
2	+13V. DC	+ 10 V DC	0 V DC
3	+26V. DC	+ 13 V DC	0 V DC
6	+165V. DC	+225 V DC	+225V DC
7	+35V. DC	+ 30 V DC	+13V DC
8	+52V. DC	+ 43 V DC	+42V DC

6.2.8 STAGE GAIN CHECKS (AM RF Gain MAX CW)

In performing stage gain a low reading usually indicates the problem is between point where low reading is obtained and the last good reading. Also see Sect. 6 for proper alignment. The first step in trouble-shooting a weak stage is to change the tube for a known good one. A tube tester is not recommended as even the best ones often indicate that good tubes are weak and vice versa. A. With a VTVM connected at the Jct. of T205, C217, R217, R219 and R229set the VTVM on the -5V .DC range.

B. Set the signal generator for 455 KHz and place a .01 uF capacitor in series with the positive or hot side of the signal generator test cord.