TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT AND GENERAL SUPPORT MAINTENANCE MANUAL

RADIO TRANSMITTING SET AN/FRN-41(V)1 (NSN 5825-01-070-5843)

AND

RADIO TRANSMITTING SET AN/FRN-41(V)2 (NSN 5825-01-070-5842)

HEADQUARTERS, DEPATRMETNT OF THE ARMY

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CHANGE

No. I

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DEPARTMENT OF THE ARMY
WASHINGTON DC, *11 August 1981*

Operator's, Organizational,
Direct and General Support
Maintenance Manual
RADIO TRANSMITTING SET AN/FRN-41(V)1 (NSN 5825-01-070-5843),
RADIO TRANSMITTING SET AN/FRN-41(V)2 (NSN 5825-01-070-5842),
RADIO TRANSMITTING SET AN/FRN-41(V)3 (NSN 5825-01-088-9391),
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AND
RADIO TRANSMITTING TRAINING SET AN/FRN-41(V)T1 (NSN 5825-01-083-7365)

TM 11-5825-266-14-1, 28 January 1980, is changed as follows:

1. Title of manual is changed as above.
2. New or changed material is indicated by a vertical bar in the margin.
3. Remove old pages and insert new pages as indicated below.

Remove	*Insert*
None	A and B
i,ii	i,ii
v through xi	v through xiv
0-1	0-1 through 0-5
5-15 through 5-18	5-15 through 5-18

4. File this change sheet in front of the manual for reference purposes.

By Order of the Secretary of the Army:

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WARNING

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DON'T TAKE CHANCES!

5 SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

1. DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL

2. IF POSSIBLE, TURN OFF THE ELECTRICAL POWER

3. IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A WOODEN POLE OR A ROPE OR SOME OTHER INSULATING MATERIAL

4. SEND FOR HELP AS SOON AS POSSIBLE

5. AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION

TECHNICAL MANUAL

No. 11-582266-14-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC *28 January 1980*

OPERATOR'S, ORGANIZATIONAL,
DIRECT SUPPORT, AND GENERAL SUPPORT
MAINTENANCE MANUAL
RADIO TRANSMITTING SET AN/FRN-41(V)I
(NSN 5825-01-070-5843)

AND

RADIO TRANSMITTING SET AN/FRN-41(V)2
(NSN 5825-01-070-5842)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS
You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSELME-MQ, Fort Monmouth, NJ 07703.

A reply will be furnished direct to you.

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CHAPTER 0

INTRODUCTION

0-1. SCOPE. This set of manuals, TM 11-5825-266-14-1, -14-2, and -14-3 describes Radio Transmitting Sets AN/FRN-41(V)1 through AN/FRN-41(V)4 and Radio Transmitting Training Set AN/FRN-41(V)-T1 and provides instructions for operation and maintenance. Coverage of the AN/FRN-41(V)1 and (V)2 as provided in Chapters 1 through 7; the AN/FRN-41(V)-T1 in Chapter 8; the AN/FRN-41(V)3 and (V)4 in Chapter 9. A Components of End Items List is provided in Appendix B and Maintenance Allocation Chart is provided in Appendix C.

0-2. INDEXES OF PUBLICATIONS.

DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, modification work orders (MWOs), or additional publications pertaining to the equipment.

0-3. MAINTENANCE FORMS, RECORDS, AND REPORTS.

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those described by TM 38-750, The Army Maintenance Management System.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/ NAVMATINST 4355.73/AFR 400-54/MCO 4430.3E.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

0-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR). If your Radio Transmitting Set AN/FRN-41 needs improvement, let us know. Send us an EIR. You, the user, are the onlt one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications and Electronics Materiel Readiness Command and Fort Monmouth, ATTN: DRSEL-ME-MQ, Fort Monmouth, New Jersey 07703. We'll send you a reply.

0-5. ADMINISTRATIVE STORAGE. Administrative storage of equipment issued to and used by Army activities shall be in accordance with TM 11-5825-266-14-3.

0-6. DESTRUCTION OF ARMY ELECTRONICS MATERIEL Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

0-7. DIFFERENCES IN MODELS. There are five nomenclatured configurations of the VOR Radio Navigational Set, A matrix (table 1) indicates the equipment used in each configuration. This variety of configurations allows each individual site to be configured to its particular need. Usable on codes have been established for each conguration. The usable on codes with their applicable configurations apply as indicated below:

DN3 Radio Transmitter Set, AN/FRN-41(V)1 50 watt single systemwith shelter) (See Chapters 1 through 7).

DQ4 Radio Transmitter Set, AN/FRN-41(V)2 (100 watt single system without shelter (See Chapters 1 through 7).

EGP Radio Transmitter Set, AN/FRN-41(V)3 (50 watt dual system with shelter) (See Chapter 9).

EGQ Radio Transmitter Set, AN/FRN-41(V)4 (100 watt dual system without shelter) (See Chapter 9).

EGR Radio Transmitting Training Set, AN/FRN-41(V)-T1 (see Chapter 8).

a. Single System Configuration. The following assemvlies are used in the OT-117/FRN-41(V) for the single system:

Electrical Equipment Rack (lAl) MT-6011/FRN-41(V)

Control Indicator (1A2) C-10527/FRN-41(V)

Phase Modulation Monitor (1A3) ID-2179/FRN-41(V)

Radio Transmitter (1A4) T-1394/FRN-41(V)
Sideband Transmitter (lA5) T-1395/FRN-41(V)

There are no transfer capabilities in the single system; therefore, the RF power monitor panel (part of the electrical equipment rack) contains only three RF power sensors as opposed to the additional transfer switches and dummy loads contained in the dual system RF monitor.

b. Dual System Configuration. The dual system configuration is shown in Figures 5, 6, and 8. The following assemblies are used in the Transmitter Group, OT-124/FRN-41(V) for dual configuration.

Electrical Equipment Rack (lAl) MT-6134/FRN-41

Control Indicator (1A2) C-10527/FRN-41

Phase Modulation Monitor (1A3) ID-2179/FRN-41(V)

Phase Modulation Monitor (1A6) ID-2240/FRN-41(V)

Radio Transmitter (1A4) T-1394/FRN-41(V)

Radio Transmitter (1A7) T-1394/FRN-41(V)

Sideband Transmitter (1A5) T-1395/FRN-41(V)

Sideband Transmitter (1A8) T-1395/FRN-41(V)

The dual system employs an additional Phase Modulation Monitor (1A6) Radio Transmitter (1A7) and Sideband Transmitter (1A8).

(1) Phase Modulation Monitor. The Phase Modulation Monitor (1A6) does not contain a test generator circuit card assembly. The test generator circuit card assembly located on Phase Modulation Monitor (1A3) outputs a composite VOR signal consisting of a 30 Hz variable signal, and a 9960 Hz subcarrier which is FM modulated with a reference 30 Hz signal which is used by both monitors.

(2) Electrical Equipment Rack. The electrical equipment rack is usable for either the dual system or single system configuration. However, the power monitor (which is part of the electrical equipment rack) in the dual system contained circuit components which accomplish RF transfer of the carrier and two sideband outputs, measures incident and reflected power output of the carrier and both sidebands, and provides dummy loads for operation of the standby system. There is no transfer capablity in the single system; therefore, the RF power monitor assembly in the single system contains only three sensors which are used to measure the incident and reflected power output of the carrier and both sidebands. (See table 1 for Electrical Equipment Rack difference data).

REFERENCE DATA. The reference data listed in table 0-1 is applicable for both the dual system configuration as well as for the single system configuration.

TABLE 0-1

A. Radio Transmitting Set, AN/FRN-41 (V)1, 2, 3 and 4 and Radio Transmitting Training Set, AN/FRN-41 (V)-T1.

Unit No.	Nomenclature	Common Name	Configuration V1	V2	V3	V4	T1
1	Transmitter Group (Unit 1) OT-117/FRN-41(V)	VOR Electronic Assy	x	x			x
1	Transmitter Group (Unit 1) OT-124/FRN-41 (V)	VOR Electronic Assy			x	x	
1	Electrical Equipment Rack (1A1) MT-6011/FRN-41 (V)	Electrical Equipment Assy	x	x			x
	Electrical Equipment Rack (1A1) MT-6134/F RN-41 (V)	Electrical Equipment Assy			x	x	
	Control-Indicator (1A2) C-10527/FRN-41(V)	Local Control	x	x	x	x	x
	Phase Modulation Monitor (1A3) ID-2179/FRN-41 (V)	Monitor	x	x	x	x	x
	Phase Modulation Monitor (1A6) ID-2240/FRN41 (V)	Monitor			x	x	
	Radio Transmitter (1A4) T-1394/FRN-41(V)	Carrier Transmitter	x	x	x	x	x
	Radio Transmitter (1A7) T-1394/FRN-41(V)	Carrier Transmitter			x	x	
	Sideband Transmitter (1A5) T-1395/FRN-41(V)	Sideband Transmitter			x	x	
	Sideband Transmitter (1A8) T-1395/FRN-41(V)	Sideband Transmitter			x	x	
2	Radio Frequency Detector (Unit 2) DT-603/FRN-41 (V)	Field Detector	x	x	x	x	
3	Antenna (Unit 3) AS-3323/FRN-41(V)	Antenna	x	x	x	x	
4	Control Indicator (Unit 4) C-10526/FRN-41 (V)	Remote Control	x	x	x	x	
5	Shelter (Unit 5) S-597/FRN-41(V)	Shelter	x		x		
6	Radio Frequency Simulator Detector (Unit 6) SM-774/FRN-41 (V)-T1	Field Detector Simulator					x

B. Phase Modulation Monitor. The following is a list of parts which are not common to both monitors.

Nomenclature	ID-2179/FRN-41 (V)	ID-2240/FRN-41(V)
Plug, P/N 003813-3	x	Not Used
Test Generator Circuit Card Assembly P/N 136531-100	x	Not Used
Rotary Switch, P/N 910235-001	x	Not Used
Knob, MS9152&1P2B	x	Not Used

C. Electrical Equipment Rack.

Nomenclature	MT-6011 /FRN -41 (V)	MT-6135/FRN-41 (V)
RF Transfer Relay, K1-K3, P/N 910198-001		3
Bracket, P/N 136322-001		2
Termination (AT1) P/N 910812-001		1
Connector Adapter, CP1-CP3, P/N 910364-001		3
Buss Strap, P/N 910013-001	1	1
Cable Assembly (W3) P/N 136324-102	1	1
Cable Assembly (E5) P/N 136324-103	1	1
Cable Assembly (W7) P/N 136304-105	1	1
Cable Assembly (W16) P/N 136305-103	1	1
Cable Assembly (W14) P/N 136305-102	1	1
Cable Assembly (W2) P/N 136325-102	1	1
Cable Assembly (W4) P/N 136325-103	1	1
Harness, P/N 136324-100	1	1
Cable Assembly (W6) P/N 136306-104	1	1
Cable Assembly (W8) P/N 136306-105	1	1
Ident Plate, P/N 136028-004	1	1
Rivet, P/N 910384-002	4	4
Diode, IN4148, CR1, CR2, CR3, P/N 910068-001		3
Termination AT2, AT3, P/N 910199-002		2
Screw, PHN 6-32 X 3/8, MS51957-30		4
Cable Clamp, MS21219DG12		1

CHAPTER 1

GENERAL INFORMATION

1-1. GENERAL This manual provides data in the form of text, illustrations and tables necessary for installation, operation and maintenance of the Radio Transmitting Set AN/FRN-41.

1-2. DESCRIPTION AND PURPOSE. The Radio Transmitting Set AN/FRN-41, hereafter referred to as VOR, is part of the 50 watt ground station facility which transmits bearing information to enroute aircraft Cognizant aircraft personnel are then able to measure the angular position of the aircraft with respect to the VOR facility; or, by using information received from two VOR facilities, the aircraft's position can accurately be determined by triangulation computations In addition to the navigational signals radiated by the VOR, provisions are also made for voice transmission over the VOR and automatic identification of the facility. The voice transmission and identification features, as well as the built-in self-test and equipment monitoring functions, are secondary to the principal purpose of navigational transmissions.

1-3. SYSTEM EQUIPMENT DESCRIPTION. The VOR system is comprised of a Transmitter Group OT-117/FRN41, Radio Frequency Detector DT-603/FRN-41, Antenna AS-3323/FRN-41, Control Indicator, C-10526/FRN-41, and Shelter S-597/FRN-41, as shown in figure 1-1. Table 1-1 lists the relationship between the official designated nomenclature and the common names used throughout this manual. The VOR system reference data is detailed in table 1-2. The VOR transmitter group (unit 1) is generally housed inside of a shelter. The antenna is mounted on top of the shelter inside a fiberglassradome with the roof of the shelter acting as a counterpoise. The field detector is mounted on the outside rim of the counterpoise for ground check purposes. For normal operation, the field detector is mounted on a post a short distance from the shelter. This post is located on the 900 or 270° radial relative to the antenna and magnetic north.

Table 1-1. Equipment Nomenclature

Unit No..	Equipment Nomenclature	Common Name
1	Radio Transmitting Set. AN/FRN-41	VOR Electronics Assembly
1Al	Electrical Equipment Rack MT-6011/FRN-41	Electrical Equipment Rack
1A2	Control Indicator C-10527/FRN-41	Local Control
1A3	Phase Modulation Monitor ID-2179/FRN-41	Monitor
1A4	Radio Transmitter T-1394/FRN-41	Carrier Transmitter
1A5	Sideband Transmitter T-1395/FRN-41	Sideband Transmitter
2	Radio Frequency Detector DT-603/FRN-41	Field Detector
3	Antenna AS-3323/FRN-41	Antenna
4	Control Indicator C-10526/FRN-41	Remote Control
5	Shelter S-597/FRN-41	Shelter

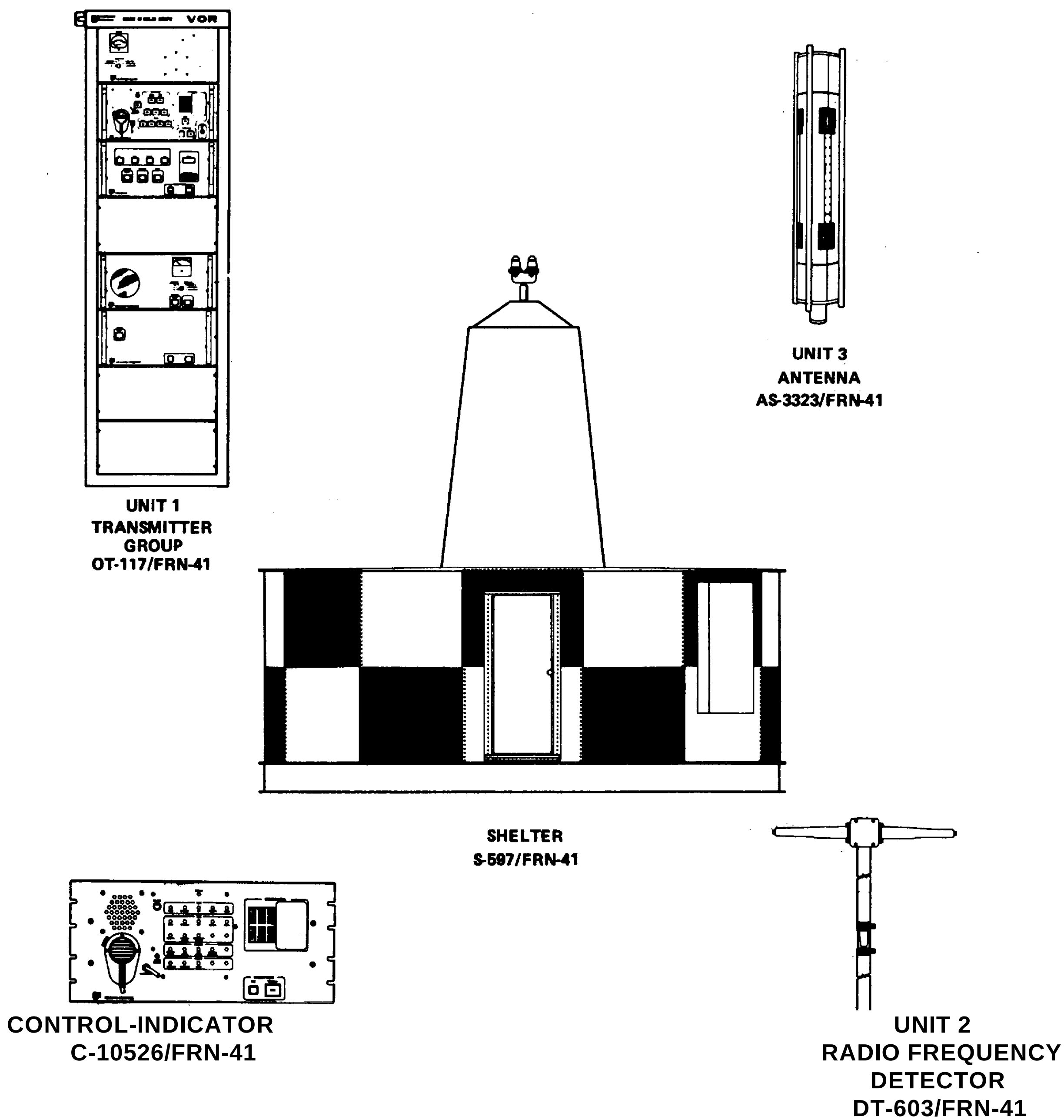


FIGURE1-1 Radio transmitting set AN/FRN-41

Table 1-2. VOR System Reference Data

ITEM	CHARACTERISTICS
GENERAL	
Power Requirements (Transmitter Group)	
Input Power	210 to 260 VRMS or 105 to 130 VRMS
Frequency	47 to 63 Hz
Power Consumption	1200 Watts Max 600 Watts Normal
Frequency	108to.118 MHz
Frequency Stabillty	0.002%
Effective Radiated Power	50 Watts (Army System)
Maximum Range	line of sight
System Azimuth Accuracy	±2.0 degrees
Ground Check Azimuth Accuracy	1.5 degrees
Performance Standrds	Meets or exceeds the standards outlined in FAA Maintenance Handbook 6790-4A, Chapter 3.
Modulation:	
VOR Reference	AM 30 ± 2% with a 9960 Hz + 1% subcarrier which is frequency modulated with 30 Hz ±0.1% at a deviation ratio of 16 ±1. AM on the 9960 Hz subcarrier is less than5%.
VOR Variable	AM, 30 ±2% with a 30 Hz +0.1% signal
Identification	AM adjustable (5% typical) with keyed 1020 Hz ± 1%
Voice Modulation	Audio compression to 30%
Harmonic Radiation	Meets or exceeds USA FCC requirements
Operating Conditions	
Temperature	-10 degrees C to +50 degrees C
Relative Humidity	Up to 95%
Antenna and Field Detector	-55 degrees C to +70 degrees C
TRANSMITTER GROUP OT-117/FRN-41	
PHASE MODULATION MONITOR ID-2179/FRN-41	
Stability	± 0.2° with changes in temperature, supply voltage and frequency
Alarm Parameters	Bearing 9960 Hz subcarrier modulation level 30 Hz variable signal modulation level Identification

Table 1-2. VOR System Reference Data (Contd)

ITEM	CHARACTERISTICS
PHASE MODULATION MONITOR (CONTD)	
Alarm Limits	Bearing Adjustable from ± 0.3 to 4.0 degrees 9960 Hz Subcarrier Detects a 9960 Hz signal level reduction of 15±1% within 30 seconds 30 Hz Variable Signal Detects a 30 Hz signal level reduction of 15± 1% within 30 seconds Identification Detects either the absence of or continuous presence of the 1020 Hz identification tone within 30 seconds
RADIO TRANSMITTER, T-1394/FRN-41	
Carrier power to antenna system	50 watts
Frequency	108-118 MHz in 50 Hz increments
Frequency Stability	± 0.002%
Modulation Distortion	1.0% Maximum
Reference Subcarrier	9960 Hz ± 2 Hz
Subcarrier Modulation	30 Hz ± 0.1%
Carrier Harmonic Suppression	60 dB down minimum
Subcarrier Harmonic Suppression minimum	2nd - 30 dB, 3rd - 50 dB, 4th - 60 dB down
SIDEBAND TRANSMITTER T-1395/FRN-41	
Max Power	Up to 5 watts (adjustable)
Nominal Sideband Modulation	Adjustable to provide 28% to 32% modulation of the carrier output
Sideband Power Symmetry	Adjustable
Sideband Audio Phasing	90 degrees ±2 degrees (Adjustable)
Carrier Suppression	Greater than 30 dB with respect to the carrier
ANTENNA. AS-3323/FRN-41	
Frequency Range	Tunes continuously to any VOR channel from 108 MHz to 118 MHL
Antenna VSWR	The VSWR for the carrier or either sideband Is less than 1.1.
Carrier Power Range	The antenna will handle carrier powers from 0 to 200 watts at altitudes up to 15,000 feet above sea level.
Ambient Temperature Range	The antenna will operate from -55 degrees to +70 degrees C.
Altitude to 200 watts at altitudes up to 15,000 feet above	The antenna will operate at carrier power levels up sea level.
Humidity	The antenna will operate satisfactorily in the presence of 0 to 90% humidity at 50 degrees C. Air from the shelter is circulated up throuqh the antenna and discharged into the radome.

Table 1-2. VOR System Reference Data (Contd)

ITEM	CHARACTERISTICS
ANTENNA (CONTD)	
Vertical Polarization Error	The vertical component radiated by the antenna is down 38 dB below the horizontal energy. This low level results in a vertical polarization error within ± 1 degree.
30 Hz Modulation Level	The 30 Hz modulation level of the antenna is within 28% to 32% and is set by adjusting the modulation level (power output) on the sideband transmitter.
Antenna Pattern	The reference pattern radiated by the antenna is omni-directional within ±0.5 dB. The four lobes are circular. The nulls and equal signal points of the four lobes are within ± 0.5 degree of each other.
Maintainability	The antenna has access provided for all antenna tuning and maintenance adjustments.
Physical Construction	The antenna contains no moving parts. Monocoque construction with aluminum castings and skin is employed.
Input Impedance	The input impedance is 50 ohms.
Counterpoise	The antenna will operate on any size counterpoise larger than one wavelength (9 feet). A 21-foot circular counterpoise is normally provided.

a. System Configuration. The VOR system is comprised of modular units which may be arranged in a variety of configurations in accordance with the requirements of each individual site. The VOR system ground station can be supplied in any of the following configurations:

(1) Dual 50 watt system with dual monitoring (115 Vac or 230 Vac)

(2) Single 50 watt system with single monitoring (115 Vac or 230 Vac)

(3) Dual 100 watt system with dual monitoring. (115 Vac or 230 Vac)

(4) Single 100 watt system with single monitoring. (115 Vac or 230 Vac)

b Difference Data The VOR single system configuration is identical to the VOR dual system configuration with the exceptions as outlined below:

(1) There is no transfer capability in the single system. Therefore, the RF power monitor panel in the single system contains only three RF power sensors as opposed to the additional transfer switches and dummy loads contained in the dual system RF power monitor.

(2) The dual system employs an additional monitor (1A6), carrier transmitter (1A7), and sideband transmitter (1A8). Otherwise, the corresponding components (i.e., monitor 1A3, carrier transmitter 1A4, sideband transmitter 1A5 and field detector, unit 5) are all identical. The local control assembly for both configurations is also identical.

The same interconnection wiring harness is used for both the VOR single and dual systems This manual specifically covers the single system configuration. Each unit is described in detail in the following paragraph.

1-4. TRANSMITTER GROUP, OT-117/FRN-41 (UNIT 1) (reference Figure 1-2) The Transmitter Group, OT-117/FRN-41, is comprised of the following assemblies.

a. Electrical Equipment Rack (1A1) MT-6011/FRN-41

b. Control-Indicator (1A2) C-10527/FRN-41

c. Phase Modulation Monitor (1A3) ID-2179/FRN-41

d. Radio Transmitter (1A4) T-1394/FRN-41

e. Sideband Transmitter (1A5) T-1395/FRN-41

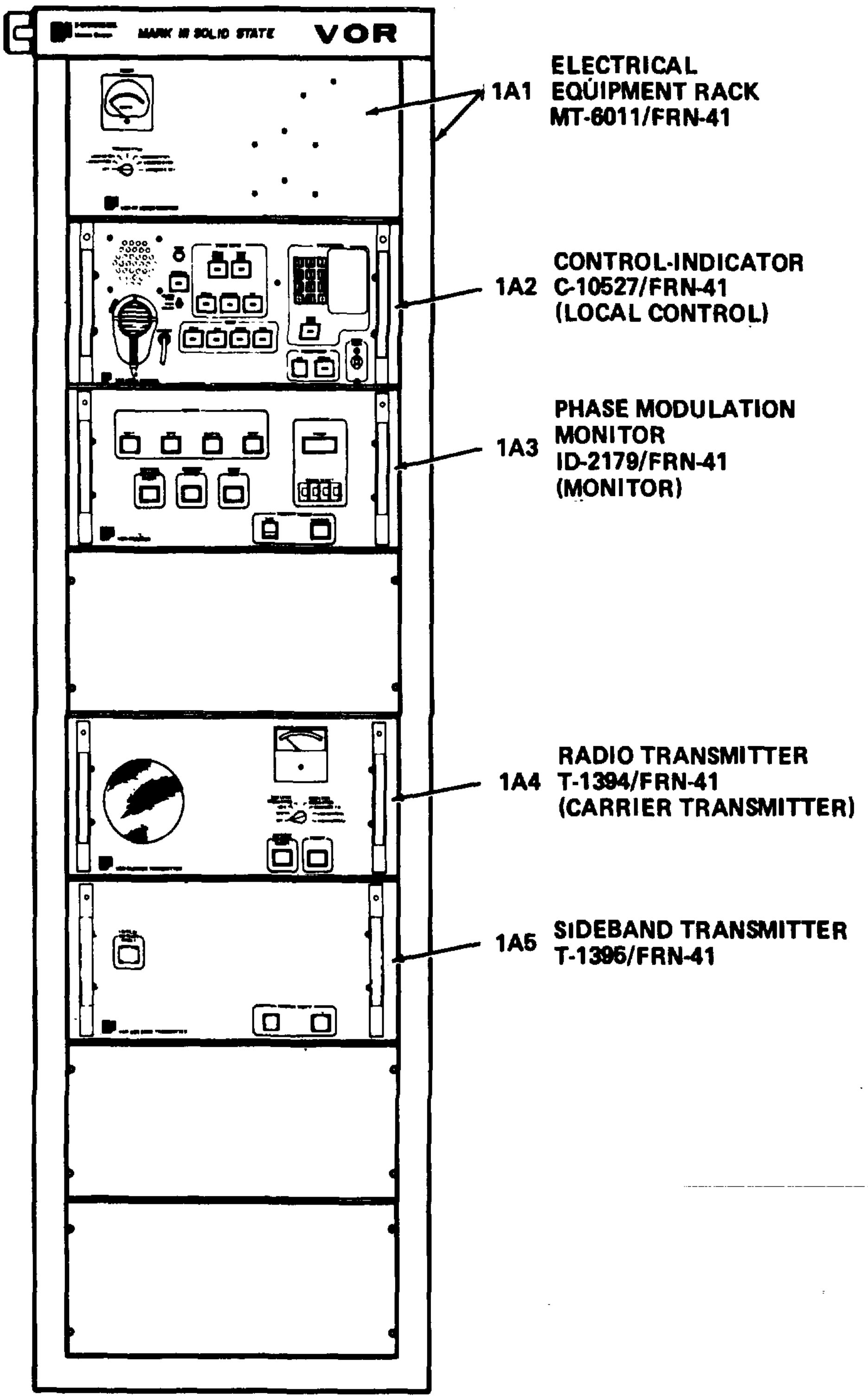


Figure 1-2. Transmitter Group OT-117/FRN-41 (Unit 1)

The electrical equipment rack is a single, 19 inch, cabinet. The RF power monitor panel is part of this assembly. The four drawer assemblies 1A2, 1A3, 1A4 and 1A5 listed above are housed in the electrical equipment rack.

In the single system configuration, blank panels replace the space allocated for the dual configuration assemblies 1A6, 1A7 and 1A8 and may be removed for later expansion to a dual system configuration.

The Transmitter Group OT-117/FRN-41, equipment is all solid state utilizing state-of-the-art CMOS integrated circuits. Each drawer contains built-in self-test and calibration features. System controls are front panel mounted to facilitate maintenance and alignment requirements as well as overall operator control. The local control drawer, the carrier transmitter drawer and the monitor drawer have self-contained power supplies. The sideband transmitter uses a 28 Vdc supply generated in the carrier transmitter. All units, except the RF power monitor, are mounted in the cabinet with drawer slides. Cable retractors are employed for each drawer to avoid harness abrasion. The following subparagraphs provide a description of each major assembly contained in the electronics assembly.

a. Electrical Equipment Rack MT-6011/FRN-41 (1A1). The electrical equipment rack contains the RF power monitor which is a panel mounted unit located at the top of the electronics assembly cabinet. This assembly contains three power sensors. The primary purpose of this assembly is to measure both the forward and reflected power for the two sideband and the main carrier transmitter lines going to the antenna.

A selector switch and power meter are located on the front panel. The selected power measurement is displayed on the meter.

b. Control-Indicator C-10527/FRN-41. The control-indicator, commonly referred to as the local control, provides the interfacing and controls necessary for both local and remote control of all normal DME and VOR system functions. The front panel provides system status indication, alarm indication for VOR parameters, and system control. Local commands are entered via a keyboard. The local control interfaces with the Control-Indicator, C-10526/FRN-41, commonly referred to as the remote control unit via a telephone line (a microwave link may be part of the telephone line).

Status and control data are interfaced between the local/remote system over telephone lines by modulated frequency shift keying (FSK) serial data. The system also has the ability to send voice from the local control unit to the remote control unit for maintenance purposes. In addition to the voice transmission, there is an interface capability for a customer supplied communications receiver. This interface capability allows communication from the aircraft to be processed through the communications receiver into the VOR local control. The communication is then sent to the remote site via the 4-wire twisted pair telephone lines, microwave, etc. If the communications receiver is used, the circuit can be programmed for the communications receiver voice to have priority over intercom transmissions.

In addition to the status and control indications and the voice transmission capability, the local/remote system is also capable of transmitting the ident tone over the intercom. The ident tone can be controlled ON or OFF through the keyboard on the local control front panel. In addition, the system will also receive voice transmissions from the remote site and output it over a speaker located on the local control front panel for intercom use or a 2870 Hz key tone will switch the voice to modulate the VOR transmitter which broadcasts voice to aircraft in the range of the VOR station.

c. Phase Modulation Monitor, ID-2179/FRN-41 (1A3). The monitor drawer provides monitoring of the radiated VOR signal through a remote field detector. The performance of the VOR is evaluated by monitoring the following four parameters:

(1) 30 Hz modulation level

(2) 9960 Hz modulation level

(3) Bearing

(4) Identification

The monitor can also be used as test equipment for ground check of the VOR station. As an option, the monitor can be supplied with a VOR test generator as an integral part of the circuitry.

All normal monitor functions are controlled from the local control assembly. The monitor measures the four most critical system parameters and indicates the status of each by a green indicator light on the front panel. In addition, a LED display indicates the actual bearing error. When the parameters are within the specified limits, the green indicators will be illuminated. An alarm condition is indicated when one or more of the green lights are extinguished. When an alarm is indicated by the monitor, a logic signal is sent to the local control drawer for further action (system transfer or shutdown). A test generator circuit card assembly is also incorporated in the monitor. This assembly is self-contained with the exception that a radial select switch is mounted on the monitor drawer meter panel. This assembly is used to verify the monitor calibration between flight inspections. Four additional indicators are on the monitor front panel. A green light indicates ac power on. The CRITICAL SWITCHES MISSET (red) indicator illuminates when any switch on the monitor is in any position other than normal. An amber light indicates when the monitor has been bypassed (i.e., the input switch is not in the NORM position) and a blue light indicates when the identification signal is being transmitted. A four digit, thumb-wheel switch is provided to select the radial which is being monitored. The test meter, test points, calibration switches and other adjustments are accessible for maintenance with the drawer withdrawn. Manual operation of the monitor is possible with the power switch inside the drawer.

d. Radio Transmitter T-1394/FRN-41 (1A4) - The radio transmitter, T-1394/FRN-41, generates the carrier signal for the composite VOR signal. The carrier transmitter output consists of the carrier RF signal (at the assigned VOR frequency) amplitude modulated by a 9960 Hz subcarrier, which is FM modulated by the 30 Hz reference signal. The carrier signal is radiated omni-directionally and provides the 30 Hz reference signal. The carrier signal is also amplitude modulated with external voice and identity information.

All normal system functions are controlled through the local/remote system. The front panel provides visual status indicators for power-on, critical switches misset and transmitter status (carrier amp on or off).

The identification keyer is all solid state and the identification codes are changed by adding or removing jumpers.

e. Sideband Transmitter T-1395/FRN-41 (1A5) - The sideband transmitter replaces the conventional mechanical goniometer. It electronically generates, with all solid state circuitry, two amplitude modulated suppressed carrier double sideband signals. These signals are modulated in time quadrature at 30 Hz and when fed to the antenna and combined with the carrier, result in the total VOR signal.

All normal sideband transmitter functions are controlled through the local/remote system. The front panel provides visual status indicators for power on (green) and critical switches misset (red). A test meter, test points, tuning controls, phasing adjustments, and switches for manual operation are accessible when the sideband transmitter drawer is withdrawn.

1-5. RADIO FREQUENCY DETECTOR DT-603/FRN-41 (UNIT 2) - The Radio Frequency Detector, DT-603/FRN-41, (reference figure 1-3) provides the capability to continuously monitor the radiated antenna signal. The field detector is mounted on a post at a specified distance from the antenna for normal operation or on the top outside edge of the counterpoise during ground checks. The radiated antenna signal is intercepted and demodulated at one of two predetermined radials (90º or 270º radial). The demodulated signal is routed to the monitor for evaluation of the following signal parameters: reference signal, variable signal, modulation levels, bearing accuracy and identification.

1-6. ANTENNA AS-3323/FRN-41 (UNIT 3) The antenna supplied with the VOR is a stationary cylindrical slot antenna (reference figure 1-4). The antenna radiates two figure-eight patterns at right angles to each other. These two patterns are fed with sidebands that are modulated, in time quadrature, at 30 Hz which results in a rotating figure-eight pattern. This signal is combined with the omni-directionally radiated carrier signal to generate the rotating VOR pattern.

The antenna is constructed to eliminate the problems normally experienced in service with corrosion. The antenna utilizes all aluminum construction throughout. Sideband RF feed lines are rigid coax with specially designed fittings and joints. Joints between dissimilar metals have been avoided. The antenna is

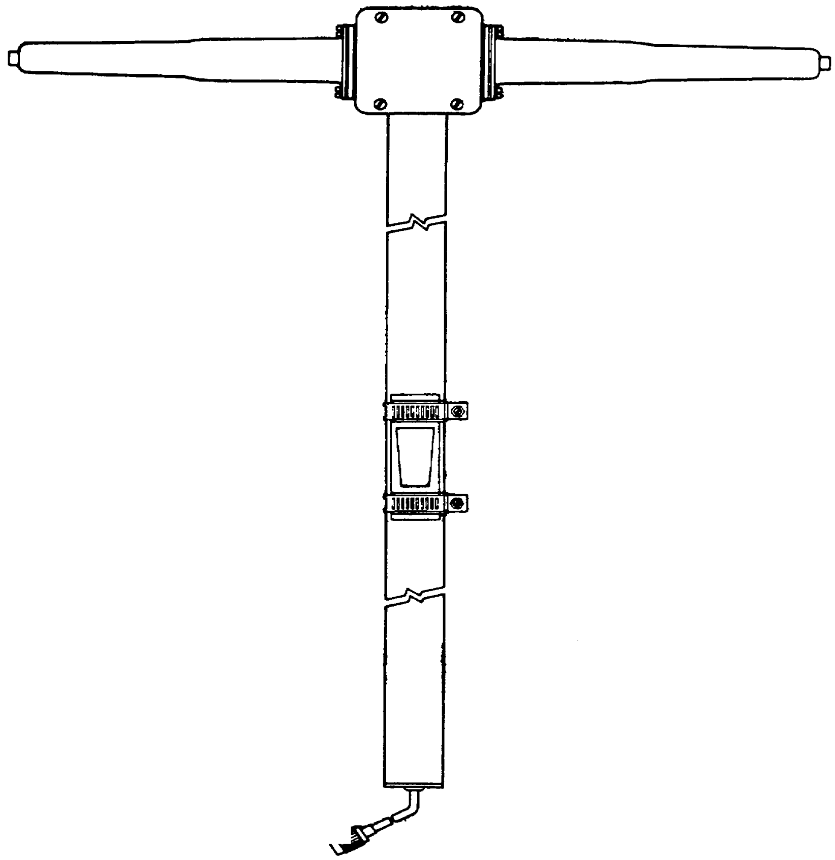


Figure 1-3. Radio Frequency Detector DT-603/FRN-41

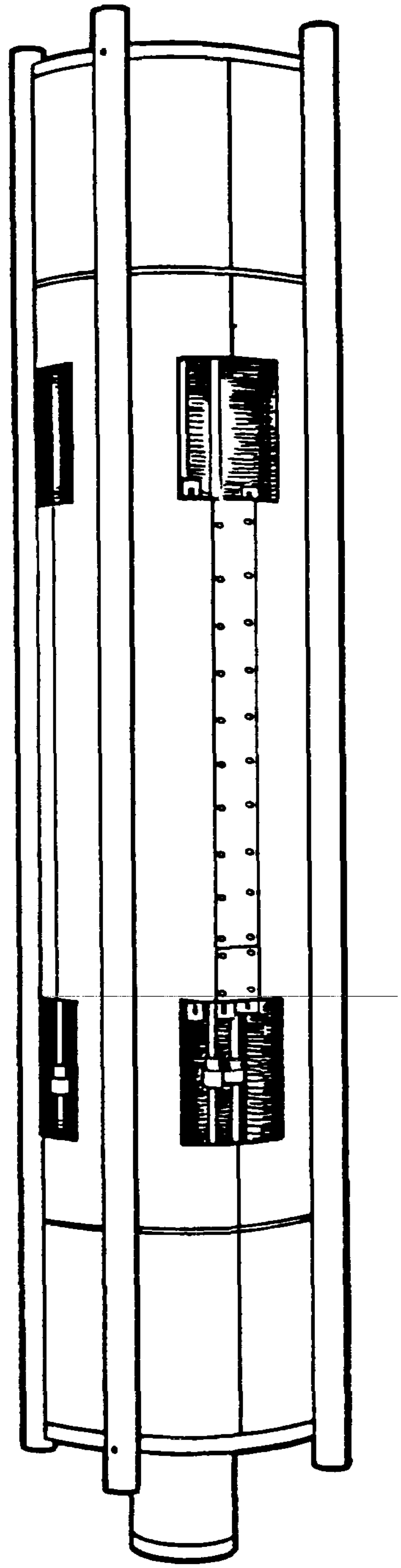


Figure 14. Antenna AS3323/FRN41 (Unit 3)

easily tuned by adjustment of the bridges and slugs and installation of the proper shunts. The antenna is housed in a fiberglass, walk-in radome. Nylon bolts are used to join the sections and secure the door. The radome includes provisions for mounting obstruction lights, a collocated DME antenna or TACAN antenna. The slot antenna includes four conduits up the outside for obstruction lights and collocated DME or TACAN cables

1-7. CONTROL-INDICATOR. C-10256/FRN-41 (UNIT 4). The control-indicator, commonly referred to as the remote control unit (reference figure 1-5) provides complete remote control and status Indication for the VOR and DME. This unit allows a VOR/DME facility to be unmanned and remotely controlled via a telephone link. In addition to displaying the VOR/DME site status indications, the remote control is capable of several command functions. The command functions for the DME are to select the No. 1 transponder as the main "on air" transponder, to select the No. 2 transponder as the main "on air" transponder, to command both transponders to standby, or to completely shutdown both transponders. Whichever transponder is selected as the "on air" transponder, the alternate automatically becomes the "standby" transponder. The command functions for the VOR are almost identical to the DME except there is not a separate command which commands both transmitters to a standby condition. The obstruction lights on the shelter can also be commanded on or off using the keyboard. Remote status data provide a visual indication of normal operation, primary alarm and DME secondary alarm. The remote control command functions are activated using the keyboard.

The remote control unit also has the capability to function as a communications buffer between a flight service center operator (equipped with an auxiliary/remote indicator panel which interfaces with the remote control unit) via the VOR to aircraft in the vicinity. Aircraft voice transmission is received at the VOR site by a collocated communication receiver and transmitted through the VOR local control to the remote control unit and can go on to an auxiliary indicator/voice panel or other applicable equipment for use by a flight service center operator. The remote control unit is also equipped for two-way voice intercom transmission between the remote and local site with the air traffic operator given priority to interrupt intercom conversation as necessary.

There is also a capability to accept Air Traffic Information System (ATIS) (recorded flight, weather information) and send the voice on to be broadcast from the VOR transmitter. The intercom and air traffic operator both have priority to interrupt ATIS.

1-8. VOR SHELTER ASSEMBLY. The VOR Shelter Assembly (P/N 136131-100) consists of the shelter, the environmental control unit and the power distribution box.

a. Shelter (reference figure 1-6). The shelter consists of prefabricated metal sections assembled around a concrete base. The shelter is 21 feet (6.4008 meters) in diameter. The circular metal shelter houses the radio transmitter set with the slotted antenna mounted on the roof protected by a fiberglass radome. The field detector unit is located on the outside rim on top of the shelter at a predetermined specified

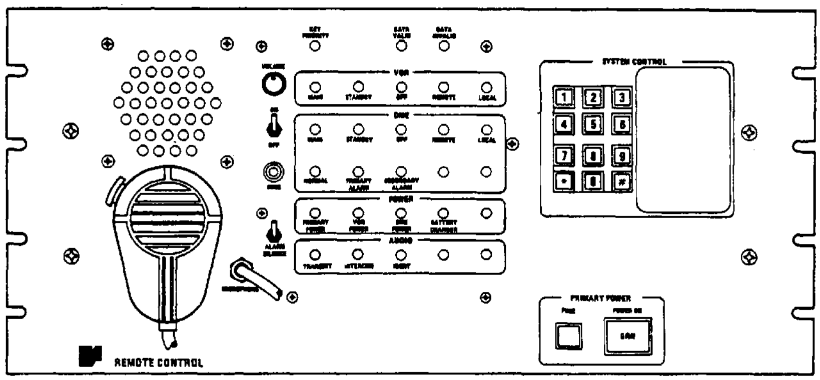


Figure 1-5. Control-Indicator C-10526/FRN-41

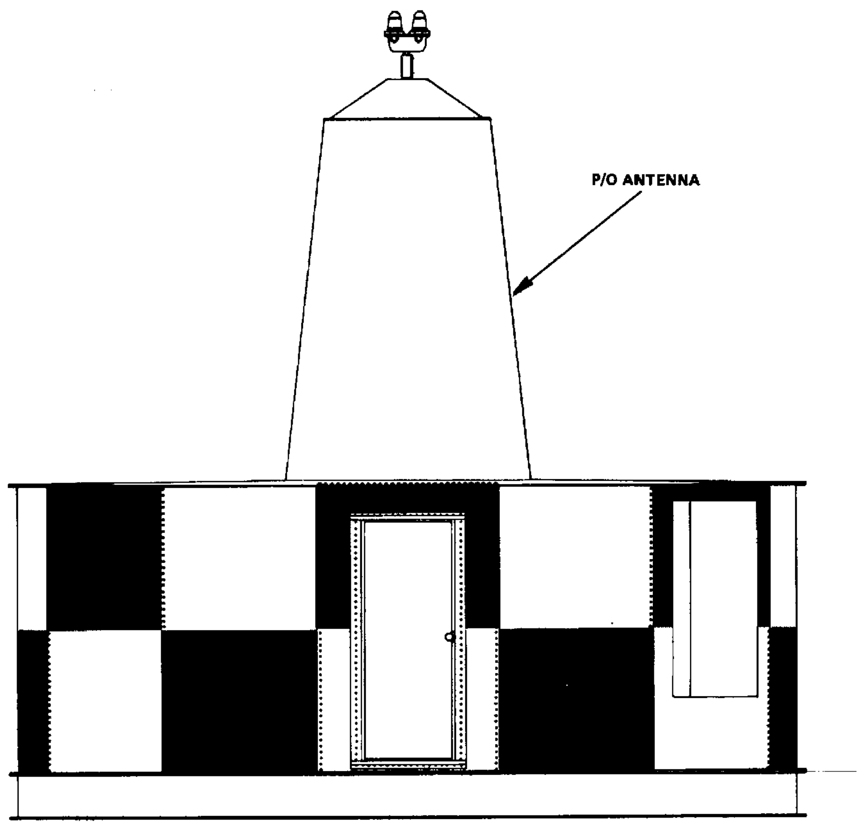


Figure 1-6. Shelter S-597/FRN41

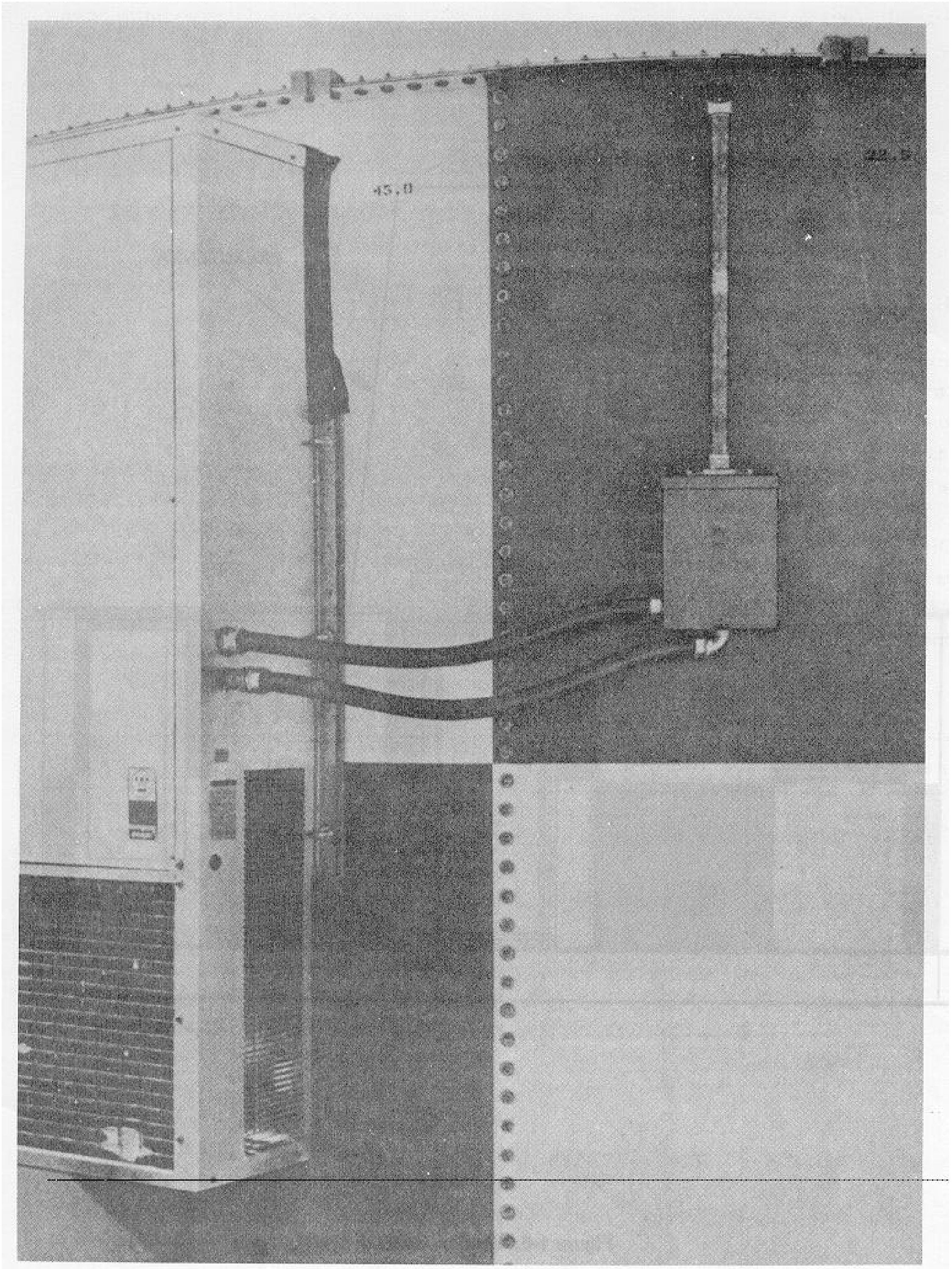


Figure 1-7. Environmental Control Unit

radial during ground checks. The pedestal is the hub of the shelter and also supports the antenna. The hollow pedestal directs the antenna cabling into the shelter. Other external cabling for the primary power and remote control lines are directed into the shelter via conduit buried in the floor.

b. Environmental Control Unit (reference figure 1-7). The environmental control unit consists of an air conditioning unit with a built-in supplementary heater. The shelter is thermostatically controlled by a 24 volt thermostat mounted on a wall of the shelter. The environmental control unit enclosure is embossed, anodized aluminum which prevents rust and does not require painting.

c. Power Distribution Box. The power distribution box contains circuit breakers which apply operating power to all of the equipment contained in the shelter.

1-9. RELATED PUBLICATIONS AND REFERENCE DATA. This manual contains specific information relating to the VOR single system configuration equipment. Applicable data contained in existing publications are not duplicated in this manual; therefore, all related publications listed in table 1-2 must be used in conjunction with this manual to provide complete disclosure of service and maintenance data. Reference data for the environmental control unit is contained in the appendices of this manual.

1-10. DIFFERENCE BETWEEN MODELS. The radio transmitting set is available in two different models referred to as AN/FRN-41(V1) and AN/FRN-41(V2). The difference between the two models is AN/FRN-41(V1) is complete with a shelter and model AN/FRN-41(V2) is without a shelter but includes the antenna (with radome), obstruction lights, obstruction light relay and photo cell.

Table 1-3. Related Technical Manuals

Publication Number	Publication Title	Equipment Nomenclature
TM-11-5825-266-24P	Repair Parts and Special Tools List	Radio Transmitting Set AN/FRN-41

CHAPTER 2

INSTALLATION

2-1 INTRODUCTION. **This chapter contains installation data, logistics, and initial alignment procedures for the VOR electronic equipment, shelter and shelter construction, field detector, VOR antenna, remote site equipment and equipment alignment . Presentation of the various aspects of installation is expanded into four sections which include illustrations, charts and tables for easy reference. Section I, installation planning, explains the considerations required for successful planning of the shelter site, construction and equipment installation. Section II, logistics, presents information pertaining to the receipt, unpacking, storage and housing of the equipment. Section III, shelter construction, contains all information required to erect the prefabricated metal shelter. Section IV, installation procedures, outlines instructions for installation and interconnection of equipment units and components, including the tests and adjustments required to make the equipment operational.**

SECTION I

INSTALLATION PLANNING

2-2. GENERAL. **This section contains information pertinent to the solution of problems associated with planning the installation of the VOR system and accessories.**

2-3. SITE SELECTION. **The information contained in the following subparagraphs will ensure conformance to the siting criteria of the VOR (Single and Dual).**

Site selection is a compromise between ideal conditions and practical necessity. The presence of obstructions with appreciable mass is the principle siting problem because they alter the radiated signal. Reflection or absorption of the radiated signal by these obstructions must be kept to a minimum as deterioration of the radiated signal could affect aircraft guidance.

Ideally, the installation should be located on high terrain, absolutely flat and devoid of metallic fences, aerial conductors (including power and control lines for the station), trees, buildings, etc., for several thousand feet in all directions from the shelter.

2-4. SITING CRITERIA. **The following siting criteria is in addition to compliance with FAA regulations and local airport authority (in the United States), or with the equivalent authority in other countries. Unless otherwise specified, measurements are made from the center of the shelter.**

a. Refer to figure 2-1 for specific topographical requirements in accordance with the following criteria.

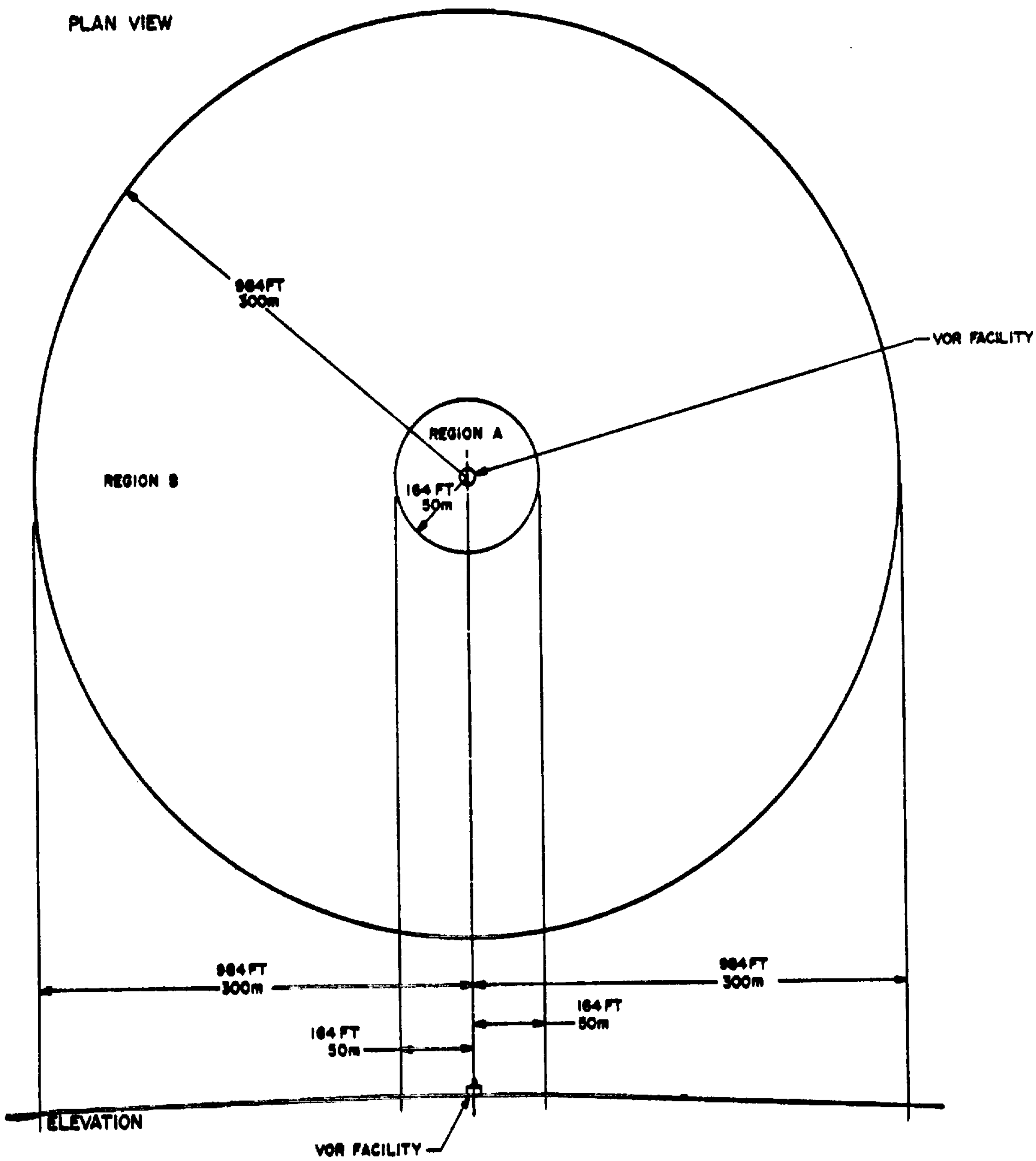


Figure 2-1 Topographic Requirements for a VOR Facility

NOTE

This drawing is based on ICAO Annex 10, Attachment C to Part I, 3.2.1 and FAA VOR/VORTAC Siting Criteria Handbook 6700.11.

(1) The terrain within region A should be smooth, flat and horizontal.

(2) The terrain within region B should be flat or sloping downward.

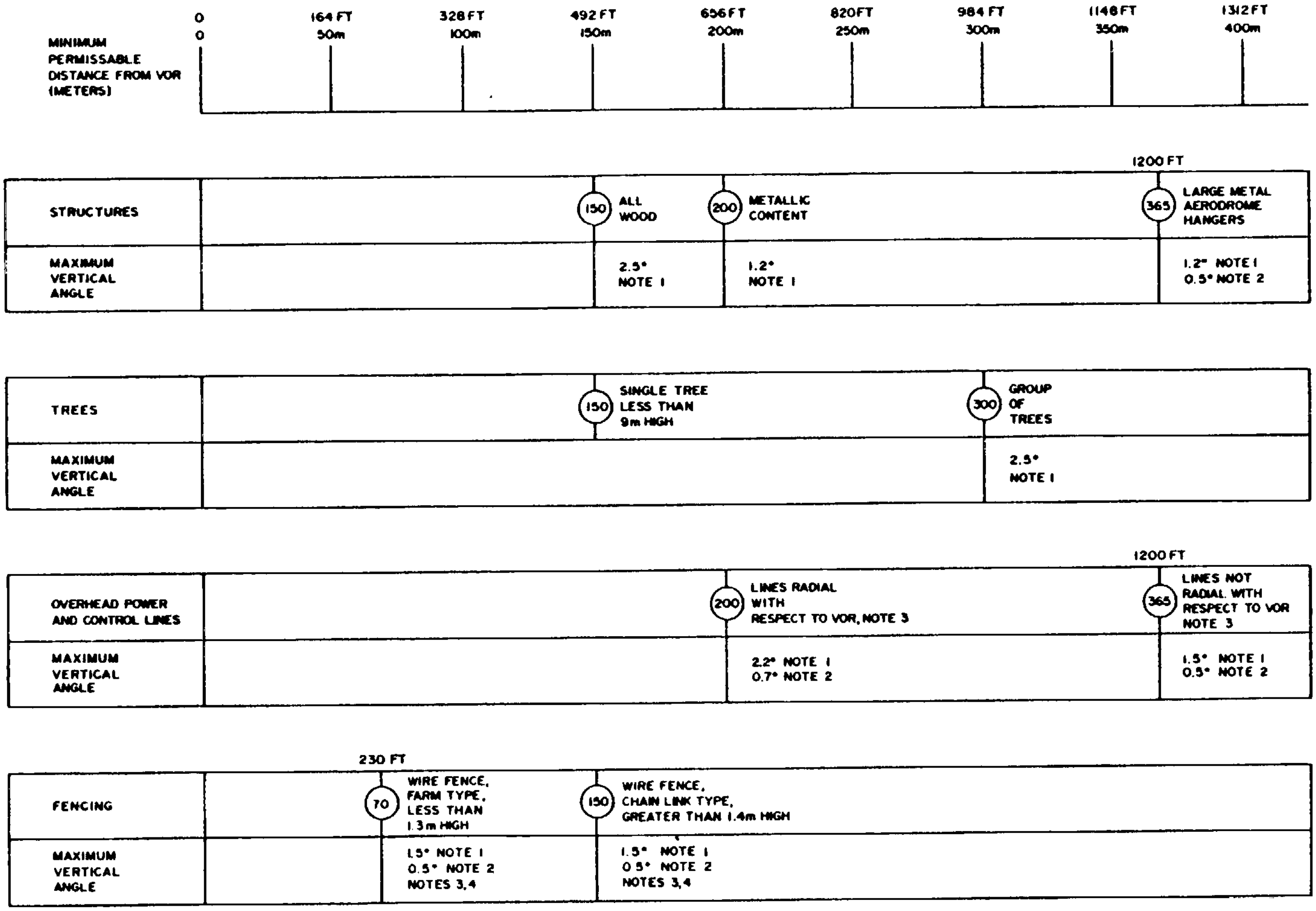
(3) The contour of the terrain should be as even as possible about the station. Undulations in the first 1000 feet should not exceed the average grade by more than three percent of the distance between the center of the shelter and such undulations. For example, a 34-foot (10.4 meter) hill or ditch is the maximum variance at 1000 feet.

(4) The maximumpermissable roughness (vertical local variation) of terrain for a VOR antenna height of 12 feet (3.6 m) is:

DISTANCE FROM VOR	ROUGHNESS
98 ft/30 m	3 ft./1.0 m
164 ft./50 m	5 ft./1.5 m
328 ft./100 m	15 ft./4.5 m
656 ft./200 m	20 ft./6.1 m
984 ft./300 m	34 ft./10.4 m

(5) The terrain should be relatively flat and unobstructed out to 1968 feet (600 meters) from the facility.

b. The basic criteria of various types of obstructions is provided in figure 2-2.



NOTES:

1. ANGLE MEASURED FROM GROUND AT VOR.
2. ANGLE MEASURED FROM ANTENNA AT VOR.
3. "RADIAL" IS DEFINED AS SUBTENDING A HORIZONTAL ANGLE LESS THAN 10°.
4. RADIAL FENCING MAY BE ALLOWED CLOSER TO VOR IN SOME CASES.
5. CHART BASED ON:
   (A) ICAO ANNEX 10, ATTACHMENT C TO PART I, 3.2.1.
   (B) FAA VOR/VORTAC SITING CRITERIA HANDBOOK 6700.11

Figure 2-2. VOR Obstruction Criteria

SECTION II

LOGISTICS

2-5. GENERAL. **This section contains information relating to receiving, unpacking and housing the VOR and associated accessories The items which comprise the VOR system are packaged in accordance with best commercial practices.**

2-6. RECEIVING DATA. **Upon receipt of the VOR system, unpack each crate and check its contents for damage and that each item listed on the packing list contained in the crate has been received. Immediately report any damage or shortages to the proper authority. After inspection, repack each item to prevent damage or loss. During installation, unpack items only as they are needed.**

2-7. EQUIPMENT SUPPLIED. **The list of equipment supplied for this facility is provided in table 2-1.**

2-8. INTERFACE AND CABLE REQUIREMENTS. **Interface requirements for the VOR Navigational Set are listed in figure 7-1. Cable requirements for the VOR system are listed in table 2-2.**

Table 2-1. Equipment Supplied

Qty Per Equip	Nomenclature		Unit No.	Overall Dimension(In)			Wt (Lb)
	Name	Designation		Height	Width	Depth	
1	Transmitter Group consisting of:	OT-117/FRN-41	1				
	Electrical Equipment Rack (1A1)	MT-6011/FRN-41	1A1	6'2" (188cm)	22" (55.9cm)	24" (60.7cm)	270 (122.47 kg)
	Control-Indicator	C-10527/FRN 41	1A2	8 3/4 (22.2cm)	19 (48.3cm)	19 3/4 (50.2cm)	18 (8.16 kg)
	Phase Modulation Monitor	ID-2179/FRN-41	1A3	8 3/4 (22.2cm)	19 (48.3cm)	19 3/4 (50.2cm)	22 (10 kg)
	Radio Transmitter	T-1394/FRN-41	1A4	8 3/4 (22.2cm)	19 (48.3cm)	19 3/4 (50.2cm)	41 (18.60 kg)
	Sideband Transmitter	T-1395/FRN-41	1A5	8 3/4 (22.2cm)	19 (48.3cm)	19 3/4 (50.2cm)	24 (10.89 kg)
1	Antenna	AS-3323/FRN-41	3	8' (243.8cm)	18" dia. (45.7cm)	--	82 (37.20 kg)
1	Radio Frequency Detector	DT-603/FRN-41	2	39" (99cm)	22" (55.9cm)	3" (7.62cm)	4 (1.81 kg)
1	Control-Indicator	C-10526/FRN-41	4	8 1/2 (22.6cm)	19 (48.3cm)	19 3/4 (15.2 cm)	18 (8.16)
1	Far Field Detector Kit (Part No. 136849)	-	-				
1	Shelter	S-597/FRN	-	98 1/2" (246.3)	21' 6 1/2" dia (6.6m)		Approx 6500 (2948.4 kg)

Table 2-2. AN/FRN-41 VOR Cable Requirements

REF. DESIG.	PART NO.	FUNCTION (FROM/TO)	END 1 (FROM)	COMPONENTS	END 2 (TO)	LENGTH
W1	136111-103	Field Detector Cable	Spade Lug	RG-223B/U Coaxial Cable	Connector-TNC M39012/27-0011	600" (15.24m)
2W1	136111-102	Field Detector Cable	Spade Lug	RG-223B/U Coaxial Cable	Connector-TNC M39012/27-0011	270" (6.86m)
2W3	136112-100	Field Detector Cable	Connector, TNC P/NM39012/26-0011	RG-223B/U Coaxial Cable	Connector TNC P/N M39012/27 -0011	400" (10.16m)
1A1W2	136325-102	From 1A4J1 To 1A5A5J1	Connector, BNC P/N 005478	RG-316/U Coaxial Cable	Connector, Straight Plug , Type BNC P/N910964-001	135" (3.43m)
1A1W3	136324-102	From 1A4FLIJ2 To 1A1U1J1	Connector,TNC Plug, P/N 910263-001	RG-223B/U Coaxial Cable	Connector, Straight Plug, Type N P/N 910360-001	125" (3.18cm)
1A1W4	136325-103	Installed but not used	Connector, BNC P/N 005478	RG-316/U Coaxial Cable	Connector, Straight Plug Type BNC .P/N 910964-001	135" (3.43m)
1A1W5	136324-103	Installed but not used	Connector,TNC Plug P/N 910263-001	RG-223 B/U Coaxial Cable	Connector, Straight Plug Type N P/N 910360-001	125" (3.18m)

Table 2-2 AN/FRN41 VOR Cable Requirements (Contd)

REF DESIG.	PART NO.	FUNCTION (FROM/TO)	END 1 (FROM)	COMPONENTS	END 2 (TO)	LENGTH
1A1W6	136306-104 Matched Set	From 1A5A2J2 To 1A1ATSJ1 From 1A5A3J3 To 1A1AT5J1	Connector, BNC P/N M39012/ 16-0001	RG-223B/U Coaxial Cable	Connector, Straight Plug Type N P/N 910360-001	150" (3.81m)
1A1W7	136304-105	Installed but not used	Connector, Straight Plug, Type N P/N 910360-001	RG-316/U Coaxial Cable	Connector, Straight Plug Type N P/N 910360-001	40" (101.6cm)
1A1W8	136306-105 Matched Set	Installed but not used	Connector, BNC P/N MS39012/ 16-0001	RG-223 B/U Coaxial Cable	Connector, Straight Plug, Type N P/N 910360-001	150" (3.81m)
1A1W14	136305-102 Matched Set	From 1A1U2J2 To Sideband A and From 1A1U3J2 To Sideband B	Connector, Straight Plug, Type N P/N 910360-001	RG-223B/U Coaxial Cable	Connector Coaxial-Bulkhead Jack, Series N P/N 004518	Approx. 46" (116.84cm)
1A1W16	136305-103	From 1A1U1J2 To Carrier	Connector, Straight Plug Type N P/N 910360-001	RF-2238/U Coaxial Cable	Connector, Coaxial-Bulkhead Jack, Series N P/N 004518	41" (104.14cm)
3W1	136244-102	From 1A1W16P2 To 3CP1J2	Connector, Straight Plug, Type N P/N 910361-001	RF-214/U Coaxial Cable	Connector, Straight Plug Type N P/N 910361-001	288" (7.32m)

TABLE 2-2. AN/FRN-41 VOR Cable Requirements (Contd)

REF. DESIG.	PART NO.	FUNCTION (FROM/TO)	END 1 (FROM)	COMPONENTS	END 2 (TO)	LENGTH
3W2	136244-101 Matched Set	From 3Z2J2 To 3J1 and From 3Z3J2 To 3J2	Connector, Straight Plug Jack, Type N P/N 910361-001	RG-214/U Coaxial Cable	Connector, Straight Plug, Type N P/N 910498-001	92-3/4" (2.36m)
1A4W1	136498-103	From 1A4A3J1 To 1A4A5J1	Connector, BNC P/N 910694-001	RG-188/U Coaxial Cable	Connector, BNC P/N 910694-001	11" (27.94cm)
1A4W2	136497-103	Not used				
1A4W3	136498-104	Not used				
1A4W4	136499-100	Not used				
1A4W5	136497-101	Not used				
1A4W6	136497-102	Not used				
1A4W7	136498-101	Not used				
1A4WB	136499-101	From 1A4A7J1 To Carrier Phase Reference	Connector, BNC Right Angle Crimp P/N 910694-001	RG-188/U Coaxial Cable	Connector,Female Jack, BNC P/N 006107	8" (20.32cm)
1A4W9	136498-102	From 1A4DC1J3 To 1A4FL1J1	Connector, BNC Right Angle Crimp P/N910694-001	RG-188/U Coaxial Cable	Connector, BNC Right Angle Crimp P/N 910694-001	8" (20.32cm)

Table 2-2. AN/FRN41 VOR Cable Requirements (Contd)

REF. DESIG.	PART NO.	FUNCTION (FROM/TO)	END 1 (FROM)	COMPONENTS	END 2 (TO)	LENGTH
1A4W10	**136498-105**	**From 1A4A5J2 To 1A4AR1J1**	**Connector,BNC Right Angle Crimp P/N 910694-001**	**RG-188/U Coaxial Cable**	**Connector, BNC Right Angle Crimp P/N 910694-001**	**12” (30.48cm)**
1A4W11	**136498-106**	**From 1A4AR1J2 To 1A4ADC1J2C**	**Connector, BNC Right Angle Crimp P/N 910694-001**	**RG-188/U Coaxial Cable**	**Connector, BNC Right Angle Crimp P/N 910694-001**	**15” (38cm)**

Note: Cables W2 through W7 are not used in the carrier transmitter in a 50 Watt system and cables W10 and W11 are not used in the carrier transmitter in a 100 Watt system

SECTION III

SHELTER CONSTRUCTION

2-9. GENERAL. **This section contains installation data for the 21-foot (6.61 meters), prefabricated metal shelter. General requirements for the shelter site are detailed in paragraph 2-3. These requirements must be carefully followed prior to erecting the shelter.**

2-10. SITE PREPARATION. **Prior to erecting the shelter, the site must be prepared as follows:**
Line Trenching and Installation. (Reference figure 2-3.) To ensure accurate line runs for the power and control lines, line trenches should be made during preparation of the shelter site.

a. Drive a reference stake at the center of the shelter site, or if the shelter materials have arrived, use the ground rod in place of a stake. The stake or ground rod will be used to locate a transit. Drive the stake as straight as possible leaving approximately 10 inches (25.4 cm) above the ground.

b. Center the transit over this stake and sight in the direction of the power source. Place a reference stake along this line at least 750 feet (230 meters) out from the transit. This stake will mark the location of the terminal pole. Place a second reference stake approximately 75 feet (23 meters) beyond the first stake and in the same line. These two stakes initially locate the radial line that the utility lines will follow to the power source. Drive a third stake along this line approximately 12 feet (3.66 meters) from the transit. This stake and the other two stakes locate the radial that the power line trench should follow (reference figure 2-3).

c. Using the transit (with the transit located over the center reference stake), sight on magnetic north and locate a stake at 55 feet (16.76 meters) and another stake at 100 feet (30.48 meters) out. These stakes will be used to assist in orientation of the shelter. After the shelter foundation is completed, these stakes can be used for general reference (reference figure 2-3).

d. If the location of the remote control is not in the same direction as the power source, repeat step b., sighting in the direction of the remote site location and establish a second radial for the remote control unit control lines.

e. The depth of the trench from the shelter to the utility pole is governed by local conditions, including applicable laws such as easements and the marking of cable routes. If there are no other contingencies, the trench need be no deeper than 24 inches (61 cm) to avoid interference with the VOR signal. If the power and control lines are routed to the shelter from the same radial, place the power line at the bottom of the trench and backfill with approximately 12 inches (30.5 cm) of dirt. Then, place the control lines in the trench and completely fill in the trench with dirt. This procedure will prevent mutual coupling. For this same reason, keep the control and power lines separated approximately 24 inches (61 cm) on the utility poles.

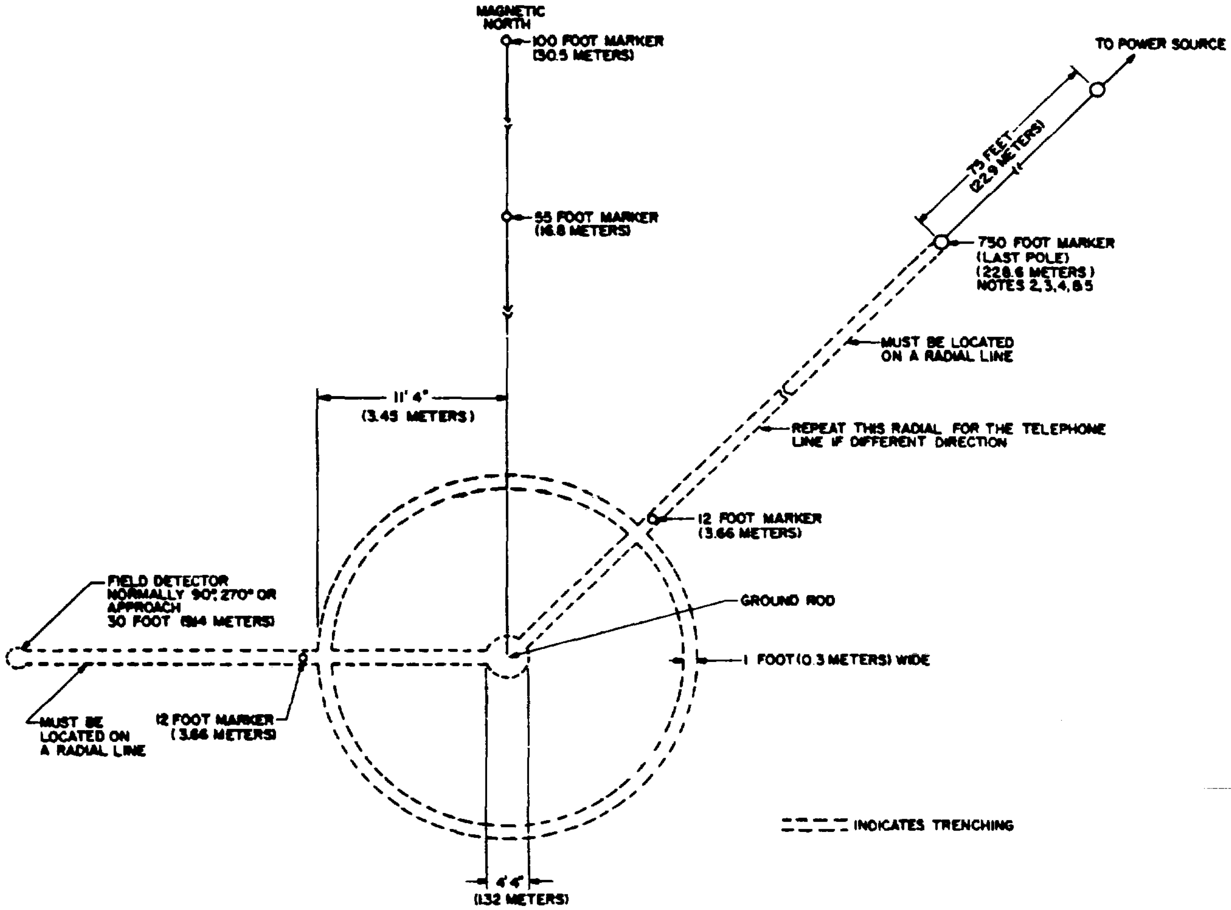


Figure 2-3. Establishing Site Bearing and Trenches

f. Power line wire sizes are usually governed by local installation requirements and the power consumption listed for the navigation equipment with an adequate safety factor.

g. Establish a radial from the center of the shelter to the field detector location, normally 90º, or 270º.

NOTE

The 90º and 270º radials are preferred because they monitor both sideband signals and are capable of detecting reverse signal rotation. The next preference, if these cannot be used, is either the 0/360º or 180º radials The third preference is a radial between an antenna slot and a cardinal compass point. In no case must the following radials be used; 45º 135º 225º or 315º.

h. Place a reference stake along this line at 30 feet (9.14 meters) and at 12 feet (3.66 meters). The depth of the trench from the shelter to the antenna post is governed by local conditions, including applicable laws such as easements and the marking of cable routes. If there are no other contingencies, the trench shall be 24 inches (61 cm) deep. Place the monitor antenna cable in conduit at the bottom of the trench and backfill.

2-11 SHELTER FOUNDATION**. Construction of the shelter foundation requires removal of earth from the footings and floor area, assembly of the prefabricated foundation forms and pouring the concrete for the footings and floor. Detailed instructions for the construction of the shelter foundation are as follows:**

a. Using the reference stake or ground rod as the center of the site, mark a circle on the ground (having a radius of 11 feet, 4 inches (3.45 meters). Using the circumference of this circle as a center line, dig a circular one-foot wide (30.48 cm) trench completely around the circumference to a minimum depth of 24 inches (61 cm). See figure 2-3. This trench should be deep enough to place the bottom of the concrete footing below the frost line. Local soil conditions may also govern the depth of this trench.

b. Using the reference stake or ground rod as the center point, dig a circular depression 52 inches (1.32 meters) in diameter to a minimum depth of 10 inches (25.4 cm). Remove four inches (10.16 cm) of earth from the remaining area within the circular footing trench.

c. Using the instructions outlined in paragraph 2-10, (Line Trenching and Installation), determine the direction of the trench(s) for the power and control lines. In addition, the location of the shelter door must be established at this time (reference figure 2-4). Two lengths of 1 1/4 inch EMT conduit are supplied with the shelter. These conduits will carry the power and control lines into the shelter as outlined in figure 2-4. At the proper point on the circumference of the site depression, dig the trench(s) outward in the

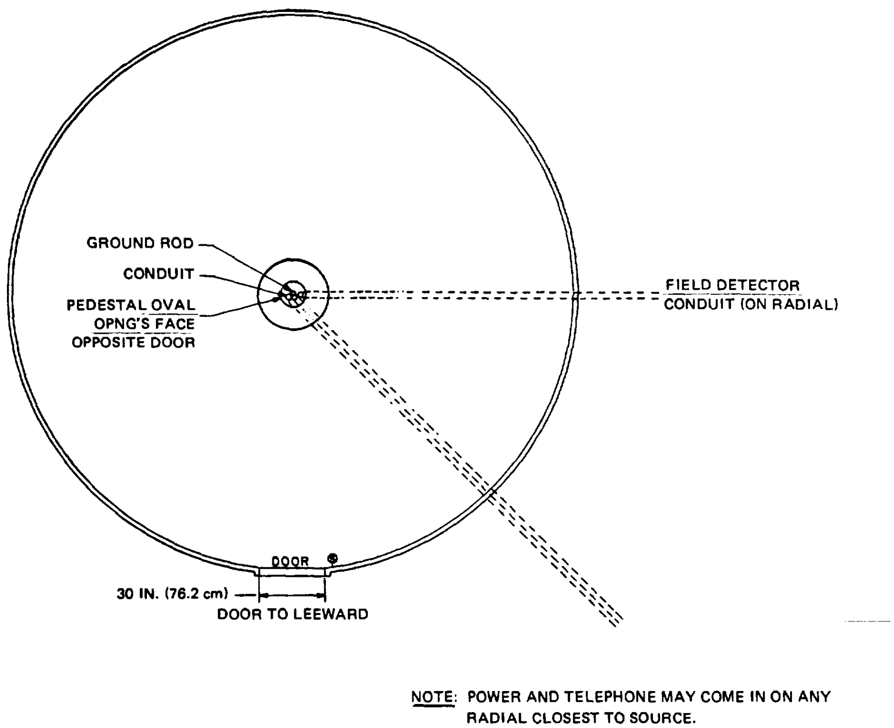


Figure 2-4. 21-Foot Shelter Floor Layout

direction to accommodate the conduits. The trench(s) should slope downward toward the outside ends (reference figure 2-5) and terminate several feet outside the large circular trench.

d. In order to keep the conduit trench(s) open when the concrete footing is being poured, block off the portion of the footing trench through which each length of conduit will pass. The reinforcing bar for the concrete shall be a mild steel, deformed bar, No. 4 (12 mm) minimum diameter. The bar should be spliced at intersections and conform to ASTM-A-615, Grade 40. The reinforcing bar shall have a 2 inch (5.08 cm) clearance from the side, bottom or top of the concrete. Pour the concrete in the footing trench to whatever level is necessary to place the top of the foundation form 10 inches (25 cm) above the grade line. Keep the surface of the entire footing as near level as possible.

NOTE

The concrete shall be structural grade with a minimum compression strength, after 28 days of curing, at 3,000 lbs./square-inch (22 x 10^6 pascals). The minimum recommended richness of mixture (by volume) is one part cement to two parts fine aggregate, to three parts coarse aggregate. Rock fill requirements are determined by terrain contours and soil properties.

e. The form for the shelter floor is comprised of 14 curved steel foundation sections. The diameter of the assembly form is approximately 21 feet, 6 inches (6.55 meters). Figure 2-6 illustrates the assembly details fo the completed form, including the pedestal anchor ring (which also serves as a centering device) and seven centering straps. Join the foundation sections at each joint using two 1/2 x 1 inch black bolts and nuts, one each in the top and bottom holes (reference figure 2-6). Fasten the seven centering straps to the bottom flange of the foundation form, at equally-spaced points around the circumference of the form, using 1/2 x 1 inch black bolts, washers and nuts. Be sure to insert the bolt through the flange with one washer between the bolt head and the centering strap. Fasten the 1/2-13 UNC x 8 inch black bolts through the holes in the pedestal anchor ring with the ends of the centering straps connected on the underside of the ring at every other bolt. Use two 1/2 inch black nuts and washers on each bolt. Place one nut and washer above the ring and one nut and washer below the ring. Be sure to allow the threaded end of the eight-inch bolts to extend at least 2 (5.08 cm) inches above the top surface of the anchor ring. Figure 2-6 illustrates the proper method of connecting anchor bolts to the pedestal anchor ring at each section joint (centering strap joint).

f. One foundation form seam must be near the center of the area previously selected for the shelter door. Positioning the foundation form seams in this manner will ensure that the foundation form seams will not fall on the same points as the wall seams. With this seam requirement in mind, determine which radials the seven foundation form centering straps will occupy when the form is installed. After the foundation footing has hardened, remove sufficient earth along these seven radials to allow clearance for

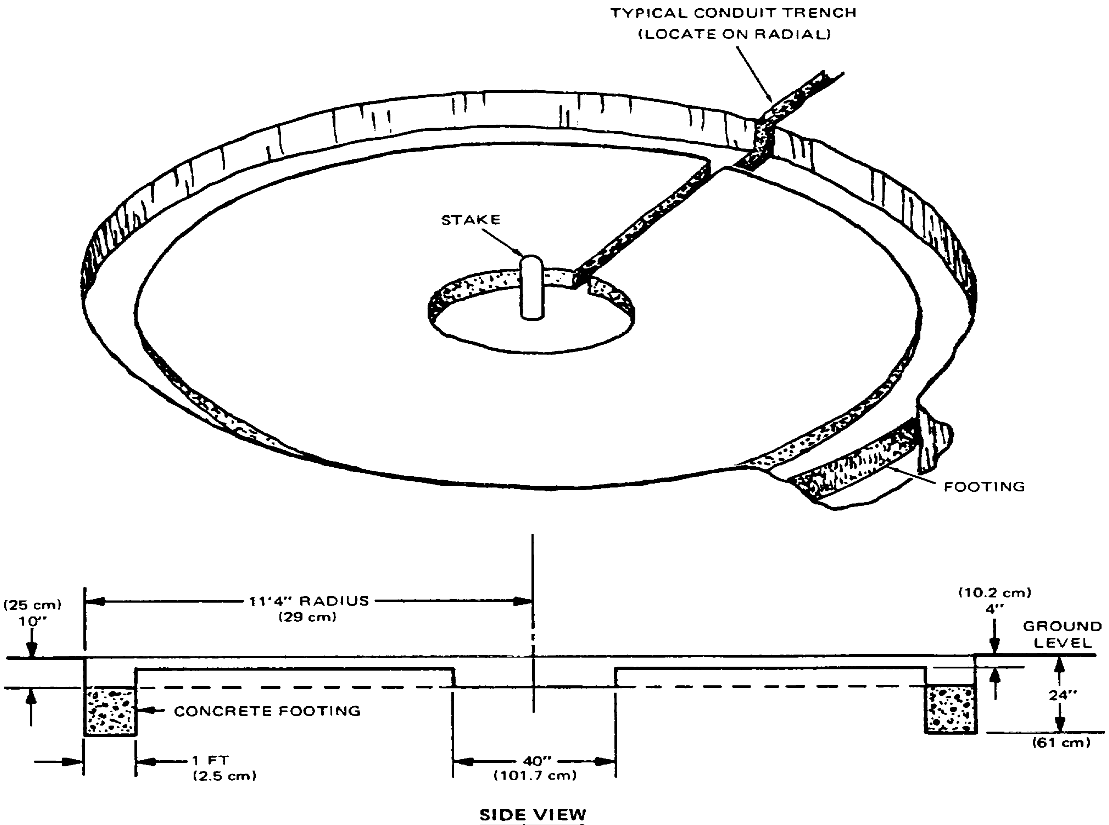
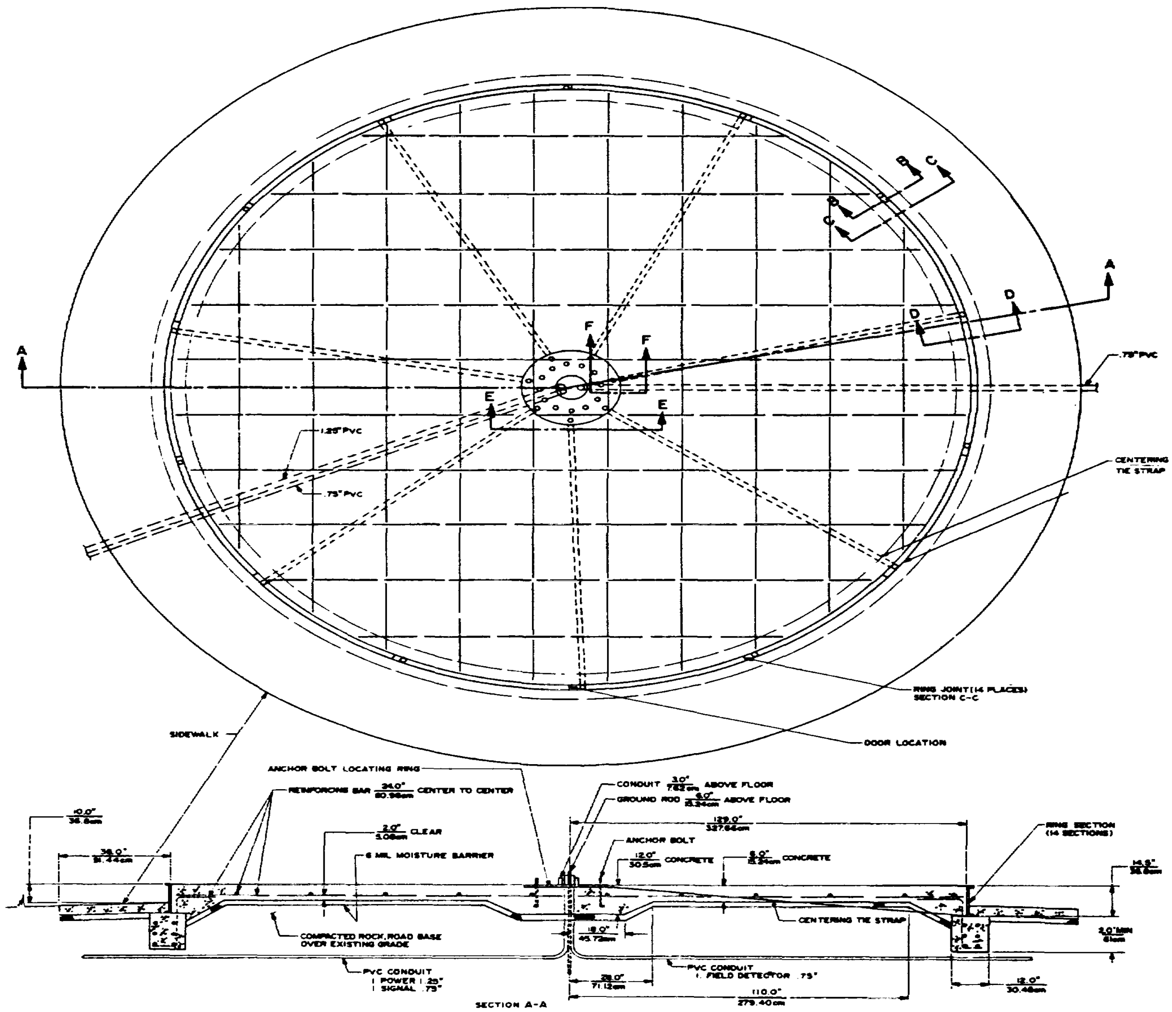


Figure 2-5. 21-Foot Shelter Excavation and Footing



SECTION A-A

Figure 2-6. 21-Foot Shelter Foundation Details (Sheet 1 of 2)

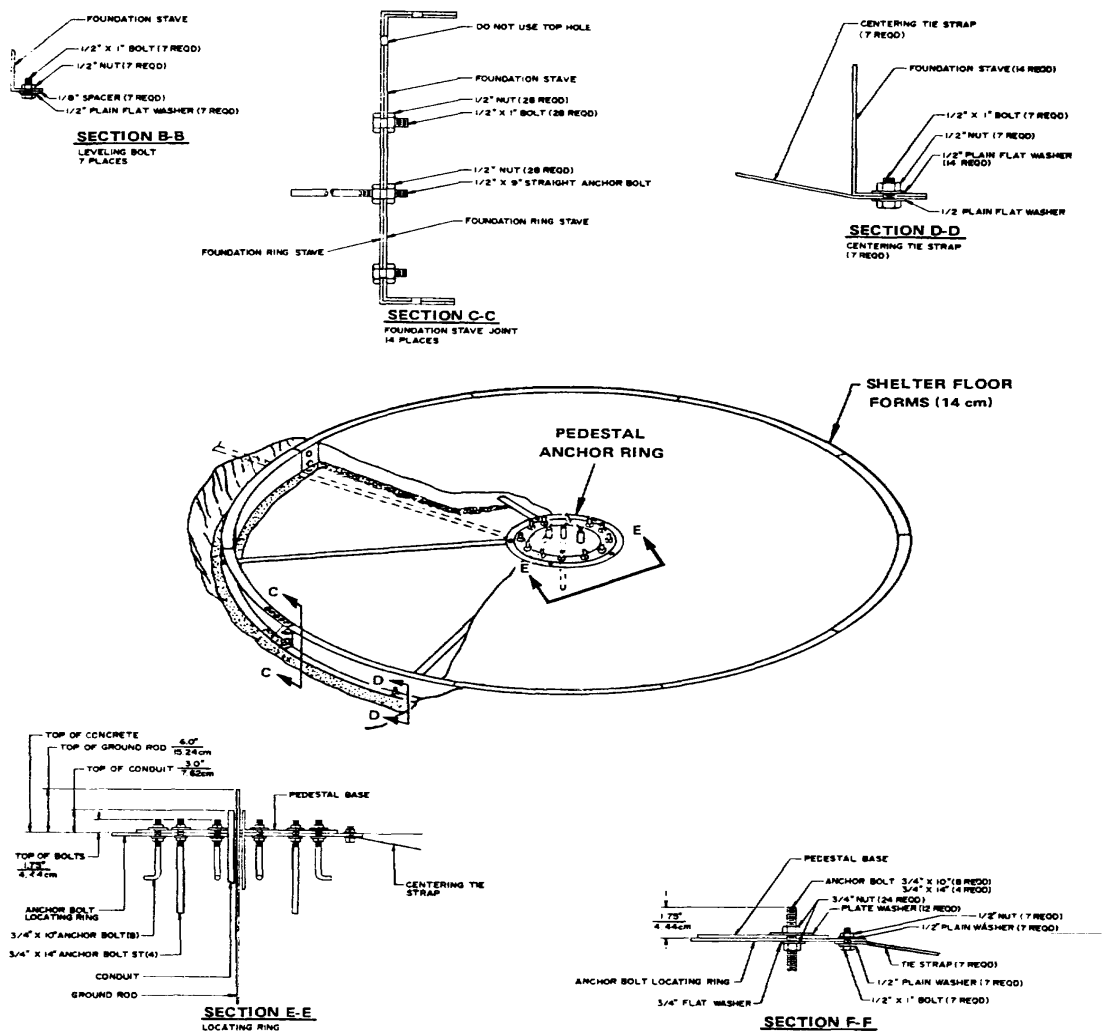


Figure 2-6. 21-Foot Shelter Foundation Details (Sheet 2 of 2)

the centering straps and permit the foundation form to rest solidly on top of the footing. Place the foundation form on top of the footing. Make the foundation form and anchor ring as level as possible, using the four 3/4 x 14-inch bolts in the centering ring and suitable materials under the form and/or anchor ring as required. Be sure that the surface of the anchor ring is a maximum of 3/16 (5 mm) inch higher than the top edge of the foundation form.

CAUTION

Check the geometry of the foundation ring, centering straps and center plate. The ring must be circular (as close as possible) and level within ± 1/4” (6.4 m). Securely block the outer ring to prevent movement during concrete pour.

g. A six-foot (1.83 meter) copper jacketed steel rod is supplied with the shelter to provide an earth ground for the system. Drive this rod into the ground at the exact center of the pedestal ring. (This step may already be accomplished - refer to paragraph 2-10.) Drive the rod as straight as possible into the ground until approximately five to seven inches (12.7 to 17.78 cm) of the rod will remain above the finished shelter floor.

h. The ends of the two conduits, which terminate inside of the shelter, should be located as close as possible to the ground rod and extend approximately three inches (7.6 cm) above the finished floor. Incorrect positioning of the conduit could prevent the antenna pedestal from being positioned over the conduit ends. If the conduits are installed in the same trench, they may be bound together for the major portion of their length. Securely tighten the conduits in their trench(s) and to the ground rod to ensure that they will not move out of position when the concrete floor is poured. Cover the conduit trench(s) with earth.

i. Build a sidewalk 36 inches (91.44 cm) wide around the circumference of the foundation form. The sidewalk is constructed of 4.0 inches (10.16 cm) wire mesh reinforced over 4.0 inches (10.16 cm) of crushed rock.

NOTE

The wire mesh shall be 3/16” (5 mm) diameter wire, welded square mesh, no greater than 6.0 inches (15.2 cm) between wire centers.

j. Install a moisture barrier of 6 Mil polyethylene with lapped joints of 6 inches (15.24 cm) minimum on the floor inside of the foundation form. Cover this barrier with 2 inches (5.08 cm) of crushed rock

NOTE

The shelter finished floor shall be 10.0 inches (25 cm) minimum above the sidewalk and grade to the sidewalk.

k. Install a reinforcing bar for the shelter floor in the same manner as detailed in paragraph 2-11, item d. Pour the concrete both inside and outside the foundation form as shown in figure 2-6. Load the anchor ring evenly with concrete to keep it circular during the pour, and carefully tamp the concrete around the bolts in the pedestal anchor ring. Backfill earth to sidewalk grade.

2-12 POWER AND CONTROL LINES**. The types of power and control lines to be used and the principal considerations for their installation are described in detail in paragraph 2-10. After the required line trenches have been dug, install the power and control lines as follows:**

a. Lay the power and control lines in their trench(s) up to the shelter foundation.

b. Obtain a 21-foot (6.61 meters) length of solid wire or other strong flexible material to be used as a messenger to draw the lines through the rigid conduits.

c. At the pedestal anchor ring, run the messenger wire through the control line conduit to the control line. Fasten the messenger to the control line and pull the line back through the conduit. Use this same procedure for the power line.

d. Allow at least 6-feet (1.83 meters) of power line and 8 feet (2.44 meters) of control line to extend from the ends of the conduit at the center of the shelter floor. Coil the lines into the proper size and shape to easily fit through the hole in the base of the antenna pedestal.

e. Fill the trenches with earth.

2-13. SHELTER ASSEMBLY**. The tools required for assembly of the shelter are listed in table 2-3. Step by step procedures for the shelter assembly are as follows:**

a. Antenna pedestal.

(1) Remove the nuts and washers from the 12 bolts in the antenna pedestal anchor ring (refer to figure 2-7).

NOTE

Due to the weight of the pedestal, 550 pounds (249.48 kilograms), a crane or similar equipment should be used to position the pedestal.

Table 2-3. Recommended Special Tools List for Navigation Systems Installation

ITEM	QTY	DESCRIPTION	PART NUMBER	SOURCE
1	1	Engineers Transit/Level w/built -in compass, tripod, case, 22 power, H = 120 sec/2mm, V = 60 sec/2mm, double vernier, 1 minute resolution, hardwood tripod 37" to 59" extension, case, plumb bob and string, sunshade, magnifier and manual	F9HT46106	Sears
2	1	Engineers Rod, 10' Vernier to 1/1000'	9HT46112C	Sears
3	1	Carpenters Level 28" aluminum, closed end frame, 1 level vial, 2 plumb vials	9HT39925C	Sears
4	1	Axe, solid steel head and neck, 13" cushion grip handle, nail slot, leather sheath	9HT4810	Sears
5	2	Socket, heavy duty six point, regular 1/2" drive 3/4" size for impact wrench	9HT44006	Sears
6	2	Wrench, adjustable 12" long 1-5/16" capacity	9HT44605	Sears
7	1	Wrench, impact kit 1/3 HP, 1750 RPM, 2 impacts/rev., vairable torque to 100' LBS., reversable, premanently lubricated, double insulated, 6 FT-2 wire neoprene cord, 110-120 Vac 60 Hz 480W., UL listed. Kit includes: wrench, drill chuck 1/8" to 1/2", and plastic case.	9HT8303	Sears
8	1	Wrench, speeder 1/2" drive	9HT4416	Sears
9	1	Wrench, ratchet 1/2" drive	9HT44975	Sears
10	1	Wrench, adapter-universal 1/2" drive	9HT4425	Sears
11	1	Wrench, 12 piece, deep, 12 point x 1/2" drive, inch standard, socket set. (Sizes; 1/2", 9/16", 5/8", 11/16:, 3/4", 13/16", 7/8", 15/16", 1", 1-1/16", 1-1/8".)	9HT44458	Sears
12	1	Wrench, 6 piece, combination (box/open end), inch standard, set. (Sizes; 7/16", 1/2", 9/16", 5/8", 11/16", 3/4".)	9HT4462	Sears

Table 2-3. Recommended Special Tools List for Navigation Systems Installation

ITEM	QTY	DESCRIPTION	PART NUMBER	SOURCE
13	1	Wrench, 14 piece, hexagonal key, inch standard, set w/pouch. (Sizes: short arm; .050", 1/16", 5/64", 3/32", 7/64", 9/64". Long arm; 7/64", 1/8" 9/64", 5/32", 3/16", 7/321", ¼", 5/16 ".)	9HT46683	Sears
14	1	Pliers, Linemans 8-1/2"	9HT45181	Sears
15	1	Pliers, wide jaw diagonal cutting 7"	9HT45074	Sears
16	1	Pliers, long chain nose 8"	9HT45082	Sears
17	1	Pliers, crimping, wire stripping	71B392	Jensen
18	1	Pliers, channel joint 12-1/2" x 2-1/2"	9HT45271	Sears
19	1	Pliers, channel joint 16" x 4"	9HT45384	Sears
20	1	Pliers, vise, locking, curved jaw 10"	9HT45961	Sears
21	1	File, flat, mill, 10"	9HT31295	Sears
22	1	File, half round, bastard 10"	9HT31235	Sears
23	1	File, round, bastard 8"	9HT31244	Sears
24	1	File, cleaning brush	9HT6782	Sears
25	1	File, handle	9HT67812	Sears
26	2	File, handle	9HT67813	Sears
27	1	Screwdriver, slot 3/8" x 12"	9HT41588	Sears
28	1	Screwdriver, slot 5/16" x 8"	9HT41587	Sears
29	1	Screwdriver, slot 1/4" x 6"	9HT41584	Sears
30	1	Screwdriver, slot 3/16" x 4"	9HT41581	Sears
31	1	Screwdriver, Phillips #2 x 8"	9HT41296	Sears
32	1	Hammer, Ballpien 8 oz	9HT38463	Sears
33	1	Hammer, claw, curved, solid steel handle, cushion grip, 16 oz	9HT3825	Sears
34	1	Hammer, heavy duty 2-1/2lb	9HT38262	Sears
35	1	Hacksaw	9HT3562	Sears
36	1	Hacksaw,Pkg 5 blades 10" 32 tooth/inch	9HT65885	Sears
37	1	Hacksaw,pkg 5 blades 10" 24 tooth/inch	9HT65883	Sears

Table 2-3. Recommended Special Tools List for Navigation Systems Installation (Contd)

ITEM	QTY	DESCRIPTION	PART NUMBER	SOURCE
38	1	Hacksaw, pkg 5 blades 10" 18 tooth/inch	9HT65881	Sears
39	1	Drill, 29 piece set 1/16" to 1/2" (1/64" steps)	9HT6705	Sears
40	1	Holesaw, 1-1/8"	9HT25773	Sears
41	1	Holesaw, 1-1/4"	9HT25774	Sears
42	1	Holesaw, 1-3/8"	9HT25775	Sears
43	1	Holesaw, 1-1/2"	9HT25776	Sears
44	1	Snips, tin, duckbill 12”	9HT45462	Sears
45	1	Knife, electricians	9HT9560	Sears
46	1	Center Punch 3/8” x 4-1/2”	9HT42861	Sears
47	1	Tube Cutter 1/8” to 1-1/16”	9HT5531	Sears
48	1	AWL/scribe	40B275	Jensen
49	1	Crate Opener	66B425	Jensen
50	1	Measuring Tape, inch/mm - 50’	222B050	Jensen
51	1	Soldering Gun, heavy duty 100/140W	47B470	Jensen
52	1	Outlet Box, 110-120V, 15A, 3 wire, W/6’ cord, 5 grounded outlets	34HT5010	Sears
53	1	Trouble Light, w/grounded outlet, switch, 15’ heavy duty cord	34HT5918	Sears
54	4	Extension cord, 3W - 14 AWG, 25’	34HT5834	Sears
		NOTE: The following items are optional.		
55	1	Volt/Ammeter, compact 0 to 110A, 0-250V, ac, clip-on	34HT5188	Sears
56	1	Line Cord Energizer for item 55	34HT5197	Sears
57	1	Voltage Tester, checks; 100-550 Vac, 110-600 Vdc 25 to 60 Hz, continuity, ac or dc, dc polarity, blown fuses, grounds, leakage	34HT5193	Sears
58	1	Outlet Analyzer, for 3 wire grounded out-lets 120 Vac	43HT6088	Sears

Table 2-3. Recommended Special Tools List for Navigation Systems Installation (Cont.)

ITEM	QTY	DESCRIPTION	PART NUMBER	SOURCE
59	1	Flashlight, 2 cell, D size	221B618	Jensen
60	1	Hardhat	45B635	Jensen
61	1	Hardhat, chinstrap	45B370	Jensen
62	1	Goggles, flexible, impact, mask	9HT1859	Sears
63	1	First Aid Kit	165B759	Jensen
64	1	Rolling Wedge/Drift Pin Bar	9HT42892	Sears
65	1	Tool Pouch, 7 pocket, leather	9HT4580	Sears
66	1	Web Belt, cotton - for Item 65	9HT45895	Sears
67	1	Tool Box, Steel w/hasp and tray 40-11/16” x 16-1/2” x 12-1/8"	9HT65242N 38B410	Sears
68 38B410	1	Lock, combination 1/4" shank		Jensen

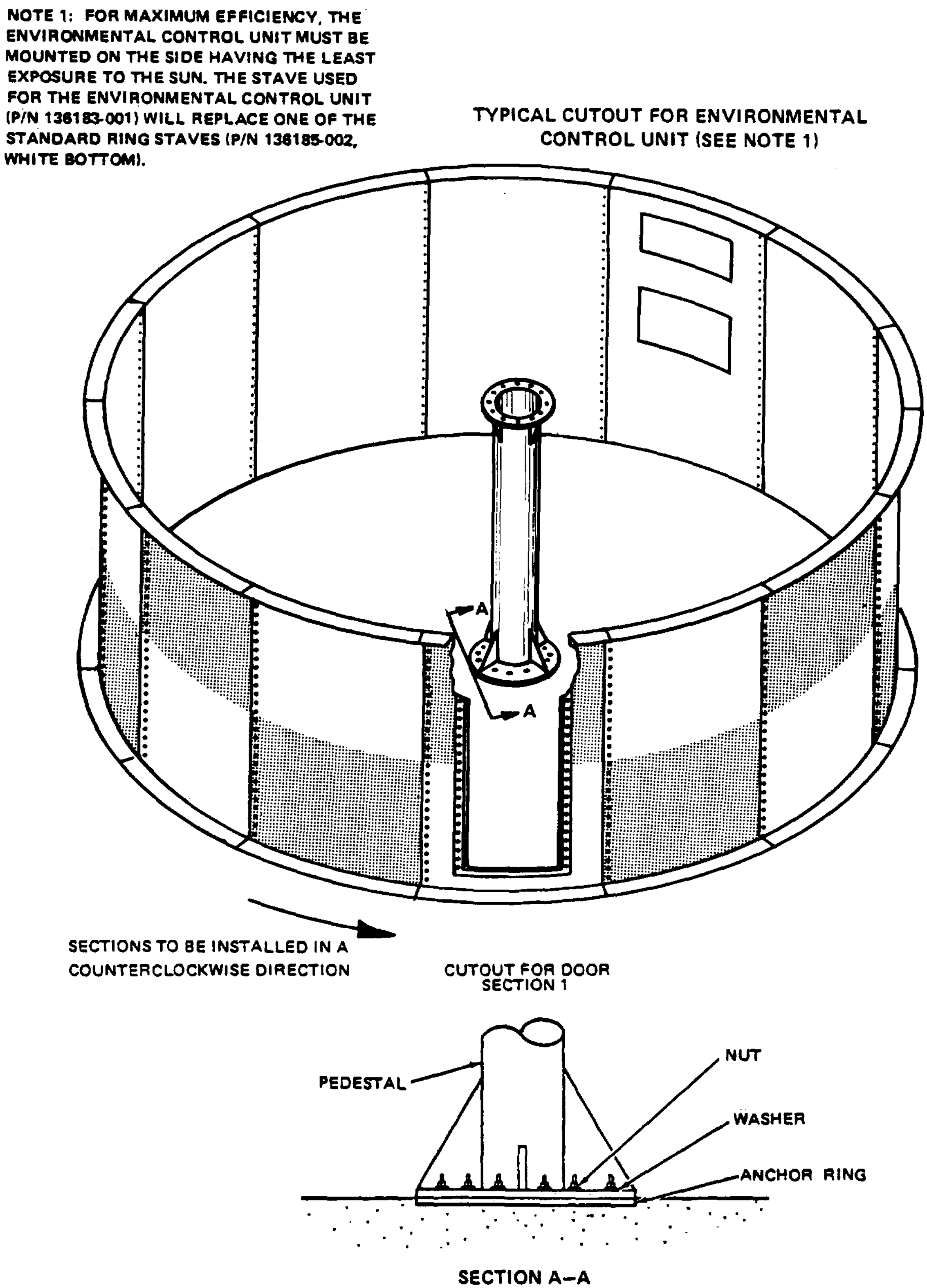


Figure 2-7. Shelter Assembly

(2) Determine the correct orientation of the antenna pedestal. Tilt the pedestal on the edge of the base and move the base over the anchor ring bolts. Carefully insert the coiled power and control lines into the pedestal's hollow center.

(3) Raise the pedestal above the anchor ring bolts,align the holes in the pedestal base with the bolts and lower the pedestal into position. Ensure that the power and control lines are not pinched between the pedestal base flange and the shelter floor.

(4) Replace the 12 washers and nuts previously removed from the anchor ring bolts. Hand tighten the nuts as the pedestal may have to be adjusted during later stages of the shelter assembly.

b. Shelter wall.

(1) Install the strip gasket and bolts on the foundation flange (reference figure 2-8). Overlap gasket two holes and taper cut edge. The covered edge of the strip gasket should face to the outside of the shelter. A supply of asbestos wicking and cement is provided to seal overlapping seams. This is accomplished by applying cement to the notch at an overlap, then laying asbestos wicking in the notch and covering with another coating of cement After this is completed and the bolts are tightened, it is advisable to caulk the joint with the blunt edge of a caulking tool.

(2) Fourteen curved wall sections form the shelter side wall. Assembly details are illustrated in figure 2-8 Prior to placing a wall section on the foundation flange, install the vertical strip gasket, bolt retainer channel and bolts on the wall section (reference figure 2-8).

(3) Start with the wall section that has the large door (white bottom) cutout for the shelter. As previously determined, place this section on the foundation flange (orientation of this section is critical). As the wall section is placed on the foundation flange, align the bolts with the holes in the wall section, install four nuts, equally spaced, and hand tighten. (Door may be opened and blocked for temporary support.)

NOTE

Align pedestal so that the cutouts on the pedestal are opposite door opening.

(4) Going counterclockwise from the inside of the shelter, install the second wall section. While holding the first section upright, position the next section with its vertical edge overlapping the edge of the first section to form a seam and align holes in flanges of second wall section and foundation form.

(5) Install pedestal roof support ring. After the four angle brackets are in place, install roof support ring using one bolt, washer and nut at each intersection with angle brackets. Do not tighten nuts as support ring may have to be adjusted to facilitate orientation with roof sections Install strip gasket and bolts on the perimeter of the top of the wall sections Overlap gasket two holes and taper cut edge.

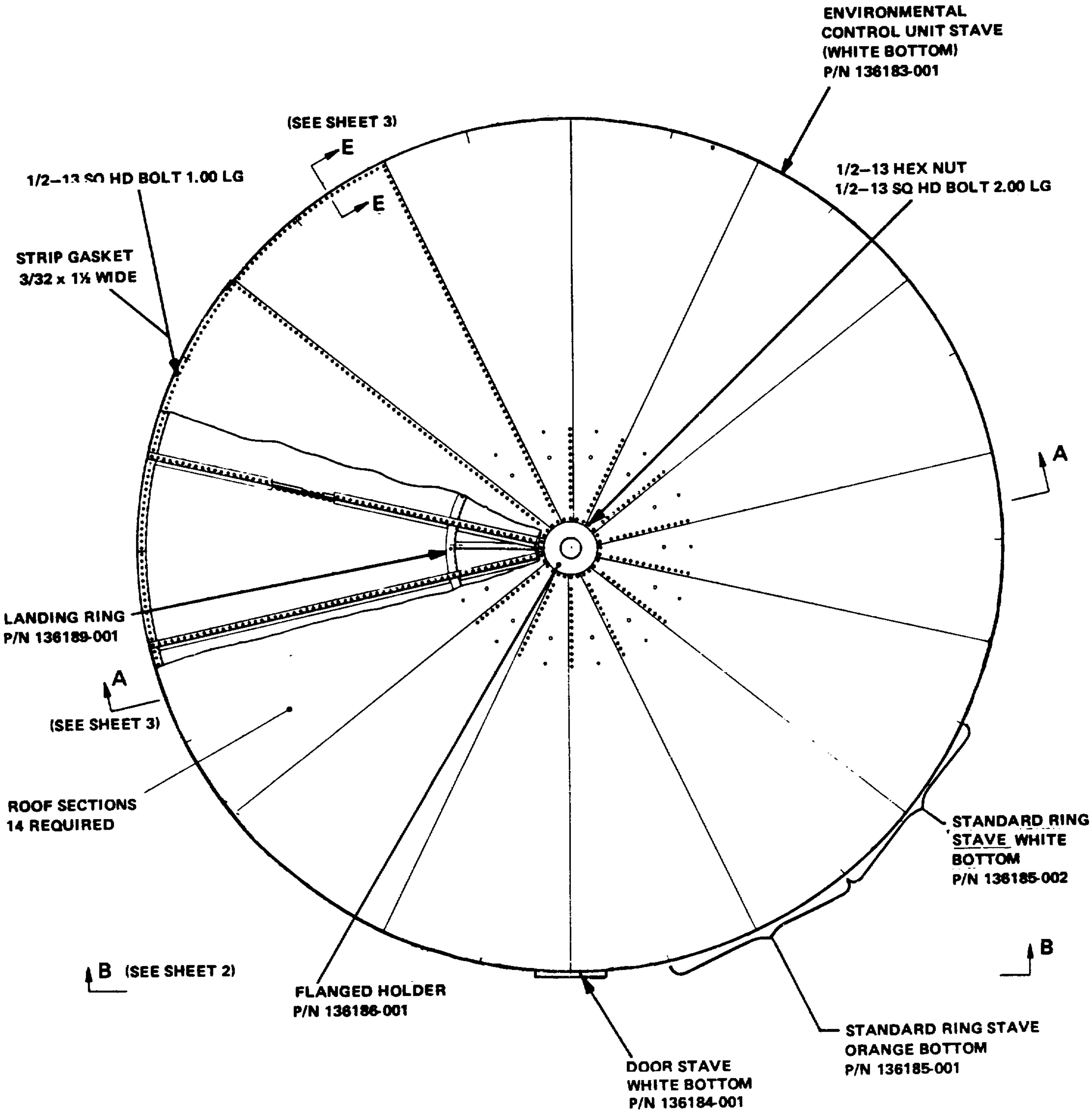


Figure 2-8. Shelter Assembly Construction Diagram (Sheet 1 of 4)

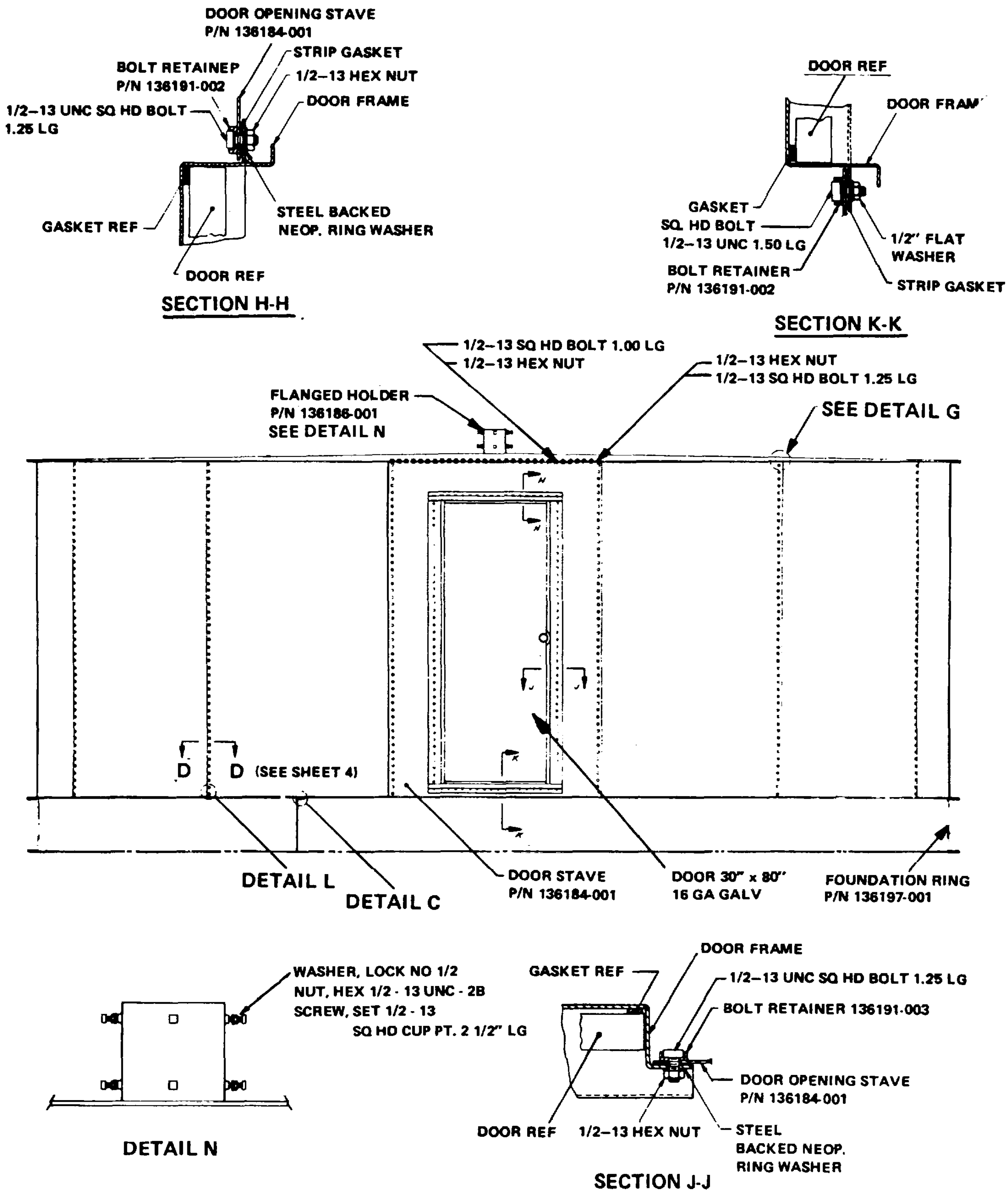


Figure 2-8. Shelter Assembly Construction Diagram (Sheet 2 of 4)

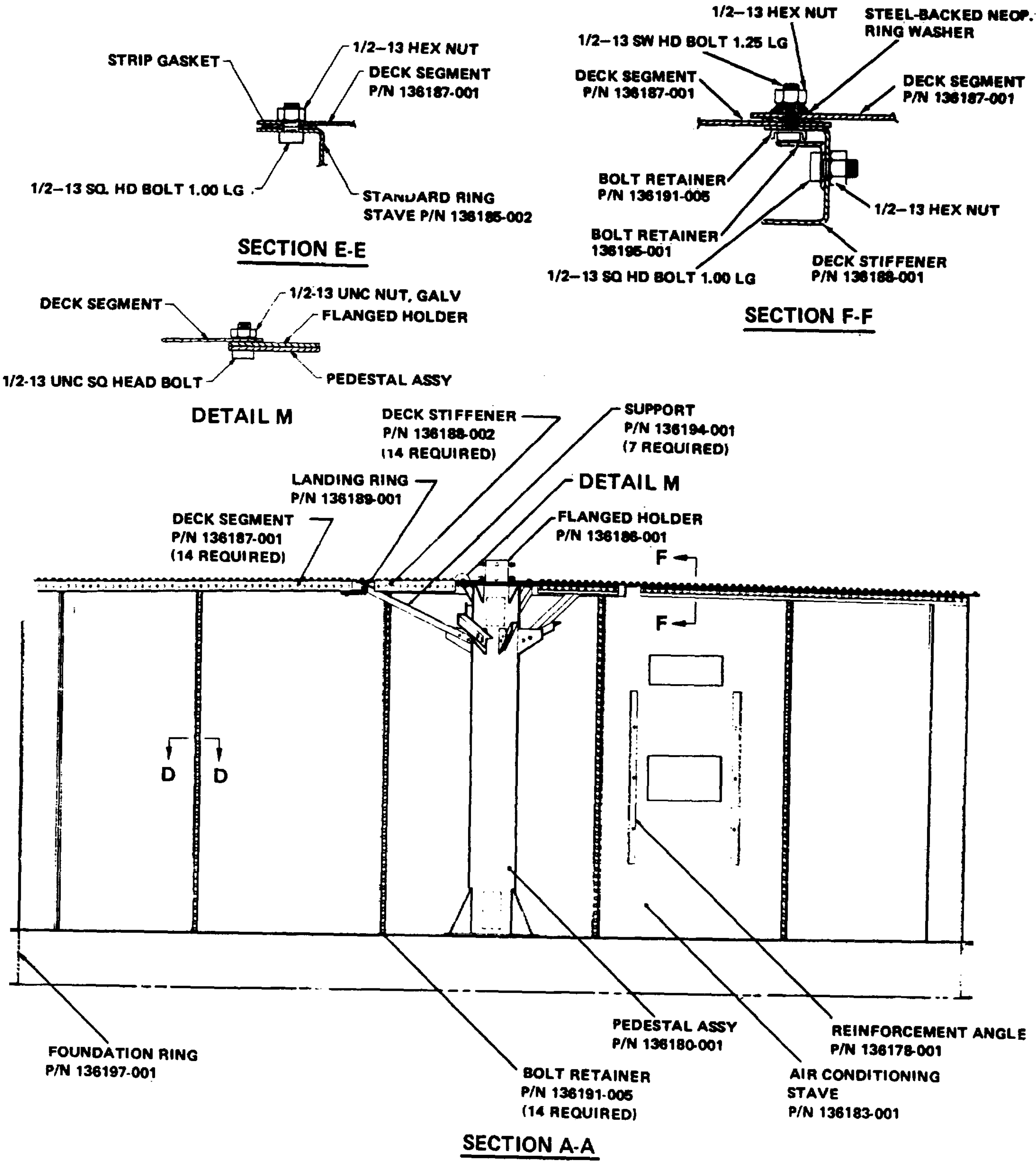


Figure 2-8. Shelter Assembly Construction Diagram (Sheet 3 of 4)

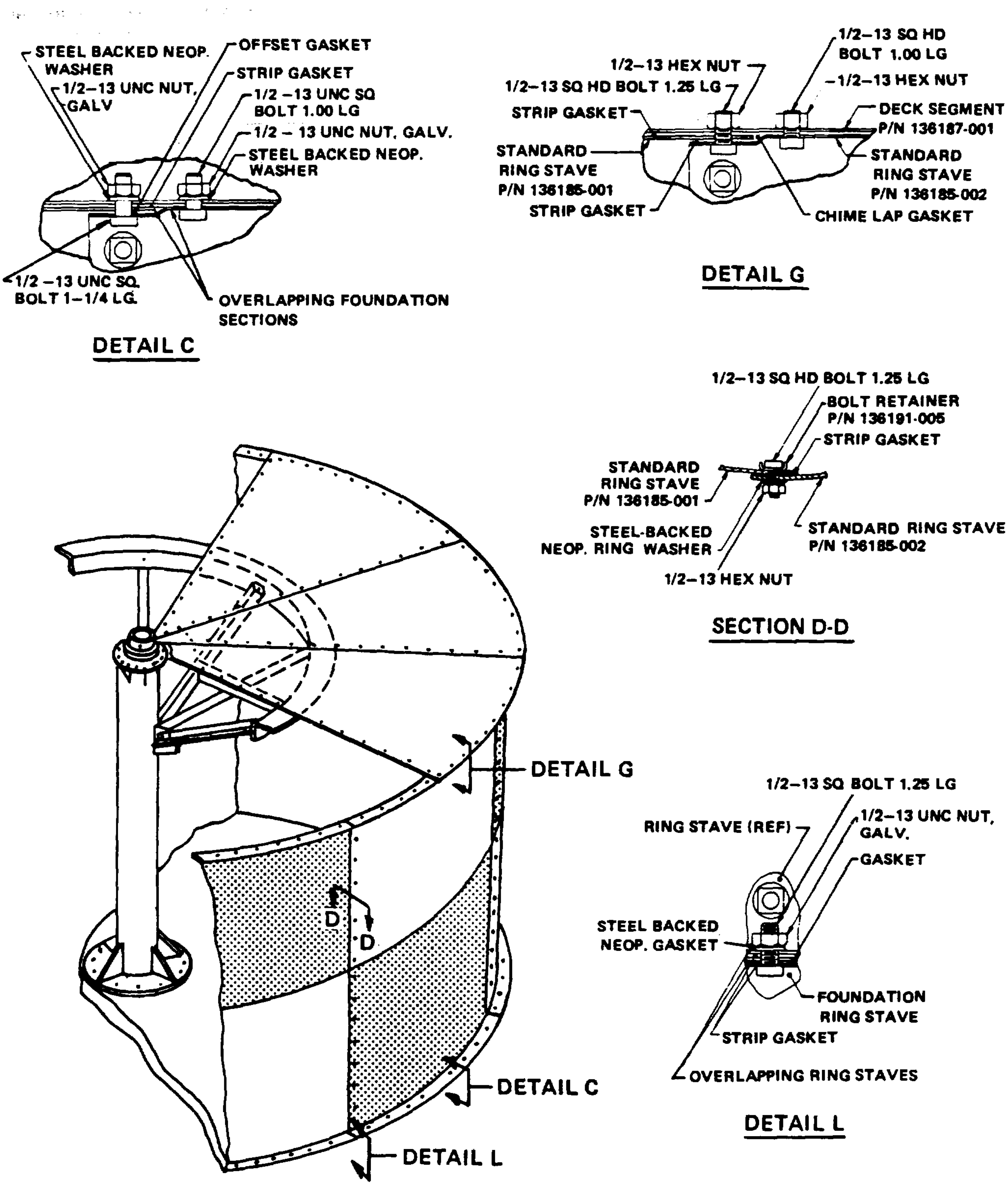


Figure 2-8. Shelter Assembly Construction Diagram (Sheet 4 of 4)

(6) While holding the two wall sections upright, place and hand tighten four nuts on equally spaced bolts from outside the shelter on the foundation form and wall seam.

(7) Working counterclockwise (from inside of the shelter), continue with assembly of the wall sections. Install one wall section at a time and attach it to the foundation form and preceding wall section as described in preceding steps (2) through (5). Assemble the wall sections in the following order:

(a) Door section P/N 136184-001

(b) Plain wall section with orange bottom P/N 136185-001

(c) Plain wall section with white bottom P/N 136185-002

NOTE

Continue to alternate wall sections (b) and (c) until complete. The wall section with the cutout for the environmental unit (P/N 136183-001) should be placed in a position resulting in the least amount of direct sunlight This wall section will be used in lieu of one of the wall sections PIN 136185-001.

(d) Double check to ensure all gaskets are secure.

c. Shelter roof.

(1) Fourteen wedge-shaped aluminum sections form the shelter roof. Refer to figure 2-9 for assembly details. Each roof section has a three-inch (7.62 cm) flange along its straight edge to furnish rigidity to the completed roof. Two bolt retainers (channels) are to be used along the flange of each roof section to hold bolt heads in place. Prior to raising the first roof section into place, install bolt retainers, strip gasket, and bolts. Place the roof section in a cleared area with flange facing upward. Support the roof section as required and insert 1/2 - 13 UNC x 1-inch bolts through all of the holes adjacent to the flange, except the last hole at each end and the three adjacent holes where no flange exists. Align bolt heads and install the two bolt retainers, using 1/2 - 13 UNC X 1-1/4 inch bolts and nuts at every third hole. Tighten retainer mounting bolts securely.

(2) Turn the roof section over with the flange facing downward. Install rubber strip gasket, allowing a small amount of gasket material to extend beyond the ends of the overlapping edges. Start at one end, align holes in gasket with the ends of the bolts and press gasket material over the threaded portion of the bolts. Cut the gasket from the roll only after the material has been installed along the entire edge of the roof section.

(3) Use the procedure outlined in steps (1) and (2) to install bolts, bolt retainers and gasket material on the remaining roof sections.

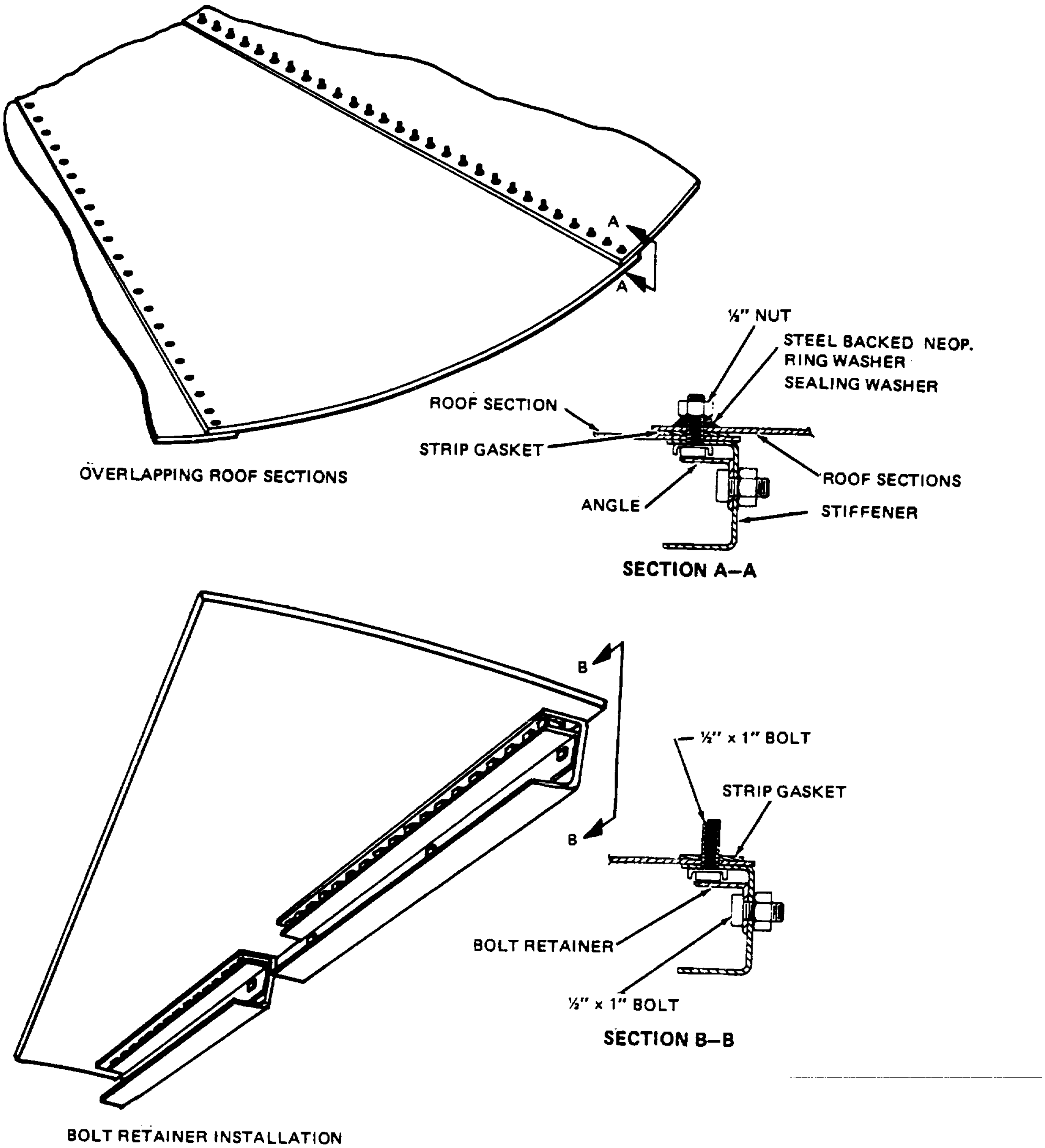


Figure 2-9. Roof Section Assembly

(4) Remove the 12 bolts and nuts that fasten the antenna mount to the pedestal.

(5) Raise one roof section with small end resting on the pedestal flange and the large end resting on the wall sections Adjust position of the first roof section until the straight edge with bolts and gasket will terminate in the center of one wall section. Positioning the roof section in this manner will ensure that the roof seams will not align with the wall seams Use drift pins to align holes in outside end of roof section with bolts in top flange of wall sections.

(6) Raise the second roof section and place it to the right side of the first section, as viewed from outside the shelter. Align bolt holes in left edge of second section with captive bolts in right edge of first section to form an overlapping seam.

(7) At each roof seam, (reference figure 2-8, detail M) insert a strip gasket between roof sections and gasket segments on pedestal flange. All bolts around pedestal flange are to be inserted from inside the shelter. Fasten roof sections to pedestal flange with 1/2-13 UNC x 1-1/4-inch bolts, recessed washers, ring gaskets, and nuts at holes where sections overlap. Use 1/2-13 UNC x 1-inch bolts, recessed washers ring gaskets and nuts at all other holes in flange. Insert preformed caulking (Strip-mastik) between each roof section and strip gasket (reference figure 2-9, section A-A). Tighten all flange bolts securely.

(8) Use the 1/2-13 UNC x 1-inch captive bolts already installed in roof sections, recessed washers, ring gaskets and nuts, and fasten overlapping edges of roof sections. Tighten nuts securely on captive bolts At this time, do not install bolts at points where roof seams rest underneath flange of pedestal flange. Remove excess caulking material from roof seams

d. Final assembly

(1) The wall sections should now be permanently bolted together at the seams, as shown in figure 2-& Complete the work at one seam before moving to the next. Leave holes open in top and bottom flange of seam. Tighten all bolts securely.

(2) The shelter roof should be bolted to top flange of wall sections at seams as shown in figure 2-& Fasten roof to wall sections with 1/2-13 UNC x 1-1/4 inch bolts, recessed washers, ring gaskets, and nuts at all other holes around roof circumference Tighten all bolts securely.

(3) The wall sections should be bolted to foundation form as shown in figure 2-8. Fasten wall sections to foundation form with 1/2-13 UNC x 1-1/4 inch bolts, recessed washers, ring gaskets, and nuts at holes where wall sections overlap and where foundation sections overlap. Use 1/2-13 UNC x 1-inch bolts, recessed washers, ring gaskets, and nuts at all other holes around foundation circumference. Tighten all bolts securely.

(4) The antenna pedestal should now be aligned so that the roof mounting holes, the antenna mounting base holes and the pedestal holes are in alignment (See figure 2-8, section A-A). Install bolts and tighten.

(5) A caulking gun and caulking compound are supplied with the shelter. Perform the following caulking operations after all electronics equipment has been installed and the initial alignment completed:

(a) Outside the shelter, caulk the joint formed by roof sections and antenna pedestal flange.

(b) Inside the shelter, caulk the joints formed by overlapping wall sections, roof and wall sections, and foundation form and wall sections Save some of the caulking compound for use around the shelter blower housing and exhaust vents.

2-14. ELECTRICAL Figure 2-10 is a detailed layout of the shelter power distribution system. An overall system interconnection diagram is detailed in figure 7-1. Install the electrical wiring for the shelter as follows:

a. Install circuit breaker box using the two mounting straps and mounting plate as indicated in figure 2-10.

b Install connection boxes for the four light fixtures as outlined in figure 2-10.

c. Install and connect antenna blower assembly as shown in figure 2-10.

d. Install and connect vent fan assembly as shown in figure 2-10.

e. Using the 1/2-inch flexible conduit, run the conduit for the four light fixtures, exhaust vent fan, antenna blower assembly, obstruction lights and VOR antenna (reference figure 2-10). Attach conduit with clips and screws to roof flange.

f. Install 1-inch flexible conduit from circuit breaker box for the electronic assembly (reference figure 2-10).

g. Install 1-1/4inch flexible conduit from input power line, using connection box, to circuit breaker box (reference figure 2-10).

h. Using figures 2-10 and 7-1, run wires through conduit. Leave enough wire at each terminal to allow proper connection.

2

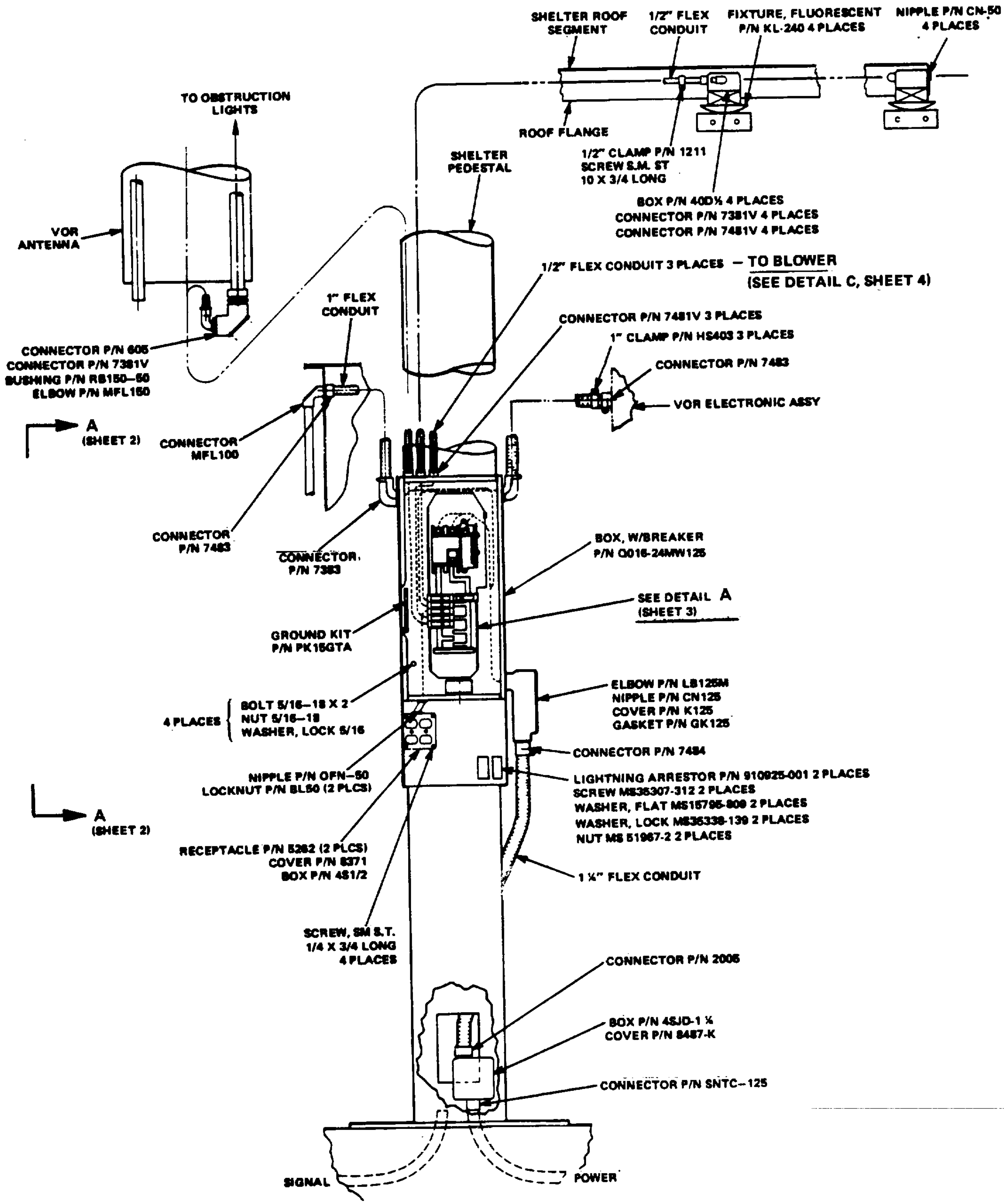
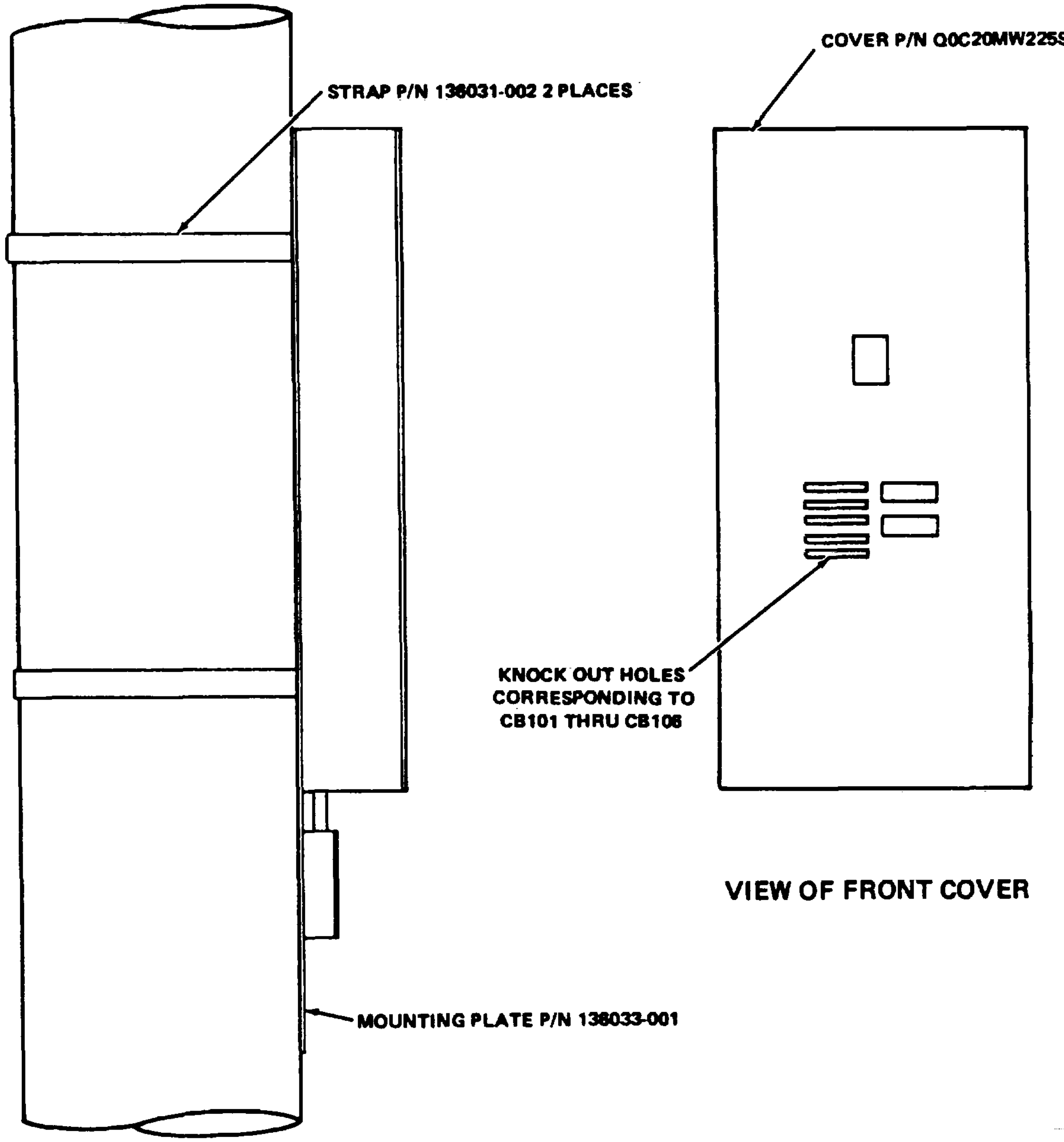
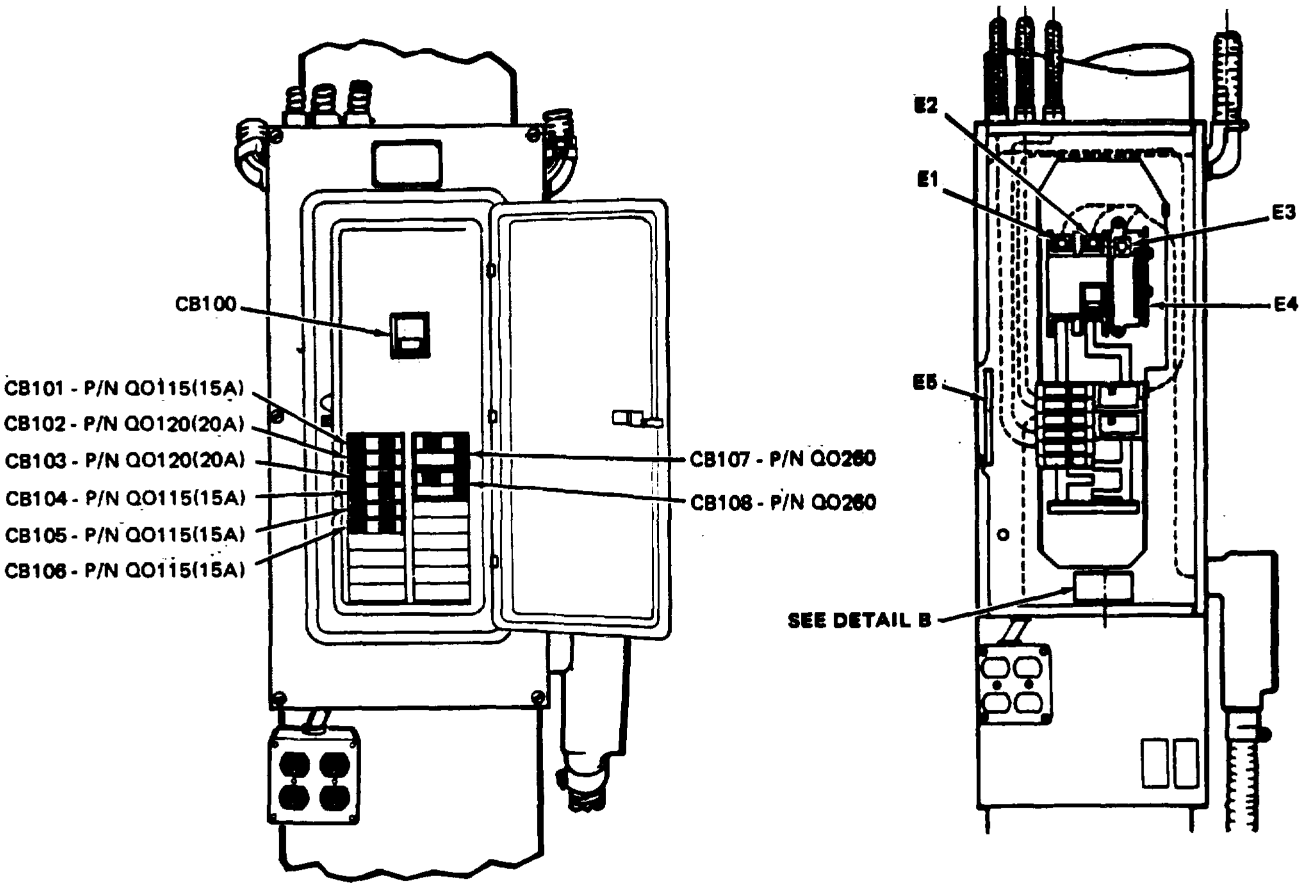


Figure 2-10. Power Distribution Layout (Sheet 1 of 4)



VIEW A-A

Figure 2-10. Power Distribution Layout (Sheet 2 of 4)



NOTE:
Point to point wiring information for the Power Distribution System is provided in table 2-4. The wire numbers listed in table 2-4 correspond to the wire numbers shown in parentheses on figure 7-1.

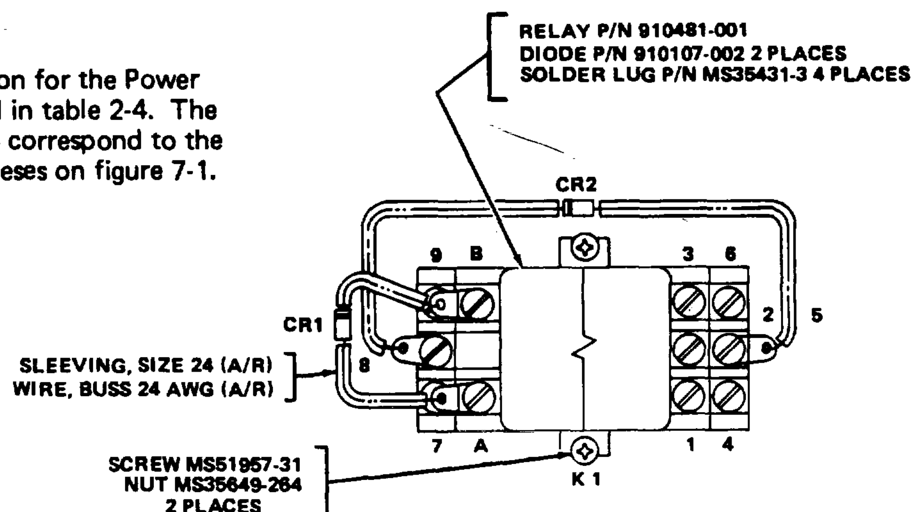


Figure 2-10. Power Distribution Layout (Sheet 3 of 4)

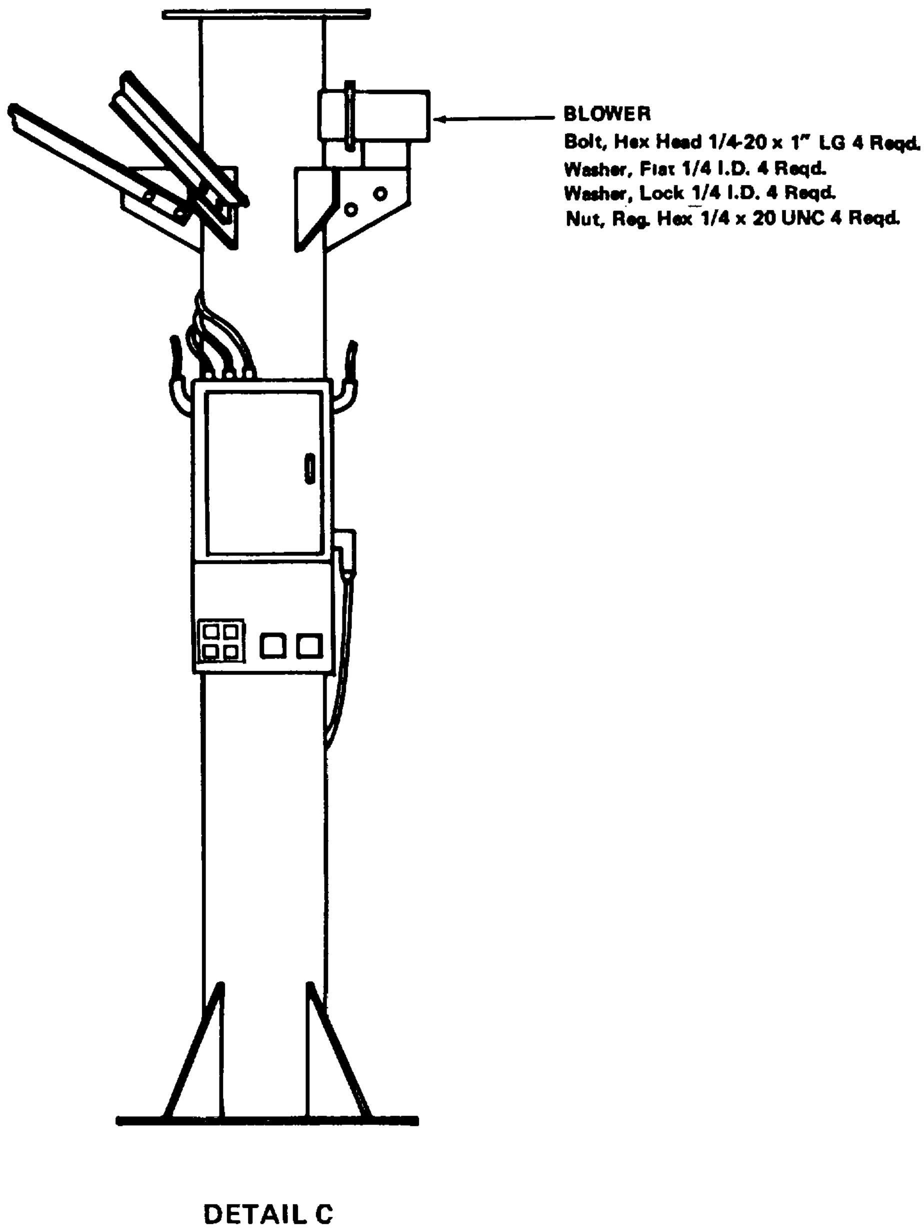


Figure 2-10. Power Distribution - Layout (Sheet 4 of 4)

WIRING LIST							
Wire No.	Make From Item No.	Approx Length Inches	From: Circuit Point	From: Access Item No.	To: Circuit Point	To: Access Item No.	Remarks
1	10		Mp1E2		A2E1		
2	8		MP1E2		A2E2		
3	9		MP1E3				
4	5	7	E1		A2E5		
5	7	2	A2CB101		S2		Include blk wire from XDS1 & wire 6 in splice
5A	7	12	s2		xds1e1		
6	7	12	XDS1E1		XDSE2E1		Include blk wire from XDS2 & wire 7 in splice
7	7	12	XDs2e1		XDs2e1		Include blk wire from XDS3 & wire 8 in splice
8	7	12	XDS3e1		XDS4E1		Include blk wire from XDS4 in splice
9	6	12	A2		S2		Include wht wire from XDS1 & wire 10 in splice
9A	6		S2		XDS1E2		
10	6	12	XDS1e2		XDSe2		Include wht wire from XDS2 wire 11 in splice
11	6	12	XDS2E2		XDS3E2		Include wht wire from XDS3 12 wire splice
12	6	12	XDS3E3		XDS4E2		Include white wire from XDS4 in splice
13	5	A2			XDS1E3		
14	5	12	XDS1e4		XDS2E3		
15	5	12	XDS2E4		XDS3E3		
16	5	12	XDS3E4		XDS4E3		
17	7	2	A2CB103		E2		Silver colored mtg screw
18	6	2	A2E4		E1		Gold colored mtg screw
19	5	2	A2E5		E3		Grn colored mtg screw
20	6	1	E1		E4		Silver colored mtg screw
21	7	1	E2		E5		Gold colored mtg. Screw
22	7	6	A2CB104		B1E1		Splice with blk wire from B1
23	6	6	A2E4		B1E2		Splice with wht wire from B1
24	5	6	A2E5				Connect to B1 frame
25			Not used				
26			Not used				
27			Not used				
28	7	12	A2CB102		1ATTB1-1		
29	6	12	A2E4		1ATTB1-2		
30	5	12	A2E5		1ATTB1-3		
31	7	A1xk1-4			3A1A1BT1-blk		Gold colored mtg screw
32		Not used					
33	6	20			3A1A1BT1-wht		Silver colored mtg screw

Table 2-4. VOR Power Distribution Wiring List

WIRING LIST							
Wire No.	Make From Item No.	Approx Length Inches	From		To		Remarks
			Circuit Point	Access Item No.	Circuit Point	Access Item no.	
34	5	20	A2E5		Connect to 3A1A1BT1 frame		
35	3	13	A2XK1-A		1ATTB3		
36	1	13	A2XK-5		1ATTB3-11		
37	4	13	A2XK-8		1ATTB3-12		
38			not used				
39	7	2	A2CB105		A1Xk1-7		
40			Not used				
41	4	1	A2XK1-B		A2XK1-8		
100	10		A2CB106		A1E1		Lowerpole of CB106
101	8		A2CB106		A1e2		Upperpole of CB106
102	9		A2e5		A1E5		
103			Not used				
104			Not used				
105	10		A2CB108		A1E3		Splice with 2A6H1 and 2A6H2
106	8		A2CB108		A1E4		Splice with 2A6H3
107			Not used				
108			Not used				
109			Not used				

<u>* WIRING MATERIALS LIST</u>

MAKE FROM	DESCRIPTION
1	WIRE, 22 AWG W/GRN
2	WIRE, 22 AWG W/VIO
3	WIRE, 22 AWG W/GRA
4	WIRE, 22 AWG ORN
5	WIRE, 12 AWG, CU, GRN, STR TYPE THHN
6	WIRE, 12 AWG, CU,'WHT, STR TYPE THHN
7	WIRE, 12 AWG, CU, BLK, STR TYPE THHN
8	WIRE, 4 AWG, CU, RED, STR TYPE THHN
9	WIRE, 4 AWG, CU, WHT, STR TYPE THHN
10	WIRE, 4 AWG, CU, BLK, STR TYPE THHN

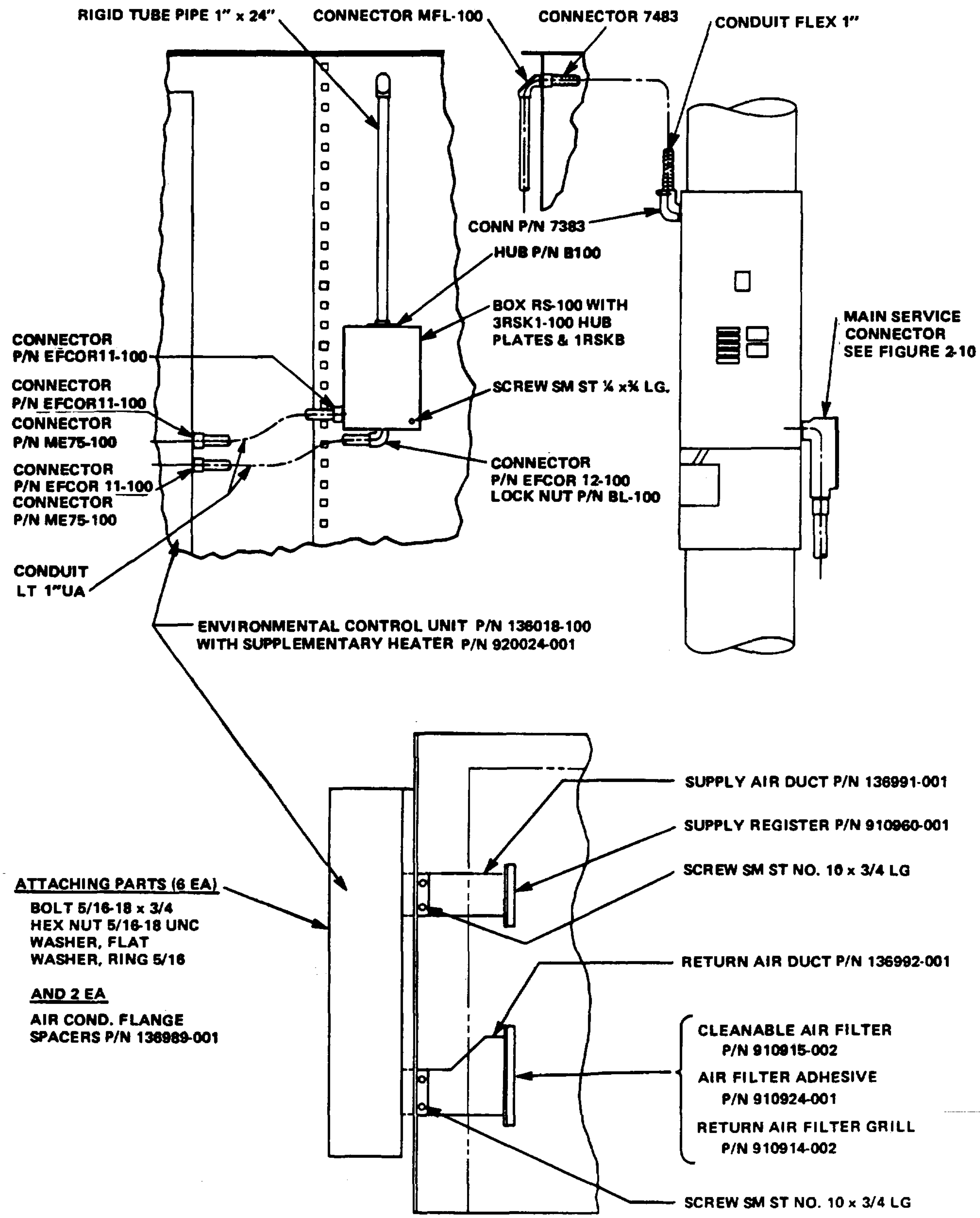


Figure 2-11. Environment Control Unit Installation Diagram

2-15. ENVIRONMENTAL CONTROL UNIT. The environmental control unit is installed in accordance with the requirements outlined in figure 2-11, figure 7-1 and the following procedures:

a. Remove covers from shelter outside sidewalls and install environmental control unit at designated location.

b. Apply caulking (Handi patch) around environmental control unit starting at the spacer block, which holds the unit to the shelter, and continue up to the top, across the top, and down the spacer block on the opposite side. Press caulking firmly into place to seal the joint between the shelter wall and the environmental unit.

c. To install the thermostat (P/N T872C1038), locate a point on the shelter sidewall joint approximately 60" (152.4 cm) from the floor and close to the 3150 radial (see figure 2-12).

d Remove two each, 1/2" x 1" bolts which secure the shelter sidewall joints and loosen six each of the same bolts above and below the designated location of the thermostat

e. Install thermostat bracket between shelter wall and bolt retainer and secure in place.

f. Tighten all bolts loosened in step d. above.

g. Install thermostat on bracket

h. Wire in accordance with the requirements outlined in figure 7-1.

2-16. FIELD DETECTOR MOUNTING POST. (Reference figure 2-13.) Installation of the field detector mounting post is accomplished as follows:

a. At the site previously established for the field detector (paragraph 2-10, item g), inbed a 4" x 4" (10.16 cm x 10.16cm) **wood** post, 2 feet (60.46 cm) below ground into concrete anchor with 3 feet (91.44 cm) clear height. Ensure post is vertical.

b. Mount field detector bracket at top of post facing the antenna.

2-17. FIELD DETECTOR MOUNTING KIT. Installation of the field detector mounting kit is accomplished as follows:

a. Set up a transit on the shelter roof and plumb transit to shelter center.

b. Back sight transit to magnetic north stakes (reference figure 2-3).

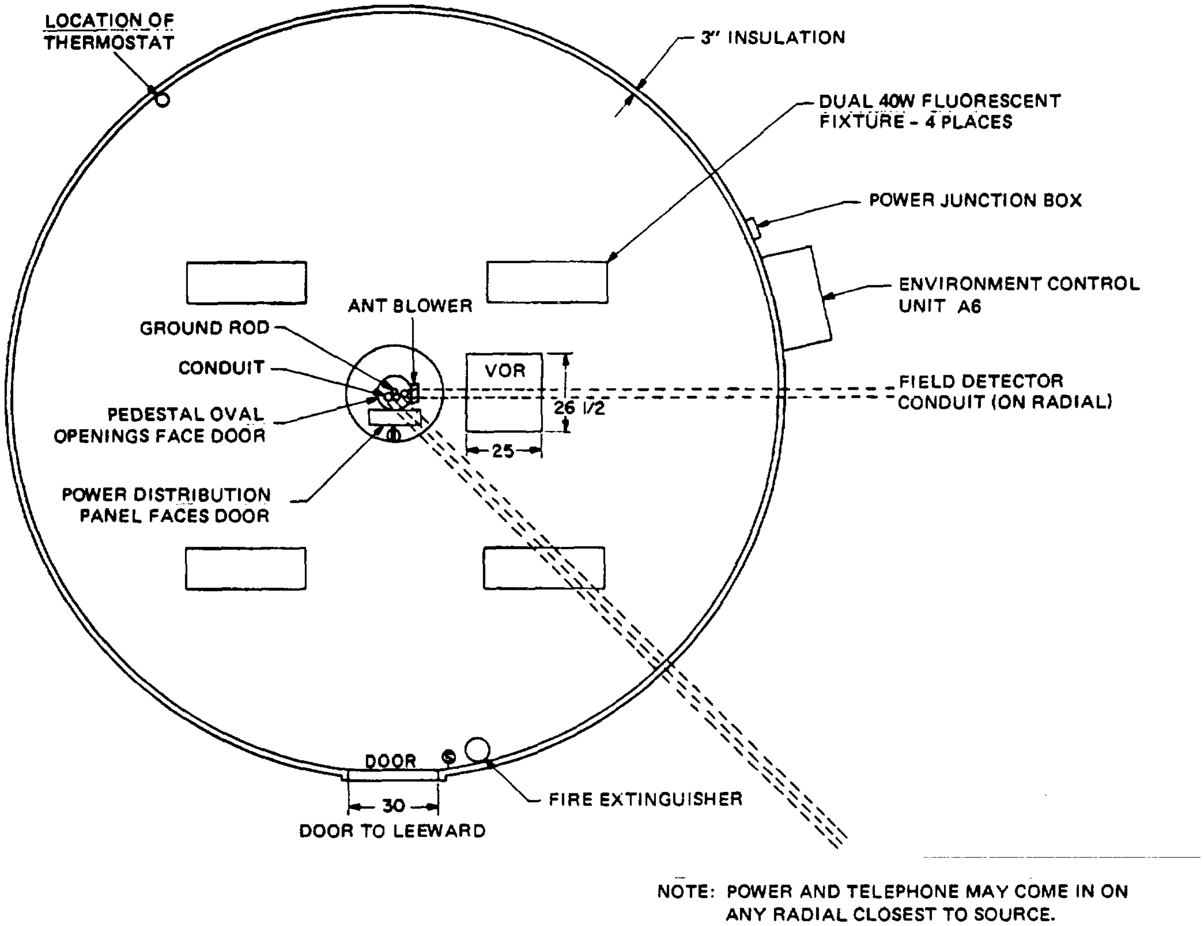


FIGURE 2-12. VOR/DME Facility Equipment Location Cutaway View

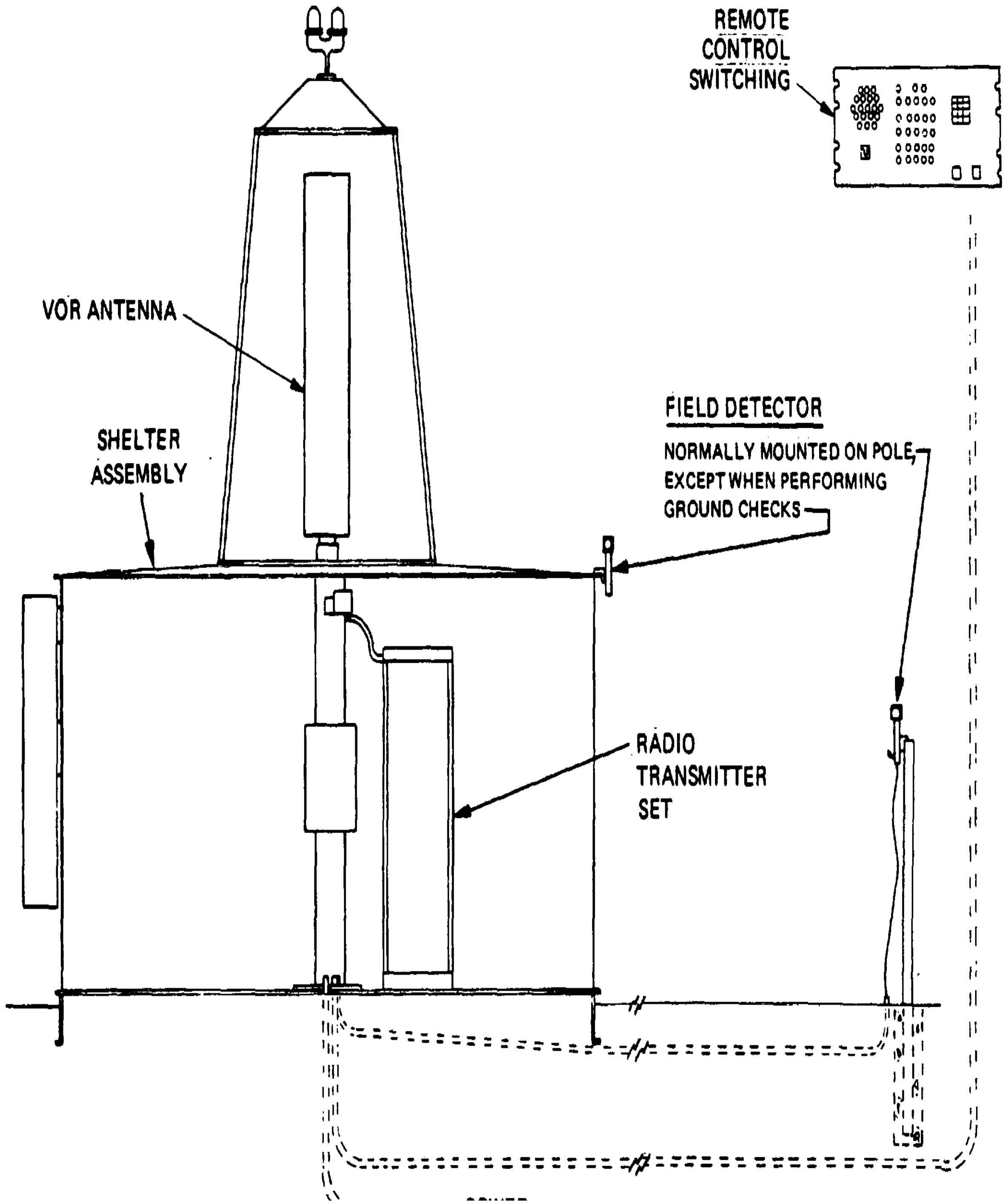


Figure 2-13. VOR System Cutaway View

c. Per instructions detailed in figure 2-14, proceed to install and accurately align the field detector mounting kit

d. Prior to removing the transit, check the location of each mounting bracket and securely tighten mounting bolts.

NOTE

The field detector is mounted on the counterpoise for ground checks only.

2-18. ANTENNA. Procedures for installation of the VOR antenna are as follows:

a. Setup transit on the 55-foot (16.5 m) magnetic north marker (reference figure 2-3) and back sight to the center of the shelter and far field magnetic north marker to verify correct alignment.

b. Three cables will extend from the open end of the antenna support pipe. These cables must be carefully inserted into the antenna pedestal and connected per figure 2-15. The cable for the obstruction lights will run up one of the external tubes on the antenna and to the obstruction light (reference figure 2-15).

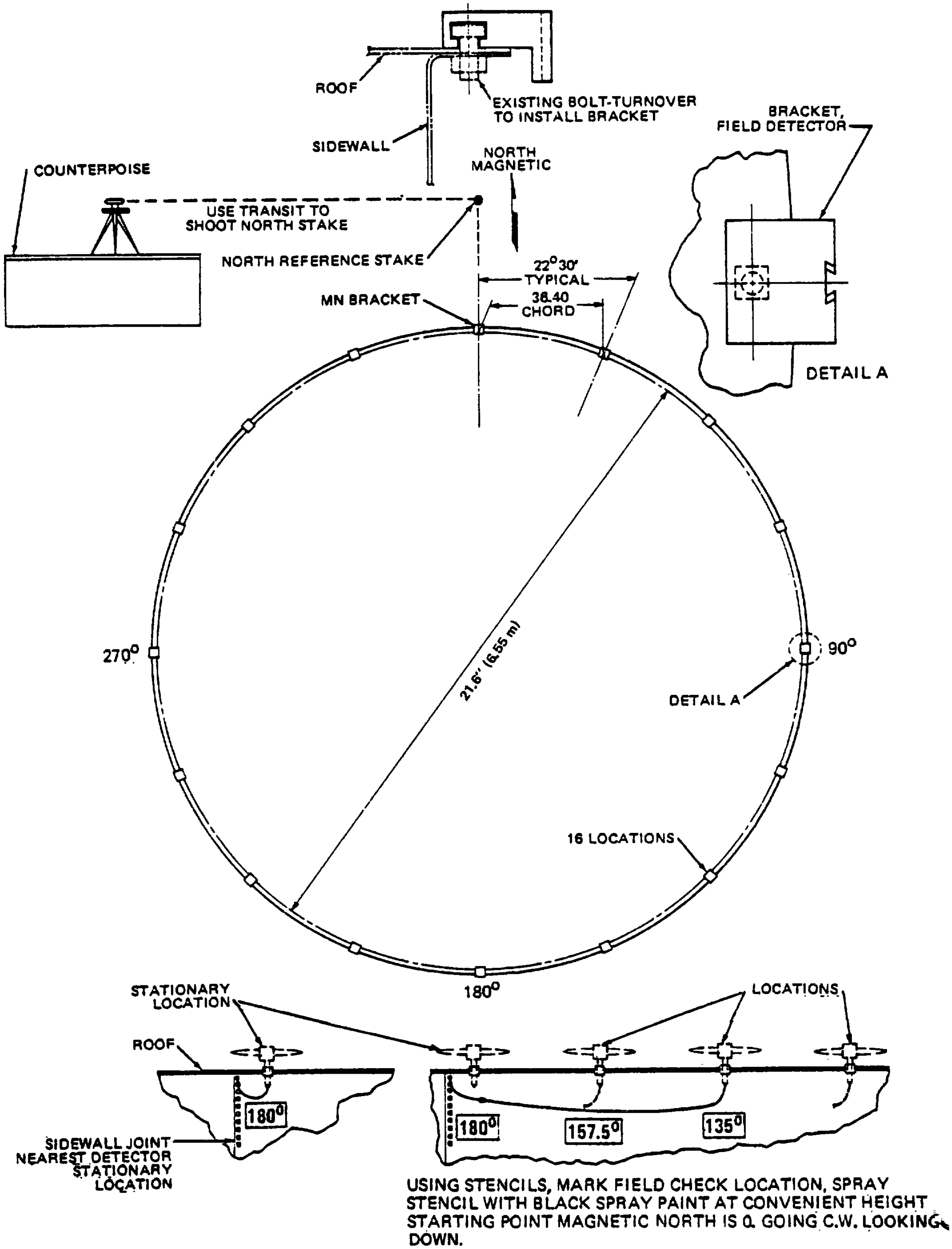
c. Place the antenna into the pipe socket of the antenna support with the black (north) strip facing magnetic north (transit). Adjust the eight jack screws to approximately level the antenna and hold the antenna in position. Using the transit for alignment, place the antenna in the magnetic north position and ensure antenna is vertical from top to bottom. Once alignment is complete and jack screws are tight, tighten the additional lock nut on each jack screw. Double check antenna orientation.

2-19. RADOME. The radome is divided into three basic pieces: two halves and a top cap. These pieces are gasketed and held in place with nylon bolts and sealing washers. Installation of theradome is as follows:

a. Determine the correct direction of the radome access door (450, 1350, 2450, or 3150) and place that half of the radome on the shelter roof. Align holes in bottom of radome with anchor bolt holes in shelter roof.

b. Place 1/2" x 1-1/4" bolts through bottom of radome half into matching holes in roof (nuts will be inside of shelter). Do not tighten.

c. Install 1/8" x 1-1/2"*Y'* rubber gasket This is accomplished by removing backing strip and pressing gasket to appropriate area Place gasket againstradome flange, vertical seams and around the access door and trim off excess gasket with a knife. After gasket is in place, punch holes in the gasket at each bolt hole using the special gasket hole punch. This is accomplished by placing a wooden block behind the gasket and rotating the gasket punch through the bolt hole and gasket.


ROOF
EXISTING BOLT-TURNOVER TO INSTALL BRACKET
SIDEWALL
NORTH MAGNETIC
BRACKET, FIELD DETECTOR
COUNTERPOISE
USE TRANSIT TO SHOOT NORTH STAKE
NORTH REFERENCE STAKE
22°30' TYPICAL
36.40 CHORD
MN BRACKET
DETAIL A
270°
90°
21.6' (6.55 m)
DETAIL A
16 LOCATIONS
180°
STATIONARY LOCATION
LOCATIONS
ROOF
180°
180°
157.5°
135°
SIDEWALL JOINT NEAREST DETECTOR STATIONARY LOCATION
USING STENCILS, MARK FIELD CHECK LOCATION, SPRAY STENCIL WITH BLACK SPRAY PAINT AT CONVENIENT HEIGHT STARTING POINT MAGNETIC NORTH IS 0. GOING C.W. LOOKING DOWN.

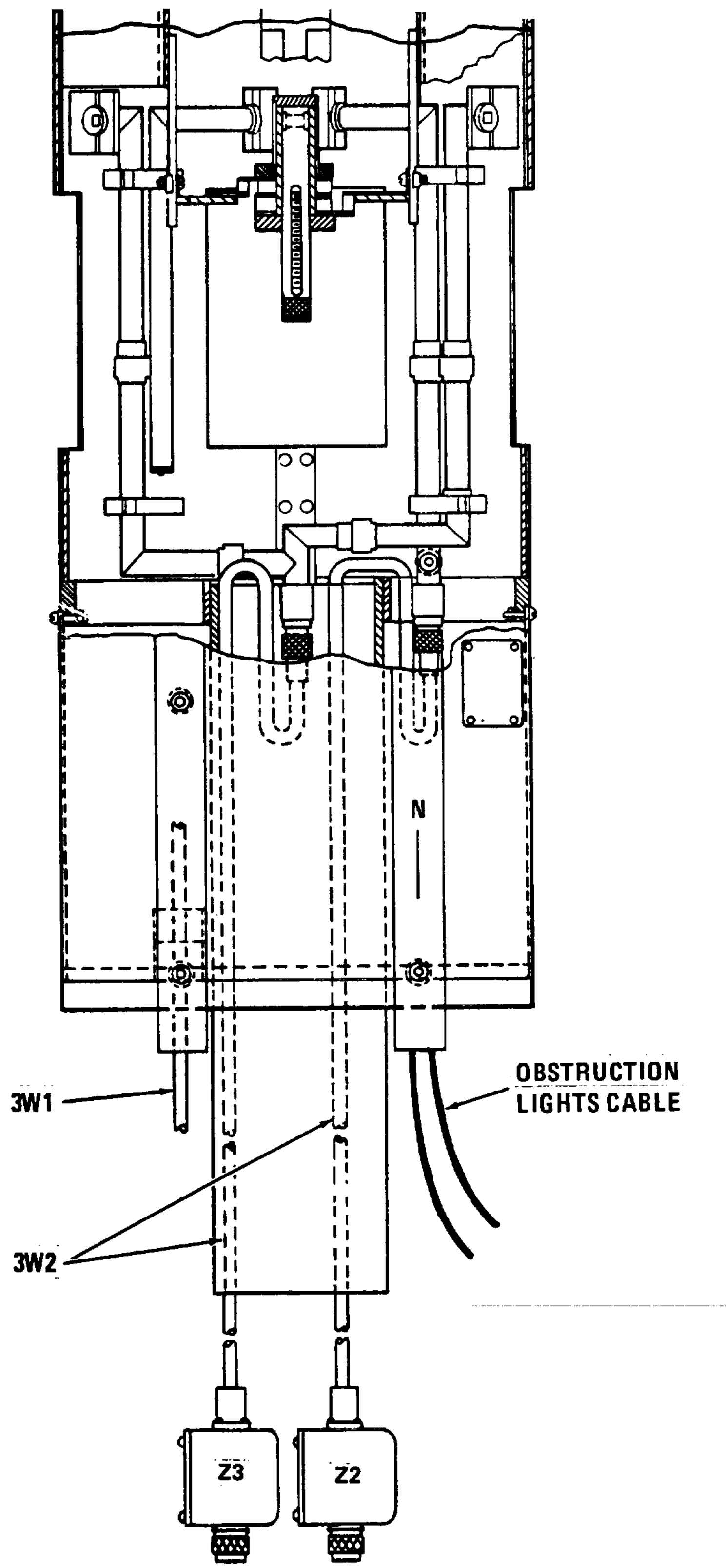


Figure 2-15. Antenna Cable Location

NOTE

Place nylon washer and O-ring against bolt head and O-ring and washer between nut and radome.

d. Place the other radome half in position and insert the 1/2'" x 1-1/4" bolts through radome flange and roof. Do not tighten nutl Bolt radome halves together using nylon bolts Do not overtighten nylon bolts.

e. After radome halves are bolted together, raise the radome (using a flat tool) and caulk a full 1/2-inch bead under the radome flange at the bolt circle. Push radome down against roof and tighten boltl After radome is securely in place, use a caulking gun and place another bead of caulking at the edge of the radome flange and roof. Smooth caulking in place to seal all crackl

f. Place the 1/2" x 1-1/2" rubber gasket against the radome cap flange and press securely in place Punch holes in gasket as described in c. above. Place radome top cap in place and bolt to radome using nylon bolts and seal washers Do not overtighten nylon bolts. Place flange and flange gasket on radome cap.

2-20. OBSTRUCTION LIGHTS. To mount the obstruction lights and photo cell assembly to the top of the radome, proceed as follows - (Reference figure 2-16.)

a. Remove junction box cover from junction box.

b. Run wires from VOR antenna into junction box. Do not connect wires at this time.

c Screw the obstruction lights and photo cell assembly into the radome.

d. Connect wires from VOR antenna as follows: White to white and black to black.

e. Replace junction box cover and gasket

2-21. INSULATION KIT. After all electrical wiring and the environmental unit have been installed, the insulation kit should be installed. The insulation kit consists of self-adhesive stick clips, two rolls of 48" wide vinyl covered insulation, and 14 sets of ceiling panels. The insulation kit may be installed as follows:

a. Attach stick clips to the roof sections and wall panels as detailed in figure 2-17.

b. Attach the 14 sets of ceiling panels, cutting around the four light fixtures, as described in figure 2-17.

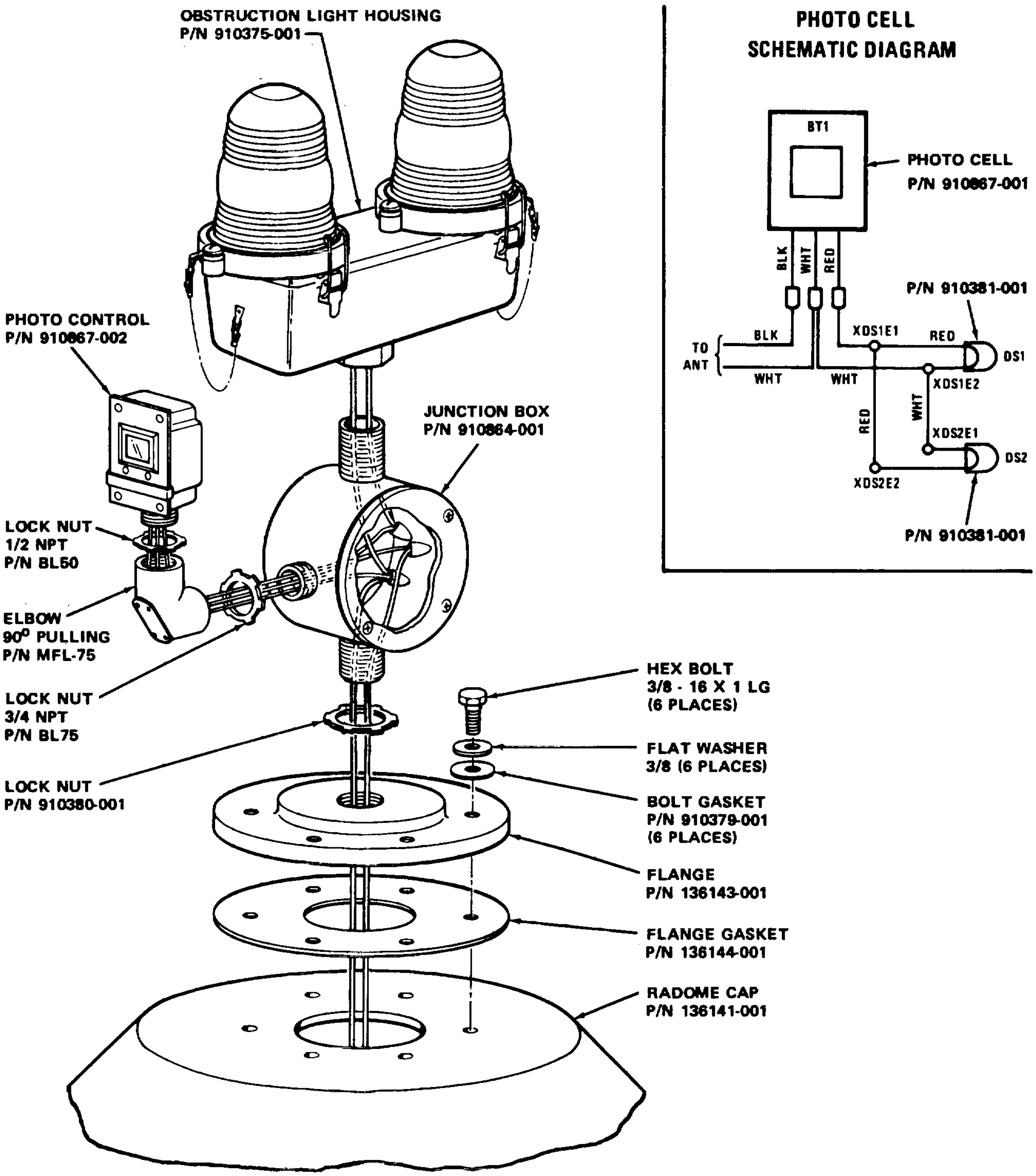


Figure 2-16. Obstruction Lights Assembly

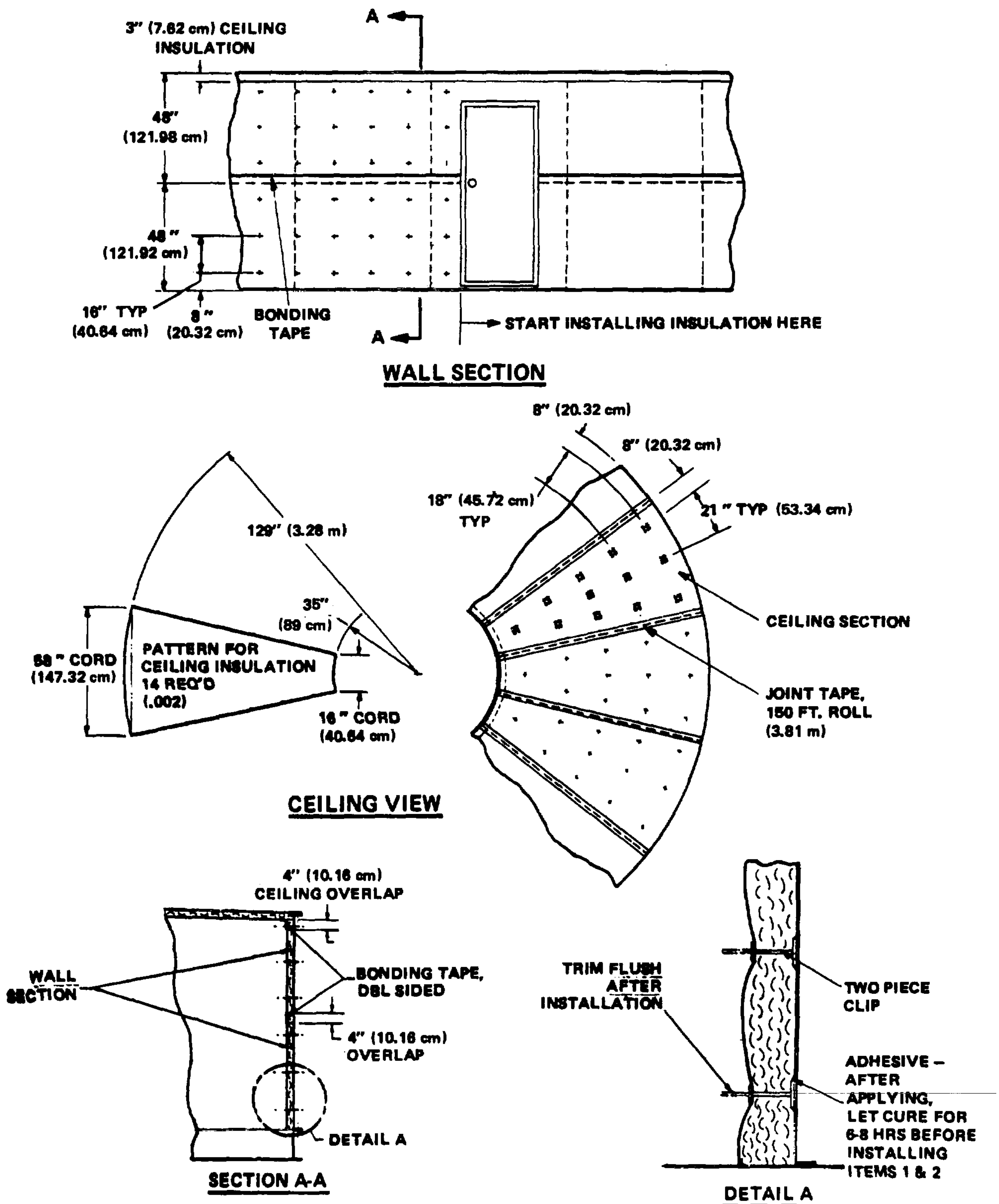


Figure 2-17 Insulation Installtion

c. Starting at the left hand side of door (from inside of the shelter) set the end of the 48" (121.92 cm) wide roll of insulation flush with the door jamb (ensure that the 4" (10.16 cm) tab on the roll; is at the top) and impale the insulation on the nails of the stick clips. Continue this operation around the entire shelter until reaching the right side of the door. Cut the insulation flush with the door jamb.

d. Repeat procedure described in b above for the top half of the shelter walls. Trim insulation flush with exhaust and intake vents and across the top of the door.

e. Attach the mating part of the stick clips to protruding nails and carefully force into place making sure that only 1/16" (. 159 cm) of the nail protrudes through the clip.

f. On the wall section, pull down the 4" (10.16 cm) flaps (flap should be cut every 12 inches (30.48 centimeters) to facilitate attachment to curved wall) and attach double face tape to the flap. Carefully pull the flap back up and attach it to the insulation above, ensuring that it is smooth.

g. Finish ceiling panels by applying white vinyl tape to the seams between the insulation pieces. Place vinyl tape on the seam over the door jamb.

h. After all joints have been taped and trimmed, push stick clips approximately one-inch (2.54 cm) onto nail and trim nail flush with clip.

SECTION IV

VOR INSTALLATION

2-22 ELECTRONIC EQUIPMENT. This section contains instructions for installation and initial setup of the electronics equipment. The following items must have been accomplished prior to electronic equipment installation.

a Shelter erected and power distribution system installed.

b. Antenna, field detector and field detector mounting brackets installed.

c. Radome installed.

NOTE

Refer to Section I for specific instructions for mounting the antenna, radome and field detector.

2-23. POWER REQU I REMENTS. This sytem is designed to operate on 115 Vac or 230 Vac.

a Power Supply Modification for 115/230, 50 to 60 Hz Vac Operation. The power supplies contained in the local control (1A2) and the monitor (1A3) drawers can be connected to be used for either a 115 Vac or 230 Vac source. This method of strapping for the local control (1A2) and monitor (1A3) power supplies is detailed in figure 7-2, note 5 and 6 respectively. (Also detailed on figure 7-3 and 7-10.) In addition, the remote control unit, unit 4, power supply can also be wired in the same way for 115Vac or 230 Vac. The wiring requirements for this unit are specified in figure 7-31. To change the power requirements for the carrier transmitter, it is necessary to use a different power supply. The power supply (1A4PS1) for 115 Vac operation is Part No. 910692-003 and the power supply (1A4PS1) for 230Vac operation is part number 910692-004.

b. Primary AC Power Application. The primary ac power is normally routed through conduit to a power distribution box, through a circuit breaker and then through another conduit to enter the electrical equipment rack on the top left hand side (when viewed from the front of the cabinet). The input power is connected to a terminal strip located on a panel in the top rear of the rack equipment. A full length door on the rear of the rack opens to provide easy access to the terminal strip. Refer to figure 7-1 for the appropriate terminal numbers to connect the primary power.

NOTE

Before connecting primary power, ensure that the circuit breaker in the power distribution box is off.

It is recommended that a minimum 12 AWG three color conductor cable be used for 115 Vac primary power cable and a minimum 12 AWG four color conductor cable be used for 230 Vac primary power cable.

2-24. EQUIPMENT INSTALLATION. Remove the electrical equipment rack from its shipping container and install inside the shelter as shown in figure 2-12. Install the drawer assemblies and interfacing cables in accordance with the following instructions.

a. Drawer Assembly Installation. Remove all drawers from their shipping containers and referring to figure 1-2, install them in their respective positions on the slide rails provided. In the single system configuration, blank panels are used in place of the monitor 1A6, carrier transmitter 1A7, and sideband transmitter 1A8 drawer assemblies. Connect all harness connectors and coaxial cable connectors to each drawer assembly as shown in the system interconnection diagram, figure 7-2 in this manual.

b. Antenna Cable Installation. Refer to figure 7-2 and figure 7-30 for the proper interface connections. There are three antenna cables which connect to the electrical equipment rack. The antenna cables are routed from the top of the shelter through the shelter pedestal assembly and out an access hold adjacent to where the VOR electrical equipment rack is located. Antenna sideband A cable connector 3W2P2 connects to line matching network connector 3Z2J1. The other connector, J1, on line matching network 3Z2, connects to the SIDEBAND A output connector 1A1W14P2 on the electrical equipment rack. Antenna sideband B cable connector 3W2P3 connects to line matching network connector 3Z3J1. The other connector, J1, on line matching network 3Z3 connects to SIDEBAND B output connector 1A1W14P4 on the electrical equipment rack.

NOTE

Refer to paragraph 2-25 and 2-26 for installation requirements for the remote control unit and field detector.

2-25. REMOTE CONTROL UNIT. The remote control unit can be located at any facility up to 20 miles away using 4 wire, twisted pair, or any distance as required, using a 4-wire interface with the public telephone system or microwave link.

a. Primary Power Interface. Connect the appropriate primary ac power (1 15V or 230V, 50 to 60 Hz) to P1 on the remote control unit Refer to figures 7-1 and 7-31 in TM 11-5825-266-14-2.

b. Connector J2 Installation. Interface between the local control and remote control is made via a telephone link or microwave line. The termination at each end is made via a 4-wire (twisted pair) interface. One pair of wires connects to pins 13 and 14 on terminal block A1TB4 and the other pair of wires connects t pins 19 and 20 on terminal block A1TB4 located inside the electrical equipment rack. Refer to figure 7-1 to insure proper pin connections. The termination of the four wire interface at the remote control site is connected into a mating connector supplied with the remote control. This 25 pin connector, P2, mates with connector J2 on the remote control, unit 4. All contact pins are supplied with the mating connector. Wire the connector so that the interconnection requirements of figure 7-1 are met.

c. VORTAC VOICE Interface. A mating connector, P4, is provided for VORTAC VOICE, connector J4. Proper interface can be made when the necessary interfacing equipment is provided at the remote site. The connector can be wired using figure 7-1 for the interface requirements of the remote control and the equipment manual for the interface requirements for the VORTAC VOICE equipment.

d. ATIS Interface. A mating connector, P5, is provided for ATIS, connector J5. Proper interface between the ATIS communication equipment and the remote control can be made using figure 7-1 and the ATIS communication equipment manual.

2-26. FIELD DETECTOR INSTALLATION. For normal operation, the field detector is located on a bracket on a mounting post at a specified radial. When performing ground checks, the field detector is installed on mounting brackets located on the periphery of the shelter counterpoise. The following procedures detail the requirements for installation of the field detector mounting post and brackets.

a. Field Detector Mounting. Refer to paragraph 2-17 for instructions for installing field detector mounting brackets around a shelter counterpoise and for installing a permanent mounting post for the field detector for use during normal operation.

b. Field Detector Interface. Connect the spade lug ends of field detector cable 2Wl through the cable entrance at the top of the electrical equipment rack and connect to terminal block A1TB2, located inside the equipment rack at the top rear portion. Easy access may be attained via the rear door of the electrical equipment rack. See figure 7-1 for correct terminal connections.

NOTE

The following procedures must be accomplished in the sequence specified.

2-27. INITIAL POWER TURN ON PROCEDURES. Perform the following procedures when initially applying operating power to a new installation. Primary power is applied through a circuit breaker in a power distribution box before it is applied to the VOR equipment (VOR electronics assembly). This circuit breaker should be in the off position before applying any power to the electronics assembly.

a. Ensure that the SYSTEM POWER circuit breaker (CB1) on the local control (1A2) is turned to the OFF position before primary power is applied. When this is accomplished, energize the circuit breaker in the power distribution box to apply operating power to the VOR electronics assembly.

b. Open Carrier Transmitter (1A4) drawer and turn the ON/OFF/NORMAL power switch located on the inside chassis to the OFF position.

c. Open sideband transmitter (1A5) drawer and turn POWER SWITCH SI to OFF position.

d. Turn SYSTEM POWER circuit breaker CB1 on local control (1A2) to the ON position. Verify the following conditions on local control 1A2.

I. POWER ON Indicator 1A2DS1 Is illuminated.

2. SYSTEM INHIBIT SWITCH 1A2S2 indicator should be Illuminated. If not, press until illuminated.

3. REMOTE SWITCH 1A2S2 should be extinguished. If illuminated, press the switch until extinguished. (When REMOTE SWITCH 1A2S2 indicator Is extinguished, the VOR electronics assemb can be controlled by the VOR local control keyboard)

4. Enter command code 17 from keyboard on local control 1A2.

5. Verify that (SYSTEM STATUS) OFF Indicator 1A2DS2 is illuminated and (SYSTEM STATUS) CRITICAL SWITCHES NORMAL indicator 1A2DS9 is extinguished.

NOTE

One or more of the ALARM indicators may be illuminated.

2-28 CARRIER TRANSMITTER INITIAL SETUP PROCEDURES.

a. Crystal Installation. If the correct crystals corresponding to the operating frequency of the site have not been Installed in the oscillator/exciter assembly (A3) in either carrier transmitter 1A4 or 1A7, then the appropriate crystals must be Installed in accordance with the following procedure.

1. Disassemble oscillator/exciter assembly 1A4A3 to the extent necessary so that the access cover can be removed.

2. Install the correct crystal in the corresponding crystal socket (XY1) located on circuit card assembly 1A3A1.

3. Replace the access cover for 1A4A3 and carefully position so that the voltage lead connections at the top of the module do not touch any part of the carrier transmitter chassis.

b Ensure that the ON/OFF/NORMAL power switch in carrier transmitter 1A4 is in the OFF position. Ensure that the POWER SWITCH on sideband transmitter 1A5 is in the OFF position. Set the TEST/NORMAL switch on modulator assembly A4 in the carrier transmitter 1A4 to the TEST position.

c. Disconnect the antenna carrier cable from the CARRIER output connector located at the top left side of the VOR electrical equipment rack. Connect a 100 watt dummy load at the CARR IER output connector in place of the antenna.

d. On the local control keyboard, enter command code 15 by pressing the appropriate keys. This selects carrier transmitter 1A4 as the main on transmitter.

e. If a new crystal was installed in step a. the carrier oscillator circuit must be tuned in accordance with the following procedure.

CAUTION

Whenever disconnecting RF cables, ensure only the specified cable is disconnected as damage to the VOR cabinet or test equipment can result.

1. Disconnect cable W8 from attenuator AT1 and connect one end of a BNC test cable to AT1J2. Attach the other end of the test cable to the digital frequency counter to monitor carrier transmitter 1A4 frequency. Set the ON/OFF/NORMAL power switch in carrier transmitter 1A4 to the NORMAL position.

CAUTION

Ensure that the attenuator is connected between the frequency meter and the directional coupler when making this test Reconnect attenuator after test.

2. Tune capacitor AlC9 by inserting a tuning tool through the corresponding hole located in the access cover of oscillator/exciter assembly 1A4A3. Tune for the correct operating frequency as read on the frequency counter.

3. Disconnect the BNC test cable and reconnect W8 to attenuator connector AT1J2.

4. With the power monitor select switch in CARRIER FWD position, tune inductor A1 L1 by inserting a tuning tool through the corresponding hole located on the access cover of oscillator/exciter assembly 1A4A3. Tune for maximum power as indicated on the RF power monitor meter.

5. Reinstall oscillator/exciter assembly 1A4A3 to the appropriate carrier transmitter chassis

f. With the meter selector switch in the CARRIER FWD position, adjust PWR ADJ potentiometer R22 located in carrier modulator assembly 1A4A4 for 100 watts for a 100 watt system, or 50 watts for a 50 watt system, as indicated on the RF power monitor front panel meter. If the system cannot be adjusted for 50 watts, proceed to step g. and check meter reading.

g. Place the meter switch on the front panel of carrier transmitter 1A4 to each of the following positions and verify the following readings: (Note, repeat step f. if any meter reading adjustments are required.)

POSITION	50w (Army)	100w
+12v	+12vi±1v	+12v%±1v
+28v	+28v ± 2v	+28v - 30v (Power supply may be adj. to 30v)
low level modulation (Adjust 1A4A4R18 if required)	6v -.10v (15v scale)	7v; 14v (15v scale)
high level modulation (Adjust 1A4A4R27 if required)	10v - 18v (30v scale)	13v - 19v (30 v scale)
envelope FB	reference reading	reference reading
low current	2A (not to exceed) (15A scale)	1A - 3A (15 A scale)
high current	10A - 14A (30A scale)	13A - 16A (30 A scale)

NOTE

Switch TEST/NORMAL switch 1A4A4S1 between NORMAL and TEST positions and adjust 1A4A4R27 for equal power output in either position. Return TEST/NORMAL switch to NORMAL position and adjust 1A4A4R22 for a 50 watt output as indicated on the RF power meter.

h. This initially adjusts carrier transmitter 1A4 for proper power levels into a 50 ohm load.

i. Enter command code 17 on local control 1A2 keyboard. This turns the system off.

j. Critical Switches Check.

1. Ensure the following switches on circuit card 1A4A2 are set to the position indicated: VOICE ON/OFF switch to ON, SUBCARR switch to ON, and IDENT CT/NORM/OFF switch to NORM. The red CRITICAL SWITCHES MISSET indicator, 1A4DS1, on the front carrier transmitter panel should extinguish when the switches are set as indicated.

2. Ensure CRITICAL SWITCHES MISSET indicator lA4DS1 illuminates when any one or all of the switches are set to a position other than above.

3. Return all switches to their normal position as listed in step 1. above. Verify CRITICAL SWITCHES MISSET indicator 1A4DS1 is extinguished.

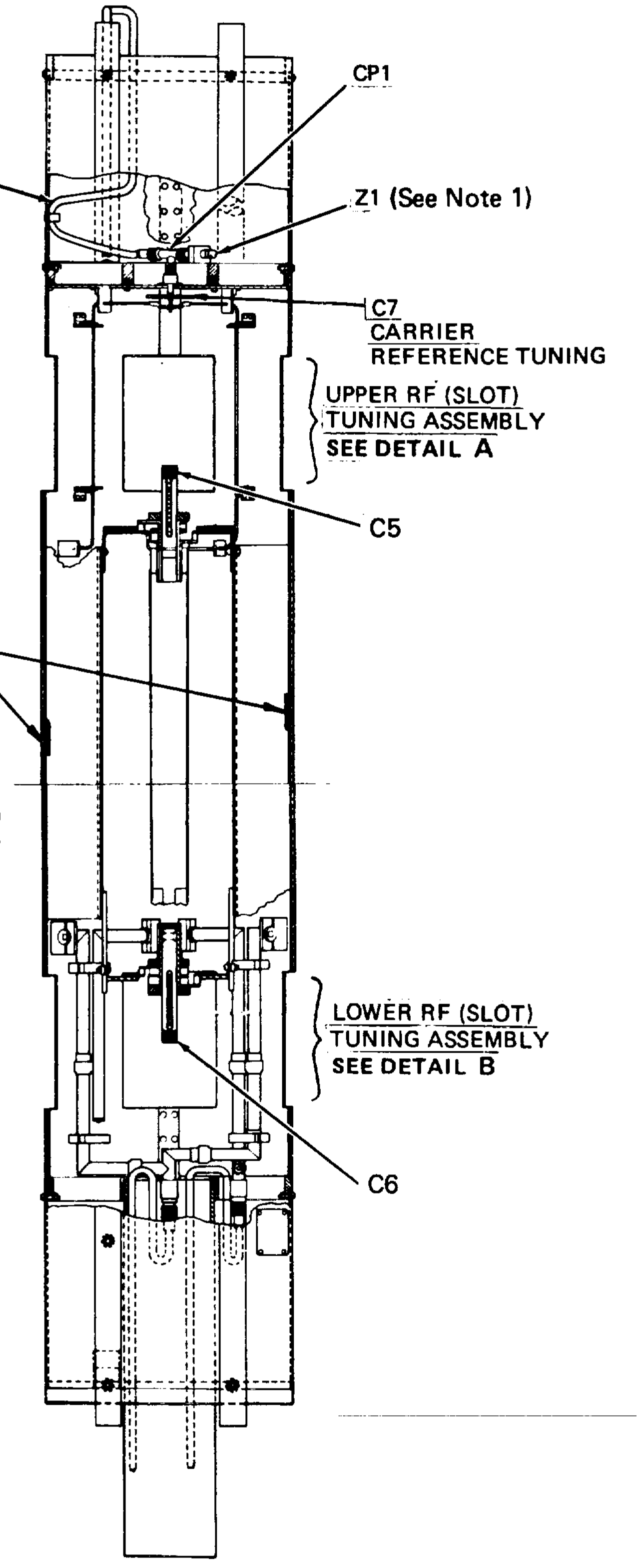
2-29. INITIAL ANTENNA TUNING ADJUSTMENTS. The initial antenna tuning adjustments are dependent upon the user's operating frequency. When the frequency is known before shipment, the antenna is adjusted at the factory. Otherwise, the tuning adjustments must be made at the VOR site as described in the following paragraphs. Even though the antenna has been tuned at the factory, some fine tuning may be required.

a. Initial Antenna RF Tuning Capacitor (Plunger) and Tuning Bridge Settings. Two RF tuning assemblies comprise the upper and lower RF (slot) tuning assembly shown in figures 2-18, 2-19 and 2-20. Each RF (slot) tuning assembly is comprised of an RF tuning capacitor and a tuning bridge. Figure 2-21. provides the initial settings for antenna RF tuning capacitors, C5 and C6 which tunes the carrier portion of the antenna, and the tuning bridges which tune the sideband portions. No initial settings are required for line tuning networks 3Z2 and 3Z3. The chart only provides a starting point to establish initial settings for the RF tuning capacitors and tuning bridges.

CAUTION

Under no circumstances should any adjustments other than those described in the following steps be made in the field. Do not loosen the screws that hold the dielectric strip between the slots as this will disturb the precise alignment of the slot loading fins and will require antenna recalibration at the factory.

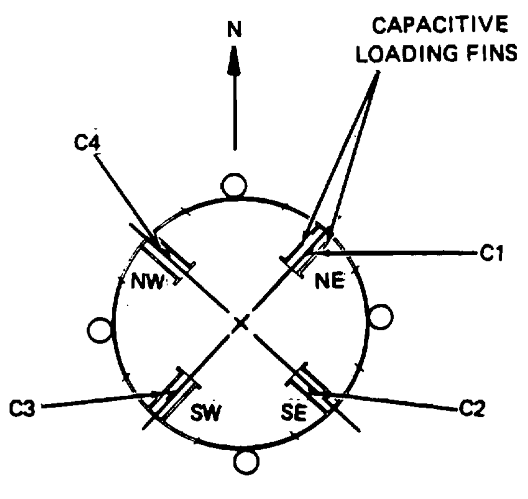
b. Initial RF Power Setup Procedure. RF carrier power inputs to the antenna, used for the antenna tuning, are supplied by the VOR carrier transmitter output. To avoid damage to the equipment, ensure that the dummy load is connected as described in paragraph 2-28.c. and set TEST/NORMAL switch S 1 on modulator assembly 1A4A4 to the TEST position. Enter command code 15 on the local control 1A2 keyboard. Set PWR ADJ potentiometer 1A4A4R22 to approximately 15 to 30 watts as indicated on the



NOTE 1. Several different sizes of shunts, Z1, are available. The antenna is normally pretuned at the factory and the proper shunt corresponding to the operating frequency designated for the antenna is installed. If a condition exists where the operating frequency is changed or if difficulty in tuning for the proper VSWR is encountered, then another shunt may be selected from the following list:

Operating Frequency	Shunt Size	Shunt Part Number
High end of band 115 ½ - 118	1/16"	136240-102
Mid high band range 113-115 ½	1/4	136240-105
Mid low band range 110.5 - 113	1/2	136240-108
Low band range 108 to 110.5	3/4	136240-109

NOTE 2. It is necessary to use an allen wrench to loosen the fin capacitors. It is imperative that after adjustments are made, the allen screws are retightened to lock the fin capacitors in place.



CROSS SECTION VIEW

Figure 2-18. Antenna Cutaway

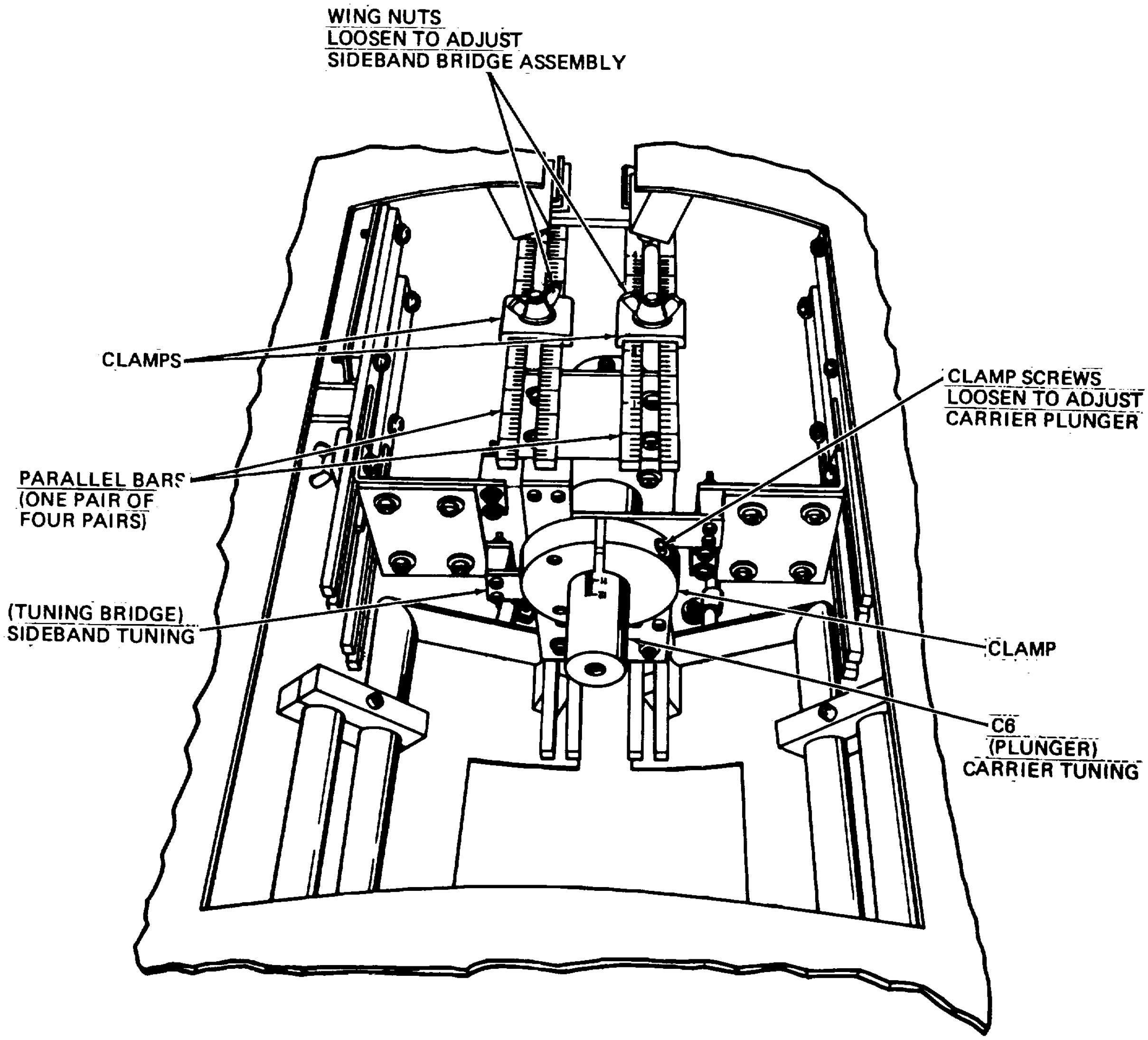


Figure 2-19. Antenna Lower RF (Slot) Tuning Assembly Adjustments

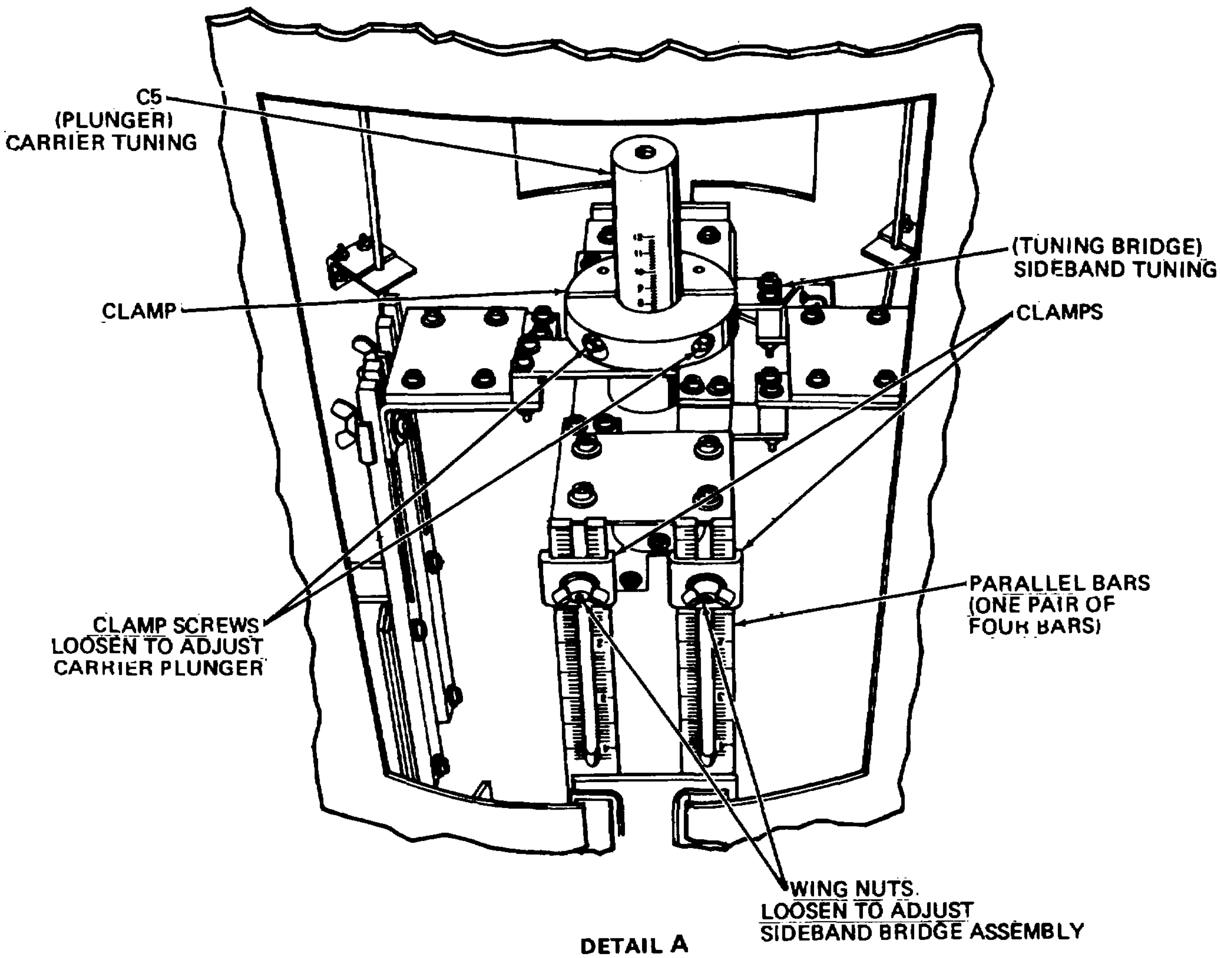
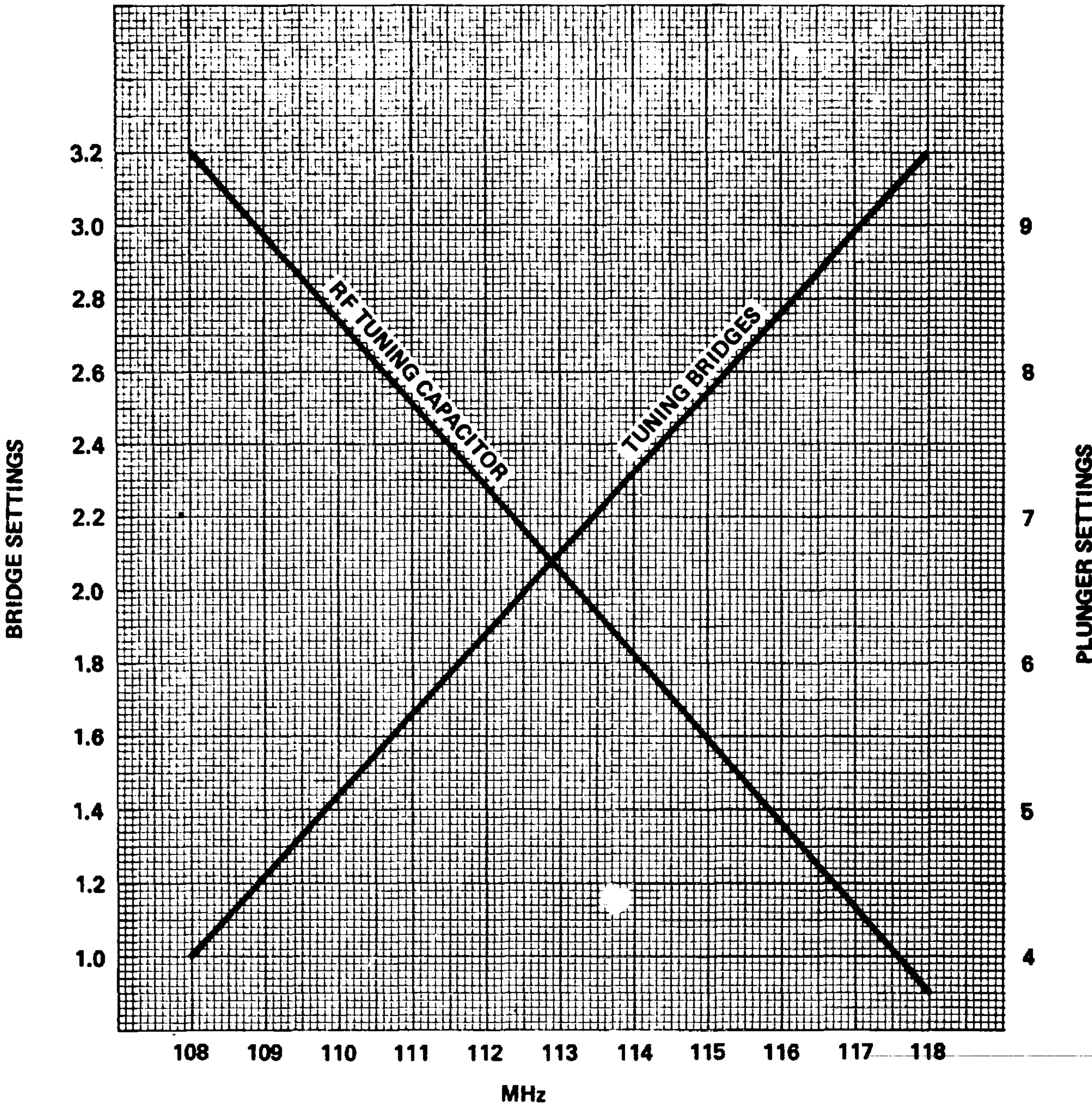


Figure 2-20 Antenna Upper RF (Slot) Tuning Assembly Adjustments



PRELIMINARY SETTINGS FOR VOR ANTENNA

Figure 2-21. Tuning Chart

RF monitor meter. The power can be increased as reflected power is improved on the port being tested. Enter command code 17 on local control 1A2 keyboard. Remove 100 watt dummy load (connected per paragraph 2-28) from the carrier output connector on the electrical equipment rack 1A1. Connect carrier cable assembly 3W1 to the carrier output connector.

C. Initial Carrier **RF** Tuning Procedure. To tune the carrier portions perform the following steps.

CAUTION

To properly tune the carrier inputs to the antenna requires a series of steps. These steps must be repeated until a minimum reflected power is achieved. While making adjustments to the antenna or disconnecting any RF cables, turn the carrier transmitter OFF to avoid damage to the equipment by entering code 17 on the local control keyboard. After making adjustments, turn the carrier transmitter back ON and take a new reference reading by entering command code 15 on the local control keyboard

1 Remove access cover from radome.

NOTE

If the antenna has been preset at the factory for the operating frequency of the site, it is not necessary to set the RF tuning capacitors and RF tuning bridges to the settings indicated in figure 2-21. If the operating frequency has been preset at the factory, proceed to step 8. as some fine tuning may be required.

2. To adjust the lower **RF** tuning bridge, loosen the eight wing nuts and set the bridge to the setting indicated in figure 2-21. Ensure that each bridge segment is adjusted equally per, the divisions on the scale.

3. Repeat step 2. for the upper **RF** tuning bridge.

4. Ensure that antenna carrier cable assembly 3W1 is connected to the **CARRIER** output connector on the electrical equipment rack (1A1).

5. Turn **POWER SWITCH** S1 on sideband transmitter 1A5 to the **OFF** position.

6. Set the meter switch on the RF power monitor to the **CARRIER REV** position.

CAUTION

During adjustment of slot tuning capacitor 3C5, hold C35 with one hand to prevent it from accidentally slipping out and falling into the antenna pedestal while the clamp screws are loosened.

7. Set RF tuning capacitors 3C5 and 3C6 to the settings indicated in figure 2-21. To adjust the tuning capacitors, loosen the two screws holding capacitors in place.

8. Enter command code 15 on local control 1A2. Place switch on RF power monitor to the **CARRIERREV** position and take a reference reading Tune for low reverse power by moving the **RF** tuning capacitors in or out in one division increments. Set **RF** tuning capacitors 3C5 and 3C6 and take another reading.

9. Repeat above steps until the minimum reverse power reading on the RF power monitor meter is obtained. Maximum reverse power should not exceed 0.115 watt with 50 watts of forward power. (This equates to 1.1:1 power ratio. See nomograph, figure 2-21A.)

NOTE

As the reflected power reading on the **RF** power monitor %~ meter is improved, **PWR ADJ** potentiometer 1A4A4R22 can be used to increase the carrier power output so that more reverse power can be observed. This will improve the accuracy of the reading.

10. Return **PWR ADJ** potentiometer 1A4A4R22 to 15 to 30 watts as indicated on the RF power monitor meter. Enter command code 17 on local control 1A2 keyboard.

d. Initial Sideband Antenna Ports Tuning Procedures. To tune the sideband antenna ports, perform the following procedures

NOTE

To properly tune the sideband inputs to the antenna requires a series of steps. These steps must be repeated until a minimum reverse power is achieved. While making adjustments to the antenna, turn the carrier transmitter OFF. After making adjustment, turn the carrier transmitter back ON and take a new reference reading.

This nomograph permits rapid calculation of the VSWR of a transmission line after the incident power (P_f) and reflected power (P_r) have been measured. The solution of the equation

$$VSWR = \frac{1 + \sqrt{P_r/P_f}}{1 - \sqrt{P_r/P_f}}$$

is the basis of the VSWR nomograph. With this nomograph the VSWR can be found merely by aligning a straightedge through the measured points on the P_r and P_f scales, and reading the value from the center scale.

Example

Determine the VSWR of a transmission line for reflected power, P_r, of .115W, and forward power, P_f of 50.0W.

Solution

Align a straightedge through points P_r = .115 and P_f = 50.0. The straightedge intersects the center scale at 1.27, which is the VSWR of the line.

For sideband calculations, divide both "sides" of the graph by a factor of 10. (The VSWR center line is not divided by 10).

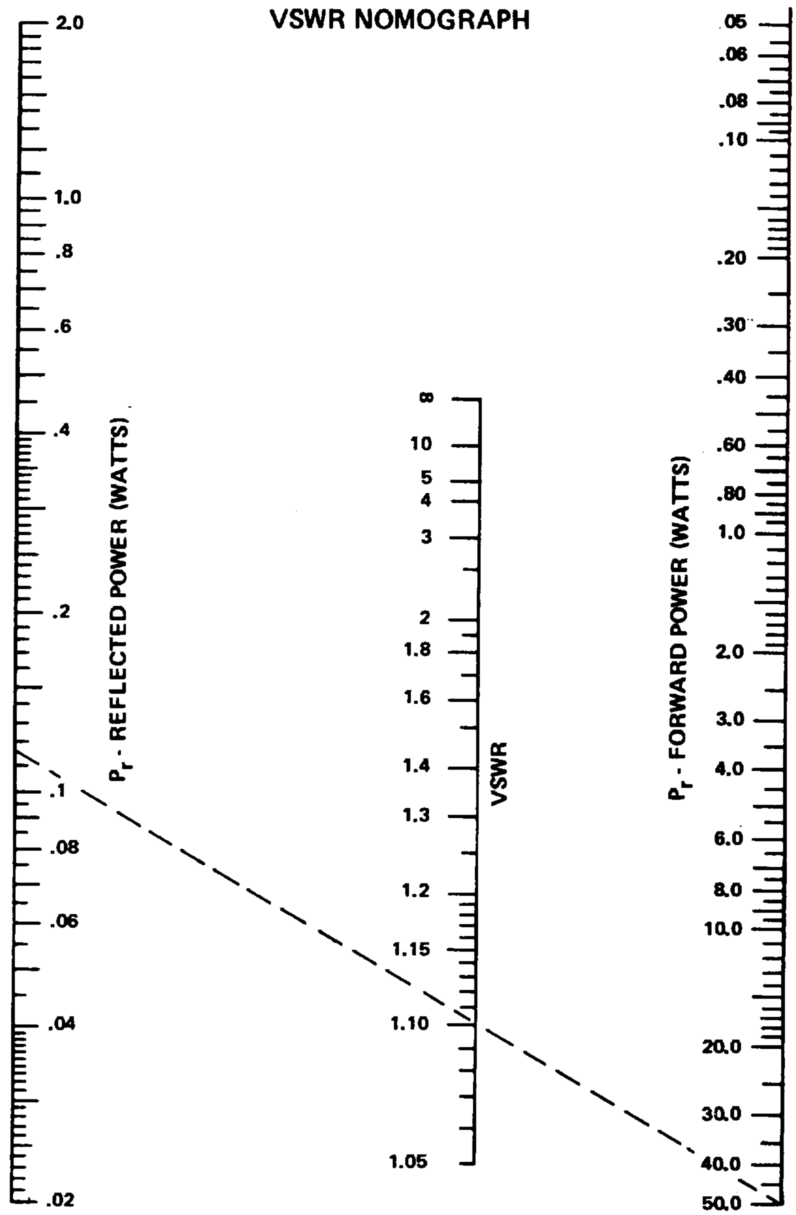


Figure 2-21A. VSWR Nomograph

1. Select sideband A port prior to tuning sideband, and disconnect antenna carrier cable 3W1. Disconnect line matching network 3Z2 from **SIDEBAND** A output connector and connect line matching network 3Z2 to the **CARRIER** output connector.

2. Turn carrier transmitter 1A4 **ON**. Tune line matching network 3Z2 for minimum reverse power. Obtain a reference reading at the **CARRIERREV** position on the RF power monitor meter. Adjust **PWR ADJ** Potentiometer 1A4A4R22 for 50 watts as **VSWR** improves

NOTE

Do not exceed a maximum of 50 watts.

3. To reduce the reverse power, select the upper tuning bridge and adjust one half incremental step in the direction which produces the minimum reverse power output. Also, set lower RF tuning bridge in the same incremental steps keeping them the same distance from the center of the antenna as the upper bridges

4. Retune line matching network 3Z2 for minimum reflected power. It may be necessary to repeat steps 2. and 3. to obtain the best possible results. Record the reading obtained.

5. When the best results obtainable are reached with sideband A input, disconnect sideband A antenna cable and line matching network 3Z2 from the **CARRIER** output connector. Connect sideband B antenna cable and line matching network 3Z3 to the **CARRIER** output connector.

6. Tune line matching network 3Z3 for minimum reverse power. If this port reading is not the same as the minimum reverse power reading obtained for sideband A port (as recorded in step 4.), adjust fin capacitors 3C2 and 3C4 as shown in figure 2-18.

NOTE

Adjust fin capacitors 3C2 and 3C4 in small increments (1/4 turn - both in the same direction).

7 .Repeat steps 3. through 6. until reverse power on both sideband inputs is below 0.115 watt with 50 watts power indication as read on the **RF** power monitor meter with the function switch in the **CARRIER FWD** position. **PWR ADJ** potentiometer R22 on modulator assembly 1A4A4 is used to adjust for desired power output in order to obtain this indication. Enter command code 17 on local control 1A2 keyboard.

8. Set the locks on both line matching networks 3Z2 and 3Z3. Be careful not to change the settings

9. Reconnect all cables to their normal position.

e. Tuning For Isolation. Occasionally there is Interaction between the sideband transmitter and the antenna in a **VOR** system. Any carrier power that is fed back down the sideband inputs (spillover) is modulated by the sideband transmitter. A small amount of carrier power fed back Into the sideband transmitter is much worse than the reverse output of the sideband transmitter due to mismatch. For this reason, It Is important to reduce the carrier power fed back to the sideband transmitter. To reduce the carrier power feed back (spillover) to the sideband transmitter, perform the following procedure.

1. Ensure that sideband transmitter 1AS is turned **OFF** and enter command code 16 on the local control 1A2 keyboard.

2. Adjust **PWR ADJ** potentiometer R22 on modulator assembly 1A4A4 (ensure that the **TEST/NORMAL** switch is in **TEST** position) for 50 watts as indicated on the RF power monitor meter with the function switch in the **CARRIER FWD** position.

3. Measure reverse power with the RF power monitor meter select switch in **SIDEBAND A REV** position and tune for minimum reverse power as follows. (This measured reversed power is the spillover into the sideband antenna elements) The upper RF tuning bridge is used to adjust for minimum spillover. The lower RF tuning bridge is then adjusted to obtain minimum sideband **VSWR**.

NOTE

This measurement is of the carrier power fed from the carrier element through the sideband element in the antenna and back down the antenna sideband cables. If the antenna is tuned properly, this would be a minimum amount But if the carrier power spillover is high enough to overdrive the meter with the R F power monitor meter select switch in either the **SIDEBAND A REV** or **SIDEBAND B REV** position, it is necessary to adjust **PWR ADJ** potentiometer R22 on modulator assembly 1A4A4 for a visible ON scale meter indication.

CAUTION

When disconnecting antenna cables, enter command code 17 to shut the system down in order to avoid damage to the equipment After proper connections have been made, enter command code 15 to turn system back on.

(a) Experimentally adjust the upper RF tuning bridge In 1/2 Incremental steps to achieve minimum spillover. Record **SIDEBAND A REV** reading

(b) Switch the **RF** power monitor meter select switch to **SIDEBAND B REV** position and verify it is the same as the reading recorded in step (a) above. If not, tune **SIDEBAND B** fin capacitors 3C2 and 3C4 located in the two slots inside the antenna (see figure 2-18). These adjustments are made in 1/4 turn increments in the direction to achieve minimum spillover.

(c) Disconnect the antenna carrier cable from the **CARRIER** output connector. Connect the sideband A antenna cable, with line matching network 3Z2 attached, to the **CARRIER** output connector. To reduce **VSWR**, as seen in the RF power monitor meter and with the meter select switch in the **CARRIER REV** position, adjust the lower RF tuning bridge and **SIDEBAND A** fin capacitors 3C1 and 3C3 until best results are obtained. Record the final result

(d) Disconnect sideband A antenna cable and line matching network 3Z2 from **CARRIER** output connector and connect sideband B antenna cable and line matching network 3Z3 to the **CARRIER** output connector. Verify that the reverse power reading indicated on the RF power monitor meter with the meter select switch in the **SIDEBAND B REV** position is the same as the reading obtained in step (c) for the **SIDEBAND A REV** reading. If the readings are not the same or within i 1 milliwatt, adjust line matching network 3Z3 and if necessary, **SIDEBAND B** fin capacitors 3C2 and 3C4 until the best results are obtained Record the final result

(e) Disconnect sideband B antenna cable and line matching network 3Z3 and return all cables to their normal positions

(f) Repeat steps a through e. until a spillover of less than 0.005 watt is obtained in step (b) and a reflected power (VSWR) which reads less than 0.115 watt as obtained in steps (c) and (d) above. Enter code 17 on the local control keyboard.

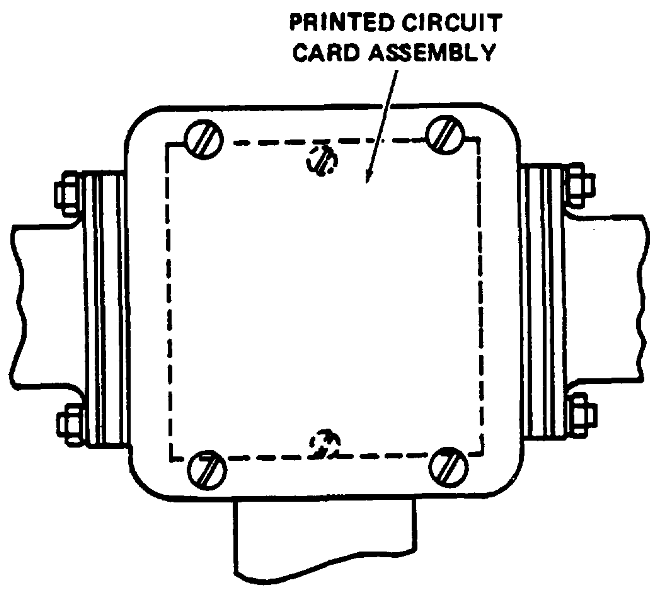
2-30. **FIELD DETECTOR ADJUSTMENT.** This procedure describes the adjustment for the field detector for the proper signal level sent to the respective monitor (see figure 2-22).

a. Set the **TEST/NORMAL** switch on modulator assembly A4 in carrier transmitter 1A4 to the **NORMAL** position.

b. Enter command code 15 on local control 1A2 keyboard and adjust PWR ADJ potentiometer R22 on modulator assembly 1A4A4 for 100 watts on a 100 watt system, or 50 watts on a 50 watt system.

c. Ensure that sideband transmitter 1A5 **POWER SWITCH** is in the **NORMAL** position.

d. Temporarily place field detector unit 2 on the mounting on the counterpoise bracket near the shelter door. Mount the field detector so that the side with the access cover is away from the radome. This provides easy access to the field detector for adjustments required when mounted in the brackets



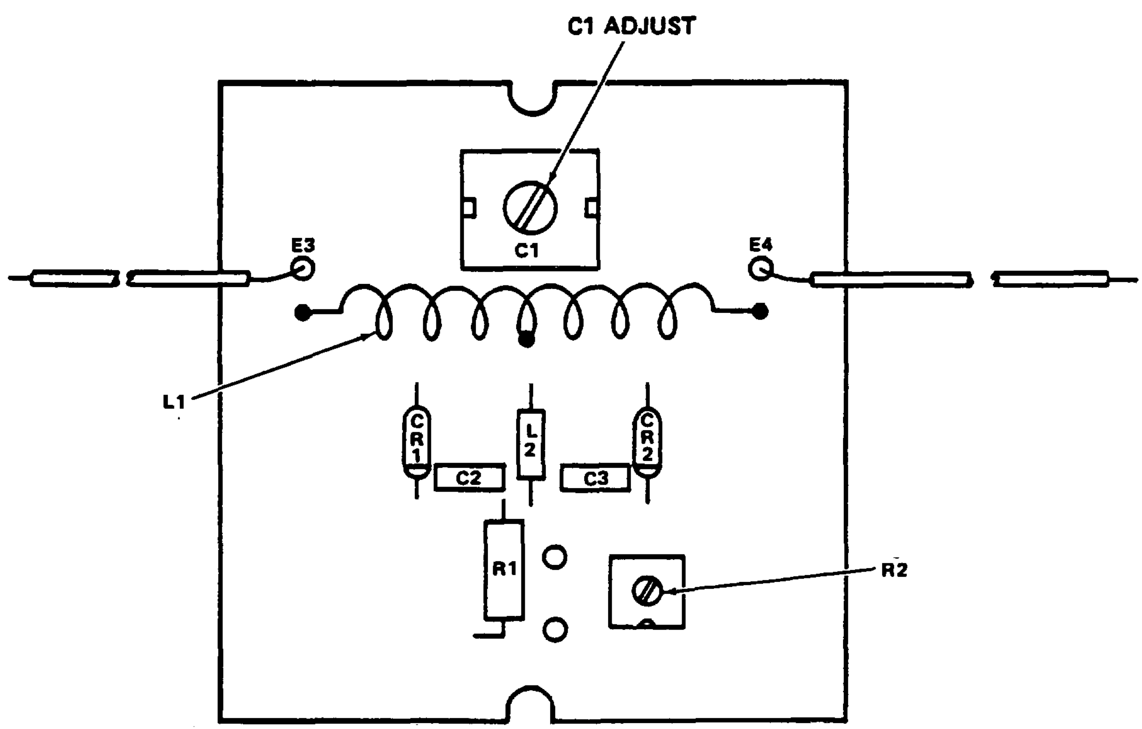


Figure 2-22. Field Detector Adjustment

e. Remove the access cover from the field detector. Set potentiometer 2A1R2 inside the field detector to a midrange position.

f. Monitor the output voltage at **FLD DET MONITOR** connector J2 test point on monitor 1A3 meter panel with the **VOM**. Set the appropriate -dc range (-2 to -10vdc). Adjust field detector tuning capacitor 2A1C1 for maximum indication on **VOM.** If the tuning capacitor is fully open or fully closed, it will be necessary to squeeze or spread the turns of coil L1 in the field detector to allow proper tuning.

9. Adjust 2A1 R2 for maximum indication on **VOM** (should be within -2.5 Vdc to -3.5 Vdc) If not within this tolerance adjust detector height until within this range.

NOTE

If coil adjustment is required, keep turns evenly spaced and both halves as identical as possible.

h. Enter command code 17 and replace the access cover on the ield detector.

2-31. SIDEBAND INSERTION PHASE COMPENSATION. Although sideband transmitter 1A5 has an electronic phase control loop to maintain a constant **RF** phase on the output signals, it is necessary to perform a static adjustment procedure to center this phase control about a proper operating point. For each phase control loop (A or B), there are two static adjustments. One adjustment varies the **RF** amp insertion by 0° to 180° continuously, while the other causes an apparent 180° step change in the insertion phase. The first is accomplished by **RF PHASE ADJ** potentiometer R21 in **RF** amplifier assemblies A2 and A3, while the discrete change is accomplished by **A PHASE** switch S2 and **B PHASE** switch S5 on modulation control assembly A4 for channels A and B, respectively.

The following procedure is used to align the phase control loop. This alignment must be performed on both sideband transmitters

a. During phasing operations, power levels out of the sideband transmitters can exceed 10 watts. In order to protect the 2 dB pads (1A1AT4 and 1A1AT5) behind the RF power monitor panel during phasing, temporarily remove attenuators 1A1AT4 and 1AlAT5 and connect 1A1W6P2 to power sensor A1U2J1l and 1A1W6P4 to power sensor 1A1U3J1.

NOTE

If required, use adapter to extend cable 1A2W6.

b. Enter command code 15 on local control 1A2 keyboard.

c. On sideband transmitter 1A5, place **A CONT** switch 1A4S1 to the **NORM** position. Place **B CONT** switch 1A4S4 to the **OFF** position.

d. On sideband transmitter 1A5, place **METER SELECT** switch S2 to the **PH ERROR** A position. On RF power monitor panel 1Al, place meter switch S2 to the **SIDEBAND A FWD** position.

e. Observe that **ON/OFF/NORMAL** power switch S2 in carrier transmitter 1A4 and **POWER SWITCH S1** in the sideband transmitter are in the **NORMAL** position.

f. Adjust RF PHASE potentiometer 1A2R21 for a center green zone reading on meter 1A5M1. It may be necessary to slide **A PHASE** switch 1A4S2 on the modulation control assembly to its opposite position to accomplish this During the phasing operation, monitor the power as displayed on RF power monitor meter 1A1M1. The reading should be minimum when sideband transmitter meter 1A5M1 reads green zone.

9. On sideband transmitter 1A5, place **METER SELECT** switch S2 to the **PH ERROR B** position. On power monitor panel 1Al, place meter switch S2 to the **SIDEBAND B FWD** position.

h. Place **B CONT** switch A4S4 to the **NORM** position.

i. Adjust **RF PHASE** potentiometer A3R21 for a center green zone reading on meter 1A5M1. It may be necessary to slide **B PHASE** switch A4S5 on the modulation control assembly to its opposite position to accomplish this During the phasing operation, monitor the power as displayed on RF power monitor meter 1A1M1. The reading should be minimum when sideband transmitter meter 1A5M1 reads green zone.

j. Enter command code 17 on local control 1A2 keyboard on RF power monitor panel 1Al.

k. Reinstall the 2 dB attenuator (1A1T4) between cable connector 1A1W6P4 and power sensor 1A1U2J1 and also attenuator 1A1AT5 between cable connector 1A1W6P2 and to power sensor 1A1U3J1.

NOTE

If required, remove adapter used to extend cable 1A1W6.

I. Enter command code 15 on local control 1A2 keyboard.

m. On modulation control assembly 1A5A4, place A **PWR ADJ** potentiometer R5 and **B PWR ADJ** potentiometer R50 in the center of the adjustment range (approximately 12 turns from either stop).

n. Adjust **VAR MOD ADJ** potentiometer R2 on reference and subcarrier generator circuit card assembly 1A5A1 for a reading of 2 watts as read on power monitor meter 1A1M1 with selector switch 1AlSl in the **SIDEBAND A FWD** position for a **100** watt system (1.1 watts for a 50 watt system).

o. Adjust **B PWR ADJ** potentiometer R50 on modulation control assembly 1A5A1 for a reading of 2 watts on a **100** watt system, or 1.1 watts for a 50 watt system as read on power monitor meter 1A1M1 with selector switch 1AlSl in the **SIDEBAND B FWD** position. Alignment is complete when there is no discernible difference in power between this reading and the reading in step n.

p. Enter command code 17 on local control 1A2 keyboard to turn system off.

2-32 RF PHASING This procedure provides for initial RF phasing of sideband A and B outputs relative to the RF carrier output There are two adjustments in the sideband'transmitter that provide a continuous RF phase adjustment from 0° to 360°. This adjustment range allows proper phasing regardless of the frequency involved. A continuous 0° to 180° RF phase shift is provided by 0°/180° **RF PHASE** switch S3 in modulation control assembly 1A5A4. To perform R F phasing, proceed as follows:

a Set the field detector on the 45° counterpoise bracket

b. Verify that the **ON/OFF/NORMAL** power switch on carrier transmitter 1A4 and the **POWER SWITCH** on sideband transmitter 1A5 are in the **NORMAL** position.

c. Enter command code 15 on local control 1A2 keyboard.

d On carrier transmitter 1A4, place **VOICE** (S2,), **IDENT** (S3) and **SUBCARR** (S1) switches on ident oscillator circuit card assembly 1A4A2 to the OFF position.

e. Connect an ac voltmeter to **FLD DET MONITOR** test connector J2 on 1A3 monitor meter panel.

f. On sideband transmitter 1A5, adjust **RF PHASE** potentiometer R6 on modulation eliminator assembly 1A5A5 until the ac voltmeter reading is peaked.

NOTE

At certain frequencies, there may be two peaks. Select the peak that falls further within the adjustment range of 1A5R6.

9. Set the field detector on the 135° counterpoise bracket.

h. Read the ac voltmeter indication and record it. Repeat step f. If no increase in reading is obtainable, A and B sideband outputs are In phase agreement. Peak the reading (to where it was) and proceed to step **u.** If the reading can be increased, A and B sideband outputs are not in phase agreement Proceed to step i. for a first try at improvement; to step m. for the second try.

i. Place **B CONT** switch A4S4 (in the sideband transmitter) to **OFF**.

j. Remove the **RF** cable from J2 (**RF** output) on B power amplifier. Add two **BNC** adapters (UG414A/U and UG914/U) in series on J2 and then connect therf cable to the added connectors.

k. Place **B CONT** switch A4S4 to **ON**.

I. Repeat steps a through h.

m. Place **A CONT** switch A4S1 and **B CONT** switch A4S4 (sideband transmitter) to **OFF**.

n. Move the added **BNC** connectors from J2 on the B power amplifier, in the sideband transmitter, to J2 on the A power amplifier, connecting RF cables as before.

o. Place **A CONT** switch A4S1 and **B CONT** switch A4S4 to **ON**.

p. Repeat steps a through h. In rare instances, more than two connectors may have to be added to achieve good results The procedure from step a. through h. may be followed with four connectors added (two UG414A/U and two UG914/U).

q. Set **A CONT** switch A4**S1** and **B CONT** switch A4S4 to **OFF**.

r. If phasing between A and B sidebands was achieved byadding connectors, it is necessary to shorten one RF cable. Select the cable leading to the power amplifier, which does not have connectors added on the output connector, J2. Remove a length equal to that of the added connectors and replace the BNC connector on the cable.

a Set **A CONT** switch A4S 1 and **B CONT** switch A4S4 to **ON**.

t Repeat steps a. through h.

u. Enter command code 17 on local control 1A2 keyboard to turn the system off.

v. On carrier transmitters 1A4, place **VOICE** (S2), **IDENT** (S3) and **SUBCARR** (S1) switches on ident oscillator circuit card assembly 1A4A2 to the **ON** or **NORM** positions.

2-33. SUBCARRIER, IDENTIFICATION, AND VARIABLE SIGNAL PERCENT MODULATION

This procedure checks and adjusts the percentage of modulation of the various signals which modulate the VOR carrier. Adjustments are made in the carrier transmitter and sideband transmitter as follows:

a. Enter command code 15 on the local control (1A2) keyboard. Move field detector to 90° bracket on counterpoise edge.

b. Set the **ON/OFF/NORMAL** power switch on carrier transmitter 1A4 to **OFF**.

c. Set the **SUBCARR** switch (S1), **IDENT** switch (S3) and the **VOICE** switch (S2) on ident oscillator circuit card 1A4A2 to the **OFF** position.

d. Connect an oscilloscope to **FLD DET MONITOR** connector J2 on monitor meter panel.

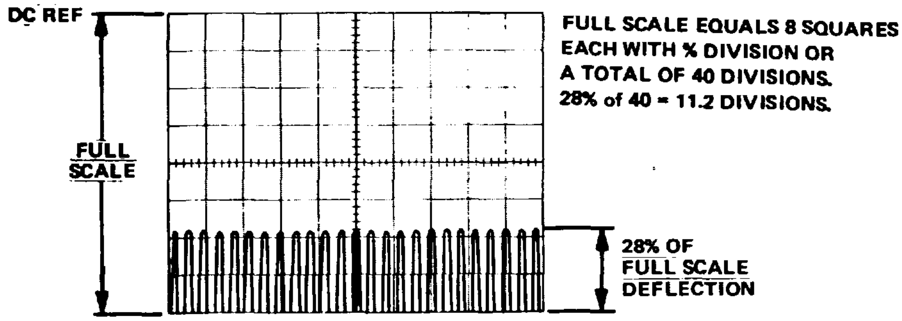
e. Set oscilloscope for dc and adjust vertical positioning to set trace on top grid line. Place A **CONT** and **B CONT** switches A4S1 and A4S2 on the modulation control circuit card assembly in sideband transmitter 1A5 to the **OFF** position.

f. Set carrier transmitter 1A4 **ON/OFF/NORMAL** power switch to **ON**. The oscilloscope deflection is caused by the rectified dc from the 50 watt or 100 watt carrier. Adjust oscilloscope dc gain so that the trace is deflected to bottom grid line.

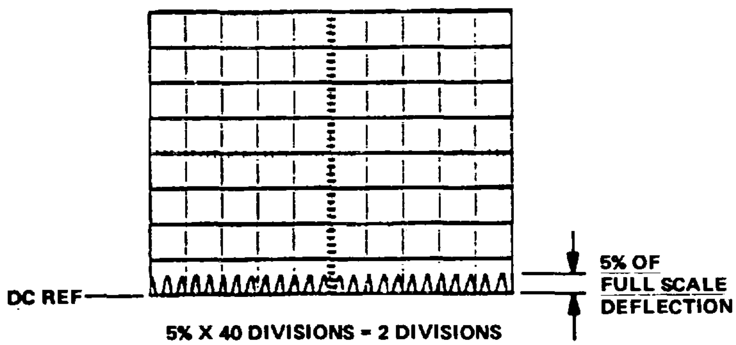
NOTE

Repeat steps e. and f. as required (controls interact).

9. Adjust the 9960 Hz subcarrier for 30 percent modulation as follows: Turn the **SUBCARR** switch on circuit card A2 on carrier transmitter 1A4 back to the **ON** position. The 9960 Hz subcarrier should cause the oscilloscope trace to deflect above the bottom grid line. This deflection, expressed as a percentage of total deflection, is the modulation percent. Due to the nonlinearity caused by driving the field detector diodes over a wide range, a correction factor must be used when initially adjusting the 9960 Hz subcarrier modulation. A modulation percent of 28, as read using the field detector, is equivalent to 30 percent as seen by an aircraft receiver. Therefore, adjustment should be made as necessary to produce the 28 percent modulation reading. This is equivalent to saying that the 9960 Hz modulation, as read using the field detector, should be multiplied by a correction factor of 1.07 to determine what the aircraft would see. Adjust the 9960 Hz to obtain a 28% reading by adjusting 9960 **SUBCARR MOD** potentiometer R10 on circuit card assembly A2 in carrier transmitter 1A4. (see waveform A.)



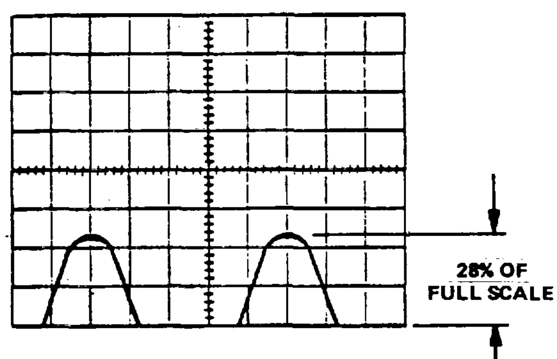
WAVEFORM A



WAVEFORM B

h. Adjust the 1020 Hz identification tone for 5 percent modulation as follows: Set **SUBCARR** switch to **OFF** and set the **IDENT** switch to circuit card A2 in carrier transmitter 1A4 to **CT (CONT)** position. The 1020 Hz signal should now appear on the oscilloscope screen and should equal 2 division (one-sixth or 5%/30% of the screen). Adjust **IDENT MOD** potentiometer R21 on circuit card assembly A2 in carrier transmitter 1A4 to obtain the desired reading. (See waveform B above.)

i. Adjust the 30 Hz variable signal modulation as follows: Set the **IDENT** switch on circuit card assembly A2 in the carrier transmitter to **OFF**. Place the **A CONT** and **B CONT** switches on modulation control assembly A4 in sideband transmitter 1A5 will set the 30 Hz variable level. Due to proximity of the field detector to the main antenna, and also the angle of radiation between the two, the 30 Hz modulation read using the field detector is less than 30%, as seen by an aircraft. Therefore, the 30 Hz amplitude is adjusted for 28% of the full scale deflection. (See waveform C below.)



WAVEFORM C

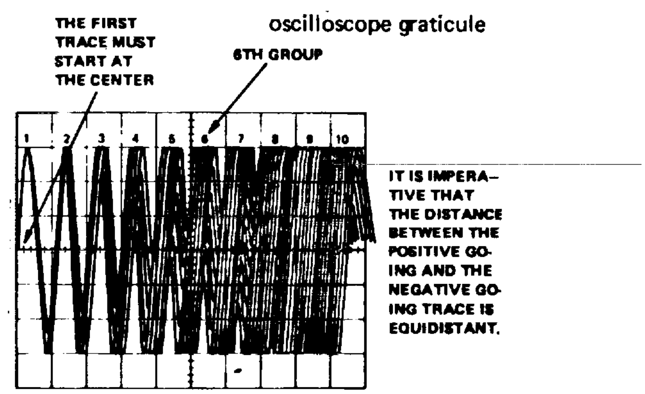
NOTE

This procedure assumes the ground check error curve is satisfactory. Variable modulation adjustment is valid only after completion of the initial ground check procedures.

j. Set the **VOICE** switch, the **IDENT** switch and the **SUBCARR** switch on ident oscillator/ modulation mixer circuit card assembly A2 to ON. Set the **ON/OFF/NORMAL** power switch on the carrier transmitter to **NORMAL** The system is now restored to normal operation.

2-34. SUBCARRIER DEVIATION (30 HZ). This procedure checks the FM deviation of the 9960 Hz subcarrier.

a. Connect the vertical input on the oscilloscope to **FLD DET MONITOR** test connector J2 located on the meter panel of monitor 1A3. Set the **IDENT** switch on ident oscillator modulation circuit card assembly 1A4A2 to the **OFF** position. Set the **A CONT**, **B CONT** switches to the **OFF** positions.

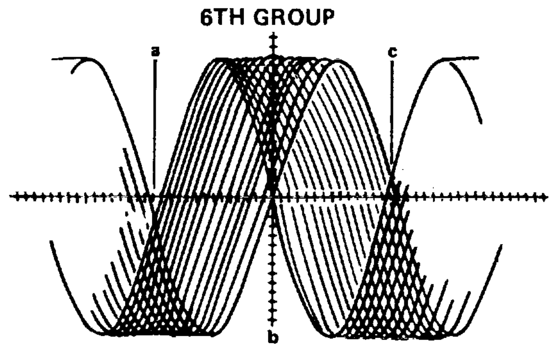


b. Set the oscilloscope to obtain a waveform showing at least eight vertical peaks as shown below. Adjust the vertical gain and position controls to center the waveform within the graticule.

c. Adjust the trigger level control on the oscilloscope so that crossover at the initial trigger point is at the 50% peak value.

d. Count the positive peaks from left to right and position the sixth group to the central graticule.

e. Switch the oscilloscope horizontal amplifier to the X10 magnification to obtain the following waveform.



f. Adjust **DEV** potentiometer R20 on reference and subcarrier generator circuit card assembly Al on sideband transmitter 1A5 to obtain an exact zero crossover point on the waveform for the sixth group as shown at point b in step e. Set **IDENT** switch on ident oscillator/modulation mixer circuit card assembly 1A4A2 to on position. Place the **A CONT** and **B CONT** switches to the **ON** position.

2-35. MONITOR ADJUST.

NOTE

The following procedure is to be used only for an initial installation. Refer to the level 3 preventative maintenance performance check, table 54, for the proper procedure at times other than the initial installation. This procedure assumes all previous procedures of Chapter 2 have been accomplished. All level adjustments made in the monitor must be made with the field detector mounted 30 feet from the **VOR** antenna with potentiometer 2A1R2 adjusted for maximum amplitude (full **CCW**). When the field detector is mounted on a counterpoise bracket, potentiometer 2A1R2 must be adjusted as follows to reduce the signal amplitude. Do not reset input LVL potentiometer R22 on the 1A3A3 circuit card. Adjust potentiometer 2A1R2 in the field detector to reduce the 30 Hz amplitude read on the monitor **TEST SELECT** switch to within the center of the green zone. Ignore other levels (9960 Hz will read somewhat high). The monitor will read bearing accurately under these conditions. For future convenience, potentiometer 2A1R2 in the field detector may be marked to show the setting required for the counterpoise use. Normally the field detector is mounted on the monitoring post for continuous monitoring.

a. Enter command code 15 on local control 1A2, and perform the following procedures on monitor 1A3. Set **POWER SWITCH 1A3S1** to **NORMAL** and note the following: The **POWER ON** indicator (1A3DS2) illuminates and the **CRITICAL SWITCHES MISSET** indicator ((1A3DS9) extinguishes.

b. Set monitor **TEST SELECT** switch 1A3S4 to **CARRIER LEVEL** position and adjust INPUT LVL potentiometer R22 on circuit card assembly 1A3A3 for center green zone indication on monitor **TEST METER 1A3M1**

c. Press spring loaded 30 Hz **LIMIT SET** switch S2 and adjust 30 Hz **LIMIT** No. 1 potentiometer R38 on circuit card assembly 1A3A3 until 30 Hz indicator 1A3DS3 is midway between being illuminated and extinguished. Release switch S2.

d. Press spring loaded 9960 Hz **LIMIT SET** switch S1 and adjust 9960 Hz No. 1 **LIMIT** potentiometer R40 on circuit card assembly 1A3A4 until 9960 Hz indicator 1A3DS2 is midway between being illuminated and extinguished. Release switch S1.

e. On circuit card assembly 1A3A3, press spring loaded **LIMIT TEST** switch S1 to H (high) and note both 30 Hz and 9960 Hz green indicators remain illuminated. Release switch and both indicators should remain illuminated.

f. On circuit card assembly 1A3A3, press spring loaded **LIMIT TEST** switch SI to L (low) and note the 30 Hz and 9960 Hz indicators extinguish.

9. Set **INPUT SELECT** switch S3 on monitor 1A3 to **TEST GEN** position. (If the built-in test generator option has been omitted, an external test generator is required.) The external test generator, if required, is connected to terminals A1TB2-15 and A1TB2-16 located at the rear of the cabinet.

h. Set **TEST SELECT** switch S4 on monitor 1A3 to the 30 Hz **LEVEL** position. Set **MOD SEL** switch S2 on circuit card assembly 1A3A5 to the **BOTH** position. Adjust VAR 30 Hz LVL potentiometer R28 on test generator circuit card 1A3A5 to obtain a center green zone Indication on the monitor meter panel **TEST METER**.

I. Set **TEST SELECT** switch S4 on monitor 1A3 to the 9960 Hz **LEVEL** position. Adjust 9960 Hz **LVL** potentiometer R14 on the test generator to obtain a center green zone indication on the monitor meter panel **TEST METER**

J. Set monitor 1A3 **RADIAL SELECT** switch A1S1 for a 900 radial setting and et monitor 1A3 **TEST GEN BEARING SELECT** switch S2 for 90°.

k. Verify that **BEARING ERROR** readout on the monitor Is ± 0.2. If the reading falls outside of this limit, refer to table 6-4, step 7 Chapter 5, Maintenance.

NOTE

Do not use the preceding procedure once a station is installed and commissioned.

2-36. FINAL RF PHASING This procedure is used for final **RF** phasing of sideband A and B outputs relative to the R F carrier output. To perform final R F phasing proceed as follows:

a. Verify that the **ON/OFF/NORMAL** power switches on carrier transmitters 1A4 and the **POWER SWITCH** on sideband transmitter 1A5 are in the **NORMAL** position.

b. Enter command code 15 on local control 1A2 keyboard.

c. Set the field detector In the 90° ground check bracket on the counterpoise.

d. Using the **RADIAL SELECT** switches on monitor 1A3, determine the bearing. Reading should be 90° ± 20°. If actual bearing is 270° ± 20°, then slide 0°/180° **RF PHASE** switch A5A4S3 to the opposite position. Reading should now be 90° ± 20°.

NOTE

If the switch is changed, repeat the procedures outlined in paragraph 2-32.

e. Enter command code 17 on local control keyboard 1A2.

2-37. FIELD DETECTOR BALANCE ADJUSTMENT Balancing the field detector requires two people. Set the field detector in a counterpoise bracket near the shelter door (door must be completely open). Adjust field detector output level potentiometer 2A1R2 to place the 30 Hz variable level to within the green zone as read on the monitor meter 1A3M1. (Using the radial select switches on the monitor, determine the bearing with **BEARING ERROR** readout on monitor set to 0.0.) Lift the field detector out of the bracket and rotate it 180°. Hold it against the bracket as nearly as possible in the same position it occupied while in the bracket (radial position being most important). The reading on the **BEARING ERROR** readout should be within ± 0.2° of the reference reading. If not; use the following procedure to correct the Imbalance:

a. Remove the field detector access cover. Check position of ground wires. Reroute ground wires if they lie across coil or tuning capacitor. Recheck balance.

b. Spread the turns on one side of the RF coil and compress the turns on the other side Adjustment should be slight

c. Check for balance as described above.

d. If the balance is worse, compress the turns on one side of the **RF** coil and spread the turns on the other side. (Opposite from step b. above.)

e. When balance has been improved to within ± 0.2°, it is necessary to check field detector tuning **Tune** 2A1C1 in-field detector for maximum 30 Hz variable indication on the monitor **TEST METER** with the meter **SELECT** switch in the 30 Hz position.

f. Repeat the balance test

2-38. IDENT CODE SELECTION. The ident keyer circuit card assembly A1, contained in carrier transmitter is programmed as follows:

a Determine the station identification letters and translate those into the ident code format

b. Remove ident keyer circuit card assembly A1 from carrier transmitter 1A4.

c. On the edge of the component side of the circuit card assembly there are two columns of holes arranged in three groups Each group of holes is associated with a character (letter) of the ident code. Each group is further subdivided into 4 bits Starting at character 1, solder in wire jumpers (22 AWG) per the following table.

NOTE

Solder a jumper between the plated-through holes listed in column 1 and column 2 to generate a dash and between the plated-through holes listed in column 2 and column 3 to generate a skip. A dot will be generated if no jumper is installed.

Character Number	**Bit Number**	**Column 1**	**Dash Column 2**	**Skip Column 2**
1	1	E12	E13	Ell
	2	E15	E16	E14
	3	E18	E19	E17
	4	E21	E22	E20
2	1	E24	E25	E23
	2	E27	E28	E26
	3	E30	E31	E29
	4	E33	E34	E32
3	1	E36	E37	E35
	2	E39	E40	E38
	3	E42	E43	E41
	4	E45	E46	E44

NOTE

If an entire character is to be skipped, it is necessary to install a skip in the first and second bits

d. For **VOR** only operation, install wire jumpers (22 AWG) between E9 and E10 and between E3 and E4 on circuit card assembly 1A4A1.

e. For **VOR/DME** operation, install wire jumpers (22 AWG) between E8 and E9 and between E3 and E5 on circuit card assemblylA4A1.

f. For **VORTAC** operation, install wire jumpers (22 AWG) between E8 and E9 and between E4 and E5 on circuit card assembly 1A4A1.

9. Replace ident keyer circuit card assembly Al in carrier transmitter 1A4 and 1A7.

h. Enter command code 15 and verify proper ident code is flashed on the **IDENT CODE** indicator on monitors 1A3 and 1A6 every 7.5 seconds for **VOR** only operation. For **VOR/DME** operation, a set of three ident codes should occur on a 7.5 second interval basis. A 14 second interval should then occur before the next ident code. The cycle should then repeat **VORTAC** operation is similar except the 14 second intervals should be separated by four 7.5 second intervals.

i. Enter command code 17 on local control 1A2 keyboard.

2-39. LOCAL INTERFACE AND INSTALLATION CHECKOUT PROCEDURES.

a. Local Control and Voice Setup. Verify that voice communications can be properly sent and received by performing the procedures outlined in paragraph 5-20 e. and 5-20 f.

NOTE

To verify the following status and voice indications, it is necessary for the remote site to be manned. Verifications of status indications are made via the phone lines four seconds after command codes are entered at the local control 1A2 keyboard.

CAUTION

When removing circuit card assemblies, turn **SYSTEM POWER** switch on local control 1A2 to **OFF** position.

b. Communications Receiver Installation Checkout Procedure. When a communications receiver is connected to the local control at connector 1A2J6, the following procedure is used to verify proper operation.

NOTE

The voice is input to local input transformer T1 with a 600 ohm impedance. The voice level can be from -17 dBm to +5 dBm.

1. Connect a function generator to connector J6 pins 1 and 2 at a 0 dBm input level.

2 Adjust RCVR VOL potentiometer R93 on 1A2A4 for a maximum of 10 volts peak-to-peak on an oscilloscope connected to U26A pin 12 on 1A2A4. Note: Tone will be keyed in speaker. Remove audio signal generator from J2 pins 1 and 2.

c. VOR RCVR Squelch Checkout. If the VOR RCVR squelch option is used, verify proper operation with the following procedure.

1. Apply a fictitious squelch control voltage by applying jumpers between pins 4 and 6 and between pins 3 and 5 of connector J6 to actuate integrated circuit U20 on circuit card assembly 1A2A5.

2. Strap terminals E9 (U18A pin 1) for the right control sense (i.e., on or off). Check input with jumpers in and out while checking an audible test count through the mike and observe results on an oscilloscope at test point E5 on 1A2A5. No output will be observed at test point E5 when the jumpers are connected; However, an output will be observed at test point E5 when the jumpers are not connected. Return circuit to normal.

d. Local Control Operational Checkout. Verify that local control status data can be properly sent and received by using the following procedures.

1. Turn the INTERCOM switch on the local control 1A2 panel to the A TRAFF (transmit) and A FACIL (intercom) position several times. Hold switch in each position for a minimum of three seconds and verify that the A TRAFF (transmit) and A FACIL (intercom) indicators on the remote control illuminate per the switch positions

2. Press and release REMOTE switch S2 on the local control 1A2 several times and verify VOR REMOTE indicator A1DS4 or LOCAL indicator A1DS5 at the remote site illuminate according to the switch indication at the local control. Return control to local site.

3. Enter command code 15 on the local control 1A2 keyboard to turn the system on. Verify VOR MAIN indicator A1DS1 illuminates at the remote site.

4. Verify standby status indication by the following procedure.

a Turn carrier transmitter 1A4 ON/OFF/NORMAL switch to the OFF position.

b Press system inhibit switch on 1A2 local control. Verify that it is extinguished.

5. After a time period of not to exceed 30 seconds, verify VOR OFF indicator DS4 on local control 1A2 illuminates, VOR OFF indicator AIDS2 illuminates at the remote site and VOR MAIN indicator A1 DS1 at the remote has extinguished

6. After approximately 30 seconds, verify at the remote site that the VOR OFF indicator illuminates and VOR MAIN indicator A1DS1 and VOR STANDBY indicator A1DS2 are extinguished.

7. If a DME is colocated with the VOR, enter command code 25 at the local control 1A2 to turn the DME on. Verify at the remote site that DME MAIN indicator AlDS6 illuminates.

8. Enter command code 28 on the local control 1A2 keyboard to cause a DME standby situation to occur. Verify DME STANDBY indicator A1DS7 illuminates at the remote site. Also verify that DME MAIN indicator A1DS6 and DME OFF indicator A1DS8 are extinguished.

9. Enter command code 27 on the local control 1A2 keyboard and verify DME OFF A1DS8 indicator illuminates at the remote site.

2-40. REMOTE INTERFACE INSTALLATION.

NOTE

The remote control unit can be located at any facility up to 20 miles away using 4 wires, 600 ohm pair wire, or any other distance as required using a 4-wire interface with the public telephone system or microwave link. The telephone connection between the local and remote is accomplished at the remote with a cable connected to the J2 connector on the remote chassis The other end of the cable is tied into a 4-wire telephone tie which goes to the local control. One pair of wires transmits voice and the other pair receives voice and FSK data.

The telephone connection must match the 600 ohm impedance of the send and receive lines. To insure that the combined voice and FSK data can be properly transmitted and received, the telephone line send and receive levels must be compatible. Use a Burndy M8ND Crimping Tool and N20ORT-29 Positioner to wire connectors supplied with the remote control.

a. Remote Control Voice Setup. Verify that voice communications can be properly sent and received by performing the level setup procedures outlined in paragraph 5-23.b. through 523.c.

b. Command Code Checkout Procedure. Verify that the various command codes properly control the system by performing the following procedures.

1. Check to see that REMOTE indicator A1DS4 is illuminated at the remote control site (this implies control of the system is at the remote). If the REMOTE indicator is not illuminated, have the operator at the local control press REMOTE switch S2. Enter command codes per Chapter 3, paragraph 3-11. on the remote control keyboard. Verify the equipment receives and is controlled by the command codes as read on the local control 1A2 panel.

c. ATIS Interface Checkout Procedure. If the ATIS option is used, perform the following procedures.

NOTE

ATIS is recorded weather and flight information. ATIS input originates at the remote site and is sent over the telephone lines to the local site and on into the VOR transmitter. This input is then broadcast via the VOR transmitter to aircraft The remote ATIS input is 600 ohm impedance which goes through an input transformer. A level from -17 dBm to +5 dBm can be used with a 0 dBm typical input ATIS input is enabled with a keying current (see paragraph 2-41).

1. Connect an function generator to connector J5 pins 1 and 2 at the remote Set the function generator for 1000 Hz and a 0 dBm output.

2. Make the ATIS voice level consistent with the other voice inputs by turning system power on and adjust ATIS INPUT potentiometer R32 for a tone or voice peak level of 1.5V peak-to-peak at test point El1 on circuit card 4A2

a. Enable the ATIS input with a keying current by connecting a jumper between pin 3 and pin 5 (+12V) and between pin 4 and pin 6 (GND) on connector 4J5. Verify on the operations voice buffer circuit card assembly 4A2 test point E34 XMTR LINE, that a 2870 Hz (key tone) and the ATIS voice (test tone) are sent on the phone line and received at the local control.

4. Remove test connections from the J5 connector.

5. Connect the ATIS cable to connector J5.

6. Turn on the ATIS playback and verify that the ATIS information is keyed in at the remote and transmitted over the VOR station.

NOTE

Intercom or auxiliary indication voice inputs have priority and will block the ATIS voice.

d. Auxiliary Indication/Voice Optional Interface. Verify that the auxiliary indication voice can be properly sent and received by performing the following procedures (Note: Not installed in Army system).

NOTE

The remote Input is 600 ohms impedance which is fed through a transformer. A level from -17 dBm to +5 can be used with a 0 dBm typical input A keying current of 18 to 25 ma is used to enable the voice input (see paragraph 2-41).

1. Connect a function generator to connector J4 pins 1 and 2 with the generator set to 1000 Hz and 0 dBm output

2. With system power on, adjust the Input level gain with AUX GAIN potentiometer 4A2R19 to get a tone or voice peak amplitude of 10V peak-to-peak at 4A2U118, pin 10.

3. Input a key current (18 to 25 ma) connectorJ4 pin S (jumper pin 3 to pin 5 and pin 4 to pin 8) to enable the auxiliary Indication voice to be transmitted via the remote to the local control. With a keyed input, verify at test point 4A2E34 XMTR LINE that a 2870 Hz (key tone) and auxiliary voice are present Also, verify that this Is received properly at the local control.

4. Remove the inputs from connector J4.

5. Connect the auxiliary indication voice cable to connector J4. Turn on the auxiliary Indication voice and verify all functions operate.

2-41. KEY CURRENT. (The explanation here provides additional interconnection information needed to interface to auxiliary equipment) Key current, as used in the preceding voice interfaces, is brought through and sensed by an optical isolator. This isolator has a LED light emitting diode which generates light proportional to the diode current The light then turns on a photo transistor which enables the various voice circuits in the remote control. The methods by which the keying current is provided are described in the following procedures.

NOTE

The following method of keying is only required when any auxiliary equipment is used (i.e., ATIS, VORTAC, RCVR squelch or auxiliary indicator/voice option.) Paragraph a. describes the preferred hookup for interconnecting auxiliary equipment. Paragraph b. describes the alternate method which is easier to use for test purposes.

a. An external power supply (in auxiliary equipment) can provide a voltage source with current controlled by series resistance of the circuit There is approximately a 1-1/2 volt diode LED drop.. A 180 ohm resistance is built into the receive circuit. Line resistance, plus 180 ohms, plus additional resistance are used in a series circuit to generate an 18 to 25 milliamp key current through the optical isolator and back to the external supply. An external transistor or switch contact (relay) is used to open or close the circuit to key when current flows. This is the preferred keying method since the optical isolator provides isolation of the drive circuit from the remote circuits.

b. An alternate method to key inputs is as follows. The remote control power supply can provide power for the 18 to 25 ma current with isolated switch or relay contacts turning the current on or off.

CAUTION

Ensure the contacts and series circuit are completely isolated electrically from equipment external to the remote as damage to the remote control could result from electrical connection of this circuit to other equipment

The remote +12 volt power voltage is applied through a 180 ohm resistor and is available at pin 3 of the connectors (On both the local and remote control, the input connectors pin numbers are the same.) Pin 3 is jumpered to pin 5 which puts current through an optical isolator, through 180 ohms and out on pin 6. This connects to one wire of a twisted pair which ties to the on/off contacts, a series resistance (use 140 ohm line resistance), and returns via the other wire to connector pin 4 (remote ground).

2-42. TELEPHONE LINE REQUIREMENTS. Telephone lines interconnecting the remote and local control, in addition to having the proper level, must have acceptable frequency response, group delay, etc., per the appropriate FAA specification. If telephone lines do not meet the specification, voice and data transfer may be marginal.

2-43. VOICE MODULATION. This procedure checks that the voice modulation is limited to 30%.

a. Enter command code 15 on the local control 1A2 keyboard, set the SUBCARR switch to OFF, VOICE switch to OFF, and IDENT switch to OFF on the 1A4A2 circuit card.

b. Set up the oscilloscope to measure voice modulation the same as designated in paragraph 2-33 steps d through f.

c. Connect a jumper lead from the 1020 Hz test point E2 to VOICE test point E1 on circuit card 1A4A2. Adjust VOICE LIMIT potentiometer 1A4A2R16 for the same modulation percentage as the 9960 Hz subcarrier in paragraph 2-33 step g Substitute 1020 Hz for 9960 Hz and do not change the position of the SUBCARR switch.

d. Remove the jumper lead from 1020 Hz test point E3 to VOICE test point E1 on circuit card 1A4A2 and turn the VOICE switch to the ON position.

e. Remove the cable and connector (if used) for connector J5 on the remote control. Connect a function generator set for 1000 Hz between pin 1 and pin 2 in connector J5. Connect a jumper from pin 3 to pin 5 and pin 4 to pin 6 on connector J5 to initiate a 2870 Hz keytone. Adjust the function generator for a -8 dB output between terminals E9 and E12 on circuit card 4A4.

f. Verify that a -17 dBm or higher level is present between pins 20 and 21 in connector J1 in the local control.

g. Adjust TRAF VOL potentiometer R70 on circuit card 1A2A4 in the local control for 10 volts peak-to-peak as measured at test point E3 on circuit card 1A2A5.

h. Switch the INTERCOM switch to A FACIL position and verify that a 1000 Hz tone can be heard over the speaker at a comfortable level as adjusted by the volume control. Repeat this step with the INTERCOM switch in the A TRAF position.

i. Adjust potentiometer R 12 on circuit card 1A4A2 for 1/2 the peak-to-peak voltage display on an oscilloscope connected to the FLD DET MONITOR connector in the monitor meter panel for the conditions stipulated in paragraph 2-33 step g (i.e., 15% modulation).

j. Place and hold the INTERCOM switch in local control 1A2 to A TRAFF position. Verify that the 1 KHz tone is absent. Release the INTERCOM switch.

k. Remove the continuous keying J5 jumpers at the remote control. Verify that no 1000 Hz tone is heard at the local control although a continuous 1000 Hz tone is still applied at the remote control site (i.e., the 1000 Hz modulation is blocked).

l. Observe that the 1000 Hz tone can still be heard over the local control speaker when the INTERCOM switch is placed in the A TRAFF or A FACIL position.

m. Disconnect the function generator from pins 1 and 2 in connector J5 on the remote control.

n. Reconnect the ATIS cable (if used) to J5 and check with the ATIS on for a good voice output of the VOR transmitter.

2-44. CONCLUDING INSTALLATION PROCEDURES. At the conclusion of all installation procedures, perform a ground check) pre-flight inspection, and post flight inspection as delineated in Chapter 5, Section II.

2-45. 10 KHZ SPECTRUM CHECK. Verify that the modulation spectrum of the 9960 Hz does not exceed the limits shown in figure 2-23 by performing the following procedures.

a. Enter code 17 on local control keyboard 1A2 to turn the system off.

b. Disconnect cable W8 from attenuator AT1 in carrier transmitter 1A4. Connect the 30 dB attenuator to attenuator 1A4AT1. Connect one end of a BNC test cable to the 30 dB attenuator and the other end to the input of the spectrum analyzer.

NOTE

The 30 dB attenuator is used for protecting the receiver RF input section of the spectrum analyzer from overload. Additional attenuation may have to be added, up to 50 dB, depending on the Spectrum Analyzer used. If a Tektronix analyzer is used, 50 dB of attenuation will have to be used.

c. Ensure the POWER switches in sideband transmitters 1A5 and 1A7 are in the NORMAL position. Also, ensure the A and B CONT switches (A4S1 and A4S4 respectively) are in the OFF position. Set the OFF/NORMAL switch (A1S1) in the OFF position (FM deviation).

d. Ensure the SUBCARR switch on circuit card 1A4A2 is in the ON position.

e. Enter code 15 on local control 1A2 keyboard to turn the system on. Ensure 50 or 100 watts for the respective system is present on the RF monitor power meter.

f. Tune the spectrum analyzer frequency readout to the carrier transmit frequency and center the presentation on the center of the display screen. Decrease the resolution and frequency scan per div so that the display in figure 2-23 is observed on the spectrum analyzer with the center peak even with the top grid line. The 10 KHz sidebands are 16.5 dB down from the center peak for 30% modulation. Verify that the modulation spectrum of the 9960 Hz does not exceed the following limits

1. The 20 KHz sidebands are down 30 dB minimum from the 10 KHz sidebands.

2 The 30 KHz sidebands are down 50 dB minimum from the 10 KHz sidebands

3. All other 10 KHz sidebands are at least 60 dB minimum down from the 10 KHz sidebands,

4. If out of tolerance condition exists, perform the spectrum adjustment procedures in paragraph 5-24.

9. Remove 30 dB attenuator AT1 from 1A4AT1 and replace the W8 cable.

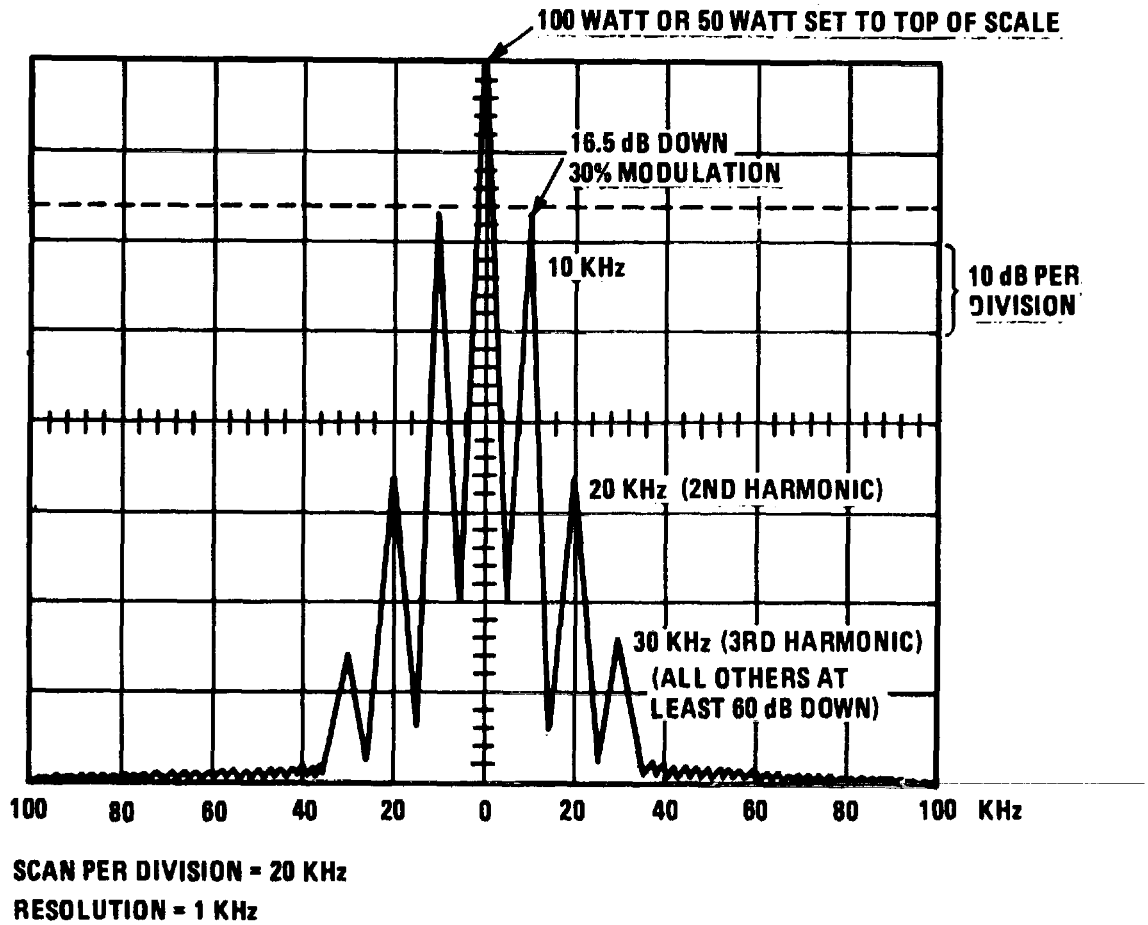


Figure 2-23. Spectrum Analyzer With 9960 Hz Modulation on Carrier 30%

CHAPTER 3

OPERATION

3-1. INTRODUCTIQN. This chapter provides operating instructions, in the form of text and illustrations, for the VOR. This chapter is divided into three sections. Section I contains a listing and description of all front panel controls and indicators along with the function and operation that each performs Illustrations are included showing meters, switches, controls, and indicators used for operation. A description of the equipment power interlocks is also contained in section I. Section II contains detailed starting, operating, and stopping instructions for each unit of the VOR preceded by a general description of the operation of the unit These instructions are presented in a step-by-step sequence. Notes are included where necessary to highlight special procedures or conditions. Section III contains emergency operating instructions for maintaining on the air operation of the transmitters.

SECTION I

CONTROLS AND INDICATORS

3-2. ENERAL. Controls and indicators required in the operation of the VOR are generally located on the front panels of the respective units A description of the operation and function of each control and indicator is presented in the following paragraphs.

3-3. VOR RF POWER MONITOR AND CABINET ASSEMBLY (1A1) CONTROLS AND INDICATORS. The front panel controls and indicators of the power monitor are listed in table 31 and illustrated in figure 31.

3-4 VOR LOCAL CONTROL (1A2) CONTROLS AND INDICATORS. The front panel controlsand indicators of the local control are listed in table 3-2 and illustrated in figure 3-2.

3-5. VOR MONITOR (1A3) CONTROLS AND INDICATORS The front panel controls and indicators of the monitor are listed in table 3-3 and illustrated in figure 33.

3-6 VOR CARRIER TRANSMITTER (1A4) CONTROLS AND INDICATORS. The front panel controls and indicators of the carrier transmitter are listed in figure 3-4.

3-7. VOR SIDEBAND TRANSMITTER (1A5) CONTROLS AND INDICATORS. The front panel controls and indicators of the sideband transmitter are listed in table 3-5 and illustrated in figure 35.

3-8. VOR REMOTE CONTROL (UNIT 4) CONTROLS AND INDICATORS. The front panel controls and indicators of the remote control are listed in table 3-6 and illustrated in figure 36.

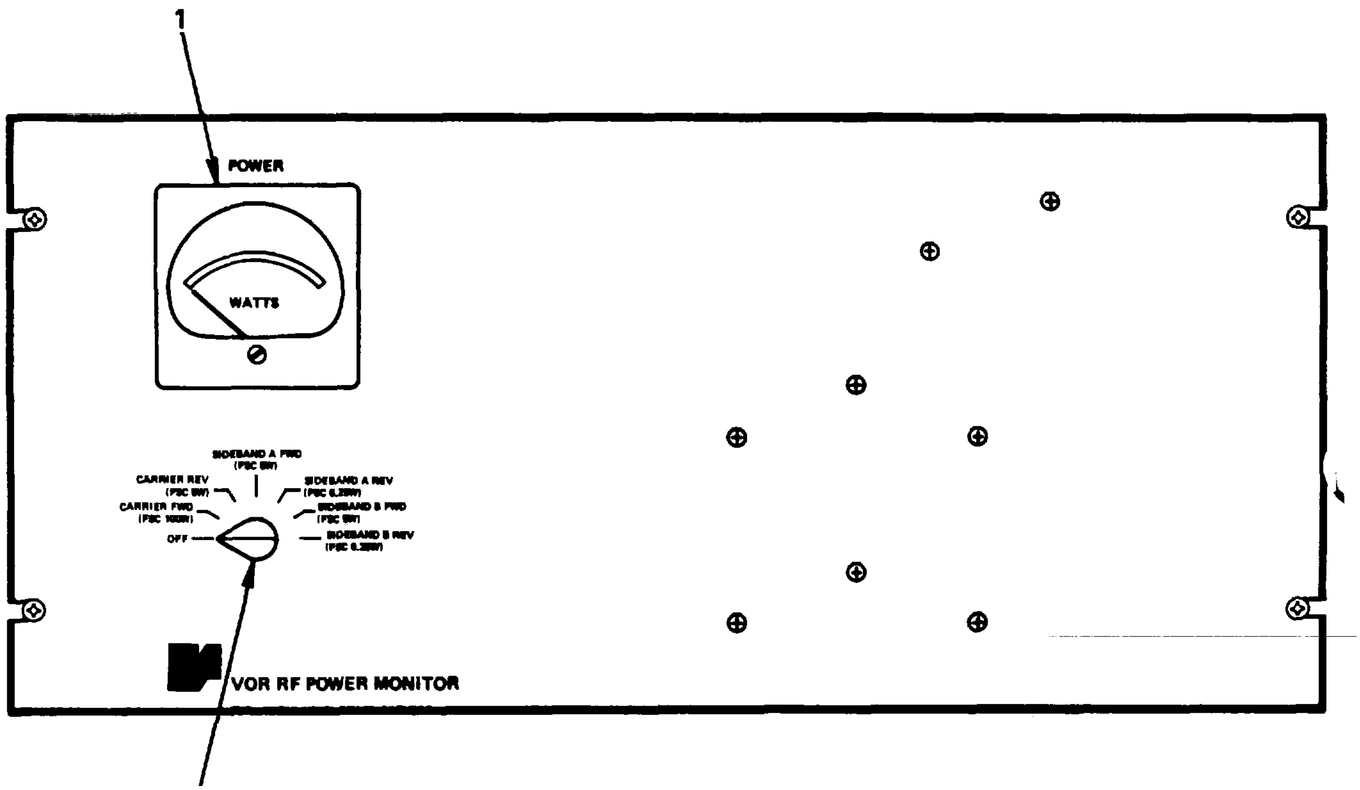


Figure 3-1. VOR RF Power Monitor (Part Of 1AI) Controls ad Indicators Location Diagram

Table 3-1. RF Power Monitor Assembly (1A1) Controls and Indicators

Index No.	Name	Reference Designation	Function
1	POWER Meter	M1	Provides a scaled visual readout of sampled RF power selected by the POWER meter selector switch.
2	POWER Meter Selector Switch	S1	Selects the designated RF power sampled by the sensors, rectified and applied to the POWER meter.

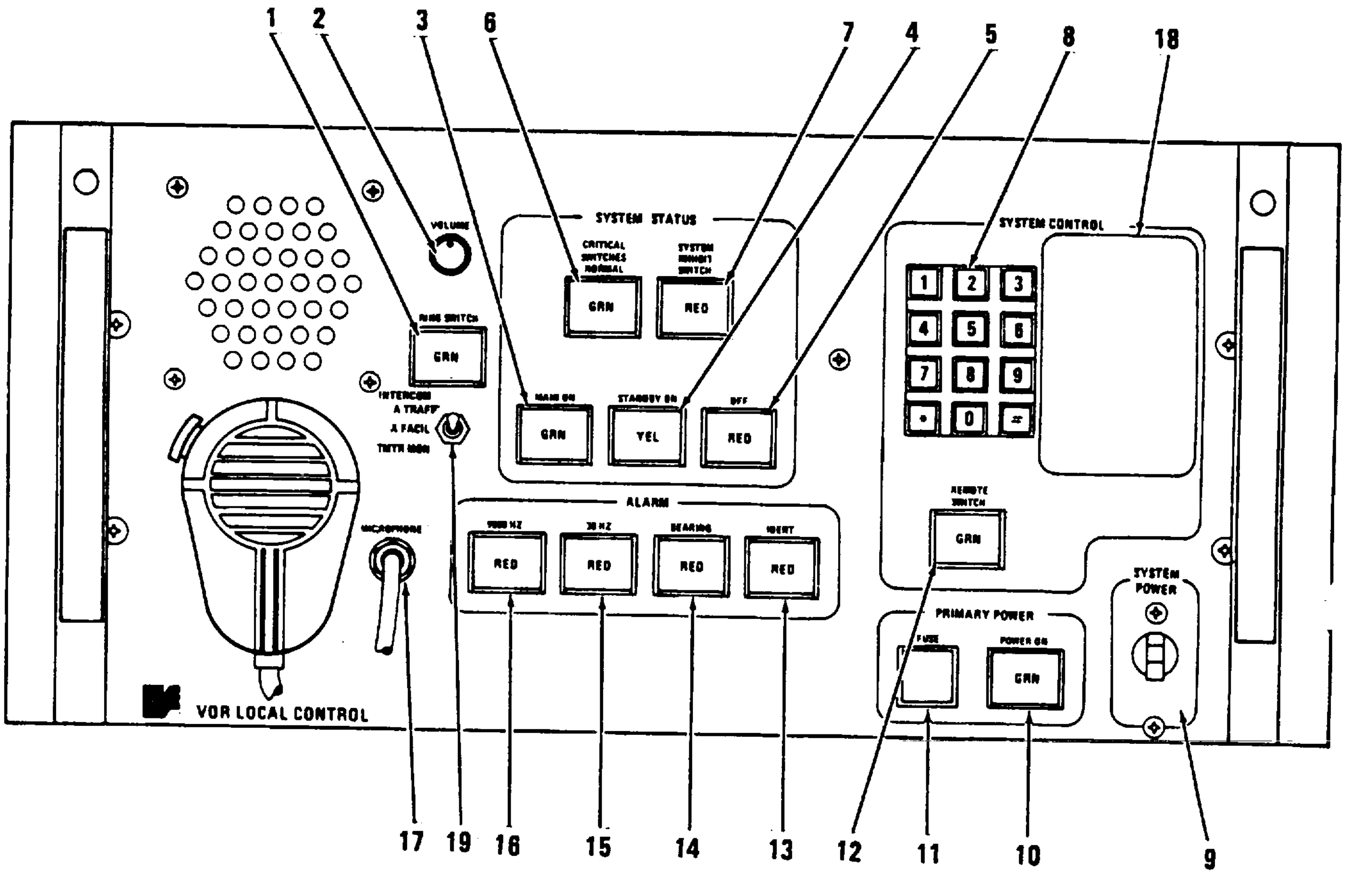


Figure 3-2. VOR Local Control (1A2) Controls and Indicators

Table 3-2. VOR Local Control Controls and Indicators

Index No.	Name	Reference Designation	Function
1	RING Switch	S3	Rings operator at remote enc. (See switch, item 19, to select ring point).
2	VOLUME	R1	Controls volume of the speaker.
3	SYSTEM STATUS MAIN ON Indicator	DS3	Illuminates green when the transmitter selected as the main unit is on the air. Extinguishes when a transfer or shutdown has occurred.
4	STANDBY ON Indicator	DS4	Illuminates yellow after a transfer condition has occurred placing the standby transmitter on the air. (Dual system only).
5	OFF Indicator	DS2	Illuminates red when a system shutdown has occurred or when the transmitter has been commanded off (i.e. no signal is being transmitted).
6	CRITICAL SWITCHES NORMAL Indicator	DS9	Illuminates green when all switches are placed in their normal position. Extinguishes when any system critical switch is placed in any position other than normal.
7	SYSTEM INHIBIT SWITCH	S1	Locks system in existing operating status when activated; therefore, the system will not recognize faults or initiate a transfer or shutdown.
8	SYSTEM CONTROL Keyboard Selector	U1	Touchtone telephone type keyboard utilizing two digit command codes which when enabled provides local control of the VOR system. Spare codes provide future capability for unique additional requirements
9	SYSTEM POWER Switch	CB1	Applies system power to all assemblies in the electronic equipment rack.
10	PRIMARY POWER POWER ON Indicator	DS1	Illuminates green when power is applied.
11	FUSE	Fl	Protects input lines from circuit overload and illuminates when fuse is open.
12	REMOTE SWITCH	S2	Determines whether the remote or local control keyboard has control of the VOR system.
13	ALARM Indicators IDENT Indicator	DS8	Illuminates when an identification pulse is not received after 30 seconds or if the identification interval exceeds 30 seconds.

Table 3-2. VOR Local Control Controls and Indicators (Contd)

Index No.	Name	Reference Designation	Function
14	BEARING Indicator	DS7	Illuminate when the phase error between the references signal and the variable 30 Hz signal exceeds the adjustable preset radial error limit. This may be adjusted from t0.1 I to ±4.9 degree
15	30 Hz Indicator	DS6	Illuminates a 15% or greater reduction In signal level Is detected within a 15 second interval.
16	9960 Hz Indicator	DS5	illuminates when a 15% or greater reduction in signal level is detected within a 15 second Interval.
17	MICROPHONE Jack	J5	Provides front panel connection point for microphone.
18	Commend Code Label	-	Provides a listing of the two digit command codes applicable to the system in use and identifies the function of each code.
19	INTERCOM Switch	S4	
	A TRAFF Position		A TRAFF (Airway Traffic) blocks audio from air traffic controller to carrier transmitter. Allows communication between VOR site and air traffic controller without putting It on the air. The A TRAFF is a spring loaded momentary switch which prevents casual conversation, maintenance information and other erata from going on the air.
	A FACIL Position		A FACIL (Airways Facility) An intercom type position used for maintenance personnel to communicate with the remote and other facilities personnel. The air traffic operator can key his microphone end take priority over this position. Control logic gates in the remote give the air traffic controller precedence over maintenance or service communication
	TMTR MON		Reduces speaker voice level of air traffic controller or Intercom remote transmissions but permits a high level ring signal to be audible at the local control (transmitter) site for the purpose of alerting personnel It the local control to switch to A FACIL position for a message over the intercom.

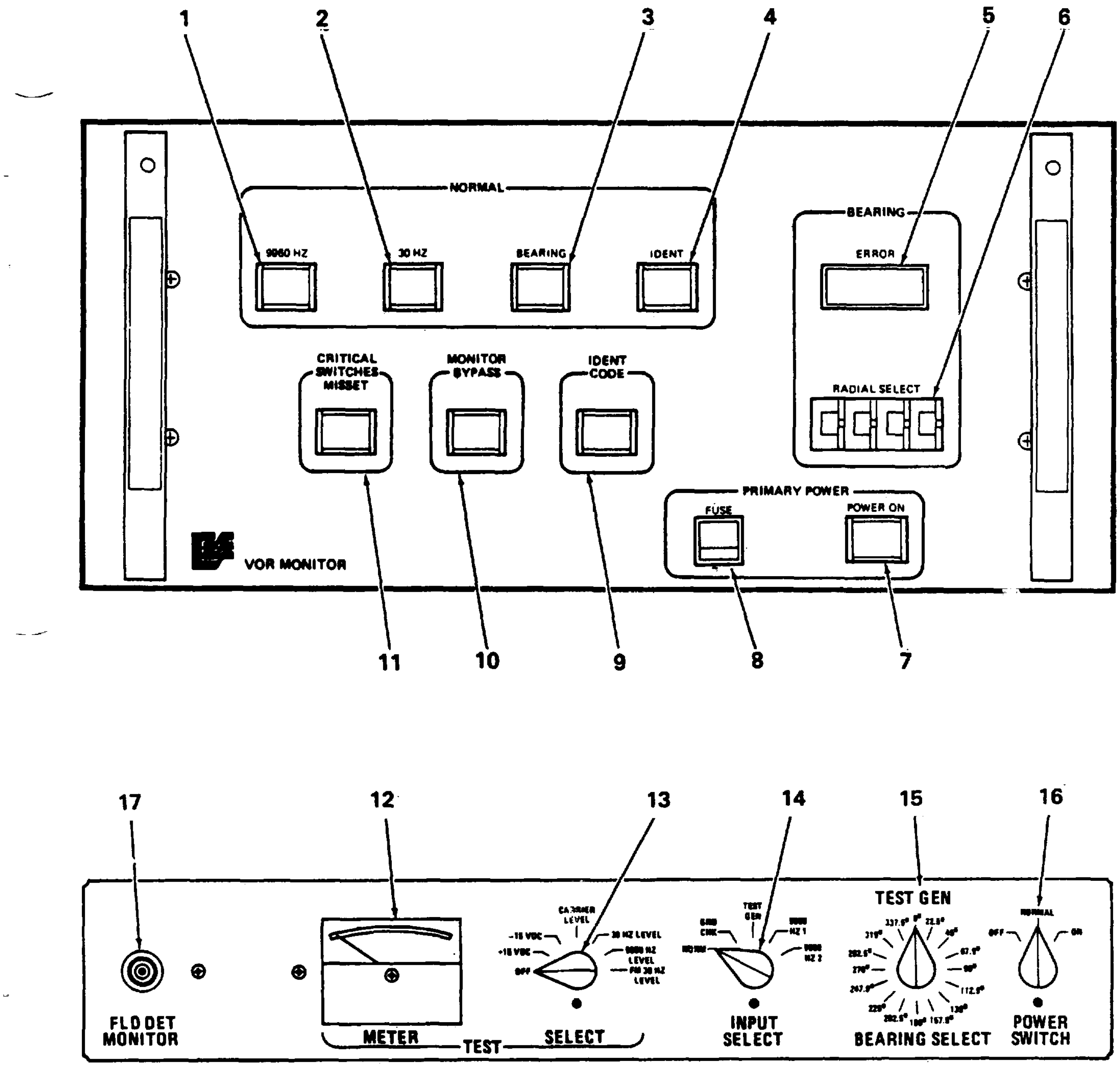


Figure 3.3 VOR Monitor (1A3) Controls and Indicators Location Diagram

Table 3-3. VOR Monitor (1A3) Controls and Indicators

Index No.	Name	Reference Designation	Function
	NORMAL Indicators		The following four indicators illuminate green to indicate a normal condition with the parameter being evaluated. If the parameter exceeds its specified limits, a fault and alarm is initiated and the indicator corresponding to the malfunctioned parameter extinguishes.
1	9960 Hz Indicator	DS7	Illuminates green to indicate a normal condition and extinguishes when a 15% or greater reduction in signal level is detected.
2	30 Hz Indicator	DS3	Illuminates green to indicate a normal condition and extinguishes when a 15% or greater reduction in signal level is detected.
3	BEARING Indicator	DS6	Illuminates green if the error between the shifted reference signal and the variable 30 Hz signal does not exceed the adjustable radial error factor preset in the monitor logic circuit. This factor may be adjusted from ± 0.1 to 4.9 degrees in 0.1 degree increments.
4	IDENT Indicator	DS5	Illuminates green to indicate a normal condition and extinguishes when the absence of or the continuous presence of the 1020 Hz identification tone is detected within a 30 second interval.
5	BEARING ERROR Display		Digital display (LED) which displays the actual bearing error measured by the monitor.
6	RADIAL SELECT Switches	AlS1	Four thumbwheel switches select the radial which is to be monitored.
7	PRIMARY POWER POWER ON Indicator	DS2	Illuminates green when ac power is applied.
8	FUSE	Fl	Protects input lines from circuit overload.
9	IDENT CODE Indicator	DS4	Illuminates blue (flashes) when the identification signal is being transmitted.
10	MONITOR BYPASS Indicator	DS8	Illuminates yellow when the monitor Input select switch is in any position other than the NORM position indicating a monitor condition exists.

Table 3-3. VOR Monitor (1A3) Controls and Indicators (Contd)

Index No.	Name	Reference Designation	Function
11	CRITICAL SWITCHES MISSET Indicator	DS9	Illuminates red when any critical switch on the monitor is in any position other than normal.
12	TEST		
	METER	Ml	Provides visual indication of the 30 Hz level, 9960 Hz level, detected carrier level, FM 30 Hz level and the power supply voltages.
13	SELECT Switch	S4	Used to select voltages and signals for display on test meter.
14	INPUT SELECT Switch	S3	The INPUT SELECT switch utilizes five positions to facilitate performing maintenance and test functions as follows: 1. NORM. The monitor is connected directly to the field detector for normal monitoring operation in this position. 2. GRD CHK. Same functions for this as for the NORM position except that four alarms are artificially induced and are used to perform ground check. In a dual system configuration, this places control of the system in the monitor which is not being tested. 3. TEST GEN. In this position, a test generator is connected directly to the monitor for calibration purposes. 4. 9960 HZ 1. This position provides the capability for running a ground check without radiating the 10 KHz subcarrier from the No. 1 system. 5. 9960 HZ 2. Same as for the 9960 Hz 1 except applies to system No. 2 when the system is deployed in a dual system configuration.
15	TEST GEN BEARING SELECT Switch (Optional)	S2	This switch supplied with the built-in test generator option allows the selection of one of sixteen radials spaced every 22.5 starting at 00 for testing purposes
16	POWER SWITCH	S1	Three position switch designed to operate as follows: 1. ON. Applies power to the monitor directly and disables power on control from the control unit. 2. OFF. Disconnects power to the monitor. The ON and OFF positions are primarily used for maintenance. 3. NORM. Power applied to the monitor is controlled by the local control unit

Table 3-3. VOR Monitor (1A3) Controls and Indicators (Contd)

Index No.	Name	Reference Designation	Function
17	FLD DET MONITOR Output Test Connector	J2	Provides capability to connect signals directly from the Field Detector or the test generator to external test equipment or may be used as a signal input depending on switch position.

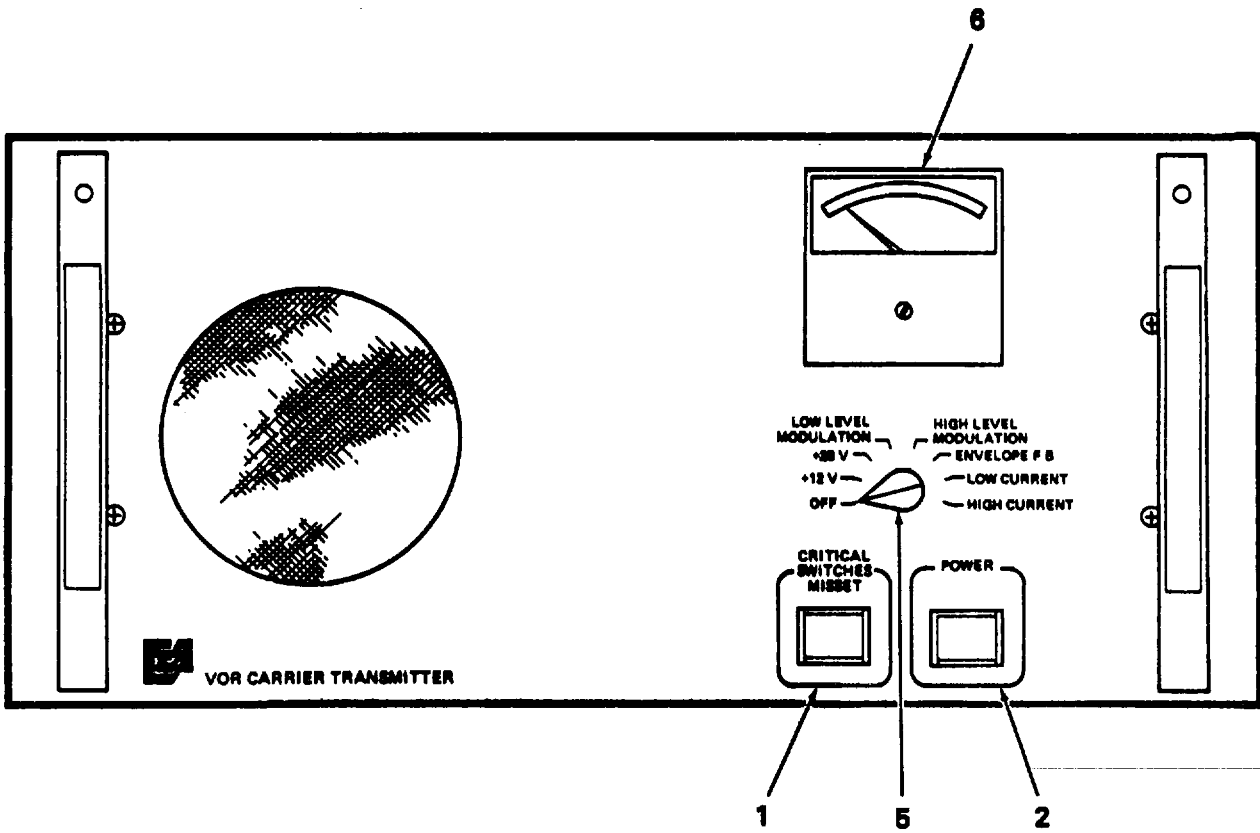


Figure 3-4. VOR Carrier Transmitter (1A4) Control and Indicators Location Diagram

Table 3-4. VOR Carrier Transmitter (1A4) Controls and Indicators

Index No.	Name	Reference Designation	Function
1	CRITICAL SWITCHES MISSET Indicator	DS1	Illuminates red when any switch in the carrier transmitter is in any position other than normal
2	POWER Indicator	DS2	Illuminates green when ac power is applied.
3	NORMAL/TEST Switch (Located on Modulator Assembly A4)	A4S1	ALC/envelope feedback applied in normal posit Test position removes ALC and envelope feedback.
4	POWER Switch (Chassis mounted by power amplifier),	S2	Three position switch designed to operate as follows: 1. ON. Applies power to the carrier directly overriding the local control signal. 2. OFF. Disconnects power to the carrier transmitter. The ON and OFF positions are primarily used for maintenance. 3. NORMAL Power applied to the carrier transmitter is controlled via the local control.
5	Test Select Switch	S1	Used in conjunction with test meter for checking the CW signal, operation, voltages and general adjustment and alignment requirements.
6	Test Meter	MI	Indicates levels for critical outputs and voltage requirements. Provides visual indications for selected settings of the TEST SELECT switch.

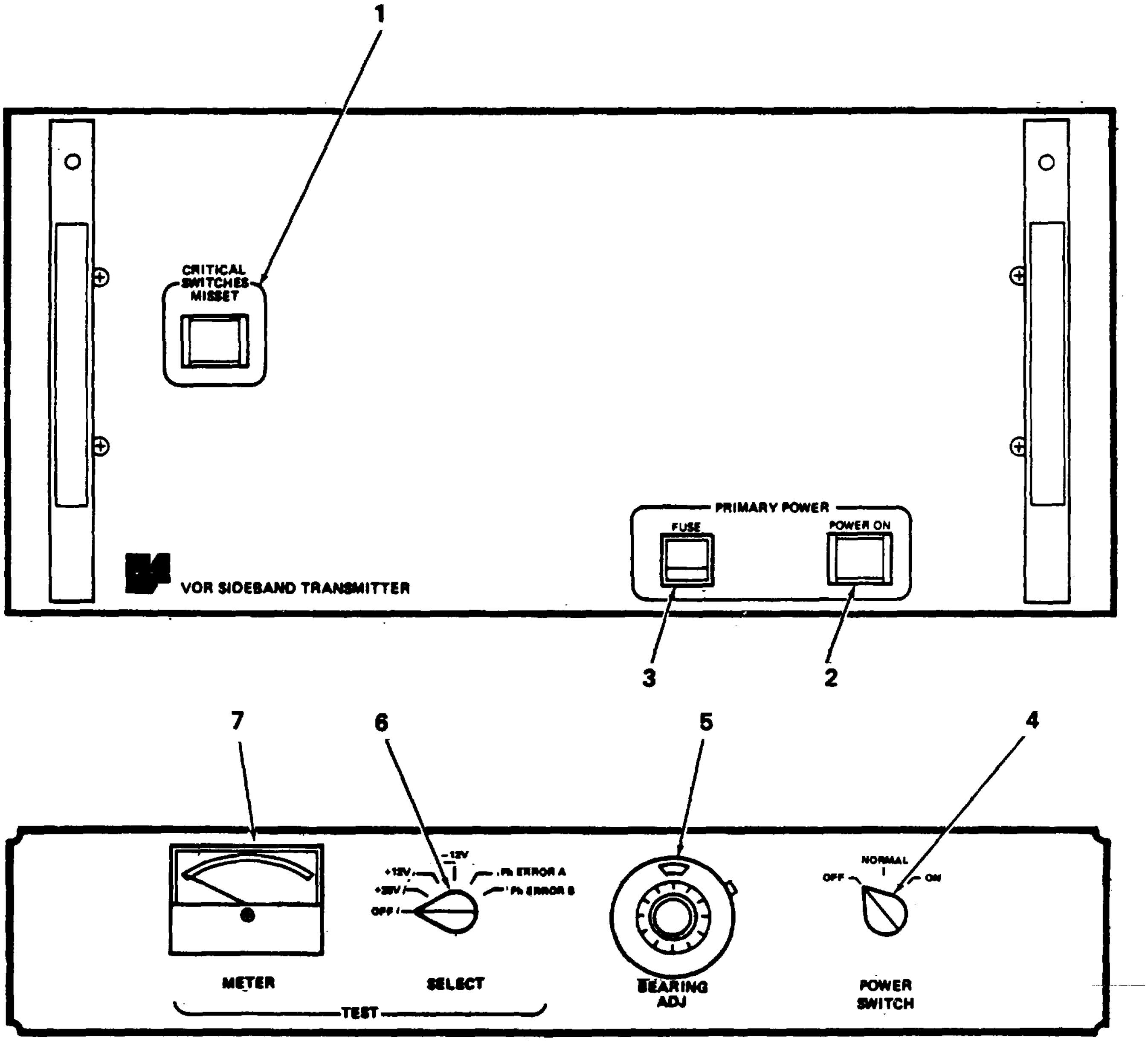


Figure 3-5. VORSideband Transmitter (1A5) Controls and Indicators Location Diagram

Table 3-5. VORSideband Transmitter (1A5) Controls and Indicators

Index No	Name	Reference Designation	Function
1	CRITICAL SWITCHES MISSET Indicator	DS1	Illuminates red when any critical switch in the sideband transmitter is in any position other than normal.
	PRIMARY POWER		
2	POWER ON Indicator	DS2	Illuminates green when ac power is applied.
3	FUSE	F1	Protects input lines from circuit overload
4	POWER SWITCH	Si	Three position switch designed to operate as follows: 1. ON. Applies power to the sideband transmitter directly and overrides the power on control signal from the local control. 2. OFF. Disconnects power to the sideband transmitter. The ON and OFF positions are primarily used for maintenance. 3. NORM. Power applied to the sideband transmitter is - controlled from the control unit.
5	BEARING ADJ Potentiometer	R1	Calibrates the actual bearing being transmitted by changing the phase of the 30 Hz variable with respect to the phase of the 30 Hz reference. In effect, it rotates the station.
	TEST		
6	SELECT Switch	S2	Used in conjunction with test meter for checking signal level and voltages for general adjustment and alignment requirement
7	METER	M1	Provides visual indication for selected settings of the TEST SELECT switch.

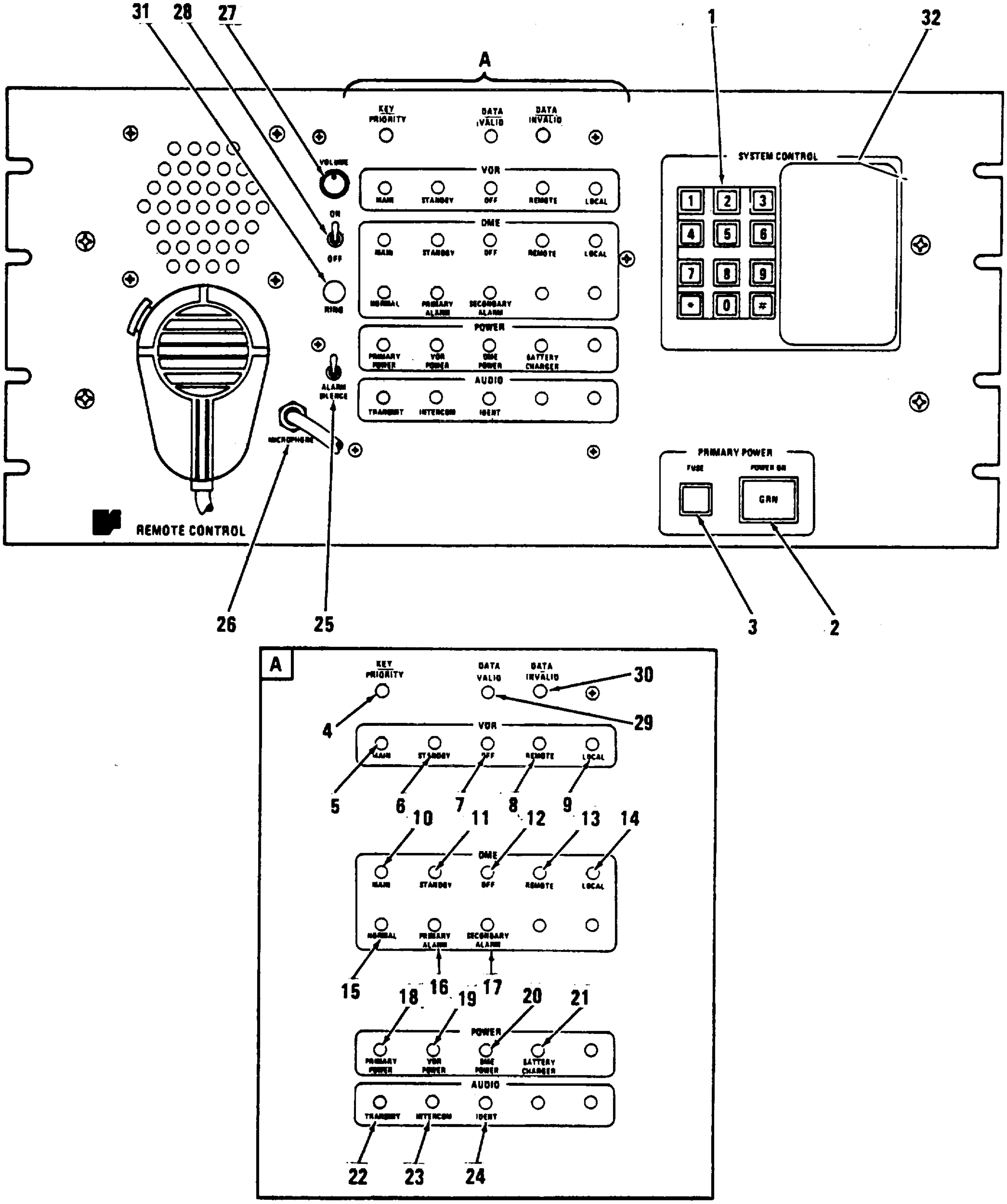


Figure 36. VOR Remote Control (Unit 4) Controls and Indicators

Table 3-6. VOR Remote Control (Unit 4) Controls and Indicators

Index No.	Name	Reference Designation	Function
	SYSTEM CONTROL		
1	Keyboard Selector	U1	Touchtone telephone type keyboard utilizing two digit command codes which ,when enabled, provides remote control of the VOR system. Spare codes provide future capability for additional requirements
	PRIMARY POWER		
2	POWER ON Switch Indicator	A1S1	Applies operating power.
3	FUSE	A1F1	Protects input lines from circuit overload.
4	KEY PRIORITY (yellow) Indicator	A1DS28	Illuminates indicating voice communication is being fed to the VOR carrier transmitter to be transmitted. (Sending 2870 Hz key tone with voice.)
5	MAIN Indicator – VOR	A1DS1	Illuminates green when the VOR transmitter selected as the MAIN unit is on the air. Extinguishes when a transfer or shutdown has occurred.
6	STANDBY Indicator –VOR	A1DS2	Illuminates yellow after a transfer condition has occurred placing the standby transmitter on the air.
7	OFF Indicator – VOR	A1DS3	illuminates red when a system shutdown has occurred or when the transmitter has been commanded off.
8	REMOTE Indicator – VOR	A1DS4	Illuminates green when the remote control unit has control of VOR.
9	LOCAL Indicator - VOR	A1DS5	Illuminates yellow when the local control unit has control of VOR.
10	MAIN Indicator – DME	A1DS6	Illuminates green when one transponder is on the air and the second transponder is in standby.
11	STANDBY Indicator- DME	A1DS7	Illuminates yellow when the standby transponder is on the air and the primary transponder is off.
12	OFF Indicator – DME	A1DS8	Illuminates red when a DME system shutdown has occurred or when the transponder has been commanded off.
13	REMOTE Indicator – DME	A1DS9	Illuminates green when remote control has control of DME.

Table 3-6. VOR Remote Control (Unit 4) Controls and Indicators (Contd)

Index No	Name	Reference Designation	Function
14	LOCAL Indicator – DME	A1DS10	Illuminates yellow when local control unit-has control of DME.
15	NORMAL Indicator – DME	A1DS11	Indicates green when a normal condition exists in the DME.
16	PRIMARY ALARM Indicator- DME	A1DS12	Illuminates red when DME is in primary alarm condition.
17	SECONDARY ALARM Indicator DME	A1DS13	Illuminates red when DME is in secondary alarm condition.
	POWER		
18	PRIMARY POWER Indicator	A1DS16	Illuminates green when primary power source is providing the system operating power.
19	VOR POWER Indicator	A1DS17	Illuminates green when power is being applied to the VOR.
20	DME POWER Indicator	A1DS18	Illuminates green when power is being applied to the DME.
21	BATTERY CHARGER Indicator	A1DS19	Illuminates green when battery is being charged
	AUDIO		
22	TRANSMIT Indicator	A1DS21	Illuminates yellow when local control INTERCOM switch is in the A TRAFF position.
23	INTERCOM Indicator	A1DS22	Illuminates green when the local control INTERCOM switch is in the A FACIL position.
24	IDENT Indicator	A1DS23	Pulses yellow when identity code is being transmitted over VOR or DME when the IDENT monitor is commanded on.
25	ALARM SILENCE Switch	A1S1	Resets audible alarm.
26	MICROPHONE JACK	J1	Front panel microphone input jack.
27	SPEAKER CONTROLS VOLUME Control	A1R27	Adjusts speaker volume level.

Table 3-6. VOR Remote Control (Unit 4) Controls and Indicators (Contd).

Index No.	Name	Reference Designation	Function
28	ON/OFF (transmit/Intercom) Selector	A1S2	
	A. With E20 to E21 jumper in on 4A2 Circuit Card Assembly		The ON position enables voice transmissions from the transmitter during the times when the press to talk switch of the microphone Is depressed. This is indicated by an illuminated condition of the KEY PRIORITY (yellow) indicator when the press to talk switch Is depressed. The OFF position enables intercom communication and also inhibits voice transmissions from the transmitter. This is indicated by an extinguished KEY PRIORITY (yellow) indicator when holding press to talk microphone switch.
	B. With E20 to E21 jumper out.		The ON position enables intercom conversations between the local and remote. The FSS operator at he auxiliary indicator/voice panel will block intercom when the FSS mike is keyed. The OFF position blocks voice output; however, a RING (from local) is output for either the on or off position.
29	DATA VALID (green) Indicator	A1DS26	illuminates to indicate proper transmission and update of status data.
30	DATA INVALID Indicator	A1DS27	illuminates to indicate malfunction or absence of data transmissions.
31	RING Switch	A1S3	Used to contact personnel at the local control (transmitter site) by means of an audible tone. Rings while switch is depressed.
32	COMMAND CODE Label		Provides a listing of the two digit command codes applicable to the system in use and identifies the function of each code.

SECTION II

OPERATING INSTRUCTIONS

3-9. GENERAL OPERATING INFORMATION. The Solid State VOR system consists of four units connected in either a dual or single system configuration. Turn on, operating and shutdown procedures for each system configuration are contained in the following paragraphs. All operating controls are either front panel mounted or located on a control panel immediately behind the front panel on the rack mounted equipment. These controls and indicators are described in Section 1 of Chapter 3.

3-10. SYSTEM TURN ON, OPERATING AND SHUTDOWN PROCEDURES FOR SINGLE SYSTEM CONFIGURATION FROM THE LOCAL SITE.

NOTE

This procedure is to be used for routine operations only. The initial turn-on of the equipment upon completion of the installation effort should be accomplished in accordance with the procedures outlined in Chapter 2.

a. System TURN ON. Turn the SYSTEM POWER circuit breaker 1A2CB1 on the local control 1A2 to the ON position. Observe the following on the local control.

1. All ALARM indicators should be extinguished.

2. The POWER ON indicator 1A2DS1 should be illuminated.

3. If the REMOTE SWITCH indicator 1A2S2DS1 is illuminated, press this switch 1A2S2 transferring control to the local control.

4. If the SYSTEM STATUS OFF indicator is extinguished, enter command code 17 from local control 1A2 keyboard.

5. If the SYSTEM INHIBIT indicator 1A2S1DS1 is illuminated, remove the inhibit by pressing the SYSTEM INHIBIT switch 1A2S1.

6. Verify the CRITICAL SWITCHES MISSET indicators on 1A3, 1A4 and 1A5 drawers are extinguished If not, locate the applicable misset switch and place in the position designated NORM or NORMAL.

7. Enter command code 15 and verify MAIN ON indicator DS3 on the local control 1A2 illuminates. The VOR system is now in the proper starting state for normal maintenance operations.

b. Transfer of Control to Remote. After the VOR has been certified by performing the required weekly, monthly or quarterly checks and steps in the above paragraph have been accomplished proceed as follows to transfer control to the remote site.

1. Press the REMOTE SWITCH 1A2S2 which transfers control to the remote site. Verify the REMOTE SWITCH indicator 1A2S2DS1 illuminates.

2. Press the SYSTEM INHIBIT SWITCH 1A2S1. Verify SYSTEM INHIBIT SWITCH indicator 1A2DS1 extinguishes.

3. Verify CRITICAL SWITCHES NORMAL indicator 1A2DS9 illuminates. If not, locate misset switch and place in proper position.

c. Shutdown Procedures. For routine shutdown of the VOR system perform the following steps:

1. If the REMOTE SWITCH indicator 1A2S2DS1 is illuminated, press this switch 1A2S2 transferring control to the local control.

2. Enter command code 17 on the local control 1A2 keyboard and verify SYSTEM STATUS OFF indicator 1A2DS2 illuminates At this point VOR transmissions have ceased.

3-11. REMOTE CONTROL TURN ON OPERATING AND SHUTDOWN PROCEDURES. Place the SYSTEM POWER circuit breaker 1A2CB1 on the local control to the OFF position.

a. Turn on procedures Press the PRIMARY POWERPOWER ON switch indicator 4A1S1 to apply operating power to the remote control. The indicator will illuminate green.

I. Verify the DATA INVALID indicator 4A1DS27 illuminates.

2. Hold the ALARM SILENCE switch 4A1S1 up to silence alarms. Release the switch after alarms have been silenced.

NOTE

Check for jumper between E15 and E16. If not present, Install jumper.

3. Turn the ON/OFF (transmit/intercom) switch 4A1S2 to the ON position.

4. Press the RING switch 4A1S3 to alert personnel at the local site.

5. Use the microphone to talk to personnel at the local control and verify the telephone channel is operating.

b. Operating Procedures.

1. Check that the DATA INVALID indicator 4A1DS27 has extinguished and that the DATA VALID indicator 4A1DS28 is illuminated (green). (Normally a delay between 20 seconds to 1 minute occurs after the power is initially applied before the DATA VALID indicator 4A1DS27 will illuminate. Status indication will not be correct until the DATA VALID A1DS28 indicator illuminates

2. Ensure that the PRIMARY POWER indicator 4A1DS16 is illuminated.

3. On the remote control check to see that the VOR REMOTE indicator 4A1DS4 is illuminated green (this implies control of the VOR is at the remote site). If the remote indicator 4A1DS4 is not illuminated, contact the local control site via the telephone channel and have the operator there press the REMOTE switch. This action will transfer control of the system to the remote control.

4. Verify the AUDIO INTERCOM indicator 4A1DS2 is illuminated green. Have personnel at local control hold the A TRAFF switch position for approximately 10 seconds and verify that the TRANSMIT indicator A1DS21 illuminates amber and then extinguishes.

5. Enter command code 19 on the remote control keyboard to cause the AUDIO IDENT indicator 4A1DS21 to pulse yellow (indicating the identity code of the station is being transmitted). Turn the ON/OFF (transmit/intercom) selector to the ON position and verify that the 1020 Hz ident morse code can be heard over the speaker and corresponds with the flashing of the IDENT indicator.

6. Enter command code 18 on the remote control keyboard to cause the AUDIO IDENT indicator 4A1DS21 to extinguish.

7. Check to see that the VOR is on. Verify the VOR MAIN indicator 4A1DS1 is illuminated. If this indicator is not illuminated, contact the air traffic operator and obtain clearance to command the VOR/DME on for normal operation. Enter command code 15 to turn the VOR on.

NOTE

If DME equipment is colocated with the VOR, perform the following steps.

8. Check to see that the DME is on. Verify the DME MAIN indicator 4A1DS26 is illuminated. If this indicator is not illuminated, contact the air traffic operator and obtain clearance to command the DME on for normal operation. Enter command code 25 to turn the DME on.

9. Ensure the DME NORMAL indicator A1DS11 is illuminated.

10. Verify the DME PRIMARY ALARM indicator 4A1DS12 and the DME SECONDARY ALARM indicator 4A1DS13 are extinguished. If these indicators are not extinguished, contact the air traffic operator for instructions.

c. Shutdown Procedures.

1. Prior to turning the remote control off, contact the air traffic operator to obtain clearance to do so.

2. Enter command code 17 on the remote control keyboard to turn the VOR off.

3. If a DME is colocated with the VOR, on the remote control keyboard enter command code 27 to turn the DME off.

4. Press the PRIMARY POWER POWER ON switch indicator 4A1D1 to turn the remote off. Verify the PRIMARY POWER POWER indicator extinguishes.

CHAPTER 4

PRINCIPLES OF OPERATION

4-1 INTRODUCTION. This chapter describes the principles of operation of the AN/FRN-41 Solid State VOR System. This chapter provides an overall functional system description of the VOR system and the functional operation of the units within the system. Detailed circuit description is also provided for the assemblies within each unit. Associated and interconnection diagrams and schematic foldout diagrams which support the principles of operation discussion are provided following the last section of this manual. Reference data sheets for all integrated circuits designated on the schematics are contained in Section I of Chapter 7 and a discussion of logic fundamentals for common logic symbols used is presented in Section II of Chapter 7.

SECTION I

SYSTEM DESCRIPTION

4-2. GENERAL DESCRIPTION. The AN/FRN-41 solid state VOR is a visualomni-directional range system which affords an aircraft a direct reading visual indication of the "true" bearing of the station as seen from the aircraft relative to magnetic north. The VOR operates in the frequency range of 108 to 118 MHz with channels spaced every 50 kHz. The course information directivity is omni-directional, or more specifically, it radiates course headings radially outward in all directions.

The VOR can be used for one way voice communication with the aircraft without interfering with the navigational information being radiated. In addition, the VOR identifies itself periodically by Morse code to properly identify the station and its locality.

The AN/FRN-41 VOR system consists of four basic units. These units are designated as follows:

Unit 1	Electronics Assembly
Unit 2	Field Detector
Unit 3	Antenna
Unit 4	Remote Control

The electronics assembly is housed in a shelter and the antenna is mounted an top of the flat shelter roof and is housed in a fiberglass radome. The roof top of the shelter acts as a counterpoise. The field detector is located around the top perimeter of the shelter for ground checks or on a port located at a specified radial and distance from the shelter for normal operation, and the remote control may be located at a site up to 20 miles distance from the VOR station.

Each functional unit contains interrelated stages which perform specific functions in the overall system. Subsequent paragraphs detail the principles of operation for each functional circuit contained in the VOR system. However, to aid in understanding the principles of the AN/FRN-41 VOR system, a preliminary discussion of basic VOR operation is provided.

4-3. BASIC THEORY OF OPERATION. VOR is the abbreviation of Very-High-Frequency Omnidirectional Range. As the name implies, this equipment operates in the VHF band of the radio frequency spectrum. The transmitted navigational information is radiated in al! directions Theoretically, the VOR radiates an infinite number of radial courses However, for practical purposes, it can be said that the VOR transmits a separate course for each degree of azimuth or 360 separate courses. The indicating instrument in the aircraft is calibrated in 360 degrees of azimuth with magnetic north being the 0° reference. The pilot is therefore able to measure his angular position with respect to a specific VOR station. By utilizing the transmission from two separate VOR's, the aircraft personnel can accurately determine aircraft position by triangulation computation.

a. Navigational Signal Description. The VOR signal seen from the receiving source is comprised of four distinct signals. These signals are a subcarrier contained in frequency band around 10 Hz; voice transmission contained in a frequency band between 300 to 3500 hertz;ident code transmission contained in a frequency band around 1020 Hz; and a set of sidebands, amplitude modulated at 30 Hz. All of these signals are actually sidebands of the VHF carrier.

The navigational data for determining the bearing is derived from the reference 30 Hz component transmitted on the subcarrier and the variable 30 Hz component contained in the set of 30 Hz sideband transmissions The omnicourse information in the aircraft is determined by measuring the audio phase difference between these two 30 Hz signals The reference signal has a constant phase at any given radial. The variable signal has a phase that changes one degree for each degree of radial change in azimuth around the VOR.

To ensure that two different 30 Hz signals can be radiated from a single source without interacting or combining with each other someplace between the equipment originating the signals and the aircraft, the two 30 Hz navigational signals must be isolated from each other in some manner until they are in the aircraft receiver. To accomplish this separation, the reference 30 Hz signal is frequency modulated upon a 9960 Hz signal which for simplicity is called the 10 Hz sub-carrier. In turn, this sub-carrier amplitude modulates the RF carrier of the transmitter which is radiated omnidirectionally. The variable phase is accomplished through space modulation of the RF carrier by the sideband energy radiated from the four antenna slots It is important to point out that the total 30 Hz variable modulation from the transmitting source is comprised of two distinct sideband radiated transmissions with modulation envelopes 900 out of phase with one another. Both of these signals space modulate the RF carrier transmission. It is this composite signal that is seen at the receiving end. The variable 30 Hz and reference 30 Hz components are detected and isolated within the receiver. Both the carrier energy and the sideband energy are radiated from the same antenna slot using balanced transmission line bridges to give isolation between sources.

A more detailed discussion of the development of the VOR signal is provided in paragraph 4-14, relating to antenna (Unit 3) functional description.

b. Basic Principles of VOR Operation. The VOR system furnishes bearing information to properly equipped aircraft. The monitor and local control units provide a continual check on system operation and provides aural and visual alarm at the remote site in the event of system malfunction. In the event of a malfunction, the local control will initiate a transfer from a primary transmitter to a standby transmitter. If both transmitters malfunction, the local control will initiate a complete system shutdown. A discussion of the basic operation of each major assembly or unit is presented in the following paragraphs.

4-4. VOR SYSTEM FUNCTIONAL DESCRIPTIONS. An overall block diagram of the VOR system is presented in figure 41 and a system interconnection diagram is provided in figure 7-1. Most of the electronics are contained in the VOR electronics assembly which is housed in the shelter. The antenna counterpoise is the shelter roof. The exterior of the shelter is painted with alternate squares of international orange and white. The radome is fiberglass and provides a walk in access door for maintenance. The system includes ventilation for the shelter. A basic description of the other units and components of the electronics assembly is presented in the following subparagraphs.

a. Antenna Description (Unit 3). The antenna supplied with the AN/FRN-41 VOR is a stationary cylindrical slot antenna. The antenna radiates two figure-eight patterns at right angles to each other. These two patterns are fed with sidebands that are modulated, in time quadrature, at 30 Hz which results in a composite rotating figure eight pattern. This signal is combined with the omnidirectionally radiated carrier signal in space to generate the rotating VOR pattern. The antenna is constructed to eliminate the problems normally experienced in service with corrosion. The AN/FRN-41 antenna utilizes all aluminum construction throughout. All RF feed lines are rigid coax with specially designed fittings and joints. Joints between dissimilar metals have been avoided. The antenna is tuned by adjustment of the bridges and slugs, and installation of the proper shunts. The antenna is housed in a fiberglass, walk inradome. Nylon bolts are used to join the sections and secure the door. Theradome includes provisions for mounting obstruction lights on the radome or a colocated DME or TACAN antenna. The AN/FRN-41 slot antenna includes four conduits up the outside for obstruction lights and collocated DME or TACAN cables.

b. RF Power Monitor Description (Part of 1A1). The RF power monitor is a panel mounted assembly located in the top portion of the AN/FRN-41 electronics assembly cabinet. This assembly measures incident and reflected power of the carrier and sideband transmitters

c. Local Control Description (1A2). The local control unit provides the interfacing and controls necessary for complete local and remote control of all normal VOR system functions All power is applied to the various system drawers through circuits controlled by the local control unit The front panel provides system status indication, alarm memory and control. This unit also contains the logic necessary to evaluate alarm information from the monitors and initiate shutdown action. Local commands are entered via a

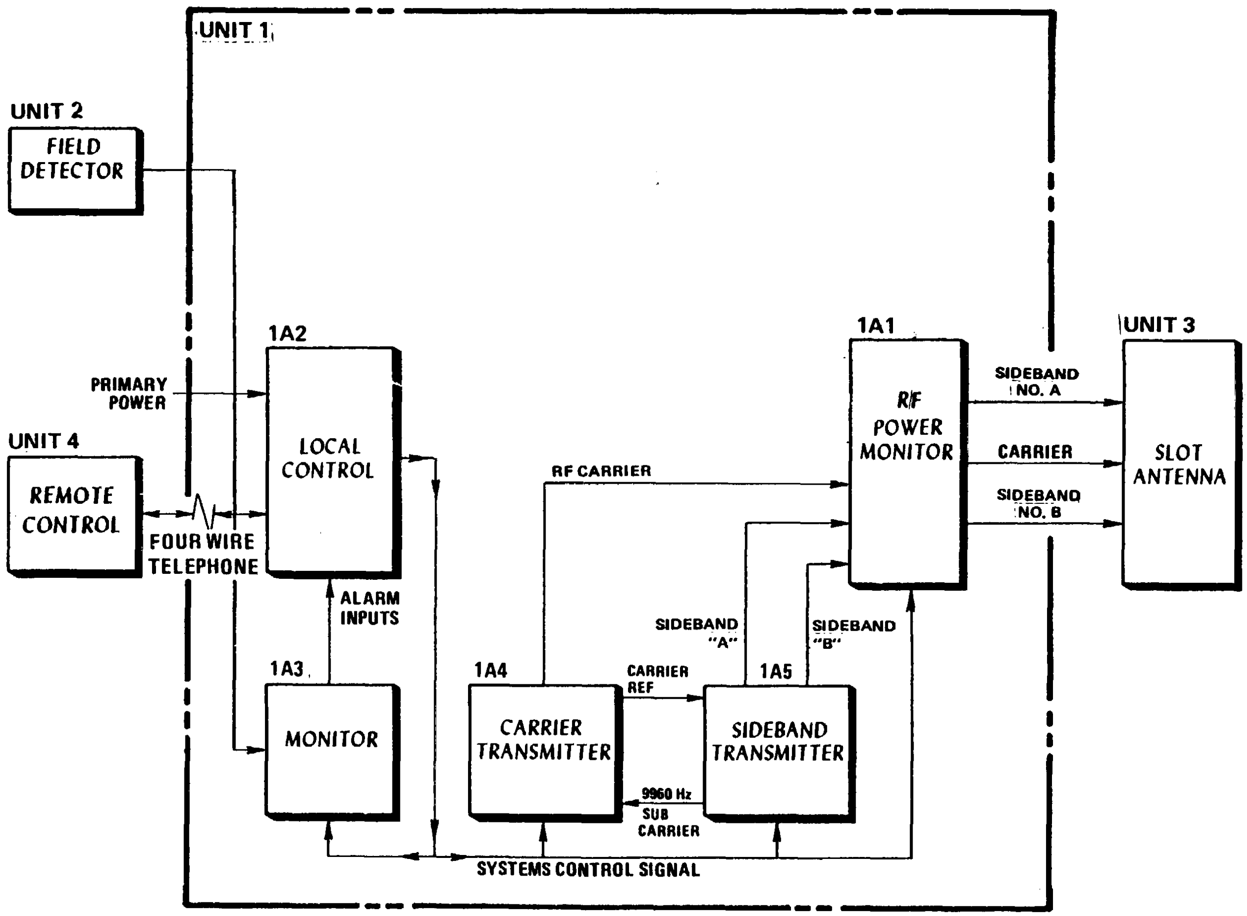


Figure 4-1. VOR Single System Configuration Block Diagram

telephone type keyboard. The AN/FRN-41 local control unit interfaces with a remote unit which utilizes a tone code for remote control and remote status indication.

d. Monitor Description (1A3). The monitor unit provides monitoring of the radiated VOR signal through a remote field detector. The performance of the VOR is evaluated by monitoring the following four parameters:

(1) 30 Hz Modulation Level

(2) 9960 Hz Modulation Level

(3) Bearing Error

(4) Identification

The monitor can also be used as test equipment for ground check of the VOR station.

e Carrier Transmitter Description (1A4). The carrier transmitter generates the carrier signal for the composite VOR signal. The carrier transmitter output consists of the carrier RF signal (at the assigned VOR frequency) amplitude modulated by a 9960 Hz subcarrier, which is FM modulated at 30 Hz The carrier signal is radiated omnidirectionally and provides the 30 Hz reference signal: The carrier signal is also amplitude modulated with external voice and identity information.

f. Sideband Transmitter Description (1A5). The sideband transmitter replaces the conventional mechanical goniometer. It electronically generates two amplitude modulated, carrier suppressed, double sideband signals. These signals are modulated in time quadrature at 30 Hz and when fed to the antenna and combined with the carrier, result in the total VOR signal.

g. Remote Control Description (Unit 4). The remote control unit provides the interfacing and controls necessary for complete remote control of all VOR and collocated system functions The front panel provides status indication for the main and standby VOR, collocated DME, and primary power systems This unit provides both visual and audio alarms when any of the units change status

h. Field Detector (Unit 5). The field detector picks up a sample of the transmitted signal and routes it back to the monitor to provide a means to check system performance This detector is designed to provide increased performance and temperature stability, as well as ease in operation and maintenance.

SECTION II

RF POWER MONITOR

4-5. RF MONITOR (Part of the Electrical Equipment Rack, MT-6011/FRN-41) FUNCTIONAL DESCRIPTION (reference figure 7-2). The primary control on the front panel is a selector switch for selecting which power measurement will be displayed on the meter. Figure 7-2 contains the schematic diagram of the RF Power Monitor. The carrier and sidebands are connected to the antenna via power monitors AIUI through AIU3, A front panel selector switch is provided for measuring forward or reverse power readings for the three lines routed to the antenna. The selected power measurement is displayed on the front panel mounted meter.

SECTION III

LOCAL CONTROL

4-6. FUNCTIONAL DESCRIPTION. The local control provides five distinct functions: system control, system status indication, system status transmission, voice intercom, and voice transmit/receive capability. The local control, in conjunction with the remote control (unit 4), form a remote/local control system. This system provides the capability to send operational control signals to a VOR navigational system and/or DME facility from a remote location. Thus, system control capability is provided either at the on-site location via the local control or as commanded from a remote location. In return, a visual indication of the operational status of the equipment is displayed at the remote site. The VOR system status indications are provided at both the local control site and the remote control site. In addition, this equipment provides the capability for two-way voice communication between the equipment site and the remote command center. This data is transmitted over a 4wire full duplex link. The system may be used with other types of equipment or with VOR or DME equipment produced by another manufacturer.

The VOR local control is normally installed in the VOR electronic equipment cabinet and interfaces with the DME (if both the DME and VOR are collocated) through terminal board connections. However, if a VOR system is not used, the VOR local control must be mounted in a cabinet or rack space and interfaced with the DME control. If only a single DME is used, the local control may be mounted in the DME equipment cabinet utilizing one of the empty positions.

a. Control Functions The control function includes application of ac power to the monitors, carrier transmitters and sideband transmitters. If the system is connected in a dual configuration, the VOR local control contains logic circuitry which will initiate a transfer from a primary to a standby set of transmitters in the event of a system malfunction, or as commanded by the keyboard located on the front panel of the local control or through a telephone link connected to the remote control unit. When both the primary and standby transmitters malfunction, the local control will cause the system to shutdown. In a single system configuration, there would be no standby transmitter set; therefore, only a shutdown would occur. The basic control input is a twelve-button pushbutton keyboard located on the remote control unit which produces two tones for each button as it is depressed. These tones are decoded to allow control functions to be implemented by entering a two digit code on the keyboard. Tone commands from the local or remote keyboard are routed to the tone decoder circuit card assembly via the local/remote switch. The tone decoder circuit card assembly decodes the commands and initiates the commanded function. The following codes are typical examples which are decoded for the indicated functions:

NOTE

These codes are examples why the actual codes for each site will be listed on the command code label on the front panel of both the local and remote control.

VOR Command Control Codes	Action
15	VOR No. 1 Main
16 (not used in single system)	VOR No. 2 Main
17	VOR Off
46	Obstruction Lights On
48	Obstruction Lights Off

Additional codes for ident tone check are as follows:

Code	Action
19	Ident Monitor On
18	Ident Monitor Off

System codes used for DME operation (when a Mark III DME is collocated with the VOR system) are as follows:

Code	Action
25	DME No. 1 Main
26	DME No. 2 Main
27	DME Off
28	DME Standby

(1) Description of VOR Codes.

(a) Code 15 is VOR Main On. This code turns the VOR on. (In a dual system, the No. 2 transmitter automatically becomes the standby transmitter).

(b) In a dual system, code 16 is the same as code 15 except No. 2 transmitter is treated as the main and No. 1 transmitter as the standby.

(c) Code 17 turns the VOR off.

(d) Codes 46 and 48 turn the shelter obstruction lights on and off. (NOTE: A photo electric control turns lights off during daytime.)

(e) Code 19 places the Morse code of the ident tones on the voice channel and code 18 will remove the ident tone code from the voice channel. This allows an operator to monitor the morse code for presence and correct keying.

(2) Description of DME Codes. Codes 25, 26, 27 and 29 perform the indicated control functions on the DME from the remote site only. Local control of the DME is from the DME control assembly in the DME equipment cabinet. A description of the operation of the DME codes is listed below:

(a) Code 27 commands both DME transponders to off.

(b) Code 29 commands both DME transponders to standby.

(c) Code 25 commands the DME No. 1 transponder to the primary or "on air" condition and commands the DME No. 2 transponder to a standby condition.

(d)Code 26 commands the DME No. 2 transponder to the primary or "on air" condition and commands the DME No. 1 transponder to a standby condition.

NOTE

Spare codes are provided for unique customer requirements. Also, any of the previous codes which are not used due to the type of installation may be reassigned. All codes begin with a 1, 2, 3 or 4 and end with a 5, 6, 7, 8 or 9.

b. System Status The VOR system status is provided via five status indicators. A green light illuminates when the system is on. A red light illuminates when the system is off. Another green light is illuminated when all critical switches in the system are normal. A yellow light indicates a system disable, and a red indicating switch is provided to inhibit the system which prevents a false system changeover from the prime to standby transmitter due to a monitor alarm while performing a maintenance routine. The indicator illuminates when an inhibit condition exists. The alarm section contains four red indicators which illuminate when an alarm has occurred. These lights remain illuminated until reset manually to serve as a maintenance aid (alarm memory). Reset is automatically performed when a command code is entered on the keyboard.

The remote control unit displays VOR status data MAIN, OFF, etc., when the VOR local control is used with E-Systems VOR equipment In this configuration, complete control of the VOR is accomplished via the VOR local control. The VOR local control can also be interfaced with the DME equipment to process the DME status data. The DME data is then sent to the VOR remote control which monitors the DME system status. In addition, the DME primary alarm, and DME critical functions data are displayed and also processed in the remote unit with an alarm for DME/VOR function loss. The DME is also controlled from the remote unit However, local operating control of the DME is accomplished by the DME control drawer and not the VOR local control unit A more detailed description of all of the front panel controls for both the VOR local control and remote control unit is provided in table 3-2 and table 3-8. All of the above status information is routed to the remote unit over a telephone link. In addition to the status information, voice and ident keying information is also sent to the remote unit.

c. Voice Transmission. Both the local and remote control units are equipped with a microphone and transmission circuit to provide communications between the VOR/DME site and the remote site. The remote site may be used as a flight control center. The local control is also capable of receiving voice transmission from a communications receiver. This receiver can be collocated at the VOR/DME site but is not part of the VOR equipment Basically, this receiver is set up at the VOR site so that a pilot can tune that frequency with his transmitter and call by radio. The receiver then receives the communication, places it into the VOR facility and converts it into a telephone signal. This information is then transmitted to a remote site. The operator at the flight service station can also communicate with the pilot via telephone signal, local control and VOR transmitter.

d. Interface. The remote control interface is accomplished by the status XMTR modem circuit card assembly and the XMTR/RCVR voice buffer circuit card assembly section. This section accepts status information from the VOR system, the DME (or both), and the primary power source. Status is converted into a coded FSK tone for transmission to the remote indicator. A telephone link is used for transmission of status, remote control commands, and two way voice. This section also interfaces the remote audio inputs for transmission via the VOR.

4-7. DETAILED CIRCUIT CARD DESCRIPTIONS The following subparagraphs contain detailed descriptions of the circuit card assemblies in the local control.

a. Tone Decoder Circuit Card Assembly (reference figure 7-4). The primary input to the tone decoder circuit card assembly is the audio input from the remote keyboard via the telephone link. The audio input signal consists of two tones which are generated simultaneously by either the system control keyboard located on the VOR local or remote control unit. This system for providing command signals to operate the VOR is essentially the same principle used in touch tone type telephones. The keyboard (located on the remote control) is programmed to output two tones selected when any numeric pushbutton is depressed. The tones are selected from the matrix shown in figure 4-2. A combination of the two tones, one row and one column, is selected when the corresponding pushbutton is depressed. For example, if any button along the top row was pressed, the tone frequency selected would be 697 Hz. The second frequency would correspond to the column selected. For example, pressing pushbutton 3 would give both 697 Hz and 1477 Hz tone frequencies simultaneously. Both frequencies would be applied through pin 13 on the tone decoder circuit card to six phase lock loop tone decoders Each phase lock loop has its own frequency adjustment and corresponding test point. When there is no signal applied, each loop free runs and can be adjusted for its assigned frequency. The frequency of each loop corresponds to one of the two frequencies generated in the keyboard. When a button is depressed, the two tone frequencies are applied to the tone decoder loops. Each key selected will correspond to a particular frequency of two phase lock loop decoders. As long as the incoming frequency is within 5% of the frequency at which the loop is oscillating, a phase lock condition occurs.

A phase lock condition causes the output of two tone decoders to go low. This low output is applied to a series of gates. The gates which are enabled correspond to a particular frequency combination which represents a digit of the keyboard. The following table indicates which gates and decoders are affected for each pushbutton.

Pushbutton	Tone Decoder Phase Lock Loops	Gates Affected
1	U3 and UI4	U4A
2	U3 and UI5	U4B
3	U3 and U9	U4C
4	U7 and UI4	U4D
5	U7 and UI5	U8B
6	U7 and U9	U12B
7	U11 and U14	U12A
8	U1 and U15	U12C
9	U11 and U9	U8A

Gates U4A, U4B, U4C, U4D, U8B, U12B, U12A, U12C and U8A decode the command signals applied to the tone decoders and process these commands through a storage latch. A delay turn-on input

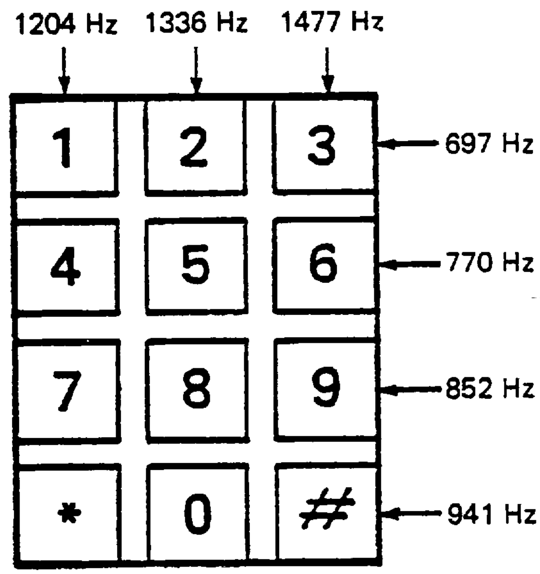


Figure 4-2. Touch Tone Keyboard Frequency Matrix

applied at pin 18 disables the storage latch for approximately five seconds after the time power is initially turned on. This prevents any unwanted transient pulses, which could switch transmitters when the power is initially applied. Application of a high to enable input at pin 5 on U5 allows the latch "Q" outputs to propagate to their respective output pins.

The latch performs identically as a set/reset flip flop. A high applied at any S input provides a set function. The R inputs perform a reset function. Initially, when any one of gates for key 1 through 4 go high, this high is routed through gate U6A, gate U10A, gate U10B,and OR gate CRI/CR2 to reset all of the storage latches. This occurs simultaneously with the same output from any one of gates of U4 applied through the storage latch to set one output. As any one of the gates U4A through U4C are activated, the high output is applied through gate U6A, gate U10A,and OR gate CR1/CR2to momentarily reset the rest of the storage latches before one output is set.

The other output from gate U10A is applied to a 10 millisecond delay circuit. At the end of 10 milliseconds, the high is applied through gate U10B to remove the reset pulse. However, the high output from the selected gate lasts longer than the 10 millisecond reset function and that high will be stored in the latch until another tone is applied through the tone decoder causing another chain of events.

The VOR/DME code commands consist of two digit codes. Gates U4A through U4D respond to keyboard digits 1 through 4 and gates U8B, U12B, U12A, U12C, and U8A respond to keyboard digits 5 through 9, respectively.

All codes begin with a 1, 2, 3, or 4 and end with 5, 6, 7, 8, or 9. After a 1, 2, 3 or 4 has been stored in the storage latch, gates U8B, U12B,U12A,U12C,and U8A are enabled by the output of gate U6B. If pushbutton 5 through 9 is subsequently pushed, this information is transmitted through gates U8B, UI2B, UI2A, UI2C and U8A and through gate UI3. At this time and for the next 100 ms, the digit code is decoded by other gates and is available at the output. At the end of 100 ms, gate U10A is enabled and the latches are reset disabling the inputs to the other gates UI6, UI7, UI9 and U20.

The sequence of events for code 15 (see figure 4-3) which commands the transmitter to be "on air" for VOR operation is as follows: When the pushbutton for digit No. 1 is pressed, two tone frequencies, 697 and 1204, are applied at pin 13. These two frequencies cause tone decoders U3 and UI4 to lock, thereby enabling gate U4A. The high out from gate U4A is applied through the storage latch to enable gates U16,and U20A. In addition, the same high is applied to enable gates U8B,U12B, U12C and U8A. When digit 5 is pressed, the two tone frequencies, 770 and 1336, are applied at pin 13. These frequencies cause tone decoders 2 and 5 to lock. Both outputs from the decoder are applied to gate U8A. Since the third output to gate U8B was previously applied through gate U6B, gate U8B is enabled. The output from gate U8B is applied to gate UI6A. Since a high at Q1 from the storage latch is still present, gate U16A is enabled and a low output is applied through pin 17 to command the VOR transmitter to the "on air" status. The output of gate U8B is also applied through gate UI3 in a manner similar to the 10 millisecond delay, the 100

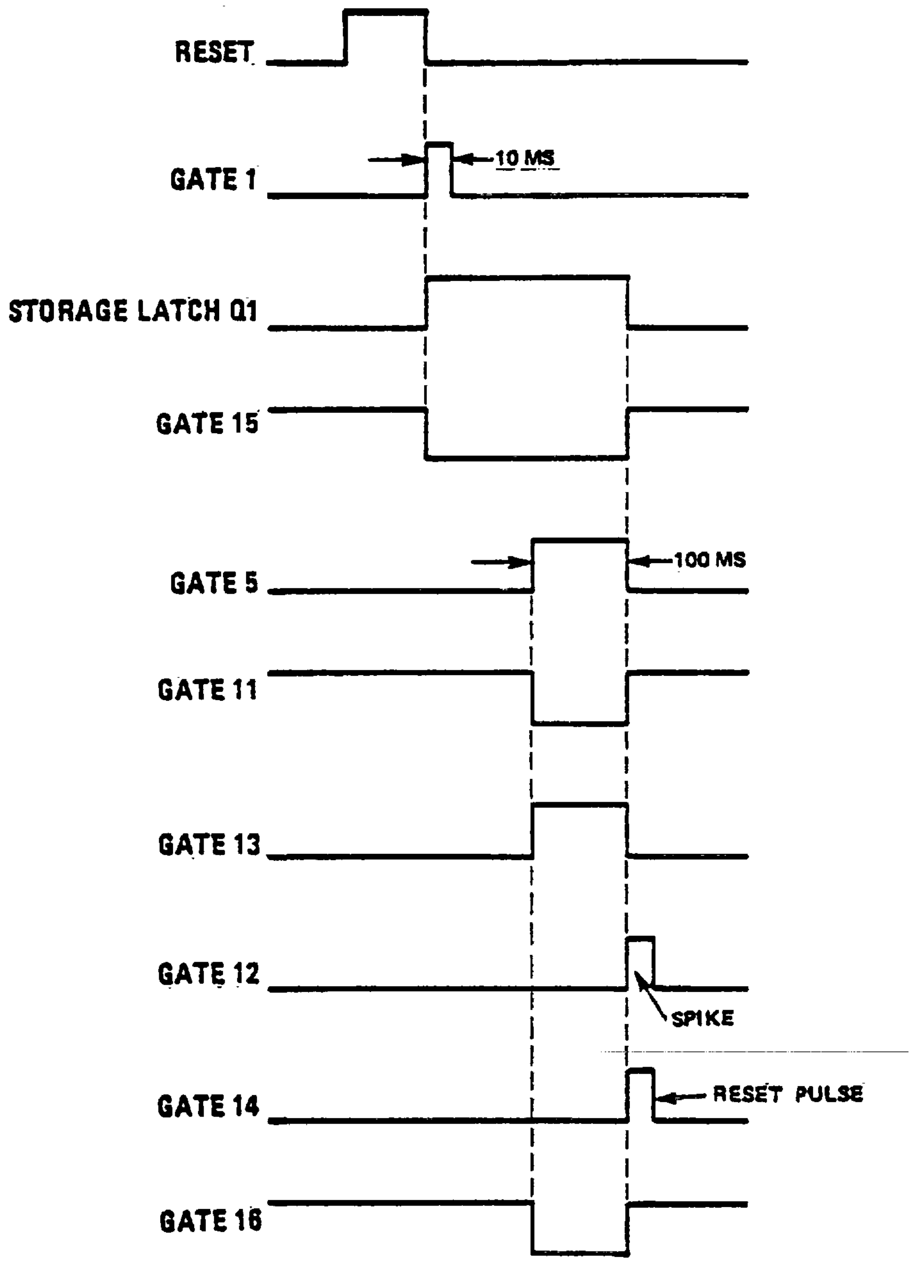


Figure 4-3. Timing Diagram for VOR No. 1 Main CMD

millisecond delay is initiated into gate UI0A pin 2 input. Output is applied directly to gate UI0B causing its output to go high. However, because of the 100 millisecond delay circuit (C7 and R45), the output of gate UI0A is low. After approximately 100 milliseconds, the output of gate UI0A 12 goes high initiating a reset pulse. This resets the storage causing the output of gate U6B to go high disabling gates UI2B, UI2A, UI2C and U8A. A similar chain of events can be followed for any other command previously specified. The delay time between gate UI3 output and gate UI0B output determines the time the pulse is presented at the output of the card.

The control status input at pin 4 ensures that the commands that apply to a DME function can only be controlled from the remote unit. This input is applied to gates of UI8 and U20C which are utilized to decode DME input commands.

b. Alarm and Transfer Circuit Card Assembly (reference figure 7-5). This circuit card assembly contains the necessary circuitry to evaluate system control requirements; to process detected VOR alarm status; to determine power failure and maintain operational status; and provide status indicator output data. A brief functional block diagram discussion corresponding to figure 4-4 is provided preceding a more detailed circuit description in order to simplify the overall presentation.

(I) The system control requirements are processed by the command decoder and storage circuit shown in the block diagram in figure 4-4. The command decoder circuit responds to three VOR command signals. These commands are decoded to provide on/off status. This data is sent to the system control logic circuitry.

The alarm detection logic processes detected VOR system alarms which come from the VOR monitors. The alarm detection logic circuit examines the alarm to ensure that it is valid. A valid alarm starts the main alarm timing circuit. If the alarm persists for 14 seconds, the appropriate memory flip flop (located in the alarm storage circuit) corresponding to the detected alarm parameter is set. In addition, this alarm output from the main alarm timing circuit is applied to an on/off flip-flop located in the system control logic circuitry. If the VOR system is connected in a dual system configuration, the main/standby flip flop changes state and applies the power control signal to the standby transmitter. In the event the system is connected in a single system configuration, the on/off flip flop changes state and this output causes the system to shut down.

An auxiliary alarm checking circuit provides a back up circuit to the main alarm timing circuit so that in case the main alarm timing system fails, the auxiliary alarm checking circuit activates a power control circuit which immediately removes the power control output signal to both VOR transmitters. The additional discrepancy logic circuit causes an indicator on the circuit card assembly to illuminate whenever an alarm is detected by one alarm timing circuit but not by the other.

A system inhibit signal can be applied to both alarm circuits to prevent a monitor alarm, which may be generated during a maintenance or a test condition, from causing a system shutdown or transfer.

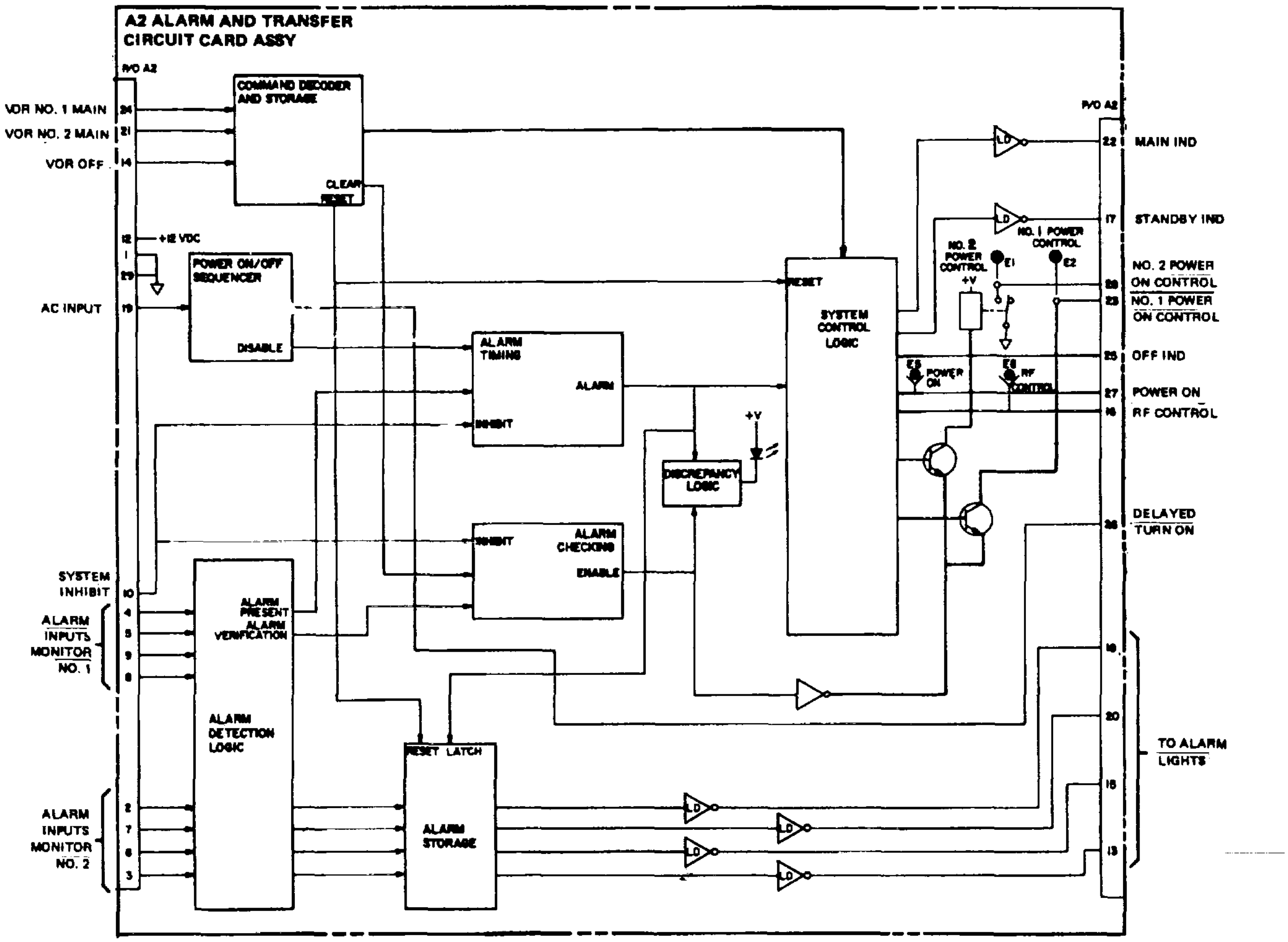


Figure 4-4. Alarm and Transfer Block Diagram

The power on/off sequencer circuit detects an ac power failure and disables the transmitter via the RF control output signal. The RF control signal at pin 16 is applied to the carrier transmitter to enable the RF output. The RF control signal is inhibited, to prevent arcing on the transfer switch during initial power turn on, during a transfer and in case of a power loss. In addition, the power on/off sequencer circuit outputs a delayed turn on signal. The delayed turn on pulse is generated during initial power turn on or power loss conditions. This output is applied to the tone decoder circuit card assembly to prevent any unwanted transient pulses which could cause a change in transmitter status.

In dual systems, this command decoder and storage circuitry contains latching relays programmed so that if the power fails at any time, the transfer relay will recall which transmitter had been selected as the main "on air" transmitter before the power failure. However, if the power fails with the standby transmitter operational, then the main transmitter will come on when power is restored. Similarly, the on/off relay can recall if the station was on or off at the time of power failure.

(2) The status logic section responds three command signals applied from the tone decoder circuit card assembly. These three commands are VOR No. 1 main, VOR No. 2 main and VOR off command. A command is represented by a 100 millisecond low going pulse. When the VOR system is connected in a dual configuration, these commands allow selection between two transmitters of which one will become the main transmitter. The other transmitter then becomes the standby. When a malfunction in the main transmitter occurs, the system is able to transfer to the standby. The commands are applied at pins 24, 21 and 14. The two main commands at pins 24 and 21 are applied through separate inverters and driver circuits to latching relay K2. A low going pulse at either input pin causes the relay to latch to a state corresponding to the input. At the same time, the low going pulse at either pin is inverted and applied through gate U17D, inverter U17C and driver Q14 to latch relay K3 in the on position; and through UI6B to reset alarm flip-flops, U6 and U7. This applies a ground to gates U9D, U9C and USA. These NOR gates perform the zero logic input and invert function. Therefore, whichever input at pins 24 or pin 21 went low, sets relay K2 to No. I or No. 2 state. The output of K2 applied through gate U9A and exclusive OR UI0C and UI0D turns on the corresponding transmitter which becomes the main transmitter. Thus, when flip flop U8B was reset, the output at Q (pin 15) went low and the output at Q (pin 14) went high. Initially, then, gate U9D is enabled causing its output to go high and the output of Q2 to go low. This output is applied out at pin 22 causing the main indicator lamp to illuminate. The high output from gate U9D is also applied to exclusive OR gate UI0C and similarly the low output from gate U9C is applied to exclusive OR gate UI0D. Both exclusive OR gates operate according to the requirements that either input to the gate can be of opposite logic levels for a high output, but if both logic levels are the same, the output of the gate is low. The output of gate U9A determines which transmitter had been selected. For example, if No. 2 transmitter was selected, a high would be applied through the contacts of K2 to gate USA, pin 2, and the output is low. Because of the low input applied through the contacts of K3, the output of gate U9A would be low. This low is applied to both gates UI0C and UI0D. Since the activating requirements for gates UI0C and UI0D require opposite logic states, then the output of gate UI0C goes high. This high is applied to Q6 causing relay KI to be energized and the output at pin 28 to go low causing transmitter No. 2 to turn on. If VOR main No. 1 had been selected, the output of gate U9A would have been high and gate UI0D would have been activated to a high (UI0D output is low) causing Q7 to turn on; thereby applying a low output at pin 23, causing transmitter No. I to turn on.

The main alarm detection logic is comprised of gates UIC, U2B, U2A and UID. Gates UIC, U2B and U2A comprise a priority logic arrangement. This means that the 9960 Hz alarm has priority over both the 30 Hz alarm input and the bearing alarm input and the 30 Hz alarm input has priority over the bearing alarm input. For example, when an alarm condition exists at gate UIC, its output goes high, this high output is applied to disable gates U2B and U2A giving gate UIC priority. Similarly, gate U2B establishes a priority over gate U2A. Gates U3B, U3C, U3D, U3A and U4B comprise the alarm network associated with the auxiliary alarm checking circuit.

Any alarm condition detected by gates UIC, U2B, U2A or UID are applied to OR gate U5B. When an alarm occurs, the output of U5B goes low and is applied to gate U5A. Gate U5A will be enabled (all inputs low) provided that the following conditions are satisfied: (1) inverter UI7C is low. This means that a No. I or No. 2 turn on condition is not taking place. (i.e., A logic "I" condition at pin 21 and pin 24. (2) There is no alarm condition indicated at the output of the 100 millisecond alarm clock single shot UIIB. (3) A power failure has not been detected so consequently the output at pin 10 of the latch which is comprised of U15D and U15C will also be low. With all of the foregoing conditions satisfied, gate U5A will be enabled and its high output will be applied to gate U13B. Provided that no system inhibit signal is applied at pin 10, this input will be high and gate U13B is enabled applying a low going level to the resettable single shot U11A. The low input at pin 5 inhibits the action of the oscillator circuit comprised of C3, U1B, U1A, R43 and R44. The action of this oscillator in continually retriggering UIIA has kept the output at pin 6 high since the circuit retriggers every time a pulse or trigger is applied. However, the constant low input applied at pin 5 will block the retriggering action and cause the single shot to time out The output at pin 6 will go low in 14 seconds unless within this time the alarm is cleared. The 100 millisecond single shot is triggered on the trailing edge of the output from the 14 second single-shot U11A. Therefore at the end of the 14 second time interval, the output of U11A pin 6 goes low and the output at pin 10 of U11B goes high for a 100 millisecond interval to initiate an alarm trigger (clock) output.

The low to high output at pin 10 constitutes a valid alarm condition. This low to high trigger is applied to the alarm storage flip-flops U6A, U6B, U7A and U7B and clocks whichever alarm condition is applied to the J input of the alarm storage flip-flops. This causes a latched condition; thus, the logic 1 input is clocked into the flip-flops and latched until the flip-flop is reset. The output of the alarmed flip-flop goes high causing a corresponding lamp driver QI, Q3, Q5 or Q9 to go low applying a ground via pins 18, 20, 15 or 13 to illuminate the applicable alarm indicator lamps.

The low to high at pin 10 is also applied to flip-flops U8A and U8B. If the VOR system is connected in a dual configuration, flip-flop U8B will be set. Thus, the output at pin 15 will go high and the output at pin 14 will go low which is exactly opposite of the initial conditions when the main transmitter was operational. Therefore, because of this reversal, the standby transmitter is selected as the operational transmitter and the main indicator lamp will extinguish. The output of flip-flop U8B pin 15 is also applied to the J input of flip-flop U8A. The second alarm will also cause UIIB to generate a 100 millisecond pulse.

Therefore, if the initial alarm is not cleared before a second alarm occurs, flip-flop U8A will be set (pin I of U8A is clocked to a logic I state) and gate UI3D will be enabled. The output of gate UI3D is applied through gate UI6C to an on/off relay, K3, to energize the OFF coil and shut down the system.

The auxiliary alarm checking circuit provides a fail-safe alarm detection backup circuit. Gate U3 will detect the same alarm that gates UIC, U2B, U2A and UID detect. Therefore, in an alarm condition, the output of gate U4B will go low. This low is applied to gate U9B. If both inputs to gate UI3C are high, then gate U9B will be enabled. Gate UI3C will disable gate U9B if the system inhibit input at pin 10 is low indicating an inhibit condition or if the output of the 100 millisecond single shot (U12B) pin 9 is low. The output of U12B pin 9 will be low for 100 milliseconds if a power failure is detected.

When the output of gate U9B goes low, it causes the 30 second retriggerable single shot UI2A to block the retrigger start to time out. Single shot U12A operates in a similar manner as U11A previously explained above except the trigger pins are reversed with the clock on pin 5. This reverses the sense so that a logic "I" on pin 4 will block retriggering.

If the 30 second single shot times out, the output at pin 6 will go low causing power control transistor Q8 to turn off. When Q8 is turned off, the power control output drivers Q7 and KI are disabled.

If the output of the 14 second single shot (UIIA) and the output of the 30 second single shot are at opposite logic levels, then exclusive OR gate UI0A will go high. This high causes QI0 to go low and causes discrepancy light DS1 to illuminate.

c. Ident Control Circuit Card Assembly (reference figure 7-6). The ident control circuit card assembly provides critical misset switch status and DME keyer capability. The ident oscillator is also contained on this board.

The critical switch status inputs are all applied to positive NAND gate 1. The low output from gate 1 is inverted twice to provide a low output at pin 24. This low is applied through the system inhibit switch to the CRITICAL SWITCHES NORMAL indicator. If all switches which affect system operation are not placed in their normal operating position, a ground applied at any input to gate 1 will disable gate 1 causing the indicator to turn off.

Timer U3 functions as an oscillator which generates a 1020 Hz frequency out pin 26 when a low input signal applied at pin 18 enables the timer.

Gates U4A and U4B provide a DME ident sync signal out pin 25 to match with the applicable transponder selected.

d. Status XMTR Modem Circuit Card Assembly (1A2A4) and XMTR/RCVR Voice Buffer Circuit Card Assembly (1A2A5) (Reference figures 7-7 and 7-8). Because of the interaction between the status

XMTR modem circuit card assembly (1A2A4) and the XMTR/RCVR voice buffer circuit card assembly, the circuit operation for both circuit card assemblies is provided in the following discussion.

Basically, the status XMTR modem circuit card assembly acts as a controller and sequencer to provide status data to the remote control unit. Transferring status data is accomplished by utilizing FSK data serial data transmission. This circuit card assembly also receives voice communication from the remote control unit and/or or a collocated communication receiver and also can be heard on the front panel mounted speaker.

The XMTR/RCVR voice buffer circuit card assembly provides the voice transmission circuitry used to communicate with the remote site. This audio transmission is comprised of voice communications originating at the VOR/DME site and voice communications relayed via a collocated communication receiver from the aircraft through the local control to the remote control unit ident tone generated by the VOR and DME equipment. The FSK channel data originating at the station XMTR modem circuit card assembly is also routed through this circuit card assembly to the remote control unit.

(1) FSK Data Channel Operation. The basic input of the status transmitter modem card is parallel status data that comes from the VOR transmitter, the DME transmitter and other equipment that has status that needs to be sent back and monitored from the remote control unit. This unit may be a short distance away or many miles away with communication being established over a microwave or telephone link. The status data is applied into the status data multiplexer. This status data multiplexer receives parallel information via the input gates in four bytes of eight bits each. Each byte represents a status word. Each status word that goes back with data consists of six bits of status information, plus two bits of information of which data word it is. There are four blocks like this that are sequentially transmitted. This is basically controlled by a sequence control circuit. The sequence is comprised of a transmit control circuit and a data select group circuit. The sequence control circuitry basically increments each time a new parallel to serial transmission is made, the sequence control counter is incremented one count to the next one of four states. It then allows the next 8 bits (data bits) to be brought in of which two are word identification and six are status information to be transmitted.

Two of the bits (bit 7 and bit 8) in each byte are encoded as a 00, 0I, I0 and II at the input leaving 6 bits of information per byte. The two permanently encoded bits are used when the information is decoded to determine which byte is being decoded. The sequencer is advanced in circular fashion by the "end of character" output out of the UART. The data select group enables one set of gates at a time in a continuous sequence so status information is continually updated.

This information is converted from parallel into a serial data train to be transmitted by a UART which is commonly used to send binary serial data.

The UART frames each byte of status information with a start bit, a stop bit and a parity bit. If these bits are not correct, the status display lights on the remote control will not be updated, thus preventing incorrect information from being displayed in case noise on the line changes a bit.

As noted, the serial form of data information is formatted so that after a stop, a start bit goes low out of the UART to indicate the start of the next data word. This is followed by bit one through bit eight of serial data, a parity bit and finally a one end bit. This can either be immediately followed by another start bit and the next data word, or at intervals there will be a pause put in to guarantee that the receiving end will know exactly where the start bit is and be able to establish a resync in case something has happened and the start bit sync point has slipped.

The serial data train out of the UART, in asynchronous (non-return to zero) format, is sent into a frequency shift key modulator. This modulator takes the digital 1, 0 information in the serial data train and converts it into a 2416 Hz tone for a logical 0, or a 2655 Hz tone for a logical 1. This conversion is made so that the information will be in a sinusoidal form which can be transmitted across telephone lines and transformers without significant loss. Thus, the sinusoidal frequency key information is able to be efficiently transferred out to the telephone lines. It is taken from the modulator and run through a filter network to take out some of the high frequency components that the modulator produces in generating an essentially sinusoidal output form. The modulated signal is then put into the driver amplifier where it combines with other voice information. The driver amplifier then feeds an output transformer to drive the telephone line out

(2) Oscillator and Counter Circuit. The overall clock and stable frequencies that are needed for operating this board are generated in a crystal oscillator with a 3.58 MHz crystal controlling the frequency. Coupled with the oscillator is a 14 stage counter which applies a clock output to the ring tone gate and to the parallel to serial UART and sequence control circuit. The output of the 14 stage counter is applied to a divide-by-3 circuit to essentially make it into a 1.18 mega cycle square wave into the modulator integrated circuit. This clock is used to allow the frequency shift key modulator to operate and convert the serial digital data into the frequency shift key serial data.

(3) Voice Channel Circuits. The local control unit is equipped with a mocrophone mounted on the front panel. This microphone enables maintenance personnel to communicate with the flight service center in order to obtain proper clearance for disrupting equipment operation and also for checking local/remote interface operation. Also, the intercom mode can be used to talk to air facilities personnel at the remote station.

The microphone input is applied at 1A2A5 pin B-9 to an input amplifier, U14B. Since the microphone is a dynamic type, the low level input must be amplified and U14B also provides the capability to adjust the level of the microphone. The output of the amplifier is applied to an analog gate, U9D.

The VOR RCVR voice input originates from a communications receiver which can be collocated with the VOR equipment. When this is done, the communication receiver transmits voice communication received from an aircraft to the flight control center via the local control telephone lines. When this communication receiver is collocated with the VOR equipment, the squelch can give priority over intercom transmission. This is accomplished in the following manner.

Optical isolator A5U20 can be operated off a squelch type output of the communication receiver. The intercom microphone can be blocked by the optical isolator input giving the flight communication from the airplane priority in case an emergency condition in the aircraft exists.

Depending on the type of input applied, optical-isolator A5U20 determines the final mode of operation. In any event, the output of the optical isolator is either applied through an inverter or jumper directly to gate A5U18A. This input is used to inhibit the mike key (not) input from pin A5B13 and in this manner, establishes the priority condition for the communications receiver.

As previously discussed, the microphone output from microphone amplifier A5U14B is applied through analog gate A5U9D providing that the mike key (not) control input has passed gate U18A. If this is the case, the output of the analog gate is applied through amplifier A5U14A to summing amplifier A5U13A. The other input to the summing amplifier is applied at pin A5B10. This is the voice transmission from the collocated communication receiver (providing that a communication receiver is collocated). The voice input from the communication receiver is applied through A4BY and A4B21 to the RCVR voice input transformer. The transformer provides isolation of the receiver transmission. The output of the transformer is applied to RCVR amplifier A4U26A. This input amplifier is provided with an adjustable gain to allow for adjustment of different input levels. The output of the amplifier is applied out pin A4B4 through A5B10 to summing amplifier A5U13A, and also through analog gate A4U29 to speaker driver amplifier U26B. Analog gate U29 is controlled by the front panel intercom switch and is only inhibited in the TMTR MON position. At all other times, the receiver voice is applied through speaker driver amplifier A4U26B, A4Q1 and A4Q2 to pin A4B11 and then to a front panel mounted speaker. The receiver voice is also sent on the telephone line to the remote.

The other output from RCVR amplifier A4U26A is applied out pin A4B4 to A5B10 and then to summing amplifier A5U13A. The output of the summing amplifier is applied to an AGC (automatic gain control) stage where the level gain is amplified or dropped down if it is too high a level. If the input is really loud, the AGC circuit may even do some squaring so it does not provide too high of a level. The output of the automatic gain control amplifier is then applied through three low pass filter sections, each of which has a three pole low pass filter function. These together then make a nine pole filter with a three dB level slightly above a 2000 Hz cycle. The 2416 and 2655 Hz notch filters remove voice in the FSK band and the low pass filter feeds driver amplifier A5U19A. This driver amplifier also provides a function of mixing in the frequency shift key information and the ident tone (when in ident monitor).

The status data is applied through the parallel to serial data encoder circuit into a modulator to FSK serial data, through a 3000 Hz low pass filter and out A4B2 to A5B4. The input at A5B4 is then applied through the driver amplifier and out the output transformer to a pair of telephone lines for transmission to the remote site. The ident tone is a 1020 Hz tone which the VOR also transmits to allow the pilot to verify he is tuned into the correct VOR station. The ident tone circuit is set up so it can be added or deleted from the voice transmission that is mixed in the driver amplifier and sent out on the telephone line. The control signal applied at pins A5A19 and A5A20 control the analog gate through which the ident tone passes. The input at pins A5A19 and A5A20 comes from tone decoder circuit card assembly A1. Therefore, the command to turn the ident monitor on or off comes from a command initiated through the pushbutton keyboard control.

Transmission from a remote site is applied through a twisted pair of telephone lines applied in at pins A4B18 and A4BV. This input is applied to voice input transformer A4T2. This transformer provides isolation from the telephone lines or other communications type input. The output of the transformer is then applied to input amplifier A4U27.

The input amplifier is set up to match the impedance of the transformer and there is also variable gain adjustment on the input amplifier so that loss in the phone line can be compensated for. The output of input amplifier A4U27 is applied out pin A4B10 through pin A5A3 to limit amplifier A5U4B and high pass filter A5U1A. It is also applied to ring tone detector circuit A4U28.

The path of the output of the input amplifier applied to limit amplifier A5U4B is discussed in the following paragraphs.

The limit amplifier senses if the voice level is above the level it should be. The limit amplifier is basically set up to sense impulse noise such as that generated by lightening and possibly introduced into the telephone lines or the communications equipment. The input and output is compared by a noise detection circuit. In the event a loud impulse noise is sensed, an output from A5U2 is applied through A5U16A and A5Ul5A to open the analog gate briefly to blank out the noise impulse. The noise detector circuit also includes a high pass filter and differentiator section to monitor whether white noise is on the line which would not want to be transmitted. The white noise is something that could be generated if there is a microwave fade on the line, if the telephone line opens, or if the telephone line deteriorates and allows the noise to be put in. White noise at this point would actuate the differentiator and the sensing circuitry and cause the telephone line channel to be shut off by analog gate A5U9A in the manner as previously discussed so that the noise would not be transmitted out over the VOR transmitter.

The output of the analog gate is applied through amplifier U6B and split into two circuits. One output is applied through three sections of low pass filtering which make a combination of nine poles of filter with about 3 dB point to filter some of the upper frequency noise and also to not allow the 2870 Hz key tone to pass through in a level high enough to be objectionable to the VOR transmitter. A 2870 Hz notch filter is used to block the key tone in audio to the transmitter.

The other output path from A5U6B goes down through high pass three pole filter A5U5B at 2800 Hz and is followed by a tone detector utilizing phase lock loop A5U8 as the detector and is set up to detect a 2870 Hz tone which is used to cause the voice to be keyed onto the transmitter. However, when the airways traffic switch is held up in the A TRAFF position, a gate blocks the voice from modulating the transmitter. When the circuit is not blocked, the driver amplifier then takes the voice and buffers it over to the VOR modulator transmitter. The VOR modulator/transmitter then broadcasts it on the VOR station.

In addition to the voice and FSK data transmitted over the telephone lines, a ring tone can be used. The ring tone can be actuated from the remote end and consists of adding a 2330 Hz tone in with the voice. This signal is applied through input amplifier A4U27 and goes into ring tone detector A4U28. A phase lock loop is used to sense the ring tone. The ring tone then actuates gate U30D which puts a loud, higher frequency tone into driver amplifier U26B at a loud enough level that it would alert anyone present at the VOR/DME site to turn the INTERCOM switch to aircraft airways facility (A FACIL) position and talk to the remote end.

The ring tone will sound and alert someone in the station even though the INTERCOM switch may be in the transmitter monitor (TMTR MON) position and the voice level is very low.

(4) Intercom Switch Circuit The air traffic switch has three positions. One position is transmitter monitor (TMTR MON) which basically lets a low level voice through. The air traffic position (A TRAF) is a momentary spring loaded position and is used for personnel who wish to communicate with the flight service center for maintenance purposes or to be able to talk to the air traffic operator, but not to allow the conversation to be transmitted on the air. By holding the switch in the momentary position (A TRAF), the technician blocks the voice that comes from the air traffic operator from going out onto the VOR transmitter. The center position of the switch is the airways facility position (A FACIL) and this is basically used when a technician or maintenance personnel is at the site and needs to talk with another technician at the remote site in setting levels for maintenance purposes, etc., and to bypass the air traffic operator.

NOTE

If there is an emergency, the air traffic switch position must not be used as this will block voice messages to the aircraft.

(e) Voltage Surge Suppressor Circuit Card Assembly (reference figure 7-9). The suppressor circuit card assembly is basically a device inserted in the cable run of the drawer to tie four of the lines of ribbon cable to insert suppressor circuitry. These four lines are the telephone in and telephone out circuits (four wire circuit - 2 wires send/wires receive).

SECTION IV

VOR MONITOR

4-8. FUNCTIONAL DESCRIPTION (reference figure 7-10). The monitor provides a continual check on four of the system's most critical parameters. These are: the 9960 Hz reference signal, the 30 Hz variable signal, the bearing and the identification signal. When a malfunction or fault is indicated, the monitor initiates an alarm signal identifying which parameter failed and sends an alarm logic signal to the local control for system evaluation. In addition, a status indicator for each parameter is mounted on the front panel. When the parameters are within specified limits, the designated indicators will illuminate green. Four additional indicators are on the front panel: green light indicates AC power on; red light labeled "Critical Switches Misset" indicates when any switch on the monitor is in any position other than normal; a yellow light indicates that the monitor has been bypassed; and a blue light indicates that the identification signal is being transmitted. A four digit, thumb-wheel switch selects the radial being monitored by the field detector.

The VOR radiated signals are received by the field detector and transmitted back to the monitor to J1-15. This input field detector signal is comprised of the variable 30 Hz modulation, and the 9960 Hz subcarrier. The 9960 Hz subcarrier is frequency modulated by the reference 30 Hz signal.

This input is applied through INPUT SELECT switch S3 to an input amplifier with the switch in NORM. The output of this amplifier is applied to a variable 30 Hz filter, a 1020 Hz filter and a sample is applied to the test meter to sample the carrier signal level. Each of the above circuits is designed to isolate specific components of the composite VOR field detector signal in order to monitor critical parameters as explained in the following subparagraphs.

One output of the input amplifier is applied to a 30 Hz filter to isolate the variable 30 Hz signal component. The filtered variable 30 Hz component is applied to both a 30 Hz "zero" crossover detector and a 30 Hz peak detector. The output of the 30 Hz peak detector is applied through a limit switch utilized to control the alarm limits of the 30 Hz modulation. The 30 Hz level output from the limit switch is applied to the test meter for a quick built-in signal level test. In addition, this level is also applied through a 30 Hz level detector to establish signal level alarm limits. The other output from the 30 Hz filter is applied through a "zero" crossover detector and routed to a variable frequency doubler and divide-by-three circuitry. This circuitry is designed to reduce spurious noise possibilities. This output is applied to an error counter circuit and is then compared with the referenced 30 Hz component.

Another output from the input amplifier is applied through a 9960 Hz filter, a 9960 Hz zero crossover detector circuit and a 30 Hz demodulation circuit in order to isolate the reference 30 Hz component.

This 30 Hz reference component is applied through a filter and zero crossover detector circuit to a 30 Hz frequency doubler and divide-by-three inverter circuit similar to the circuitry that the 30 Hz variable component was applied to. This reference signal is delayed by an angle equal to the difference phase between the 30 Hz variable and the 30 Hz reference signal; e.g., the angle by which the variable lags the reference signal and is equal to the radial course corresponding to the location of the field detector. The difference between the variable and the delayed reference signal is the bearing error. The bearing error is displayed on a digital error readout and if the bearing error exceeds a preset limit, a bearing alarm is initiated. The monitor initiates an alarm if the error exceeds plus or minus one degree; however, the overall alarm limit is variable from plus or minus 0.1 degree to plus or minus 4.9 degrees.

As previously indicated, a 30 Hz filter separates the variable 30 Hz signal and a 30 Hz level detector compares the 30 Hz modulation to a preset reference. If the 30 Hz modulation decreases by 15%, an alarm is initiated. This output is applied out J1-11 to the local control. When an alarm condition exists, the 30 Hz NORMAL indicator extinguishes.

In addition to providing isolation of the 9960 Hz signal from the 30 Hz reference signal, the 9960 Hz filter separates the 9960 Hz signal and drives a level detector. The 9960 Hz level is then compared to a preset reference. If the 9960 Hz level is reduced by 15%, an alarm is initiated. This output is applied out J1-10 to the local control and when an alarm condition exists, the 9960 Hz NORMAL indicator is extinguished.

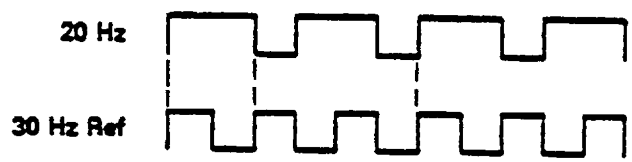
Another output from the input amplifier is applied through the INPUT SELECT switch to a 1020 Hz filter and decoder to isolate the 1020 Hz component. The 1020 Hz tone decoder is used to decode the identification signal and to drive the front panel identification light The tone decoder also feeds a level detector which compares the tone decoder output to a reference voltage. If the 1020 Hz tone is present for 30 seconds or absent for more than 30 seconds, the level detector will initiate an alarm.

4-9. DETAILED CIRCUIT CARD DESCRIPTIONS. The following subparagraphs contain detailed descriptions of the circuit assemblies in the VOR Monitor.

a. Reference Delay/Readout Circuit Card Assembly (reference figure 7-11). The primary purpose of this circuit card assembly is to convert the reference 30 Hz and variable 30 Hz signal input to a 20 Hz negative and positive error signal, respectively and to delay the 30 Hz reference signal. In addition, this circuit card also provides a digital readout of the bearing error. Conversion of both 30 Hz input signals to 20 Hz for evaluation reduces harmonic distortion and periodic noise sources.

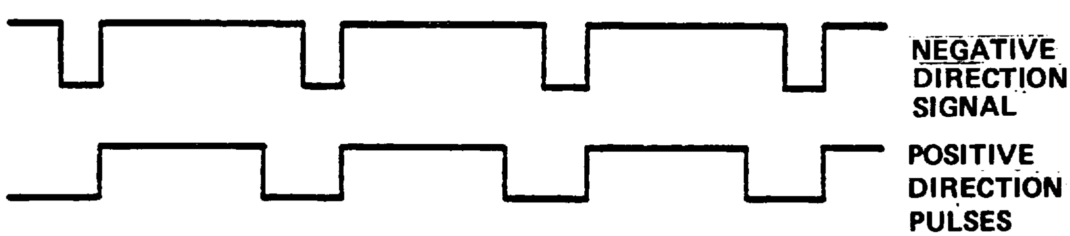
The two main inputs to this circuit card are the isolated variable 30 Hz component applied at XP1-8 and the demodulated reference 30 Hz component applied at XP1-10. The reference 30 Hz component has the same phase at all monitoring points and the variable 30 Hz signal varies linearly with respect to the azimuth angle. Thus, the phase difference between the two is equal to the monitored radial. When the zero degree radial is being monitored, both signals are directly in phase with one another. By comparing the leading edges or trailing edges of the two signals, the phase difference between the two signals can be determined. Although the two signals are in phase at the zero degree radial, the same comparison can be made at any other radial provided that the reference input is delayed by an amount proportional to the phase difference between the reference 30 Hz component and the variable 30 Hz component. This difference is a known quantity and corresponds to the radial location in degrees of the field detector, around the rim of the counterpoise, with respect to magnetic north. The following discussion details the method used to generate the two in phase error signals in order that any difference in phase relationship between them may be compared. Refer to figure 4-5, error signal generation diagram, to aid in this discussion.

To remove some of the noise interference normally experienced with VOR systems (such as 60 cycle line interference and 2nd harmonic generation), the input for both 30 Hz components is fed to a doubler and then to a divide-by-three counter. This frequency doubler and divide-by-three circuit preserves the appropriate edges produced by the 30 Hz signal, and the resultant 20 Hz signal and 30 Hz reference signal are compared below.



To be able to monitor any radial, the 20 Hz leading edges generated from the 30 Hz reference signal are shifted through a programmable delay register by an angle equal to the radial being monitored. The radial in degrees, corresponding to the location of the field detector, is entered on the four thumbwheel RADIAL SELECT switches S1A, S1B, S1C and S1D. These data are entered in binary coded decimal form into the programmable counter. The clock input to the counter is a 108 kHz squarewave. The counter counts down such that if the field detector is an north, there would be no delay and the countdown would be zero. If the field detector were placed 180° from north, the counter would have to count down from 1800, each count representing 0.1°.

The output of the delay circuit triggers a monostable multivibrator which is applied to the data synchronization circuit. The variable 30 Hz component is also applied to the data synchronization circuit and the output of the data synchronizer is applied to the variable divide-by-three circuit to ensure that the signals being compared are in phase and not 180° out of phase. The output of the variable divide-by-three circuit is also applied out XP1-9 as the positive direction signal. The output of the monostable multivibrator, taken ahead of the synchronization circuit, is the negative direction signal; i.e., the two signals should be in phase, and there should be no error. If the reference (negative direction) signal arrives at the phase detection circuits first, a negative error will be indicated on the monitor read-out panel. If the variable (positive direction) signal arrives first, a positive error will be indicated on the monitor read-out panel.



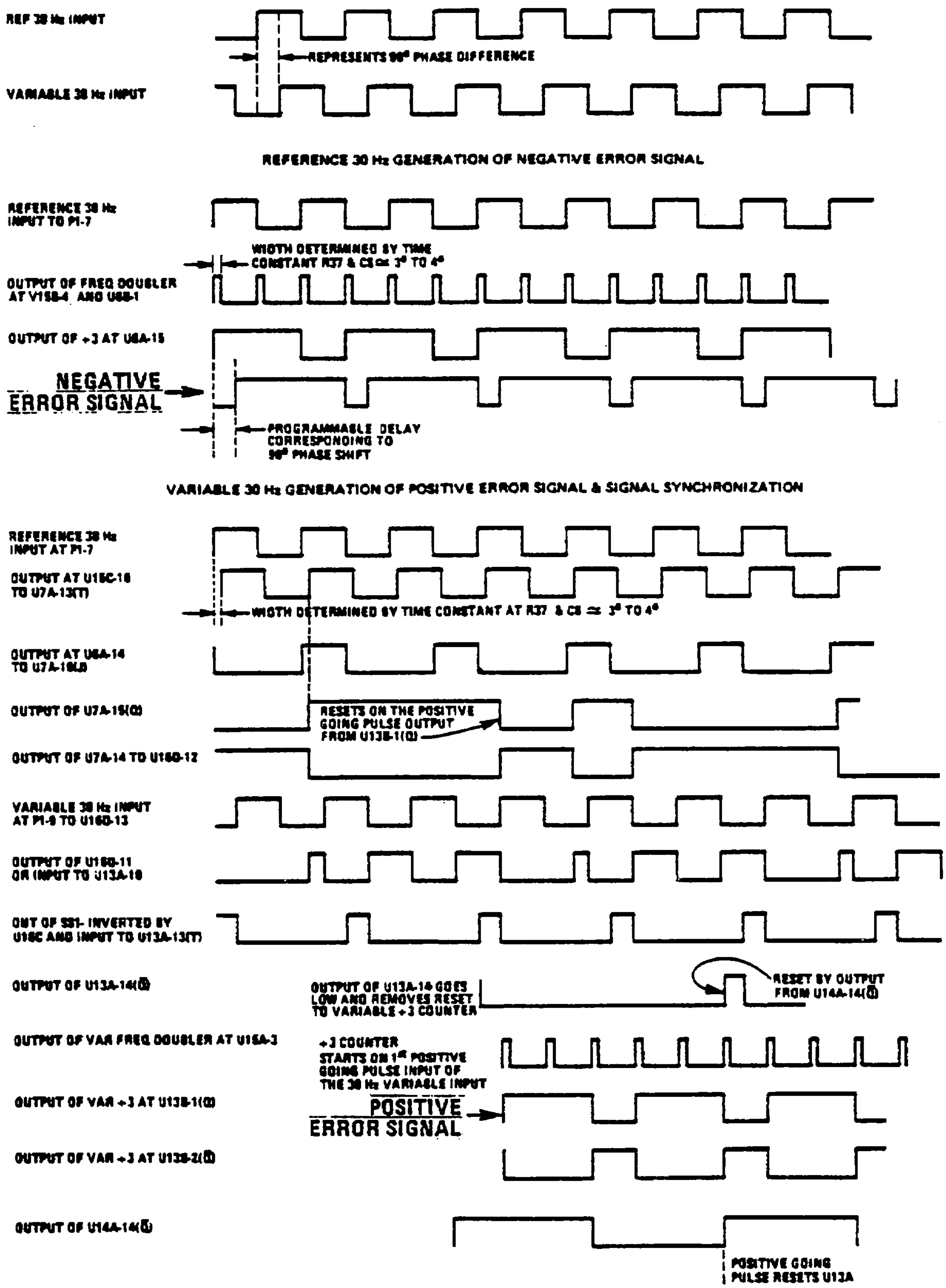


Figure 4-5. Generation of Error Signals for 90º Radial

The difference between these signals is evaluated in circuit card A2 and allows a digital readout of the bearing error. If the amount of bearing error exceeds 1°, an alarm is initiated. The two error signals are fed into phase detector circuit card A2, which looks at the leading edges and produces a pulse output at one port if one signal arrives first, and a pulse output at another port if the other signal arrives first. Either output is terminated by the arrival of the other signal. Therefore, if one signal leads the other by 1°, the phase detector will output a stream of 1° pulses at one port at a rate of 20 Hz, and if the other signal leads by 1°, the phase detector will output a stream of 1° pulses at a rate of 20 Hz at the opposite port. If the two signals are in phase, but one contains a second harmonic component, the phase detector will produce output pulses on alternating ports with a combined rate of 20 Hz. These ports are connected to a digital up/down counter. The circuitry averages 20 pulses and sends an error signal back to circuit card A1.

The error is normally a two-digit number. This number is decoded from a BCD input received from circuit card A2 by decoder driver No. 1 and No. 2 (U8 and U9) and applied for display on readouts 1 and 2 (U10 and U11), respectively. A polarity indicator is also provided to indicate if the error is positive or negative.

b. Phase Comparator Circuit Card Assembly (reference figure 7-12). The primary purpose of this circuit card is to evaluate the negative and positive error input supplied by circuit card A1. In addition, a bearing alarm will be initiated if the count exceeds an error limit proportional to plus or minus a programmable one degree deviation. This card also supplies BCD counter data to the digital readouts on circuit card assembly A1.

This circuit card can be broken down into eight basic circuits: A clock generator circuit, counter control circuit, bearing error counter circuit, error comparator circuit, a self-test circuit, alarm detection circuit, sequence counter circuit and a timing control circuit.

A crystal oscillator (U1B) produces a 1.08 MHz squarewave which is applied to a divide-by-ten counter (U19) to produce the 108 kHz clock output at pin 12, to U23A, U8C and U8D. It is significant to note that 30 Hz multiplied by 360 degrees equals 10800 degree cycles or that each 1/10 of a degree corresponds to one period of the 108 kHz clock. This clock is also applied out pin 2 to circuit card A1.

The positive and negative error signals applied at pin 17 and 11 respectively is applied to both the counter control circuit and the sequence control circuit. The sequence control circuit counts out a 20 pulse interval during which the two error signals are evaluated. At the end of the 20 pulse count, a timing control circuit starts a self-check and error count evaluation. This action occurs during the 20th to 29th count cycle. If no out of tolerance condition is detected, all counters are cleared and a new count cycle is initiated.

As previously indicated, the positive and negative error signals applied at pins 17 and 11, respectively, will always vary. In order to account for this continual change, the error count circuit will be updated every 30 count cycle (approximately 1-1/2 seconds). This is equivalent to 29 pulses being applied at pin 11 to clock the sequence counter circuit. Since the negative and positive error flip flops, U4A and U4B toggle on the leading edge, the count cycle for the error circuit is activated on the leading edge of the first pulse to be applied at either pin 11 or pin 17. Whichever pulse is applied first depends on whether the positive error input is leading or lagging the negative error input. If the positive error pulse leads the negative pulse, flip flip U4B is set and U8C is enabled. As soon as the negative error pulse arrives at pin 11, flip flop U4B is reset; however, since the input at pin 17 is high, both flip flops are in a reset condition. The reverse is true if the negative error signal leads the positive error signal. Thus, the count cycle is only initiated during the interval between the incoming error pulses. If U8C is enabled, the counter circuit counts up and if U8D is enabled, the counter circuit counts down. The pulses applied at gates U8C and U8D are added in. The bearing error counter circuit is comprised of counters U9, U10, U7 and U14. The count is averaged over 20 cycles. Counters U9, U10, U7 and U14 are up/down counters. Counter U7 is a units digit counter and counter U14 is a tenths digit counter. Whereas a positive error signal may provide an up count, a negative error signal provides a down count. If units digit counter U7 overflows, error polarity flip flop U3A is triggered. The output of U3A is applied to an exclusive OR gate, U6A. This changes the up/down control so that the counter will count accordingly. The output of U3A also determines the sign of the count. The output of U3A-pin 2 is applied to flip flop U3B. The output of U3B is routed to pin 10 and applied to the polarity indicator in circuit card Al to change the sign of the readout display.

Terminals E5 through E25 constitute a programmable bearing limit. This limit can be set from plus or minus 0.1 degree to plus or minus 7.9 degrees. The programmed limit is compared to the bearing error output of U7 and U14 by comparator circuits U5 and U12. If the bearing error is within the programmed limits, pin 12 of U5 will always be high. U5 pin 12 is a high going pulse and is applied to U17D. If the bearing error exceeds the programmed limits, pin 12 of U5 will be low and when sampled will inhibit gate U17D. This action prevents a 21st count pulse from U15B from passing U17D and latching U18B. If U18B does not latch at this time, an alarm will be initiated. The method of how this occurs is addressed in the following subparagraphs.

The sequence counter circuit allows the count to be averaged over 20 cycles or 20 pulses applied at pin 11. Since this input is applied at a 20 Hz rate, 20 pulses are equivalent to one second. The input at pin 11 provides a clock for decade counter U15 in the sequence counter circuit. At the end of the 20 counts, gate U15A is enabled. The output of U15A is applied to latch circuit U17B. The output of the latch is applied through U18D and disables decade counter U9. On the 21st count, an output is applied out pin 14 to update the readout counter in the A1 circuit card.

Decade counters U11 and U13 in the sequence counter circuit counts the error signals input from pin 11. After 20 counts, the self-check is activated to check the counters. This operation is described as follows. After a count of 20, gate U15A is enabled. The output of U15A sets latch U17A/U17B. The output of the latch is applied through U18D to stop counter U9.

The purpose of the test circuit is to recheck all counters to ensure that the counters will count from 0 to 7.9 before a no alarm condition created by comparator U5 is recognized by the alarm detection circuit Comparator U5 determines if the count is less than the program limit. Digital comparators U5 and U12 are preprogrammed for maximum allowable error limits. The count at the comparator is sampled on the 21st count if the error count is less than the program limit, the output of U5 pin 12 is high, and gate U17D is enabled. The fact that gate U17D is enabled implies that a no alarm condition exists. The output of U17D sets latch U18B/U18C. The output of the latch enables a gate in the self-test circuit. The same latch output enables gate U23A which is applied to the 108 kHz clock through U23B to counter U9. The opposite side of the latch is applied through gate U23C and sets the (up/down) counter (U9) to the up count mode. The counter is now checked by running through a test cycle. While counter U9 is counting, the test circuit, comprised of U22F, U21A, U21B, U18A, U20A, U20B and U2B, decodes the count. Gate U21A decodes the numbers 4 and 5. Gate U21B decodes count number 7. As the counter is passed through count 4 and 5, latch U20A/U20B is set this output is applied to gate U21C. As the count gets to 7.9 (gate U21B decodes number 7 and gate U18A decodes 9), gate U2B is enabled and its output is applied to gate U21C. A sample pulse, which is applied on the 26th count via gate U15D, enables gate U21C. The low output of U21C causes U22C output to go high and capacitor C5 charges. If capacitor C5 receives a pulse every three seconds, a positive level will be maintained by invertor U22D. Should any of the above conditions fail, capacitor C5 would discharge sufficiently through R8 initiating a bearing alarm condition.

The counter continues counting up to count 28. At this count, U16A is enabled; therefore, latch U18B/U18C is reset, latch U20A/U20B is reset and a reset pulse is applied to reset all of the counters.

When the 29th count is reached, latch U16C/U16D is set and counters U11 and U13 are cleared causing the cycle to be repeated.

c. Variable Signal Processing Circuit Card Assembly (reference figure 7-13). The purpose of this circuit card is to process the field detector input signal, to separate the variable 30 Hz component and adjust the 30 Hz modulation alarm level.

The field detector input is applied at pin 4, provided that the front panel **INPUT SELECT** switch is placed in any position other than the **TEST GEN** position. This input is applied to input amplifier U7A and U2A. Since the dc component of the field detector input is directly proportional to the carrier level, the input level can be adjusted by **LEVEL ADJ, R22**. The dc level output of input amplifier U2-12 is applied through a resistor (R3) and pin 25 to the carrier level position on the **TEST METER** switch. When the **TEST METER** switch is placed in the **CARRIER LEVEL** position, the carrier level can be adjusted by **LEVEL ADJ** potentiometer R22 for a green zone reading.

The output at U2-12 of the input amplifier not only contains the dc level, but is also comprised Of the 9960 Hz subcarrier, the variable 30 Hz modulation, voice transmission and the 1020 Hz Identification code. This composite signal is applied out at pin 6 to the **INPUT SELECT** switch. The other Output from the input amplifier (U4A) is applied to a 30 Hz filter (comprised of U2B, U4A, U4B, U5A, U5B and U3B). This filter circuit eliminates everything except the variable 30 Hz zero component. The output of the filter is applied to a 30 Hz crossover detector and a 30 Hz peak level detector. The output of the 30 Hz zero crossover detector U1B is a squarewave at a 30 Hz frequency. This signal is applied out at pin 21 to circuit card Al and eventually is compared against the reference 30 Hz component in circuit cards Al and A2 to measure the bearing error.

The other output from the 30 Hz filter at U3-10 is applied to the peak level detector. The peak level detector compares this output to a reference dc level and also provides a 30 Hz modulation alarm level adjustment The dc voltage, which is proportional to the variable 30 Hz component, is created across capacitor C11 at the output of peak level detector. The level is adjusted for the signal received from transmitter No. 1 by 30 Hz **LIMIT ADJ** No. 1 (R38) and for the signal received from transmitter No. 2 by 30 Hz LIMIT ADJ No. 2 (R35). The output of the peak level detector is applied to two analog switches, No. 1 and 2 (U6A and U6C). The transmitter select signal applied at pin 2 determines which analog **LIMIT ADJ** is activated. The status of the transmitter select input is determined by which transmitter is used to provide the transmitted signal.

If transmitter No. 2 is selected as the on air transmitter, a high input is applied at pin 2 and analog 30 Hz limit switch No. 2 (U6C) is activated. Then, the output from the peak level detector is applied to buffer amplifier U3A to 30 Hz level detector U1D. This signal is compared with a voltage reference supplied by voltage reference diode **CR2.** If the Input to the 30 Hz level detector from the buffer amplifier is at the proper level, the output level detector will be applied through lamp driver Q1 to illuminate the 30 Hz **ALARM NORMAL** Indicator. If the level falls below a certain limit, the light will extinguish. This limit is set at 15% below the calibrated signal level. The calibrated signal level was initially adjusted by R22. The alarm level is set by limit set switch S2.

The alarm level is determined by a resistor combination of R8, R13 and R 18. These resistors are selected so that when LIMIT SET switch S2 is pushed to an unstable condition (S2 is a spring-loaded switch), the reference level to the 30 Hz level detector U1D increases 15%. If, for example, transmitter No. 1 II the “on air” transmitter, resistor R38 is adjusted so that the 30 Hz **ALARM NORMAL** indicator will just be on the verge of extinguishing when switch S2 is depressed. The final adjustment is checked by alarm **LIMIT TEST** switch S1. This switch has two unstable conditions; a low limit and a high limit. The **LOW** limit causes the input signal level to drop 16% and the HIGH limit causes the input level to drop 14%. When the switch is placed in the high limit position, the 30 Hz no alarm indicator should still be illuminated and when **LIMIT TEST** switch S1 is placed in the low limit position, the indicator should extinguish. This switch serves two purposes, it not only checks the variable 30 Hz level indicator, but it is also used to check the 9960 Hz level circuit since both circuits receive their input signal from input amplifier U7A. Therefore, **LIMIT** switch S2 sets the alarm level, and **LIMIT TEST** switch S1 checks proper alarm operation.

The bearing adjust potentiometer R9 Is a calibration adjustment for the bearing monitor. The test L generator is a calibration standard for adjusting R9. This compensates for the small variation inherent in the equipment. Once R9 is adjusted, it does not normally require further adjustment.

d. Reference Ident Circuit Card Assembly (reference figure 7-14). This circuit card evaluates the 9960 Hz signal level, the reference 30 Hz level and the indication code interval.

The amplifier VOR signal is applied at pin 6 from circuit card A3 via the INPUT SELECT switch. This signal is the amplified signal received from the field detector and contains the 9960 subcarrier, variable 30 Hz modulation, 1020 Hz identification code, and voice transmission. This signal is applied to a 1020 Hz input filter and a 9960 Hz filter.

The 1020 Hz input filter is a simple 3-pole filter comprised of R16, C6 and C1. The output of the filter is applied to 1020 Hz tone decoder U2. This decoder is a phase lock loop tone decoder. A five-volt regulator supplies operating power for the decoder since the VOR system primarily operates on +15 Vdc. The output of tone decoder U2 is a logic signal which goes low when the ident signal is present and high when it is absent The output is applied to a timing circuit which initiates an alarm if the output of U2 is high or low beyond a preset period. The ident alarm timing circuit is comprised of two delay circuits. The circuit delay combination of C5 and R15 provides the timing interval during which the ident signal should be absent, and circuit delay combination R6 and C2 provides the time interval during which the ident signal should be present. An output from inverter U3A and lamp driver Q1 is routed to pin 4 to indicate when the ident signal is present The output through the ident detector U3B initiates an ident alarm when one of the specified conditions is not met.

The input signal at pin 6 is also applied to an active 9960 Hz filter (U4B). The output of the filter Is applied through U4A and U6B. This zero crossover detector provides a 9960 Hz squarewave which is Applied to single shot U8. This circuit acts as a demodulator designed to isolate the reference 30 Hz FM Component which was frequency modulated on the 9960 Hz subcarrier. The output of this circuit is applied To a 30 Hz filter to further isolate the reference 30 Hz component. The output of the filter is applied to a Peak level detector and to a 30 Hz zero crossover detector. The output of the filter applied through the Peak level detector is the reference 30 Hz level applied out at pin 23 to the **TEST METER** to indicate Power level. The output applied through the 30 Hz zero crossover detector is applied out at pin 18 to Circuit cards Al via circuit card A2 and is used to compare the phase relationship of the reference 30 Hz Component to the variable 30 Hz component

Another output sent through the 9960 Hz filter U4B and amplifier U4A, is applied to 9960 Hz peak detector U 11. The operation of this circuit is identical to the operation of the 30 Hz peak detector circuit and limit adjust circuit discussed as part of circuit card A3.

e. Test Generator Circuit Card Assembly (reference figure 7-15). The **VOR** test generator is designed to produce a **VOR** composite signal consisting of a 30 Hz variable signal and a 9960 Hz subcarrier which is **FM** modulated with a reference 30 Hz signal. Adjustments are provided to control the variable 30 Hz level, the 9960 Hz level, the 9960 Hz center frequency, the 9960 Hz deviation (normally set at 16) and the 9960 Hz symmetry adjustment which is set at the factory for minimum harmonic distortion of the

9960 Hz and normally does not need to be reset. The frequency reference for the 30 Hz variable and reference signals is a 1.08 MHz crystal clock which is divided by U2, U3 and U4 to produce a 960 Hz signal at El. The 960 Hz signal is applied to a sinewave synthesizer consisting of U16, U9C, U10A, B, and D, U11 and U12B and associated resistors. The circuit produces a 30 Hz sine wave at U12 pin 10, by selecting channels 0-7 of U 11 which control the gain of U 12B. The operation is as follows:

Referring to Figure 46, at zero degree on the sinewave, channel 0 is selected on the multiplexer by providing a logical zero at inputs A, B and C. At this time, U9, pin 10, is high and this high signal is coupled through R26 and R31 to amplifier U12B. Pin 7 on U12 is approximately the same potential as pin 6 which is determined by resistor divider R32 and R33 to be +V/2 or approximately 7.5V. One cycle of the 9960 Hz signal later, Channel 1 of the multiplexer is selected which couples the parallel combination of R23 and R44 into the amplifier instead of R26. This produces a slightly higher gain at the output of U12B which corresponds to the second step in figure 4-6.

Each succeeding cycle of the 960 Hz signal advances the multiplexer and its associated resistor or resistors pair up to channel 7 which has no resistor. This point represents 900 of the 30 Hz signal. The next cycle of the 960 Hz signal reverses inputs 1, 5 and 13 to U10 which in effect converts U16 to a down counter. Successive cycles of the 960 Hz signal then select channel 6, 5, 4, etc., down to zero. This completes 1800 of the 30 Hz signal. At this point, U9C output goes to ground and the previous cycle repeats since the input to the U12B is referenced at +V/2, the output of U12B will go negative producing the second 1800 of the 30 Hz signal.

The output of U12B is applied through U13 to the FM input of a sine wave VCOU14. The center frequency of this VCO is set at 9960 Hz by R9 and the deviation is controlled by the amplitude of the 30 Hz input which is controlled by R7. The output of the VCO (U14 pin 2) is coupled through U13A to output amplifier U15A. Potentiometer R 14 controls the gain of U13A which controls the amplitude of the 9960 Hz output

The 30 Hz variable signal is produced similarly to the 30 Hz reference, except that binary counter outputs are added to the outputs of a binary encoded 16 position switch by 4-bit adder U18. This switch is mounted on the shelf inside the front panel of the monitor. The result of this addition is to shift the 30 Hz variable signal in relation to the 30 Hz reference signal by an amount proportional to the binary word input from the switch. This represents 1/16 of 3600 per position or 22-1/2°. In position 1, this would represent the 22-1/2° radial. The 30 Hz variable signal is applied to the output amplifier U15A through R28. R28 controls the amplitude of the 30 Hz variable signal.

The output amplifier amplitude can be reduced by the limit test switch S1. In the high limit position, the amplitude is reduced 13%. In the low limit position the amplitude is reduced 17%. This switch is used to test the alarm level of the monitor which is normally set at 15%. The monitor should initiate an alarm in the low-limit position only.

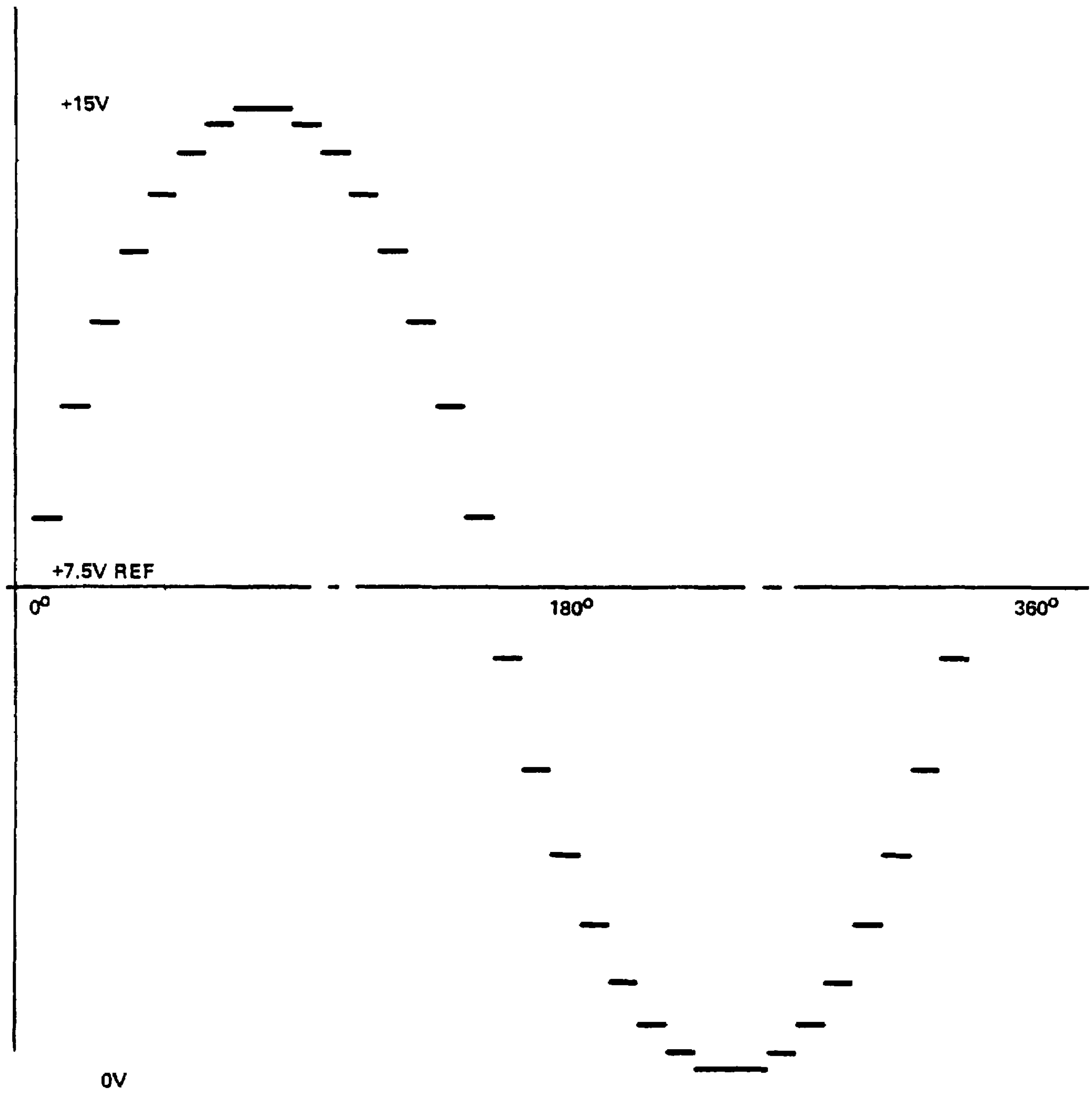


Figure 4-6. Step Function Output of Multiplexer

Mode select switch S2 grounds out either the variable 30 Hz or the FM input of the **VCO** which stops the oscillation of the 9960 Hz **VCO**. The output then consists of only the 9960 Hz subcarrier or only the 30 Hz variable, depending on the position of SZ In the center position, both signals are applied to the output amplifier.

SECTION V

VOR CARRIER TRANSMITTER

4-10. FUNCTIONAL DESCRIPTION (reference figure 7-16). The primary function of the carrier transmitter is to generate the **RF** carrier signal. The **RF** carrier signal forms part of the composite **VOR** signal and consists of the carrier **RF** signal (at the assigned **VOR** frequency) amplitude modulated by a 9960 Hz subcarrier which is **FM** modulated at 30 Hz. This carrier signal is also amplitude modulated by a voice modulation input supplied by a source external to the carrier transmitter assembly and by a programmable identification code generated within the carrier transmitter assembly. This assembly also supplies a separate output for the **DME** identification code provided for external application. The function of other input and output signals is provided in the following detailed functional operation analysis.

4-11. DETAILED CIRCUIT CARD DESCRIPTIONS. The following subparagraphs contain detailed descriptions of the circuit assemblies in the carrier transmitter.

a. Ident Keyer Circuit Card Assembly (reference figure 7-17). The primary purpose of this circuit card assembly is to generate the ident keyer signal. The keyer signal is a digital train of pulses representing Morse code dots and dashes. For collocated **DME** or **TACAN** equipment, the keyer provides a synchronizing signal to the collocated equipment which in turn is used to generate the **DME** or **TACAN** ident.

The ident keyer circuit card assembly is capable of generating three characters in Morse code. The desired dots and dashes are programmed on the circuit card assembly using soldered wire jumpers. There are provisions for up to 4-bits per character where a bit represents either a dot or a dash. The interval between bits is equal to a dot width (0.125 second) and the interval between characters is equal to a dash width (0.375 second)., The interval between transmissions of the ident code, called the ident cycle time, is 7.5 seconds for **VOR**, 30 seconds for the collocated **DME** and 37.5 seconds for collocated **TACAN**. There is one exception to the dash width interval between characters. In a dual system, the ident keyer circuit card assembly in carrier transmitter No. 2 (1A7) has an interval between the second and third characters equal to a dash width plus 2 dot widths or 0.625 second total. This feature allows remote determination in a dual system of which transmitter is on the air (No. 1 or No. 2) by listening to the transmitted ident code.

The keyer clock frequency is determined by an astable multivibrator (U3) oscillating at 8 Hz. The period of the oscillator is adjusted for 0.125 second using A1R3 and all other time relationships are derived from this time interval. For example, a dash width is equal to 3 dot widths or 0.375 second. The output of the oscillator is applied to dot flip flop U1A where the frequency is divided by 2 to produce a 4 Hz square wave clock. This signal, which has a half period equal to a dot width, is used as the basic clock frequency in the keyer circuit card assembly. Because of the low clock frequency used for normal operation, it is extremely difficult to view the waveforms on an oscilloscope. To circumvent this difficulty during troubleshooting operations, provisions are made for speeding up the oscillator frequency from 8 Hz to 800

Hz. This is accomplished by removing the soldered in jumper between E47 and E48 and temporarily installing the jumper between E47 and E49. After troubleshooting operations are complete, it is necessary to remove the temporary jumper between E47 and E49 and reinstall the jumper between E47 and E48.

The basic ident cycle time of 7.5 seconds between ident transmissions is determined by two counters, U7 and U12 (refer to figure 4-7). U7 is a 4-bit binary up counter while U12 is a 4-bit decade up counter. U12 performs a dual function with the first bit of U12 used in conjunction with the 4-bits of U7 to form a 5-bit binary counter referred to as the ident cycle time, while the last 3-bits of U12 are used to perform the selection of ident transmission periods between the **VOR** and a collocated **DME** or **TACAN** and are referred to as the ident selection counter. The ident cycle is initiated by the negative going edge of the differentiated start of ident pulse outputted from U12-6 (Q1) which presets U7 counter to the count of 2 via the U7 preset enable input (U7-1).

Figure 4-8 illustrates the timing relationship associated with the ident cycle timing and is keyed to the preset enable pulse applied to U7 pin 1. After the preset enable pulse occurs, the clock (applied to U7-15) with a period of 0.25 second increases the count in U7 from 2 to 15. At count 15, the carry out from U7-7 goes low and the next clock pulse causes the count in U7 to overflow returning to 0 which, in turn, causes the carry out signal to go high. The carry out signal is applied to the U12 counter as a clock (U12-5) so that the high going trailing edge causes the first stage of U12 (Q1) to go high. At this point, 14 clock pulses have been applied to U7 for a total elapsed time of 14 x 0.25 = 3.5 seconds. U7 now begins a second counting cycle only this time it starts from a count of 0 (because no preset pulse occurred). Sixteen clock pulses later it again recycles to 0; however, simultaneously Q1 of U12 (U12-6) goes low and the resulting negative going edge is differentiated and applied through inverter U4C to preset U7 to count 2. Thus, U7 stays in count 0 for less than 100 nanoseconds; and because of scale considerations, this factor is omitted from the timing diagram. Sixteen clock pulses give 16 x (0.25) = 4 seconds which when added to the 3.5 seconds gives 7.5 seconds total for the ident cycle time. The above described operation is then repeated.

When the **VOR** is located with a DME, the ident transmissions for the two units must be synchronized and controlled so that three **VOR** idents are transmitted on a 7.5 second period basis, while DME ident transmissions are inhibited. In the next period, the **DME** ident is transmitted while the **VOR** ident transmission is inhibited. Operation with a collocated TACAN is similar except four **VOR** idents occur for one **TACAN** ident.

Selection of **VOR** only, **VOR**/**DME** or **VOR/TACAN (VORTAC**) ident operation is accomplished by two soldered-in wire jumpers. One jumper is used to provide the 2 preset input to U12. For **VOR** and **VOR/DME** operation, the jumper is connected between E3 and E4 causing U12 to be preset to a count of 2. For VORTAC operation, the jumper is connected between E4 and E5 causing U12 to be preset to a count of a The reasons for the different preset values will be covered in subsequent discussion.

The other jumper is used to determine whether or not the ident selection counter (U12) is to control the **VOR** ident signal. For VOR only operation, the jumper is installed from E9 to E10 which

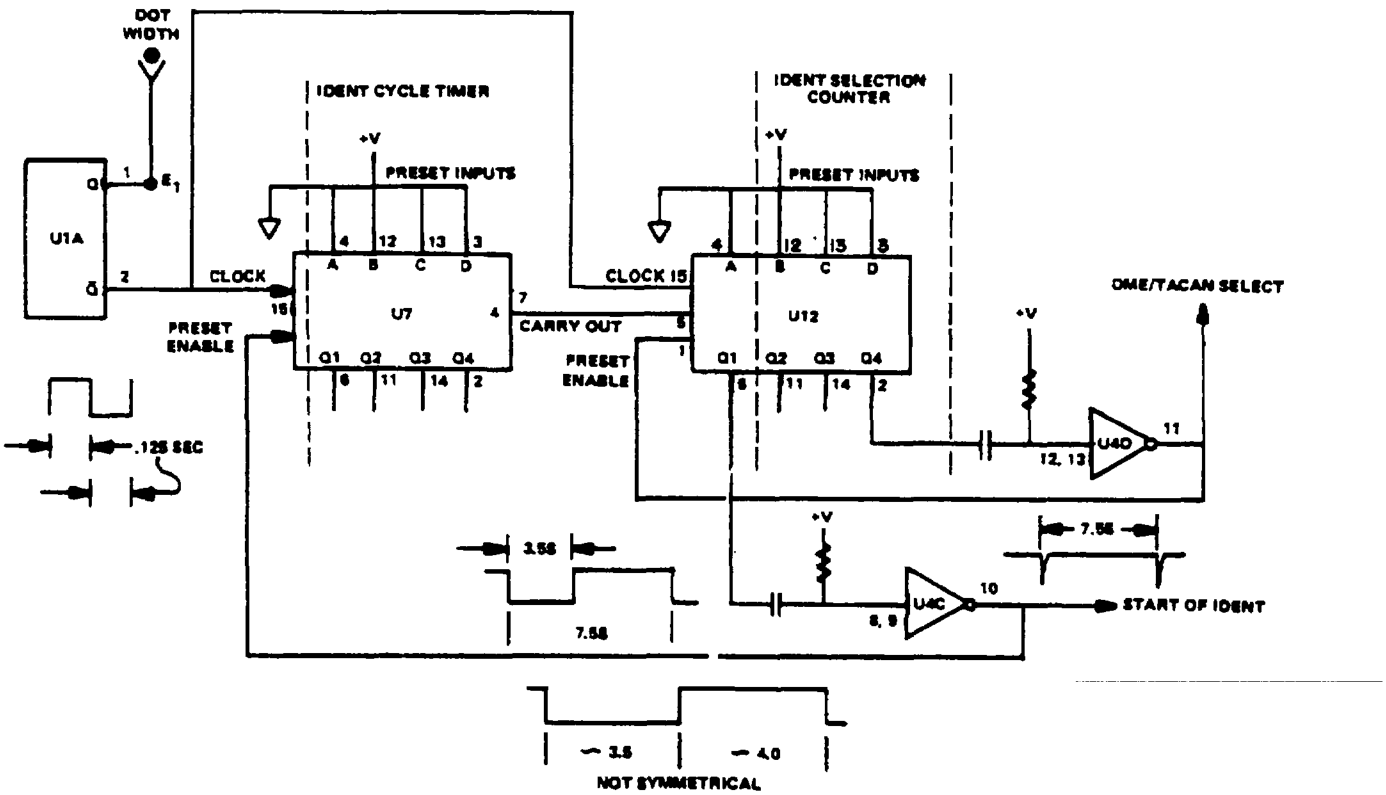
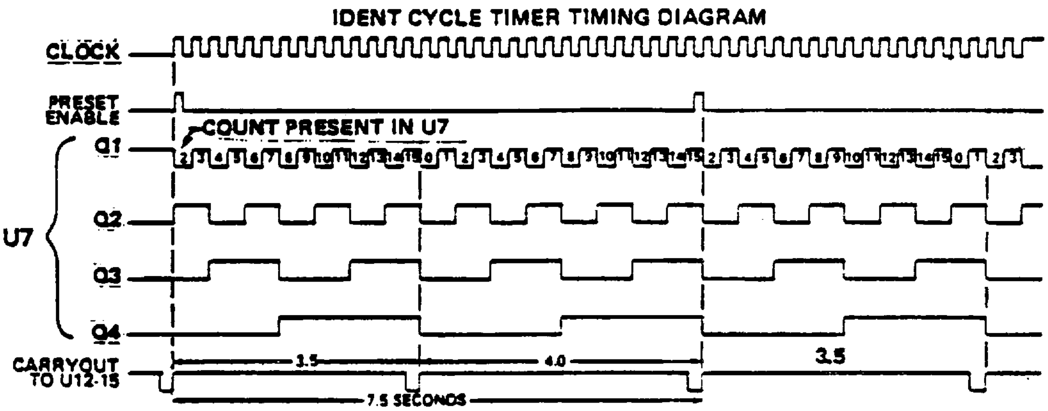
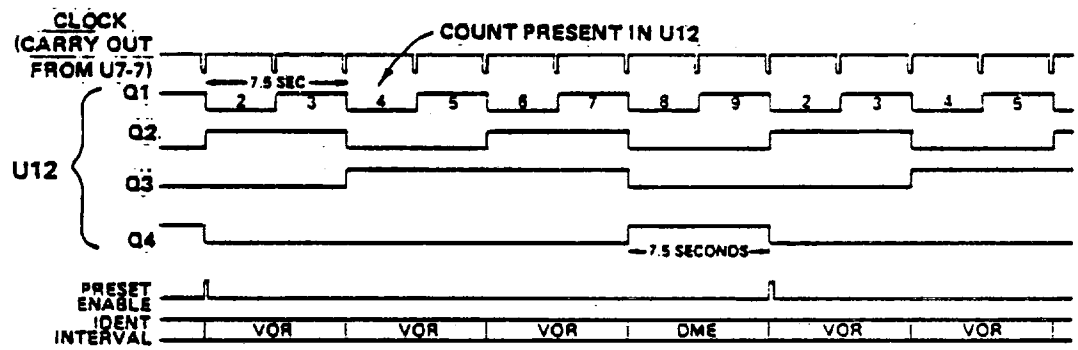


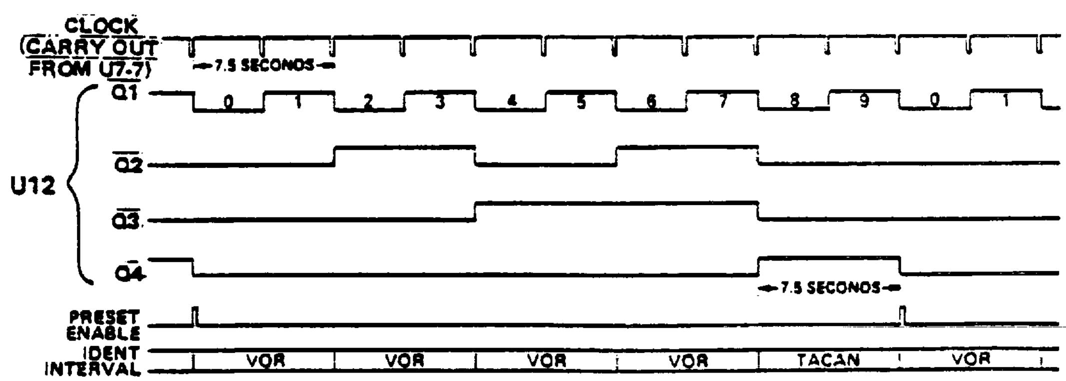
Figure 47. Ident Counter Section Simplified Schematic Diagram



A. IDENT CYCLE TIMER TIMING DIAGRAM



B. IDENT DECADE COUNTER TIMING DIAGRAM
WIRED FOR DME/VOR (E3 CONNECTED TO E4)



C. IDENT DECADE COUNTER TIMING DIAGRAM
WIRED FOR VORTAC (E5 CONNECTED TO E4)

Figure 4-8. Ident Timing Diagrams

provides a constant enabling input to gate U13B (i.e., the ident selection counter has no control on the VOR ident). For **VOR/DME** or **VORTAC** operation, the jumper is installed between E9 and E8 transferring control of gate U13B to the ident selection counter. Under this situation, during the time slot a **DME** or **TACAN** ident transmission occurs a high signal from the ident selection counter (U12-2) blocks the **VOR** ident at gate U 13B.

Figure 4-8 illustrates the timing diagram for **VOR/DME** operation. For this situation, the preset input at U12 pin 12 is connected to a +V (+12 Vdc) by connecting a jumper between E3 and E4, so that when the U12 preset enable occurs the count in U12 is set to 2. U12, a **BCD** counter, counts up from 2 to 9 advancing one count for each pulse received from U7. On the eighth pulse, the count in U12 goes to zero but only momentarily (100 nanoseconds) as the negative going edge of the Q4 output is differentiated by C9 and R14, inverted by U4D and then applied to the preset enable input on U12-1 causing U12 to assume the count of 2 The cycle then repeats. It takes 8 clock pulses on Pin 15 for the cycle; however, these clock pulses are not uniformly spaced. As noted above, a 3.5 second space alternates with a 4 second space so the cycle time is 4 x (3.5) + 4 (4) = 30 seconds. During the time the U1204 output is high, (counts 8 and 9) U13A is enabled via inverter U13C and DME ident sync is transmitted via inverter Q1 to Pin A1-16. During this period, DME ident is transmitted while **VOR** ident is disabled by the high signal applied from U12Q4 to gate U13C. For **VORTAC** systems, the operation is similar except U12 preset input at pin 12 is grounded by tying E4 and E5. Under this condition, U12 is preset to count 0 and it takes 10 counts to recycle the ident selection counter or 37.5 seconds. Refer to figure 4-8c for timing diagram information.

The generation of the programmable ident code is best understood by focusing on the function of several circuit elements that govern the code generation operation. The following is a brief description of these elements

(1) Bit Sequencer (U2). The bit sequencer is a decoded decade counter which is used to keep track of which particular bit in a character is presently being transmitted. The count in the bit sequencer is always one less than the bit number being transmitted. For example, when bit 2 is being transmitted the count is 1.

(2) Sequencer (U8). This sequencer is identical with the bit sequencer but keeps track of the character being transmitted.

(3) Dash Flip Flop (U1B). This flip-flop is set whenever a dash is to be transmitted and isreset at all other times

(4) Skip Flip-Flop (U10A). This flip flop is set whenever a skip is programmed (except on the first bit of a character as will be explained later) and at the end of each character. It is reset at all other times

(5) Code Control Flip Flop (U10OB). This flip flop is set at the start of ident and is reset after the last bit of the last character is transmitted. In essence, U10B turns on ident when set and shuts off ident when reset.

(6) Code Selection gates this array of gates and diodes are used for programming and generating the desired code. The selection gates are scanned by the bit and character sequencers, and depending on programming, produce a dot, dash or skip command.

(7) Spacing Flip Flop (U14A). This flip flop is used to add the extra 2 dot widths to the spacing parameter between the second and third characters for System No. 2 ident transmissions. If normal spacing is required, then U14A is set and if the long space is required, then U14A is reset during the interval between the second and third characters. No programming is required to accomplish this as the spacing is varied automatically, depending on whether the keyer circuit card assembly is located in carrier transmitter A4 or A7.

The applicable ident code to be transmitted is programmed by appropriate placement of soldered-in wire jumpers the three possibilities for each bit of a character are dot, dash or skip. Each bit of each character has a terminal assigned to the bit. For example, E12 (see figure 7-17) is associated with the first bit of the first character while E33 is associated with the fourth bit of the second character. Each terminal can bejumpered to either one of two terminals located adjacent to the assigned terminal. As an example, consider bit I of character I. the assigned terminal is E12 and the associated terminals are Ell and E13. If a dash is desired, then a jumper is installed between E12 and E13 while, if a skip is desired, then the jumper is installed between E12 and Ell.

A skip is used when the remaining bits of a character aren’t used or when it is desired to skip a complete character. For example, the transmission of the letter A requires only two bits of the available 4 bits of the character, thus it is necessary to program a skip into the third bit. This skip will then terminate the character and advance the character sequencer to the next character. It isn’t necessary, in this case, to program a skip into the fourth bit as the keyer recognizes only the first skip. An exception to this comes about if a complete character is to be skipped. Under this condition, it is necessary to install a skip in the first and the second bit positions of the code selection gate in order to complete the skip of the entire character.

One approach to understanding the detailed operation of the code generation is to assume that the dot width pulse train (waveform B, figure 4-9) passes through the keyer to become the ident code. During the passage through the keyer, it is modified to produce dots, dashes and spaces between characters The path through the keyer starts at gate U1A (pin 1) and passes through the dash gate U5A, the skip gate U5B, the character advance gate U5C, and the ident selection gate U13B to become the VOR ident code. When a dot is desired, the waveform passes through the gates and is inverted at each gate but emerges at the collector of Q2 unchanged in width. For a dash, the dash flip flop is set and “stretches” the dot in the dash gate to three-dot widths which is subsequently sent down the remainder of the path to become a dash at

C. SAMPLE IDENT CODE GENERATION TIMING DIAGRAM

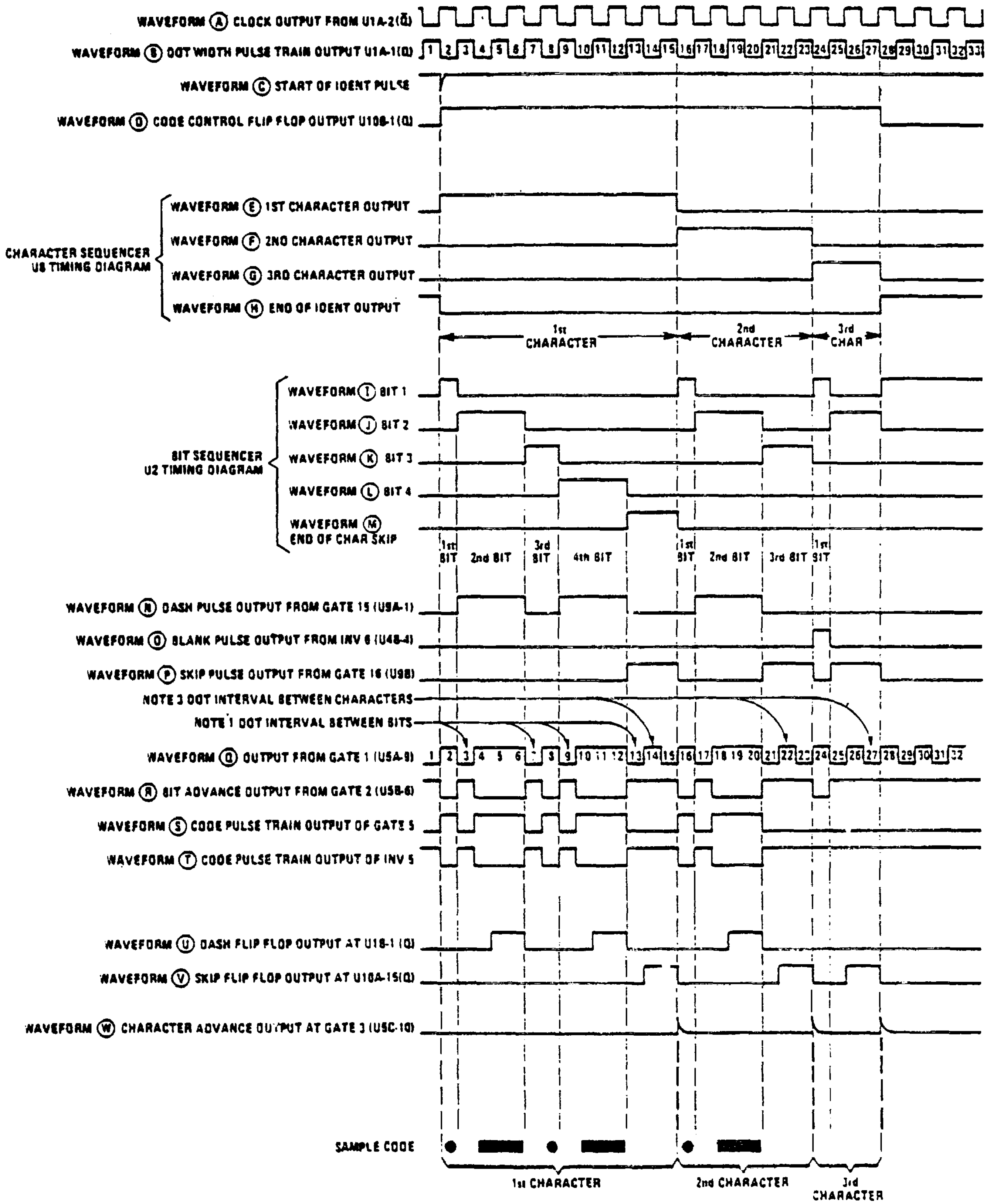


Figure 49. Timing Diagram for Generation of Two Characters

the collector of Q2. For a skip, or equivalently the space between characters, the waveform is blocked at the skip gate by the skip flip flop in the set state. The skip gate is also the point at which the code control flip flop exercises its control over the ident transmissions. The trailing edge of the dot or dash pulse, as it exits the skip gate, advances the bit sequencer from one bit to the next bit The character sequencer is advanced by the output of the character advance gate (U5C) at the time the skip flip flop resets which occurs after the space between characters has occurred but before the beginning of the next character. At this same time, the bit sequencer is reset to a count of 0 which corresponds to bit 1.

In summary, the keyer will produce three characters composed of four dots each every 7.5 seconds unless the ident code selection gates are programmed to change the code which is accomplished by setting the dash or skip flip-flops or by issuing a blanking pulse. The blanking pulse is only used on the first bit of a character and then only when the entire character is to be skipped. Recall that in order to skip an entire character, it is necessary to program in a skip in the first two bit positions. The skip in the first bit position causes a blanking pulse to occur which inhibits the ident code transmission for the first bit. On the second bit, the programmed skip sets the skip flip flop and the normal skip operation ensues. Figure 4-10 shows the blanking circuitry. The ident code selection gates have been regrouped to emphasize the blanking operation. The inputs to the blank selection gate are individually energized by the output of the character sequencer. If, for example, a jumper has been added, say between E24 and E23, then a high signal will be present at the lower input of gate U6D during the interval the character sequencer energizes the character 2 output line (U82). When the bit sequencer outputs bit 1 (a high on the U2-3 output) gate U6D output goes low and inverter U4B goes high which in turn disables U13B, shutting off the ident pulses issuing from the skip gate. This inhibit lasts as long as bit 1 lasts.

The skip portion of the code selection gates is depicted on figure 4-11, which has been regrouped to emphasize the skip operation. The inputs to the skip selection gates are individually energized by the output of the character sequencer with each character bit going to each of the three gates. Each gate output is then controlled by its respective bit (bits 2, 3 or 4 in gates U6A, U11A and U11C, respectively). The controlled outputs are combined in gate U9B whose output becomes the set input to the skip flip flop. As an example, suppose bit 3 of character 2 (and subsequent bits) is to be skipped. In this case, a jumper is installed between E30 and E29. During character 2, the character 2 output for U8-2 causes a high to be present at the U11A-2 input via the jumper installed between E29 and E30 and CR13. When bit 3 occurs, the output of U11A goes low which causes a high output from gate U9B. This high output becomes the set command for the skip flip flop.

Between each character, a space is required. This is also accomplished by the skip circuitry in the following manner: If all four bits of a character are used, then the bit sequencer outputs a fifth bit immediately after the termination of the fourth bit. This fifth bit, called the end of character skip, is inverted by gate U4A and applied to gate U9B causing a high output which becomes the set command for the skip flip flop. Thus, the end of character skip is essentially a non-programmable skip that is used only if all four bits of a character are used. The dash portion of the code selection gates is depicted on figure 4-12.
The operation is the same as the skip circuitry except there are four sets of gates as a dash can be

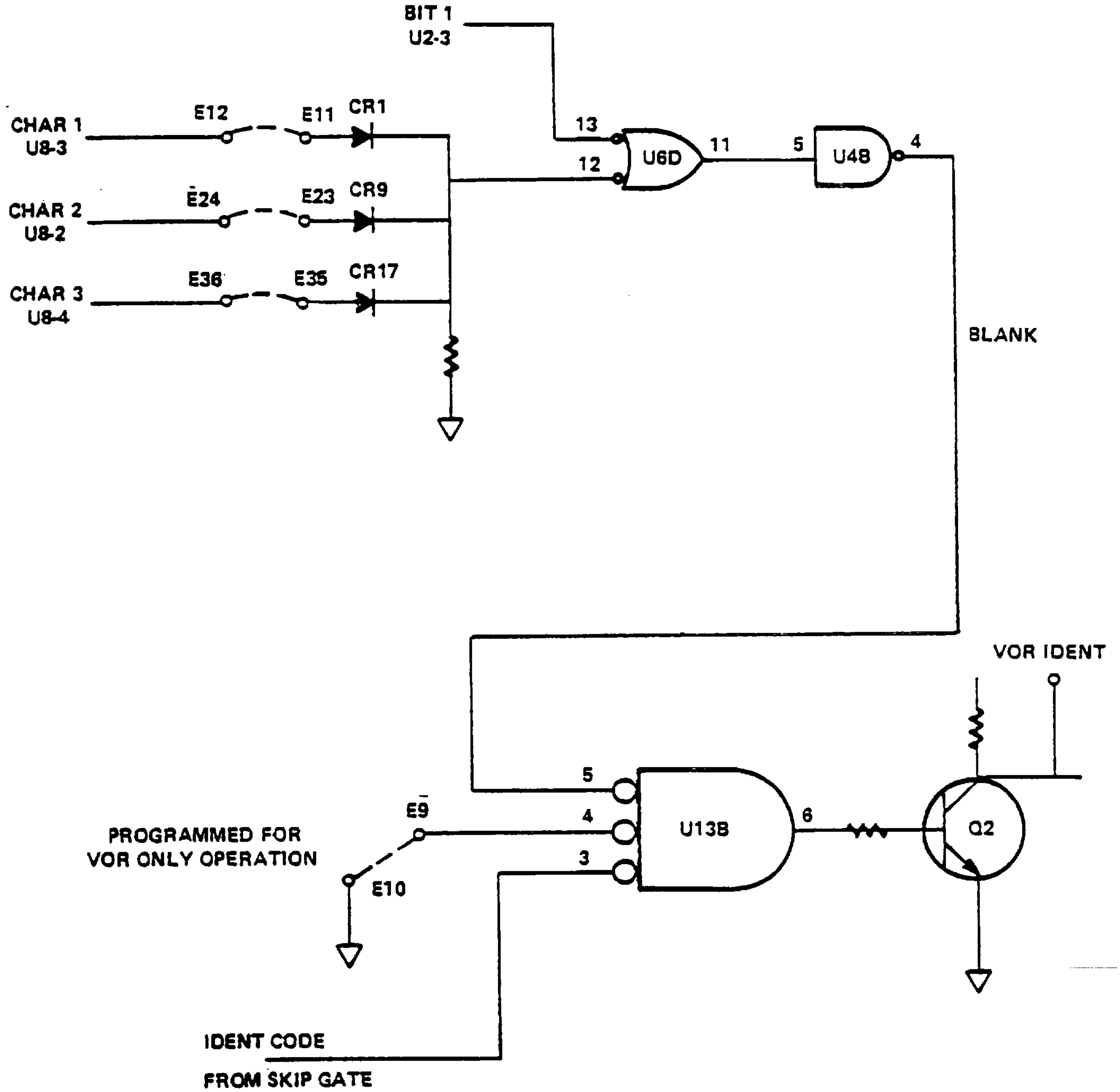
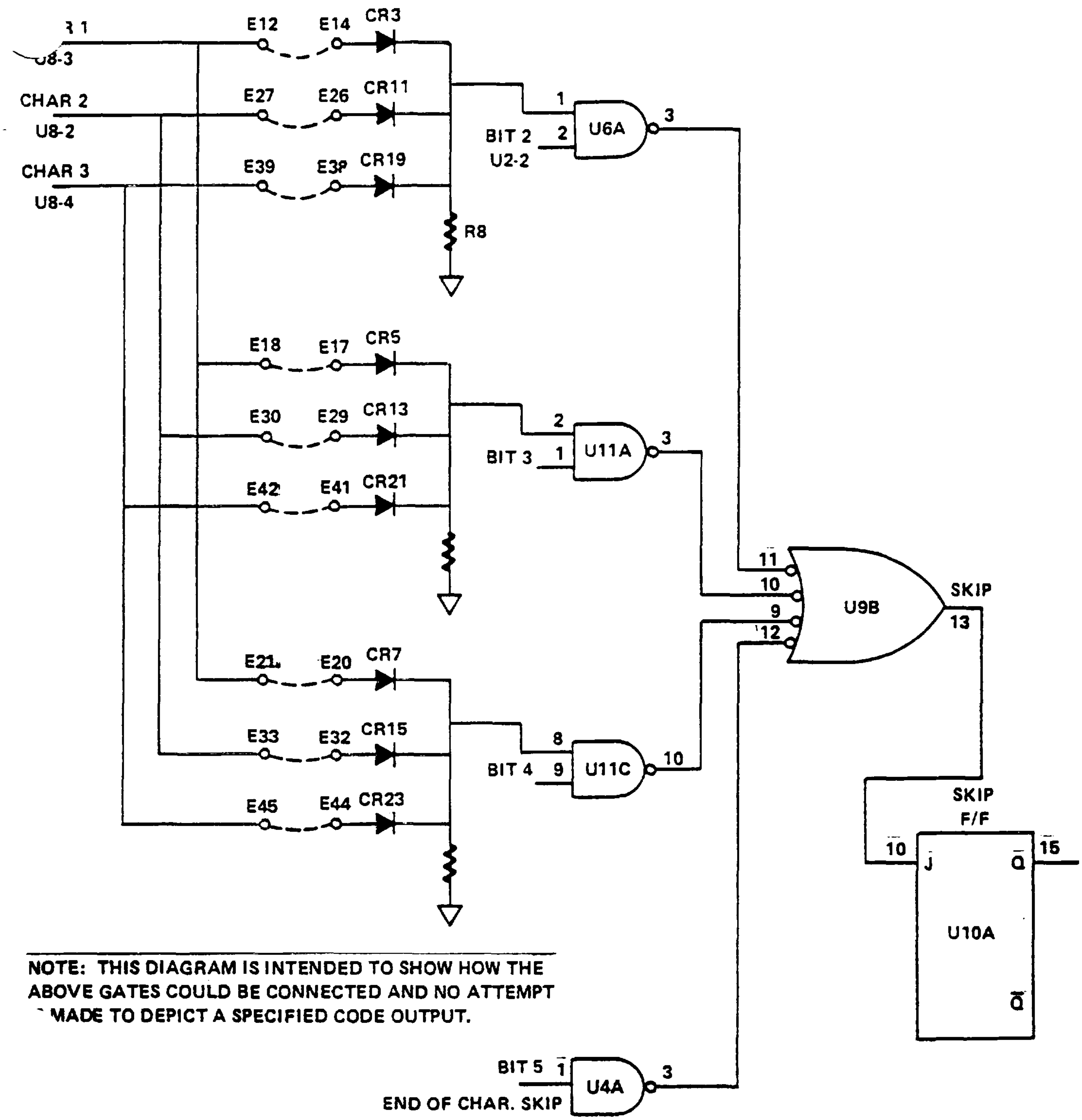


Figure 410. Blank Selection Gating



NOTE: THIS DIAGRAM IS INTENDED TO SHOW HOW THE ABOVE GATES COULD BE CONNECTED AND NO ATTEMPT MADE TO DEPICT A SPECIFIED CODE OUTPUT.

Figure 4-11. Skip Selection Gating

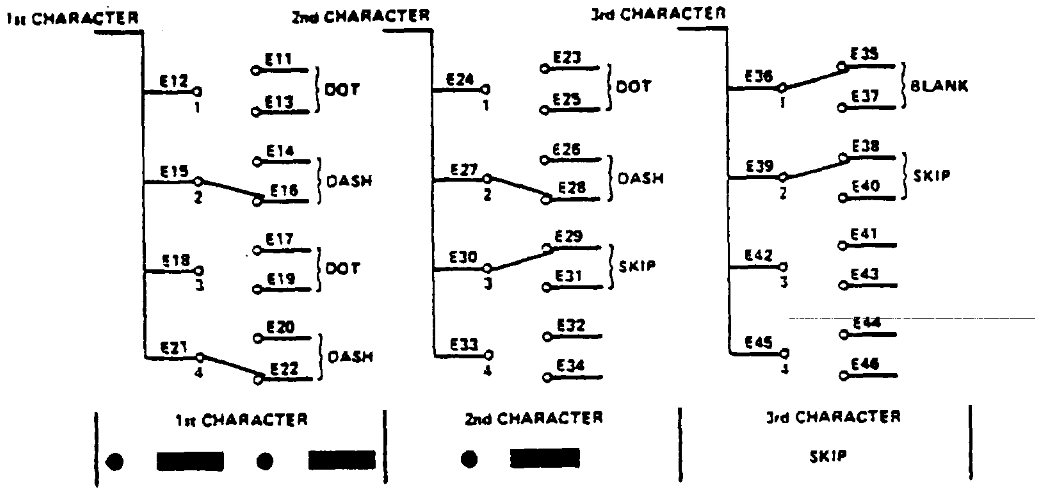


Figure 412. Code Selector Gates Wiring Diagram for Generation of Sample Code for 2 Characters

programmed for any bit and there is no end of character skip. The output of U9A becomes the set and reset commands to the dash flip flop.

As an aid in understanding the operation of the identity code generation circuit, a timing diagram to illustrate all of the features of this circuitry is presented in figure 4-9. The code selection gates have been wired to produce a three-character code consisting of a dot, dash, dot, dash for the first character, a dot and a dash for the second character and a skip feature for the third character. The alpha designation for this code is immaterial since the code selection was designed only to show circuit operation in generating a sample code. The proper wiring of the code select gates to generate this code is shown in figure 4-13. Normal spacing between second and third characters will be assumed as well as VOR ident operation.

During the discussion of the detailed operation of the ident keyer, frequent reference will be made to the waveforms presented in figure 49. The ident code cycle is initiated by the start of ident pulse (waveform C). This negative going spike is applied through inverter U4C to reset the dash flip flop (U1B), the skip flip flop (U10A), the character sequencer (U8) and to set the code control flip flop (U1OB). It is also applied through gate U5C to reset the bit sequencer (U2). Setting the code control flip flop (U1OB) provides an enabling high signal to the skip gate (U5B) transferring control of that gate to the skip flip flop (U10A).

At this point, the bit and character sequencer are set for the first bit of the first character and the dash gate, skip gate and gate U13B are all enabled. Therefore, the first negative going pulse (interval 2 waveform B) from the dot flip flop passes through the code channel (all gates in the channel are enabled) to emerge as a negative going pulse at the collector of Q2 (waveform T). At 0.125 second later, the dot is terminated and the positive going trailing edge of the first dot pulse at the output of the skip gate advances the bit counter from bit 1 to bit 2. This enables gate U6B, which passes and inverts the high char 1 signal from the character sequencer via the jumper between E15 and E16 and CR4. The low output of U6B causes a high output at gate U9A. This high output referred to as the dash command, is applied to the set input of the dash flip flop. The dash flip flop doesn’t set at this time, as its T input is high and a low to high transition on the T input is required. During interval 3 of waveform B the collector of Q2 is high representing the space between the first and second bit of the first character. During interval 4, the channel passes waveform B causing a low at collector Q. The T input to the dash flip flop is also low during this interval. At the beginning (leading edge) of interval 5, the T input to the dash flip flop goes high causing the flip flop to set which maintains a high out of the dash gate, even though the other input to the dash gate, the dot width, R2 and C2 provide sufficient delay so that the dash flip flop can set before the voltage across C2 rises from a low to high. This insures the output of the dash gate remains high during the transition. During intervals 5 and 6, the dash flip flop via the dash gate hold the collector of Q2 low. At the end of interval 6, the collector of Q2 has been low for 0.375 second, which is the normal dash length. At the beginning of the 7 interval, the T input to the dash flip flop sees another positive going clock pulse and, at this time, the dash flip flop resets causing a low out of the dash gate. This low is inverted by the skip gate and applied to the bit sequencer to advance the count to 2 or equivalently bit 3. In a similar manner, bit 3 and bit 4 of the first character are processed.

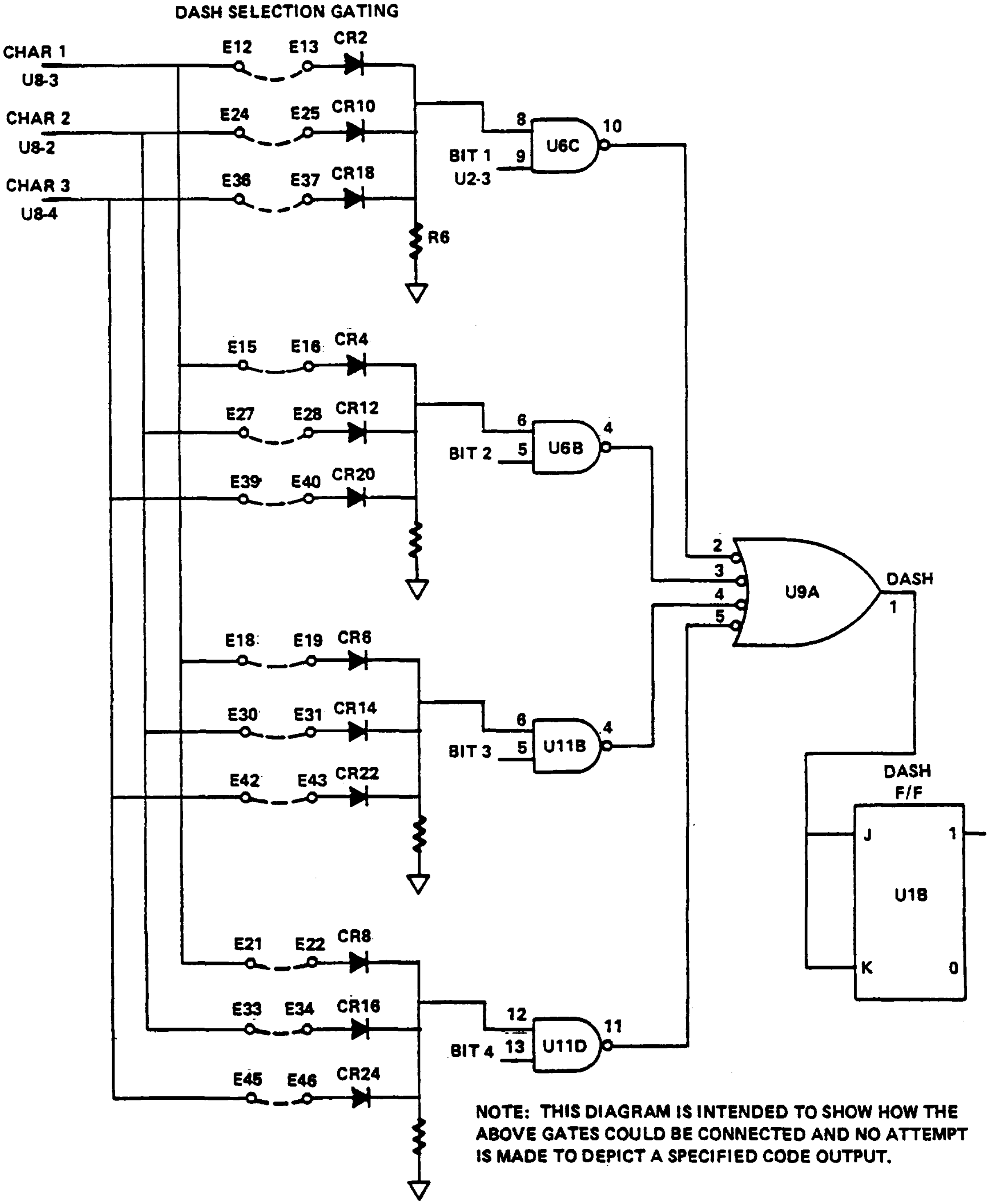


Figure 4.13. Dash Selection Gating

At the end of bit 4 and the start of time interval 13, the space between characters begins. At the same time, the bit sequencer is set to count 5 which produces a high on the end of character skip output from U2 pin 10. This high is inverted by U4A and applied to U9B, to produce the skip signal at the output This skip signal becomes the set input of the skip flip flop. However, the skip flip flop doesn't set at this time, as the dot width signal applied to its T input is low. Thus, during interval 13, the ident channel processes the low dot width signal producing a high on Q2 collector. At the start of interval 14, the dot width goes high setting the skip flip flop which provides a low to the skip gate disabling the dot generated by the low dot width propogating down the channel. The skip flip flop disables the ident channel for the intervals 14 and 15, which when combined with interval 13, a total of 0.375 second has elapsed since the fourth bit of the first character was terminated. At the start of interval 16, the dot width goes high resetting the skip flip flop (assuming the spacing flip flop is set). As the skip flip flop resets, a low going signal is produced at its Q output which is differentiated by C4 and R1O producing at output of the character advance gate, a positive going spike (waveform W) which advances the character sequencer 1 count producing in turn a high at the character 2 output (pin 2). The generation of the first two bits of the second character are identical with corresponding bits of the first character. Intervals 21, 22 and 23 represent a skip within a character which operates like the skip between characters described above except the skip flip flop set command is generated at interval 21 by the high bit 3 signal applied to gate U 1 B. The other input to gate U11B is high during the time the character sequencer outputs character 2. This is accomplished by applying the high character 2 signal via the jumper installed between E30 and E29 and CR 13. The resulting high skip command sets the skip flip flop at interval 22. At the start of interval 24, the skip flip flop resets and the count in the character sequencer advances to count 2, corresponding to the third character. In the example given, the third character is skipped entirely. This skip operation is similar to the aforementioned skips except the blank operation is used to skip the first bit During interval 24, the high character 3 signal is applied to gate U6D via the jumper installed between E36 and E35 and CR17. Also, the high bit 1 signal is applied causing a low output from U6D thus blocking the dot pulse which is propogating down the channel. Thus, even though the dot is blocked at U13B, it still advances the bit sequencer via the skip gate to the second bit at which the normal skip operation ensues.

To terminate ident, it is necessary to reset the code control flip flop. Note that at the end of the last skip (end of interval 27 and beginning of interval 28) the count in the character sequencer is advanced to 3 producing a high on the end of ident output (U8-3) which is then applied to the direct reset input of the code control flip flop causing the flip flop to reset and disabling the skip gate (U5B). This halts the processing of the dot pulses in the channel until the receipt of the next start of ident pulse.

The ident circuit card assembly can be used to produce a 5 dot space (.625 second) between the second and third characters. This is accomplished automatically by the logic level provided externally to the system No. 2 spacing selection input on Pin 2. For normal spacing, a logic high is applied to the input which holds the spacing flip flop in a set condition and the operation of the keyer is that already described. For the increased spacing situation, a logic low is provided which allows the state of the spacing flip flop to be controlled by either the char 1 signal from the character sequencer, or the skip flip flop.

To illustrate this operation, the previous example has been modified to make the third character a dash. Figure 4-14 shows the code selection gate programming necessary to accomplish this. Refer to figure 4-15 for the timing diagram corresponding to the increased spacing operation.

In order to have a normal space between the first and second character, it is necessary for the spacing flip flop to be set This is accomplished by applying the Char 1 output from the character sequencer through R20 which sets the spacing flip flop via the direct set input. Thus, for intervals 1 through 17, the operation is identical to that previously described. At interval 18, the spacing flip flop resets. With that exception, the operation up through interval 23 is identical with that previously described. At the beginning of interval 24, under the normal spacing situation, the skip flip flop would reset; however, under the extended spacing situation, it can't because the K input which is supplied from the spacing flip flop is low. Note that at the beginning of interval 24, the spacing flip flop sets as its set input is high being the Q output of the set skip flip flop. This does apply a high to the reset input of the skip flip flop but it doesn't react to this input until interval 26; at which time, the skip flip flop resets and the character sequencer is advanced to the third character. The space between the second and third characters encompasses intervals 21 through 25 which corresponds to 0.625 second.

During VOR/DME or VORTAC operation, gate U13B is disabled and gate U13A is enabled; however, the ident code isn't sent to the collocated DME or TACAN, rather a sync signal is sent This sync signal is generated by the setting of the code control flip flop at the start of ident. The resulting low signal from the code control Q output applied to U13A causes the collector of Q1 to go low. The collocated units use the leading edge of this low going signal to synchronize the generation of their respective ident codes.

b. Ident Oscillator/Modulator Mixer Circuit Card Assembly (reference figure 7-18). The ident oscillator circuit card assembly essentially provides two primary functions One, it takes the ident code generated in circuit card Al and uses it to gate the 1020 Hz ident oscillator to provide the ident tone signal. The other function is to sum together all the modulation inputs such as voice, ident code and subcarrier into one modulation signal.

The ident oscillator circuit card assembly operates with only positive supply voltages (+12 Vdc and +28 Vdc); thus, internally the signal reference isn't ground but rather a voltage 14 Vdc above ground. The signal reference is established by two resistor voltage dividers, R7-R9 and R19-R20. Modulation summing amplifier U1B performs the modulation mixing function summing the 9960 Hz subcarrier signal from amplifier U5B with the voice modulation from amplifier U1A and the gated ident tone from analog switches U2A and U2B. The output of U1B, the composite modulation, is sent to the modulator (A4A4).

The 9960 Hz subcarrier enters the circuit card assembly on pin 28 and then goes through a 5 pole active filter composed of amplifiers U5A and U5B to significantly reduce any 10 kHz harmonics present in the subcarrier. R10 is used to adjust the level of the subcarrier for proper carrier modulation percentage. One output of U5B exits on pin 24 and is used as an input to the monitor (A3/A6) in the 10 kHz direct position. The other output goes to switch S1 and then to the modulation summing amplifier. S1 is used to

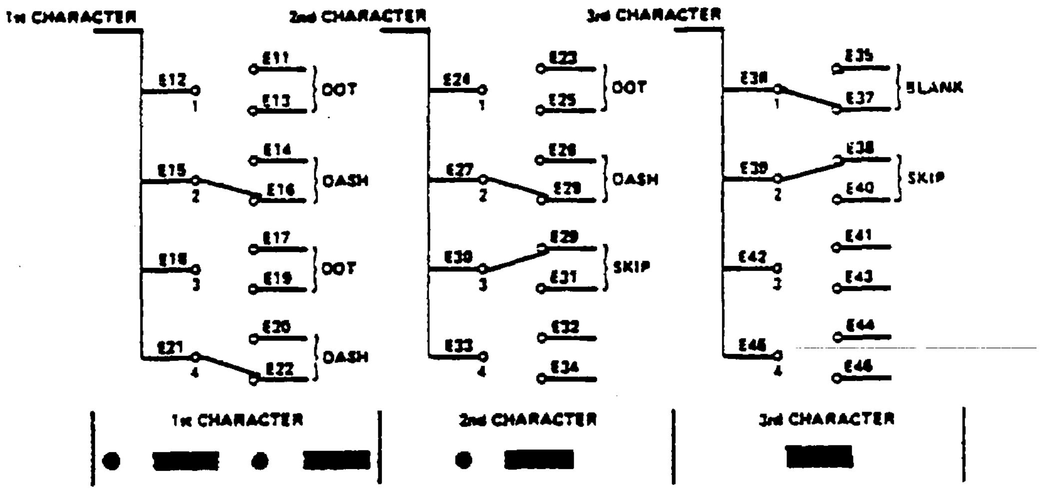


Figure 4-14 Code Selector Gates Wiring Diagram for Generation of Sample Code for 3 Characters

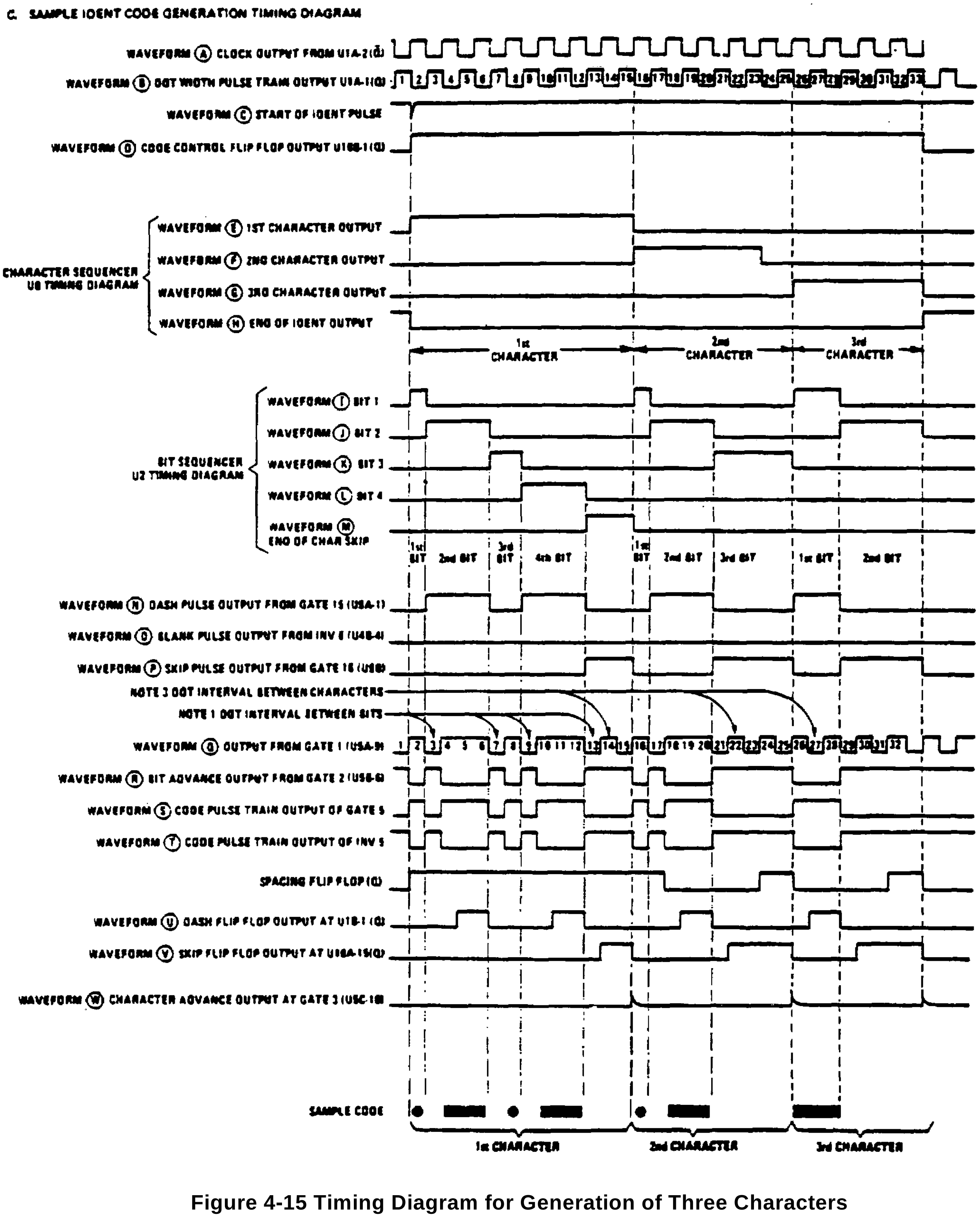


Figure 4-15 Timing Diagram for Generation of Three Characters

control the transmission of the subcarrier and is used during maintenance and calibration operations In the NORM position, the subcarrier is applied to the modulation summing amplifier and is modulated on the carrier output In the OFF position,the signal path between U5B and the modulation summing amplifier is broken and the subcarrier modulation is removed from the carrier output

The voice input is applied to pin 15 and routed through switch S2 to a limiter amplifier (U1A). The limiter amplifier ensures that the maximum modulation level due to voice is less than 30%. The limit level is adjusted by R16 and the relative modulation percentage level is controlled by R12. The limiter amplifier is a two stage limiter with the first or soft limit reached when zeners CR3 and CR4 break down. When this happens, the incremental gain of the amplifier is dropped in half. The second limit or the hard limit occurs when zener CR1 and CR2 break down causing the incremental gain of the amplifier to drop well below unity. S2 allows the removal of the voice modulation for maintenance and calibration purposes

The 1020 Hz ident tone originates in oscillator U4. The frequency determining elements of this sinewave oscillator are C18, R32, R35 and R34,where R34 is used to set the frequency to 1020 Hz. The output on U4 pin 2, is a sinewave riding on a +6 Vdc level. The 1020 Hz signal path splits and is applied through amplifier U3A and analog gate U2A on one path and through low pass filter R29 and C15, amplifier U3B and analog gate 112B on the other path. The output of amplifier U3A is the sinewave riding on the 6 Vdc level while the output of amplifier U3B is just the 6 Vdc level as the sinewave has been removed by the low pass filter.

Analog gates U2A and U2B are controlled by the ident code produced in the ident keyer circuit card assembly. The ident code enters the card on pin 14 and is routed to the control inputs of analog gates U2C and U2B. Analog gate U2C, in conjunction with R24, acts like a logic inverter so that U2A and U2B see complimentary logic signals on their control inputs. During the interval, a dot or dash is to be transmitted. The ident cbde input on pin 14 is low which opens analog gates U2B and U2C. When U2C opens, the voltage on the control gate U2A goes high via R24. This connects the output of U3A to the modulation summing amplifier. At all other times, the ident code signal on pin 14 is high which in turn closes analog gates U2B and U2C. Closing U2C shorts R24 to ground which gives a low to the control input of analog gate U2A causing it to open.

The net result is that the output of U3B is connected to the modulation summing amplifier, however, output amplifier U3B is a dc voltage. In fact, it is the precise dc voltage necessary to keep the dc level at the input to the modulation summing amplifier constant. A shift in the dc voltage at this point would manifest itself as a glitch in the received ident code. R21 is used to adjust the relative ident modulation percentage. S3, a three position switch, is used for maintenance, test and calibration purposes and in the normal position, allows the ident keyer to control the ident tone switching. In the off position, the control inputs to U2B and U2C are held high and the 1020 Hz signal is blocked regardless of the desire of the ident keyer. In the on position, the ident keyer is again overridden and gate U2A is turned on while gate U2B is shut off. This condition results in a continuous 1020 Hz tone being applied to the modulation summing amplifier.

Switches S1, S2 and S3 are all connected to the critical switch status line. Placing S1 and/or S2 In the OFF position or S3 in the OFF or CONT position will place a ground on the critical switch status line.

c. Oscillator/Exciter Assembly (reference Figure 7-19). This module is divided into two printed boards which ar separated by a metal partition. The oscillator is in one section, and three stages of amplification are In the other.

(1) Oscillator. The oscillator operates at the output frequency (108-118 MHz) with a crystal operating on the fifth mode. It is basically a Colpitts oscillator, with the series mode crystal in the feedback path, between the emitter of Q1 and the junction of C5 and C3. The collector tuned circuit is comprised of L1 (tuning adjustment) and the series capacitance of C5 and C3, paralleled with it Y1, the crystal, has about 30 ohms series impedance at the crystal resonant frequency, and the capacity of C3 is paralleled with some capacitive Impedance due to C7, C9, and the crystal resistance. Inductor L2 serves the purpose of resonating the crystal holder capacity, and preventing oscillation in the event of crystal failure. C9 is used
to pull the crystal frequency onto the exact nominal frequency. A counter must be used when tuning C9. 02 and its associated components form a buffer amplifier, which prevents feedback into the oscillator.

(2) Exciter. The exciter consists of three RF stages which amplify the RF signal to a level sufficient to drive the intermediate power amplifier. Output is around 0.5 watt, and has some variance across the band. No tuning is necessary, coils are factory adjusted to provide good performance across the VOR band.

(3) Power Supply. The final stages of the exciter are operated from- 12V. The other stages are operated from zener regulated voltages The purpose of this is to provide the best possible isolation for the low level RF amplifier circuits

d. Modulator Assembly (reference figure 7-20).

(1) Functions There are three inputs into the modulator: (1) 28V direct voltage from a power supply, (2) modulation signals, and (3) feedback from the detected RF output.

There are three operational outputs: (1) high level modulation for the RF power transistors (4 output and 1 driver), (2) low level modulation to two transistors in the intermediate power amplifier, and (3) regulated 12V to the circuit card assemblies and the oscillator/exciter.

There are five status outputs: (1) 28V to meter, (2) 12V to meter, (3) high level modulation current to meter, (4) low level modulation current to meter, and (5) envelope feedback to meter.

(2) 12 Volt Power Supply. A regulated 12 volt supply is required in the carrier transmitter. This is furnished by a regulator mounted on the modulator heat sink. It operates with 28V from the power supply applied to Its Input (pin 1 of U1). This Input Is routed through a transistor switch (Q15, TIP 126)

which is turned on by Q14 (2N2219A) which in turn is switched on by a positive voltage from the control unit This positive signal (applied to TB1-3) is labeled as enable. The effect of the positive signal from the control unit is to turn on Q14, Q15 and U1 applying 12V to the oscillator/exciter (which generates RF drive), to the ident keyer board, and to the ident oscillator board (which processes audio signals). The 12V also serves as a reference for the modulator circuits; therefore, the entire modulator switches on and off with the 12V supply, controlling the voltage applied to all RF transistors. Thus, the enable signal controls the transmitter output However, it does not control the 28V power supply. That module is separately controlled by a relay. The 7812 integrated circuit used in this power supply is rated at 1.0 ampere, is short-proof, and over-temperature proof.

(3) High Level Modulation. Five output terminals are devoted to the high level modulation: TB1-10, 11, 12, 13, 14. One of these, TB10, furnishes a meter input The other four supply current to the modulated RF transistors; four terminals are used because of the amount of current supplied. One wire is insufficient for carrying this current. The output is a modulated direct voltage; in the 100 watt transmitter, it is about 18V average and in the 50 watt version it is about 14V average. The direct voltage determines the power level of the transmitter output. To control this voltage, a reference voltage is derived from the 12V power supply with a voltage divider, R7 and R10. This is compared to a feedback voltage sample from R22. The two voltages are applied to opposite sides of a differential amplifier, comprised of Q5 and Q6. The reference voltage turns on Q5 which causes the output of the modulator to rise in a positive direction. A portion of this modulator output is fed back to turn on Q6. As Q6 turns on, it applies voltage to R11,
which tends to turn off 05. A balance occurs when the sample of the feedback voltage equals the sample of the reference voltage. The output is varied by controlling the portion of output which is fed back. R22 provides this capability. In the test position of S1, the feedback voltage comes from output of the modulator; however, in normal position, it is derived from the RF output of the transmitter. Audio modulation is fed into the base of Q5. It varies the reference voltage at this input, causing the modulator output to vary. The feedback, mentioned above, also stabilizes audio gain and minimizes audio distortion.

The differential amplifier, Q5 and Q6, provides current for Q1 which drives the modulator output transistors. The output transistors, Q2, Q3, Q4 and Q7, are connected in parallel with 0.1 ohm resistors connected in series with the emitters, to help maintain proper current sharing. One of these resistors, R13, also is used to sense output current. This is both fed to the meter, by way of R29 and R30, and also used for the current limiting circuit.

(4) Low Level Modulator. The final RF transistor, in the power amplifiers and the final transistor in the intermediate power amplifier are modulated by the high level modulation. However, this is too high a level for the first two stages of the intermediate power amplifier. Therefore, a lower level output is provided. Q11 and Q12 are connected in a Darlington configuration and serve this purpose. The high level modulation is impressed across potentiometer R18. A portion of it is used to drive the low level modulator, whose output is an in-phase, reduced amplitude, replica of the high level modulator output An 0.1 ohm resistor, R20, is connected in series with the output of the low level modulator and is used to sense output current One current sensing output is fed to the meter via R32.

(5) Limit Circuits. Protection circuits are included which will switch off the modulator in the event of any one of three following conditions occurring: (1) An overcurrent condition occurring on the high level modulator output is detected by Q10 which turns on when current through R13 becomes sufficient to cause the voltage across R35 to exceed the Q10 base-emitter threshold. When Q10 turns on, it pulls current through Q8, turning it on. This applies current to the gate of SCR Q9, and triggers it. When Q9 is triggered, it turns on, and remains on and reduces the voltage on the base of Q5 to a value less than 1 volt Because this removes the reference voltage from the differential amplifier, the modulator is shut down. Sufficient current is supplied through R36, from the 28V supply, to cause the SCR to remain in conduction. Turning off the 12V supply will allow the SCR to recover. Therefore, the modulator must be turned off, and then on again, to recover after an overcurrent condition. (2) Overcurrent occurring on the low level modulator output is sensed across R20 by Q13 which also will turn on Q8. (3)Overvoltage is sensed by zener CR2, which will also trigger Q9. The zener is an IN5257B which has a zener voltage of 33V.
Therefore, a voltage of slightly more than 33V will trigger the SCR. The presence of such a voltage at the output of the modulator would be an indication of a failure in both the power supply and the modulator.

e. Intermediate Power Amplifier Assembly (IPA) (reference figure 7-21). The IPA consists of three stages of RF amplification, which amplify a low level signal (0.3 to 0.8 watt), up to about 25 watts level, at the same time being collector modulated to produce a drive level sufficient for the power amplifiers. The input is an unmodulated CW from the oscillator/exciter.

(1) Collector Voltage/Modulation. The final stage is a transistor of the same type as that used in the power amplifiers and it operates at nearly the same power level. The same voltage is used on the collector which is the high level modulation. The first two stages use the low level modulation, which is adjustable in relation to the high level modulation, and may typically be 14 to 16V. Modulation is impressed on all three stages.

(2) Impedances Input and output impedances are matched to 50 ohms impedance. The module can, therefore, be tested and operated out of the transmitter.

(3) Tuning. Three of the transmitter tuned stages are in the IPA. The principal purpose of this tuning is to reduce unwanted harmonics of the 10 kHz modulation; and these can be seen only with a high resolution spectrum analyzer. Therefore, they are never tuned in the field unless such equipment is available, or unless absolutely necessary. In the latter case, the tuning can be done by tuning for maximum RF output However, it must be understood that this will not necessarily produce the optimum results.

f. Power Amplifier Assembly (reference figure 7-22). Each power amplifier module contains two power transistors, each of which is rated at 100 watts of RF output. These are securely mounted to a heat sink which exhausts the heat from the transistor cases and transfers it to the air, which moves past the heat sink by natural convection. Each power amplifier is mounted edgewise on the chassis, to facilitate this air movement Each transistor operates with about 18 Vdc on the collector in the 100 watt transmitter, or 14 Vdc in the 50 watt version. Each produces more than 25W of R F power with something less than 5W of drive. Due to modulation of both the collectors and the input RF, peak power output reaches about 75 watts for each transistor. To help compensate fornonlinearities in the characteristics of these and other transistors, envelope feedback is applied to the modulating circuits.

The two transistors are driven in phase from a common input and the outputs are combined for a common output Both the divider and the combiner, which are identical, are Wilkinson power combiner circuits identical to those used in the power divider/combiner modules. These are described under the power divider/combiner paragraph. Since the two transistor circuits are alike, only one will be described. The junction of Z1 and R1 is at a 50 ohm impedance level. That is, a 50 ohm resistive load could be placed from this output to ground and would absorb all of the power at that port. The input impedance looking into the junction of L2 and C18 is a resistive 50 ohms at the frequencies of interest. The components, L2, C18, C3, and C4, are not the entire matching network. These are mounted on a printed circuit board, and the printed paths on the board provide inductors which are part of the network. The input impedance of Q1 is low (about 0.75 ohm) and therefore the inductance values required are also low. Actual inductance values are not shown. The placement of C3 and C4 is used to effect a division of inductance in the circuit and measurement of the inductance is not normally made. The output circuit consists of L3, L1, C17 and C8. C5 and C6 are bypass capacitors, L3 is the collector inductor through which power is applied to the collector and C17 is a dc blocking capacitor. L1 and C8 match the collector impedance to the 50 ohm load impedance at the junction of Z2 and R3. The collector impedance is that value of impedance which allows the required power to be generated with a given value of voltage across the collector - in this instance, about 12 ohms.

g. Directional Coupler Assembly. The directional coupler performs two functions: (1) it provides a sample of carrier output for use in the sideband transmitter, and (2) it provides a sample of carrier output for use in the ALC and metering circuits. This output is detected by a diode detector circuit mounted on the module. Each of the two outputs is 20 dB below the carrier level and is a sample of forward power (to the antenna) only. The coupler is built using a strip transmission line. The conductors are copper foil on epoxy glass board, which is mounted above a ground plane. Impedance of the resulting coaxial line is 50 ohms. Each of the coupled lines is also 50 ohms impedance and are terminated at one end with 51 ohms resistive load and at the other end with the output load.

h. Low Pass Filter. The low pass filter has only one function; it suppresses harmonics of the RF carrier frequency which may be present at the output of the carrier transmitter. The filter is a 7-pole circuit and suppresses the second harmonic of the carrier by more than 40 dB. Because the second harmonic is already much more than 20 dB below the carrier at the output of the power amplifiers, this is sufficient. Third and higher harmonics are suppressed by more than 60 dB. Input and output ports are matched to 50 ohms impedance. The filter is a factory adjusted module and should not normally be repaired in the field. If replacement of a capacitor should become absolutely necessary, it should be done with care to avoid distorting coils.

SECTION VI

SIDEBAND TRANSMITTER

4-12. FUNCTIONAL OPERATION (reference figure 7-24). The sideband transmitter performs the following functions:

a. Provides the 9960 Hz subcarrier frequency, modulated by the 30 Hz reference signal to the carrier transmitter.

b. Provides a pair of double sideband, suppressed, carrier, modulated RF signals (referred to as sideband A and sideband B).

The following provides a block diagram discussion of signal flow within the sideband transmitter (reference figure 7-23).

The reference and subcarrier generator circuit card assembly, 1A5A1, generates two major outputs: a 30 Hz variable signal and a 9960 Hz subcarrier signal. Both signals are derived from a crystal-controlled oscillator in the divide-by-65336 frequency divider circuit. The output of the oscillator is divided to produce the 30 Hz squarewave at terminal 1A5E2. This signal is then routed through a harmonic filter to produce a low-distortion 30 Hz sinewave.

The 30 Hz sinewave is applied to a variable gain amplifier which is used to adjust the transmitted variable modulation level. The amplitude of the sideband A and sideband B outputs from the R F amplifiers change in direct proportion to a change in the 30 Hz variable signal amplitude. This occurs because the 30 Hz sinewave is the reference for the feedback control loops in the modulation control assembly, 1A5A4, and directly controls the amplitude and modulation envelope shape of the. sideband outputs of the RF amplifiers, 1A5A2 and 1A5A3.

The 30 Hz sinewave from the harmonic filter is also connected to a bearing phase shifter and is controlled by bearing adjust potentiometer 1A5R1, located on the meter bracket inside the sideband drawer. The nominal phase shift through the phase shifter is -45°. By adjusting the bearing adjust potentiometer, the phase can be varied at least + 100 from this nominal value.

The output of the bearing phase shifter is routed through a switch (S1) which controls the deviation.
In the NORMAL position, the 30 Hz sinewave goes through to a summing amplifier and in the OFF position, the path is interrupted, removing the 30 Hz deviation from the 9960 Hz subcarrier for troubleshooting or calibration purposes. When applied to the phase locked loop, the 30 Hz reference signal frequency modulates the internal VCO.

The summing amplifier is part of a frequency control loop used to control the 9960 Hz subcarrier frequency. This is accomplished by dividing the 9960 Hz output from the address generator by 332 This process removes any frequency modulation present in the 9960 Hz output. The resultant 30 Hz signal is used in the phase locked loop to lock the subcarrier with the 30 Hz square wave output from the frequency divider circuit

The 9960 Hz subcarrier is synthesized digitally. The VCO in the phase locked loop runs at 16 times the frequency of the subcarrier or approximately 160 kHz. The output of the VCO is applied to the address generator which generates 16 different addresses at a 9960 Hz rate which are applied to the sinewave synthesizer. Each address produces a certain voltage level on the output of the synthesizer. These voltage levels are selected so that a stepped approximation to a sinewave is produced at the output of the output amplifier at a 9960 Hz rate. The signal is then sent to the carrier transmitter.

The purpose of the modulation eliminator assembly (1A5A5) is to take the amplitude modulated carrier phase reference (which is a sample of the signal being transmitted) and produce a clean RF signal, of the proper phase and amplitude, for use in the sideband modulation process. This is accomplished in the modulation eliminator by hard limiting the carrier phase reference which strips off the amplitude modulation and by sending the stripped signal through an adjustable RF phasing network. The RF phasing network is adjustable over a 0° to 180° range. The stripped and properly phased signal is then amplified in a three stage amplifier to the proper level and is then routed to the modulation control assembly (1A5A4) for further processing.

The modulation control assembly consists of two essentially identical channels for controlling the generation and amplification of the sideband A and B signals. In addition, this module contains a 90° nominal phase shifter for establishing the quadrature phase relationship between the modulation envelopes of sideband A and B. Also included is the capability of shifting the phase of the 30 Hz variable signal by 180°. This discreet shift of 180°, in conjunction with the 180° variable phase shift in the modulation eliminator assembly, allows for varying the RF phase shift between sidebands and carrier from 0° to 360°.

Both the A and the B channel inputs are applied through a switch which provides the capability to turn off each channel independently. In normal position, the 30 Hz signal is applied through an adjustable remistor a one Input to a summing junction. The adjustable resistor provides the capability to Independently adjust the output power of a particular channel. The other input to the summing junction Is a sample of the 30 Hz envelope which is actually being transmitted. These two Inputs are summed and the error Is amplified by the amplitude error summing amplifier. The output of the summing amplifier Is applied through a 0° or 180° audio phase network to a double sideband RF modulator.

One of the Inputs to the modulation control assembly Is the RF reference from the modulation eliminator assembly. This Input is applied through J3 to a four-way power splitter (i.e., four equal output amplitudes). Two of the splitter outputs go to the A modulator and B modulator circuits. The other Inputs to these modulators are the 30 Hz error signals discussed previously. The net output of each modulator is a double sideband suppressed carrier output signal. The other two outputs ;from the four-way splitter are applied to the A and B amplitude and phase detector circuits. The detectors are phase sensitive and require a phase reference for proper operation.

The other inputs to the amplitude detector and the phase detector are provided by thequadrature hybrid. A sample of the output signal from the RF amplifiers comes in at J2 and goes through the quadrature hybrid. The quadrature hybrid splits the signal into equal parts and adds a 90° RF phase shift to one of the parts. The signal without the 90° phase shift added reports to the amplitude detector. When the double sideband amplitude modulated signal sample coming from the RF amplifier is mixed with the unmodulated RF frequency in the detector, the output is a 30 Hz sinewave representing the modulation envelope.

The other output of the quad hybrid, which is the 90° output, is applied to the phase detector. If there is truly a 90° phase relationship between the RF reference on the phase detector and thequadrature hybrid 90° output, then a null condition will exist on the output of the phase detector. If there is any other phase relationship, an error voltage proportional to the phase difference will be generated in the form of a sinewave. Therefore, when the phase detector output is driven to a null, the two inputs to the amplitude detector are in the same phase with the detected voltage as a maximum and the two inputs to. the phase detector 90° apart.

The output of the phase detector is applied to a synchronous demodulator. Essentially, the synchronous demodulator circuit multiplies the sinewave output of the phase detector and by a chopping signal derived from the output of the demod driver which, in turn, is driven from the output of the amplitude error summing amplifier.

The output Of the synchronous demodulation circuit is a dc voltage with an amplitude proportional to the R F phase error. The error voltage is applied to a phase error integrator and the integrator output is used to control an RF phase shifter in the RF amplifier to shift the RF phase in the direction that causes the output of the phase detector to approach a null.

Two identical RF amplifier assemblies (A2 and A3) are used to boost the power level of the signal produced at the modulator from -5 dBm to +36 dBm. The RF phase of the output signal must be in phase with the carrier signal after the amplification has taken place. To accomplish this requirement, two phase shifters are incorporated in each amplifier. One phase shifter acts in conjunction with the 180° RF compensation circuit in the modulation control to compensate for insertion and frequency (channel) dependent phase shifts. The other phase shifter is electronically controlled and is the control element in the phase control loop. The amplifier has a directional coupler in the output line that is used to obtain a sample of the output signal for use in the amplitude and phase control loops.

4-13. DETAILED CIRCUIT CARD DESCRIPTIONS. The following subparagraphs contain detailed descriptions of the circuit assemblies in the sideband transmitter.

a. Reference and Subcarrier Generator Circuit Card (reference figure 7-24). This card performs three basic functions as follows:

(1) Generates a crystal controlled, low distortion, 30 Hz sinewave. This signal is referred to as the 30 Hz VAR signal.

(2) Generates a crystal controlled, low distortion frequency modulated 9960 Hz (center frequency) sinewave. The modulating signal is a 30 Hz sinewave. This signal is referred to as the 9960 Hz subcarrier.

(3) Provides a modulating 30 Hz sinewave that lags the sinewave in (1) by 450 nominal and is adjustable ±5° around this nominal phase shift. This signal is referred to as the 30 Hz reference signal and the adjustment is referred to as the bearing adjustment, 30 Hz variable signal generation. The crystal controlled frequency reference is provided by U3 which is a combination, 14-stage frequency divider and oscillator. In this particular case, the crystal Y1 output frequency of 1.96608 MHz is applied to the frequency dividing portion of U3 which divides it by 16,384 to produce 120 cycles at the output of U3 pin 3. This 120 cycles is then divided by U4A to 60 cycles, and further divided by U4B to 30 cycles This 30 cycle squarewave is applied as one input to the phase detector section of the phase locked loop, U8, providing the frequency reference for the 9960 Hz subcarrier generator.

The other output of U4B is applied across C5 where the dc component is removed. The resulting squarewave is applied to an active filter composed of U2B and U2A. The function of this filter is to remove all of the frequencies above 40 cycles from the squarewave, leaving only a 30 Hz sinewave fundamental component The output of U2A is thus a fairly low distortion, 30 Hz sinewave with a crystal controlled frequency.

The output of U2A goes two places. In one case, it goes to an output amplifier, U1A, through potentiometer R2, which controls the amplitude of the 30 Hz VAR signal.

Varying the amplitude of the 30 Hz VAR will cause both sideband A and B RF outputs to vary in power together. Thus, this control is used to adjust the 30 Hz VAR modulation percentage on the radiated VOR signal.

The other output of U2A goes to the bearing adjust phase shifter to be discussed later.

(1) 9960 Hz Subcarrier Generation. The subcarrier generator circuit is composed of U7, U8, U9 US, US and U1O plus a frequency divider composed of U14A, U11, U12 and U13. This circuit can be

broken into two parts: one part which determines the frequency of the 9960, and the other part which determines the wave shape. The frequency determining parts are U7, U8, U9, U14, U11, U12 and U13. The output of U8 pin 4 is a nominal 160 kHz signal. This output is applied to pin 15 on U9 which is a 4-bit binary counter that divides the input frequency by 16. The output of U9 pin 2 at 10 kHz (160 kHz divided by 16) is applied as an input to the frequency divider chain U14, U11, U12 and U13. The division factor of the chain is 332, producing a 30 Hz pulse train at test point FL for a 9960 Hz input signal. The FL pulse train becomes the second input to the phase detector section of phase locked loop U8.

The phase detector has two inputs, a 30 Hzsquarewave on pin 14, and a frequency around 30 Hz on pin 3. The phase detector will produce an output signal that is indicative of the difference in frequency and phase between the two signals This output comes out on pin 13 of U8. If the frequency of the input on pin 3 is higher than the reference frequency on pin 14, the phase detector output is high. If the input frequency on pin 3 is lower than the reference frequency on pin 14, the phase detector output is low. If the two are equal in frequency, the phase detector output is a pulse train with a pulse width that is proportional to the phase difference between the two signals. The polarity indicates whether it is a leading phase or a lagging phase. The net result is to provide a proportional correction signal out of pin 13 which is applied through the compensation network of R25, C13 and R26 as one of the inputs to summing amplifier U7. U7 amplifies the compensated signal and applies it as a correction signal to pin 9 of the VCO section of phase locked loop U8. This completes the loop closure of the VCO frequency control loop, causing the VCO to shift frequency and phase so that the input signals on the phase detector are both equal in frequency and phase. This is done to get a 9960 kHz signal with a center frequency stability of ± 0.1% plus the ability to frequency modulate the subcarrier.

When the subcarrier is frequency modulated, the output of the VCO varies in frequency but the output at FL is a fixed frequency when the loop is locked.

The 30 Hz reference signal used to frequency modulate the subcarrier is applied to summing amplifier U7 through R21.

Therefore, the input to the VCO has two components. It has a dc component which is used by the loop for phase locking purposes, and has impressed upon it, via the summing action of U7, a 30 Hz reference sinusoid which puts the small ac signal on top of the dc on pin 9 of U8 and is used to frequency modulate the VCO.

The waveform generation section of the subcarrier generator is composed of U9 (it shares a dual function), U5, U6 and U10. Basically, it is a digital analog converter that switches in the appropriate resistor networks at the right time via the U6 multiplexer. There are four networks. One network is composed of R11 and R12. Another network is composed of a short circuit between pins 1 and 12. The third network is composed of R13 and R14 and the fourth network is composed of R17 and R18. Each network is applied twice during a cycle, but with different signal levels from U5A. For example, the top network is applied when channel 2 switch or when channel 5 switch is closed on the multiplexer. When channel 2 switch is closed on the multiplexer, the output of U5A is high. When channel 5 switch is closed on the multiplexer, the output of U5A is low. This level change is accomplished by U5A which is driven off the squarewave coming out of U9. U9 also generates the multiplexer address on Q1, Q2 and Q3 outputs which determines which multiplexer switch is going to be closed. Timing diagram 4-16 shows the waveform generation.

(2) Bearing Adjustment Circuit This circuit, consisting of U 1 B and associated components R22,
C12, R19 and R15, is an adjustable phase lag circuit. The adjustable portion of the circuit is a 10 turn potentiometer (R1) located on the meter bracket immediately behind the front panel. The nominal phase lag of this circuit is 45° which can be varied ± 5° by the external control. This adjustment is used during flight check operations to allow final aligning of the station. The output of U1B is applied to potentiometer R20 which controls the amplitude of the 30 Hz reference signal applied to the VCO. By changing the adjustment, the FM deviation ratio can be adjusted to the required value of 16:1.

b. RF Amplifier Assembly (reference figure 7-26). The purpose of this assembly is to take a 0.3 mw double sideband modulated signal input at J1 and produce up to a 4 or 5 watt doublesideband modulated signal with as little phase shift and amplitude distortion as possible at the output J2.

Starting at J1, the input signal goes into the first phase shifter. This circuit is composed of hybrid U2 and tuned circuits L16, CR5 and L18, CR6. Diodes CR5 and CR6 arevaractor diodes and are operated with reverse bias at all times.

The first phase shifter is part of the RF amplifier insertion phase compensation network. The phase shift is controlled by varying the C of the LC tuned circuit This is accomplished by changing the back bias on varactor diodes, CR5 and CR6, which results in a capacitance change. The higher the reverse voltage on CR5 and CR6, the less capacitance.

The function of the first or variable phase shifter is to compensate for 0° to 180° of the frequency dependent insertion phase. Regardless of what the insertion phase happens to be, this will remove at least 0° to 180° of it The remaining 180° insertion phase is removed on the modulation control and will be discussed later. The setting of potentiometer R21 is varied to change the compensation phase.

Next. the signal is sent to the second phase shifter composed of U1, L1, L3, CR1 and CR2. This circuit is like the first only the reverse bias across varactor CR 1 and CR2 is controlled electronically as part of the phase control loop.

The output of U1 at pin 4 is applied to an attenuator composed of R6, R7 and R8 and then to the first stage. The first stage, Q1, is a class A amplifier stage which provides linear amplification of the low level signal. The output of Q1 is applied through matching networks C15, C38, C21 and L11 to the base of Q2. The second stage, Q2, is a class AB stage with the base bias stabilized by the network L23, L22, R10,

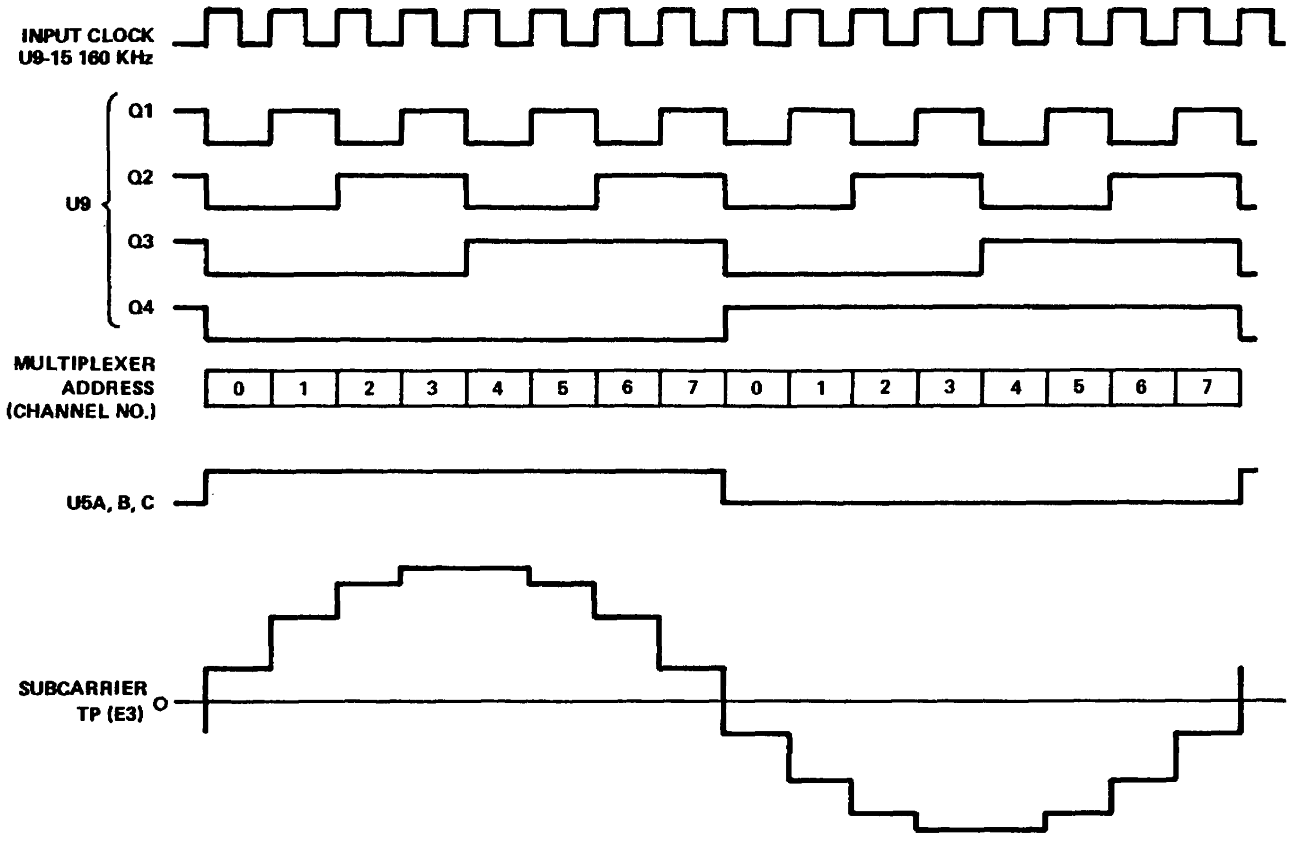


Figure 4-16. 9960 Hz Subcarrier Generator Timing Diagram

R14, half of CR3, R12 and R16. Potentiometer R16 is varied to change Q2's base voltage and hence set the no signal collector current at 5 to 10 milliamps.

Both Q2 and CR3 are mounted to an underlying heat sink so they are thermally connected. Consequently, any changes in temperature of Q2 which would normally change the collector current are sensed by CR3 and partial compensation results.

The output of Q2 is then applied to the third stage class AB amplifier. The third stage amplifier, Q3, has a bias circuit similar to the second stage; however, the no signal collector current is set for 25 milliamps The output of Q3 is then applied to a 7-pole low pass filter which is used to pass the fundamental 108 to 118 MHz and block the second harmonic and higher harmonics. The output of the filter is applied to the directional coupler (DC1) with the main line being the primary output signal at J2. The coupled output is used as the source for feedback data which is applied back to the modulator control assembly via J3.

In order to provide a stabilized operation, the collector supply for the second and third amplifier stages is provided from voltage regulator U3 attached to the common heat sink.

c. Modulation Control Assembly (reference figure 7-27). The modulation control unit is split into two essentially identical channels referred to as the A and B channels. The operation of channel A will be described in the following discussion.

The RF reference from the modulation eliminator enters the modulation control on P3 and is sent to U11, a four way power splitter. The four outputs of U11 are equal in amplitude and have the same RF phase. Two of the outputs go to the A channels and two go to the B channel.

In each channel, one of the outputs is used as the reference for the balanced modulator (U3 or U14) while the other is further split and applied as the reference to the amplitude detector (U4 or U15) and the phase detector (U6 or U17).

The 30 Hz VAR signal which is used as the standard in the closed loop modulation process (i.e., the modulation envelope is forced to match the 30 Hz VAR signal in phase and form) is either applied directly to the modulation loops (with the exception of a 90° phase shift in channel A to be discussed later) or with a 180° phase reversal (provided by U1B) depending on position switch S3. Changing the phase of the 30 Hz VAR signal at this point has the effect of or is equivalent to shifting the RF phase of both sidebands with respect to the carrier. This feature, in conjunction with the 0° to 180° adjustable phase shifter in the modulation eliminator, allows phasing the carrier and sidebands over a 360° range.

From S3, the signal is sent directly to B channel control switch S4 and to thequadrature phasing circuit, U1A. This phasing circuit satisfies the requirement of having the modulation envelopes of the two sideband outputs differ in phase by 90°. This is accomplished by providing a 90° phase shift between the standards sent to the A and B modulation loops. Thequadrature phase can be adjusted + 50 around the nominal 90° by potentiometer R4.

Switch S1 is used to apply the 30 Hz VAR standard to the closed loop modulator in the NORM position. In the OFF position a "zero" signal is applied and the sideband output signal goes to zero. S1 thus provides a means of turning channel A on or off. The output of U1-12 is applied to potentiometer R5 which is part of an input resistance to summing amplifier U2A. The other input to U2A comes from amplitude detector U4 via R10 and R11. As will be shown in ensuring discussions, the signal at the output of the amplitude detector represent. he modulation envelope being transmitted. By comparing the detected signal from the amplitude detector with the standard, deficiencies in the modulation envelope can be determined and corrections made. The three parameters the control loop corrects for are 30 Hz phase shifts in envelope, envelope distortion as compared to the standard and output power as represented by amplitude of the detected signal. U2A performs the role of the comparison element for the control loop. The standard and the detected signal are fed into U2A in opposite phase such that U2A performs a subtraction on the two signals and amplifies the difference signal which is eventually used to modulate the U3 modulator. This difference signal represents the discrepancy between what is desired (the standard) and what is actually being transmitted (the detected signal). Because of the distortion introduced by the RF amplifiers, the difference signal in normal operation looks distorted. In other words, the signal applied to modulator U3 is predistorted in such a manner that the additional distortion in the RF amplifier exactly cancels this predistortion to produce a low distortion envelope.

Between the output of summing amplifier U2A and modulator U3, lies switch S2 and amplifier U2B. The function of these elements is to provide either 0° or 180° of phase shift to the difference signal depending on the position of S2. This accomplishes the same effect as a 180° RF phase shift in the RF amplifiers and is used in conjunction with the 0° to 180° insertion phase compensation network in the RF amplifier to provide 0° to 360° R F phase shift cancellation capability. There is no preferred position of S2 as the position is a function of frequency.

Modulator U3 is a balanced modulator that performs the double sideband modulation process The two Inputs to the modulator are the 30 Hz difference signal (predistorted) and the RF reference from the power splitter. The output Is a suppressed carrier doublesideband modulated signal that Is a low power version of the required high power sideband A output signal (reference figure 417).

The RF amplifier provides the necessary power gain to achieve the required power levels In doing so, Inevitable envelope distortion results To complete the closing of the amplitude control loop, a sample of the RF amplifier output is brought back to the modulation control on P6 and sent to US, a quadrature hybrid. The hybrid splits the Input signal into equal amplitude outputs but provides a 90° RF phase shift between outputs The 0° output is sent to amplitude detector U4 while the 90° output goes to phase detector U6.

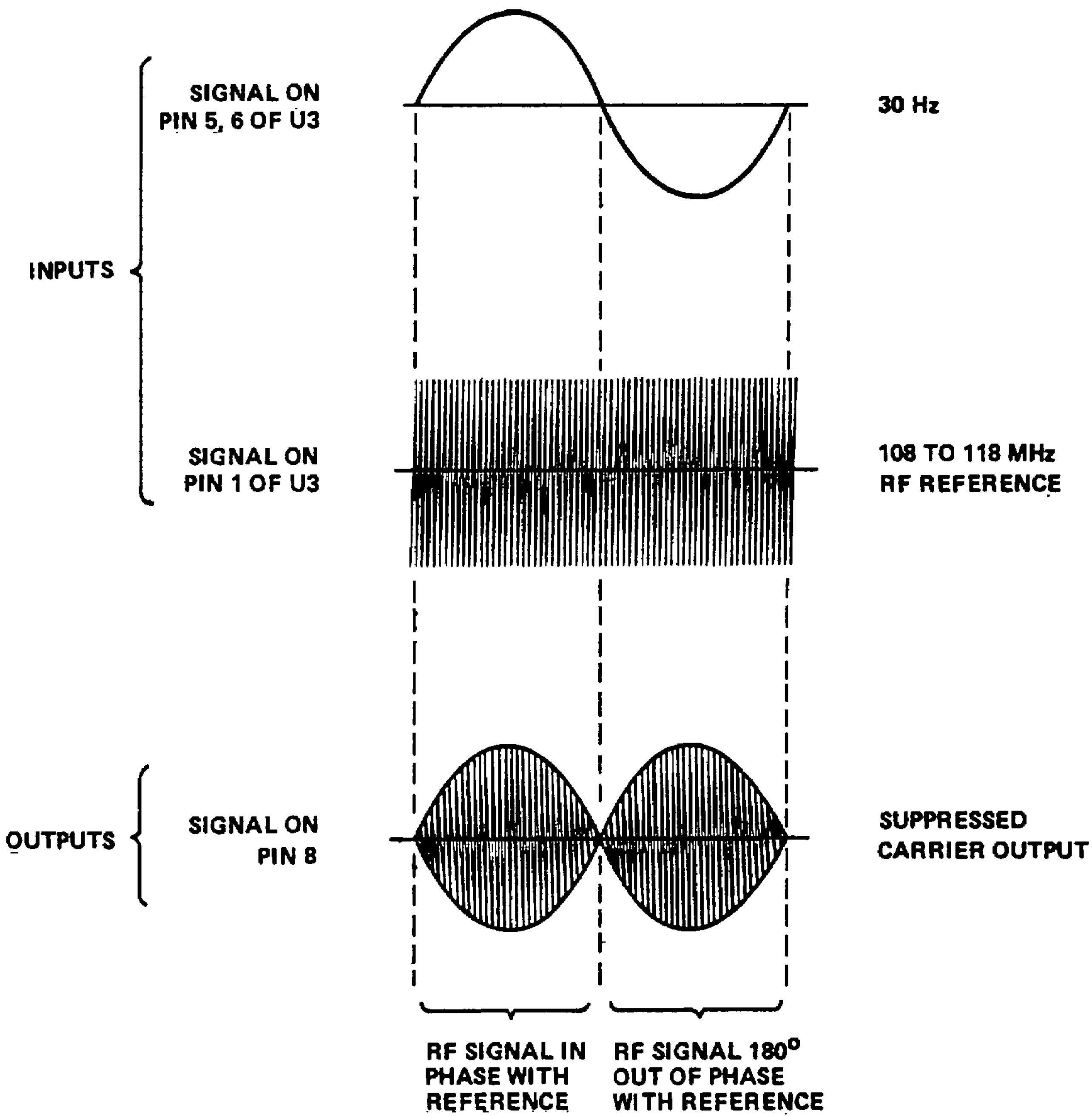


Figure 4-17 Suppressed Carrier Output Waveform Diagram

The amplitude detector thus has as its inputs a sample of the sideband output and an unmodulated RF reference signal from U11. The output of the detector is the modulation envelope (a 30 Hz signal), but the amplitude depends on the cosine of the RF phase angle difference between the two input signals The amplitude will be maximum when the phase angle is equal to zero. Because the detected signal amplitude is used as a reference for controlling the sideband output power (a very critical parameter), it is necessary that the amplitude of the detected signal be related by a constant proportion to the output power and not vary as the phase angle difference between the two input signals to the amplitude detector. This requires that the phase angle between inputs be fixed and furthermore, that it remain constant at the fixed value. The mechanization chosen for the sideband transmitter uses 0° as the phase angle and in order to maintain the phase angle at zero, a phase control loop is added.

Phase detector U6 operates similarly to the amplitude detector, but the RF sample is shifted 90° by U5. As the amplitude of the detected signal is proportional to the cosine of the phase angle between inputs, the detected signal will be at a null if the phase angle is 90°. Under these conditions, the phase angle to the amplitude detector will be the desired 0°. The strategy then is to control the RF phase shift of the RF amplifier such that the two signals at the inputs to the phase detector are 90° apart causing a null on the phase detector output When this occurs, the two input signals to the amplitude detector are at the desired 0° relationship.

If the inputs to the phase detector aren't 90° apart, the output is a 30 Hz signal whose amplitude increases as the phase shift increases and whose phase (either 0° or 180°) when compared to the phase of the 30 Hz applied to the modulator U3 (pin 1), determines whether the RF sample phase is leading or lagging the reference phase. The phase shifter in the RF amplifier requires a +2 to +15 Vdc control signal for proper operations Thus, it becomes necessary to convert the 30 Hz phase detector output to a dc signaland to change the level of the dc signal in a direction (increasing or decreasing) that is dependent on the 30 Hz phase of the phase detector output.

The above requirements are met by synchronously detecting the phase detector output. Basically, this is accomplished by chopping the output with analog gate U7B which is driven by the output of U2A squared up by comparator U 18. Depending on the phase of the 30 Hz error signal from the phase detector, the output of U7B is either the positive halves or negative halves of the phase detector 30 Hz output signal. The resulting halfwave rectified signal is amplified by U8A and applied as an input to integrator U 12A. The dc component in the halfwave rectified signal will cause the integrator to change its output voltage in such a direction as to shift the sideband output signal phase so that the phase detector input signals approach 90° phase shift between them and cause a resulting null on the phase detector output. The integrator stores the necessary dc voltage on C7 to keep the sideband phase at the null producing value. Figure 4-18 describes in detail the synchronous detection operation.

In order to remove the ambiguity present in the phase error control loop, the loop has a protection circuit that senses if the loop is trying to correct in the wrong direction. This is accomplished by

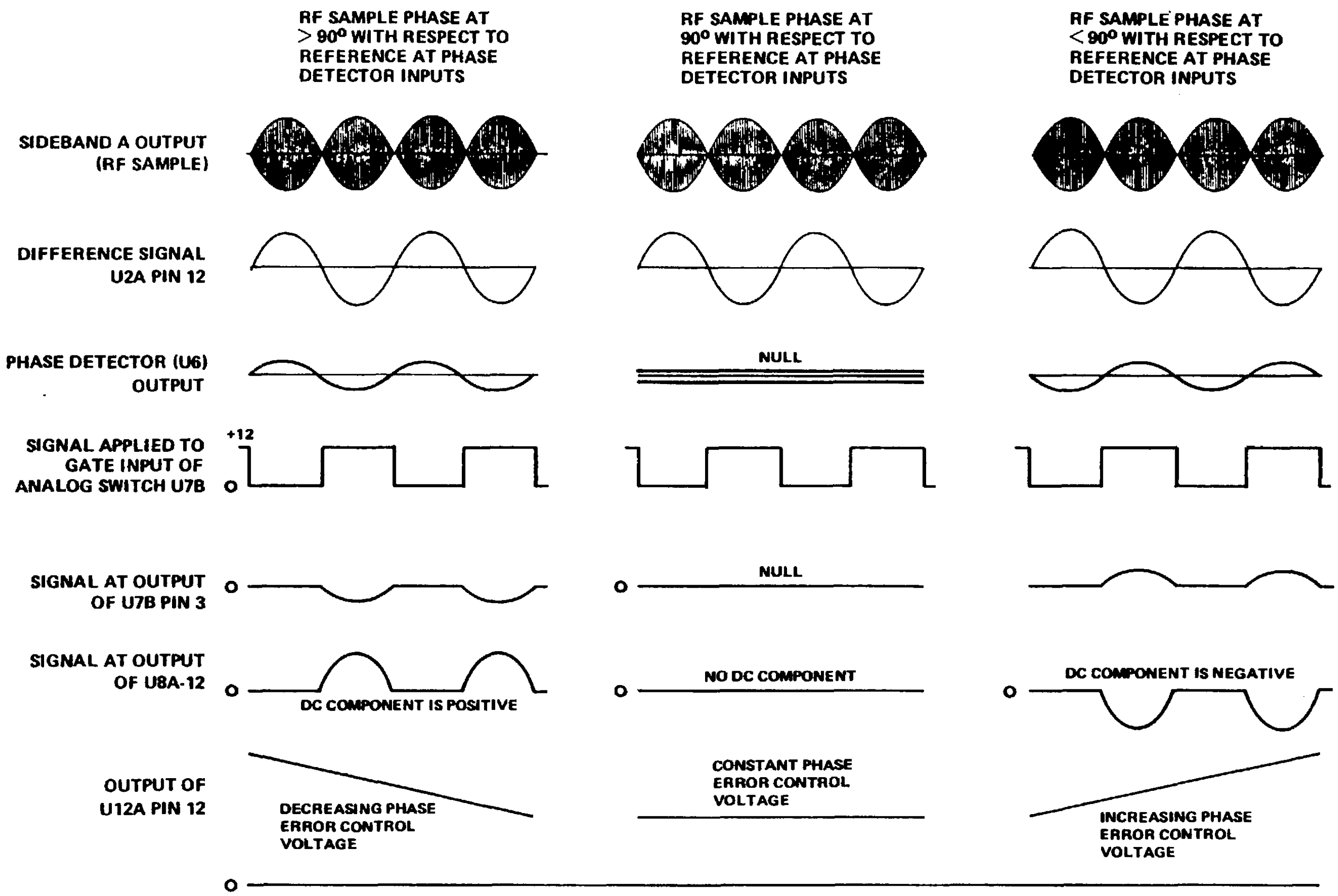


Figure 4-18. Subcarrier Generator Waveform Generation Diagram

U10A and UL10B acting as a window comparator controlling analog gate U9B. The window comparator looks at the phase error control voltage and remains inactive if the phase error control voltage is in the Normal operating range of +2 to +18 Vdc. If the error voltage is less than +2 or greater than +18 Vdc, then the output voltage at the junction of the cathodes of CR5 and CR6 goes high which closes analog switch U9B. Closing this switch feeds back the integrator output voltage via R39 to the integrator input. This causes the integrator output voltage to slew to +6 Vdc. As this is within the normal operating range, the output of the window comparator goes low and the analog switch opens and control of the integrator passes to the phase control loop. The following table illustrates this.

	Phase error control Voltage less than +2 Vdc.	Phase error control voltage between +2 and +18 Vdc.	Phase error control voltage > +18 Vdc
U10A-12	LOW	LOW	HIGH
U10B-10	HIGH	LOW	LOW
U9B control Input pin 5	HIGH	LOW	HIGH
Action:	Integrator (U12A) out-Put increases to +6 Vdc	Integrator under control of phase control loop.	Integrator output de-creases to 6 Vdc.

d. Modulation Eliminator Assembly (reference figure 7-27). The modulation eliminator takes the up to 70% amplitude modulated carrier phase reference and strips the modulation off the signal. The input signal at a level of +20 dBm is sent first to a pad composed of R4, R5 and R7. This pad cuts the signal level down to +12 dBm. From here, the signal is sent to 3 hard limiter, U1. The signal emerges from the limiter greatly reduced in amplitude (about -3 dBm), but with the modulation component removed. The output of the limiter is sent next to a phase shifter (U2, L1, L3, CR2 and CR3) which provides a variable phase shift of 0° to 180º.between (ultimately) the carrier and sideband transmitter outputs. The operation of the phase shifter is the same as those described in the amplifier assembly.

The output of the phase shifter (U2 pin 4) is then sent to a three stage amplifier (Q1, Q2 and Q3). The first two stages are class A while the last stage is class AB. The operation of these three stages is similar to the corresponding stages in the RF amplifier assembly.

The output power is set by changing the collector supply voltage on the last stage with potentiometer R8.

SECTION VII

ANTENNA

4-14. FUNCTIONAL DESCRIPTION. The VOR antenna is a stationary, cylindrical, four-slot antenna. This antenna,in principle, is essentially similar to crossed dipoles; whereas the slots function the same as dipole elements. The antenna is tunable from 108 to 118 MHz. It is mounted on the VOR shelter roof and uses the roof as a counterpoise. Radiation is horizontally polarized.

The antenna radiates an omnidirectional (circular) pattern and a clockwise rotating figure-of-eight pattern that space modulates the circular pattern. This space modulation produces a composite rotating signal called a Limacon. The Limacon has directivity caused by the vector addition of circular pattern voltage and figure-of-eight lobe voltages. Because the voltages of the two figure-of-eight lobes are opposite in polarity, the Limacon has a voltage maximal and voltage minimal, 1800 removed. The figure-of-eight pattern rotates at 30 revolutions per second and at any given instant, the point of azimuth where voltage maximal occurs is called a radial, and is made relative to magnetic north to provide bearing information. (See figure 419.)

A direct indication of ten true bearing of the transmitting site, as seen from the aircraft, is provided to an aircraft receiving the transmission radiation by two 30 Hz signals transmitted by the antenna. This is accomplished by comparing the relative phase of the two 30 Hz transmitted signals. The phase of one signal, referred to as the reference 30 Hz carrier signal, does not vary with the azimuth; however, the phase of the signal, referred to as the 30 Hz variable signal, varies linearly with the azimuth angle. Both signals are transmitted on the same carrier frequency. Figure 4-19, for VOR signal generation, shows the 30 Hz signals as they relate after detection in the VO R receiver.

As can be seen from figure 4-19A, the variable phase signal amplitude varies relative to bearing. Whereas the reference phase signal has the same amplitude for all bearings. By detecting and comparing the instantaneous amplitude differences between the reference signal and the variable, the receiver can determine the phase difference. This relationship is illustrated in figure 4-19B and C.

a. Physical Configuration. Metal cylinders with one or more longitudinal slots have been used in the pot to provide several types of radiation patterns A potential applied across a slot by means of a coaxial line whose Inner and outer conductors are connected to the opposite side of the slot causes currents to flow around the slot when the slot is relatively narrow In terms of the wavelength, vertically polarized radiation caused by vertical components of the currents substantially cancels, while horizontally polarized radiation results from the horizontal currents across the top and bottom of the slot.

When there are two slots on opposite sides of a cylinder and both are similarly excited but in phase opposition to each other, a figure-of-eight pattern is radiated. When there are four equally spaced slots, two figure-of-eight patterns at right angles to each other can be had by exciting alternately, now one

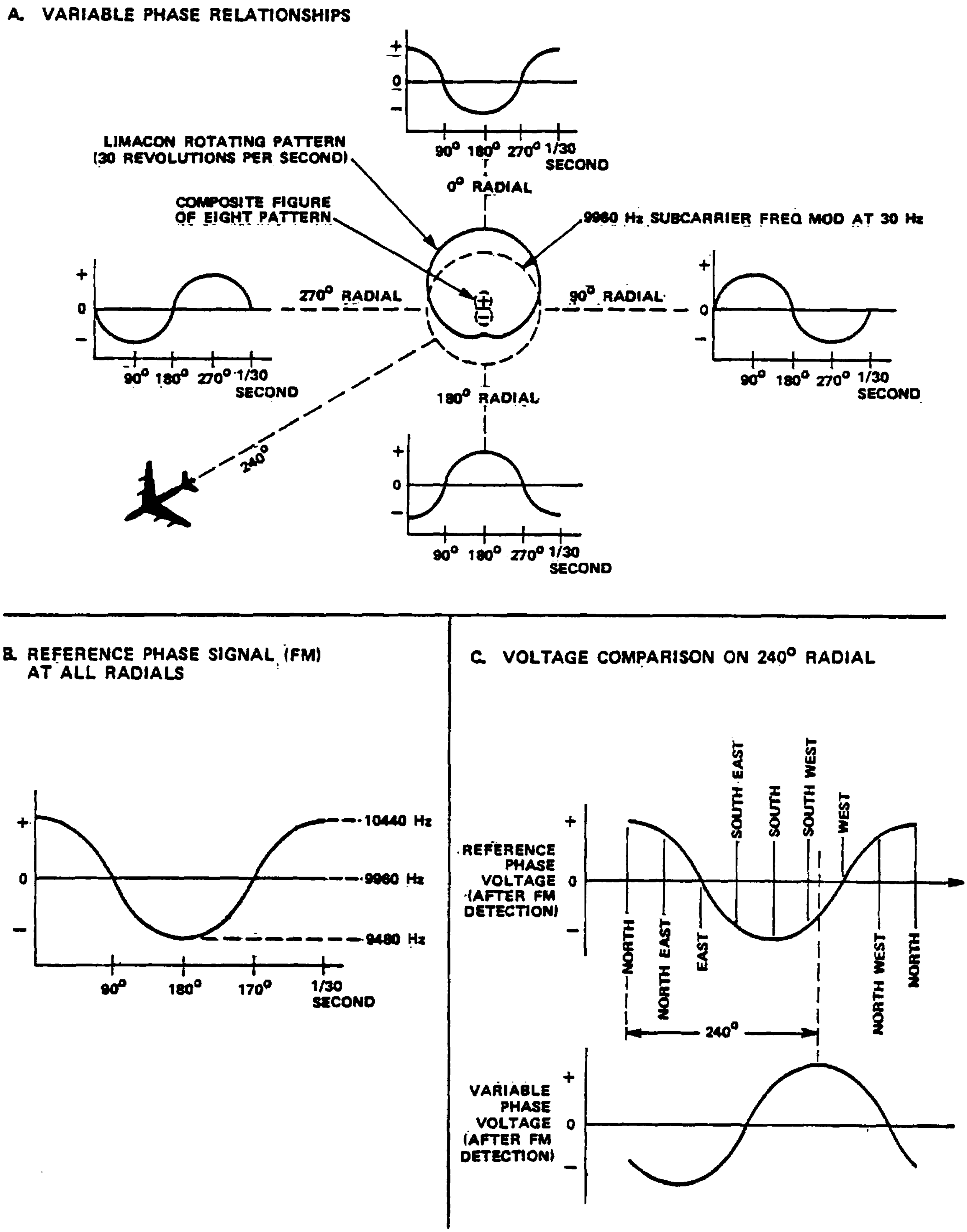


Figure 4-19. VOR Signal Generation

pair of opposite slots, then the other pair of opposite slots. If all four slots are excited so that the horizontal currents associated with all four are in the same direction, a pattern omnidirectional in azimuth results.

A sketch of a four-slot antenna is shown in figure 4-20. Four slots (1, 2, 3 and 4) are cut in the cylinder, equally spaced around the circumference. The diameter of the cylinder is approximately 0.15 wavelength, as the best compromise between two factors. A cylinder of too large a diameter results in a deviation of the lobes of the figure-of-eight patterns from true circles. A cylinder of too small a diameter would reduce the radiation resistance of the slots, making impedance matching difficult the four antenna slots are designated NE (northeast), SE (southeast), SW (southwest), and NW (northwest). (See figure 4-21.) Slots are rectangular with fins along the vertical edges to produce capacitive slot loading and support adjustable bridge circuit elements. Small adjustable capacitors are placed across each slot to compensate for manufacturing tolerances in slot dimensions. The variable carrier internal feeder lines are enclosed in metal tubing and terminate on the antenna wall near the lower end of the slots. The reference carrier uses open feeder lines terminated at the upper end of the slots.

NOTE

Reference figure 7-30 for the following discussion

b. Detailed Description of Antenna Radiation Development. The feeding method is depicted in figure 421, in which a developed or spread open view of the interior of the cylinder is shown. The reference carrier, sideband A and sideband B RF power is applied to the antenna through three distinct feedlines the three feedlines maintain isolation between the two sidebands and the reference carrier output, and provide impedance matching. Correct slot excitation polarities and cancellation of undesirable reactive components of the slots, are obtained by specific feed line sections. Each of the three coaxial feed lines provide a resistive load of 50 ohms to the sideband transmitter and the carrier transmitter.

The antenna slots are excited by the reference carrier through four 200-ohm open-wire transmission lines, which terminate near the upper end of each slot each slot termination is on the antenna wall adjacent to the point where the loading fins attach. Each feed line excites the slot in the same direction and uses the antenna wall as the ground return. Because the slots are excited identically, a continuous field is produced around the antenna resulting in an omnidirectional radiation pattern. The 200-ohm lines are approximately one-quarter wavelength long and join at the center of the antenna. A 50-ohm coaxial cable is attached between this point and the transmitter. A small ring capacitor, at the junction of the four open wire lines and the 50 ohm coaxial cable, cancels the inductive reactance at the junction. This cancellation results in a purely resistive feed point with a very low VSWR on the transmitter feed line.

The imput impedance (as seen at Z2 or Z3) of each sideband feedline is 50 ohms. The two sidebands are identical in construction. Therefore, the following explanation for sideband A will also apply to sideband B with the exception of a 90º phase difference. The two coaxial lines feeding one pair of slots

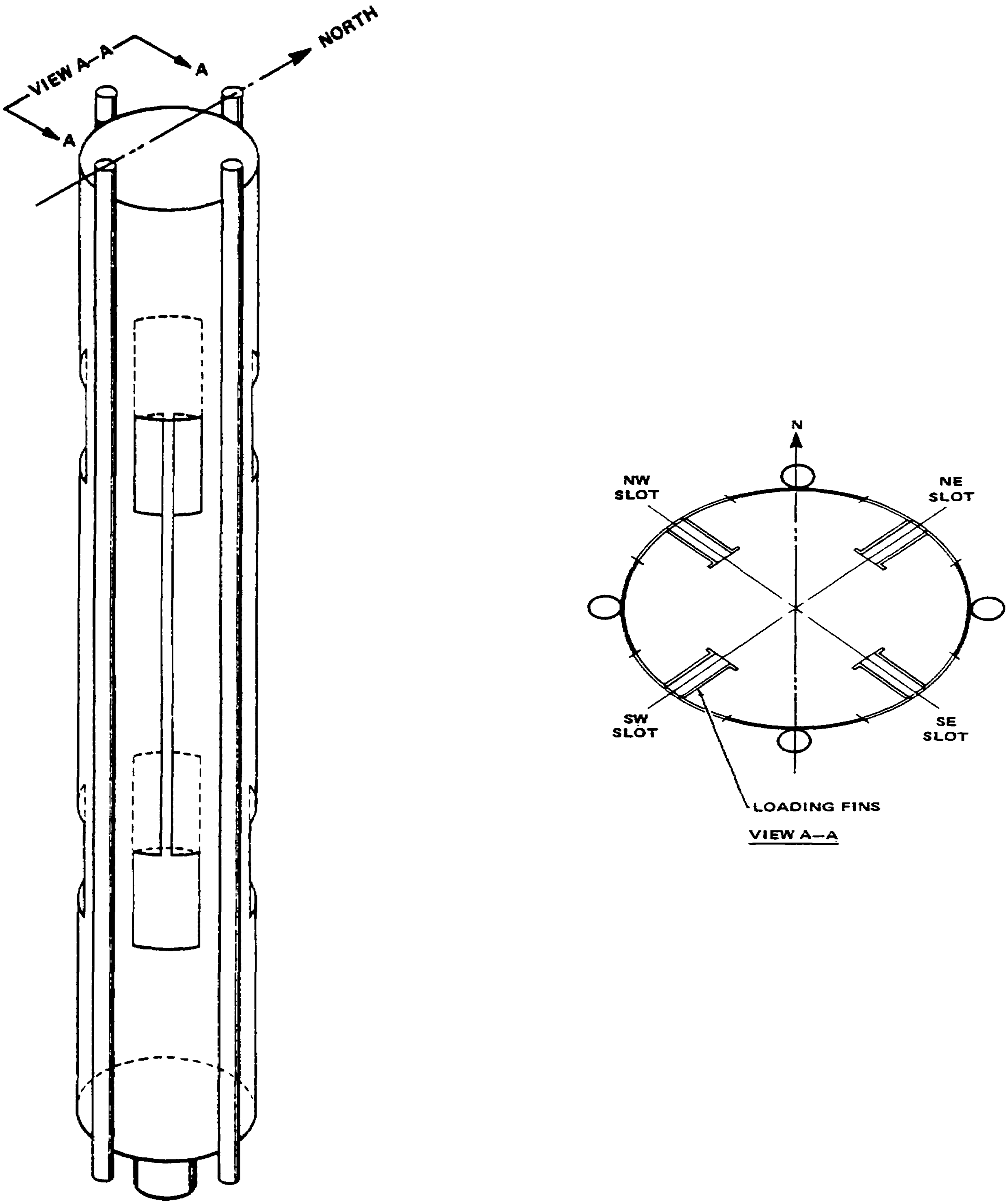


Figure 4-20. Physical Location of Antenna Slots

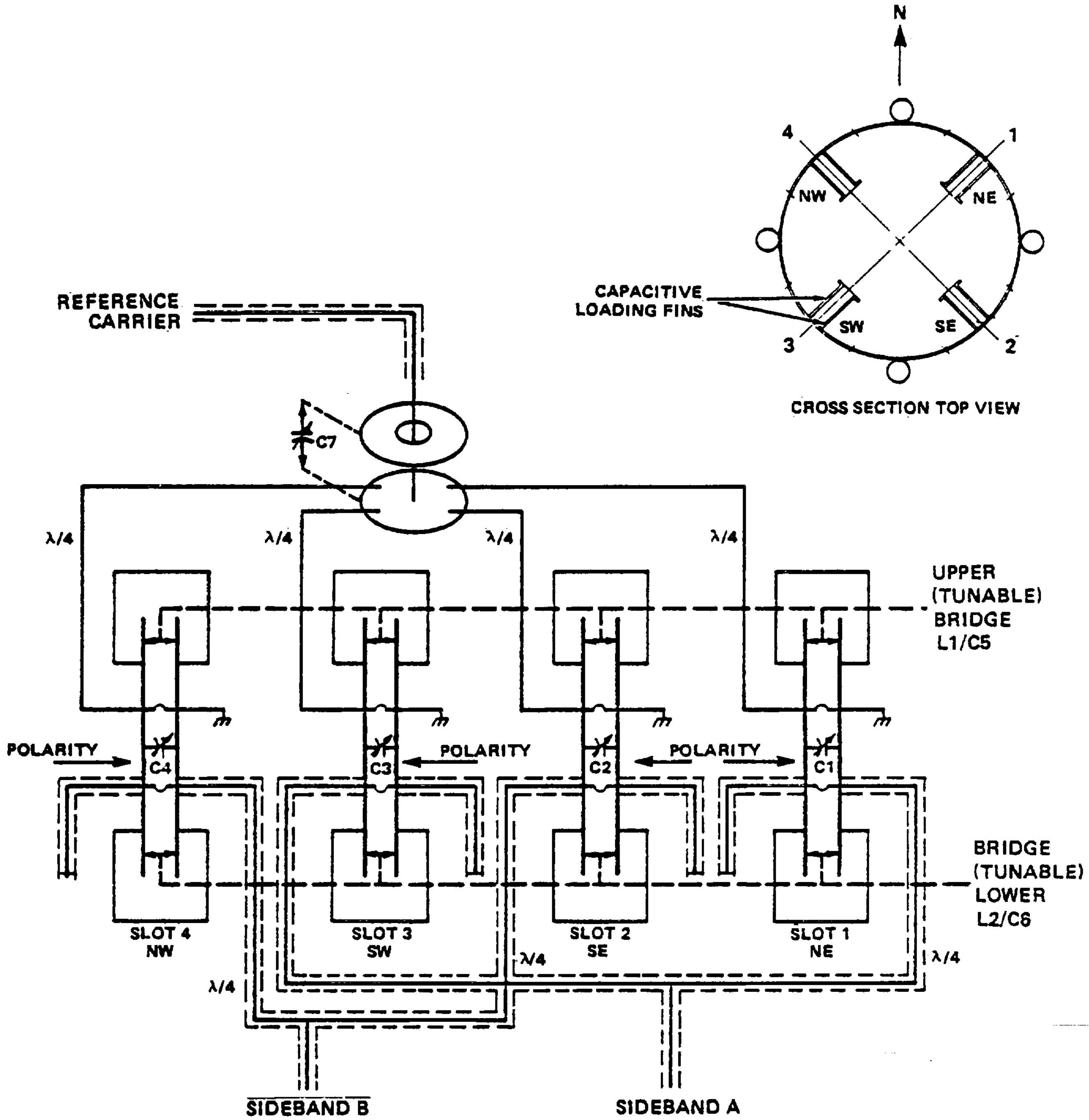


Figure 4-21. Antenna Slot Location Diagram

with sideband power are not connected directly across the slots. The outer conductor connects to the antenna wall adjacent to the lower end of the slot, while the inner conductor crosses the slot and joins the inner conductor of an RF line assembly (a shorted coaxial inductive stub). By connecting the outer conductor of the RF line assembly to the antenna wall on the opposite side of the slot, with the far end shorted, the stub is effectively in series with the coaxial feed line to the antenna slot The RF line assembly is factory set to be inductive and cancels the capacitive reactance of the antenna slot. The two coaxial cables feeding the two antenna slots are approximately one-quarter wavelength long between the tee block and the slot the resonant antenna slots have individual characteristic impedances of approximately 70 ohms and considerable capacitive reactance because of the loading fins. Each line has a characteristic impedance of 100 ohms and converts the 70-ohm slot resistance to 150 ohms. Paralleling the two 150-ohm ends in the tee block produces a 75-ohm resistive value at a common input terminal in the tee block. The tee block is effectively feeding RF power into the center of the coaxial line, which is one-half wavelength long and connected between diagonally-opposite antenna slots. The polarities of energy at the ends of a line one-half wavelength long are reversed and therefore the polarities of the slots are reversed.

The output impedance of the sideband transmitter is 50 ohms, and the impedance of the tee block common input is 75 ohms. To match these two impedances, a 50-ohm coaxial line one and three-eighths wavelength long is connected to the common input of the tee block. The other end of the line is terminated in a line matching network (Z2). Z2 (Z3 for sideband B) is shunted across the line to cancel the inherent inductive reactance of the one and three-eighths wavelength line. Therefore, the impedance at the input is purely resistive and matched to the 50-ohm feed line from the sideband transmitter.

c. Navigation Signal Development Antenna. The reference signal is generated by amplitude modulating the carrier by a 9960 cycle subcarrier, which in turn is frequency modulated by a thirty-cycle signal. The carrier, modulated in this manner, is radiated equally in all directions of the azimuth. This thirty-cycle signal, as received by a double detection (AM-FM) receiver, is in the same phase at all points of azimuth. The sideband transmitter electronically generates two amplitude modulated, double sideband, carrier suppressed signals, modulated in time quadrature. The variable phase is generated by radiating a rotating figure-of-eight pattern. This concept, as seen from the transmitting source, should not be confused with the single set of sidebands containing the 30 Hz component as seen from the receiving end, although the latter is a result of the first The RF phase in one lobe of this pattern is the same as that of the carrier. (See figure 4-22.) The RF phase in the second lobe of the figure-of-eight pattern is opposite to that of the carrier. If each lobe of the pattern is a true circle and the pattern is rotating at a thirty-cycle per second rate, the carrier as received in an aircraft, will be effectively amplitude modulated at a thirty-cycle rate and the phase of this thirty-cycles will vary linearly with the azimuth angle.

The rotating figure-of-eight pattern is generated by modulating two stationary figure-of-eight patterns at right angles to each in time quadrate at thirty cycles to produce a single rotating figure-of-eight pattern.

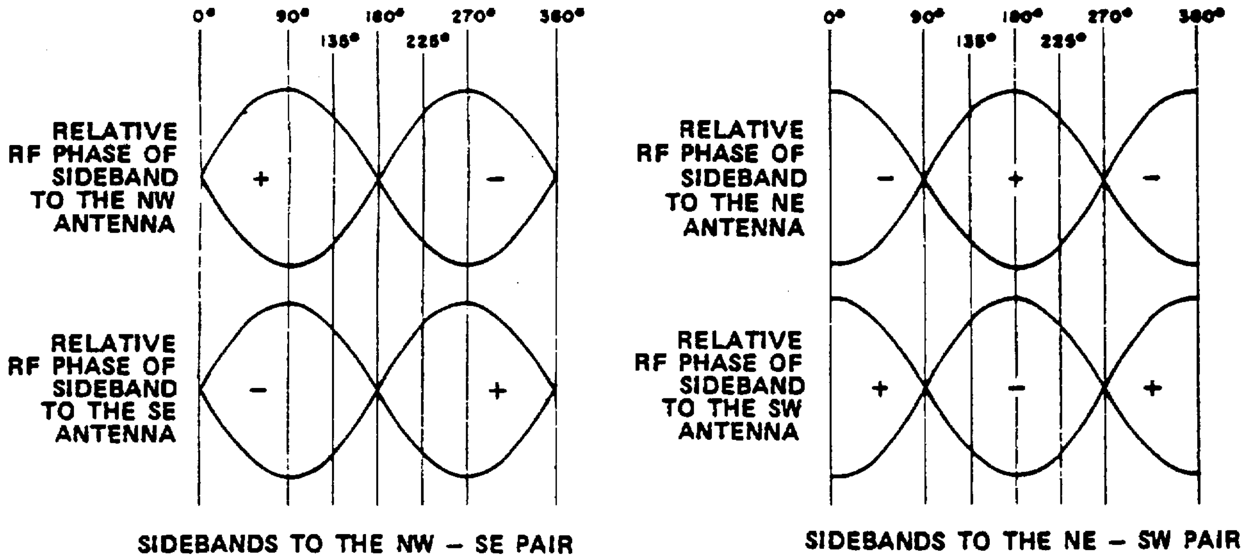


Figure 4-22. Relationship of Sidebands to the Sideband Pairs

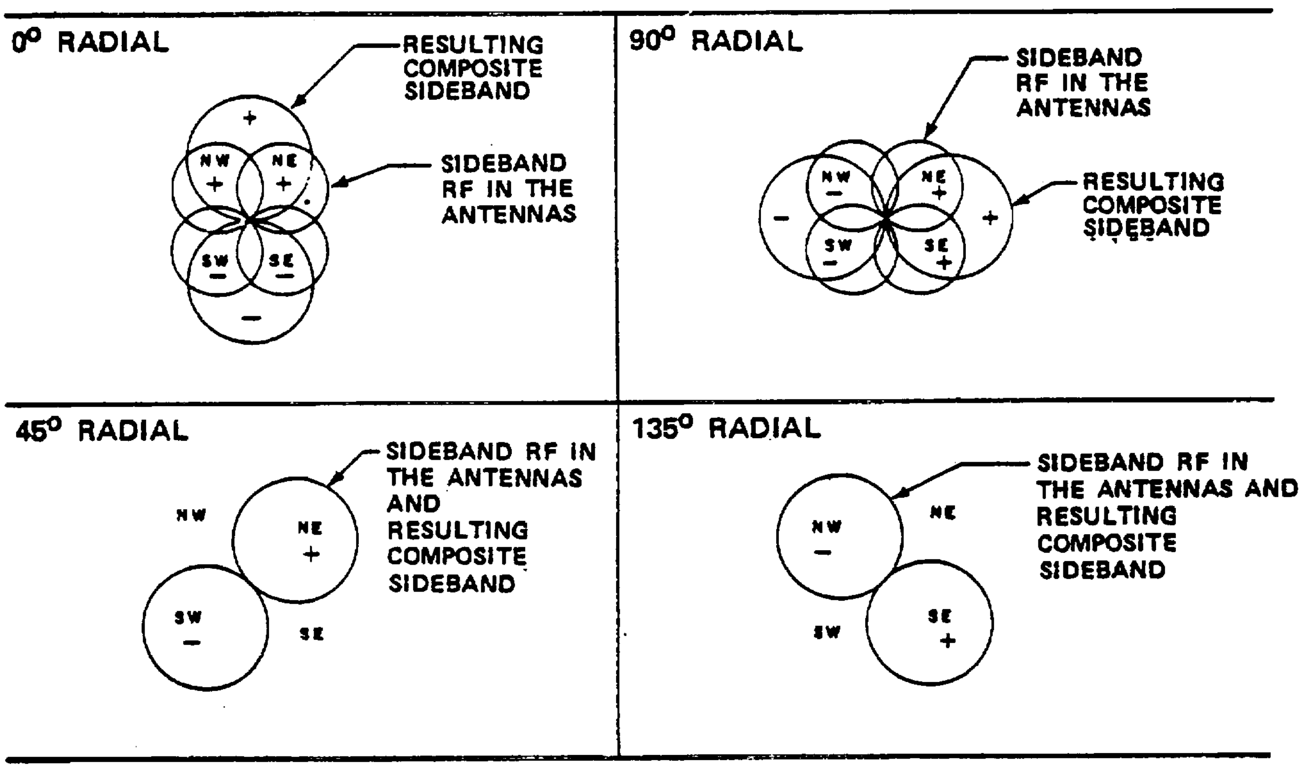


Figure 4-23. Sideband RF Energy for Various Radial Resulting Composite Sideband Radiation Pattern

The VOR carrier transmitter excites the slots with one signal, and the electrostatic fields are crossed figures-of-eight whose lobe polarities produce a circular pattern of constant phase throughout 360º. The VOR sideband excites the same slots but in pairs. Each pair of slots is driven by a double sideband, suppressed-carrier signal, which is modulated at 30 Hz to vary its amplitude from near zero to maximum at that frequency. As electrostatic fields, these two sideband signals are also crossed figure-of-eight signals, but they vary constantly in phase and amplitude (relative to each other) and cause a resultant figure-of-eight signal to be radiated. The varying phase and amplitude relationships of the crossed figures-of-eight impart rotation to the resultant figure-of-eight signal, which then space modulates the circular pattern (being in its field) to create the composite navigation signal. This composite signal is a rotating Limacon whose voltage maximal is relative to azimuth. (See figure 4-22.) The carrier transmitter generates the reference carrier signal and the sideband transmitter generates the double sideband, suppressed-carrier signals. A portion of the carrier signal is fed to the sideband transmitter to ensure that the reference and variable signals are in phase when the azimuth (relative to the antenna) coincides with magnetic north.

Because vertically polarized radiation is undesirable, the overall antenna design and equipment shelter design and location has reduced the vertical radiation of the antenna to a minimum. Therefore, the antenna produces only horizontally-polarized radiation fields because any vertical radiation is negligible. Vertical radiation is held to a minimum by the slot dimensions of the antenna. In addition, another factor governing vertical radiation is the size of the counterpoise and its distance from the antenna. The equipment shelter is designed and positioned to reflect as small a vertical radiation component as is practical. It is important to minimize the vertical radiation because vertical radiation, mixed with horizontal radiation, will be slightly out of phase with the horizontal radiation at the receiving antenna and will cause bearing errors

The reference carrier radiation pattern is horizontally polarized and circular, with the antenna at the center. Because all antenna slots are excited equally, and are of the same polarity, the phase of the reference carrier radiation pattern is the same at any point of azimuth around the antenna. The two sidebands, displaced electrically by 90º, excite pairs of antenna slots, which are displaced physically by 90°. Sideband A excites the northeast/southwest slots, and sideband B the northwest/southeast slots. This displacement configuration does not change physically at any time, and produces a pattern of crossed figure-of-eight's as shown in figure 4-23. The strength of the polarized fields varies and the polarity reverses. These changes are controlled by the modulated output from the sideband transmitter. When equal power and like polarities are fed to the antenna slots, the resultant figure-of-eight pattern of figure 4-23 is produced; caused by vector addition of the individual slot lobes.

The figure-of-eight patterns and the resultant pattern for the Limacon are illustrated for four radials in figures 4-23 and 4-24.

Since the sideband signal modulates the transmitter signal, the power ratio determines the percentage of space modulation and the form that the Limacon takes. The variable carrier power to the

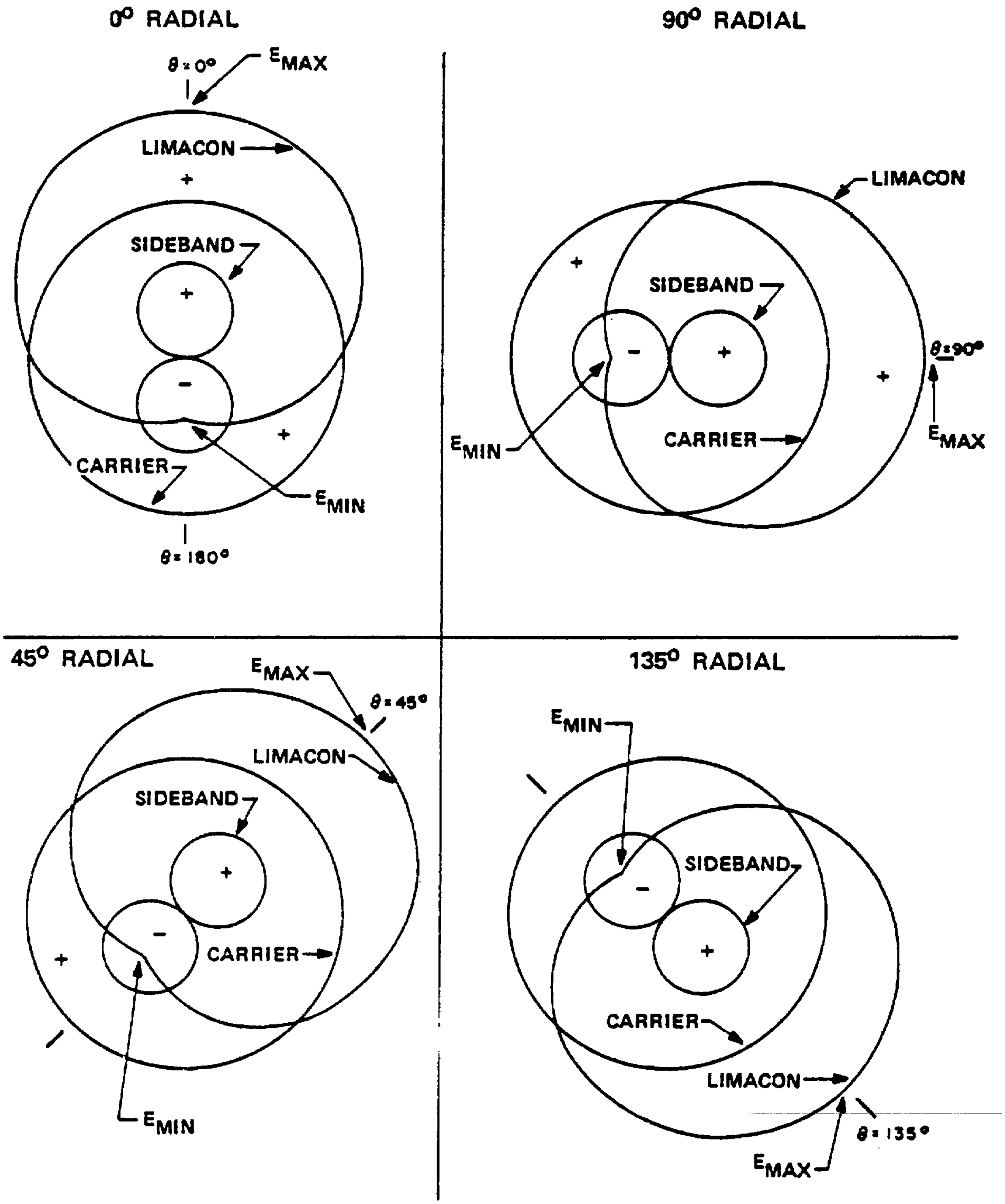


Figure 4-24. Limacon Resulting from the Addition of the Composite Sideband and Carrier Radiation

antenna is adjusted for 30% modulation, which corresponds to a sideband transmitter to carrier transmitter power ratio of about 1: 10.

In summary, one non-directional reference signal is generated with a phase that at any instant is different in all directions. The phase of the variable phase signal is the same as the phase of the reference signal only at the 0° radial (north). As the angle measured from the 0° radial increases, the phase of the variable phase signal lags the phase of the reference signal by the number of degrees of the angle from 0º. The reference and variable phase signals, which are 30 Hz voltages, are carried by RF to make radio transmission and reception possible. The VOR receiving equipment must separate the 30 Hz reference and variable phase signals from the RF carrier and compare the phase of the two signals. The phase difference is indicated on a course indicator or RMI.

The audio phase relationship, which exists at several azimuth locations, is shown in figure 4-20. As previously indicated, the phase of the variable 30 Hz signal changes one degree for each degree change in azimuth. Therefore, by definition, the omnicourse at a given azimuth about the VOR is numerically the number of degrees that the variable signal lags the reference signal. The antenna is indexed so that the reference and variable signals are in phase only at magnetic north. At all other points on the compass, the reference and variable signals have a phase difference that relates to magnetic north. If some phase measuring device were placed so as to observe the signals radiated to the north of the ideal VOR, it would be found that these two signals were in phase. If the device were then moved 10º clockwise from magnetic north to a magnetic azimuth of 10º and the phase of the signals were measured, it would be found that the reference 30 Hz signal would have the same phase as at north but the variable signal would be delayed 10º from its phase at north. The measured omnicourse at this point would be 10º since the variable now lags the reference by 10º. At a magnetic azimuth of 45º, the variable signal would lag the reference signal by 45º, resulting in a 45º omnicourse. From the preceding, it can be seen that the variable signal lags one degree for each degree of change of magnetic azimuth in a clockwise direction around the VOR. This being the case, the omnicourse must also vary one degree for each degree change of magnetic azimuth. For example, at 170º magnetic azimuth, the variable signal will lag the reference signal by 270º and the resulting omnicourse will be 270º. It is true that a lag of 270º of the variable is the same as a lead of 90° of the reference; but, since omnicourse is defined in terms of the lag of the variable behind the reference, it is more convenient to work in these terms. From the preceding, it follows that the omnicourse at a given azimuth about the VOR is numerically the number of degrees that the variable signal lags the reference signal. (Reference figure 4-25.)

4-15 ANTENNA SLOTS AND SLOT TUNING (reference figure 4-21). Antenna slots are approximately 0.5 wavelength long by 0.01 wavelength wide, and are cross-connected by upper and lower reactance-bridge circuit assemblies Slots are tuned by repositioning the bridge assemblies on inductive slot extensions, and by adjusting capacitor plungers.

Upper and lower reactance bridges are identical and have adjustable inductive and capacitive elements which may be adjusted without upsetting radiation symmetry. Inductance is adjusted by sliding the

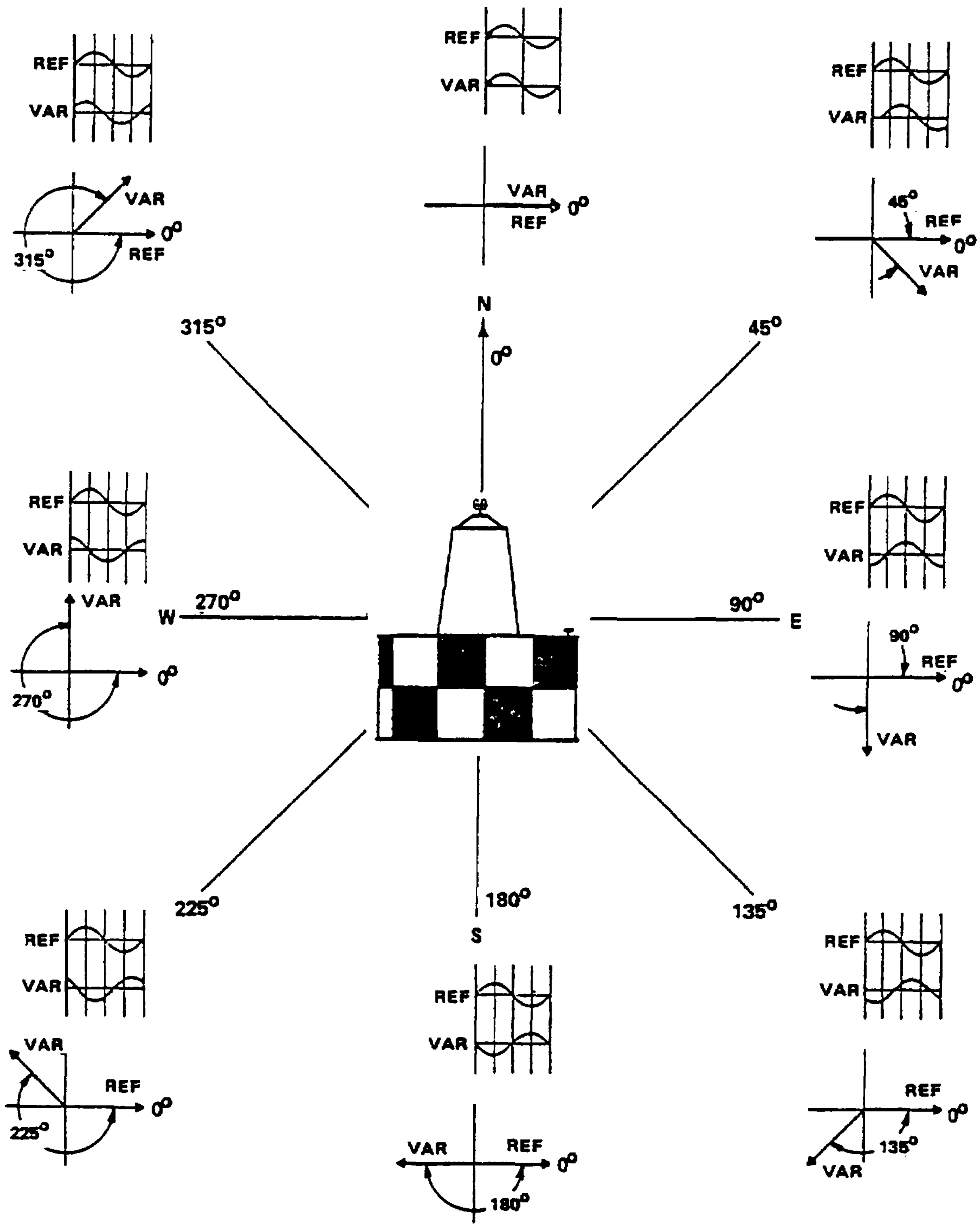


Figure 4-25. Phase Relationship Between the Reference and Variable Signals at Various Azimuth Locations

complete bridge up or down on the tuning bars at the ends of the loading fins. Capacitance is adjusted by sliding the capacitor plunger in or out of the stator ring in the bridge center. Both inductive and capacitive elements have graduated scales that are used with the tuning chart furnished with the antenna. Decreasing inductance across the antenna slot (higher scale setting) effectively shortens the slot and raises the resonant frequency. Increasing the capacitance across the antenna slot effectively lengthens the slot and lowers the resonant frequency. By cross-connecting opposite pairs of slots, the impedance placed between them is effectively placed across each slot. Because all four slots can be tuned simultaneously, antenna radiation symmetry is maintained at all frequencies when the antenna is properly resonated.

NOTE

Further discussion relating to antenna error curves is provided in Appendix F in TM 11-5825-266-14-2.

SECTION VIII

REMOTE CONTROL UNIT

4-16 FUNCTIONAL DESCRIPTION. The remote control is the companion unit to the VOR local control. The remote control displays the status data transmitted by the local control. The remote control unit controls operating status of the VOR equipment at all times except during maintenance actions. The control command and codes used to perform basic operating functions are converted to dual tones and transmitted to the local control unit. Voice communication can be maintained between the local and remote site since the remote control unit also has voice transmission circuitry. The remote control has the capability to interface with ATIS (air traffic in-flight service) equipment. This equipment utilizes the remote control unit to transmit to enroute aircraft, via the VOR transmitter, general aircraft information such as weather conditions, flight information, etc. In addition, the remote control unit can also interface with an auxiliary/indicator voice panel to provide communications directly from a flight service center operator to enroute aircraft or with other personnel (i.e., maintenance) located at the VOR via the local control equipment . The remote control unit is comprised of four circuit card assemblies. A detailed description of each circuit card is provided in the following paragraphs.

4-17 DETAILED CIRCUIT CARD ASSEMBLY. The following subparagraphs contain detailed descriptions of the circuit card assemblies in the remote control unit.

a. LED Display Circuit Card Assembly (reference figure 7-32). The LED display circuit card assembly is mounted on the front panel of the remote control unit and contains all the lamps for displaying status data. In addition, this circuit card also contains an alarm silence switch, a ring switch, and a speaker voice switch. Since these switches operate in conjunction with the circuitry in the operations voice buffer circuit card assembly and the operation site modem circuit card assembly, their function and operation are discussed under the description of these circuit card assemblies.

b. Operations Voice Buffer Card and Operations Site Modem Card (reference figures 7-33 and 7-34). Because of the interaction between these two circuit card assemblies, the detailed circuit description is provided for both in the following subparagraphs.

These two circuit card assemblies receive serial frequency shift key (FSK) data and demodulate the data and display status information transmitted from the local control assembly. These two assemblies also provide two-way voice communication between the local and remote sites. If the interface connections provided for by the rear panel mounted ATIS VOICE and VOR XMIT VOICE connects are utilized, these circuit cards provide voice transmission through the VOR local control assembly to enroute aircraft. The system is designed so that the VOR XMIT voice key takes priority of ATIS transmission and two-way voice transmission between the local and remote site. The INTERCOM switch takes priority over the ATIS voice transmission.

(1) Voice Communication Circuit The VOR XMIT voice function is keyed in by a microphone located on an auxiliary operators panel where the flight service center operator is located. This interface is established via connector J4 and is applied through pins A2B L and A2BM into VOR transmitter voice transformer A2T1. The flight service center operator's voice is applied on the VOR transmitter voice twisted telephone lines into the transformer and is routed to input amplifier A2U11B. This amplifier is equipped with adjustable gain to compensate for the transmission level, since the location of the flight service center operator may be located 1000 feet away in the same building or next door depending on their particular setup. The output of input amplifier A2U11B is applied into an analog gate, A2U16A. This analog gate may be opened when the flight service center operator keys his microphone. That keying input is applied through pins A2BX and A2B5 to a VOR optical isolator, A2U7. The output of the optical isolator controls the analog gate. An optical isolator is basically a photo diode which emits a light, usually in the infra-red range. The optical isolator also contains a photo transistor. The photo transistor receives the light and causes a current in the transistor. The optical isolator allows a complete isolation of up to 1000 volts, both ac and dc isolation with 17 to 30 ma of current needed to key. However, 12V power from the remote can feed the circuit with isolated switch or relay contacts used to key the 17 to 30 ma key current.

Analog gate A2U16A applies the VOR transmitter voice signal to summing amplifier A2U17B. All voice transmission circuits are applied to summing amplifier U17B. The ATIS voice circuit also has an input transformer, A2T2, with an input amplifier, A2U18B, with variable gain set up for varying levels . The output of this input amplifier is applied to analog gate A2U16D which feeds into summing amplifier A2U17B. The microphone input is applied through input amplifier A3U2A, pins A3AC and A2BN to analog gate A2U16B which also feeds into summing amplifier A2U17B. The control established by the analog gates determines the priority established for transmission. The output of the summing amplifier is applied to an automatic gain control (AGC) amplifier, A2U17A.

All of the voice transmission inputs are channeled into the automatic gain control amplifier which provides some voice leveling This then drives three sections of low pass filter which make a nine-pole filter, with a 2300 Hz low pass type of response. This filter feeds a driver and transformer output, A2T5, to the telephone line output to the VOR/DME site over the telephone line or microwave.

Line driver A2U24B also has two additional inputs. One is a 2870 Hz tone which is keyed and applied through the line driver whenever an air traffic voice transmission is initiated. The other additional input is a ring tone of 2330 Hz which can be applied through the line driver to alert maintenance personnel working at the local site.

The other direction of communication is accomplished by receiving telephone line status information from the VOR/DME transmitter site, referred to as the VOR receiver voice. This comes in on a twisted pair of 4-wire telephone lines through pins A2A13 and A2A14 and brings the VOR receiver voice into transformer A2T3 for isolation. The output of the transformer is applied through input amplifier

A2U21A with variable gain to compensate for telephone and microwave losses in the system. This then drives low pass filter section A2U21B. The output of this filter is then applied through to notch filters A2U22A and A2U22B. The FSK data is separated and applied through a 2400 Hz high pass filter, A2U23B, a 2700 Hz low pass filter and out pin A2A17 to the operation site modem circuit card assembly where it is tracked and squared up by a phase lock loop and demodulated into digital serial data. This data is converted to parallel data by the UART.

The VOR receiver voice is sent on through two low pass filter sections after it is separated from the FSK data

These low pass filters, A2U19A and A2U19B, have two functions. First, they block the frequency shift key tones, which are 2416 Hz for "zero" and 2655 Hz for "one" which are being put on the voice circuit at a low level and sent along with voice information. The 2416 Hz and 2655 Hz notch filters block FSK tones They also act to filter out any high frequency noise which may be picked up on the telephone lines in the process of bringing the voice in. This filter goes into FSS driver amplifier A2U11A which then drives transformer A2T4. The output of the transformer is applied through a twisted pair of telephone lines which carry the VOR receiver voice out to the flight service center auxiliary/indication/voice panel where the flight service center operator can receive voice and talk to aircraft. Also on-off status of VOR and DME are displayed as lights on the panel.

The voice signal from low pass filter A2U19B is also applied through analog gate A2U6B to intercom driver amplifier A2U5A. The analog gate is controlled by an ON intercom (not) signal applied at pin A2B19 or by a jumpered ground connect if this function is not available. The output of intercom driver amplifier A2U5A is applied through A2Q1 and A2Q2 to drive a front panel mounted speaker.

(2) Data Status Circuit The VOR receiver voice is brought into transformer, A2T3, input amplifier A2U21A, and low pass 2700 Hz filter A2U21B. The frequency shift key data (2416 Hz for a zero and 2655 Hz for a one) is reduced slightly in amplitude by going through the first low pass filter section, A2U22A, and then the high frequency section, A2U22B. Some of the high frequency noise will also be cut down in the process. The FSK data is then applied through high pass 2400 Hz filter section A2U23B, which, in conjunction with the following 2700 Hz low pass filter section, A2U23A, acts somewhat as a band pass. The output of the 2700 Hz filter is applied through A2A17 to A3A25 and then into a phase lock loop. The phase lock loop is tuned for half way between the two frequency shift tones and is used as an additional filtering section to track the frequency shift key tone and also square out the tones that come out of the output which are then fed onto demodulator A3U14, which takes the squared frequency shift key tones and converts them into digital "one" and "zero" serial information. This serial information data is then serially input to UART receiver A3U3. The UART decodes the serial information into parallel data. This circuit also looks at bits 7 and 8 of the information to tell which one of the four data words is being transferred. These two bits allow four information words, which are sequentially sent, to be identified and inserted into one of four display and status storage registers. This information is then driven off the board into LED line display circuit card assembly Al and shown on the front panel.

(3) Status Evaluation Circuitry. Two current loop driver circuits are used to transmit VOR and DME status Since both circuits are identical, only the discussion for the path for the VOR is provided. The VOR OFF (not) output from pin 11 of A3U15 is applied through A3U29B and A3Q10 to analog gate U3U27D. The analog gate controls the current loop driver circuit. The driver is switched off by the analog gate when the frequency shift key data is not being received or it does not have proper format and may be invalid. Current in or out shows status or no current shows data invalid.

If the data sampled is identified as being valid, it is driven into a current loop driver which provides ON/OFF information or alternatively an invalid indication. This is done by providing a 20-30 milliamp current out for one indication which can be either ON or OFF state and also providing an opposite direction current 20-30 milliamps for the opposite condition. So current flow will be either in or out of the driver, depending on whether status is on or off. No current flow means loss of data (or power loss).

(4) Alarm Sensing Circuit . The basic alarm functions are VOR ON/OFF, DME ON/OFF and VOR/DME POWER. In addition there are several other primary alarms which are monitored. If an alarm occurs, it will actuate a gate which puts a lower frequency beep tone onto the audio to alert the flight operator that an important status change has occurred at the station and that it should be investigated. (This can be blocked by ;opening a jumper so that the alarm is not sent out.)

(5) Oscillator and Counter Circuit. This panel has a basic 3.58 crystal controlled oscillator and a 14 stage divider/counter which feeds another counter which generates 2330 Hz and also generates additional tones which are used in sending an alarm out on the voice channel. The VOR receiver voice is added into the voice which goes to the flight service center operator at the remote panel when an alarm is sent . The alarm sensing circuit monitors the status information that is brought in (only the critical alarms, however, not the total information).

CHAPTER 5

MAINTENANCE

5-1. INTRODUCTION. This chapter contains maintenance instructions for the Radio Transmitting Set, AN/FRN-41. This chapter is divided into two sections Section I contains maintenance data for the organizational and field maintenance personnel or maintenance which can be performed at a VOR site and Section II contains ground check instructions.

a. Section I, Organization and Intermediate Maintenance. This section contains data required for maintenance (checkout, servicing, troubleshooting, alignment, adjustment, and repair procedures) of the equipment at the organizational and intermediate level. Maintenance procedures for routine or emergency actions, which require the use of special or common tools and test equipment, are also included.

b. Section II, Ground Check Instructions. This section contains instructions for performing omnirange station ground checks to minimize the need for expensive flight checks. The information of prime interest obtained from a completed ground check is the total error spread; i.e., the difference in degrees between the greatest bearing error in the negative direction and the greatest bearing error in the positive direction. Individual bearing errors are most useful for analyzing plotted error curves to find the cause of bearing error. Ground check procedures should be performed on a periodical basis of from 30 to 90 days in order to minimize bearing inaccuracies.

SECTION I

ORGANIZATIONAL/INTERMEDIATE MAINTENANCE

5-2. GENERAL INFORMATION. This section contains data necessary for normal performance of organizational and intermediate level maintenance on the Radio Transmitting Set, AN/FRN-41. The data includes information on required test equipment, system and unit performance tests and equipment alignment

5-3. TEST EQUIPMENT. Test equipment required but not supplied is contained in table 5-1. This listing identifies the test equipment for organizational/field level requirements. Further information pertaining to a particular piece of test equipment may be found in the applicable service manual.

5-4. PREVENTIVE MAINTENANCE. Preventive maintenance procedures in the form of performance test procedures are supplied as an aid to determine potential trouble before it starts interfering with the performance of the equipment or system. The performance tests should be performed on a periodic basis and the reference standards used for an evaluation of the equipment minimum operating performance level. Good preventive maintenance also includes performing periodic visual inspection and cleaning tasks. Suggested procedures for both functions are also contained in this section.

5-5. PERFORMANCE STANDARDS TESTS. Performance test tables provide system performance standards designed for an evaluation of the overall capability of the VOR system. The performance tests provided in this section are designed to test the equipment as a system. The performance of these tests is necessary to verify that the system or unit, whichever is applicable, meets the minimum acceptable specification standards The system performance standards tests should also be performed whenever calibration or repair has been performed on any unit, or whenever the overall system calibration accuracy is questioned. In the event the performance tests are not within the tolerances listed in the reference standards column, confirm the applicable alignment or adjustment procedure corresponding to the function under test. In the event that the problem is not corrected, refer to the interconnection or schematic diagrams and theory provided to aid in troubleshooting A brief description of the column headings used in the performance test tables is listed below.

a. Step Column. This column contains a numerical listing of specific performance checks, tests, and maintenance procedures to be performed at the level designated by the performance test title.

b. Test description Column. This column contains a brief description of what is to be tested or serviced for a designated performance check.

c. Procedure Column. This column contains step-by-step instructions required to set up the test, operate the equipment in order to obtain the necessary results and designate the functions to be checked.

Table 5-1. AN/FRN-41 Test Equipment List

Nomenclature	Part No/ Model No.	Used At (Note 1)	FMC	National Stock No/ Mfg. Part No.
Multimeter	ME-498/U (HP34702A)	O, F, D	28480	662500-538-9794
Display	ID-2101/U (HP 34750A)	O, F, D	28480	6625-00-538-9758
Frequency Converter	CV-2002/U (HP 5253B)	O, F, D	28480	6625-00-226-3483
Digital Counter	CP-772A/U (HP 5245L)	O, F, D	28480	6625-00-973-4837
Oscilloscope (Probes included)	OS-261/U (TEK 475)	O	80009	6625-00-127-0079
Oscilloscope (Main Frame)	OS-262/U (TEK 7623A)	O, F, D	80009	6625-01-007-9416
Spectrum Analyzer Plug in	7L13	O, F, D	80009	6625-00-538-9809
Dual Trace Amplifier	AM6785/U 7A26	O, F, D	80009	
Time Base	TD-1159/U (TEK 7B53A)	O, F, D	80009	6625-00-261-5139
Switchable Attenuator Probe, 6 ft (2 ea.) used with OS-262/U	P6062A	O, F, D	80009	6625-04-368-0475
RF Signal Generator (HP 8640 OPT004)	SG-1112/U	F, D	28480	6625-00-566-3067
Telephone Test Set (See note 2)	AN/USM-423 (HP 35508-H03)	O, F, D	28480	662501-015-6563
Pulse Generator	110B	O, F, D	52542	6625-00-113-6353
Average Power Meter (HP 432A)	ME-441/U	O, F, D	28480	6625-00-436-4883
Thermistor Mount	478A	0, F, D	28480	6625-00-886-1955

Table 51. AN/FRN-41 Test Equipment List (Contd)

Nomenclature	Part No/ Model No;	Used At (Note 1)	FMC	National Stock No/ Mfg. Part Number
Radio Frequency Power Test Set	AN/USM-298 (BIRD 43)	O, F, D	70998	6625-00-880-5119
250 Milliwatt Element	430-24	0, F, D		
25 Watt Element (95150 MHz)	095-2	0, F, D		
5 Watt Element	5C	O, F, D	70998	6625-00-767-4215
100 Watt Element	100C	O, F, D	70998	6625-00-804-9671
Attenuator 20 dB	768-20	0, F, D	99899	5985-00-256-8449
Attenuator 30 dB	768-30	F, D	99899	5985-00-233-4626
RF Probe	HP11096B	O, F, D	28480	6625-00-471-0575
VOR Navigational Set Training Configuration		F, D	19156	136138-100
Extender Card 29 Pin		O, F, D	19156	135919-100
Extender Card 100 Pin, 10 inch		O, F, D	19156	136733-101
Extender Card 100 Pin, 14 inch		O, F, D	19156	136733-102
RF Dummy load 150 Watt	Bird 8135	O, F, D	70998	6625-00773-73
RF Dummy load 5 Watt (2 ea.)	Bird 80M	O, F, D	70998	5840-0(669-867

The following accessories are also recommended items which should be included in the test equipment list as required but not supplied equipment.

Table 5-1. AN/FRN-41 Test Equipment List (Contd)

Nomenclature	Part No/ Model No.	Used At (Note 1)	FMC	National Stock No/ Mfg Part Number
Magnifying Glass 3X		O, F, D		
16-Pin Test Clip		O, F, D	Archer	276-1951
Adjustment Tool		O, F, D	JFD	5284

Note 1: The following codes are used to establish compatibility with referenced Logistic Support Analysis record summaries contained in the Appendix.

O = Organizational F= Intermediate D = Depot

Note 2: The Telephone Test Set is comprised of: an Electronic Voltmeter ME-204B/U (HP403B-001); Signal Generator. SG-543B/U (HP 20-204B); and Impedance MatchingAttenuator CN-1491/U (HP353A).

d. Read Indication On Column. This column indicates the device used to display data or verify the parameter or function to be checked.

e. Reference Standard Column. This column indicates the normal value or test result that is to be observed, measured or recorded. The reference standard specified includes both an upper and lower tolerance limit The reference standard may be a dc voltage, waveform, resistance measurement, timing diagram or other criteria which adequately defines an acceptable operating condition. Should the equipment fail to perform within the limits specified, take appropriate corrective action such as reconfirming adjustment/alignment procedures, if applicable, or begin fault isolation action (block diagrams or schematics) are provided as an aid in taking the appropriate corrective action.

NOTE

The performance tests for this system are all contained in tables 5-2, 53, 5-4 and 5-5 (located at the end of paragraph 5-18 in this section).

5-6. PERIODIC MAINTENANCE REQUIREMENTS. The following is a list of requirements which must be accomplished prior to performing any scheduled maintenance effort.

a. Notification of Cognizant Aviation Authority. Whenever it is necessary to remove the VOR system from service, maintenance personnel shall obtain permission from the cognizant authority. This must be accomplished at least one hour in advance so that the proper NOTAM may be issued. Immediately after resumption of service, maintenance personnel must notify the cognizant authority so they can cancel the NOTAM.

b. Weather Minimums. During routine maintenance, shutdowns will not be accomplished unless the weather minimums are at least 4,000 feet and three miles, and approved by the cognizant local authority.

c. Removal of Identification During Maintenance Shut Down. Identification must be removed from the transmitter during maintenance periods. When checking modulation of the transmitter by the tone identification, continuous ident will be transmitted.

5-7. RECORDS. The following forms should be maintained for each facility and constitute a complete station log. All maintenance activities must be properly recorded.

Facility Maintenance Log All maintenance activities must be recorded in this log. See sample, figure 53.

a. Level 1 and Level 3 Performance Check Data Sheets (see figures 51 and 52). These records provide a ready reference and history of system performance and should be updated on the periodic basis specified.

b. VOR Ground Check Data Sheet (see Chapter 5, Section II, figure 58). This form is utilized each time a ground check is performed, and updated on either a monthly or quarterly basis.

5-8. PERIODIC MAINTENANCE SCHEDULE. To evaluate the performance of the system, periodic maintenance should be conducted at scheduled intervals to ensure that the equipment is operating within specified limits. Performance checks are listed in three categories; level 1, level 2, and level 3. The required interval at which these checks will be performed will be determined by the local authority. A suggested schedule for periodic maintenance checks is provided as follows:

a. Level 1 Checks It is recommended that a level 1 check be performed on a weekly or monthly basis as required by the local authority. Enter the time and level 1 performance check into the facility maintenance log. Perform the following visual inspection:

(1) Evaluate the significance of any discrepancies and take proper action.

(2) Complete any required comments in the station log. See sample, figure 53.

(3) The guidelines for filling out the facility maintenance log are as follows:

(a) Date and time (local) should appear for each entry.

(b) Initials should appear after each entry.

(c) Upon completion of a page, sign your name in the bottom right corner under "Signature of Maintenance Technician."

(d) Begin a new page with each calendar month. On the first line put "First Entry for Month of ____________."

(e) After the last entry of each month, state "Last Entry for Month of." Draw a slash (/) through all unused lines

(f) Be sure to insert page numbers for all succeeding pages.

(g) If you make an error in the log, draw one straight line through the erroneous information and initial above the erroneous information.

VOR LEVEL 1 PERFORMANCE CHECK DATA SHEET

STATION IDENTIFIER ____________ LOCATION _________ REF. RADIAL _______ FREQUENCY ______

		FLIGHT INSPECTION REF. DATA	DATE______ TIME______		DATE______ TIME______		DATE______ TIME______		DATE______ TIME______	
SYSTEM NO.			1	2	1	2	1	2	1	2
CARRIER POWER FWD - REF ± 5% MAX REV - 0.2% OF FWD REF	FWD	(a)								
	REV	(b								
SIDEBAND A PWR FWD - REF± 5% MAX REV - 2% OF FWD REF	FWD	(c}								
	REV	(d)								
SIDEBAND B PWR FWD - REF ± 5% MAX REV - 2% OF FWD REF	FWD	(a)								
	REV									
MONITOR BEARING ERROR (REF +.5°) & ±.5° BETWEEN SYS 1 & SYS 2 ON ONE MONITOR)	A3	(g)								
	A6	(h)								
CARRIER LEVEL (GREEN ZONE)	A3	(i)								
	A6	(j)								
30 Hz LEVEL (GREEN ZONE)	A3	(k)								
	A6	(i)								
9960 H2 LEVEL (GREEN ZONE)	A3	(m)								
	A6	(n)								
30 Hz FM LEVEL (GREEN ZONE)	A3	(0)								
	A6	(p)								
RADIAL SELECT SETTING (SAME AS REF GND CHK)	A3	(q)								
	A6	(r)								
IDENT CODE O.K.(√)		(s)								
SIDEBAND BEAR-ING ADJUST (SAME AS REF)		(t)								
CONTROLS & IN-DICATORS NORM-AL (√) g1		(u)								
(√) SYSTEM IS) _ MAIN & ON AIR		(v)								
HIGH LEVEL MODULATION		(w)								
INITIALS										

NOTE: SEE APPENDIX E FOR FORMS WHICH MAY BE DUPLICATED.

Figure 5-1. Level 1 Preventive Maintenance Inspection Data Sheet

LEVEL 3 TEST GENERATOR CALIBRATION DATA SHEET

STATION IDENTIFIER________________________________LOCATION___________________________TEST GENERATOR SERIAL NO.____________________________MON. SERIAL NO.__________________________

NOTE: WHERE NO CHECK MARK (√) IS INDICATED, A NUMERICAL VALUE MUST BE RECORDED		FLIGHT IN-SPECTION	1ST INTERVAL	2ND INTERVAL	3 RD INTERVAL	4TH INTERVAL	SUPPLE - MENTARY
STEP 5.1.1 DUTY CYCLE	OFF & ON TIMES EQUAL (√)						
STEP 5.1.3 FREQUENCY	9960±2 Hz						
STEP 5.2.3 DEVIATION	6th GROUP (√)						
STEP 5.2.4 DEVIATION	EXACT ZERO CROSSOVER (√)						
STEP 6.1.1 30 Hz LEVEL	STEP 6.1.1= 61 (√)						
STEP 6.2.2 9960 Hz LEVEL	STEP 6.2.2=6.2.1 (√)						
STEP 6.3.1 BEARING ERROR	±.2° (±.1° @ FLIGHT INSPECTION)						
STEP 7.3 VOLTAGE 7.4	FLIGHT INSPECTION ±2 %						
STEP 7.4 VOLTAGE	FLIGHT INSPECTION± 2%						
STEP 7.4 1 %	0.87± 2%						
STEP 7.5 VOLTAGE	FLIGHT INSPECTION± 2%						
STEP 7.5.1 %	0.83± 2%						
STEP 7.6.3 SCOPE DISPLAY	CENTERED& SUPERIMPOSED (√)						
STEP 7.6.5 COINCIDENCE	±5 µ SECOND (√)						
STEP 7.6.7 ZERO CROSSING	COINCIDENCE ONE CYCLE AFTER START OF SCOPE SWEEP (√)						
STEP 7.6.9 30 Hz VAR	DISPLACED & DELAYED 2 STEP INCREMENTS (360°) (√)						
STEP 7.6.10 180° PHASE	SIMULTANEOUS ZERO CROSSING & 180° OUT OF PHASE (√)						
FOR STEP 7.3, 7.4, & 7.5 ENTER MODEL NO. (M/N). SERIAL NO. (SIN) AND CALIBRATION DATE(C/D) OF METER USED.		M/N S/N C/D	M/N S/N C/D	M/N S/N C/D	M/N S/N C/D	M/N S/N C/D	M/N S/N C/D
		DATE NAME	DATE INITIALS	DATE INITIALS	DATE INITIALS	DATE INITIALS	DATE INITIALS

NOTE: SEE APPENDIX E FOR FORMS WHICH MAY DUPLICATED.

Figure 5-2. VOR Level 3 Test Generator Calibration Date Sheet

FACILITY MAINTENANCE LOG	STATION: ANY SITE	PAGE ___ OF ___
	SUBJECT OF LOG: VOR	MONTH AND YEAR: JAN 1977

DATE	TIME (24 HOURS)	CODE	REMARKS	INITIALS
6	0800		FIRST ENTRY MONTH OF JANUARY	CBH
6	0800		ARRIVED AT SITE – SYSTEM NORMAL	CBH
6	0815		REQUESTED PERMISSION TO REMOVE STATION FROM SERVICE FOR	
			MONTHLY INSPECTION.	CBH
6	0830		PERMISSION GRANTED BY EH FOR 2 HOURS	CBH
6	1030		MONTHLY CHECK OK. SYSTEM RETURNED TO SERVICE. COGNIZANT	
			AUTHORITY NOTIFIED ~~INITIALS~~ ~~VIA~~ CBH (EH).	CBH
6	1051		MONITOR 1 MALFUNCTION. SYSTEM NORMAL WITH MONITOR 2.	
			TROUBLESHOOT MONITOR 1.	CBH
6	1130		MONITOR 1 REPAIRED. Q-26 OF MODE CONTROL	
			CCA – A2 SHORTED – REPLACED AND TESTED OK.	CBH
6	1200		SYSTEM NORMAL – DEPARTED SITE FOR LUNCH.	CBH
6	~~1230~~ ~~1200~~ 1230 CBH		RETURNED TO SITE. JOHN WEBB ARRIVED FOR QUARTERLY	
			INSPECTION.	CBH
6	1350		QUARTERLY INSPECTION COMPLETED OK. ~~JOHN WEBB~~ CBH DEPARTED SITE WITH	
			JOHN WEBB – SYSTEM NORMAL.	CBH
21	1000		ARRIVED SITE – SYSTEM NORMAL.	CBH
21	1048		BI-WEEKLY CHECK OK – DEPARTED SITE	CBH
2 FEB	0800		(DELAYED ENTRY) LAST ENTRY MONTH OF JAN.	CBH

DATE	SIGNATURE OF MAINTENANCE MANAGER	DATE	SIGNATURE OF MAINTENANCE TECHNICIAN
		2 FEB 77	C.B. Horsely

NOTE: SEE APPENDIX E FOR FORMS WHICH MAY BE DUPLICATED.

Figure 5-3. Facility Maintenance Log Form (Sample)

(h) Upon' each visit, show "Arrived Site" and "Departed Site," and show what was found and/or done.

b. Level 2 Checks Level 2 may be performed on a monthly or quarterly basis as required by local authority. Some parts of the level 2 performance checks require that the station be removed from service. If the weather is not within weather minimums, postpone the check until the following week and note the weather conditions in the station log If, during the monthly checks, the equipment is shutdown for any reason, enter the time the station was NOTAMED out of service and the reason in the station log.

c. Level 3 Checks Level 3 may be performed on a quarterly or semi-annual basis as required by the local authority. Perform the tests outlined in table 5-4 and check audio lines quarterly for leakage, loop resistance and audio levels at the telephone demarcation strip at the remote site. Record results in facility maintenance log book.

d. Annual Checks On an annual basis, and at flight inspection, accomplish the following:

(1) Level 3 Preventive Maintenance Check.. See Table 5-4.

(2) Antenna VSWR check. See (11) below.

(3) Frequency check. See paragraph 5-24.

(4) Antenna and antenna cable connection inspection.

(5) Building bolt tightness check and inspection.

(6) Field detector mounting brackets inspection.

(7) Antenna base bolts tightness check and inspection.

(8) Audio line signal to noise ratio check.

(9) Visual inspection and cleaning per paragraphs 5-14 through 5-15.

(10) Critical switches check per paragraph 5-25.

NOTE

Record results of each of the above in the facility maintenance logbook.

(11) Antenna system VSWR check. Perform whenever required.

(a) Verify that the most recent station operating data indicates no significant change from normal performance.

(b) Verify that modulation percentages are in tolerance.

(c) Verify error curve of ground check is within tolerance.

(d) Plot most recent FWD and REV power readings on VSWR nomograph. VSWR should be better than 1.1.1.

(e) If a trend indication is desired, use readings from several level 1 performance checks.

(12) Perform Level 1 preventive maintenance performance check again to be sure that all controls and indicators are normal, then notify the responsible agent at the remote site when your work is finished. Make appropriate logbook entries for each task completed.

5-9. COMPARISONS AND DISCREPANCIES. Immediately following the completion of the level 2 ground check, the data should be compared with the reference ground check. If the difference at any azimuth exceeds + 1 degree, the facility must be NOTAMED out of service and corrective action initiated to restore normal facility operation. If the station is within tolerance, it should be returned to service (turn identification on) and the proper notation made on the station log.

5-10. CRITICAL CHANGES TO THE STATION. Any component of the system can be changed or adjusted (with the exception of the antenna monitor or test generator) as long as the station meets the repeatability error requirements of a ground check after the equipment is changed or adjusted. For the monitor or test generator, the quarterly performance check must be completed and the replacement must match the recorded data for the unit replaced. A new flight check is required if the antenna is adjusted or replaced or if the monitor or test generator does not satisfy the above requirement.

5-11. TROUBLESHOOTING. The following troubleshooting concepts are based upon the philosophy that any trouble can be isolated to the faulty unit and to the faulty module or printed circuit board of the indicated unit The repair concept is primarily that of replacing the defective module or printed circuit board with a known serviceable unit This method of troubleshooting is designed to impart to the technician a quick, efficient method of fault isolation. This manual contains several troubleshooting aids to be used when troubleshooting. These are: the detailed functional analysis of Chapter 4, the adjustment procedures of this section, the performance check standards and the functional logic interconnection diagrams and schematics contained in Chapter 7.

5-12. LOGICAL TROUBLESHOOTING GUIDE. When adequate historical data is not available, troubleshooting procedures should be based on the following six logical steps:

a. Symptom Recognition. This is the first step in the troubleshooting procedure and is based on a complete knowledge and understanding of equipment operating characteristics. All equipment troubles are not the direct result of component failure. Therefore, a trouble in an equipment is not always easy to recognize since all conditions of less than peak performance are not always apparent. It is important that the "not so apparent" troubles, as well as the apparent troubles, be recognized.

b. Symptom Elaboration. After an equipment trouble has been "recognized," all available aids designed into the equipment should be used to further elaborate on the original trouble symptoms Where the equipment interfaces with another system, controls or other indicating devices may be used to provide better identification of the original trouble symptom. Checking or otherwise manipulating such controls may eliminate the trouble.

c. Listing Probable Faulty Function. The next step in logical troubleshooting is to formulate a number of "logical choices" or mental decisions which are based on knowledge of the equipment operation, a full identification of the trouble symptom, and information contained in this manual. The overall functional description and its associated block diagram should be referred to when selecting possible faulty functional sections

d. Localizing the Faulty Function. For the greatest efficiency in localizing trouble, the functional sections which have been selected by the "logical choice" method should be tested in an order that will require the least time. This requires a mental selection to determine which section to test first. The selection should be based on the validity of the "logical choice" and the difficulties in making the necessary tests If the tests do not prove that functional section to be at fault, the next selection should be tested, and so on until the faulty functional section is located. As aids in this process, the manual contains a functional description and a functional logic interconnection diagram. Also, test data (such as information on control settings, critical adjustments, and required test equipment) are supplied to augment the functional description and interconnection diagram for each functional section.

e. Localizing Trouble to the Circuit. After the faulty functional section has been isolated, it is often necessary to make additional "logical choices" as to which group of circuits or circuit (within the functional section) is at fault. A functional logic interconnection diagram provides the signal flow and test location information needed to bracket and then isolate the faulty circuit. Functional descriptions of circuit operation is provided in Section 4 and adjustments and performance test procedures are provided in this section.

f. Failure Analyses. After the trouble has been located (but prior to performing corrective action), the procedures followed up to this point should be reviewed to determine exactly why the fault affected the equipment in the manner it did. This review is usually necessary to make certain that the fault discovered is actually the cause of the malfunction, and not just the result of the malfunction.

If the system fails to meet optimum performance requirements, and the logical troubleshooting guide above fails to aid in locating the problem, perform the tests outlined in Table 5-5, using the functional logic interconnection diagrams in Chapter 7 to fault isolate to the module or printed circuit board level.

5.13. EXTENDER BOARDS. The extender board carries straight-through circuitry and is used for troubleshooting circuit card assemblies

CAUTION

To prevent damage to the circuit board contacts, use care when inserting the extender board. A pull strap is provided on one end of the extender board for ease of extraction.

a. To use the extender board, remove the circuit card to be tested and insert the extender board in its place. One end of the extender board is provided with a connector to accommodate the circuit card assembly. In this manner, the entire circuit card assembly is exposed and functioning.

CAUTION

Extreme caution must be used to ensure that the proper circuit card assembly is in place in the connector designated.The extender cards will interface with all sockets. Because of this capability, it will be necessary to correctly identify the circuit card being replaced to insure the reference designator of the card corresponds to that recorded on the card rack position.

b. Occasionally inspect the extender board contacts for cleanliness If cleaning is required, use alcohol as a detergent When the extender boards are not in use, store in areas provided for protection.

5-14. INSPECTION. In keeping with a good preventive maintenance philosophy, a periodic visual inspection of the VOR equipment should be periodically performed. Defects resulting from wear, physical damage, deterioration, or other causes can be found by these inspection procedures. To aid inspection, suggested inspection procedures are provided in the following sub-paragraphs:

a. Chassis Inspect the chassis for deformation, dents, punctures, badly worn surfaces, damaged connectors, damaged fastener devices, damaged handles, component corrosion and damage to the finish.

b. Connectors Inspect connectors for broken parts, deformed shells or clamps, and other irregularities Inspect for cracked or broken insulation and for contacts that are broken, deformed or out of alignment Also check for corroded or damaged plating on contacts and for loose, improperly soldered, broken or corroded terminal connections

c. Capacitors, Fixed. Inspect capacitors for case damage, body damage, and cracked, broken or charred insulation. Check for loose, broken or corroded terminal studs, lugs or leads. Inspect for loose, broken or improperly soldered connections.

d. Capacitors, Variable. Inspect trimmers for chipped and cracked bodies, damaged dielectrics and damaged contacts.

e. Covers and Shields. Inspect covers and shields for punctures, deep dents and badly worn surfaces. Also check for damaged fastener devices, corrosion and damage to finish.

f. Indicators Inspect indicators for cracked or broken face plate or housing.

g. Insulators. Inspect all insulators for evidence of damage, such as broken or chipped edges, burned areas and presence of foreign matter.

h. Jacks. Inspect all jacks for corrosion, rust, loose or broken parts, cracked insulation, bad contacts or other irregularities.

i. Potentiometers. Inspect all potentiometers for evidence of damage such as dents, cracked insulation or other irregularities.

j. Circuit Card Assemblies. Inspect all integrated circuit cards for broken leads of components mounted on each board. Check for damaged crystals. The cards should be free of all foreign material. Check connector pins for damage or contamination. Verify position and condition of guide pins, keys, etc. Connectors of circuit card assemblies may be dirty and can be cleaned by rubbing with a clean (non-abrasive) eraser (item 4, Section II, Appendix G).

k. RF Coils. Inspect all RF coils for broken leads, loose mountings and loose,improperly soldered or broken terminal connections. Check for crushed, scratched, cut or charred windings. Inspect the windings, leads, terminals and connections for corrosion or physical damage. Check for physical damage to forms and tuning slug adjustment screws.

I. Resistor, Fixed. Inspect the fixed resistors for cracked, broken, blistered or charred bodies and loose, broken or improperly soldered or corroded terminal connections

m. Switches, Push Buttons. Examine' the push buttons or switches for bent shafts, contacts, wafers or broken cases.

n. Terminal Connections Soldered.

(1) Inspect for cold-soldered or resin joints. These joints present a porous or dull, rough: appearance. Re-solder where necessary.

(2) Examine the terminals for excess solder, protrusions from the joint, pieces adhering to adjacent insulation and particles lodged between joints, conductors or other components.

(3) Inspect for insufficient solder and unsoldered or broken strands of wire protruding from conductor at the terminal. Check for insulation that is stripped back too far from the terminal.

(4) Inspect for corrosion at the terminal.

o. Transformers.

(1) Inspect for signs of excessive heating, physical damage to case, cracked or broken insulation and other abnormal conditions.

(2) Inspect for corroded, poorly soldered or loose connecting wires.

p. Wiring. Inspect open and laced wiring of chassis, subassembly chassis and parts of equipment for breaks in insulation, conductor breaks, cut or broken lacing and improper dress in relation to adjacent wiring or chassis, abrasion or chaffing of insulation, and cold flow of teflon insulation.

5-15. CLEANING. Accumulation of dirt on electronic components can cause overheating and component breakdown. A layer of dirt on a component acts as an insulating cover and hinders efficient heat diffusion. It also provides an electrical conduction path. Covers of the VOR electronics assembly drawers afford protection against dust in the interior of the drawers. Operation without the covers in place will require more cleaning. All panel covers should be installed for storage and transportation.

CAUTION

Do not apply chemical cleaning agents which might damage plastic parts used in the drawers.

a. Exterior. All components of the VOR electronic equipment are to be cleaned using the following uniform procedure. Observe that the external power source is off and that all power switches on the front panels of the electronics assembly are off. Start the cleaning procedure from the top and work to- wards the bottom of the cabinet. Cleaning should be accomplished with a softhaired brush, or a vacuum, and a soft, lint free cloth (item 3, Section II, Appendix G). Avoid high pressure air cleaning This could lodge foreign matter in blind areas and possibly blow attached parts free. On hard to get at spots, use a common solvent such as isopropyl or denatured alcohol (item 1, Section II, Appendix G). However, do not over use, as alcohol will leave a light residue.

b. Interior. The interior of all drawers should occasionally be cleaned of dust due to the electrical conductivity of the dust under high-humidity conditions. Remove dust with a soft paint brush, (item 2, Section II, Appendix G) vacuum or a cloth, (item 3, Section II, Appendix G) dampened with a mild deter- gent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces, or for cleaning ceramic terminal strips and wiring boards. Excessive dirt or dust in areas of high voltage can result in arcing and improper unit operation.

5-16. LUBRICATION. Since the bearings in the antenna blower motor, B1, are not sealed it is necessary to properly oil these bearings monthly. It is necessary to dismount the blower to do this. No more than six drops of oil (SAE 30 non-detergent ML or equivalent) (item 5, Section II, Appendix G) per oil hole.

5-17. REPAIR. After a module has been found to be faulty, it should be replaced with a good replacement and the system brought back to operating status. Should it be necessary to replace components in the module, the following procedure should be accomplished before a repair action is initiated.

5-18. DISASSEMBLY/REASSEMBLY PROCEDURES. There are no difficult disassembly procedures for removing components associated with the VOR system, with the exception of the antenna. Maintenance action on the antenna is limited to replacement of components on the upper and lower bridge. Reassembly is essentially the reverse of disassembly.

Table 5-2. Level 1 Preventive Maintenance Performance Check

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
1	Control and Indicator Verification	Observe and verify that controls and indicators exhibit NORMAL operation. NOTE: Log any discrepancies (other than lamp failures). Always check for burned out lamps before commencing any other troubleshooting for a lamp off condition.	System Front Panels	See steps of this procedure.
2	Obstruction Light Check	observe that both obstruction illuminated.	Top of Antenna	
3	Facility Check	Check shelter for leaks or other damp Check vicinity for change that could affect the facility.		
4	Environmental Checks	Check operation of environmental control system blowers and verify thermostat or control settings.	Applicable Equipment	Dependent on Local Policy
5	Equipment Checks	Readings and observations re to be taken per the level 1 preventative maintenance data sheet. (See Figure S-1).	Front Panel and In-Drawer meter/ control panel	Per this manual and the site standards established for location.
5.1	Power Meter	Before proceeding, et power monitor meter switch to OFF and check zero wt NOTE: Use screw on face of meter to adjust for zero and allow time for mater to settle" NOTE: Permission of cognizant local authority must be obtained before proceeding with this test	RF Power Monitor Panel	POWER mater needle should be aligned with left most scale graduation.
5.2		Inhibit remote control and local control of facility.	VOR Local Control Unit	Remote indicator extinguished.
5.3		Enter command code 15 if System Is not presently ON AIR.	VOR Local Control Unit	System control code chart on Local Control Unit.
5.4	Carrier Power	observe and record carrier forward and reverse power out.	VOR RF Power Monitor - POWER meter	Forward power should be within 5% of the forward carrier reference (See Figure 5-1, cols (a) and (b). Maximum reverse power should be less than 0.2% of the forward reference power.

Table 5-2. Level 1 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
5.5	"A" Sideband Power	Observe and record sideband "A" forward and reverse power out.	VOR RF Power Monitor - POWER Meter.	Forward power should be within 5% of the Sideband reference. Reverse power should be less than 2% of the forward sideband reference power. (See Figure 5-1, cols (c) and (d).
5.6	"B" Sideband Power	Observe and record sideband "B" forward and reverse power out.	VOR RF Power Monitor - POWER Meter.	Use same as step 5.5 except use cols (e) and (f).
5.7	Monitor Bearing Error	Observe and record monitor bearing error readings	Digital bearing	(See Figure 5-1, cols (g) and (h).
5.8	Meter Readings	Observe and record a Carrier level b. 30 Hz level c. 9950 Hz level d. 30 Hz FM level	Monitor in-drawer meter panel meter	Typically in the GREEN zone (see Figure 5-1, coi. (i) through (p)).
5.9	Radial Select	Observe and record radial select setting.	Bearing radial select thumb-wheel switches on monitor.	Same as the flight inspection reference data recorded during commis-sioning flight inspection (see Figure 5-1, cols (q) and (r)).
5.10	Ident Code	Observe and verify identity code during its transmission.	Ident Code indicator on monitor.	Flashes assigned international Morse code at 7.5 second intervals (see Figure 5-1. cols. (s)).
5.11	Bearing Adjustment	Observe and verify sideband bearing adjust.	Bearing Adjust Control on in-drawer meter panel of sideband transmitter.	Same as reference ground check (see Figure 5-1, col. (u)).
5.12	High Level Modulation Check	Place the METER SELECT switch 1A4M1 to the HIGH LEVEL MODULATION position. Observe and record reading.		High level modulation voltage should be within t 2 volts of reference (see Figure 5-1 column (w)).
6.0		Return system control to remote unit. Depress remote indicator. Notify cognizant authority.	Remote switch indicator on front panel of VOR local control unit.	Remote switch (green) indicator should illuminate.

Table 52. Level 1 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
7.0	Monitor Indicators	Observe and verify monitor indicator status.	VOR monitor indicators: Both monitors.	
			a. POWER ON	Illuminated
			b. CRITICAL SWITCHES MISSET	Extinguished
			c. MONITOR BYPASS	Extinguished
			d. IDENT CODE	Periodic flashing
			e. 9960 Hz	Illuminated
			f. 30 Hz	Illuminated
			g. BEARING	Illuminated
			h. IDENT	Illuminated
			i. BEARING ERROR	Approximately 0.0
8.0	Local Control Status	Observe and verify indicators.	VOR Local Control Indicators:	
			a. POWER ON	Illuminated
			b. REMOTE SWITCH	Illuminated
			c. 9960 Hz	Extinguished
			d. 9960 Hz	Extinguished
			e. BEARING	Extinguished
			f. IDENT	Extinguished
			g. MAIN ON	Illuminated
			h. STANDBY ON	Extinguished
			i. OFF	Extinguished
			j. CRITICAL SWITCHES NORMAL	Illuminated
			k. SYSTEM INHIBIT SWITCH	Extinguished
			l. RING SWITCH	Extinguished
			m. INTERCOM SWITCH	A FACIL
9.0	Log Entry	Make a log entry indicating successful completion of each performance check accomplished or note any exceptions in the facility maintenance log.		See cognizant authority for log book directives.

Table 5-a Level 2 Preventive Maintenance Performance Check

Step No.	Test Description	Procedure	Read Indication On	Reference standards
		NOTE: Do not perform this procedure without permission of the local cognizant authority and when flying conditions are below the weather minimums which are typically 4000 foot ceilings and 3 mile visibility. (The VOR is disabled during parts of this test.) The actual minimums must be established by the cognizant authority.		
1		Obtain permission from cognizant authority at the remote site to inhibit the remote unit and assume local control.		
2		Depress REMOTE SWITCH indicator.	VOR Local Control Unit	REMOTE SWITCH indicator extinguished.
3	Select System	Verify that the system is presently on the air. If it is not, enter command code 15.	VOR Local Control Unit	SYSTEM STATUS indicators and command code label on local control. On RF Power Monitor POWER meter. verify carrier and sideband power output.
4	9960 Hz Alarm & Shutdown Test	On carrier transmitter, place the SUBCARR switch on circuit card assembly A2 to OFF position.	VOR Monitor and Local Control	Monitor 9960 Hz NORMAL indicator should extinguish and local control 99-0 Hz ALARM Indicator should Illuminate. System shutdown Shouldoccurwithin15seconds.
4.1		Return the SUBCARR switch to the NORMAL position.		
4.2		Repeat step 3.		
5	30 Hz Alarm and Shutdown Test	On sideband transmitter place A CONT and B CONT switches on circuit card assembly A4 to the OFF position.	VOR Monitor end Local Control	Monitor 30 Hz NORMAL indicators should extinguish and Local Control 30 Hz ALARM indicator should Illuminate. System shutdown should occur within 15 seconds.
L.1		Return switches of Step 5 to the NORM position.		
5.2		Repeat Step 3.		

Table 5-3. Level 2 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
6.0	Bearing Alarm & Shutdown Test			
6.1		Increase the BEARING RADIAL SELECT setting by 2° on the monitor.	VOR Monitor and Local Control Units	Monitor BEARING NORMAL indicators should extinguish and Local Control BEARING ALARM indicator should illuminate. System shutdown should occur within 15 seconds.
6.2		Return the BEARING RADIAL SELECT switches setting to the reference radial setting.	Monitor RADIAL SELECT switches	Same a RADIAL SELECT setting reference data recorded on weekly data sheet shown in Figure 5-1.(q) and (r).
6.3		Repeat Step 3.		
6.4	Deviation Check	Place DEV CONTROL switch 1A5A1S1to the OFF position.	Same as Step 6.	same as Step 6.
6.4.1		Place DEV CONTROL switch 1A5A1S1 to the NORMAL position		
6.4.2		Repeat Step 3.		
7	No Ident Alarm & Shutdown Test	On carrier transmitter place IDENT switch on circuit card assembly A2 to the OFF position.	VOR Monitor & Local Control	Monitor IDENT NORMAL indicators Should extinguish and Local Control IDENT ALARM indicator Should illuminate. System shutdown Should occur within 30 seconds.
7.1		Return switch of Step 7 to NORM.		
7.2		Repeat Step 3.		
8.0	Continuous Ident Alarm & Shutdown Test	On carrier transmitter, place IDENT switch on circuit on card A2 to CONT position.	VOR Monitor & Local Control	Monitor IDENT NORMAL indicator should extinguish and Local Control IDENT ALARM indicator should illuminate. System shutdown should occur within 30 seconds.

Table 5-3. Level 2 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standard
8.1		Repeat Steps 7.1 and 3.		
9	NOT USED			
10	Ground Check	Perform ground check procedure in Chapter 5,ction II, paragraph 5-33 through and including 5-37 and record results on VOR Ground Check Date Sheet (See Figure 5-10). NOTE: If you are not familiar with the ground check procedure for this system, study the information given In paragraph 5-27 before proceeding.		As outlined in Chapter 5, Section II
11	Final Check	Perform VOR level 1 preventive maintenance performance test listed in table 5-2 and record results on the weekly performance check data sheet. NOTE: If doing this check as part of a commissioning flight inspection record data as the reference on a new data sheet.		Reference Figure 5-1.
12	Log Entry	Enter completion of this performance check in the facility log book.		

Table 5-4. Level 3 Preventive Maintenance Performance Check

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
		NOTE		

The ac voltage levels to calibrate the modulation depth are established by the test generator circuit card assembly (1A3A5) and are adjusted prior to commissioning the flight inspection and again as pert of the final commissioning flight inspection procedures (following adjustment of the monitor levels).They are adjusted at that time to correspond to levels coming from the field detectors The critical ac voltage levels, 9960 Hz and 30 Hz variable, are measured using a digital voltmeter and are recorded as part of the flight inspection commissioning data. The test generator may be independently calibrated for correct 30 Hz deviation on the 9960 Hz subcarrier at any time. Bearing accuracy can be confirmed in accordance with procedures contained in the table, but there are no provisions for adjustments in the test generator circuit card assembly, 1A3A5. Verification of the test generator operation is possible at any time; however, the 9960 Hz subcarrier level and 30 Hz variable level must always be set to the same level as recorded in the data sheet following commission flight inspection. These recorded levels are the ultimate reference levels for 9960 Hz variable in the monitoring system, the test generator becomes the calibrated reference for the monitor. Therefore, maintenance checks are performed in the following order:

1. Verification of test generator.
2. Verification of monitor using the test generator
3. VOR system verification using the monitor and independent test equipment.

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
1		Obtain permission from cognizant authority at the remote site to inhibit the remote unit and assume local control.		
2		Before proceeding, switch all meters In the system of OFF position and verify that they are correctly "zoeroed" on the leftmost scale graticule. Allow time for needle to settle. Use the adjustment screw on the meter face if adjustment is necessary.		
3		Depress remote switch indicator.	VOR Local Control Unit	Remote indicator Extinguished.
		NOTE: The following procedure is to be performed using monitor 1A3 as the reference monitor.		
4	Monitor Calibration to Transmitter.	Set INPUT SELECT switch of monitor to the NORM position.	Monitor Meter Panel.	

Table 54. Level 3 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
		NOTE: Field detector must be located at the mounting post 30 feet from the antenna with extension cable removed.		
4.1		Verify the POWER ON and CRITICAL SWITCHES MISSET indicators.	VOR Monitor	POWER ON is illuminated CRITICAL SWITCHES MISSET is extinguished.
4.2		Verify that the desired system is presently on the air. If it is not, enter command code 15 on local control	VOR Local Control	SYSTEM STATUS indicators end command code label on the local control. On RF POWER MONITOR power meter verify carrier end sideband power output.
4.3	Monitor Power Supply	With TEST SELECT switch, check each power supply voltage	Test Meter	Green Zone.
		NOTE: For interim checks, omit step 4.4 through 4.4.4. These steps must be done for flight inspections and if recalibration is required.		
4.4	Power Supply Accurate Test			
4.4.1		Connect digital dc voltmeter across U-1 (orange wire is +15 and the case is ground).	Digital Voltmeter	+ 15 + 1 Vdc
4.4.2		Switch digital voltmeter to ac.	Digital Voltmeter	< 0.0177 Vac
4.4.3		Connect digital dc voltmeter across U-2 (violet wire is -15 and the case Is ground).	Digital Voltmeter	-15 + 1 Vdc
4.4.4		Switch digital voltmeter to ac.	Digital Voltmeter	<0.0177 Vac
		CAUTION: Steps 4.5 through 4.7 are to be performed only immediately following or as part of a commission flight inspection.		
4.5	Carrier Level Set	Set TEST SELECT switch to CARRIER LEVEL position.	Monitor TEST METER	
4.5.1		Adjust INPUT LVL potentiometer A3R22. METER	Monitor TEST on monitor TEST METER	Center line of Green Zone

Table 5-4. Level 3 Preventive Maintenance Performance Check(Contd)

Step No.	Description	Tests Procedure	Read Indication On	Reference Standards
4.6	30 Hz Limit Set	On circuit card assembly A3, actuate and hold 30 Hz LIMIT SET switch in the detent position and adjust 30 Hz LIMIT NO. 1 potentiometer A3R38.	Monitor NORMAL 30 Hz indicator	Barely pat threshold of illumination and Illuminated.
4.6.1		Release 30 Hz LIMIT SET 'witch.		
4.7	9960 Hz Limit Set	On circuit card assembly A4. actuate and hold 9960 Hz LIMIT SET switch in the DETENT position and adjust 990 Hz No. 1 LIMIT potentiometer A4R40.	Monitor NORMAL 9960 Hz indicator	Barely past threshold of illumination and illuminated.
4.7.1		Release 9e60 Hz LIMIT SET switch.		
4.8	Alarm Test	On circuit card assembly A3, hold H/L LIMIT TEST switch to H (high).	Monitor NORMAL 30 Hz end 9960 Hz Indicators.	Should remain illuminated.
4.S1	*Release* switch.		Monitor NORMAL 30 Hz end 9960 Hz Indicators.	Should remain Illuminated.
4.S2		On circuit card assembly A3, hold H/L LIMIT TEST witch to L (low).	Monitor NORMAL 30 Hz and 9960 Hz Indicators.	Extinguished
4.S3		Release switch.	Monitor NORMAL 30 Hz and 9960 Hz Indicators.	Should remain illuminated.
4.9	Bearing Set	Verify Monitor BEARING RADIAL SELECT switch settings and BEARING ERROR display readout. Note readings. NOTE: If This test is part of a commissioning flight inspection, adjust and record BEARING RADIAL SELECT switch settings on level 1 performance check data sheet Figure 5-1. This becomes the reference for future checks.	Monitor BEARING RADIAL SEL-ECT ERROR Display.	RADIAL SELECT switches must be et the same as recorded on level 1 Performance check data sheet Figure 5-1. ,t commissioning flight inspection. BEARING ERROR display indication of 0.0° 0.5°.

Table 5-4. Level 3 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
		NOTE: For the following, record data on level 3 test generator calibration data sheet (Figure 5-2). Set POWER switch on monitor to OFF. Remove circuit card AS and place on extender card. Turn POWER switch to the NORMAL position.		
5.0	Teat Generator Calibration			
5.1	9960 Hz Symmetry Adjust	Connect scope vertical channel to 9960 Hz test point ES on Test Gen Circuit Card Assembly A5.		
5.1.1		Set MOD SEL switch on A5 to REF and ground the 30 Hz R EF test point on A5 and observe duty cycle and verify off time is equal to on time.	Oscilloscope Display	Off time - On time
5.1.2		This adjustment is to minimize second harmonic output and normally is not to be adjusted. However, if adjustment Is necessary, adjust A5R8 to satisfy step 5.1:1 requirement. Leave 30 Hz REF test point grounded for step 5.1.3.		
5.1.3	9960 Hz Adjust	Place INPUT SELECT switch to the TEST GEN position. Connect frequency counter to test generator circuit card assembly A5 9960 Hz test point ES and adjust R9. Disconnect ground on 30 Hz REF test point.	Frequency Counter Display	9960 2 Hz
5.2	FM Deviation Adjust (Test Gen)			
5.21		Connect oscilloscope vertical input to FLD DET MONITOR teat connector on monitor meter panel.	Monitor Meter Panel	
5.2.2		Adjust scope to produce display as illustrated at right.		

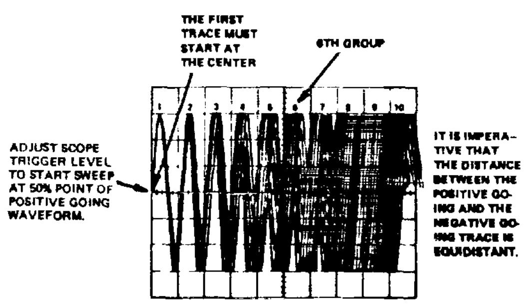


Table 5-4. Level 3 Preventive Maintenance Performance Check (Contd)

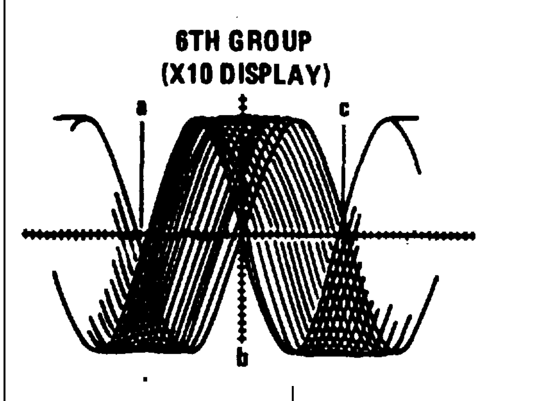
Step No.	Test Description	Procedure	Read Indication On	Reference Standards
5.2.3		Position sixth group in center of display and switch scope horizontal to X 10 position.		
5.2.4		Adjust circuit card assembly A5A1 DEV potentionmeter R20 for an exact zero crow-over at the sixth group as shown at right s point b.		
5.2.5		Set POWER twitch on monitor to OFF. Remove extender card end reinstall circuit card AS. Return POWER switch to the NORMAL position. CAUTION: Steps 6.0 through 6.3 are t be performed only immediately following or a pat of commissioning flight Inspection.		
6.0	Test Generator Alignment to System	Place Monitor TEST SELECT switch in 30 HZ LEVEL position and set MOD SEL switch on circuit card assembly A5 to BOTH position.	Monitor Test Meter Panel	
6.1	30 Hz Level	Place Monitor INPUT SELECT witch in NORM position and note reading	Monitor TEST METER	Green Zone
6.1.1 step 6.1		Place Monitor INPUT SELECT w switch TEST GEN position end adjust TestGen VAR 30 HZ LVL adjustment ASR28.	Monitor TEST METER	Exactly the same -
6.2	9980 Hz Level	Place Monitor TEST SELECT switch in 9960 HZ LEVEL position. Return the MOD SEL witch on circuit card assembly A5 to REF.	Monitor TEST METER panel	
6.2.1		Place Monitor INPUT SELECT switch in NORM position and note reading.	Monitor TEST METER	Green Zone
6.2.2		Place Monitor INPUT SELECT In TEST GEN position and adjust test generator 9960 HZ LVL adjustment A5R14.	Monitor TEST METER	Exactly the same as Step 6.2.1
6.3	Baring Error	Place MOD SEL switch to BOTH potion. Set the TEST GEN BEARING SELECT switch to correspond with the location of the field detector.	Monitor TEST METER Panel	

Table 5-4. Level 3 Preventive Maintenance Performance Check (Cont.)

Step No.	Test Description	Procedure	Read Instruction On	Reference Standards
6.3.1		TEST GEN BEARING SELECT plus Monitor BEARING ERROR display readout should equal Monitor BEARING RADIAL SELECT thumbwheel switch setting. Adjust 1A3A3R9 to obtain desired results.	Monitor a. Test Meter Panel. b. BEARING ERROR Display (front panel) c. BEARING RADIAL SELECT (front panel).	Equal to BEARING RADIAL SELECT setting ± 0.2°
7.	Test Generator Performance Check			
7.1		Place MOD SEL switch on test generator circuit card assembly A5 to REF position.		
7.2		Place Monitor INPUT SELECT switch to TEST GEN position.	Monitor Meter Panel.	
7.3		Connect ac digital voltmeter to FLD DET MONITOR test connector of monitor Record on level 3 test generator calibration data sheet.	Digital multimeter. (required accuracy ± .1%).	Flight inspection ± 2%.
7.4	High Limit Test	On test generator circuit card assembly A5, hold LIMIT TEST switch in HIGH position and record reading on data sheet.	See Step 7.3	
7.4.1		Divide step 7.3 reading into step 7.4 reading and record result on data sheet.		0.87 ± .02 of step 7.3 voltage.
7.5	Low Limit Test	On test generator circuit card assembly A5, hold LIMIT TEST switch in LOW position and record reading on data sheet.	See Step 7.3.	
7.5.1		Divide step 7.3 reading into step 7.5 reading and record result on data sheet.		0.83 ± .02 of step 7.3 voltage.
7.6	Bearing Test	Place MOD SEL switch on circuit card assembly A5 to BOTH position.		
7.6.1		Connect vertical channel 1 of scope to test generator circuit card assembly A5, 30 Hz REF test point. Set scope for channel 1 only trigger, positive, dc.		

Table 5-4. Level 3 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Instruction On	Reference Standards
7.6.2		Connect vertical channel 2 of scope to test generator circuit card assembly A5, 30 Hz VAR test point.		
7.6.3		Set scope vertical channels for dc coupled mode and chopped display mode. Center both traces with vertical inputs at ground potential (0 Vdc).	Scope Display	Both traces centered vertically and superimposed with 0 Vdc inputs.
7.6.4		On monitor meter panel set TEST GEN BEARING SELECT switch to 0° position.		
7.6.5		Adjust scope time base as required to determine that leading edges of waveforms are in coincidence and 180° out of phase. NOTE: It may be necessary to trigger scope on channel 2 signal.	Scope Display	Coincidence ± 5 microseconds
7.6.6		Set scope time base to display one complete cycle of 30 Hz.		
7.6.7		Verify that both traces cross zero reference simultaneously.	Scope Display	Coincidence one cycle after start of cope trace at zero crossing.
7.6.8		On monitor meter panel. advance TEST GEN BEARING SELECT switch clockwise one position at a time.		
7.6.9		At each position of TEST GEN BEARING SELECT switch, confirm that the signal at the 30 Hz VAR test point is displaced and delayed from the 30 Hz reference NOTE: Scope must be triggered on 30 Hz REF (channel 1 only trigger).	Scope Display	Displayed and delayed two step increments, for switch position.
7.6.10		At the 180° position of the TEST GEN BEARING SELECT switch, verify simultaneous zero crossing of waveforms (180° in phase) one cycle from start of sweep.		Coincidence one cycle after start of scope trace at zero crossing and 180° in phase.
7.6.11		Proceed to 0/360° position as in step 7.6.9		

Table 5-4. Level 3 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
8.0	Monitor Performance Check Using Test Generator			
8.1		Set INPUT SELECT switch to NORM and verify the POWER ON, CRITICAL SWITCHES MISSET, and MONITOR BYPASS indicator status. Verify the +15 Vdc and -15 Vdc position readings on the TEST METER.	VOR Monitor Front Panel and Meter Panel	POWER ON (green) indicator should be illuminated. MONITOR BYPASS (yellow) CRITICAL SWITCHES MISSET (red) indicators extinguished. TEST METER should read green zone.
8.2	Monitor Bypass Check	Set INPUT SELECT switch to TEST GEN position.	Monitor Meter Panel and Front Panel.	MONITOR BYPASS (yellow) indicator illuminated.
8.3	30 Hz Level Check	On monitor test panel, set TEST SELECT to 30 HZ LEVEL: position.	Monitor TEST METER	Green zone on monitor TEST METER.
8.4	30 Hz Limit Check	On circuit card assembly A3, hold LIMIT TEST switch to H (high) position.	Monitor Front Panel	NORMAL 30 Hz indicator is illuminated.
8.4.1		Repeat step 8.4 except hold LIMIT TEST switch in L (low) position.		NORMAL 30 Hz indicator is extinguished.
8.5	9960 Hz Level Check	Repeat steps 8.3 and 8.4 except for 9960 Hz instead of 30 Hz.		Substitute NORMAL 9960 Hz indicator for NORMAL 30 Hz indicator in reference standard column readings in steps 8.3 and 8.4
8.6	Bearing Check	Set TEST GEN BEARING SELECT switch to correspond with field detector location.		
8.6.1		Set monitor BEARING RADIAL SELECT switches to setting of step 8.6 and observe BEARING ERROR display. NOTE: If interim check is out of tolerance: Perform steps 7.0 through 7.6.11 (Test Gen Performance Check). If satisfactory, readjust monitor.	Monitor BEAR-ING ERROR	$0.0 \pm .0.1°$

Table 5-4. Level 3 Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indicated On	Reference Standards
8.6.2		Repeat step 8.6.1 for each position of TEST GEN BEARING SELECT switch. Before changing monitor BEARING RADIAL SELECT switches, observe BEARING ERROR display. It should read ± 7.9.		Monitor BEARING RADIAL SELECT switches agree and monitor BEARING ERROR reads tolerances of step 8.6.1.
8.6.3		Set monitor BEARING RADIAL SELECT switches to setting recorded on level 1 preventive maintenance performance check data sheet (Figure 5-1).	BEARING RADIAL SELECT Switches	Flight inspection reference recorded on data sheet (Figure 5-1) as radial select setting.
86.4		Return monitor INPUT SELECT switch to NORM position and TEST SELECT switch to OFF position and disconnect all test equipment.		
8.7	VOR level 2 Performance Check	Complete VOR level 2 Performance Check in Table 5-3, steps 1 through 8.1. Be certain to perform the ground check and level 1 check portions and record the required data, particularly if in conjunction with a flight inspection.		
9	Log Entry	Be sure to enter completion of this procedure in log book.		

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
		NOTE: In this procedure, any step prefixed with an asterisk **(*)** may be omitted providing that the recommended procedure contained in tables 52, 53 end 54 are also being performed. NOTE: This procedure is divided into sections by function. If the function is not utilized in the system, that a section may be omitted. This method of division may be used to great advantage for troubleshooting a only the failing function needs to be tested.		
1.0	Local Control Unit Tests			
2.0	General Tests			
*2.1	System Power Front Panel	Verify SYSTEM POWER circuit breaker position.	Local Control Front Panel	UP position.
*2.2	Primary Power Front Panel	Verify PRIMARY POWER, POWER ON (green) indicator status	Local Control Front Panel	Illuminated
2.3	System Control Test	NOTE: Obtain permission from cognizant authority before proceeding.		
2.4	Remote Switch Test	Press and release the REMOTE SWITCH (green) indicator several times.	Local Control Front Panel	REMOTE SWITCH (green) indicator should alternate between illuminated and extinguished states.
2.5	Keyboard Lock-Out Test	With REMOTE SWITCH (green) indicator illuminated, enter several two digit command code combinations into the keyboard.	Local Control Front Panel	No change of state should occur for any status indicator or associated equipment controlled by the local control.
*3.0	System Control	Press REMOTE SWITCH (green) indicator until extinguished	Local Control Front Panel	REMOTE SWITCH (green) indicator should be extinguished.
*3.1	VOR Functions (Teen Codes)			
*3.1.1	XMTR MAIN ON	On SYSTEM CONTROL keyboard, enter command code 15.	Local Control Front Panel	SYSTEM STATUS MAIN ON (green) indicator should be illuminated.

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
3.1.2		Carrier and side band transmitters should be on air and driving the antenna.	RF Power Monitor Meter	CARRIER FWD position. Normal reading SIDEBANDS A and B FWD - Normal reading
3.1.3	XMTR OFF	Repeat step 3.1.1 for command code 17 and observe change in XMTR status	RF Power Monitor Meter	CARRIER FWD - 0 reading SIDEBAND A and B FWD - 0 reading.
3.1.4		Verify SYSTEM STATUS MAIN ON (green) indicator	Local Control Front Panel	Extinguished
3.1.5		Verify SYSTEM STATUS OFF (red) indicator.	Local Control Front Panel	Illuminated
3.1.6		Repeat steps 3.1.1 and 3.1.2		
3.2	Indent Monitor ON/OFF Teen Codes)	This function is tested as part of remote control unit performance check. NOTE: The indent code tone cannot be audibly monitored at the local control; however, command codes 18 and 19 can be entered at the local control if necessary or for test purpose.	Intercom Speaker at Remote	
3.3	System Control DME Functions (twenty codes)	The following tests are used when DME equipment is co-located with VOR equipment. If DME equipment is not used, proceed to step 3.4.		
3.3.1	DME Command Code Test from Local Site	NOTE: Before performing this test, ensure the DME equipment is operating properly in accordance with checkout instructions provided in Technical Manual Doc No. CM006. Control of the DME is accomplished directly at the local site via the DME control unit. Command codes to turn the equipment ON, to standby or OFF can be controlled vie the remote control. The codes are listed below: <u>CODE</u> FUNCTION 25 Commands DME No. 1 Main Transmitter to "On Air" Status Commands DME No. 2 Main 26 Transmitter "On Air" Statue Commands DME No. 2 Main 27 Commands DME to OFF 28 Commands DME to STANDBY		

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
		None of the above command codes to control the DME can be Initiated at the local control unit. This unit acts as an interface and provides an intercom function between the local end remote site. (The local control also provide an interface for ATIS operation or for another auxiliary control panel hookup)		
3.3.1.1		With the DME on and operating depress the REMOTE SW on the DME control unit until the indicator is extinguished. Enter a series of DME twenty command codes on the Local Control SYSTEM COMCTROL keyboard (i.e., Codes 25, 26, 27, and 28.) Enter a series of DME twenty command codes at the remote control		Verify that no charge in DME status should occur.
3.3.2	DME Command Code Test From remote	With the DME on and operating, depress the REMOTE SW on the DME control unit until the indicator is illuminated.	DME control front panel	REMOTE SW indicator light illuminated.
3.3.2.1		With the REMOTE SWITCH indicator on the local control unit extinguished, enter a series of DME twenty command codes at both SYSTEM COMMAND keyboards on the local and remote.		No change in DME status
3.3.2.2		Depress the REMOTE SWITCH on the local Enter DME command codes 25, 26, 27, and 28 on the remote control SYSTEM CONTROL keyboard.		Verify that DME status Changes in accordance with the command code used
3.3.2.3		Enter DME command codes 25, 26, 27, and 28 at the local control SYSTEM CONTROL keyboard.		Verify no change in DME status
3.4	System Control Optional Functions (Thirty Codes)			

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
3.4.1		Enter any command codes of this sequence which apply to your installation and verify each function.		Special tool documentation. Same standards as in Step 3.3.4
3.4.2		Return to desired system status applicable to these codes.		
3.5	System Control obstruction lights, and optional functions. (Forty codes)	NOTE: If any of these codes are used for optional functions, special local documentation should be consulted to determine correct responses.		
3.5.1		Enter command code 45 on system control keyboard if it is utilized in your installation and verify its function.		Special local documentation.
3.5.2		Enter command 46 and verify obstruction light status	Obstruction lights on antenna	Illuminated
3.5.3		Enter command 47 on system control keyboard if it is utilized in your installation and verify its function		Special local documentation.
3.5.4		On system control keyboard, enter command code 48 and verify obstruction light status.	Obstruction lights on antenna	Extinguished
3.5.5		Enter command code 49 on system control keyboard if it is utilized in your installation and verify its function		Special local documentation.
3.5.6		Return system to the command code status desired for this section. Enter command code 46 on system control keyboard to ensure obstruction lights will illuminate at dusk.		Verify as above.
4.0	System Status Critical Test	Press and release the REMOTE SWITCH indicator several times. Note: SYSTEM INHIBIT switch indicator must be extinguished.	Local Control Front Panel	REMOTE SWITCH (green) indicator and CRITICAL SWITCHES NORMAL (green) indicator should be simultaneously illuminated or extinguished.
5.0	System Status System Inhibit Switch Test	Press and release the SYSTEM INHIBIT SWITCH (red) indicator several times. Note: REMOTE SWITCH indicator must be illuminated.	Local Control Front Panel	Same as 4.0 except CRITICAL SWITCES NORMAL indicator will be extinguished while SYSTEM INHIBIT SWITCH is illuminated and vice versa.

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
5.1		With SYSTEM INHIBIT SWITCH indicator illuminated, create an alarm condition on the VOR monitor.	XMTR RF Power Monitor	Appropriate monitor alarm should occur and XMTR set Should remain on the air and on antenna.
		Note: Let system remain in this condition for the next test only.		
6.0	System Status Main on Test	Verify MAIN ON (green) indicator status.	Local Control Front Panel	Illuminated
6.1		Press SYSTEM INHIBIT SWITCH indicator.		Extinguished
6.2		Observe the ALARM (red) indicator on monitor and observe the MAIN ON (green) indicator on local control	Local Control	The appropriate ALARM (red) indicator should illuminate. The local control MAIN ON (green) indicator should extin-guish. The sideband transmitter and carrier transmitter should be off.
7.0	System Status OFF indicator Test	Verify OFF (red) indicator status.	Front Panel	Illuminated
		Remove alarm condition	Monitor	
		Enter command code 15 on keyboard.	Local Control Front Panel	OFF (red indicator extinguished). MAIN ON indicator illuminated.
		Note: Remote switch indicator must be extinguished to use keyboard.		
8.0	Alarm Test	This function is tested as part of the VOR level 3 performance checks. If used otherwise, consult special local documentation for details.		
9.0	Remote Control Unit Test	Note: Balance of this procedure will test the remote control functions and will require one person at each site.		

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
9.1	Primary Power	Verify POWER ON (green) indicator status.	Remote Control Front Panel	Illuminated
10.0	System Control Test			
10.1	Keyboard Lockout	Repeat step 2.5 with local control REMOTE SWITCH indicator extinguished		No response to keyboard inputs.
11.0	System Control Function Test	Repeat steps 3.1 through 3.5.6	Same responses.	
12.0	Indent Monitor ON/OFF Test	On local control, enter command code 19 on SYSTEM CONTROL keyboard.	Remote Control Unit Front Panel	With remote control unit volume set to midrange or higher, identify code should be audible every 7.5 seconds and should match the international Morse code station identifier assigned.
12.1		On local control , enter command code 18 on SYSTEM CONTROL keyboard.	Remote Control Unit Front Panel	No identify code tones should be audible.
12.2		Repeat steps 13.0 and 13.1 except enter command codes on remote control unit keyboard.	Remote Control Unit Front Panel	Same as 12.0 and 12.1
13.0	Local Control Intercom Switch Test	CAUTION: Placing the local control INTERCOM switch in the A TRAFF position interrupts and inhibits voice transmission over the VOR transmitter. Therefore, it is imperative that the person using the A TRAFF function of the intercom switch complies with the following two conditions: 1. Do not place the intercom switch in the A TRAFF position until after verifying that the XMTR voice function is not in use at the moment. 2. Release the switch immediately if any aircraft emergency or distress calls are heard over the intercom via the local control loudspeaker or appropriate receivers or if requested to do so by the air traffic controllers.		

Table 5-5 VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
		NOTE: Some stations may not utilize the VOR voice channel. If not, then this condition does not apply.		
		NOTE: The equipment is designed to allow connection of the audio from a separate communications VOR receiver to enable 2-way aircraft to ground communication over the intercom system. If this option is not utilized in your system and if the XMTR is used for voice transmission, then it will be necessary to make special arrangements before using the A TRAFF function of the local control INTERCOM switch. In addition, this equipment may be wired for use with an auxiliary indication/voice panel. When this option is exercised, the remote is used for intercom only and voice transmission to aircraft can only be accessed from the auxiliary indicator/voice panel. When the auxiliary indicator/voice panel option is used (i.e., for standard FAA installation), circuit card assembly 4A2 terminals E20 and E21 are open, E6 is jumpered to E7. and E12 is jumpered to E13. Procedures in step 13 through 15 are written for use without any options exercised; however, when the auxillary indication/voice panel option is used, steps 13.4, 13.9.2, 14.3 and 14.4 are affected and a special note to each step is provided in order to indicate applicable changes.		
13.1	A TRAFF Test	Connect oscilloscope to FLD DET MONITOR test connector of monitor and adjust oscilloscope controls to display voice modulation of the transmitter when present.		
13.2		On the remote control unit, verify position of SPEAKER switch.	Remote Control	SPEAKER switch is ON position.
13.3		At the local control, verify that the voice channel is clear (see caution above) and hold the INTERCOM switch in the A TRAFF position.		

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
13.4		At the remote site, actuate the press to talk switch and speak into the microphone.		NOTE: KEY PRIORITY Indicator must be illuminated when the microphone press to talk switch is depressed.
		NOTE: This test assumes that the remote XMIT jumper on circuit card assembly A2 is connected as follows: E20 to E21 E6 to E13 E7 to E12		
		NOTE: for the auxiliary indication/voice panel modifications, step 13.4 is accomplished at the auxiliary site and not at the remote site.		NOTE: When the auxiliary indication/voice panel modification is exercised, the transmission is from the auxiliary indication voice panel microphone through the remote control via the local control to enroute aircraft. The remote KEY PRIORITY Indicator illuminates when the auxiliary indication voice panel microphone is keyed (with select).
13.5		Using oscilloscope, verify that voice transmitters from the remote control unit are NOT transmitted over the VOR station when the person at the remote control unit speaks into the microphone with the press to talk switch depressed and the key priority indicator illuminated at the same time that the person at the local control holds the INTERCOM switch in the A TRAFF position.		
13.6	A TRAFF/ INTERCOM/ Remote Audio Indicator Test	Hold the INTERCOM switch of the local control in the A TRAFF position and verify AUDIO status indicators. (Allow 2 seconds for updates).	Remote Control Unit Front Panel Audio Status Indicators	TRANSMIT (A TRAFF) indicator illuminated. INTERCOM (A FACIL) indicator extinguished.
13.7	INTERCOM Test	Verify two way communication is possible between the local control and remote control unit.	Local Control Remote Control Unit loudspeakers and Microphones	NOTE: KEY PRIORITY (amber) indicator on remote control Must be ON when the microphone press to talk switch is depressed

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
13.8	A FACIL Test	On the local control, release the INTERCOM switch.	Local Control Front Panel	INTERCOM switch is in A FACIL position.
13.8.1		After 2 seconds, verify the REMOTE CONTROL UNIT AUDIO indicator status.	Remote Control Front Panel Audio Indicators	TRANSMIT-indicator extinguished and INTERCOM indicator is illuminated (amber).
13.9	Loudspeaker/ Volume Test	With system in intercom mode, have someone speak into remote unit microphone while adjusting the volume control CW and CCW on the local panel.	Loudspeaker	Loudness should increase for CW and decrease for CCW Audio should be clear and intelligible as the person talks.
13.9.1		Repeat step 13.9 except have someone at the Remote listen to and adjust the VOLUME control at the remote control while actuating and speaking into the local control microphone.	Remote Control Unit Front Panel	(As above.)
13.9.2		When exercising auxiliary indication/voice panel modification, repeat step 13.9 with air traffic operator speaking into his microphone from the auxiliary panel.		
13.10.	TMTR Mon Test	On the local control, place the INTERCOM switch in the TMTR MON position.		
13.10. 1		Verify voice levels coming from the local	Local Control	Voice levels significantly
		control loudspeaker when someone is speaking into the microphone at the remote control unit.	Loudspeaker	reduced in volume but still audible.
14.0	Key Priority Test	Oscilloscope should be connected as in step 13.1.		
14.1		On the remote control unit, place the speaker switch is the OFF position, actuate the microphone press to talk switch while speaking into the microphone.	VOR Remote Control Unit	Verify that the KEY PRIORITY indicator does not illuminate. Also, No voice modulation should be observed on the VOR signal displayed on the scope at the transmitter site.
		NOTE: This step assumes a jumper between terminals E20 and E21 on circuit card assembly A2 and E9 to E10.		
14.2		Place the remote control unit SPEAKER switch to the ON position.		

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
14.3		On the remote control unit microphone, actuate the press to talk switch while speaking into it. NOTE: When the auxiliary indicator/voice panel modification is exercised, it is necessary to have the air traffic operator at the auxiliary indicator/voice panel actuate the press to talk switch on the microphone while speaking into it.	VOR Remote Control Unit	Verify that the KEY PRIORITY indicator Illuminates. Also, at the t transmitter, site, verify presence of voice modulation on VOR signal displayed on the oscilloscope.
14.4		On the auxiliary indicator/voice panel, air traffic operator should press the press to talk switch and speak into the microphone (with the Remote selected)	Same as 14.3	Same as 14.3
15.0	Ring Test	On the local control unit place INTERCOM switch in the A FACIL position.		NOTE: When the microphone at the remote control is actuated only and intercom function is available. When the auxiliary indication/voice panel modification is exercised, the KEY PRIORITY indicator does not illuminate and there is no voice modulation on the VOR.
15.1		On the local control, press the RING SWITCH (green) indicator for 3 seconds.	Remote Control Unit	Audible ring tone emitted from the loudspeaker - Remote
15.2		At the remote control unit, press and hold the RING switch for 3 seconds.	Local control	Audible ring to be emitted from the loudspeaker - Local
15.3		On the local control, place the INTERCOM switch in the TMTR MON position.		
15.4		Repeat step 15.1		Same as 15.1
15.5		Repeat step 15.2.		Same as 15.2, except ring tone volume is significantly higher than intercom voice levels. NOTE: the ring tone volume may also be slightly lower than that of step 15.2.

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
15.6		Repeat step 14.3 and press and hold the RING switch (green) indicator for 3 seconds. (Also hold A TRAFF switch.)	1. Remote Control Unit Loudspeaker 2. Aux/Remote indication unit (if used).	No audible ring tone present. Audible ring tone present.
16.0	Speaker ON/OFF Switch Test	Oscilloscope should be connected and adjusted as in step 13.1.		
16.1		On remote control unit, place SPEAKER switch in the OFF position.	Remote Control Unit Front Panel	
16.2		Actuate the press to talk switch of the remote control unit microphone while Speaking into it.	Oscilloscope display at XMTR Site	NO voice modulation evident on transmitter signal.
16.3		On the remote control unit, place SPEAKER switch in the ON position.	Remote Control Unit Front Panel	
16.4		Repeat step 16.2	Step 16.2	Exception: Voice modulation will be present on the transmitter signal. NOTE: Voice modulation will not be present on transmitter signal in standard FAA setup.
16.5		Disconnect test equipment.		
17.0	Data Valid/ Data Invalid Test	On remote control unit, disconnect J-2.	Remote Control Unit Front Panel	DATA VALID (green) indicator is extinguished and DATA INVALID (yellow) indicator is illuminated.
17.1		Reconnect J-2 NOTE: System must be operation normally for this test.	Remote control Unit Front Panel	DATA VALID (green) indicator is illuminated and DATA INVALID (yellow) indicator is extinguished.
18.0	Audible Alarm Test	Repeat steps 3.5.1 and then 6.1. Press ALARM SILENCE switch down.	Loudspeaker	Loud audible alarm until Silenced by pressing alarm silence switch.

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
19.0	VOR Indicator Test	Repeat steps 5.1 through 7.2		
20.0	VOR/Remote/ Local	Repeat step 2.4	Remote Control Unit front panel	VOR LOCAL indicator should be illuminated (yellow) when local control has keyboard control.
		Steps 21.0 through 39.0 apply only when collocated E-Systems, Inc., DME is utilized.	Remote Control Unit front panel	VOR REMOTE indicator should be illuminated (yellow) when remote unit has keyboard control of system.
21.0	DME Indicator Test	Steps 20 through 35 and 44 and 44.1 apply when a collocated E-Systems DME is utilized. Repeat step 20 except press REMOTE indicator on E-Systems DME control unit.	DME REMOTE/ LOCAL Indicators on Remote Control Unit front panel.	Same as 20.0 except substitute DME for VOR
22.0	DME Normal Indicator Test 1	Verify status of DME NORMAL (green) indicator.	Remote Control Front Panel.	Illuminated.
23.0	DME Secondary Alarm Indicator Test	Have person at local site create DME secondary alarm condition within DME	DME Secondary Alarm (yellow) Indicator	Illuminated. NOTE: Silence audible alarm as required.
24.0	DME Normal Indicator Test 2	Verify status DME NORMAL (green) indicator.	Remote Control Front Panel	Extinguished
25.0	DME Main Indicator Test 1	Verify status of DME MAIN (green) indicator	Remote Control Front Panel	Illuminated
26.0	DME Primary Alarm Indicator Test 1	Have person at local site create DME primary alarm condition within DME.	DME primary Alarm (yellow) Indicator	Illuminated
27.0	DME Standby Indicator Test 1 (not applicable for single system).	Verify status of DME STANDBY (yellow) indicator	Remote Control Front Panel	Illuminated. NOTE: DME should have transferred to standby XMTR On Air.
28.0	DME Main Indicator Test 2	Verify status of DME MAIN (green) indicator.	Remote Control Front Panel	Extinguished

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
29.0	(Omit for single system)	Repeat step 23.0		No status change should occur on remote unit.
30.0	(Omit for single system	Repeat step 26.0		
31.0	DME standby Indicator Test 2 (Omit for single system)	Verify status of DME STANDBY (yellow) indicator	Remote Control Front panel	Extinguished.
32.0	DME Off Indicator Test 1	Verify status of DME OFF (red) indicator.	Remote Control Front Panel	Illuminated.
32.1		Enter command code 15 into keyboard and remove alarms of steps 23.0 and 25.0		Verify desired transponder system is ON AIR ON Antenna.
33.0	DME Off Indicator Test 2	Verify status of DME OFF (red) indicator.	Remote Control Front Panel	Extinguished
34.0	DME STANDBY Indicator Test 3	Verify status of DME STANDBY (yellow) indicator.	Remote Control Front Panel	Extinguished
35.0	DME MAIN Indicator Test 3	Verify status of DME MAIN (green) indicator.	Remote Control Front Panel	Illuminated
36.0	DME Secondary Alarm Indicator	Verify status of DME Secondary Alarm (yellow) indicator.	Remote Control Front Panel	Extinguished
37.0	DME Primary Alarm Indicator Test 2.	Verify status of DME Secondary Alarm (yellow) indicator.	Remote Control Front Panel	Extinguished
38.0	DME Normal Indicator Test 3	Verify status of DME NORMAL (green) indicator	Remote Control Front Panel	Illuminated
39.0	DME Unlabeled Indicators Test	Verify performance if used in your system in a manner similar to that preceding this step.	Remote Control Front Panel & Equipment Controlled	
40.0	Power Tests			

Table 5-5. VOR/DME Local and Remote Control Preventive Maintenance Performance Check (Contd)

Step No.	Test Description	Procedure	Read Indication On	Reference Standards
41.0	PRIMARY POWER Indicator/Data INVALID Indicator Test	Simulates power failure at local site and verify status of Primary Power (green) indicator. NOTE: If battery backup power is not utilized, disregard PRIMARY POWER (green) indicator.	Remote Control Front Panel	PRIMARY POWER (green) indicator extinguished. DATA VALID (green) indicator extinguished. DATA INVALID (yellow) indicator is illuminated.
41.1		Restore primary power and verify primary power (green) and Data Valid (yellow) indicators status.	Remote Control	PRIMARY POWER (green) indicator is illuminated and DATA VALID (yellow) indicator is illuminated.
42.0	Battery Charger Test	If power left off long enough in previous test, Battery charger indicator (green) should illuminate.	Remote Control Front Panel	Illuminated
42.1		If batteries not discharged very much, battery charger indicator should extinguish.	Remote Control Front Panel	Extinguished.
43.0	VOR Power Indicator Test	Simulates power failure to VOR and verify VOR POWER indicator status.	Remote Control Front Panel	Extinguished.
43.1		Repeat step 41.1 for VOR POWER.		
44.0	DME Power Indicator Test	Repeat step 43.0 for DME power.		
44.1		Repeat step 41.1 for DME power.		
45.0	Spare Indicator Test	If spare indicator used for your system test this function in appropriate manner.		Special local documentation.
46.0	Audio Ident Indicator Test	Verify ident (yellow) indicator flashes and ident code is audible in loudspeaker during identity transmissions.	Remote Control Front Panel	Flashes assigned international Morse code at 7.5 second Intervals (for VOR).
47.0	Audio Spare Indicators Test	Test as in step 45.0		
48.0	Log Entry	Enter completion of this procedure in log book.		
49.0		Return to step 10, VOR level 2 performance check, Table 5-3.		

5-19. ALIGNMENT AND ADJUSTMENT PROCEDURES. The following alignment and adjustment procedures should be performed in the event that the VOR system does not meet the performance standards specified in the system performance checks.

In the event the alignment and adjustment procedures fail to correct the problem, refer to the troubleshooting section outlined in this chapter in paragraph 5-11 and to the troubleshooting chart contained in volume 3 of TM-11-5825-266-14/3 in order to isolate the problem and perform the appropriate corrective action.

5-20. VOR LOCAL CONTROL (1A2) ALIGNMENT AND ADJUSTMENT PROCEDURE.

a. Power Supply Procedure.

(1) Test equipment required:

(a) VOM (calibrated)

(2) Instructions:

(a) Ensure that the VOR equipment is on and operating as outlined in paragraph 3-10.

(b) Pull the drawer out from the cabinet and locate the points of test on the power supply in order to verify the following power measurements.

NOTE

Reference voltages to ground on the green wire.

(c) Using the VOM, verify +12 (± 1) Vdc at the output of the voltage regulator on 1A2PS1. The positive output is an orange wire.

(d) Using the VOM, verify +5 (-0.1 to +0.4) Vdc at the output of the voltage regulator on 1A2PS1. The +5 Vdc output is on the yellow wire.

(e) Using the VOM, verify -12 (± 1) Vdc at the output of the voltage regulator on 1A2PS1. This measurement can be made from the violet wire and ground.

CAUTION

Turn circuit breaker (main power) switch OFF when removing circuit cards. Do not dial the system OFF.

b. Tone Decoder Circuit Card Assembly (1A2A1) Procedure.

(1) Test equipment required:

(a) Frequency counter

(2) Instructions:

(a) Connect frequency counter to 697 Hz test point (1A2A1E1) and adjust potentiometer 1A2A1R4 for 697 ± 5 Hz indication.

(b) Connect frequency counter to 770 Hz test point (1A2A1E2) and adjust potentiometer 1A2A1R9 for 770 ± 5 Hz indication.

(c) Connect frequency counter to 852 Hz test point (1A2A1E4) and adjust potentiometer 1A2A1R16 for 852 ± 5 Hz indication.

(d) Connect frequency counter to 1204 Hz test point (1A2A1E5) and adjust potentiometer 1A2A1R21 for 1204 ± 5 Hz indication.

(e) Connect frequency counter to 1336 Hz test point (1A2A1E6) and adjust potentiometer 1A2A1R26 for 1336 ± 5 Hz indication.

(f) Connect frequency counter to 1477 Hz test point (1A2A1E7) and adjust potentiometer 1A2A1 R31 for 1477 ± 5 Hz indication.

c. Alarm and Transfer Circuit Card Assembly (1A2A2) Procedure.

(1) Test equipment required:

(a) Oscilloscope

(2) Instruction:

(a) Turn system INHIBIT switch to OFF.

(b) On oscilloscope, verify a three to five second turn-on delay at 1A2XA2-26 (ON = +12 Vdc).

(c) Connect the oscilloscope to pin 26 on the alarm and transfer circuit card assembly, 1A2AZ.This pin can be easily located from the bottom side on connector XA2. (When the equipment is on and operating, the voltage level at this point should be approximately 12 Vdc.)

(d) Turn the PRIMARY POWER POWER ON switch OFF and using the second hand on a watch, verify that the level at pin 10 on circuit card 1A2A2 drops to zero at the time the POWER ON is turned off and returns to the +12 Vdc level within seven seconds (nominal time - not to exceed 20 seconds) after the POWER ON switch has been turned back on.

d. Ident Control Circuit Card Assembly (1A2A3) Alignment and Adjustment Procedure.

(1) Test equipment required:

(a) Frequency counter

(b) Oscilloscope

(c) VOM (calibrated)

(2) Instructions:

(a) Place the ident control circuit card assembly (1A2A3) on an extender card in order to facilitate making the following measurements.

(b) The critical switch indication is derived from the inputs of gate U1. All inputs must be high (logic one) to enable a low logic output on 1A2XA3-24. Check that a low (logic zero) input on any input of gate U1 will cause the circuit output at 1A2XA3-24 to go high (logic one) and cause the CRITICAL SWITCHES NORMAL indicator to extinguish.

NOTE

A low "ZERO" on pin 24 will turn the CRITICAL SWITCHES NORMAL indicator on.

(c) Switch IDENT SW S3 on circuit card assembly 1A4A2 to CONT position. Connect frequency counter to pin 3 of U3 on 1A2A3 and adjust potentiometer 1A2A3R14 for 1020± 20 Hz frequency output. Disconnect the frequency counter on 1A2A3 and switch IDENT SW S3 on circuit card assembly 1A4A2 to NORM position.

NOTE

If the local drawer is not connected to a system, then tie a ground to pin 18 of the circuit card to enable U3 (release reset "0" on pin 4).

(d) Verify that the aux audio output on pin 26 follows the VOR transmitter ident tone (i.e., the tone switches on and off as the ident is transmitted).

e. Local Control Voice Level and Tone Setup on circuit card assembly 1A2A4.

(1) Test equipment required:

(a) Frequency counter

(b) Audio Signal Generator (P/O Telephone Test Set)

(c) AC voltmeter calibrated to read dBm across a 600 ohm line or VOM (P/O Telephone Test Set)

(d) Oscilloscope

(2) Instructions: Perform steps (a), (b) and (c) below with no signal insertion.

NOTE

Frequency counter will monitor the signal generator at all times.

CAUTION

Turn the circuit breaker (MAIN POWER) switch OFF when removing circuit card assemblies from local control.

(a) RCVR (Receiver) BAL Adjustment. Place the oscilloscope probe on 1A2A4U26A, pin 12 Adjust potentiometer 1A2A4R68 so the output dc level is at ground.

(b) SPKR (Speaker) BAL Adjustment Place the oscilloscope probe on 1A2A4U26B, pin 10. Adjust potentiometer 1A2A4R87 so that any noise is balanced about a 0 dc level.

(c) TRAF (Traffic) BAL Adjustment. Place the oscilloscope probe on 1A2A4U27, pin 1. Adjust potentiometer 1A2A4R78 so the output is at ground.

(d) Using a telephone test set, measure the FSK (frequency shift key) tone output between terminals 19 and 20 of A1TB4 (located on the back of the electrical equipment rack) for the following conditions:

1. On circuit card 1A2A4, disconnect the jumper between terminals E11 and E12 and connect terminal E12 to E13 to measure an FSK "one." The output of the VOM should be between -19 dBm and -21 dBm. If not, adjust potentiometer R109 (DRVR GAIN ADJ) on 1A2A5 circuit card

assembly for proper output (-20 dBm ± 1 dBm). With counter at 1A2A4U22, pin 1, measure 2655 Hz ± 20 Hz (level is 08 volt peak-to-peak).

2. On circuit card 1A2A4, disconnect the jumper between terminals E12 and E13 and connect the jumper between terminals E12 and E14 to measure an FSK "zero." The output of the VOM should be between -19 dBm and -21 dBm, and counter should read 2416 Hz ± 20 Hz at 1A2A4U22, pin 1 (level is 0.8 volt peak-to-peak).

3. On circuit card 1A2A4, disconnect the jumper between terminals E12 and E14 and reconnect terminal E12 to E11 for normal operation.

(e) Audio Input VOR Receiver Voice Adjustment. Set the signal generator to 1000 Hz and -17 dBm. Connect the signal generator to J6, pins 1 and 2 on back of local control. Connect the AC voltmeter to A1TB4 pins 19 and 20. Adjust RCVR VOL potentiometer A4R93 on the circuit card assembly (1A2A4) to get -8 dBm on the telephone test set

(f) Air Traffic Operations Voice Adjustment. Set the signal generator to 1000 Hz and -17 dBm. Connect the signal generator to terminals E4 and E5 on circuit card assembly 1A2A6 (located on the underneath side of the chassis). Connect the oscilloscope probe to 1A2A4U27, pin 1. Adjust TRAF VOL potentiometer 1A2A4R70 to get 10V peak-to-peak on the oscilloscope.

(g) Switch the INTERCOM switch to A FACIL position and verify that a 1000 Hz tone can be heard over the speaker at a comfortable level as adjusted by the volume control. Repeat this step with the INTERCOM switch in the A TRAFF position.

(h) Audio Ring Tone Adjustment. Change signal generator to 2330 Hz. At the same level output, connect the oscilloscope probe to 1A2A4U28, pin 8. Adjust potentiometer 1A2A4R81 so 1A2A4U28, pin 8, goes low at 2330 ±5% Hz. Change the frequency back and forth above and below 2330 Hz. Pin 8 of 1A2A4U28 should be high until 2330 Hz is reached and it then goes to 0. While it is low, adjust RING/VOL potentiometer 1A2A4R83 so that volume is audible in the speaker and a 5 VPP level at 1A2A4U26, pin 10.

(i) Digital Circuitry Verification. With the frequency counter verify the following:

1. Verify there is 874 Hz at 1A2A4U18B, pin 4.

2. Verify there is 218 Hz at 1A2A4U18, pin 10.

3. Verify there is 3.58 MHz at 1A2A4U1D, pin 11.

4. 1A2A4U23A and 1A2A4U23B is a divide-by-three circuit. Verify there is 1.19 MHz at FSK CLK test point at 1A2A4U 18, pin 12.

(j) Status Parallel Input Data Word Selection Check. Parallel status inputs may vary between 0 volt and +12 volts The inputs are fed through analog gates 1A2A4U2, U9, U13, U14, U15, U20, U24 and U25. Selected 8 bit words are then fed through the non-inverting hex buffers 1A2A4U8 and A4U 12 The signal is buffered from a 12 volt logic level to a 0.5 volt TTL level by the inverter.

(k) Parallel to Serial Data Conversion. The UART A4U5 changes the parallel input to serial data in the transmitter section and the serial data goes to 1A2A4U21. It is then modulated into FSK sinusoidal tones. A circuit comprised of 1A2A4U4B, U3, U6 and U7, sequentially selects each one of the four parallel status word inputs A data interrupt circuit comprised of 1A2A4U10 and U11 is used to periodically interrupt the serial data stream to allow a positive resynchronization of the data words.

f. Local Control Voice Level and Tone Setup (1A2A5)

(1) Test equipment required:

(a) Frequency Counter

(b) Audio Signal Generator (P/O Telephone Test Set)

(c) AC Voltmeter

(d) Oscilloscope

(e) Pulse Generator

(2) Instructions. Perform steps (a), (b), (c) and (d) below with no signal applied and 1A2A4 circuit card assembly removed.

(a) MIC (Microphone) BAL Adjustment. Place oscilloscope probe on 1A2A5U14, pin 10. Adjust potentiometer 1A2A5R68 so that the output dc level is at ground.

(b) RCVR (Receiver) BAL Adjustment. Place oscilloscope probe on 1A2A5U13, pin 12. Adjust potentiometer 1A2A5R85 so that the output dc level is at ground.

(c) DRVR (Driver) BAL Adjustment. Place oscilloscope probe on 1A2A5U19, pin 1. Adjust potentiometer 1A2A5R81 so that the output dc level is at ground.

(d) VO (Voice) BAL Adjustment. Place oscilloscope probe on 1A2A5U6, pin 1. Adjust potentiometer 1A2A5R37 so that the output dc level is at ground.

(e) Insert 1000 Hz 10 volt peak-to-peak sinewave signal between 1A2A5, pin 3 and ground Connect oscilloscope probe to terminal 1A2A5E3 or to 1A2A5U4, pin 7, and verify 10 volt peak-to-peak output Increase the tone input at 1A2A5, pin 3, to 18 volts peak-to-peak and verify the waveform is clipped at approximately 16 volts peak-to-peak at terminal 1A2A5E3. Reduce input tone back to 10 volts peak-to peak. Connect oscilloscope to 1A2A5U4A, pin 1, and adjust SEN potentiometer 1A2A5R 117 for minimum signal. Convert oscilloscope to 1A2A5U3, pin 1. Adjust potentiometer NOTCH FILTER M 1A2A5R7 for minimum output signal. Connect oscilloscope to 1A2A5U6, pin 1, and verify no signal output when input frequency is increased to 15 kHz. Remove sinewave signal from 1A2A5, pin 3.

(f) Using the pulse generator, insert a positive pulse then a negative pulse at 1A2A5, pin 3, with the following characteristics:

Pulse Width	50 ± 5 μ sec.
Rise and Fall Time	Min 5 ± 1 μ sec.
Repetition Rate	500 ± 50 pps (use frequency counter)
Amplitude	1 volt peak-to-peak

Connect oscilloscope at 1A2A5U6, pin 1. Observe output pulse is approximately the same as input pulse. Increase input pulse amplitude to 10 volts peak-to-peak. Observe output pulse at 1A2A5U6, pin 1, is blocked out by 1A2A5U9A except for a possible leading and/or trailing edge spike. Disconnect pulse generator and oscilloscope.

(g) XMTR Keying Tone Adjustment

1. Insert signal generator set at 2870 Hz 10 volts peak-to-peak at 1A2A5, pin A3, and connect oscilloscope probe on 1A2A5U3, pin 7. Adjust the notch filter comprised of potentiometers 1A2A5R19, 1A2A5R25 and 1A2A5R13 (NOTCH FILTERS J, K and L respectively) for a minimum output If required, repeat the preceding adjustments of potentiometers in the sequence indicated.

2. With the oscilloscope probe on 1A2A5U3, pin 1, observe the output signal is greater than 4 volts peak-to-peak.

3. With the oscilloscope probe on 1A2A5U7, pin 12, check the output of the low pass filter at 2200 Hz while varying the frequency of the signal generator. The output should be greater than 6 volts peak-to-peak at 2200 Hz.

4. With the signal generator set at 2870 Hz and the oscilloscope probe on 1A2A5U5, pin 7, the output should be greater than 1.5 volts peak-to-peak. With the oscilloscope probe at 1A2A5U8, pin 8, adjust PLL potentiometer 1A2A5R46 so that pin 8 goes to 0. This will cause 1A2A5U9, pin 8, to go high which turns on analog gate 1A2A5U9B sending voice to the transmitter.

5. With the oscilloscope probe on 1A2A5U7, pin 10, check the output of the low pass filter at 2400 Hz while varying the frequency of the signal generator. The output should be greater than 3 volts peak-to-peak at 2400 Hz.

6. Set the signal generator at 1000 Hz and -50 dBm at J5, pin 2, mike input. With the oscilloscope probe on 1A2A5U14, pin 10, adjust MIC GAIN potentiometer 1A2A5R67 so the output of pin 10 is 2.5 volts peak-to-peak. With the oscilloscope probe on 1A2A5U13, pin 12 (RCVR VOICE), key the microphone input at pin B 13 and verify the output is 2.5 volts peak-to-peak. Verify approximately 12 volts peak-to-peak at 1A2A5U10, pin 1.

7. Increase input voltage for 3.5 volts peak-to-peak at 1A2A5U14, pin 10, and verify the output at 1A2A5U10, pin 1, is flattened out at approximately 12 volts peak-to-peak. Disconnect signal generator. (Note that the signal barely flattens out.)

(h) Notch Filter Adjustment to Block Voice from FSK Tones. Turn system off and insert 1A2A4 circuit card assembly, then turn system on.

1. With the signal generator set at 2655 Hz, and signal in at J6 pins 1 and 2, adjust generator for 2.5 volts peak-to-peak at E5. Place the oscilloscope probe on 1A2A5U10, pin 7 and adjust potentiometers 1A2A5R76, R79 and R89 (NOTCH FILTERS D, E and F respectively) in this order three times for minimum output.

2. With the signal generator set at 2416 Hz, place the oscilloscope probe on 1A2A5U10, pin 1. Adjust potentiometers 1A2A5R72, R75 and R88 (NOTCH FILTERS A, B and C respectively) in this order three times for minimum output

(i) Disconnect test equipment, reinstall circuit card assembly 1A2A4 and return system to normal operation.

NOTE

See level 3 preventive maintenance performance check, table 5-4, for VOR monitor and alignment adjustment procedures.

5-21. VOR CARRIER TRANSMITTER (1A4) ALIGNMENT AND ADJUSTMENT PROCEDURE.
Perform all of the following carrier alignment procedures on carrier 1A4.

NOTE

The following procedures should be accomplished with the carrier transmitter under test in the standby mode.

a. Power Output Test Adjustment Procedure.

(1) Test Equipment Required. None.

(2) Instructions.

(a) Set the POWER select switch located on the front panel of the RF power monitor to the CARRIER FWD position.

(b) Ensure that the ON/OFF/NORMAL power switch located on the carrier transmitter is in the ON position.

(c) Adjust PWR ADJ potentiometer R22 on the carrier modulator assembly (1A4A4) on the carrier under test for a reading of 100 watts on a 100 watt system or 50 watts on a 50 watt system on the RF power monitor POWER meter.

b. 1020 Hz Frequency Adjustment Procedure.

(1) Test equipment required:

(a) Frequency counter

(2) Instructions:

(a) Connect a frequency counter to the 1020 Hz test point, E3, on ident oscillator circuit card assembly A2 on carrier transmitter 1A4.

(b) Adjust 1020 Hz potentiometer 1A4A2R34 for 1020 ±10 Hz on the digital frequency counter.

c. Modulation Adjustment Procedure,

(1) Test Equipment Required:

(a) Oscilloscope

(b) Signal Generator

(2) Instructions:

(a) Set the ON/OFF/NORMAL power switch on the carrier transmitter to OFF, the POWER switch on the sideband transmitter to NORMAL and the SUBCARR switch, the IDENT switch and

VOICE switch on circuit card 1A4A2 to the OFF position. Set the A CONT and B CONT switches on modulation control assembly in the sideband transmitter (1A5A4) to the OFF position.

(b) Connect the oscilloscope to the FLD DET MONITOR test jack located on the monitor meter panel.

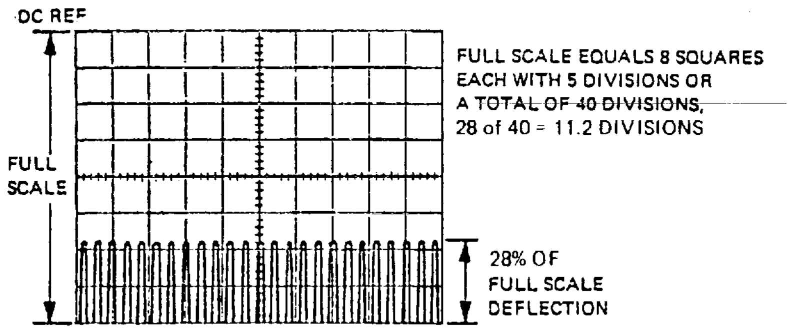
(c) Set the oscilloscope to DC and position the oscilloscope trace on the top line of the graticule.

(d) Turn the POWER switch on the carrier transmitter to ON. The oscilloscope deflection is caused by the rectified R F from the carrier transmitter.

(e) Adjust the vertical gain controls on the oscilloscope to position the trace to the bottom of the graticule for a full scale deflection.

(f) Repeat steps (a) through (e) to obtain a full scale deflection from the top of the oscilloscope graticule to the bottom.

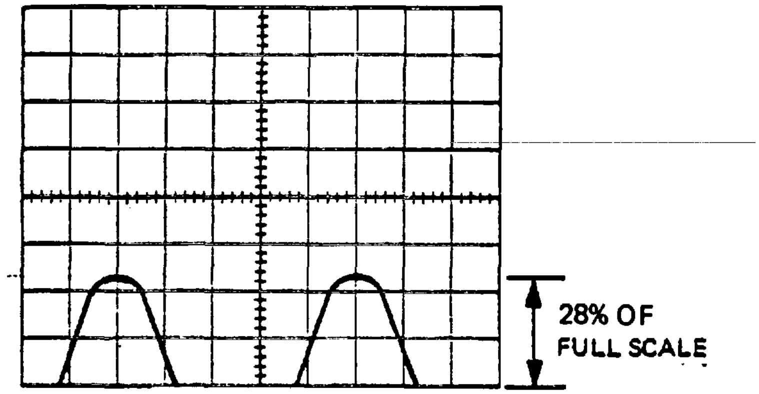
(g) Turn the SUBCARR switch on circuit card 1A4A2 on the carrier transmitter to the ON position. The 9960 Hz output will appear on the scope as shown on the following waveform.



(h) Consult the recorded data for the station. Use the amount of 9960 Hz modulation recorded at the time of the last flight check as the reference. The modulation percentage must be within ± 1.5% of the reference reading. Adjust potentiometer R 10 (9960 SUBCARR MOD) on circuit card assembly 1A4A2 until this level is reached. Normally, this will be on the order of 28%, which is 11.2 out of 40 graticule divisions.

(i) Turn the SUBCARR switch on circuit card 1A4A2 to the OFF position.

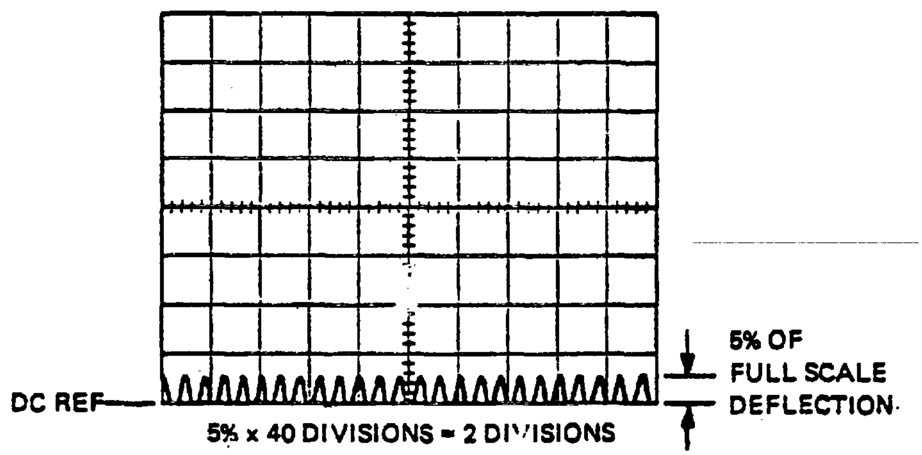
(j) Place the A CONT and B CONT switches on modulation control assembly A4 to the NORM position. Consult the recorded data for the station. Use the amount of 30 Hz modulation recorded at the time of the last flight check as the reference. The modulation percentage must be within + 1.5% of the reference reading. Adjust potentiometer R2 (VAR MOD) on circuit card 1A5A1 until this level is reached Normally, this will be on the order of 28%, which is 11.2 out of 40 graticule divisions as shown below.



(k) Recheck the ground and dc reference points as outlined in steps (a) through (e) above.

(I) Turn A CONT (S1) and B CONT (S2) switches on modulation control circuit card assembly 1A5A4 OFF and set the IDENT switch on circuit card 1A4A2 to the CT (CONT) position.

(m) The output on the oscilloscope will appear as shown below with the 102Cqz signal equal to approximately 5% of the deflection or 2 divisions.



(n) Consult recorded data to find the 1020 Hz modulation percentage that should be read. Adjust IDENT MOD potentiometer R21 on ident oscillator circuit card assembly 1A4A2 to obtain the same percent modulation reading. Normally, this will be on the order of 5% which is 2 out of 40 graticule divisions.

(o) Turn IDENT switch on circuit card 1A4A2 to OFF position.

(p) Connect the audio signal generator and oscilloscope as shown in figure 54 to the carrier transmitter under test.

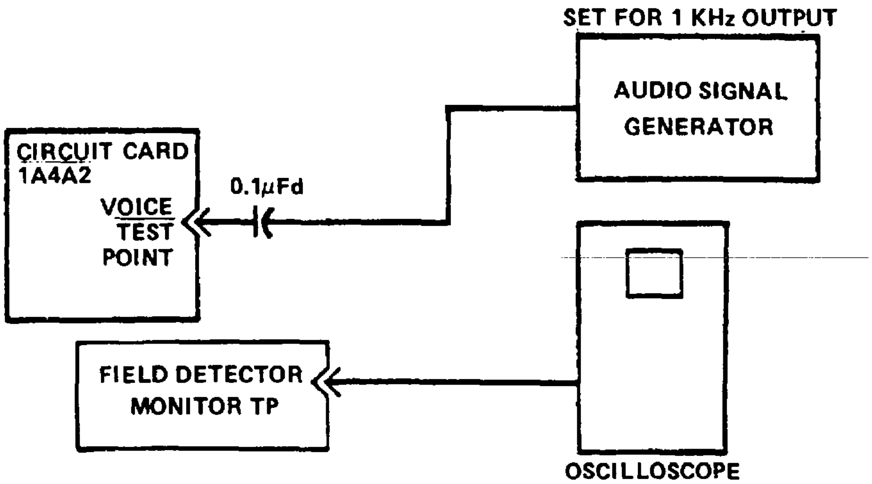
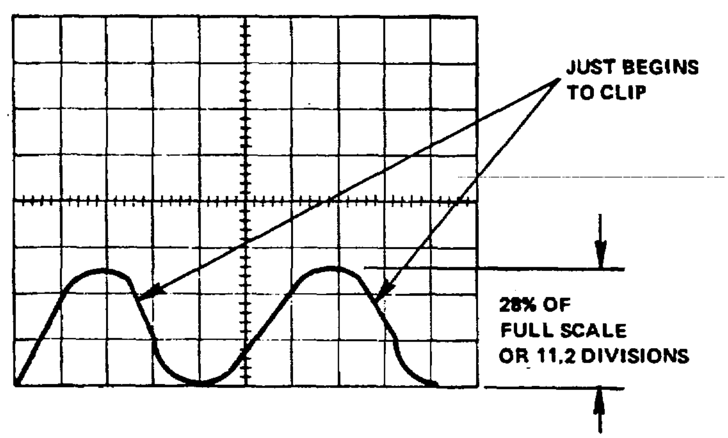


Figure 54. Voice Channel Limiting Test Set-Up

(q) Set the dc reference level and ground trace on the oscilloscope as outlined in steps (a) through (d) before applying the signal output from the audio signal generator.

(r) Increase output on signal generator until wave shown on oscilloscope begins to clip.

(s) Adjust VOICE LIMIT potentiometer 1A4A2R16 until the point where the waveform just begins to clip occurs at the 28% deflection point as shown in the waveform below.



(t) Disconnect all test equipment on ident oscillator circuit card assembly A2, and set the voice switch to ON, the IDENT switch to NORM and the SUBCARR switch to ON. Set the power switch on the carrier transmitter to NORMAL and set A CONT and B CONT switches on 1A5A4 to ON. The system is now restored to normal operation.

d. Ident Keyer Circuit Card Assembly (1A4A1) Alignment and Adjustment Procedure.

(1) Test Equipment Required:

(a) Oscilloscope

(2) Instructions:

(a) Connect oscilloscope to DOT WIDTH test point A1E1 on ident keyer circuit card assembly Al. Adjust potentiometer A1R3 for 250 + 10 milliseconds which constitutes a period of one complete cycle.

(b) Connect oscilloscope to VOR IDENT test point AlE7 and verify dash length is 3 times dot length. Verify identity cycle of 7.5 + .005 seconds If not correct, check strapping (jumpers) per figure 7-17.

5-22. SIDEBAND TRANSMITTER ALIGNMENT AND ADJUSTMENT PROCEDURES. Perform all of the following alignment and adjustment procedures first on sideband 1A5 and then repeat for sideband 1A8

a. Subcarrier FM Deviation (30 Hz) Adjustment.

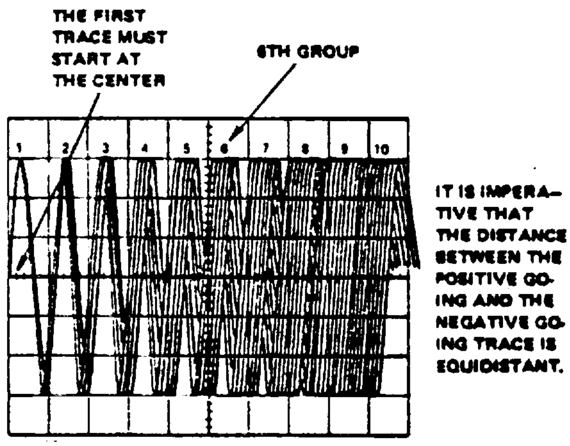
(1) Test Equipment Required:

(a) Oscilloscope

(2) Instructions:

(a) Connect the vertical input on the oscilloscope to FLD DET monitor test connector located on the meter panel of monitor 1A3 and set A CONT and B CONT switches on circuit card 1A5A4 to OFF. Set IDENT switch on circuit card assembly 1A4A2 to the OFF position.

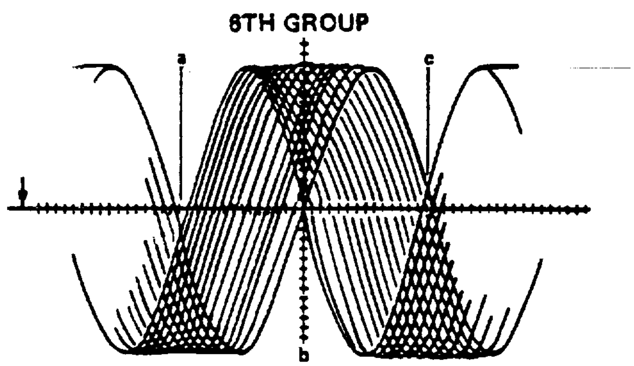
(b) Set the oscilloscope to obtain a waveform showing at least eight vertical peaks as shown below. Adjust the vertical gain to center the waveform within the graticule.



(c) Adjust the trigger level control on the oscilloscope so that crossover at the initial trigger point is at the 50% peak value.

(d) Count the positive peaks from left to right and position the sixth group to the central graticule.

(e) Switch the oscilloscope to the X10 position to obtain the following waveform.



(f) Adjust the DEV potentiometer R20 on the reference and subcarrier generator circuit card assembly 1A5A1 on the sideband transmitter to obtain an exact zero crossover point on the waveform for the sixth group as shown at point (b) above.

b. Modulation Eliminator (1A5A5) Adjustments.

(1) Test Equipment Required:

(a) Multimeter

(b) Average power meter and thermistor mount

(c) 20 dB attenuator

(2) Instructions. Potentiometer 1A5A5R24 sets the no signal collector current of Q1 for 10 to 15 milliamperes Normally, this is a factory adjustment but can be set in the field after replacement of Q1. The procedures are as follows:

(a) Turn off power to carrier transmitter.

(b) Unsolder the wire connected to terminal E5 (28V supply). Connect a 10 ohm resistor between terminal E5 and the disconnected wire. Connect a digital multimeter across the resistor.

(c) Remove the RF drive from the modulation eliminator by disconnecting the BNC connector from connector 1A5A5J1.

(d) Turn on the carrier transmitter.

(e) Adjust potentiometer R24 to minimum position (CCW) to reduce the digital multimeter reading to minimum. If this reading is less than 50 mv, increase the setting of potentiometer R24 to produce a reading of 50 millivolts (5 milliamperes current). The reading must not exceed 250 millivolts (25 milliamperes current).

(f) Reconnect the cable connector to connector 1A5A5J1.

(g) Turn off power to the carrier transmitter and unsolder series resistor used in step (b). Resolder the disconnected wire to terminal E5.

(h) Potentiometer 1A5A5R8 sets the output power level and is only adjusted if output power level is grossly wrong and is causing probleml

(i) Turn off power to the carrier transmitter.

(j) Connect an average power meter and thermistor mount to a 20 dB pad and connector 1A5A5J2.

(k) Turn on power to the carrier transmitter and sideband transmitter.

(l) Adjust potentiometer 1A5A5R8 for a -3 dBm reading on the power meter. (This corresponds to 50 milliwatts output at J2.)

(m) Disconnect the average power meter and thermistor mount from the 20 dB pad and restore the equipment to normal operation.

c. Sideband Amplifiers (1A5A2 and 1A5A3) Adjustments

(1) Test equipment required:

(a) Multimeter

(2) Instructions Potentiometer 1A5A2R 16 sets the no signal collector current of 1A5A2Q2 for 5 ma. Potentiometer 1A5A2R17 sets the no signal collector current of 1A5A2Q3 for 15 to 20 ma. Normally, this is a factory set adjustment but can be set in the field after replacement of 1A5A202. The procedure is as follows:

(a) Turn of power to the carrier transmitter.

(b) Disconnect connector 1A4W8P1 from attenuator 1A4AT1T1 in the carrier transmitter.

(c) Unsolder the wire connected between terminal E4 and E15 at terminal E15 on circuit card assembly 1A5A2.

(d) Solder a 10-ohm resistor in series with the unsoldered wire and connect the other end of the resistor to terminal 1A5A2E15.

(e) Turn on power to the carrier transmitter.

(f) Turn potentiometer 1A5A2R17 clockwise until 200 millivolts are measured on a multimeter connected across the 10-ohm resistor used in step (d) above.

(g) Turn off power to the sideband transmitter. Unsolder series resistor between terminals E4 and E15 and reconnect wire to terminal 15. Unsolder the wire from E4 to E17 at terminal E17 on circuit card assembly 1A5A2.

(h) Solder a 10-ohm resistor in series with the unsoldered wire and connect the other end of the resistor to terminal 1A5A2E17.

(i) Turn on power to the sideband transmitter. Turn potentiometer 1A5A2R 16 clockwise until 50 millivolts are measured on a multimeter connected across the 10-ohm series resistor used in step (h).

(j) Turn off power to carrier transmitter. Unsolder series resistor from terminal 1A5A2E17 and wire. Reconnect wire to terminal 1A5A2E17. Reconnect connector 1A4W8P1 to attenuator 1A4A11J1 in the carrier transmitter.

(k) Return system to normal operation

(I) Perform steps (a) through (k) substituting circuit card assembly 1A5A3 for 1A5A2.

5.23. REMOTE CONTROL (UNIT 4) ALIGNMENT AND ADJUSTMENT PROCEDURE

a. Power Supply Procedure.

(1) Test Equipment Required:

(a) Multimeter (calibrated)

(2) Instructionts.

(a) Ensure that the power is on and the status indication lights are on.

(b) Remove the remote control unit from its cabinet and locate the points to test on the power supply transformer.

(c) Measure the positive +12 supply (orange wire) and verify that it is +12 + 1 volts.

(d) Measure the +5 supply (yellow wire) and verify it is 4.9 to 5.4 volts.

(e) Measure the -12 supply (purple wire) and verify it is -12 ± 1 volts.

b. Operations Voice Buffer Circuit Card Assembly (4A2) Adjustment Procedures and Site Modem Circuit Card Assembly (4A3) Microphone Balance Procedure.

(1) Test equipment Required.

(a) Oscilloscope

(b) Signal Generator (P/O Telephone Test Set)

(c) Frequency Counter

(d) AC Voltmeter (P/O Telephone Test Set)

(2) Instructions:

NOTE

Frequency counter will monitor the signal generator at all times.

(a) With no input signals to the pc board, adjust the balance trimpots so the outputs of the operational amplifier goes to 0 volt

1. Adjust MIKE BAL potentiometer 4A3R14 so that an oscilloscope probe placed at pin 12 on integrated circuit 4A3U2 will read ground level.

2. Adjust SPKR BAL potentiometer 4A2R13 so the oscilloscope probe on 4A2U5, pin 12, will read ground level.

3. Adjust VOR BAL potentiometer 4A2R21 so the oscilloscope probe on 4A2U11, pin 10, will read ground level.

4. Adjust ATIS BAL potentiometer 4A2R42 so the oscilloscope probe on 4A2U18, pin 10, will read ground level.

5. Adjust SUM BAL potentiometer 4A2R43 so the oscilloscope probe on 4A2U17, pin 10, will read ground level.

6. Adjust RCVR BAL potentiometer 4A2R70 so the oscilloscope probe on 4A2U21, pin 12, will read ground level.

7. Adjust AGC BAL potentiometer 4A2R66 so the oscilloscope probe on 4A2U17, pin 12, will read ground level.

8. Adjust AUX BAL potentiometer 4A2R73 so the oscilloscope probe on 4A2U11, pin 12 will read ground level.

NOTE

Ensure that FSK is on the phone line from the local site for DATA VALID indication at the remote unit.

(b) Remove the J5 ATIS connector and hook up the test generator between J5 pin 1, to J5-2 with the generator set at 1000 Hz and the specified input level (nominally -8 dBm) of users ATIS unit. Adjust ATIS GAIN potentiometer 4A2R32 for 1.5 volts peak-to-peak as observed with oscilloscope at 4A2E14, with ATIS keyed.

NOTE

Place a jumper between pin 4 and pin 6 (ground) and between pin 3 and pin 5 (+12V) on connector J5 to simulate keying of ATIS.

(c) Connect the voltmeter to J2 pin 16 to 18 and measure the output. Adjust potentiometer 4A2R 104 XMTR DRVE for -8 dBm (note - make sure other inputs do not block ATIS while measuring level).

(d) With the 1 kHz level input off, check A2E34 for a 2870 Hz tone while ATIS is still keyed. (Jumper between J5, pin 5, and J5 pin 3 and between J5, pin 6 and J5, pin 4.)

(e) Connect an ac voltmeter to the telephone line output at the remote control and adjust potentiometer 4A2R6 for -20 + 3 dBm.

(f) Insert 1 kHz tone (1.5 volts peak-to-peak) at J2, 15 and 17 and adjust potentiometer 4A2R57, RCVR GAIN, for 10 volts peak-to-peak at the 4A2 RCVR INPUT, pin E22. Remove signal.

(g) With the 1000 Hz tone removed (and any other keying inputs which might turn on the 2870 Hz tone also removed), press the ring switch and observe the 2330 Hz ring TONE at A2E34 XMTR LINE test point. Adjust potentiometer 4A2R10 (2330 LEVEL) as required for a -10dBm output at J2 pin 16 to 18.

(h) Release the ATIS key and then press each key of the touch tone keyboard while observing the output at terminal A2E34 XMTR LINE with the oscilloscope. The level at J2, pin 16 to 18, should be between -10 dBm and -14 dBm when pressing key tone. (Note: There is no adjustment provided.)

NOTE 1

Normal operation, i.e., For aux operator panel to key transmitter, place jumper wires on E6 to E7 and E12 to E13, then proceed to step 1. and 2. Auxiliary operator panel currently is not used in Army system.

NOTE 2

When aux operator panel is not used, jumper wires should be between E7 and E10 and between E13 to logic 1 (E36), causing VOR transmitter to be keyed via remote control mike. Proceed to step 2.

1. Set potentiometer 4A2R19 at midrange and set voice switch to off position. Connect signal generator to A2J4, pins 1 and 2 and set signal generator for 1000 Hz and an output level of 1.5 volts peak-to-peak as observed at A2E14 with oscilloscope when keying XMTR key (jumper J4, pins 3 to 5 and J4, pins 4 to 6). Note: Signal generator output level will be approximately -27 dBm. Disconnect signal input, but leave key line in keyed status and observe presence of 2870 Hz signal at A2E34.

2. Connect signal generator to mike input and adjust for 1000 Hz at -50 dBm. Connect oscilloscope to 4A2E14 on circuit card assembly 4A3 and adjust potentiometer 4A3R10, MIKE GAIN, for 1.5 volts peak-to-peak while keying mike key line 4A2 B-D. Verify approximately -8 dBm to -12 dBm at J2, pins 16 and 18. When note 2, above is used, disconnect mike input and verify 2870 Hz tone present at A2E34 while keying mike key line and voice switch to on position.

(i) Set the generator to 1000 Hz at -17 dBm and connect it to the input of J2, pins 15 and 17. Adjust RCVR GAIN potentiometer 4A2R57 for 10 volts peak-to-peak at 4A2U21, pin 12, or terminal 4A2E22 test point. Verify 9 volts peak-to-peak at 4A2U21, pin 10.

(j) Set the generator to 2655 Hz at -17 dBm level and adjust the notch filter potentiometer R76, Notch D, potentiometer R79, Notch E, and potentiometer R97 Notch F for a minimum output on the oscilloscope at 4A2U22, pin 7 (or E28). Make these adjustments in order listed three times to get the minimum output.

(k) Set the generator to 2416 Hz at -17 dBm level. Adjust the notch filter potentiometer 4A2R84 Notch A, potentiometer 4A2R87 Notch B, and potentiometer 4A2R98 Notch C, in the order listed three times to get the minimum output with the oscilloscope on 4A2U22, pin 1.

(l) With these two notch filters adjusted, vary signal generator around 2400 Hz with the oscilloscope at E27 and verify operation of high pass filter 4A2U23B. With the oscilloscope at E27 and signal generator varied around 2700 Hz, verify operation of low pass filter 4A2U23A.

(m) Set the generator to 1020 Hz at -17 dBm. Measure 8.4 volts peak-to-peak with the oscilloscope at 4A2U19, pin 10. Adjust potentiometer 4A2R55 (located on side of card) with the oscilloscope on U20, pin 8 for a low. Then, U20 is adjusted to 1020 Hz. The audioident light will also illuminate. Pin 5 of 4A2U20 will oscillate at 1020 Hz when turned to the correct frequency setting. With oscilloscope at U11, pin 12, adjust potentiometer A2R68, AUX DRIVE, for 10 volts peak-to-peak. Verify audio tone out of speaker. Remove input signal.

c. Operations Site (Remote) Modem Circuit Card Assembly (4A3) Adjustment Procedures.

(1) Test Equipment Required.

(a) Oscilloscope

(b) Audio Signal Generator (P/O Telephone Test Set)

(c) Frequency Counter

(2) Instructions.

(a) With no input on FSK data pin A25, connect a counter to 4A3U26, pin 5, and adjust potentiometer 4A3R59 (PLL FREQ) for a 2570 Hz counter reading. Set signal generator to 2500 Hz 0.6 volt peak-to-peak and connect the signal generator to the FSK data input at 4A3, pin A25. Vary the frequency on the signal generator from 2200 to 2900 Hz. With potentiometer 4A3R59 adjusted properly, 4A3U26, pin 8, goes low when 2416 to 2655 Hz are scanned on the signal generator. Disconnect input signal.

(b) 4A3U13 is an oscillator and 14 stage counter. When a 3.58 MHz crystal is used in the oscillator, the pin number and frequency outputs are as follows: pin 9 is 3.58 MHz, pin 7 is 224 kHz, pin 6 is 28 kHz, pin 14 is 14 kHz, pin 13 is 7 kHz, pin 15 is 3.5 kHz, pin 1 is 874 Hz, pin 2 is 437 Hz, pin 3 is 218 Hz (verify these frequencies)

(c) To verify operation of the remote control, connect to an operating local control and verify transfer of status data.

(d) The FSK data comes into 4A3U26, pin 3. It is demodulated by 4A3U 14 and goes to the UART 4A3U3, pin 20, as digital data. The UART converts the serial data to 8 bit parallel data. Six data lines go to the four display latch drivers The two data lines on pins 6 and 5 go to decoder 4A3U5 which selects one of four output latches according to the incoming code. This loads data in one of the latch drivers The latch drivers activate the LED display on the front panel to display status sent from the local.

(e) 4A3U15 is the critical status latch. The output of this goes to 4A3U17 and 4A3U19. The output of 4A3U19 goes to 4A3U20 which takes the output from 4A3U17 and compares it with new incoming data. The output of 4A3U17 and 4A3U20 goes to 4A3U24A, which senses if an ON or OFF change occurs If both 4A3U17 and 4A3U20 are positive, a clock sends a signal through 4A3U24A. With all inputs positive, the signal clocks 4A3U22B and enables 4A3U21C. The alarm tone then goes to the operations voice buffer circuit card assembly (4A2), pin B-F. With terminals E15, E16, E18 and E19, the alarm tone can be jumpered to output at the speaker and/or the FSS remote operator panel. Transistor 4A3Q3 and 4A3U10C are alarm outputs for future use.

(f) Connect the microphone and verify that the intercom voice can be sent and received properly.

(g) After obtaining clearance, verify that the command code will turn the ident tone on/off and control the VOR and DME off/on.

(h) Verify that the DATA VALID indicator is illuminated and that status light indications are proper.

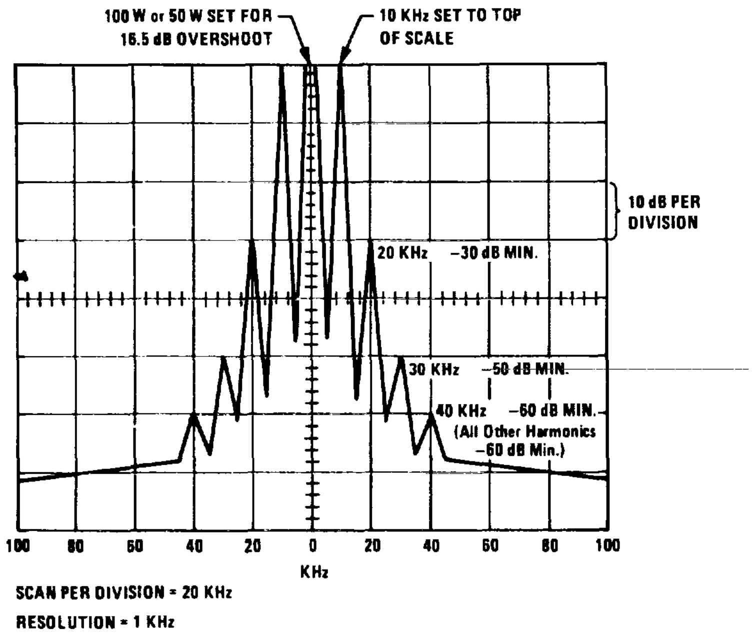
(i) Press the RING switch on the local control with the INTERCOM switch in the A FACI L position and check that the ring at the remote control is received. With volume set for adequate voice reception, adjust SPKR RING potentiometer R23 on circuit card 4A2 for a loud ring output.

(j) If the auxiliary indication/voice panel is used, hold switch to A TRAFF position and press the RING switch at the LOCAL. Adjust AUX RING potentiometer R29 on circuit card 4A2 for a loud ring at the auxiliary indication/voice panel.

(k) If the operation, setups, and checks were normal and within the limits specified, return the remote to normal service configuration.

(l) If operation/checks are faulty, replace the operations voice buffer and/or operations site modem circuit card assembly (as required) and repeat the alignment and adjustment procedure.

5-24. SPECTRUM ADJUSTMENT PROCEDURE. Perform the following procedures in the sequence indicated whenever the modulation spectrum of the 9960 Hz exceeds the limits shown on the following waveform.



a. Enter code 17 on the local control 1A2 keyboard to turn off power to the carrier transmitter, 1A4.

b. In order to obtain easy access to the intermediate power amplifier assembly, 1A4A5, it is necessary to first disconnect the cables connected at connector J1 and connector J2 on 1A4A5 assembly. The second step is to disconnect the hardware which secures the A5 assembly to the 1A4 chassis and lift the A5 assembly up and carefully place it between the edge of the 1A4 chassis and the power amplifier assembly, 1A4AR1. Be careful not to allow any terminals or the attaching wires on the 1A4A5 assembly to short against other metal objects during this process. Reconnect the cables which were previously connected to connector J1 and connector J2 on 1A4A5.

c. Disconnect cable W8 from attenuator AT1 in carrier transmitter 1A4. Connect a 30 dB attenuator to attenuator 1A4AT1. Connect one end of a BNC test cable to the 30 dBattenuator and the other end to the input of a spectrum analyzer.

NOTE

The 30 dB attenuator is used to protect the receiver RF input of the spectrum analyzer from overload.

d. Ensure the POWER SWITCH in sideband transmitter 1A5 is in the NORMAL position. Also, ensure that the A CONT and B CONT switches (1A5A4S1 respectively) are in the OFF position. Set the DEV CONTROL switch 1A5A1S1 to the OFF position.

e. Ensure that SUBCARR switch 1A4A2S1 is in the ON position.

f. Enter code 15 on local control 1A2 keyboard to apply power to carrier transmitter 1A4. Adjust PWR ADJ potentiometer 1A4A4R22 for a proper power output level (i.e., 50 watts for a 50 watt system and 100 watts for a 100 watt system).

g. Turn the spectrum analyzer frequency readout to the carrier transmit frequency and center the presentation in the center of the display screen. Decrease the resolution and frequency scan per division so that the preceding waveform showing the spectrum is observed on the spectrum analyzer. Set the center peak even with the top grid line.

h. Set the 9960 Hz modulation level by adjusting 9960 Hz SUBCARR MOD potentiometer 1A4A2R 10 for 30% modulation points as shown on the preceding waveform.

i. Initially adjust capacitors C11, C21, C18 and C26 on assembly 1A4A5 for a minimum voltage dip as indicated on carrier transmitter 1A4 test meter with the test meter select switch in the HIGH LEVEL modulation position.

j. In the sequence indicated, adjust capacitor C11, C21 and C18 to minimize the 2nd and 3rd harmonic. (Look for equal symmetry.) Repeat the adjustments in the sequence indicated until the desired results are obtained.

k. Adjust capacitor C26 for fine tuning.

l. Adjust potentiometer R18 on assembly 1A4A4 to ensure that the HIGH and LOW LEVEL MODULATION test positions fall within the proper range in carrier transmitter 1A4 test meter.

m. The spectrum is properly adjusted when the following conditions are met.

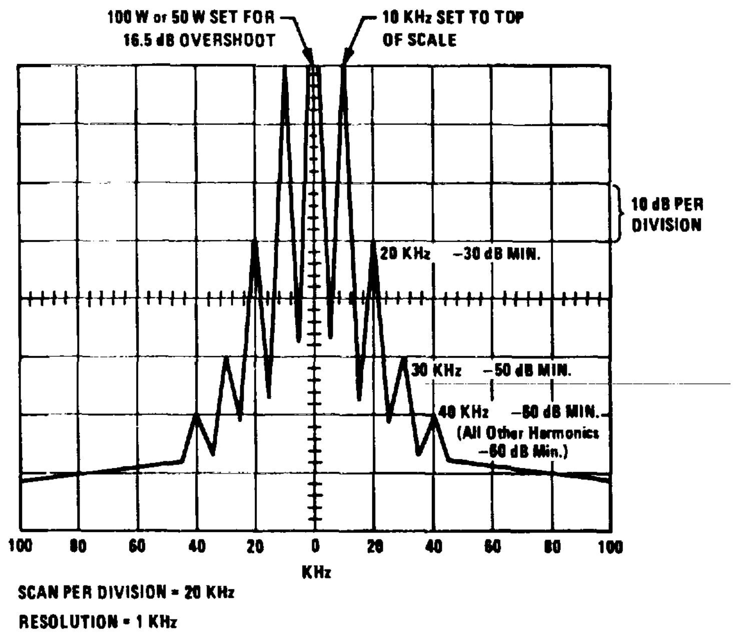
1. The 10 kHz sidebands are 16.5 dB down from the center peak for 30% modulation.

2. The 20 kHz sidebands are down 30 dB minimum from the 10 kHz sidebands.

3. The 30 kHz sidebands are down 50 dB from the 10 kHz sidebands.

4. All other 10 kHz sidebands are at least 60 dB minimum down from the 10 kHz sideband.

NOTE
A clearer view of the fourth and higher harmonics can be seen by adjusting the spectrum analyzer to obtain the waveform shown below.



n. Enter code 17 on the local control 1A2 keyboard and return the system to its normal operation (i.e., disconnect all test equipment, re-install the 1A4A5 assembly, and re-connect all cables).

5-25. FREQUENCY CHECKS

a. Test equipment required.

(1) Frequency counter

b. RF Frequency Check Instructions.

(1) In the carrier transmitter, set the following switches to the OFF position.

SUBCARR	1A4A2S1
IDENT	1A4A2S3
VOICE	1A4A2S2

(2) In the sideband transmitter, set the following switches to the OFF position.

DEV CONTROL	1A5A1S1
A CONT	1A5A4S 1
B CONT	1A5A4S2

(3) Disconnect cable W8 from ATI (on J2DC1) and connect frequency counter to AT1 of DC1 in carrier transmitter.

CAUTION

Do not disconnect J1 or J3 on DC1 or transmitter damage could occur.

(4) Frequency should be within station tolerances.

c. Sideband Transmitter Frequency Check Instructions.

(1) Connect frequency counter to test points of sideband transmitter listed below and verify frequencies are within tolerances given.

SUBCARRIER	1A5A1E3	9960 t9.9 Hz
30 Hz	1A5A1E2	30 + 0.3 Hz (33.333
30 Hz VAR	1A5A1El	±.033 milliseconds)

d. Figure 5-6 is provided for power calculations, if required.

5-26. CRITICAL SWITCHES CHECK. Listed below are the critical switches and their normal positions Placing any of these switches in any position other than normal will cause the CRITICAL SWITCHES MISSET (red) indicator in the affected drawer to illuminate and cause the CRITICAL SWITCHES NORMAL (green) indicator of the local control to extinguish. Check all positions of all switches.

DRAWER	SWITCH	POSITION
LOCAL CONTROL	REMOTE SWITCH	ILLUMINATED
MONITOR	INPUT SELECT	NORM
	POWER	NORMAL
CARRIER	ON/OFF/POWER	NORMAL
	SUBCARR (A2)	ON
	VOICE (A2)	ON
	IDENT (A2)	NORM
SIDEBAND	A CONT	NORM
	B CONT	NORM
	DEV CONTROL	NORM
	POWER	NORMAL

Table I

dB Factor	Power Factor
0	1
10	10
20	100
30	1000
40	10000
50	100000
60	1000000
70	10000000

Table II

dB Factor	Power Factor
+0 0=	1.000
+1.0=	1.259
+2.0=	1.585
+3.0=	1.995
+4.0=	.2512
+5.0=	3.162
+6.0=	3.981
+7.0=	5.012
+8.0=	6.310
+9.0=	7.943

Table III

dB Factor	Power Factor
+1.0=	1.000
+0.1=	1.023
+0.2=	1.047
+0.3=	1.072
+04=	1.096
+0.5=	1.122
+0.6=	1.148
+0.7=	1.175
+0.8=	1.202
+09=	1.230

SAMPLE COMPUTATIONS:

Example 1: Convert 5373 Watts to dBw*

Step 1 - Determine largest power factor that will divide into 5373 from Table 1 and divide:

5373 + 1000 - 5.373

Step 2 - Write down its dB factor.

1000 = 30

Step 3 - Determine the largest power factor that will divide into 5.373 from Table II and divide:

5.373 + 5.012 - 1.072

Step 4 - Write down its dB factor.

5.012 - 7.0

Step 5 - Determine nearest power factor to 1.072, write itsdb factor and add dB factors.

1.072 - + 0.3

30 + 7.0 + 0.3 - 37.3 dBw

Step 6 - To convert dBw to dBm add 30

37.3 dbW - 67.3 dBm

Example 2: Convert 67.3 dBm to Watts
Watts = A X B X C
A = Table I db factor (+60)
B = Table II db factor (+7.0)
C = Table III db factor (+0.3)

67.3 dBm - 1,000,000 X 5.012 X 1.072 - 5,372,864 Milliwatts
(or 5373 Watts)

Example 3: Convert 37.3 dBw to Watts
Watts- A X B X C
A - Table I db factor (+30)
B - Table II db factor (+7.0)
C - Table II db factor (+0.3)

37.3 dBw = 1--- X 5.012 X 1.072 - 5373 Watts

Figure 5-6. Conversion Formulas

SECTION II

MAINTENANCE FLIGHT/GROUND-CHECK INSTRUCTIONS

5-27. INTRODUCTION. The ground check is a means by which the overall system bearing accuracy maybe determined. The primary purpose in performing omnirange station ground checks is to minimize the need for expensive flight checks by determining the amount and direction of any course be inaccuracies being transmitted. If bearing inaccuracies are excessive, they can be reduced to an acceptable minimum by corrective maintenance before the flight check is conducted. This section explains how the VOR ground-check procedure is conducted, how the resulting ground-check data is used to calculate the amount and sources of station error, and how error curves are plotted for graphical analysis. The ground check procedure is conducted with all the equipment connected for normal operation with the exception of the field detector which is placed at 22.5 degree intervals to obtain the desired readings. A VOR test generator circuit card installed in the VOR monitor, 1A3, is used as a standard during the performance of the ground check.

Ground-check procedures performed on commissioned systems within the U.S.A. generally must comply with the rules and regulations set forth by the Federal Aviation Administration under Standard Ground Check in VHF FAA order 6790, Section 4A, Maintenance of Omni-Range Equipment. All ground-check procedures in this manual are performed using permanent ground-check mounting bracket swhich have been installed at 22.5 degree intervals, located around the omnirange shelter as shown in figure 5-7.

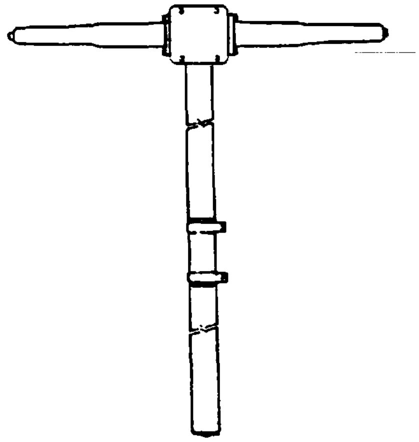
5-28. FLIGHT INSPECTION REQUIREMENTS. The primary purpose of performing a flight inspection is to ensure the accuracy of the bearing transmission. This provides calibration of the facility upon initial commissioning and at regularly scheduled intervals thereafter. Once the facility has been properly calibrated with regards to the bearing accuracy, it is imperative that these adjustments not be disturbed unless another complete calibration cycle is going to be performed. See note at beginning of the level 3 performance check.

5-29. BEARING ACCURACY CALIBRATION PROCEDURES. The bearing accuracy calibration procedures consist of the following tasks:

a. Performing preliminary ground checks and using information to direct the adjustments made towards reducing station error during installation and after major repair actions in sideband transmitter(1A5) and antenna (unit 3).

b. Performing preflight inspection checks and alignment.

c. Performing a flight inspection to establish the transmitted bearing error after completion of initial station error reduction and at regularly scheduled intervals as determined by the cognizant authority.



UNIT 2
VOR FIELD DETECTOR

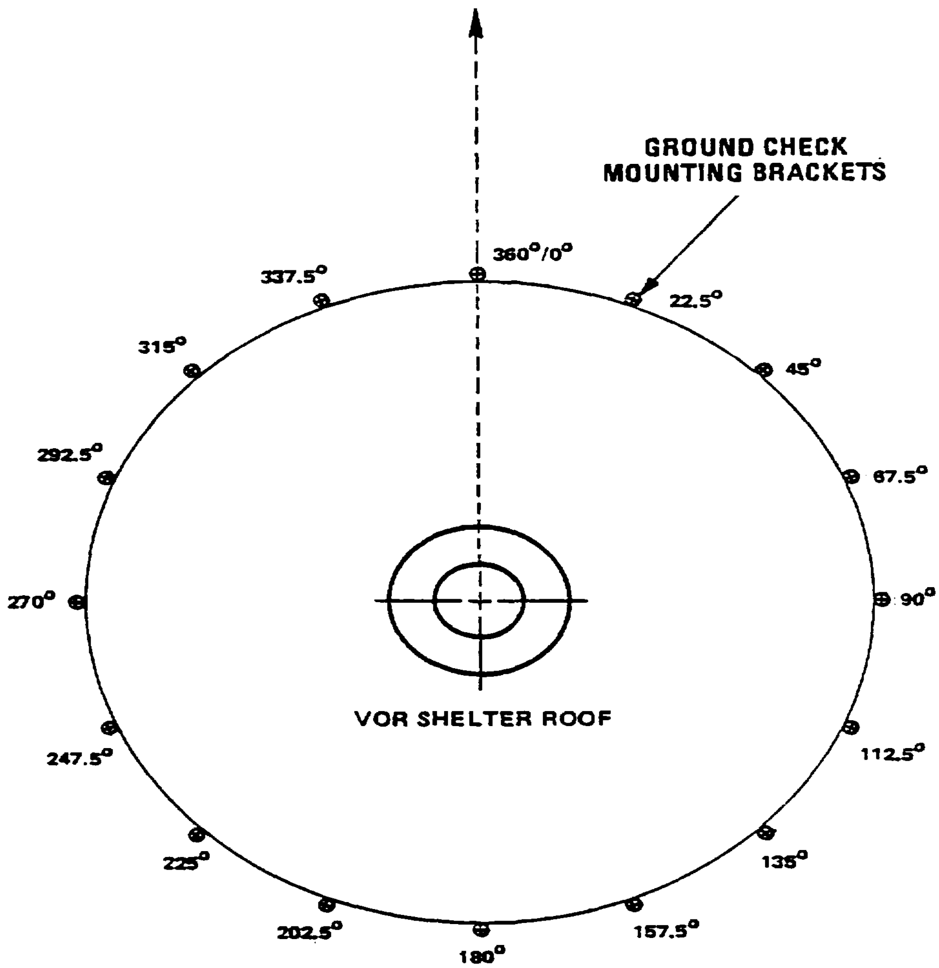


Figure 5-7. Ground-Check Mounting Bracket Locations

At this time, the monitor bearing alarm detection capability will be verified and final adjustments for station orientation will be made.

d. Conducting post-flight inspection operations which are detailed below:

1. Performing a ground check after flight inspection to establish reference ground check data used to compare with future ground check data to indicate station operation and performing the level 1, level 2 and level 3 performance checks and recording the required data which is then used as the reference for future checks

2. Performing final alignment of the monitor alarm detection circuitry and calibration of the VOR test generator immediately after flight inspection to match the characteristics of the radiated VOR signal as verified by flight inspection.

5-30. PRELIMINARY GROUND-CHECK ERROR MINIMIZATION. In order to minimize the peak-to-peak ground check error, it is necessary to perform an initial alignment of the sideband transmitter (1A5) and the antenna (unit 3). The alignment consists of adjusting the quadrature phase relationship between the sideband A and sideband B modulation envelope (quadrature phase adjustment) and setting the relative power balance between these two outputs. The antenna alignment consists of balancing the radiated outputs between the slots of a pair. This procedure assumes the procedures of Chapter 2 have been completed.

a. Quadrature Phase Adjustment. Proceed as follows for adjusting quadrature phase:

1. Perform power turn on procedure per paragraph 3-10.

2. Press SYSTEM INHIBIT switch 1A2S1 until the SYSTEM INHIBIT indicator 1A2S1DS1 is illuminated. Enter command code 15 from local control 1A2 keyboard.

3. Place the field detector (unit 2) at the 1350 bracket on the counterpoise edge.

4. On monitor 1A3, set in 135.0 on the RADIAL SELECT switches and set INPUT SELECT switch S3 to GND CHK position.

5. On sideband transmitter 1A5, place POWER SWITCH S1 to the OFF position. Disconnect line matching network 3Z2 from SIDEBAND A connector on electrical equipment rack. Connect a dummy load to the SIDEBAND A connector on the electrical equipment rack.

6. On sideband transmitter 1A5, place POWER SWITCH S1 to the NORM position. Adjust BEARING ADJ potentiometer in sideband transmitter 1A5 meter panel bracket until the BEARING ERROR readout on monitor 1A3 is 0.0.

7. On sideband transmitter 1A5, place POWER SWITCH Sl to the OFF position. Disconnect dummy load from SIDEBAND A connector or equipment cabinet and reconnect line network 3Z3 to SIDEBAND A connector. Disconnect line matching network 3Z3 from SIDEBAND B connector or electrical equipment rack. Connect a dummy load to the SIDEBAND B connector or the electrical equipment rack.

8. Place the field detector (unit 2) at the 450 bracket on the counterpoise edge.

9. On monitor 1A3, set in 045.0 on the RADIAL SELECT switches.

10. On sideband transmitter 1A5, place POWER SWITCH S1 to the NORM position. Adjust QUAD PHASE ADJ potentiometer 1A5A4R4 on the sideband transmitter for a BEARING ERROR readout of C.' on monitor 1A3.

11. On sideband transmitter 1A5, place POWER SWITCH S2 to the OFF position. Disconnect dummy load from SIDEBAND B connector on electrical equipment rack and reconnect line matching network 3Z3 to SIDEBAND B connector on electrical equipment rack.

12. On sideband transmitter 1A5, place POWER SWITCH S1 to the NORM position.

This completes the quadrature phase adjustment portion of the initial ground check error minimization procedure. This adjustment must be made prior to performing remainder of ground error minimization procedures.

b. Sideband Power Balance Adjustment. (Refer to figure 5-8 for an example.)

Proceed as follows for performing sideband power adjustment.

1. Ensure that steps 1 and 2 in paragraph 5-30. a. have been accomplished.

2. Place the field detector (unit 2) at the 0° bracket on the counterpoise edge.

3. On monitor 1A3, set in 000.0 on the RADIAL SELECT switches and set INPUT SELECT switch S3 to GND CHK position. Read and record the display on the monitor ERROR BEARING.

4. Repeat steps 2 and 3 for 90°, 180° and 270°.

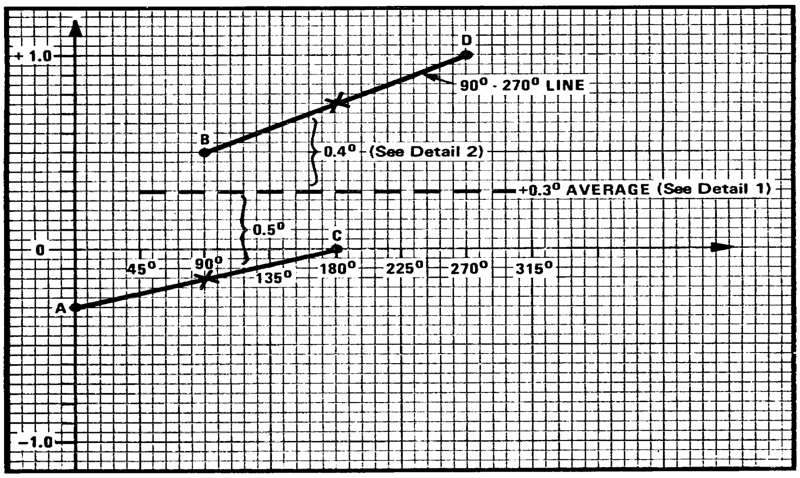
5. Compute algebraic average as follows:

$$\text{Average} = \frac{(\text{Reading at } 0°) + (\text{Reading at } 90°) + (\text{Reading at } 180°) + (\text{Reading at } 270°).}{4}$$

POINTS ON GRAPH	FIELD DETECTOR LOCATION	READING
A	0°	−0.3°
B	90°	+0.5°
C	180°	0.0
D	270°	+1.0°
		+1.2°

$\frac{+1.2^\circ}{4} = +0.3^\circ$ AVERAGE

(Detail 1



$\frac{0.4^\circ + 0.5^\circ}{2} = 0.45^\circ$ ERROR TO BE REMOVED

REDUCE ERROR READING AT 180° BY 0.45°
AS 90° - 270° LINE LIES ABOVE AVERAGE

Detail 2

Figure 5-8. Typical Example of Sideband Power Balance Adjustment Computation

6. Plot the four readings obtained in steps 3 and 4 as points on a graph similar to the one Shown in figure 58. Also, draw a horizontal line at a vertical distance equal to the average computed in step 5 on the same graph. The vertical dimension of the graph is in degrees of error while the horizontal Dimension is in degrees of azimuth.

7. With a straightedge, connect the 0° and 180° reading points. Likewise, connect the 90° and 270° reading points on the 0° - 180° line, locate the midpoint (at 90°) and mark an X. on the 90° - 270° line, locate the midpoint (at 180°) and mark another X.

8. Measure the distances (in degrees of error) from each midpoint to the average line computed In step 5.

9. Disregarding the signs associated with the distances determined in step 8, compute the Average of the true distances by adding the magnitudes and dividing by two. Round off to the nearest 0.1°. This average is the magnitude of the power balance error.

10. Place the field detector on the 180°0 bracket on the counterpoise edge.

11. On monitor 1A3, set in 180.0 on the RADIAL SELECT switches. Note the reading displayed on the BEARING ERROR readout.

12 the power balance error is reduced by adjusting A POWER ADJ potentiometer 1A5A4R5 as follows:

(a) If the midpoint of the 90° - 270° line plotted in step 7 lies above the average line plotted in step 6 turn A POWER ADJ potentiometer 1A5A4R5 in such a direction to reduce the reading displayed on the monitor BEARING ERROR readout by the value computed in step 9.

(b) If the midpoint of the 90° - 270° line plotted in step 7 lies below the average line plotted step 6, turn A POWER ADJ potentiometer 1A5A4R5 in such a direction to increase the reading displayed on the monitor BEARING ERROR readout by the value computed in step 9.

Repeat steps 2 through 12 at least one more time to further reduce error.

c. Antenna Power Balance Between Slots of A Pair. Proceed as follows:

NOTE

The antenna is normally adjusted at the factory. The Following procedure should be accomplished only when the Requirements for the ground check error curve cannot be met as specified in paragraph 5-30.

1. Ensure that steps 1 and 2 in paragraph 5-30 have been accomplished.

2 Place field detector at the 45° bracket on the counterpoise edge.

3. On monitor 1A3, set in 045.0 on the RADIAL SELECT switches and at the INPUT SELECT switch set S3 to the GND CHK position. Read and record the value displayed on the monitor BEARING ERROR READOUT.

4. Repeat steps 2 and 3 for 135°, 225° and 315°°°.

5. Determine sideboard A pair unbalance by subtracting the reading at 135° from the reading at 315°. f difference exceeds 0.2 degree, go on to step 6. If not, go on to step 11.

6 Enter command code 17 on the local control (1A2) keyboard.

7. Remove access cover from antenna radome to gain entrance to antenna. On slots 1 and 3, Rotate slot fin capacitors Cl and C3 one quarter turn in opposite directions noting direction for future Reference.

8. Replace radome access cover and enter command code 15 on the local control (1A2) Keyboard.

9. Repeat steps 2 and 3 for 135° and 315°.

10. Subtract the reading at 135° from the reading at 315°. If difference is less in magnitude (i.e., disregard algebraic sign) than the difference obtained in step 5, repeat steps 6 through 9 until difference is less than 0.2°. It may be necessary to turn slot fin capacitors by less than a quarter turn as difference gets smaller. If difference after first iteration is greater in magnitude than the difference obtained In step 5, then repeat steps 6 through 9, but rotate slot fin capacitors in direction opposite to that used in The first iteration.

11. Repeat steps 3 and 4, and then determine sideband B pair unbalance by subtracting the reading At 45° from the reading at 225°. If difference exceeds 0.2 degree, go on to step 13. If not, go on to step d. In paragraph 5-30

12. Enter command code 17 from local control keyboard.

13. Remove access cover from antenna radome to gain entrance to antenna. On slots 2 and 4, Rotate slot fin capacitors one-quarter turn in opposite directions noting directions for future reference.

14. Replace radome access cover and enter command code 15 from local control (1A2) keyboard.

15. Repeat steps 2 and 3 for 45° and 225°

16. Subtract the reading at 45° from the reading at 225°. If difference is less in magnitude (i.e., disregard algebraic sign) than the difference obtained in step 6, repeat steps 12 through 16 until difference Is less than 0.2°. It may be necessary to turn slot capacitors by less than a quarter turn as difference gets smaller. If difference after iteration is greater in magnitude than the difference obtained in step 11, then repeat steps 12 through 16, but rotate slot capacitors in direction opposite to that used in the first iteration.

NOTE

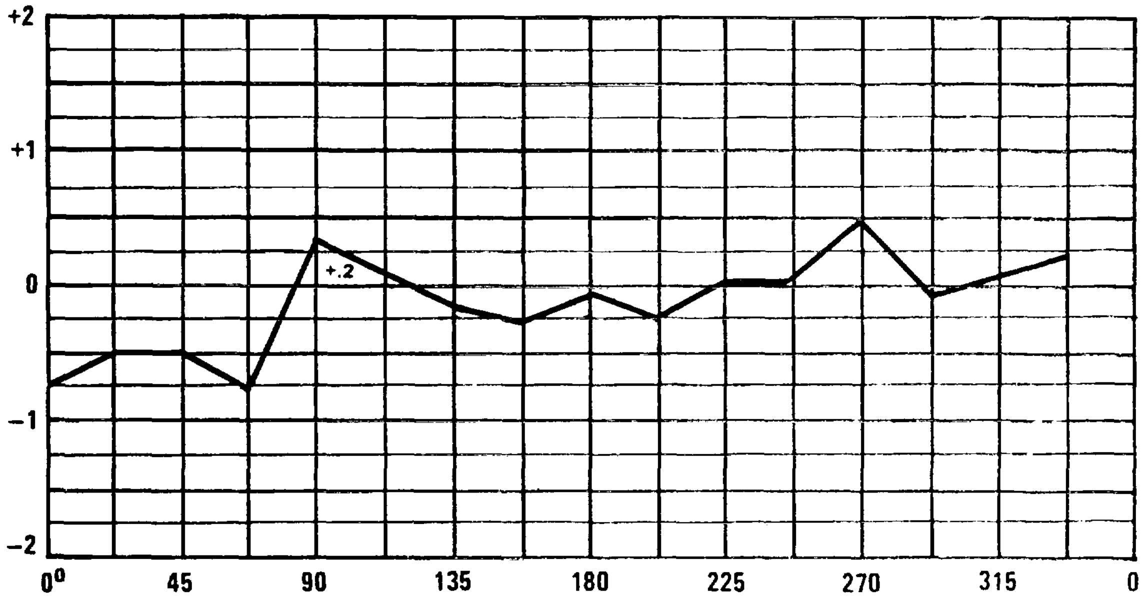
The above procedure adjusts antenna error.

The procedures outlined in paragraphs a, b, and c above should be repeated at least once more to remove the effects of multiple errors. If overall error exceeds 1.5°, proceed to paragraph 5-39 and perform an error curve analysis and correction.

d. Station Orientation. The VOR pattern can be rotated electrically by varying the phase of the reference 30 Hz with respect to the phase of the variable 30 Hz signals. This is done by adjusting BEARING ADJ potentiometer R1 in sideband transmitter 1A5. This is a good adjustment when properly used; however, it is unwise to use it to compensate for excessive misalignment of the antenna. The field detector brackets located on the counterpoise during installation become the ultimate bearing reference. The field detector, unit 2, must be properly tuned and balanced in accordance with paragraph 2-37. An unbalanced field detector will shift the pattern as read by the monitor. The relative phase between reference 30 Hz and the variable signals is established in step a., paragraph 5-30 which must be accomplished prior to performing this procedure. The quadrate adjustment is confirmed by looking at one sideband at a time. Thereafter, any rotation of the pattern is due to the relative angular position of the antenna with respect to the field detector brackets (There may also be a combination of errors which cause some apparent rotation.) Plot an error curve in accordance with the example shown in figure 5-9. In general, it is safe to assume that the mean value of the error curve is due to rotation, once the error curve is reduced to a 2.5° spread. If the pattern is rotated, with respect to the brackets, by more than 10, loosen the antenna and mechanically rotate it to correct the relative rotation too less than 10°.

NOTE

The analysis of error curves is easier, and more accurate, when the principal field detector brackets are correctly aligned with the VOR antenna slots



NOTE: THE ABOVE GRAPH IS AFTER BEARING ROTATION

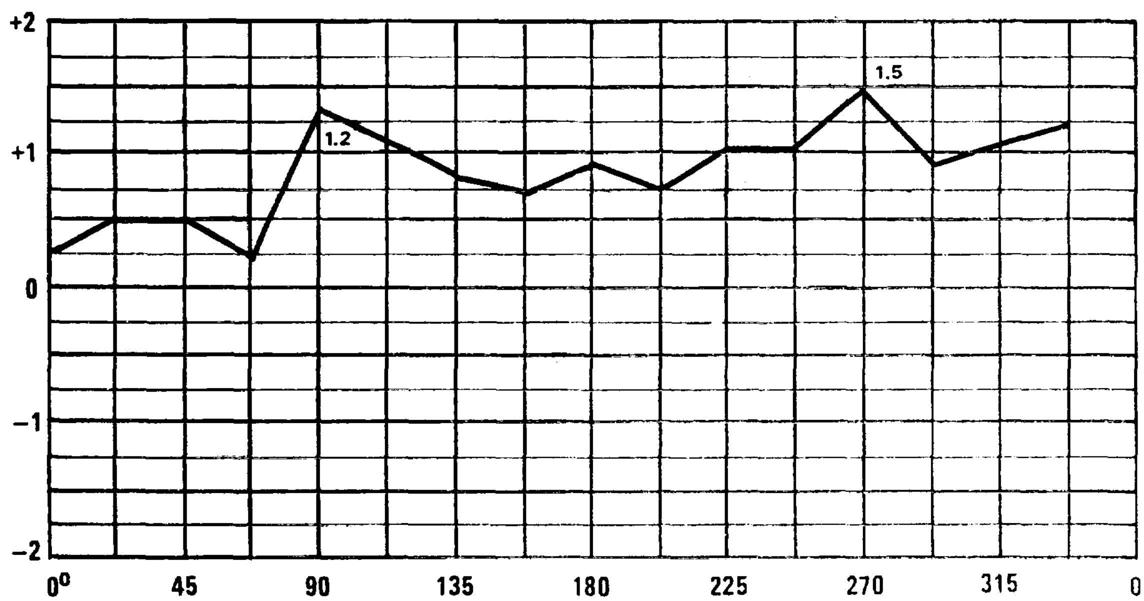


Figure 5-9. Examples of Plotting Error Curves

It will be necessary to take the last few tenths of a degree rotation out by using the electrical adjustment in accordance with the following.

NOTE

The adjustment to BEARING ADJ potentiometer R1 may have to be adjusted again during flight check to rotate the pattern somewhat if required by the flight crew. The position of R 1 is then recorded in commissioning data.

e. The following information defines the requirements to ensure that the system is ready for flight inspection and outlines the procedures to be followed to ensure that the requirements are met.

1. Requirements

(a) The peak-to-peak bearing error spread should be less than 1.5°.

2. Verification Procedure.

(a) Perform a complete 16-point ground check per paragraphs 5-35 through 5-38. If the peak-to-peak ground check error exceeds 1.5° repeat steps a., b. and c. in paragraph 5-30.

5-31. PREFLIGHT INSPECTION INSTRUCTIONS. In order to minimize flight inspection operations, it is necessary to verify that the alignment of the VOR is satisfactory. The following matrix (Table 5-6) lists the preflight check verifications to be performed, the parameter limits where applicable, and the paragraphs giving alignment information applicable to the situation. Preflight operations are complete when the VOR system meet the applicable requirements (See Table 5-6.)

NOTE

The information/instructions in this section apply only to preflight operations and not too normal maintenance. Normal maintenance operations are to be conducted in accordance with the instructions in Chapter 5, Section I.

Table 5-6 Preflight Verification Check List Matrix

PARAMETER	INITIAL LIMITS	INSTRUCTION REF	COMENTS
Ground Check error curve			
1.Peak to peak bearing error spread	≤ 1.5°	Refer to paragraph 5-30 d and e	
Modulation percentages			
1. 9960 Hz modulation	28% (Note 1)	Refer to paragraph 5-21e(2)(g) through (2)(h)	Note 28% as monitored at the field detector location corresponds to 30'% modulations under normal flight conditions.
2. 30 Hz modulation	28% (Note 1)	Refer to paragraph 5-21e(2)(i)and (2)(j)	
3. Voice modulation	28%	Refer to paragraph 2-30	Note28% (maximum as monitored at the field detector location, while VOR is voice modulated from remote microphone.
4. Ident modulation	5%	Refer to paragraph 5-21e(2)(1) through (2)(m)	Actual percentage to be dictated by cognizant authority
l			

Table 5-6. Preflight Verification Check List Matrix (Contd)

PARAMETER	INITIAL LIMITS	INSTRUCTIONS REF	COMMENTS
FM deviation	Crossover occures at 6th group	Refer to paragraph 5-22a	
Carrier frequency	Assigned channel frequency ±.002%	Refer to paragraph 5-25b	
Carrier output power	50± 5% watts for 50 watt system	Step 5.4, table 5-2	
Ident oscillator frequency	1020 Hz ± 10 Hz	Refer to paragraph 5-21b	
Monitor Alarm tolerances			
1.Bearing alarm	Alarm occurs if course shift exceeds 1 °	Refer to table 5-5	
2.9960 Hz alarm	No alarm at 14% drop Alarm at 16% drop	Refer to table 5-5	
3.30 Hz alarm	No alarm at 14% drop Alarm at 16% drop	Refer to table 5-5	
4. Ident alarm	Alarm if Ident tone is continuous, Alarm if Ident code doesn't occur	Refer to table 5-5	
Subcarrier frequency	9960Hz ± 2Hz	Refer to paragraph 5-25c	

Table 5-6. Preflight Verification Check List ,Matrix (Contd)

PARAMETER	INITIAL LIMITS	INSTRUCTIONS REF	COMMENTS
Alarm shutdown	10 to 15 seconds	Refer to table 5-3 Step 4	
System shutdown	Transfer from main to off	Refer to table 5-5 Step 3.1	
IDENT Code	Transmitted code matches assigned code	Refer to paragraph 2-25	
DOT WIDTH	250 ± 10 milliseconds for Complete period	Refer to paragraph 5-21e	
Monitor bearing calibration	±0. 2•	Refer to table 5-4 Step 6.3	
Test generator 9960 Hz 9960 Hz level	 9960 Hz + 50 Hz Note 1	 Refer to table 5-4 Step 5.0 and Step 6.0	 Note 1 level is determined by procedural.
30 Hz level	Note 1		
CRITICAL SWITCHES MISSET indicator on 1A3, 1A4 and 1 A5 drawers	OFF	Refer to paragraph 5-26	
SYSTEM INHIBIT SWITCH indicators	OFF		

5-32. POST FLIGHT INSPECTION INSTRUCTIONS. Upon completion of a successful flight check, it is necessary to calibrate the monitors to the verified VOR signal parameters as well as determine a reference ground check and record certain VOR signal parameters.

a. Monitor Calibration to Transmitters

NOTE

This procedure is to be accomplished immediately after the completion of a successful flight inspection and at no other time. Adjustment of the monitor at other times must be accomplished in accordance with the procedures described in table 5-4.

1. Place field detector at its normal monitoring position.

2 Verify all CRITICAL SWITCHES MISSET indicators are extinguished on 1A3, 1A4 and 1A5 drawers

3. On local control, depress REMOTE switch until associated indicator is extinguished.

4 On local control, depress SYSTEM INHIBIT switch until associated indicator is illuminated.

5. Enter command code 15 on local control keyboard.

6. On monitor 1A3, set TEST SELECT switch to CARRIER LEVEL position and adjust INPUT LVL potentiometer 1A3A3R22 for centerline of green zone on monitor TEST METER.

7. On circuit card assembly 1A3A3, actuate and hold 30 Hz LIMIT SET switch in thedetent position and adjust 30 Hz LIMIT NO. 1 potentiometer 1A3A3R38 until the monitor 30 Hz NORMAL indicator is at the turn on/turn off threshold.

8. On circuit card assembly 1A3A4, actuate and hold 9960 Hz LIMIT SET switch in the detent position and adjust 9960 Hz NO. 1 LIMIT potentiometer 1A3A4R40 until the monitor 9960 Hz NORMAL indicator is at the turn on/turn off threshold.

9. On circuit card assembly 1A3A3, hold LIMIT TEST switch to HIGH position. Monitor 30 Hz NORMAL and 9960 Hz NORMAL indicators should remain illuminated.

10. On circuit card assembly 1A3A3, hold LIMIT TEST switch to LOW position. Monitor 30 Hz NORMAL and 9960 Hz NORMAL indicators should extinguish.

11. Set the monitor BEARING RADIAL SE LECT switches for a 0.0 BEARING ERRORdis- play readout.

b. Reference Ground Check Data. Reference ground check is a ground check obtained by performing the ground check procedures contained in paragraphs 5-35 through 5-38 after a satisfactory flight inspection has been made. This reference ground check is the algebraic average of three normal ground checks conducted at closely spaced intervals performed as soon as possible after a satisfactory flight inspection has been accomplished.

The reference ground check data are recorded on a data sheet similar to the one shown in figure 5-1a the reference ground check data are computed by dividing the algebraic sum of these ground check data at each check point by three to obtain the average error. The resulting data may be used to plot a reference ground check error curve. A second set of parallel curves are then, plotted + 10 away from the ground check error curve to establish the tolerance envelope.

The reference ground check curve establishes a standard which all future readings recorded on the data form (reference figure 5-10) must meet within the tolerance of t 10. Each time that the omnirange station course bearings are recalibrate because of flight inspection, the reference ground check must be redone. Proper notation must be entered in the station log to indicate the date that the last flight inspection was performed recalibrating the course bearing.

Proceed as follows:

1. Perform three consecutive ground checks per procedures given in paragraph 5-35 through 5-38 using monitor 1A3.

2. Compute the algebraic sum of the three data points at each ground check azimuth. Divide each sum by three to obtain the average.

3. Record average on VOR ground check data sheet, figure 5-10.

c. With field detector mounted at monitoring point, determine modulation percentages as described in steps 1 through 4 below and record in block marked "Commissioned Modulation Percentage" (ground check block of figure 5-10).

NOTE

Steps I., 2. and a are measurements and NO adjustments are permitted here. These adjustments are made in conjunction with a flight inspection and should already have been accomplished.

VOR GROUND CHECK DATA SHEET

IDENTIFIER ______		LOCATION ______				MON. SER. NO. ______			MON. RADIAL SELECT ______		
FLIGHT INSPECTION REFERENCES	TEST RADIAL	FLIGHT INSPECTION REFERENCE GROUND CHECK		LEVEL 2 GROUND CHECK		LEVEL 2 GROUND CHECK		LEVEL 2 GROUND CHECK		LEVEL 3 GROUND CHECK	
COMMISSIONED MODULATION PERCENTAGES (GROUND CHECK)		NAME ______		NAME ______		NAME ______		NAME ______		NAME ______	
		DATE ____ TIME ____		DATE ____ TIME ____		DATE ____ TIME ____		DATE ____ TIME ____		DATE ____ TIME ____	
		SYS # 1	SYS # 2	SYS # 1	SYS # 2	SYS # 1	SYS # 2	SYS # 1	SYS # 2	SYS # 1	SYS # 2
9960 Hz %	0										
30 Hz VAR %	22.5										
1020 Hz %	45.0										
VOICE %	67.5										
LEVEL 3 MODULATION PERCENTAGES (GROUND CHECK)	90.0										
	112.5										
	135.0										
9960 Hz %	157.5										
30 Hz VAR %	180.0										
1020 Hz %	202.5										
VOICE %	225.0										
LEVEL 3 FREQUENCIES	247.5										
RF ± 0.002%	270.0										
9960 Hz ± 2 Hz	292.5										
1020 Hz ± 10 Hz	315.0										
30 HzA 33.333 ± 0.033 milliseconds	337.5										
30 HzB 33.333 ± 0.033 milliseconds	360.0										
ERROR SPREAD											
MAX. EQUIP. DIFFERENCE											
MAX. DEVIATION FROM REF.		N/A	N/A								
TEST GEN. VERIFICATION OF MON. ± 0.2° @ 16 TEST RADIALS (YES/NO)		YES/NO ______		YES/NO ______		YES/NO ______		YES/NO ______		YES/NO ______	
VERIFICATION		INITIALS ______		INITIALS ______		INITIALS ______		INITIALS ______		INITIALS ______	

Figure 5-10. VOR Ground Check Data Sheet.

1. 960 Hz Modulation Percentage. See Chapter 5, Section 1, Paragraphs 521 c, steps (2) (a) through (2) (h), but do not adjust potentiometer 1A4A2R10 (9960 SUBCARR MOD). The toleranceis+ 2% of that recorded at flight inspection (nominally 28 - 32%). Record on ground check data sheet.

2. 30 Hz Modulation Percentage. See Chapter 5, Section I, Paragraph 521 c steps (2) (i) and (2) (j). Do not adjust 1A5A1R2 (VAR MON). The tolerance is± 2% of that recorded at light inspection (nominally 28 - 32%). Record on ground check data sheet.

3. 1020 Hz Identity Modulation Percentage. See Chapter 5, Section I, Paragraphs 521 c (2) (k) through (2) (o), but do not adjust 1A4A2R21 potentiometer (IDENT MOD). The tolerance is +- 1% of that recorded at flight inspection (nominally 5%).

4. Voice Modulation Percentage. See Chapter 5, Section I, Paragraphs 5-21 c (2) (p) and (2) (t). Note percentage as above. The tolerance is + 2% of that recorded at flight inspection (nominally 28-32%).

d. Perform level performance check per table 52, recording values obtained in appropriate columns for system No. 1 under "Flight Inspection Reference Data" heading of figure 5-1.

e. Final Post Flight Check Instructions

1. On local control, press REMOTE switch until associated indicator illuminates. Press SYSTEM INHIBIT switch until associated indicator illuminates.

2 Verify system is on the air and the MAIN ON indicator is illuminated.

3. Verify CRITICAL SWITCHES NORMAL indicator is illuminated.

5-33. PERIODIC GROUND CHECKS. Ground checks shall be conducted at 30-day intervals to provide data to maintain a continuing record of station course bearing (azimuth) accuracy. Record the station check point errors to the station log. This par.ph applies to all TVOR stations commissioned or not, including training facilities.

5-34. GROUND-CHECK EQUIPMENT REQUIRED. Table 57 lists the equipment required to perform omnirange station ground checks and to record ground check information.

5-35. GROUND CHECK PROCEDURE. The ground check outlined in the following subparagraphs provides needed data used to determine sideband transmitter and antenna errors. The information of prime interest which can be obtained from a completed ground check is the total error spread. This is the difference between the greatest error in the negative direction and the greatest error in the positive direction. This information should be compared with the reference ground check data to ensure that the new ground check data is within the one-degree limit envelope. If the new ground check data is outside of

Table 5-7. Ground-Check Equipment Required

QUANTITY	ITEM	REQUIRED CHARACTERISTICS
1	Monitor	Part of AN/FRN-41 VOR System
1	Field Detector	Part of AN/FRN-41 VOR System
1	Field Detector Ground-Check Cable	400 inch cable (one only supplied with omnirange system)
A/R	Ground-Check Form	This form (see figure 510). Facilitate the recording and computation of ground-check data and it may be duplicated from the one in the appendix.
A/R	Graph Paper	8 - 1/2 x 11 inch with 10 x 10 lines to the 1/2 inch (to be used for plotting errors).
1	VOR Test Generator	Part of AN/FRN-41 VOR Monitor

the specified limits, a plot of the error curves will provide the necessary data to analyze and isolate the cause of the error. During initial ground check, a large apparent error may be encountered at various check points these errors may be the results of the additive effects of field detector positioning, check point misplacement and radiated course error.

5-36. INITIAL GROUND CHECK PREPARATIONS. Certain preparations must be completed before the actual ground check process can begin.

NOTE

The ground check is a part of table 5-3, level 2 preventive maintenance performance check. Before proceeding, read the notes preceding step 1 and perform steps 1 and 2 in table 5-3.

a. On the local control unit, press the REMOTE SELECT switch (green) indicator to place the system in local control. (The indicator should extinguish.)

b. Press the SYSTEM INHIBIT switch (red) indicator to prevent the system from alarming. (This indicator should illuminate.)

c. Disconnect the cable connector from the field detector receptacle and remove the field detector (see figure 57) from its normal monitoring location.

d. Connect the field detector ground-check extension cable (W3) female plug to J1 on the field detector. Tighten connector securely.

e. Connect opposite end of the ground-check extension cable to the cable connector which was originally connected to the field detector. Tighten the connector securely.

f. Mount field detector on the 0° ground-check bracket. Extend the extender cable around the circumference of the shelter. Keep the cable within 3 inches (7.5 cm) of the shelter wall and laying on the ground.

NOTE

Before proceeding with the following steps, all personnel and vehicles must be cleared to a distance of 100 feet (30.5 meters), preferably 200 feet (61 meters) from the shelter. This precaution will prevent reflected signals from influencing the output signal levels from the field detector. A person who is moving the field detector may stand under bracket next to shelter during the ground check. However, this person must remain motionless during the ground check reading it is also important to keep the shelter door closed while the ground check readings are being made.

5-37. GROUND CHECK. At the time of a successful flight inspection, a reference ground check is to be accomplished. The same monitor must be used on all ground checks between flight inspections.

NOTE

The following procedures are written assuming the use of the test generator built into the monitor. An external test generator can be connected to A1TB2-15 if this option isn't supplied, or if the test generator is out of service.

a. Enter command code 15 on the local control 1A2 SYSTEM CONTROL keyboard to place system in operation.

NOTE

If the ground check is to be conducted in conjunction with an official flight inspection it is essential to verify the monitor and test generator per table 5-4, steps 5.1 through 8.6.4. The test generator then becomes a reference standard. No adjustments of the test generator are to be allowed between flight inspections.

b. Set the INPUT SELECT switch on monitor 1A3 to the TEST GEN position.

c. Set the TEST GEN BEARING SELECT switch to the 0° position.

d. Set the TEST SELECT switch to the 30 HZ LEVEL position and verify that the VORF test generator 30 Hz modulation level exhibits green zone reading on the monitor 1A3 TEST METER.

e. Set the TEST SELECT switch to the 9960 HZ LEVEL position and verify that the VOR test generator 9960 Hz modulation level exhibits green zone reading on the monitor 1A3 TEST METER.

f. Set the BEARING RADIAL SELECT thumbwheel switches to 000.0 and verify that the BEARING ERROR reading on the monitor 1A3 front panel is within ± 0.1 degree. If not, refer to the monitor alignment procedures in table 5-4, level 3 preventive maintenance performance check.

g. increase setting of BEARING RADIAL SELECT switches by 0.1° and verify corresponding increase in display readout. Repeat for all 10 settings of 0.1° switch. Verify plus sign display readout.

h. Repeat step f.

i. Decrease BEARING RADIAL SELECT switch setting 0.5° (i.e., 359.5°) and verify 0.5° change in display readout and that the minus sign is displayed. Repeat step f.

j. Repeat step . for units BEARING RADIAL SELECT switch. Verify polarity and corresponding change in BEARING display readout Note that maximum display is 7.9° greater than 7.9° bearing change will indicate 7.9°.

k. Repeat steps f. and i. for unit's position.

l. Repeat step f. for each position of the TEST GEN BEARING SELECT switch (22.50 increments of monitor RADIAL SELECT thumbwheel switches).

m. Set the INPUT SELECT switch to GND CHK position. If the field detector (unit 2) has been mounted on a post (30 feet from the VOR antenna) it will be necessary to remove the access cover and adjust potentiometer 2A1R2 to give a reading on the monitor meter (1A3M1) with the TEST SELECT switch 1A3S4 in the 30 Hz VAR position for a 30 Hz variable level reading in the green zone. (It should be noted that other levels may not be centered in the green zone.)

NOTE

If it is desired that 9960 Hz be routed directly from the carrier transmitter instead of from the antenna, set INPUT SELECT switch to 9960 Hz 1 position.

n. Starting at zero degrees, observe the monitor BEARING ERROR readout indicator and record the reading on the data sheet form similar to the one shown in figure 5-9.

o. The field detector must now be moved to the next ground-check bracket (the 22.5° check point) (see figure 5-7) (i.e., the next bracket in a clockwise direction as viewed from the top of the shelter).

p. When the field detector is properly positioned in the ground-check bracket, increase the BEARING RADIAL SELECT thumbwheel switch setting on monitor 1A3 by 22.5°.

q. Record the course error reading as displayed on the BEARING ERROR display of monitor 1A3 on the ground-check data sheet in the space provided for this test radial.

r. Repeat preceding steps o. through q. at all the omnirange station check points, continuing in a clockwise direction, until the field detector is once again at the 0/3600 point and the bearing error reading has been recorded opposite 3600 on the data form. The peak to peak error spread of the ground check must not exceed ± 1.50. Also, the readings obtained from the ground check must be within + 10 of the reference ground check at each test radial.

5-38. CONCLUDING THE GROUND CHECK PROCEDURE. After all the desired ground checks have been completed, the ground check procedure is concluded as follows:

a. Ensure the field detector is mounted in the normal monitoring location.

b. Disconnect the field detector ground check cable at both ends and reconnect the shelter cable to receptacle J1 on the field detector.

c. Set monitor BEARING RADIAL SELECT switches to previously recorded setting which was determined by flight inspection and recorded on the level 1 performance check data sheet.

d. Loosely fold the ground check cable and store it.

CAUTION

Avoid coiling the cable too tightly in order to prevent unnecessary damage caused by kinks and binds.

e. If it is desired to compute or plot ground check errors, refer to paragraph 5-30 d. (figure 59).

f. If this ground check is part of level 2 inspection, return to the level 2 check, step 11, table 53. If this ground check is part of level 3 or flight inspection, return to step 8.7, table 5.4.

5-39. GROUND CHECK ERROR ANALYSIS. Techniques for analyzing station error and determining corrective action are provided in Appendix F located in TM 11-5825-266-14-2

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ARNG: None
USAR: None
For explanation of abbreviations used, see AR 310-50.

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