SECTION 9. INSTALLATION, INTEGRATION, AND CHECKOUT

9.1 INTRODUCTION.- This section contains instructions and installation drawings for the installation, integration, and operational verification of the EFGS antenna system.

9.2 SITE PREPARATION.- The actual site preparations include laying out the installation with driving stakes, digging holes and trenches, and pouring concrete for pilings or continuous forms. The location of the antennas will be determined with reference to the runway point of intercept (RPI).

9.3 CONSTRUCTION DRAWING.- The following figures are provided in this section: 9-1 (sheet 1 of 5, which include Notes 1-14), 9-2 Piling Details "A" (sheet 2 of 5), 9-3 Trenching Details “B” (sheet 2 of 5), 9-4 Pedestal Layout Template Detail “C” (sheet 3 of 5), 9-5 Monitor Pilings Detail “D” (sheet 3 of 5), 9-6 Critical Area Detail “E” (sheet 4 of 5), Table 9-1 Main Antenna Pedestal Taping Radii Detail “F” (sheet 5 of 5), and Table 9-2 Clearance Antenna Pedestal Locations Detail “G” (sheet 5 of 5). These figures are provided to supplement the step-by-step procedures pertaining to: antenna locations, foundation layouts, and trenching for routing the RF cable.

NOTE 1 - Siting Information: The site chosen should provide a runway shoulder, graded normally, unobstructed in the area between the front and rear main antennas and to at least 500 feet forward of the front antenna. The “CRITICAL AREA”, detail “E”, is the area within which the movement of vehicles or aircraft may cause a disturbance to the glide slope information observed by an approaching aircraft. If installation is to be made on the side opposite to that shown, this drawing should be mirrored about the runway centerline. Layout of the system is accomplished with respect to a point known as the RPI. The RPI is the intersection of the straight-line extension of the desired glide slope with the runway centerline, and is chosen to provide an acceptable threshold crossing height (TCH). The RPI must be established before siting the antenna system. This system is not intended for installation at up-slope sites as defined in the ILS Siting Manual, FAA 6750.16.

NOTE 2 - Theodolite Location: A permanent marker for the theodolite location should be installed 25 feet from the runway edge and a distance “DT” forward of the RPI:

DT = (62 - DS) x 4.77/GA, feet,

Where 62 represents the approved height, in inches, for the theodolite eyepiece as defined in the FAA Flight Inspection Manual 8200.1 and “DS” is the depression in inches of the shoulder grade, at the theodolite offset distance and considering longitudinal slopes, below the elevation of the RPI. “GA” is the glide angle in degrees, and the number 4.77 is derived from 1/(TAN (one degree) x 12 inches).

NOTE 3 - Phase Center (Origin): The phase center of the system at the shoulder grade elevation is considered to be the “ORIGINATION POINT” of the glide slope signal. It is also used as the origin of coordinates “X” and “Y” for laying out the locations of the antenna elements. It is positioned to ensure that no part of the antenna will be within 25 feet of the runway edge. A permanent marker for the phase center should be installed 103 feet from the runway edge and a distance “DP” behind the RPI:

DP = DC x 4.77/GA, feet,

Where “DC” is the depression in inches of the shoulder grade, at the phase center offset distance and approximate longitudinal location, below the elevation of the RPI, and “GA” is the glide angle in degrees, and the number 4.77 is derived from 1/(TAN (one degree) x 12 inches).

NOTE 4 - Taping Points: Establish a base line (“X” - Axis) through the phase center parallel to the runway edge. Install permanent markers “TR” and “TF” with bolt insert or pin suitable for hooking on a measuring tape. These taping points will be used for initial layout of the main antennas and for future antenna pedestal position checks.

TR	X = -80 feet,	Y = 0 feet
TF	X = +80 feet,	Y = 0 feet

NOTE 5 - Main Antennas: Stake the rear and front #1 pedestal (PED) locations:

R	X = -206.67 feet,	Y = 67.00 feet
F	X = +228.42 feet,	Y = 36.92 feet

Check the two stake locations against the PED #1 radii from the taping points “TR” and “TF” as given in the first line of each taping table, detail “F”. Before continuing with the layout, it is necessary to choose the correct column in the taping tables for each main antenna. This is done by independently computing the column heading “FRFU” (Frequency Function) for each antenna as follows:

FRFU REAR = FREQ – 327.60 - (0.14 x RS),

where “FREQ” is the assigned station frequency in MHz and “RS” is the transverse slope of the shoulder in percent in the region of the rear antenna. If this value of “FRFU” falls between the tabular headings it will be necessary to calculate a new column of radii by interpolation. The tolerance to be applied to each radius measurement is plus or minus 1/10 foot. Compute the lateral slope from 55 feet away from the runway edge to 175 feet from the runway edge at a distance of approximately 210 feet back from the phase center.

FRFU FRONT = FREQ – 327.60 - (0.14 x FS),

where “FREQ” is the assigned station frequency in MHz and “FS” is the transverse slope of the shoulder in percent in the region of the front antenna. If this value of “FRFU” falls between the tabular headings it will be necessary to calculate a new column of radii by interpolation. The tolerance to be applied to each radius measurement is plus or minus 1/10 foot. Compute the lateral slope from 25 feet away from the runway edge to 145 feet from the runway edge at a distance approximately 230 feet forward of the phase center.

PILINGS NOTICE (pertaining to notes 6, 7, 8 and 9):

Pilings are considered a suitable and perhaps the least expensive method to mount the End-Fire antennas in regions of very stable soil and shallow frost depths. However, movement of pilings has historically been problematic in regions of severe cold and where the soil is not particularly stable. Unstable pilings will result in repetitive and costly system outages, re-optimization and flight inspection re-certification. Some outages may exist for long periods through winter months. For any climate, the manufacturer strongly recommends the use of continuous form concrete foundations for mounting any antenna used in the system. Continuous form foundations greatly increase the system stability, continuity of service, and prevent piling damage by snow removal or grass cutting equipment. Regional civil engineering professionals should be consulted to determine the most suitable foundations for the local climate. Under no circumstances should the forms be poured elsewhere and laid in place or buried to support the antenna. Such a foundation will be repetitively problematic.

Figure 9-1. Construction Drawing (Sheet 1 of 5)

Figure 9-1. Construction Drawing (Sheet 1 of 5)

NOTE 6 - Pilings, Rear and Front Antennas (See Pilings Notice in NOTE 5): Observe that the pilings are in equally spaced pairs except at the ends where they are closer to give extra support. Construct a layout template according to Detail “C”, and place the corner (Mark “A”) of the template against the PED #1 stake. Stretch a measuring tape from the taping point. Rotate the template about the PED #1 stake until the taped radius to Mark “D” location corresponds to the tabular value for PED #2 and drive a stake there. Also drive stakes at Marks “B” and “C” to locate the pilings for PED #1. Relocate the template corner (Mark “A”) against the PED #2 stake. Rotate the template until the taped radius to Mark “E” location corresponds to the tabular value for PED #3 and drive a stake there. Also drive stakes at Marks “B” and “C” to locate the pilings for PED #2. Follow this procedure through the entire length of each antenna, using template Mark “E” for spacing to the next pedestal location, except when reaching end PED #18, use Mark “D” again for the closer spacing.

NOTE 7 - Pilings, Clearance Antenna (See Pilings Notice in NOTE 5): The clearance antenna piling locations should form a straight line oriented 11 degrees toward the runway from a line parallel to the runway intersecting the phase center. To locate the piling positions, place stakes at the XY pedestal locations given in the table below. With the template shown in Figure 9-4, sheet 3 of 5, DETAIL ”C”, place the inside corner of the template marked “A” over the stake for pedestal one with the long edge of the template in the direction of stake for pedestal two. Align the leading edge with the stake for pedestal two and place stakes at positions B and C of the template. Repeat this process to locate the pilings for pedestals 2, 3 and 4. For pedestal 4, the template must be flipped over so that the long edge is in the direction of pedestal 3. The template is used as a long 90-degree corner square and markings ”D” and “E” should be ignored.

NOTE 8 –Pilings, Field Monitor Antennas (See Pilings Notice in NOTE 5): Drive stakes at corner piling locations:

M1 X = +560 feet 0 inches, Y = +3.0 feet 0 inches

As shown in Figure 9-5, sheet 3 of 5, Detail “D”, lay out and stake remaining pilings in rectangles, aligning perpendicular to the runway.

NOTE 9 - Concrete: (See Pilings Notice in NOTE 5). There are 92 pilings total see Figure 9-2, sheet 2 of 5, Detail “A”. Concrete shall develop 3000 psi in 28 days with a maximum slump of 3 inches. Maximum aggregate size shall be 3/4 inch. The tops of the pilings shall project at least 1 inch above the ground, and, where possible, should follow the existing shoulder curvature or grade. In the case of the main antennas, it may be necessary for very modest grading to avoid bending an antenna too sharply while following the shoulder curvature: A straight line extended from the tops of any two adjacent pairs of pilings must not pass above or below the tops of the next pair of pilings by more than 5 inches.

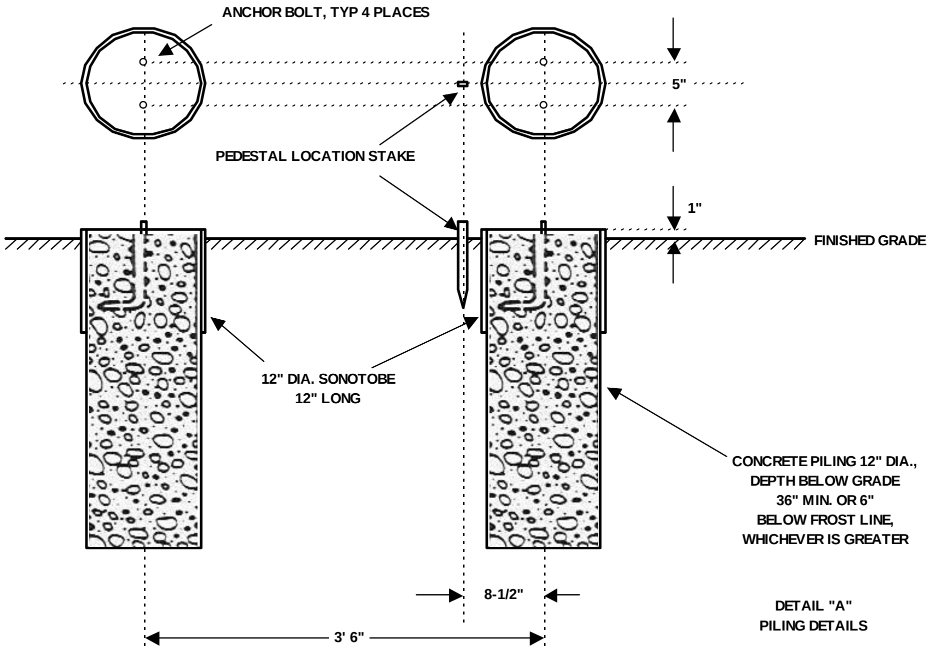


Figure 9-2. Piling Details, Detail "A"

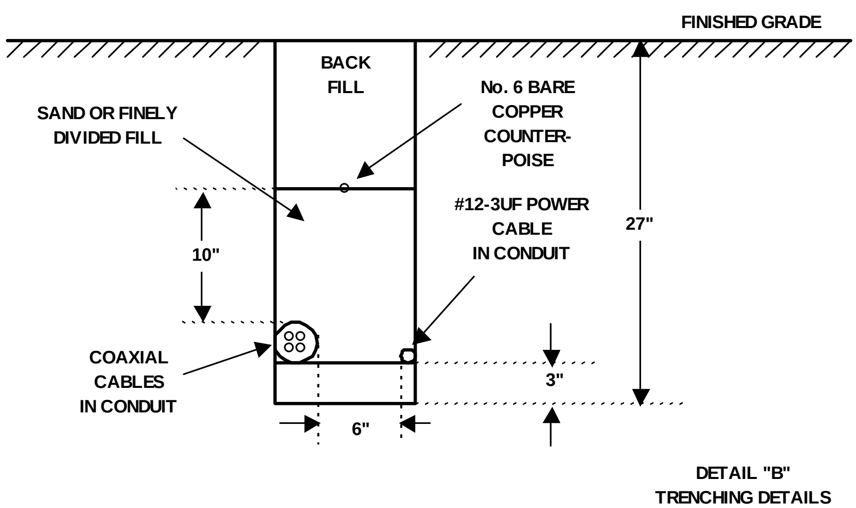


Figure 9-3. Trenching Details, Detail "B"

Construction Drawing (Sheet 2 of 5)

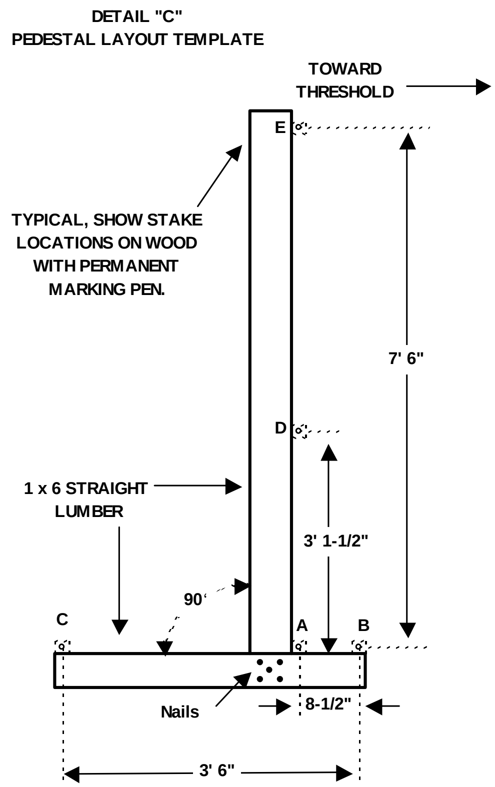


Figure 9-4. Pedestal Layout Template, Detail "C"

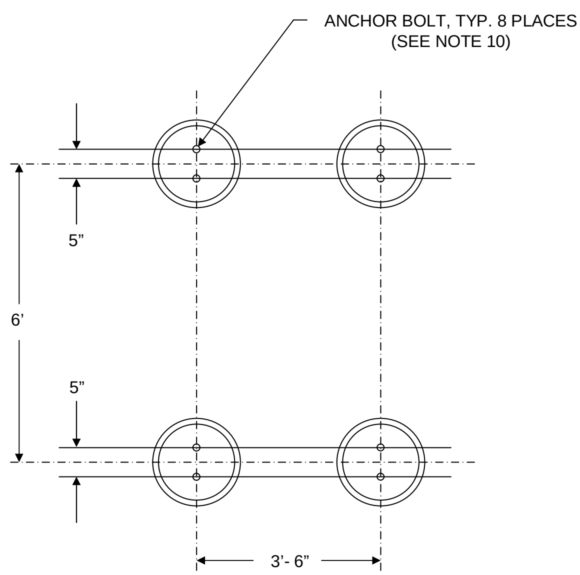


Figure 9-5. Monitor Pilings, Detail "D"

Construction Drawing (Sheet 3 of 5)

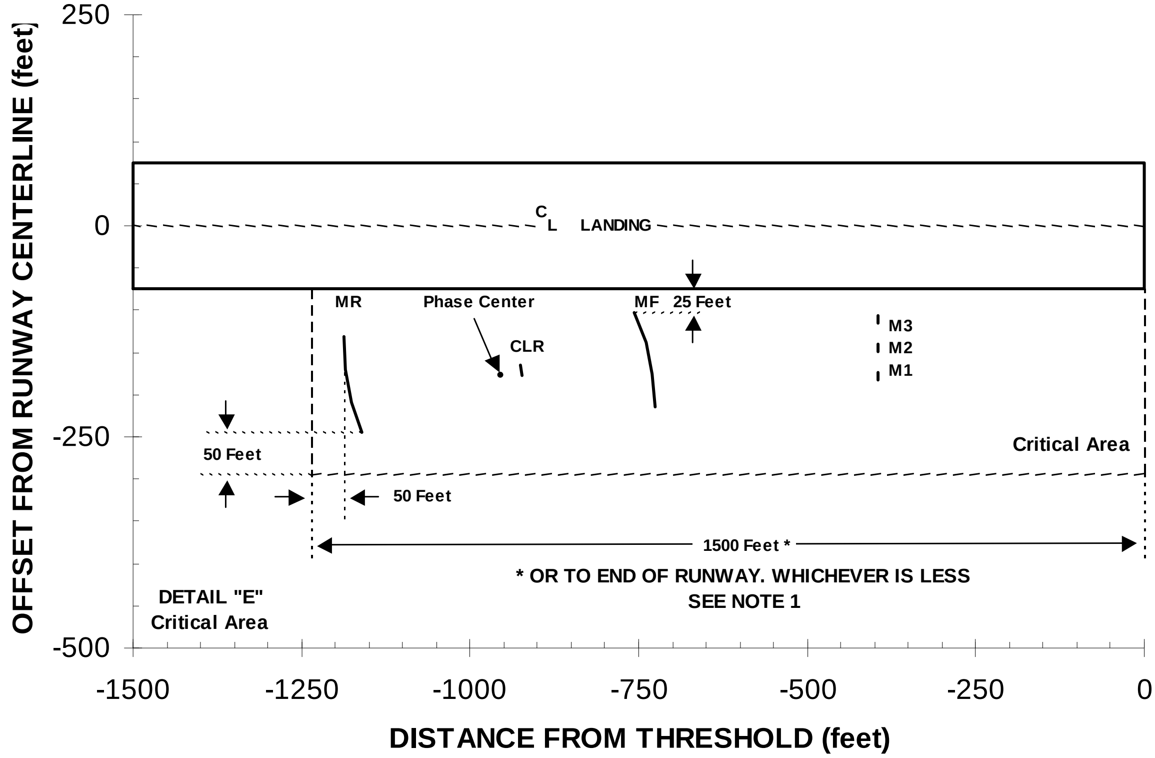


Figure 9-6. Critical Area, Detail "E"

Construction Drawing (Sheet 4 of 5)

Table 9-1. Main Antenna Pedestal Taping Radii, Detail "F"

REAR MAIN ANTENNA						
FRFU	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**
PED	**FEET**	**FEET**	**FEET**	**FEET**	**FEET**	**FEET**
1	143.33	143.33	143.33	143.33	143.33	143.33
2	143.42	143.42	143.33	143.33	143.33	143.25
3	143.67	143.67	143.58	143.58	143.50	143.50
4	144.08	144.00	143.92	143.83	143.75	143.75
5	144.50	144.42	144.33	144.25	144.17	144.00
6	145.08	144.92	144.83	144.67	144.58	144.42
7	145.75	145.58	145.42	145.25	145.17	145.00
8	146.58	146.42	146.25	146.00	145.83	145.67
9	147.50	147.33	147.08	146.92	146.67	146.42
10	148.58	148.33	148.08	147.83	147.58	147.33
11	149.75	149.50	149.25	149.00	148.67	148.42
12	151.08	150.83	150.50	150.17	149.92	149.58
13	152.50	152.25	151.83	151.50	151.17	150.83
14	154.08	153.75	153.33	153.00	152.67	152.25
15	155.75	155.42	155.00	154.67	154.25	153.92
16	157.58	157.25	156.83	156.42	156.00	155.58
17	159.58	159.17	158.75	158.33	157.92	157.50
18	160.50	160.08	159.58	159.17	158.75	158.33
FRONT MAIN ANTENNA						
FRFU	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**
PED	**FEET**	**FEET**	**FEET**	**FEET**	**FEET**	**FEET**
1	152.92	152.92	152.92	152.92	152.92	152.92
2	152.08	152.08	152.17	152.17	152.17	152.17
3	150.25	150.25	150.33	150.33	150.42	150.42
4	148.58	148.58	148.67	148.75	148.83	148.92
5	147.00	147.08	147.17	147.25	147.42	147.50
6	145.58	145.75	145.92	146.00	146.08	146.25
7	144.33	144.50	144.67	144.83	145.00	145.08
8	143.17	143.33	143.58	143.75	144.00	144.17
9	142.17	142.42	142.58	142.83	143.08	143.25
10	141.33	141.58	141.83	142.08	142.25	142.50
11	140.58	140.83	141.17	141.42	141.67	141.92
12	140.00	140.25	140.58	140.92	141.17	141.50
13	139.50	139.83	140.17	140.50	140.83	141.17
14	139.17	139.50	139.92	140.25	140.58	141.00
15	138.92	139.33	139.75	140.08	140.50	140.83
16	138.83	139.17	139.58	140.00	140.42	140.83
17	138.75	139.17	139.58	140.00	140.42	140.92
18	138.75	139.17	139.58	140.08	140.50	140.92

Table 9-2. Clearance Antenna Pedestal Locations, Detail "G"

PED	X	Y
1	31.00 feet	0.00 feet
2	30.13 feet	-4.50 feet
3	29.21 feet	-9.25 feet
4	28.34 feet	-13.75 feet

Construction Drawing (Sheet 5 of 5)

NOTE 10 - Anchor Bolts: B700-J4, 184 anchor bolts, 1/2 - 13 x 8 inches, hot dip galvanized steel per ASTM A153, are required (2 per piling, Details “A” and “D”). Install with 3-inch thread projection above finish surface of concrete. The first thread at the bottom of the bolt should start no more than 1/8 inch above the level of the concrete. In the event that a continuous form concrete foundation is used to mount the antennas, see Pilings Notice in Note 5, it is permissible to drill holes in the foundation and use stainless steel all-thread and epoxy in place of the standard anchor bolts. Due to the possibility of cracking the piling, drilling is not recommended when using discrete antenna support pilings.

NOTE 11 – Trenching Details and Cable Layout: Cable trenching is laid out to maintain equality of lengths of cable pairs from the shelter as follows, with tolerance of plus or minus one foot: R = F and MR = MF. All other cable lengths are not critical. Before laying cables, place a 3 inch layer of sand or finely divided fill in bottom of trenches. See Detail “B”, Figure 9-2 Trenching Details, of the construction drawings sheet 2 of 5. Placing the cables in conduit is highly recommended. After cables are laid in place, cover with 10 inches of sand. Cable jackets must not be punctured. RF cables have to be separated from the obstruction light power cable by at least 6 inches. After the cables have be laid in place, lay #6 bare copper counterpoise on top of each 10-inch sandfill and back-fill to original grade.

NOTE 12 - Cables: All RF cables are air dielectric transmission lines. When “pulling in” the RF cable, care must be taken to ENSURE NO WATER is permitted to enter the cable ends and that the cable jackets ARE NOT PUNCTURED. Take care not to kink RF cables and to observe minimum bend radius. The cables run from the shelter to each location as shown in Figure 9-1. Cable ends should extend 7 feet out of each trench to allow for antenna position adjustments during optimization or to accommodate a change in the station frequency assignment. Each end should be protected by a 2-foot sleeve of 1-1/2 inch PVC plastic pipe, or equivalent, where the cable exits the ground.

Table 9-3. Cable Information

NOMENCLATURE	TYPE	FEET	MIN BEND RADIUS
REAR FEED, R	7/8 DIA., HJ5-50	240-270	10 in.
FRONT FEED, F	7/8 DIA., HJ5-50	SEE NOTES 11, 12	10 in.
CLEARANCE FEED, C	7/8 DIA., HJ5-50	80-140	10 in.
FIELD MONITOR, M1	1/2 DIA., HJ4-50	600-635	5 in.
FIELD MONITOR, M2	1/2 DIA., HJ4-50	620-670	5 in.
FIELD MONITOR, M3	1/2 DIA., HJ4-50	635-700	5 in.
INTEGRAL MONITOR REAR, MR	1/2 DIA., HJ4-50	280-320	5 in.
INTEGRAL MONITOR FRONT, MF	1/2 DIA., HJ4-50	SEE NOTES 11, 12	5 in.
INTEGRAL MONITOR CLEARANCE, MC	1/2 DIA., HJ4-50	80-140	5 in.
OBST.LT., R, F, MR, MF, M1, M3 (RWY END)	#12-3UF	____	____

NOTE

The End-Fire system can be viewed as a system of cables. The quality, precision, and uniformity of the cable lengths and their installation can greatly affect the overall stability of the system.

Cables should be as short as possible while allowing comfortable routing and maintenance of the system. Any system modification that would result in longer cable lengths should be discussed with the manufacturer.

Main Antenna feedlines R and F are considered matched pairs and MUST BE replaced at the same time and from the same roll of cable.

Monitor Antenna feedlines MR and MF are considered matched pairs and MUST BE replaced at the same time and from the same roll of cable.

The lengths of the Field Monitor lines M1, M2, and M3 as well as Clearance feed and monitor lines C and MC are not critical.

The coiling and/or burying of excess cable WILL adversely affect system stability and MUST BE removed.

Excess cable MUST BE removed while maintaining equal lengths for the main antenna feed and monitor lines: F = R and MF = MR.

The purchase of the “phase stabilized” version of the main antenna feed and monitor lines F, R, MF, and MR respectively, will improve the antenna systems initial stability. Consult with the cable manufacturer for the availability of phase stabilized version of the cable identified in Table 9-3.

NOTE 13 - Finish: Restore area to grade and remove surplus material. Treat the soil around each group of pilings to a radius of 6 feet with a commercial weed killer to completely eliminate vegetation. The weed killer and its application shall be approved by the resident engineer. Once the weed killer has been effective, cover the same area with limestone gravel with a height not exceeding the top of the concrete pilings. Alternatively, pave with asphalt.

NOTE 14 - Tolerances: Unless otherwise specified, tolerance on dimensions less than 250 feet is plus or minus 1 inch. Larger dimensions have a tolerance of 0.5 percent.

9.4 ANTENNA INSTALLATION.- The step-by-step procedures and figures included in this section provide the instructions for assembling the antenna supports and mounting the antennas. In addition to common hand tools, the following tools are necessary for antenna assembly:

1 open end wrench, 1-1/2 inch
1 open end wrench, 1 inch
1 open end wrench, 3/4 inch
1 steel measuring tape, 200 foot, divided into feet and inches
1 battery powered 3/8 inch drill with a #2 phillips screwdriver bit
1 #2 phillips screwdriver
1 1/4 inch slotted screwdriver
1 post level
1 megger (for checking cable)
1 Soldering torch
1 Roll of emery-cloth sandpaper
1 Tin of soldering paste
1 Roll of solder

9.4.1 Unpacking Procedures.- The system is supplied in packages, with contents listed on each package, as detailed in the packing list, Table 9-4. The packages are all wood boxes as noted on the list. A battery powered 3/8 inch drill with a #2 phillips bit is needed to remove the screws from the box lid so the contents of the boxes can be removed at the appropriate time. The boxes containing the Interface Unit EF9 and the Test Probe EF10 should be opened and stored indoors out of the weather. The remaining boxes may be stored outdoors at a central location on site, to be opened as needed.

Table 9-4. Packing List, Model 105 EFGS Antenna System

PC	TP	QTY	CONTENTS	L,W,H (IN.)	LBS
1	BX	4	L-906-55 ANTENNA SECTION MAIN	190, 16, 6	190
2	BX	4	L-906-55 ANTENNA SECTION MAIN	190, 16, 6	190
3	BX	4	L-906-55 ANTENNA SECTION MAIN	190, 16, 6	190
4	BX	4	L-906-55 ANTENNA SECTION MAIN	190, 16, 6	190
5	BX	1	L-943-57 ANTENNA SECTION CLEARANCE	190, 8, 6	120
		1	B-906-37 INPUT ADAPTER		
		1	B-906-40 OUTPUT ADAPTER		
6	BX	3	L-906-57 ANTENNA SECTION MONITOR	114, 10, 6	100
7	BX	23	A-906-82 PEDESTAL ASSEMBLY	51, 23, 22	145
		1	B-906-37 INPUT ADAPTER		
		1	B-906-40 OUTPUT ADAPTER		
8	BX	23	A-906-82 PEDESTAL ASSEMBLY	51, 23, 22	145
		1	B-906-37 INPUT ADAPTER		
		1	B-906-40 OUTPUT ADAPTER		
9	BX	46	A-906-76 BRACE	51, 23, 22	120
		50	H-10SS HOSE CLAMP		
		30	W1022 COUPLING, TUBE		
10	BX	20	A-906-26 SPACER ASSEMBLY	35, 14, 7	70
11	BX	20	A-906-26 SPACER ASSEMBLY	35, 14, 7	70
12	BX	24	B24-48 CHANNEL (48’’)	52, 10, 7	150
13	BX	24	B24-48 CHANNEL (48’’)	52, 10, 7	150
14	BX	24	B24-48 CHANNEL (48’’)	52, 10, 7	150
15	BX	20	B24-48 CHANNEL (48’’)	52, 10, 7	150
16	BX	2	B54-100 CHANNEL (100”)	100, 4, 3	134
		3	B54-84 CHANNEL (84”)		
		2	B54-64 CHANNEL (64”)		
17	BX	23	B54SH-6-HDG CHANNEL (6")	35, 14, 7	150
		23	B24-11 CHANNEL (11")		
		280	HHCS1/2X1 BOLT, HEX HEAD		
		280	TN525 NUT, PLAIN HEXAGON		
		39	B2015 HANGER, PIPE		
		46	HHCS1/2X1-1/4 BOLT, HEX HEAD W/FLAT WASHER AND HEX NUT W/ NYLON INSERT		
18	BX	23	B54SH-6-HDG CHANNEL (6")	35, 14, 7	150
		23	B24-11 CHANNEL (11")		
		280	HHCS1/2X1 BOLT, HEX HEAD		
		280	TN525 NUT, PLAIN HEXAGON		
		39	B2015 HANGER, PIPE		
		46	HHCS1/2X1-1/4 BOLT, HEX HEAD W/FLAT WASHER AND HEX NUT W/ NYLON INSERT		
19	BX	46	B162 BRACKET, ANGLE, 30 DEG.	35, 14, 7	124
		46	B159 BRACKET, ANGLE, 30 DEG.		
		106	B101 BRACKET, ANGLE, 90 DEG.		
		7	B129 TWO-HOLE SPLICE		
		6	A-906-26 SPACER ASSEMBLY		
20	BX	200	B105 BRACKET, ZEE	35, 14, 7	122

Table 9-4. Packing List, Model 105 EFGS Antenna System

PC	TP	QTY	CONTENTS	L,W,H (IN.)	LBS
21	BX	21	M-1/2 TUBE, COPPER, 20 FT	240, 4, 3	80
22	BX	18	M-1/2 TUBE, COPPER, 20 FT	240, 4, 3	75
		9	M-1/2 TUBE, COPPER, 10 FT		
23	BX	6	OB22WC31 OBSTRUCTION LIGHT, DUAL	35, 28, 15	62
		12	116W120V LAMP, 120V		
		6	B54SH-8-HDG CHANNEL (8”)		
		12	B2029 CLAMP		
		6	78-0020-00441 CONDUIT W/BUSHING 1223		
24	BX	184	B700-J4 BOLT, ANCHOR	35, 14, 7	100
		184	MS51967-14 NUT, HEX, 1/2 X 13		
		368	FW1/2 WASHER, FLAT, 1/2"		
25	BX	1	A-906-96-105 INTERFACE UNIT, MODEL 105	35, 28, 15	100
		1	A-906-100 PC BOARD, SYNC, (SPARE)		
		1	A-906-103 PC BOARD, CHAN, (SPARE)		
		1	A-906-178 EXTENDER BOARD, SYNC		
		1	A-906-179 EXTENDER BOARD, CHAN		
		1	A-906-118 CABLE ASSY W5, (CLR MIX)		
		2	INSTRUCTION BOOKS		
		1	TEST DATA		
		1	PACKING LIST		
26	BX	1	L-906-65 TEST PROBE	40, 30, 10	50
		1	A-937-117 PIGTAIL CABLE KIT:		
		50 ft	FSJ1-50A HELIAX CABLE		
		1	MCPT-1412 ESIAX PREP TOOL CUTTER		
		1	A-937-118 PIGTAIL LABEL KIT FOR:		
			W4 CABLE RF (FRONT ANT OUT)		
			W8 CABLE RF (REAR ANT OUT)		
			W11 CABLE RF (CLR ANT OUT)		
			W24 CABLE RF (MF)		
			W25 CABLE RF (MR)		
			W26 CABLE RF (MC)		
			W27 CABLE RF (M1)		
			W29 CABLE RF (M2)		
			W31 CABLE RF (M3)		
		17	7-10-63 CONNECTOR N MALE		
		1	5-10-604 CONNECTOR TNC MA.		
		1	W34, WIRE, POWER LEAD (RED)		
		1	W35, WIRE, POWER LEAD (BLACK)		
		20	25436-68 CONNECTOR, AIR, MALE 1/8”NPT		
		50 ft	25435-5 AIR TUBE 3/8” POLYETHELYNE		

9.4.2 Antenna Support Assembly.- Before starting actual assembly, study the following figures:

Figure 9-7 - Pedestal/Spacer Assembly
Figure 9-8 - Antenna Support, Front View
Figure 9-9 - Antenna Orientation
Figure 9-10 - Antenna Support, Rear View

9.4.2.1 Pedestal/Spacer Assembly.- All 46 of these assemblies should be made at the central site location.

a. Refer to Figure 9-7.

b. Start with an A-906-82 PEDESTAL ASSEMBLY at the end having the filler block retaining screw.

c. Using a B2015 HANGER, PIPE, loosely clamp a B24-11 CHANNEL, 11" to the pedestal, leaving a 1-1/4 inch space to the end as shown.

d. Center the pipe hanger on the channel.

e. Rotate the pipe hanger on the PEDESTAL ASSEMBLY to line up the filler block retaining screw with the pipe hanger slot as shown.

f. Tighten the pipe hanger securely.

g. Using a HHCS1/2X1 BOLT, HEX HEAD and a TN525 NUT, PLAIN HEXAGON, fasten the short end of a B162 BRACKET, ANGLE, 30 DEG. to the center hole of a short perforated channel B54SH-6-HDG CHANNEL 6".

h. Orient the angle bracket perpendicular to the channel and tighten the bolt securely.

i. Insert an A-906-26 SPACER ASSEMBLY into the top of the pedestal as far as it will go, rotating it to align with the filler block retaining screw as shown.

j. Using another B2015 HANGER, PIPE, loosely clamp the angle bracket/channel assembly to the antenna pedestal, centering the pipe hanger on the assembly, and leaving a 4-1/2 inch space to the end of the antenna pedestal as shown.

k. Rotate the angle bracket/channel assembly into alignment with the lower assembly as shown.

l. Tighten the pipe hanger securely.

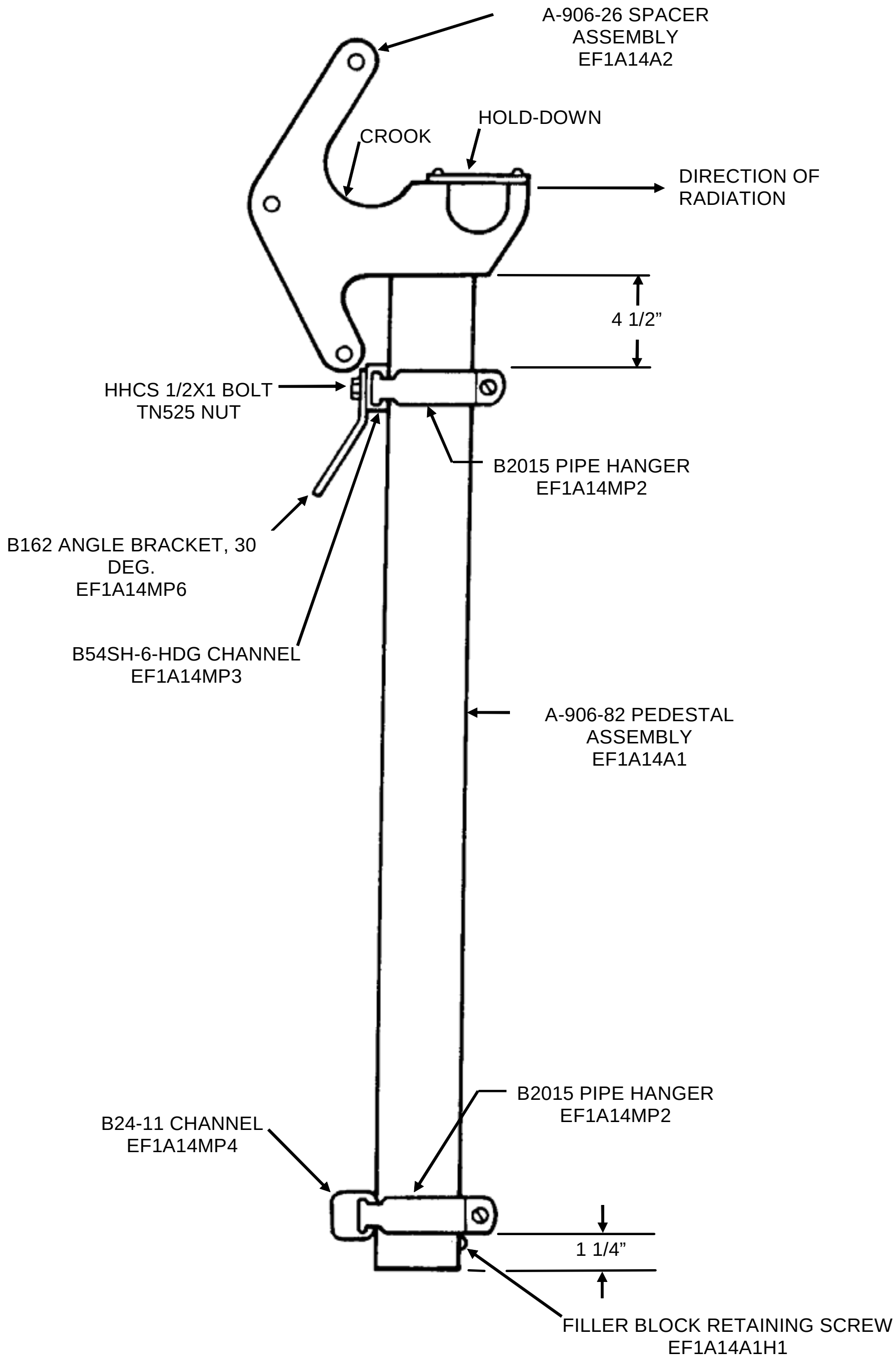


Figure 9-7. Pedestal/Spacer Assembly

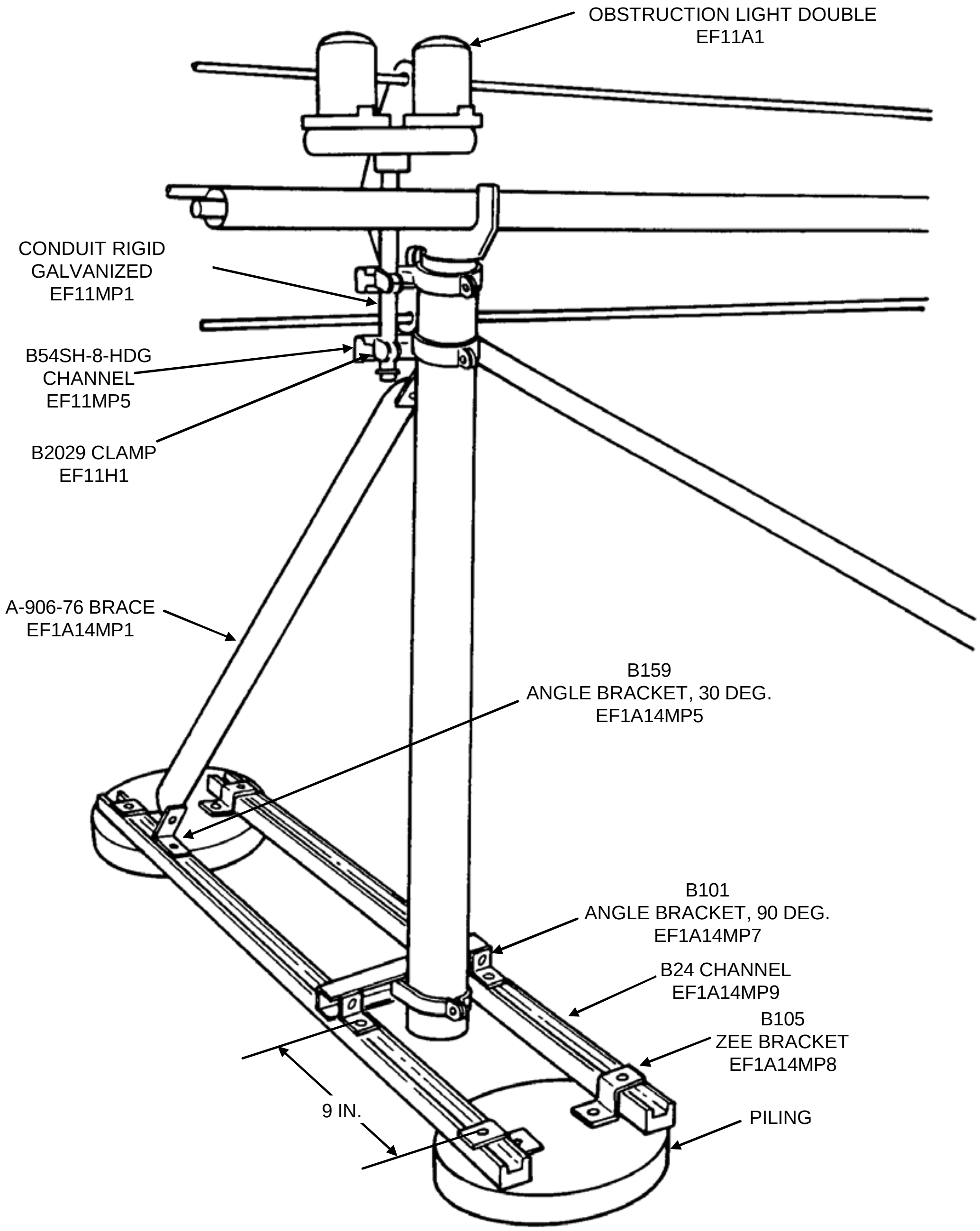


Figure 9-8. Antenna Support, Front View (Including Obstruction Light)

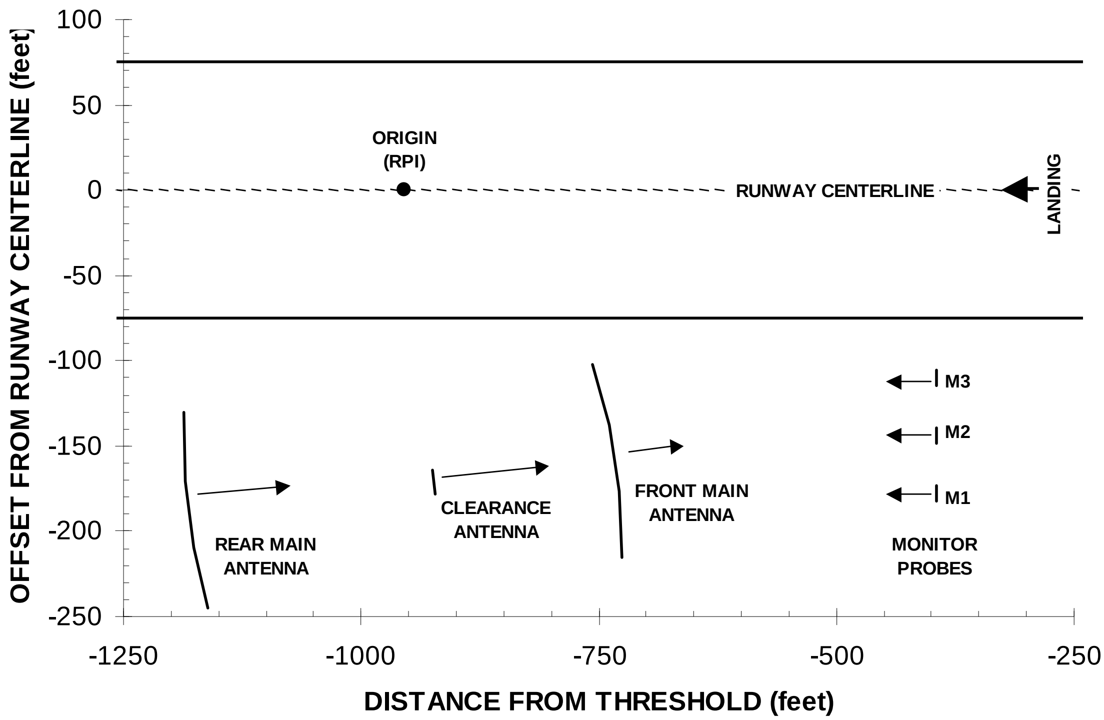


Figure 9-9. Antenna Orientation

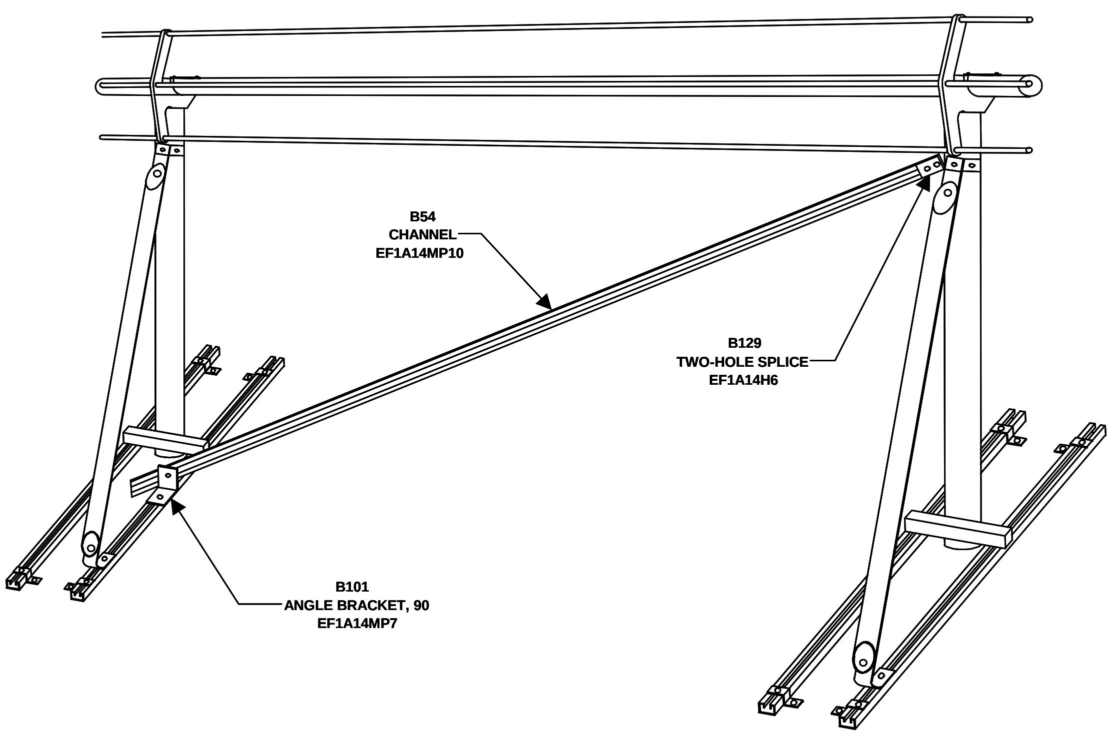


Figure 9-10. Antenna Support, Rear View (Including Transverse Brace)

9.4.2.2 Antenna Pedestal Set-Up.- The following procedure applies to all 46 antenna pedestals. Obstruction lighting and transverse bracing will be added later to some of the antenna pedestals.

a. Refer to Figures 9-8 and 9-9.

b. To each pair of pilings, loosely attach four B105 ZEE BRACKETs using with each an MS51967-14 NUT, HEX, 1/2-13 and two FW1/2 WASHERs, FLAT, 1/2" (supplied with the anchor bolts). Place flat washers under the zee brackets.

c. To the zee brackets, loosely attach two B24-48 CHANNELs as shown, using four HHCS1/2X1 BOLTs, HEX HEAD and four TN525 NUTs, PLAIN HEXAGON.

d. Tighten the nuts and bolts securely using the 3/4 inch wrench.

e. On the two channels, set-up an antenna pedestal/spacer assembly, fastening loosely with two B101 BRACKET, ANGLE, 90 DEG. using four HHCS1/2X1 BOLTs, HEX HEAD and four TN525 NUTs, PLAIN HEXAGON as shown. Observe the proper orientation as shown in Figure 9-8.

f. Slide the antenna pedestal/spacer assembly on the channels as required to obtain the 9-inch hole-to-hole spacing shown in Figure 9-8, with orientation shown in Figures 1-2 and 9-9, and then tighten the bolts securely using the 3/4 inch wrench.

g. Attach a B159 BRACKET, ANGLE, 30 DEG. loosely to a channel as shown using a HHCS1/2X1 BOLT, HEX HEAD and a TN525 NUT, PLAIN HEXAGON.

h. Attach an A-906-76 BRACE, ANTENNA between the angle brackets using two HHCS1/2X1-1/4 BOLTs, HEX HEAD, two UNDERSIZED WASHERs, FLAT, and two NYLON INSERT LOCK NUTs, HEXAGON.

i. Plumb the antenna pedestal by placing the post level just below the upper B2015 pipe hangar and sliding the B159 BRACKET, ANGLE, 30 DEG. forward or backward as necessary on the channel, then tighten the bolts securely using the 3/4 inch wrench.

9.4.3 Transverse Bracing.- Only seven of the 46 antenna pedestals receive transverse bracing: one on each of the main antennas, two on the clearance antenna, and one on each monitor antennas. The remainder of the antenna pedestals are braced transversely simply by being fastened to the antenna radomes. The following steps should be taken to install the transverse steel channel braces.

a. Refer to Figure 9-10 and Figure 9-15.

b. At the top of antenna pedestal number 9 of the FRONT MAIN antenna, attach one end of a B54-100 CHANNEL, as shown, to the end hole in the short channel. The connection is made using a B129 TWO HOLE SPLICE with two HHCS1/2X1 BOLTs, HEX HEAD and two TN525 NUTs, PLAIN HEXAGON. Orient the two-hole splice in line with the channel as shown.

c. Attach the lower end of the transverse brace loosely to the channel at the base of the adjacent antenna pedestal, as shown, using a B101 BRACKET, ANGLE, 90 DEG. with two HHCS1/2X1 BOLTs, HEX HEAD and two TN525 NUTs, PLAIN HEXAGON.

d. Adjust the brace to plumb antenna pedestal number 9. The post level should be used to plumb the pedestal. Once the pedestal is plumb, tighten the upper and lower connections of the transverse brace securely with the 3/4 wrench.

e. Repeat steps a. through d. for the REAR MAIN antenna.

f. At the top of antenna pedestal numbers 1 and 4 of the CLEARANCE antenna, attach one end of a B54-64 CHANNEL, as shown, to the end hole in the short channel. Antenna pedestal 1 is furthest from the runway and pedestal 4 is closest to the runway. Each connection is made using a B129 TWO HOLE SPLICEs with two HHCS1/2X1 BOLTs, HEX HEAD and two TN525 NUTs, PLAIN HEXAGON. Orient the two-hole splice in line with the channel as shown.

g. Attach each lower end of the transverse braces loosely to the channel at the bases of antenna pedestal numbers 2 and 3 respectively, as shown. Each connection is made using a B101 BRACKET, ANGLE, 90 DEG. with two HHCS1/2X1 BOLTs, HEX HEAD and two TN525 NUTs, PLAIN HEXAGON.

h. Adjust the braces to plumb the antenna pedestals. The post level should be used to plumb the pedestal. Once the pedestal is plumb, tighten the upper and lower connections of the transverse brace securely with the 3/4 wrench.

i. For each of the three FIELD MONITOR antennas proceed in the same fashion, using B54-84 CHANNEL for the transverse bracing. For M1 and M3, which each have an obstruction light, install the brace to the top of the antenna pedestal carrying the light.

9.4.3.1 Obstruction Lights.- Only six of the antenna pedestals receive obstruction lights: numbers 1 and 18 for both front and rear main antennas, monitor M3, closest to the runway, and monitor M1, farthest from the runway.

a. Refer to Figure 9-8 for typical installation.

b. Replace the short upper cross channel with the longer B54SH-8-HDG CHANNEL, 8 LG from the obstruction light kit, extended toward the outside as shown.

c. Screw the OB22WC31 OBSTRUCTION LIGHT KIT, DUAL onto a 78-0020-00441 CONDUIT and fasten the conduit, top and bottom, to the pedestal assembly cross channels using two B2029 CLAMPs as shown.

d. Orient the power cable from the trench for proper lead-in to the CONDUIT. Assure that the alignment is accurate to avoid future antenna adjustments that may require sliding the whole antenna pedestal assembly forward or backward a few inches.

e. Tighten the conduit clamps securely.

9.4.4 Front and Rear Main Antenna Installation.- After the antenna supports are assembled, each L-906-55 ANTENNA SECTION MAIN may be carried into position, eight for the rear main antenna and eight for the front main antenna. The antenna sections MUST BE placed in order as the taper screws have already been installed at the factory. Consult Figure 9-11 to identify the feed end of a section. Lay the sections loosely in the supports in the larger crook area behind the U-shaped recess with the feed ends positioned away from the runway.

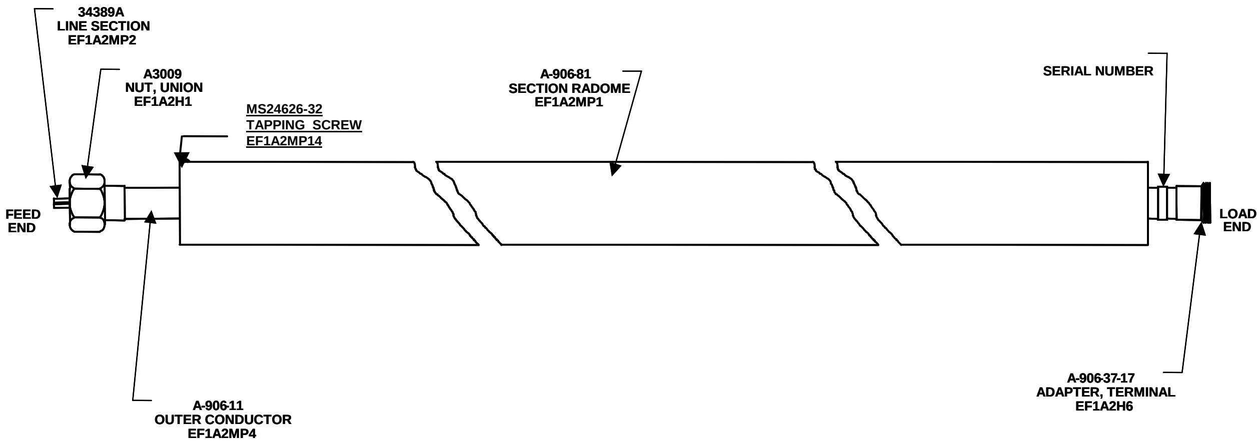


Figure 9-11. Main Antenna Section, L-906-55, EF1A2

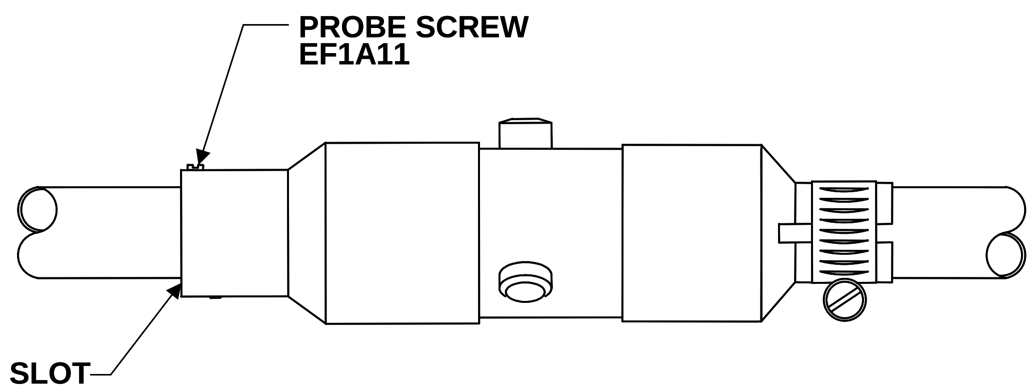


Figure 9-12. Radiating Structure Showing Probe Screw and Slot (Radome Removed)

9.4.4.1 Identification of Sections.- The main antenna sections are all identical and interchangeable except for the slot probe screws (see Figure 9-12). In order to suppress minor lobes, the slots nearer the ends of the antenna must radiate less than the slots in the middle. This is accomplished by tapering off the lengths of the screws toward the ends. In this system, the taper screws have been installed at the factory. This means that the sections must be identified by serial number and installed in the order specified on the packing list. The proper location for each serial number should also be recorded in Figure 9-13. The serial number for each section is found on the 7/8 inch diameter copper outer conductor at the load (runway) end.

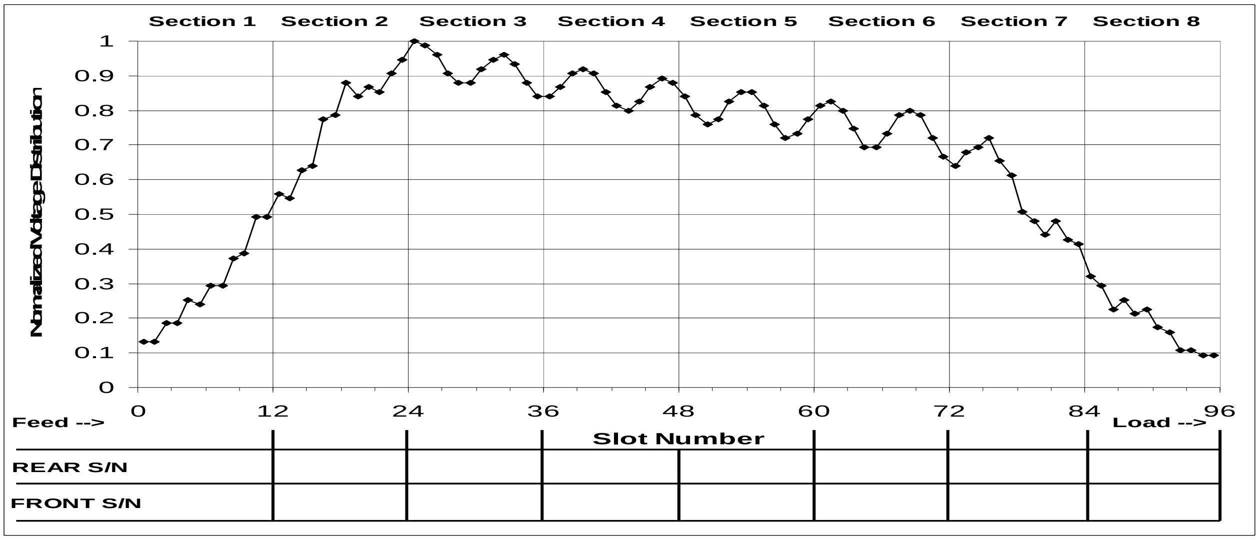


Figure 9-13. Identification of Sections by Serial Number and Locations

9.4.4.2 Probe Screw Lengths .- Table 9-5 shows the main antenna taper screw lengths. The screw length used in the main antenna uniform sections (sections 3, 4, 5, and 6) is 0.625 inches. Table 9-6 shows the lengths of the screws used in the clearance antenna, and Table 9-7 shows the lengths of the screws used in the field monitors. Probe screw lengths are supplied for reference only and will not need to be consulted in a normal installation.

Table 9-5. Taper Screw Set, A-906-64

SECTION	SLOT NUMBER FROM FEED END	LENGTH, IN.	SLOT NUMBER FROM LOAD END	SECTION
1	1	0.403	24	8
1	2	0.403	23	8
1	3	0.419	22	8
1	4	0.419	21	8
1	5	0.438	20	8
1	6	0.438	19	8
1	7	0.459	18	8
1	8	0.459	17	8
1	9	0.482	16	8
1	10	0.482	15	8
1	11	0.507	14	8
1	12	0.507	13	8
2	13	0.532	12	7
2	14	0.532	11	7
2	15	0.556	10	7
2	16	0.556	9	7
2	17	0.579	8	7
2	18	0.579	7	7
2	19	0.598	6	7
2	20	0.598	5	7
2	21	0.612	4	7
2	22	0.612	3	7
2	23	0.621	2	7
2	24	0.621	1	7

Table 9-6. Clearance Antenna Probe Screw Set, A-943-64

SLOT NUMBER FROM FEED END	LENGTH, IN.
1	0.283
2	0.717
3	0.283
4	0.283
5	0.746
6	0.501
7	0.746
8	0.746
9	0.283
10	0.436
11	0.746
12	0.615

Table 9-7. Field Monitor Antenna Probe Screw Set, A-906-57

SLOT NUMBER FROM FEED END	LENGTH, IN.
1	0.438
2	0.556
3	0.865
4	0.865
5	0.556
6	0.438

9.4.4.3 Joining of Sections.- This operation comprises joining the eight sections of each main antenna, together with the input and output adapters necessary for connection to the buried RF semi-rigid cables. The procedure is best done with the sections resting in the crook behind the hold-down bar of the plastic spacers, as shown in Figure 9-7.

CAUTION

Severe over-tightening of the copper unions may result in deforming the fittings and damage to the outer conductor of the antenna sections.

NOTE

The 3/4 copper unions that join adjacent antenna sections and the end adapters are not supposed to require a sealant. However, air leaks may exist due to main antennas being positioned to form an arc. To eliminate the possibility of leakage, use either Teflon tape or a plumbing sealant on the threads of each union. In some cases, Teflon tape or sealant may also be required on the raised copper stop flange for the nut. If using Teflon tape, the tape should be wrapped in a direction so that tightening the fitting will not cause the tape to unwrap. When selecting a sealant, use standard plumbing sealants and be sure that the material will not set-up to form an adhesive that would later hinder the ability to disconnect the antennas. UNDER NO CIRCUMSTANCES should the sealant be applied to the beveled flanges of the union that serve as the antenna coaxial ground connection.

a. Refer to Figures 9-11 and 9-13.

b. Carefully connect the A-906-37 INPUT ADAPTER feed to the end of the rear main antenna section number 1. Ensure that the gas pass line section (bullet) does not miss the inner conductor and enter the space between the inner and outer conductors.

c. Thread the loose union nut on the antenna section input onto the mating union seat on the outer conductor of the input adapter.

d. Tighten the union nut and union seat securely using a 1-1/2 inch open-end wrench and a 1 inch open-end wrench with the EIA standard 7/8-inch flange of the input adapter pointing toward the ground.

e. Repeat steps b. through d. for sections 2 through 8, connecting the load end of one antenna section to the feed end of the next antenna section. Push the sections into a fair curve as the couplings are tightened.

NOTE

> The slot numbers on the radomes should be upward facing and in alignment with adjacent radome slot numbers.

f. In the same manner as with the input adapter in steps b, c and d, join a B-906-40 OUTPUT ADAPTER to the load end of section 8, with the EIA standard 7/8-inch flange of the output adapter pointing toward the ground.

g. Repeat steps a. through f. for the front main antenna.

9.4.4.4 Installation of Antennas in Supports.- At this stage, the main antennas are complete units, resting in the crooks of the spacer assemblies.

a. At every spacer assembly, temporarily remove the rear screw from the hold-down bar (using the #2 phillips screwdriver) (see Figure 9-7) and loosen the front screw sufficiently to rotate the hold-down bar forward out of the way.

b. Move each antenna out of the crook and into its U-shaped recess in the antenna spacer.

c. Position each antenna transversely to center it overall, and plumb the pedestals.

d. Orient the antenna slightly forward from vertical and toward the threshold, ensuring that the slot numbers are visible by field personnel standing in front of the antenna to measure the slot distribution with the field probe.

e. Reinstall the hold-down bars. Tighten the screws firmly, but do not strip the threads in the plastic.

f. Carefully prepare the semi-rigid cable ends for installation of the gas pass EIA standard 7/8-inch flange connectors by straightening the cable where the cable will be cut. Allow enough slack to permit the possibility of 12 inches of movement of the end pedestals in either direction.

g. Bend the cable downward while cutting to ensure that metal shavings will drop into the section of cable being removed.

NOTE

> Cutting the cable on a bend will result in misalignment when the connector is installed.

h. After cutting and preparing the cable ends, ENSURE that there are no loose shavings or metal shavings bridging the inner and outer conductors.

i. Install the gas pass EIA standard 7/8-inch flange connectors onto the system cables in accordance with the connector manufacturer's instructions.

j. After installing the connectors, visually inspect inside the connectors to ensure that the gas pass openings are not obstructed. This is a convenient time to meg the 7/8 inch cable to double-check that the inner and outer conductors are not shorted. If the inner and outer conductors are shorted, it is likely that it is due to metal filings from the connector installation. Connector removal may be necessary to remove the filings.

k. Connect the EIA flange from the RF cables to the EIA standard 7/8-inch flanges of the input and output adapters, following the instructions provided with the cable connectors.

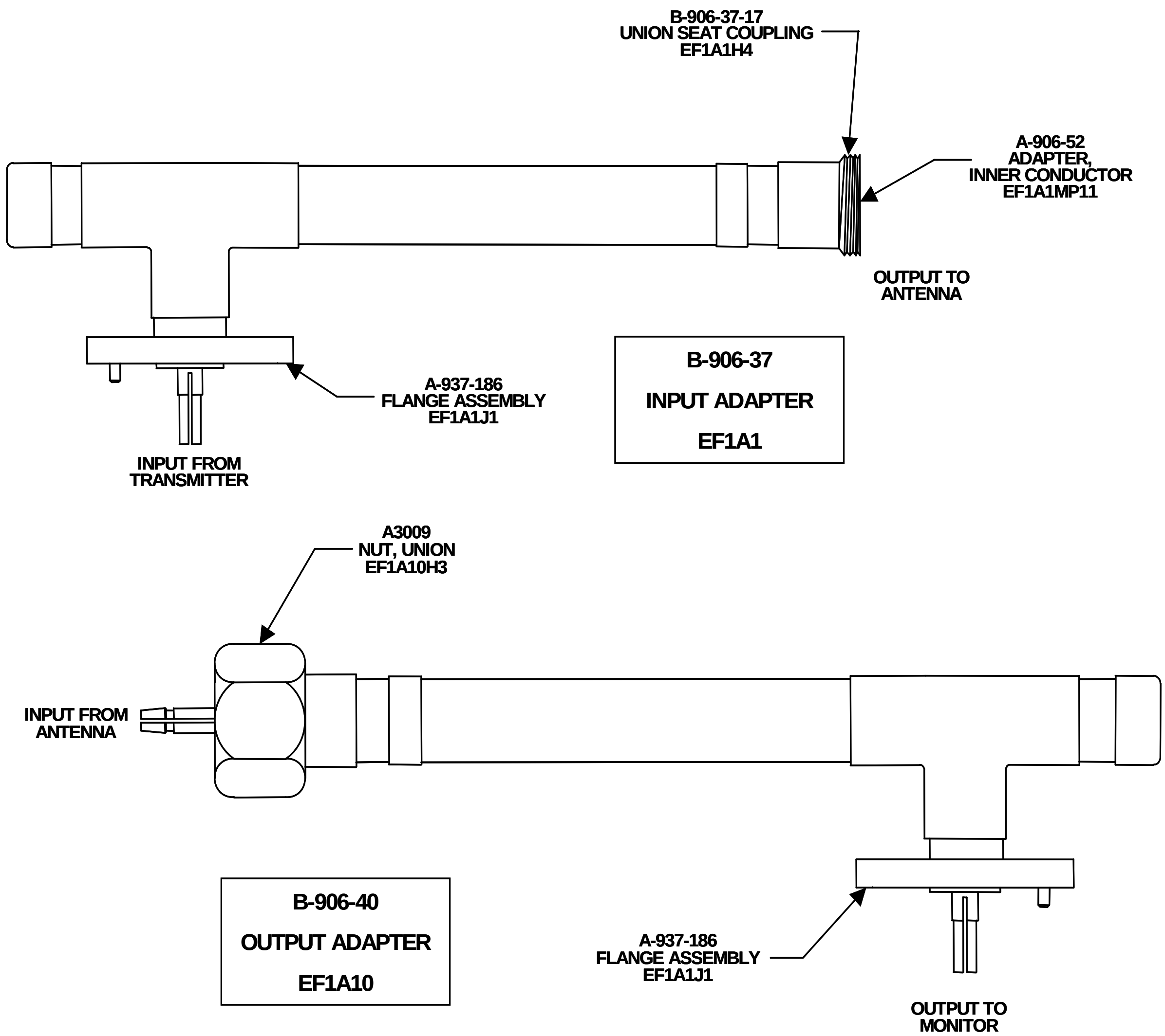


Figure 9-14. Front and Rear Main Antenna, and Clearance Antenna Input and Output Adapters

<u>9.4.5</u> <u>Clearance Antenna Installation</u>.- The clearance antenna (C) uses a single pre-assembled L-943-57 CLEARANCE ANTENNA connected at the feed end by one B-906-37 INPUT ADAPTER and the return line end by one B-906-40 OUTPUT ADAPTER and supported by four pedestal and spacer assemblies and two B-54-64 TRANSVERSE BRACES. See Figure 9-15. The mounting instructions are as follows:

a. At every spacer, use the #2 phillips screwdriver to remove temporarily the rear screw from the hold-down bar and loosen the front screw sufficiently to rotate the hold-down bar forward out of the way.

b. Place the single clearance antenna in the U-shaped recess of the antenna spacers with the element centered between pedestals 1 and 4 and with slot 1 on the radome farthest from the runway.

c. Orient the clearance antenna so that the slot numbers on the radome are slightly forward from vertical and toward the threshold, ensuring that the slot numbers are visible by field personnel standing in front of the antenna to measure the slot distribution with the field probe.

d. Plumb the pedestals with the post level and reinstall the hold-down bars using the #2 phillips screwdriver. Tighten the screws firmly, but do not strip the threads in the plastic.

e. Carefully connect the A-906-37 INPUT ADAPTER feed to the clearance antenna end farthest from the runway. ENSURE that the gas pass line section (bullet) does not miss the inner conductor. It should not enter the space between the inner and outer conductors.

f. After applying Teflon tape, thread the loose union nut on the clearance antenna input onto the mating union seat on the outer conductor of the input adapter.

g. Tighten the union nut and union seat securely using a 1-1/2-inch open-end wrench and a 1 inch open-end wrench with the EIA standard 7/8-inch flange of the input adapter pointing toward the ground.

h. Carefully connect the B-906-40 OUTPUT ADAPTER to the clearance antenna end closest to the runway. ENSURE that the gas pass line section (bullet) does not miss the inner conductor. It should not enter the space between the inner and outer conductors.

i. After applying Teflon tape, thread the loose union nut on the output adapter onto the mating union seat on the clearance antenna.

j. Tighten the union nut and union seat securely using a 1-1/2-inch open-end wrench and a 1 inch open-end wrench with the EIA standard 7/8-inch flange of the output adapter pointing toward the ground.

k. Carefully prepare the semi-rigid cable ends for installation of the gas pass EIA standard 7/8-inch flange connectors by straightening the cable where the cable will be cut. Allow enough slack to permit the possibility of 12 inches of movement of the end pedestals in either direction.

l. Bend the cable downward while cutting to ensure that metal shavings will drop into the section of cable being removed.

NOTE

Cutting the cable on a bend will result in misalignment when the connector is installed.

m. Install the gas pass EIA standard 7/8-inch flange connectors onto the system cables in accordance with the connector manufacturer's instructions.

n. After installing the connectors, visually inspect inside the connectors to ensure that the gas pass openings are not obstructed. This is a convenient time to meg the 7/8 inch and 1/2 inch cable to double-check that the inner and outer conductors are not shorted. If the inner and outer conductors are shorted, it is likely that it is due to metal filings from the connector installation. Connector removal may be necessary to remove the filings.

o. Connect the EIA flange from the RF cables to the EIA standard 7/8-inch flanges of the input and output adapters, following the instructions provided with the cable connectors.

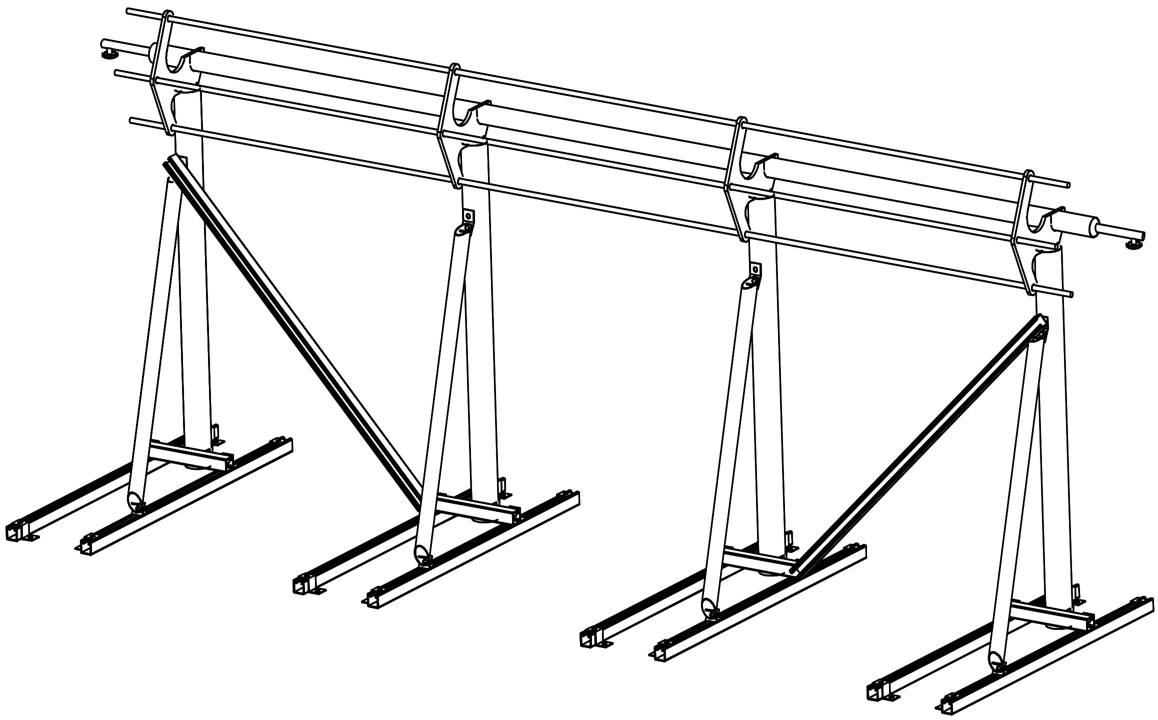


Figure 9-15. Antenna Clearance, Rear View

9.4.6 Monitor Antenna Installation.- The monitor antennas (M1, M2, and M3) each use a single identical pre-assembled L-906-57 ANTENNA SECTION MONITOR. The mounting instructions are as follows:

a. At every spacer, use the #2 phillips screwdriver to remove temporarily the rear screw from the hold-down bar and loosen the front screw sufficiently to rotate the hold-down bar forward out of the way.

b. Lay an antenna in the U-shaped recess of the antenna spacers in each location, positioning the input end away from the runway and centering the antenna transversely with respect to the pedestals. Orient the EIA standard 7/8-inch flange of the antenna toward the ground.

c. Plumb the pedestals using the post level and reinstall the hold-down bars using the #2 phillips screwdriver. Tighten the screws firmly, but do not strip the threads in the plastic.

d. Carefully prepare the semi-rigid cable ends for installation of the gas pass EIA standard 7/8-inch flange connectors by straightening the cable where the cable will be cut. Allow enough slack to permit the possibility of 12 inches of movement of the pedestals in either direction.

e. Bend the cable downward while cutting to ensure that metal shavings will drop into the section of cable being removed.

NOTE

Cutting the cable on a bend will result in misalignment when the connector is installed.

f. After cutting and preparation of the cable ends, ENSURE that there are no loose shavings or metal shavings bridging the inner and outer conductors.

g. Install the gas pass EIA standard 7/8-inch flange connectors onto the system cables in accordance with the connector manufacturer's instructions.

h. After installing the connectors, visually inspect inside the connectors to ensure that the gas pass openings are not obstructed. This is a convenient time to meg the 1/2 inch cable to double-check that the inner and outer conductors are not shorted. If the inner and outer conductors are shorted, it is likely that it is due to metal filings from the connector installation. Connector removal may be necessary to remove the filings.

i. Connect the EIA flange from the RF cables to the EIA standard 7/8-inch flanges of the field monitor antennas, following the instructions provided with the cable connectors.

9.4.7 Antenna Reflector Installation.- The antenna reflector rods are constructed of 1/2-inch Type M hard-drawn copper tube. Assemble as follows:

a. In each main antenna, insert 18 M-1/2 TUBE, COPPER, 20 FT through the holes in the plastic antenna spacers until all positions are complete.

b. Join the lengths using 30 W1022 COUPLING. Use the emery-cloth sandpaper and solder paste to prepare the copper tubes prior to soldering. Solder couplings to copper tubes using the Soldering torch and solder.

c. At the clearance antenna, use the 3 M-1/2 TUBE, COPPER, 20 FT provided. No soldering is required.

d. At the monitor antennas, use the 9 M-1/2 TUBE, COPPER, 10 FT provided. No soldering is required.

e. Secure each reflector element using H10SS HOSE CLAMPs, installed as shown in Figure 9-16.

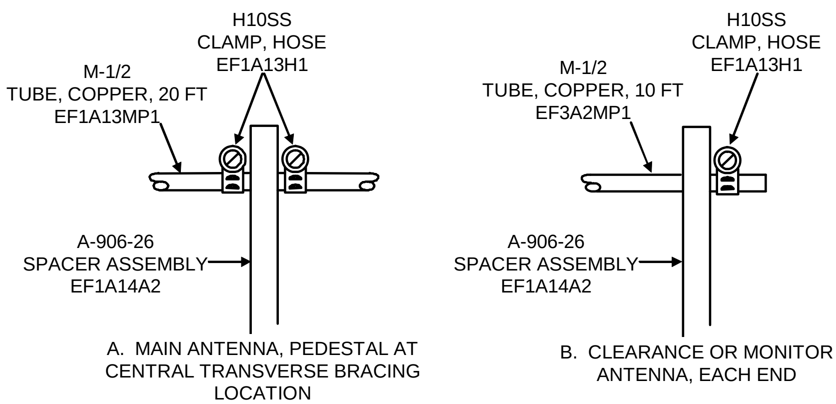


Figure 9-16. Typical Hose Clamp Installation for Securing Reflector Rods

9.4.8 RF Cable Terminations, Shelter.- The equipment shelter should be equipped with an outside junction box as shown in Figure 9-17. This junction box receives, from below, four rigid electrical conduits for the antenna cables and the AC power cables. Two electrical conduit openings in the rear of the box pass through the shelter wall and connect to the wall-mounted AC power panel inside the shelter. A third electrical conduit leads to the inside of the interface unit and is visible only when the interface unit door is open. The larger conduit is used to interconnect the interface unit input and output ports, via RF pigtail cables, to the pressurized feedlines. Air pressure lines are routed through the same opening as the pigtail cables. The feedline, monitor, and AC power cables are distributed to and from the antenna system through the four electrical conduits in the outside junction box as shown in Figure 9-18.

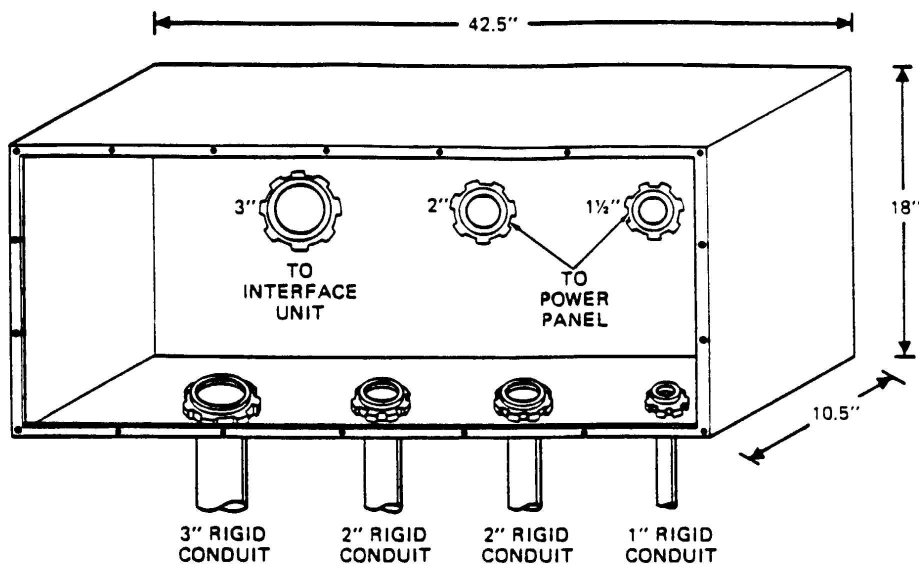


Figure 9-17. Outside Junction Box

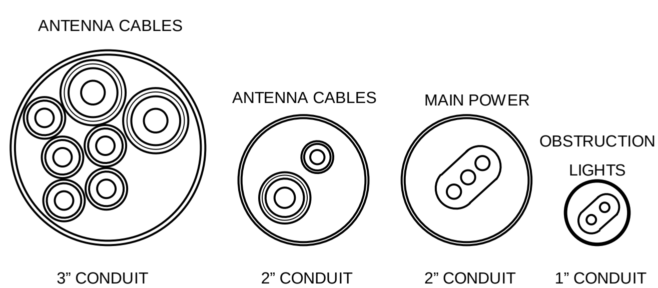


Figure 9-18. Distribution of Cables in Outside Junction Box Openings to Trench

9.4.8.1 RF Cable Terminations.- The following are step-by-step procedures required to establish the RF cable terminations at the shelter.

CAUTION

It may be necessary to deepen the trench in the area under the outside junction box in order to have working room. If this is done with the cables in place, remember that a light touch with a shovel can damage a cable. The trench must be deep enough to be able to move the cable bundles, enclosed in their conduits, down and then up into their respective openings in the bottom of the junction box. An alternative is to remove the outside junction box from the side of the building so that it can be dropped down from above onto the cable bundles.

a. Form the cables by hand into smooth bends leading up out of the trench. Observe the specified minimum bend radii of 10 inches for the 7/8-inch cable and 5 inches for the 1/2-inch cable.

b. Gather the cables by hand into straight vertical groups as indicated in Figure 9-18.

c. Wrap at several places with plastic strapping tape to hold the groups together.

d. Slide the 3-inch and 2-inch rigid (or plastic) conduits down over the cable bundles.

e. If the conduits do not slide easily down, do not use force as this will cause one or more of the cables to collapse. Remove the conduits and reform the cable bundles by hand. Repeat step d.

f. Holding the conduits in vertical position against the side of the junction box, mark the cables for cutting to length, making space allowances for the cable connectors (with elbows). Stagger the endings so as to have minimum physical interference between connectors.

g. Remove the conduits from the bundles and prepare the cable ends to receive the connectors (Type H5PNF 7/8-to-N female for the larger HJ5-50 feed cables and Type H4PNF 1/2-to-N female for the HJ4-50 monitor cables) in accordance with the manufacturer's instructions packed with each connector, but do not install the connectors.

h. Replace the conduits over the cable bundles, insert the bundles into the bottom of the junction box, and install the conduit nuts.

i. Bend the prepared cable ends slightly away from each other to allow room to install the connectors.

j. ENSURE that there are no loose shavings or metal shavings bridging the inner and outer conductors.

k. Install the appropriate connectors onto the system cables in accordance with the connector manufacturer's instructions.

l. After installing the connectors, visually inspect inside the connectors to ensure that the gas pass openings are not obstructed. This is a convenient time to meg each cable to double-check that the inner and outer conductors are not shorted. If the inner and outer conductors are shorted, it is likely that it is due to metal filings from the connector installation. Connector removal may be necessary to remove the filings.

9.5 INSTALLATION OF INTERFACE EQUIPMENT.- The installation of the EFGS antenna system is a replacement for the antenna system supplied with a capture effect glide slope station. Table 9-8 lists electronic equipment, or the equivalent normally supplied as part of the station, assumed to be installed and operational.

Table 9-8. Electronic Equipment Required

QUANTITY	NOMENCLATURE	Part Number** (Note 2)
1	Two-frequency Transmitting Electronics with Monitor Electronics and Power Supply	**
1	Glide Slope Clearance Detector * (Note 1)	**
3	Integral Detector * (Note 1)	**
1	End-Fire Glide Slope Interface Kit* (Note 1)	**

* NOTE 1. Some equipment manufacturers may have specialized detectors and/or an EFGS interface kit to connect with the antenna system. Detectors required include, path, width, quad (path 2) and clearance.

** NOTE 2. Consult the preferred equipment manufacturer for part numbers and interface instructions.

Integral Detector (GS13A1) with associated wiring harness W14 is also required. It provides a signal to the Glide Slope Monitor FA-9921, which would have been provided by the Monitor Detector Antenna FA-9927.

The following Mark 1F equipment, or the equivalent, which may be supplied as part of the station, is not required:

NOMENCLATURE	TYPE
Glide Slope Monitor Combining Network	FA-9926
Capture Effect Amplitude/Phase Control Unit (APCU)	FA-9928
Glide Slope Antenna	FA-9924
Glide Slope Tilt Monitor	FA-9925
Glide Slope Monitor Detector-Antenna	FA-9927

The interface unit accepts three transmit signals from the station equipment rack: CSB (carrier plus sideband), SBO (sideband only), and CLR (clearance). The signals are distributed to the appropriate transmitting antennas by the interface unit. The interface unit receives +25 to 30 VDC power from the station equipment rack.

The interface unit supplies to the station equipment rack four monitor signals: PATH 1 MON (integral path), QUAD MON (CSB/SBO quadrature phase), WIDTH MON (integral width), and CLR MON (integral clearance). The snap-down monitor, contained in the interface unit, alarms the station rack monitor by shutting off the CLR MON signal.

<u>9.5.1</u> <u>Interface Unit Installation</u>.- Figure 9-19 is a general view of the station equipment. The interface unit replaces the wall-mount inside junction box of a conventional capture effect station that typically contains the monitor combining network, path detector, width detector, clearance detector, path 2 detector (near-field monitor), transient suppressor, cabling, and other components. The following are step-by-step procedures for installing the End-Fire interface unit.

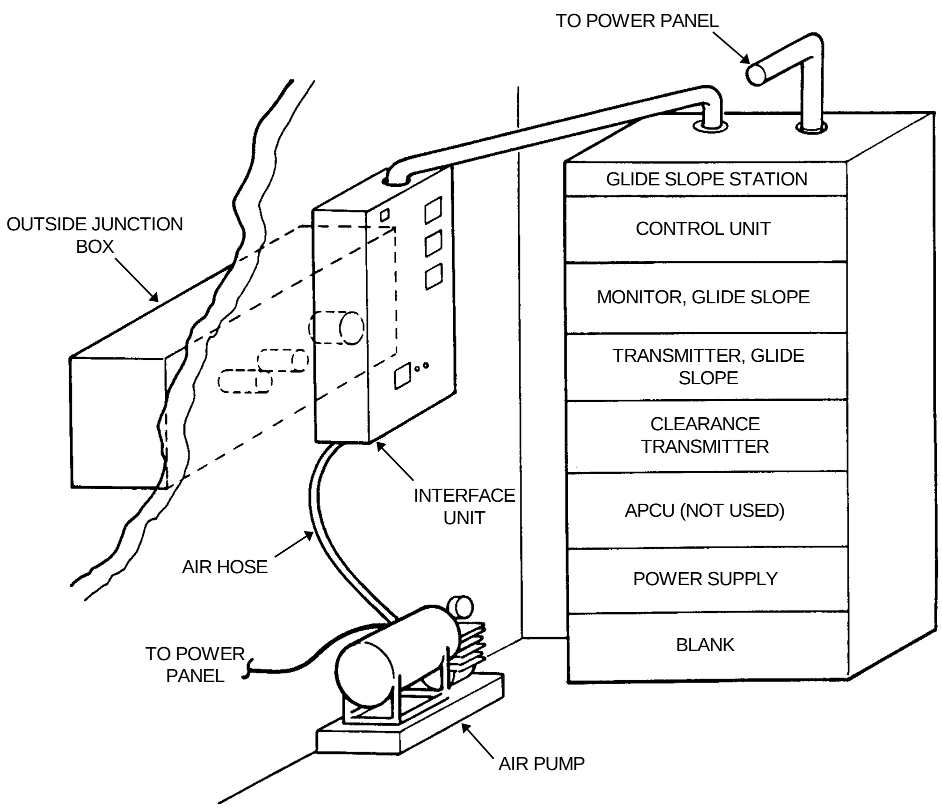


Figure 9-19. General View of Typical Station Equipment

a. Remove the path detector, width detector, clearance detector, path 2 detector (near-field), transient suppressor and their associated wiring harnesses from the capture-effect junction box and set them aside.

b. Mount the interface unit on the inside shelter wall using the four holes provided in the back wall of the unit.

c. Install the 2-inch and 3-inch conduits to the top of the interface unit.

d. Feed wire assemblies W34 and W35 through the 2-inch conduit. Refer to Figure 9-20 and connect the electronic equipment rack side to the station 28 VDC power supply.

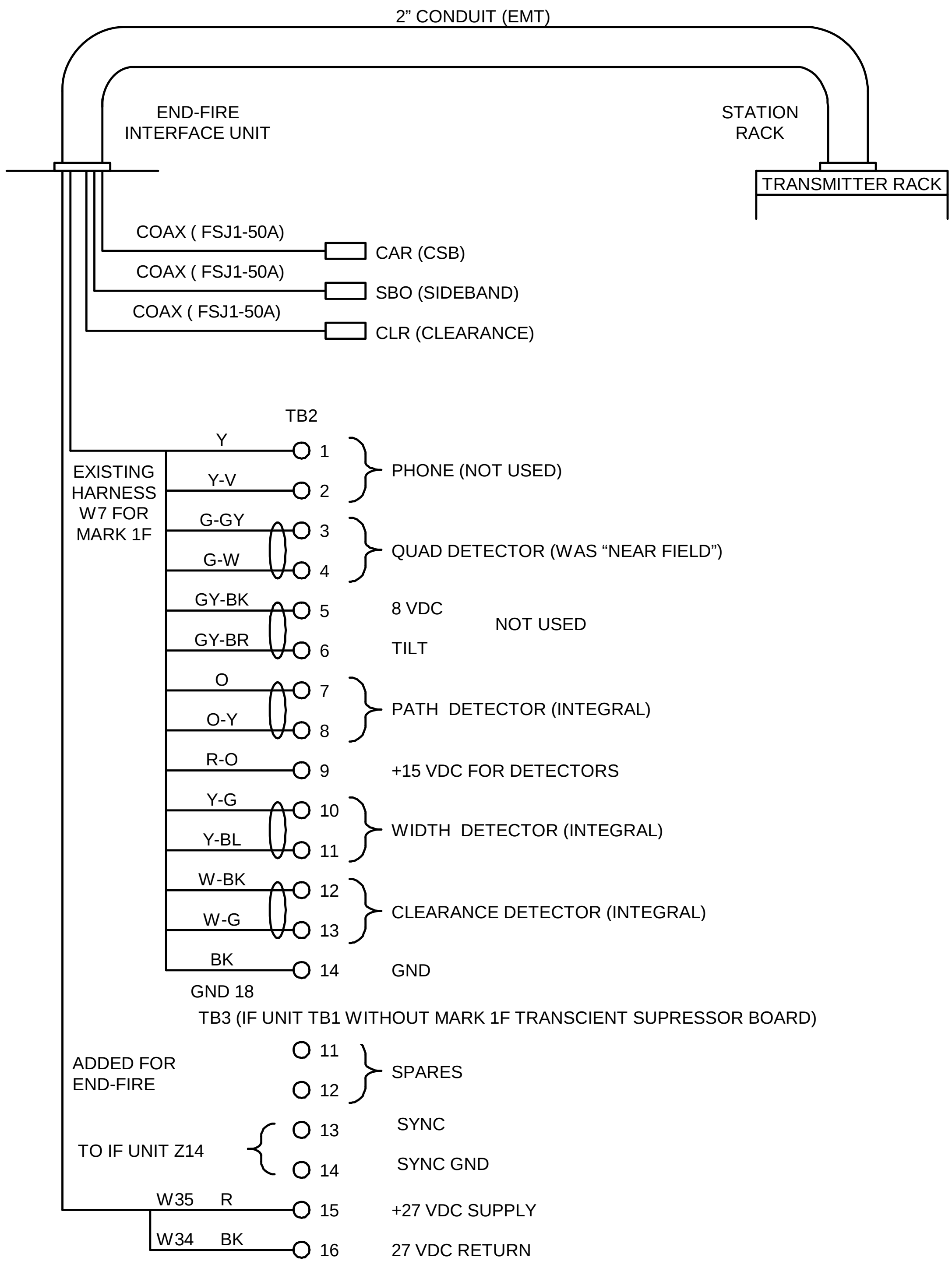


Figure 9-20. Station Rack Connections, Typical

NOTE

Paragraphs e. through i. are for Mark 1F equipment only.

e. Remove TB1 and legend card from the interface unit shown in Figure 9-21. Discard mounting bracket.

f. Remove the transient suppressor panel GS11A2 from inside the capture-effect junction box, retaining the mounting hardware. Install the panel in the End-Fire IF unit at the location of TB1 shown in Figure 9-21, using the same hardware.

g. Install TB1 and legend card in TB3 location of GS11A2.

h. Connect the wiring harness, the two #16 wires, W34 and W35, to the terminal boards mounted on the panel GS11A2 in the interface unit as shown in Figure 9-21. Connect W33, already connected to the rear of the card cage, to GS11A2TB3.

i. Install #6 ground wire from GS11A2E1 to shelter multi-point ground.

j. Connect the two #16 wires, W34 and W35, to the terminal board TB-1. For Mark 1F electronics see steps e. through h. above.

k. Install the monitor detectors removed in paragraph 9.5.1 step a. in the spaces provided in the interface unit labeled correspondingly PATH DET, WIDTH DET, QUAD DET, and CLR DET (See Figure 9-21).

l. Install W5 cable from the sampling TEE on Port J3 of HY1 labeled RF MIX to clearance detector carrier input port. This step pertains only to clearance detector types that require a dual input of clearance and course signal, otherwise cable W5 is not used.

m. Connect each detector's wiring harness to TB-1 or to GS11A2 for Mark 1F electronics. See Figure 9-22.

n. If used, attach the RF MIX Signal from W5 to the CLR DET as shown in Figure 9-22.

o. Attach the RF cables CSB, SBO and CLEARANCE entering the interface unit from the 2-inch conduit at the top, shown in Figure 9-20, to the thru-line bodies labeled CAR IN, SBO IN, and CLR IN respectively. Refer also to Figure 9-21.

REF DES PREF EF9

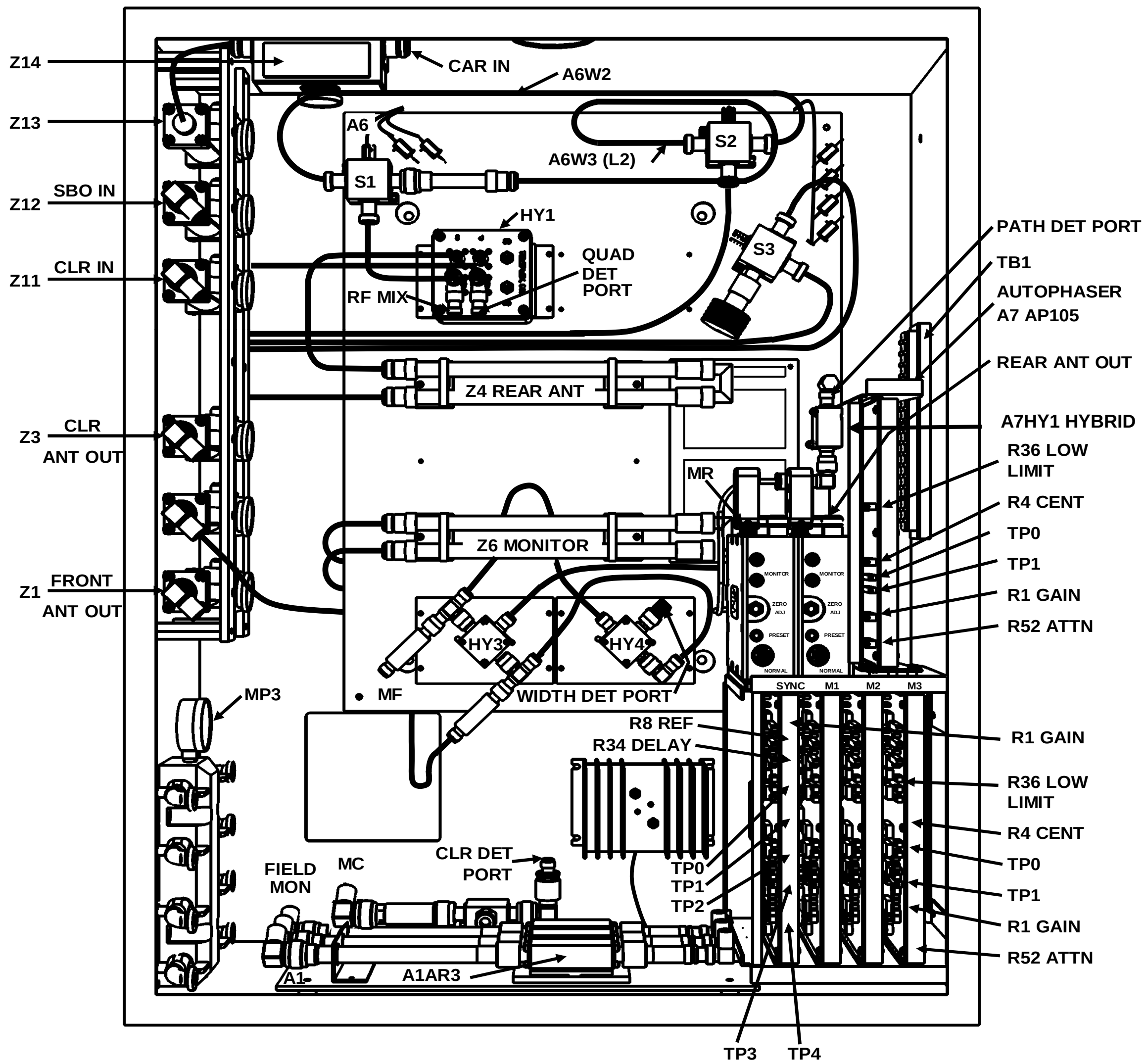


Figure 9-21. Interface Unit, Front Panel Removed

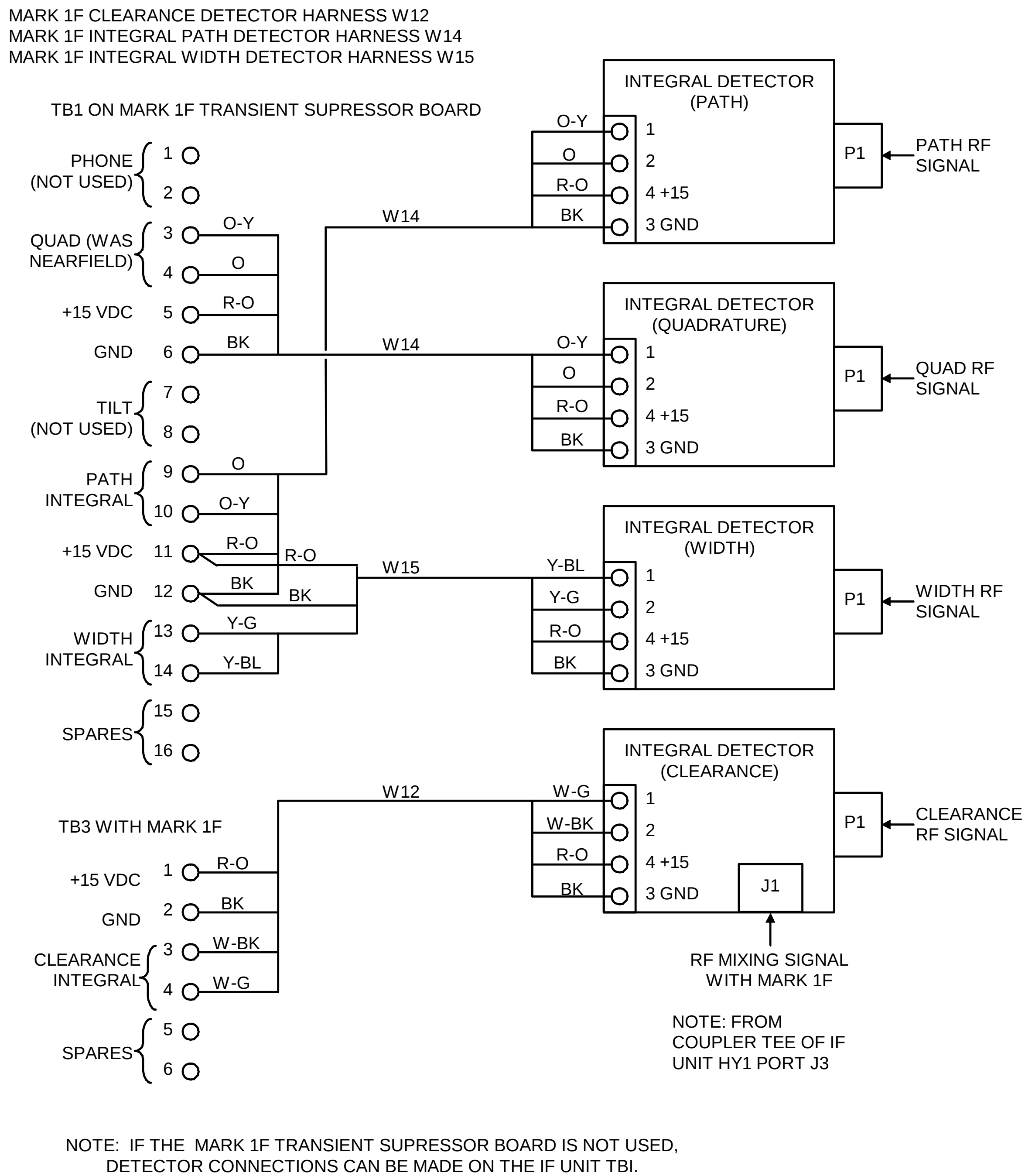


Figure 9-22. Wiring to Monitor Detectors, Typical

9.5.2 Fabrication and Connection of Pigtail Cables. - A Pigtail Cable Kit A-937-117 containing the following items is provided for fabrication of the nine pigtail cables required:

50 ft.	Heliax Cable, FSJ1-50A
1 ea.	Cable Prep Tool Cutter, MCPT-1412
17 ea.	Connector, Type N Male, 7-10-63
1 ea.	Connector, Type TNC Male, 5-10-604
1 set	Cable Labels for Pigtails, A-906-118

a. Refer to Table 9-9. Using the prep tool cutter provided, cut the FSJ1-50A cable allowing enough length to route pigtail cable W4 (Front Ant Out) from its connection in the interface unit to the 3-inch conduit to connect to the outside air-filled cable without stressing the cable or requiring excess cable to be coiled.

NOTE

During the tune-up process to insure proper phasing, it may be necessary to remove 180-degrees, approximately 11.75 inches, from either pigtail cable W4 (Front Ant Out), W8 (Rear Ant Out), W24 (MF), or W25 (MR). Rather than provide excess to accommodate this potential condition, it may be desirable to replace one of the cables with a longer length if required. To the extent practicable, the lengths of pigtail cables W4 (Front Ant Out) should equal W8 (Rear Ant Out) and W24 (MF) should equal W25 (MR).

b. Slide pigtail label W4P1 (Front Ant Out) over the end of the cable to be connected inside the interface unit and orient the label as shown in Figure 9-23 and Figure 9-24. The label provided should not require heat shrinkage.

c. Slide pigtail label W4P2 (Front Ant Out) over the end of the cable to be connected the outside air-filled cable in the junction box and orient the label as shown in Figure 9-23 and Figure 9-24. The label provided should not require heat shrinkage. (P1 of the three transmit cables W4, W8, and W11 will connect inside the interface unit and P2 will connect to the cables in the junction box. P2 of the six monitor cables, W24, W25, W26, W27, W29, and W31 will connect inside the interface unit and P1 will connect to the air-filled cables in the junction box.)

d. Select the type cable connectors for P1 and P2 in accordance with Table 9-9.

e. Slide the heat shrink provided with the connectors over the end of the cables.

f. Solder the connector pins to each end of the cable and heat shrink after soldering.

NOTE

In the event of an intermittent condition in the system, solder the pins on connectors to W4 (Front Ant Out), W8 (Rear Ant Out), W24 (MF), and W25 (MR) to isolate the source of the problem.

g. Repeat steps a. through f. for the remaining pigtail cables, W8, W11, W24, W25, W26, W27, W29, and W31.

h. Insert the nine RF "pigtails" labeled W26P1 (MC), W27P1 (M1), W29P1 (M2), W31P1 (M3), W24P1 (MF), W25P1 (MR), W4P2 (FRONT ANT OUT), W8P2 (REAR ANT OUT), W11P2 (CLR ANT OUT) from the interface unit through the 3-inch conduit into the outside junction box. Attach to the antenna cable terminations as shown in Figure 9- 25. Connect the pigtail cables to the correspondingly labeled points inside the interface unit.

Table 9-9. Pigtail Cables: Labels, Types, and Connectors

P1 LABEL TEXT	P2 LABEL TEXT	CABLE TYPE	P1 CONNECTOR	P2 CONNECTOR
W4P1 (FRONT ANT OUT)	W4P2 (FRONT ANT OUT)	A	N (7-10-63)	N (7-10-63)
W8P1 (REAR ANT OUT)	W8P2 (REAR ANT OUT)	A	N (7-10-63)	N (7-10-63)
W11P1 (CLR ANT OUT)	W11P2 (CLR ANT OUT)	A	N (7-10-63)	N (7-10-63)
W24P1 (MF)	W24P2 (MF)	B	N (7-10-63)	T (5-10-604)
W25P1 (MR)	W25P2 (MR)	A	N (7-10-63)	N (7-10-63)
W26P1 (MC)	W26P2 (MC)	A	N (7-10-63)	N (7-10-63)
W27P1 (M1)	W27P2 (M1)	A	N (7-10-63)	N (7-10-63)
W29P1 (M2)	W29P2 (M2)	A	N (7-10-63)	N (7-10-63)
W31P1 (M3)	W31P2 (M3)	A	N (7-10-63)	N (7-10-63)

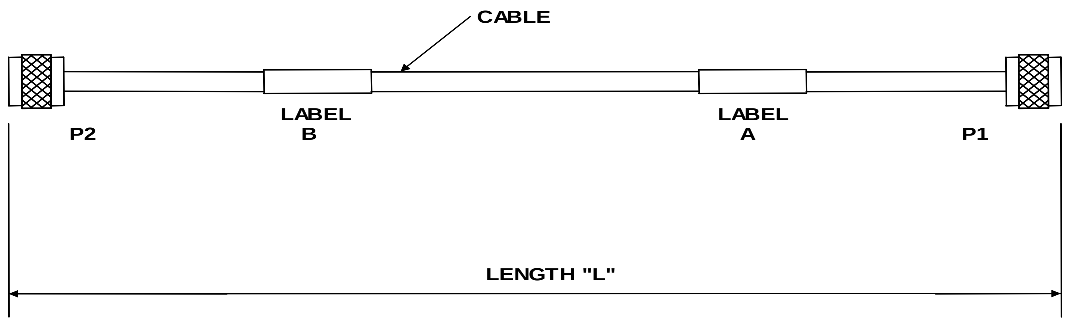


Figure 9-23. Pigtail Cable Type A.

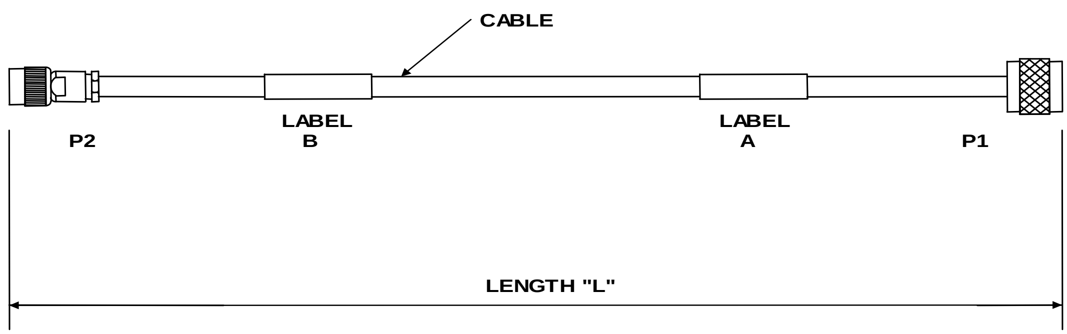


Figure 9-24. Pigtail Cable Type B.

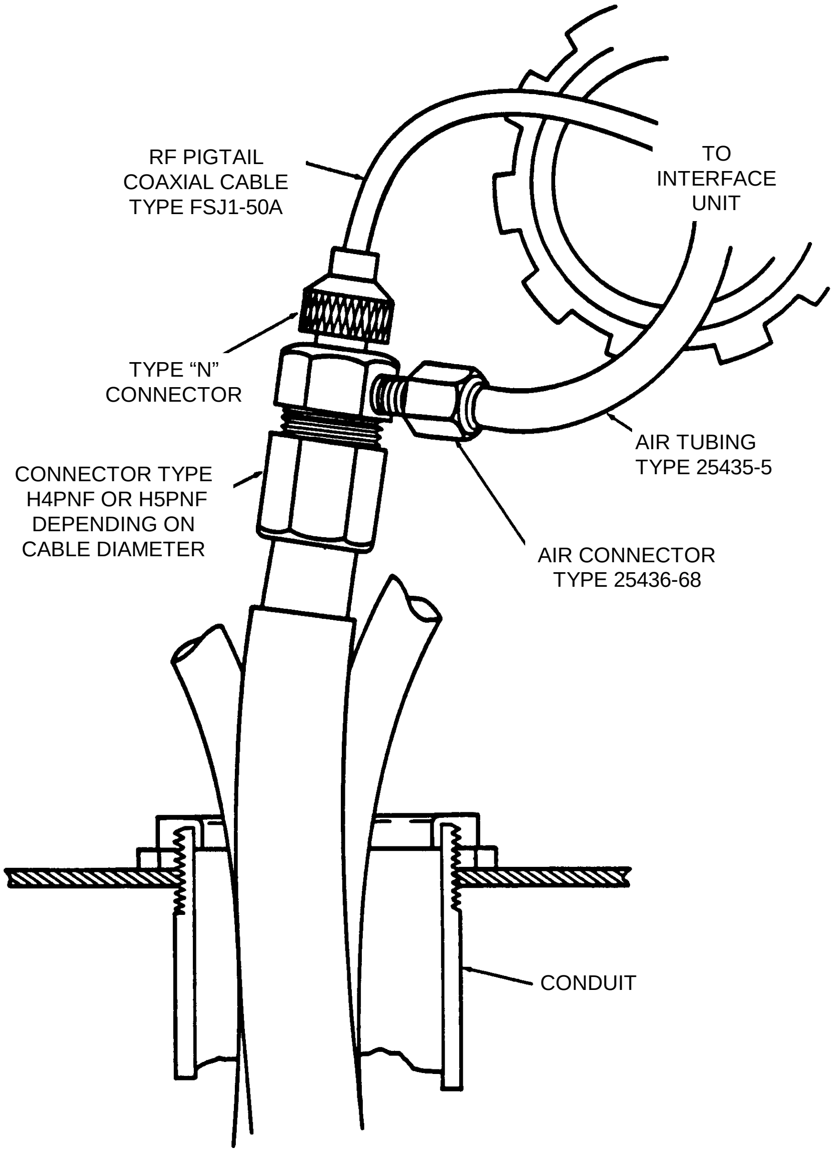


Figure 9-25. Typical Cable Termination in Outside Junction Box

9.5.3 Air System Installation.- An air distribution manifold (MP3) is provided inside the interface unit as shown in Figure 9-21. The following are step-by-step procedures for connecting the air distribution system.

NOTE

> In order to provide more room in the interface unit, some sites may prefer to remove the air manifold assembly from the interface unit and mount it on the shelter wall.
>
> RF cables MR, MF, and MC do not need pressure lines from the air manifold because air is fed from the feed end of the antennas through RF cables R, F, and C respectively to pressurize the cables.
>
> Any unused air manifold ports should be plugged. Teflon tape should be wrapped in a direction so that tightening the fitting will not cause the tape to unwrap.

a. Insert one end of the Type 25435-5 polyethylene tubing supplied through the 3-inch conduit to the outside junction box.

b. Apply Teflon tape to male air connector Type 25436-68, as shown in Figure 9-26, and install on the air inlet of one of the RF cable connectors. See Figure 9-25.

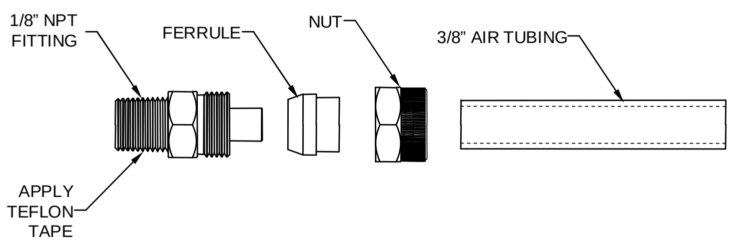


Figure 9-26. Air Connector Type 25436-68 Installation

c. Route the tubing to a valve outlet fitting on the air manifold and cut the tubing to length. See Figure 9-21.

d. Apply Teflon tape to another male connector Type 25436-68 and install on one of the eight outputs of the air manifold.

e. Remove the nuts and ferrules from the male connectors installed in steps b and d. See Figure 9-26.

f. Slide the nuts and ferrules on both ends of the air tubing and connect the air tubing between the two male fittings. See Figure 9-26.

g. Apply Teflon tape to the backside threads of the 1/8 inch NPT fitting and tighten the nut firmly.

h. Repeat steps a. through e. for the remaining five RF cables and manifold outputs.

i. Install the automatic dehydrator pump on the floor directly beneath the power panel as shown in Figure 9-19. (See Appendix 2 for Type MT300 dehydrator installation instructions).

j. Connect the dehydrator pump's air output hose to the inlet fitting of the air manifold assembly in the left bottom of the interface unit box. See Figure 9-21.

k. Connect the pump's 110 VAC input to a spare circuit breaker in the power panel.

9.6 INITIAL CHECKOUT.- The following procedure assumes that the antenna installation has been completed, the RF cables are all connected, the trenches are back-filled, the interface unit has been installed, and all of the required government-furnished station equipment is in place and operational. Record all readings and measurements on standard FAA forms.

Table 9-10 lists the test equipment (marked with X) used for the procedures in paragraph 9.6.1 through paragraph 9.6.10:

CAUTION

With the End-Fire system, course transmitter modulation balance should only be set when the sidebands are terminated into a dummy load.

NOTE

It is assumed in the following procedures that the system transmitter has been tested, is operating properly, and that all input and output ports are properly terminated to the interface unit.

TABLE 9-10. Test Equipment for Initial Checkout

REFERENCE PARAGRAPH/ PROCEDURE	PORTABLE ILS RECEIVER (PIR)	OSCILLO-SCOPE	DIGITAL VOLT METER (DVM)	OTHER TEST EQUIPMENT OR MATERIALS
Para. 9.6.1 Air System Integrity	…	…	…	Spray Bottle, Soapy Mixture, Rags, Megohmeter (megger)
Para. 9.6.2 Main Antenna Alignment Check	…	…	…	200-ft Steel Tape (resolution in hundredths of a foot) Spring tension scale
Para. 9.6.3 Transmitter Power Levels	…	…	…	2W Dummy Load
Para. 9.6.4 SBO/CAR Quadrature Phase Adjustment.	X	…	…	N-fitting Elbow Adapter
Para. 9.6.5 Antenna Amplitude Distributions	…	…	…	EFGS Test Probe
Para. 9.6.6 Interface Unit Alignment.				
Para. 9.6.6.1 SYNC Electronics Board Alignment	…	X	X	…
Para. 9.6.6.2 Front-to-Rear Main Antenna Initial Phasing.	X	…	…	2W Dummy Load
Para. 9.6.6.3 Monitor Channel (CHAN) Circuit Board Alignment.	X	…	X	2W Dummy Load
Para. 9.6.6.4 SYNC Circuit Board RF Level Alarms.	X	…	X	…
Para. 9.6.6.5 Initial Path Angle	X	…	…	Vector Voltmeter
Para. 9.6.6.6 Field Monitor AGC Activation.	…	…	X	…
Para. 9.6.6.7 Main Bridge (Teleplex Hybrid) Tuning	X	…	…	2W Dummy Load
Para. 9.6.6.8Integral Monitor Adjustment.	X	…	…	2W Dummy Loads
Para. 9.6.6.9 Clearance Blocking	…	X	…	…
Para. 9.6.7 Main Antenna Pedestal Adjustments. See Appendix 1. Model 105 End-Fire Glide Slope Antenna System – Optimization Supplement.	X	X	X	EFGS Test Probe 200-ft Steel Tape
Para. 9.6.8 Clearance Antenna Adjustments. See Appendix 1. Model 105 End-Fire Glide Slope Antenna System – Optimization Supplement.	X	X	X	EFGS Test Probe 200-ft Steel Tape
Para. 9.6.9 Initial Alarm Limits. Refer to station instruction book	X	…	…	
Para. 9.6.10 Autophaser Adjustment.	X	…	X	2W Dummy Load

9.6.1 Air System Integrity.- The following procedure checks the integrity of the air system.

a. Turn on the air pump.

b. Check the air manifold in the interface unit or the air system line monitor to ensure that all of the air valves are fully opened.

c. Allow the pressure to stabilize to the operating value stated in the dehydrator instruction book. (See Appendix 2 and Table 1-1 for Type MT300). Failure to reach the nominal operating pressure indicates a leak in the air system.

d. Fill a clean spray bottle with a soapy mixture. The mixture may be produced by diluting liquid hand soap. An optimum mixture is the soapy mixture children use to “blow bubbles” and can be found at most child specialty or department stores.

e. Heavily spray each antenna joint, both end seal areas of the antenna, and the OUTSIDE of the air filled coax at the connectors to verify that no leaks exist. Also spray all joints of the air tubing and connectors to include the air manifold assembly. A rag may be placed around the area to be sprayed in order to avoid excessive cleanup.

f. Repair any leaks that are found.

NOTE

> Over-tightening of the retaining screw located on the feed end of the main, clearance, and monitor antenna radomes will deform the end of the radome near the seal and result in an air leak. Backing out the retaining screw until the screw head lightly touches the radome may be sufficient to stop the leak.

g. Clean the soapy mixture off of the antenna and air manifold using plain water and rags or paper towels.

h. Turn off the dehydrator or close all of the air valves on the air manifold assembly or the air system line monitor.

i. Record the gauge reading on the air manifold or line monitor and check periodically to see that pressure drops no more than 20% over a period of three hours. If leakage is excessive, repeat steps a. through k.

NOTE

> Pressure may vary up or down 1 or 2 psi with changes in outside temperature or intensity of sunshine.

j. Turn on the dehydrator or open all of the air valves on the air manifold assembly or the air system line monitor.

k. Allow the pressure to stabilize to the operating value stated in the dehydrator instruction book.

l. In the equipment shelter outside junction box, temporarily remove the 1/8 inch NPT air connector plug of the 1/2 inch-N female connector (H4PNF) installed on integral monitor cable MF.

m. Verify the presence of air in the monitor cable.

NOTE

> Absence of air in the monitor cable indicates a blockage between the air manifold to the feedline, through the antenna and on to the monitor cable termination at the junction box.

n. If air is not detected, inspect all connections in the loop to verify that gas pass interconnections are used and continue until the blockage is found.

o. Allow the system to stabilize again and repeat steps n. through p. for monitor cables MR and MC independently.

p. Allow the system to stabilize.

q. Check the outside RF cables and antennas for accumulated moisture by measuring resistance between inner conductors and ground with all antenna feed and monitor cables disconnected from the interface unit. A resistance reading in excess of 50 megohms is expected. This can be accomplished from inside the equipment shelter by disconnecting each antenna's feed and monitoring cables and measuring the entire loop. For field monitors M1, M2, and M3, only the return cable applies.

NOTE

> The source voltage for the megger should not exceed 1000 Volts. At higher voltages, the voltage may discharge due to the long probe screws used in the antennas and could be misinterpreted as faulty cable. In addition, readings using greater than 1000 Volts will appear different between the main antennas and the clearance antenna because of the longer probe screws in the clearance antenna.

r. If moisture is detected, bleed air and replace with dry air. Do this until all resistance readings are in excess of 50 megohms.

s. To isolate a defective feed cable, monitor cable, or an antenna, the cable should be disconnected and independent resistance measurements should be made of each. All resistance readings should be in excess of 50 megohms.

<u>9.6.2</u> <u>Main Antenna Alignment Check</u>.- This procedure requires two people and a 200-foot steel tape, calibrated in feet, tenths, and hundredths. It should not be done on a windy day.

a. Ensure that all pedestal hardware is tight.

b. Starting with the rear main antenna, hook the end of the tape to the rear taping point and stretch the tape across the top of the antenna cover at the first support.

c. Read the tape to the nearest 0.01 foot where it crosses the top of the antenna cover while maintaining a constant tension (i.e. 20 lbs) on the tape. Record the measured reading, "M", in column (3) of Table 9-11.

d. Repeat steps a. through c. for all 18 of the support points of the rear main antenna.

e. Repeat steps a. through d. on the front main antenna using the front taping point.

f. In column (2) of Table 9-11, enter the reference taping radii, "R" that should be contained Facility Data Reference File (FRDF) or in the facility construction drawings, Table 9-1, Detail "F", sheet 5 of 5.

g. In column (4), enter the difference, D = (M - R), with due regard to preserving the signs.

h. For each antenna, compute a constant "K" which is an average of all the values "D" in column (4). In column (5), enter the values (D - K) in inches.

i. Any values of (D - K) that are greater than 0.5 inch should be corrected by an adjustment of the corresponding pedestal hardware. Ensure that hardware is retightened securely.

j. File all readings for future reference.

Table 9-11. Pedestal Alignment, Taping Radii

(1) PED #	(2) Tabular Value R	(3) Measured Value M	(4) Difference D = (M - R)	(5) Deviation (D - K*)
REAR				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
FRONT				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

*Note: K is the average of all the D's.

9.6.3 Transmitter Power Levels.- Refer to Figure 9-27 and perform the following procedure:

a. Place the METER SELECTOR on CAR.

b. Turn on the transmitter (alarm by-passed) and adjust its output for a reading of 4.0 watts on the RF POWER meter on the interface unit.

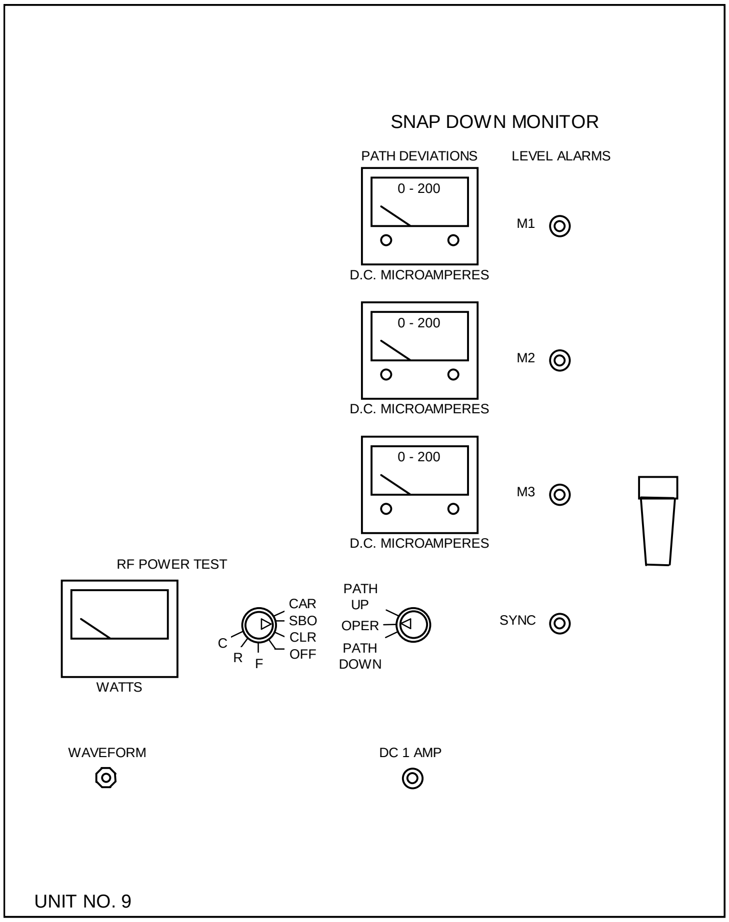


Figure 9-27. Interface Unit, Front Panel

NOTE

Due to the bridge imbalance produced by the dissimilar complex impedances on the outputs of the main hybrid HY1, some energy from the sideband input to the bridge is evident at the CSB input port. Likewise, some CSB energy will leak through the bridge and be evident at the SBO input port. This condition, which will be minimized in a subsequent procedure where the bridge is tuned, may produce a high apparent VSWR. This is not actual VSWR, as the waves are forward propagating from the opposite side of the bridge and are not reflected. To measure actual CSB input VSWR, the sidebands must be terminated into a dummy load. Likewise, to measure actual SBO VSWR, the CSB input must be terminated with a dummy load.

c. Open the front panel of the interface unit and rotate the CSB wattmeter element to read reflected power on the RF POWER meter and record the reading, typically 0.04 watts. Calculate VSWR.

d. Restore the CSB wattmeter element to its normal position.

e. Place the METER SELECTOR on SBO. The final reading of the sideband (SBO) power will be dependent on the results of the flight check, but a typical value would be 250 milliwatts.

f. Rotate the SBO wattmeter element to read reflected sideband power and record the reading, typically 0.02 watts. Calculate VSWR.

g. Restore the SBO wattmeter element to normal.

h. Place the METER SELECTOR on CLR. The final reading of the clearance (CLR) power will be dependent on the results of the flight check, but a typical value would be 700 milliwatts.

i. Rotate the CLR wattmeter element to read reflected clearance power, typically 0.005 watts. Calculate VSWR.

j. Restore the CLR wattmeter element to its normal position. Similarly, check and record the meter readings of forward and reflected power at F, R, and C. Typical forward readings would be 1.4, 1.9, and 0.6 watts respectively. Calculate VSWR.

9.6.4 SBO/CAR Quadrature Phase Adjustment.- Setting CSB to SBO phasing does NOT require the use of a 90 degree “quadrature” line section. Phasing is established with a RF sample taken from the front main antenna signal and by adjusting for 0.000 DDM on the portable ILS receiver (PIR). Proper sensing is verified by placing an elbow in the SBO line and verifying that the DDM reading indicates a predominance of 90 Hz. The 30 dB down sampling tee (HM-30T) is installed in the front antenna output on port 1 (lower right) of Hybrid A6HY1, Figure 9-21 and is the location for the QUAD DET (quadrature detector) that feeds the station PATH 2 OR “NEAR-FIELD” MONITOR channel.

NOTE

> Review facility installation drawings to determine if the runway shoulder slopes up toward threshold greater than 0.25 degree. If so, install a 2 dB 10-Watt attenuator, preferred model number 10-A-MFN-02, in the CSB feedline to the interface unit. This step will insure that adequate relative SBO signal is available to achieve path narrow condition for establishing monitor limits during flight inspection. The step is performed in this order because, if needed, inserting the attenuator later would require re-establishing the CSB/SBO phase.

a. Bypass station monitor. Connect the portable ILS receiver (PIR) directly into the sampler output port, QUAD detector location (see Figure 9-21 and Figure 9-28), and configure to read RF level.

b. Measure and record the RF level.

c. Consult the transmitting equipment instruction book and verify the level measured is appropriate to drive a station detector.

d. Configure the PIR to read DDM.

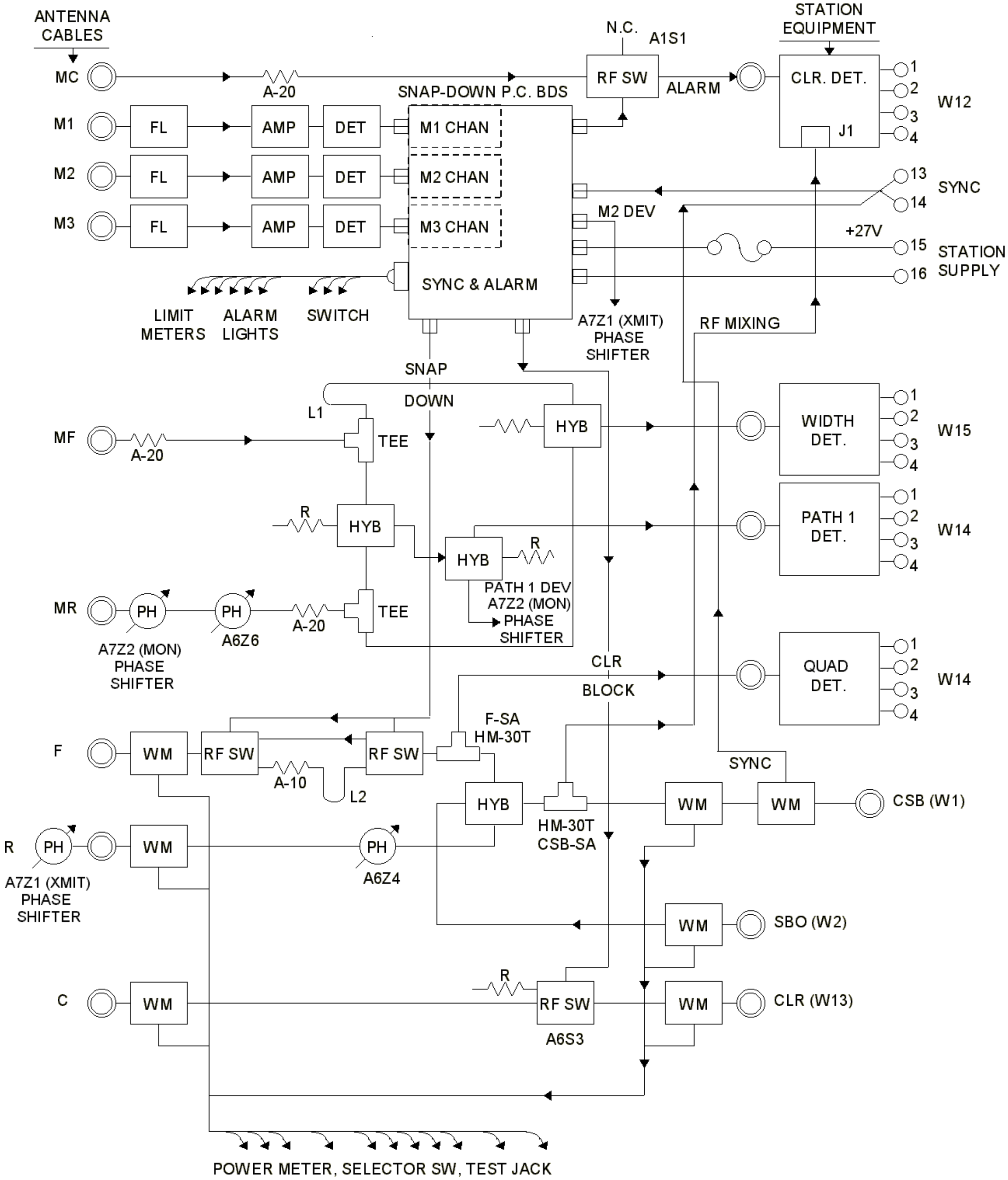


Figure 9-28. Interface Unit, Partial Block Schematic

e. Adjust the transmitter CAR/SBO phase control for a reading of 0 +/- 0.005 DDM on the PIR. The adjustment will be very sensitive and can be expected to drift around +/- 0.010 DDM. If 0.000 DDM is beyond the range of the control, it will be necessary to add to or trim the length of either the CSB or SBO cable feeding the interface unit.

f. Verify that the sensing is correct by temporarily inserting an N-fitting elbow adapter in the SBO feedline to the interface unit and verifying the reading shows predominance of 90 HZ, typically 0.175 to 0.225 DDM.

g. If the reading indicates predominant 150 HZ then sensing is reversed and approximately 11.75 inches of cable (corresponds to a 180-degree phase shift) must be removed from either the CSB or SBO cable feeding the interface unit.

h. Trim the cable so that the 0.000 DDM indication is well centered in the range of adjustment of the transmitter SBO phase control.

i. This adjustment should not be changed during, or as a result of, the flight inspections, except for purposes of monitor alarm checks.

j. Restore system to normal.

9.6.5 Antenna Amplitude Distributions.- This check requires two people, one to hold and read the test probe shown in Figure 9-29 and the second to record the readings for future use. The test probe must be held in a horizontal position in front of the slot being measured and the recorder should stand 10 feet farther away from the antenna. The slot locations are marked, 1 through 12, on the radome of each antenna section.

NOTE

Slot amplitude distribution measurements should be taken with the manufacturer provided test probe and voltmeter shown in Figure 9-29. Measurements taken with equipment displaying decibel units will NOT provide the necessary resolution to identify irregularities in the antenna slot distribution or to compare with the theoretical voltage distribution provided in Figure 9-13.

The feed side of any antenna measured with the test probe is the side closest to the equipment shelter and the load side is closest to the runway.

a. Place the plastic hook of the test probe over the slot No. 1 of the third antenna section nearest the feed end of the rear main antenna.

b. If the reading is off scale, reduce the transmitter power until the reading is approximately 90% full scale.

c. Proceed to the slot No. 1 (feed end) first section of the rear main antenna and measure and record the reading on the form given in Table 9-12. If meter deflection is too small to read, record a zero. Table 9-14 is provided to allow conversion of the field probe meter reading in microamps to millivolts or milliwatts. For purposes of recording slot distribution data, meter readings can be recorded directly in Table 9-12 and compared to the distribution curve in Figure 9-13.

d. Similarly, measure and record the readings of remaining 95 slots on the rear main antenna in sequence.

e. Repeat for the front main antenna.

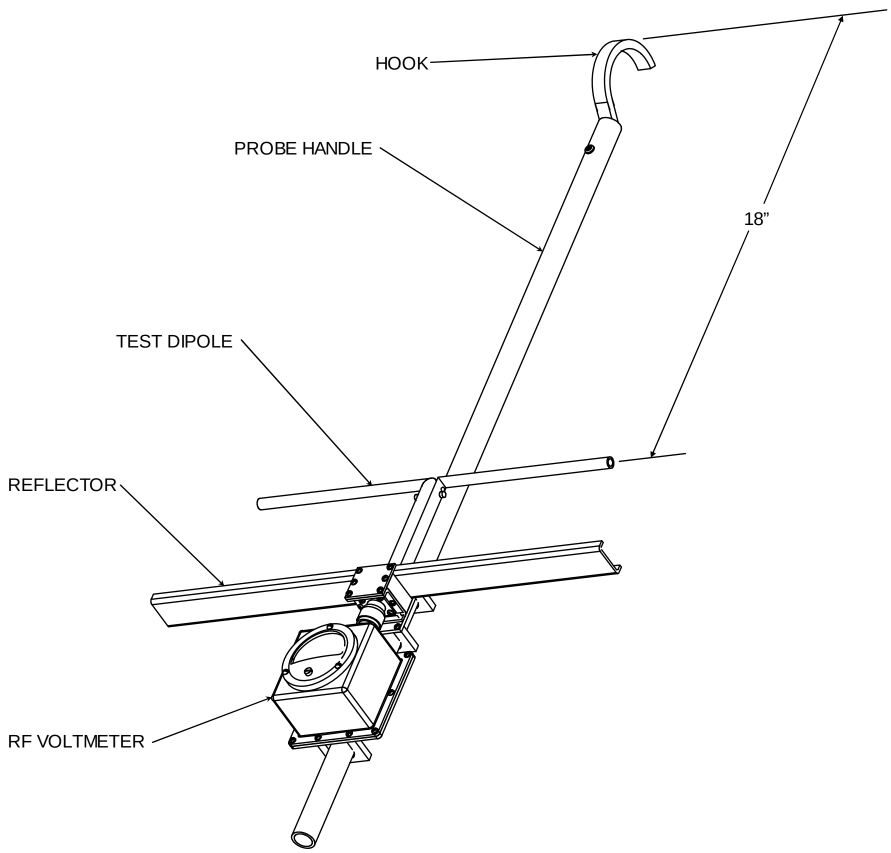


Figure 9-29. Test Probe, EF10.

f. Place the plastic hook of the test probe over slot No. 7 of the clearance antenna.

g. If the reading is off scale, reduce the transmitter power until the reading is approximately 90% full scale.

h. Proceed to the slot No. 1 (feed end) of the clearance antenna and measure and record the reading on the form given in Table 9-13. If meter deflection is too small to read, record a zero. Meter readings can be recorded directly in Table 9-13 and compared to the FRDF or in the facility construction drawings, Table 9-1, Detail “F”, sheet 5 of 5.

i. Restore powers to normal. File readings.

Table 9-12. Slot Amplitude Distributions, Main Antennas

SLOT #	SECTION #							
REAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
FRONT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Table 9-13. Slot Amplitude Distribution, Clearance Antenna

SLOT #	Value
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Table 9-14. RF Probe Typical Voltmeter Reading

UA SCALE	RF VOLTS	RF mW	UA SCALE	RF VOLTS	RF mW
1	0.05	0.05	26	0.46	4.2
2	0.07	0.10	27	0.47	4.4
3	0.09	0.16	28	0.49	4.8
4	0.11	0.24	29	0.50	5.0
5	0.13	0.35	30	0.52	5.4
6	0.15	0.45	31	0.53	5.7
7	0.17	0.60	32	0.55	6.0
8	0.19	0.70	33	0.56	6.3
9	0.21	0.86	34	0.57	6.6
10	0.22	1.0	35	0.59	7.0
11	0.24	1.1	36	0.61	7.3
12	0.26	1.3	37	0.62	7.7
13	0.27	1.5	38	0.63	7.9
14	0.28	1.6	39	0.65	8.3
15	0.30	1.8	40	0.66	8.7
16	0.31	1.9	41	0.68	9.2
17	0.33	2.1	42	0.69	9.5
18	0.34	2.3	43	0.70	9.9
19	0.36	2.5	44	0.71	10.2
20	0.37	2.8	45	0.73	10.6
21	0.39	3.0	46	0.75	11.2
22	0.40	3.2	47	0.76	11.5
23	0.42	3.5	48	0.77	12.0
24	0.43	3.7	49	0.79	12.4
25	0.44	4.0	50	0.80	12.8

9.6.6 Interface Unit Alignment. - The following procedures are used to align the EF-9 interface unit. Instructions are provided for the SYNC and MONITOR CHAN electronics boards, the snap-down monitor, initial path angle setting, main bridge HY1 tuning, the integral monitor, AGC activation and the autophaser assembly.

9.6.6.1 SYNC Electronics Board Alignment.- The following procedures are provided to check and adjust the SYNC electronics board. Refer to Figure 9-21 for test points.

NOTE

The system sync signal that drives the SYNC electronics board is derived from the transmitter CSB output by the use of the RF wattmeter body and 5-Watt element Z14 (See Figure 9-21) mounted inverted on the inside top of the interface unit. Be sure that the wattmeter element is fully seated, locked in position and oriented to detect forward power.

After the system is commissioned, if the element is rotated or removed a system shut-down will occur.

The SYNC electronics board has internal upper and lower RF level alarms that are factory set by voltage divider circuits contained on the circuit board. When establishing transmitter RF level alarm limits during the commissioning flight inspection, consideration must be given to whether the integral path RF level alarm is lower than the sync signal alarm.

a. On SYNC electronics board, use a digital voltmeter (DVM) to check the +15 supply voltage between TP3 and chassis ground, TP0, for greater than 14.1 VDC but less than 15.9 VDC, nominally +15 VDC +/- 0.25.

b. Check the -15 supply voltage between TP4 and TP0 for greater than -13.5 VDC but less than 16 VDC, nominally -15 VDC +/- 0.25.

c. Check the +5 supply voltage between TP2 and TP0. Adjust for +5.00 VDC using REF potentiometer R8, if necessary.

d. Connect DVM between TP1 and TP0.

e. Adjust the sync signal level for +4.3 VDC using GAIN control potentiometer R1.

f. Connect an oscilloscope to the WAVEFORM jack on door, Figure 9-27.

g. Ensure that the front panel mode switch is in the operate position.

h. Set the METER SELECTOR to R (rear main antenna) and observe the 90/150 Hz modulation pattern shown in Figure 9-30(a). This pattern is not the same as CSB due to the addition of quadrature SBO sidebands. Note that the pattern observed may vary slightly from that shown due to variations in modulation balance measurements when using an oscilloscope versus a portable ILS receiver (PIR).

i. Set the METER SELECTOR to F (front main antenna) and observe the similar 90/150 Hz modulation pattern as shown in Figure 9-30(b) but showing the timing of the snap-down pulse and the effect of temporarily switching a 10-dB attenuator into the front antenna line. Note that the pattern observed may vary slightly from that shown due to variations in modulation balance measurements when using an oscilloscope versus a portable ILS receiver (PIR).

j. Adjust the snap-down sample pulse timing using DELAY control potentiometer R34, Figure 9-21, to center the snap-down pulses on the waveform tangency as shown in Figure 9-30(b).

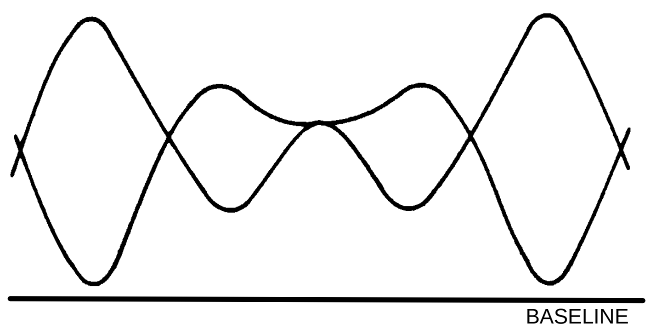
k. Temporarily set the mode switch to PATH UP and observe that the snap-down pulses are absent from the waveform. Return the mode switch to OPERATE.

l. Increase the sync signal level to the SYNC board upper level RF alarm point, nominally +5.00 VDC, using GAIN control potentiometer R1. Verify the front panel SYNC LEVEL alarm lamp is lit and the snap-down pulse remains centered.

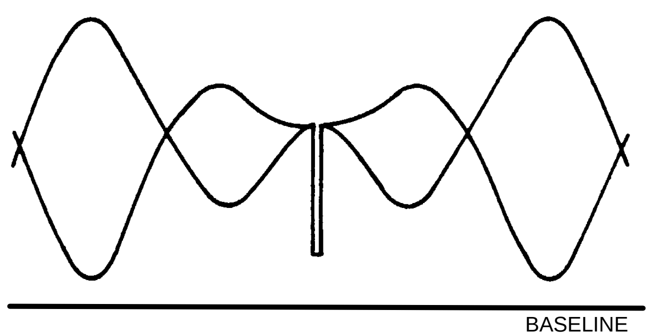
m. Decrease the sync signal level to the SYNC board lower level RF alarm point, nominally +3.60 VDC, using GAIN control potentiometer R1. Verify the front panel SYNC LEVEL alarm lamp is lit and the snap-down pulse remains centered.

n. Re-adjust the sync signal level for the normal operating voltage of +4.3 VDC, using GAIN control potentiometer R1.

o. Remove the test equipment.



(a) REAR MAIN ANTENNA MODULATION PATTERN



(b) FRONT MAIN ANTENNA MODULATION PATTERN
(SHOWING TIMING OF SNAP-DOWN PULSE)

Figure 9-30. Front and Rear Main Antenna Modulation Patterns

9.6.6.2 Front-to-Rear Main Antenna Initial Phasing.- This procedure is identified as initial phasing because it is used to establish the front-to-rear in phase condition on the ground while in snap-down. When the system mode switch is placed in the operate position, in a later procedure (9.6.6.5), the snap-down line length will determine the initial path angle radiated until the angle is adjusted during the commissioning flight inspection.

NOTE

This procedure involves first identifying a RF level maximum to identify the proper in phase condition, and then later to fine adjust using DDM.

Do not attempt to use only the DDM method for this procedure because the quadrature sideband signals of the main antennas will provide 0.000 DDM also when the signals are unbalance and 180 degrees out-of-phase. The RF level method used first is to remove this ambiguity.

When following these procedures, it is assumed that all open ports and cables are properly terminated. For all cable and connector references, see Figure 11-2.

a. Bypass Station monitor and set interface mode switch to PATH DOWN

b. Place the mode switches of phase shifters Z1 (XMIT) and Z2 (MON) of the EF9A7 autophaser assembly in the PRESET position and observe that both red LEDs are illuminated.

c. Ensure that the AGC amplifier connections to the field monitor CHAN circuit card TP1 jacks are disconnected.

d. Turn transmitter off.

e. Disconnect front main antenna pigtail cable W4P1 and replace with a 2-watt dummy load.

f. Disconnect M2 pigtail cable W29P1, from A1CP5 on the input of the M2 channel filter A1FL2.

g. Connect the PIR to the M2 pigtail cable W29P1.

h. Configure the PIR to read RF level.

i. Turn the course transmitter on and note the reading on the PIR due to radiation from the rear main antenna.

j. Turn off the transmitter and remove the 2-watt dummy load. Disconnect the rear main antenna feed cable W8P1 and replace with the 2-watt dummy load.

k. Reconnect the front main antenna feed cable W4P1.

l. Turn on the transmitter and note the reading on the PIR due to radiation from the front main antenna. The reading should be approximately the same as measured for the rear main antenna.

m. Temporarily place the mode switch to PATH UP and observe a nominal increase of 10 dB on the PIR due to the electronic bypassing of the 10 dB attenuator in the front antenna line.

n. Return mode switch to PATH DOWN.

o. Turn off the transmitter, remove the 2-watt dummy load, and reconnect the rear main antenna feed line W8P1.

p. Turn on the transmitter.

q. Note that the reading of the composite front and rear main antenna signal is stronger than either antenna radiated alone. If not, the front and rear signals may be substantially out-of-phase and the length of the front and rear pigtail cables, W4 and W8 respectively, may need to be shortened. Proceed with the next step before considering trimming the feedline lengths.

r. While observing the PIR reading due to the combination of radiation from the front and rear main antennas, adjust the REAR ANTENNA PHASER (A6Z4) for a maximum signal level so that the level drops slowly when the phaser length is increased or decreased. The maximum is expected to be very broad on the phaser range.

s. Configure the PIR to read DDM.

t. Fine adjust REAR ANTENNA PHASER (A6Z4) to obtain 0 DDM. Only a small phaser adjustment should be required.

u. Coarse trim either the front or rear pigtail cable, W4 and W8 respectively, until the 0 DDM reading on the PIR is well within the range of adjustment of REAR ANTENNA PHASER Z4. DO NOT attempt to perfectly center the phaser at this time as tuning adjustments in the following procedures will likely require additional trimming.

v. Remove the PIR and reconnect the M2 pigtail cable W29P1.

w. Restore system to normal.

9.6.6.3 Monitor Channel (CHAN) Circuit Board Alignment.- Alignment of the CHAN board consists of setting the nominal gain, lower RF level alarm limit, and centering voltage for each field monitor CHAN circuit board and the associated front panel set-point meter.

CAUTION

After the CHAN board has been aligned following a flight inspection, adjustment of any control on the card may circumvent the failsafe characteristics of the snap-down monitor circuitry.

NOTE

The Monitor CHAN circuit board has an upper level RF alarm limit of 5.0 VDC that is referenced to the +5.0 VDC supply voltage.

Activation of the AGC amplifiers in a later procedure will decrease the lower level RF level alarm point by an additional 20 dB. However, transmitter RF level is being monitored by the SYNC circuit board and also by the integral path detector.

a. Place the interface unit front panel mode switch in PATH DOWN.

b. Verify the mode switches of phase shifters Z1 (XMIT) and Z2 (MON) of the EF9A7 autophaser assembly in the PRESET position and observe that both red LEDs are illuminated.

c. Bypass station monitor. Install a dummy load on SBO, so that only CSB is being radiated.

d. Verify that the AGC amplifier connection to the M1 field monitor CHAN circuit card TP1 is disconnected. (See Figure 9-21)

e. On the M1 field monitor CHAN circuit card (See Figure 9-21), install DVM between RF level test point TP1 and chassis ground, TP0.

f. On the M1 monitor channel board, adjust input level GAIN control potentiometer, R1, for maximum clockwise as evidenced by clicking or when the voltage at TP1 stops increasing.

g. Adjust input level attenuation ATTN control potentiometer R52 for a reading between 6.0 and 10.0 volts, nominally 8.0 VDC.

h. Re-adjust GAIN R1, reducing reading to 1.55 volts to set the input level at the CHAN board alarm comparator circuit at the lower RF level alarm point.

i. Adjust M1 RF level LOW LIMIT control potentiometer, R36, until M1 LEVEL ALARM LAMP just lights, establishing the alarm limit.

j. Readjust M1 GAIN, R1, for the nominal operating voltage of 2.2 VDC on DVM.

k. Center the M1 front panel path deviation meter using CENT control potentiometer, R4 on the circuit board.

l. Repeat d. through k. for M2 and M3 field monitor CHAN circuit boards.

NOTE

The front panel deviation meters, M1 PATH, M2 PATH, and M3 PATH should now all read 100 microamperes, center scale.

m. Move the front panel mode switch from PATH DOWN to OPERATE and observe no appreciable change on the M1, M2, or M3 path deviation meters.

n. On the front panel setpoint meters M1, M2, and M3, use the control potentiometers to position all lower limit alarm wipers fully to the left side of the meter and all upper wipers fully to the right.

o. Remove the clearance detector from alarm switch A1S1 and substitute the PIR configured to read RF level.

p. Confirm the reading on the PIR is sufficient to drive the station detector, which indicates that no alarm exists from the snap-down monitor.

q. Adjust the M1 PATH DEVIATION METER lower path limit alarm wiper toward the deflection needle until the reading on the PIR drops at least 20 dB, indicating an alarm.

NOTE

Do not expect any interface unit alarm lamp indication for an alarm produced from the path deviation meters. The front panel RF level alarm lamps for M1, M2, and M3 are only illuminated for conditions relating to the associated channel RF level inputs.

r. Confirm the alarm limit wiper is in alignment with the deflection needle when the alarm occurs.

s. Restore the alarm limit wiper to the full left position.

t. Likewise, adjust the M1 PATH DEVIATION METER upper path limit alarm wiper toward the deflection needle until the reading on the PIR drops at least 20 dB, indicating an alarm.

u. Confirm the alarm limit wiper is alignment with the deflection needle when the alarm occurs.

v. Restore the alarm limit wiper to the full right position.

w. Repeat steps q. through v. for M2 and M3 PATH DEVIATION METERS.

x. On the M1 field monitor CHAN board, install DVM between RF level test point TP1 and chassis ground, TP0.

y. Measure and record the reading on the DVM.

z. On the M1 field monitor CHAN board, adjust input level GAIN control potentiometer, R1, to decrease the voltage on the DVM until the front panel alarm lamp just lights.

aa. Confirm the reading on the DVM is within the range of 1.45 to 1.65 VDC (3.0 +/- 0.6 dB) and that the PIR reading drops by at least 20 dB, indicating low RF level alarm.

bb. Adjust GAIN control R1 to increase the voltage at TP1 until the alarm lamp just lights.

cc. Confirm the reading on the DVM is within the range of 5.0, +/- 0.25 VDC (7.0 +/- 0.4 dB) and that the PIR reading drops by at least 20 dB, indicating high RF level alarm.

dd. Adjust GAIN control R1 to the same voltage reading as measured in step y. and confirm that the PIR indicates no alarm from the snap-down monitor.

ee. Repeat steps x. through dd. for M2 and M3 CHAN boards.

ff. Remove the dummy load, reconnecting SBO.

gg. Note and record the reading of the M2 PATH deviation meter.

hh. Observe that lengthening REAR ANTENNA PHASER Z4 raises the path, causing all deviation meters to read farther to the right (indicating increased 150 Hz).

ii. Observe that shortening REAR ANTENNA PHASER Z4 lowers the path, causing all deviation meters to read farther to the left (indicating increased 90 Hz).

jj. Restore REAR ANTENNA PHASER Z4 to the M2 PATH deviation meter reading observed in step gg.

kk. Restore system to normal operation.

NOTE

> If this procedure is performed after alignment of any of the CHAN boards, the procedure in paragraph 9.6.6.6 Field Monitor AGC Activation must be completed.

<u>9.6.6.4</u> <u>SYNC Circuit Board RF Level Alarms.</u>- The following procedure is to verify the SYNC circuit RF level alarm limits and to insure that a system shutdown will occur if the alarm is reached.

a. Bypass station monitor. Confirm the interface unit is in OPERATE, the SBO is connected, and connect the PIR to the output of alarm switch A1S1.

b. Confirm that the reading on the PIR is sufficient to drive a station detector, indicating no alarm exists in the snap-down monitor. Consult the transmitting equipment instruction book and verify that the level measured is appropriate to drive a station detector.

c. On the SYNC circuit board, install a DVM between TP1 and chassis ground, TP0.

d. Measure and note the reading on the DVM.

e. Decrease the voltage at TP1 by adjusting GAIN control R1 until the front panel SYNC level alarm lamp just lights.

f. Confirm the reading on the DVM is within the range 3.6 +/- 0.25 VDC and that the reading on the PIR has dropped at least 20 dB, indicating low SYNC level alarm.

g. Increase the voltage at TP1 by adjusting GAIN control R1 until the front panel SYNC level alarm lamp just lights.

h. Confirm the reading on the DVM is within 5.0 +/- 0.25 VDC and that the reading on the PIR has dropped at least 20 dB, indicating high SYNC level alarm.

i. Restore the voltage at TP1 to the same value as measured in step d., nominally 4.3 VDC.

j. Disconnect the PIR from alarm switch A1S1 and substitute the clearance detector.

k. Restore system to normal operation.

NOTE

During a commissioning flight inspection where the monitor is set, the possibility exists that the allowable course RF level alarm, monitored by the integral detector, will be less than the lower limit internal to the SYNC board. It is important to insure that the snap-down circuit is functioning properly when configured for course RF level. To accomplish this, use R1 GAIN control on the SYNC circuit board to temporarily increase the TP1 voltage to just below the 5.0 volt upper RF level alarm point, then decrease the course transmitter output for course RF level alarm.

Do not use the SYNC board RF limit to establish the station course RF level limit.

9.6.6.5 Initial Path Angle.**-** The initial path angle procedure provides a "coarse" method to obtain a glide path angle as close as possible to the commissioning angle, yet without the assistance of an aircraft. The method should provide a path-in-space at the desired commissioning angle +/- 0.20 degrees and is therefore considered both "coarse" and an initial adjustment. The final angle adjustment will be made during flight inspection. Because the End-Fire is a phase reference system, it is given that a known phase delay in the front antenna line will bring the path angle down to ground level. However, the longitudinal slope of the runway shoulder that contains the antenna system, which defines ground level, must be known. For example, if the runway shoulder slopes down toward the runway threshold by 0.30 degree, then an electric angle of 3.30 degrees must be radiated to obtain a physical angle of 3.00 degrees. Conversely, if the runway slopes upward by 0.30 degrees, then an electric angle of only 2.70 degrees must be radiated to obtain the physical angle of 3.00 degrees. Using this characteristic, but working backwards, it is given that if the system is phased for a path at ground level and then a given delay line is removed from the front antenna, then the glide path will rise predictably to near the desired angle. This is the basis to establish the initial angle.

NOTE

> Line length L2 (A6W3) in the snap-down circuit (see Figures 9-21 and 9-28) has been factory-cut (relative to A6W2). The factory length of L2, typically 86 degrees at midband, is provided such that a 3.2 degree angle between ground level and the desired path angle can be accommodated. The value of this "insertion length" represents the physical L2 cable and the differential path lengths through various devices in two signal paths. It does not represent only electrical length of cable L2. The differential path length, in electrical degrees phase lag, is measured at the factory and has been recorded on the test data sheet DS016A, shipped with the interface unit. The delay length determines what the angle between the path and the runway will be, in normal operation, when the limit meters are reading 100 microamperes (center-scale), corresponding to zero DDM.

a. Refer to Table 9-15 with the insertion length DL, in electrical degrees, that is provided by the factory on Data Sheet DS016A.

b. Determine the maximum corresponding angle AR, in degrees, between a given glide path and the physical runway that can be "snapped-down" or brought to ground level using the factory delay line. For example, if the factory measurement is 87.0 degrees, an angle AR of 3.22 can be accommodated between the glide path angle and the physical runway.

c. Compare the value of the angle obtained in step b. to the angle that exists at the site between the physical glide path angle and the longitudinal angle of the runway. Consult the facility installation drawing to determine the longitudinal slope of the runway toward the threshold and the desired commissioned angle. If the runway slopes downward, the longitudinal slope angle, in degrees, should be added to the desired commissioned angle. Conversely, if the runway slopes upward, the longitudinal slope angle, in degrees, should be subtracted from the commissioned angle.

d. If the insertion length in electrical degrees, as supplied, is too large, use Table 9-15 to choose a new value for DL, and carefully trim the difference from L2, in the amount of 0.070 inch per electrical degree. Use a vector voltmeter to measure the factory cable and fabricate a longer one if the cable is already too short.

e. Trim front main antenna pigtail cable W4, or rear main antenna pigtail cable W8 as required, so that when the REAR ANTENNA PHASER A6Z4 is adjusted to provide a reading of 100 microamps, i.e., center scale (zero DDM), on the M2 path deviation meter. Insure that the phaser is well within the phaser scale range, but DO NOT attempt to perfectly center the phaser at this time as tuning adjustments in the following procedures will likely require additional trimming.

Table 9-15. Snap-Down Insertion Phase

Electrical degrees of delay, DL, to be inserted in the front main antenna feed by the snap-down circuit path cable L2 (A6W3) versus the angle AR, given in degrees, of the glide path angle relative to the longitudinal slope of the runway shoulder, also represented in degrees, for a standard antenna spacing 55092 electrical degrees.

$$DL = \frac{55092 \times (AR)^2}{2 \times (57.3)^2}$$

AR	0.00	0.02	0.04	0.06	0.08
2.20	40.6	41.3	42.1	42.9	43.6
2.30	44.4	45.2	45.9	46.7	47.5
2.40	48.3	49.1	49.9	50.8	51.6
2.50	52.4	53.3	54.1	55.0	55.8
2.60	56.7	57.6	58.5	59.4	60.3
2.70	61.2	62.1	63.0	63.9	64.8
2.80	65.8	66.7	67.7	68.6	69.6
2.90	70.6	71.5	72.5	73.5	74.5
3.00	75.5	76.5	77.5	78.6	79.6
3.10	80.6	81.7	82.7	83.8	84.8
3.20	85.9	87.0	88.1	89.2	90.3
3.30	91.4	92.5	93.6	94.7	95.8
3.40	97.0	98.1	99.3	100.4	101.6
3.50	102.8	104.0	105.1	106.3	107.5
3.60	108.7	109.9	111.2	112.4	113.6
3.70	114.9	116.1	117.4	118.6	119.9
3.80	121.1	122.4	123.7	125.0	126.3
3.90	127.6	128.9	130.2	131.6	132.9
4.00	134.2	135.6	136.9	138.3	139.7

NOTE

Alternatively, the correct snap-down phase difference can be set directly using vector-voltmeter readings from directional samplers placed in the front and rear main wattmeter bodies. However, the CSB sidebands must exist for the snap-down circuits to function properly and the CSB sidebands must be removed to allow some modern vector-voltmeters to lock. In path-up you must temporarily remove the sidebands from the CSB producing only carrier, phase reference the vector-voltmeter, turn the transmitter sidebands back on, switch into path-down mode, remove the system sideband again, and read the delta phase change. Restore the system to normal.

9.6.6.6 Field Monitor AGC Activation.- The use of field monitors M1, M2, and M3 are necessary to detect any changes in the transverse structure of the End-Fire system. Transverse changes occur principally from the movement of antenna pedestals and cannot be detected by the system integral monitor. The field monitor channel circuitry will detect changes in DDM and RF level. However, RF level changes in excess of 22 dB will cause an outage to occur. Each channel amplifier has a fixed RF gain of approximately 52 dB and an additional 20 dB gain actuated by an internal automatic gain control (AGC) circuit driven by the output level of each monitor CHAN circuit board. The AGC circuit maintains a constant input level to the channel cards to provide a “DDM” reading independent of the received signal level. The AGC amplifier control lines are color-coded to ensure that each monitor CHAN board is always connected to its respective amplifier.

NOTE

AGC activation should be initiated only after each CHAN board has been initially adjusted for the nominal value 2.2 VDC at TP1 and without snow on the ground. Do not attempt to readjust CHAN board gain after the AGC circuit has been activated, unless the AGC wires are disconnected from TP1.

a. Ensure the front panel path mode switch is in the OPERATE position.

b. Observe and record the deflection readings of the M1, M2, and M3 front panel set-point meter deflection needles.

c. With a DVM, measure the differential DC voltage between terminal E3 on AGC amplifier AR1 and the M1 channel card TP1.

d. Adjust the R1 GAIN control on the M1 CHAN board until a reading of zero volts is obtained indicating that no difference in potential exists between the two points.

e. Activate the AGC function by inserting the plug (blue wire) from the amplifier terminal E3 to the M1 channel board TP1.

f. Repeat steps a. through f. for AR2, M2 (grey) and AR3, M3 (green).

g. Verify that the readings of the M1, M2, and M3 monitor channels are the same as in step b. taken prior to energizing the AGC circuit.

h. Verify the meter readings are stable within approximately +/- one meter division.

<u>9.6.6.7 Main Bridge (Teleplex Hybrid) Tuning:</u> The Teleplex hybrid has two tuning capacitors in one output line that allows for balancing of a 2:1 VSWR existing at the bridge output. See Figure 9-31. Balancing the bridge will optimize for equal power division between the front and rear main antennas and will minimize leakage from the CSB input to the SBO port, and vice-versa. For systems that provide alarms for VSWR on the CSB and SBO ports, balancing the bridge will reduce the apparent VSWR caused by bridge leakage. The following procedure is used to optimize the bridge.

NOTE

Balancing the bridge is not required to meet specifications. However, several benefits can result. A new replacement hybrid can be installed in the system without tuning.

The tuning adjustments are “sealed” by using Loc-tite on the tuning screws. A standard screwdriver can be used to break the factory seal if necessary.

The bridge is balanced at this point in the tune-up procedure because the REAR ANTENNA PHASER A6Z4 needs to be in the approximate operating position. The snap-down line section needs to be trimmed so that the bridge would “see” the approximate complex impedances expected in normal operation.

Balancing the bridge will introduce a phase change between the front and rear main antennas. This will require re-trimming the front or rear main antenna pigtail cable to re-center REAR ANTENNA PHASER A6Z4. For optimum bridge isolation and balance, the process requires iteration between balancing the bridge tuning capacitors and adjusting the feedline to center phaser REAR ANTENNA PHASER A6Z4.

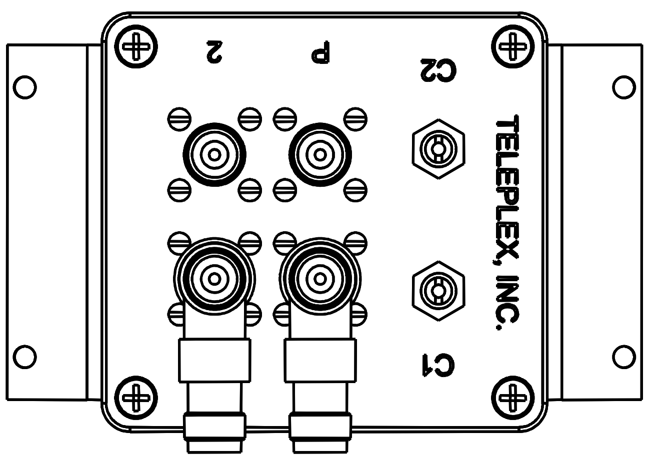


Figure 9-31. Teleplex Hybrid, Main Bridge (shown as mounted in interface unit)

a. Ensure that all system feedlines are properly connected to the EF9 interface unit and that all antenna VSWR reading are within tolerances. DO NOT attempt to adjust the bridge while a high VSWR exists for an antenna or feedline.

b. Verify the front panel mode switch is in Operate.

c. Read and record the reading of the field monitor channel M2, front panel set-point meter deflection needle.

d. Dummy load the SBO input to the interface unit.

e. Rotate the SBO wattmeter element to read “reflected” power.

f. Place the RF POWER TEST meter selector to SBO.

g. While observing the apparent “reflected” signal in the RF POWER TEST meter, iteratively adjust the two tuning capacitors C1 and C2 on the bridge, to achieve minimum deflection on meter.

h. If the reading is beyond the resolution of the meter, replace the SBO element with a smaller value or insert a directional sampler oriented to read reflected power and connect the sampler output to a PIR.

i. While observing either the RF POWER TEST meter or RF level on the PIR, iteratively adjust the two tuning capacitors to achieve a minimum reading on meter.

j. Reconnect the SBO input to the Interface unit.

k. Rotate the SBO wattmeter element to read forward power.

l. If necessary, adjust REAR ANTENNA PHASER Z4 to restore the M2 meter reading to the reference taken in step c.

m. If an adjustment of less than 15 degrees is required, repeat the bridge tuning procedure. If an adjustment of more than 15 degrees is required, trim 50 percent of the adjustment required from the front or rear pigtail cable and repeat the bridge tuning procedure.

n. Bridge balancing is complete when an adjustment of 10 degrees or less is required on the REAR ANTENNA PHASER A6Z4 to set the M2 reference when the phaser is near center range.

o. Place the METER SELECTOR on SBO and record the forward power reading.

p. Rotate the SBO wattmeter element to read reflected sideband power and record the reading.

q. Restore the SBO wattmeter element to normal.

r. Place the METER SELECTOR on CAR and record the forward power reading.

s. Rotate the CAR wattmeter element to read reflected power and record the reading.

t. Restore the CAR wattmeter element to normal.

u. Place the METER SELECTOR on F (front antenna out) and record the forward power reading.

v. Rotate the F wattmeter element to read reflected power and record the reading.

w. Restore the F wattmeter element to normal.

x. Place the METER SELECTOR on R (rear antenna out) and record the forward power reading.

y. Rotate the R wattmeter element to read reflected power and record the reading.

z. Restore the R wattmeter element to normal.

aa. Calculate the ratio of main antenna feedline powers REAR/FRONT to determine that the ratio is within 1.6 to 1.0.

bb. Restore the system to Normal.

cc. When bridge tuning is complete, apply a medium-strength Loc-tite to the outside of tuning capacitors C1 and C2.

9.6.6.8 Integral Monitor Adjustment.- The following procedures are used to tune the path, width, QUAD and clearance detector input circuits.

NOTE

Historically, overly conservative monitor limit settings have resulted in unnecessary system outages. Effort should be made to establish reasonable monitor settings while safeguarding the operation of the glide slope.

Line length L1 (A6W8) in the WIDTH DET circuit has been factory-cut (relative to A6W10) to provide a suitable below-path (150 Hz high) signal, and needs no adjustment to line length.

The PATH and WIDTH DET circuits outputs are interactive and should always be terminated into the detector unless connected to the PIR.

a. Bypass station monitor. Ensure the front panel mode switch is in OPERATE, that all cables are connected to the interface unit, and that all interface unit monitor outputs are terminated with the appropriate detector.

b. Confirm the mode switch of autophasers A7Z1 and A7Z2 are in PRESET position and red LEDs are illuminated.

c. Disconnect PATH 1 DET from its combiner hybrid A7HY1 on the autophaser assembly and substitute a PIR configured to read RF level. **(**Refer to Figure 9-21.)

d. Disconnect W24 (MF), front antenna integral monitor pigtail cable, from the interface unit and terminate both ends with 2W dummy loads.

e. Measure and record reading on the PIR of the rear main antenna integral monitor signal.

f. Disconnect W25 (MR), rear antenna integral monitor pigtail cable, and terminate both ends with 2W dummy loads.

g. Reconnect the front antenna monitor cable (MF).

h. Measure and record reading on the PIR of the front main antenna integral monitor signal.

i. Compare the PIR readings of the rear and front main integral monitor signals recorded in steps e. h. respectively.

j. Due to the insertion loss characteristics of the two phase shifters in the autophaser assembly, one in the rear transmit line and the other in the rear antenna integral monitor line, the front antenna integral signal should be approximately 1 dB stronger than the rear antenna integral monitor signal.

k. Temporarily switch the front panel mode switch to PATH DOWN and observe a nominal decrease of 10 dB on the PIR due to the attenuator that is switched into the front antenna line during snap-down. Return front panel mode switch to OPERATE.

l. Remove the dummy load and reconnect the rear antenna monitor cable (MR).

m. While observing the PIR reading due to the combined front and rear antenna integral monitor signals, adjust the trombone phaser PH (A6Z6) in rear antenna integral monitor line (MR) for maximum signal level.

n. Configure the PIR to read DDM. Re-adjust trombone phaser (A6Z6) to obtain 0 DDM. Only several degrees of trombone phaser adjustment should be required.

o. Trim either feed line MR or line MF as required until the 0 DDM reading on the PIR is well centered in the range of adjustment of the trombone phaser.

p. Configure the PIR to Read RF level. Consult the electronic equipment manufacturer's instruction books to determine that adequate signal level exists to drive the station PATH detector.

q. Reconnect PATH 1 DET.

r. Disconnect WIDTH DET from its combiner hybrid A6HY4 and substitute the PIR. (Refer to Figure 9-21.)

s. Confirm that the integral WIDTH monitor channel reading is greater than 150 DDM of 150-Hz "fly-up" signal. A typical reading is between 0.175 and 0.275 DDM depending on the sideband power.

t. Configure the PIR to read RF level. Consult the electronic equipment manufacturer's instruction books to determine that adequate signal level exists to drive the station WIDTH detector.

u. Restore the WIDTH DET.

v. Disconnect QUAD DET from its 30 dB sampler on the A6HY1 bridge (See Figure 9-21) and substitute the PIR.

w. Configure the PIR to read DDM and adjust the transmitter SBO phase control for zero DDM. The adjustment will be very sensitive.

x. Configure the PIR to Read RF level. Consult the electronic equipment manufacturer's instruction books to determine that adequate signal level exists to drive the station QUAD (PATH 2 or NEAR-FIELD) detector.

y. Reconnect the QUAD DET.

z. Remove the CLEARANCE DETECTOR from the output of alarm switch A1S1 and substitute the PIR.

aa. Configure the PIR to Read RF level. Consult the electronic equipment manufacturer's instruction books to determine that adequate signal level exists to drive the station CLEARANCE DETECTOR. Reconnect clearance detector.

bb. If used, disconnect the CLR DET RF mixing signal from its 30 dB sampler output on the A6HY1 bridge and substitute the PIR.

cc. Configure the PIR to Read RF level. Consult the electronic equipment manufacturer's instruction books to determine that adequate signal level exists to drive the station clearance detector RF MIX input.

dd. Disconnect the PIR and reconnect CLR DET J1 RF mixing signal.

ee. Observe integral path monitor display and adjust the monitor rack circuitry for zero DDM, RF level for 100 percent.

ff. Observe PATH 2 or NEAR-FIELD monitor display used as the QUAD monitor channel, and adjust the monitor rack circuitry for zero DDM.

gg. Observe WIDTH monitor display and adjust the monitor rack circuitry for desired DDM.

hh. Observe clearance monitor display. Adjust monitor rack RF level circuitry for 100 percent.

9.6.6.9 Clearance Blocking.- The snap-down monitor provides circuitry for effectively turning off the clearance transmit signal during the time interval that the path is snapped down. During this interval the clearance transmit signal is switched to a dummy load. Simultaneously an attenuator and a delay line are electrically switched into the front antenna. To verify proper operation perform the following procedures.

a. Plug oscilloscope into waveform TEST jack (Figure 9-27).

b. Set RF POWER TEST meter selector to C (Clearance antenna).

c. Observe the 150 Hz modulation pattern and compare with the blocking pulse shown in Figure 9-32. The interruption in the clearance waveform, described as a blocking pulse, is the result of a brief interruption in the clearance output signal.

d. Note wattmeter reading of C.

e. Remove phone plug from the waveform TEST jack.

f. Temporarily turn mode switch for OPERATE to PATH DOWN and observe that the wattmeter reading of C drops to zero. The drop to zero is a result of the clearance signal being switched to a dummy load. Observe that a clearance RF level alarm is evident on the station monitor electronics rack.

g. Return front panel mode switch to OPERATE.

h. Set RF POWER TEST meter selector to F (Front antenna).

i. Temporarily turn mode switch from OPERATE to PATH DOWN and observe that the wattmeter reading of F drops significantly (approximately 10 dB). The drop in level is a result of the 10 dB attenuator being switched into the front antenna. Return front panel mode switch to OPERATE.

j. Restore the system to normal.

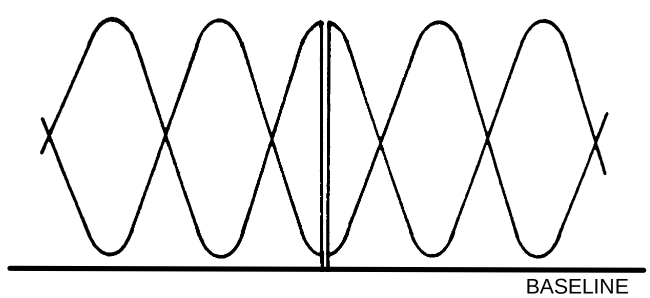


Figure 9-32. Clearance Antenna Waveform, Blocking Pulse

9.6.7 Main Antenna Pedestal Adjustments.– Pedestal adjustments are typically required to optimize the signal-in-space. The process involves locating ground check points near the threshold and physically moving antenna pedestals based on PIR readings taken during a ground check in path down. Further adjustments may be required during the commissioning flight inspection. The procedures for adjusting pedestals are extensive and are not considered as part of the electrical alignment of the system.

NOTE

Instructions to optimize the main antenna signal-in-space by pedestal adjustment are contained in Appendix 1. Model 105 End-Fire Glide Slope Antenna System – Optimization Supplement.

Main antenna pedestal adjustments will result in the need to realign the path angle, integral monitor, and snap-down circuits.

9.6.8 Clearance Antenna Adjustments. - Adjustments of the physical orientation of the clearance antenna and/or the radiated power level may be required to optimize the clearance antenna signal-in-space. The process involves locating ground check points near the threshold and rotating the antenna clockwise or counter clockwise based on PIR readings taken during a ground check in path down. Further adjustments may be required during the commissioning flight inspection. The procedures for adjusting the clearance antenna are not considered as part of the electrical alignment of the system.

NOTE

Instructions to optimize the clearance antenna signal-in-space by rotation and power adjustment are contained in Appendix 1. Model 105 End-Fire Glide Slope Antenna System – Optimization Supplement.

Clearance antenna adjustments may result in the need to realign the clearance integral monitor circuit for RF level.

9.6.9 Initial Alarm Limits.- This system provides for the direct movement of the glide path angle up and down by adjustment of the REAR ANTENNA trombone PHASER A6Z4. An increase (delay) of 10 degrees in the electrical length of the trombone raises the angle 0.2 degrees. Shortening the phaser length by 10 degrees (advance) will lower the path by 0.2 degrees. Using R4, CENTering controls on the CHANnel boards, set the snap-down meters M1, M2, M3 PATH deflection each to 100 microamperes (center scale), then establish the initial settings for the upper and lower limit pointers of the snap-down monitor meters M1 PATH, M2 PATH, and M3 PATH, and the integral monitor path channel corresponding to an angle change of + 0.25 degree (12.5 degrees delay) and -0.18 degrees (9 degrees advance). The QUAD phase monitor detector signal that is applied to the PATH 2 or NEAR-FIELD channel input on the station monitor should be set for +/- 75 uA alarm points. An initial clearance antenna RF level of 84 percent (1.5 dB) is recommended on the station monitor. To set the initial alarm limits of the station monitor, follow the procedures given in the station instruction book. These settings are subject to change and verification during and after the flight check.

NOTE

To establish initial limits, both phase shifters in the autophaser assembly must be in PRESET.

Overly conservative monitor limit settings will result in an increase in the number of system outages. Effort should be made to establish reasonable monitor settings while safeguarding the operation of the glide slope.

9.6.10 Autophaser Adjustment.- The autophaser subassembly Type AP-105, reference designation EF9A7, is used to stabilize the path angle in space and the integral path monitor by removing small errors resulting from a difference in temperature or characteristics of the transmission line that would otherwise place the system monitor closer to alarm. The unit is comprised of two analog phase shifters: VERTEX RSI Model DPO-105A, reference designations EF9A7Z1 (XMIT) and EF9A7Z2 (MON). XMIT phase shifter Z1 is inserted in the rear main antenna feedline (R) and receives its error signal from the M2 field monitor circuit by a tap from the corresponding channel front panel deviation meter. MON phase shifter Z2 is inserted in the rear main antenna monitor return line MR and receives its error signal from a tap of the integral path 1 that is processed by the MON AP CHAN board, which is the same board as and interchangeable with the M1, M2, and M3 CHAN boards. Other than an initial alignment to verify functionality, the autophaser assembly should be adjusted only after flight inspection when alignment of the integral monitor and snap-down monitors have been completed. This procedure provides instructions to align both the transmit and monitor phase shifters and the MON AP CHAN board. The alignment procedure is also used to verify that the shifters are capable of providing phase correction of at least 5 degrees but not greater than 9 degrees. Refer to the controls and test points shown in Figure 9-33 and throughout the autophaser alignment procedure.

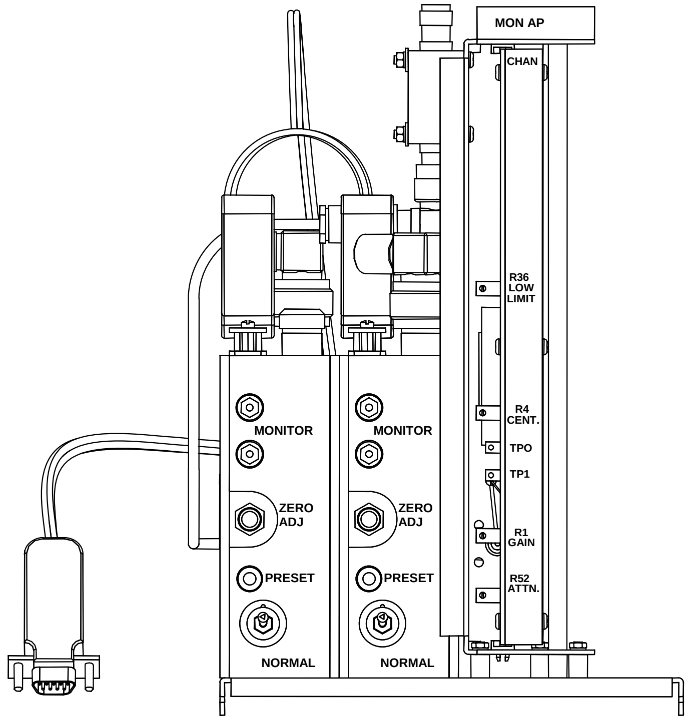


Figure 9-33. Autophaser Assembly, Type AP-105, Front View

a. Confirm that the mode switches of both phase shifters, A7Z1 (XMIT, right shifter) and A7Z2 (MON, left shifter), are in the PRESET position with the red LEDs illuminated, and the system is operating normally.

b. Bypass station monitor. Remove the PATH 1 detector from its Combining Hybrid A7HY1 port 1 and substitute the PIR configured to read DDM.

c. Confirm the M2 monitor channel meter reading is precisely 100 uA centered, and integral PATH 1 channel reads precisely 0 DDM with the PIR. If the reading on the PIR is not 0 DDM, but within +/-0.003 DDM, then fine adjust integral monitor phaser Z6 to obtain precisely 0 DDM. If the reading is greater than +/- 0.003 DDM, repeat the integral monitor alignment procedure in paragraph 9.6.6.8.

d. Place interface unit front mode switch in PATH DOWN.

e. Turn transmitter off

f. Install a dummy load on SBO input to the interface unit so that only CSB is being radiated.

g. Remove the AGC control line from TP1 on the M1 monitor channel board.

h. Remove the M1 CHAN board from its slot and temporarily set it aside.

i. Calibrate the autophaser MON AP CHAN board by substitution into the empty M1 CHAN board slot.

j. Turn transmitter on.

k. Install DVM between RF level test point TP1 and chassis ground, TP0.

l. On the autophaser MON AP board in the M1 slot, adjust input level GAIN control potentiometer, R1, for maximum clockwise as evidenced by clicking when screw is turned or when the voltage at TP1 stops increasing.

m. Adjust input level ATTN control potentiometer, R52, (clockwise) for a reading between 6.0 and 10.0 volts, nominally 8.0 VDC.

n. Re-adjust GAIN, R1, reducing reading to 1.55 volts.

o. Adjust M1 RF level LOW LIMIT, R36, until M1 LEVEL ALARM lamp just lights.

p. Readjust M1 GAIN, R1, (clockwise) for a reading of 2.2 VDC on the DVM.

q. Center the M1 front panel path deviation meter to read 100 microamperes, using CENT control potentiometer, R4, on the circuit board.

NOTE

> This MON AP circuit board CENT control potentiometer, R4, should not be adjusted subsequently since the MON phase shifter A7Z2 has its own centering control.
>
> The front panel limit meter M1 PATH should now read 100 microamperes. Restoring the mode switch from PATH DOWN to OPERATE should not change the reading appreciably.

r. Turn the transmitter off. Remove Fuse, XF1, to de-energize the EFGS APCU.

s. Remove the autophaser MON AP CHAN board from the M1 slot and return it to its slot in the autophaser assembly. Also restore the M1 CHAN board to the M1 slot in the interface unit. Note: Card is not keyed, care should be taken to ensure proper card orientation.

t. Reconnect the AGC control line to TP1 on the M1 monitor channel board.

u. Reinstall Fuse, XF1, and turn the transmitter on.

v. On the MON AP CHAN circuit board, install a DVM between TP1 and chassis ground, TP0.

w. Readjust the MON AP GAIN control potentiometer R1, for 2.2 VDC on DVM. If 2.2 VDC cannot be achieved within range of R1, fine adjust ATTN R52 for 2.2 VDC.

x. Place the interface unit front panel mode switch in OPERATE.

y. Remove dummy load and reconnect SBO to the interface unit.

z. Install DVM between the two external MONITOR test points on the front of Z1 (XMIT) phase shifter (right shifter).

aa. Note and record the voltage reading. Verify the reading is within the tolerance of 1.60 volts +/- 0.15 VDC.

bb. Observe the centered M2 path deviation meter reading of 100 uA, the MONITOR test point voltage reading of phase shifter Z1, and 0 DDM on the PIR connected to the integral PATH detector port. Place the Z1 XMIT phase shifter mode switch to the NORMAL position.

cc. Adjust Z1 PHASER ZERO ADJ control to restore the MONITOR reading to the same value observed in the PRESET mode and confirm that path deviation M2 deflection is restored to 100uA (centered) and the PATH 1 PIR reading is restored to 0 DDM.

NOTE

The phase shifter MONITOR test points provide a DC voltage that can be related to electrical degrees, advance and retard that the autophaser is introducing into the system. See Table 9-16, which shows the correlation from test point voltage to electrical degrees of phase shift. The asterisks identify the region where the phase shifter limit has been reached, and no further change in voltage is evident. The Monitor test point voltage is extremely sensitive and can be expected to drift slightly.

If concern exists regarding the stability of the test point voltage, consult Table 9-16 to determine if the phase change introduced by the shifter is significant.

dd. Confirm that temporarily switching the Z1 mode switch from NORMAL to PRESET shows no appreciable change in the readings of the PATH 1 PIR, the Z1 MONITOR test points or the path deviation M2 deflection.

ee. Note the reading of the REAR ANTENNA trombone PHASER A6Z4.

ff. Advance REAR ANTENNA trombone PHASER A6Z4 slowly until a reading of -0.005 DDM is observed on the PIR, indicating that the autophaser is out of range and can no longer compensate for the change in phase.

gg. Read the setting of REAR ANTENNA trombone PHASER A6Z4 and calculate the difference from the setting recorded in step ee. Record the difference and confirm the reading is within tolerance limits of at least 5 degrees but not greater than 9 degrees. Confirm path deviation meter M2 is slightly displaced to the left from center scale.

hh. Retard REAR ANTENNA trombone PHASER A6Z4 slowly until a reading of +0.005 DDM is observed on the PIR, indicating that the autophaser is out of range and can no longer compensate for the change in phase.

ii. Read the setting of the REAR ANTENNA trombone PHASER A6Z4 and calculate the difference from the setting observed in step ee. Record the difference and confirm the reading is within tolerance limits of at least 5 degrees but not greater than 9 degrees. Confirm path deviation meter M2 is slightly displaced to the right from center scale.

jj. Throw phaser Z1 (XMIT) mode switch from NORMAL to PRESET to disable the shifter and adjust the REAR ANTENNA trombone PHASER A6Z4 so that the path deviation M2 deflection is restored to 100uA (centered). Confirm that the REAR ANTENNA trombone PHASER A6Z4 is returned to the same value as identified in step ee.

kk. Note the reading indicated with a DVM connected at the MONITOR test points for phase shifter Z2 (MON). Verify the reading is within the tolerance of 1.60 volts +/- 0.15 VDC.

ll. Place the Z2 (MON) phase shifter mode switch from PRESET to NORMAL to engage the monitor shifter.

mm. Adjust Z2 (MON) phase shifter ZERO ADJ control to restore the MONITOR test point reading to the same value observed in the PRESET mode, step kk, and confirm that the PATH 1 PIR reading is restored to 0 DDM.

nn. Confirm that temporarily switching the Z2 (MON) phase shifter mode switch from NORMAL to PRESET shows no change in the reading of the PATH 1 PIR or the Z2 (MON) phase shifter MONITOR test point voltage.

oo. Throw the Z2 (MON) switch back to NORMAL. Note the reading of the MONITOR trombone PHASER A6Z6.

pp. Advance MONITOR trombone PHASER A6Z6 slowly until a reading of -0.005 DDM is observed on the PIR, indicating that the autophaser is out of range and can no longer compensate for the change in phase.

qq. Read the setting of MONITOR trombone PHASER A6Z6 and calculate the difference in the setting observed in step oo. Calculate the difference and confirm the reading is within the tolerance limit of greater than 5 degrees but less than 9.

rr. Retard MONITOR trombone PHASER A6Z6 slowly until a reading of +0.005 DDM is observed on the PIR, indicating that the autophaser is out of range and can no longer compensate for the change in phase.

ss. Read the setting of MONITOR trombone PHASER A6Z6 and calculate the difference from the setting observed in step oo. Calculate the difference and confirm the reading is within the tolerance limit of greater than 5 degrees but less than 9.

tt. Throw Z2 (MON) phase shifter mode switch from NORMAL to PRESET to disengage the monitor shifter.

uu. Restore MONITOR trombone PHASER A6Z6 to the setting observed in step oo and confirm a reading of approximately +0.000 DDM is observed on the PATH 1 PIR.

vv. Throw both Z1 (XMIT) shifter and Z2 (MON) phase shifter mode switches from PRESET to NORMAL to engage the shifters. Confirm that a reading of approximately +0.000 DDM is observed on the PATH 1 PIR and the path deviation M2 deflection is restored to 100uA (centered).

Table 9-16. Phase Shifter MONITOR Test Point Voltage to Phase Correlation

Degrees	Volts
+9	*** 0.47 ***
+8	*** 0.47 ***
+7	*** 0.47 ***
+6	**0.67**
+5	**0.82**
+4	**1.01**
+3	**1.18**
+2	**1.34**
+1	**1.50**
0	**1.62**
-1	**1.89**
-2	**2.21**
-3	**2.44**
-4	**2.70**
-5	**3.08**
-6	**3.60**
-7	*** 3.79 ***
-8	*** 3.79 ***
-9	*** 3.79 ***

9.7 FLIGHT CHECK..- The flight check should be performed in accordance with the applicable portions of the current edition of the United States Standard Flight Inspection Manual, OA P 8200.1, with due regard for characteristics that are peculiar to End-Fire glide slope antenna systems. At the conclusion of any flight checks, with the facility in normal configuration, check the angle, width, symmetry, and structure below path.

NOTE

> To establish the system baseline during flight inspection, and to observe the changes on the integral monitor, Transmit (XMIT) and Monitor (MON) Autophasers, Z1 and Z2 respectively, front panel meter switches must be in PRESET. Failure to do so will result in an autophaser response that will remove the intended path angle adjustment.
>
> Overly conservative monitor limit settings will result in an increase in the number of system outages. Effort should be directed to establishing reasonable monitor settings while safeguarding the operation of the glide slope.

9.7.1 Preliminary Set-up.- A radio telemetering theodolite (RTT) should be set up at the location prescribed on the installation drawing to provide correct eyepiece height relative to the RPI. Establish voice radio communication between the theodolite operator and the inspection airplane.

9.7.2 Modulation Level.- Modulation level should be measured in the usually prescribed manner.

9.7.3 Modulation Equality.- Modulation equality should be recorded in the aircraft while CSB only is being radiated during a simulated “on-path” approach. This approach should be continued all the way to threshold. The importance of this test is in detection of spurious radiation from the building, a particular concern with End-Fire systems because of the low height advantage of the antenna. Deviations of 5 microamperes or more should be investigated further.

9.7.4 Airborne Phasing.- Airborne phasing check of SBO/CSB phase should not be conducted with End-Fire systems. This is an internal adjustment for quadrature in the antenna feed lines and changing this setting can only degrade system performance.

9.7.5 Initial Path Angle (Commissioning). – United States Flight Inspection tolerances for high and low path angle are 10 percent and 7.5 percent, respectively, of the commissioned angle. Maintenance personnel should avoid establishing the nominal angle below 3.0 degrees elevation. Favoring the upper side of the commissioning tolerance, will provide more symmetric monitor limit settings and reduce outages.

9.7.6 Path Angle and Path Width.- Angle, width, symmetry, and structure below path should all be determined on centerline in the usual way by means of several measurements to assure repeatability. If the path angle requires adjustment, it can be made with the REAR ANTENNA trombone PHASER A6Z4 (Figure 9-21). Lengthening the REAR ANTENNA trombone PHASER by 1 degree raises the path 0.02 degree. Shortening the phaser by 1 degree lowers the path 0.02 degree. (See note on previous page regarding autophaser). When the angle is changed, the width varies inversely without any change in SBO power. When raising the path angle by 0.20 degrees the width can be expected to narrow by approximately 0.05 degrees. For a substantial change in the path angle, if needed, a simultaneous adjustment of the sideband power can be made to minimize flight inspection time. To broaden the path without any angle change, reduce SBO power with the transmitter sideband power control.

9.7.7 Angular Reference. – End-Fire systems require inbound and level runs at azimuth angles outside of the 150 HZ localizer edges. It is absolutely imperative that the flight inspection aircraft provide the means to conduct these runs when referencing the runway point of intercept (RPI), which is on the runway centerline, and typically directly abeam the glide slope phase center.

NOTE

> At no time should the flight inspection aircraft reference the position of the ILS localizer antenna when performing flight measurements of the glide slope service volume at azimuth angles outside of the localizer course sector. To evaluate the glide slope outside of the localizer course sector, the runway point of intercept (RPI) should be used as the origin. The practice stated herein is consistent with the US Flight Inspection Manual 8200.1 and ICAO Annex 10. For runs on the runway centerline and at the localizer course sector edges, it is appropriate to use the localizer as the reference.
>
> Failure to use the correct reference for runs outside the localizer course sector will result in an improper evaluation of the glide slope system performance, unnecessary system adjustments, and the potential to fail the flight inspection when the glide slope is operating within commissioning tolerances.

9.7.8 Standard Measurements.- Clearance below path, tilt, structure, transverse structure, and coverage should all be checked in the prescribed manner only after the path angle and width have been set. The path angle should be set using an inbound approach before the width is established due to the interaction between the path width and changes of the path angle.

9.7.9 Transverse Structure. – A transverse structure run evaluates the lateral shape of the glide slope horizontal conic. During the run, changes in the glide slope vertical angle as a function of lateral displacement are measured and recorded. The USFIM describes the tolerances applied to the transverse structure as “Recommended Engineering Tolerances”. The tolerances are recommended because End-Fire systems provide a means to optimize the approach structure with moderate affect to the transverse shape. Any transverse structure exceeding the recommended tolerances MUST BE reviewed by engineering personnel. Measuring a transverse structure within the recommended tolerances does not necessarily imply the system will meet all other tolerances. However, a high probability exists that measurements outside of the tolerance may fail the flight inspecting during a subsequent run. Careful review of the material contained in Chapter 2 and Appendix 1 of this instruction book will provide the knowledge to determine, from a transverse structure run, the probability of successfully passing the flight inspection. The transverse structure is optimized by physically adjusting the pedestal positions of the front and rear main antennas (thus affecting antenna orientation) and by clearance power adjustments. Before pedestal adjustments are attempted, two repeatable transverse structure recordings taken in the same flight direction with only the course array radiating are needed. Another recording with course and clearance signals combined are needed.

NOTE

> Attempting to adjust antenna pedestals without first establishing repeatability in obtaining the flight recordings stated above will likely result in improper adjustment of the antenna system and potentially failing the flight inspection.

9.7.10 Clearance Power. – When analyzing a transverse structure recording with clearance signal, particular attention should be paid to the transitions from the main array signal to the clearance array signal on both sides. These capture regions occur around 5 degrees azimuth on the antenna side of the runway and 9.5 degrees azimuth on the opposite side. The inspection aircraft should explore these regions for excessive (greater than 60 microamperes) “fly-down” signal. Such condition indicates insufficient clearance signal. With normal CSB power, increase the CLR power just enough to eliminate the condition and record the wattmeter reading. This level may be used for the CLR low RF power alarm limit. Raise the clearance power the prescribed amount above this value for the normal setting, and then verify flight check performance.

9.7.11 Monitors.- The purpose of these checks is to measure the glide path parameters as prescribed by the flight inspection procedure when the facility is in alarm condition. If a parameter is found out of tolerance, the monitor channel alarm limit that should have sensed the condition must be checked and reset. Standards and Tolerances for the monitor system and permissible alarm limits can be found in the latest version of the ILS Maintenance Manual 6750.49. At the conclusion of monitor checks, return the facility to normal, and recheck the angle, width, symmetry, and structure below path.

WARNING

After the monitor has been established during commissioning, adjusting any control or limit in the snap-down, or integral monitor circuits, to prevent outages without a confirming flight inspection will serve to bypass the safeguards of the monitor and could result in catastrophic injury or loss of life.

NOTE

For the first run of a monitors flight inspection measuring the glide path angle in normal, the autophaser should be operating normally.

With exception to the initial run in Normal, to configure the system for a monitor flight inspection, Transmit (XMIT) and Monitor (MON) Autophasers, Z1 and Z2 respectively, must be in PRESET. Failure to do so will result in an autophaser response that will remove the intended path angle adjustment.

Overly conservative monitor limit settings will result in an increase in the number of system outages. Effort should be directed to establishing reasonable monitor settings while safeguarding the operation of the glide slope.

9.7.12 Monitor Configuration. - High and low angle path alarms may be set using the REAR ANTENNA trombone PHASER A6Z4 to move the path. Wide alarm is obtained by reducing the SBO power and narrow alarm is obtained by increasing the SBO power.

9.7.13 Temperature Effects on the System Monitor. - Due to the long copper main antennas and long transmission line lengths, the system and monitor will exhibit changes with temperature. Temperature effects on the main antennas result in a “tilting” of the readings across the three field monitors. Field monitor readings for M1 and M3 will go in opposite directions at one extreme and then will reverse and go in opposite directions during the other extreme. Although the effect on M1 and M3 cannot be compensated for, the autophaser transmit phase shifter will introduce the needed phase change to maintain a constant reading on field monitor M2. This characteristic is expected in varying degrees depending on the local climate. Temperature effects on the transmission line result in a bias across all three field monitors, all moving in one direction, and will also be evident in the integral path channel. The integral width channel will also indicate a change. The transmit and monitor phase shifters will remove all of this effect but will begin to consume the limited shifter range. In this condition, if the phase shifters are switched to PRESET the front panel meters may deflect significantly and integral path and width readings may change sufficiently to produce a system shutdown. Consequently, a recommendation is made that the system monitor be established during an intermediate temperature to balance the temperature effects on the monitor. Although this may not be practical during the initial commissioning flight inspection, a subsequent monitor flight inspection should occur where the limits are re-established during a moderate climate period.

NOTE

In regions of severe climate variations, establishing the monitor limits during a temperature extreme will likely result in an increase in system outages during the other temperature extreme.

9.7.14 Initial Integral Alarm Limits.- The system hardware provides for the direct movement of the glide path angle up and down by adjustment of the REAR ANTENNA trombone PHASER A6Z4. (SEE NOTE ABOVE REGARDING AUTOPHASER.) An increase (delay) of 1 degree in the electrical length of the trombone raises the angle 0.02 degree. Shortening the phaser length by 1degree (advance) will lower the path by .02 degree. Establish limits for the integral monitor PATH channel corresponding to an angle change of + 0.25 degree (12.5 degrees delay) and -0.18 degrees (9 degrees advance). The QUAD phase detector signal that is applied to the PATH 2 or NEAR-FIELD channel input on the station monitor should be set for +/- 75 uA alarm points. Path width alarm points for broad and sharp should be near the maximum permissible. An initial clearance antenna RF level of 84 percent (1.5 dB) is recommended on the station monitor. To set the initial alarm limits of the station monitor, follow the procedures given in the station instruction book. These settings are subject to change and verification during and after the flight check. Consult the latest version of FAA 6750.49 and the USFIM 8200.1 to determine the monitor and flight inspection limits.

9.7.15 Initial Snap-down Monitor Limits. – During the initial tune-up procedure for the snap-down monitor, the snap down line section A6W3 (L2) was trimmed to provide a reading of 100 uA (center scale) on the M2 field monitor channel front panel meter. The length of the line was calculated to bring the path down from the commissioned path angle to the height of field monitor antenna M2. Typically, during commissioning, the REAR trombone ANTENNA PHASER A6Z4 will require additional adjustment to achieve the desired commissioned angle in space and the M2 meter will no longer read 100 uA. After commissioning, when the path angle has been set by airborne measurement, the length of the snap-down monitor cable will likely require further adjustment. If the M2 meter is deflected to the left, the snap-down line should be shortened until a reading of +/- 20 uA is obtained. If however, the meter is deflected to the right, the cable is already too short and a new cable must be fabricated for replacement. Refer to the procedure in paragraph 9.6.6.4 for trimming the line section. After reaching the initial tolerance of +/- 20 uA, use R4, CENTering controls on the CHANnel boards to set the snap-down meters M1, M2, M3 PATH deflection each to 100 uA (center scale) then establish the limit settings. The initial settings for the upper and lower limit pointers of the snap-down monitor meters should correspond to an angle change of + 0.25 degree (12.5 degrees delay) and -0.18 degrees (9 degrees advance), respectively.

NOTE

> The integral path and width monitor should be aligned immediately following flight inspection to provide a reference to center the REAR trombone ANTENNA PHASER A6Z4 and to safeguard the operation of the glideslope.
>
> After the REAR ANTENNA trombone PHASER A6Z4 has been centered, use the integral path channel to verify that changes made to the snap-down line section had no effect on the radiated angle.

9.7.16 Snap-down Line Section A6W3 (L2).- When the snap-down line section is the ideal length, 0 DDM is represented on the M2 monitor channel meter (mid-scale reading of 100 uA) and no adjustment is needed to the M2 CHAN board ZERO potentiometer R4. In this condition the M2 channel is not sensitive to changes in the level of the front antenna, rear antenna, or the combined signal feeding the M2 MON CHAN card. The two system parameters that can produce autophaser correction are a change in the SBO/CSB phase if the front-to-rear powers at M2 are unbalanced, or the front-to rear antenna phase for which the autophaser is intended. The SBO/CSB phase is closely monitored by proper setting of the QUAD phase monitor, and therefore cannot theoretically be a factor. If the DDM reading at M2 is not actually 0 DDM but is adjusted to represent 0 DDM (center scale) using the R4 centering control or remains deflected on the meter, changes in all of the parameters identified above are capable of producing some autophaser corrections, however small. In addition, the readings on the M1 and M3 monitor channels are more sensitive to these parameter changes because of the unbalanced front-to-rear signals at the monitor antenna locations. For improved system stability and monitoring, it is recommended that the snap-down line section be trimmed for a reading no greater than +/- 20 uA in the snap-down mode. System outages will be reduced by trimming to obtain the optimum snap-down section length.

9.7.17 Periodic Flight Inspection with Monitors (with Autophaser Assembly AP-105). - Other than establishing the initial monitor limits at commissioning, all subsequent monitors flight inspections should be conducted WITH THE AUTOPHASER IN FULL OPERATION. Configuring for high angle alarm is achieved by lengthening REAR ANTENNA trombone PHASER A6Z4 until the autophaser range is exceeded and the M2 PATH DEVIATION METER is at its upper limit. Likewise, low path angle alarm is achieved by shortening the REAR ANTENNA trombone PHASER A6Z4 until the M2 PATH DEVATION METER is at the lower alarm point.

9.7.18 Narrow Alarm.- At some sites, particularly those with a greater than 0.3 degree upward slope from the antenna phase center towards threshold, most transmitting equipment will not provide enough SBO power to reach a reasonable narrow alarm setting. For a path width of 0.70 degree, a sharp alarm setting of 0.53 is permissible. Failure to establish a sharp alarm setting near the limit will greatly increase the probability of unnecessary system outages. If the facility commissioning documentation indicates the site condition where excessive SBO power is needed for narrow alarm, strongly consider installing a 2dB 10-Watt attenuator, Model number 10-A-MFN-02, in the CSB line to the interface unit. This step will insure that adequate relative SBO signal exists to achieve the narrow alarm monitor condition.

9.8 PERFORMANCE RECORDS.- Record all measurements and technical data pertaining to the installation and original commissioning of the glide slope station on appropriate FAA standard forms. When filled out, these forms provide a complete record of performance, meter indications, and dial settings at the time of certifications. Revisions should be entered whenever major changes are made that affect the data. Make sure that the forms remain with the station at all times.

9.8.1 Ground Check with Autophaser Assembly AP-105.- The path down ground check should be conducted with the AUTOPHASER ASSEMBLY IN FULL OPERATION.