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MODEL F108, 14 GHZ CRYOGENIC FRONT-END

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MODEL F108, 14 GHz CRYOGENIC FRONT-END

Section 1. SYSTEM DESCRIPTION

1.1 Block Diagram Description

Model F108 is a dual-channel, low-noise amplifier system covering the frequency range of 12.1 to 15.4 GHz. The system is cryogenically cooled, relatively compact and sufficiently lightweight for one person to handle. Figure 1.1-1 shows a block diagram of the system. Photographs appear in Figures 1.1-2 and 1.1-3.

Model F108 primarily fills a design requisite in the Very Long Baseline Array project. The VLBA incorporates a series of receiver systems providing key frequency coverages over the range of 330 MHz to 43 GHz. Further details on the VLBA project are available in separate reports.

Over its 12.1 to 15.4 GHz range, the F108 receiver noise temperature measures less than 40 K (noise figure less than .561 dB). The dual-channel capability furnishes both left and right circularly polarized signals.

After the feedhorn, circular waveguide, 1.778 cm (.700") in diameter, provides system input, propagating both TE11 linearly polarized waves. An iris-matched window (see Section 2.2) in the waveguide supports the dewar vacuum necessary for cryogenic cooling. Thermal isolation of 300 K and 15 K waveguide surfaces requires a 0.025 mm (.010") gap in the waveguide wall. A radial choke at this point prevents signal leakage from the gap (see Section 2.3).

Inside the dewar, a compact polarizer (see Section 2.4) transduces the two circular waveguide modes to SMA coaxial-line outputs. The polarizer cools to ~ 15 K, minimizing noise associated with resistive losses.

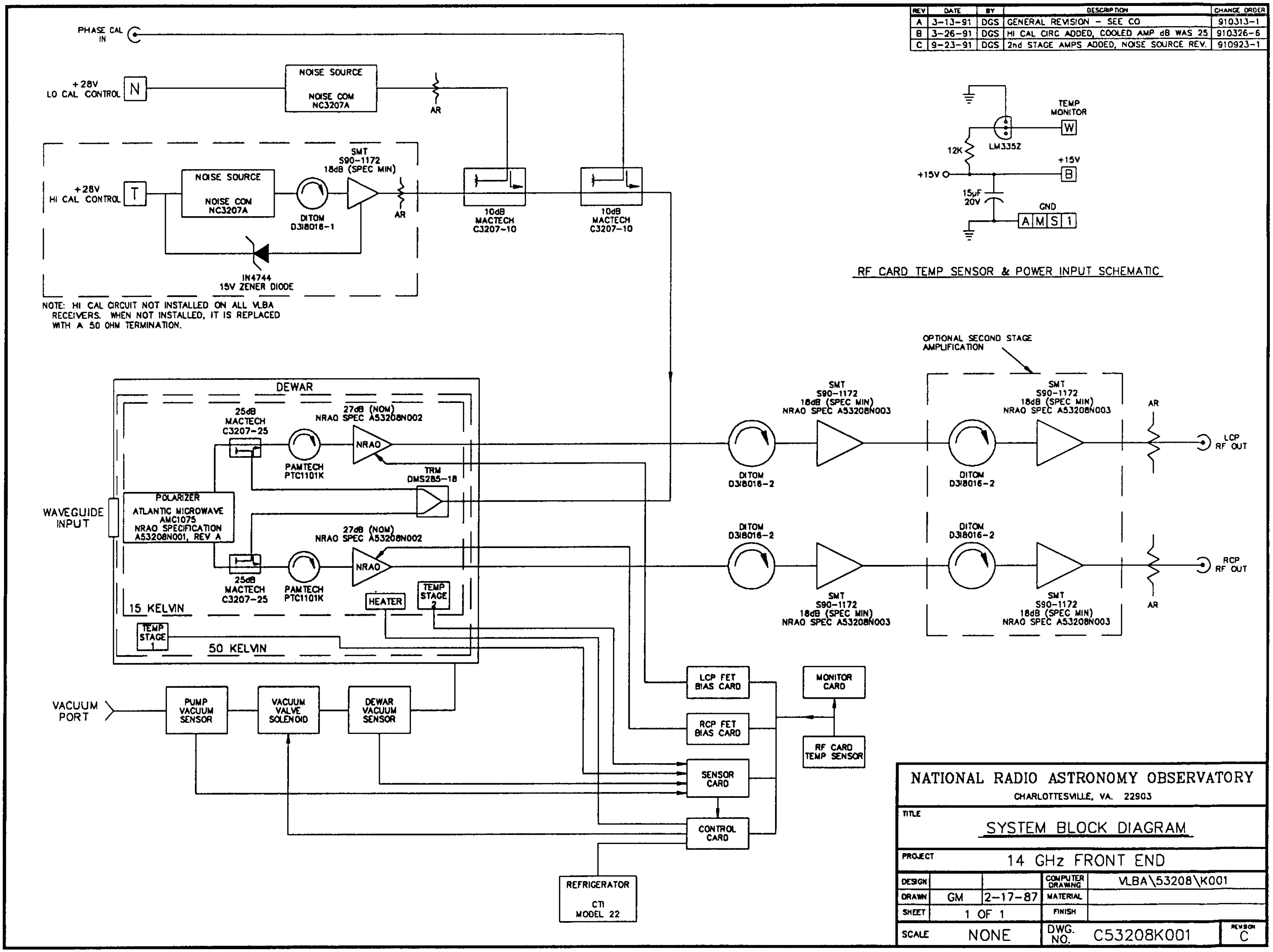
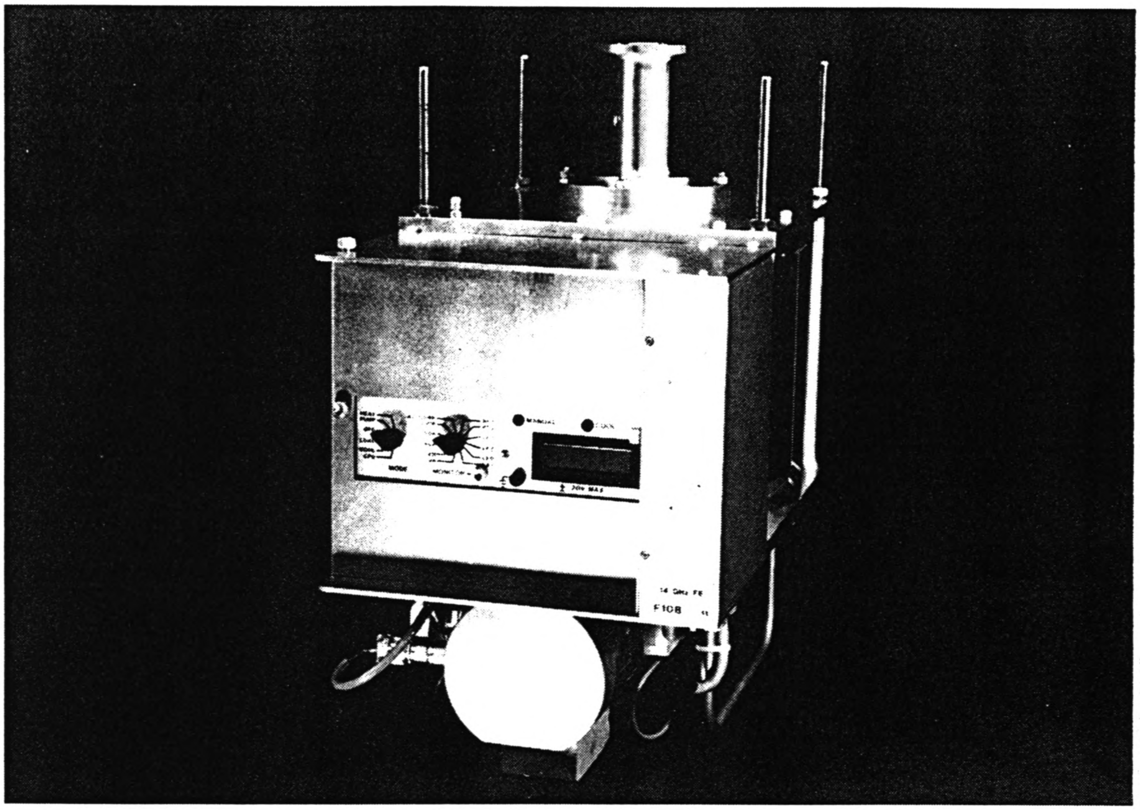


Fig. 1.1-1. System block diagram.



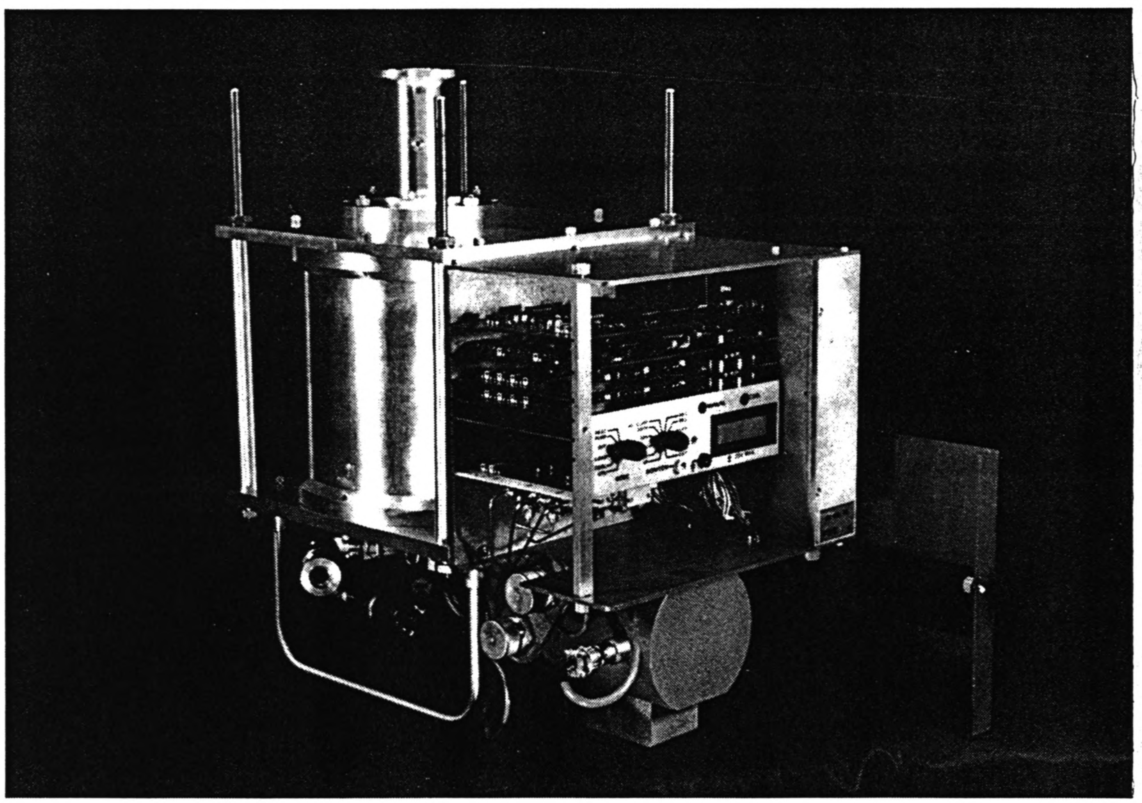


Fig. 1.1-2. Assembled 14 GHz front-end.

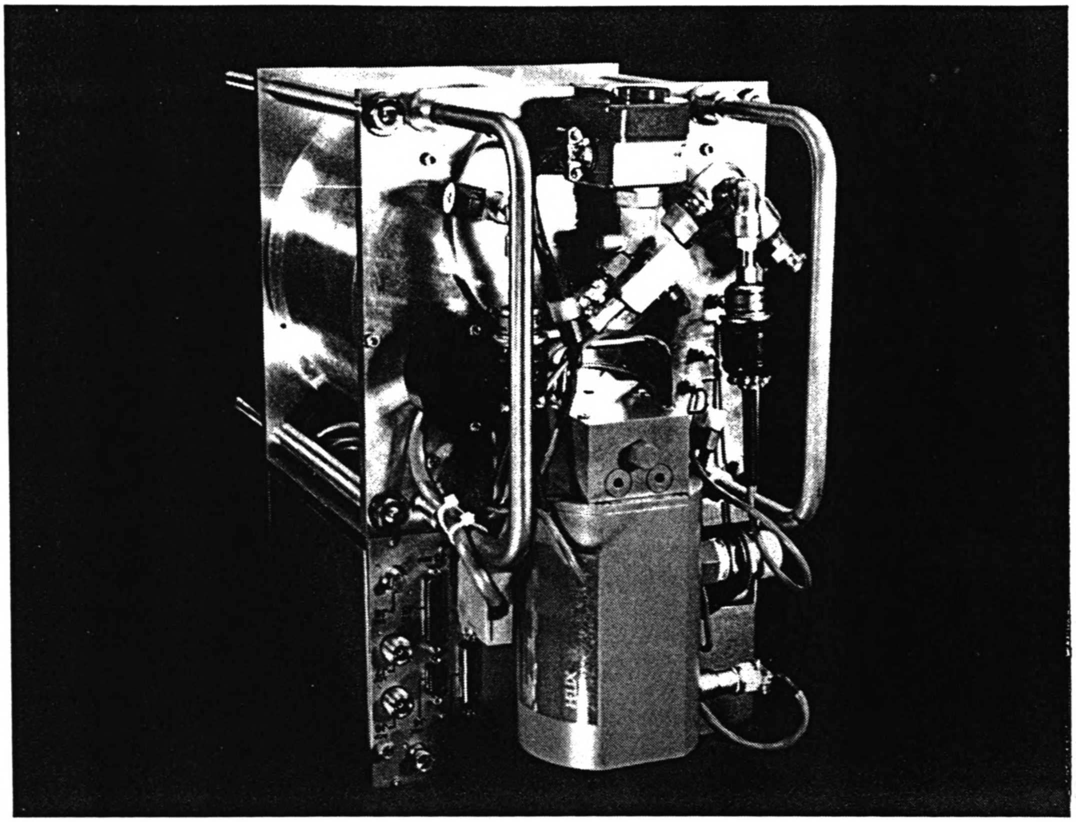


Fig. 1.1-3. Bottom plate view of 14 GHz front-end.

Polarizer SMA outputs connect via short lengths of .141" coaxial cable and isolators to three stage, ~ 25 dB gain, HEMT amplifiers. From the amplifier outputs, 2.159 mm (.085") diameter coaxial cables carry the signals to the dewar wall. Because they connect 15 K and 300 K surfaces, output cable composition is stainless-steel with beryllium-copper center conductors. Commercial hermetically-sealed SMA connectors pass the amplified signals through the dewar wall.

Semirigid 0.358 mm (.141") diameter coaxial cables transmit the signals from the SMA feedthroughs to isolator/post-amplifier combinations mounted in the card cage. The RF post-amplifiers have noise figures of approximately

2.4 dB and typical gains of 19 dB. The RCP and LCP RF outputs, 12.1-15.4 GHz, are available on connectors J6 and J7, respectively.

The F108 noise cal design utilizes coaxial components cooled to 15 K for injection of calibration noise (see Section 2.5). From the RF card, the calibration signal enters the dewar via hermetic SMA feedthroughs and stainless-steel coaxial cable. Inside the dewar, a power divider splits the calibration signal, feeding it through the coupled port of coaxial couplers connected to the input of each cryo-amplifier. Circuitry mounted on the RF card supports two types of calibration signals:

a) a low-noise calibration signal, ~ 3.0 K, for continuous pulsed gain and noise calibration of the system,

b) an externally applied signal, coupled -39 dB to both inputs, for the purposes of phase or time-delay calibration of the system.

Total coupling loss from Cal connector J8 is approximately 39 dB. From the noise source, coupling loss is approximately 46 dB.

A Cryogenics Technology, Inc. (CTI) Model 22 refrigerator provides cooling for dewar components. The Model 22 requires an external helium compressor. Cooling capacity of the second stage is approximately one watt.

Vacuum service connects to the dewar using a clamped o-ring flange. Use of a dedicated two-stage mechanical pump or a vacuum manifold servicing several dewars constitutes typical connection schemes. A solenoid-operated valve opens the dewar to the pumping line.

The card cage attached to the front-end automates cryogenic procedures and provides monitoring and control functions. Card cage circuitry permits either local or remote monitoring and control. The card cage contains six printed circuit cards: control, sensor, bias (2), monitor, and RF. See

Section 2.11 for additional information. A separate report contains detailed descriptions of the individual cards.

1.2 Specifications

Unless otherwise stated, the specifications apply to the system at its cryogenic operating temperature. Appendix I contains a typical set of test data which will be required for all front-ends.

1.2.1 Noise Temperature

The receiver noise temperature shall be less than 40 K between 12.1 and 15.4 GHz. It shall be measured between the front-end waveguide input flange and either output. The noise temperature shall be measured with properly calibrated circular waveguide noise temperature standards. The test shall occur on an automated system giving the noise temperature at 250 MHz intervals from 12 to 17 GHz.

1.2.2 Input Return Loss

The return loss at the input circular waveguide flange shall be greater than 15 dB throughout the band. The return loss shall be taken for two orthogonal linear TE11 modes.

1.2.3 Calibration Coupling

The calculated coupling from the Phase Cal input jack J8 to the CRYOFET input shall be 39 ± 2 dB from 12.0 to 15.4 GHz (not measured on all systems).

1.2.4 Calibration Noise Temperature

The noise added to the system in each channel when +28 volts is applied to the Cal control line shall be 3.0 ± 2 K.

1.2.5 Output Total Noise Power

With a short-circuit plate placed across the input waveguide, the noise power out of LCP and RCP output jacks, J7 and J6, shall be -47 ± 4 dBm. Measurement shall be taken through a 14.9 GHz/1450 MHz BW bandpass filter. The total noise power shall also be recorded under the input conditions of both hot and cold loads, and shorted input with calibration signal turned on.

1.2.6 Output Noise Power Stability

The receiver input waveguide shall be short-circuited, and a test receiver with 30 MHz IF bandwidth and 1 kHz post detection bandwidth connected to the LCP and then the RCP output. The receiver shall be tuned to 13.5 GHz and gain adjusted for 5 ± 1 volts DC from the test receiver. The peak-to-peak AC (greater than 2 Hz) output shall be less than 500 mV as viewed on an oscilloscope. This test shall be passed under conditions of light tapping upon the dewar, RF card, and output coaxial cables. This test checks for mechanical looseness, vibration sensitivity, 60 Hz modulation, and refrigerator-induced 2.4 Hz modulation.

1.2.7 Front-End Gain

The front-end shall have a minimum dewar gain of 25 dBm and a minimum system gain of 40 dBm.

1.2.8 Cold Station Temperatures

The temperature of the refrigerator first stage shall be less than 55 K. The second stage temperature as measured on the cold strap shall be less than 18 K.

1.2.9 HEMT Bias Data

The optimum drain voltage VD, drain current ID, and gate voltage VG, shall be recorded for each of three stages of the two CRYOFET amplifiers. Both 300 K and cryogenic operating temperature data shall be recorded.

1.2.10 Cool-Down Time

The time required to cool the cryogenic components from 300 K to operating temperature shall be less than 7 hours.

1.2.11 Physical Weight and Size

The front-end shall weigh less than 50 pounds and shall have the outline shown in Figure 1.3-1.

1.3 Interface Description

Descriptions of the mechanical and electrical interfaces of the system follow:

1.3.1 Mechanical Interface

Figure 1.3-1 shows locations of the input waveguide, helium supply and return, vacuum port, and mounting rods.

The input waveguide connection to the antenna feed must be pressurized with dry nitrogen or sealed with a desiccant. This prevents condensation of water on the input window which cools slightly due to radiation into the dewar. A .052" diameter opening into the circular waveguide input flange exists for this purpose. The opening is counterbored 1/4" deep to accept a 10-32 thread. The pressure should be limited to < 3 psi.

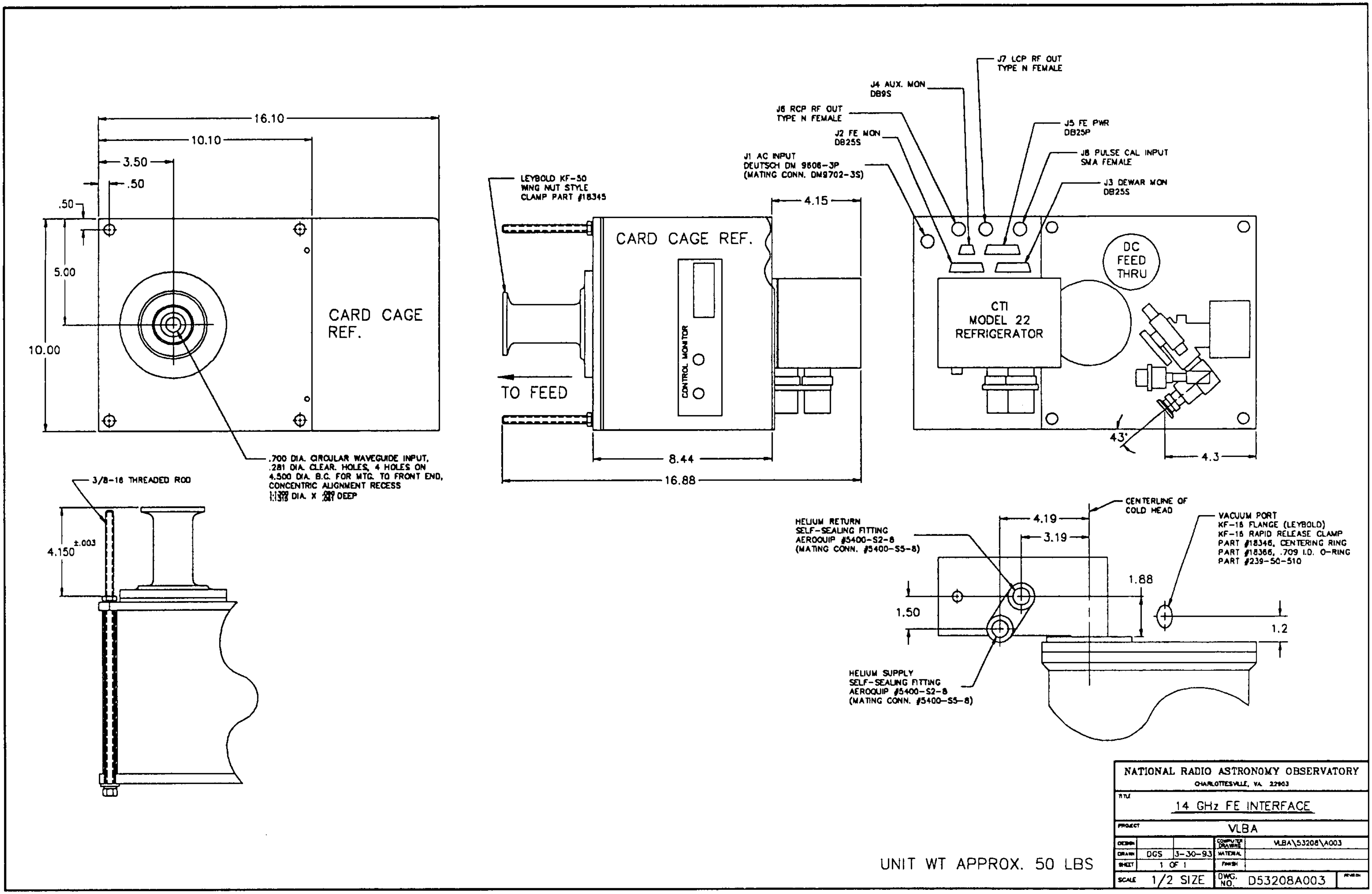


Fig. 1.3-1. Front-end outline and locations of interfaces.

The intended system mounting utilizes four 3/8" threaded rods in the corners of the dewar top and bottom plates. The front-end should be aligned to the antenna feed using the input waveguide flange and flange clamp. The four threaded rods may then support most of the front-end weight. When mounted, provide convenient access to the circuit cards and refrigerator motor. It should be possible to remove the refrigerator motor and displacers without demounting the front-end assembly.

1.3.2 Vacuum and Helium Interface

The vacuum port connection uses a Leybold-Heraeus type KF16 flange, type 18321 centering ring, and type 18346 quick-disconnect clamp. Dewar volume is 8.8 liters. A pumping speed of 0.18 liters/second (10.5 liters/minute or 0.37 CFM) will bring the dewar from atmosphere to 5 μm in 10 minutes. Blank-off pressure of the pump must be < 10 μm with < 5 μm desirable.

Connector J4 outputs a PUMP REQUEST signal. PUMP REQUEST shifts to logical high (+5V) when vacuum pumping is needed. This signal is useful for automated pumping control, *i.e.*, turn on a pump or open a solenoid-operated valve to a pump manifold.

The helium interface employs Aeroquip 5400-S2-8 self-sealing fittings. The helium compressor should be a CTI Model SC or compatible. Helium supply pressure should be 225 ± 5 psi static and 250 ± 10 psi dynamic with a return pressure of 60 ± 15 psi. System flow rate is 7.3 ± 0.2 SCFM. A larger compressor accommodating several refrigerators is also feasible.

1.3.3 RF Interface

RF outputs J6 and J7 are coaxial type-N female connectors. Phase Cal input J8 is a SMA female connector. The RF outputs supply a signal from 12.1 to 15.4 GHz. The system following the front-end should have a noise figure, including cable losses, of less than 15 dB. This ensures a contribution of less than 1 K to the receiver noise temperature. In the VLBA system the Model F108 RF outputs connect to the T108 14 GHz Converter Module.

1.3.4 Front-End DC Interface Connectors

Monitor connector J2 provides all analog measurements pertaining to the front-end state. J2 additionally provides monitoring of the digital control bits. Power, Control, and ID connector J5 supplies front-end power, dewar status control bits, cal source controls, and a twelve-bit ID word. Auxiliary connector J4 allows for interfacing with equipment related to the front-end. The AC current monitor and vacuum pump control connect via this connector.

Interfacing with the VLBA Monitor/Control bus requires Front-End Interface Module F117. Tables I through IV give pin assignments for the DC interface connectors. Descriptions of the signals on these connectors follow:

TABLE I

J2-MONITOR (DB25S ON FRONT-END)		
Pin	**Label**	**Function**
1	VP	PUMP VAC
2	VD	DEWAR VAC
3	15K	TEMP MON,
4	50K	10 mV/^{o}K
5	300K	
6	AC I	AC CURRENT
7	RF1	RCP STAGE 1
8	RF2	OTHER STAGES
9	LF1	LCP STAGE 1
10	LF2	OTHER STAGES
11	LED	LED VOLTAGE
12	-	-
13	QGND	QUALITY GND
14	SENS	TEMP SENS A
15		
16		
17		
18		
19		
20	S	SOLENOID MON
21	P	PUMP REQ
22	$\overline{M}$	MANUAL MON
23	X	CONTROL
24	C	MODE
25	$\overline{H}$	MONITOR

TABLE II

J5-PWR, CONTROL, AND ID (DB25P ON FRONT-END)		
Pin	**Label**	**Function**
1	GND	POWER GROUND
2	+15	600 mA
3	-15	100 mA
4		
5		
6	X	CONTROL BITS
7	C	
8	$\overline{H}$	
9	PA	FE PARITY (EVEN)
10		
11	CAL	28.0 V, 4-10 mA
12	HI CAL	28.0 V, ~ 50 mA
13	GND	
14	FØ	LSB
15	F1	FREQUENCY
16	F2	ID
17	F3	MSB
18	SØ	LSB
19	S1	SERIAL
20	S2	NUMBER
21	S3	
22	S4	
23	S5	MSB
24	MØ	MODIFICATION
25	M1	MSB

TABLE III

J4-AUXILIARY (DB9S ON FRONT-END)		
Pin	**Label**	**Function**
1	AC+	CURR MON, 10V/AMP
2	AC-	RETURN
3	P	PUMP REQUEST
4	GND	GROUND
5		
6		
7		
8		
9		

TABLE IV

FREQUENCY ID CODE		
Code	**Frequency**	**$\overline{PA}$**
0	75	0
1	327/610	1
2	1.5	1
3	2.3	0
4	4.9	1
5	8.4	0
6	10.7	0
7	14	1
8	23	1
9	43	0
A	86	0
B		
C		
D		
E		
F		

1.3.4.1 Power, Control, and ID Connector, J5

Circuit design allows for the refrigerator to continue running if connector J5 is unplugged. This permits maintenance of certain sub-systems without necessitating a warm-up. Note that power will be applied to the refrigerator motor regardless of the dewar vacuum under this condition. Table VI indicates the effect of the control bit (C, NOT-H, and X) states. A control data failure which forces all bits high will keep the system in COOL mode. Although an all-zero state is not defined, that state currently defaults to STRESS mode. There is no memory in the dewar control circuitry. Consequently, switching from one mode to another causes no damage. Unless pump vacuum is sufficiently low, the control card will not open the vacuum valve solenoid. It also protects the dewar from overheating during warm-up cycles. All control bits are TTL levels with each driving one LS-type load.

TABLE V. Front-End Control States

C	H	X	MODE	COMMENT
0	1	1	OFF	No refrigerator power, heater power, or vacuum pumping.
1	1	1	COOL	Normal cooled operation.
0	0	1	STRESS	COOL with small added heat load to stress-test cryogenics.
1	0	1	HEAT	Fast warm-up of dewar with 35 watts of heat added. PUMP REQ becomes high when dewar vacuum is greater than 10 microns.
1	0	0	PUMP	No refrigerator or heater power. PUMP REQ high. Vacuum solenoid open when manifold pressure less than dewar pressure.

The Cal control signal requires +28 volts at 4 to 10 mA. It directly drives the calibration noise source. The coefficient of calibration power output versus supply voltage is less than 0.1 dB/%.

The twelve bit ID word on J5 functionally divides into four frequency bits, six serial number bits, and two modification number bits. Frequency ID codes appear in Table IV. In the VLBA system, the frequency ID bits allow monitor and control addressing assignment. Accordingly, a parity bit (NOT-PA) on J5 furnishes the inverted Even parity of the four frequency bits. Inverted in the Front-end Interface Module, this bit provides Odd parity of the M/C address. Low ID bits are connected to ground; high bits are open circuits. The ID bits require pull-up resistors. They are typically supplied in the Front-end Interface Module F117.

1.3.4.2 Monitor Connector, J2

Connector J2 provides six TTL monitor signals as follows: The pump request signal P is high if dewar vacuum pumping is required. P should be monitored and connected to the vacuum control circuits. Both J2 and J4 provide P. The vacuum solenoid signal S is for monitoring purposes. S is high when the vacuum valve is open. NOT-M is high when the front-end card cage is in the CPU position. C, NOT-H, and X monitors are provided on J2 to indicate the active control state.

The analog monitor signals on J2 permit fault detection and isolation. A chart in Figure 1.3-2 gives the vacuum pressure as a function of the vacuum monitor voltages V_p and V_d.

J2 provides three linearized (10 mV/K) temperature monitors. Sensors on the refrigerator first (50 K) and second (18 K) stages indicate internal temperature. An ambient (300 K) sensor on the RF card reports card cage temperature. The second-stage temperature is also available as a non-linearized voltage, buffered by a unity-gain amplifier. This output furnishes greater sensitivity and potential accuracy at low temperatures than the linearized version.

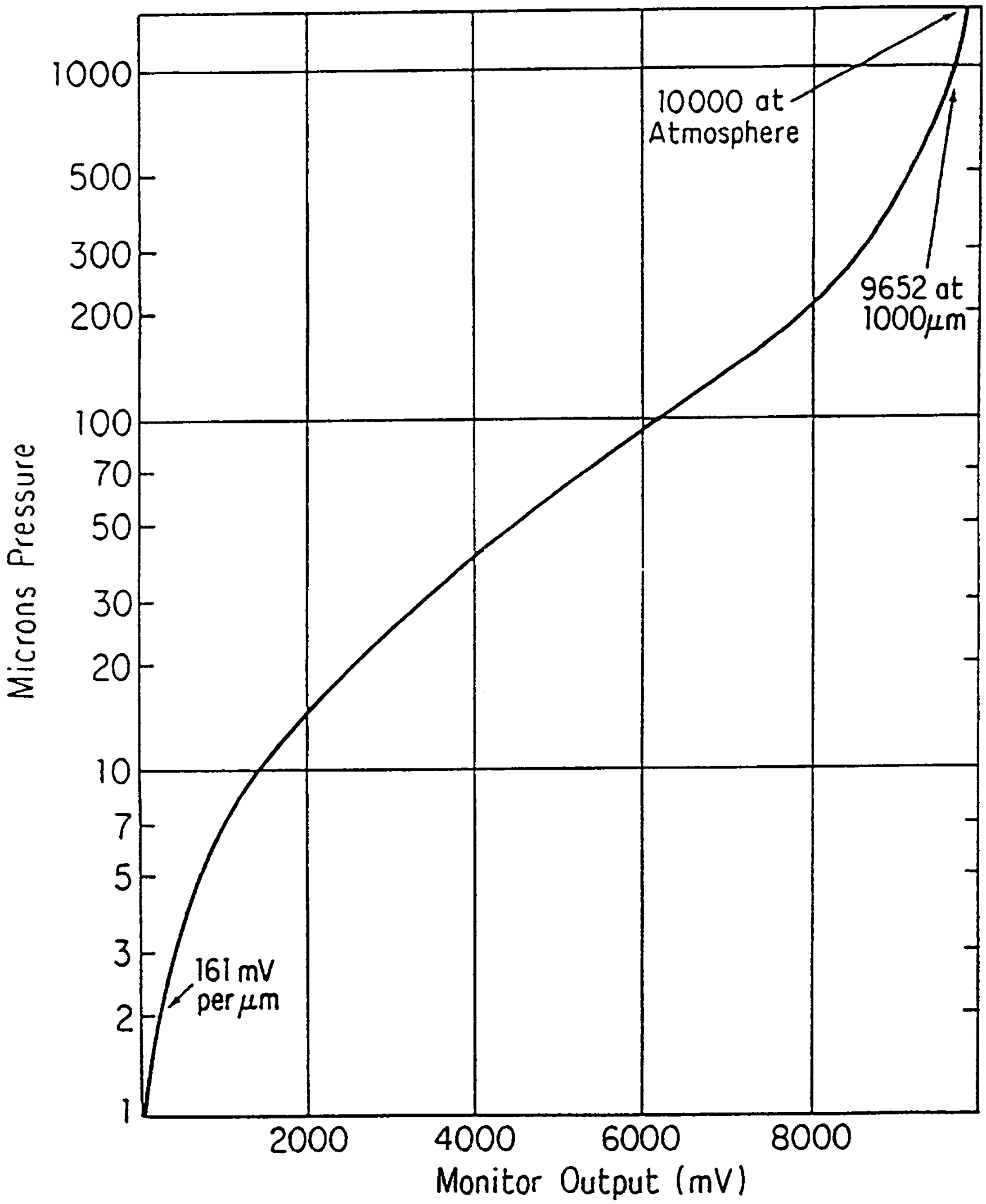


Fig. 1.3-2. Vacuum monitor voltage vs. pressure.

RF1 and LF1 are the first-stage gate voltages of the RCP and LCP cooled amplifiers, respectively. RF2 and LF2 constitute a voltage sum of the remaining stages' gate voltages for the two channels. A large change in any gate voltage indicates a problem. In such a case, one of the amplifier stages may have a fault or a problem exists in the bias card or front-end wiring.

Output AC I is a dc voltage monitoring the 150 volt AC current drawn by the front-end. This monitor voltage (10 volts/amp) sums the refrigerator motor, vacuum valve solenoid, and dewar heater currents. The refrigerator power supply P111 produces this voltage. It enters the card cage on Auxiliary connector J4 pins 1 and 2. AC I allows a monitor to verify that AC power consumption by the front-end is within normal limits. Typical currents in the various front-end modes are: COOL - 0.76 A, STRESS - 0.79 A, and HEAT - 0.40 A. Quality Ground (QGND), provided on J2, is a low current return path for the front-end analog monitors. Isolate QGND from the system power supply grounds where analog monitor measurements are taken.

1.3.4.3 Auxiliary Connector, J4

Pins 1 and 2 input the AC voltage monitor (10 volts/amp) from refrigerator supply P111. Pins 3 and 4 output the TTL compatible PUMP REQUEST signal, useful for controlling the external vacuum device. Section 1.3.4.2, above, further explains the AC current monitor and the PUMP REQUEST signal.

1.3.5 AC Power Interface, J1

The CTI Model 22 refrigerator requires two-phase, 150 volt, 60 or 50 Hz AC power. Connector J1, supplying this power, is a three-pin receptacle, Deutsch DM9606-3P. J1 requires a mating plug, Deutsch DM9702-3S. Table VI gives J1's pin assignments.

TABLE VI

J1-AC POWER	150 VAC 2ϕ (DEUTSCH DM9606-3P ON FRONT-END)		0.5-1.0 A
PIN	LABEL	FUNCTION	MS PIN POWER SUPPLY
1	Ø1	SHIFTED PHASE	A
2	Ø2	LINE PHASE	B
3	R	RETURN	C

Figure 1.3-3 illustrates a simplified AC power schematic of the entire system and a suggested AC power supply.

Note that the plug may be removed from J1 and plugged directly into the refrigerator motor. This action preserves the COOL mode while removing AC power from the control circuits.

The rms current drawn by the various loads is as follows:

Refrigerator Motor	0.76 amps
Vacuum Solenoid[1]	0.25 amps
Heaters in HEAT Mode	0.40 amps
Heaters in STRESS Mode	0.03 amps

1.4 System Parameter Budgets

Table VII shows a typical noise temperature budget for the 14 GHz receiver. Table VIII provides a front-end gain budget. Table IX illustrates the estimated heat loads on the refrigerator second (15 K) stage.

[1] If the vacuum solenoid is powered but through a fault does not actuate, it will draw 0.40 amps.

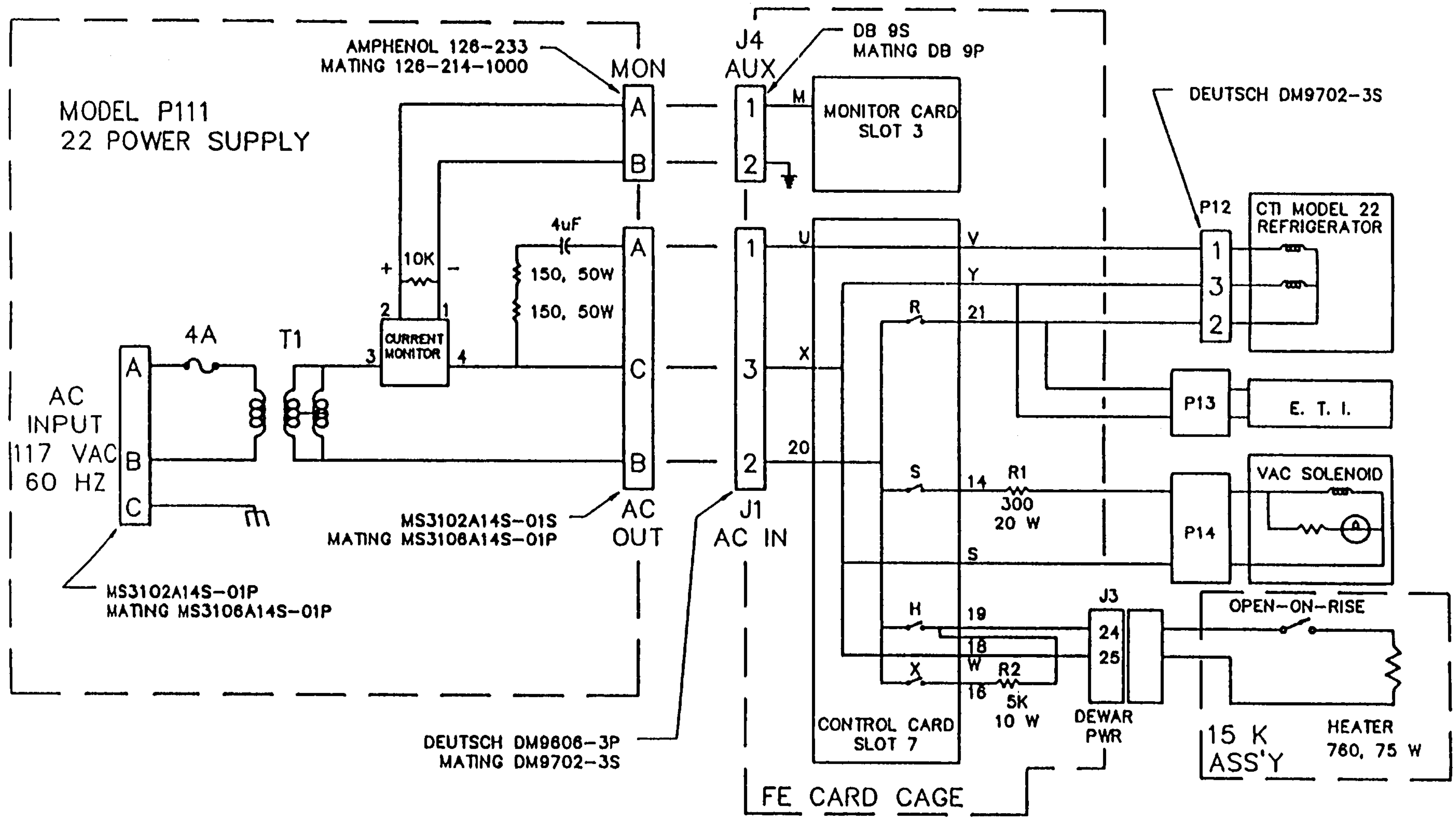


Fig. 1.3-3. Front-end AC wiring.

TABLE VII. System Noise Budget

Component	Physical Temperature	Noise Figure or Loss (dB)	System Contribution
Window	300 K	.01	.7 K
Polarizer	18 K	.15	.6
Input isolator	18 K	.4	1.8
HEMT amplifier	18 K	.25	22.6
RF post-amplifier	300 K	2.5	1.6
			27.3 K

TABLE VIII. Front-End Gain Budget

Input Losses	- 0.6 dB
Three-Stage HEMT	+25.0
9" .085" SS/AG Cable	- 0.6
300 K Isolator	- 0.5
IF Post-Amplifier	+19.0
	+42.3 dB

TABLE IX. Heat Load Budget

Radiation	0.24 watts
Polarizer Support	0.20
Coaxial Lines to 300 K (3)	0.08
No. 32 Brass Wire (22)	0.05
7 x 38 40% Cu Wire (2)	0.03
HEMT Amplifier DC Bias	0.40
	1.00 watts

Section 2. COMPONENT DESCRIPTIONS AND OPERATIONAL NOTES

2.0 General

Appendix II contains key drawings. These drawings include bill-of-materials (BOM) documents which index other drawings. Appendix III holds selected manufacturer's data sheets for commercial components used in this front-end.

2.1 Vacuum Dewar

Two aluminum plates (both 10" square, top .375 thick, bottom .450 thick) and an aluminum pipe (.5" wall x 9" inside diameter) make up the basic dewar. Joints seal with o-rings; no welding or brazing is required. This construction is a standard dewar fabrication technique at NRAO.

2.1.1 Vacuum Pumping

The dewar volume is approximately 8.8 liters. If a dewar has been stored under vacuum, pumping to 50 microns by a 127 liter/minute roughing pump typically takes less than 30 minutes. Newly assembled dewars or units which have been open for several days in humid conditions contain many contaminants. Under these conditions, a similar pump may require up to four hours to achieve 50 microns.

There are two charcoal plates, at 50 K and 15 K, to aid in cryopumping. During HEAT mode, the 15 K charcoal plate directly receives heat. This is helpful in boiling off contaminants trapped in the charcoal. Before initial cooling, pump the front-end at room temperature for 24 hours, if possible.

2.1.2 Radiation Shield

A radiation shield encloses all cryogenic surfaces in the dewar. The shield ties to 50 K, reducing radiation loading between the 15 K stage and the dewar vessel wall. It consists of a thin aluminum sheet, rolled into a cylinder and bolted to the refrigerator first stage (50 K). End covers for the shield mount on plastic standoffs epoxied into the top and bottom dewar plates.

2.1.3 System Cool-Down Procedure

It is best to place the dewar in PUMP mode for at least 24 hours prior to initial installation. For routine tests or if the dewar has been stored under vacuum, this is not necessary. In either case, observe the following procedure:

1) Check compressor operation, verifying that the supply pressure is 250 ± 10 psi. Connect the refrigerator helium ports to the compressor lines, return line first.

2) Connect the front-end vacuum port to a pump or vacuum manifold.

3) Connect Monitor connector J2, Power connector J5, Auxiliary connector J4, and AC connector J1 to the proper cables. Verify AC and DC power supply operation. Using the meter on the local control panel, check for appropriate monitor voltages.

4) Check that the dewar vent valve is closed. Unless manual control will be used, place the control switch on the card cage in the CPU position.

5) Place the front-end in the COOL state, using either the local control panel or the station computer.

From this point, the cool-down procedure is automatic. The front-end will generate a PUMP REQUEST. When pump vacuum exceeds dewar vacuum, the vacuum valve solenoid will open. At approximately 50 microns of vacuum, the refrigerator motor will start. The solenoid valve will close when dewar vacuum drops below 5 microns or whenever dewar vacuum exceeds pump vacuum. When the dewar vacuum drops to less than 3 microns, the PUMP REQUEST signal shifts to a logic low.

Figure 2.1-1 shows chart recordings of a typical cool-down and HEAT mode warm-up. Cool-down time is approximately 6.5 hours to a temperature of 14 K to 17 K on the second stage and 50 K to 55 K on the first stage. The warm-up time with 35 watts of heat applied is two hours.

2.1.4 Disassembly of Dewar

Figures 2.1-2 and 2.1-3 show the dewar at several stages of disassembly. Removal of only the inspection cover[2] allows some limited access to cryogenic components. Full disassembly requires some initial disconnections performed through the inspection opening. A recommended disassembly procedure follows. The dewar should be warmed to room temperature, with all interfacing lines disconnected.

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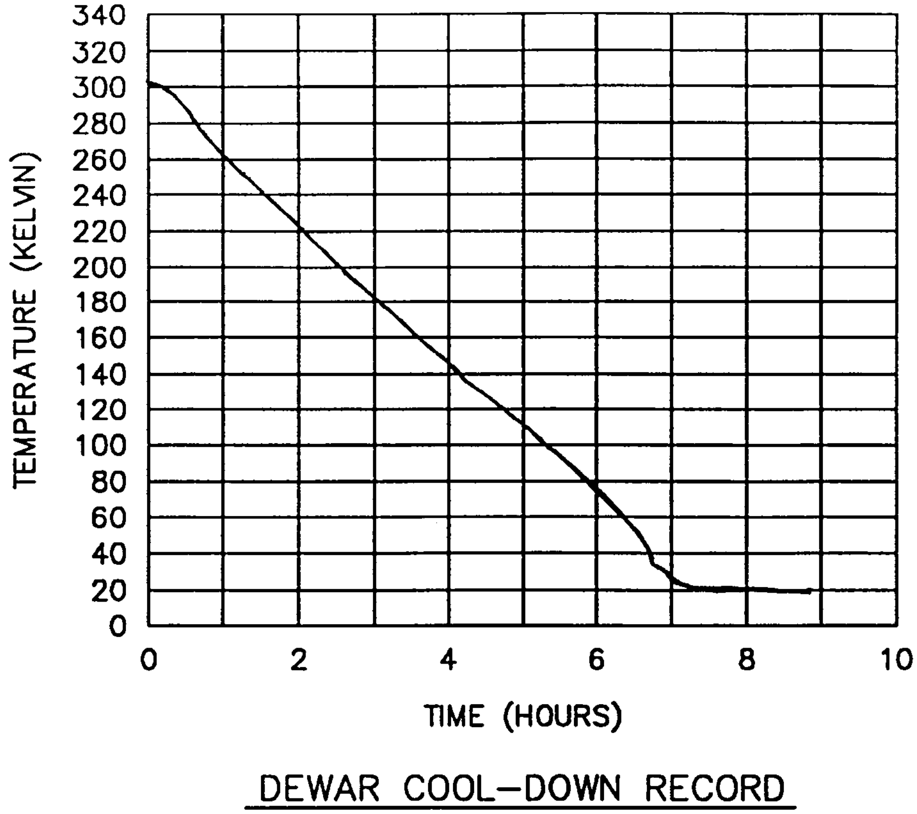
[2] Dewar plate housing vacuum interface components, adjacent to refrigerator motor.



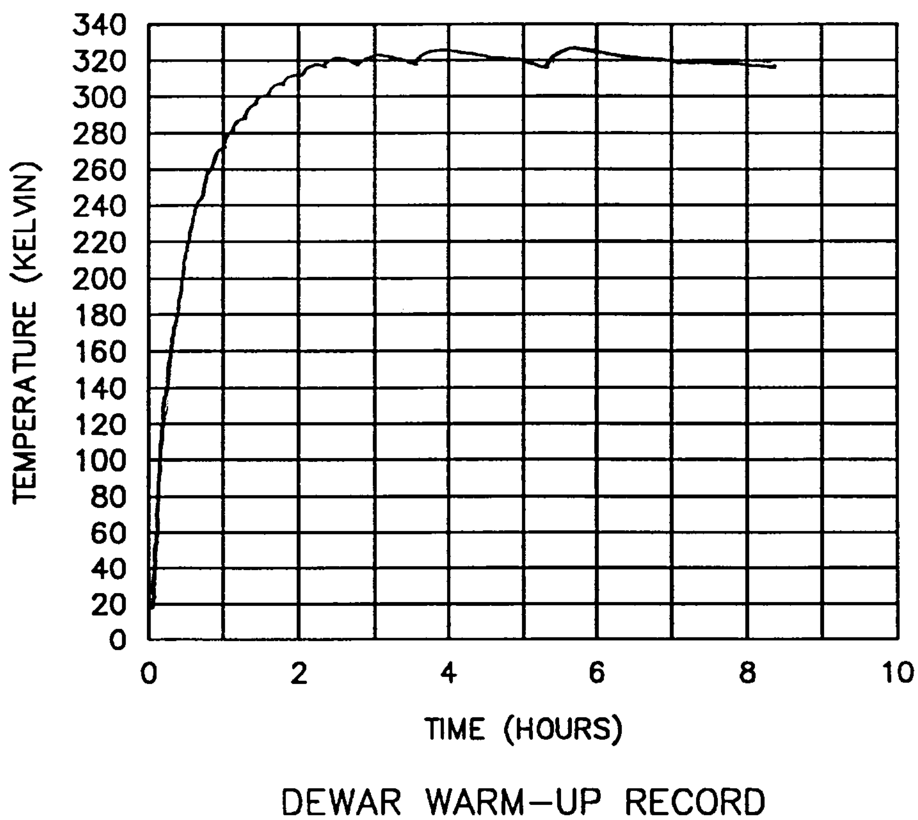


Fig. 2.1-1. Chart recordings of dewar cool-down and warm-up.

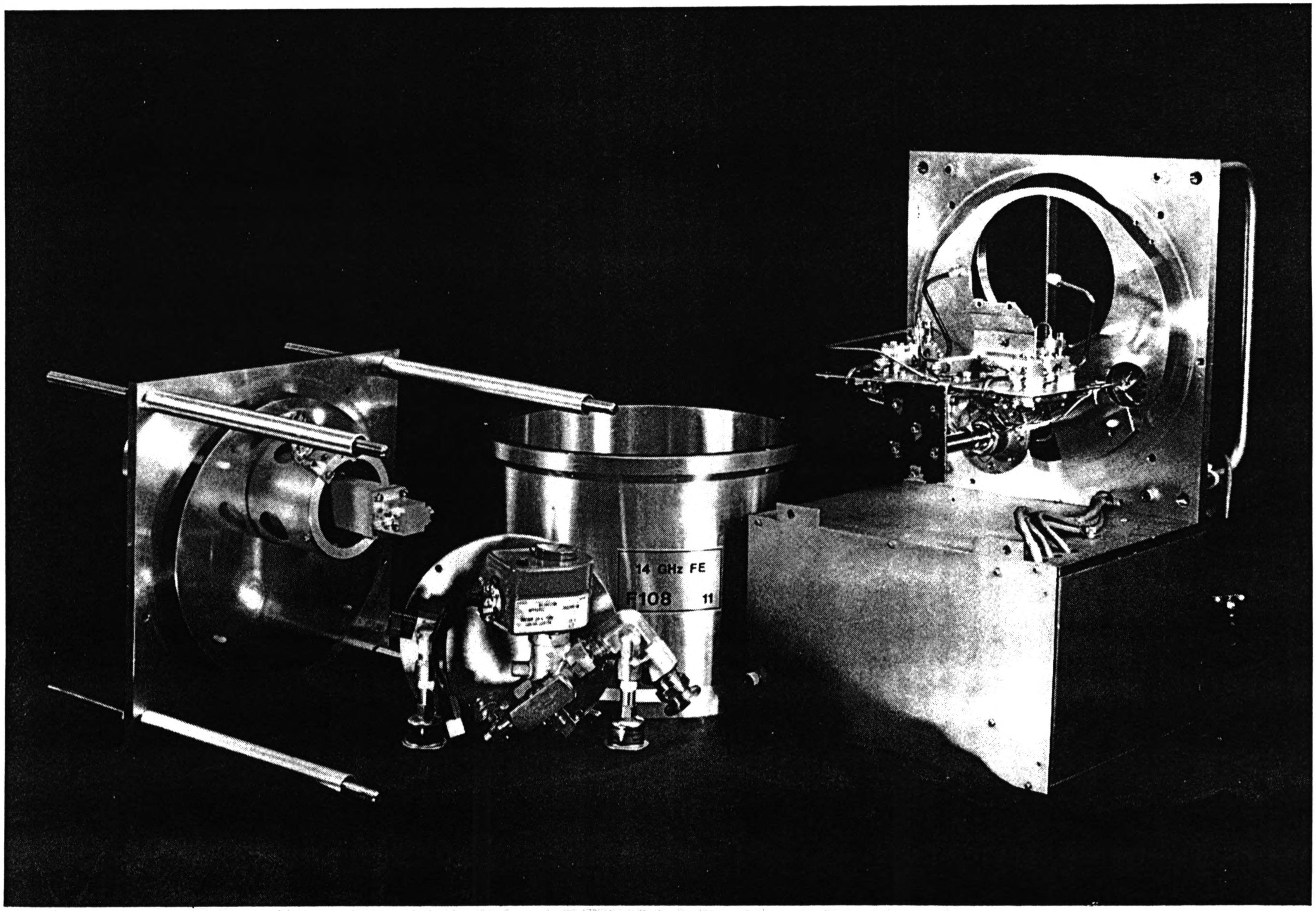


Fig. 2.1-2. Disassembled dewar.

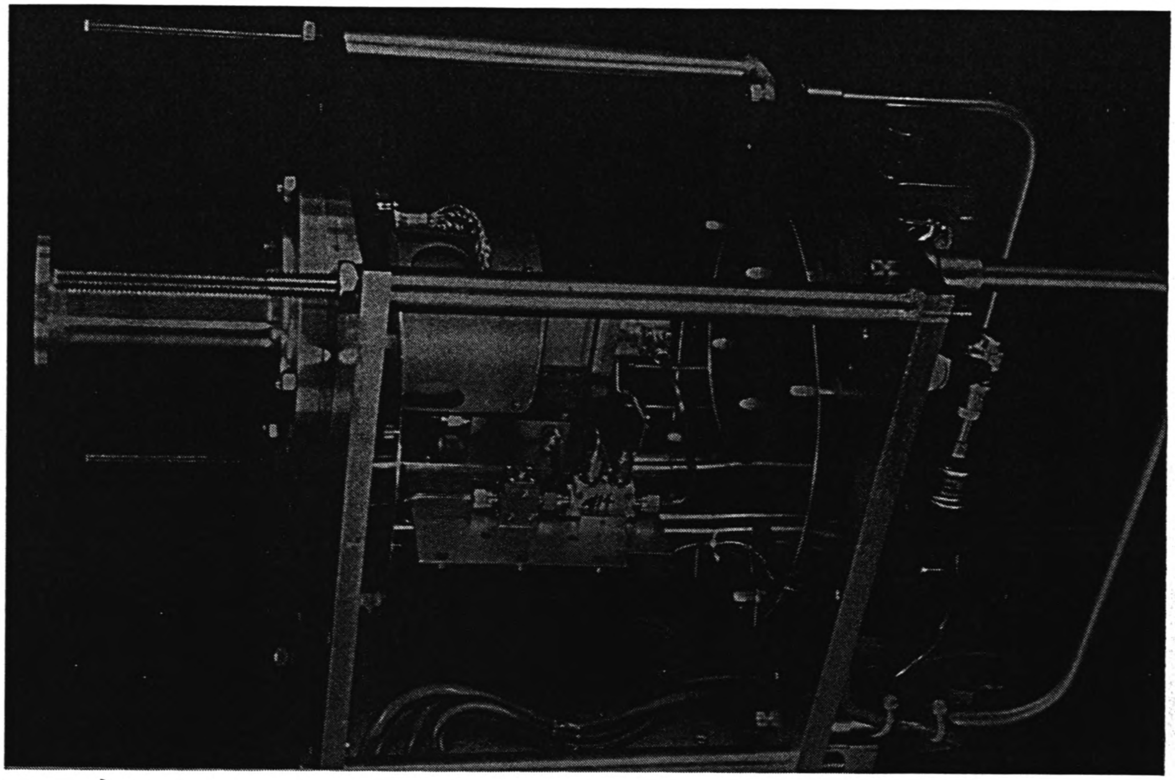


Fig. 2.1-3. Assembled dewar minus outer cylinder and shield.

1) Preliminary. On a convenient work surface, orient the dewar horizontally so that it rests on the card cage. Open the manual vent valve, bringing the dewar to atmospheric pressure.
2) Inspection cover. Disconnect vacuum sensor and solenoid valve connections. Remove four 8-32 screws holding the inspection cover to the dewar bottom plate. Remove the inspection cover.
3) Internal connections. Through the inspection opening, remove two 6-32 screws holding the cold strap to the polarizer. Remove the 6-32 screw attaching the tinned

copper braid to the aluminum support ring near the polarizer base. Loosen both ends of the two .141" semirigid cables connecting the polarizer outputs to the cryo-coupler inputs. Completely disconnect the ends attached to the polarizer ports.

4) External connections. Remove the nuts and washers on the four 3/8" threaded rods at the four corners of the bottom plate[3]. Remove six 10-32 bolts attaching the bottom plate to the dewar cylinder. At the opposite end of the cylinder, remove two 10-32 bolts attaching the top plate to the card cage.

5) Cylinder removal. At this point, an assembly consisting of the top plate, dewar cylinder, threaded rods, and polarizer will slide away from the rest of the front-end. Care should be exercised that none of the internal cabling snags as this operation occurs.

6) Cylinder and radiation shield. Removal of the dewar cylinder from the assembly removed in step five, above, allows access to the polarizer. Removal of the radiation shield allows access to the HEMT amplifiers, couplers and isolators, refrigerator stages and internal cabling. The radiation shield attaches to the refrigerator first stage via a 6-32 pan head screw and to the bottom plate via four 6-32 screws.

[3] The dewar endplate mounting the refrigerator, handles, and the inspection cover.

2.1.5 Reassembly of Dewar

Reassembly of dewar uses reverse order of the disassembly instructions. When reassembling or disassembling the dewar, observe the following precautions:

a) Note the surfaces which must seal against an o-ring. Be careful not to scratch any of these surfaces. When closing the dewar, check for dirt or foreign objects on the o-ring surfaces. Lubricate the o-rings with a small amount of vacuum grease. Check during assembly that the o-rings are seated properly.

b) The presence of a film on internal surfaces greatly increases emissivity of those surfaces. An aluminum surface cleaned with acetone instead of freon produced a doubling of measured emissivity. This precaution is important for the interior of the dewar walls and exterior of the radiation shield. Clean these surfaces with freon and then exercise care in handling them. The 18 K components should be kept reasonably clean but may be handled for maintenance without cleaning.

c) During reassembly, tighten all RF connections to 8 in.lbs. (9.2 cm-kgf) of torque using a standard SMA torque wrench.

2.2 Window

A circular waveguide window preserves vacuum within the cryogenics dewar. A replaceable plate housing the window as shown in Figure 2.2-1. Figure 2.2-2 shows a cross-sectional view of the window. The basic design is a mylar sheet, .010" thick, matched by inductive irises on both sides. One iris forms a convenient lip for epoxy bonding of the mylar. As a dielectric, mylar bonds easily and can tolerate mechanical shock.

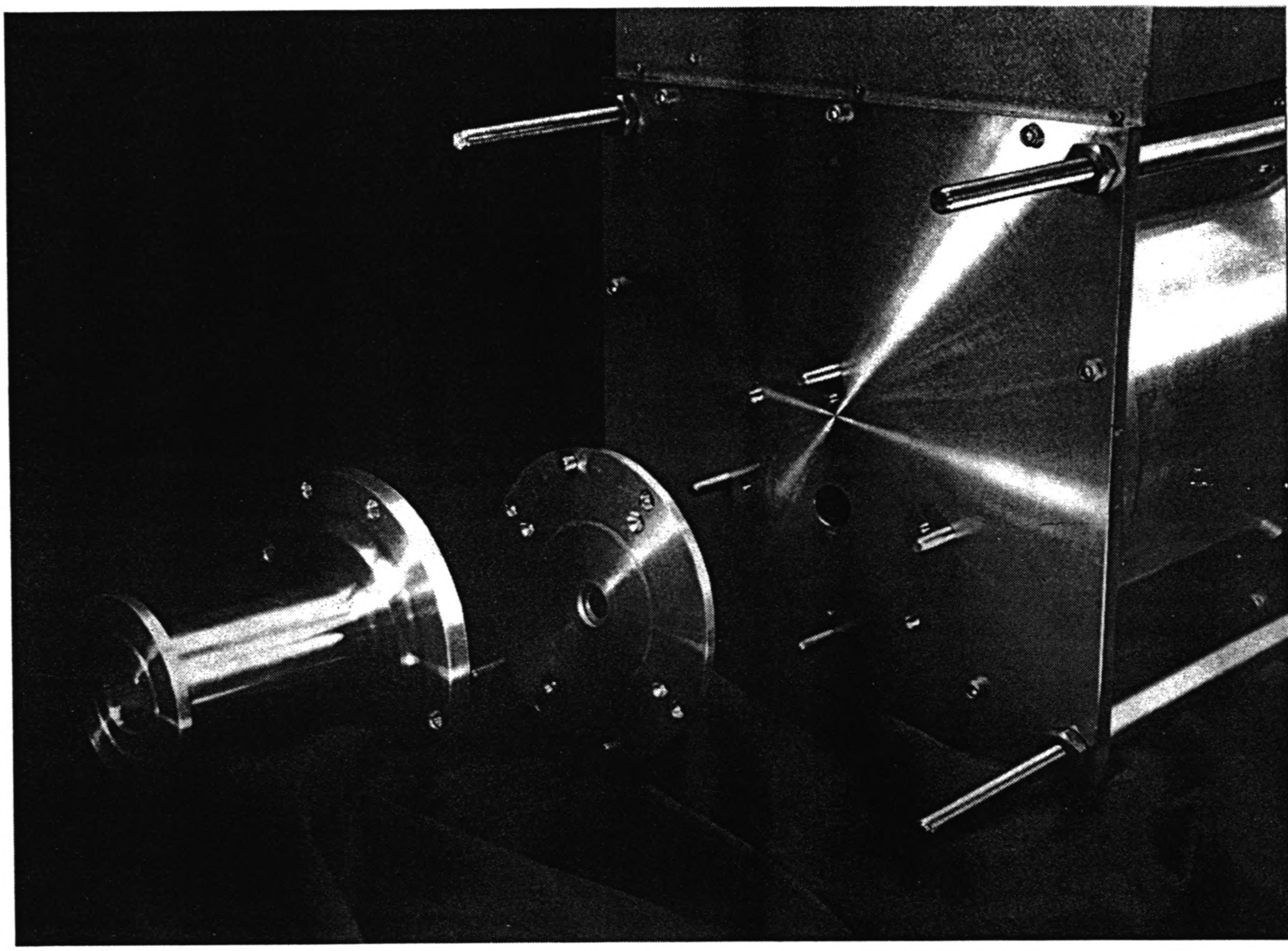


Fig. 2.2-1. Exploded view of window and top plate.

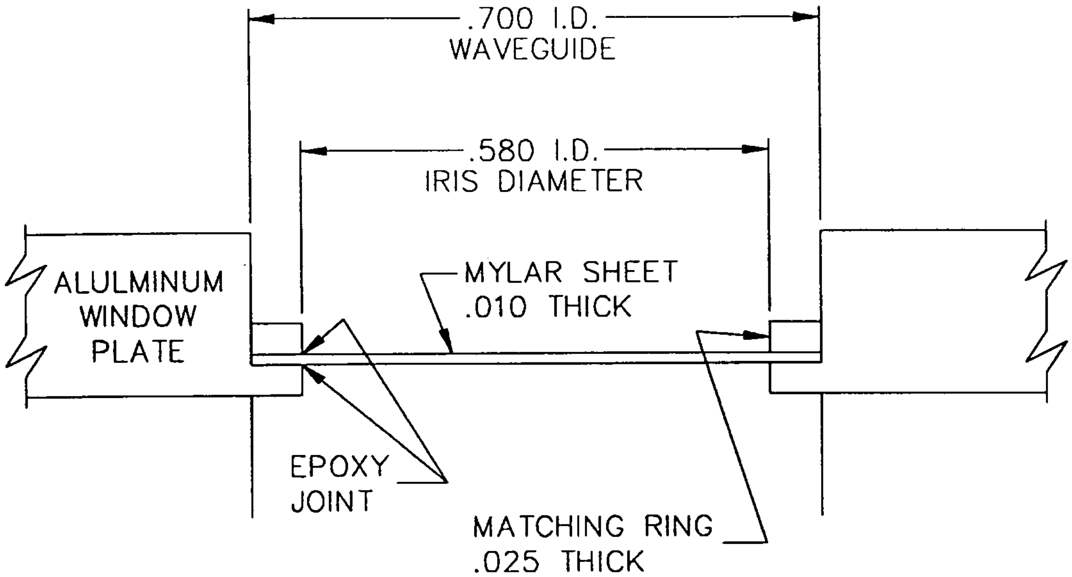


Fig. 2.2-2. Cross-section view of window.

2.3 Waveguide Thermal Transition

A 0.010 inch (.253 cm) gap in the waveguide wall provides thermal isolation between the dewar input flange and the polarizer at 15 K. G-10 epoxy-glass tubing, in a folded cylindrical arrangement, maintains the gap. See Figure 2.3-1 for illustration. Evaporated gold, 1500 ± 500 angstroms thick, coats the G-10 tubes. This coating reduces thermal radiation coupling without forming a significant heat conduction path. The calculated conduction load is .33 W on the 50 K station and .05 W on the 15 K station.

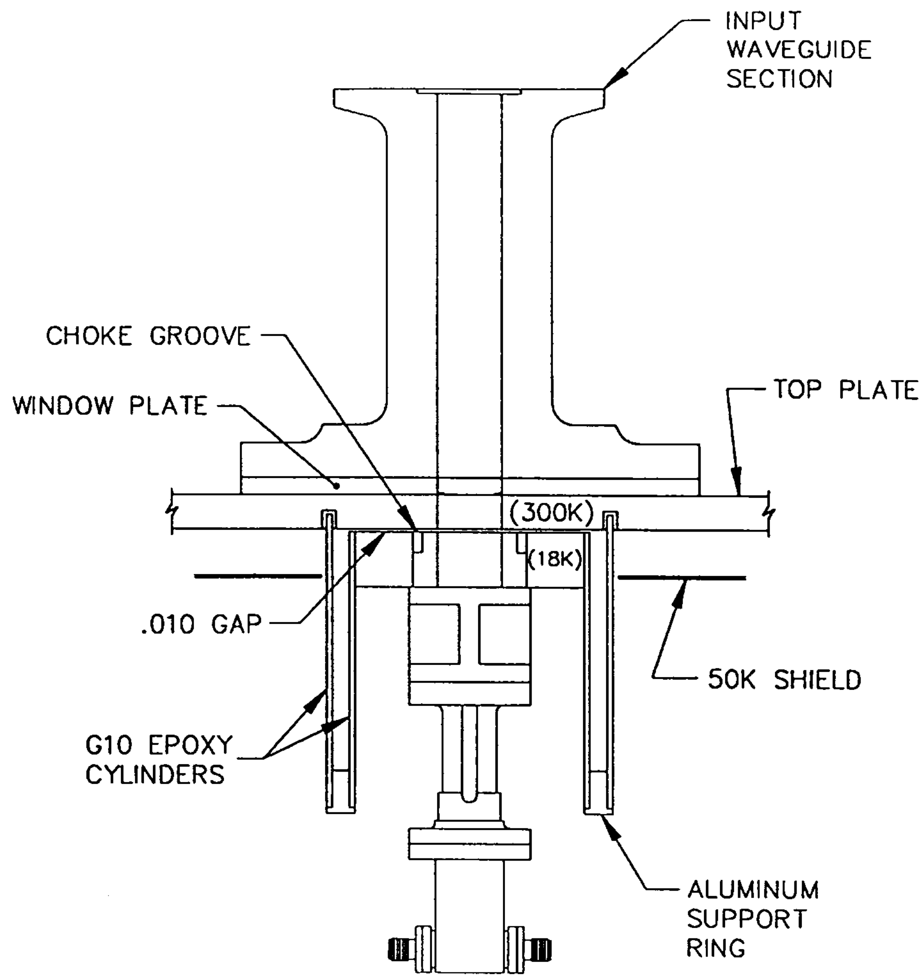


Fig. 2.3-1. Input interface cross-sectional view.

During construction, a .010" thick shim accurately maintains spacing. After the epoxy adhesive bonding the outer cylinder to the top plate cures, the shim is removed. A round plug inserted in the waveguide during curing maintains axial alignment.

A choke groove (1.030" I.D., 1.230" O.D., x 0.22" deep) in a 2.50" diameter flange surrounds the waveguide gap. See NRAO drawings A53208M003, Rev. A and B53208M001, Rev. B. At the junction of the G-10 tubes, an aluminum ring ties to the 50 K refrigerator station.

2.4 Polarizer

The polarizer is a sloped-septum waveguide structure, manufactured by Atlantic Microwave, Model AMC 1075 (see Figure 2.4-1). NRAO Specification A53208N001, Rev. A (Appendix II) provides complete details. Mounted in square waveguide, the sloped-septum separates the two circularly polarized waves to SMA coaxial outputs. 75 ± 25 microinches of gold coat the polarizer, reducing thermal radiation absorption. A summary of electrical specifications appears below:

Specification	Requirement 12.0-15.4 GHz
Ellipticity	≤ 1.0 dB
Isolation	≤ -25 dB
Return Loss	< 17 dB

The left-circular polarization port is on the left side when looking in the circular waveguide with septum (fin) on the bottom wall.

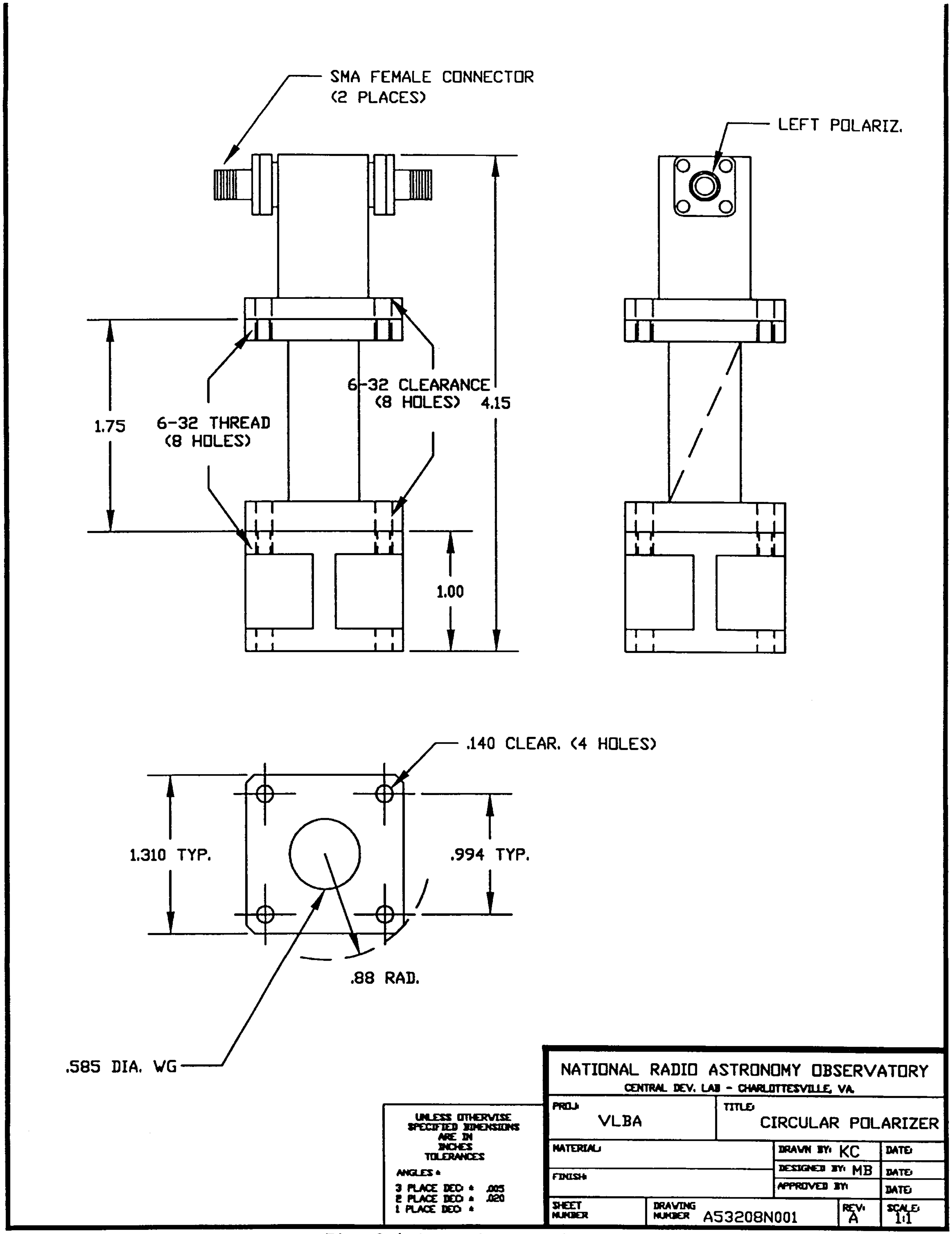


Fig. 2.4-1. Polarizer drawing.

2.5 Noise Calibration System

The block diagram in Figure 1.1-1 shows the noise calibration components. 25 dB coaxial couplers inside the dewar inject the calibration signal via the noise diode (~ 3 K), or an externally applied pulse calibration signal. A coaxial power divider within the dewar splits the common calibration signal to the two channels. The calibration signal enters the dewar through a SMA hermetic feedthrough. The coupling from this jack to each receiver input is approximately -29 dB (including 1 dB of cable losses).

On the RF card, the cal signal originates in a 30 dB ENR[4] noise source. After a 9 dB pad, it passes into the coupled port of a 10 dB coaxial coupler. 0.085" coaxial cable connects the cal signal to the SMA feedthrough port entering the dewar. A second 10 dB coupler in the cal line allows an externally applied pulse cal signal to be injected into the system.

The ENR referred to the receiver input is approximately -20 dB, which is 3 K. Allowing for 2-3 dB cable losses, this breaks down as: 30 - 9 - 10 - 3 - 3 - 25 = -20 dB. The CAL control line must supply +28 volts at 4 to 10 mA.

2.6 Cryo-Amplifiers

A three-stage HEMT amplifier provides ~ 25 dB initial gain. Table VII gives the noise budget for the cooled RF components. The typical power dissipated by each amplifier is 0.1 watt (see heat load budget in Table IX).

2.7 Post-Amplifier Card

See Figure 1.1-1 for a block diagram of the RF card and related circuitry.

---

[4] Excess noise temperature = $290 \times 10^{ENR/10}$.

The post-amplifier in the front-end is a two-stage SMT (Sierra Microwave Technology) S90-1172 which has 19 ± 1 dB gain, noise figure of < 2.5 dB, 1 dB gain compression output power of > 10 dBm, and the input and output VSWR of ≤ 1.5:1 from 12.0 to 15.4 GHz. A DiTom D3I8016-2 isolator mounts to the input of the post-amplifier on the RF card. Provision is made on the RF card for installing a second isolator/post-amplifier stage per each channel.

Circuitry mounted on the RF card supports two types of calibration signals:

a) a low noise calibration signal, ~ 3.0 K, for continuous pulsed gain and noise calibration of the system,

b) an externally applied signal, connector J8, coupled -39 dB to both inputs, for the purposes of phase or time-delay calibration of the system.

The noise source is a Noise Com NC 3207A, ENR 30 dB. See Section 2.5 for a discussion of the calibration circuitry. Supplying +28 volts (4-10 milliamperes) to pin 11 and 13 of connector J5 activates the noise source.

A National Semiconductor LM335 on the RF card functions as an ambient card cage temperature sensor. Its output is a linear 10 mV/°K and may be read on the monitor panel or by remote computer.

2.8 Dewar Internal Wiring and Coaxial Lines

Eighteen wires connect the 300 K dewar RFI feedthrough plate and components at 15 K. Two wires run from the feedthrough to the 50 K temperature sensor. Use of a special brass wire reduces the heat load of these conductors. The wire is #32 soft brass (type 260), part number B2322111-001, from MWS Precision Wire in Chatsworth, CA. Use of this wire provides a factor of 8 lower heat load than copper and higher tensile strength. Resistance is 2.3 times that of copper at 300 K. The wire comes as a two conductor red/green pair, coated with a polyurethane insulation. Soldering iron heat will remove the insulation. Alcohol dissolves the polyvinyl butral bonding the two wires together.

Wire lengths inside the dewar are all ~ 12". The total heat load for 14 wires (HEMT bias and 15 K temperature sensor) is .03 watts. The two wires to the dewar heater are 12" of 7 x #38 stranded copper-clad steel wire (type W-12 manufactured by Microtech, Boothwyn, PA). These wires cause an additional heat load of .03 watts. The 50 K temperature sensor connection uses the brass wire previously mentioned.

NRAO EDIR #223 gives heat flow and attenuation data for various types of coaxial cables at cryogenic temperatures. The following table summarizes heat load and loss of the lines inside the dewar.

Purpose	Length-Type	Heat Loss	RF Loss
Calibration Input	12" - .085" SS/BC	.022	-1.3 dB
LCP Output	9" - .085" SS/BC	.030	-0.9 dB
RCP Output	9" - .085" SS/BC	.030	-0.9 dB

2.9 Refrigerator Power Supply

The refrigerator motor requires two-phase (90° phase difference) AC power. It will operate at 120 to 160 volts RMS from 50 to 60 Hz. The P111 Model 22 Power Supply, an NRAO design, provides the proper voltages (150 VAC, 2 phase, 1 A), derived from 120 volt, 60 Hz, single-phase power. Figure 2.9-1 shows a schematic.

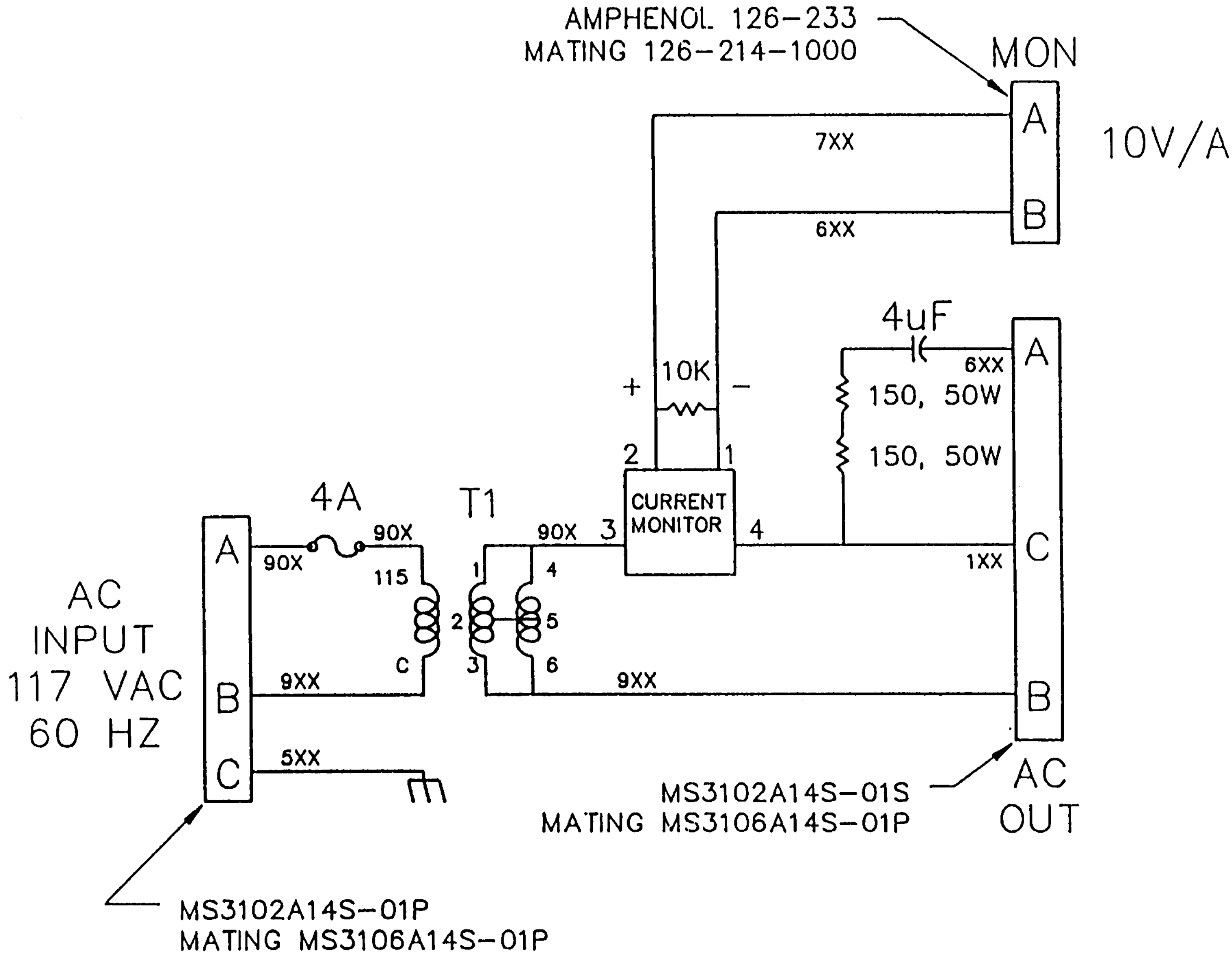


Fig. 2.9-1. Power supply schematic.

The P111 uses an isolation transformer with an unloaded output voltage of 160 volts RMS. An RC network provides the shifted phase output. The resistance consists of a 150 ohm, 50 watt, 1% wirewound resistor. The capacitance is a 6 μf oil-filled capacitor.

A current transducer in the P111 senses AC current delivered to the front-end. The transducer sensor produces a DC current proportional to the AC current draw (1 mA-DC/1 A-AC). A 10 K ohm resistor across its DC output terminals produces a voltage of 10 VDC/amp when measured with a high impedance circuit. The DC sensor voltage appears on connector J3, pins A and B on the front panel of the P111. These pins normally connect to pins 1 and 2 of the front-end Auxiliary connector J4. As was previously stated, this allows a station computer to monitor AC current via the Monitor/Control bus.

The CTI Model SC compressor mentioned in Section 1.3.2 furnishes a built-in split-phase AC supply. This supply may alternately provide AC power to the front-end.

2.10 Front-End Card Cage

Section 1.3 describes the card cage interface signals. VLBA Technical Report No. 1 provides a preliminary version of the card cage, associated circuit cards, and test and calibration procedures. An addendum to Technical Report No. 1 will describe subsequent changes to the card cage assembly.

Section 3. TROUBLESHOOTING

3.0 Introduction

This section gives a few suggestions for locating and correcting problems experienced with the system.

3.1 Low or No Gain

Check HEMT amplifier bias voltages. RF1 and LF1 on the Monitor card correspond to first-stage gate voltages. RF2 and LF2 are voltage sums of the remaining stages' gate voltages. RF1, RF2, LF1, and LF2 will normally range between 0 and -2 volts. They should not vary more than ± .02 volts from recorded values. Narrow down abnormal readings by checking at the test points on the bias cards. A value greater than 0 volts (usually + 14 volts) indicates insufficient drain current. Values less than -2 volts (usually -14 volts) indicate a drain current short. Try replacing the applicable bias card. If that does not work, examine the Dewar Power connector, J3, and the dewar feedthroughs. Otherwise, the internal cabling or amplifiers may require checking.

If bias voltages are correct, check for proper post-amp operation on the RF card. Check that +15 volts is present on the card at each device requiring it. Check RF connections for tightness. It may be possible to isolate the problem by observing a total power indicator while tapping or shaking the cables and RF components.

Inside the dewar, repeated temperature cycling causes premature failure of any marginal connection. Weak solder joints in the coaxial output cable, as well as the amplifier bias connectors, may be suspect. Failures of this nature are statistically more likely than outright component failures.

3.2 Cool-Down Failure

3.2.1 Refrigerator Motor Never Starts

The front-end must be in COOL or STRESS mode. Dewar vacuum must be below 50 microns (4.5 volts on the V_d monitor). Check that the vacuum valve solenoid is energized (indicator on the valve cover lit). If not, check that pump vacuum (V_p monitor) is less than dewar vacuum (V_d monitor). If these appear reasonable, check that AC is present. An easy way is to unplug the AC cable from the card cage and plug it directly into the refrigerator motor. If the front-end vacuum valve is open, but the dewar and pump vacuums do not fall (refer to Section 2.1.1 for a discussion of the dewar pumping characteristics), command the front-end OFF to close the valve. The pump vacuum should fall to near its blank-off pressure. If it does, a vacuum leak has likely occurred in the front-end dewar (refer to Section 3.2.2).

If the dewar vacuum is less than 50 microns but the refrigerator doesn't run, try connecting the AC power cable directly into the refrigerator motor. If it runs, replace the control card in the cage. If not, either the AC supply isn't working or the refrigerator requires servicing.

3.2.2 Refrigerator Runs, But System Doesn't Cool

This problem may be due to a vacuum leak, a refrigerator defect, or a thermal fault inside the dewar. Make initial checks of refrigerator motor current, refrigerator sound, and helium supply and return pressures. Otherwise, it will be necessary to warm up the front-end to room temperature for further tests.

While a leak tester is desirable, one may still effectively troubleshoot a vacuum defect without it. Pump the dewar for greater than one hour at 300 K. Command the system to OFF (closes solenoid valve) and observe the rate of vacuum rise. A vacuum rise greater than 10 micron/min. indicates a leak. Petroleum ether sprayed around o-ring joints may help locate a gross leak. The mechanical vacuum pump will labor as petroleum ether enters the dewar.

Refer to Section 2.1.5 for precautions to observe when reassembling the dewar. The cause of vacuum leaks is most often a missing, dirty, or pinched o-ring. Loose bolts may cause an o-ring to be less than fully compressed.

APPENDIX I. Sample Test Data

14 GHz FRONT-END, S/N 9 Date: 8/11/92

FET BIAS SETTINGS

Stage	LCP AMP #U44				RCP AMP #U45			
	V_D	I_D	V_G 300 K	V_G 15 K	V_D	I_D	V_G 300 K	V_G 15 K
1	2.5	4.5	-.348	-.267	2.5	4.5	-.366	-.285
2	3.0	10.0	-.521	-.513	3.0	7.5	-.510	-.478
3	3.0	10.0	-.525	-.517	3.0	10.0	-.463	-.487

TOTAL RF POWER OUT INTO 1.4 GHz BANDWIDTH AS MEASURED WITH HP436/8484A POWER METER

	15K		300K	
Input Condition	LCP dBm	RCP dBm	LCP dBm	RCP dBm
302K Load	-40.20	-38.27	-41.90	-40.57
79.7K Load	-45.03	-43.16	-44.03	-42.68
Short	-48.31	-46.60	-41.89	-40.55
Short + Cal	-47.95	-46.20	-41.85	-40.52

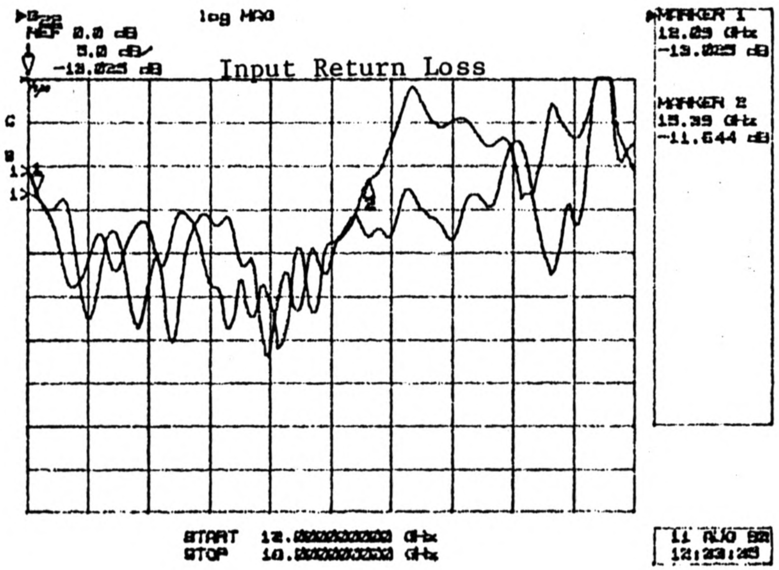
SERIAL NUMBER DATA FOR FRONT-ENDS		
UNIT INFORMATION		
MODEL F108		
SERIAL NUMBER 9		
REFRIGERATOR INFORMATION		
SERIAL # 11L96303	CYLINDER # 20-6303	CROSSHEAD # 6919

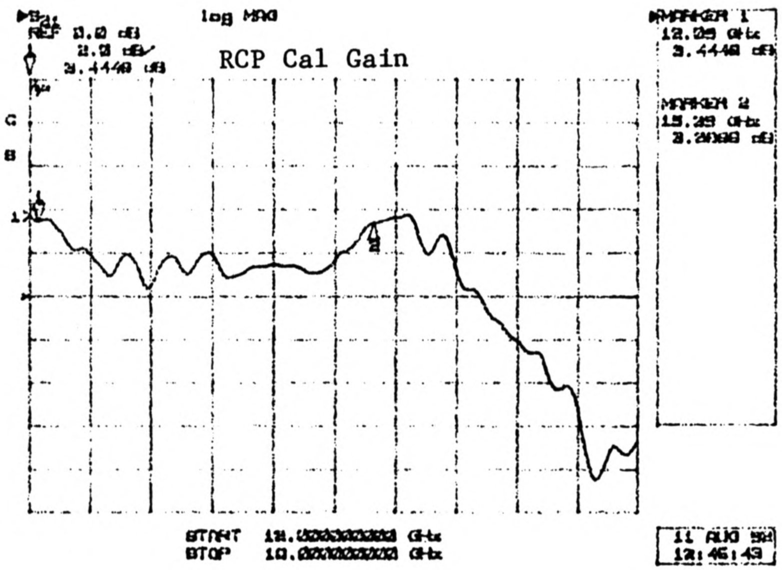
CRYO-AMP INFORMATION	
RCP CRYO AMP U45	LCP CRYO AMP U44
RCP CRYO COUPLER 6	LCP CRYO COUPLER 18
RCP CRYO ISOLATOR 118	LCP CRYO ISOLATOR 121
CRYO POWER DIVIDER -----	
RF CARD INFORMATION	
RF CARD SERIAL # RF-10	
RCP AMB AMP 91111125	LCP AMB AMP 91101111
RCP AMB ISOL IN 143	LCP AMB ISOL IN 146
RCP AMB ISOL OUT -----	LCP AMB ISOL OUT -----
CAL COUPLER IN 105004	CAL COUPLER OUT* 105002
NOISE SOURCE HI -----	NOISE SOURCE LO 2111
HI CAL AMP -----	
GENERAL INFORMATION	
RCP BIAS CARD SERIAL # BC-260	LCP BIAS CARD SERIAL # BC-261
SENSOR CARD SERIAL # SC-111	CONTROL CARD SERIAL # CC-108
MONITOR CARD SERIAL # MC-103	
TEMP SENSOR 50K 352	TEMP SENSOR 15K 367

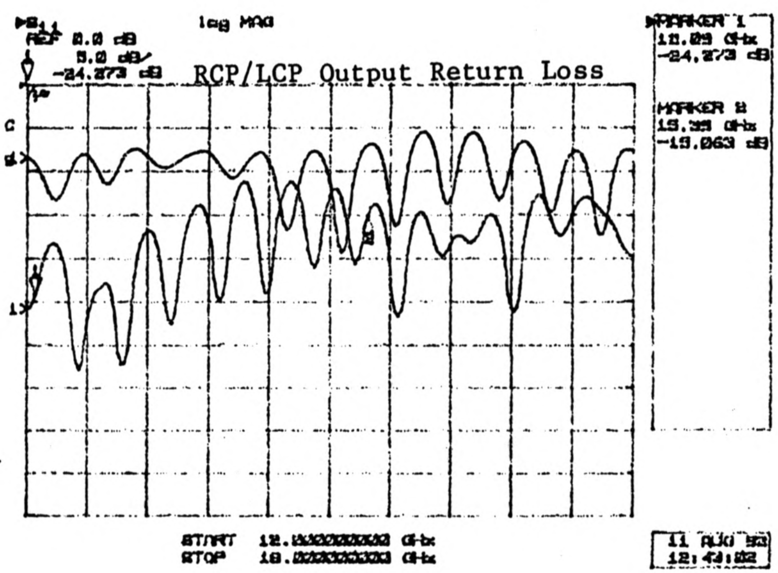
DATE:	RECORDED BY:	
8/10/92	K. Crady	

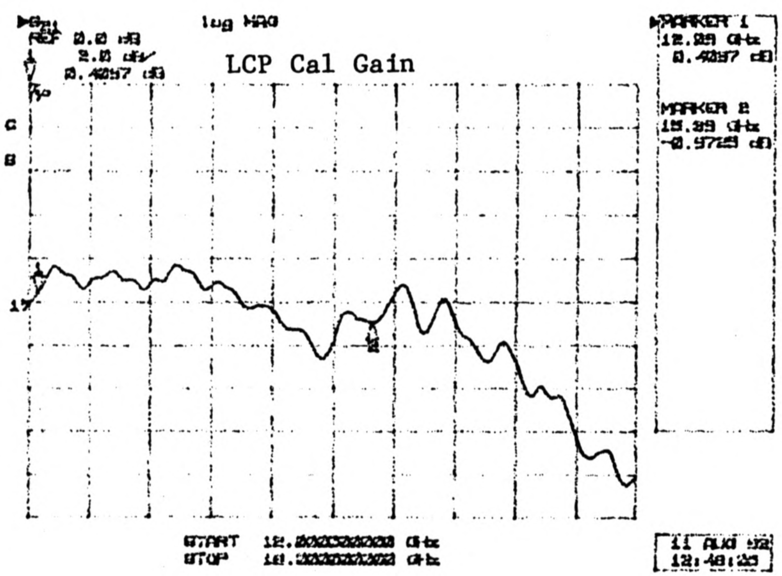
*(CONNECTED TO DEWAR)

14 GHz RECEIVER 08/11/92
F108-9







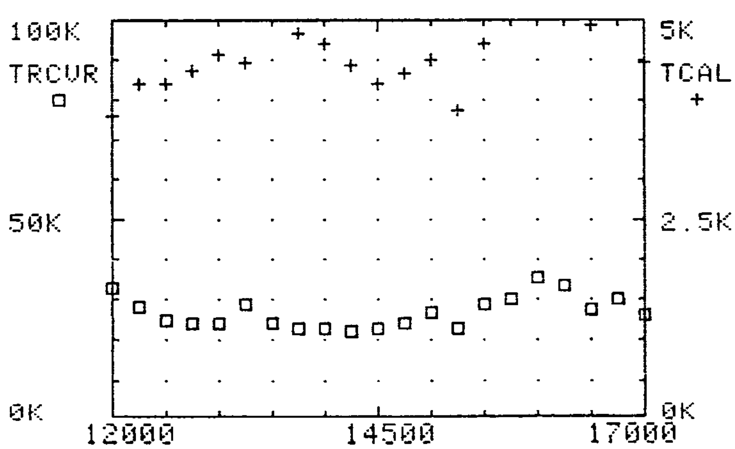


CALIBRATION RECORD OF 14.GHz RECEIVER, SERIAL#9 , MOD #Ø
RCP POLARIZATION, TESTED BY CRADY, DATE Ø8/11/92 TIME Ø9:ØØ.7
COMMENT: NONE

15K TEMP = 16.81 5ØK TEMP = 55.58 3ØØK TEMP = 3Ø6.28
AC AMPS = Ø.462 DEWR VAC = -26 PUMP VAC = 995Ø
HEMT LED = 9.37 +15 VOLT = 15.361 TA SENS V= 7.ØØ7
CAL VOLT = 28.12 HIGH CAL = 28.19 SPARE = -.Ø1
FETS: LF1= -.264 LF2= -.511 RF1= -.283 RF2= -.479
CRYØ MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

Ø9:Ø6.9 Ø8/11/91 THOT=296 TCOLD=79.5 41DB INPUT ATTEN., 3ØMHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
12ØØØ	32.3	3.8Ø	Ø.Ø	24.6
1225Ø	27.4	4.2Ø	Ø.Ø	23.7
125ØØ	24.5	4.17	Ø.Ø	23.7
1275Ø	23.7	4.34	Ø.Ø	27.6
13ØØØ	23.5	4.56	Ø.Ø	25.9
1325Ø	28.1	4.46	Ø.Ø	23.Ø
135ØØ	23.5	4.97	Ø.Ø	19.5
1375Ø	22.1	4.81	Ø.Ø	23.1
14ØØØ	22.5	4.7Ø	Ø.Ø	23.3
1425Ø	21.6	4.43	Ø.Ø	24.Ø
145ØØ	22.4	4.2Ø	Ø.Ø	23.1
1475Ø	24.Ø	4.31	Ø.Ø	2Ø.3
15ØØØ	26.1	4.47	Ø.Ø	22.4
1525Ø	22.2	3.85	Ø.Ø	23.9
155ØØ	28.2	4.69	Ø.Ø	18.7
1575Ø	29.6	5.9Ø	Ø.Ø	35.8
16ØØØ	34.8	5.6Ø	Ø.Ø	34.6
1625Ø	33.2	5.44	Ø.Ø	2Ø.Ø
165ØØ	27.2	4.93	Ø.Ø	34.9
1675Ø	29.7	6.ØØ	Ø.Ø	23.2
17ØØØ	25.7	4.46	Ø.Ø	22.9

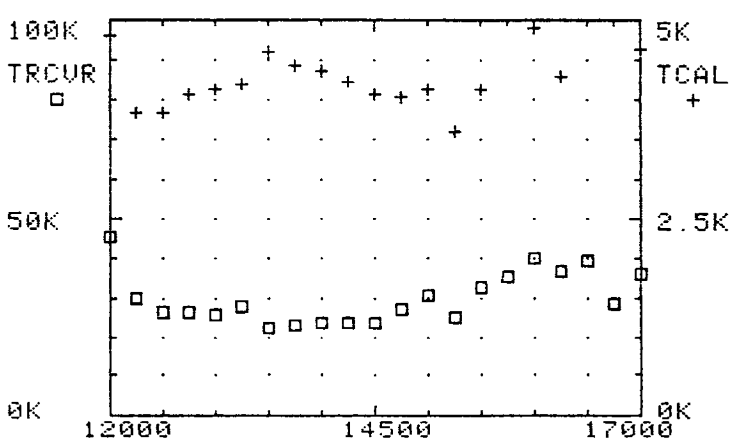


CALIBRATION RECORD OF 14 GHz RECEIVER, SERIAL #9, MOD #0
LCP POLARIZATION, TESTED BY CRADY, DATE 08/11/92 TIME 08:55.5
COMMENT: NONE

15K TEMP = 16.82 50K TEMP = 55.78 300K TEMP = 306.33
AC AMPS = 0.463 DEWR VAC = -25 PUMP VAC = 9951
HEMT LED = 9.38 +15 VOLT = 15.362 TA SENS V= 6.990
CAL VOLT = 28.12 HIGH CAL = 28.19 SPARE = -.01
FETS: LF1= -.263 LF2= -.510 RF1= -.282 RF2= -.478
CRY0 MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

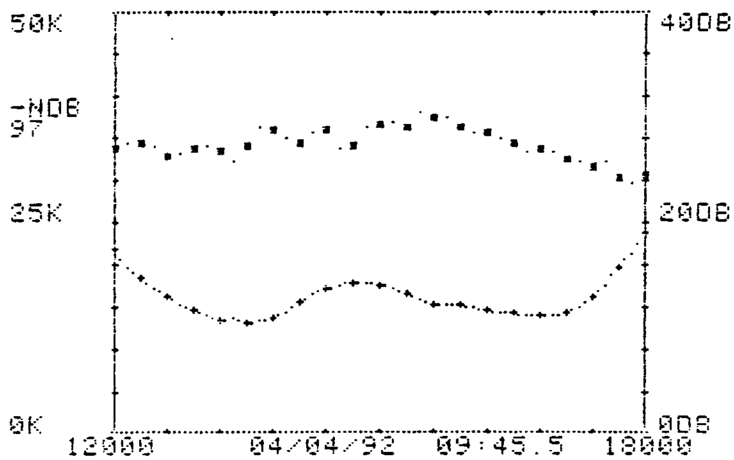
09:00.1 08/11/91 THOT=296 TCOLD=79.5 41DB INPUT ATTEN, 30MHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
12000	44.8	4.79	0.0	25.5
12250	29.4	3.83	0.0	24.2
12500	26.5	3.82	0.0	23.6
12750	26.3	4.05	0.0	23.1
13000	25.6	4.12	0.0	22.1
13250	28.0	4.20	0.0	21.2
13500	22.5	4.60	0.0	20.1
13750	23.3	4.41	0.0	23.9
14000	23.4	4.36	0.0	22.4
14250	23.5	4.23	0.0	22.4
14500	24.0	4.05	0.0	24.1
14750	26.7	4.02	0.0	21.2
15000	30.6	4.13	0.0	22.8
15250	25.2	3.58	0.0	25.0
15500	32.3	4.13	0.0	18.5
15750	35.2	5.74	0.0	30.6
16000	39.7	4.87	0.0	27.0
16250	36.1	4.30	0.0	19.8
16500	39.3	5.39	0.0	36.6
16750	28.3	5.04	0.0	23.0
17000	35.9	4.61	0.0	23.1



1) #U45, OPT BIAS, LED ON
Ø9:45.5 Ø4/Ø4/92 TAV=16 TLO=13 @ 135ØØ GL=23.6 GH=3Ø.4 T=18K

2.52,4.3,-.366 3.Ø1,7.7,-.464 3.Ø4,1Ø.2,-.496 .~~Ø2,.2,.664~~

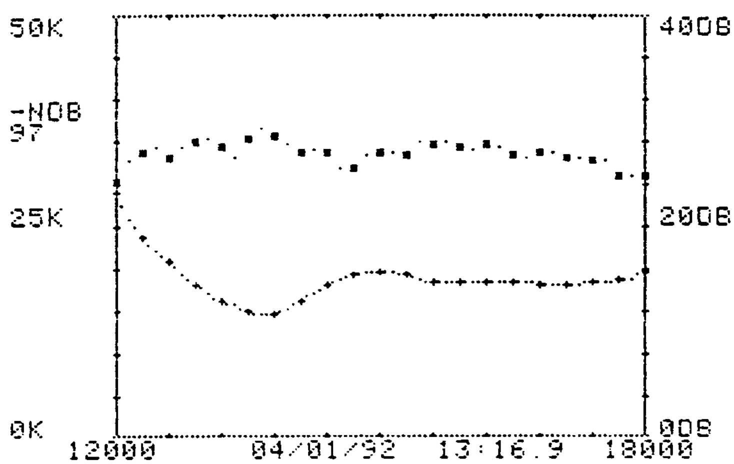


Ø9:46.8 Ø4/Ø4/92 ZERO=12.4 ADB=15 TF=15.5 -NDB=97

F,GHZ	NOISE	GAIN,DB	F,GHZ	NOISE	GAIN,DB
12.ØØØ	21.6	26.9	12.75	15.3	26.4
13.5ØØ	13.Ø	27.1	14.25	16.3	28.3
15.ØØØ	17.5	29.2	15.75	15.1	29.9
16.5ØØ	14.1	27.3	17.25	14.9	25.7
18.ØØØ	23.4	24.3	18.75	Ø.Ø	Ø.Ø

1) #U44, OPT BIAS, LED ON
13:16.9 Ø4/Ø1/92 TAV=18.6 TLO=14.4 @ 1365Ø GL=24.1 GH=29 T=18.5K

2.52,4.3,-.361 3.Ø2,1Ø.2,-.49 3.Ø5,9.9,-.52 ~~Ø2,.2,.663~~



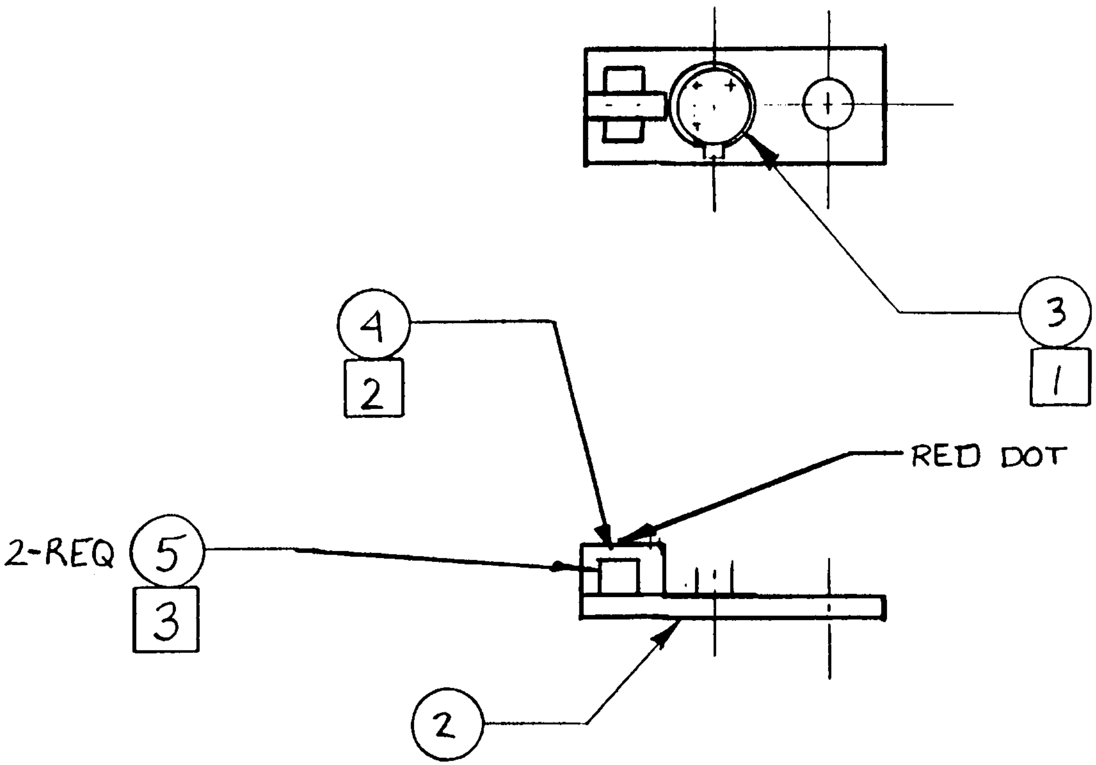
13:18.Ø Ø4/Ø1/92 ZERO=12.4 ADB=15 TF=15.6 -NDB=97

F,GHZ	NOISE	GAIN,DB	F,GHZ	NOISE	GAIN,DB
12.ØØØ	28.9	24.1	12.75	19.3	27.3
13.5ØØ	14.8	28.2	14.25	17.Ø	27.1
15.ØØØ	19.7	26.9	15.75	18.1	28.Ø
16.5ØØ	18.3	26.6	17.25	18.Ø	26.3
18.ØØØ	19.5	24.7	18.75	Ø.Ø	Ø.Ø

APPENDIX II. Drawings and Bill of Materials

The VLBA drafting system contains full documentation and associated drawings of the front-end. This appendix includes key assembly drawings, wiring lists, and bills of materials from which all associated documentation can be determined. The following documents are included here:

Drawing No.	Title
A53200A001	Assembly, Temperature Sensor
A53200B001	BOM, Temperature Sensor
A53206B007	BOM, Inspection Cover Assembly
A53206B008	BOM, Solenoid
A53206B012	BOM, DC Feedthrough
A53208B001	BOM, 14 GHz Front-End
A53208B004	BOM, 14 GHz Card Cage
A53208B005	BOM, 14 GHz Front-End Card Cage
A53208B006	BOM, 14 GHz Bottom Plate Assembly
A53208B007	BOM, 14 GHz Top Plate Assembly
A53208B008	BOM, 14 GHz Cold Strap Assembly
A53208B009	BOM, 14 GHz Amplifier Plate Assembly
A53208B010	BOM, 14 GHz Window Plate Assembly
A53208B011	BOM, 14 GHz Shield Assembly
A53208D007	Connector Orientation
A53208N001	SPEC, Circular Polarizer
A53208W001	14 GHz Cage Cage Wire List
B53206A008	Assembly, Solenoid
C53206A007	Assembly, Inspection Cover
D53209A004	Assembly, Card Cage



NOTES

1. SOLDER W/20E2
ALIGN AS SHOWN

2. SOLDER W/ 60/40 RC
PAINT RED DOT ON SIDE OF CONNECTER INDICATED WITH ARROW.
EPOXY CONNECTOR BETWEEN CAPACITOR BLOCKS

3. SOLDER CAPACITOR AND LEADS W/ SN62 SOLDER.

1 BOM A53200B001

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLBA

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ANGLES ± 3 PLACE DEC.(xxx) ± 2 PLACE DEC.(xx) ± 1 PLACE DEC. (x) ±	PROJ: COMMON F.E.	TITLE: ASS'Y TEMP. SENSOR		
	MATERIAL: ~	DRAWN BY: H DILL	DATE: 840530	
	FINISH: ~	DESIGNED BY:	DATE:	
		APPROVED BY:	DATE:	
	SHEET NUMBER: 1:1	DRAWING NUMBER: A53200A001	REV.	SCALE: 2X

50

H. T. HALL

A53200B001 - TEMPERATURE SENSOR
BILL OF MATERIALS

May 28, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
0	NRAO	A53200A001	ASSY TEMPERATURE SENSOR	1
1	NRAO	A53200B001	BOM TEMPERATURE ASSY	1
2	NRAO	A53200M002	TEMPERATURE SENSOR MOUNT	1
3	LAKE SHORE	DT-500-KL	M/N SILICA DIODE TEMP. SENSORS	1
4	MICROTECH	GM-2	MALE 2 PIN STRIP CONTACT	1
5	ATC	100-B-681-M-P50	CHIP CAPACITOR 680pF	2

A53206B007 - INSPECTION COVER ASSY
BILL OF MATERIALS

May 28, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	NRAO	A53206B007	BOM INSPECTION COVER	1
2	NRAO	B53206A008	ASSY SOLENOID	1
3	NRAO	B53206M007	INSPECTION COVER	1
4	NRAO	A53206M018	INSPECTION SHIELD	1
5	NRAO	A53206M028	SE FITTING REWORK	1
6	NRAO	A53206M029	ME FITTING REWORK	1
7	NRAO	A53206M050	VAC CONN. RW	1
8	NRAO	C53206A007	ASSY INSPECTION COVER	1
9	CAJON	B-2-FE	FEMALE ELBOW 1/8 NPT	1
10	ASCO	8030A17VH	VALVE	1
11	TELEDYNE-HASTIN	DV-6 R	VACUUM GAUGE TUBE	2
12	CAJON	B-8-ME	MALE ELBOW 1/2 NPT	1
13	CAJON	B-2-ME	MALE ELBOW 1/8 NPT	1
14	CAJON	B-8-SE	STREET ELBOW 1/2 NPT	1
15	CAJON	B-2-SE	STREET ELBOW 1/8 NPT	1
16	CAJON	B-8-HN	HEX NIPPLE 1/2 NPT	1
17	LEYBOLD-HERAEUS	910-280-019	FLANGE MALE KF-16	1
18	NUPRO	B-2P4T4	PLUG VALVE, 1/8 FEMALE	1
19	NUPRO	B-2P4T2	PLUG VALVE, 1/8 PORT MALE	1
20	ALPHA	FIT-221-3/4 BLK	HEAT SHRINK TUBING 3/4 ID BLACK	A/R
21	ALPHA	FIT-221-3/8 BLK	HEAT SHRINK TUBING 3/8 ID BLACK	A/R
22				
23				
24	ARO		FILTER	1
25	AMERLOK	PCS-16	SPACER	3
26				
27	ARMSTRONG	A-12	EPOXY	A/R
28	PSM	4-1	1/4 DIA. 1/16 BRONZE FILTER	1
29	PSM	10-1	5/8 DIA. 1/16 BRONZE FILTER	1
30	TRADEMASTER	1/2" x 520"	TEFLON TAPE	A/R

A53206B008 - SOLENOID
BILL OF MATERIALS

May 28, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	NRAO	A53206B008	BOM SOLENOID	1
2	ASCO	8030A17VH	VALVE	1
3	LEECRAFT	45RN2111	INDICATOR LIGHT	1
4			ROMEX CONNECTOR 1/2" COND.	1
5	MOLEX	03-09-2022	CONN 2 PIN PLUG	1
6	MOLEX	02-09-2103	MALE .093 DIA. 14-20 GA.	2
7	ALPHA	FIT-221-3/8 BLK	HEAT SHRINK TUBING 3/8 ID BLACK	A/R
8	ALPHA	FIT-221-3/4 BLK	HEAT SHRINK TUBING 3/4 ID BLACK	A/R
9	NRAO	A53206M070	SOLENOID COVER REWORK	1
10	NRAO	B53206A008	ASSY SOLENOID	1

A53206B012 - DC FEEDTHRU
BILL OF MATERIALS

May 28, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	BELDEN		25 PIN "D" CONN HOOD	1
2	BELDEN	9747	22 AWG / 24 COND.	A/R
3	CINCH (TRW)	DBM-25P	TYPE "D" CONN 25 PINS	1
4	NRAO	A53200I002	DC FEEDTHRU ARTWORK	1
5	NRAO	A53206B012	BOM DC FEEDTHRU	1
6	NRAO	A53206M008	DC FEEDTHRU	1
7	NRAO	B53206A012	BOM CABLE ASSY J1 TO DEWAR	1
8	US MICROTECK CO	XS1F2-332H	FEED THRU CAP. FILTER 3000 pf	2
9	VICLAN	7648-1011-102	FEED THRU CAP. FILTER 1000 pf	22

A53208B001 - 14 GHZ FRONT-END
BILL OF MATERIALS

Mar. 23, 1993 Page 1

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		1/4-20 HEX NUT	4
2	ALL-METAL		4-40 x 1/2 SS SHCS	4
3	ALL-METAL		6-32 x 1/2 SS SHCS	4
4	ALL-METAL		8-32 x 1/2 SS SHCS	4
5	ALL-METAL		8-32 x 3/8 SS SHCS	2
6	ALL-METAL	3/8-16	HEAVY HEX JAM NUTS	4
7	ALPHA	FIT-221-1/4 BLK	HEAT SHRINK TUBING 1/4 ID BLACK	A/R
8	ALPHA WIRE	1855	7/30 #22 AWG PVC JACKETED WIRE	A/R
9	KEYSTONE	1957	8-32 THREADED STANDOFF	2
10	NRAO	A53208B001	BOM 14 GHZ FRONT END	1
11	NRAO	A53206B007	BOM INSPECTION COVER	1
12	NRAO	A53206M060	DC FEEDTHRU COVER	1
13	NRAO	A53208B004	BOM CARD CAGE	1
14	NRAO	A53208B006	BOM BOTTOM PLATE ASSY	1
15	NRAO	A53208B007	BOM TOP PLATE ASSY	1
16	NRAO	A53208B008	BOM COLD STRAP ASSY	1
17	NRAO	A53208B009	BOM AMPLIFIER PLATE ASSY	1
18	NRAO	A53208B010	BOM WINDOW ASSY	1
19	NRAO	A53209B011	BOM SHIELD ASSY	1
20	NRAO	C53208M032	WAVEGUIDE	1
21	NRAO	D53206M015-1	DEWAR CYLINDER	1
22	NRAO	D53206A005	ASSY CARD CAGE	1
23	NRAO	D53208I003	F.E & CARD CAGE FREQ/SN LABELS	1
24	OMNI-SPECTRA	2001-7941-00	SMA .141 PLUG MODEL 201-1	16
25	PANDUIT	PLT.7M-C	3.1" CABLE TIE	1
26	PANDUIT	PLT2M-C	8" CABLE TIE	2
27	PARKER	-031	O-RING (KF-50 FLANGE JUNCTN)	1
28	PARKER	2-130	O-RING (DC FEEDTHRU)	1
29	PARKER	2-230	O-RING (REF/WINDOW)	1
30	PARKER	2-251	O-RING (INSPECTION COVER)	1
31	PARKER	2-270	O-RING (CYLINDER)	2
32	SOUTHCO	74-13-106-24	6-32 NC SS INSERT	1
33	UNIFORM TUBES	UT-141A	.141 CABLE	A/R
34	WILLIAMS	10-741-90768	3/8 FLAT WASHER	4

A53208B004 - CARD CAGE 14 GHZ
BILL OF MATERIALS

Mar. 23, 1993

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
0	NRAO	D53206A005	ASSY CARD CAGE	1
1	NRAO	A53208B004	BOM CARD CAGE	1
2	NRAO	C53209M047	FRONT PANEL	1
3	NRAO	B53206M063-1	SIDE PLATE	1
4	NRAO	C53206M067	BACK PANEL	1
5	NRAO	A53206M061-1	SIDE RAIL	1
6	NRAO	C53206M065-1	COVER (SIDE)	1
7	NRAO	D53206M069-1	TOP SIDE	1
8	AMP	205208	'D' CONN. 25 POSITION PLUG	1
9	AMP	205207-1	'D' CONN. 25 POSITION RECEPT.	2
10	OMNI-SPECTRA	21011	SMA-TYPE N BULKHEAD	2
11	CINCH	50-44A-30	EDGECARD CONN. 44PIN	7
12	CINCH	50-PK-2	POLARIZING KEY	7
13	DALE	RH-25 300	RES. 300 25W 1%	1
14	DALE	RH-10 5K	RES. 5K 10W 1%	1
15	VOLTREX	ECC-6	CABLE CLAMP	1
16	DEUTSCH	DM9606-3P	AC INPUT CONNECTOR	1
17	NRAO	B53206M062-1	BAR	1
18	AMP	205203-1	'D' CONN. 9 POS. RECEPT.	1
19	SOUTHCO	74-13-210-24	10-32 NF SS INSERT	2
20	ALL-METAL		2-56 x 3/16 SS SHCS	2
21	ALL-METAL		4-40 x 3/16 SS SHCS	12
22	ALL-METAL		4-40 x 1/4 SS SHCS	4
23	ALL-METAL		4-40 x 5/16 SS SHCS	11
24	ALL-METAL		4-40 x 3/8 SS SHCS	14
25	ALL-METAL		4-40 x 3/8 FHSS	2
26	NRAO	C53206M066-1	COVER	1
27				
28	ALL-METAL		10-32 x 3/8 SS SHCS	1
29	KEYSTONE	7311	#4 GROUND LUG	5
30	NRAO	B53206M064-1	END PLATE	1
31	NRAO	A53206W001	WIRE LIST CARD CAGE	1
32				
33	AMPHENOL	78-PF8-11	OCTAL SOCKET PLUG WITH CLAMP	2
34	CINCH	D-20418-2	CONNECTOR JACK SCREW KIT (1 PAIR)	4
35	MOLEX	03-09-1022	2 PIN CONN. RECEPTACLE	2
36	MOLEX	02-09-1103	FEMALE .093 DIA PIN 20-14 AWG	2
37	DEUTSCH	DM9702-3S	AC CONNECTOR PLUG	1
38	SOUTHCO	47-11-103-10	CAPTIVE SCREW ASSY 1/8 PANEL	3
39	SOUTHCO	47-11-101-10	CAPTIVE SCREW ASSY 1/16 PANEL	2
40	SOUTHCO		4-40 SS INSERT	1
41	HELICOIL		4-40 HELICOIL INSERT	4
42	ALL-METAL		3/32 DIA. x 1/4 SS DOWEL	2
43	BELDEN	8443	JACKET 3 WIRE 22 AWG	A/R
44	BELDEN	9740	JACKETED 2 WIRE 18 AWG TWISTED PR.	A/R
45	BELDEN	8442	JACKETED 2 WIRE 22 AWG TWISTED PR.	A/R

A53208B004 - CARD CAGE 14 GHZ
BILL OF MATERIALS

Mar. 23, 1993

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
46	MANHATTEN CABLE	M39076	JACKETED 3 WIRE 18 AWG	A/R
47	ALPHA	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	A/R
48	ALPHA	FIT-221-1/4 BLK	HEAT SHRINK TUBING 1/4 ID BLACK	A/R
49	ALPHA	FIT-221-3/8 BLK	HEAT SHRINK TUBING 3/8 ID BLACK	A/R
50	ALPHA	FIT-221-3/4 BLK	HEAT SHRINK TUBING 3/4 ID BLACK	A/R
51	AMP	66506-9	HD-20 'D' CONTACT-PIN	25
52	AMP	66504-9	HD-20 'D' CONTACT-SOCKET	59
53	AMPHENOL	9779-513-4	RUBBER BOOT STRAIN RELIEF	2
54	MOLEX	02-09-2118	MALE .093 DIA. PIN 24-18 AWG	2
55	NRAO		FRONT PANEL SILKSCREEN	1
56	ALPHA	1855 OR 3155	STRANDED 22 AWG WIRE COLORS A/R	A/R
57	ALLEN BRADLEY		RES. 510 1.2W 5%	1
58	ALPHA	1857	STRANDED 18 AWG HOOKUP WIRE	A/R
59	ALPHA	296	SOLID 18 AWG BUS WIRE	A/R
60	MOTOROLA	1N5355A	DIODE, 1N5355A (ZENER 18V)	2
61	NRAO	A53200M051	PULSE CAL INPUT ADAPTER PLATE	1
62	OMNI SPECTRA	2084-0000-00	JACK-JACK ADAPT. BULKHEAD FEEDTHRU	1

A53208B005 - 14 GHZ FE RF CARD
BILL OF MATERIALS

Mar. 23, 1993

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	NRAO	C53208Q001	CIRCUIT BOARD	1
2	NRAO	C53208P001	DRILL DRAWING	1
3	NRAO	A53208M024	NOISE SOURCE MOUNTING BRACKET	1
4	NRAO	A53208M025	NOISE SOURCE CLAMP	2
5	NRAO	A53208M028	ISOLATOR MOUNTING BRACKET	2
6	NRAO	A53208M027	AMPLIFIER MOUNTING BRACKET	2
7	NRAO	A53208M026	COUPLER MOUNTING BRACKET	1
8	NRAO	D53208A001	RF CARD ASSEMBLY	1
9	ALL-METAL		2-56 x 1/2 SS SHCS	6
10	ALL-METAL		4-40 x 1/4 SS SHCS	6
11	ALL-METAL		4-40 x 3/8 SS SHCS	1
12	ALLEN BRADLEY	RC07GF123J	12K 1/4 WATT 5% RESISTOR	1
13	ALLEN BRADLEY	RC07GF10GJ	1 OHM 1/4 WATT 5% RESISTOR	1
14	SPRAGUE	TE-1205	CAPACITOR, 15 uF 25V TANT.	2
15	NATIONAL SEM.	LM335Z	TEMPERATURE SENSOR	1
16	KEYSTONE	6056	HORIZONTAL TEST JACK, BLACK	1
17	KEYSTONE	6067	HORIZONTAL TEST JACK, RED	1
18	KEYSTONE	6057	HORIZONTAL TEST JACK, YELLOW	1
19	SMT	S90-1172	RF AMPLIFIER	2
20	DITOM	D3I8016-2	ISOLATOR	2
21	MAC	C3207-10	COUPLER	2
22	NOISE COM	NC3207A	NOISE SOURCE	1
23	OMNI-SPECTRA	1001-5041	.085 STRAIGHT CABLE PLUG	10
24	OMNI-SPECTRA	2081-0000-00	SMA MALE TO MALE ADAPTER	3
25	SOLITRON	8018-6005	50 OHM TERMINATION	1
26	PRECISION TUB	AA50085	.085 SEMI-RIGID CABLE	A/R
27	ALPHA WIRE	7055 RED	#22 AWG STRANDED WIRE	A/R
28	BELDEN	8216	RG-174U COAXIAL CABLE	A/R
29	AMPHENOL	31-315	BNC MALE FOR RG-174U	1
30	NARDA	4779-8	ATTENUATOR, 8 DB OR A/R	1

A53208B006 - 14 GHZ BOTTOM PLATE ASSY
BILL OF MATERIALS

Mar. 24, 1993

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		1/4-20 x 1 SS SHCS	4
2	ALL-METAL		10-32 x 1/2 SS SHCS	2
3	AMERLOK	FPCS-8	NYLON SPACERS	4
4	ARMSTRONG	A-12	EPOXY	A/R
5	CTI CRYOGENICS	MODEL 22	REFRIGERATOR	1
6	DEARBORN	805036W	LACING TAPE	A/R
7	NRAO	A53200B001	BOM TEMPERATURE SENSOR	1
8	NRAO	A53206B012	BOM CABLE ASSY J1 TO DEWAR	1
9	NRAO	A53206M019	HANDLE COLLAR	4
10	NRAO	A53209B006	BOM BOTTOM PLATE ASSY	1
11	NRAO	B53206M020	HANDLE	2
12	NRAO	C53206M021	BOTTOM SHIELD	1
13	NRAO	D53200M027	BOTTOM PLATE	1
14	OMNI-SPECTRA	2001-5032-00	SMA PLUG .085 DIA CABLE MOD. 201-2A	6
15	OMNI-SPECTRA	2084-1100-00	HERMETIC FEEDTHRU MODEL 208A	3
16	PARKER	2-230	O-RING (REF/WINDOW)	1
17	UNIFORM TUBES	UT-85-50-SS-B	.085 SEMI RIGID CABLE SS-Be	A/R

A53208B007 - 14 GHZ TOP PLATE ASSY
BILL OF MATERIALS

Mar. 24, 1993 Page 1

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ACCRABOND	146	STUD LOCKING SEALANT	A/R
2	ALL-METAL		1/4-20 x 1-1/4 SS SHCS	4
3	ALL-METAL		10-32 x 1 SS SHCS	7
4	ALL-METAL		4-40 x 3/16 SS SHCS	12
5	ALL-METAL		6-32 x 1/2 SS SHCS	4
6	ALL-METAL		6-32 x 1/4 SS SHCS	3
7	ALL-METAL	3/8-16	HEAVY HEX JAM NUTS	4
8	AMERLOK	FPCS-8	NYLON SPACERS	4
9	ARMSTRONG	A-12	EPOXY	A/R
10	ATLANTIC MICROW	A53208N001A/ NRAO	CIRCULAR POLARIZER	1
11	COLEFLEX	SPP 3/8 NAT	SPIRAL WRAP	A/R
12	CONNER WIRE	NE24-7-30T	CU BRAID	A/R
13	ECCOBOND	27	EPOXY	A/R
14	NRAO	A53206M001	INNER SUPPORT	1
15	NRAO	A53206M002	OUTER SUPPORT	1
16	NRAO	A53206M003	SUPPORT RING	1
17	NRAO	A53206M006	TOP SHIELD	1
18	NRAO	A53206M053	STRAP TOP SHIELD	1
19	NRAO	A53208B007	BOM 14GHZ TOP PLATE ASSY	1
20	NRAO	B53200M041-1	STOP TUBE	4
21	NRAO	B53206M048-1	THREADED ROD	4
22	NRAO	B53208M001-1	WAVEGUIDE CHOKE OUTER RING	1
23	NRAO	D53200M007-5	TOP PLATE 14GHZ	1
24	PIC DESIGN	B12-2	3/8 SPACER WASHER - .006"	12
25	PIC DESIGN	B12-6	3/8 SPACER WASHER - .014"	8
26	THOMAS & BETTS	54104	CU RED LUG 8 STR	4

A53208B008 - 14 GHZ COLD STRAP ASSY

BILL OF MATERIALS

Mar. 24, 1993 Page 1

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	AIRPAX	5003091-254	THERMAL CUTOFF 160DEG. +/- 4 F	1
2	ALL-METAL		#6 HEX NUT	2
3	ALL-METAL		4-40 x 3/8 SS SHCS	2
4	ALL-METAL		6-32 x 1/4 SS SHCS	2
5	ALL-METAL		2-56 x 1/2 SS SHCS	1
6	ALL-METAL		#2 HEX NUT	1
7	ALPHA	FIT-221-1/4 BLK	HEAT SHRINK TUBING 1/4 ID BLACK	A/R
8	ALPHA	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	A/R
9	ARMSTRONG	A-12	EPOXY	A/R
10	HOTWATT	SC252.25	HEATER 75W 240V	1
11	LINDE	AC-4051	CHARCOAL (6 x 8 PELLETS)	A/R
12	MICROTECH	GM-2	MALE 2 PIN STRIP CONTACT	1
13	NRAO	A53200B001	BOM TEMPERATURE SENSOR	1
14	NRAO	A53206M056	HEATER CLAMP	1
15	NRAO	A53208B008	BOM COLD STRAP ASSY	1
16	NRAO	C53208M029	2ND STAGE STATION STRAP	1
17	OMNI-SPECTRA	2001-5032-00	SMA PLUG .085 DIA CABLE MOD. 201-2A	4
18	TRM	DMS285-18	POWER DIVIDER	1

A53208B009 - 14 GHZ AMPLIFIER PLATE ASSY
BILL OF MATERIALS

Mar. 25, 1993

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		#2 SS FLAT WASHER	1
2	ALL-METAL		#2 HEX NUT	1
3	ALL-METAL		2-56 x 1/4 SS SHCS	3
4	ALL-METAL		2-56 x 1/4 SS FHS	6
5	ALL-METAL		2-56 x 3/8 SS SHCS	3
6	ALL-METAL		2-56 x 1 SS SHCS	1
7	ALL-METAL		6-32 x 3/8 SS SHCS	1
8	ALPHA	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	A/R
9	MICROTECH	GF-2	2 CONTACT STRIP RECEPT.	2
10	MICROTECH	GM-2	MALE 2 PIN STRIP CONTACT	1
11	MWS WIRE INDUST	B232211110-001	BRASS BIFILAR MAGNET WIRE	A/R
12	NRAO		14 GHZ AMPLIFIER	1
13	NRAO	A53208B009	BOM AMPLIFIER PLATE ASSY	1
14	NRAO	A53208M007	COUPLER MOUNT	1
15	NRAO	A53208M033	ISOLATOR MOUNTING PLATE	1
16	NRAO	B53208M006	AMPLIFIER PLATE	1
17	OMNI-SPECTRA	2001-7941-00	SMA .141 PLUG MODEL 201-1	4
18	SOUTHCO	74-13-106-24	6-32 INSERT	12
19	UNIFORM TUBES	UT-141A	.141 SEMI-RIGID CABLE	A/R

A53208B010 - 14 GHZ WINDOW PLATE ASSY
BILL OF MATERIALS

Mar. 25, 1993 Page 1

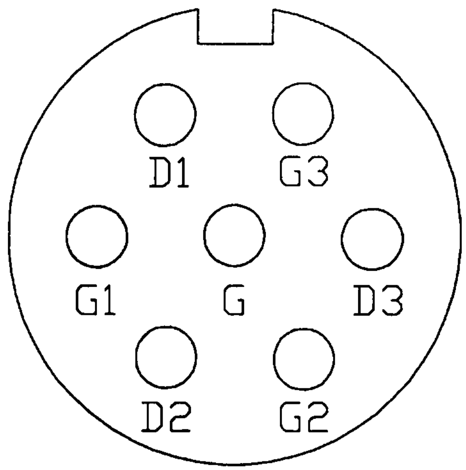
NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		3/32 x 1/4 DOWEL PIN	2
2	ECCOBOND	45	EPOXY	A/R
3	NRAO	A53200M020-3	IRIS	1
4	NRAO	A53206M054-6	WINDOW	1
5	NRAO	A53208B010	BOM 14 GHZ WINDOW PLATE ASSY	1
6	NRAO	B53206M013-3	WINDOW PLATE	1

A53208B011 - 14 GHZ SHIELD ASSY
BILL OF MATERIALS

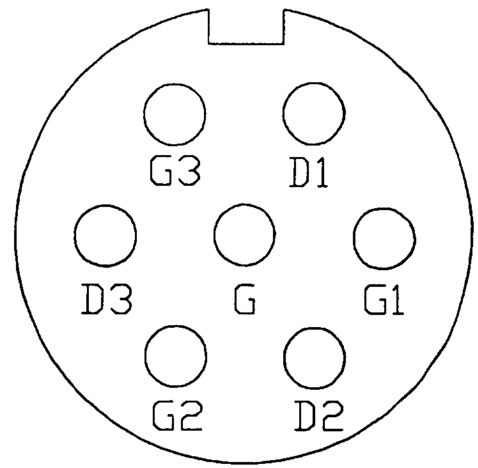
Mar. 25, 1993

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		#6 NYLON FLAT WASHER	4
2	ALL-METAL		6-32 x 1/2 SS SHCS	1
3	ALL-METAL		6-32 x 1/4 NYLON PAN HEAD	2
4	ALL-METAL		6-32 x 1/4 SS SHCS	2
5	ALL-METAL		6-32 x 1/8 PAN HEAD	1
6	LINDE	AC-4051	CHARCOAL (6 x 8 PELLETS)	A/R
7	NRAO	A53206M004	CHARCOAL PLATE	1
8	NRAO	A53206M009-1	SHIELD SUPPORT	2
9	NRAO	A53206M010	70 DEG K SHIELD CONNECTION	1
10	NRAO	A53206M011-1	SIDE SHIELD	1
11	NRAO	A53206M052	STRAP SIDE SHIELD	1
12	NRAO	A53209B011	BOM SHIELD ASSY	1

* REAR OF CHASSIS MT. (ER-7S-6)
FRONT OF CABLE (EP-7S-1)



FRONT OF CHASSIS MT. (FR-7S-6)
* REAR OF CABLE (EP-7S-1)



* NOTE: REAR IS
SOLDER SOCKET SIDE

NATIONAL RADIO ASTRONOMY OBSERVATORY CHARLOTTESVILLE, VA. 22903				
TITLE: MICROTECH CONNECTOR ORIENTATION				
PROJECT: 14 GHz F.E.				
DESIGN			COMPUTER DRAWING	
DRAWN	WKC	03/26/93	MATERIAL	
SHEET			FINISH	
SCALE	8:1		DWG. NO.	A53208D007
			REVISION	

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

SPECIFICATION: A53208N001, Rev. A

TITLE: Circular Polarizer

DATE: April 5, 1990

PREPARED BY: M Balister APPROVED BY: A.R. Thompson

1. General Description

A microwave component having a circular waveguide input and two SMA female coaxial outputs is desired. An outline drawing is shown in the attached Figure 1. The ideal device transfers left-circular-polarization (LCP) in the input waveguide to one coaxial output and right-circular-polarization (RCP) to the other output. Deviations from ideal performance are described by specifications for ellipticity, isolation, and return loss.

The frequency range for the device is 12.0 GHz to 15.4 GHz.

2. Environment and Materials

The polarizer will be used in a cryogenically cooled, low-noise receiver and will be cooled to a temperature of -260°C. It shall be made of aluminum, have as little mass as is practical without sacrifice of performance, and shall utilize no dielectric materials other than in the SMA connectors which shall be Omni-Spectra Model 204CC. These connectors shall be bolted (rather than bonded by solder or epoxy) to the polarizer. Any other joints in the polarizer shall be bolted.

3. Surface Finish

In order to reduce the absorption of thermal radiation by the polarizer, its outside surface should be goldplated (75 ± 25 microinches) over a copper-flash/zincate adhesion layer. The interior of the waveguide need not be masked or surrounded by an anode during the exterior plating operation.

4. <u>Ellipticity</u>

The ellipticity is defined as the ratio of maximum to minimum power out of either SMA output as a function of orientation of a linearly-polarized input to the circular waveguide. In the full frequency range, the ellipticity shall be $\leq$ 1.0 dB.

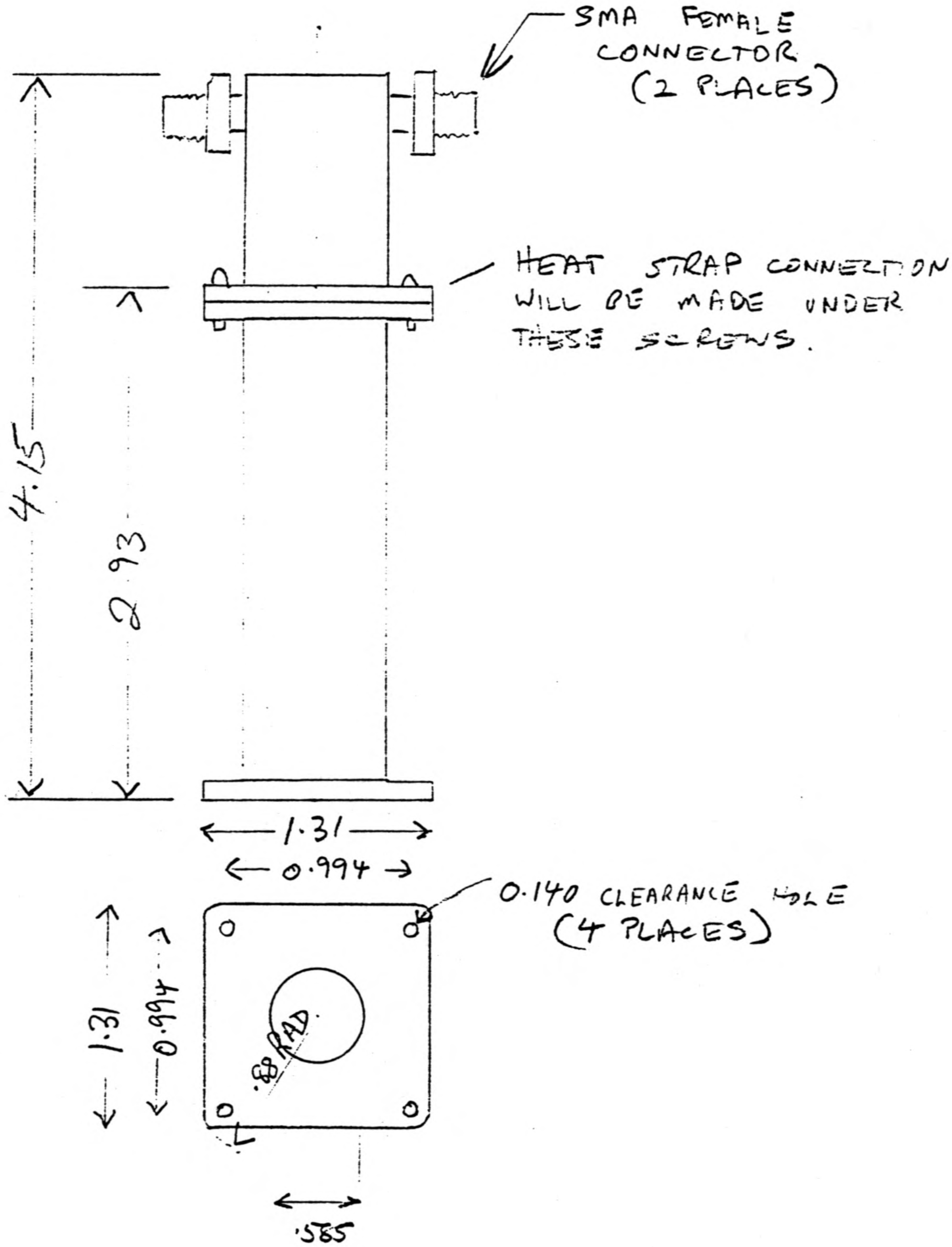
5. <u>Isolation</u>

With the circular-waveguide terminated, the coupling between SMA outputs shall be $\leq$ -25 dB in the full frequency range.

6. <u>Return Loss</u>

With the circular-waveguide terminated, the return loss at each SMA output shall be less than 17 dB in the full frequency range.

Attachment:
Outline Drawing



OUTLINE DRAWING CIRCULAR POLARIZER

SPEC A 53208N901

MB 3-20-90

VLBA 14 GHZ FRONT-END
CARD CAGE

WIRING LIST

Note:

Unless noted all wire 22 AWG stranded. Noted types are:

Jacketed 3-wire 22 AWG cable

Jacketed twisted pair 18 AWG cable

Jacketed 3-wire 18 AWG

Jacketed twisted pair 22 AWG

18 AWG stranded wire

18 AWG solid wire

Ref: Bill of Materials A53208B004

COLOR CODE

X-NONE	N1 N2 N3
0-BLACK	
1-BROWN	N1-PRIMARY COLOR
2-RED	N2-1st TRACER IF SPECIFIED
3-ORANGE	N3-2nd TRACER IF SPECIFIED
4-YELLOW	
5-GREEN	
6-BLUE	
7-VIOLET	
8-GRAY	
9-WHITE	
P-PINK	
T-TAN	

GROUND LUGS

GL1, GL2, GL3, GL4, GL5, GL6- SEE D53209A004 FOR PLACEMENT.

Mar. 26, 1993
By: W. K. Crady

Dwg. No.: A53208W001
Sheet: 1 of 14

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 1
CARD: RF Card

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 2

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS S1-M	BUS 0XX	1	GROUND	GL1 BUS	0XX
B	+15 VOLTS	BUS J5-2	BUS 2XX	2	+15 VOLTS	BUS *1	2XX
C	-15 VOLTS	BUS J5-3	BUS 4XX	3	-15 VOLTS	BUS *2	4XX
D				4			
E				5			
F				6			
H				7			
J				8			
K				9			
L				10			
M	LO CAL RET	S1-S S1-A	0XX	11			
N	LO CAL IN	J5-11	8XX	12			
P				13			
R				14			
S	HI CAL RET.	S1-M	0XX	15			
T	HI CAL IN	J5-12	8XX	16			
U				17			
V				18			
W	300K TEM MON.	S3-L	92X	19			
X				20			
Y				21			
Z	QUA. GND	J2-13 GL2	5XX	22			

SPECIAL INSTRUCTIONS:
*1 WIRE 1N5355A ZENER DIODE BETWEEN GL1 AND PIN 2 WITH BAND TOWARD PIN 2.
*2 WIRE 1N5355A ZENER DIODE BETWEEN GL1 AND PIN 3 WITH BAND TOWARD GL1.

'BUS' SIGNIFIES 18 AWG SOLID BUS WIRE STRAPPED THROUGH ALL SEVEN CARD SLOT CONNECTORS.

KEY BETWEEN 1 & 2.

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 2
CARD: Spare

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 3

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D				4			
E				5			
F				6			
H				7			
J				8			
K				9			
L				10			
M				11			
N				12			
P				13			
R				14			
S				15			
T				16			
U				17			
V				18			
W				19			
X				20			
Y				21			
Z				22			

SPECIAL INSTRUCTIONS:

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 3
CARD: MONITOR CARD

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 4

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS S3-X	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D				4			
E	QUALITY GROUND	GL2 S4-J	5XX	5			
F	PUMP VAC MON	J2-1 S6-14	8XX	6			
H	DEWAR VAC MON	J2-2 S6-N	6XX	7			
J	15K MON (TEMP A)	J2-3 S6-D	96X	8			
K	50K MON (TEMP B)	J2-4 S6-5	95X	9			
L	300K MON	J2-5 S1-W	92X	10			
M	AC CURRENT MON	J2-6 J4-1	PXX	11			
N	RCP GATE 1 MON	J2-7 S4-7	90X	12	X-MON	J2-23	7XX
P	RCP GATE 2,3 MON	J2-8 S4-6	904	13	C-MON	J2-24	9XX
R	LCP GATE 1 MON	J2-9 S5-7	94X	14	NOT H-MON	J2-25	3XX
S	LCP GATE 2,3 MON	J2-10 S5-6	97X	15			
T	LED MON	J2-11*1 J3-22	903	16			
U	SPARE MON	J2-12	1XX	17	X-CPU	J5-6	7XX
V	*2			18	X-OUTPUT	S7-4	7XX
W	MANUAL MON	J2-22	902	19	C-CPU	J5-7	9XX
X	LED +15 VOLTS	S3-B*1	2XX	20	C-OUTPUT	S7-M	9XX
Y				21	NOT H-CPU	J5-8	3XX
Z				22	NOT H-OUTPUT	S7-L	3XX

SPECIAL INSTRUCTIONS:
*1 CONNECT R3 (510 OHM, 1/2 WATT CARBON) ACROSS PINS S3-T,X.
*2 RESERVED LOCATION (USED IN PLACE OF PIN X ON SOME EARLY MODELS NOT RECOMMENDED FOR NEW DESIGNS).

KEY BETWEEN 3 & 4.

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 4
CARD: RCP FET BIAS

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 5

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	GATE 4	J3-19	7XX	4	GATE 4 MON	N.C.	
E	GATE 3	J3-17	98X	5	GATE 3 MON	S4-6	904
F	GATE 2	J3-15	4XX	6	GATE 2 MON	S3-P	904
H	GATE 1	J3-13	90X	7	GATE 1 MON	S3-N	90X
J	QUALITY GROUND	S3-E S5-J	5XX	8			
K	DRAIN 4	J3-20	902	9			
L	DRAIN 3	J3-18	6XX	10			
M	DRAIN 2	J3-16	3XX	11			
N	DRAIN 1	J3-14	25X	12			
P				13			
R				14			
S				15			
T				16			
U				17			
V				18			
W				19			
X				20			
Y				21			
Z	6 VOLT CONTROL	N.C.		22			

SPECIAL INSTRUCTIONS:

KEY BETWEEN 4 & 5.

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 5
CARD: LCP FET BIAS

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 6

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	GATE 4	J3-11	7XX	4	GATE 4 MON	N.C.	
E	GATE 3	J3-9	98X	5	GATE 3 MON	S5-6	904
F	GATE 2	J3-7	4XX	6	GATE 2 MON	S3-S	904
H	GATE 1	J3-5	90X	7	GATE 1 MON	S3-R	90X
J	QUALITY GROUND	GL6	0XX	8			
K	DRAIN 4	J3-12	902	9			
L	DRAIN 3	J3-10	6XX	10			
M	DRAIN 2	J3-8	3XX	11			
N	DRAIN 1	J3-6	25X	12			
P				13			
R				14			
S				15			
T				16			
U				17			
V				18			
W				19			
X				20			
Y				21			
Z	6 VOLT CONTROL	N.C.		22			

SPECIAL INSTRUCTIONS:

KEY BETWEEN 4 & 5.

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 6
CARD: SENSOR CARD

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 7

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	A MON OUT (15K)	S3-J S7-D	96X	4	TEMP SENSOR A	J3-2	96X
E	SENSOR A RTN	J3-1 S6-F	93X	5	B MON OUT (50K)	S3-K	95X
F	SENSOR B RTN	J3-3 S6-E	92X	6			
H	SENSOR B	J3-4	95X	7			
J	VAC TUBE DWR-1	P16-3	2XX*1	8			
K	VAC TUBE DWR-2	P16-5	0XX*1	9			
L	VAC TUBE DWR-3	P16-7	5XX*1	10			
M	VAC DWR LOCAL MON	N.C.		11			
N	VAC DWR MON	S3-H S7-E	6XX	12			
P				13			
R				14	VAC PUMP MON	S3-F	8XX
S	TEMP A NLIN	J2-14	906	15	TEMP A NLIN	N.C.	
T	TEMP B NLIN	N.C.		16	TEMP B NLIN	N.C.	
U				17	VAC TUBE PUMP-3	P15-7	5XX*2
V				18			
W				19			
X				20			
Y				21	VAC TUBE PUMP-1	P15-3	2XX*2
Z				22	VAC TUBE PUMP-2	P15-5	0XX*2

SPECIAL INSTRUCTIONS:
*1 AND *2 - USE 22 AWG THREE CONDUCTOR JACKETED CABLE.
TERMINATE EACH AS SPECIFIED BY D53206A005.

KEY BETWEEN 5 & 6.

CARD SLOT WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 7
CARD: CONTROL CARD

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 8

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
A	GROUND	BUS	BUS	1	GROUND	BUS	BUS
B	+15 VOLTS	BUS	BUS	2	+15 VOLTS	BUS	BUS
C	-15 VOLTS	BUS	BUS	3	-15 VOLTS	BUS	BUS
D	TEMP A MON IN	S6-D	96X	4	X EVAC CONTROL	S3-18	7XX
E	VAC DWR MON IN	S6-N	6XX	5			
F	VAC PUMP MON IN	S6-14	8XX	6			
H				7			
J	S-SOL MON OUT	J2-20	98X	8			
K	P-PUMP REQ OUT	J2-21 J4-3	91X	9			
L	NOT H-NO HEAT CTRL	S3-22	3XX	10			
M	C-COOL CONTROL	S3-20	9XX	11			
N				12			
P				13			
R				14	SOLENOID RTN	R1-2	9XX*1
S	SOLENOID SUPPLY	P14-1	0XX*2	15			
T				16	RESISTOR LOAD	R2-1	0XX
U	150VAC IN, PHASE 2	J1-1	2XX*1	17			
V	150VAC REFR, PHA 2	P12-1	2XX*3	18	LOAD HEATER RTN	R2-2	TXX
W	DEWAR HEATER	J3-24	1XX*5	19	DEWAR HEATER RTN	J3-25	TXX
X	150VAC IN, PHASE 1	J1-3	0XX*1	20	150VAC RTN IN	J1-2	9XX*1
Y	150VAC REFR, PHA 1	P12-3 P13-1	0XX*3 0XX*4	21	REFR RTN	P12-2 P13-2	9XX*3 9XX*4
Z				22			

SPECIAL INSTRUCTIONS:
KEY BETWEEN 6 & 7.
*1 - USE 18 AWG STRANDED WIRE. TWIST S7-U,X,20.
*2 - USE TWO CONDUCTOR JACKETED CABLE. CONNECT RED CONDUCTOR (FREE END IN CARD CAGE) TO R1-1. OPPOSITE END TERMINATED IN P14-2.
*3 - USE THREE CONDUCTOR JACKETED CABLE. OPPOSITE END TERMINATED IN P12.
*4 - USE JACKETED 22 AWG TWISTED PAIR. OPPOSITE END TERMINATED IN P13.
*5 - TWIST S7-W.19.

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNCT: FRONT END MONITOR

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 9
DESIGNATION: J2

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	VAC PUMP MONITOR	S3-F	8XX	14	TEMP A NLIN	S6-S	906
2	VAC DEWAR MONITOR	S3-H	6XX	15			
3	15K MON (TEMP A)	S3-J	96X	16			
4	50K MON (TEMP B)	S3-K	95X	17			
5	300K MON (AMBIENT)	S3-L	92X	18			
6	AC CURRENT MONITOR	S3-M	PXX	19			
7	RCP GATE 1 MON	S3-N	90X	20	S-SOL MON	S7-J	98X
8	RCP GATE 2,3 MON	S3-P	904	21	P-PUMP REQUEST	S7-K	91X
9	LCP GATE 1 MON	S3-R	94X	22	MANUAL MON	S3-W	902
10	LCP GATE 2,3 MON	S3-S	97X	23	X-MON	S3-12	7XX
11	LED MON	S3-T	903	24	C-MON	S3-13	9XX
12	SPARE MON	S3-U	1XX	25	NOT H-MON	S3-14	3XX

SPECIAL INSTRUCTIONS:
ORIENT CONNECTOR WITH SOCKETS 14-25 CLOSEST TO WIRING EDGE OF FRONT PANEL (SEE D53206A005).

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNCT: DEWAR/POWER MONITOR

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 10
DESIGNATION: J3

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	SENSOR A RTN	S6-E	93X	14	RCP DRAIN 1	S4-N	25X
2	SENSOR A (15K)	S6-4	96X	15	RCP GATE 2	S4-F	4XX
3	SENSOR B RTN	S6-F	92X	16	RCP DRAIN 2	S4-M	3XX
4	SENSOR B	S6-H	95X	17	RCP GATE 3	S4-E	98X
5	LCP GATE 1	S5-H	94X	18	RCP DRAIN 3	S4-L	6XX
6	LCP DRAIN 1	S5-N	20X	19	RCP GATE 4	S4-D	7XX
7	LCP GATE 2	S5-F	97X	20	RCP DRAIN 4	S4-K	902
8	LCP DRAIN 2	S5-M	24X	21	DEWAR GROUND	GL6	0XX
9	LCP GATE 3	S5-E	9XX	22	LED	S3-T	903
10	LCP DRAIN 3	S5-L	PXX	23			
11	LCP GATE 4	S5-D	91X	24	DEWAR HEATER	S7-W	1XX
12	LCP DRAIN 4	S5-K	8XX	25	DEWAR HEATER RTN	S7-19	TXX
13	RCP GATE 1	S4-H	90X				

SPECIAL INSTRUCTIONS:
TWIST J3-24,25.
ORIENT CONNECTOR WITH SOCKETS 1-13 CLOSEST TO WIRING EDGE OF FRONT PANEL (SEE D53206A005).

<u>25 PIN D-CONNECTOR WIRING LIST</u>

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNCT: AUXILIARY MONITOR

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 11
DESIGNATION: J4

PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	AC CURRENT MONITOR	S3-M	PXX	6			
2	AC CURR. MON RTN	GL2	0XX	7			
3	PUMP REQUEST	S7-K	91X	8			
4	PUMP REQUEST RTN	GL2	0XX	9			
5							

<u>SPECIAL INSTRUCTIONS</u>:
ORIENT CONNECTOR WITH SOCKETS 6-9 CLOSEST TO WIRING EDGE OF FRONT PANEL (SEE D53206A005).

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 14 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: MALE PINS
FUNCT: DC POWER AND CONTROL

DWG. NO.: A53208W001
DATE: Mar. 26, 1993
BY: W. K. CRADY
SHEET: 12
DESIGNATION: J5

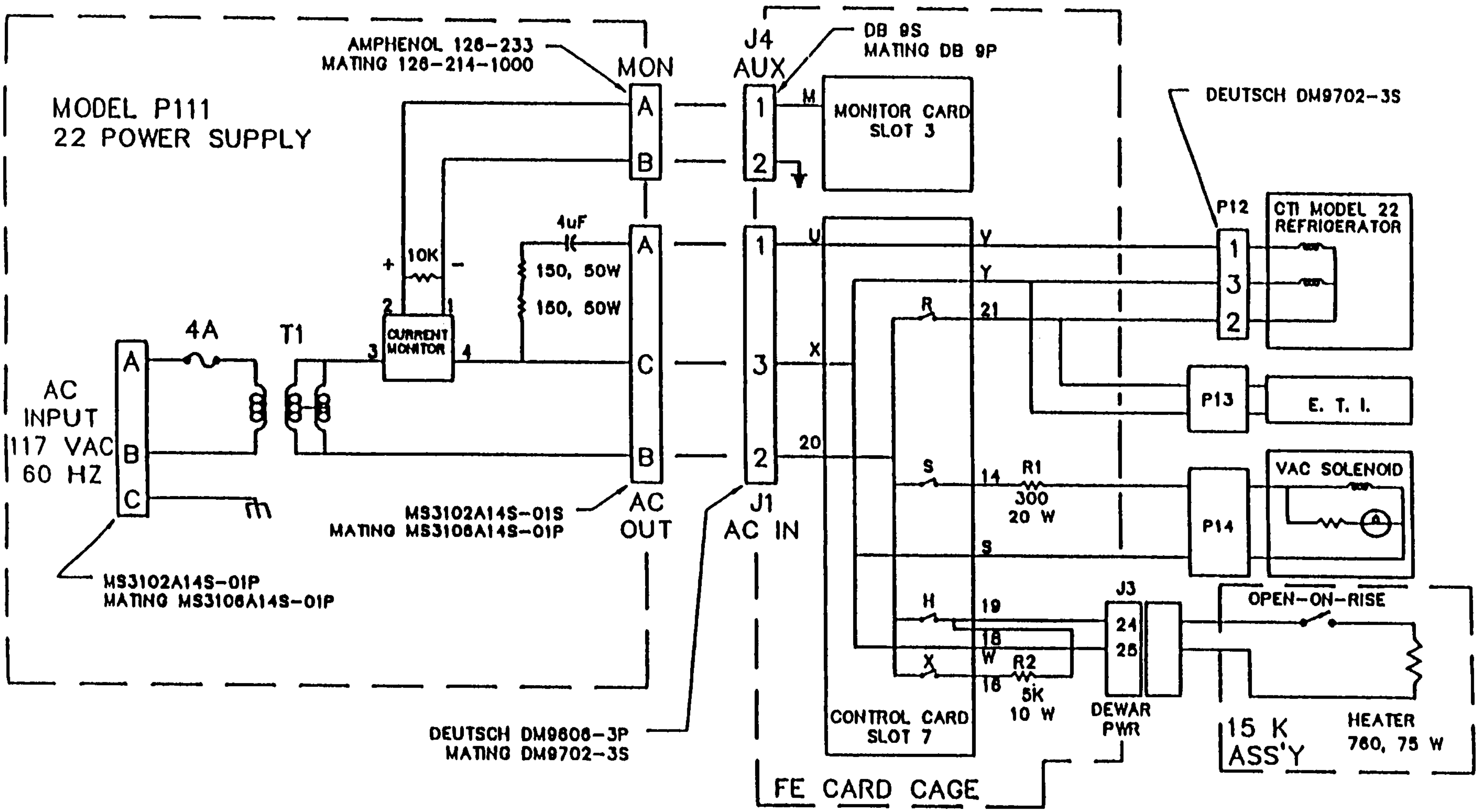
PIN	FUNCTION	TO	COLOR	PIN	FUNCTION	TO	COLOR
1	GROUND	GL6	0XX	14	ID F0	*1	0XX
2	+15 VOLT SUPPLY	S1-B	2XX	15	F1	*1	0XX
3	-15 VOLT SUPPLY	S1-C	4XX	16	F2	*1	0XX
4				17	F3	*1	0XX
5				18	ID SN0	*2	0XX
6	X (EVAC CONTROL)	S3-17	7XX	19	SN1	*2	0XX
7	C (COOL CONTROL)	S3-19	9XX	20	SN2	*2	0XX
8	H (NO HEAT CTRL)	S3-21	3XX	21	SN3	*2	0XX
9	NOT PARITY (EVEN)	*4	0XX	22	ID SN4	*2	0XX
10				23	SN5	*2	0XX
11	CAL CONTROL	S1-N	8XX	24	MOD0	*3	0XX
12	HIGH CAL CONTROL	S1-T	8XX	25	MOD1	*3	0XX
13							

SPECIAL INSTRUCTIONS:

*1 - FREQUENCY CODE WILL BE WIRED BY GROUNDING APPROPRIATED BITS, F0-F3, TO GL3 TO READ THE PROPER CODES.
*2 - THE UNIT SERIAL NUMBER CODE WILL BE WIRED BY GROUNDING APPROPRIATED BITS, SN0-SN5, TO GL5 TO READ THE PROPER SERIAL NUMBER.
*3 - MODIFICATIONS WILL BE CODED BY GROUNDING APPROPRIATE BITS, MOD0-MOD1, TO GL4.
*4 - NOT PARITY WILL BE GROUNDED TO ENSURE EVEN PARITY OF THE FREQUENCY CODE.

NOTE: THE FREQUENCY CODE, SERIAL NUMBER, MOD CODE AND PARITY BITS WILL BE WIRED IN UPON THE FINISHED ASSEMBLY OF THE COMPLETE FRONT-END. THESE WILL BE MADE UP OF GROUND LUGS WITH THE PROPER NUMBER OF WIRES AND PINS.

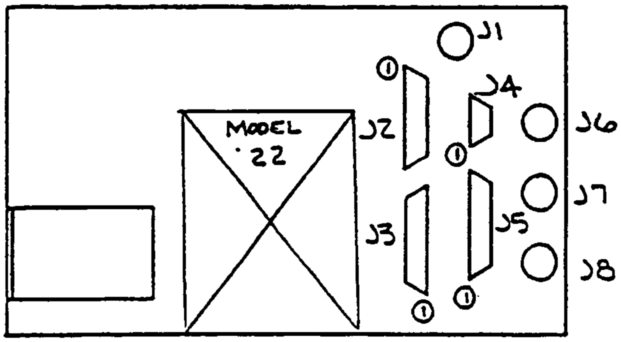
ORIENT CONNECTOR WITH PINS 14-25 CLOSEST TO WIRING EDGE OF FRONT PANEL (SEE D53206A005).



A53209W001

SHEET 13

REV.	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION



FRONT OF CARD CAGE

#	DESCRIPTION	CONN.	MATING CONN.
J1	AC POWER TO F.E.	DEUTSCH 3P	P1
J2	MONITOR FROM F.E.	25 RECEP	P2
J3	MONITOR FROM DEWAR	25 RECEP	P3
J4	AUX. MONITOR TO F.E	9 RECEP	P4
J5	DC POWER & CONTROL BITS	25 PLUG	P5
J6	RCP OUT	TYPE N	P6
J7	LCP OUT	TYPE N	P7
J8	CAL IN	TYPE N	P8
J9	RCP DEWAR	SMA	P9
J10	LCP DEWAR	SMA	P10
J11	CAL DEWAR	SMA	P11
J12	AC POWER REFR.	DEUTSCH 3S	P12
J13	ELASPED TIME INDICATOR	MOLEX	P13
J14	SOLENOID	MOLEX	P14
J15	V PUMP	OCTAL	P15
J16	V DEWAR	OCTAL	P16

NATIONAL RADIO ASTRONOMY OBSERVATORY

PROJECT: FRONT ENDS

TITLE: DEWAR INPUTS

SHEET NUMBER 14

DRAWING NUMBER A53208W001

REV

APPENDIX III

Manufacturer's Data Sheets

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2-WAY DIRECT ACTING SOLENOID VALVES
NORMALLY CLOSED OPERATION — 3/8 AND 1/2 NPT

BULLETINS
8030
8031

ASCO

Form No. V-5304R2

DESCRIPTION

Bulletin 8030's are 2-way normally closed direct acting solenoid valves. Valves are constructed with forged brass or stainless steel bodies and soft seating for tight seating on low pressure service. Standard valves have a General Purpose NEMA Type I Solenoid Enclosure.

Bulletin 8031's are the same as Bulletin 8030's except the solenoids are equipped with an enclosure which is designed to meet NEMA Type 4 - Watertight, NEMA Type 7 (C or D) Hazardous Locations - Class I, Group C or D and NEMA Type 9 (E, F or G) Hazardous Locations - Class II, Groups E, F or G and are shown on separate sheets of Installation and Maintenance Instructions, Form Nos. V-5380 and V-5381.

OPERATION

Normally Closed: Valve is closed when solenoid is de-energized. Valve opens when solenoid is energized.

IMPORTANT: No minimum operating pressure required.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. The temperature limitations listed are for UL applications. For non UL applications, higher ambient and fluid temperature limitations are available. Consult factory. Check catalog number and wattage on nameplate to determine maximum temperatures.

CONSTRUCTION	COIL CLASS / WATT RATING	Catalog Number Prefix	Maximum Ambient Temp. °F	Maximum Fluid Temp. °F
A-C Construction (Alternating Current)	A / 10.5	None	77	180
	A / 15.4	None	77	200
	F / 10.5 or 15.4	FT	122	200
	H / 10.5 or 15.4	HT	140	200
D-C Construction (Direct Current)	A, F or H / 11.2	None, FT or HT	77	150
	A, F or H / 16.8	None, FT or HT	77	180

POSITIONING/MOUNTING

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertical and upright so as to reduce the possibility of foreign matter accumulating in the core tube area. For mounting bracket (optional feature) dimensions, refer to Figure 1.

PIPING

Connect piping to the valve according to marking on valve body. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening the pipe, do not use valve as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

IMPORTANT: For the protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on service conditions. See Bulletins 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. Solenoid housings are provided with a 7/8 diameter hole, for 1/2 inch conduit. The general purpose solenoid enclosure may be rotated to facilitate wiring by removing the retaining cap or clip. CAUTION: When metal retaining clip disengages, it will spring upwards. Rotate enclosure to desired position. Replace retaining cap or clip before operating.

NOTE: Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the complete solenoid base sub-assembly and core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power supply and depressurize valve before making repairs. It is not necessary to remove the valve from the pipe line for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary, depending upon media and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive leakage or noise will indicate that cleaning is required. Be sure to clean valve strainer or filter when cleaning solenoid valve.

PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on media and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

Form No. V-5304R2 PRINTED IN U.S.A. 1976 Automatic Switch Co.

ASCO Valves ASCO

FLORHAM PARK, NEW JERSEY 07932

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open circuited or grounded coil, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check the voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

COIL REPLACEMENT

Turn off electrical power supply and disconnect coil lead wires. Determine valve size (NPT) and proceed in the following manner:

3/8 NPT CONSTRUCTION - Refer to Figure 2.

1. Remove retaining cap or clip, nameplate and housing. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Remove spring washer, insulating washer and coil. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.

1/2 NPT CONSTRUCTION - Refer to Figure 3.

1. Remove retaining cap or clip, nameplate and cover. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used. Slip coil, sleeves and insulating washers from yoke. For D-C Construction, a single fluxplate over the coil replaces yoke, sleeves and insulating washers.
3. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.

CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place insulating washers at each end of coil, if required.

VALVE DISASSEMBLY AND REASSEMBLY (Refer to Figures 2 and 3)

Depressurize valve and turn off electrical power supply. Proceed in the following manner:

1. Remove the retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Unscrew solenoid base sub-assembly and remove body gasket, core assembly and core spring.
3. For normal maintenance, it is not necessary to disassemble the manual operator unless external leakage is evident. If disassembly is required, remove stem pin, stem and stem gasket.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
6. Replace body gasket, core assembly and core spring. For 1/2 NPT Construction, be sure wide end of core spring goes into core first and closed end protrudes from the top of the core. Replace solenoid base sub-assembly and torque to 175 ± 25 inch pounds. Replace solenoid enclosure and retaining cap or clip.
7. After maintenance, operate the valve a few times to be sure of proper opening and closing.

SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts or Coils Specify Valve Catalog Number, Serial Number and Voltage.

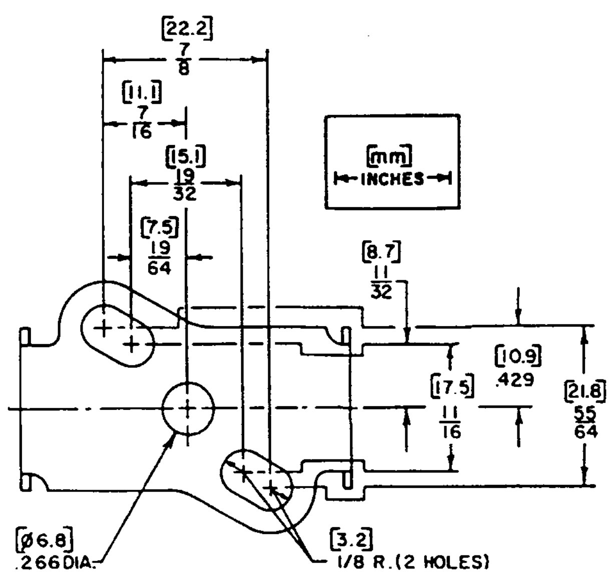
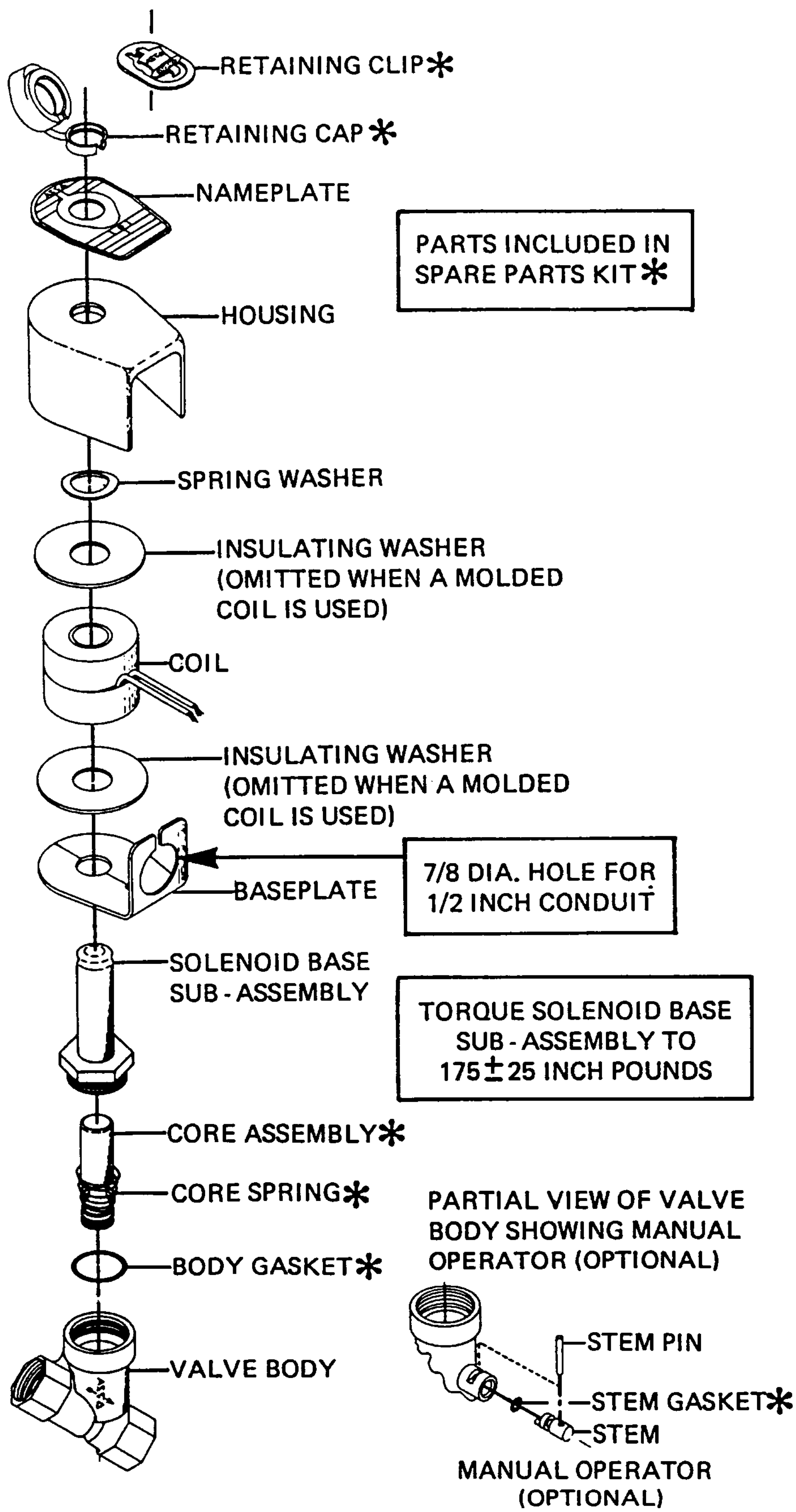


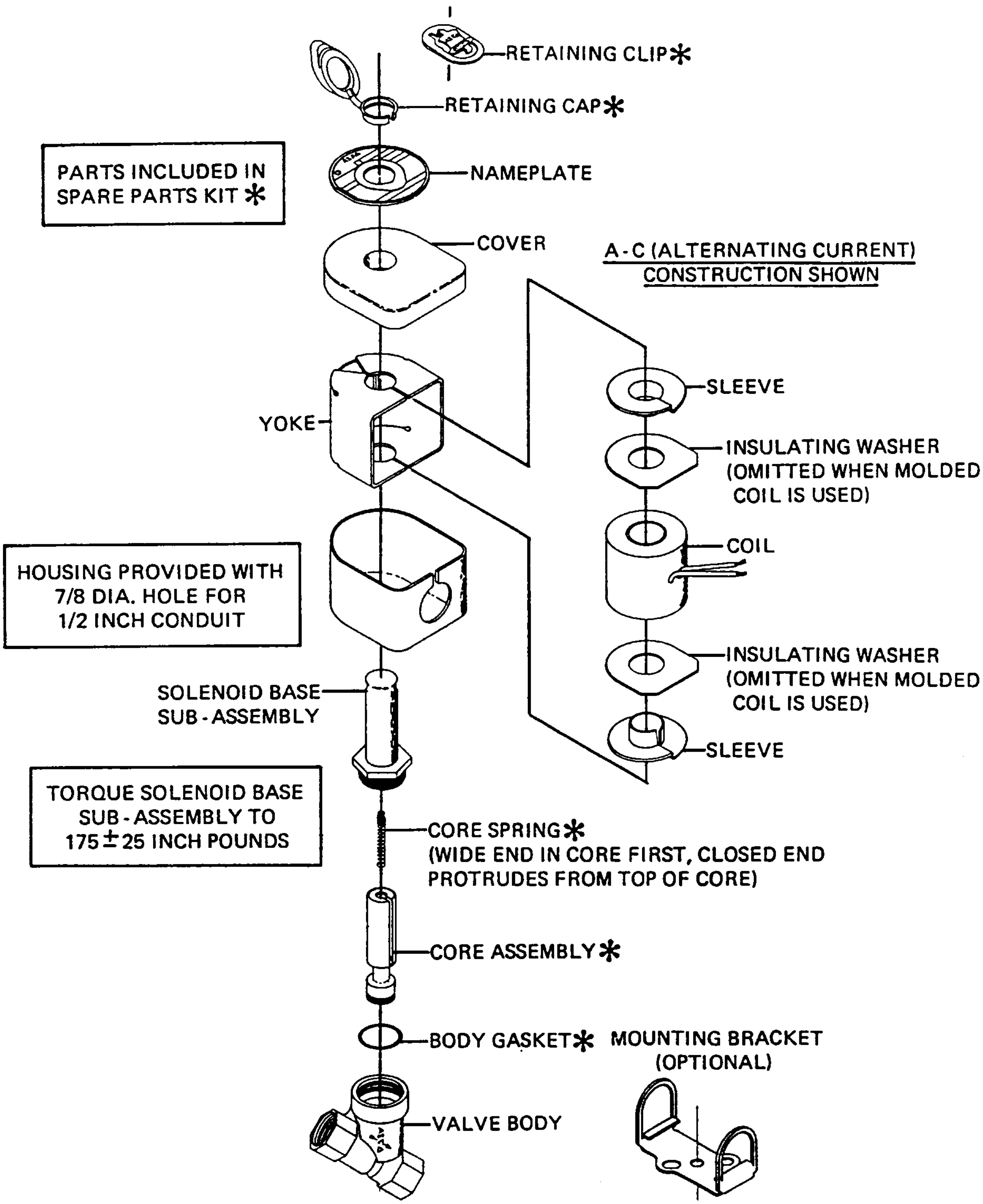
Figure 1. **Dimensions for Mounting Bracket (Optional Feature)**

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 Form No. V-5304R2 PRINTED IN U.S.A. 1976



Bulletin 8030 - 3/8 NPT
General Purpose Solenoid Enclosure Shown.
For Explosion-proof/Watertight Solenoid Enclosure used on Bulletin 8031, See Form No. V-5380.

Figure 2.

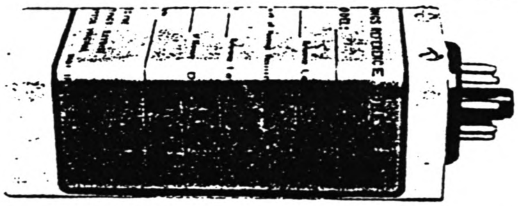


Bulletin 8030 - 1/2 NPT
General Purpose Solenoid Enclosure Shown.
Figure 3. **For Explosion-proof/Watertight Solenoid Enclosure used on Bulletin 8031, See Form No. V-5381.**

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 Form No. V-5304R2 PRINTED IN U.S.A. 1976

reference tube

A QUICK CALIBRATION DEVICE FOR HASTINGS VACUUM GAUGES



The Hastings Reference Tube is an evacuated, sealed vacuum gauge tube accurately calibrated and marked at its exact pressure. It is electrically equivalent to our metal and Pyrex gauge tubes. It permits quick and easy recalibration of Hastings Vacuum Gauges by merely plugging the instrument into the reference and adjusting the calibration potentiometer until the instrument reads the exact pressure noted on the reference tube.

Equivalent Gauge Tube and Range			Reference Tube Model No.
Metal	Pyrex	Range	
DV-4D	DV-16D	0-20 mm Hg	DB-16D
*DV-5M	*DV-18	0-100 Microns Hg	*DB-18
DV-6M	DV-20	0-1000 Microns Hg	DB-20
DV-8M	DV-31	.01-10 Microns Hg	DB-31
DV-23	—	0-5000 Microns Hg	DB-33
DV-24	—	0-50 Torr	DB-44
DV-100	—	0-100 Torr	Not Available
DV-77	—	10^{-6} to 10^{-2} Torr	Not available
DV-100	—	0-100 Torr	Not available
DV-800	—	0-800 Torr	Not available

*State reference letter of your Gauge Tube type for matching purposes.

ADVANTAGES OF HASTINGS VACUUM INSTRUMENTS

- **Fully compensated for both temperature and rate-of-change of temperature**
- **Designed for panel mounting or in instrument cabinets.**

Hastings instruments have many exclusive advantages. Self contained, solid-state circuitry throughout assures long life and low maintenance costs. All instruments use frictionless, taut-band pivotless meters. Instruments are electrical to provide rapid response and permit remote installations.

Hastings gauge tubes can withstand great g-shock and vibration, using short firmly connected thermocouples with no suspended weld to an external heater. They are corrosion resistant and non-contaminating using noble metal thermopiles which assures stable calibration held indefinitely. Gauge tubes are easily cleaned with any suitable solvent. Each gauge tube is specifically designed and checked out for the range it covers, assuring maximum sensitivity.

gauge tubes

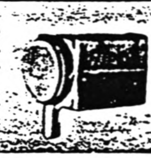
THE ONLY GAUGE TUBES COMPENSATED FOR BOTH AMBIENT TEMPERATURE AND RATE OF TEMPERATURE CHANGE

- **METAL** Constructed of nickel plated steel with plastic bases color coded to prevent mix-up.
- **PYREX GLASS** Available for high temperature and bakeable systems.
- **"R" SERIES** Ruggedized with a gold-plated hermetic seal base with monel housing for weather resistance.
- **STAINLESS STEEL** For weather-proof, corrosive and bakable applications. Withstands high over-pressurization. May be brazed or welded to system. Plain or threaded connection.

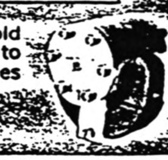
FOR PROPER ACCURACY AND PERFORMANCE, HASTINGS VACUUM GAUGES SHOULD ALWAYS BE USED WITH THE PROPER RANGE OF HASTINGS VACUUM GAUGE TUBES!

INSTRUMENT SERIES	RANGE	METAL TYPE	BASE COLOR	PYREX TYPE	"R" SERIES TYPE	STAINLESS STEEL TYPE
NV-8	10^{-5} torr 10^{-2} torr	DV-8	Green	DV-31	—	—
VT-5, CVT-15/25	0-100 µ Hg	DV-5M	Red	DV-18	—	—
VT-6, CVT-16/26, DAV-6, TV-4A, MRV-6, TV-47	0-1000 µ Hg	DV-6M	Yellow	DV-20	DV-6R	DV-36
VH-3, CVH-3/23	0-5 torr	DV-23	Orange	—	—	—
VT-4, CVT-14/24, DAV-4, TP-7A, MRV-4, TV-47	0-20 mm Hg	DV-4D	Purple	DV-16D	DV-4R	DV-34
VH-4, CVH-4/24	0-50 torr	DV-24	White	—	—	—
NV-100	0-100 torr	DV-100	Brown	—	—	—

MODEL DV-800 GAUGE TUBE is used with Wide Range Vacuum Gauges, Models NV-800 and DNNV-800. This linear voltage displacement transformer type is for the range of 0-800 torr.



MODEL DV-77 GAUGE TUBE is used with the Cold Cathode Ion Gauge, Model NV-77. Range is 10^{-6} to 10^{-2} torr. Replacement cathode-anode assemblies are available.



SIERRA MICROWAVE TECHNOLOGY

AMPLIFIER TEST DATA SHEET

NOISE METER S/N 01156.
NOISE SOURCE S/N 01171
CURRENT DRAWN FROM AC/DC SUPPLY OF +15.0 V 95 MA
(120 MA ~~MAX~~/TYP)

SMT PART # S90-1172
CUST. PART # —
SERIAL # 1114

FREQUENCY (GHz)	GAIN (dB) FLATNESS ±0.75	VSWR :1 IN	VSWR :1 OUT	POWER (dBm) 1dB	POWER (dBm) SAT	NOISE FIGURE (dB)		
SPEC.	18.0 MIN	1.50	1.50	+10.0	—	2.5		
12.00	19.8	1.20	1.24	+13.1	-	2.4		
12.85	19.1	1.14	1.17	+13.4	—	2.4		
13.70	18.7	1.14	1.22	+13.4	-	2.3		
14.55	18.5	1.27	1.24	+13.6	-	2.4		
15.40	18.5	1.46	1.31	+14.5	—	2.5		
MIN.	18.5	—	—	+13.1	-	—		
MAX.	19.8	1.46	1.31	—	-	2.5		

TECH. Kenneth C. Stiffy DATE 5/24/91

QA. [signature] DATE 5-24-91

NOTE: DATA TAKEN AT 25 °C.

DWG. NO.
AFD-0001-001

DIRECTIONAL COUPLER

TEST DATA

mac technology
3104 So. Side Bypass
Klamath Falls, OR 97601
TEL. (503) 883-3352
TWX 510-756-0053

Tested By: MAC 3

Date: 11-1-90

MODEL: C 3207-25

SPECIFICATIONS

COUPLING:
25 ± 1.00 dB*

FREQUENCY SENSITIVITY:
± 0.50 dB

DIRECTIVITY:
15 dB Min.

INSERTION LOSS:
0.55 dB Max.
(Including Coupled Power)

VSWR:
PRIMARY LINE:
1.20 Max.

SECONDARY LINE:
1.20 Max.

Serial No.	COUPLING Frequency GHz 12.0	13.7	15.4	DIRECTIVITY db Min.	INSERTION LOSS dB Max.	VSWR Max. Pri.	Sec.
1	25.4	24.9	24.8	23	<0.55	1.09	1.15
2	25.6	25.0	24.8	17		1.16	1.08
3	25.4	24.8	24.5	19		1.07	1.10
4	25.4	24.8	24.6	17		1.17	1.12
5	25.5	25.0	24.7	18		1.09	1.14
6	25.1	24.4	24.3	17		1.18	1.13
7	25.5	24.9	24.7	20		1.13	1.12
8	25.8	25.2	25.0	19		1.12	1.10
9	25.9	25.3	25.1	19		1.07	1.14
10	25.4	24.9	24.7	17		1.16	1.18
11	25.3	24.7	24.5	18		1.20	1.16
12	25.3	24.7	24.6	17		1.20	1.20
13	25.6	25.0	24.8	19		1.09	1.15
14	25.4	24.8	24.5	18		1.15	1.16
15	25.0	24.5	24.3	16		1.14	1.14
16	25.7	25.2	25.0	16		1.13	1.19
17	25.3	24.7	24.7	20		1.20	1.20
18	25.2	24.6	24.3	18		1.16	1.15
19	25.5	24.9	24.7	16		1.16	1.19
20	25.7	25.1	24.9	17	<0.55	1.20	1.13

*Frequency Sensitivity is included in Coupling.

Job No. 4028

Serial No.	COUPLING Frequency GHz 12.0	13.7	15.4	DIRECTIVITY db Min.	INSERTION LOSS dB Max.	VSWR Max. Pri.	Sec.
21	25.5	25.0	24.7	18	<0.55	1.15	1.20
22	25.7	25.1	24.9	21	<0.55	1.12	1.19

NOISE/COM

NOISE COM Inc.
East 64 Midland Avenue
Paramus, NJ 07652

(201) 261-8797
FAX: (201) 261-8339
TWX: 910-380-8198

ACCEPTANCE TEST DATA

PART NO. NC 3207A

DATE 7/23/91

SERIAL NO. 5974

CUSTOMER NRAO

SHEET 1 OF 1

CUSTOMER PART NO.

CUSTOMER SPECIFICATION NO.

REVISION

PURCHASE ORDER NO. C 17186

FREQUENCY GHz	EXCESS NOISE RATIO (DB) MEASURED	SPECIFICATION	VSWR MEAS'D.	SPEC.	INPUT VOLTAGE
12.0	32.92	26-32 ± 1.0			+28 V
13.0	31.53	"			"
14.0	31.27	"			"
15.0	32.03	"			"
16.0	32.26	"			"
17.0	32.14	"			"
18.0	31.99	"			"

TESTED	DATE	APPROVED	DATE
GK	7/23/91	QC 4	7/23/91

Form 11760

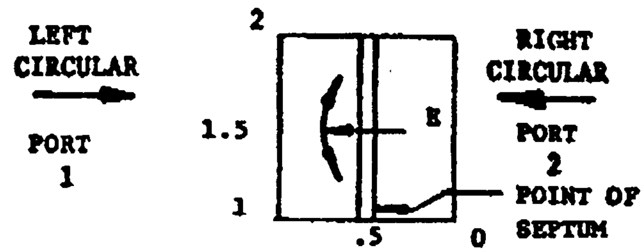
CUSTOMER N.R.A.O.	PART NO. A53208N001
CUSTOMER P.O. NO. G17085	ATL. REF. NO. 7606
TESTED BY SGH	DATE 9-25-91

TEST RESULTS

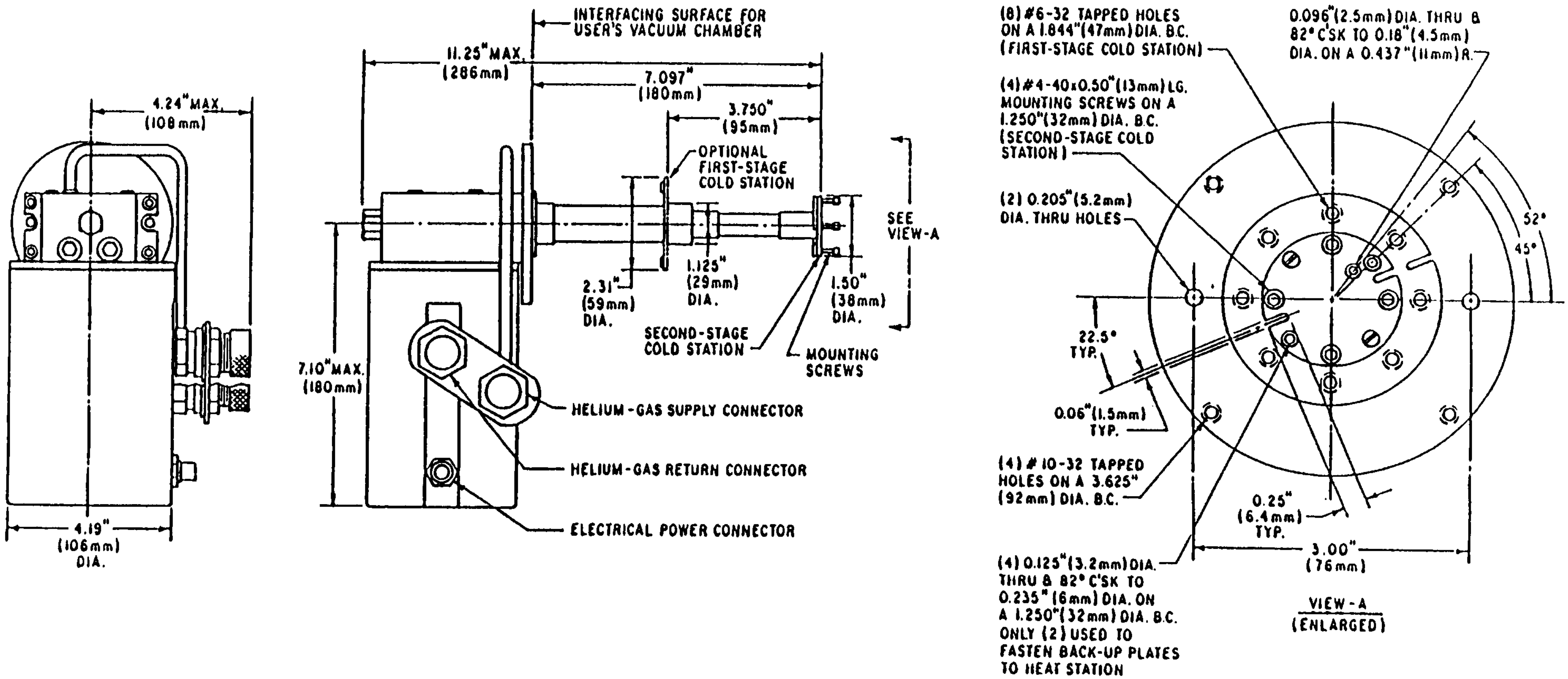
POLARIZER

Catalog # AMC1075

SERIAL NUMBER	FREQUENCY GHz	VSWR PORT 1	VSWR PORT 2	ISOLATION IN dB	ELLIPTICITY IN dB	POSITION OF MAXIMUM
	12.0	1.29	1.27	~~16.5~~	.30	
12	12.1	1.25	1.21	~~22.6~~	.25	
	12.2	1.14	1.15	18.0	.60	
	12.43	1.07	1.12	28.0	.27	
	12.85	1.27	1.26	~~21.5~~	.40	
	13.26	1.22	1.20	~~21.0~~	.98	
	13.52	1.10	1.10	~~23.0~~	.75	
	13.70	1.12	1.11	25.0	.80	
	14.28	1.17	1.16	27.0	~~1.08~~	
	14.66	1.07	1.06	28.0	.88	
	15.07	1.05	1.05	28.0	.90	
	15.24	1.07	1.08	26.5	.32	
	15.40	1.16	1.20	~~21.5~~	.13	
DESIGN LIMITS		1.33 MAX	1.33 MAX	25 dB MIN.	1.0 dB MAX.	



Die #



CTI-CRYOGENICS
266 Second Avenue
P. O. Box 9171
Waltham, MA 02254-9171

FIGURE 2-5. INSTALLATION INTERFACE OF THE MODEL 22 COLD HEAD