NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

VLBA TECHNICAL REPORT NO. 20

MODEL F109, 23 GHZ CRYOGENIC FRONT-END

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MODEL F109, 23 GHZ CRYOGENIC FRONT-END

Section 1. SYSTEM DESCRIPTION

1.1 Block Diagram Description

Model F109 is a dual-channel, low-noise amplifier system covering the frequency range of 21.7 to 24.1 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.

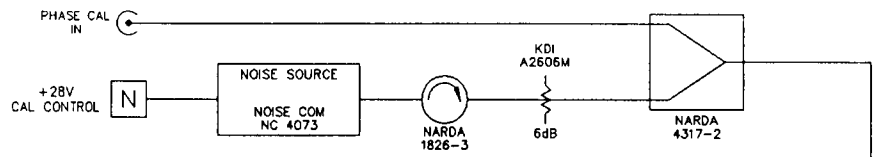
Model F109 primarily fills a design requisite in the Very Long Baseline Array Project. The VLBA incorporates a series of receiver systems providing key frequency coverages over the range of 330 MHz to 43 GHz. Further details on the VLBA project are available in separate reports.

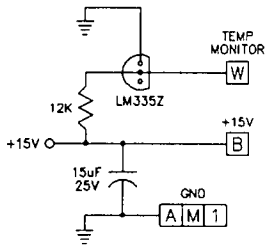
Over its 21.7 to 24.1 GHz range, the F109 receiver noise temperature measures less than 60 K (noise figure less than .817 dB). The dual-channel capability furnishes both left and right circularly polarized signals.

Describing the front-end in terms of signal path: circular waveguide, .930 cm (0.366") in diameter, provides system input, propagating both TE_{11} 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 18 K waveguide surfaces requires a 0.015 mm (.006") gap in the waveguide wall. A radial choke at this point prevents signal leakage from the gap (see Section 2.3).

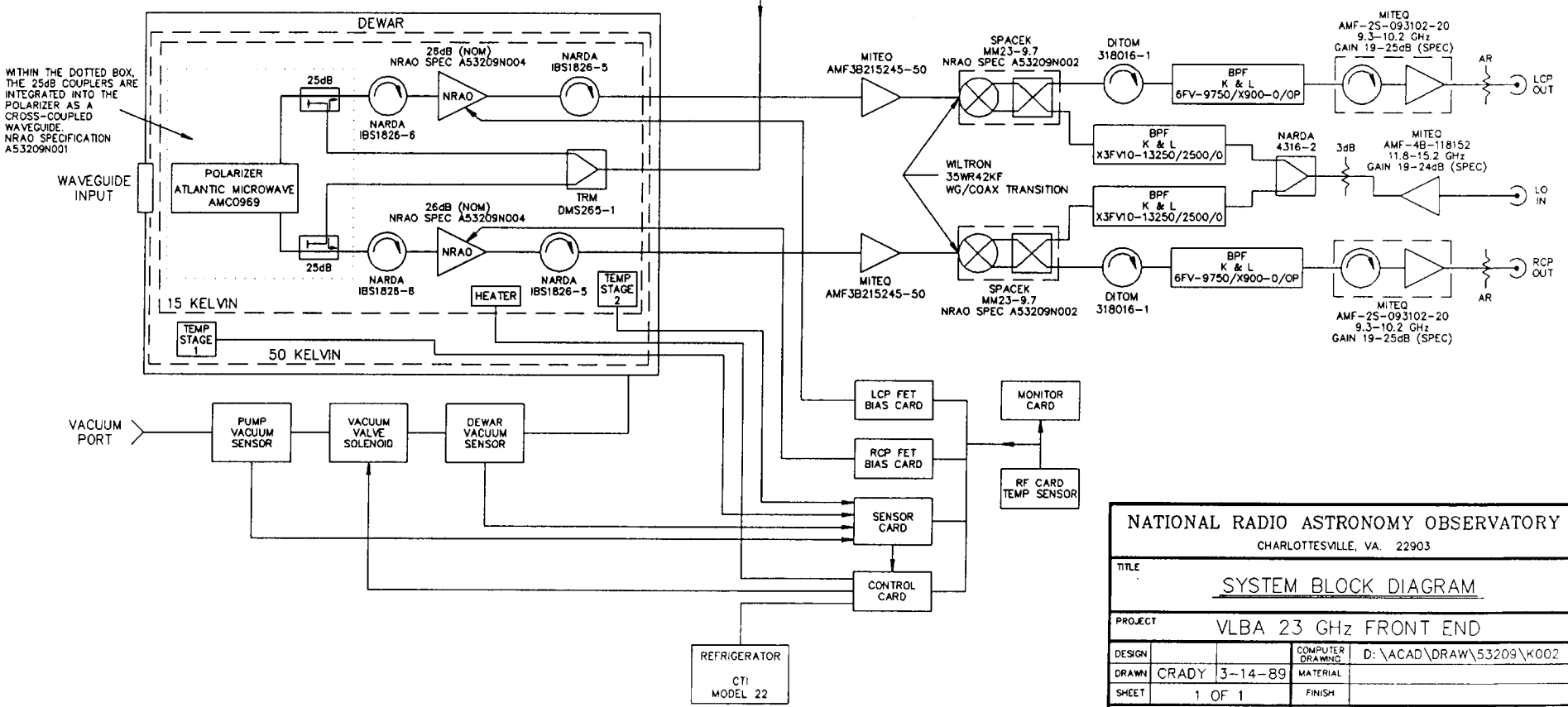
Inside the dewar, a compact polarizer (see Section 2.4) transduces the two circular waveguide modes to SMA coaxial-line outputs. The polarizer cools to ~18 K, minimizing noise associated with resistive losses.

REV	DATE	BY	DESCRIPTION	CHANGE ORDER
A	4-12-88	GS	CHG. CAL CKT., LO AMP, SPACEK MIXERS	—
B	3-14-89	KC	CHG. IF AMP, ADD ISOL/FILTER. IN IF LINE	—
C	3-11-91	DGS	GENERAL REVISION - SEE CO	910311-1
D	3-26-91	DGS	POST AMP ATTENUATORS ADDED	910326-7
E	12-31-91	DGS	AMP SPEC @ LO IN WAS IN ERROR @ 9.3-10.2 GHz	911231-1





RF CARD TEMP SENSOR & POWER INPUT SCHEMATIC



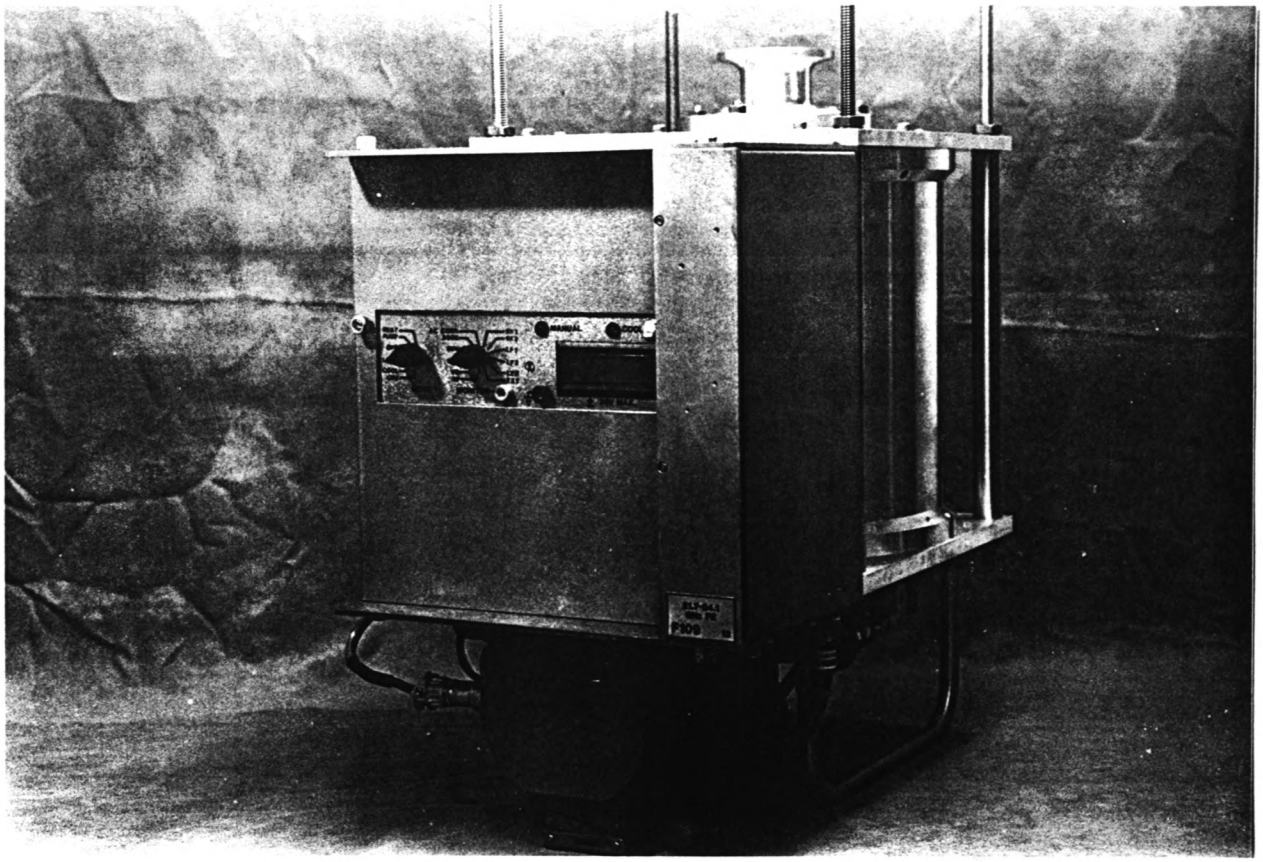
NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22903

TITLE: SYSTEM BLOCK DIAGRAM

PROJECT: VLBA 23 GHz FRONT END

DESIGN		COMPUTER DRAWING	D:\ACAD\DRAW\53209\K002
DRAWN	CRADY 3-14-89	MATERIAL	
SHEET	1 OF 1	FINISH	

[redacted] DWG. C[redacted]9K0[redacted] REV. [redacted]



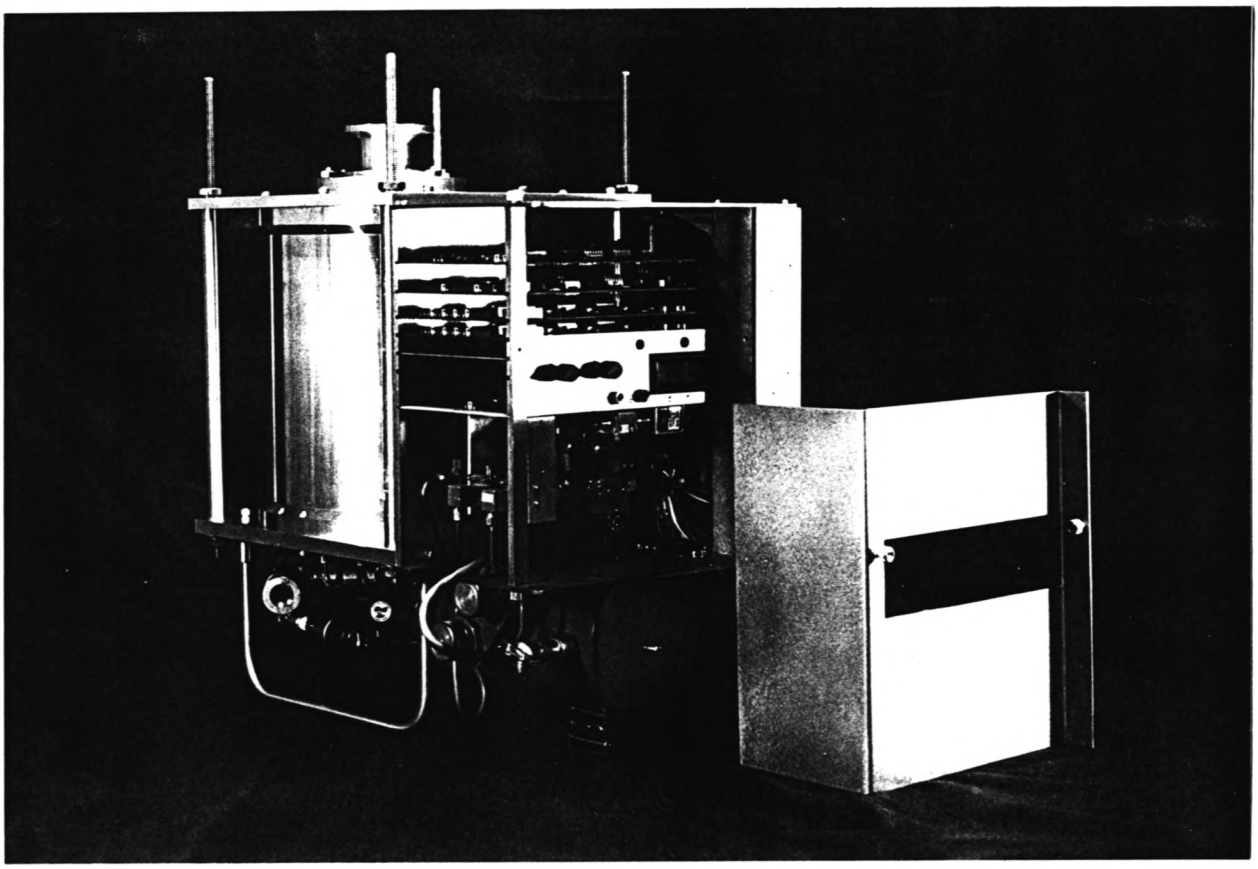


Fig. 1.1-2. Assembled 23 GHz front-end.

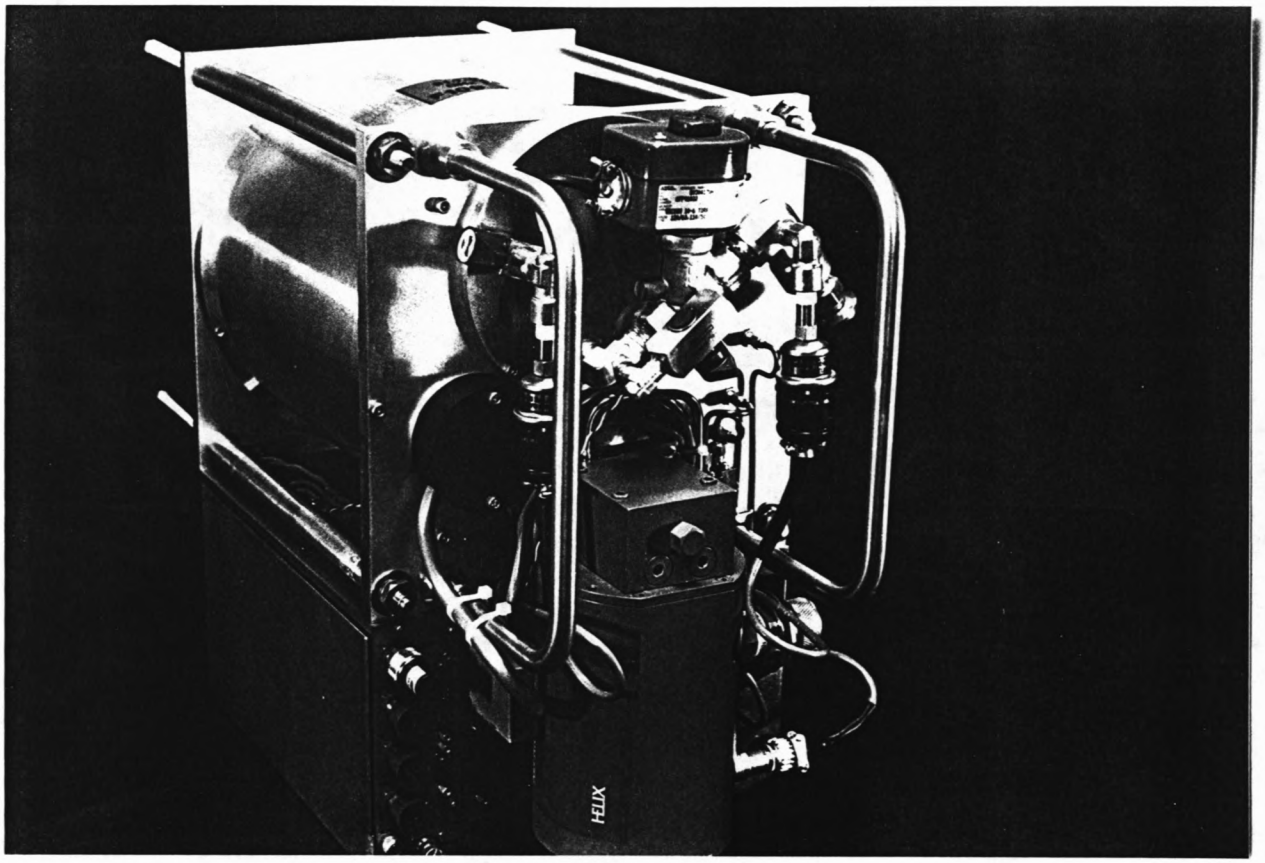


Fig. 1.1-3. Bottom plate view of 23 GHz front-end.

Polarizer SMA outputs connect via isolators to four-stage, ~27 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 18 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.

Outside the dewar, the two signals connect immediately to post-amplifiers providing another 10 dB gain at RF frequencies. The RF post-amplifier noise figure is approximately 4.35 dB. Semirigid 0.358 mm (.141") diameter coaxial cables transmit the signal to dual channel microwave mixers. The mixing assembly is part of an RF card mounted in the front-end card cage.

IF output range is between 9.3 and 10.2 GHz, with conversion losses of approximately 8 dB. An isolator and bandpass filter (9.75 GHz, BW 900 MHz) connect each channel to a final isolator/post-amplifier combination. The IF post-amplifiers have noise figures of approximately 2 dB and typical gains of 25 dB. The RCP and LCP IF outputs, 9.3 - 10.2 GHz, are available on connectors J6 and J7, respectively.

The F109 polarizer design utilizes cross waveguide couplers for injection of calibration noise (see Section 2.5). From the RF card, the calibration signal enters the dewar via a hermetic SMA feedthrough and stainless-steel coaxial cable. Inside the dewar, a power divider splits the calibration signal, feeding it to each coupler. Circuitry mounted on the RF card supports two types of calibration signals:

a) a low noise calibration signal, ~ 7.5 K, for continuous pulsed gain and noise calibration of the system,

b) an externally applied signal, coupled -34 dB to both inputs, for the purposes of phase or time-delay calibration of the system.

Total coupling loss from Cal connector J17 is approximately 34 dB. From the noise source, coupling loss is approximately 41 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 60 K between 21.7 and 24.1 GHz. It shall be measured between the front-end waveguide input flange and either IF 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 120 MHz intervals from 21.4 to 25.12 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 TE_{11} modes.

1.2.3 Calibration Coupling

The calculated coupling from the Phase Cal input jack J8 to the CRYOFET input shall be -41 ± 2 dB from 21.7 to 24.1 GHz (not measured on all systems).

1.2.4 LO Input Power

The LO input power for the input connector J17 shall be -6 ± 1 dBm and shall have a stable phase to within 4° in this power range.

1.2.5 Calibration Noise Temperature

The noise added to the system in each channel when +28 volts is applied to the Cal control line shall be 7.5 ± 2.5 K.

1.2.6 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 -44 ± 4 dBm. The value shall be measured with an LO frequency of 13.5 GHz and LO power of -6 dBm applied. Measurement shall be taken through a 9.750 GHz/ 900 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.

1.2.7 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 9.76 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.

1.2.8 Front-End Gain

The front-end shall have a minimum dewar gain of 25 dBm and a minimum system gain of 45 dBm.

1.2.9 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 20 K.

1.2.10 HEMT Bias Data

The optimum drain voltage V_d, drain current I_d, and gate voltage V_g shall be recorded for each of four stages of the two CRYOFET amplifiers. Both 300 K and cryogenic operating temperature data shall be recorded.

1.2.11 Cool-Down Time

The time required to cool the cryogenic components from 300 K to operating temperature shall be less than 8 hours.

1.2.12 Physical Weight and Size

The front-end shall weigh less than 55 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.

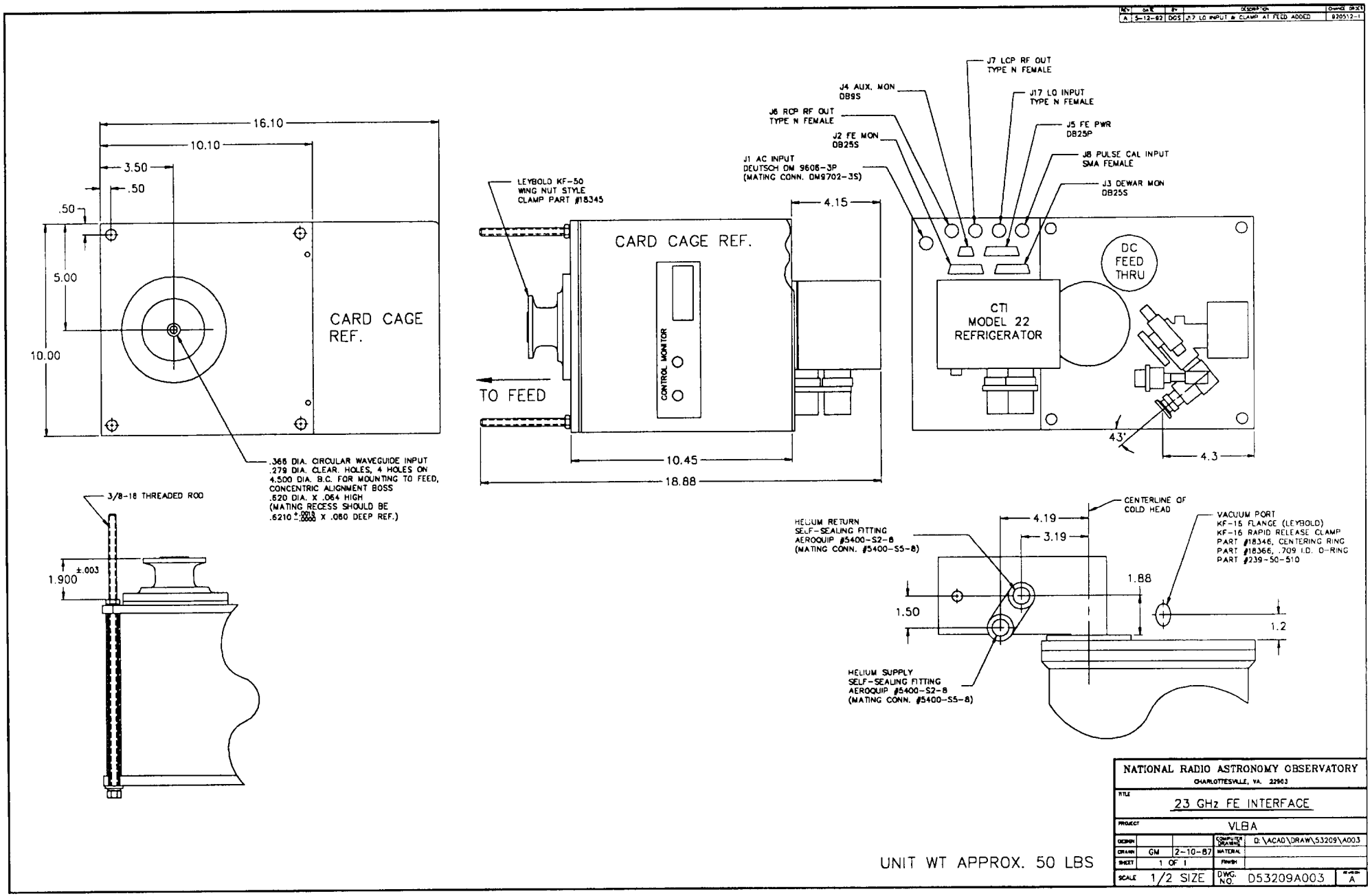


Fig. 1.3-1. Front-end outline and locations of interfaces.

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.

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. A proper mounting orientation should 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 10.0 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 12 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 and LO input J17 are coaxial type-N female connectors. Phase Cal input J8 is a SMA female connector. The RF outputs supply an IF signal from 9.3 to 10.2 GHz. This IF window of the front-end's band (21.7-24.1 GHz) depends upon the local oscillator setting. LO input range is 11.8 to 15.2 GHz, with -6 dBm input power. The system following the front-end should have a noise figure, including cable losses, of less than 12 dB. This ensures a contribution of less than 1 K to the receiver noise temperature. In the VLBA system the Model F109 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/°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	$\overline{PA}$	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 subsystems without necessitating a warm-up. Note that power will be applied to the refrigerator motor regardless of the dewar vacuum under this condition. Table V 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 lower temperatures than the linearized version.

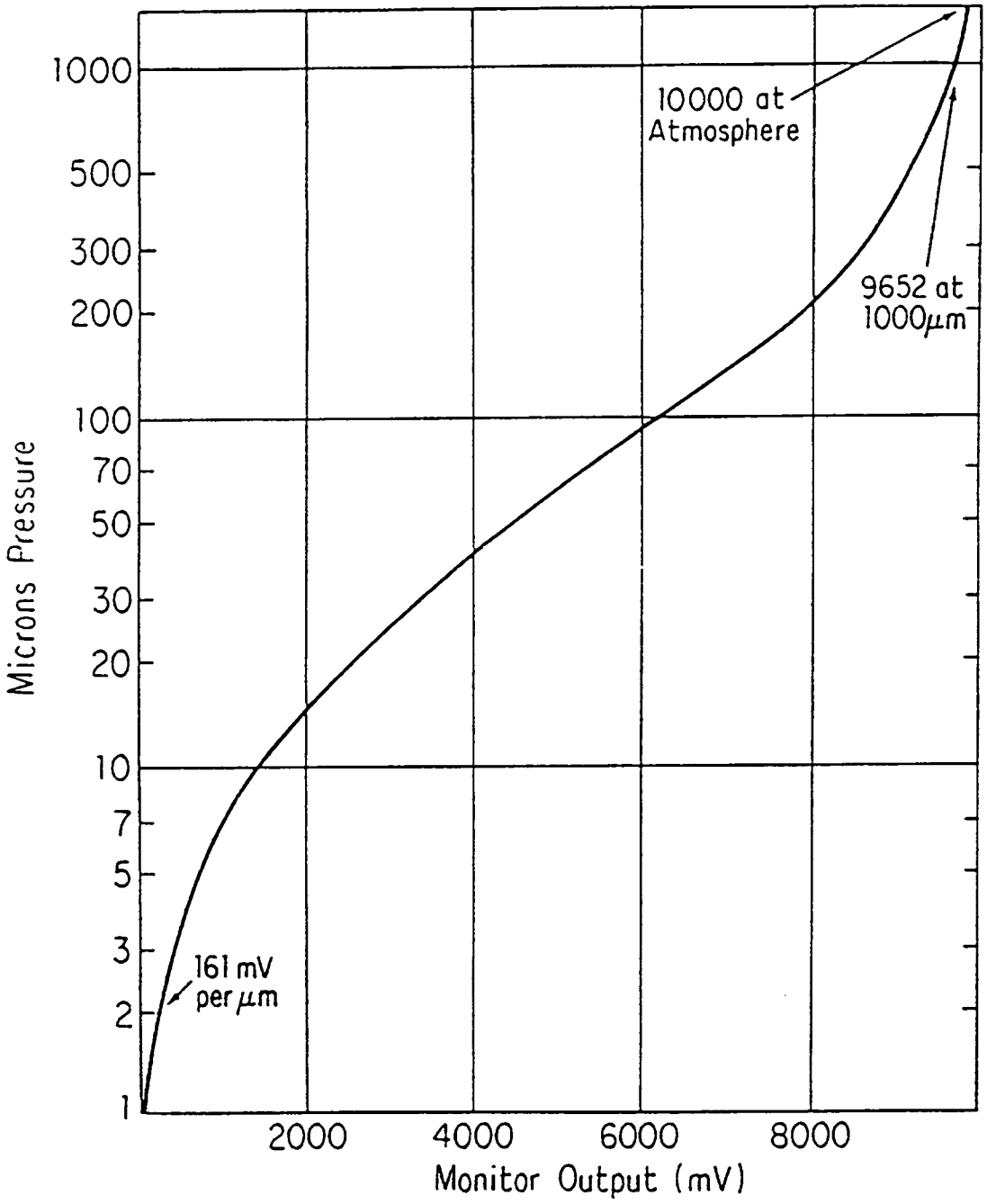


Fig. 1.3-2. Vacuum monitor voltage vs. pressure.

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 Parameters Budget

Table VII shows a typical noise temperature budget for the 23 GHz receiver. Table VIII provides a front-end gain budget. Table IX illustrates the estimated heat loads on the refrigerator second (18 K) stage.

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

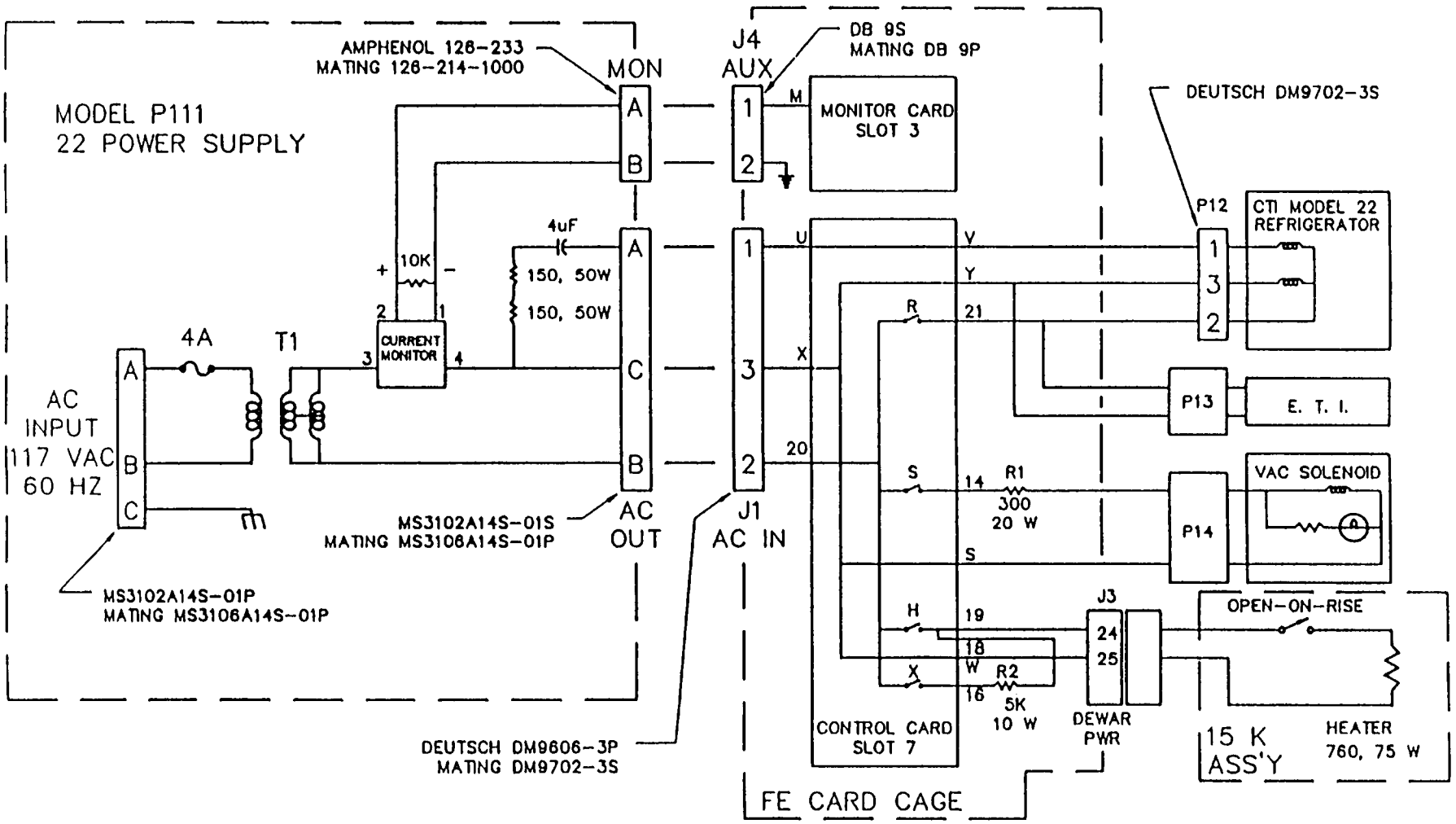


Fig. 1.3-3. Front-end AC wiring.

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	.56	45.4
RF post-amplifier	300 K	4.35	.6
Mixer/IF components	300 K	11.50	1.7
			50.8 K

TABLE VIII. Front-End Gain Budget

Input Losses	- 0.6 dB
Four-Stage HEMT	+27.0
9" .085" SS/AG Cable	- 0.6
RF Post-Amplifier	+10.0
Mixer	- 8.0
BP Filter	- 0.5
Two 300 K Isolators	- 1.0
IF Post-Amplifier	+25.0
	+51.3 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 10.0 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 18 K, to aid in cryopumping. During HEAT mode, the 18 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 18 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 7 hours to a temperature of 16 K to 18 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. The ratio of these times gives an average refrigerator cool-down power of 10.4 watts, including 0.4 watts to compensate for HEMT DC bias power.

2.1.4 Disassembly of Dewar

Figures 2.1-2 through 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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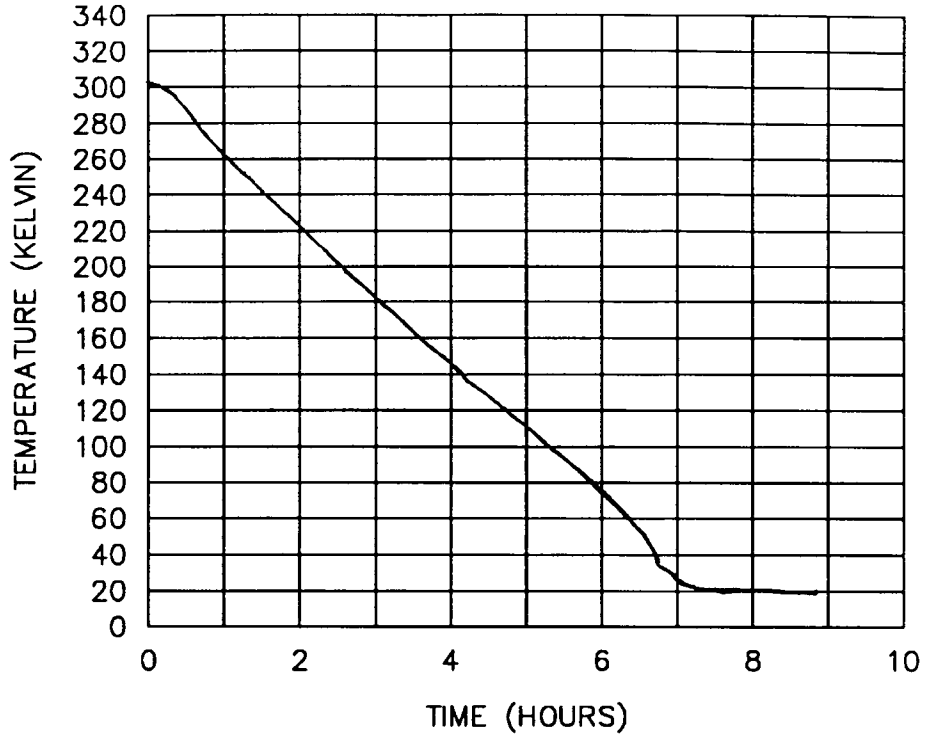
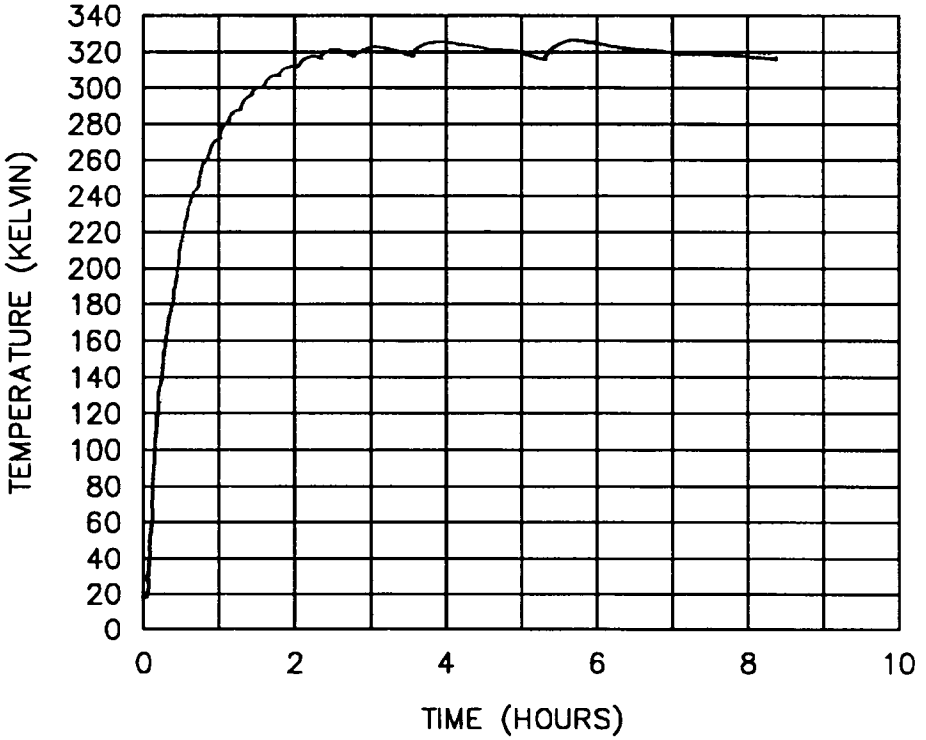
[2] dewar plate housing vacuum interface components, adjacent to refrigerator motor.



DEWAR COOL–DOWN RECORD



DEWAR WARM–UP RECORD

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

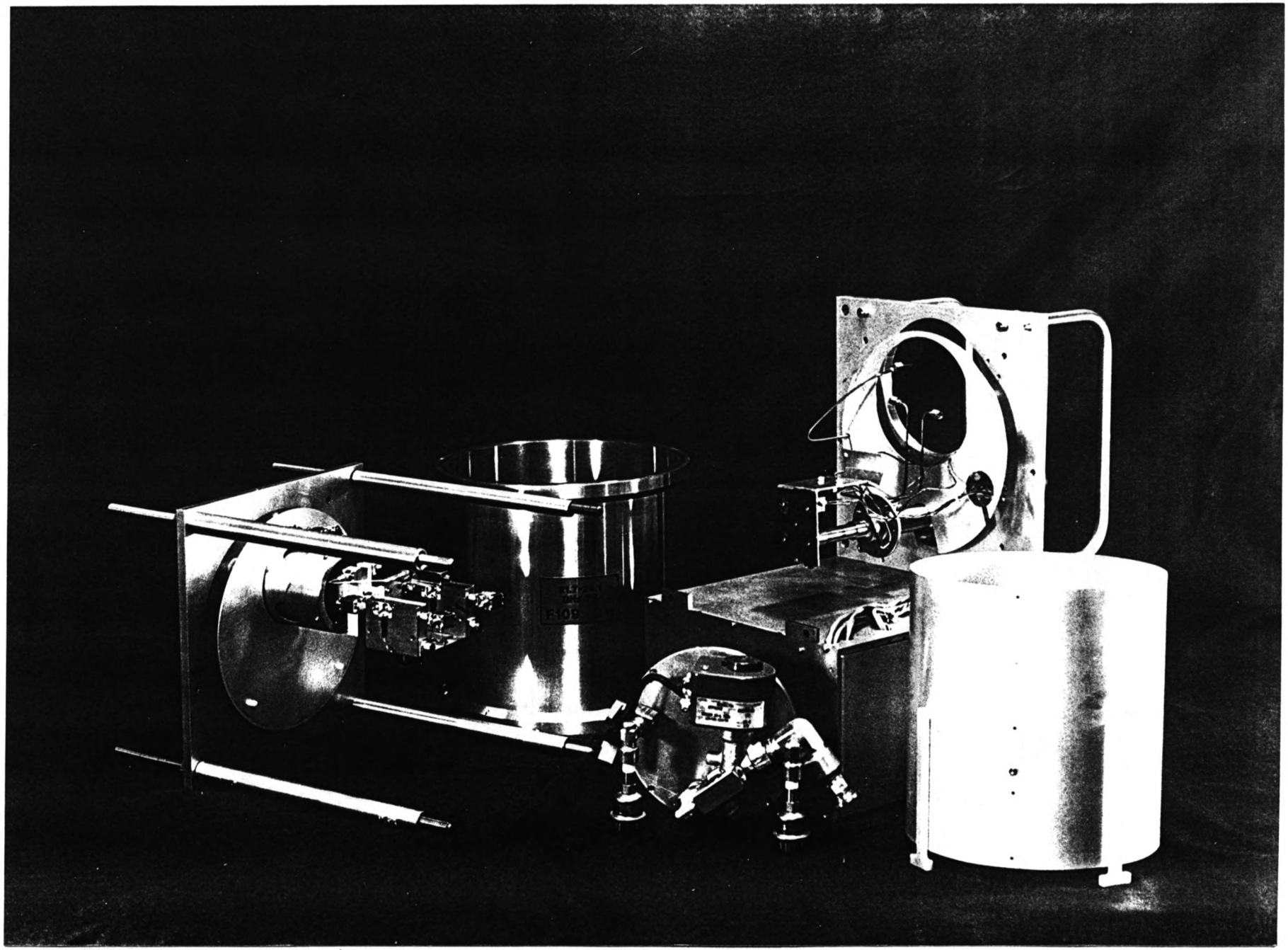
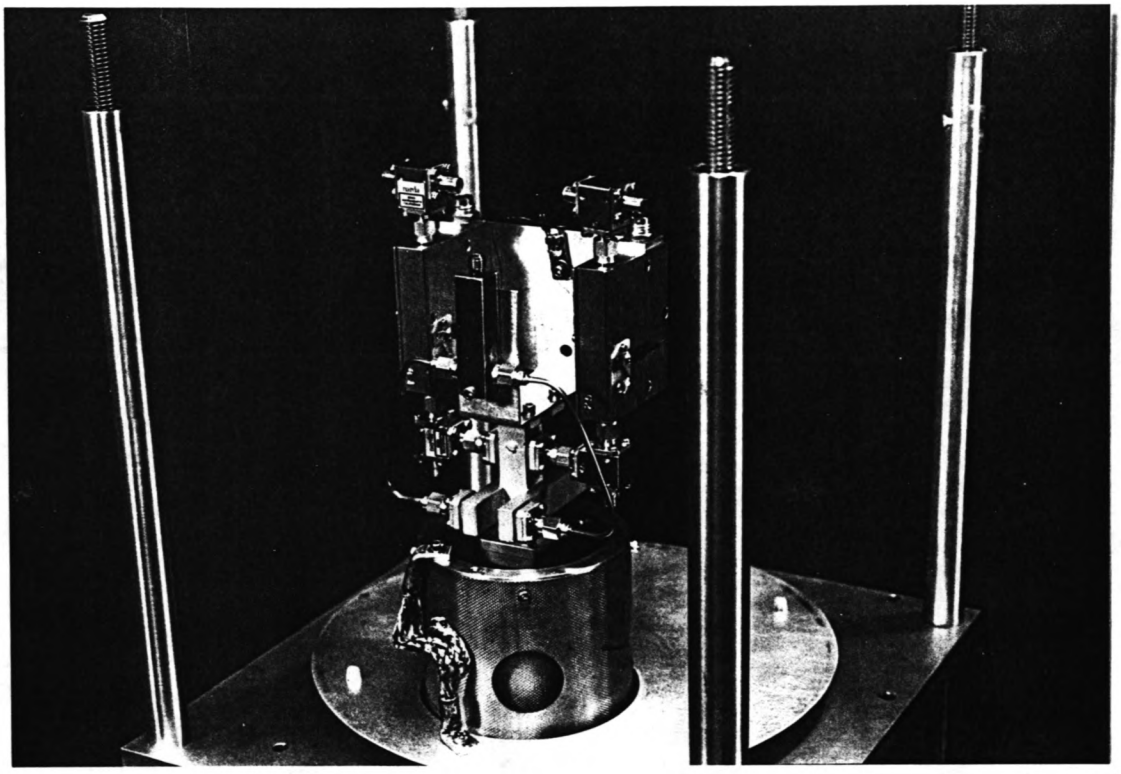
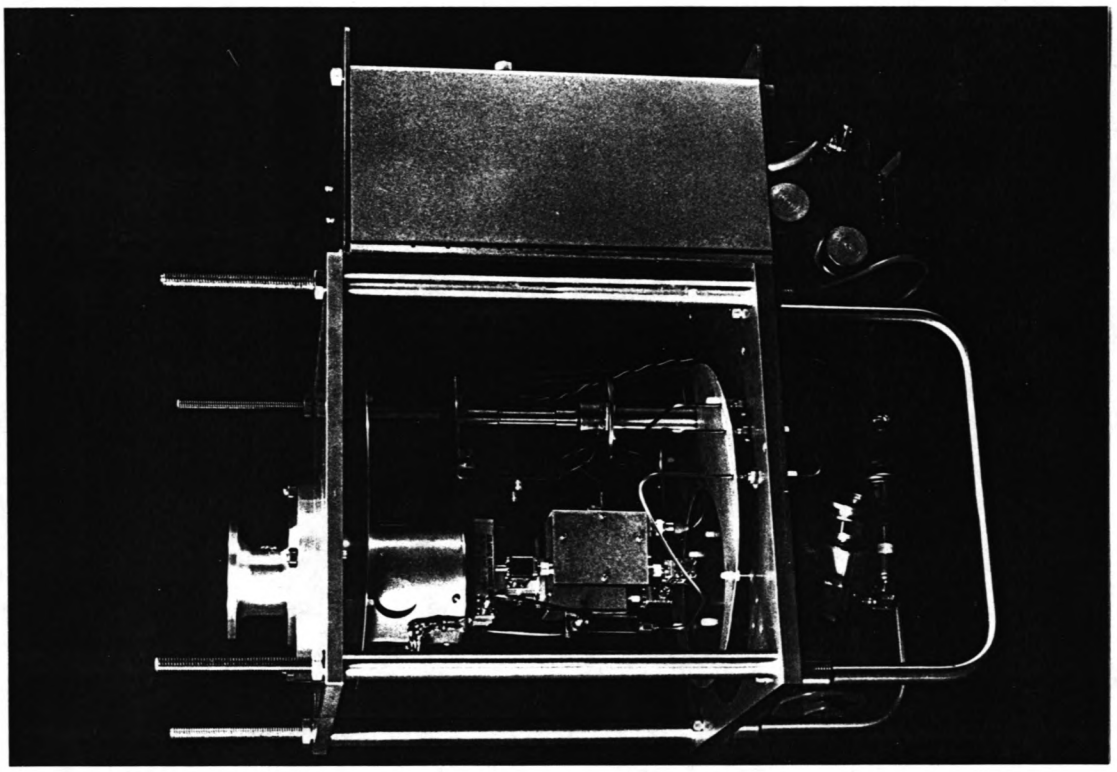


Fig. 2.1-2. Disassembled dewar.



(a) Top plate, polarizer and amplifier mounting.



(b) Assembled dewar minus outer cylinder and shield.

Fig. 2.1-3

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 4-40 screws holding the cold strap to the amplifier mounting assembly. Disconnect the stainless steel coaxial lines attached to the two amplifier outputs and the power divider input. Remove the bias connections to the two amplifiers. Remove the connector attached to the temperature sensor on the amplifier mount assembly. Disconnect the two-pin connector supplying power to the amplifier LED's. Remove the 6-32 screw attaching the tinned copper braid to the aluminum support ring near the polarizer base.

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,

---

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

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, polarizer, and HEMT amplifiers will slide away from the rest of the front-end. Care should be exercised that none of the internal cabling snags during this step.

6) Cylinder and radiation shield. Removal of the dewar cylinder from the assembly removed in step five, above, allows access to the polarizer and HEMT amplifiers. Removal of the radiation shield allows access to the 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.

2.1.5 Reassembly of Dewar

Reassembly of the 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 is 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, .005" 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.

2.3 Waveguide Thermal Transition

A 0.006 inch (.152 cm) gap in the waveguide wall provides thermal isolation between the dewar input flange and the polarizer at 18 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 18 K station.

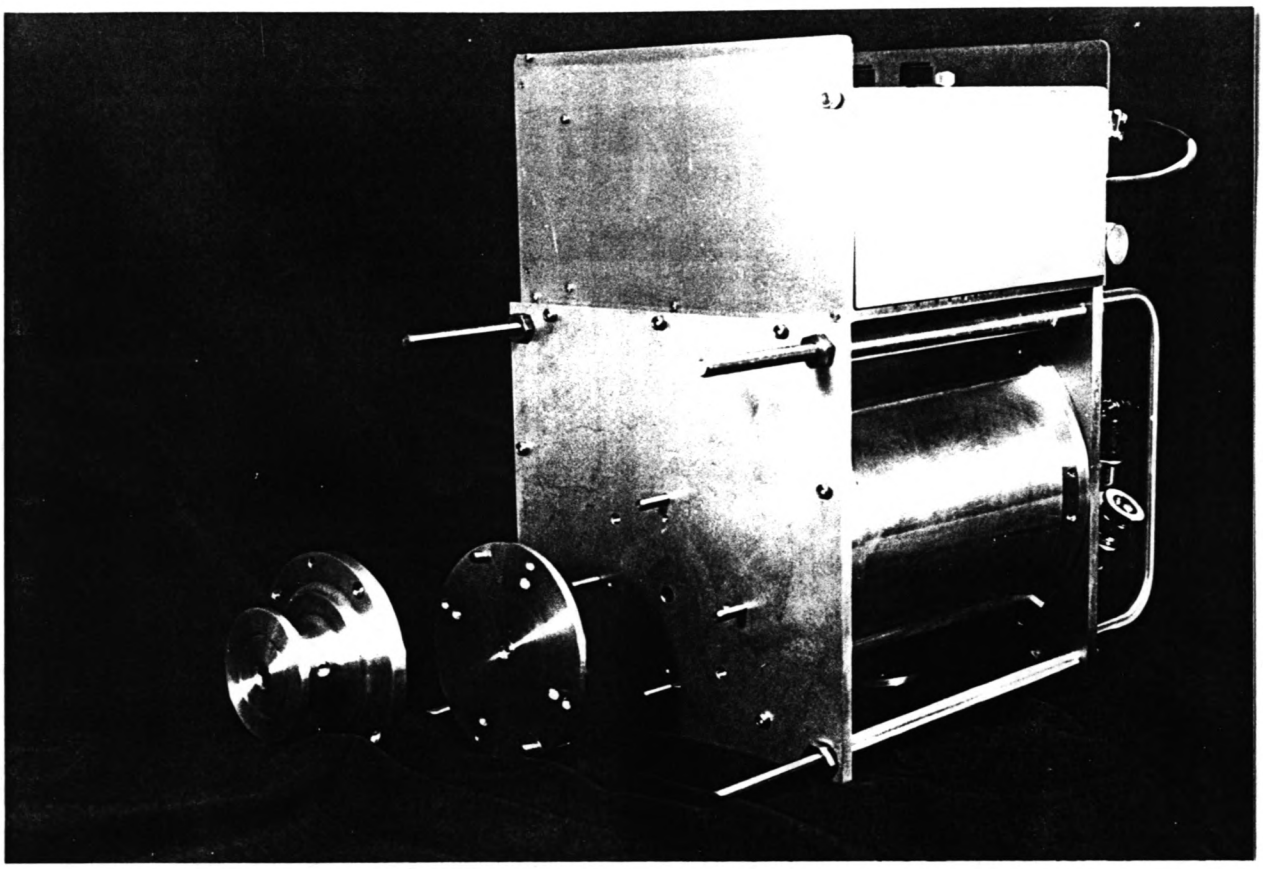


Fig. 2.2-1. Exploded view of window and top plate.

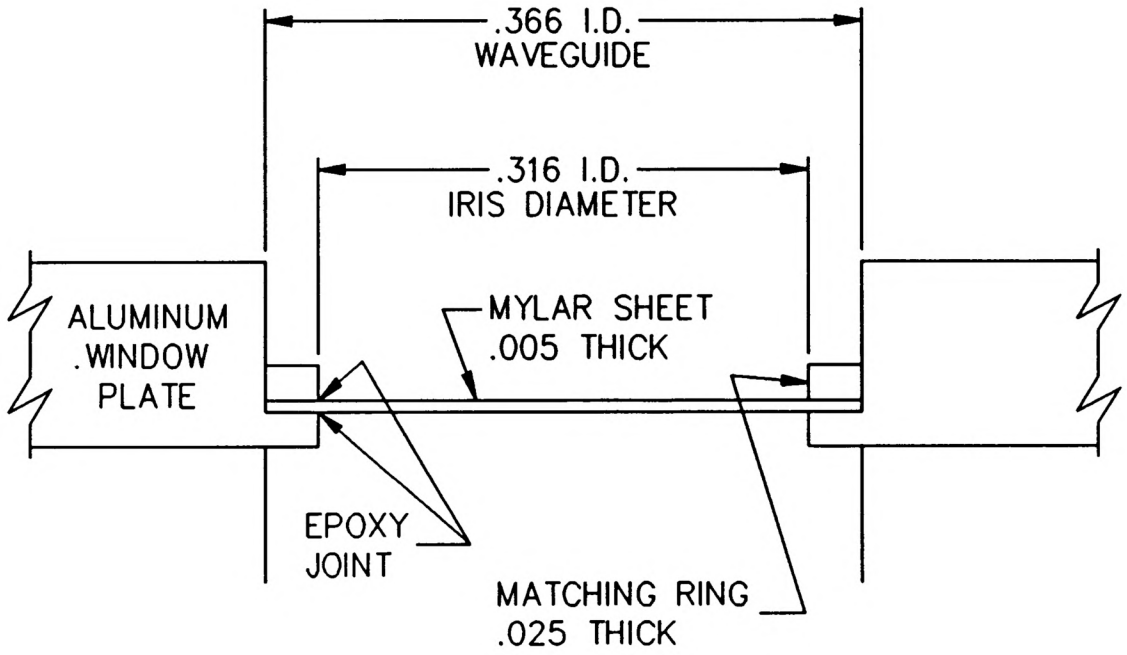


Fig. 2.2-2. Cross-section view of window.

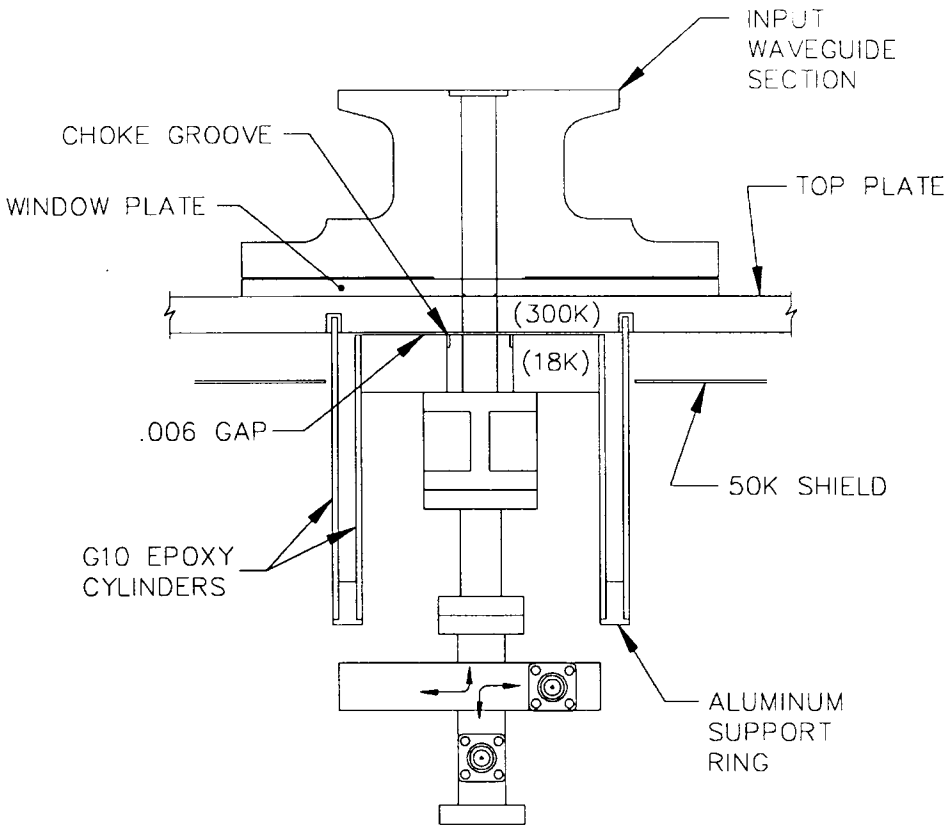


Fig. 2.3-1. Input interface cross-sectional view.

During construction, a .006" 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 (0.630" I.D., 0.700" O.D., x 0.13" 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 0969 (see Figure 2.3-2). NRAO Specification A53209N001, Rev. E (Appendix II) provides complete details. Mounted in square waveguide, the sloped-septum separates the two circularly polarized waves to SMA coaxial outputs. Two additional SMA coaxial ports provide -25 dB of directional coupling to each of the output ports. 75 ± 25 microinches of gold coat the polarizer, reducing thermal radiation absorption. A summary of electrical specifications appears below:

Specification	Requirement 21.7 - 24.1 GHz
Ellipticity	≤ 0.7 dB
Isolation	≤ -25 dB
Return Loss	< 15 dB
Coupling	25 ± 1.5 dB

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

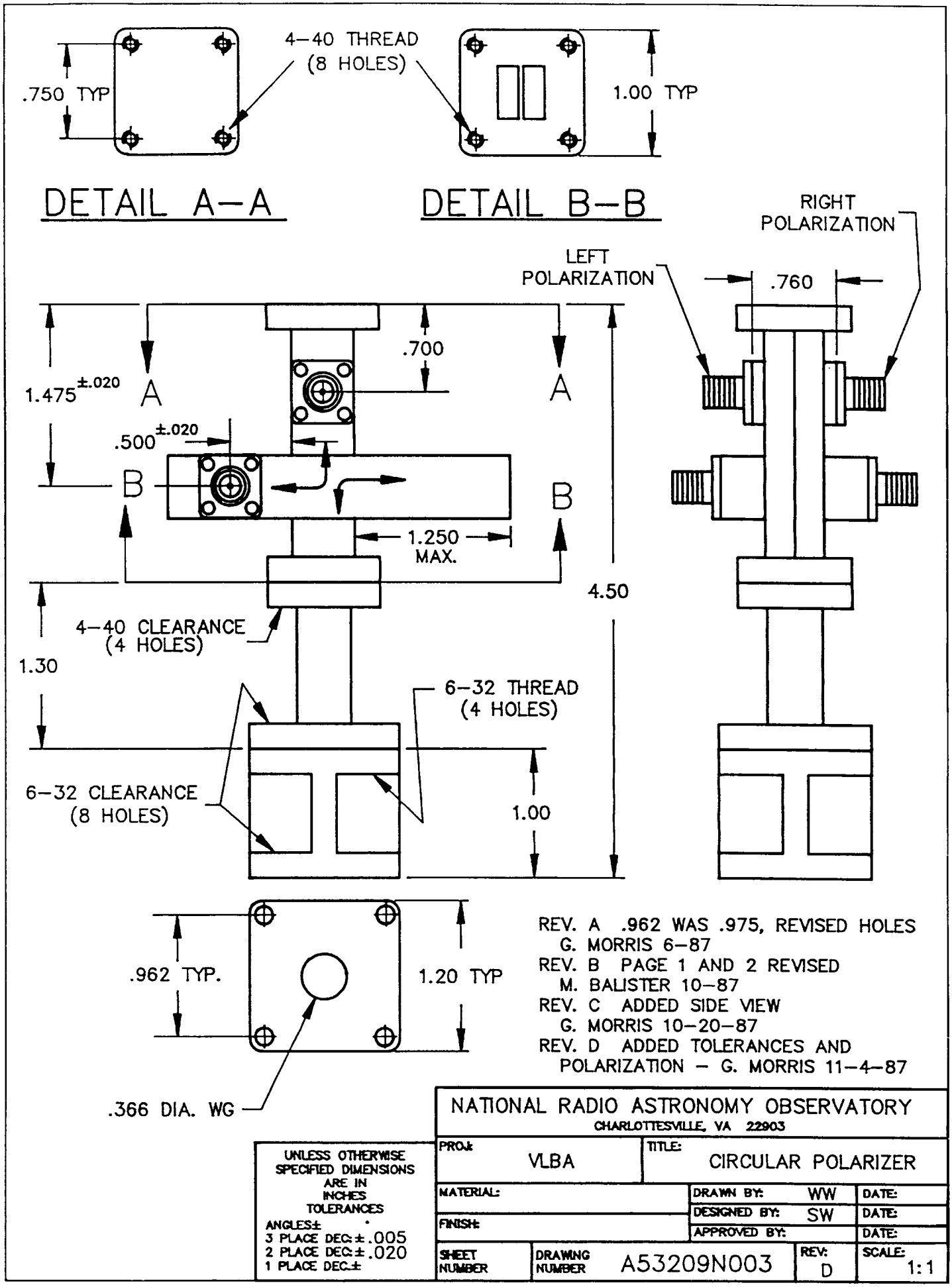


Fig. 2.3-2. Polarizer Drawing

2.5 Noise Calibration System

The block diagram in Figure 1.1-1 shows the noise calibration components. 25 dB cross waveguide couplers inject a cal signal 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 25 dB ENR noise source. It couples through an isolator and 6 dB pad into one leg of a power divider. The other divider leg allows for an externally applied pulse calibration signal. From the divider, a .141" coaxial cable carries the cal signal to the dewar.

The ENR referred to the receiver input is approximately -16 dB, which is 7.5 K. Allowing 3.5 dB per power divider, 1 dB isolator loss, and 2 dB cable losses, this breaks down as: 25 - 7 - 1 - 2 - 6 - 25 = -16 dB. The CAL control line must supply +28 volts at 4 to 10 mA.

2.6 Cryo-Amplifiers

A four-stage HEMT amplifier provides ~ 27 dB initial gain. Table VII gives the noise budget for the cooled RF components. The typical power dissipated by each amplifier is 0.2 watts (see heat load budget in Table IX).

2.7 RF Post-Amplifiers

Miteq AMF-3B-215245-50 amplifiers provide ~ 10 dB gain in the signal path immediately following the dewar. They mount adjacent to the SMA dewar feedthrough signal outputs, *i.e.*, within 2-3 inches of cable length. Their

presence insures sufficient drive for the subsequent mixer stage. Specified frequency range is 21.5 to 24.5 GHz. Noise figure is ~ 4.35 dB (500 K).

2.8 Mixer/IF Amplifier Card

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

Spacek Labs supplies the mixer units, Model MM23-9.7. Each mixer assembly consists of a Wiltron 35WR42KF coaxial/waveguide input transition, the MM23-9.7 mixer, and Narda Model 4605 90° hybrid coupler. Each mixer requires an LO level of about +8 dBm. The LO path includes a Miteq AMF-4B-1181152 amplifier (11.8 - 15.2 GHz, gain ~20 dB), 3 dB pad, Narda 4316-2 power divider, and K & L bandpass filters (12 - 14.5 GHz BW). Mixer conversion loss is ~ 8 dB. LO input at connector J17 should be -6 dBm.

Mixer IF signal output passes through DiTom 318016-1 isolators and K & L bandpass filters (9.75 GHz, 900 MHz BW). The final stage is a Miteq isolator/amplifier combination. Miteq AMF-2S-093102-20 (9.3 - 10.2 GHz) has a noise figure of approximately 2 dB and a typical gain of 25 dB. The RCP and LCP IF outputs, 9.3 - 10.2 GHz, are available on connectors J6 and J7, respectively.

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

a) a low noise calibration signal, ~ 7.5 K, for continuous pulsed gain and noise calibration of the system,

b) an externally applied signal, connector J8, coupled -34 dB to both inputs, for the purposes of phase or time-delay calibration of the system.

The noise source is a Noise Com NC 4073, ENR 25 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.

2.9 Dewar Internal Wiring and Coaxial Lines

Sixteen wires connect the 300 K dewar RFI feedthrough plate and components at 18 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" or less. The total heat load for 14 wires (HEMT bias and 18 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 No. 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

2.10 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, two-phase, 1 A), derived from 120 volt, 60 Hz, single-phase power. Figure 2.10-1 shows a 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 two 150 ohm, 50 watt, 1% wirewound resistors. The capacitance is a 4 μf oil-filled capacitor.

A current transducer in the P111 senses AC current delivered to the front-end. The transducer 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. This 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.

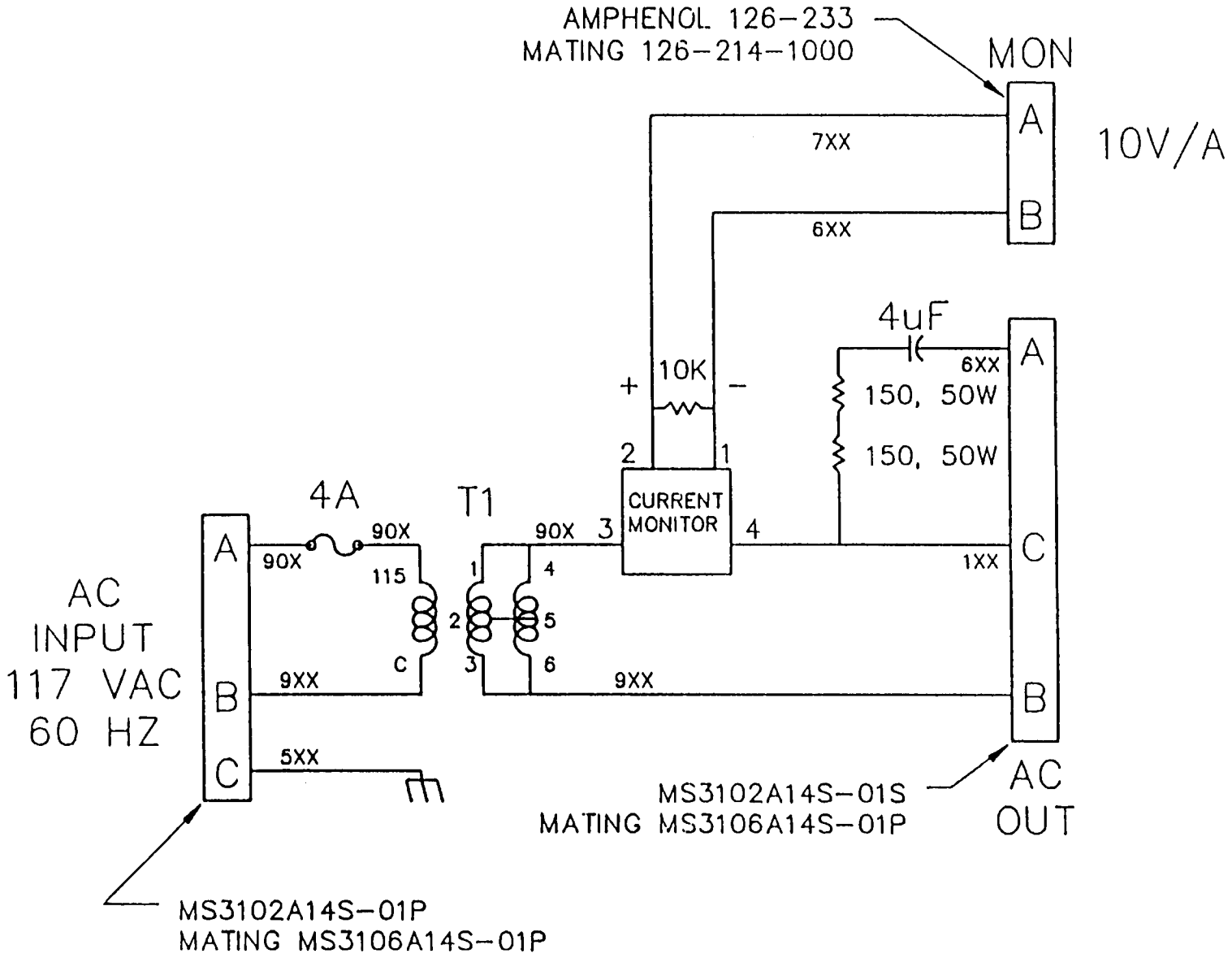


Fig. 2.10-1. Power supply schematic.

2.11 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. Pursue abnormal readings by further checks at the bias card test points. 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 mixer/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 coaxial output cables, as well as 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/minute 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.

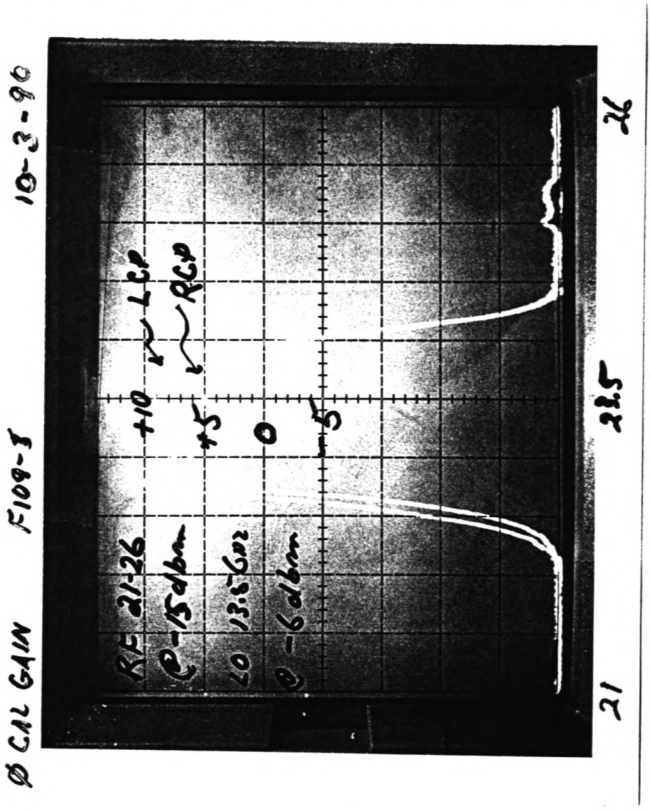
Refer to Section 2.1.5 for precautions to observe when reassembling the dewar. The cause of vacuum leaks is most often a missing, dirty, or pinched o-ring. Loose bolts may cause an o-ring to be less than fully compressed.

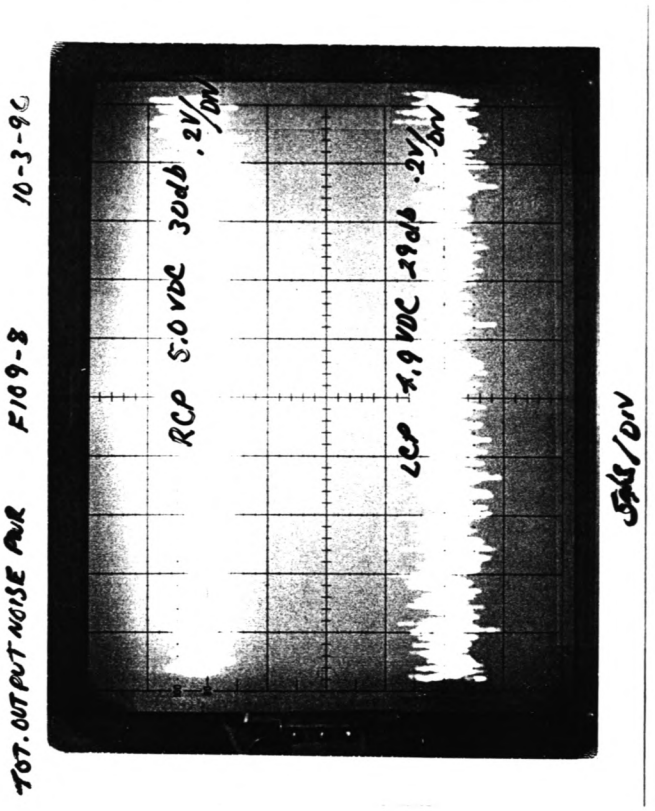
APPENDIX I. Sample Test Data

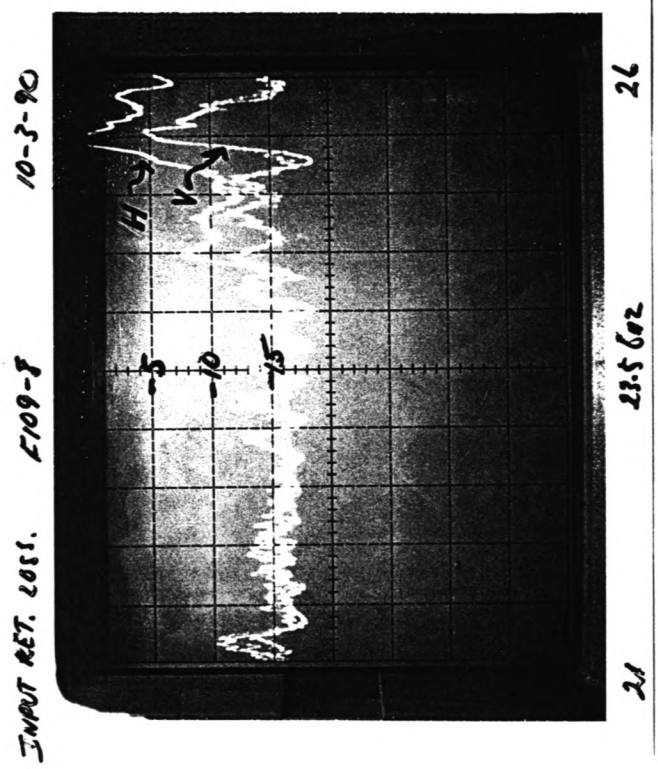
23GHz RECEIVER TEST DATA

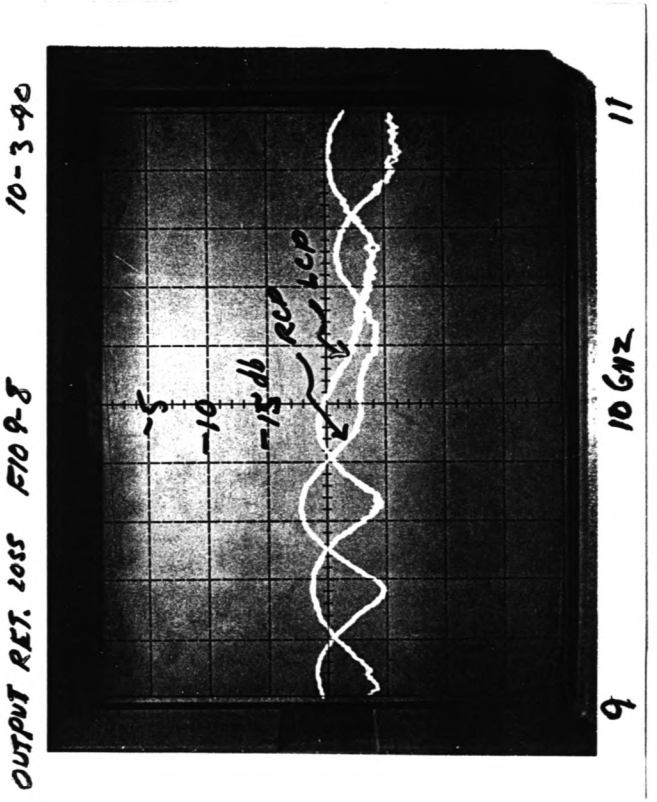
Front-End S/N: F109-8 Date: 10/3/90

By: K. CRADY Remarks:









F109 GHz FRONT-END, S/N 8 Date: 10/2/90

FET BIAS SETTINGS

Stage	LCP AMP #91				RCP AMP #15			
	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	2.0	7.0	-.181	-.278	2.5	7.0	-.256	-.354
2	3.0	6.0	-.377	-.484	3.0	6.0	-.541	-.628
3	4.5	25.0	+.937	+.122	4.5	25.0	+.093	-.095
4	5.5	25.0	-.060	-.313	5.5	17.0	-.196	-.475

TOTAL IF POWER OUT INTO 9750/900 FILTER AS
MEASURED WITH HP438A/8484A POWER METER
LO 13.5 GHz, LO Level -6 dBm

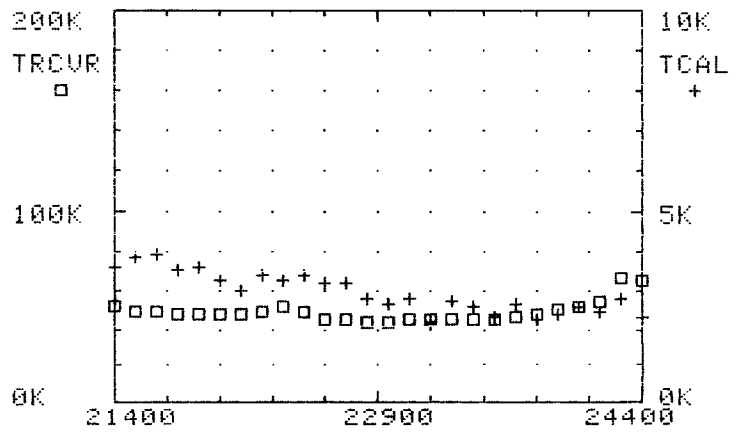
Input Condition	15K		300K	
	LCP dBm	RCP dBm	LCP dBm	RCP dBm
302K Load	-40.30	-41.19	-47.58	-44.68
79.7K Load	-44.45	-45.56	-48.94	-46.30
Short	-47.19	-47.73	-47.56	-44.67
Short + Cal	-46.54	-47.16	-47.55	-44.65

CALIBRATION RECORD OF 23 GHZ RECEIVER. SERIAL #8. MOD #0
RCP POLARIZATION. TESTED BY CRADY, DATE 10/08/90 TIME 09:35.3
COMMENT: 9.4 GHZ IF

15K TEMP = 23.02 50K TEMP = 63.31 300K TEMP = 310.44
AC AMPS = 0.457 DEWR VAC = -111 PUMP VAC = 10052
HEMT LED = 6.50 +15 VOLT = 15.341 TA SENS V= 6.870
CAL VOLT = 28.11 HIGH CAL = 0.00 SPARE = 0.00
FETS: LF1= -.256 LF2= -.164 RF1= -.332 RF2= -.338
CRYO MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

09:40.1 10/08/90 THOT=297 TCOLD=78.8 RCP. 9.4GHZ IF, 39DB ATTEN.
INPUT TO NRAO DETECTOR

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
21400	52.0	3.54	0.0	27.9
21520	49.3	3.83	0.0	30.0
21640	48.2	3.92	0.0	33.7
21760	46.7	3.53	0.0	32.8
21880	47.6	3.56	0.0	30.4
22000	46.8	3.23	0.0	31.8
22120	47.4	2.97	0.0	30.7
22240	49.2	3.37	0.0	28.3
22360	51.0	3.24	0.0	27.1
22480	48.6	3.37	0.0	29.4
22600	45.0	3.17	0.0	29.7
22720	44.3	3.20	0.0	27.6
22840	43.8	2.77	0.0	29.4
22960	44.0	2.66	0.0	33.6
23080	44.4	2.79	0.0	33.5
23200	44.1	2.16	0.0	33.4
23320	44.9	2.73	0.0	31.3
23440	45.3	2.60	0.0	30.4
23560	45.1	2.30	0.0	29.4
23680	45.7	2.65	0.0	28.7
23800	47.3	2.26	0.0	29.6
23920	49.4	2.38	0.0	31.3
24040	51.6	2.59	0.0	32.6
24160	53.9	2.42	0.0	33.0
24280	65.8	2.79	0.0	29.9
24400	64.8	2.30	0.0	30.9

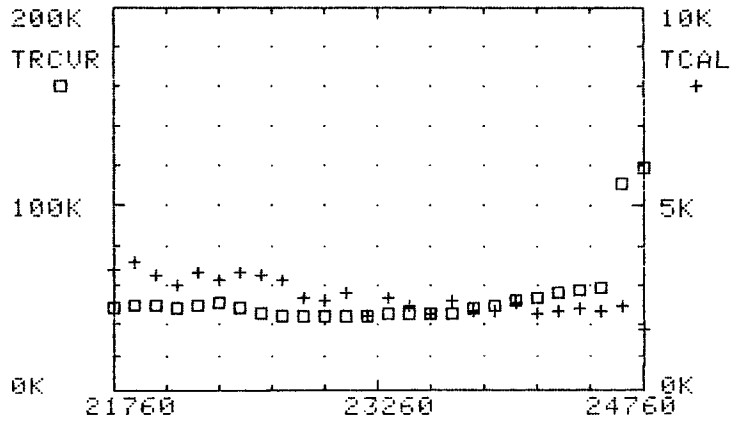


CALIBRATION RECORD OF 23 GHZ RECEIVER, SERIAL #8, MOD #0
RCP POLARIZATION, TESTED BY CRADY, DATE 10/08/90 TIME 09:41.3
COMMENT: 9.76 GHZ IF

15K TEMP = 22.90 50K TEMP = 63.25 300K TEMP = 310.52
AC AMPS = 0.456 DEWR VAC = -110 PUMP VAC = 10050
HEMT LED = 6.50 +15 VOLT = 15.337 TA SENS V= 6.816
CAL VOLT = 28.11 HIGH CAL = -.01 SPARE = 0.00
FETS: LF1= -.257 LF2= -.165 RF1= -.333 RF2= -.340
CRYO MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

09:47.9 10/08/90 THOT=297 TCOLD=78.8 RCP,9.76GHZ IF,41DB INPIT
ATTEN. TO NRAO DETECTOR, 30MHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
21760	47.9	3.35	0.0	32.8
21880	48.6	3.57	0.0	30.5
22000	48.2	3.21	0.0	31.8
22120	47.0	2.95	0.0	31.2
22240	48.9	3.28	0.0	28.4
22360	50.4	3.13	0.0	27.6
22480	46.8	3.30	0.0	30.2
22600	44.2	3.22	0.0	29.8
22720	43.8	3.11	0.0	27.6
22840	43.6	2.65	0.0	29.7
22960	43.8	2.57	0.0	34.1
23080	43.9	2.77	0.0	33.9
23200	43.4	2.20	0.0	33.8
23320	44.3	2.66	0.0	31.9
23440	45.0	2.46	0.0	30.6
23560	44.6	2.24	0.0	29.7
23680	45.1	2.57	0.0	29.1
23800	47.0	2.28	0.0	29.8
23920	48.8	2.28	0.0	32.0
24040	50.8	2.49	0.0	33.0
24160	53.0	2.23	0.0	32.6
24280	55.7	2.28	0.0	28.4
24400	56.8	2.40	0.0	30.1
24520	58.2	2.27	0.0	32.6
24640	110.5	2.42	0.0	33.1
24760	118.2	1.82	0.0	34.2



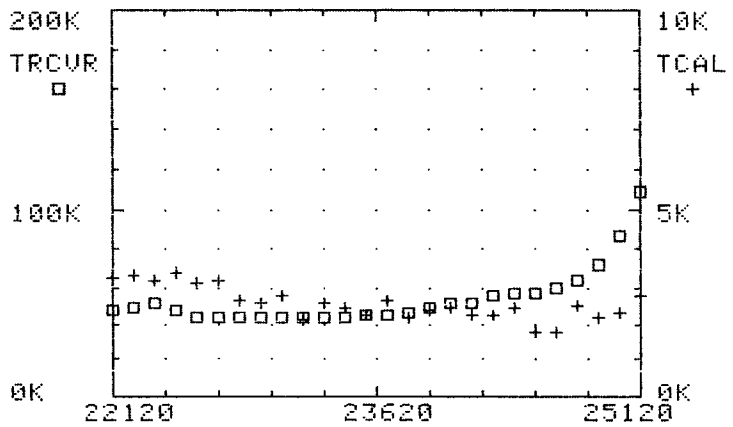
CALIBRATION RECORD OF 23 GHZ RECEIVER, SERIAL #8, MOD #0
RCP POLARIZATION, TESTED BY CRADY, DATE 10/08/90 TIME 0?:58.3
COMMENT: 10.12GHZ IF

15K TEMP =	23.10	50K TEMP =	63.30	300K TEMP =	310.56
AC AMPS =	0.455	DEWR VAC =	-108	PUMP VAC =	10051
HEMT LED =	6.50	+15 VOLT =	15.339	TA SENS V=	6.841
CAL VOLT =	28.11	HIGH CAL =	-.01	SPARE =	0.00
FETS: LF1=	-.256	LF2=	-.164	RF1=	-.332 RF2= -.339

CRYO MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

10:02.9 10/08/90 THOT=297 TCOLD=78.8 10.12GHZ IF, 41DB IF ATTEN., 30MHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
22120	47.1	3.23	0.0	30.5
22240	49.3	3.30	0.0	27.4
22360	50.7	3.16	0.0	27.1
22480	46.7	3.40	0.0	30.2
22600	43.2	3.13	0.0	30.1
22720	43.1	3.20	0.0	27.8
22840	43.2	2.63	0.0	30.0
22960	42.7	2.60	0.0	34.8
23080	43.0	2.79	0.0	34.3
23200	43.4	2.12	0.0	33.8
23320	43.7	2.59	0.0	32.1
23440	43.7	2.46	0.0	31.2
23560	44.2	2.25	0.0	29.9
23680	45.3	2.63	0.0	29.3
23800	46.4	2.19	0.0	30.3
23920	48.4	2.38	0.0	32.2
24040	50.7	2.43	0.0	33.2
24160	52.0	2.23	0.0	33.0
24280	55.0	2.22	0.0	28.7
24400	57.2	2.41	0.0	29.7
24520	57.2	1.80	0.0	32.3
24640	59.1	1.75	0.0	31.1
24760	64.0	2.52	0.0	33.8
24880	71.0	2.14	0.0	33.9
25000	85.9	2.28	0.0	30.9
25120	108.2	2.74	0.0	43.8

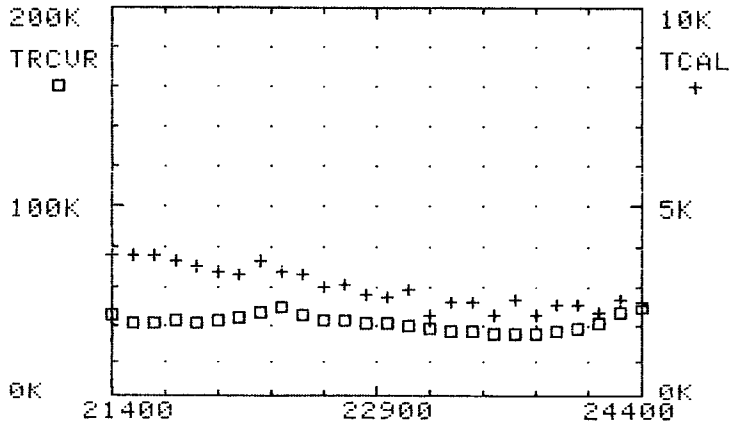


CALIBRATION RECORD OF 23 GHZ RECEIVER, SERIAL #8, MOD #0
LCP POLARIZATION, TESTED BY CRADY, DATE 10/08/90 TIME 10:03.6
COMMENT: 9.4 GHZ IF

15K TEMP = 23.12 50K TEMP = 63.41 300K TEMP = 310.71
AC AMPS = 0.454 DEWR VAC = -105 PUMP VAC = 10051
HEMT LED = 6.50 +15 VOLT = 15.339 TA SENS V= 6.825
CAL VOLT = 28.11 HIGH CAL = 0.00 SPARE = 0.00
FETS: LF1= -.256 LF2= -.164 RF1= -.332 RF2= -.338
CRYO MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

10:08.2 10/08/90 THOT=297 TCOLD=78.8 9.4GHZ IF, 42DB INPUT ATTEN., 30MHZ BWQ

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
21400	44.1	3.79	0.0	29.1
21520	41.2	3.75	0.0	32.1
21640	40.1	3.76	0.0	36.3
21760	41.6	3.66	0.0	33.2
21880	41.2	3.53	0.0	31.7
22000	42.4	3.39	0.0	31.9
22120	43.5	3.27	0.0	30.6
22240	45.7	3.66	0.0	28.7
22360	48.1	3.38	0.0	27.2
22480	45.2	3.32	0.0	30.4
22600	42.0	2.98	0.0	30.9
22720	41.4	3.02	0.0	28.8
22840	41.0	2.76	0.0	30.7
22960	40.1	2.69	0.0	35.2
23080	39.1	2.87	0.0	35.0
23200	37.6	2.23	0.0	34.9
23320	36.4	2.60	0.0	32.2
23440	36.2	2.58	0.0	31.1
23560	34.8	2.22	0.0	30.8
23680	34.8	2.61	0.0	30.0
23800	35.7	2.26	0.0	30.3
23920	36.9	2.50	0.0	32.2
24040	38.1	2.52	0.0	33.9
24160	40.8	2.27	0.0	33.5
24280	46.2	2.62	0.0	28.2
24400	48.7	2.48	0.0	30.5



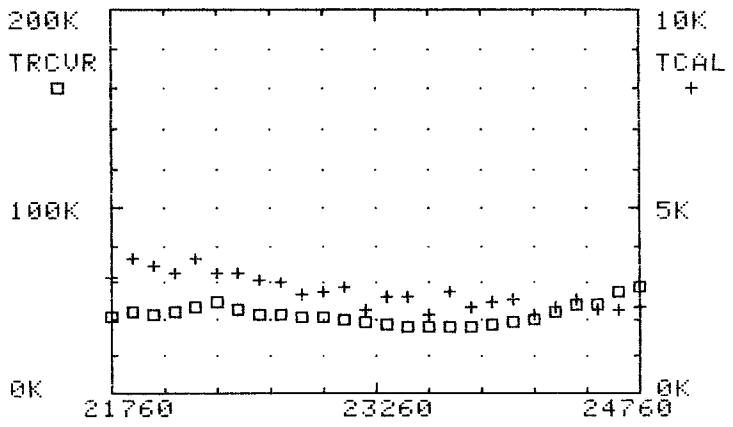
CALIBRATION RECORD OF 23 GHZ RECEIVER, SERIAL #8, MOD #0
LCP POLARIZATION, TESTED BY CRADY, DATE 10/08/90 TIME 10:09.3
COMMENT: 9.76GHZ IF

15K TEMP =	23.04	50K TEMP =	63.27	300K TEMP =	310.58
AC AMPS =	0.454	DEWR VAC =	-105	PUMP VAC =	10049
HEMT LED =	6.50	+15 VOLT =	15.337	TA SENS V=	6.801
CAL VOLT =	28.11	HIGH CAL =	-.01	SPARE =	0.00
FETS: LF1=	-.257	LF2=	-.165	RF1=	-.333 RF2= -.340

CRYO MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

10:13.6 10/08/90 THOT=297 TCOLD=78.8 9.76GHZ IF, 44DB INPUT ATTEN.
TO NRAO DETECTOR, 30MHZ BW

F,MHZ	TRCVR	TCAL	HI CAL	SHORT
21760	40.9	3.10	0.0	33.7
21880	43.2	3.61	0.0	30.5
22000	42.2	3.43	0.0	32.1
22120	43.1	3.21	0.0	30.5
22240	45.9	3.64	0.0	28.0
22360	48.2	3.21	0.0	26.7
22480	44.1	3.26	0.0	30.9
22600	42.4	3.01	0.0	30.3
22720	41.4	2.97	0.0	28.7
22840	40.9	2.61	0.0	30.8
22960	40.2	2.69	0.0	35.4
23080	38.9	2.86	0.0	35.2
23200	37.7	2.26	0.0	35.6
23320	37.1	2.57	0.0	32.6
23440	35.9	2.58	0.0	31.5
23560	34.7	2.09	0.0	31.0
23680	35.1	2.68	0.0	30.0
23800	35.5	2.28	0.0	30.7
23920	36.7	2.43	0.0	32.7
24040	38.5	2.52	0.0	33.7
24160	39.6	2.11	0.0	34.1
24280	43.2	2.30	0.0	29.1
24400	47.3	2.51	0.0	30.1
24520	47.9	2.24	0.0	31.8
24640	53.4	2.23	0.0	30.5
24760	56.4	2.33	0.0	32.2

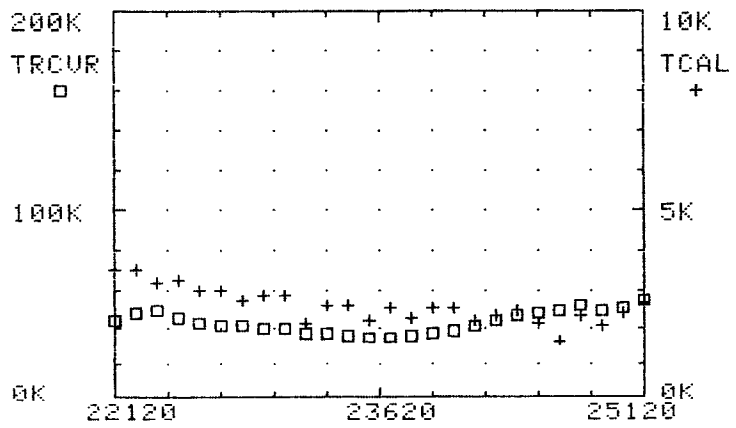


CALIBRATION RECORD OF 23 GHZ RECEIVER, SERIAL #8, MOD #0
LCP POLARIZATION, TESTED BY CRADY, DATE 10/08/90 TIME 10:14.3
COMMENT: 10.12GHZ IF

15K TEMP = 23.03 50K TEMP = 63.37 300K TEMP = 310.61
AC AMPS = 0.455 DEWR VAC = -104 PUMP VAC = 10050
HEMT LED = 6.50 +15 VOLT = 15.338 TA SENS V= 6.847
CAL VOLT = 28.11 HIGH CAL = -.01 SPARE = 0.00
FETS: LF1= -.256 LF2= -.165 RF1= -.333 RF2= -.339
CRYO MODE IS COOL (7) CONTROLLED BY MANUAL. PARITY IS CORRECT

10:18.9 10/08/90 THOT=297 TCOLD=78.8 10.12GHZ IF, 44DB INPUT ATTEN.
TO NRAO DETECTOR, 30MHZ BW

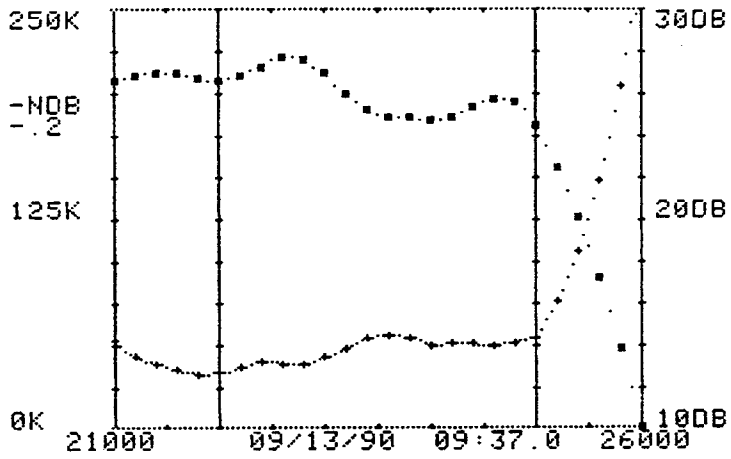
F,MHZ	TRCVR	TCAL	HI CAL	SHORT
22120	43.7	3.49	0.0	30.8
22240	46.7	3.52	0.0	28.2
22360	48.8	3.14	0.0	27.4
22480	45.0	3.25	0.0	31.1
22600	42.0	2.95	0.0	30.9
22720	41.1	2.94	0.0	29.0
22840	40.6	2.70	0.0	31.2
22960	39.7	2.82	0.0	35.7
23080	38.7	2.83	0.0	35.0
23200	37.0	2.13	0.0	35.0
23320	36.4	2.60	0.0	32.5
23440	35.7	2.59	0.0	31.0
23560	34.4	2.18	0.0	30.9
23680	34.6	2.53	0.0	30.3
23800	35.7	2.25	0.0	30.6
23920	36.7	2.47	0.0	32.8
24040	38.2	2.49	0.0	34.1
24160	40.2	2.15	0.0	33.6
24280	43.7	2.28	0.0	28.9
24400	46.3	2.41	0.0	30.7
24520	47.6	2.10	0.0	32.4
24640	48.7	1.64	0.0	30.8
24760	50.7	2.31	0.0	34.4
24880	48.7	2.03	0.0	34.8
25000	50.1	2.39	0.0	30.8
25120	53.9	2.65	0.0	46.2



SERIAL NUMBER DATA FOR FRONT-ENDS		
UNIT INFORMATION		
MODEL F109		
SERIAL NUMBER 8		
REFRIGERATOR INFORMATION		
SERIAL # 11L96308	CYLINDER # 20-6308	CROSSHEAD # 6925
CRYO-AMP INFORMATION		
RCP CRYO AMP 15	LCP CRYO AMP 91	
RCP CRYO ISOL IN 119	LCP CRYO ISOL IN 118	
RCP CRYO ISOL OUT 122	LCP CRYO ISOL OUT 123	
CRYO POWER DIVIDER ---		
RF CARD INFORMATION		
RF CARD SERIAL # RF-8		
RCP MIXER 0810	LCP MIXER 0805	
RCP HYB COUPLER ----	LCP HYB COUPLER ----	
RCP AMB ISOL 114	LCP AMB ISOL 116	
RCP AMB AMP 160239	LCP AMB AMP 160241	
LO AMP 160784	LO POWER DIVIDER 02655	
RCP LO FILTER WB522-3	LCP LO FILTER WB522-4	
NOISE SOURCE 1577 8739	NOISE SOURCE ISOL 1386	
CAL POWER DIVIDER 01394		
GENERAL INFORMATION		
RCP BIAS CARD SERIAL # BC-164	LCP BIAS CARD SERIAL # BC-163	
SENSOR CARD SERIAL # SC-81	CONTROL CARD SERIAL # CC-80	
MONITOR CARD SERIAL # MC-71		
TEMP SENSOR 50K 358	TEMP SENSOR 15K 356	
DATE 10/2/90	RECORDED BY K. Crady	

1) #15,UPGRADED, OPT BIAS, LIGHT ON
09:37.0 09/13/90 TAV=46.6 TLO=33.4 @ 22000 GL=24.4 GH=27.7 T=16.2K

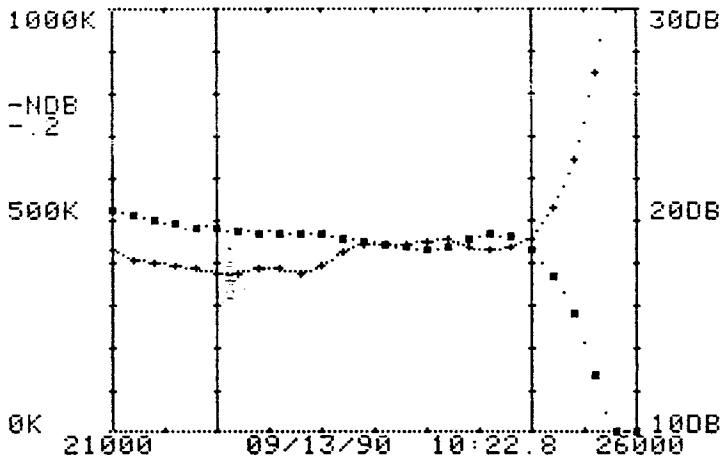
2.52,6.9,-.343 3.01,6,-.603 4.53,24.7,-.088 5.48,17.2,-.44



09:38.6 09/13/90 ZERO=11.2 ADB=23 TF=300 -NDB=-.2

F,GHZ	NOISE	GAIN,DB	F,GHZ	NOISE	GAIN,DB
21.000	52.2	26.6	21.20	42.2	26.8
21.400	38.5	26.9	21.60	35.0	26.9
21.800	32.7	26.7	22.00	33.4	26.5
22.200	36.1	26.8	22.40	39.8	27.2
22.600	38.7	27.6	22.80	38.4	27.6
23.000	42.4	26.9	23.20	47.0	26.0
23.400	53.3	25.2	23.60	55.4	24.9
23.800	54.1	24.9	24.00	49.7	24.7
24.200	51.0	24.8	24.40	50.0	25.4
24.600	49.3	25.7	24.80	51.2	25.6
25.000	54.3	24.4	25.20	75.1	22.4
25.400	105.0	20.1	25.60	148.1	17.2
25.800	203.5	13.8	26.00	295.3	10.1

1) #15 @300K WITH OPT COLD BIAS
10:22.8 09/13/90 TAV=417.5 TLO=372.5 @ 22100 GL=18.6 GH=19.5 T=303.2
K
2.52,6.9,-.249 3.01,6,-.533 4.53,24.7,.101 5.48,17.2,-.172

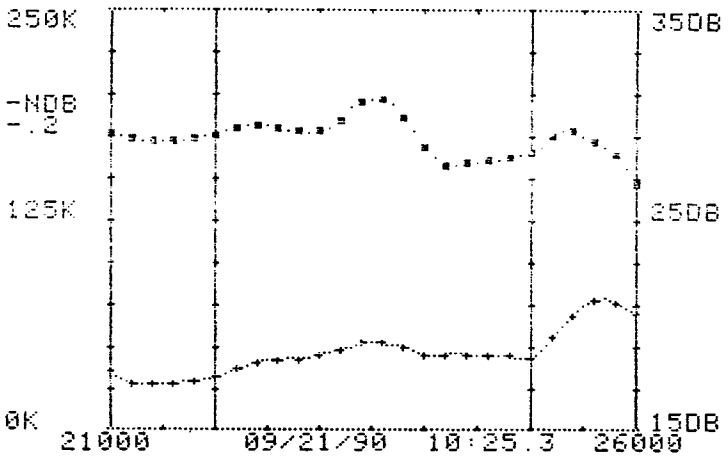


10:24.2 09/13/90 ZERO=11.2 ADB=23 TF=300 -NDB=-.2

F,GHZ	NOISE	GAIN,DB	F,GHZ	NOISE	GAIN,DB
21.000	427.1	20.5	21.20	405.2	20.2
21.400	397.6	19.9	21.60	392.2	19.8
21.800	382.0	19.5	22.00	374.7	19.5
22.200	374.9	19.4	22.40	385.8	19.3
22.600	384.2	19.3	22.80	373.5	19.3
23.000	392.7	19.3	23.20	421.3	19.1
23.400	441.8	19.0	23.60	441.3	18.8
23.800	442.9	18.7	24.00	444.8	18.6
24.200	451.1	18.7	24.40	435.0	19.1
24.600	426.2	19.3	24.80	436.1	19.1
25.000	456.2	18.6	25.20	527.6	17.4
25.400	639.3	15.5	25.60	849.5	12.6
25.800	1202.0	9.0	26.00	1843.6	4.8

1) #91, OPT BIAS
10:25.3 09/21/90 TAV=44.3 TLO=31.5 @ 22000 GL=27.6 GH=30.7 T=16.3K

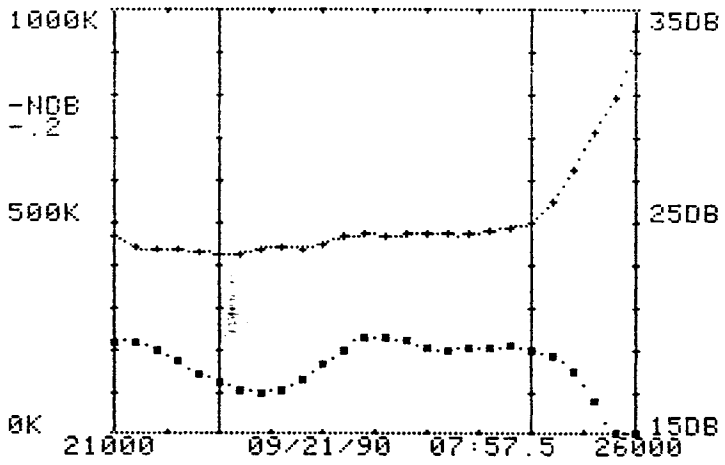
2.04,6.8,-.269 3,5.9,-.467 4.52,24.8,.123 5.5,24.9,-.289



10:27.1 09/21/90 ZERO=11.2 ADB=23 TF=300 -NDB=-.2

F,GHZ	NOISE	GAIN,DB	F,GHZ	NOISE	GAIN,DB
21.000	35.2	29.1	21.20	27.6	28.8
21.400	27.0	28.7	21.60	27.7	28.7
21.800	28.6	28.8	22.00	31.5	29.0
22.200	36.1	29.3	22.40	40.5	29.4
22.600	41.7	29.3	22.80	42.0	29.1
23.000	45.2	29.2	23.20	47.9	29.7
23.400	52.1	30.6	23.60	51.9	30.7
23.800	50.0	29.9	24.00	44.4	28.5
24.200	45.0	27.6	24.40	45.0	27.7
24.600	44.2	27.8	24.80	44.3	27.9
25.000	42.3	28.2	25.20	55.0	28.9
25.400	68.1	29.2	25.60	77.4	28.7
25.800	76.2	28.0	26.00	69.6	26.7

1) #91 @ 300K WITH OPT COLD BIAS
07:57.5 09/21/90 TAV=459.8 TLO=422.9 @ 22100 GL=16.9 GH=19.6 T=295.3 K
2.04,6.8,-.175 3,6,-.366 4.52,24.8,.295 5.5,24.9,-.062



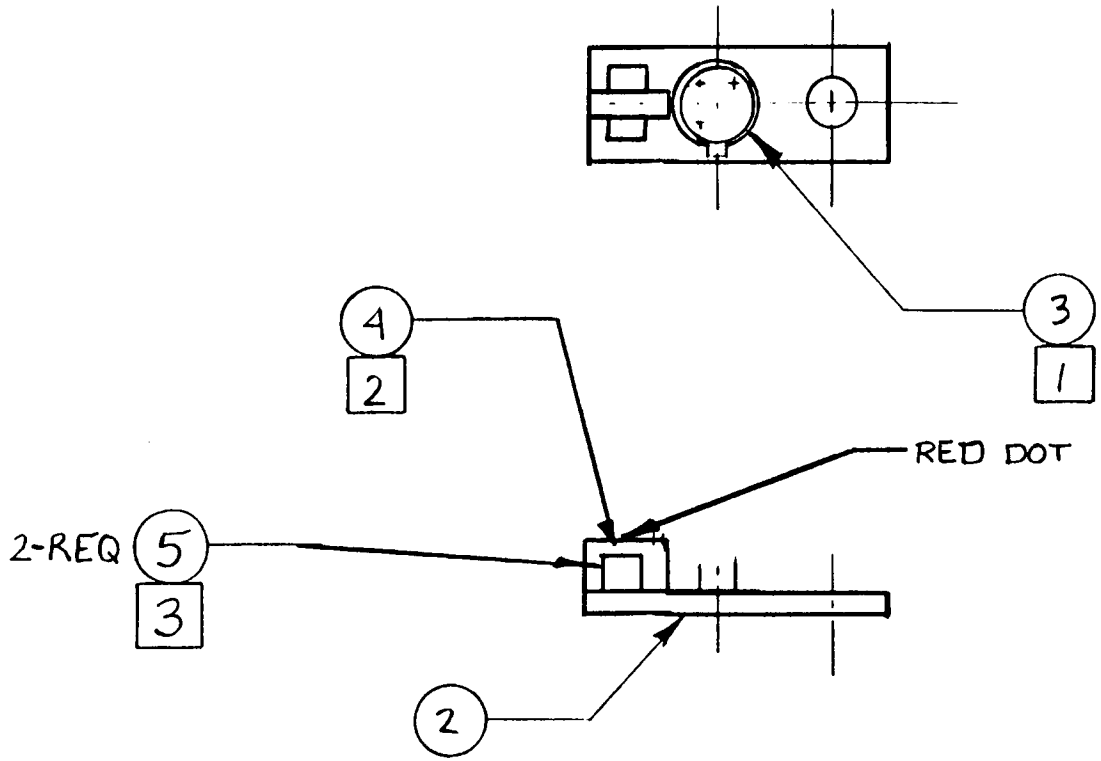
07:58.7 09/21/90 ZERO=11.2 ADB=23 TF=300 -NDB=-.2

F,GHZ	NOISE	GAIN,DB	F,GHZ	NOISE	GAIN,DB
21.000	464.1	19.3	21.20	439.9	19.4
21.400	434.9	18.9	21.60	434.2	18.4
21.800	425.4	17.8	22.00	423.3	17.5
22.200	424.4	17.1	22.40	435.6	16.9
22.600	442.2	17.1	22.80	436.8	17.5
23.000	448.9	18.3	23.20	463.9	19.0
23.400	469.2	19.5	23.60	467.2	19.6
23.800	470.3	19.4	24.00	470.4	19.0
24.200	471.0	19.0	24.40	470.9	19.1
24.600	478.1	19.1	24.80	487.5	19.1
25.000	495.3	19.0	25.20	549.8	18.7
25.400	622.6	18.0	25.60	712.2	16.5
25.800	793.4	14.5	26.00	949.9	11.3

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
A53209B001	BOM, 23 GHz Front-End
A53209B004	BOM, 23 GHz Card Cage
A53209B005	BOM, 23 GHz Front-End RF Card
A53209B006	BOM, 23 GHz Bottom Plate Assembly
A53209B007	BOM, 23 GHz Top Plate Assembly
A53209B008	BOM, 23 GHz Cold Strap Assembly
A53209B009	BOM, 23 GHz Amplifier Plate Assembly
A53209B010	BOM, 23 GHz Window Plate Assembly
A53209B011	BOM, 23 GHz Shield Assembly
A53209D002	Connector Orientation
A53209N001	SPEC, Circular Polarizer/Coupler Assembly
A53209W001	23 GHz Card 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			
PROJ: COMMON F.E.	TITLE: ASS'Y TEMP SENSOR		
MATERIAL: ~		DRAWN BY: H DILL	DATE: 890530
FINISH: ~		DESIGNED BY:	DATE:
		APPROVED BY:	DATE:
SHEET NUMBER: 1:1	DRAWING NUMBER: A53200A001	REV.	SCALE: 2X

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
3 PLACE DEC. (xxx) ±
2 PLACE DEC. (xx) ±
1 PLACE DEC. (x) ±

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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	A53206M028	SE FITTING REWORK	1
5	NRAO	A53206M029	ME FITTING REWORK	1
6	NRAO	A53206M050	VAC CONN. RW	1
7	NRAO	C53206A007	ASSY INSPECTION COVER	1
8				
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

A53209B001 - 23 GHZ FRONT-END
BILL OF MATERIALS

May 28, 1992

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	MITEQ	AMF-3B215245-50	21.5 - 24.5 GHZ AMPLIFIER	2
11	NRAO	A53209B001	BOM 23 GHZ FRONT-END	1
12	NRAO	A53206B007	BOM INSPECTION COVER	1
13	NRAO	A53206M060	DC FEEDTHRU COVER	1
14	NRAO	A53209B004	BOM CARD CAGE	1
15	NRAO	A53209B006	BOM BOTTOM PLATE ASSY	1
16	NRAO	A53209B007	BOM TOP PLATE ASSY	1
17	NRAO	A53209B008	BOM COLD STRAP ASSY	1
18	NRAO	A53209B009	BOM AMPLIFIER PLATE ASSY	1
19	NRAO	A53209B010	BOM WINDOW ASSY	1
20	NRAO	A53209B011	BOM SHIELD ASSY	1
21	NRAO	C53200M047	FRONT-END WAVEGUIDE 15 & 23 GHZ	1
22	NRAO	D53206M015-2	DEWAR CYLINDER	1
23	NRAO	D53209A004	ASSY CARD CAGE	1
24	NRAO	D53209I001	F.E & CARD CAGE FREQ/SN LABELS	1
25	OMNI-SPECTRA	2001-7941-00	SMA .141 PLUG MODEL 201-1	10
26	PANDUIT	PLT.7M-C	3.1" CABLE TIE	1
27	PANDUIT	PLT2M-C	8" CABLE TIE	2
28	PARKER	-031	O-RING (KF-50 FLANGE JUNCTION)	1
29	PARKER	2-130	O-RING (DC FEEDTHRU)	1
30	PARKER	2-230	O-RING (REF/WINDOW)	1
31	PARKER	2-251	O-RING (INSPECTION COVER)	1
32	PARKER	2-270	O-RING (CYLINDER)	2
33	SOUTHCO	74-13-106-24	6-32 NC SS INSERT	1
34	UNIFORM TUBES	UT-141A	.141 CABLE	A/R
35	WILLIAMS	10-741-90768	3/8 FLAT WASHER	4

A53209B004 - CARD CAGE 23 GHZ
BILL OF MATERIALS

May 28, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
0	NRAO	D53209A004	ASSY CARD CAGE	1
1	NRAO	A53209B004	BOM CARD CAGE	1
2	NRAO	C53209M047	FRONT PANEL	1
3	NRAO	B53206M063-2	SIDE PLATE	1
4	NRAO	C53206M067	BACK PANEL	1
5	NRAO	A53206M061-2	SIDE RAIL	1
6	NRAO	C53206M065-2	COVER (SIDE)	1
7	NRAO	D53206M069-2	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	B53206M062-2	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	C53206M066-2	COVER	1
27				
28	ALL-METAL		10-32 x 3/8 SS SHCS	1
29	KEYSTONE	7311	#4 GROUND LUG	5
30	NRAO	B53206M064-2	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

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	B53209I002	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

A53209B005 - 23 GHZ FE RF CARD
BILL OF MATERIALS

June 5, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	NRAO	C53209Q006	CIRCUIT BOARD	1
2	NRAO	C53209P003	DRILL DRAWING	1
3	NRAO	B53209K002	BLOCK DIAGRAM	1
4	NRAO	C53209A005	ASSEMBLY DRAWING	1
5	NRAO	A53209M048	NOISE SOURCE BRACKET	1
6	NRAO	A53209M049	NOISE SOURCE STRAP	2
7	NRAO	B53209M052	MIXER MOUNTING BRACKET	1
8	ALL-METAL		2-56 x 1 SS SHCS	2
9	ALL-METAL		2-56 x 1/4 SS SHCS	4
10	ALL-METAL		2-56 HEX NUT	2
11	ALL-METAL		4-40 x 1/4 SS SHCS	13
12	ALL-METAL		4-40 x 1-1/2 SS SHCS	1
13	ALL-METAL		#4 FLAT WASHER	9
14	ALLEN BRADLEY	RC07GF123J	12K 1/4 WATT 5% RESISTOR	1
15	ALLEN BRADLEY	RC07GF10GJ	1 OHM 1/4 WATT 5% RESISTOR	1
16	SPRAGUE	TE-1205	CAPACITOR, 15 uF 25V TANT.	1
17	NATIONAL SEM.	LM335Z	TEMPERATURE SENSOR	1
18	KEYSTONE	6056	HORIZONTAL TEST JACK, BLACK	1
19	KEYSTONE	6067	HORIZONTAL TEST JACK, RED	1
20	KEYSTONE	6057	HORIZONTAL TEST JACK, YELLOW	1
21	MITEQ	AMF-4B-118152	LO AMPLIFIER	1
22	MITEQ	AMF-2S-093102-20	IF AMPLIFIER	2
23	K & L	6FV-9750/X900-0-0P	IF FILTER	2
24	K & L	X3FV10-13250/X2500-0	LO FILTER	2
25	NARDA	4316-2	POWER DIVIDER	1
26	NARDA	4317-2	POWER DIVIDER	1
27	NOISE COM	NC4073	NOISE SOURCE	1
28	SPACEK	MM23-9.7W	MIXER	2
29	OMNI-SPECTRA	2001-7941-00	.141 STRAIGHT CABLE PLUG	20
30	OMNI-SPECTRA	2002-5015-00	.141 STRAIGHT CABLE JACK	2
31	OMNI-SPECTRA	2081-0000-00	SMA MALE TO MALE ADAPTER	2
32	PRECISION TUB	AA50141	.141 SEMI-RIGID CABLE	A/R
33	ALPHA WIRE	7055 RED	#22 AWG STRANDED WIRE	A/R
34	BELDEN	8216	RG-174U COAXIAL CABLE	A/R
35	AMPHENOL	31-315	BNC MALE FOR RG-174U	1
36	H.H. SMITH	9233	THREADED SPACER	1
37	NARDA	IBS 1826-3	ISOLATOR, MALE IN/MALE OUT	1
38	DITOM	D3I-8016-1	ISOLATOR, MALE IN/FEMALE OUT	2
39	KDI	A2606M	ATTENUATOR, 6 DB	1
40	NARDA	4779-3	ATTENUATOR, 3 DB	1
41	NARDA	4778-10	ATTENUATOR, 10 DB	0*
42	WILTRON	35WR42KF	WAVEGUIDE TO K-FEMALE ADAPTER	2

* QTY. 2 REQ. IF 3-STAGE AMP. (MITEQ AMF-3S-093102-20) IS INSTALLED AS ITEM 22.

A53209B006 - 23 GHZ BOTTOM PLATE ASSY
BILL OF MATERIALS

May 28, 1992

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

A53209B007 - 23 GHZ TOP PLATE ASSY
BILL OF MATERIALS

May 28, 1992

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	A53209N003 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	NARDA	1826-5	FEM/MALE RT ANGLE ISOLATOR	2
15	NRAO	A53206M001	INNER SUPPORT	1
16	NRAO	A53206M002	OUTER SUPPORT	1
17	NRAO	A53206M003	SUPPORT RING	1
18	NRAO	A53206M006	TOP SHIELD	1
19	NRAO	A53206M053	STRAP TOP SHIELD	1
20	NRAO	A53208M003-3	WAVEGUIDE CHOKE INNER RING	1
21	NRAO	A53209B007	BOM 23 GHZ TOP PLATE ASSY	1
22	NRAO	B53200M041-3	STOP TUBE	4
23	NRAO	B53206M048-3	THREADED ROD	4
24	NRAO	B53208M001-3	WAVEGUIDE CHOKE OUTER RING	1
25	NRAO	D53200M007-4	TOP PLATE 23 GHZ	1
26	PIC DESIGN	B12-2	3/8 SPACER WASHER - .006"	12
27	PIC DESIGN	B12-6	3/8 SPACER WASHER - .014"	8
28	THOMAS & BETTS	54104	CU RED LUG 8 STR	4

A53209B008 - 23 GHZ COLD STRAP ASSY
BILL OF MATERIALS

May 28, 1992

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	ALPHA	FIT-221-1/4 BLK	HEAT SHRINK TUBING 1/4 ID BLACK	A/R
6	ALPHA	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	A/R
7	ARMSTRONG	A-12	EPOXY	A/R
8	HOTWATT	SC252.25	HEATER 75W 240V	1
9	LINDE	AC-4051	CHARCOAL (6 x 8 PELLETS)	A/R
10	MICROTECH	GM-2	MALE 2 PIN STRIP CONTACT	1
11	NRAO	A53206M056	HEATER CLAMP	1
12	NRAO	A53209B008	BOM COLD STRAP ASSY	1
13	NRAO	B53209M044	2ND STAGE STATION STRAP	1
14	OMNI-SPECTRA	2001-5032-00	SMA PLUG .085 DIA CABLE MOD. 201-2A	4

A53209B009 - 23 GHZ AMPLIFIER PLATE ASSY
BILL OF MATERIALS

May 28, 1992

NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		#4 FLAT WASHER	4
2	ALL-METAL		#4 LOCK WASHER	4
3	ALL-METAL		2-56 x 1/4 SS SHCS	8
4	ALL-METAL		4-40 x 1/4 SS SHCS	4
5	ALL-METAL		4-40 x 3/8 SS SHCS	1
6	ALPHA	FIT-221-1/8 CLR	HEAT SHRINK TUBING 1/8 ID CLEAR	A/R
7	MICROTECH	GF-2	2 CONTACT STRIP RECEPT.	2
8	MICROTECH	GM-2	MALE 2 PIN STRIP CONTACT	1
9	MWS WIRE INDUST	B232211110-001	BRASS BIFILAR MAGNET WIRE	A/R
10	NARDA	1826-6	MALE/MALE RT ANGLE ISOLATOR	2
11	NRAO		23 GHZ AMPLIFIER	1
12	NRAO	A53200B001	BOM TEMPERATURE SENSOR	1
13	NRAO	A53209B009	BOM AMPLIFIER PLATE ASSY	1
14	NRAO	C53209M041	AMPLIFIER MOUNTING SUPPORT ASSEMBLY	1
15	TRM	DMS 265-1	18 - 26.5 GHZ POWER DIVIDER	1
16	UNIFORM TUBES	UT-85A	.085 SEMI-RIGID CABLE	A/R

A53209B010 - 23 GHZ WINDOW PLATE ASSY
BILL OF MATERIALS

May 28, 1992

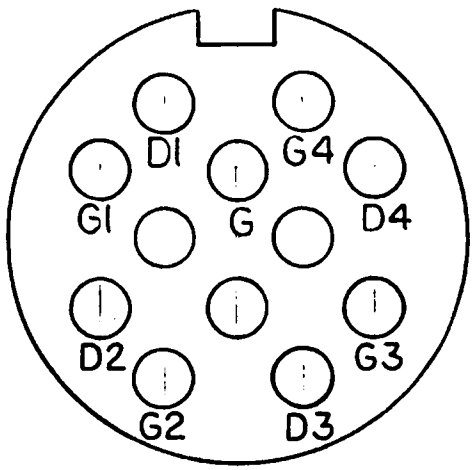
NO.	MANUFACTURER	PART NUMBER	DESCRIPTION	QUANT.
1	ALL-METAL		3/32 x 1/4 DOWEL PIN	2
2	ECCOBOND	45	EPOXY	A/R
3	NRAO	A53200M020-5	IRIS	1
4	NRAO	A53206M0054-4	WINDOW	1
5	NRAO	A53209B010	BOM 23 GHZ WINDOW PLATE ASSY	1
6	NRAO	B53206M013-5	WINDOW PLATE	1

A53209B011 - 23 GHZ SHIELD ASSY
BILL OF MATERIALS

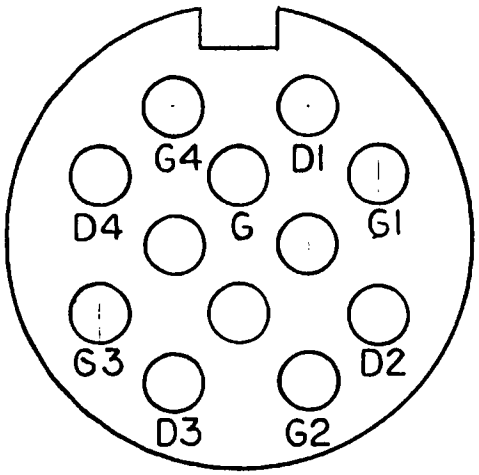
May 28, 1992

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	A53206M009-2	SHIELD SUPPORT	2
9	NRAO	A53206M010	70 DEG K SHIELD CONNECTION	1
10	NRAO	A53206M011-2	SIDE SHIELD	1
11	NRAO	A53206M052	STRAP SIDE SHIELD	1
12	NRAO	A53209B011	BOM SHIELD ASSY	1

* REAR OF CHASSIS MT. (FP-12S-6)
FRONT OF CABLE (FP-12S-1)



FRONT OF CHASSIS MT (FP-12S-6)
* REAR OF CABLE (FP-12S-1)



*NOTE: REAR IS SOLDER SOCKET SIDE.

(MICROTECH)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ANGLES ± 3 PLACE DEC. (xxx) ± 2 PLACE DEC. (xx) ± 1 PLACE DEC. (x) ±	NATIONAL RADIO ASTRONOMY OBSERVATORY VLBA		
	PROJ: 23 GHz F.E	TITLE: CONNECTOR ORIENTATION	
	MATERIAL:	DRAWN BY: GM	DATE: 4-86
	FINISH:	DESIGNED BY:	DATE:
		APPROVED BY:	DATE:
	SHEET NUMBER:	DRAWING NUMBER: A53209D002 REV.	SCALE: 8:1

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H. T. HALL

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

SPECIFICATION: A53209N001, Rev. E

TITLE: Circular Polarizer/Coupler Assembly

DATE: February 9, 1989

PREPARED BY: _____ APPROVED BY: _____

1. General Description

A microwave component having a circular waveguide input and two SMA female coaxial outputs is desired. Two further SMA female coaxial ports provide -25 dB of directional coupling to each of the two SMA output ports. 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, loss, return loss, and isolation.

The full frequency range for the device is 21.7 GHz to 24.1 GHz while the prime frequency range is 22.2 to 23.0 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 gold plated (75 $\pm$ 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. Ellipticity

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 $\leq$ 0.7 dB; in the prime frequency range, $\leq$ 0.40 dB.

5. Isolation

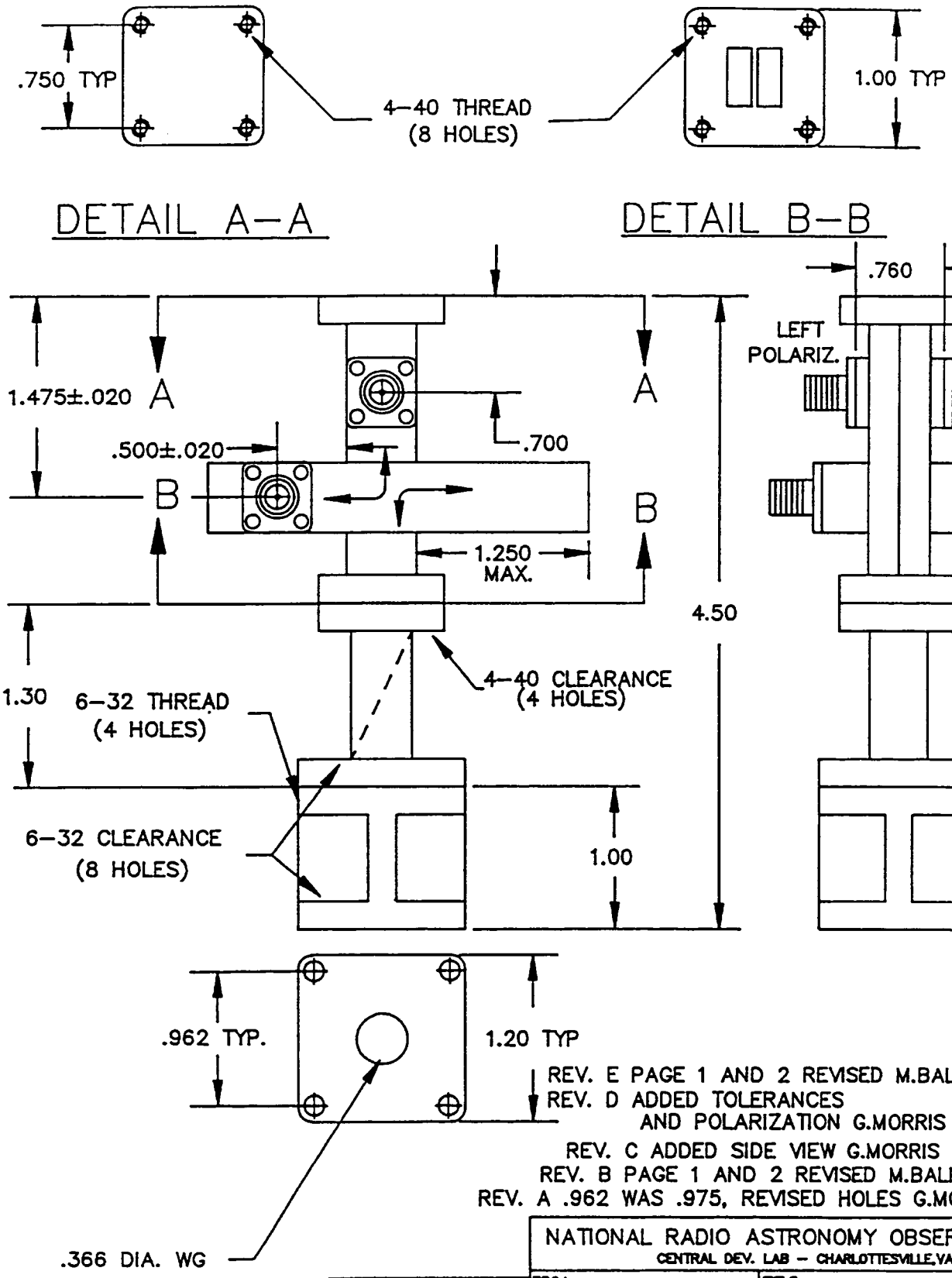
With the circular-waveguide terminated, the coupling between SMA outputs shall be $\leq$ -25 dB in the full frequency range and $\leq$ -27 dB in the prime frequency range.

6. Return Loss

With the circular-waveguide terminated, the return loss at each SMA output shall be less than 15 dB in the full frequency range and 17 dB in the prime frequency range.

7. Coupling

The coupling from each coupled SMA input to the main SMA output (see Figure 1) shall deviate by $\leq \pm 1$ dB from a mean value of 25 $\pm$ 0.5 dB over the full frequency range. The coupler directivity shall be greater than 15 dB in the full frequency range. A short waveguide termination shall be built into each coupler arm.



REV. E PAGE 1 AND 2 REVISED M.BALISTER 2-89
REV. D ADDED TOLERANCES
AND POLARIZATION G.MORRIS 11-4-87
REV. C ADDED SIDE VIEW G.MORRIS 10-20-87
REV. B PAGE 1 AND 2 REVISED M.BALISTER 10-87
REV. A .962 WAS .975, REVISED HOLES G.MORRIS 6-87

NATIONAL RADIO ASTRONOMY OBSERVATORY
CENTRAL DEV. LAB - CHARLOTTESVILLE,VA.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ANGLES± 3 PLACE DEC: ±.005 2 PLACE DEC: ±.020 1 PLACE DEC.±	PROJ: VLBA	TITLE: CIRCULAR POLARIZER	
	MATERIAL:	DRAWN BY: GM	DATE:
		DESIGNED BY: SW	DATE:
	FINISH:	APPROVED BY:	DATE:
	SHEET NUMBER	DRAWING NUMBER A53209N001 REV: E	SCALE: 1:1

VLBA 23 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 A53209B004

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.

June 1, 1992
By: W. K. Crady

Dwg. No.: A53209W001
Sheet: 1 of 14

CARD SLOT WIRING LIST

SYSTEM: VLBA 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 1
CARD: RF Card

DWG. NO.: A53209W001
DATE: June 1, 1992
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	3002K 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 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 2
CARD: Spare

DWG. NO.: A53209W001
DATE: June 1, 1992
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 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 3
CARD: MONITOR CARD

DWG. NO.: A53209W001
DATE: June 1, 1992
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 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 4
CARD: RCP FET BIAS

DWG. NO.: A53209W001
DATE: June 1, 1992
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 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 5
CARD: LCP FET BIAS

DWG. NO.: A53209W001
DATE: June 1, 1992
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	J3-19	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 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 6
CARD: SENSOR CARD

DWG. NO.: A53209W001
DATE: June 1, 1992
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 S7-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 23 GHZ FRONT-END
ASSY: CARD CAGE
SLOT: 7
CARD: CONTROL CARD

DWG. NO.: A53209W001
DATE: June 1, 1992
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:

*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.

KEY BETWEEN 6 & 7.

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 23 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNCT: FRONT-END MONITOR

DWG. NO.: A53209W001
DATE: June 1, 1992
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 D53209A004).

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 23 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNCT: DEWAR/POWER MONITOR

DWG. NO.: A53209W001
DATE: June 1, 1992
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 D53209A004).

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 23 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: FEMALE (SOCKET)
FUNCT: AUXILIARY MONITOR

DWG. NO.: A53209W001
DATE: June 1, 1992
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							

SPECIAL INSTRUCTIONS:
ORIENT CONNECTOR WITH SOCKETS 6-9 CLOSEST TO WIRING EDGE OF FRONT PANEL (SEE D53209A004).

25 PIN D-CONNECTOR WIRING LIST

SYSTEM: VLBA 23 GHZ FRONT-END
ASSY: CARD CAGE
TYPE: BULKHEAD
SEX: MALE PINS
FUNCT: DC POWER AND CONTROL

DWG. NO.: A53209W001
DATE: June 1, 1992
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.

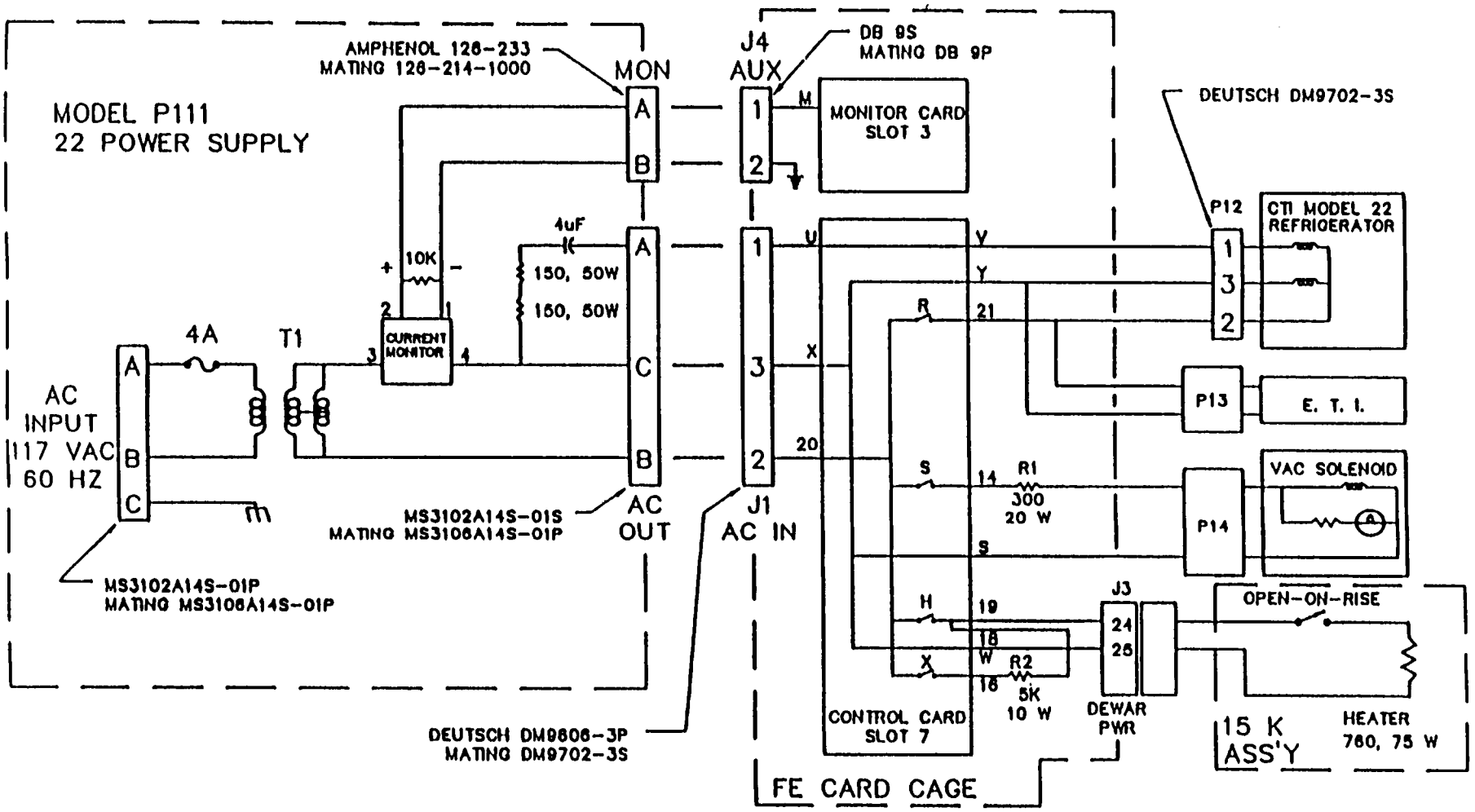
*2 - THE UNIT SERIAL NUMBER CODE WILL BE WIRED BY GROUNDING APPROPRIATED BITS, SN0-SN5, TO GL5 TO READ THE PROPER SERIAL NUMBER.

*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.

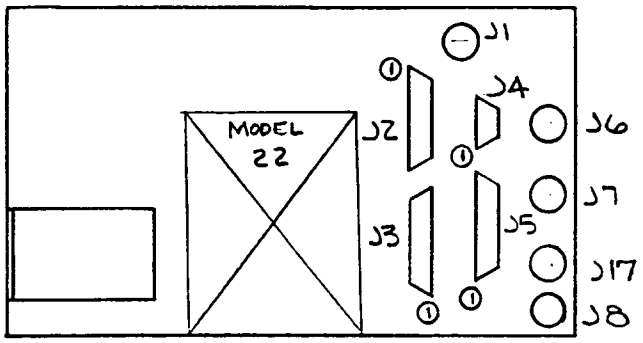
ORIENT CONNECTOR WITH PINS 14-25 CLOSEST TO WIRING EDGE OF FRONT PANEL (SEE D53209A004).



A53209W001

SHEET 13

REV.	DATE	DRAWN BY	APPRV'D BY	DESCRIPTION

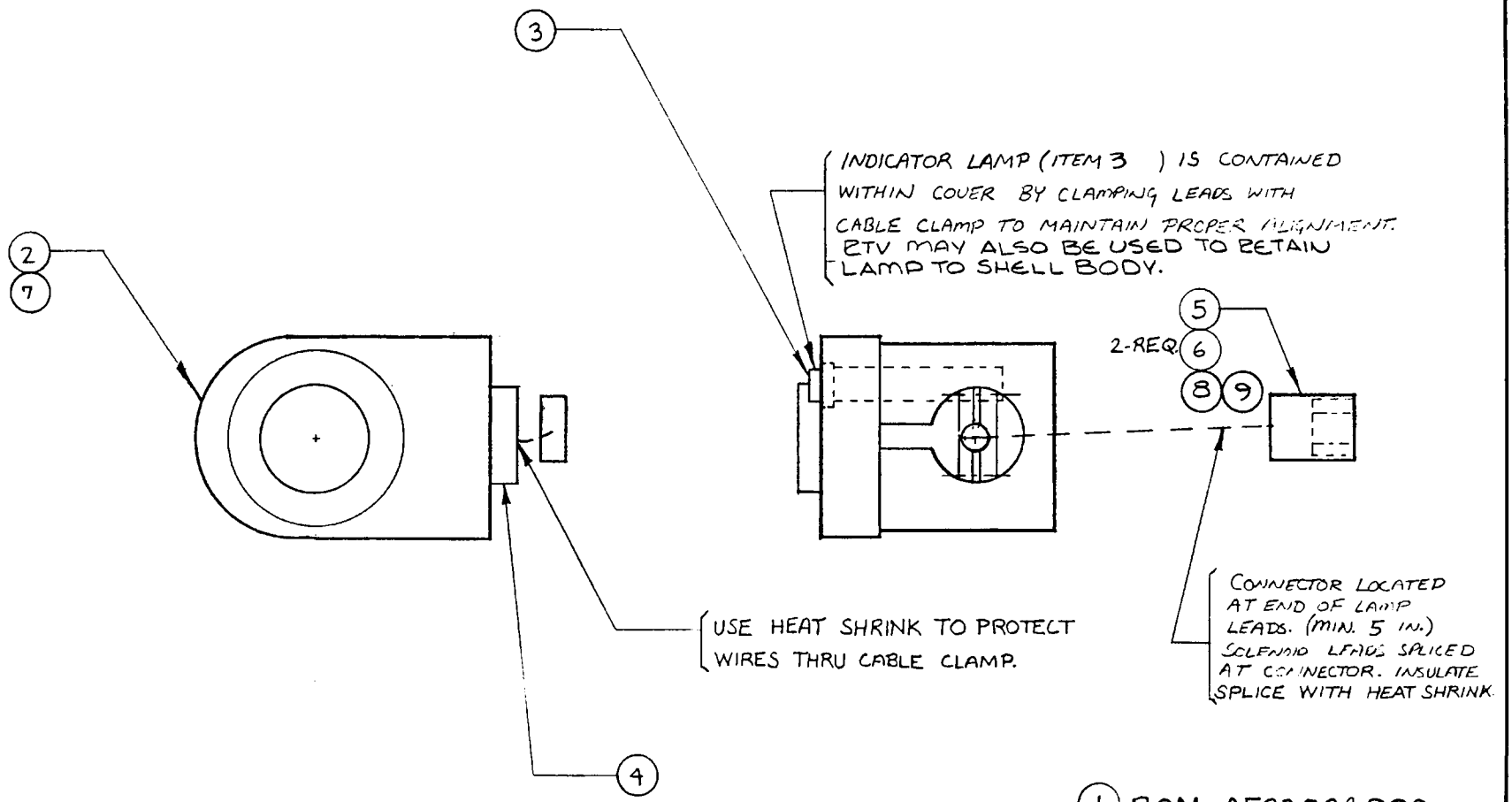


FRONT OF CARD CAGE

#	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 35	P12
J13	ELASPED TIME INDICATOR	MOLEX	P13
J14	SOLENOID	MOLEX	P14
J15	V PUMP	OCTAL	P15
J16	V DEWAR	OCTAL	P16
J17	LO	SMA	P17

MASTER

NATIONAL RADIO ASTRONOMY OBSERVATORY	PROJECT: FRONT ENDS	TITLE: DEWAR INPUTS	
	SHEET NUMBER 14	DRAWING NUMBER A53209 W001	REV. A



(1) BOM A53206B008

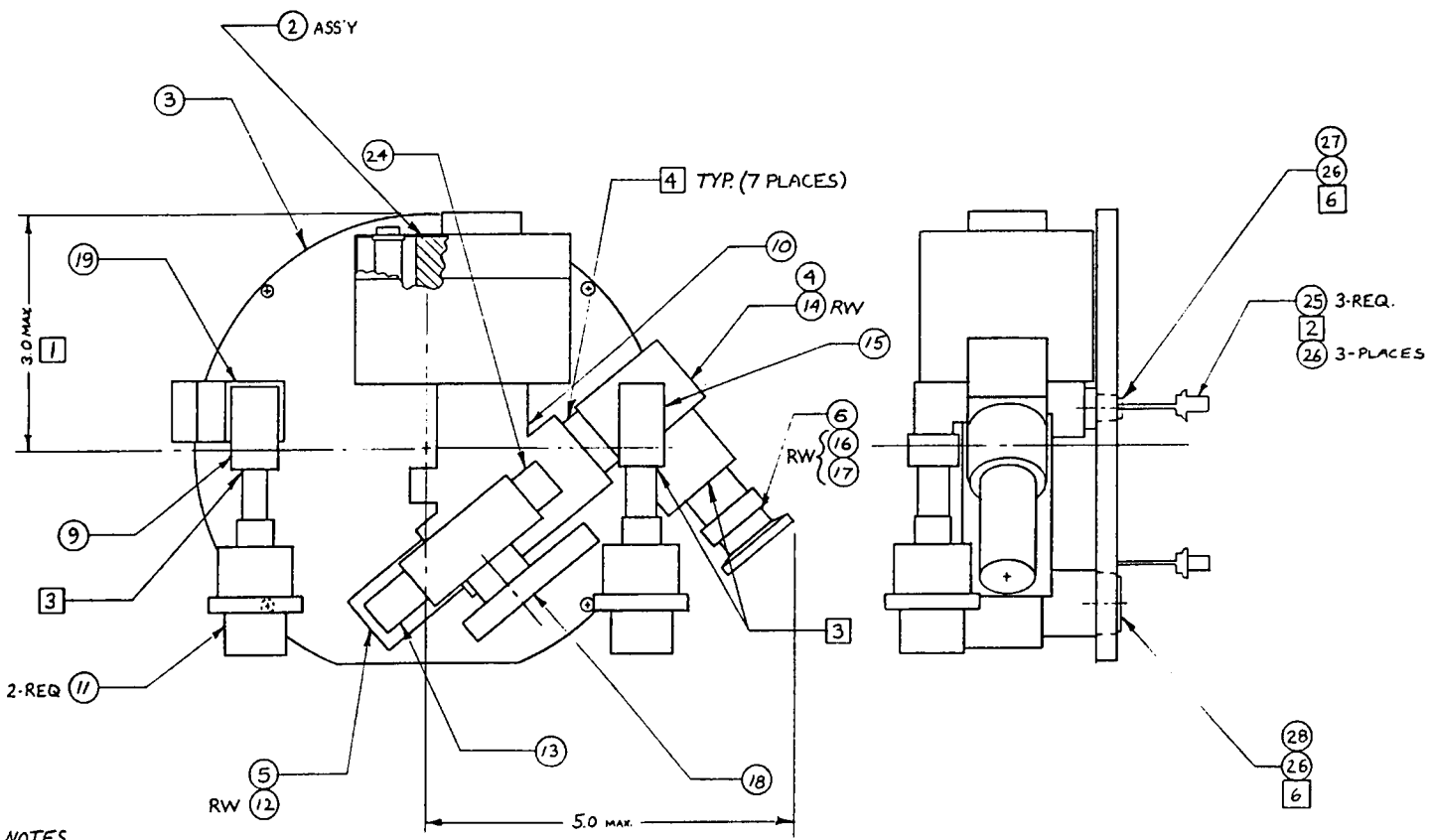
USED ON D53206A001
NEXT ASS'Y C53206A007

NATIONAL RADIO ASTRONOMY OBSERVATORY VLBA	
PROJ: 8.4 GHZ F.E.	TITLE: ASS'Y SOLENOID
MATERIAL:	DRAWN BY: H. DILL DATE: 8/06/90
FINISH:	DESIGNED BY: DATE:
	APPROVED BY: DATE:
SHEET NUMBER: 1:1	DRAWING NUMBER: B53206A008 REV. SCALE: FULL SIZE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
3 PLACE DEC. (xxx) ± .005
2 PLACE DEC. (xx) ± .02
1 PLACE DEC. (x) ±

H. T. HALL

06



NOTES

1. VALVE ASS'Y CAN BE ROTATED CW TO CLEAR 3.0 EDGE LINE.
2. TAILS OF SPACERS TO BE CUT .1 FROM BASE. SPACER EPOXIED IN PLACE.
3. TEFLON TAPE TO SEAL PIPE JOINT.
4. EPOXY (ITEM 26) USED TO SEAL JOINT.
5. STEM AND HANDLE OF ITEM 18 NEED TO BE DISASSEMBLED, ROTATED 90° AND REASSEMBLED.
6. EPOXY DISK OVER OPENING BY LAYING A BEAD OF EPOXY AROUND THE PERIMETER OF THE DISK.

BOM A53206B007

REV.	DATE	DRAWN BY	APPR'D BY	DESCRIPTION

D53206A001	
NEXT ASSY	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ±
3 PLACE DECIMALS (.XXX): ±
2 PLACE DECIMALS (.XX): ±
1 PLACE DECIMALS (.X): ±

MATERIAL:

FINISH:

PROJECT: VLBA 8.4 GHZ F.E.

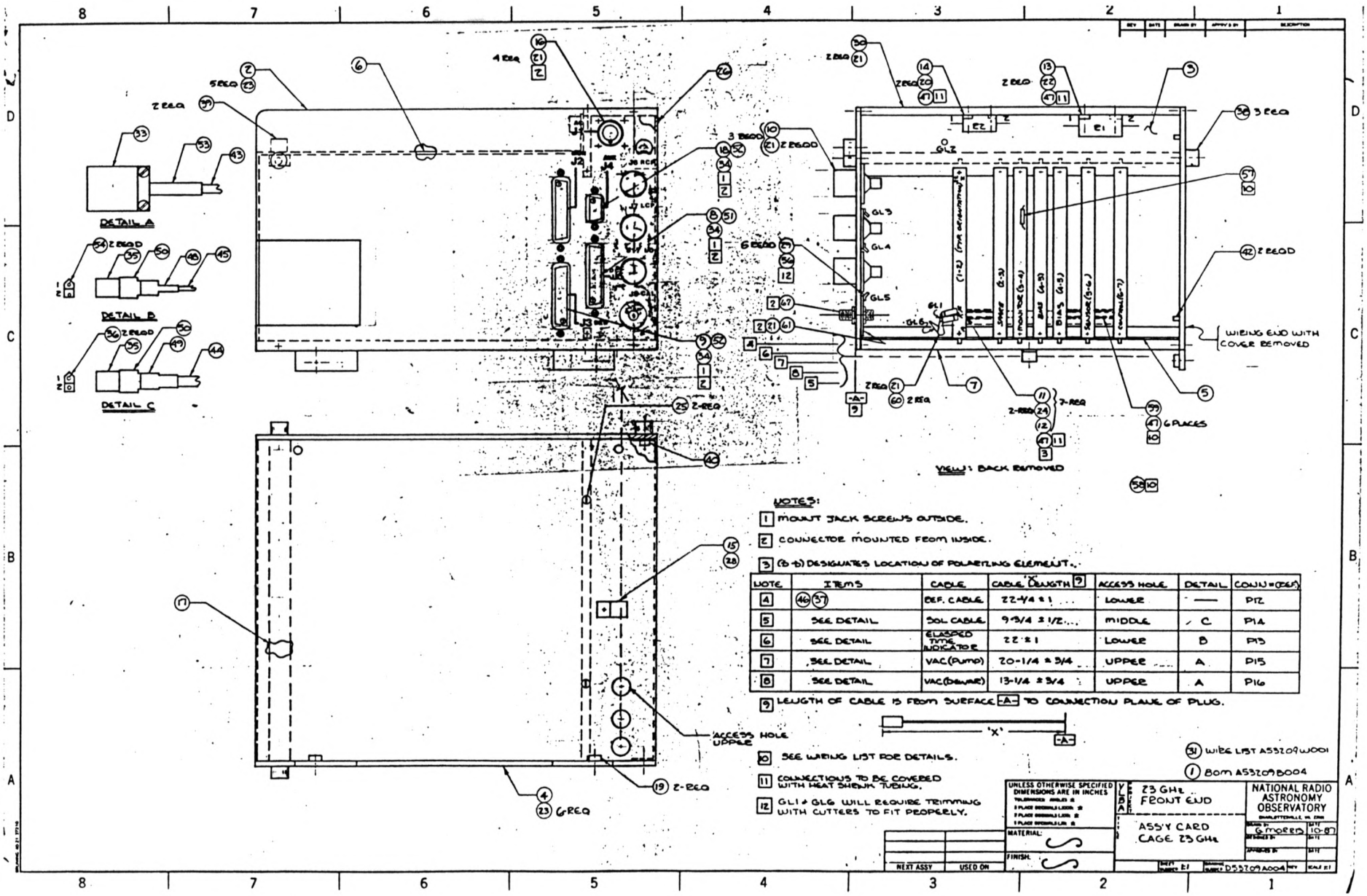
TITLE: A'SSY INSPECTION COVER

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22901

DRAWN BY H DILL	DATE 5-17-94	
DESIGNED BY	DATE	
APPROVED BY	DATE	

SHEET NUMBER 1:1 | DRAWING NUMBER C53206A007 | REV. | SCALE ~

BRUNING 40-32 24964-1



NOTE	ITEMS	CABLE	CABLE LENGTH [9]	ACCESS HOLE	DETAIL	CONN=(REF)
4	46 37	REF. CABLE	22-1/4 ± 1	LOWER	—	P12
5	SEE DETAIL	SOL CABLE	9-3/4 ± 1/2	MIDDLE	C	P14
6	SEE DETAIL	FLASHED TYPE INDICATOR	22 ± 1	LOWER	B	P13
7	SEE DETAIL	VAC(PUMP)	20-1/4 ± 3/4	UPPER	A	P15
8	SEE DETAIL	VAC(DEWAR)	13-1/4 ± 3/4	UPPER	A	P16

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

FLORHAM PARK, NEW JERSEY 07932

ASCO

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.

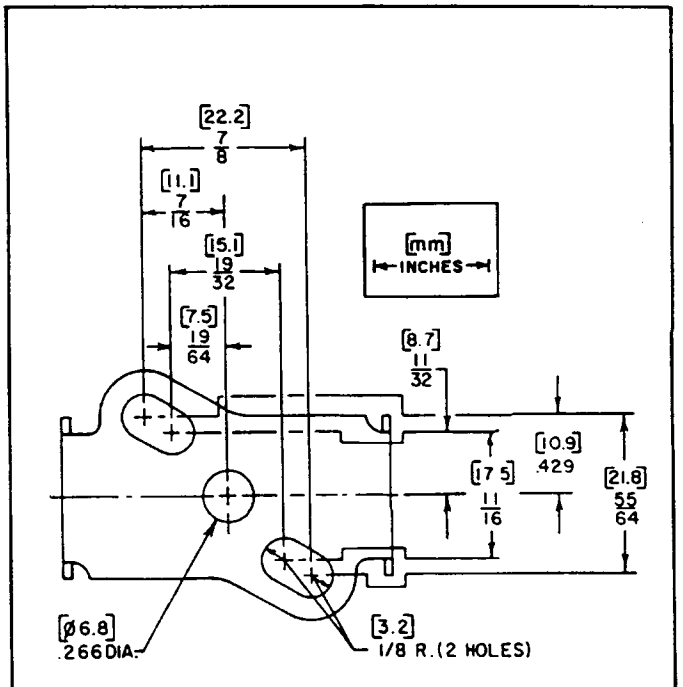
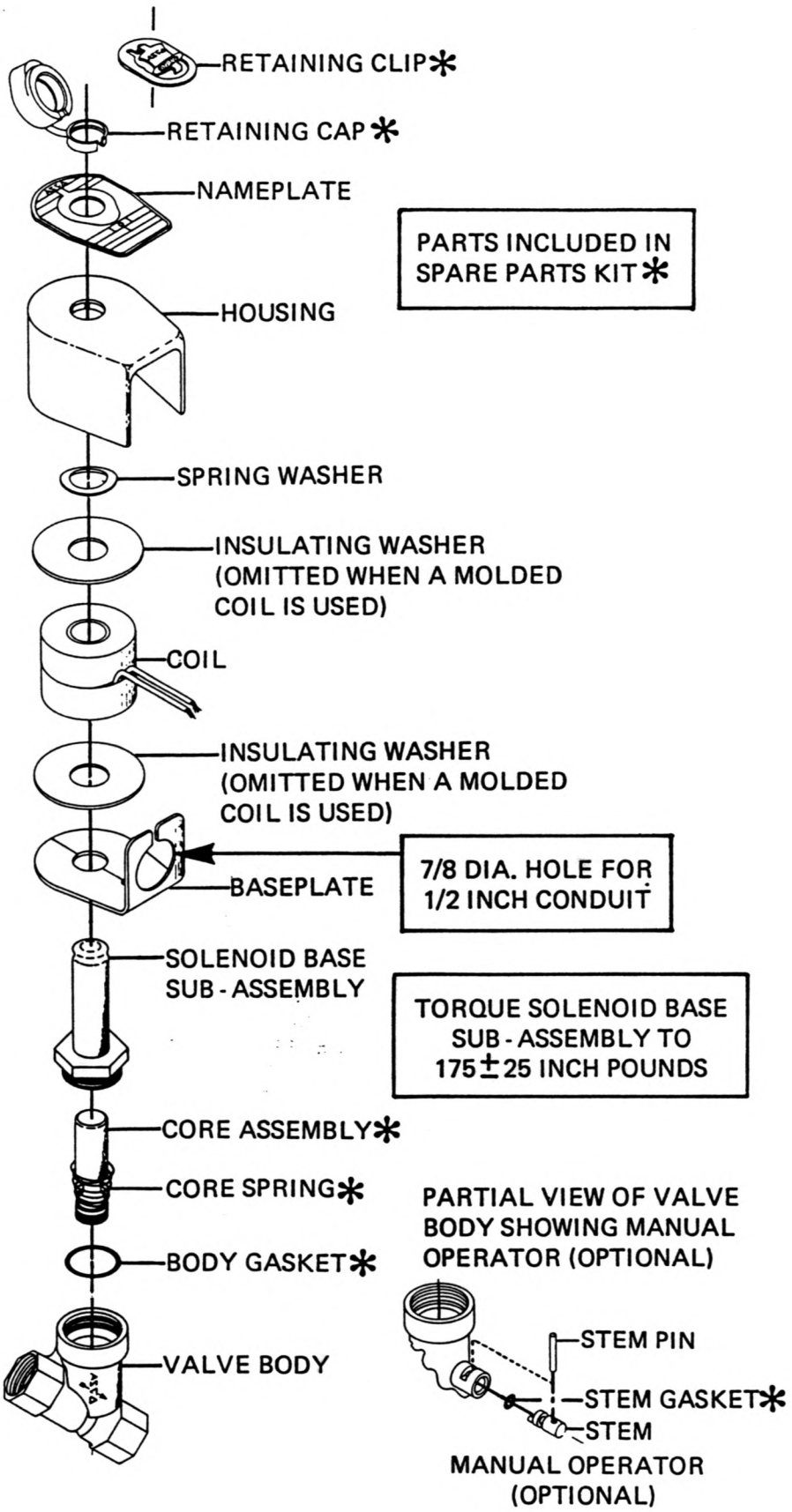


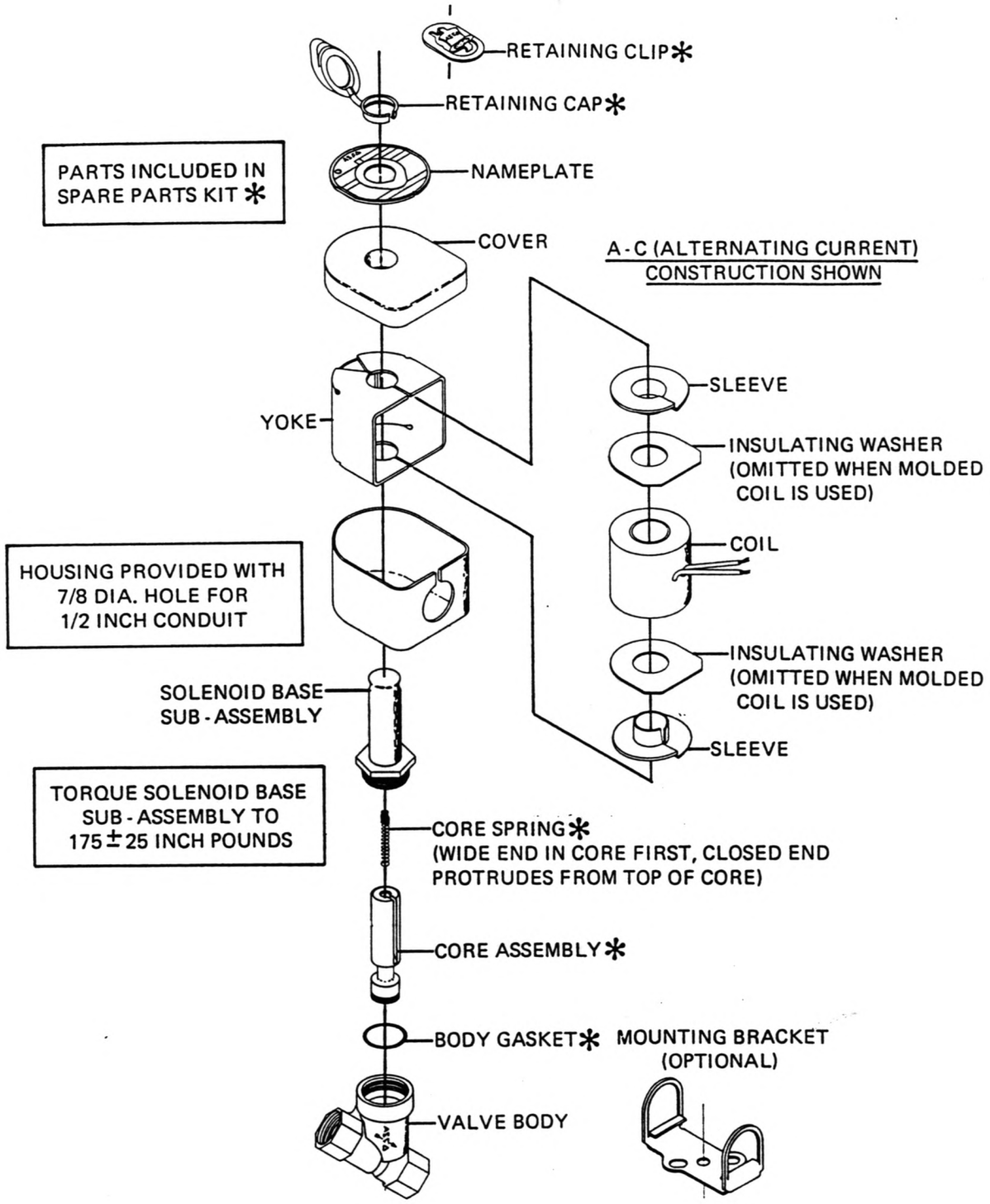
Figure 1. **Dimensions for Mounting Bracket (Optional Feature)**

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.



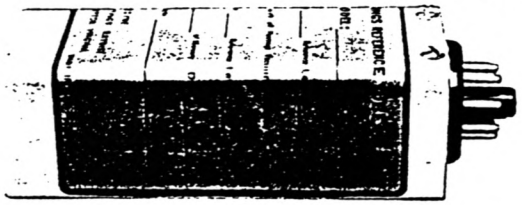
Bulletin 8030 - 1/2 NPT
General Purpose Solenoid Enclosure Shown.
For Explosion-proof/Watertight Solenoid Enclosure used on Bulletin 8031, See Form No. V-5381.

Figure 3.

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^{-4} 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.

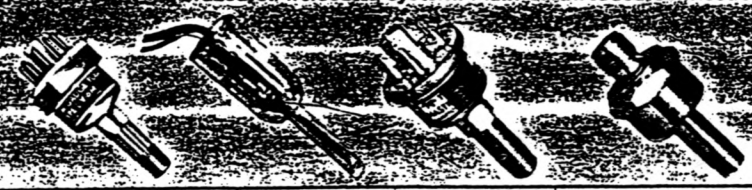
Hastings gauge tubes can withstand great g-shock and vibration, using short firmly connected thermocouples with no suspended weld to an external heater. They are corrosion resistant and non-contaminating using noble metal thermopiles which assures stable calibration held indefinitely. Gauge tubes are 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 base, 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^{-3} 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^{-4} to 10^{-2} torr. Replacement cathode-anode assemblies are available.

MITEQ

Project No.: P21671

File No.: _____

TEST DATA

Model No.: AMF-4B-118152 Serial No.: 126488

Frequency: 11.8 - 15.2 GHz Purchase Order No.: _____

Specifications: _____

Frequency (GHz)	11.8 - 15.2	Output Power (dBm) at 1 dB Compression	+11.0 min
Gain (dB) window	19.0 min, 24.0 max	Voltage	+15 Vdc
Gain Flatness (dB)	±0.5 max	I_T Measured Current (mA)	156
VSWR Input	2:1 max	Noise Figure (dB)	10.0 max
VSWR Output	2:1 max		

Test Data: _____

Frequency (GHz)	Gain (dB)	VSWR In	VSWR Out	Noise Figure (dB)	Output Power (dBm) at 1 dB Compression
11.80	see	1.78:1	1.79:1	5.20	+ 15.5
12.65	Attached	MAX	MAX	5.12	+ 16.1
13.50	GRAPH			4.94	+ 16.3
14.35				4.71	+ 16.4
15.20	↓	↓	↓	5.06	+ 16.2

Tested By C. Metaxas

Date 2/5/88

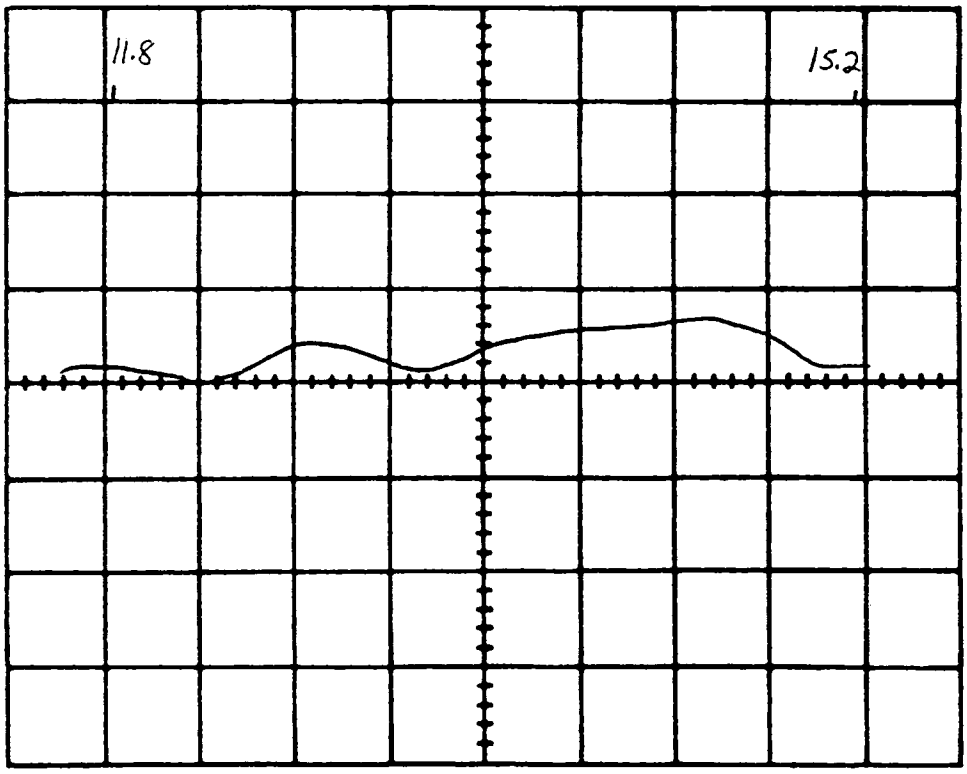
P 21671

MITEQ INC./125 RICEFIELD LANE/HAUPPAUGE, NEW YORK 11787/(516) 543-8873

Amplifier Model AmF-4B-118152

Serial No. 126481

GAIN BANDWIDTH



C. Metafora
2/5/88

MITEQ

Project P22793

Internal Transfer

Customer P/N

Model AMF-3S-093102-20

Serial No. 132327

SPECIFICATIONS

Frequency (GHz)	9.3 - 10.2	Output Power (dBm) at 1 dB Compression	+ 10.0 min
Gain (dB) window	27.0 min, 33.0 max	Voltage	+ 15 vdc
Gain Flatness (dB)	± 0.5 max	IT Measured Current (mA)	88
VSWR Input	1.3:1 max	Noise Figure (dB)	2.0 max
VSWR Output	1.5:1 max		

TEST DATA

Frequency (GHz)	Gain (dB)	VSWR In	VSWR Out	Noise Figure (dB)	Output Power (dBm) at 1 dB Compression
9.30	See	1.18:1	1.20:1	1.81	+ 16.0
9.75	Attached	MAX	MAX	1.83	+ 16.5
10.20	GRAPH	↓	↓	1.88	+ 16.6

Tested By C. Metaxas Date 5/25/88

MITEQ INC. • 100 Davids Drive • Hauppauge, New York 11788-2086 • Tel. (516)436-7400

MITEQ

Project P22793

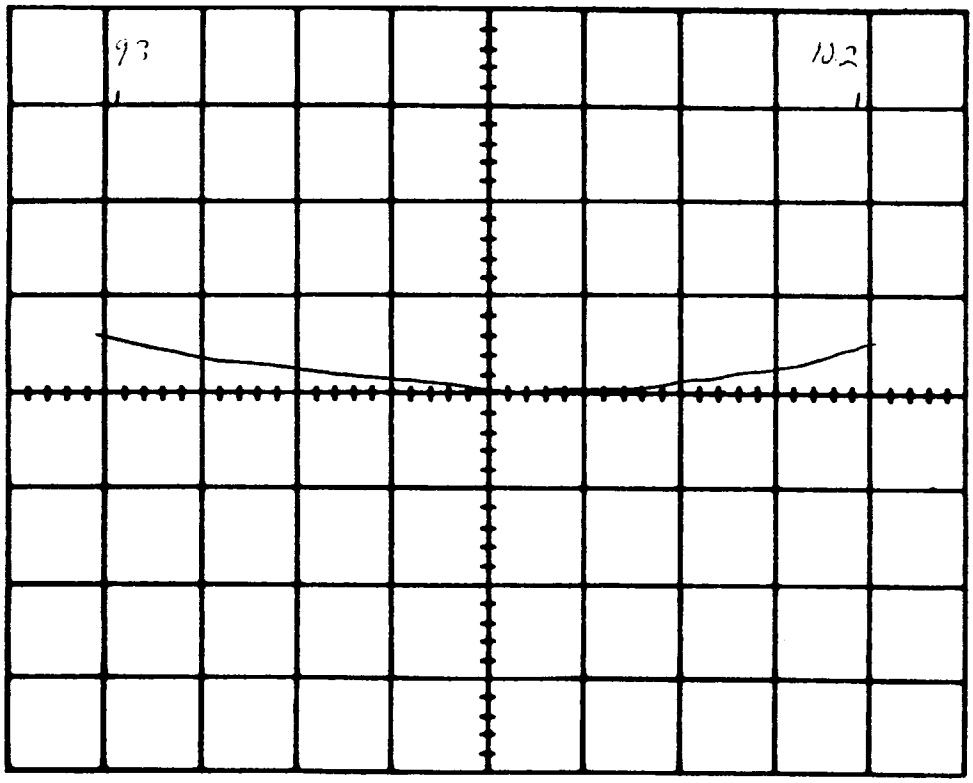
Internal Transfer _____

Customer P/N _____

Model AMF-3S-093102-20

Serial No. 132327

GAIN BANDWIDTH



Tested By C. Metafax Date 5/25/88

Cavity Filters

Combline

To Order

5FV20	–	3000/U75	–	P/P
1 2 3		4 5 6		7 8

1. Number of sections
2. Series (FV – Combline)
3. Package designator – 20 Series
4. Center frequency (MHz)
5. Supplemental codes. (See page 32)
6. Bandwidth (MHz)
7. Input connector
8. Output connector

Features

K&L Microwave's series of combline filters covers the frequency range from 500MHz to 18GHz. These filters are available with 2 to 17 resonant sections, and bandwidths from 3% to 50%. Although standard designs offer VSWR specifications of 1.5:1 maximum, the series lends itself to specifications as low as 1.2:1.

Although the standard product offers excellent characteristics, K&L can enhance parameters such as insertion loss and power handling capacity (both peak and average) through special package design.

The combline filter series provides an extremely small high "Q" device suitable for rugged environmental requirements in a practically unlimited range of applications.

As a result of computer aided design and computerized machining equipment, the package size for this series can be optimized for performance requirements; therefore there are no limitations of fixed package size.

Spurious response suppression can be designed as far out-of-band as 50 times the fundamental passband. The recurring passband begins at $4.5 \times f_C$ for the standard design.

NOTE:

For a detailed explanation of changes to K&L's part numbering system, see page 32

Mechanical

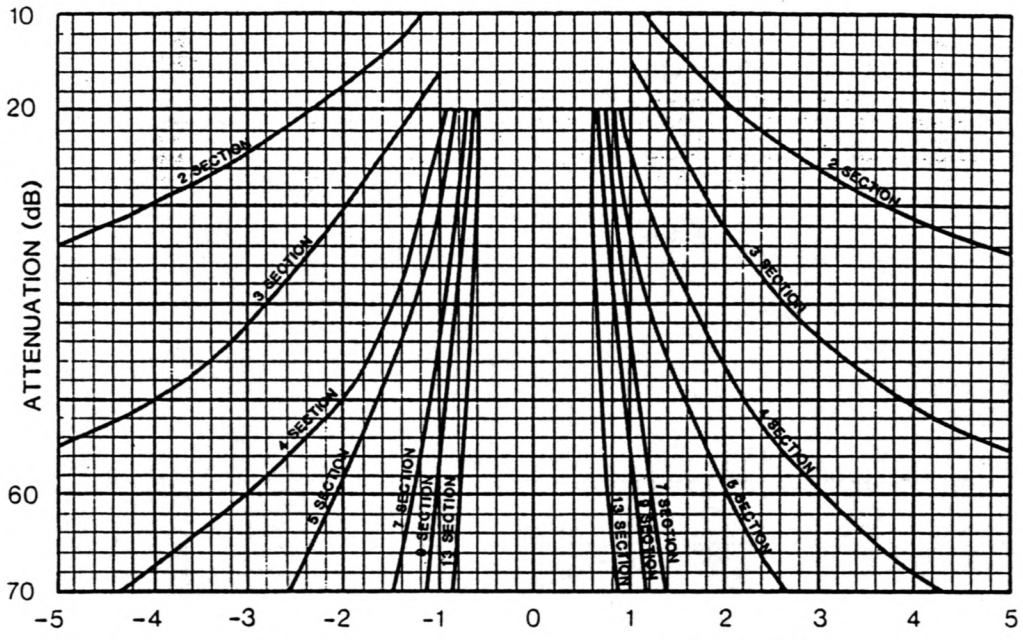
See page 42 for sizes and connectors.

Specifications

Model	Freq. MHz	3dB % BW	VSWR	Avg. Power	Impedance	No. Sect.	Shock	Vibration	Temp.	Rel. Humidity
FV	100 to 18,000	3 to 50	1.5/1	*	50 Ohms	2 to 17	10 G	10 G	-55°C to -85°C	0-95%

* Dependent on size/performance requirements up to 300 Watts (peak can go to 15 KW)

Phone 301-749-2424 • TWX 710-864-9683 • FAX 301-749-5725



Attenuation

The adjacent curve is used to determine the out-of-band or stop-band attenuation for K&L combline filters. This curve shows the attenuation as multiples of the 3dB bandwidth for filters with 2 to 13 sections.

The formula for stopband attenuation:

$$\text{3dB BW from } f_C = \frac{\text{Reject. Freq.} - \text{Center Freq.}}{\text{3dB BW}}$$

EXAMPLE:

Center frequency = 6,575MHz
3dB Bandwidth = 750MHz
Number of sections = 7
Find the attenuation at 5,600MHz and 7,550MHz
substituting in the formula

$$\text{3dB BW from } f_C = \frac{5{,}600 - 6{,}575}{750} = -1.3 \text{ BW}$$

and

$$\text{3dB BW from } f_C = \frac{7{,}550 - 6{,}575}{750} = +1.3 \text{ BW}$$

From the 7 section curves . . .
- 1.3 BW and + 1.3 BW yield 63dB.

Passband Insertion Loss

The importance of the combline style of filter is that it offers the systems designer an extremely low loss filter in the medium to wide bandwidth designs.

Typical losses are less than 1dB for most designs with bandwidths of 5% or more.

A rough rule of thumb is 0.1dB per section.

Losses are even less for wider band filters.

K&L MICROWAVE INCORPORATED
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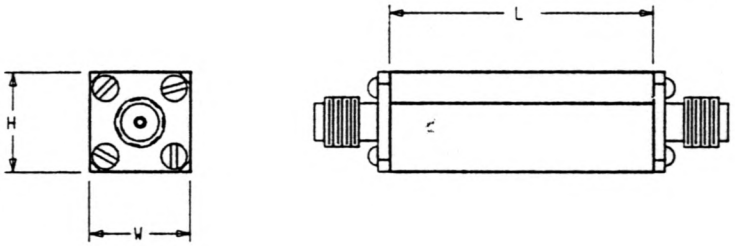
Tapped holes at the bottom of the filter are normally provided for mounting purposes. The location and size of these holes is determined at the time of design.

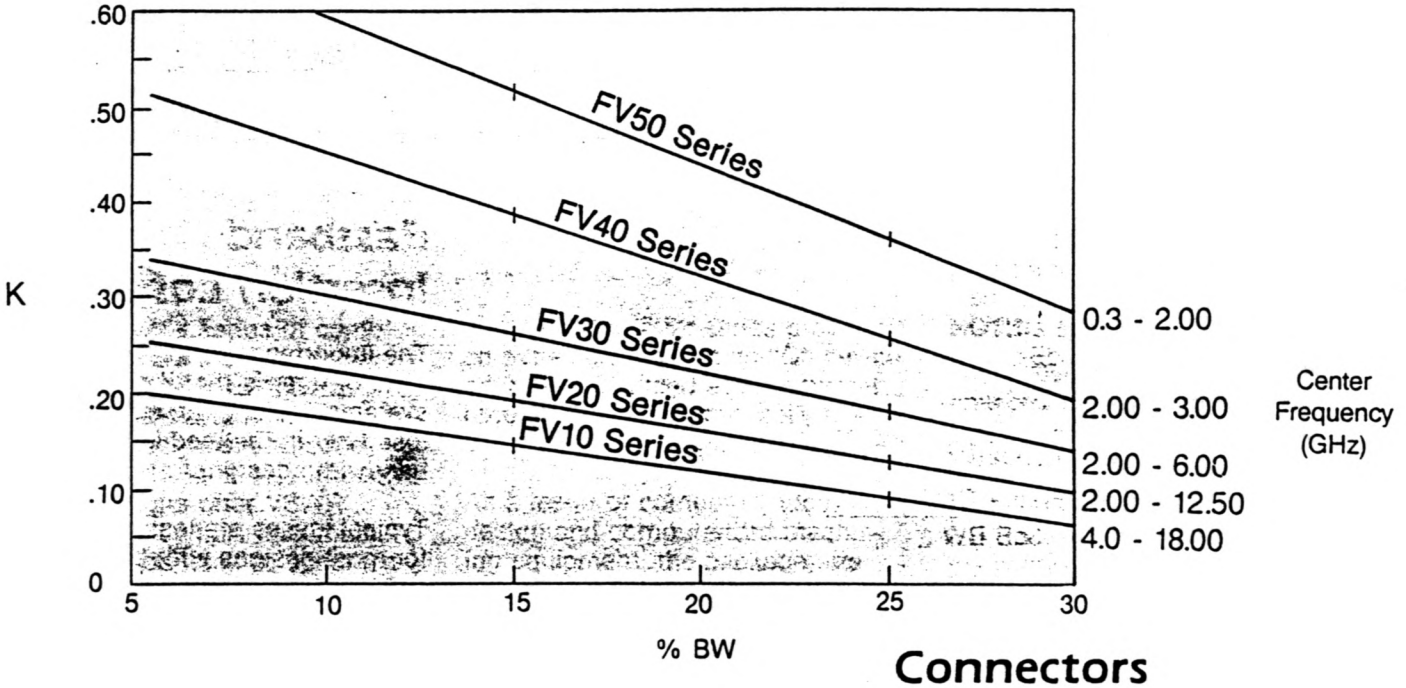


Use this formula to calculate approximate length of a filter

$L = (K)(N) + .4$

N = Number of sections
K = from chart.

W = see table
H = see table



FREQ. GHz	W (MAX)	H
7-18	.50"	.50"
6-7	.75"	.50"
5-6	1.00"	.63"
3-5	1.25"	.63"
2-3	1.50"	.63"
1-2	2.50"	.75"

Example: 7FV20-6000/U600
7 sections
FV20 series:
1 dB BW = 10%
K = .225 (from chart)
.225(7) + .4 = 1.975 length
.75 width
.50 height

Connectors

Connector	Code
SMA Female	O
SMA Male	OP
"N" Female	N*
"N" Male	NP*
TNC Female	T*
TNC Male	TP*
RF Pins	P
Removable SMA	RO
Blind Mate	OB

*Requires .75 min cross Section

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K&L MICROWAVE INCORPORATED

SPECIFICATIONS

FREQUENCY RANGE GHz	MODEL	VSWR Input (Max)	VSWR Output	INSERTION LOSS (Max)	ISOLATION dB (Min)	AMP BAL dB (Max)	PHASE BAL Degrees (Max)	AVERAGE* POWER Watts A	AVERAGE* POWER Watts B	AVERAGE* POWER Watts C	WEIGHT Oz	WEIGHT Gr
2-Way Power Dividers												
0.5-1.0	4311-2	1.25	1.15	0.4	22	0.2	2.0	30	20	3	1.1	30
1-2	4312-2	1.25	1.15	0.35	20	0.2	2.0	30	20	3	0.9	23
2-4	4313-2	1.30	1.20	0.4	20	0.2	2.0	30	20	3	0.8	20
4-8	4314-2	1.35	1.25	0.6	20	0.2	2.0	30	20	3	0.8	20
8-12.4	4315-2	1.35	1.30	0.5	20	0.2	3.0	30	10	1	0.8	20
12-18	4316-2	1.40	1.35	0.7	19	0.3	6.0	30	10	1	0.8	20
18-26.5	4317-2	2.00	2.00	1.0	15	0.5	12.0	30	10	1	0.8	22
4-Way Power Dividers												
0.5-1.0	4311B-4	1.45	1.30	0.9	22	0.3	3.0	30	10	1	2.9	80
1-2	4312B-4	1.40	1.25	0.8	20	0.3	3.0	30	10	3	2.0	56
2-4	4313B-4	1.35	1.35	0.6	20	0.3	3.0	30	10	1	2.0	56
4-8	4314B-4	1.45	1.35	0.5	20	0.3	3.0	30	20	3	2.7	75
8-12.4	4315-4	1.45	1.35	0.8	18	0.4	4.0	30	10	1	2.2	60
12-18	4316-4	1.5	1.4	1.5	18	0.5	6.0	30	10	1	2.2	60

*Average Power Rating into a load VSWR of (A) 1.2 to 1, (B) 2 to 1 and (C) ∞VSWR

NOTE: (1) Connectors; All models provide SMA (Female) connectors except model 4317-2 which uses 3.5mm (Female) type

Customer NRAO

P.O. Number: C 15335

SPACEK LABS, INC.
MM-WAVE TECHNOLOGY
210 EAST COTA STREET
SANTA BARBARA, CALIFORNIA 93101
(805) 564-4404

TEST DATA

FOR

Doubly Balanced Mixer MODEL MM23-9.7 W S/N 9G29

RF Input -15 dBm (GHz)	LO Input @ +7 dBm (GHz)	IF Output Freq (GHz)	IF Output Level (dBm)	Conversion Loss (dB)		
21.5	12.2	9.3	21.5	6.5		
22.0	↓	9.8	21.0	6.0		
22.4	↓	10.2	20.8	5.8		
22.5	13.2	9.3	21.3	6.3		
23.0	↓	9.8	20.9	5.9		
23.4	↓	10.2	21.5	6.5		
23.5	14.2	9.3	20.9	5.9		
24.0	↓	9.8	21.0	6.0		
24.4	↓	10.2	21.4	6.4		
24.5	15.2	9.3	21.1	6.1		
↓	14.7	9.8	21.0	6.0		
↓	14.3	10.2	21.3	6.3		

Note: Lo Power is not critical over +3 dBm to +11 dBm range.
Measured with LO source and IF load DC-wise open

Date 7/28/89 Tested by

narda
A SUBSIDIARY OF LORAL CORPORATION
11101 TRADE CENTER DRIVE, RANCHO CORDOVA, CALIFORNIA 95670. - 916/638-5500. TWX: 910-367-3181

CERTIFICATE OF CONFORMANCE

CUSTOMER National Radio Astronomy CUSTOMER P.O. C 15188

CUSTOMER P/N N/A MODEL NO. IBS-1826-3

QUANTITY 6 DATE OF MANUFACTURE 3 April 1989

SERIAL NO. (s) 1497 → 1502

SPECIFICATIONS

FREQUENCY RANGE	18.0 → 26.5 GHz
INSERTION LOSS	0.6 db max.
ISOLATION	17 db min.
VSWR	1.40:1 max.
OPERATING TEMPERATURE RANGE	−20° → +65° C

Narda certifies that the above devices have been processed in accordance with established procedures and have been found to conform to all Narda quality standards and applicable customer specified requirements.

Test Technician Steve Walker Quality Assurance [signature]

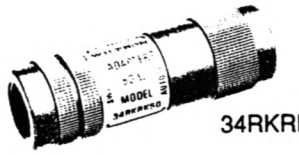
Date 4/3/89 Date 4/5/89

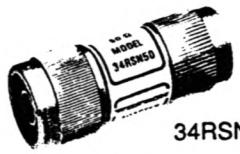
Warranty: Narda warrants its products to be free from defects in material and workmanship for a period of 12 months from date of manufacture. Narda's obligation under this warranty is limited to repairing or replacing, at its option, products returned to the factory with transportation prepaid. Units damaged through customer negligence or misuse void this warranty. Units returned and found to be not defective will incur a minimum $50.00 per unit handling charge.

Out of Warranty Returns: Units sent back for repair will be inspected and/or retested upon receipt. Estimated repair charges will be determined at that time. Any units returned will incur a minimum $50.00 per unit handling charge.

Ruggedized and W/G-to-Coaxial Adapters

34R Series, DC to 40 GHz; 35 Series, 7.5 to 60 GHz


34RKRK50


34RSN50


35WRD750K


35WR19K


35WR22V


35WR42K


35WR19V

34R Ruggedized Adapter Highlights

- Enhanced Reliability of Microwave Test Setup
- Easy-to-Grasp Type N Outside Diameter
- Rigid Test Connections for Improved Test Data Repeatability
- Compatibility with WSMA and K Connectors®

The 34RKRK50 and 34RSN50 Adapters provide a rugged, rigid connection between a 6600 Series Sweep Generator that has a WSMA or K Connector output and Wiltron SWR Autotesters or SWR Bridges.

Both adapters have an outside diameter equal to that of a Type N connector, adding mechanical strength to the test setup and making installation convenient and fast.

Specifications

Model	Frequency Range (GHz)	Connectors	SWR	Price
34RSN50	DC to 20	RS Male to N Male	1.25	$275
34RKRK50	DC to 40	RK Male to RK Male	2	$350

Impedance: 50Ω

35 Waveguide-to-Coaxial Adapter Highlights

- 7.5 to 60 GHz Frequency Coverage
- K Connector® Compatibility with SMA and APC–3.5™
- V Connector® Compatiblility with 2.4 mm
- Standard and Double-Ridge Designs

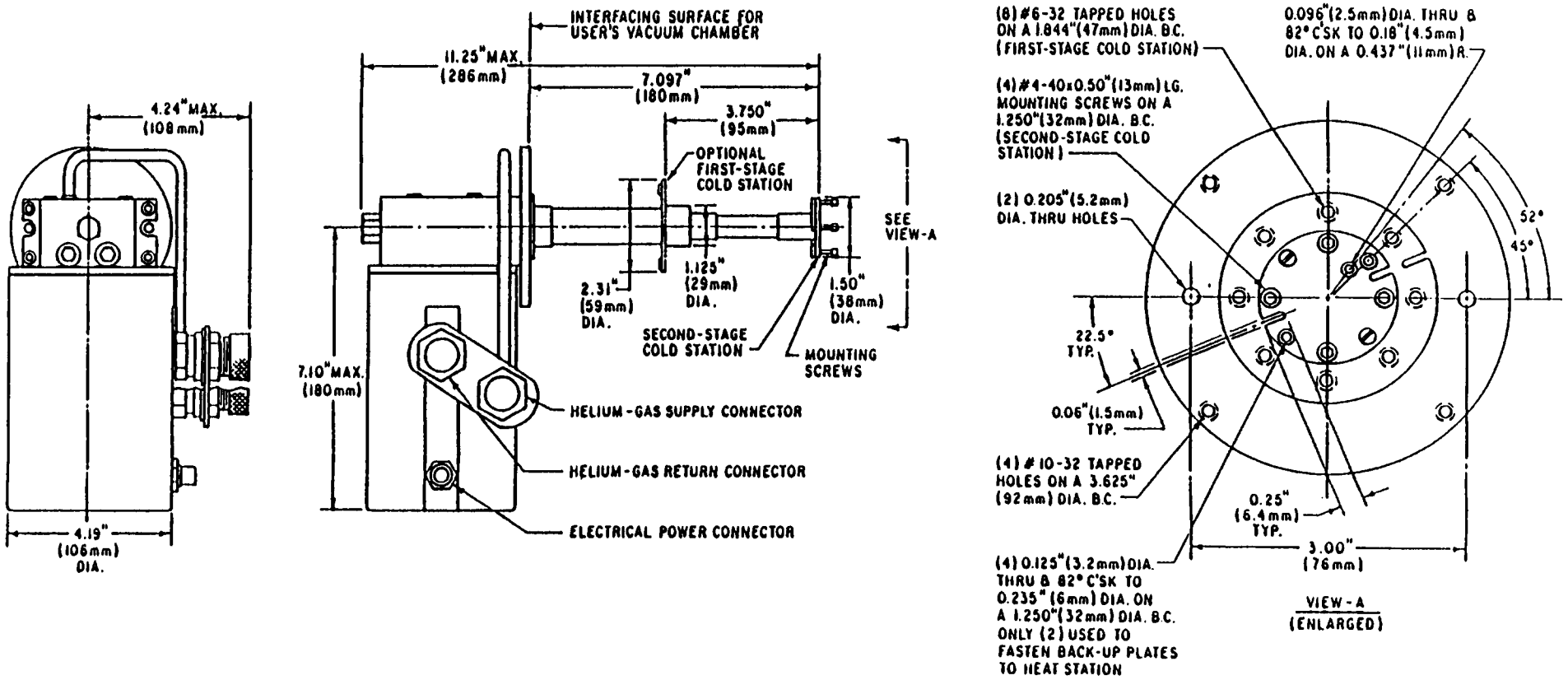
The 35 Series precision adapters transform standard or double-ridge waveguide to coaxial K and V Connectors.

The 16 models listed below cover the 7.5 to 60 GHz range.

Specifications

Model	Frequency Range (GHz)	Connectors	W/G Flange UG-(__)U	SWR	Price
35WRD750K	7.5 to 18	WRD750 to K Male	1580	1.25	$450
35WRD750KF		WRD750 to K Female			$450
35WR42K	18 to 26.5	WR42 to K Male	595	1.25	$320
35WR42KF		WR42 to K Female			$320
35WRD180K	18 to 40	WRD180 to K Male	N/A	1.25	$450
35WRD180KF		WRD180 to K Female			$450
35WR28K	26.5 to 40	WR28 to K Male	599	1.25	$320
35WR28KF		WR28 to K Female			$320
35WR22K	33 to 50	WR22 to K Male	383	1.25	$400
35WR22KF		WR22 to K Female			$400
35WR22V	33 to 50	WR22 to V Male	383	1.30	$450
35WR22VF		WR22 to V Female			$450
35WR19K	40 to 50	WR19 to K Male	383	1.25	$400
35WR19KF	Usable to 54	WR19 to K Female			$400
35WR19V	40 to 60	WR19 to V Male	383	1.30	$500
35WR19VF		WRX19 to V Female			$500

Impedance: 50Ω
Maximum Input Power: 1 W



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

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

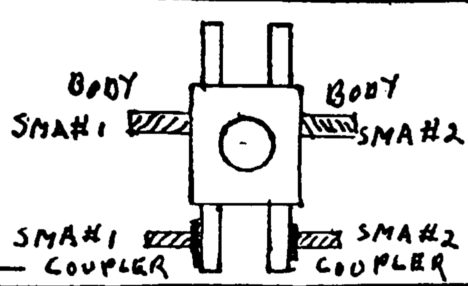
CUSTOMER	NRAO	PART NO.	A53209001
CUSTOMER P.O. NO.	B02803	ATL. REF. NO.	
TED BY	SGH	DATE	11-1-88

TEST RESULTS

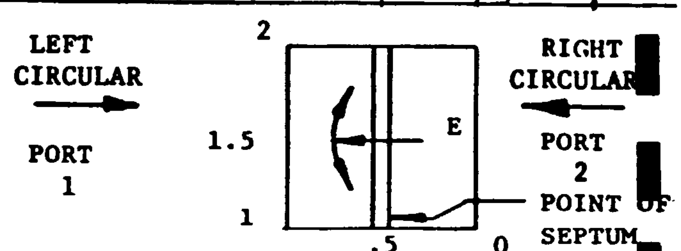
POLARIZER

Catalog # AMC096

SERIAL NUMBER	FREQUENCY GHz	VSWR OF COUPLER SMA #1	VSWR OF COUPLER SMA #2	VSWR OF BODY SMA #1	VSWR OF BODY SMA #2	ISOLATION IN dB	ELLIPTICITY IN dB	COUPLING #1	COUPLING #2	DIRECTIVITY #1	DIRECTIVITY #2
	21.7	1.15	1.11	1.24	1.27	32.0	.38	25.56	25.30	18.0	[illegible]
	22.0	1.35	1.33	1.18	1.22	35+	.52	25.44	25.30	20.5	17.5
79	22.5	1.28	1.15	1.10	1.15	35+	.14	25.44	25.30	20+	[illegible]
	23.0	<1.05	1.05	1.06	1.11	34.0	.31	25.53	25.35	20+	[illegible]
	24.1	1.10	1.24	1.07	<1.05	30.0	.60	26.0	25.76	18.0	[illegible]
	DESIGN LIMITS										



Die # 175



ATLANTIC MICROWAVE CORPORATION
ROUTE 117 • BOLTON, MASS. 01740
TEL (617) 779-5525 • TWX 710-392-1585

ATLANTIC

TR-20
CUSTOMER COPY ☐
FILE COPY ☐

Project P26936

Internal Transfer

Customer P/N

Model AMF-3B-215245-50

Serial No. 160520

SPECIFICATIONS

Frequency (GHz)	21.5 - 24.5 GHz	Output Power (dBm) at 1 dB Compression	0dBm min.
Gain (dB)	10.0dB min.	Voltage	+15VDC
Gain Flatness (dB)	±1.0dB max.	IT Measured Current (mA)	56mA
VSWR Input/Output	2:1 max.		
Noise Figure (dB)	5.0dB max.		
Noise Temp °K			

TEST DATA

Frequency (GHz)	Gain (dB)	VSWR In	VSWR Out	N. F. dB	Noise temp °K	Po at 1dB comp.	Po hard satu.
21.5		1.79:1 max	1.63:1 max.	4.60		+13.1	
22.0				4.19			
22.5	SEE			4.24		+12.4	
23.0	ATTACHED			4.37			
23.5	DATA			4.57		+10.6	
24.0				4.68			
24.5				4.58		+9.1	

Tested By [signature] Date 9/25/89

MITEQ INC. • 100 Davids Drive • Hauppauge, New York 11788-2086 • Tel. (516)436-7400

Project P26936

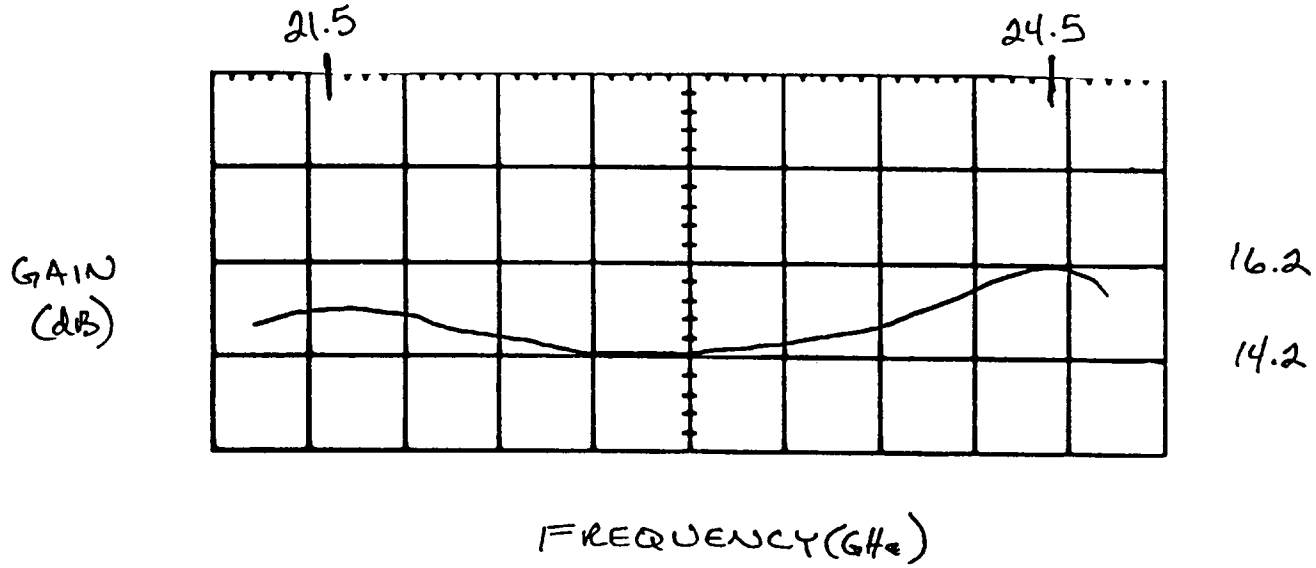
Internal Transfer

Customer P/N

Model AMF-3B-215245-50

Serial No. 160520

GAIN BANDWIDTH



Tested By

Date 9/25/89

MITEQ INC. • 100 Davids Drive • Hauppauge, New York 11788-2086 • Tel. (516)436-7400