GBT Technical Report No. 3

Q-Band (40-50 GHz Receiver)

Technical Manual

G. N. Anderson
April 3, 2007

Note: On-screen resolution may be less than the resolution of the filed images.

Table of Contents

The purpose of this document is to provide a bound archive of all current Q-Band documentation

Block Diagram

The Q-Band GBT Receiver block diagram is shown as Figure 1-1.

The dewar has a single large vacuum window consisting of a 5 mil kapton sheet backed by foam. Cooled feeds for two independent beams are within the dewar and are attached to the 70 K refrigerator stage. A Septum Polarizer with a circular waveguide input separates the input signal into left and right circular components.

Each polarization is amplified by cryogenic amplifiers from the NRAO Technology Center that provide a minimum of 30 dB of gain at a noise temperature of 14 to 25 K when cooled to 15-20 K. After the first amplifier stage, signals pass outside of the dewar. All stages after this point operate at room temperature.

A waveguide attenuator terminates the input of the second amplifier stage to reduce any termination ripple between the first and second amplifier stages. These are constructed in-house and have a positive gain slope with respect to frequency to partially compensate for the negative gain slope of the amplifiers.

The second (room temperature) amplifier is of the same design as the cryogenic amplifier stages. Each is biased with higher drain current for room-temperature operation.

Spacek mixers convert the 40-50 GHz sky frequency to an intermediate frequency (IF) range centered at 6 GHz. Note that these mixers were originally ordered to a specification that called for cryogenic operation. The specification called for vendor testing in liquid nitrogen. ***Do not impose this requirement upon Spacek for any future procurement or repair, as the mixers are now used at room temperature.***

Waveguide attenuators (again designed and fabricated in-house) terminate the RF and LO ports to improve the mixer's stability. Each mixer requires, by the vendor's specification, a DC block on its IF output. Each DC block is followed by a terminating attenuator.

Local Oscillator power is produced by an HP 83620 signal generator as is used with all other GBT receivers. This output is multiplied four times to produce an LO signal in the 34 to 42 GHz range. Spurious outputs from the mixer were detected that indicated that a significant x5 component was output from the mixer. A waveguide bandpass filter was added to the output of the x4 multiplier to remove any x5 component of the multiplier.

The 6 GHz IF output from the mixer then travels to a coupler to allow a reference test tone to be injected into the signal path. An isolator terminates the room temperature amplifier's input. After amplification and filtering through a 4 GHz bandpass filter, the signal then passes through an isolator. The output of that isolator is the receiver output.

Note that this receiver is a modification of an earlier design dating from 1999. The original design had dual polarization for four beams, omitted the second stage of amplification (the first room-temperature amplifier), and had cooled mixers. Some features, such as the four feeds that reside in the dewar, have been left in place as originally designed for the sake of mechanical stability. They are not used electrically.

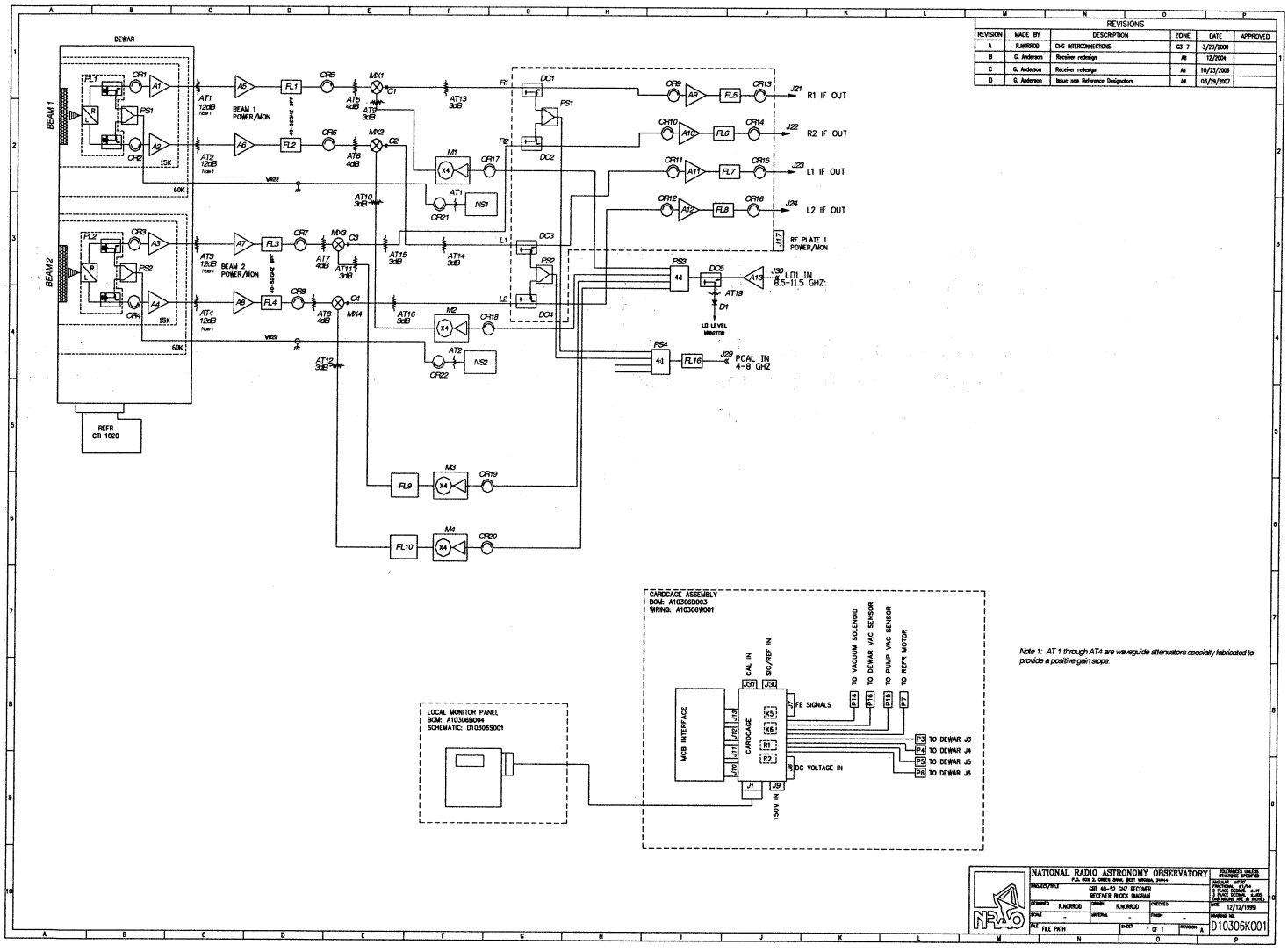


Figure 1-1: Block Diagram

Section II
Drawing List

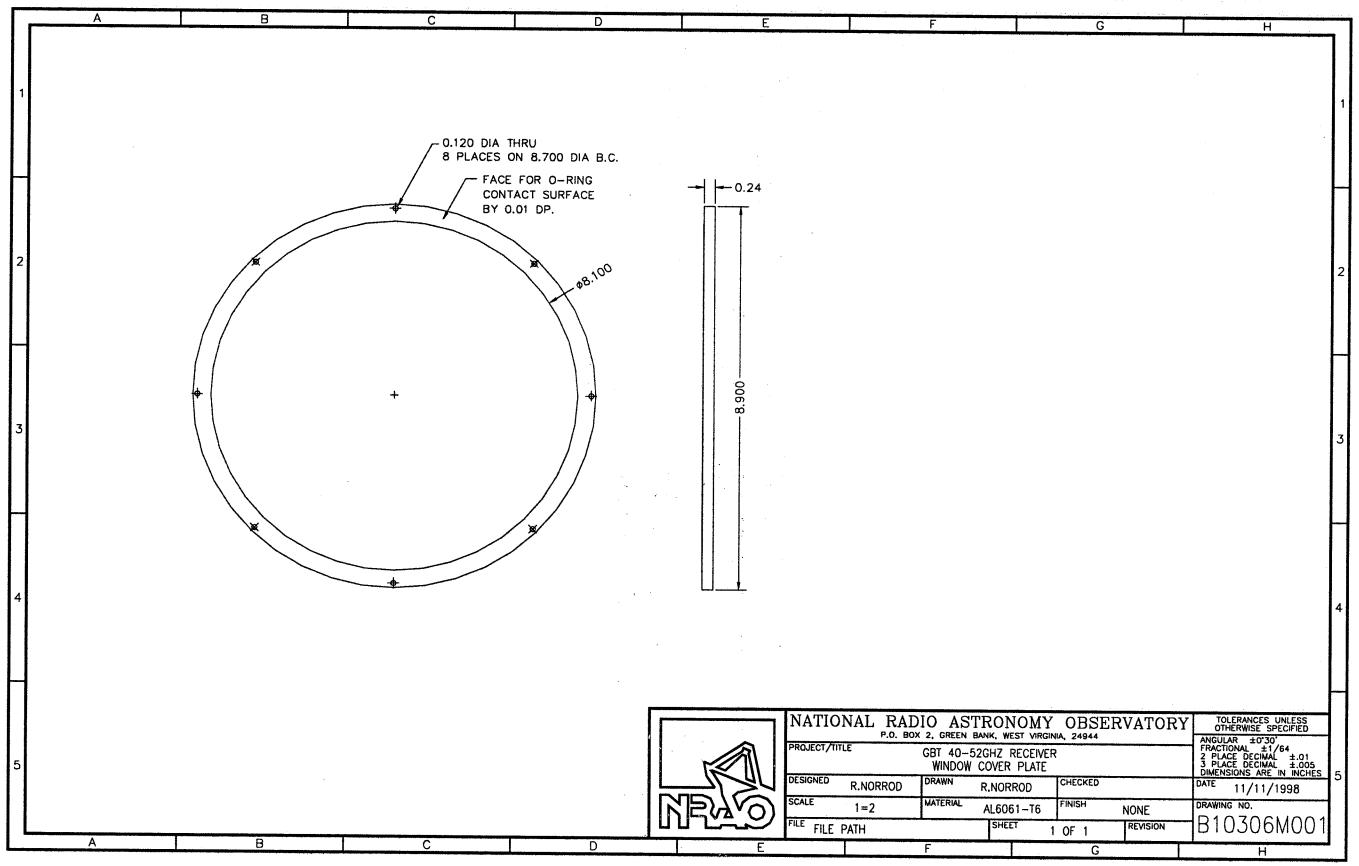
Unless otherwise noted, all drawings referenced herein may be viewed in the original in the GBT archives under:

/doc/drawing/archive/gbelec/10306

Drawing List----- 10306 ----- 40.0 - 52.0 GHZ RECEIVER

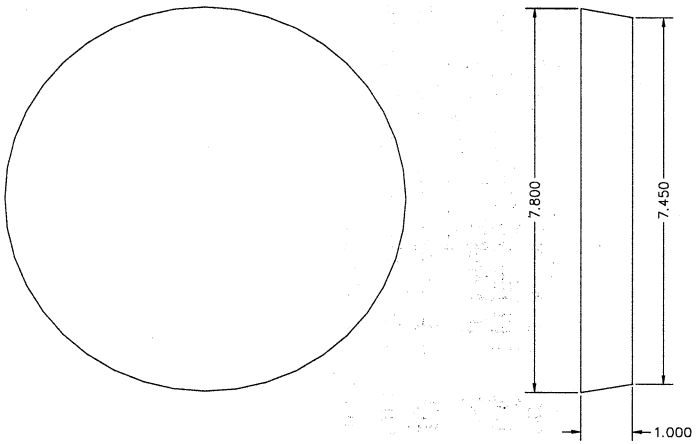
DWG NO.	DWG DATE	REV	REV DATE	SHTS	DRAWN BY	DRAWING TITLE
A10306B001				1	NORROD	RECEIVER ASSEMBLY
A10306B003				1	NORROD	CARDCAGE ASSEMBLY
A10306B004				1	NORROD	LOCAL MONITOR PANEL
A10306D001	4/17/2000			1	NORROD	MONITOR & CONTROL INTERFACE
B10306I001	1/10/2000			1	NORROD	LOCAL MONITOR BOX ARTWORK
D10306K001	12/12/1999	B		1	ANDERSON	Q-BAND RECEIVER BLOCK DIAGRAM
B10306M001	11/11/1998			1	NORROD	WINDOW COVER PLATE
B10306M002	11/11/1998			1	NORROD	WINDOW FOAM INSERT
D10306M003	11/19/1998			1	NORROD	TEST DEWAR TOP PLATE
B10306M004	11/19/1998			1	NORROD	FEED LOCATOR
D10306M005	1/18/1999			1	NORROD	TEST DEWAR 50K PLATE
B10306M006	1/18/1999			1	NORROD	HEAT SHIELD TAB
D10306M007	1/19/1999			1	NORROD	TEST DEWAR HEAT SHIELD
B10306M008	3/11/1999			1	NORROD	WINDOW CAP RING
D10306M009	4/7/1999			1	NORROD	RADOME SUPPORT
C10306M010	6/9/1999			1	TAGGART	PC BOARD MOUNTING BRACKET & CHARCOAL TRAP
B10306M011	7/14/1999			1	NORROD	WAVEGUIDE FEEDTHRU PLATE
B10306M012	7/1/1996	A		1	SRIKANTH	FEED HORN
D10306M013	10/12/1999	A		1	NORROD	DEWAR BOTTOM PLATE
D10306M014	10/13/1999	B		1	NORROD	DEWAR TOP PLATE
D10306M015	10/14/1999	B		1	NORROD	DEWAR CYLINDER
B10306M016	10/19/1999			1	BEALE	WAVEGUIDE FEEDTHRU ASSEMBLY
D10306M017	10/19/1999			1	NORROD	REFRIGERATOR ADAPTER
D10306M018	10/19/1999			1	NORROD	DEWAR 15K PLATE
D10306M019	10/19/1999	A		1	NORROD	TURRET PLATE
D10306M020	11/2/1999			1	NORROD	VACUUM WINDOW TRANSITION
B10306M021	11/11/1999			1	TAGGART	CARD CAGE SPACER BLOCK
D10306M022	12/16/1999			1	TAGGART	MANUAL / MONITOR BOX SIDE PLATES
B10306M023	1/20/2000			1	NORROD	LOAD PADDLE
C10306M024	1/24/2000			1	NORROD	LOCAL MONITOR BOX FRONT PLATE
D10306M025	9/8/2000			1	ELLISON	AMBIENT LOAD ASSEMBLY
D10306M026	6/1/2001			1	WATTS	RADOME
B10306M027				1	WATTS	LOAD CHOPPER PADDLE BRACKET
B10306M028	4/19/2004			1	NORROD	WR22 - UG599 SPACER FLANGE
B10306M029	11/10/2005			1	ANDERSON	SEPTUM POLARIZER TEST FIXTURE
B10306M030	3/15/2006			1	ANDERSON	CIRCULAR TERMINATION
D10306S001	12/10/1999			1	NORROD	LOCAL MONITOR BOX SCHEMATIC
D10306S002	1/18/2000			1	NORROD	CAL CONTROLLER PC BOARD SCHEMATIC
A10306W001	12/9/1999			1	NORROD	Q-BAND RECEIVER CARD CAGE WIRING LIST
B10306W002	2/29/2000			1	NORROD	Q-BAND DEWAR WIRING

Section III
Mechanical drawings



NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE	GBT 40-52GHZ RECEIVER WINDOW COVER PLATE			TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ±0°30' FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
DESIGNED R.NORROD	DRAWN R.NORROD	CHECKED		DATE 11/11/1998
SCALE 1=2	MATERIAL AL6061-T6	FINISH NONE		DRAWING NO. B10306M001
FILE FILE PATH	SHEET 1 OF 1	REVISION		



NOTE: MATERIAL CUMING MICROWAVE C-STOCK RH-5
MACHINE TO CLOSE FIT IN WINDOW TRANSITION

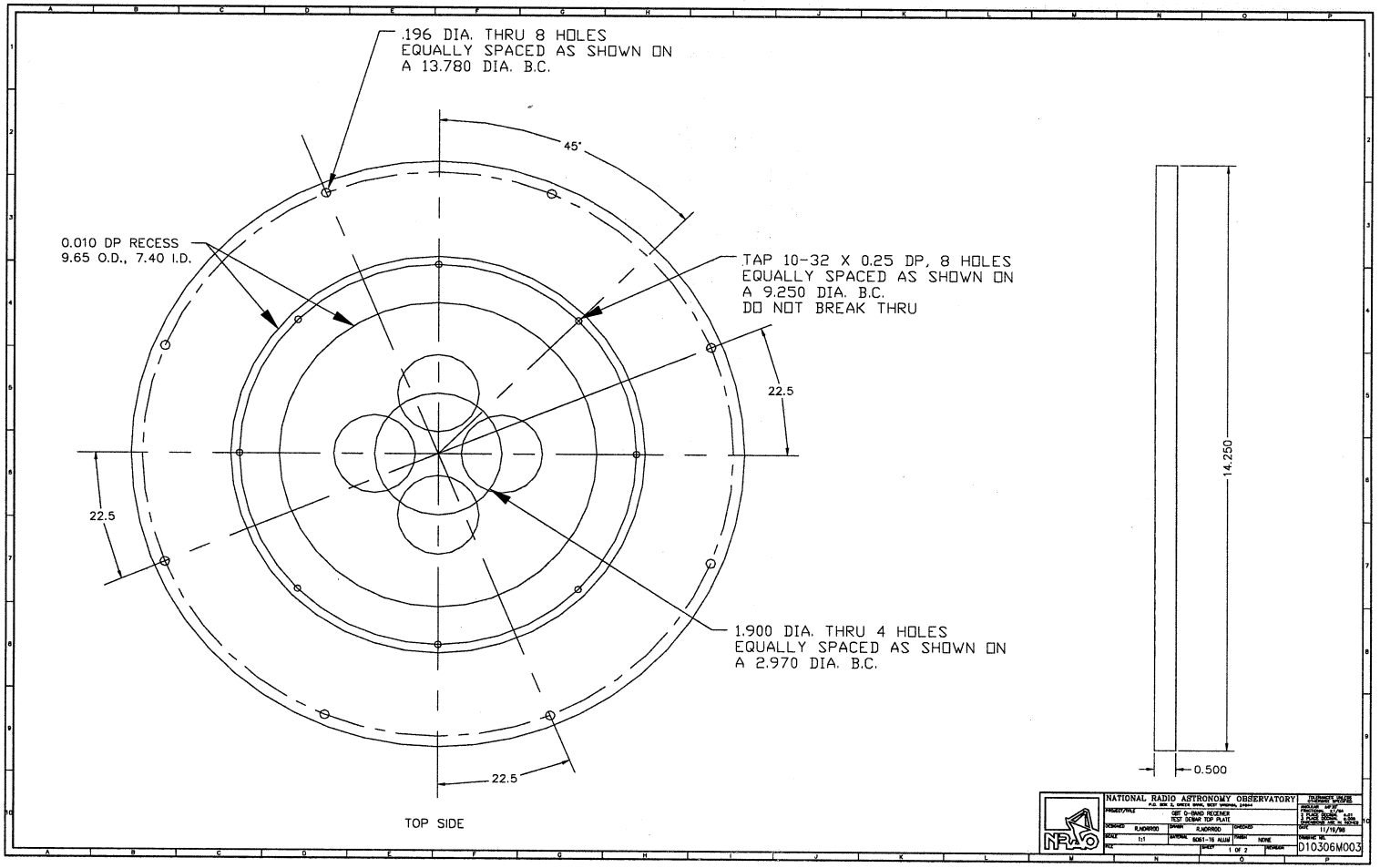
NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

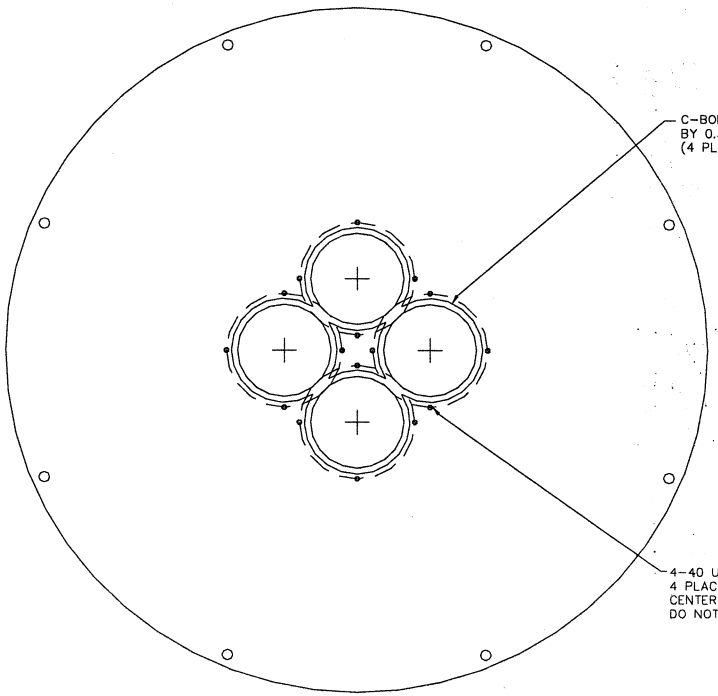
PROJECT/TITLE	GBT 40-52 GHZ RECEIVER WINDOW FOAM INSERT			
DESIGNED	R.NORROD	DRAWN R.NORROD	CHECKED	
SCALE	1=2	MATERIAL	FINISH NONE	
FILE	FILE PATH	SHEET 1 OF 1	REVISION	

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES

DATE 11/11/1998

DRAWING NO. B10306M002


.196 DIA. THRU 8 HOLES
EQUALLY SPACED AS SHOWN ON
A 13.780 DIA. B.C.
45°
0.010 DP RECESS
9.65 O.D., 7.40 I.D.
TAP 10-32 X 0.25 DP, 8 HOLES
EQUALLY SPACED AS SHOWN ON
A 9.250 DIA. B.C.
DO NOT BREAK THRU
22.5
22.5
22.5
1.900 DIA. THRU 4 HOLES
EQUALLY SPACED AS SHOWN ON
A 2.970 DIA. B.C.
TOP SIDE
14.250
0.500
NATIONAL RADIO ASTRONOMY OBSERVATORY
GBT S-BAND RECEIVER
TEST DEWAR TOP PLATE
R.LINDROD
1:1
6061-T6 ALUM
NONE
11/15/00
D10306M003
1 OF 2



BOTTOM SIDE

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE	GBT C-BAND RECEIVER TEST DEWAR TOP PLATE
DESIGNED	R.NORROD
DRAWN	R.NORROD
CHECKED	
SCALE	1:1
MATERIAL	6061-T6 ALUM
FINISH	NONE
SHEET	2 OF 2
REVISION	
DATE	11/15/00
STANDARD NO.	D10306M003

UNLESS OTHERWISE SPECIFIED:
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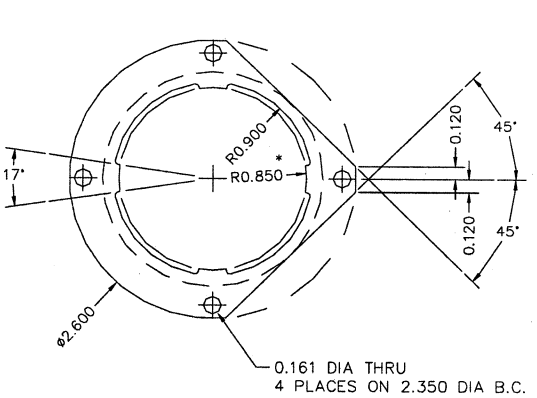
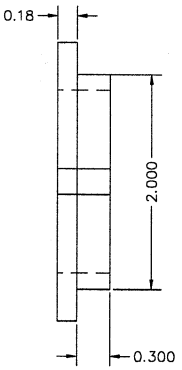
FRACTIONAL: ±1/64
2 PLACE DECIMAL: ±.01
3 PLACE DECIMAL: ±.005
DIMENSIONS ARE IN INCHES





* RADIUS 0.850 TO BE SNUG FIT ON FEEDHORN O.D.

NATIONAL RADIO ASTRONOMY OBSERVATORY P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944			TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ±0°30' FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
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DESIGNED: R.NORROD	DRAWN: R.NORROD	CHECKED	
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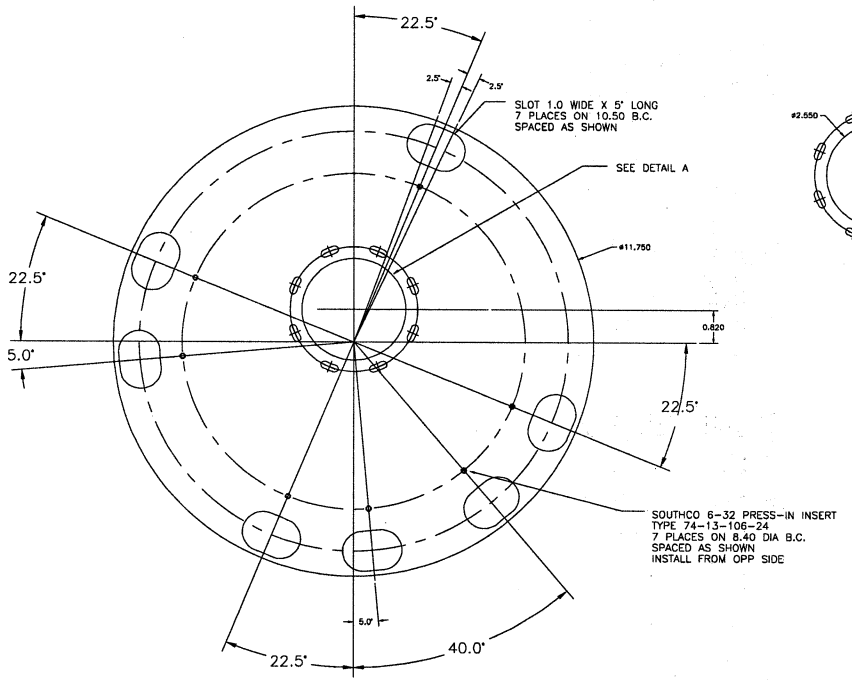
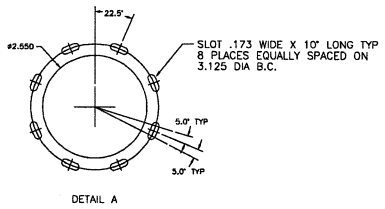


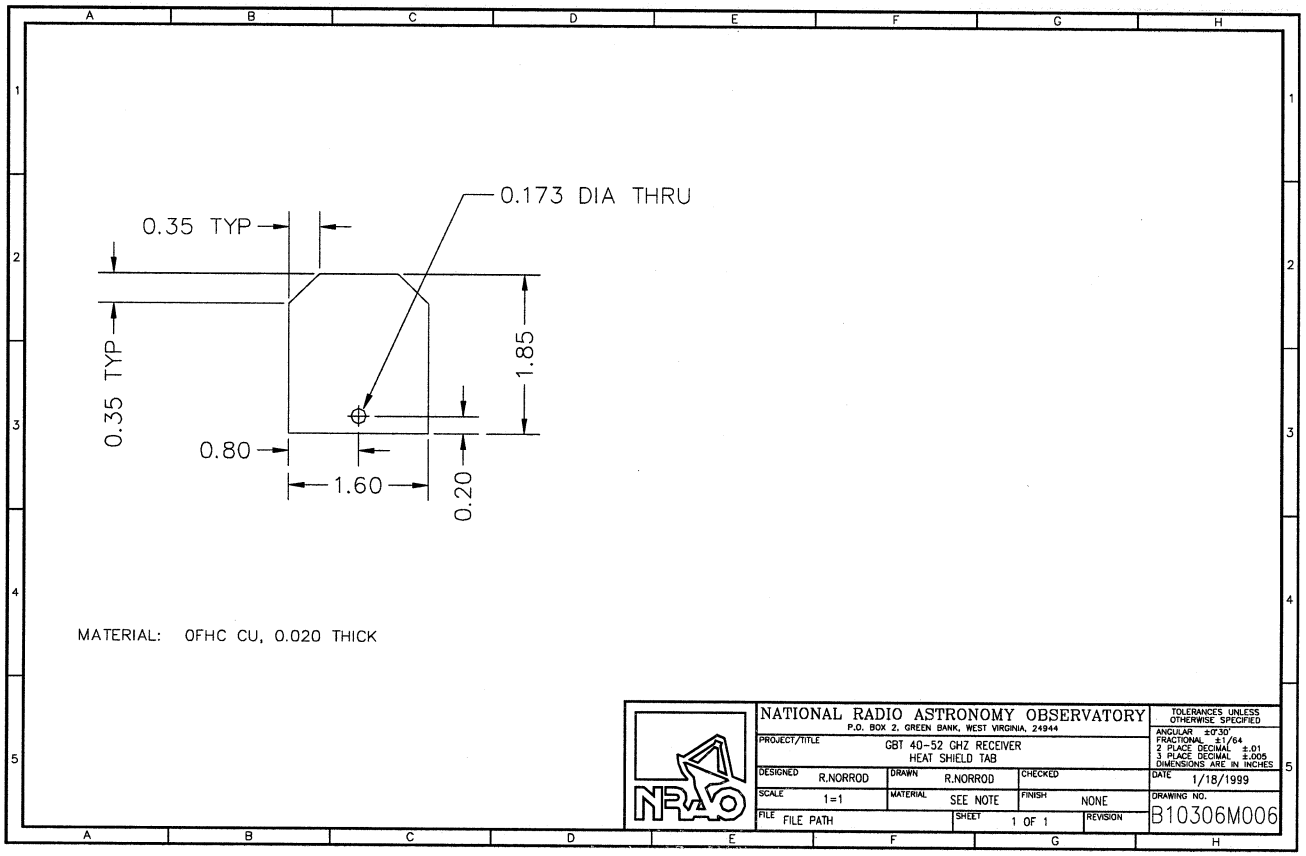


DETAIL A

MATERIAL: OFHC COPPER, 0.09 THICK

NATIONAL RADIO ASTRONOMY OBSERVATORY

D10306W005



MATERIAL: OFHC CU, 0.020 THICK

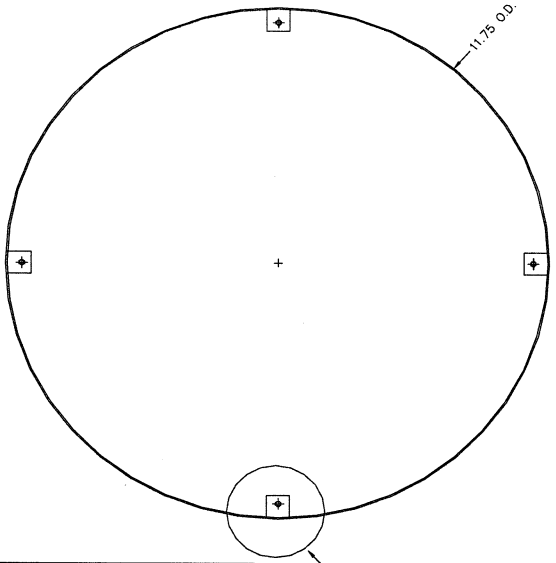
NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

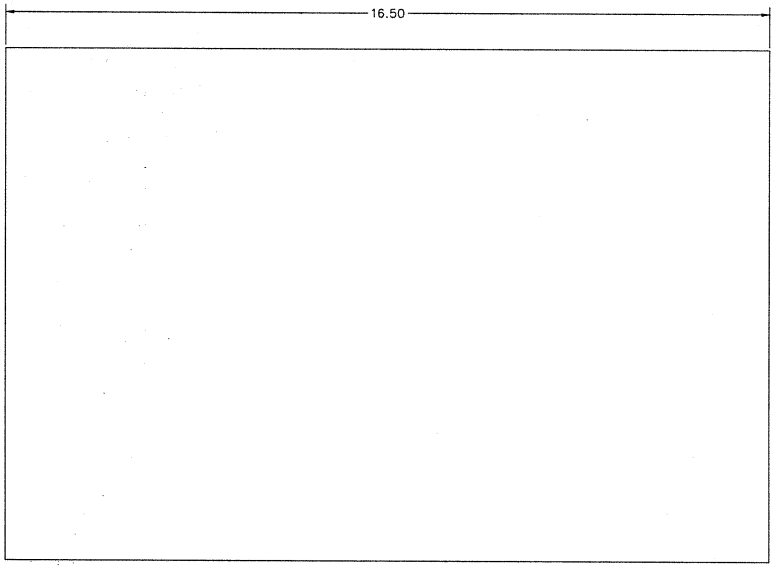
PROJECT/TITLE	GBT 40-52 GHZ RECEIVER HEAT SHIELD TAB		
DESIGNED R.NORROD	DRAWN R.NORROD	CHECKED	
SCALE 1=1	MATERIAL SEE NOTE	FINISH NONE	
FILE FILE PATH	SHEET 1 OF 1	REVISION	

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES

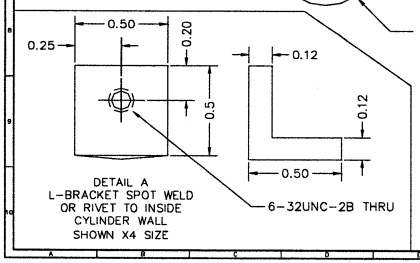
DATE 1/18/1999
DRAWING NO. B10306M006

-01 HEAT SHIELD CYLINDER





MATERIAL: AL 1100, 0.032 THK



DETAIL A
L-BRACKET SPOT WELD
OR RIVET TO INSIDE
CYLINDER WALL
SHOWN X4 SIZE

DETAIL A
4 PLACES EACH END
8 PLACES TOTAL

NATIONAL RADIO ASTRONOMY OBSERVATORY

GBT 40-52 GHz RECEIVER
TEST DEWAR HEAT SHIELD

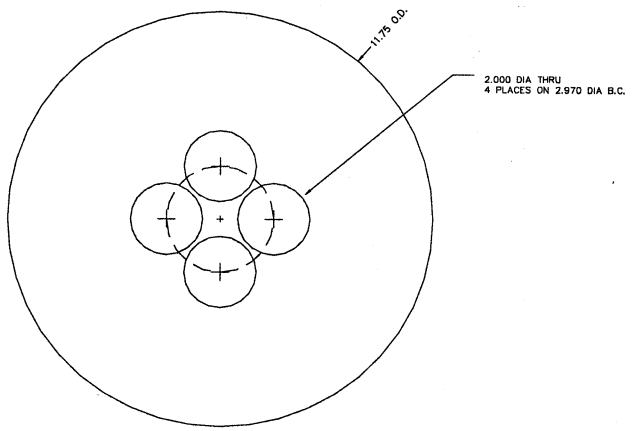
RJADROCO | RJADROCO | 1/16/1999

1=1 | SEE NOTE | NONE

FILE PATH | 1 OF 2

D10306M007

-02 HEAT SHIELD TOP

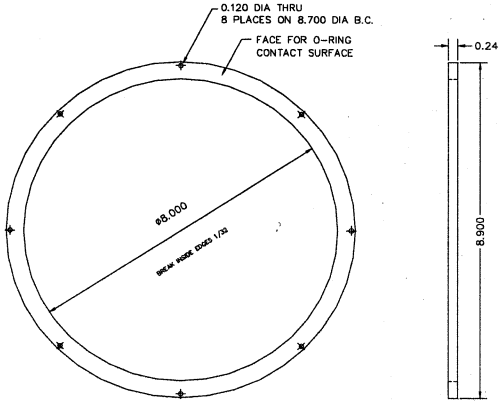


MATERIAL: AL 1100, 0.032 THK

NOTE: HOLES TO ATTACH TOP (-02) TO CYLINDER (-01) SHOULD BE TRANSFERRED FROM CYLINDER AND DRILLED IN TOP AFTER CYLINDER ATTACHED TO 50K PLATE (D10306M005) AND TOP ALIGNED WITH FEEDS

NATIONAL RADIO ASTRONOMY OBSERVATORY

D10306M007



NATIONAL RADIO ASTRONOMY OBSERVATORY P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944					TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ±0'30" FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
PROJECT/TITLE	GBT 40-52GHZ RECEIVER WINDOW CAP RING				
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SCALE 1=2	MATERIAL AL6061-T6	FINISH NONE			DRAWING NO. B10306M008
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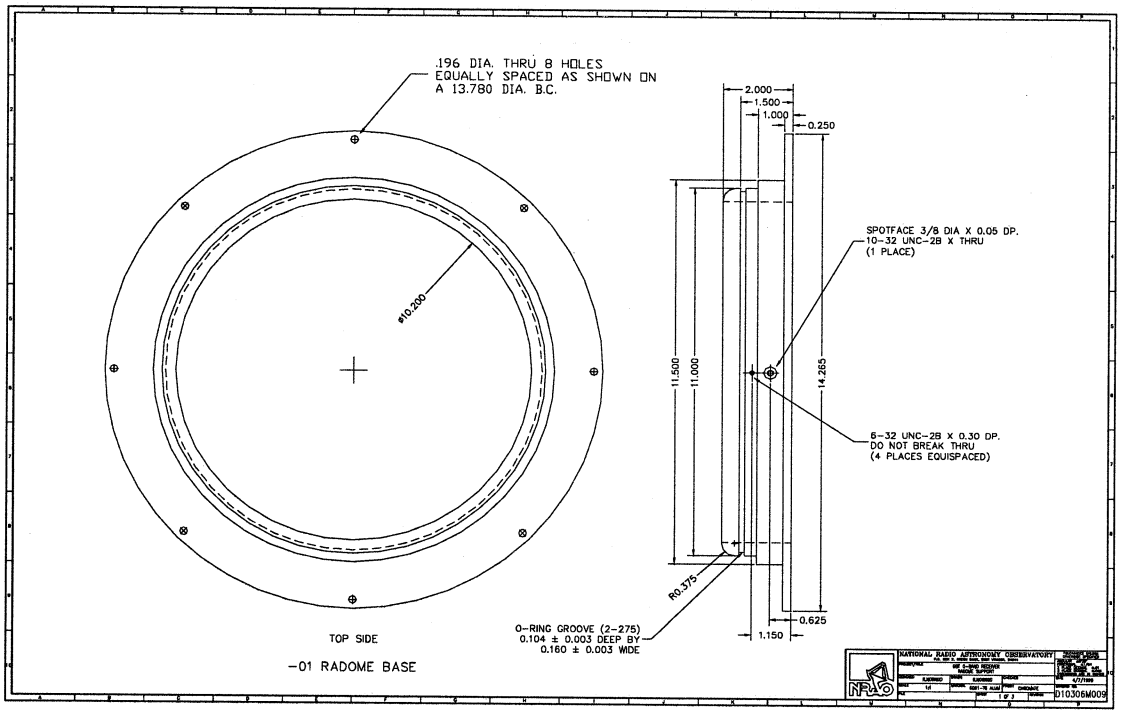
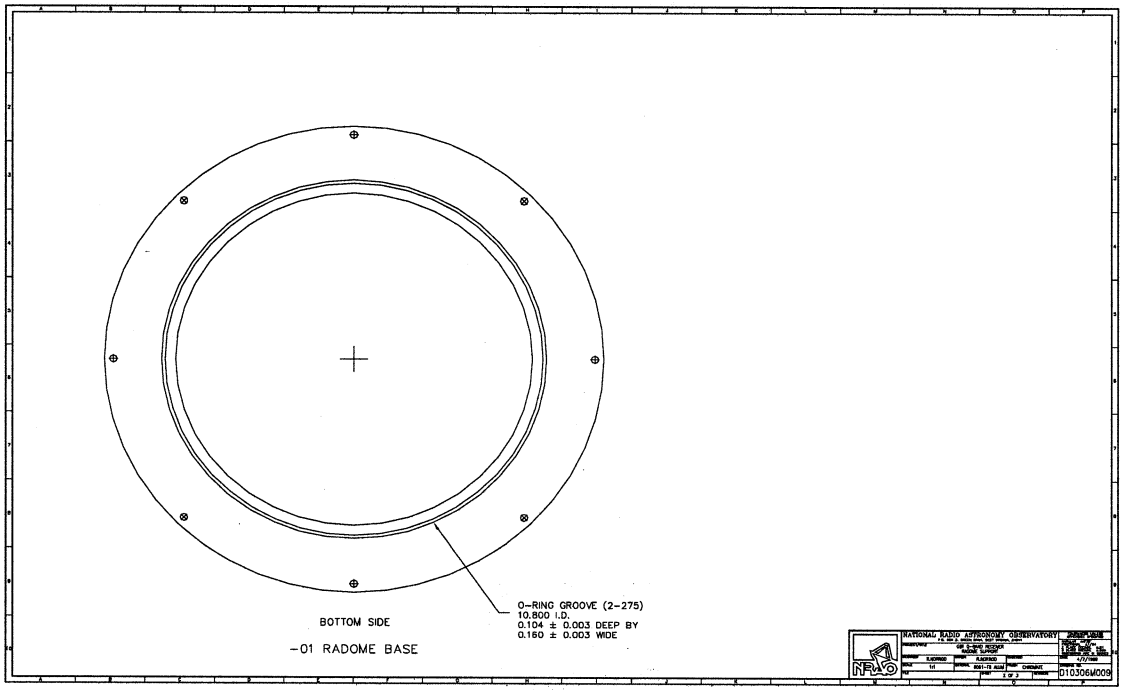
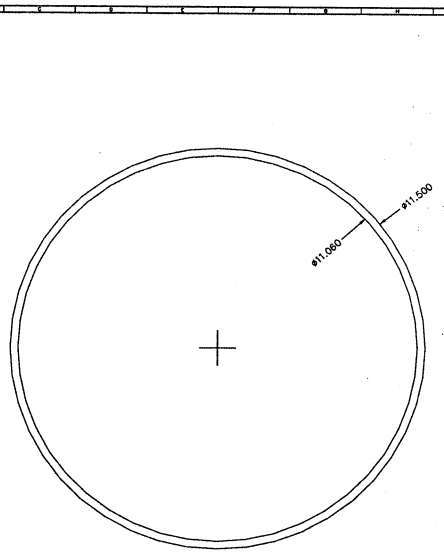
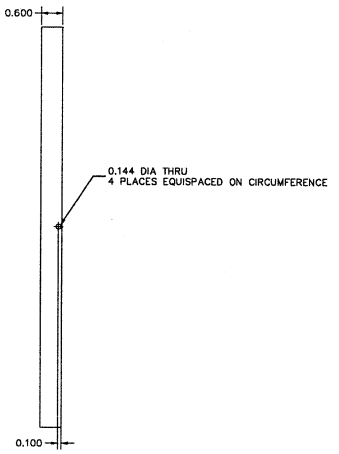

.196 DIA. THRU 8 HOLES
EQUALLY SPACED AS SHOWN ON
A 13.780 DIA. B.C.
ø10.200
TOP SIDE
-01 RADOME BASE
2.000
1.500
1.000
0.250
SPOTFACE 3/8 DIA X 0.05 DP.
10-32 UNC-2B X THRU
(1 PLACE)
11.500
11.000
14.265
6-32 UNC-2B X 0.30 DP.
DO NOT BREAK THRU
(4 PLACES EQUISPACED)
R0.375
O-RING GROOVE (2-275)
0.104 ± 0.003 DEEP BY
0.160 ± 0.003 WIDE
0.625
1.150
NATIONAL RADIO ASTRONOMY OBSERVATORY
D10306M009


O-RING GROOVE (2-275)
10.800 I.D.
0.104 ± 0.003 DEEP BY
0.160 ± 0.003 WIDE
BOTTOM SIDE
-01 RADOME BASE
NATIONAL RADIO ASTRONOMY OBSERVATORY
010306M009





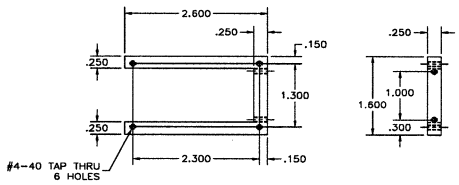
-02 RADOME SLEEVE

NOTE: BREAK ALL EDGES 1/16 INCH. THE -02 SLEEVE FITS OVER THE GORETEX RADOM MATERIAL AND ATTACHES TO THE -01 BASE WITH FOUR 6-32 SCREWS.

NATIONAL RADIO ASTRONOMY OBSERVATORY

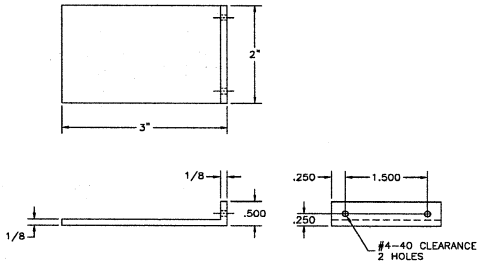
D10306M009

REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
X	X	X	X-X	XX/XX/XX	



PC BOARD MOUNTING BRACKET

SCALE: FULL
MATERIAL: COPPER
4 REQUIRED



CHARCOAL TRAP

SCALE: FULL
MATERIAL: COPPER

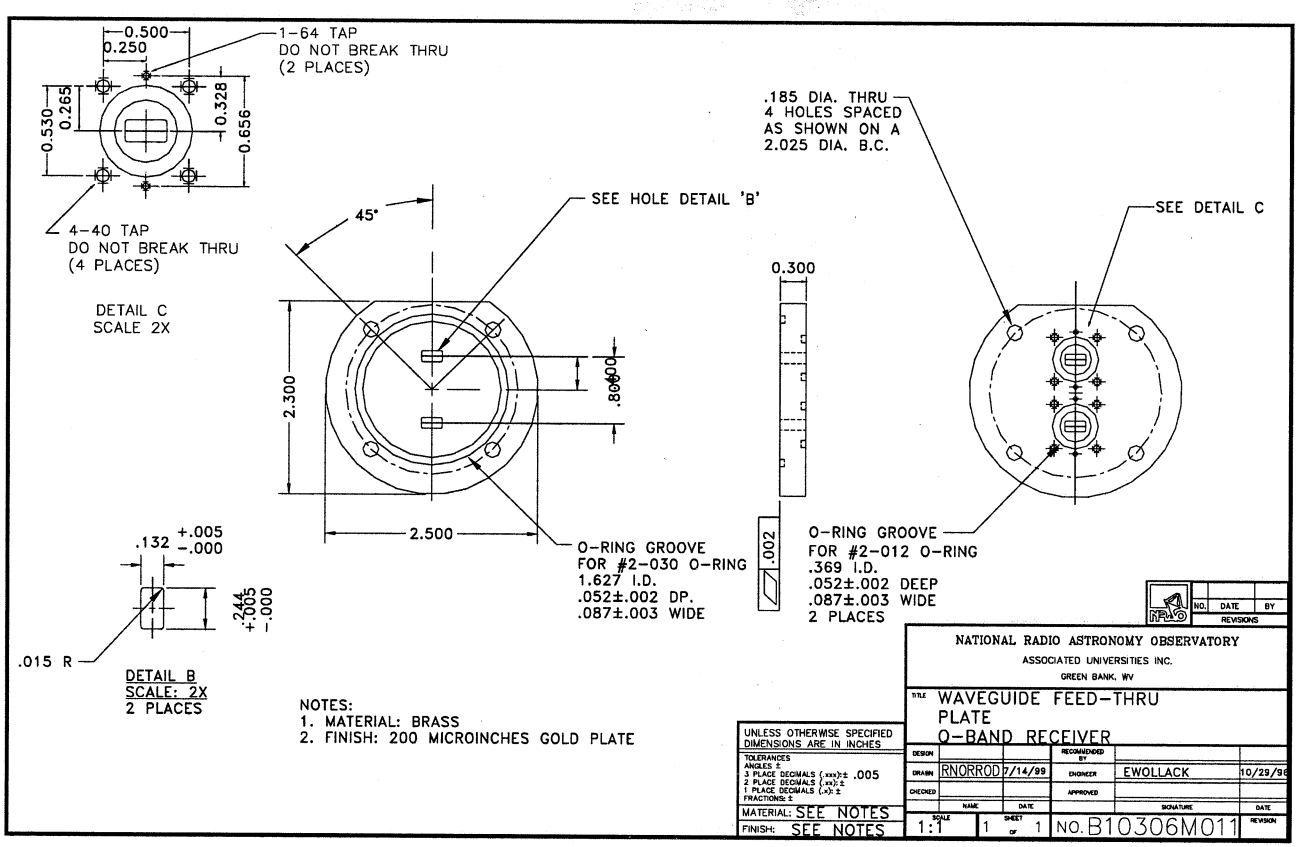
X	X	X	X	X
ITEM	PART NO.	QTY	DESCRIPTION	MATL

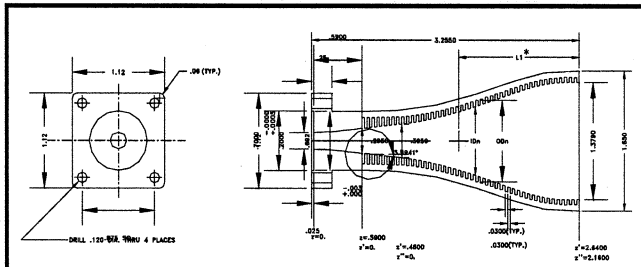
PARTS LIST

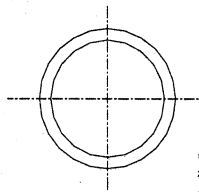
NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE	40-52 GHZ RECEIVER PC BOARD MOUNTING BRACKET & CHARCOAL TRAP		
DESIGNED	L. BEALE	DRAWN	R. TAGGART
CHECKED		DATE	08/09/99
SCALE	AS NOTED	MATERIAL	AS NOTED
FINISH	AS NOTED	DRAWING NO.	C10306M010
FILE	ARCHIVE\GBELEC\10306\M010	SHEET	1 OF 1
REVISION	-		

UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°15'/64
2 PLACE DECIMAL ± 0.01
3 PLACE DECIMAL ± 0.005
FRACTIONS ARE IN INCHES


0.500
0.250
1-64 TAP
DO NOT BREAK THRU
(2 PLACES)
0.530
0.265
0.328
0.656
4-40 TAP
DO NOT BREAK THRU
(4 PLACES)
DETAIL C
SCALE 2X
45°
SEE HOLE DETAIL 'B'
2.300
.800
2.500
O-RING GROOVE
FOR #2-030 O-RING
1.627 I.D.
.052±.002 DP.
.087±.003 WIDE
0.300
.002
.185 DIA. THRU
4 HOLES SPACED
AS SHOWN ON A
2.025 DIA. B.C.
SEE DETAIL C
O-RING GROOVE
FOR #2-012 O-RING
.369 I.D.
.052±.002 DEEP
.087±.003 WIDE
2 PLACES
.132 +.005 -.000
.244 +.005 -.000
.015 R
DETAIL B
SCALE: 2X
2 PLACES
NOTES:
1. MATERIAL: BRASS
2. FINISH: 200 MICROINCHES GOLD PLATE
NO. DATE BY
REVISIONS
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES INC.
GREEN BANK, WV
TITLE WAVEGUIDE FEED-THRU
PLATE
Q-BAND RECEIVER
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
3 PLACE DECIMALS (.xxx)± .005
2 PLACE DECIMALS (.xx)± .
1 PLACE DECIMALS (.x)± .
FRACTIONS± .
MATERIAL: SEE NOTES
FINISH: SEE NOTES
DESIGN
DRAWN RNORROD 7/14/99
CHECKED
NAME DATE
RECOMMENDED BY
ENGINEER EWOLLACK 10/29/99
APPROVED
SIGNATURE DATE
SCALE 1:1
SHEET 1 OF 1
NO. B10306M011
REVISION





* PHASE CENTER LOCATION MEAS 9/1999					
FREQ	L1	NOTES	FREQ	L1	NOTES
40	1.244	H-PLANE	49	1.473	H-PLANE
40	1.244	E-PLANE	49	1.473	E-PLANE
43	1.357	H-PLANE	50	1.463	E-PLANE
43	1.353	E-PLANE			
45	1.463	E-PLANE			
46	1.473	H-PLANE			
46	1.473	E-PLANE			

NOTES:
1. Between z=0. and z=.5900 for ID follow Table 1.
2. Between z=.230 and z=.590 outside diameter is .692.
3. Between z'=0. and z'=.4800 inside has a taper of 6 degrees.
4. Between z''=0. and z''=2.1800 for inside dia. follow Table 2.
5. Between z'=0 and z'=2.6400 for corrugation IDn and ODn follow Table 3.

TABLE 1.

INPUT TRANSITION DIAMETER
DIA = 2.* (a + b * Sech(c*z))

where a = 0.216623
b = −0.116623
c = 1.88789

z	DIA	z	DIA	z	DIA	z	DIA
0.0000	0.2000	0.1750	0.2122	0.3750	0.2483	0.5750	0.2818
0.0050	0.2000	0.1800	0.2128	0.3800	0.2494	0.5800	0.2929
0.0100	0.2000	0.1850	0.2135	0.3850	0.2504	0.5850	0.2939
0.0150	0.2001	0.1900	0.2142	0.3900	0.2515	0.5900	0.2950
0.0200	0.2002	0.1950	0.2150	0.3950	0.2526		
0.0250	0.2003	0.2000	0.2157	0.4000	0.2537		
0.0300	0.2004	0.2050	0.2164	0.4050	0.2548		
0.0350	0.2005	0.2100	0.2172	0.4100	0.2558		
0.0400	0.2007	0.2150	0.2180	0.4150	0.2569		
0.0450	0.2008	0.2200	0.2188	0.4200	0.2580		
0.0500	0.2010	0.2250	0.2196	0.4250	0.2591		
0.0550	0.2013	0.2300	0.2204	0.4300	0.2602		
0.0600	0.2015	0.2350	0.2212	0.4350	0.2613		
0.0650	0.2017	0.2400	0.2221	0.4400	0.2624		
0.0700	0.2020	0.2450	0.2229	0.4450	0.2635		
0.0750	0.2023	0.2500	0.2238	0.4500	0.2646		
0.0800	0.2026	0.2550	0.2246	0.4550	0.2657		
0.0850	0.2030	0.2600	0.2255	0.4600	0.2668		
0.0900	0.2033	0.2650	0.2264	0.4650	0.2679		
0.0950	0.2037	0.2700	0.2273	0.4700	0.2690		
0.1000	0.2041	0.2750	0.2283	0.4750	0.2701		
0.1050	0.2045	0.2800	0.2292	0.4800	0.2712		
0.1100	0.2049	0.2850	0.2301	0.4850	0.2723		
0.1150	0.2054	0.2900	0.2311	0.4900	0.2734		
0.1200	0.2059	0.2950	0.2320	0.4950	0.2745		
0.1250	0.2063	0.3000	0.2330	0.5000	0.2756		
0.1300	0.2069	0.3050	0.2340	0.5050	0.2767		
0.1350	0.2074	0.3100	0.2349	0.5100	0.2778		
0.1400	0.2079	0.3150	0.2359	0.5150	0.2789		
0.1450	0.2085	0.3200	0.2369	0.5200	0.2800		
0.1500	0.2090	0.3250	0.2379	0.5250	0.2811		
0.1550	0.2096	0.3300	0.2389	0.5300	0.2822		
0.1600	0.2103	0.3350	0.2400	0.5350	0.2832		
0.1650	0.2109	0.3400	0.2410	0.5400	0.2843		
0.1700	0.2115	0.3450	0.2420	0.5450	0.2854		
0.1500	0.2090	0.3500	0.2431	0.5500	0.2865		
0.1550	0.2096	0.3550	0.2441	0.5550	0.2876		
0.1600	0.2103	0.3600	0.2451	0.5600	0.2886		
0.1650	0.2109	0.3650	0.2462	0.5650	0.2897		
0.1700	0.2115	0.3700	0.2473	0.5700	0.2908		

TABLE 3.

INSIDE & OUTSIDE DIAMETERS OF CORRUGATIONS

n	z'	IDn	ODn	n	z'	IDn	ODn
1	0.0000	0.2950	0.5422	36	2.1000	1.2763	1.4039
2	0.0600	0.3078	0.5454	37	2.1600	1.3045	1.4305
3	0.1200	0.3202	0.5478	38	2.2200	1.3287	1.4531
4	0.1800	0.3328	0.5509	39	2.2800	1.3484	1.4721
5	0.2400	0.3455	0.5541	40	2.3400	1.3635	1.4855
6	0.3000	0.3581	0.5573	41	2.4000	1.3736	1.4948
7	0.3600	0.3707	0.5604	42	2.4600	1.3786	1.4982
8	0.4200	0.3833	0.5636	43	2.5200	1.3790	1.4978
9	0.4800	0.3959	0.5668	44	2.5800	1.3790	1.4964
10	0.5400	0.4097	0.5782	45	2.6400	1.3790	
11	0.6000	0.4258	0.5927				
12	0.6600	0.4441	0.6095				
13	0.7200	0.4647	0.6285				
14	0.7800	0.4873	0.6487				
15	0.8400	0.5120	0.6719				
16	0.9000	0.5386	0.6969				
17	0.9600	0.5671	0.7230				
18	1.0200	0.5973	0.7517				
19	1.0800	0.6292	0.7819				
20	1.1400	0.6626	0.8137				
21	1.2000	0.6973	0.8469				
22	1.2600	0.7334	0.8814				
23	1.3200	0.7706	0.9170				
24	1.3800	0.8088	0.9537				
25	1.4400	0.8479	0.9912				
26	1.5000	0.8877	1.0294				
27	1.5600	0.9281	1.0682				
28	1.6200	0.9689	1.1075				
29	1.6800	1.0101	1.1471				
30	1.7400	1.0514	1.1868				
31	1.8000	1.0926	1.2264				
32	1.8600	1.1331	1.2662				
33	1.9200	1.1724	1.3039				
34	1.9800	1.2097	1.3397				
35	2.0400	1.2446	1.3729				

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
2 PLACE DECIMALS (.xx)± .005
3 PLACE DECIMALS (.xx)± .005
1 PLACE DECIMALS (.x)± .
FRACTIONS ±
MATERIAL: Copper
FINISH:

NO.	DATE	BY	REVISIONS
A	9/23/99	RDN	ADDED P.C. DATA

NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES INC.
CHARLOTTESVILLE, VA.

TITLE: FEEDHORN
GBT 40-52 GHZ RECEIVER

	NAME	DATE	SIGNATURE
DESIGN	S.Srikanth		RECOMMENDED BY
DRAWN	S.Srikanth	7/98	ENGINEER
CHECKED			APPROVED

SCALE | SHEET 1 of 2 | NO. B10306M012 | REVISION A

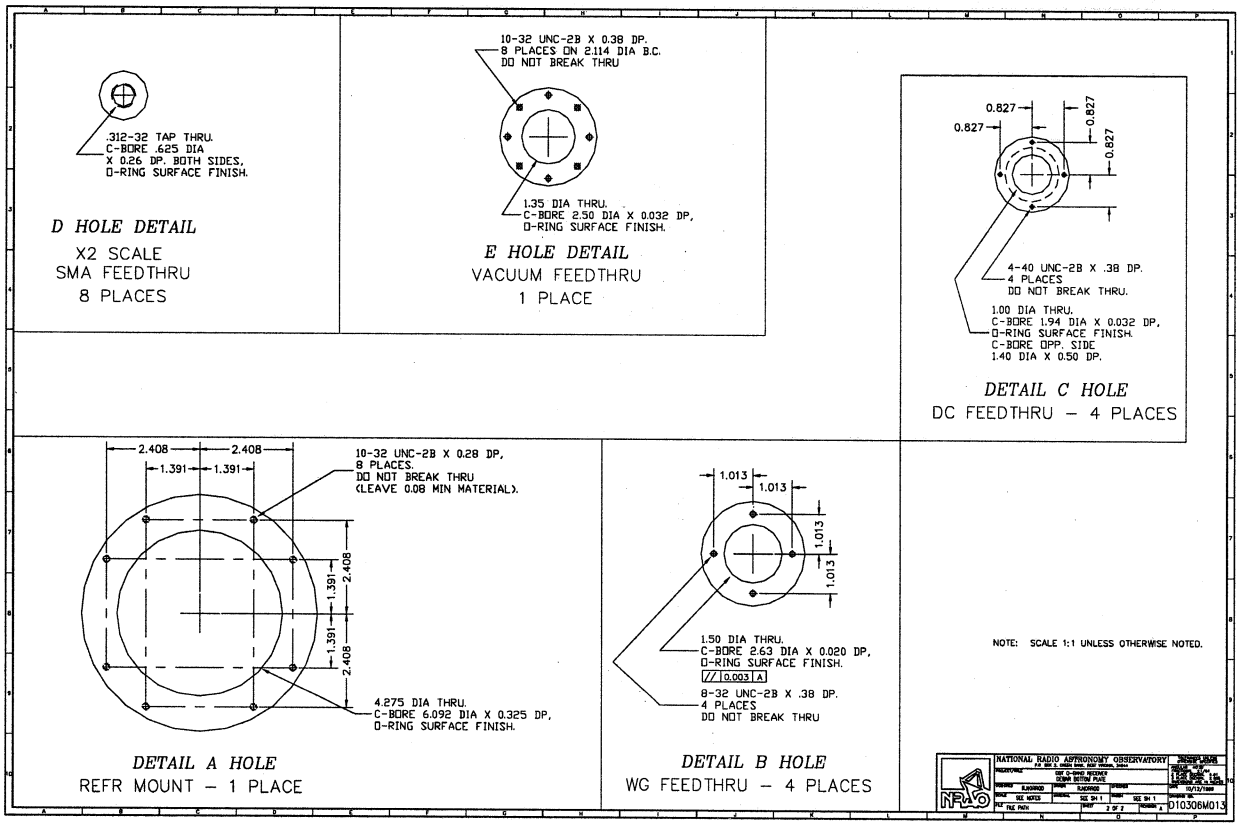

.312-32 TAP THRU.
C-BORE .625 DIA
X 0.26 DP. BOTH SIDES,
O-RING SURFACE FINISH.
D HOLE DETAIL
X2 SCALE
SMA FEEDTHRU
8 PLACES
10-32 UNC-2B X 0.38 DP.
8 PLACES ON 2.114 DIA B.C.
DO NOT BREAK THRU
1.35 DIA THRU.
C-BORE 2.50 DIA X 0.032 DP,
O-RING SURFACE FINISH.
E HOLE DETAIL
VACUUM FEEDTHRU
1 PLACE
0.827
0.827
0.827
0.827
4-40 UNC-2B X .38 DP.
4 PLACES
DO NOT BREAK THRU.
1.00 DIA THRU.
C-BORE 1.94 DIA X 0.032 DP,
O-RING SURFACE FINISH.
C-BORE OPP. SIDE
1.40 DIA X 0.50 DP.
DETAIL C HOLE
DC FEEDTHRU – 4 PLACES
2.408
2.408
1.391
1.391
10-32 UNC-2B X 0.28 DP,
8 PLACES.
DO NOT BREAK THRU
(LEAVE 0.08 MIN MATERIAL).
1.391
2.408
1.391
2.408
4.275 DIA THRU.
C-BORE 6.092 DIA X 0.325 DP,
O-RING SURFACE FINISH.
DETAIL A HOLE
REFR MOUNT – 1 PLACE
1.013
1.013
1.013
1.013
1.50 DIA THRU.
C-BORE 2.63 DIA X 0.020 DP,
O-RING SURFACE FINISH.
// 0.003 A
8-32 UNC-2B X .38 DP.
4 PLACES
DO NOT BREAK THRU
DETAIL B HOLE
WG FEEDTHRU – 4 PLACES
NOTE: SCALE 1:1 UNLESS OTHERWISE NOTED.
NATIONAL RADIO ASTRONOMY OBSERVATORY
D10306M013

TABLE 2.

PROFILE SECTION DIAMETER

z"	DIA
0.0000	0.3959
0.0050	0.3970
0.0100	0.3980
0.0150	0.3991
0.0200	0.4002
0.0250	0.4014
0.0300	0.4025
0.0350	0.4037
0.0400	0.4048
0.0450	0.4060
0.0500	0.4072
0.0550	0.4084
0.0600	0.4097
0.0650	0.4109
0.0700	0.4122
0.0750	0.4135
0.0800	0.4148
0.0850	0.4161
0.0900	0.4174
0.0950	0.4188
0.1000	0.4202
0.1050	0.4215
0.1100	0.4229
0.1150	0.4244
0.1200	0.4258
0.1250	0.4272
0.1300	0.4287
0.1350	0.4302
0.1400	0.4317
0.1450	0.4332
0.1500	0.4347
0.1550	0.4362
0.1600	0.4378
0.1650	0.4393
0.1700	0.4409
0.1750	0.4425
0.1800	0.4441
0.1850	0.4458
0.1900	0.4474
0.1950	0.4491

z"	DIA
0.2000	0.4507
0.2050	0.4524
0.2100	0.4541
0.2150	0.4559
0.2200	0.4576
0.2250	0.4593
0.2300	0.4611
0.2350	0.4629
0.2400	0.4647
0.2450	0.4665
0.2500	0.4683
0.2550	0.4701
0.2600	0.4720
0.2650	0.4739
0.2700	0.4757
0.2750	0.4776
0.2800	0.4795
0.2850	0.4815
0.2900	0.4834
0.2950	0.4854
0.3000	0.4873
0.3050	0.4893
0.3100	0.4913
0.3150	0.4933
0.3200	0.4953
0.3250	0.4974
0.3300	0.4994
0.3350	0.5015
0.3400	0.5036
0.3450	0.5057
0.3500	0.5078
0.3550	0.5099
0.3600	0.5120
0.3650	0.5142
0.3700	0.5163
0.3750	0.5185
0.3800	0.5207
0.3850	0.5229
0.3900	0.5251
0.3950	0.5273
0.4000	0.5295
0.4050	0.5318
0.4100	0.5341
0.4150	0.5363
0.4200	0.5386

z"	DIA
0.4250	0.5409
0.4300	0.5433
0.4350	0.5456
0.4400	0.5479
0.4450	0.5503
0.4500	0.5526
0.4550	0.5550
0.4600	0.5574
0.4650	0.5598
0.4700	0.5622
0.4750	0.5647
0.4800	0.5671
0.4850	0.5696
0.4900	0.5720
0.4950	0.5745
0.5000	0.5770
0.5050	0.5795
0.5100	0.5820
0.5150	0.5845
0.5200	0.5871
0.5250	0.5896
0.5300	0.5922
0.5350	0.5947
0.5400	0.5973
0.5450	0.5999
0.5500	0.6025
0.5550	0.6051
0.5600	0.6078
0.5650	0.6104
0.5700	0.6131
0.5750	0.6157
0.5800	0.6184
0.5850	0.6211
0.5900	0.6238
0.5950	0.6265
0.6000	0.6292
0.6050	0.6319
0.6100	0.6346
0.6150	0.6374
0.6200	0.6401
0.6250	0.6429
0.6300	0.6457
0.6350	0.6485
0.6400	0.6513
0.6450	0.6541

z"	DIA
0.6500	0.6569
0.6550	0.6597
0.6600	0.6626
0.6650	0.6654
0.6700	0.6683
0.6750	0.6711
0.6800	0.6740
0.6850	0.6769
0.6900	0.6798
0.6950	0.6827
0.7000	0.6856
0.7050	0.6885
0.7100	0.6914
0.7150	0.6944
0.7200	0.6973
0.7250	0.7003
0.7300	0.7033
0.7350	0.7062
0.7400	0.7092
0.7450	0.7122
0.7500	0.7152
0.7550	0.7182
0.7600	0.7212
0.7650	0.7243
0.7700	0.7273
0.7750	0.7303
0.7800	0.7334
0.7850	0.7364
0.7900	0.7395
0.7950	0.7426
0.8000	0.7457
0.8050	0.7487
0.8100	0.7518
0.8150	0.7549
0.8200	0.7581
0.8250	0.7612
0.8300	0.7643
0.8350	0.7674
0.8400	0.7706
0.8450	0.7737
0.8500	0.7769
0.8550	0.7800
0.8600	0.7832
0.8650	0.7864
0.8700	0.7896
0.8750	0.7928

z"	DIA
0.8800	0.7959
0.8850	0.7991
0.8900	0.8024
0.8950	0.8056
0.9000	0.8088
0.9050	0.8120
0.9100	0.8152
0.9150	0.8185
0.9200	0.8217
0.9250	0.8250
0.9300	0.8282
0.9350	0.8315
0.9400	0.8348
0.9450	0.8380
0.9500	0.8413
0.9550	0.8446
0.9600	0.8479
0.9650	0.8512
0.9700	0.8545
0.9750	0.8578
0.9800	0.8611
0.9850	0.8644
0.9900	0.8677
0.9950	0.8710
1.0000	0.8743
1.0050	0.8777
1.0100	0.8810
1.0150	0.8843
1.0200	0.8877
1.0250	0.8910
1.0300	0.8944
1.0350	0.8977
1.0400	0.9011
1.0450	0.9045
1.0500	0.9078
1.0550	0.9112
1.0600	0.9146
1.0650	0.9179
1.0700	0.9213
1.0750	0.9247
1.0800	0.9281
1.0850	0.9315
1.0900	0.9349
1.0950	0.9383
1.1000	0.9417

z"	DIA
1.1050	0.9451
1.1100	0.9485
1.1150	0.9519
1.1200	0.9553
1.1250	0.9587
1.1300	0.9621
1.1350	0.9655
1.1400	0.9689
1.1450	0.9724
1.1500	0.9758
1.1550	0.9792
1.1600	0.9826
1.1650	0.9861
1.1700	0.9895
1.1750	0.9929
1.1800	0.9963
1.1850	0.9998
1.1900	1.0032
1.1950	1.0066
1.2000	1.0101
1.2050	1.0135
1.2100	1.0170
1.2150	1.0204
1.2200	1.0238
1.2250	1.0273
1.2300	1.0307
1.2350	1.0342
1.2400	1.0376
1.2450	1.0410
1.2500	1.0445
1.2550	1.0479
1.2600	1.0514
1.2650	1.0548
1.2700	1.0583
1.2750	1.0617
1.2800	1.0651
1.2850	1.0686
1.2900	1.0720
1.2950	1.0755
1.3000	1.0789
1.3050	1.0823
1.3100	1.0857
1.3150	1.0892
1.3200	1.0926
1.3250	1.0960
1.3300	1.0994

z"	DIA
1.3350	1.1028
1.3400	1.1062
1.3450	1.1096
1.3500	1.1130
1.3550	1.1164
1.3600	1.1197
1.3650	1.1231
1.3700	1.1265
1.3750	1.1298
1.3800	1.1331
1.3850	1.1365
1.3900	1.1398
1.3950	1.1431
1.4000	1.1464
1.4050	1.1497
1.4100	1.1530
1.4150	1.1562
1.4200	1.1595
1.4250	1.1627
1.4300	1.1660
1.4350	1.1692
1.4400	1.1724
1.4450	1.1756
1.4500	1.1788
1.4550	1.1819
1.4600	1.1851
1.4650	1.1882
1.4700	1.1913
1.4750	1.1945
1.4800	1.1975
1.4850	1.2006
1.4900	1.2037
1.4950	1.2067
1.5000	1.2097
1.5050	1.2127
1.5100	1.2157
1.5150	1.2187
1.5200	1.2217
1.5250	1.2246
1.5300	1.2275
1.5350	1.2304
1.5400	1.2333
1.5450	1.2361
1.5500	1.2390
1.5550	1.2418

z"	DIA
1.5600	1.2446
1.5650	1.2473
1.5700	1.2501
1.5750	1.2528
1.5800	1.2555
1.5850	1.2582
1.5900	1.2609
1.5950	1.2635
1.6000	1.2661
1.6050	1.2687
1.6100	1.2713
1.6150	1.2738
1.6200	1.2763
1.6250	1.2788
1.6300	1.2813
1.6350	1.2837
1.6400	1.2861
1.6450	1.2885
1.6500	1.2909
1.6550	1.2932
1.6600	1.2955
1.6650	1.2978
1.6700	1.3001
1.6750	1.3023
1.6800	1.3045
1.6850	1.3067
1.6900	1.3088
1.6950	1.3109
1.7000	1.3130
1.7050	1.3151
1.7100	1.3171
1.7150	1.3191
1.7200	1.3211
1.7250	1.3230
1.7300	1.3249
1.7350	1.3268
1.7400	1.3287
1.7450	1.3305
1.7500	1.3323
1.7550	1.3340
1.7600	1.3358
1.7650	1.3375
1.7700	1.3391
1.7750	1.3408
1.7800	1.3424
1.7850	1.3439

z"	DIA
1.7900	1.3455
1.7950	1.3470
1.8000	1.3484
1.8050	1.3499
1.8100	1.3513
1.8150	1.3527
1.8200	1.3540
1.8250	1.3553
1.8300	1.3566
1.8350	1.3578
1.8400	1.3590
1.8450	1.3602
1.8500	1.3613
1.8550	1.3624
1.8600	1.3635
1.8650	1.3645
1.8700	1.3655
1.8750	1.3665
1.8800	1.3674
1.8850	1.3683
1.8900	1.3692
1.8950	1.3700
1.9000	1.3708
1.9050	1.3715
1.9100	1.3723
1.9150	1.3729
1.9200	1.3736
1.9250	1.3742
1.9300	1.3748
1.9350	1.3753
1.9400	1.3758
1.9450	1.3763
1.9500	1.3767
1.9550	1.3771
1.9600	1.3775
1.9650	1.3778
1.9700	1.3781
1.9750	1.3783
1.9800	1.3786
1.9850	1.3787
1.9900	1.3789
1.9950	1.3790
2.0000	1.3790
2.0050	1.3790
2.0100	1.3790

z"	DIA
2.0150	1.3790
2.0200	1.3790
2.0250	1.3790
2.0300	1.3790
2.0350	1.3790
2.0400	1.3790
2.0450	1.3790
2.0500	1.3790
2.0550	1.3790
2.0600	1.3790
2.0650	1.3790
2.0700	1.3790
2.0750	1.3790
2.0800	1.3790
2.0850	1.3790
2.0900	1.3790
2.0950	1.3790
2.1000	1.3790
2.1050	1.3790
2.1100	1.3790
2.1150	1.3790
2.1200	1.3790
2.1250	1.3790
2.1300	1.3790
2.1350	1.3790
2.1400	1.3790
2.1450	1.3790
2.1500	1.3790
2.1550	1.3790
2.1600	1.3790

NO.	DATE	BY
REVISIONS		

NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES INC.
CHARLOTTESVILLE, VA.

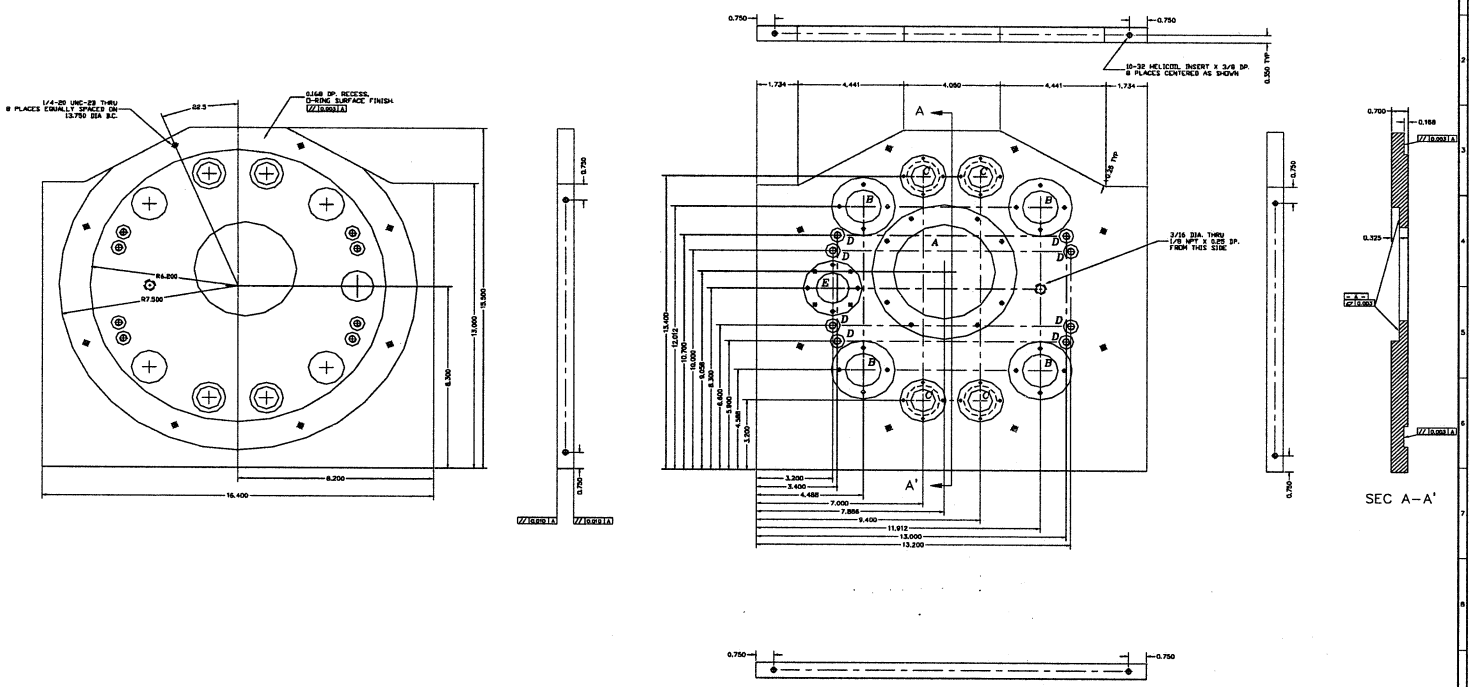
TITLE: FEEDHORN
GBT 40-52 GHZ RECEIVER

	NAME	DATE	
DESIGN	S.Srikanth		RECOMMENDED BY
DRAWN	S.Srikanth	7/98	ENGINEER
CHECKED			APPROVED
	NAME	DATE	NSRA NAME / DATE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
3 PLACE DECIMALS (.xxx) ± .0005
2 PLACE DECIMALS (.xx) ± .005
1 PLACE DECIMALS (.x) ±
FRACTIONS ±
MATERIAL: Copper
FINISH:

SCALE | SHEET 2 OF 2 | No.B10306M012 | REVISION

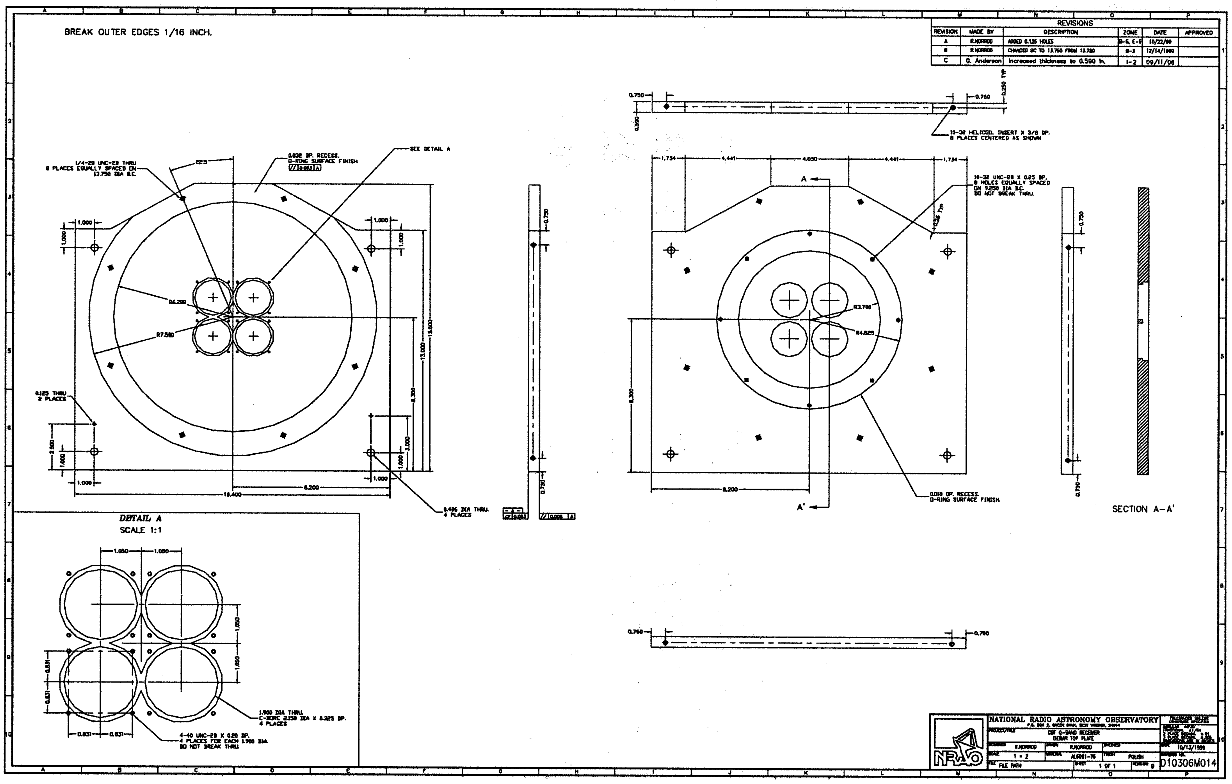
REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
A	RJNORROD	CHANGED BC TO 13.750 FROM 13.780	B-3	12/14/1999	



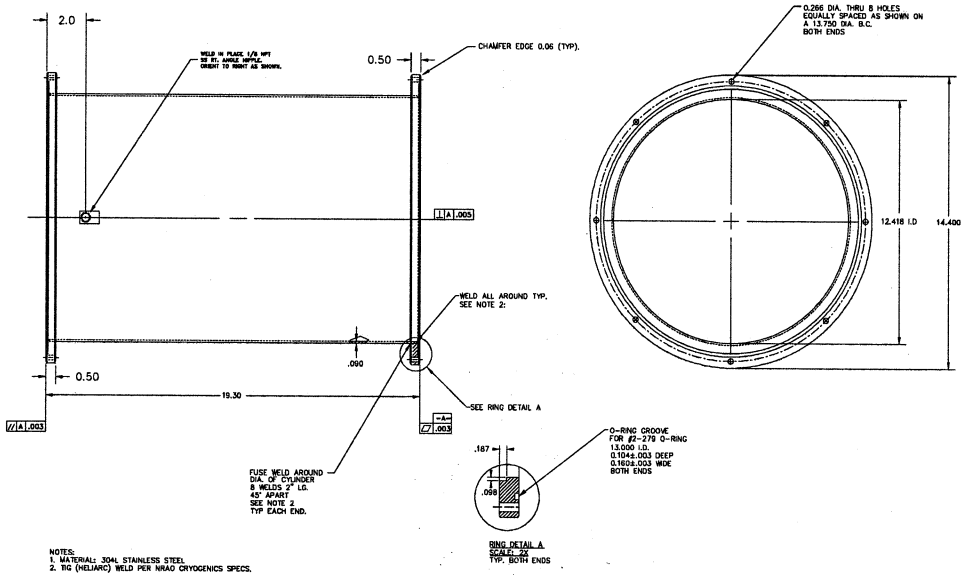
BREAK OUTER EDGES 1/16 INCH.

NOTE: DETAILS ON HOLES A-E FOUND ON SHEET 2.

NATIONAL RADIO ASTRONOMY OBSERVATORY P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944			
PROJECT/TITLE	DST O-RING RECEIVER CRYOSTAT BOTTOM PLATE		
DESIGNED	RJNORROD	DRAWN	RJNORROD
CHECKED		DATE	10/12/1999
SCALE	1 = 2	MATERIAL	AL6061-T6
FINISH	POLISH	DRAWING NO.	
FILE	FILE PATH	SHEET	1 OF 2
REVISION	A		D10306M013

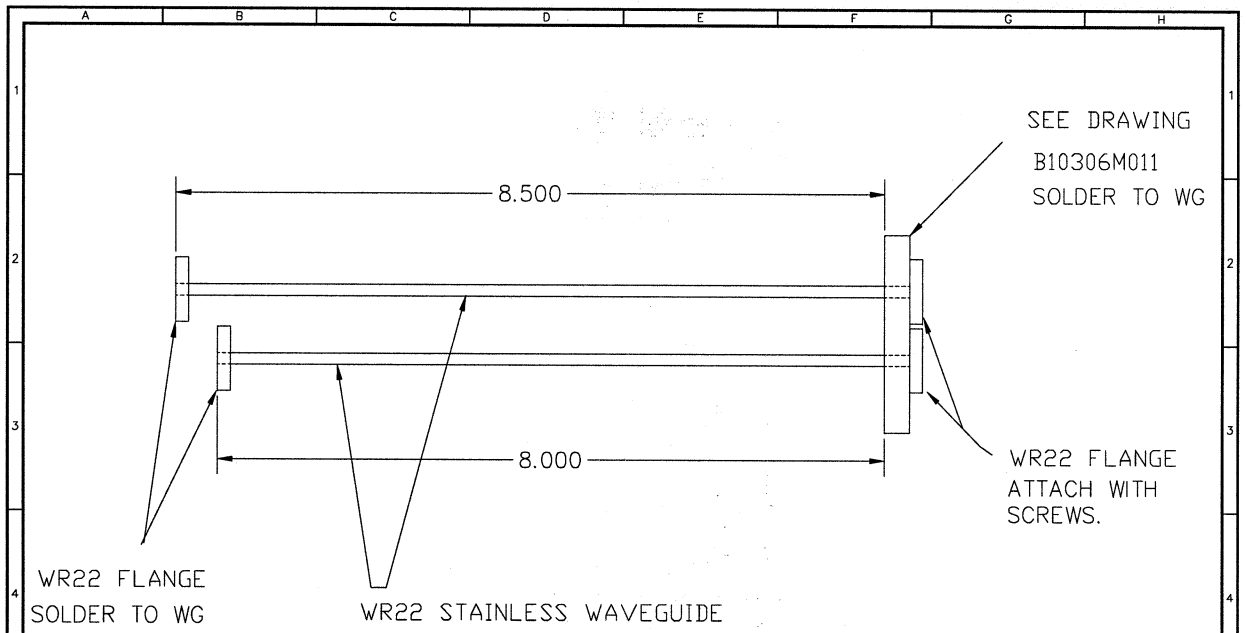

BREAK OUTER EDGES 1/16 INCH.
REVISIONS
REVISION | MADE BY | DESCRIPTION | ZONE | DATE | APPROVED
A | R.NORROD | ADDED 0.125 HOLES | | 10/22/99 |
B | R.NORROD | CHANGED BC TO 13.750 FROM 13.780 | B-3 | 12/14/1999 |
C | G. Anderson | Increased thickness to 0.590 in. | 1-2 | 09/11/06 |
10-32 HELICOIL INSERT X 3/8 DP.
8 PLACES CENTERED AS SHOWN
1/4-20 UNC-2B THRU
8 PLACES EQUALLY SPACED ON
13.750 DIA B.C.
SEE DETAIL A
10-32 UNC-2B X 0.25 DP.
8 HOLES EQUALLY SPACED
ON 9.250 DIA B.C.
DO NOT BREAK THRU
0.125 THRU
2 PLACES
0.010 DP. RECESS
O-RING SURFACE FINISH.
SECTION A-A'
DETAIL A
SCALE 1:1
1.900 DIA THRU
4 PLACES
4-40 UNC-2B X 0.20 DP.
4 PLACES FOR EACH 1.900 DIA
DO NOT BREAK THRU
NATIONAL RADIO ASTRONOMY OBSERVATORY
GBT Q-BAND RECEIVER
DEWAR TOP PLATE
R.NORROD
R.NORROD
1 = 2
AL6061-T6
POLISH
FILE PATH
1 OF 1
10/13/1999
D10306M014

REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
A	RJADRICO	ADDED NPT NIPPLE	C-1	10/22/98	
B	RJADRICO	CHANGED BC TO 13.750 FROM 13.700	M-2	1/14/2000	



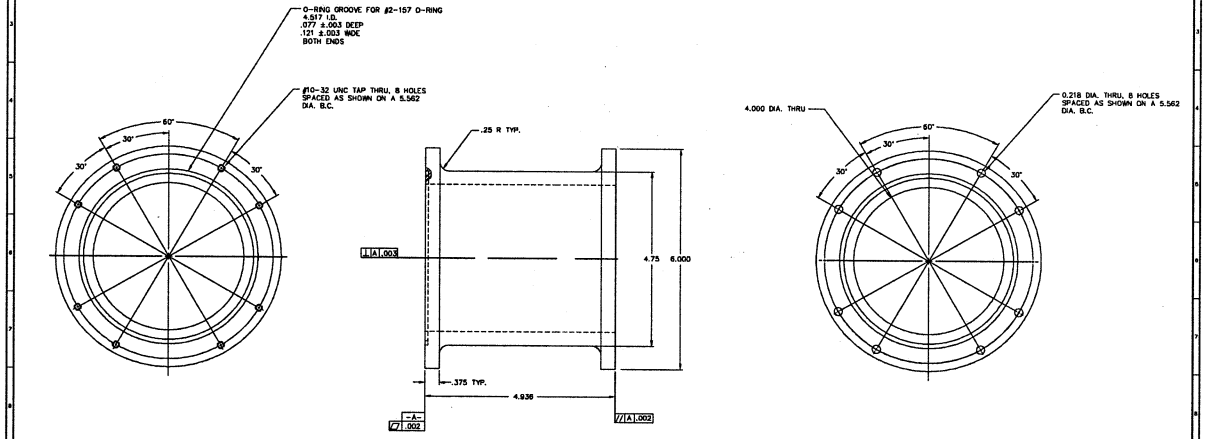
NOTES:
1. MATERIAL: 304L STAINLESS STEEL
2. TIG (HELIARC) WELD PER NRAO CRYOGENICS SPECS.

NATIONAL RADIO ASTRONOMY OBSERVATORY					
PROJECT/FAB: GBT 12-BMB RECEIVER CRYOSTAT CYLINDER					
DRAWN: RJADRICO	CHKD: RJADRICO	APPD:	DATE: 10/14/1998		
SCALE: 1 = 2	MATERIAL: 304L SS	FINISH: ELECTROPOLISH	DRAWING NO: 010306M015		
NEXT ASSY:	USED ON:	NEXT HIGHER ASSY:	SHEET: 1 OF 1	REVISION: B	



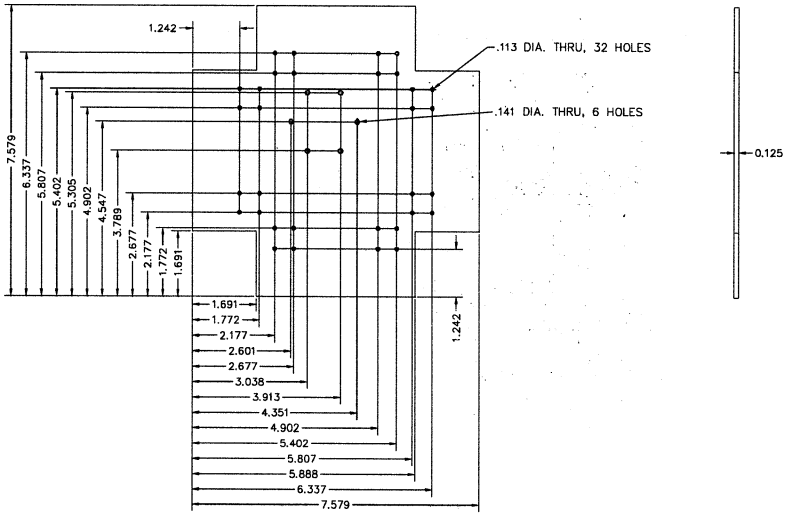
FINISH: GOLD FLASH BRASS; MASK SS.

NATIONAL RADIO ASTRONOMY OBSERVATORY P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944				TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ±0°30' FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
PROJECT/TITLE: GBT Q-BAND RECEIVER WAVEGUIDE FEEDTHRU ASSEMBLY				DATE: 10/19/1999
DESIGNED: W.GRAMMER	DRAWN: L.BEALE	CHECKED:		
SCALE: 1 = 1	MATERIAL: –	FINISH: SEE NOTE		DRAWING NO.: B10306M016
FILE: FILE PATH	SHEET: 1 OF 1	REVISION: –		



NOTES:
1. MATERIAL: 6061-T6 ALUMINUM
2. FINISH: 32 ALL OVER

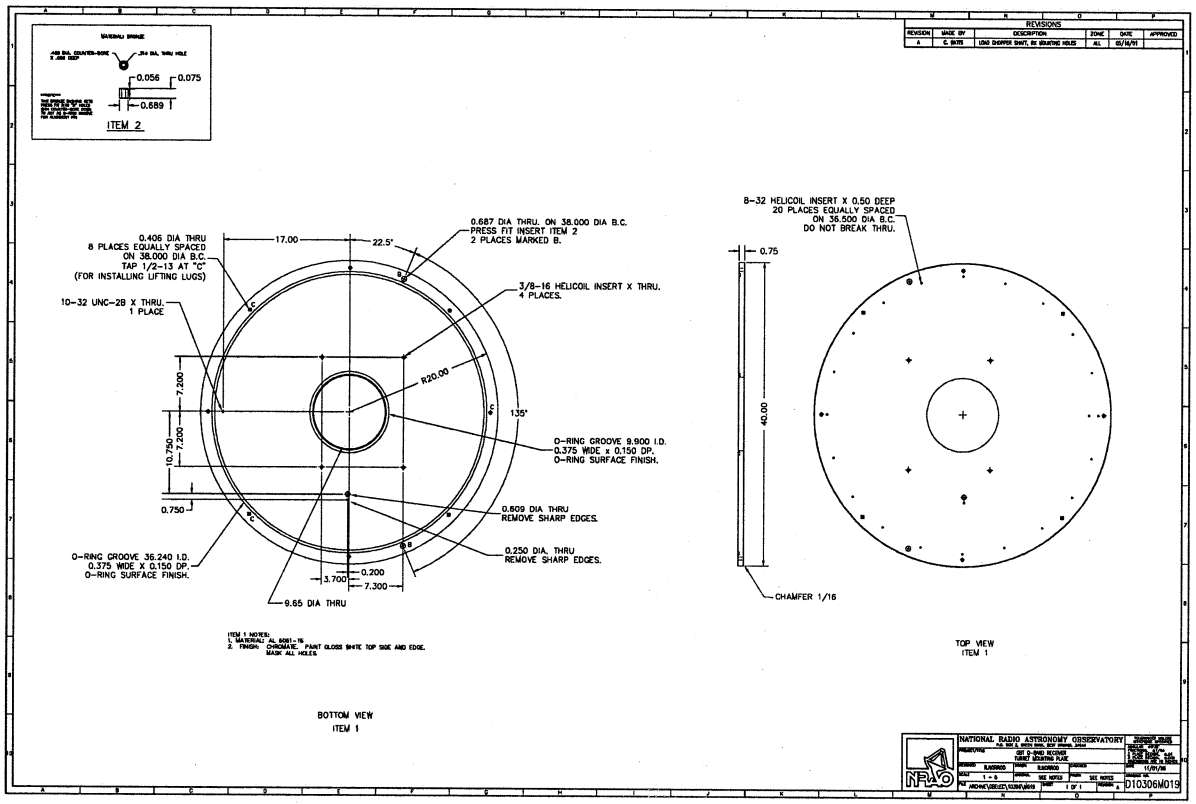
NRAO	NATIONAL RADIO ASTRONOMY OBSERVATORY		
	REFRIGERATOR ADAPTER		
	M.C		5/19/98
	1=1		D10306M017

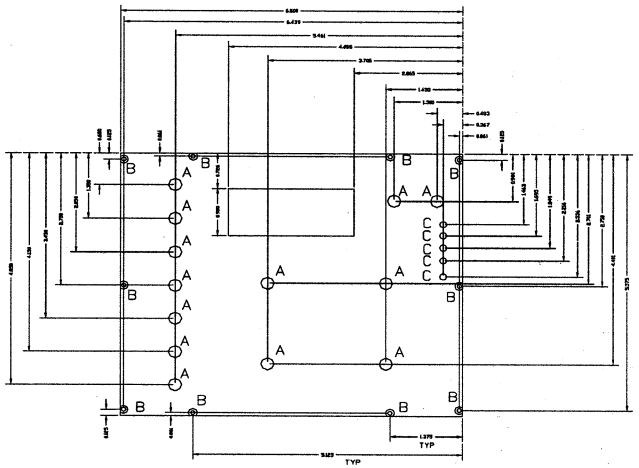


NOTE: ALL DIMENSIONS +/-0.001" TOLERANCE

NATIONAL RADIO ASTRONOMY OBSERVATORY

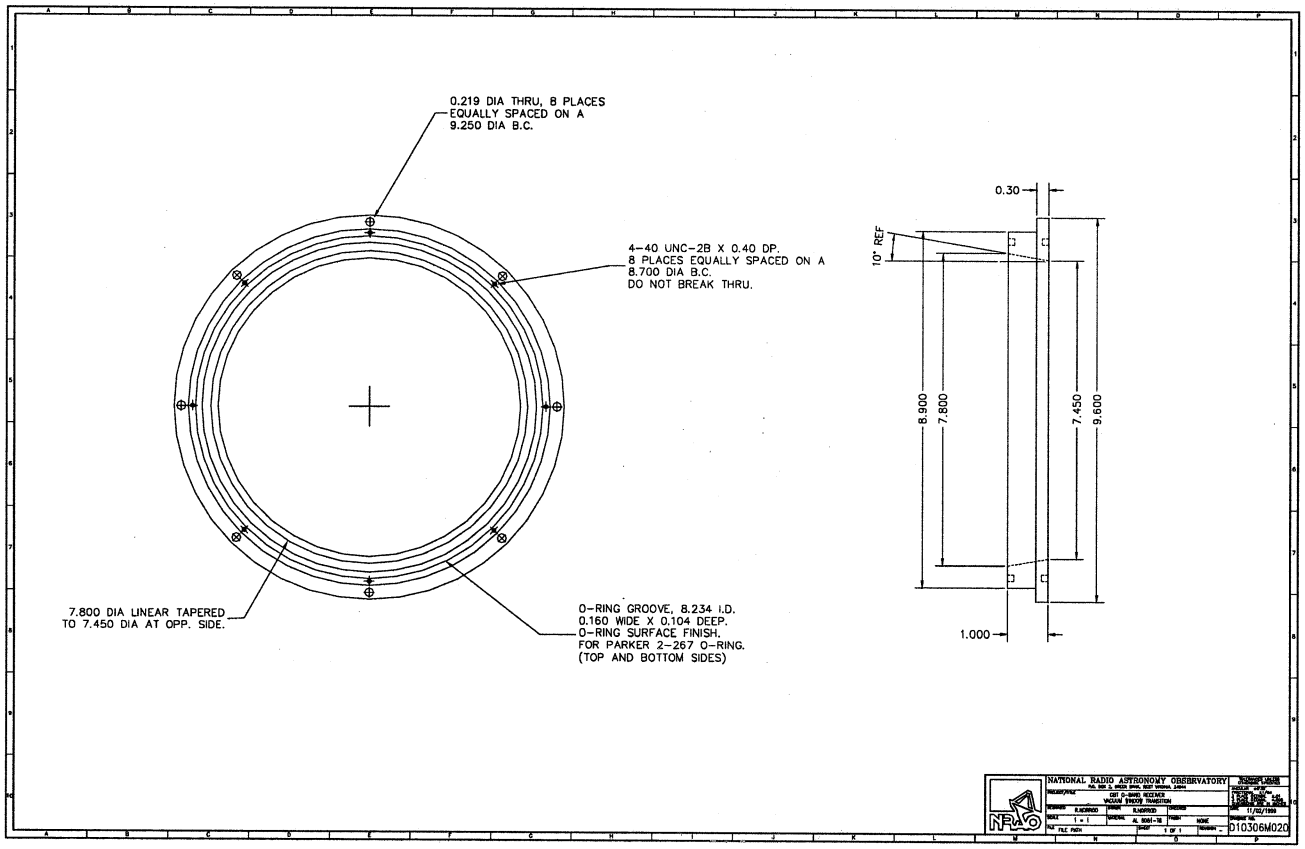
010306M018


REVISIONS
REVISION | MADE BY | DESCRIPTION | ZONE | DATE | APPROVED
A | C. SMITH | LOAD CHOPPER SHAFT, RE DRAWING HOLES | ALL | 02/15/01
MATERIAL: BRONZE
0.056
0.075
0.689
ITEM 2
0.406 DIA THRU
8 PLACES EQUALLY SPACED
ON 38.000 DIA B.C.
TAP 1/2-13 AT "C"
(FOR INSTALLING LIFTING LUGS)
10-32 UNC-2B X THRU.
1 PLACE
17.00
22.5°
0.687 DIA THRU. ON 38.000 DIA B.C.
PRESS FIT INSERT ITEM 2
2 PLACES MARKED B.
3/8-16 HELICOIL INSERT X THRU.
4 PLACES.
R20.00
135°
7.200
7.200
10.750
0.750
O-RING GROOVE 9.900 I.D.
0.375 WIDE x 0.150 DP.
O-RING SURFACE FINISH.
0.609 DIA THRU
REMOVE SHARP EDGES.
0.250 DIA. THRU
REMOVE SHARP EDGES.
O-RING GROOVE 36.240 I.D.
0.375 WIDE X 0.150 DP.
O-RING SURFACE FINISH.
0.200
3.700
7.300
9.65 DIA THRU
ITEM 1 NOTES:
1. MATERIAL: AL 6061-T6
2. FINISH: CHROMATE. PAINT GLOSS WHITE TOP SIDE AND EDGE. MASK ALL HOLES.
BOTTOM VIEW
ITEM 1
8-32 HELICOIL INSERT X 0.50 DEEP
20 PLACES EQUALLY SPACED
ON 36.500 DIA B.C.
DO NOT BREAK THRU.
0.75
40.00
CHAMFER 1/16
TOP VIEW
ITEM 1
NATIONAL RADIO ASTRONOMY OBSERVATORY
SIZE D-SIZE RECEIVER TURRET MOUNTING PLATE
DRAWN: R.NORRIS
CHECKED: R.NORRIS
APPROVED: 11/01/00
SCALE: 1 = 5
MATERIAL: SEE NOTES
FINISH: SEE NOTES
DRAWING NO. D10306M019
SIZE: A
SHEET: 1 OF 1
REVISION: A



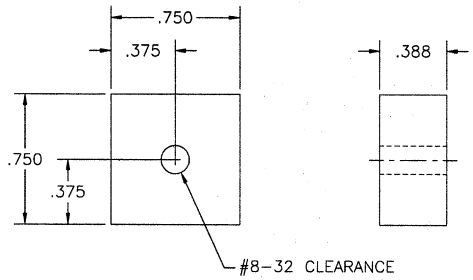
A – .250 TO .260 DIA THRU HOLES
B – #2 CLEARANCE COUNTER SUNK
C – .136 DIA THRU HOLES

NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ: GBT 40-52 GHZ RX	TITLE: LOCAL MONITOR BOX FRONT PLATE		
MATERIAL: AL6061-T6		DRAWN BY: R. NORROD	DATE: 1/24/00
FINISH: CHROMATE		DESIGN BY: R. NORROD	DATE: 1/24/00
SHEET: 1 OF 1	DRAWING NUMBER: C10306M024	REV:	SCALE: 1:1



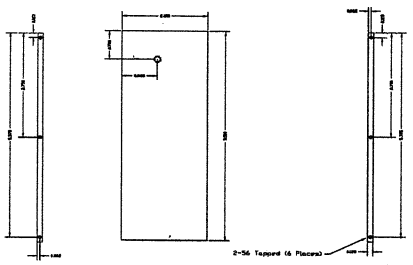
NATIONAL RADIO ASTRONOMY OBSERVATORY

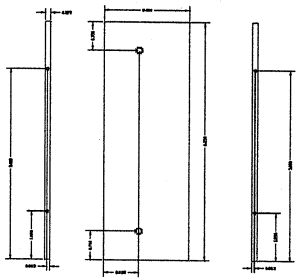
D10306M020



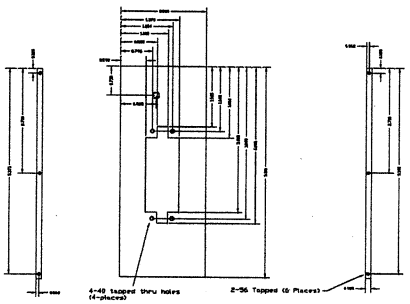
NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE: Q-BAND RECEIVER CARD CAGE SPACER BLOCK				TOLERANCES UNLESS OTHERWISE SPECIFIED: ANGULAR ±0°30' FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
DESIGNED: L. BEALE	DRAWN: R. TAGGART	CHECKED:		DATE: 11/11/99
SCALE: 2X	MATERIAL: ALUMINUM	FINISH: CHROMATE		DRAWING NO.: B10306M021
FILE: ARCHIVE\GBELEC\10306\M021	SHEET: 1 OF 1	REVISION: _		

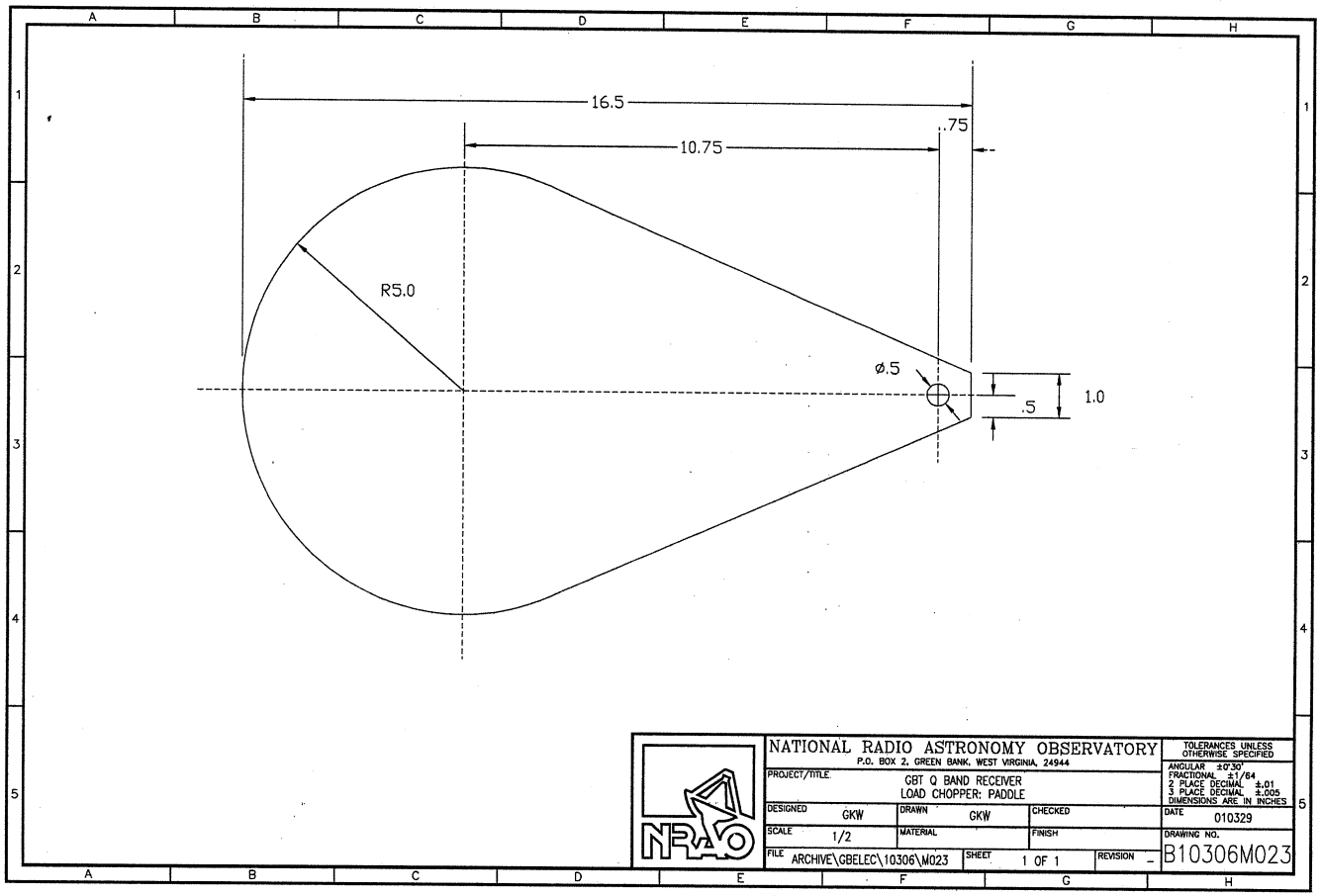




2 REQUIRED

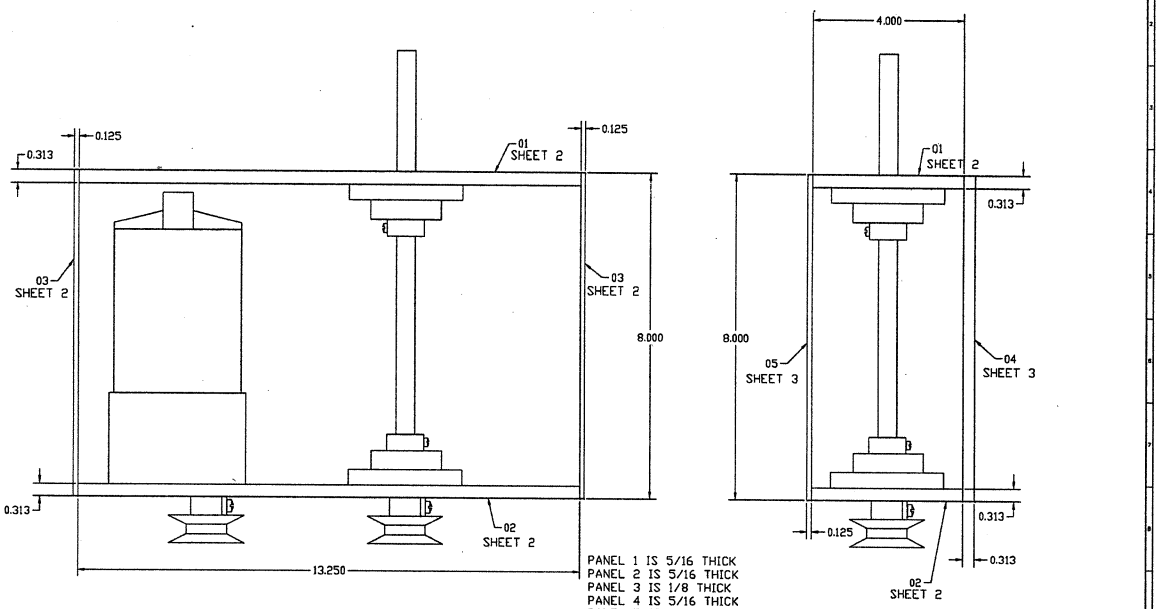


NATIONAL RADIO ASTRONOMY OBSERVATORY GREEN BANK, WV 24944			
PROJ: GBT 40-50 GHz RECEIVER	TITLE: MANUAL/MONITOR BOX SIDE PLATES		
MATERIAL: ALUMINUM	DRAWN BY: MMASTERMAN		DATE: 12/16/99
FINISH: CHROMATE	SCHEM BY: MMASTERMAN		DATE: 4/93
SHEET: 1 OF 1	DRAWING NUMBER: D10306M022	REV:	SCALE: 1:1



NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE: GBT Q BAND RECEIVER LOAD CHOPPER: PADDLE			TOLERANCES UNLESS OTHERWISE SPECIFIED: ANGULAR ±0°30' FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
DESIGNED: GKW	DRAWN: GKW	CHECKED:	DATE: 010329
SCALE: 1/2	MATERIAL:	FINISH:	DRAWING NO.: B10306M023
FILE: ARCHIVE\GBELEC\10306\M023	SHEET: 1 OF 1	REVISION: _	

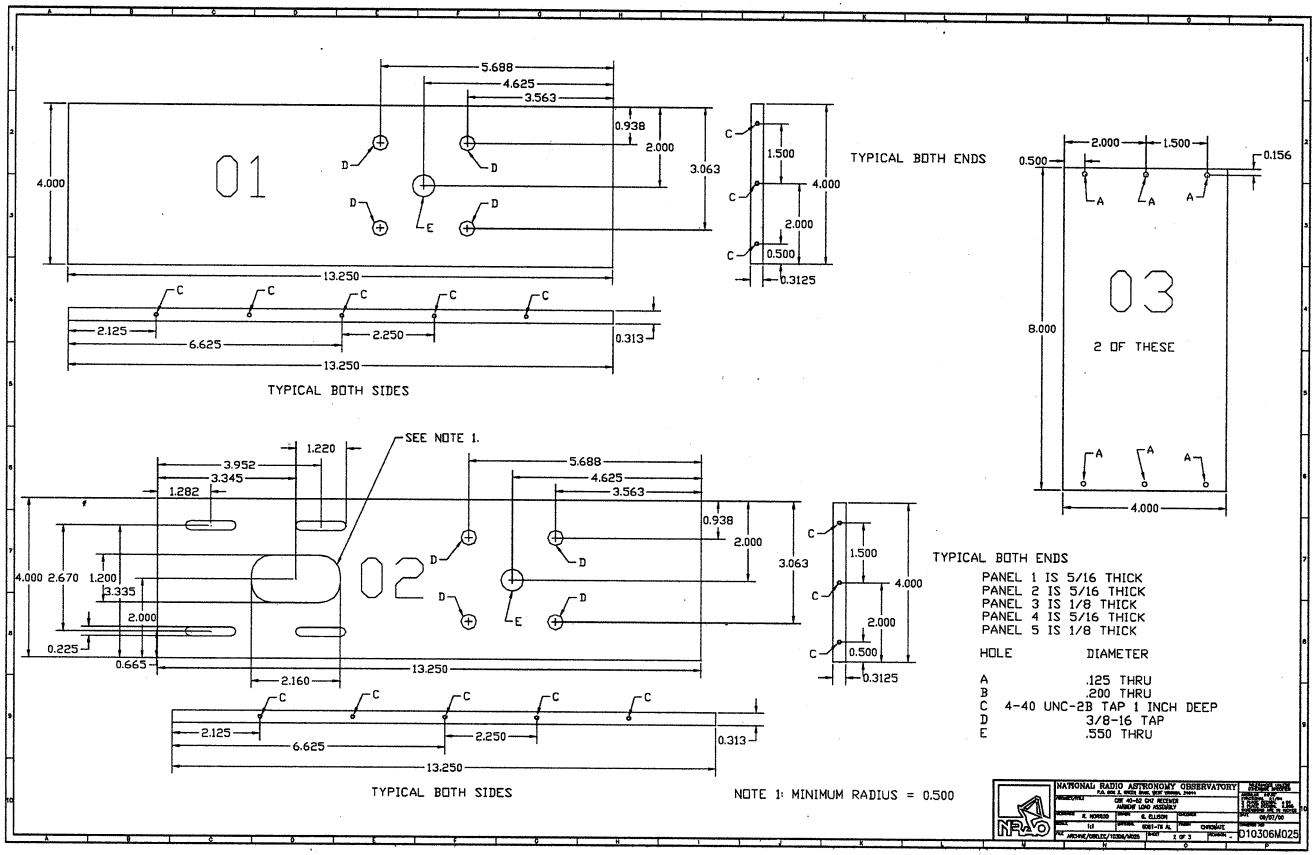


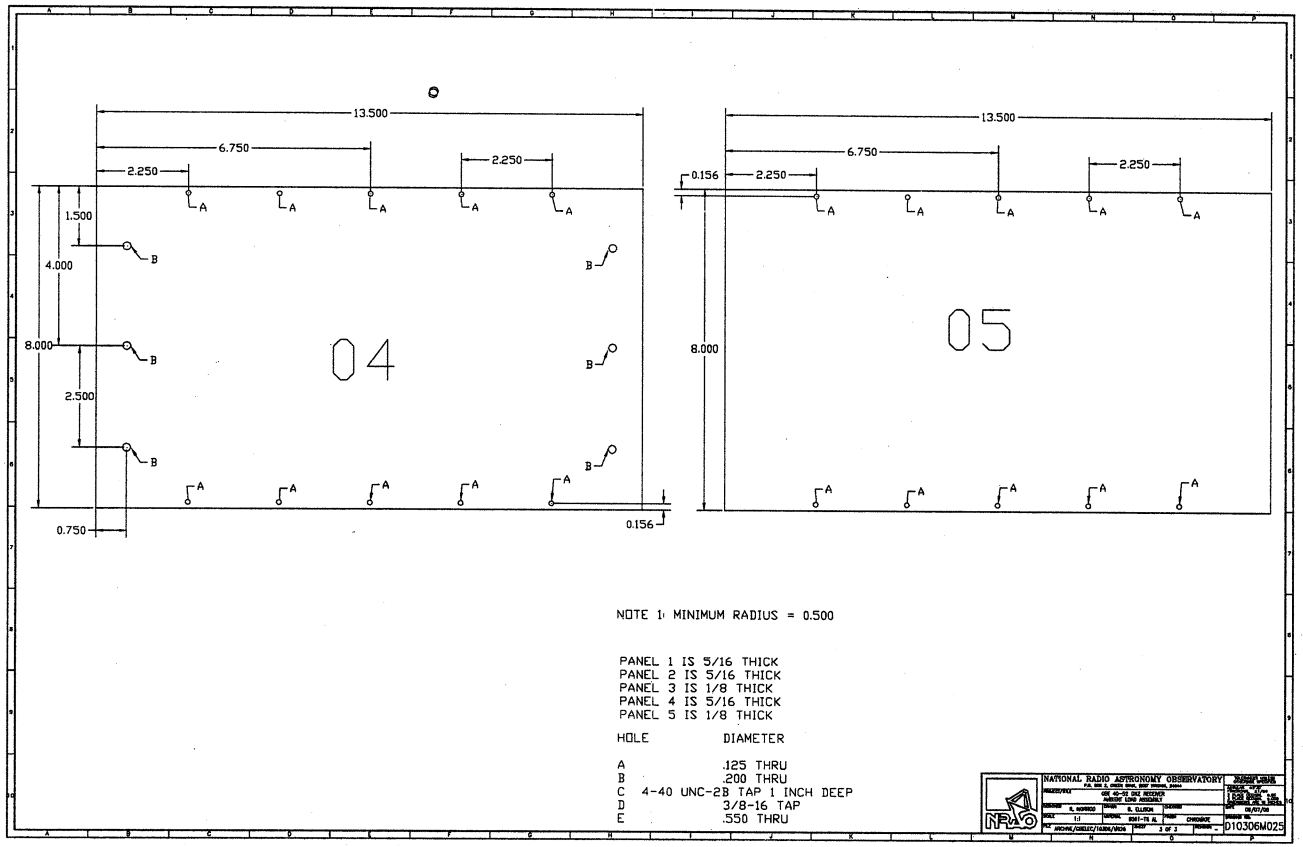
PANEL 1 IS 5/16 THICK
PANEL 2 IS 5/16 THICK
PANEL 3 IS 1/8 THICK
PANEL 4 IS 5/16 THICK
PANEL 5 IS 1/8 THICK

HOLE	DIAMETER
A	.125 THRU
B	.200 THRU
C	4-40 UNC-2B TAP 1 INCH DEEP
D	3/8-16 TAP
E	.550 THRU

NATIONAL RADIO ASTRONOMY OBSERVATORY

D10306M025


01
5.688
4.625
3.563
0.938
2.000
3.063
4.000
13.250
1.500
0.500
0.3125
2.125
6.625
2.250
0.313
TYPICAL BOTH SIDES
TYPICAL BOTH ENDS
03
2 OF THESE
2.000
1.500
0.156
0.500
8.000
02
SEE NOTE 1.
1.220
3.952
3.345
1.282
2.670
1.200
3.335
0.225
0.665
2.160
TYPICAL BOTH SIDES
TYPICAL BOTH ENDS
PANEL 1 IS 5/16 THICK
PANEL 2 IS 5/16 THICK
PANEL 3 IS 1/8 THICK
PANEL 4 IS 5/16 THICK
PANEL 5 IS 1/8 THICK
HOLE DIAMETER
A .125 THRU
B .200 THRU
C 4-40 UNC-2B TAP 1 INCH DEEP
D 3/8-16 TAP
E .550 THRU
NOTE 1: MINIMUM RADIUS = 0.500
NATIONAL RADIO ASTRONOMY OBSERVATORY
D10306M025



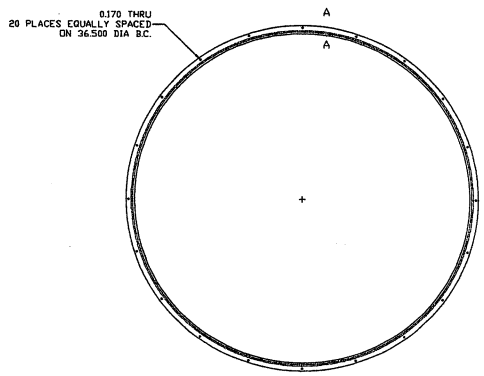
NOTE 1: MINIMUM RADIUS = 0.500

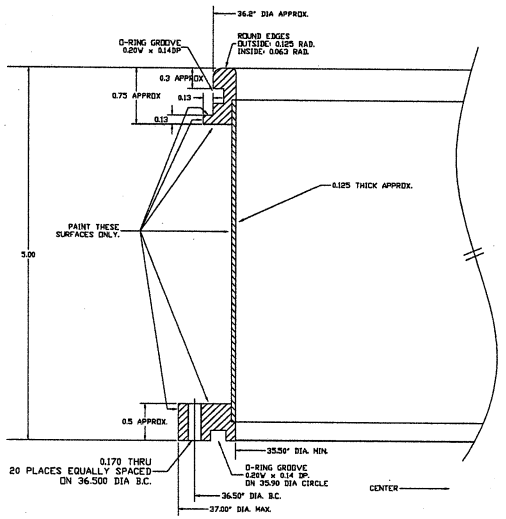
PANEL 1 IS 5/16 THICK
PANEL 2 IS 5/16 THICK
PANEL 3 IS 1/8 THICK
PANEL 4 IS 5/16 THICK
PANEL 5 IS 1/8 THICK

HOLE	DIAMETER
A	.125 THRU
B	.200 THRU
C	4-40 UNC-2B TAP 1 INCH DEEP
D	3/8-16 TAP
E	.550 THRU

NATIONAL RADIO ASTRONOMY OBSERVATORY

D10306M025





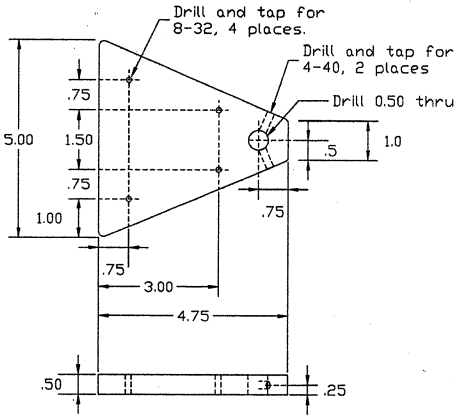
SECTION A-A

NOTES:
1. MATERIAL: AL 6061-T6
2. FINISH: CHROMATE. PAINT GLOSS WHITE AS INDICATED.

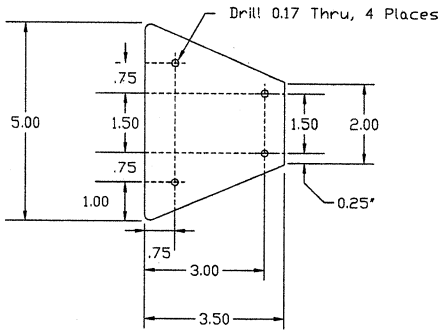
NATIONAL RADIO ASTRONOMY OBSERVATORY

D10306M026

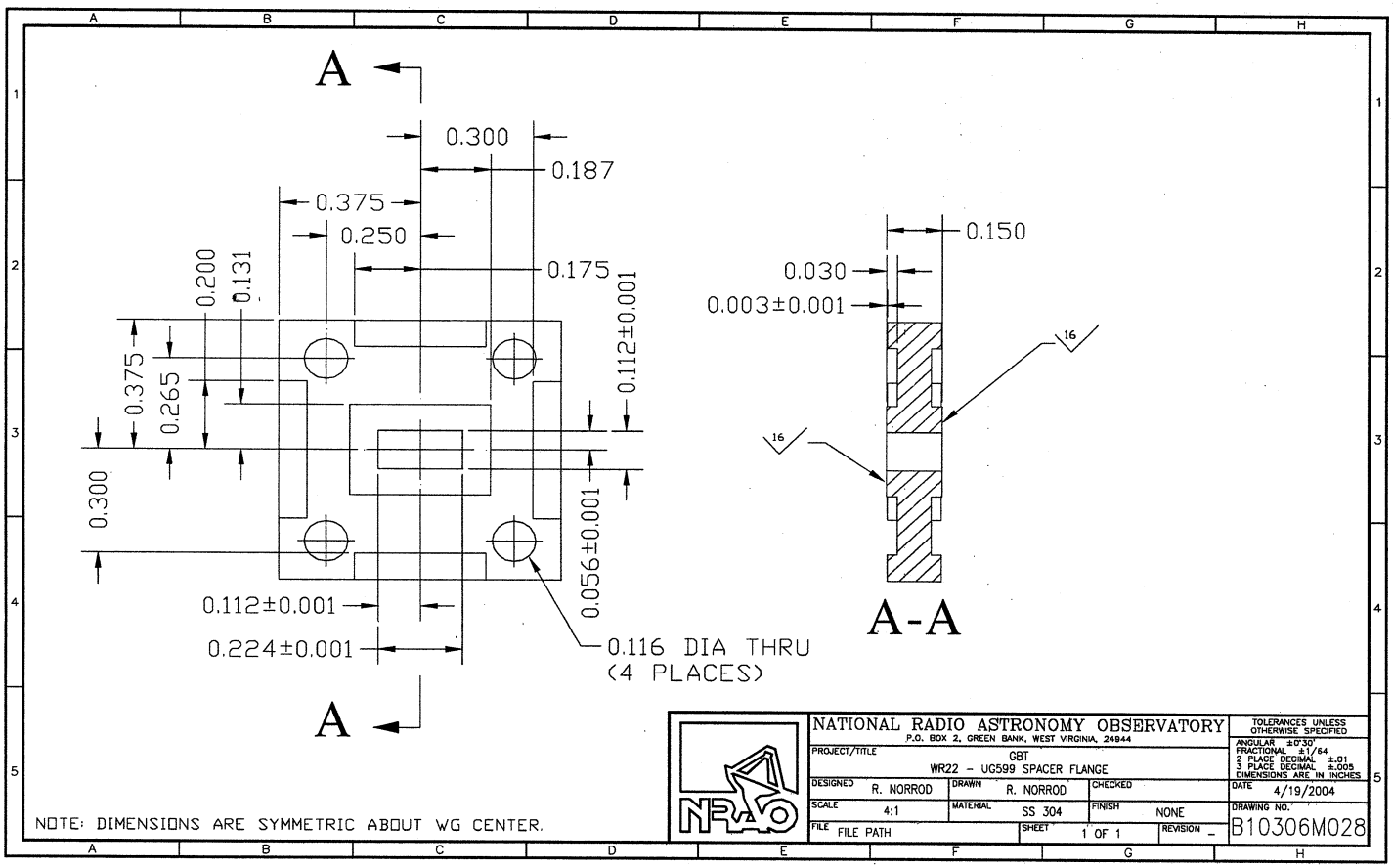
BRACKET



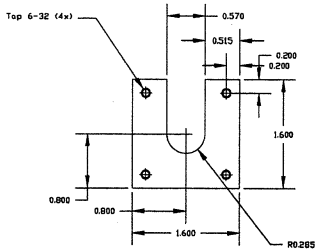
PLATE, THICKNESS: 0.125

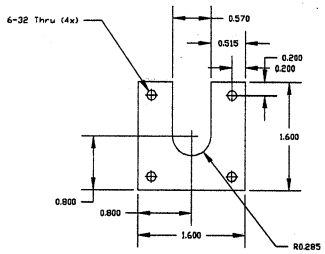


NATIONAL RADIO ASTRONOMY OBSERVATORY P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944				TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ±0'30" FRACTIONAL ±1/64 2 PLACE DECIMAL ±.01 3 PLACE DECIMAL ±.005 DIMENSIONS ARE IN INCHES
PROJECT/TITLE: GBT Q BAND RECEIVER LOAD CHOPPER: PADDLE BRACKET				DATE: 010329
DESIGNED: GKW	DRAWN: GKW	CHECKED		
SCALE: 1/2	MATERIAL: ALUMINUM	FINISH: CHROMATE		DRAWING NO.: B10306M027
FILE: ARCHIVE\GBELEC\10306\M027	SHEET: 1 OF 1	REVISION		


A
0.300
0.187
0.375
0.250
0.175
0.200
0.131
0.112±0.001
0.375
0.265
0.300
0.056±0.001
0.112±0.001
0.224±0.001
0.116 DIA THRU
(4 PLACES)
A
0.150
0.030
0.003±0.001
16
16
A-A
NOTE: DIMENSIONS ARE SYMMETRIC ABOUT WG CENTER.
NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944
PROJECT/TITLE
GBT
WR22 – UG599 SPACER FLANGE
DESIGNED R. NORROD
DRAWN R. NORROD
CHECKED
SCALE 4:1
MATERIAL SS 304
FINISH NONE
FILE FILE PATH
SHEET 1 OF 1
REVISION –
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES
DATE 4/19/2004
DRAWING NO.
B10306M028

REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
X	X	X	X-X	XX/XX/XX	





ITEM	PART NO.	QTY	DESCRIPTION	MATL
X	X	X	X	X

PARTS LIST

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

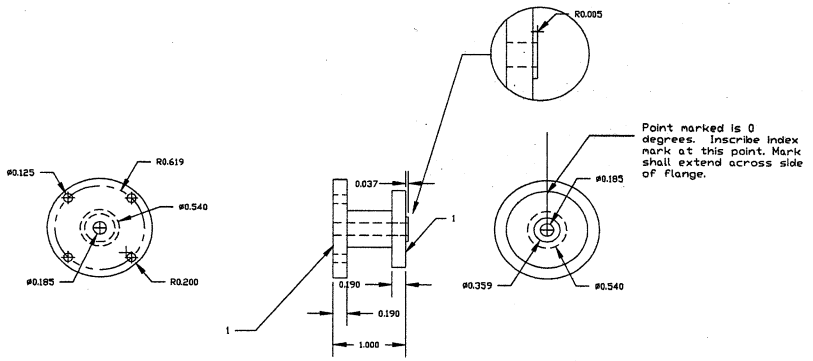
PROJECT/TITLE	GBT 40-52 GHz Receiver Septum Polarizer Test Fixture			
DESIGNED	G. Anderson	DRAWN G. Anderson	CHECKED	
SCALE	1 in. = 1 in.	MATERIAL .090 AL	FINISH X	
FILE	FILE PATH	SHEET 3 OF 3	REVISION X	

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES

DATE 11/10/05

DRAWING NO. B10306M029

REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
X	X	X	X-X	XX/XX/XX	



ITEM	PART NO.	QTY	DESCRIPTION	MATL
X	X	X	X	X

PARTS LIST

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE: GBT 40-52 GHz Receiver
Septum Polarizer Test Fixture

DESIGNED: C. Anderson | DRAWN: C. Anderson | CHECKED:

SCALE: 1 in. = 1 in. | MATERIAL: AL | FINISH: X

FILE: FILE PATH | SHEET: 1 OF 3 | REVISION: 0

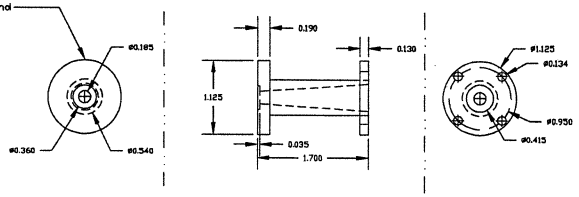
TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES

DATE: 11/10/05

DRAWING NO.: B10306M029

REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
X	X	X	X-X	XX/XX/XX	

Inscribe at this point and every 10 deg. around circumference. Index point shall extend across side of flange.



ITEM	PART NO.	QTY	DESCRIPTION	MATL
X	X	X	X	X

PARTS LIST

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE	GBT 40-52 GHz Receiver Septum Polarizer Test Fixture		
DESIGNED	G. Anderson	DRAWN G. Anderson	CHECKED
SCALE	1 in. = 1 in.	MATERIAL AL	FINISH X
FILE	FILE PATH	SHEET 2 OF 3	REVISION X

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES
DATE 11/10/05
DRAWING NO. B10306M029

Section IV
Parts List

GBT Q-Band Receiver Parts List

Reference Designator	Description
Dewar	
A1	Amplifier, Q-Band , NRAO NTC
A2	Amplifier, Q-Band , NRAO NTC
A3	Amplifier, Q-Band , NRAO NTC
A4	Amplifier, Q-Band , NRAO NTC
Feeds (4)	Feed, GBT Q-Band, NRAO NTC
CR1	Isolator, Dorado, 4IWC47-1
CR2	Isolator, Dorado, 4IWC47-1
CR3	Isolator, Dorado, 4IWC47-1
CR4	Isolator, Dorado, 4IWC47-1
	Specified to cover 42-52 GHz. By measurement, they work well down to 40 GHz
	Make sure any replacements do, also.
	(The original item was specified from 40-50 GHz, Dorado 4IWC46-1)
PL1	Septum Polarizer, Atlantic Microwave AMC-1233
PL2	Septum Polarizer, Atlantic Microwave AMC-1233
	Note: Noise cal couplers are a part of the Septum Polarizer as purchased.
Dewar, Mechanical	
Conflat Tee	Varian, FT0150, 1.5 in.
Conflat Double Flange	Varian, FD2750150E75
Conflat/KF-40 Adaptor	Varian, FA0275NW40S
Connector	For LNA (Micro D), ITT/Cannon M83513/02-BN
Connector	23 Pin Hermetic, Detronics, DTIH16-23PN
Connector	SMA, Hermetic Feedthrough, M/A COM 2084-1100-00
Feedthru, SMA	MA/Com, 2084-8001-90, (8)
Feedthru, DC	Deteronics, 23PDTIH1623PN, (4)
Foam Window	Ecco-foam, PS-102 (old style)
Heater	Hotwatt, SC25-2.25 (2)
O-Ring (refrigerator)	Parker, 2-157 (2)
O-Ring (upper dewar)	Parker, 2-279
O-Ring (lower dewar)	Parker, 2-279
O-Ring (Vac window)	Parker, 2-267
O-Ring (Kapton Window)	Parker, 2-267
O-Ring (W'v'g Feedthru)	Parker 2-030
O-Ring (Vac Adapt)	Parker 2-222
O-Ring (W'v'g Window)	Parker, 2-012 (8)
Pipe fitting	1/8 NPT nipple
Refrigerator	Refrigerator, Model 1020, CTI
Temperature Sensor	Lakeshore, DT-471 (2)
Thermostat	Elmwood, 3450-87-315-L140 (2)
Vacuum Gasket	Varian, Conflat Gasket, FG0275CI, (5)
Vacuum Connector	Varian, NW-40, KQ40AWP
Vacuum Connector	Varian, NW-40 Centering Ring, KC40SV
Vacuum Window	Kapton, 5 mil
Vacuum Valve	Varian, Right Angle, L6591307
Vacuum Guage Tube	Hastings, DV-6M

Waveguide	Aerowave, PN22-0914 Stainless (.010 wall)
Waveguide	Aerowave, PN22-0914 OFHC Copper (.040 wall)
Window Cover Plate	B10306M001
Window Foam Insert	B10306M002
	B10306M003
Feed Locator	B10306M004
Dewar 50K plate	D10306M005
Heat Shield Tab	B10306M006
Dewar Heat Shield	D10306M007
Window Cap Ring	B10306M008
Radome Support	D10306M009
Charcoal Trap	C10306M010
Waveguide Feedthru Plate	B10306M011
Feedhorn	B10306M012
Dewar Bottom Plate	D10306M013
Dewar Top Plate	D10306M014
Dewar Cylinder	D10306M015
Waveguide Feedthru Assembly	D10306M016
Bias Feedthru Plate	A35240M016
Refrigerator Adaptor	D10306M017
Dewar 15K Plate	D10306M018
Vacuum Port Adaptor	B35248M038

Room Temp, Elect

A5	Amplifier, Q-Band, NRAO NTC
A6	Amplifier, Q-Band, NRAO NTC
A7	Amplifier, Q-Band, NRAO NTC
A8	Amplifier, Q-Band, NRAO NTC
A9	Amplifier, 4-8 GHz, NRAO GB (S. White design)
A10	Amplifier, 4-8 GHz, NRAO GB (S. White design)
A11	Amplifier, 4-8 GHz, NRAO GB (S. White design)
A12	Amplifier, 4-8 GHz, NRAO GB (S. White design)
A13	Amplifier, 8-12 GHz, JCA, 812-275
AT1	Attenuator, WR-22, Waveguide, NRAO-GB, 12 db, positive gain slope
AT2	Attenuator, WR-22, Waveguide, NRAO-GB, 12 db, positive gain slope
AT3	Attenuator, WR-22, Waveguide, NRAO-GB, 12 db, positive gain slope
AT4	Attenuator, WR-22, Waveguide, NRAO-GB, 12 db, positive gain slope
AT5	Attenuator, WR-22, Waveguide, NRAO-GB, 4 db, flat response
AT6	Attenuator, WR-22, Waveguide, NRAO-GB, 4 db, flat response
AT7	Attenuator, WR-22, Waveguide, NRAO-GB, 4 db, flat response
AT8	Attenuator, WR-22, Waveguide, NRAO-GB, 4 db, flat response
AT9	Attenuator, WR-22, Waveguide, NRAO-GB, 3 dB, positive gain slope
AT10	Attenuator, WR-22, Waveguide, NRAO-GB, 3 dB, positive gain slope
AT11	Attenuator, WR-22, Waveguide, NRAO-GB, 3 dB, positive gain slope
AT12	Attenuator, WR-22, Waveguide, NRAO-GB, 3 dB, positive gain slope
AT13	Attenuator, 18 GHz, Coaxial SMA, Midwest Microwave ATT-0263
AT14	Attenuator, 18 GHz, Coaxial SMA, Midwest Microwave ATT-0263
AT15	Attenuator, 18 GHz, Coaxial SMA, Midwest Microwave ATT-0263

AT16	Attenuator, 18 GHz, Coaxial SMA, Midwest Microwave ATT-0263
AT17	Attenuator, Variable, Aerowave, 22-2100
AT18	Attenuator, Variable, Aerowave, 22-2100
AT19	Attenuator, 18 GHz, Coaxial SMA, Midwest Microwave ATT-0263, Value Select-a Test
C1	DC Block, M/A COM, 2046-6030-00
C2	DC Block, M/A COM, 2046-6030-00
CR5	Isolator, Q-Band,Dorado, 4IWC47-2
CR6	Isolator, Q-Band,Dorado, 4IWC47-2
CR7	Isolator, Q-Band,Dorado, 4IWC47-2
CR8	Isolator, Q-Band,Dorado, 4IWC47-2
CR9	Isolator, 4-8 GHz, SMI, SMI-4080-12
CR10	Isolator, 4-8 GHz, SMI, SMI-4080-12
CR11	Isolator, 4-8 GHz, SMI, SMI-4080-12
CR12	Isolator, 4-8 GHz, SMI, SMI-4080-12
CR13	Isolator, 4-8 GHz, SMI, SMI-4080-21
CR14	Isolator, 4-8 GHz, SMI, SMI-4080-21
CR15	Isolator, 4-8 GHz, SMI, SMI-4080-21
CR16	Isolator, 4-8 GHz, SMI, SMI-4080-21
CR17	Isolator, 8-12 GHz, SMI, SMI-7012-12
CR18	Isolator, 8-12 GHz, SMI, SMI-7012-12
CR19	Isolator, 8-12 GHz, SMI, SMI-7012-12
CR20	Isolator, 8-12 GHz, SMI, SMI-7012-12
CR21	Isolator, 33-50 GHz, MRI, FRQ-500
CR22	Isolator, 33-50 GHz, MRI, FRQ-500
D1	Tunnel Diode detector, Herotek, DT8012
DC1	Coupler, 10 dB, MAC Technologies, C3205-10
DC2	Coupler, 10 dB, MAC Technologies, C3205-10
DC3	Coupler, 10 dB, MAC Technologies, C3205-10
DC4	Coupler, 10 dB, MAC Technologies, C3205-10
DC5	Coupler, 20 dB, MAC Technologies, C3206-20
FL1	Filter, Bandpass, Q-Band, Spacek, F45-9
FL2	Filter, Bandpass, Q-Band, Spacek, F45-9
FL3	Filter, Bandpass, Q-Band, Spacek, F45-9
FL4	Filter, Bandpass, Q-Band, Spacek, F45-9
FL5	Filter, Bandpass, 4-8 GHz, Salisbury Microwave, CVE-11-6000-X4000-M/M
FL6	Filter, Bandpass, 4-8 GHz, Salisbury Microwave, CVE-11-6000-X4000-M/M
FL7	Filter, Bandpass, 4-8 GHz, Salisbury Microwave, CVE-11-6000-X4000-M/M
FL8	Filter, Bandpass, 4-8 GHz, Salisbury Microwave, CVE-11-6000-X4000-M/M
FL9	Filter, Bandpass, 34-42 GHz, Spacek, Fc1-38-7
FL10	Filter, Bandpass, 34-42 GHz, Spacek, Fc1-38-7
M1	Multiplier, x4, NARDA/DBS Microwave, DB99-0582
M2	Multiplier, x4, NARDA/DBS Microwave, DB99-0582 NOTE: Ensure that the waveguide flange is for WR-22 waveguide.
MX1	Mixer, Q-Band, Spacek, MQQ-11B (special)
MX2	Mixer, Q-Band, Spacek, MQQ-11B (special)
MX3	Mixer, Q-Band, Spacek, MQQ-11B (special)
MX4	Mixer, Q-Band, Spacek, MQQ-11B (special)
NS1	Noise Source, NoiseCom, NC5222: WR22 w/ UG383U flange
NS2	Noise Source, NoiseCom, NC5222: WR22 w/ UG383U flange
PS1	Power Divider, MAC Technologies, P8205-2

PS2	Power Divider, MAC Technologies, P8205-2
PS3	Divider, 4-way, MAC Technologies, P8206-4
PS4	Divider, 4-way, MAC Technologies, P8206-4

Connector	23 Pin Hermetic, Detronics, DTIH16-23S
Connector	Elco, 38-Pin, 8016038000702 (7)
Connector	Amphenol, BNC feedthru, 7486UG625U (2)
Connector	Amphenol, 10-pin, circular, MS3102A1801P
Connector	Burndy, Cable-mount, 23-pin circular, MS3116F1623S
Connector	Cinch, edge-card, 44-pin, 5044A30 (14)
Connector	Deutsch, 3-pin, chassis-mount, DM96063P
Connector	Deutsch, 3-pin, cable, DM96063P
Connector	ELCO, 56-pin,
Connector	Cinch, 50-pin D, DD050S (4)
Connector	Acculex, meter, C-12
Knob, Pointer	PPC, 7041G
Meter	Acculex, DP2002A
Relay	Gordos, solid-state, GA84B02 (2)
Switch, Toggle	Alcoswitch, A101SYCB
Switch, Rotary	Grayhill, 2P6T, 51CD30012AJN
Switch, Rotary	Grayhill, 2P12T, 71AD30021AJN

Box Bottom Plate	C35246M009
Box Front Plate	C10306M024
Box Side Plates	D35246M008
Cardcage Edge Connector Rail	D35246M011
Cardcage End Plate	D35246M012
Cardcage Bottom Plate	D35246M013
Cardcage Top Plate	D35246M014
Cardcage Conn End Plate	D35246M015
Cardcage Rail Guide Bracket	D35246M018
Cardcage Rail Block	D35246M019
Cardcage Spacer Block	D10306M021

Section V
Wiring List

GBT Q-Band Receiver
40-52 GHz

Cardcage Wiring List

A10306W001

REFERENCE:

Cardcage Bill of Materials:	A10306B003	
Receiver Bill of Materials:	A10306B001	
	Receiver Block Diagram:	D10306K001

Created: January 14, 2000

: R. D. Norrod

System: Q-Band Receiver

Slot: 1 Conn Type: 22Pin Edgecard

Card: HFET Bias, Ch R1

Pin	Function	To	Color		
A	GROUND	BUS	BUS		
B	+15 Volts	BUS	BUS		
C	-15 Volts	BUS	BUS		
D	Gate 4	P3-S	7XX		
E	Gate 3	P3-R	98X		
F	Gate 2	P3-Y	4XX		
H	Gate 1	P3-M	90X		
J					
K	Drain 4	P3-B	902		
L	Drain 3	P3-A	6XX		
M	Drain 2	P3-P	3XX		
N	Drain 1	P3-N	905		
P					
R					
S					
T					
U					
V					
W					
X					
Y					
Z	Control Relay	J13-21		94X	
1	GROUND	BUS	BUS		
2	+15 Volts	BUS	BUS		
3	-15 Volts	BUS	BUS		
4	Gate Mon 4	S11-F,J1-r		7XX	
5	Gate Mon 3	S1-6/S11-E	98X		
6	Gate Mon 2	S1-5		4XX	
7	Gate Mon 1	S11-D,J1-l		90X	
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20	Gate 3 Adj			NC	
21	Gate 4 Adj			J11-35	93X
22					

System: Q-Band Receiver
Slot: 2 Conn Type: 22Pin Edgecard
Card: HFET Bias, Ch L1

Pin	Function	To	Color			
A	GROUND	BUS	BUS			
B	+15 Volts	BUS	BUS			
C	-15 Volts	BUS	BUS			
D	Gate 4	P3-U	97X			
E	Gate 3	P3-V	8XX			
F	Gate 2	P3-W	94X			
H	Gate 1	P3-X	9XX			
J						
K	Drain 4	P3-F	903			
L	Drain 3	P3-G	904			
M	Drain 2	P3-H	906			
N	Drain 1	P3-J	901			
P						
R						
S						
T						
U						
V						
W						
X						
Y						
	Z			Control Relay	J13-22	96X
1	GROUND	BUS		BUS		
2	+15 Volts	BUS		BUS		
3	-15 Volts	BUS		BUS		
4	Gate Mon 4	S11-K,J1-s		97X		
5	Gate Mon 3	S2-6/S11-J		9XX		
6	Gate Mon 2			S2-5	9XX	
7	Gate Mon 1			S11-H,J1-m	93X	
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20	Gate 3 Adj			NC		
21	Gate 4 Adj			J11-36	95X	
22						

System: Q-Band Receiver
Slot: 3 Conn Type: 22Pin Edgecard
Card: HFET Bias, Ch R2

Pin	Function	To	Color		
A	GROUND	BUS	BUS		
B	+15 Volts	BUS	BUS		
C	-15 Volts	BUS	BUS		
D	Gate 4	P4-S	7XX		
E	Gate 3	P4-R	98X		
F	Gate 2	P4-Y	4XX		
H	Gate 1	P4-M	90X		
J					
K	Drain 4	P4-B	902		
L	Drain 3	P4-A	6XX		
M	Drain 2	P4-P	3XX		
N	Drain 1	P4-N	905		
P					
R					
S					
T					
U					
V					
W					
X					
Y					
Z	Control Relay	J13-23		91X	
1	GROUND	BUS	BUS		
2	+15 Volts	BUS	BUS		
3	-15 Volts	BUS	BUS		
4	Gate Mon 4			S11-N,J1-t	1XX
5	Gate Mon 3	S3-6/S11-M		4XX	
6	Gate Mon 2			S3-5	4XX
7	Gate Mon 1			S11-L,J1-n	96X
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20	Gate 3 Adj			NC	
21	Gate 4 Adj			J11-37	8XX
22					

System: Q-Band Receiver
Slot: 4 Conn Type: 22Pin Edgecard
Card: HFET Bias, Ch L2

Pin	Function	To	Color		
A	GROUND	BUS		BUS	
B	+15 Volts	BUS		BUS	
C	-15 Volts	BUS		BUS	
D	Gate 4	P4-U		97X	
E	Gate 3	P4-V		8XX	
F	Gate 2	P4-W		94X	
H	Gate 1	P4-X		9XX	
J					
K	Drain 4	P4-F		903	
L	Drain 3	P4-G		904	
M	Drain 2	P4-H		906	
N	Drain 1	P4-J		901	
P					
R					
S					
T					
U					
V					
W					
X					
Y					
Z	Control Relay	J13-24		906	
1	GROUND	BUS		BUS	
2	+15 Volts	BUS		BUS	
3	-15 Volts	BUS		BUS	
4	Gate Mon 4	S11-S,J1-u		6XX	
5	Gate Mon 3	S4-6/S11-R		8XX	
6	Gate Mon 2			S4-5	8XX
7	Gate Mon 1			S11-P,J1-p	1XX
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20	Gate 3 Adj			NC	
21	Gate 4 Adj			J11-38	907
22					

System: Q-Band Receiver
Slot: 5 Conn Type: 22Pin Edgecard
Card: HFET Bias, Ch R3

Pin	Function	To	Color		
A	GROUND	BUS	BUS		
B	+15 Volts	BUS	BUS		
C	-15 Volts	BUS	BUS		
D	Gate 4	P5-S	7XX		
E	Gate 3	P5-R	98X		
F	Gate 2	P5-Y	4XX		
H	Gate 1	P5-M	90X		
J					
K	Drain 4	P5-B	902		
L	Drain 3	P5-A	6XX		
M	Drain 2	P5-P	3XX		
N	Drain 1	P5-N	905		
P					
R					
S					
T					
U					
V					
W					
X					
Y					
Z	Control Relay	J13-25	94X		
1	GROUND	BUS	BUS		
2	+15 Volts	BUS	BUS		
3	-15 Volts	BUS	BUS		
4	Gate Mon 4	S11-V,J1-z	9XX		
5	Gate Mon 3	S5-6/S11-U	91X		
6	Gate Mon 2		S5-5		91X
7	Gate Mon 1		S11-T,J1-v		96X
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20	Gate 3 Adj		NC		
21	Gate 4 Adj		J11-39	93X	
22					

System: Q-Band Receiver
Slot: 6
Card: HFET Bias, Ch L3

Conn Type: 22Pin Edgecard

Pin	Function	To	Color		
A	GROUND	BUS		BUS	
B	+15 Volts	BUS		BUS	
C	-15 Volts	BUS		BUS	
D	Gate 4	P5-U		97X	
E	Gate 3	P5-V		8XX	
F	Gate 2	P5-W		94X	
H	Gate 1	P5-X		9XX	
J					
K	Drain 4	P5-F		903	
L	Drain 3	P5-G		904	
M	Drain 2	P5-H		906	
N	Drain 1	P5-J		901	
P					
R					
S					
T					
U					
V					
W					
X					
Y					
Z	Control Relay	J13-26		96X	
1	GROUND	BUS		BUS	
2	+15 Volts	BUS		BUS	
3	-15 Volts	BUS		BUS	
4	Gate Mon 4	S11-Y,J1-AA		7XX	
5	Gate Mon 3	S6-6/S11-X		98X	
6	Gate Mon 2			S6-5	98X
7	Gate Mon 1			S11-W,J1-w	90X
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20	Gate 3 Adj			NC	
21	Gate 4 Adj			J11-40	95X
22					

System: Q-Band Receiver
Slot: 7 Conn Type: 22Pin Edgecard
Card: HFET Bias, Ch R4

Pin	Function	To	Color	
A	GROUND	BUS	BUS	
B	+15 Volts	BUS	BUS	
C	-15 Volts	BUS	BUS	
D	Gate 4	P6-S	7XX	
E	Gate 3	P6-R	98X	
F	Gate 2	P6-Y	4XX	
H	Gate 1	P6-M	90X	
J				
K	Drain 4	P6-B	902	
L	Drain 3	P6-A	6XX	
M	Drain 2	P6-P	3XX	
N	Drain 1	P6-N	905	
P				
R				
S				
T				
U				
V				
W				
X				
Y				
Z	Control Relay	J13-27	91X	
1	GROUND	BUS	BUS	
2	+15 Volts	BUS	BUS	
3	-15 Volts	BUS	BUS	
4	Gate Mon 4	S12-4,J1-BB	97X	
5	Gate Mon 3	S7-6/S11-2	95X	
6	Gate Mon 2		S7-5	95X
7	Gate Mon 1		S11-Z,J1-x	6XX
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20	Gate 3 Adj		NC	
21	Gate 4 Adj		J11-41	8XX
22				

System: Q-Band Receiver
Slot: 8 Conn Type: 22Pin Edgecard
Card: HFET Bias, Ch L4

Pin	Function	To	Color		
A	GROUND	BUS		BUS	
B	+15 Volts	BUS		BUS	
C	-15 Volts	BUS		BUS	
D	Gate 4	P6-U		97X	
E	Gate 3	P6-V		8XX	
F	Gate 2	P6-W		94X	
H	Gate 1	P6-X		9XX	
J					
K	Drain 4	P6-F		903	
L	Drain 3	P6-G		904	
M	Drain 2	P6-H		906	
N	Drain 1	P6-J		901	
P					
R					
S					
T					
U					
V					
W					
X					
Y					
Z	Control Relay	J13-28		906	
1	GROUND	BUS		BUS	
2	+15 Volts	BUS		BUS	
3	-15 Volts	BUS		BUS	
4	Gate Mon 4	S12-Y,J1-CC		9XX	
5	Gate Mon 3	S8-6/S12-Z		6XX	
6	Gate Mon 2			S8-5	6XX
7	Gate Mon 1			S12-1,J1-y	7XX
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20	Gate 3 Adj			NC	
21	Gate 4 Adj			J11-42	907
22					

System: Q-Band Receiver
Slot: 9 Conn Type: 22Pin Edgecard
Card: Control

Pin	Function	To	Color		
A	GROUND	BUS	BUS		
B	+15 Volts	BUS	BUS		
C	-15 Volts	BUS	BUS		
D	Temp A Mon In	S10-D/J10-5	96X		
E	Vac Dewar Mon In	S10-N/J10-8	6XX		
F	Vac Pump Mon In	S10-14/J10-9	8XX		
H					
J	S-Solenoid Mon Out	J12-6	98X		
K	P-Pump Req Out	J12-4	91X		
L	Not H-No Heat Ctrl	J1-k/J12-2	3XX		
M	C- Cool Control	J1-j/J12-1	9XX		
N					
P					
R					
S	Solenoid Supply	P14-2	0XX*3		
T					
U	150 VAC In, Phase 2	J9-1	2XX*4		
V	150 VAC Refr, Pha 2	K6-1	2XX*5		
W	Dewar Heater	P3-K		1XX	
X	150 VAC In, Phase 1	J9-3	0XX*4		
Y	150 VAC Refr, Pha 1	K5-1	0XX*5		
Z					
1	GROUND	BUS/chs	BS/0XX		
2	+15 Volts	BUS	BUS		
3	-15 Volts	BUS	BUS		
4	X Evac Control	J1-d/J12-3	6XX		
5					
6					
7					
8					
9					
10					
11					
12					
13					
14	Solenoid RTN	R1-2	2XX*3		
15					
16	Stress Heater			R2-1	91X*6
17					
18	Stress Heater RTN			R2-2	91X*6
19	Dewar Heater RTN	P3-L		91X	
20	150 VAC RTN	J9-2/K5-4		9XX*4	
		K6-4/P7-2			
21	Refrig Control	K5-3/K6-3		5XX	
22					

System: Q-Band Receiver
Slot: 10 Conn Type: 22Pin Edgecard
Card: Sensor

Pin	Function	To	Color
A	GROUND	BUS	BUS
B	+15 Volts	BUS	BUS
C	-15 Volts	BUS	BUS
D	A Mon Out (15K)	J1-C/S9-D	96X
E	Sensor A RTN	P3-E	93X
F	Sensor B RTN	P4-E	93X
H	Temp Sens B	P4-T	96X
J	Vac Tube Dewar-1	P16-3	2XX*2
K	Vac Tube Dewar-2	P16-5	0XX*2
L	Vac Tube Dewar-3	P16-7	5XX*2
M	Vac Dewar Local Mon	N.C.	
N	Vac Dewar Mon	J1-F/S9-E	6XX
P			
R			
S	Temp Sens A	N.C.	
T	Temp Sens B	N.C.	
U			
V			
W			
X			
Y			
Z			
1	GROUND	BUS	BUS
2	+15 Volts	BUS	BUS
3	-15 Volts	BUS	BUS
4	Temp Sens A	P3-T	96X
5	B Mon Out (50K)	J1-D/J10-6	95X
6			
7			
8			
9			
10			
11			
12			
13			
14	Vac Pump Mon	J1-H/S9-F	8XX
15			
16			
17	Vac Tube Pump-3	P15-7	5XX*2
18			
19			
20			
21	Vac Tube Pump-1	P15-3	2XX*2
22	Vac Tube Pump-2	P15-5	0XX*2

System: Q-Band Receiver
Slot: 11 Conn Type: 22Pin Edgecard
Card: 1/2 Amp Board

Pin	Function	To	Color		
A	GND	BUS			
B	+15 volts	BUS			
C	-15 volts	BUS			
D	R1/1st, IN			S1-7	90X
E	R1/2nd & 3rd, IN			S1-5	98X
F	R1/4th, IN			S1-4	7XX
H	L1/1st, IN			S2-7	93X
J	L1/2nd & 3rd, IN			S2-5	9XX
K	L1/4th, IN			S2-4	97X
L	R2/1st, IN			S3-7	96X
M	R2/2nd & 3rd, IN			S3-5	4XX
N	R2/4th, IN			S3-4	1XX
P	L2/1st, IN			S4-7	1XX
R	L2/2nd & 3rd, IN			S4-5	8XX
S	L2/4th, IN			S4-4	6XX
T	R3/1st, IN			S5-7	96X
U	R3/2nd & 3rd, IN			S5-5	91X
V	R3/4th, IN			S5-4	9XX
W	L3/1st, IN			S6-7	90X
X	L3/2nd & 3rd, IN			S6-5	98X
Y	L3/4th, IN			S6-4	7XX
Z	R4/1st, IN			S7-7	6XX
1	GND	BUS			
2	R4/2nd & 3rd, IN			S7-5	95X
3	R4/2nd & 3rd, OUT			J10-28	95X
4	R1/1st, OUT			J10-14	90X
5	R1/2nd & 3rd, OUT			J10-22	98X
6	R1/4th, OUT			J10-30	7XX
7	L1/1st, OUT			J10-15	93X
8	L1/2nd & 3rd, OUT			J10-23	9XX
9	L1/4th, OUT			J10-31	97X
10	R2/1st, OUT			J10-16	96X
11	R2/2nd & 3rd, OUT			J10-24	4XX
12	R2/4th, OUT			J10-32	1XX
13	L2/1st, OUT			J10-17	1XX
14	L2/2nd & 3rd, OUT			J10-25	8XX
15	L2/4th, OUT			J10-33	6XX
16	R3/1st, OUT			J10-18	96X
17	R3/2nd & 3rd, OUT			J10-26	91X
18	R3/4th, OUT			J10-34	9XX
19	L3/1st, OUT			J10-19	90X
20	L3/2nd & 3rd, OUT			J10-27	98X
21	L3/4th, OUT			J10-35	7XX
22	R4/1st, OUT			J10-20	6XX

System: Q-Band Receiver
Slot: 12 Conn Type: 22Pin Edgecard
Card: 1/2 Amp\ LED\ Tswitch Ctrl

Pin	Function	To	Color		
A	GND	GND	0XX		
B	+15 Volts	BUS	2XX		
C	-15 Volts	BUS	4XX		
D	+5 Volts	BUS	3XX		
E	LED 4 Mon			J1-N/J10-4	97X
F	LED 3 Mon			J1-M/J10-3	96X
H	To LED R3			P5-C	94X
J	To LED L3			P5-D	5XX
K	To LED R1			P3-C	94X
L	TO LED L1			P3-D	5XX
M	LED 1 Mon			J1-K/J10-1	1XX
N	LED 2 Mon			J1-L/J10-2	91X
P	To LED L2			P4-D	5XX
R	To LED R2			P4-C	94X
S	To LED L4			P6-D	5XX
T	To LED R4			P6-C	94X
U	-15 Volt Monitor	J10-11	91X		
V	+15 Volt Monitor	J10-10	90X		
W	L4/2nd & 3rd, OUT			J10-29	94X
X	L4/4th OUT			J10-37	95X
Y	L4/4th IN			S8-4	9XX
Z	L4/2nd & 3rd, IN			S8-5	6XX
1	L4/1st, IN			S8-7	7XX
2	L4/1st, OUT			J10-21	93X
3	R4/4th, OUT			J10-36	92X
4	R4/4th, IN			S7-4	97X
5	SW-R1-2 MCB Ctrl			J13-13	3XX
6	SW-R1-2 Man Ctrl			J1-Z	7XX
7	Man Ctrl Select			J1-FF	97X
8	EXT SIG REF Select	J13-14	8XX		
9	EXT SIG REF Control	J30		904*7	
10	EXT SIG REF Indicator	J12-26		8XX	
11	Transfer Switch Ind.	J1-U	901		
12	SW-L1-2 Man Ctrl			J1-a	8XX
13	SW-L1-2 MCB Ctrl			J13-15	4XX
14	SW-L1-2 Ctrl Out			J7-B/J12-28	98X
15	SW-R1-2 Ctrl Out			J7-A/J12-27	97X
16	SW-L3-4 Man Ctrl			J1-c	90X
17	SW-L3-4 MCB Ctrl			J13-19	6XX
18	SW-L3-4 Ctrl Out			J7-D/J12-30	96X
19	SW-R3-4 Ctrl Out			J7-C/J12-29	95X
20	SW-R3-4 MCB Ctrl			J13-17	5XX
21	SW-R3-4 Man Ctrl			J1-b	9XX
22					

System: Q-Band Receiver
Slot: 13 Conn Type: 22Pin Edgecard
Card: LO Detector/ Cal Control

Pin	Function	To	Color			
A	GND	BUS		0XX		
B	+15 Volts	BUS		2XX		
C	-15 Volts	BUS		4XX		
D	+5 Volts	BUS		3XX		
E	+28 Volts	BUS		8XX		
F	28 V Monitor			J10-13		98X
H	Cal 1 Pwr Ctrl In			S13-R,J1-V		92X
J	Cal 2 Pwr Ctrl In			S13-S,J1-W		93X
K	MCB Cal 1 Ctrl In			J13-9		5XX
L	MCB Cal 2 Ctrl In			J13-10		6XX
M	Ext Cal Control Mon	J12-23		8XX*7		
N	NS1-2 Power Out			J7-E,J7-J		9XX
P	NS3-4 Power Out			J7-F,J7-K		91X
R	Cal 1 Sw Out J12-25			S13-H,		92X
S	Cal 2 Sw Out			S13-J, J12-24		93X
T	Cal 1 Current Mon			J10-40	94X	
U	Cal 2 Current Mon			J10-41	95X	
V	Cal 1 Voltage Mon			J10-42	96X	
W	Cal 2 Voltage Mon			J10-43	97X	
X	Man/MCB Ctrl Select			J1-FF	97X	
Y	Cal 1 Man Ctrl In			J1-DD	95X	
Z	Cal 2 Man Ctrl In			J1-EE	94X	
1	GND	BUS	0XX			
2						
3						
4						
5						
6						
7						
8						
9						
10						
11	External Cal In			J31	8XX	
12						
13						
14						
15						
16						
17						
18	EXT Ctrl Select			J13-7	6XX	
19						
20	LO1 Detector Output			J10-38	901	
21						
22	LO1 Detector Input			J7-N	902	

Note: Voltage Divider for 28V Monitor - Connect 3740 Ohm, 1% Resistor Pins E to F; Connect 1240 Ohm, 1% Resistor Pins F to Gnd. (Pin F is not used on PCB.)

System: Q-Band Receiver
Slot: 14 Conn Type: 22Pin Edgecard
Card: Spare

Pin	Function	To	Color

System: Q-Band Receiver
Designation: J1 Conn Type: Elco 56 Pin Protected
Function: To Local Monitor Box

Pin	Function	To	Color	
A	GND	GND BUS	0XX	
B	+5 Volts	BUS	3XX	
C	15 K TEMP	S10-D	96X	
D	50 K TEMP	S10-5	95X	
E	300 K TEMP	J10-7,AD590	92X*8	
F	DEWAR VAC	S10-N	6XX	
H	PUMP VAC	S10-14		
K	LED 1 S12-M		1XX	
L	LED 2 S12-N		91X	
M	LED 3 S12-F		96X	
N	LED 4 S12-E		97X	
P	MANUAL MONITOR	J12-7	8XX	
R	NOT-H MCB	J13-2	3XX	
S	C MCB	J13-1	9XX	
T	X MCB	J13-3	7XX	
U	Transfer Switch Ind		S12-11	901
V	Cal 1 Ind		S13-H	92X
W	Cal 2 Ind		S13-J	93X
X				
Y				
Z	SW-R1-2 Local Control		S12-6	7XX
a	SW-L1-2 Local Control		S12-12	8XX
b	SW-R3-4 Local Control		S12-21	9XX
c	SW-L3-4 Local Control		S12-16	90X
d	X-OUTPUT1		S9-4	6XX
e	C-OUTPUT2		N.C.	
f	NOT-H-OUTPUT2		N.C.	
h	X-OUTPUT2		N.C.	
j	C-OUTPUT1		S9-M	9XX
k	NOT-H-OUTPUT1		S9-L	3XX
l	Stg 1 GV Mon R1		S1-7	90X
m	Stg 1 GV Mon L1		S2-7	93X
n	Stg 1 GV Mon R2		S3-7	96X
p	Stg 1 GV Mon L2		S4-7	1XX
r	Stg 4 GV Mon R1		S1-4	7XX
s	Stg 4 GV Mon L1		S2-4	97X
t	Stg 4 GV Mon R2		S3-4	1XX
u	Stg 4 GV Mon L2		S4-4	6XX
v	Stg 1 GV Mon R3		S5-7	96X
w	Stg 1 GV Mon L3		S6-7	90X
x	Stg 1 GV Mon R4		S7-7	6XX
y	Stg 1 GV Mon L4		S8-7	7XX
z	Stg 4 GV Mon R3		S5-4	9XX

System: Q-Band Receiver
Designation: J1 (Continued)
Function: To Local Monitor Box

Pin	Function	To	Color
AA	Stg 4 GV Mon L3	S6-4	7XX
BB	Stg 4 GV Mon R4	S7-4	97X
CC	Stg 4 GV Mon L4	S8-4	9XX
DD	Cal 1 Man Ctrl	S13-Y	95X
EE	Cal 2 Man Ctrl	S13-Z	94X
FF	Man/MCB Ctrl Select	S13-X/S12-7	97X
HH			
JJ			
KK			
LL			
MM			
NN			

System: Q-Band Receiver
Designation: P3 *1
Function: Dewar, Beam 1

Conn Type: MS3116F16-23S Plug

Pin	Function	To	Color			
A	Drain 3, R1	S1-L	6XX			
B	Drain 4, R1	S1-K	902			
C	LED R1			S12-K	94X	
D	LED L1			S12-L	5XX	
E	Temp Sensor A RTN	S10-E		93X		
F	Drain 4, L1	S2-K	903			
G	Drain 3, L1	S2-L	904			
H	Drain 2, L1	S2-M	906			
J	Drain 1, L1	S2-N	901			
K	15K HTR-1			S9-W		1XX See Note
L	15K HTR-2			S9-19		91X See Note
M	Gate 1, R1	S1-H	90X			
N	Drain 1, R1	S1-N	905			
P	Drain 2, R1	S1-M	3XX			
R	Gate 3, R1	S1-E	98X			
S	Gate 4, R1	S1-D	7XX			
T	Temp Sens A	S10-4		96X		
U	Gate 4, L1	S2-D	97X			
V	Gate 3, L1	S2-E	8XX			
W	Gate 2, L1	S2-F	94X			
X	Gate 1, L1	S2-H	9XX			
Y	Gate 2, R1	S1-F		4XX		
Z	GND			0XX		

Note: Install a Molex 2-pin plug/socket pair between S9-W,19 and P3-K,L as a disconnect, and to allow external powering of the 15K heater. Place exposed pins on P3 side of plug/socket pair. Make Molex accessible at open end of cardcage.

System: Q-Band Receiver
Designation: P4 *1 Conn Type: MS3116F16-23S Plug
Function: Dewar, Beam 2

Pin	Function	To	Color			
A	Drain 3, R2	S3-L	6XX			
B	Drain 4, R2	S3-K	902			
C	LED R2			S12-R	94X	
D	LED L2			S12-P	5XX	
E	Temp Sensor B RTN			S10-F		93X
F	Drain 4, L2	S4-K	903			
G	Drain 3, L2	S4-L	904			
H	Drain 2, L2	S4-M	906			
J	Drain 1, L2	S4-N	901			
K	Trap HTR-1					1XX
L	Trap HTR-2					1XX
M	Gate 1, R2	S3-H	90X			
N	Drain 1, R2	S3-N	905			
P	Drain 2, R2	S3-M	3XX			
R	Gate 3, R2	S3-E	98X			
S	Gate 4, R2	S3-D	7XX			
T	Temp Sensor B	S10-H		96X		
U	Gate 4, L2	S4-D	97X			
V	Gate 3, L2	S4-E	8XX			
W	Gate 2, L2	S4-F	94X			
X	Gate 1, L2	S4-H	9XX			
Y	Gate 2, R2	S3-Y	4XX			
Z	GND			0XX		

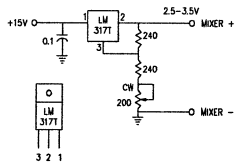
Note: Connect a Molex 2-pin plug (exposed pins) to P4-K,L to allow external powering of the charcoal trap heater. Make Molex accessible at open end of cardcage.

System: Q-Band Receiver
Designation: P5 *1
Function: Dewar, Beam 3

Conn Type: MS3116F16-23S Plug

Pin	Function	To	Color		
A	Drain 3, R3	S5-L	6XX		
B	Drain 4, R3	S5-K	902		
C	LED R3			S12-H	94X
D	LED L3			S12-J	5XX
E					
F	Drain 4, L3	S6-K	903		
G	Drain 3, L3	S6-L	904		
H	Drain 2, L3	S6-M	906		
J	Drain 1, L3	S6-N	901		
K	Mixer Bias +			SEE BELOW	92X
L	Mixer Bias -			SEE BELOW	0XX
M	Gate 1, R3	S5-H	90X		
N	Drain 1, R3	S5-N	905		
P	Drain 2, R3	S5-M	3XX		
R	Gate 3, R3	S5-E	98X		
S	Gate 4, R3	S5-D	7XX		
T					
U	Gate 4, L3	S6-D	97X		
V	Gate 3, L3	S6-E	8XX		
W	Gate 2, L3	S6-F	94X		
X	Gate 1, L3	S6-H	9XX		
Y	Gate 2, R3	S5-F	4XX		
Z	GND				0XX

Mixer Bias Regulator, mount at convenient location in cardcage:



System: Q-Band Receiver
Designation: P6 *1
Function: Dewar, Beam 4

Conn Type: MS3116F16-23S Plug

Pin	Function	To	Color		
A	Drain 3, R4	S7-L	904		
B	Drain 4, R4	S7-K	903		
C	LED R4			S12-T	94X
D	LED L4			S12-S	5XX
E					
F	Drain 4, L4	S8-K	903		
G	Drain 3, L4	S8-L	904		
H	Drain 2, L4	S8-M	906		
J	Drain 1, L4	S8-N	901		
K					
L					
M	Gate 1, R4	S7-H	90X		
N	Drain 1, R4	S7-N	901		
P	Drain 2, R4	S7-M	906		
R	Gate 3, R4	S7-E	8XX		
S	Gate 4, R4	S7-D	97X		
T					
U	Gate 4, L4	S8-D	97X		
V	Gate 3, L4	S8-E	8XX		
W	Gate 2, L4	S8-F	94X		
X	Gate 1, L4	S8-H	9XX		
Y	Gate 2, R4	S7-F	4XX		
Z	GND				0XX

System: Q-Band Receiver
Designation: J7
Function: Front-end signals

Conn Type: ELCO 38Pin Protected

Pin	Function	To	Color			
				A	SW-R1-2 Ctrl	S12-15 97X
B	SW-L1-2 Ctrl			S12-14	98X	
C	SW-R3-4 Ctrl			S12-19	95X	
D	SW-L3-4 Ctrl			S12-18	96X	
E	NS 1-2 Ctrl			S13-N		9XX
F	NS 3-4 Ctrl			S13-P		91X
H	GND	GND BUS		0XX		
J		NS 1-2 Ctrl		S13-N		9XX
K		NS 3-4 Ctrl		S13-P		91X
L	GND	GND BUS		0XX		
M		GND		GND BUS		0XX
N	LO1 Det Volt			S13-22		902*7
P		GND		GND BUS		0XX
R		GND		GND BUS		0XX
S						
T	GND	GND BUS		0XX		
U	+5 Volts	5V BUS		3XX		
V	-15 Volts	-15V BUS		4XX		
W	+15 Volts	15V BUS		2XX		
X	+15 Volts	15V BUS		2XX		
Y		GND		GND BUS		0XX
Z		GND		GND BUS		0XX
AA		GND		GND BUS		0XX
BB		GND		GND BUS		0XX
CC		GND		GND BUS		0XX
DD						
EE						
FF						
HH						
JJ						
KK		+5 Volts	5V BUS	3XX		
LL		+5 Volts	5V BUS	3XX		
MM		-15 Volts	-15V BUS	4XX		
NN		-15 Volts	-15V BUS	4XX		
PP		+15 Volts	15V BUS	2XX		
RR		+15 Volts	15V BUS	2XX		
TT		+15 Volts	15V BUS	2XX		

System: Q-Band Receiver
Designation: J8
Function: Front-end Voltage In

Connector Type: MS3102A18-10P

Pin	Function	To	Color
A	+15 Volts	15V BUS	2XX
B	+15 Volts	15V BUS	2XX
C	+5 Volts	5V BUS	3XX
D	+5 Volts	5V BUS	3XX
E	-15 Volts	-15V BUS	7XX
I	GND	GND BUS	0XX
F	+28 Volts	28V BUS	29X
G	GND	GND BUS	0XX
H	GND	GND BUS	0XX
J			

Note: Use 14 or 16 AWG Wire for this connector. Connect GND Bus to cardcage chassis at convenient location.

System: Q-Band Receiver

Designation: J10 Conn Type: D-50S

Function: MCB Interface Analog Monitor

Pin	Function	To	Color
1	LED Voltage A, Mon	S12-M	1XX
2	LED Voltage B, Mon	S12-N	91X
3	LED Voltage C, Mon	S12-F	96X
4	LED Voltage D, Mon	S12-E	97X
5	Temp A Mon (15K)	S9-D	96X
6	Temp B Mon (50K)	S10-5	95X
7	Temp Mon (300K)	J1-E	92X
8	Dewar Vacuum	S9-E	6XX
9	Pump Vacuum	S9-F	8XX
10	+15 Volt Monitor	S12-V	90X
11	-15 Volt Monitor	S12-U	91X
12	+5 Volt Monitor	5V BUS	3XX
13	+28 Volt Monitor	S13-F	98X
14	R1 1st, GV	S11-4	90X
15	L1 1st, GV	S11-7	93X
16	R2 1st, GV	S11-10	96X
17	L2 1st, GV	S11-13	1XX
18	R3 1st, GV	S11-16	96X
19	L3 1st, GV	S11-19	90X
20	R4 1st, GV	S11-22	6XX
21	L4 1st, GV	S12-2	93X
22	R1 2nd & 3rd, GV	S11-5	98X
23	L1 2nd & 3rd, GV	S11-8	9XX
24	R2 2nd & 3rd, GV	S11-11	4XX
25	L2 2nd & 3rd, GV	S11-14	8XX
26	R3 2nd & 3rd, GV	S11-17	91X
27	L3 2nd & 3rd, GV	S11-20	98X
28	R4 2nd & 3rd, GV	S11-3	95X
29	L4 2nd & 3rd, GV	S12-W	94X
30	R1 4th, GV	S11-6	7XX
31	L1 4th, GV	S11-9	97X
32	R2 4th, GV	S11-12	1XX
33	L2 4th, GV	S11-15	6XX
34	R3 4th, GV	S11-18	9XX
35	L3 4th, GV	S11-21	7XX
36	R4 4th, GV	S12-3	92X
37	L3 4th, GV	S12-X	95X
38	LO1 Detector Voltage	S13-20	901
39			
40	Cal Current Mon (L)	S13-T	94X
41	Cal Current Mon (R)	S13-U	95X
42	Cal Voltage Mon (L)	S13-V	96X
43	Cal Voltage Mon (R)	S13-W	97X
44			
45			
46			
47			
48			
49			
50			

System: Q-Band Receiver

Designation: J11 Conn Type: D-50S

Function: MCB Interface Analog Control

Pin	Function	To	Color		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15	+5 Volt Supply	J8-C	3XX		
16	+5 Volt Supply	J8-C	3XX		
17	+5 Volt Supply	J8-D	3XX		
18	+5 Volt Supply	J8-D	3XX		
19	+5 Volt Supply	J8-C	3XX		
20	+5 Volt Supply	J8-C	3XX		
21	+5 Volt Supply	J8-D	3XX		
22	+15 Volt Supply	J8-A	2XX		
23	+15 Volt Supply	J8-A	2XX		
24	+15 Volt Supply	J8-B	2XX		
25	-15 Volt Supply	J8-E	4XX		
26	-15 Volt Supply	J8-E	4XX		
27	-15 Volt Supply	J8-E	4XX		
28	GND	GND BUS		0XX	
29	GND	GND BUS		0XX	
30	GND	GND BUS		0XX	
31	GND	GND BUS		0XX	
32	GND	GND BUS		0XX	
33	GND	GND BUS		0XX	
34	GND	GND BUS		0XX	
35	R1 4th STG Gate Adj.			S1-21	93X
36	L1 4th STG Gate Adj.			S2-21	95X
37	R2 4th STG Gate Adj.			S3-21	8XX
38	L2 4th STG Gate Adj.			S4-21	907
39	R3 4th STG Gate Adj.			S5-21	93X
40	L3 4th STG Gate Adj.			S6-21	95X
41	R4 4th STG Gate Adj.			S7-21	8XX
42	L4 4th STG Gate Adj.			S8-21	907
43					
44					
45					
46					
47					
48					
49					
50					

System: Q-Band Receiver

Designation: J12 Conn Type: D-50S

Function: MCB Interface Digital Monitor

Pin	Function	To	Color			
1	C - Cool Control	S9-M	9XX			
2	Not-H - Heat Ctrl			S9-L	3XX	
3	X Evac Control	S9-4	6XX			
4	Pump REQ Mon			S9-K	91X	
5						
6	Solenoid Mon			S9-J	98X	
7	Manual Mon			J1-P		8XX
8						
9	Freq ID LSB			OPEN		
10	Freq ID	OPEN				
11	Freq ID	OPEN				
12	Freq ID	GND	0XX			
13	Freq ID			GND	0XX	
14	Freq ID	GND	0XX			
15	Freg ID MSB			GND	0XX	
16	Freq ID Parity	OPEN				
17	S/N 0	OPEN				
18	S/N 1	GND	0XX			
19	S/N 2	GND	0XX			
20	MOD # 0	GND	0XX			
21	MOD # 1	GND	0XX			
22	MOD # 2	GND	0XX			
23	EXT CAL Mon			S13-M	8XX	
24	NS3-4 Ctrl Mon			S13-S	93X	
25	NS1-2 Ctrl Mon			S13-R	92X	
26	EXT SIG/REF Mon			S12-10	8XX	
27	SW-R1-2 Ctrl Mon			S12-15	97X	
28	SW-L1-2 Ctrl Mon			S12-14	98X	
29	SW-R3-4 Ctrl Mon			S12-19	95X	
30	SW-L3-4 Ctrl Mon			S12-18	96X	
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

System: Q-Band Receiver

Designation: J13 Conn Type: D-50S

Function: MCB Interface Digital Control

Pin	Function	To	Color
1	C - MCB	J1-S	9XX
2	Not-H - MCB	J1-R	3XX
3	X - MCB	J1-T	7XX
4			
5			
6			
7	Cal Ext Ctrl Select	S13-18	6XX
8			
9	NS1-2 MCB Ctrl	S13-K	5XX
10	NS3-4 MCB Ctrl	S13-L	6XX
11			
12			
13	SW-R1-2 MCB Ctrl	S12-5	3XX
14	Sig/Ref Ext Ctrl Sel	S12-8	8XX
15	SW-L1-2 MCB Ctrl	S12-13	4XX
16			
17	SW-R3-4 MCB Ctrl	S12-20	5XX
18			
19	SW-L3-4 MCB Ctrl	S12-17	6XX
20			
21	R1 HFET Pwr Ctrl	S1-Z	94X
22	L1 HFET Pwr Ctrl	S2-Z	96X
23	R2 HFET Pwr Ctrl	S3-Z	91X
24	L2 HFET Pwr Ctrl	S4-Z	906
25	R3 HFET Pwr Ctrl	S5-Z	94X
26	L3 HFET Pwr Ctrl	S6-Z	96X
27	R4 HFET Pwr Ctrl	S7-Z	91X
28	L4 HFET Pwr Ctrl	S8-Z	906
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			

Wire List Notes

Unless noted all wire 22 AWG stranded.

*1	P3-P6 on pigtails for Dewar Power/Monitor. Use jacketed 23 conductor, 22 AWG cable. Cable length to be determined during assembly.
*2	P15 and P16 on pigtails for Vacuum Sensors. Use jacketed 3 conductor, 22 AWG cable. Cable length to be determined during assembly.
*3	P14 on pigtail for Vacuum Solenoid Power. Use jacketed 2 conductor, 18 AWG cable, Connect R1 (300 Ohm, 25W, RH-25) in series with red conductor, between S9-14 and P14-1, Cable length to be determined during assembly.
*4	Use 18 AWG wire for AC wiring.
*5	P7 on pigtail for refrigerator power. Use jacketed 3 conductor, 18 AWG cable. Connect K5-2 to P7-3. Connect K6-2 to P7-1. Connect P7-2 to S9-20. Cable length to be determined during assembly.
*6	R2 limits current to dewar heater in STRESS or LOAD mode. R2 = 5K, 10W, RH-10 Resistor mounted on cardcage interior.
*7	Use shielded wire such as RG188.
*8	An AD590KH Temperature sensor IC is mounted on the cardcage chassis, in series with +5V and a 10K, 1% resistor to GND. The AD590/Resistor junction is connected to J1-E and J10-7.

Section VI
MCB Interface

A10306D001

GBT 40-52 GHz RECEIVER MONITOR/CONTROL INTERFACE DOCUMENT

Reference:

Receiver Bill of Materials: A10306B001
Receiver Block Diagram: D10306K001

Revision A: January 4, 2007 – Updated to reflect redesign of receiver to 2 beams with an additional room temperature amplifier in each signal path. G.N. Anderson

Created April 17, 2000 R. Norrod

1) Receiver Description

This receiver operates in the frequency range of 40-52 GHz with two dual-polarized feeds, designated Beams 1-2. Each beam is dual-circular polarized producing four total channels of output signal. The feedhorns are designed for operation at the secondary focus of the GBT, and receive through a shared low-loss vacuum window. The two feedhorns are

corrugated, profiled horns. The two feedhorns, along with two others used in a previous version of this receiver, are arranged in a 2.100 inch square pattern, and have -12 dB beamwidth of 30°. The resulting GBT beams will be separated on the sky by approximately 56 arcseconds. The feeds, polarizers, low-noise HFET amplifiers, and mixers are cooled to 15 Kelvin by a closed-cycle CTI 1020 refrigerator.

The local oscillator (LO) signal for the balanced mixers is obtained using amplified X4 multipliers, driven via LO input connector J30 from the GBT system LO synthesizers. There are four mixer IF outputs designated R1-R2, L1-L2. (the letters R and L indicate Right or Left circular polarization; the numbers 1-2 indicate the beam number.) These IF signals are amplified, filtered to 4-8 GHz, and connected to SMA output connectors J21-J24 for transmission to the GBT IF Router.

Independent diode noise sources are provided for each beam. The noise source outputs are split for the two polarizations and injected via waveguide directional couplers immediately following the septum polarizers.

A Phase Cal input SMA connector (J29) is available for injection of test signals from the GBT Test Tone Router. Note that the test signals are injected in the 4-8 GHz IF signal path, not in the 40-52 GHz RF path. This is because neither the LO synthesizers nor the Phase Cal generator module produces output signals in the 40-52 GHz range.

All monitor and control functions are accomplished through a single VLBA MCB Standard Interface Board (SIB).

NOTE: This receiver was originally designed as a 4-beam receiver. Later, it was modified to 2-beams. Although external wiring was removed, wiring within the cardcage to control beams 3 and 4 was left in place. Therefore, references to Beam 3 and Beam 4 wiring and control within this document have been left in place as well.

2) System Control

Control is accomplished by writing a code to a specified control relative address. This data is latched and may be verified by a read to the same relative address. Note that the LOCAL/MCB switch on the receiver local control box (located on the front-end) must be in the MCB position before MCB control of certain receiver functions (the noise cal sources and the beam switches) is possible. In addition, the cryogenic control switch on the manual control box must be in the CPU position before MCB control of the cryogenics state is possible. Both of these switches may be monitored via the MCB (see Table III).

Control of the receiver may be divided into four categories, cryogenic state control, calibration signal control, beam transfer switch control, and cryogenic amplifier control.

2.1) Cryogenic State Control

Three Bits, X, C and not-H allow control of the receiver's refrigerator and heater. The cryogenic state may be set by writing the desired code to the Cryo Control address, relative address 48h. The cryogenic control code description is given in table II.

The cryogenic state control is not absolute. The circuitry within the receiver will not execute a command which will cause damage to the receiver. In order for the refrigerator to start the vacuum of the dewar must be sufficiently low. The circuitry used in controlling this receiver is the same used in VLBA receivers and is described in VLBA Technical Report No. 1. One exception is that this receiver has a manually operated vacuum valve rather than a solenoid operated unit.

Note: In normal operation, refrigerator power bypasses the cardcage, rendering these control functions unusable. They are being preserved so that, when needed, refrigerator power may be temporarily routed through the cardcage so that it may be remotely controlled.

2.2) Calibration Signal Control

Three bits control the noise calibration sources. By writing the desired code to the Cal Control address, relative address 49h, the noise sources may be turned on or off, or control of the noise sources may be turned over to an external digital signal.

Bit 2 - The EXT/MCB Cal Control Select bit. When set low (EXT), control of all four noise sources is turned over to an external TTL control signal, input to the receiver through BNC connector J31. When set high (MCB), the noise cal switches are controlled through bits 4 and 5.

Bit 4 - Controls the diode noise source for beams 1 and 2. When bit 4 is set high the noise source is ON.

Bit 5 - Controls the diode noise source for beams 3 and 4. When bit 5 is set high the noise source is ON.

When in the EXT control mode (bit 2 low), a TTL low signal at connector J31 turns all the noise sources ON; TTL high turns them OFF.

Bits 0, 1, 3, 6, and 7 are unused.

2.3) Beam Transfer Switch Control (software left in place but unused)

The Beam Switch Control address, at relative address 4Ah, is reserved for control of the beam switching transfer switches.

Bit 0 Controls the R1-R2 beam switch when in MCB mode. A logic 0 places the switch in the normal THRU condition: channel R1 is connected to output J21; channel R2 is connected to output J22. A logic 1 places the switch in the CROSS condition: channel R1 is connected to output J22; channel R2 is connected to output J21.

Bit 1 Is the EXT/MCB control select bit for the beam switches. Logic 0 (EXT mode) turns control of all the transfer switches is over to an external SIG/REF TTL control signal, input to the receiver through BNC connector J30. When set to logic 1 (MCB mode), the transfer switches are controlled through bits 0, 2, 4, and 6.

Bit 2 Controls the L1-L2 beam switch when in MCB mode. A logic 0 places the switch in the normal THRU condition: channel L1 is connected to output J23; channel L2 is connected to output J24. A logic 1 places the switch in the CROSS condition: channel L1 is connected to output J24; channel L2 is connected to output J23.

Bit 4 Controls the R3-R4 beam switch when in MCB mode. A logic 0 places the switch in the normal THRU condition: channel R3 is connected to output J25; channel R4 is connected to output J26. A logic 1 places the switch in the CROSS condition: channel R3 is connected to output J26; channel R4 is connected to output J25.

Bit 6 Controls the L3-L4 beam switch when in MCB mode. A logic 0 places the switch in the normal THRU condition: channel L3 is connected to output J27; channel L4 is connected to output J28. A logic 1 places the switch in the CROSS condition: channel L3 is connected to output J28; channel L4 is connected to output J27.

When in the EXT control mode (bit 1 low), a TTL low signal at connector J30 CROSSES all the transfer switches.

Bits 3 and 7 are unused.

2.4) Amplifier Control

Relative address 4Bh provides control of the bias voltage for each of the eight low-noise HFET amplifiers, according to the following table:

RA 4Bh Bit	Amplifier
0	R1
1	L1
2	R2
3	L2

4	R1-Room Temp
5	L1-Room Temp
6	R2-RoomTemp
7	L4-RoomTemp

When a bit is set high this removes power from the associated amplifier thus shutting it off. Control software should always default to the amplifiers ON.

Relative addresses 40h through 47h allow trimming the bias of the fourth stage of each HFET amplifier. Eight D/A converters are provided with their outputs connected so as to trim the bias of the amplifiers' final stage. By this means, the gain may be adjusted a small amount, typically about 2 dB. The address assignment is according to the following table:

RA hex	**Amplifier**
40	R1
41	L1
42	R2
43	L2
44	R1-Room Temp
45	L1-Room Temp
46	R2-RoomTemp
47	L4-RoomTemp

The digital control code used to set the D/A output voltage is offset binary where:

4095 counts = +10 Volts
2048 counts = 0 Volts
0 counts = -10 Volts

Control software should default to 0 volts D/A output.

2.5) Amplifier Control

Relative address 4Ch controls the load chopper. When bit RA 4C-DC0 is high/on/1, the load is commanded to move in front of the feeds. When DC0 is low/off/0, the load paddle is commanded to move off of the feeds.

3.0) Monitor

The contents of the registers at all control addresses can be read by monitor command to the control address. Additional monitor points are also provided.

3.1) Digital Monitor

The cryogenic state, transfer switch condition, noise switch condition and external cal/sig ref signals are all monitored at points closer to the actual hardware for fault detection within the control circuitry.

3.1.1 Cryogenic Status Monitor

Bits at relative address 50 are used to monitor the status of the dewar cryogenic control system, and Local/MCB hardware switches. Details are given in Table III.

3.1.2 Receiver Identification Monitor

The identification of the receiver can be read at relative address 51h. Bits 0 through 6 return the seven bit MCB ID Byte for this device. Bit 7 is an odd parity bit for the ID Byte. Bits 8, 9, and 10 are designated for the receiver serial number. Bits 11, 12, and 13 give the modification level of the receiver.

3.1.3 Switch Status Monitor

The Switch Status address, relative addresses 52h, monitors the state of the calibration noise sources, the external CAL control signal, and the external SIG/REF control signal. This eight bit monitor is defined as follows:

Bit 0 Monitors the external CAL control signal supplied to the dewar on connector J31. Logic 0 on bit 0 indicates logic 0 on J31.

Bit 1 Monitors the present state of noise sources for beams 3 and 4. Logic 0 indicates ON; logic 1 indicates OFF.

Bit 2 Monitors the present state of noise sources for beams 1 and 2. Logic 0 indicates ON; logic 1 indicates OFF.

Bit 3 Monitors the external SIG/REF control signal supplied to the dewar on connector J30. Logic 1 on bit 3 indicates a logic 0 on J30 (REF condition).

Bit 4 Shows the state of the R1-R2 beam transfer switch. Logic 1 indicates CROSS and logic 0 THRU. **Left in place but No Longer Used.**

Bit 5 Shows the state of the L1-L2 beam transfer switch. Logic 1 indicates CROSS and logic 0 THRU. **Left in place but No Longer Used.**

Bit 6 Shows the state of the R3-R4 beam transfer switch. Logic 1 indicates CROSS and logic 0 THRU. **Left in place but No Longer Used.**

Bit 7 Shows the state of the L3-L4 beam transfer switch. Logic 1 indicates CROSS and logic 0 THRU. **Left in place but No Longer Used.**

3.2 Analog monitor

Bit 1	Bit 0	State

Analog monitors are detailed in Table I.

Relative Address List
Table I

Hex Rel. Addr.	Description
Control	
48	Cryogenic Control
49	Cal Control
4A	Beam Transfer Switch Control
4B	Amplifier Power Control
40	Amp Bias adjust for R1.
41	Amp Bias adjust for L1.
42	Amp Bias adjust for R2.
43	Amp Bias adjust for L2.
44	Amp Bias adjust for R1-RoomTemp.
45	Amp Bias adjust for L1-Room Temp.
46	Amp Bias adjust for R2-RoomTemp.
47	Amp Bias adjust for L2-RoomTemp.
Digital Monitor	
50	Cryogenic Status Monitor
51	Receiver Identification
52	Transfer Switch & Noise Switch Status Monitor
53	Load Chopper RA53-DM0: Hi = 1 = Load is ON Lo = 0 = Load is NOT ON RA53-DM1: Lo = 1 = Load is OFF Lo = 0 = Load is NOT OFF

Note that during motion, both bits may be assigned lo/0/off. See Both bits ON is not allowed.
Chopper State

0	0	Moving
0	1	ON
1	0	OFF
1	1	N/A

(Table I continued) Analog Monitor

Display = Mult * Counts * 4.8828e-3

Note: The 12-bit A/D Counts value is returned by the SIB in two's complement form, with the MSB in bit position 15. Hence the returned value must be bit shifted right 4 positions and converted to a decimal float value before applying the above formula to obtain the Display value. The units of Counts * 4.8828e-3 is volts. The value of Mult and the resulting units are given below for each analog monitor point.

Rel Add	Description	Mult.	Units	Norm Range	Sig. Digit
---	----------	------	------	------	------
00	LED Voltage A	2	Volts	0-10	x.xxx
01	LED Voltage B	2	Volts	0-10	x.xxx
O2	LED Voltage A(RT)	2	Volts	0-10	x.xxx
O3	LED Voltage B(RT)	2	Volts	0-10	x.xxx
O4	15K Temp	100	Kelvin	0-360	x.x
O5	50K Temp	100	Kelvin	0-360	x.x
O6	300 K Temp	100	Kelvin	0-360	x.x
07	Dewar Vacuum	1000	mV	0-9999	x.
08	Pump Vacuum	1000	mV	0-9999	x.
09	+15 Supply Mon	2	Volts	0-20	x.xxx
0A	-15 Supply Mon	2	Volts	-20-0	x.xxx
0B	+5 Supply Mon	1	Volts	0-10	x.xxx
0C	+28 Supply Mon	1/0.249	Volts	0-40	x.xxx
0D	R1, Gate 1	2	Volts	-20-0	x.xxx
0E	L1, Gate 1	2	Volts	-20-0	x.xxx
0F	R2, Gate 1	2	Volts	-20-0	x.xxx
10	L2, Gate 1	2	Volts	-20-0	x.xxx
11	R1(RT), Gate 1	2	Volts	-20-0	x.xxx
12	L1(RT), Gate 1	2	Volts	-20-0	x.xxx
13	R2(RT), Gate 1	2	Volts	-20-0	x.xxx
14	L2(RT), Gate 1	2	Volts	-20-0	x.xxx
15	R1, Gate 2, 3	2	Volts	-20-0	x.xxx
16	L1, Gate 2, 3	2	Volts	-20-0	x.xxx
17	R2, Gate 2, 3	2	Volts	-20-0	x.xxx
18	L2, Gate 2, 3	2	Volts	-20-0	x.xxx
19	R1(RT), Gate 2,3	2	Volts	-20-0	x.xxx

1A	L1(RT), Gate 2,3	2	Volts	-20-0	x.xxx	
1B	R2(RT), Gate 2,3	2	Volts	-20-0	x.xxx	
1C	L2(RT), Gate 2,3	2	Volts	-20-0	x.xxx	
1D	R1, Gate 4	2	Volts	-20-0	x.xxx	
(Table I continued)						
1E	L1, Gate 4	2	Volts	-20-0	x.xxx	
1F	R2, Gate 4	2	Volts	-20-0	x.xxx	
20	L2, Gate 4	2	Volts	-20-0	x.xxx	
21	R1(RT), Gate 4	2	Volts	-20-0	x.xxx	
22	L1(RT), Gate 4	2	Volts	-20-0	x.xxx	
23	R2(RT), Gate 4	2	Volts	-20-0	x.xxx	
24	L2(RT), Gate 4	2	Volts	-20-0	x.xxx	
25	LO1 Level	1	Volts	0-10	x.xxx	
26	Not Used					
27	Cal Current, 1-2.	10	mA	0-50	x.xx	
28	Cal Current, 3-4	10	mA	0-50	x.xx	No Longer Used
29	Cal Volts, 1-2	3	V	0-30	x.xx	
2A	Cal Volts, 3-4	3	V	0-30	x.xx	No Longer Used

(RT) = Room Temperature

Table II
Cryogenic Control
Relative Address 48

b_2 X	b_1 H	b_0 C	Code	Name	
1	1	0	6	OFF	No refrigerator or heater power.
1	1	1	7	COOL	Normal cooled operation.
1	0	1	5	HEAT	Fast warm up of dewar with 33 watts of heat added. PUMP REQ becomes high when dewar vacuum is greater than 10 microns
0	0	1	1	PUMP	No refrigerator or heater power. PUMP REQ high.

Cryogenic Status Monitor
Relative Address 50

b_2	b_1	b_0	Code	Name
X	H	C		
1	1	0	6	OFF
1	1	1	7	COOL
1	0	1	5	HEAT
0	0	1	1	PUMP

Pump Request (b3)

This bit indicates the state of the Control card Pump Request bit. Logic 1 indicates the dewar vacuum is higher than normal.

Solenoid (b5)

This bit indicates the state of the Control card solenoid bit.

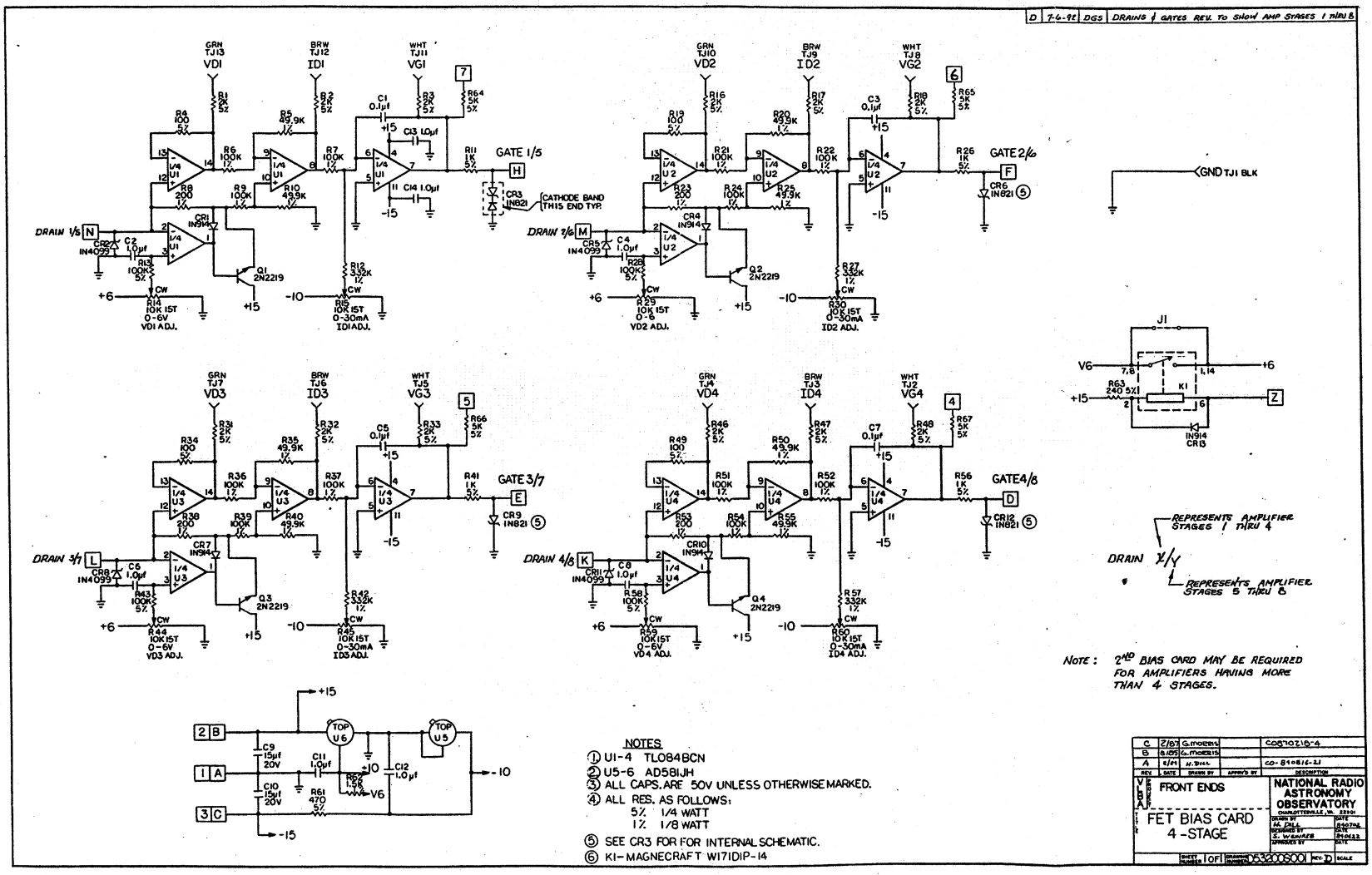
Refr CPU Monitor (b6)

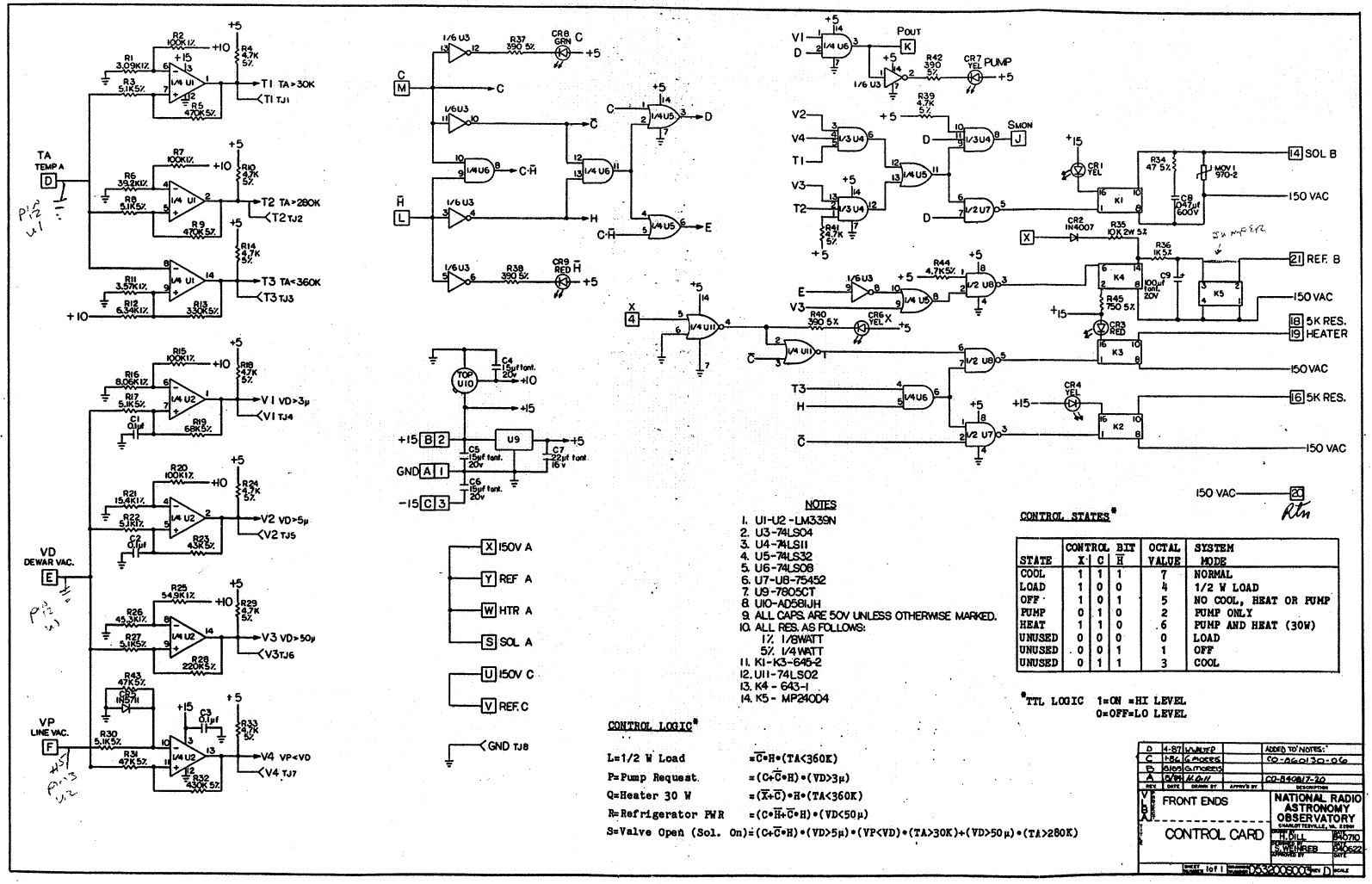
This bit is logic 1 when the Refrigerator Control rotary switch on the receiver local control box is in the CPU position. Logic 0 indicates RA 48 does NOT have control of the cryogenic state.

Cal Local Monitor (b7)

This bit is logic 1 when the MCB/Local control toggle switch is on the receiver local control box is in the Local position. In this condition, RA 49 and 4A do NOT have control of the noise cal sources or the beam transfer switches.

Section VII
PC Card Schematics


D 7-6-98 DGS DRAINS & GATES REV. TO SHOW AMP STAGES 1 THRU 8
GRN TJ13 VD1
BRW TJ12 ID1
WHT TJ11 VG1
GATE 1/5
DRAIN 1/5
GRN TJ10 VD2
BRW TJ9 ID2
WHT TJ8 VG2
GATE 2/6
DRAIN 2/6
GND TJ1 BLK
J1
K1
GRN TJ7 VD3
BRW TJ6 ID3
WHT TJ5 VG3
GATE 3/7
DRAIN 3/7
GRN TJ4 VD4
BRW TJ3 ID4
WHT TJ2 VG4
GATE 4/8
DRAIN 4/8
CATHODE BAND THIS END TYP.
REPRESENTS AMPLIFIER STAGES 1 THRU 4
REPRESENTS AMPLIFIER STAGES 5 THRU 8
NOTE: 2ND BIAS CARD MAY BE REQUIRED FOR AMPLIFIERS HAVING MORE THAN 4 STAGES.
NOTES
1. U1-4 TL084BCN
2. U5-6 AD581JH
3. ALL CAPS. ARE 50V UNLESS OTHERWISE MARKED.
4. ALL RES. AS FOLLOWS:
5% 1/4 WATT
1% 1/8 WATT
5. SEE CR3 FOR FOR INTERNAL SCHEMATIC.
6. K1- MAGNECRAFT W171DIP-14
FRONT ENDS
FET BIAS CARD 4-STAGE
NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22901
SHEET NUMBER 1 OF 1
DRAWING NUMBER 5532005001
REV. D



NOTES

1. U1-U2 - LM339N
2. U3 - 74LS04
3. U4 - 74LS11
4. U5 - 74LS32
5. U6 - 74LS08
6. U7 - U8 - 75452
7. U9 - 7805CT
8. U10 - AD581JH
9. ALL CAPS. ARE 50V UNLESS OTHERWISE MARKED.
10. ALL RES. AS FOLLOWS:
    1% 1/8WATT
    5% 1/4WATT
11. K1 - K3 - 645-2
12. U11 - 74LS02
13. K4 - 643-1
14. K5 - MP2404

CONTROL STATES*

STATE	CONTROL BIT X	C	H	OCTAL VALUE	SYSTEM MODE
COOL	1	1	1	7	NORMAL
LOAD	1	0	0	4	1/2 W LOAD
OFF	1	0	1	5	NO COOL, HEAT OR PUMP
PUMP	0	1	0	2	PUMP ONLY
HEAT	1	1	0	6	PUMP AND HEAT (30W)
UNUSED	0	0	0	0	LOAD
UNUSED	0	0	1	1	OFF
UNUSED	0	1	1	3	COOL

*TTL LOGIC 1=ON =HI LEVEL
0=OFF=LO LEVEL

CONTROL LOGIC*

L=1/2 W Load $=\overline{C}\cdot H\cdot(TA<360K)$

P=Pump Request. $=(C+\overline{C}\cdot H)\cdot(VD>3\mu)$

Q=Heater 30 W $=(\overline{X}+\overline{C})\cdot H\cdot(TA<360K)$

R=Refrigerator PWR $=(C\cdot\overline{H}+\overline{C}\cdot H)\cdot(VD<50\mu)$

S=Valve Open (Sol. On)$=(C+\overline{C}\cdot H)\cdot(VD>5\mu)\cdot(VP<VD)\cdot(TA>30K)+(VD>50\mu)\cdot(TA>280K)$

REV	DATE	DRAWN BY	APPROVED BY	DESCRIPTION
D	4-87	W.WILKEP		ADDED TO NOTES:*
C	1-86	G.MOSES		CO-8601310-06
B	6/85	G.MOSES		
A	6/84	M.DILL		CO-8408117-30

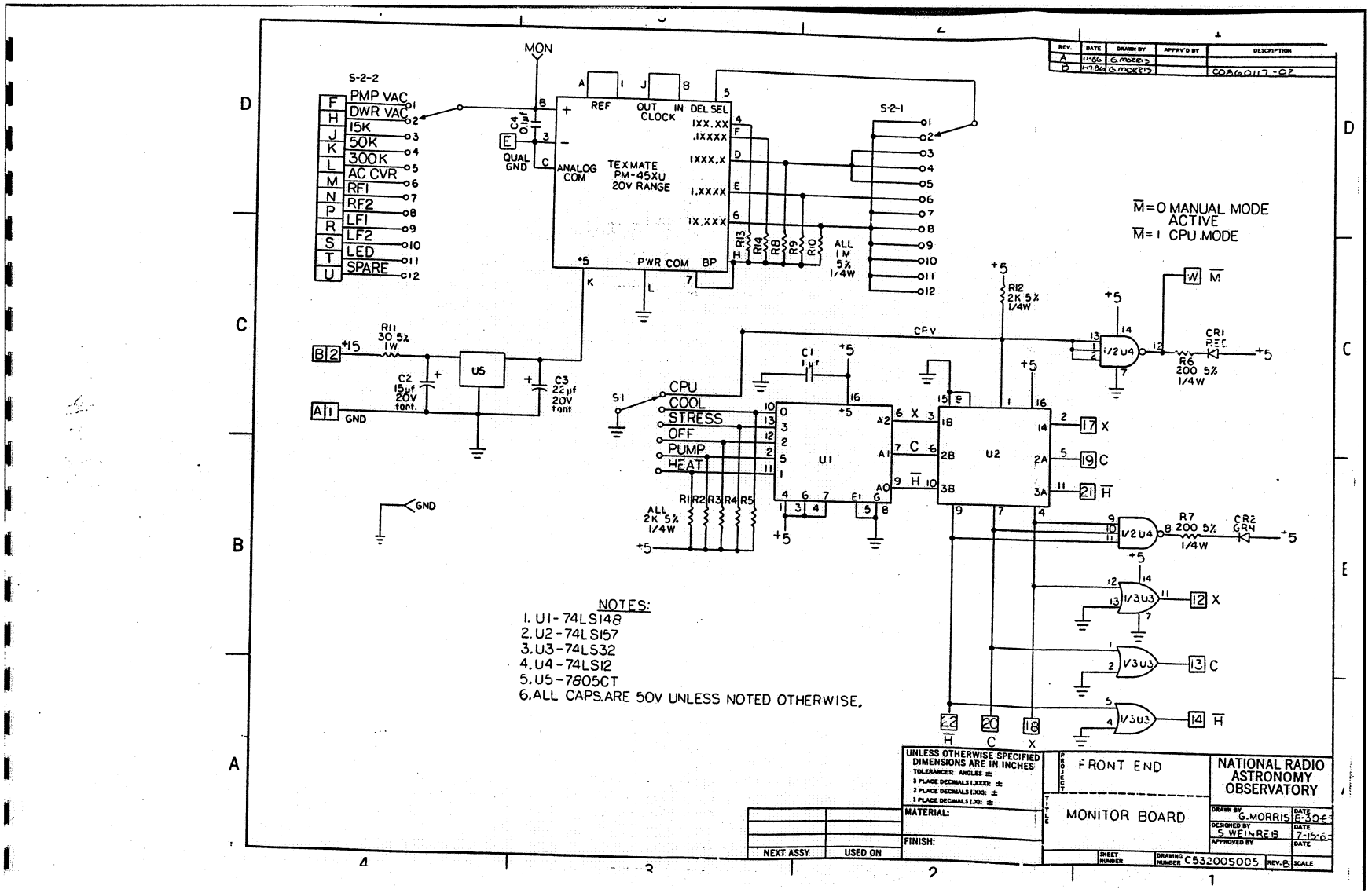
VLBA FRONT ENDS

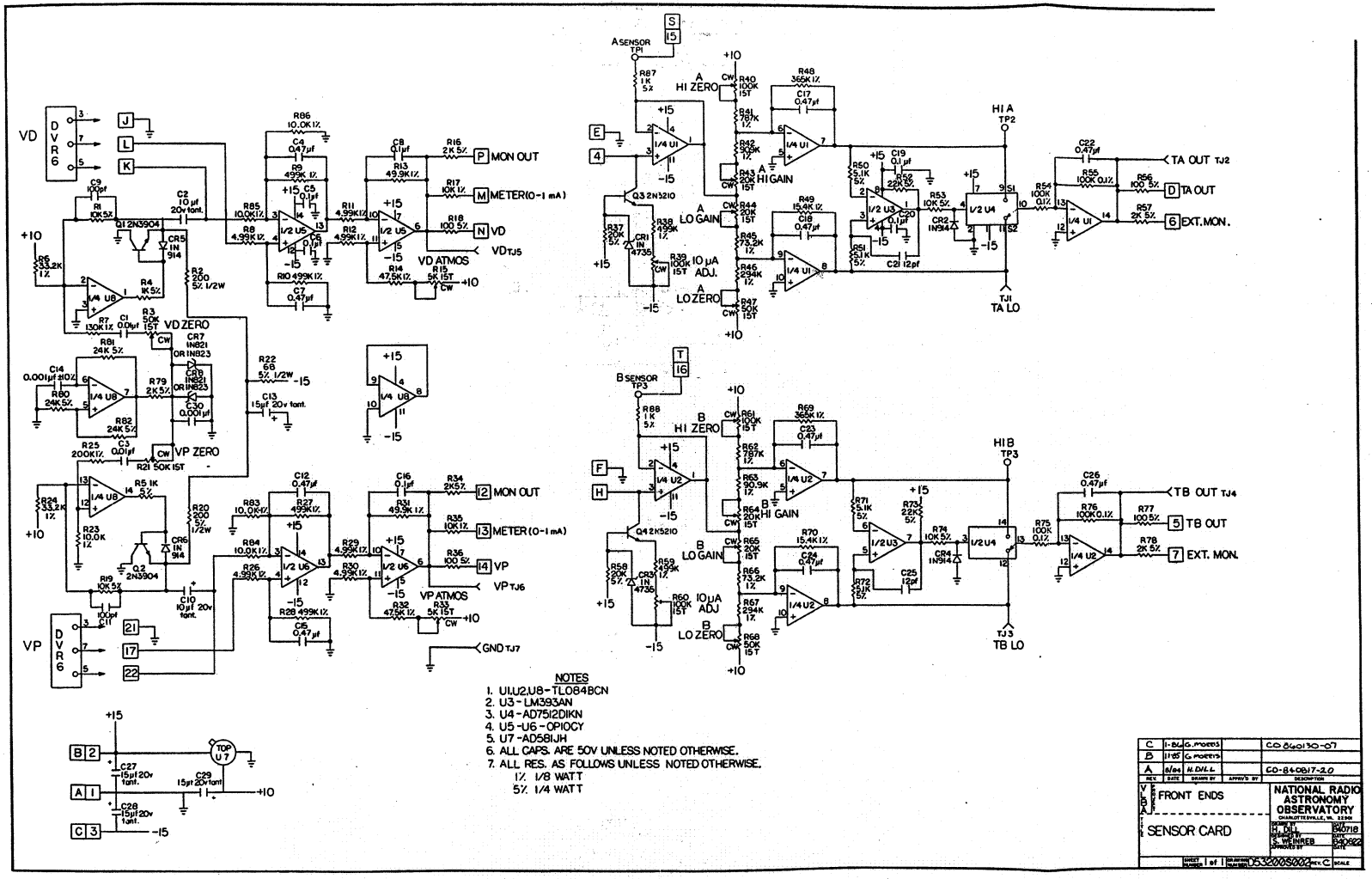
CONTROL CARD

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22901

DRAWN BY M.DILL 840710
PROJECT ENGR. W.WILKINSON 840622
APPROVED BY
DATE

SHEET 1 of 1 DRAWING 0532005005 REV D SCALE


MON
S-2-2
PMP VAC
DWR VAC
15K
50K
300K
AC CVR
RFI
RF2
LFI
LF2
LED
SPARE
TEXMATE PM-45XU 20V RANGE
ANALOG COM
QUAL GND
REF
OUT CLOCK
IN
DEL SEL
PWR COM
S-2-1
M=0 MANUAL MODE ACTIVE
M=1 CPU MODE
CPU
COOL
STRESS
OFF
PUMP
HEAT
U1
U2
U5
GND
NOTES:
1. U1-74LS148
2. U2-74LS157
3. U3-74LS32
4. U4-74LS12
5. U5-7805CT
6. ALL CAPS ARE 50V UNLESS NOTED OTHERWISE.
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
MATERIAL:
FINISH:
NEXT ASSY
USED ON
FRONT END
MONITOR BOARD
NATIONAL RADIO ASTRONOMY OBSERVATORY
DRAWN BY G.MORRIS
DESIGNED BY S.WEINREIS
APPROVED BY
DRAWING NUMBER C532005005
REV. B



NOTES

1. U1,U2,U8 - TL084BCN
2. U3 - LM393AN
3. U4 - AD7512DIKN
4. U5 -U6 - OP10CY
5. U7 - AD581JH
6. ALL CAPS. ARE 50V UNLESS NOTED OTHERWISE.
7. ALL RES. AS FOLLOWS UNLESS NOTED OTHERWISE.
   1% 1/8 WATT
   5% 1/4 WATT

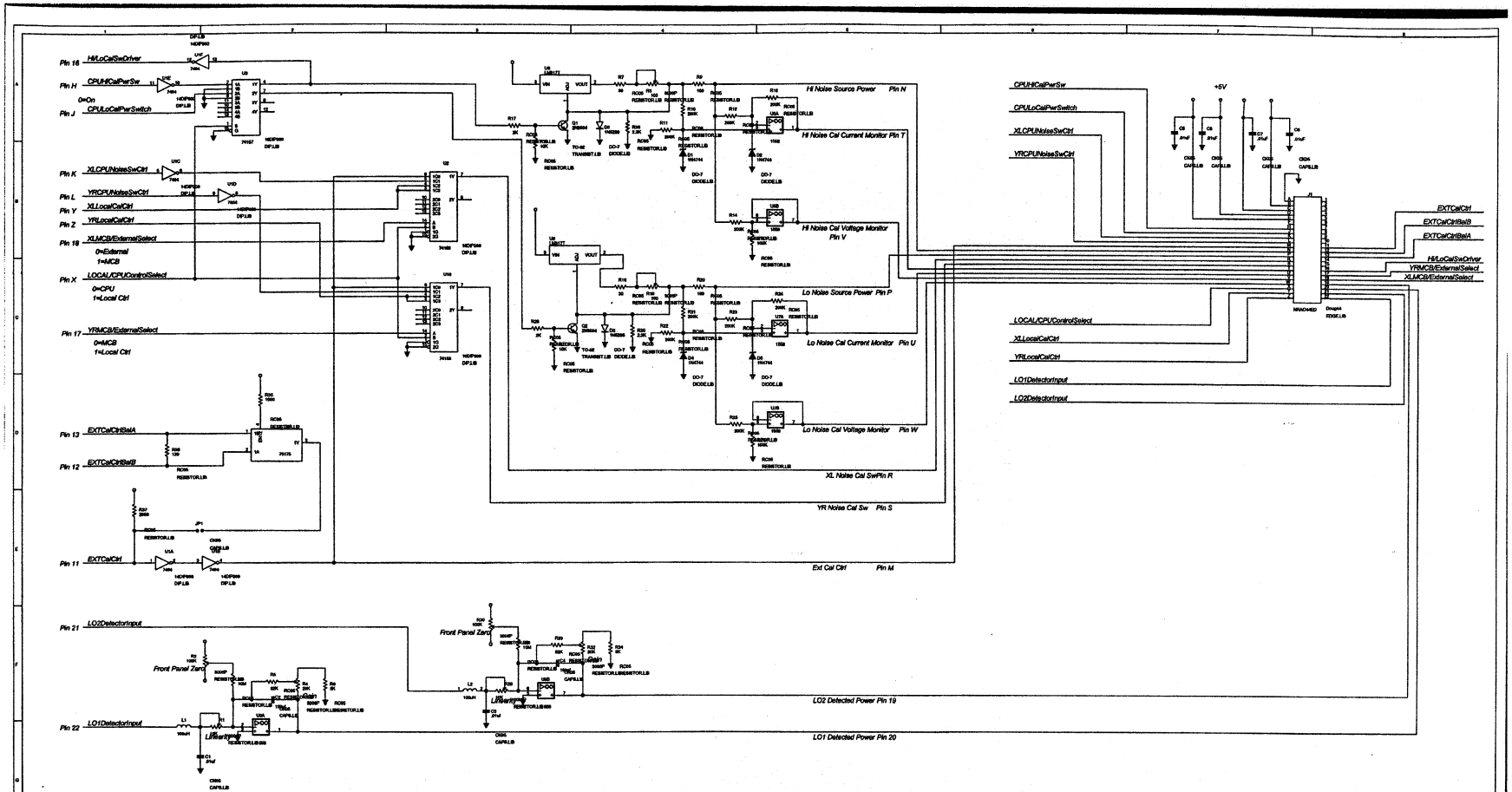
REV	DATE	DRAWN BY	APPR'D BY	DESCRIPTION
C	1-84	G. MORRIS		CO-860130-07
B	11-83	G. MORRIS		
A	6/84	M.DIVILA		CO-840817-20

FRONT ENDS

SENSOR CARD

NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VA. 22901

DRAWN BY	M. DIVILA
ENGINEER	S. WEINREB
APPROVED BY	
DWG NO.	5A0718
SIZE	D
CAD NO.	5A0522
SHEET NUMBER	1 of 1
DRAWING NUMBER	5320085002
REV	C
SCALE	



ManualControlSelect comes from the receiver control box switch marked "Manual on/off" (or similar).

LX and YRManualCalCtrl come from the two receiver control box swithches marked "Cal on/off" (or similar).

Install jumper at JP1 for Prime Focus use.

Drawn by: Gary Anderson	National Radio Astronomy Observatory PO Box 2 Green Bank, WV 24944
	Sheet title: LO Detector/Cal Control Card
Sheet file name: Noisegg.Sch	Size: D Document Number: B252015089 Rev: A
Sheet Creation date: 02/03/88	Modification date: 10/25/101 SHEET 1 OF 1

Section VIII
Data Sheets

Notes on Component Specifications

1) Dorado manufactured the isolators used in this project. They were purchased in multiple lots with two different specifications. -46 units were specified to cover 40-50 GHz while the -47 units were specified to cover 42-52 GHz.

Tests showed that there was little practical difference in the units for our application. We used the -47 units since they had slightly better high-frequency performance and adequate low-frequency performance. This was a judgment based upon components we had in-hand: there is no guarantee that this would be true for newly ordered components. Any future specification should emphasize performance from 40 - 49 GHz.

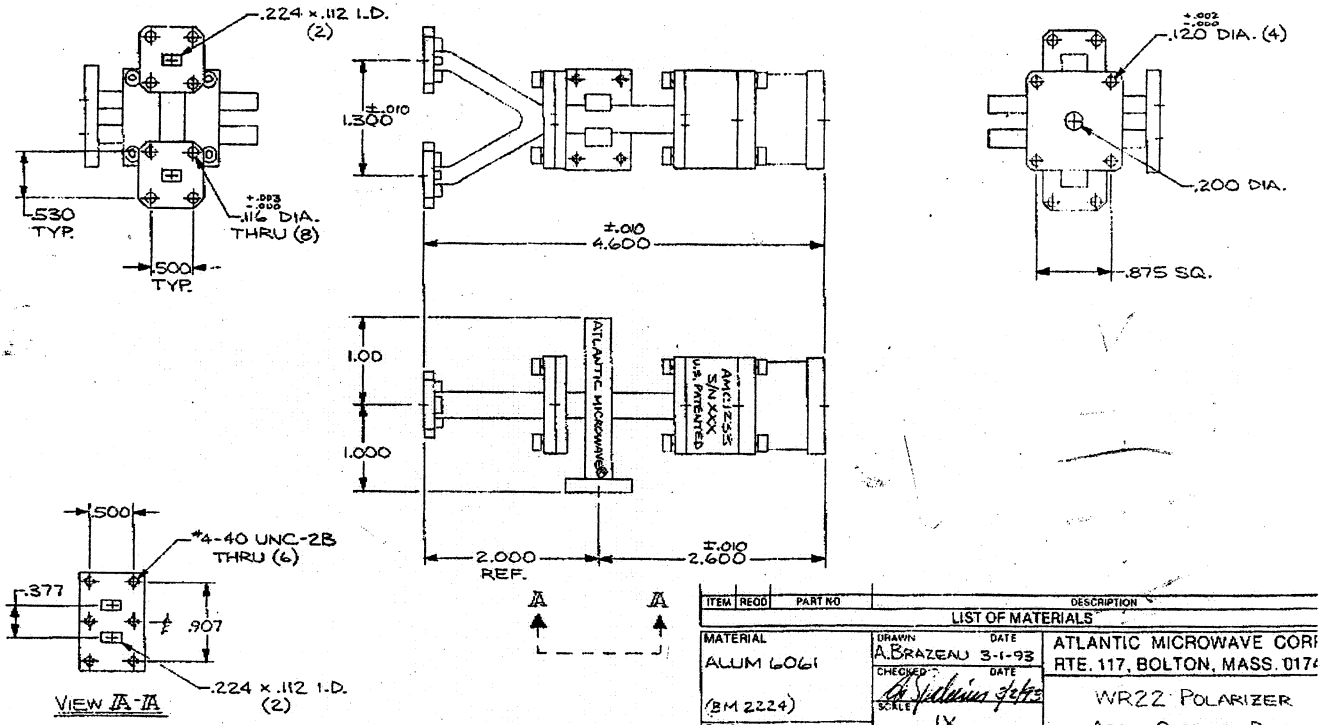
2) Spacek mixers convert the 40-50 GHz sky frequency to an intermediate frequency (IF) range centered at 6 GHz. Note that these mixers were originally ordered to a specification that called for cryogenic operation. The specification called for vendor testing in liquid nitrogen. ***Do not impose this requirement upon Spacek for any future procurement or repair, as the mixers are now used at room temperature.***

3) An error was made in procurement of the x4 multipliers from DBS Microwave. The original intent was to have WR-22 waveguide at the output. The multipliers were ordered in two lots and the second lot was shipped with WR-19 outputs. Since the error was not discovered until several years later, it could not be corrected by the vendor. Tests showed that the multipliers with WR-19 flanges could be attached to WR-22 waveguide directly without noticeable problems, so no replacement units were procured. **Be sure that any future orders specify that the output of the unit use WR-22 waveguide.**

4) DBS Microwave originally designed the IF amplifiers. They were specified for a minimum gain of 48 dB. This was too much gain in a single block, especially after additional gain was added before the mixer. Therefore the amplifiers were replaced by an in-house amplifier designed by Steve White with approximately 30 dB gain. The DBS amplifier data is included for completeness.

Note that this receiver is a modification of an earlier design dating from 1999. The original design had dual polarization for four beams, omitted the second stage of amplification (the first room-temperature amplifier), and had cooled mixers. Some features, such as the four feeds that reside in the dewar, have been left in place as originally designed for the sake of mechanical stability. They are not used electrically.

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROV
A	ADDED MARKING. 1/4/94		



ITEM	REQD	PART NO	DESCRIPTION
		LIST OF MATERIALS	

MATERIAL ALUM 6061 (BM 2224)	DRAWN A.BRAZEAU 3-1-93	ATLANTIC MICROWAVE CORP. RTE. 117, BOLTON, MASS. 017
FINISH GOLD PLATE 75 ±25 MICROINCHES OVER A COPPER-FLASH/ZINCATE ADHESION LAYER	CHECKED DATE SCALE 1X	WR22 POLARIZER ASSY OUTLINE DWG. AMC 1233
	UNLESS OTHERWISE SPECIFIED TOLERANCES ON XX ±.02, XXX ±.005, ANGLES ±.5° DIMENSIONS ARE IN INCHES	CODE IDENT. NO. 28916 / DWG. NO. B23136

NATIONAL RADIO ASTRONOMY OBSERVATORY
SUITE 219 2015 IVY ROAD
CHARLOTTESVILLE, VA 22903-1733
TELEPHONE: (804) 296-0211 FAX: (804) 296-0324

July 11, 1996

Mr. Ken Shade
Blackhart Associates
6120 N. Desert Foothills Dr.
Tucson, AZ 85743
Phone: (520) 579-0399
FAX: (520) 579-0098

Dear Sir:

We are interesting in receiving a written quotation for a magic-tee with the configuration indicated in the accompanying drawing. The desired device is based upon Microwave Development Laboratories components (Ref. Mod. # 22TH12B, MDL # 148666, Ser. # 54). The following specificaitons are desired:

- Quantity: 1-4 units
- Waveguide: WR22 (flanges per attached drawing)
- VSWR: 1.2 (max)
- E/H Arm Isolation: 40 dB (min)
- Amplitude Unbalance: 0.2 dB (max)
- Center Frequency: 45 GHz

If any questions arise, please feel free to contact me (Phone/Voice Mail: 804-296-0356). Thank you in advance for timely consideration of this matter.

Respectfully,

Ed Wollack

Edward J. Wollack
ewollack@nrao.edu

Section 3

H plane folded hybrid tees

Waveguide Size	Operating Frequency GHz	MDL MODEL NUMBER	VSWR Maximum H Arm	VSWR Maximum E Arm	Isolation DB Min Between E&H Arms	Isolation DB Min Between Parallel Arms	Unbal DB Max	Dimensions (Inches) E	Dimensions (Inches) H	Common Wall Thickness (Inches)	Terminations E&H Arms	Terminations Parallel Arms	Recommended Dual Flange (12)
WR 10	91.75-95.75	10TH16-1[12]	1.25	1.25	34	19	.25	1.12	0.38	0.56	.040	COVER[16] / FLANGE	50FS12	10FS12
WR 15	50.0-60.0	15TH26-1[12]	1.30	1.30	35	18	.25	1.00	0.56	0.50	.040	UG385/U	15FS52	15SF52
	67.0-73.0	15TH16-1[12]	1.30	1.30	35	18	.25							
WR 22	43.5-45.5	22TH12	1.15	1.15	40	–	.20	1.04	0.60	0.60	.040	WG	CORRAL	–
WR 28	29.0-33.2	28TH42	1.25	1.25	35	22	.25	0.97	0.72	0.48	.040	WG	CORRAL	28FS12
	33.0-39.5	28TH22	1.35	1.35	35	22	.25							
	34.0-36.0	28TH12	1.20	1.20	35	22	.25							

MICROWAVE DEVELOPMENT LABS MDL 190 ELECT. MOD.# 22TH12B FT GEN. 1124

SER.# 51 MDL# 148666

FREQUENCY RANGE (Gc)	VSWR E ARM	VSWR H ARM	UNBALANCE E ARM	UNBALANCE H ARM	ISOLATION H ARM TO E ARM
43.5 -45.5	OK	OK	OK	OK	OK

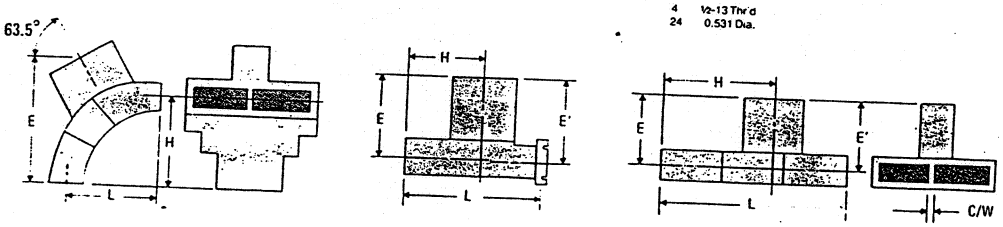
MICROWAVE DEVELOPMENT LABS MDL 190 ELECT. MOD.# 22TH12B FT GEN. 1124

SER.# 54 MDL# 148666

FREQJENCY RANGE (Gc)	VSWR E ARM	VSWR H ARM	UNBALANCE E ARM	UNBALANCE H ARM	ISOLATION H ARM TO -E ARM
43.5 -45.5	OK	OK	OK	OK	OK

*All tees exhibit reasonable electrical characteristics over a broader frequency range than specified. Maximum VSWR's specified does not indicate typical performance but only the highest VSWR over the operating range of the tee.

2. Available only in copper alloy with flanges.
3. This flange is integral cast to the tee.
7. Add 0.17 to Dimension "L" when using recommended dual flange.
8. E = E' and H = H' unless otherwise shown.
9. Available only in non-brazable aluminum with flanges.
10. Available only in aluminum with flanges.
13. No physical commonwall. .050 commonwall required by mating component to function electrically.
14. Panty output with two single flanges. 2100 FA27 CPR2100 Except Holes
    4 1/2-13 Thrd
    24 0.531 Dia.
15. No physical commonwall. .160 commonwall required by mating component to function electrically.
16. Similar to UG387.U



FAX

DORADO INTERNATIONAL CORPORATION
270 SOUTH HANFORD ST. SUITE 204, SEATTLE, WASHINGTON 98134 USA
PHONE: (206) 583-0000
FAX: (206) 583-0345

To: Ed Wollack
N.R.A.O.
Subject: 42-50 GHz Isolator W/UG599/U
From: Harry Rutstein

Date: April 8, 1996
Fax No: 804-296-0324
Dorado Ref: 10592
Page 1 of: 2

Dorado is pleased to offer its quotation on your requirement for cryogenic isolators with special square flanges. We propose the following:

Type:	Cryogenic Isolator
Model:	4IWC46-1
Frequency:	42 to 50 GHz
Test Range:	40 to 52 GHz
Insertion Loss:	0.5 dB (Max)
Isolation:	-15 dB (Min)
VSWR:	1.5:1 (Max)
Size:	See Enclosed Drawing
Temperature:	10° to 20°K
Unit Price:	
2 to 5 pcs.	$1100.00 ea.
10 pcs.	$ 990.00 ea.

Delivery can be made in 60 days after receipt of your order.

We hope this proposal meets with your approval. Please contact us if there are any questions.

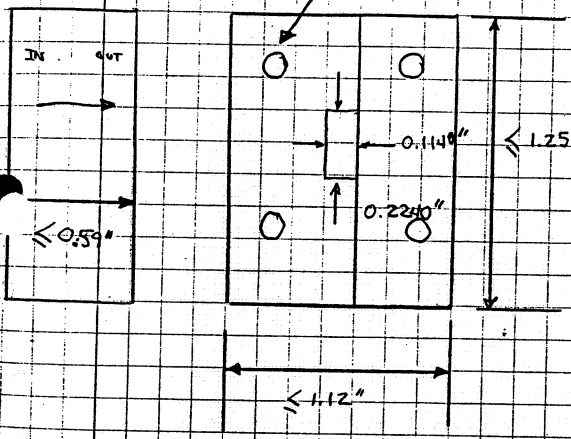
Best regards,

Harry Rutstein

WR 22 — WAVE GUIDE:

TO MATE UG 599/U SQUARE FLANGE

4-40 THRU HOLES
FOUR LOCATIONS



① FREQUENCY: 42-50 GHz (40-52 TYP.

② INSERTION LOSS: 0.5dB (MAX)

③ ISOLATION: -15dB (MIN)

④ VSWR: 1.5:1 (MAX)

⑤ TEMPERATURE: 10-20 °K

Q-BAND ARRAY ISOLATOR SPECIFICATIONS:

(REF. MODEL 4IWC46-1 DORADO # 9871)

NRAO — EJW / 04-03-96

DORADO INTERNATIONAL CORPORATION
270 South Hanford St. Suite 204, Seattle, Washington 98134 USA

Waveguide cryogenic isolator
Model 4IWC46-1

Certificate

1. General specifications

Serial number:	181	Date:	10/6/96
Waveguide		WR-22	
Flange		UG-599/UM	
Dimensions, mm		15 x 32 x 22	
Weight, g		70	

2. Main performance characteristics

2.1 Test data (Temperature range 10 ÷ 20 K)

Frequency, GHz		42	44	46	48	50	52
Insert.loss, dB		0.4	0.4	0.4	0.3	0.3	0.6
Isolation, dB		22	21	21	21	20	11
VSWR	input	1.3	1.25	1.3	1.22	1.3	1.6
	output	1.25	1.18	1.25	1.15	1.25	1.6

3. Application

to be used in measurement system.

DORADO INTERNATIONAL CORPORATION
270 South Hanford St. Suite 204, Seattle, Washington 98134 USA

Waveguide cryogenic isolator
Model 4IWC46-1

Certificate

1. General specifications

Serial number:	182	Date:	10/6/96
Waveguide		WR-22	
Flange		UG-599/UM	
Dimensions, mm		15 x 32 x 22	
Weight, g		70	

2. Main performance characteristics

2.1 Test data (Temperature range 10 ÷ 20 K)

Frequency, GHz		42	44	46	48	50	52
Insert.loss, dB		0.3	0.3	0.3	0.35	0.5	1.0
Isolation, dB		29	28	28	29	18	12
VSWR	input	1.15	1.1	1.22	1.1	1.4	1.9
	output	1.13	1.13	1.1	1.14	1.4	1.86

3. Application

to be used in measurement system.

DORADO INTERNATIONAL CORPORATION
270 South Hanford St. Suite 204, Seattle, Washington 98134 USA

Waveguide cryogenic isolator
Model 4IWC46-1

Certificate

1. General specifications

Serial number:	183	Date:	10/6/96
Waveguide		WR-22	
Flange		UG-599/UM	
Dimensions, mm		15 x 32 x 22	
Weight, g		70	

2. Main performance characteristics

2.1 Test data (Temperature range 10 ÷ 20 K)

Frequency, GHz		42	44	46	48	50	52
Insert.loss, dB		0.3	0.3	0.3	0.3	0.3	0.8
Isolation, dB		26	25	24	23	20	13
VSWR	input	1.15	1.1	1.2	1.15	1.25	1.9
	output	1.25	1.18	1.15	1.15	1.3	1.45

3. Application

to be used in measurement system.

DORADO INTERNATIONAL CORPORATION
270 South Hanford St. Suite 204, Seattle, Washington 98134 USA

Waveguide cryogenic isolator
Model 4IWC46-1

Certificate

1. General specifications

Serial number: 184 Date: 10/6/96
Waveguide WR-22
Flange UG-599/UM
Dimensions, mm 15 x 32 x 22
Weight, g 70

2. Main performance characteristics

2.1 Test data (Temperature range 10 ÷ 20 K)

Frequency, GHz		42	44	46	48	50	52
Insert.loss, dB		0.5	0.5	0.45	0.45	0.4	0.8
Isolation, dB		22	22	21	22	20	14
VSWR	input	1.3	1.25	1.35	1.3	1.2	1.45
	output	1.24	1.18	1.23	1.18	1.24	1.85

3. Application

to be used in measurement system.

DORADO INTERNATIONAL CORPORATION
716 INDUSTRY DRIVE, Seattle, Washington 98188 USA

Waveguide Cryogenic Isolator
Model 4IWC47–1

C E R T I F I C A T E

1. General specification

- Serial number: 019 Date: Jan / ___ / 2000
- Waveguide WR–22
- Flange UG–599/U
- Dimensions, mm 15 x 32 x 22
- Weight, g 90

2. Main performance characteristics

2.1 Test data (Temperature **12 K**)

Frequency, GHz	42	44	46	48	50	52
Insertion loss, dB	0.3	0.3	0.3	0.4	0.4	0.5
Isolation, dB	20	22	20	18	19	17
VSWR input	1.22	1.25	1.3	1.25	1.22	1.4
output	1.2	1.18	1.25	1.35	1.42	1.25

3. Application

- To be used in communication equipment.

DORADO INTERNATIONAL CORPORATION
716 INDUSTRY DRIVE, Seattle, Washington 98188 USA

Waveguide Cryogenic Isolator
Model 4IWC47–1

C E R T I F I C A T E

1. General specification

- Serial number: 019 Date: Jan / ___ / 2000
- Waveguide WR–22
- Flange UG–599/U
- Dimensions, mm 15 x 32 x 22
- Weight, g 90

2. Main performance characteristics

2.1 Test data (Temperature **12 K**)

Frequency, GHz	42	44	46	48	50	52
Insertion loss, dB	0.3	0.3	0.3	0.4	0.4	0.5
Isolation, dB	20	22	20	18	19	17
VSWR input	1.22	1.25	1.3	1.25	1.22	1.4
output	1.2	1.18	1.25	1.35	1.42	1.25

3. Application

- To be used in communication equipment.

DORADO INTERNATIONAL CORPORATION
716 INDUSTRY DRIVE, Seattle, Washington 98188 USA

Waveguide Cryogenic Isolator
Model 4IWC47–2

C E R T I F I C A T E

1. General specification

- Serial number: 025 Date: Jan / 2000
- Waveguide — WR–22
- Flange — UG–383/U
- Dimensions, mm — 15 x 32 x 32
- Weight, g — 150

2. Main performance characteristics

2.1 Test data (Temperature **12 K**)

Frequency, GHz	42	44	46	48	50	52
Insertion loss, dB	0.45	0.3	0.3	0.3	0.3	0.5
Isolation, dB	20	22	21	20	21	21
VSWR input	1.4	1.25	1.15	1.14	1.18	1.3
output	1.43	1.25	1.2	1.3	1.2	1.35

3. Application

- To be used in communication equipment.

NATIONA[L RA]DIO ASTRONOMY OBSERVATORY
[ASSO]CIATED UNIVERSITIES, INC.

PURCHA[S]E REQUISITION

10067

SUCCESSFUL VENDOR: SPACEK LABS, SANTA BARBARA CA
Att. Dave Green

NEED DATE: 5/1/95
ACCOUNT NO.: 49101.7655
PROJECT NO.: 10301 GB
DELIVER TO: E. Wollack
LOCATION: (IR)

TECHNICAL INSPECTION REQUIRED: YES ☐ NO ☐

PURCHASE ORDER NO.

SHADED AREAS FOR BUYER USE ONLY

ITEM NO.	QUANTITY	DESCRIPTION	ESTIMATED UNIT PRICE	ESTIMATED TOTAL PRICE
1	2	MIXER MODEL MQQ-11	3000	6000
		RF INPUT: 40 - 52 GHz		
		LO FREQUENCY: 39 - 44 GHz		
		IF FREQUENCY: 1 - 8 GHz		
		LO CONNECTOR WR-22		
		RF CONNECTOR WR-22		
		IF CONNECTOR SMA-(FEMALE)		
		CONVERSION LOSS 9 dB (MAX) ±1.5 FLATNESS		
		* BIASED MIXER +3 dBm	~~200~~	~~400~~
		CRYO-GENIC TEST DATA (included)		
		bias 3V 5 5ma.		

REQUISITIONER / DATE: EW 03/21/95
APPROVAL / DATE: [signature] 3/4/95
TOTAL ▶ 6400

NOTE: REQUISITIONER KEEP 2nd COPY

The Items Listed Are Not ☐ Available From Stock

SUGGESTED VENDORS		USE OTHER SIDE FOR JUSTIFICATION
SPACEK LABS, DAVE GREEN	(805) 966-3249	805 564-4404

REV. 1979

DIVISION COPY

QUOTATION NO. 9F29

TO NRAO
Attn: Roger Norrod
Fax: 304-456-2200

1 of 3 pages

SPACEK LABS, INC.
MM-WAVE TECHNOLOGY
212 EAST GUTIERREZ STREET
SANTA BARBARA, CALIFORNIA 93101
(805) 564-4404
FAX: 805-966-3249

We take pleasure in quoting you on equipment or components indicated subject to terms and conditions mentioned on the back hereof, except as specifically modified.

REF.	F.O.B.	QUOTATION EFFECTIVE	DATE	TERMS
Telecom of 6/29/99	SANTA BARBARA CALIFORNIA	90 days	6/29/99	NET 30 DAYS

ITEM NO.	DESCRIPTION	SHIPPING * SCHEDULE	QTY.	UNIT PRICE	TOTAL
1	Model MQQ-11B RF: 40-52 GHz, WR-22 LO: 39-44 GHz, WR-22 IF: 1-8 GHz, SMA (F) Conv. Loss: 9 dB max Flatness: ±1.5 dB Bias: +3 V @ 5 mA LO Input Power: +3 dBm includes diode test in liquid nitrogen	45 days	3 ea	3,000	
2	Model F45-9 WR-22 filter Square UG-599 flange one end UG 383/u flange other end Length: 1.75" Insertion Loss: 1.0 dB max Rejection @ 39 GHz: 20 dB min Pass band: 40-52 GHz	45 days	3 ea	750	

AFTER RECEIPT OF CONFIRMING ORDER - SUBJECT TO PRIOR SALE

BY Dave Greim Dave Greim

SPACEK LABS inc.

DOWNCONVERTERS

Moderate Bandwidth

Band	Model No.	RF Input (GHz)	LO Input (GHz)	IF Output (GHz)	Max SSB Conv. Loss (dB)
75-110GHz	M89-1	88-90	88-90	DC-1	5.0
	M94-1	93-94	93-94	DC-1	5.0
	M94-10	93-95	84	9-11	7.0
	M85-11	84-86	74	10-12	7.0
50-75GHz	M60-1	59-61	59-61	DC-2	5.0
	M53-8	50-56	40-60	DC-16	7.0
	M58-9	56-60	42-60	DC-18	7.5
40-60GHz	M42-1	40-44	40-44	DC-4	4.5
	M42-7	40-44	33-50	DC-11	6.0
	M44-7	42-46	40-60	DC-14	6.5
33-50GHz	M40-7	40-41	33.0	7-8	5.5
	M43-4	43-43.5	39.3	3.7-4.2	3.2***
	M44-MS	43.5-45.5	37.4	6.1-8.1	6.5
	M44.5-MS	43.5-45.5	9.0-9.5*	6.6-6.9	6.0
26-40GHz	M28-5	26-30	26-40	DC-10	5.0
	M32-5	30-34	26-44	DC-10	5.0
	M37-6	34-40	34-52	DC-12	5.5
18-26.5GHz	M20-4	18-22	18-26	DC-8	5.0
	M24-4	22-26	18-26	DC-8	5.0
	MM23-9.7**	21.5-24.5	12-15	9.2-10.2	7.0

*Internal 4X LO multiplier **Doubly-balanced ***LN cooled

Broad Bandwidth

Band	Model No.	RF Input (GHz)	LO Input (GHz)	IF Output (GHz)	Max SSB Conv. Lo (dB)
75-110GHz	M90-U	85-95	85-95	DC-1	7.0
	M95-U	90-100	90-100	DC-1	8.0
	M95-U(3X)*	90-100	30-33.3	DC-1	9.0
	M94-5(3X)*	91-97	29.66	2-8	8.0
50-75GHz	MV-U	50-75	50-75	DC-2	7.0
	M60-15	55-65	40-50	15	5.5
40-60GHz	MU-V	40-60	40-60	DC-2	6.0
	MUU-11	40-60	40-60	DC-20	9.5
	MUQ-11	40-60	33-50	DC-18	7.0
33-50GHz	MQ-U	33-50	33-50	DC-2	6.0
	MQQ-11	33-50	33-50	DC-17	8.5
	MQU-11	33-50	40-60	DC-22	9.0
26-40GHz	MKa-U	26.5-40	26.5-40	DC-2	6.0
	MKaKa-9	26.5-40	26.5-40	DC-14	7.5
	MKaQ-10	26.5-40	33-50	DC-20	8.0
18-40GHz	M180-U	18-40	18-40	DC-1	6.5
	M180Q-9	18-40	33-50	DC-18	8.0
	M180Ka-9	18-40	26-40	DC-18	8.0
18-26GHz	MK-U	18-26.5	18-26.5	DC-1	5.5
	MKK-6	18-26.5	18-26.5	DC-8.5	7.0
	MKKa-7	18-26.5	26-40	DC-14	7.0

*Internal LO Tripler

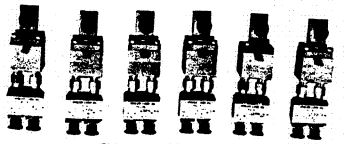
HIGH-LEVEL UPCONVERTERS/SSB MODULATORS

Output Band	Model No.	IF Input Freq. (GHz)	IF Input Power (mW)	LO Input Freq. (GHz)	LO Input Power (mW)	RF Output Freq. (GHz)	RF Output Power (mW) 1dB comp.
40-60GHz	MM2-60*	2	11	58	30	60	4
	MM4-50*	3-4	60	46	100	49-50	5
	M1-51	1	40	51.6	60	50.6 & 52.6	10**
	M2-47	1-2	15	45.6	40	46.6-47.6	3
	M7-43	5-8	8	37	20	42-45	2
	M12-42	12	20	30	40	42	5
	M6.9-MS	6.4-7.4	20	9.3-9.5***	100	43.5-45.5	3
26-40GHz	M1-37	DC-1	25	36.6	50	36-38	10**
	M2-33	1-2	12	31.2	35	32.2-33.2	3
	M3-35	3	50	31	60	32 & 38	20**
	MM7-38*	6-8	50	31	60	37-39	12
18-26GHz	M2-22	1.3	100	20.9	75	19.6 & 22.2	20**
	M4-21	4-5	20	15.5	35	19.5-20.5	5
12-18GHz	M6-14	4-8	20	4	50	12-16	6
	M6-15	5-7	20	9.6	50	14.6-16.6	7

*Doubly-balanced SSB modulator **DSB output ***Internal LO quadrupler

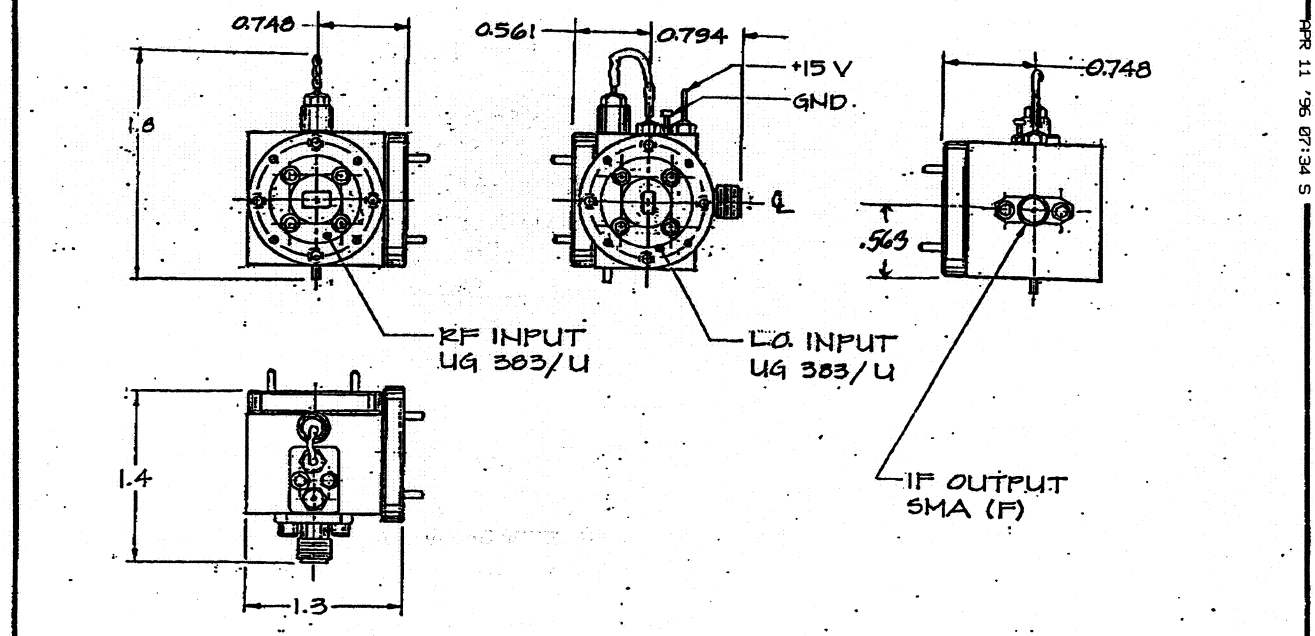
- Up to 20mW output power
- 20 to 40dB undesired sideband suppression

Although downconverters can also be used as upconverters for applications requiring either high output power or single-sideband output the upconverters described below were developed. These units are either single-balanced mixers with integrated output filter to suppress the undesired sideband, or they are doubly-balanced SSB modulators with integrated hybrids in which the undesired sideband is suppressed by phasing.



Model MM23-9.7

Model M180Ka-9



SPACEK LABS, INC. MM-WAVE TECHNOLOGY 212 EAST GUTIERREZ STREET SANTA BARBARA, CALIFORNIA 93101	SCALE FULL	MODEL MQ-1B	DRWN BY AZS DATE 9-10-84	REV A	SHT 1 OF 1
	MATL —	DESC OUTLINE	ENG RDM DATE 9-18-84		
CODE IDENT NO 7W232	FIN —		APPR [illegible] DATE 9/18/84 (QA SL1)	SIZE A	DRWG NO 1178

DATA

SPACEK LABS
Millimeter Wave Technology

CUSTOMER NRAO

DESCRIPTION Q-Band Mixer

MODEL No. MQQ-11B

SERIAL No. 5F20

DATE 6/29/95

SALES ORDER No. 100163

TESTED BY

LO Freq (GHz)	RF Freq (GHz)	IF Freq (GHz)	Conversion Loss (dB)			
39.0	40	1	5.9			
	42	3	6.2			
	44	5	5.9			
	46	7	7.0			
	48	8	5.9			
41.5	42.5	1	6.0			
	44.5	3	7.0			
	46.5	5	5.5			
	48.5	7	7.0			
	49.5	8	6.2			
44.0	45	1	6.3			
	47	3	6.2			
	49	5	6.0			
	51	7	6.3			
	52	8	6.0			

COMMENTS Bias Voltage = +3 V. LO Input Power = +3 dBm.
The units were DC tested in liquid nitrogen. QA 1

212 E. Gutierrez St. • Santa Barbara, CA 93101 • (805)564-4404 • FAX: (805)966-3249

TEST DATA

COPY

SPACEK LABS
Millimeter Wave Technology

CUSTOMER NRAO

DESCRIPTION WR-22 Waveguide Filter

MODEL No. F45-9

SERIAL No. 6H07 DATE 8-7-96

SALES ORDER No. 100704 TESTED BY [illegible]

Frequency (GHz)	Insertion Loss (dB)	Rejection (dB)				
38.9	-	20				
40	1.4	-				
42	1.6	-				
44	1.0	-				
46	0.8	-				
48	0.6	-				
50	0.9	-				
52	0.9	-				

COMMENTS

212 E. Gutierrez St. • Santa Barbara, CA 93101 • (805)564-4404 • FAX: (805)966-3249

TEST DATA

SPACEK LABS
Millimeter Wave Technology

CUSTOMER NRAO

DESCRIPTION Q-Band Mixer

MODEL No. MQQ-11B

SERIAL No. 5F19 DATE 6/19/95

SALES ORDER No. 100163 TESTED BY DA

LO Freq (GHz)	RF Freq (GHz)	IF Freq (GHz)	Conversion Loss (dB)			
39.0	40	1	5.9			
↓	42	3	6.3			
	44	5	5.5			
	46	7	5.7			
↓	48	8	5.5			
41.5	42.5	1	5.8			
↓	44.5	3	6.2			
	46.5	5	5.5			
	48.5	7	5.6			
↓	49.5	8	5.4			
44.0	45	1	5.7			
↓	47	3	5.8			
	49	5	5.3			
	51	7	5.5			
↓	52	8	5.9			

COMMENTS Bias Voltage = +3 V. LO Input Power = +3 dBm.
The unit were DC tested in liquid nitrogen. QA 1

212 E. Gutierrez St. • Santa Barbara, CA 93101 • (805)564-4404 • FAX: (805)966-3249

P. O. Box 2
Green Bank, WV 24944
October 11, 2006

Spacek Labs Inc.
212 East Gutierrez Street
Santa Barbara, California USA 93101

Please find enclosed two of your mixers (Model MQQ-11B, s/n 5F19 and 5F20).

Please evaluate the mixers and provide us with pricing and schedule for repair.

In the original purchase order, we specified that the mixers must be tested for cryogenic operation. Your test data indicates that they were tested in Liquid Nitrogen. For repair pricing, we relieve you of that requirement, as we have redesigned our application so that the mixers are operated at room temperature.

Your evaluation and any questions may be directed to Gary Anderson at 304-456-2317.

Many Thanks,

Gary N. Anderson

Precision Calibrated Waveguide Noise Sources-18 GHz-50 GHz

NC 5000 Series

FEATURES:

- Input power +28 volts, 25 ma. max.
- Noise output variation with temperature less than 0.01 DB/°C
- Noise output variation with voltage less than 0.1 DB/%V
- Operating temperature range -55°C to +85°C
- Calibration charts are supplied with each unit
- Calibration points are listed on each noise source
- Noise output rise time and fall time <usec
- Noise diode is hermetically sealed

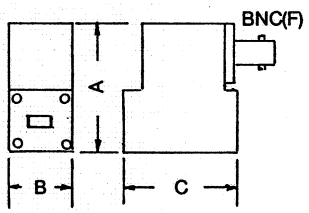
NOISE FIGURE METER COMPATIBLE - FULL BAND:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	VSWR TYPICAL	MATING FLANGE	CALIBRATION FREQUENCIES	WAVEGUIDE
NC 5142	18 – 26.5	15.5 ± .75	1.3	UG595/u	1 GHz STEPS	WR-42
NC 5128	26.5 – 40	15.5 ± .75	1.3	UG599/u	2 GHz STEPS	WR-28

WAVEGUIDE	A	B	C
WR 42	1.72	.88	1.55
WR 28	1.5	.75	1.25
WR 22	1.5	1.13	1.25

HIGH NOISE OUTPUT - FULL BAND:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT		MATING FLANGE	CALIBRATION FREQUENCIES	WAVEGUIDE
		ENR (DB)	FLATNESS			
NC 5242	18 – 26.5	25.0	± 1.5DB TYP ± 2.0DB max	UG595/u	1GHz STEPS	WR-42
NC 5228	26.5 – 40	23.0	± 2.0DB TYP ± 3.0DB max	UG599/u	2GHz STEPS	WR-28
NC 5222	33 – 50	21.0	± 2.0DB TYP ± 3.0DB max	UG383/u	2GHz STEPS	WR-22



HIGH NOISE OUTPUT - NARROW BAND:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT		MATING FLANGE	CALIBRATION FREQUENCIES	WAVEGUIDE
		ENR (DB)	FLATNESS			
NC 5342	18 – 26.5 One GHz BAND*	25	± .5DB	UG595/u	MINIMUM	WR-42
NC 5328	26.5 – 40 One GHz BAND*	23	± .5DB	UG599/u	CENTER	WR-28
NC 5322	33 – 50 One GHz BAND*	21	± .5DB	UG383/u	MAXIMUM	WR-22
NC 5442	19.9 – 23.1	25	± .6DB	UG595/u		WR-42

OPTIONS:

1. Input voltages as low as 15 volts are available in some models. Consult factory.

NOTES: * Bandwidths of one GHz may be specified anywhere in the band. Other bandwidths may be specified, however, wider bandwidths may result in a different flatness specification.

DBS Microwave Inc.

FINAL TEST DATA
AMPLIFIER MODEL
DB99-0629 R1

S/N: 001

FREQUENCY RESPONSE	GAIN	NOISE FIGURE	P-1DB	VSWR 50 OHMS	
(GHz)	(DB)	(DB)	(DBM)	IN	OUT
4.0	50.9	0.9	14.2	1.99	1.86
5.0	50.1	0.9	17.4	1.49	1.04
6.0	49.7	0.7	18.6	1.66	1.09
7.0	49.4	0.8	19.5	1.50	1.46
8.0	49.5	0.9	19.8	1.92	1.54
		.			
		.			
		.			
MIN.	49.3	-------	14.2	------	------
MAX.	50.9	0.9	-------	1.99	1.86
SPEC.	48.0 min	1.0 max	14.0 min	2.0:1	2.0:1

Supply Voltage + 15.0 Vdc

Current 266 mA Spec. 280 ~~max~~ mA

* All measurements taken at +25 C unless otherwise stated.

D.B.S. Microwave Inc. 1A Accept 03

Technician Scott Leek Q.A. BS

Date 10-12-99 Date 10/12/99

4805 Golden Foothill Parkway • El Dorado Hills, CA 95762 • (916) 939-7545 Fax (916) 939-7540

DBS Standard Active Multipliers, continued..

DBS Standard Active X4 Multipliers

Model Number	Guaranteed @ +25 C Input Frequency (GHz)	Output Frequency (GHz)	Pin (dBm) Min.	Pout (dBm) Min.	Signal Purity (dBc) Max.	Current @12Vdc (mA) Max.	Case Options*
DBS-1012X420	2.62-3.13	10.48-12.52	10	20	-20	350	DBX-6
DBS-1416X420	3.5-4.0	14.0-16.0	10	20	-20	475	DBX-8
DBS-1719X420	4.37-4.88	17.48-19.52	10	20	-20	475	DBX-8
DBS-1820X420	4.62-5.13	18.48-20.52	10	20	-20	475	DBX-8
DBS-2123X420	5.25-5.75	21-23	10	20	-20	475	DBK-8
DBS-2729X420	6.87-7.38	27.48-29.52	10	20	-20	500	DBK-8
DBS-2640X420	6.5-10.0	26-40	10	20	-20	600	DBK-8
DBS-4346X415	10.75-11.50	43-46	10	15	-20	500	DBK-8
DBS-3350X410	8.25-12.5	33-50	10	10	-20	500	DBV-8
DBS-4060X410	10-15	40-60	10	10	-20	600	DBV-8
DBS-7080X407	17.5-20.0	70-80	10	7	-20	600	Special
DBS-9094X407	22.5-23.5	90-94	10	7	-20	600	Special

DBS Standard Active X6 Multipliers

Model Number	Guaranteed @ +25 C Input Frequency (GHz)	Output Frequency (GHz)	Pin (dBm) Min.	Pout (dBm) Min.	Signal Purity (dBc) Max.	Current @12Vdc (mA) Max.	Case Options*
DBS-7080X607	11.67-13.33	70-80	10	7	-20	600	Special
DBS-9096X607	15-16	90-96	10	7	-20	600	Special

Notes:
1. All above mentioned amplifiers include internal voltage regulator with input voltage of +11.5Vdc to +15.5Vdc.
2. Maximum RF input power is 17dBm (CW) or 27dBm pulse, 1micro second and 1% duty cycle.
3. All above mentioned multipliers are also offered with a variety of input-power/output-power under special request.

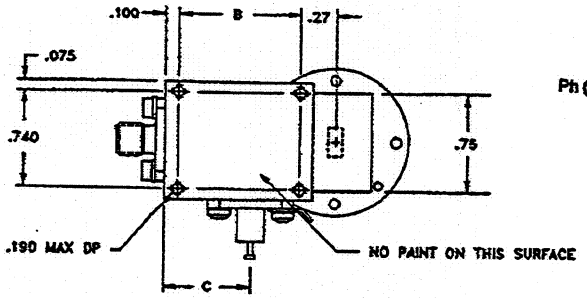
* All above mentioned multipliers are offered with Coax input connector and a WG or Coax output connector. Please specify at the time of order!
* Case drawings for various case options are contained in this catalog.

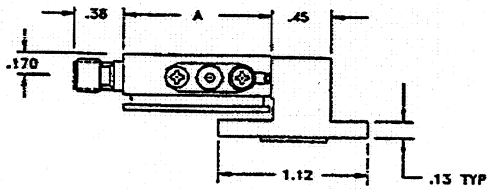
DBS will supply the highest quality products for the best value!

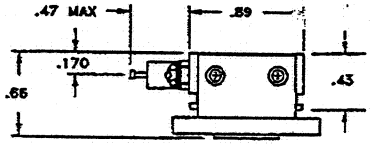
4919 Windplay Drive, Suite Two • El Dorado Hills, CA 95762 • Phone 916-939-7545 Fax 916-939-7540

DBV SERIES
INSTALLATION DWG.
SMA/WR-19 CONN.

DBS MICROWAVE, INC.
4919 Windplay Dr.
El Dorado Hill, CA 95762
Ph (916) 939-7545 Fax (916) 939-7540

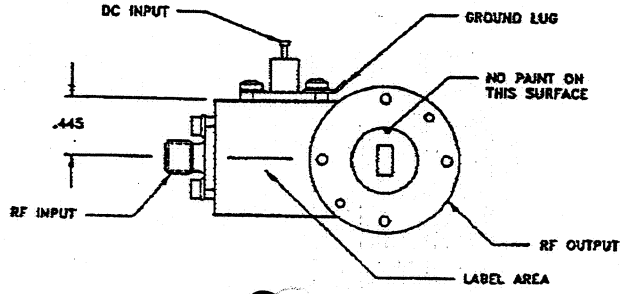






NOTES:
1. ALL DIMENSIONS ARE IN INCHES.
2. TOLERANCE: .XX= +/-.02
   .XXX= +/-.010
3. ALL TOLERANCES APPLY BEFORE PAINT & LABELING.
4. RF INPUT CONNECTOR IS 1.8MM FEMALE COAX.
5. RF OUTPUT CONNECTOR IS WR-19, UG-383/U-M.

CASE	"A" DIM	"B" DIM	"C" DIM
DBV-4	1.097	.897	.64
DBV-6	1.495	1.295	1.03



DIRECTIONAL COUPLER

TEST DATA

MAC Technology Inc.
3104 South Side Bypass
Klamath Falls, OR 97603-8403
Tel: 541-883-3352, 800-428-0341
Fax: 541-884-2752, 800-344-0846
CAGE/FSCM CODE: 63782

mac technology inc.

Tested By: _____

Date: 11-15-99

MODEL: C3205-10

Serial No.	COUPLING Frequency GHz 4.0	6.0	8.0	DIRECTIVITY db Min.	INSERTION LOSS dB Max.	VSWR Max. Pri.	VSWR Max. Sec.
119901	10.3	9.3	10.4	29	<0.9	<1.25	<1.25
2	10.5	9.5	10.7	29	〃	〃	〃
3	10.6	9.6	10.7	30	〃	〃	〃
4	10.3	9.3	10.5	31	<0.9	<1.25	<1.25

SPECIFICATIONS

COUPLING:
10 ± 1.25 dB*

FREQUENCY SENSITIVITY:
± 0.75 dB

DIRECTIVITY:
20 dB Min.

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

VSWR:
PRIMARY LINE:
1.25 Max.

SECONDARY LINE:
1.25 Max.

*Frequency Sensitivity is included in Coupling.

Job No. 9753

NRAO

MICROWAVE RESOURCES INC.

DATA SHEET

MODEL NO.: FRQ-500 SERIAL NO.: 300

FREQUENCY (GHz)	ISOLATION (db)	INS. LOSS (db)	VSWR	
			INPUT	OUTPUT
33	28	1.0	1.09	1.12
34	35	1.0	1.06	1.09
35	37	1.0	1.22	1.12
36	40	1.0	1.22	1.22
37	40	1.0	1.20	1.12
38	40	1.0	1.22	1.22
39	40	1.0	1.11	1.06
40	36	1.0	1.16	1.17
41	36	1.0	1.17	1.17
42	40	1.0	1.14	1.20
43	35	1.0	1.17	1.17
44	35	1.0	1.25	1.29
45	34	1.0	1.22	1.20
46	28	1.0	1.12	1.22
47	35	1.0	1.20	1.12
48	32	1.0	1.17	1.12
49	32	1.0	1.25	1.25
50	29	1.0	1.20	1.17

DATE: 11/30/99 TESTED BY: cancheta

14250 Central Avenue, Chino, California 91710 • (909) 627-4125 FAX: (909) 627-4295

MICROWAVE RESOURCES INC.

DATA SHEET

MODEL NO.: FRQ-500 SERIAL NO.: 301

FREQUENCY (GHz)	ISOLATION (db)	INS. LOSS (db)	VSWR	
			INPUT	OUTPUT
33	30	1.1	1.10	1.04
34	36	1.0	1.10	1.12
35	36	1.0	1.12	1.22
36	32	1.0	1.20	1.22
37	30	1.0	1.20	1.14
38	37	1.0	1.22	1.22
39	31	1.0	1.12	1.12
40	40	1.0	1.20	1.16
41	39	1.0	1.14	1.12
42	34	1.0	1.12	1.12
43	32	1.0	1.14	1.17
44	35	1.0	1.20	1.25
45	40	1.0	1.22	1.22
46	30	1.0	1.08	1.04
47	30	1.0	1.14	1.17
48	31	1.0	1.22	1.22
49	35	1.1	1.25	1.25
50	30	1.2	1.29	1.14

DATE: 11/30/99 TESTED BY: sanchez

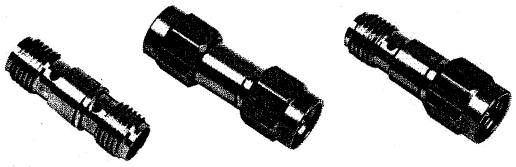
14250 Central Avenue, Chino, California 91710 • (909) 627-4125 FAX: (909) 627-4295

Coaxial Components

dc Blocks • Inside • Outside

Inside/Outside

- Small Size
- Broadband Performance 0.01 to 50 GHz
- Low Insertion Loss
- Rugged Construction
- Light Weight
- Meets MIL-E-5400 and MIL-E-16400 Environments
- Connectors: OSM/SMA per MIL-C-39012 or OS-50 (2.4mm)
- Power: Average 20 Watts CW
  Peak 1000 Watts



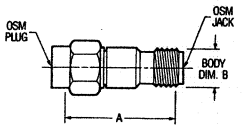


FIG. 1

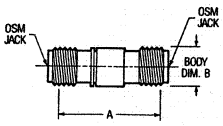


FIG. 2

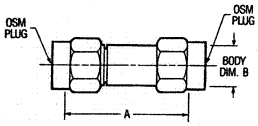


FIG. 3

NOTE: All dimensions are ± .020.

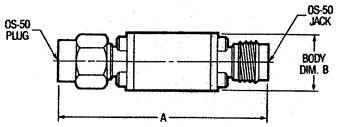


FIG. 4

SPECIFICATIONS

PART NO.	FIG. NO.	FREQUENCY RANGE GHz	VSWR (max.)	INSERTION LOSS dB (max.)	MAIN LINE MAXIMUM VOLTAGE (Vdc)	SIZE, INCHES (mm) A	SIZE, INCHES (mm) B	WEIGHT oz.	WEIGHT g
Inside dc Block									
2046-6010-00[1]	1	.01-2.0	1.15	0.2	200	1.375 (35)	.31 SQ. (7.9)	.25	7
2046-6020-00[1]	1	0.5-18.0	1.25 (0.5-8.0) 1.35 (8.0-12.4) 1.45 (12.4-18.0)	0.4 (0.5-8.0) 0.5 (8.0-12.4) 0.6 (12.4-18.0)	600	1.10 (28)	.300 DIA. (7.6)	.21	6
2046-6030-00[2]	1	.25-18.0	1.35	0.5	300	.88 (22.4)	.25 DIA. (6.4)	.18	5.1
2046-6031-00[2]	2	.25-18.0	1.35	0.5	300	.78 (19.8)	.25 DIA. (6.4)	.16	4.5
2046-6032-00[2]	3	.25-18.0	1.35	0.5	300	.98 (24.9)	.25 DIA. (6.4)	.20	5.7
8546-6001-00[2]	4	1.0-50.0	1.40 (1.0-26.5) 1.50 (26.5-50.0)	1.0	50	1.50 (38.1)	.375 SQ. (9.5)	.56	16
Outside dc Block									
2045-6010-00[1]	1	1.0-18.0	1.35 (1.0-12.4) 1.45 (12.4-18.0)	0.5	400	1.10 (28)	.300 DIA. (7.6)	.21	6
Inside/Outside dc Block									
2044-6010-00[1]	1	1.0-18.0	1.35 (1.0-12.4) 1.45 (12.4-18.0)	0.4 (1.0-18.0) 0.6 (8.0-12.4) 0.8 (12.4-18.0)	300	1.10 (28)	.300 DIA. (7.6)	.21	6

Finish: Passivated Stainless Steel

[1] Temperature Range: −54° to +71°C
[2] Temperature Range: −54° to +125°C

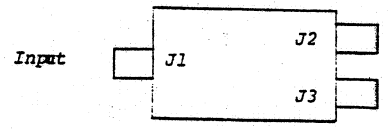
2-Way Pow[illegible]ivider
Test [illegible]

mac technology inc.
MAC T[illegible] Inc.
3104 Sou[illegible]e Bypass
Klamath Falls, OR 97603-8403
Tel: 541-883-3352, 800-428-0341
Fax: 541-884-2752, 800-344-0846
CAGE/FSCM CODE: 63782

Tested By MAC 3

Date 11-15-99

Model P8205-2



Specifications

Amplitude Balance: 0.2 dB

Phase Balance: 4.0 Degrees

Insertion Loss: 0.35 dB

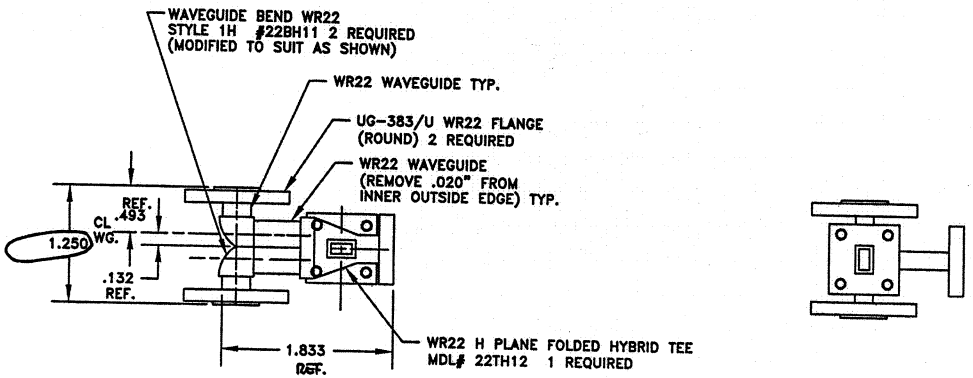
Isolation: 20 dB

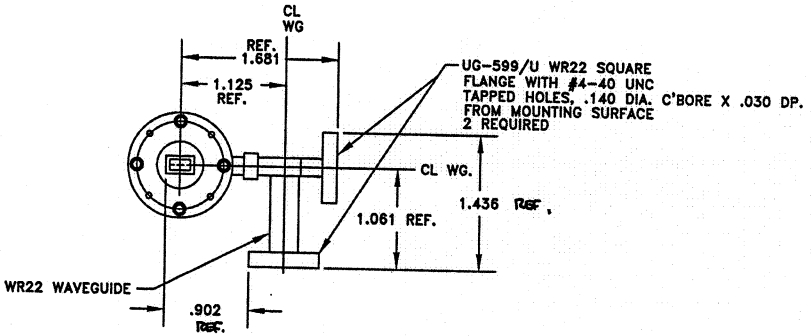
VSWR (max.)
Input: 1.30

Output: 1.25

Serial No.	Power Out (J2) Frequency GHz 4.0	6.0	8.0	Power Out (J3) Frequency GHz 4.0	6.0	8.0	Amplitude Balance dB Max.	Phase Balance deg Max.	Isolation dB Min.	VSWR Input Max.	VSWR Output Max.
1199001	3.10	3.09	3.11	3.12	3.10	3.15	<0.2	<4.0	21	<1.30	<1.25
2	3.12	3.12	3.15	3.10	3.11	3.15	<0.2	<4.0	21	<1.30	<1.25

Job No. 2841
NRAO





NOTES:
1. SOLDER ALL CONNECTIONS TOGETHER AS REQUIRED.
2. FINISH: 100 MICROINCHES GOLD

NO.	DATE	BY
A	7/23/98	CM

REVISIONS

NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES INC.
CHARLOTTESVILLE, VA.

TITLE: Q-BAND RECEIVER
LO POWER COUPLER

DESIGN			RECOMMENDED BY		
DRAWN	GMORRIS	6/24/98	ENGINEER	EWOLLACK	6/24/98
CHECKED			APPROVED		
	NAME	DATE		SIGNATURE	DATE
SCALE: FULL	SHEET OF		NO.		REVISION: A

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ±
2 PLACE DECIMALS (.xx) ± .001
3 PLACE DECIMALS (.xxx) ± .005
1 PLACE DECIMALS (.x) ±
FRACTIONS ±
MATERIAL: SEE ABOVE
FINISH: SEE NOTES

FACSIMILIE COVER SHEET

Microwave Resources Inc.
14250 Central Avenue
Chino, California 91710
USA
(909) 627-4125
Fax: (909) 627-4295

SEND TO	From
NATIONAL RADIO ASTRONOMY OBS.	M. Hassan Arain
Attention: Mr. Ed Wollack	Date: April 8, 1996
Fax Number: 804- 296 0324	Phone Number: 804 296 0356

☐ Urgent ☐ Reply ASAP ☐ Please Comment ☐ Please Review ☒ For your information

Total pages, including cover sheet: 1

SUBJECT: RFQ - WR-22 WAVEGUIDE BANDPASS FILTER

BANDPASS FILTER
Waveguide size = WR-22
No. of sections = 9
RF Bandwidth = 40 - 52 GHz
Insertion loss
(over 40 - 50GHz)= 1.5 dB max. (1.0 dB goal)
Input flange = UG599/U
Out put flange = UG383/U
Size (L x W x H) = 1.75"x1.2" x1.2"
Input/output in line

Price (Qty. 1) = $1350
Delivery = 60 days ARO

Best Regards,

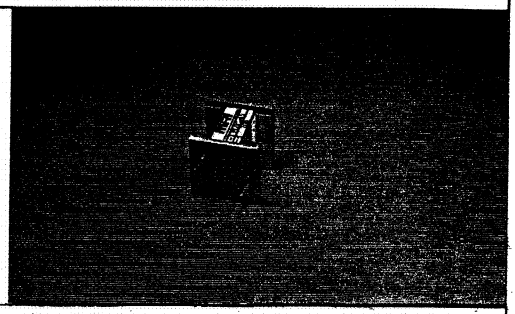
M. Hassan Arain

MICROWAVE AND MILLIMETERWAVE

BANDPASS FILTERS

MRI waveguide bandpass filters covering the frequency range of 18 - 110 GHz are available in up to 30% bandwidths. The filters utilize an inductive strip circuit inserted in the middle of the waveguide parallel to the E-plane, or a parallel coupled resonator structure suspended in a rectangular channel. Standard filters with bandwidths of 2%, 5%, 10%, and 15% are described here, but other bandwidths are available on request.

The filters operate over -30 to +50 C^{o} and have power handling capability in excess of 1 Watt.



ELECTRICAL SPECIFICATIONS

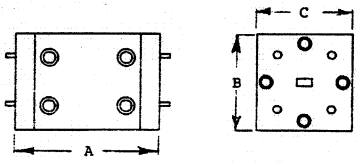
MODEL	RF BAND		2% BANDWIDTH			5% BANDWIDTH			10% BANDWIDTH			15% BANDWIDTH		
	FREQUENCY GHz	EIA WAVEGUIDE	INS.. LOSS dB MAX.	REJECTION dB MIN. AT		INS. LOSS dB MAX.	REJECTION dB MIN. AT		INS. LOSS dB MAX.	REJECTION dB MIN. AT		INS. LOSS dB MAX.	REJECTION dB MIN. AT	
				.96xFo	1.04xFo		.90xFo	1.10xFo		.90xFo	1.10xFo		.98xFo	1.08xFo
FLKX-XX	18.0- 26.5	WR-42	1.5	35	40	1.0	30	40	0.8	30	40	1.0	25	40
FLRX-XX	26.5- 40.0	WR-28	1.5	35	40	1.0	30	40	0.8	30	40	1.0	25	40
FLQX-XX	33.0- 50.0	WR-22	1.5	35	40	1.0	30	40	0.8	30	40	1.2	25	40
FLUX-XX	40.0- 60.0	WR-19	1.7	35	40	1.2	30	40	1.0	30	40	1.2	25	40
FLVX-XX	50.0- 75.0	WR-15	1.8	35	40	1.2	30	40	1.0	30	40	1.2	25	40
FLEX-XX	60.0- 90.0	WR-12	1.8	35	40	1.2	30	40	1.0	30	40	1.2	25	40
FLWX-XX	75.0-110.0	WR-10	1.8	35	40	1.5	30	40	1.2	30	40	1.5	25	40

MECHANICAL SPECIFICATIONS

MODEL	A IN.(CM)	B IN.(CM)	C IN.(CM)	FLANGE TYPE
FLKK-XX	2.00(5.1)	0.90(2.3)	0.90(2.3)	UG-595/U
FLRX-XX	1.50(3.8)	0.80(2.1)	0.80(2.1)	UG-599/U
FLQX-XX	1.25(3.2)	1.20(3.1)	1.20(3.1)	UG-383/U
FLUX-XX	1.25(3.2)	1.20(3.1)	1.20(3.1)	UG-383/UM
FLVX-XX	1.10(2.8)	0.80(2.1)	0.80(2.1)	UG-385/U
FLEX-XX	1.10(2.8)	0.80(2.1)	0.80(2.1)	UG-387/U
FLWX-XX	1.10(2.8)	0.80(2.1)	0.80(2.1)	UG-387/UM

1) Fo is the center frequency of the filter.
2) In-band VSWR (MAX.) is 1.25:1.
3) Design ripple is 0.1 dB.
4) Operating temperature is -30°C to 50°C.

OUTLINE DRAWING



ORDERING INFORMATION:

MODEL NO. FL-X-XX

Frequency Band
2% Bandwidth = A
5% Bandwidth = B
10% Bandwidth = C
15% Bandwidth = D

Center Frequency in GHz

14250 CENTRAL AVENUE,CHINO,CA 91710 (909)627-4125 FAX(909)627-4295

MRI MICROWAVE RESOURCES INC

millitech®

Millimeter Wave Products and Services

March 1, 1996

This fax consists of 2 *page(s).*

Ed Wollack
NRAO
Charlottesville, VA
Fax: 804-296-0324

Reference: Verbal Request
Millitech Ref.Q.960350

Dear Ed :

Millitech is pleased to provide the following quotation:

Item	Quantity	Description		Unit Price U.S.$	Extended Price U.S.$
01	1	FWP-19-26085		$3,890	
		Wide Bandpass Filter			
		Passband	= 40 to 52 GHz		
		Insertion Loss	= 1.4 dB maximum		
		Rejection @ 39 GHz	= 15 dB typical, 25 dB goal		
		Waveguide	= WR-19 ?		
		Flange	= MIL.F-3922/67B-007		

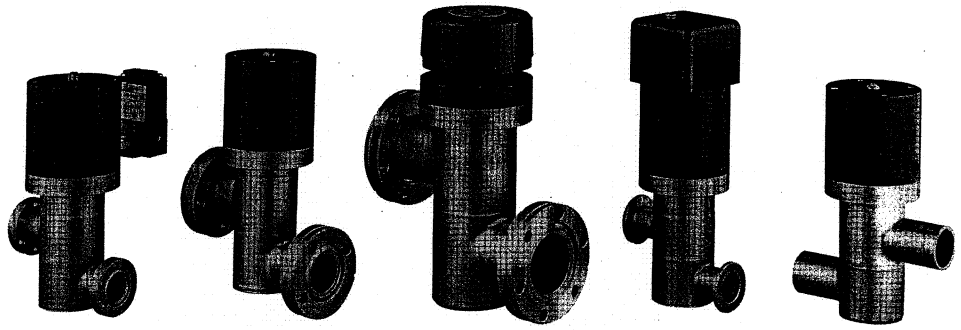
Ship Date: 90 days maximum, 60 days goal, after acknowledgment of hard copy purchase order.

Terms: Net 30 days - FOB South Deerfield, Massachusetts. Prices do not include shipping, taxes, or insurance. Shipping and insurance charges will be added to the invoice. If you are tax exempt, please make certain a blanket tax certificate has been filed with Millitech, or send a certificate with the hardcopy purchase order. Millitech is a small business corporation. Visa and Mastercard are accepted. This quotation is valid for 60 days from date of quotation.

Local representation: CMA
Tel: (301) 953-7740

Valves

Stainless Steel Tube Valves



Wherever reliable elastomer seals are required for high or ultra-high vacuum systems, the stainless steel right angle and in-line valves fit the need.

Features	Benefits
• Improved conductance	• Increased productivity
• 1 million cycles	• Less down time
• Metal bonnet gasket option	• Reduced outgassing, to achieve lower base pressure
• Fail safe air-operated version	• System protection
• Double-lead thread stem (manual actuator)	• Fewer turns to open valve
• Kalrez® O-Ring option (upon request)	• Increased bakeability (to 300°C)
• Visual position indicator (standard)	• Minimizes operator error
• Remote position indicator (optional)	• System automation

Technical Specifications

Vacuum Range

Atmosphere to below 1 x 10^{-10} Torr (mbar) range

Leak Rate

No leak detectable with a helium mass spectrometer leak detector with a sensitivity of < 1 x 1^{-9} std cc/sec

Conductance

	Right Angle	In-Line
¾"	8 *l/s*	7 *l/s*
1"	13 *l/s*	12 *l/s*
1½"	46 *l/s*	37 *l/s*

Bakeable To

Hand-operated valve: 225°C
Air-operated valve: 225°C

Rate Cycles

1 million

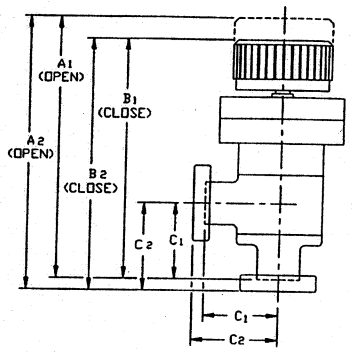
Mounting Positions

Valve can be mounted in any orientation and sealed against atmospheric pressure at either port

Air Pressure

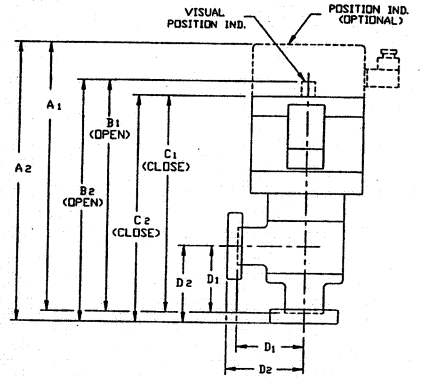
¾", 1"	50 to 100 PSIG
1½"	60 to 100 PSIG

Right-Angle H/O Stainless Steel Valve inches (mm)



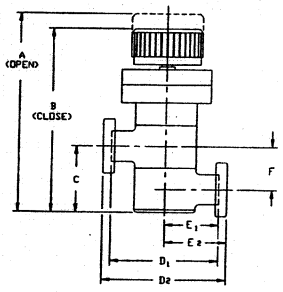
VALVE SIZE	TUBE END DIM.			KLAMP FLANGE DIM.				CONFLAT FLANGE DIM.			
	A_1	B_1	C_1	SIZE	A_2	B_2	C_2	SIZE	A_2	B_2	C_2
3/4	4.91 (125)	4.21 (107)	1.33 (34)	NV16	5.05 (128)	4.35 (110)	1.48 (38)	1-1/3	5.08 (129)	4.38 (111)	1.50 (38)
1	5.31 (135)	4.61 (117)	1.85 (47)	NV25	5.50 (140)	4.80 (122)	2.04 (52)	2-1/8	5.50 (140)	4.80 (122)	2.04 (52)
1-1/2	7.01 (178)	5.89 (150)	2.26 (57)	NV40	7.32 (186)	6.20 (158)	2.56 (65)	2-3/4	7.22 (183)	6.10 (155)	2.47 (63)

Right-Angle A/O Stainless Steel Valve inches (mm)



VALVE SIZE	TUBE END DIM.				KLAMP FLANGE DIM.				CONFLAT FLANGE DIM.			
	A_1	B_1	C_1	D_1	SIZE	A_2	B_2	C_2	D_2	SIZE	A_2	B_2	C_2	D_2
3/4	6.38 (162)	5.48 (139)	4.88 (124)	1.33 (34)	NV16	6.53 (166)	5.63 (143)	5.03 (128)	1.48 (38)	1-1/3	6.56 (167)	5.66 (144)	5.06 (129)	1.50 (38.1)
1	6.79 (173)	5.89 (150)	5.29 (134)	1.85 (47)	NV25	6.98 (177)	6.08 (154)	5.48 (139)	2.04 (52)	2-1/8	6.98 (177)	6.08 (154)	5.48 (139)	2.04 (52)
1-1/2	8.08 (205)	6.86 (174)	6.58 (167)	2.26 (57)	NV40	8.39 (213)	7.17 (182)	6.89 (175)	2.56 (65)	2-3/4	8.29 (211)	7.07 (180)	6.79 (173)	2.47 (63)

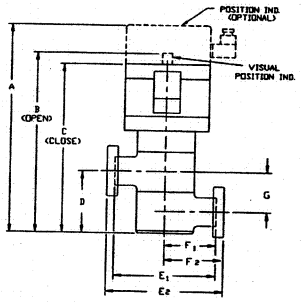
In-Line H/O Stainless Steel Valve inches (mm)



VALVE SIZE	TUBE END DIM.						KLAMP FLANGE DIM.						
	A	B	C	D_1	E_1	F	SIZE	A	B	C	D_2	E_2	F
3/4	5.21 (132)	4.51 (115)	1.63 (41)	2.66 (68)	1.33 (34)	1.06 (27)	NV16	5.21 (132)	4.51 (115)	1.63 (41)	2.98 (76)	1.48 (38)	1.06 (27)
1	5.46 (139)	4.76 (121)	2.01 (51)	3.70 (94)	1.85 (47)	1.31 (33)	NV25	5.46 (139)	4.76 (121)	2.01 (51)	4.04 (103)	2.04 (52)	1.31 (33)
1-1/2	7.97 (202)	6.75 (171)	3.32 (84)	4.52 (115)	2.26 (57)	2.00 (51)	NV40	7.97 (202)	6.75 (171)	3.32 (84)	5.12 (130)	2.56 (65)	2.00 (51)

VALVE SIZE	CONFLAT FLANGE DIM.						
	SIZE	A	B	C	D_2	E_2	F
3/4	1-1/3	5.21 (132)	4.51 (115)	1.63 (41)	3.00 (76)	1.50 (38)	1.06 (27)
1	2-1/8	5.46 (139)	4.76 (121)	2.01 (51)	4.08 (104)	2.04 (52)	1.31 (33)
1-1/2	2-3/4	7.97 (202)	6.75 (171)	3.32 (84)	4.94 (126)	2.47 (63)	2.00 (51)

In-Line A/O Stainless Steel Valve inches (mm)



VALVE SIZE	TUBE END DIM.							KLAMP FLANGE DIM.							
	A	B	C	D	E_1	F_1	G	SIZE	A	B	C	D	E_2	F_2	G
3/4	6.70 (170)	5.80 (147)	5.20 (132)	1.63 (42)	2.66 (68)	1.33 (34)	1.06 (27)	NV16	6.70 (170)	5.80 (147)	5.20 (132)	1.63 (41)	2.98 (76)	1.48 (38)	1.06 (27)
1	6.94 (176)	6.04 (153)	5.44 (138)	2.01 (51)	3.70 (94)	1.85 (47)	1.31 (33)	NV25	6.94 (176)	6.04 (153)	5.44 (138)	2.01 (51)	4.04 (103)	2.04 (52)	1.31 (33)
1-1/2	9.04 (230)	7.82 (199)	7.54 (192)	3.32 (84)	4.52 (115)	2.26 (57)	2.00 (51)	NV40	9.04 (230)	7.82 (199)	7.54 (192)	3.32 (84)	5.12 (130)	2.56 (65)	2.00 (51)

VALVE SIZE	CONFLAT FLANGE DIM.						
	SIZE	A	B	C	D	E_2	F_2	G
3/4	1-1/3	6.70 (170)	5.80 (147)	5.20 (132)	1.63 (41)	3.00 (76)	1.50 (38)	1.06 (27)
1	2-1/8	6.94 (176)	6.04 (153)	5.44 (138)	2.01 (51)	4.08 (104)	2.04 (52)	1.31 (33)
1-1/2	2-3/4	9.04 (230)	7.82 (199)	7.54 (192)	3.32 (84)	4.94 (126)	2.47 (63)	2.00 (51)

Ordering Information

Description		Part Number	Price	Part Number	Price	Shipping Weight lbs (kg)
½" Right-Angle SST Valves	**Solenoid**	**Metal Bonnet**		**Viton Bonnet**		
Hand-Operated						
2.75" CFF		L6591301	$395	L6591307	$355	6 (2.7)
NW40 KF				L6591302	$325	6 (2.7)
Tube		L6591308	$355	L6591309	$295	6 (2.7)
Air-Operated	NONE					
2.75" CFF		L6591303	$415	L6591310	$375	7 (3.2)
NW40 KF				L6591304	$350	7 (3.2)
Tube		L6591311	$395	L6591312	$340	7 (3.2)
Air-Operated with Solenoid						
2.75" CFF	110 V	L6591320	$435	L6591322	$395	7 (3.2)
NW40 KF				L6591321	$385	7 (3.2)
Tube		L6591323	$415	L6591324	$375	7 (3.2)
2.75" CFF	220 V	L6591325	$435	L6591327	$395	7 (3.2)
NW40 KF				L6591326	$385	7 (3.2)
Tube		L6591328	$415	L6591329	$375	7 (3.2)
2.75" CFF	24 VDC	L6591330	$435	L6591332	$395	7 (3.2)
NW40 KF				L6591331	$385	7 (3.2)
Tube		L6591333	$415	L6591334	$375	7 (3.2)
Air-Operated with Solenoid & Position Indicator						
2.75" CFF	110 V	L6591305	$585	L6591340	$545	8 (3.6)
NW40 KF				L6591306	$535	8 (3.6)
Tube		L6591341	$565	L6591342	$525	8 (3.6)
2.75" CFF	220 V	L6591343	$585	L6591345	$545	8 (3.6)
NW40 KF				L6591344	$535	8 (3.6)
Tube		L6591346	$565	L6591347	$525	8 (3.6)
2.75" CFF	24 VDC	L6591348	$585	L6591350	$545	8 (3.6)
NW40 KF				L6591349	$535	8 (3.6)
Tube		L6591351	$565	L6591352	$525	8 (3.6)
" In-Line SST Valves	**Solenoid**	**Metal Bonnet**		**Viton Bonnet**		
Hand-Operated						
1.33" CFF		L9250305	$425	L9250304	$385	2 (0.9)
NW16 KF				L9250303	$355	2 (0.9)
Tube		L9250302	$385	L9250301	$325	2 (0.9)
Air-Operated						
1.33" CFF	NONE	L9250315	$445	L9250314	$405	3 (1.4)
NW16 KF				L9250313	$380	3 (1.4)
Tube		L9250312	$425	L9250311	$370	3 (1.4)
Air-Operated with Solenoid						
1.33" CFF	110 V	L9250325	$465	L9250324	$425	3 (1.4)
NW16 KF				L9250323	$415	3 (1.4)
Tube		L9250322	$445	L9250321	$405	3 (1.4)
1.33" CFF	220 V	L9250330	$465	L9250329	$425	3 (1.4)
NW16 KF				L9250328	$415	3 (1.4)
Tube		L9250327	$445	L9250326	$405	3 (1.4)
1.33" CFF	24 VDC	L9250335	$465	L9250334	$425	3 (1.4)
NW16 KF				L9250333	$415	3 (1.4)
Tube		L9250332	$445	L9250331	$405	3 (1.4)
Air-Operated with Solenoid & Position Indicator						
1.33" CFF	110 V	L9250345	$615	L9250344	$575	3 (1.4)
NW16 KF				L9250343	$565	3 (1.4)
Tube		L9250342	$595	L9250341	$555	3 (1.4)
1.33" CFF	220 V	L9250350	$615	L9250349	$575	3 (1.4)
NW16 KF				L9250348	$565	3 (1.4)
Tube		L9250347	$595	L9250346	$555	3 (1.4)
1.33" CFF	24 VDC	L9250355	$615	L9250354	$575	3 (1.4)
W16 KF				L9250353	$565	3 (1.4)
Jbe		L9250352	$595	L9250351	$555	3 (1.4)