VLBA Technical Report No. 35

I. F. Processing Electronics Part of the DataAcquisition Rack (DAR) MODULE T121

Alan E.E. Rogers

November 1988

Very Long Baseline Array (VLBA)

Manual for I.F. processing electronics
Part of the Data Acquisition Rack (DAR)

prepared by Alan E.E. Rogers
Haystack Observatory
Westford, Mass 01886

November 1988

Contents:

Notes:
1] Information on the formatter is contained in a separate manual
2] Documentation (except assembly photos and manufacturer's data sheets) is in computer files (to be maintained on UNIX system at Haystack - which is accessible via various computer networks) as follows:

Manual text	*.wp (Word Perfect files)
Parts database	parts.dbf (dBaseIII format)
Firmware	rad*.asm (ASCII input to 8051 assembler)
Firmware ROM	rad*.hex (ASCII input to Promlink)
Drawings	*.dwg (ACAD files)
Logic diagrams	*.dwg (FutureNet files)
Wirewrap files	*.wrp (ASCII in Wrapid format for DataCon)
Check-out software	*.c (C code in user area 500 on motorola)

Copies made for:

AEER - Haystack
John Webber - Interferometrics
Alan Stratton- Signatron
Bob Simon - NRAO Chville
Jack Campbell- NRAO VLA
Jim Oty - NRAO Pietown
George Peck - NRAO Socorro
Dick Thompson- NRAO Charlottesville
Peter Napier - NRAO VLBA project office

VLBA I.F. DISTRIBUTOR - MODULE T121

Alan E.E. Rogers
October 1988

Table of Contents

Drawing List:

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54110S001	I.F. Distributor	Circuit/Block Diagram
54110S002	Power Distribution and Switch Drivers	Circuit Diagram
54110M003	Front Panel Drilling	Drilling Plan
54110I004	Front Panel Artwork	Silkscreen
54110Q005	Power Dist. PC Board	PC Board
54110D008	Digital Interface Cable	Cable Assembly
54110M009	Mounting Plate	Drilling Plan
54110M010	Rear panel	Mechanical
54110M011	Rear panel labels	Mechanical
54110S012	Test signal injection	Circuit/Mechanical

Specifications:

Input Frequency Range	500-1000 MHz
Gain	4 +/- 1 dB
Input Atten. Range	0, -30 +/- 1 db
Phase Change With Gain	<0.6 Deg. Peak to Peak
Square Law Linearity	Better Than 1% from 5% to Full Scale
Isolation Between Outputs	>20 dB
Isolation Between Channels	>70 dB
Noise Temperature	<100,000 Deg. K

General Description:

The I.F. Distributor fans the I.F. signals out to the baseband converters. Each module contains two channels which share one digital interface board. Each channel has one bit of attenuation (a 30 dB step) and an external signal/I.F. disconnect switch. The I.F. total power (wideband average) can be monitored for each channel. The external input can be used to inject a test signal into the rack. A semi-permanent connection is made on the DAR between the L.O. output monitor and the alternate external input of the second channel of the second I.F. distributor. This is implemented with a jumper (which inludes a 3 dB attenuator) between the BNC connectors which are adjacent to each other when the modules are in the rack.

Theory of Operation:

The attenuation step is provided with low phase shift by using diode switches to provide a direct path or alternate path through a fixed attenuator. The direct path cable can be adjusted to provide the same phase delay path as that through the attenuator.

Circuit Details:

The diode switches are driven with CMOS buffers. The total power detector and voltage to frequency converters are the same as used in the baseband converter as is the digital interface board.

Front Panel Monitor and Test Inputs:

BNC connectors are provided on the front panel for the following:

a) Alternate input - can be driven from baseband converter L.O. output monitor via BNC patch cable.

b) Total power monitor output - 1 volt = -30 dBm output.

c) I.F. monitor - for attachment of spectrum analyser.

I/O Connections and Power Levels:

Pin #	Function
1	Ground
2	+ 5v (600 ma)
3	5 MHz + 13 dBm nominal
4	NC
5	1 PPS >1v <5v 50 ohms
6	MCB Monitor Output (-)
7	MCB Monitor Output (+)
8	NC
9	NC

10		NC
11		NC
12		MCB Command Input (-)
13		MCB Command Input (+)
14		-15v (20 ma)
15		+15v (180 ma)
16		NC
17		NC
18	Inner	Bin Slot Address Bit 0 (Pull ups on Board, 0 = GND, 1 = Open)
18	Outer	Bin Slot Address Bit 1 (Pull ups on Board, 0 = GND, 1 = Open)
19	Inner	Bin Slot Address Bit 2 (Pull ups on Board, 0 = GND, 1 = Open)
19	Outer	Bin Slot Address Bit 3 (Pull ups on Board, 0 = GND, 1 = Open)
20	Inner	Bin Slot Address Bit 4 (Set to 0 for Rack 1, 1 for Rack 2)
20	Outer	Bin Slot Address Bit Parity

Rear OSP connectors:

Upper right (viewed from rear of module)	I.F. 1 output
Lower right	I.F. 1 input
Upper left	I.F. 2 output
Lower right	I.F. 2 input

Address and Bit Assignments:

	Rack #	IF A/B	IF C/B
Bit Slot Addresses	1	28H	29H
	2	38H	39H
Control Bit Relative* Addresses	19H	Channel 1	30 dB
	1AH	Channel 1	Alt Input
	11H	Channel 2	30 dB
	12H	Channel 2	Alt Input
	28H-2FH	8751 up Mode Control	
Monitor Bit Relative Addresses (Firmware and Digital	60H-6FH	Channel 1	Total Power
	70H-7FH	Channel 2	Total Power
	E0H-EFH	Channel 1	Switched P.
	F0H-FFH	Channel 2	Switched P.
Interface are the same as Baseband Converter)	40H-4BH	Serial Number	
	4CH-4DH	8751 uP Status	
	4EH	Radiometry cycle	

Absolute Address = Address Placed in Indirect Location + Relative Address

Indirect Location = (Slot Address)*2 + 1

Test Procedures:

Use signal generator and spectrum analyser to check gain through the distributor. With attenuation set to zero the gain from input to output of power spitters on rear of rack or to the front panel BNC should be zero dB. Control status can be tested using a meter to check control voltages on the diode switches. See section on the baseband converter for tests of the digital interface board (The IFD uses the same board as the BBC).

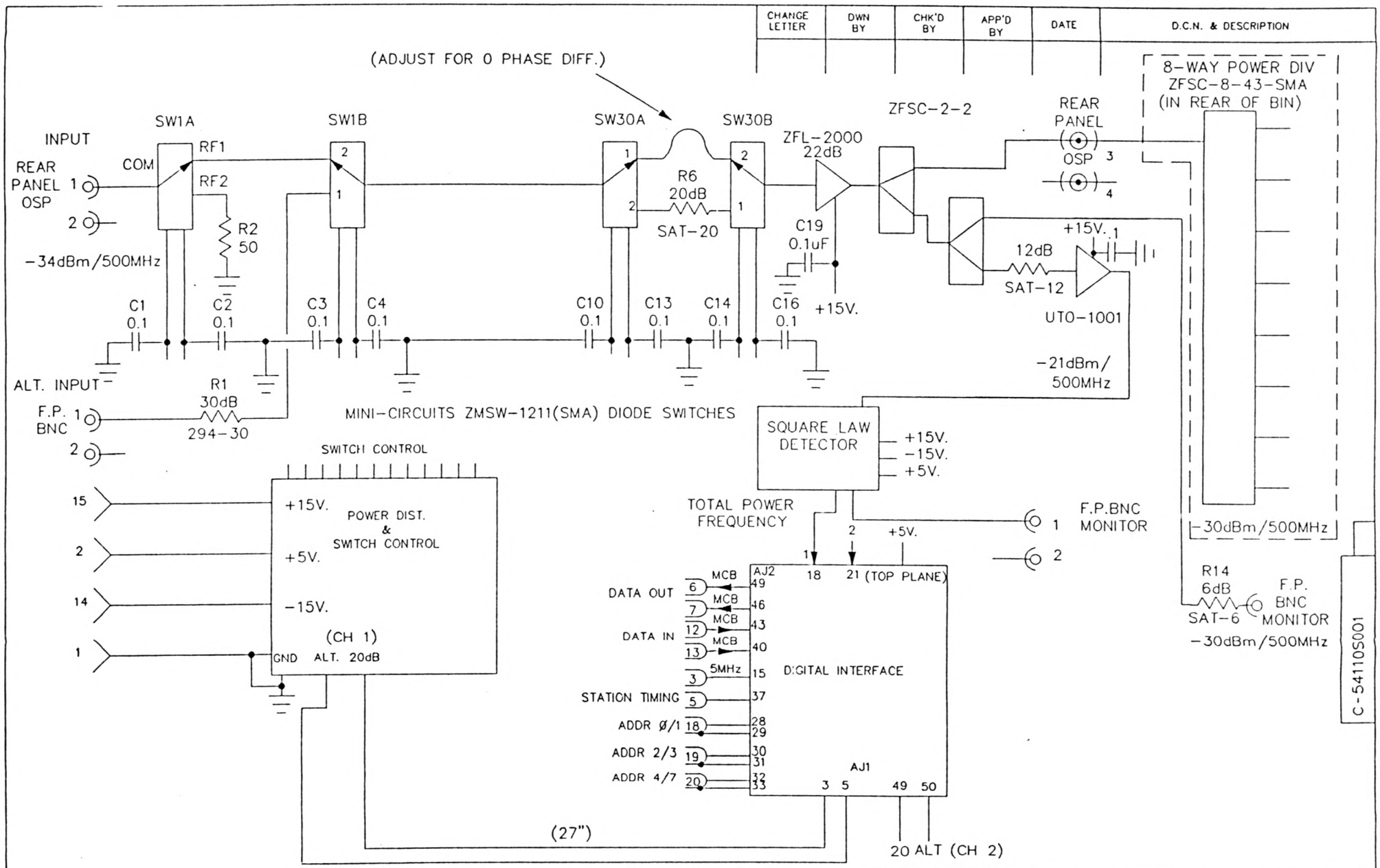
Replacement Instructions:

Replace submodules as necessary.

Parts List:

Data Sheets:

Mini-Circuits	ZMSW-1211 ZFL-2000
Avantek	UTO-1001



CHANGE LETTER	DWN BY	CHK'D BY	APP'D BY	DATE	D.C.N. & DESCRIPTION

NOTES:

1. 2 I.F. CHANNELS ARE CONTAINED IN ONE MODULE AND ARE SERVICED BY ONE DIGITAL INTERFACE.
2. ALL CAPACITORS ARE ATC100B201KM550 IN PARALLEL WITH 0.1uF CERAMIC.

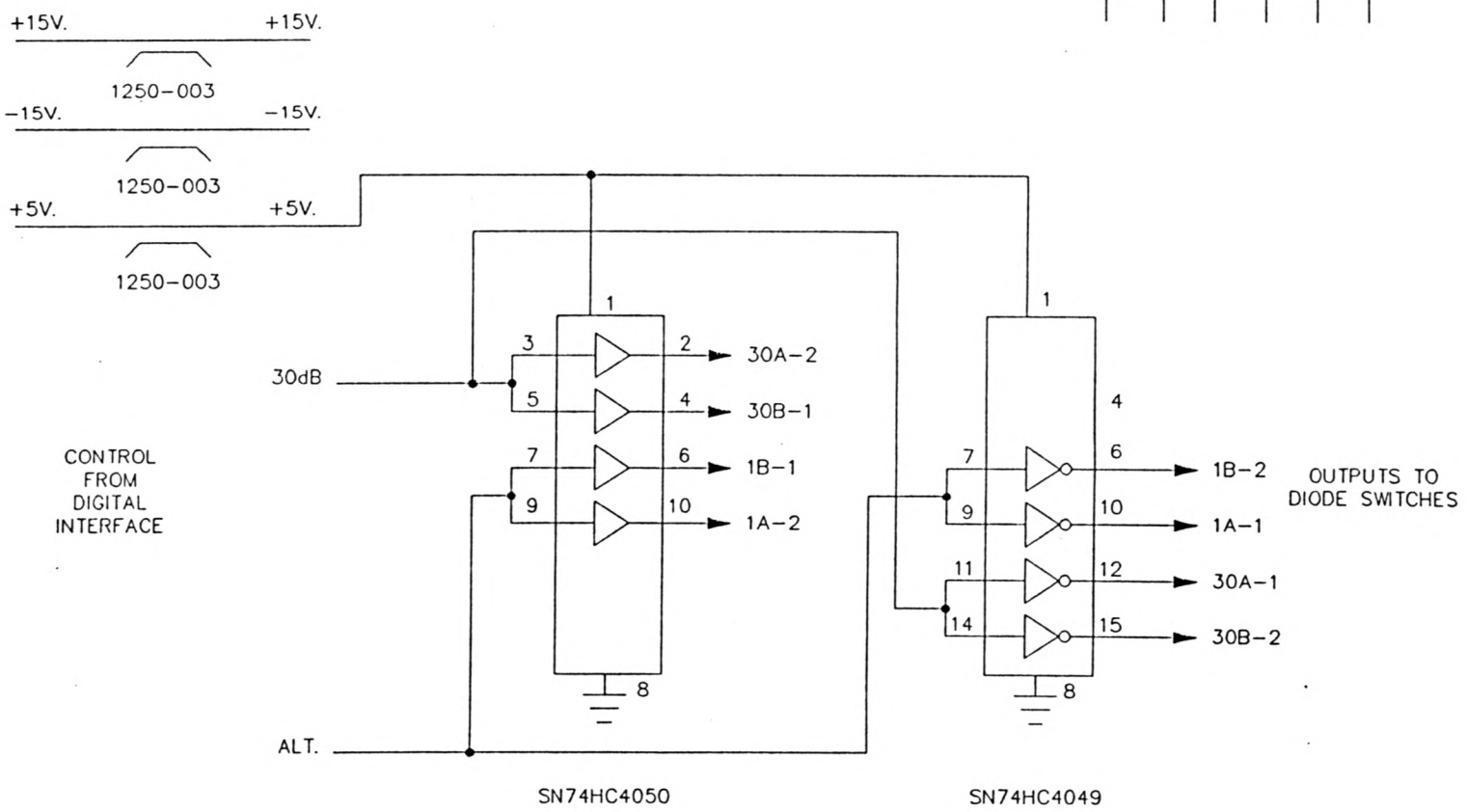
ELECTRONIC NOTES: UNLESS OTHERWISE NOTED: RESISTORS: CAPACITORS: INDUCTORS:	USED ON	DRAWN FOR: A.E.ROGERS	DATE: 7-87
		DRAWN BY: A.PHILBROOK	7-87
		CHECKED BY:	
	SCALE NONE	PROJECT	
	CLASSIFICATION	ENGINEER:	

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS

I.F. DISTRIBUTOR VLBA
(2 WIDE MODULE)
(DUAL CHANNEL)

C | 54110S001

CHANGE LETTER	D'WN BY	CHK'D BY	APP'D BY	DATE	D.C.N. & DESCRIPTION



SHOP NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES
2. TOLERANCE ON DIMENSIONS
   FRACTIONAL ± 1/64
   DECIMAL .XX ± .01
   DECIMAL .XXX ± .005
   ANGULAR ± 0°30'
3. SURFACE ROUGHNESS PER MIL-STD-10
4. REMOVE BURRS AND BREAK SHARP EDGES 1/64 MAX.
5. SCREW THREADS PER MIL-STD-9
6. ALL DIMENSIONS TO APPLY BEFORE PLATING OR CONVERSION COATING.

USED ON

NEXT ASSEMBLY

WEIGHT

SCALE

CLASSIFICATION

DRAWN FOR A.E ROGERS	DATE 7-87	NORTHEAST RADIO OBSERVATORY CORPORATION HAYSTACK OBSERVATORY WESTFORD, MASSACHUSETTS
DRAWN BY A.PHILBROOK	7-87	
CHECKED BY		
APPROVALS: PROJECT		I.F. DISTRIBUTOR POWER DISTRIBUTION AND SWITCH DRIVERS
ENGINEER		
MATL. & PROCESS		
STRUCTURES		
THERMAL		
MECH. ANALYSIS		

	B	54110S002	
AER\IFPDSD	DWG. SIZE	DWG. NO.	REV.

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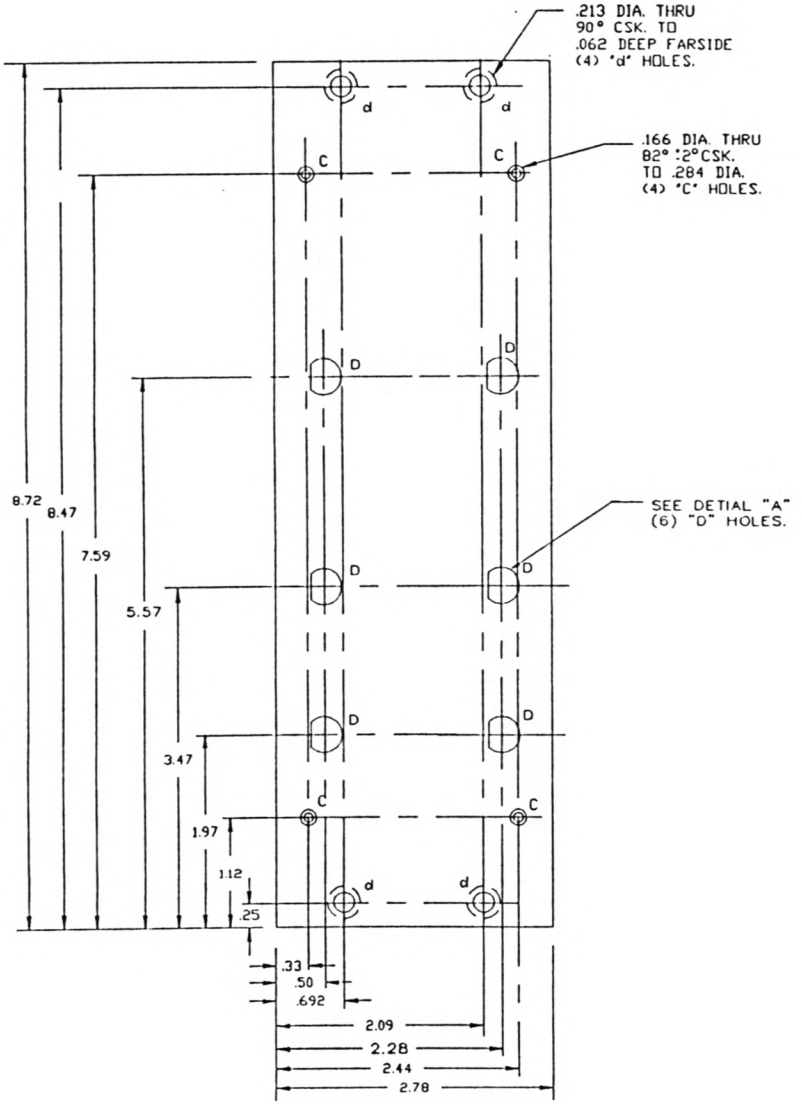
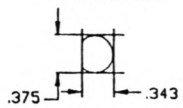


DETAIL "A"



CUT-OUT FOR
KINGS-153 BNC
CONNECTOR

C — 54110M003

NOTES

MATERIAL

.125 THICK ALUM. 6061-T6
REMOVE ALL BURRS AND
SHARP EDGES.

FINISH AND/OR HEAT TREATMENT

YELLOW CHROMATE
CONVERSION ALL OVER

SHOP NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES
2. TOLERANCE ON DIMENSIONS
   FRACTIONAL ± 1/64
   DECIMAL .XX ± .01
   DECIMAL .XXX ± .005
   ANGULAR ± 0°30'
3. SURFACE ROUGHNESS
   PER MIL-STD-10
4. REMOVE BURRS AND BREAK
   SHARP EDGES 1/64 MAX.
5. SCREW THREADS PER MIL-STD-9
6. ALL DIMENSIONS TO APPLY
   BEFORE PLATING OR CON-
   VERSION COATING

USED ON

NEXT ASSEMBLY

WEIGHT

SCALE

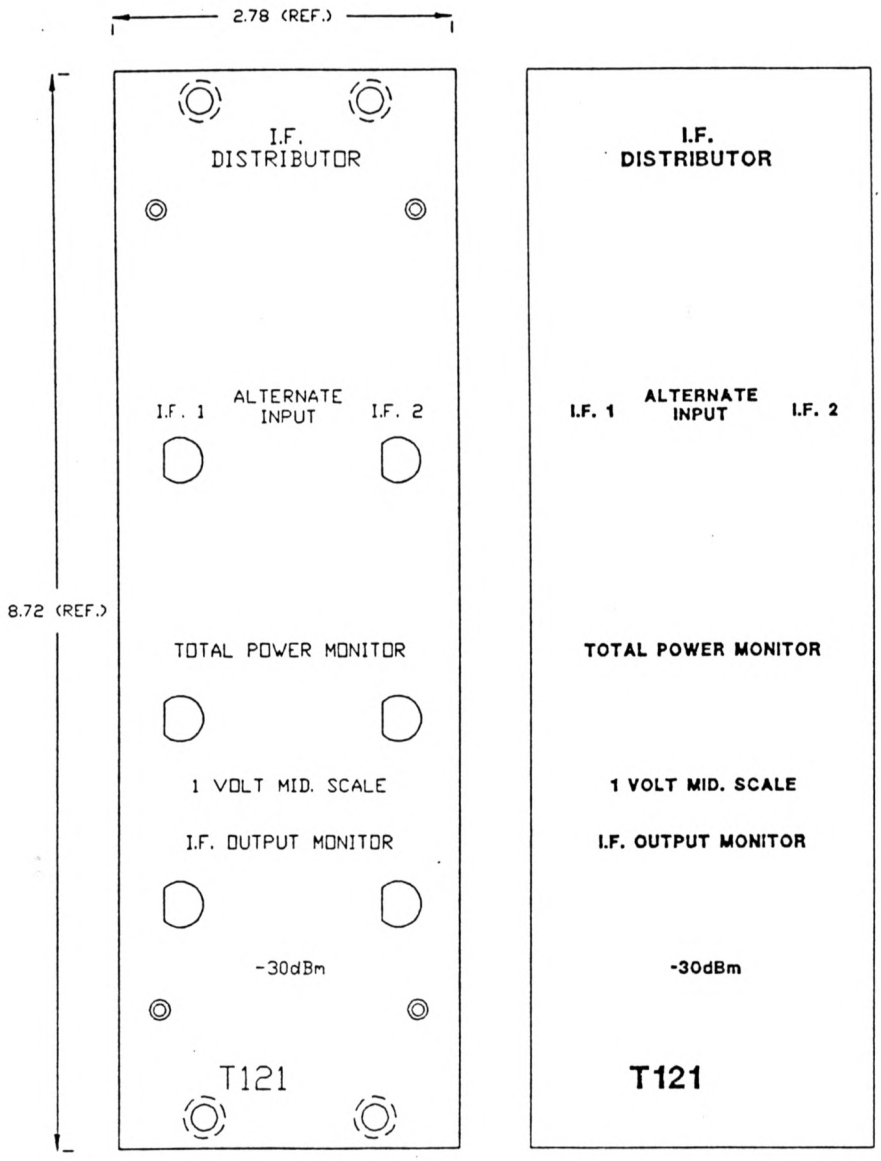
CLASSIFICATION

DRAWN FOR	A.E.ROGERS	7-87
DRAWN BY	A.PHIL BROOK	7-87
CHECKED BY		
APPROVALS: PROJECT		
ENGINEER		
MATL. & PROCESS		
STRUCTURES		
THERMAL		
ANALYSIS		

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS

I.F. DISTRIBUTOR
FRONT PANEL
DRILLING PLAN

[redacted] FRPNL [redacted] C [redacted] 54110M003 [redacted] NO. [redacted] V



SILK SCREENED PANEL

ARTWORK

NOTES:
1. SILK SCREEN CHARACTERS AND LINES BLACK.
2. PAINT: HEWLETT PACKARD, MINT GRAY,
P/N 6010-0577, FRONT AND EDGES ONLY,
PER ORDER NRAO SPEC. NO. A13030N1.

D - 541101004

CHANGE LETTER	DWN BY:	CHK'D BY:	APP'D BY:	DATE	DCA # DESCRIPTION

ELECTRONICS NOTES:
UNLESS OTHERWISE NOTED
RESISTORS:
INDUCTORS:
CAPACITORS:

USED ON

SCALE: 2X

CLASSIFICATION:

DRAWN FOR: AE ROGERS
DRAWN BY: A PHILBROOK
CHECKED BY:
ENGINEER:
PROJECT:

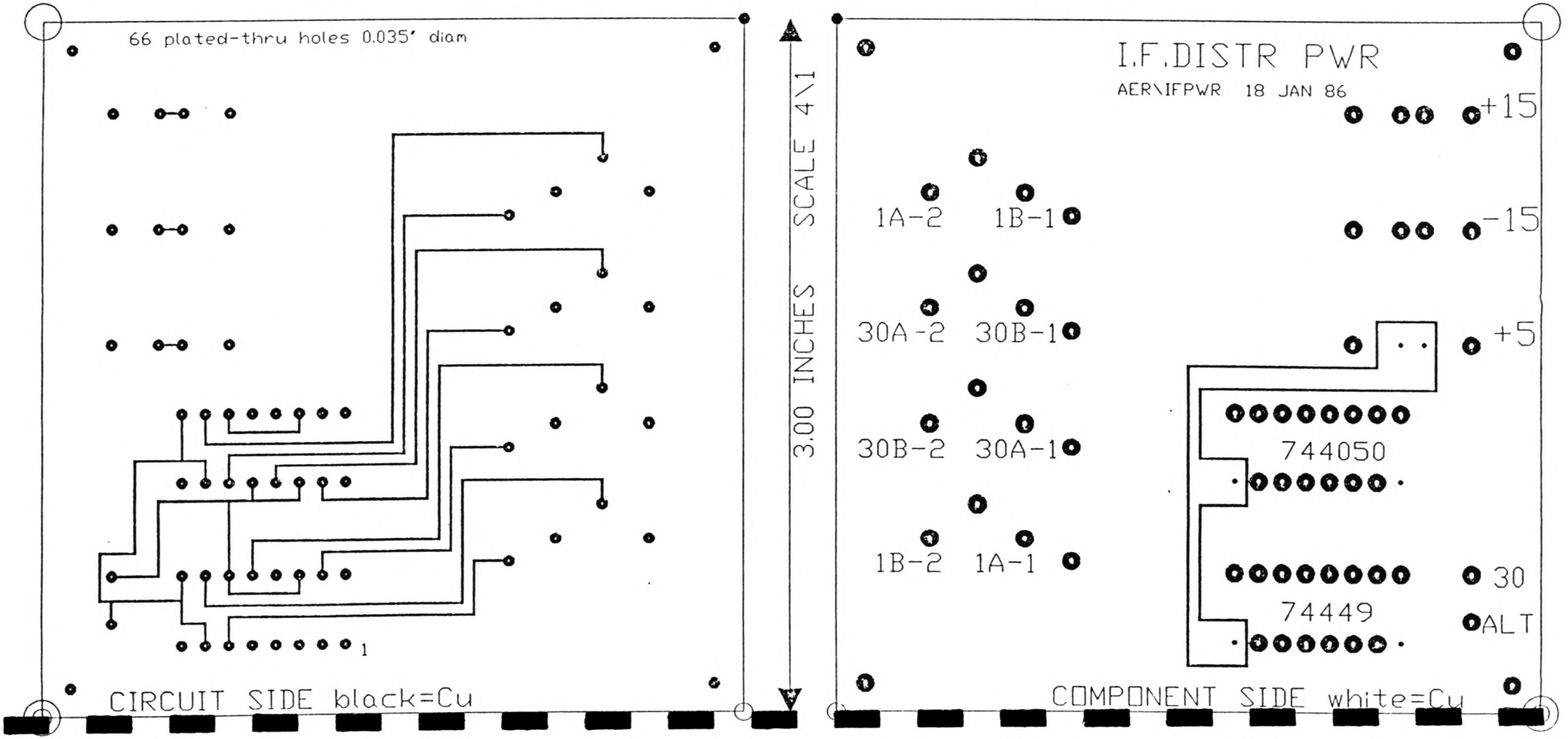
DATE: 1-87

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD MASSACHUSETTS

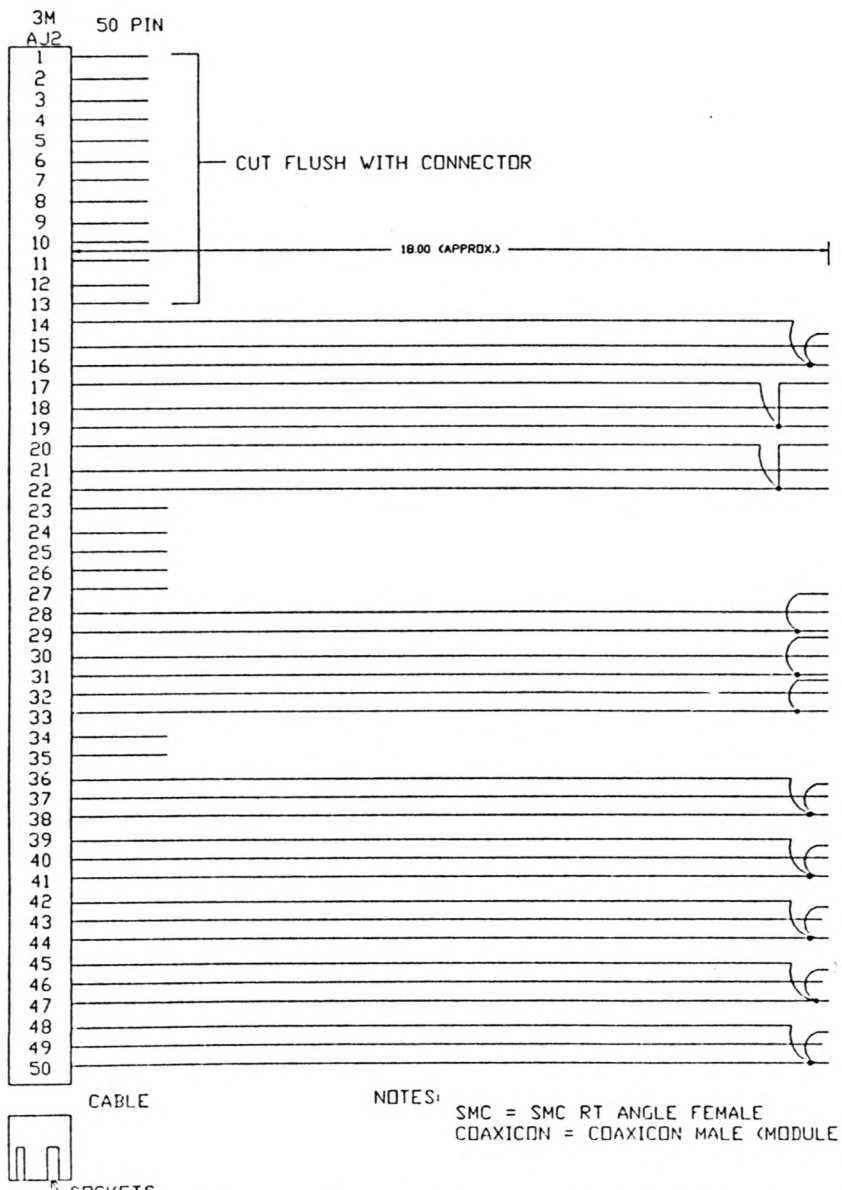
SILK SCREENING ARTWORK FOR
I.F. DISTRIBUTOR

MATERIAL	SIZE	DRAWING NO.	REV
	B	541101004	
	SCALE	SHEET	

Drawing Number: 54110Q005



CHANGE LETTER	DWN BY:	CHK'D BY:	APP'D BY:	DATE:	D.C.N. & DESCRIPTION



CONNECTOR TYPE	FUNCTION	PIN #
COAXICON	5MHz	3
SMC I.F. 1	T.P.	SQ. LAW
SMC I.F. 2	T.P.	SQ. LAW
COAXICON	ADDR Ø/1	18
COAXICON	ADDR 2/3	19
COAXICON	ADDR 4/7	20
COAXICON	1PPS	5
COAXICON	MCB IN	13
COAXICON	MCB $\overline{\text{IN}}$	12
COAXICON	MCB OUT	7
COAXICON	MCB $\overline{\text{OUT}}$	6

NOTES:
SMC = SMC RT ANGLE FEMALE
COAXICON = COAXICON MALE (MODULE CONNECTOR)

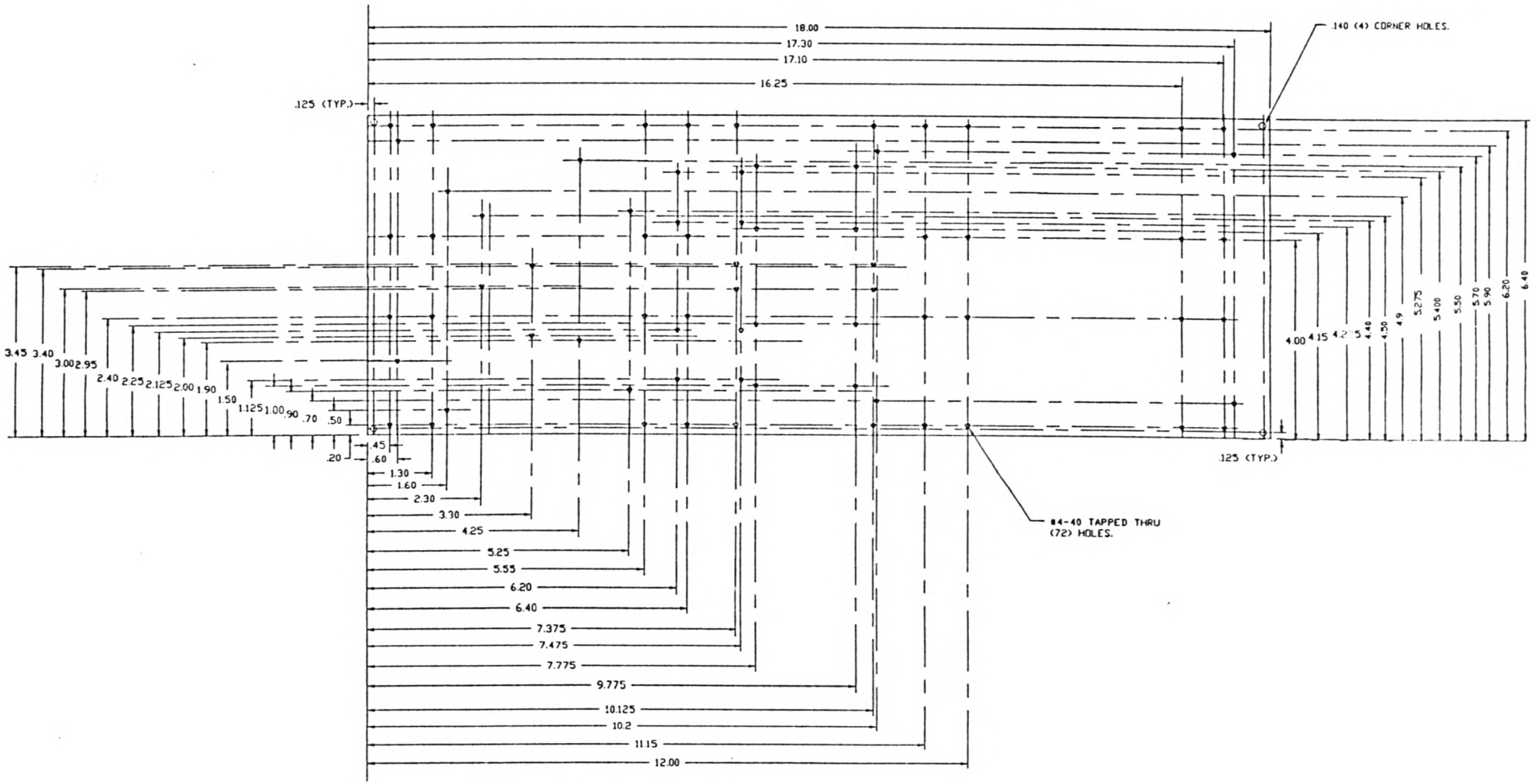
D - 541100008

ELECTRONICS NOTES: UNLESS OTHERWISE NOTED:	USED ON	DRAWN FOR: A.E.ROGERS	DATE: 7-87
RESISTORS:		DRAWN BY: A.PHILBROOK	7-87
INDUCTORS:		CHECKED BY:	
CAPACITORS:	SCALE:	ENGINEER:	
	CLASSIFICATION:	PROJECT:	

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD,MASSACHUSETTS

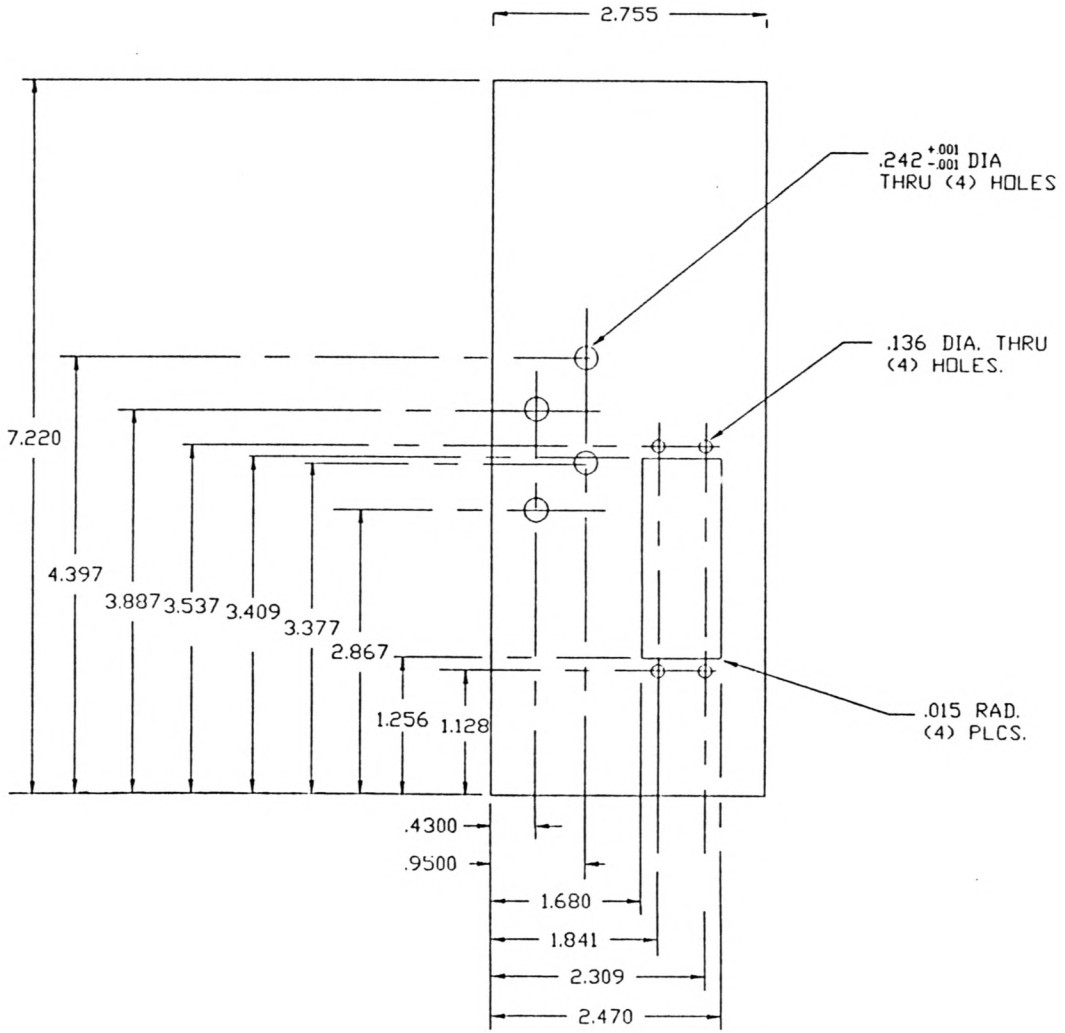
I.F. DISTRIBUTOR
CABLE ASSEMBLY

AER\IFCABLE | D | 541100008



MATERIAL: .125 ALUM. 6061-T6	DRAWN FOR: AE ROGERS	NORTHEAST RADIO OBSERVATORY CORPORATION HAYSTACK OBSERVATORY WESTFORD, MASSACHUSETTS
	DRAWN BY: A.PHILBROOK	
FINISH: CLEAR ALODINE	DATE: JULY 14,1987	VLBA IF DISTRIBUTOR MODULE MOUNTING PLATE (2 [redacted] MODULE)
[redacted]	DWG. NO. [redacted]009	FILE NAME: ACR.SMTPLT

CHANGE LETTER	D'WN BY	CHK'D BY	APP'D BY	DATE	D.C.N. & DESCRIPTION



C-54110M010

NOTES

MATERIAL

FINISH AND/OR HEAT TREATMENT

SHOP NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES
2. TOLERANCE ON DIMENSIONS
   FRACTIONAL ± 1/64
   DECIMAL .XX ± .01
   DECIMAL .XXX ± .005
   ANGULAR ± 0°30'
3. SURFACE ROUGHNESS PER MIL-STD-10
4. REMOVE BURRS AND BREAK SHARP EDGES 1/64 MAX.
5. SCREW THREADS PER MIL-STD-9
6. ALL DIMENSIONS TO APPLY BEFORE PLATING OR CONVERSION COATING.

USED ON

NEXT ASSEMBLY

WEIGHT

SCALE

CLASSIFICATION

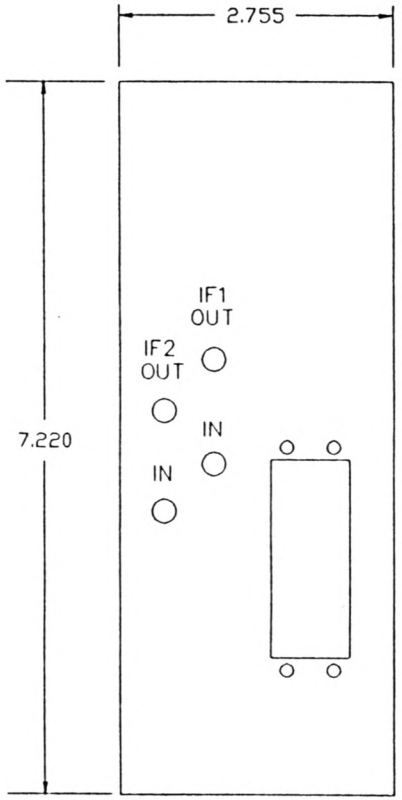
APPROVALS		
	DRAWN FOR A.E.ROGERS	DATE 9/87
	DRAWN BY A.P.HEBERT	9/87
	CHECKED BY	
	PROJECT	
	ENGINEER	
	MATL. & PROCESS	
	STRUCTURES	
	THERMAL	
	MECH. ANALYSIS	

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS

IF DISTRIBUTOR
REAR PANEL

AERIEREAR	C	54110M010	
	DWG SIZE	DWG NO.	REV

CHANGE LETTER	D'WN BY	CHK'D BY	APP'D BY	DATE	D.C.N. & DESCRIPTION



C-54110M011

NOTES

MATERIAL

FINISH AND/OR HEAT TREATMENT

SHOP NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES
2. TOLERANCE ON DIMENSIONS
   FRACTIONAL ± 1/64
   DECIMAL .XX ± .01
   DECIMAL .XXX ± .005
   ANGULAR ± 0°30'
3. SURFACE ROUGHNESS PER MIL-STD-10
4. REMOVE BURRS AND BREAK SHARP EDGES 1/64 MAX.
5. SCREW THREADS PER MIL-STD-9
6. ALL DIMENSIONS TO APPLY BEFORE PLATING OR CONVERSION COATING

USED ON

NEXT ASSEMBLY

WEIGHT

SCALE FULL

CLASSIFICATION

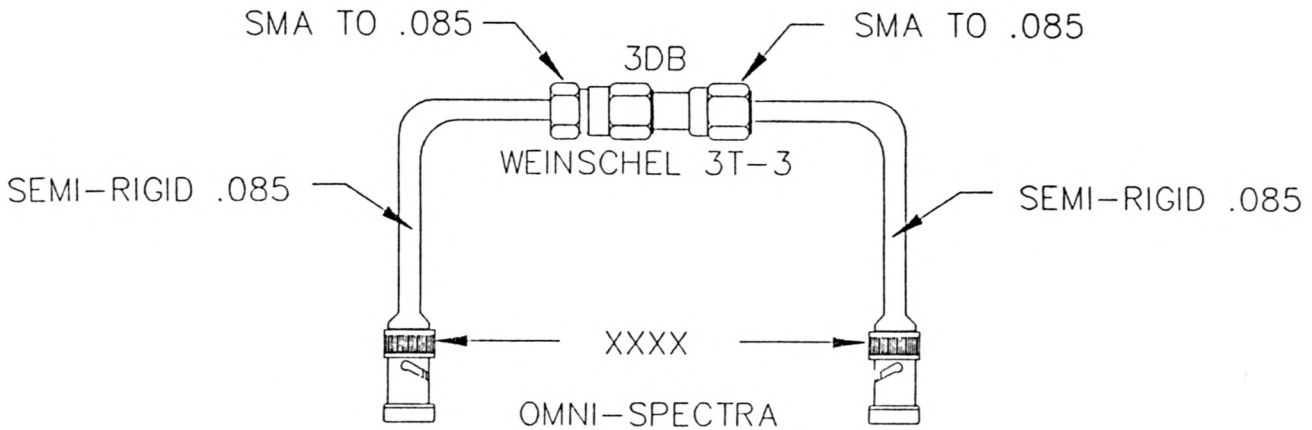
		DATE
DRAWN FOR	A.E.ROGERS	4/88
DRAWN BY	A.P.HEBERT	4/88
CHECKED BY		
APPROVALS: PROJECT		
ENGINEER		
MATL. & PROCESS		
STRUCTURES		
THERMAL		
ANALYSIS		

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS

IF DISTRIBUTOR REAR PANEL LABEL DESIGNATIONS

	C	54110M011

CHANGE LETTER	D'WN BY	CHK'D BY	APP'D BY	DATE	D.C.N. & DESCRIPTION



NOTES:
1. PERMANENT CONNECTION BETWEEN L.O. MONITOR OUTPUT ON BBC #1 AND ALTERNATE INPUT ON IFC (RIGHT CONNECTOR ON 2ND IF DISTR.)

DWG. LAST CHANGED -/-/-

SHOP NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES
2. TOLERANCE ON DIMENSIONS
   FRACTIONAL ± 1/64
   DECIMAL .XX ± .01
   DECIMAL .XXX ± .005
   ANGULAR ± 0°30'
3. SURFACE ROUGHNESS PER MIL-STD-10
4. REMOVE BURRS AND BREAK SHARP EDGES 1/64 MAX.
5. SCREW THREADS PER MIL-STD-9
6. ALL DIMENSIONS TO APPLY BEFORE PLATING OR CONVERSION COATING.

USED ON

NEXT ASSEMBLY

WEIGHT

SCALE NONE

CLASSIFICATION

DRAWN FOR A.E.ROGERS	DATE 11/88	NORTHEAST RADIO OBSERVATORY CORPORATION HAYSTACK OBSERVATORY WESTFORD, MASSACHUSETTS
DRAWN BY C.KOSTKA	11/88	
CHECKED BY		
APPROVALS: PROJECT		TEST SIGNAL INJECTION
ENGINEER		
MATL. & PROCESS		
STRUCTURES		
THERMAL		
MECH. ANALYSIS		

TESTSIGI	A	54110S012	
	DWG. SIZE	DWG. NO.	REV.

PARTS LIST FROM DBASE FILE:PARTS.DBF

REF	SUBMOD	PART	DESC	MFR	COST	QTY	TOTAL COST
C	IFD-A	100B201JMS50	200 PF MICROWAVE	ATC	2.87	16	45.92
C001	IFD-A	104K	0.1 UF	AVX	0.10	28	2.80
MP	IFD-A	1105-7521-003	SMC CABLE PLUG	AEP	2.49	6	14.94
MP12	IFD-A	200458-1	BLOCK	AMP	3.00	2	6.00
MP13	IFD-A	200833-4	GUIDE PINS	AMP	0.36	4	1.44
MP14	IFD-A	200835-4	GUIDE SOCKETS	AMP	0.48	4	1.92
MP15	IFD-A	202394-2	HOOD	AMP	1.04	2	2.08
MP16	IFD-A	202422-1	POWER PINS	AMP	0.50	8	4.00
MP11	IFD-A	4533-7388-02	R.P. OSP	OMNI SPECTRA	13.55	4	54.20
SS	IFD-A	541101004	F.P.SILK SCREEN	NYES	100.00	1	100.00
MS	IFD-A	54110M003	FRONT PANEL	HAYSTACK	100.00	1	100.00
MS	IFD-A	54110M009	CENTER PLATE	HAYSTACK	20.00	1	20.00
MS	IFD-A	54110M010	REAR PNL DRILLIN	HAYSTACK	20.00	1	20.00
MS	IFD-A	C53306M013-2UA	FRONT PANEL	PREC.MACHINE	20.00	1	20.00
MS	IFD-A	C53306M014-2UA	PERFORATED COVER	PREC.MACHINE	10.00	2	20.00
MS	IFD-A	C53306M015-2UA	MODULEREAR PANEL	PREC.MACHINE	20.00	1	20.00
MS	IFD-A	C53306M016	BAR SUPPORT	PREC.MACHINE	10.00	4	40.00
MS	IFD-A	C53306M017	SIDE PLATE	PREC.MACHINE	10.00	2	20.00
WORK	IFD-A	ENGINEER	CHECKOUT	HAYSTACK	100.00	2	200.00
MP10	IFD-A	KC19-153	F.P. BNC	KINGS	6.76	6	40.56
MPX	IFD-A	SAT-12	12 DB ATTEN	MINICIRCUITS	15.00	2	30.00
MP	IFD-A	SAT-20	20 DB ATTEN	MINICIRCUITS	15.00	2	30.00
MP5	IFD-A	SAT-30	30 DB ATTEN	MINICIRCUITS	15.00	2	30.00
MP7	IFD-A	SAT-6	6 DB ATTEN	MINICIRCUITS	15.00	2	30.00
MP8	IFD-A	STRM-50	50 TERM	MINICIRCUITS	7.00	2	14.00
WORK	IFD-A	TECH	ASSEMBLY	HAYSTACK	10.00	20	200.00
MP4	IFD-A	UTO-1001	AMP W/ASSEMBLY	AVANTEK	160.00	2	320.00
MP2	IFD-A	ZFL-2000	AMP	MINICIRCUITS	179.00	2	358.00
MP3	IFD-A	ZFSC-2-2	POWER SPLIT	MINICIRCUITS	45.00	4	180.00
MP9	IFD-A	ZFSC-8-43-SMA	8-WAY SPLIT	MINICIRCUITS	165.00	2	330.00
MP1	IFD-A	ZMSW-1211	DIODE SWITCH	MINICIRCUITS	60.00	8	480.00
MP2	IFD-DIB	1874010446	40 PIN ADAPTOR	EMC	10.00	4	40.00
D	IFD-DIB	1N4148	DIODE		0.20	1	0.20
C	IFD-DIB	226K	22 UF		0.20	2	0.40
C	IFD-DIB	330J	33 PF		0.20	4	0.80
MP3	IFD-DIB	616-CG1	HOLDERS	AUGAT	0.50	5	2.50
U006	IFD-DIB	74HCT00N	7400	RCA	1.40	1	1.40
U007	IFD-DIB	74HCT14N	7414	RCA	1.50	1	1.50
U014	IFD-DIB	74HCT251N	74251	RCA	1.62	16	25.92
U004	IFD-DIB	74HCT259N	74259	RCA	1.90	24	45.60
U008	IFD-DIB	74HCT32N	7432	TI	1.58	1	1.58
U003	IFD-DIB	74HCT390N	74390	SIGNETICS	2.60	3	7.80
U009	IFD-DIB	74HCT573N	74573		2.89	1	2.89
U005	IFD-DIB	74HCT74N	7474	RCA	1.50	2	3.00
U001	IFD-DIB	75174N	75174	TI	1.00	1	1.00
U002	IFD-DIB	75175N	75175	TI	1.00	1	1.00
U010	IFD-DIB	D8751H	8751	INTEL	65.95	1	65.95
U013	IFD-DIB	D8755A-2	8755	INTEL	30.00	1	30.00
MP1	IFD-DIB	EM09388-A2T-2SF	WIRE WRAP PANEL	EMC	253.97	1	253.97
U011	IFD-DIB	P8032AH	8032	INTEL	24.80	1	24.80
U012	IFD-DIB	P8156H	8156	INTEL	6.00	1	6.00
R	IFD-DIB	RCR05G102J	1 K OHMS 1/8W	AB	0.20	1	0.20
R	IFD-DIB	RCR05G471J	470 OHMS 1/8W	AB	0.20	8	1.60
R	IFD-DIB	RCR05G472J	4.7 K OHMS 1/8W	AB	0.20	2	0.40
R	IFD-DIB	RCR05G510J	51 OHMS 1/8W	AB	0.20	1	0.20
X	IFD-DIB	U49-S1105	11.05 MHZ XTAL	USC	2.85	2	5.70
WIRE	IFD-DIB	WIRE	WIRE WRAP	DATACON	0.14	999	139.86
MP1	IFD-PWR	1250-003	FEED-THRU	ERIE	1.53	14	21.42
U002	IFD-PWR	74HC4049	744049	TI	0.47	1	0.47
U001	IFD-PWR	74HC4050	744050	RCA	0.78	1	0.78
PC	IFD-PWR	AER\IFPWR	PC BOARD	PACLAB	40.00	1	40.00
MP2	IFD-SQL	1019-1511-000	SMC BULKHEAD	AEP	1.77	3	5.31
C03	IFD-SQL	102J	1000 PF	AVX	0.50	1	0.50
C01	IFD-SQL	104K	0.1 UF	AVX	0.10	4	0.40
MP1	IFD-SQL	1250-003	FEED THRU	ERIE	1.53	3	4.59
CR	IFD-SQL	1N5232	ZENER DIODE	MOTOROLA	0.50	1	0.50
C05	IFD-SQL	331J	330 PF	AVX	0.08	1	0.08
MS	IFD-SQL	54120M019	BOX DRILLING	HAYSTACK	20.00	1	20.00
U02	IFD-SQL	ADVFC32KN	VOLT TO FREQ CON	ANALOG DEV	8.95	1	8.95
PC	IFD-SQL	AER\SQDET	PC BOARD	PACLAB	40.00	1	40.00
CR1	IFD-SQL	BD-4	BACK DIODE	CUSTOM COMP.	6.00	1	6.00
MS	IFD-SQL	HAY17515	BOX WITH COVERS	PREC.MACHINE	34.50	1	34.50
U01	IFD-SQL	OP-27EN	OP AMP	ANALOG DEV	7.15	1	7.15
R06	IFD-SQL	RCR05G100J	10 OHM 1/8W	AB	0.20	1	0.20
R05	IFD-SQL	RCR05G102J	1000 OHM 1/8W	AB	0.20	3	0.60
R04	IFD-SQL	RCR05G274J	270K OHM 1/8W	AB	0.20	1	0.20
R02	IFD-SQL	RCR05G362J	3.6K OHM 1/8W	AB	0.20	1	0.20
R03	IFD-SQL	RCR05G471J	470 OHM 1/8W	AB	0.20	1	0.20
R07	IFD-SQL	RCR05G475J	4.7M OHM 1/8W	AB	0.20	1	0.20
R01	IFD-SQL	RCR05G510J	51 OHM 1/8W	AB	0.20	1	0.20
R08	IFD-SQL	RCR05G822J	8.2K OHM 1/8W	AB	0.20	1	0.20
*** Total ***							3592.78

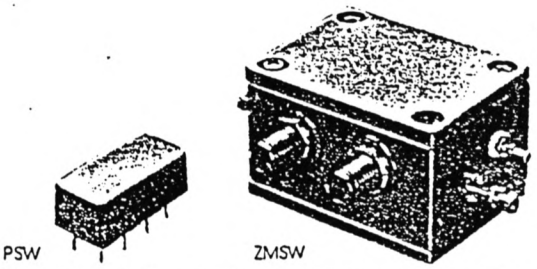
pin diode

Switches

SPST/SPDT

10 to 2500 MHz

Mini-Circuits

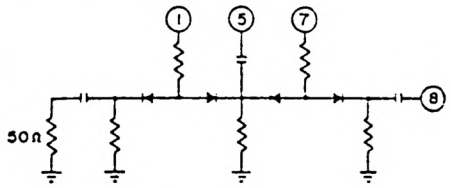


	MODEL NO.	TYPE	FREQUENCY MHz f_L-f_U	INSERTION LOSS dB low-band lw Typ.	lw Max.	Upper band U Typ.	U Max.	IN-OUT ISOLATION dB L Typ.	L Min.	M Typ.	M Min.	U Typ.	U Min.	PRICE, $ Ea.	Qty.
PSW case A06	PSW-1111	SPST	10-2500	1.1	1.7	1.7	2.7	50	40	35	30	28	22	29.95	(6-24)
	PSW-1211	SPDT	10-2500	1.1	1.7	1.7	2.7	50	40	35	30	28	22	29.95	(6-24)
PSW case JJ77	ZMSW-1111	SPST	10-2500	1.1	1.7	1.7	2.7	50	45	35	30	28	22	59.95	(1-4)
	ZMSW-1211	SPDT	10-2500	1.1	1.7	1.7	2.7	50	45	35	30	28	22	59.95	(1-4)

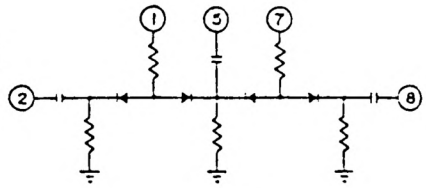
L = low range (f_L to 10 f_L) M = mid range (10f_L to f_U/2) U = upper range (f_U/2 to f_U)

lw = low-band (f_L to f_U/2)

Model PSW-1111



Model PSW-1211



pin and coaxial connections

see case style outline drawings

Series	PSW		ZMSW	
Models	1111	1211	1111	1211
RF COMMON	5	5	com	com
RF-1 port	8	2	—	RF-1
RF-2 port	—	8	RF-2	RF-2
CONTROL RF-1	7	1	—	1
CONTROL RF-2	—	7	2	2
CONTROL 50 ohm TERMINATION	1	—	1	—
GND	2,4	4	—	—
CASE GND	3,6	3,6	—	—

computer-automated performance data

typical production unit / for data of other models consult factory

PSW-1211

RF (MHz)	INSERTION LOSS, dB com RF-1	com RF-2	ISOLATION, dB com RF-1	com RF-2
10	-1.29	-1.28	-49.04	-49.44
110	- .93	- .97	-49.74	-49.78
210	- .91	- .90	-48.87	-44.32
310	- .92	- .84	-44.55	-45.60
410	- .83	- .71	-42.88	-44.53
610	-1.09	- .96	-39.47	-39.28
810	-1.13	-1.12	-37.53	-36.80
1010	-1.12	-1.09	-35.83	-34.95
1310	-1.14	-1.10	-33.28	-32.77
1510	-1.16	-1.12	-32.93	-32.41
1810	-1.30	-1.26	-31.80	-31.32
2010	-1.40	-1.32	-30.31	-29.93
2110	-1.45	-1.34	-28.33	-28.99
2310	-1.44	-1.31	-28.08	-28.09
2510	-1.59	-1.45	-27.89	-28.11

In Stock... Immediate Delivery

broadband linear

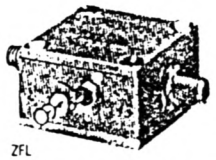
Power Amplifiers

up to 100mW (+20 dBm)

50 KHz to 2000 MHz

case style selection

outline drawings section 1



ZFL

MODEL NO.	FREQUENCY MHz	GAIN, dB			MAXIMUM POWER, dBm		DYNAMIC RANGE		VSWR		DC POWER		PRICE $	
		Min.	Flatness Max	Control range	Output (1dB) Compression	Input (no damage)	NF, dB typ.	Intercept pt., dBm 3rd order	In	Out	Volt.	Current	Ea.	Qty.
ZFL ZFL-500	0.05-500	20	±1.0	—	+9	+5	5.3	+18	1.9	1.9	+15	85mA	69.95	(1-24)
▲ ZFL-500LN	0.1-500	24	±0.3	—	+5	+5	2.9	+14	1.5:1	1.6	+15V	60mA	79.95	(1-24)
ZFL-750	0.2-750	18	±0.5	—	+9	+5	6.0	+18	1.5:1	2.1	+15V	90mA	74.95	(1-24)
■ ZFL-1000	0.1-1000	17	±0.6	—	+9	+5	6.0	+18	1.5:1	2.1	+15V	90mA	79.95	(1-24)
ZFL-1000G	10-1000	17	±1.5	30	+3	0	12	+13	2.1	2.1	+15V	90mA	199	(1-9)
ZFL-1000LN	0.1-1000	20	±0.5	—	+3	+5	2.9	+14	1.5	2.1	+15V	60mA	89.95	(1-24)
ZFL-2000	10-2000	20	±1.5	—	+17*	+5	7.0	+25	2.1	2.1	+15V	100mA	219	(1-9)
ZFL-1000H	10-1000	28	±1.0	—	+20	+5	5	+33	2.1	2.1	15	150mA	219	(1-9)

NOTES:

* +15dBm below 1000 MHz
■ ZFL-1000 output VSWR 2.8:1 maximum over 750-1000 MHz.
▲ VSWR 1.6 maximum from 0.1 to 0.2 MHz.
1. Operating temperature is −55°C to +71°C except the ZFL-2000 is −55°C to +100°C. When models ZFL-1000H and ZFL-2000 are mounted to chassis using a thermoconductive paste, their operating temperature range will be increased
2. Withno load output, durate maximum input power (no damage) by 10 dB
3. Prices and specifications subject to change without notice

NSN GUIDE

MCL NO. NSN

ZFL-2000 5895-01-220-2213

ZFL-500

FREQ. (MHz)	GAIN, dB FORWARD	GAIN, dB REVERSE	LINEARITY Comp. (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE (dB)	VSWR in	VSWR out
.050	22.8	37.70	0.6	10.6	—	—	—
.104	22.9	38.80	0.6	10.9	—	1.33	1.09
.217	23.0	38.70	.7	11.0	—	1.33	1.09
.453	23.4	38.60	.8	11.4	—	1.34	1.08
.943	23.3	38.50	.7	11.3	—	1.35	1.09
1.966	23.4	38.30	.8	11.4	6.0	1.35	1.07
4.048	23.5	38.30	.8	11.4	5.9	1.35	1.09
8.541	23.5	38.20	.8	11.4	5.9	1.35	1.07
10.910	23.4	38.30	.8	11.4	6.0	1.37	1.08
22.738	23.4	38.20	.8	11.4	5.9	1.36	1.09
47.389	23.5	38.10	.8	11.4	5.8	1.36	1.07
98.767	23.6	38.00	.9	11.6	5.9	1.37	1.07
126.160	23.8	38.00	.8	11.7	5.9	1.38	1.07
161.151	23.7	38.00	.9	11.6	5.8	1.38	1.09
205.846	23.7	38.00	.9	11.6	5.8	1.36	1.10
262.938	23.6	38.00	.9	11.6	5.8	1.39	1.09
335.865	23.5	37.70	.8	11.4	5.7	1.41	1.08
429.019	23.1	37.20	.9	11.0	5.6	1.44	1.08
548.008	22.5	36.00	.7	11.4	5.6	1.50	1.11
700.000	21.4	34.90	.5	9.3	5.8	1.56	1.16

ZFL-500LN

FREQ (MHz)	GAIN (dB)	LINEARITY Comp (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE	RETURN LOSS in	RETURN LOSS out
.100	30.90	0.72	7.65	—	33.84	16.81
.300	30.83	.89	7.62	—	27.01	16.81
.505	30.81	.87	7.92	—	26.10	17.15
1.100	30.80	.86	7.99	—	25.48	17.35
2.390	30.77	.83	7.77	—	25.30	17.43
5.190	30.76	.81	7.45	—	25.25	17.53
10.130	30.76	.80	7.39	2.52	25.19	17.56
24.460	30.74	.77	7.36	2.47	25.25	17.55
40.490	30.75	.76	7.35	2.50	25.09	17.63
50.120	30.70	.75	7.24	2.52	24.96	17.70
100.720	30.71	.72	7.16	2.56	24.00	18.01
190.970	30.67	.67	6.97	2.57	21.77	19.07
250.520	30.72	.67	6.91	2.59	20.21	20.28
322.330	30.75	.62	6.77	2.57	18.43	22.69
503.450	30.68	.56	6.52	2.65	15.38	23.08

Mini-Circuits P.O. BOX 350166, Brooklyn, New York 11235-0003 (718) 934-4500
FAX (718) 332-4661 TELEX 6852844 or 620156

Mini-Circuits

ZFL-750

FREQ (MHz)	GAIN (dB)	LINEARITY Comp (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE	RETURN LOSS in	RETURN LOSS out
0.100	19.63	0.96	10.68	—	22.92	28.41
0.200	19.89	0.94	10.70	—	22.92	28.41
0.300	19.91	1.16	11.45	—	25.71	35.78
10.300	19.96	1.08	11.08	6.21	27.16	32.20
110.270	19.92	1.16	10.65	6.06	25.45	32.80
195.240	19.91	1.06	10.37	6.00	23.54	30.92
305.210	19.90	.74	9.82	6.16	21.66	27.51
400.180	19.91	.77	9.71	6.10	21.73	23.63
500.150	20.03	.67	9.40	6.14	23.07	20.01
610.120	20.20	.58	9.05	6.12	28.88	16.05
667.600	20.34	.44	8.35	—	34.56	14.33
700.090	20.35	.44	8.35	6.01	34.61	13.48
750.080	20.41			6.06	29.25	12.33
917.520	20.19			6.06	20.36	9.54
1000.000	19.90			6.13	18.64	8.97

ZFL-1000G

FREQUENCY (MHz)	GAIN, dB 0V	1V	1.4V	1.87V
10.000	26.99	20.12	10.35	.87
39.750	27.67	20.03	9.46	.61
69.500	27.66	19.75	8.90	−1.38
99.250	27.61	19.58	8.61	−1.74
129.000	27.51	19.41	8.37	−2.03
158.750	27.42	19.29	8.21	−2.23
188.500	27.31	19.17	8.05	−2.39
218.250	27.21	19.07	7.92	−2.49
248.000	27.12	18.98	7.83	−2.62
277.750	27.06	18.92	7.76	−2.63
307.500	27.01	18.87	7.68	−2.73
396.750	26.71	18.61	7.49	−2.81
456.250	26.59	18.45	7.34	−2.93
545.500	26.44	18.20	7.12	−2.98
634.750	26.36	17.98	6.91	−3.07
724.000	26.30	17.77	6.71	−3.11
813.250	26.33	17.61	6.54	−3.11
902.500	26.16	17.43	6.35	−3.09
991.750	25.75	17.20	6.15	−3.13
1021.500	25.51	17.08	6.06	−3.18

ZFL-1000H

FREQ. (MHz)	GAIN, dB FORWARD	GAIN, dB REVERSE	LINEARITY Comp. (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE (dB)	VSWR in	VSWR out
10.000	31.15	48.0	1.02	20.13	5.63	1.36	1.33
84.500	31.04	49.3	.97	20.09	5.32	1.39	1.31
121.750	31.04	48.2	.95	20.09	4.57	1.45	1.36
159.000	31.04	48.0	.94	20.09	4.37	1.47	1.36
196.250	31.06	47.6	.96	20.08	4.23	1.39	1.38
233.500	31.07	48.4	.95	20.08	4.23	1.39	1.30
270.750	31.06	47.4	.94	20.08	4.31	1.33	1.37
308.000	31.07	47.2	.95	20.06	4.32	1.40	1.30
382.500	31.15	46.8	1.00	20.09	4.32	1.40	1.32
494.250	31.20	48.4	.97	20.16	4.34	1.31	1.39
606.000	31.09	48.0	.89	20.13	4.33	1.41	1.38
680.500	30.84	48.0	.77	20.00	4.33	1.42	1.50
792.250	30.65	49.3	.53	20.01	4.29	1.36	1.40
904.000	30.86	48.1	.31	20.22	4.18	1.45	1.44
1015.800	31.82	45.9	.36	21.17	4.22	1.39	1.38
1127.500	32.18	43.5	.61	21.37	4.30	1.26	1.91
1239.300	31.03	36.8	.49	20.17	4.29	1.44	2.10
1313.800	31.08	47.0	.49	20.48	4.34	1.29	2.12
1388.300	31.02	42.5	.56	20.43	4.38	1.84	2.02
1500.000	29.31	43.2	.26	19.06	4.19	3.42	1.48

ZFL-1000

FREQ (MHz)	GAIN (dB)	LINEARITY Comp (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE	RETURN LOSS in	RETURN LOSS out
0.100	19.63	0.96	10.68	—	22.92	28.41
0.200	19.89	0.94	10.70	—	22.92	28.41
0.300	19.91	1.16	11.45	—	25.71	35.78
10.300	19.96	1.08	11.08	6.21	27.16	32.20
110.270	19.92	1.16	10.65	6.06	25.45	32.80
195.240	19.91	1.06	10.37	6.00	23.54	30.92
305.210	19.90	.74	9.82	6.16	21.66	27.51
400.180	19.91	.77	9.71	6.10	21.73	23.63
500.150	20.03	.67	9.40	6.14	23.07	20.01
610.120	20.20	.58	9.05	6.12	28.88	16.05
667.600	20.34	.44	8.35	—	34.56	14.33
700.090	20.35	.44	8.35	6.01	34.61	13.48
750.080	20.41			6.06	29.25	12.33
917.520	20.19			6.06	20.36	9.54
1000.000	19.90			6.13	18.64	8.97

ZFL-1000LN

FREQ (MHz)	GAIN (dB)	LINEARITY Comp (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE	RETURN LOSS in	RETURN LOSS out
0.100	22.93	1.42	5.66	—	21.51	19.99
1.000	24.50	1.35	5.73	—	31.01	35.40
5.010	24.48	1.28	5.70	—	31.98	42.86
10.520	24.48	1.25	5.60	2.67	31.97	48.17
47.030	24.44	1.28	5.40	2.70	32.34	47.40
100.000	24.41	1.16	5.42	2.85	31.56	48.92
201.500	24.18	1.14	5.98	2.85	30.62	41.18
252.250	24.19	1.10	6.07	2.95	31.01	34.22
303.000	24.16	1.03	6.01	2.92	29.01	27.61
498.750	24.19	.71	5.92	2.96	28.71	24.55
600.250	24.27	.64	6.10	2.95	28.50	21.00
701.750	24.33	.54	5.93	2.97	29.19	19.66
803.250	24.40	.50	5.96	3.02	30.28	18.43
897.500	24.41	.48	5.86	3.03	28.64	14.35
999.000	24.26	.44	5.71	3.05	25.58	11.97

ZFL-2000

FREQ. (MHz)	GAIN, dB FORWARD	GAIN, dB REVERSE	LINEARITY Comp. (dB)	LINEARITY P_{out} (dBm)	NOISE FIGURE (dB)	VSWR in	VSWR out
10.00	22.68	33.41	1.26	15.44	4.1	1.44	1.28
105.42	22.58	33.31	1.26	15.35	4.1	1.46	1.21
200.83	22.60	33.35	1.30	15.32	4.1	1.44	1.13
296.25	22.48	33.37	1.28	15.24	4.1	1.35	1.09
391.67	22.32	33.45	1.05	15.19	4.0	1.24	1.13
487.08	21.96	33.60	0.92	15.11	3.9	1.18	1.14
582.50	21.63	34.05	0.80	14.74	4.3	1.21	1.18
677.92	21.60	34.33	0.82	14.86	4.4	1.37	1.24
773.33	22.03	34.03	0.74	15.28	4.5	1.48	1.30
868.75	22.42	33.59	0.71	15.74	4.7	1.53	1.36
964.17	22.64	33.12	0.62	15.98	4.8	1.49	1.45
1059.40	22.89	32.74	0.68	16.25	4.9	1.39	1.59
1154.70	23.14	32.22	0.79	16.42	5.1	1.25	1.71
1250.20	23.44	31.64	0.88	16.54	5.2	1.05	1.76
1345.80	23.34	31.15	0.73	16.57	5.2	1.19	1.67
1441.00	23.18	30.81	0.63	16.55	5.3	1.44	1.52
1535.90	22.96	30.64	0.49	16.45	5.3	1.64	1.31
1631.50	22.64	30.73	0.38	16.22	5.2	1.77	1.10
1726.90	22.32	30.57	0.33	15.97	5.0	1.78	1.11
1822.20	22.08	30.05	0.26	15.80	5.1	1.67	1.28
1917.60	21.70	29.21	0.02	15.67	5.2	1.54	1.43
2014.80	21.03	29.26	0.46	15.58	5.4	1.55	1.53
2108.20	20.24	28.70	0.89	15.20	5.6	1.97	1.57
2204.00	19.23	28.44	1.17	14.47	5.9	2.93	1.48
2299.70	18.26	28.28	1.11	13.35	5.3	4.15	1.29

In Stock...Immediate Delivery

)01 Series

Thin Film Cascadable Amplifier 5-1000 MHz

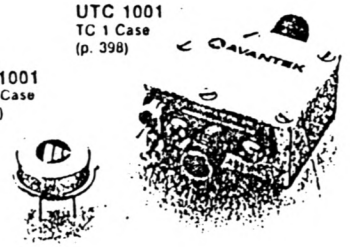
AVANTEK

TURES

5.0 dB Gain Stage

UTC 1001
TC 1 Case
(p. 398)

UTO-1001
TO 8T Case
(p. 402)



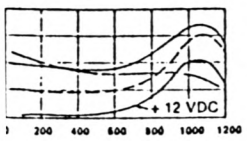
CTRICAL SPECIFICATIONS (Measured in a 50-ohm system @ +15 VDC nominal unless otherwise noted)

ymbol	Characteristic	Typical T_C = 25°C	Guaranteed Specifications T_C = 0°-50°C	Guaranteed Specifications T_C = -55°- +85°C	Unit
BW	Frequency Range	5-1000	5-1000	5-1000	MHz
GP	Small Signal Gain	15.0	14.0 Min.	13.5 Min.	dB
—	Gain Flatness	±0.5	±1.0 Max.	±1.0 Max.	dB
NF	Noise Figure	4.5	5.0 Max.	5.5 Max.	dB
$P_{1\,dB}$	Power Output @ +1 dB Compression	+1.0	-2.0 Min.	-3.0 Min.	dBm
—	Input VSWR	<1.5:1	2.0:1 Max.	2.0:1 Max.	—
—	Output VSWR	<1.4:1	2.0:1 Max.	2.0:1 Max.	—
IP_3	Two Tone 3rd Order Intercept Point	+11.0	—	—	dBm
—	One Tone	+53.0	—	—	dBm
I_D	DC Current	10	—	—	mA

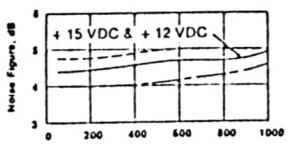
CAL PERFORMANCE OVER TEMPERATURE (@ +15 VDC unless otherwise noted)

+25°C ——————
+85°C — — — —
-55°C —·—·—·—

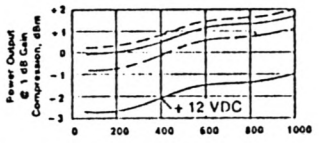
Gain



Noise Figure



Power Output



IMUM RATINGS

ltage	+17 Volts
uous RF Input Power	+13 dBm
ting Case Temperature	-55°C to +125°C
e Temperature	-62°C to +150°C
erles Burn-In Temperature	+125°C

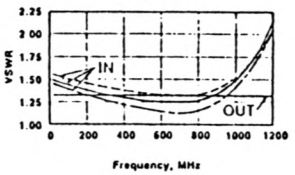
THERMAL CHARACTERISTICS*

θ_{JC}	155°C/W
Active Transistor Power Dissipation	67 mW
Junction Temperature Above Case Temperature	10°C
MTBF	962,932 Hrs.

*For further information, see High Reliability section.

GHT: (typical) UTO — 2.1 grams; UTC — 21.5 grams

VSWR



AUTOMATIC NETWORK ANALYZER MEASUREMENTS (Typical production unit @ +25°C ambient)

NUMERICAL READINGS — BIAS = 15.00 VOLTS

FREQ MHz	VSWR IN	GAIN dB	PHASE DEG	PHASE DEV	PHASE DEV	FLAT dB	GROUP DELAY nS	VSWR OUT	ISOL dB
100.0	1.24	15.77	157.94	-3.57	-2.35	-.22	—	1.23	20.48
150.0	1.24	15.65	148.39	-2.08	-1.06	-.10	.55	1.25	20.47
200.0	1.22	15.55	138.08	-1.36	-.53	-.01	.60	1.24	20.55
250.0	1.24	15.53	126.62	-1.77	-1.15	.00	.60	1.24	20.44
300.0	1.25	15.57	116.62	-.73	-.30	-.02	.56	1.26	20.23
350.0	1.25	15.41	106.42	.10	.33	.12	.60	1.25	20.30
400.0	1.25	15.41	95.06	-.21	-.18	.12	.59	1.26	20.30
450.0	1.25	15.47	85.15	.91	.74	.06	.56	1.24	20.20
500.0	1.25	15.41	74.99	1.80	1.43	.12	.58	1.25	20.13
550.0	1.23	15.44	64.38	2.20	1.64	.10	.59	1.26	20.18
600.0	1.20	15.42	53.62	2.51	1.75	.11	.59	1.25	20.23
650.0	1.20	15.36	43.04	2.98	2.02	.17	.62	1.24	20.23
700.0	1.18	15.52	31.25	2.22	1.07	.01	.60	1.23	20.22
750.0	1.15	15.58	21.59	3.60	2.25	-.04	.58	1.28	19.98
800.0	1.09	15.54	10.53	3.58	2.03	.00	.66	1.25	20.35
850.0	1.09	15.61	-2.21	1.88	.12	-.06	.67	1.24	20.28
900.0	1.15	15.67	-13.77	1.38	-.58	-.12	.67	1.22	20.38
950.0	1.25	15.63	-26.34	-.17	-2.32	-.08	.72	1.23	20.13
1000.0	1.38	15.69	-39.78	-2.57	-4.92	-.15	.73	1.20	20.14
1050.0	1.56	15.62	-52.70	-4.46	—	—	.71	1.19	20.85
1100.0	1.05	15.42	-65.49	-6.21	—	—	.76	1.19	20.35
1150.0	2.26	15.28	-80.08	—	—	—	.82	1.20	21.04
1200.0	2.75	14.78	-94.92	—	—	—	.85	1.25	21.58
LINEARIZATION RANGE:				100.0 TO 1100.0	100.0 TO 1000.0	100.0 TO 1000.0			

S-PARAMETERS, MAGNITUDES AND ANGLES — BIAS = 15 VOLTS

FREQ MHz	11 RATIO	11 ANGLE	21 RATIO	21 ANGLE	12 RATIO	12 ANGLE	22 RATIO	22 ANGLE
100.00	.036	-8.9	5.741	155.9	.102	-7.2	.016	89.7
200.00	.052	-23.3	5.651	136.8	.102	-18.3	.031	83.5
300.00	.079	-36.4	5.659	114.5	.102	-25.8	.038	43.2
400.00	.110	-51.7	5.587	92.5	.098	-34.8	.037	17.9
500.00	.146	-68.0	5.572	71.2	.100	-45.6	.029	-19.9
600.00	.177	-85.3	5.548	50.1	.099	-55.6	.027	-89.8
700.00	.198	-101.8	5.632	27.5	.097	-65.1	.048	-151.0
800.00	.206	-121.8	5.557	6.3	.095	-76.2	.081	177.8
900.00	.187	-147.0	5.701	-18.8	.094	-88.7	.114	149.6
1000.00	.139	172.7	5.854	-44.1	.095	-100.7	.133	125.6
1100.00	.146	87.9	5.882	-72.5	.092	-118.0	.122	95.6
1200.00	.320	24.2	5.593	-105.3	.084	-138.4	.052	58.9
1300.00	.558	-16.2	4.894	-141.6	.069	-161.7	.074	-130.1
1400.00	.744	-47.1	3.735	-174.0	.048	176.6	.212	-166.6
1500.00	.839	-71.6	2.625	157.7	.029	158.6	.325	168.4