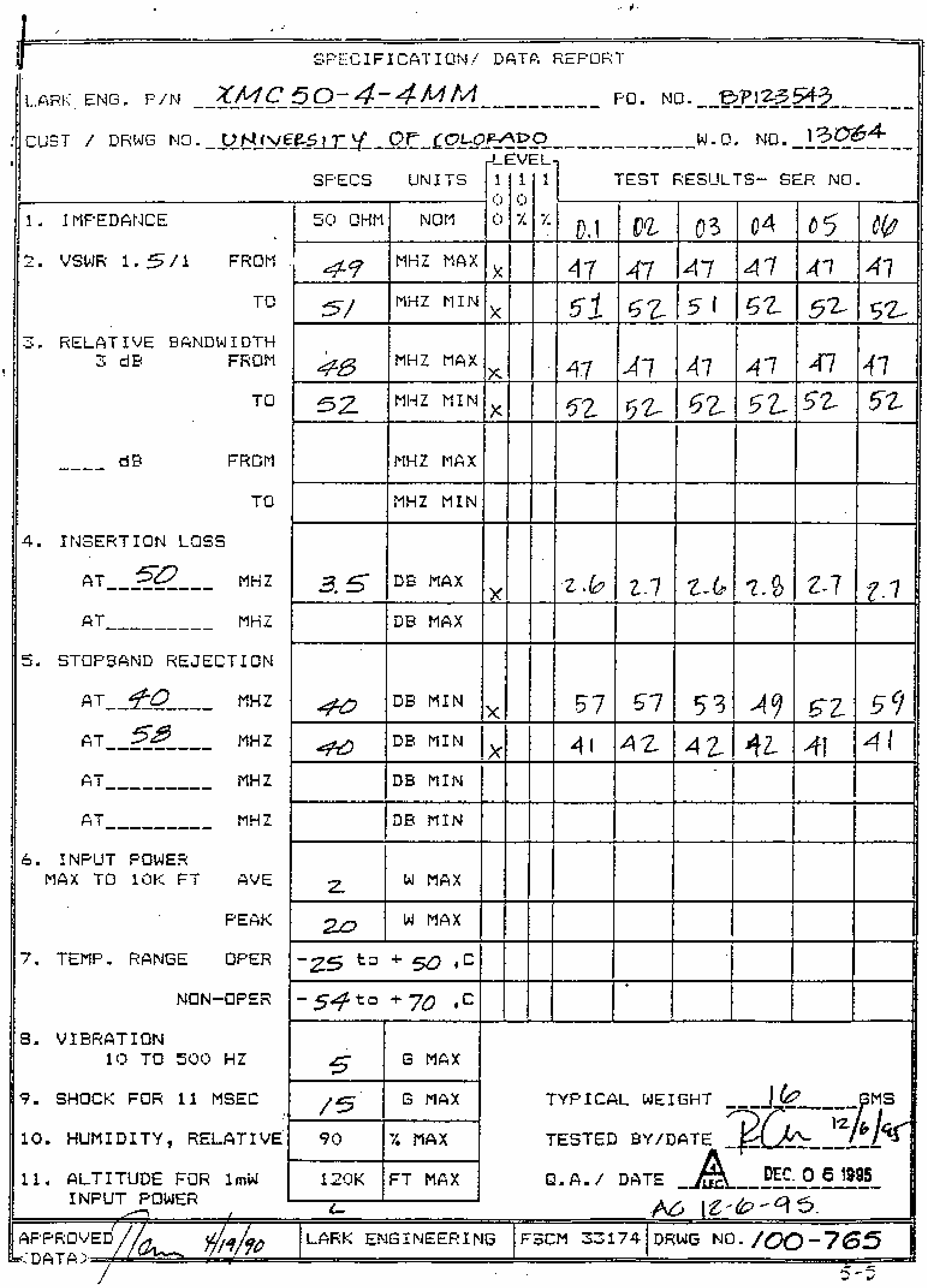
ANEXO A

DATOS TÉCNICOS



SPECIFICATION/ DATA REPORT

LARK ENG. P/N XMC50-4-4MM PO. NO. BP123543

CUST / DRWG NO. UNIVERSITY OF COLORADO W.O. NO. 13064

	SPECS	UNITS	LEVEL			TEST RESULTS– SER NO.					
			100	10 %	1 %						
1. IMPEDANCE	50 OHM	NOM				0.1	02	03	04	05	06
2. VSWR 1.5/1 FROM	49	MHZ MAX	X			47	47	47	47	47	47
TO	51	MHZ MIN	X			51	52	51	52	52	52
3. RELATIVE BANDWIDTH 3 dB FROM	48	MHZ MAX	X			47	47	47	47	47	47
TO	52	MHZ MIN	X			52	52	52	52	52	52
____ dB FROM		MHZ MAX									
TO		MHZ MIN									
4. INSERTION LOSS AT 50 MHZ	3.5	DB MAX	X			2.6	2.7	2.6	2.8	2.7	2.7
AT________ MHZ		DB MAX									
5. STOPBAND REJECTION AT 40 MHZ	40	DB MIN	X			57	57	53	49	52	59
AT 58 MHZ	40	DB MIN	X			41	42	42	42	41	41
AT________ MHZ		DB MIN									
AT________ MHZ		DB MIN									
6. INPUT POWER MAX TO 10K FT AVE	2	W MAX									
PEAK	20	W MAX									
7. TEMP. RANGE OPER	-25 to +50 ,C										
NON-OPER	-54 to +70 ,C										
8. VIBRATION 10 TO 500 HZ	5	G MAX									
9. SHOCK FOR 11 MSEC	15	G MAX									
10. HUMIDITY, RELATIVE	90	% MAX									
11. ALTITUDE FOR 1mW INPUT POWER	120K	FT MAX									

TYPICAL WEIGHT 16 GMS

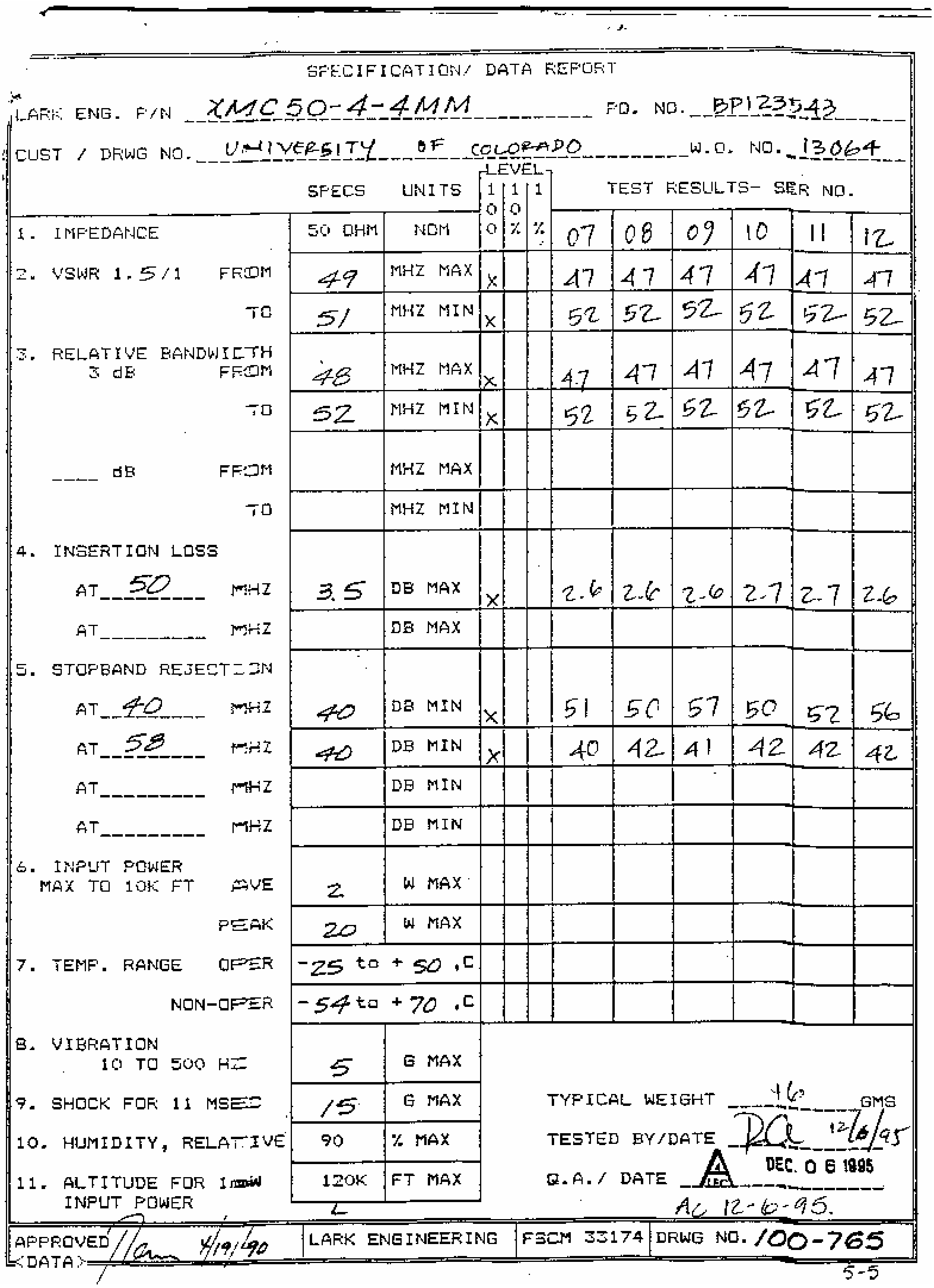
TESTED BY/DATE 12/6/95

Q.A./ DATE LEC DEC. 0 6 1995

AG 12-6-95.

APPROVED <DATA> 4/19/90 LARK ENGINEERING FSCM 33174 DRWG NO. 100-765

5-5



SPECIFICATION/ DATA REPORT

LARK ENG. P/N XMC50-4-4MM P.O. NO. BP123543

CUST / DRWG NO. UNIVERSITY OF COLORADO W.O. NO. 13064

	SPECS	UNITS	LEVEL 100	LEVEL 10%	LEVEL 1%	TEST RESULTS- SER NO.					
1. IMPEDANCE	50 OHM	NOM				07	08	09	10	11	12
2. VSWR 1.5/1 FROM	49	MHZ MAX	X			47	47	47	47	47	47
TO	51	MHZ MIN	X			52	52	52	52	52	52
3. RELATIVE BANDWIDTH 3 dB FROM	48	MHZ MAX	X			47	47	47	47	47	47
TO	52	MHZ MIN	X			52	52	52	52	52	52
____ dB FROM		MHZ MAX									
TO		MHZ MIN									
4. INSERTION LOSS AT 50 MHZ	3.5	DB MAX	X			2.6	2.6	2.6	2.7	2.7	2.6
AT ________ MHZ		DB MAX									
5. STOPBAND REJECTION AT 40 MHZ	40	DB MIN	X			51	50	57	50	52	56
AT 58 MHZ	40	DB MIN	X			40	42	41	42	42	42
AT ________ MHZ		DB MIN									
AT ________ MHZ		DB MIN									
6. INPUT POWER MAX TO 10K FT AVE	2	W MAX									
PEAK	20	W MAX									
7. TEMP. RANGE OPER	-25 to +50 .C										
NON-OPER	-54 to +70 .C										
8. VIBRATION 10 TO 500 HZ	5	G MAX									
9. SHOCK FOR 11 MSEC	15	G MAX									
10. HUMIDITY, RELATIVE	90	% MAX									
11. ALTITUDE FOR 1mW INPUT POWER	120K	FT MAX									

TYPICAL WEIGHT 16 GMS

TESTED BY/DATE RC 12/6/95

DEC. 0 6 1995

Q.A./ DATE AC 12-6-95.

APPROVED 4/19/90 <DATA>	LARK ENGINEERING	FSCM 33174	DRWG NO. 100-765

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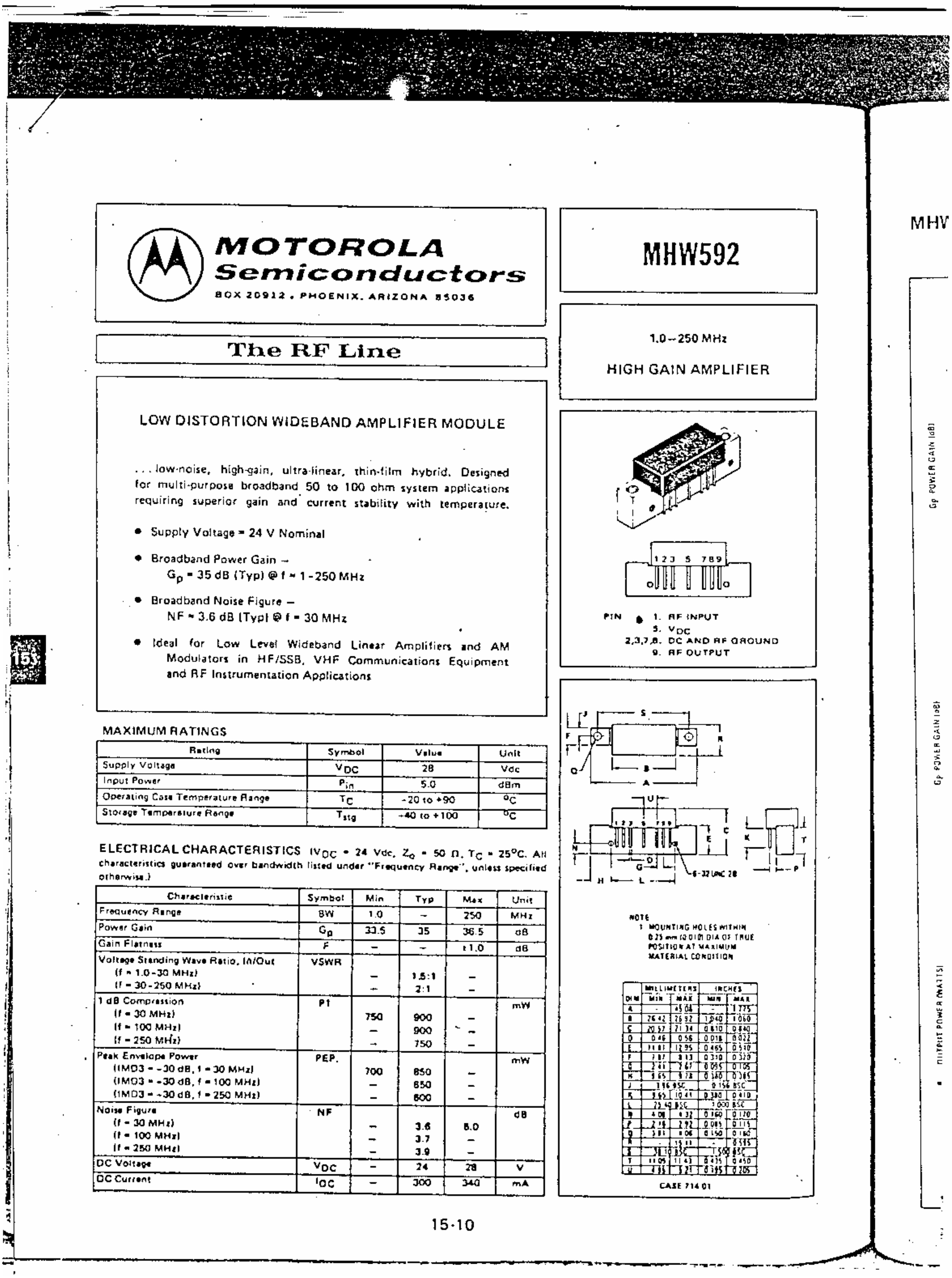


MOTOROLA Semiconductors

BOX 20912 • PHOENIX, ARIZONA 85036

MHW592

The RF Line

1.0–250 MHz

HIGH GAIN AMPLIFIER

LOW DISTORTION WIDEBAND AMPLIFIER MODULE

. . . low-noise, high-gain, ultra-linear, thin-film hybrid. Designed for multi-purpose broadband 50 to 100 ohm system applications requiring superior gain and current stability with temperature.

- Supply Voltage = 24 V Nominal
- Broadband Power Gain –
  G_p = 35 dB (Typ) @ f = 1-250 MHz
- Broadband Noise Figure –
  NF = 3.6 dB (Typ) @ f = 30 MHz
- Ideal for Low Level Wideband Linear Amplifiers and AM Modulators in HF/SSB, VHF Communications Equipment and RF Instrumentation Applications

PIN
1. RF INPUT
5. V_{DC}
2,3,7,8. DC AND RF GROUND
9. RF OUTPUT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{DC}	28	Vdc
Input Power	P_{in}	5.0	dBm
Operating Case Temperature Range	T_C	-20 to +90	°C
Storage Temperature Range	T_{stg}	-40 to +100	°C

ELECTRICAL CHARACTERISTICS

(V_{DC} = 24 Vdc, Z_o = 50 Ω, T_C = 25°C. All characteristics guaranteed over bandwidth listed under "Frequency Range", unless specified otherwise.)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	1.0	–	250	MHz
Power Gain	G_p	33.5	35	36.5	dB
Gain Flatness	F	–	–	±1.0	dB
Voltage Standing Wave Ratio, In/Out	VSWR				
(f = 1.0-30 MHz)		–	1.5:1	–	
(f = 30-250 MHz)		–	2:1	–	
1 dB Compression	P1				mW
(f = 30 MHz)		750	900	–	
(f = 100 MHz)		–	900	–	
(f = 250 MHz)		–	750	–	
Peak Envelope Power	PEP.				mW
(IMD3 = -30 dB, f = 30 MHz)		700	850	–	
(IMD3 = -30 dB, f = 100 MHz)		–	650	–	
(IMD3 = -30 dB, f = 250 MHz)		–	600	–	
Noise Figure	NF				dB
(f = 30 MHz)		–	3.6	6.0	
(f = 100 MHz)		–	3.7	–	
(f = 250 MHz)		–	3.9	–	
DC Voltage	V_{DC}	–	24	28	V
DC Current	I_{DC}	–	300	340	mA

NOTE
1. MOUNTING HOLES WITHIN 0.25 mm (0.010) DIA OF TRUE POSITION AT MAXIMUM MATERIAL CONDITION

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	-	45.08	-	1.775
B	26.42	26.92	1.040	1.060
C	20.57	21.34	0.810	0.840
D	0.46	0.56	0.018	0.022
E	11.81	12.95	0.465	0.510
F	7.87	8.13	0.310	0.320
G	2.41	2.67	0.095	0.105
H	9.65	9.78	0.380	0.385
J	3.96 BSC		0.156 BSC	
K	9.65	10.41	0.380	0.410
L	25.40 BSC		1.000 BSC	
N	4.06	4.32	0.160	0.170
P	2.16	2.92	0.085	0.115
Q	3.81	4.06	0.150	0.160
R	-	13.11	-	0.515
S	38.10 BSC		1.500 BSC	
T	11.05	11.43	0.435	0.450
U	4.95	5.21	0.195	0.205

CASE 714-01

FIGURE 7 — INTERMODULATION DISTORTION versus OUTPUT POWER

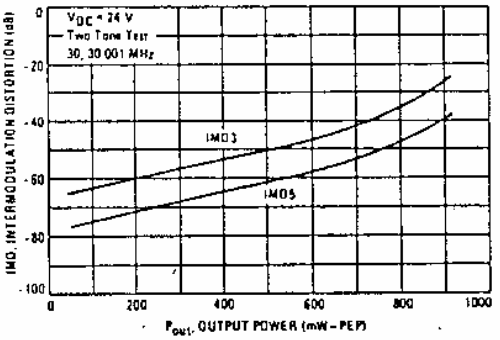


FIGURE 8 — INTERMODULATION DISTORTION versus OUTPUT POWER

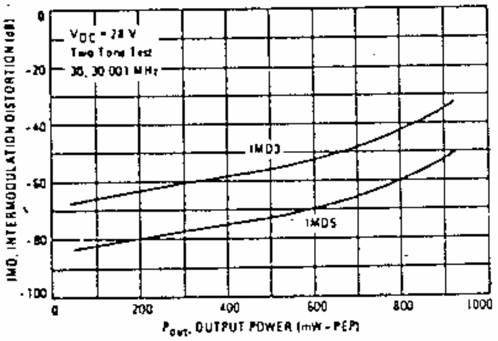


FIGURE 9 — DC CURRENT DRAIN versus SUPPLY VOLTAGE

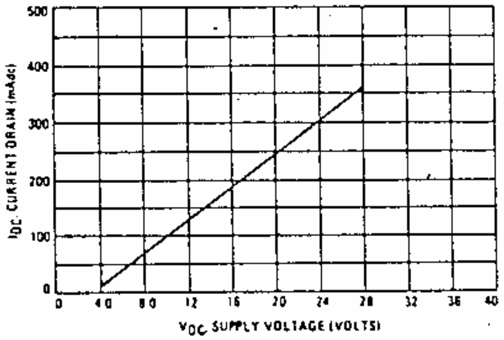


FIGURE 1 – POWER GAIN versus FREQUENCY

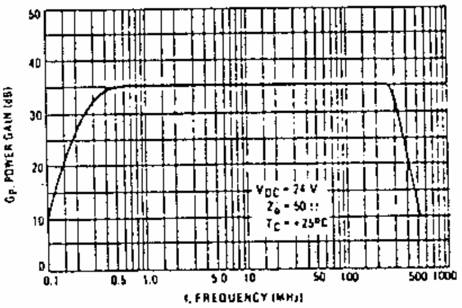


FIGURE 2 – POWER GAIN versus FREQUENCY

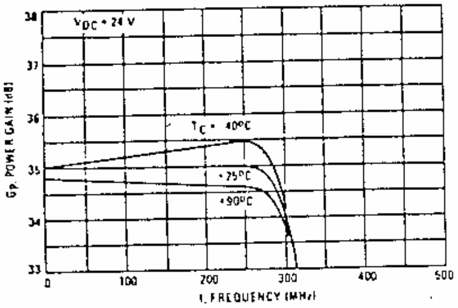


FIGURE 3 – POWER GAIN versus SUPPLY VOLTAGE

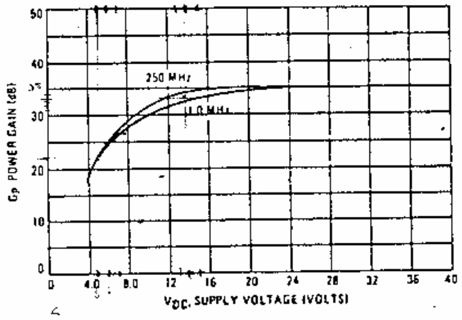
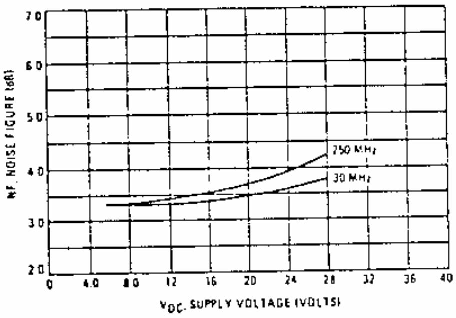


FIGURE 4 – NOISE FIGURE versus SUPPLY VOLTAGE



3 3

2 5

FIGURE 5 – OUTPUT POWER versus INPUT POWER

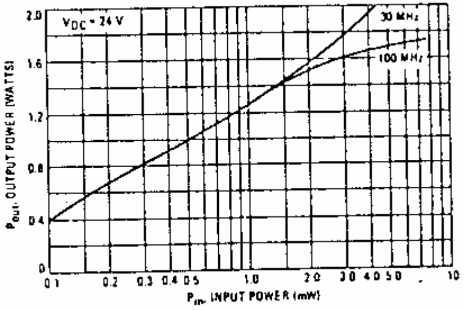
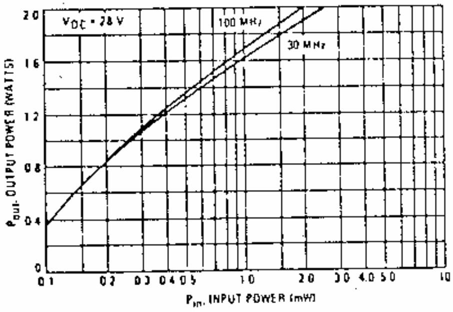
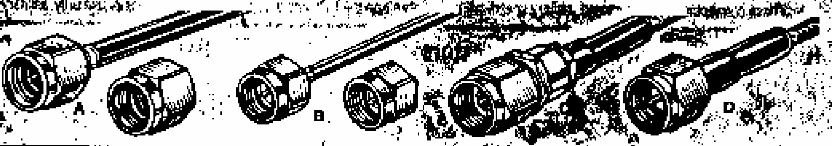


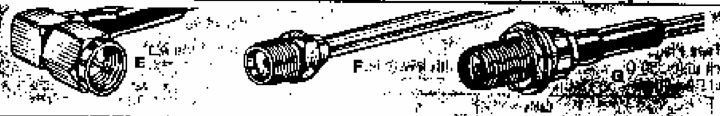
FIGURE 6 – OUTPUT POWER versus INPUT POWER



iniature Coaxial Connectors



Mfr.'s Type	Fig.	Cable RG-/U	Cable Attachment		Construction Notes	EACH	
			Outer	Inner		1-4	10-24
901-9723	B	.086" (2.2mm) semi-rigid RG-405 (M17/133)	Solder	Press ■	Center conductor of cable is press fit into pre-installed center contact. Not gasketed	8.00	8.40
901-9201-1A	A	.141" (3.6mm) semi-rigid RG-402 (M17/130)	Solder	None	Center conductor and insulation of cable used as center contact and insulator of connector	8.42	6.74
901-9201-1ASF	A	.141" (3.6mm) semi-rigid RG-402 (M17/130)	Solder	None	Center conductor and insulation of cable used as center contact and insulator of connector	6.72	6.15
901-9601-3	C	RG-174, 178, 187, 188, 316	Braid crimp	Solder	Captivated contact	19.38	16.54
901-9601-3SF	C	RG-174, 179, 187, 188, 316	Braid crimp	Solder	Captivated contact	16.20	14.59
901-9511-3	D	RG-174, 179, 187, 188, 316	Braid crimp	Solder	Non-captive contact	10.97	9.87
901-9511-3SF	D	RG-174, 179, 187, 188, 316	Braid crimp	Solder	Non-captive contact	11.80	10.44

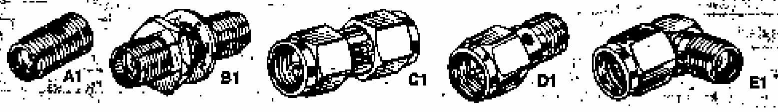


ngle Plugs, Straight Jacks, Bulkhead Jacks

Mfr.'s Type	Fig.	Cable RG-/U	Conn. Type	Cable Attachment		Plating	Construction Notes	EACH	
				Outer	Inner			1-9	10-24
901-9202-1A	F	.141" (3.6mm) semi-rigid RG-402 (M17/130)	Jack	Solder to body	Solder	Gold		10.74	9.66
901-9531-1	E	RG-55, 142, 223, 400	Angle Plug	Braid crimp	Solder	Gold plate nut, passivated nut	Captivated contact	14.87	13.38
901-9531-1SF	E	RG-55, 142, 223, 400	Angle Plug	Braid crimp	Solder	Gold plate nut, passivated nut	Captivated contact	14.34	12.90
901-9531-3	E	RG-174, 179, 187, 188, 316	Angle Plug	Braid crimp	Solder	Gold plate nut, passivated nut	Captivated contact	15.07	13.56
901-9531-3SF	E	RG-174, 179, 187, 188, 316	Angle Plug	Braid crimp	Solder	Gold plate nut, passivated nut	Captivated contact	14.82	13.34
901-8810-3	G	—	Bulkhead jack	Braid crimp	Solder	Gold	Captivated contact	17.82	16.04
901-8810-3SF	G	—	Bulkhead jack	Braid crimp	Solder	Gold	Captivated contact	17.82	16.04

lkhead and Printed Circuit Receptacles, Female Contacts

Mfr.'s Type	Fig.	Description	Terminal Type	Plating	Construction Notes	EACH	
						1-9	10-24
801-9211	H	Bulkhead jack receptacle rear mount	Solder cup	Gold plated	Captive contact/.062" (1.6mm) exposed TFE	16.58	14.92
901-9211-SF	H	Bulkhead jack receptacle rear mount	Solder cup	Passivated	Captive contact/.062" (1.6mm) exposed TFE	13.70	12.33
801-8220	I	Bulkhead jack receptacle front or rear mount	Blunt post	Gold plated	Captive contact/.062" (1.6mm) exposed TFE	12.85	11.57
801-8220-SF	I	Bulkhead jack receptacle front or rear mount	Blunt post	Passivated	Captive contact/.062" (1.6mm) exposed TFE	10.72	9.65
901-144	J	Printed circuit board straight jack receptacle	Blunt post	Gold plated	Captive contact/BeCu body and legs	13.32	11.99
901-143	K	Printed circuit board angle jack receptacle	Blunt post	Gold plated	Captive contact/BeCu body and legs	17.72	15.95



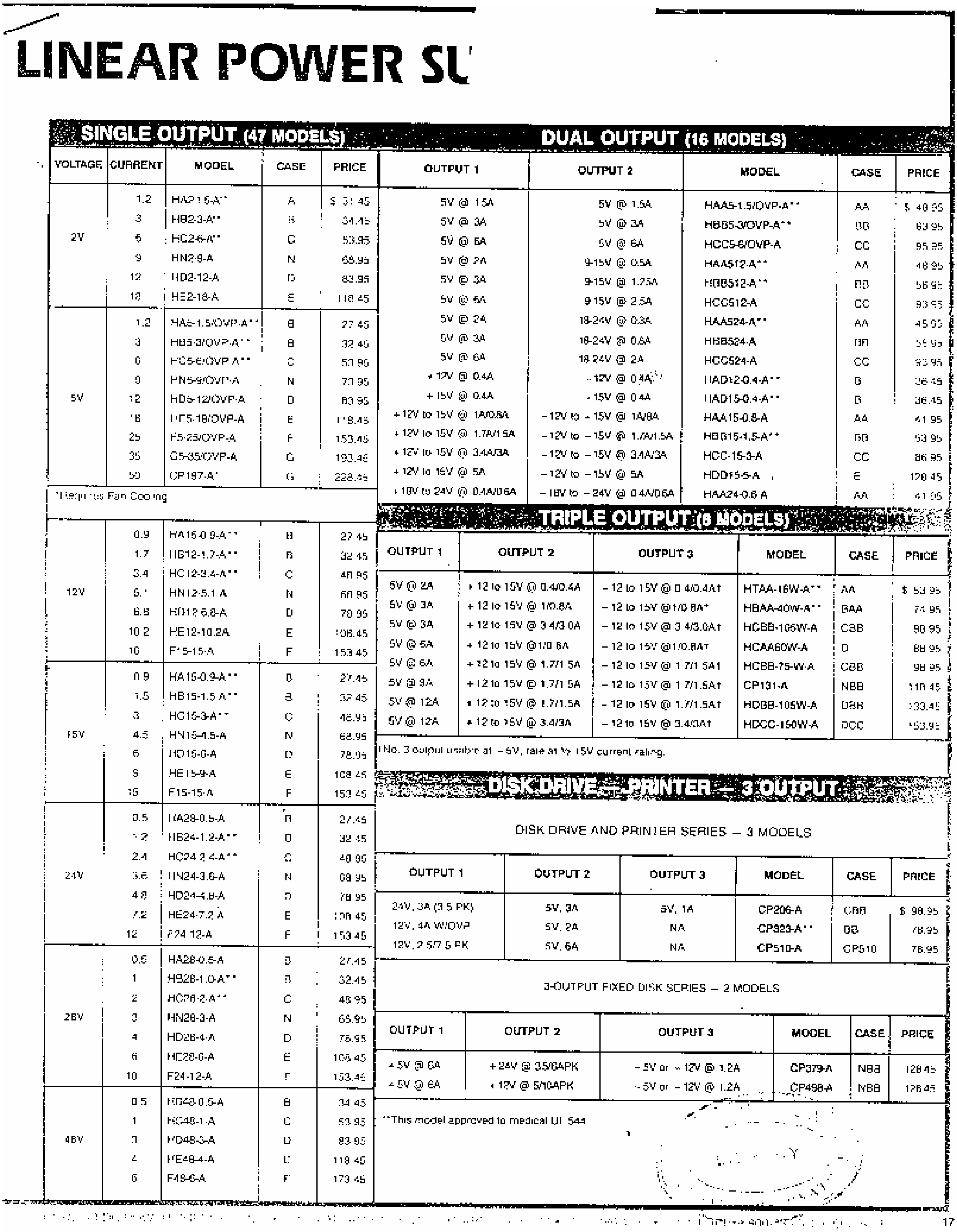
series Adapters

Mfr.'s Type	Fig.	Description		Notes	Plating	EACH	
						1-9	10-24
901-9217	A1	Straight	Jack-jack	DC-18GHz max. VSWR 1.14 captive contact	Gold plated	22.42	20.18
901-9217-SF	A1	Straight	Jack-jack	DC-18GHz max. VSWR 1.14 captive contact	Passivated	18.24	16.42
901-9209-A	B1	Bulkhead	Jack-jack front or rear mount	DC-18GHz max. VSWR 1.14 captive contact	Gold plated	18.27	16.44
901-9209-ASF	B1	Bulkhead	Jack-jack front or rear mount	DC-18GHz max. VSWR 1.14 captive contact	Passivated	19.18	17.26
901-9218	C1	Straight	Plug-plug	DC-18GHz max. VSWR 1.14 captive contact	Gold plated	20.70	18.63
901-9218-SF	C1	Straight	Plug-plug	DC-18GHz max. VSWR 1.14 captive contact	Passivated	16.54	14.88
901-9216	D1	Straight	Plug-jack	DC-18GHz max. VSWR 1.14 captive contact	Gold plated	24.88	22.37
901-9216-SF	D1	Straight	Plug-jack	DC-18GHz max. VSWR 1.14 captive contact	Passivated	20.48	18.43
901-9219ASF	E1	Angle	Plug-jack	DC-18GHz max. VSWR 1.25 captive contact	Passivated	22.78	20.50

ugs, Angle Plugs, Bulkhead and Printed Circuit Receptacles

ol SMB connectors meet or exceed the requirements of MIL-C-39012 series SMB. These subminiature units feature snap-on mating and broadband performance with low n DC-4 GHz (usable to 10GHZ). The connectors shown in this catalog are 50Ω impedance, with voltage rating of 375V peak.

Mfr.'s Type	Fig.	Cable RG-/U	Connector Description	Cable Attachment		Construction Notes	EACH	
				Outer	Inner		1-4	10-24
903-285P-51S	G2	RG-174, 179, 187, 188, 316	Plug	Crimp	Solder	Gold plated body	8.08	7.27
903-370P-51S	G2	RG-174, 178, 187, 188, 316	Plug	Crimp	Solder	Nickel plated body	7.20	6.48
903-289P-51A	H2	RG-174, 179, 187, 188, 316	Plug, angle plug	Crimp	Solder	Gold plated body	6.88	6.20
903-367P-51A	H2	RG-174, 179, 187, 188, 316	Plug, angle plug	Crimp	Solder	Nickel plated body	7.08	6.38
903-287P-51S	G2	RG-178, 196	Plug	Crimp	Solder	Gold plated body	9.14	8.23
903-371P-51S	G2	RG-178, 196	Plug	Crimp	Solder	Nickel plated body	7.20	6.48
903-291P-51A	H2	—	Angle plug	Crimp	Solder	Gold plated body	10.76	9.83
903-368P-51A	H2	—	Angle plug	Crimp	Solder	Nickel plated body	7.85	7.07
903-306J-51A	I2	—	Bulkhead jack receptacle rear mount	—	—	Gold plated/captive contact	7.84	6.79
903-415J-51P	J2	—	PC jack receptacle post terminal/four legs	—	—	Gold plated body	6.92	6.33
903-456J-51S	J2	—	PC jack receptacle post terminal/four legs	—	—	Nickel plated body	6.82	4.52
903-373J-51A	K2	—	PC jack receptacle post terminal/four legs	—	—	Tin lead pit body/legs/leak tight	8.30	7.47



LINEAR POWER SU

SINGLE OUTPUT (47 MODELS)

VOLTAGE	CURRENT	MODEL	CASE	PRICE
2V	1.2	HA2-1.5-A**	A	$ 31.45
	3	HB2-3-A**	B	34.45
	6	HC2-6-A**	C	53.95
	9	HN2-9-A	N	68.95
	12	HD2-12-A	D	83.95
	18	HE2-18-A	E	118.45
5V	1.2	HA5-1.5/OVP-A**	B	27.45
	3	HB5-3/OVP-A**	B	32.45
	6	HC5-6/OVP-A**	C	53.95
	9	HN5-9/OVP-A	N	73.95
	12	HD5-12/OVP-A	D	83.95
	18	HE5-18/OVP-A	E	118.45
	25	F5-25/OVP-A	F	153.45
	35	G5-35/OVP-A	G	193.45
	50	CP197-A*	G	228.45

*Requires Fan Cooling

VOLTAGE	CURRENT	MODEL	CASE	PRICE
12V	0.9	HA15-0.9-A**	B	27.45
	1.7	HB12-1.7-A**	B	32.45
	3.4	HC12-3.4-A**	C	48.95
	5.1	HN12-5.1-A	N	68.95
	6.8	HD12-6.8-A	D	78.95
	10.2	HE12-10.2A	E	108.45
	10	F15-15-A	F	153.45
15V	0.9	HA15-0.9-A**	B	27.45
	1.5	HB15-1.5-A**	B	32.45
	3	HC15-3-A**	C	48.95
	4.5	HN15-4.5-A	N	68.95
	6	HD15-6-A	D	78.95
	9	HE15-9-A	E	108.45
	15	F15-15-A	F	153.45
24V	0.5	HA28-0.5-A	B	27.45
	1.2	HB24-1.2-A**	B	32.45
	2.4	HC24-2.4-A**	C	48.95
	3.6	HN24-3.6-A	N	68.95
	4.8	HD24-4.8-A	D	78.95
	7.2	HE24-7.2-A	E	108.45
	12	F24-12-A	F	153.45
28V	0.5	HA28-0.5-A	B	27.45
	1	HB28-1.0-A**	B	32.45
	2	HC28-2-A**	C	48.95
	3	HN28-3-A	N	65.95
	4	HD28-4-A	D	76.95
	6	HE28-6-A	E	105.45
	10	F24-12-A	F	153.45
48V	0.5	HB48-0.5-A	B	34.45
	1	HC48-1-A	C	53.95
	3	HD48-3-A	D	83.95
	4	HE48-4-A	E	118.45
	6	F48-6-A	F	173.45

DUAL OUTPUT (16 MODELS)

OUTPUT 1	OUTPUT 2	MODEL	CASE	PRICE
5V @ 1.5A	5V @ 1.5A	HAA5-1.5/OVP-A**	AA	$ 48.95
5V @ 3A	5V @ 3A	HBB5-3/OVP-A**	BB	63.95
5V @ 6A	5V @ 6A	HCC5-6/OVP-A	CC	95.95
5V @ 2A	9-15V @ 0.5A	HAA512-A**	AA	48.95
5V @ 3A	9-15V @ 1.25A	HBB512-A**	BB	56.95
5V @ 6A	9-15V @ 2.5A	HCC512-A	CC	93.95
5V @ 2A	18-24V @ 0.3A	HAA524-A**	AA	45.95
5V @ 3A	18-24V @ 0.6A	HBB524-A	BB	55.95
5V @ 6A	18-24V @ 2A	HCC524-A	CC	93.95
+12V @ 0.4A	−12V @ 0.4A	HAD12-0.4-A**	B	36.45
+15V @ 0.4A	−15V @ 0.4A	HAD15-0.4-A**	B	36.45
+12V to 15V @ 1A/0.8A	−12V to −15V @ 1A/8A	HAA15-0.8-A	AA	41.95
+12V to 15V @ 1.7A/1.5A	−12V to −15V @ 1.7A/1.5A	HBB15-1.5-A**	BB	53.95
+12V to 15V @ 3.4A/3A	−12V to −15V @ 3.4A/3A	HCC-15-3-A	CC	86.95
+12V to 15V @ 5A	−12V to −15V @ 5A	HDD15-5-A	E	120.45
+18V to 24V @ 0.4A/0.6A	−18V to −24V @ 0.4A/0.6A	HAA24-0.6-A	AA	41.95

TRIPLE OUTPUT (8 MODELS)

OUTPUT 1	OUTPUT 2	OUTPUT 3	MODEL	CASE	PRICE
5V @ 2A	+12 to 15V @ 0.4/0.4A	−12 to 15V @ 0.4/0.4A†	HTAA-16W-A**	AA	$ 53.95
5V @ 3A	+12 to 15V @ 1/0.8A	−12 to 15V @1/0.8A†	HBAA-40W-A**	BAA	74.95
5V @ 3A	+12 to 15V @ 3.4/3.0A	−12 to 15V @ 3.4/3.0A†	HCBB-105W-A	CBB	90.95
5V @ 6A	+12 to 15V @1/0.8A	−12 to 15V @1/0.8A†	HCAA60W-A	D	88.95
5V @ 6A	+12 to 15V @ 1.7/1.5A	−12 to 15V @ 1.7/1.5A†	HCBB-75-W-A	CBB	98.95
5V @ 9A	+12 to 15V @ 1.7/1.5A	−12 to 15V @ 1.7/1.5A†	CP131-A	NBB	110.45
5V @ 12A	+12 to 15V @ 1.7/1.5A	−12 to 15V @ 1.7/1.5A†	HDBB-105W-A	DBB	133.45
5V @ 12A	+12 to 15V @ 3.4/3A	−12 to 15V @ 3.4/3A†	HDCC-150W-A	DCC	153.95

† No. 3 output usable at −5V, rate at ½ 15V current rating.

DISK DRIVE — PRINTER — 3 OUTPUT

DISK DRIVE AND PRINTER SERIES — 3 MODELS

OUTPUT 1	OUTPUT 2	OUTPUT 3	MODEL	CASE	PRICE
24V, 3A (3.5 PK)	5V, 3A	5V, 1A	CP206-A	CBB	$ 98.95
12V, 4A W/OVP	5V, 2A	NA	CP323-A**	BB	78.95
12V, 2.5/7.5 PK	5V, 6A	NA	CP510-A	CP510	78.95

3-OUTPUT FIXED DISK SERIES — 2 MODELS

OUTPUT 1	OUTPUT 2	OUTPUT 3	MODEL	CASE	PRICE
+5V @ 6A	+24V @ 3.5/6APK	−5V or −12V @ 1.2A	CP379-A	NBB	128.45
+5V @ 6A	+12V @ 5/10APK	−5V or −12V @ 1.2A	CP498-A	NBB	128.45

**This model approved to medical UL 544

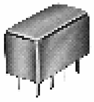
17

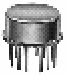
DIRECTIONAL COUPLERS

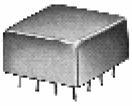
50 & 75Ω

6 to 30 dB COUPLING 5 kHz to 2000 MHz


TDC


PDC


TODC


P4DC
PDC-20A-6

MODEL NO.	FREQ. RANGE MHz f_L-f_U	COUPLING dB Nom.	Flatness	MAINLINE LOSS dB L Typ.	Max.	M— Typ.	Max.	U Typ.	Max.	DIRECTIVITY dB L Typ.	Min.	M— Typ.	Min.	U Typ.	Min.	VSWR (:1) Typ.	POWER INPUT, W L Max.	M/U Max.	CAPD DATA	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (1-9)
TDC-6-1	10-400	6.3±0.4	±0.4	2.0	2.4	2.0	2.4	2.0	2.6	36	30	30	25	20	15	1.6	1	2		B02	cw	23.95
TDC-10-1	1-400	10.0±0.5	±0.5	1.2	1.6	1.0	1.3	1.2	1.6	35	25	30	20	20	15	1.5	1	2		B02	cw	17.95
TDC-10-2	5-1000	11±0.5	±0.6	1.4	1.8	1.6	1.8	1.6	2.0	50	35	25	20	20	15	1.5	0.5	0.5		B02	cw	25.95
PDC-10-1	0.5-500	11.5±0.5	±0.6	0.85	1.3	0.65	1.0	0.85	1.3	32	25	32	25	22	15	1.2	1.5	3		A01	cu	13.45
■ PDC-10-18D	1-400	11.5±0.5	±0.5	0.6	0.9	0.8	1.1	0.9	1.3	65	35	35	20	22	15	1.2	2.0	4		A01	cv	11.45
■ PDC-10-2	250-1000	10.5±0.5	±0.6	1.4	1.6	—	—	1.6	2.0	30	23	—	—	25	15	1.5	—	5		A01	cu	34.45
PDC-10-5	1-2000	10.5±0.5	±1.0	1.2	1.9	1.3	1.9	2.0	2.5	35	25	30	18	22	18	1.3	0.5	0.5		A01	cu	40.95
PDC-10-6	0.005-20	11±0.5	±0.5	0.4	1.2	0.4	0.8	0.4	1.0	40	30	40	30	35	25	1.3	1.5	3	FOR DATA SEE YOU! ON OUR WEBSITE	A01	cu	23.95
PDC-10-21**	1-1000	11±0.5	±0.5	1.2	1.7	1.2	1.7	1.6	2	40	30	25	20	25	20	1.3	1	2		A01	cu	32.95
PDC-10-22	5-750	11±0.5	±0.5	1.1	1.6	1.2	1.7	1.6	1.9	35	30	25	20	25	20	1.25	1	2		A01	cu	23.95
PDC-10-54	10-1500	10.5±0.5	±0.7	1.2	1.8	1.3	1.9	1.6	2.3	35	25	28	23	28	23	1.3	0.5	0.5		A01	cu	35.95
PDC-15-6	0.01-35	15±0.5	±0.5	0.3	0.6	0.2	0.4	0.3	0.6	38	30	35	28	28	20	1.15	2	4		A01	cu	23.95
PDC-15-21	1-500	14.7±0.5	±0.6	0.7	1.1	0.7	1.1	0.8	1.2	35	30	35	30	30	23	1.4	1	2		A01	cu	23.95
PDC-20-1*	25-400	21±0.75	±0.5	0.2	0.25	0.3	0.35	0.35	0.5	25	20	35	25	25	20	1.25	3	5		A01	cu	23.95
■ PDC-20-18D	0.5-200	19.2±0.5	±0.5	0.3	0.7	0.3	0.5	0.4	0.6	40	30	35	20	22	15	1.1	3	5		A01	cv	16.95
PDC-20-1W	10-700	19.2±0.5	±0.5	0.25	0.5	0.4	0.7	0.7	1.1	34	30	27	23	23	20	1.4	1	2		A01	cu	23.95
■ PDC-20-3	0.2-250	19.5±0.5	±0.5	0.35	0.6	0.25	0.5	0.35	0.6	35	30	33	25	25	20	1.2	1.5	4		A01	cu	15.95
■ PDC-20-38D	0.2-250	19.5±0.5	±0.5	0.3	1.0	0.25	0.9	0.35	0.7	47	25	40	25	30	20	1.1	1.5	4		A01	cv	17.95
PDC-20A-6	0.1-2000	20.0±0.5	±1.0	0.6	1.5	0.6	1.5	1.9	2.9	34	20	25	15	20	10	1.5	0.5	2		C145	cv	44.95
■ PDC-10-1-75	1-250	10.5±0.5	±0.75	1.1	1.5	1.1	1.5	1.1	1.5	30	20	30	20	30	20	2.0	2	4		A01	cu	14.95
■ PDC-10-6-75	0.2-100	10.0±0.5	±0.2	1.2	1.6	0.9	1.2	0.9	1.3	50	30	40	25	37	25	1.5	1	2		A01	cu	23.95
■ PDC-15-6-75	0.02-35	14.5±0.5	±0.5	0.3	0.7	0.3	0.7	0.3	0.7	35	20	35	20	35	20	1.3	1.5	4		A01	cu	25.95
■ PDC-20-3-75	1-150	19.5±0.5	±0.75	0.35	0.8	0.35	0.8	0.35	0.8	25	20	25	20	25	20	2.0	2	4		A01	cu	14.95
■ PDC-20-6-75	0.05-40	20.4±0.4	±0.25	0.1	0.25	0.1	0.2	0.1	0.3	45	35	35	20	25	18	1.2	1.5	3		A01	cu	23.95
TODC-10-1	10-400	11.3±0.5	±0.5	1.2	1.5	1.0	1.3	1.2	1.5	35	25	30	20	25	20	1.5	0.5	1		QQ96	ct	17.95
■ P4DC-30A-2	5-1000	30.5±0.5	±1	0.7	1.2	0.7	1.2	0.8	1.6	30	15	32	20	20	10	1.15	1	2		C07	db	34.95

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

NOTES:
- * L = 25-50 MHz, M = 50-300 MHz, U = 300-400 MHz
- ** Upper range coupling ±0.75 dB
- – L = 30-100 MHz, M = 100-200 MHz, Operating Temperature +50°C
- — L = 40-100 MHz, M = 100-200 MHz
- ✦ Bi-directional
- ✥ $L = f_L$-$2f_L$
- ✱ 4-coupled ports, isolation between coupled ports, 25 dB minimum.
- ❋ Insertion loss specification in L range may degrade up to 1dB at cold temperature, -55°C
- ✪ When only specification for M range given, specification applies to entire frequency range.
- △ Available only with SMA connectors

- ■ Denotes 75 Ohm models
- A. General Quality Control Procedures, Environmental Specifications, Hi-Rel and MIL description are given in General Information (Section 0).
- B. Connector types and case mounted options, case finishes are given in section 0, see "Case styles & Outline Drawings".
- C. Prices and specifications subject to change without notice.
- 1. Mainline Loss includes theoretical power loss at coupled port.
- 2. For PDC-HP models, external heat sinking is recommended to reduce case temperature.

991230

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P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661
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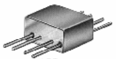
PHASE DETECTORS

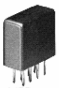
Surface Mount ❏ Plug-In & Coaxial

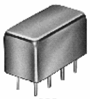
HIGH OUTPUT 1000 mV DC output, 1 to 400 MHz

SURFACE MOUNT


SYPD


LPD


MPD

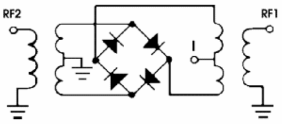

RPD


ZRPD

MODEL NO.	FREQUENCY MHz RF1 RF2	I	POWER IN RF1 RF2 (dBm)	SCALE FACTOR mV/degree	IMPEDANCE (ohms) OUTPUT LOAD I	ISOLATION (dB) RF1-RF2 Min.	OUTPUT POLARITY RF1/RF2 in-phase	DC OUTPUT (mV) Note 2 MAX. Typ.	Min.	OFFSET Typ.	Max.	FIGURE-OF-MERIT M Typ.	CAPD DATA	CASE STYLE Note B	connection	PRICE $ Qty. (1-9)
SYPD-1	1-100	DC-50	7	8	500	40	neg.	1000	700	0.2	1	143		TTT167	ec	14.95
SYPD-2	10-200	DC-50	7	8	500	40	neg.	1000	700	0.3	1	143		TTT167	ec	18.95
LPD-1	1-100	DC-50	7	8	500	40	neg.	1000	700	0.2	1	143	(see YONI on our website)	BB48	eb	26.45
MPD-1	1-100	DC-50	7	8	500	40	neg.	1000	700	0.2	1	143		A11	ea	21.45
MPD-2	10-200	DC-50	7	8	500	40	neg.	1000	700	0.3	1	143		A11	ea	24.95
MPD-21	50-400	DC-50	7	7	500	40*	neg.	800	500	0.5	1	120		A11	ea	26.95
RPD-1	1-100	DC-50	7	8	500	40	neg.	1000	700	0.2	1	143		A01	ea	18.45
RPD-2	5-150	DC-50	7	8	500	40	neg.	1000	700	0.3	1	143		A01	ea	20.95
ZRPD-1	1-100	DC-50	7	8	500	40	neg.	1000	700	0.2	1	143		M22	gg	57.95

NOTES:

❏ Non-hermetic
* 30 dB from 200 to 400 MHz
A. General Quality Control Procedures, Environmental Specifications, Hi-Rel and MIL description are given in General Information (Section 0).
B. Connector types and case mounted options, case finishes are given in section 0, see "Case Styles & Outline Drawings".
C. Prices and Specifications subject to change without notice.
1. Absolute maximum power, voltage and current rating:
   1a. RF input power, 50mW
   1b. Peak IF current, 20mA
2. For LPD-1, MPD-1, RPD-1 & ZRPD-1 DC output decreases to 550 mV over 1-10 MHz as temperature decreases to -55°C



pin connections

see case style outline drawings for pin locations

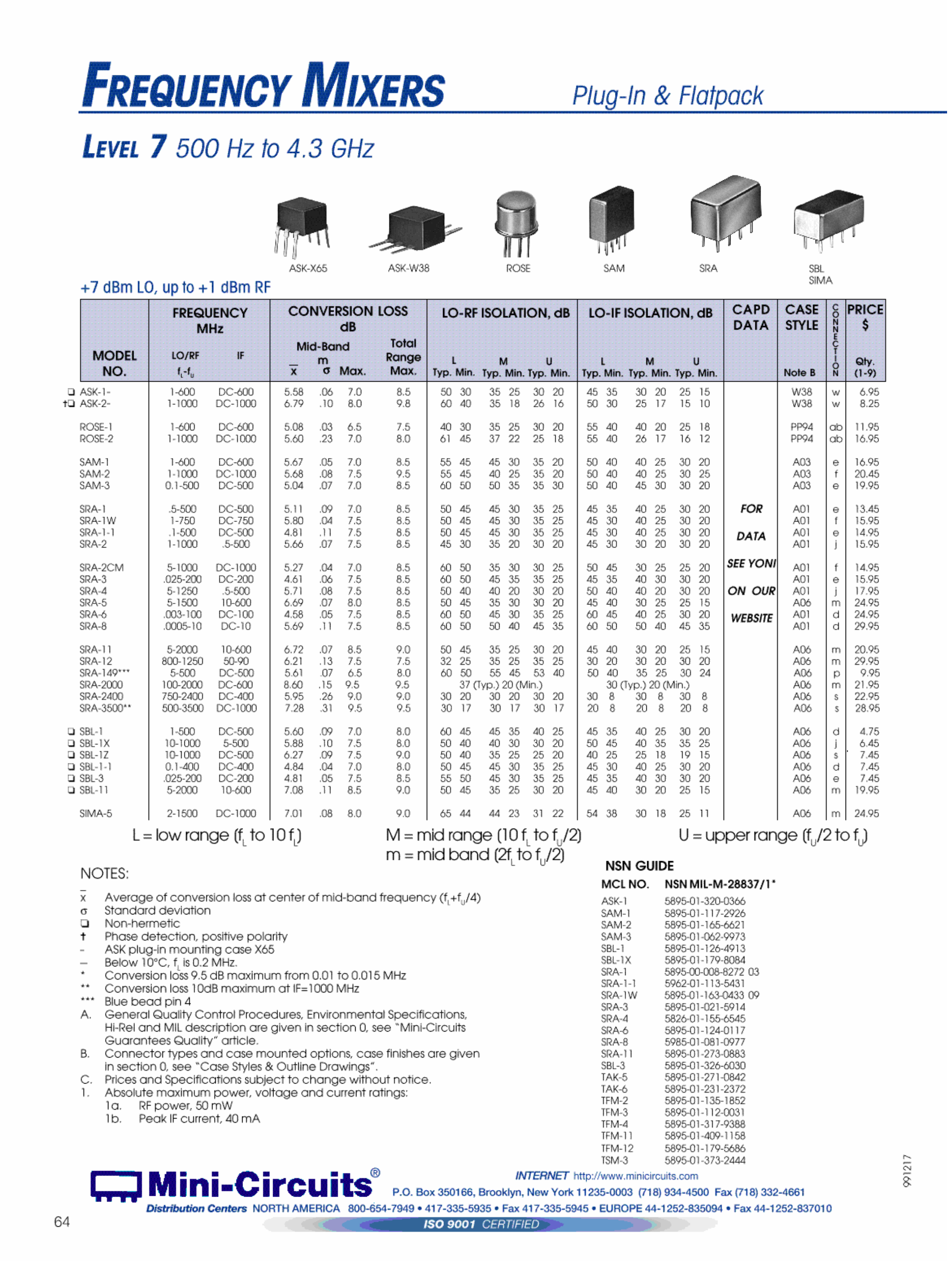
PORT	ea	eb	ec	gg
RF REF (RF2)	8	8	2	1
RF IN (RF1)	1	5	1	3
DC OUT (I)	3,4	4	3	2
GND EXT.	2,5,6,7	1,2,3,6,7	4,5,6	—
CASE GND	2	1,2,3,6,7	—	—

NSN GUIDE

MCL NO.	NSN
MPD-1	6625-01-294-7152
MPD-21	5895-01-389-3572
RPD-1	5895-01-250-8525

991230

X



FREQUENCY MIXERS

Plug-In & Flatpack

LEVEL 7 *500 Hz to 4.3 GHz*

+7 dBm LO, up to +1 dBm RF

MODEL NO.	FREQUENCY MHz		CONVERSION LOSS dB				LO-RF ISOLATION, dB						LO-IF ISOLATION, dB						CAPD DATA	CASE STYLE	CONNECTION	PRICE $
	LO/RF f_L-f_U	IF	Mid-Band m $\bar{x}$	σ	Max.	Total Range Max.	L Typ.	Min.	M Typ.	Min.	U Typ.	Min.	L Typ.	Min.	M Typ.	Min.	U Typ.	Min.		Note B		Qty. (1-9)
❏ ASK-1-	1-600	DC-600	5.58	.06	7.0	8.5	50	30	35	25	30	20	45	35	30	20	25	15		W38	w	6.95
†❏ ASK-2-	1-1000	DC-1000	6.79	.10	8.0	9.8	60	40	35	18	26	16	50	30	25	17	15	10		W38	w	8.25
ROSE-1	1-600	DC-600	5.08	.03	6.5	7.5	40	30	35	25	30	20	55	40	40	20	25	18		PP94	ab	11.95
ROSE-2	1-1000	DC-1000	5.60	.23	7.0	8.0	61	45	37	22	25	18	55	40	26	17	16	12		PP94	ab	16.95
SAM-1	1-600	DC-600	5.67	.05	7.0	8.5	55	45	45	30	35	20	50	40	40	25	30	20		A03	e	16.95
SAM-2	1-1000	DC-1000	5.68	.08	7.5	9.5	55	45	40	25	35	20	50	40	40	25	30	25		A03	f	20.45
SAM-3	0.1-500	DC-500	5.04	.07	7.0	8.5	60	50	50	35	35	30	50	40	45	30	30	20		A03	e	19.95
SRA-1	.5-500	DC-500	5.11	.09	7.0	8.5	50	45	45	30	35	25	45	35	40	25	30	20	*FOR DATA SEE YONI ON OUR WEBSITE*	A01	e	13.45
SRA-1W	1-750	DC-750	5.80	.04	7.5	8.5	50	45	45	30	35	25	45	30	40	25	30	20		A01	f	15.95
SRA-1-1	.1-500	DC-500	4.81	.11	7.5	8.5	50	45	45	30	35	25	45	30	40	25	30	20		A01	e	14.95
SRA-2	1-1000	.5-500	5.66	.07	7.5	8.5	45	30	35	20	30	20	45	30	30	20	30	20		A01	j	15.95
SRA-2CM	5-1000	DC-1000	5.27	.04	7.0	8.5	60	50	35	30	30	25	50	45	30	25	25	20		A01	f	14.95
SRA-3	.025-200	DC-200	4.61	.06	7.5	8.5	60	50	45	35	35	25	45	35	40	30	30	20		A01	e	15.95
SRA-4	5-1250	.5-500	5.71	.08	7.5	8.5	50	40	40	20	30	20	50	40	40	20	30	20		A01	j	17.95
SRA-5	5-1500	10-600	6.69	.07	8.0	8.5	50	45	35	30	30	20	45	40	30	25	25	15		A06	m	24.95
SRA-6	.003-100	DC-100	4.58	.05	7.5	8.5	60	50	45	30	35	25	60	45	40	25	30	20		A01	d	24.95
SRA-8	.0005-10	DC-10	5.69	.11	7.5	8.5	60	50	50	40	45	35	60	50	50	40	45	35		A01	d	29.95
SRA-11	5-2000	10-600	6.72	.07	8.5	9.0	50	45	35	25	30	20	45	40	30	20	25	15		A06	m	20.95
SRA-12	800-1250	50-90	6.21	.13	7.5	7.5	32	25	35	25	35	25	30	20	30	20	30	20		A06	m	29.95
SRA-149***	5-500	DC-500	5.61	.07	6.5	8.0	60	50	55	45	53	40	50	40	35	25	30	24		A06	p	9.95
SRA-2000	100-2000	DC-600	8.60	.15	9.5	9.5	37 (Typ.) 20 (Min.)						30 (Typ.) 20 (Min.)							A06	m	21.95
SRA-2400	750-2400	DC-400	5.95	.26	9.0	9.0	30	20	30	20	30	20	30	8	30	8	30	8		A06	s	22.95
SRA-3500**	500-3500	DC-1000	7.28	.31	9.5	9.5	30	17	30	17	30	17	20	8	20	8	20	8		A06	s	28.95
❏ SBL-1	1-500	DC-500	5.60	.09	7.0	8.0	60	45	45	35	40	25	45	35	40	25	30	20		A06	d	4.75
❏ SBL-1X	10-1000	5-500	5.88	.10	7.5	8.0	50	40	40	30	30	20	50	45	40	35	35	25		A06	j	6.45
❏ SBL-1Z	10-1000	DC-500	6.27	.09	7.5	9.0	50	40	35	25	25	20	40	25	25	18	19	15		A06	s	7.45
❏ SBL-1-1	0.1-400	DC-400	4.84	.04	7.0	8.0	50	45	45	30	35	25	45	30	40	25	30	20		A06	d	7.45
❏ SBL-3	.025-200	DC-200	4.81	.05	7.5	8.5	55	50	45	30	35	25	45	35	40	30	30	20		A06	e	7.45
❏ SBL-11	5-2000	10-600	7.08	.11	8.5	9.0	50	45	35	25	30	20	45	40	30	20	25	15		A06	m	19.95
SIMA-5	2-1500	DC-1000	7.01	.08	8.0	9.0	65	44	44	23	31	22	54	38	30	18	25	11		A06	m	24.95

L = low range (f_L to 10 f_L)

M = mid range (10 f_L to $f_U/2$)
m = mid band ($2f_L$ to $f_U/2$)

U = upper range ($f_U/2$ to f_U)

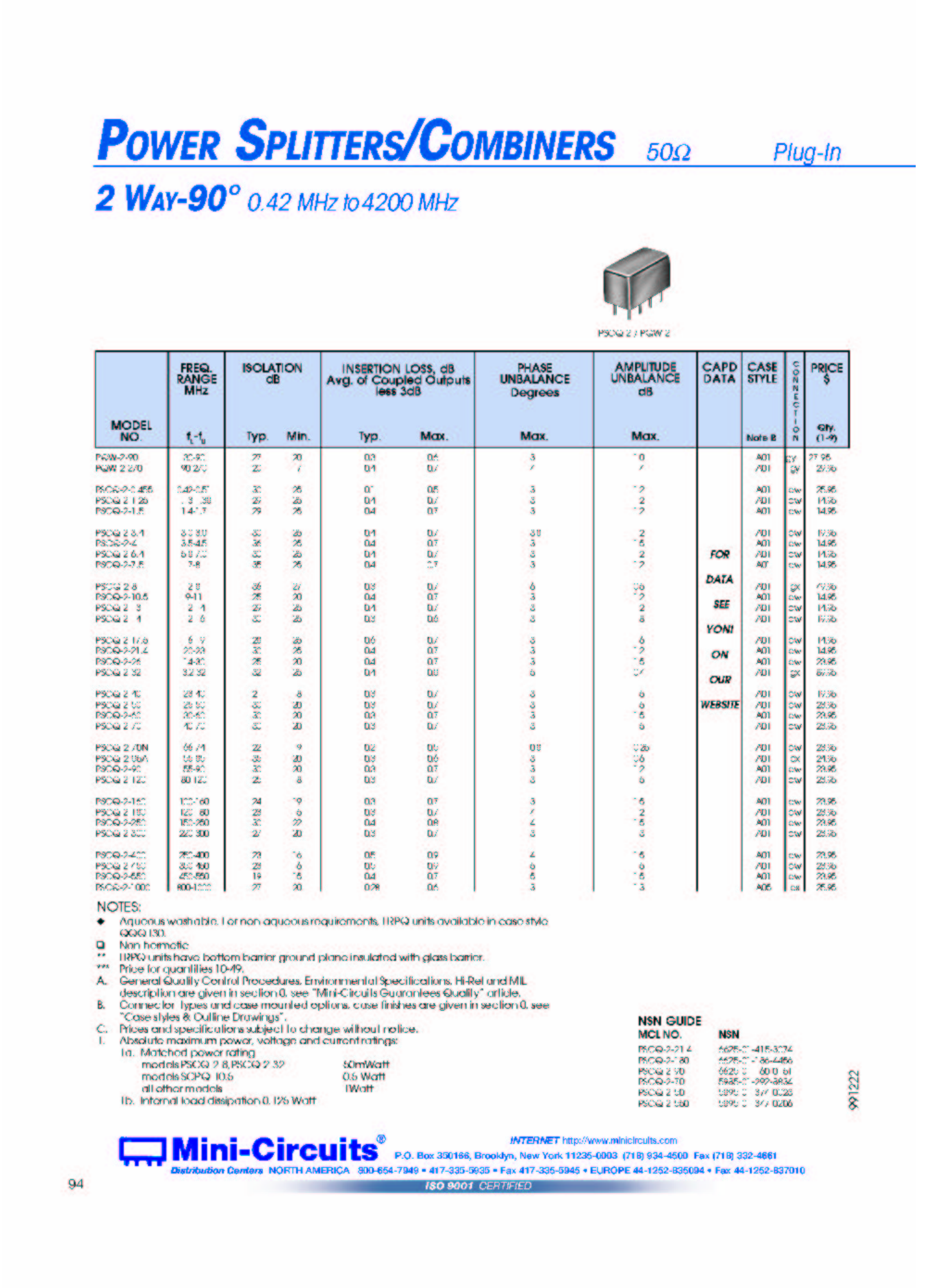
NOTES:

$\bar{x}$ Average of conversion loss at center of mid-band frequency ($f_L+f_U/4$)
σ Standard deviation
❏ Non-hermetic
† Phase detection, positive polarity
\- ASK plug-in mounting case X65
— Below 10°C, f_L is 0.2 MHz.
* Conversion loss 9.5 dB maximum from 0.01 to 0.015 MHz
** Conversion loss 10dB maximum at IF=1000 MHz
*** Blue bead pin 4
A. General Quality Control Procedures, Environmental Specifications, Hi-Rel and MIL description are given in section 0, see "Mini-Circuits Guarantees Quality" article.
B. Connector types and case mounted options, case finishes are given in section 0, see "Case Styles & Outline Drawings".
C. Prices and Specifications subject to change without notice.
1. Absolute maximum power, voltage and current ratings:
    1a. RF power, 50 mW
    1b. Peak IF current, 40 mA

NSN GUIDE

MCL NO.	NSN MIL-M-28837/1*
ASK-1	5895-01-320-0366
SAM-1	5895-01-117-2926
SAM-2	5895-01-165-6621
SAM-3	5895-01-062-9973
SBL-1	5895-01-126-4913
SBL-1X	5895-01-179-8084
SRA-1	5895-00-008-8272 03
SRA-1-1	5962-01-113-5431
SRA-1W	5895-01-163-0433 09
SRA-3	5895-01-021-5914
SRA-4	5826-01-155-6545
SRA-6	5895-01-124-0117
SRA-8	5985-01-081-0977
SRA-11	5895-01-273-0883
SBL-3	5895-01-326-6030
TAK-5	5895-01-271-0842
TAK-6	5895-01-231-2372
TFM-2	5895-01-135-1852
TFM-3	5895-01-112-0031
TFM-4	5895-01-317-9388
TFM-11	5895-01-409-1158
TFM-12	5895-01-179-5686
TSM-3	5895-01-373-2444

991217



POWER SPLITTERS/COMBINERS 50Ω Plug-In

2 WAY-90° 0.42 MHz to 4200 MHz

PSCQ 2 / PGW 2

MODEL NO.	FREQ. RANGE MHz f_L-f_U	ISOLATION dB Typ.	ISOLATION dB Min.	INSERTION LOSS, dB Avg. of Coupled Outputs less 3dB Typ.	INSERTION LOSS, dB Max.	PHASE UNBALANCE Degrees Max.	AMPLITUDE UNBALANCE dB Max.	CAPD DATA	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (1-9)
PGW-2-90	30-90	27	20	0.3	0.6	3	1.0		A01	GY	27.95
PGW-2-270	90-270	23	7	0.4	0.7	[illegible]	[illegible]		A01	GY	27.95
PSCQ-2-0.455	0.42-0.5	30	25	[illegible]	0.5	3	.2		A01	CW	25.95
PSCQ-2-1.25	[illegible]	27	25	0.4	0.7	3	2		A01	CW	14.95
PSCQ-2-1.5	1.4-1.7	29	25	0.4	0.7	3	.2		A01	CW	14.95
PSCQ-2-3.4	3.0-3.8	30	25	0.4	0.7	3.8	2		A01	CW	17.95
PSCQ-2-4	3.5-4.5	36	25	0.4	0.7	3	.5		A01	CW	14.95
PSCQ-2-6.4	5.8-7.0	30	25	0.4	0.7	3	2	FOR DATA SEE YONI ON OUR WEBSITE	A01	CW	14.95
PSCQ-2-7.5	7-8	35	25	0.4	0.7	3	.2		A01	CW	14.95
PSCQ-2-8	2-8	36	27	0.3	0.7	6	0.6		A01	GX	[illegible]
PSCQ-2-10.5	9-11	25	20	0.4	0.7	3	.2		A01	CW	14.95
PSCQ-2-13	[illegible]	27	25	0.4	0.7	3	2		A01	CW	14.95
PSCQ-2-14	[illegible]	30	25	0.3	0.6	3	8		A01	CW	17.95
PSCQ-2-17.5	[illegible]	28	25	0.6	0.7	3	6		A01	CW	14.95
PSCQ-2-21.4	20-23	30	25	0.4	0.7	3	.2		A01	CW	14.95
PSCQ-2-26	[illegible]4-30	25	20	0.4	0.7	3	.5		A01	CW	29.95
PSCQ-2-32	3.2-32	32	25	0.4	0.8	6	[illegible]		A01	GX	[illegible]
PSCQ-2-40	28-40	[illegible]	[illegible]	0.3	0.7	3	6		A01	CW	17.95
PSCQ-2-50	25-50	30	20	0.3	0.7	3	6		A01	CW	25.95
PSCQ-2-60	30-60	30	20	0.3	0.7	3	.5		A01	CW	29.95
PSCQ-2-70	40-70	30	20	0.3	0.7	3	6		A01	CW	25.95
PSCQ-2-70N	66-74	22	9	0.2	0.5	0.8	0.25		A01	CW	25.95
PSCQ-2-[illegible]	[illegible]	35	20	0.3	0.6	3	0.6		A01	CX	24.95
PSCQ-2-90	55-90	30	20	0.3	0.7	3	.2		A01	CW	29.95
PSCQ-2-120	80-120	25	[illegible]	0.3	0.7	3	6		A01	CW	25.95
PSCQ-2-160	100-160	24	19	0.3	0.7	3	.5		A01	CW	29.95
PSCQ-2-180	120-180	28	[illegible]	0.3	0.7	[illegible]	2		A01	CW	25.95
PSCQ-2-250	150-250	30	22	0.4	0.8	4	.5		A01	CW	29.95
PSCQ-2-300	220-300	27	20	0.3	0.7	3	3		A01	CW	25.95
PSCQ-2-400	250-400	23	16	0.5	0.9	4	.5		A01	CW	29.95
PSCQ-2-450	[illegible]	28	[illegible]	0.5	0.9	6	6		A01	CW	25.95
PSCQ-2-650	[illegible]	19	15	0.4	0.7	5	.5		A01	CW	29.95
PSCQ-2-1000	800-1000	27	20	0.28	0.5	3	.3		A05	CX	25.95

NOTES:

- ◆ Aqueous washable. For non aqueous requirements, HRPQ units available in case style QQQ130.
- ❑ Non hermetic
- ** HRPQ units have bottom barrier ground plane insulated with glass barrier.
- *** Price for quantities 10-49.
- A. General Quality Control Procedures, Environmental Specifications, Hi-Rel and MIL description are given in section 0, see "Mini-Circuits Guarantees Quality" article.
- B. Connector types and case mounted options, case finishes are given in section 0, see "Case styles & Outline Drawings".
- C. Prices and specifications subject to change without notice.
- 1. Absolute maximum power, voltage and current ratings:
  - 1a. Matched power rating
    - models PSCQ-2-8, PSCQ-2-32 50mWatt
    - models SCPQ-10.5 0.5 Watt
    - all other models 1Watt
  - 1b. Internal load dissipation 0.125 Watt

NSN GUIDE

MCL NO.	NSN
PSCQ-2-21.4	[illegible]-415-3074
PSCQ-2-180	[illegible]-186-4456
PSCQ-2-90	[illegible]
PSCQ-2-70	[illegible]-292-3834
PSCQ-2-50	[illegible]-377-0028
PSCQ-2-160	[illegible]-377-0206

991222

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HA-2520, HA-2522, HA-2525

Data Sheet September 1998 File Number 2894.3

20MHz, High Slew Rate, Uncompensated, High Input Impedance, Operational Amplifiers

HA-2520/2522/2525 comprise a series of operational amplifiers delivering an unsurpassed combination of specifications for slew rate, bandwidth and settling time. These dielectrically isolated amplifiers are controlled at close loop gains greater than 3 without external compensation. In addition, these high performance components also provide low offset current and high input impedance.

120V/µs slew rate and 200ns (0.2%) settling time of these amplifiers make them ideal components for pulse amplification and data acquisition designs. These devices are valuable components for RF and video circuitry requiring up to 20MHz gain bandwidth and 2MHz power bandwidth. For accurate signal conditioning designs the HA-2520/2522/2525's superior dynamic specifications are complemented by 10nA offset current, 100MΩ input impedance and offset trim capability. MIL-STD-883 product and data sheets are available upon request.

Ordering Information

PART NUMBER (BRAND)	TEMP. RANGE (^{o}C)	PACKAGE	PKG. NO.
HA2-2520-2	-55 to 125	8 Pin Metal Can	T8.C
HA2-2522-2	-55 to 125	8 Pin Metal Can	T8.C
HA2-2525-5	0 to 75	8 Pin Metal Can	T8.C
HA3-2525-5	0 to 75	8 Ld PDIP	E8.3
HA7-2520-2	-55 to 125	8 Ld CERDIP	F8.3A
HA7-2525-5	0 to 75	8 Ld CERDIP	F8.3A
HA9P2525-5 (H25255)	0 to 75	8 Ld SOIC	M8.15

Features

- High Slew Rate	120V/µs
- Fast Settling	200ns
- Full Power Bandwidth	2MHz
- Gain Bandwidth ($A_V \geq 3$)	20MHz
- High Input Impedance	100MΩ
- Low Offset Current	10nA

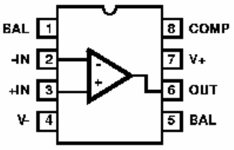
- Compensation Pin for Unity Gain Capability

Applications

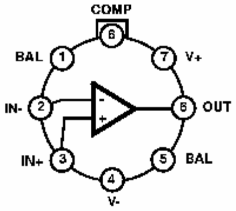
- Data Acquisition Systems
- RF Amplifiers
- Video Amplifiers
- Signal Generators

Pinouts

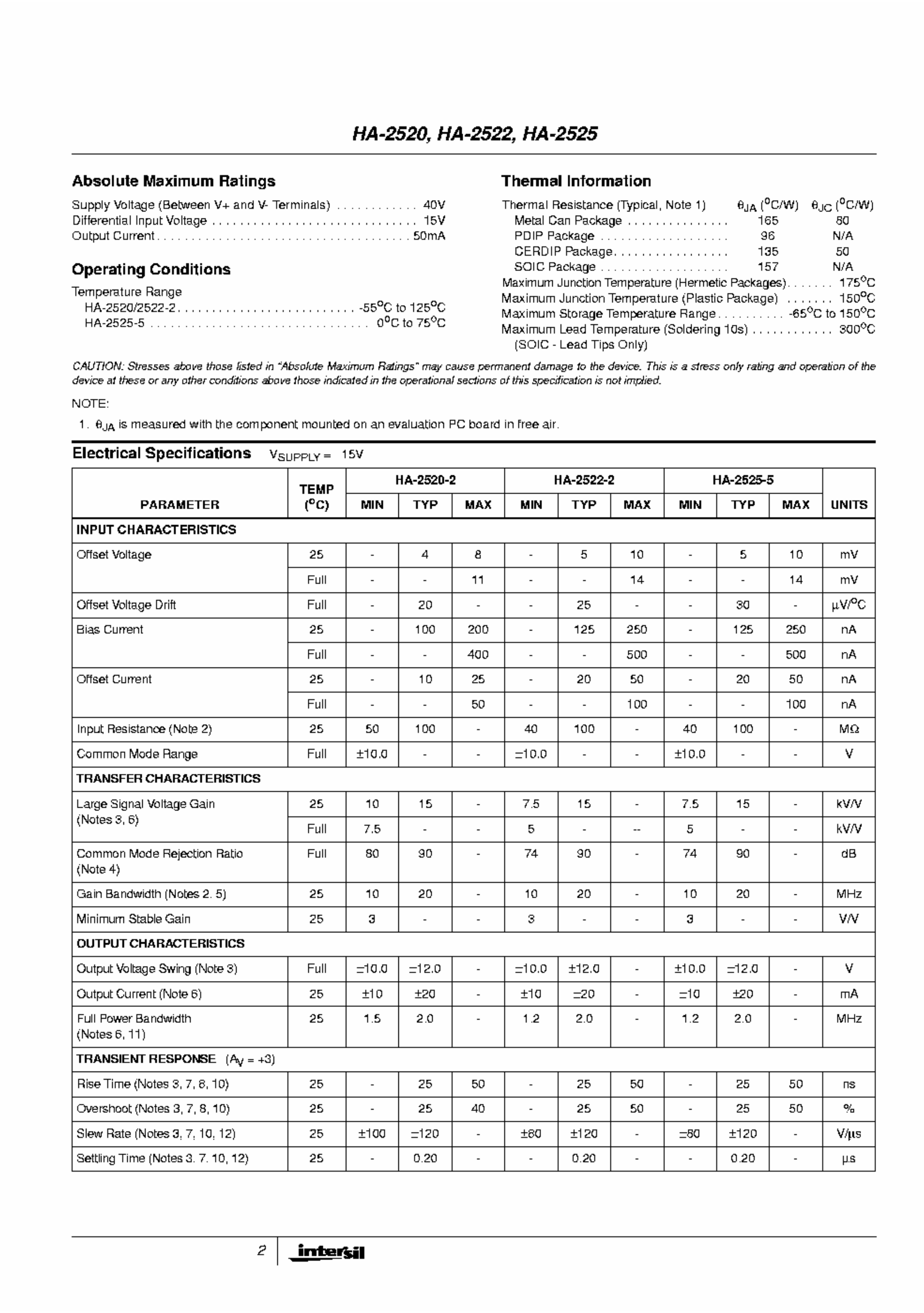
HA-2520 (CERDIP)
HA-2525 (PDIP, CERDIP, SOIC)
TOP VIEW



HA-2520/22/25
(METAL CAN)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
1-888-INTERSIL or 321-724-7143 |



Absolute Maximum Ratings

Supply Voltage (Between V+ and V- Terminals) 40V
Differential Input Voltage 15V
Output Current 50mA

Operating Conditions

Temperature Range
HA-2520/2522-2 . . . . -55°C to 125°C
HA-2525-5 . . . . 0°C to 75°C

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
Metal Can Package	165	80
PDIP Package	96	N/A
CERDIP Package.	135	50
SOIC Package	157	N/A

Maximum Junction Temperature (Hermetic Packages). . . . . . . 175°C
Maximum Junction Temperature (Plastic Package) . . . . 150°C
Maximum Storage Temperature Range . . . . -65°C to 150°C
Maximum Lead Temperature (Soldering 10s) . . . . 300°C
(SOIC - Lead Tips Only)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

1. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications V_{SUPPLY} = 15V

PARAMETER	TEMP (°C)	HA-2520-2			HA-2522-2			HA-2525-5			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS											
Offset Voltage	25	-	4	8	-	5	10	-	5	10	mV
	Full	-	-	11	-	-	14	-	-	14	mV
Offset Voltage Drift	Full	-	20	-	-	25	-	-	30	-	µV/°C
Bias Current	25	-	100	200	-	125	250	-	125	250	nA
	Full	-	-	400	-	-	500	-	-	500	nA
Offset Current	25	-	10	25	-	20	50	-	20	50	nA
	Full	-	-	50	-	-	100	-	-	100	nA
Input Resistance (Note 2)	25	50	100	-	40	100	-	40	100	-	MΩ
Common Mode Range	Full	±10.0	-	-	±10.0	-	-	±10.0	-	-	V
TRANSFER CHARACTERISTICS											
Large Signal Voltage Gain (Notes 3, 6)	25	10	15	-	7.5	15	-	7.5	15	-	kV/V
	Full	7.5	-	-	5	-	--	5	-	-	kV/V
Common Mode Rejection Ratio (Note 4)	Full	80	90	-	74	90	-	74	90	-	dB
Gain Bandwidth (Notes 2. 5)	25	10	20	-	10	20	-	10	20	-	MHz
Minimum Stable Gain	25	3	-	-	3	-	-	3	-	-	V/V
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 3)	Full	±10.0	±12.0	-	±10.0	±12.0	-	±10.0	±12.0	-	V
Output Current (Note 6)	25	±10	±20	-	±10	±20	-	±10	±20	-	mA
Full Power Bandwidth (Notes 6, 11)	25	1.5	2.0	-	1.2	2.0	-	1.2	2.0	-	MHz
TRANSIENT RESPONSE (A_V = +3)											
Rise Time (Notes 3, 7, 8, 10)	25	-	25	50	-	25	50	-	25	50	ns
Overshoot (Notes 3, 7, 8, 10)	25	-	25	40	-	25	50	-	25	50	%
Slew Rate (Notes 3, 7, 10, 12)	25	±100	±120	-	±80	±120	-	±80	±120	-	V/µs
Settling Time (Notes 3. 7. 10, 12)	25	-	0.20	-	-	0.20	-	-	0.20	-	µs

Electrical Specifications $V_{SUPPLY} =$ 15V **(Continued)**

PARAMETER	TEMP (°C)	HA-2520-2			HA-2522-2			HA-2525-5			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
POWER SUPPLY CHARACTERISTICS											
Supply Current	25	-	4	6	-	4	6	-	4	6	mA
Power Supply Rejection Ratio (Note 9)	Full	80	90	-	74	90	-	74	90	-	dB

NOTES:

2. This parameter value is based on design calculations.
3. $R_L = 2k\Omega$.
4. $V_{CM} = \pm 10V$.
5. $A_V > 10$.
6. $V_O = \pm 10.0V$.
7. $C_L = 50pF$.
8. $V_O =$ 200mV.
9. $\Delta V = \pm 5.0V$.
10. See Transient Response Test Circuits and Waveforms.
11. Full Power Bandwidth guaranteed based on slew rate measurement using: $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$.
12. $V_{OUT} =$ 5V.

Test Circuits and Waveforms

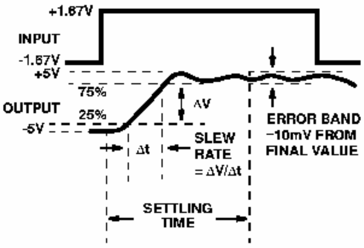
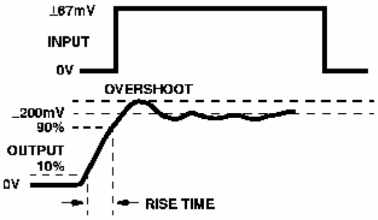


FIGURE 1. SLEW RATE AND SETTLING TIME



NOTE: Measured on both positive and negative transitions from 0V to +200mV and 0V to -200mV at the output.

FIGURE 2. TRANSIENT RESPONSE

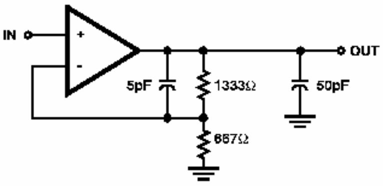
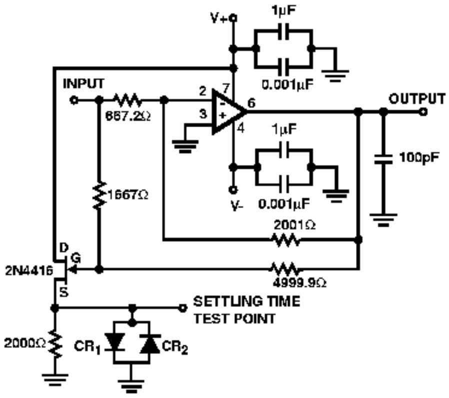


FIGURE 3. SLEW RATE AND TRANSIENT RESPONSE

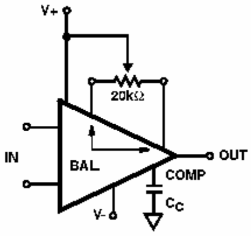


NOTES:

13. $A_V = -3$.
14. Feedback and summing resistor ratios should be 0.1% matched.
15. Clipping diodes CR_1 and CR_2 are optional. HP5082-2810 recommended.

FIGURE 4. SETTLING TIME TEST CIRCUIT

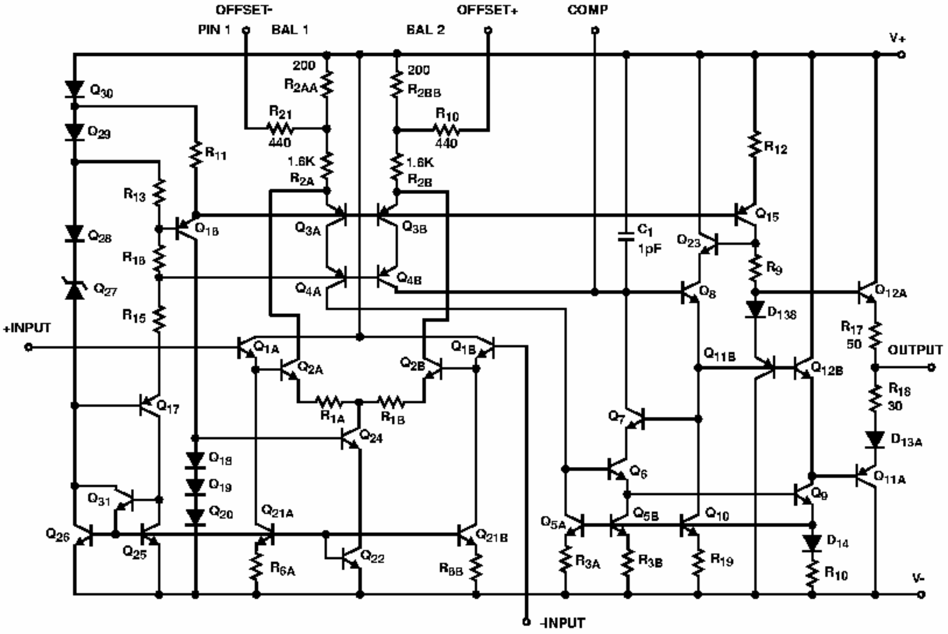
Test Circuits and Waveforms (Continued)



NOTE: Tested offset adjustment range is $|V_{OS} + 1mV|$ minimum referred to output. Typical ranges are 20mV with $R_T = 20k\Omega$.

FIGURE 5. SUGGESTED V_{OS} ADJUSTMENT AND COMPENSATION HOOK-UP

Schematic Diagram



All Intersil semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

Typical Application

Inverting Unity Gain Circuit

Figure 6 shows a Compensation Circuit for an inverting unity gain amplifier. The circuit was tested for functionality with supply voltages from ±4V to ±15V, and the performance as tested was: Slew Rate ≈ 120V/µs; Bandwidth ≈ 10MHz; and Settling Time (0.1%) ≈ 500ns. Figure 7 illustrates the amplifier's frequency response, and it is important to note that capacitance at pin 8 must be minimized for maximum bandwidth.

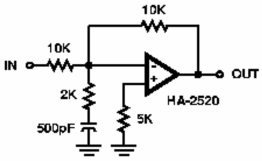


FIGURE 6. INVERTING UNITY GAIN CIRCUIT

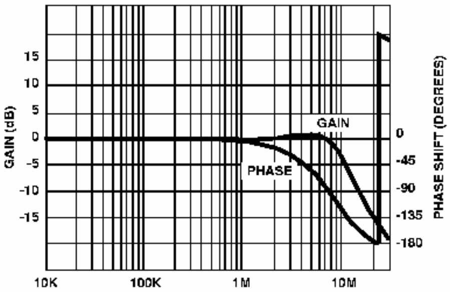


FIGURE 7. FREQUENCY RESPONSE FOR INVERTING UNITY GAIN CIRCUIT

Typical Performance Curves V_S = 15V, T_A = 25°C, Unless Otherwise Specified

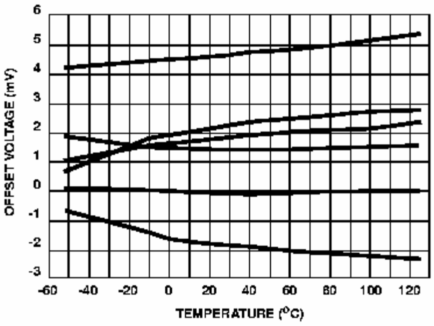


FIGURE 8. OFFSET VOLTAGE vs TEMPERATURE (6 TYPICAL UNITS FROM 3 LOTS)

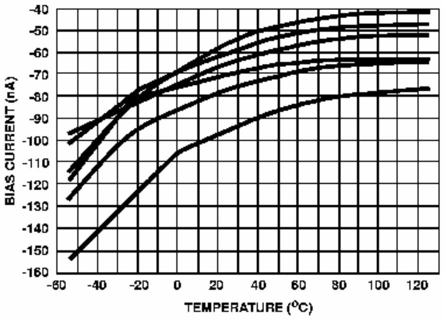


FIGURE 9. BIAS CURRENT vs TEMPERATURE (6 TYPICAL UNITS FROM 3 LOTS)

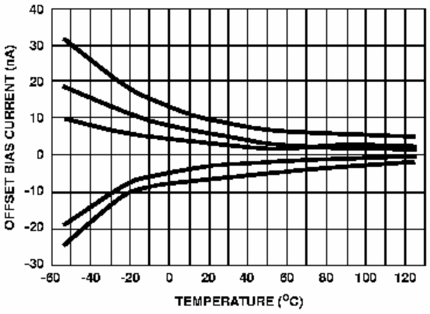


FIGURE 10. OFFSET CURRENT vs TEMPERATURE (5 TYPICAL UNITS FROM 3 LOTS)

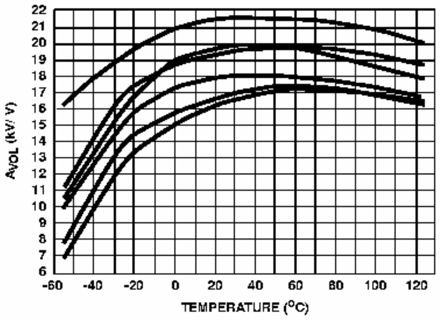


FIGURE 11. OPEN LOOP GAIN vs TEMPERATURE (6 TYPICAL UNITS FROM 3 LOTS)

Typical Performance Curves $V_S = \pm15V$, $T_A = 25^oC$, Unless Otherwise Specified **(Continued)**

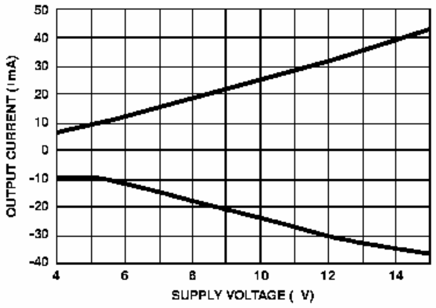


FIGURE 12. OUTPUT CURRENT vs SUPPLY VOLTAGE

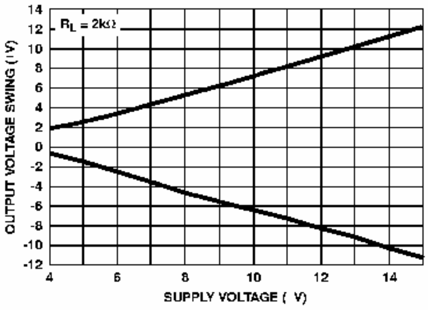


FIGURE 13. OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE

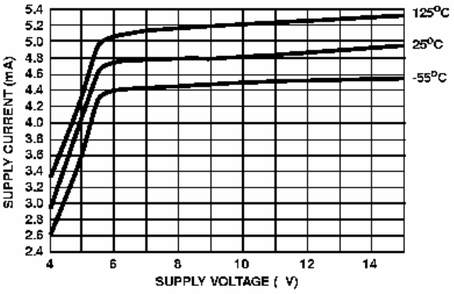


FIGURE 14. SUPPLY CURRENT vs SUPPLY VOLTAGE

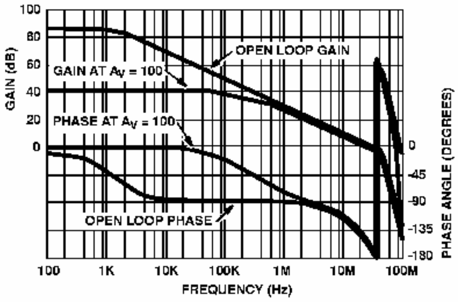


FIGURE 15. FREQUENCY RESPONSE

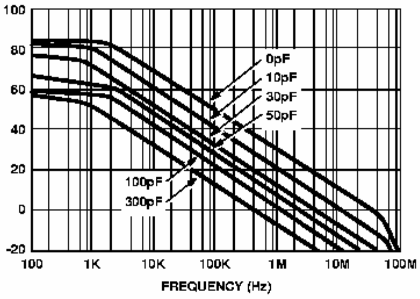


FIGURE 16. OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMP PIN TO GROUND

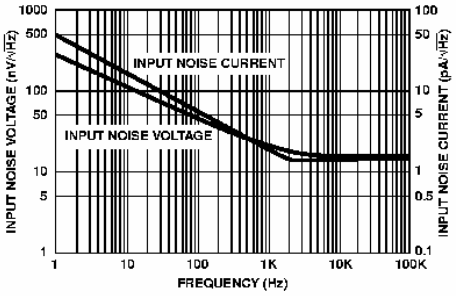


FIGURE 17. INPUT NOISE CHARACTERISTICS

Typical Performance Curves V_S = 15V, T_A = 25°C, Unless Otherwise Specified **(Continued)**

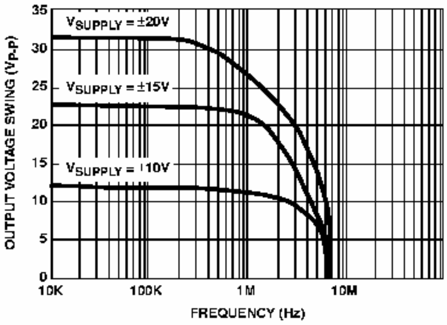


FIGURE 18. OUTPUT VOLTAGE SWING vs FREQUENCY

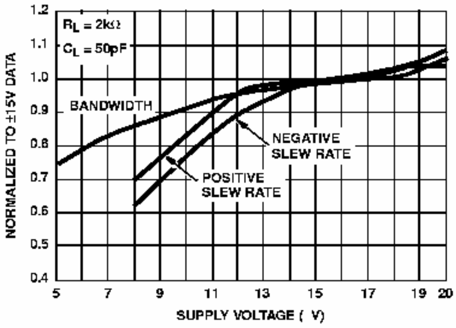


FIGURE 19. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

Die Characteristics

DIE DIMENSIONS:
67 mils x 57 mils x 19 mils
(1700μm x 1440μm x 483μm)

METALLIZATION:
Type: Al, 1% Cu
Thickness: 16kÅ ±2kÅ

SUBSTRATE POTENTIAL:
Unbiased

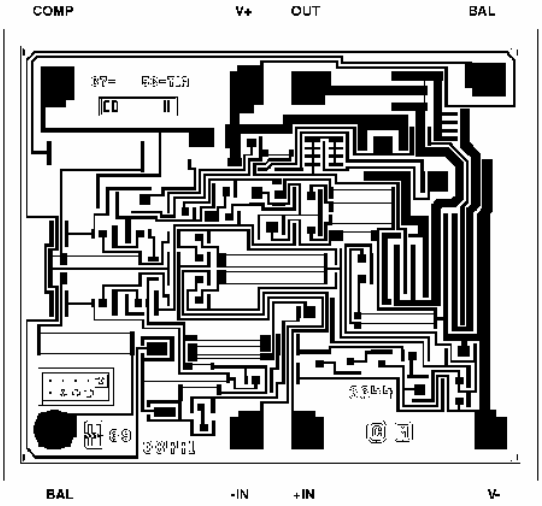
PASSIVATION:
Type: Nitride (Si_3N_4) over Silox (SiO_2, 5% Phos.)
Silox Thickness: 12kÅ ±2kÅ
Nitride Thickness: 3.5kÅ ±1.5kÅ

TRANSISTOR COUNT:
40

PROCESS:
Bipolar Dielectric Isolation

Metallization Mask Layout

HA-2520, HA-2522, HA-2525



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ZFAT


ZSAT

MODEL NO.	FREQ. MHz		PRIMARY ATTENUATION STEPS (dB) @TTL CONTROL PORT			ATTENUATION (dB) LOGIC STATE*		VSWR			CAPD DATA (see RF/IF Designer Handbook)	Case Style	CONNECTION	Price $
	f_L	f_U	#1	#2	#3	(1,1,1)** Nom.	(0,0,0) Max.	L	M	U	Page	Note B		Qty. (1-9)
TOAT-R512	10	1000	0.5± 0.18	1± 0.25	2± 0.25	3.5	4.0	1.6	1.4	1.5	5-6	QQ96	cq	59.95
TOAT-124	10	1000	1± 0.25	2± 0.25	4± 0.3	7.0	4.0	1.6	1.4	1.5	5-7	QQ96	cq	59.95
TOAT-3610	10	1000	3± 0.3	6± 0.4	10± 0.4	19.0	4.0	1.6	1.4	1.5	5-8	QQ96	cq	59.95
TOAT-4816	10	1000	4± 0.4	8± 0.4	16± 0.5	28.0	4.0	1.6	1.4	1.5	5-9	QQ96	cq	59.95
TOAT-51020	10	1000	5± 0.4	10± 0.4	20± 0.5	35.0	4.0	1.6	1.4	1.5	5-10	QQ96	cq	59.95
ZFAT-R512	10	1000	0.5± 0.18	1± 0.25	2± 0.25	3.5	4.0	1.6	1.4	1.5	5-6	SSS173	-	89.95
ZFAT-124	10	1000	1± 0.25	2± 0.25	4± 0.3	7.0	4.0	1.6	1.4	1.5	5-7	SSS173	-	89.95
ZFAT-3610	10	1000	3± 0.3	6± 0.4	10± 0.4	19.0	4.0	1.6	1.4	1.5	5-8	SSS173	-	89.95
ZFAT-4816	10	1000	4± 0.4	8± 0.4	16± 0.5	28.0	4.0	1.6	1.4	1.5	5-9	SSS173	-	89.95
ZFAT-51020	10	1000	5± 0.4	10± 0.4	20± 0.5	35.0	4.0	1.6	1.4	1.5	5-10	SSS173	-	89.95
				SIX CONTROL PORTS										
ZSAT-31R5	10	1000	(1) 0.5± 0.18 (4) 4± 0.3	(2) 1± 0.25 (5) 8± 0.4	(3) 2± 0.25 (6)16± 0.5	31.5	7.0	1.7	1.5	1.6	5-5	AR214	-	119.00

L = 10 to 100 MHz M = 100 to 500 MHz U = 500 to 1000 MHz

features

- wide frequency band, 10-1000 MHz
- excellent step accuracy, 0.2 dB typ.
- excellent VSWR, 1.3 typ.
- low DC current, 6 mA typ.
- operates over -55° to 100 °C
- small case, 0.6" dia., TO-8

NOTES:

* For ZSAT-31R5: Total attenuation (1,1,1,1,1,1)
Thru-Loss(0,0,0,0,0,0)

** Total attenuation above thru-loss.

A. General Quality Control Procedures, Environmental Specifications, Hi-Rel, MIL and TX description are given in section 0, see "Mini-Circuits Guarantees Quality" article.

B. Connector types and case mounted options, case finishes are given in section 0, see "Case Styles & Outline Drawings".

C. Prices and Specifications subject to change without notice.

1. Absolute maximum power, voltage and current rating:
    - 1a. Input power, 15 dBm
    - 1b. DC voltage, 5.5 Volts
    - 1c. TTL, 5.5 Volts
    - 1d. Storage temperature -55°C to +125°C for TOAT models.
2. Step accuracy is specified for basic steps. For combination of steps accuracy is additive.
3. Thru-loss is minimum insertion loss with all attenuation elements bypassed (All TTL controls state are Low).
4. For optimum operation of TOAT models, ensure the device case is properly connected to the ground plane (of PC board).

Additional Specifications

DC Voltage +5V
DC current 10mA max.
Switching Time (50% TTL to within specified accuracy of the next-selected attenuation step, and to within 0.1 dB of steady-state Thru-Loss) 10 µs typ., 15µs max.
TTL input High Threshold 2V min.
TTL input Low Threshold 0.8V max.
TTL Toggle Rate: 50 kHz typ.
1dB compression: 0 dBm (10-100MHz)
+10dBm(100-1000MHz)
For ZSAT-31R5:
1dB compression: +10dBm (10-100 MHz)
+15dBm (100-1000 MHz)

Logic function:

TTL High activates associated in-line attenuation
TTL Low bypasses this attenuation

NSN GUIDE

MCL NO.	NSN
TOAT-124	5985-01-416-9021
TOAT-51020	5985-01-416-9020

pin connections

see case style outline drawing

PORT	cq
RF IN	4
RF OUT	11
TTL CONTROL #1	2
TTL CONTROL #2	3
TTL CONTROL #3	1
+5VDC	12
CASE GND	5,6,7,8,9,10

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ANEXO B

ANÁLISIS DEL FILTRO BESSEL

En el caso del filtro Bessel de segundo orden es necesario que los valores de k y f_n sean 1.286 y 1.272 respectivamente, (Horowitz, [12]).

En la figura B.1 se tiene un circuito sencillo y fácil de implementar para obtener el filtro Bessel de segundo orden.

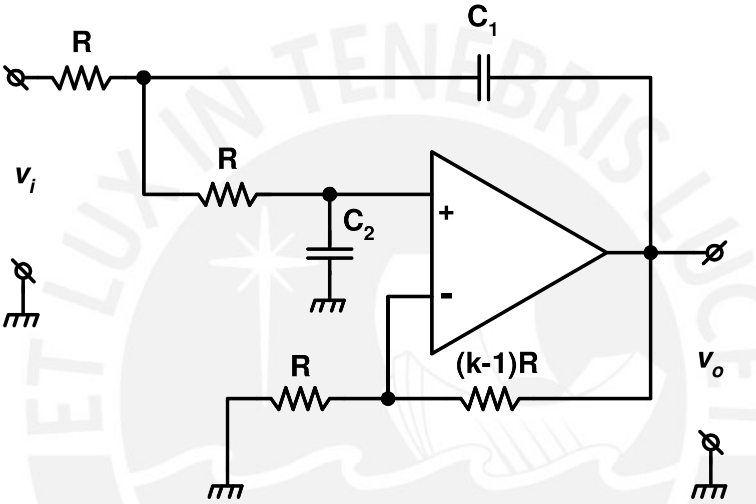

Figura B.1. Esquema del filtro Bessel de segundo orden

El primer valor que se debe calcular es la frecuencia de corte, la cual va a tomar el siguiente valor:

$$RC = \frac{1}{2\pi f_c f_n} \Rightarrow f_c = \frac{1}{2\pi RC f_n} \qquad \text{(B.1)}$$

Donde $\boldsymbol{f_c}$ es la frecuencia de corte y $\boldsymbol{f_n}$ es el factor de normalización.

A continuación, se va a deducir la función de transferencia del filtro Bessel. Para ello, en la figura B.2, analizamos el diagrama de corrientes del filtro Bessel

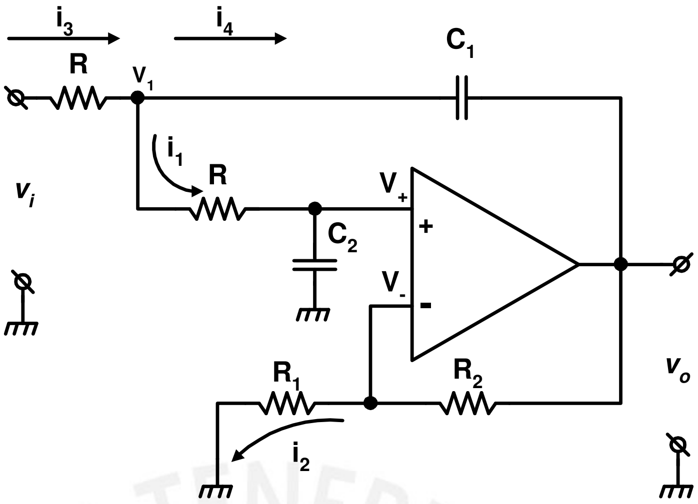

Figura B.2. Diagrama de corrientes en el operacional

Sabemos que las impedancias de los condensadores C_1 y C_2 son:

$$Zc_2 = \frac{1}{sC_2}$$

$$Zc_1 = \frac{1}{sC_1}$$

Utilizando las propiedades del amplificador operacional obtenemos las siguientes relaciones de voltajes:

$$V_+ = \frac{V_1 Z_{c2}}{Z_{c2} + R} \qquad \text{(B.2)}$$

$$V_+ = V_- = \frac{V_o R_1}{R_1 + R_2} \qquad \text{(B.3)}$$

A continuación, analizando las corrientes de la figura B.2 se obtiene:

$$i_1 = \frac{V_1}{Z_{c2} + R}$$

$$i_3 = \frac{v_i - V_1}{R}$$

$$i_4 = \frac{v_i - V_1}{R} - \frac{V_1}{Z_{c2} + R}$$

Despejando las variables para obtener V_o.

$$v_o = V_1 - i_4 Z_{c1}$$

$$\Rightarrow V_1 = \frac{Z_{c2}+R}{Z_{c2}} V_+$$

$$v_o = V_1\left[1+\frac{Z_{c1}}{R}+\frac{Z_{c1}}{R+Z_{c2}}\right]-v_i\frac{Z_{c1}}{R} \qquad \text{(B.4)}$$

Utilizando las ecuaciones B.2 y B.3:

$$\Rightarrow V_1 = \frac{Z_{c2}+R}{Z_{c2}}\frac{R_1}{R_1+R_2}v_o \qquad \text{(B.5)}$$

$$A_v = \frac{\frac{1}{R_2}\frac{R_1+R_2}{R_1C_1C_2}}{s^2+s\frac{1}{R}\left[\frac{2C_2R_1-C_1R_2}{R_1C_1C_2}\right]+\frac{1}{R^2}\frac{1}{C_1C_2}} \qquad \text{(B.6)}$$

Obtenemos de B.6 en B.5

$$\frac{v_o}{v_i} = A_v = \frac{1}{s^2\left[\frac{R^2C_1C_2R_1}{R_1+R_2}\right]+s\left[\frac{(2C_2+C_1)RR_1}{R_1+R_2}-C_1R\right]+\frac{R_1}{R_1+R_2}}$$

Donde A_v es la ganancia en voltaje.

Definiremos los siguientes valores:

$$A = \frac{R_1+R_2}{R_1C_1C_2} = \frac{R_1+R_2}{R_1C^2} \qquad \text{(B.7)}$$

$$B = \frac{2C_2R_1-C_1R_2}{R_1C_1C_2} \qquad \text{(B.8)}$$

$$C^2 = C_1C_2 \qquad \text{(B.9)}$$

De la definición de filtro Bessel de segundo orden, obtenemos la relación siguiente:

$$A_v = \frac{H_o w_o}{w_o s^2 + s\alpha w_o + w_o{}^2} \qquad \text{(B.10)}$$

Identificando componentes con B.6, obtenemos las siguientes igualdades:

$$H_o w_o = \frac{A}{R^2}$$
$$\alpha w_o = \frac{B}{R}$$
$$w_o{}^2 = \frac{1}{R^2 C^2}$$

De lo anterior, despejamos las variables y obtendremos.

$$w_o = \frac{1}{RC} \qquad \text{(B.11)}$$
$$\alpha = BC \qquad \text{(B.12)}$$
$$H_o = \frac{AC}{R} \qquad \text{(B.13)}$$

Luego, utilizando los siguientes valores que se tienen en el filtro de **JULIA**:

$C_1 = 200pF$
$C_2 = 690pF$
$R_1 = 2K\Omega$
$R_2 = 8.25K\Omega$

Por lo tanto, reemplazando estos valores en las ecuaciones B.7, B.8. y B.9, obtenemos lo siguiente:

$$A = 3.7137681 * 10^{19} \qquad \text{(i.1)}$$
$$B = 4021.7391 * 10^{6} \qquad \text{(i.2)}$$
$$\frac{1}{C^2} = 7.2463768 * 10^{18} \qquad \text{(i.3)}$$

Despejando el valor de B.1 en B.6 se obtiene:

$$\alpha = 1.49402$$

Para el modelo matemático del filtro Bessel se tiene:

$$\alpha 1=\sqrt{3}$$
$$w_o 1=\sqrt{3}$$

La ganancia en B.6 se obtiene reemplazando $\propto 1$ y $w_o 1$, de la siguiente forma:

$$A_v=\frac{\frac{A}{R^2}}{-w^2+\frac{B}{R}wj+\left(\frac{1}{RC}\right)^2}\Rightarrow A_v=\frac{\frac{A}{R^2}\left(\left(\frac{1}{R^2C^2}-w^2\right)-\frac{B}{R}wj\right)}{\left(\frac{Bw}{R}\right)^2+\left(\frac{1}{R^2C^2}-w^2\right)^2} \quad \text{(B.14)}$$

En este caso, el módulo de la ganancia es:

$$\left|A_v\right|=\frac{\frac{A}{R^2}}{\sqrt{\left(\frac{Bw}{R}\right)^2+\left(\frac{1}{R^2C^2}-w^2\right)^2}}$$

Suponiendo que w sea igual a cero, se tiene:

$$\left|A_v\right|=AC^2$$

Con los valores de i.1 y i.3 obtenemos:

$|A_v|=5.125$

Este valor viene a ser la ganancia del filtro Bessel.

CÁLCULO DE LA FRECUENCIA DE CORTE

De la ecuación B.1 tenemos:

$$f_c=\frac{1}{2\pi RC(1.272)}.......(a')$$

De la ecuación B.14 se calcula la frecuencia de corte, donde la ganancia para una caída de 3dB se tiene:

$$\frac{AC^2}{\sqrt{2}} = \frac{A}{R^2\sqrt{\left(\frac{Bw}{R}\right)^2 + \left(\frac{1}{R^2C^2} - w^2\right)^2}}$$

Despejando en función de *w* se obtiene:

$$\Rightarrow 0 = w^4 + w^2\left(\frac{B^2}{R^2} - \frac{2}{C^2R^2}\right) - \frac{1}{R^4C^4}$$

Resolviendo, se obtiene la solución positiva:

$$\Rightarrow w_c = \frac{\sqrt{\frac{2}{C^2} - B^2 + \sqrt{B^4 + \frac{8}{C^4} - \frac{4B^2}{C^2}}}}{R\sqrt{2}} \qquad \text{(B.15)}$$

Tenemos de las ecuaciones B.7, B.8 y B.9. Además, para C_1=C_2=C y R_1=R y R_2=(k-1)*R obtendremos:

$$A = \frac{Rk}{RC^2} = \frac{k}{C^2}$$

$$B = \frac{2R-(k-1)R}{RC} = \frac{3-k}{C}$$

Por lo tanto, la frecuencia de corte es:

$$\omega_c = \frac{\sqrt{\frac{2}{C^2} - \frac{(3-k)^2}{C^2} + \sqrt{\frac{(3-k)^4}{C^2} + \frac{8}{C^4} - \frac{4}{C^2}\frac{\left(3-k^2\right)}{C^2}}}}{R\sqrt{2}}$$

$$\Rightarrow f_c = \frac{1}{2\pi CR\sqrt{\frac{2}{2-(3-k)^2+\sqrt{(3-k)^2\left((3-k)^2-4\right)+8}}}}$$

$$\Rightarrow \omega_c = \frac{\sqrt{2-(3-k)^2+\sqrt{(3-k)^2\left((3-k)^2-4\right)+8}}}{CR\sqrt{2}} \qquad \text{(B.16)}$$

Para el valor de *k*=1.268 el resultado en B.16 es:

$$f_c = \frac{1}{2\pi CR(1.271969)}$$

De la relación *a'* se observa que el factor f_n es el mismo. Entonces, se obtiene la comprobación de la formula B.1.

SALIDA DEL FILTRO BESSEL

Este circuito se encuentra en la salida del filtro Bessel, la cual se encarga de amplificar y dar el nivel de corriente necesario para la siguiente etapa de adquisición. El diagrama de la figura B.3 muestra el circuito utilizado en **JULIA**.

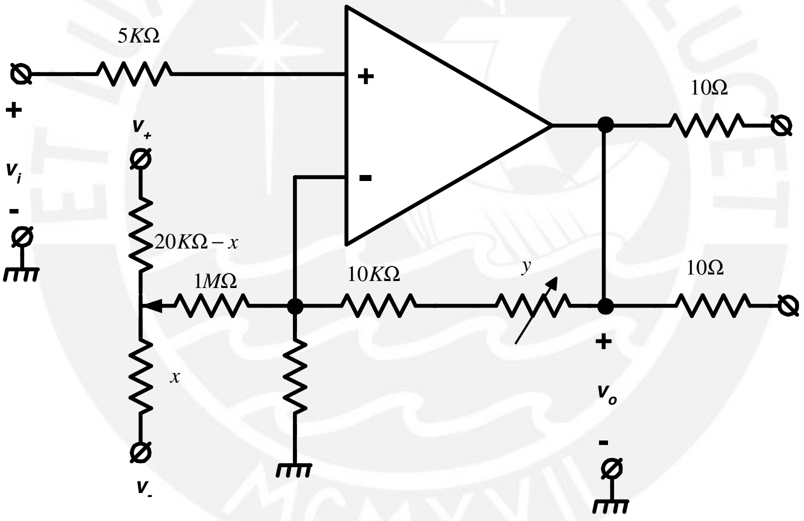

Figura B.3

Tenemos los valores de los potenciómetros en el circuito:

$x \in [0{,}20K\Omega]$,

$y \in [0{,}50K\Omega]$

Reduciendo mediante Thevenin las alimentaciones V_+ y V_-, obtenemos el circuito de la figura B.4:

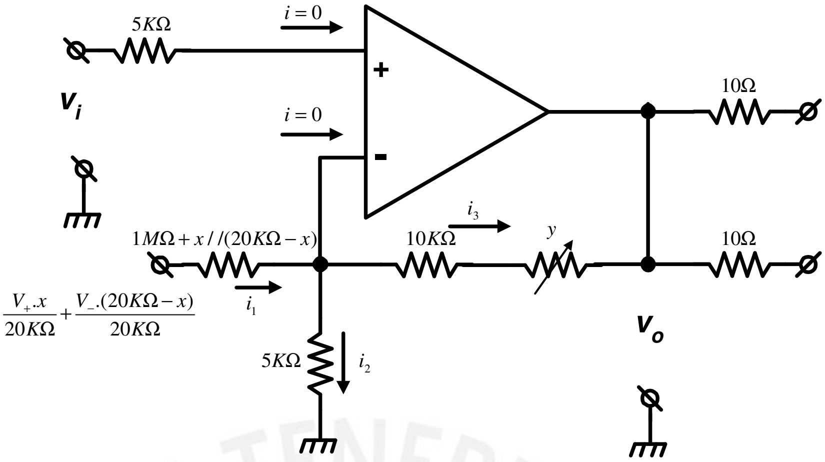

Figura B.4

Se analizan las corrientes del circuito:

$$i_1 = \frac{\left(\frac{V_+.x + V_-.(20K\Omega - x)}{20K\Omega} - v_i\right)}{1M\Omega}$$

$$i_3 = i_1 - i_2$$

Luego, la tensión de salida del circuito es:

$$vo = v_i - i_3.(10K\Omega + y)$$

$$v_o = v_i\left(1 + \frac{10K\Omega + y}{1M\Omega} + \frac{10K\Omega + y}{5K\Omega}\right) - \frac{V_+x + V_-(20K\Omega - x)(10K\Omega + y)}{1M\Omega * 20K\Omega} \qquad \text{(B.17)}$$

Además, si suponemos que:

$$1M\Omega >> x//(20K\Omega - x)$$

Tendremos la siguiente aproximación:

$$v_o = v_i - \left\{\left[\frac{V_+x + V_-(20K\Omega - x)}{20K\Omega} - v_i\right]\frac{1}{1M\Omega} - \frac{v_i}{5K\Omega}\right\}(10K\Omega + y)$$

Definiendo Λ como

$$\Lambda = \frac{[V_+ * x + V_- * (20K\Omega - x) * (10K\Omega + y)]}{20K\Omega * 1M\Omega}$$

Con los valores de V_+=15V y V_-=-15v obtenemos:

$$\Lambda = \frac{15*[2*x-20K\Omega]*(10K\Omega+y)}{20K\Omega*1M\Omega}$$

Además, como sabemos que ***y*** tiene valores entre 0 a 50KΩ, se puede realizar la siguiente reducción:

$$\frac{10K\Omega+y}{1M\Omega} << \frac{10K\Omega+y}{5K\Omega}$$

Finalmente, aplicando esta reducción en B.17 se obtiene:

$$v_o = v_i\left[1+\frac{10K\Omega+y}{5K\Omega}\right]-\frac{15(2x-20K\Omega)(10K\Omega+y)}{20K\Omega*1M\Omega}$$

Esta relación nos da el rango de valores de la ganancia en la salida del Filtro Bessel.

ANEXO C

MÓDULO DE CONVERSION TTL

Este circuito recibe señal TTL y lo convierte a un nivel de voltaje que pueda manejar el mezclador y los interruptores **RF,** el diagrama se muestra en la figura C.1.

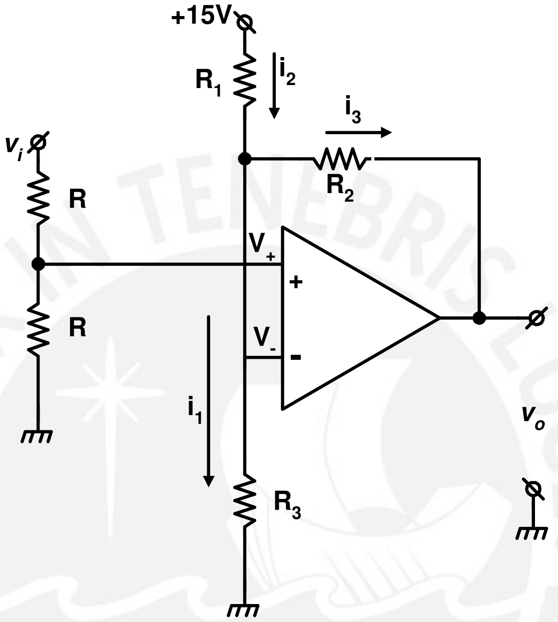

Figura C.1

A partir de las características del operacional, se deducen los siguientes voltajes:

$$V_+ = \frac{V_i}{2} = V_-$$

Además, si R_1=R_3 entonces las corrientes del circuito son:

$$i_1 = \frac{V_i}{2R_3}$$

$$i_2 = \frac{15 - V_i}{2R_1}$$

$$i_3 = i_2 - i_1$$

Resolviendo para

$$V_o = V_+ - i_3 R_2$$

$$\Rightarrow V_o = \frac{V_i}{2} - \left[\frac{15 - \frac{V_i}{2}}{R_1} - \frac{V_i}{2R_3} \right] R_2$$

$$\Rightarrow V_o = \frac{V_i}{2} \left[1 + R_2 \left(\frac{1}{R_1} + \frac{1}{R_3} \right) \right] R_2 - \frac{15R_2}{R_1}$$

$$R_1 = 15K\Omega$$
$$R_2 = 10K\Omega$$
$$R_3 = 1K\Omega$$

$$\Rightarrow V_o = 5.83V_i - 10$$

ANEXO D

DESCRIPCIÓN DEL MEZCLADOR

En la actualidad, uno de los principales componentes utilizados en las comunicaciones es el mezclador, el cual se puede encontrar en infinidad de aparatos; por ejemplo: celulares, equipos de radio, laboratorios de comunicaciones, etc. Además, en el transcurso del tiempo, su tamaño ha ido disminuyendo mientras que su eficiencia y uso ha ido aumentando.

En la figura D.1 se muestra un el diagrama de un mezclador, en el cual se combina la señal de entrada **RF**, por lo tanto, va a ser desplazada respecto a una señal de referencia conocida como oscilador local **OL**; ésta se llama así porque generalmente es suministrada por un oscilador y es parte del sistema de recepción. Finalmente, la señal se desplaza a una frecuencia intermedia **FI**.

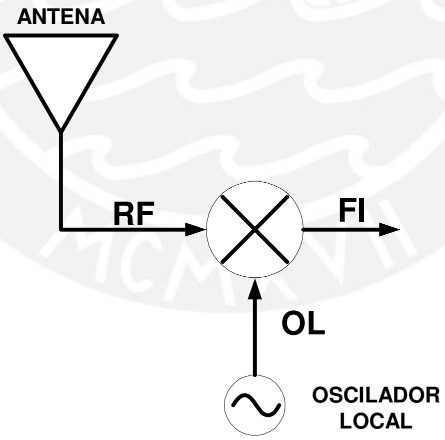

Figura D.1.

Los mezcladores deben presentar comportamiento no lineal, debido a que se busca conseguir una relación cuadrática entre **RF** y **OL**. Sabemos que en los circuitos lineales solo pueden cambiar las amplitudes y fases del conjunto de ondas sinusoidales; pero, éstos no generan cambios en la frecuencia. En cambio, los mezcladores generan el producto de un conjunto de ondas sinusoidales, es decir, se generan el producto de la señal de entrada **RF** y la **OL**. La resta de los sinusoidales o multiplicación producen nuevas señales a frecuencias distintas de las señales entrantes. En la figura D.2 se muestra la salida del producto de los senos, la cual contiene componentes a frecuencias mayores y menores de las originales.

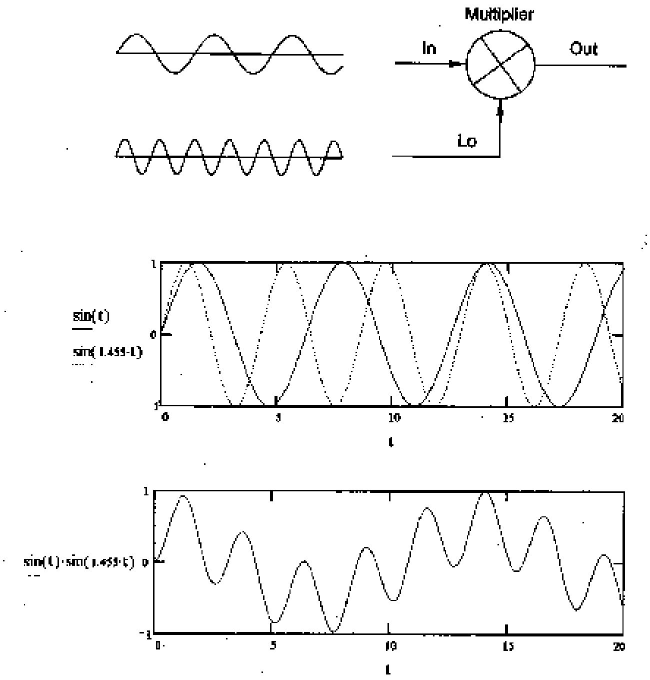

Figura D.2

Una relación trigonométrica que se va a utilizar es la siguiente:

$$Sin(w_R t)Sin(w_L t) = \frac{1}{2}\left(Cos(w_R - w_L)t - Cos(w_R + w_L)t\right) \qquad \text{D.1}$$

Esta relación nos muestra que el producto de dos señales nos da como resultado dos componentes, las cuales están relacionadas a la suma y diferencia de las frecuencias de las señales originales.

A partir de lo anterior, vamos a trabajar los mezcladores como si fueran conmutadores de señal. Si la señal **OL** es una onda cuadrada, entonces la salida no solo va a contener los componentes de la suma y diferencia; sino, van aparecer otros componentes (armónicos) de orden impar. Estas componentes provienen de la descomposición de Fourier de la señal cuadrada, las usualmente son fáciles de filtrar.

Por lo tanto, no hay ninguna desventaja en utilizar una señal cuadrada en la línea **OL**. Por ellos, se utiliza el modelo del interruptor, el cual va a conectar la salida de la señal de entrada o la desfasada 180°, como muestra la figura D.3. Además, se observa que la implementación de los conmutadores se puede hacer con FET's.

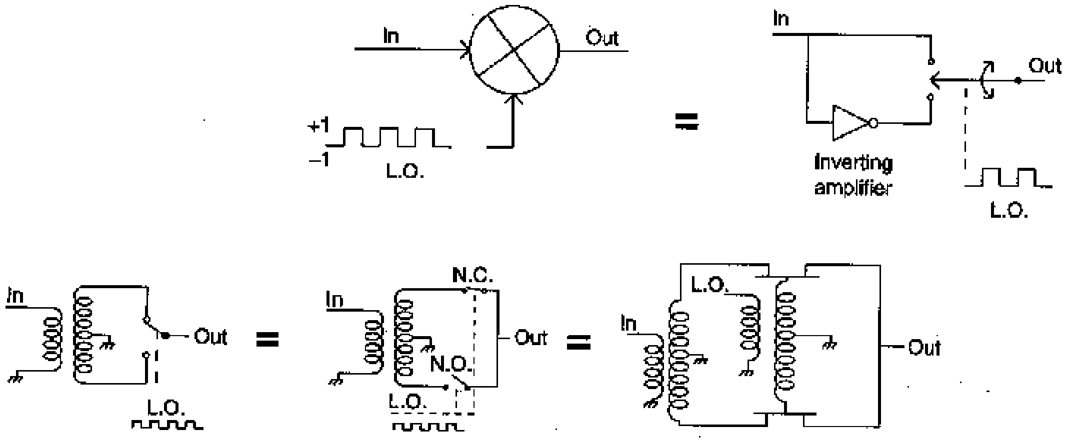

Figura D.3

Asimismo, este circuito se puede implementar con diodos, por ello, éstos son utilizados normalmente como interruptores, como en el circuito de la Figura D.4:

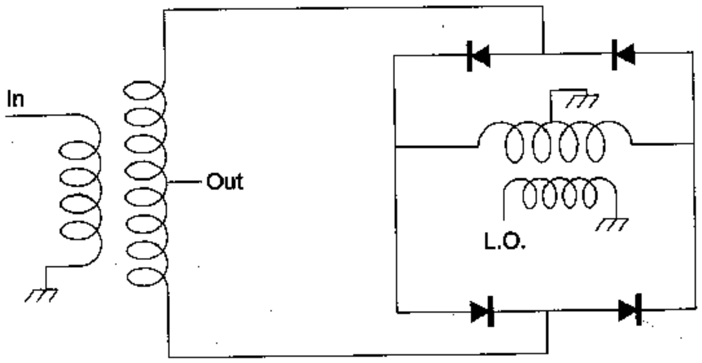

Figura D.4

Este componente es conocido como mezclador de doble balanceo, y una de sus principales características es el aislamiento entre compuertas. Por ello, esta configuración es muy utilizada en un receptor, ya que brinda el aislamiento y protección en las primeras etapas de entrada de señal. Es decir, el mezclador no permitirá que la energía proveniente de la compuerta **RF** alcance las compuertas **IF** y **RF**.

En la figura D.5 se muestra un hipotético circuito de un solo diodo, y se puede observar que el primer operacional realiza el proceso de suma, mientras que el segundo funciona como un conversor de corriente a voltaje.

La ecuación del diodo es una relación exponencial cuya relación es:

$$I = Is\left(e^{\frac{V}{V_{th}}} - 1\right) \qquad \text{D.2}$$

Donde V_{th} es igual a kT/e = 26mA. En el caso de tener V<<26mV, se puede expandir la salida exponencial, en la siguiente sumatoria

$$Vout = IsR\left(V/V_{th} + \frac{\left(V/V_{th} \right)^2}{2!} + \frac{\left(V/V_{th} \right)^3}{3!} + \ldots \right) \qquad D.3$$

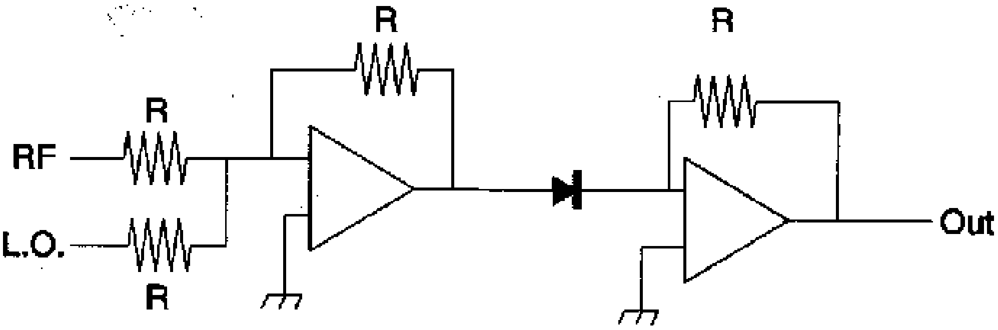

Figura D.5

Donde V = $V_{RF} + V_{LO}$

El producto de estas dos señales es la función que se busca, y esta contenida en el segundo término;

$$\frac{\left(V/V_{th} \right)^2}{2!}$$

Al desarrollar la relación cuadrática se obtiene el producto $2V_{RF}V_{LO}$, el cual viene a ser el primer término de la ecuación D.1; de esta forma, se obtiene la diferencia de frecuencias deseada.

ANEXO E

FILTRO ADAPTADO “MATCHED FILTER”

Una forma de optimizar la relación señal a ruido de la señal proveniente de la antena de radar en el sistema de recepción es modelar el comportamiento del receptor como un filtro, por ello, ésta se debe diseñar de tal forma que deje pasar la señal de interés, pero a su vez, rechazar el ruido o señales extrañas que son externas al ancho de banda a la señal, como se muestra en al figura E.1.

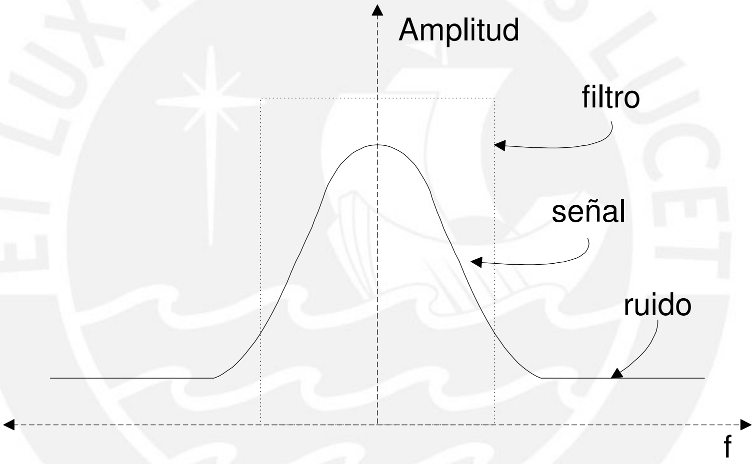

Figura E.1. Espectro de la señal y ruido

Suponiendo una señal de entrada $s_i(t)$ con un espectro $S_i(f)$, esta señal ingresa a un filtro con función de transferencia ***H(f)*** y respuesta al impulso ***h(t)***. Se diseña esta función de transferencia de forma tal:

$$H(f) = GS_i^*(f)e^{-j2\pi\ f\tau} \qquad \text{E.1}$$

$$h(t) = Gs_i^*(\tau - t) \qquad \text{E.2}$$

Donde ***G*** es la ganancia o perdida del filtro, τ es un retardo fijo a través del filtro, y el asterisco “$*$” se refiere a la conjugada de la función.

Suponiendo una ganancia de uno y un retardo igual a cero se tiene:

$$H(f) = S_i^*(f) \qquad \text{E.3}$$

$$h(t) = s_i^*(-t) \qquad \text{E.4}$$

Se observa que la función de transferencia de un filtro adaptado es proporcional a la conjugada del espectro de la señal, y la respuesta al impulso del filtro emparejado es proporcional a la conjugada de tiempo de la señal.

Los filtros adaptado no son diseñados para una señal de entrada, por lo contrario, la adaptación se hace sobre la base del pulso de transmisión, el cual, permanece constante sin importar el blanco. Luego, es posible diseñarlos sobre una amplia variedad de formas de onda, uno forma muy utilizada en radar es conocida como pulso comprimido.

LA FUNCIÓN DE AMBIGÜEDAD

Ésta función es muy utilizada y será útil para entender el funcionamiento de los filtros adaptados, ya que esta función nos describe el comportamiento del filtro bajo distintas condiciones de entrada.

La función de ambigüedad de una onda se define como la co-relación cruzada, del ingles *crosscorrelation*, del Doppler de la función ***s_1(t)exp(j2fD)*** de forma que:

$$X(\tau, f_D) = \int_{-\infty}^{\infty} [s_1(t) e^{j2\pi f_D t}][s_1^*(t-\tau)]dt \qquad \text{E.6}$$

Reordenando términos tenemos:

$$X(\tau, f_D) = \int_{-\infty}^{\infty} [s_1(t) s_1^*(t-\tau)][e^{j2\pi f_D t}]dt \qquad \text{E.7}$$

El valor absoluto se refiere a cómo la superficie de ambigüedad es dependiente enteramente de los parámetros de la forma de onda. Una expresión normalizada se obtiene con la condición de:

$$\int_{-\infty}^{\infty} \left| s_1(t)^2 \right| dt = 1 \qquad \text{E.8}$$

Con esta normalización se observa que en el caso del punto (0,0), el valor de la función es uno.

FUNCIÓN DE RESPUESTA DEL FILTRO EMPAREJADO

La salida espectral de la función de transferencia producida por ***s_1(t)*** es

$$S_o(f) = H(f) S_i(f) \qquad \text{E.9}$$

Donde ***H(f)*** es a la función de transferencia del filtro y ***S_i(f)*** es el espectro de la señal de entrada. La respuesta temporal del filtro a la señal ***s_1(t)*** es:

$$s_o(t) = h(t) \otimes s_i(f) = \int_{\infty}^{\infty} h(t-\tau) * s_i(\tau) \qquad \text{E.10}$$

Donde el símbolo ⊗ indica la operación de convolución.

$$s_o(t, f_D) = \int_{\infty}^{\infty} h(t-\tau) * s_i(\tau) e^{j2\pi f_D \tau} d\tau \qquad \text{E.11}$$

La función de respuesta ***s*** $s_o(t)$ puede ser definida como la salida del filtro emparejado mostrado en la figura E.2 cuando la señal $s_i(t)$ pasa a través del filtro. Cuando la entrada de señal es desplazada en frecuencia, la respuesta de convolución utilizado se convierte.

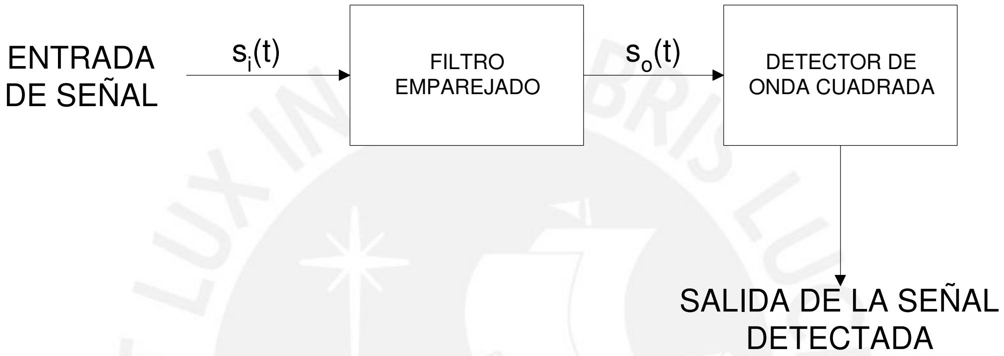

Figura E.2. Diagrama de la recepción con filtro

$$h(t-\tau) = s_i * [-(t-\tau)] = s_i * (\tau - t) \qquad \text{E.12}$$

De *h(t)* adaptándolo a $s_i(t)$:

$$s_o(t, f_D) = \int_{\infty}^{\infty} s_i(\tau - t)^* s_i(\tau) e^{j2\pi f_D \tau} d\tau \qquad \text{E.13}$$

Reordenando los términos obtenemos:

$$s_o(t, f_D) = \int_{\infty}^{\infty} s_i(\tau) s_i(\tau - t)^* e^{j2\pi f_D \tau} d\tau \qquad \text{E.14}$$

Al final, resulta tener la función de ambigüedad de la ecuación, como en el caso anterior, el valor máximo se da en las coordenadas (0,0).

RESPUESTA AL PULSO RECTANGULAR

Un ejemplo de la aplicación y entendimiento de este concepto se presenta a continuación con el análisis de un pulso de radio frecuencia el cual es utilizado en un radar. La figura E.3 muestra la señal pulsada de radiofrecuencia de ancho τ y de frecuencia de la señal f_o, el análisis espectral nos muestra como se aleja de la función impulso teniendo un ancho dependiente de la inversa de τ donde C_v es igual a 1 V para:

$$A(f) = C_v \frac{\sin(\pi\tau f)}{\pi\tau f}(V/Hz) \qquad \text{E.15}$$

La energía del pulso es:

$$E = \int_{-\infty}^{\infty} a^2(t)dt = \int_{-\infty}^{\infty} A^2(f)df = C_v{}^2\tau(W\_s) \qquad \text{E.16}$$

La respuesta al impulso del filtro emparejado es, para obtener una respuesta idéntica de *A(f)*:

$$H(f) = \frac{\sin \pi\tau f}{\pi\tau f} \qquad \text{E.17}$$

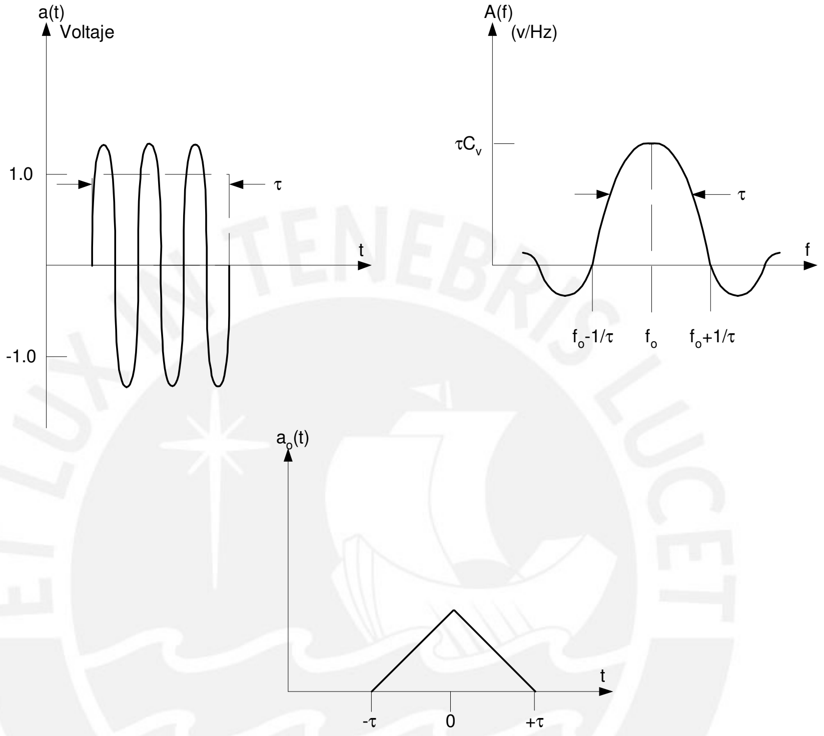

Figura E.3. Diagrama de la entrada de señal pulsada, del espectro de la señal pulsada y la salida del filtro emparejado a esta señal pulsada

La salida en frecuencia es.

$$A_o(f) = A(f)H(f) = C_v \frac{\sin^2 \pi\tau f}{(\pi\tau f)^2}(V/Hz)$$

E.18

Utilizando la función de ambigüedad, para f_d=0, t_d=0:

$$X_o(0,0) = \int_{-\infty}^{\infty} C_v \tau \frac{\sin^2 \pi\tau f}{(\pi\tau f)^2} df = C_v = 1\ V \qquad \text{E.19}$$

Sabemos que la densidad de potencia del ruido es:

$$N = N_o \int_{-\infty}^{\infty} |H(f)|^2 df = N_o B_n = N_o / \tau \ \ (W) \qquad \text{E.20}$$

Donde ***B_n*** es el ancho de banda de ruido efectivo del filtro. Entonces la relación señal a ruido queda determinada de la siguiente forma:

$$E / N_o = C_v{}^2 \tau / N_o \qquad \text{E.21}$$

Por lo tanto, esta relación maximiza la relación señal a ruido, la cual es proporcional al ancho de pulso τ de transmisión; y en el caso de no tener un filtro adaptado, este valor disminuye por el incremento del ruido a la salida del filtro.