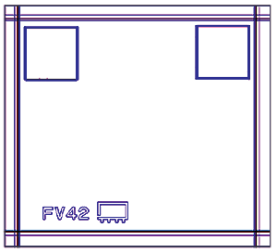
Low Current, Wideband

Monolithic Amplifier Die

EHA-24L-D+

50Ω DC to 20 GHz



The Big Deal

- Super Wideband, DC to 20 GHz
- Excellent Gain Flatness(±1.1dB up to 10 GHz)
- Low Current, 19.1 mA

Product Overview

The EHA-24L-D+ is a low current, wideband gain block die that operates up to 20 GHz fabricated using highly reliable HBT process. This Darlington pair amplifier delivers excellent gain flatness, good return loss, low current with acceptable P1dB and OIP3 across a wide bandwidth without the need of external matching network.

Key Features

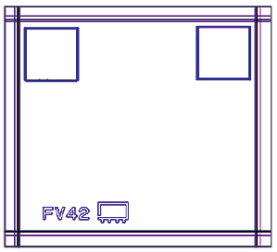
Feature	Advantages
Super Wideband: DC to 20 GHz	General purpose wideband amplifier is suitable for various applications.
Low Current, 19.1mA typ.	Low current consumption is ideal for use in amplifier chain.
Excellent gain flatness ± 1.1dB up to 10GHz ± 2.7dB up to 20GHz	As a desirable characteristic of a wideband amplifier, excellent gain flatness allows amplification of a signal without changing the waveform in time domain.
No external matching component required	EHC-24L-D+ provides typical input & output return loss of 15 dB up to 20 GHz without the need for any external matching components.
Unpackaged Die	Enables the user to integrate the amplifier directly into hybrids

Low Current, Wideband

Monolithic Amplifier Die

EHA-24L-D+

50Ω DC to 20 GHz



+RoHS Compliant
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

Product Features

- Super Wideband, DC to 20 GHz
- Low Current, 19.1mA
- Excellent Gain Flatness
  (±1.1dB up to 10 GHz)
  (±2.7dB up to 20 GHz)
- Good Input & Output Return Loss (>15 dB typ. up to 20 GHz)
- Repeatable performance (HBT Process)

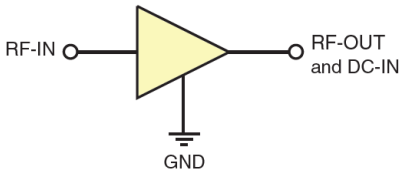
Typical Applications

- Instrumentation
- Cable Infrastructure
- 5G

General Description

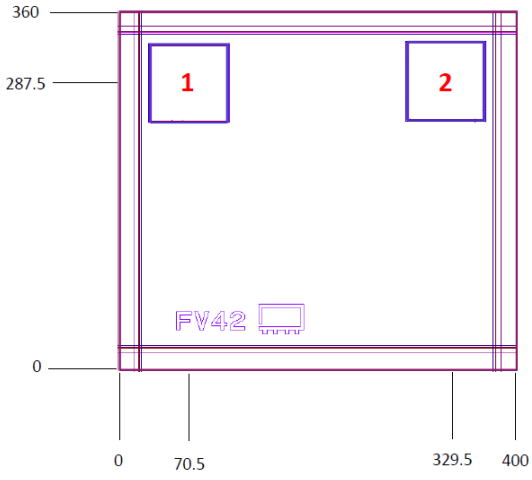
The EHA-24L-D+ is a low current, wideband gain block die that operates up to 20 GHz fabricated using highly reliable HBT process. This Darlington pair amplifier delivers excellent gain flatness, good return loss, low current with acceptable P1dB and OIP3 across a wide bandwidth without the need of external matching network. It has highly repeatable performance from lot to lot.

Simplified Schematic and Pad description



Pad #	Function	Description
1	RF-IN	RF Input pad.
2	RF-OUT & DC-IN	RF Output pad and DC-IN
Bottom of die	GND	Ground

Bonding Pad Position



Dimensions in µm, Typical

Parameter	Values
Die Thickness, um	100
Die Width, um	400
Die Length, um	360
Bond Pad Size, um	70 x 70

Electrical Specifications at 25°C, Vs=5V, Zo=50Ω unless noted

Parameter	Condition (MHz)	Vs=5V[1]			Units
		Min.	Typ.	Max.	
Frequency range[5]		0.01		20	GHz
Gain	10		15.5		dB
	5000		14.1		
	8000		13.4		
	12000		12.8		
	15000		12.5		
	20000		10.2		
Input return loss	10		18		dB
	5000		14		
	8000		15		
	12000		10		
	15000		15		
	20000		11		
Output return loss	10		15		dB
	5000		14		
	8000		16		
	12000		11		
	15000		16		
	20000		11		
Reverse isolation	10000		21		dB
Output power @1dB compression	10		7.0		dBm
	5000		5.5		
	8000		6.8		
	12000		4.4		
	15000		2.6		
	20000		-0.6		
Output IP3[2]	10		19.2		dBm
	5000		17.0		
	8000		16.6		
	12000		12.8		
	15000		11.3		
	20000		9.6		
Noise figure	10		5.2		dB
	5000		5.2		
	8000		5.1		
	12000		5.3		
	15000		5.2		
	20000		5.7		
DC Supply (Vs)		4.75	5	5.25	V
Device operating current			19.1	24	mA
Device current variation vs voltage[4]			0.0188		mA/mV
Thermal Resistance, junction-to-ground lead at 85°C stage temp.			349		°C/W

1. Die is packaged in 4-lead ceramic package and soldered on test board MB-022. See characterization circuit (Fig. 1)
2. Tested at Pout=-5dBm / tone.
3. (Current at 85°C — Current at -45°C)/130
4. (Current at 5.25V-current - Current at 4.75V)/1000
5. Low frequency cut-off determined by external coupling capacitors & RF choke.

Absolute Maximum Ratings[6]

Parameter	Ratings
Operating Temperature (ground lead)	-40°C to 85°C
Junction Temperature	150°C
Power Dissipation	0.2W
Input Power (CW)	+22 dBm (5 minutes max.) +8 dBm (continuous)
Vs Supply voltage (Pin 3)	6V

6. Permanent damage may occur in any of these limits are exceeded.
Electrical maximum ratings are not intended for continuous normal operation.

Characterization Test Circuit

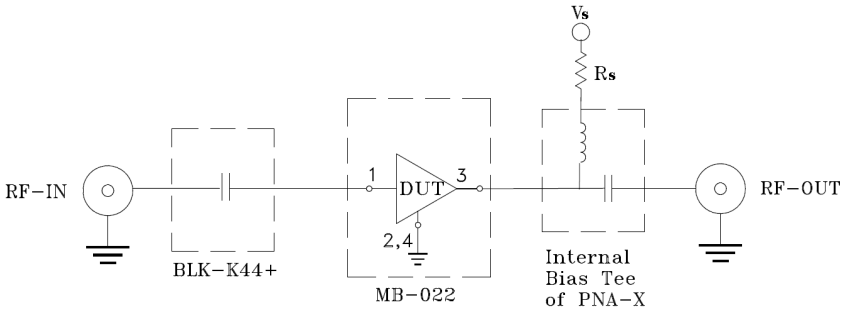
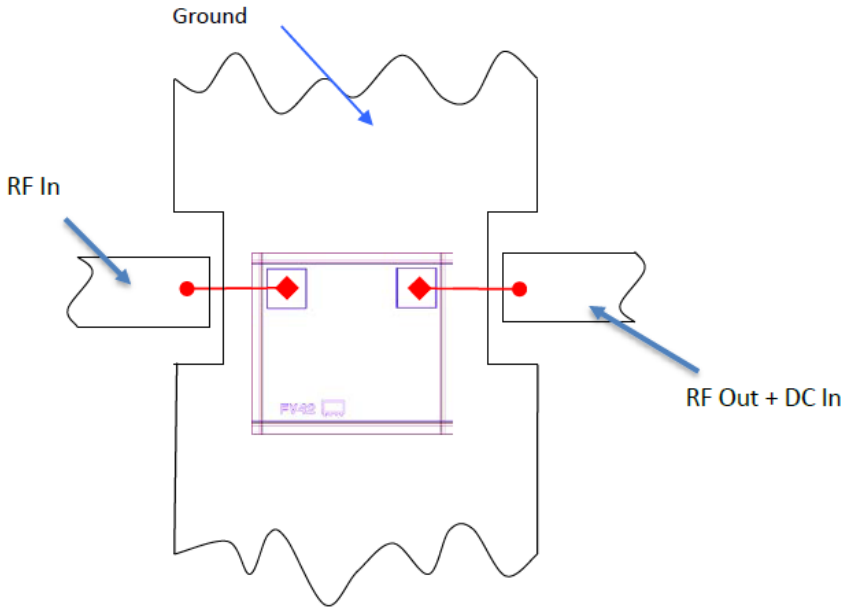


Fig 1. Characterization Circuit
Note: This block diagram is used for characterization. (Die is packaged in 70 mil, 4-lead ceramic package soldered on Mini-Circuits Characterization test board MB-022) Gain, Return loss, Output power at 1dB compression (P1 dB), output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA- X microwave network analyzer. RS=49.9 ohms, Vs = 5V
Conditions:
1. Gain and Return loss: Pin= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, -5 dBm/tone at output.

Assembly Diagram



Assembly and Handling Procedure

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC HBT amplifier dice are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be opened in clean room conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickup tips or sharp antistatic tweezers to deter ESD damage to dice.
3. Die Attach
   The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are DieMat DM6030HK-PT/H579 or Ablestik 84-1LMISR4. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total die periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. It is recommended to use antistatic die pick up tools only.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the dice gold bond pads. Thermosonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1 mil diameter. Bonds must be made from the bond pads on the die to the package or substrate. All bond wires should be kept as short as low as reasonable to minimize performance degradation due to undesirable series inductance.

Additional Detailed Technical Information

additional information is available on our dash board.

Performance Data	Data Table	
	Swept Graphs	
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)	
Case Style	Die	
Die Ordering and packaging information	Quantity, Package	Model No.
	Small, Gel - Pak: 5,10,50,100 KGD*	EHA-24L-DG+
	Medium†, Partial wafer: KGD*<3840	EHA-24L-DP+
	Large†, Full Wafer	EHA-24L-DF+
	†*Available upon request contact sales representative*	
	Refer to AN-60-067	
Environmental Ratings	ENV80	

*Known Good Dice ("KGD") means that the dice in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such dice fall within a predefined range. While DC testing is not definitive, it does help to provide a higher degree of confidence that dice are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

ESD Rating**

Human Body Model (HBM): Class 1A (pass 250V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard 70 mil, 4-lead ceramic MCLP package

Additional Notes

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.

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Typical Performance Data

NOTE: Use PDF Bookmarks to view DATA at required conditions

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5.00V, Id = 15.89mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
10	15.43	18.74	18.58	15.46	1.06	0.49	19.17	6.79	5.22
100	15.54	18.83	18.46	15.22	1.06	0.49	18.84	6.58	4.87
150	15.53	18.83	18.47	15.20	1.06	0.49	18.84	6.54	4.88
200	15.52	18.86	18.41	15.17	1.06	0.49	18.86	6.35	4.85
250	15.51	18.83	18.47	15.17	1.06	0.49	19.08	6.51	4.86
300	15.50	18.84	18.42	15.17	1.06	0.49	18.54	5.99	4.80
350	15.49	18.87	18.40	15.21	1.06	0.50	19.16	6.34	4.91
400	15.49	18.88	18.43	15.19	1.07	0.50	19.23	6.43	4.93
450	15.47	18.88	18.44	15.21	1.07	0.50	18.88	6.18	4.95
500	15.46	18.89	18.34	15.19	1.07	0.50	18.37	6.19	4.92
550	15.46	18.91	18.35	15.22	1.07	0.50	18.55	6.22	4.96
600	15.45	18.87	18.27	15.15	1.07	0.50	18.54	6.23	4.87
650	15.44	18.91	18.18	15.15	1.07	0.51	18.35	6.01	4.94
700	15.43	18.89	18.18	15.12	1.07	0.51	18.66	6.22	4.94
750	15.42	18.89	18.14	15.11	1.07	0.51	18.92	6.44	4.91
800	15.41	18.91	18.06	15.14	1.07	0.51	18.92	6.41	4.93
1000	15.36	18.92	17.83	15.01	1.07	0.52	18.65	6.65	4.98
2000	15.09	19.02	16.56	14.60	1.08	0.55	18.80	6.15	5.11
3000	14.76	19.12	15.31	13.90	1.10	0.59	17.94	5.74	5.13
4000	14.46	19.16	15.53	14.91	1.12	0.63	18.86	6.48	5.06
5000	14.17	19.13	15.70	15.11	1.14	0.65	17.85	6.05	5.05
6000	13.77	19.28	13.56	13.82	1.16	0.68	17.36	5.93	5.16
7000	13.46	19.47	12.90	13.07	1.19	0.72	16.99	5.97	5.13
8000	13.38	19.44	15.43	16.36	1.21	0.75	16.44	6.74	5.09
9000	13.39	19.57	16.36	16.62	1.23	0.75	15.49	6.26	5.13
10000	13.33	19.77	14.33	15.34	1.25	0.76	14.66	6.18	5.17
11000	13.10	20.21	11.45	12.60	1.27	0.77	13.86	5.28	5.35
12000	12.84	20.70	9.97	11.19	1.30	0.80	13.05	4.23	5.28
13000	12.85	20.78	12.41	13.21	1.34	0.82	12.22	3.88	5.13
14000	12.76	20.87	14.45	13.91	1.39	0.82	12.04	3.21	5.07
15000	12.41	21.09	13.04	14.27	1.46	0.85	11.15	2.48	5.17
16000	11.93	21.41	12.35	12.69	1.55	0.85	10.89	1.62	5.31
17000	11.31	21.99	10.04	12.58	1.68	0.91	10.95	1.04	5.51
18000	10.50	22.88	8.27	9.73	1.82	0.91	10.35	0.68	5.71
19000	10.00	23.33	8.68	8.34	1.96	0.86	10.69	0.29	5.72
20000	10.14	23.13	10.64	10.28	2.05	0.89	9.42	-0.48	5.78
21000	10.11	22.94	12.03	16.95	2.15	0.98	9.34	-0.97	5.92
22000	8.93	23.66	8.47	12.21	2.28	1.04	9.68	-1.59	6.43
23000	7.93	24.10	7.42	9.15	2.42	1.01	9.30	-1.76	6.55
24000	7.92	23.46	8.49	9.96	2.41	0.99	8.91	-2.27	6.67

Note: Test data of Die packaged in 4-lead ceramic package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 4.75V, Id = 11.50mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
10	14.62	18.56	15.13	13.20	1.08	0.53	14.94	3.05	5.19
100	14.69	18.45	15.22	12.75	1.07	0.50	14.73	2.74	4.81
150	14.69	18.40	15.17	12.75	1.07	0.50	14.74	2.74	4.82
200	14.68	18.44	15.16	12.74	1.07	0.50	14.65	2.53	4.82
250	14.67	18.46	15.21	12.76	1.07	0.51	14.95	2.69	4.82
300	14.66	18.43	15.19	12.75	1.07	0.50	14.42	2.21	4.84
350	14.65	18.44	15.18	12.77	1.07	0.51	14.99	2.53	4.89
400	14.65	18.47	15.21	12.77	1.07	0.51	15.07	2.68	4.91
450	14.64	18.49	15.23	12.81	1.08	0.51	14.73	2.37	4.91
500	14.63	18.49	15.17	12.78	1.08	0.51	14.30	2.41	4.86
550	14.62	18.49	15.19	12.79	1.08	0.52	14.39	2.42	4.84
600	14.61	18.49	15.13	12.76	1.08	0.52	14.41	2.43	4.87
650	14.60	18.48	15.08	12.75	1.08	0.52	14.25	2.25	4.93
700	14.59	18.49	15.10	12.74	1.08	0.52	14.46	2.49	4.89
750	14.58	18.50	15.08	12.73	1.08	0.52	14.73	2.63	4.95
800	14.57	18.50	15.03	12.77	1.08	0.52	14.82	2.62	4.90
1000	14.53	18.52	14.93	12.69	1.08	0.53	14.52	2.86	4.92
2000	14.28	18.62	14.26	12.51	1.09	0.56	14.70	2.39	5.03
3000	13.98	18.76	13.48	12.08	1.11	0.59	14.12	2.04	5.07
4000	13.74	18.77	13.83	13.02	1.13	0.63	15.37	2.80	5.00
5000	13.49	18.75	14.08	13.28	1.15	0.65	14.91	2.50	5.02
6000	13.11	18.91	12.33	12.34	1.17	0.68	15.03	2.55	5.08
7000	12.84	19.12	11.91	11.82	1.20	0.71	15.59	2.72	5.04
8000	12.82	19.04	14.39	14.80	1.22	0.74	17.33	3.77	5.00
9000	12.83	19.18	14.86	15.08	1.24	0.75	17.98	3.78	5.06
10000	12.73	19.45	12.99	13.75	1.26	0.75	18.12	4.45	5.14
11000	12.45	19.92	10.46	11.46	1.28	0.77	16.48	4.26	5.24
12000	12.19	20.44	9.47	10.26	1.32	0.79	15.96	3.38	5.17
13000	12.24	20.48	12.04	12.14	1.37	0.81	14.41	3.56	5.00
14000	12.12	20.67	13.76	12.84	1.44	0.82	13.21	2.88	4.93
15000	11.74	20.94	12.56	12.97	1.51	0.85	12.25	2.26	5.03
16000	11.22	21.31	11.75	11.57	1.61	0.85	11.92	1.52	5.16
17000	10.58	22.00	9.65	11.42	1.76	0.91	11.65	0.97	5.36
18000	9.76	22.82	8.21	8.87	1.91	0.89	11.30	0.82	5.57
19000	9.25	23.39	8.80	7.66	2.08	0.84	11.42	0.30	5.59
20000	9.40	23.20	10.73	9.35	2.18	0.88	9.85	-0.45	5.59
21000	9.36	23.02	11.51	14.61	2.30	0.98	9.82	-0.98	5.67
22000	8.19	23.71	8.18	11.18	2.42	1.04	10.16	-1.50	6.21
23000	7.22	24.35	7.32	8.42	2.62	0.98	9.77	-1.60	6.40
24000	7.25	23.63	8.42	9.06	2.58	0.97	9.25	-2.37	6.40

Note: Test data of Die packaged in 4-lead ceramic package

Typical Performance Data

Definitions:
Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

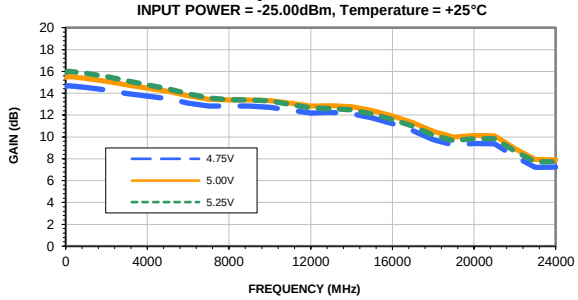
TEST CONDITIONS: Vd = 5.25V, Id = 20.92mA @ Temperature = +25°C

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
10	15.91	19.07	20.95	17.50	1.06	0.49	22.49	9.78	5.29
100	16.02	19.11	21.31	17.12	1.06	0.48	22.27	9.53	4.94
150	16.01	19.06	21.19	17.10	1.06	0.48	22.38	9.46	4.95
200	15.99	19.11	21.22	17.06	1.06	0.48	22.35	9.30	4.97
250	15.99	19.14	21.16	17.11	1.06	0.49	22.56	9.42	4.93
300	15.98	19.10	21.16	17.08	1.06	0.48	22.10	8.93	5.02
350	15.97	19.09	21.12	17.07	1.06	0.48	22.91	9.26	4.97
400	15.95	19.13	21.12	17.06	1.06	0.49	22.87	9.36	5.03
450	15.94	19.17	21.08	17.11	1.06	0.50	22.53	9.11	5.05
500	15.93	19.14	20.94	17.06	1.06	0.49	21.90	9.10	5.01
550	15.93	19.14	20.90	17.08	1.06	0.49	22.01	9.15	5.02
600	15.91	19.14	20.76	17.00	1.06	0.50	22.04	9.15	5.00
650	15.90	19.17	20.62	16.96	1.06	0.50	21.84	8.95	5.08
700	15.89	19.15	20.58	16.91	1.06	0.50	22.20	9.15	5.06
750	15.88	19.16	20.48	16.89	1.06	0.50	22.32	9.38	5.04
800	15.87	19.16	20.32	16.92	1.06	0.50	22.35	9.35	5.02
1000	15.82	19.17	19.82	16.71	1.06	0.51	22.06	9.58	5.06
2000	15.52	19.22	17.55	15.88	1.07	0.55	22.12	9.09	5.15
3000	15.14	19.29	15.73	14.81	1.09	0.59	20.91	8.64	5.22
4000	14.76	19.27	15.51	15.51	1.10	0.63	21.25	9.27	5.16
5000	14.41	19.21	15.45	15.48	1.12	0.65	19.41	8.78	5.16
6000	13.95	19.30	13.25	13.95	1.14	0.69	18.34	8.49	5.25
7000	13.57	19.48	12.50	12.96	1.17	0.72	17.34	8.26	5.22
8000	13.43	19.39	14.75	15.58	1.19	0.75	16.34	8.10	5.22
9000	13.40	19.52	15.66	15.59	1.21	0.75	15.13	7.24	5.23
10000	13.29	19.69	13.79	14.58	1.23	0.75	14.14	6.48	5.38
11000	12.98	20.15	11.10	11.92	1.26	0.77	13.33	5.51	5.48
12000	12.65	20.64	9.75	10.66	1.29	0.80	12.47	4.58	5.45
13000	12.60	20.69	12.11	12.22	1.34	0.82	11.62	4.13	5.30
14000	12.48	20.81	14.16	12.82	1.40	0.82	11.49	3.33	5.21
15000	12.11	21.03	12.89	13.16	1.48	0.85	10.61	2.62	5.36
16000	11.60	21.39	12.23	11.81	1.57	0.85	10.29	1.67	5.56
17000	10.99	22.03	10.03	11.81	1.72	0.90	10.31	1.05	5.76
18000	10.18	22.90	8.33	9.23	1.87	0.90	9.57	0.60	5.97
19000	9.66	23.52	8.76	7.92	2.04	0.85	9.98	0.10	5.98
20000	9.83	23.29	10.81	9.74	2.13	0.88	8.91	-0.56	6.04
21000	9.85	23.06	12.23	15.72	2.23	0.97	8.75	-1.16	6.20
22000	8.71	23.82	8.56	11.74	2.37	1.03	9.01	-1.81	6.92
23000	7.72	24.34	7.48	8.84	2.53	0.99	8.63	-1.94	6.92
24000	7.72	23.74	8.57	9.49	2.51	0.98	8.32	-2.52	6.90

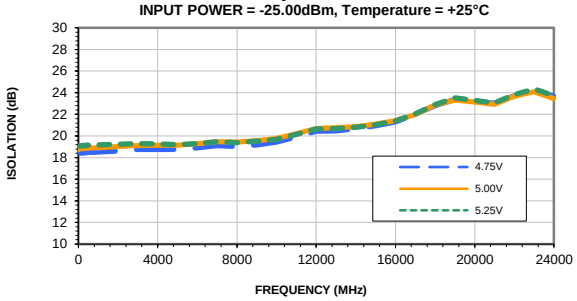
Note: Test data of Die packaged in 4-lead ceramic package

Typical Performance Curves

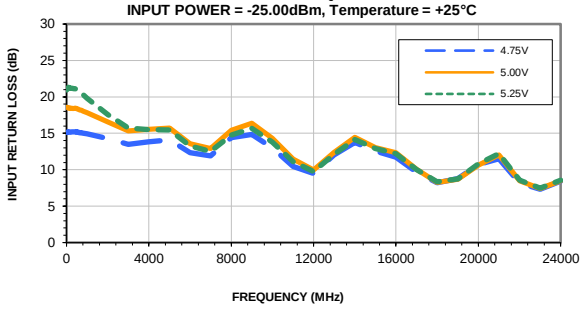
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



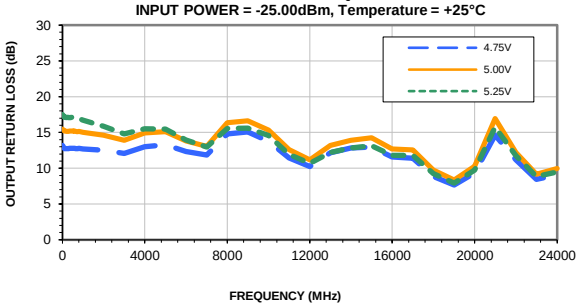
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



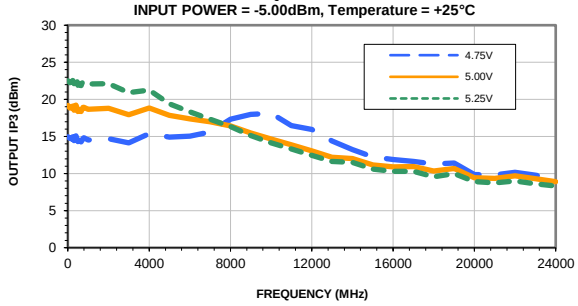
INPUT RETURN LOSS vs. FREQ. & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



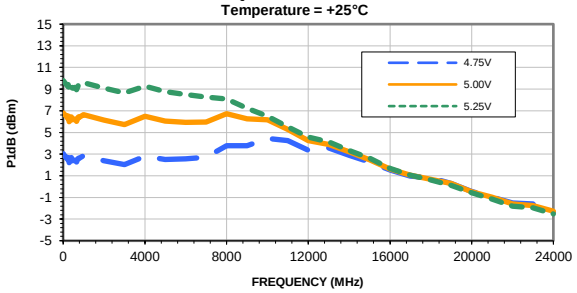
OUTPUT RETURN LOSS vs. FREQ. & DEVICE VOLTAGE
INPUT POWER = -25.00dBm, Temperature = +25°C



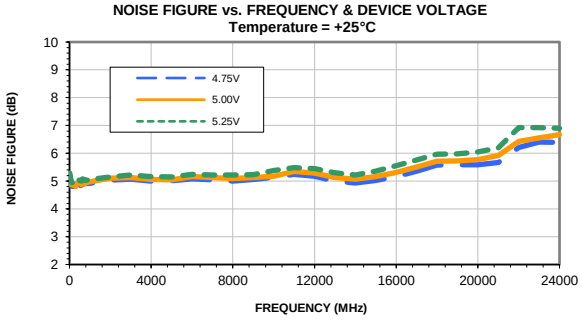
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -5.00dBm, Temperature = +25°C



P1dB vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



NOISE FIGURE vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



Note: Test data of Die packaged in 4-lead ceramic package

Mini-Circuits

Environmental Specifications ENV80

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C or -40° to 105° C or -55° to 105° C or -45° to 105° C Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment (Die)	-65° to 150°C	Individual Model Data Sheet
Storage Environment(Packaging)	-40° to 70°C and 40 to 60% humidity (In Factory Shipped Package)	