

Wideband

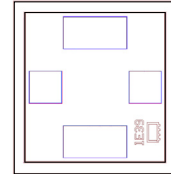
# Monolithic Amplifier Die

## GALI-39-D+

50Ω DC to 7 GHz

### The Big Deal

- Frequency range, DC to 7 GHz
- Output power, 10.5 dBm typ.
- High Gain, 19.7 dB at 2 GHz



### Product Overview

GALI-39-D+ (RoHS compliant) is a wideband amplifier Die offering high dynamic range. It uses patented Transient Protected Darlington configuration and is fabricated using InGaP HBT technology. GALI-39-D+ is designed to be rugged for supply switch-on transients.

### Key Features

Feature	Advantages
Broad Band: DC to 7 GHz	Broadband covering primary wireless communications bands: Cellular, PCS, LTE
Low Noise Figure, 2.4 dB typ. at 2 GHz	A unique feature of the GALI-39-D+ which separates this design from all competitors is the low noise figure performance in combination with the high IP3 resulting in high dynamic range.
Unpackaged Die	Enables the user to integrate the amplifier directly into hybrids



Wideband

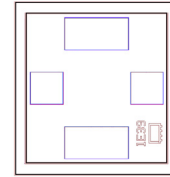
# Monolithic Amplifier Die

## GALI-39-D+

50Ω DC to 7 GHz

### Product Features

- Frequency range, DC to 7 GHz
- Internally Matched to 50 Ohms
- Output power, 10.5 dBm typ.
- High Gain, 19.7 dB at 2GHz
- Protected by US Patent 6,943,629



### +RoHS Compliant

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

Ordering Information: Refer to Last Page

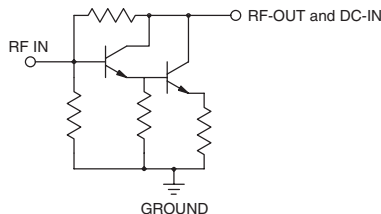
### Typical Applications

- Cellular infrastructure
- Military/Defense
- VHF/UHF Transmitter/Receiver

### General Description

GALI-39-D+ (RoHS compliant) is a wideband amplifier Die offering high dynamic range. It uses patented Transient Protected Darlington configuration and is fabricated using InGaP HBT technology. GALI-39-D+ is designed to be rugged for supply switch-on transients.

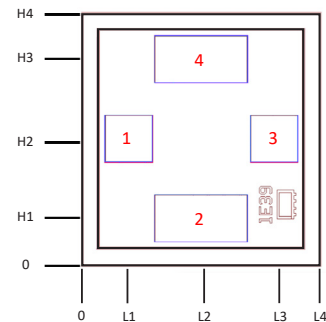
### Simplified Schematic and Pad description



Pad #	Function	Description
1	RF IN	RF input pad. This pad requires the use of an external DC blocking capacitor chosen for the frequency of operation.
3	RF-OUT and DC-IN	RF output and bias pad. DC voltage is present on this pin; therefore a DC blocking capacitor is necessary for proper operation. An RF choke and Bias resistor are needed to feed DC bias without loss of RF signal due to the bias connection, as shown in "Recommended Application Circuit".
2,4	GROUND	Ground pads. Connect to ground per assembly diagram.

Note: 1. Bond Pad material - Gold  
2. Bottom of Die - Gold plated

### Bonding Pad Position



Dimensions in μm, Typical

L1	L2	L3	L4	H1	H2	H3	H4
95.0	245.0	395.0	490.0	95.0	260.0	425.0	520.0
Bond pad #1&#3		Bond pad #2&#4		Die size		Thickness	
95.0 x 95.0		190.0 x 95.0		490.0 x 520.0		100	



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REV. OR  
M168961  
GALI-39-D+  
WP/RS/CP  
180731  
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Electrical Specifications<sup>1</sup> at 25°C and 35mA, unless noted

Parameter		Min.	Typ.	Max.	Units
Frequency Range*		DC		7	GHz
Gain	f=0.1 GHz	—	20.8	—	dB
	f=1 GHz	—	21.1	—	
	f=2 GHz	—	19.7	—	
	f=3 GHz	—	17.7	—	
	f=4 GHz	—	17.0	—	
	f=5 GHz	—	16.1	—	
	f=7 GHz	—	17.6	—	
Input Return Loss	f= DC to 3 GHz		12.5		dB
	f= 3 to 7 GHz		11		
Output Return Loss	f= DC to 3 GHz		14		dB
	f= 3 to 7 GHz		8.0		
Output Power @ 1 dB compression	f=7 GHz	—	10.5	—	dBm
Output IP3	f=2 GHz		22.9		dBm
Noise Figure	f=2 GHz		2.4		dB
Recommended Device Operating Current			35		mA
Device Operating Voltage		3.1	3.5	3.9	V
Device Voltage Variation vs. Temperature at 35 mA			-2.5		mV/°C
Device Voltage Variation vs. Current at 25°C			2.9		mV/mA
Thermal Resistance, junction-to-case <sup>1</sup>			127		°C/W

1. Measured on Mini-Circuits characterization test board TB-313, DUT packaged in industry standard SOT-89 package. See characterization test circuit (Fig. 1)

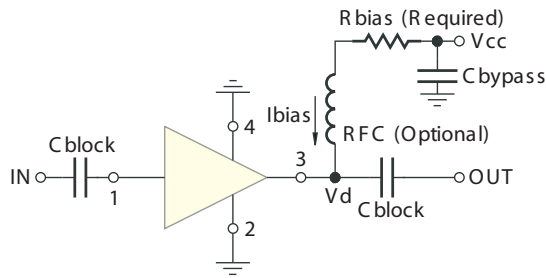
2. Guaranteed specification DC-7 GHz. Low frequency cut off determined by external coupling capacitors.

Absolute Maximum Ratings<sup>3</sup>

Parameter	Ratings
Operating Temperature	-45°C to 85°C
Storage Temperature	-65°C to 150°C
Operating Current	55 mA
Input Power	13 dBm

<sup>3</sup> Permanent damage may occur if any of these limits are exceeded.  
Electrical maximum ratings are not intended for continuous normal operation.

**Recommended Application and Characterization Test Circuit**



Test Board includes case, connectors, and components (in bold) soldered to PCB

R BIAS	
Vcc	"1%" Res. Values (ohms) for Optimum Biasing
7	107
8	133
9	162
10	191
11	221
12	249
13	280
14	309
15	340
16	365
17	392
18	422
19	453
20	475

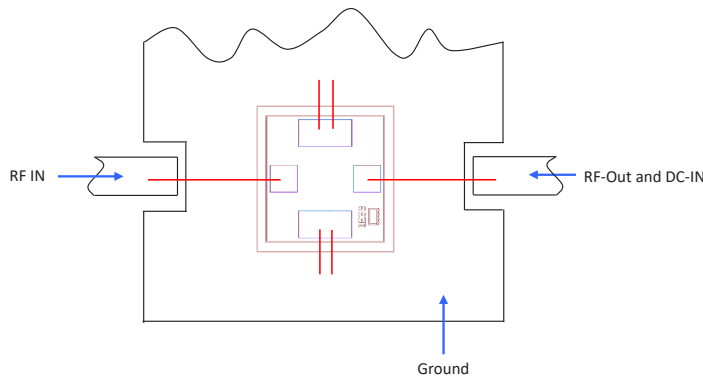
Fig 1. Block Diagram of Test Circuit used for characterization. (DUT, Die packaged in SOT-89 package, soldered on Mini-Circuits Characterization test board TB-313)

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.

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.

<b>Additional Detailed Technical Information</b> <i>additional information is available on our dash board.</i>	
<b>Performance Data</b>	Data Table
	Swept Graphs
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)
<b>Case Style</b>	Die
<b>Die Ordering and packaging information</b>	Quantity, Package Model No. Small, Gel - Pak: 5,10,50,100 KGD* GALI-39-DG+ Medium†, Partial wafer: KGD*<3020 GALI-39-DP+ Large†, Full Wafer GALI-39-DF+
	† Available upon request contact sales representative  Refer to <a href="#">AN-60-067</a>
<b>Environmental Ratings</b>	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 (250V to <500V) in accordance with ANSI/ESD STM 5.1 - 2001

\*\* Tested in industry standard SOT-89 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.
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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: Id = 35mA, Vd = 3.61V @Temperature = +25degC

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
					K	Measure			
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	23.37	25.47	34.83	26.79	1.03	0.79	25.44	12.34	2.10
100	23.39	25.50	34.38	26.25	1.03	0.79	25.39	12.09	2.30
200	23.29	25.46	33.11	25.57	1.03	0.78	25.42	12.17	2.16
300	23.17	25.47	31.75	25.11	1.03	0.77	25.44	12.08	2.38
400	23.03	25.42	31.39	24.15	1.04	0.76	25.00	12.15	2.20
500	22.86	25.40	29.97	23.72	1.04	0.75	24.87	11.98	2.34
600	22.69	25.33	29.35	23.12	1.04	0.74	24.76	12.06	2.21
700	22.51	25.32	28.81	22.85	1.05	0.73	25.10	12.19	2.22
800	22.31	25.28	28.51	22.49	1.06	0.71	25.31	12.14	2.23
1000	21.91	25.19	28.11	22.07	1.07	0.69	25.34	11.98	2.24
1200	21.51	25.12	28.00	21.81	1.08	0.66	25.07	11.64	2.32
1400	21.11	25.02	27.49	21.80	1.10	0.64	24.75	11.89	2.38
1600	20.70	24.94	27.18	22.13	1.12	0.62	24.96	11.59	2.43
1800	20.29	24.87	26.21	22.55	1.14	0.59	25.45	11.52	2.35
2000	19.89	24.77	25.06	23.11	1.15	0.57	25.50	11.68	2.32
2200	19.52	24.71	24.17	23.94	1.18	0.55	25.44	11.94	2.39
2400	19.12	24.64	23.04	25.04	1.20	0.53	25.35	11.97	2.40
2600	18.78	24.61	22.03	26.52	1.22	0.51	25.24	11.59	2.36
2800	18.46	24.56	20.61	27.98	1.24	0.49	25.30	11.63	2.41
3000	18.16	24.48	19.32	28.80	1.26	0.48	25.48	11.64	2.43
3200	17.88	24.48	18.24	29.80	1.28	0.46	25.44	11.47	2.44
3400	17.61	24.41	17.32	29.02	1.30	0.45	25.38	11.72	2.54
3600	17.37	24.38	16.57	27.52	1.32	0.44	25.02	11.62	2.69
3800	17.13	24.45	15.95	26.07	1.35	0.43	24.73	11.67	2.70
4000	16.91	24.48	15.59	24.69	1.37	0.42	24.70	11.94	2.70
4200	16.71	24.50	15.43	23.83	1.39	0.41	24.80	11.79	2.62
4400	16.56	24.48	14.98	23.08	1.41	0.41	24.78	11.68	2.67
4600	16.42	24.50	15.08	22.74	1.43	0.40	24.49	11.56	2.68
4800	16.29	24.58	15.07	22.11	1.45	0.40	24.15	11.63	2.81
5000	16.25	24.62	15.08	21.88	1.46	0.39	23.82	11.93	2.77
5200	16.19	24.71	15.07	21.68	1.48	0.39	23.81	11.69	2.64
5400	16.17	24.80	15.22	21.42	1.50	0.38	23.57	11.41	2.66
5600	16.13	24.78	15.81	21.06	1.51	0.38	23.45	11.41	2.75
5800	16.14	24.82	16.18	20.94	1.51	0.38	23.03	10.72	2.84
6000	16.19	24.89	16.25	20.98	1.52	0.38	22.40	10.46	2.87
6200	16.18	24.83	16.75	21.20	1.51	0.38	22.22	10.55	2.92
6400	16.22	24.93	17.01	21.15	1.52	0.38	21.97	10.34	2.94
6600	16.14	24.95	17.10	21.70	1.54	0.37	21.69	10.41	2.95
6800	16.28	24.42	18.41	18.94	1.45	0.41	21.31	10.23	3.02
7000	16.07	24.63	16.76	18.74	1.50	0.39	20.98	10.09	3.10

Note: Test data of Die packaged in industry standard SOT-89 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: Id = 28mA, Vd = 3.59V @Temperature = +25degC

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
					K	Measure			
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	22.68	24.88	26.23	33.35	1.03	0.78	22.13	9.02	2.11
100	22.69	24.85	26.64	32.85	1.03	0.78	22.11	8.97	2.23
200	22.61	24.83	26.34	33.97	1.03	0.77	22.11	9.19	2.19
300	22.49	24.84	27.36	32.65	1.04	0.76	22.12	8.82	2.31
400	22.36	24.78	27.18	33.30	1.04	0.76	21.70	8.90	2.26
500	22.24	24.76	27.71	32.23	1.04	0.75	21.61	8.98	2.29
600	22.08	24.70	27.01	31.91	1.04	0.74	21.55	8.89	2.27
700	21.88	24.68	27.54	31.10	1.05	0.72	21.91	9.11	2.16
800	21.72	24.66	27.59	30.66	1.05	0.71	22.16	9.09	2.26
1000	21.38	24.59	26.74	29.58	1.07	0.69	22.22	8.89	2.22
1200	21.00	24.53	25.78	28.62	1.08	0.66	21.94	8.69	2.31
1400	20.62	24.46	24.43	27.96	1.09	0.64	21.69	8.78	2.36
1600	20.20	24.42	23.26	27.64	1.11	0.61	21.92	8.67	2.39
1800	19.83	24.39	22.11	27.24	1.13	0.59	22.60	8.58	2.30
2000	19.46	24.32	20.89	27.07	1.15	0.57	22.69	8.87	2.27
2200	19.09	24.28	20.13	27.38	1.17	0.55	22.85	8.97	2.35
2400	18.71	24.25	19.19	27.25	1.19	0.52	22.97	8.98	2.33
2600	18.38	24.25	18.48	27.05	1.22	0.50	23.03	9.16	2.32
2800	18.07	24.21	17.46	26.15	1.24	0.49	23.28	8.85	2.37
3000	17.79	24.16	16.56	25.25	1.25	0.47	23.57	8.79	2.39
3200	17.49	24.19	15.66	24.58	1.28	0.46	23.55	8.69	2.42
3400	17.23	24.15	15.03	23.63	1.29	0.45	23.52	8.81	2.53
3600	17.00	24.16	14.44	22.53	1.31	0.44	23.29	8.73	2.66
3800	16.76	24.25	14.01	21.63	1.34	0.42	23.18	8.60	2.71
4000	16.56	24.30	13.71	20.90	1.37	0.42	23.28	9.02	2.69
4200	16.38	24.34	13.66	20.28	1.39	0.41	23.42	9.13	2.61
4400	16.23	24.34	13.30	20.03	1.41	0.40	23.28	9.06	2.66
4600	16.09	24.37	13.42	19.86	1.43	0.40	23.02	8.95	2.70
4800	15.97	24.46	13.41	19.63	1.46	0.39	22.78	9.14	2.77
5000	15.92	24.52	13.48	19.49	1.47	0.39	22.61	9.61	2.70
5200	15.87	24.62	13.50	19.55	1.49	0.38	22.85	9.26	2.61
5400	15.83	24.71	13.56	19.38	1.51	0.38	22.81	9.22	2.62
5600	15.81	24.70	14.07	19.36	1.52	0.38	22.88	8.71	2.70
5800	15.82	24.74	14.35	19.46	1.53	0.38	22.59	8.86	2.77
6000	15.85	24.80	14.28	19.53	1.53	0.38	22.05	8.80	2.80
6200	15.86	24.74	14.65	19.99	1.53	0.38	21.99	8.99	2.85
6400	15.90	24.81	14.72	20.05	1.53	0.38	21.75	9.26	2.86
6600	15.80	24.83	14.84	20.95	1.55	0.37	21.46	9.33	2.86
6800	15.91	24.29	15.66	18.66	1.47	0.40	21.19	9.39	2.94
7000	15.70	24.50	14.59	18.95	1.51	0.38	20.84	9.17	3.03

Note: Test data of Die packaged in industry standard SOT-89 package

## Typical Performance Data

### Definitions:

Input Return Loss = -S11 (dB)

Gain(Power Gain) = S21 (dB)

Reverse Isolation = -S12 (dB)

Output Return Loss = -S22 (dB)

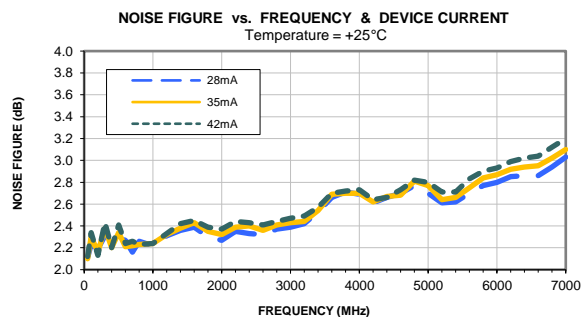
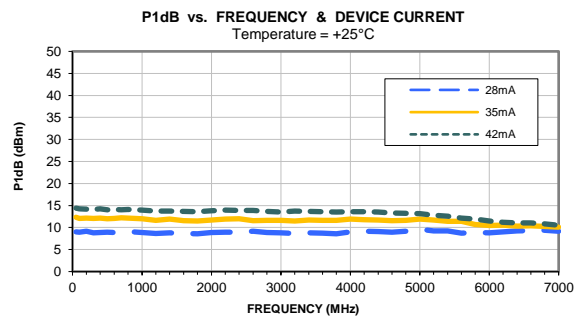
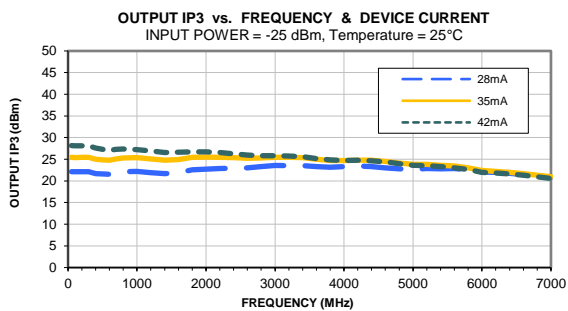
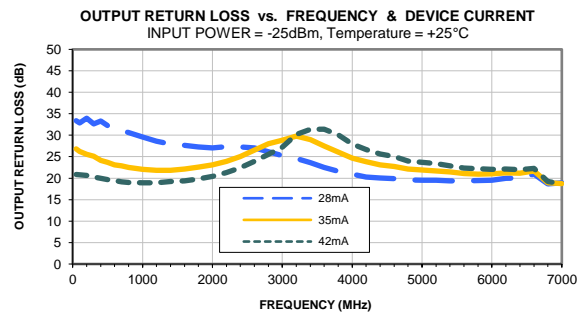
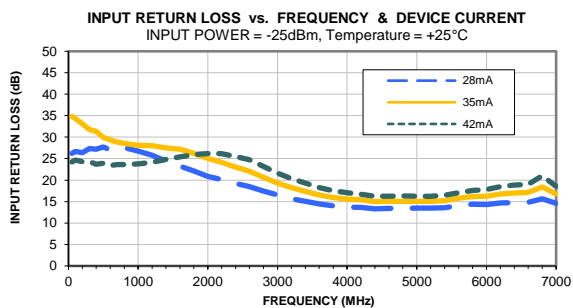
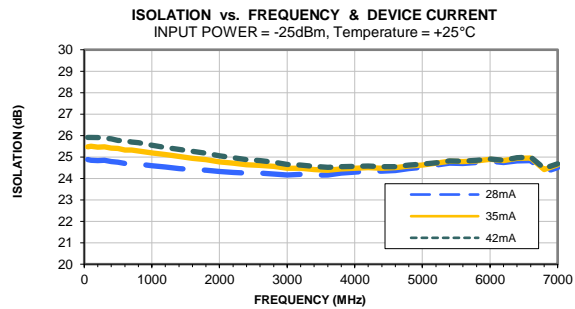
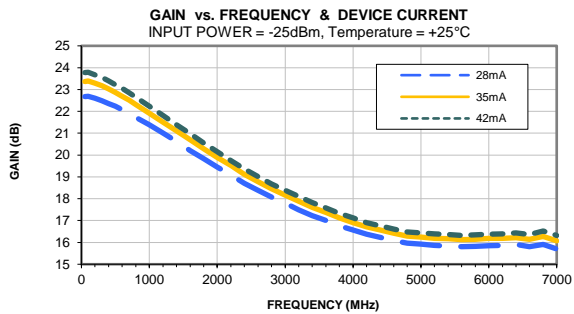
TEST CONDITIONS: Id = 42mA, Vd = 3.63V @Temperature = +25degC

FREQ	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
					K	Measure			
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	23.78	25.91	24.23	20.89	1.03	0.79	28.15	14.41	2.12
100	23.79	25.91	24.65	20.82	1.03	0.79	28.11	14.24	2.34
200	23.67	25.90	24.29	20.60	1.03	0.78	28.14	14.20	2.13
300	23.55	25.87	24.32	20.25	1.03	0.77	28.10	14.14	2.43
400	23.40	25.85	23.70	19.93	1.04	0.76	27.59	14.25	2.20
500	23.22	25.77	23.89	19.64	1.04	0.75	27.29	14.02	2.41
600	23.05	25.75	23.38	19.47	1.04	0.74	27.08	14.09	2.24
700	22.85	25.70	23.60	19.14	1.05	0.73	27.26	14.05	2.26
800	22.64	25.66	23.60	19.00	1.06	0.71	27.34	14.11	2.23
1000	22.23	25.55	23.80	18.90	1.07	0.69	27.23	13.98	2.24
1200	21.81	25.44	24.15	18.95	1.08	0.67	26.94	13.73	2.33
1400	21.39	25.35	24.79	19.21	1.10	0.64	26.54	13.76	2.42
1600	20.97	25.26	25.44	19.35	1.12	0.62	26.64	13.64	2.45
1800	20.55	25.17	25.91	19.81	1.14	0.59	26.68	13.62	2.39
2000	20.15	25.05	26.19	20.43	1.16	0.57	26.67	13.80	2.37
2200	19.75	24.97	26.18	21.32	1.18	0.55	26.54	13.94	2.44
2400	19.37	24.88	25.51	22.41	1.20	0.53	26.24	13.88	2.43
2600	19.01	24.83	24.73	23.88	1.22	0.51	25.95	13.89	2.41
2800	18.68	24.75	23.17	25.58	1.24	0.50	25.84	13.67	2.44
3000	18.39	24.65	21.60	27.16	1.26	0.48	25.83	13.55	2.47
3200	18.10	24.62	20.34	30.17	1.28	0.47	25.71	13.71	2.49
3400	17.82	24.56	19.26	31.36	1.30	0.46	25.60	13.65	2.57
3600	17.58	24.51	18.25	31.41	1.32	0.45	25.15	13.62	2.70
3800	17.33	24.55	17.50	30.12	1.34	0.43	24.85	13.53	2.72
4000	17.12	24.56	17.07	27.91	1.37	0.43	24.72	13.61	2.73
4200	16.91	24.57	16.70	26.71	1.39	0.42	24.77	13.62	2.64
4400	16.76	24.54	16.23	25.62	1.40	0.41	24.63	13.49	2.66
4600	16.61	24.55	16.24	25.00	1.42	0.41	24.38	13.28	2.73
4800	16.48	24.62	16.29	24.00	1.45	0.40	23.97	13.26	2.82
5000	16.44	24.66	16.23	23.72	1.45	0.40	23.60	13.17	2.80
5200	16.39	24.73	16.22	23.42	1.47	0.39	23.55	12.78	2.71
5400	16.36	24.82	16.46	22.86	1.49	0.39	23.30	12.55	2.71
5600	16.32	24.80	17.08	22.38	1.49	0.39	23.04	12.14	2.83
5800	16.34	24.85	17.57	22.19	1.50	0.39	22.64	11.94	2.90
6000	16.38	24.91	17.77	22.04	1.50	0.38	21.98	11.49	2.93
6200	16.39	24.85	18.46	22.15	1.50	0.39	21.83	11.21	2.99
6400	16.44	24.96	18.87	22.01	1.50	0.38	21.61	11.05	3.02
6600	16.36	24.99	19.02	22.28	1.52	0.38	21.29	11.05	3.04
6800	16.52	24.47	21.04	19.23	1.43	0.41	20.95	10.86	3.12
7000	16.32	24.68	18.56	18.70	1.48	0.40	20.57	10.52	3.20

Note: Test data of Die packaged in industry standard SOT-89 package



## Typical Performance Curves



Note: Test data of Die packaged in industry standard SOT-89 package



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.

<b>Specification</b>	<b>Test/Inspection Condition</b>	<b>Reference/Spec</b>
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)	