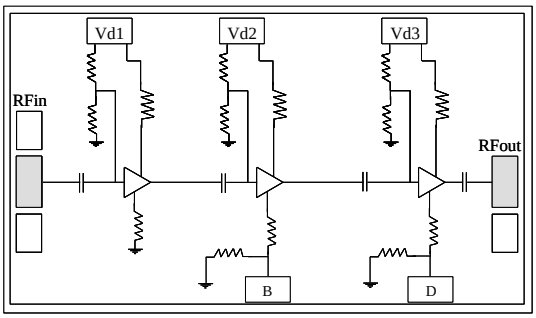
12.5-30GHz Low Noise Amplifier

GaAs Monolithic Microwave IC

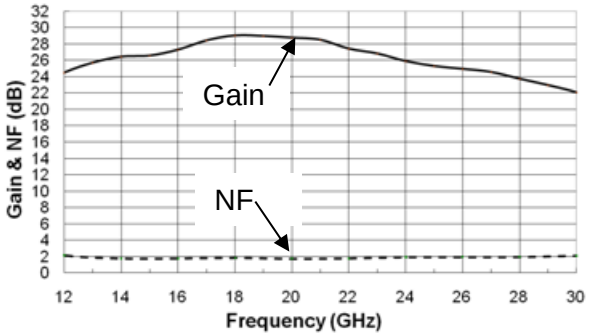
Description

The CHA3689-99F is a three-stage self biased wide band monolithic low noise amplifier.
It is designed for a wide range of applications, from military to commercial communication systems.
The circuit is manufactured with a pHEMT process, 0.25µm gate length, via holes through the substrate, air bridges and electron beam gate lithography.
It is available in chip form.



Main Features

- Broadband performance: 12.5-30GHz
- 2.0dB noise figure
- 26dB gain (12.5-26GHz)
- 26dBm output IP3 (18-30GHz)
- Low DC power consumption
- DC bias: Vd=4 Volt @ Id= 90 /120mA
- Chip size : 2.45 x 1.21 x 0.1mm



On wafer typical measurements @ 120mA

Main Characteristics

Tamb = +25°C, Vd1=Vd2=Vd3 = +4V Pads B, D = GND (High current configuration)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	12.5		30	GHz
Gain	Linear Gain		26		dB
NF	Noise Figure		2	2.6	dB
Pout1dB	Output Power @1dB comp.	14	15		dBm

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Main Characteristics (low current configuration)

Tamb = +25°C, Vd1=Vd2=Vd3= +4V **Pads B, D = not connected**

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	12.5		30	GHz
Gain	Gain (12.5 - 24GHz) Gain (24.5 - 30GHz)	23 20	26 22		dB dB
ΔG	Gain flatness (12.5 - 24GHz) Gain flatness (24.5 - 30GHz)		±2.5 ±2		dB dB
NF	Noise figure (12.5 - 24GHz) Noise figure (24.5 - 30GHz)		1.8 2.0	2.3 2.5	dB dB
S11	Input return loss (12.5 - 16GHz) (27 - 30GHz) Input return loss (16 - 27GHz)		3.0:1 2.0:1	3.5:1 2.5:1	dB dB
S22	Output return loss		2.5:1	3.0:1	dB
OIP3	3rd order intercept point (18 – 30GHz)	23	24		dBm
P1dB	Output power at 1dB gain compression	13	14		dBm
Id	Drain bias current		90	120	mA
Vd	Drain bias voltage		4		V

These values are representative of on-wafer measurements that are made without bonding wires at the RF ports.

Main Characteristics (high current configuration)

Tamb = +25°C, Vd1=Vd2=Vd3= +4V **Pads B, D = GND**

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	12.5		30	GHz
Gain	Gain (12.5 - 24GHz) Gain (24.5 - 30GHz)	24 21	27 23		dB dB
ΔG	Gain flatness (12.5 - 24GHz) Gain flatness (24.5 - 30GHz)		±2.5 ±2		dB dB
NF	Noise figure (12.5 - 24GHz) Noise figure (24.5 - 30GHz)		1.9 2.1	2.4 2.6	dB dB
S11	Input return loss (12.5 - 16GHz) (27 - 30GHz) Input return loss (16 - 27GHz)		3.0:1 2.0:1	3.5:1 2.5:1	dB dB
S22	Output return loss		2.5:1	3.0:1	dB
OIP3	3rd order intercept point (18 – 30GHz)	25	26		dBm
P1dB	Output power at 1dB gain compression	14	15		dBm
Id	Drain bias current		120	150	mA
Vd	Drain bias voltage		4		V

These values are representative of on-wafer measurements that are made without bonding wires at the RF ports.

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Absolute Maximum Ratings (1)

Tamb.= +25°C

Symbol	Parameter	Values	Unit
Vd	Drain bias voltage	4.5V	V
Pin	RF input power	+10	dBm
Tj	Junction temperature	175	°C
Ta	Operating temperature range	-40 to +85	°C
Tstg	Storage temperature range	-55 to +150	°C

(1) Operation of this device above anyone of these parameters may cause permanent damage.

Typical Bias Conditions

Tamb.= +25°C

Symbol	Parameter	Values	Unit
Vd1	DC Drain voltage	4	V
Vd2	DC Drain voltage	4	V
Vd3	DC Drain voltage	4	V
B	DC Gate voltage	Connected to ground or not	
D	DC Gate voltage		

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Typical on-wafer Sij parameters for low current configuration

Tamb = +25°C, Vd1=Vd2=Vd3= +4V, Id = 90 mA and Pads B, D not connected

Freq (GHz)	S11 (dB)	PhS11 (°)	S12 (dB)	PhS12 (°)	S21 (dB)	PhS21 (°)	S22 (dB)	PhS22 (°)
2.0	-0.1	-23	-67.3	-16	-65.4	67	-0.2	-30
3.0	-0.1	-35	-61.6	-160	-70.6	-166	-0.3	-47
4.0	-0.2	-48	-81.4	132	-56.0	10	-0.5	-66
5.0	-0.2	-64	-60.5	-176	-33.7	-32	-1.3	-90
6.0	-0.3	-81	-63.3	-15	-16.5	-89	-3.3	-118
7.0	-0.5	-106	-59.5	-2	-1.4	-160	-8.0	-147
8.0	-1.5	-141	-61.4	73	7.4	123	-14.9	-143
9.0	-3.9	170	-55.2	-83	15.1	54	-19.6	-142
10.0	-6.7	110	-59.4	-68	19.5	-20	-14.6	-73
11.0	-6.5	53	-61.7	-76	22.2	-81	-11.6	-108
12.0	-5.0	7	-51.4	-156	23.9	-137	-12.2	-134
13.0	-4.5	-26	-51.6	176	25.1	173	-12.5	-153
14.0	-5.1	-53	-49.3	-136	25.8	126	-13.1	-178
15.0	-5.9	-67	-61.1	-1	26.2	85	-15.0	155
16.0	-5.9	-81	-44.5	67	27.3	49	-12.3	147
17.0	-8.0	-102	-47.5	60	27.7	7	-12.3	121
18.0	-8.9	-118	-47.7	20	28.7	-30	-9.9	101
19.0	-12.8	-137	-52.1	7	28.5	-72	-8.1	78
20.0	-15.3	-150	-49.2	10	28.4	-108	-7.8	56
21.0	-20.3	-172	-59.8	-56	27.9	-147	-7.3	36
22.0	-25.7	170	-72.9	24	26.9	180	-8.2	19
23.0	-26.6	105	-55.4	71	26.2	147	-8.8	9
24.0	-24.2	47	-54.5	41	25.1	116	-9.3	1
25.0	-22.4	43	-54.8	13	24.4	88	-10.2	-8
26.0	-18.9	57	-61.9	-85	24.1	60	-12.2	3
27.0	-12.0	62	-47.8	177	24.0	26	-10.1	8
28.0	-9.2	45	-63.2	-179	23.0	-4	-9.9	-1
29.0	-7.1	27	-48.4	99	22.2	-35	-9.6	-1
30.0	-5.4	15	-49.5	-2	21.2	-67	-9.0	-2
31.0	-3.5	0	-47.3	-75	19.8	-100	-7.9	-1
32.0	-2.7	-15	-47.6	-133	17.9	-133	-6.7	-9
33.0	-2.6	-29	-45.0	-160	15.5	-162	-6.1	-14
34.0	-2.6	-38	-49.3	40	12.9	172	-5.4	-22
35.0	-2.4	-46	-38.8	98	10.7	149	-4.9	-26
36.0	-2.4	-57	-45.5	124	8.2	129	-4.4	-34
37.0	-2.3	-64	-51.5	114	6.2	109	-4.0	-40
38.0	-2.7	-73	-46.1	-96	4.1	92	-4.0	-48
39.0	-3.2	-76	-56.0	142	2.4	75	-4.0	-54
40.0	-3.6	-87	-47.4	153	1.1	56	-4.1	-62

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Typical on-wafer Sij parameters for high current configuration

Tamb = +25°C, Vd1=Vd2=Vd3= +4V, Id = 120 mA and Pads B, D Grounded

Freq (GHz)	S11 (dB)	PhS11 (°)	S12 (dB)	PhS12 (°)	S21 (dB)	PhS21 (°)	S22 (dB)	PhS22 (°)
2.0	-0.1	-23	-62.8	-51	-59.9	-140	-0.2	-30
3.0	-0.1	-35	-60.7	9	-58.1	-121	-0.3	-46
4.0	-0.1	-48	-63.5	-105	-54.9	31	-0.5	-65
5.0	-0.2	-63	-72.0	63	-33.8	-31	-1.2	-88
6.0	-0.3	-80	-74.5	-171	-15.8	-87	-3.2	-115
7.0	-0.5	-105	-66.5	137	-0.7	-159	-8.0	-142
8.0	-1.5	-140	-57.0	-133	8.1	124	-14.6	-133
9.0	-3.8	171	-65.6	-97	15.7	55	-17.5	-128
10.0	-6.6	112	-53.8	-100	20.1	-18	-13.4	-77
11.0	-6.5	55	-53.3	-131	22.7	-80	-10.7	-109
12.0	-5.0	9	-52.2	-152	24.5	-136	-11.4	-134
13.0	-4.6	-25	-59.8	165	25.7	174	-11.7	-152
14.0	-5.2	-51	-49.6	84	26.4	127	-13.3	-179
15.0	-6.7	-67	-45.7	147	26.6	86	-14.6	161
16.0	-6.6	-76	-44.7	79	27.3	51	-13.2	148
17.0	-7.1	-100	-48.0	85	28.4	11	-12.3	125
18.0	-9.1	-115	-60.5	63	29.0	-27	-10.2	107
19.0	-12.0	-134	-59.0	-25	29.0	-68	-8.4	78
20.0	-14.8	-142	-61.1	131	28.8	-104	-8.1	56
21.0	-18.5	-171	-56.6	-81	28.5	-142	-7.5	36
22.0	-23.6	150	-62.0	18	27.4	-176	-8.0	18
23.0	-26.6	101	-57.1	174	26.8	152	-8.7	6
24.0	-23.6	58	-59.9	150	25.9	121	-9.3	-1
25.0	-21.8	48	-56.2	22	25.3	93	-10.2	-10
26.0	-17.3	54	-56.5	-113	24.9	64	-11.9	-1
27.0	-12.9	54	-51.9	139	24.6	32	-10.8	1
28.0	-10.1	42	-49.9	-2	23.7	1	-10.1	-6
29.0	-7.3	27	-49.0	33	23.0	-30	-10.2	-3
30.0	-5.6	12	-44.7	120	22.1	-61	-9.4	-4
31.0	-4.0	1	-53.1	29	20.8	-95	-8.4	-3
32.0	-3.1	-14	-53.6	128	19.1	-129	-7.2	-8
33.0	-2.8	-27	-59.1	-80	16.6	-159	-6.2	-12
34.0	-2.8	-37	-48.0	99	14.0	174	-5.6	-20
35.0	-2.3	-46	-47.2	-155	11.6	151	-4.8	-24
36.0	-2.5	-55	-43.6	141	9.1	130	-4.3	-32
37.0	-2.3	-65	-63.3	109	6.8	110	-4.0	-39
38.0	-3.1	-75	-45.0	179	4.5	91	-3.9	-43
39.0	-3.3	-77	-46.0	101	2.4	75	-3.9	-50
40.0	-3.9	-85	-31.5	144	0.7	57	-3.5	-54

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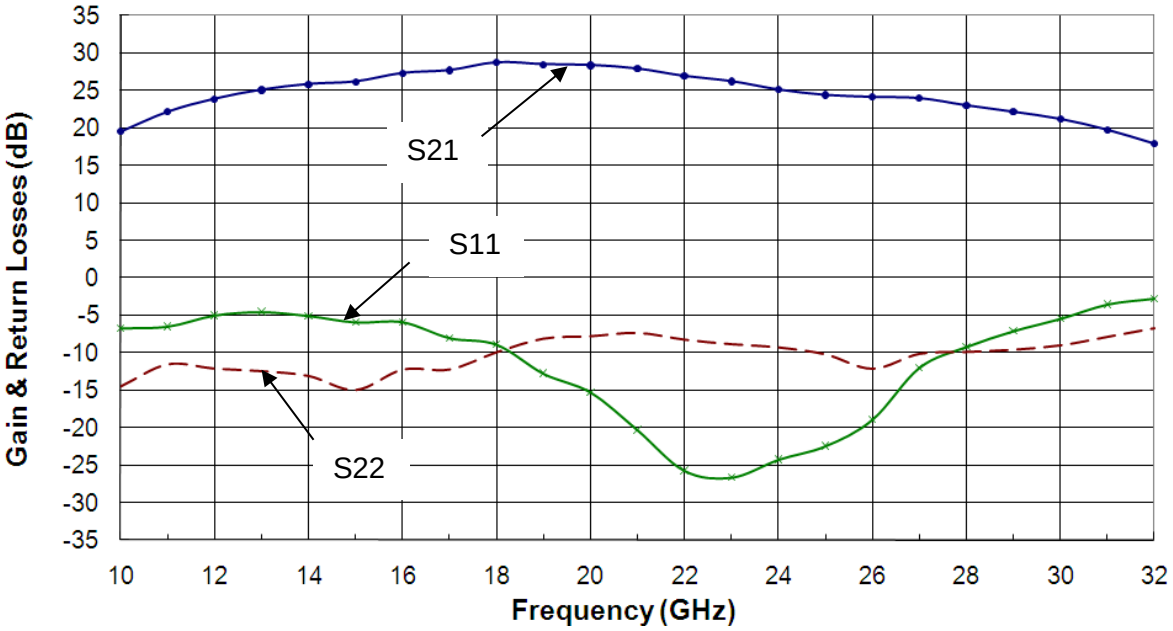
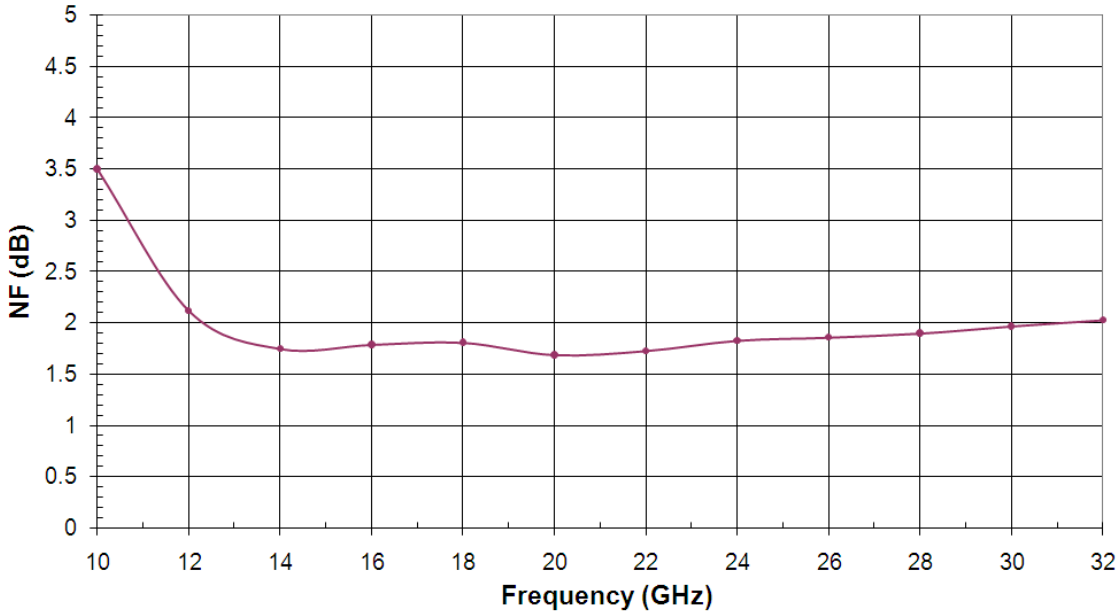
Typical on wafer Measurements

Tamb = +25°C, Vd1=Vd2=Vd3= +4V Id = 90 mA
Pads B, D = not connected (low current configuration)

Gain and return losses versus frequency



Noise figure versus frequency



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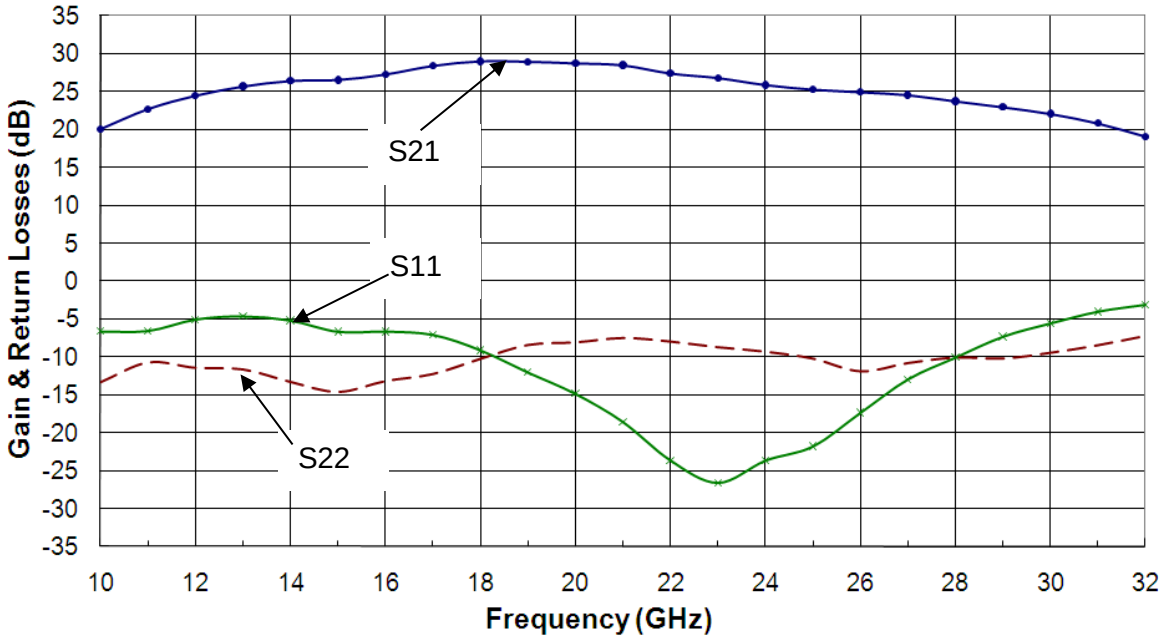
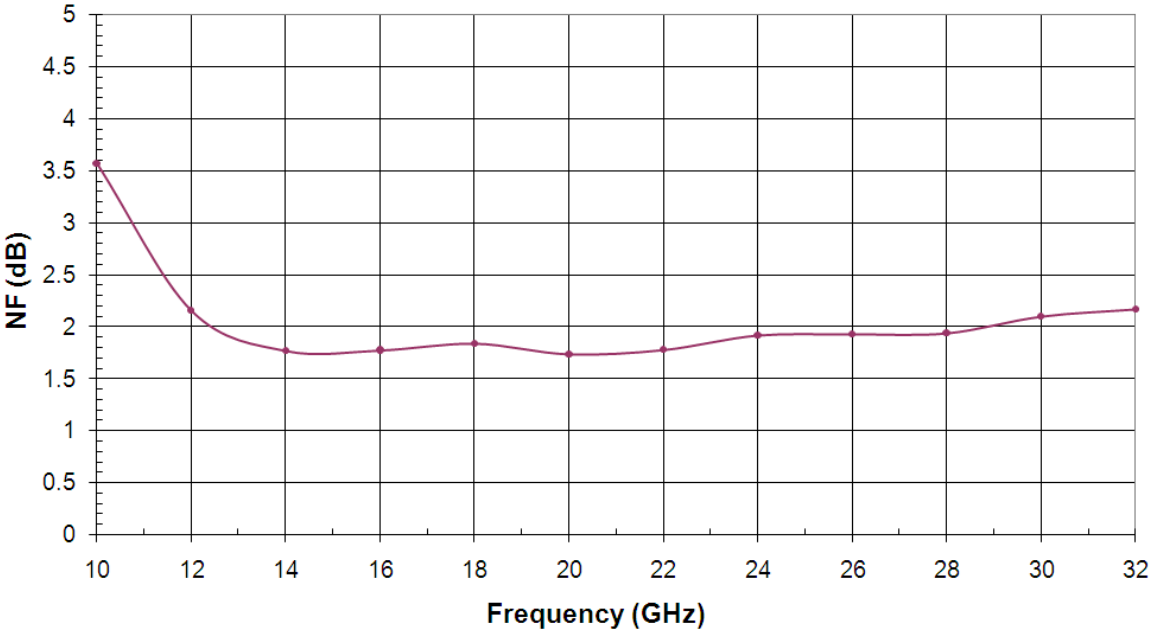
Typical on wafer Measurements

Tamb = +25°C, Vd1=Vd2=Vd3= +4V Id = 120 mA
Pads B, D = GND (high current configuration)

Gain and return losses versus frequency



Noise figure versus frequency



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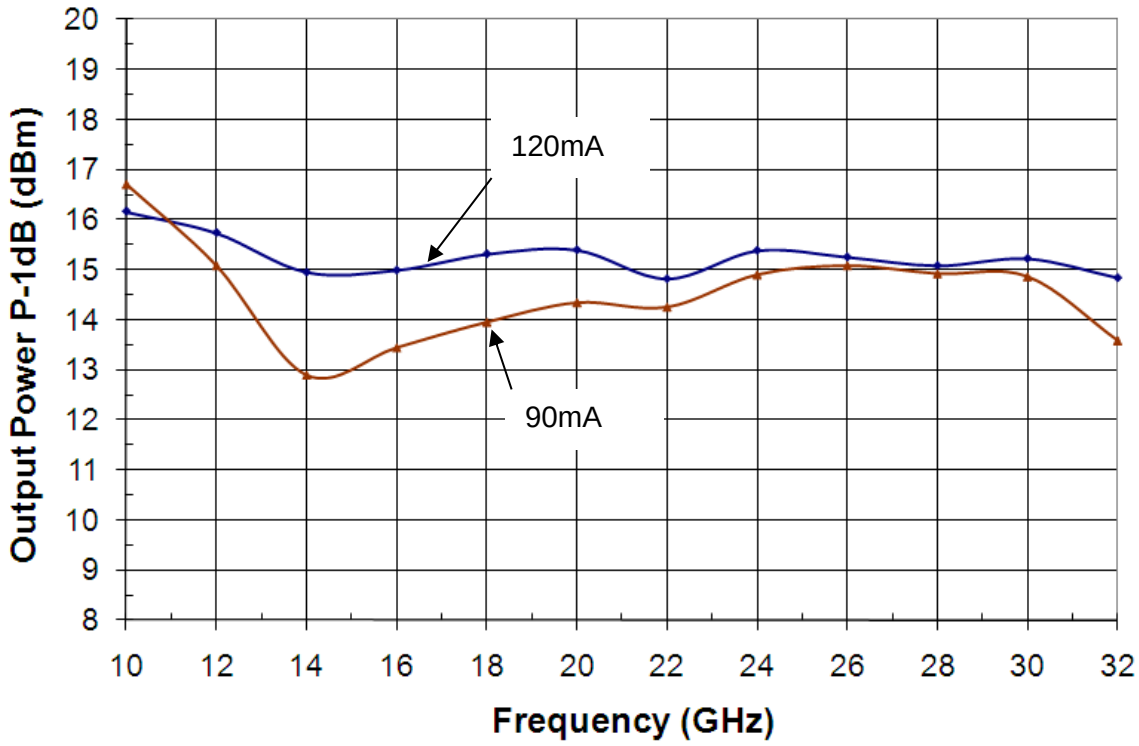
Typical on wafer Measurements

Tamb = +25°C, Vd1=Vd2=Vd3= +4V Id = 90/120 mA

Output power -1dB for low and high current configurations



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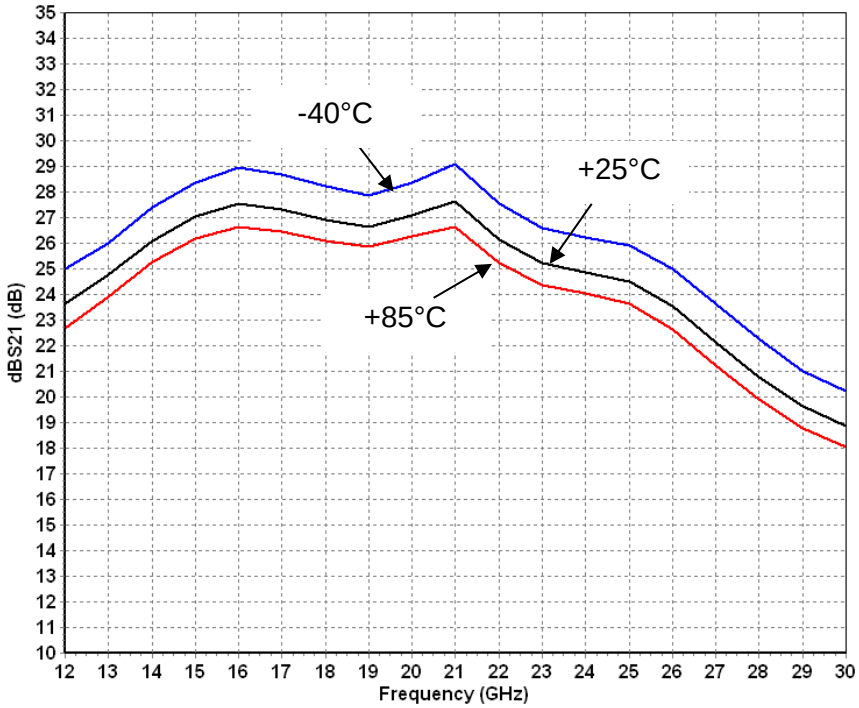
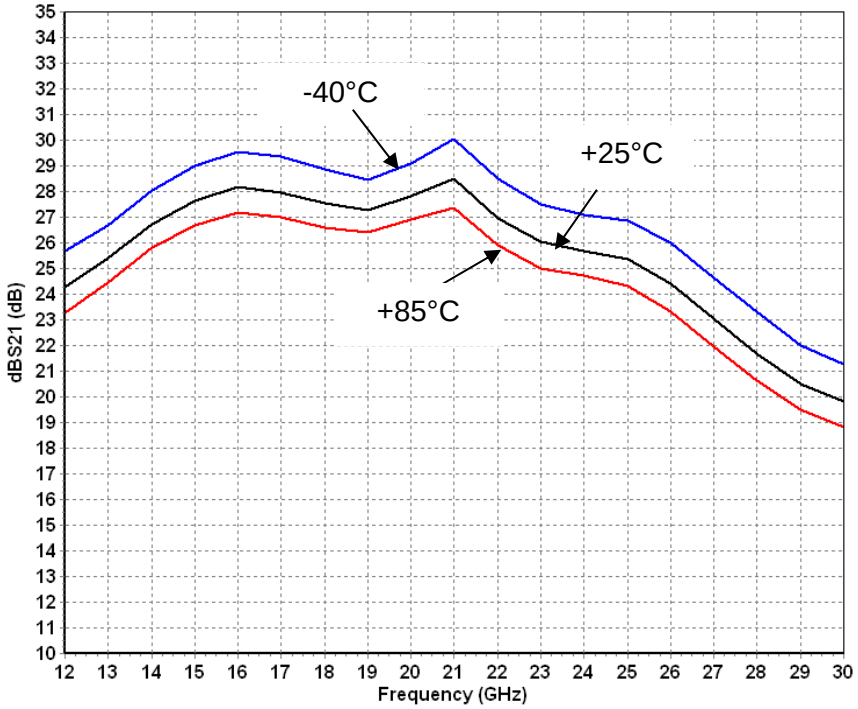
Typical Test Fixture Measurements

Tamb = -40°C / +25°C / +85°C, Vd1=Vd2=Vd3= +4V
Measurements are given in the connectors' access plans. Losses are not de-embedded.

Gain measurement for low current configuration
Pads B, D = not connected



Gain measurement for high current configuration
Pads B, D = GND



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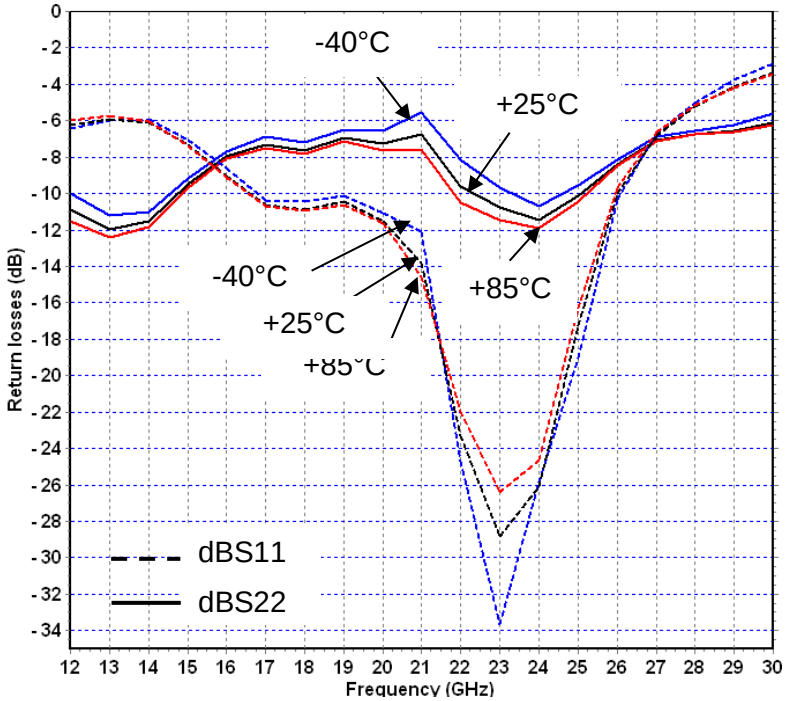
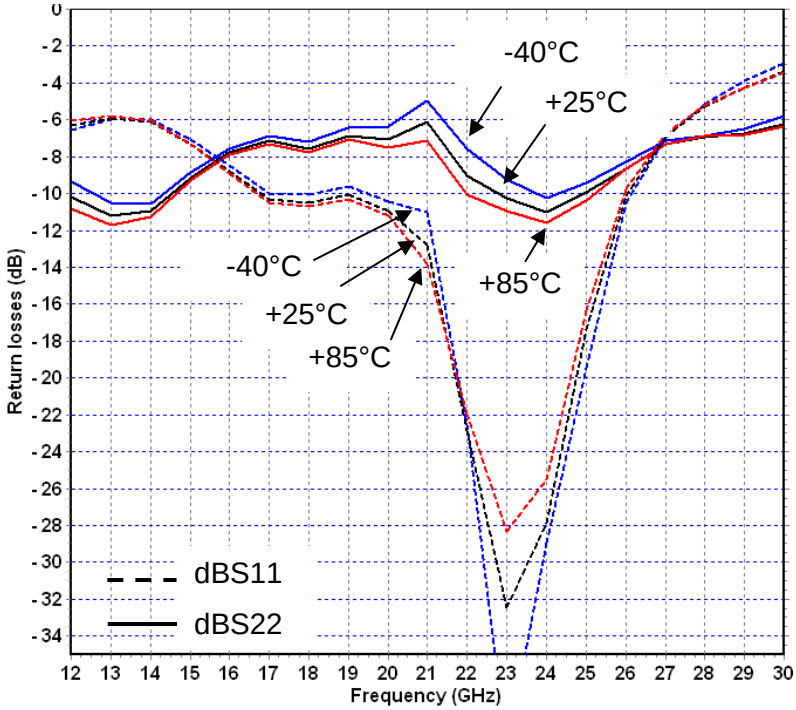
Typical Test Fixture Measurements

Tamb = -40°C / +25°C / +85°C, Vd1=Vd2=Vd3= +4V
Measurements are given in the connectors' access plans. Losses are not de-embedded.

Return losses for low current configuration
Pads B, D = not connected



Return losses for high current configuration
Pads B, D = GND



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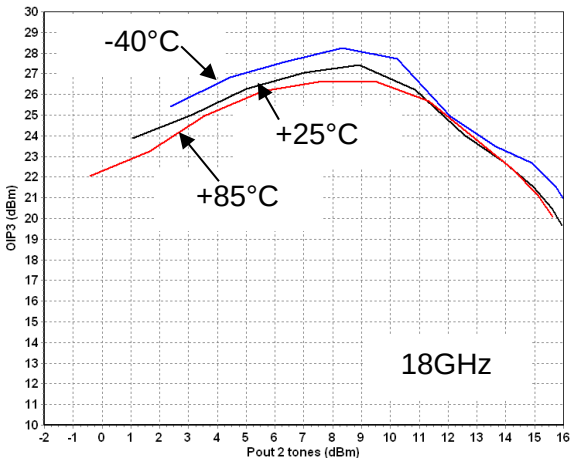
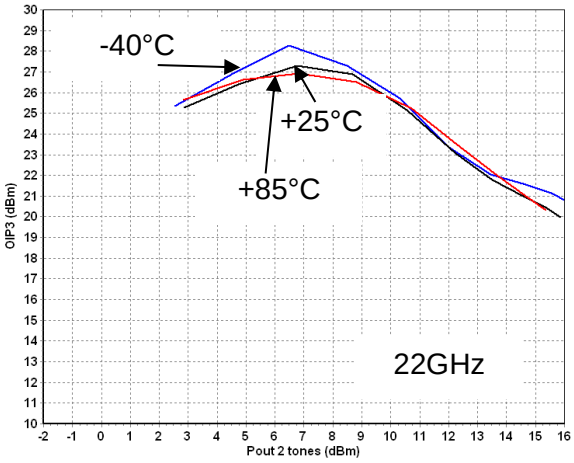
Typical Test Fixture Measurements

Tamb = -40°C / +25°C / +85°C, Vd1=Vd2=Vd3= +4V Id = 90 mA
Pads B, D = GND (high current configuration)
Measurements are given in the connectors' access plans. Losses are not de-embedded.

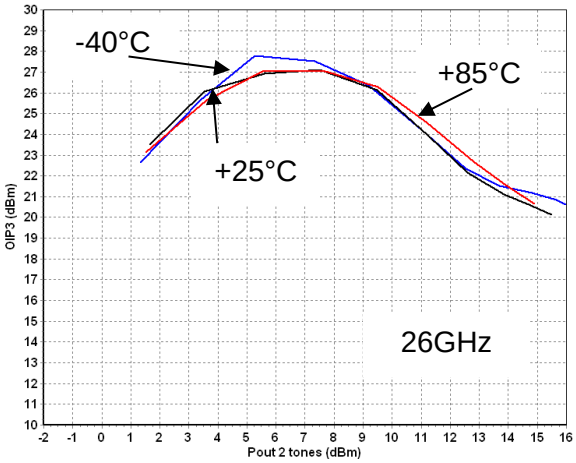
Output IP3 versus input power @ 18GHz



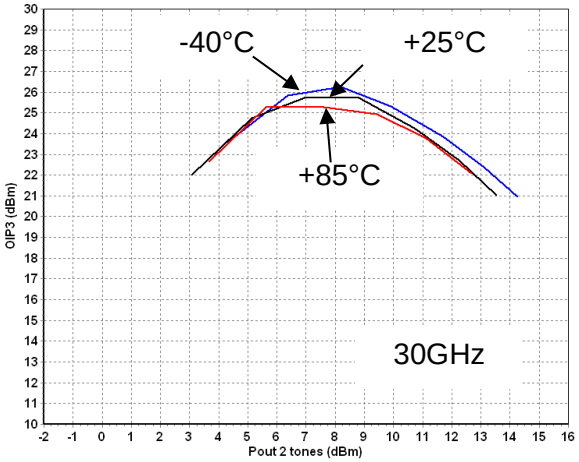
Output IP3 versus input power @ 22GHz



Output IP3 versus input power @ 26GHz



Output IP3 versus input power @ 30GHz



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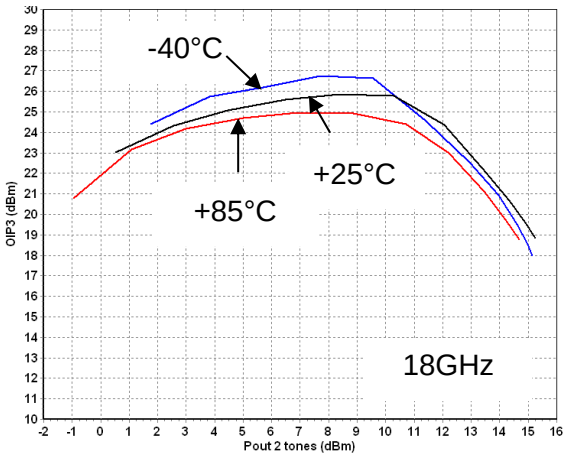
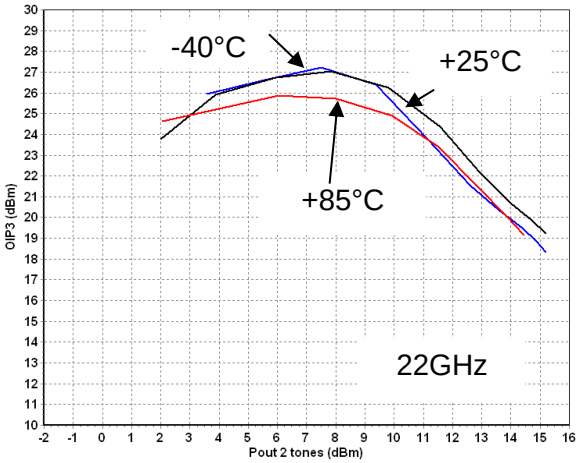
Typical Test Fixture Measurements

Tamb = -40°C / +25°C / +85°C, Vd1=Vd2=Vd3= +4V Id = 120 mA
Pads B, D = not connected (**low current configuration**)
Measurements are given in the connectors' access plans. Losses are not de-embedded.

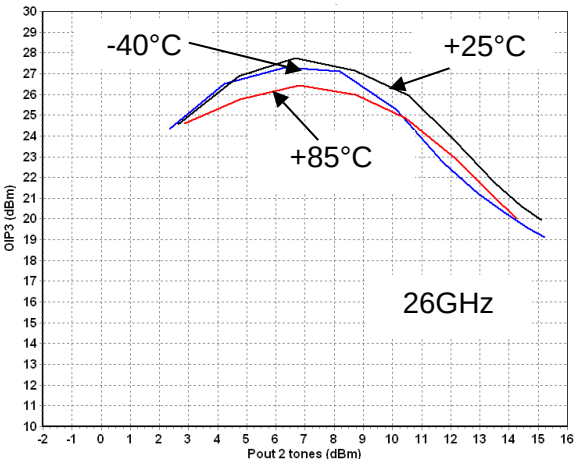
Output IP3 versus input power @ 18GHz



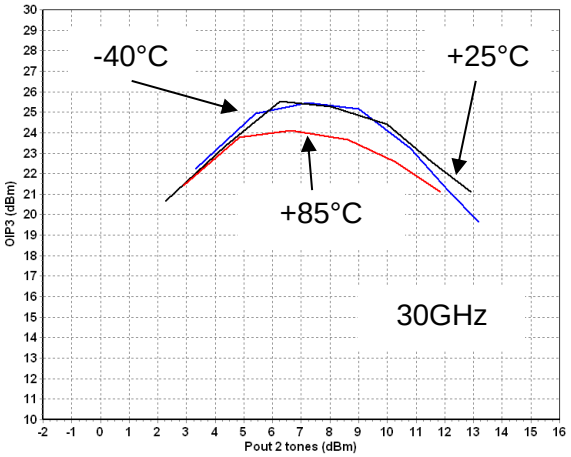
Output IP3 versus input power @ 22GHz



Output IP3 versus input power @ 26GHz



Output IP3 versus input power @ 30GHz



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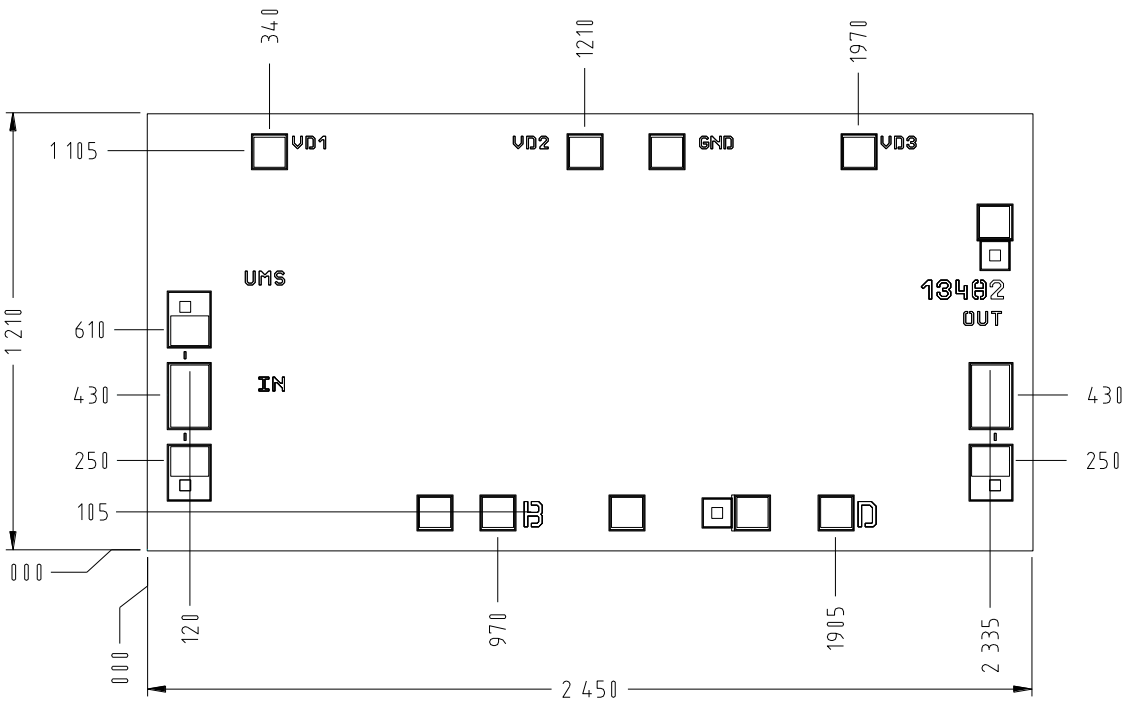
Mechanical data



DC Pads Size: 100/100 µm, Chip thickness: 100 µm
Chip size: 2.45 x 1.21 x 0.1mm ±35µm
All dimensions are in micrometers

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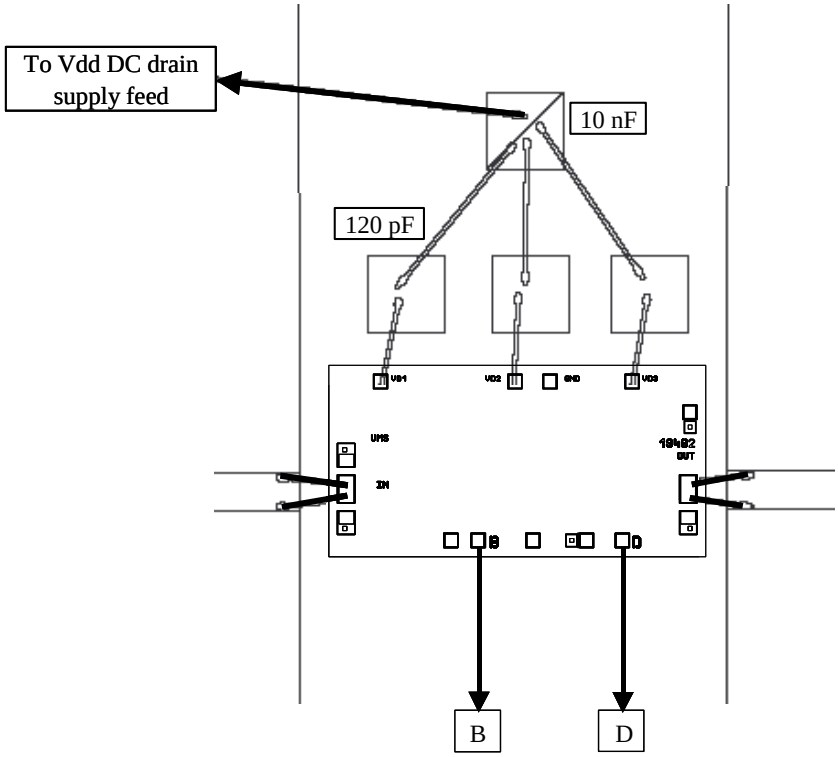
Recommended assembly plan



25µm wedge bonding is preferred

Note: Supply feed should be bypassed.

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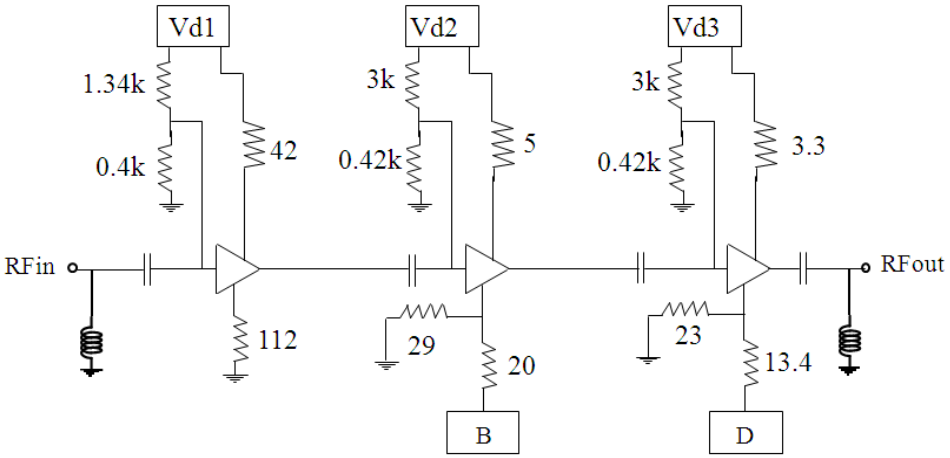
Chip Biasing options

This chip is self-biased, and flexibility is provided by the access to number of pads. The internal DC electrical schematic is given in order to use these pads in a safe way.



The requirement is not to exceed Vds = 3.5Volt (internal Drain to Source voltage).

We propose two standard biasings:

- Low Noise and low consumption: Vd = 4V and B, D not connected (NC).
  Idd = 90mA & Pout-1dB = 14dBm Typical

- Low Noise and higher output power: Vd = 4V and B, D grounded.
  Idd = 120mA & Pout-1dB = 15dBm Typical

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Recommended ESD management

Refer to the application note AN0020 available at https://www.ums-rf.com for ESD sensitivity and handling recommendations for the UMS products.

Ordering Information

Chip form:	CHA3689-99F/00

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