# L-Band Low Noise Amplifier

## GaAs Monolithic Microwave IC

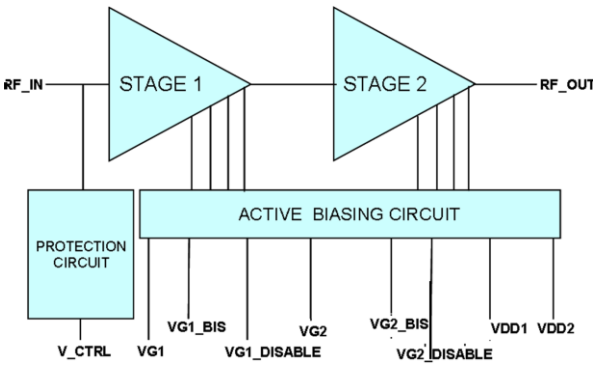
## Description

The CHA3801-99F is an L-Band LNA monolithic circuit including an active bias network. Furthermore a protection network is included in order to allow high input power survivability.

The circuit is dedicated to space applications, and also well suited for a range of microwave applications and 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.

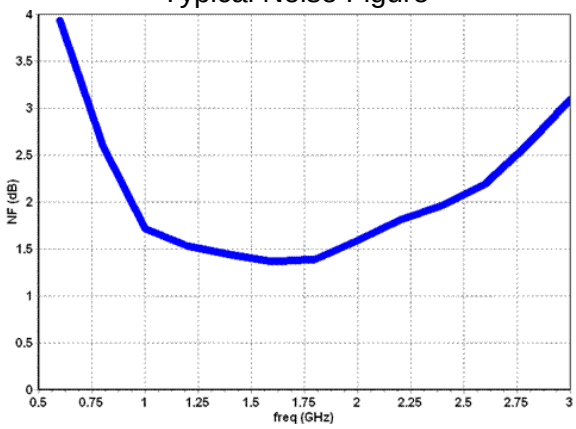
It is available in chip form.




## Main Features

- L-Band performances: 1-2GHz
- 1.45dB Noise Figure
- 28dB Linear Gain
- 17dBm Saturated Power
- 27dBm Output Third Order Intercept
- DC bias: Vd = 5Volt @ 70mA
- Chip size 1.6x1.4x0.1mm

Typical Noise Figure




## Main Characteristics

Tamb.= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 1 | | 2 | GHz |
| Gain | Linear Gain | | 28 | | dB |
| NF | Noise Figure | | 1.45 | | dB |
| Pout | Output Power @1dB comp. | | 15 | | dBm |



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## Main Characteristics

Tamb.= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $F_{RF}$ | RF input frequency Range | 1 | | 2 | GHz |
| G (1) | Gain | | 28 | | dB |
| - | Gain flatness (1) | | 0.5 | | dBp-p |
| \|S11\| | Input Return Loss | | -15 | | dB |
| \|S22\| | Output Return Loss | | -15 | | dB |
| NF ** | Noise Figure | | 1.45 | | dB |
| \|S12\| | Reverse Isolation | | 40 | | dB |
| OIP3 ** | Output Third order Intercept Point | | 27 | | dBm |
| OP1dB ** | Output 1dB Compression Point | | 15 | | dBm |
| Id_1a | Total drain current (mode 1a) | | 70 | | mA |
| Id_1b | Total drain current (mode 1b) | | 90 | | mA |
| Id_1c | Total drain current (mode 1c) | | 50 | | mA |
| Vd | Drain Voltage | | 5 | | V |

(1) Under working mode 1a and input protection disabled

These values are representative of on-wafer measurements that are made without bonding wires at the RF ports.
A bonding wire of typically 0.1 to 0.15nH will improve the matching at the accesses.

## Working Modes

| Mode | Description | PAD #3<br>PAD #6 | PAD #4<br>PAD #7 | PAD #5<br>PAD #8 | PAD #9<br>PAD #10 |
|---|---|---|---|---|---|
| 1a | Nominal bias current (70mA) | -5V | n.c.* | n.c. * | +5V |
| 1b | High bias current (+30%) | n.c.* | -5V | n.c. * | +5V |
| 1c | Low bias current (-30%) | -5V | -5V | n.c. * | +5V |

* not connected

| Input protection state | PAD #2 |
|---|---|
| enabled | GND |
| disabled | -5V |



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## Absolute Maximum Ratings [1]

Tamb.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain bias voltage (Vg=-5V) | 6.5 | V |
| Vctrl | Control voltage | -6 to 0 | V |
| Vg | Gate bias voltage (Vd=+5V) | -6 to 0 | V |
| Pin | Protection switch enabled | +20 | dBm |
| Pin | Protection switch disabled | +6 | 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.



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## Typical on-wafer Sij parameters

Tamb.= +25°C, Vd = +5V, Nominal bias current

| Freq (GHz) | S11 (dB) | PhS11 (°) | S12 (dB) | PhS12 (°) | S21 (dB) | PhS21 (°) | S22 (dB) | PhS22 (°) |
|---|---|---|---|---|---|---|---|---|
| 0.2 | -0.7363 | -34.13 | -54.05 | 63.29 | -25.41 | -139.5 | -0.9557 | -42.84 |
| 0.4 | -1.232 | -76.43 | -56.62 | 112.00 | -6.87 | -20.58 | -1.602 | -89.75 |
| 0.6 | -5.797 | -147.5 | -56.18 | 129.5 | 13.98 | -134.00 | -3.895 | -147.6 |
| 0.8 | -12.17 | 118.7 | -69.11 | 0.9509 | 24.9 | 141.8 | -15.53 | 147.8 |
| 1.0 | -14.1 | 36.92 | -56.16 | -118.8 | 27.62 | 76.17 | -22.07 | -92.14 |
| 1.2 | -15.93 | 4.04 | -54.31 | -127.1 | 28.45 | 31.2 | -19.33 | -107.1 |
| 1.4 | -20.02 | 2.275 | -50.91 | -156.5 | 28.82 | -6.376 | -19.3 | -101.00 |
| 1.6 | -20.28 | 36.82 | -48.07 | 176.2 | 28.74 | -38.87 | -17.64 | -92.55 |
| 1.8 | -16.18 | 50.27 | -46.14 | 151.00 | 28.38 | -67.66 | -15.35 | -96.02 |
| 2.0 | -13.16 | 44.78 | -45.74 | 125.2 | 27.73 | -93.68 | -14.35 | -102.6 |
| 2.2 | -11.58 | 37.8 | -44.24 | 109.00 | 26.99 | -116.9 | -13.69 | -109.2 |
| 2.4 | -10.59 | 32.05 | -44.33 | 92.94 | 26.2 | -138.4 | -13.4 | -113.6 |
| 2.6 | -9.907 | 28.51 | -42.73 | 76.43 | 25.37 | -158.6 | -13.18 | -116.00 |
| 2.8 | -9.157 | 27.16 | -41.75 | 62.9 | 24.49 | -177.8 | -12.83 | -115.4 |
| 3.0 | -8.175 | 26.17 | -41.91 | 44.11 | 23.6 | 163.5 | -12.06 | -114.8 |
| 3.2 | -6.95 | 24.36 | -41.19 | 34.49 | 22.6 | 145.4 | -10.98 | -115.9 |
| 3.4 | -5.646 | 20.49 | -41.34 | 8.98 | 21.53 | 127.7 | -9.788 | -119.3 |
| 3.6 | -4.456 | 14.89 | -41.52 | 3.437 | 20.31 | 110.00 | -8.732 | -126.00 |
| 3.8 | -3.43 | 8.087 | -41.12 | -12.47 | 18.89 | 93.67 | -8.145 | -133.9 |
| 4.0 | -2.633 | 0.6992 | -41.32 | -25.8 | 17.4 | 78.74 | -7.838 | -140.5 |
| 4.2 | -2.014 | -6.844 | -42.61 | -40.22 | 15.87 | 64.99 | -7.539 | -146.9 |
| 4.4 | -1.576 | -14.11 | -41.5 | -48.33 | 14.31 | 52.42 | -7.448 | -153.1 |
| 4.6 | -1.261 | -20.93 | -43.41 | -58.21 | 12.78 | 41.09 | -7.41 | -158.1 |
| 4.8 | -1.045 | -27.5 | -43.6 | -60.29 | 11.31 | 30.13 | -7.227 | -164.2 |
| 5.0 | -0.9556 | -33.86 | -42.22 | -78.08 | 9.888 | 19.45 | -7.018 | -170.2 |
| 5.2 | -1.182 | -38.42 | -42.29 | -91.97 | 8.052 | 10.52 | -7.657 | -177.3 |
| 5.4 | -0.7425 | -41.62 | -45.25 | -106.5 | 6.816 | 3.948 | -8.043 | 178.9 |
| 5.6 | -0.578 | -47.13 | -46.64 | -105.4 | 5.591 | -3.491 | -8.368 | 176.7 |
| 5.8 | -0.4952 | -51.86 | -46.99 | -112.9 | 4.417 | -10.59 | -8.558 | 174.4 |
| 6.0 | -0.4492 | -56.3 | -47.28 | -112.1 | 3.284 | -17.47 | -8.719 | 171.6 |
| 6.2 | -0.4078 | -60.46 | -47.00 | -114.6 | 2.226 | -23.99 | -8.905 | 169.00 |
| 6.4 | -0.3896 | -64.32 | -48.25 | -129.3 | 1.239 | -30.16 | -9.084 | 166.8 |
| 6.6 | -0.3677 | -68.06 | -48.41 | -134.2 | 0.3255 | -36.53 | -9.113 | 164.3 |
| 6.8 | -0.3468 | -71.64 | -47.15 | -127.4 | -0.5797 | -43.18 | -9.131 | 159.2 |
| 7.0 | -0.3351 | -75.01 | -46.72 | -140.9 | -1.536 | -48.5 | -9.809 | 155.2 |
| 7.2 | -0.3236 | -78.25 | -47.18 | -142.8 | -2.243 | -53.62 | -10.31 | 154.2 |
| 7.4 | -0.324 | -81.39 | -47.23 | -147.9 | -2.863 | -59.15 | -10.59 | 152.8 |
| 7.6 | -0.3218 | -84.5 | -48.12 | -146.2 | -3.418 | -64.74 | -10.72 | 151.2 |
| 7.8 | -0.3208 | -87.49 | -49.56 | -145.00 | -3.961 | -70.13 | -11.23 | 147.8 |
| 8.0 | -0.3328 | -90.33 | -48.2 | -148.4 | -4.277 | -75.94 | -11.63 | 147.1 |
| 8.2 | -0.3474 | -93.23 | -46.71 | -143.7 | -4.54 | -82.03 | -11.96 | 145.3 |
| 8.4 | -0.3661 | -96.02 | -47.63 | -168.6 | -4.699 | -88.35 | -12.45 | 144.2 |
| 8.6 | -0.3976 | -98.76 | -46.31 | -164.6 | -4.662 | -95.49 | -12.89 | 144.1 |
| 8.8 | -0.3993 | -101.7 | -42.67 | -172.8 | -4.439 | -103.6 | -13.35 | 144.5 |
| 9.0 | -0.5436 | -104.5 | -43.18 | -178.3 | -4.083 | -114.00 | -13.73 | 144.8 |



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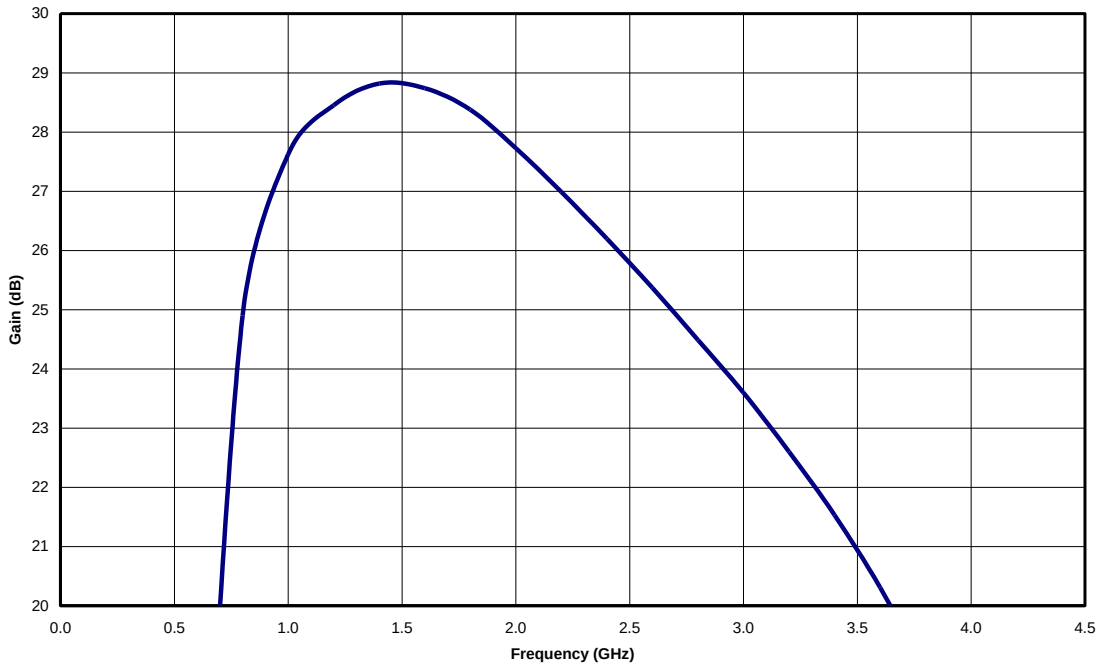
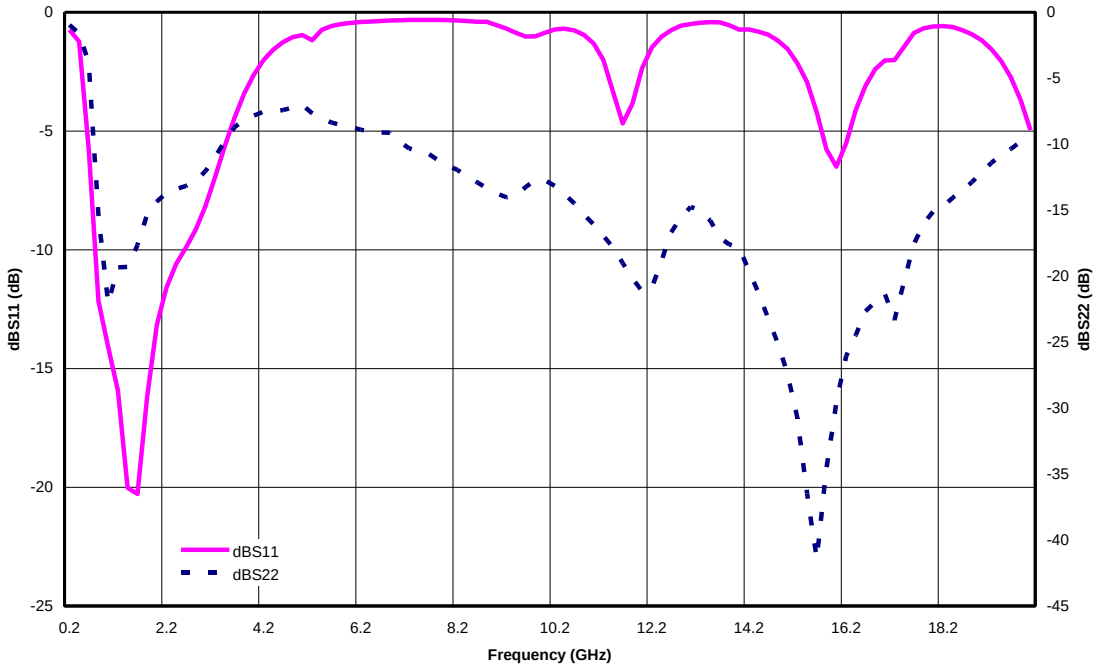
## Typical on wafer Measurements

Tamb.= +25°C, Vd = +5V, working mode 1a with input protection disabled

**Linear Gain versus Frequency**




**Input and Output Return Loss versus Frequency**



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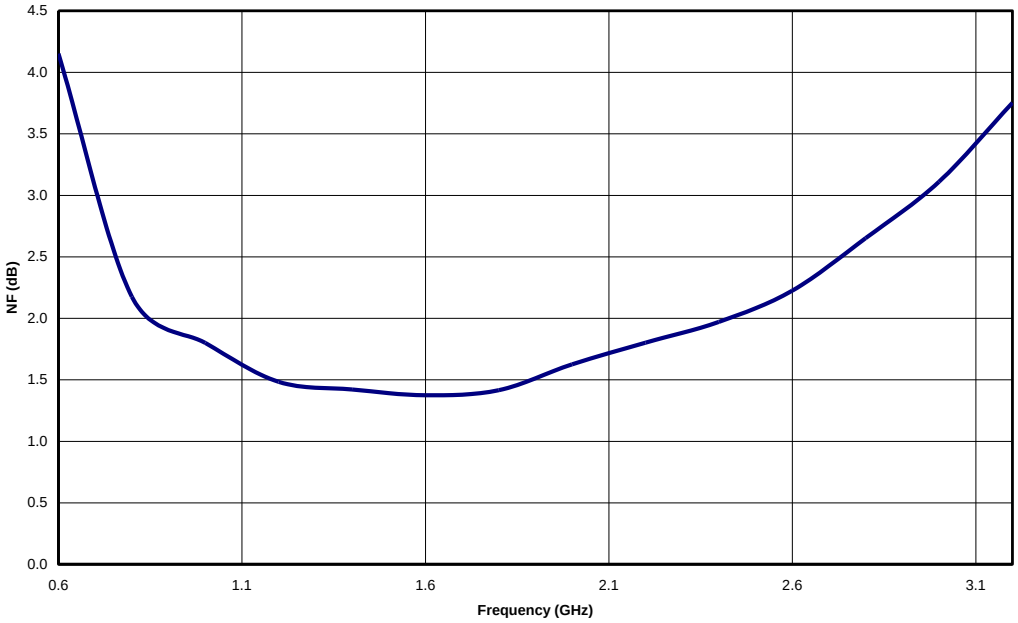
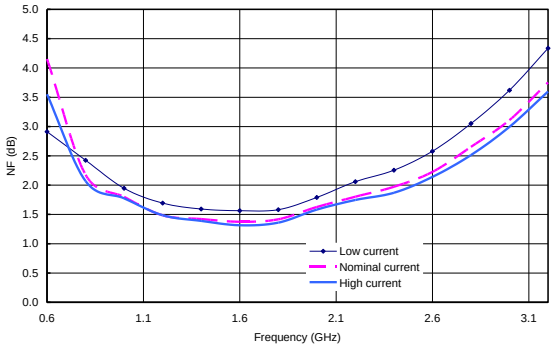
## Typical on wafer Measurements

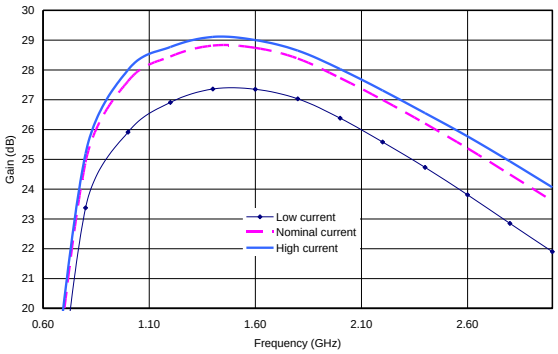
Tamb.= +25°C, Vd = +5V, working mode 1a with input protection disabled

### Noise Figure versus Frequency

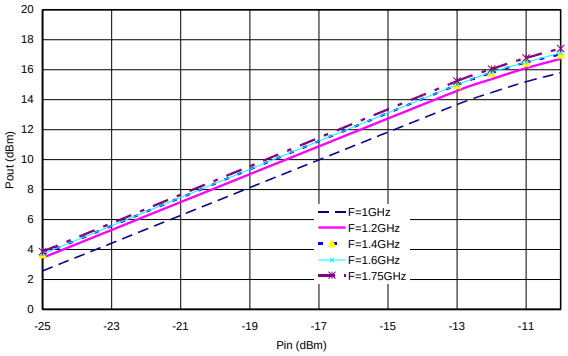


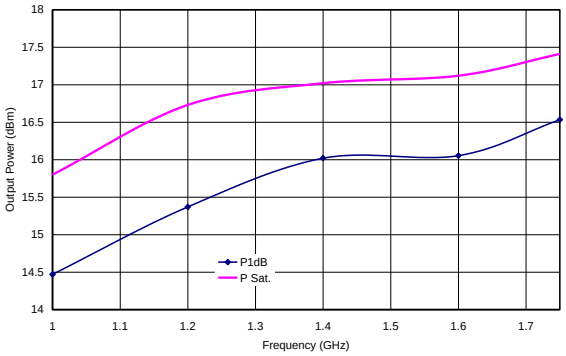

### Noise Figure and Gain vs Bias configuration




### Output Power (F= 1 to 1.75GHz)



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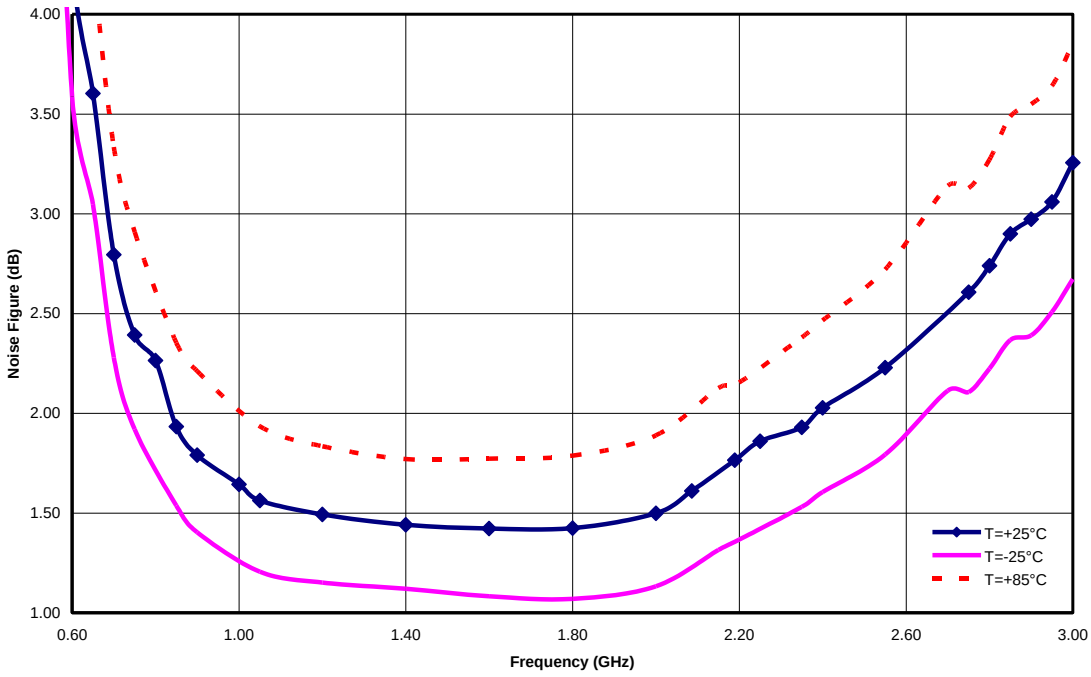
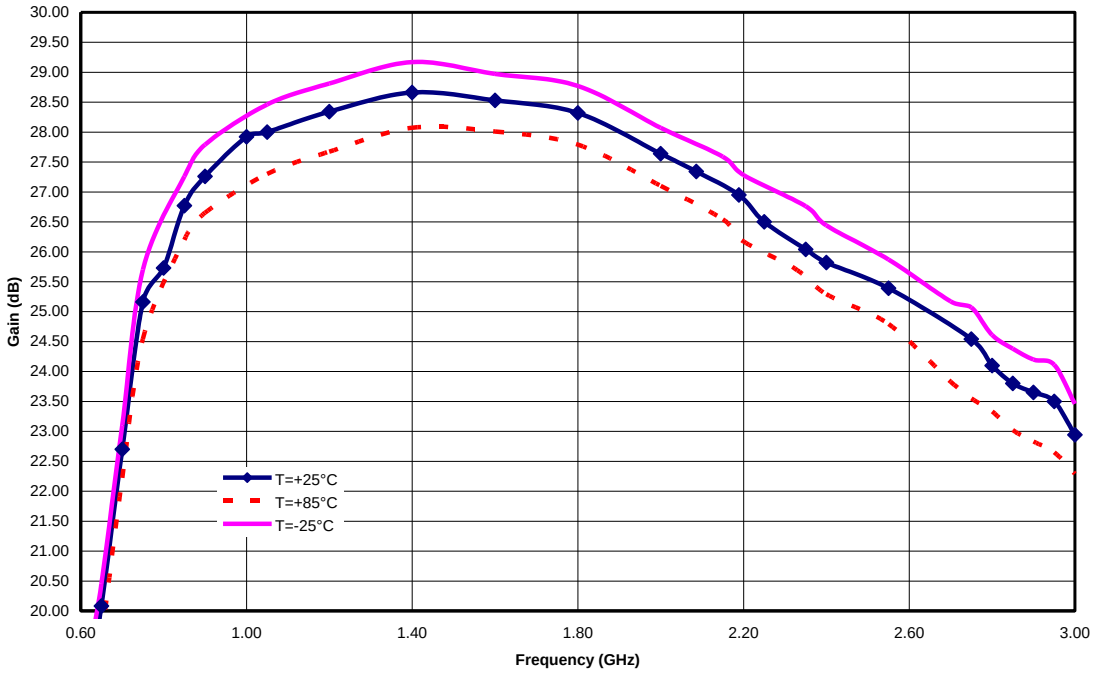
## Typical Test Fixture Measurements

Tamb.= +25°C, Vd = +5V, Nominal bias current

**Noise Figure vs Frequency and Temperature**




**Gain vs Frequency and Temperature**



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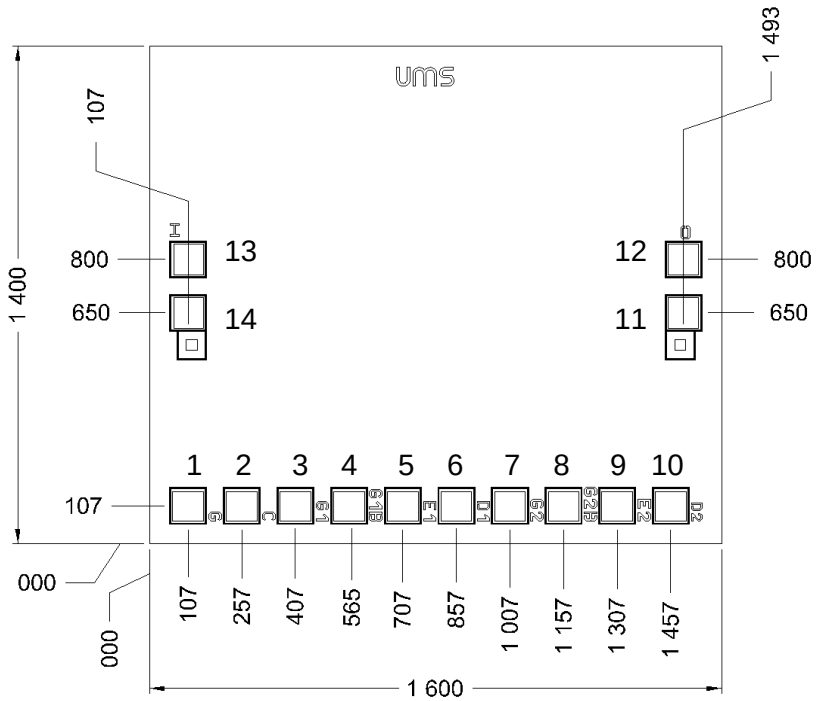
## Mechanical data




All dimensions are in micrometers

Chip thickness: 100µm.
Chip size: 1600*1400 ±35µm

RF pads = 100x100µm²
DC pads = 100x100µm²

| PAD number | Description |
|---|---|
| 1 | Ground (no connection required) |
| 2 | Control voltage to be changed depending on input protection state, i.e. enabled or disabled |
| 3 | Gate supply voltage (stage 1) |
| 4 | Gate supply voltage bis (stage 1) |
| 5 | Active bias enable/disable voltage (stage 1) |
| 6 | Gate supply voltage (stage 2) |
| 7 | Gate supply voltage bis (stage 2) |
| 8 | Active bias enable/disable voltage (stage 2) |
| 9 | Drain voltage (stage 1) |
| 10 | Drain voltage (stage 2) |
| 12 | RF Output |
| 13 | RF Input |
| 11 | Ground pad for RF output |
| 14 | Ground pad for RF input |

Note: pad information printed on chip is misleading for chip version 16051 available for sampling. Please refer only to the pad numbering shown above.



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## Notes



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## Recommended ESD management

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

## Recommended environmental management

UMS products are compliant with the regulation in particular with the directives RoHS N°2011/65 and REACh N°1907/2006. More environmental data are available in the application note AN0019 also available at http://www.ums-gaas.com.

## Ordering Information

| | |
|---|---|
| Chip form: | CHA3801-99F/00 |





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