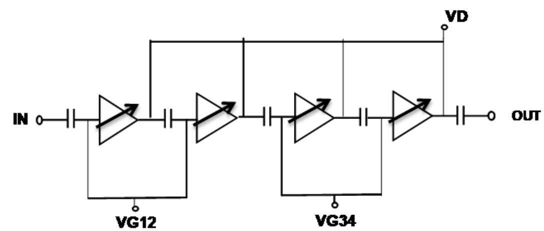
# 71-86GHz Low Noise Amplifier

## GaAs Monolithic Microwave IC

## Description

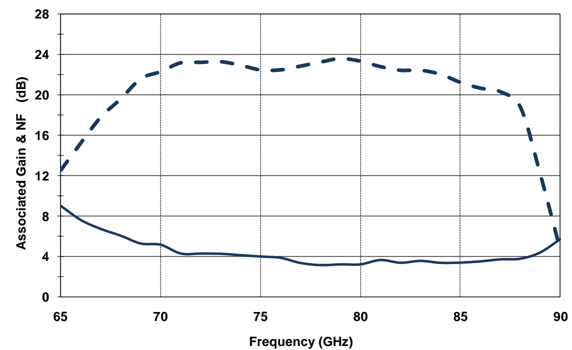
The CHA2080-98F is a Low Noise Amplifier with variable gain. This circuit integrates four stages and provides 3.5dB Noise Figure associated to 22dB Gain and +10dBm Output Power at 1dB compression.
This amplifier is dedicated to telecommunication, particularly well suited for the two main E-Bands used in new generation of High Capacity Backhaul.
It is manufactured with a pHEMT process, 0.1µm gate length, via holes through the substrate, air bridges, and electron beam gate lithography and is available in chip form with BCB Layer protection.



Functional diagram

## Main Features

- Broadband performances: 71-86GHz
- Very low Noise Figure: 3.5dB
- High Gain: 22dB
- Dynamic Gain control: 12dB
- 10dBm Pout@1dB compression
- BCB Layer protection
- DC bias: Vd=3.5Volt@Id=75mA
- Chip size 3.35x1.12x0.07mm



Typical Linear gain and Noise Figure

## Main Electrical Characteristics

Tamb.= +25°C

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Freq | Frequency range | 71 | | 86 | GHz |
| Gain | Linear Gain | | 22 | | dB |
| NF | Noise Figure | | 3.5 | | dB |
| Pout | Output Power @1dB compression | | 10 | | dBm |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## Electrical Characteristics

Tamb.=+25°C, Vd=+3.5V, Id=75mA

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Fop | Frequency range | 71 | | 86 | GHz |
| Gain* | Linear Gain | | 22 | | dB |
| ΔGain(Fop) | Gain variation:<br>Low Band [71-76 GHz]<br>High Band [81-86 GHz] | | <br>±0.2<br>±0.8 | | <br>dB<br>dB |
| Dyn_Gain | Gain Dynamic with VGx [-3; -2V] | | 12 | | dB |
| NF* | Noise Figure@ nominal gain<br>Low Band [71-76 GHz]<br>High Band [81-86 GHz] | | <br>4<br>3.5 | | <br>dB<br>dB |
| Pout@1dB comp.* | Output power at 1 dB compression<br>Low Band [71-76 GHz]<br>High Band [81-86 GHz] | | <br>12<br>10 | | <br>dBm<br>dBm |
| VSWR_in* | VSWR at input port | | 2:1 | | |
| VSWR_out* | VSWR at output port | | 2:1 | | |
| VG12 & VG34 | Negative supply voltage | | -2 | | V |
| Ig* | Negative supply current | | -4.25 | | mA |
| Id | Positive supply current | | 75 | | mA |

*Nominal conditions: VG12=VG34 are tuned to obtain Id=75mA (#-2V)
These values are representative of on-wafer measurements that are made without bonding wires at the RF ports.
A ribbon (75 µm wide) connection at the input and the output of the MMIC amplifier (see chapter recommended chip assembly) could improve the results.

## Absolute Maximum Ratings (1)

Tamb.= +25°C

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Drain bias voltage | 4 | V |
| Id | Drain bias current | 95 | mA |
| Vg | Gate bias voltage | -3 to +0.4 | V |
| Pin | Maximum peak input power overdrive (2) | +0 | 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.
(2) Duration < 1s.



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## Typical on-wafer Sij parameters

Tamb.=+25°C, Vd=+3.5V, Id=75mA

| Freq (GHz) | S11 (dB) | PhS11 (°) | S12 (dB) | PhS12 (°) | S21 (dB) | PhS21 (°) | S22 (dB) | PhS22 (°) |
|---|---|---|---|---|---|---|---|---|
| 68 | -3.3 | 9 | -39.7 | 152 | 19.5 | 106 | -10.3 | 73 |
| 68.5 | -4.3 | -5 | -45.9 | 160 | 19.9 | 86 | -9.6 | 58 |
| 69 | -5.4 | -21 | -45 | 159 | 20.8 | 63 | -8.7 | 59 |
| 69.5 | -6.8 | -36 | -47.7 | 166 | 21.2 | 42 | -9.8 | 63 |
| 70 | -8.1 | -51 | -42.8 | 160 | 21.5 | 21 | -11.6 | 62 |
| 70.5 | -9.3 | -66 | -42.3 | 144 | 21.7 | 0 | -12.8 | 57 |
| 71 | -10.4 | -82 | -44.5 | 132 | 21.8 | -19 | -12.8 | 52 |
| 71.5 | -11.6 | -98 | -43.8 | 119 | 21.7 | -39 | -11.3 | 47 |
| 72 | -12.7 | -115 | -44.5 | 123 | 21.6 | -58 | -10.4 | 45 |
| 72.5 | -14.5 | -135 | -44.7 | 111 | 21.6 | -77 | -11 | 44 |
| 73 | -14.9 | -151 | -46.4 | 98 | 21.5 | -97 | -12.4 | 33 |
| 73.5 | -15.7 | -158 | -48.5 | 95 | 21.3 | -115 | -13 | 20 |
| 74 | -16.5 | -164 | -47.7 | 66 | 21.3 | -131 | -13.3 | 10 |
| 74.5 | -17.3 | -175 | -50.5 | 53 | 21.5 | -146 | -12.8 | 4 |
| 75 | -16.5 | 172 | -53.6 | 2 | 21.4 | -164 | -12.9 | -4 |
| 75.5 | -17 | 160 | -52.2 | 1 | 21.5 | 180 | -14.5 | -13 |
| 76 | -17 | 151 | -54.4 | -34 | 21.5 | 163 | -14.9 | -32 |
| 76.5 | -17.2 | 139 | -56.9 | -65 | 21.6 | 146 | -15.3 | -48 |
| 77 | -17.6 | 123 | -53.5 | -86 | 21.7 | 128 | -15.3 | -57 |
| 77.5 | -19.4 | 107 | -51.8 | -101 | 21.7 | 110 | -15.5 | -71 |
| 78 | -20.6 | 87 | -50.1 | -131 | 21.9 | 91 | -15.7 | -94 |
| 78.5 | -24.8 | 55 | -48.8 | -158 | 22.1 | 74 | -15.7 | -117 |
| 79 | -30.8 | 16 | -49.4 | -174 | 22.1 | 55 | -15 | -139 |
| 79.5 | -29.3 | -56 | -50.1 | 165 | 22.1 | 34 | -15.2 | -160 |
| 80 | -28.6 | -109 | -50.8 | 145 | 22 | 15 | -16 | -177 |
| 80.5 | -24.2 | -130 | -49.7 | 143 | 21.8 | -3 | -15.8 | 164 |
| 81 | -21.4 | -154 | -50.2 | 113 | 21.5 | -22 | -15.4 | 146 |
| 81.5 | -19.6 | -172 | -53.8 | 88 | 21.3 | -40 | -15.1 | 131 |
| 82 | -18.1 | 173 | -53.2 | 70 | 21.2 | -58 | -15 | 118 |
| 82.5 | -17 | 156 | -64.1 | 43 | 21 | -78 | -15.4 | 102 |
| 83 | -15.7 | 139 | -59.5 | 88 | 20.9 | -96 | -15.4 | 86 |
| 83.5 | -14.3 | 122 | -61.6 | 85 | 20.9 | -115 | -15.2 | 72 |
| 84 | -12.8 | 101 | -59.4 | 29 | 20.8 | -136 | -14.5 | 60 |
| 84.5 | -11.3 | 82 | -60.9 | 15 | 20.5 | -157 | -13.7 | 41 |
| 85 | -10 | 60 | -53.3 | -39 | 20.5 | -180 | -14.6 | 30 |
| 85.5 | -8.8 | 42 | -51.4 | -73 | 20.4 | 159 | -15 | 18 |
| 86 | -7.7 | 24 | -51 | -108 | 19.9 | 136 | -15.6 | 0 |
| 86.5 | -6.6 | 7 | -51.5 | -130 | 19.9 | 109 | -16.8 | -8 |
| 87 | -5.7 | -9 | -50.9 | -148 | 19.6 | 84 | -17 | -1 |
| 87.5 | -4.9 | -24 | -50.8 | -165 | 18.6 | 51 | -16.7 | 1 |
| 88 | -4.3 | -40 | -50 | 171 | 17 | 18 | -15.2 | 2 |
| 88.5 | -4 | -54 | -51.2 | 137 | 14.2 | -12 | -13.9 | -7 |
| 89 | -3.9 | -67 | -51.7 | 110 | 10.8 | -41 | -12.7 | -18 |



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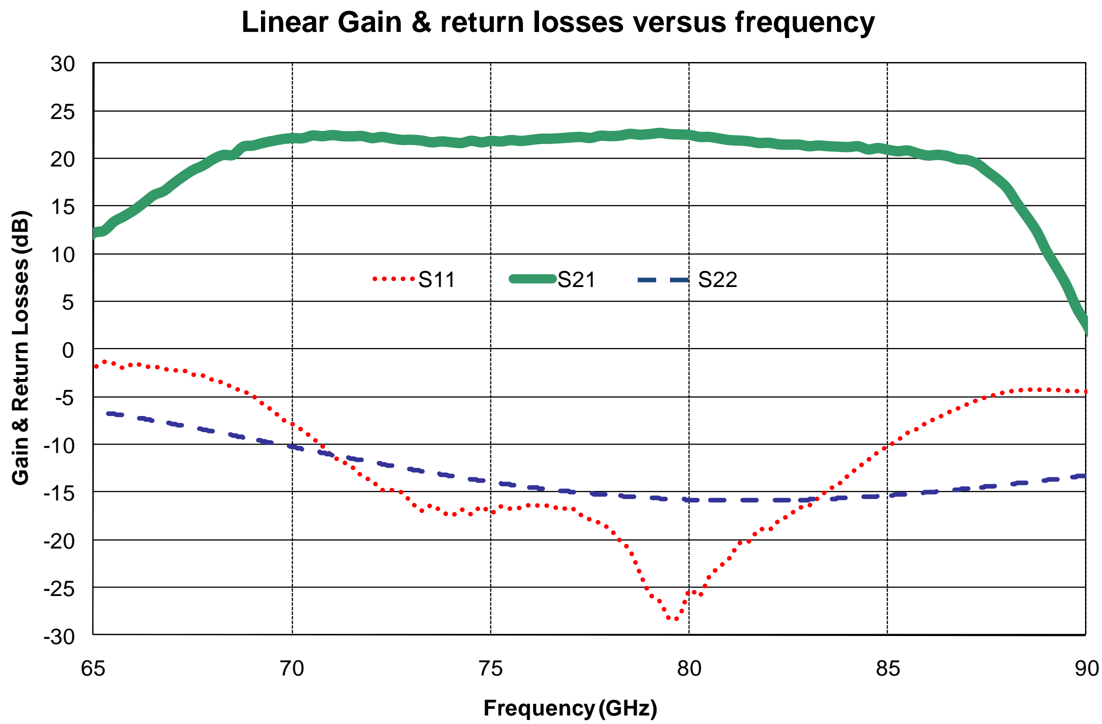
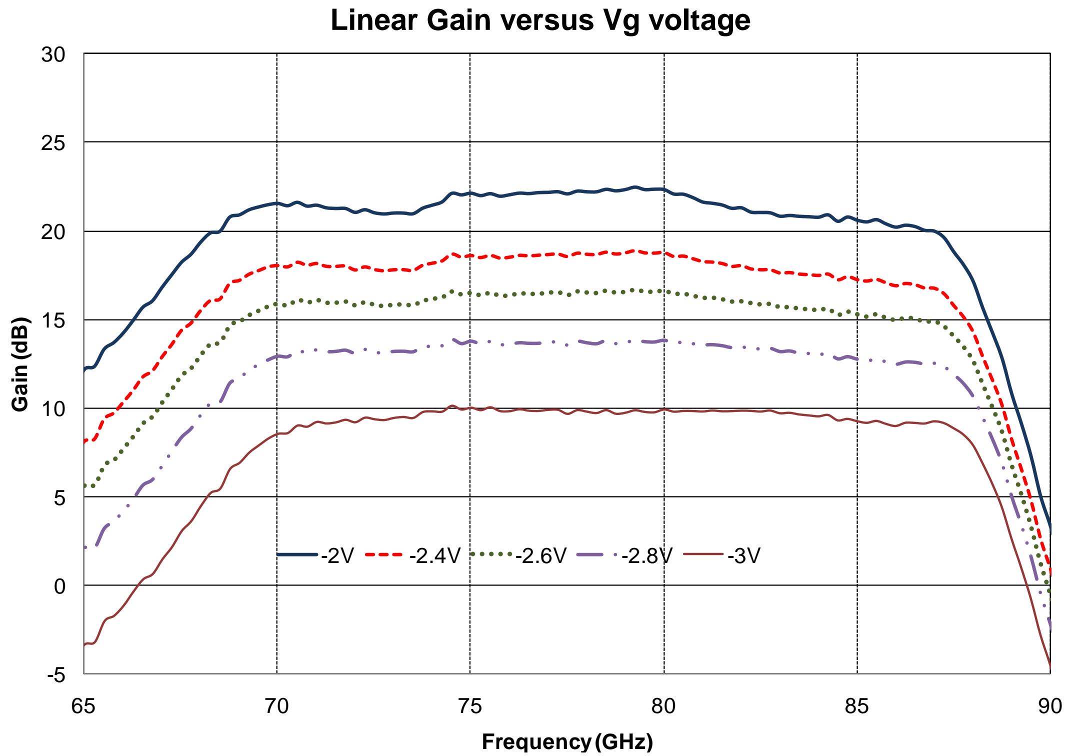
## Typical on wafer Measurements

Tamb.=+25°C, Vd =+3.5V, Id=75mA



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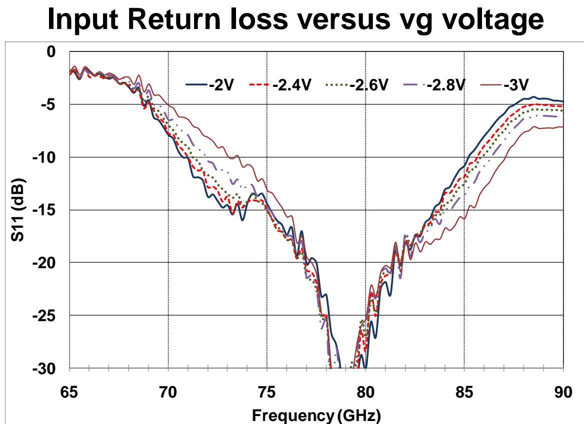


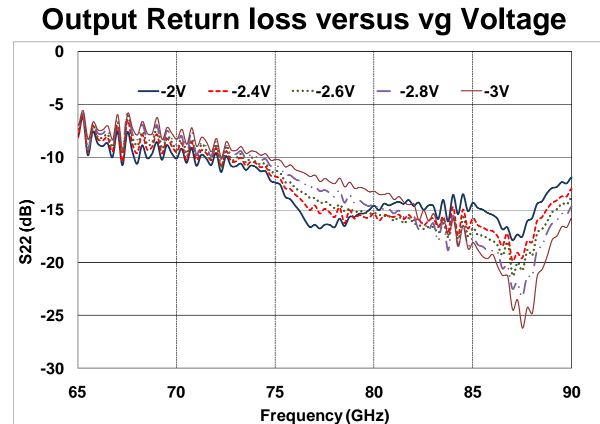


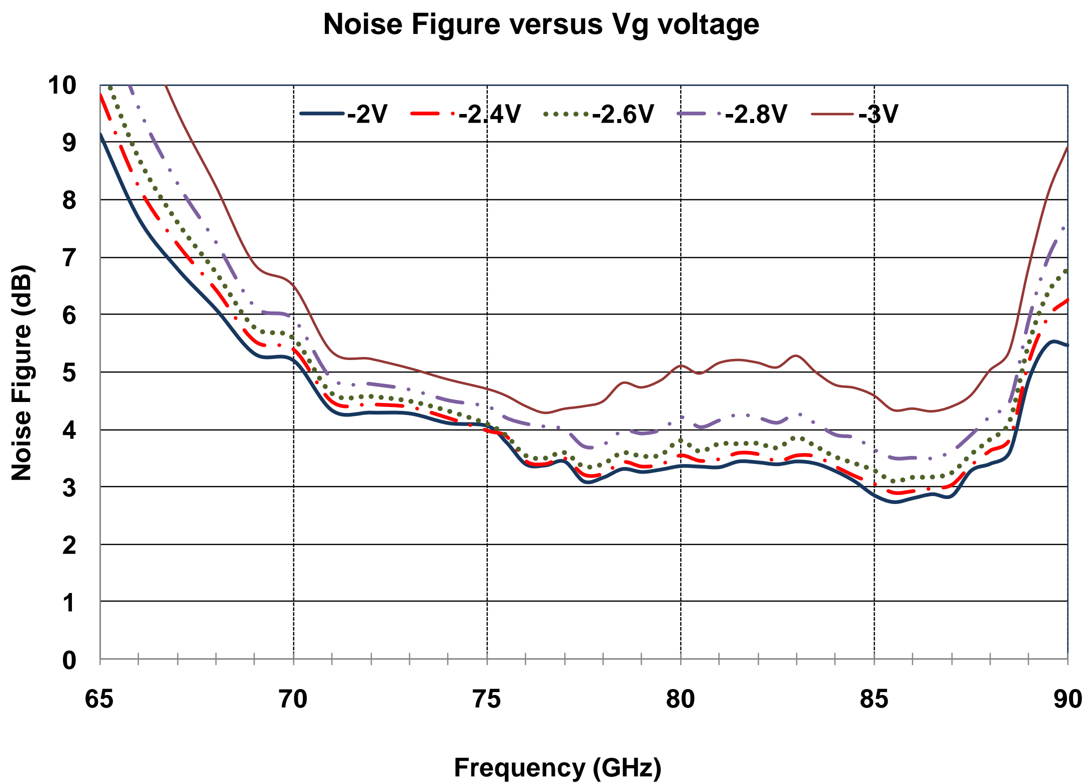




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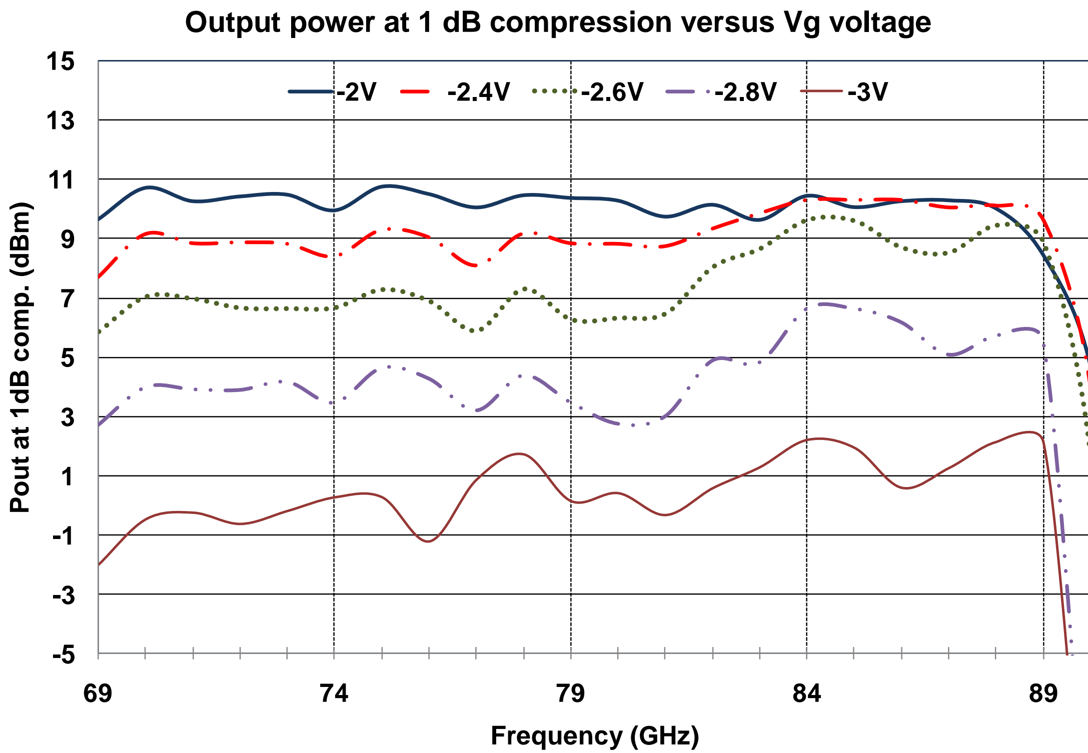


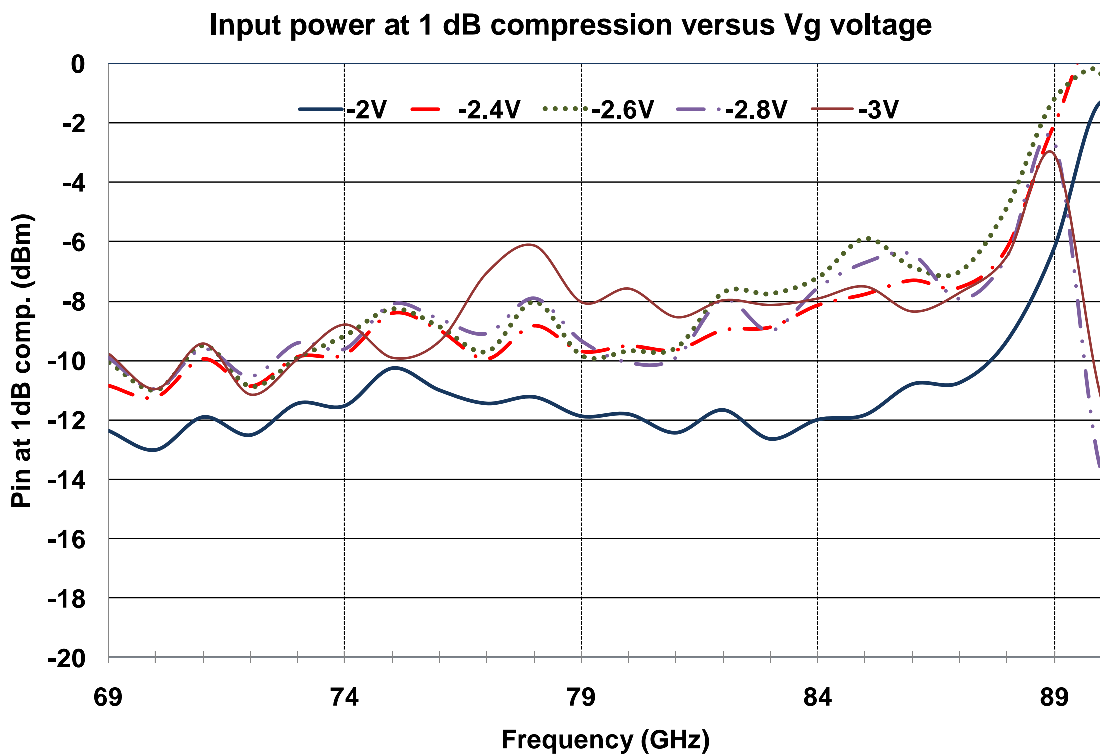




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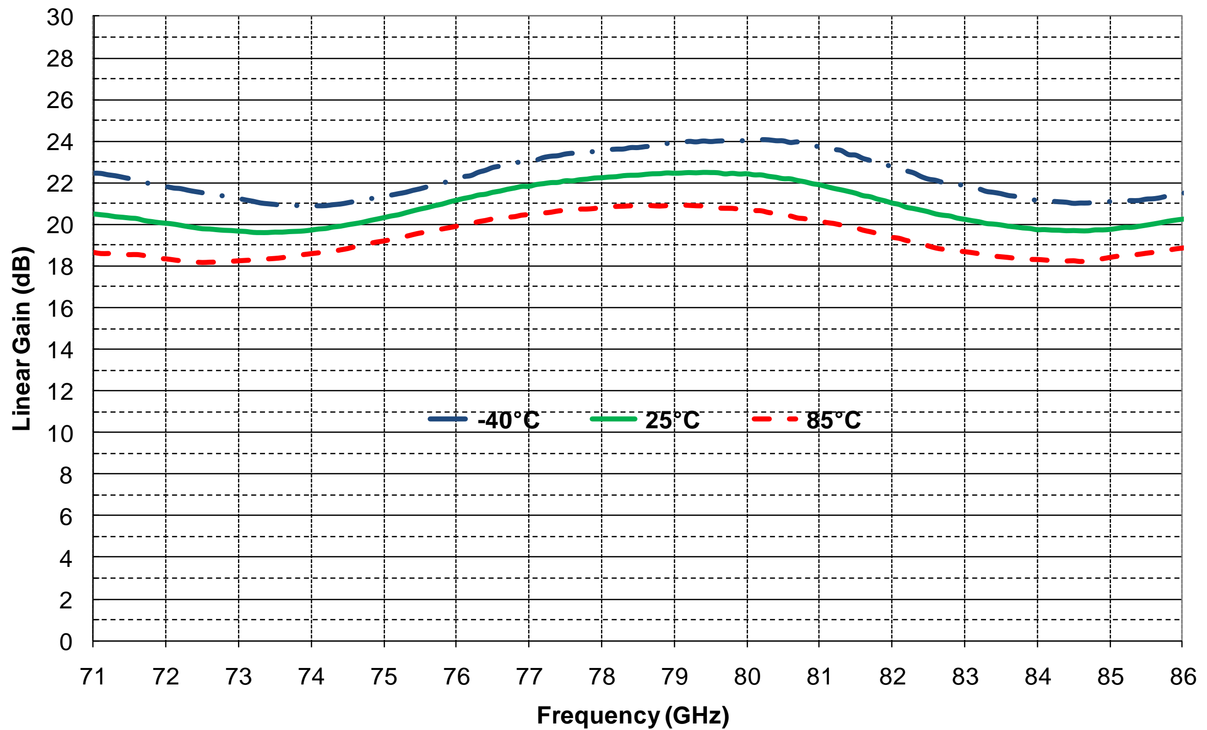
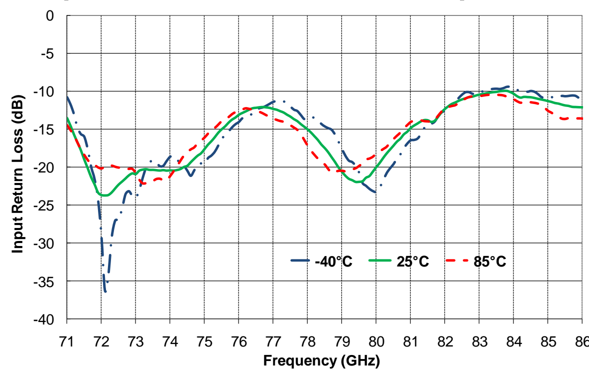
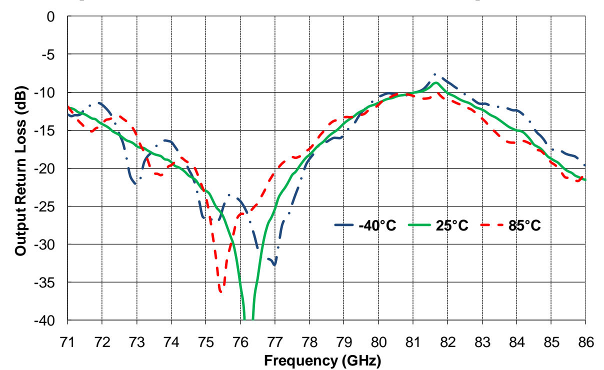
## Typical Test Fixture Measurements

Tamb.=-40°C / +25°C / +85°C, Vd=+3.5V
Id=75 mA @ +25°C
Measurements are given in the test fixture access plans



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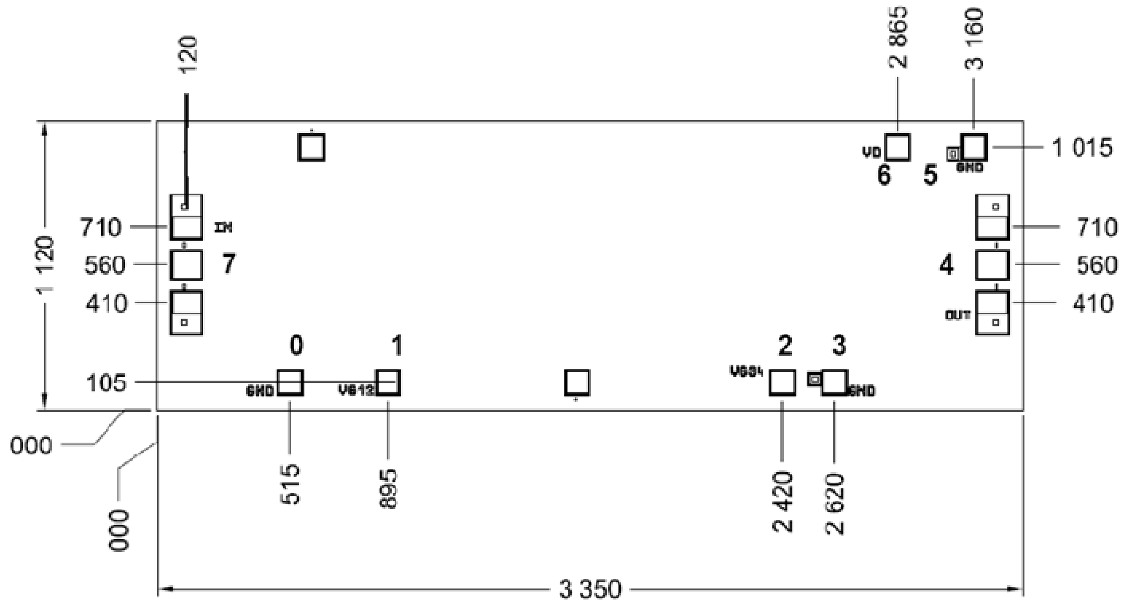
## Mechanical data




Chip thickness: 70µm. ±10µm
Chip size: 3350x1120 ±35µm
All dimensions are in micrometers

RF Pads (4,7) = 108 x 106 (BCB opening)
DC Pads = 86 x 83 (BCB opening)

| Pin number | Pin name | Description |
|---|---|---|
| 0, 3, 5 | GND | Ground: should not be bonded |
| 4 | OUT | RF output port |
| 7 | IN | RF input port |
| 6 | VD | Positive supply voltage |
| 1 | VG12 | Negative supply voltage for the first & second stage |
| 2 | VG34 | Negative supply voltage for the third and fourth stage |



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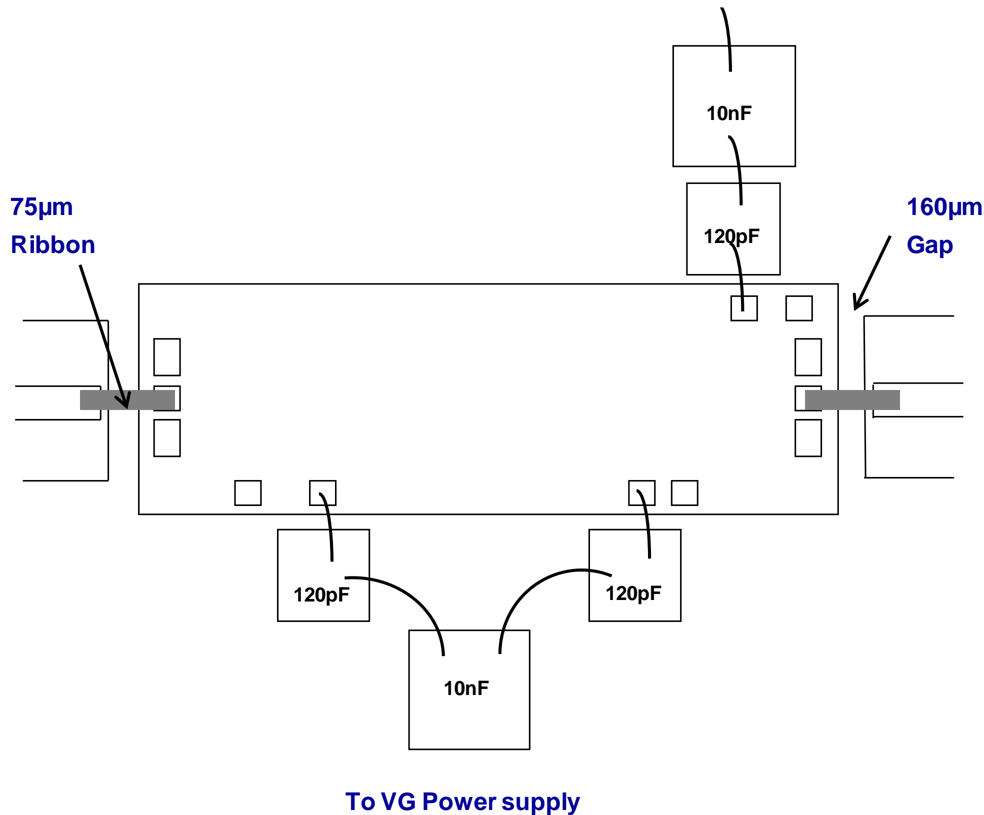
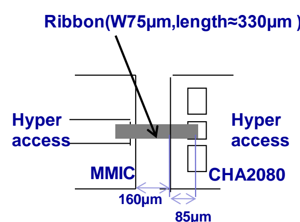
## Recommended chip assembly




The design of the circuit integrates a half ribbon (75µm wide) connection at the input and the output of the MMIC amplifier compliant with a 50 Ohm line on GaAs MMIC.

Circuits having to be as close as possible to each other, the ribbon length must be reduced to the achievable minimum (160µm gap between two chips is considered) and the loop height must also be the smallest realizable (80µm).




A second solution is the use of double wires (Ø 25µm), wedge bonded. In this case, a minimum of two wires and the same chip to chip distance than ribbon solution are necessary to reduce the inductance effect. Nevertheless, simulations have demonstrated an improvement of RF performance for E-band frequency range with the use of ribbon connection instead of wire.

Regarding the connection of the DC pads, a 25µm wedge bonding is preferred.



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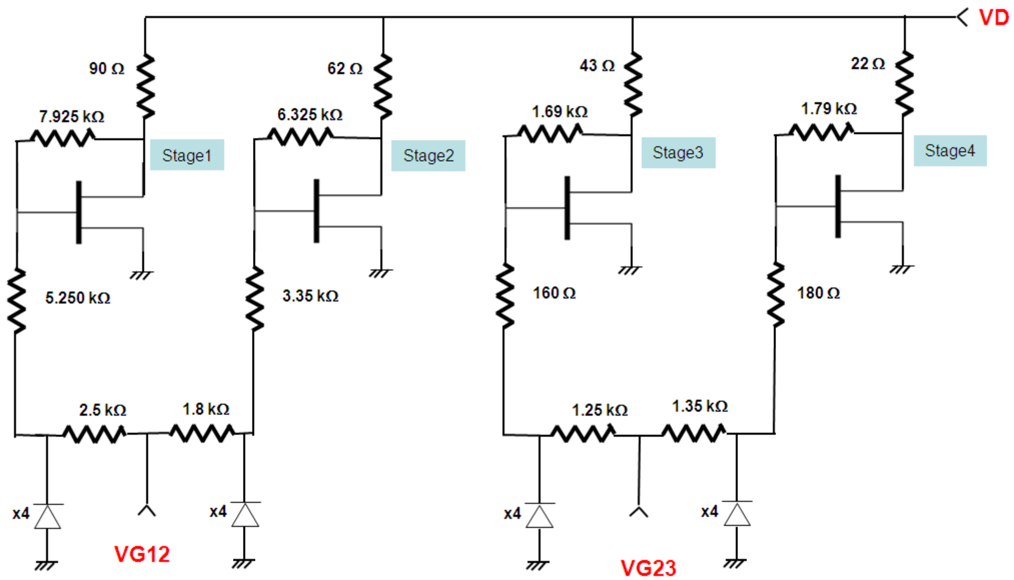
## DC Schematic




**LNA: 3.5V, 75mA**



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## Notes



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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.

## 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 https://www.ums-rf.com.

## Ordering Information

Chip form: CHA2080-98F/00

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