# 6-18GHz Low Noise Digital Variable Amplifier

## GaAs Monolithic Microwave IC

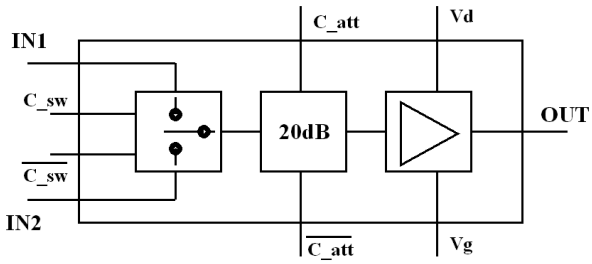
preliminary

## Description

The CHA3512 is composed by a Single Pole Double Through (SPDT) switch followed by a one step digital attenuator and a double stage travelling wave amplifier. It is designed for defense applications. The backside of the chip is both RF and DC grounded. This helps to simplify the assembly process.

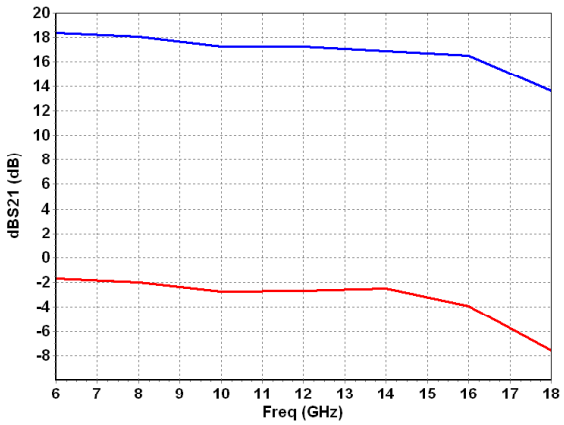
The circuit is manufactured with a PM-HEMT process, 0.25µm gate length, via holes through the substrate, air bridges and electron beam gate lithography.

It is available in chip form.




**Typical on wafer Measurements**

Gain versus attenuation states




## Main Features

- Performances : 6-18GHz
- 23 dBm saturated output power
- 16 dB gain
- 1 bit attenuator for 20dB dynamic range
- DC power consumption : 210mA @ 4.5V
- Chip size : 4.27 x 2.46 x 0.1 mm

## Main Characteristics

Tamb. = 25°C

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Fop | Operating frequency range | 6 | | 18 | GHz |
| G | Small signal gain @ Attenuator state 0dB | | 16 | | dB |
| Psat | Saturated Output power @ Attenuator state 0dB | | 23 | | dBm |
| ATT dyn | Attenuator range | | 20 | | dB |

ESD Protection : Electrostatic discharge sensitive device. Observe handling precautions !



**United Monolithic Semiconductors S.A.S.**
**Route Départementale 128 - B.P.46 - 91401 Orsay Cedex France**
**Tel. : +33 (0)1 69 33 03 08 - Fax : +33 (0)1 69 33 03 09**

## Electrical Characteristics on wafer

Tamb = +25℃
Vd= Pads B, C = 4.5V, Vg = Pads A, C tuned for Id = 210mA

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| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Fop | Operating frequency range (1) | 6 | | 18 | GHz |
| G | Small signal gain @ Attenuator state 0dB (1) | | 16 | | dB |
| ATT dyn | Attenuator range | | 20 | | dB |
| Is | Small signal gain @ Attenuator state 0dB & switch OFF (1) | | -35 | | dB |
| P1dB | Output power at 1dB compression @ Attenuator state 0dB (1) | | 20 | | dBm |
| Psat | Saturated Output power @ Attenuator state 0dB (1) | | 23 | | dBm |
| NF | Noise figure @ Attenuator state 0dB | | 7 | | dB |
| VSWRin | Input VSWR all attenuator states | | 2.0:1 | | |
| VSWRout | Output VSWR all attenuator states & switch ON | | 2.0:1 | | |
| Vd | Drain bias DC voltage (Pads B,D) | | 4.5 | | V |
| Id | Bias current @ small signal | | 210 | 250 | mA |
| Vc | Control voltage for Attenuator bit & SPDT switch | -5 | | 0 | V |

(1) These values are representative for on-wafer measurements that are made without bonding wires at the RF ports.



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## Absolute Maximum Ratings

Tamb. = 25℃ (1)

| Symbol | Parameter | Values | Unit |
|---|---|---|---|
| Vd | Maximum Drain bias voltage ( Pads B, D) | +5 | V |
| Id | Drain bias current with Vd=4.5V | 300 | mA |
| Vg | Gate bias voltage (Pads A,C) | -2 to +0.4 | V |
| Vc | Attenuator bit & SPDT control voltage | -7 to +0.6 | V |
| Pin | Maximum input power overdrive (2) | +20.0 | dBm |
| Tch | Maximum channel temperature | +175 | ℃ |
| Ta | Operating temperature range | -40 to +70 | ℃ |
| Tstg | Storage temperature range | -55 to +125 | ℃ |

(1) Operation of this device above anyone of these parameters may cause permanent damage.
(2) Duration < 1s.
Thermal Resistance channel to ground paddle =123℃/W for Tamb. = +70℃.

## LNA Control interface

The attenuator state is controlled by 2 voltages.
The SPDT switch is controlled by 2 voltages.

| state | Theoretical attenuation (dB) | Voltage CONTROL PAD | | Switch control | |
|---|---|---|---|---|---|
| | | 20A (V) | 20B (V) | E (V) | F (V) |
| 0 | 0 référence | -5 | 0 | -5 | 0 |
| 1 | 20 | 0 | -5 | -5 | 0 |
| 2 | Isolation | -5 | 0 | 0 | -5 |



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## Typical on wafer Measurements @ 25℃

Bias conditions: Vd=4.5V, Vg tuned for Id = 210mA

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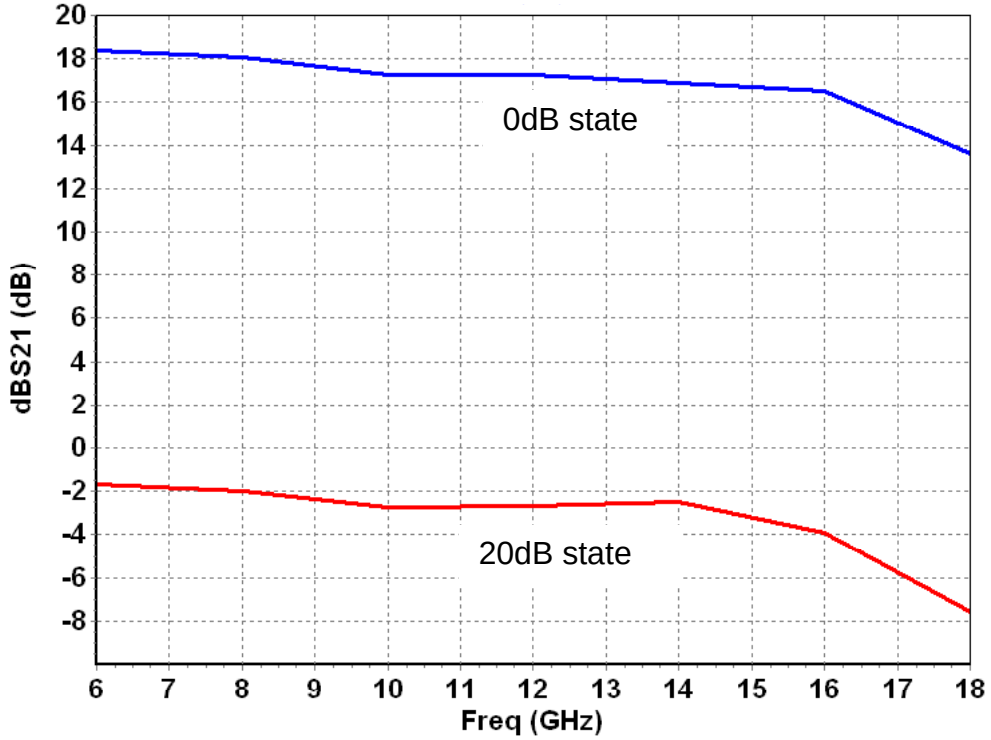
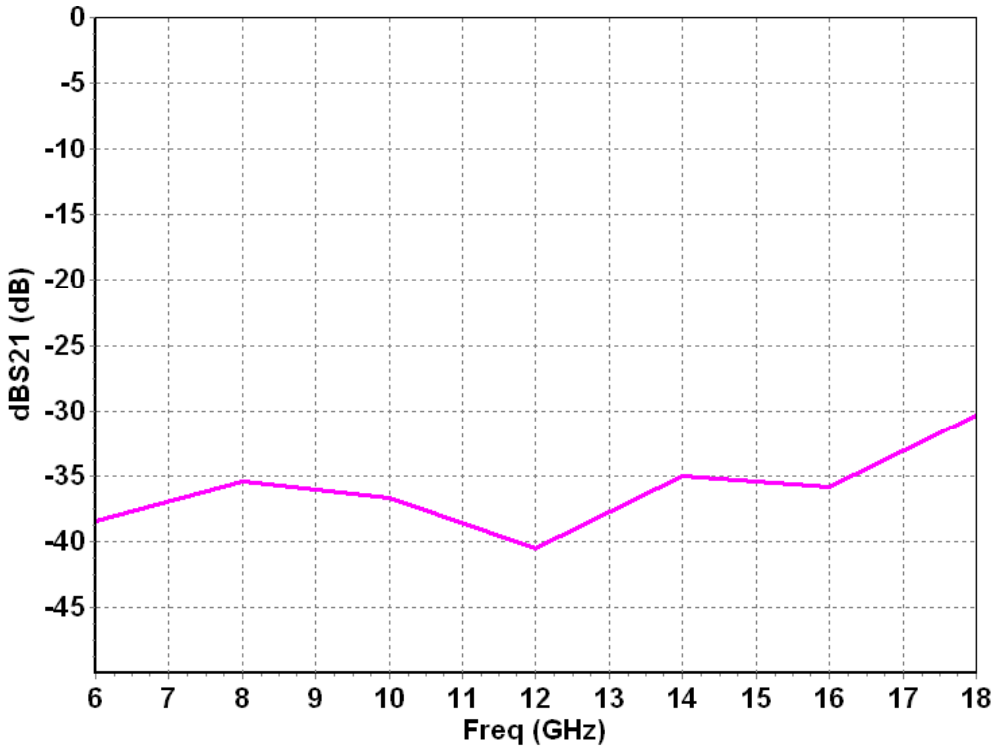
**Linear Gain versus attenuator states**




**Linear Gain with SPDT switch OFF**



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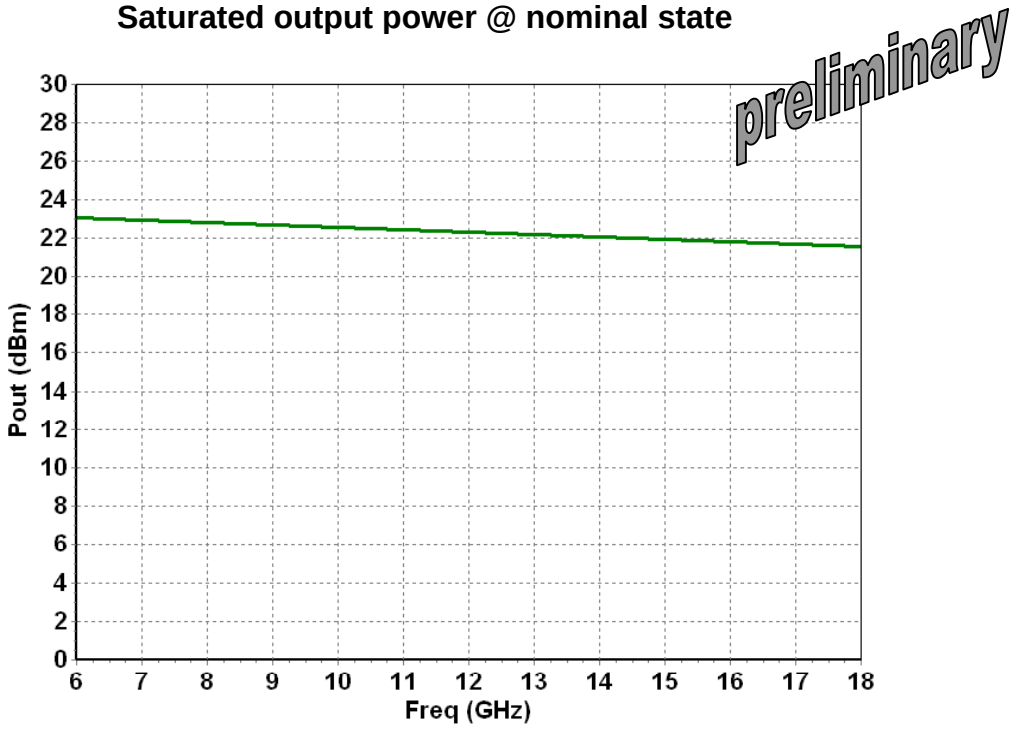
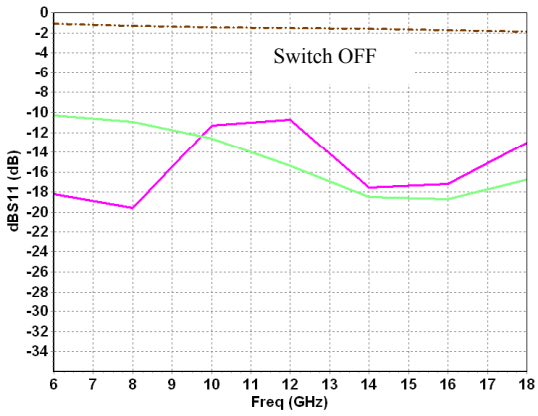
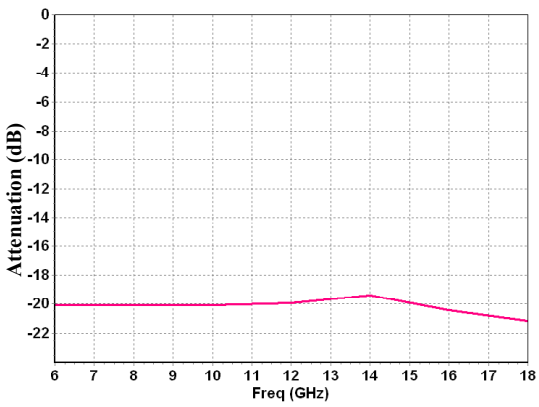
## Saturated output power @ nominal state



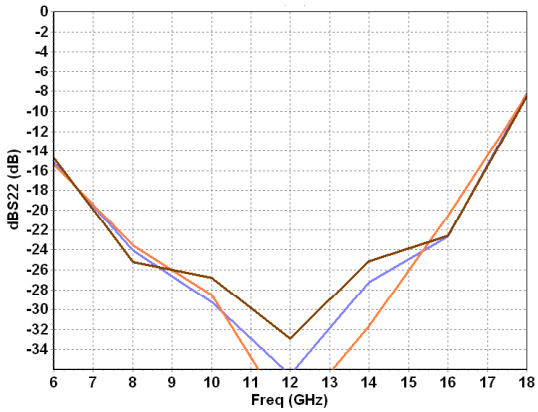

dB(S11) versus frequency for all states




Attenuator accuracy versus frequency




dB(S22) versus frequency for all states



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## Typical test fixture Measurements @ 25°C

Bias conditions: Vd=4.5V, Vg tuned for Id = 210mA

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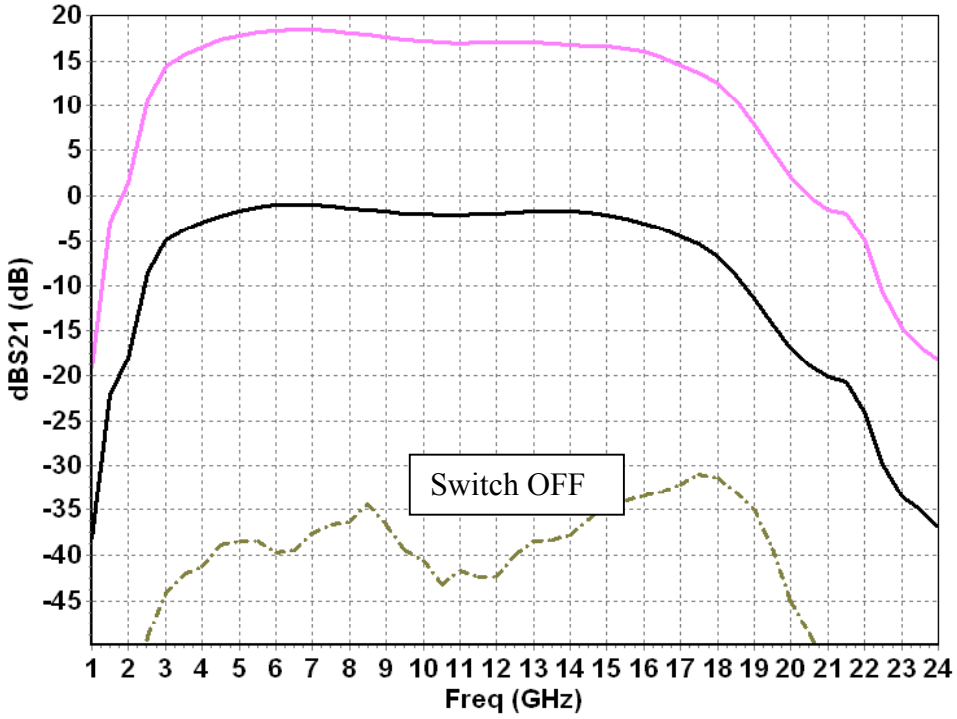
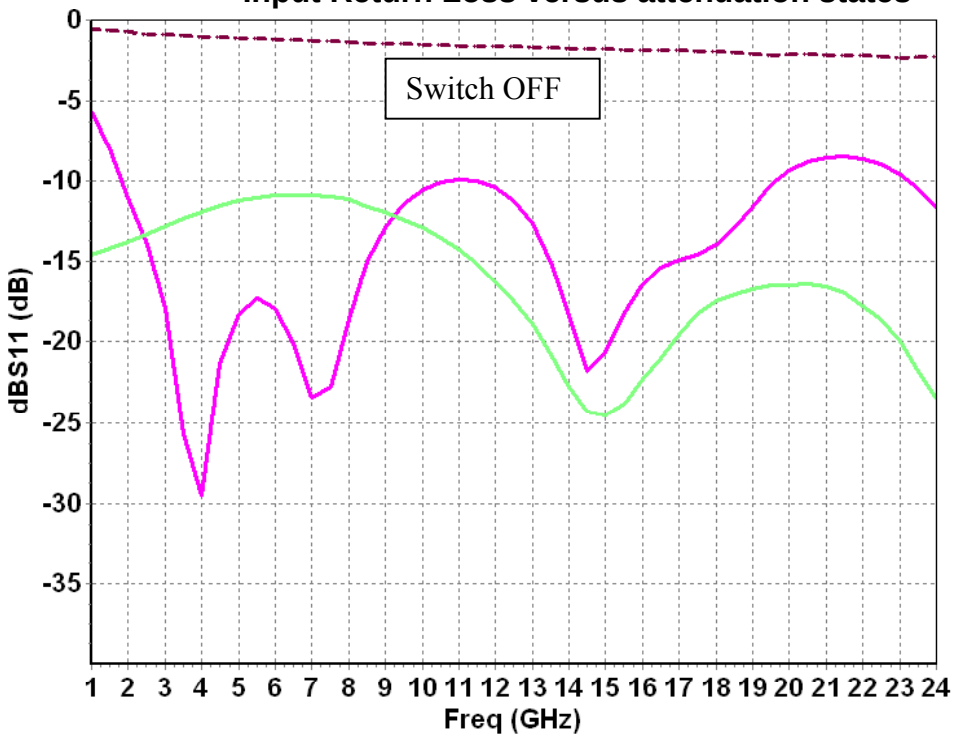
### Linear Gain versus attenuation states




### Input Return Loss versus attenuation states



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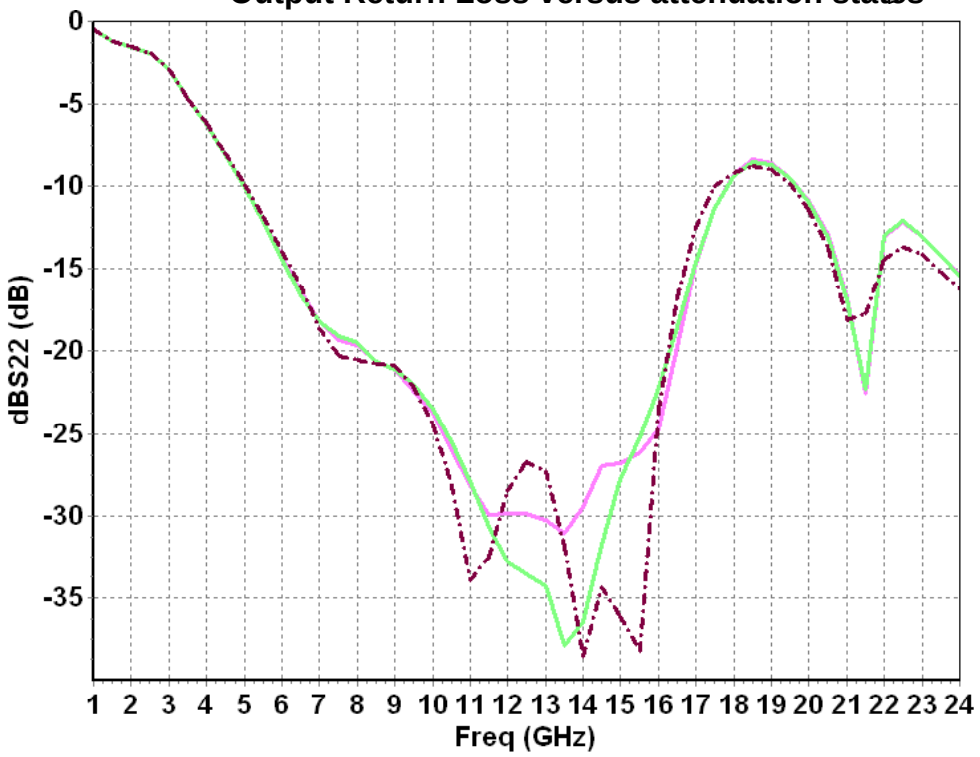
**Output Return Loss versus attenuation states**



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## Typical Chip on wafer Sij parameters for reference state

Tamb = +25°C, Vd1 = +4.5 V, Id = 210 mA , 0dB state (20A = -5V, 20B = 0V)

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| Freq (GHz) | dB(S11) | P(S11) (°) | dB(S21) | P(S21) (°) | dB(S12) | P(S12) (°) | dB(S22) | P(S22) (°) |
|---|---|---|---|---|---|---|---|---|
| 1.0 | -5.5 | -92.5 | -20.7 | 161.9 | -62.1 | 112.2 | -0.5 | -57.6 |
| 1.5 | -8.0 | -124.4 | -2.7 | 69.1 | -66.5 | -40.1 | -1.2 | -85.9 |
| 2.0 | -11.1 | -149.5 | 0.3 | 94.1 | -68.7 | 91.4 | -1.5 | -107.3 |
| 2.5 | -13.9 | -167.5 | 10.0 | 50.3 | -64.9 | 14.8 | -1.9 | -132.8 |
| 3.0 | -17.9 | 170.0 | 13.8 | -2.9 | -83.1 | 140.3 | -2.8 | -157.7 |
| 3.5 | -25.6 | 167.5 | 15.6 | -54.8 | -87.8 | 39.6 | -4.7 | -175.7 |
| 4.0 | -28.0 | -112.8 | 16.3 | -91.9 | -73.1 | 116.8 | -6.1 | 167.0 |
| 4.5 | -20.8 | -106.6 | 17.1 | -127.4 | -67.2 | 82.5 | -8.0 | 152.1 |
| 5.0 | -17.8 | -121.1 | 17.6 | -161.5 | -63.8 | 57.4 | -10.0 | 140.7 |
| 5.5 | -16.9 | -137.3 | 18.0 | 165.7 | -61.5 | 22.6 | -12.2 | 132.5 |
| 6.0 | -17.4 | -152.0 | 18.2 | 133.9 | -60.0 | -7.1 | -14.5 | 127.7 |
| 6.5 | -19.4 | -161.4 | 18.3 | 103.0 | -57.6 | -33.7 | -16.7 | 127.0 |
| 7.0 | -22.7 | -156.8 | 18.3 | 72.7 | -56.5 | -63.6 | -18.7 | 129.8 |
| 7.5 | -23.3 | -123.6 | 18.2 | 43.1 | -55.2 | -89.9 | -19.7 | 136.0 |
| 8.0 | -19.3 | -107.8 | 18.0 | 14.2 | -54.0 | -115.4 | -20.2 | 140.3 |
| 8.5 | -15.6 | -107.5 | 17.8 | -13.9 | -53.6 | -142.5 | -21.1 | 137.2 |
| 9.0 | -13.3 | -118.9 | 17.5 | -41.2 | -53.7 | -160.6 | -21.5 | 132.1 |
| 9.5 | -11.7 | -131.3 | 17.3 | -68.0 | -52.6 | -177.3 | -22.9 | 127.6 |
| 10.0 | -10.5 | -147.0 | 17.1 | -94.5 | -51.6 | 153.2 | -24.4 | 126.2 |
| 10.5 | -10.2 | -161.0 | 16.9 | -120.6 | -53.2 | 131.7 | -26.5 | 125.0 |
| 11.0 | -10.0 | -174.3 | 16.9 | -146.6 | -53.3 | 114.2 | -28.6 | 130.5 |
| 11.5 | -10.1 | 172.0 | 16.9 | -173.0 | -53.7 | 99.0 | -29.8 | 142.9 |
| 12.0 | -10.4 | 157.6 | 17.0 | 159.8 | -55.4 | 76.4 | -29.7 | 148.2 |
| 12.5 | -11.1 | 142.7 | 17.0 | 131.8 | -59.3 | 61.7 | -30.1 | 140.1 |
| 13.0 | -12.4 | 125.9 | 17.0 | 102.9 | -59.3 | 48.4 | -32.0 | 109.0 |
| 13.5 | -14.7 | 112.4 | 16.8 | 74.2 | -62.4 | -22.1 | -34.9 | 37.3 |
| 14.0 | -17.6 | 104.1 | 16.7 | 45.8 | -59.0 | -113.2 | -29.6 | -36.7 |
| 14.5 | -20.9 | 107.6 | 16.6 | 16.4 | -54.6 | -169.8 | -25.4 | -71.4 |
| 15.0 | -20.5 | 120.0 | 16.6 | -14.5 | -51.5 | 171.1 | -24.5 | -93.5 |
| 15.5 | -18.4 | 113.6 | 16.4 | -46.8 | -48.0 | 149.4 | -25.2 | -99.5 |
| 16.0 | -16.8 | 92.0 | 16.1 | -80.4 | -45.8 | 126.8 | -25.9 | -79.2 |
| 16.5 | -15.7 | 63.4 | 15.5 | -114.6 | -43.8 | 100.8 | -21.5 | -60.8 |
| 17.0 | -14.9 | 31.3 | 14.7 | -148.5 | -43.3 | 75.6 | -15.9 | -66.5 |
| 17.5 | -14.5 | 2.8 | 14.0 | 175.9 | -42.6 | 52.2 | -12.2 | -84.5 |
| 18.0 | -13.8 | -20.5 | 12.9 | 138.1 | -42.4 | 25.5 | -9.6 | -106.7 |
| 18.5 | -12.8 | -39.8 | 11.3 | 98.1 | -43.0 | -5.1 | -8.4 | -131.5 |
| 19.0 | -11.5 | -57.4 | 8.9 | 59.2 | -45.7 | -39.8 | -8.3 | -154.4 |
| 19.5 | -10.3 | -75.6 | 6.0 | 23.7 | -50.7 | -77.9 | -8.9 | -174.8 |
| 20.0 | -9.3 | -93.4 | 3.2 | -8.9 | -60.5 | -154.2 | -10.2 | 167.0 |
| 20.5 | -8.7 | -110.5 | 0.8 | -40.4 | -57.9 | 108.5 | -12.1 | 151.2 |
| 21.0 | -8.4 | -127.9 | -0.9 | -74.3 | -50.5 | 78.2 | -15.0 | 138.3 |
| 21.5 | -8.4 | -144.2 | -1.8 | -118.3 | -47.7 | 52.1 | -21.2 | 150.9 |
| 22.0 | -8.6 | -159.1 | -3.7 | 176.5 | -44.3 | 19.4 | -15.1 | -171.3 |
| 22.5 | -8.9 | -175.4 | -8.9 | 108.2 | -45.6 | -14.4 | -12.2 | 157.4 |
| 23.0 | -9.5 | 167.6 | -13.6 | 57.0 | -47.3 | -35.8 | -12.7 | 134.3 |
| 23.5 | -10.4 | 150.2 | -16.4 | 15.7 | -49.2 | -46.6 | -13.9 | 117.4 |
| 24.0 | -11.6 | 130.5 | -18.1 | -17.7 | -52.6 | -62.7 | -15.2 | 103.7 |



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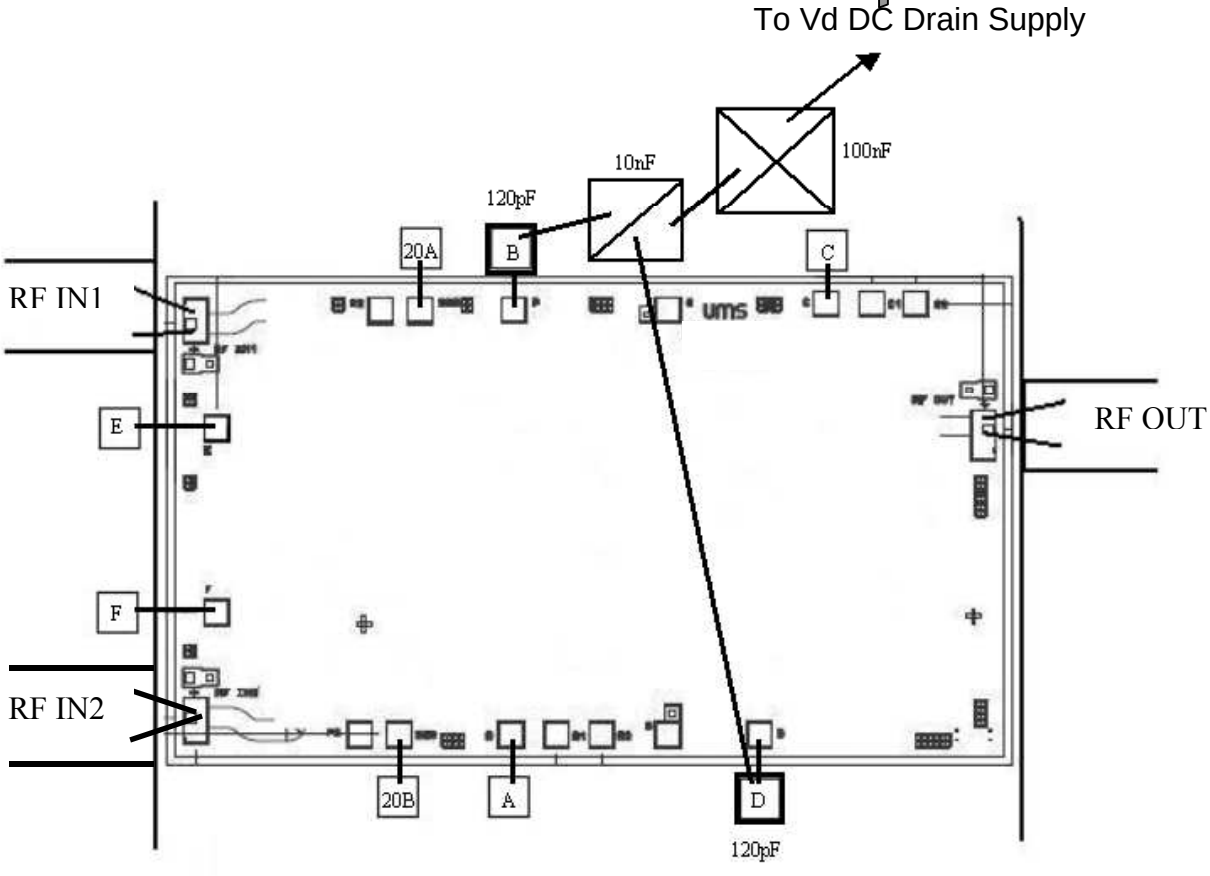
## Chip Assembly and Mechanical Data




Note : RF wire bondings should be as short as possible, lower than 0.35mm.
25µm diameter gold wire is to be prefered.

### Recommended circuit bonding table

| Label | Type | Decoupling | Comment |
|---|---|---|---|
| 20A, 20B | Vc | *Not required* | 20dB attenuator control |
| B | Vd | 120pF / 10nF | Drain Supply |
| D | Vd | 120pF / 10nF | Drain Supply |
| A | Vg | *Not required* | Gate Supply |
| C | Vg | *Not required* | Gate Supply |
| E, F | Vc | *Not required* | Switch control |



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## Bonding pad positions

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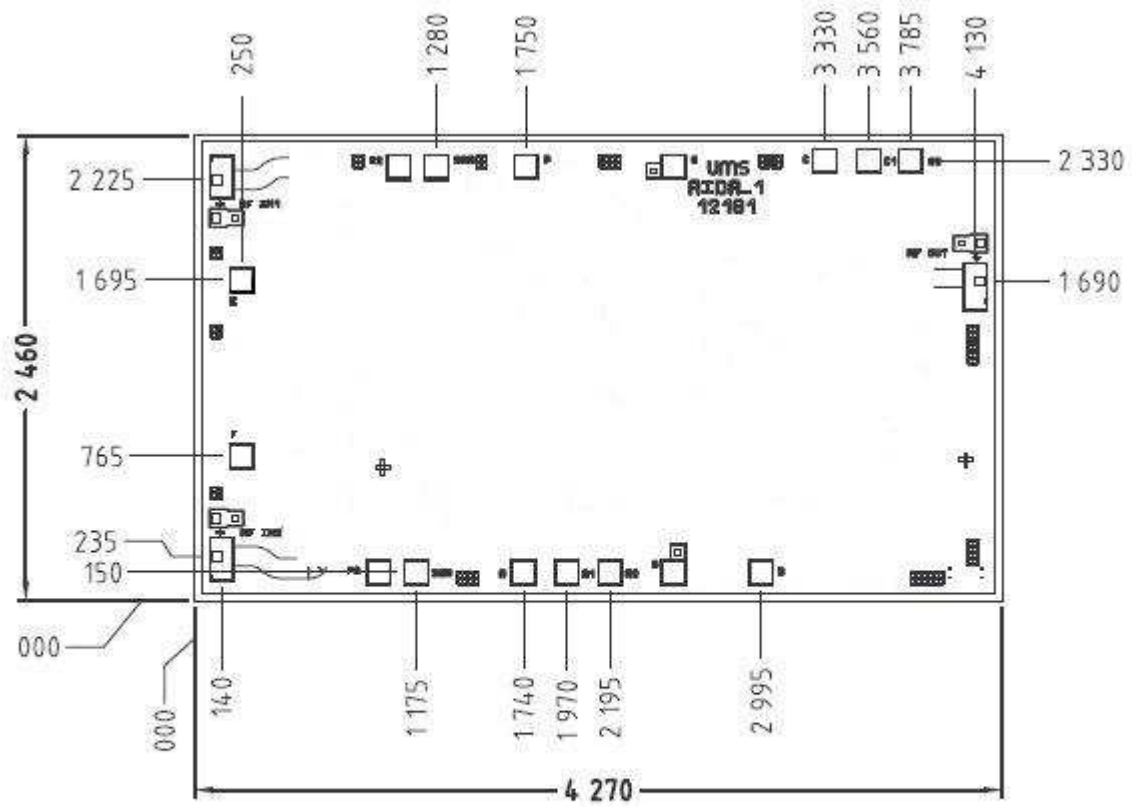


Chip thickness : 100µm

UNITS : µm
Tol : ±35µm

## Ordering Information

Chip form : CHA3512-99F/00





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