

ALM-1106

GPS Low Noise amplifier with Variable bias current and Shutdown function



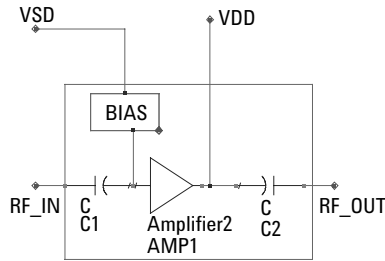
Data Sheet

Description

Avago Technologies's ALM-1106 is a LNA designed for GPS/ISM/Wimax applications in the (0.9-3.5)GHz frequency range. The LNA uses Agilent Technologies's proprietary GaAs Enhancement-mode pHEMT process to achieve high gain operation with very low noise figures and high linearity. Noise figure distribution is very tightly controlled. Gain and supply current are guaranteed parameters. A CMOS compatible shutdown pin is included to turn the LNA off and provide a variable bias.

The ALM-1106 LNA is useable down to 1V operation. It achieves low noise figures and high gain even at 1V, making it suitable for use in critical low power GPS/ISM band applications.

Simplified Schematic

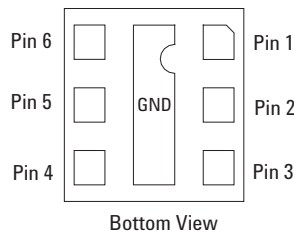


Surface Mount 2.0 x 2.0 x 1.1 mm³



Note:
Package marking provides Orientation and identification
"A" = Product Code
"Y" = Year
"WW" = Work Week

Pin Configuration



LNA I/O's:
1. NC 4. VSD
2. RF_IN 5. RF_OUT
3. NC 6. VDD
BOTTOM PADDLE : GND

Features

- Advanced GaAs E-pHEMT
- Low Noise: 0.8 dB typ
- High Gain : 14.3 dB typ
- Low component count
- High IIP3 and IP1dB
- Wide Supply Voltage: 1V to 3.6V
- Shutdown current : < 0.1uA
- CMOS compatible shutdown pin (VSD) current @ 2.85V : 90uA
- Adjustable bias current via one single external resistor/voltage
- Small Footprint: 2x2mm²
- Low Profile: 1.1mm typ
- Ext matching for non-GPS freq band operation

Specifications (25 deg): At 1.575GHz, 2.85V 8mA (Typ)

- Gain = 14.3 dB (Typ)
- NF = 0.8 dB (Typ)
- IIP3 = 4.7 dBm (Typ)
- IP1dB = 1.8 dBm (Typ)
- S11 = -11.8 dB (Typ)
- S22 = -12.4 dB (Typ)

Typical performance @ 1.0V supply

S21 = 12.3dB

NF = 1.0dB

Ids = 3.6mA

Note:
Measurements obtained using demoboard described in Figure 4.

Absolute Maximum Ratings [1]

| Symbol | Parameter | Units | Absolute Maximum |
|------------------|-----------------------------|-------|------------------|
| VDS | Drain - Source Voltage[2] | V | 3.6 |
| IDS | Drain Current[2] | mA | 15 |
| Pdiss | Total Power Dissipation [3] | mW | 54 |
| Pin max. | RF Input Power | dBm | +10 |
| TCH | Channel Temperature | °C | 150 |
| TSTG | Storage Temperature | °C | -65 to 150 |
| θ_{ch_b} | Thermal Resistance [4] | °C/W | 232 |

Notes:

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Assuming DC quiescent conditions.
3. Board (package belly) temperature T_B is 25°C. Derate 4.32mW/°C for $T_B > 137$ °C.
4. Channel-to-board thermal resistance measured using 150°C Liquid Crystal Measurement method.

Product Consistency Distribution Charts [5,6]

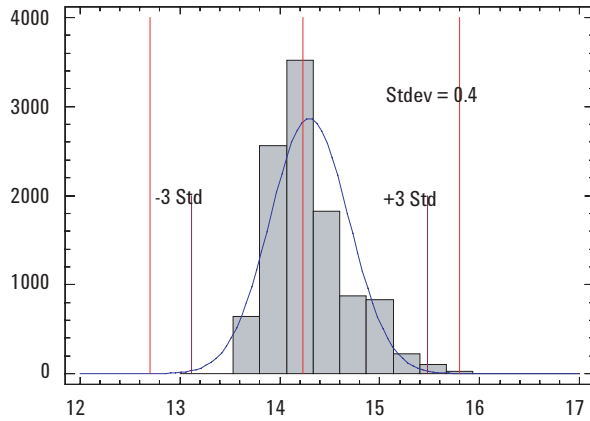


Figure 1. Gain @ 1.575GHz; LSL = 12.7dB, Nominal = 14.3dB, USL = 15.8dB

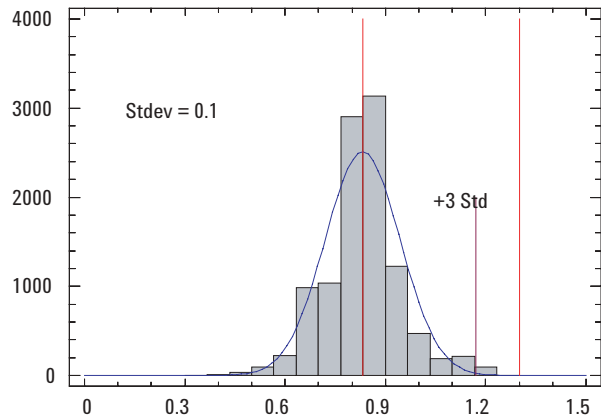


Figure 2. NF @ 1.575GHz; Nominal = 0.8dB, USL = 1.3dB

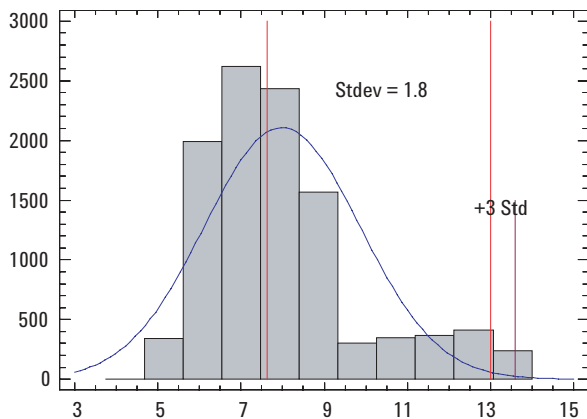


Figure 3. Ids @ 1.575GHz; Nominal = 8mA, USL = 13mA

Notes:

5. Distribution data sample size is 10K samples taken from 3 different wafers and 3 different lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
6. Measurements are made on production test board, which represents a trade-off between optimal Gain, NF, IIP3, IP1dB and VSWR. Circuit losses have been de-embedded from actual measurements.

Electrical Specifications

$T_A = 25\text{ }^\circ\text{C}$, DC bias for RF parameter is $V_{DD} = V_{SD} = +2.85\text{V}$ @ 8mA (unless otherwise specified)

$V_{DD} = V_{SD} = +2.85\text{V}$, $R_1 = 18\text{K Ohm}$, Freq=1.575GHz – Typical Performance

Table 1. Performance table at nominal operating conditions

| Symbol | Parameter and Test Condition | Units | Min. | Typ | Max. |
|------------------------|---|-------|------|--------|------|
| G | Gain | dB | 12.7 | 14.3 | 15.8 |
| NF | Noise Figure | dB | - | 0.8 | 1.3 |
| IP1dB | Input 1dB Compressed Power | dBm | | 1.8 | |
| IIP3 | Input 3rd Order Intercept Point (2-tone @ $F_c \pm 2.5\text{MHz}$) | dBm | | 4.7 | |
| S11 | Input Return Loss | dB | | -11.8 | |
| S22 | Output Return Loss | dB | | - 12.4 | |
| I _{ds} | Supply Current | mA | | 8 | 13 |
| I _{sh} | Shutdown Current @ $V_{SD} = 0\text{V}$ | uA | | 0.1 | |
| V _{ds} | Supply Voltage | V | | 2.85 | |
| IP1dB _{1710M} | Out of Band IP1dB (DCS 1710MHz) blocking | dBm | | 2.9 | |
| IIP3 _{OUT} | Out of Band IIP3 (DCS 1775MHz & 1950MHz) | dBm | | 5.5 | |

$V_{DD} = +2\text{V}$, $V_{DD} = +1.5\text{V}$ & $V_{DD} = +1.0\text{V}$, Freq=1.575GHz – Typical Performance ($V_{SD}=V_{DD}$, $R_1=0\text{ Ohm}$)

Table 2 – Typical performance at low operation voltages with R1 (see Fig 5) set to 0 Ohm

| Symbol | Parameter and Test Condition | Units | VDD=2V | VDD=1.5V | VDD=1.0V |
|------------------------|---|-------|--------|----------|----------|
| G | Gain | dB | 15 | 14.2 | 12.3 |
| NF | Noise Figure | dB | 0.8 | 0.9 | 1 |
| IP1dB | Input 1dB Compressed Power | dBm | -1.4 | -2.4 | -3.8 |
| IIP3 | Input 3rd Order Intercept Point (2-tone @ $F_c \pm 2.5\text{MHz}$) | dBm | 7.3 | 4.9 | 5.2 |
| S11 | Input Return Loss | dB | -13.8 | -11.5 | -8 |
| S22 | Output Return Loss | dB | -15.5 | -14.5 | -11.7 |
| I _{ds} | Supply Current | mA | 13 | 7.5 | 3.6 |
| I _{sh} | Shutdown Current @ $V_{SD} = 0\text{V}$ | uA | 0.1 | 0.1 | 0.1 |
| V _{ds} | Supply Voltage | V | 2 | 1.5 | 1.0 |
| IP1dB _{1710M} | Out of Band IP1dB (DCS 1710MHz) blocking | dBm | -0.3 | -1.9 | -2.9 |
| IIP3 _{OUT} | Out of Band IIP3 (DCS 1775MHz & 1950MHz) | dBm | 8.7 | 5.8 | 3 |

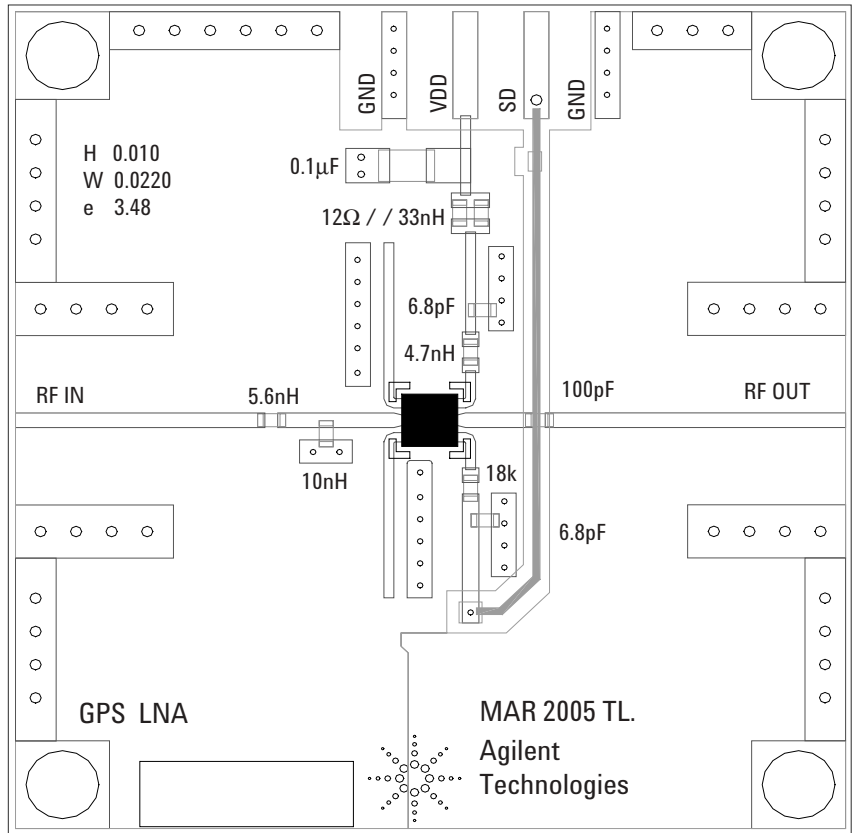


Figure 4. Demoboard and Application Circuit Components

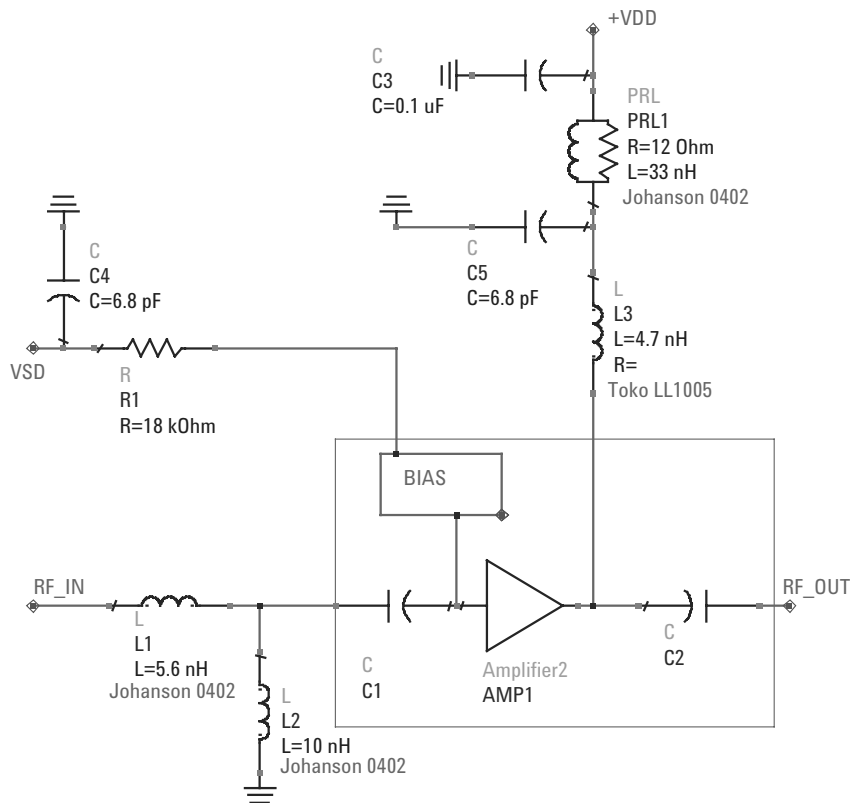


Figure 5. Demoboard schematic

Notes

- L1 and L2 form the input matching network. The LNA module has a integrated coupling and DC-blocking capacitors at the input and output. Best noise performance is obtained using high-Q wirewound inductors. This circuit demonstrates that low noise figures are obtainable with standard 0402 chip inductors. Replacing L1, L2 and L3 with high-Q wirewound inductors (eg. Cilcraft 0402CS series) will yield 0.1dB lower NF and 0.6dB higher Gain.
- L3 is an output matching inductor.
- C5 is a RF bypass capacitor.
- PRL1 is a network that isolates the measurement demoboard from external disturbances. C3 and C4 mitigates the effect of external noise pickup on the VSD and VDD lines. These components are not required in actual operation.
- Bias control is achieved by either varying the VSD voltage without R1 or fixing the VSD voltage to VDD and varying R1. Typical value for R1 is 18k Ohm for 8mA total current at VDD=+2.85V.
- Higher gain and IP3 performance can be obtained by increasing the supply current. This can be achieved by reducing the value for R1 to obtain desired current.
- For low voltage operation such as 1.5V or 1.0V, the R1 may be omitted and VSD connected directly to the supply pins.

ALM-1106 Typical Performance Curves, R1 = 18K Ohm (At 25°C unless specified otherwise)

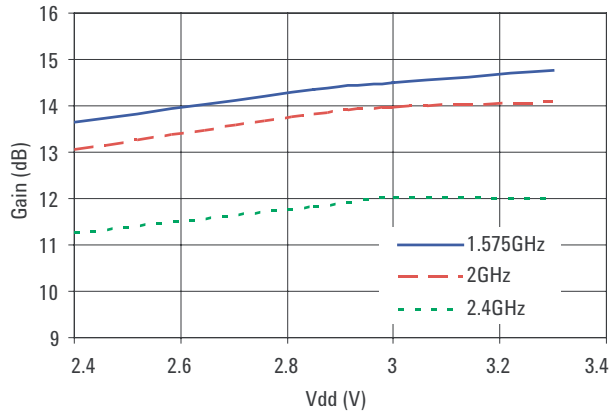


Figure 6. Gain vs Vdd vs Freq

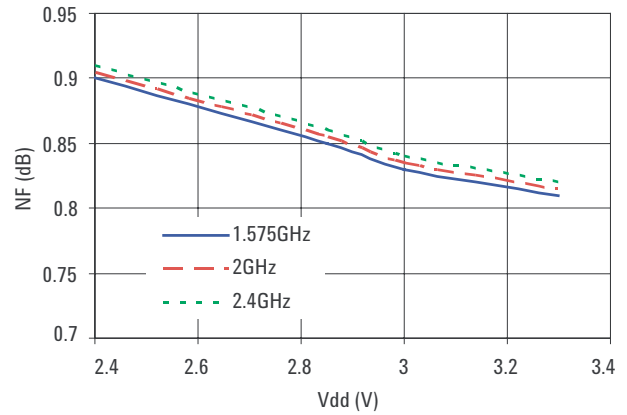


Figure 7. NF vs Vdd vs Freq

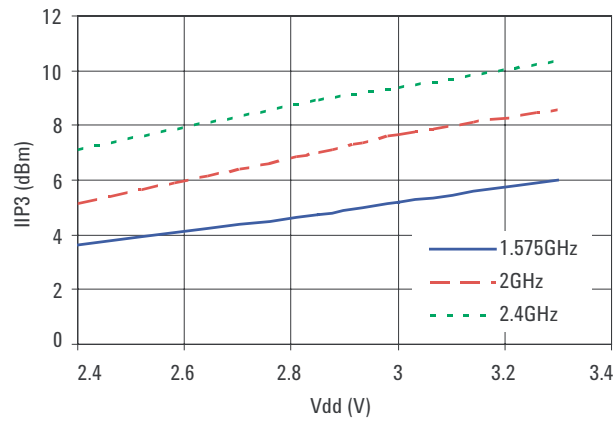


Figure 8. IIP3 vs Vdd vs Freq

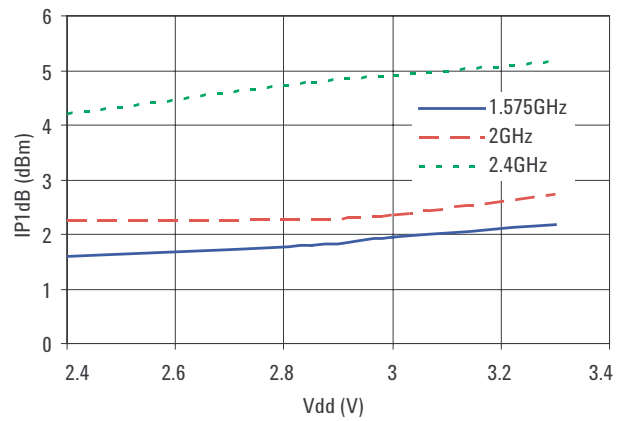


Figure 9. IP1dB vs Vdd vs Freq

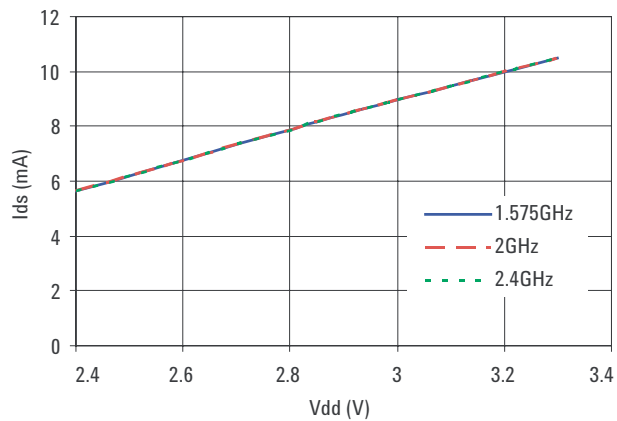


Figure 10. Ids vs Vdd vs Freq

ALM-1106 Typical Performance Curves, R1 = 18K Ohm (At 25°C unless specified otherwise)

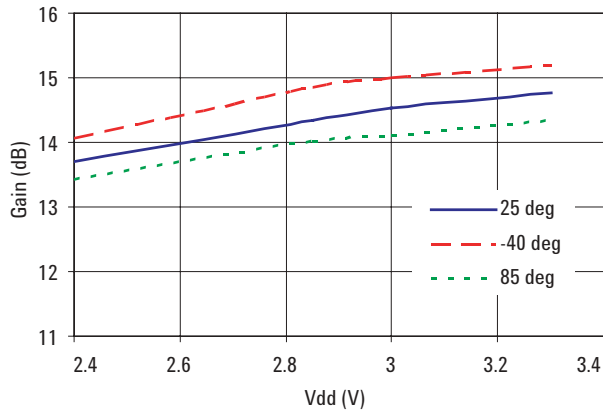


Figure 11. Gain vs Vdd vs Temp

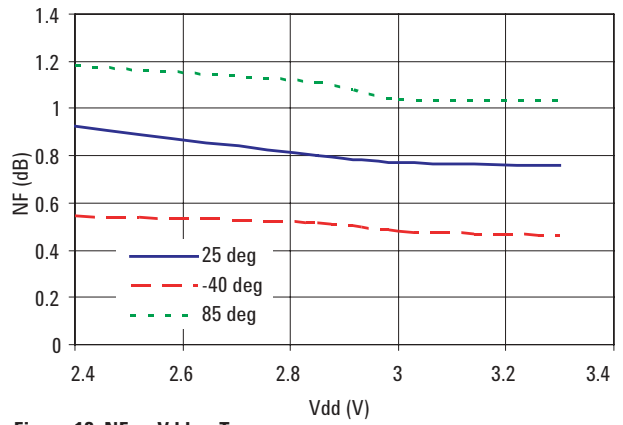


Figure 12. NF vs Vdd vs Temp

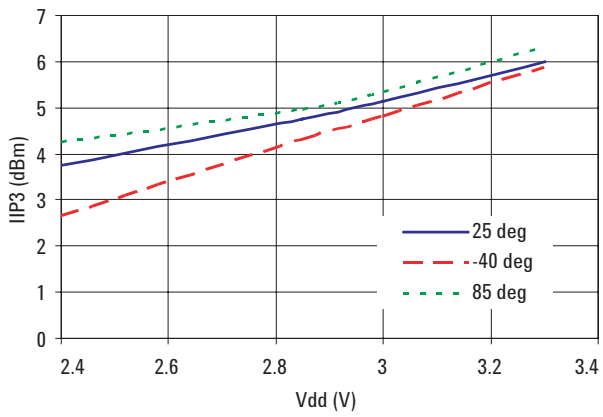


Figure 13. IIP3 vs Vdd vs Temp

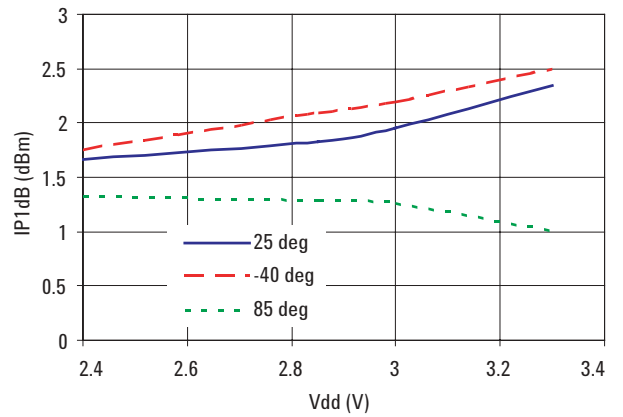


Figure 14. IP1dB vs Vdd vs Temp

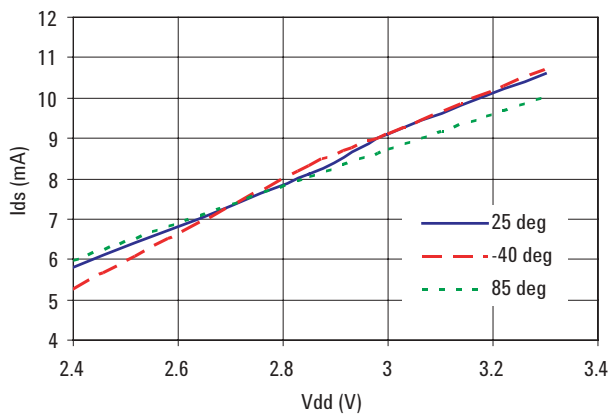


Figure 15. Ids vs Vdd vs Temp

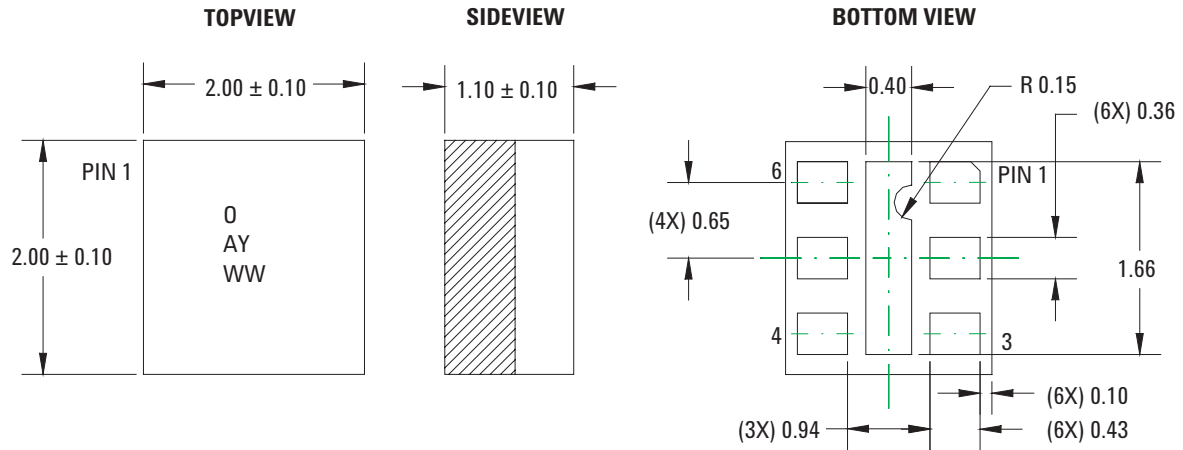
ALM-1106 Typical Scattering Parameters at 25°C, V_{DD} = 2.85V, I_{DS} = 8 mA

| Freq. | S11 | | S21 | | S12 | | S22 | | | |
|-------|-------|--------|-------|-------|-------|--------|-------|------|-------|--------|
| | Mag. | Ang. | (dB) | Mag. | Ang. | (dB) | Mag. | Ang. | | |
| 0.1 | 0.998 | -4.7 | 15.01 | 5.633 | 176.7 | -47.96 | 0.004 | 89.2 | 0.526 | -5 |
| 0.5 | 0.946 | -23.5 | 14.62 | 5.381 | 153.1 | -34.42 | 0.019 | 78.6 | 0.503 | -19 |
| 0.9 | 0.866 | -40.4 | 13.72 | 4.854 | 134.1 | -29.90 | 0.032 | 71.8 | 0.475 | -31.9 |
| 1 | 0.843 | -44.4 | 13.47 | 4.714 | 129.7 | -29.37 | 0.034 | 70.5 | 0.468 | -34.9 |
| 1.1 | 0.821 | -48.2 | 13.20 | 4.573 | 125.5 | -28.64 | 0.037 | 69.3 | 0.459 | -37.9 |
| 1.2 | 0.8 | -52 | 12.95 | 4.44 | 121.5 | -27.96 | 0.04 | 68.5 | 0.451 | -40.5 |
| 1.3 | 0.78 | -55.8 | 12.69 | 4.31 | 117.6 | -27.33 | 0.043 | 67.4 | 0.443 | -43.2 |
| 1.4 | 0.757 | -59.7 | 12.42 | 4.178 | 113.6 | -26.94 | 0.045 | 66.5 | 0.435 | -45.8 |
| 1.5 | 0.731 | -63.4 | 12.13 | 4.039 | 109.7 | -26.38 | 0.048 | 65.7 | 0.428 | -48.2 |
| 1.6 | 0.705 | -66.8 | 11.83 | 3.905 | 106.1 | -26.02 | 0.05 | 64.8 | 0.421 | -50.7 |
| 1.7 | 0.683 | -69.7 | 11.55 | 3.78 | 102.9 | -25.51 | 0.053 | 64.7 | 0.414 | -52.8 |
| 1.8 | 0.663 | -71.6 | 11.29 | 3.669 | 99.5 | -25.19 | 0.055 | 63.9 | 0.408 | -55.5 |
| 1.9 | 0.643 | -73.4 | 10.99 | 3.544 | 96 | -24.73 | 0.058 | 63.1 | 0.399 | -58 |
| 2 | 0.623 | -75.3 | 10.48 | 3.343 | 97 | -24.58 | 0.059 | 66.3 | 0.398 | -58.8 |
| 2.1 | 0.603 | -77.2 | 10.25 | 3.253 | 93.5 | -24.15 | 0.062 | 65.5 | 0.398 | -59.6 |
| 2.2 | 0.583 | -79 | 10.01 | 3.165 | 90.2 | -23.74 | 0.065 | 64.6 | 0.397 | -60.3 |
| 2.3 | 0.563 | -80.9 | 9.77 | 3.079 | 87 | -23.48 | 0.067 | 63.8 | 0.396 | -61.1 |
| 2.4 | 0.543 | -82.8 | 9.49 | 2.983 | 83.8 | -23.10 | 0.07 | 63 | 0.396 | -62.1 |
| 2.5 | 0.522 | -85.3 | 9.23 | 2.895 | 81.1 | -22.73 | 0.073 | 62.3 | 0.395 | -62.7 |
| 3 | 0.434 | -105.2 | 7.95 | 2.498 | 66.6 | -21.21 | 0.087 | 56.9 | 0.345 | -74.4 |
| 3.5 | 0.334 | -119.5 | 6.47 | 2.105 | 57.3 | -20.26 | 0.097 | 54 | 0.324 | -86.8 |
| 4 | 0.302 | -132.1 | 6.25 | 2.054 | 48.8 | -18.42 | 0.12 | 53.7 | 0.271 | -108 |
| 4.5 | 0.297 | -141.8 | 5.50 | 1.883 | 33.1 | -16.95 | 0.142 | 43.4 | 0.265 | -113.3 |
| 5 | 0.274 | -157.1 | 4.44 | 1.667 | 23.9 | -15.97 | 0.159 | 38 | 0.259 | -118.6 |
| 5.5 | 0.254 | -170.1 | 3.63 | 1.519 | 16.1 | -15.04 | 0.177 | 33.7 | 0.26 | -133.2 |
| 6 | 0.211 | 178.7 | 2.82 | 1.383 | 6.3 | -14.11 | 0.197 | 25.3 | 0.249 | -142.7 |
| 6.5 | 0.204 | 165.4 | 1.89 | 1.243 | -0.7 | -13.64 | 0.208 | 16.7 | 0.263 | -154.7 |
| 7 | 0.189 | 137.1 | 1.56 | 1.197 | -5.4 | -13.27 | 0.217 | 12.7 | 0.306 | -171.3 |
| 7.5 | 0.193 | 117.3 | 1.03 | 1.126 | -14.4 | -12.88 | 0.227 | 9.5 | 0.31 | 179.8 |
| 8 | 0.206 | 90.6 | 0.87 | 1.105 | -22.2 | -12.40 | 0.24 | 4.7 | 0.314 | 170.8 |

ALM-1106 Typical Noise Parameters, V_{DD} = 2.85V, I_{DS} = 8mA

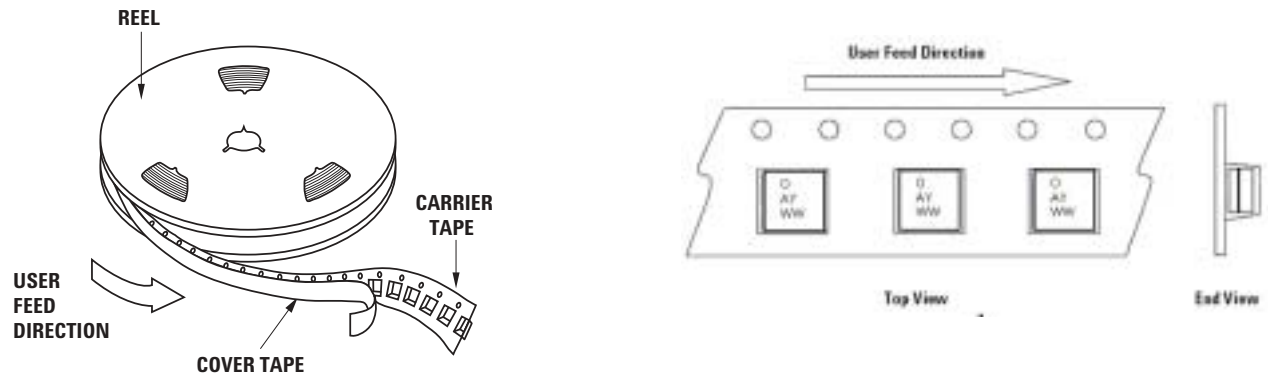
| Freq (GHz) | F _{min} (dB) | Γ _{opt} Mag. | Γ _{opt} Ang. | R _n /50 | NF @ 50dB |
|------------|-----------------------|-----------------------|-----------------------|--------------------|-----------|
| 0.5 | 0.53 | 0.64 | 13.8 | 0.41 | 1.46 |
| 0.9 | 0.65 | 0.69 | 32.2 | 0.28 | 1.07 |
| 1.5 | 0.8 | 0.71 | 47.4 | 0.24 | 1.22 |
| 1.7 | 0.82 | 0.69 | 58.1 | 0.22 | 1.14 |
| 2 | 0.91 | 0.68 | 59.5 | 0.23 | 1.1 |
| 2.4 | 0.93 | 0.64 | 71.3 | 0.27 | 1.72 |
| 3 | 1.21 | 0.52 | 99.2 | 0.16 | 1.45 |
| 3.5 | 1.33 | 0.44 | 135.8 | 0.12 | 1.6 |
| 4 | 1.69 | 0.35 | 161.3 | 0.08 | 1.27 |
| 4.5 | 1.73 | 0.31 | 171.3 | 0.06 | 1.47 |
| 5 | 1.82 | 0.32 | -179.6 | 0.06 | 1.65 |
| 5.5 | 1.98 | 0.34 | -171.2 | 0.08 | 2.16 |
| 5.8 | 2.37 | 0.43 | -174.8 | 0.14 | 2.88 |

Package Dimensions

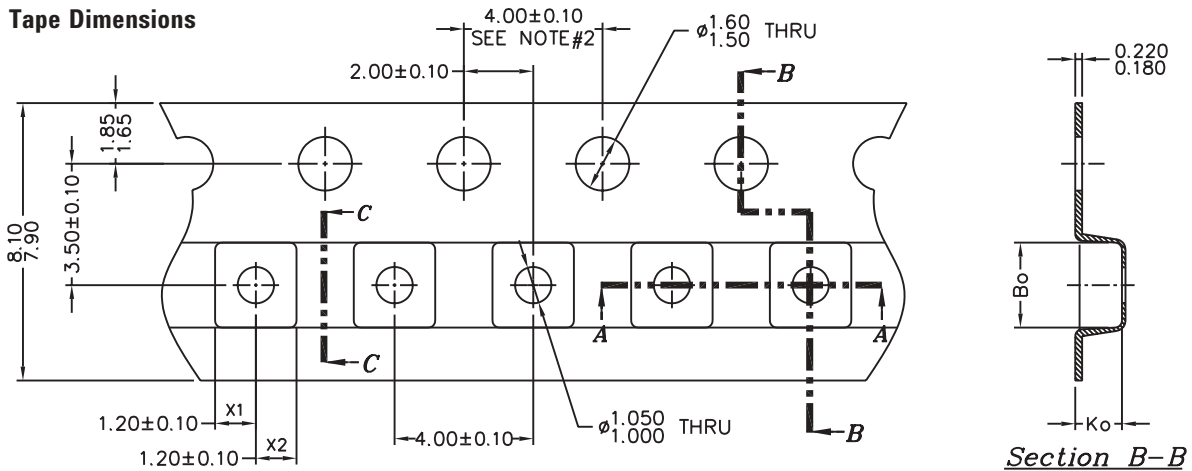


Existing Thermal Ground to pad clearance = 0.16mm
 Samsung Thermal Ground to pad min clearance = 0.25mm

Device Orientation



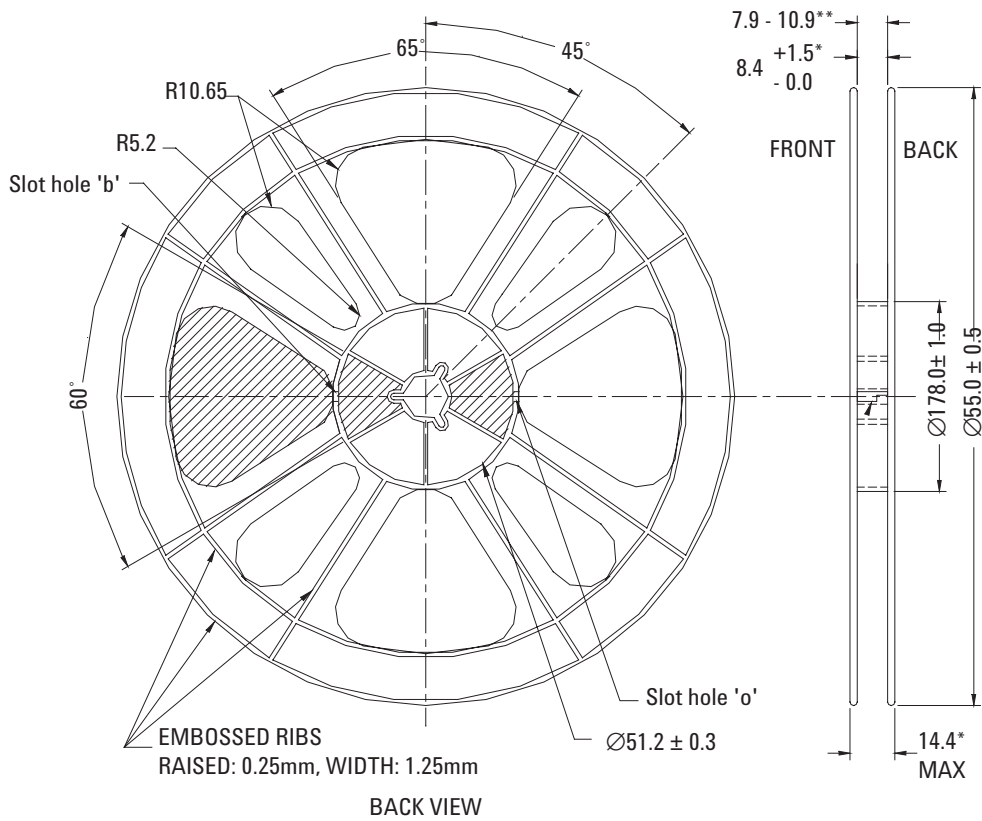
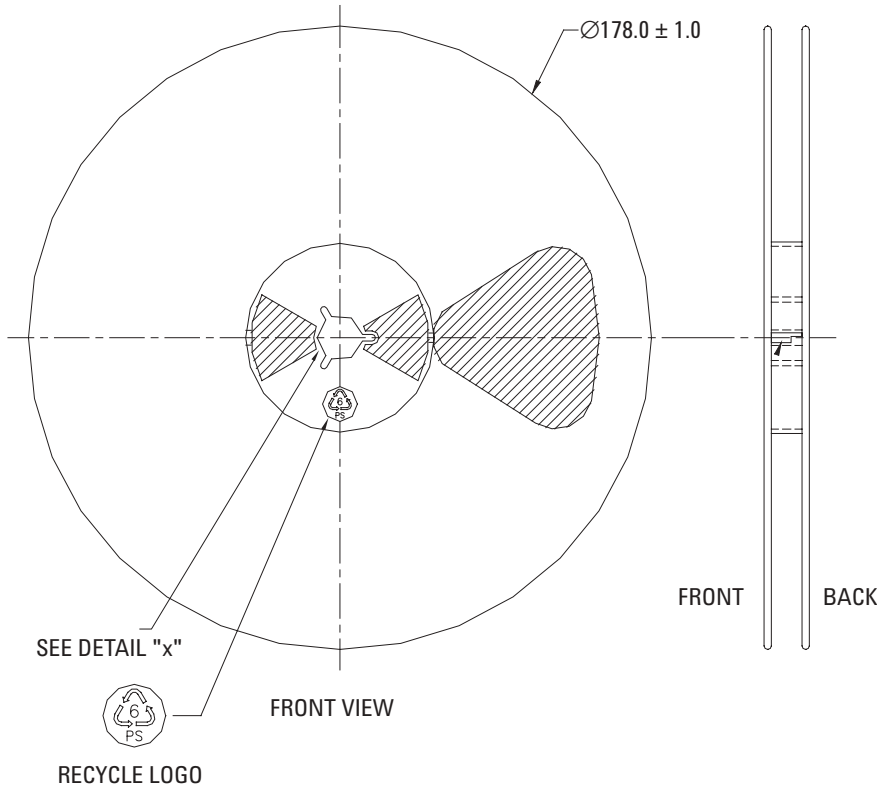
Tape Dimensions



Notes:

1. Measured from centerline of sprocket hole to centerline of pocket
 2. Cumulative tolerance of 10 sprocket holes is ± 0.20
- All dimensions in millimeters unless otherwise stated.

Reel Dimensions



Part Number Ordering Information

| Part Number | No. of Devices | Container |
|--------------|----------------|----------------|
| ALM-1106-TR1 | 3000 | 7" Reel |
| ALM-1106-TR2 | 10000 | 13" Reel |
| ALM-1106-BLK | 100 | antistatic bag |

For product information and a complete list of distributors, please go to our web site: www.avagotech.com

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