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# ALM-GP001

## GPS Filter-LNA-Filter Front-End Module



### Data Sheet

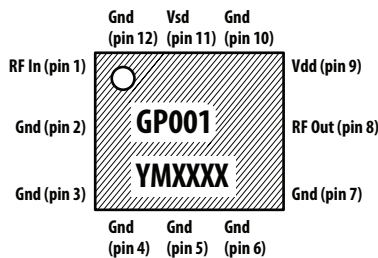
#### Description

Avago Technologies' ALM-GP001 is an ultra low-noise GPS front-end module that combines a low-noise amplifier (LNA) with GPS FBAR filters. The LNA uses Avago Technologies' proprietary GaAs Enhancement-mode pHEMT process to achieve high gain with very low noise figure and high linearity. Noise figure distribution is very tightly controlled. A CMOS-compatible shutdown pin is included either for turning the LNA on/off, or for current adjustment. The integrated filter utilizes an Avago Technologies' leading-edge FBAR filter for exceptional rejection at Cellular, DCS, PCS and WLAN band frequencies. Bypass functionality with an external RF switch is possible with separate RF switching.

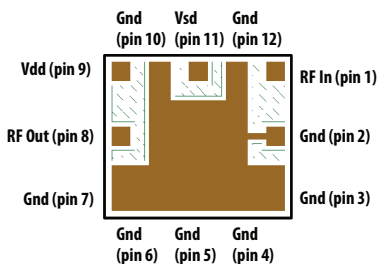
The low noise figure and high gain, coupled with low current consumption make it suitable for use in critical low-power GPS applications or during low-battery situations.

#### Component Image

Surface Mount (3.0 x 2.5 x 1) mm<sup>3</sup> 12-lead MCOB



TOP VIEW



BOTTOM VIEW

Note:  
 Package marking provides orientation and identification  
 "GP001" = Product Code  
 "Y" = Year of manufacture  
 "M" = Month of manufacture  
 "XXXX" = Last 4 digit of lot number

#### Features

- Operating temperature range -40 to +85 °C
- Very Low Noise Figure: 1.26 dB typ.
- Exceptional Cell/DCS/PCS/WLAN-Band rejection
- Advanced GaAs E-pHEMT & FBAR Technology
- Low external component count.
- CMOS compatible shutdown pin (SD)
- ESD: > 3kV at RFin pin
- Adjustable bias current via single external resistor/voltage
- Useable down to 1.8V supply voltage
- Small package dimension: 3.0(L)x2.5(W)x1(H) mm<sup>3</sup>
- Meets MSL3, Lead-free and halogen free

#### Specifications (Typical performance @ 25°C)

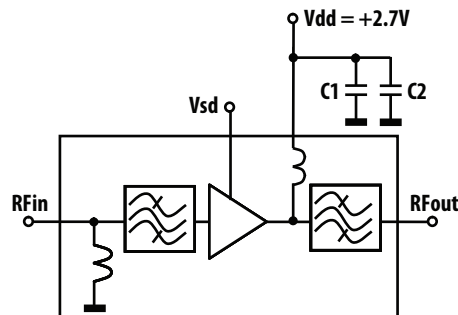
At 1.575GHz, Vdd = 2.7V, Idd = 7.5mA

- Gain = 14.2 dB
- NF = 1.26 dB
- IIP3 = +5 dBm, IP1dB = +2 dBm
- S11 = -9 dB, S22 = -12 dB
- Low-Band Rejection (824 – 928MHz): 89 dBc
- High-Band Rejection (1710 – 1980MHz): 80 dBc
- WLAN-Band Rejection (2400 – 2500MHz): 72 dBc

#### Application

- GPS Front-end Module

#### Application Circuit



**Attention: Observe precautions for handling electrostatic sensitive devices.**

RF In (Pin 1) to GND: ESD Human Body Model = 3 kV  
 All other Pins : ESD Machine Model = 50 V  
 : ESD Human Body Model = 300 V

Refer to Avago Application Note A004R:  
 Electrostatic Discharge, Damage and Control.

## Absolute Maximum Rating<sup>[1]</sup> T<sub>A</sub>=25°C

| Symbol              | Parameter   | Units | Absolute Max. |
|---------------------|---|-------|---------------|
| V <sub>dd</sub>     | Device Drain to Source Voltage <sup>[2]</sup>                       | V     | 3.6           |
| I <sub>dd</sub>     | Drain Current <sup>[2]</sup>  | mA    | 20            |
| P <sub>in,max</sub> | CW RF Input Power (V <sub>dd</sub> = 2.7V, I <sub>dd</sub> = 7.5mA) | dBm   | 15            |
| P <sub>diss</sub>   | Total Power Dissipation <sup>[4]</sup>                              | mW    | 72            |
| T <sub>j</sub>      | Junction Temperature  | °C    | 150           |
| T <sub>STG</sub>    | Storage Temperature   | °C    | -65 to 150    |

## Thermal Resistance<sup>[3]</sup> (V<sub>dd</sub> = 2.7V, I<sub>dd</sub> = 7.5mA), θ<sub>jc</sub> = 92°C/W

Notes:

1. Operation of this device in excess of any of these limits may cause permanent damage.
2. Assuming DC quiescent conditions.
3. Thermal resistance measured using Infra-Red measurement technique.
4. Board (module belly) temperature T<sub>B</sub> is 25°C. Derate 10.87 mW/°C for T<sub>B</sub>>143°C.

## Electrical Specifications

T<sub>A</sub> = 25°C, Freq = 1.575GHz, measured on demo board<sup>[1]</sup> unless otherwise specified – Typical Performance<sup>[1]</sup>

**Table 1. Performance at V<sub>dd</sub> = V<sub>sd</sub> = 2.7V, I<sub>dd</sub> = 7.5mA (R<sub>bias</sub> = 6.8k Ohm) nominal operating conditions**

| Symbol                   | Parameter and Test Condition  | Units | Min. | Typ  | Max. |
|--------------------------|---|-------|------|------|------|
| G                        | Gain  | dB    | 12   | 14.2 | 16.3 |
| NF <sup>[2]</sup>        | Noise Figure  | dB    | –    | 1.26 | 1.7  |
| IP1dB                    | Input 1dB Compressed Power  | dBm   | –    | +2   | –    |
| IIP3 <sup>[3]</sup>      | Input 3 <sup>rd</sup> Order Intercept Point (2-tone @ F <sub>c</sub> +/- 2.5MHz)          | dBm   | 0    | +5   | –    |
| S11                      | Input Return Loss   | dB    | –    | -9   | –    |
| S22                      | Output Return Loss  | dB    | –    | -12  | –    |
| S12                      | Reverse Isolation   | dB    | –    | -22  | –    |
| Low Band Rejection       | Worst-case relative to 1.575GHz within (827-928)MHz band, tested at 928MHz                | dBc   | 79   | 89   | –    |
| High Band Rejection      | Worst-case relative to 1.575GHz within (1710-1980)MHz band, tested at 1850MHz             | dBc   | 74   | 80   | –    |
| WLAN Band Rejection      | Worst-case relative to 1.575GHz within (2400-2500)MHz band, tested at 2500MHz             | dBc   | 67   | 72   | –    |
| IP1dB <sub>890MHz</sub>  | Input 1dB gain compression interferer signal level at 890MHz                              | dBm   | –    | 21   | –    |
| IP1dB <sub>1710MHz</sub> | Input 1dB gain compression interferer signal level at 1710MHz                             | dBm   | –    | 32   | –    |
| IP1dB <sub>1885MHz</sub> | Input 1dB gain compression interferer signal level at 1885MHz                             | dBm   | –    | 37   | –    |
| IP1dB <sub>2500MHz</sub> | Input 1dB gain compression interferer signal level at 2500MHz                             | dBm   | –    | 35   | –    |
| OOB IIP3 <sup>[4]</sup>  | Out of Band Input 3 <sup>rd</sup> Order Intercept Point (2-tone @ 1712.7 MHz and 1850MHz) | dBm   | –    | 62   | –    |
| I <sub>dd</sub>          | Supply DC current at Shutdown (SD) voltage V <sub>sd</sub> = 2.7V                         | mA    | 4    | 7.5  | 15   |
| I <sub>sh</sub>          | Shutdown Current @ V <sub>SD</sub> = 0V   | uA    | –    | 0.5  | 110  |

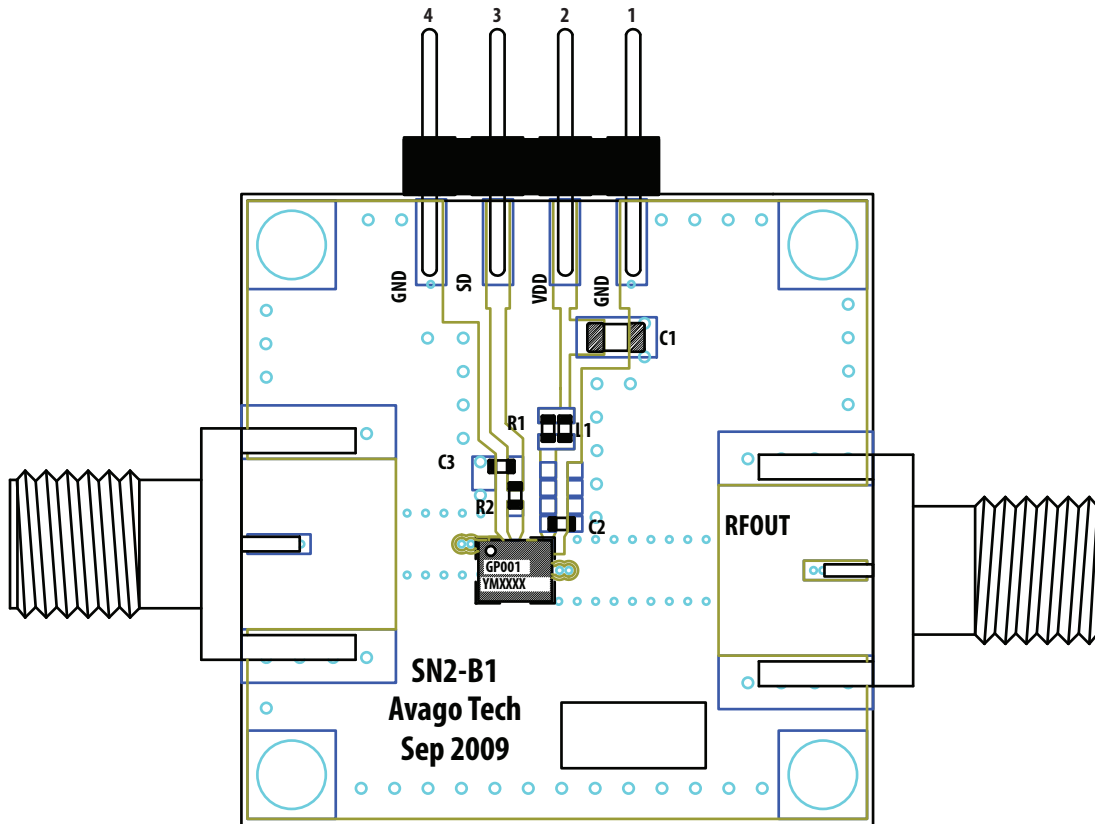


**Table 2. Performance at Vdd = Vsd = 1.8V, Idd = 5mA (Rbias = 2.7k Ohm) nominal operating conditions**

| Symbol              | Parameter and Test Condition  | Units | Typ   |
|---------------------|---|-------|-------|
| G                   | Gain  | dB    | 12.8  |
| NF <sup>[2]</sup>   | Noise Figure  | dB    | 1.35  |
| IP1dB               | Input 1dB Compressed Power  | dBm   | 0     |
| IIP3 <sup>[3]</sup> | Input 3 <sup>rd</sup> Order Intercept Point (2-tone @ Fc +/- 2.5MHz)          | dBm   | 3.5   |
| S11                 | Input Return Loss   | dB    | -8    |
| S22                 | Output Return Loss  | dB    | -11.5 |
| S12                 | Reverse Isolation   | dB    | -21   |
| Low Band Rejection  | Worst-case relative to 1.575GHz within (827-928)MHz band, tested at 928MHz    | dBc   | 89    |
| High Band Rejection | Worst-case relative to 1.575GHz within (1710-1980)MHz band, tested at 1850MHz | dBc   | 79    |
| WLAN Band Rejection | Worst-case relative to 1.575GHz within (2400-2500)MHz band, tested at 2500MHz | dBc   | 71    |
| IP1dB890MHz         | Input 1dB gain compression interferer signal level at 890MHz                  | dBm   | 20    |
| IP1dB1710MHz        | Input 1dB gain compression interferer signal level at 1710MHz                 | dBm   | 32    |
| IP1dB1885MHz        | Input 1dB gain compression interferer signal level at 1885MHz                 | dBm   | 37    |
| IP1dB2500MHz        | Input 1dB gain compression interferer signal level at 2500MHz                 | dBm   | 35    |
| Idd                 | Supply DC current at Shutdown (SD) voltage Vsd = 1.8V                         | mA    | 5     |

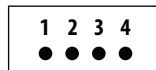
## Notes:

1. Measurements at 1.575GHz obtained using demo board
2. Losses from demoboard deembedded
3. 1.575GHz IIP3 test condition:  $F_{RF1} = 1572.5$  MHz,  $F_{RF2} = 1577.5$  MHz with input power of -20dBm per tone measured at the worst case side band
4. 1.575GHz IIP3 test condition:  $F_{RF1} = 1712.7$  MHz,  $F_{RF2} = 1850$  MHz with input power of 10dBm per tone measured at the worst case side band



**DC Pin Configuration of 4-Pins connector**

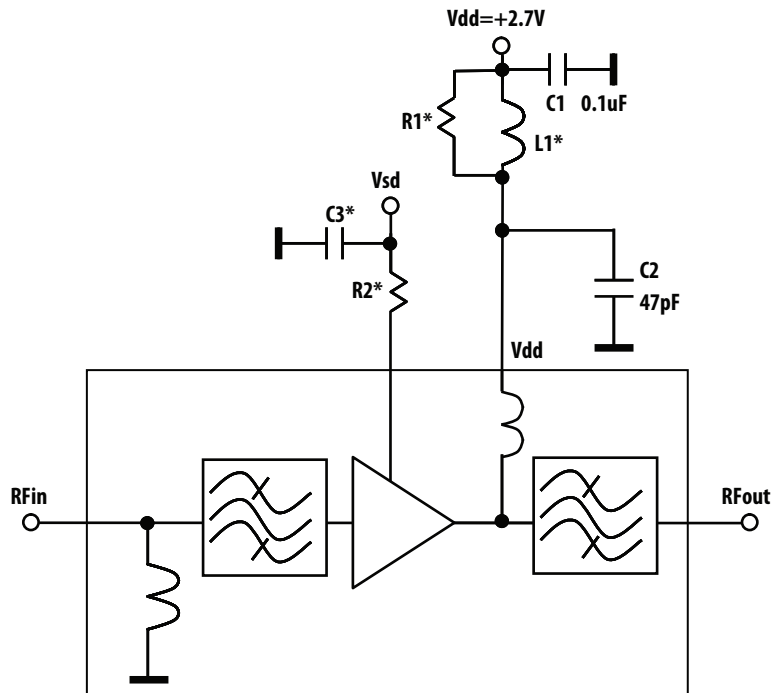
Pins pointing out of the page



Pins 1, 4 = GND  
 Pin 2 = Vdd Supply  
 Pin 3 = Shutdown (SD)

| Circuit Symbol | Size | Description                                  |
|----------------|------|--|
| L1             | 0402 | 22 nH Inductor (Taiyo Yuden HK100522NJ-T)    |
| C1             | 0805 | 0.1 uF Capacitor (Murata GRM21BR71H104KA01L) |
| C2             | 0402 | 47 pF Capacitor (Kyocera CM05CH470J50AHF)    |
| C3             | 0402 | 6.8 pF Capacitor (Kyocera CM05CG6R8C50AHF)   |
| R1             | 0402 | 12 Ohms Resistor (RK73B1ETTP120J)            |
| R2             | 0402 | 6.8 kohm Resistor (RK73B1ETTP6R8J)           |

Figure 1. Demoboard and application circuit components table



**Figure 2. Application Circuit**

\* optional, see notes below

Notes:

- The ALM-GP001 can be operated with supply voltage (Vdd) from 1.5V to 2.85V. Vsd can operate from 1V to Vdd.
- The module is fully matched at the input and output RF pins. The RFinpin pin is connected directly to a shunt inductor. As such a DC blocking capacitor is required if DC voltages are present. The RFoutput pin is already DC-blocked by the internal filter inside the module.
- Best noise performance is obtained using high-Q wirewound inductors. This circuit demonstrates that low noise figures are obtainable with standard 0402 chip inductors.
- C1 and C2 are bypass capacitors for RF and low frequency stability and linearity .
- L1 and R1 isolates the demoboard from external disturbances during measurement. It is not needed in actual operation. Likewise, C3 mitigate the effect of external noise pickup on the Vsd line. This component are not required in actual operation. Minimal component operation is as shown in the schematic on page 1.
- Bias control is achieved by either varying the Vsd voltage with/ without R2, or fixing the Vsd voltage to Vdd and adjusting R2 for the desired current.

### ALM-GP001 Typical Performance Curves at 25°

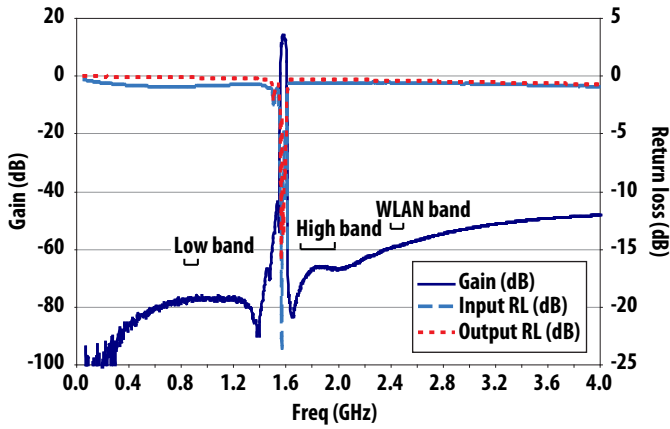


Figure 3a. Typical S-Parameter Plot @ Vdd = 2.7V, Idd = 7.5mA

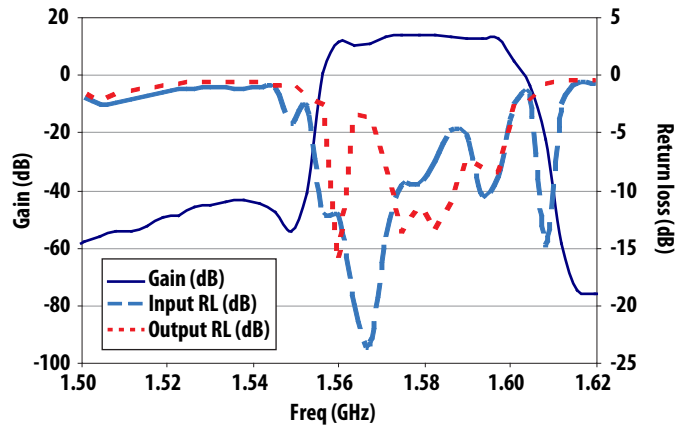


Figure 3b. Passband response of typical S-Parameter Plot @ Vdd = 2.7V, Idd = 7.5mA

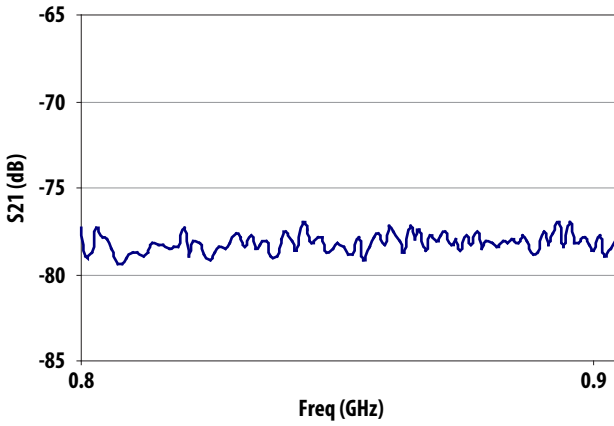


Figure 3c. Rejection plot for Low band @ Vdd = 2.7V, Idd = 7.5mA

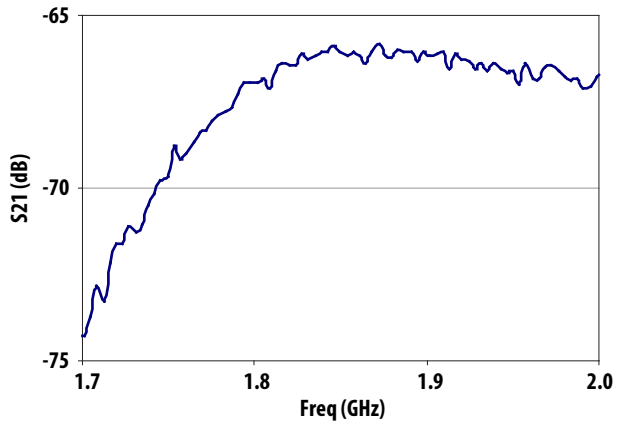


Figure 3d. Rejection plot for High band @ Vdd = 2.7V, Idd = 7.5mA

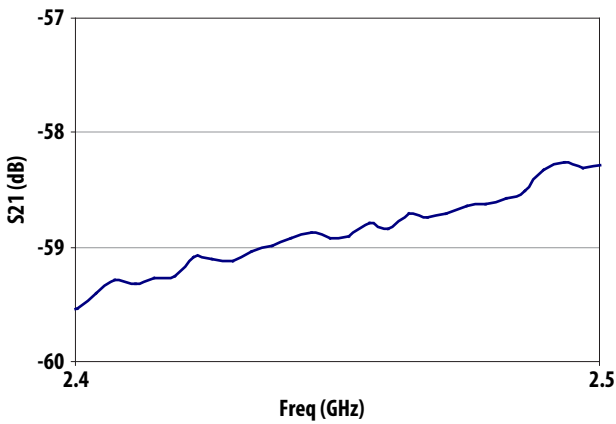


Figure 3e. Rejection plot for WLAN band @ Vdd = 2.7V, Idd = 7.5mA

## ALM-GP001 Typical Performance Curves at 25°

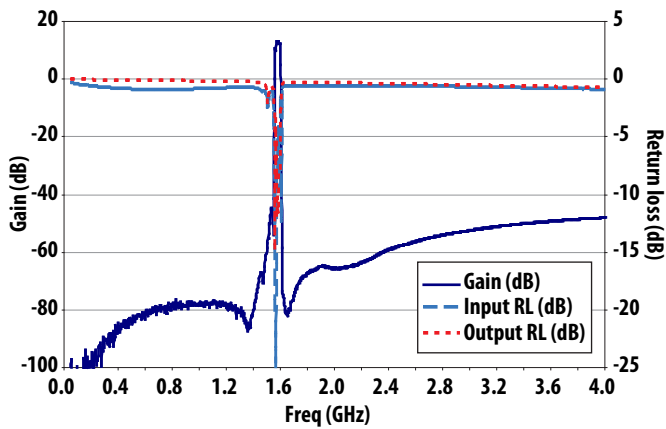


Figure 4a. Typical S-Parameter Plot @ Vdd = 1.8V, Idd = 5mA

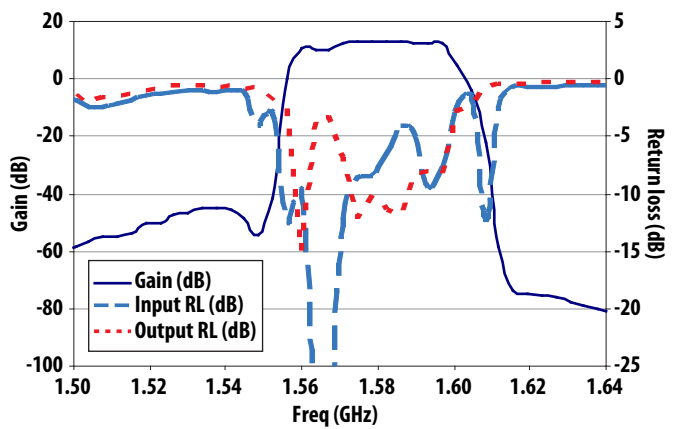


Figure 4b. Passband response of typical S-Parameter Plot @ Vdd = 1.8V, Idd = 5mA

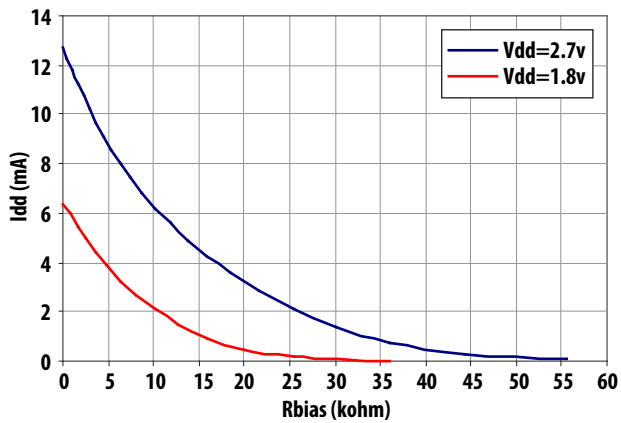


Figure 5. Idd vs Rbias at 25°C

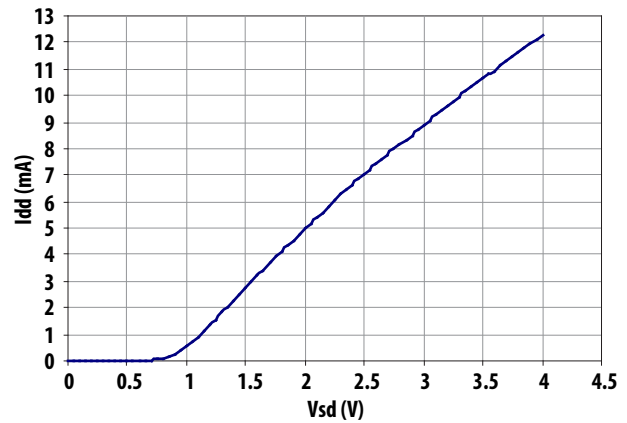


Figure 6. Idd vs Vsd for Vdd = 2.7V, R2 = 6.8k Ohm

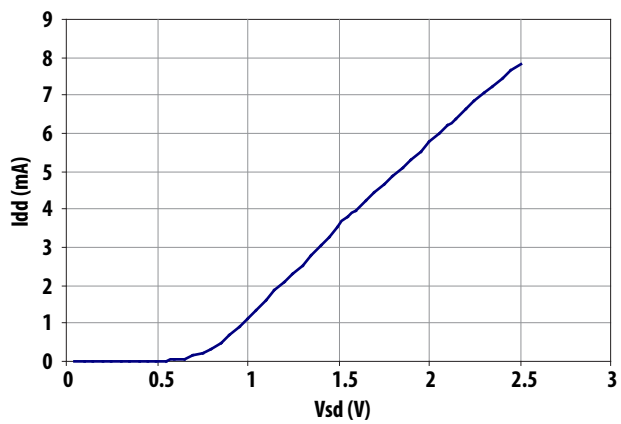


Figure 7. Idd vs Vsd for Vdd = 1.8V, R2 = 2.7k Ohm



## ALM-GP001 Typical Performance Curves

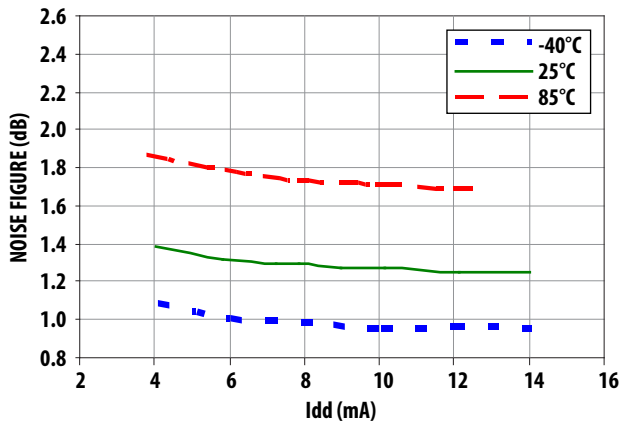


Figure 8. NF vs. Idd at Vdd = 2.7V

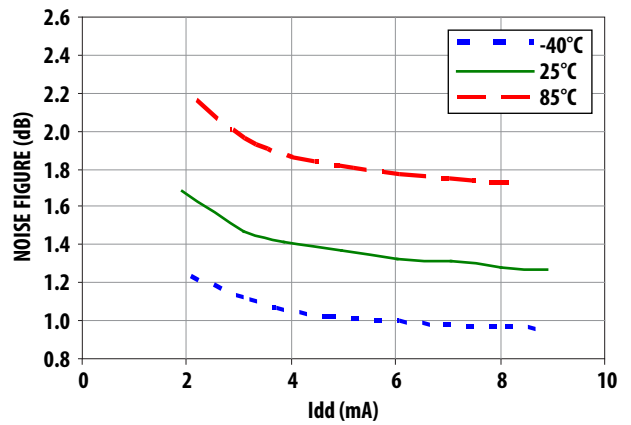


Figure 9. NF vs Idd at Vdd = 1.8V

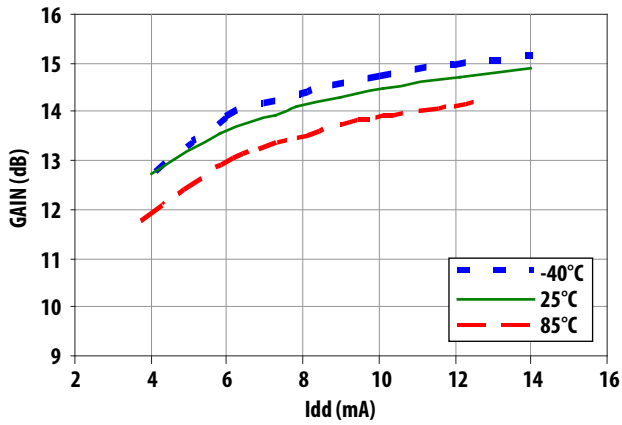


Figure 10. Gain vs. Idd at Vdd = 2.7V

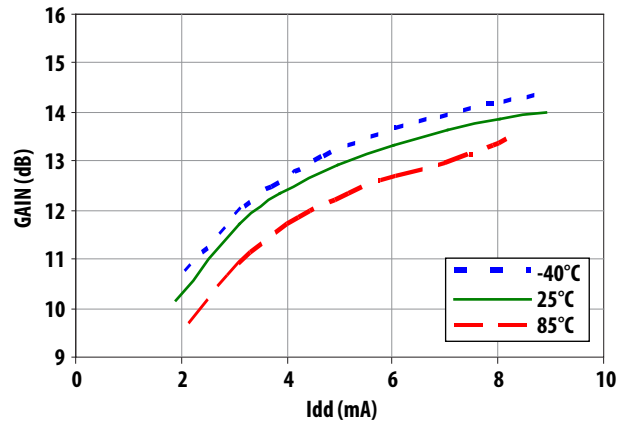


Figure 11. Gain vs. Idd at Vdd = 1.8V

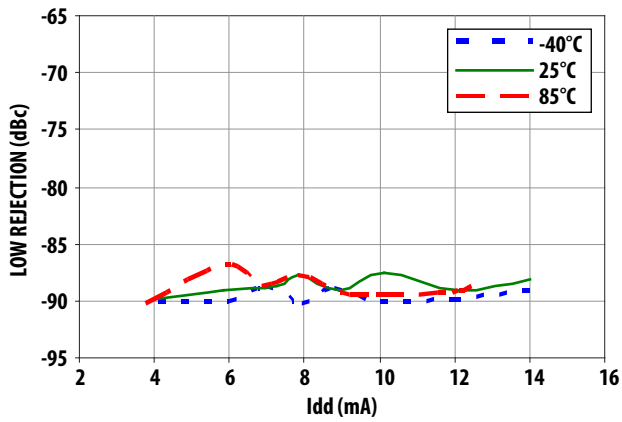


Figure 12. Low band rejection vs. Idd at Vdd = 2.7V

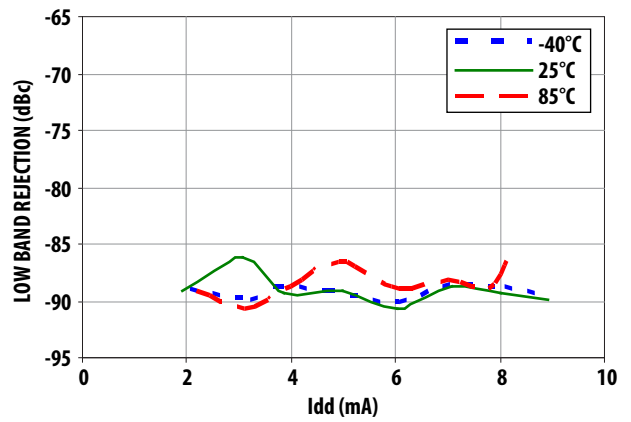


Figure 13. Low band rejection vs. Idd at Vdd = 1.8V

## ALM-GP001 Typical Performance Curves

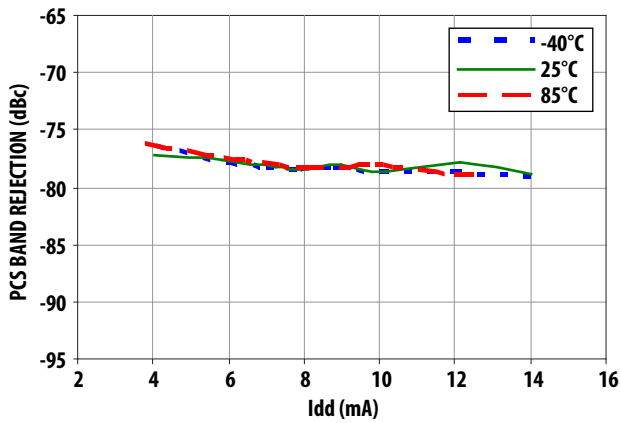


Figure 14. High band rejection vs. Idd at Vdd = 2.7V

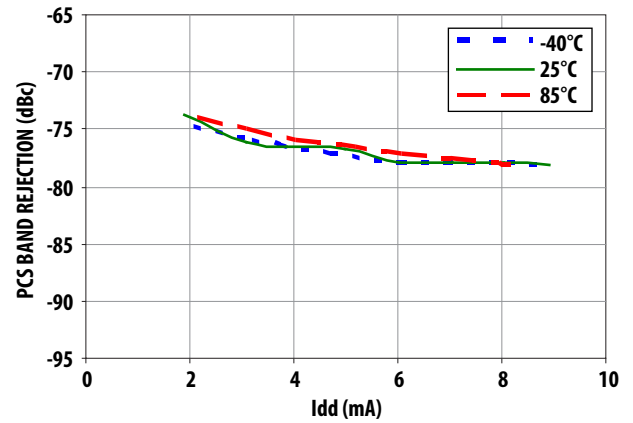


Figure 15. High band rejection vs. Idd at Vdd = 1.8V

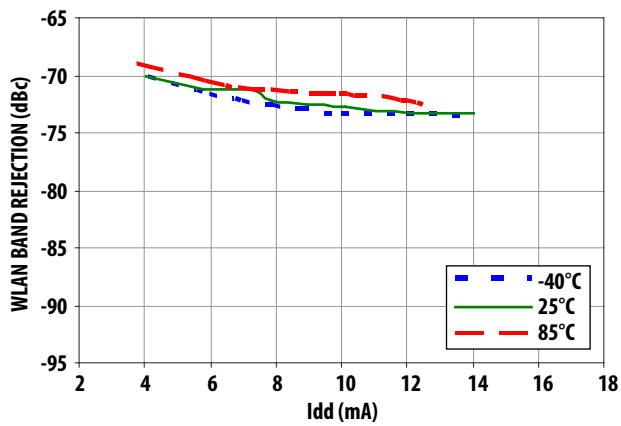


Figure 16. WLAN band rejection vs. Idd at Vdd = 2.7V

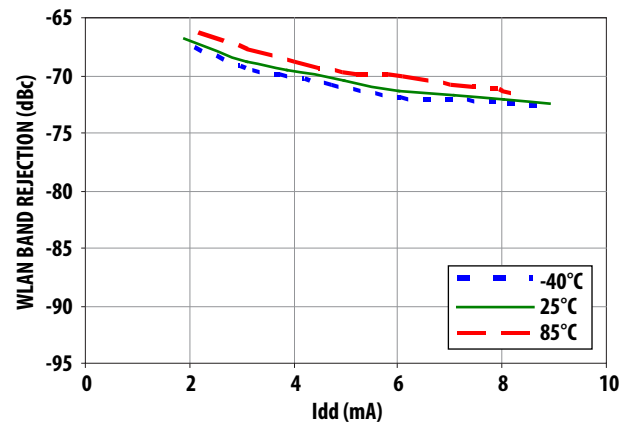


Figure 17. WLAN band rejection vs. Idd at Vdd = 1.8V

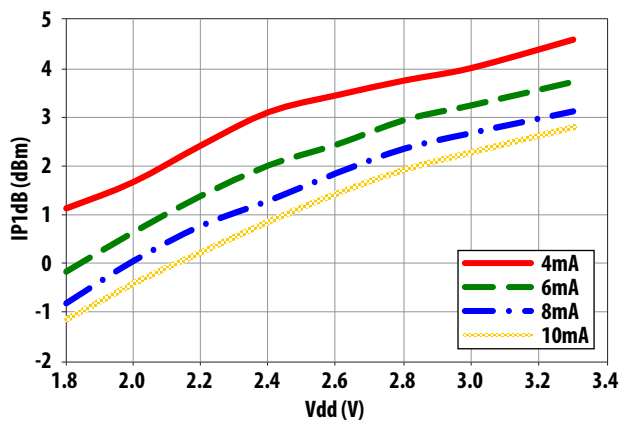


Figure 18. IP1dB vs. Vdd at 25°C

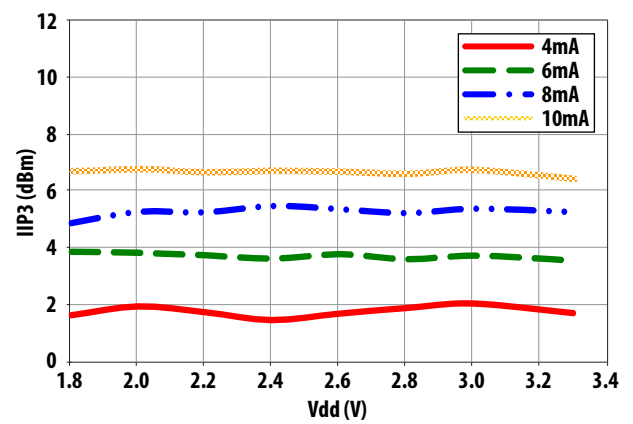


Figure 19. IIP3 vs. Vdd at 25°C

### ALM-GP001 Typical Performance Curves at 25°

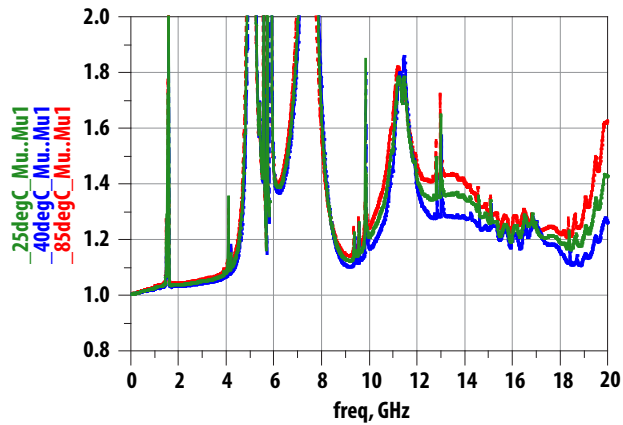


Figure 20. Edwards-Sinsky Output Stability Factor ( $\mu$ ) at  $V_{dd} = 2.7V$

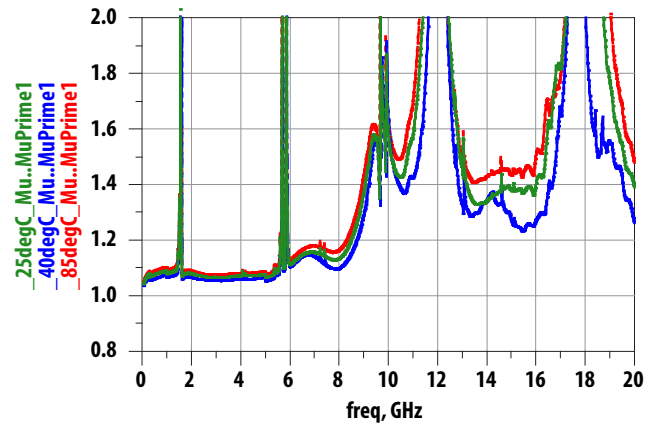


Figure 21. Edwards-Sinsky Input Stability Factor ( $\mu'$ ) at  $V_{dd} = 2.7V$

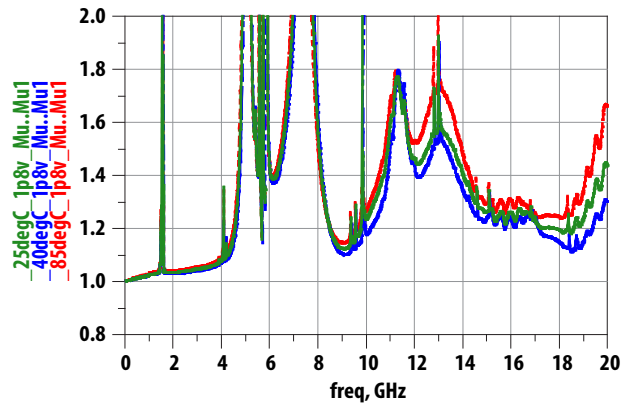


Figure 22. Edwards-Sinsky Output Stability Factor ( $\mu$ ) at  $V_{dd} = 1.8V$

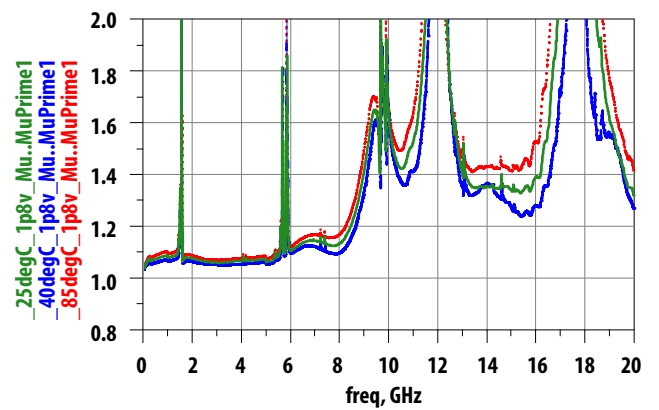


Figure 23. Edwards-Sinsky Input Stability Factor ( $\mu'$ ) at  $V_{dd} = 1.8V$

## ALM-GP001 module with differential output

A differential output can be implemented for the ALM-GP001 using the schematic shown below. Suggested component values are listed in Table 3. C1, C2 and L1, L2 are to convert the single-ended output to differential outputs while C3, C4 and L3 provide matching to 100 ohm differential impedance.

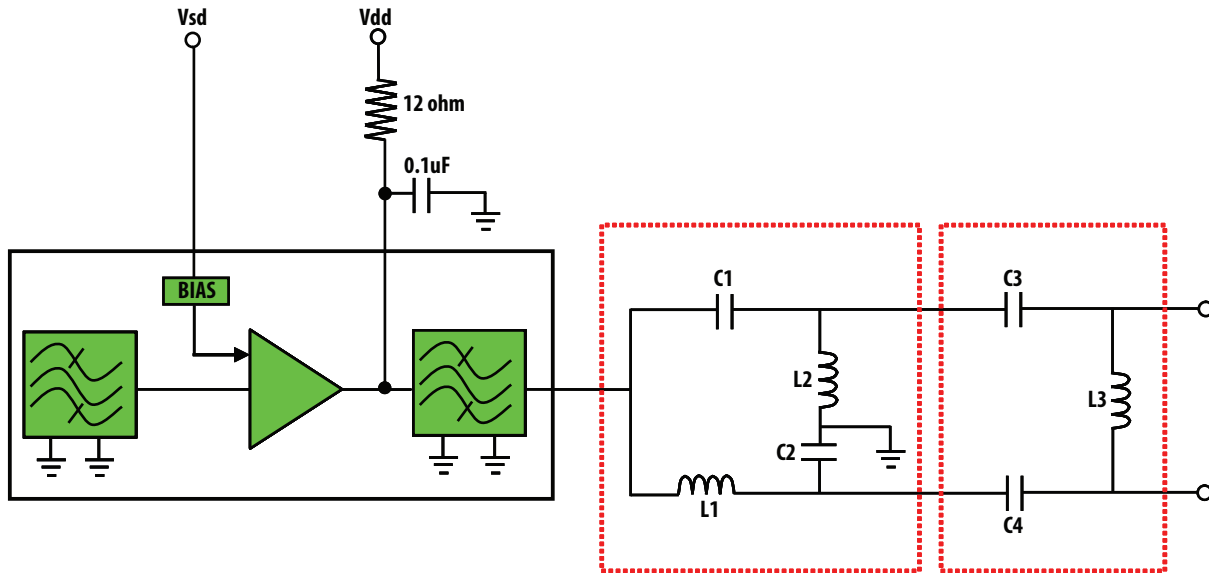


Figure 24. Proposed Balun design for ALM-GP001

Table 3. Components table for proposed balun design

| Circuit Symbol | Size | Description                        |
|----------------|------|------------------------------------|
| C1             | 0402 | GRM1555C1H1R5CZ01 - 1.5pF (Murata) |
| C2             | 0402 | GRM1555C1H1R5CZ01 - 1.5pF (Murata) |
| C3             | 0402 | GRM1555C1H101JZ01 – 100pF (Murata) |
| C4             | 0402 | GRM1555C1H101JZ01 – 100pF (Murata) |
| L1             | 0402 | LQG15HN6N2S02B – 6.2nH (Murata)    |
| L2             | 0402 | LQG15HN6N2S02B – 6.2nH (Murata)    |
| L3             | 0402 | LQG15HN56NJ02 – 56nH (Murata)      |

### ALM-GP001 Scattering Parameter and Measurement Reference Planes

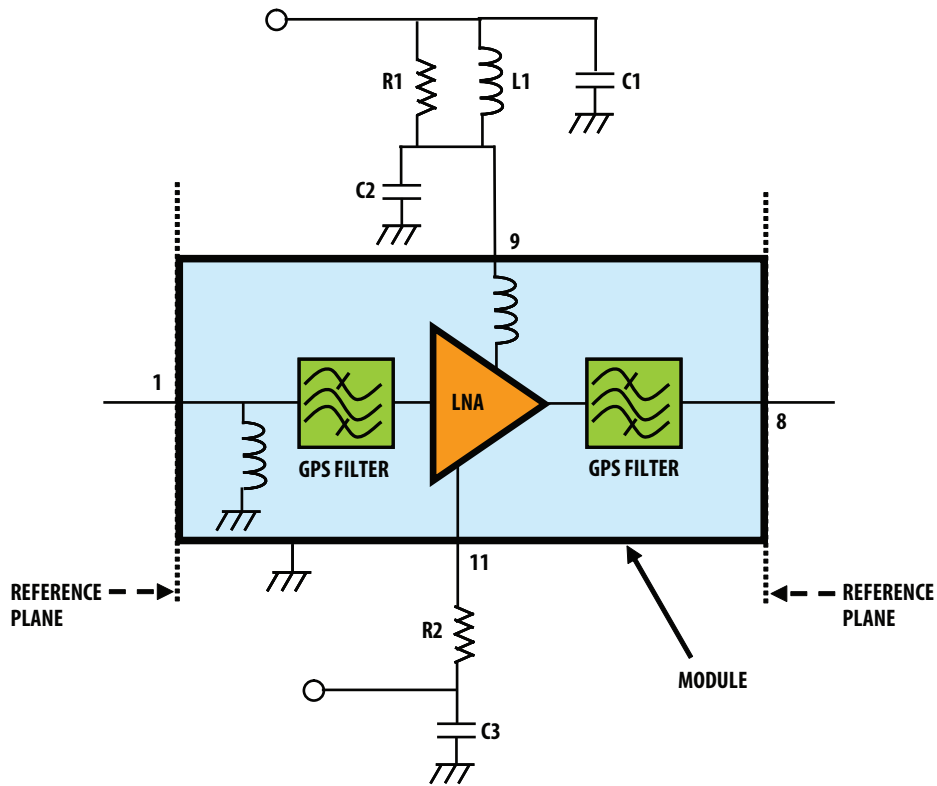


Figure 31. Scattering parameter measurement reference planes

### ALM-GP001 Typical Scattering Parameters at 25°C, Vdd = 2.7V, Idd = 7.5mA

The S- and Noise Parameters are measured using a coplanar waveguide PCB with 10 mils Rogers® RO4350. Figure 31 shows the input and output reference planes. The circuit values are as indicated in Figure 1.

| Freq<br>(GHz) | S11      | S11     | S21      | S21     | S12      | S12     | S22      | S22     |
|---------------|----------|---------|----------|---------|----------|---------|----------|---------|
|               | Mag.(dB) | Ang.    | Mag.(dB) | Ang.    | Mag.(dB) | Ang.    | Mag.(dB) | Ang.    |
| 0.05          | -0.31    | 170.80  | -83.03   | -104.09 | -82.07   | 44.11   | -0.04    | -2.10   |
| 0.1           | -0.45    | 162.63  | -91.19   | -133.63 | -87.29   | -117.58 | -0.04    | -4.04   |
| 0.2           | -0.61    | 146.95  | -85.49   | -158.63 | -105.71  | -138.14 | -0.05    | -8.05   |
| 0.3           | -0.69    | 131.52  | -86.12   | -170.11 | -84.75   | 173.60  | -0.07    | -12.05  |
| 0.4           | -0.63    | 116.78  | -80.42   | 172.45  | -81.30   | 149.19  | -0.09    | -16.75  |
| 0.5           | -0.65    | 101.23  | -76.99   | 164.58  | -79.54   | 129.05  | -0.11    | -20.80  |
| 0.6           | -0.67    | 85.53   | -74.18   | 152.43  | -77.96   | 123.93  | -0.12    | -24.96  |
| 0.7           | -0.70    | 69.54   | -71.57   | 142.72  | -77.13   | 115.74  | -0.14    | -28.91  |
| 0.8           | -0.70    | 53.51   | -69.94   | 134.56  | -77.23   | 108.18  | -0.15    | -33.17  |
| 0.8275        | -0.71    | 48.94   | -69.50   | 132.51  | -78.12   | 101.20  | -0.16    | -34.23  |
| 0.9           | -0.73    | 37.09   | -68.30   | 124.17  | -79.59   | 98.55   | -0.15    | -37.27  |
| 1.0           | -0.71    | 20.53   | -67.39   | 115.43  | -84.87   | 94.32   | -0.18    | -41.80  |
| 1.1           | -0.64    | 3.58    | -66.86   | 105.52  | -86.38   | -135.83 | -0.26    | -46.16  |
| 1.2           | -0.64    | -13.44  | -67.13   | 94.85   | -75.73   | -136.45 | -0.28    | -51.10  |
| 1.3           | -0.66    | -31.46  | -69.21   | 85.99   | -69.32   | -143.51 | -0.29    | -56.59  |
| 1.4           | -0.72    | -52.97  | -70.77   | 155.40  | -64.17   | -155.77 | -0.31    | -63.87  |
| 1.5           | -3.28    | -87.10  | -50.68   | 128.48  | -60.23   | 163.10  | -1.27    | -81.99  |
| 1.575         | -6.86    | 155.59  | 14.22    | 158.05  | -24.45   | 109.55  | -16.06   | 48.60   |
| 1.6           | -1.40    | 75.37   | 2.56     | -23.68  | -35.92   | -70.72  | -2.87    | 7.77    |
| 1.7           | -0.54    | -42.34  | -72.93   | -43.73  | -66.72   | -157.70 | -0.34    | -56.92  |
| 1.8           | -0.55    | -64.37  | -67.05   | -140.19 | -62.07   | -159.89 | -0.33    | -65.96  |
| 1.885         | -0.55    | -76.05  | -65.86   | 171.74  | -59.97   | -167.07 | -0.33    | -71.06  |
| 1.9           | -0.54    | -77.85  | -66.28   | 167.55  | -59.76   | -167.56 | -0.32    | -71.84  |
| 2.0           | -0.52    | -88.32  | -68.97   | 165.02  | -57.77   | -174.89 | -0.30    | -76.82  |
| 2.1           | -0.48    | -97.15  | -67.77   | -167.31 | -56.38   | 179.56  | -0.29    | -81.40  |
| 2.2           | -0.47    | -104.75 | -63.73   | -159.31 | -55.14   | 173.45  | -0.29    | -85.72  |
| 2.3           | -0.45    | -111.48 | -60.55   | -161.04 | -53.94   | 168.47  | -0.30    | -89.76  |
| 2.4           | -0.42    | -117.48 | -58.09   | -167.11 | -53.02   | 164.21  | -0.28    | -93.56  |
| 2.5           | -0.42    | -122.83 | -56.14   | -173.64 | -52.16   | 159.82  | -0.29    | -97.37  |
| 3.0           | -0.39    | -143.61 | -49.78   | 157.21  | -48.64   | 141.38  | -0.31    | -113.86 |
| 3.5           | -0.38    | -159.85 | -46.25   | 130.99  | -45.99   | 125.86  | -0.38    | -129.21 |
| 4.0           | -0.41    | -175.25 | -43.82   | 103.12  | -43.47   | 110.17  | -0.57    | -147.20 |
| 4.5           | -0.43    | 169.03  | -42.02   | 66.73   | -40.64   | 87.29   | -1.49    | 179.88  |
| 5.0           | -0.45    | 152.81  | -43.25   | 13.11   | -40.32   | 28.92   | -13.91   | -1.00   |
| 6.0           | -0.74    | 133.10  | -34.84   | -41.55  | -45.21   | -18.94  | -2.78    | -127.80 |
| 7.0           | -1.03    | 84.73   | -23.30   | -162.23 | -33.21   | -171.36 | -5.31    | 166.63  |
| 8.0           | -1.26    | 47.03   | -17.99   | 69.49   | -24.52   | 63.46   | -3.22    | -171.73 |
| 9.0           | -4.34    | -6.32   | -23.93   | -24.57  | -27.17   | -37.05  | -0.92    | 131.53  |
| 10.0          | -4.99    | -41.52  | -32.95   | 28.66   | -39.02   | -143.79 | -1.74    | 86.44   |
| 11.0          | -5.07    | -81.98  | -17.92   | -12.54  | -31.83   | 38.92   | -4.49    | 21.14   |
| 12.0          | -9.49    | -60.36  | -16.24   | -131.21 | -26.66   | -90.81  | -3.09    | 3.65    |
| 13.0          | -2.31    | -96.01  | -16.02   | 172.58  | -24.60   | -156.01 | -2.18    | -31.75  |
| 14.0          | -1.86    | -143.41 | -13.71   | 113.85  | -20.54   | 140.40  | -2.65    | -52.46  |
| 15.0          | -2.24    | -164.69 | -10.91   | 48.60   | -16.10   | 71.01   | -3.81    | -53.45  |
| 16.0          | -1.53    | -179.61 | -13.27   | -10.99  | -17.57   | 4.74    | -2.11    | -65.14  |
| 17.0          | -3.24    | 149.33  | -12.37   | -32.48  | -18.09   | -15.22  | -2.37    | -95.58  |
| 18.0          | -13.98   | -109.52 | -12.08   | -53.35  | -15.98   | -30.05  | -1.01    | -123.66 |
| 19.0          | -7.00    | 168.64  | -6.40    | -112.24 | -9.24    | -87.81  | -1.72    | -141.00 |
| 20.0          | -10.28   | 172.65  | -2.59    | 173.75  | -4.38    | -165.83 | -20.74   | 95.73   |



**ALM-GP001 Typical Scattering Parameters at 25°C, Vdd = 1.8V, Idd = 5mA**

| Freq<br>(GHz) | S11      | S11     | S21      | S21     | S12      | S12     | S22      | S22     |
|---------------|----------|---------|----------|---------|----------|---------|----------|---------|
|               | Mag.(dB) | Ang.    | Mag.(dB) | Ang.    | Mag.(dB) | Ang.    | Mag.(dB) | Ang.    |
| 0.05          | -0.31    | 170.81  | -77.61   | -81.92  | -80.55   | -58.15  | -0.04    | -2.10   |
| 0.1           | -0.45    | 162.64  | -94.26   | -167.43 | -87.82   | 118.85  | -0.04    | -4.03   |
| 0.2           | -0.61    | 146.96  | -96.81   | 135.59  | -94.38   | -173.28 | -0.05    | -8.04   |
| 0.3           | -0.69    | 131.53  | -88.74   | 147.68  | -84.55   | 166.83  | -0.07    | -12.05  |
| 0.4           | -0.63    | 116.79  | -84.40   | 166.61  | -82.69   | 144.01  | -0.09    | -16.76  |
| 0.5           | -0.65    | 101.24  | -79.10   | 165.96  | -80.74   | 125.53  | -0.11    | -20.81  |
| 0.6           | -0.67    | 85.55   | -74.78   | 146.65  | -78.31   | 117.68  | -0.12    | -24.96  |
| 0.7           | -0.69    | 69.56   | -73.51   | 140.49  | -78.18   | 118.80  | -0.13    | -28.92  |
| 0.8           | -0.70    | 53.54   | -71.44   | 134.00  | -77.80   | 105.74  | -0.15    | -33.17  |
| 0.8275        | -0.71    | 48.96   | -71.30   | 131.37  | -77.54   | 104.95  | -0.15    | -34.24  |
| 0.9           | -0.72    | 37.11   | -70.19   | 126.32  | -78.57   | 93.95   | -0.14    | -37.27  |
| 1.0           | -0.70    | 20.56   | -69.21   | 120.45  | -83.41   | 100.05  | -0.18    | -41.81  |
| 1.1           | -0.64    | 3.61    | -68.64   | 113.54  | -86.60   | -148.54 | -0.26    | -46.17  |
| 1.2           | -0.64    | -13.41  | -68.93   | 104.86  | -75.47   | -136.57 | -0.28    | -51.12  |
| 1.3           | -0.66    | -31.42  | -71.27   | 98.24   | -69.48   | -143.75 | -0.29    | -56.61  |
| 1.4           | -0.71    | -52.93  | -69.91   | 167.28  | -64.36   | -154.58 | -0.31    | -63.89  |
| 1.5           | -3.27    | -87.09  | -52.30   | 133.00  | -60.25   | 168.15  | -1.27    | -82.00  |
| 1.575         | -6.62    | 169.84  | 12.90    | 162.11  | -21.82   | 100.95  | -13.61   | 57.50   |
| 1.6           | -1.21    | 76.66   | 1.31     | -22.01  | -33.19   | -81.74  | -2.99    | 7.65    |
| 1.7           | -0.53    | -42.32  | -76.33   | -67.22  | -68.06   | -133.30 | -0.33    | -56.94  |
| 1.8           | -0.55    | -64.34  | -65.49   | -150.00 | -61.97   | -160.04 | -0.33    | -65.97  |
| 1.885         | -0.54    | -76.02  | -63.54   | 175.01  | -59.86   | -167.29 | -0.33    | -71.08  |
| 1.9           | -0.53    | -77.80  | -63.44   | 171.11  | -59.56   | -167.56 | -0.31    | -71.85  |
| 2.0           | -0.51    | -88.30  | -65.49   | 160.86  | -57.74   | -174.81 | -0.30    | -76.83  |
| 2.1           | -0.48    | -97.12  | -65.69   | -179.62 | -56.42   | 178.84  | -0.29    | -81.41  |
| 2.2           | -0.46    | -104.71 | -62.61   | -167.76 | -55.07   | 174.31  | -0.29    | -85.72  |
| 2.3           | -0.44    | -111.44 | -59.59   | -167.37 | -54.02   | 169.37  | -0.30    | -89.76  |
| 2.4           | -0.42    | -117.46 | -57.12   | -171.77 | -53.01   | 164.16  | -0.28    | -93.55  |
| 2.5           | -0.41    | -122.79 | -55.34   | -177.94 | -52.13   | 159.89  | -0.29    | -97.36  |
| 3.0           | -0.38    | -143.57 | -49.45   | 154.06  | -48.61   | 141.44  | -0.30    | -113.86 |
| 3.5           | -0.37    | -159.81 | -46.14   | 129.65  | -45.96   | 125.97  | -0.37    | -129.26 |
| 4.0           | -0.40    | -175.18 | -43.72   | 104.76  | -43.49   | 110.10  | -0.56    | -147.34 |
| 4.5           | -0.42    | 169.08  | -41.69   | 71.59   | -40.74   | 87.15   | -1.47    | 179.69  |
| 5.0           | -0.45    | 152.85  | -43.01   | 17.04   | -40.77   | 30.19   | -13.70   | -6.62   |
| 6.0           | -0.72    | 133.14  | -36.12   | -33.98  | -45.30   | -12.03  | -2.83    | -129.05 |
| 7.0           | -1.01    | 84.76   | -24.40   | -161.09 | -33.57   | -172.42 | -5.84    | 168.64  |
| 8.0           | -1.25    | 46.81   | -18.71   | 73.57   | -24.83   | 66.78   | -3.27    | -174.08 |
| 9.0           | -4.36    | -5.43   | -24.36   | -26.76  | -26.84   | -38.03  | -0.89    | 131.47  |
| 10.0          | -4.98    | -41.21  | -33.39   | 32.50   | -40.93   | -164.30 | -1.84    | 85.82   |
| 11.0          | -5.17    | -82.21  | -18.05   | -12.05  | -29.46   | 34.91   | -4.45    | 21.32   |
| 12.0          | -8.58    | -58.62  | -16.59   | -134.08 | -25.33   | -93.88  | -3.11    | 4.41    |
| 13.0          | -2.24    | -97.70  | -16.73   | 171.51  | -23.94   | -154.79 | -2.58    | -28.58  |
| 14.0          | -1.86    | -144.22 | -14.44   | 112.09  | -20.14   | 142.24  | -2.66    | -50.63  |
| 15.0          | -2.23    | -166.30 | -11.88   | 50.77   | -15.99   | 77.15   | -3.40    | -55.52  |
| 16.0          | -1.70    | 179.38  | -13.55   | -9.10   | -16.80   | 11.54   | -1.95    | -64.65  |
| 17.0          | -3.87    | 149.02  | -12.86   | -37.76  | -16.33   | -13.32  | -1.96    | -95.34  |
| 18.0          | -13.35   | -100.14 | -13.12   | -52.83  | -15.15   | -31.69  | -1.02    | -126.61 |
| 19.0          | -5.76    | 179.34  | -6.66    | -106.45 | -8.01    | -87.53  | -2.40    | -146.31 |
| 20.0          | -7.61    | 164.77  | -3.09    | 174.03  | -4.01    | -170.19 | -19.04   | 5.34    |

**ALM-GP001 Typical Noise Parameters at 25°C,  
Freq = 1.575 GHz, Vdd = 2.7V, Idd = 7.5mA**

| Freq<br>(GHz) | Fmin<br>(dB) | GAMMA OPT |      |        |
|---------------|--------------|-----------|------|--------|
|               |              | Mag       | Ang  | Rn/50  |
| 1.575         | 1.14         | 0.084     | 44.1 | 0.1714 |

**ALM-GP001 Typical Noise Parameters at 25°C,  
Freq = 1.575 GHz, Vdd = 1.8V, Idd = 5mA**

| Freq<br>(GHz) | Fmin<br>(dB) | GAMMA OPT |      |        |
|---------------|--------------|-----------|------|--------|
|               |              | Mag       | Ang  | Rn/50  |
| 1.575         | 1.21         | 0.100     | 78.1 | 0.1780 |

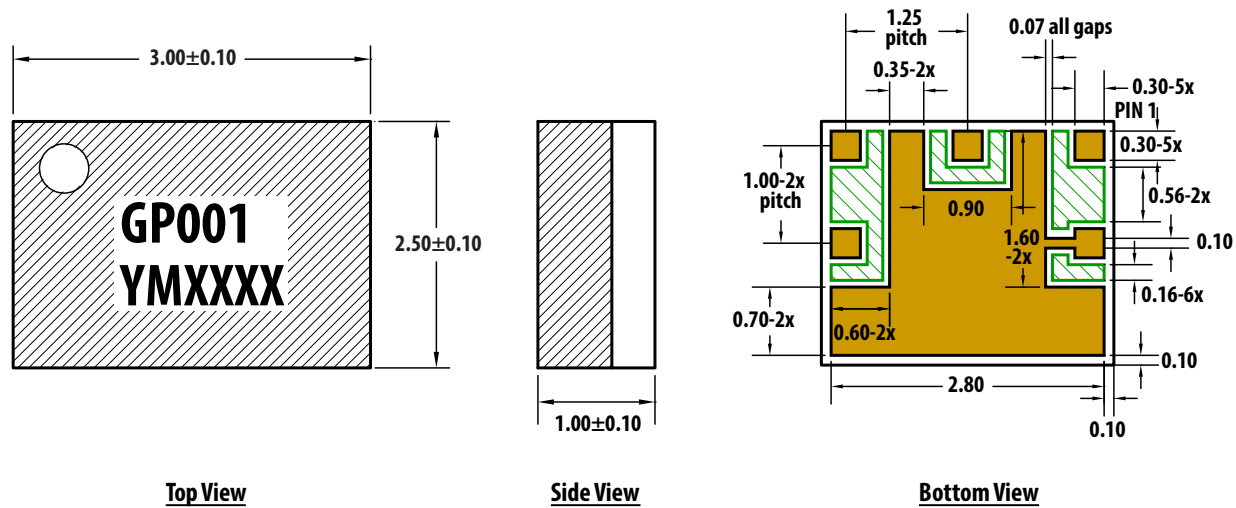
Note:

The exceptional noise figure performance of the ALM-GP001 is due to its highly optimized design. In this regard, the  $F_{min}$  of the ALM-GP001 shown above is locked down by the internal input pre-match. This allows the use of relatively inexpensive chip inductors for external matching.

**Part Number Ordering Information**

| Part Number    | Qty  | Container      |
|----------------|------|----------------|
| ALM-GP001-BLKG | 100  | Antistatic bag |
| ALM-GP001-TR1G | 3000 | 13" Reel       |

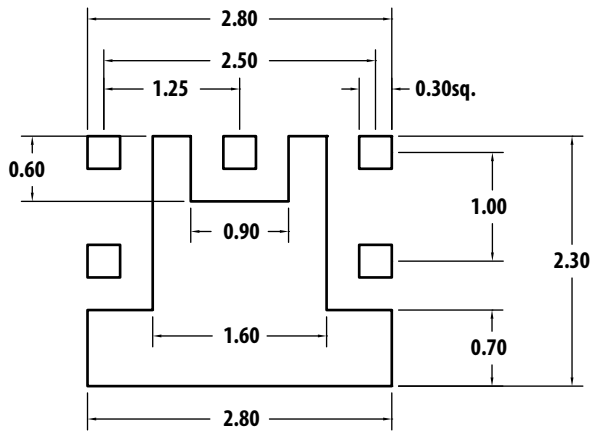
**Package Dimensions**



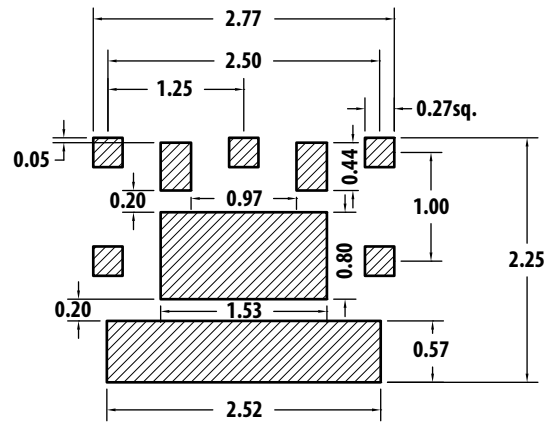
Notes:

1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold flash and metal burr.
4. Y refers to year, M refers to month & XXXX refers to last 4 digits of the lot number.

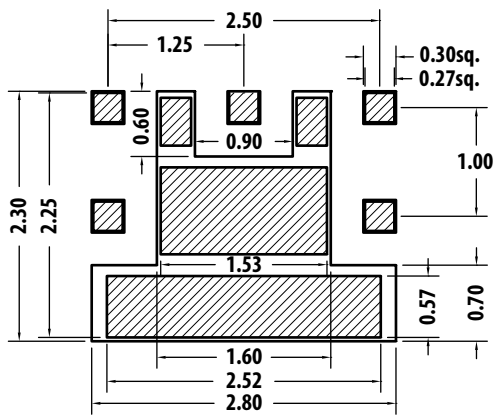
## PCB Land Patterns and Stencil Design



Land Pattern



Stencil Opening

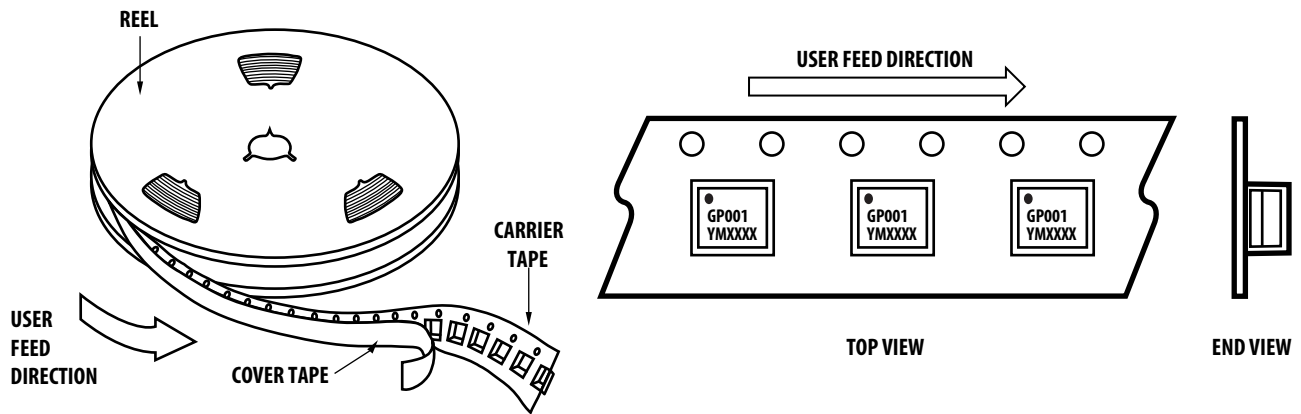


Combination of Land Pattern and Stencil Opening

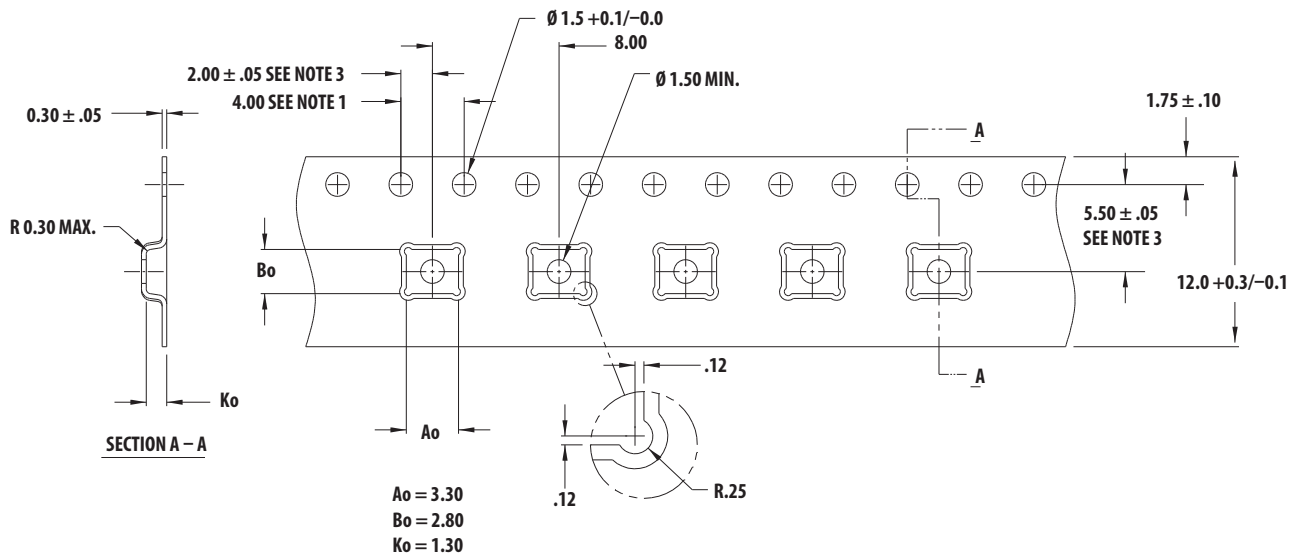
Notes:

1. All dimensions are in millimeters
2. Recommended stencil thickness is 4mils

## Device Orientation



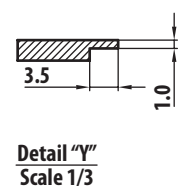
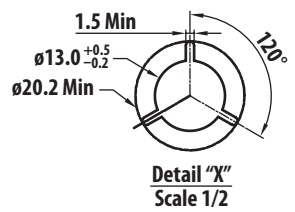
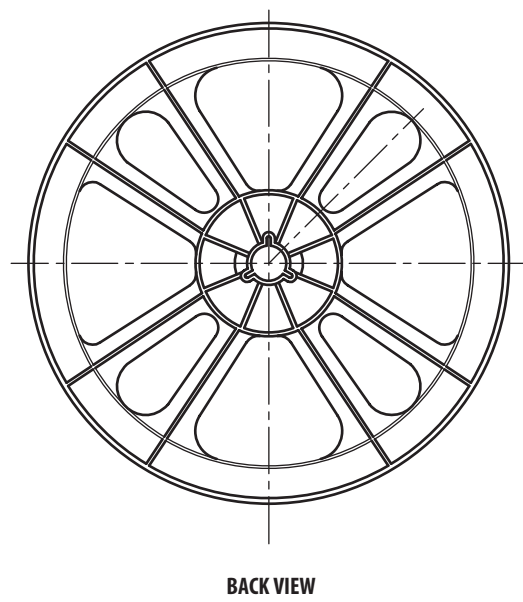
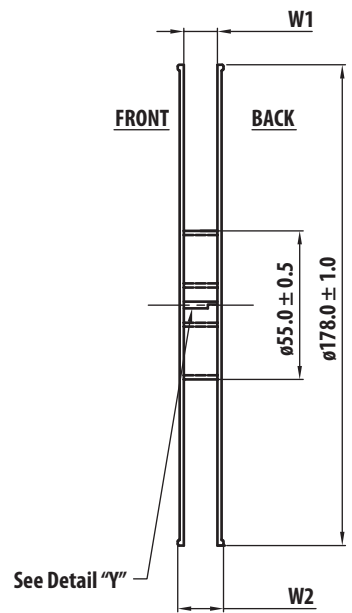
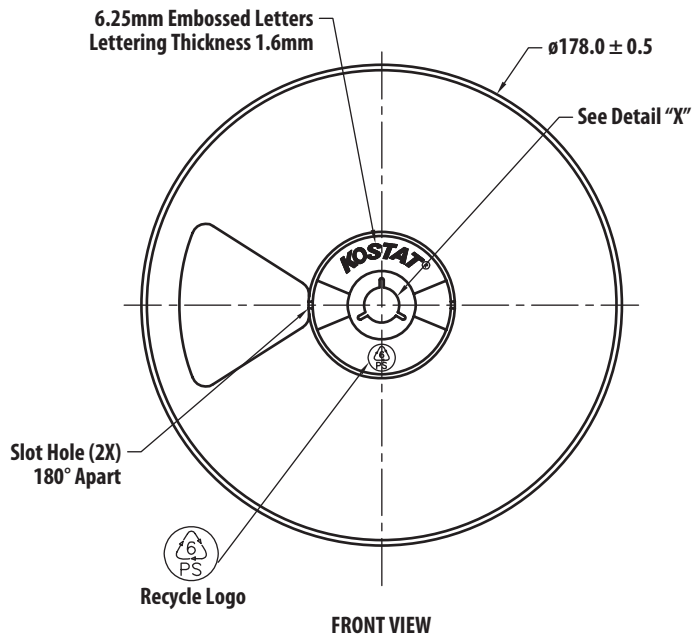
## Tape Dimensions



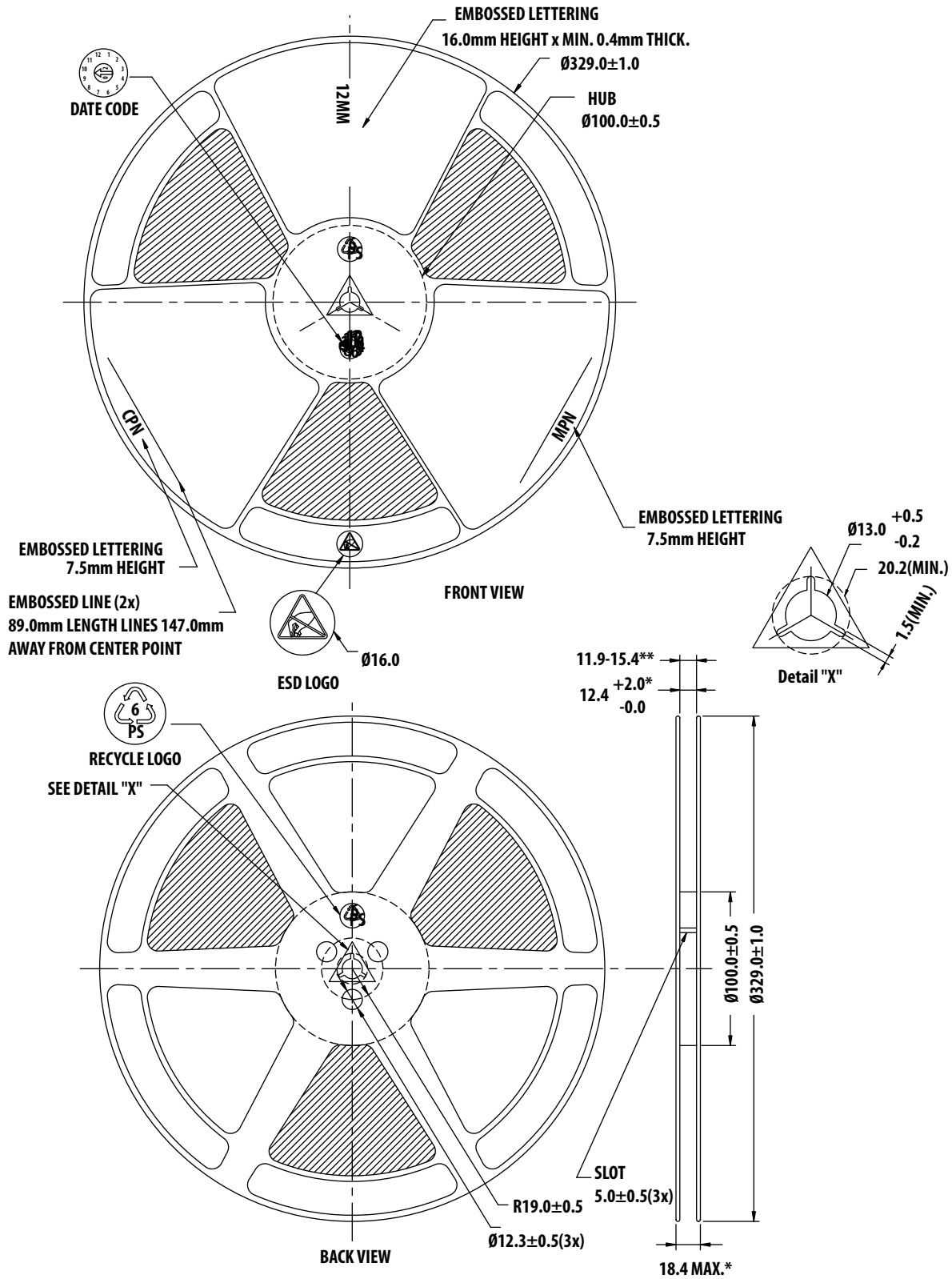
### Notes:

1. All dimensions in mm
2. 10 sprocket hole pitch cumulative tolerance  $\pm 0.2$
3. Camber in compliance with EIA 481
4. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole
5. Ao and Bo are calculated on a plane at a distance "R" above the bottom of the pocket.

# Reel Dimensions (7" reel)



# Reel Dimensions (13" reel)



For product information and a complete list of distributors, please go to our web site: [www.avagotech.com](http://www.avagotech.com)

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