

# ALM-31222

## 1.7-2.7GHz

### 1-Watt High Linearity Amplifier



## Data Sheet

### Description

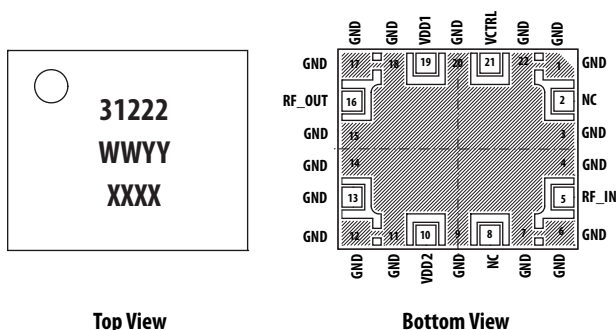
Avago Technologies' ALM-31222 is a high linearity 1 Watt PA with good OIP3 performance and exceptionally good PAE at 1dB gain compression point, achieved through the use of Avago Technologies' proprietary 0.25um GaAs Enhancement-mode pHEMT process.

All matching components are fully integrated within the module. This makes the ALM-31222 extremely easy to use. The adjustable temperature-compensated internal bias circuit allows the device to be operated at either class A or class AB operation.

The ALM-31222 is housed inside a miniature 5.0 x 6.0 x 1.1 mm<sup>3</sup> 22-lead multiple-chips-on-board (MCOB) module package.

### Component Image

5.0 x 6.0 x 1.1 mm<sup>3</sup> 22-lead MCOB



Top View

Bottom View

#### Notes:

Package marking provides orientation and identification

"31222" = Device Part Number

"WWYY" = Work week and Year of manufacture

"XXXX" = Last 4 digit of Lot number

### Features

- Fully matched, input and output
- High linearity and P1dB
- Unconditionally stable across load condition
- Built-in adjustable temperature-compensated internal bias circuitry
- GaAs E-pHEMT Technology<sup>[1]</sup>
- 5V supply
- Excellent uniformity in product specifications
- Tape-and-Reel packaging option available
- MSL-3 and Lead-free
- High MTTF for base station application

### Specifications

2GHz; 5V, 415mA (typical)

- 14.9 dB Gain
- 47.9 dBm Output IP3
- 31.5 dBm Output Power at 1dB gain compression
- 52.6% PAE at P1dB
- 2.7 dB Noise Figure

### Applications

- Class A driver amplifier for GSM/PCS/W-CDMA/WiMAX Base Stations.
- General purpose gain block.

#### Note:

1. Enhancement mode technology employs positive gate voltage, thereby eliminating the need of negative gate voltage associated with conventional depletion mode devices.



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

ESD Machine Model = 200 V

ESD Human Body Model = 700 V

Refer to Avago Application Note A004R:

*Electrostatic Discharge, Damage and Control.*

## Absolute Maximum Rating <sup>[2]</sup> T<sub>A</sub>=25°C

| Symbol                | Parameter                              | Units | Absolute Max. |
|-----------------------|----------------------------------------|-------|---------------|
| V <sub>dd,max</sub>   | Device Voltage, RF output to ground    | V     | 5.5           |
| I <sub>ds,max</sub>   | Device Drain Current                   | mA    | 750           |
| V <sub>ctrl,max</sub> | Control Voltage                        | V     | 5.5           |
| P <sub>in,max</sub>   | CW RF Input Power                      | dBm   | 25            |
| P <sub>diss</sub>     | Total Power Dissipation <sup>[4]</sup> | W     | 4.125         |
| T <sub>j,max</sub>    | Junction Temperature                   | °C    | 150           |
| T <sub>STG</sub>      | Storage Temperature                    | °C    | -65 to 150    |

Thermal Resistance <sup>[3]</sup>  $\theta_{jc} = 25\text{ }^{\circ}\text{C/W}$   
(V<sub>dd</sub> = 5V, I<sub>dd</sub> = 400mA, T<sub>c</sub> = 85 °C)

Notes:

2. Operation of this device in excess of any of these limits may cause permanent damage.
3. Thermal resistance measured using Infra-Red measurement technique.
4. This is limited by maximum V<sub>dd</sub> and I<sub>ds</sub>. Derate 40mW/ °C for T<sub>c</sub>>46.9 °C.

## Product Consistency Distribution Charts<sup>[5, 6]</sup>

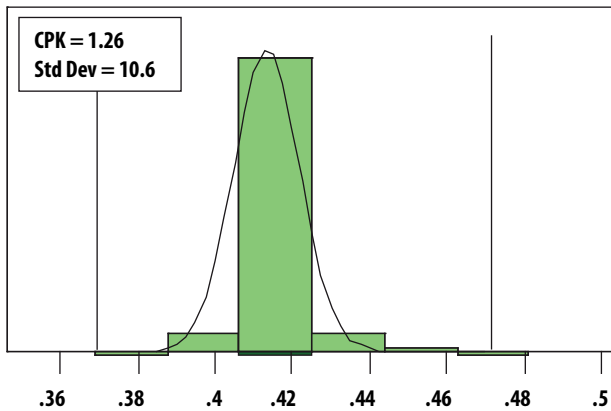


Figure 1: I<sub>ds</sub>; LSL = 370mA, nominal = 415mA, USL = 470mA

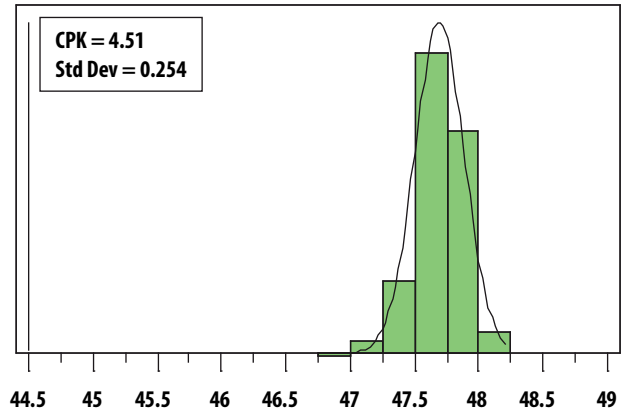


Figure 2: OIP3; LSL = 44.5dBm, nominal = 47.9dBm

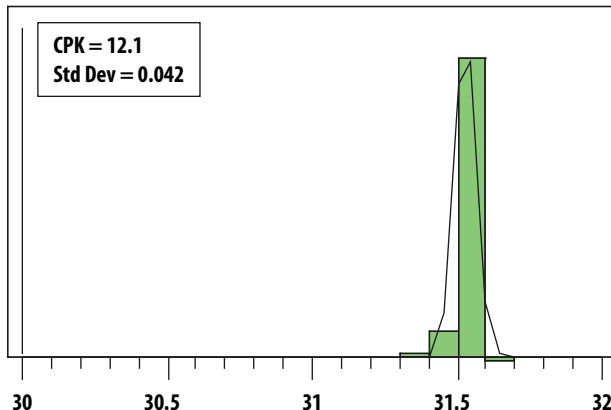


Figure 3: P1dB; LSL = 30dBm, nominal = 31.5dBm

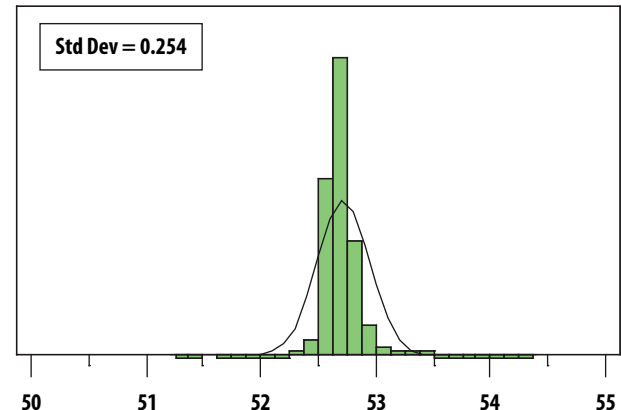


Figure 4: PAE at P1dB; nominal = 52.6%

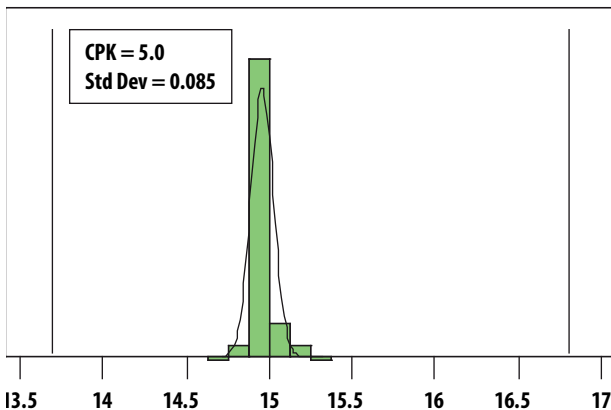


Figure 5: Gain; LSL=13.7dB, Nominal = 14.9dB, USL=16.8dB

Notes:

5. Distribution data sample size is 500 samples taken from 2 different wafers lots. T<sub>A</sub> = 25°C, V<sub>dd</sub> = 5V, V<sub>ctrl</sub> = 5V, RF performance at 2GHz unless otherwise specified. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
6. Measurements are made on a production test board. Input trace losses have not been de-embedded from actual measurements.

## Electrical Specifications <sup>[7]</sup>

$T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $V_{ctrl} = 5\text{V}$ , RF performance at 2.0 GHz, measured on demo board (see Figure 7) unless otherwise specified.

| Symbol              | Parameter and Test Condition          | Units | Min. | Typ. | Max. |
|---------------------|---------------------------------------|-------|------|------|------|
| $I_{ds}$            | Quiescent current                     | mA    | 370  | 415  | 470  |
| $I_{ctrl}$          | $V_{ctrl}$ current                    | mA    | -    | 10.4 | -    |
| Gain                | Gain                                  | dB    | 13.7 | 14.9 | 16.8 |
| OIP3 <sup>[8]</sup> | Output Third Order Intercept Point    | dBm   | 44.5 | 47.9 | -    |
| OP1dB               | Output Power at 1dB Gain Compression  | dBm   | 30   | 31.5 | -    |
| PAE                 | Power Added Efficiency                | %     | -    | 52   | -    |
| NF                  | Noise Figure                          | dB    | -    | 2.7  | -    |
| S11                 | Input Return Loss, 50 $\Omega$ source | dB    | -    | -10  | -    |
| S22                 | Output Return Loss, 50 $\Omega$ load  | dB    | -    | -10  | -    |
| S12                 | Reverse Isolation                     | dB    | -    | -30  | -    |

Notes:

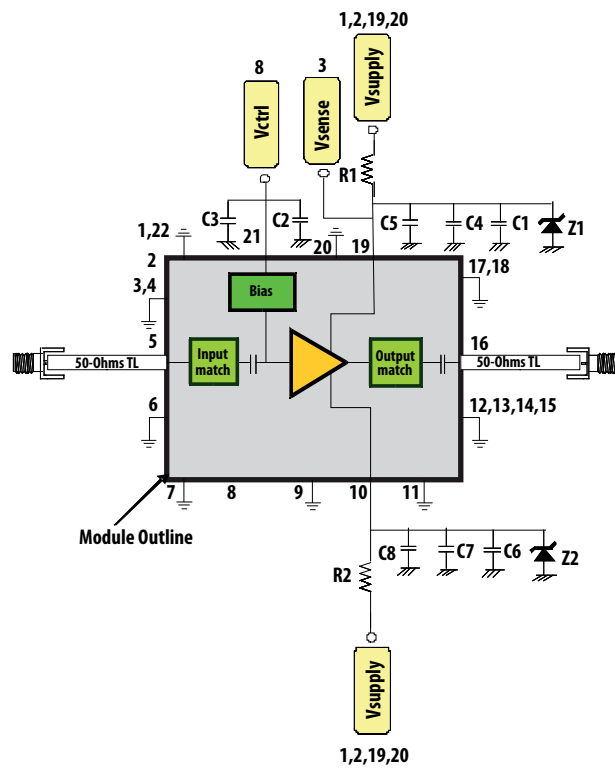
7. Measurements at 2GHz obtained using demo board described in Figure 6 and 7.
8. 2GHz OIP3 test condition:  $F_{RF1} - F_{RF2} = 10\text{MHz}$  with input power of -5dBm per tone measured at worse case side band.
9. Use proper bias, heat sink and de-rating to ensure maximum channel temperature is not exceeded. See absolute maximum ratings and application note (if applicable) for more details.

**S-Parameter (Vdd=5V, Vctrl=5V, T=25°C, matched 50 ohm)**

| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 0.1        | -0.28    | 175.96    | -83.18   | 176.23    | -85.32   | -67.51    | -1.24    | -142.79   |
| 0.2        | -0.33    | 173.13    | -52.64   | 161.11    | -79.55   | 71.39     | -1.1     | -167.79   |
| 0.3        | -0.32    | 169.83    | -39.35   | 128.52    | -75.05   | 83.66     | -1.02    | 179.87    |
| 0.4        | -0.38    | 166.32    | -29.95   | 100.99    | -69.64   | 85.21     | -0.99    | 169.14    |
| 0.5        | -0.39    | 162.45    | -23.54   | 79.41     | -68.48   | 69.93     | -1.01    | 158.91    |
| 0.6        | -0.51    | 158       | -17.63   | 69.24     | -65.17   | 52.89     | -1.05    | 147.9     |
| 0.7        | -0.57    | 152.77    | -11.35   | 54.33     | -60.41   | 26.3      | -1.17    | 134.94    |
| 0.8        | -0.78    | 146.84    | -5.72    | 35.54     | -56.11   | 6.3       | -1.45    | 119.17    |
| 0.9        | -0.82    | 139.57    | -0.4     | 13.28     | -51.07   | -19.9     | -2.03    | 99.51     |
| 1          | -1.16    | 129.83    | 4.3      | -13.32    | -46.1    | -49.33    | -3.2     | 75.34     |
| 1.1        | -1.48    | 119.45    | 8.01     | -41.24    | -42.01   | -78.55    | -5.01    | 50.04     |
| 1.2        | -2.16    | 104.83    | 11.14    | -73.66    | -38.32   | -111.37   | -7.73    | 22.1      |
| 1.3        | -3.45    | 86.86     | 13.49    | -106.74   | -35.37   | -144.38   | -10.47   | -3.04     |
| 1.4        | -5.75    | 64.05     | 15.1     | -139.71   | -33.12   | -176.73   | -11.98   | -25.11    |
| 1.5        | -9.86    | 34.92     | 16.01    | -171.85   | -31.64   | 151.79    | -11.99   | -48.46    |
| 1.6        | -16.32   | -12.66    | 16.29    | 157.85    | -30.83   | 122.31    | -11.45   | -73.83    |
| 1.7        | -18.73   | -104.19   | 16.1     | 130.8     | -30.55   | 96.01     | -11.22   | -98.63    |
| 1.8        | -15.14   | -151.56   | 15.8     | 108.62    | -30.51   | 74.43     | -11.43   | -119.98   |
| 1.9        | -12.68   | -179.03   | 15.4     | 86.61     | -30.55   | 52.91     | -12.04   | -141.78   |
| 2          | -11.46   | 157.09    | 15.05    | 64.4      | -30.61   | 31.14     | -13.09   | -165.11   |
| 2.1        | -10.95   | 139.46    | 14.78    | 46.1      | -30.69   | 13.01     | -14.18   | 174.4     |
| 2.2        | -10.67   | 120.01    | 14.51    | 26.44     | -30.8    | -6.7      | -15.59   | 149.47    |
| 2.3        | -10.67   | 101.25    | 14.25    | 6.6       | -30.97   | -26.97    | -17.05   | 119.92    |
| 2.4        | -10.76   | 80.58     | 13.98    | -13.62    | -31.23   | -47.79    | -18.2    | 83.09     |
| 2.5        | -11.08   | 60.42     | 13.69    | -32.78    | -31.57   | -67.87    | -18.1    | 43.43     |
| 2.6        | -11.15   | 35.78     | 13.32    | -54.85    | -32.11   | -90.91    | -16.32   | 1.98      |
| 2.7        | -11.14   | 8.61      | 12.79    | -78.85    | -32.95   | -114.76   | -13.6    | -31.62    |
| 2.8        | -10.62   | -17.4     | 11.76    | -105.67   | -34.13   | -137.54   | -10.54   | -58.62    |
| 2.9        | -9.29    | -41.86    | 9.7      | -131.03   | -34.8    | -158.21   | -7.5     | -85.47    |
| 3          | -7.64    | -67.59    | 7.59     | -150.93   | -35.42   | 175.41    | -5.5     | -111.51   |
| 3.1        | -6.29    | -92.79    | 5.59     | -171.05   | -36.65   | 148.66    | -4.2     | -132.99   |
| 3.2        | -5.37    | -113.14   | 3.48     | 170.73    | -38.05   | 126.66    | -3.34    | -149.42   |
| 3.3        | -4.44    | -133.05   | 0.91     | 152.1     | -39.61   | 105.49    | -2.67    | -164.34   |
| 3.4        | -3.78    | -150.27   | -1.89    | 135.32    | -41.07   | 87.89     | -2.19    | -176.6    |
| 3.5        | -3.23    | -165.06   | -4.83    | 120.49    | -42.43   | 73.22     | -1.87    | 173.41    |
| 3.6        | -2.89    | -178.18   | -7.85    | 107.48    | -43.41   | 61.54     | -1.65    | 165.31    |
| 3.7        | -2.64    | 170.43    | -10.94   | 96.02     | -44.11   | 52.9      | -1.5     | 158.68    |
| 3.8        | -2.53    | 159.49    | -14.05   | 85.79     | -44.41   | 45.89     | -1.38    | 153.37    |
| 3.9        | -2.55    | 149.92    | -17.01   | 77.16     | -44.37   | 39.92     | -1.3     | 149.34    |
| 4          | -2.7     | 138.27    | -20.45   | 68.04     | -43.94   | 32.99     | -1.23    | 145.77    |

| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 4.1        | -3.12    | 124.98    | -24.48   | 59.64     | -43.26   | 24.59     | -1.19    | 142.81    |
| 4.2        | -4       | 107.04    | -29.94   | 54.26     | -42.41   | 14.09     | -1.16    | 140.48    |
| 4.3        | -5.88    | 80.14     | -38.62   | 78.06     | -41.52   | 0.14      | -1.14    | 138.59    |
| 4.4        | -9.12    | 29.56     | -35.16   | 141.21    | -40.94   | -18.9     | -1.14    | 137.06    |
| 4.5        | -8.89    | -53.48    | -31.02   | 131.79    | -41.43   | -41.31    | -1.14    | 135.82    |
| 4.6        | -5.46    | -101.97   | -30.5    | 114.9     | -43      | -59.92    | -1.15    | 134.88    |
| 4.7        | -3.25    | -130.17   | -31.67   | 99.57     | -45.29   | -73.84    | -1.17    | 134.07    |
| 4.8        | -2.22    | -146.59   | -33.51   | 88.44     | -47.71   | -82.07    | -1.19    | 133.29    |
| 4.9        | -1.67    | -156.9    | -35.58   | 80.35     | -49.9    | -85.77    | -1.21    | 132.54    |
| 5          | -1.38    | -164.03   | -37.74   | 74.33     | -51.68   | -87.52    | -1.25    | 131.78    |
| 5.1        | -1.19    | -168.88   | -39.92   | 69.9      | -53.54   | -88.6     | -1.29    | 130.96    |
| 5.2        | -1.08    | -172.79   | -42      | 66.23     | -55.04   | -88.69    | -1.34    | 130.02    |
| 5.3        | -1       | -175.55   | -44.09   | 63.38     | -56.69   | -88.55    | -1.39    | 128.84    |
| 5.4        | -0.97    | -177.74   | -46.1    | 60.82     | -57.75   | -86.81    | -1.45    | 127.63    |
| 5.5        | -0.93    | -179.47   | -48.16   | 58.9      | -59.67   | -84.83    | -1.51    | 125.96    |
| 5.6        | -0.91    | 178.98    | -50.38   | 55.72     | -61.1    | -80.67    | -1.6     | 123.94    |
| 5.7        | -0.89    | 177.9     | -52.39   | 55.19     | -62.67   | -75.2     | -1.69    | 121.57    |
| 5.8        | -0.88    | 176.77    | -54.31   | 53.59     | -64.48   | -61.6     | -1.78    | 118.67    |
| 5.9        | -0.89    | 175.77    | -56.07   | 50.42     | -65.31   | -47.79    | -1.9     | 115.35    |
| 6          | -0.91    | 174.44    | -58.26   | 46.84     | -64.83   | -33.25    | -2.01    | 111.39    |

## Demo Board Schematic



| Circuit Symbol | Size | Value    | Description                 |
|----------------|------|----------|-----------------------------|
| C1, C6         | 0805 | 2.2uF    | Ceramic Chip Capacitor      |
| C2, C4, C8     | 0402 | 0.1uF    | Ceramic Chip Capacitor      |
| C3, C5, C7     | 0402 | 10nF     | Ceramic Chip Capacitor      |
| R1             | 0805 | 0 Ohm    | Chip Resistor               |
| R2             | 0805 | Not Used | N/A                         |
| Z1, Z2         | 0805 | Not Used | Zener Diode 5.6V (Optional) |

Figure 6. Demo board application schematics and components table

## Demo Board Layout

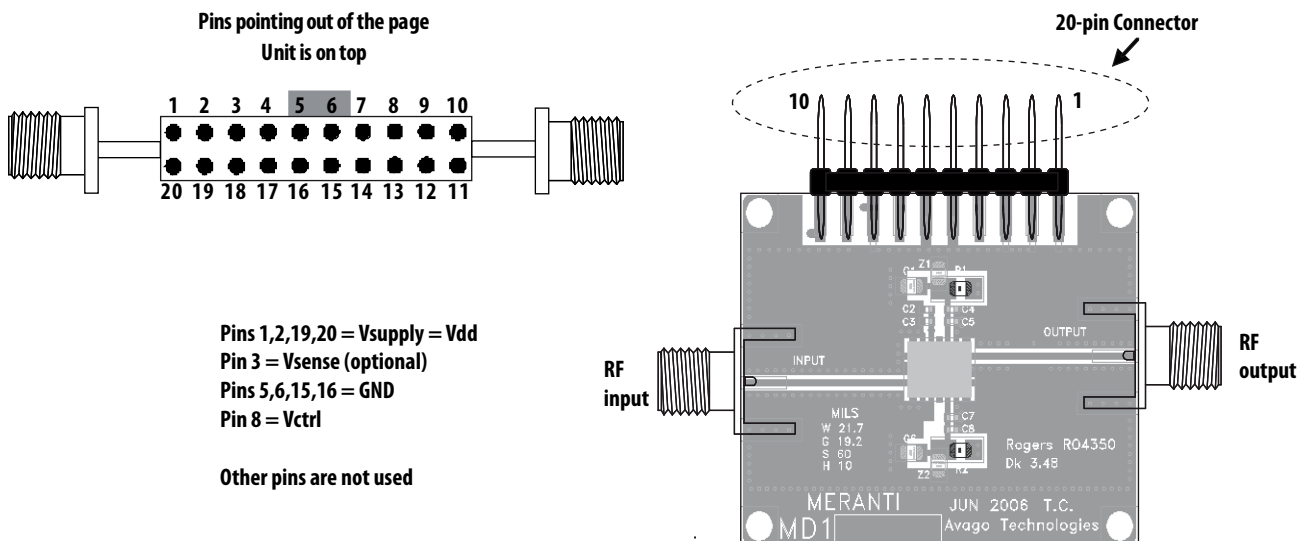


Figure 7. Demo Board Layout Diagram

1. Recommended PCB material is 10 mils Rogers RO4350, with FR4 backing for mechanical strength.
2. Suggested component values may vary according to layout and PCB material.

## ALM-31222 Typical Performance

$T_A = +25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $V_{ctrl} = 5\text{V}$ , Input Signal=CW unless stated otherwise.

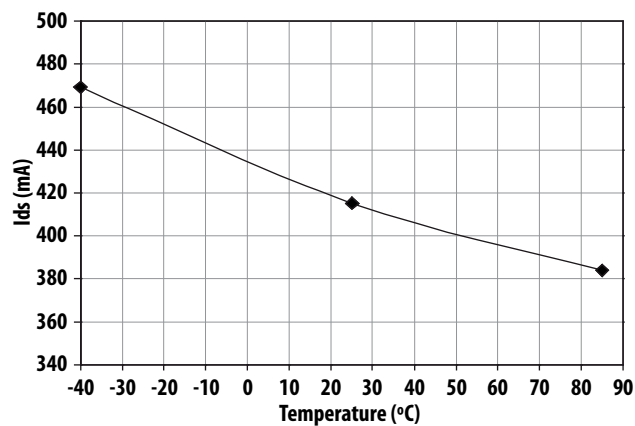


Figure 8.  $I_{ds}$  vs Temperature

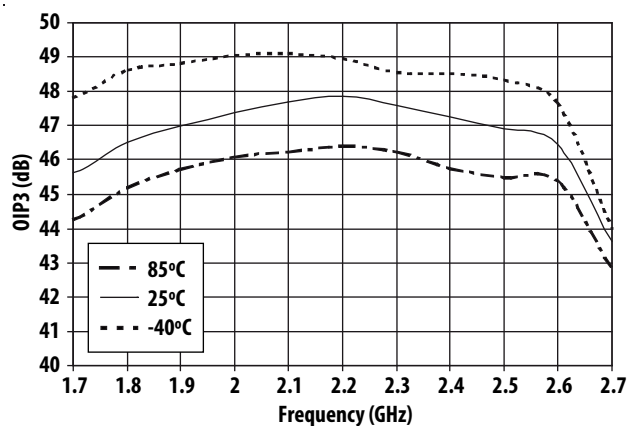


Figure 9. Over temperature OIP3 vs Frequency

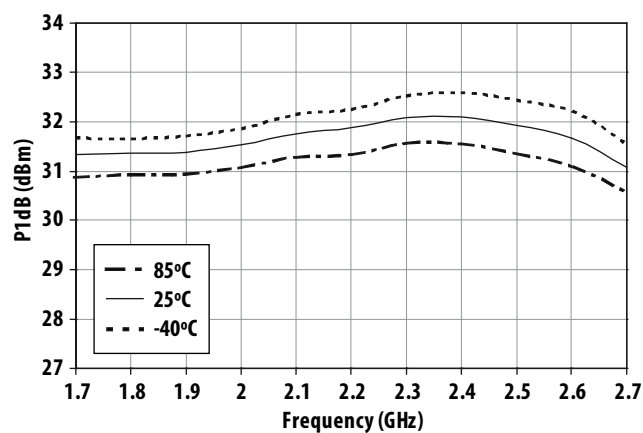


Figure 10. Over temperature P1dB vs Frequency

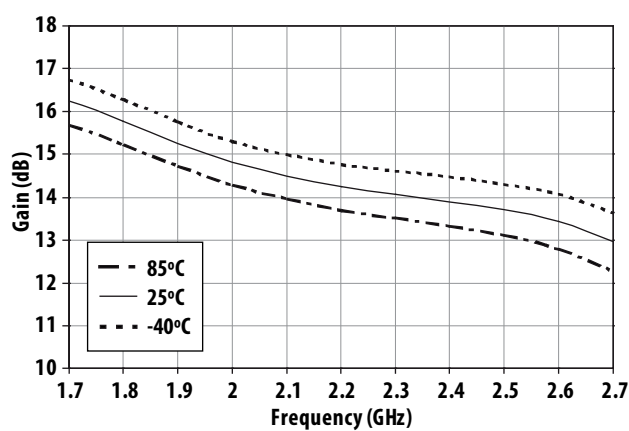


Figure 11. Over temperature Gain vs Frequency

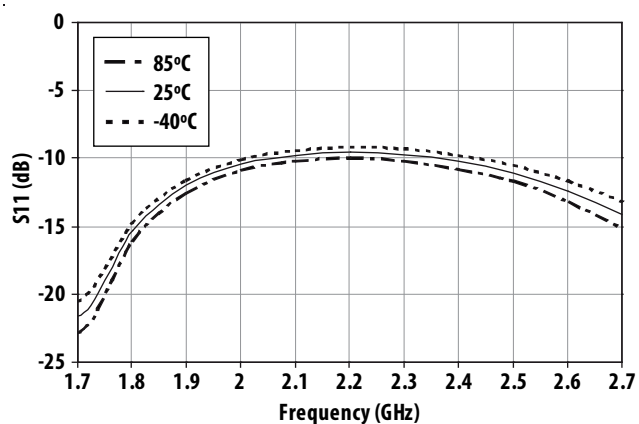


Figure 12. Over temperature S11 vs Frequency

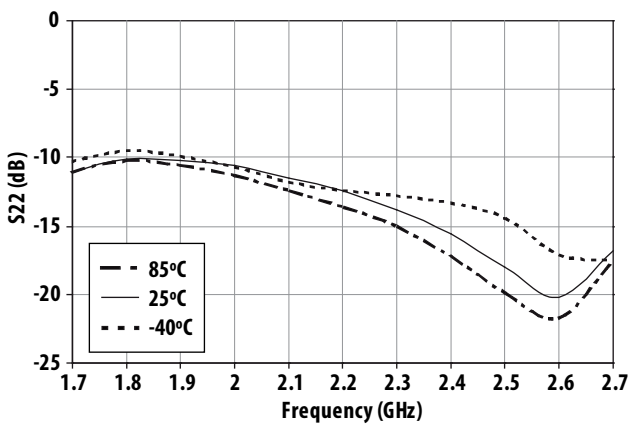


Figure 13. Over temperature S22 vs Frequency

## ALM-31222 Typical Performance

$T_A = +25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $V_{ctrl} = 5\text{V}$ , Input Signal=CW unless stated otherwise.

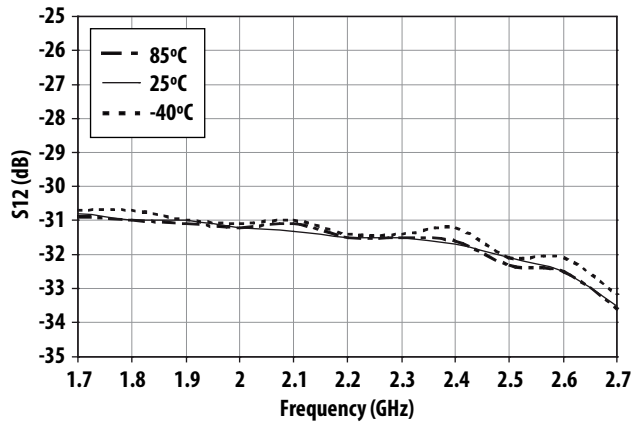


Figure 14. Over temperature S12 vs Frequency

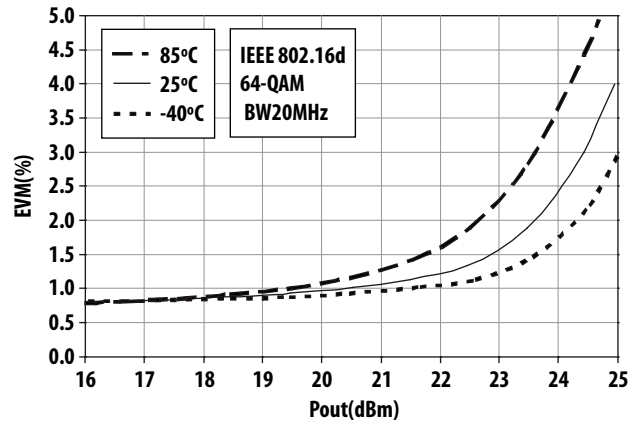


Figure 15. Over temperature EVM vs Pout at 2.5GHz

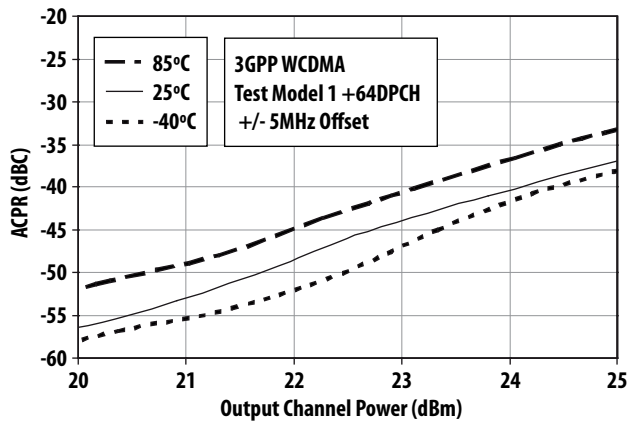


Figure 16. Over temperature ACPR vs Channel Power at 2.14GHz

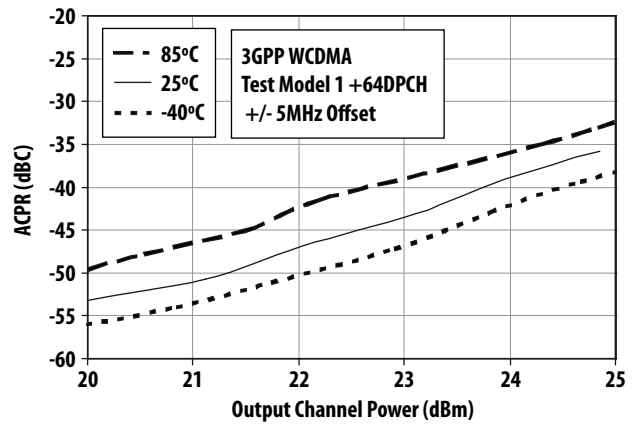


Figure 17. Over temperature ACPR vs Channel Power at 2.5GHz

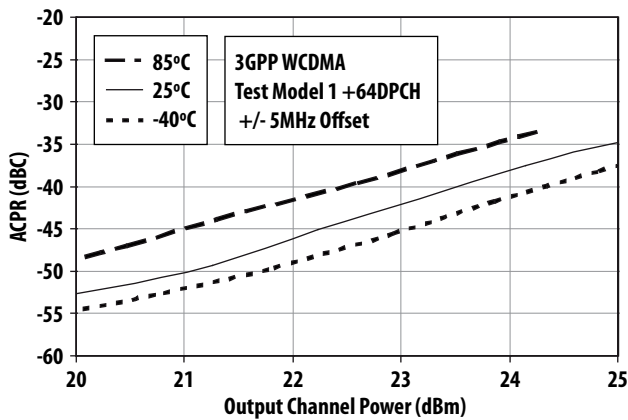


Figure 18. Over temperature ACPR vs Channel Power at 2.6GHz

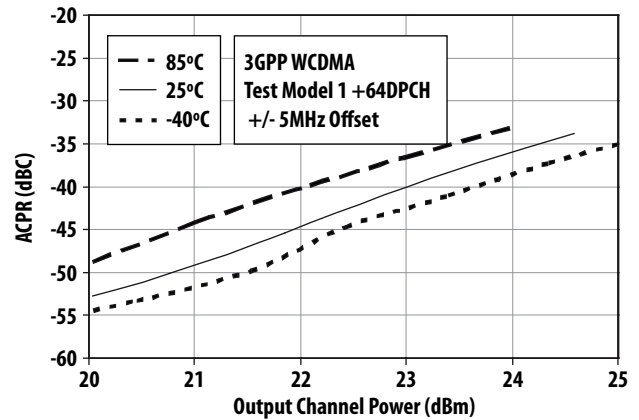
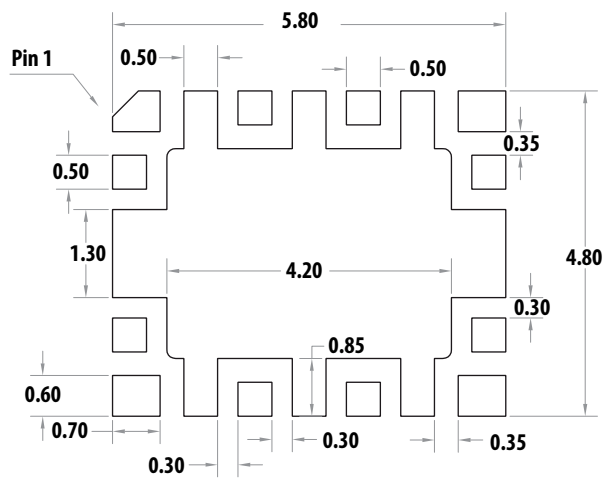
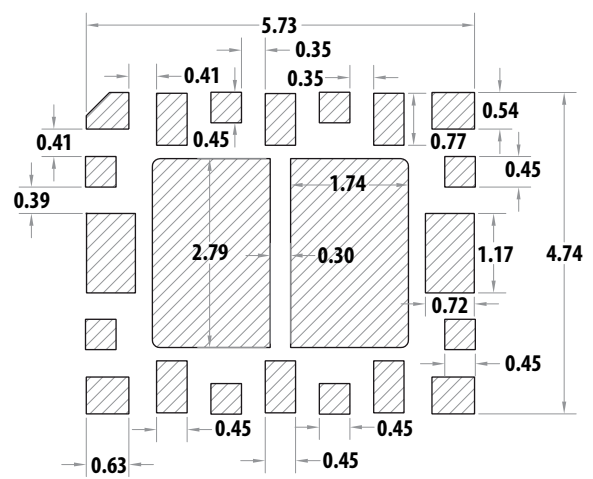


Figure 19. Over temperature ACPR vs Channel Power at 2.7GHz

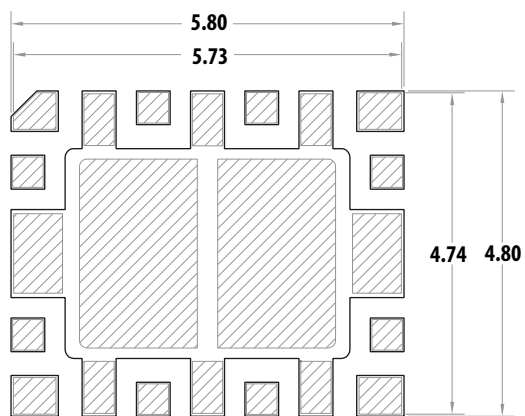
## PCB Layout and Stencil Design



PCB Land Pattern



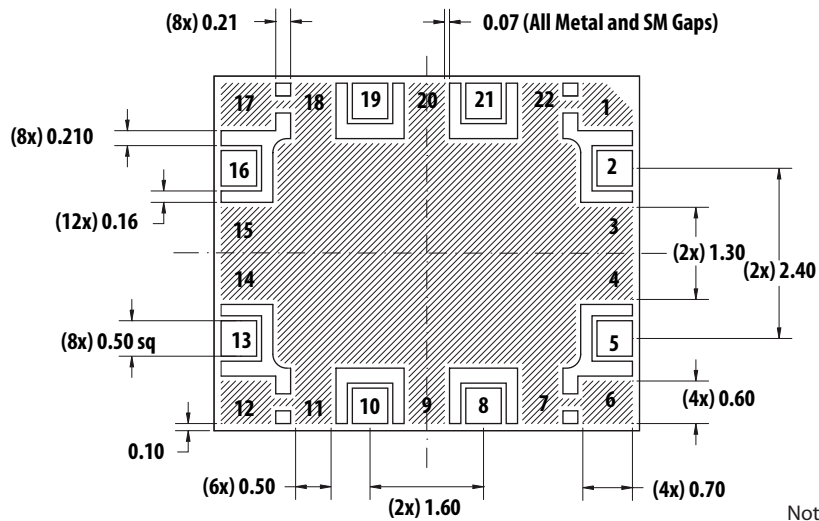
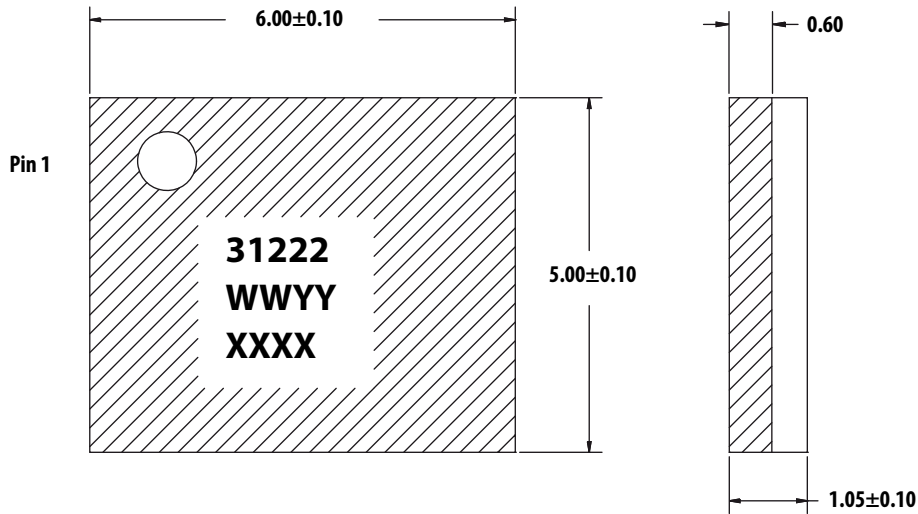
Stencil Opening



Combines Land Pattern and Stencil Layout

Note:  
All dimensions are in millimeters.

## MCOB 5x6 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

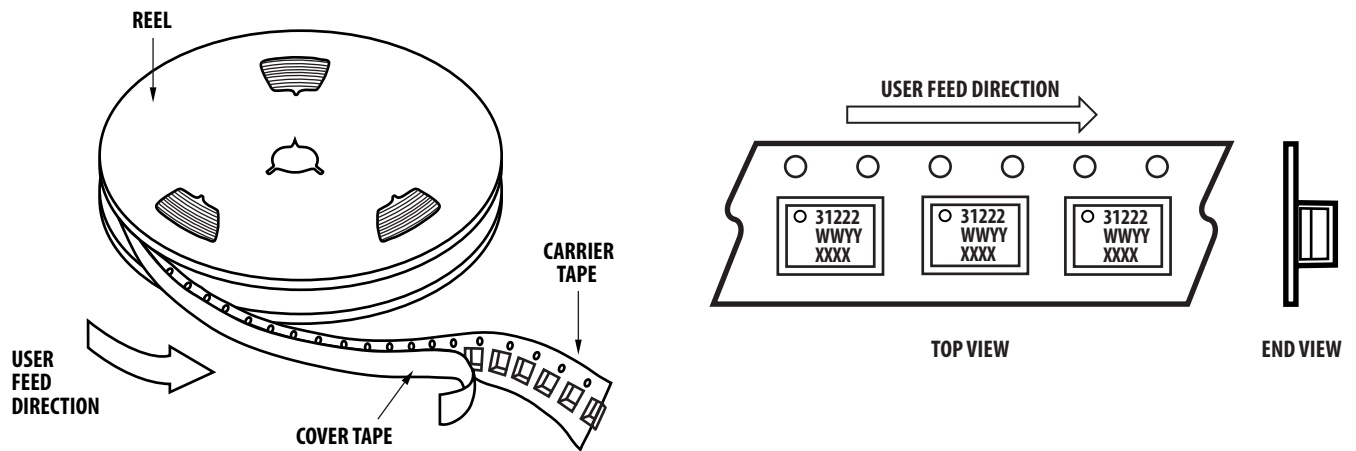
## Part Number Ordering Information

| Part Number   | No. of Devices | Container      |
|---------------|----------------|----------------|
| ALM31222-TR1G | 1000           | 7" Reel        |
| ALM31222-TR2G | 3000           | 13" Reel       |
| ALM31222-BLKG | 100            | antistatic bag |

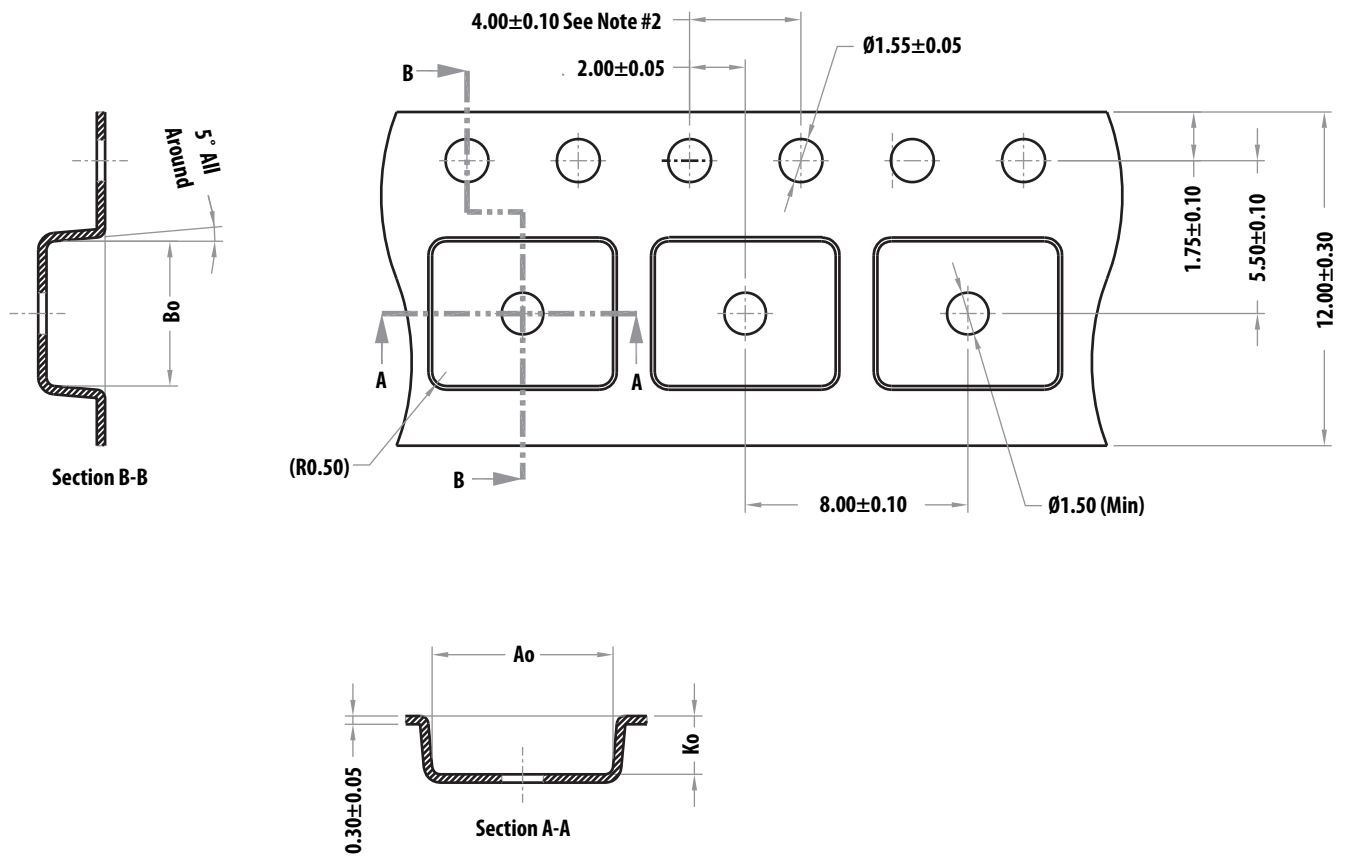
## Product Family

| Output Power | Frequency Band |             |            |
|--------------|----------------|-------------|------------|
|              | 700MHz-1GHz    | 1.7- 2.7GHz | 3.3-3.9GHz |
| 0.5W         | MGA-30116      | MGA-30216   | MGA-30316  |
| 1W           | ALM-31122      | ALM-31222   | ALM-31322  |
| 2W           | ALM-32120      | ALM-32220   | ALM-32320  |

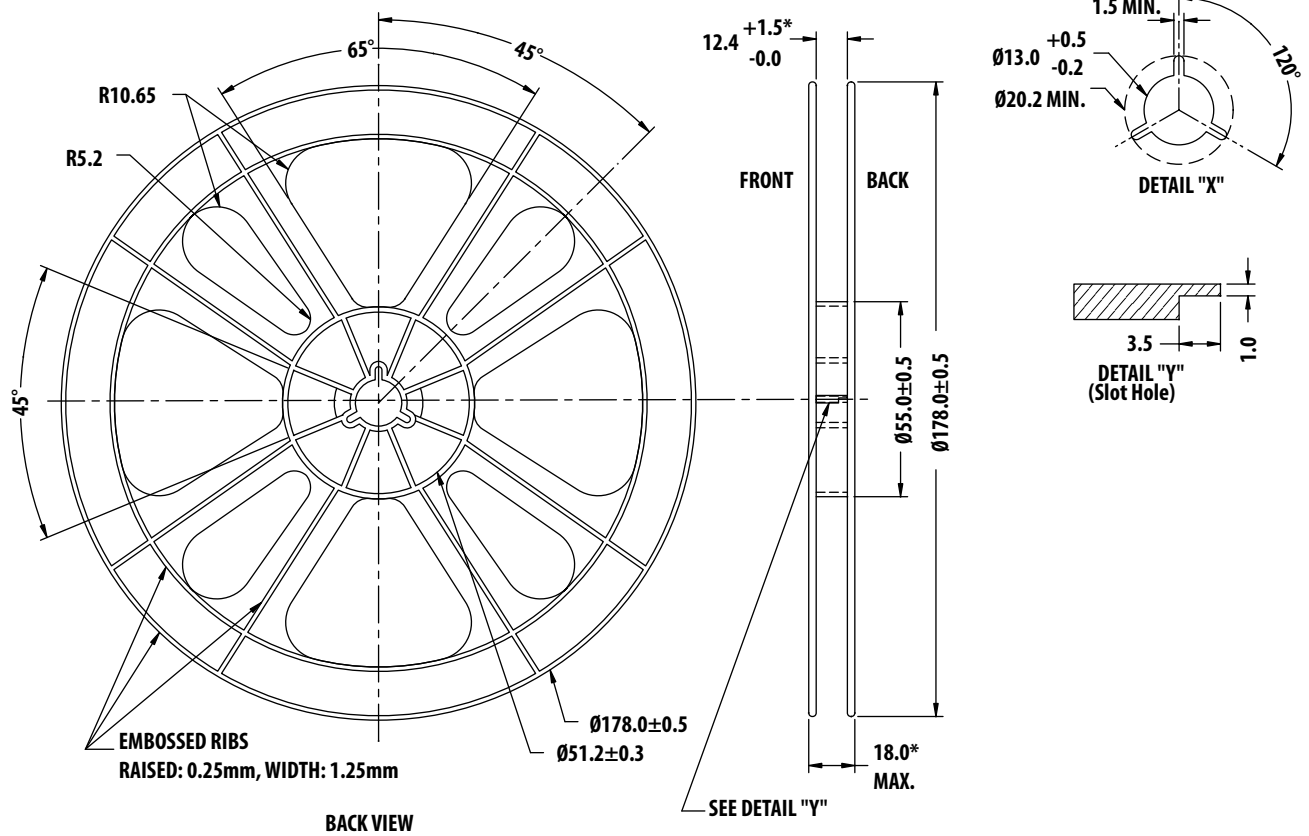
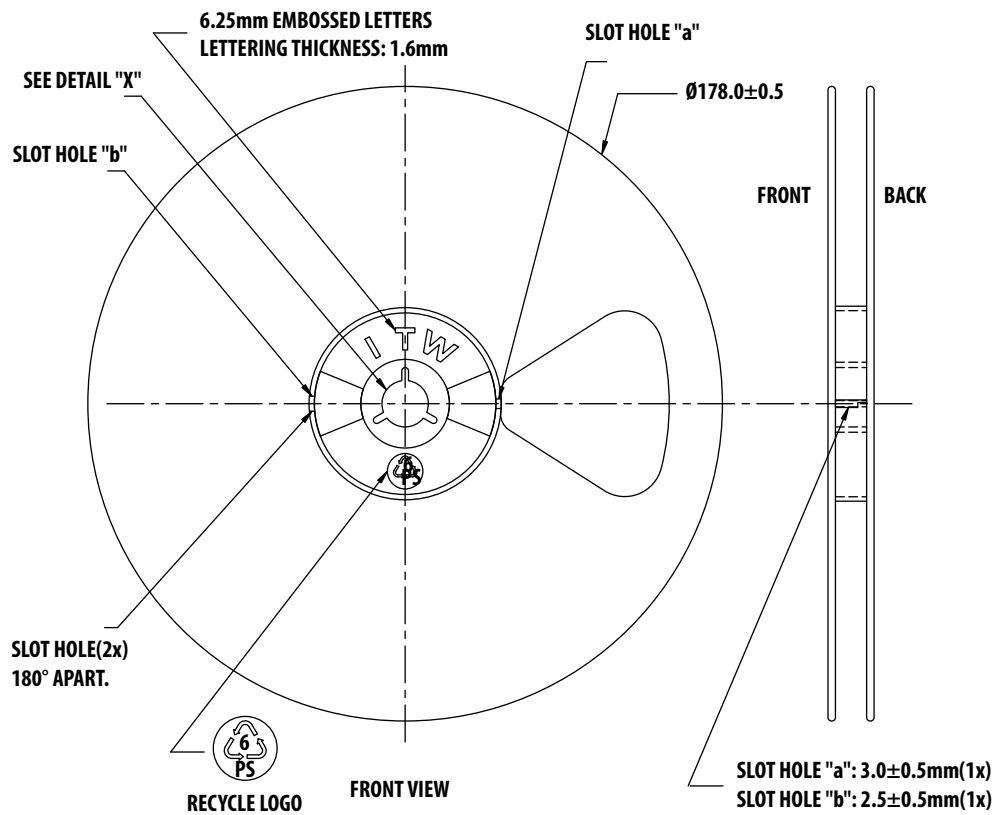
## Device Orientation



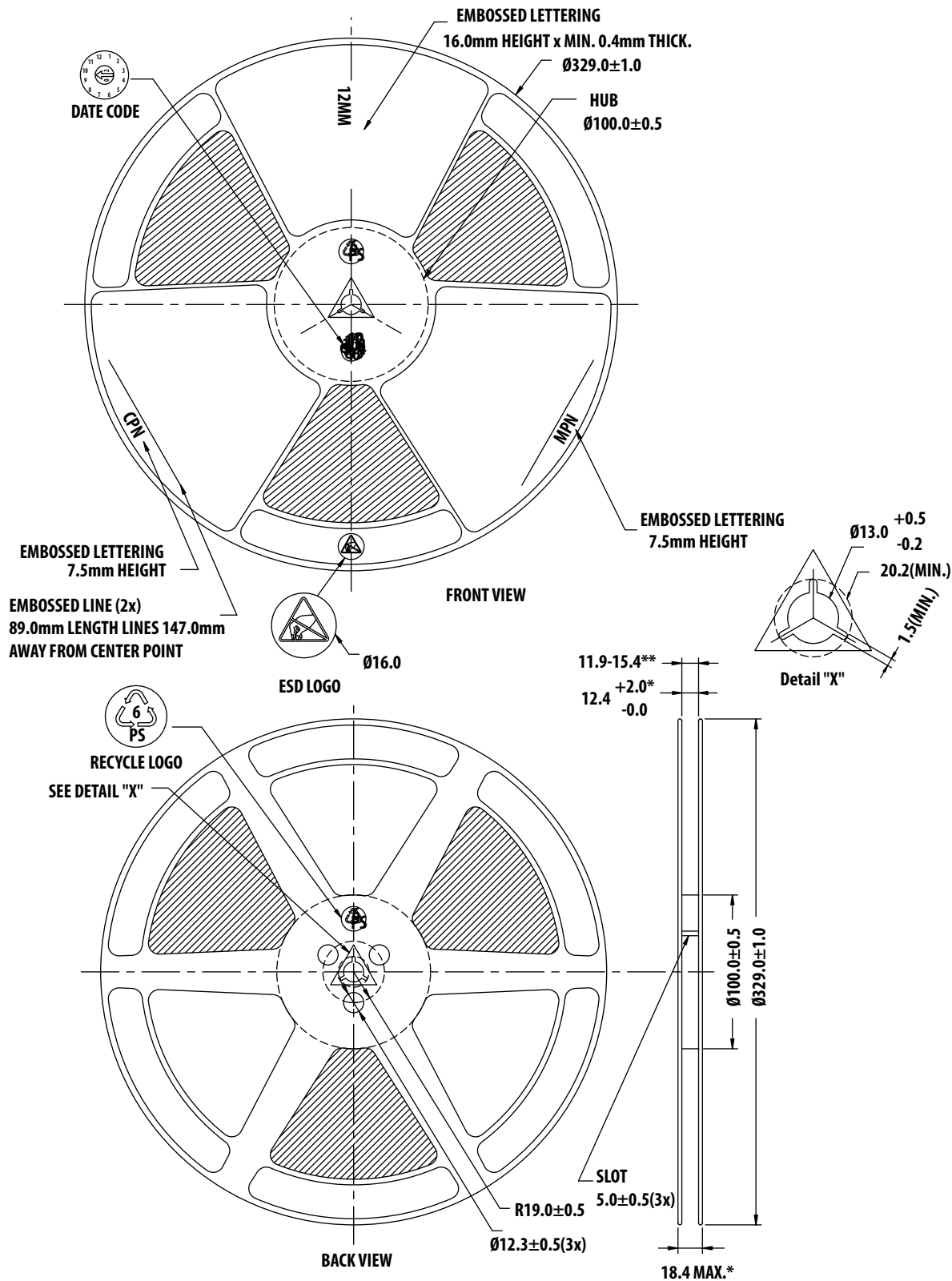
## Tape Dimensions



## Reel Dimension - 7 inch



## Reel Dimension - 13 inch



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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