

# ALM-32320

3.3GHz – 3.9GHz

2 Watt High Linearity Amplifier



## Data Sheet

### Description

Avago Technologies' ALM-32320 is a high linearity 2 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 and the 50Ω RF input and output pins are already internally AC-coupled. This makes the ALM-32320 extremely easy to use as the only external parts are DC supply bypass capacitors.

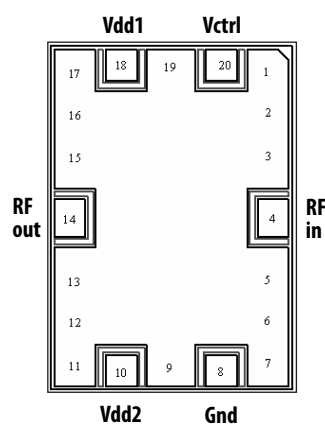
The adjustable temperature-compensated internal bias circuit allows the device to be operated at either class A or class AB operation. The ALM-32320 is housed inside a miniature 7.0 x 10.0 x 1.1 mm<sup>3</sup> 20-lead multiple-chips-on-board (MCOB) module package.

### Component Image

7.0 x 10.0 x 1.1mm<sup>3</sup> 20-Lead MCOB Package



Top View



Bottom View

Note:

Package marking provides orientation and identification

"32320" = 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

3.5GHz; 5V, 810mA (typical)

- 12.6 dB Gain
- 51.0 dBm Output IP3
- 34.5 dBm Output Power at 1dB Gain Compression
- 46.6% PAE at P1dB
- 2.5dB Noise Figure

### Applications

- Class A driver amplifier for 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 = 80 V

ESD Human Body Model = 800 V

Refer to Avago Application Note A004R:

Electrostatic Discharge, Damage and Control.

## Absolute Maximum Rating<sup>[2]</sup> $T_A=25^\circ\text{C}$

| Symbol         | Parameter                              | Units            | Absolute Max. |
|----------------|----------------------------------------|------------------|---------------|
| $V_{dd,max}$   | Device Voltage, RF output to ground    | V                | 5.5           |
| $I_{ds,max}$   | Device Drain Current                   | mA               | 1500          |
| $V_{ctrl,max}$ | Control Voltage                        | V                | 5.5           |
| $P_{in,max}$   | CW RF Input Power                      | dBm              | 28            |
| $P_{diss}$     | Total Power Dissipation <sup>[4]</sup> | W                | 8.25          |
| $T_{j,max}$    | Junction Temperature                   | $^\circ\text{C}$ | 150           |
| $T_{STG}$      | Storage Temperature                    | $^\circ\text{C}$ | -65 to 150    |

Thermal Resistance<sup>[3]</sup>  $\theta_{jc} = 15^\circ\text{C/W}$   
( $V_{dd} = 5\text{V}$ ,  $I_{ds} = 810\text{mA}$ ,  $T_c = 85^\circ\text{C}$ )

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  $V_{dd}$  and  $I_{ds}$ . Derate  $66.7\text{mW}/^\circ\text{C}$  for  $T_c > 26.2^\circ\text{C}$ .

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

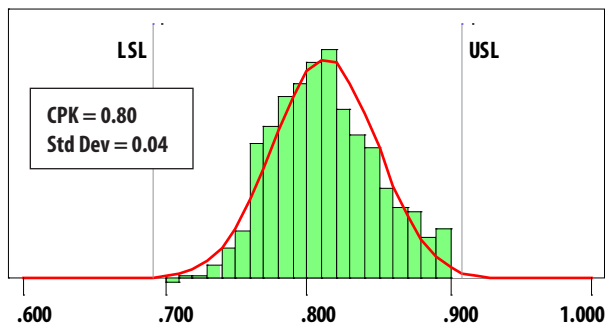


Figure 1.  $I_{ds}$ ; LSL = 690mA, nominal = 810mA, USL = 910mA

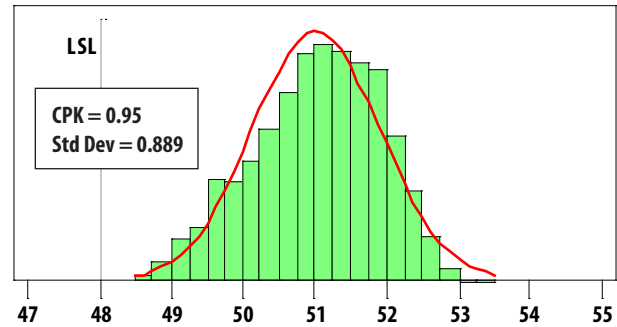


Figure 2. OIP3; LSL = 48dBm, nominal = 51dBm

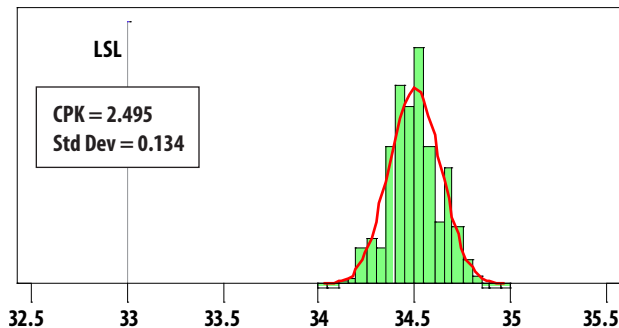


Figure 3. P1dB; LSL = 33dBm, nominal = 34.5dBm

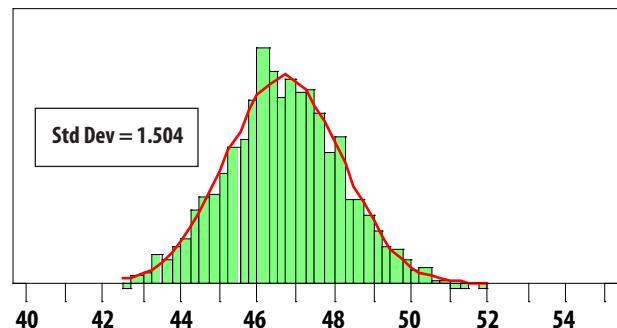


Figure 4. PAE at P1dB; nominal = 46.6%

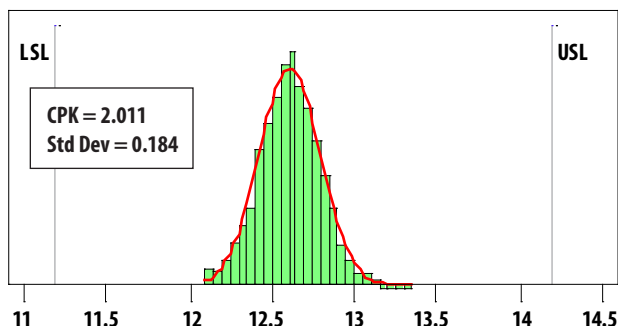


Figure 5. Gain; LSL=11.2dB, Nominal = 12.6dB, USL=14.2dB

Note:

5. Distribution data sample size is 500 samples taken from 3 different wafer lots.  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $V_{ctrl} = 5\text{V}$ , RF performance at 3.5GHz 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 [7]

$T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $V_{ctrl} = 5\text{V}$ , RF performance at 3.5GHz, measured on demo board (see Figure 7) unless otherwise specified.

| Symbol     | Parameter and Test Condition          | Units | Min. | Typ.  | Max. |
|------------|---------------------------------------|-------|------|-------|------|
| $I_{ds}$   | Quiescent current                     | mA    | 690  | 810   | 910  |
| $I_{ctrl}$ | $V_{ctrl}$ current                    | mA    | -    | 28    | -    |
| Gain       | Gain                                  | dB    | 11.2 | 12.6  | 14.2 |
| OIP3 [8]   | Output Third Order Intercept Point    | dBm   | 48.0 | 51.0  | -    |
| OP1dB      | Output Power at 1dB Gain Compression  | dBm   | 33.0 | 34.5  | -    |
| PAE        | Power Added Efficiency                | %     | -    | 46.6  | -    |
| NF         | Noise Figure                          | dB    | -    | 2.5   | -    |
| S11        | Input Return Loss, 50 $\Omega$ source | dB    | -    | -9.0  | -    |
| S22        | Output Return Loss, 50 $\Omega$ load  | dB    | -    | -12.0 | -    |
| S12        | Reverse Isolation                     | dB    | -    | -26.5 | -    |

Notes:

7. Measurements at 3.5GHz obtained using demo board described in Figure 6 and 7.

8. OIP3 test condition:  $F_{RF1} - F_{RF2} = 10\text{MHz}$  with input power of -5dBm per tone measured at worst side band

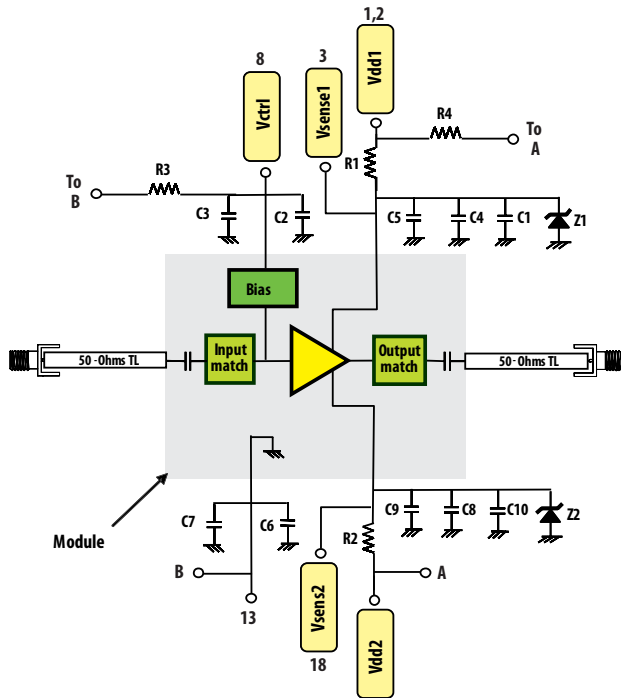
9. Use proper biasing, heat sink and de-rating to ensure maximum channel temperature is not exceeded. See absolute maximum ratings and application note (if applicable) for more details.

**S-Parameter<sup>[1]</sup> (Vdd = 5V, Vctrl = 5V, T = 25°C, matched 50Ω)**

| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 0.1        | -0.10    | 165.36    | -46.76   | 86.43     | -75.48   | 131.67    | -0.11    | -47.83    |
| 0.2        | -0.16    | 151.20    | -39.77   | 17.60     | -79.16   | 171.28    | -0.20    | -87.79    |
| 0.3        | -0.21    | 137.01    | -29.26   | 5.79      | -78.13   | -125.39   | -0.43    | -123.18   |
| 0.4        | -0.25    | 122.73    | -19.86   | -51.05    | -74.97   | -170.01   | -0.70    | -151.68   |
| 0.5        | -0.28    | 108.27    | -16.81   | -91.60    | -73.25   | 166.30    | -0.81    | -175.68   |
| 0.6        | -0.32    | 93.54     | -14.57   | -118.94   | -70.71   | 147.37    | -0.88    | 162.84    |
| 0.7        | -0.35    | 78.43     | -12.50   | -143.80   | -67.59   | 134.33    | -0.97    | 143.43    |
| 0.8        | -0.38    | 62.85     | -10.65   | -165.69   | -64.70   | 120.85    | -1.05    | 125.42    |
| 0.9        | -0.40    | 46.63     | -8.84    | 173.68    | -61.99   | 107.92    | -1.13    | 108.39    |
| 1.0        | -0.43    | 29.61     | -7.03    | 153.47    | -59.26   | 95.45     | -1.21    | 92.02     |
| 1.1        | -0.48    | 11.60     | -5.25    | 133.16    | -56.09   | 83.91     | -1.31    | 76.06     |
| 1.2        | -0.54    | -7.59     | -3.50    | 113.04    | -52.34   | 67.20     | -1.44    | 60.44     |
| 1.3        | -0.62    | -28.29    | -1.65    | 92.77     | -49.13   | 43.83     | -1.56    | 45.02     |
| 1.4        | -0.72    | -50.97    | 0.30     | 71.24     | -46.81   | 20.96     | -1.70    | 29.59     |
| 1.5        | -0.91    | -79.31    | 2.46     | 45.09     | -44.22   | -2.94     | -1.88    | 12.09     |
| 1.6        | -1.17    | -107.37   | 4.28     | 20.21     | -41.88   | -25.35    | -2.08    | -3.60     |
| 1.7        | -1.55    | -138.31   | 5.96     | -6.19     | -39.65   | -49.49    | -2.32    | -19.44    |
| 1.8        | -2.05    | -171.92   | 7.41     | -33.89    | -37.65   | -75.10    | -2.59    | -35.46    |
| 1.9        | -2.65    | 152.43    | 8.60     | -62.44    | -35.92   | -101.75   | -2.88    | -51.68    |
| 2.0        | -3.27    | 115.83    | 9.51     | -91.24    | -34.46   | -128.87   | -3.20    | -68.20    |
| 2.1        | -3.86    | 79.43     | 10.19    | -119.75   | -33.27   | -156.02   | -3.53    | -85.09    |
| 2.2        | -4.38    | 44.15     | 10.69    | -147.71   | -32.29   | 177.07    | -3.88    | -102.44   |
| 2.3        | -4.85    | 10.36     | 11.08    | -175.14   | -31.45   | 150.50    | -4.25    | -120.32   |
| 2.4        | -5.29    | -22.00    | 11.40    | 157.86    | -30.73   | 124.23    | -4.65    | -138.74   |
| 2.5        | -5.72    | -53.24    | 11.67    | 131.13    | -30.10   | 98.17     | -5.09    | -157.68   |
| 2.6        | -6.16    | -83.76    | 11.91    | 104.56    | -29.54   | 72.28     | -5.55    | -177.11   |
| 2.7        | -6.64    | -113.98   | 12.10    | 78.01     | -29.04   | 46.42     | -6.04    | 162.91    |
| 2.8        | -7.12    | -144.19   | 12.26    | 51.44     | -28.59   | 20.54     | -6.56    | 142.33    |
| 2.9        | -7.61    | -174.59   | 12.38    | 24.81     | -28.20   | -5.41     | -7.11    | 121.09    |
| 3.0        | -8.08    | 154.75    | 12.45    | -1.93     | -27.86   | -31.52    | -7.72    | 99.03     |
| 3.1        | -8.49    | 123.83    | 12.49    | -28.77    | -27.57   | -57.86    | -8.39    | 76.04     |
| 3.2        | -8.82    | 92.71     | 12.49    | -55.71    | -27.33   | -84.40    | -9.15    | 51.87     |
| 3.3        | -9.04    | 61.57     | 12.46    | -82.82    | -27.14   | -111.09   | -10.01   | 26.15     |
| 3.4        | -9.13    | 30.52     | 12.40    | -110.18   | -26.98   | -138.18   | -10.96   | -1.70     |
| 3.5        | -9.11    | -0.40     | 12.32    | -137.86   | -26.87   | -165.80   | -11.96   | -32.47    |
| 3.6        | -9.00    | -31.17    | 12.20    | -165.93   | -26.83   | 166.13    | -12.89   | -66.90    |
| 3.7        | -8.86    | -61.82    | 12.05    | 165.54    | -26.84   | 137.57    | -13.50   | -105.08   |
| 3.8        | -8.71    | -92.60    | 11.86    | 136.44    | -26.90   | 108.37    | -13.52   | -145.81   |
| 3.9        | -8.62    | -128.04   | 11.58    | 102.88    | -27.06   | 74.59     | -12.74   | 168.40    |
| 4.0        | -8.66    | -161.13   | 11.25    | 72.14     | -27.28   | 43.60     | -11.55   | 129.88    |
| 4.1        | -8.84    | 163.00    | 10.83    | 40.36     | -27.61   | 11.48     | -10.17   | 93.85     |
| 4.2        | -9.05    | 122.85    | 10.26    | 7.35      | -28.10   | -21.91    | -8.77    | 59.74     |
| 4.3        | -9.03    | 77.66     | 9.45     | -26.93    | -28.84   | -56.59    | -7.42    | 26.88     |
| 4.4        | -8.41    | 29.24     | 8.30     | -62.22    | -29.92   | -92.29    | -6.19    | -5.15     |
| 4.5        | -7.18    | -17.99    | 6.73     | -97.79    | -31.44   | -128.32   | -5.10    | -36.36    |
| 4.6        | -5.72    | -60.25    | 4.71     | -132.62   | -33.42   | -163.61   | -4.19    | -66.47    |
| 4.7        | -4.43    | -96.47    | 2.31     | -165.73   | -35.81   | 162.91    | -3.46    | -95.05    |
| 4.8        | -3.46    | -127.30   | -0.35    | 163.53    | -38.48   | 131.84    | -2.90    | -121.75   |
| 4.9        | -2.77    | -153.80   | -3.13    | 135.33    | -41.33   | 103.30    | -2.46    | -146.46   |
| 5.0        | -2.29    | -176.97   | -5.90    | 109.46    | -44.24   | 77.09     | -2.12    | -169.19   |
| 5.1        | -1.96    | 162.40    | -8.57    | 85.59     | -47.17   | 52.58     | -1.85    | 169.87    |
| 5.2        | -1.74    | 143.72    | -11.06   | 63.31     | -50.14   | 29.02     | -1.64    | 150.53    |
| 5.3        | -1.58    | 126.50    | -13.30   | 42.16     | -53.21   | 5.16      | -1.47    | 132.56    |
| 5.4        | -1.49    | 110.37    | -15.22   | 21.56     | -56.41   | -21.35    | -1.34    | 115.80    |
| 5.5        | -1.47    | 95.00     | -16.71   | 0.71      | -59.63   | -56.42    | -1.23    | 100.06    |
| 5.6        | -1.56    | 80.12     | -17.62   | -21.91    | -61.17   | -107.54   | -1.14    | 85.20     |
| 5.7        | -1.90    | 65.91     | -17.87   | -49.71    | -59.14   | -166.70   | -1.08    | 71.05     |
| 5.8        | -2.55    | 55.09     | -18.00   | -88.45    | -54.64   | 136.94    | -1.02    | 57.49     |
| 5.9        | -2.75    | 48.74     | -19.45   | -137.25   | -51.56   | 82.26     | -0.98    | 44.40     |
| 6.0        | -2.17    | 41.43     | -22.52   | 172.96    | -51.45   | 37.70     | -0.98    | 31.67     |

Notes:

1. S-parameter is measured with reference plane at SMA end launch using demo board shown in Figure 7.
2. Demo board 50Ω transmission line is CPWG with W = 21.7 mils, G = 19.2 mils, L = 615.5 mils, 10 mils Rogers RO4350, 0.5oz Cu.
3. Demo board SMA end launch is Johnson 142-0701-851.



Note:  
To supply Vdd1 and Vdd2 individually, remove R4 and supply Vdd1 from pin 1,2 and Vdd2 from pin 19,20

Figure 6. Demo board application schematics and components table

## Demo board layout

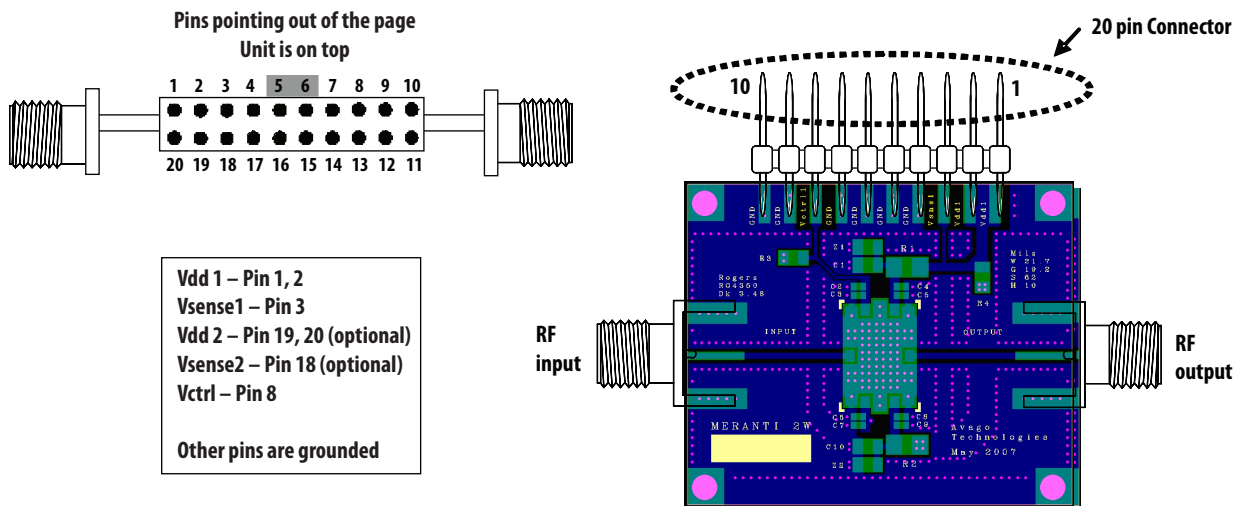


Figure 7. Demo board layout diagram

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-32320 Typical Over-Temperature Performance

Vdd = 5V, Vctrl = 5V, Input Signal = CW unless stated otherwise.

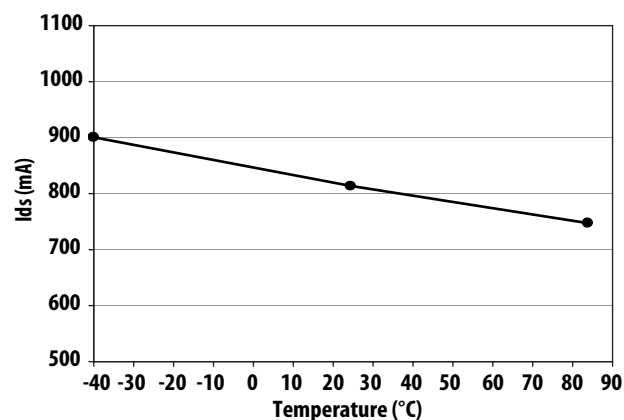


Figure 8. Over temperature Ids

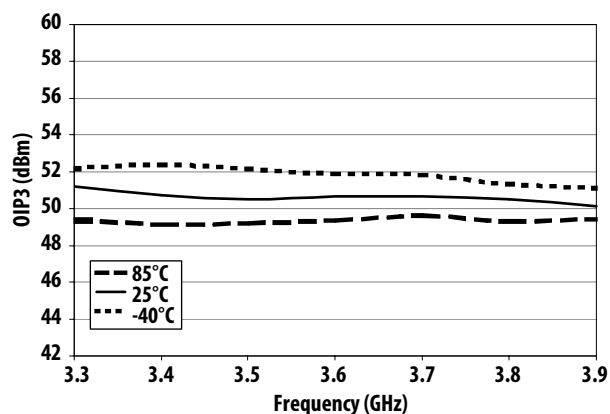


Figure 9. Over temperature OIP3 vs Frequency

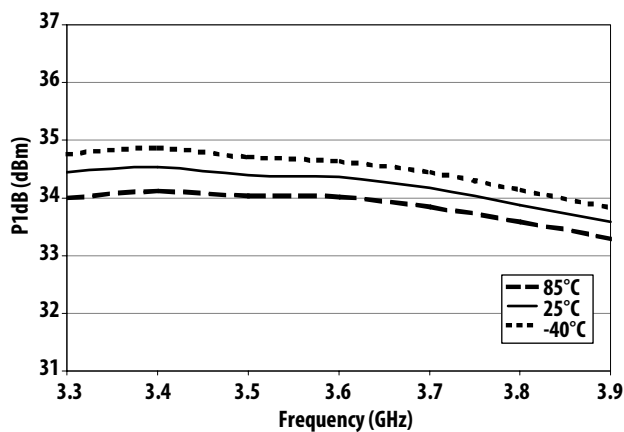


Figure 10. Over temperature P1dB vs Frequency

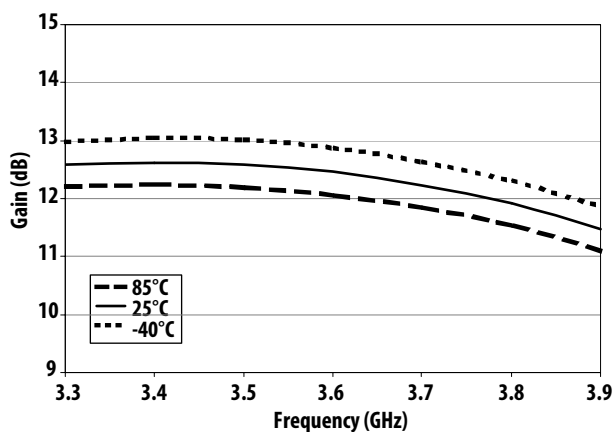


Figure 11. Over temperature Gain vs Frequency

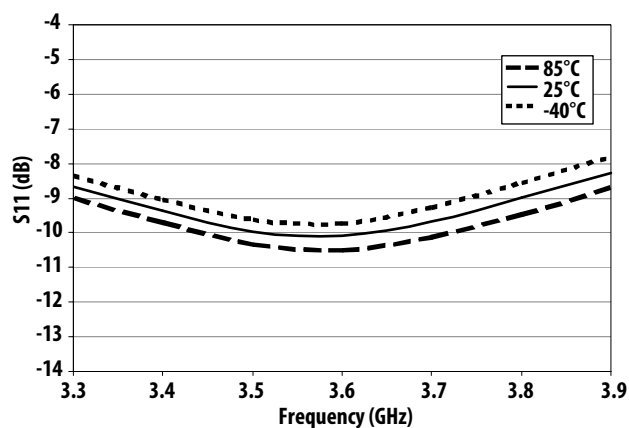


Figure 12. Over temperature S11 vs Frequency

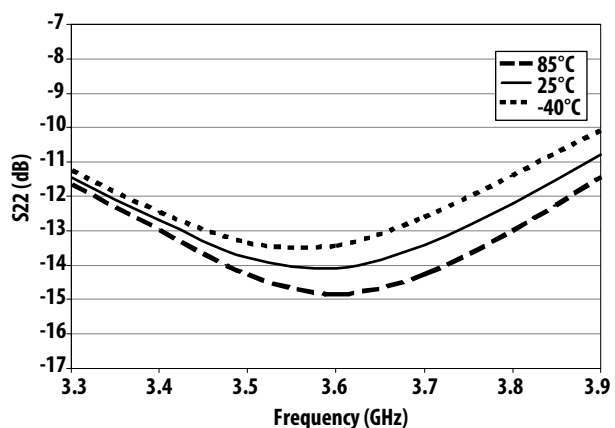


Figure 13. Over temperature S22 vs Frequency

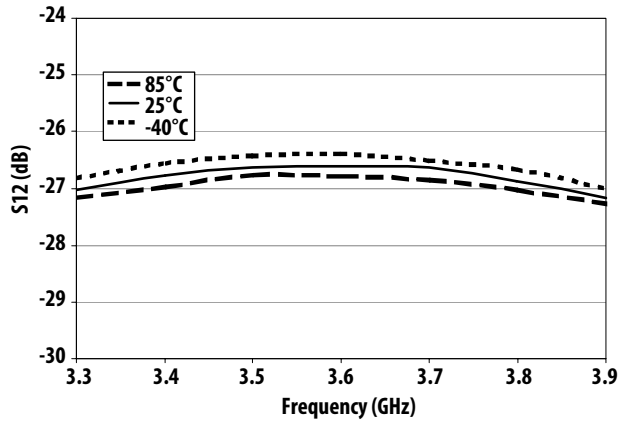


Figure 14. Over temperature S12 vs Frequency

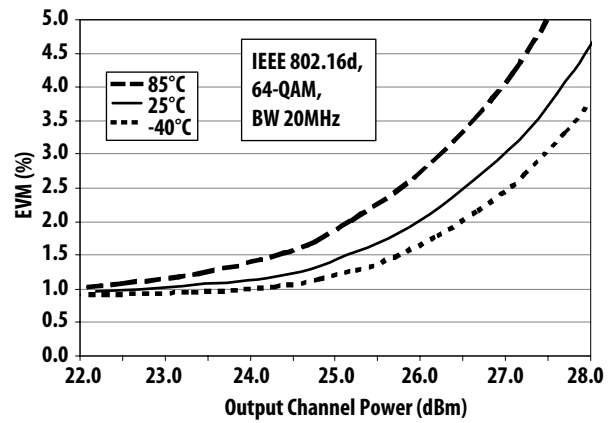


Figure 15. Over temperature WiMAX EVM vs Output Power @ 3.3GHz

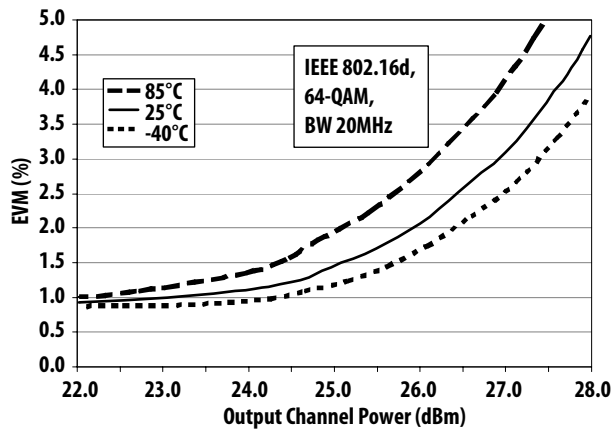


Figure 16. Over temperature WiMAX EVM vs Output Power @ 3.5GHz

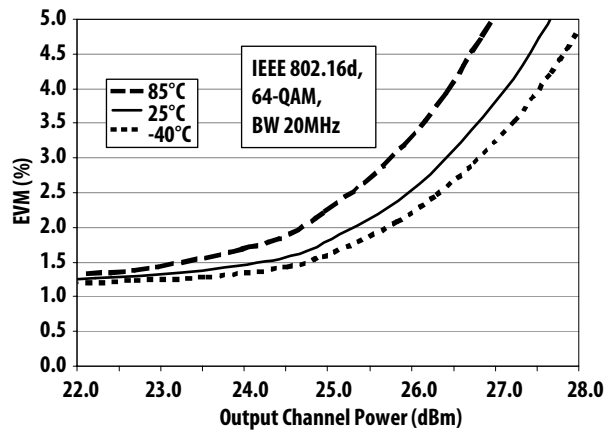
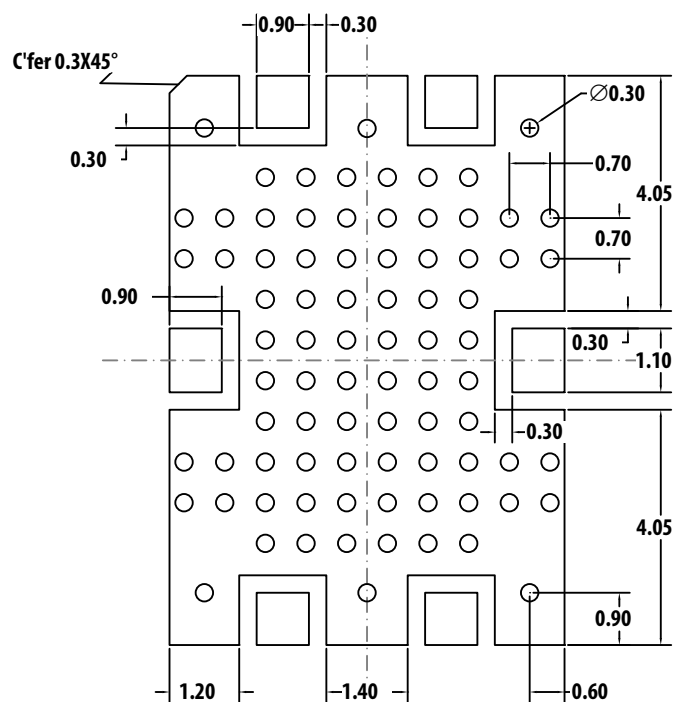
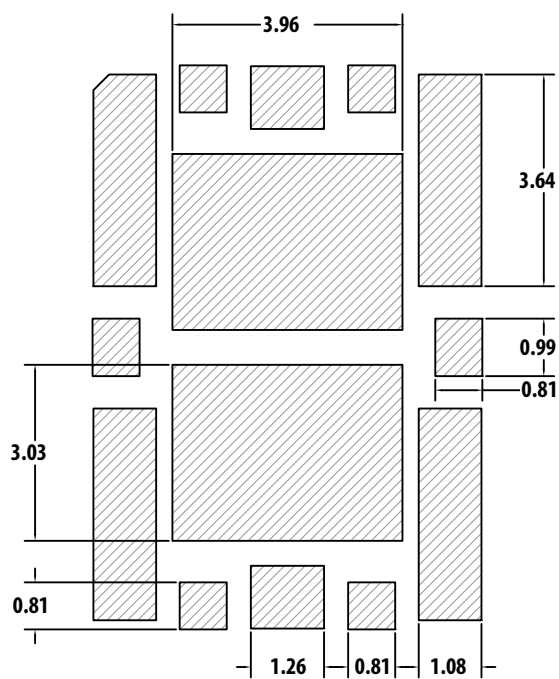


Figure 17. Over temperature WiMAX EVM vs Output Power @ 3.9GHz

## PCB Layout and Stencil Design

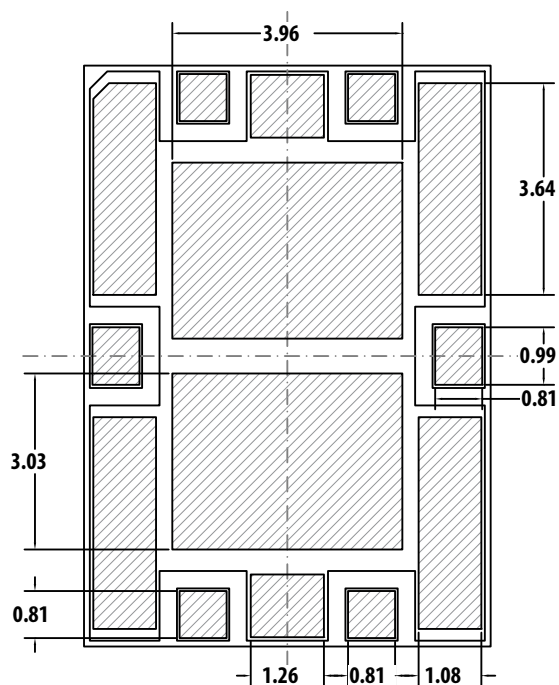


### PCB Land Pattern (Top View)



## Stencil Outline

Note: All dimensions are in millimeters.



**Combined PCB and stencil layout Land Pattern (Top View)**

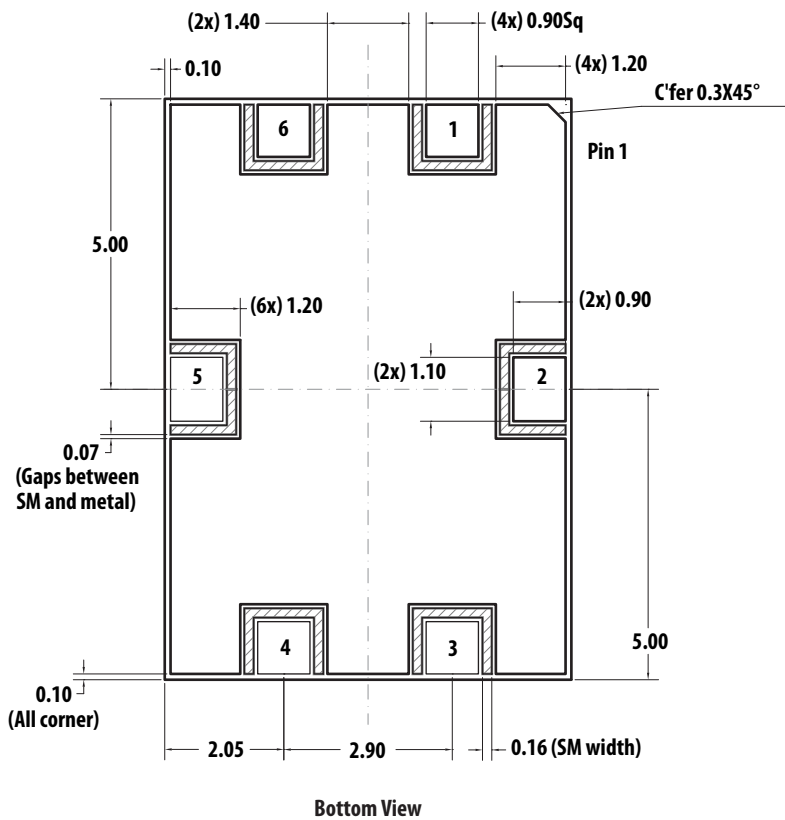
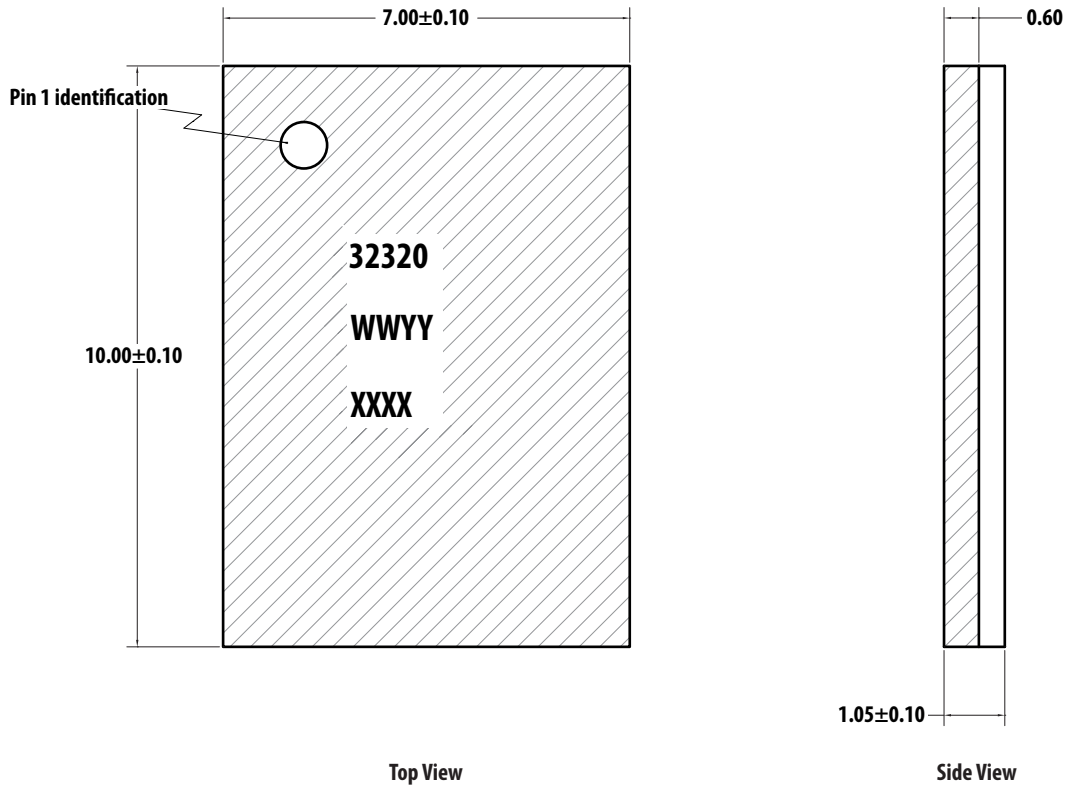
## Part Number Ordering Information

| Part Number    | No. of Devices | Container      |
|----------------|----------------|----------------|
| ALM-32320-TR1G | 1000           | 13" Reel       |
| ALM-32320-TR2G | 3000           | 13" Reel       |
| ALM-32320-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  |

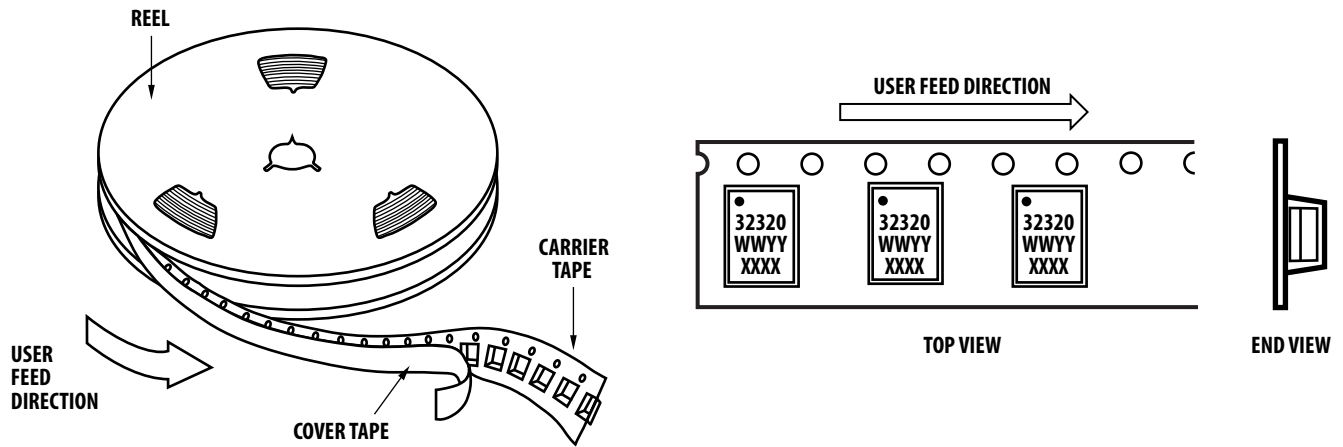
## MCOB 7 x 10 Package Dimensions



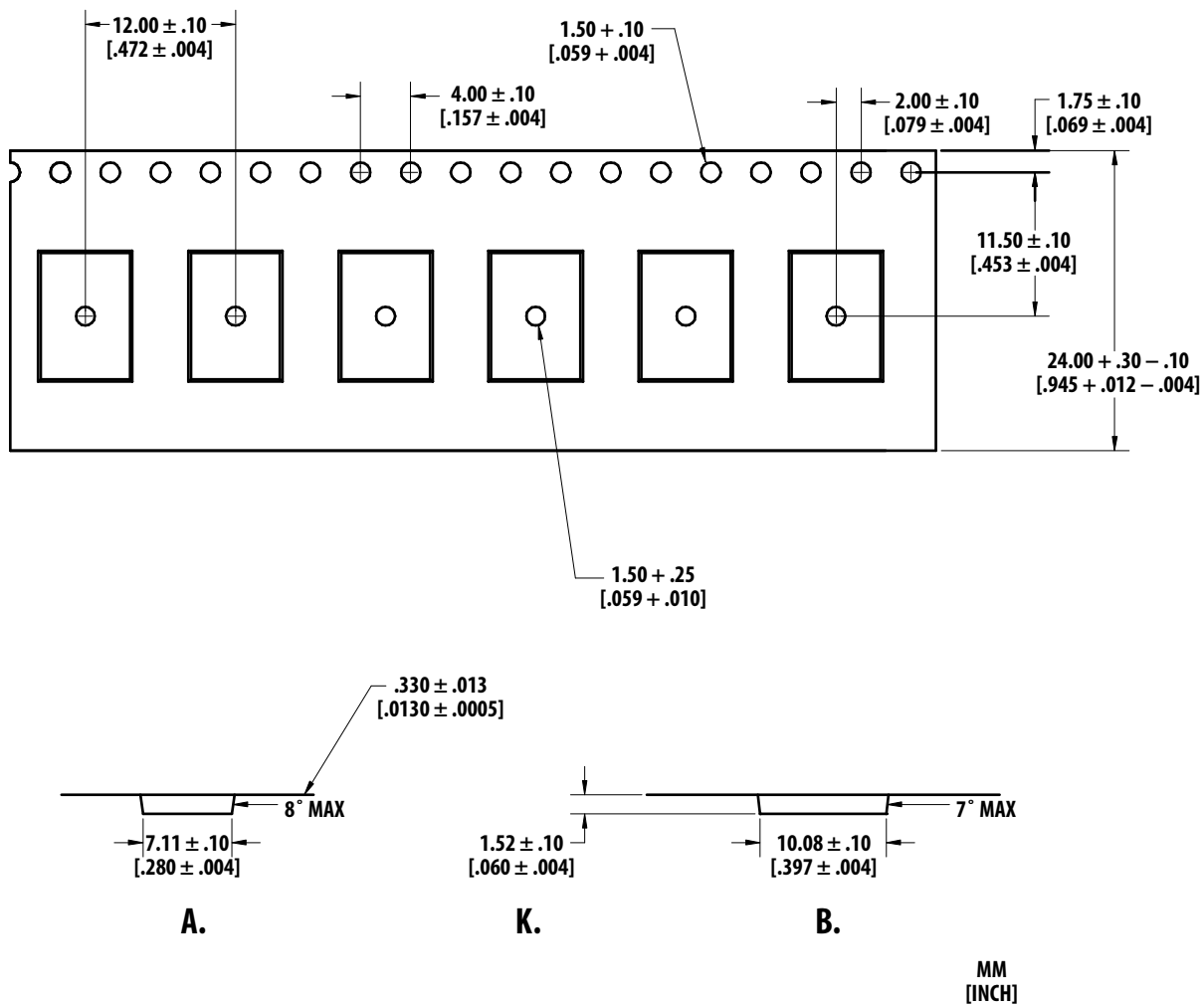
### Notes:

1. All dimensions are in millimeters
2. Dimensions are inclusive of plating
3. Dimensions are exclusive of mold flash and metal burr

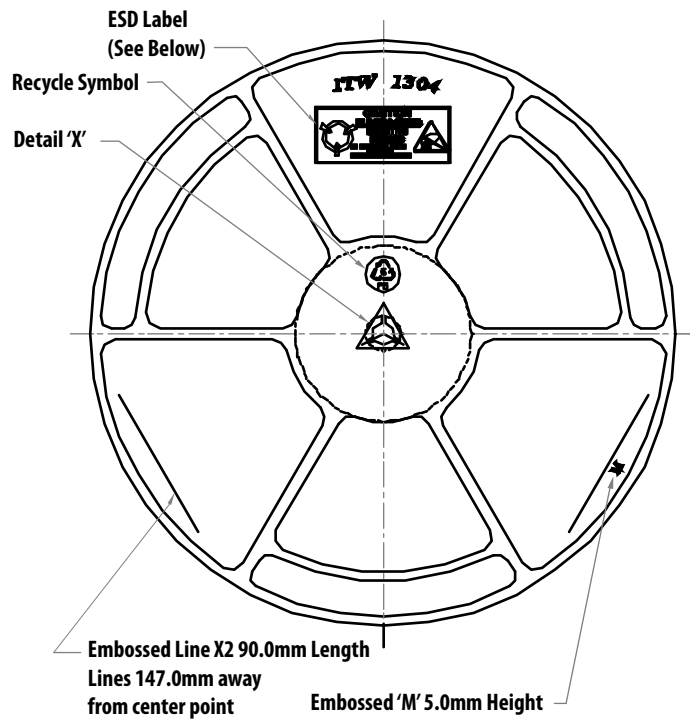
## Device Orientation



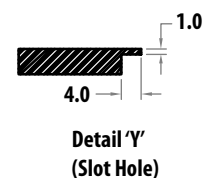
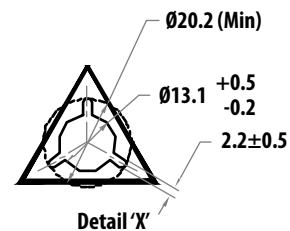
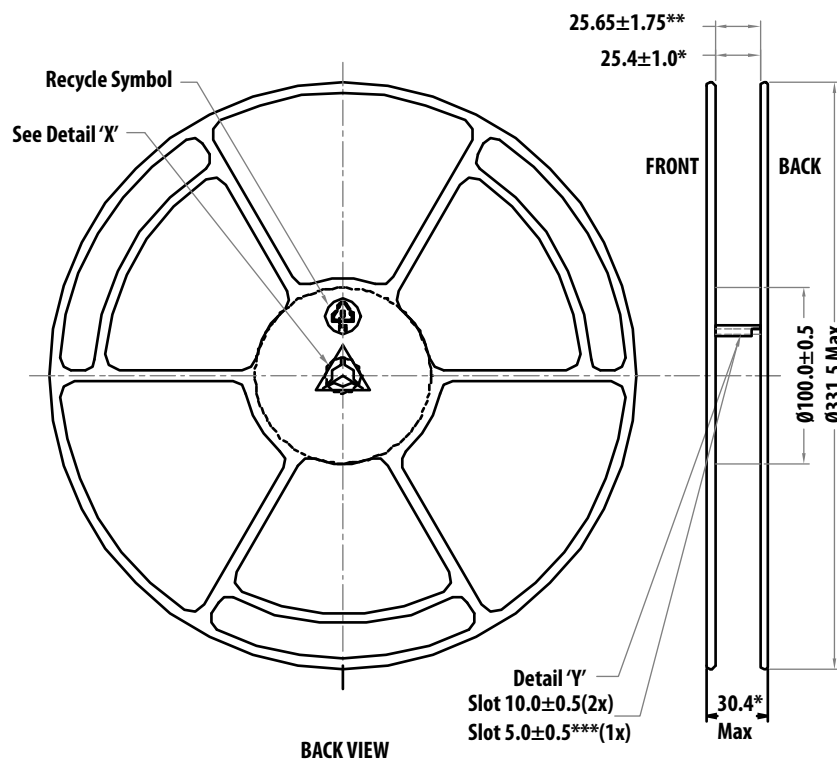
## Tape Dimensions



## Reel Dimensions - 13" Reel



FRONT VIEW



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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