MGA-635P8
Ultra Low Noise, High Linearity Low Noise Amplifier

Data Sheet

Description
Avago Technologies’ MGA-635P8 is an economical, easy-to-use GaAs MMIC Low Noise Amplifier (LNA). The LNA has low noise and high linearity achieved through the use of Avago Technologies’ proprietary 0.25μm GaAs Enhancement-mode pHEMT process. It is housed in a miniature 2.0 x 2.0 x 0.75mm³ 8-pin Quad-Flat-Non-Lead (QFN) package. It is designed for optimum use from 2.3GHz up to 4GHz. The compact footprint and low profile coupled with low noise, high gain and high linearity make the MGA-635P8 an ideal choice as a low noise amplifier for cellular infrastructure for LTE, GSM and CDMA. For optimum performance at lower frequency from 450MHz up to 1.5GHz, MGA-633P8 is recommended. For optimum performance at frequency from 1.5GHz up to 2.3GHz, MGA-634P8 is recommended. All these 3 products, MGA-633P8, MGA-634P8 and MGA-635P8 share the same package and pinout configuration.

Pin Configuration and Package Marking
2.0 x 2.0 x 0.75 mm³ 8-lead QFN

Top View
- Pin 1 – Vbias
- Pin 2 – RFinput
- Pin 3 – Not Used
- Pin 4 – Not Used

Bottom View
- Pin 5 – Not Used
- Pin 6 – Not Used
- Pin 7 – RFout/Vdd
- Pin 8 – Not Used
Centre tab - Ground

Note:
Package marking provides orientation and identification “35” = Device Code, where X is the month code.

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model = 50 V (Class A)
ESD Human Body Model = 500 V (Class 1B)
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Features
- Ultra Low noise Figure
- High linearity performance
- GaAs E-pHEMT Technology[1]
- Low cost small package size: 2.0 x 2.0 x 0.75 mm³
- Excellent uniformity in product specifications
- Tape-and-Reel packaging option available

Specifications
2.5GHz; 5V, 56mA
- 18 dB Gain
- 0.56 dB Noise Figure
- 12.5 dB Input Return Loss
- 35.9 dBm Output IP3
- 22 dBm Output Power at 1dB gain compression

Applications
- Low noise amplifier for cellular infrastructure for LTE, GSM and CDMA.
- Other ultra low noise application.

Simplified Schematic

Notes:
- The schematic is shown with the assumption that similar PCB is used for all MGA-633P8, MGA-634P8 and MGA-635P8.
- Detail of the components needed for this product is shown in Table 1.
- Enhancement mode technology employs positive gate voltage, thereby eliminating the need of negative gate voltage associated with conventional depletion mode devices.
- Good RF practice requires all unused pins to be earthed.
**Absolute Maximum Rating** \(^{(1)}\) \(T_A = 25^\circ C\)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Units</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{dd})</td>
<td>Device Voltage, RF output to ground</td>
<td>V</td>
<td>5.5</td>
</tr>
<tr>
<td>(V_{bias})</td>
<td>Gate Voltage</td>
<td>V</td>
<td>0.7</td>
</tr>
<tr>
<td>(P_{in,max})</td>
<td>CW RF Input Power ((V_{dd} = 5.0V, I_{dd} = 50 \text{ mA}))</td>
<td>dBm</td>
<td>+20</td>
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<tr>
<td>(P_{diss})</td>
<td>Total Power Dissipation (^{(2)})</td>
<td>W</td>
<td>0.5</td>
</tr>
<tr>
<td>(T_j)</td>
<td>Junction Temperature</td>
<td>°C</td>
<td>150</td>
</tr>
<tr>
<td>(T_{stg})</td>
<td>Storage Temperature</td>
<td>°C</td>
<td>-65 to 150</td>
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</table>

**Thermal Resistance**

<table>
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<tr>
<th>Thermal Resistance (^{(3)})</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>((V_{dd} = 5.0V, I_{dd} = 50mA))</td>
<td>(\theta_{jc} = 75^\circ C/W)</td>
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</table>

**Notes:**
1. Operation of this device in excess of any of these limits may cause permanent damage.
2. Power dissipation with device turned on. Board temperature \(T_B\) is 25°C. Derate at 13mW/°C for \(T_B > 112^\circ C\).
3. Thermal resistance measured using Infra-Red Measurement Technique

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**Electrical Specifications** \(^{(1)}, \,(4)\)

RF performance at \(T_A = 25^\circ C\), \(V_{dd} = 5V\), \(R_{bias} = 3.6 \text{kOhm}\), 2.5 GHz, measured on demo board in Figure 1 with component listed in Table 1 for 2.5 GHz matching.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter and Test Condition</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
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<tr>
<td>(I_{dd})</td>
<td>Drain Current</td>
<td>mA</td>
<td>46</td>
<td>56</td>
<td>71</td>
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<tr>
<td>Gain</td>
<td>Gain</td>
<td>dB</td>
<td>16.5</td>
<td>18</td>
<td>19.5</td>
</tr>
<tr>
<td>OIP3 (^{(2)})</td>
<td>Output Third Order Intercept Point</td>
<td>dBm</td>
<td>32.5</td>
<td>35.9</td>
<td></td>
</tr>
<tr>
<td>NF (^{(3)})</td>
<td>Noise Figure</td>
<td>dB</td>
<td>0.56</td>
<td>0.78</td>
<td></td>
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<tr>
<td>OP1dB</td>
<td>Output Power at 1dB Gain Compression</td>
<td>dBm</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRL</td>
<td>Input Return Loss, 50Ω source</td>
<td>dB</td>
<td>12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORL</td>
<td>Output Return Loss, 50Ω load</td>
<td>dB</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REV ISOL</td>
<td>Reverse Isolation</td>
<td>dB</td>
<td>35</td>
<td></td>
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</tr>
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</table>

**Notes:**
1. Measurements at 2.5 GHz obtained using demo board described in Figure 1.
2. OIP3 test condition: \(F_{RF1} = 2.5 \text{ GHz}, F_{RF2} = 2.501 \text{ GHz}\) with input power of -10dBm per tone.
3. For NF data, board losses of the input have not been de-embedded.
4. Use proper bias, heatsink and derating to ensure maximum device temperature is not exceeded. See absolute maximum ratings and application note for more details.
Product Consistency Distribution Charts [1, 2]

Figure 1. \( \text{Idd} @ 2.5\text{GHz}, 5V, 56\text{mA} \) Mean = 56

Figure 2. Noise Figure @ 2.5GHz, 5V, 56mA Mean = 0.56

Figure 3. \( \text{OIP3} @ 2.5\text{GHz} \), 5V, 56mA Mean = 35.9

Figure 4. Gain @ 2.5GHz, 5V, 56mA Mean = 18

Notes:
1. Distribution data samples are 500 samples taken from 3 different wafers. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
2. Circuit Losses have not been de-embedded from the actual measurements.
Figure 5. Demo Board Layout Diagram
– Recommended PCB material is 10 mils Rogers RO4350.
– Suggested component values may vary according to layout and PCB material.

Figure 6. Demo Board Schematic Diagram

Table 1. Component list for 2.5 GHz matching

<table>
<thead>
<tr>
<th>Part</th>
<th>Size</th>
<th>Value</th>
<th>Detail Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C2</td>
<td>0402</td>
<td>1000pF (Murata)</td>
<td>GRM155R71H102KA01E</td>
</tr>
<tr>
<td>L1</td>
<td>0402</td>
<td>6.8nH (CoilCraft)</td>
<td>0402CS-6N8XGLU</td>
</tr>
<tr>
<td>L2</td>
<td>0402</td>
<td>6.8nH (Toko)</td>
<td>LLP1005-FH6N8C</td>
</tr>
<tr>
<td>C3, C4</td>
<td>0402</td>
<td>10pF (Murata)</td>
<td>GRM1555C1H100JZ01E</td>
</tr>
<tr>
<td>C5, C6</td>
<td>0805</td>
<td>4.7uF (Murata)</td>
<td>GRM21BR60J475KA11L</td>
</tr>
<tr>
<td>R1</td>
<td>0402</td>
<td>49.9 Ohm (Rohm)</td>
<td>MCR01 MZS F 49R9</td>
</tr>
<tr>
<td>R2</td>
<td>0402</td>
<td>0 Ohm (Kamaya)</td>
<td>RMC1/16S-JPTH</td>
</tr>
<tr>
<td>Rbias</td>
<td>0402</td>
<td>3.6 kohm (Koa)</td>
<td>RK73B1ETTP</td>
</tr>
</tbody>
</table>

Note:
C1, C2 are DC Blocking capacitors
L1 input match for NF
L2 output match for OIP3
C3, C4, C5, C6 are bypass capacitors
R1 is stabilizing resistor
Rbias is the biasing resistor
MGA-635P8 Typical Performance

RF performance at $T_A = 25^\circ C$, $Vdd = 5V$, $I_d = 55mA$, measured using 50ohm input and output board, unless otherwise stated. OIP3 test condition: $F_{RF1} = 2.5$ GHz, $F_{RF2} = 2.501$ GHz with input power of -10dBm per tone.

Figure 7. $F_{\text{min}}$ vs $I_{dd}$ at 5V at 2.5GHz.

Figure 8. $F_{\text{min}}$ vs $I_{dd}$ at 5V at 2GHz.

Figure 9. Gain vs $I_{dd}$ at 5V Tuned for Optimum OIP3 and $F_{\text{min}}$ at 2.5GHz.

Figure 10. Gain vs $I_{dd}$ at 5V Tuned for Optimum OIP3 and $F_{\text{min}}$ at 2GHz.

Figure 11. OIP3 vs $I_{dd}$ at 5V Tuned for Optimum OIP3 and $F_{\text{min}}$ at 2.5GHz.

Figure 12. OIP3 vs $I_{dd}$ at 5V Tuned for Optimum OIP3 and $F_{\text{min}}$ at 2GHz.
Figure 13. OP1dB vs Idd at 5V Tuned for Optimum OIP3 and Fmin at 2.5GHz.

Figure 14. OP1dB vs Idd at 5V Tuned for Optimum OIP3 and Fmin at 2GHz.

Figure 15. Fmin vs Frequency and Idd at 5V

Figure 16. OIP3 vs Frequency and Temperature for Optimum OIP3 and Fmin at 5V 55mA

Figure 17. Gain vs Frequency and Temperature for Optimum OIP3 and Fmin at 5V 55mA

Figure 18. Fmin vs Frequency and Temperature for Optimum OIP3 and Fmin at 5V 55mA
Figure 19. OP1dB vs Frequency and Temperature for Optimum OIP3 and Fmin at 5V 55mA

Below is the table showing the MGA-635P8 Reflection Coefficient Parameters tuned for maximum OIP3, Vdd = 5V, Idd = 55mA

<table>
<thead>
<tr>
<th>Frequency (GHz)</th>
<th>Magnitude</th>
<th>Angle</th>
<th>OIP3 (dBm)</th>
<th>OP1dB (dBm)</th>
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<tr>
<td>1.9</td>
<td>0.28</td>
<td>-30</td>
<td>39.8</td>
<td>19.66</td>
</tr>
<tr>
<td>2</td>
<td>0.28</td>
<td>-60</td>
<td>40.9</td>
<td>20.46</td>
</tr>
<tr>
<td>2.2</td>
<td>0.28</td>
<td>-60</td>
<td>42.2</td>
<td>19.76</td>
</tr>
<tr>
<td>2.5</td>
<td>0.28</td>
<td>-60</td>
<td>41.63</td>
<td>20.26</td>
</tr>
<tr>
<td>2.7</td>
<td>0.28</td>
<td>-60</td>
<td>42.17</td>
<td>19.86</td>
</tr>
<tr>
<td>3.3</td>
<td>0.14</td>
<td>0</td>
<td>40.44</td>
<td>21.98</td>
</tr>
<tr>
<td>3.5</td>
<td>0.14</td>
<td>-60</td>
<td>41.5</td>
<td>21.46</td>
</tr>
</tbody>
</table>

Notes:
1. The maximum OIP3 values are calculated based on Load pull measurements on approximately 136 different impedances using Focus’ Load Pull test system.
2. Measurements are conducted on 0.010 inch think ROGER 4350. The input reference plane is at the end of the RFin pin and the output reference plane is at the end of the RFout pin as shown in Figure 20.
3. Gamma Load for maximum OIP3 with biasing of 5V 40mA, 5V 50mA, 5V 55mA, 5V 70mA and 5V 80mA from 1.9GHz to 3.5GHz are available upon request.
MGA-635P8 Typical Performance in Demoboard

RF performance at $T_A = 25^\circ C$, $Vdd = 5V$, $Rbias = 3.6k\Omega$, measured on demo board in Figure 5 with component list in Table 1 for 2.5 GHz matching, unless otherwise stated.

![Figure 21. NF vs Frequency vs Temperature](image1)

![Figure 22. Gain vs Frequency vs Temperature](image2)

![Figure 23. OIP3 vs Frequency vs Temperature](image3)

![Figure 24. OP1dB vs Frequency vs Temperature](image4)

![Figure 25. S-Parameter performance with DUT on demoboard shown in Figure 1.](image5)

![Figure 26. K-factor vs Frequency vs Temperature](image6)
Figure 27. Idd vs Rbias

Figure 28. Gain vs Frequency vs Idd

Figure 29. NF vs Frequency vs Idd

Figure 30. OP1dB vs Frequency vs Idd

Figure 31. OIP3 vs Frequency vs Idd
<table>
<thead>
<tr>
<th>Freq (GHz)</th>
<th>( S_{11} ) Mag.</th>
<th>( S_{11} ) Ang.</th>
<th>( S_{21} ) Mag.</th>
<th>( S_{21} ) Ang.</th>
<th>( S_{12} ) Mag.</th>
<th>( S_{12} ) Ang.</th>
<th>( S_{22} ) Mag.</th>
<th>( S_{22} ) Ang.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.24</td>
<td>-164.18</td>
<td>4.79</td>
<td>1.74</td>
<td>-116.80</td>
<td>0.00</td>
<td>28.89</td>
<td>0.97</td>
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<tr>
<td>0.50</td>
<td>0.51</td>
<td>146.66</td>
<td>12.63</td>
<td>4.28</td>
<td>-176.70</td>
<td>0.00</td>
<td>11.09</td>
<td>0.76</td>
</tr>
<tr>
<td>0.90</td>
<td>0.51</td>
<td>54.95</td>
<td>21.10</td>
<td>11.35</td>
<td>146.58</td>
<td>0.00</td>
<td>127.98</td>
<td>0.53</td>
</tr>
<tr>
<td>1.00</td>
<td>0.43</td>
<td>22.28</td>
<td>22.61</td>
<td>13.51</td>
<td>120.90</td>
<td>0.00</td>
<td>108.37</td>
<td>0.45</td>
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<td>1.50</td>
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<td>-140.63</td>
<td>21.25</td>
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<td>44.76</td>
<td>0.01</td>
<td>21.99</td>
<td>0.32</td>
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<td>0.21</td>
<td>148.17</td>
<td>20.14</td>
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<td>-12.86</td>
<td>0.01</td>
<td>-17.75</td>
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<td>19.66</td>
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<td>-26.25</td>
<td>0.01</td>
<td>-27.60</td>
<td>0.26</td>
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<td>2.50</td>
<td>0.22</td>
<td>82.31</td>
<td>17.84</td>
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<td>-4.09</td>
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<td>0.74</td>
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<td>127.69</td>
<td>0.05</td>
<td>64.82</td>
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<td>0.79</td>
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<td>-156.50</td>
<td>0.12</td>
<td>66.14</td>
<td>0.70</td>
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</table>

**Figure 32**
Typical Noise Parameters, \(V_{dd} = 5\, V, I_{dd} = 55\, mA\)

<table>
<thead>
<tr>
<th>Freq GHz</th>
<th>(F_{min}) dB</th>
<th>(\Gamma_{opt}) Mag.</th>
<th>(\Delta) opt Ang.</th>
<th>(R_{n/50})</th>
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<tr>
<td>1.9</td>
<td>0.38</td>
<td>0.2</td>
<td>95.5</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>0.39</td>
<td>0.206</td>
<td>96.4</td>
<td>0.06</td>
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<tr>
<td>2.2</td>
<td>0.45</td>
<td>0.205</td>
<td>113.2</td>
<td>0.05</td>
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<td>0.53</td>
<td>0.216</td>
<td>128.8</td>
<td>0.05</td>
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<td>172.7</td>
<td>0.04</td>
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<tr>
<td>3.5</td>
<td>0.77</td>
<td>0.289</td>
<td>174.7</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Notes:
1. The \(F_{min}\) values are based on noise figure measurements at 100 different impedances using Focus source pull test system. From these measurements a true \(F_{min}\) is calculated.
2. Scattering and noise parameters are measured on coplanar waveguide made on 0.010 inch thick ROGER 4350. The input reference plane is at the end of the RF input pin and the output reference plane is at the end of the RF output pin as shown in figure 32.
3. S2P file with scattering and noise parameters for biasing 5V 40mA, 5V 55mA, 5V 70mA and 5V 80mA are available upon request.

Part Number Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>No. of Devices</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGA-635P8-BLKG</td>
<td>100</td>
<td>Antistatic Bag</td>
</tr>
<tr>
<td>MGA-635P8-TR1G</td>
<td>3000</td>
<td>7 inch Reel</td>
</tr>
</tbody>
</table>

SLP2X2 Package

Top View

Bottom View

Notes:
1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold flash and metal burr.
Recommended PCB Land Pattern and Stencil Design

**Land Pattern**

- **Metal surface**
- **Soldermask Open**

**Stencil Opening**

- **Metal surface**
- **Soldermask Open**

**Combination of Land Pattern and Stencil Opening**

Note:
1. Recommended Land Pattern and Stencil Opening
2. Stencil thickness is 0.1mm (4 mils)
3. All dimension are in mm unless otherwise specified
### Tape Dimensions

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SYMBOL</th>
<th>SIZE (mm)</th>
<th>SIZE (INCHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAVITY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LENGTH</td>
<td>(A_0)</td>
<td>2.30 ± 0.05</td>
<td>0.091 ± 0.004</td>
</tr>
<tr>
<td>WIDTH</td>
<td>(B_0)</td>
<td>2.30 ± 0.05</td>
<td>0.091 ± 0.004</td>
</tr>
<tr>
<td>DEPTH</td>
<td>(K_0)</td>
<td>1.00 ± 0.05</td>
<td>0.039 ± 0.002</td>
</tr>
<tr>
<td>PITCH</td>
<td>(P)</td>
<td>4.00 ± 0.10</td>
<td>0.157 ± 0.004</td>
</tr>
<tr>
<td>BOTTOM HOLE DIAMETER</td>
<td>(D_1)</td>
<td>1.00 ± 0.25</td>
<td>0.039 ± 0.002</td>
</tr>
<tr>
<td><strong>PERFORATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIAMETER</td>
<td>(D)</td>
<td>1.50 ± 0.10</td>
<td>0.060 ± 0.004</td>
</tr>
<tr>
<td>PITCH</td>
<td>(P_0)</td>
<td>4.00 ± 0.10</td>
<td>0.157 ± 0.004</td>
</tr>
<tr>
<td>POSITION</td>
<td>(E)</td>
<td>1.75 ± 0.10</td>
<td>0.069 ± 0.004</td>
</tr>
<tr>
<td><strong>CARRIER TAPE</strong></td>
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</tr>
<tr>
<td>WIDTH</td>
<td>(W)</td>
<td>8.00 ± 0.30</td>
<td>0.315 ± 0.012</td>
</tr>
<tr>
<td>THICKNESS</td>
<td>(t_1)</td>
<td>0.254 ± 0.02</td>
<td>0.010 ± 0.0008</td>
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<tr>
<td><strong>COVER TAPE</strong></td>
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<tr>
<td>WIDTH</td>
<td>(C)</td>
<td>5.4 ± 0.10</td>
<td>0.205 ± 0.004</td>
</tr>
<tr>
<td>TAPE THICKNESS</td>
<td>(T_1)</td>
<td>0.062 ± 0.001</td>
<td>0.0025 ± 0.0004</td>
</tr>
<tr>
<td><strong>DISTANCE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAVITY TO PERFORATION (WIDTH DIRECTION)</td>
<td>(F)</td>
<td>3.50 ± 0.05</td>
<td>0.138 ± 0.002</td>
</tr>
<tr>
<td>CAVITY TO PERFORATION (LENGTH DIRECTION)</td>
<td>(P_2)</td>
<td>2.00 ± 0.05</td>
<td>0.079 ± 0.002</td>
</tr>
</tbody>
</table>
Reel Dimensions – 7 inch

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

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