# 1 – 6 GHz Positive Gain Slope LNA

## VMMK-3603

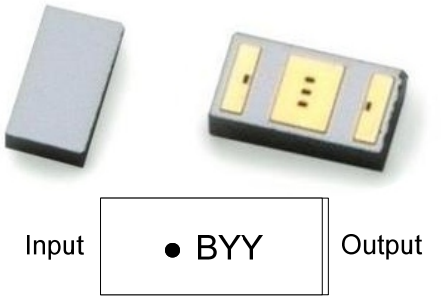
**V3.0 01/26/10 JK**

### Description

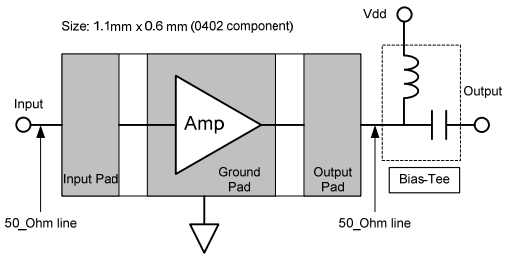
The VMMK-3603 is an easy-to-use and high-performance broad-band amplifier from 1-6GHz. It is housed in the Avago Technologies industry-leading and revolutionary sub-miniature chip scale package. The VMMK-3603 features a relatively flat gain response and good input, output match from 1-6GHz. The broad-band and low noise performance, coupled with an ultra compact package make this amplifier ideal for broad-band applications in the 1-6GHz band.

Avago's GaAsCap wafer scale leadless package is small and ultra thin yet can be handled and placed with standard 0402 pick and place assembly equipment.

WLP 0402 (1x0.5x0.25mm) Top, Bottom View




Note:
"B" = Device Code
"YY" = Year Code




### Features

- **1 x 0.5 mm Surface Mount Package**
- **Ultrathin (0.25mm)**
- **Broadband Match to 50 ohm**
- **Frequency Range 1 to 6 GHz**
- **High Average Gain of 17dB**
- **1dB Positive Gain Slope**
- **Operating Voltage 3V to 5V**

Specifications (Vdd = 5.0V, Idd = 36mA)

- **Small-Signal Gain: 16.8dB typ. at 5GHz**
- **Noise Figure : 1.5 dB typ. at 5 GHz**

### Applications

- 2.4 GHz, 3.5GHz, 5-6GHz WLAN and WiMax notebook computer, access point and mobile wireless applications
- 802.16 & 802.20 BWA, Military Radar, radio and ECM systems

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

RoHS ✓
EARTH FRIENDLY

Table 1. Absolute Maximum Ratings [1]

| Sym | Parameters/Condition | Unit | Absolute Max |
|---|---|---|---|
| Vd | Supply Voltage (RF Output)[2] | V | 7V |
| Id | Device Current [2] | mA | TBD |
| $P_{in, max}$ | CW RF Input Power (RF Input) [3] | dBm | 15 |
| $P_{diss}$ | Total Power Dissipation | mW | TBD |
| Tch | Max channel temperature | $_oC$ | +150 |
| $T_{STG}$ | Storage Temperature | $^oC$ | +150 |
| θjc | Thermal Resistance [4] | $^oC/W$ | 95.3 |

Notes
1. Operation of this device above any one of these parameters may cause permanent damage
2. Bias is assumed DC quiescent conditions
3. With the DC (typical bias) and RF applied to the device at board temperature Tb= 25$^oC$
4. Thermal resistance is measured from junction to board using IR method

DC and RF Specifications $T_A$= 25$^o$C, Vd=5V, $I_{dd}$=36mA, Freq=5GHz, $Z_{in}$=$Z_{out}$=50Ω (unless otherwise specified)

| Symbol | Parameters / Condition | Unit | Min | Typical | Max |
|---|---|---|---|---|---|
| Idd(2) | Supply Current | mA | 30 | 36 | 42 |
| S11 | Input Return Loss | dB | | 12 | |
| S22 | Output Return Loss | dB | | 12 | |
| Ga(1,2) | Associated Gain | dB | 15 | 16.8 | 18 |
| NF(1,2) | Noise Figure | dB | | 1.5 | 1.7 |
| OIP3(1,2,3) | Output 3rd Order Intercept Point | dBm | 22.5 | 25.2 | |

Notes:
1. Losses of the test system have been de-embedded from final data
2. Measured Data obtained from wafer-probing using a G-S, S-G pyramid probe
3. OIP3 test condition: F1=5.0GHz, F2=5.01GHz, Pin=-15dBm

## VMMK-3603 Typical Performance

$T_A$ = 25°C, Vdd=3V, Idd=22mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless noted, Data obtained using 300um G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane

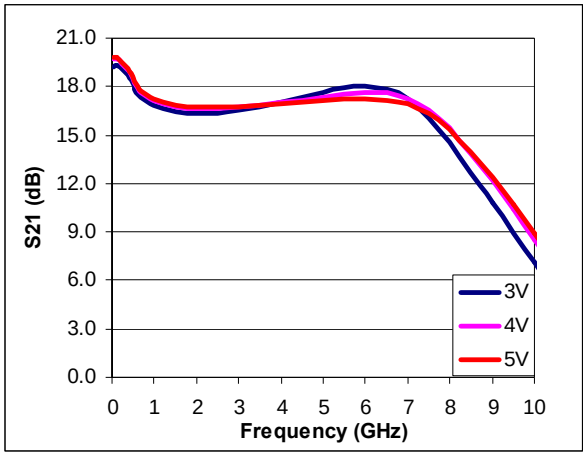



**Figure 1. Small Signal Gain Over Bias**

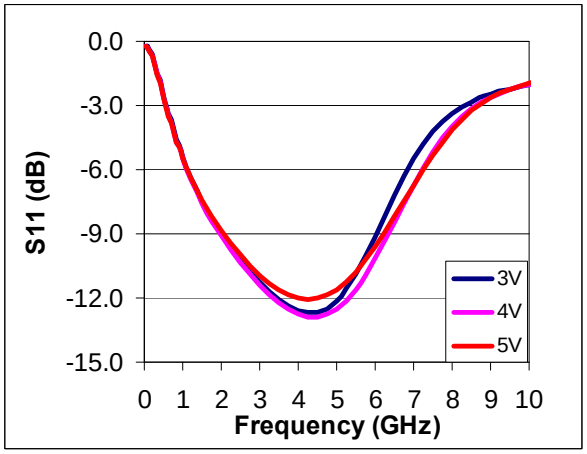



**Figure 2. Input Return Loss Over Bias**

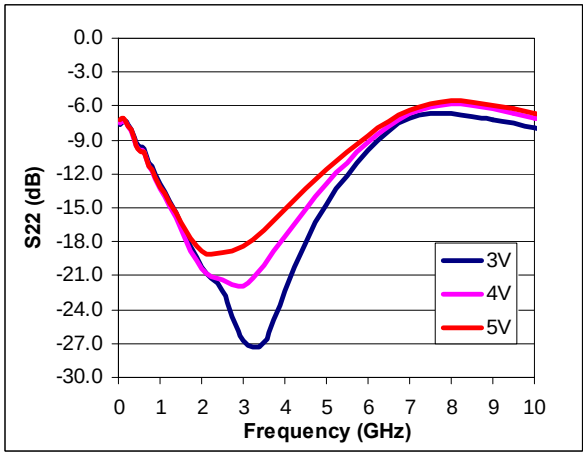



**Figure 3. Output Return Over Bias**

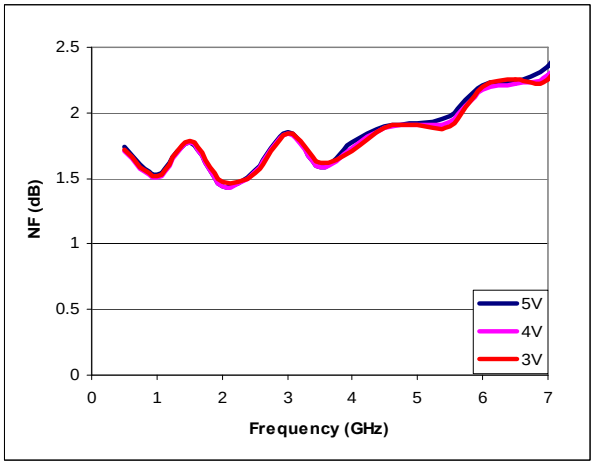



**Figure 4. NF Over Bias(1)**

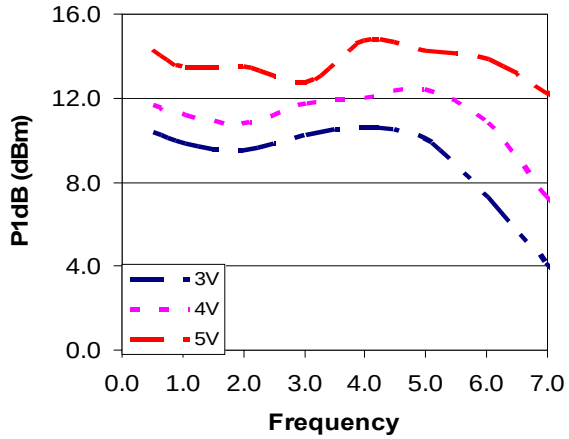



**Figure 5. OP1dB Over Bias (1)**

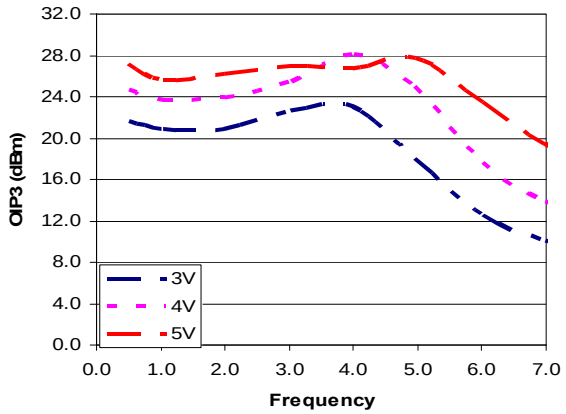



**Figure 6. OIP3 Over Bias(1)**

Notes:

1. Vdd=3V, Idd=20mA; Vdd=4V, Idd=27mA; Vdd=5V, Idd=33mA

## VMMK-3603 Typical Performance

$T_A$ = 25°C, Vdd=3V, Idd=22mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless noted, Data obtained using 300um G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane

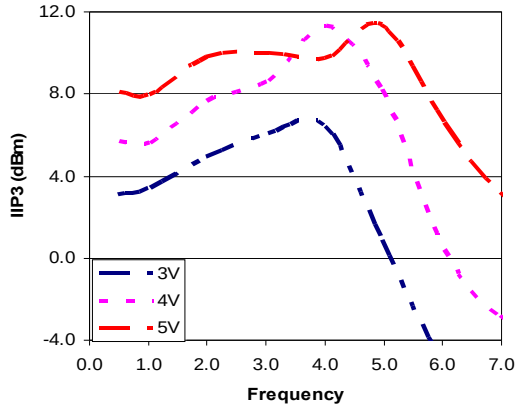



**Figure 7. IIP3 over Bias[1]**

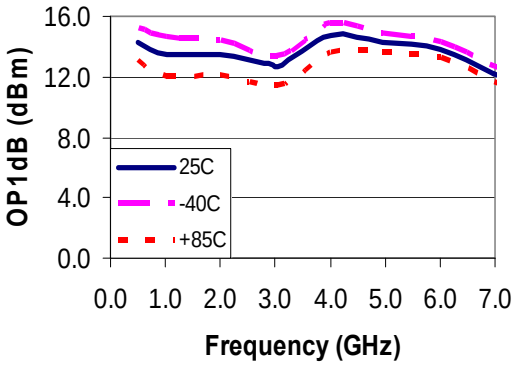



**Figure 8. OP1dB Over Temp[2]**

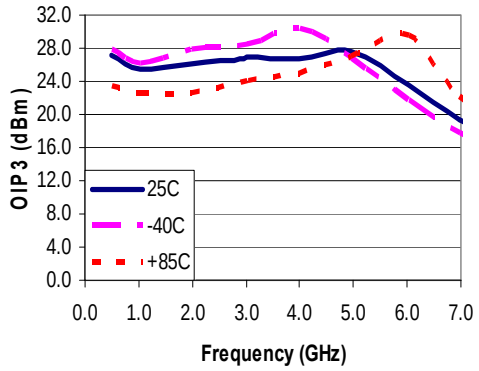



**Figure 9. OIP3 Over Temp[2]**

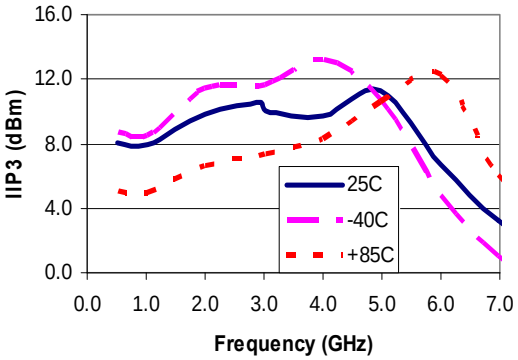



**Figure 10. IIP3 Over Temp[2]**

Notes:

1. Vdd=3V, Idd=20mA; Vdd=4V, Idd=27mA; Vdd=5V, Idd=33mA
2. Vdd=5V, T=+25C, Idd=33mA; T=-40C, Idd=39mA; T=+85C, Idd=24mA

## Typical Scattering Parameters

$T_A$ = 25°C, Vdd=3V, Idd=20mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless noted, Data obtained using 300um G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane

| Freq | S11 | | | S21 | | | S12 | | | S22 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GHz | dB | mag | Phase | dB | mag | phase | dB | mag | phase | dB | mag | Phase |
| 0.05 | -0.2 | 0.977 | -4.8864 | 19.2 | 9.153 | -179.6516 | -38.2 | 0.0123 | 91.3266 | -7.7 | 0.4127 | 0.6165 |
| 0.1 | -0.3 | 0.9706 | -9.9273 | 19.3 | 9.2677 | 176.9829 | -35.4 | 0.0169 | 75.7197 | -7.3 | 0.431 | -6.0822 |
| 0.2 | -0.6 | 0.931 | -19.6121 | 19.2 | 9.1431 | 170.3651 | -30.1 | 0.0312 | 66.652 | -7.4 | 0.4254 | -17.5835 |
| 0.3 | -1.2 | 0.8726 | -28.1505 | 18.9 | 8.8217 | 165.3938 | -27.3 | 0.0432 | 57.1804 | -8.0 | 0.3971 | -27.3636 |
| 0.4 | -1.8 | 0.8098 | -35.3755 | 18.5 | 8.4556 | 161.4364 | -25.5 | 0.0533 | 48.1187 | -8.8 | 0.3638 | -35.3407 |
| 0.5 | -2.5 | 0.7468 | -41.2905 | 18.2 | 8.1299 | 158.4159 | -24.3 | 0.061 | 40.9588 | -9.6 | 0.3308 | -41.8528 |
| 0.6 | -3.1 | 0.701 | -41.9333 | 17.6 | 7.5629 | 156.9294 | -23.8 | 0.0645 | 35.7729 | -9.8 | 0.3233 | -37.1208 |
| 0.7 | -3.7 | 0.6527 | -45.824 | 17.3 | 7.3442 | 154.9164 | -23.3 | 0.0687 | 30.5102 | -10.6 | 0.2959 | -40.3919 |
| 0.8 | -4.3 | 0.6098 | -49.2059 | 17.1 | 7.1755 | 153.0505 | -22.8 | 0.0723 | 25.8161 | -11.4 | 0.2699 | -42.9121 |
| 0.9 | -4.9 | 0.5718 | -52.08 | 16.9 | 7.0187 | 151.3266 | -22.5 | 0.0746 | 21.5702 | -12.1 | 0.2487 | -44.9453 |
| 1 | -5.4 | 0.5385 | -54.7877 | 16.8 | 6.9197 | 149.6624 | -22.3 | 0.0767 | 18.0463 | -12.9 | 0.2273 | -46.2074 |
| 1.5 | -7.5 | 0.4229 | -65.4212 | 16.4 | 6.6173 | 141.4379 | -21.8 | 0.0816 | 4.0387 | -16.4 | 0.1522 | -49.2137 |
| 2 | -9.0 | 0.3552 | -75.7226 | 16.3 | 6.5474 | 132.6275 | -21.6 | 0.0831 | -6.4352 | -20.2 | 0.0975 | -47.4521 |
| 2.5 | -10.2 | 0.308 | -81.3963 | 16.4 | 6.5943 | 123.4518 | -21.6 | 0.0828 | -14.7788 | -22.4 | 0.0759 | -43.3979 |
| 3 | -11.3 | 0.2738 | -91.3794 | 16.5 | 6.7138 | 113.3991 | -21.8 | 0.0817 | -22.0721 | -26.7 | 0.0461 | -22.5111 |
| 3.5 | -12.1 | 0.2493 | -103.0569 | 16.8 | 6.8955 | 102.6078 | -21.9 | 0.0804 | -29.1338 | -26.9 | 0.045 | 26.9498 |
| 4 | -12.6 | 0.2339 | -115.7385 | 17.0 | 7.1158 | 90.9712 | -22.0 | 0.0794 | -35.6715 | -22.3 | 0.0767 | 53.6397 |
| 4.5 | -12.7 | 0.2322 | -129.9118 | 17.4 | 7.3808 | 78.2102 | -22.2 | 0.0778 | -42.3765 | -18.1 | 0.1244 | 59.6162 |
| 5 | -12.2 | 0.2468 | -145.5479 | 17.7 | 7.64 | 64.0695 | -22.3 | 0.0765 | -49.1329 | -14.7 | 0.1836 | 56.8991 |
| 5.5 | -10.9 | 0.2852 | -160.1544 | 17.9 | 7.8875 | 48.8364 | -22.6 | 0.0744 | -55.7584 | -12.1 | 0.2475 | 49.0542 |
| 6 | -9.1 | 0.3497 | -178.3697 | 18.1 | 7.9936 | 31.1873 | -22.8 | 0.0726 | -63.9077 | -9.9 | 0.3195 | 39.2463 |
| 6.5 | -7.2 | 0.4355 | 162.2221 | 17.9 | 7.8279 | 11.7967 | -23.1 | 0.0697 | -73.028 | -8.2 | 0.3882 | 26.8159 |
| 7 | -5.5 | 0.5303 | 142.0171 | 17.2 | 7.2517 | -8.7294 | -23.8 | 0.0648 | -82.9034 | -7.1 | 0.4402 | 12.7602 |
| 7.5 | -4.2 | 0.614 | 122.194 | 16.0 | 6.3347 | -28.2846 | -24.7 | 0.058 | -92.9795 | -6.6 | 0.4657 | -1.134 |
| 8 | -3.4 | 0.6782 | 104.6622 | 14.5 | 5.3295 | -45.6505 | -26.1 | 0.0494 | -101.8767 | -6.7 | 0.4647 | -14.159 |
| 8.5 | -2.8 | 0.7231 | 88.2588 | 12.7 | 4.3137 | -60.8796 | -27.5 | 0.0422 | -108.8013 | -6.9 | 0.451 | -24.0745 |
| 9 | -2.5 | 0.7529 | 74.4856 | 10.8 | 3.4774 | -73.6841 | -29.1 | 0.035 | -114.8967 | -7.3 | 0.4338 | -32.6621 |
| 10 | -2.0 | 0.7925 | 51.7086 | 7.1 | 2.2691 | -94.1122 | -32.3 | 0.0242 | -124.2559 | -7.9 | 0.4012 | -46.0125 |
| 11 | -1.7 | 0.8225 | 33.4831 | 3.7 | 1.5278 | -109.423 | -36.0 | 0.0158 | -131.9905 | -8.5 | 0.3765 | -55.8495 |
| 12 | -1.5 | 0.8456 | 17.4077 | 0.6 | 1.069 | -121.8166 | -40.8 | 0.0091 | -139.6964 | -8.7 | 0.3655 | -63.6328 |
| 13 | -1.2 | 0.8722 | 4.7204 | -2.5 | 0.7536 | -131.9503 | -53.2 | 0.0022 | -142.2453 | -8.7 | 0.3686 | -70.3725 |
| 14 | -1.1 | 0.8802 | -7.1979 | -5.1 | 0.5578 | -140.5919 | -54.0 | 0.002 | 0.5436 | -8.6 | 0.3709 | -77.0036 |
| 15 | -1.0 | 0.8961 | -17.3162 | -7.5 | 0.4238 | -148.3565 | -50.2 | 0.0031 | 6.8353 | -8.5 | 0.3737 | -84.129 |
| 16 | -0.8 | 0.9118 | -27.6757 | -9.7 | 0.3259 | -155.8471 | -42.0 | 0.0079 | 19.5505 | -8.3 | 0.3841 | -91.3885 |
| 17 | -0.7 | 0.9244 | -37.4873 | -11.9 | 0.2546 | -163.0428 | -39.9 | 0.0101 | 15.9588 | -8.1 | 0.3922 | -97.2096 |
| 18 | -0.6 | 0.9282 | -46.3774 | -14.0 | 0.199 | -169.2785 | -36.9 | 0.0143 | 2.392 | -7.9 | 0.402 | -103.6084 |

## Typical Scattering Parameters

$T_A$ = 25°C, Vdd=4V, Idd=27.4mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless noted, Data obtained using 250um G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane

| Freq | S11 | | | S21 | | | S12 | | | S22 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GHz | dB | mag | Phase | dB | mag | phase | dB | mag | phase | dB | mag | Phase |
| 0.05 | -0.2 | 0.9765 | -5.3473 | 19.8 | 9.7378 | 179.865 | -41.0 | 0.0089 | 101.6421 | -7.2 | 0.4351 | -3.1298 |
| 0.1 | -0.3 | 0.969 | -10.4315 | 19.8 | 9.7954 | 176.3417 | -35.4 | 0.0169 | 76.4418 | -7.1 | 0.4395 | -7.9442 |
| 0.2 | -0.7 | 0.9274 | -20.7156 | 19.6 | 9.6011 | 169.8445 | -30.3 | 0.0305 | 65.854 | -7.5 | 0.424 | -18.0476 |
| 0.3 | -1.2 | 0.8665 | -29.613 | 19.3 | 9.2449 | 164.9479 | -27.5 | 0.0423 | 55.4655 | -8.1 | 0.3922 | -26.6857 |
| 0.4 | -1.9 | 0.8011 | -37.1751 | 18.9 | 8.8561 | 161.1065 | -25.8 | 0.0514 | 46.9769 | -9.0 | 0.356 | -33.6356 |
| 0.5 | -2.6 | 0.7382 | -43.3115 | 18.6 | 8.5166 | 158.0882 | -24.7 | 0.0585 | 39.3595 | -9.9 | 0.32 | -39.0593 |
| 0.6 | -3.2 | 0.692 | -44.0449 | 18.0 | 7.9383 | 156.6006 | -24.3 | 0.0613 | 33.9254 | -10.0 | 0.3153 | -33.3994 |
| 0.7 | -3.8 | 0.6439 | -48.1284 | 17.8 | 7.7203 | 154.5257 | -23.8 | 0.0649 | 28.7538 | -10.8 | 0.2874 | -35.3222 |
| 0.8 | -4.4 | 0.602 | -51.7328 | 17.6 | 7.5547 | 152.582 | -23.3 | 0.0682 | 24.1196 | -11.6 | 0.2621 | -36.6951 |
| 0.9 | -5.0 | 0.565 | -54.8713 | 17.4 | 7.3962 | 150.7578 | -23.0 | 0.0706 | 19.7084 | -12.4 | 0.2411 | -37.3403 |
| 1 | -5.5 | 0.5331 | -57.8302 | 17.3 | 7.2968 | 148.9784 | -22.8 | 0.0722 | 16.1648 | -13.1 | 0.2204 | -37.2186 |
| 1.5 | -7.4 | 0.4246 | -70.3244 | 16.9 | 6.9736 | 140.009 | -22.3 | 0.0763 | 1.6183 | -16.3 | 0.1525 | -31.3163 |
| 2 | -8.8 | 0.3619 | -83.2252 | 16.7 | 6.854 | 130.4826 | -22.2 | 0.0772 | -9.1633 | -18.8 | 0.1143 | -16.0481 |
| 2.5 | -10.0 | 0.3174 | -92.634 | 16.7 | 6.8325 | 120.5905 | -22.3 | 0.0768 | -18.3171 | -18.9 | 0.1135 | -5.6824 |
| 3 | -10.9 | 0.2844 | -106.7897 | 16.7 | 6.8564 | 110.0668 | -22.5 | 0.0749 | -26.6003 | -18.5 | 0.1195 | 10.6561 |
| 3.5 | -11.6 | 0.263 | -123.054 | 16.8 | 6.9151 | 99.0187 | -22.7 | 0.0732 | -33.7451 | -17.0 | 0.142 | 21.9712 |
| 4 | -12.0 | 0.2502 | -140.3754 | 16.9 | 6.9917 | 87.4663 | -23.0 | 0.071 | -40.969 | -15.1 | 0.1751 | 27.5352 |
| 4.5 | -12.0 | 0.2507 | -158.2552 | 17.0 | 7.0797 | 75.2214 | -23.3 | 0.0685 | -48.1875 | -13.3 | 0.2151 | 28.9598 |
| 5 | -11.6 | 0.2633 | -176.0757 | 17.1 | 7.1631 | 62.193 | -23.6 | 0.0658 | -55.6692 | -11.6 | 0.2629 | 27.4716 |
| 5.5 | -10.8 | 0.2877 | 169.4924 | 17.2 | 7.2488 | 48.8057 | -24.1 | 0.0622 | -62.7037 | -10.0 | 0.3145 | 22.774 |
| 6 | -9.6 | 0.3314 | 154.7483 | 17.2 | 7.2799 | 33.8787 | -24.6 | 0.0589 | -70.5383 | -8.6 | 0.3699 | 16.8808 |
| 6.5 | -8.2 | 0.3897 | 140.9916 | 17.2 | 7.2266 | 17.7439 | -25.1 | 0.0554 | -78.5427 | -7.4 | 0.4259 | 9.1522 |
| 7 | -6.7 | 0.4614 | 127.6033 | 16.9 | 6.9966 | 0.4678 | -25.9 | 0.0507 | -87.777 | -6.4 | 0.4766 | -0.4897 |
| 7.5 | -5.3 | 0.543 | 113.6728 | 16.3 | 6.5277 | -17.6841 | -26.8 | 0.0455 | -98.0373 | -5.8 | 0.5131 | -11.0861 |
| 8 | -4.1 | 0.6221 | 100.0949 | 15.4 | 5.8749 | -35.6531 | -28.3 | 0.0383 | -108.0513 | -5.5 | 0.5292 | -22.568 |
| 8.5 | -3.2 | 0.6908 | 85.6471 | 14.0 | 5.0108 | -52.8713 | -29.9 | 0.032 | -116.1758 | -5.6 | 0.5224 | -32.165 |
| 9 | -2.6 | 0.7394 | 72.7048 | 12.4 | 4.1718 | -68.1977 | -31.9 | 0.0255 | -123.9911 | -5.9 | 0.5066 | -40.9205 |
| 9.5 | -2.2 | 0.7743 | 60.9436 | 10.7 | 3.4196 | -81.6336 | -34.0 | 0.0199 | -130.6645 | -6.3 | 0.4869 | -48.246 |
| 10 | -1.9 | 0.7993 | 50.3166 | 8.9 | 2.7894 | -93.3719 | -36.4 | 0.0151 | -135.8243 | -6.7 | 0.4642 | -54.412 |
| 11 | -1.6 | 0.8348 | 32.1122 | 5.4 | 1.8683 | -112.2912 | -42.3 | 0.0077 | -149.8587 | -7.4 | 0.4279 | -63.6579 |
| 12 | -1.3 | 0.8576 | 16.1694 | 2.2 | 1.2907 | -127.1685 | -52.8 | 0.0023 | 174.2257 | -7.8 | 0.4092 | -70.3075 |
| 13 | -1.1 | 0.8829 | 3.6129 | -0.9 | 0.8968 | -139.2016 | -46.6 | 0.0047 | 47.2364 | -7.8 | 0.4073 | -75.9325 |
| 14 | -1.1 | 0.8802 | -7.1979 | -5.1 | 0.5578 | -140.5919 | -54.0 | 0.002 | 0.5436 | -8.6 | 0.3709 | -77.0036 |
| 15 | -1.0 | 0.8961 | -17.3162 | -7.5 | 0.4238 | -148.3565 | -50.2 | 0.0031 | 6.8353 | -8.5 | 0.3737 | -84.129 |
| 16 | -0.8 | 0.9118 | -27.6757 | -9.7 | 0.3259 | -155.8471 | -42.0 | 0.0079 | 19.5505 | -8.3 | 0.3841 | -91.3885 |
| 17 | -0.7 | 0.9244 | -37.4873 | -11.9 | 0.2546 | -163.0428 | -39.9 | 0.0101 | 15.9588 | -8.1 | 0.3922 | -97.2096 |
| 18 | -0.6 | 0.9282 | -46.3774 | -14.0 | 0.199 | -169.2785 | -36.9 | 0.0143 | 2.392 | -7.9 | 0.402 | -103.6084 |

## Typical Scattering Parameters

$T_A$ = 25°C, Vdd=5V, Idd=33mA, $Z_{in}$ = $Z_{out}$ = 50 Ω unless noted, Data obtained using 250um G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane

| Freq | S11 | | | S21 | | | S12 | | | S22 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GHz | dB | mag | Phase | dB | mag | phase | dB | mag | phase | dB | mag | Phase |
| 0.1 | -0.3 | 0.964 | -10.502 | 19.3 | 9.204 | 177.101 | -37.1 | 0.014 | 79.682 | -8.0 | 0.398 | -7.037 |
| 0.2 | -0.7 | 0.920 | -20.406 | 19.2 | 9.079 | 170.167 | -30.8 | 0.029 | 67.457 | -8.0 | 0.397 | -18.357 |
| 0.3 | -1.2 | 0.874 | -30.163 | 19.0 | 8.942 | 163.384 | -27.2 | 0.044 | 55.422 | -8.1 | 0.394 | -29.490 |
| 0.4 | -1.8 | 0.809 | -37.240 | 18.7 | 8.589 | 159.333 | -25.7 | 0.052 | 46.856 | -8.9 | 0.360 | -37.192 |
| 0.5 | -2.6 | 0.745 | -44.318 | 18.3 | 8.236 | 155.282 | -24.5 | 0.060 | 38.290 | -9.7 | 0.327 | -44.894 |
| 0.6 | -3.2 | 0.6881 | -50.2018 | 18.0 | 7.941 | 151.981 | -23.6 | 0.066 | 31.1837 | -10.5 | 0.297 | -51.161 |
| 0.7 | -3.9 | 0.6368 | -55.1238 | 17.7 | 7.693 | 149.283 | -23.1 | 0.070 | 25.2522 | -11.4 | 0.269 | -56.275 |
| 0.8 | -4.6 | 0.5862 | -59.9730 | 17.4 | 7.451 | 146.609 | -22.6 | 0.074 | 19.4090 | -12.4 | 0.241 | -61.305 |
| 0.9 | -5.2 | 0.5492 | -63.6184 | 17.3 | 7.304 | 144.312 | -22.4 | 0.076 | 15.0270 | -13.2 | 0.220 | -64.962 |
| 1 | -5.8 | 0.512 | -67.264 | 17.1 | 7.157 | 142.014 | -22.2 | 0.078 | 10.645 | -14.0 | 0.198 | -68.619 |
| 2 | -9.8 | 0.325 | -94.585 | 16.5 | 6.664 | 119.092 | -21.6 | 0.083 | -20.082 | -22.8 | 0.073 | -92.997 |
| 3 | -11.9 | 0.253 | -121.167 | 16.6 | 6.782 | 93.581 | -21.7 | 0.082 | -42.470 | -40.3 | 0.010 | 112.871 |
| 4 | -13.0 | 0.225 | -150.025 | 17.1 | 7.144 | 65.207 | -22.0 | 0.079 | -62.033 | -21.2 | 0.087 | 54.403 |
| 5 | -12.2 | 0.247 | 179.765 | 17.7 | 7.648 | 32.834 | -22.4 | 0.076 | -81.033 | -14.6 | 0.186 | 30.886 |
| 6 | -9.1 | 0.349 | 145.680 | 18.1 | 8.016 | -5.728 | -22.8 | 0.072 | -102.125 | -10.2 | 0.309 | 2.069 |
| 7 | -5.6 | 0.525 | 103.854 | 17.4 | 7.382 | -50.946 | -23.7 | 0.065 | -126.950 | -7.6 | 0.417 | -32.891 |
| 8 | -3.5 | 0.671 | 60.677 | 14.8 | 5.511 | -94.258 | -25.8 | 0.051 | -151.810 | -7.0 | 0.444 | -66.630 |
| 9 | -2.5 | 0.746 | 24.399 | 11.3 | 3.673 | -129.117 | -28.7 | 0.037 | -171.889 | -7.6 | 0.418 | -93.375 |
| 10 | -2.1 | 0.788 | -5.342 | 7.7 | 2.420 | -156.489 | -31.9 | 0.025 | 171.776 | -8.1 | 0.391 | -113.461 |
| 11 | -1.7 | 0.818 | -30.476 | 4.3 | 1.637 | -178.906 | -35.8 | 0.016 | 157.001 | -8.6 | 0.370 | -130.182 |
| 12 | -1.5 | 0.840 | -52.700 | 1.1 | 1.140 | 161.702 | -40.8 | 0.009 | 142.728 | -8.9 | 0.360 | -145.257 |
| 13 | -1.3 | 0.859 | -72.885 | -1.7 | 0.820 | 144.618 | -49.2 | 0.003 | 142.278 | -9.0 | 0.357 | -159.120 |
| 14 | -1.2 | 0.874 | -91.427 | -4.4 | 0.603 | 129.013 | -54.7 | 0.002 | -94.758 | -9.0 | 0.357 | -172.491 |
| 15 | -1.0 | 0.887 | -108.795 | -6.9 | 0.454 | 114.579 | -45.0 | 0.006 | -93.892 | -8.9 | 0.361 | 174.725 |
| 16 | -1.0 | 0.895 | -125.146 | -9.1 | 0.349 | 101.135 | -41.9 | 0.008 | -99.616 | -8.7 | 0.368 | 162.531 |
| 17 | -0.9 | 0.905 | -140.662 | -11.3 | 0.272 | 87.798 | -39.5 | 0.011 | -111.227 | -8.6 | 0.371 | 150.364 |
| 18 | -0.8 | 0.911 | -155.481 | -13.4 | 0.215 | 75.456 | -38.4 | 0.012 | -122.199 | -8.5 | 0.376 | 138.518 |
| 19 | -0.8 | 0.917 | -169.604 | -15.3 | 0.173 | 63.263 | -37.1 | 0.014 | -133.582 | -8.3 | 0.383 | 126.959 |
| 20 | -0.7 | 0.921 | 176.737 | -17.1 | 0.140 | 51.243 | -36.7 | 0.015 | -144.962 | -8.3 | 0.387 | 115.805 |

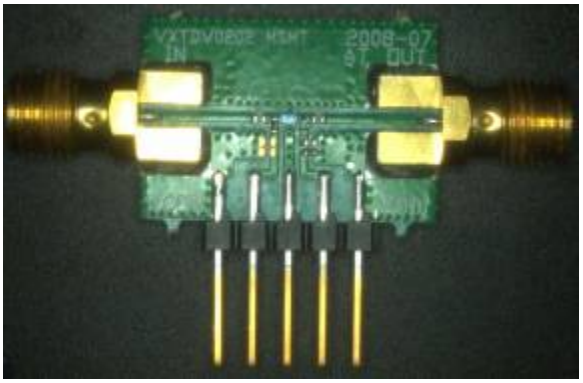


**Figure 1. Evaluation/Test Board (available to qualified customers upon request)**

## Biasing and Operation

The VMMK-3603 is biased with a positive supply connected to the output pin Vd through an external user supplied bias decoupling network. Nominal current draw is 22 mA. A typical biasing scheme is shown in Figure 1.

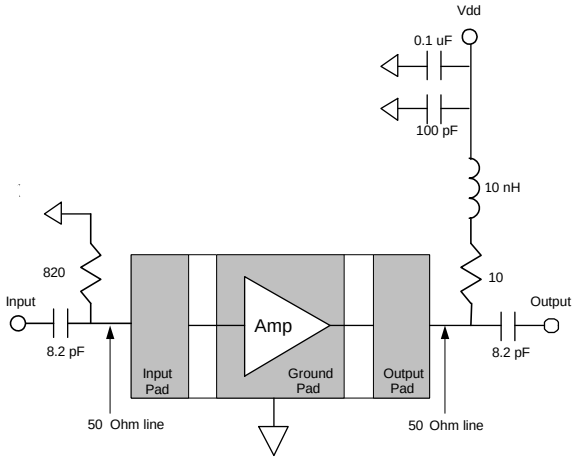



**Figure 2. Example demonstration circuit of VMMK-3603 for broadband operation (1GHz to 6GHz).**

A layout of a typical demo board is shown in Figure 3. The output bias decoupling network can be easily constructed using small surface mount components. The value of the output inductor can have a major effect on both low and high frequency operation. The demo board uses a 10 nH inductor that has a self resonant frequency higher than the maximum desired frequency of operation.

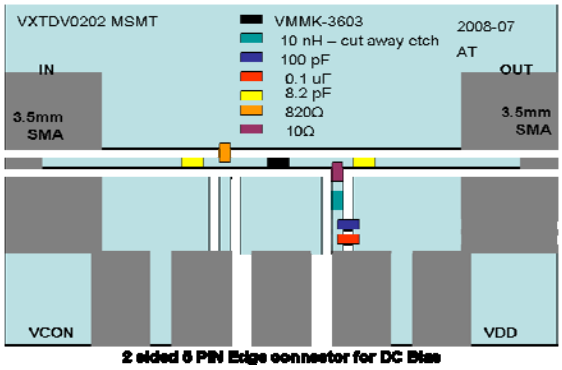



**Figure 3. Biasing the VMMK-3603**

If the self-resonant frequency of the inductor is too close to the operating band, the value of the inductor will need to be adjusted so that the self-resonant frequency is significantly higher than the highest frequency of operation. A 10 ohm resistor is placed in series with the inductor to help provide greater bandwidth and to help with low frequency stability. To help with low frequency stability an 820 ohm resistor is used to shunt the input line to ground. 8.2 pF capacitors are used as dc blocks on the RF input and RF output lines.

Typically a passive component company like Murata does not specify S parameters at frequencies higher than 5 or 6 GHz for larger values of inductance making it difficult to properly simulate amplifier performance at higher frequencies. It has been observed that the Murata LQW15AN series of 0402 inductors actually works quite well above their normally specified frequency.

The parallel combination of the 100pF and 0.1uF capacitors provide a low impedance in the band of operation and at lower frequencies and should be placed as close as possible to the inductor. The low frequency bypass provides good rejection of power supply noise and also provides a low impedance termination for third order low frequency mixing products that will be generated when multiple in-band signals are injected into any amplifier.

## S Parameter Measurements

The S parameters are measured on a .016 inch thick RO4003 printed circuit test board, using G-S-G (ground signal ground) probes. Coplanar waveguide is used to provide a smooth transition from the probes to the device under test. The presence of the ground plane on top of the test board results in excellent grounding at the device under test. TRL (Thru – Reflect – Line) calibration is used to correct for the effects of the test board, resulting in accurate device S-parameters.

## Outline Drawing

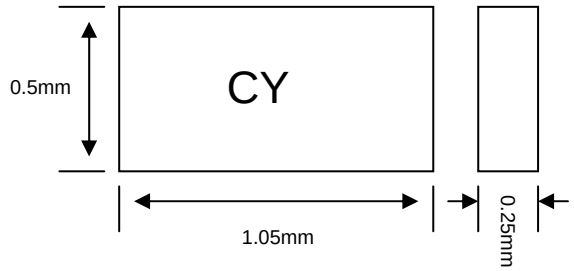



**Figure 4. Top and Side View**

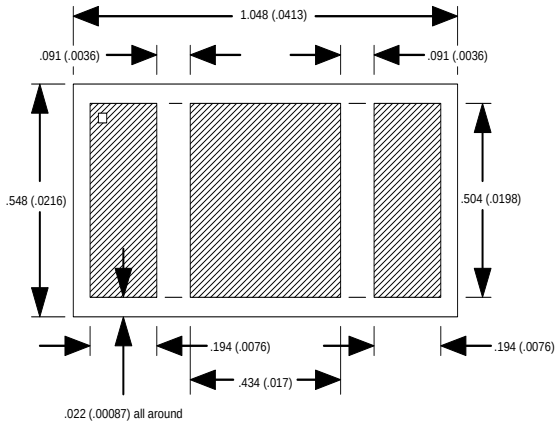



**Figure 5. Bottom View**

NOTES:

1. ● indicates pin 1
2. Dimensions are in millimeters
3. Pad Material is minimum 5.0 um thick Au/Ni/Au

## Suggested PCB Material and Land Pattern

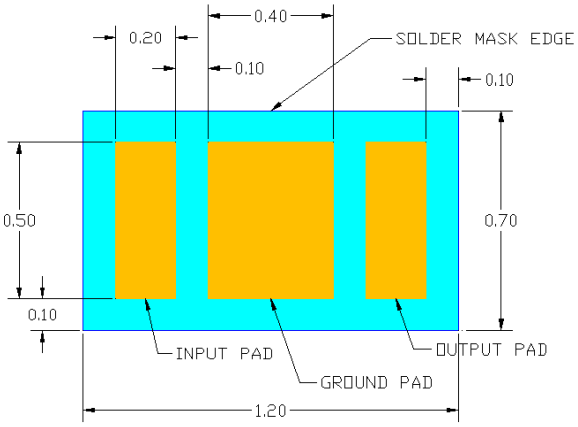



**Figure 6. Recommended PCB land pattern**

NOTES:

1. 0.010" Rogers RO4350

## Recommended SMT Attachment

The VMMK Packaged Devices are compatible with high volume surface mount PCB assembly processes.

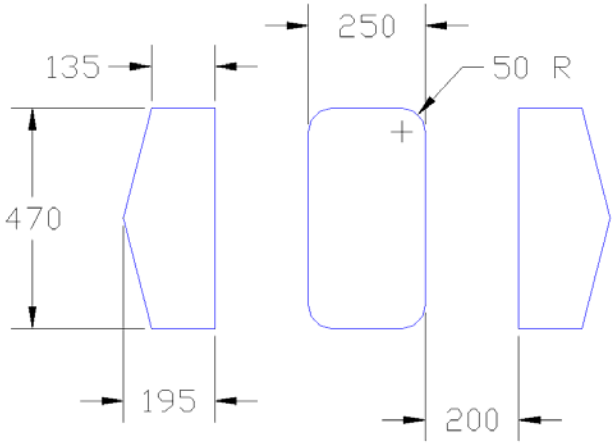



**Figure 7. Suggested stencil pattern.**

Notes:

1. Dimensions in microns
2. Stencil thickness 100 microns
3. Stencil type: laser cut.

## Manual Assembly for Prototypes

1. Follow ESD precautions while handling packages.
2. Handling should be along the edges with tweezers or from topside if using a vacuum collet.
3. Recommended attachment is solder paste. Please see recommended solder reflow profile. Conductive epoxy is not recommended. Hand soldering is not recommended.
4. Apply solder paste using either a stencil printer or dot placement. The volume of solder paste will be dependent on PCB and component layout and should be controlled to ensure consistent mechanical and electrical performance. ***Excessive solder will degrade RF performance.***
5. Follow solder paste and vendor's recommendations when developing a solder reflow profile. A standard profile will have a steady ramp up from room temperature to the pre-heat temp to avoid damage due to thermal shock.

6. Packages have been qualified to withstand a peak temperature of 280°C for 15 sec. Verify that the profile will not expose device beyond these limits.
7. Clean off flux per vendor's recommendations.
8. Clean the module with Acetone. Rinse with alcohol. Allow the module to dry before testing.

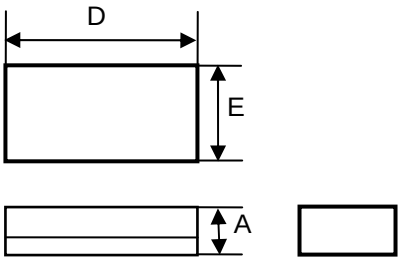
Note: These devices are ESD sensitive. The following precautions are strongly recommended. Ensure that an ESD approved carrier is used when die are transported from one destination to another. Personal grounding is to be worn at all times when handling these devices. For more detail, refer to Avago Application Note A004R: Electrostatic Discharge Damage and Control

ESD Machine Model (Class A)
ESD Human Body Model (Class A)

## Ordering Information

| Part Number | Devices Per Container | Container |
|---|---|---|
| VMMK-3603-BLKG | 100 | Antistatic Bag |
| VMMK-3603-TR1G | 5000 | 7" Reel |

## Package Dimension Outline

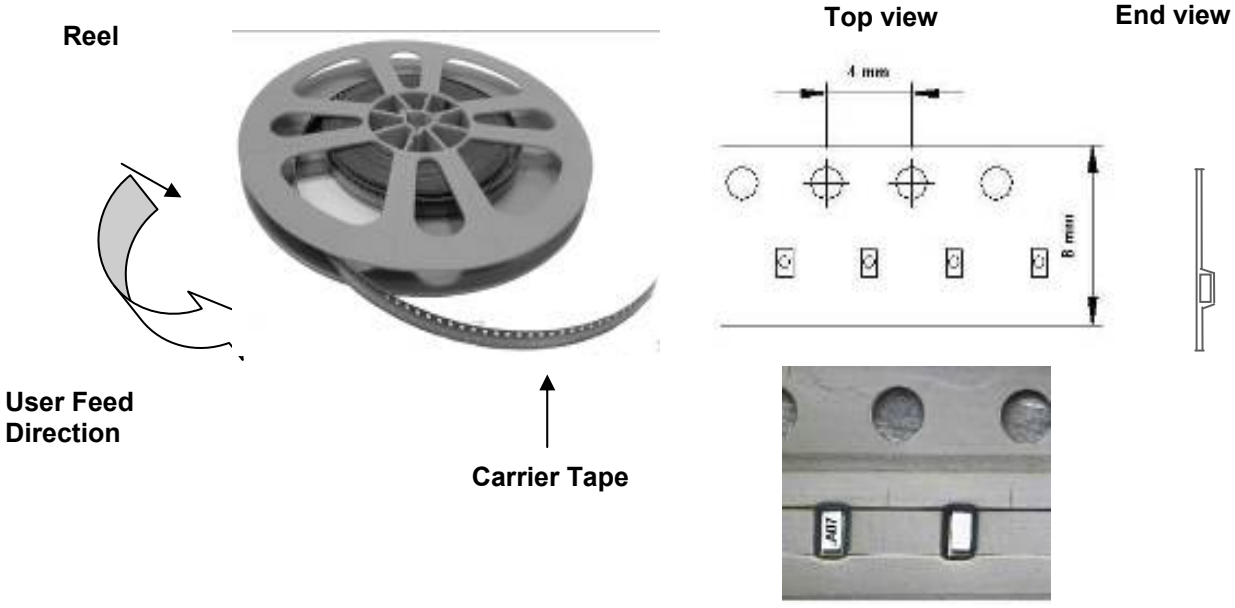


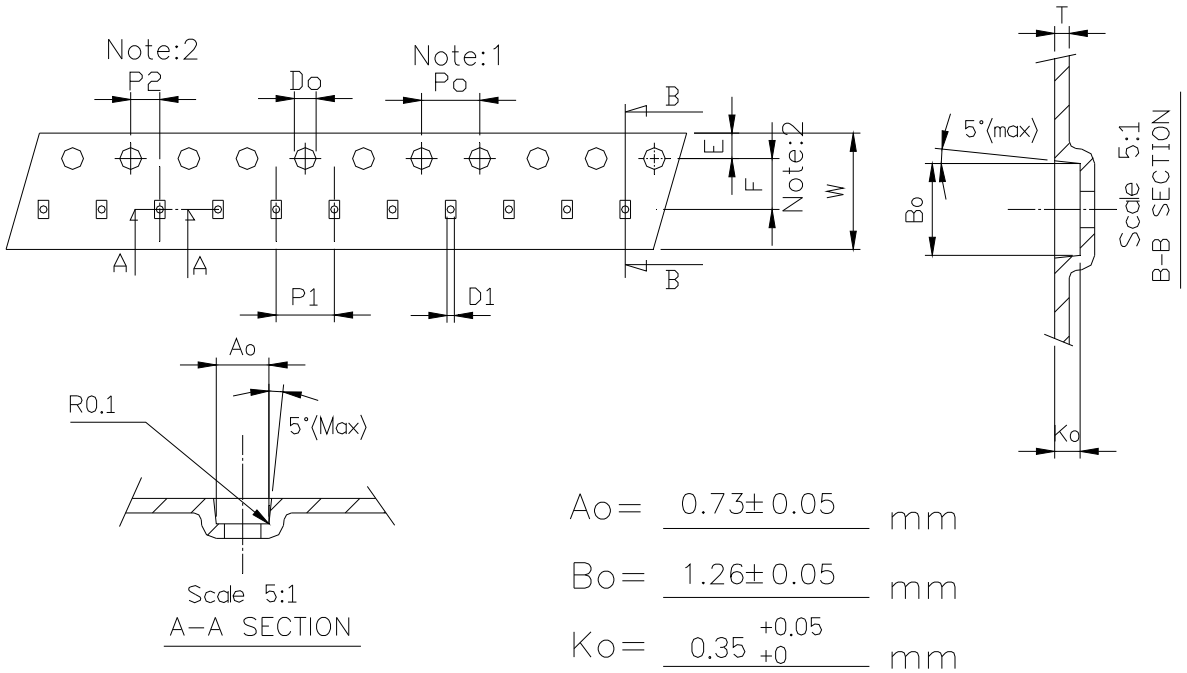

Dimensions

| Symbol | Min (mm) | Max (mm) |
|---|---|---|
| E | 0.500 | 0.566 |
| D | 1.004 | 1.066 |
| A | 0.235 | 0.265 |

Note:
All dimensions are in mm

**Device Orientation**






Ao= 0.73± 0.05 mm

Bo= 1.26± 0.05 mm

Ko= $0.35^{+0.05}_{+0}$ mm

Unit: mm

| Symbol | Spec. |
|---|---|
| K1 | – |
| Po | 4.0± 0.10 |
| P1 | 4.0± 0.10 |
| P2 | 2.0± 0.05 |
| Do | 1.55± 0.05 |
| D1 | 0.5± 0.05 |
| E | 1.75± 0.10 |
| F | 3.50± 0.05 |
| 10Po | 40.0± 0.10 |
| W | 8.0± 0.20 |
| T | 0.20± 0.02 |

Notice:

1. 10 Sprocket hole pitch cumulative tolerance is ±0.1mm
2. Pocket position relative to sprocket hole measured as true position of pocket not pocket hole.
3. Ao & Bo measured on a place 0.3mm above the bottom of the pocket to top surface of the carrier.
4. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
5. Carrier camber shall be not than 1mm per 100mm through a length of 250mm.