

# VMMK-3603

1 - 6 GHz Positive Gain Slope Low Noise Amplifier in SMT Package



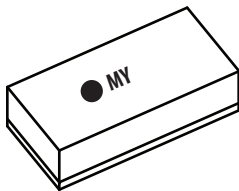
## Data Sheet



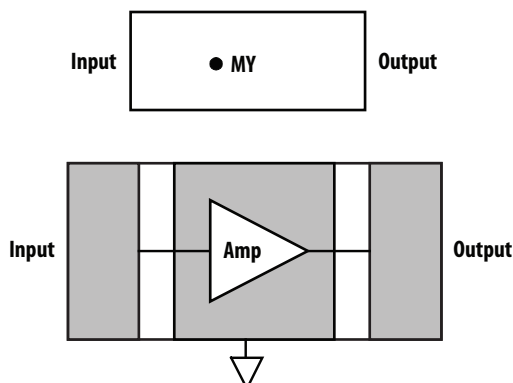
### Description

The VMMK-3603 is a small and easy-to-use, broadband, positive gain slope low noise amplifier operating in various frequency bands from 1 to 6 GHz with typical noise figure of 1.4 dB. It is housed in the Avago Technologies' industry-leading and revolutionary sub-miniature chip scale package (GaAsCap wafer scale leadless package) which is small and ultra thin yet can be handled and placed with standard 0402 pick and place assembly equipment. The VMMK-3603 provides a typical gain of 17 dB with good linearity of +25 dBm typical OIP3 and input and output return losses. It can be operated from 3 V to 5 V power supply. It is fabricated using Avago Technologies unique 0.25  $\mu\text{m}$  E-mode PHEMT technology which eliminates the need for negative gate biasing voltage.

WLP0402, 1 mm x 0.5 mm x 0.25 mm



### Pin Connections (Top View)



Note:  
"M" = Device Code  
"Y" = Month Code

### Features

- 1 x 0.5 mm surface mount package
- Ultrathin (0.25 mm)
- Wide frequency range: 1 to 6 GHz
- Low noise figure
- Positive gain slope
- Self-Biasing: 3 to 5 V

### Specifications (5 GHz, Vdd = 5 V, Zin = Zout = 50 $\Omega$ )

- Small signal gain: 17 dB typ.
- Noise Figure = 1.5 dB typ.
- Output 3<sup>rd</sup> Order Intercept Point = 25 dBm

### Applications

- 2.4, 3.5, and 5-6 GHz WLAN and WiMax
- 802.16 & 802.20 BWA systems
- Radar and ECM systems
- Generic IF amplifier



**Attention: Observe precautions for handling electrostatic sensitive devices.**  
ESD Machine Model = 50 V  
ESD Human Body Model = 300 V  
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

## Electrical Specifications

**Table 1. Absolute Maximum Rating** <sup>[1]</sup>

| Symbol               | Parameters/Condition                        | Unit | Absolute Max |
|----------------------|---------------------------------------------|------|--------------|
| Vd                   | Supply Voltage (RF Output) <sup>[2]</sup>   | V    | 8            |
| Id                   | Supply Current <sup>[2]</sup>               | mA   | 56           |
| P <sub>in, max</sub> | CW RF Input Power (RF Input) <sup>[3]</sup> | dBm  | 15           |
| P <sub>diss</sub>    | Total Power Dissipation                     | mW   | 460          |
| Tch                  | Max Channel Temperature                     | °C   | +150         |
| θ <sub>jc</sub>      | Thermal Resistance <sup>[4]</sup>           | °C/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 T<sub>b</sub> = 25° C
4. Thermal resistance is measured from junction to board using IR method

**Table 2. DC and RF Specifications** <sup>[1]</sup>

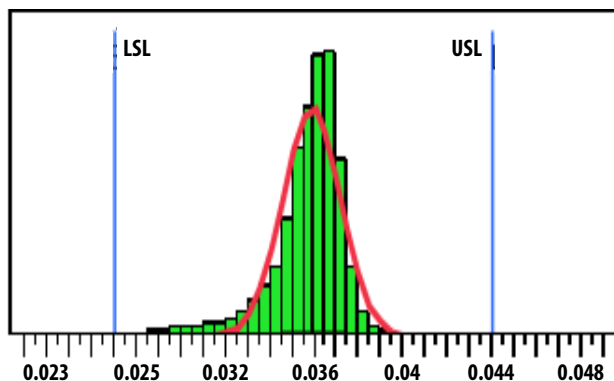
T<sub>A</sub> = 25° C, Vd = 5 V, Freq = 5 GHz, Z<sub>in</sub> = Z<sub>out</sub> = 50 Ω (unless otherwise specified)

| Symbol                         | Parameters/Condition                         | Unit | Minimum | Typical | Maximum |
|--------------------------------|----------------------------------------------|------|---------|---------|---------|
| Id <sup>[2]</sup>              | Supply Current                               | mA   | 27      | 36      | 44      |
| NF <sup>[2,3]</sup>            | Noise Figure                                 | dB   |         | 1.5     | 1.9     |
| Ga <sup>[2,3]</sup>            | Associated Gain                              | dB   | 15.5    | 16.8    | 19.5    |
| S <sub>11</sub> <sup>[4]</sup> | Input Return Loss                            | dB   |         | -11     |         |
| S <sub>22</sub> <sup>[4]</sup> | Output Return Loss                           | dB   |         | -11     |         |
| OIP3 <sup>[4,5]</sup>          | Output 3 <sup>rd</sup> Order Intercept Point | dBm  |         | 25      |         |

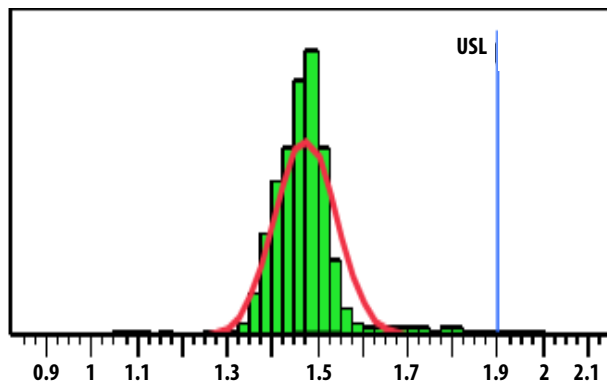
Notes

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. NF and Ga obtained from Noise Figure Meter
4. S-parameters and OIP3 data obtained using 300 μm G-S-G probing on PCB substrate
5. OIP3 test condition: Center frequency = 5 GHz, 2 tone offset = 10 MHz, Pin = -25 dBm

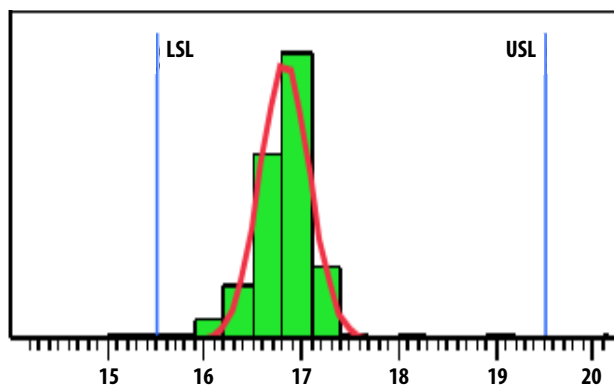
## Product Consistency Distribution Charts at 5.0 GHz, Vd = 5 V



Id @ Vd = 5 V, Mean = 36 mA, LSL = 27 mA, USL = 44mA



NF @ 5 GHz, Mean = 1.5 dB, USL = 1.9 dB



Gain @ 5GHz, Mean = 16.8 dB, LSL = 15.5 dB, USL = 19.5 dB  
(Data obtained using Noise Figure Analyzer)

Notes:  
Distribution data based on 65 Kpcs part sample size from MPV lots.  
Future wafers allocated to this product may have nominal values  
anywhere between the upper and lower limits.

## VMMK-3603 Typical Performance

$T_A = 25^\circ\text{C}$ ,  $Z_{in} = Z_{out} = 50\ \Omega$ ; biasing by a broadband bias tee; S-param data obtained using 300  $\mu\text{m}$  GSG probing on PCB substrate, NF, IP3, and P1dB obtained using eval board; losses calibrated out to the package reference plane.

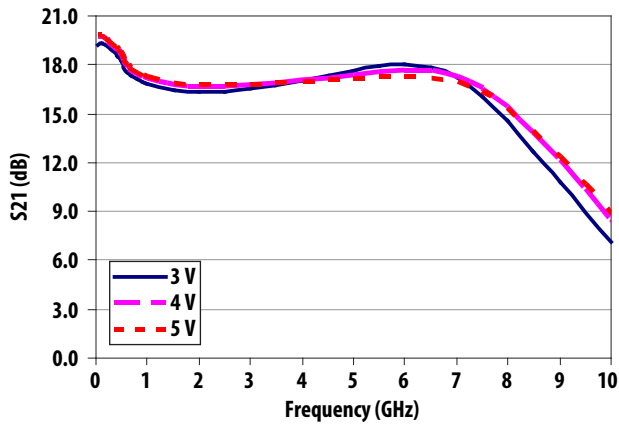


Figure 1. Small Signal Gain Over Bias

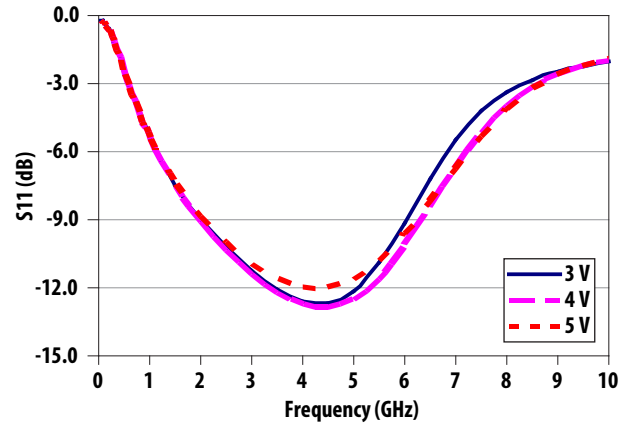


Figure 2. Input Return Loss Over Bias

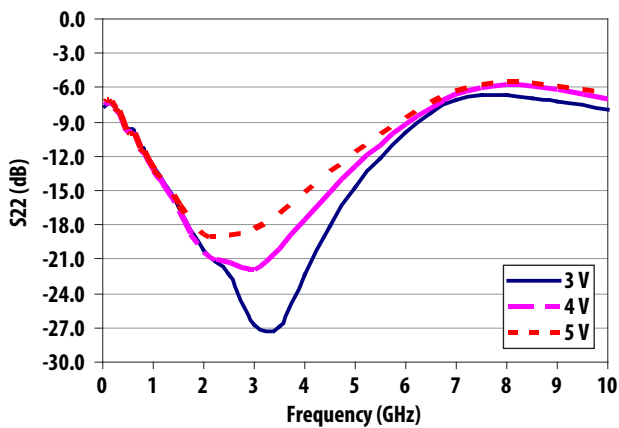


Figure 3. Output Return Loss Over Bias

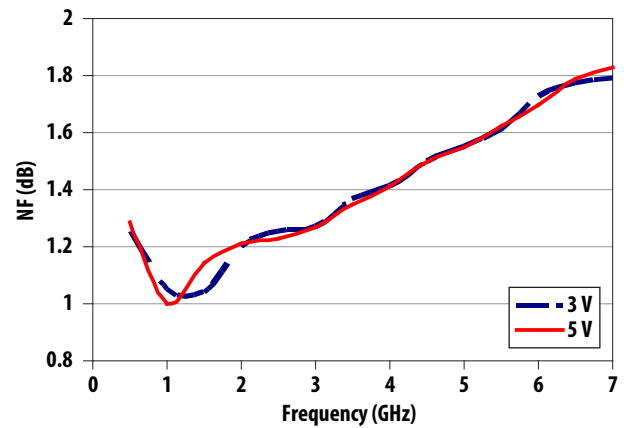


Figure 4. NF Over Bias

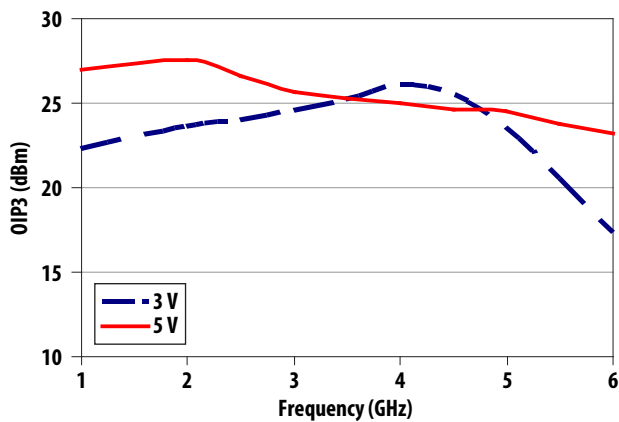


Figure 5. OIP3 Over Bias

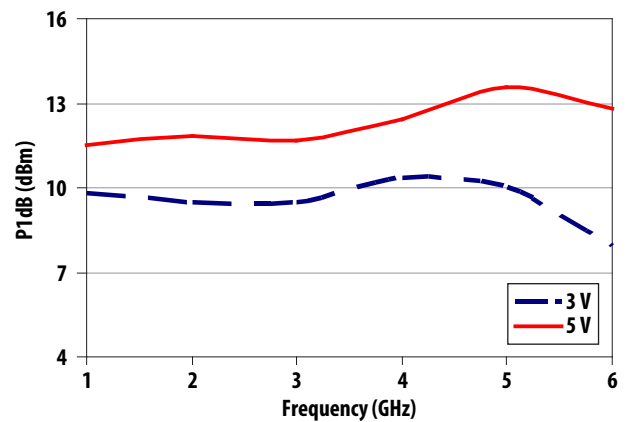


Figure 6. OP1dB Over Bias

## VMMK-3603 Typical Performance

$V_d = 5\text{ V}$  unless noted,  $Z_{in} = Z_{out} = 50\ \Omega$ , biasing by a broadband bias tee; over temp data obtained using eval board; losses calibrated out to the package reference plane.

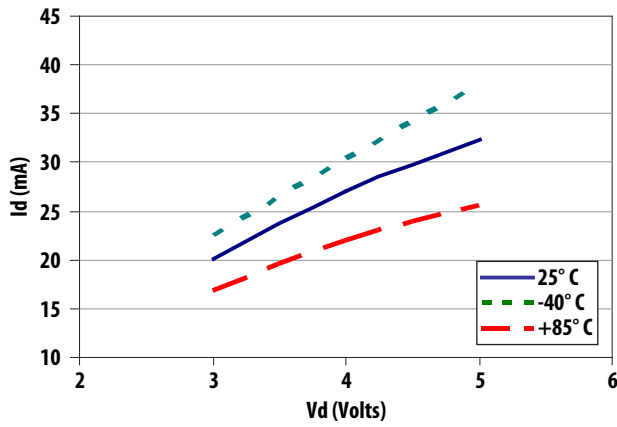


Figure 7. Id vs. Vd over Temp

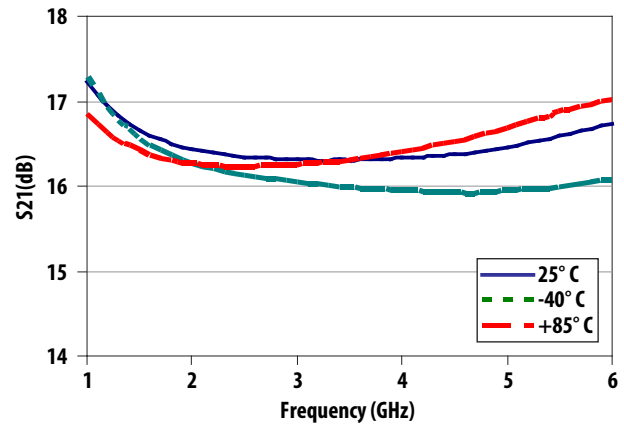


Figure 8. Gain over Temp

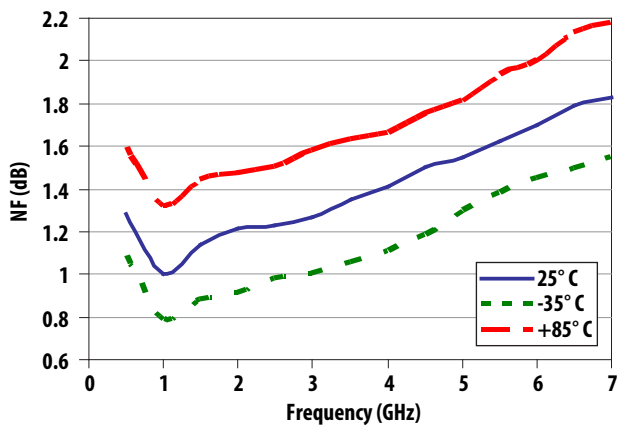


Figure 9. NF Over Temp

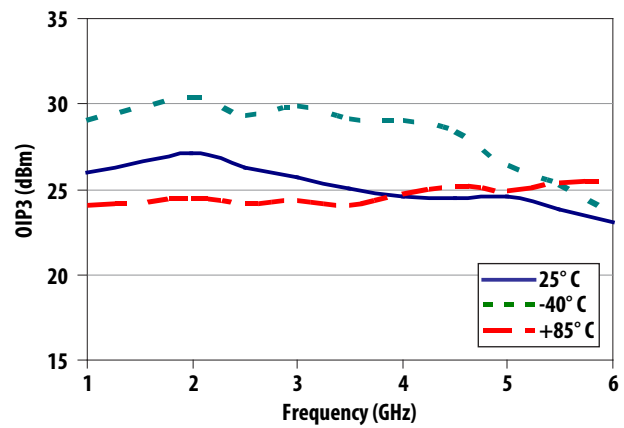


Figure 10. OIP3 Over Temp

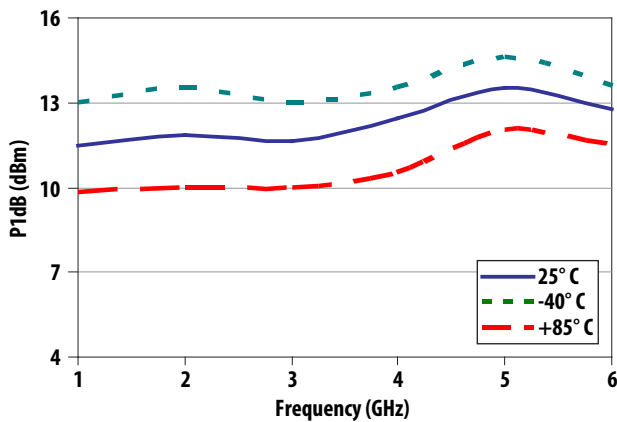


Figure 11. OP1dB Over Temp

## Typical Scattering Parameters

$T_A = 25^\circ \text{C}$ ,  $V_d = 3 \text{ V}$ ,  $Z_{in} = Z_{out} = 50 \Omega$  unless noted. Data obtained using 300  $\mu\text{m}$  G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane.

| Freq<br>GHz | S11   |        |           | S21   |        |           | S12   |        |           | S22   |        |           |
|-------------|-------|--------|-----------|-------|--------|-----------|-------|--------|-----------|-------|--------|-----------|
|             | 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   |
| 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   |
| 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   |
| 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 |
| 19          | -0.6  | 0.9369 | -55.4445  | -15.9 | 0.1606 | -174.9897 | -37.6 | 0.0132 | -10.438   | -7.7  | 0.4107 | -108.8462 |
| 20          | -0.6  | 0.9385 | -63.2833  | -17.8 | 0.1288 | 178.771   | -37.1 | 0.0139 | -8.8364   | -7.6  | 0.4181 | -113.2307 |
| 21          | -0.5  | 0.9455 | -71.189   | -19.9 | 0.1012 | 173.6276  | -34.7 | 0.0185 | -18.2437  | -7.4  | 0.425  | -117.8475 |
| 22          | -0.5  | 0.9461 | -77.8723  | -21.3 | 0.0861 | 169.4539  | -36.6 | 0.0148 | -34.0351  | -7.3  | 0.4314 | -122.2301 |
| 23          | -0.4  | 0.9518 | -84.7844  | -22.9 | 0.0718 | 162.3099  | -37.7 | 0.013  | -25.5129  | -7.2  | 0.4363 | -125.4319 |
| 24          | -0.4  | 0.9516 | -91.3249  | -25.1 | 0.0555 | 157.727   | -35.3 | 0.0171 | -31.2849  | -7.2  | 0.4362 | -128.9087 |
| 25          | -0.4  | 0.9543 | -97.0884  | -26.0 | 0.0504 | 150.9037  | -38.6 | 0.0117 | -36.8647  | -7.2  | 0.4361 | -132.6289 |

## Typical Scattering Parameters

$T_A = 25^\circ \text{C}$ ,  $V_d = 5 \text{ V}$ ,  $Z_{in} = Z_{out} = 50 \Omega$  unless noted. Data obtained using 250  $\mu\text{m}$  G-S-G PCB substrate & broadband bias tees, losses calibrated out to the package reference plane.

| Freq<br>GHz | S11   |        |           | S21   |        |           | S12   |        |           | S22   |        |           |
|-------------|-------|--------|-----------|-------|--------|-----------|-------|--------|-----------|-------|--------|-----------|
|             | 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   |
| 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   |
| 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   |
| 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  |
| 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          | -1.0  | 0.8885 | -8.2264   | -3.7  | 0.6537 | -149.3954 | -42.9 | 0.0072 | 28.2504   | -7.8  | 0.4067 | -81.6577  |
| 15          | -0.9  | 0.9029 | -18.1508  | -6.2  | 0.4898 | -158.4144 | -41.6 | 0.0083 | 19.5155   | -7.8  | 0.4089 | -87.9     |
| 16          | -0.7  | 0.9173 | -28.4392  | -8.6  | 0.3727 | -167.162  | -38.0 | 0.0126 | 19.2396   | -7.6  | 0.4188 | -94.5239  |
| 17          | -0.6  | 0.9284 | -38.1504  | -10.8 | 0.2876 | -175.4717 | -36.5 | 0.015  | 15.2695   | -7.4  | 0.4264 | -99.7235  |
| 18          | -0.6  | 0.9313 | -46.9227  | -13.0 | 0.2227 | 176.9209  | -34.8 | 0.0183 | 4.0748    | -7.2  | 0.4356 | -105.7808 |
| 19          | -0.5  | 0.9389 | -55.9194  | -15.0 | 0.1778 | 170.0955  | -35.3 | 0.0171 | -7.7662   | -7.1  | 0.4435 | -110.7482 |
| 20          | -0.5  | 0.9399 | -63.6621  | -17.0 | 0.1416 | 162.632   | -35.3 | 0.0171 | -8.2348   | -6.9  | 0.4507 | -114.8575 |
| 21          | -0.5  | 0.946  | -71.499   | -19.2 | 0.1101 | 155.5804  | -33.6 | 0.021  | -16.9273  | -6.8  | 0.4566 | -119.3594 |
| 22          | -0.5  | 0.9467 | -78.2123  | -20.7 | 0.092  | 150.8211  | -35.3 | 0.0171 | -30.2145  | -6.7  | 0.4632 | -123.5707 |
| 23          | -0.4  | 0.9515 | -85.0468  | -22.3 | 0.0767 | 142.117   | -36.1 | 0.0156 | -25.443   | -6.6  | 0.4678 | -126.9413 |
| 24          | -0.4  | 0.9513 | -91.568   | -24.6 | 0.0589 | 134.4502  | -34.3 | 0.0193 | -32.1079  | -6.6  | 0.4674 | -130.3008 |
| 25          | -0.4  | 0.9531 | -97.3009  | -25.5 | 0.0531 | 127.8596  | -37.2 | 0.0138 | -33.6267  | -6.6  | 0.4662 | -134.0917 |

## VMMK-3603 Applications and Usage Information

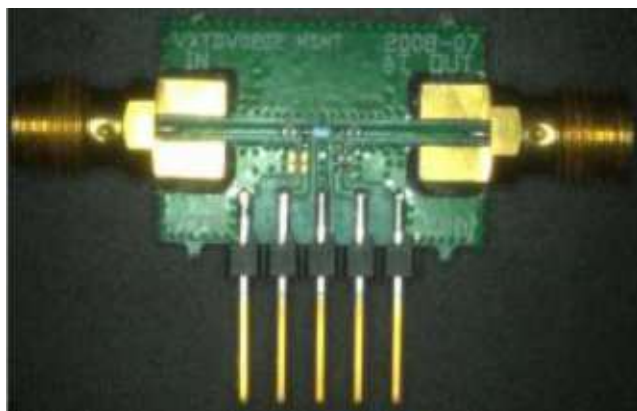


Figure 12. Evaluation/Test Board (available to qualified customers upon request)

### 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 12.

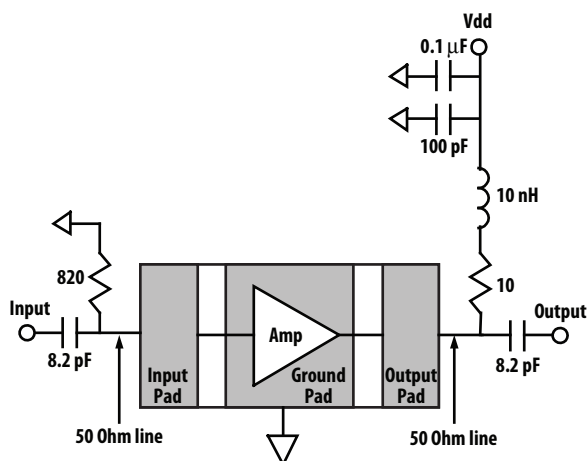


Figure 13. Example demonstration circuit of VMMK-3603 for broadband operation (1 GHz to 6 GHz).

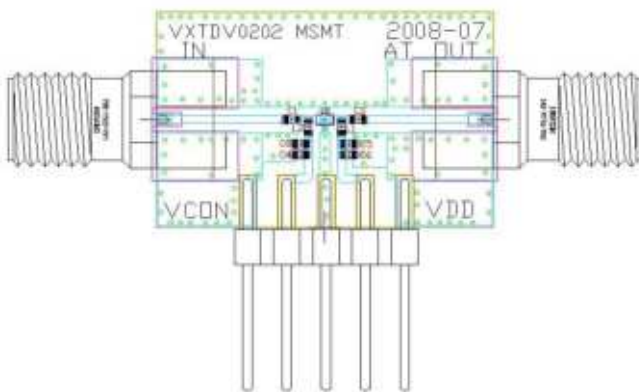


Figure 14. Biasing the VMMK-3603

Table 3. VMMK-3603 Demo Board BOM

| Component | Value     |
|-----------|-----------|
| DUT       | VMMK-3603 |
| C1        | 100 pF    |
| C2        | 8.2 pF    |
| C5        | 0.1 μF    |
| C6        | 100 pF    |
| R1        | 820 Ohms  |
| R2        | 10 Ohms   |
| L1        | 10 nH     |

A layout of a typical demo board is shown in Figure 14. 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.

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 100 pF and 0.1 μF 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 0.016 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. A combination of SOLT (Short – Open – Load – Thru) and TRL (Thru – Reflect – Line) calibration techniques are used to correct for the effects of the test board, resulting in accurate device S parameters.

## Package and Assembly Note

For detailed description of the device package, handling and assembly, please refer to Application Note 5378.

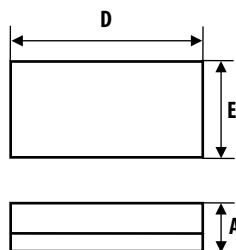
## ESD Precautions

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.

## Ordering Information

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

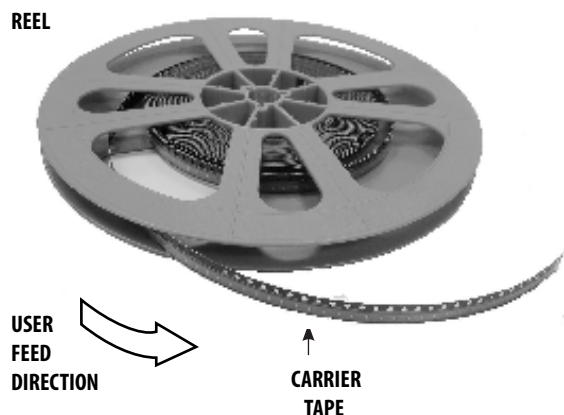
## Package Dimension Outline



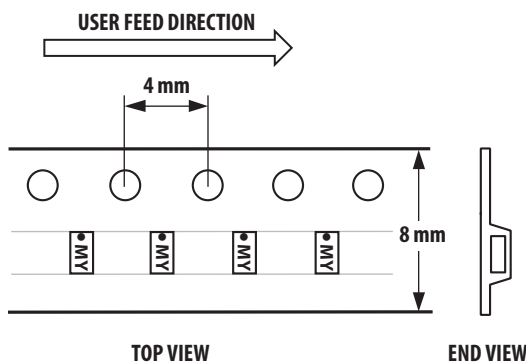
| Dimensions Symbol | Min (mm) | Max (mm) |
|-------------------|----------|----------|
| E                 | 0.500    | 0.585    |
| D                 | 1.004    | 1.085    |
| A                 | 0.225    | 0.275    |

Note:  
All dimensions are in mm

## Reel Orientation

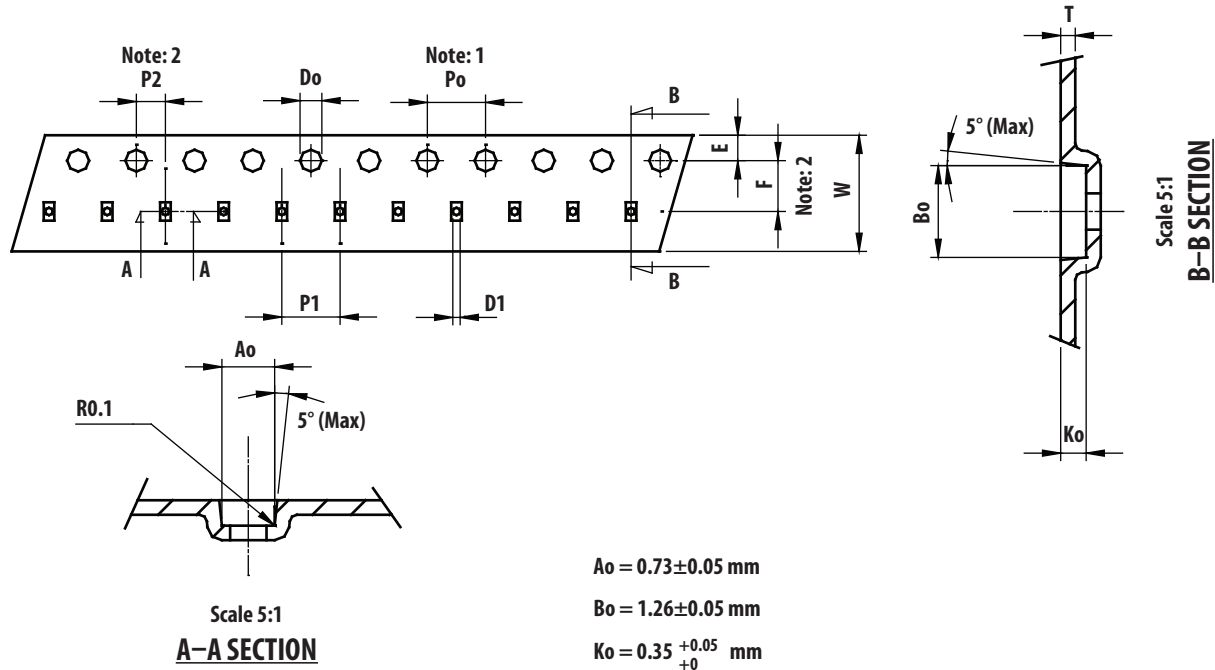


## Device Orientation



Notes:  
"M" = Device Code  
"Y" = Month Code

## Tape Dimensions



Unit: mm

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

Notice:

- 10 Sprocket hole pitch cumulative tolerance is  $\pm 0.1 \text{ mm}$ .
- Pocket position relative to sprocket hole measured as true position of pocket not pocket hole.
- Ao & Bo measured on a plane 0.3 mm above the bottom of the pocket to top surface of the carrier.
- Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
- Carrier camber shall be not than 1 m per 100 mm through a length of 250 mm.

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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