VMMK-2203

0.9-11 GHz E-pHEMT Wideband Amplifier in Wafer Level Package

Data Sheet

Lead (Pb) Free
RoHS 6 fully
compliant

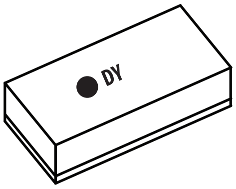
Description

Avago Technologies has combined its industry leading E-pHEMT technology with a revolutionary wafer level package (WLP).

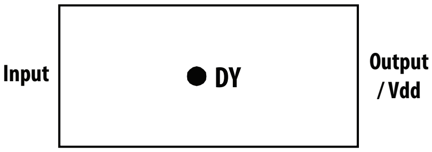
The VMMK-2203 is an easy-to-use GaAs MMIC amplifier that offers excellent gain and noise figure from 0.9 to 11 GHz. The input and output are matched to 50 Ω so no external matching is needed. Bias is supplied through a simple external choke and DC blocking network.

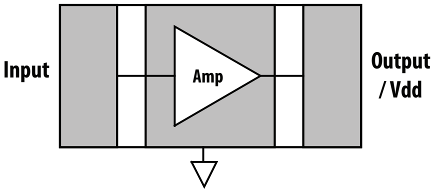
The wafer level package is small and ultra thin, yet can be handled and placed with standard 0402 pick and place assembly. This product is easy to use since it requires only a single positive DC voltage for bias and no matching coefficients are required for impedance matching to 50 Ω systems.

WLP 0402, 1mm x 0.5mm x 0.25 mm



Pin Connections (Top View)





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

Features

- 1 x 0.5 mm Surface Mount Package
- Ultrathin (0.25mm)
- Gain Block
- Ultra-wide Bandwidth
- 5V Supply
- RoHS6 + Halogen Free

Specifications (6GHz, 5V, 25mA Typ.)

- Noise Figure: 2.0dB typical
- Associated Gain: 16.5dB
- Output IP3: +14dBm
- Output P1dB: +5dBm

Applications

- Low Noise and Driver for Cellular/PCS and WCDMA Base Stations
- 2.4 GHz, 3.5GHz, 5-6GHz WLAN and WiMax notebook computer, access point and mobile wireless applications
- 802.16 & 802.20 BWA systems
- WLL and MMDS Transceivers
- Point-to-Point Radio
- UWB
- Antennas

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model = 40V
ESD Human Body Model = 450V
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Table 1. Absolute Maximum Ratings [1]

Sym	Parameters/Condition	Unit	Absolute Max
Vd	Supply Voltage (RF Output) [2]	V	8
Id	Device Current [2]	mA	50
$P_{in, max}$	CW RF Input Power (RF Input) [3]	dBm	+13
P_{diss}	Total Power Dissipation	mW	400
Tch	Max channel temperature	°C	150
θjc	Thermal Resistance [4]	°C/W	107

Notes
1. Operation in excess of any of these conditions may result in permanent damage to this device.
2. Bias is assumed DC quiescent conditions
3. With the DC (typical bias) and RF applied to the device at board temperature Tb = 25°C
4. Thermal resistance is measured from junction to board using IR method

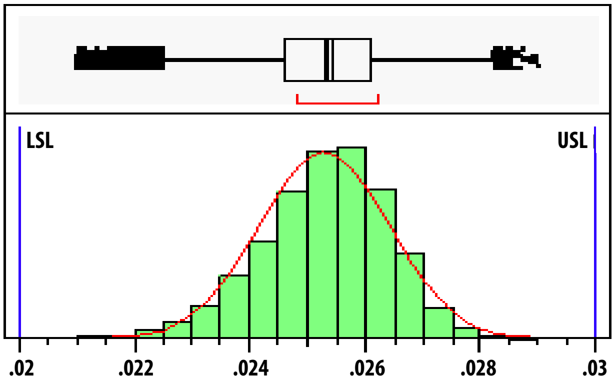
Table 2. DC and RF Specifications

T_A= 25°C, Frequency = 6 GHz, Vd = 5V, $Z_{in} = Z_{out} = 50\Omega$ (unless otherwise specified)

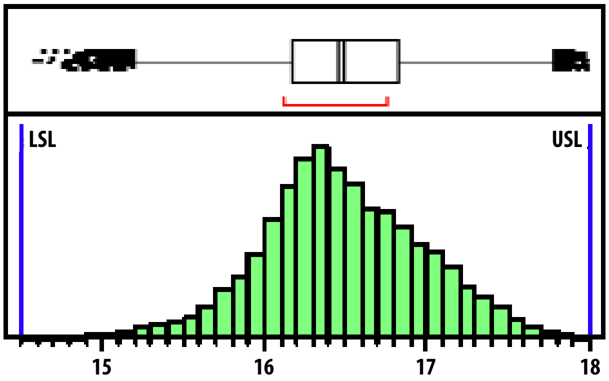
Sym	Parameters/Condition	Unit	Minimum	Typ.	Maximum
Id	Device Current	mA	20.0	25	30.0
NF[1]	Noise Figure	dB	–	2	2.5
Ga [1]	Associated Gain	dB	15	16.5	18
OIP3 [2,3]	Output 3rd Order Intercept	dBm		+14	–
Output P-1dB[2]	Output Power at 1dB Gain Compression (Pin = 0dBm)	dBm		+5	–
IRL [2]	Input Return Loss	dB	–	-11	–
ORL [2]	Output Return Loss	dB	–	-16	–

Notes:
1. Measure Data obtained using 300um G-S probe on production wafer
2. Measure Data obtained using 300um G-S-G probe on PCB substrate
3. OIP3 test condition: F1 = 6.0GHz, F2 = 6.01GHz, Pin = -20dB

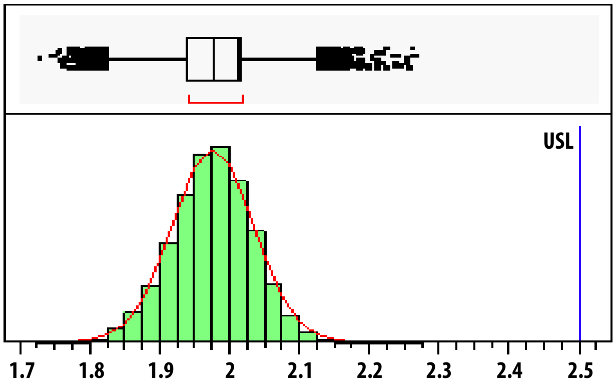
Product Consistency Distribution Charts at 6.0 GHz, Vd = 5 V



Id @ 5V, Mean=25mA, LSL=20mA, USL=30mA



Gain @ 6GHz, Mean=16.5, LSL=15dB, USL=18dB



NF @ 6GHz, Mean=2dB, USL=2.5dB

Note: Distribution data based on 500 part sample size from 3 lots during initial characterization.
Measurements were obtained using 300um G-S production wafer probe.
Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.

VMMK-2203 Typical Performance

(T_A = 25°C, Vdd = 5V, Idd = 25mA, $Z_{in} = Z_{out}$ = 50 Ω unless noted)

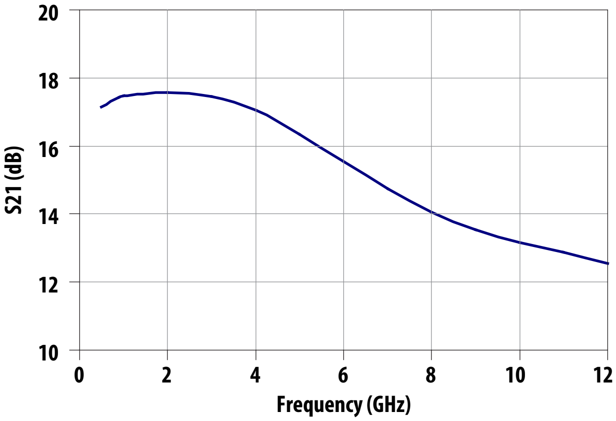


Figure 1. Small-signal Gain [1]

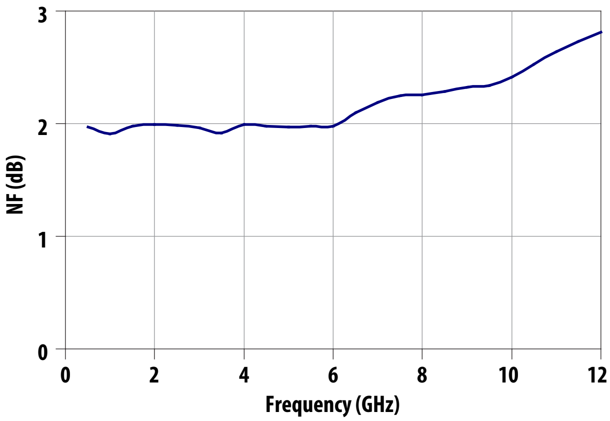


Figure 2. Noise Figure [1]

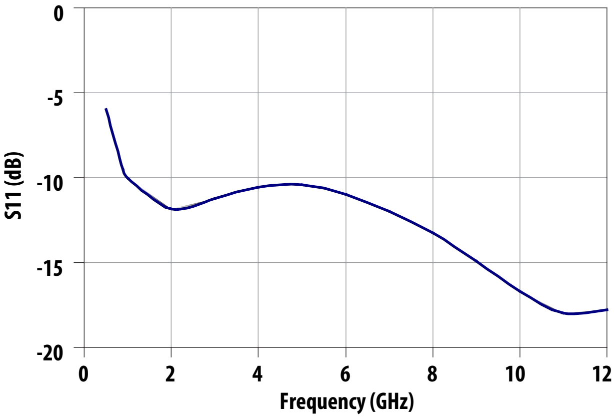


Figure 3. Input Return Loss [1]

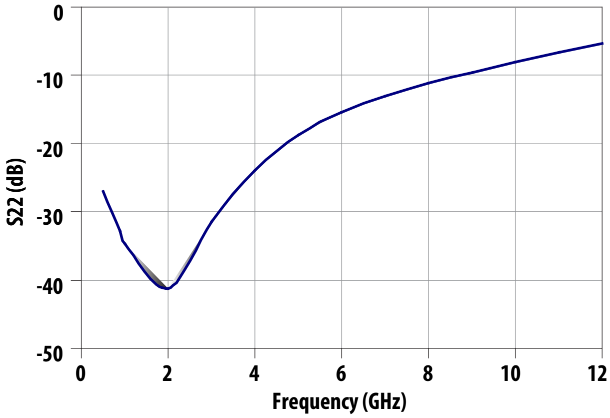


Figure 4. Output Return Loss [1]

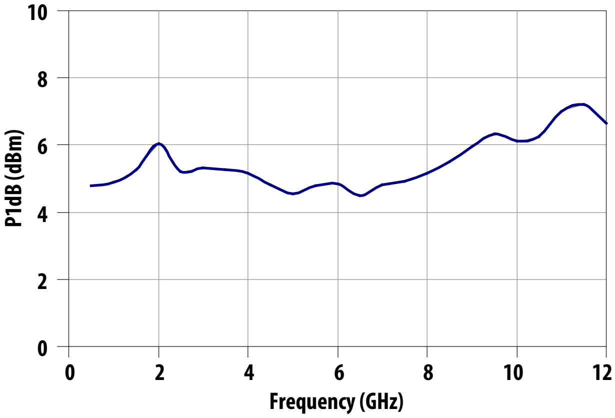


Figure 5. Output P-1dB [1]

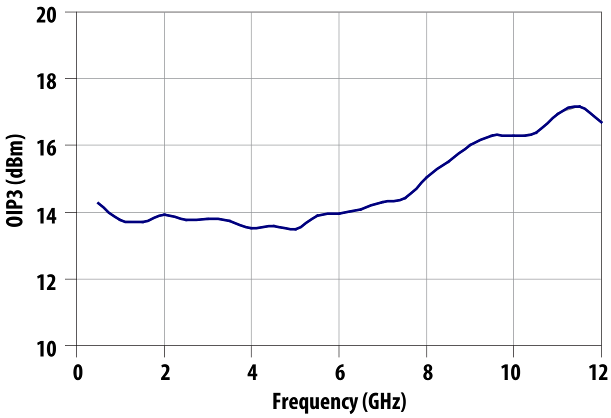


Figure 6. Output IP3 [1]

Notes:

1. Data taken on a G-S-G probe substrate fully de-embedded to the reference plane of the package
2. Output IP3 data taken at Pin= -20dBm

VMMK-2203 Typical Performance (continue)

(T_A = 25°C, Vdd = 5V, Idd = 25mA, $Z_{in} = Z_{out}$ = 50 Ω unless noted)

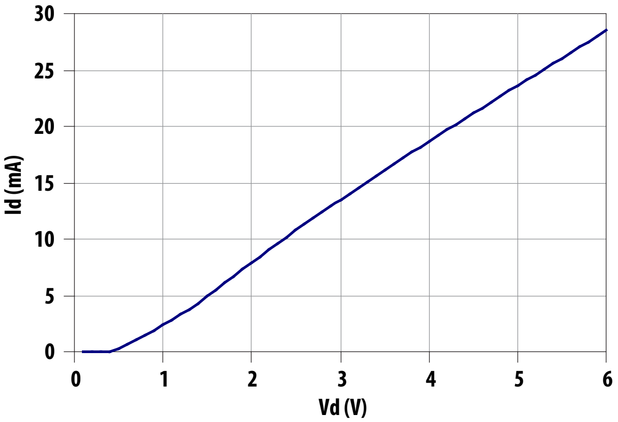


Figure 7. Total Current [1]

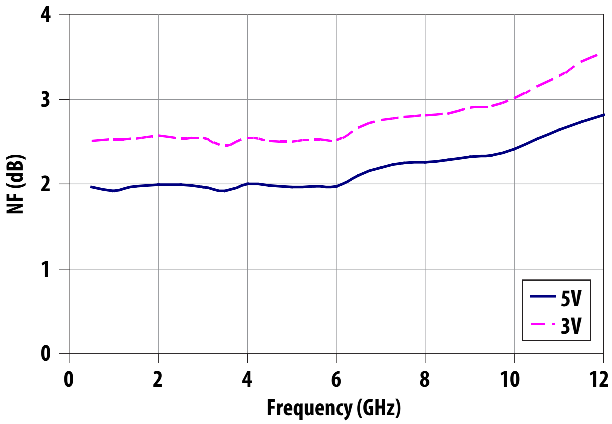


Figure 8. Noise Figure over Vd [1]

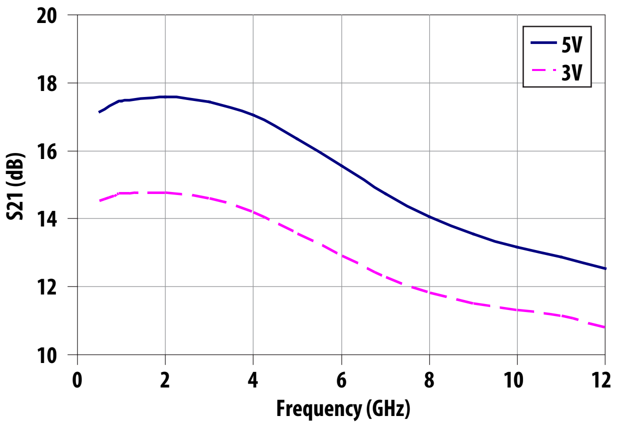


Figure 9. Gain over Vd [1]

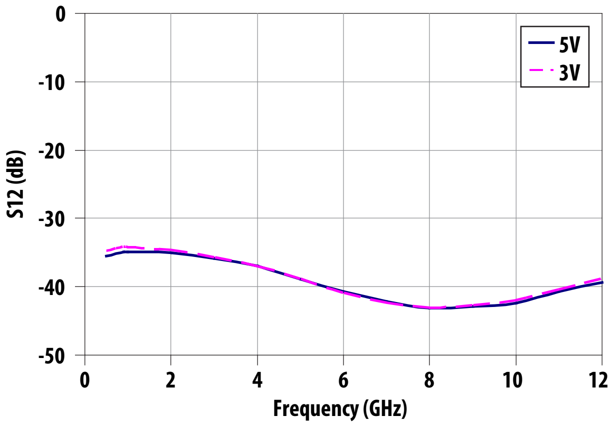


Figure 10. Isolation over Vd [1]

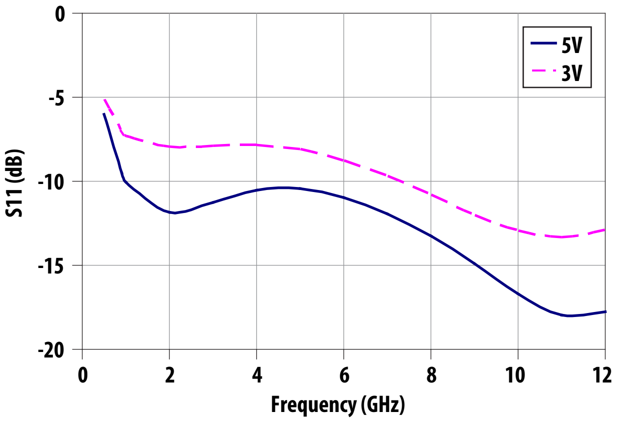


Figure 11. Input Return Loss Over Vdd [1]

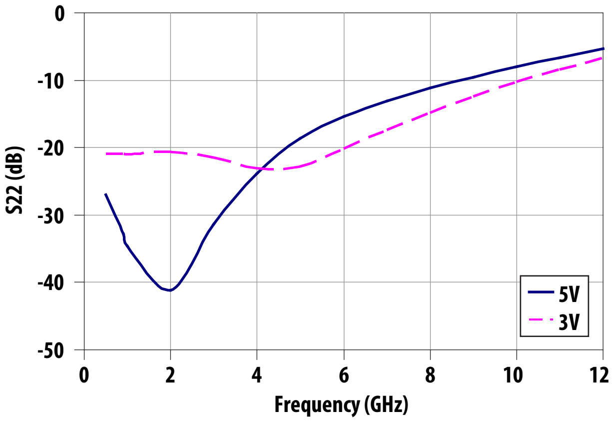


Figure 12. Output Return Loss Over Vdd [1]

Notes:

1. Data taken on a G-S-G probe substrate fully de-embedded to the reference plane of the package

VMMK-2203 Typical Performance (continue)

(T_A = 25°C, Z_{in} = Z_{out} = 50 Ω unless noted)

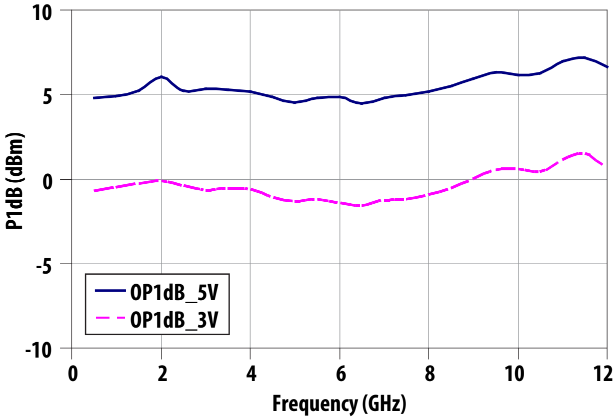


Figure 13. Output P-1dB over Vdd [1]

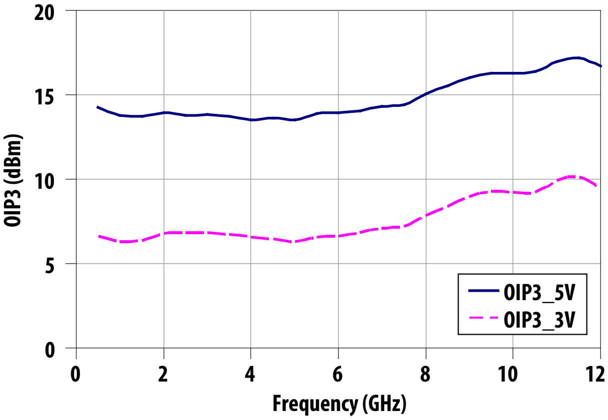


Figure 14. Output IP3 Over Vdd [1,2]

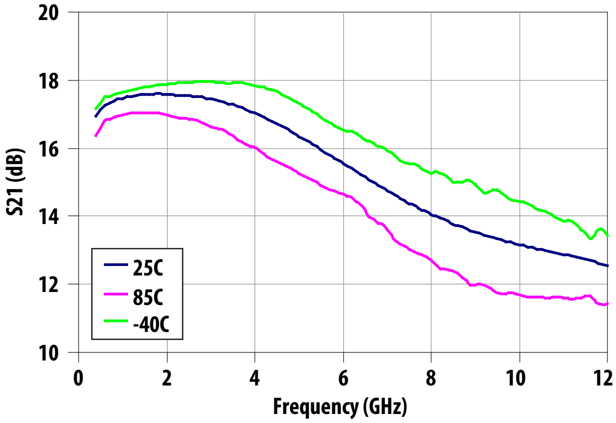


Figure 15. Gain over Temp [3]

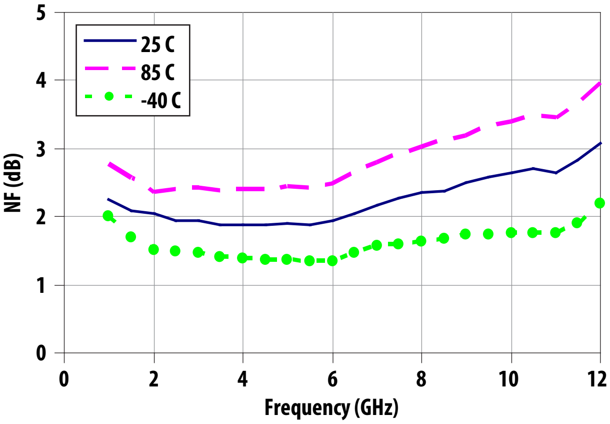


Figure 16. Noise Figure over Temp [3]

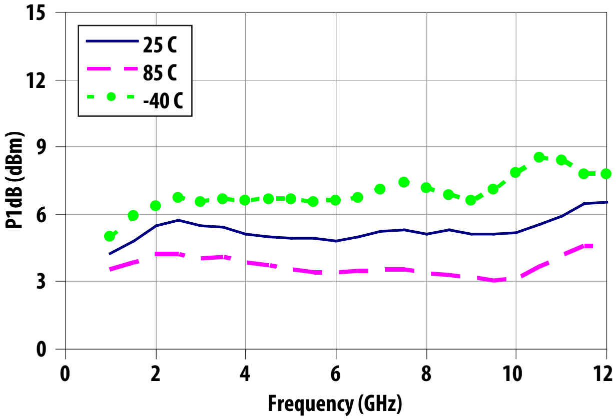


Figure 17. Output P1dB Over Temp [3]

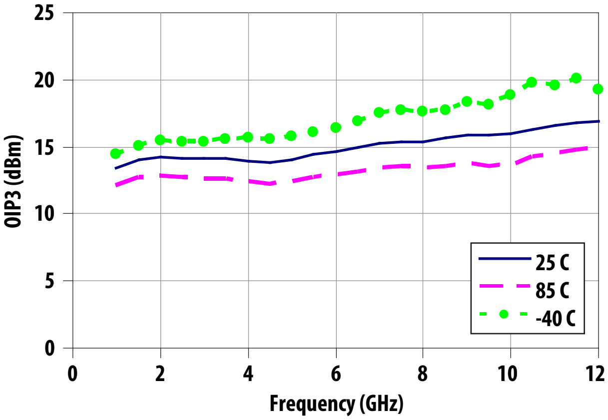


Figure 18. Output IP3 Over Temp [2,3]

Notes:

1. Data taken on a G-S-G probe substrate fully de-embedded to the reference plane of the package
2. Output IP3 data taken at Pin=-15dBm
3. Over temp data taken on a test fixture (Figure 20) without de-embedding

Typical Scattering Parameters

(Data obtained using 300um G-S-G PCB substrate, losses calibrated out to the package reference plane)
T_A = 25°C, V_{DD} = 5V, I_{dq} = 25mA, Z_{in} = Z_{out} = 50Ω

Freq GHz	S11			S21			S12			S22		
	db	mag	Phase	db	mag	phase	db	mag	phase	db	mag	Phase
0.1	-0.623	0.931	-17.303	15.410	5.895	24.706	-43.098	0.007	58.201	-14.226	0.194	-60.924
0.2	-1.806	0.812	-30.763	16.296	6.528	11.177	-39.251	0.011	49.500	-18.666	0.117	-67.718
0.3	-3.217	0.691	-40.107	16.744	6.874	3.676	-37.202	0.014	38.074	-21.230	0.087	-71.757
0.4	-4.789	0.576	-42.585	16.937	7.028	0.281	-36.138	0.016	30.992	-25.224	0.055	-69.531
0.5	-6.014	0.500	-45.376	17.138	7.193	-4.222	-35.494	0.017	23.868	-27.013	0.045	-72.073
0.9	-9.520	0.334	-46.030	17.440	7.447	-19.422	-34.943	0.018	10.054	-32.841	0.023	-83.598
1	-10.053	0.314	-45.287	17.468	7.471	-22.849	-34.846	0.018	8.211	-34.657	0.019	-82.547
2	-11.859	0.255	-36.749	17.573	7.562	-54.672	-34.992	0.018	-7.465	-41.210	0.009	161.055
3	-11.242	0.274	-40.341	17.447	7.453	-85.386	-35.810	0.016	-16.631	-31.341	0.027	84.468
4	-10.554	0.297	-54.521	17.046	7.117	-115.626	-36.954	0.014	-23.677	-23.890	0.064	49.757
5	-10.446	0.300	-70.762	16.351	6.570	-144.946	-38.862	0.011	-26.344	-18.666	0.117	27.200
6	-10.989	0.282	-88.565	15.548	5.989	-172.420	-40.724	0.009	-25.092	-15.376	0.170	10.065
7	-11.965	0.252	-105.725	14.741	5.458	161.832	-42.158	0.008	-15.494	-13.046	0.223	-5.275
8	-13.267	0.217	-123.379	14.054	5.043	137.412	-43.098	0.007	-4.492	-11.179	0.276	-18.954
9	-14.919	0.180	-142.510	13.539	4.753	113.475	-42.853	0.007	8.295	-9.538	0.334	-31.497
10	-16.701	0.146	-166.823	13.159	4.550	89.158	-42.384	0.008	19.326	-8.011	0.398	-43.146
11	-17.972	0.126	163.087	12.879	4.405	63.721	-40.724	0.009	23.652	-6.616	0.467	-55.112
12	-17.781	0.129	128.897	12.543	4.238	36.160	-39.332	0.011	26.908	-5.338	0.541	-68.500
13	-16.496	0.150	97.602	11.875	3.924	6.410	-37.924	0.013	22.544	-4.465	0.598	-83.481
14	-14.943	0.179	72.431	10.617	3.395	-24.069	-37.788	0.013	14.404	-4.124	0.622	-98.826
15	-13.731	0.206	54.358	8.757	2.741	-53.104	-37.589	0.013	8.991	-4.278	0.611	-112.509
16	-12.597	0.235	40.489	6.512	2.116	-78.994	-37.856	0.013	6.710	-4.834	0.573	-123.438
17	-11.805	0.257	29.853	4.131	1.609	-101.974	-38.273	0.012	7.867	-5.430	0.535	-132.619
18	-10.906	0.285	20.369	1.789	1.229	-122.236	-38.416	0.012	4.077	-5.883	0.508	-139.697
19	-10.128	0.312	12.841	-0.460	0.948	-140.763	-38.862	0.011	3.017	-6.200	0.490	-145.124
20	-9.549	0.333	5.210	-2.569	0.744	-158.032	-39.412	0.011	-1.898	-6.375	0.480	-150.506

VMMK-2203 Application and Usage

(Please always refer to the latest Application Note AN5378 in website)

Biasing and Operation

The VMMK-2203 is biased with a positive supply connected to the output pin through an external user supplied bias-tee as shown in Figure 19. The recommended supply voltage is between 3 and 5V. The corresponding drain currents are approximately 15 and 25 mA. Biasing the device at 5V results in higher gain, lower noise figure, higher IP3 and P1dB. In a typical application, the bias-tee can be constructed using lumped elements. The value of the output inductor can have a major effect on both low and high frequency operation. The demo board uses an 8.2 nH inductor that has self resonant frequency higher than the maximum desired frequency of operation.

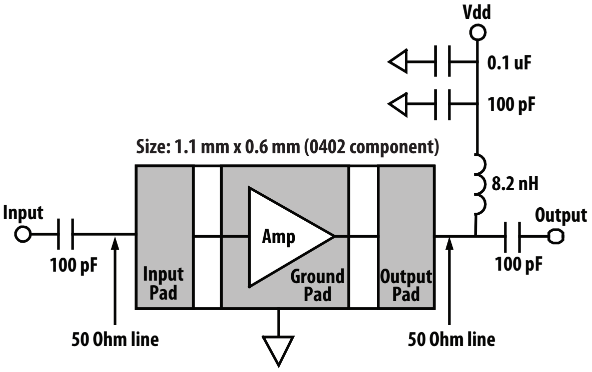


Figure 19. Usage of the VMMK-2203

At frequencies higher than 6 GHz, it may be advantageous to use a quarter-wave long microstrip line to act as a high impedance at the desired frequency of operation. This technique proves a good solution but only over relatively narrow bandwidths. Another approach for using the VMMK-2203 in broadband is to put in series two different value inductors with the smaller value inductor placed closest to the device and favoring the higher frequencies. The larger value inductor will then offer better low frequency performance by not loading the output of the device. The parallel combination of the 100pF and 0.1uF capacitors provides a low impedance in the band of operation and at lower frequencies. They 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.

Refer the Absolute Maximum Ratings table for allowed DC and thermal conditions.

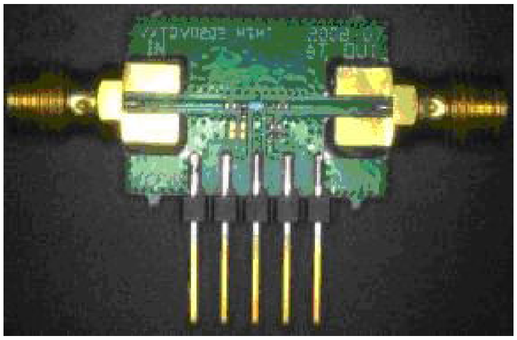


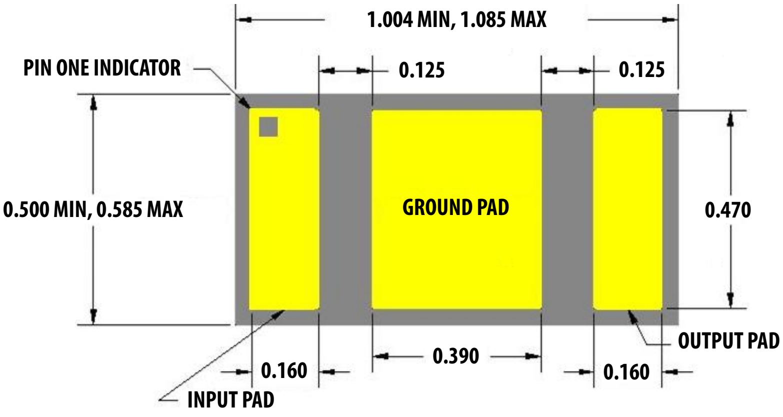
Figure 20. Evaluation/Test Board (available to qualified customer request)

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. 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. The reference plane for the S Parameters is at the edge of the package.

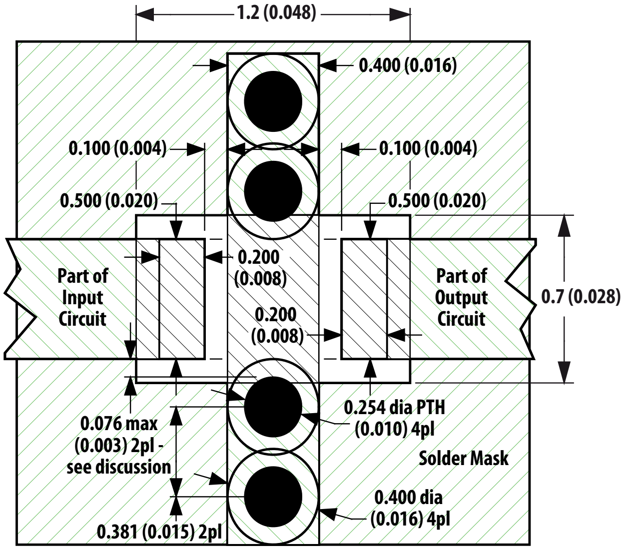
The product consistency distribution charts shown on page 2 represent data taken by the production wafer probe station using a 300um G-S wafer probe. The ground-signal probing that is used in production allows the device to be probed directly at the device with minimal common lead inductance to ground. Therefore there will be a slight difference in the nominal gain obtained at the test frequency using the 300um G-S wafer probe versus the 300um G-S-G printed circuit board substrate method.

Outline Drawing



Notes:
Solderable area of the device shown in yellow.
Dimensions in mm.
Tolerance ± 0.015 mm

Suggested PCB Material and 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.

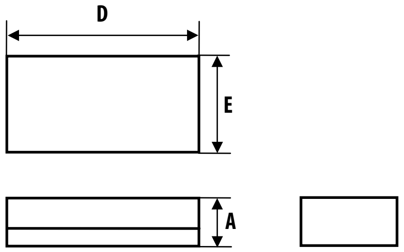
Manual Assembly for Prototypes

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 260°C for 20 to 40 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.

Ordering Information

Part Number	Devices Per Container	Container
VMMK-2203-BLKG	100	Antistatic Bag
VMMK-2203-TR1G	5000	7″ Reel

Package Dimension Outline

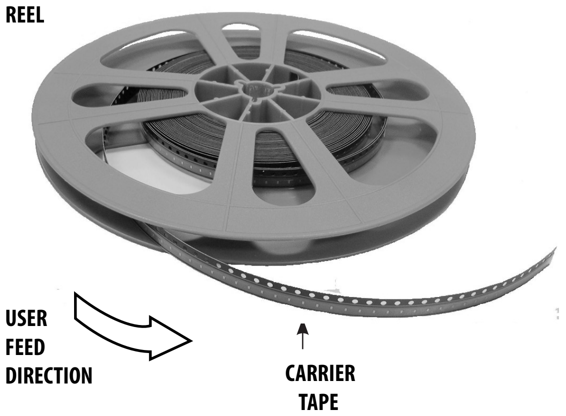


Die dimension:

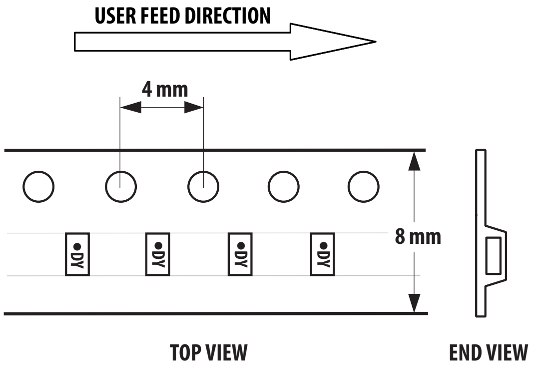
Dim	Range	Unit
D	1.004 - 1.085	mm
E	0.500 - 0.585	mm
A	0.225 - 0.275	mm

Note:
All dimensions are in mm

Reel Orientation

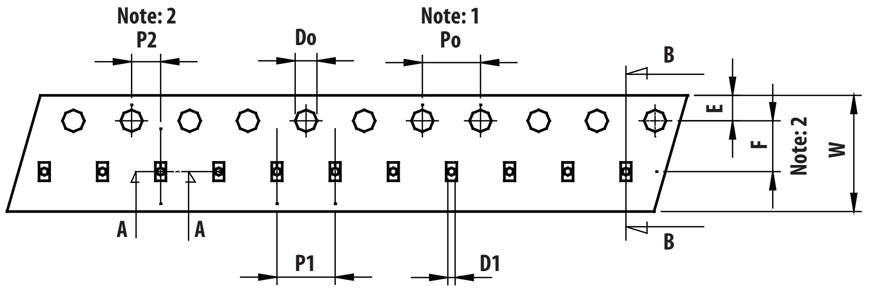


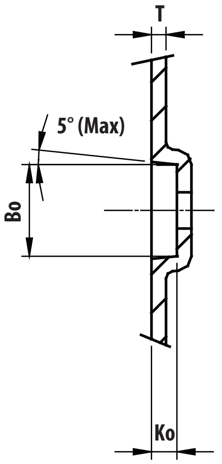
Device Orientation



Note:
“D” = Device Code
”Y” = Month Code

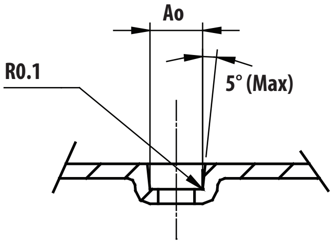
Tape Dimensions





Scale 5:1

B–B SECTION



Scale 5:1

A–A SECTION

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 1m per 100mm through a length of 250mm.

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