

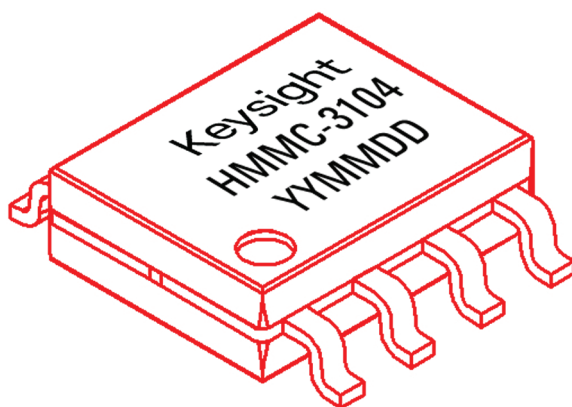
## Keysight Technologies

# HMMC-3104 DC-16 GHz Packaged Divide-by-4 Prescaler

1GC1-8202-TR1-7" diameter reel/500 each

1GC1-8202-BLK-bubble strip/10 each

Data Sheet



## Features

- Wide frequency range:  
0.2 - 16 GHz
- High input power sensitivity:  
On-chip pre- and post-amps
  - 20 to +10 dBm (1 - 10 GHz)
  - 15 to +10 dBm (10 - 12 GHz)
  - 10 to +5 dBm (12 - 15 GHz)
- $P_{out}$ : +6 dBm (0.99  $V_{p-p}$ )  
will drive ECL
- Low phase noise:  
-153 dBc/Hz @ 100 kHz offset
- (+) or (-) Single supply bias  
with wide range: 4.5 to 6.5 V
- Differential I/O with on-chip  
50  $\Omega$  matching

## Description

The Keysight Technologies, Inc. HMMC-3104 is a packaged GaAs HBT MMIC pre-scaler which offers dc to 16 GHz frequency translation for use in communications and EW systems incorporating high-frequency PLL oscillator circuits and signal-path down conversion applications. The prescaler provides a large input power sensitivity window and low phase noise.

## Absolute maximum ratings<sup>1</sup>

(@  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise indicated)

Symbol	Parameters/conditions	Min	Max	Units
$V_{CC}$	Bias supply voltage		+7	volts
$V_{EE}$	Bias supply voltage	-7		volts
$V_{CC}-V_{EE}$	Bias supply delta	0	+7	volts
$V_{Logic}$	Logic threshold voltage	$V_{CC} - 1.5$	$V_{CC} - 1.2$	volts
$P_{in(CW)}$	CW RF input power		+10	dBm
$V_{RFIn}$	DC input voltage (@ $RF_{in}$ or $RF_{in}$ ports)		$V_{CC} \pm 0.5$	volts
$T_{BS}^2$	Backside ambient temperature	-40	+85	$^\circ\text{C}$
$T_{st}$	Storage temperature	-65	+165	$^\circ\text{C}$
$T_{max}$	Max. assembly temperature (60 s max.)		310	$^\circ\text{C}$

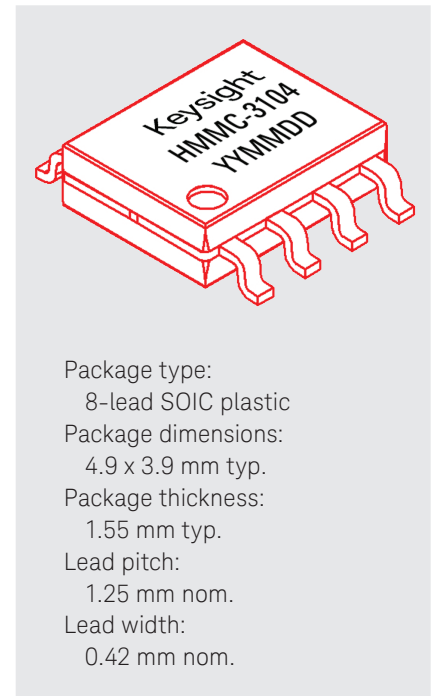
1. Operation in excess of any parameter limit (except  $T_{BS}$ ) may cause permanent damage to the device.
2.  $MTTF > 1 \times 10^6$  hours @  $T_{BS} \leq 85\text{ }^\circ\text{C}$ . Operation in excess of maximum operating temperature ( $T_{BS}$ ) will degrade MTTF.

## DC specifications/physical properties<sup>1</sup>

( $T_A = 25\text{ }^\circ\text{C}$ ,  $V_{CC} - V_{EE} = 5.0$  volts, unless otherwise listed)

Symbol	Parameters/conditions	Min	Typ	Max	Units
$V_{CC} - V_{EE}$	Operating bias supply difference <sup>1</sup>	4.5	5.0	6.5	Volts
$ I_{CC} $ or $ I_{EE} $	Bias supply current	68	80	92	mA
$V_{RFIn(q)}$ , $V_{RFout(q)}$	Quiescent dc voltage appearing at all RF ports		$V_{CC}$		Volts
$V_{Logic}$	Nominal ECL Logic Level ( $V_{Logic}$ contact self-bias voltage, generated on-chip)	$V_{CC} - 1.45$	$V_{CC} - 1.35$	$V_{CC} - 1.25$	Volts

1. Prescaler will operate over full specified supply voltage range,  $V_{CC}$  or  $V_{EE}$  not to exceed limits specified in *Absolute maximum ratings* section.



## RF specifications

( $T_A = 25\text{ }^\circ\text{C}$ ,  $Z_0 = 50\ \Omega$ ,  $V_{CC} - V_{EE} = 5.0\text{ volts}$ )

Symbol	Parameters/conditions	Min	Typ	Max	Units
$f_{in(max)}$	Maximum input frequency of operation	16	18		GHz
$f_{in(min)}$	Minimum input frequency of operation <sup>1</sup> ( $P_{in} = -10\text{ dBm}$ )		0.2	0.5	GHz
$f_{Self-Osc.}$	Output self-oscillation frequency <sup>2</sup>		3.4		GHz
	@ DC (Square-wave input)	-15	> -25	+10	dBm
	@ $f_{in} = 500\text{ MHz}$ (Sine-wave input)	-15	> -20	+10	dBm
$P_{in}$	$f_{in} = 1\text{ to }10\text{ GHz}$	-15	> -25	+10	dBm
	$f_{in} = 10\text{ to }12\text{ GHz}$	-10	> -15	+10	dBm
	$f_{in} = 12\text{ to }15\text{ GHz}$	-4	> -10	+4	dBm
RL	Small-signal input/output return loss (@ $f_{in} < 12\text{ GHz}$ )		15		dB
$S_{12}$	Small-signal reverse isolation (@ $f_{in} < 12\text{ GHz}$ )		30		dB
$\phi_N$	SSB phase noise (@ $P_{in} = 0\text{ dBm}$ , 100 kHz offset from a $f_{out} = 1.2\text{ GHz}$ carrier)		-153		dBc/Hz
Jitter	Input signal time variation @ zero-crossing ( $f_{in} = 10\text{ GHz}$ , $P_{in} = -10\text{ dBm}$ )		1		ps
$T_r$ or $T_f$	Output transition time (10% to 90% rise/fall time)		70		ps
$P_{out}^3$	@ $f_{out} < 1\text{ GHz}$	4	6		dBm
	@ $f_{out} = 2.5\text{ GHz}$	3.5	5.5		dBm
	@ $f_{out} = 3.5\text{ GHz}$	0	2.0		dBm
$ V_{out(p-p)} ^4$	@ $f_{out} < 1\text{ GHz}$		0.99		Volts
	@ $f_{out} = 2.5\text{ GHz}$		0.94		Volts
	@ $f_{out} = 3.5\text{ GHz}$		0.63		Volts
$P_{Spitback}$	$f_{out}$ power level appearing at $RF_{in}$ or $\overline{RF}_{in}$ (@ $f_{in} = 12\text{ GHz}$ , unused $RF_{out}$ or $\overline{RF}_{out}$ unterminated)		-40		dBm
	$f_{out}$ power level appearing at $RF_{in}$ or $\overline{RF}_{in}$ (@ $f_{in} = 12\text{ GHz}$ , both $RF_{out}$ and $\overline{RF}_{out}$ terminated)		-47		dBm
$P_{feedthru}$	Power level of $f_{in}$ appearing at $RF_{out}$ or $\overline{RF}_{out}$ (@ $f_{in} = 10\text{ GHz}$ , $P_{in} = 0\text{ dBm}$ , referred to $P_{in}(f_{in})$ )		-23		dBc
$H_2$	Second harmonic distortion output level (@ $f_{out} = 3.0\text{ GHz}$ , referred to $P_{out}(f_{out})$ )		-25		dBc

1. For sine-wave input signal. Prescaler will operate down to D.C. for square-wave input signal. Minimum divide frequency limited by input slew-rate.
2. Prescaler may exhibit this output signal under bias in the absence of an RF input signal. This condition may be eliminated by use of the Input dc offset technique described on page 4.
3. Fundamental of output square wave's Fourier Series.
4. Square wave amplitude calculated from  $P_{out}$ .

## Applications

The HMMC-3104 is designed for use in high frequency communications, microwave instrumentation, and EW radar systems where low phase-noise PLL control circuitry or broad-band frequency translation is required.

## Operation

The device is designed to operate when driven with either a single-ended or differential sinusoidal input signal over a 200 MHz to 16 GHz bandwidth. Below 200 MHz the prescaler input is “slew-rate” limited, requiring fast rising and falling edge speeds to properly divide. The device will operate at frequencies down to dc when driven with a square-wave.

Due to the presence of an off-chip RF-bypass capacitor inside the package (connected to the VCC contact on the device), and the unique design of the device itself, the component may be biased from either a single positive or single negative supply bias. The backside of the package is not dc connected to any dc bias point on the device.

For positive supply operation, VCC pins are nominally biased at any voltage in the +4.5 to +6.5 volt range with pin 8 (VEE) grounded. For negative bias operation VCC pins are typically grounded and a negative voltage between -4.5 to -6.5 volts is applied to pin 8 (VEE).

## ac-Coupling and dc-Blocking

All RF ports are dc connected on-chip to the VCC contact through on-chip 50  $\Omega$  resistors. Under any bias conditions where VCC is not dc grounded the RF ports should be ac coupled via series capacitors mounted on the PC-board at each RF port. Only under bias conditions where VCC is dc grounded (as is typical for negative bias supply operation) may the RF ports be direct coupled to adjacent circuitry or in some cases, such as level shifting to subsequent stages. In the latter case the package heat sink may be “floated” and bias applied as the difference between VCC and VEE.

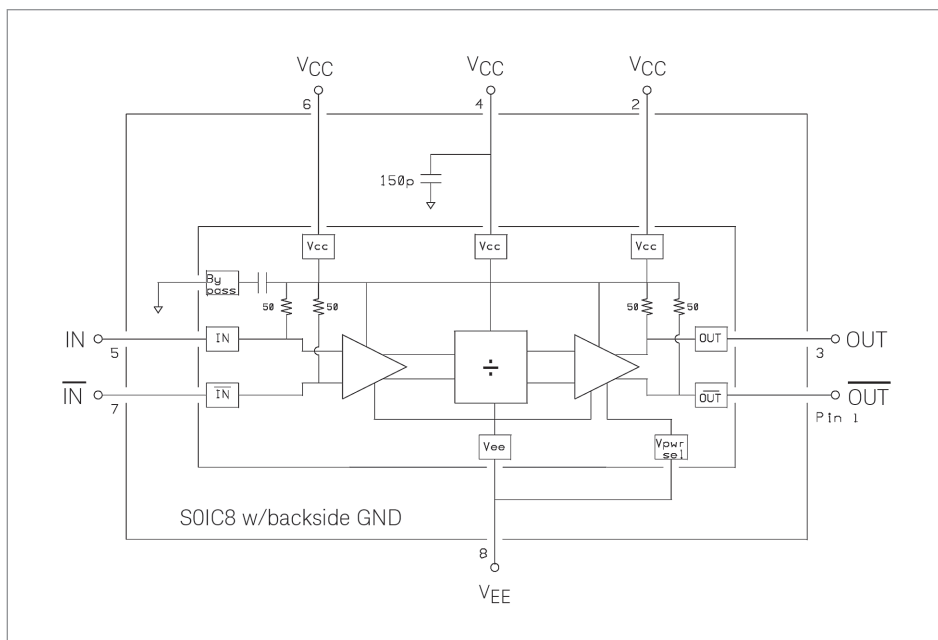


Figure 1. Simplified schematic diagram

## Input dc Offset

If an RF signal with sufficient signal to noise ratio is present at the RF input lead, the prescaler will operate and provide a divided output equal the input frequency divided by the divide modulus. Under certain “ideal” conditions where the input is well matched at the right input frequency, the component may “self-oscillate”, especially under small signal input powers or with only noise present at the input. This “self-oscillation” will produce a undesired output signal also known as a false trigger. To prevent false triggers or self-oscillation conditions, apply a 20 to 100 mV dc offset voltage between the RFin and RF<sub>in</sub> ports. This prevents noise or spurious low level signals from triggering the divider.

Adding a 10 k $\Omega$  resistor between the unused RF input to a contact point at the V<sub>EE</sub> potential will result in an offset of  $\approx$  25 mV between the RF inputs. Note however, that the input sensitivity will be reduced slightly due to the presence of this offset.

## Assembly Notes

Independent of the bias applied to the package, the backside of the package should always be connected to both a good RF ground plane and a good thermal heat sinking region on the PC board to optimize performance. For single-ended output operation the unused RF output lead should be terminated into 50  $\Omega$  to a contact point at the VCC potential or to RF ground through a dc blocking capacitor.

A minimum RF and thermal PC board contact area equal to or greater than 2.67  $\times$  1.65 mm (0.105”  $\times$  0.065”) with eight 0.020” diameter plated-wall thermal vias is recommended.

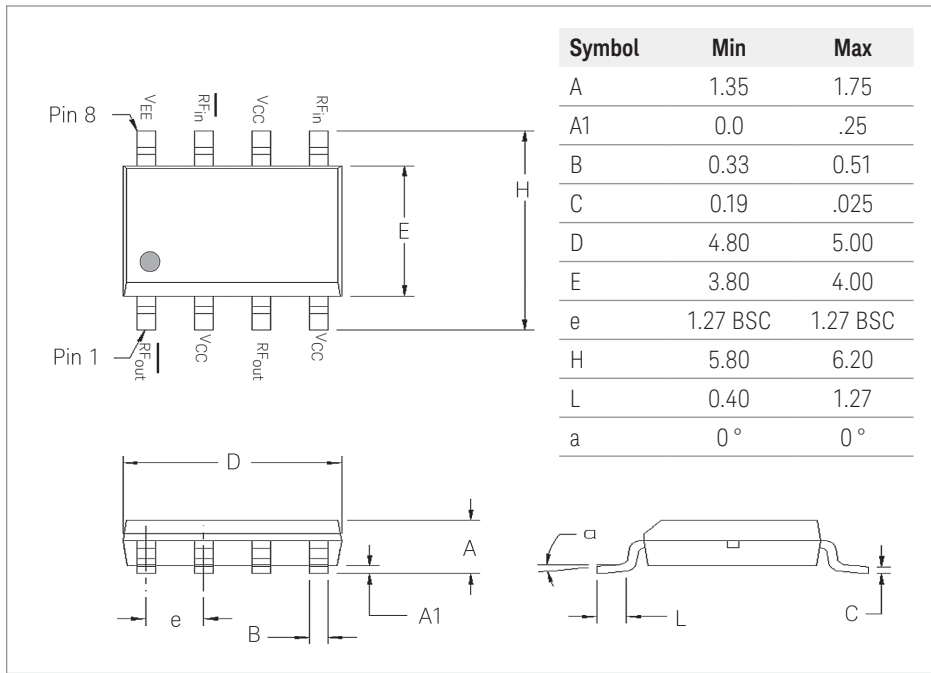
MMIC ESD precautions, handling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

Keysight application note, literature number 5991-3484EN, *GaAs MMIC ESD, Die Attach and Bonding Guidelines* provides basic information on these subjects.

Moisture Sensitivity Classification: Class 5A, per JESD22-A112-A.

## Additional References

Keysight Technologies Technical Overview, literature number 5991-3578EN, *HBT Prescaler Evaluation Board*.



## Notes

- All dimensions in millimeters.
- Refer to JEDEC Outline MS-012 for additional tolerances.
- Exposed heat slug area on package bottom =  $2.67 \times 1.65$ .
- Exposed heat sink on package bottom must be soldered to PCB rf ground plane.

Figure 2. Package and dimensions

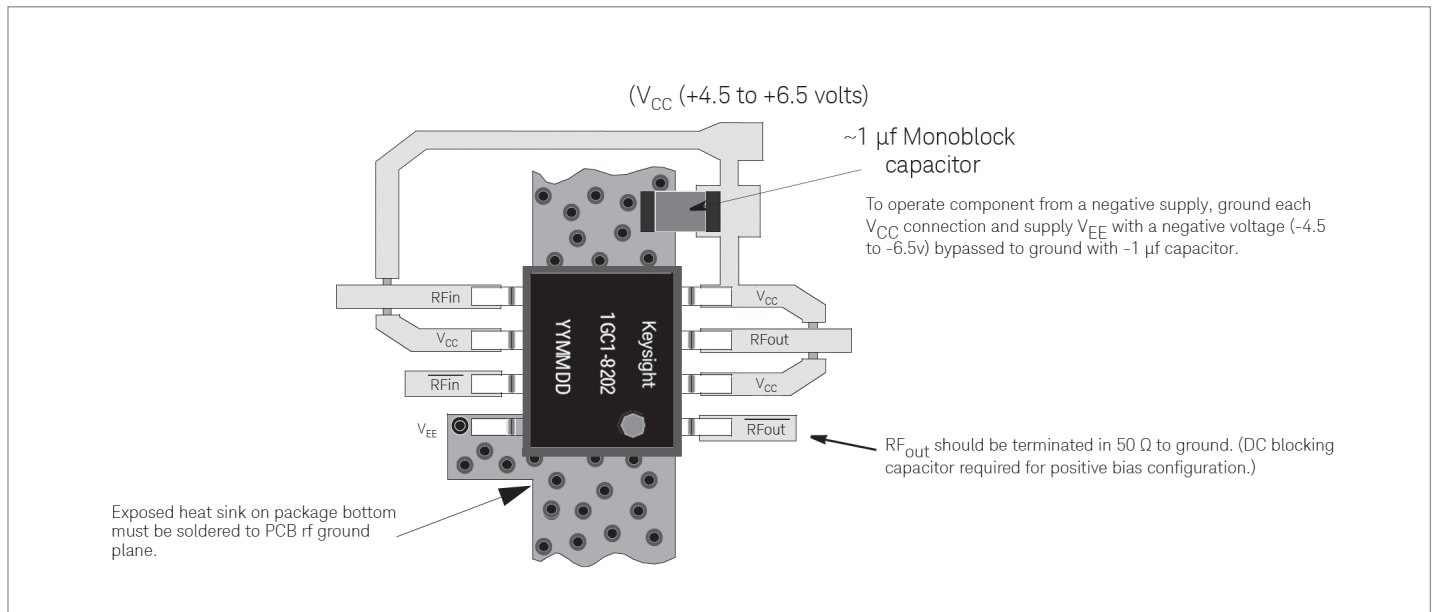


Figure 3. Assembly diagram (Single-supply, positive-bias configuration shown)

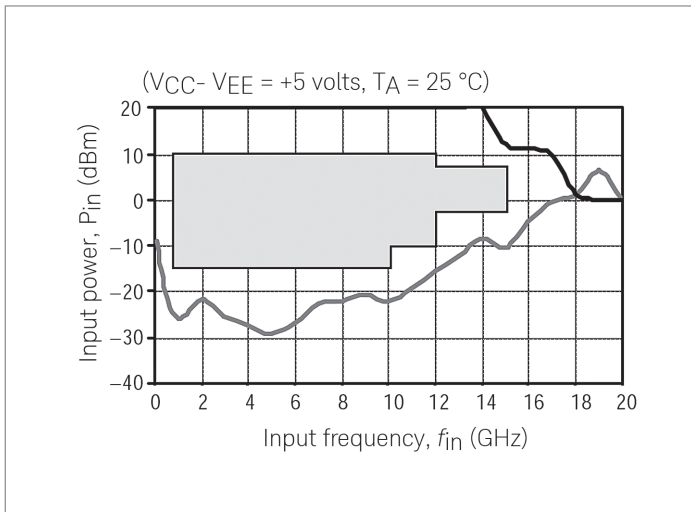


Figure 4. Typical input sensitivity window

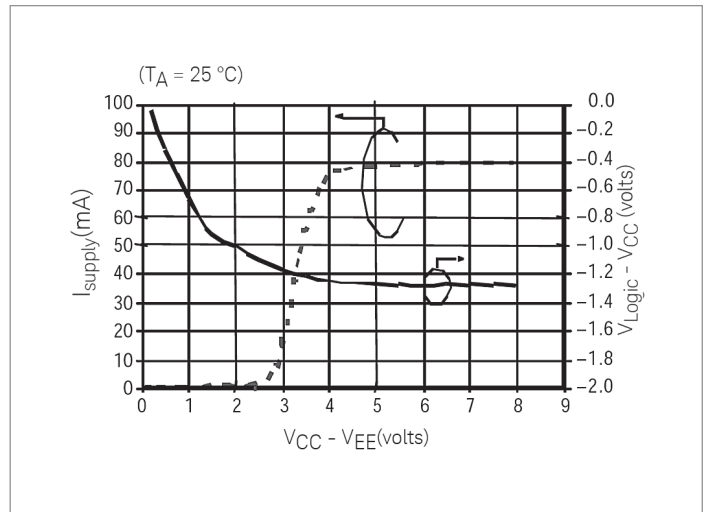


Figure 5. Typical supply current &  $V_{L\text{Logic}}$  vs. supply voltage

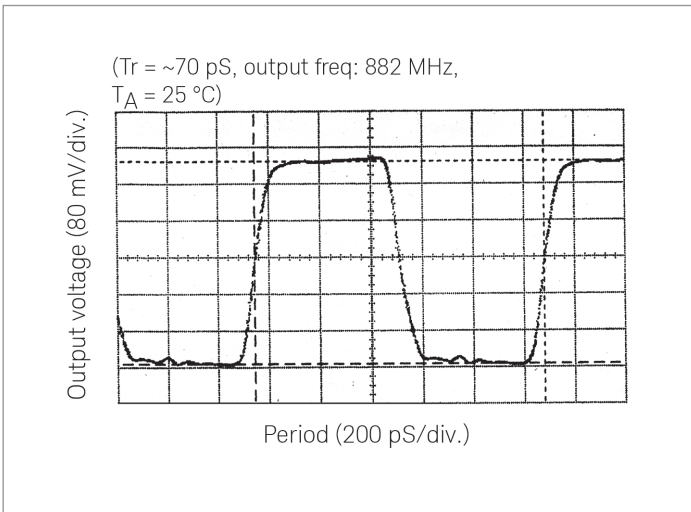


Figure 6. Typical output voltage waveform

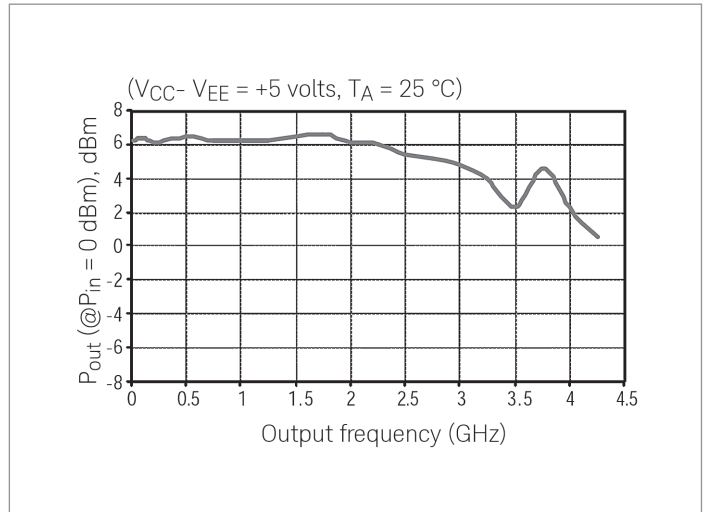


Figure 7. Typical output power vs. output frequency,  $f_{\text{out}}$  (GHz)

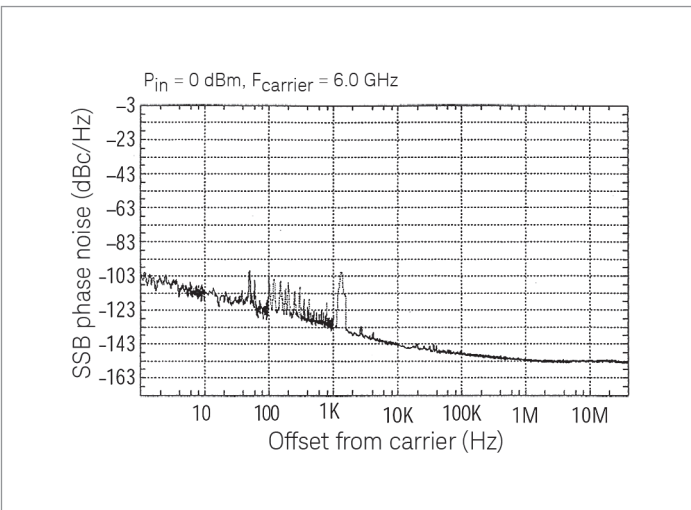


Figure 8. Typical phase noise performance

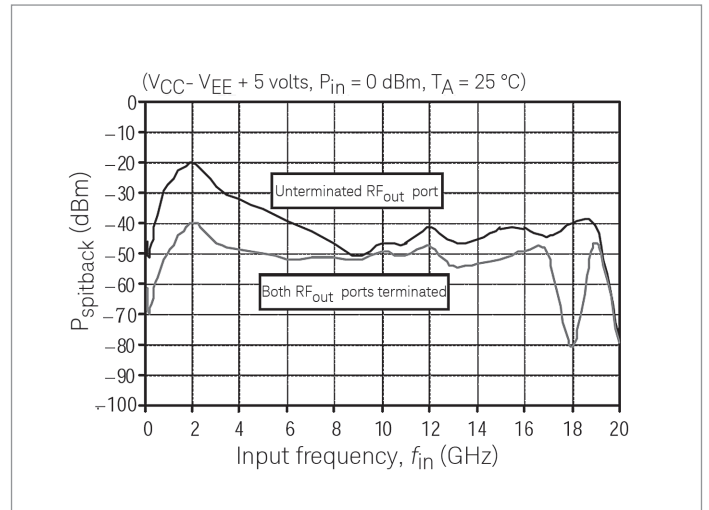
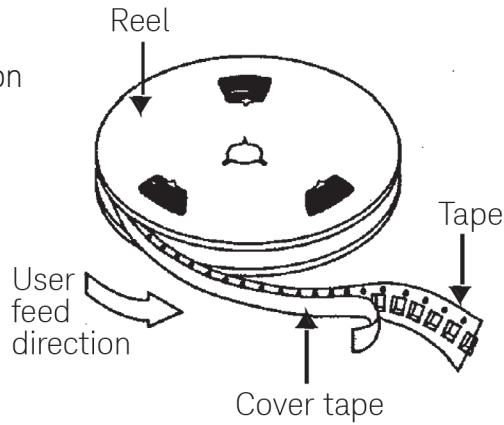


Figure 9. Typical HMMC-3104 "Spitback" power  $P(f_{\text{out}})$  appearing at RF input port

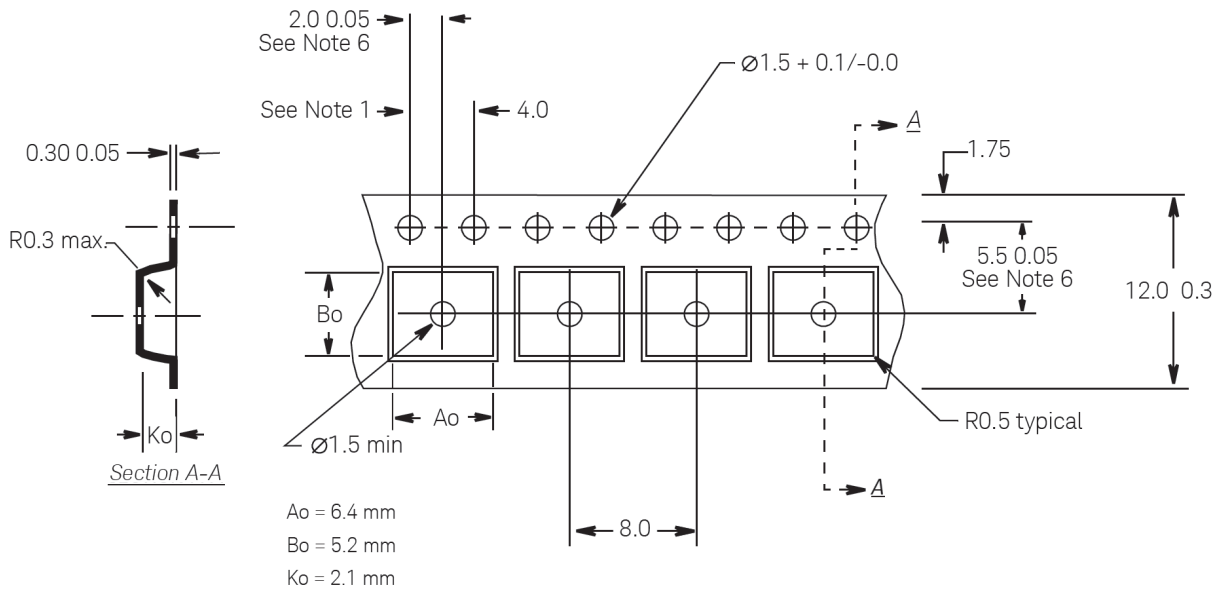
Device orientation



Notes

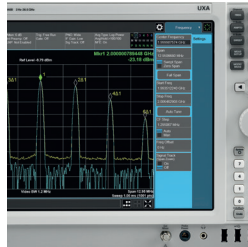
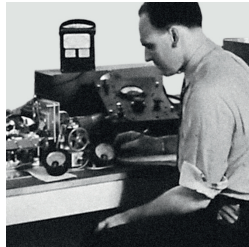
1. 10 sprocket hole pitch cumulative tolerance: 0.2 mm.
2. Camber not to exceed 1 mm in 100 mm.
3. Material: Black Conductive Advantek Polystyrene.
4. Ao and Bo measured on a plane 0.3 mm above the bottom of the pocket.
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

Tape dimensions and product orientation



This data sheet contains a variety of typical and guaranteed performance data. The information supplied should not be interpreted as a complete list of circuit specifications. Customers considering the use of this, or other Keysight Technologies GaAs ICs, for their design should obtain the current production specifications from Keysight. In this data sheet the term typical refers to the 50th percentile performance. For additional information contact Keysight at [MMIC\\_Helpline@keysight.com](mailto:MMIC_Helpline@keysight.com).

From Hewlett-Packard through Agilent to Keysight  
 For more than 75 years, we've been helping you unlock measurement insights.  
 Our unique combination of hardware, software and people can help you reach  
 your next breakthrough. **Unlocking measurement insights since 1939.**



For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

**Americas**

Canada (877) 894 4414  
 Brazil 55 11 3351 7010  
 Mexico 001 800 254 2440  
 United States (800) 829 4444

**Asia Pacific**

Australia 1 800 629 485  
 China 800 810 0189  
 Hong Kong 800 938 693  
 India 1 800 11 2626  
 Japan 0120 (421) 345  
 Korea 080 769 0800  
 Malaysia 1 800 888 848  
 Singapore 1 800 375 8100  
 Taiwan 0800 047 866  
 Other AP Countries (65) 6375 8100

**Europe & Middle East**

Austria 0800 001122  
 Belgium 0800 58580  
 Finland 0800 523252  
 France 0805 980333  
 Germany 0800 6270999  
 Ireland 1800 832700  
 Israel 1 809 343051  
 Italy 800 599100  
 Luxembourg +32 800 58580  
 Netherlands 0800 0233200  
 Russia 8800 5009286  
 Spain 800 000154  
 Sweden 0200 882255  
 Switzerland 0800 805353  
 Opt. 1 (DE)  
 Opt. 2 (FR)  
 Opt. 3 (IT)  
 United Kingdom 0800 0260637

For other unlisted countries:  
[www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)  
 (BP-07-24-15)



[www.keysight.com/go/quality](http://www.keysight.com/go/quality)  
 Keysight Technologies, Inc.  
 DEKRA Certified ISO 9001:2008  
 Quality Management System

This information is subject to change without notice.  
 © Keysight Technologies, 2007 - 2015  
 Published in USA, September 28, 2015  
 5989-7350EN  
[www.keysight.com](http://www.keysight.com)

**myKeysight**

[www.keysight.com/find/mykeysight](http://www.keysight.com/find/mykeysight)  
 A personalized view into the information most relevant to you.

**Three-Year Warranty**

[www.keysight.com/find/ThreeYearWarranty](http://www.keysight.com/find/ThreeYearWarranty)  
 Keysight's committed to superior product quality and lower total cost of ownership. Keysight is the only test and measurement company with three-year warranty standard on all instruments, worldwide. And, we provide a full one-year warranty on all accessories, calibration devices, systems and custom products.



**Keysight Assurance Plans**

[www.keysight.com/find/AssurancePlans](http://www.keysight.com/find/AssurancePlans)  
 Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.



**Keysight Infoline**

[www.keysight.com/find/service](http://www.keysight.com/find/service)  
 Keysight's insight to best in class information management. Free access to your Keysight equipment company reports and e-library.

**Keysight Infoline**

**Keysight Channel Partners**

[www.keysight.com/find/channelpartners](http://www.keysight.com/find/channelpartners)  
 Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

[www.keysight.com/find/mmic](http://www.keysight.com/find/mmic)