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Sales & Customer Support: sales@markimicrowave.com
Tech Support: support@markimicrowave.com

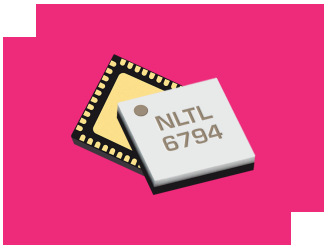
NLTL-6794SM

GaAs MMIC Non-Linear Transmission Line

DEVICE OVERVIEW

General Description

NLTL-6794SM is a MMIC non-linear transmission line (NLTL) based comb generator. This NLTL offers excellent phase noise performance over a low 100MHz to 1 GHz input frequency range with output tones beyond 30 GHz. NLTL-6794SM is fabricated with GaAs Schottky diode-based varactors and packaged into a surface mount 6x6 mm² QFN.



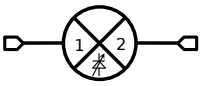
Features

- Low Phase Noise
- Broadband Input Frequencies
- No External DC Bias Required

Applications

- Comb Line Generation
- High Efficiency Multiplication
- Samplers
- Phase Locked Loops

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
NLTL-6794SM	GaAs MMIC Non-Linear Transmission Line	QFN	RoHS REACH	Released	EAR99
EVAL-NLTL-6794	Evaluation Board, GaAs MMIC 0.1-1 GHz Non-Linear Transmission Line	EVAL	RoHS REACH	Released	EAR99

Table Of Contents

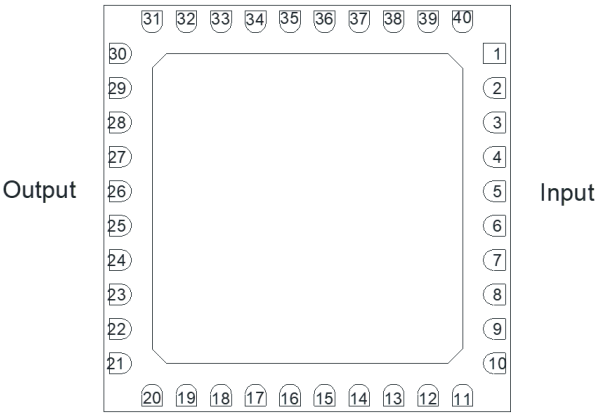
Revision History

Revision Code	Revision Date	Comment
-	2019-12-01	Initial Release
A	2022-01-01	Phase Noise Plot Added
B	2022-10-01	Recommended Input Power Updated

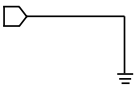
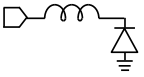
Port Configuration and Functions

Port Diagram

A bottom-up view of the NLTL-6794's SM package outline drawing is shown below. The NLTL should only be used in the forward direction, with the input and output ports given in Port Functions.



Port Functions

Port	Function	Description	DC Equivalent Circuit
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 26	Output	2x Input Frequency output port. Pin 26 is diode connected and AC matched to 50Ω.	
Pin 5	Input	Input 1x Frequency Port. Pin 5 is diode connected and AC matched to 50Ω.	

Specifications

Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Unit
Maximum Operating Temperature	100	°C
Maximum Storage Temperature	125	°C
Minimum Operating Temperature	-55	°C
Minimum Storage Temperature	-65	°C
Power Handling, at any Port	33	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Dimensions	-	6 x 6 mm
Moisture Sensitivity Level	-	MSL 1

Recommended Operating Conditions

The Recommended Operating Conditions indicate the limits inside which the device should be operated to guarantee the performance given in Electrical Specifications. Operating outside these limits may not necessarily cause damage to the device, but the performance may degrade outside the limits of the electrical specifications. For limits, above which damage may occur, see Absolute Maximum Ratings.

Parameter	Min	Nominal	Max	Unit
Ambient Temperature	-55	25	100	°C
Input Power	-	20	28	dBm

Sequencing Requirements

This is a passive NLTL that requires no external DC bias. Self-bias of the diodes is sufficient for operation. It is not required, but is recommended to provide a 50Ω termination to each port before applying RF power.

Electrical Specifications

The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for the NLTL used in the forward direction with a +20 dBm 250MHz sine wave input and no bias resistor (open circuit) unless otherwise stated. Square Wave input generated using either the ADM1-0026PA or the APM-7098PA amplifier at +7V/-0.3V and +8V/+8V respectively. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All bare die are 100% DC tested and visually inspected.

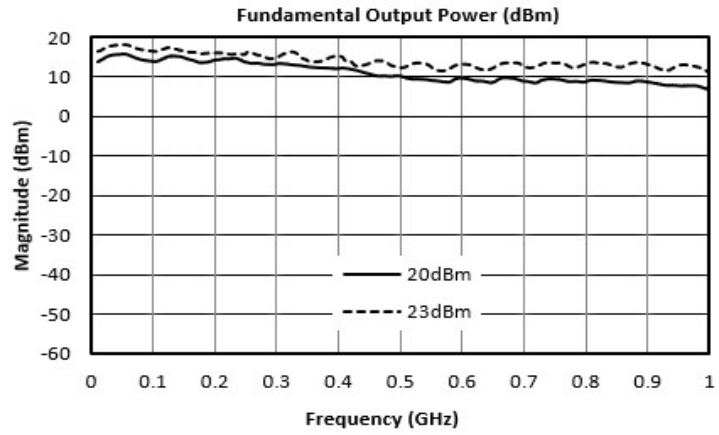
Parameter	Test Conditions	Minimum Frequency (GHz)	Maximum Frequency (GHz)	Min	Typ	Max	Unit
Highest Frequency Harmonic Output [1]	100 MHz Input	-	-	-	6.1	-	GHz
Highest Frequency Harmonic Output [2]	1 GHz Input	-	-	-	22	-	GHz
Highest Frequency Harmonic Output [3]	250 MHz Input	-	-	-	23.25	-	GHz
Highest Frequency Harmonic Output [4]	500 MHz Input	-	-	-	29.5	-	GHz
Highest Frequency Harmonic Output [5]	750 MHz Input	-	-	-	27	-	GHz
Input Frequency Range	-	-	-	0.1	-	1	GHz
Input Power [6]	-	-	-	-	20	-	dBm
Output Frequency Range	-	-	-	0.1	-	30	GHz

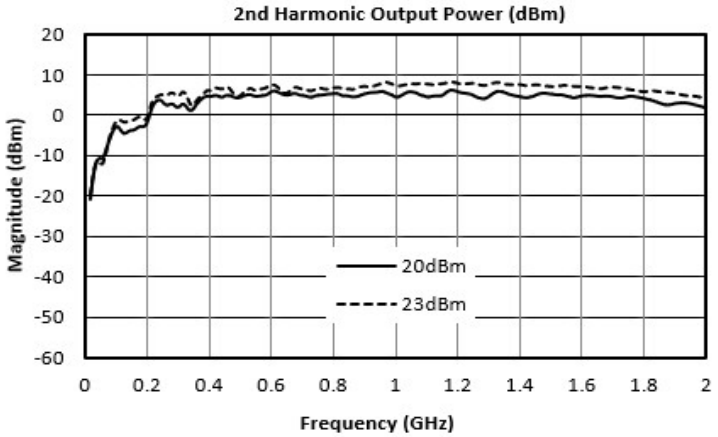
[1][2][3][4][5] The Highest Frequency Harmonic Output was determined as the highest frequency harmonic that was above a -60dBm threshold as seen on a spectrum analyzer.

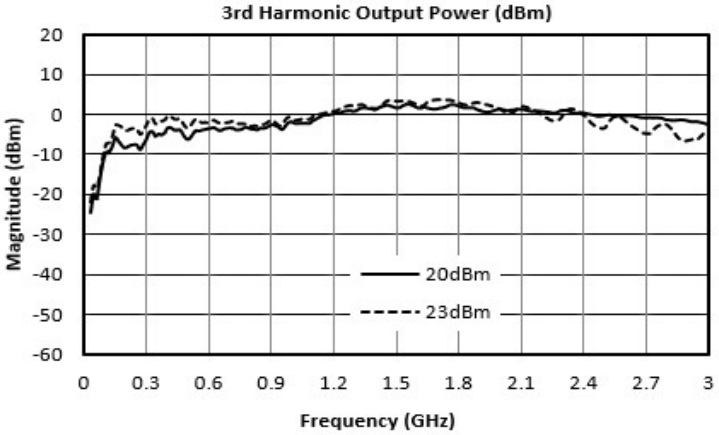
[6] Input power to square wave driver amps is lower but high enough to saturate the amplifier. Power levels in square wave plots refer to input power to the amplifier, not the amplifier's output power.

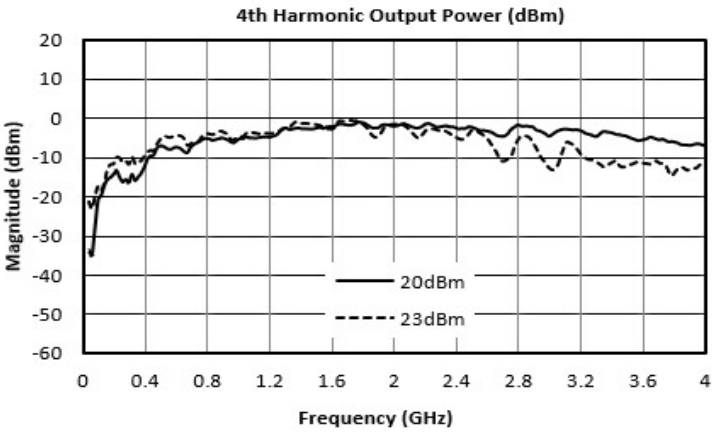
Input power levels refer to drive level going into the NLTL chain input in Application Circuit. Square wave plots are referenced to drive level entering the square wave driver amplifier, not the output power of the amplifiers.

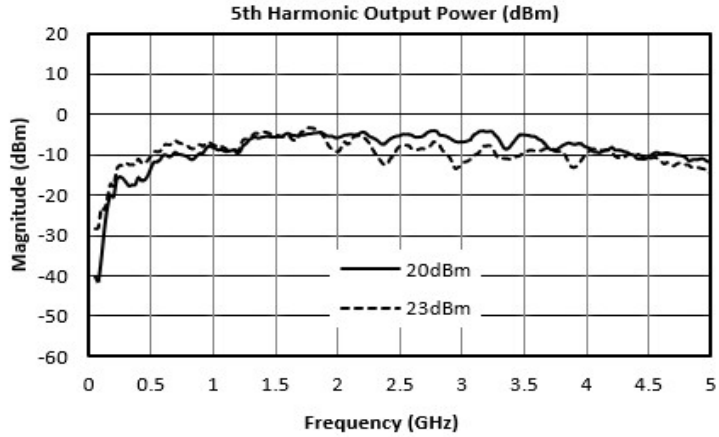
Typical Performance Plots: Harmonic Output Power w/ Sine Input

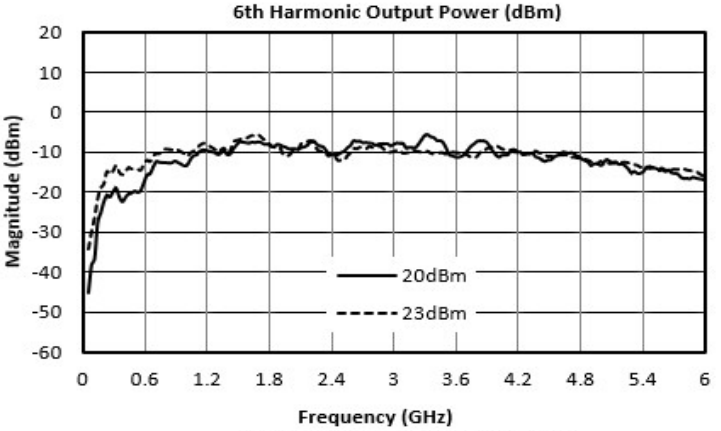


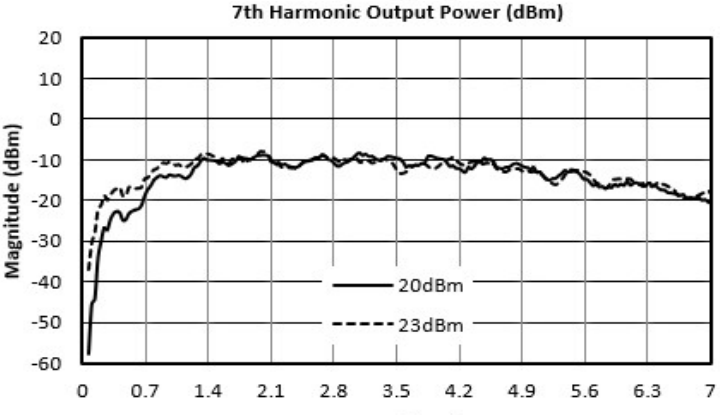


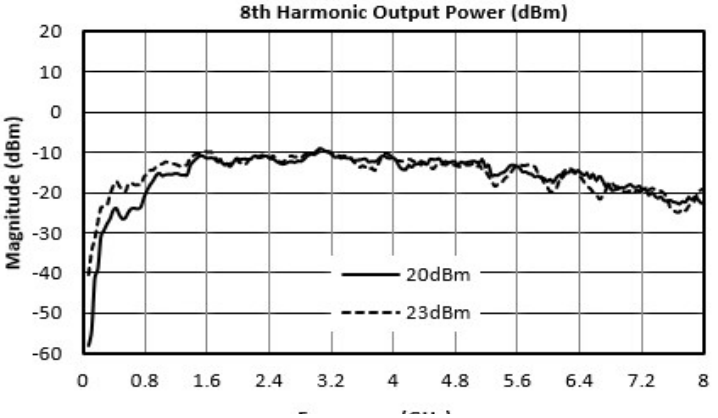


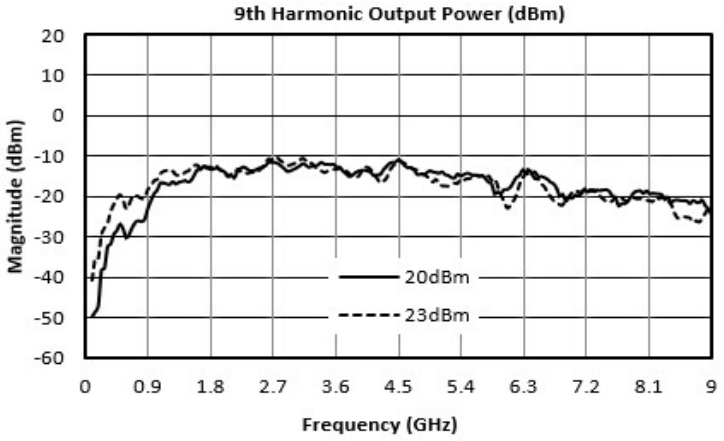


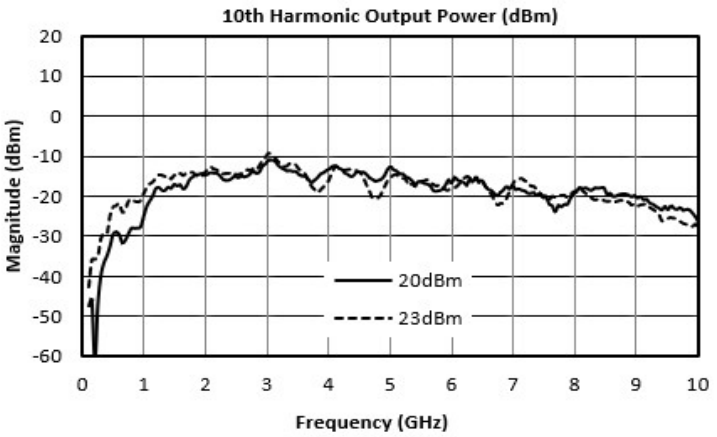


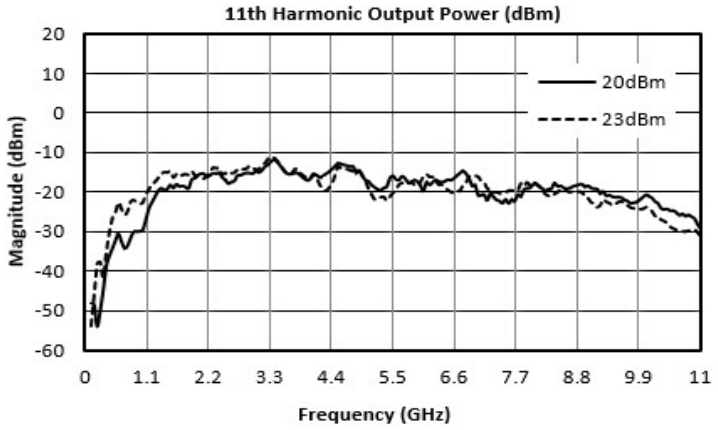


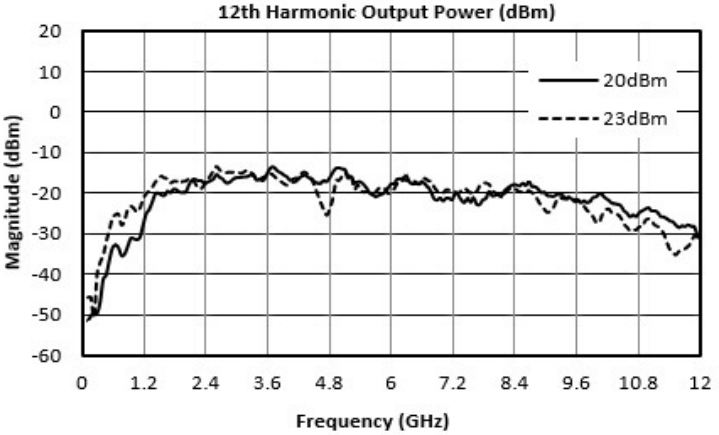


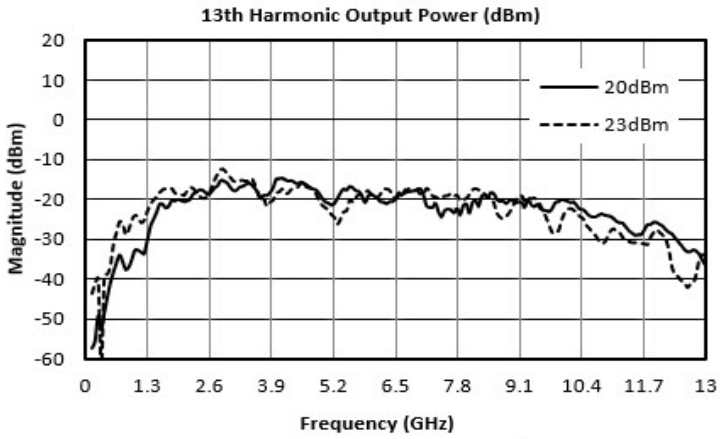


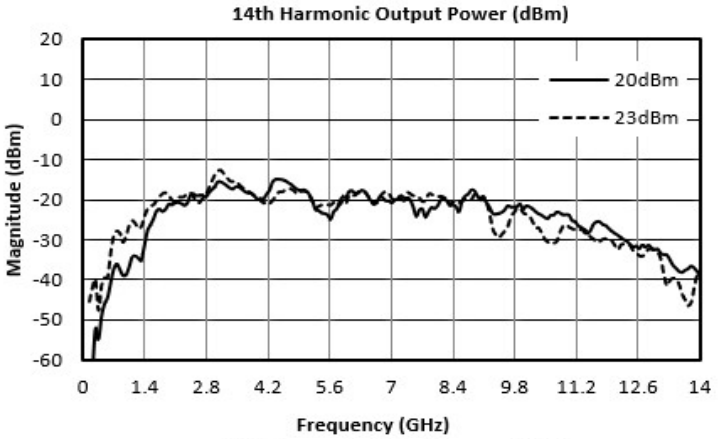


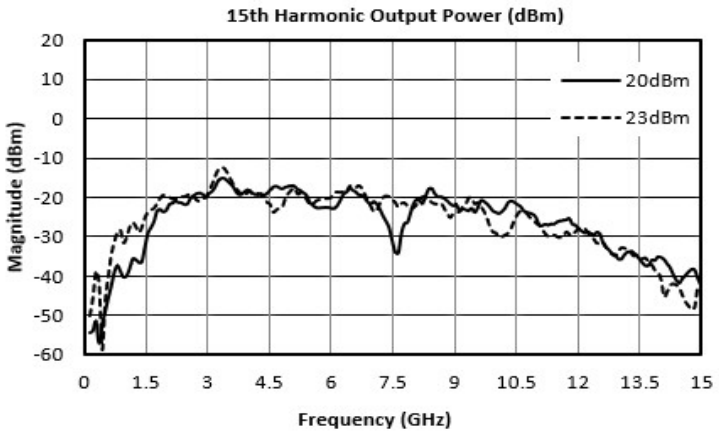


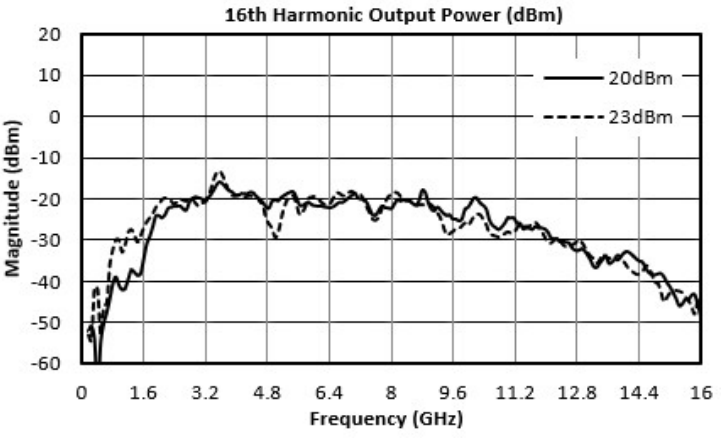


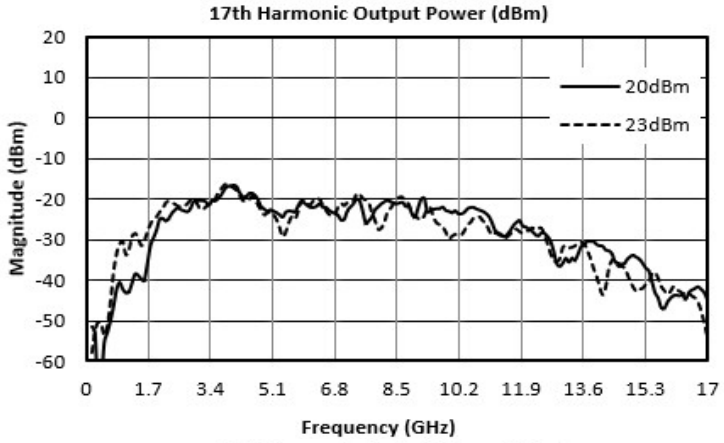


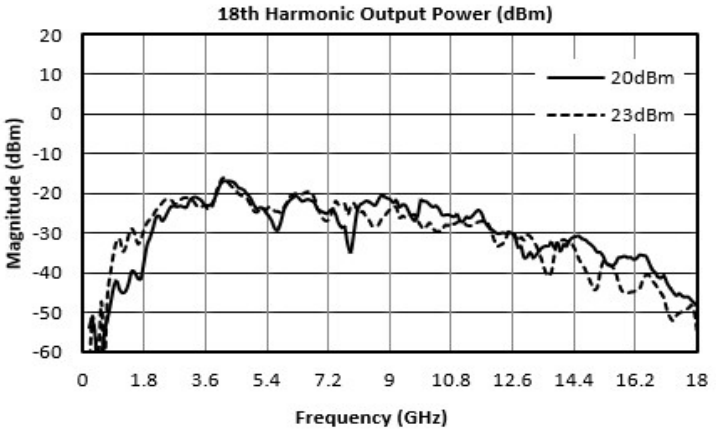


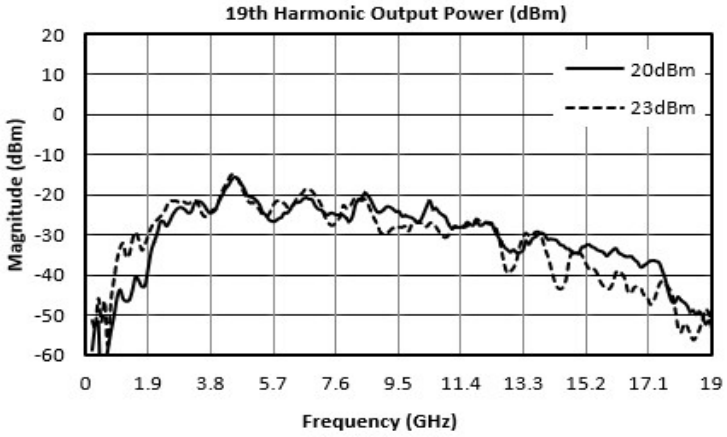


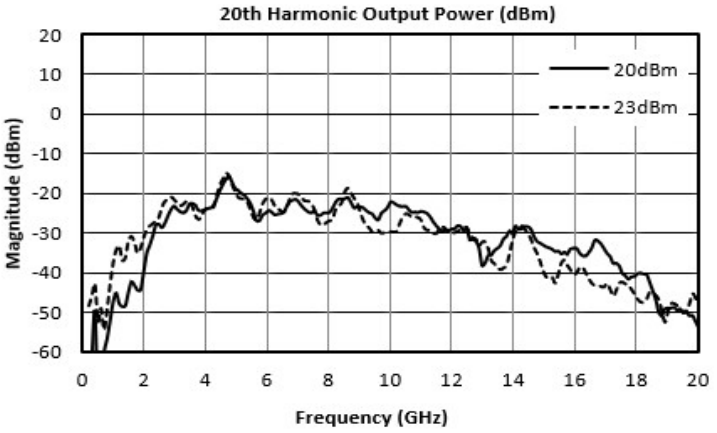




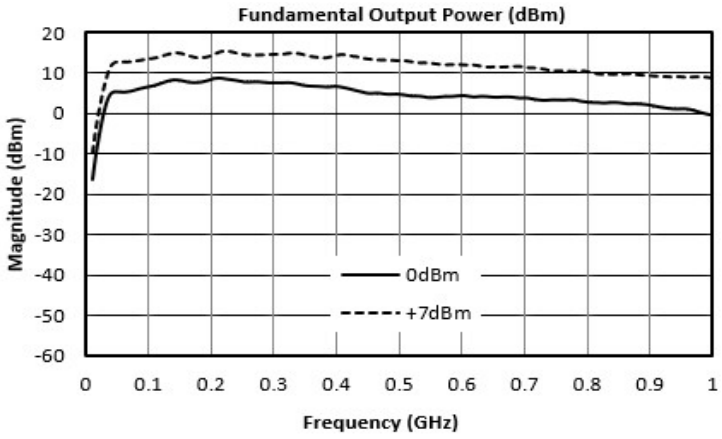


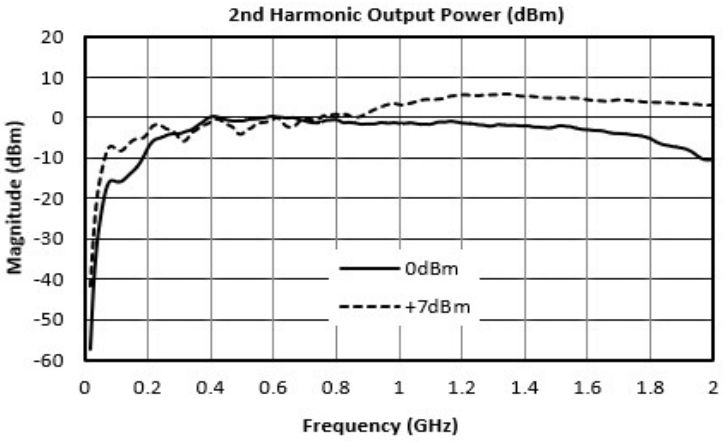


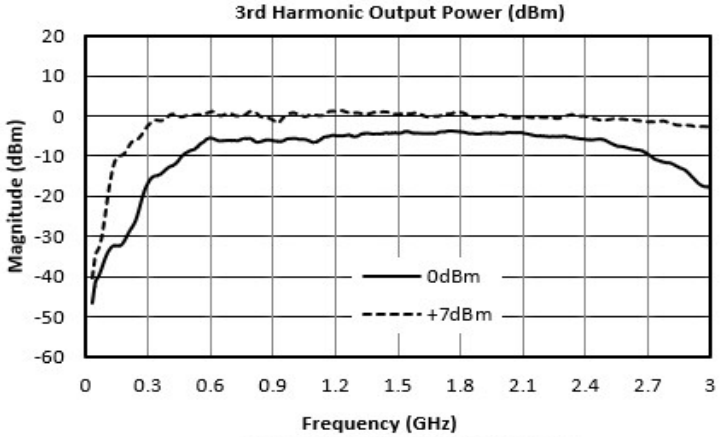


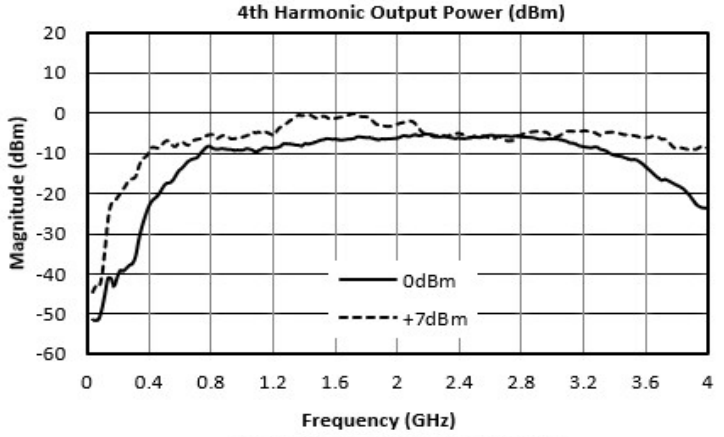


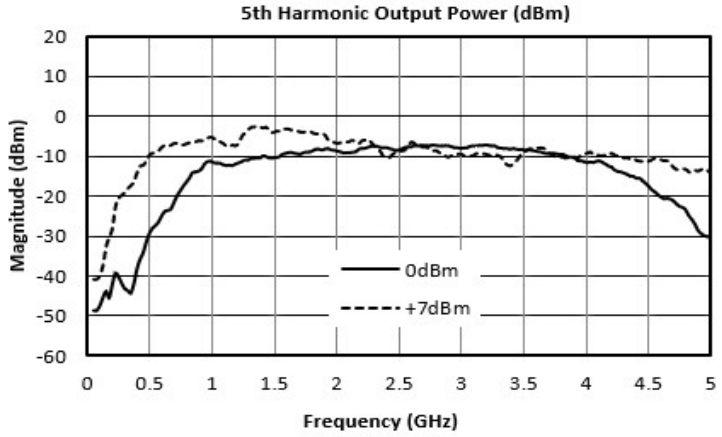
Typical Performance Plots: Harmonic Output Power w/ Square Wave from APM-7098PA

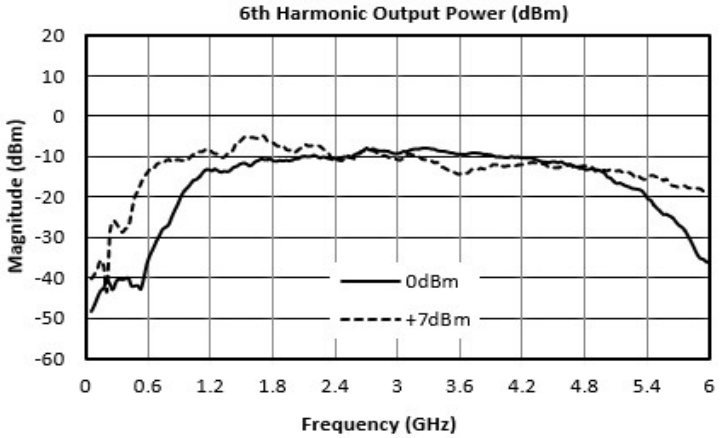


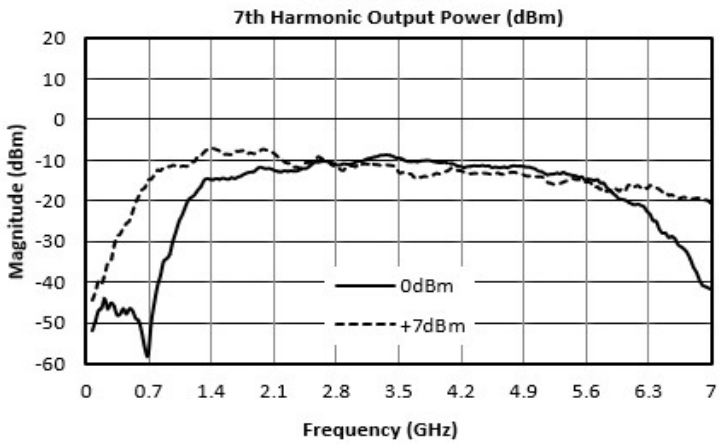


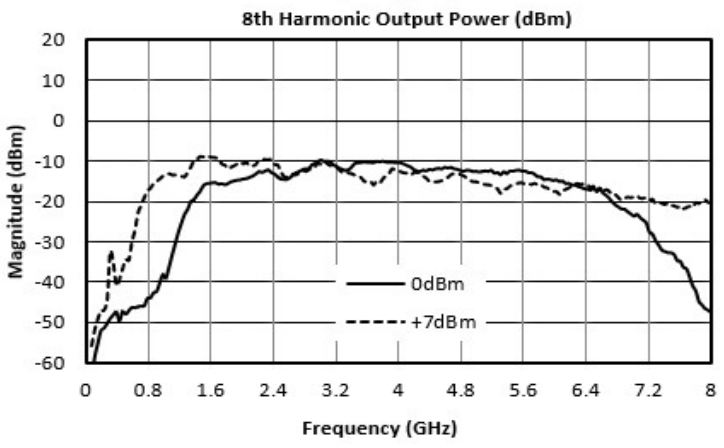




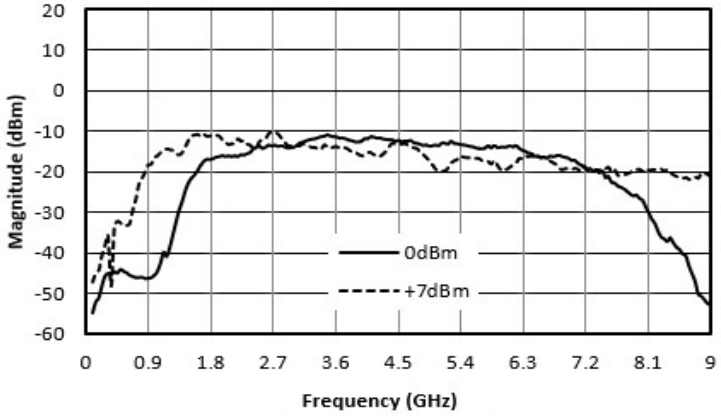




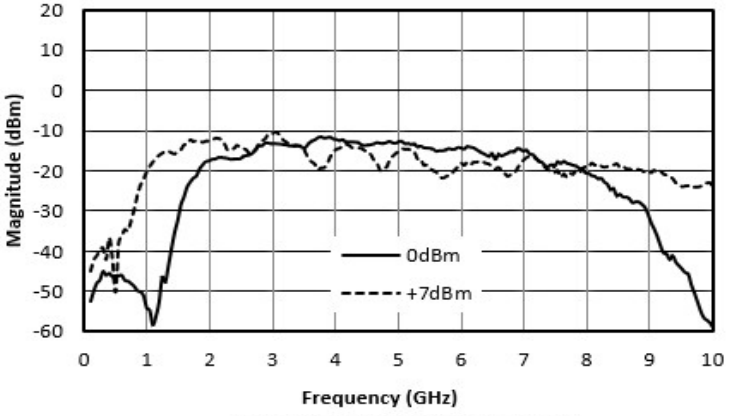




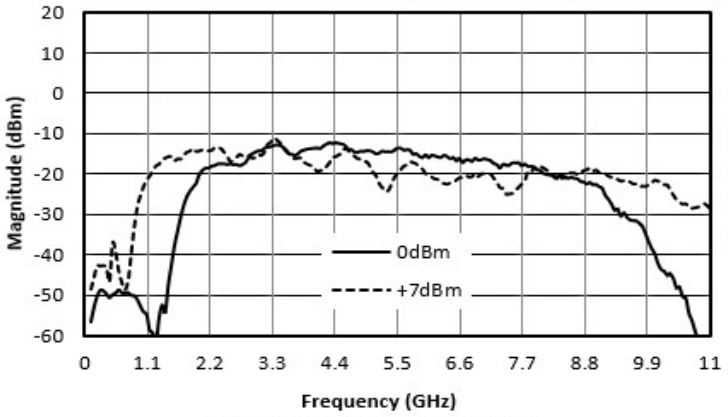
9th Harmonic Output Power (dBm)



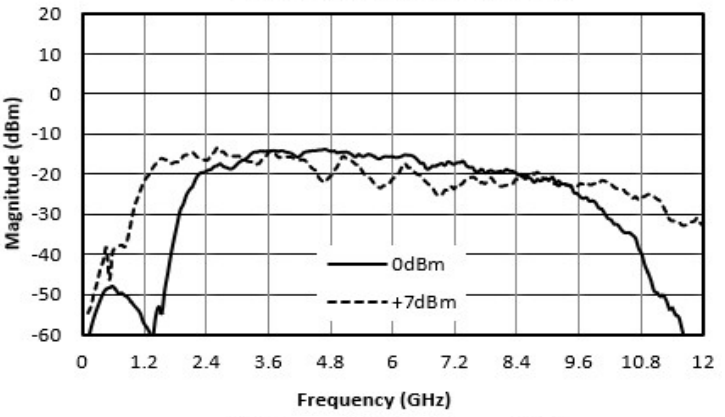
10th Harmonic Output Power (dBm)



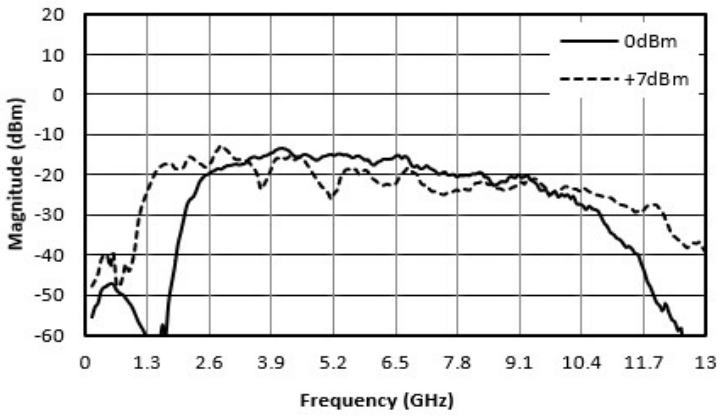
11th Harmonic Output Power (dBm)



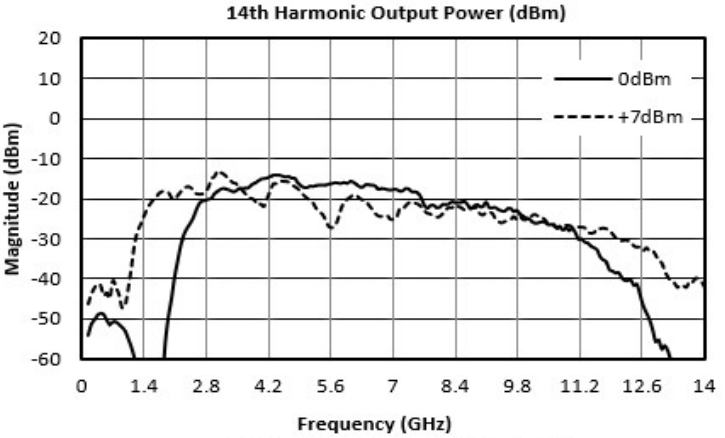
12th Harmonic Output Power (dBm)



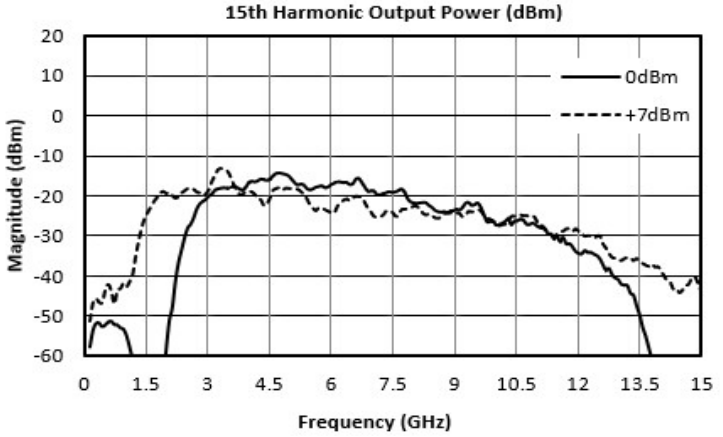
13th Harmonic Output Power (dBm)



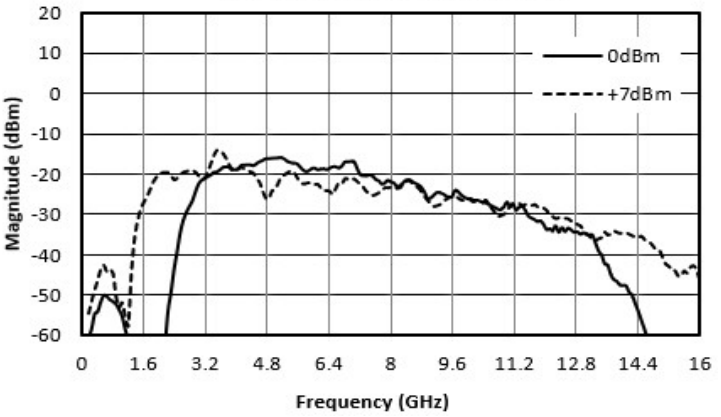
14th Harmonic Output Power (dBm)

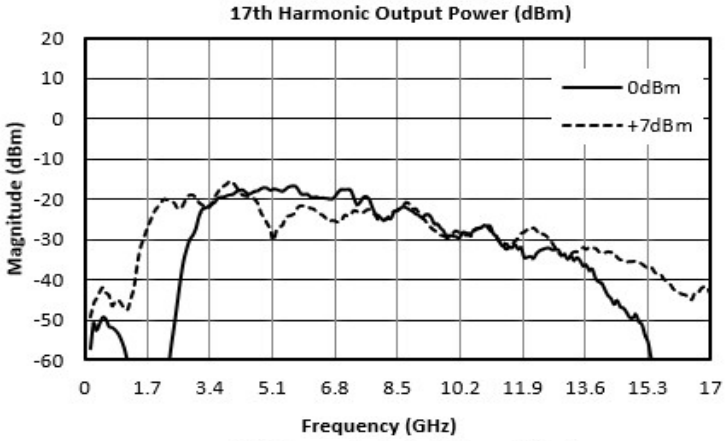


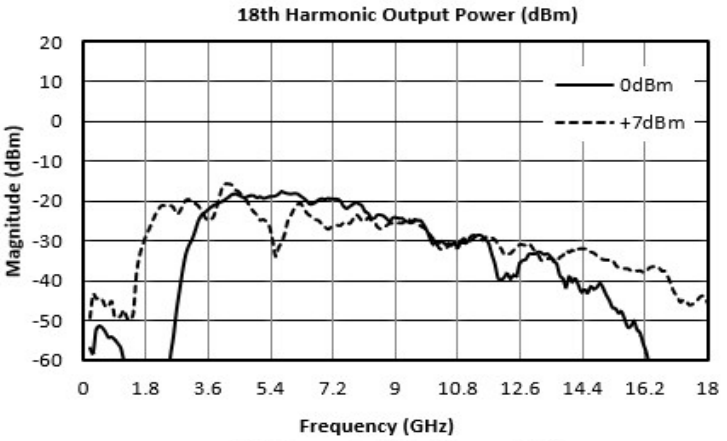
15th Harmonic Output Power (dBm)

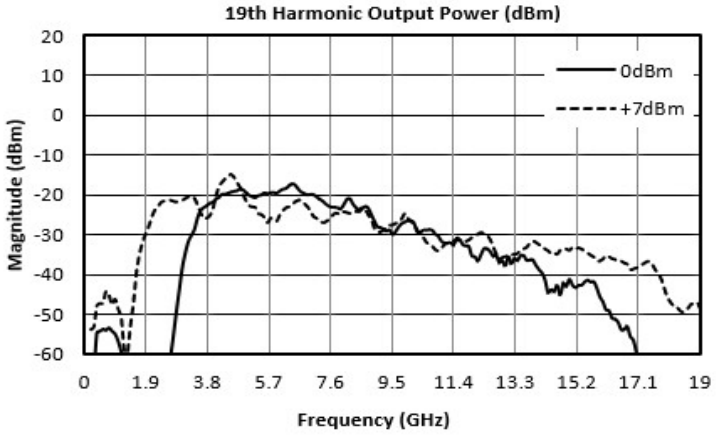


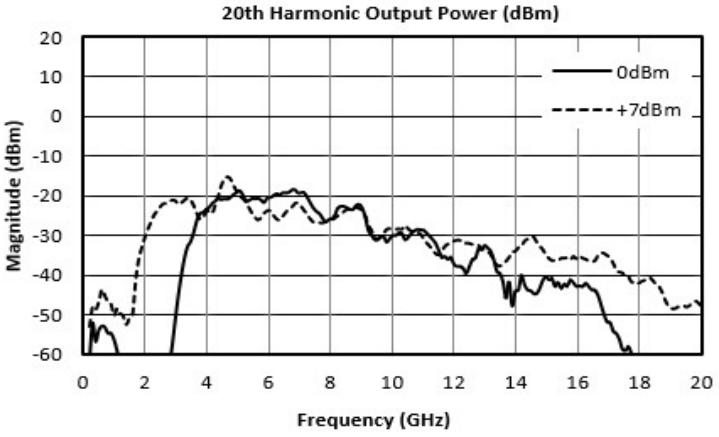
16th Harmonic Output Power (dBm)



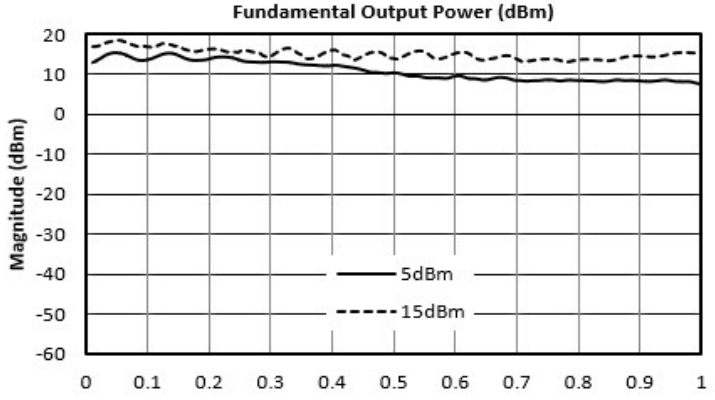


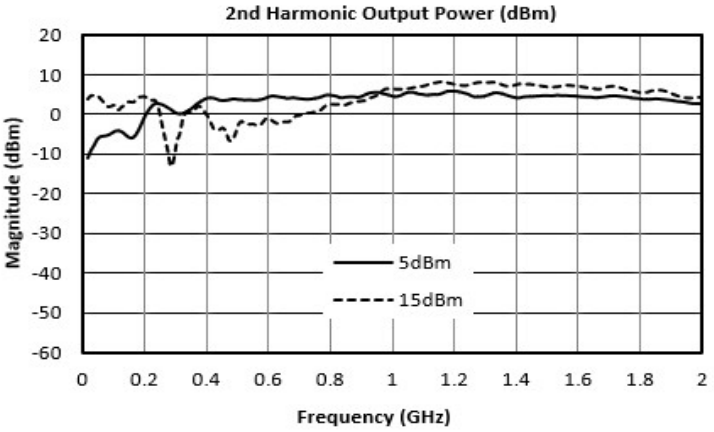


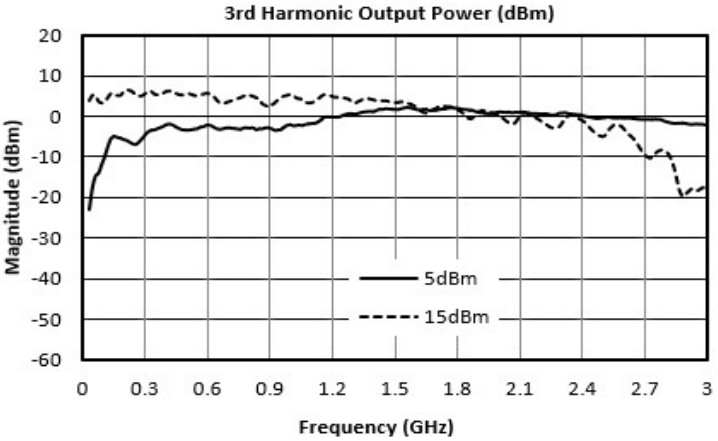


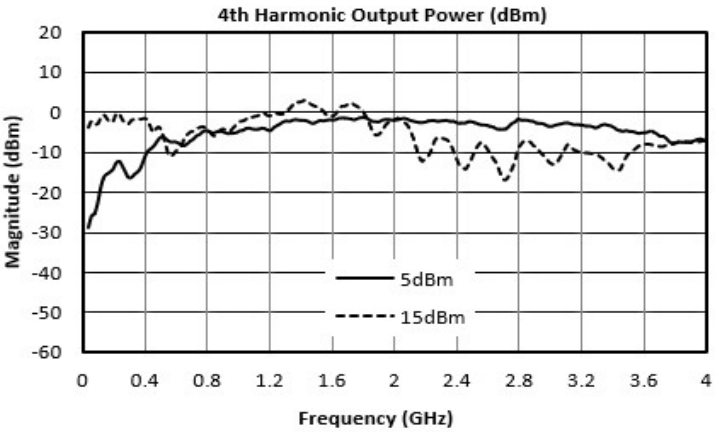


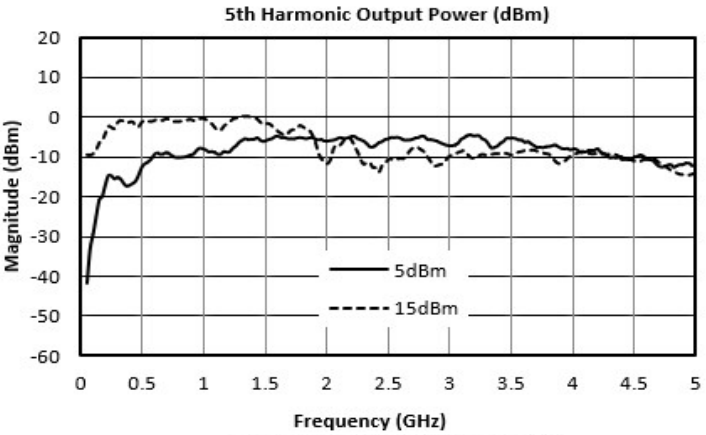
Typical Performance Plots: Harmonic Output Power w/ Square Wave from ADM1-0026PA

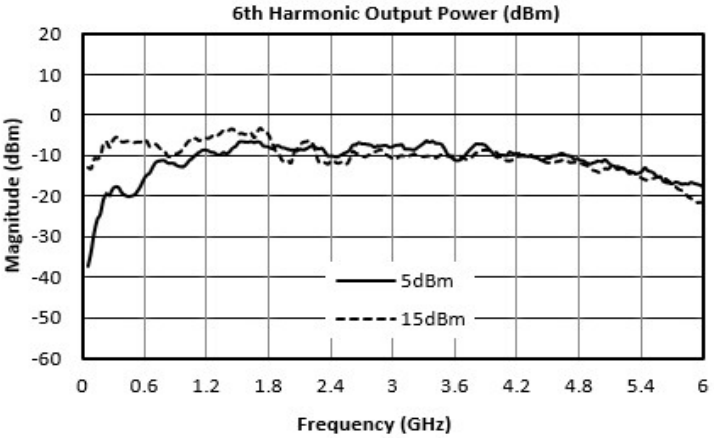


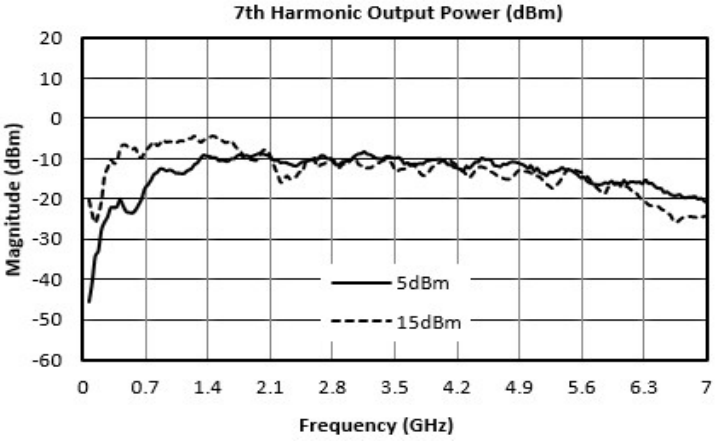


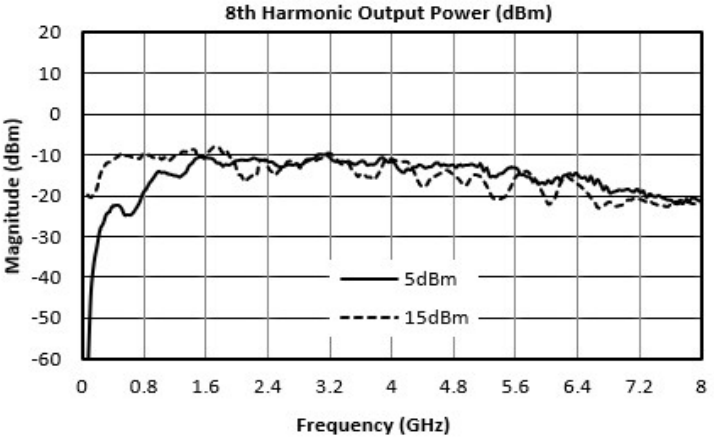


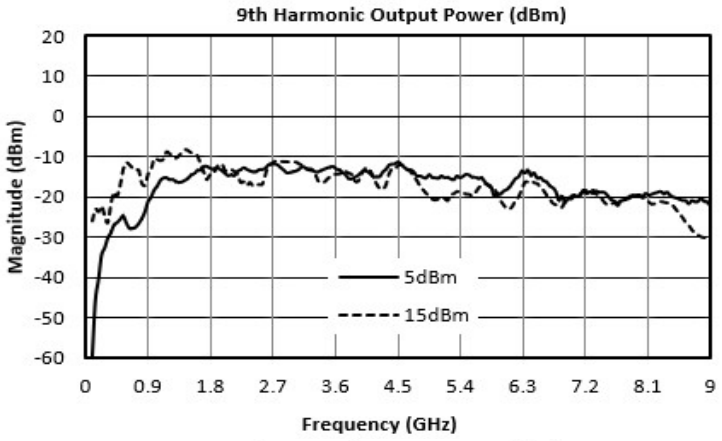


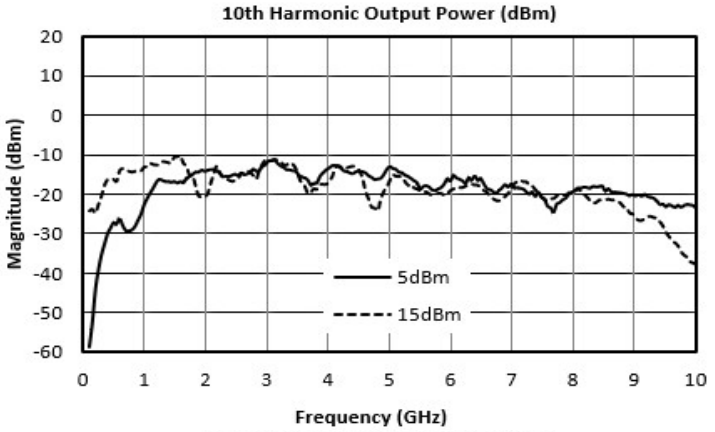


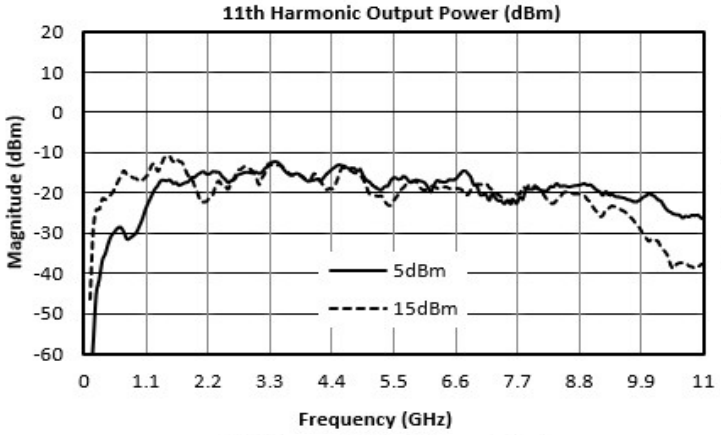


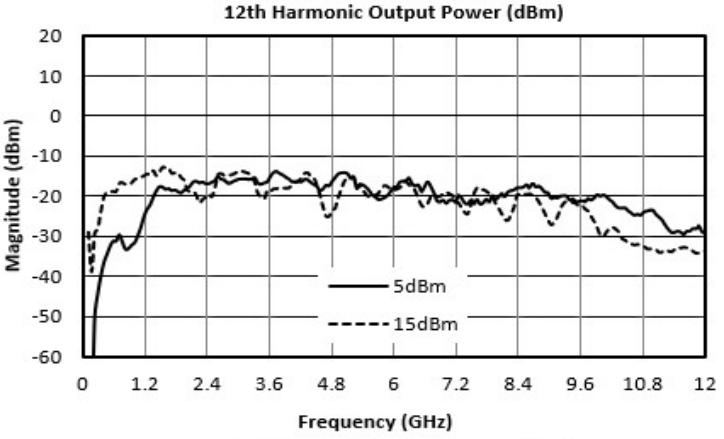


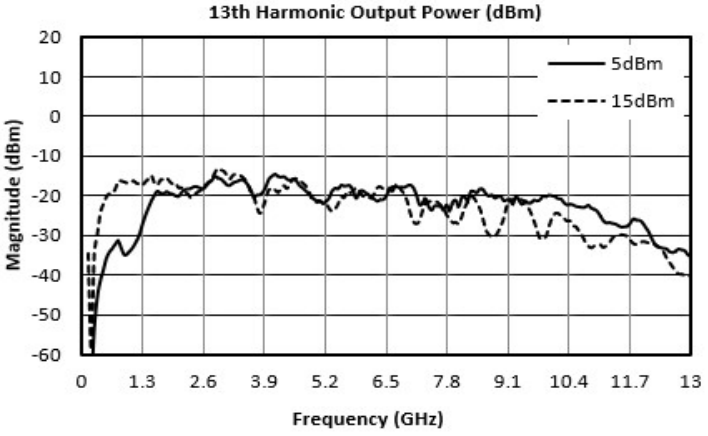


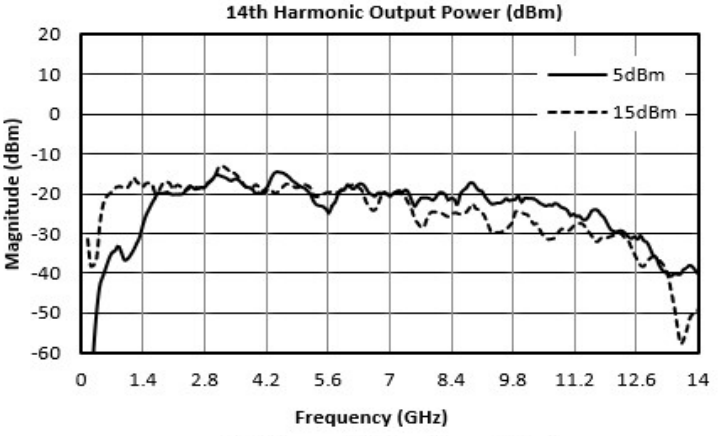


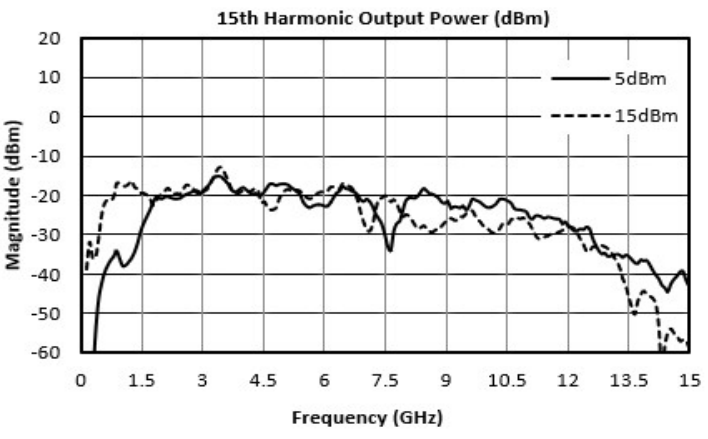


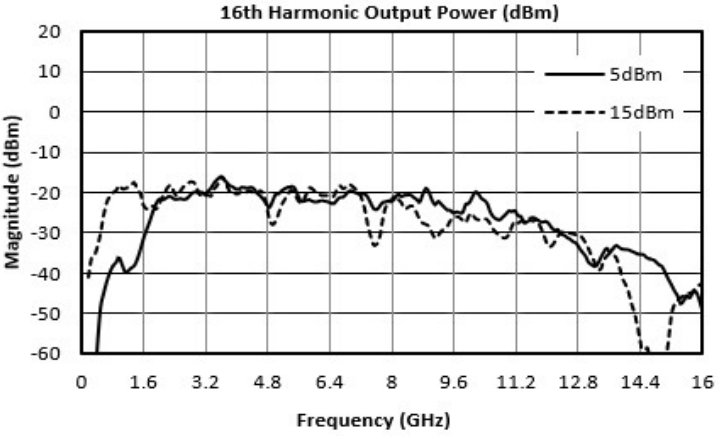


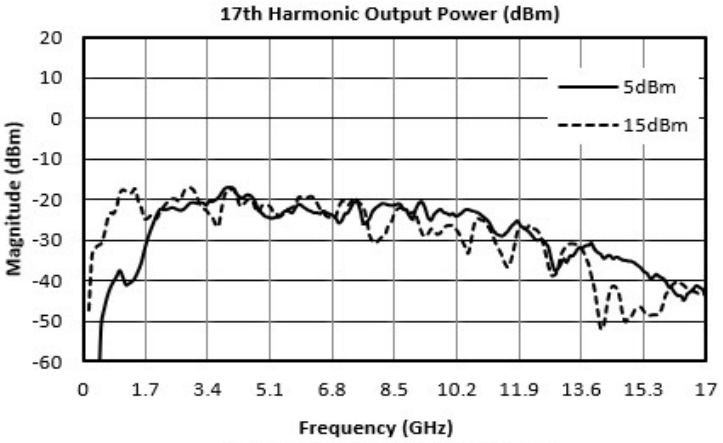


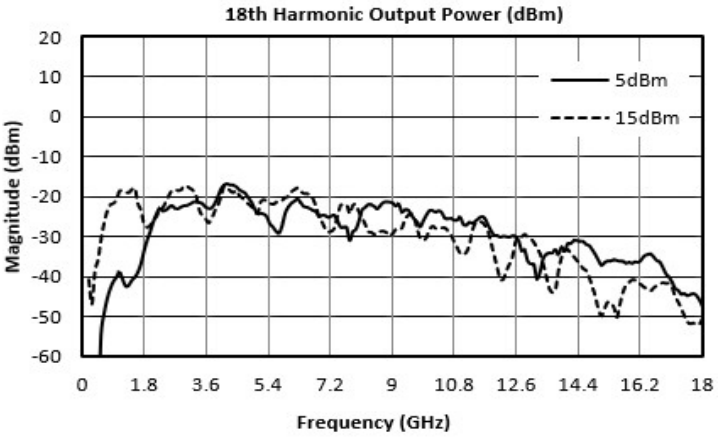


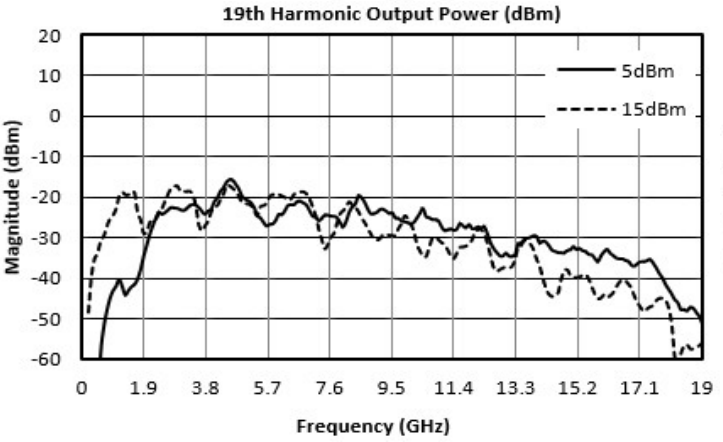


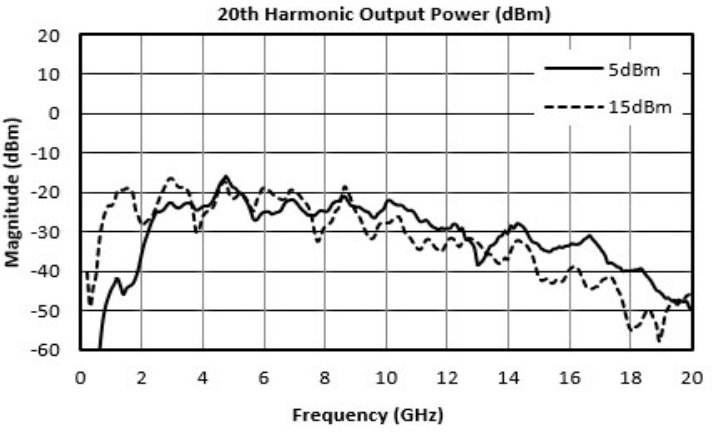




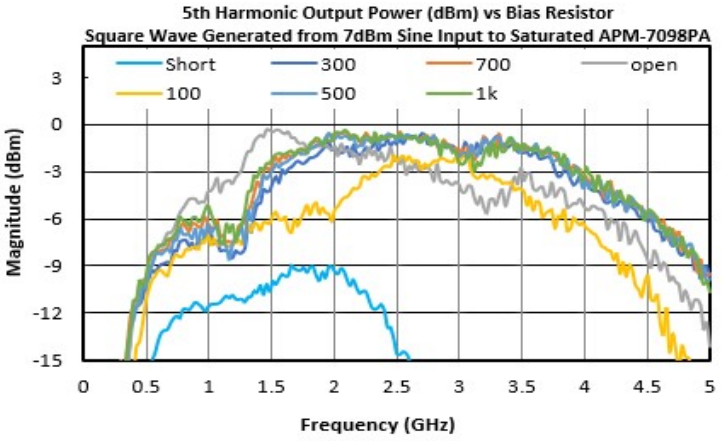


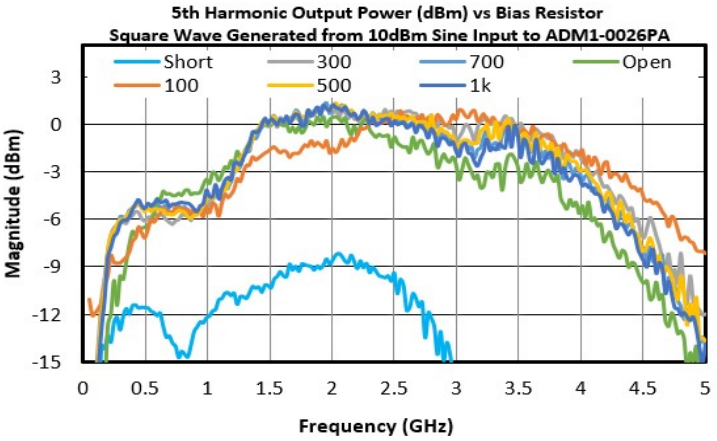


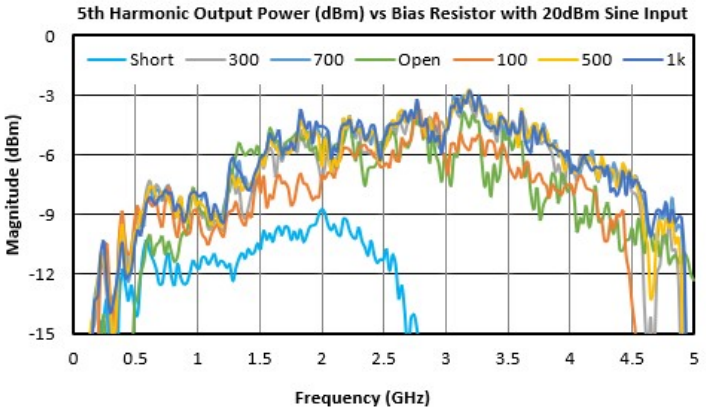




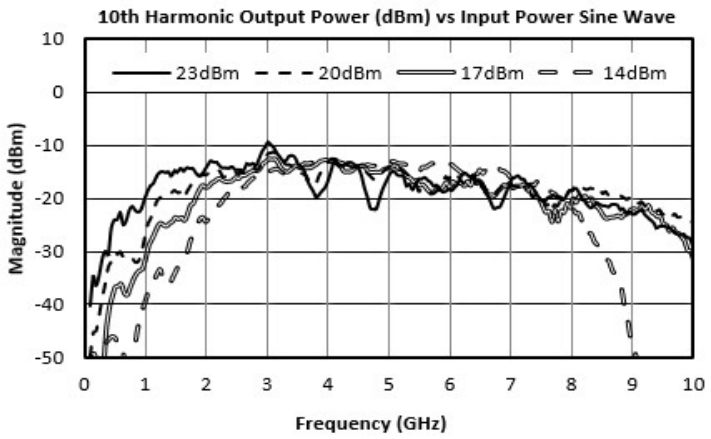
Typical Performance Plots: 5th Harmonic Output Power vs Bias Resistor

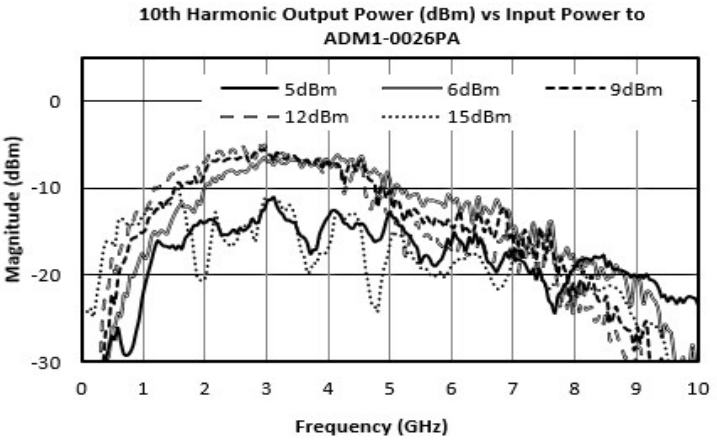


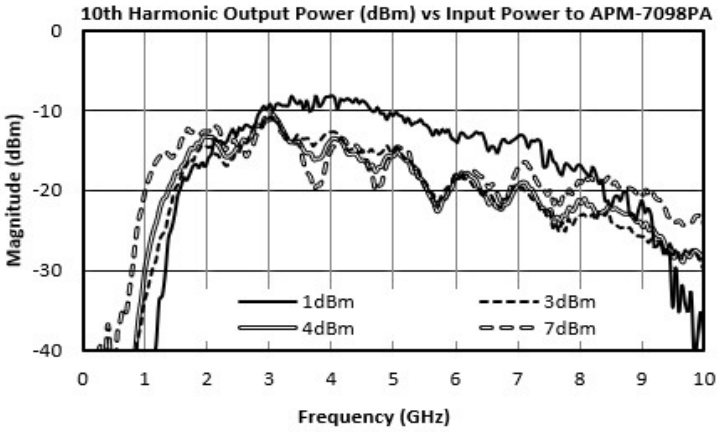




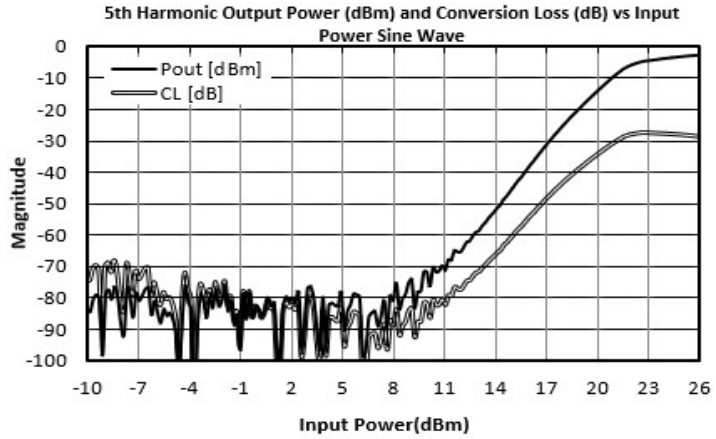
Typical Performance Plots: 10th Harmonic Output Power vs Input Power

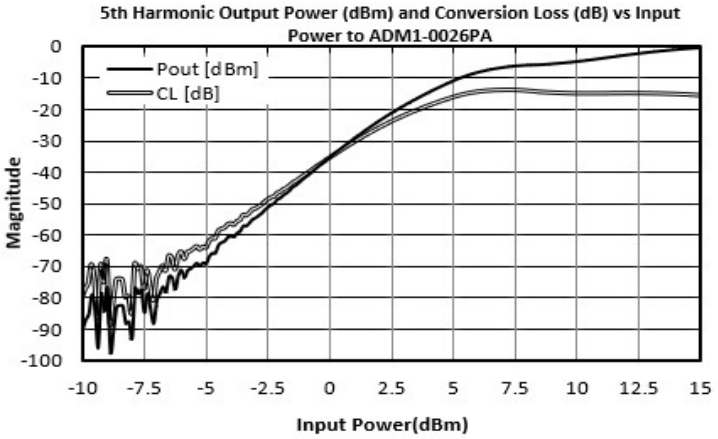


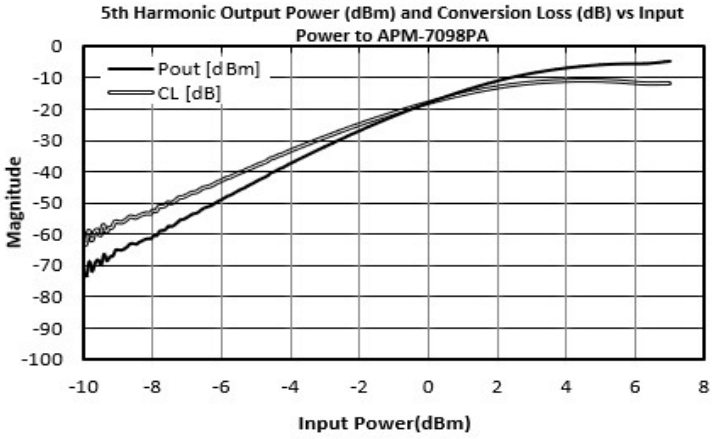




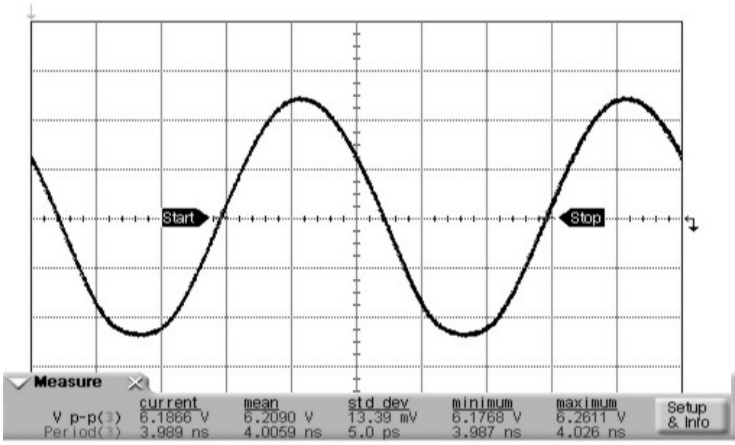
Typical Performance Plots: Conversion Loss and Output Power vs Input Power

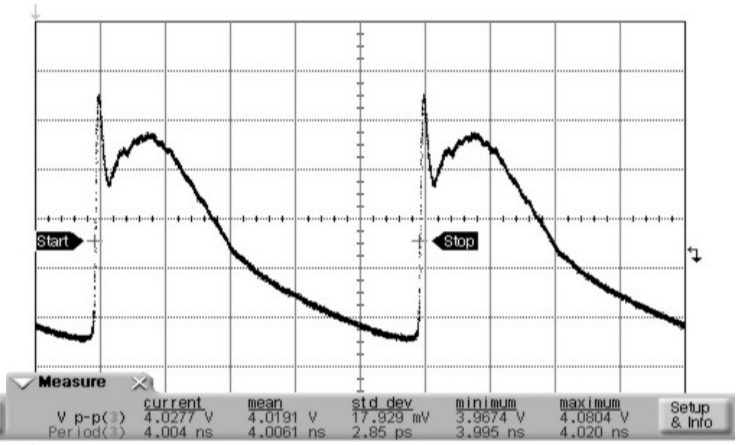


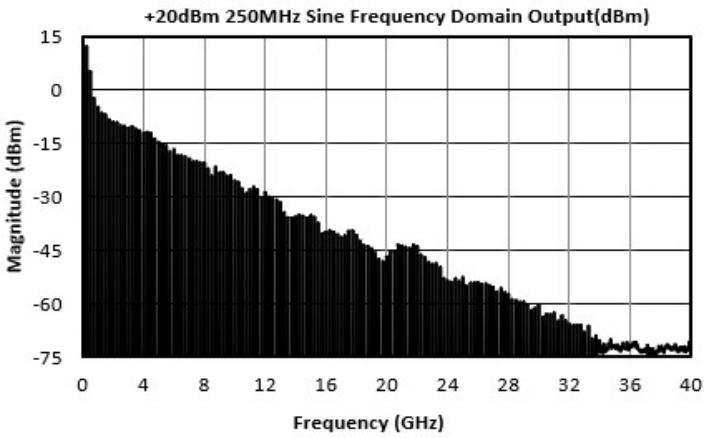


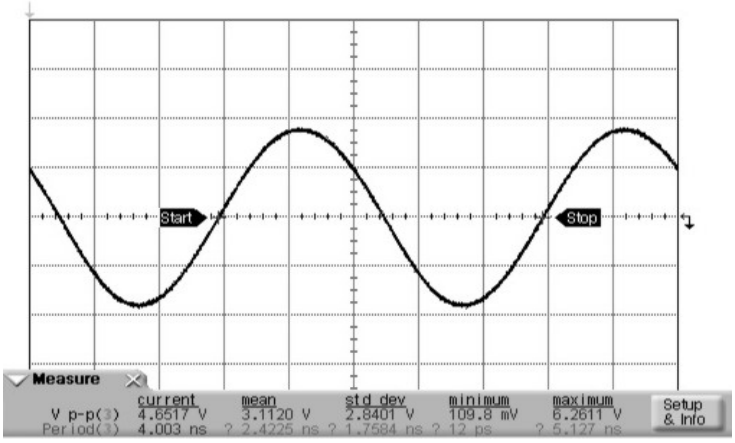


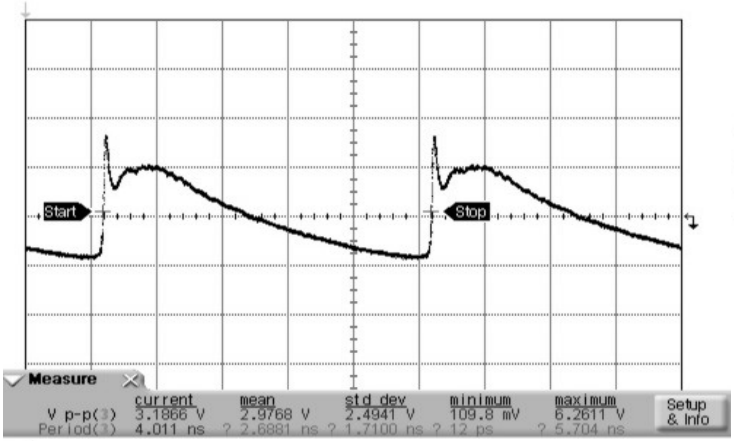
Typical Performance Plots: Time and Frequency Domain Plots

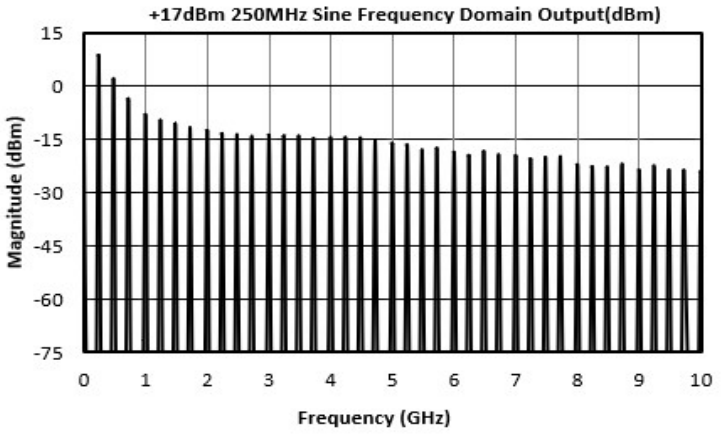


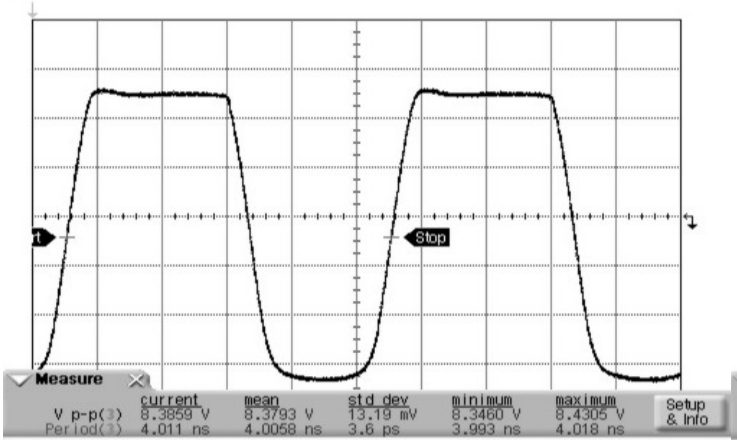


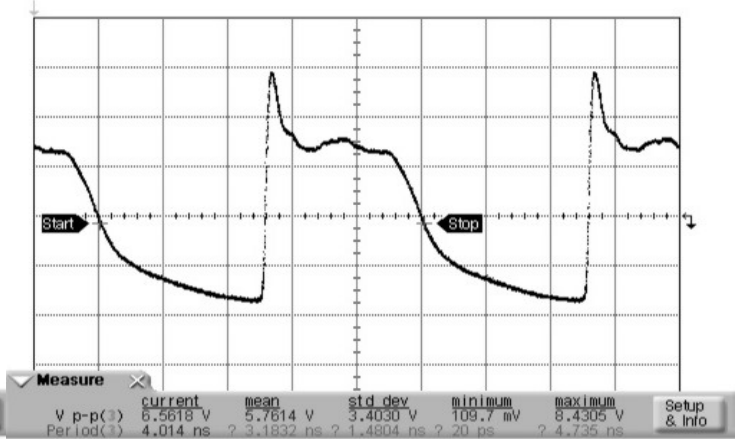




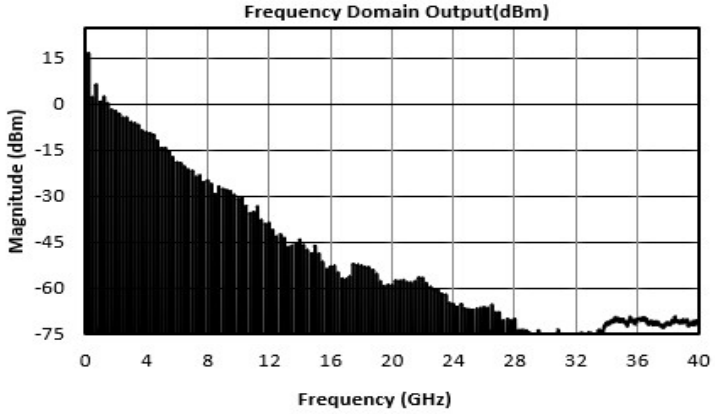


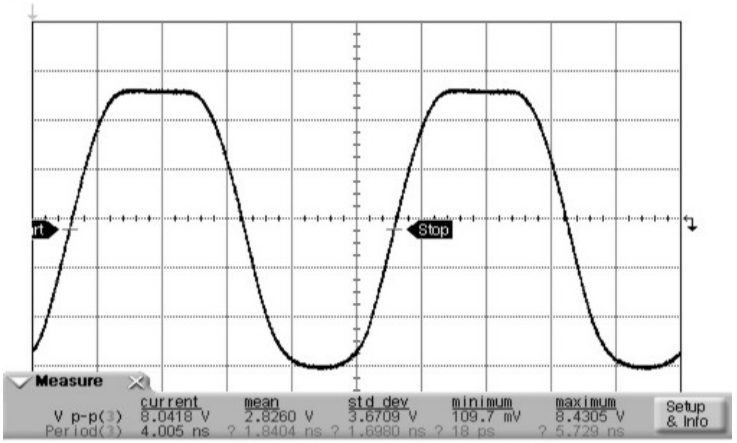


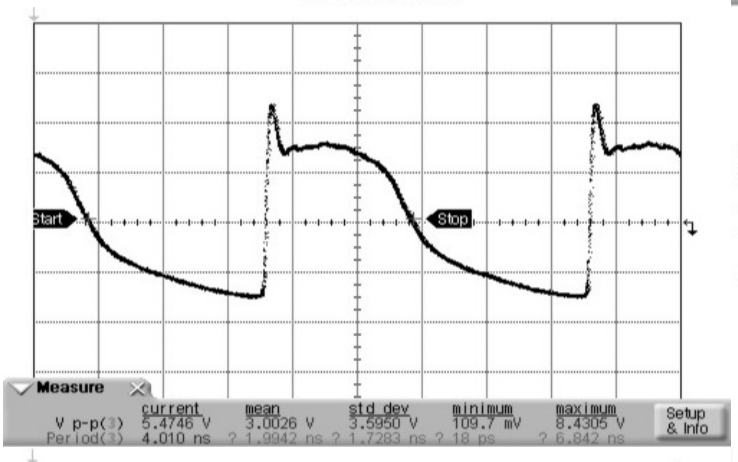




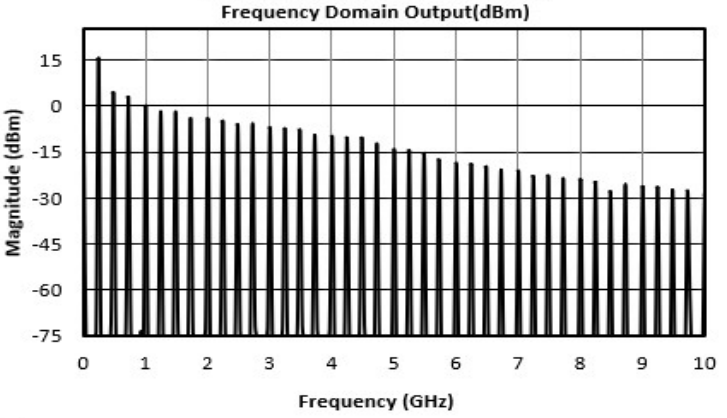
+15dBm 250MHz into ADM1-0026PA
Frequency Domain Output(dBm)

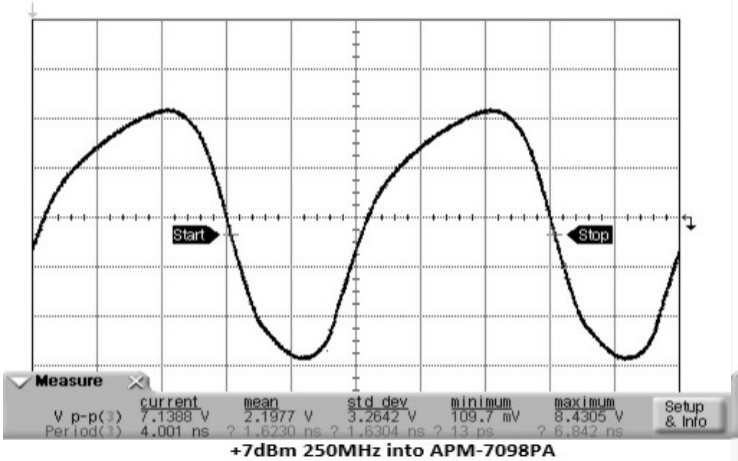


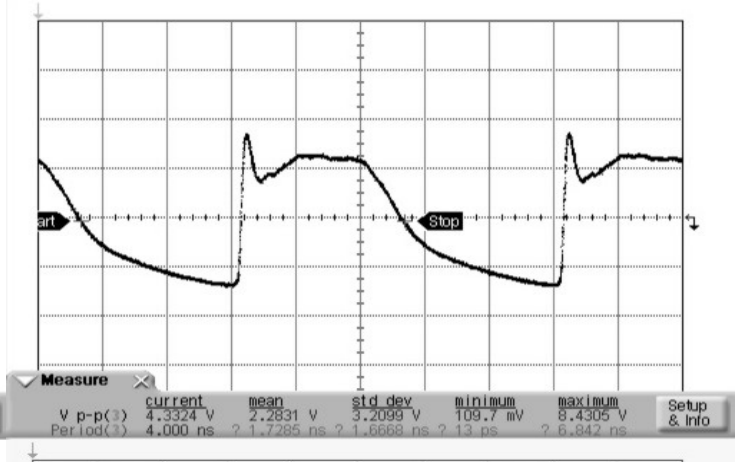




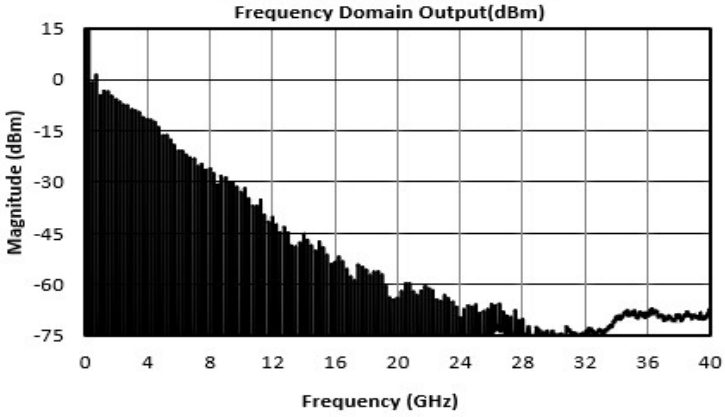
+10dBm 250MHz into ADM1-0026PA
Frequency Domain Output(dBm)

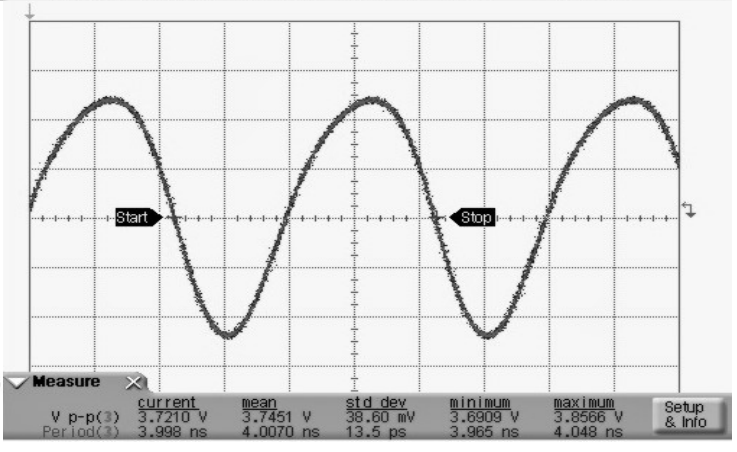






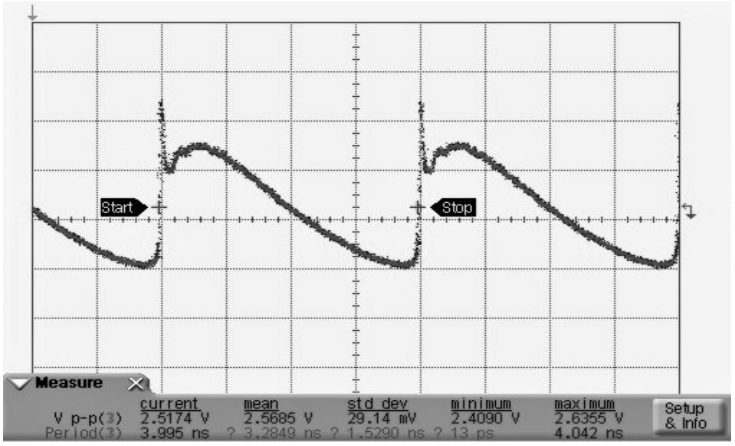
+7dBm 250MHz into APM-7098PA
Frequency Domain Output(dBm)

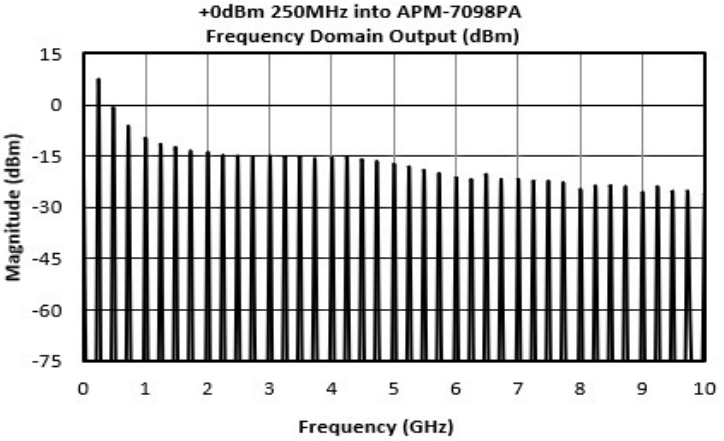




NLTL-6794SM

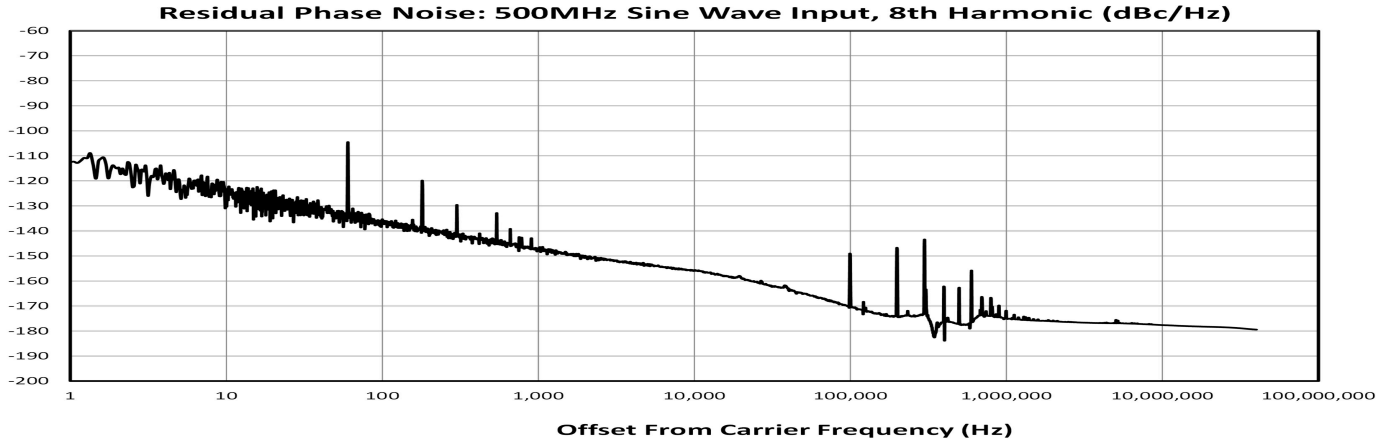
GaAs MMIC Non-Linear Transmission Line





Typical Performance Plots: Residual Phase Noise

500 MHz, +23 dBm Sine Wave Input	Parameter	Min	Typical	Max	Units
8th Output Harmonic	1 Hz Offset		-112		dBc/Hz
	10 Hz Offset		-125		
	100 Hz Offset		-135		
	1 KHz Offset		-147		
	10 KHz Offset		-155		
	100 KHz Offset		-170		
	1 MHz Offset		Thermal Floor		



Application Information

Detailed Description

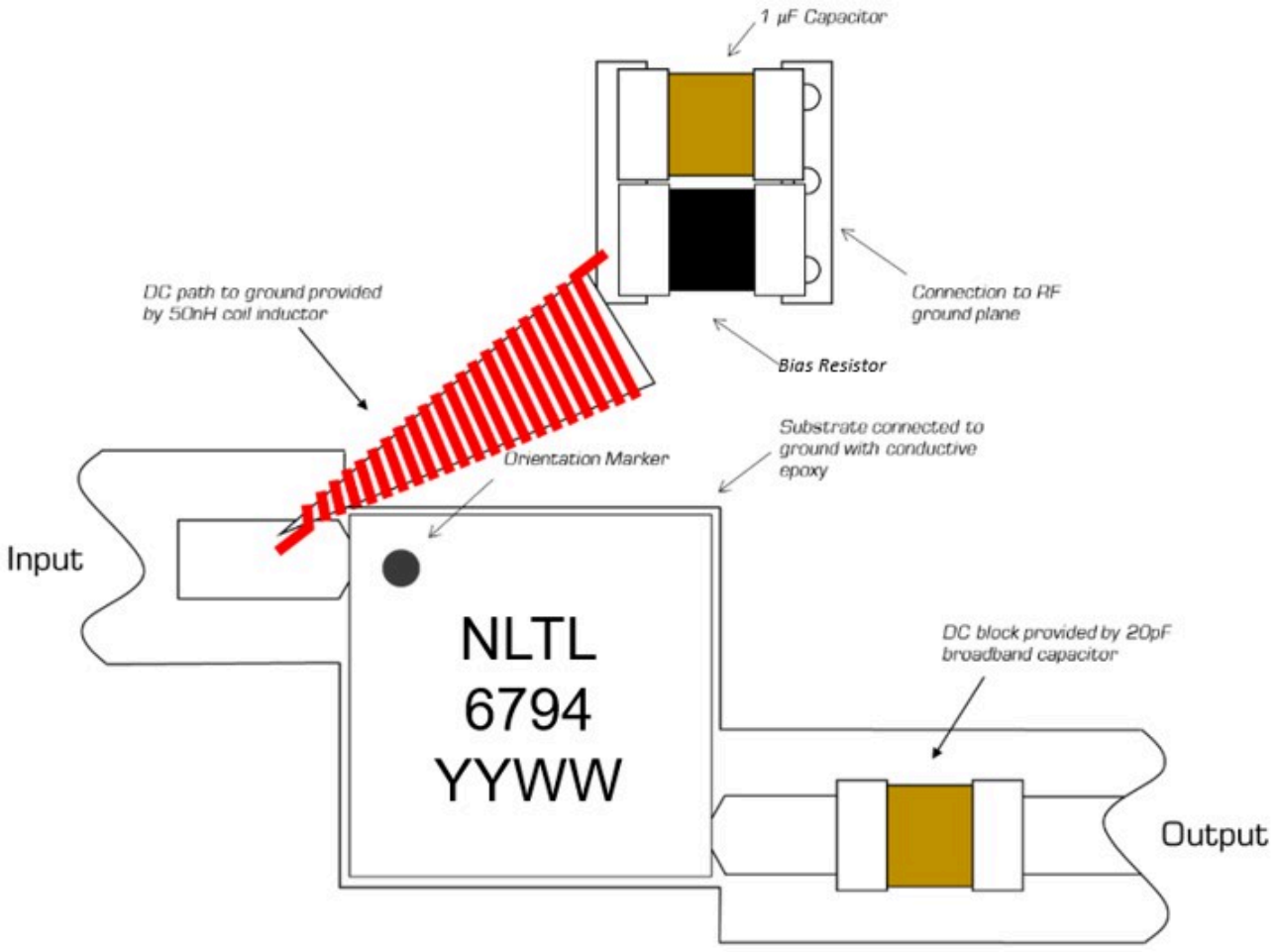
The NLTL-6794SM belongs to Marki Microwave's NLTL family of multipliers and non-linear transmission lines. The NLTL product line consists of passive GaAs MMIC non-linear transmission lines designed and fabricated with GaAs Schottky diode-based varactors. NLTLs take an input signal and create an impulse train of harmonics. Harmonic outputs up to and beyond 30 GHz are generated by the NLTL. The NLTL-6794SM is a 6 mm QFN and the EVAL-NLTL-6794 is a connectorized module with the QFN reflowed onto a PCB.

Port 1 supports up to 1GHz input signals. Port 2 will output integer multiples of the input signal (i.e., x2, x3, x4, etc.) up to a maximum of ~30 GHz given a -60dBm threshold. Higher harmonics are generated but at a lower efficiency.

The operating conditions of the NLTL are extremely important to optimize performance. High power inputs will increase the output power observed; however, the conversion efficiency will decrease. This is increasingly true for higher input frequencies and at input powers above the recommended limit. Optimal conversion efficiency of the NLTL is achieved using a square wave input with a fast rise time. Doing so causes a degradation in the 2nd output harmonic but otherwise improves the conversion efficiency at all other harmonics. It is for this reason that the typical performance plots are shown driven with a sine wave input as well as with two amplifiers, the ADM1-0026PA, a square wave driver amp, and the APM-7098PA, a low phase noise amplifier. Typical Performance Plots: Time and Frequency Domain Plots shows the results of these driver amplifiers in time and frequency domain.

NLTL-6794SM requires no external DC bias. The self-bias of the diodes caused by the rectified RF input signal is sufficient for operation. For the best performance, optimization of the DC return path through a bias resistor is recommended for each specific application to optimize the harmonic output power distribution.
The phase noise of a non-linear transmission line is outstanding. If verification of performance is necessary, the application circuit used and input conditions are extremely important. NLTLs are AM sensitive. If there is excessive AM noise on the input of the NLTL, observing the output of the NLTL will show excessive PM/phase noise because of the high AM to PM conversion property of NLTLs.

Application Circuit



Application Circuit Description

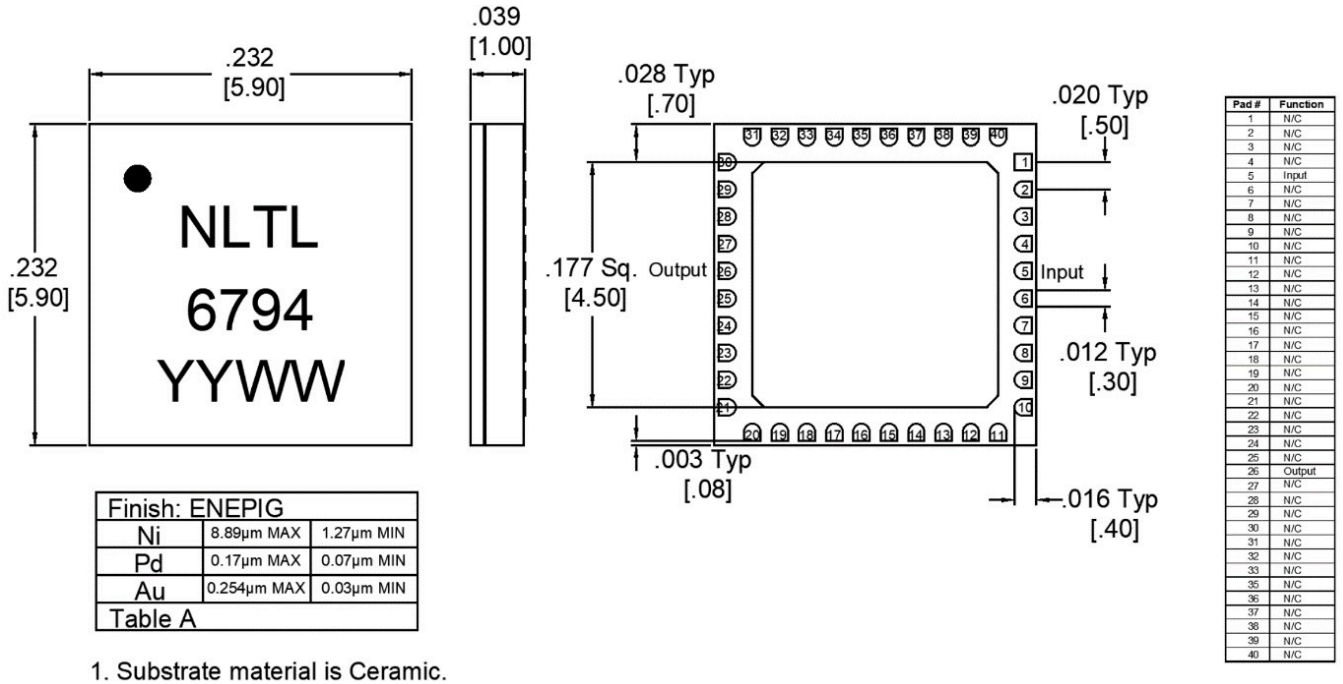
DC Path to Ground — An RF choke followed by a bias resistor should be used to provide a DC path to ground on the input port of the NLTL SM package. The current through the resistor will create Johnson/white noise; a shunt capacitor (for example 1uF) is used to filter noise generated by the resistor. This forms the circuit which self-biases the NLTL. The DC return to ground removes DC rectified current created by high power RF signal injection. A conical coil inductor is recommended to push the self-resonance frequency of the inductor past the operating bandwidth of the NLTL. The recommended inductance value of the conical coil inductor is 50nH or higher. If using a connectorized application setup, a bias tee will provide a DC path to ground and the NLTL can be biased with an additional resistor on the bias tee. See Typical Performance Plots: 5th Harmonic Output Power vs Bias Resistor for output power vs bias resistor plots.

Blocking Capacitor — A DC blocking capacitor on the output of the NLTL-6794SM's integrated circuit is there to prevent unwanted DC current flow from or to the output. If there is a DC signal on the input, place a DC block or bias tee on the input to avoid disrupting the self-biasing of the diodes.

Mechanical Data

Outline Drawing

Download : Outline 2D Drawing | Outline 3D Drawing | Outline 3D STP



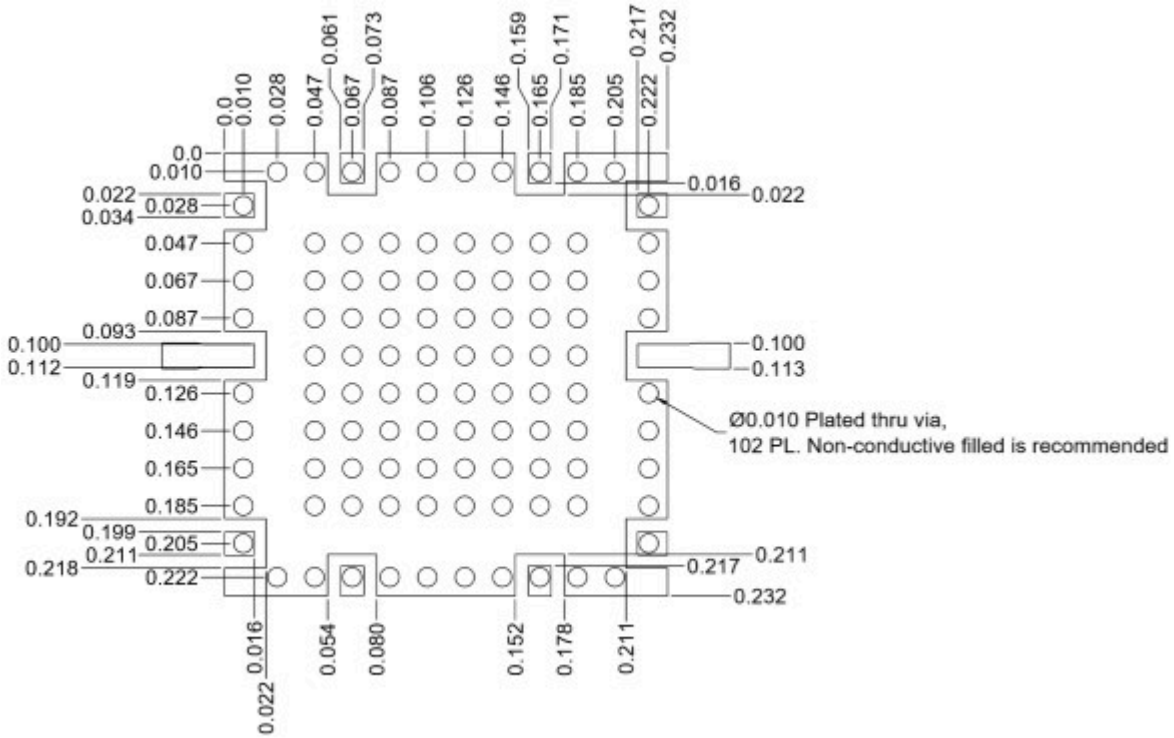
Finish: ENEPIG		
Ni	8.89µm MAX	1.27µm MIN
Pd	0.17µm MAX	0.07µm MIN
Au	0.254µm MAX	0.03µm MIN
Table A		

Pad #	Function
1	N/C
2	N/C
3	N/C
4	N/C
5	Input
6	N/C
7	N/C
8	N/C
9	N/C
10	N/C
11	N/C
12	N/C
13	N/C
14	N/C
15	N/C
16	N/C
17	N/C
18	N/C
19	N/C
20	N/C
21	N/C
22	N/C
23	N/C
24	N/C
25	N/C
26	Output
27	N/C
28	N/C
29	N/C
30	N/C
31	N/C
32	N/C
33	N/C
35	N/C
36	N/C
37	N/C
38	N/C
39	N/C
40	N/C

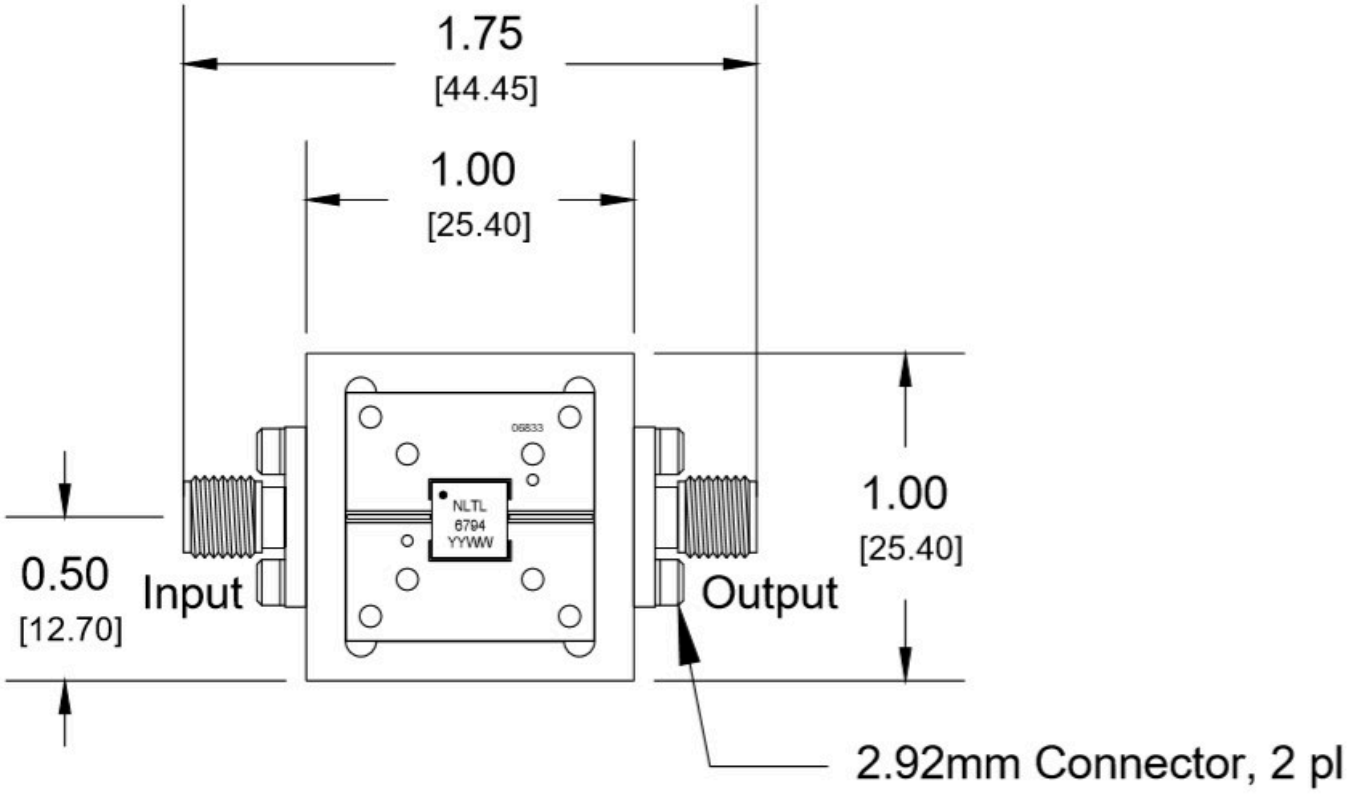
1. Substrate material is Ceramic.
2. All unconnected pins should be connected to PCB RF ground.

Footprint Image

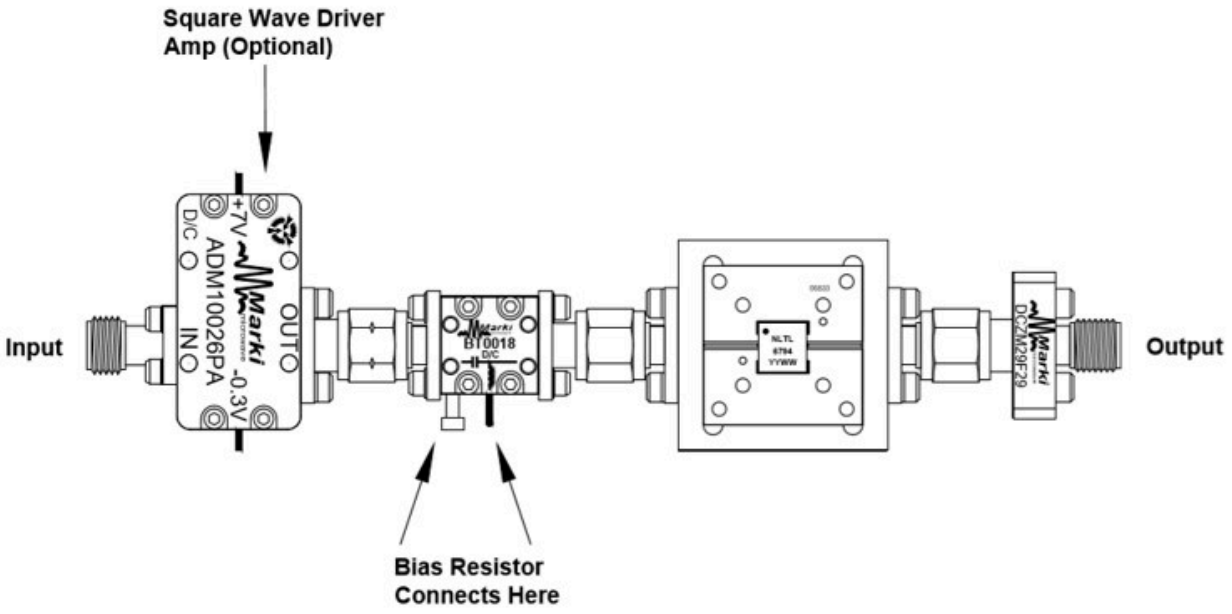
Download : Footprint Drawing



Evaluation Board - Outline Drawing



Evaluation Board - Application Circuit



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