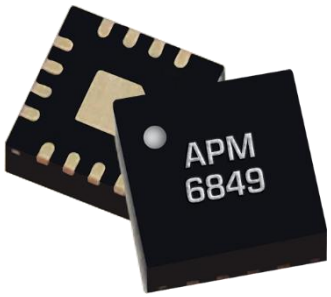
2-30 GHz Surface Mount Low Phase Noise Amplifier APM-6849SM

1. Device Overview

1.1 General Description



The APM-6849SM is a single stage broadband, low phase noise pre-amplifier designed to provide 11 dB typical gain packaged in a 3 mm QFN with low current consumption. This amplifier uses GaAs HBT technology for low phase noise, and provides industry leading -170 dBc/Hz at 10 kHz offset from carrier frequency. It offers low power dissipation while providing sufficient gain and power to drive a saturated LO driver amplifier such as the APM-7516SM, APM-7098SM, or APM-7099SM.

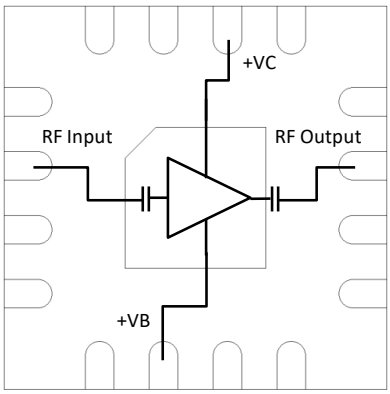
1.2 Features

- -170 dBc/Hz phase noise at 10 kHz offset frequency
- Low DC power consumption
- Positive-only biasing
- No sequencing required
- Unconditionally stable
- Integrated DC blocks – No bias-tees or off-chip blocking required

1.3 Applications

- Mobile test and measurement equipment
- Radar and satellite communications
- 5G Transceivers
- Pre-amplifier for saturated LO driver amplifiers
- Suitable as a T3 mixer LO pre-amplifier

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
APM-6849SM	3x3 mm Surface Mount	QFN	**RoHS**	Active	EAR99
EVAL-APM-6849SM	Connectorized Evaluation Fixture	EVAL	**RoHS**	Active	EAR99

[1] Refer to our website for a list of definitions for terminology presented in this table.

Table of Contents

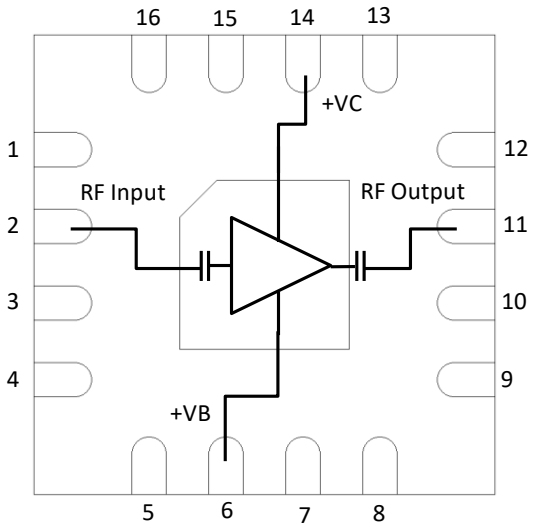
Revision History

Revision Code	Revision Date	Comment
-	November 2019	Datasheet Initial Release
A	May 2020	Updated EVAL board outline
B	July 2020	Updated Small Signal Gain Min Spec
C	July 2020	Updated Max Operating Temperature
D	October 2020	Updated Min Specs and Input Power for Saturation
E	November 2020	Updated Thermal Specs and Min Specs, added link to landing pattern
F	January 2023	Updated device description, input power limit, and plots

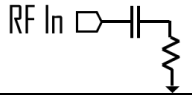
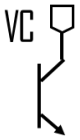
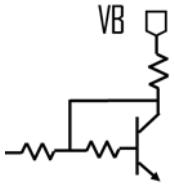
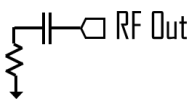
2. APM-6849SM Port Configurations and Functions

2.1 APM-6849SM Port Diagram

A port diagram of the APM-6849SM is shown below.



2.2 APM-6849SM Port Functions

Port	Function	Description	Equivalent Circuit for Package
2	RF Input	This is the amplifier die RF Input port. It is internally DC blocked and RF matched to 50 Ω.	
14	Collector Supply Port	Pin 14 is the amplifier IC's DC voltage supply pad. See section 3.6 for performance at different bias conditions.	
6	Base Supply Port	Pin 6 is the current mirror DC voltage supply port that controls the collector current supplied to the amplifier. VB port voltage is proportional to VC port collector current. VB effectively functions as a gain control pin. See section 3.6 for performance at different bias conditions.	
11	RF Output	Pin 11 is the amplifier die RF Output port. It is internally DC blocked and RF matched to 50 Ω. Must have less than 7:1 VSWR when operating with voltage greater than 5V on VC.	
GND	Ground	IC backside must be connected to a DC/RF ground with high thermal and electrical conductivity.	

3. Specifications

3.1 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 become inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Units
Collector Positive Bias Voltage (VC)	7	V
Positive Bias Current (Ic)	90	mA
Current Mirror Positive Bias Voltage (VB)	7	V
Current Mirror Positive Bias Current (Ib)	4	mA
RF Input Power[1]	+16	dBm
Output Load VSWR	7:1	-
Operating Temperature	-40 to +85	°C
Storage Temperature	-65 to +150	°C
θ_{JC}	78	°C/W
Max Junction Temperature for MTTF > 1E6 Hours	125	°C

[1] Maximum RF input power for instantaneous failure. Reliable operation requires RF input power limited to maintain Positive Bias Current Ic within reliable limits.

3.2 Package Information

Parameter	Details	Rating
Weight	EVAL-APM-6849SM	43.6

3.3 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.

	Min	Nominal	Max[2]	Units
T_A, Ambient Temperature	-40	+25	+85	°C
Positive DC Voltage (VC)	+3	+5	+6	V
Positive DC Current (Ic)	8	21	32	mA
Positive DC Current Mirror Voltage (VB)	+3	+5	+6	V
Positive DC Current Mirror Current (Ib)	0.9	2	2.6	mA

3.4 Sequencing Requirements

There is no sequencing required to power up or power down the amplifier.

Amplifier must have an output load connected when operating with a VC voltage greater than +5V.

[2] Maximum recommended operating current conditions without RF input applied. Please see typical performance plots on page 9 for relationship between RF input power and DC current draw.

3.5 Electrical Specifications

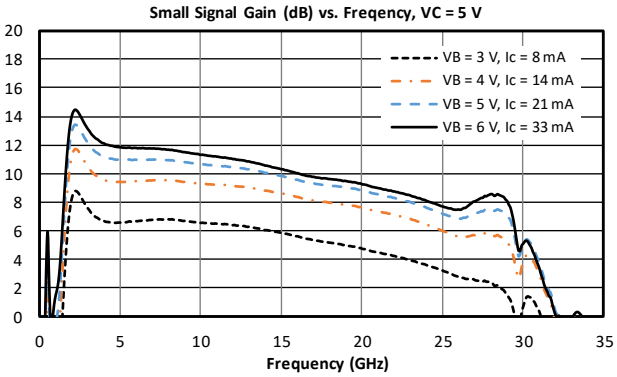
The electrical specifications apply at T_A=+25°C in a 50Ω system.

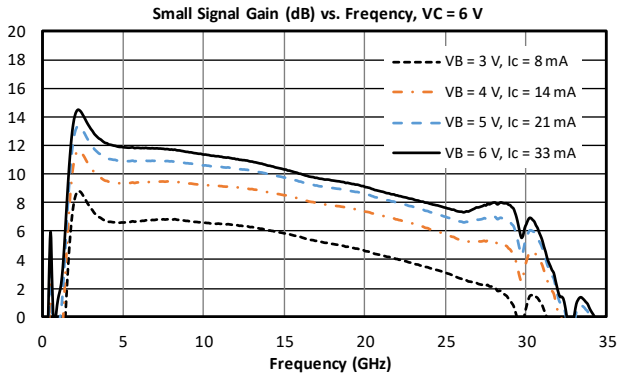
QFNs are 100% RF tested.

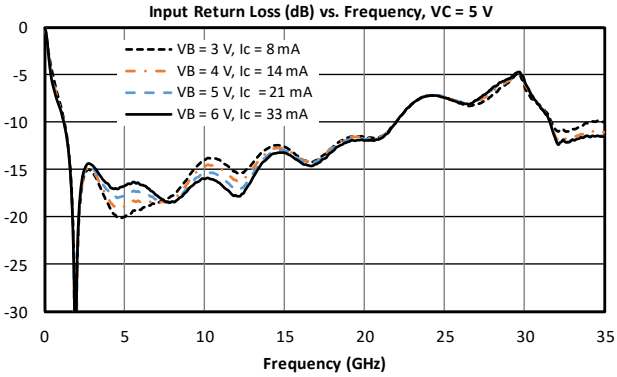
Parameter	Test Conditions	Frequency	Min	Typical	Units
Small Signal Gain	5V/5V bias, -25 dBm Input Power	2 GHz – 20 GHz	8	11	dB
		20 GHz – 30 GHz		7.5	
Input Return Loss		2 GHz – 20 GHz		15	
		20 GHz – 30 GHz		8	
Output Return Loss		2 GHz – 20 GHz		16	
		20 GHz – 30 GHz		8	
Noise Figure		2 GHz – 26.5 GHz		5	
Reverse Isolation		2 GHz – 30 GHz		42	
Collector Current[3], Ic	5V/4V	-		13	mA
	5V/5V	-		21	
	5V/6V	-		32	
Current Mirror Current, Ib	5V/4V	-		1.5	
	5V/5V	-		2.0	
	5V/6V	-		2.6	
Input IP3 (IIP3)	5V/5V bias, -15 dBm Input Power	2 GHz – 30 GHz		+11	dBm
Output IP3 (OIP3)		2 GHz – 30 GHz		+20	
Output P_{1dB}	5V/5V bias	2 GHz – 20 GHz		+20	
		20 GHz – 30 GHz		+14	
Phase Noise @ 10 kHz Offset	5V/5V bias, +9 dBm Input power	2-30 GHz		-170	dBc/Hz

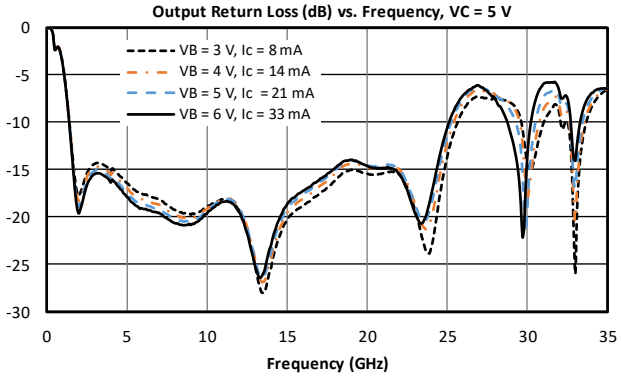
[3] Bias conditions for Ic and Ib tested with no RF input power. See section 3.6 for DC current vs. RF power. Bias conditions presented as VC/VB.

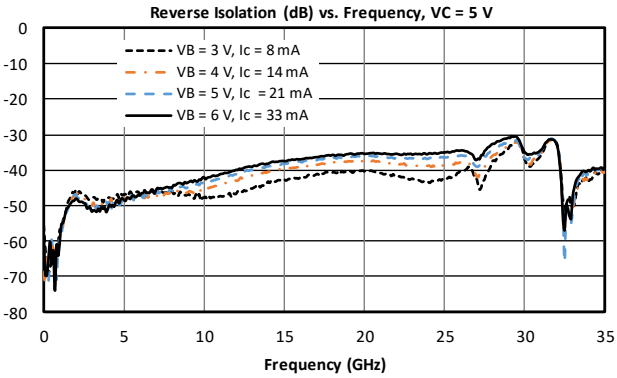
3.6 APM-6849SM Typical Performance Plots[4]

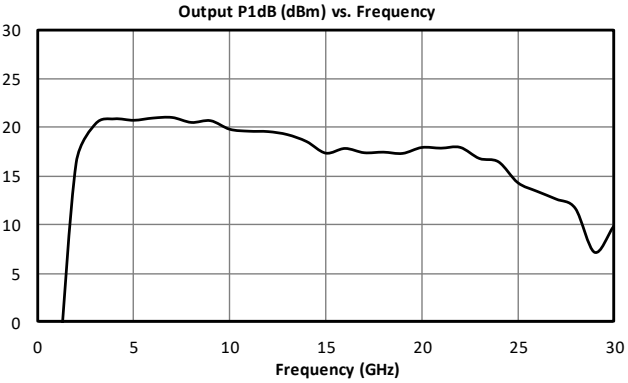






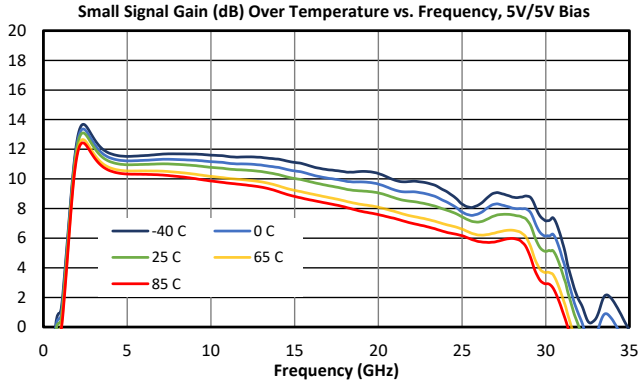




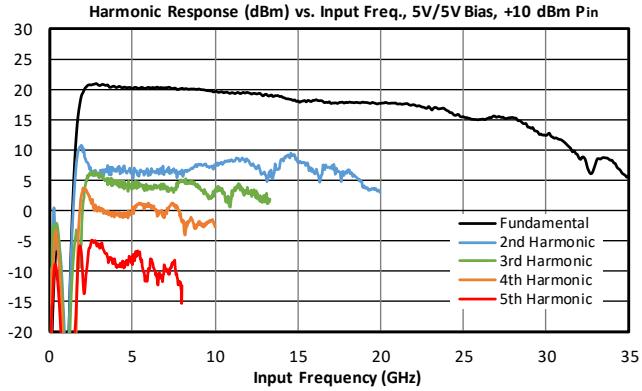


[4] APM-6849SM measurements taken in EVAL-APM-6849 evaluation board.

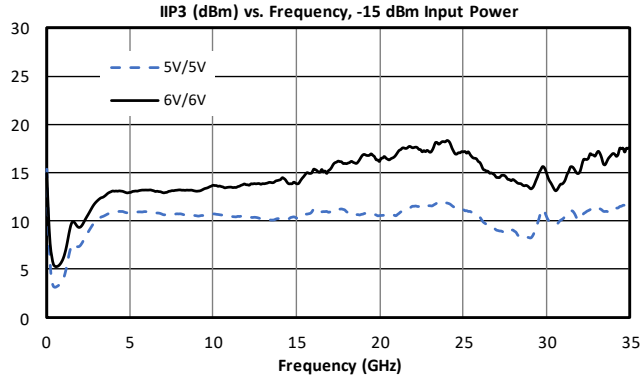
Small Signal Gain (dB) Over Temperature vs. Frequency, 5V/5V Bias



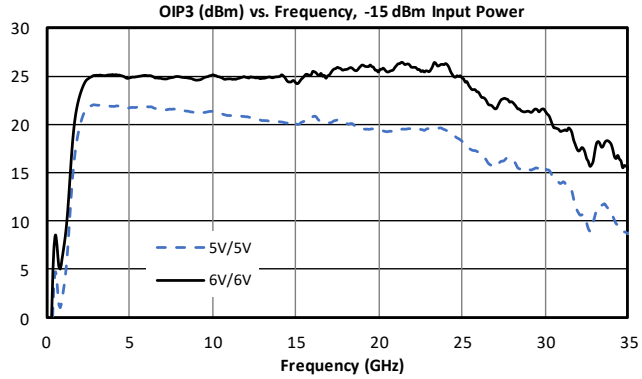
Harmonic Response (dBm) vs. Input Freq., 5V/5V Bias, +10 dBm Pin



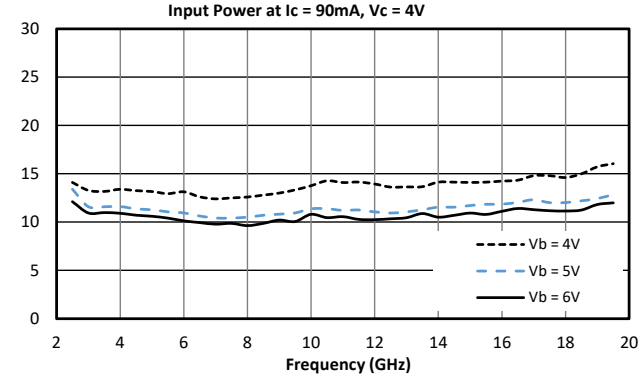
IIP3 (dBm) vs. Frequency, -15 dBm Input Power



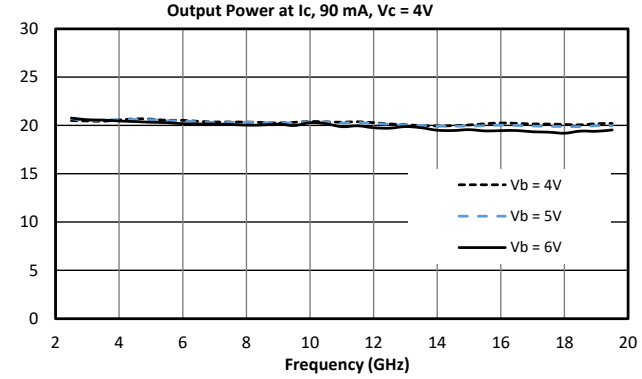
OIP3 (dBm) vs. Frequency, -15 dBm Input Power



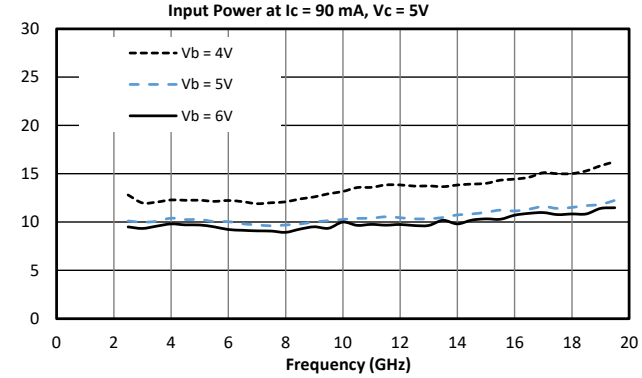
Input Power at Ic = 90mA, Vc = 4V



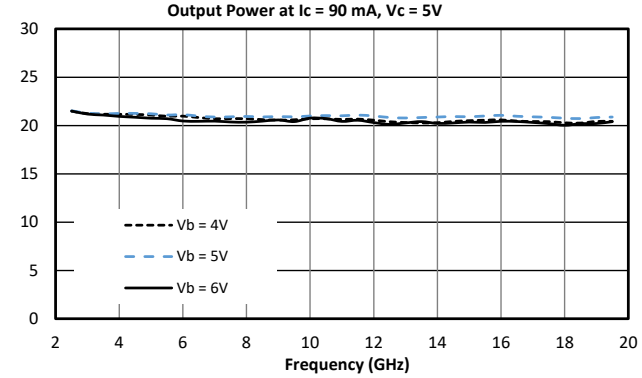
Output Power at Ic, 90 mA, Vc = 4V

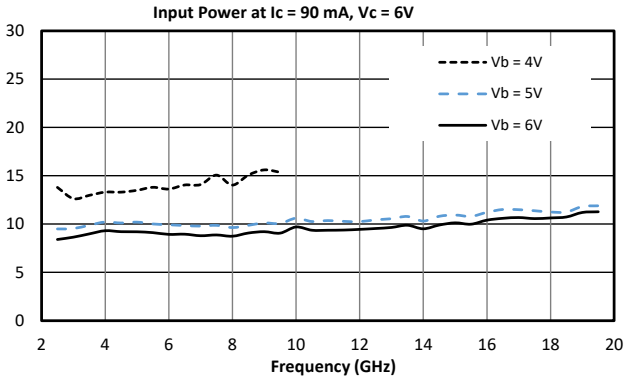


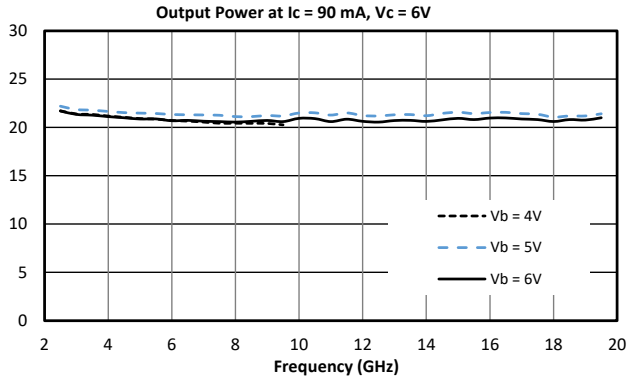
Input Power at Ic = 90 mA, Vc = 5V



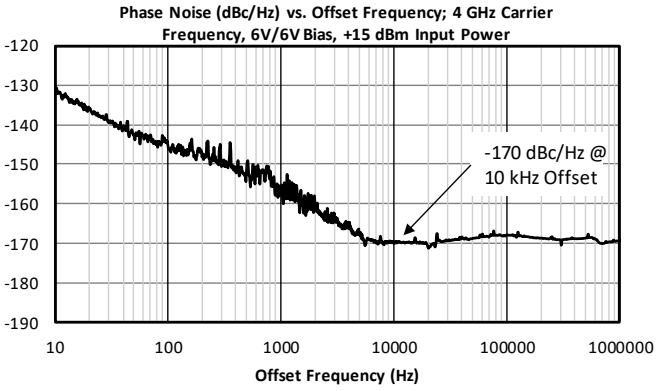
Output Power at Ic = 90 mA, Vc = 5V

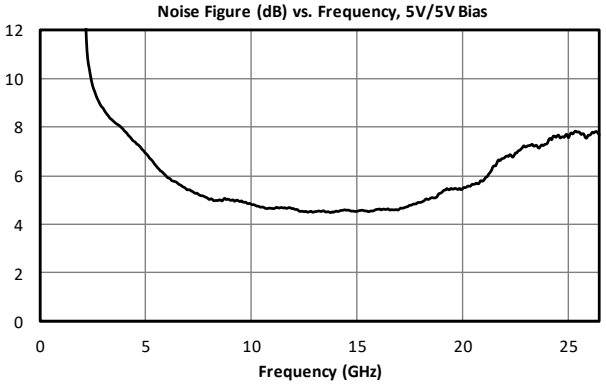


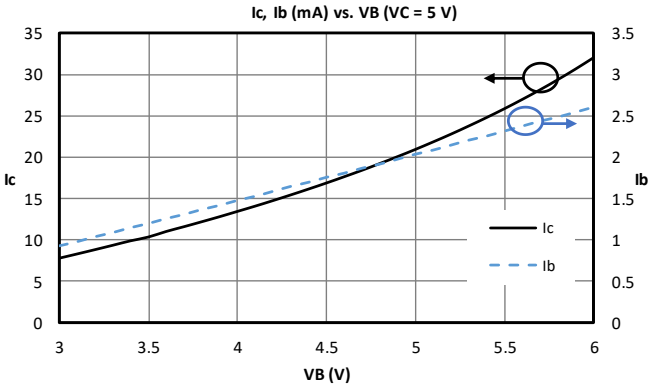


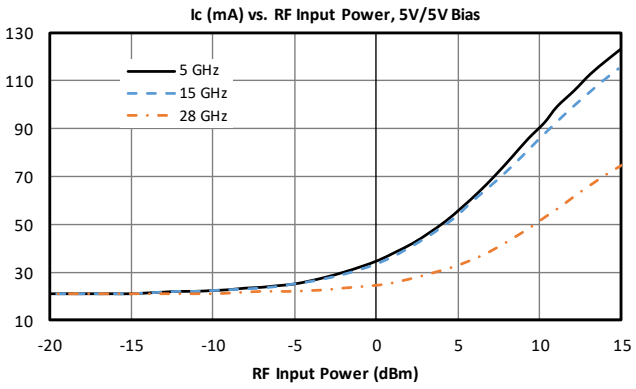


3.7 Connectorized Module APM-6849PA Performance Plots[5]

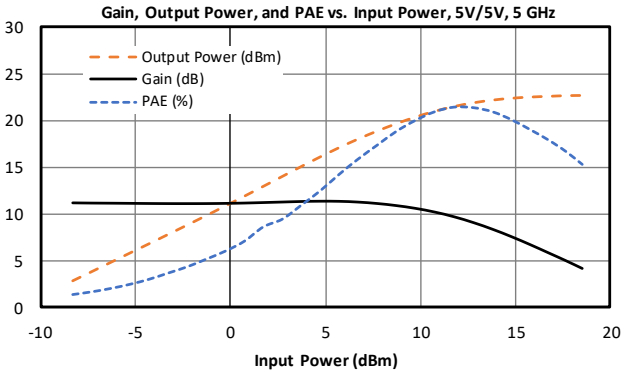


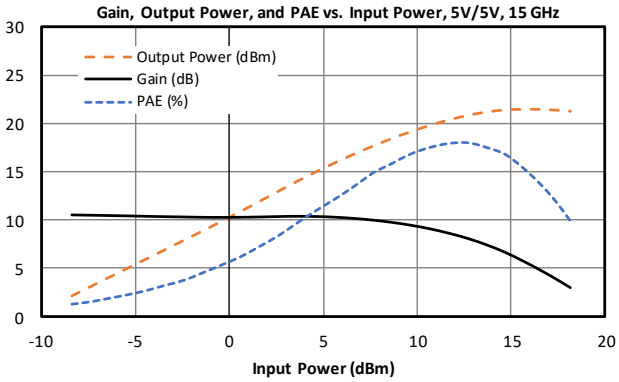






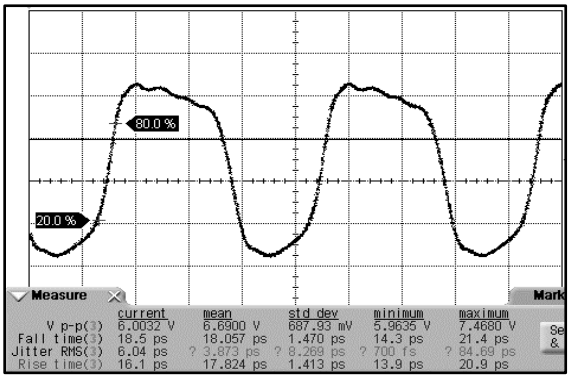
[5] Surface mount module APM-6849SM performance is expected to be similar to connectorized module performance.



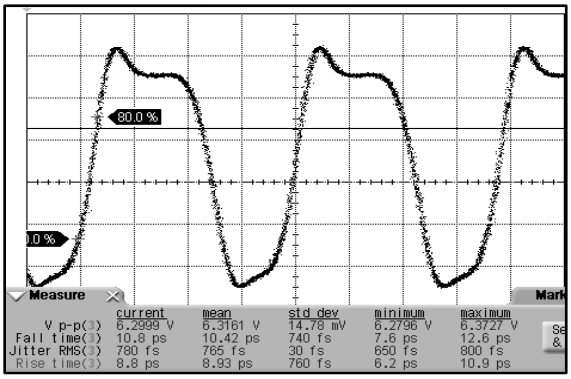


3.9 Time Domain Plots[6]

5 GHz, +10 dBm P_{in}, 5V/5V Bias



10 GHz, +10 dBm P_{in}, 5V/5V Bias

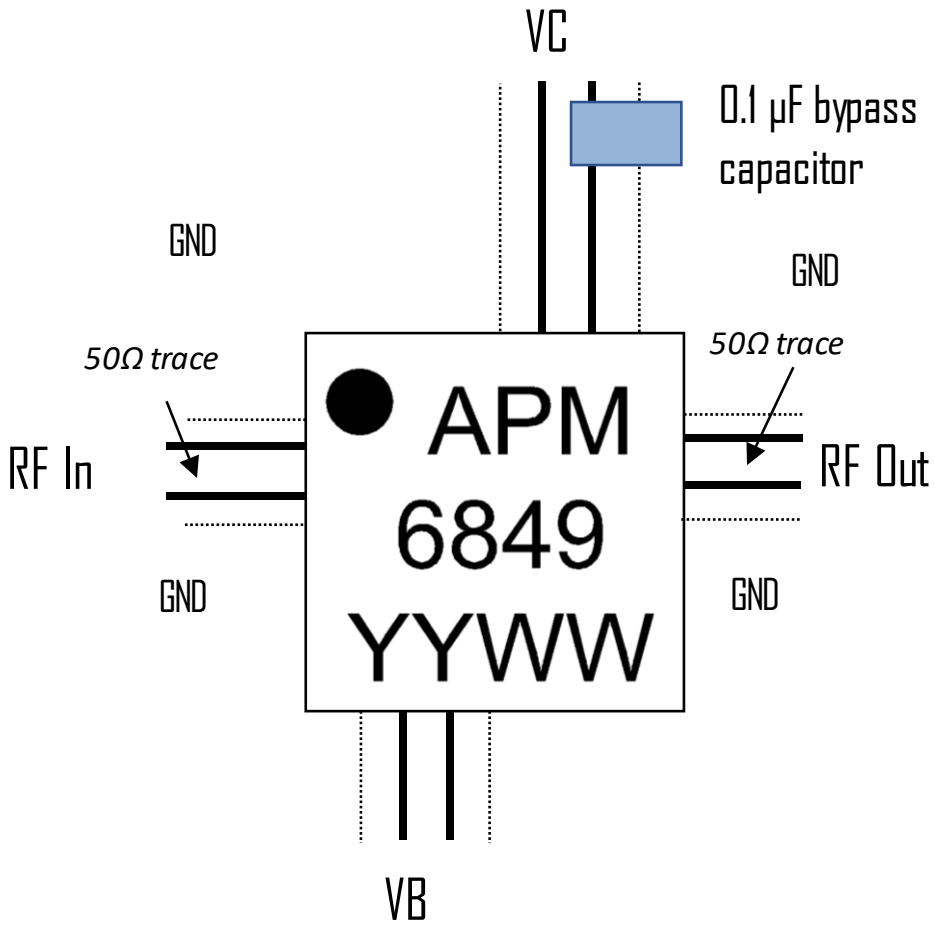


[6] Fast rise time is desirable for linear T3 mixer operation.

4. Application Information

4.1 APM-6849SM Application Circuit

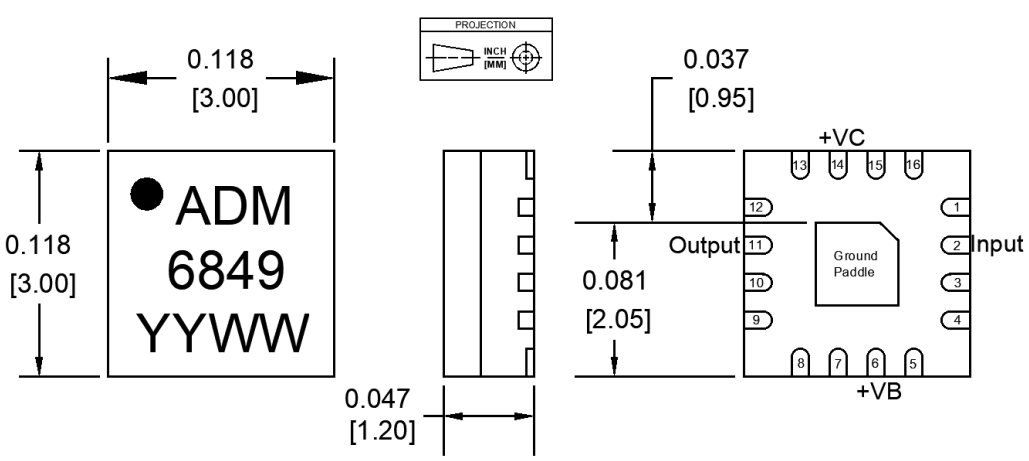
Below is the recommended application circuit for the APM-6849SM.



RF input and output should be soldered to 50 Ω traces. This is a single stage amplifier, and feedback oscillations are unlikely to occur. However, a bypass capacitance to ground on the VC supply line is recommended for consistent RF performance.

5. Mechanical Data

5.1 APM-6849SM Package Outline Drawing

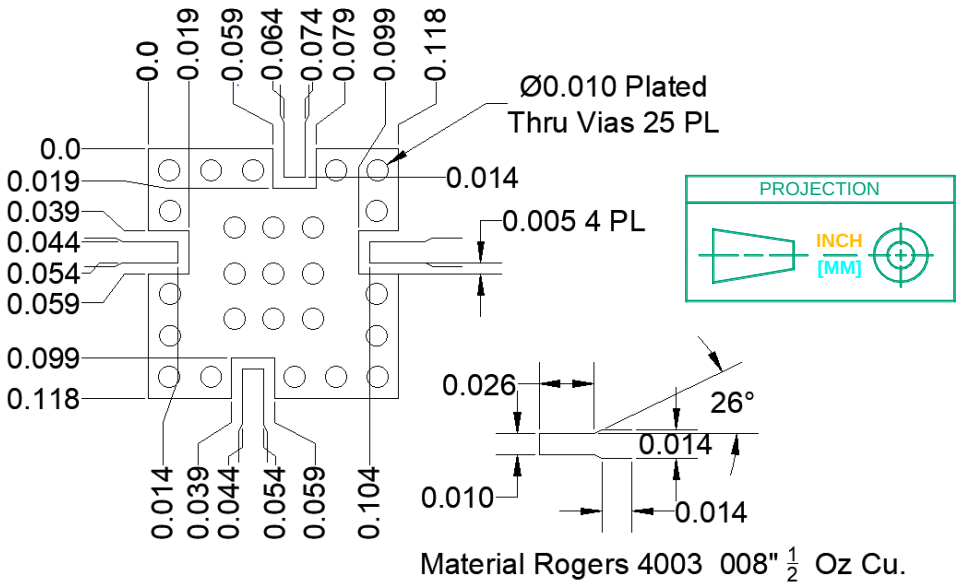


Pad #	Function
1	N/C
2	RF Input
3	N/C
4	N/C
5	N/C
6	+VB
7	N/C
8	N/C
9	N/C
10	N/C
11	RF Output
12	N/C
13	N/C
14	+VC
15	N/C
16	N/C

Notes:

1. Substrate Material is Plastic.
2. I/O Leads and Die Paddle are 0.05 microns Au over 0.02 microns Pd over 0.5 microns Ni.
3. All unconnected pins should be connected to PCB RF ground.

5.2 APM-6849SM Landing Pattern



Landing pattern drawing: Landing Pattern APM6849SM.dxf

5.3 EVAL-APM-6849SM Outline