GaAs Broadband Low Phase Noise Amplifier APM-6849

1. Device Overview

1.1 General Description

The APM-6849 is a single stage broadband, low phase noise LO driver amplifier designed to provide saturated +21 dBm output power. This amplifier uses GaAs HBT technology for low phase noise, and provides industry leading -170 dBc/Hz at 10 kHz offset from carrier frequency. The amplifier is also highly efficient with 21% peak PAE at 5 GHz input frequency and low DC current draw. It is optimized to provide enough power to drive the LO port of an S-diode mixer (2 – 20 GHz) and an H/L-diode mixer (2 - 32 GHz). This amplifier is operational with a variety of bias conditions for both low and high-power applications.

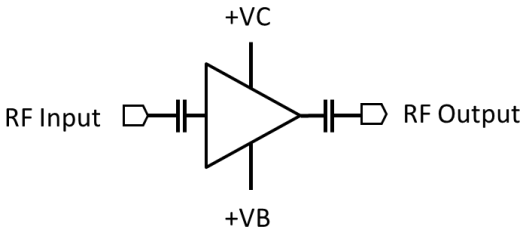
1.2 Features

- -170 dBc/Hz phase noise at 10 kHz offset frequency
- +21 dBm output power
- Low DC power consumption
- Positive-only biasing
- No sequencing required
- Unconditionally stable
- Integrated DC blocks – No bias-tees or off-chip blocking required
- Small Signal S-parameter .s2p Files: APM-6849CH.s2p

1.3 Applications

- Mobile test and measurement equipment
- Radar and satellite communications
- 5G Transceivers
- Driver amplifier for S, H, and L – diode mixers
- Suitable as a T3 drive

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
APM-6849CH	Wire Bondable Die	Bare Die	**RoHS**	Active	EAR99
APM-6849PA	Connectorized Module	PA	**RoHS**	Active	EAR99

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

Table of Contents

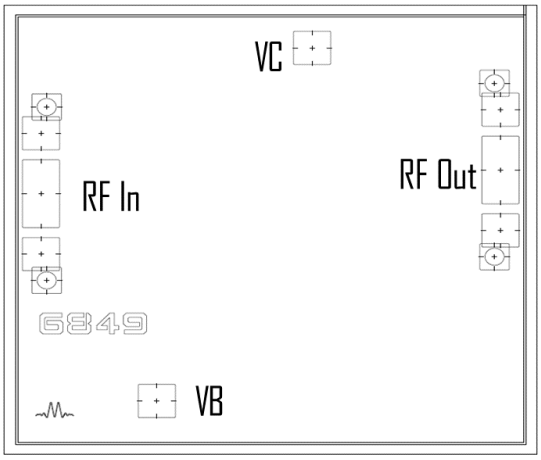
Revision History

Revision Code	Revision Date	Comment
-	November 2019	Datasheet Initial Release
A	January 2020	Added Time Domain Plots
B	July 2020	Updated Max Operating Temperature
C	July 2020	Updated Thermal Resistance Specification
D	October 2020	Updated Thermal Specs, Updated Min Specs

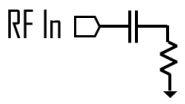
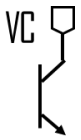
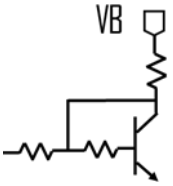
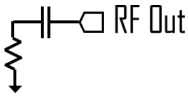
2. APM-6849 Port Configurations and Functions

2.1 APM-6849CH Port Diagram

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

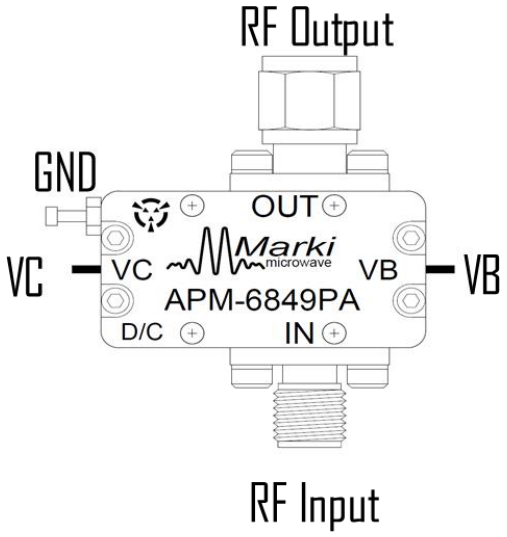


2.2 APM-6849CH Port Functions

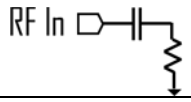
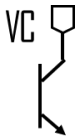
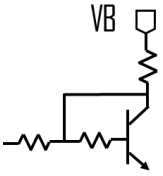
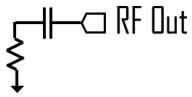
Port	Function	Description	Equivalent Circuit for Package
RF In	RF Input	This is the amplifier die RF Input port. It is internally DC blocked and RF matched to 50 Ω. RF input pad is GSG with 175 µm pitch.	
VC	Collector Supply Port	Pad VC is the amplifier IC's DC voltage supply pad. See section 3.6 for performance at different bias conditions.	
VB	Base Supply Port	Port VB 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.	
RF Out	RF Output	This is the amplifier die RF Output port. It is internally DC blocked and RF matched to 50 Ω. The RF output pad is GSG with 175 µm pitch. Must have less than 7:1 VSWR when operating with voltage greater than +5V on port VC.	
GND	Ground	IC backside must be connected to a DC/RF ground with high thermal and electrical conductivity.	

2.3 APM-6849PA Port Diagram

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



2.4 APM-6849PA Port Functions

Port	Function	Description	Equivalent Circuit for Package
RF In	RF Input	This is the RF input port of the amplifier. It is internally DC blocked and RF matched to 50 Ω.	
VC	Collector Supply	Port VC is the 1-stage amplifier DC voltage supply port. The PA module VC port connects internally to the IC's VC port described in section 2.2 of this datasheet.	
VB	Base Supply	Port VB 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. The VB port in the PA module internally connects to the IC's VB port described in section 2.2 of this datasheet.	
RF Out	RF Output	This is the amplifier 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 port VC.	
GND	Ground	Housing or coaxial cable's outer metal layer must be connected to a DC/RF ground potential 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	+16	dBm
Output Load VSWR	7:1	-
Operating Temperature	-40 to +85	˚C
Storage Temperature	-65 to +150	˚C
Thermal Resistance, θ_{JC}	78	ºC/W
Max Junction Temperature for MTTF > 1E6 Hours	125	ºC

3.2 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	TBD
Weight	APM-6849PA	14.7g

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 10 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.

Min and Max limits apply only to our connectorized units and are guaranteed at T_A=+25°C. Die are 100% DC tested and RF tested on a per lot basis.

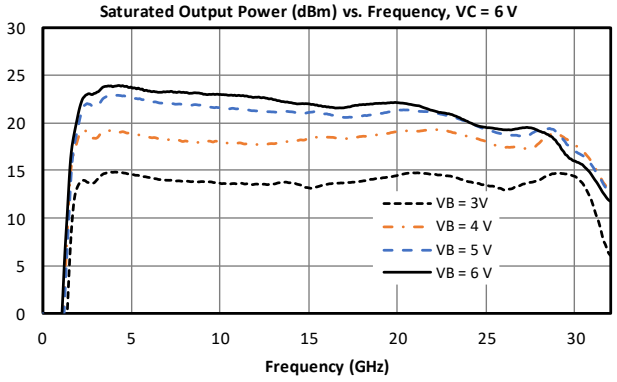
Parameter	Test Conditions	Frequency	Min	Typical	Units
Psat[3]	5V/5V Bias, Input Driver (See footnote)	2 GHz – 20 GHz	+19	+21	dBm
		20 GHz – 29 GHz		+19	
Small Signal Gain	5V/5V bias, -25 dBm Input Power	2 GHz – 20 GHz	9	11	dB
		20 GHz – 29 GHz		10	
Input Return Loss		2 GHz – 20 GHz		15	
		20 GHz – 29 GHz		8	
Output Return Loss		2 GHz – 20 GHz		15	
		20 GHz – 29 GHz		11	
Noise Figure		2 GHz – 26.5 GHz		5	
Reverse Isolation		2 GHz – 29 GHz		41	
Collector Current[4], 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 – 29 GHz		+10	dBm
Output IP3 (OIP3)		2 GHz – 29 GHz		+21	
Output P1dB	5V/5V bias	2 GHz – 20 GHz		+20	
		20 GHz – 29 GHz		+15	
Input Power for Saturation	5V/5V bias	2 GHz – 29 GHz		+10	dBm
Phase Noise @ 10 kHz Offset	5V/5V bias, +9 dBm Input power	2 – 29 GHz		-170	dBc/Hz

[3] Saturated Output Power tested with two APM-6849PA connected in series; +6 dBm RF input power, corresponding to ~+16 dBm into DUT.

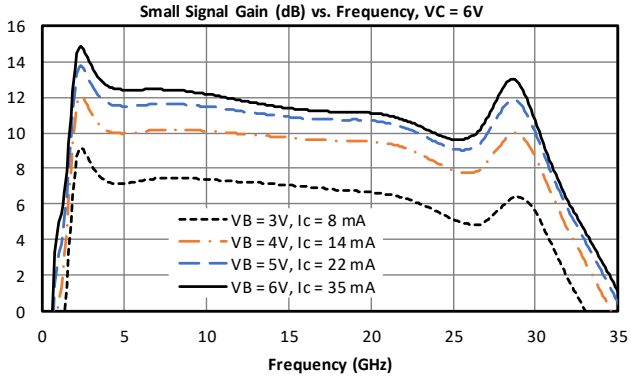
[4] Bias conditions for Ic and Ib tested with no RF input power. See section 3.6 for DC current vs. RF power. Bias conditions presented as VC/VB.

3.6 APM-6849CH Typical Performance Plots[5]

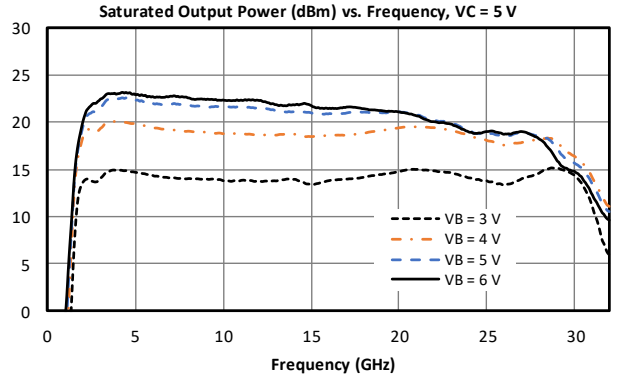
Saturated Output Power (dBm) vs. Frequency, VC = 6 V



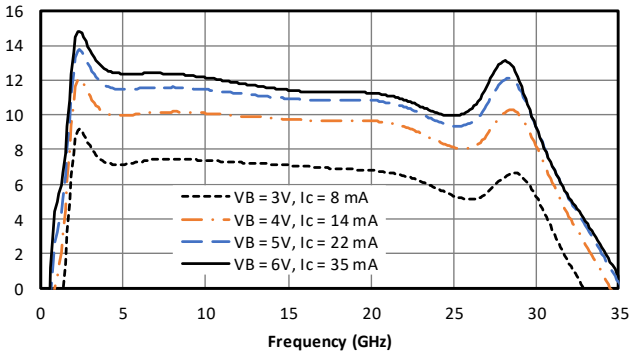
Small Signal Gain (dB) vs. Frequency, VC = 6V



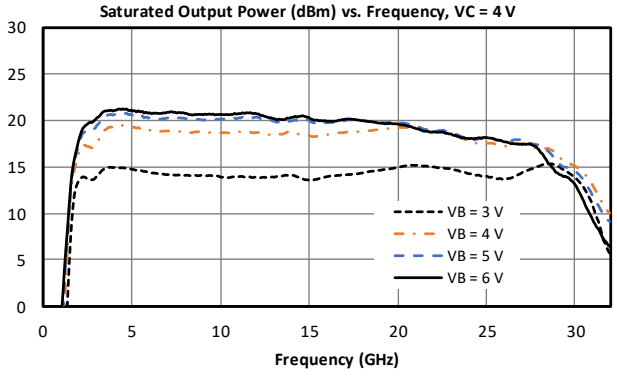
Saturated Output Power (dBm) vs. Frequency, VC = 5 V



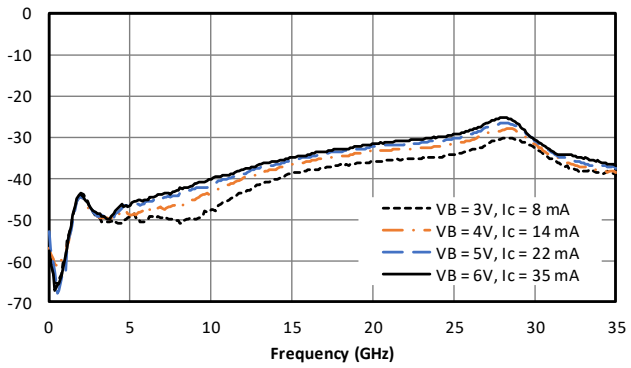
Small Signal Gain (dB) vs. Frequency, VC = 5V



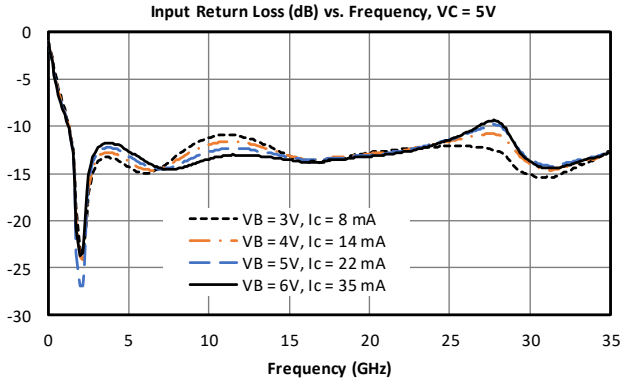
Saturated Output Power (dBm) vs. Frequency, VC = 4 V



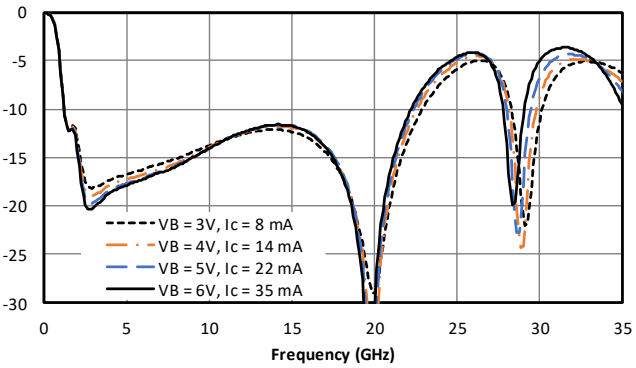
Reverse Isolation (dB) vs. Frequency, VC = 5V



Input Return Loss (dB) vs. Frequency, VC = 5V



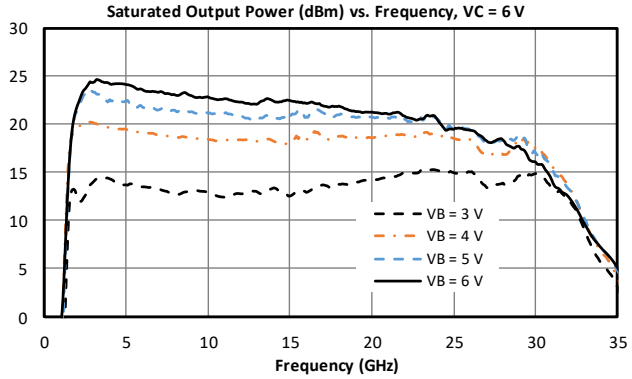
Output Return Loss (dB) vs. Frequecny, VC = 5V



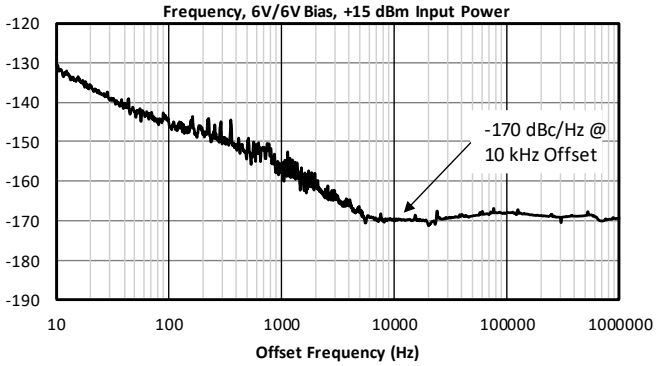
[5] Probe tested on chip

3.7 APM-6849PA Typical Performance Plots

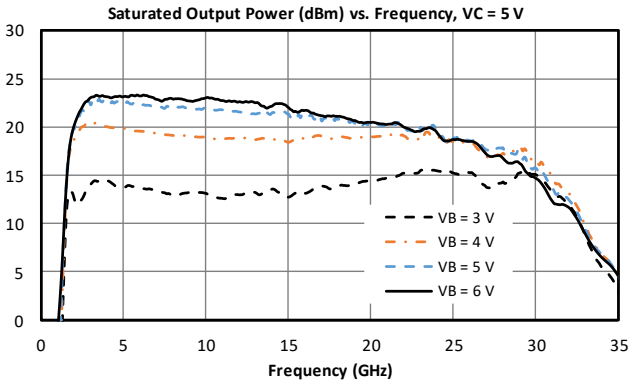
Saturated Output Power (dBm) vs. Frequency, VC = 6 V



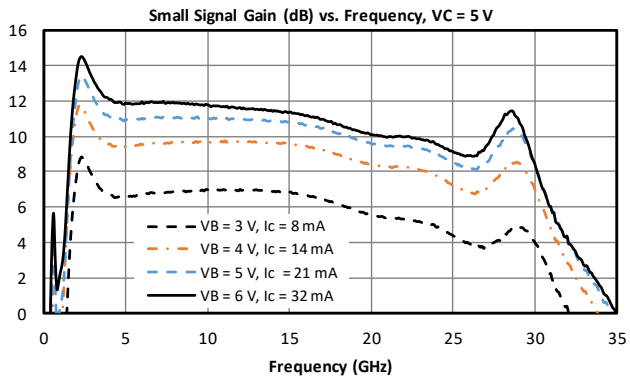
Phase Noise (dBc/Hz) vs. Offset Frequency; 4 GHz Carrier Frequency, 6V/6V Bias, +15 dBm Input Power



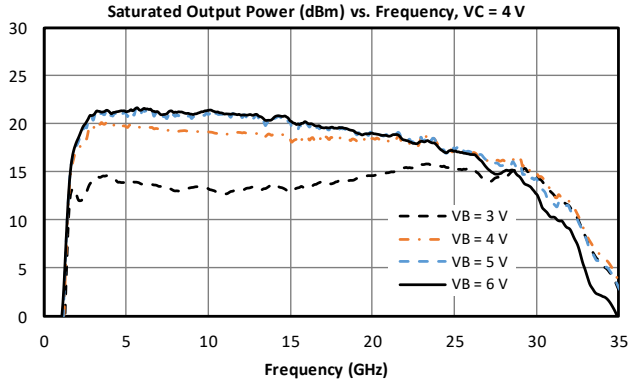
Saturated Output Power (dBm) vs. Frequency, VC = 5 V



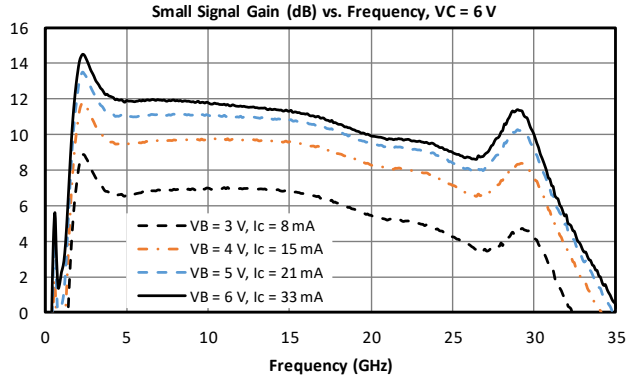
Small Signal Gain (dB) vs. Frequency, VC = 5 V



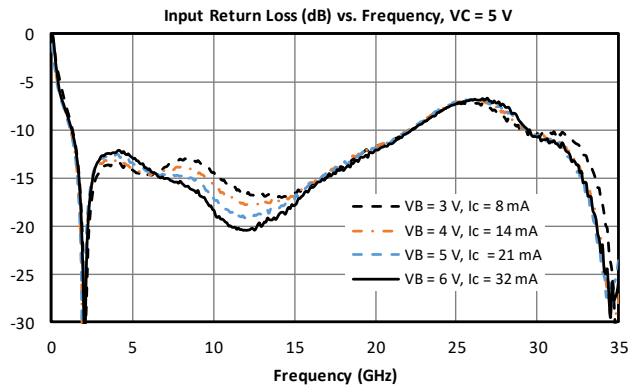
Saturated Output Power (dBm) vs. Frequency, VC = 4 V



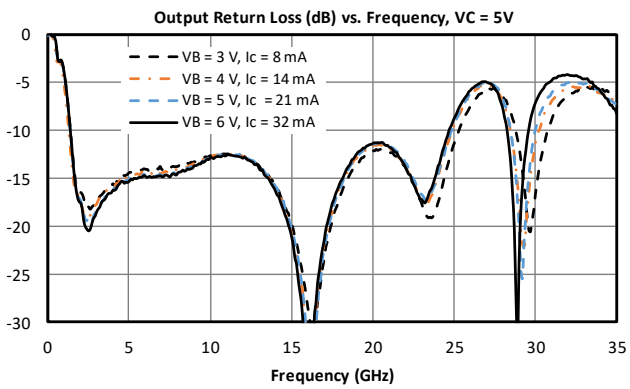
Small Signal Gain (dB) vs. Frequency, VC = 6 V



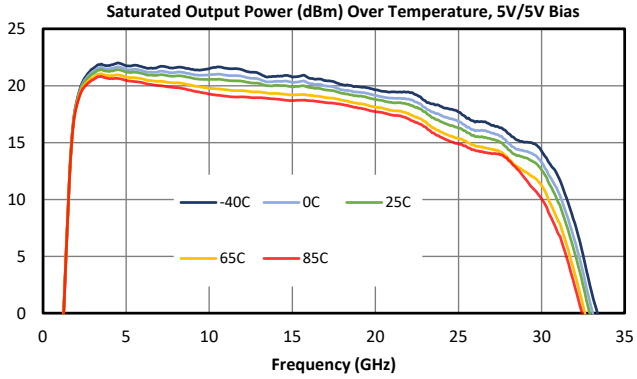
Input Return Loss (dB) vs. Frequency, VC = 5 V



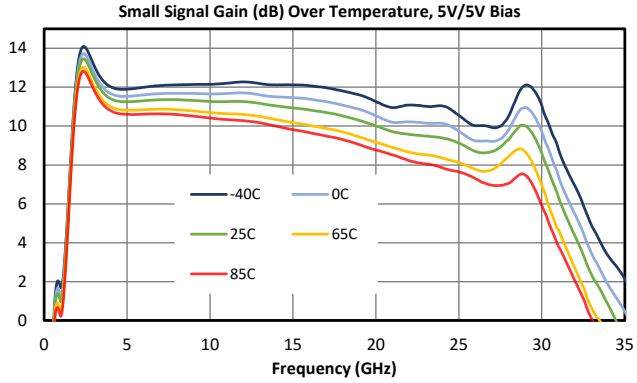
Output Return Loss (dB) vs. Frequency, VC = 5V



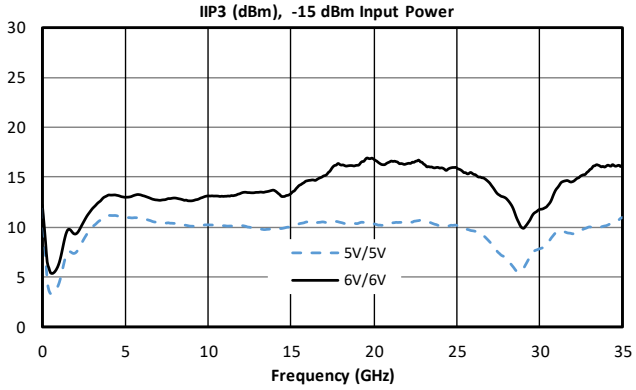
Saturated Output Power (dBm) Over Temperature, 5V/5V Bias



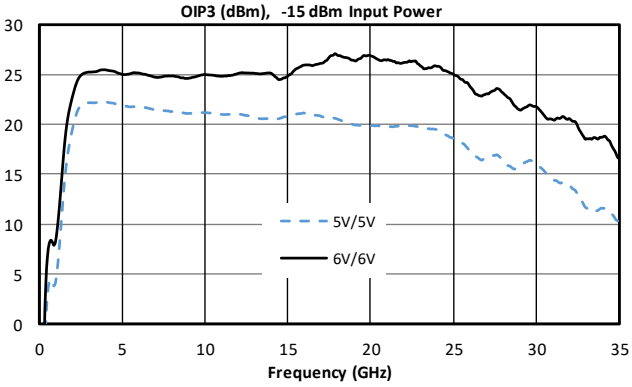
Small Signal Gain (dB) Over Temperature, 5V/5V Bias



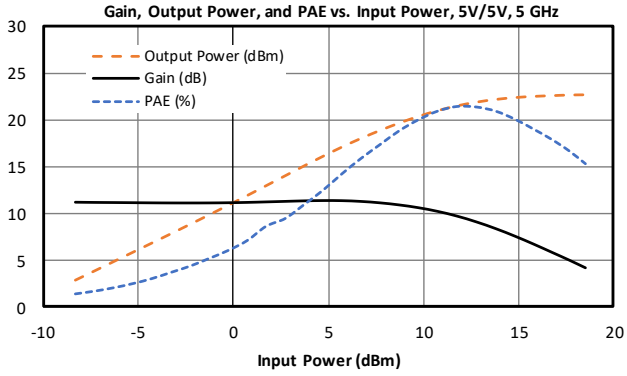
IIP3 (dBm), -15 dBm Input Power



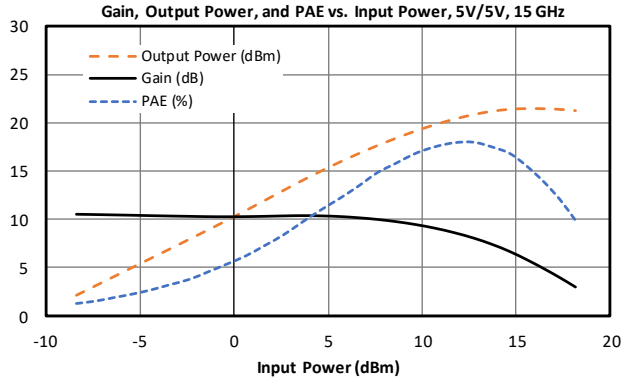
OIP3 (dBm), -15 dBm Input Power



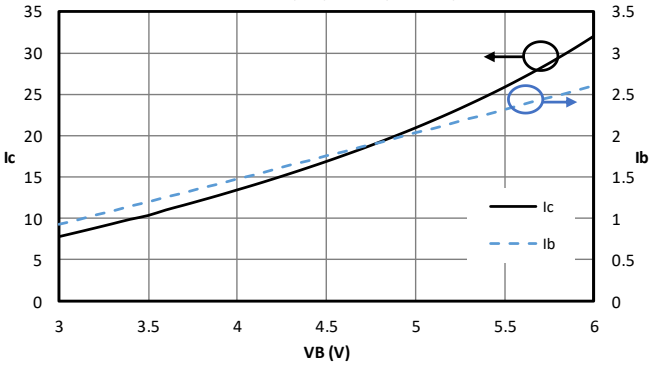
Gain, Output Power, and PAE vs. Input Power, 5V/5V, 5 GHz



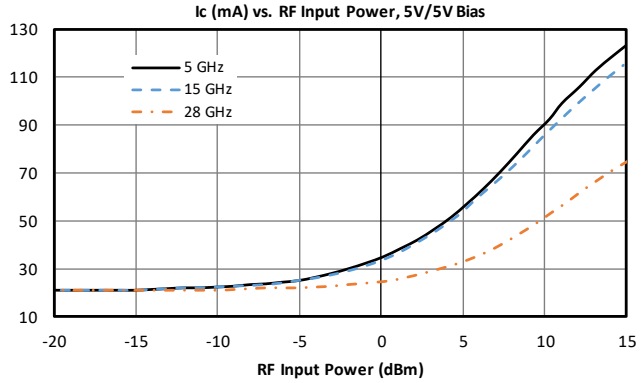
Gain, Output Power, and PAE vs. Input Power, 5V/5V, 15 GHz

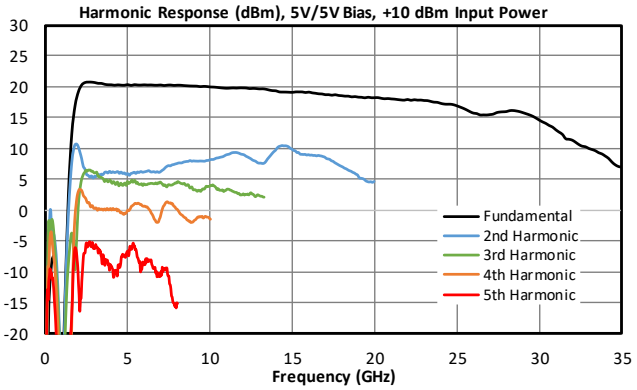


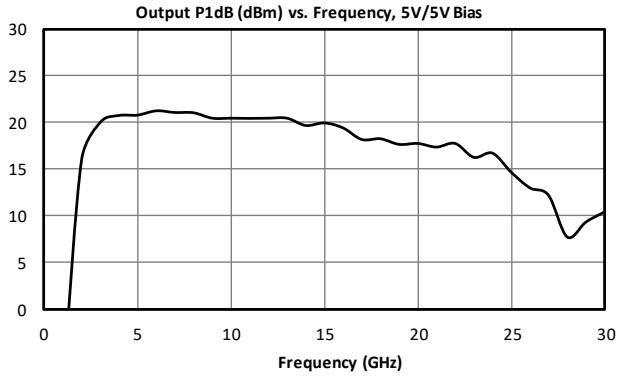
Ic, Ib (mA) vs. VB (VC = 5 V)

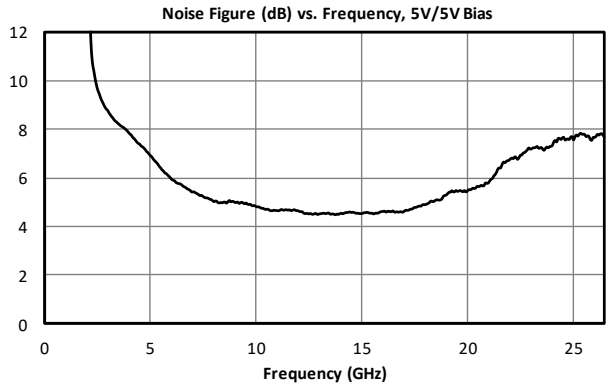


Ic (mA) vs. RF Input Power, 5V/5V Bias

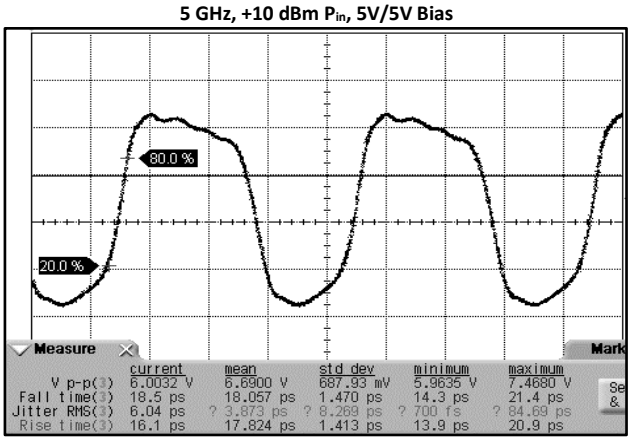


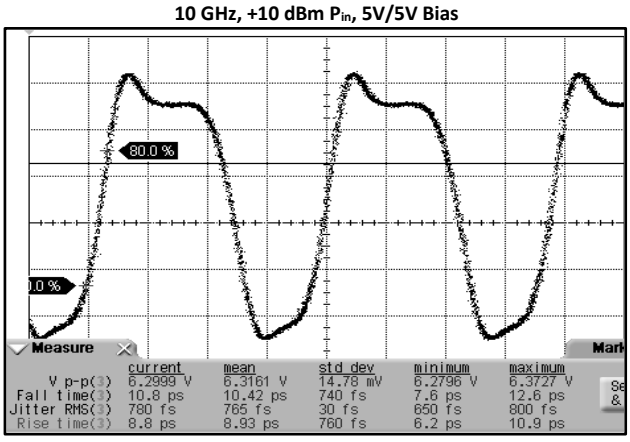






3.8 Time Domain Plots[6]

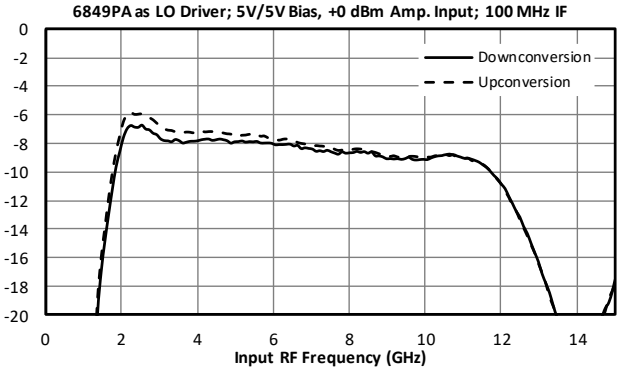




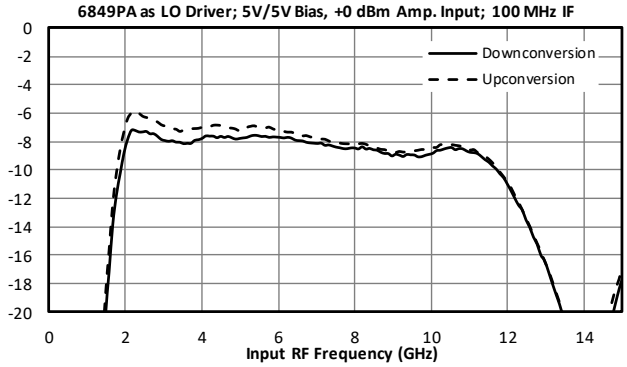
[6] Fast rise time is desirable for linear Marki T3 mixer operation.

3.9 Typical Performance Plots of Marki Mixers Driven With APM-6849PA

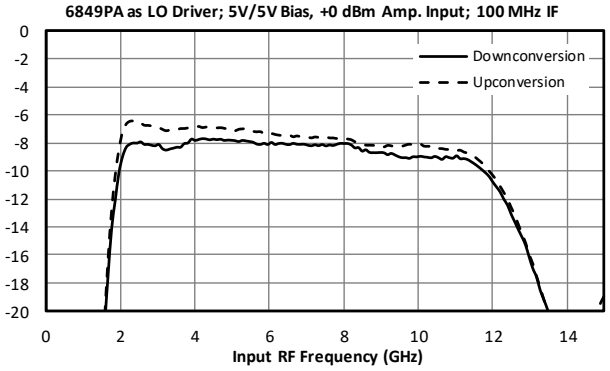
Conv. Loss (dB) of Marki MM1-0212L (Config. A) using two APM-6849PA as LO Driver; 5V/5V Bias, +0 dBm Amp. Input; 100 MHz IF



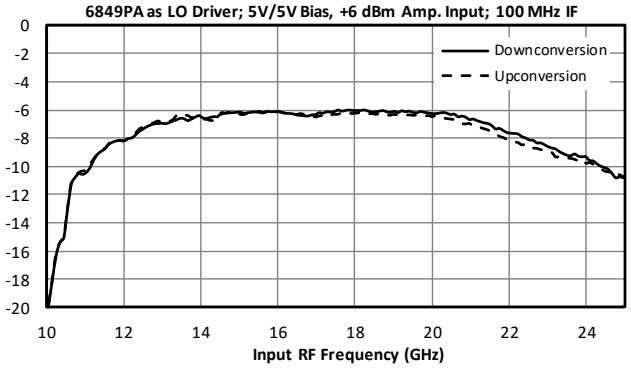
Conv. Loss (dB) of Marki MM1-0212H (Config. A); two series APM-6849PA as LO Driver; 5V/5V Bias, +0 dBm Amp. Input; 100 MHz IF



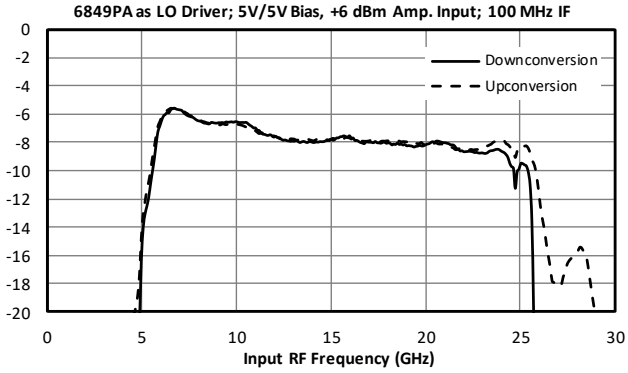
Conv. Loss (dB) of Marki MM1-0212S (Config. A); two series APM-6849PA as LO Driver; 5V/5V Bias, +0 dBm Amp. Input; 100 MHz IF



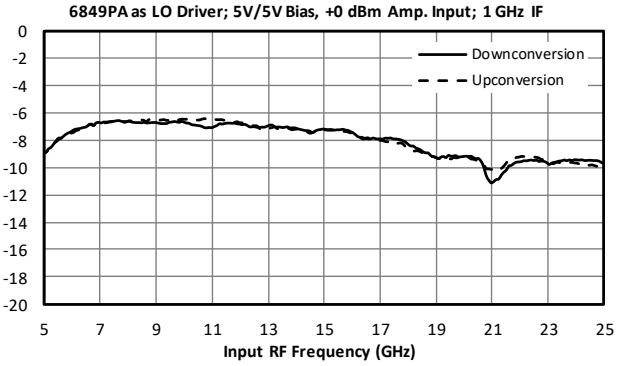
Conv. Loss (dB) of Marki MM1-1240S (Config. A); two series APM-6849PA as LO Driver; 5V/5V Bias, +6 dBm Amp. Input; 100 MHz IF



Conv. Loss (dB) of Marki MM1-0626S (Config. A); two series APM-6849PA as LO Driver; 5V/5V Bias, +6 dBm Amp. Input; 100 MHz IF



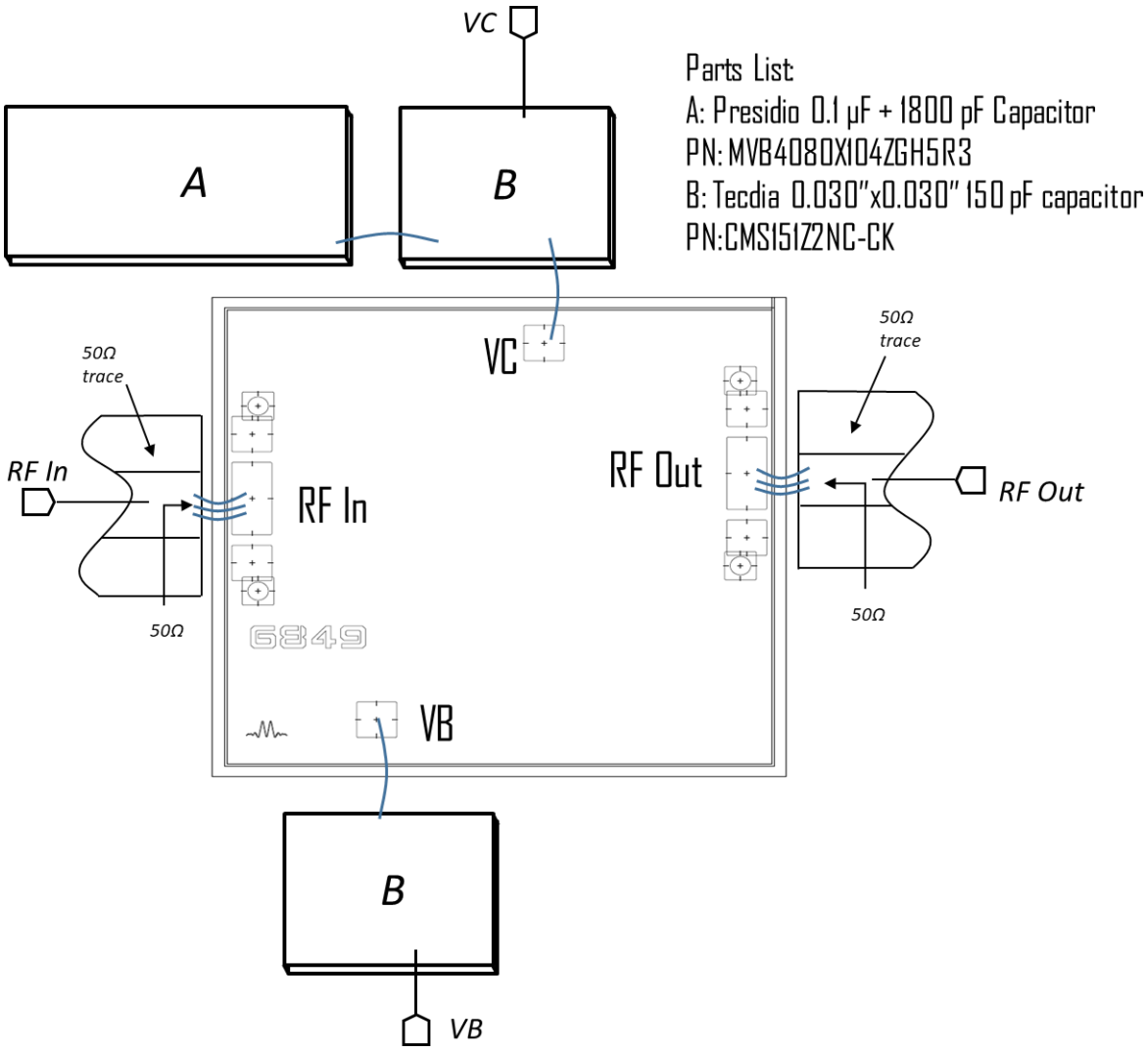
Conv. Loss (dB) of Marki MM1-0530L (Config. A) using two APM-6849PA as LO Driver; 5V/5V Bias, +0 dBm Amp. Input; 1 GHz IF



4. Application Information

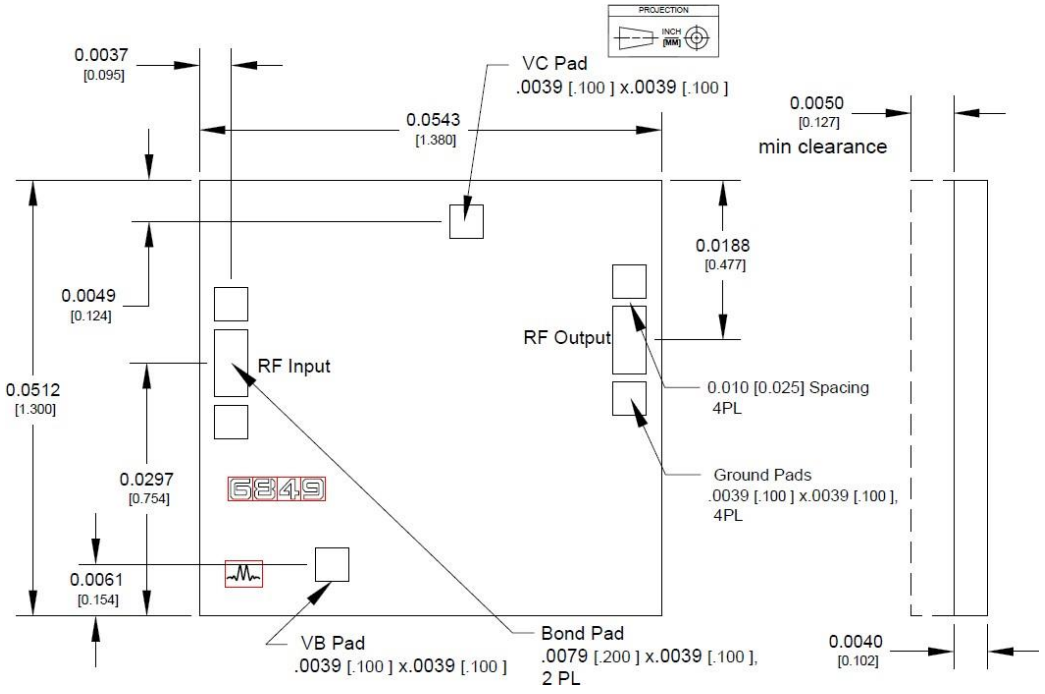
4.1 APM-6849CH Application Circuit

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



5. Mechanical Data

5.1 APM-6849CH Outline Drawing



5.2 APM-6849PA Package Outline Drawing