20-55 GHz GaAs LO Driver Amplifier AMM-6702

1. Device Overview

1.1 General Description

The AMM-6702 is a broadband MMIC LO buffer amplifier that efficiently provides high gain and output power over a 20-55 GHz frequency band. It is designed to provide a strong, flat output power response when driven with an input power at 0 dBm. It has built-in DC blocking capacitors on the input and output.

Module

Bare Die

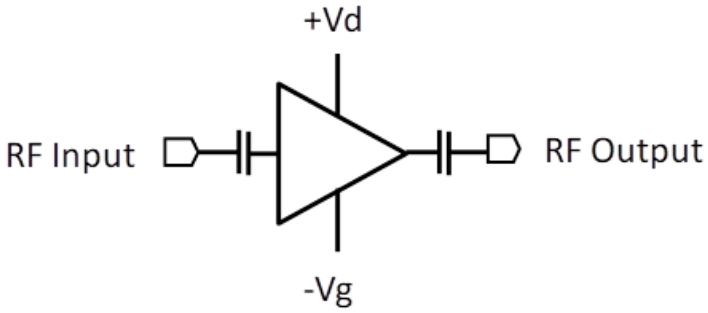
1.2 Features

- High 25+ dB gain
- Broadband performance
- +20 dBm output power
- 20%+ PAE
- .s2p Files for Various Bias Conditions: AMM-6702CH.zip
- 5V Single Supply Voltage Module: Tech Note

1.3 Applications

- Mobile test and measurement equipment
- Radar and satellite communications
- 5G transceivers
- Optimal LO driver amp for Marki S-diode and H-diode mixers and millimeter-wave multipliers
- LO driver for Marki MM1-1850, MM1-1467, MM1-1857 mixers

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
AMM-6702CH	Chip	Bare Die	RoHS	Active	3A001.b.2.d
AMM-6702UC	Module	UC	RoHS	Active	EAR99
AMM-6702UC5[2]	5V Positive Only Sequenced Module	UC5	RoHS	Active	EAR99

[1] Refer to our website for a list of definitions for terminology presented in this table.
[2] See our tech note here for detailed information about the design of our UC5 5V single-supply sequencer board.

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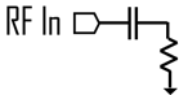
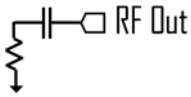
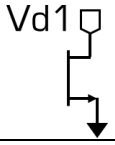
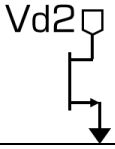
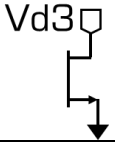
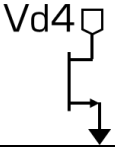
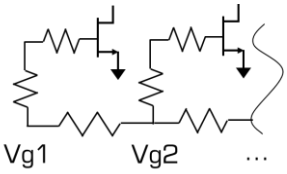
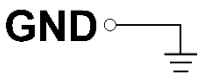
2. Port Configurations and Functions

2.1 AMM-6702CH Port Diagram

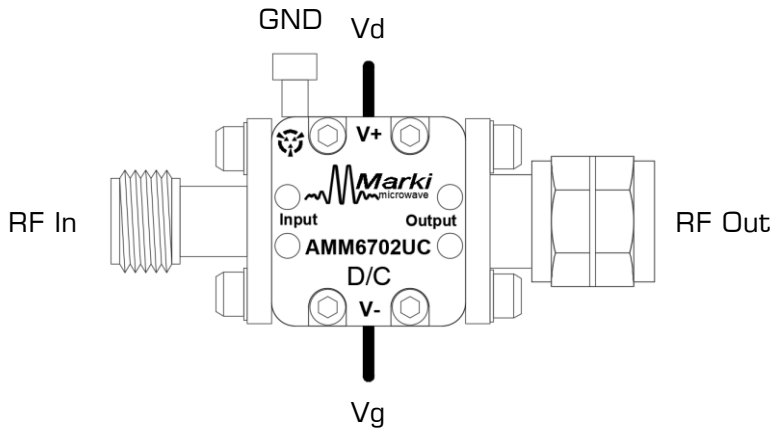
A top-down view of the AMM-6702CH's outline drawing is shown below. The port functions are detailed in section 2.2 of this datasheet.

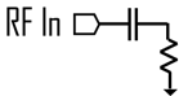
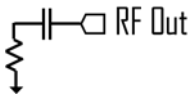
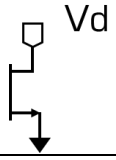
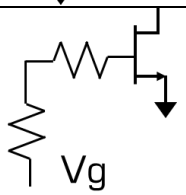
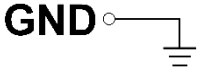
2.2 AMM-6702CH Port Functions

Port	Function	Description	Equivalent Circuit for Package
RF In	RF Input	This is the RF Input port of the amplifier die. It is internally DC blocked and RF matched to 50 Ω. RF input pad is GSG with 150 µm pitch.	
RF Out	RF Output	This is the RF Output port of the amplifier die. It is internally DC blocked and RF matched to 50 Ω. RF output pad is GSG with 150 µm pitch.	
Vd1	Drain Supply Port 1	Pad Vd1 supplies drain voltage to the first stage of the 4-stage amplifier IC. **Apply gate voltage Vg before applying drain voltage.**	
Vd2	Drain Supply Port 2	Pad Vd2 supplies drain voltage to the second stage of the 4-stage amplifier IC. **Apply gate voltage Vg before applying drain voltage.**	
Vd3	Drain Supply Port 3	Pad Vd3 supplies drain voltage to the third stage of the 4-stage amplifier IC. **Apply gate voltage Vg before applying drain voltage.**	
Vd4	Drain Supply Port 4	Pad Vd3 supplies drain voltage to the fourth stage of the 4-stage amplifier IC. **Apply gate voltage Vg before applying drain voltage.**	
Vg1-4	Gate Supply Voltage Pads	The Vg pads are connected resistively on chip. The user should apply between -0.4V and -0.6V to any one of the 4 Vg pads before applying positive DC voltage to any Vd port. Lower (more negative) voltages on a Vg pad will result in lower drain current and lower small signal gain.	
GND	Ground	Bottom side must be connected to a DC/RF ground potential with high thermal and electrical conductivity.	

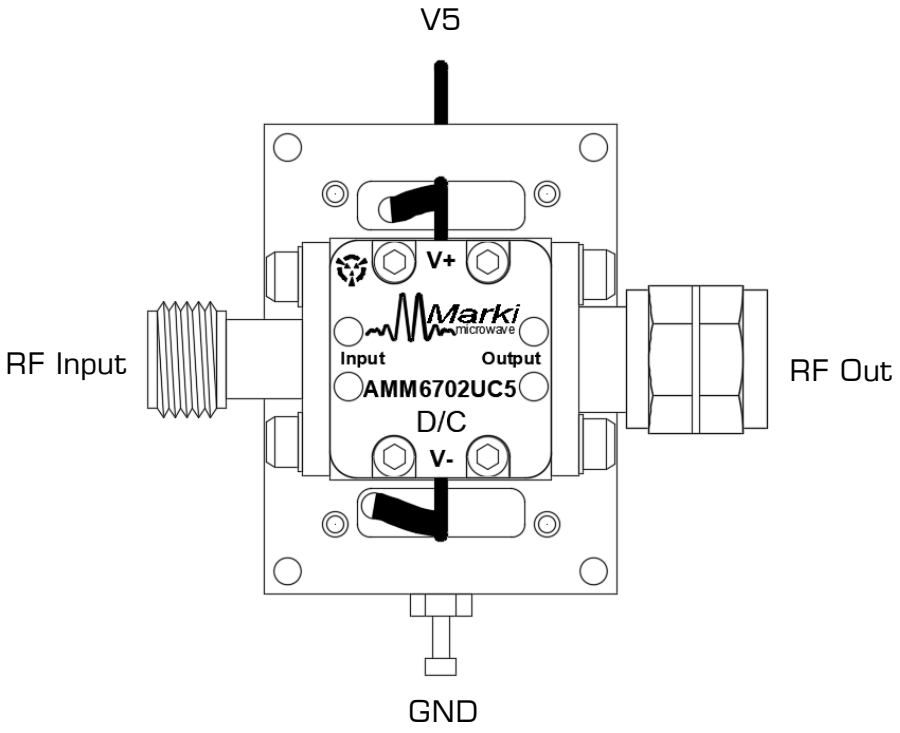
2.3 AMM-6702UC Port Diagram

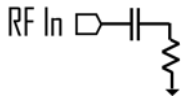
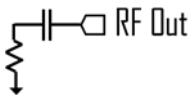
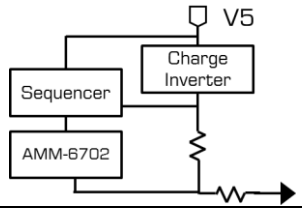
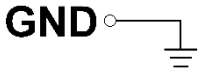
A top-down view of the AMM-6702UC's outline drawing is shown below. The port functions are detailed in section 2.2 of this datasheet.



Port	Function	Description	Equivalent Circuit for Package
RF In	RF Input	This is the RF Input port of the amplifier die. It is internally DC blocked and RF matched to 50 Ω.	
RF Out	RF Output	This is the RF Output port of the amplifier die. It is internally DC blocked and RF matched to 50 Ω.	
Vd	Drain Supply Pin	The Vd pin supplies drain voltage to the amplifier IC. **Apply gate voltage Vg before applying drain voltage.**	
Vg	Gate Supply Pin	The Vg pin supplies negative control voltage to the amplifier and controls the amplifier gain. Lower (more negative) voltages on a Vg pad will result in lower drain current and lower small signal gain.	
GND	Ground	Exterior housing must be connected to a DC/RF ground potential with high thermal and electrical conductivity.	

2.4 AMM-6702UC5 Port Diagram



Port	Function	Description	Equivalent Circuit for Package
RF In	RF Input	This is the RF Input port of the amplifier die. It is internally DC blocked and RF matched to 50 Ω.	
RF Out	RF Output	This is the RF Output port of the amplifier die. It is internally DC blocked and RF matched to 50 Ω.	
V5	5V Voltage Pin	The 5V voltage pin activates an internal negative voltage generator and a voltage sequencer with 5V of externally applied bias. Nominally applies 3.5V to Vd and -0.5V to Vg at the amplifier level. See our tech note for details.	
GND	Ground	Exterior housing must be connected to a DC/RF ground potential with high thermal and electrical conductivity.	

3. Specifications

3.1 AMM-6702CH and AMM-6702UC 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	Units
Positive Bias Voltage (Pin 1)	4.5	V
Positive Bias Current (Pin 1)[3]	400	mA
Negative Bias Voltage (Pin 4)	-2	V
Negative Bias Current (Pin 4)	10	µA
RF Input Power	+22	dBm
Continuous Power Dissipation (P_{DISS})	824	mW
Thermal Resistance, θ_{JC}	90	°C/W
Operating Temperature	-40 to +85	°C
Storage Temperature	-65 to +150	°C
Max Junction Temperature for MTTF > 1E6 hours	175	°C

3.2 AMM-6702UC5 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	Units
V5 Voltage	6	V
Positive Bias Current (Pin 1)	430	mA
RF Input Power	+22	dBm
Operating Temperature	-40 to +85	°C
Storage Temperature	-65 to +150	°C

[3] Maximum current draw is 400 mA when not limited by continuous power dissipation rating

3.3 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	Class 0
Weight	AMM-6702UC	12.3g
Weight	AMM-6702UC5	45.8g

3.4 AMM-6702CH and AMM-6702UC 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 (3.5). 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 (3.1).

	Min	Nominal	Max	Units
T_A, Ambient Temperature	-55	+25	+85	°C
Positive DC Voltage	+2	+3.5	+4	V
Positive DC Current	100	180	350	mA
Negative DC Voltage	-0.4	-0.5	-0.6	V

3.5 AMM-6702UC5 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 (3.5). 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 (3.2).

	Min	Nominal	Max	Units
T_A, Ambient Temperature	-55	+25	+85	°C
Positive DC Voltage	+3.5	+5	+5.5	V
Positive DC Current	200	230	400	mA

3.6 AMM-6702CH and AMM-6702UC Sequencing Requirements

Turn-on Procedure:

1) Apply <-0.4V to Vg (Pin 4)
2) Apply Vd (Pin 1)

Turn-off Procedure:

1) Turn off Vd (Pin 1)
2) Turn off Vg (Pin 4)

3.7 AMM-6702UC5 Sequencing Requirements

There are no sequencing requirements for the AMM-6702UC5.

3.8 AMM-6702CH and AMM-6702UC 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.

Parameter	Test Conditions	Frequency	Min	Typical	Units
Saturated Output Power	3.0V/-0.5V Bias	21 GHz – 55 GHz		+19	dBm
	3.5V/-0.5V Bias	21 GHz – 25 GHz		+20	
		25 GHz – 48 GHz	+17	+21	
		48 GHz – 55 GHz		+17	
	4.0V/-0.5V Bias	21 GHz – 55 GHz		+20	
Small Signal Gain	3.0V/-0.5V Bias	21 GHz – 55 GHz		24	dB
	3.5V/-0.5V Bias	21 GHz – 25 GHz		25	
		25 GHz – 48 GHz	20	24	
		48 GHz – 55 GHz		22	
	4.0V/-0.5V Bias	21 GHz – 55 GHz		23	
Input Return Loss	3.5V/-0.5V bias, -25 dBm Input Power	21 GHz – 55 GHz		8	
Output Return Loss				9	
Noise Figure				6.5	
Reverse Isolation				45	
Bias Requirements[4]	3.5V/-0.6V			130	mA
	3.5V/-0.5V			180	
	3.5V/-0.4V			230	
Input IP3 (IIP3)	3.5V/-0.5V bias, -25 dBm Input Power	21 GHz – 55 GHz		+3	dBm
Output IP3 (OIP3)				+27	
P_{1dB}	3.5V/-0.5V bias			+14.8	
Input Power for Saturation	3.5V/-0.5V bias			+3	

[4] Bias conditions tested with no RF input power. See section 3.6 for DC current vs. RF power

3.9 AMM-6702UC5 Electrical Specifications

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

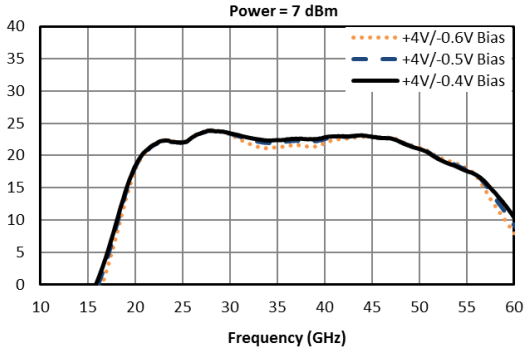
Min and Max limits apply only to our connectorized units and are guaranteed at T_A=+25°C.

Parameter	Test Conditions	Frequency	Min	Typical	Units
Saturated Output Power	+5V bias, +5 dBm Input Power	21 GHz – 25 GHz		+20	dBm
		25 GHz – 48 GHz	+17	+21	
		48 GHz – 55 GHz		+17	
Small Signal Gain	+5V bias, -25 dBm Input Power	21 GHz – 25 GHz		25	dB
		25 GHz – 48 GHz	20	24	
		48 GHz – 55 GHz		22	
Input Return Loss	+5V bias, -25 dBm Input Power	21 GHz – 55 GHz		8	
Output Return Loss				9	
Noise Figure				6.5	
Reverse Isolation				45	
Bias Requirements[5]	+5V			230	mA
Input IP3 (IIP3)	5V bias, -25 dBm Input Power	21 GHz – 55 GHz		+3	dBm
Output IP3 (OIP3)				+27	
P_{1dB}	+5V Bias			+14.8	
Input Power for Saturation				+3	

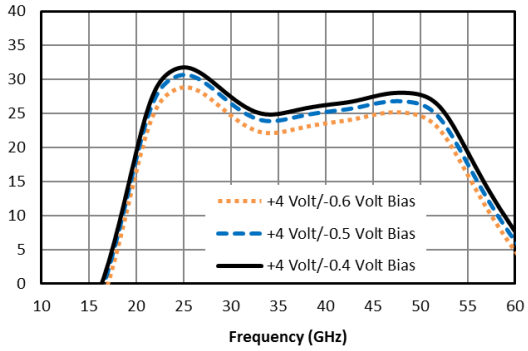
[5] Bias conditions tested with no RF input power. See section 3.6 for DC current vs. RF power

3.10 AMM-6702CH Typical Performance Plots

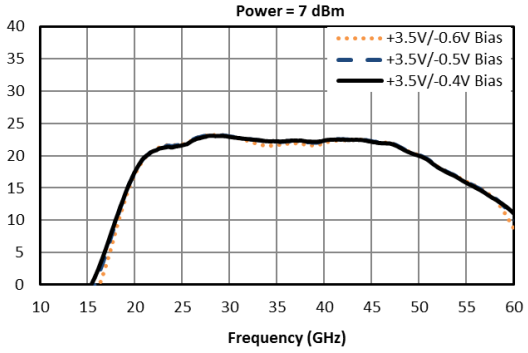
AMM-6702CH Saturated Output Power (dBm), Vd = 4V, Input Power = 7 dBm



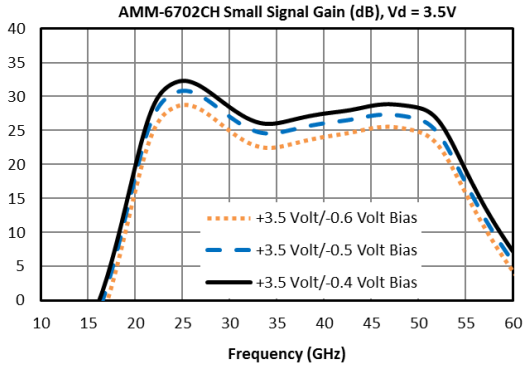
AMM-6702CH Small Signal Gain (dB), Vd = 4V



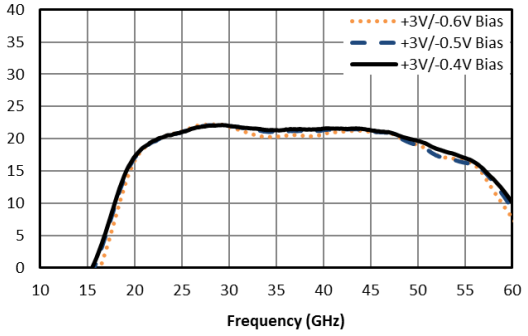
AMM-6702CH Saturated Output Power (dBm), Vd = 3.5V, Input Power = 7 dBm



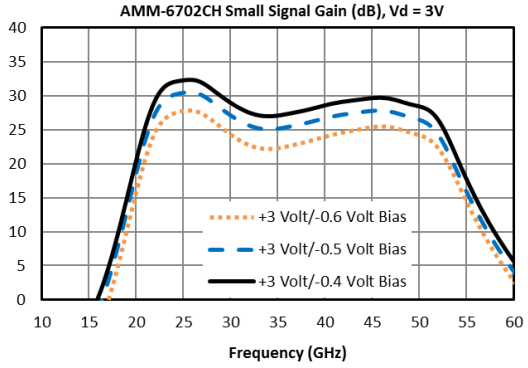
AMM-6702CH Small Signal Gain (dB), Vd = 3.5V



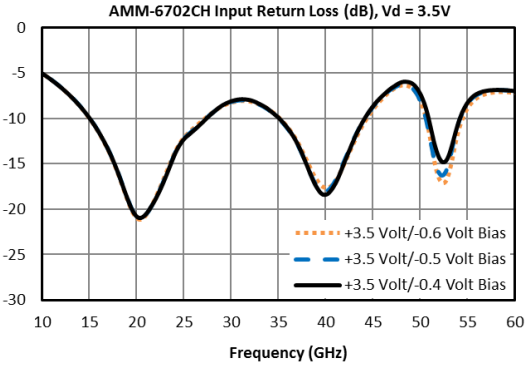
AMM-6702CH Saturated Output Power (dBm), Vd = 3V, Input Power = 7 dBm



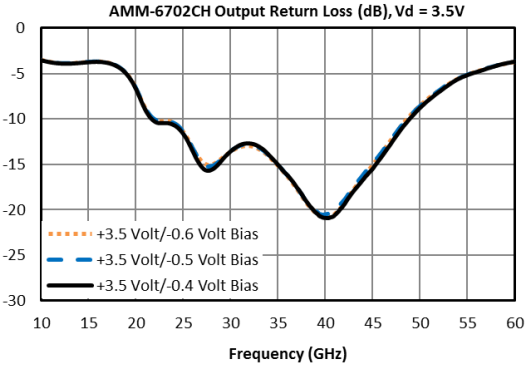
AMM-6702CH Small Signal Gain (dB), Vd = 3V

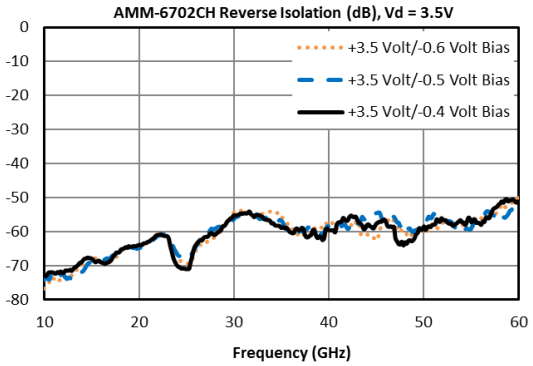


AMM-6702CH Input Return Loss (dB), Vd = 3.5V

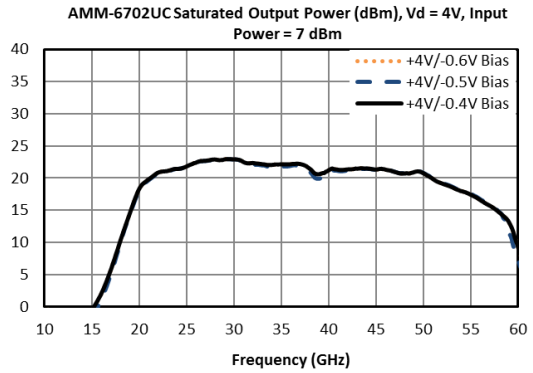


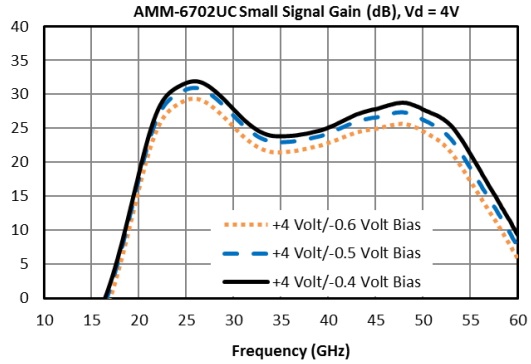
AMM-6702CH Output Return Loss (dB), Vd = 3.5V

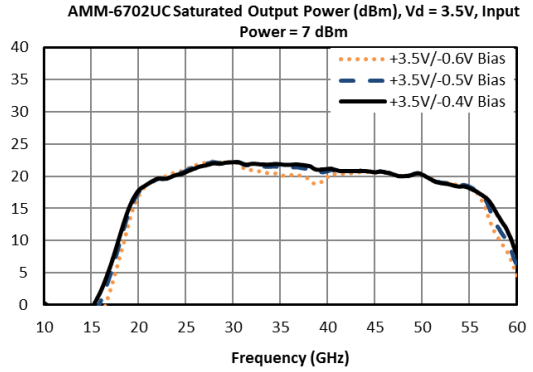


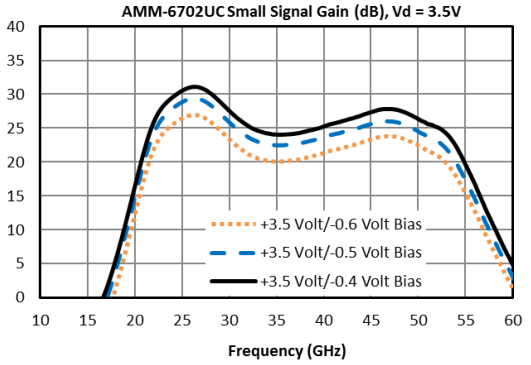


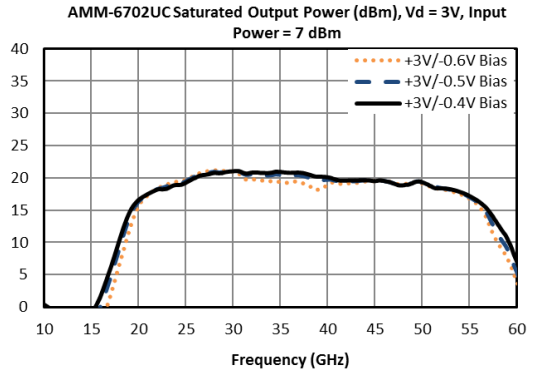
3.11 AMM-6702UC Typical Performance Plots

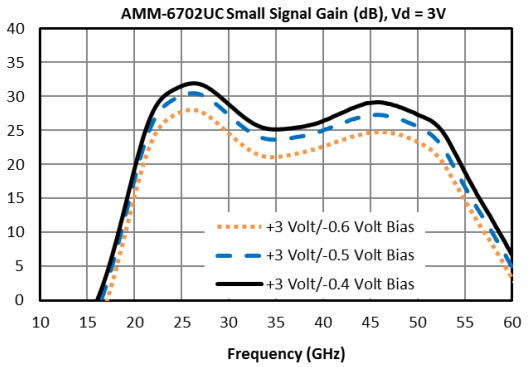




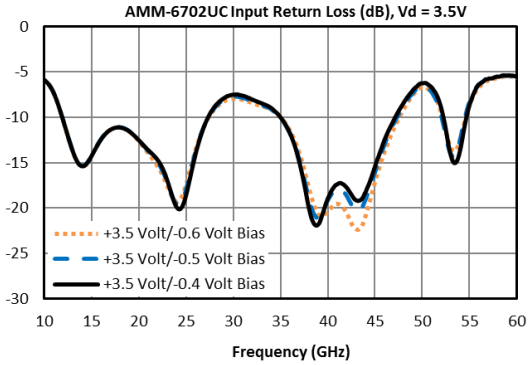




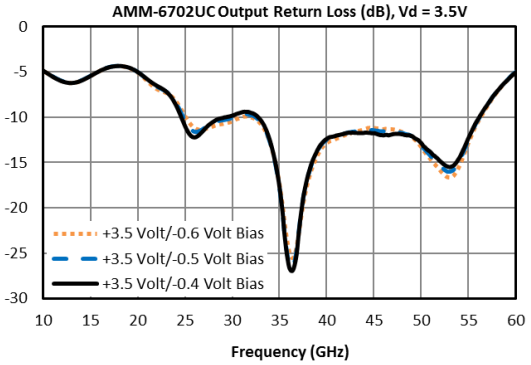




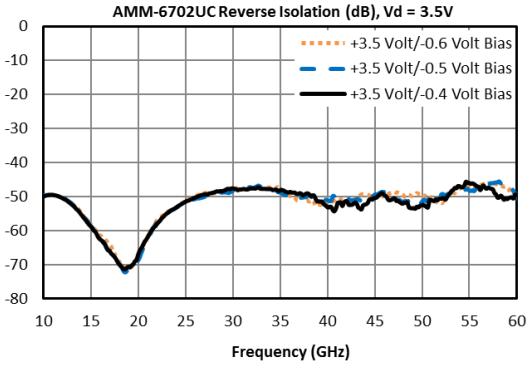
AMM-6702UC Input Return Loss (dB), Vd = 3.5V



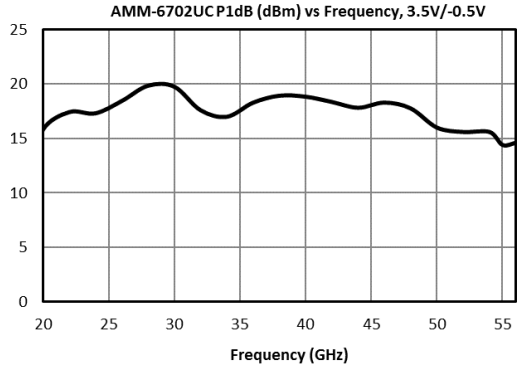
AMM-6702UC Output Return Loss (dB), Vd = 3.5V



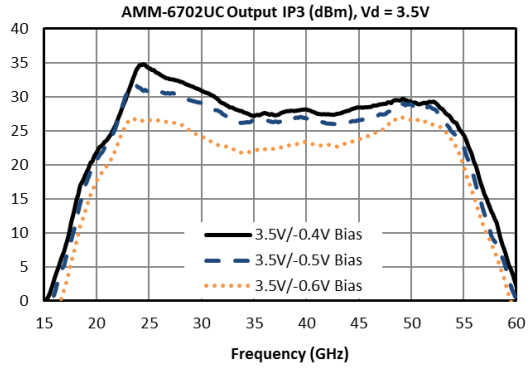
AMM-6702UC Reverse Isolation (dB), Vd = 3.5V



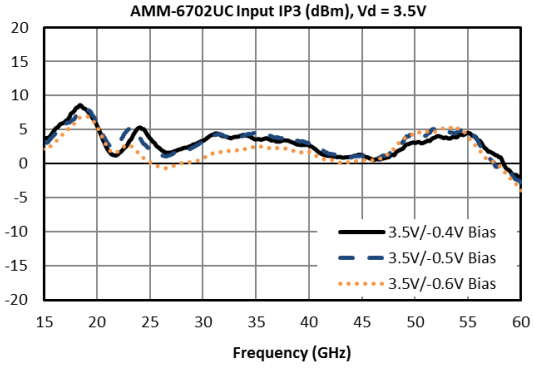
AMM-6702UC P1dB (dBm) vs Frequency, 3.5V/-0.5V



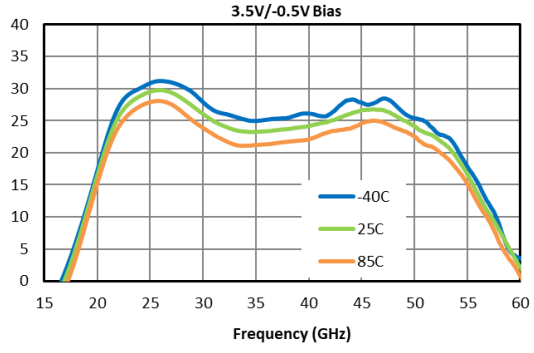
AMM-6702UC Output IP3 (dBm), Vd = 3.5V



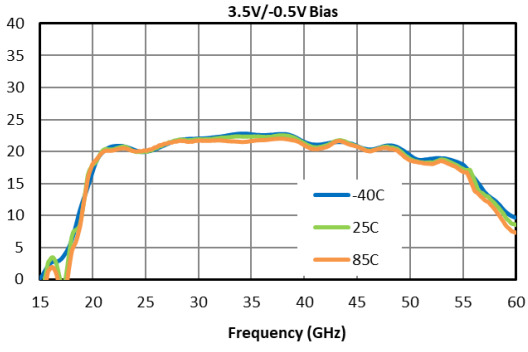
AMM-6702UC Input IP3 (dBm), Vd = 3.5V



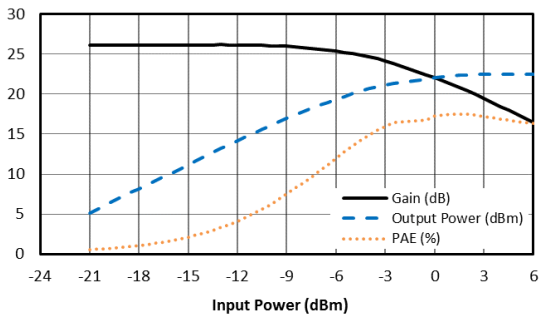
AMM-6702UC Small Signal Gain (dB) vs Temperature, 3.5V/-0.5V Bias



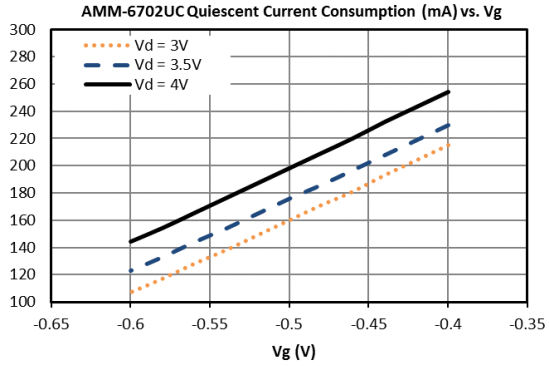
AMM-6702UC Saturated Output Power (dBm) vs Temperature, 3.5V/-0.5V Bias



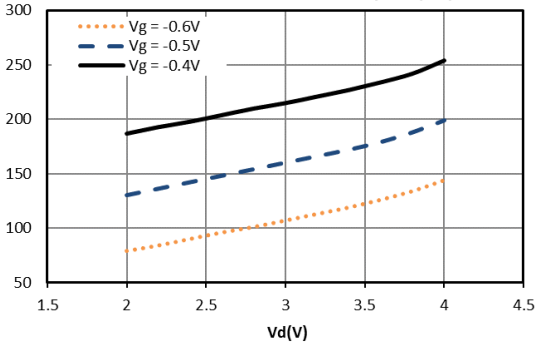
AMM-6702UC Gain, Output Power, PAE vs. Input Power @ 30 GHz, 3.5V/-0.5 V Bias



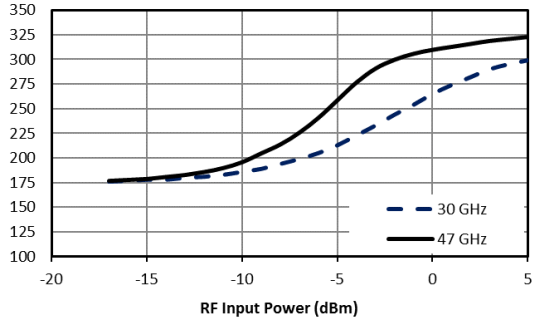
AMM-6702UC Quiescent Current Consumption (mA) vs. Vg



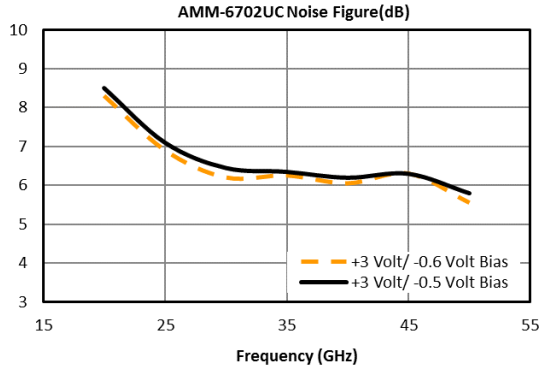
AMM-6702UC Quiescent Current Consumption (mA) vs. Vd



AMM-6702UC Current Consumption (mA) vs. RF Input Power, 3.5V/-0.5V Bias

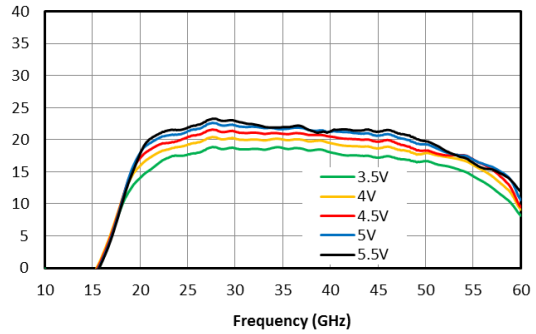


AMM-6702UC Noise Figure(dB)

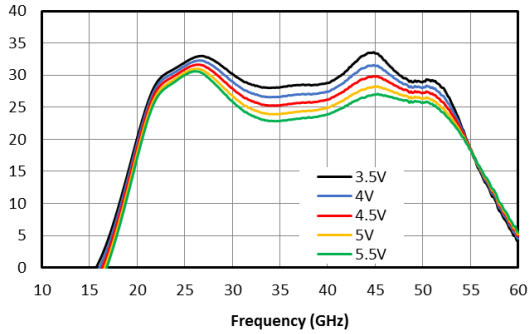


3.12 AMM-6702UC5 Typical Performance Plots

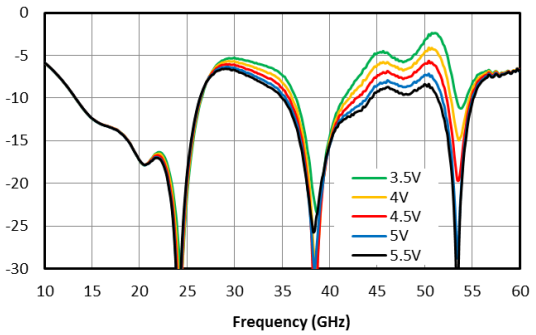
AMM-6702UC5 Psat (dBm) vs. Frequency; Input Power = +5 dBm



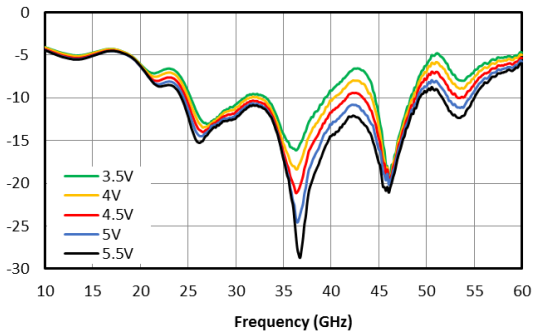
AMM-6702UC5 Small Signal Gain (dB) vs. Frequency



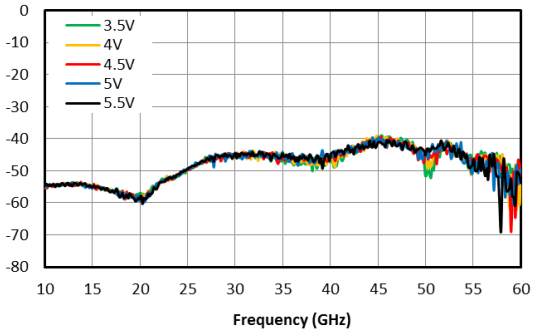
AMM-6702UC5 Input Return Loss (dB) vs. Frequency



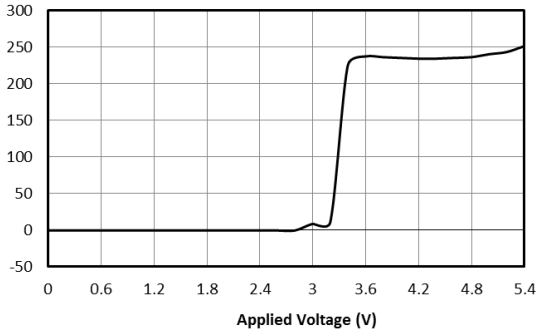
AMM-6702UC5 Output Return Loss (dB) vs. Frequency



AMM-6702UC5 Reverse Isolation (dB) vs. Frequency

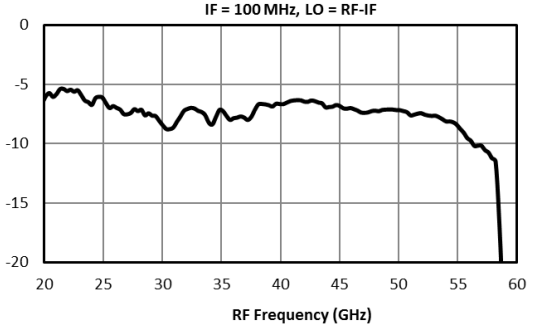


AMM-6702UC5 DC Current (mA) vs. Applied Voltage

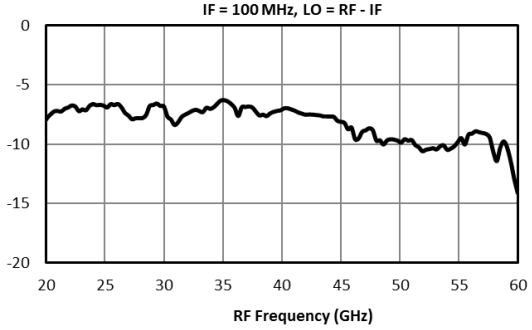


3.13 Conversion Loss of Marki Mixers Using AMM-6702UC as LO Driver

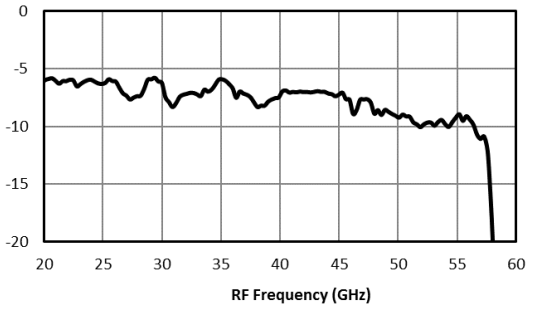
Conversion Loss of Marki MM1-1857H Mixer using AMM-6702UC as LO Driver Amplifier (dB), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF-IF



Conversion Loss of Marki MMIQ-1865L Mixer using AMM-6702UC as LO Driver Amplifier (dB), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF - IF

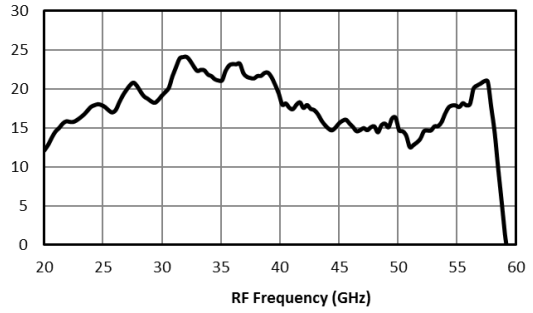


Conversion Loss of Marki MMIQ-1865H Mixer using AMM-6702UC as LO Driver Amplifier (dB), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF-IF

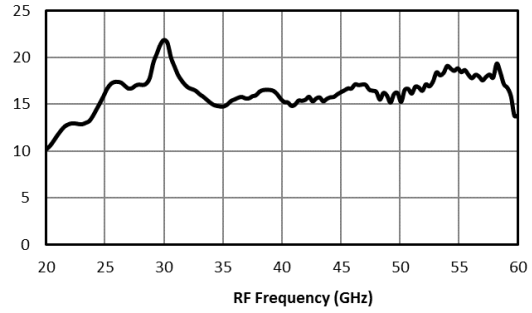


3.14 Input-Referred IP3 of Marki Mixers Using AMM-6702UC as LO Driver

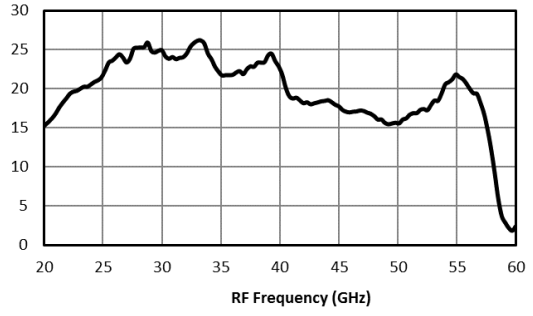
Input IP3 of Marki MM1-1857H Mixer using AMM-6702UC as LO Driver Amplifier (dBm), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF - IF



Input IP3 of Marki MMIQ-1865L Mixer using AMM-6702UC as LO Driver Amplifier (dBm), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF - IF



Input IP3 of Marki MMIQ-1865H Mixer using AMM-6702UC as LO Driver Amplifier (dBm), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF - IF

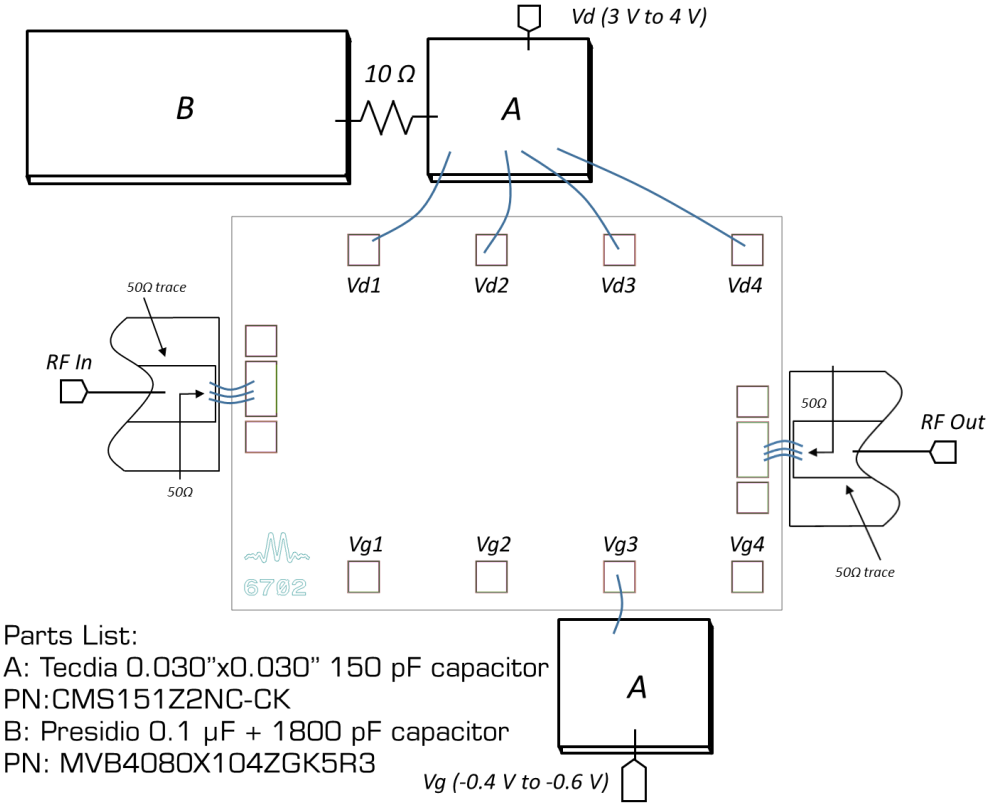


4. Application Information

4.1 Example AMM-6702CH Application Circuit

Below is an example application circuit for the AMM-6702CH. It is particularly important to use sufficient external capacitance on the Vd pads to prevent potential feedback oscillations from occurring. We have found that adding some small (10 Ω) shunt resistance as shown in the application circuit diagram creates very reliable operation.

Since the amplifier IC has very high gain, it is possible for positive radiative feedback to occur between the wire bonds on the RF traces and the power supply network. We have observed that the most effective ways to protect against radiative feedback oscillations is to epoxy ferritic absorber material near the input and output traces and to avoid mounting the chip inside of an extremely small cavity. Email support@markimicrowave.com for any additional questions and assistance in avoiding oscillations in the AMM-6702CH in your specific application.

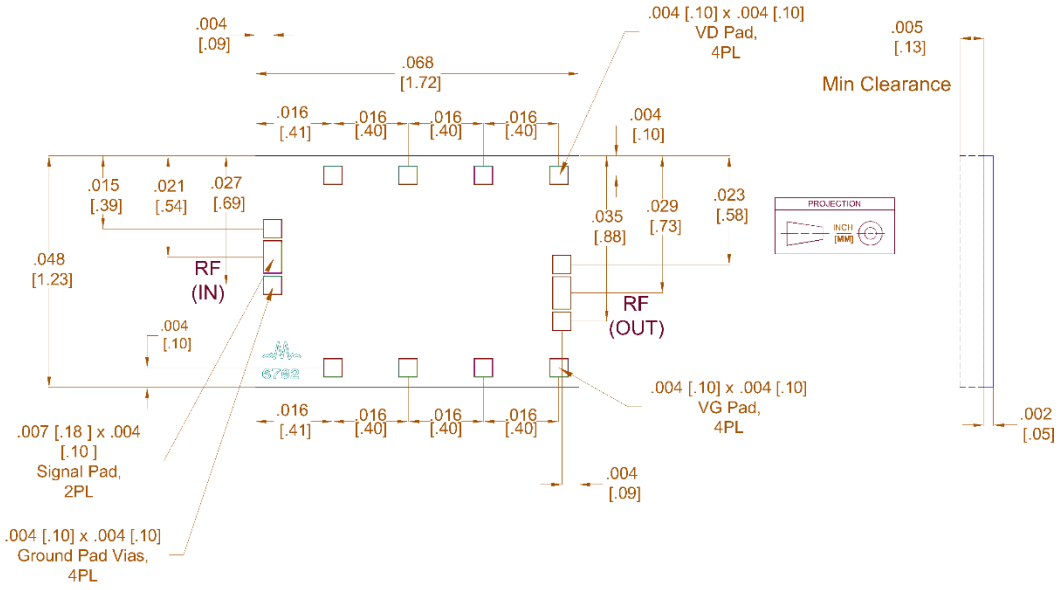


Parts List:
A: Tecdia 0.030"x0.030" 150 pF capacitor
PN:CMS151Z2NC-CK
B: Presidio 0.1 µF + 1800 pF capacitor
PN: MVB4080X104ZGK5R3

The AMM-6702 has a potential oscillation if driven between -10 dBm and -8 dBm with a frequency between 22 GHz and 27 GHz with a Vd higher than 3.3V. If your application or frequency plan requires this specific condition, we advise that the user either reduce Vd or add an attenuator or pre-driver to the input to change the input power presented to the amplifier. The most stable condition to run this amplifier is in compression with at least 0 dBm to 5 dBm of input power.

5. Mechanical Data

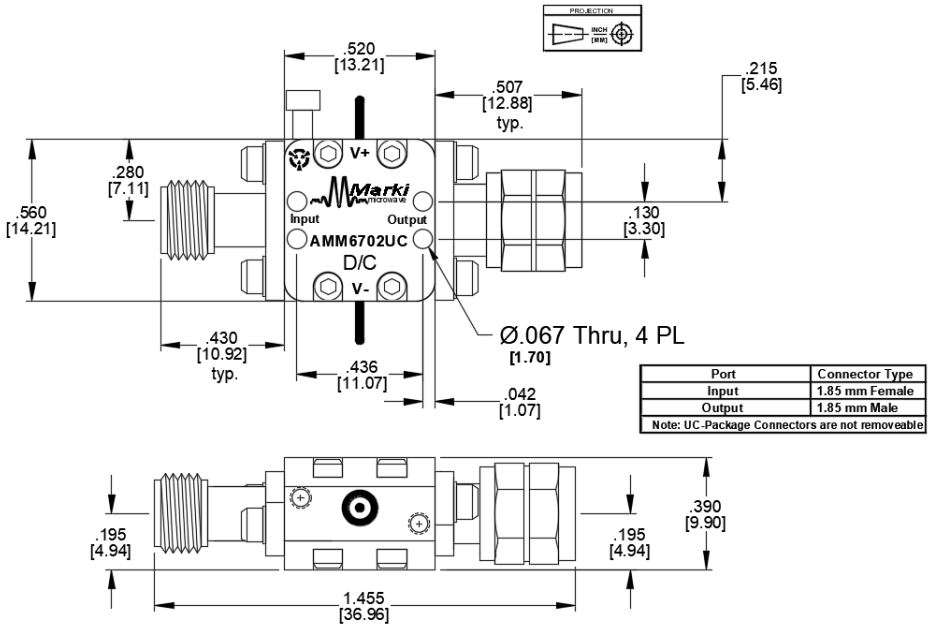
5.1 AMM-6702CH Package Outline Drawing



Notes:

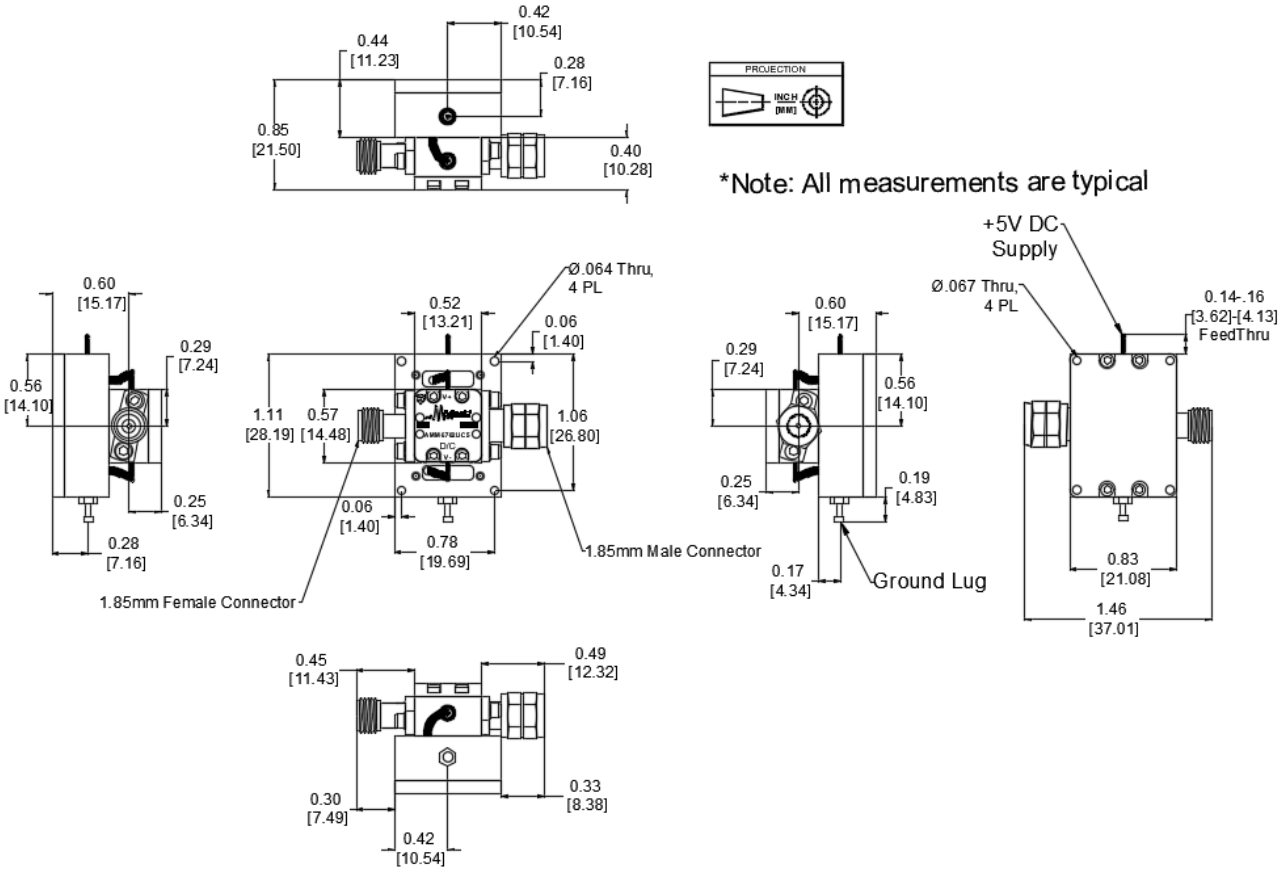
1) RF GSG probe pitch is 150 µm.
2) CH substrate is .002 inches thick GaAs.
3) I/O trace finish is 4 µm Au. Ground finish is 5 µm Au.
4) Die are not passivated

5.2 AMM-6702UC Package Outline Drawing



Port	Connector Type
Input	1.85 mm Female
Output	1.85 mm Male
Note: UC-Package Connectors are not removeable	

5.3 AMM-6702UC5 Package Outline Drawing



Revision History

Revision Code	Revision Date	Comment
-	October 2018	Datasheet Initial Release
A	January 2019	AMM-6702UC Release, additional data
B	February 2019	Updated Export Classification
C	March 2019	Updated Module Production Specs
D	August 2019	Updated Module Production Specs
E	September 2019	Updated Absolute Maximum Ratings
F	January 2020	Added .s2p Files Link
G	February 2020	Updated Datasheet Format, Expanded Performance Plots, Expanded Electrical Specs, Added Sequencing Procedure, Added AMM-6702UC5 Package
H	April 2020	Updated AMM-6702UC5 Specs and Performance Plots
I	June 2020	Corrected AMM-6702UC Outline Drawing to include Ground Screw
J	June 2020	Updated Absolute Maximum Ratings
K	July 2020	Update AMM-6702UC5 Saturated Output Power Min Spec
L	July 2020	Revised Max Operating Temperature
M	September 2020	Updated Ground Pin Location on AMM-6702UC5 Module
N	October 2020	Updated Thermal Specs, Updated OIP3 Spec
O	November 2020	Updated Min Frequency Spec
P	December 2020	Updated Electrical Specifications Table