

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.



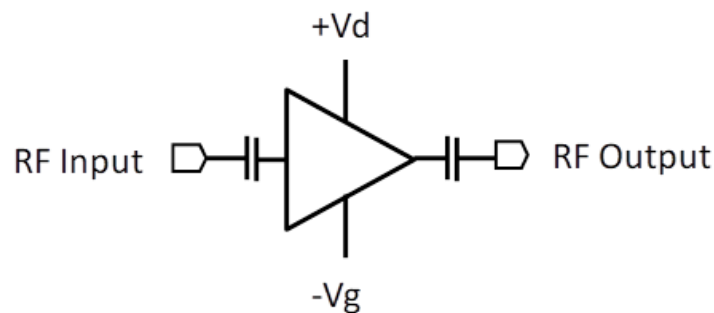
1.2 Features

- 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 Options¹

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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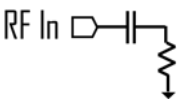
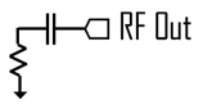
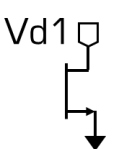
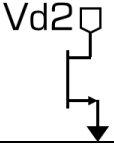
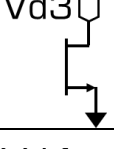
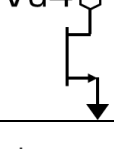
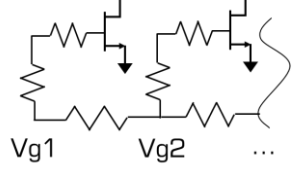
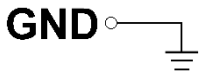
2. Port Configurations and Functions

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.

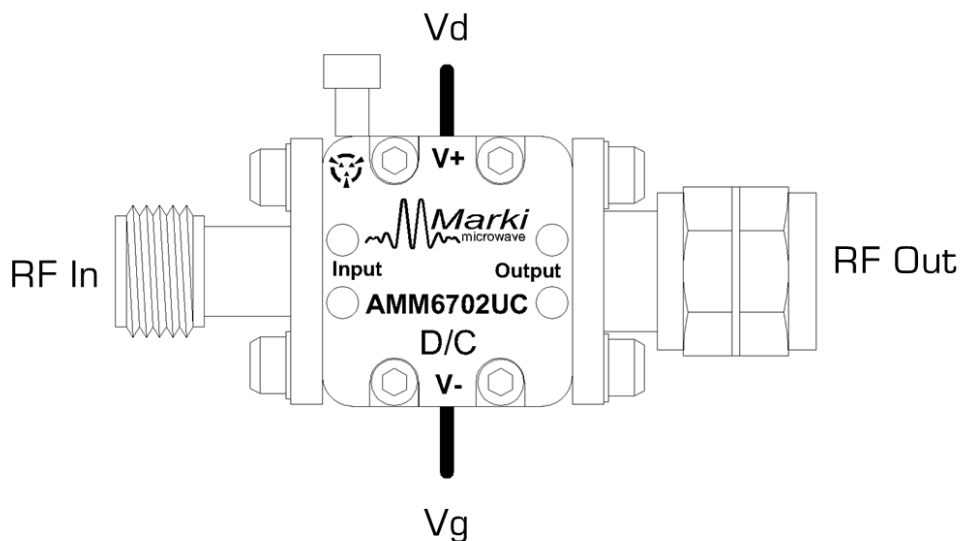


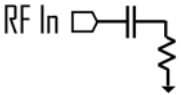
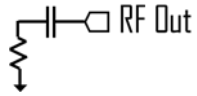
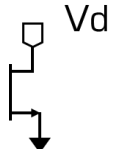
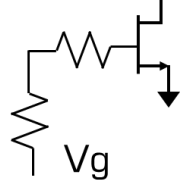
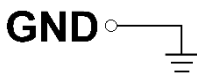
2.2 AMM-6702CH Port Functions

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.	

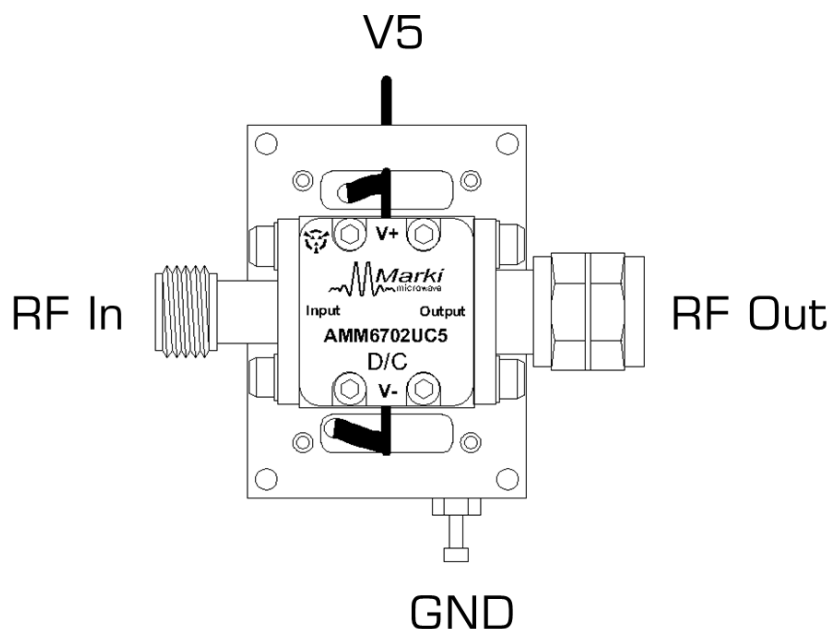
2.3 AMM-6702UC Port Diagram

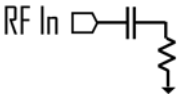
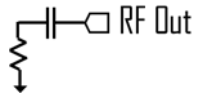
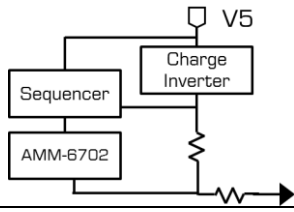
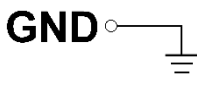
A top-down view of the AMM-6702UC's outline drawing is shown below. The port functions are detailed in section 2.2 of this datasheet.



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)	5	V
Positive Bias Current (Pin 1)	400	mA
Negative Bias Voltage (Pin 4)	-2	V
Negative Bias Current (Pin 4)	100	μA
RF Input Power	+24	dBm
Operating Temperature	-40 to +125	°C
Storage Temperature	-65 to +150	°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	+24	dBm
Operating Temperature	-40 to +85	°C
Storage Temperature	-65 to +150	°C

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	+125	°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 V_g (Pin 4)
- 2) Apply V_d (Pin 1)

Turn-off Procedure:

- 1) Turn off V_d (Pin 1)
- 2) Turn off V_g (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 $T_A = +25^\circ\text{C}$ in a 50Ω system.

Min and Max limits apply only to our connectorized units and are guaranteed at $T_A = +25^\circ\text{C}$.

Parameter	Test Conditions	Min	Typical	Max	Units
Frequency Range		20		55	GHz
Saturated Output Power	3V/-0.5V bias, +5 dBm Input Power		19		dBm
	3.5V/-0.5V bias, +5 dBm Input Power	17	20		
	4V/-0.5V bias, +5 dBm Input Power		20		
Small Signal Gain	3V/-0.5V bias, -25 dBm Input Power		24		dB
	3.5V/-0.5V bias, -25 dBm Input Power	18	24		
	4V/-0.5V bias, -25 dBm Input Power		23		
Input Return Loss	3.5V/-0.5V bias, -25 dBm Input Power		8		
Output Return Loss			9		
Noise Figure			6.5		
Reverse Isolation			45		
Bias Requirements ³	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		3		dBm
Output IP3 (OIP3)			21		
P_{1dB}	3.5V/-0.5V bias		14.8		

³ Bias conditions tested with no RF input power. See section 3.6 for DC current vs. RF power

3.9 AMM-6702UC5 Electrical Specifications

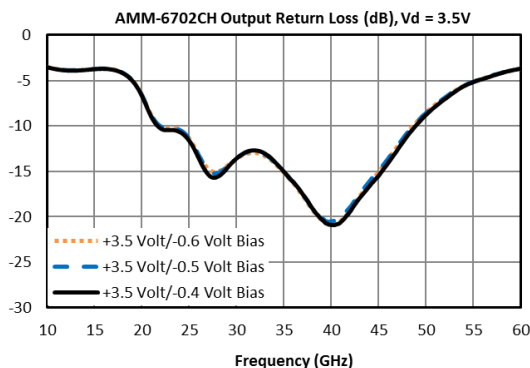
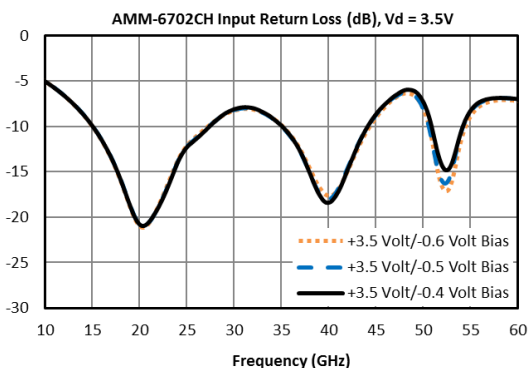
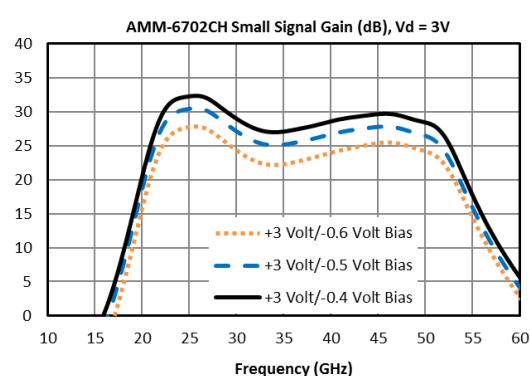
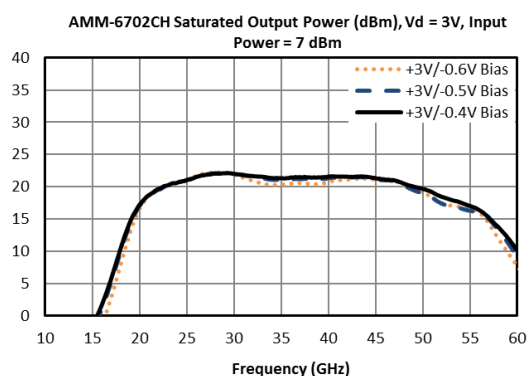
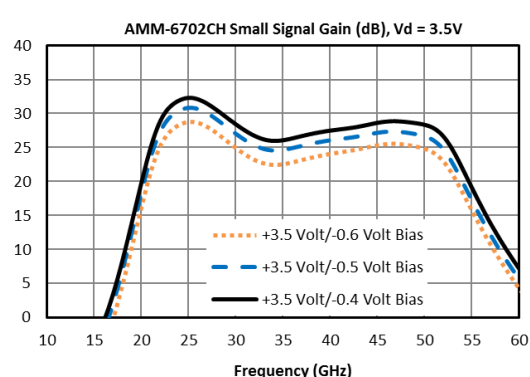
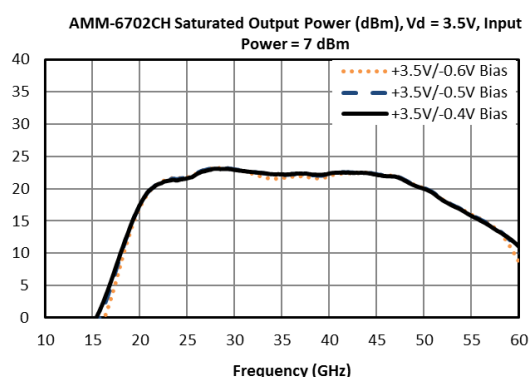
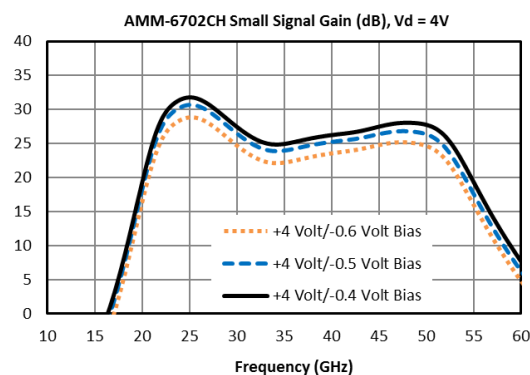
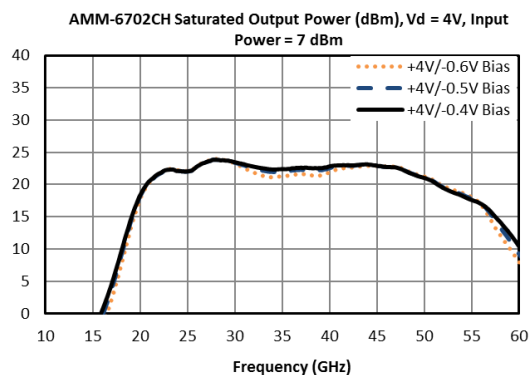
The electrical specifications apply at $T_A = +25^\circ\text{C}$ in a 50Ω system.

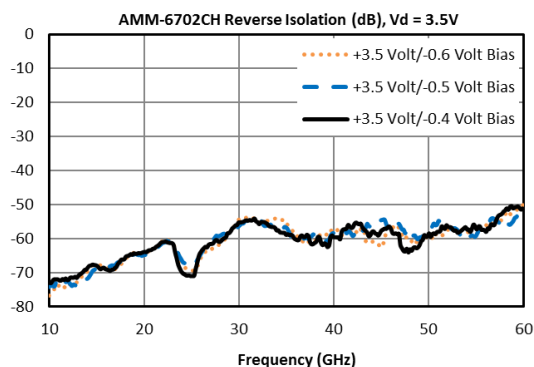
Min and Max limits apply only to our connectorized units and are guaranteed at $T_A = +25^\circ\text{C}$.

Parameter	Test Conditions	Min	Typical	Max	Units
Frequency Range		20		55	GHz
Saturated Output Power	5V bias, +5 dBm Input Power	17	20		dBm
Small Signal Gain	5V bias, -25 dBm Input Power	18	24		dB
Input Return Loss	5V bias, -25 dBm Input Power		8		
Output Return Loss			9		
Noise Figure			6.5		
Reverse Isolation			45		
Bias Requirements ⁴	5V		230		mA
Input IP3 (IIP3)	5V bias, -25 dBm Input Power		3		dBm
Output IP3 (OIP3)			21		
P_{1dB}	5V bias		14.8		

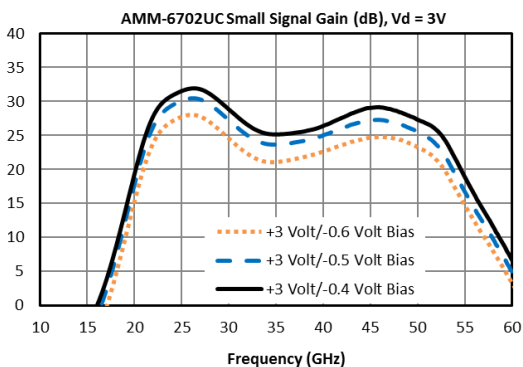
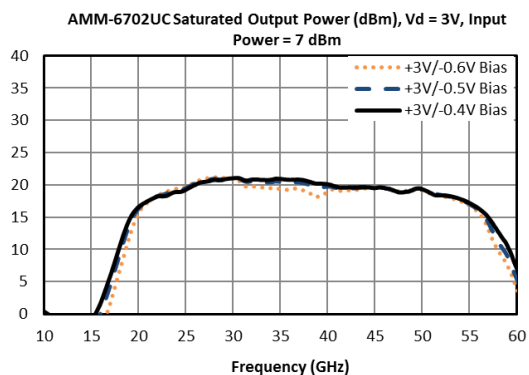
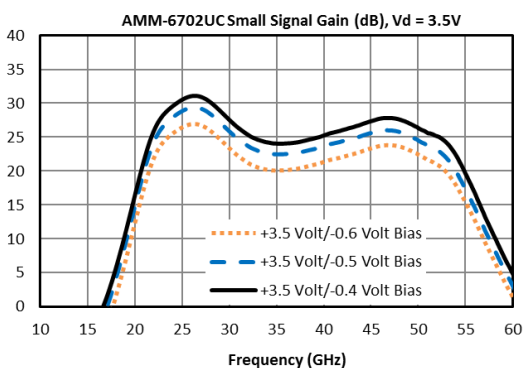
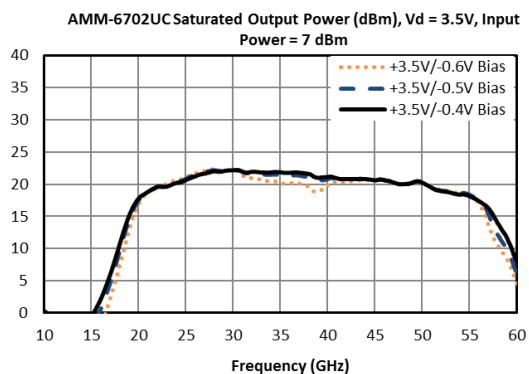
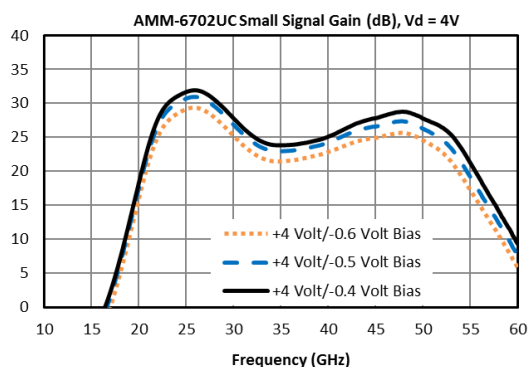
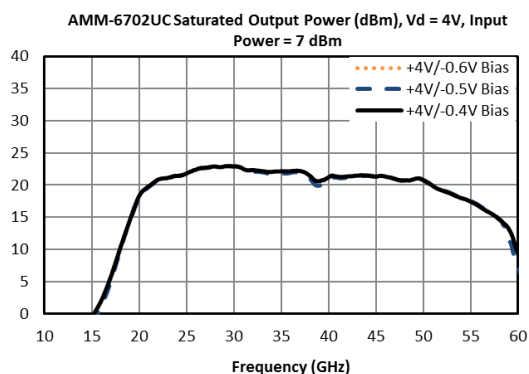
⁴ Bias conditions tested with no RF input power. See section 3.6 for DC current vs. RF power

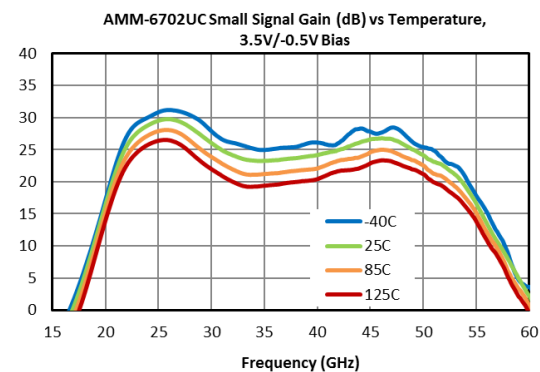
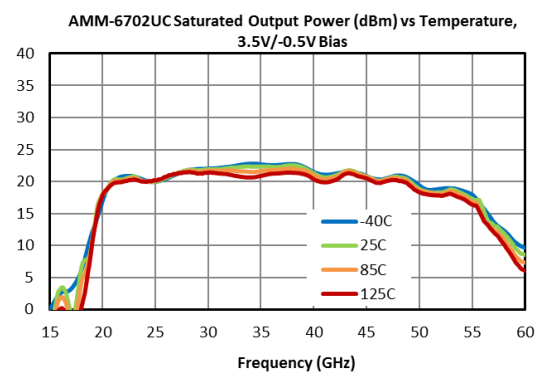
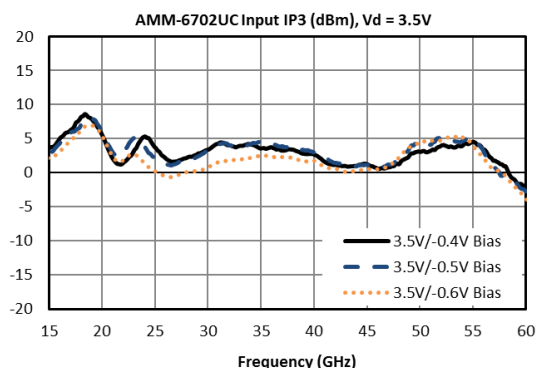
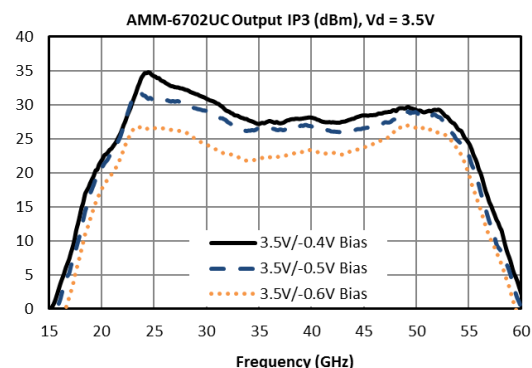
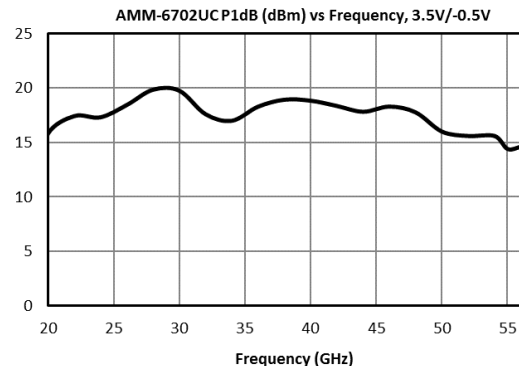
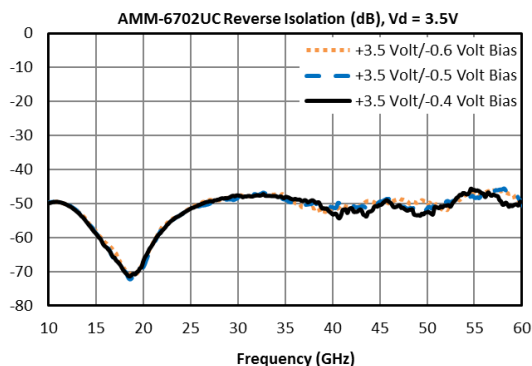
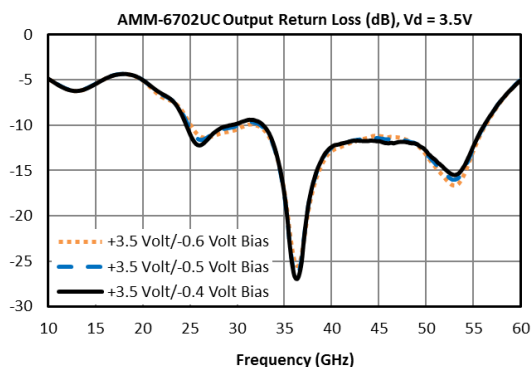
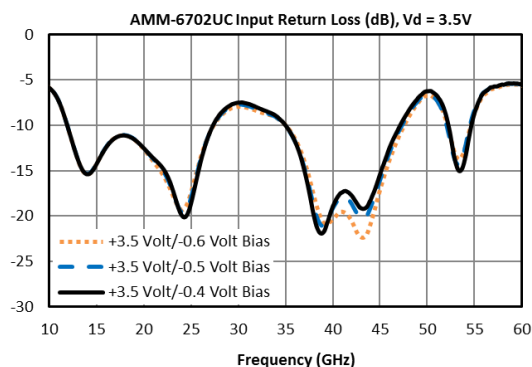
3.10 AMM-6702CH Typical Performance Plots



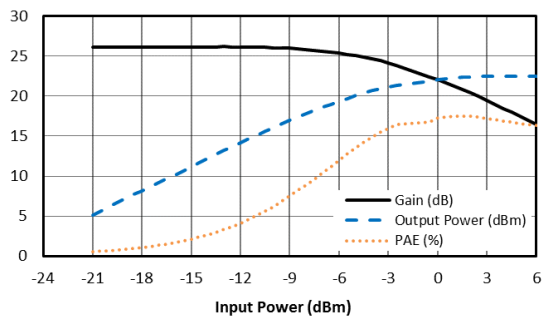


3.11 AMM-6702UC Typical Performance Plots

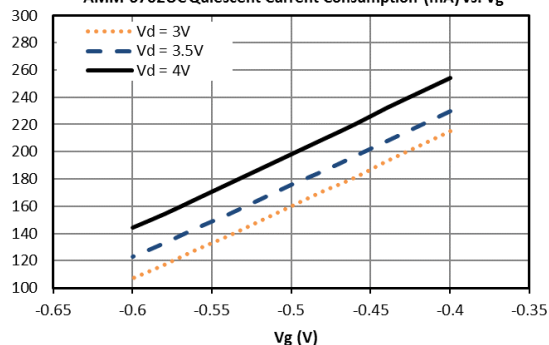




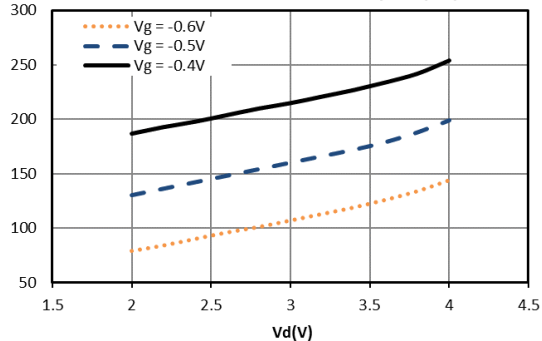
**AMM-6702UC Gain, Output Power, PAE vs. Input Power @ 30 GHz,
3.5V/-0.5 V Bias**



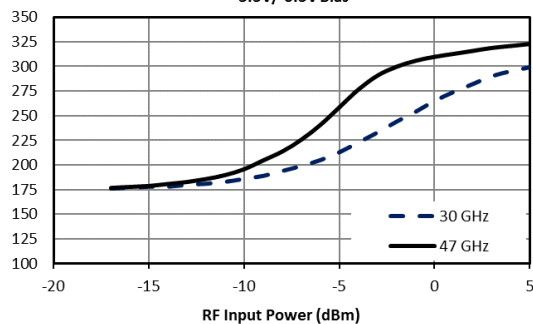
AMM-6702UC Quiescent Current Consumption (mA) vs. V_g



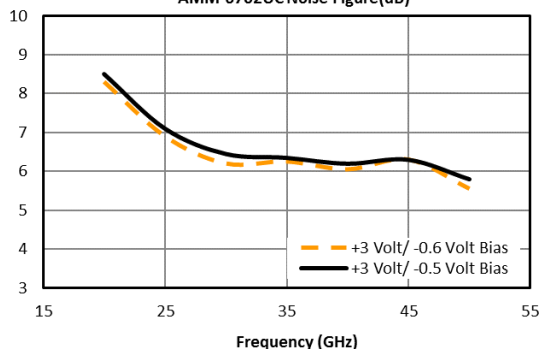
AMM-6702UC Quiescent Current Consumption (mA) vs. V_d



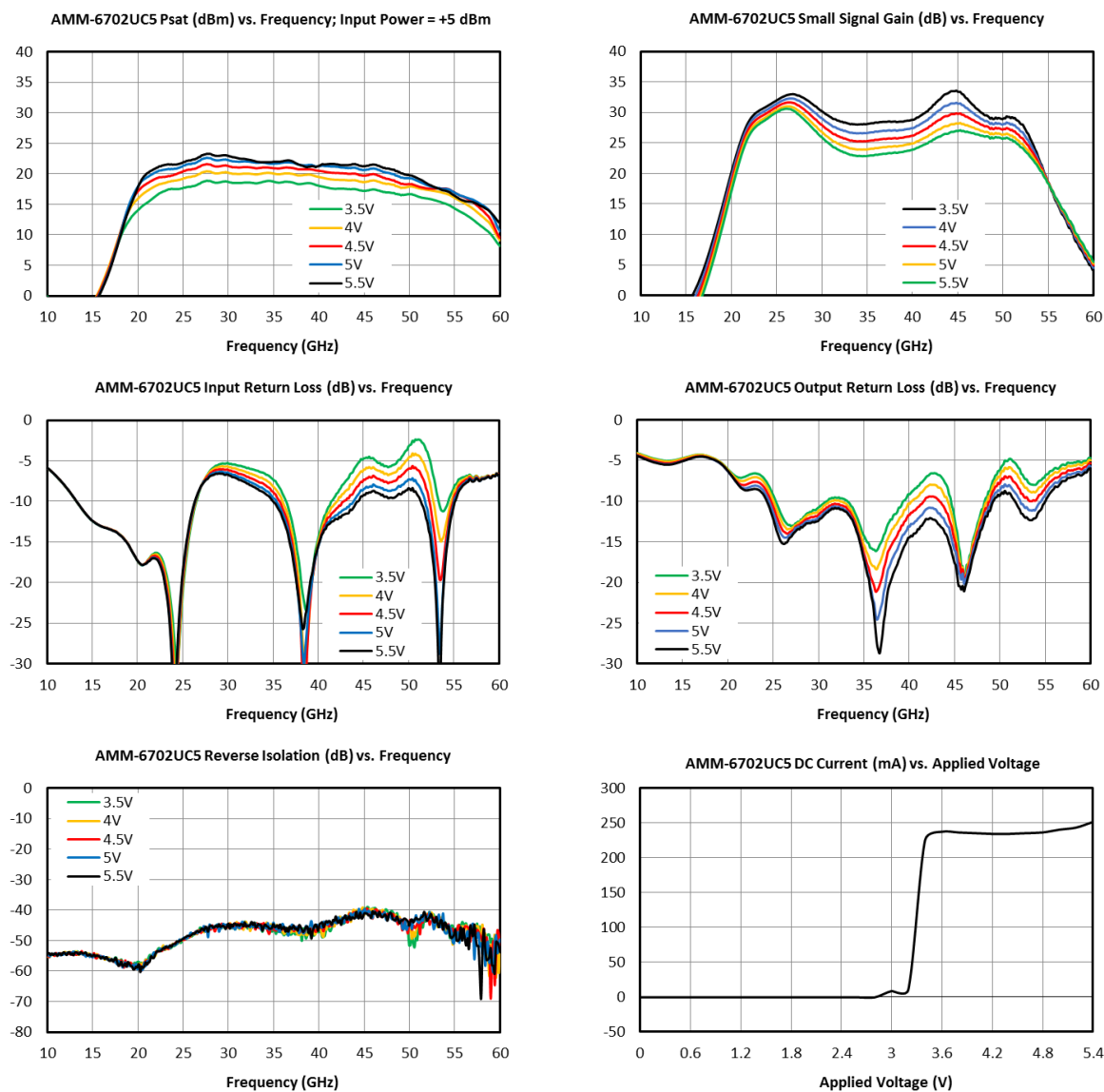
**AMM-6702UC Current Consumption (mA) vs. RF Input Power,
3.5V/-0.5V Bias**



AMM-6702UC Noise Figure (dB)

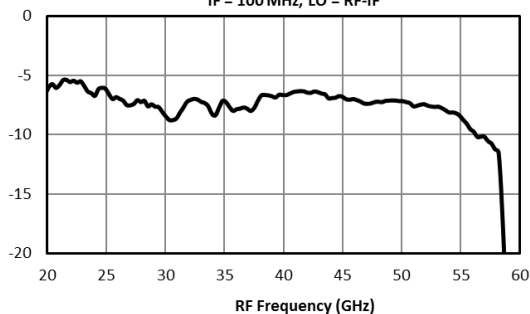


3.12 AMM-6702UC5 Typical Performance Plots

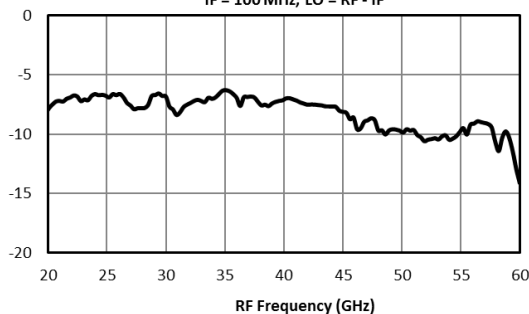


3.13 Conversion Loss of Marki Mixers Using AMM-6702UC as LO Driver

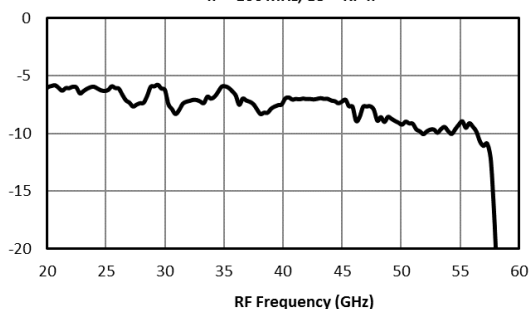
Conversion Loss of Marki MM1-1857H Mixer using AMM-6702UC as LO Driver Amplifier (dB), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF-IF



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

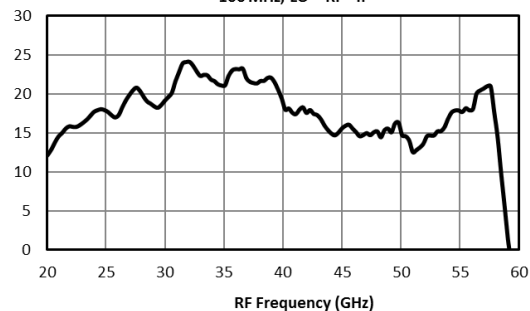


Conversion Loss of Marki MMIQ-1865H Mixer using AMM-6702UC as LO Driver Amplifier (dB), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF-IF

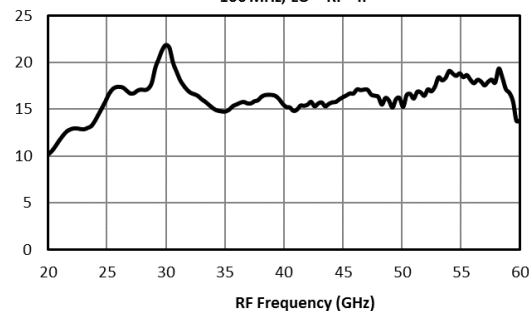


3.14 Input-Referred IP3 of Marki Mixers Using AMM-6702UC as LO Driver

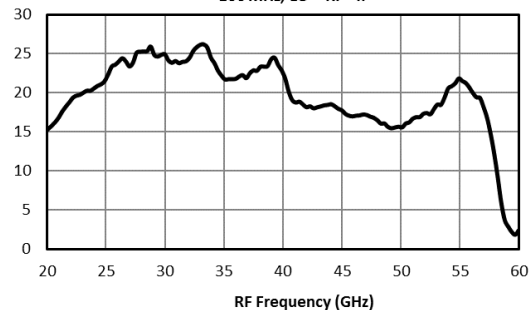
Input IP3 of Marki MM1-1857H Mixer using AMM-6702UC as LO Driver Amplifier (dBm), 3.5V/-0.4V Bias Condition, 3dBm Input, IF = 100 MHz, LO = RF - IF



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

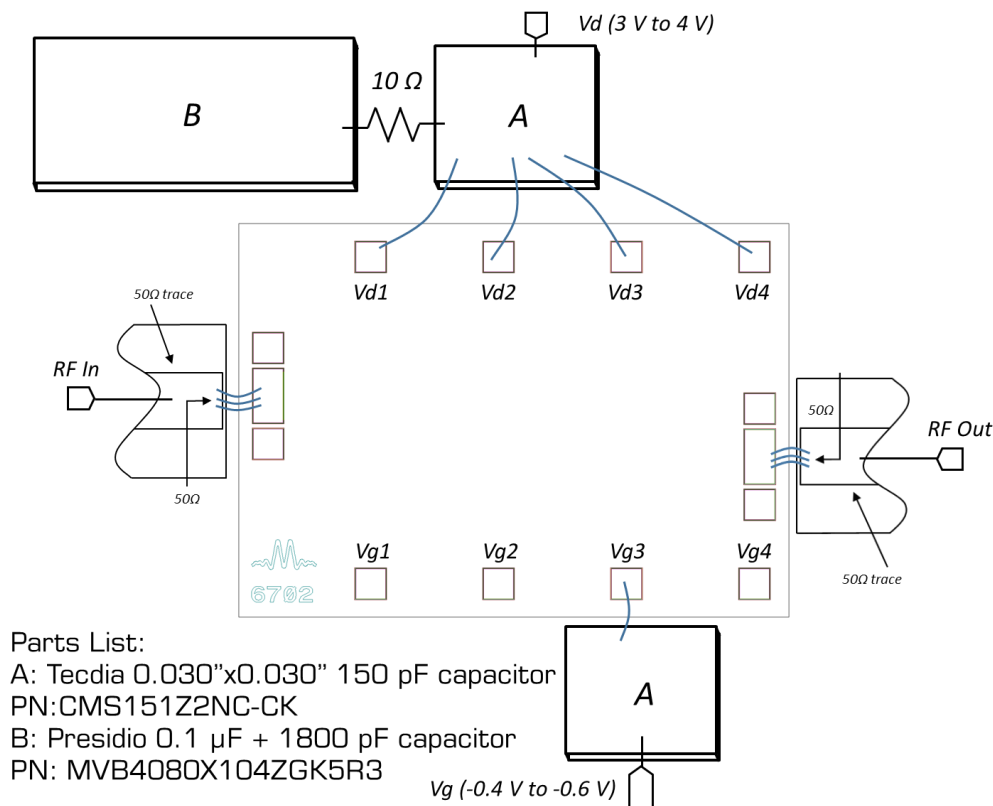


4. Application Information

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.

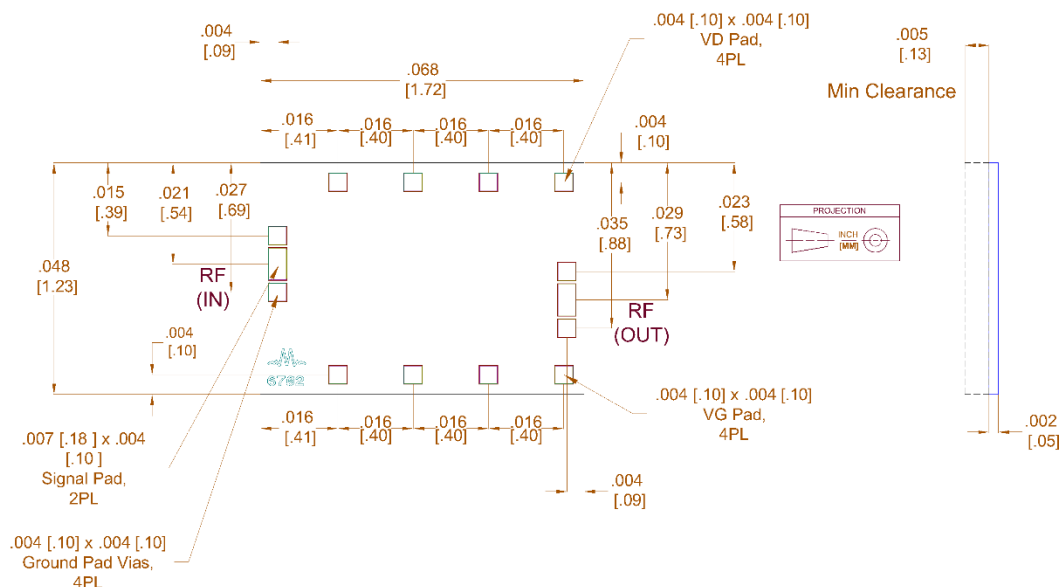
Since the amplifier IC has very high gain, it is possible for positive radiative feedback to occur between the wire bonds on the RF traces and the power supply network. We have observed that the most effective ways to protect against radiative feedback oscillations is to epoxy ferritic absorber material 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.



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

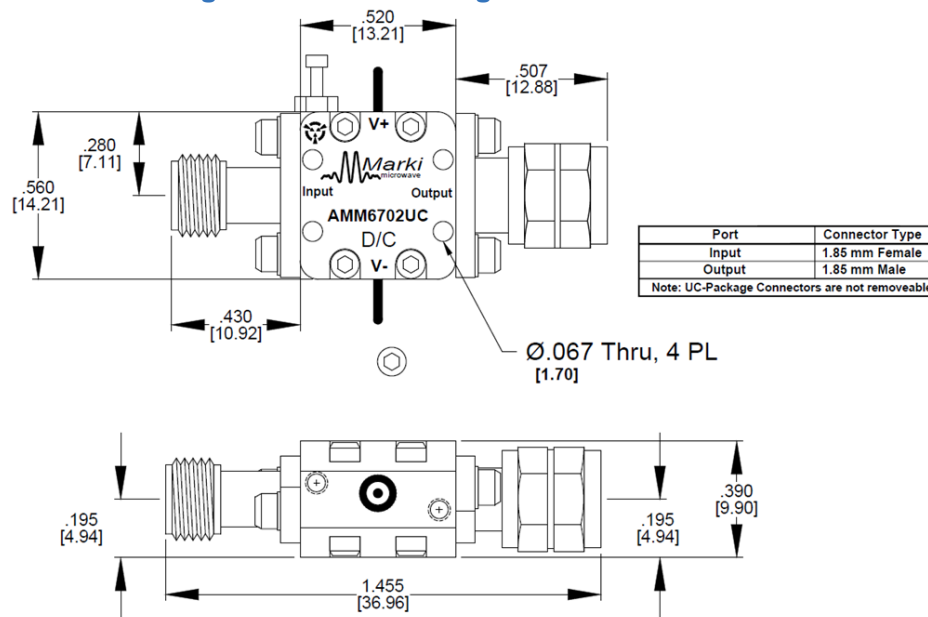
5.1 AMM-6702CH Package Outline Drawing



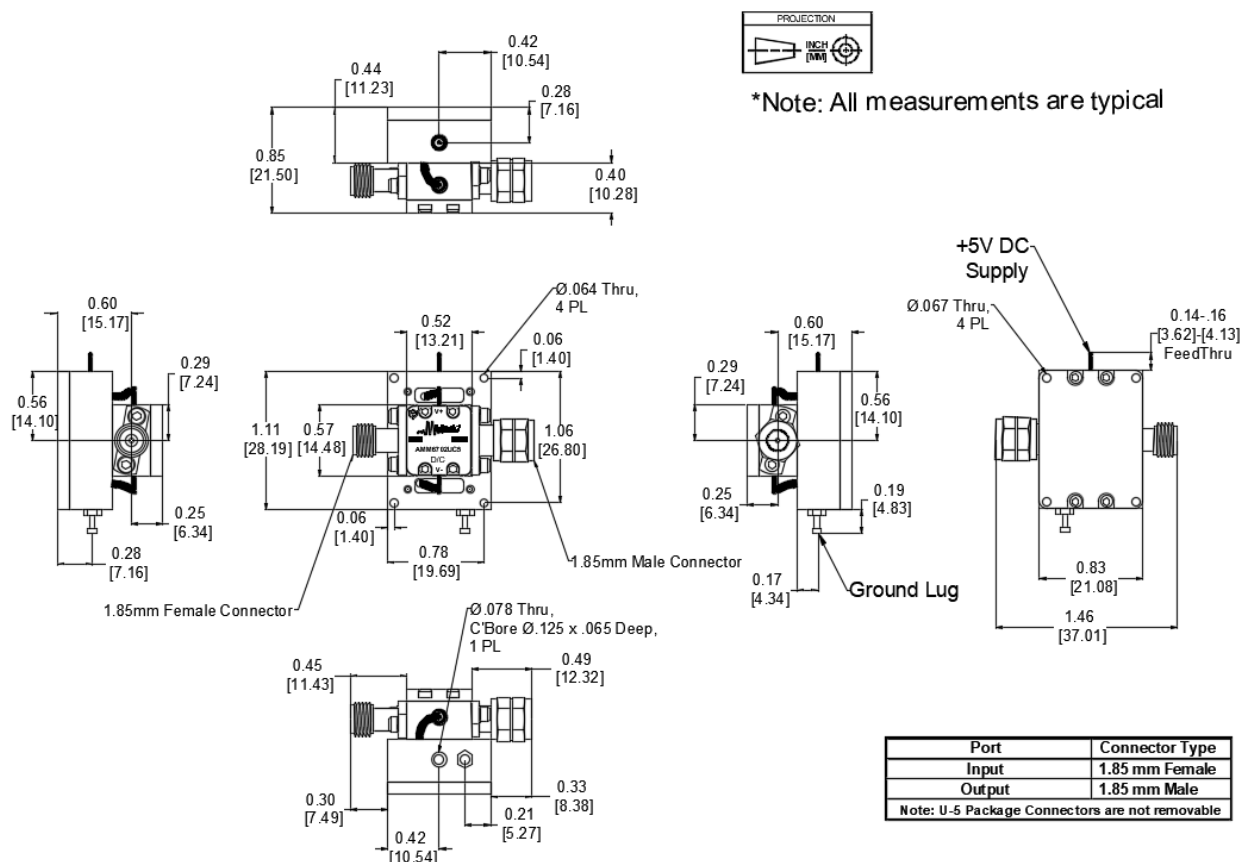
Notes:

- 1) RF GSG probe pitch is 150 μm .
- 2) CH substrate is .002 inches thick GaAs.
- 3) I/O trace finish is 3.3 μm Au. Ground finish is 5 μm Au.
- 4) Die are not passivated

5.2 AMM-6702UC Package Outline Drawing



5.2 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