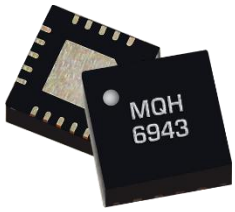
1 Device Overview



QFN

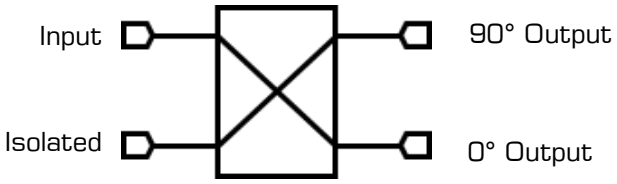
1.1 General Description

The MQS-0518SM is a MMIC 5 GHz – 18 GHz 90° splitter/combiner. Passive GaAs MMIC technology allows production of smaller constructions that replace larger form factor circuit board constructions. Low variation allows for accurate simulations using the provided S4P file taken from measured production units. Tight fabrication tolerances allow for less unit to unit variation than traditional splitter/combiner technologies. The MQS-0518SM is available as 4X4 mm QFN Package. Evaluation boards are also available. Applications include single sideband upconverters, image rejection downconverters, IQ modulators, balanced amplifiers, microwave correlators. The MQS-0518SM is not recommended for applications involving reflected signals.

1.2 Features

- Designed for C to Ku-band applications
- High amplitude and phase balance
- High isolation
- Low insertion loss
- Off Chip termination
- S4P data MQS-0518SM.zip

1.3 Functional Block Diagram



1.4 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MQS-0518SM	4x4 mm QFN	SM	RoHS	Active	EAR99
EVAL-MQS-0518	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

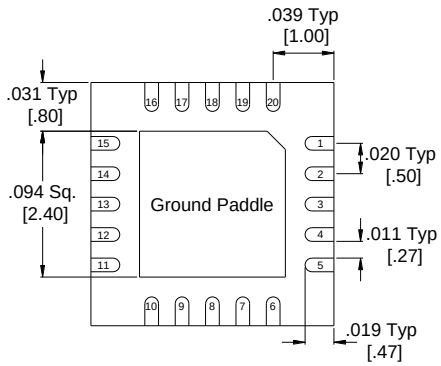
Revision History

Revision Code	Revision Date	Comment
-	June 2020	Initial Datasheet Release

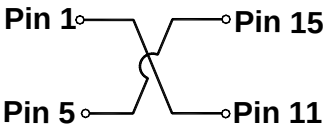
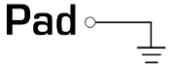
2 Port Configurations and Functions

2.1 Port Diagram

A bottom-up view of the MQS-0518SM's SM package outline drawing is shown below. Only Pins 5 and 11 may be used as an input. Pins 1 and 15 are not recommended as inputs. Device is not recommended for applications requiring reflected signals.



2.2 Port Functions[2]

Port	Configuration A	Configuration B	Description	Equivalent Circuit
Pin 1	Isolated	0° Output	Pin 1 is DC short to pin 11 and open to ground.	
Pin 5	Input	90° Output	Pin 5 is DC short to pin 15 and open to ground.	
Pin 11	90° Output	Input	Pin 11 is DC short to pin 1 and open to ground.	
Pin 15	0° Output	Isolated	Pin 15 is DC short to pin 5 and open to ground.	
Pad	Ground	Ground	SM package ground path is provided through the ground paddle.	

[2] Each configuration describes a different application of the same product.

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 be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Units
DC Current at any port	TBD	mA
Operating Temperature	-55 to +100	°C
Storage Temperature	-65 to +125	°C
RF Power Handling	10	W

3.2 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	N/A

3.3 Electrical Specifications[3]

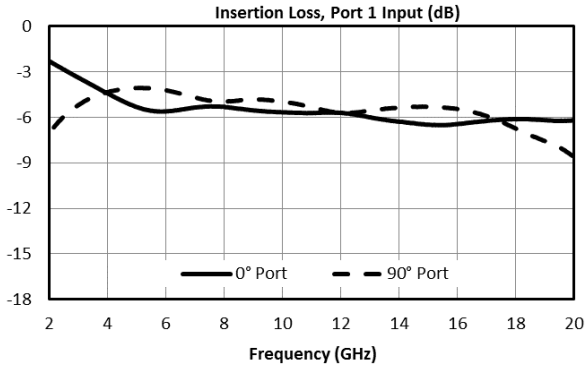
The electrical specifications apply at T_A=+25°C in a 50Ω system.

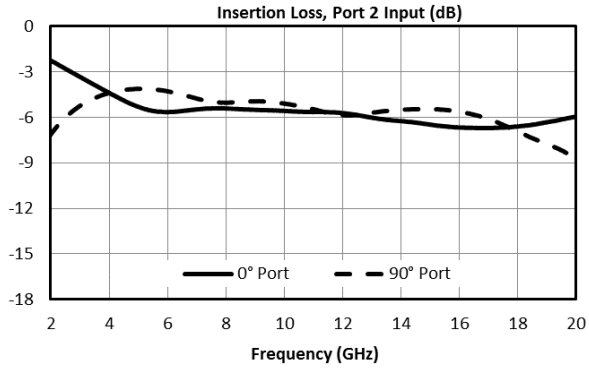
Min and Max limits are guaranteed at T_A=+25°C.

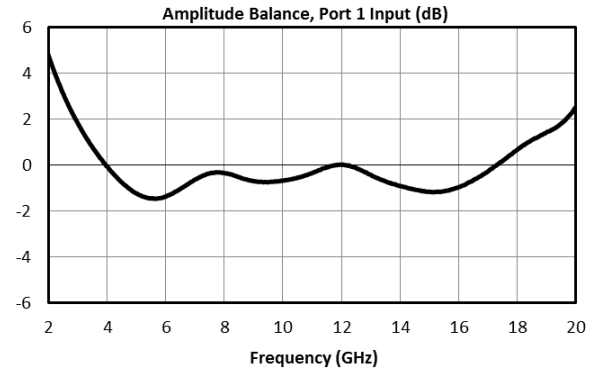
Parameter	Frequency (GHz)	Min	Typ.	Max	Units
Coupling	5-18		3		dB
Nominal Phase Shift			90		Degrees
Amplitude Balance			0.5	2.5	dB
Phase Balance			2.5	10	Degrees
Excess Through Line Insertion Loss[4]			4.5	6	dB
Isolation		10	17		dB
VSWR			1.2		
Impedance			50		Ω

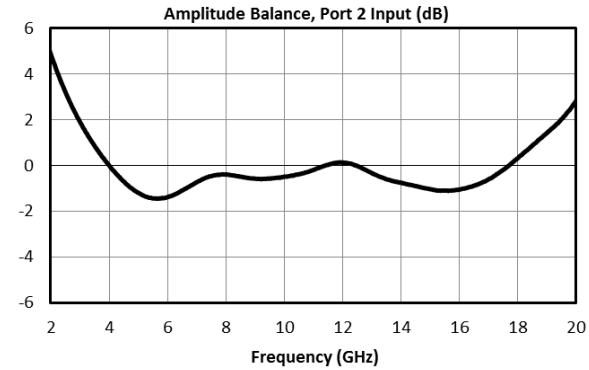
[3] Device is non-reciprocal. Operation not guaranteed when ports 3 or 4 are used as an input.
[4] Excess Insertion Loss = (Input Port to Common Port Insertion Loss) – 3 dB.

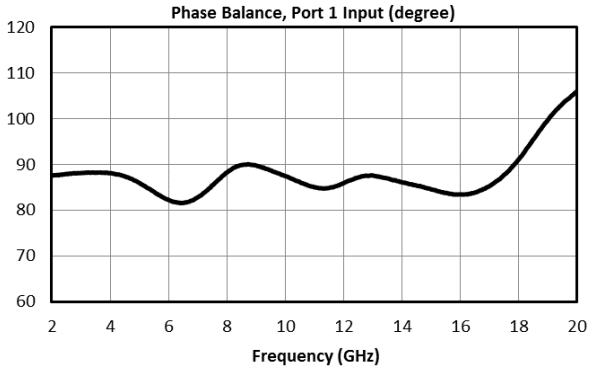
3.4 Typical Performance Plots[5-6]

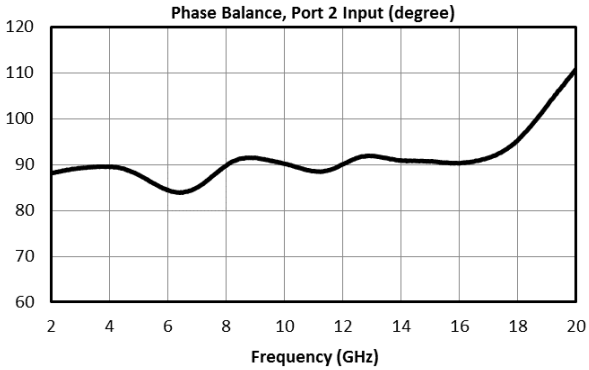






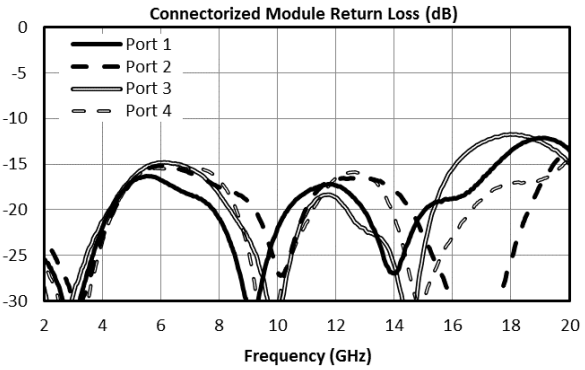


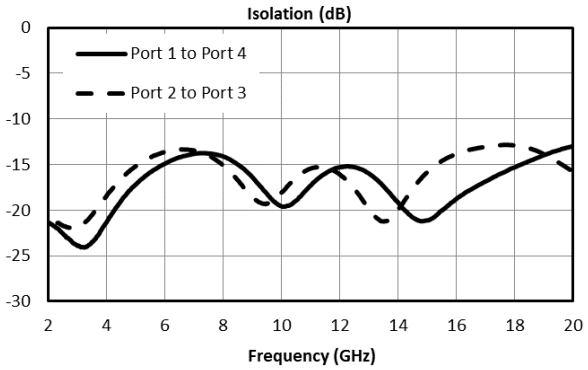




[5] All measured data is taken from the eval board without de-embedding of the connectors and traces

[6] Ports 1 – 4 correspond to the Evaluation board package designation.





4 Application Information

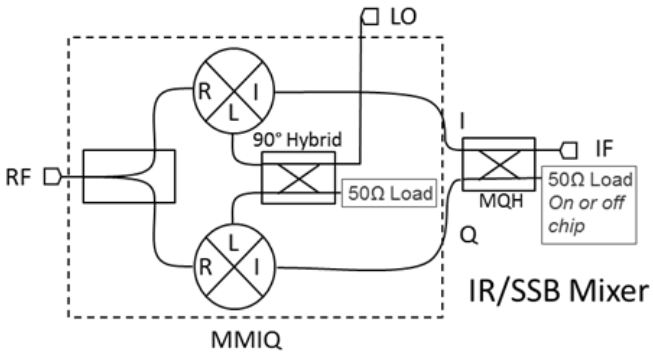
Quadrature signal generation is useful for many applications in analog signal processing. Marki MQH (MMIC quadrature hybrids) and MQS (MMIC 90˚ Splitter/Combiners) offer this functionality in a small factor with high repeatability. Below are applications and how they can be realized with the MQH and MQS product lines.

Quadrature Hybrids vs 90˚ Splitter/Combiners

Some products are 'true' quadrature hybrids, while others are 90˚ Splitter/Combiners. A quadrature hybrid is symmetric about all four ports, meaning that in a splitting application any port can be used as an input, with the isolated and output ports following from this selection. Likewise, for a combining application, any port can be used as an output.

A 90˚ Splitter/Combiner is not symmetric. When splitting, only ports 1 and 2 can be used as an input. If ports 3 or 4 were used, there would be significant phase walk-off between the output ports. As a combiner, only ports 1 and 2 are suitable as output ports. The phase walk-off introduced when using ports 3 or 4 as an output means that reflected signals recombine and cancel poorly inside a 90° Splitter/Combiner.

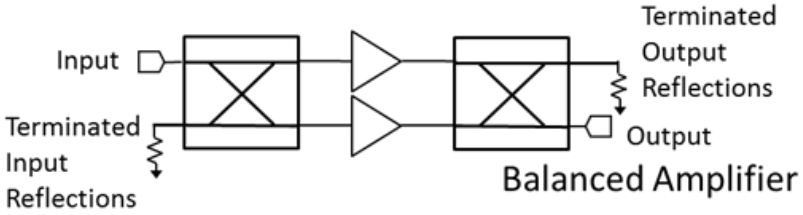
Single Sideband and Image Reject Mixers



The primary application for the MQH and MQS series is as IF or LO quadrature signal splitter/combiners. They can be used in combination with the MMIQ series of IQ mixers to create broadband single sideband and image reject mixers. Either 90˚ Splitter/Combiners or quadrature hybrids can be used as the IF hybrid, but if a 90˚ Splitter/Combiner is used only one sideband (or image) is accessible, whereas if a quadrature hybrid is used than both sidebands are accessible.

If 90˚ Splitter/Combiner is used for a single sideband upconverter or image reject mixer, port 1 (or 2) should be used as the IF input/output and ports 2 and 3 (or 1 and 4) should be connected to the I and Q ports. Selecting port 1 or 2 to terminate will select which sideband of the mixer to reject.

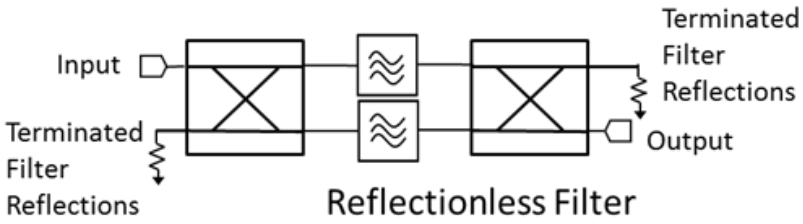
Balanced Amplifiers



In a balanced amplifier, the poor return loss of an amplifier is compensated for with a quadrature hybrid. In this application, the reflections from the input or output are collected at the isolated port of the quadrature hybrid and terminated.

Since a 90˚ Splitter/Combiner is not completely symmetric, reflected signals will not terminate as well as with a quadrature hybrid. An MQH option is recommended for this application. If a 90˚ Splitter/Combiner is used for a single sideband upconverter or image reject mixer, port 1 (or 2) should be used as the IF input/output and ports 2 and 3 (or 1 and 4) should be connected to the I and Q ports. Selecting port 1 or 2 to terminate will select which sideband of the mixer to reject. Testing/simulation is recommended when considering if a 90° Splitter/Combiner is suitable.

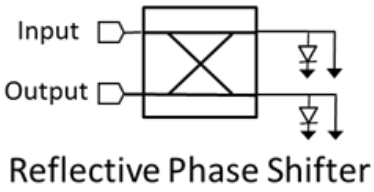
Reflectionless Filter

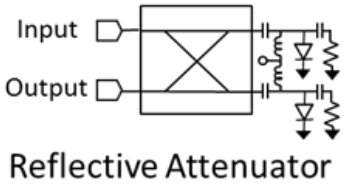


Similar to a balanced amplifier, a reflectionless filter will terminate reflections that are out of band for a filter (but in band for the quadrature hybrid) at the isolated port.

Since a 90˚ Splitter/Combiner is not completely symmetric, reflected signals will not terminate as well as with a quadrature hybrid. An MQH option is recommended for this application. If a 90˚ Splitter/Combiner is used for a single sideband upconverter or image reject mixer, port 1 (or 2) should be used as the IF input/output and ports 2 and 3 (or 1 and 4) should be connected to the I and Q ports. Selecting port 1 or 2 to terminate will select which sideband of the mixer to reject. Testing/simulation is recommended when considering if a 90° Splitter/Combiner is suitable.

Reflective Applications



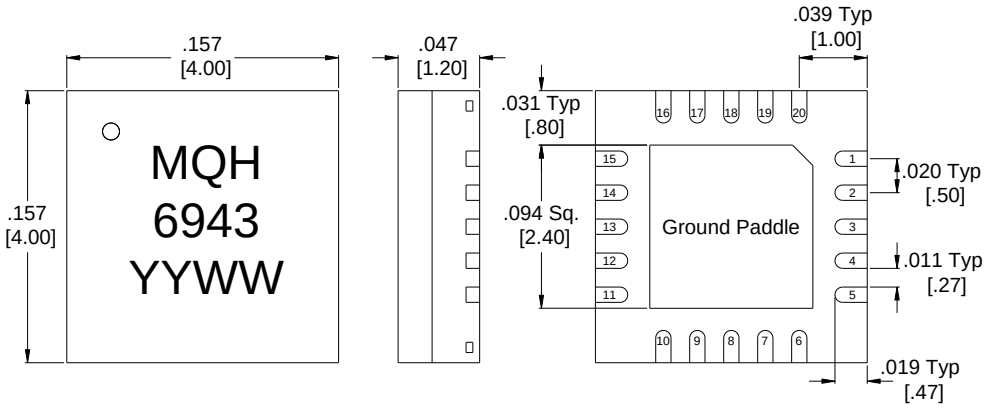


Unlike in the previous applications, reflective applications only work well with a quadrature hybrid (not a 90˚ Splitter/Combiner). In these applications a signal is reflected off of two identical structures (typically a PIN diode) and the output signal is collected at the isolated port. In this case the desired signal is deliberately reflected.

Since a 90˚ Splitter/Combiner is not completely symmetric, you will have poor results if you use these for reflective applications.

5 Mechanical Data

5.1 SM Package Outline Drawing

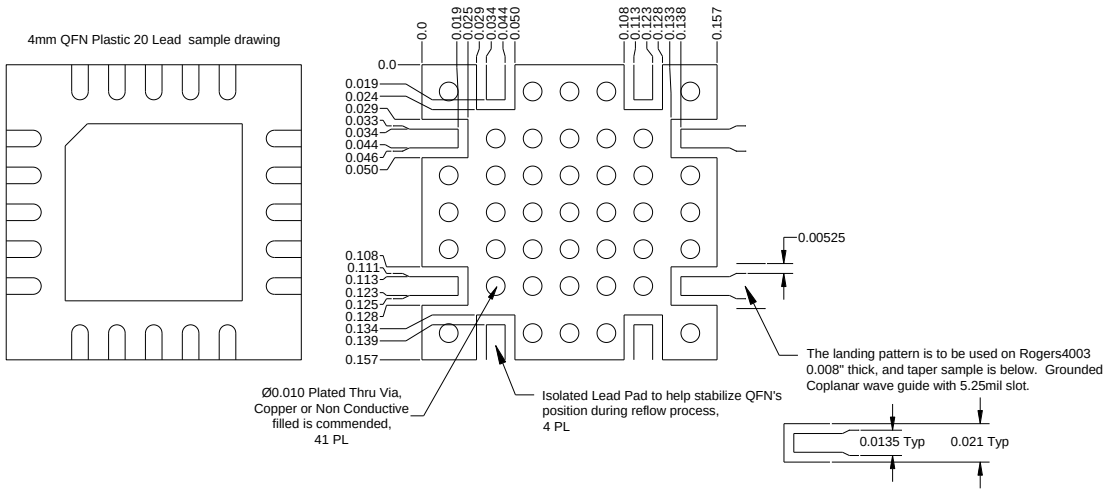


Pad #	Config A	Config B
1	Isolated	0° O/P
2	N/C	N/C
3	N/C	N/C
4	N/C	N/C
5	IN	90° O/P
6	N/C	N/C
7	N/C	N/C
8	N/C	N/C
9	N/C	N/C
10	N/C	N/C
11	90° O/P	IN
12	N/C	N/C
13	N/C	N/C
14	N/C	N/C
15	0° O/P	Isolated
16	N/C	N/C
17	N/C	N/C
18	N/C	N/C
19	N/C	N/C
20	N/C	N/C

Notes:

1. Substrate material is LCP.
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 SM Package Footprint



QFN-Package Surface-Mount Landing Pattern

Click here for a DXF of the above layout.

Click here for leaded solder reflow. Click here for lead-free solder reflow.

5.3 Evaluation Board Outline