Quonset Microwave
www.quonsetmicrowave.com

QM2010-5-10
USB RF Synthesizer Module
5 GHz – 10 GHz output

Typical Applications

- Low cost signal generators
- Test equipment
- RF system integration
- Communication systems
- C-band & X-band systems
- Frequency conversion

Features

- Wideband RF output, 5 GHz to 10 GHz
- Integer and Fractional operating modes
- Maximum output power greater than +17 dBm across the entire band
- Up to 30 dB output attenuation adjustable in 1 dB steps
- USB interface
- USBTMC VISA Compliant
- User selectable internal reference or externally applied reference

General Description

QM2010-5-10 Side View
Part Number and Serial Number

QM2010-5-10 Side View
USB, Lock Status, and External Reference LEDs
External Reference MMCX input, Reference Out MMCX output

Larger images in the Device Housing section

The QM2010 RF synthesizer series from Quonset Microwave offers a low cost solution for today's demanding RF signal generation needs.

The QM2010-5-10 RF Synthesizer Module is a low-cost, wideband 5 GHz to 10 GHz frequency synthesizer ideally suited for bench top test and measurement as well as low-cost small form-factor communications systems. Its wide output frequency range, superb spurious rejection, and excellent phase noise performance provide a high-quality, low-cost alternative to conventional bench top RF signal generators. The RF synthesizer module is capable of phase locking to its internal 50 MHz reference or a user provided external reference.

The RF synthesizer module is powered and controlled directly by a host PC through USB. The QM2010-5-10 is VISA compliant, enabling seamless cross-platform use. Users can control QM2010 series synthesizers through a lightweight control GUI, supported on Windows®, Macintosh®, or Linux® platforms, with SCPI compliant VISA commands, described in the QM2010 User Manual, or with third party development environments such as LabVIEW®.

The RF Synthesizer you can carry in your pocket!

Electrical Specifications

Parameter		Min.	Typ.	Max.	Units
RF Operating Frequency		5	-	10	GHz
Reference Input Frequency (Sine or square wave)		10	50	100	MHz
Reference Input Power (Sine or square wave)		0		15	dBm
SSB Phase Noise with internal 50 MHz reference (100 kHz Offset)	5 GHz 7.5 GHz 10 GHz		-77 -75 -72		dBc/Hz dBc/Hz dBc/Hz
RF Output Power Ranges:	5 GHz 7.5 GHz 10 GHz	-13 -14 -15		+18 +18 +17	dBm dBm dBm
RF Harmonics:	5 GHz ($2^{nd}/3^{rd}/4^{th}$) 7.5 GHz ($2^{nd}/3^{rd}/4^{th}$) 10 GHz ($2^{nd}/3^{rd}/4^{th}$)	-24.5 / -18.5 / -30.5 -22.3 / -27.3 / -48.3 -31.5 / -42.5 / > -70			dBc dBc dBc
Locking Time				1	ms
Frequency Resolution:*	Integer Mode Fractional Mode		200* 1		MHz MHz
Power Resolution			1	2	dB
Internal reference frequency			50		MHz
Internal oscillator frequency stability			±0.5		ppm
Voltage (USB Bus)			5		V
Current Draw			480		mA

** Under default conditions – a 50 MHz reference input with a reference divider of 1. See "Integer and Fractional Modes of Operation" for more information*

Programming Interface

The QM2010 series of RF synthesizers can be controlled using any computer with a USB port running Windows®, Macintosh®, or Linux® operating systems. Other configurations may be possible since the synthesizer uses the USB Test and Measurement Device (USBTMC) class standard to emulate a GPIB bus. This allows for easy integration into existing test setups. A Windows® compatible USBTMC driver is supplied with the module. Most distributions of Linux® already have USBTMC drivers included in the kernel, and Macintosh® users will need to obtain drivers from a third party. Installation of drivers is not necessary if you already have a compliant VISA runtime installation, such as one provided by National Instruments or Agilent. A lightweight GUI using the VISA runtime is provided with the module.

The synthesizer is controlled by delivering SCPI 1999.0 compliant text-based commands through the USB interface. For command structure information and a full command list, see the USB Programming manual (QM2010-99-2).

Integer and Fractional Modes of Operation

The QM2010 RF Synthesizer Module is capable of operating in integer or fractional mode. In integer mode, the frequency resolution of the QM2010-5-10 is dependent on the reference frequency and reference divider as defined by this relationship $fres = \frac{reference}{ref\ divider} * 4$. On first power-up, the QM2010-5-10 is set to integer mode and uses the internal 50 MHz reference with a reference divider value of 1. This provides a default frequency step size of 200 MHz. Operation in fractional mode allows for a frequency step size of 1 MHz. When operating in fractional mode, it is recommended to set the reference divider value to 1.

Table 1 – Integer vs. Fractional Mode Comparison

Parameter	Integer Mode	Fractional Mode
Phase Noise	• Comparable to fractional mode phase noise at offset frequencies ≤ 100 kHz, *if* the reference divider value is ≤ 2 • Degrades as reference divider increases	• Comparable to integer mode at offset frequencies ≤ 100 kHz, *if* the reference divider value = 1 (should always be 1 for best performance).
Spurious Content	• Better spurious performance	• Additional spurs present at frequency offsets ≤ 5 MHz (see Figure 2)
Recommendation	• Use whenever possible for best performance	• Use when fine frequency resolution is required

Figures 1 and 2 illustrate the performance difference between integer and fractional mode when tuning to 8.0 GHz with a 50 MHz reference. Increasing the reference divider while in integer mode increases the frequency resolution but adds phase noise. To maintain the highest performance of the QM2010-5-10, use the lowest frequency divider while operating in integer mode. If operating in fractional mode, the reference divider should be 1.

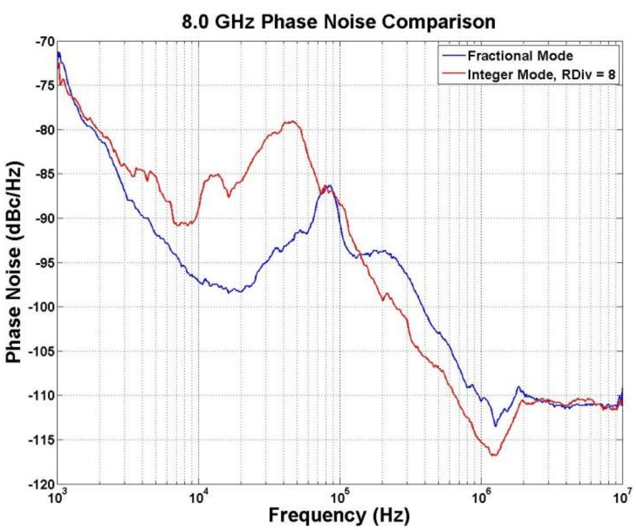

Figure 1 - Fractional vs. Integer Mode Phase Noise

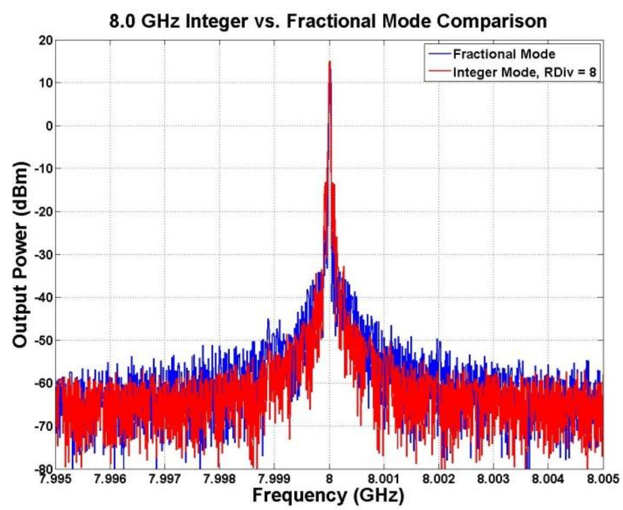

Figure 2 – Fractional vs. Integer Mode Spectrum
10 MHz span, RBW = 10 kHz, VBW = 300 Hz

Frequency Reference Considerations

Aside from reference divider selection, the phase noise performance and stability of the reference oscillator has a direct effect on QM2010 phase noise performance. The QM2010-5-10 includes an on board, high precision TXCO 50 MHz reference whose phase noise parameters are outlined in Table 2. To ensure optimal QM2010 performance when an external reference is required, it is important to choose an accurate and stable oscillator with specifications equal to or better than the 50 MHz TCXO Int Ref outlined in Table 2.

Figure 3 depicts phase noise performance differences between the QM2010-5-10 high precision TXCO internal reference and an ultra high precision OCXO external reference. Phase noise performance with different reference divider settings is also shown. Table 2 outlines the performance differences between reference oscillators.

Table 2 – Reference Characteristics – Internal Reference vs. External

Parameter	50 MHz TCXO Int Ref	20 MHz OCXO Ext Ref
SSB Phase Noise at 10 Hz Offset	-70 dBc/Hz	-110 dBc/Hz
SSB Phase Noise at 100 Hz Offset	-100 dBc/Hz	-135 dBc/Hz
SSB Phase Noise at 1 kHz Offset	-122 dBc/Hz	-150 dBc/Hz
Frequency Stability at 25 ºC	± 0.5 ppm	± 0.2 ppm
Frequency Stability vs. Temp	± 0.25 ppm	± .02 ppm

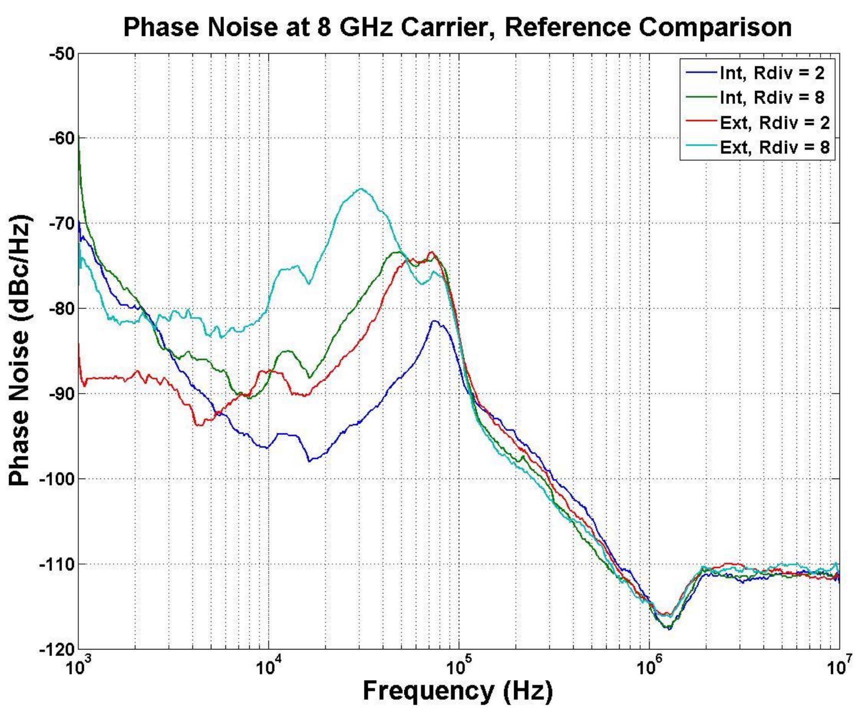

Figure 3 - Phase Noise Reference and Reference Divider Comparison

QM2010-5-10 Performance Plots

Unless explicitly defined, all data was taken with the internal 50 MHz reference operating in integer mode with a reference divider value of 1.

Figure 4 shows representative phase noise plots for 5 GHz, 7.5 GHz, and 10 GHz carrier outputs.

Figure 5 is the maximum and minimum power output vs. tuning frequency.

Figures 6-17 show the representative spectral plots at several frequencies.

Power Calibration

The QM2010 series of USB Stick Synthesizers feature output power control tunable to within ± 1 dB of a desired power level. In Figure 5, the power variation vs. frequency is shown when the user sets the power level to 0 dBm.

If the selected power level exceeds the maximum or minimum output power levels shown in Figure 5, the QM2010 will set the power level to the closest possible value.

QM2010-5-10 Performance Plots

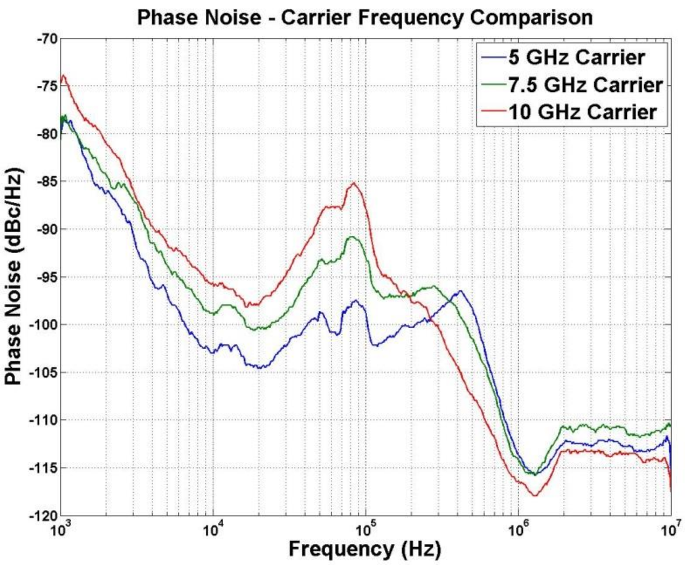

Figure 4 - Representative Phase Noise Plots

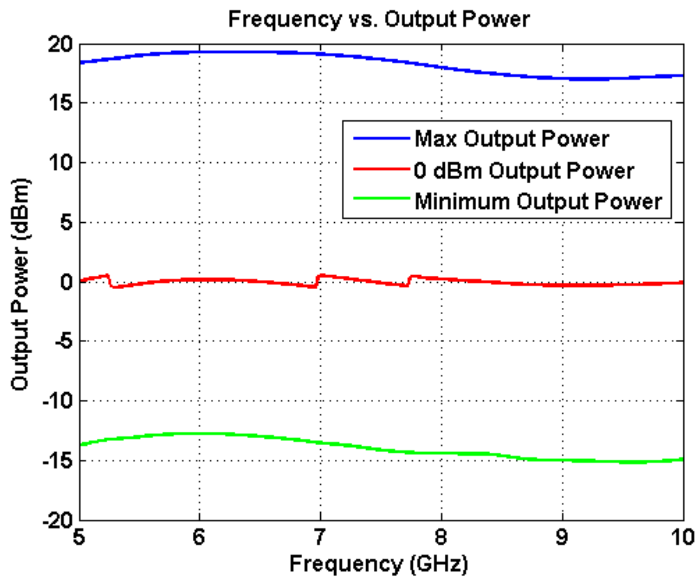

Figure 5 - Frequency vs. Output Power from 5 GHz to 10 GHz in 50 MHz steps

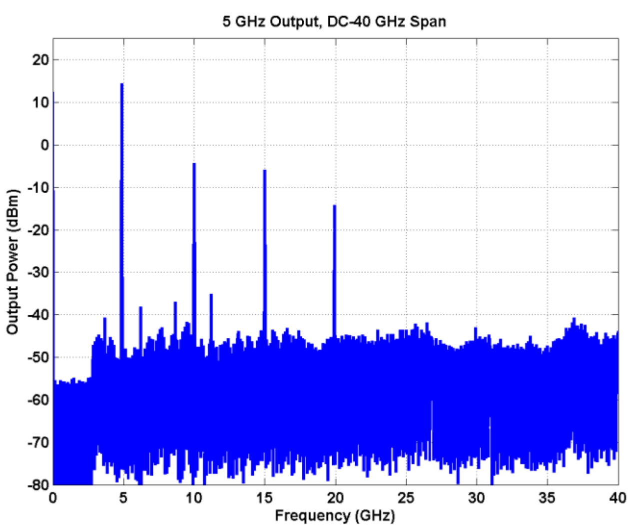

Figure 6 – 5 GHz Output, DC-40 GHz, VBW/RBW = 100 kHz

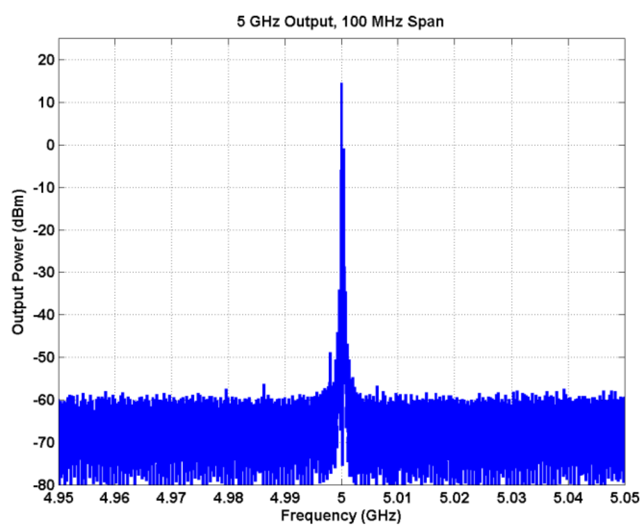

Figure 7 – 5 GHz Output, 100MHz span, VBW/RBW = 10kHz

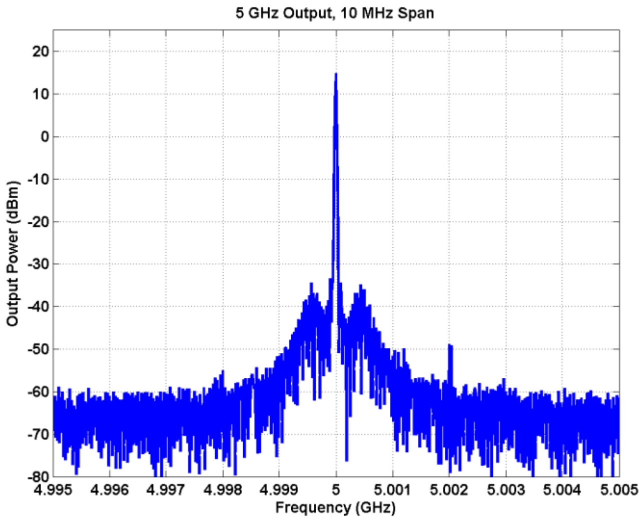

Figure 8 – 5 GHz Output, 10 MHz span, VBW/RBW = 3 kHz

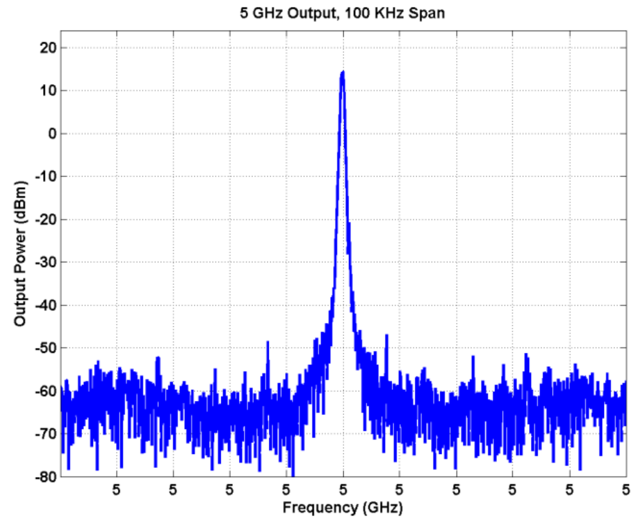

Figure 9 – 5 GHz Output, 100 kHz span, VBW = 100 Hz, RBW = 300 Hz

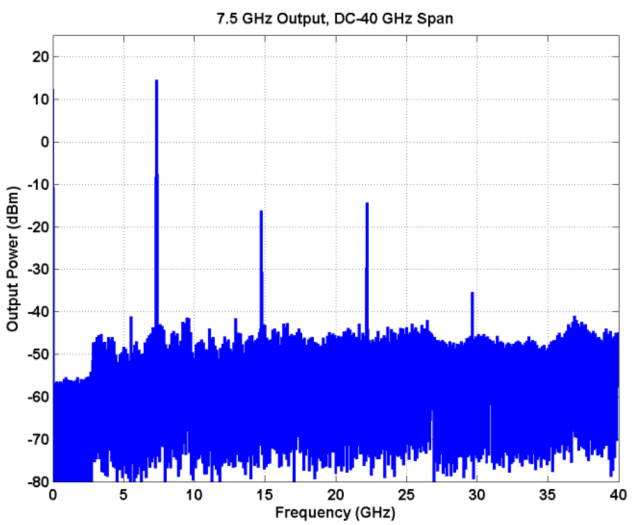

Figure 10 – 7.5 GHz Output, DC-40 GHz, VBW/RBW = 100 kHz

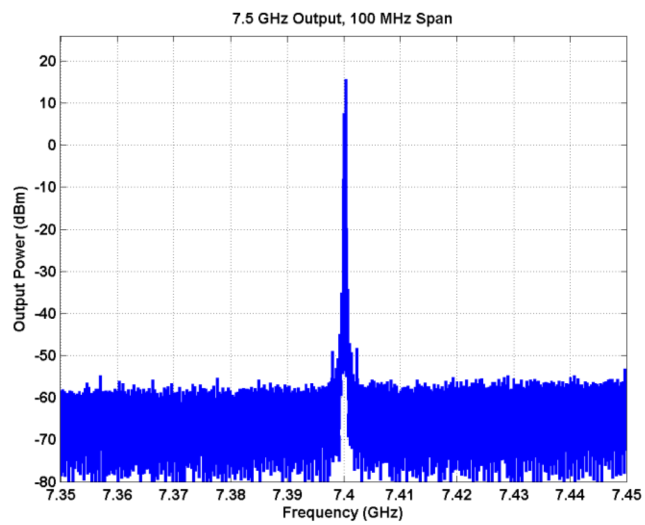

Figure 11 – 7.5 GHz Output, 100MHz span, VBW/RBW = 10kHz

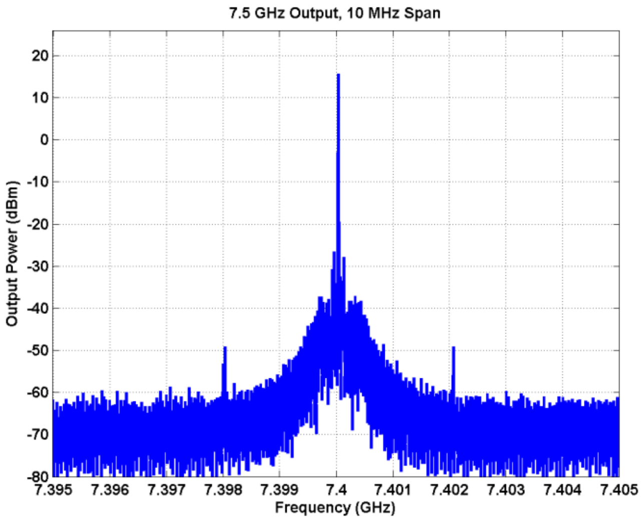

Figure 12 – 7.5 GHz Output, 10 MHz span, VBW/RBW = 3 kHz

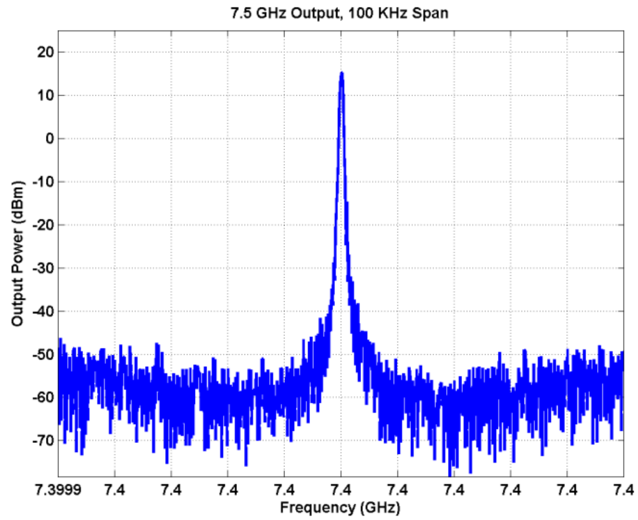

Figure 13 – 7.5 GHz Output, 100 kHz span, VBW = 100 Hz, RBW = 300 Hz

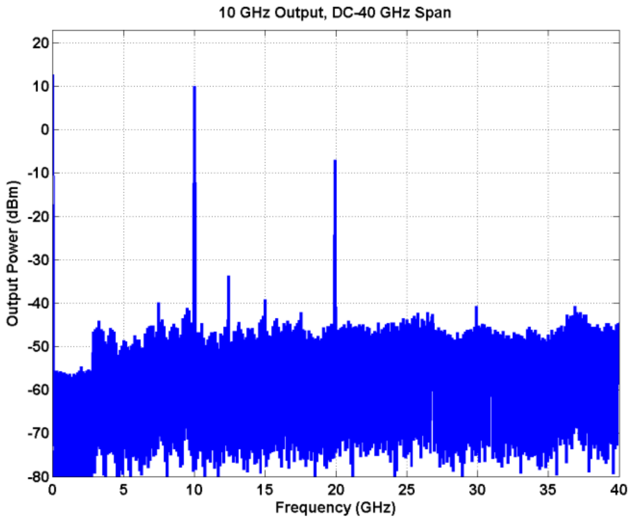

Figure 14 – 10 GHz Output, DC-40 GHz, VBW/RBW = 100 kHz

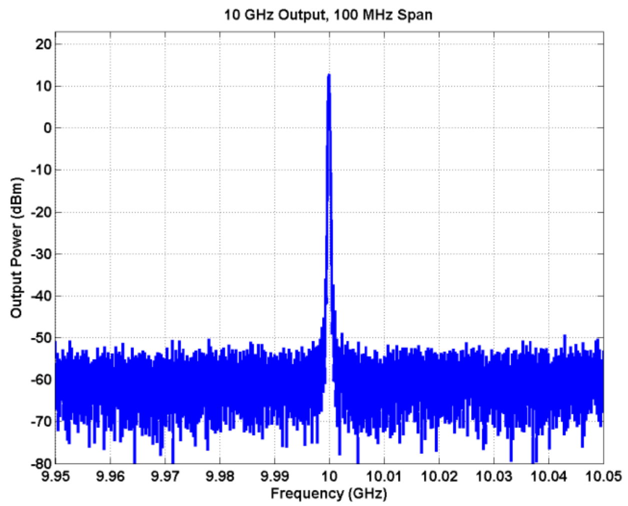

Figure 15 – 10 GHz Output, 100MHz span, VBW/RBW = 10kHz

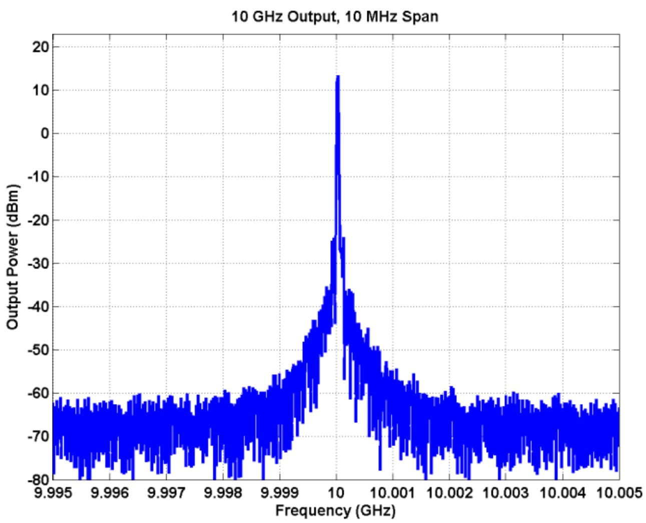

Figure 16 – 10 GHz Output, 10 MHz span, VBW/RBW = 3 kHz

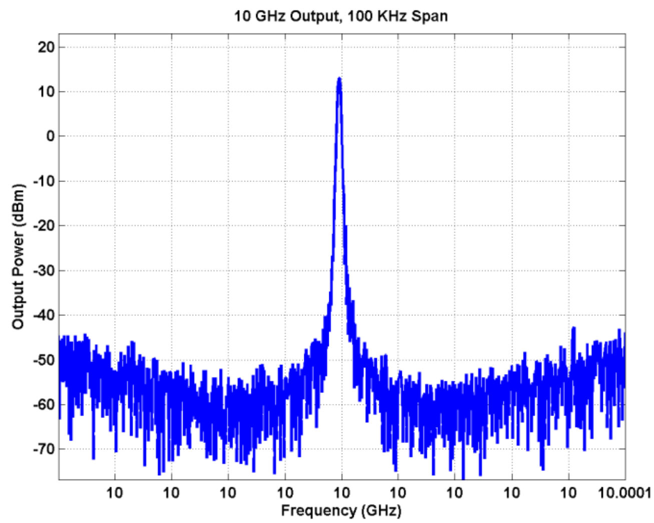

Figure 17 – 10 GHz Output, 100 kHz span, VBW = 100 Hz, RBW = 300 Hz

Device Housing

The QM2010 housing is a doubled sided pin fin heat sink constructed of anodized aluminum as shown in Figures 18 and 19. This creates an extremely rugged package that provides adequate surface area for natural convection cooling and EMI protection for the sensitive electronics housed within. The device should be kept clean and unobstructed in order to promote air circulation. Because the device is cooled through natural convection, a case temperature rise of +20 ^{o}C over ambient conditions can be expected. If this product is used outside of a lab environment (+30 ^{o}C ambient conditions) users are urged to exhibit care while handling the device, such as wearing heat resistant gloves or applying forced air cooling with an external fan.

Table 3 - QM2010 USB RF Synthesizer Module Physical Parameters

Dimensions	4.1” x 0.9” x 0.645”
Weight	0.2 lbs

Figure 48 – QM2010-5-10 Side View, Part Number and Device Name

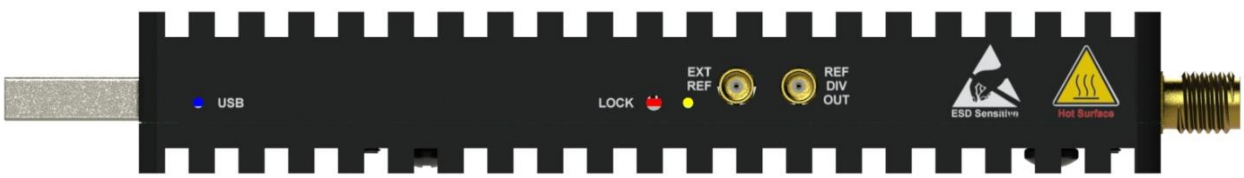

Figure 59 – QM2010-5-10 Side View, Status LEDs and External Reference Input

Figure 19 shows the status LED locations on the QM2010 series of USB stick synthesizers. The blue LED to the left of the “USB” text will illuminate when the device is enumerated by a host PC. The “LOCK” LED will be red when the device is either unlocked or has RF power off, or green when the device is locked. The “EXT REF” LED should illuminate yellow when the device is set to lock to an external reference. When locking to the internal 50 MHz reference, the EXT REF LED should be off.

Interface Connections

I/O Connector	Connector Type	Description
EXT REF	MMCX-F	External Reference input (5 MHz to 100 MHz)
REF DIV OUT	MMCX-F	Reference divider out – not used in normal operation
RF out	SMA-F	RF output: 5-10 GHz
USB	USB Type A – Male	USB signal and power

Accessories

A USB A Extension Cable, 3 feet is included. It is recommended that any non-supplied USB A Extension Cable have power strands less than or equal to 24 AWG and be as short as possible. Voltage drop across long or high gauge USB cabling will negatively affect QM2010 performance.

Associated Manuals

Description	Link
QM2010 USB Synthesizer Stick Quick Start Manual	http://www.appliedradar.com/Manuals/QM2010 USB Stick Synthesizer Quick Start_Rev2.1
QM2010 USB Stick Synthesizer User Manual	http://www.appliedradar.com/Manuals/QM2010 USB Stick Synthesizer User Manual_Rev2.0.1.pdf

Associated Products

Product Number	Description
QM2010-4400	35 MHz to 4400 MHz USB Synthesizer
QM2010-6000	25 MHz to 6 GHz USB Synthesizer
QM2010-10-20	10 GHz to 20 GHz USB Synthesizer
QM2010-21-24	21 GHz to 24 GHz USB Synthesizer
QM2010-24-27	24 GHz to 27 GHz USB Synthesizer
QM1002 Series	1U 19” Rack-mountable Single or Dual Channel RF Upconverters
QM1003 Series	1U 19” Rack-mountable Single or Dual Channel RF Downconverters
QM1004 Series	1U 19” Rack-mountable RF Up-Downconverter Module
QM1007 Series	1U 19” Rack-mountable RF Up-Downconverter Module

Absolute Maximums

Ref input power	+20 dBm
Vcc	+5.5 Vdc
Operating Temperature	0 to +55 °C
Storage Temperature	-50 to +100 °C

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Ordering Information

QM2010-5-10