



*QM1002-8-12-X | 8 to 12 GHz RF Upconverter, Single (X=1) or Dual (X=2) Channel*

**Typical Applications**

- Frequency Conversion
- Digital Receiver Exciter (DREX) Systems
- Communication systems
- X-Band Systems, EW, and ELINT
- Phased array antenna systems
- Radar systems

**Features**

**RF Output Frequency Range**

QM1003-8-12-X                      8 to 12 GHz

**IF Input Frequency Range**

Base Unit                              750 to 1250 MHz  
Option 200                              50 to 550 MHz



**QM1002-8-12-2 with Option 100, Front View**  
From left to right: Power switch, IF in (Ch1), RF out (Ch1), IF in (Ch2), RF out (Ch2), Display LCD



- 19" rack mount, 1U form factor
- Single (X=1) or Dual (X=2) channel options
- Option 100 provides internal LO generation with USB control
- 500 MHz instantaneous bandwidth
- Single or dual channel systems
- Available with external or integrated LOs
- Independent (Option 010/110) or common channel control available on dual channel systems
- Frequency agile across entire tunable band
- Single RF output and IF input per channel

**General Description**

The QM1002-8-12 1U 19" Depth Rack Mount Wideband Upconverters are frequency agile RF upconverter units capable of producing output frequencies centered between 8 and 12 GHz with 500 MHz of instantaneous bandwidth. The 500 MHz IF input frequency range is centered at 1 GHz (750 to 1250 MHz).

The QM1002 Series allows for external Local Oscillator (LO) inputs or internally generated LOs (Option 100). With Option 100 selected, the QM1002-8-12 is controlled via USB and uses VISA control drivers with the USBTMC protocol, enabling seamless integration into Windows®, Linux®, and Macintosh® environments.

All QM1002 Series specifications are customizable upon request. Please contact [sales@appliedradar.com](mailto:sales@appliedradar.com) for more information.



**Electrical Specifications:** *QM1002-8-12-X without Option 200 selected*

Parameter	Min.	Typ.	Max.	Units
RF Output Frequency Range	8		12	GHz
IF Input Center Frequency	750	1000	1250	MHz
Instantaneous 3 dB bandwidth		500		MHz
Gain				
8 GHz		29		dB
10 GHz		30		dB
12 GHz		31		dB
Channel to Channel Isolation		35		dB
Noise Figure (NF)		7		dB
Input 1 dB Compression Point (IP1dB)		-12		dBm
Output 1 dB Compression Point (OP1dB)		19		dBm
Saturated Output Power (Psat)		20		dBm
Output Third Order Intercept		25		dBm
Operating Voltage		12		VDC
Tune Frequency Step Size (Valid for Option 100 only)				
Integer Mode*		200		MHz
Fractional Mode		1		MHz
<i>The following Electrical Specifications are only valid for converters <u>without</u> Options 100 or 110 selected</i>				
LO1 Input Frequency Range	13		18	GHz
LO1 Input Power		0		dBm
LO2 Input Frequency Range		5		GHz
LO2 Input Power		0		dBm

\* With use of the internal 50 MHz reference with a reference divider of 1



**Electrical Specifications: *QM1002-8-12-X with Option 200 selected***

Parameter	Min.	Typ.	Max.	Units
RF Output Frequency Range	8		12	GHz
IF Input Center Frequency	50	300	550	MHz
Instantaneous 3 dB bandwidth		500		MHz
Gain	8 GHz	20		dB
	10 GHz	19		dB
	12 GHz	20		dB
Noise Figure (NF)		18		dB
Input 1 dB Compression Point (IP1dB)		0.5		dBm
Output 1 dB Compression Point (OP1dB)		19		dBm
Operating Voltage		12		VDC
Tune Frequency Step Size (Valid for Option 100 only)				
Integer Mode*		200		MHz
Fractional Mode		1		MHz
<i>The following Electrical Specifications are only valid for converters <u>without</u> Options 100 or 110 selected</i>				
LO1 Input Frequency Range	13		18	GHz
LO1 Input Power		0		dBm
LO2 Input Frequency Range		5		GHz
LO2 Input Power		0		dBm
LO3 Input Frequency Range		1300		MHz
LO3 Input Power Level		0		dBm

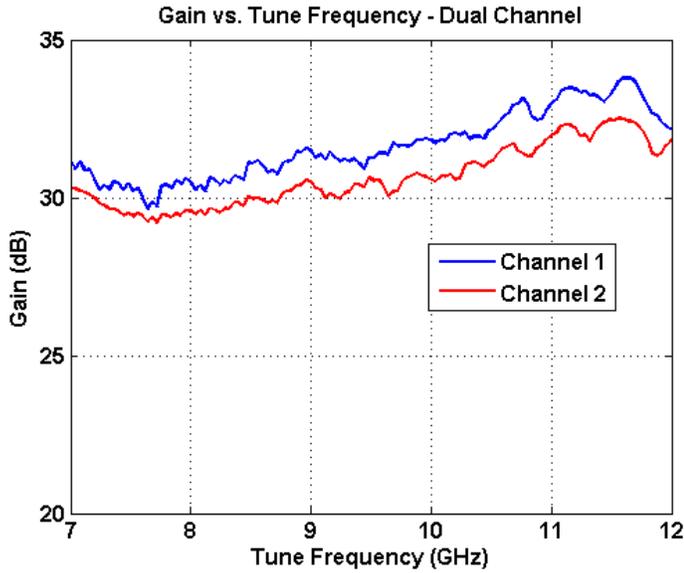
\* With use of the internal 50 MHz reference with a reference divider of 1

**Option 200 Discussion**

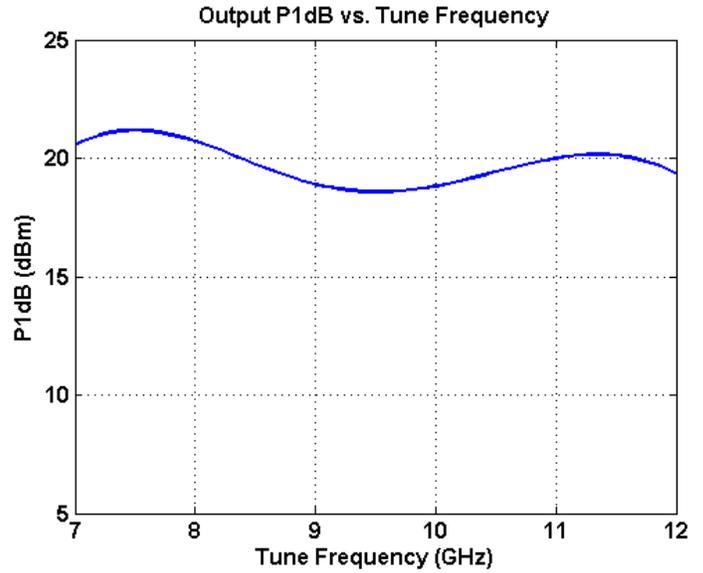
To coincide with state of the art digital-to-analog converter (DAC) output frequency ranges in the first Nyquist zone, QM1002 series frequency converter units are offered with an optional 50-550 MHz input frequency range (Option 200). DACs operating in the first Nyquist zone generally have output power levels approaching 0 dBm, and Option 200 specifications were designed with that input power level in mind. The design changes necessary to enable a lower IF input frequency range and a higher input power level result in a higher system noise figure and other system level changes that affect the gain and P1dB values specified in units without Option 200 selected.



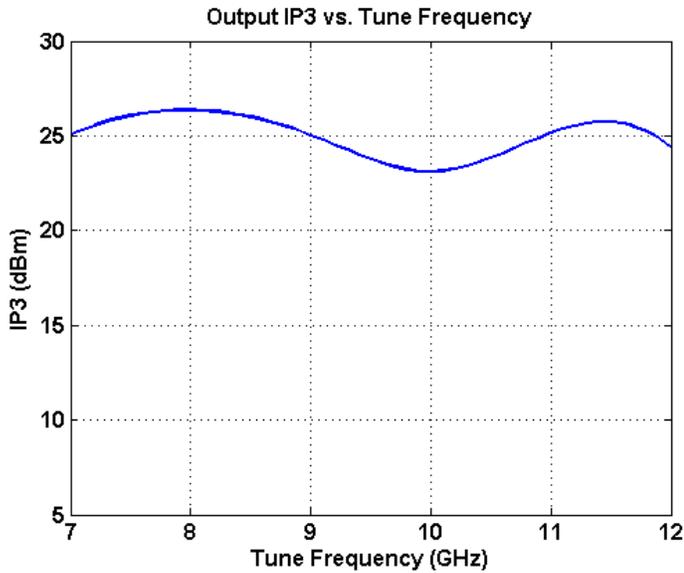
**Typical Performance Plots**



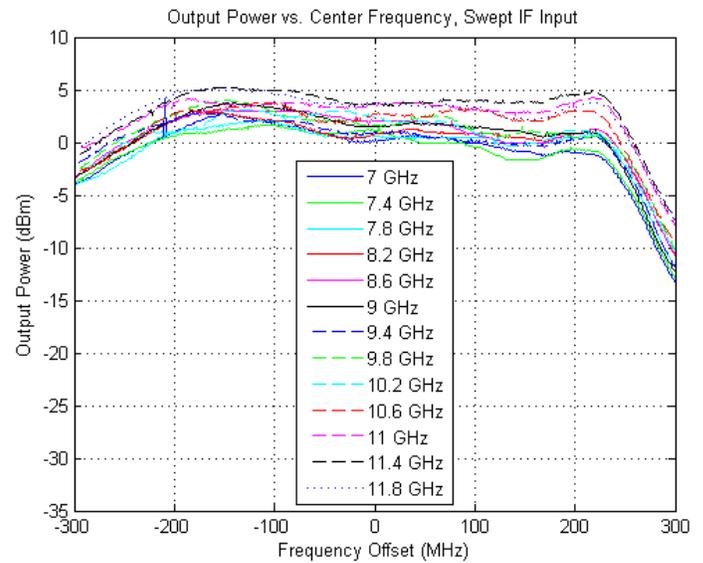
**Figure 1 – Gain vs. Frequency**



**Figure 2 – P1dB vs. Frequency**



**Figure 3 – IP3 vs. Frequency**



**Figure 4 – 750 to 1250 MHz IF Input Sweep, -25 dBm RF Output from 7 to 12 GHz in 400 MHz steps**



### Options Overview

To provide flexibility for system integration, the QM1002-8-12 series of upconverters have multiple configuration options that pertain to four categories – (1) number of channels, (2) Local Oscillator (LO) generation, (3) Independent vs. common channel control for dual channel systems, (4) IF input frequency modifications.

The number of channels in a QM1002-8-12-X Rack Mount Upconverter is specified by the X value in the part number, where **X=1** denotes a single channel upconverter, and **X=2** denotes a dual channel upconverter.

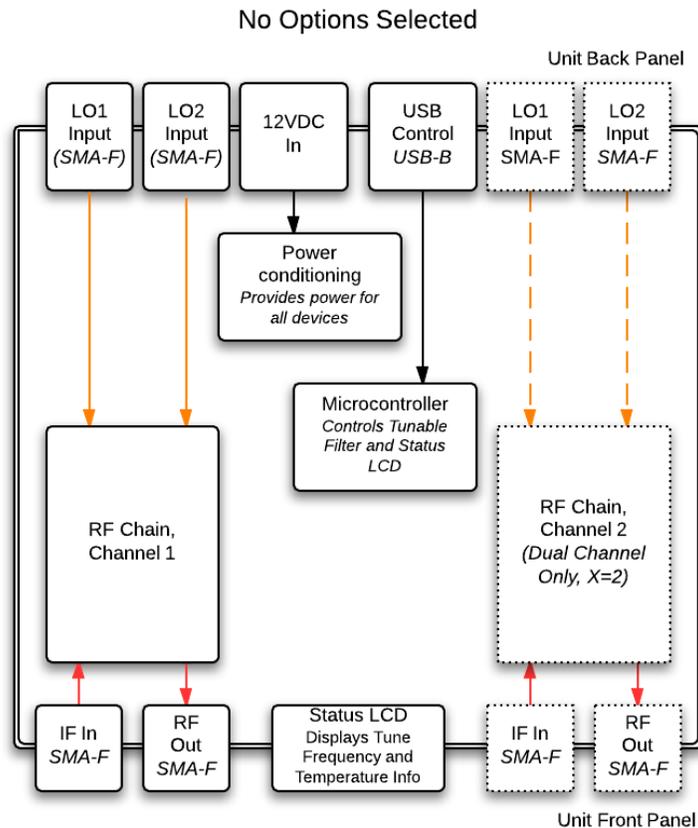
To select options related to LO generation and independent/common channel control, the following option codes are provided.

Option Code	Description
None	No LOs are included in the unit. The user is expected to provide LO1 and LO2 for each channel through back panel SMA-Female connectors. Each channel will be independently tunable.
100	LO1 and LO2 are included in the unit. LO1 and LO2 RF connectors are removed from the back panel. A USB type-A connector is added to the back panel for LO control. In dual channel systems with Option Code 100 <b>only</b> selected, LOs are common, meaning both channels are always tuned to the same frequency.
110	When Option 110 is specified, Option 100 is also selected by default. LOs are included in the unit, but each channel is independently tunable. LO1 and LO2 RF connectors are removed from the back panel. A USB type-A connector is added to the back panel for LO control.
200	The IF input is changed to 50-550 MHz. Please contact <a href="mailto:sales@appliedradar.com">sales@appliedradar.com</a> for more information.



### QM1002 Series System Block Diagrams

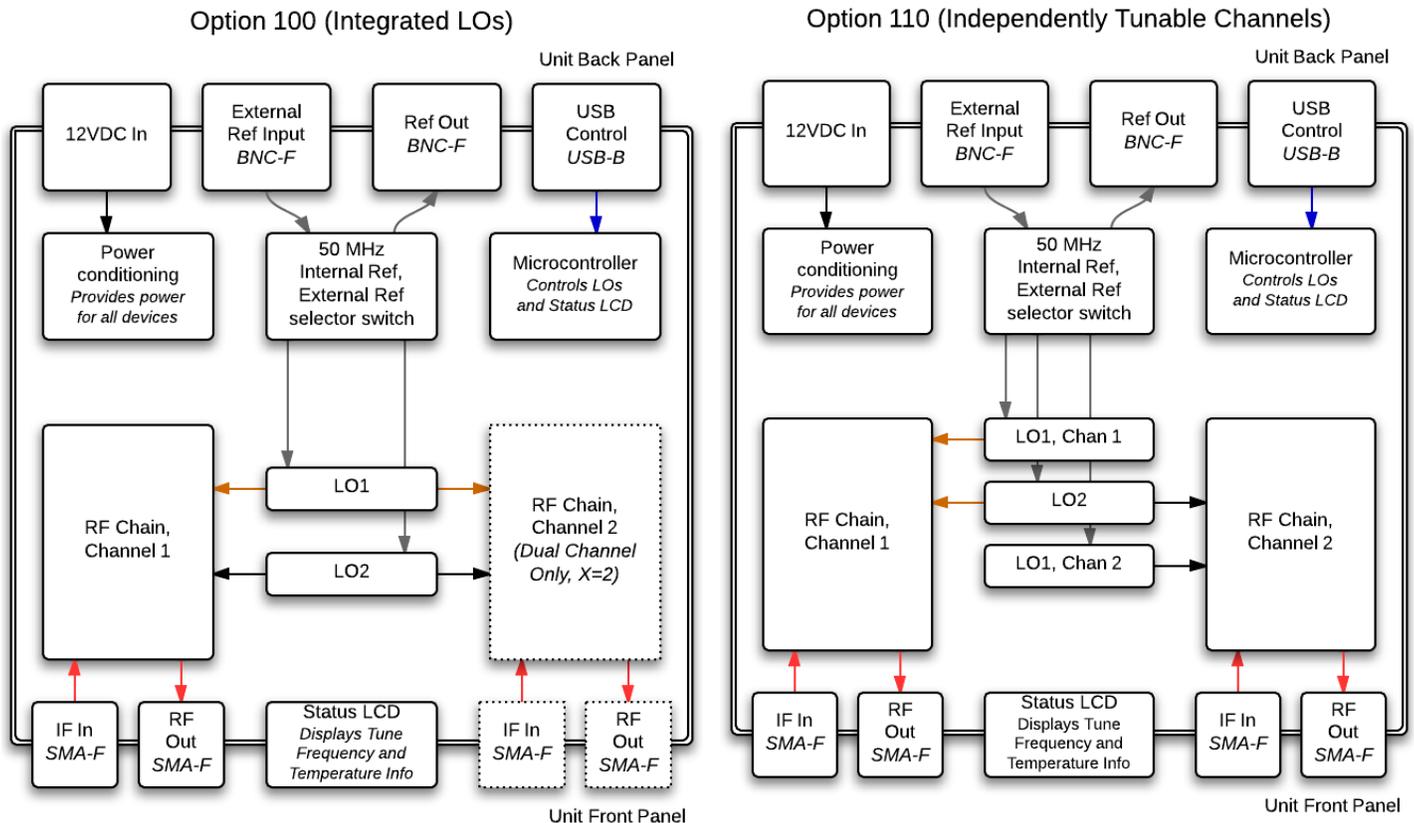
Figure 1 depicts the situation where **no options** are selected, meaning external LO inputs are required. Since LO2 is static at 5 GHz, the user can supply these two ports from an external power divider and single LO source. For systems with external LOs, the user must take care to provide the specified LO input power to achieve optimal system performance.



**Figure 5** – QM1002-8-12-X with no options selected, where X=1 for a Single Channel Upconverter and X=2 for a Dual Channel Upconverter

If **Option 100** is selected, LO1 and LO2 frequencies will be generated internally. The LOs are PLL based and require a reference clock and digital control. Figure 3 depicts the additional block elements in a system with **Option 100** selected. The LOs are controlled digitally via a microcontroller, which interfaces to a PC through USB. The microcontroller outputs basic status messages on a 32-character Liquid Crystal Display (LCD) mounted on the faceplate of the unit. An internal low phase noise 50 MHz reference clock is split between the LOs, with a BNC-F connector providing the option for LOs to lock to a user-provided external reference. A second BNC-F connector outputs whichever reference is used by the LOs (internal or external) for daisy chaining multiple pieces of equipment. Switching between the internal and external LO reference clocks is controlled by the microcontroller and a reference selector switch.

**Option 110** is only available on dual channel upconverter systems with **Option 100** selected. **Option 110** specifies a unit with internal LOs and independently tunable channels. From an I/O perspective, the front and back panel have the exact same configuration as a system with **Option 100** only. The difference in systems is shown in Figure 3, with the addition of a second LO1. As with **Option 100**, LOs are controlled digitally via a microcontroller, which interfaces to a PC through USB.



**Figure 2** – QM1002-8-12-X with Option 100 selected, where Option 100 refers integrated LOs

**Figure 3** – QM1002-8-12-2 with Options 100 and 110 selected, where Option 100 refers to internal LOs and Option 110 refers to independently tunable channels



### RF Chain Block Diagram

QM1002 Series Wideband RF Upconverters use a dual stage conversion architecture to upconvert an IF input signal centered at 1 GHz, with up to 500 MHz of instantaneous bandwidth, to an output frequency centered between 8 and 12 GHz. The frequency plans are outlined in a simplified block diagram in Figure 4. Each “RF Chain, Channel X” depicted in Figures 1 through 3 is a replica of this simplified block diagram.

### QM1002-8-12 Simplified RF Chain

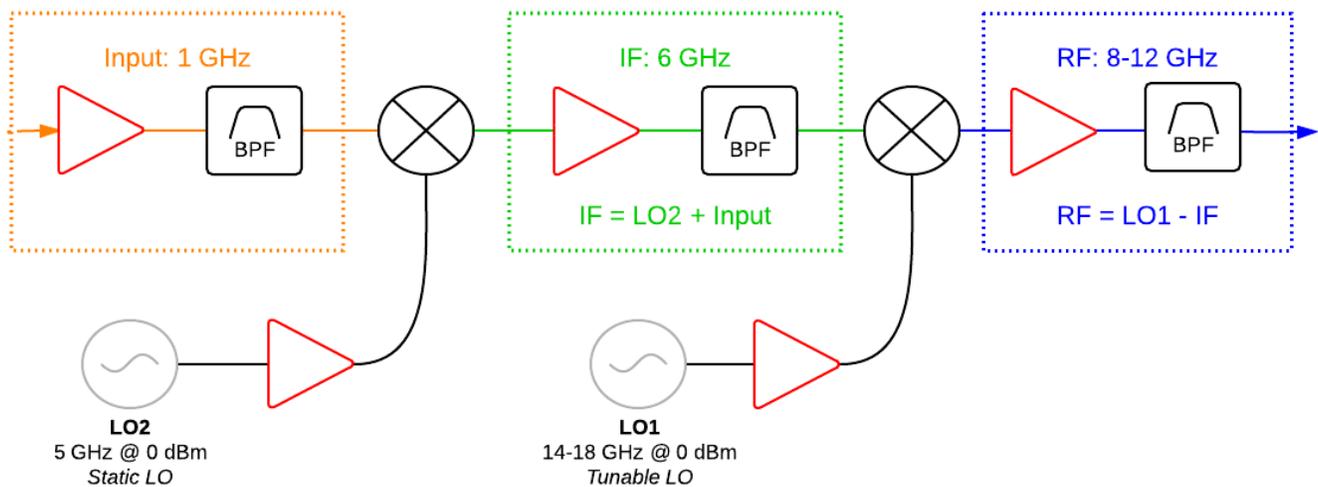


Figure 4 – Simplified RF Chain Block Diagram

The input signal, centered at 1 GHz, is conditioned by an LNA and a 500 MHz band pass filter. The first mixer is implemented as an upconverter with a static low-side LO, producing an IF output of 6 GHz described by equation (1).

$$IF = LO2 + Input \rightarrow 5 \text{ GHz} + 1 \text{ GHz} = 6 \text{ GHz} \quad (1)$$

The intermediate frequency (IF) at 6 GHz is conditioned by an additional amplifier and 500 MHz band pass filter. A secondary mixing stage is then implemented as an upconverting mixer with a tunable high-side LO, producing an RF output frequency range of 8-12 GHz. This relationship is described in equation (2).

$$RF = LO1 - IF \rightarrow 14 \text{ to } 18 \text{ GHz} - 6 \text{ GHz} = 8 \text{ to } 12 \text{ GHz} \quad (2)$$

In order to control the RF output frequency, users need only change the LO1 value to frequencies between 14 and 18 GHz. LO2 should remain static at 5 GHz. If Option 100 or 110 are selected (internal LOs), the LO1 frequency calculation is performed internally, and the user need only digitally choose their desired output frequency. The RF output frequency can be calculated for a chosen LO1 with equation (3) or the LO1 input frequency can be calculated using the desired RF output frequency with equation (4).

$$RF \text{ output} = LO1 - LO2 - Input \quad (3)$$

$$LO1 = RF + LO2 + Input \quad (4)$$

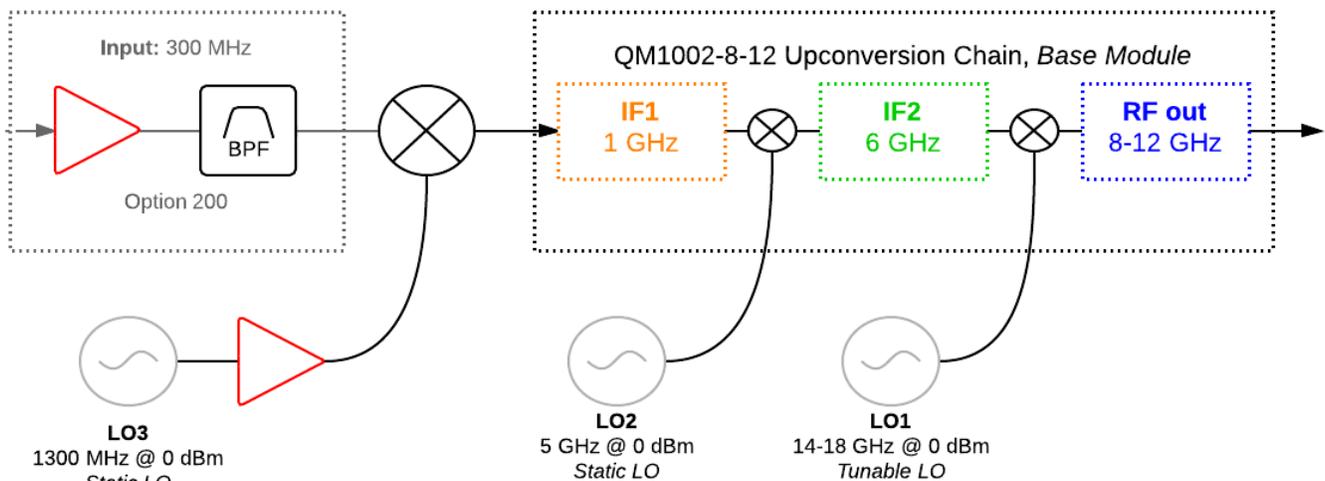
**Option 200 RF Chain Modifications**

Option 200 moves the IF input frequency range from 750-1250 MHz down to 50-550 MHz. This modification requires a third frequency conversion stage and LO placed directly before the block diagram pictured in Figure 5. With Option 200 selected, the 300 MHz IF is upconverted to a 1 GHz IF, which then enters the same frequency conversion chain as QM1002 series upconverters without Option 200 selected. This frequency plan change is outlined in Figure 5 and described by equations (5) and (6).

$$RF\ output = LO1 - LO2 - LO3 + Input \tag{5}$$

$$LO1 = RF + LO2 + LO3 - Input \tag{6}$$

**QM1002-8-12 Simplified RF Chain with Option 200**



**Figure 5 - Option 200 Frequency Conversion Block Diagram**

As with all QM1002 series upconverter units, knowledge of the LO input frequencies and frequency plan calculation is only necessary if user-generated external LOs are required. If Option 200 is selected and external LOs are required, an LO3 SMA-Female input connector will be added to the back panel of the unit.

**Controlling QM1002 Upconverters with Internal LOs (Option 100)**

QM1002 Rack Mount Upconverters with internal LOs have been designed to be VISA and USBTMC compliant. Any PC and operating system with Virtual Instrument Software Architecture (VISA) drivers installed should be able to communicate with QM1002 units. VISA drivers are provided by many Test and Measurement companies, including Agilent Technologies, National Instruments, and Tektronix. USB communication and command structure is discussed in detail in the frequency conversion programming manual. A lightweight GUI, supported in Windows® and Linux®, will be provided for units with internal LOs, providing control of all commonly used commands.



**Interface Connections**

The necessary front and back panel input/output connections on a QM1002 Series Upconverter are dependent on the specified part number and selected options. Boxes with internal LOs will not have the external LO connections on the back faceplate. Similarly, single channel QM1002 upconverters will not have SMA I/O connectors for Channel 2. Tables 1 and 2 outline the I/O connections present on the front and back panels respectively. Detailed I/O panel drawings for specified part number and option combinations can be provide upon request. **Note:** *USB control is necessary on all QM1002-8-12 frequency converters. On converters with externally applied LOs, control is required to set the tune frequency of RF filters.*



**Figure 6 - QM1002 Series Front Panel Example, Dual Channel System**



**Figure 7 - QM1002 Series Back Panel Example, Dual Channel System - External LOs**

**Table 1 – Front Panel I/O Connectors for selected part numbers and options**

Part Number	Power Switch	CH1		CH2		Status LCD
		IF in (SMA)	RF out (SMA)	IF in (SMA)	RF out (SMA)	
<b>QM1002-8-12-X</b> No Options or Option 010 (External LOs)	Yes	Yes	Yes	If X=2	If X=2	Yes
<b>QM1002-8-12-X</b> , Options 100 and/or Option 110 (Internal LOs)	Yes	Yes	Yes	If X=2	If X=2	Yes

**Table 2 - Back Panel I/O Connectors for selected part number and options**

Part Number	Ref In (BNC-F)	Ref Out (BNC-F)	LO1 In, CH1 (SMA-F)	LO1 In, CH2 (SMA-F)	LO2 In, CH1 (SMA-F)	LO2 In, CH2 (SMA-F)	LO/filter Control (USB-B)
<b>QM1002-8-12-X</b> , No Options (External LOs, Common Channel Control in Dual Channel Systems)	Unused	Unused	Yes	If X=2	Yes	If X=2	Yes
<b>QM1002-8-12-X</b> , Option 100 (Internal LOs, Common Channel Control in Dual Channel Systems)	Yes	Yes	No	No	No	No	Yes
<b>QM1002-8-12-2</b> , Options 100 and 110 (Internal LOs, Independent Channel Control)	Yes	Yes	No	No	No	No	Yes



**Quonset Microwave**  
www.quonsetmicrowave.com

# QM1002-8-12-X 8-12 GHz Wideband RF Upconverters

## Power Interface

The QM1002 Rack Mount Upconverter requires a DC input voltage of 15V applied at the 5.5mm power jack (2.5mm barrel) on the back panel of the instrument. A 60W AC-DC power adapter will be supplied with the module. Typical power draw varies based on selected options.

## Absolute Maximums

Operating Temperature	+40 °C
IF Input Power	+5 dBm



**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**

## Ordering Information

QM1002-8-12-X- [Options]-[ODU]

where

X= 1, 2 (# of Channels)

Options= 100, 110, 200, 201, 400, etc.

ODU= Optional Outdoor Unit Form-Factor