Quonset Microwave
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QM1003-8-12-X 8-12 GHz Wideband RF Downconverters

QM1003-8-12-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

QM1003-8-12-2 with Option 100, Front View
From left to right: Power switch, RF in (Ch1), IF out (Ch1), RF in (Ch2), IF out (Ch2), Display LCD

Features

RF input Frequency Range

QM1003-8-12-X	8 to 12 GHz

IF output Frequency Range

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

- 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 input and IF output per channel

General Description

The QM1003-8-12 1U 19” Depth Rack Mount Wideband Upconverters are frequency agile RF upconverter units capable of tuning to output frequencies centered between 8 and 12 GHz with 500 MHz of instantaneous bandwidth. The downconverted IF output frequency centered at 1 GHz (750 to 1250 MHz).

The QM1003 Series allows for user-generated external Local Oscillator (LO) inputs or internally generated LOs (Option 100). With Option 100 selected, the QM1003-8-12 is controlled via USB and uses VISA control drivers with the USBTMC protocol, enabling seamless integration into Windows®, Linux®, and Macintosh® environments.

All QM1003 Series specifications are customizable upon request. Please contact sales@appliedradar.com for more information.

Electrical Specifications: ***QM1003-8-12-X without Option 200 selected***

Parameter	Min.	Typ.	Max.	Units
RF Input Frequency Range	8		12	GHz
IF Output Center Frequency	750	1000	1250	MHz
Instantaneous 3 dB bandwidth		500		MHz
Gain 8 GHz 10 GHz 12 GHz		36 37 33		dB dB dB
Noise Figure (NF)		6		dB
Input 1 dB Compression Point (IP1dB)	-15		-10	dBm
Operating Voltage		+12		VDC
Tune Frequency Step Size (Valid for Option 100 only) Integer Mode* Fractional Mode		 200 1		 MHz MHz
The following Electrical Specifications are only valid for converters without Options 100 or 110 selected				
LO1 Input Frequency Range	14		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: ***QM1003-8-12-X with Option 200 selected***

Parameter	Min.	Typ.	Max.	Units
RF Input Frequency Range	8		12	GHz
IF Output Center Frequency	50	300	550	MHz
Instantaneous 3 dB bandwidth		500		MHz
Gain 8 GHz 10 GHz 12 GHz		37 38 33		dB dB dB
Noise Figure (NF)		7		dB
Input 1 dB Compression Point (IP1dB)	-19		-14	dBm
Operating Voltage		+12		VDC
Tune Frequency Step Size (Valid for Option 100 only) Integer Mode* Fractional Mode		 200 1		 MHz MHz
The following Electrical Specifications are only valid for converters without Options 100 or 110 selected				
LO1 Input Frequency Range	14		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*

Options Overview

To provide flexibility for system integration, the QM1003-8-12 series of downconverters 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 output frequency modifications.

The number of channels in a QM1003-8-12-X Rack Mount Downconverter 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 downconverter.

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 through back panel SMA-Female connectors. In dual channel systems with no Option Codes selected, LOs are common, meaning both channels are always tuned to the same frequency.
010	No LOs are included in the unit, and each channel is independently tunable. The user is expected to provide LO1-Channel1, LO1-Channel2, and LO2 through back panel SMA-Female connectors. A second LO2 input is not necessary, as LO2 is static and distributed to both channels inside the unit.
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 ***only*** 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-B connector is added to the back panel for LO control.
200	The IF output is changed to 50-550 MHz. An LO3 input is added to the back panel if Option 100 is not selected. Please contact sales@appliedradar.com for more information.

QM1003 Series System Block Diagrams

Figure 1 depicts the situation where ***no options*** are selected, meaning external LO inputs are required. For single channel systems, LO inputs are sent directly to the RF signal chain, while in dual channel systems, LO inputs are split and distributed to each channel. In a dual channel system with no options selected, LO1 and LO2 are common between the two channels. This sets the receive frequency of the downconverter to the same RF input on each channel.

Option 010 is only available on dual channel downconverter systems and specifies independently tunable channels. As shown in Figure 2, *Option 010* requires two LO1 inputs to allow for independent channel control. LO2 is still split internally, as the frequency is static, and therefore does not require a unique input for each channel.

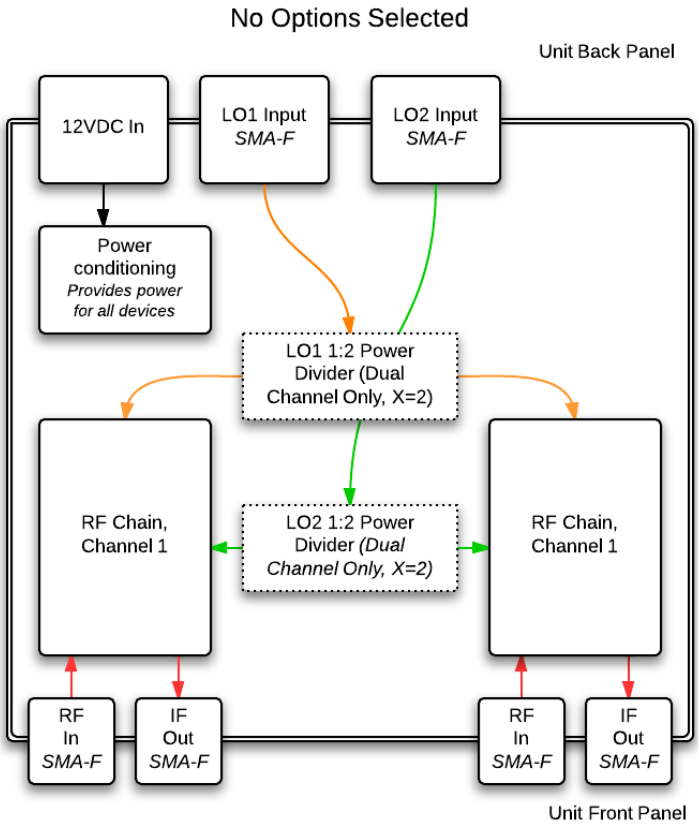

Figure 1 – QM1003-8-12-X with no options selected, where X=1 for a Single Channel Upconverter and X=2 for a Dual Channel Upconverter

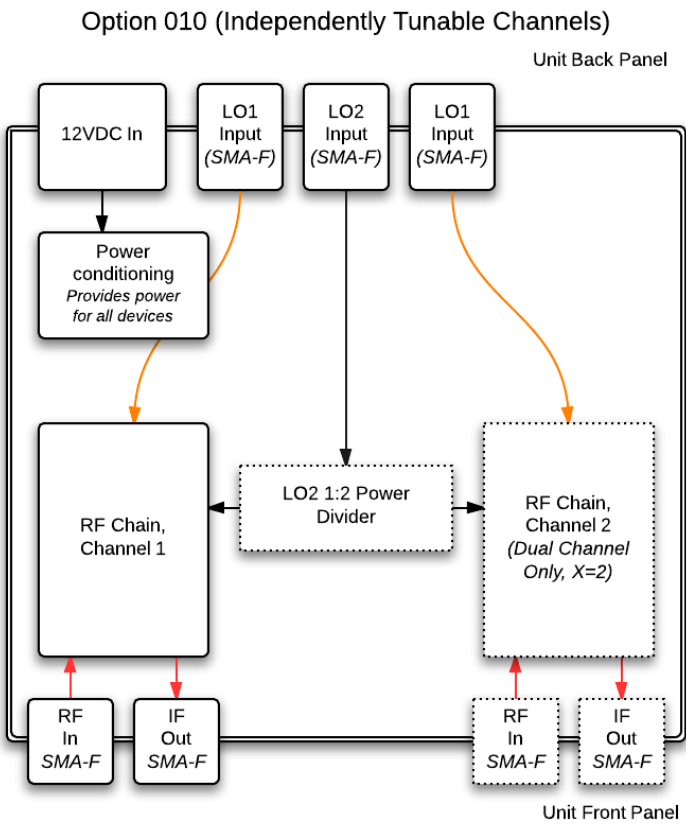

Figure 2 – QM1003-8-12-X with Option 010 selected, where X=1 for a Single Channel Upconverter and X=2 for a Dual Channel Upconverter

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 on the back panel 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 downconverter 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 internally in Figure 4, 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.

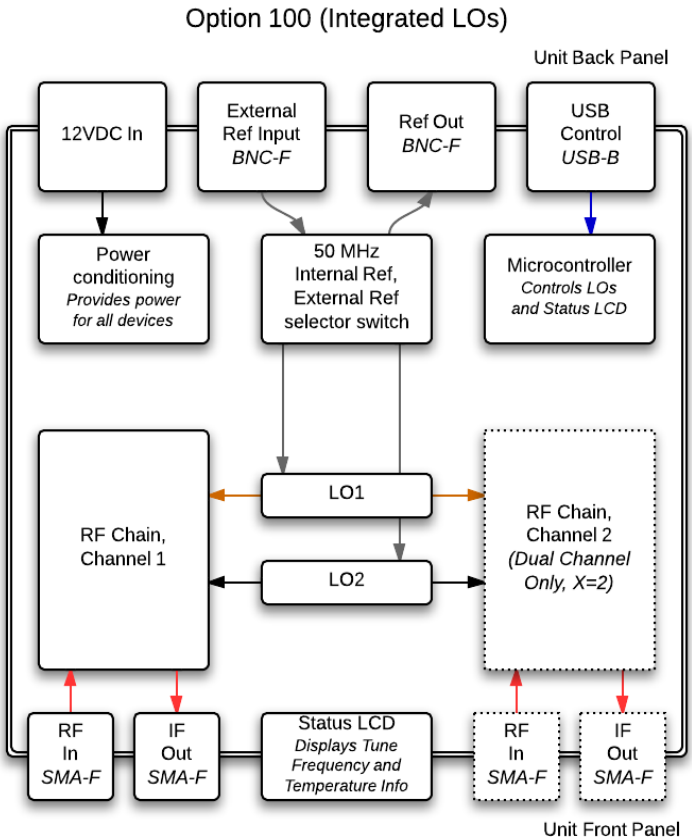

Figure 3 – QM1003-8-12-X with Option 100 selected, where Option 100 refers integrated LOs

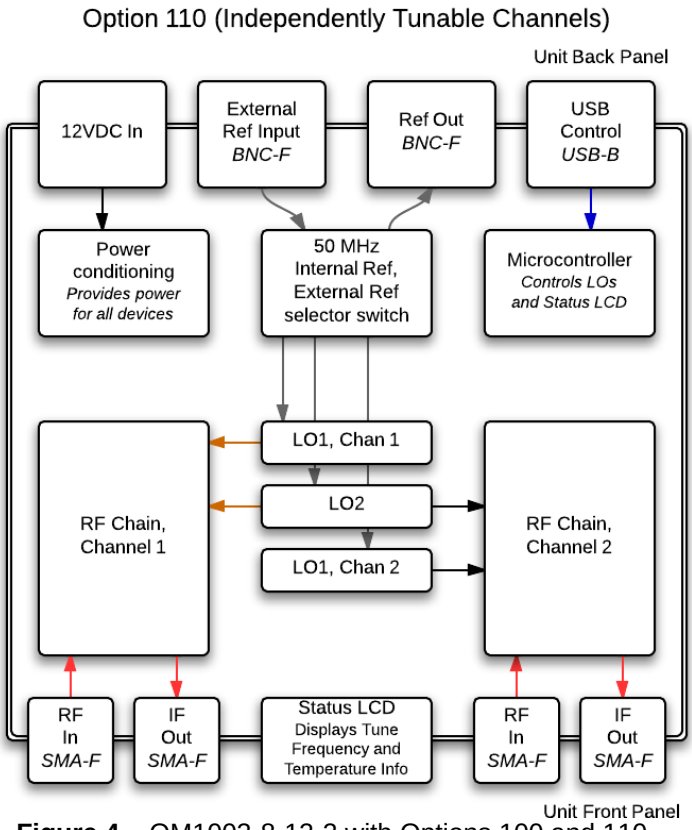

Figure 4 – QM1003-8-12-2 with Options 100 and 110 selected, where Option 100 refers to internal LOs and Option 110 refers to independently tunable channels

RF Chain Block Diagram

QM1003 Series Wideband RF Downconverters use a dual stage conversion architecture to downconvert an RF input signal centered at between 8 and 12 GHz with up to 500 MHz of instantaneous bandwidth, to an output frequency centered at 1 GHz. The frequency plan is outlined in a simplified block diagram in Figure 5. Each "RF Chain, Channel X" depicted in Figures 1 through 4 is a replica of this simplified block diagram.

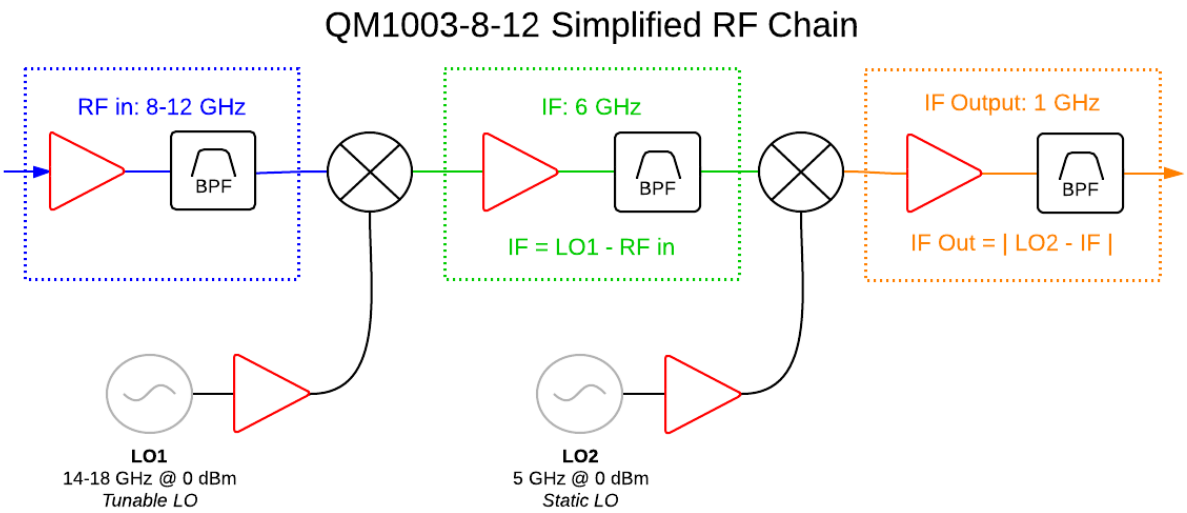

Figure 5 – Simplified RF Chain Block Diagram

The input signal, centered between 8 and 12 GHz, is conditioned by an LNA and an 8-12 GHz band pass filter. The first conversion stage is implemented as a downconverter with a tunable high-side LO, producing an intermediate frequency (IF) of 6 GHz. This relationship is described in equation (1)

$$\boldsymbol{IF = LO1 + RF\ in} \rightarrow 14\ to\ 18\ GHz - 8\ to\ 12\ GHz = \boldsymbol{6\ GHz} \quad (1)$$

The intermediate frequency (IF) centered at 6 GHz passes through an image reject band pass filter (BPF) with 500 MHz of bandwidth. A secondary mixing stage then downconverts the IF using a high-side static LO to produce an IF output frequency centered at 1 GHz. This relationship is described in equation (2).

$$\boldsymbol{IF\ Output = |LO2 - IF|} \rightarrow |5\ GHz - 6\ GHz| = |\boldsymbol{-1}\ | = \boldsymbol{1\ GHz} \quad (2)$$

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 Options 100 or 110 are selected (internal LOs), the LO1 frequency calculation is performed internally, and the user need only digitally choose their desired input tune frequency. Otherwise, the LO1 input frequency can be calculated using the desired RF tune frequency with equation (3).

$$LO1 = RF_{tune} - IF = \boldsymbol{RF_{tune} - 6\ GHz} \quad (3)$$

Option 200 RF Chain Modifications

Option 200 moves the IF output frequency range from 750-1250 MHz down to 50-550 MHz. This modification requires a third frequency conversion stage which converts the 1 GHz output IF, shown in Figure 5, down to an IF output frequency centered at 300 MHz. This frequency plan change is outlined in Figure 6. The LO1 calculation remains the same as in equation (3).

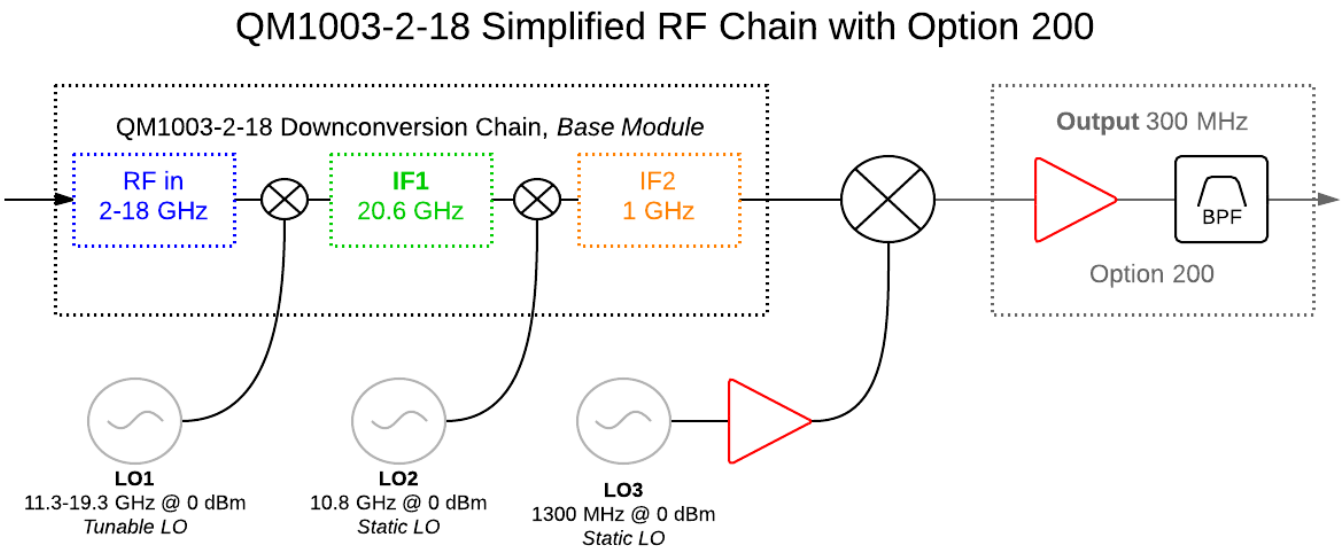

Figure 6 - Option 200 Frequency Conversion Block Diagram

As with all QM1003 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 QM1003 Upconverters with Internal LOs (Option 100)

QM1003 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 QM1003 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 QM1003 Series Upconverter are dependent on the specified part number and options selection. For example, the status LCD on the front faceplate will only be present if the QM1003 has options 100 or 110 selected (internal LOs). With internal LOs the status LCD will provide updates on LO lock status and RF input tune frequency. If the user provides external LOs, the QM1003 RF input tune frequency and LO lock status are controlled by the user, and therefore a status LCD is not required. Similarly, single channel QM1003 upconverters will not have SMA I/O connectors for Channel 2. These will only be present on dual channel systems. 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.

Figure 7 - QM1003 Series Front Panel Example, Dual Channel System

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)	
QM1003-8-12-X, No Options or Option 010 (External LOs)	Yes	Yes	Yes	If X=2	If X=2	No
QM1003-8-12-X, 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	15VDC Input	Ref In (BNC-F)	Ref Out (BNC-F)	LO1 In, CH1 (SMA-F)	LO1 In, CH2 (SMA-F)	LO2 (SMA-F)	LO Control (USB-B)
QM1003-8-12-X, No Options (External LOs, Common Channel Control in Dual Channel Systems)	Yes	No	No	Yes	No	Yes	No
QM1003-8-12-X, Option 010 (External LOs, Independent Channel Control)	Yes	No	No	Yes	Yes	Yes	No
QM1003-8-12-X, Option 100 (Internal LOs, Common Channel Control in Dual Channel Systems)	Yes	Yes	Yes	No	No	No	Yes
QM1003-8-12-2, Options 100 and 110 (Internal LOs, Independent Channel Control)	Yes	Yes	Yes	No	No	No	Yes

Power Interface

The QM1003 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. An AC-DC power adapter is supplied with the unit.

Absolute Maximums

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

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Ordering Information

QM1003-8-12-X-[Options]-[ODU]

where
X= 1, 2 (# of Channels)
Options= 100, 110, 200, 201, 400, etc.
ODU= Optional Outdoor Unit Form-Factor