



Quonset Microwave
www.quonsetmicrowave.com

QM1004A-2-18
Combined RF Upconverter/Downconverter

User Manual

Revision 1.4.3, May 2022

Notices

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No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers. For continued protection against fire hazard, replace the line fuse(s) only with fuses of the same type and rating (for example, normal blow, time delay, etc.). The use of other fuses or material is prohibited.

General Safety Information

The following general safety precautions must be observed during all phases of operation of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual or any manual associated with this product violates safety standards of design, manufacture, and intended use of the product. Quonset Microwave assumes no liability for the customer's failure to comply with these requirements.

WARNING

BEFORE APPLYING POWER TO THIS PRODUCT OR MAKING ANY CONNECTIONS TO THIS PRODUCT ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury or death.

CAUTION

- Use this device with the cables provided.
 - Do not attempt to service this device. This device should be returned to Quonset Microwave for any service or repairs.
 - Do not open the device.
-

User Environment

This instrument is designed for *indoor* use only.

Markings

The following markings may appear on the equipment or in any related documentation.



This marking indicates that a device, or part of a device, may be susceptible to electrostatic discharges (ESD) which can result in damage to the product. Observed ESD precautions given on the product, or in its user documentation, when handling equipment bearing this mark.



This marking indicates that the device complies with applicable sections of part 15 of the FCC rules.



This marking indicates that the device conforms with applicable EC directives.



This marking indicates that the device complies with the Virtual Instrument Software Architecture (VISA) specification.



This marking indicates that the device complies with the Standard Commands for Programmable Instrumentation (SCPI) specification.



This marking indicates that the device complies with the USB Test & Measurement Class (USB TMC) and the USB 488 subclass specifications.



This marking indicates that the device communicates over the Universal Serial Bus (USB).



This marking indicates that the device communicates over Ethernet.

Revision Control

Revision	Description of Changes	Date
0.0.0	Initial Creation	02/20/2019
0.0.1	Removed POWE:LO1 and POWE:LO2 commands Added SYST:TEMP query Fixed SYST:READSTATE, SYST:LOADSTATE, SYST:SAVESTATE, *SAV, *RCL	02/25/2019
0.0.2	Added MEM_CLR info to SYST:SAVESTATE, *SAV, and *SDS	03/01/2019
0.1.0	Fixed Environment Variable Name in FPGA Firmware Updates Added FPGA v1.1.0 update	04/10/2019
0.2.0	Revised FPGA Firmware Updates section	04/19/2019
1.0.0	Updated commands Added GUI Section Updated I/O Specifications	10/09/2019
1.0.1	Updated firmware and software download locations	11/12/2019
1.0.2	Added PIC v1.3.0 Firmware Update information	12/05/2019
1.4.1	Added PIC v1.4.1 Firmware Update information	10/08/2020
1.4.2	Added PIC v1.4.2 Firmware Update information	01/22/2021
1.4.3	Added PIC v1.4.3 Firmware Update information	05/11/2022

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1 Overview

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1. Input/Output Specifications

Table 1.1: Input/Output Specifications

Parameter	Min	Typ	Max	Unit
External CMOS Reference Input				
Frequency	10		250	MHz
Power Level			3.3	Vp-p
Upconverter IF Input				
Frequency	750		1250	MHz
Power Level (absolute maximum)			20	dBm
Downconverter RF Input				
Frequency	2		18	GHz
Power Level (absolute maximum)			25	dBm
LO1 Output				
Frequency	24		40	GHz
Power Level		15		dBm
LO2 Output				
Frequency		23		GHz
Power Level		5		dBm
Upconverter RF Output @ 0 dB attenuation				
Frequency	2		18	GHz
Gain	25		40	dB
Maximum Output Power Level		20		dBm
Downconverter IF Output @ 0 dB attenuation				
Frequency	750		1250	MHz
Gain	25		40	dB
Maximum Output Power Level		20		dBm

2. General Description

The QM1004A-2-18 is a Combined RF Upconverter/Downconverter housed in a 1U box. The QM1004A-2-18 is controlled either through the onboard USB or TCP/IP connection. The QM1004A-2-18 delivery kit contains a user manual, Windows Control GUI, power supply, and USB A-A cable. A model of the QM1004A-2-18 is shown below in Fig. 1.1.



Figure 1.1: QM1004A-2-18 Combined RF Upconverter/Downconverter system

The QM1004A-2-18 Combined RF Upconverter/Downconverter has been equipped with Option -100, which adds Local Oscillator (LO) sources, making the QM1004A-2-18 a self contained system, requiring only the externally applied RF or IF signals for proper operation. The Local Oscillators (LOs) in the QM1004A-2-18 are locked to a common internal 100 MHz reference. The user has the option of supplying their own reference through the BNC connector located on the back panel of the QM1004A-2-18.

3. System Block Diagram

A system block diagram for the QM1004A-2-18 Combined RF Upconverter/Downconverter is shown in Figure 1.2. Internal attenuators in the upconverter and downconverter blocks are controlled digitally via an FPGA and microcontroller, which interfaces to a PC through USB or TCP/IP. The microcontroller outputs basic status messages on a 32-character Liquid Crystal Display (LCD) mounted on the faceplate of the unit. An internal 100 MHz reference clock is phase-locked to all of the internal LOs, with a BNC-F connector providing the option for LOs to lock to a user-provided 10-250 MHz external reference. Two additional BNC-F connectors output an internally-generated 10 MHz and 100 MHz reference for use by external test equipment. Switching between the internal and external LO reference clocks is controlled either by the microcontroller or a reference selector switch. The 12-40 GHz LO1 and 23 GHz LO2 outputs are provided for external phase locking, and multi-channel or MIMO applications.

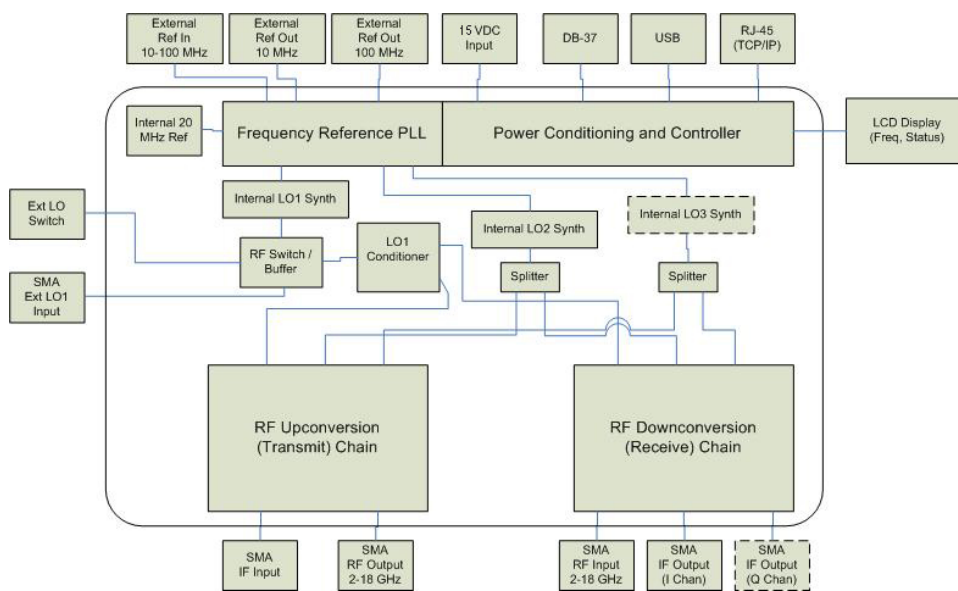


Figure 1.2: QM1004-2-18 System Block Diagram



2 Firmware Updates

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1. Introduction

The QM1004A-2-18 Combined RF Upconverter/Downconverter is continually being improved and may require firmware updates to correct problems in previous firmware versions or to add new features that were not yet implemented in previous firmware versions. Tables 2.2 and 2.1 detail Firmware Revisions that have been released and which features they fixed or introduced.

Table 2.1: FPGA Firmware Revision History

FPGA Firmware Version	Reason To Update
v1.0.0	N/A (Initial Release)
v1.1.0	Turned off Reference Outputs
v1.1.1	Recompile to confirm firmware update process
v1.2.0	Pin remap to fix SPI hardware problem

Table 2.2: PIC Firmware Revision History

PIC Firmware Version	Reason To Update
v1.0.0	N/A (Initial Release)
v1.2.0	Pin remap to fix SPI hardware problem Updated temperature code Modified timing of checkLockStatus() routine to fix intermittent errors Added missing shortform/longform commands where needed Added LNA controls for new upconverter baseband board
v1.3.0	Fixed SYST:READ? parameter bug
v1.4.0	Hardware fix to improve PIC-FPGA SPI communication
v1.4.1	Moved application of attenuation settings before RF power
v1.4.2	Corrected RF Power functionality to retain settings when toggled
v1.4.3	Fixed FREQ:TUNEACT? error

2. Firmware Update Files

The required files to perform firmware updates are uploaded onto the Quonset Microwave FTP server and need to be downloaded and extracted to a location on the computer performing the update prior to

continuing.

Firmware updates can be obtained by clicking the following link and navigating to the download link in the Software tab:

<http://www.quonsetmicrowave.com/QM1004-2-18-p/qm1004-2-18.htm>

The zip files contain the necessary files required to perform the firmware updates. PIC Firmware Updates require *.hex files and FPGA Firmware Updates require both *.bit files and *.mcs files. It is recommended to upgrade both PIC and FPGA firmware versions to ensure proper performance as they likely work together and require each other for correct interaction.

3. FPGA Firmware Updates

The QM1004A-2-18 Control Board uses a Micron™ serial flash and a Xilinx® FPGA. Micron™ serial flash are not currently fully supported by the Xilinx® iMPACT programming tool. The following sections demonstrate the steps required to successfully configure the iMPACT software and load a Micron™ flash.

Xilinx® iMPACT

Xilinx® iMPACT Standalone Programmer is included in the Xilinx® ISE Lab Tools and is used in this guide. ISE Lab Tools are available for free download using the following link:

https://www.xilinx.com/member/forms/download/xef.html?filename=Xilinx_LabTools_14.4_P.49d.3.0.tar

Note: All Xilinx® software downloads require Name and Address Verification in compliance with U.S. Government Export Regulations prior to downloading.

System Environment Variable

A system environment variable must be set to allow the iMPACT software to skip its ID Check of the Micron™ flash. In Microsoft Windows, this is done through System Properties. In Microsoft Windows 10, click the Start Button and type "Edit the system environment variables" and click on the "Environment Variables" button. The Environment Variables window is divided into two sections, User Variables and System Variables. A new System Environment Variable must be created by clicking "New" in the System Variables section. In the New System Variable window, enter the following:

Variable name: XIL_IMPACT_SKIPIDCODECHECK

Variable value: 1

USB Cable Connection

A standard USB 2.0 A-Male to B-Male Cable can be used to connect the computer to the QM1004A-2-18. The A-Male end of the cable connects to the computer and the B-Male end of the cable connects to the QM1004A-2-18 in the port on the back panel labeled FPGA PROG.

Programming with iMPACT

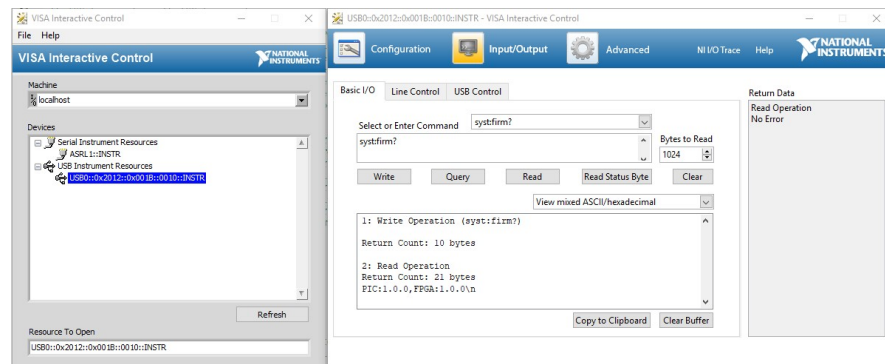


Figure 2.1: Firmware version query prior to update

Prior to performing the firmware update, the system firmware version was queried to confirm the FPGA was at version 1.0.0 before updating.

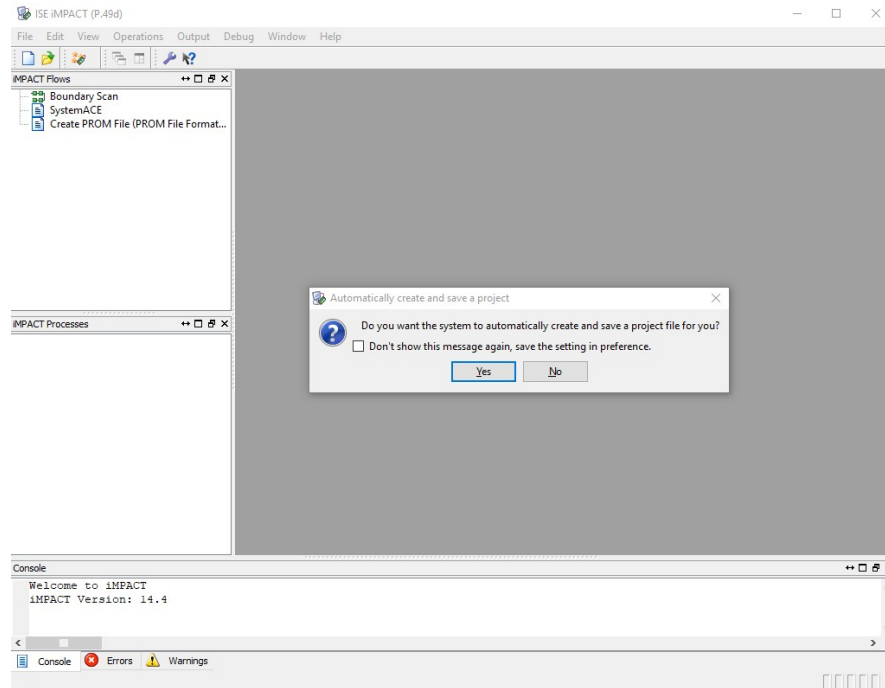


Figure 2.2: iMPACT: Automatically create project

When iMPACT is started, it will first ask if you want it to create and save a project file for you. Choose 'No', as reusing projects sometimes results in outdated files being programmed, which were saved in previous sessions.

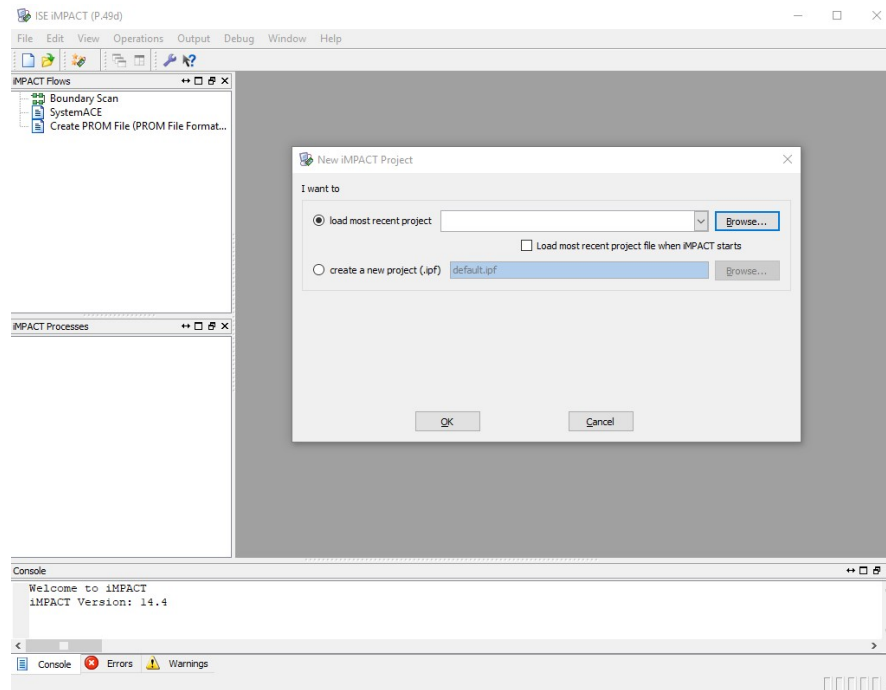


Figure 2.3: iMPACT: Manually Create Project

Similarly, select 'Cancel' when it asks you to load or create a new project next.

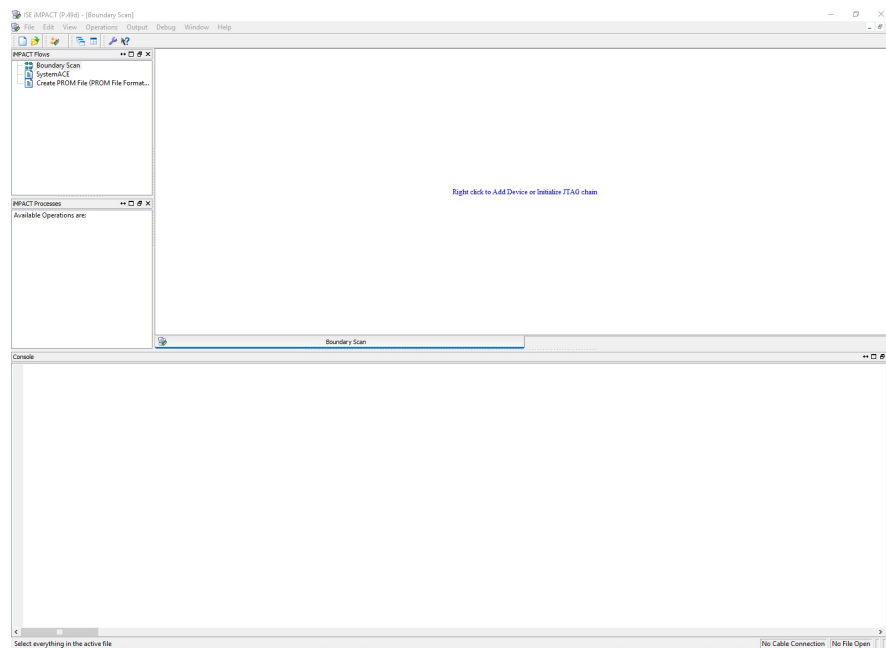


Figure 2.4: iMPACT: Boundary Scan

Double-click 'Boundary Scan' in the upper-left of the program. This will open a Boundary Scan window, which is where we interact with the device.

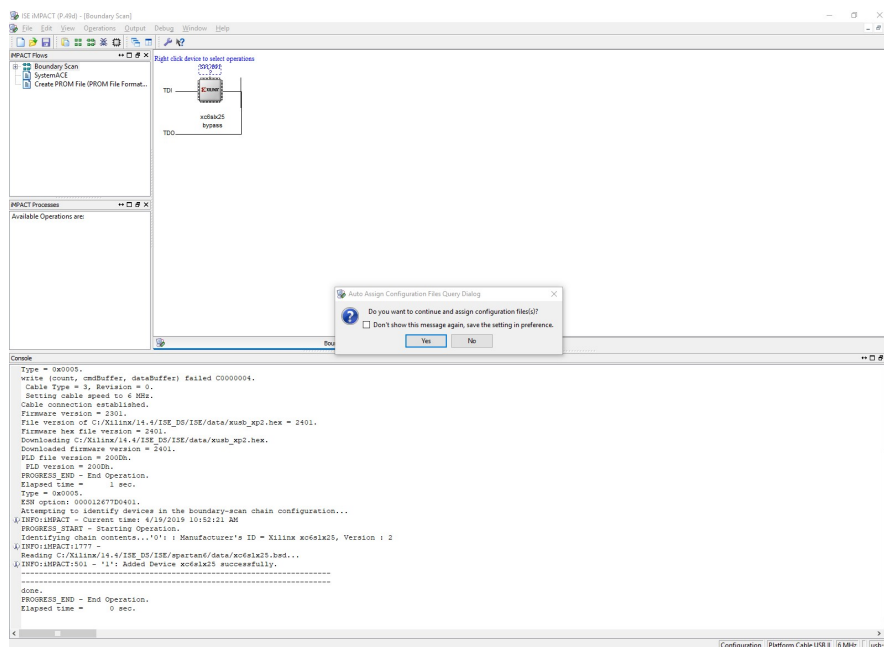


Figure 2.5: iMPACT: Assign Configuration Files

Right-click in the Boundary Scan window and select 'Initialize Chain', which will search for the target device. After the device is found, choose 'Yes' when it asks if you want to assign configuration files.

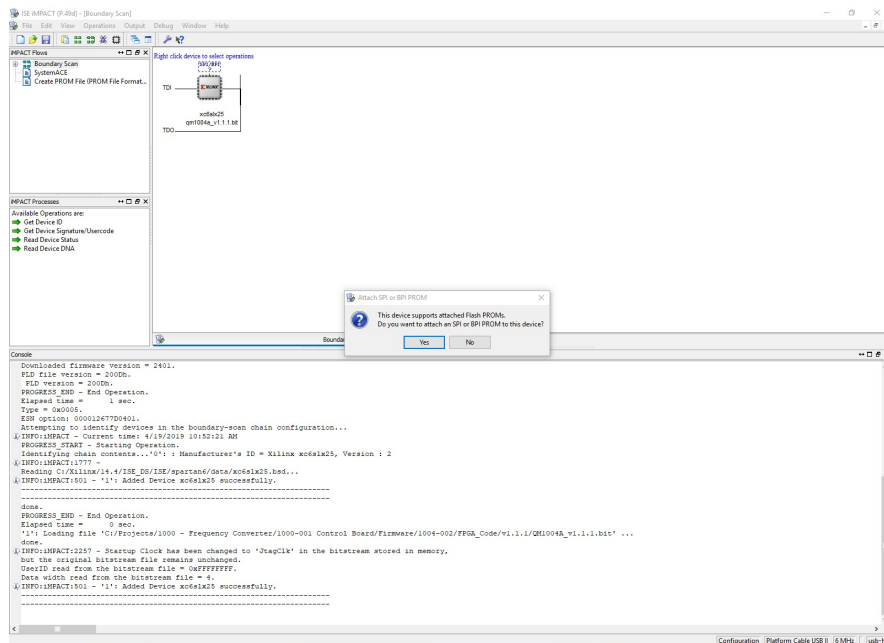


Figure 2.6: iMPACT: Attach PROM

Select the QM1004A_v1.1.1.bit file provided and the text under the device will change from 'Bypass' to qm1004a_v1.1.1.bit and it will ask if you want to attach a PROM. Choose 'Yes'.

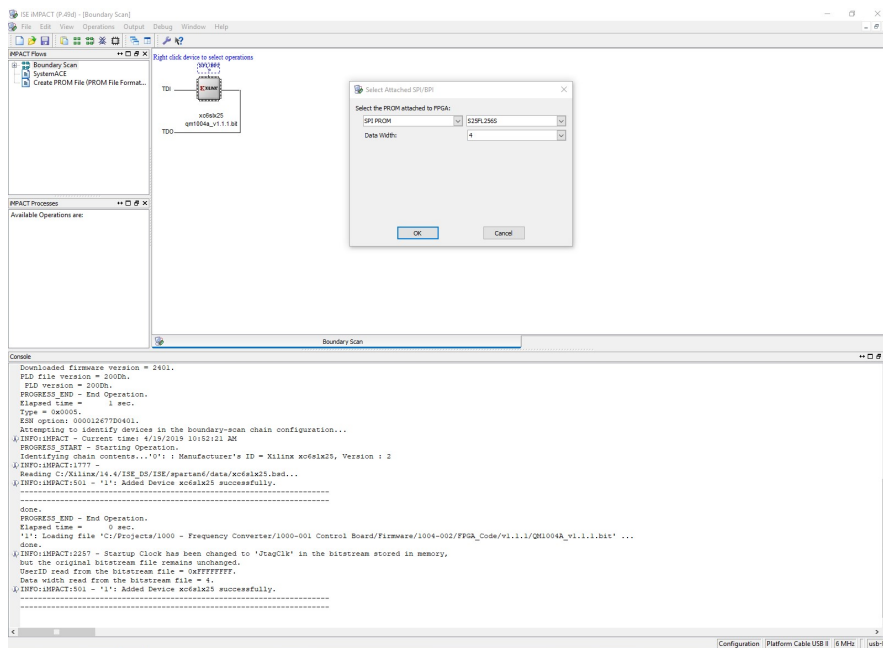


Figure 2.7: iMPACT: Configure PROM

Select the QM1004A_v1.1.1.mcs file provided and it will ask you to configure the PROM. Select 'S25FL256S' for the device and '4' for the data width as shown.

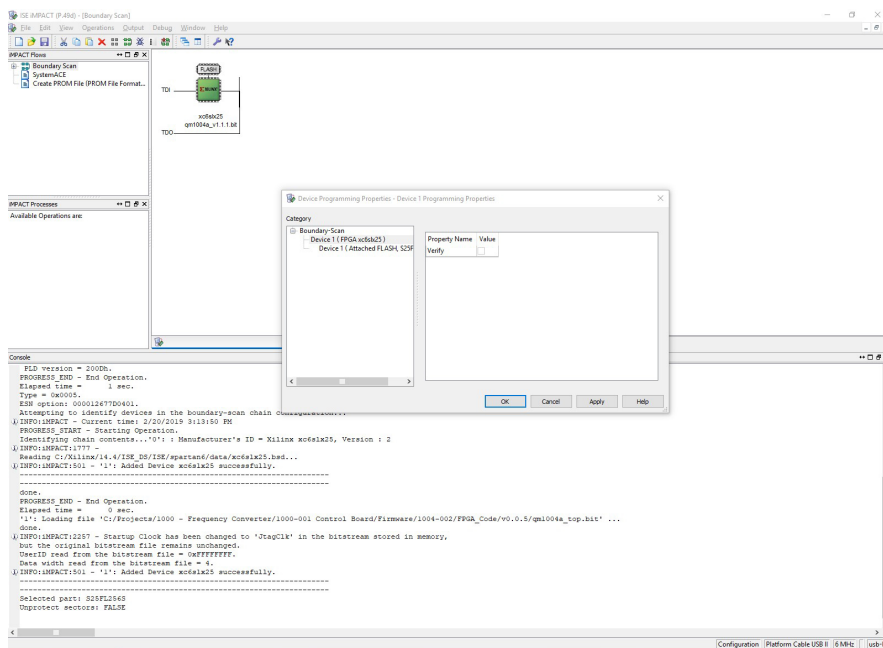


Figure 2.8: iMPACT: FPGA Programming Properties

On the first Device Programming Properties screen, leave the box to verify the FPGA write unchecked and click 'OK'.

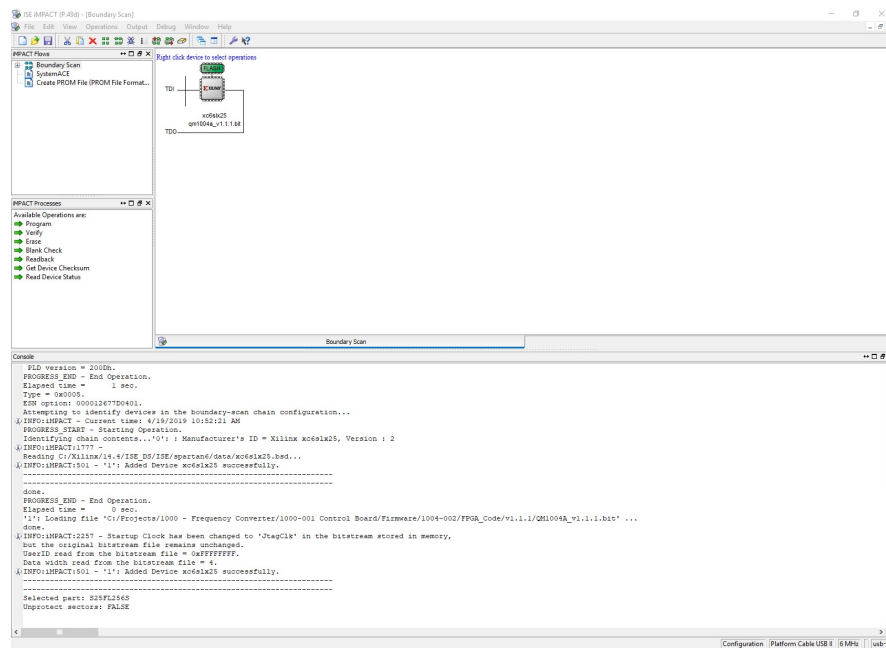


Figure 2.9: iMPACT: FPGA Programming Properties

Click the FLASH device to select the PROM as the device to be programmed.

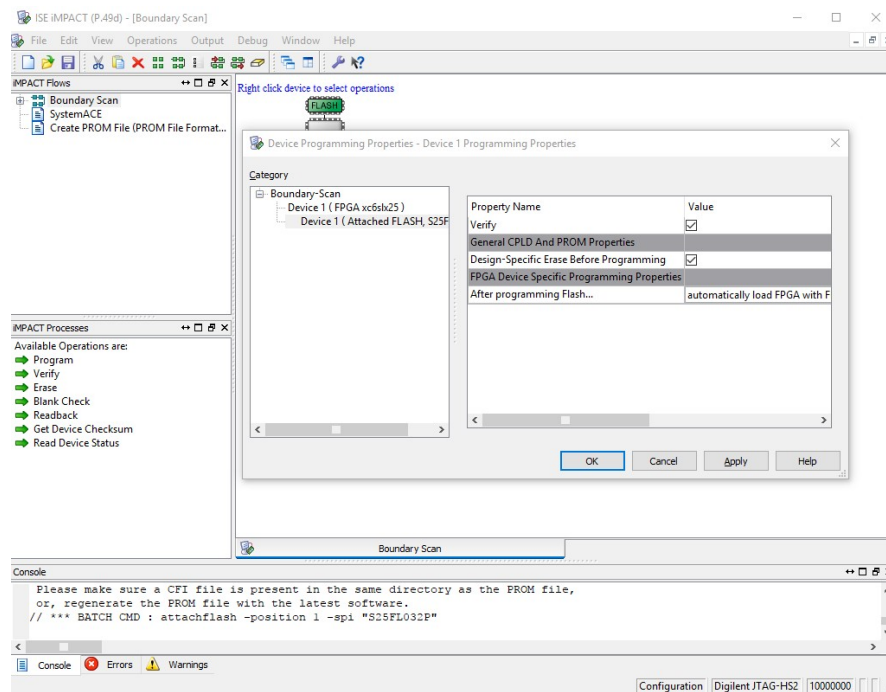


Figure 2.10: iMPACT: FLASH Programming Properties

Right-click the FLASH device and click Program, which will open the Device Programming Properties for the PROM. Leave Verify and Erase Before Programming both checked, and leave the After Programming selection set to automatically load FPGA when finished (all defaults) and click 'OK'.

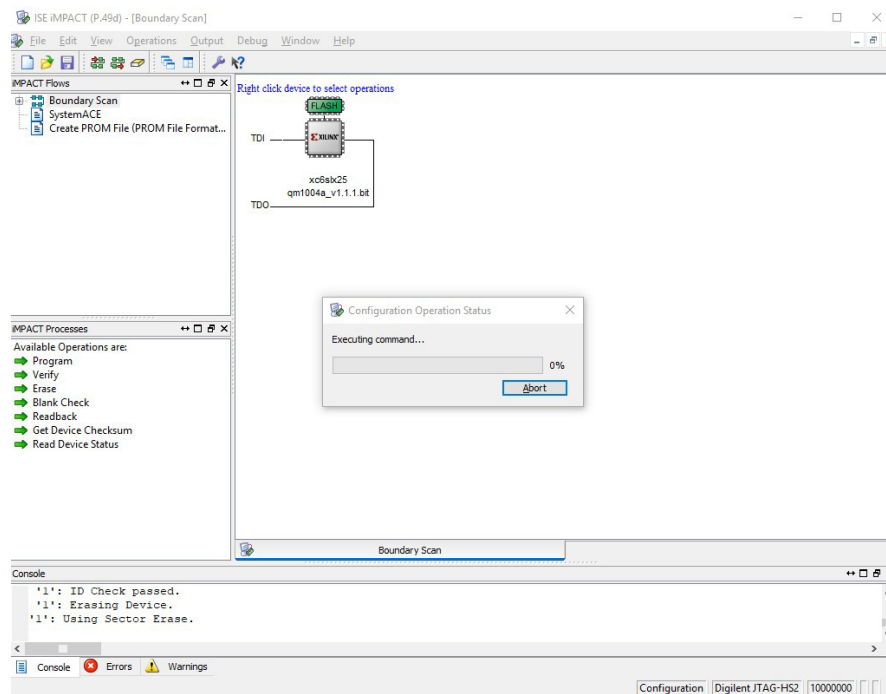


Figure 2.11: iMPACT: Programming

The erase and write operations will begin and show a Configuration Operation Status bar.

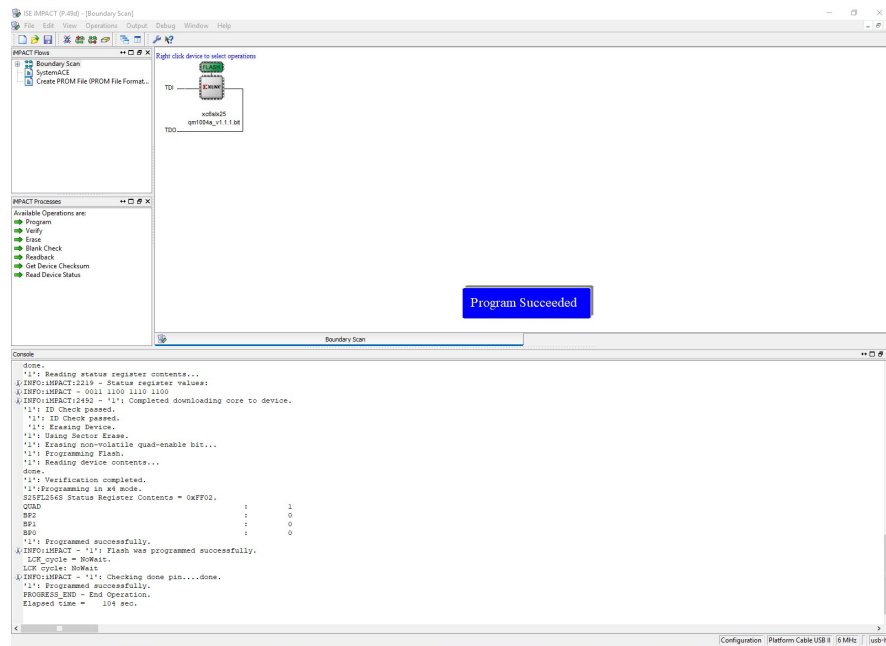


Figure 2.12: iMPACT: Program Succeeded

The status will go up to 4% before completing and displaying 'Program Succeeded'. This PROM write took 104 seconds, which is typical for a PROM write to this device. The Combined RF Upconverter/Downconverter should then be power-cycled, as the image is loaded to the FPGA on power-up by the PIC.

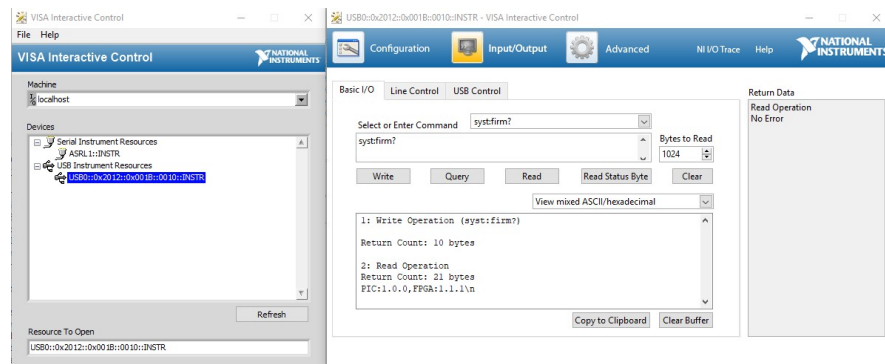


Figure 2.13: Firmware version query after update

After performing the firmware update, the system firmware version was queried again to confirm the FPGA was at version 1.1.1 after updating.

4. PIC Firmware Updates

The QM1004A-2-18 Control Board uses a Microchip Technology, Inc. PIC18F87J50 processor. The PIC Firmware update process is performed using a Custom Computer Services, Inc. (CCS) ICD-U64 Debugger/Programmer, but can be done using any In-Circuit Serial Programmer (ICSP) with an RJ-12 connection that supports the Microchip PIC18F87J50 device. The ICD-U64 from CCS includes the CCSLOAD free programmer control software, which is used to load the update.

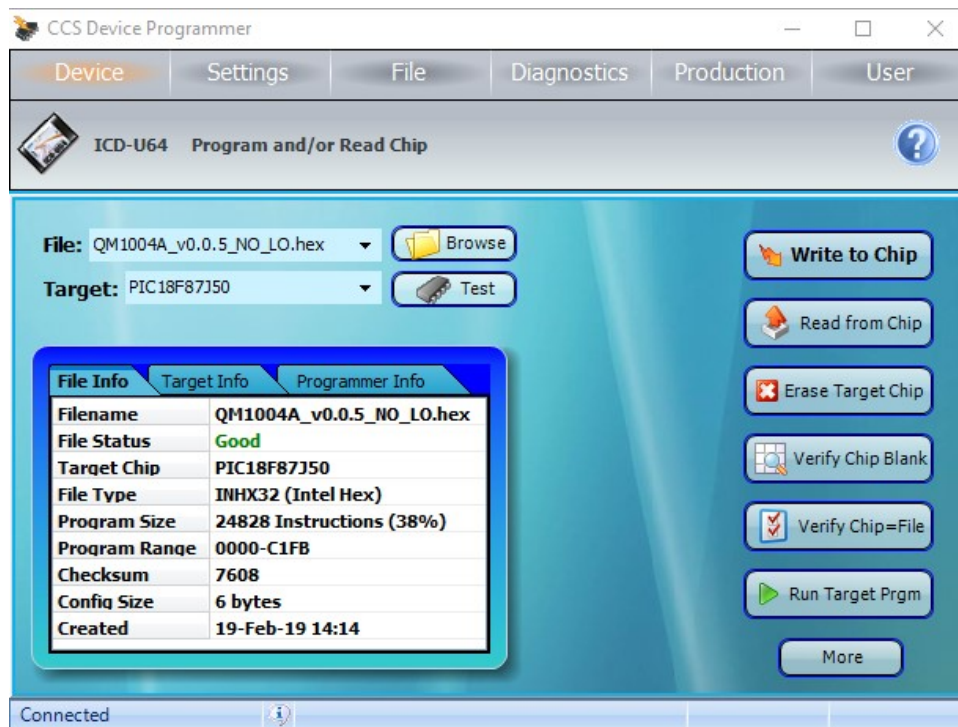
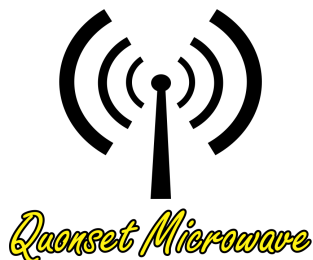


Figure 2.14: CCSLOAD: PIC Programming

After opening CCSLOAD, simply click 'Browse' and select the QM1004A_v1.0.0.hex file and click 'Write to Chip'. When complete, the status in the bottom left will change from 'Connected' to 'Target Programmed'. After programming, either close CCSLOAD or click 'Run Target Prgm' to run the new version.



3 Remote Operation

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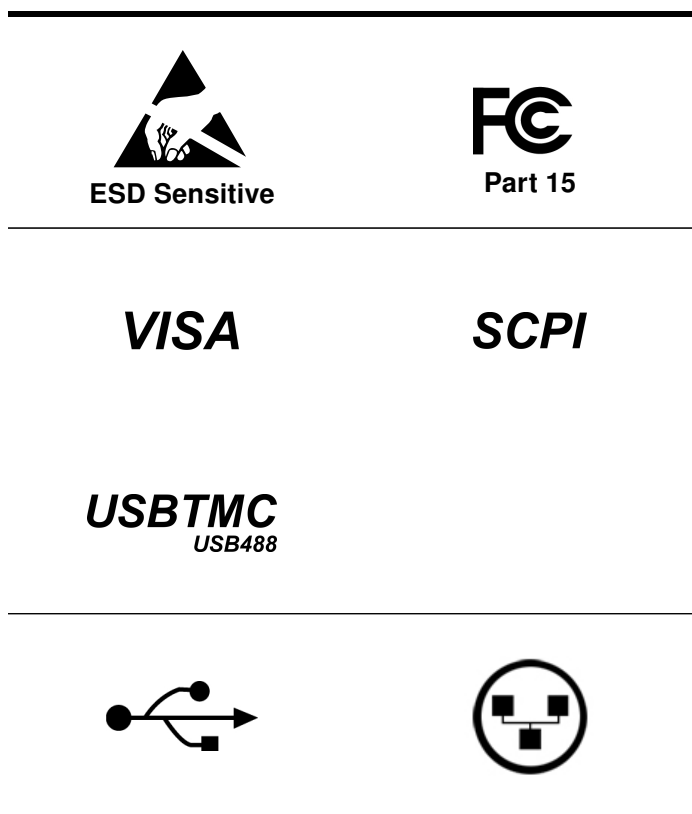
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The following markings apply to the QM1004A-2-18 Combined RF Upconverter/Down-converter family of products.



1. Introduction

1.1 USB Configuration

The Quonset Microwave QM1004A-2-18 Combined RF Upconverter/Downconverter has been designed to configure as a USBTMC or TCPIP device. No additional drivers are required.

The QM1004A-2-18 has been designed to be VISA and SCPI compliant and as such, all you need in order to communicate with the Combined RF Upconverter/Downconverter is a VISA library installed on your machine. The QM1004A-2-18 has been designed using the NI-VISA Runtime Engine, which is included with the GUI.

1.2 Command Syntax

In this manual, the following command syntax conventions are used:

- Square brackets ([]) indicate multiple keywords, one of which must be used
- Bars(|) can be read as "or" and are used to separate parameter options.

1.2.1 Mnemonic Forms

Each keyword has both a long and short form. A standard notation is used to differentiate the short form and long form keyword. The long form of the keyword is shown, with the short form of the keyword shown in uppercase letters and the rest of the keyword is shown in lowercase letters. For example, the short form of *FREQuency* is *FREQ*.

1.2.2 Using a Semicolon(;)

Use a semicolon to separate two commands within the same command string.

1.2.3 Using Whitespace

You *must* use whitespace characters, [tab], or [space] to separate a parameter from a keyword.

1.2.4 Using "?" Commands

The bus controller may send commands at any time, but a SCPI instrument may only send a response when specifically instructed to do so. Only commands that end with a "?", henceforth referred to as queries, instruct the instrument to send a response message. Queries can return either measured values, instrument settings, or internal status codes.

Note: *If you send multiple queries without reading the response between queries, only the result of the last query will be returned when the response is read. The query buffer is a first-in first-out configuration.*

1.2.5 Using "*" Commands

Commands starting with a "*" are called common commands. They are required to perform identical functions for all instruments that are compliant with the IEEE-488.2 interface standard. The "*" commands are used to control reset, self-test, and status operations in the Combined RF Upconverter/Downconverter.

1.3 Diagram Syntax Conventions

- Solid lines represent the recommended path
- Ovals enclose command mnemonics. The command mnemonic must be entered exactly as shown in the oval.
- Dotted lines indicate an optional path for passing secondary or optional keywords.

- Arrows and curved intersections indicate command path direction.
- All diagrams flow from left to right. A path may not travel to the left except in a bypass loop.

1.4 Default Units

Unless otherwise specified, the following units are assumed:

Table 3.2: Default Units

Current	A
Frequency	GHz
Power	dBm
Time	μ s
Temperature	°C
Voltage	Volts

1.5 Status Reporting

Status reporting is used to monitor the Combined RF Upconverter/Downconverter to determine which events have occurred. Status reporting is accomplished by configuring and reading status registers.

The Combined RF Upconverter/Downconverter has the following main registers:

- Status Register
- Standard Event Register
- Operation Status Register
- Questionable Status Register
- Device Status Register

Status and Standard Event registers are read using the IEEE-488.2 common commands.

Operation and Questionable Status registers are read using the SCPI *STAT* subsystem.

1.6 SCPI Data Types

The SCPI language defines different formats for use in program messages and response messages. Instruments are flexible listeners and can accept commands and parameters in various formats. However, SCPI instruments are precise talkers. This means that SCPI instruments *always* responds to a particular query in a predefined, rigid format.

1.6.1 <boolean> Definition

Throughout this document <*boolean*> is used to represent *ON|OFF|<NRf>*. Boolean parameters have a value of 0 or 1 and are unitless. *ON* corresponds to 1 and *OFF* corresponds to 0.

On input, an <NRf> is rounded to an integer. A nonzero result is interpreted as 1.

Queries always return a 1 or a 0, never *ON* or *OFF*.

1.6.2 <character_data> Definition

Throughout this document, <character_data> is used to represent character data, that is, A-Z, a-z, 0-9 and _ (underscore). STOP and A4_U2 are examples of character data. The first character must be alphanumeric, followed by either alphanumeric or underscore characters up to a maximum of 12 characters.

1.6.3 <NAN> Definition

Not a number (NAN) is represented as 9.91 E37. Not a number is defined in IEEE 754.

1.6.4 <non-decimal numeric> Definition

Throughout this document, <non-decimal numeric> is used to represent numeric information in bases other than 10 (that is, hexadecimal, octal, and binary). Examples of non-decimal numeric include #HFF4, #hff4, #Q25, #q25, and #B101011.

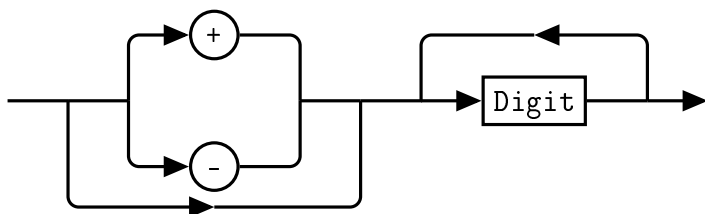
1.6.5 <NRf> Definition

Throughout this document, <NRf> is used to denote a flexible numeric representation. The following show examples of <NRf>

- +185
- -10
- +1.2E09

1.6.6 <NR1> Definition

Throughout this document, <NR1> numeric response data is defined as:

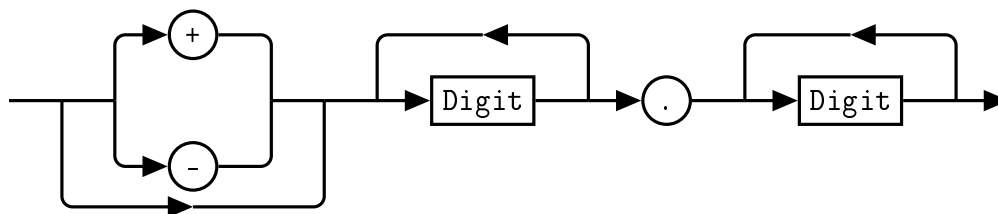


The following shows the examples of <NR1>:

- 127
- +127
- -12345

1.6.7 <NR2> Definition

Throughout this document, <NR2> numeric response data is defined as:

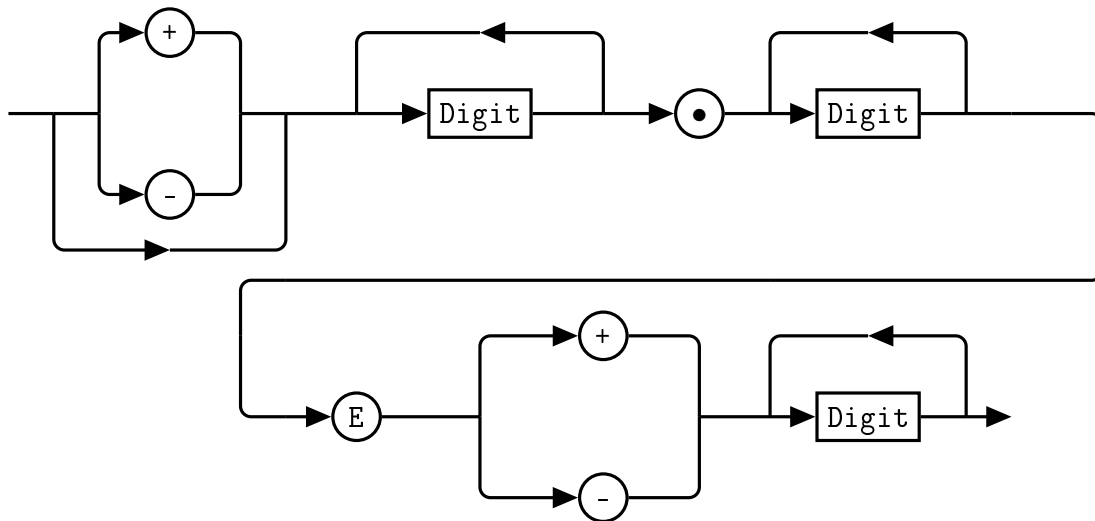


The following shows the examples of <NR2>:

- 12.7
- +127
- -1.2345
- -0.123

1.6.8 <NR3> Definition

Throughout this document, <NR3> numeric response data is defined as:



The following shows the examples of <NR3>:

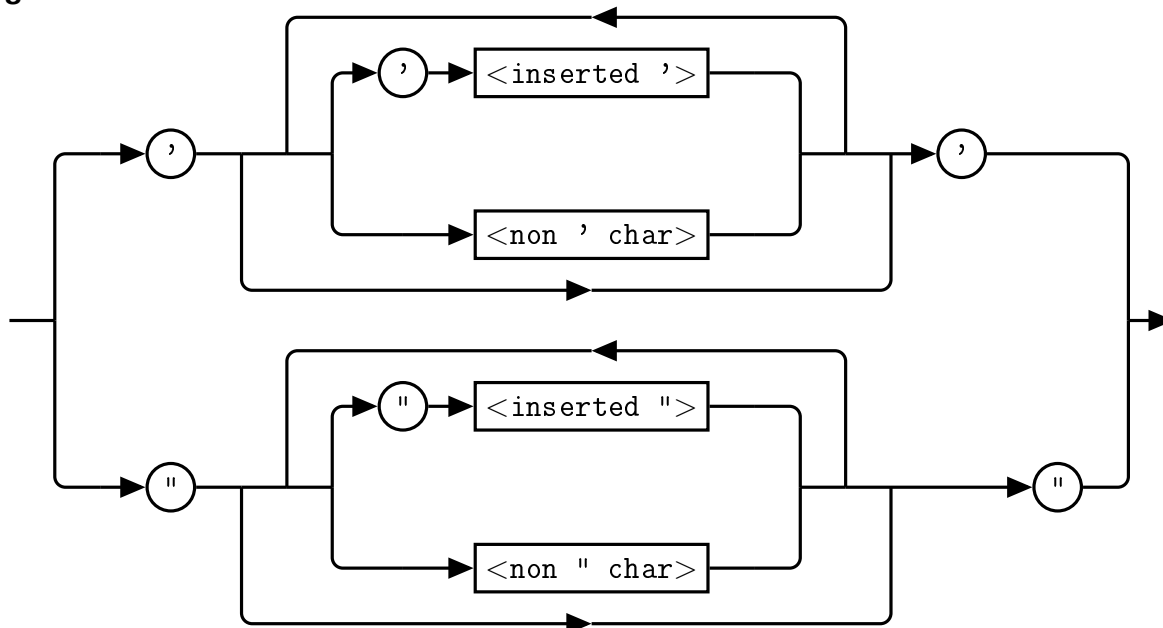
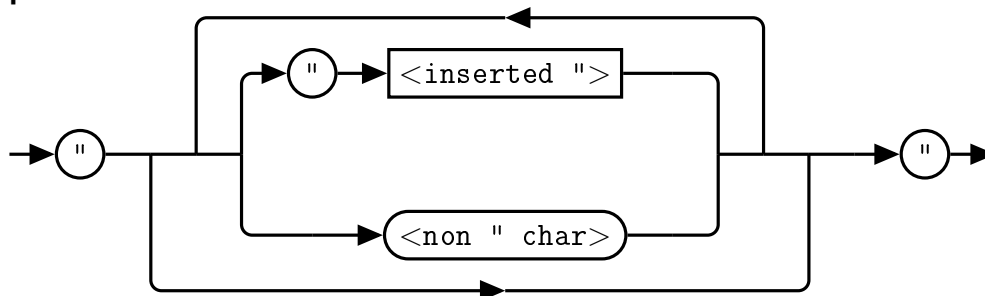
- 1.23E+4
- 12.3E-45

1.6.9 <numeric_value> Definition

Throughout this document, the decimal numeric element is abbreviated to <numeric_value>.

1.6.10 <string> Definition

Throughout this document, <string> is used to represent the 7-bit ASCII characters. The format is defined as:

Program Data**Response Data****1.7 Input Message Terminators**

Program messages sent to a SCPI instrument *must* terminate with a <newline> character. The IEEE.488 EOI (end or identify) signal is interpreted as a <newline> character and may also be used to terminate a message in place of the <newline> character. A <carriage return> followed by a <newline> character is also accepted. Many programming languages allow you to specify a message terminator character or EOI state to be automatically sent with each bus transaction. Message termination *always* sets the current path back to the root-level.

1.8 Compliance Information**1.8.1 IEEE-488.2 Compliance**

The Combined RF Upconverter/Downconverter complies with the rules and regulations of the of the IEEE-488.2 standard which are applicable to USB controlled devices.

1.8.2 USBTMC Compliance

The QM1004A-2-18 Combined RF Upconverter/Downconverter complies with the rules and regulations of the of the USBTMC (USB Test and Measurement Class). When connected to a USB bus, the QM1004A-2-18 will configure as a USB Test and Measurement device.

1.8.3 VISA Compliance

The QM1004A-2-18 Combined RF Upconverter/Downconverter complies with the rules and regulations of the of the VISA (Virtual Instrument Systems Architecture) standard. Communication with the QM1004A-2-18 is accomplished through VISA libraries, providing portability between different operating systems. *No additional drivers are required.*

2. VISA Descriptors and Configuration

2.1 USBTMC

2.1.1 VISA Descriptors

To communicate with the Quonset Microwave QM1004A-2-18 Combined RF Upconverter/Downconverter as a USBTMC device, use the following USB VISA descriptor format:

```
USB[board number]::manufacturer ID::model code::serial number::INSTR
```

Descriptor Example

```
USB0::0x2012::0x001B::0002::INSTR
```

2.1.2 USBTMC VISA Code Example

```
ViSession rscmng;  
ViSession qm1004a;  
char buf[256] = 0;  
  
viOpenDefaultRM(&rscmng);  
viOpen(rscmng,(ViRsrc)"USB0::0x2012::0x001B::0002::INSTR",VI_NULL,VI_NULL,&qm1004a);  
viPrintf(qm1004a,(ViString)"*IDN?\n");  
viScanf(qm1004a,(ViString)"%t",&buf);  
viClose((ViObject)qm1004a);  
viClose((ViObject)rscmng);
```

2.2 TCPIP

2.2.1 VISA Descriptors

To communicate with the Quonset Microwave QM1004A-2-18 Combined RF Upconverter/Downconverter as a TCP/IP device, use the following TCPIP VISA descriptor format:

```
TCPIP::IP address::port number::SOCKET
```

Descriptor Example

```
TCPIP::192.168.2.188::5025::SOCKET
```

2.2.2 VISA Attributes

When using the TCPIP SOCKET connection, the following two VISA Attributes must be set for communication to work properly:

```
VI_ATTR_TERMCHAR  
VI_ATTR_TERMCHAR_EN
```

The QM1004A-2-18 Combined RF Upconverter/Downconverter uses a newline character ('\n') to indicate end of transmission on query replies and setting these two attributes configures the communicating system to interact properly with the device.

2.2.3 TCPIP VISA Code Example

```
ViSession rscmng;  
ViSession qm1004a;  
char buf[256] = 0;  
  
viOpenDefaultRM(&rscmng);  
viOpen(rscmng,(ViRsrc)"TCPIP::192.168.2.188::5025::SOCKET",VI_NULL,VI_NULL,&qm1004a);  
viSetAttribute(qm1004a,VI_ATTR_TERMCHAR,'\n');  
viSetAttribute(qm1004a,VI_ATTR_TERMCHAR_EN,VI_TRUE);  
viPrintf(qm1004a,(ViString)"*IDN?\n");  
viScanf(qm1004a,(ViString)"%t",&buf);  
viClose((ViObject)qm1004a);  
viClose((ViObject)rscmng);
```



4 Control Commands

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1. Command Quick Reference Guide

1.1 Common (*) Commands

Table 4.1: Common (*) Commands Summary

Command	Page	Description
*CLS	73	Clears the data structures. The SCPI registers are cleared.
*ESE <NRf>	74	Sets the Standard Event Status Enable Register.
*ESE?	74	Returns the Standard Event Status Enable Register.
*ESR?	75	Returns the contents of the Standard Event Status Register and then clears it.
*IDN?	76	Returns the identification of the device connected to the computer (Host).
*OPC	77	Causes the Combined RF Upconverter/Downconverter to set the operation complete bit in the Standard Event Status Register when all pending operations have completed.
*OPC?	77	Returns the operation complete bit in the Standard Event Status Register when all pending operations have completed.
*RCL <NRf>	78	Recalls the settings of the Combined RF Upconverter/Downconverter from the specified register (memory location).
*RST	79	Returns the Combined RF Upconverter/Downconverter to its initial power up state.
*SAV <NRf>	80	Saves the settings of the Combined RF Upconverter/Downconverter to the specified register (memory location).
*SDS <NRf>	81	Saves the default settings of the Combined RF Upconverter/Downconverter to the specified register (memory location).
*SRE <NRf>	82	Sets the Service Request Enable register bits.
*SRE?	82	Returns the Service Request Enable register bits.
*STB?	83	Returns the Combined RF Upconverter/Downconverter status byte.
*TST?	84	Performs a self-test and returns the result.
*WAI	85	Causes the Combined RF Upconverter/Downconverter to wait until either all pending commands are complete, the Device Clear command is received, or the power is cycled before executing any subsequent commands or queries.

1.2 EtherNET Subsystem

Table 4.2: EtherNET Subsystem Commands Summary

Command	Page	Description
EtherNET:GATEway	33	Sets or Returns the Gateway.
EtherNET:IPADDRESS	34	Sets or Returns the IP Address.
EtherNET:MACaddress	35	Returns the MAC Address.
EtherNET:PORT	36	Sets or Returns the Port.
EtherNET:SUBnet	37	Sets or Returns the Subnet Mask.

1.3 FREQUENCY Subsystem

Table 4.3: FREQUENCY Subsystem Commands Summary

Command	Page	Description
FREQUENCY:LOCK	38	Returns the lock status of the internal LOs.
FREQUENCY:PLLMode	39	Sets or Returns the PLL Mode of the device (<i>Integer or Fractional</i>).
FREQUENCY:TUNE	45	Sets or Returns the desired tuning frequency in GHz.
FREQUENCY:TUNERACTual	46	Returns the actual tuning frequency in GHz.
FREQUENCY:REFERENCE:DIVider	41	Sets or Returns the reference divider value.
FREQUENCY:REFERENCE:EXTernal	42	Sets or Returns whether the internal or external supplied reference oscillator is used.
FREQUENCY:REFERENCE:FREQUENCY	43	Sets or Returns the reference frequency when using an externally-supplied reference.
FREQUENCY:REFERENCE:LOCK	44	Returns the lock status of the reference oscillator.

1.4 POWER Subsystem

Table 4.4: POWER Subsystem Commands Summary

Command	Page	Description
POWER:RF	50	Turns on or off the RF output of the device.
POWER:LNA	49	Turns on or off the Upconverter LNA gain stage of the device.
POWER:CH1ATTEN	47	Sets or Returns the value of upconverter attenuation.

POWER:CH2ATTEN	48	Sets or Returns the value of downconverter attenuation.
----------------	----	---

1.5 STATUS Subsystem

Table 4.5: STATUS Subsystem Commands Summary

Command	Page	Description
STATUS:OPERation	51	Returns the contents of the status event register.
STATUS:OPERation:CONDition	52	Returns the contents of the condition register.
STATUS:OPERation:ENABle	53	Sets the enable bit mask for the status event register.
STATUS:PRESet	54	Presets the STATUS:QUEStionable:ENABle register.
STATUS:QUEStionable	55	Returns the contents of the questionable register.
STATUS:QUEStionable:CONDition	56	Returns the contents of the questionable condition register.
STATUS:QUEStionable:ENABle	57	Sets the enable bit mask for the questionable register.

1.6 SYSTEM Subsystem

Table 4.6: SYSTEM Subsystem Commands Summary

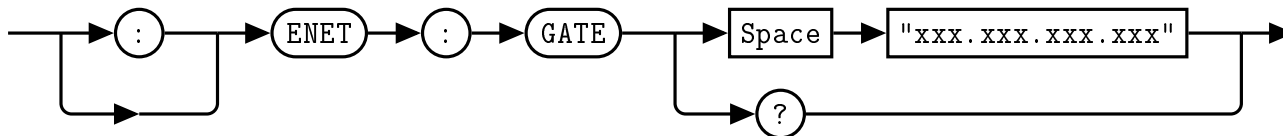
Command	Page	Description
SYSTEM:BOOTstate	58	Specifies a state to boot to at device startup.
SYSTEM:CURREnt	59	Returns the current draw of the device.
SYSTEM:ERRor	60	Returns error numbers and messages from the error queue.
SYSTEM:FIRMware	64	Returns the current firmware version of the device.
SYSTEM:LOADstate	65	Loads and sets the parameters from the specified state.
SYSTEM:READstate	66	Reads the parameters from the stored state without changing the current device setup.
SYSTEM:SAVEstate	67	Saves the current parameters to a specified state number.
SYSTEM:SERialNUMBER	68	Returns the serial number of the device.
SYSTEM:TEMPerature	69	Returns the temperature of the device.
SYSTEM:USBPID	70	Returns the USB Product ID of the device.
SYSTEM:VERSion	71	Returns the version of SCPI implemented in the Combined RF Upconverter/Downconverter.

2. EtherNET Subsystem Command Reference

2.1 EtherNET:GATEway <ipString>

This command sets the Gateway of the Combined RF Upconverter/Downconverter.

Syntax



Example

:ENET:GATE "192.168.2.1" *This command sets the Gateway to 192.168.2.1*

Default Condition

On startup, the Gateway defaults to the previously programmed value. The default Gateway is 192.168.2.1.

Query

:ENET:GATE? *This query returns the system's current Gateway.*

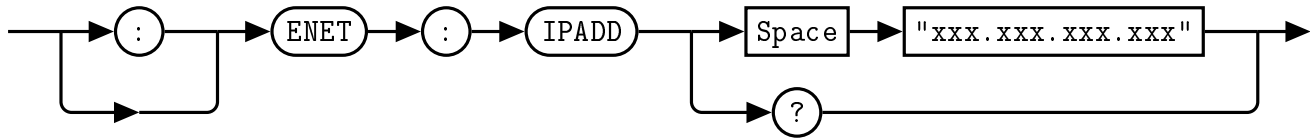
Error Message

If the ipString is not in the recognized format, error -102, "Syntax error" occurs.

2.2 EtherNET:IPADdress <ipString>

This command sets the IP Address of the Combined RF Upconverter/Downconverter.

Syntax



Example

:ENET:IPADD "192.168.2.188" *This command sets the IP address to 192.168.2.188*

Default Condition

On startup, the IP Address defaults to the previously programmed value. The default IP Address on initial units are set to 192.168.2.18x where 'x' is replaced with the single digit serial number.

Query

:ENET:IPADD? *This query returns the system's current IP Address.*

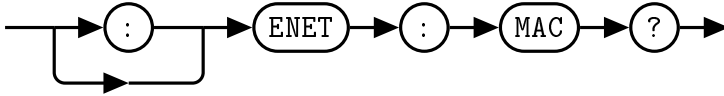
Error Message

If the ipString is not in the recognized format, error -102, "Syntax error" occurs.

2.3 EtherNET:MACaddress <ipString>

This query returns the MAC Address of the Combined RF Upconverter/Downconverter.

Syntax



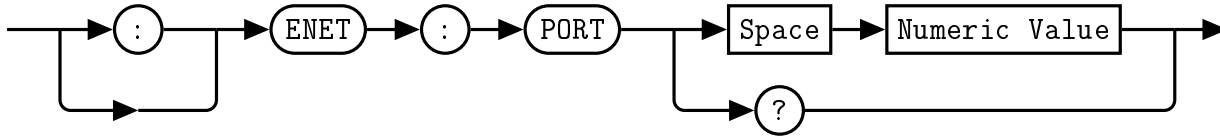
Query

:ENET:MAC? *This query returns the system's MAC Address.*

2.4 EtherNET:PORT <numeric value>

This command sets the network port of the Combined RF Upconverter/Downconverter.

Syntax



Example

:ENET:PORT 5025 *This command sets the port number to 5025*

Default Condition

On startup, the port number defaults to the previously programmed value. The default port number is 5025.

Query

:ENET:PORT? *This query returns the Combined RF Upconverter/Downconverter's current port number.*

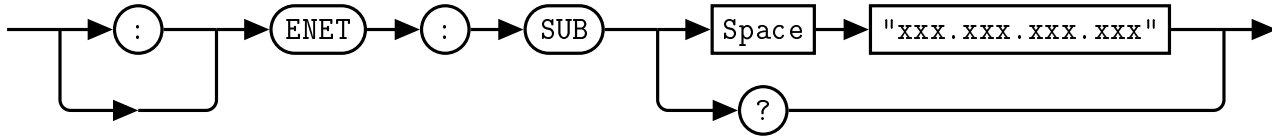
Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

2.5 EtherNET:SUBnet <ipString>

This command sets the Subnet Mask of the Combined RF Upconverter/Downconverter.

Syntax



Example

:ENET:SUB "255.255.255.0" *This command sets the Subnet Mask to 255.255.255.0*

Default Condition

On startup, the Subnet Mask defaults to the previously programmed value. The default IP Address is 255.255.255.0.

Query

:ENET:SUB? *This query returns the system's current Subnet Mask.*

Error Message

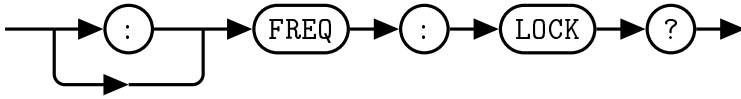
If the ipString is not in the recognized format, error -102, "Syntax error" occurs.

3. FREQuency Subsystem Command Reference

3.1 FREQuency:LOCK

This query allows the user to check the lock status of the internal LOs to the reference signal.

Syntax



Query

:FREQ:LOCK? *This query returns the lock status of the internal LOs. A lock status of 0 indicates that the LOs are unlocked, while a lock status of 1 indicates the LOs are locked.*

3.2 FREQUENCY:PLLMode [INT|FRAC|1|0]

This command sets the PLL mode of the tunable Local Oscillator (LO1) located inside the QM1004A-2-18. A PLL mode of *INT* or *1* indicates that the PLL is operating in Integer mode, while a PLL mode of *FRAC* or *0* indicates that the PLL is operating in Fractional Mode.

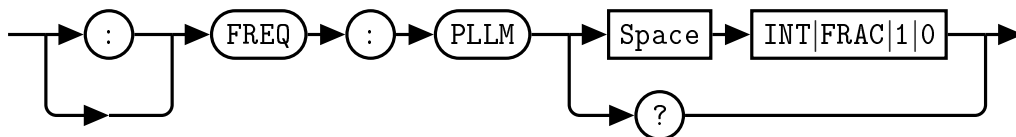
When the PLL is placed in *Integer* mode (also referred to as *Integer-N* mode), the output frequency is an integer multiple of the reference oscillator frequency, divided by the reference divider, multiplied by the hardware prescaler. The QM1004A-2-18 has a fixed hardware prescaler of 8 and a reference frequency of 100 MHz. With the reference divider set to 1, the frequency resolution of FREQUENCY:TUNE is 800 MHz. This means that 10 GHz and 10.8 GHz would both be tunable frequencies, as they are divisible by 800 MHz, but 10.4 GHz would not be. The user can manipulate the frequency step size in integer mode by changing the reference divider. By increasing the reference divider value to 2, the tunable frequency step size becomes 400 MHz, making 10.4 GHz a tunable frequency. While increasing the reference divider value decreases the tunable frequency step size, phase noise performance is degraded.

When the PLL is placed in *Fractional* mode, the tuneable frequency can be tuned with a resolution of 100 kHz. In the above example, the synthesizer would be capable of outputting a frequency of 10.0001 GHz when operated in *Fractional* mode. When operating in fractional mode, the reference divider should always be 1 for best phase noise performance.

Table 4.7 summarizes the advantages and disadvantages of the two synthesizer operational modes.

Table 4.7: Comparison between Integer and Fractional PLL modes

Mode	Advantages	Disadvantages
Integer	Lower Phase Noise	Frequency must be an integer multiple of $\frac{f_{ref}}{N} * prescaler$, where $f_{ref} = 100$ and $prescaler = 8$ for the QM1004A-2-18.
Fractional	Can tune in 100 kHz frequency steps	Increased Phase Noise Increased spurious products

Syntax**Example**

FREQ:PLLM 1 *This command sets the PLL mode of the QM1004A-2-18 to Integer mode.*

Default Condition

On power up, or when a *RST command is issued, the QM1004A-2-18 PLL mode setting returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 1.

Query

FREQ:PLLM? *This query returns the PLL mode of the QM1004A-2-18*

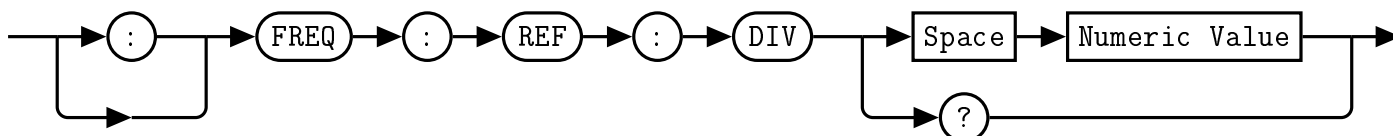
- 0 is returned if the synthesizer is Fractional Mode
- 1 is returned if the synthesizer is in Integer Mode

3.3 FREQuency:REFerence:DIVider <numeric value>

This command allows the user to set the QM1004A-2-18 LO1 reference divider value. The allowed values are integers between 1 and 16383. The reference divider is used to set the resolution of the tune frequency step size while operating in integer mode. The frequency step size in integer mode is $\frac{f_{ref}}{N} * prescaler$. In the QM1004A-2-18, the *reference frequency* (f_{ref}) is fixed at 100 MHz and the hardware *prescaler* is fixed at 8. This results in the integer mode tuning resolution being $\frac{800}{N}$, where N is the reference divider value.

Note: Phase noise will increase as the reference divider value increases.

Syntax



Example

:FREQ:REF:DIV 8 *This command sets the LO reference divider of the QM1004A-2-18 to 8.*

Default Condition

On power up, or when a *RST command is issued, the QM1004A-2-18 LO reference divider returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 1.

Query

:FREQ:REF:DIV? *This query returns the value of the QM1004A-2-18 LO reference divider.*

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is not between 10 and 250, error -222, "Data out of range" occurs.

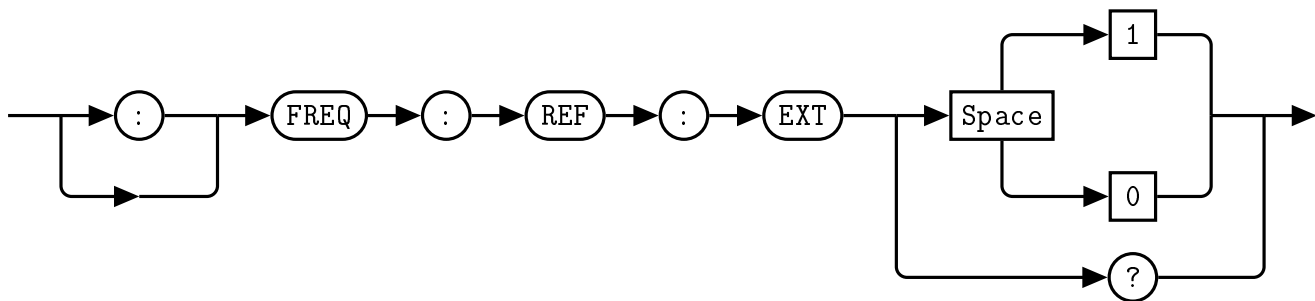
3.4 FREQuency:REFerence:EXTernal [1|0]

This command allows the user to select between the internal 100 MHz reference and an externally supplied reference. Issuing this command overrides the back panel toggle switch setting.

When *0* is specified, the internal reference oscillator is used by the Combined RF Upconverter/Downconverter.

When *1* is specified, the external reference input is used by the Combined RF Upconverter/Downconverter.

Syntax



Example

:FREQ:REF:EXT 0 *This command selects the internal reference oscillator.*

Default Condition

On power up, or when a *RST command is issued, the QM1004A-2-18 returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 0.

Query

:FREQ:REF:EXT? *This query returns a 0 or 1 to indicate the selected Combined RF Upconverter/Downconverter reference mode*

- 0 is returned if the internal reference oscillator is selected
- 1 is returned if the external reference is selected

Error Message

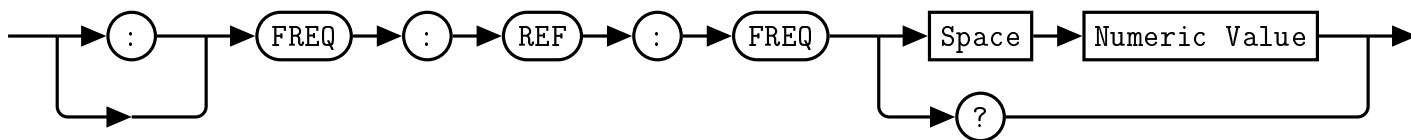
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is not 1 or 0, error -222, "Data out of range" occurs.

3.5 FREQuency:REFerence:FREQuency <numeric value>

This command allows the user to set the QM1004A-2-18 reference oscillator frequency in MHz. The allowed values are integers between 10 and 250 MHz.

Syntax



Example

:FREQ:REF:FREQ 150 *This command sets the external reference frequency of the QM1004A-2-18 to 150 MHz.*

Default Condition

On power up, or when a **RST* command is issued, the QM1004A-2-18 reference frequency returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 10.

Query

:FREQ:REF:FREQ? *This query returns the center frequency of the QM1004A-2-18 in MHz.*

Error Message

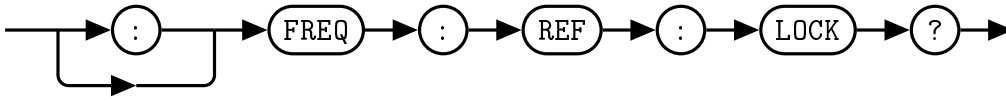
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is not between 10 and 250, error -222, "Data out of range" occurs.

3.6 FREQuency:REFerence:LOCK?

This query allows the user to check the lock status of both the onboard reference oscillator and the FPGA's internal PLL.

Syntax



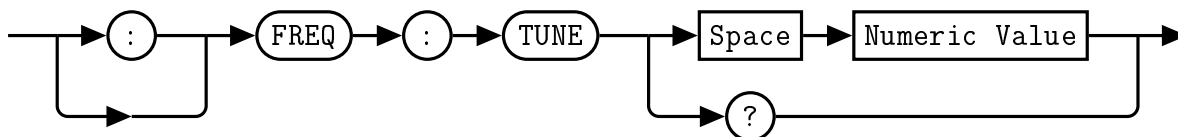
Query

:FREQ:REF:LOCK? *This query returns a 0 or 1 to indicate the lock status of the PLL and the FPGA's clocks. If the internal reference is in use, the PLL will report a 0 as lock status.*

3.7 FREQuency:TUNE <numeric value>

This command allows the user to set the tuner frequency of the QM1004A-2-18. The frequency value is specified in GHz. The range of acceptable tune frequency values is 2-18 GHz with a 4 decimal place (100 kHz) tuning resolution.

Syntax



Example

:FREQ:TUNE 10 *This command sets the center frequency of the QM1004A-2-18 to 10 GHz.*

Default Condition

On power up, or when a *RST command is issued, the QM1004A-2-18 returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 10.

Query

:FREQ:TUNE? *This query returns the center frequency of the QM1004A-2-18 in GHz.*

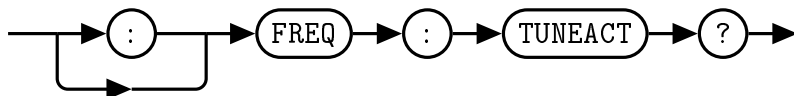
Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.
 If the parameter is not between 2 and 18, error -222, "Data out of range" occurs.

3.8 FREQuency:TUNErACTual

This query returns the actual tuner frequency of the QM1004A-2-18 in GHz. When in integer mode, the QM1004A-2-18 is only capable of tuning in discrete steps set by the reference divider. As a result, the actual tuned frequency may vary from the desired frequency set using the *FREQ:TUNE* command. To achieve the exact desired tune frequency, the user must use fractional mode or increase the reference divider value.

Syntax



Query

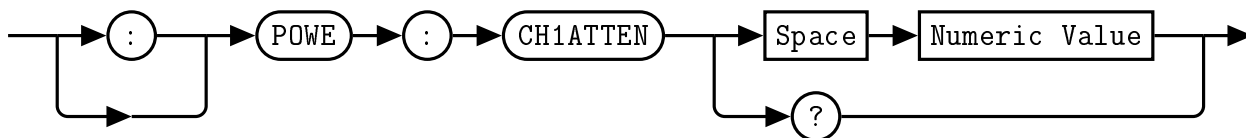
`:FREQ:TUNEACT?` *This query returns the actual tuner frequency of the QM1004A-2-18 in GHz.*

4. POWER Subsystem Command Reference

4.1 POWER:CH1ATTEN <numeric value>

This command allows the user to set the attenuation level of the QM1004A-2-18 upconverter to a specified numeric value. The range of acceptable attenuation values is 0 - 31 dB in 1 dB steps.

Syntax



Example

:POWE:CH1ATTEN 31 *This command sets the upconverter attenuation to 31 dB*

Default Condition

On power up, or when a *RST command is issued, the QM1004A-2-18 upconverter attenuation level returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 0.

Query

:POWE:CH1ATTEN? *This query returns the current upconverter attenuation level.*

Error Message

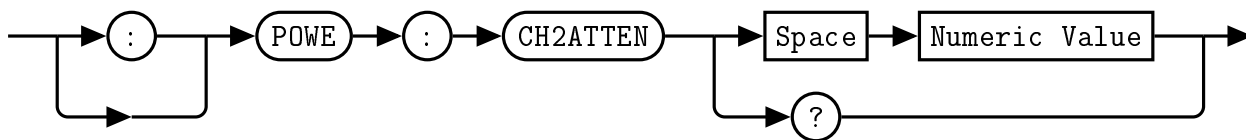
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 124.5, error -222, "Data out of range" occurs.

4.2 POWER:CH2ATTEN <numeric value>

This command allows the user to set the attenuation level of the QM1004A-2-18 downconverter to a specified numeric value. The range of acceptable attenuation values is 0 - 31 dB in 1 dB steps.

Syntax



Example

:POWE:CH2ATTEN 31 *This command sets the downconverter attenuation to 31 dB*

Default Condition

On power up, or when a **RST* command is issued, the QM1004A-2-18 downconverter attenuation level returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 0.

Query

:POWE:CH2ATTEN? *This query returns the current downconverter attenuation level.*

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 124.5, error -222, "Data out of range" occurs.

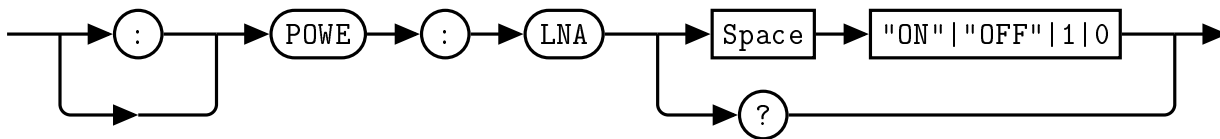
4.3 POWER:LNA [ON|OFF|1|0]

This command allows the user to turn on and off the Upconverter LNA gain stage of the QM1004A-2-18.

When *0* or *OFF* is specified, the LNA is turned off.

When *1* or *ON* is specified, the LNA is turned on.

Syntax



Example

:POWE:LNA 0 *This command turns off the LNA.*

Default Condition

On power up, or when a **RST* command is issued, the QM1004A-2-18 returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 0.

Query

:POWE:LNA? *This query returns a 0 or 1 to indicated the Combined RF Upconverter/Downconverter power state.*

- 0 is returned if the LNA is *OFF*
- 1 is returned if the LNA is *ON*

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

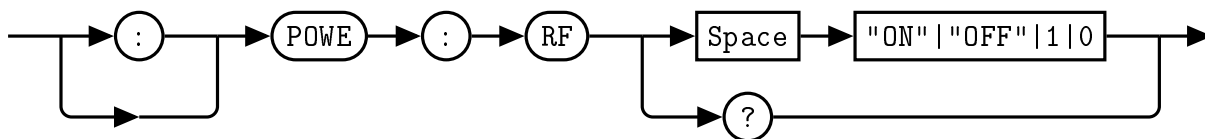
4.4 POWER:RF [ON|OFF|1|0]

This command allows the user to turn on and off the RF power of the QM1004A-2-18.

When *0* or *OFF* is specified, the RF power is turned off.

When *1* or *ON* is specified, the RF power is turned on.

Syntax



Example

:POWER:RF 0 *This command turns off the RF power.*

Default Condition

On power up, or when a **RST* command is issued, the QM1004A-2-18 returns to the boot state's setting. The Combined RF Upconverter/Downconverter default setting is 0 for Master units and 1 for Slave units.

Query

:POWER:RF? *This query returns a 0 or 1 to indicated the Combined RF Upconverter/Downconverter power state.*

- 0 is returned if the RF power is *OFF*
- 1 is returned if the RF power is *ON*

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

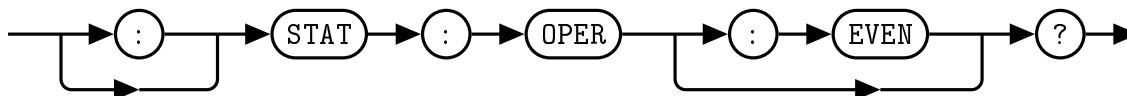
5. STATus Subsystem Command Reference

5.1 STATus:OPERation?

This query returns the contents of the status event register. Reading from this event register clears it.

The use of the :EVENT token is optional.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 32767.

Query

:STAT:OPER? *The status event register is queried.*

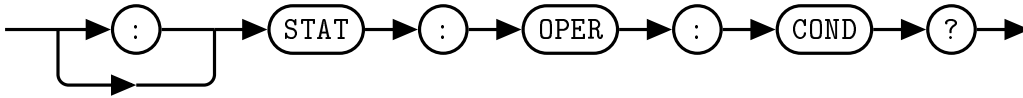
Reset Condition

On reset, the status event register is cleared.

5.2 STATus:OPERation:CONDition?

This query returns the contents of the condition register.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 32767.

Query

:STAT:OPER:COND? *The condition register is queried.*

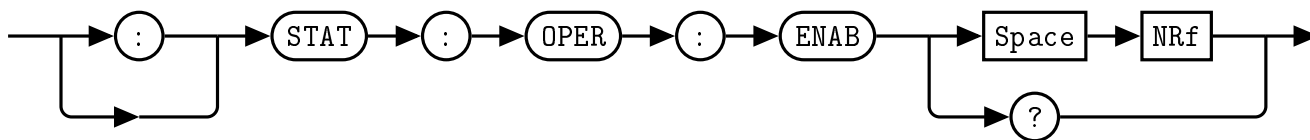
Reset Condition

On reset, the condition register is cleared.

5.3 STATus:OPERation:ENABle <NRf>

This command sets the enable mask for the status event register. A bit value of 1 in the mask will allow a positive transition in the associated summary bit of the event register if the event bit transitions to true.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 32767.

Query

:STAT:OPER:ENAB? *The event register enable bit mask is queried.*

Reset Condition

On reset, the enable bit mask register is cleared.

Error Message

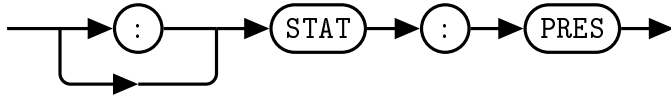
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 32767, error -222, "Data out of range" occurs.

5.4 STATus:PRESet

The PRESet command presets the STATus:QUESTionable:ENABLE register to 0. No other registers are affected. *CLS;*SRE 0;*ESE 0 is the recommended command sequence to reset all other status/event registers.

Syntax



Example

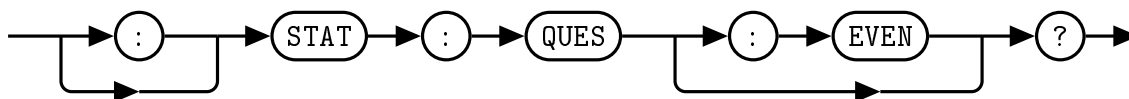
:STAT:PRES *The questionable enable register is preset.*

5.5 STATus:QUEStionable?

This query returns the contents of the questionable status register. A value of 1 in the bit indicates the accuracy of the signal is of questionable quality.

The use of the :EVENT token is optional.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 32767.

Query

:STAT:QUES? *The questionable register is queried.*

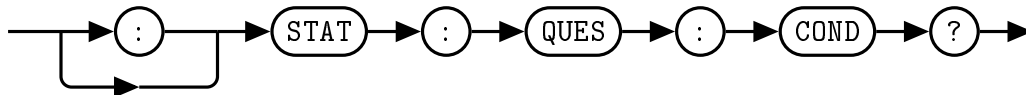
Reset Condition

On reset, the questionable register is cleared.

5.6 STATus:QUEStionable:CONDition?

This query returns the contents of the questionable condition register.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 32767.

Query

:STAT:QUES:COND? *The questionable condition register is queried.*

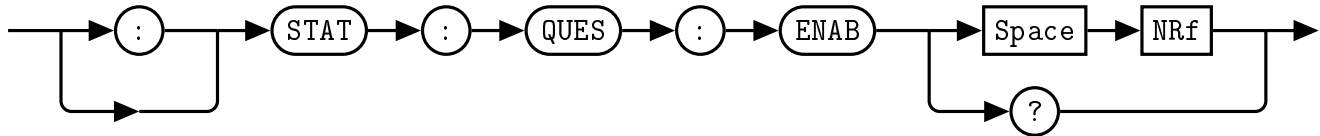
Reset Condition

On reset, the questionable condition register is cleared.

5.7 STATus:QUESTionable:ENABle <NRf>

This command sets the enable mask for the questionable event register. A bit value of 1 in the mask will allow a positive transition in the associated summary bit of the questionable event register if the event bit transitions to true.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 32767.

Query

:STAT:QUES:ENAB? *The questionable register enable bit mask is queried.*

Reset Condition

On reset, the enable bit mask register is cleared.

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

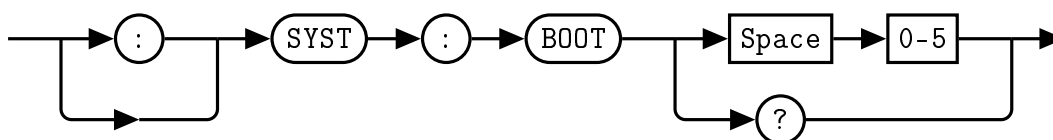
If the parameter is less than 0 or greater than 32767, error -222, "Data out of range" occurs.

6. SYSTem Subsystem Command Reference

6.1 SYSTem:BOOTstate [0-5]

This command specifies a previously saved state to be loaded upon device startup. In addition to factory default state 0, there are 5 re-writeable memory locations. Any of these 6 boot states can be selected by choosing an index between 0 and 5. The restored parameters are the *Tune Frequency*, *RF Power State*, *LNA Power State*, *Reference Frequency*, *External Reference Enabled*, *External Reference Switch Override*, *PLL Mode*, *Reference Divider*, *Upconverter Attenuation*, and *Downconverter Attenuation*. For a detailed description of the parameters saved, see the relevant command descriptions in this manual. When this command is issued, the selected state will be loaded on the next power cycle or by issuing the **RST* command.

Syntax



There are 6 memory locations, numbered 0 through 5. Memory location 0 contains the factory default settings, while locations 1-5 are user re-writeable using SYSTem:BOOTstate.

Example

:SYST:BOOT 1 *This command specifies state 1 to be loaded upon device powerup.*

Default Condition

The factory default setting for SYST:BOOT is 0.

Query

:SYST:BOOT? *This query returns a 0 - 5 to indicate the Combined RF Upconverter/Downconverter selected boot state.*

- 0 is returned if the selected boot state is 0

Error Message

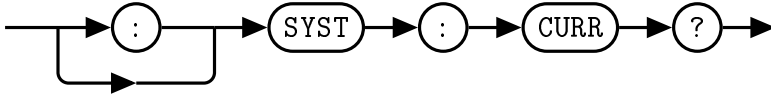
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 5, error -222, "Data out of range" occurs.

6.2 SYSTem:CURRent?

This command returns the current reading from the Combined RF Upconverter/Downconverter in Amps.

Syntax



Query Example

:SYST:CURR? *This query returns the QM1004A-2-18 current draw in Amps.*

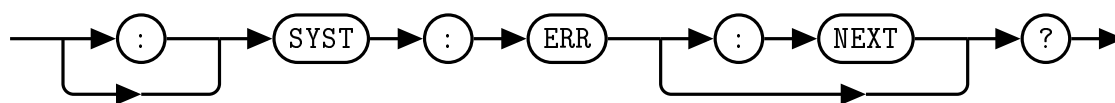
6.3 SYSTem:ERRor[:NEXT]?

This query returns error numbers and messages from the QM1004A-2-18 error queue. When an error is generated by the QM1004A-2-18, the error number and corresponding error message are stored in the error queue. Each time the error queue is queried, the first error in the error queue is returned. The errors are read out in the order of first-in first-out. To clear all errors in the error queue, use the *CLS command.

When the error queue is empty, a query of the error queue will return a 0, "No error" message. The error queue has a maximum capacity of 10 errors.

The use of the :NEXT token is optional.

Syntax



Query Example

:SYST:ERR? *Queries the system error.*

Error queue messages have the following format:



For example, -102, "Syntax error"

Reset Condition

On reset, the error queue is cleared.

Error Message List

Table 4.8: Error Codes and Messages

-101	Invalid character Invalid character was found in the command string.
-102	Syntax error Invalid syntax was found in the command string.
-103	Invalid separator Invalid separator was found in the command string.
-105	GET not allowed A Group Execute Trigger (GET) is not allowed within a command string.
-108	Parameter not allowed More parameters were received than expected for the command.

-109	Missing parameter Fewer parameters were received than expected for the command.
-112	Program mnemonic too long A command header was received which contained more than the maximum 12 characters allowed.
-113	Undefined header A command was received that is not valid for the Combined RF Upconverter/-Downconverter.
-121	Invalid character in number An invalid character was found in the number specified for a parameter value.
-123	Exponent too large A numeric parameter was found whose exponent was larger than 32,000.
-124	Too many digits A numeric parameter was found whose mantissa contained more than 255 digits.
-128	Numeric data not allowed A numeric value was received within a command which does not accept a numeric value.
-131	Invalid suffix A unit was incorrectly specified for a numeric parameter.
-134	Suffix too long A unit used contained more than 12 characters.
-138	Suffix not allowed A unit was received following a numeric parameter which does not accept a unit.
-141	Invalid character data An invalid character was received.
-148	Character data not allowed A discrete parameter was received but a character string or numeric parameter was expected.
-151	Invalid string data An invalid string was received.
-158	String data not allowed A character string was received but not allowed for the command.
-161	Invalid block data A block data element was expected but was invalid.
-168	Block data not allowed A legal block data element was encountered but not allowed by the Product.

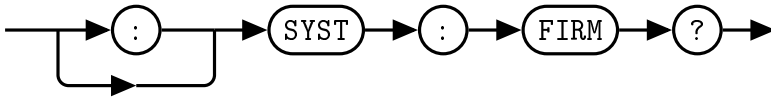
-178	<p>Expression data not allowed</p> <p>A legal expression data element was encountered but not allowed by the Product.</p>
-200	<p>Execution error</p> <p>Indicates that an execution error has occurred.</p>
-211	<p>Trigger ignored</p> <p>Indicates that a trigger command was received but ignored because the Combined RF Upconverter/Downconverter was not in the wait for trigger state.</p>
-213	<p>Trigger ignored</p> <p>Indicates that a trigger command was received but ignored because the Combined RF Upconverter/Downconverter was not in the wait for trigger state.</p>
-222	<p>Data out of range</p> <p>A numeric parameter value is outside the valid range for the command.</p>
-224	<p>Illegal parameter value</p> <p>A discrete parameter was received which was not a valid choice for the command.</p>
-230	<p>Data corrupt or stale</p> <p>This occurs when a measurement command is attempted and either a reset has been received or the state of the Combined RF Upconverter/Downconverter has changed such that the measurement is no longer valid.</p>
-241	<p>Hardware missing</p> <p>The Combined RF Upconverter/Downconverter is unable to execute the command because the hardware does not support that feature.</p>
-310	<p>System error</p> <p>This error indicates a failure with the Combined RF Upconverter/Downconverter.</p>
-330	<p>Self-test failed</p> <p>The -330, "Self-test failed" error indicates a problem with the Combined RF Upconverter/Downconverter.</p>
-350	<p>Queue overflow</p> <p>The error queue is full and another error has occurred which could not be recorded.</p>
-410	<p>Query INTERRUPTED</p> <p>A command was received which sends data to the output buffer, but the output buffer contained data from a previous command. The output buffer is cleared when power has been off or after a *RST command has been issued.</p>
-420	<p>Query UNTERMINATED</p> <p>The Combined RF Upconverter/Downconverter was addressed to talk but a command has not been received which sends data to the output buffer.</p>

-430	Query DEADLOCKED A command was received which generates too much data to fit in the output buffer and the input buffer is also full. Command execution continues but data is lost.
-440	Query UNTERMINATED after indefinite response The *IDN? command must be the last query command within a command string.
+0	No error No errors in the error queue. Device is operating normally.
+110	Invalid Command For Specified Device The issued command is invalid for the specified device.

6.4 SYSTem:FIRMware?

This command returns the current PIC and FPGA firmware versions of the Combined RF Upconverter/Downconverter.

Syntax



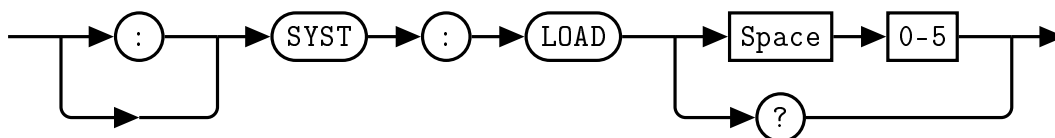
Query Example

:SYST:FIRM? *This query returns the current firmware versions of the Combined RF Upconverter/Downconverter.*

6.5 SYSTem:LOADstate [0-5]

This command restores a previously saved state from non-volatile memory. In addition to factory default state 0, there are 5 re-writeable memory locations, specified by choosing an index between 1 and 5. The restored parameters are the *Tune Frequency*, *RF Power State*, *LNA Power State*, *Reference Frequency*, *External Reference Enabled*, *External Reference Switch Override*, *PLL Mode*, *Reference Divider*, *Upconverter Attenuation*, and *Downconverter Attenuation*. For a detailed description of the parameters saved, see the relevant command descriptions in this manual. When the SYSTem:LOADstate command is called, these parameters will be applied to the device.

Syntax



There are 6 memory locations, numbered 0 through 5. Memory location 0 contains the factory default settings, while locations 1-5 are user re-writeable using SYSTem:SAVEstate.

Example

:SYST:LOAD 4 *This command loads the state 4 parameters from non-volatile memory and applies them to the device.*

Error Message

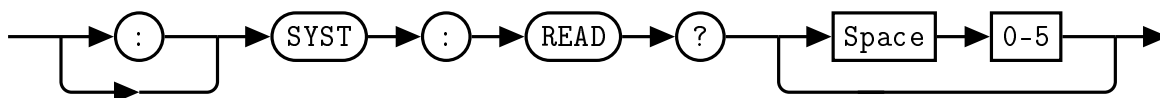
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 5, error -222, "Data out of range" occurs.

6.6 SYSTem:READstate? [0-5]

This query allows the user to read the parameters of the stored states without changing any internal registers. The query output is a list of parameters for the selected state. If no state parameter is given, the returned state is state 0. The list of state parameters contains comma separated values, without spaces, in the following order: *Tune Frequency, RF Power State, LNA Power State, Reference Frequency, External Reference Enabled, External Reference Switch Override, PLL Mode, Reference Divider, Upconverter Attenuation, and Downconverter Attenuation*. See the respective command definitions for descriptions of each parameter.

Syntax



Query

:SYST:READ? 0 *This query requests the parameter values of state 0.*

Response: 10.0000,0,0,10,0,0,1,1,0,0

- 10.0000 = FREQUENCY:TUNE is set to 10 GHz. (page 45)
- 0 = POWER:RF is set to 0 or OFF. (page 50)
- 0 = POWER:LNA is set to 0 or OFF. (page 49)
- 10 = FREQUENCY:REFERENCE:FREQUENCY is set to 10 MHz. (page 43)
- 0 = FREQUENCY:REFERENCE:EXTERNAL is set to 0 or Internal. (page 42)
- 0 = External Reference Switch Override is 0 (switch-controlled).
- 1 = FREQUENCY:PLLMODE is set to 1 or Integer. (page 39)
- 1 = FREQUENCY:REFERENCE:DIVIDER is set to 1. (page 41)
- 0 = POWER:CH1ATTEN is set to 0 dB (page 47)
- 0 = POWER:CH2ATTEN is set to 0 dB (page 48)

Error Message

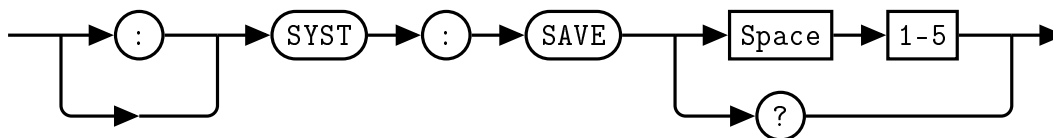
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 5, error -222, "Data out of range" occurs.

6.7 SYSTem:SAVEstate [1-5]

This command saves the current setup to non-volatile memory. There are 5 re-writeable memory locations, specified by choosing an index between 1 and 5. Any of the 5 states can be restored on startup when specified with the SYSTem:BOOTstate command. The parameters saved are the *Tune Frequency*, *RF Power State*, *LNA Power State*, *Reference Frequency*, *External Reference Enabled*, *External Reference Switch Override*, *PLL Mode*, *Reference Divider*, *Upconverter Attenuation*, and *Downconverter Attenuation*. For a detailed description of the parameters saved, see the relevant command descriptions in this manual. NOTE: The MEM_CLR button on the back panel will rewrite the contents of states 1-5 with the contents of state 0 when depressed, serving as a reset to factory defaults.

Syntax



There are 5 memory locations, numbered 1 through 5. Memory location 0 contains the factory default settings and is write-protected.

Example

:SYST:SAVE 3 *This command saves the current state to memory location 3*

Error Message

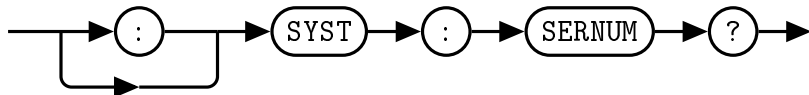
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 1 or greater than 5, error -222, "Data out of range" occurs.

6.8 SYSTem:SERialNUMBER?

This query returns the serial number of the device.

Syntax



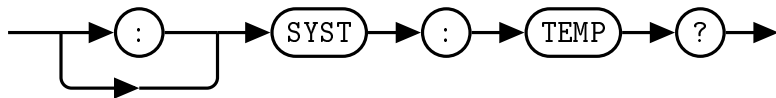
Query Example

:SYST:SERNUM? *This query returns the serial number of the device.*

6.9 SYSTem:TEMPerature? [0-5]

This query returns the temperature reading from the QM1004A-2-18 in degrees Celsius when RF Power is applied. When RF Power has not been applied, the boards are in a powered down state and the device will return 0.00 degrees.

Syntax



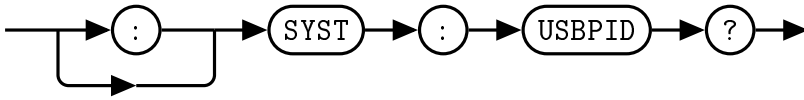
Query Example

`SYST:TEMP?` *This query returns the temperature reading from the QM1004A-2-18.*

6.10 SYSTem:USBPID?

This query returns the USB Product ID of the Combined RF Upconverter/Downconverter. The response is "0x001B" for Master units and "0x001C" for Slave units.

Syntax



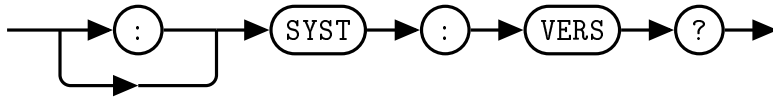
Query Example

:SYST:USBPID? *This query returns the USBPID of the Combined RF Upconverter/Downconverter.*

6.11 SYSTem:VERSion?

This query returns the version of SCPI used in the Combined RF Upconverter/Downconverter. The response is in the format XXXX.Y, where XXXX is the year and Y is the version number.

Syntax



Query Example

:SYST:VERS? *This query returns the version of SCPI used in the Combined RF Upconverter/Downconverter.*

7. IEEE 488.2 Command Reference

7.1 Introduction

This chapter contains information on the IEEE-488.2 Common Commands that the Combined RF Upconverter/Downconverter supports.

The IEEE-488.2 Common Command descriptions are listed below.

Table 4.9: IEEE 488.2 Common commands

<i>*CLS</i>	Clear Status	Page 73
<i>*ESE</i> and <i>*ESE?</i>	Event Status Enable	Page 74
<i>*ESR?</i>	Event Status Register	Page 75
<i>*IDN?</i>	Identify	Page 76
<i>*OPC</i> and <i>*OPC?</i>	Operation Complete	Page 77
<i>*RCL</i>	Recall	Page 78
<i>*RST</i>	Reset	Page 79
<i>*SAV</i>	Save	Page 80
<i>*SDS</i>	Save Default Settings	Page 81
<i>*SRE</i> and <i>*SRE?</i>	Service Request Enable	Page 82
<i>*STB?</i>	Status Byte	Page 83
<i>*TST?</i>	Test	Page 84
<i>*WAI</i>	Wait	Page 85

7.2 *CLS

The *CLS (CLear Status) command clears the data structures. The SCPI registers are all cleared.

Syntax



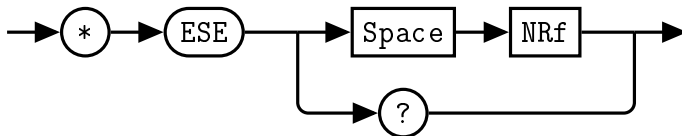
7.3 *ESE <NRf>

The *ESE (Event Status Enable) command sets the Standard Event Status Enable Register. This register contains a mask value for the bits to be enabled in the Standard Event Status Register. A 1 in the enable register enables the corresponding bit in the Status Register, a 0 disables the corresponding bit in the Status Register. The parameter value when expressed in base 2, represents the bit values of the Standard Event Status Enable Register. Table 4.10 shows the contents of this register.

Table 4.10: *ESE bit mapping

Bit	Base 2	Meaning
0	1	Operation Complete
1	2	Request Control (not used)
2	4	Query Error
3	8	Device Dependent Error
4	16	Execution Error
5	32	Command Error
6	64	Not Used
7	128	Power On

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 255.

Query

*ESE? *This query returns the contents of the Standard Event Status Enable Register.*

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 255, error -222, "Data out of range" occurs.

7.4 *ESR?

The **ESR?* query returns the contents of the Standard Event Status Register then clears it. The returned value is in the range of 0 to 255. Table 4.11 shows the contents of this register.

Table 4.11: *ESR? mapping

Bit	Base 2	Meaning
0	1	Operation Complete
1	2	Not Used
2	4	Query Error
3	8	Device Dependent Error
4	16	Execution Error
5	32	Command Error
6	64	Not Used
7	128	Power On

Syntax



7.5 *IDN?

The **IDN?* query allows the connected device to identify itself. The string returned is:

Quonset Microwave,<Product Number>,<Serial Number>,<Firmware>

where:

- *<Product Number>* identifies the product number of the host
- *<Serial Number>* uniquely identifies the host
- *<Firmware>* returns the firmware of the host

Syntax



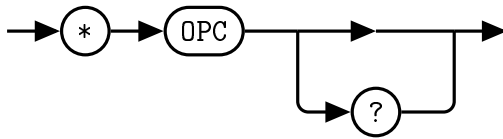
7.6 *OPC

The *OPC (Operation Complete) command causes the QM1004A-2-18 Combined RF Upconverter/Downconverter to set the operation complete bit in the Standard Event Status Register when all pending device operations have been completed.

Table 4.12: *OPC mapping

Bit	Base 2	Meaning
0	1	Operation Complete
1	2	Not Used
2	4	Query Error
3	8	Device Dependent Error
4	16	Execution Error
5	32	Command Error
6	64	Not Used
7	128	Power On

Syntax



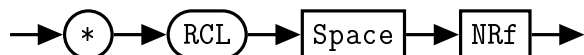
Query

*OPC? *This query places a 1 in the output queue when all device operations have been completed.*

7.7 *RCL <NRf>

The *RCL (ReCaLL) command restores a previously saved state from non-volatile memory. In addition to factory default state 0, there are 5 re-writable memory locations, specified by choosing an index between 1 and 5. The restored parameters are the *Tune Frequency*, *RF Power State*, *LNA Power State*, *Reference Frequency*, *External Reference Enabled*, *External Reference Switch Override*, *PLL Mode*, *Reference Divider*, *Upconverter Attenuation*, and *Downconverter Attenuation*. For a detailed description of the parameters saved, see the relevant command descriptions in this manual. When the *RCL command is called, these parameters will be applied to the device.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 0 to 5.

Error Message

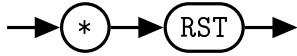
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 0 or greater than 5, error -222, "Data out of range" occurs.

7.8 *RST

The **RST* (ReSeT) command returns the QM1004A-2-18 Combined RF Upconverter/Downconverter to its initial power-up state.

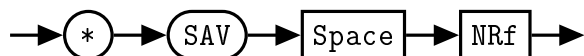
Syntax



7.9 *SAV <NRf>

The *SAV (SAVe) command saves the current setup to non-volatile memory. There are 5 re-writeable memory locations, specified by choosing an index between 1 and 5. Any of the 5 states can be restored on startup when specified with the SYSTem:BOOTstate command. The parameters saved are the *Tune Frequency*, *RF Power State*, *LNA Power State*, *Reference Frequency*, *External Reference Enabled*, *External Reference Switch Override*, *PLL Mode*, *Reference Divider*, *Upconverter Attenuation*, and *Downconverter Attenuation*. For a detailed description of the parameters saved, see the relevant command descriptions in this manual. NOTE: The MEM_CLR button on the back panel will rewrite the contents of states 1-5 with the contents of state 0 when depressed, serving as a reset to factory defaults.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 1 to 5.

Error Message

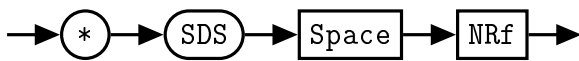
If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 1 or greater than 5, error -222, "Data out of range" occurs.

7.10 *SDS <NRf>

The *SDS (Save Default device Settings) command restores the specified state of the QM1004A-2-18 Combined RF Upconverter/Downconverter to the default state settings. There are 5 re-writeable memory locations, specified by choosing an index between 1 and 5. The parameters restored are the *Tune Frequency*, *RF Power State*, *LNA Power State*, *Reference Frequency*, *External Reference Enabled*, *External Reference Switch Override*, *PLL Mode*, *Reference Divider*, *Upconverter Attenuation*, and *Downconverter Attenuation*. For a detailed description of the parameters saved, see the relevant command descriptions in this manual. Issuing this command does not change the current settings. NOTE: The MEM_CLR button on the back panel will rewrite the contents of states 1-5 with the contents of state 0 when depressed, serving as a reset to factory defaults.

Syntax



Allowed Values

The *NRf* parameter can be any integer in the range of 1 to 5.

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.

If the parameter is less than 1 or greater than 5, error -222, "Data out of range" occurs.

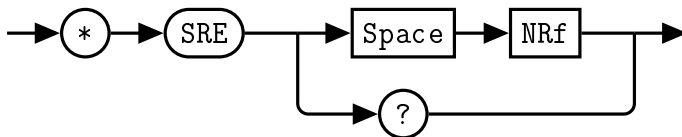
7.11 *SRE <NRf>

The *SRE command sets the Service Request Enable register bits. This register contains a mask value for the bits to be enabled in the Status Byte Register. A 1 in the enable register enables the corresponding bit in the Status Register, a 0 disables the corresponding bit in the Status Register. The parameter value when expressed in base 2, represents bits 0 to 5 and bit 7 of the Service Request Enable Register. Bit 6 is not used and is always 0. Table 4.13 shows the contents of this register.

Table 4.13: *SRE bit mapping

Bit	Base 2	Meaning
0	1	Not used
1	2	Not Used (not used)
2	4	Device Dependent
3	8	Questionable Status Summary
4	16	Message Available
5	32	Event Status Bit
6	64	Not Used
7	128	Operation Status Summary

Syntax



Allowed Values

The NRf parameter can be any integer in the range of 0 to 255.

Query

*SRE? *This query returns the contents of bits 0 to 5 and bit 7 of the Service Request Enable Register. Bit 6 is always 0.*

Error Message

If the parameter is not in the recognized format, error -102, "Syntax error" occurs.
 If the parameter is less than 0 or greater than 255, error -222, "Data out of range" occurs.

7.12 *STB?

The **STB?* (S**T**atus **B**yte) query returns bit 0 to 5 and bit 7 of the QM1004A-2-18 Combined RF Upconverter/Downconverter status byte and returns the Master Summary Status (MSS) as bit 6. The MSS is inclusive OR of the bitwise combination (excluding bit 6) of the Status Byte and the Service Request Enable registers. The format of the return is an integer between 0 and 255. Table 4.14 shows the contents of this register.

Table 4.14: *STB? mapping

Bit	Base 2	Meaning
0	1	Not used
1	2	Device Dependent 0 - No device status condition has occurred 1 - A device status condition has occurred
2	4	Error/Event Queue 0 = Queue empty 1 = Queue not empty
3	8	Questionable Status Summary 0 - No Q U E STionable status conditions have occurred 1 - A Q U E STionable status condition has occurred
4	16	Message Available 0 - no output messages are ready 1 - an output message is ready
5	32	Event Status Bit 0 - no event status has occurred 1 - an event status condition has occurred
6	64	Master Summary Status 0 - Combined RF Upconverter/Downconverter not requesting service 1 - there is at least one reason for requesting service
7	128	Operation Status Summary 0 = No O PERation status conditions have occurred 1 = An O PERation status condition has occurred

Syntax



7.13 *TST?

The **TST?* query causes the QM1004A-2-18 Combined RF Upconverter/Downconverter to perform a self-test. The result of the self-test is placed in the output queue.

- 0 is returned if the test passes

Syntax



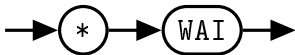
7.14 *WAI

The **WAI* (WAI) command causes the QM1004A-2-18 Combined RF Upconverter/Downconverter to wait until either:

- All pending operations are complete
- The *Device Clear* command is received
- Power is cycled

before executing any subsequent commands or queries.

Syntax





5 Windows Control GUI

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1. Overview

The Graphical User Interface (GUI) for the QM1004A-2-18 is shown below in Figure 5.1. This GUI provides the current status and provides all of the essential functionality for the Combined RF Upconverter/Downconverter system. The GUI allows the user to toggle RF power, LNA power, and to set user states, attenuation control, tune the device, and change reference settings.

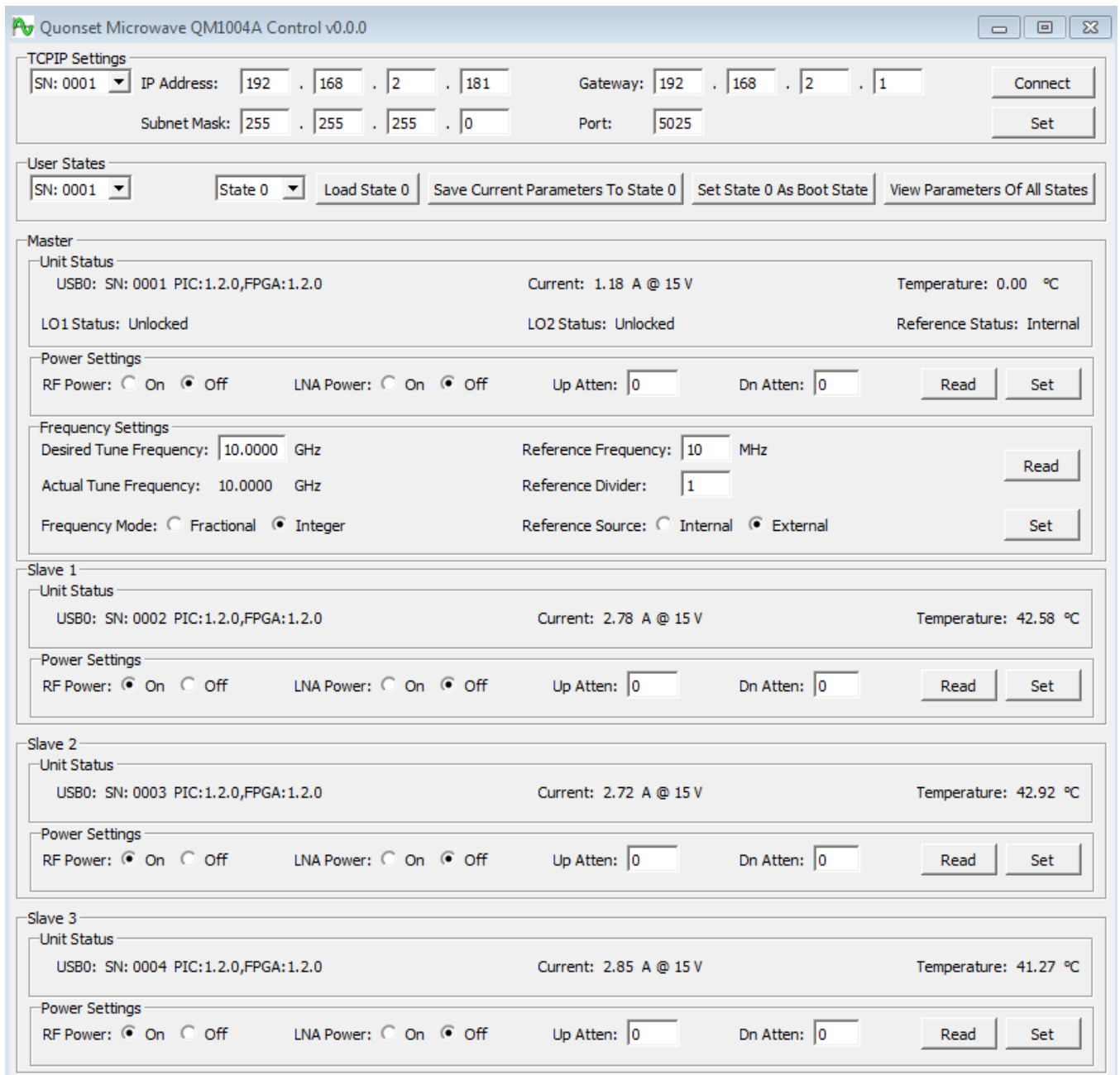


Figure 5.1: Windows® Control GUI

2. Connection

At startup, the scans the USB bus for QM1004A-2-18 devices and opens them. It then attempts to read TCPIP settings from the device and switch to a TCPIP connection if possible. In order to use the QM1004A-2-18 without connecting the USB, manually entering the TCPIP settings and clicking Connect is required.

GUI updates can be obtained by clicking the following link and navigating to the download link in the Software tab:

<http://www.quonsetmicrowave.com/QM1004-2-18-p/qm1004-2-18.htm>

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