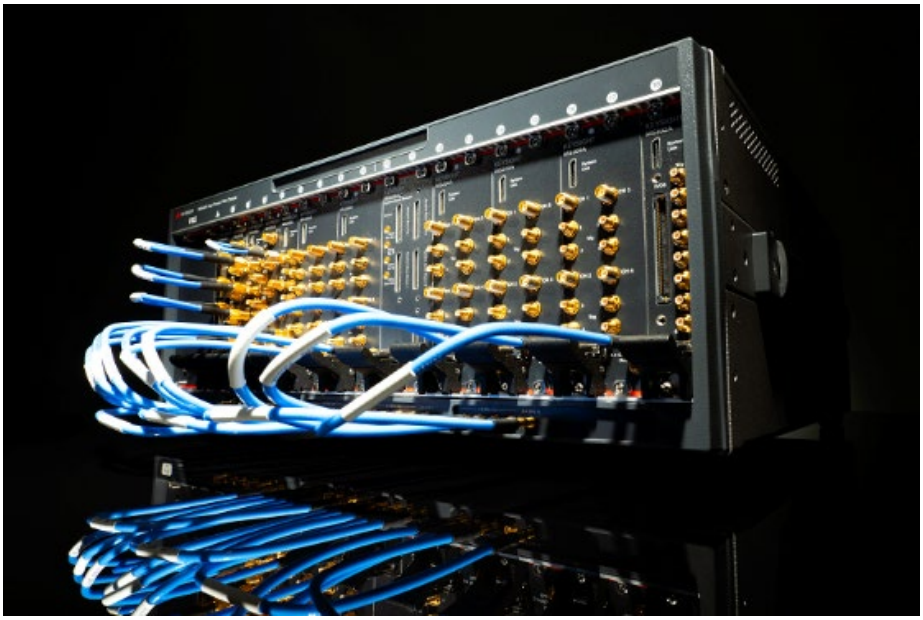
QCS Ordering Guide

This guide will help you order a Keysight Quantum Control System that is customized to meet your needs.

Introduction

The Keysight Quantum Control System (QCS) provides a modular solution for qubit control and readout including all required hardware, software, and services. The system can be customized to meet the needs of your specific quantum architecture. Follow the steps in this guide to easily configure a 1-chassis Keysight Quantum Control System. For help configuring larger QCS systems or expanding an existing system, please contact your local Keysight office.



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Preconfigured QCS Bundles

The following are preassembled bundle options for convenience. These are intended as ‘starter kits’ for the QCS system. To purchase these bundles, please contact your Keysight representative.

Table 1. QCS bundle options and components

Part number	Description	Components	
Q5401A-001	2-Qubits superconducting	M9038A	Embedded PC, 64 GB memory
		M5300A	PXIe RF AWG
		M5200A	PXIe digitizer
		M5201A	PXIe downconverter
		M9046A	PXIe chassis QS2
		M9032A	PXIe system sync module
		Q5500OSTA	Quantum control system SW – Up to 1 chassis
Q5401A-002	2-Qubits spin	M9038A	Embedded PC, 64 GB memory
		M5200A	PXIe digitizer
		M5301A	PXIe precision AWG
		M9046A	PXIe chassis QS2
		M9032A	PXIe system sync module
		Q5500OSTA	Quantum control system SW – Up to 1 chassis
Q5401A-005	2-Qubits superconducting, ultra-low phase noise	M9038A	Embedded PC, 64 GB memory
		M5300A	PXIe RF AWG
		M5200A	PXIe digitizer
		M5201A	PXIe downconverter
		M9046A	PXIe chassis QS1
		M9032A	PXIe system sync module
		Q5500OSTA	Quantum control system SW – Up to 1 chassis
Q5401A-007	5-Qubits superconducting, ultra-low phase noise	M9038A	Embedded PC, 64 GB memory
		M5300A	PXIe RF AWG
		M5300A	PXIe RF AWG
		M5200A	PXIe digitizer
		M5201A	PXIe downconverter
		M9046A	PXIe chassis QS1
		M9032A	PXIe system sync module
		Q5500OSTA	Quantum control system SW – Up to 1 chassis

Customization Steps

The following steps show you how to order components for your Keysight Quantum Control System to fit your needs.

Required Components

The following table lists the components you will need to build your Keysight QCS.

Table 2. QCS components

Part number	Quantity	Additional information
Hardware		
M9046A-QS1	1	PXIe chassis Enhanced phase noise 100 MHz and 2.4 GHz references with power splitters
M9032A	1	System synchronization module
Y1333A	1	SMA(m)-SMP(f) cable, 0.3 m
Software		**Only 1 software license from the list below is required**
Q5500OSTA	1	Quantum control system SW - OS - for Up to 1 chassis
Q5500OCHA	1	Quantum control system SW - OS - for Up to 3 chassis
Q5500OCRA	1	Quantum control system SW - OS - for Up to 6 chassis
Q5500OTRA	1	Quantum control system SW - OS - for Up to 12 chassis
Q5500OMRA	1	Quantum control system SW - OS - for Up to 60 chassis
Services		
PS-XINS-QU#	1	Discuss with your FE which service package is right for you.

Step 1. Choose the host PC connection

The Keysight QCS supports both embedded and external PCs as host controllers for the system. For external controllers, the system is compatible with both standard cables and longer optical cables. Additionally, external controllers require a PC adapter card as well as the system module. For a list of compatible external controllers, refer to this document on Tested PC and PXI Chassis Configurations.

The following table lists the available host PC types.

Table 3. Host PC and adapter cable types

Host PC type	Cable type	Part number	Additional information
Internal	-	M9038A	Embedded PC Memory, 64 GB
External	Standard	M9023A M9049B Y1202A	PC interface PXI module PCIe cable, 2 m
External	Optical	SP0630A SP0631A SP0634A	PC interface PXI module Fiber, 10 m

Step 2. Choose the channel configuraton

The Keysight QCS supports flexible channel configurations to match the needs of diverse qubit architectures.

Step 2-1. Add microwave output/control channels

Each microwave output channel has a frequency range of DC-16 GHz with 2 GHz of bandwidth. Microwave output channels are configured in groups of four. For every four microwave output channels required, add each of the following products.

No additional software products to the Q5500OXXA Quantum Control System SW are needed to use these modules.

Table 4. Microwave output/control channels

Part #	Quantity per four channels	Additional information
Hardware		
M5300A	1	RF AWG: 4 channels, DC-16 GHz
M5301A	1	Precision AWG: 4 channels, 400 MHz

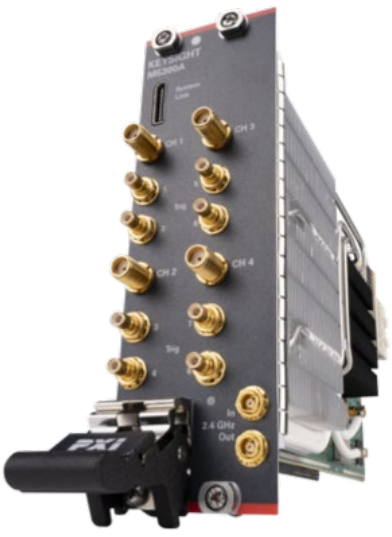

Figure 1. M5300A RF AWG

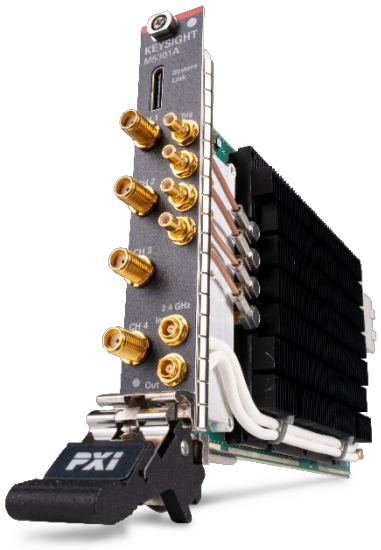

Figure 2. M5301A Precision AWG

Step 2-2. Add microwave input/readout channels

Each microwave input channel consists of two hardware components—a microwave downconverter channel with a frequency range of 2 to 16 GHz, and a digitizer with 2 GHz of bandwidth. Microwave input channels are configured in groups of four. For every four microwave input channels required, add each of the following products.

No additional software products to the Q5500OXXA Quantum Control System SW are needed to use these modules.

Table 5. Microwave input/readout channels

Part #	Quantity per four channels	Additional information
Hardware		
M5200A	1	Digitizer: 4 channels, 2 GHz
M5201A	1	Down converter: 4 channels, 3-16 GHz RF

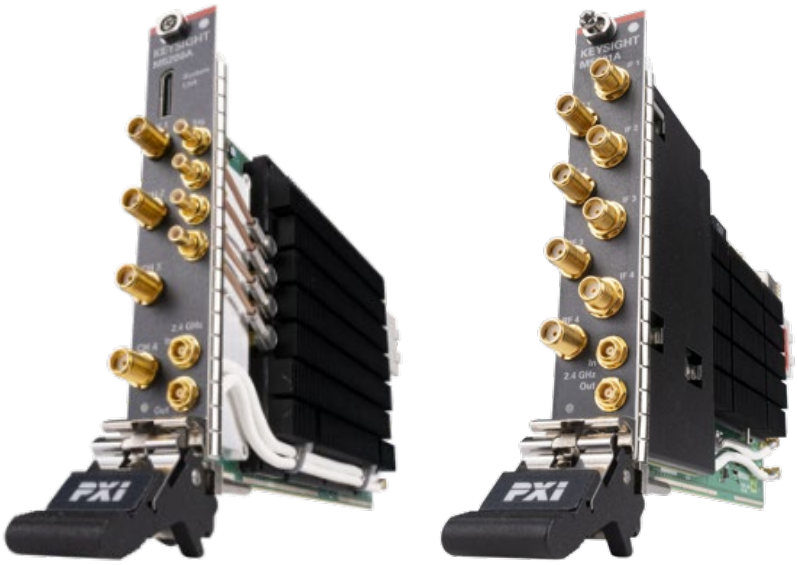

Figure 2. M5200A digitizer (left) and M5201A down converter (right)

Step 2-3. Add DC output channels

Each DC output channel can provide up to 30 V / 500 mA when used as a voltage / current source. DC output channels are configured in groups of five. For every five microwave input channels required, add each of the following products. Note that the low noise filter is optional but recommended for best noise performance.

Table 6. DC output channels

Part #	Quantity per five channels	Additional information
Hardware		
M9614A	1	5-Channel SMU, 100 pA
PX0107A	1	Low-noise filter. Optional (recommended)

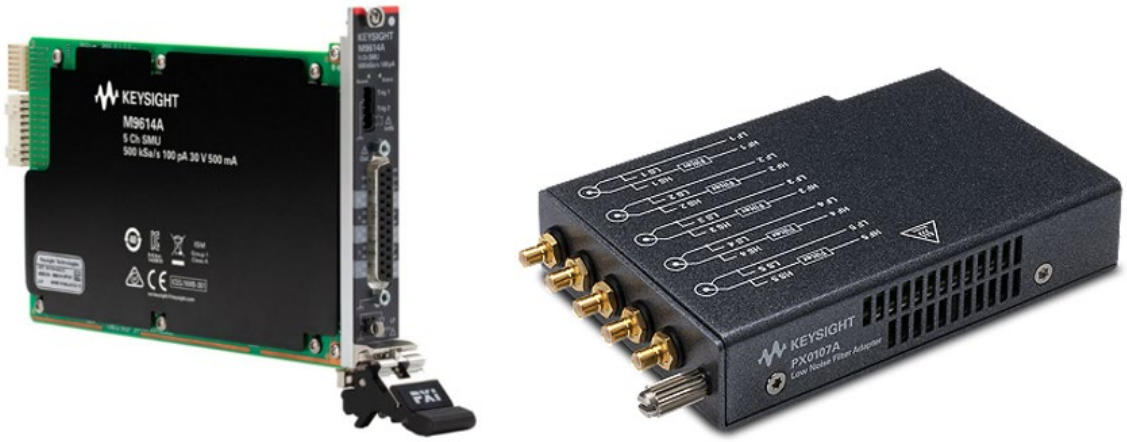

Figure 3. M9614A PXIe SMU (left) and PX0107A low noise filter adapter (right)

Step 3. Add required peripherals

After configuring the needed channels, select the necessary cabling and peripherals.

Step 3-1. Add clock distribution cables

The M9046A-QS1 chassis provides a high precision clock reference that can be distributed to all modules in the system. To calculate the required number of cables required for optimal clock distribution:

1. Count the total number of M5000 Series modules in the system, from steps 2-1 and 2-2.
2. Use the table below to find the required number of cables to add.

Table 7. Y1330A cable count

M5000 module count	Y1330A cable count
1	1
2	3
3	4
4	5
5	8
6	9
7	10
8	11

Step 3-2. Add PXIe slot blockers and filler panels

For optimal cooling and performance, each empty module slot in the chassis should be fitted with a slot blocker and EMC filter panel. Work with your FE to determine how many are required for your configuration.

Conclusion

This guide enables quick configuration of a 1-chassis Keysight Quantum Control System (QCS) with all the required components and accessories as well as a customizable channel configuration to match the needs of the user. For larger systems, additional customization, or any other questions please contact your local Keysight office. The complete list is available at www.keysight.com/find/contactus.