RIGOL

SPQ Array Measurement and Control Solution Datasheet

Product Overview

SPQ array measurement and control solution is designed for complex physical experiments, featuring a modular architecture that is divided into the platform, service module and synchronous triggering module. Users can flexibly configure the required service modules based on experimental requirements to construct various types of complex experimental systems. This modular architecture also facilitates system upgrades and expansion as needed. With industry-leading integration density, the system supports rapid deployment of microwave control and measurement systems with 100 or 1000 channels.

Feature

Digital Measurement and Control

With fully digital architecture, the measurement and control signals with lower noise are generated through combination technology, avoiding complex IQ calibration in traditional mixed frequency systems.

Flexible Configuration

The modular design allows users to make a flexible configuration as needed. The available modules include readout analysis, microwave control, fast bias, digital synchronization, and etc.

Higher Sample Rate

Generates RF control signals within the second Nyquist Zone, with a maximum sample rate of 10 GSa/s for transmit channels and 5 GSa/s for receive channels.

Convergence Computing

PXIe-to-PCIe bridge enables the server to control measurement and control device service boards via PCIe, and supports remote fiber optic connections. The collected data can be transferred to servers via low-latency and high-bandwidth DMA.

High Integration Density

With exceptional device integration density, a single 4U 19-inch device integrates 128 measurement and control channels, and a single cabinet can deploy thousands of measurement and control channels easily.

Multi-Device Synchronization

Supports multiple devices to work stably and synchronously. Just with a simple configuration, thousands of measurement and control channels of dozens of devices can work simultaneously, with phase drift less than ±5 ps.

Dedicated Instruction Sets

Equipped with the instruction set software, users can perform dynamic programming in the FPGA. In instruction set mode, the minimum feedback time is 280 ns, which allows for fast active reset.

Low-Noise Fan

High-density integrated devices achieve low power consumption. Excellent cooling design reduces fan noise to approximately 60 dB during continuous operation, ensuring quiet lab environments.

SPQ array measurement and control solution is configured flexibly with multiple device models including chassis, controller, service module, and full license of application software and APIs. Device models are categorized by functional purposes while individual device model type may have multiple part numbers based on parameters. Service modules can only function properly with accessories such as RF cables and filters.

M6301 PQ-XY Microwave Control Module

M6301 PQ-XY Microwave Control Module	
Number of Channels	8 channels, AC-coupled
DAC Resolution	14-bit
Output Frequency Range	0.1 GHz-9.8 GHz
Maximum Output Power	-7.8 dBm @ 4.3 GHz (typ)
	-8.3 dBm @ 5.3 GHz (typ)
	-8.9 dBm @ 6.3 GHz (typ)
	-10.9 dBm @ 7.3 GHz (typ)
Output Impedance	50 Ohm
DAC Sample Rate	4/6/8/10 GSa/s
Output Noise PSD	-160 dBm/Hz
Output Phase Noise	-103 dBc/Hz, cw=1 GHz, offset=100 Hz
	-117 dBc/Hz, cw=1 GHz, offset=1 KHz
	-124 dBc/Hz, cw=1 GHz, offset=10 KHz
IM3	-54 dBc @ -6dBFs, δF=20 MHz
Worst Harmonic Suppression	-44 dBc @ 8.6 GHz, cw= 4.3 G
SFDR	-50 dBc @ 4.3 GHz
Waveform Memory Depth	AWG mode: 600 Kpts/ch
	Instruction set mode: 100 Kpts/ch
Waveform Playback Duration	AWG mode: 100 us @ 6 GSa/s
	Instruction set mode: unlimited (supports fragment playback and adjustable carrier)
24-hour Phase Jitter	<5 ps
24-hour Power Drift	<0.05 dB

M6311 PQ-ZC Bias Control Module

M6311 PQ-ZC Bias Control Module	
Number of Channels	8 channels, DC-coupled
Output Frequency Range	DC-1.8 GHz
Output Impedance	50 Ohm
DC Output Voltage Range	1.35V Vpp
Output Voltage Step	85 uV
DAC Sample Rate	2/4/6 GSa/s
Output Phase Noise	-121 dBc/Hz @ 100 Hz
	-135 dBc/Hz @ 1 KHz
SFDR	-70 dBc @ 500 MHz
Waveform Memory Depth	AWG mode: 300 Kpts/ch
	Instruction set mode: 100 Kpts/ch
Waveform Playback Duration	AWG mode: 150 us @ 2 GSa/s
	Instruction set mode: unlimited
Rise Time (20% to 80%)	<200 ps
Module-to-Module Feedback Delay	Instruction set mode: <500 ns

M4910 PQ-RD Microwave Readout Module

M4910 PQ-RD Microwave Readout Module	
Module Overall Parameters	
Number of Microwave Excitation Channels	4 channels, AC-coupled
Number of Microwave Acquisition Channels	4 channels, AC-coupled
Module Characteristics	Supports reading of 4 independent links per module
Microwave Excitation Channel Specifications	
DAC Resolution	14-bit
Output Frequency Range	0.1 GHz-9.8 GHz
Maximum Output Power	-7.8 dBm @ 4.3 GHz (typ)
(8GSa/s Typical)	-8.3 dBm @ 5.3 GHz (typ)
	-8.9 dBm @ 6.3 GHz (typ)
	-10.9 dBm @ 7.3 GHz (typ)
Output Impedance	50 Ohm
DAC Sample Rate	4/6/8/10 GSa/s
Output Noise PSD	-160 dBm/Hz
Output Phase Noise	-103 dBc/Hz, cw=1 GHz, offset=100 Hz
	-117 dBc/Hz, cw=1 GHz, offset=1 KHz
	-124 dBc/Hz, cw=1 GHz, offset=10 KHz
IM3	-54 dBc @ -6dBFs, δF=20 MHz
Worst Harmonic Suppression	-44 dBc @ 8.6 GHz, cw= 4.3 G
SFDR	-50 dBc @ 4.3 GHz
Waveform Memory Depth	Combination mode: 48 Kpts/ch
	AWG mode: 600 Kpts/ch
	Instruction set mode: 100 Kpts/ch
Waveform Playback Duration	AWG mode: 100 us @ 6 GSa/s
	Instruction set mode: unlimited (supports fragment playback and adjustable carrier)
24-hour Phase Jitter	<5 ps
24-hour Power Drift	<0.05 dB
Microwave Acquisition Channel Specifications	
ADC Resolution	14-bit
Input Frequency Range	0.1 GHz-9.8 GHz
Maximum Input Power	5 dBm @ 3.2 GHz (typ)
	12 dBm @ 8.3 GHz (typ)
Input Impedance	50 Ohm
Input Power Range	-50 dBm to 10 dBm
ADC Sample Rate	3/4/5 GSa/s
SFDR	53 dBc @ 4.3 GHz
Maximum Memory Depth	8 Kpts/ch
Maximum Demodulation Duration	2 us/ch
Number of Demodulation Frequency Points	Combination mode: 8 pts/ch
	16 pts/ch
24-hour Phase Jitter	<5 ps
24-hour Power Drift	<0.05 dB
Demodulation Integration Weights	Supports
Multiple Reads within Single Trigger	Supports in instruction set mode
Data Upload Type	Raw data/Demodulated IQ data/Decision result data

M4911 PQ-MC Microwave Measurement and Control Module

M4911 PQ-MC Microwave Measurement and Control Module	
Module Overall Parameters	
Number of Microwave Excitation Channels	1 channel, AC-coupled
Number of Microwave Acquisition Channels	1 channel, AC-coupled
Number of Microwave Control Channels	6 channels, AC-coupled
Module Characteristics	A single module can control and read multiple bits on one link.
Intra-Module Feedback Delay	<280 ns
Module-to-Module Feedback Delay	<500 ns
Microwave Excitation and Control Channels Specifications	
DAC Resolution	14-bit
Output Frequency Range	0.1 GHz-9.8 GHz
Maximum Output Power	-7.8 dBm @ 4.3 GHz (typ)
	-8.3 dBm @ 5.3 GHz (typ)
	-8.9 dBm @ 6.3 GHz (typ)
	-10.9 dBm @ 7.3 GHz (typ)
Output Impedance	50 Ohm
DAC Sample Rate	4/6/8/10 GSa/s
Output Noise PSD	-160 dBm/Hz
Output Phase Noise	-103 dBc/Hz, cw=1 GHz, offset=100 Hz
	-117 dBc/Hz, cw=1 GHz, offset=1 KHz
	-124 dBc/Hz, cw=1 GHz, offset=10 KHz
IM3	-54 dBc @ -6dBFs, δF=20 MHz
Worst Harmonic Suppression	-44 dBc @ 8.6 GHz, cw= 4.3 G
SFDR	-50 dBc @ 4.3 GHz
Waveform Memory Depth	Combination mode: 48 Kpts/ch
	AWG mode: 600 Kpts/ch
	Instruction set mode: 100 Kpts/ch
Waveform Playback Duration	AWG mode: 100 us @ 6 GSa/s
	Instruction set mode: unlimited (supports fragment playback and adjustable carrier)
24-hour Phase Jitter	<5 ps
24-hour Power Drift	<0.05 dB
Microwave Acquisition Channel Specifications	
ADC Resolution	14-bit
Input Frequency Range	0.1 GHz-9.8 GHz
Maximum Input Power	5 dBm @ 3.2 GHz (typ)
	12 dBm @ 8.3 GHz (typ)
Input Impedance	50 Ohm
Input Power Range	-50 dBm to 10 dBm
ADC Sample Rate	3/4/5 GSa/s
SFDR	53 dBc @ 4.3 GHz
Maximum Memory Depth	8 Kpts/ch
Maximum Demodulation Duration	2 us/ch
Number of Demodulation Frequency Points	Combination mode: 8 pts/ch
	16 pts/ch
24-hour Phase Jitter	<5 ps
24-hour Power Drift	<0.05 dB
Demodulation Integration Weights	Supports
Multiple Reads within One Trigger	Supports in instruction set mode
Data Upload Type	Raw data/Demodulated IQ data/Decision result data

M8401B PQ-S10 Clock Synchronization Module

M8401B PQ-S10 Clock Synchronization Module	
Number of Backplane Clock Distributions	16
Slot Occupied and Slot Number	1 Slot, Slot 10
Clock Mode	Internal phase-locked crystal oscillator/external front panel clock input
Internal Clock	Internal phase-locked crystal oscillator, 100 MHz
Internal Clock Stability	⩽ 10 ppb
Internal Clock Phase Noise	-123 dBc/Hz@100 Hz
	-160 dBc/Hz@1 kHz
	-168 dBc/Hz@10 kHz
Front Panel Clock Input	SMA/SMP/SSMB, 100 MHz, replaces phase-locked crystal oscillator 100 MHz clock
Front Panel Reference Clock	SMA/SMP/SSMB, 10 MHz, as a reference clock to generate 100 MHz clock with phase-locked crystal oscillator
Front Panel Clock Output	SMA/SMP/SSMB, 100 MHz
Front Panel Trigger Output	SMA/SMP/SSMB, LVTTL 3.3 V
Front Panel External Trigger Input	SMA/SMP/SSMB, LVTTL 3.3 V
Number of Backplane Trigger Distributions	16
Trigger Step	80 ns/800 ns
Number of Triggers	1 to ∞
Feedback Link	16-link feedback connections to modules in the chassis backplane

M8402B PQ-S10Pro Clock Synchronization Module

M8402B PQ-S10Pro Clock Synchronization Module	
Number of Backplane Clock Distributions	16
Slot Occupied and Slot Number	3 Slots, Slot 9/10/11
Clock Mode	Internal phase-locked crystal oscillator/external front panel clock input
Internal Clock	Internal phase-locked crystal oscillator, 100 MHz
Internal Clock Stability	⩽ +0.3 ppm
Internal Clock Phase Noise	-132 dBc/Hz @ 100 Hz
	-157 dBc/Hz @ 1 kHz
	-168 dBc/Hz @ 10 kHz
Front Panel Clock Input	SMA/SMP/SSMB, 100 MHz, replaces phase-locked crystal oscillator 100 MHz clock
Front Panel Reference Clock	SMA/SMP/SSMB, 10 MHz, as a reference clock to generate 100 MHz clock with phase-locked crystal oscillator
Front Panel Clock Output	SMA/SMP/SSMB, 100 MHz
Front Panel Trigger Output	SMA/SMP/SSMB, LVTTL 3.3 V
Front Panel External Trigger Input	SMA/SMP/SSMB, LVTTL 3.3 V
Number of Backplane Trigger Distributions	16
Trigger Step	80 ns/800 ns
Number of Triggers	1 to ∞
Feedback Link	16-link feedback connections to modules in the chassis backplane
	Front panel supports inter-chassis feedback interconnections with QSFP/QSFP-DD/MPO
Module Characteristics	For parallel synchronization among multi-chassis modules

M2302 PQ-M02 Controller

M2302 PQ-M02 Controller	
Processor Core Parameters	AMD V2000 or equivalent CPU, with 10 GbE
Memory Parameters	32 GB, 4800 MHz
Storage Capacity	Built-in 512 GB SSD, expansion supported
Interface	USB 3.0, Gigabit Ethernet RJ45, HDMI or DP port
Operating System	CentOS 8

M2601 PQ-R01 Remote Controller

M2601 PQ-R01 Remote Controller	
Connector Parameters	QSFP X2, fiber interface, supports PCIe Gen3 X8 protocol conversion
Maximum Fiber Length	>50 m
Module Characteristics	PXIe-to-PCIe bridge, direct control of measurement devices by HPC server
Convergence Computing Supported, CPU to QPU Communication Latency	<25 us
Convergence Computing Supported, CPU to QPU Communication Latency	>6.6 GB/s

M1103B PQ-C16 Array Measurement and Control Platform

M1103B PQ-C16 Array Measurement and Control Platform	
Number of Supported Service Modules	16
Chassis Dimensions	19-inch, 4U
Dimensions	444.4 mm (W) x 177.8 mm (H) x 480.5 mm(D)
Weight	Approx. 20 kg (related to the number of modules)
Input Voltage	AC 100 V-240 V
Static	75 W
Maximum Power Consumption	1300 W @ 220 V power supply
Fan Noise	Less than 60 dB
System Integration Density	128 CH/4 U
Intra-Module Feedback Delay	<280 ns, PQ-MC module channel based
Intra-Chassis Feedback Delay	<500 ns
Inter-Chassis Feedback Delay	<650 ns
Chassis Characteristics	Applicable to large-scale measurement and control applications

M1210 PQ-C02 Small-Scale Measurement and Control Platform

M1210 PQ-C02 Small-Scale Measurement and Control Platform	
Number of Supported Service Modules	2
Dimensions	340.0 mm (W) x 68.0 mm (H) x 230.0 mm(D)
Weight	Approx. 5 kg
Input Voltage	DC 19.5 V, with adapter (100 V-240 V)
Maximum Power Consumption	180 W
Intra-Module Feedback Delay	<280 ns, PQ-MC module channel based
Chassis Characteristics	Applicable to 8-bit small-scale measurement and control application or demonstration prototypes