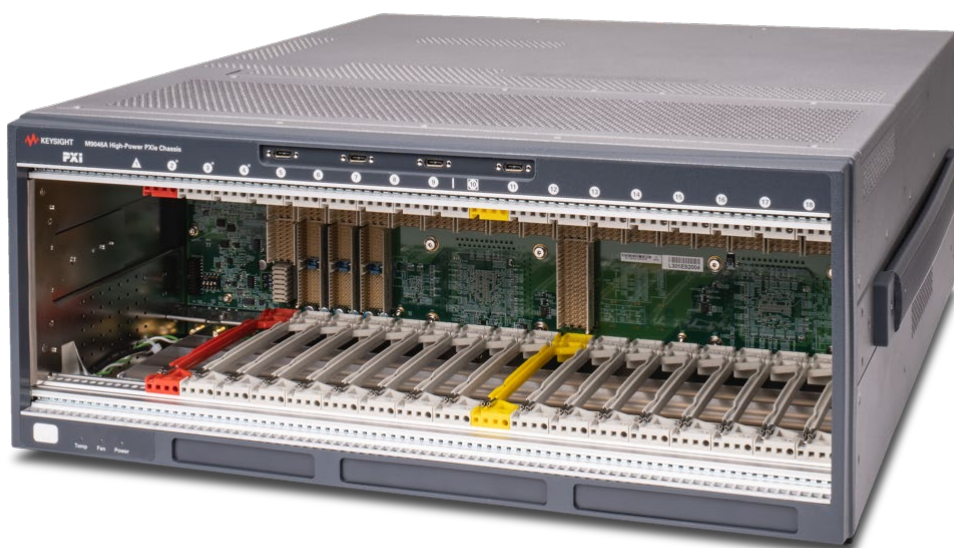


# M9046A 18-slot PXle Chassis

PCIe Gen 3, 24 GB/s, high power, exceptional cooling



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# Introduction

The Keysight Technologies, Inc. M9046A PXIe 18-slot chassis delivers the power and cooling required for high-performance applications. It includes 3 PXIe hybrid slots which gives the system designer the flexibility to mix PXIe and hybrid-compatible modules. With its Gen 3 backplane and x24 system slot, it is ready to tackle high-data bandwidth applications.

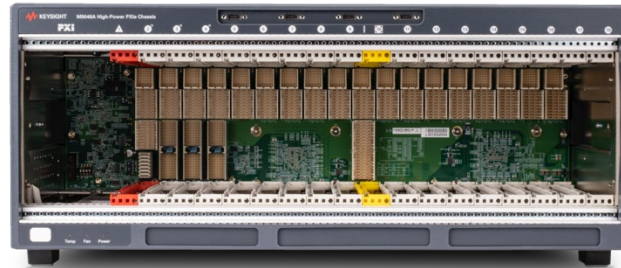
The M9046A is new from the ground up including a new power supply design providing unprecedented power per slot capabilities with the ability to monitor power and control switching frequency on a per-slot basis. With a greater than 2 times improvement in airflow compared to the previous Keysight 18-slot chassis, it delivers similar cooling performance at only 30% of the maximum fan speed. This improvement in cooling performance results in superior acoustical performance as well up to a maximum 85 watts per slot. The chassis is also designed for easy integration into large systems containing multiple PXIe chassis and other non-PXI instrumentation including access to 8 hardware trigger lines without consuming a slot.

## Key features

- 3 PXIe hybrid slots, 13 PXIe slots, 1 PXIe timing slot, and 1 PXIe system slot
- High power with up to 1675W usable power
- Up to 85W/slot cooling with exceptional acoustical performance (100W/slot with option 003)
- High performance backplane (maximum 24 GB/s system and 8 GB/s slot-to-slot) with a two-link (x8, x16) system slot and x8 links to the PXIe slots
- Multi-chassis power-sequencing and optional rear trigger access (8 triggers)
- OCXO 10/100 MHz reference clock ( $\pm 1$  ppm)
- Specified up to 55°C and 10,000 ft operating conditions

# Hardware Overview

## Backplane configuration



The M9046A PXIe chassis utilizes high performance PCIe switch fabric that operates at up to Gen 3 speeds. All the PXIe peripheral slots have a x8 PCIe link providing a maximum data bandwidth of 8 GB/s each. The two-link system slot (x8 + x16) has a maximum data bandwidth of 24 GB/s when all 24 PCIe lanes are utilized. When combined with the M9023A PXIe system module, M9049A PCIe adapter, and an external PC with a Gen 3 x16 PCIe slot, up to 16 GB/s of data bandwidth can be achieved between the PC and PXIe chassis.

The three PXIe hybrid slots are serviced by a PCIe-to-PCI bridge and all PXIe slots are also organized into three trigger bus segments with configurable interconnections between segments. An optional rear panel trigger distribution panel gives the user eight trigger ports (SMB) which are connected to the PXI [0:7].

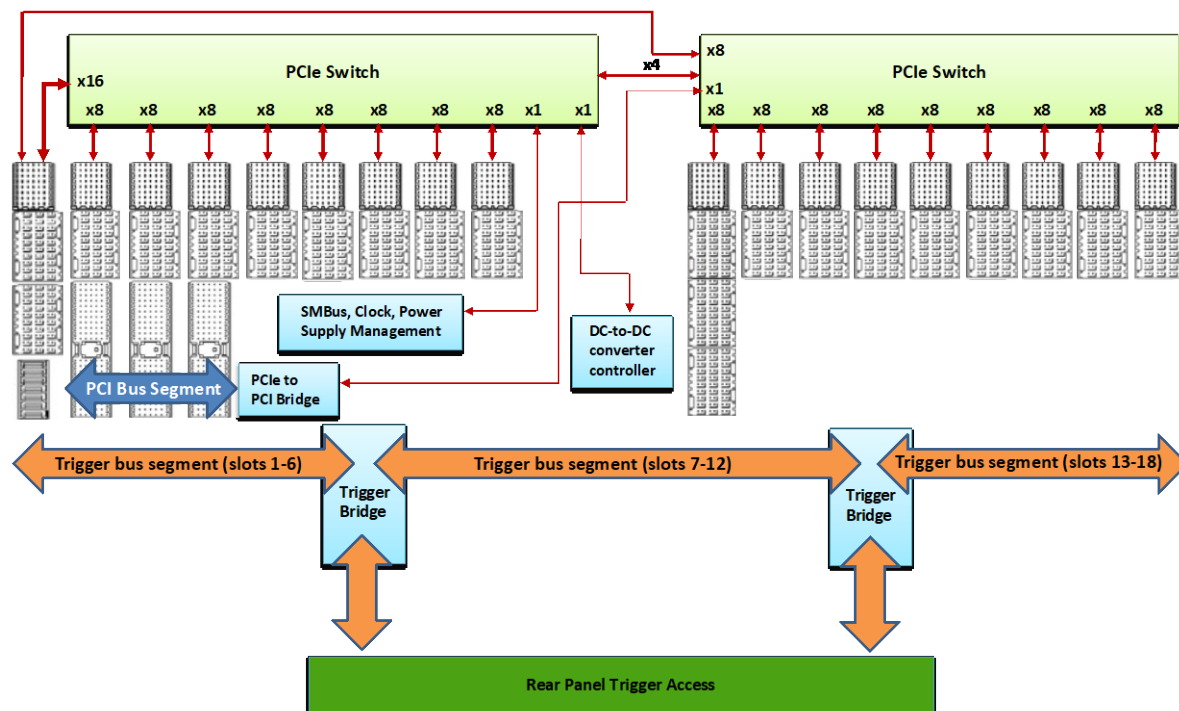


Figure 1. M9046A block diagram

## Exceptional per-slot cooling capacity

The M9046A chassis utilizes a new chassis cooling system with an increased volume of airflow resulting superb per-slot cooling while producing a lower level of acoustical noise. Three auto-speed fans on the rear panel pull in cooling air and unlike other PXI chassis, auto mode can be used over the full operating temperature range of the chassis. Hot air is then expelled out of the top of the chassis after flowing from bottom to top of the slots (Figure 2).

The fan speed is controlled by utilizing eight temperature sensors located just above the modules in the path of the module exhaust air. This enables the fans in the chassis to react to changes in module, temperatures, instead of relying on ambient air temperature readings. This can result in lower module operating temperatures when the auto fan setting is used.

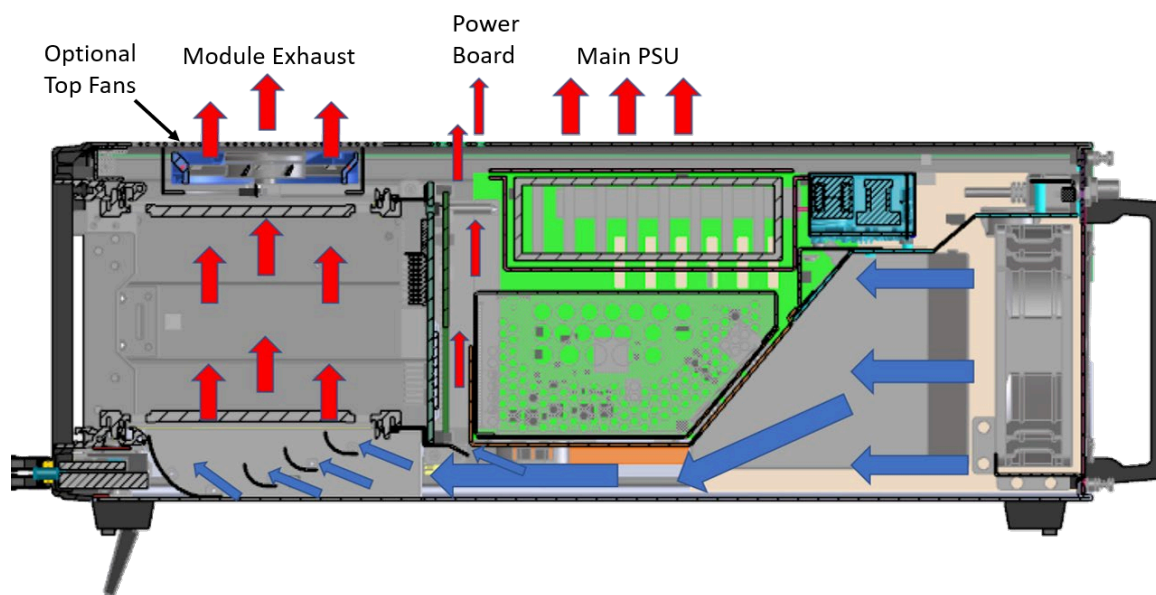


Figure 2. M9046A airflow

## System monitoring and system power

The M9046A chassis has a complete set of system monitoring functions for important parameters such as module exhaust temperatures, voltage rails, and fan speeds. Chassis operating conditions can be monitored via a software API or the soft front panel interface.

A DB-9 connector is also available at the rear of the chassis for remote inhibit and power rail monitoring. The chassis has configurable alarms that can be monitored via front panel LEDs, soft front panel interface, or software API.

The chassis includes a patented power supply design which utilizes a main power supply with a single output voltage to improve efficiency and reliability. The output is then distributed to each slot where individual DC-to-DC voltage converters provide the necessary voltage rails on a slot-by-slot basis. An optional software control utility (option 002) provides a whole new level of power supply control. This feature allows the user to monitor the power and control the DC converters on an individual slot basis.

## Designed for large systems

When connecting multiple PXIe chassis together, the power sequencing becomes very important especially when an embedded controller is used. The M9046A PXIe chassis have special features built-in to make this easy. Cat 5 cables with RJ-45 connectors are used to interconnect the chassis. In a multi-chassis configuration, a user can press a single chassis power button to enable all chassis in the system to power-up. If an embedded controller is being used, its chassis will automatically be powered up last. This provides a consistent, repeatable power-up sequence.

The chassis also has an optional, rear panel trigger distribution system (M9046A-001) which can accommodate up to eight SMB input/output triggers. These trigger ports connect to the PXIe backplane adding configuration flexibility to the system when non-PXIe instruments are used or when a PXIe instrument being used can only receive triggers over the PXIe backplane.



**Figure 3.** Rear panel with Option 001 rear trigger bus access installed

## 2.4 GHz reference clock

The M9046A can be configured to support complex applications which require internal high-performance, specialized reference signals and front panel reference distribution. These chassis also come pre-configured with the top fan tray to provide additional cooling capacity (option 003). They are not compatible with the rear trigger access (option 001).

### **M9046A-QS1**

This option provides an internal, high-performance 2.4 GHz reference clock with exceptional phase noise performance. Front panel access to this reference is provided along three front panel-mounted, 2.4 GHz 1:4 dividers. It also includes front panel access to both the 100 MHz backplane and high-performance reference clocks. Required for the primary chassis in a single or multi-chassis systems utilizing the following modules: M5200A, M5201A, M5300A, and M5301A.

### **M9046A-QS2**

This option provides front panel splitter/distribution for the 2.4 GHz reference clock as well as the 100 MHz and 2.4 GHz reference clocks from the backplane. Required for all expansion chassis in a multi-chassis system utilizing the following modules: M5200A, M5201A, M5300A, and M5301A.

### **M9046A-QS3**

This option provides an internal, high-performance 2.4 GHz reference clock with exceptional phase noise performance. Front panel access to this reference is provided along three front panel-mounted, 2.4 GHz 1:4 dividers. It also includes front panel access to both the 100 MHz backplane and high-performance reference clocks. Required for the primary chassis in a single or multi-chassis systems utilizing the following modules: M5200A, M5201A, M5300A, and M5301A.



# Software Platform

## Drivers

The M9046A PXIe chassis is supported by a set of IVI, NET, IVI-C, and LabVIEW drivers. Windows 8.1 and 10 operating systems are supported, and applications can be created using a variety of software tools including LabVIEW, LabWindows/CVI, MATLAB, VEE, Visual Basic, VisualStudio.NET (C/C++, C#, VB.NET).

## Soft front panel interface and trigger manager

The soft front panel (SFP) interface (Figure 3) and PXIe-9 compliant trigger bus manager are provided with the chassis. The SFP can be used to monitor and control the PXIe chassis and has the following functions:

- Monitor chassis fan speed, chassis temperatures, rail voltages, and PCIe links
- Configure alarms for fan speed, temperature, rail voltage, and reference clock
- Run chassis self-test and update chassis firmware
- Configure reference clock
- Review chassis information

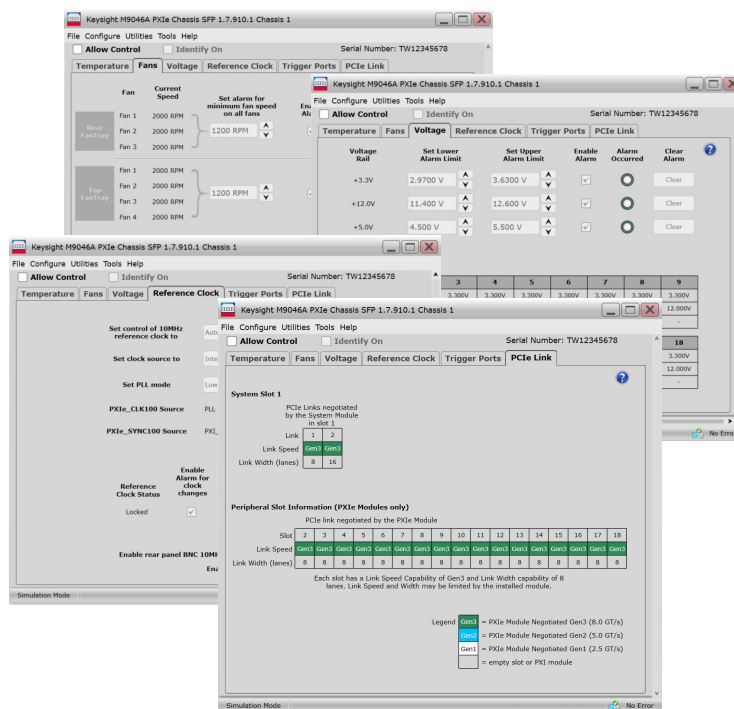


Figure 4. Soft front panel



## Advanced power monitoring and control (M9046A-002)

This option provides the ability to monitor the module power supplies on a per-slot basis. Each PXI module is powered independently using a set of DC-DC converters for each slot. The monitor software allows you control the following on a per-slot basis:

- Voltage and current reading for each rail
- Switching frequency for all rails (from 400kHz to 800kHz)
- Switching phase for all rails (0 to 360 degrees)
- Spread spectrum enable/disable for all rails

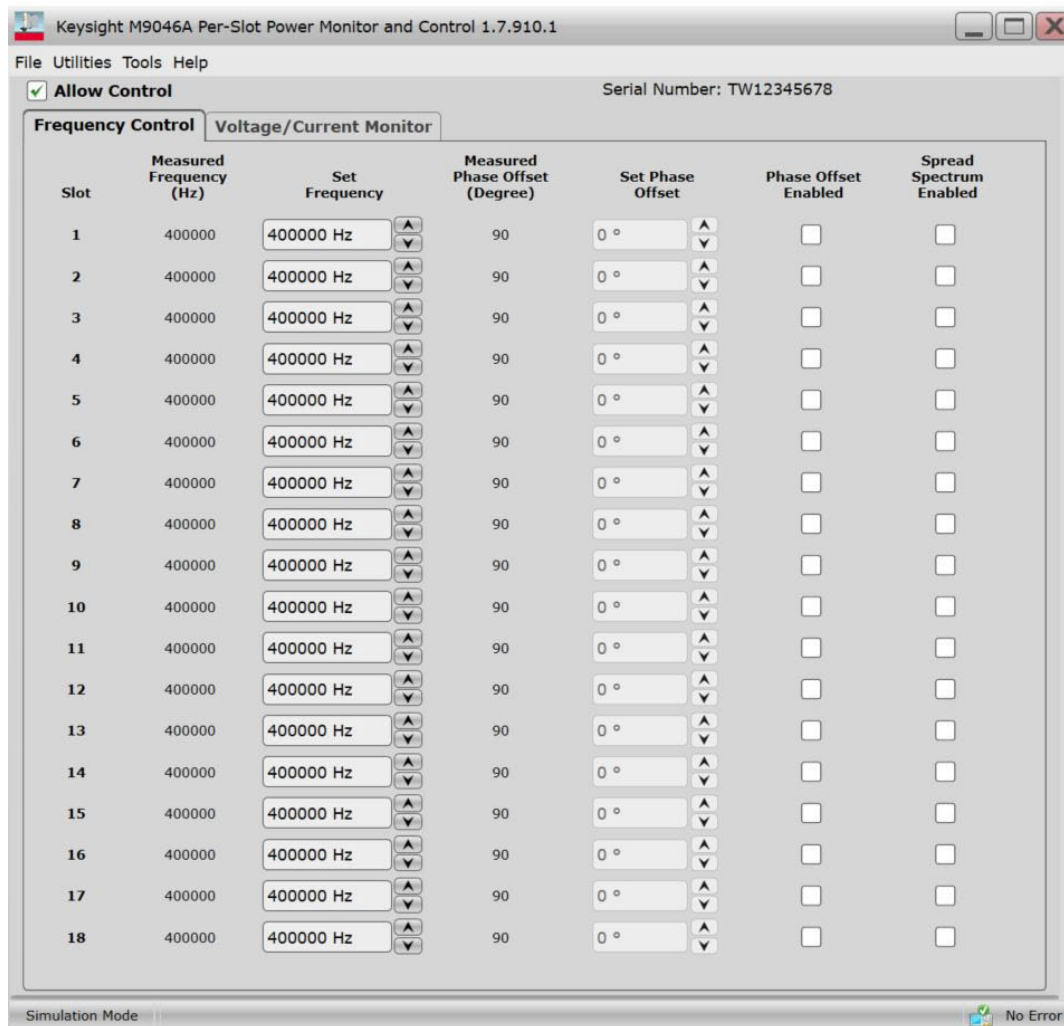


Figure 5. Power monitoring software

# Technical Specifications and Characteristics

## General chassis characteristics

### Standards compliance

- PXI-5 PXI Express hardware specification
- PXI-1 hardware specification Rev 2.2
- PICMG EXP.0 R2.0 specification

### Backplane

Module size	3U
Total slots	18
Hybrid compatible slots	3
PXle system slot	1 (with three system expansion slots)
PXle timing slot	1 (also accepts PXle module)
Module compatibility	PXle, PXI-Hybrid, PXI-1 (J1 only), and cPCI (J1 only)
System slot link configuration	2-Link (x8 and x16)
Backplane speed	PCIe revision 3.0 (Gen 3)

### Mechanical

Size	445 mm W x 193 mm H x 515 mm D (with feet installed)
	445 mm W x 178 mm H x 515 mm D (with feet removed)
	4U x 1 rack width
Weight (without modules)	18.66 kg (41.14 lbs.)

## Power supply characteristics

### AC input<sup>1</sup>

Operating voltage/power (low-line) <sup>2</sup>	100/120 V, 1350 W (maximum)
Operating voltage/power (high-line) <sup>2</sup>	220/240 V, 2000 W (maximum)
Input frequency range (100/120V)	50/60/400 Hz <sup>3</sup>
Input frequency range (220/240V)	50/60 Hz <sup>3</sup>
Over current protection	Internal fuse in line

### Available DC output power (for module slots)<sup>4</sup>

220 to 240 V input	1675 W
100 to 120 V input	887.5 W <sup>5</sup>

<sup>1</sup> The instrument can operate safely with voltage fluctuations up to  $\pm 10\%$

<sup>2</sup> Auto switching between high line and low line

<sup>3</sup> 100-120VAC 400 Hz and 220-240VAC 60 Hz operation requires redundant earth ground. See installation manual for details

<sup>4</sup> 2% derating per degree above 50°C and 2% derating per 100m (328.1ft) above 2000m (6561.7ft)

<sup>5</sup> With option 003: 820 W

### Individual slot power characteristics

DC supplies	Maximum current			Maximum power			Load regulation	Maximum ripple and noise (20 MHz BW)
	System slot	PXle slot	Hybrid slot	System slot	PXle slot	Hybrid Slot		
+3.3 V	15 A	9 A	9 A	49.5 W	29.7 W	29.7 W	5%	1.5% (pk-pk)
+5 V <sup>6</sup>	15 A	0 A	6 A	75 W	0 W	30 W	5%	1% (pk-pk)
+12 V	30 A	6 A	6 A	360 W	72 W	72 W	5%	1% (pk-pk)
-12 V <sup>7</sup>	0 A	0 A	1 A	0 W	0 W	12 W	5%	1% (pk-pk)
5 VAUX <sup>8</sup>	1 A	1 A	1A	5 W	5 W	5 W	5%	50 mV (pk-pk)

### Backplane pin current capacity (nom)

Slot	+3.3 V	+5 V	+12 V	- 12 V	5 V <sub>AUX</sub>
System controller slot	15 A	15 A	30 A	0 A	1 A
System timing/PXle slot	9 A	0 A	6 A	0 A	1 A
PXle hybrid slot	9 A	6 A	6 A	1 A	1 A

### Chassis cooling and power dissipation characteristics

Slot airflow direction	Bottom of module to top of module	
Chassis cooling intake	Rear of chassis	
Chassis cooling exhaust	Top of chassis	
Chassis cooling fans		
Standard	Three 210 cfm fans on rear panel with HIGH/AUTO speed selector	
Option 003	Four 129 cfm fans on top panel with HIGH/AUTO speed selector	
Power dissipation	Standard	With option 003
System slot	300 W max	300 W max
Peripheral slot	85 W max**	100 W max**
Timing slot	85 W max**	100 W max**

### DC supply protection

Over-current protection	Power supply is shut down when the output current is approximately 25% above maximum pin current per slot
Over-voltage protection	Maximum output is 8% of nominal voltage for all rails

<sup>6</sup> A single 25A@5V supply is shared across the 3 Hybrid slots and the System Slot

<sup>7</sup> A single 1A@-12V supply is shared across the 3 Hybrid slots

<sup>8</sup> A single 2A 5VAUX supply is shared across all slots

\*\* Maximum per slot power dissipation at 55°C with 15°C temperature rise; requires a) that the chassis top is not blocked (1U rack space above or sitting on bench and b) a slot blocker is installed in each empty slot. Module cooling can be impacted by each module's resistance to air flow.

### DC output regulator frequency characteristics

	Default	With Option -002
Switching Frequency	400 kHz	400 to 800 kHz
Phase offset	0 degrees	0 to 359 degrees
Spread Spectrum	Disabled	Enable or disable

### Spread spectrum characteristics (with Option -002)

Modulation	Triangular
Frequency	3.125 kHz
Amplitude	320 ns

### Clocks and trigger characteristics

<b>10 MHz system clock (PXI_CLK10) (typ)</b>	
Maximum slot-to-slot skew	155 ps
Accuracy	$\pm 1$ ppm
<b>100 MHz system clock (PXIe_CLK100) (typ)</b>	
Maximum slot-to-slot skew	125 ps
Accuracy	$\pm 1$ ppm
<b>100 MHz SYNC (PXIe_SYNC100) (typ)</b>	
Maximum slot-to-slot skew	125 ps
Accuracy	$\pm 1$ ppm
<b>External 10 MHz clock source input requirements (nom)</b>	
Frequency input	10 MHz $\pm$ 20 ppm
Input signal (10 MHz REF In BNC)	100 mV <sub>PP</sub> to 5 V <sub>PP</sub> (square-wave or sine-wave)
Input signal (PXI timing slot PXI_CLK10_IN)	5 V or 3.3 V TTL signal
<b>External 10 MHz clock output (nom)</b>	
Output amplitude (10 MHz REF Out BNC)	1 V <sub>PP</sub> $\pm$ 20% square-wave into 50 $\Omega$
	2 V <sub>PP</sub> unloaded
Output impedance (10 MHz REF Out BNC)	50 $\Omega$ $\pm$ 5 $\Omega$
<b>PXI star trigger (typ)</b>	
Maximum slot-to-slot skew	250 ps
<b>PXI differential star triggers (typ)</b>	
Maximum slot-to-slot skew	150 ps
Maximum differential skew	25 ps
<b>Option 001 rear panel triggers (nom)</b>	
Number of trigger ports	8
Connector type	SMB
Direction control	Input or output (configurable)
Output level	3.3 V CMOS (TTL compatible)
Output impedance	50 $\Omega$ (typ)
Output trigger source	PXI_Trig0 - PXI_Trig7 (Segment 1,2, or 3)
Input level	3.3 V CMOS (TTL compatible, 5 V tolerant)
Input impedance	2 k $\Omega$ (typ)
Input trigger destination	PXI_Trig0 - PXI_Trig7 (Segment 1, 2, or 3)
Input threshold	1.65 V (typ)
Minimum swing	250 mV (typ)
Minimum pulse width	100 ns (typ)

# Environmental Characteristics<sup>9,10,11</sup>

## Operating and storage conditions

	Operating	Storage
Temperature	0 °C to 55 °C <sup>12</sup>	-40 °C to 70 °C
Altitude	Up to 10,000 ft (Approximately 3000 m) <sup>12</sup>	Up to 15,000 ft (4572 m)
Maximum relative humidity (non-condensing)	Type tested, 95%RH up to 40 °C, decreases linearly to 45% RH at 55°C <sup>13</sup>	

## Shock and vibration

Operating random vibration	Type-tested at 5 to 500 Hz, 0.21 g <sub>rms</sub>
Survival random vibration	Type-tested at 5 to 500 Hz, 2.09 g <sub>rms</sub>
Functional shock	Type tested at half-sine, 30 g, 11 ms
Bench handling	Type tested per MIL-PRF-28800F

## Acoustical emissions with rear fans only (referenced to 20 µPa)

Sound pressure level <sup>14,15</sup>	Auto fan (25 °C ambient)	High fan (55 °C)
42 W/slot	52 dBA	72 dBA
60 W/slot	62 dBA	72 dBA
85 W/slot	69 dBA	72 dBA
Sound power level	Auto fan (25 °C ambient)	High fan (55 °C)
42 W/slot	60 dB	79 dB
60 W/slot	69 dB	79 dB
85 W/slot	77 dB	79 dB

## Acoustical emissions with option 003 (referenced to 20 µPa)

Sound pressure level <sup>15</sup>	Auto fan (25 °C ambient)	High fan (55 °C)
90 W/slot	74 dBA	80 dBA
100 W/slot	77 dBA	80 dBA
Sound power level	Auto fan (25 °C ambient)	High fan (55 °C)
90 W/slot	77 dB	83 dB
100 W/slot	80 dB	83 dB

<sup>9</sup> Samples of this product have been type-tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of storage, transportation and end-use. Those stresses include but are not limited to temperature, humidity, shock, vibration, altitude, and power line conditions.

<sup>10</sup> Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

<sup>11</sup> Intended for indoor use only

<sup>12</sup> The amount of power available derates at 2% per degree above 50°C and 2% derating per 100m (328.1ft) above 2000m (6561.7ft)

<sup>13</sup> From 40°C to 55°C, the maximum % Relative Humidity (non-condensing) follows the line of constant dew point

<sup>14</sup> At operator position.

<sup>15</sup> At sea level.

# Definitions

## **Specification (spec)**

Describes the performance of parameters covered by the product warranty and are valid for the unit's operation within the stated environmental range unless otherwise noted. Specifications include production guardbands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions. Standard calibration services offered by Keysight will ensure all these specifications are measured and a related statement of compliance with specification provided in the resulting calibration report.

## **Characteristic**

Characteristics describe product performance that is useful in the application of the product, but that is not covered by the product warranty. Characteristics are often referred to as nominal or typical values.

## **Typical (typ)**

Intended to provide additional information including the expected performance of an average unit that is not covered by the product warranty. These characteristics are shown in italics or labeled as 'typical'. Performance of a customer unit to typical specifications may or may not be measured during a calibration service.

## **Nominal (nom)**

A general, descriptive term that does not imply a level of performance. It is not covered by the product warranty. Represents the value of a parameter that is most likely to occur; the expected mean or mode of all instruments at room temperature (approximately 23 °C). These characteristics are shown in italics or labeled as 'nominal'. Performance of a customer unit to nominal specifications may or may not be measured during a calibration service.

## **Additional information**

The data contained in this document is subject to change.

# M9046A Rack Mounting and Configuration

## Standard rack mounting kit

The optional Y1257A rack mounting kit can be used to flush-mount an M9046A chassis into an instrument rack. It is adjustable so that it can be adapted to non-Keysight racks. This kit is designed to ensure proper cooling performance when a single chassis is installed into a rack.

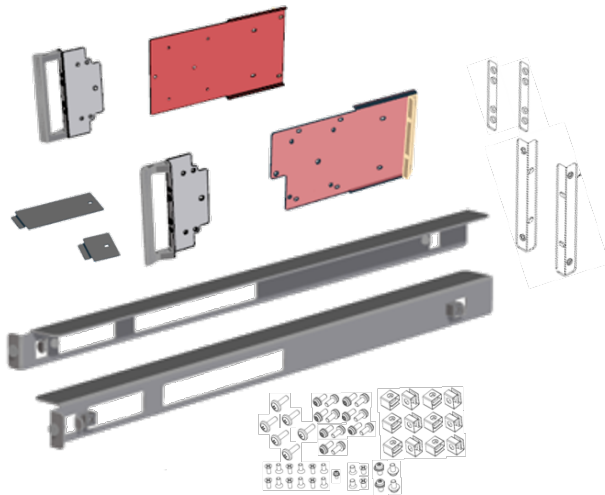


Figure 7. Y1257A rackmount kit

## Recess rack mounting kit

The optional Y1258A rack mounting kit can be used to recess-mount an M9046A chassis into an instrument rack. It is adjustable so that it can be adapted to non-Keysight racks. This kit is designed to ensure proper cooling performance when a single chassis is installed into a rack.

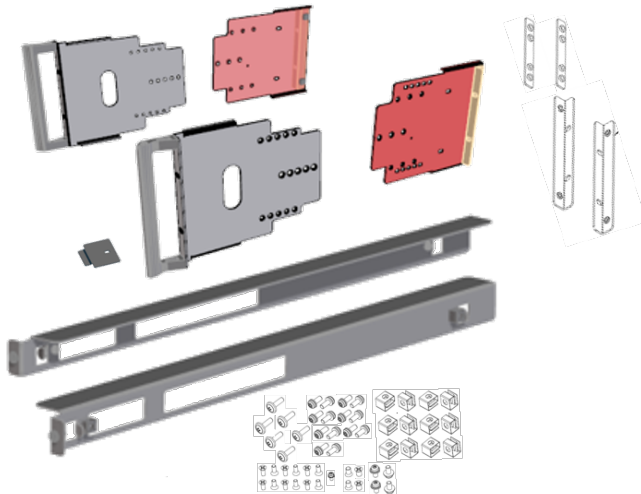


Figure 8. Y1258A recess-mounted rackmount kit



## Advanced cooling spacer kit

The optional Y1259A spacer kit is used along with the Y1257A and Y1258A rackmount kits to provide optimal cooling in high-power applications and when multiple chassis are installed into a single rack. It is designed to isolate the intake and exhaust airflows to each chassis, managing efficient heat transfer out of the top of the rack.



**Figure 9.** Y1259A advanced M9046A cooling spacer kit

## Recommended configuration

Configure the Keysight M9046A PXIe chassis as follows:

- Select a PXIe system module or embedded controller (the Keysight M9022A/23A and M9035A/38A are recommended).
- If an external computer is being used, select an appropriate PC interface card (the Keysight M9048B/49A are recommended).
- Select an appropriate cable to connect the computer interface board to the chassis interface (the Y1202A is recommended to connect the M9048B and M9022A).
- Install a slot-blocker into each empty slot (Y1275A) and cover them with blank panels.
- Select other accessories (including rack mount kits) as required.

# Ordering Information

## Software

### Supported software components

Operating systems	Microsoft Windows 7 (32/64-bit), Windows 8.1 (32/64-bit), Microsoft Windows 10 (64-bit)
Standard compliant drivers	IVI.NET, IVI-C, LabVIEW, MATLAB
Application development environments (ADE)	Visual Studio (VB.NET, C#, C/C++), LabVIEW, LabWindows/CVI
Keysight IO libraries Suite	Version 2020 Update 1 or later

## Chassis options

Model	Description
M9046A	PXle chassis: High power, 18-slot, 24 GB/s Includes standard (non-EMC) PXI filler panels
M9046A-001	Advanced trigger access
M9046A-002	Advanced power monitoring and control
M9046A-003	Push-pull cooling
M9046A-QS0	Base level 100 MHz and 2.4 GHz Reference
M9046A-QS1	Enhanced low phase noise 100 MHz and 2.4 GHz references with power splitters
M9046A-QS2	Power splitters for 2.4 GHz reference
M9046A-QS3	Low phase noise 100 MHz and 2.4 GHz references with power splitters

### Accessories

Y1212A	Slot blocker kit: 5 single-slot
Y1213A	PXI EMC filler panel kit: 5 single-slot
Y1214C	Air Inlet Kit
Y1257A	M9046A rackmount kit
Y1258A	M9046A recess rackmount kit
Y1259A	M9046A advanced cooling spacer kit
Y1275A	M9046A slot-block kit: five, one-slot blockers

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