

Keysight M9188A
PXI D/A Converter 16-Bit,
0-30 V, 0-20 mA

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Sales and Technical Support

To contact Keysight for sales and technical support, refer to the "support" links on the following Keysight web resources:

- www.keysight.com/find/M9188A
(product-specific information and support, software and documentation updates)
- www.keysight.com/find/assist
(worldwide contact information for repair and service)

Information on preventing damage to your Keysight equipment can be found at www.keysight.com/find/tips.

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

WARNING

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

The types of product users are:

- Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.
- Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.
- Maintenance personnel perform routine procedures on the product to keep it operating properly (for example, setting the line voltage or replacing consumable materials). Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.
- Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present.

A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in closed proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.

CAUTION

- Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.
 - Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.
 - If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.
 - Instrumentation and accessories shall not be connected to humans.
-

To maintain protection from electric shock and fire, replacement components in mains circuits - including the power transformer, test leads, and input jacks - must be purchased from Keysight. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keysight to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call an Keysight office for information.

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

Front and Rear Panels Symbols



The CE marking is the legal required labeling for several EU Directives of the European Union.

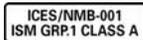
The CE marking shows that the product complies with all relevant European Legal Directives.



The RCM mark is a Compliance Mark according to the ACMA Labelling Requirement.



The KC mark shows that the product complies with the relevant Korean Compulsory Certification.



This symbol indicates product compliance with the Canadian Inter-

ference-Causing Equipment Standard (ICES-001). It also identifies the product is an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 4).



This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the

expected useful life of the product.

Cleaning Precautions

WARNING

To prevent electrical shock, disconnect the Keysight Technologies instrument from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally. To clean the connectors, use alcohol in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

End of Life: Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a "Monitoring and Control Instrument" product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit

www.keysight.com/environment/product

for more information.

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General Information and Specifications

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This chapter specifies the characteristics, environmental conditions, and specifications of the M9188A.

1 General Information and Specifications

General Information

General Information

The M9188A is a PXI based Dynamic Digital Analog Converter (Dynamic DAC). This module consists of four isolated banks. Each isolated bank has four DAC channels, resulting in a total 16 DAC channels within one module.

Every DAC channel is capable of supplying voltages between 0 V DC and 30 V DC at a 16-bit resolution. Each channel can also generate current between 0 mA and +20 mA at a 16-bit resolution.

Pre-defined waveforms (such as sine, square, and triangle) can be configured using the M9188A SFP or IVI driver. Every DAC channel also has its own 1 MSa memory for playing back arbitrary waveforms (user define waveforms) that is pre-downloaded from a host. This module is built into a single compact 3U PXI slot.

General Specifications

Table 1-1 M9188A module general specifications

Description	Specification
Temperature range	
<ul style="list-style-type: none"> • Operating • Storage 	<ul style="list-style-type: none"> • 0 °C to 55 °C • –40 °C to + 70 °C
Relative humidity	80%, 0 ° to 55 °C (Non condensing)
Altitude	<ul style="list-style-type: none"> • 10,000 ft. (Operating) • 15,000 ft. (Non-operating)
Certifications and compliance	
<ul style="list-style-type: none"> • CE mark compliance • Safety • EMC • Pollution degree 2 	<ul style="list-style-type: none"> • 2006/95/EC; 2004/108/EC • EN/ IEC 61010-1 • EN/IEC 61326-1
Warm-up time	30 minutes
PXI power requirements (typical)	25 W (16-Channel)
Recommended calibration interval	1 year
Physical characteristics	
<ul style="list-style-type: none"> • Dimensions • Weight • Front Panel Connector 	<ul style="list-style-type: none"> • PXI/cPCI module: <ul style="list-style-type: none"> • 212 (L) × 131 (H) × 21 (W) mm • 8.34 (L) × 5.15 (H) × 0.82 (W) inches • 16-Ch: 0.60 kg (1.32 lbs.) • DSUB 44-pos (f)
Warranty	<ul style="list-style-type: none"> • 3 years for the product. Please refer to http://www.keysight.com/go/warranty_terms. • Please note that for the product, the warranty does not cover: <ul style="list-style-type: none"> • Damage from contamination • Normal wear and tear of mechanical components • Manuals or fuses

Performance Specifications

DAC specifications

Number of Channels	: 16 channels
Resolution	: 16-bit
Adjacent Channel Crosstalk	: > 85 dB (typical)
Synchronization	: Software commands or external trigger
Settling Time	: 25 μ s (typical)

DC Voltage

Range	: 0 V up to 30 V
Resolution	: 16-bit = 500 μ V
Accuracy	: \pm (0.1% + 5 mV)
Ripple and Noise	: < 2 mVpk-pk (typical)

DC Current

Range	: 0 mA to 20 mA
Resolution	: 16-bit = 630 nA
Accuracy	: $\pm (0.15\% + 10 \mu\text{A})$
Ripple and Noise	: $< 1 \mu\text{Arms}$ (typical)

I/O Trigger Characteristics

Trigger Input

Input Level	: TTL compatible (3.3 V logic)
Slope	: Rising or falling (selectable)

Trigger Output

Level	: TTL compatible (3.3 V logic)
Output Impedance	: 50 Ω typical

1 General Information and Specifications
Performance Specifications

Declaration of Conformity (DoC)

The Declaration of Conformity (DoC) for this product is available on the Keysight Technologies website. You can search for the DoC by its product model or description at the following web address:

<http://regulations.products.keysight.com/DoC/search.htm>

NOTE

If you are unable to locate the DoC, please contact your local Keysight representative

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This chapter specifies the installation procedures of the M9188A PXI D/A converter 16-bit, 0-30 V, 0-20 mA.

Unpack and Inspect the Module

CAUTION

The M9188A is shipped in materials which prevent damage from static. The module should only be removed from the packaging in an anti-static area after ensuring that correct anti-static precautions are taken. Store all modules in anti-static envelopes when not in use.

ESD precaution

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. The following figure shows an example of a static-safe work station using two types of ESD protection.

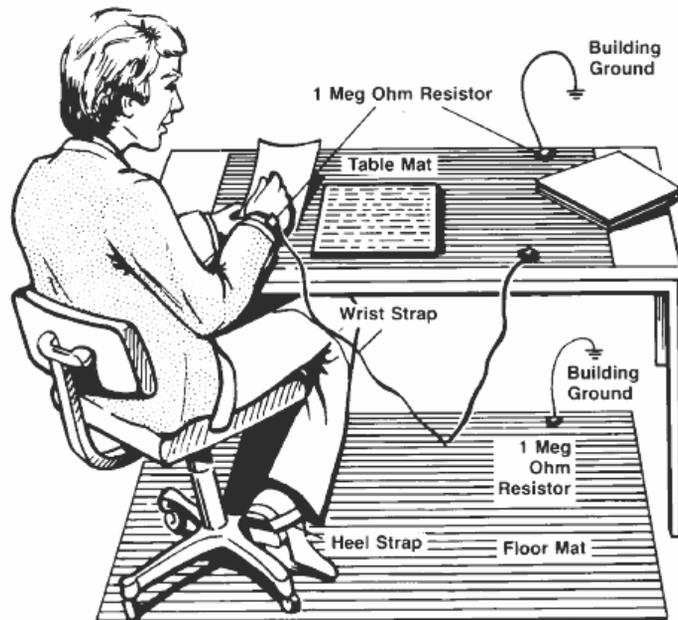


Figure 2-1 Static-safe work station example

Purchase acceptable ESD accessories from your local supplier.

- Conductive table-mat and wrist-strap combination.
- Conductive floor-mat and heel-strap combination.

Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone. To ensure user safety, the static-safe accessories must provide at least 1 Ω of isolation from ground.

WARNING

These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 V.

Inspect the module for damage

After unpacking the M9188A, carefully inspect the unit for any shipping damage. Report any damage to the shipping agent immediately, as such damage is not covered by the warranty. The warranty also does not cover:

- Damage from contamination
- Normal wear and tear of mechanical components
- Manuals or fuses

(Warranty information can be found at the beginning of this manual.)

CAUTION

To avoid damage when handling a module, do not touch exposed connector pins.

NOTE

Information on preventing damage to your Keysight equipment can be found at www.keysight.com/find/tips.

2 Module Installation

Unpack and Inspect the Module

Return the module for service

Should it become necessary to return the M9188A for repair or service, follow the steps below:

- 1 Review the warranty information shipped with your product.
- 2 Contact Keysight to obtain a Return Material Authorization (RMA) and return address. If you need assistance finding Keysight's contact information, go to www.keysight.com/find/assist (worldwide contact information for repair and service) or refer to the Support information on the product web page at www.keysight.com/find/M9188A.
- 3 Write the following information on a tag and attach it to the malfunctioning equipment.
 - Name and address of owner. A P.O. box is not acceptable as a return address.
 - Product model number (for example, M9188A).
 - Product serial number (for example, MYXXXXXXXXX). The serial number label is located on the side panel of the module. The serial number can also be read from the Soft Front Panel interface, but only after the software is installed.
 - Description of failure or service required.
- 4 Carefully pack the module in its original ESD bag and packing carton. If the original carton is not available, use bubble wrap or packing peanuts and place the instrument in a sealed container and mark the container "FRAGILE".
- 5 On the shipping label, write "**ATTENTION REPAIR DEPARTMENT**" and the RMA number.

NOTE

If any correspondence is required, refer to the product by its serial number and model number.

Verify the Shipment Contents

The following items are included in the M9188A shipment:

- *M9188A PXI D/A Converter Software and Product Information CD-ROM* (M9188-10001) - contains software, drivers, and all product documentation in PDF format.
- Printed copy of the *M9188A Startup Guide*
- Calibration certificate

NOTE

Every PXI module is shipped with a Software and Product Information CD-ROM. The M9188A-CD1 option provides the *M9188A Software and Product Information CD-ROM* (M9188-10001).

All of the files contained on the CD are available for free download at the Keysight Web site at www.keysight.com/find/M9188A.

Install the Software

System requirements

The following table lists the minimum system requirements for Keysight IO Libraries Suite. In general, any x86 or x64 (except Itanium) architecture should work but there may be a significant decrease in performance.

Table 2-1 Minimum system requirements

Operating systems	Windows [®] XP SP3 or later (32-bit) Home or Professional	Windows Vista [®] SP1 and SP2 or later (32-bit and 64-bit) Home Basic, Home Premium, Business, Ultimate, or Enterprise	Windows [®] 7 (32-bit and 64-bit) Starter, Home Basic, Home Premium, Professional, Ultimate, or Enterprise
Processor speed	600 MHz or higher required 800 MHz recommended	1 GHz 32-bit (x86) or 1 GHz 64-bit (x64), Itanium 64 is not supported	1 GHz 32-bit (x86) or 1 GHz 64-bit (x64), Itanium 64 is not supported
Available memory	256 MB minimum (1 GB or more recommended)	1 GB minimum	1 GB minimum
Available disk space ^[1]	1.5 GB available hard disk space, includes: <ul style="list-style-type: none"> • 1 GB for Microsoft[®] .NET Framework 3.5 SP1^[2] • 100 MB for Keysight IO Libraries Suite 	1.5 GB available hard disk space, includes: <ul style="list-style-type: none"> • 1 GB for Microsoft[®] .NET Framework 3.5 SP1^[2] • 100 MB for Keysight IO Libraries Suite 	1.5 GB available hard disk space, includes: <ul style="list-style-type: none"> • 1 GB for Microsoft[®] .NET Framework 3.5 SP1^[2] • 100 MB for Keysight IO Libraries Suite
Video	Super VGA (800 × 600) 256 colors or more	Support for DirectX 9 graphics with 128 MB graphics memory recommended (Super VGA graphics is supported)	Support for DirectX 9 graphics with 128 MB graphics memory recommended (Super VGA graphics is supported)
Browser	Microsoft [®] Internet Explorer 6.0 or greater	Microsoft [®] Internet Explorer 7 or greater	Microsoft [®] Internet Explorer 7 or greater
Chassis	A cPCI, PXI-1, or PXIh chassis peripheral slot. The Keysight M9018A chassis is recommended.		

Table 2-1 Minimum system requirements

Interface controller	A PXI or PXIe remote or embedded controller.
Remote controller	A Keysight M9045A ExpressCard interface (for portable laptops) or Keysight M9047A PCIe interface (for desktop PCs) or equivalent PXI or PXIe remote controllers running one of the above operating systems.
Embedded controller	A Keysight M9021A System Interface Card, or equivalent embedded controller running one of the above operating systems. Note: The embedded controller must be compatible with the Keysight M9018A chassis.

[1] Because of the installation procedures, less memory may be required for the operation than is required for the installation.

[2] .NET Framework Runtime Components are installed by default with Windows Vista and Windows 7. Therefore, you may not need this amount of available disk space.

Power up the controller

If you are using a remote controller, power up the host computer.

If you are using an embedded controller, complete the following steps:

- 1 Install the embedded controller module into a compatible chassis.

Recommended: Keysight M9018A 18 slot PXIe Chassis

- 2 Connect your I/O peripherals (mouse, keyboard, and monitor).

- 3 Power up the chassis.

Install the softwares

The M9188A softwares are located on the bundled CD (M9188-10001). The same softwares are also available for free download at the Keysight Web site:

www.keysight.com/find/M9188A.

This installation includes the following:

2 Module Installation

Install the Software

- Keysight IO Library Suite (IOLS), which includes the Keysight Connection Expert.
- Soft Front Panel (SFP), device drivers (IVI-C and IVI-COM, and LabVIEW G), and related user documentation for the M9188A.

NOTE

Each PXI module has its own device driver (IVI-C and IVI-COM, and LabVIEW G) and soft front panel (SFP) software.

- 1 From the CD browser, launch the installer.
- 2 Follow the installer prompts to install all software and documentation for the M9188A PXI D/A Converter 16-Bit, 0-30 V, 0-20 mA.

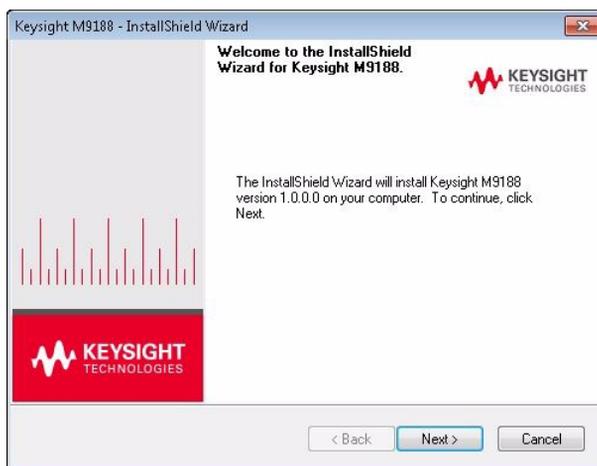


Figure 2-2 InstallShield Wizard for Keysight M9188A

- 3 After installation is complete, power down the chassis (and the host PC if using the remote controller).

Install the Module

CAUTION

- The PXI hardware does not support “hot-swapping” capabilities (changing modules while power is applied to the chassis).
- Before installing the M9188A into the chassis, ensure that the chassis is powered off and unplugged to prevent damage to the module.

NOTE

The M9188A module can be used in a chassis with a cPCI, PXI-1, or PXIh chassis peripheral slot.



The module can be installed in any standard PXI slot marked with a peripheral slot compatibility image (a circle containing the slot number).



The module can also be installed in any hybrid PXI slot marked with a peripheral slot compatibility image (the letter “H” and a solid circle containing the slot number).

- 1 Ensure that the chassis power switch is at the Off (Standby) position before you unplug the PXI chassis.
- 2 If the chassis has multiple fan speed settings, ensure that the fans are set to automatic. Do not set the fan speed to low or turn it off.
- 3 Position the chassis so that there is ample space between the chassis fan intake and exhaust vents. Blockage by walls or obstructions affects the air flow needed for cooling. (Refer to the chassis documentation for more information about cooling).
- 4 If you are using an embedded controller, proceed to **step 5**. If you using a remote controller, skip to **step 6**.

2 Module Installation

Install the Module

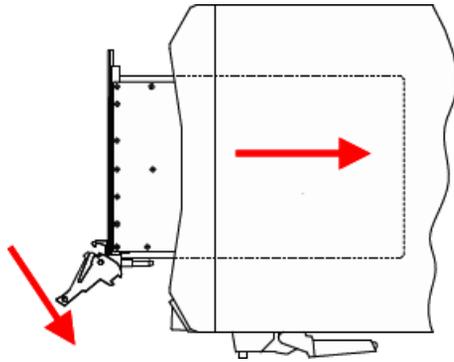


Figure 2-3 Installing the module to the chassis

- 5** Hold the module by the injector/ejector handle, and slide it into an available PXI (or hybrid) slot, as shown in **Figure 2-3**.
 - Install the module into the PXI slot of the chassis by placing the module card edges into the front module guides (top and bottom).
 - Slide the module to the rear of the chassis and assure that the injector/ejector handle is pushed down in the unlatched (downward) position.
 - Slide the module completely into the chassis.
 - When you begin to feel resistance, push up on the injector/ejector handle to fully inject the module into the chassis.
- 6** If you are using a remote controller, install the System Interface Card in the chassis.
- 7** Latch the module by pulling up on the injector/ejector handle and secure the front panel to the chassis using the module front-panel mounting screws.
- 8** Tighten the screws on the module (or remote controller) front panel. Performance may suffer if the screws are not tightened properly.
- 9** Verify that the PXI chassis fans are operable and free of dust and other contaminants that may restrict airflow.

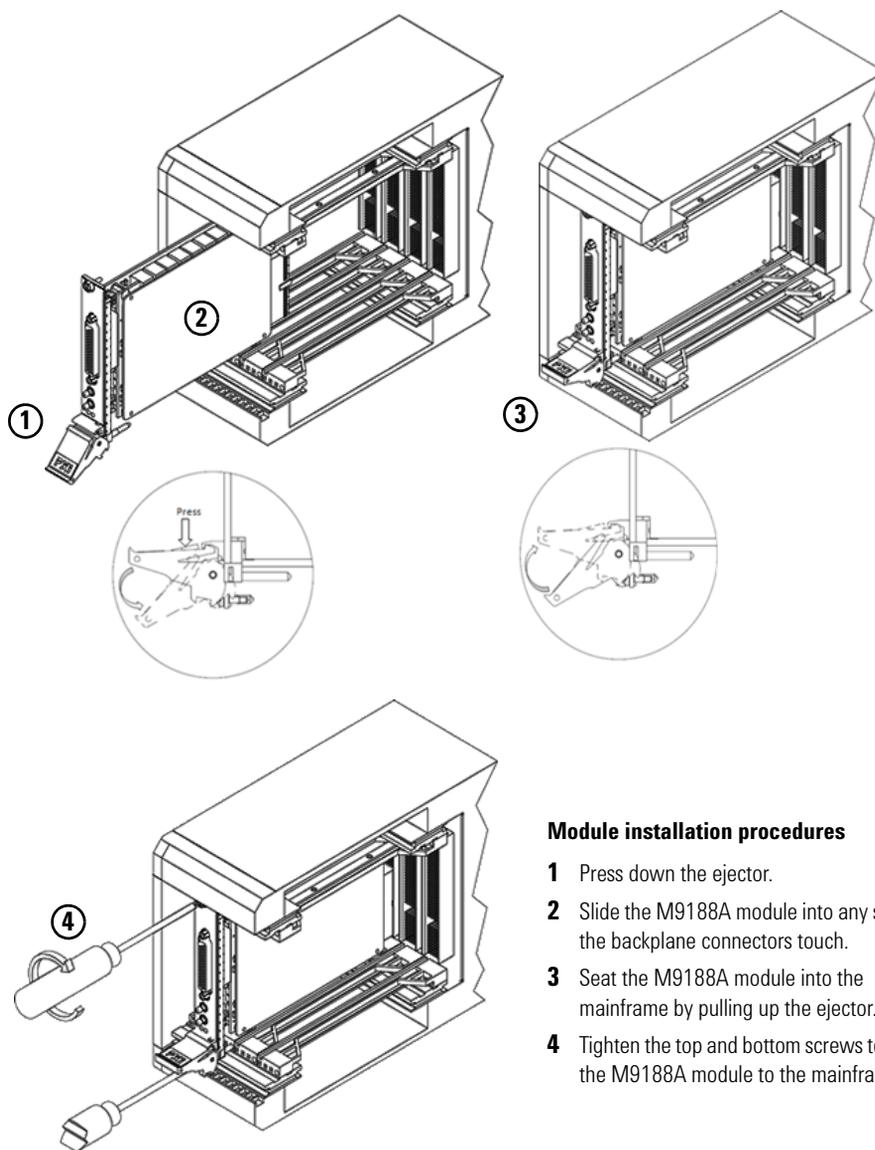
- 10** Install all chassis covers and filler panels after installing the module. Missing filler panels may disrupt necessary air circulation in the chassis.
- 11** If you are using a remote controller, connect the System Interface Card in the chassis to host computer.
- 12** Plug in and power up the PXI chassis.
- 13** If you are using a remote controller, reboot the host PC.

WARNING

Tighten the screws on the module front panel. Protection provided by the equipment could be impaired if the screws are not tightened properly.

2 Module Installation

Install the Module



Module installation procedures

- 1 Press down the ejector.
- 2 Slide the M9188A module into any slot until the backplane connectors touch.
- 3 Seat the M9188A module into the mainframe by pulling up the ejector.
- 4 Tighten the top and bottom screws to secure the M9188A module to the mainframe.

Figure 2-4 Module installation procedures

M9188A front panel

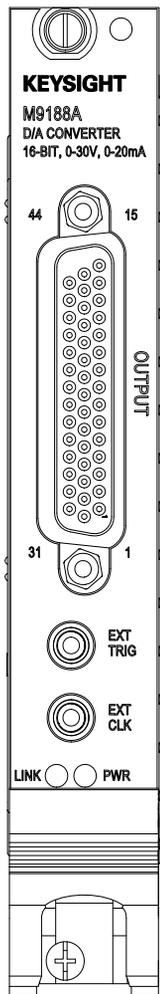


Figure 2-5 M9188A PXI D/A Converter front panel

2 Module Installation

Install the Module

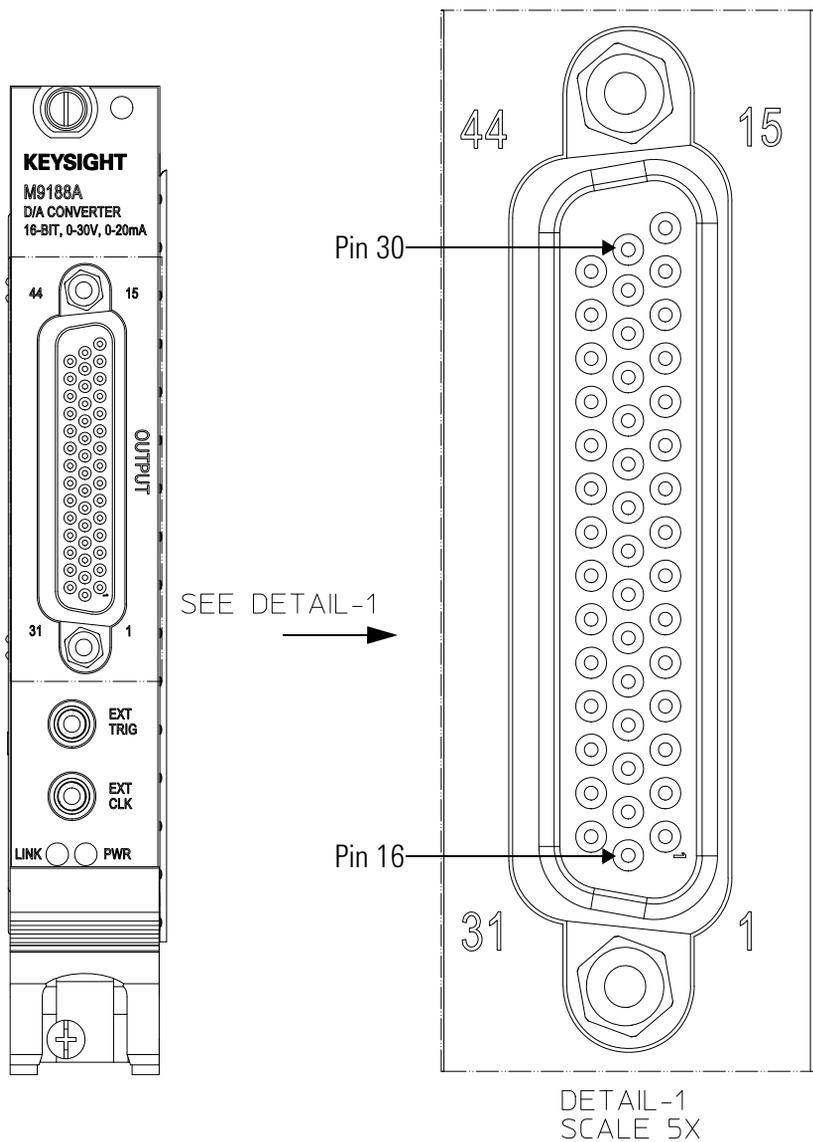


Figure 2-6 M9188A output connector pinout

Table 2-2 M9188A output DSUB pinout assignment

1	CH1+	16	CH2+	31	CH3+
2	CH1-	17	CH2-	32	CH3-
3	CH4+	18	CH5+	33	CH6+
4	CH4-	19	CH5-	34	CH6-
5	CH7+	20	CH8+	35	CH9+
6	CH7-	21	CH8-	36	CH9-
7	CH10+	22	CH11+	37	CH12+
8	CH10-	23	CH11-	38	CH12-
9	CH13+	24	CH14+	39	CH15+
10	CH13-	25	CH14-	40	CH15-
11	CH16+	26	DI0	41	SELFTEST-IN
12	CH16-	27	DI1	42	+5V-PXI
13	DI2	28	DI3	43	+12V-PXI
14	DO0	29	DO1	44	GND-PXI
15	DO2	30	DO3		

NOTE

PIN 41 should be used by qualified service personnel only.

2 Module Installation
Install the Module

M9188A system connections

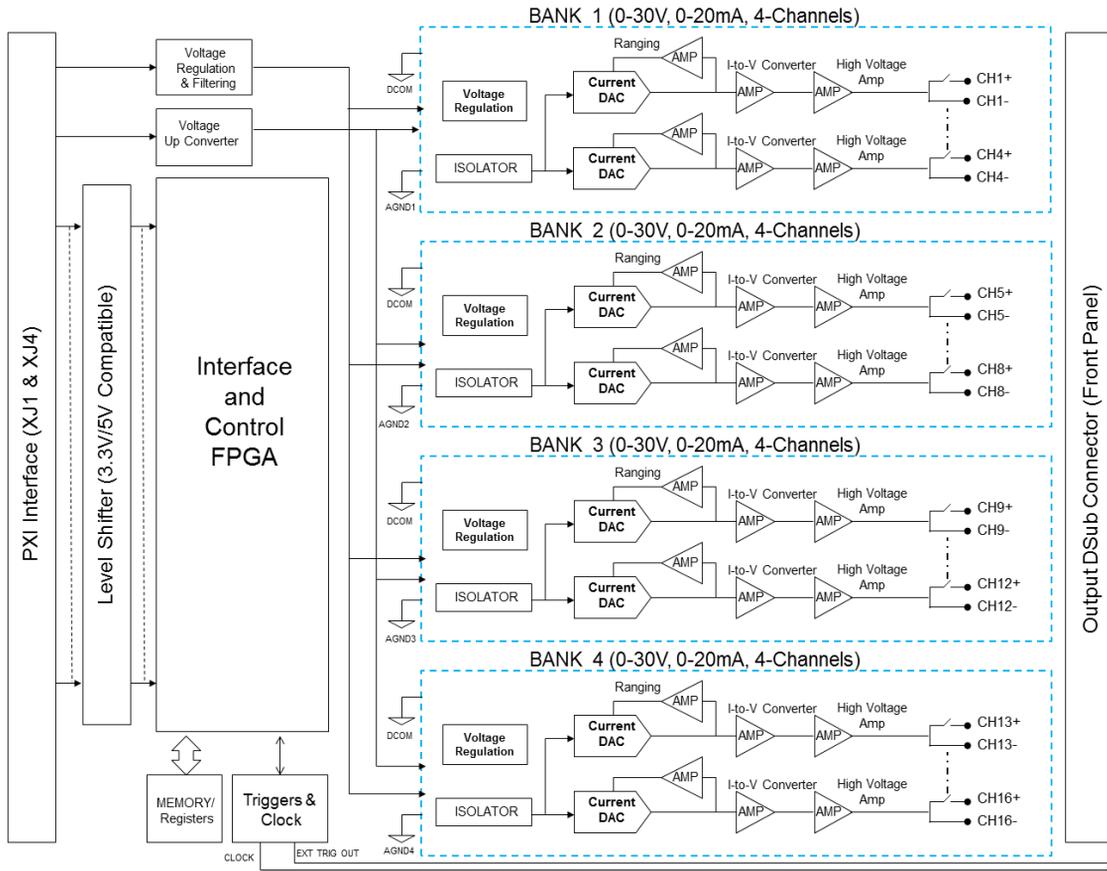


Figure 2-7 M9188A functional block diagram

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This chapter contains procedures for verification of the module's performance and adjustment (calibration).

Basic Operation Verification

The intention of this step is to verify the basic operations of the newly installed module.

Run the Keysight Connection Expert (KCE) by clicking its desktop shortcut icon, or by clicking **Start > All Programs > Keysight IO Library Suite > Keysight Connection Expert**.

The KCE will display all modules that are connected and installed. Review the configuration data and launch the M9188A Soft Front Panel (SFP). The M9188A SFP will provide control over the module for operational verification procedures.

This is a screen capture of the SFP interface:

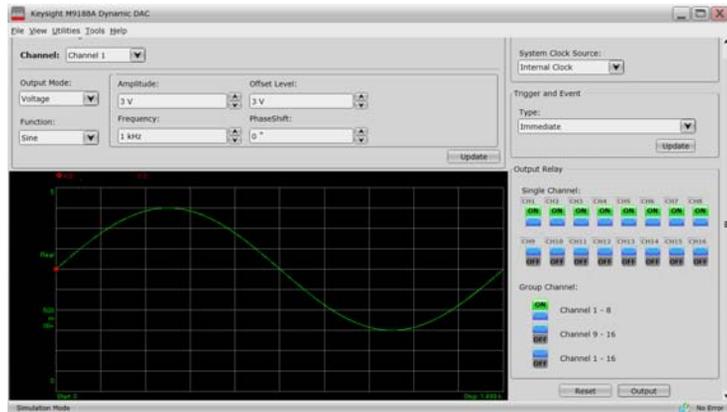
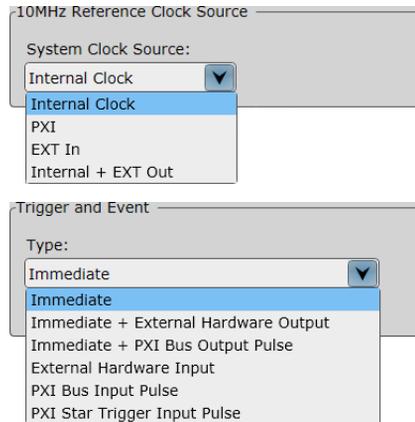


Figure 3 SFP interface

You may use the SFP as a learning tool to help you experience the module's capability and behavior through a user-friendly graphic interface.

In this example, we will configure the SFP to output DC voltage from Channel 4 the moment we click **Output**.

- 1 First, ensure that the 10 MHz Reference Clock Source and Trigger and Event is set to Internal Clock and Immediate respectively.



- 2 Next select the following Waveform Settings in the SFP.

- **Channel:** Channel 4
- **Output Mode:** Voltage
- **Function:** DC
- **Amplitude:** 25 V

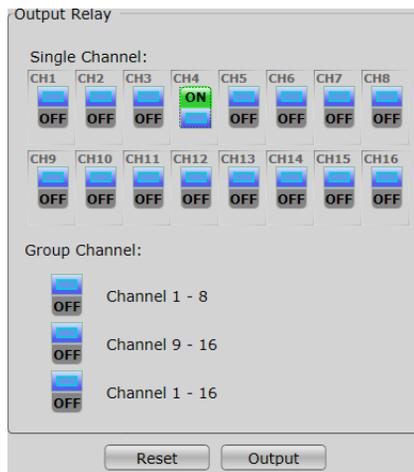


- 3 Click **Update** to configure Channel 4 to the selected settings.

3 Performance Verifications and Adjustments

Basic Operation Verification

- 4 Toggle the Output Relay, Single Channel: CH4 button to **ON**. Click on the **Output** button to output the signal.



- 5 To stop the DC voltage output from Channel 4, toggle the Output Relay, Single Channel: CH4 button to **OFF**. This will turn off the signal and disconnect the output relay.

You may refer to Keysight *M9188A Soft Front Panel Help* for details on how to use the SFP.

Module Calibration Procedure

The calibration process includes the following steps:

- 1** Verification – Verify the existing operation of the instrument. This step confirms whether the instrument is operating within its specified range.
- 2** Adjustment – Perform an external adjustment of the instrument that adjusts the calibration constants.
- 3** Re-verification – Repeat the verification procedure to ensure that the instrument is operating within its specifications after adjustment.

These steps are described in more detail in the following sections.

Calibration interval

The accuracy requirements of your application determine how often the M9188A should be calibrated. Keysight recommends that a complete calibration should be performed at least once every year. This interval can be shortened based on the accuracy demands of your application.

Test conditions

Follow these guidelines to optimize the connections and the environment during calibration:

- Always connect the outputs of the M9188A to the external equipment with short cables. Long cables and wires act as antennas, picking up extra noise that can affect measurements.
- Keep relative humidity between 10% and 90% non-condensing, or consult the M9188A specifications for the optimum relative humidity.

3 Performance Verifications and Adjustments

Module Calibration Procedure

- Maintain an ambient temperature of 23 ± 5 °C.
- Allow a warm-up time of at least 30 minutes after enabling the instrument. To enable the instrument use the driver commands `KtM9188_Open`. Allow a warm-up time for the used external equipment according to manufacturers guidelines.

NOTE

The warm-up time ensures that the instruments circuitry is at a stable operating temperature.

- During calibration always connect the output LOW to PE (Protected Earth).
- Ensure that the PXI chassis fan speed is set to HIGH, that the fan filters are clean, and that the empty slots contain filler panels.
- Plug the PXI chassis and the external equipment into the same power strip to avoid ground loops.

Requirements for verification

Measurements within the following sections have to be performed for all available channels. Ensure that the output LOW connected to PE (protected earth) is verified.

The following formulas are used to calculate the PASS/FAIL limits:

1 M9188A voltage specification limit = nominal voltage \pm (nominal voltage \times 0.1%+ 5 mV).

M9188A current specification limit = nominal current \pm (nominal current \times 0.15%+ 10 μ A).

2 M9188A factory limit = 80% \times specification limit.

3 M9188A calibration limit = \pm factory limit – reference instrument error.

4 Keysight 3458A maximum deviation of the five measurement results of the DVM used for mean value \leq 20% \times specification limit.

Required hardware

Verifying the functionality or calibration of the module requires external equipment. Refer to [Table 3-1](#) for the recommended functionality verification hardware.

Table 3-1 Required functionality verification hardware

Hardware	Description
PXI Chassis	PXI Requirements
PXI Slot-1 Controller	
Keysight 3458A	8.5-Digit Digital Multimeter

Required software

Calibrating the M9188A requires installing the instrument drivers on the calibration system. The calibration functions are C function calls provided by the instrument driver. To use these functions, you have to include `KtM9188.h` in your code when you write the calibration procedure. Refer to the section “CALIBRATION” within the header file for detailed information to the C function calls used within this section.

Voltage mode calibration

Complete the following steps to externally calibrate the voltage mode of the M9188A:

- 1** Connect the channel +ve pin to the HI input of the Keysight 3458A digital multimeter]
- 2** Connect the channel -ve pin to the LO input of the Keysight 3458A digital multimeter.
- 3** Disable the output generation of all output channels
`KtM9188_SingleChOutputEnable`

3 Performance Verifications and Adjustments

Module Calibration Procedure

- 4 Configure the M9188A output function to “DC” and mode to “Voltage”.

```
KtM9188_ConfigOutputFunction
```

- 5 Connect and enable output generation.

```
KtM9188_SingleChOutputEnable
```

- 6 Configure the M9188A to output the voltage listed under the *DC Voltage (V)* column in **Table 3-2** and start the output generation.

```
KtM9188_ConfigureDcAmplitude
```

```
KtM9188_ForceTrigger
```

- 7 Allow all instruments and equipment to settle for more than 1 second before configuring the Keysight 3458A to an appropriate measurement range, depending on the settings in **step 6**.
- 8 Perform a DC voltage mean measurement with five single readings with the calculated maximum tolerance.
- 9 Calculate the reference measurement accuracy error according to its user manual depending on the voltage range, reading, and time elapsed since the last calibration of the reference instrument. For details, refer to the specification of the used reference instrument.
- 10 Compare the measured value to the calculated calibration limits or the specification limits. If the result is within the selected test limit, the device has passed this portion of the verification.
- 11 Repeat **step 6** through **step 11** for each iteration in **Table 3-2**.
- 12 Disconnect and disable the active output channel. Repeat **step 3** through **step 12** for the output channels 2 to 16.

Table 3-2 Instrument parameters for voltage mode verification

Test Number	Mode	DC Voltage (V)
1	Voltage	0.0
2	Voltage	7.5

Table 3-2 Instrument parameters for voltage mode verification

Test Number	Mode	DC Voltage (V)
3	Voltage	15.0
4	Voltage	22.5
5	Voltage	30.0

Current mode calibration

- 1** Connect the channel +ve pin to the I input of the Keysight 3458A digital multimeter.
- 2** Connect the channel -ve pin to the LO input of the Keysight 3458A digital multimeter.
- 3** Disable the output generation of all output channels.
`KtM9188_SingleChOutputEnable`
- 4** Configure the M9188A output function to “DC” and mode to “Current”.
`KtM9188_ConfigOutputFunction`
- 5** Connect and enable output generation.
`KtM9188_ConfigOutputFunction`
- 6** Configure the M9188A to output the voltage listed under the *DC Current (mA)* column in **Table 3-3** and start the output generation.
`KtM9188_ConfigureDcAmplitude`
`KtM9188_ForceTrigger`
- 7** Allow all instruments and equipment to settle for more than 1 second before configuring the Keysight 3458A to an appropriate measurement range, depending on the settings in **step 6**.
- 8** Perform a DC current mean measurement with five single readings with the calculated maximum tolerance.
- 9** Calculate the reference measurement accuracy error according to its user manual depending on the voltage

3 Performance Verifications and Adjustments

Module Calibration Procedure

range, reading, and time elapsed since the last calibration of the reference instrument. For details, refer to the specification of the used reference instrument.

10 Compare the measured value to the calculated calibration limits or the specification limits. If the result is within the selected test limit, the device has passed this portion of the verification.

11 Repeat **step 6** through **step 11** for each iteration in **Table 3-2**.

12 Disconnect and disable the active output channel. Repeat **step 3** through **step 12** for the output channels 2 to 16.

Table 3-3 Instrument parameters for current mode verification

Test Number	Mode	DC Current (mA)
1	Current	1.0
2	Current	5.0
3	Current	10.0
4	Current	15.0
5	Current	20.0

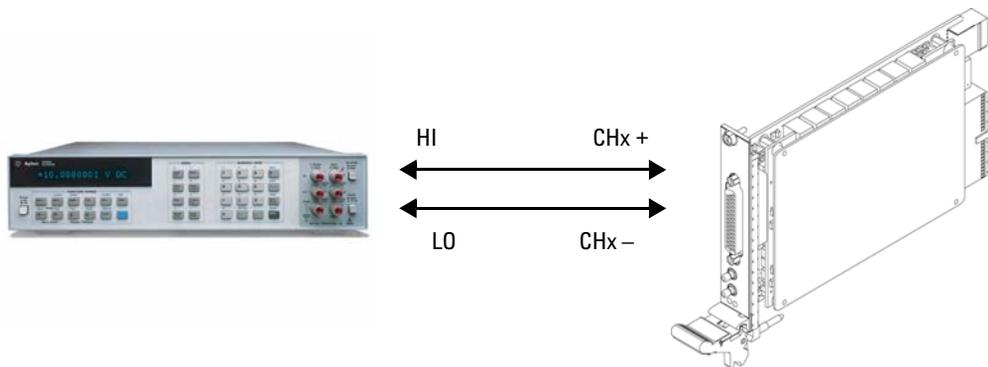


Figure 3-1 Connections For M9188A verification

Adjustment procedure

If the M9188A successfully passed each of the verification procedures within the calibration test limits, then an adjustment is recommended but not required to warrant the published specifications for the next calibration interval.

The adjustment procedure results in five readings per mode and channel. These nominal values are specified within **Table 3-2** on page 30 for voltage mode and **Table 3-3** on page 32 for current mode.

- 1** Calculate offset and gain values out of the measured values using the formulas below.

$$\text{calcOffset} = \frac{\sum_{i=1}^n x_i^2 \cdot \sum_{i=1}^n y_i - \sum_{i=1}^n x_i \cdot \sum_{i=1}^n x_i \cdot y_i}{n \cdot \sum_{i=1}^n x_i^2 - \sum_{i=1}^n x_i \cdot \sum_{i=1}^n x_i}$$

$$\text{calcGain} = \frac{n \cdot \sum_{i=1}^n x_i \cdot y_i - \sum_{i=1}^n x_i \cdot \sum_{i=1}^n y_i}{n \cdot \sum_{i=1}^n x_i^2 - \sum_{i=1}^n x_i \cdot \sum_{i=1}^n x_i}$$

with

$x_i = \{0.0V, 7.5V, 15.0V, 22.5V, 30.0V\}$ for voltage mode

or

$x_i = \{1.0mA, 5.0mA, 10.0mA, 15.0mA, 20.0mA\}$ for current mode

and

$y_i = \{\text{reading1, reading2, reading3, reading4, reading5}\}$ (corresponding measured values).

- 2** Repeat **step 1** for output modes “Voltage” and “Current” of the output channels 1 to 16.
- 3** Store the calibration values within the module’s FLASH memory.

`KtM9188_WriteCalCoefficients`

- 4** Set the calibration date.

`KtM9188_ConfigCalibrationDate`

3 Performance Verifications and Adjustments

Module Calibration Procedure

If a problem is found

If a problem is found, perform the following checks:

- 1 Verify that all relevant hardware is turned on.
- 2 Verify that the M9188A paths are correctly set from the SFP and that the multimeter is set to the proper voltage measurement range and that cable is properly connected.
- 3 If the problem persists, refer to “Return the module for service” on page 10 for details on sending the module to Keysight Technologies for service.

NOTE

For current measurement, change the HI connection to that of the ammeter.

4 Replaceable Parts

To Order Replaceable Parts 36

This chapter contains information on ordering replacement parts for your module.

4 Replaceable Parts

To Order Replaceable Parts

To Order Replaceable Parts

NOTE

Parts are listed below according to the reference designators as shown in [Figure 4-1](#). The parts list includes a brief description of each part with applicable Keysight part number.

You can order replaceable parts from Keysight using the Keysight part numbers shown in [Table 4-1](#). To order the replaceable parts from Keysight, do the following:

- 1 Contact your nearest Keysight Sales Office or Service Center.
- 2 Identify the parts by the Keysight part number shown in the replaceable parts list ([Table 4-1](#)).
- 3 Provide the instrument model number and serial number.

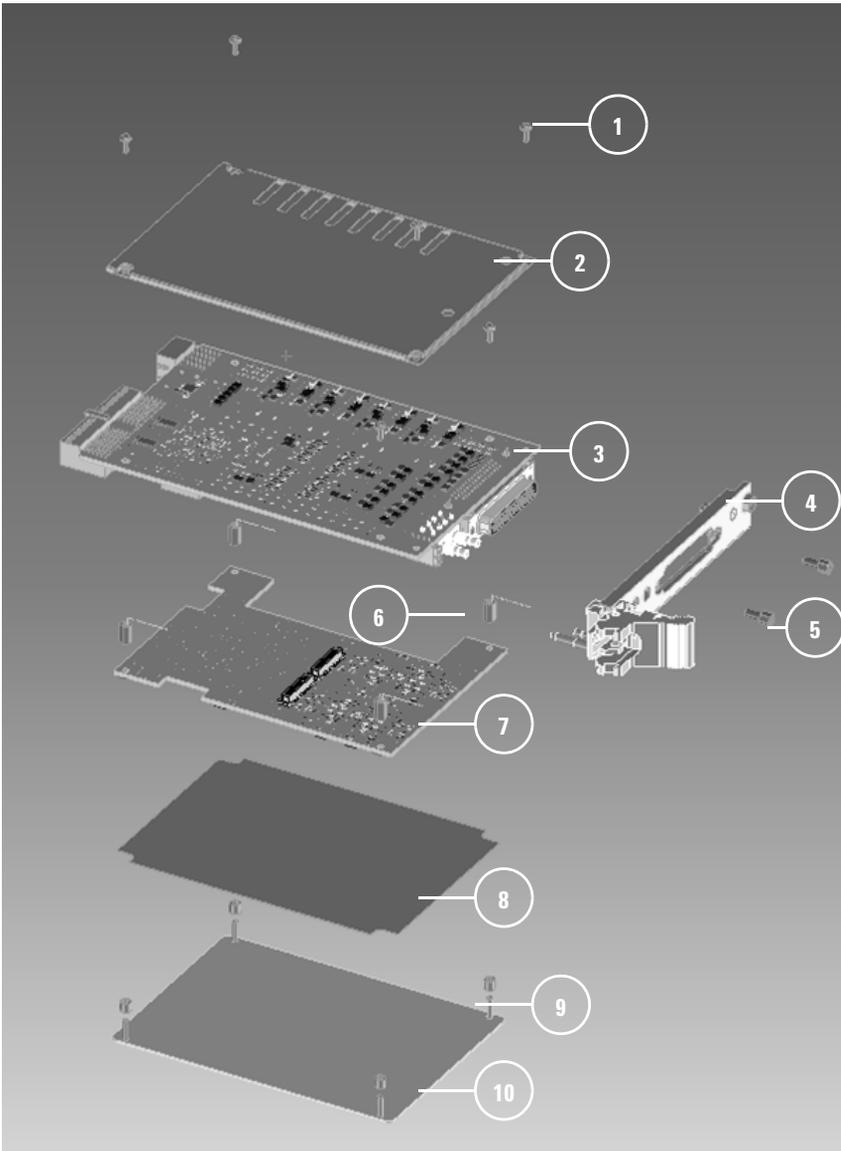


Figure 4-1 M9188A replaceable parts

4 Replaceable Parts
To Order Replaceable Parts

Table 4-1 M9188A replaceable parts list

No.	Keysight part no.	Qty	Description
1	0515-0366	6	Screw-Machine Pan-HD Torx-T8 M2.5X0.45 6mm-LG SST-300 Passivated
2	M9188-48600	1	ESD Plastic Cover
3	M9188-66601	1	PCA Dynamic DAC Main
4	M9188-00201	1	Front Panel Assembly, M9188A
5	0380-2079	2	Standoff-HEX .312-in-LG .187-in-A/F SST
6	5190-7445	4	18-8 SS Female Threaded Hex Standoff 4.5mm Hex, 8mm Length, M2.5 Screw Size
7	M9188-66602	1	PCA Dynamic DAC Analog
8	M9188-34101	1	Insulator, M9188A
9	5190-7444	4	Aluminum Unthreaded Spacer 4.5mm OD, 4mm Length, M2.5 Screw Size
10	M9188-04101	1	Top Cover, M9188A

5 Service

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This chapter contains information on servicing the module, and it includes troubleshooting guidelines and repair/maintenance guidelines.

WARNING

Do not perform any of the service procedures unless you are a qualified service personnel.

Troubleshooting Techniques

There are two main steps to troubleshoot a faulty M9188A module:

- 1 Identify the problem, and
- 2 Test the module assembly to isolate the cause.

Identifying the problem

Module problems can be divided into three general categories:

- Operator errors
- Catastrophic failures
- Performance out of specification

Operator Errors

Apparent failures may result from operator errors.

Catastrophic Failure

If a catastrophic failure occurs, use the M9188A Soft Front Panel (SFP) to communicate with the module in order to troubleshoot and isolate the module problem.

Performance out of specification

If the module performance is out of specification limits, use the adjustment/calibration procedures in [Chapter 3](#) to correct the problem.

Repair/Maintenance Guidelines

This section provides guidelines to repair and maintain the M9188A module, including:

- ESD precautions
- Soldering printed circuit boards
- Post-repair safety checks

ESD precautions

Electrostatic discharge (ESD) may damage MOS, CMOS, and other static sensitive devices in the M9188A module. This damage can range from slight parameter degradations to catastrophic failures.

When handling module assemblies, follow these guidelines to avoid damaging module components:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling module components.
- After you remove the module from the mainframe, place the module on a conductive surface to guard against ESD damage.
- After you remove a MOS or CMOS device from an assembly, place the device onto a pad of conductive foam or other suitable holding material.
- If a device requires soldering, be sure that the assembly is placed on a pad of conductive material. Also, be sure you, the pad, and the soldering iron tip are grounded to the assembly. Apply as little heat as possible when soldering.
- When you replace a MOS or CMOS device, ground the foam before removing the device from the foam.

When soldering to any circuit board, keep in mind the following guidelines:

5 Service

Repair/Maintenance Guidelines

- Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board and/or adjacent components.
- Do not use a high power soldering iron on etched circuit boards as excessive heat may lift a conductor or damage the board.
- Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, be sure the equipment is properly grounded to prevent electrostatic discharge from damaging CMOS devices.

Post-repair safety checks

After making repairs to the M9188A module, inspect the module for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and correct the cause of the condition. Then run the Verification Tests to verify that the module is functional.

Keysight Technologies Calibration Services

When your module is due for calibration, contact your local Keysight Service Center for a low-cost recalibration. The M9188A is supported on automated calibration systems, which allows Keysight to provide this service at a competitive price.

Calibration interval

A one-year interval is adequate for most applications. Accuracy specifications are under warranty only if adjustments are made at regular calibration intervals. Accuracy specifications will not be offered warranty beyond the one-year calibration interval. Keysight does not recommend extending calibration intervals beyond two years for any application. Keysight recommends that a complete readjustment should always be performed at the calibration interval. This will ensure that the M9188A will remain within specifications for the next calibration interval. The re-adjustment provides the best long-term stability and accuracy.

Types of Service Available

If your instrument fails during the warranty period, Keysight will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices.

Extended Service Contracts

Most Keysight products are provided with optional service contracts that extend the coverage period after the standard warranty expires. If you have this service contract and your instrument happens to fail during the coverage period, Keysight will repair or replace it according to the contract.

Obtaining Repair Service (Worldwide)

To obtain service for your instrument (in-warranty, under service contract, or post-warranty), contact your nearest Keysight Service Center. They will arrange to have your unit repaired or replaced, and are able to provide warranty or repair cost information where applicable. To obtain warranty, service, or technical support information you can contact Keysight at one of the following telephone numbers.

- In the United States: 800 829 4444
- In Europe: 31 20 547 2111
- In Japan: (81) 426 56 7832

You can also use our Web link for the information on contacting Keysight worldwide:

www.keysight.com/find/assist

Or contact your Keysight representative.

Before shipping your instrument, ensure that you acquire shipping instructions, including the components to be shipped, from the Keysight Service Center. Keysight recommends that you retain the original shipping carton for use in such shipments.

Re-packaging for Shipment

If the unit is to be shipped to Keysight for service or repair, make sure that you do the following.

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model number and full serial number.
- Place the unit in its original container with appropriate packaging material for shipping.
- Secure the container with strong tape or metal bands.
- If the original shipping container is not available, place your unit in a container with at least four inches of compressible packaging material around all sides for the instrument. Use static-free packaging materials to avoid additional damage to your unit.

NOTE

Keysight suggests that you always insure your shipments.

Cleaning

Clean the outer area of the module with a soft, lint-free, and slightly dampened cloth. Do not use detergent.

Disassembly is not required for cleaning.

5 Service
Cleaning

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Contact us

To obtain service, warranty, or technical assistance, contact us at the following phone or fax numbers:

United States:

(tel) 800 829 4444 (fax) 800 829 4433

Canada:

(tel) 877 894 4414 (fax) 800 746 4866

China:

(tel) 800 810 0189 (fax) 800 820 2816

Europe:

(tel) 31 20 547 2111

Japan:

(tel) (81) 426 56 7832 (fax) (81) 426 56
7840

Korea:

(tel) (080) 769 0800 (fax) (080) 769 0900

Latin America:

(tel) (305) 269 7500

Taiwan:

(tel) 0800 047 866 (fax) 0800 286 331

Other Asia Pacific Countries:

(tel) (65) 6375 8100 (fax) (65) 6755 0042

Or visit Keysight World Wide Web at:

www.keysight.com/find/assist

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