Agilent Technologies

M9514A AXIe 14-Slot Chassis and M9521A AXIe System Module

User Guide

Agilent Technologies

Notices

Manual Part Number

M9514-90005

Edition

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Agilent Technologies, Inc.
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Warranty

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Safety Information

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

This product has been designed and tested in accordance with accepted industry standards and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

General

Do not use this product in any manner not specified by the manufacturer. The protective features of this product must not be impaired if it is used in a manner specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the unit before applying power. Note the instrument's external markings described under "Safety Symbols".

Ground the Instrument

Agilent chassis' are provided with a grounding-type power plug. The instrument chassis and cover must be connected to an electrical ground to minimize shock hazard. The ground pin must be firmly connected to an electrical ground (safety ground) terminal at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Do Not Operate in an Explosive Atmosphere

Do not operate the Agilent module/chassis in the presence of flammable gases or fumes.

Do Not Operate Near Flammable Liquids

Do not operate the Agilent module/chassis in the presence of flammable liquids or near containers of such liquids.

Do Not Remove Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Cleaning

Clean the outside of the Agilent chassis with a soft, lint-free, slightly dampened cloth. Do not use detergent or chemical solvents. Cleaning connectors with alcohol shall only be done with the chassis power cord removed and in a well-ventilated area. Allow all residual alcohol moisture to evaporate and the fumes to dissipate prior to energizing the chassis.

Keep away from live circuits

Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers and shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment

Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to an Agilent Technologies Sales and Service Office for service and repair to ensure the safety features are maintained.

DO NOT block the primary disconnect

AC wiring and the Mains Disconnect is subject to local and regional electrical codes.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Agilent Sales and Service Office to ensure that safety features are maintained.

In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Cautions

Do NOT block vents and fan exhaust: To ensure adequate cooling and ventilation, leave a gap of at least 50mm (2") around vent holes on both sides of the chassis.

Do NOT operate with empty slots: To ensure proper cooling and avoid damaging equipment, fill each empty slot with an AXIe filler panel module.

Do NOT stack free-standing chassis: Stacked chassis should be rackmounted.

All modules are grounded through the chassis: During installation, tighten each module's retaining screws to secure the module to the chassis and to make the ground connection.

> **CAUTION**
>
> A CAUTION denotes a hazard. It calls attention to an operating procedure or practice 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 denotes a hazard. It calls attention to an operating procedure or practice, 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

This is a Safety Protection Class I Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.

WARNING

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

Servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

WARNING

To prevent electrical shock, disconnect the Agilent Technologies M9514A 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.

Cleaning connectors with alcohol shall only be done with the instruments power cord removed, and in a well-ventilated area. Allow all residual alcohol moisture to evaporate and the fumes to dissipate prior to energizing the instrument.

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.

WARNING

The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the product from all voltage sources while it is being opened.

WARNING

AC wiring and the Mains Disconnect is subject to local and regional electrical codes. For single-phase and 3-Phase AC Line operation, an external Mains Disconnect must be used. The Mains Disconnect disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch (disconnecting device).

CAUTION

This instrument has auto-ranging line voltage input, be sure the supply voltage is within the specified range.

Safety Symbols

Products display the following symbols:

⚡	Warning, risk of electric shock
⚠	Refer to manual for additional safety information.
	Earth Ground.
	Protective Earth Ground terminal
	Chassis Ground.
∿	Alternating Current (AC).
3∿	Three-Phase Alternating Current
	Direct Current (DC).
	Both direct and alternating current
⊥	Terminal is at earth potential.
N	Terminal for Neutral conductor on properly installed equipment
L	Terminal for Line conductor on properly installed equipment
⏻	Standby Power. Unit is not completely disconnected from AC mains when switch is in standby.
	Antistatic precautions should be taken.

CAT I
CAT II IEC Measurement
CAT III Category I, II, III, or IV
CAT IV

For localized Safety Warnings, Refer to Agilent Safety document (p/n 5185-8500) on the product CD.

The CSA mark is a registered trademark of the Canadian Standards Association and indicates compliance to the standards laid out by them. Refer to the product Declaration of Conformity for details.

Notice for European Community: This product complies with the relevant European legal Directives: EMC Directive (2004/108/EC) and Low Voltage Directive (2006/95/EC).

N10149

The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.

ICES/NMB-001

ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001.

Cet appareil ISM est conforme a la norme NMB du Canada.

This symbol represents 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 this product.

KCC-REM-ATi-BLMODSF01

South Korean Class A EMC Declaration. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

A 급 기기 (업무용 방송통신기자재) 이 기기는 업무용 (A 급) 전자파적합기 기로서 판 매자 또는 사용자는 이 점을 주 의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으 로 합니다.

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

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

Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Agilent office, or see www.agilent.com/environment/<product> for more information.

Safety-Related Specifications

This section (next page) provides a <u>partial</u> set of safety-related specifications for the Agilent M9514A AXIe chassis. Complete specifications are included in the *Agilent M9514A Data Sheet.*

CHASSIS CHARACTERISTICS	
Size[1]	482.6 mm W x 589.7 mm H x 579.1 mm D (19 in W x 23.2 in H x 22.8 in D)
Weight (nom)	48.7 kg (107 lbs)[2]

[1] From front handle to IEC 60309 AC power connector. Top cover to rubber feet.
[2] Without modules

Power supply characteristics	
AC input	
Operating voltage range	
Single Phase or 3-Phase Delta	200-240 VAC
3-Phase Wye	200/415 VAC
Input frequency range	50-60 Hz
Input current	24 Arms
Overcurrent protection	auto recovery
Efficiency (typical)	85-93%
DC Output	−52 V
Total DC module power	2800 W
Total max module current	53.8A
Load regulation	2%
Maximum ripple and noise (20 MHz BW)	500 mV pk-pk
Slot airflow direction	Bottom to top
Chassis cooling intake	Bottom front of chassis
Chassis cooling exhaust	Top rear of chassis
Chassis cooling fans	HIGH/Auto speed selector six 252.85 cfm fans in three front fan trays ten 138.0 cfm fans in rear fan tray
Power dissipation, instrument slot	200 W maximum

Environmental[*,†,‡]		
Operating and storage conditions		
	Operating	Storage
Temperature	0°C to 50°C	-25°C to 60°C
Altitude	up to 3000 meters	up to 4600 meters
Humidity	Type tested at 95%, +40°C (non-condensing)	
Operating random vibration: type tested at 5 to 500 Hz, 0.21 g rms		
Survival random vibration: type tested at 5 to 500 Hz, 2.09 g rms		
	Maximum	Nominal (25°C ambient)
Sound Pressure[**]	79 dBA	67 dBA
Sound Power	89dBA	77 dBA

* Characteristics apply to both M9514A and M9521A unless otherwise noted.

† Samples of this product have been type tested in accordance with the Agilent 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.

‡ Test methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

**At operator position.

Regulatory[*]
Safety

Complies with European Low Voltage Directive 2006/95/EC
    IEC/EN 61010-1:2010, 3rd Edition
    Canada: CSA C22.2 No. 61010-1-12
    USA: UL std no. 61010-1, 3rd Edition

EMC

Complies with European EMC Directive 2004/108/EC
    IEC/EN 61326-1
    CISPR Pub 11 Group 1, Class A
    AS/NZS CISPR 11
    ICES/NMB-001
    This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme
    Cet appareil ISM est conforme a la norme NMB-001 du Canada

* Characteristics apply to both M9514A and M9521A

Contents

5 M9521A ASM
Features and Functions

6 MultiFrame Operation

7 For Module Developers

Glossary

Documentation Map

Startup Guide

Site Preparation Guide

Product web site

Product CD

Access to all DOCUMENTATION noted below

Site Preparation Guide

- Uncrate chassis
- Verify shipment
- Installation Considerations
- AC power line requirements

Startup Guide

- Install software
- Install & connect hardware
- Verify operation
- Install modules

User Guide

- Detailed chassis configuration\ operating instructions
- WEB interface
- Module development

Service Guide

- Chassis Firmware
- Troubleshoot
- Repair
- Memory Declassification

Soft Front Panel (SFP) user interface
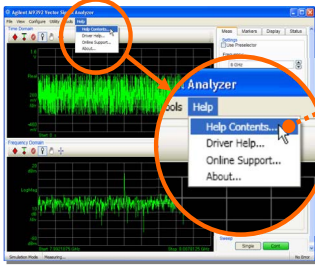
SFP help system
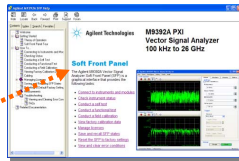
- Product theory of operation
- Configuration
- Self test
- Field calibration
- Error reports

Visual Studio

Press F1 with focus on Method
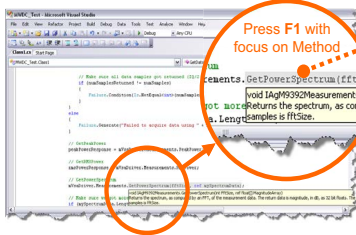
IVI Driver help system

- IVI-COM and IVI-C driver programmer's reference

LabVIEW

Context Help with link to detailed VI information
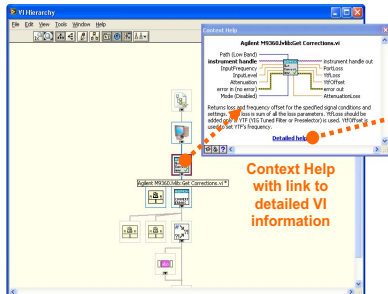
LabVIEW Driver help system
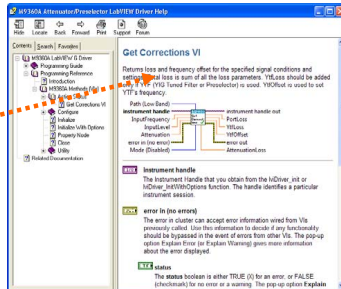
- LabVIEW driver programmer's reference

Related Documentation

The documentation listed below can be found on the *Software and Product Information* CD that came with your M9514A AXIe Chassis and M9521A AXIe System Module (ASM).

- *M9514A Site Preparation Guide*

    Provides detailed site preparation and planning information for the chassis.

- *M9514A Startup Guide*

    Provides steps to verify and start using your new chassis.

- *M9521A Startup Guide*

    Provides steps to verify and start using your new ASM.

- *M9514A and M9521A User Guide* (this document)

    A complete guide for configuring, operating, and troubleshooting the chassis.

- *M9514A Service Guide*

    It provides troubleshooting and service information for the chassis and ASM.

- Help files for the M9514A soft front panel and the M9521A soft front panel.

    This interactive help is available from any soft front panel dialog box or the help menu.

- Help files for the IVI-C and IVI-COM device drivers

    The interactive help provides instruction for programming the chassis or ASM using Microsoft development environments.

    You can access the M9514A IVI driver help from the Windows Start menu by clicking:

    Start > All Programs > Agilent IVI Drivers > AgAXIeC AXIe Chassis > AgAXIeC Documentation

    You can access the M9521A IVI driver help from the Windows Start menu by clicking:

    Start > All Programs > Agilent IVI Drivers > AgAXIeSM AXIe System Module > AgAXIeSM Documentation

- Help file for the LabVIEW G device drivers

    The interactive help provides instruction for programming the chassis using National Instruments Labview(TM). You can find this help at:

    <drive>:\Program Files (x86)\Agilent\AXIeC\LabVIEW Driver Help

- Agilent M9514A and M9521A Data Sheet.

    The Data Sheet contains complete physical and electrical specifications for the chassis and ASM.

Product specifications, available accessories, firmware and software may change over time. Please check the Agilent website at www.agilent.com/find/M9514A or www.agilent.com/find/M9521A for the latest updates to the product software, all manuals and guides, help files and data sheets.

Product Warranty

To find warranty information on your M9514A AXIe chassis, go to www.agilent.com/find/warranty and enter the model number (M9514A) in the **Product Number** field, and enter the serial number from the chassis rear panel in the **Serial No.** field.

Chassis Accessories

The following user-replaceable assemblies and accessories are available from Agilent. Only Agilent approved accessories shall be used:

Accessory	Agilent Model Number
AXIe Filler Panel: Single Slot	Y1221A
AXIe MultiFrame cable: 0.5m length*	Y1223A
AXIe MultiFrame cable: 3m length*	Y1224A
Rail kit for M9514A AXIe Chassis	Y1229A
Protective cover for M9514A	**Y1234A**
Power Cable: 1-phase, No Neutral, 250VAC, NEMA L6-30	**Y1235A**
Power Cable: 3-phase, WYE with neutral, 240/415VAC, IEC 60309	**Y1236A**
Power Cable: 3-phase, DELTA, no Neutral, 120/208VAC, NEMA L15-30	**Y1237A**
Power Cable: 3-phase, WYE with Neutral, 240/415VAC, Stripped End	**Y1238A**

Check module documentation to determine if MultiFrame cables are supported.

Other parts originally supplied with the chassis may be available from Agilent. Go to https://onlinestore.tm.agilent.com for a current parts list, or contact Agilent Service.
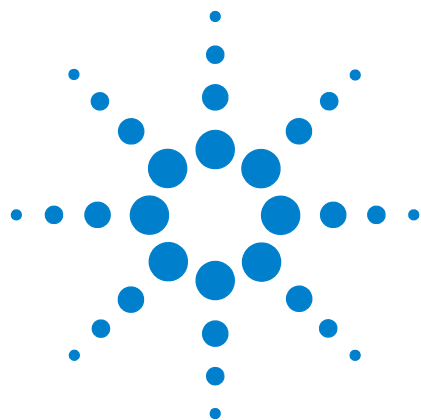
1

Introduction

This chapter provides a brief introduction to the AXIe chassis.

WARNING	Chassis exceeds 43 kg. Use a mechanical lift to lift the chassis. The chassis should be transported using a rolling cart. Do not lift the chassis by the handles on the front and rear of the chassis.

M9514A and M9521A Descriptions

The Agilent M9514A 14-slot AXIe chassis (AXIe System Module plus 13 instrument slots) is a modular instrument chassis fully compatible with the AXIe 1.0 Hardware and AXIe 2.0 Software specifications. It allows multiple application-specific instrument modules to share a common chassis frame, power supply, cooling system, PCI Express (PCIe) Gen 2 data bus, Gigabit LAN hub, local bus for module-to-module signaling, and host PC connections. Multiple chassis may be interconnected for scalability.

Each instrument slot is supplied with a Gen 2 x4 link (maximum of 2 GB/s data rate per module) to the chassis primary data 'fabric' hub—a x8 PCIe switch and data bus.

The Agilent M9521A AXIe System Module (ASM)[*] consists of a single slot AXIe module that contains the clock functions, triggering routing crosspoint matrix (includes six external bidirectional ports), the upstream/downstream PCIe fabric switch and IO communication, and MultiFrame management.

Other than a Power button and chassis status light, all monitoring, control and communication with the chassis requires a *host PC*. This can be an *embedded* controller such as the Agilent M9536A (a Windows-based PC specifically designed for use in an AXIe chassis) or *external* (a rackmount, desktop, or laptop PC).

The shared Gen 2 x8 PCIe interface from the ASM to an external host controller provides up to a 4 GB/s data rate shared among installed modules.

NOTE	In order for a computer to serve as host PC, its BIOS must support enumeration of PCIe slots in the AXIe chassis; many computers are not capable of enumerating a sufficient number of PCIe slots to ensure that slots in an external chassis are enumerated. Agilent maintains a document listing the integrated, rack mount, desktop and laptop computers that have been verified to properly enumerate PCIe devices in the AXIe chassis, entitled *PXI and AXIe Modular Instrumentation, Tested Computer List - Technical Note.* You can find this document at: www.agilent.com/find/axie-chassis..

For general host PC requirements, such as operating system and RAM requirements, please refer to the *M9514A Startup Guide*.

For the ASM and for each other installed module, appropriate control software and instrument drivers must be installed on the host PC.

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* The M9521A ASM is different than the Embedded System Module (ESM) used in the Agilent M9502A and M9505A AXIe chassis in that the ASM is not embedded in a particular AXIe chassis, and can be used in multiple AXIe chassis.

M9514A AXIe 14-Slot Chassis at a Glance

The M9514A is shipped <u>without</u> the M9521A AXIe System Module (ASM) installed. This must be ordered and installed separately. Main components on the chassis are shown below:

Chassis Status LED

Chassis IP Reset*

Power Supply Status LEDs

On/Standby button

Chassis Diagnostic Connector (Agilent use only*)

LAN connector and Shelf Manager LAN switch*

ESD Wrist Strap Terminal (4 mm banana jack)

Physical slot numbers

WARNING: Do not lift chassis by these handles

M9521A AXIe System Module (ASM) (installed in slot #7)

Removable air filter*

Bottom front fan trays (left to right, Fan Tray 1, Fan Tray 2, Fan Tray 3)

Rack mount ears integral to the chassis

Fan Tray status LEDs: When LED is on, fans are operating normally

WARNING: For chassis fan tray removal only. Do not lift chassis by fan tray handles

* Described elsewhere in this manual. The DB-9 connector on the top front panel of the chassis labeled "Service Use Only" is for internal Agilent use only. There is no user diagnostic, troubleshooting, or service information available from this connector.

The following graphic shows the M9514A side and rear panels.

Upper rear fan tray

WARNING: For power supply fan tray removal only. Do not lift chassis by these handles

Chassis inhibit/voltage monitor connector

Chassis inhibit switch

IEC 60309 AC Line Power Connector (refer to M9045A Site Preparation Guide for detailed information)

AC Line Circuit Breakers

CAUTION: These RJ45 connectors are for multiple chassis power-up synchronization. Do not connect LAN cables to these connectors.

WARNING: Do not lift chassis by these handles!

M9514A Indicator LEDs

The M9514A chassis has several indicator LEDs. In general, when the LEDs are solid green (not flashing), the monitored state or circuit is working normally. The following table indicates the various states (colors) of the chassis LEDs and their meaning:

M9514A Chassis Power Supply Indicator LEDs (PSU1, PSU2, PSU3)

LED State (color)	Description
PSU LEDs	
off	Power Supply Unit (PSU) not receiving AC power. Check circuit breaker.
solid green	Power Supply Unit (PSU). PSU functioning normally.
M9514A Chassis Status LED	
off	Chassis is powered off.
solid amber	Initial power-up state but changes to green.
flashing green	PCIe startup delay while waiting for instrument modules to be activated. Front panel identification indicator, invoked by web page, IVI function call, or Soft Front Panel to identify specific chassis.
solid green	Power On Self-Test (POST) tests passed. Chassis is ready.
flashing amber	Indicates POST failure
solid red Note: if the Status LED turns red due to any of the conditions listed, once the condition is corrected, the LED returns to green and modules are reactivated.	Indicates a non-recoverable threshold is exceeded. Run self test and review error messages either through the Soft front Panel or IVI function call. Possible failures include: • AC input voltage to any of the three PSUs is ≤130 VAC. All modules except ASM turned off. • Output voltage of one of the three PSUs ≥ –48 VDC (i.e. more positive). All modules except ASM turned off. • Chassis temperature above upper non-recoverable threshold. All modules including ASM are turned off. • Temperature sensors in fan tray above upper non-recoverable threshold. All modules including ASM are NOT turned off • Temperature sensors in any module above upper non-recoverable threshold. That module is turned off. • ASM temperature sensors above upper non-recoverable threshold. The ASM is turned off, but not other modules in the chassis. • One or more fans stop. All modules except ASM turned off.
M9514A Chassis Fan Tray LEDs	
Fan Tray LED	Normally, when the chassis is powered on, these LEDs are on. When the LEDs are off, the fan tray fans are not running.

M9521A AXIe System Module (ASM) at a Glance[*]
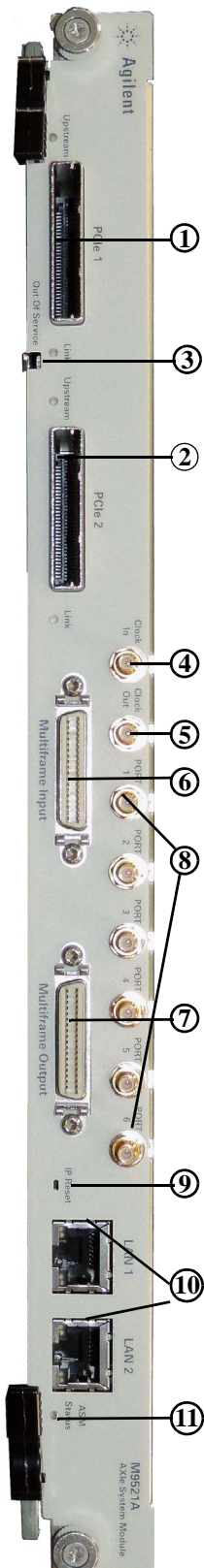
The M9521A AXIe System Module (ASM) is installed in the system slot of the M9514A (slot 7). It provides the system communication and synchronization functions required in an AXIe chassis including:

- Trigger bus and clock routing.
- Managing clocks, including internal or external reference sources.
- Gigabit LAN switching with front panel RJ45 LAN connections.
- AXIe Fabric 1 switching (Gen 2 x4 lanes to each module slot).

ASM Front Panel

1	PCIe 1	Can be used to connect an external host controller to the chassis or connect multiple chassis via PCIe. Gen 2 compliant PCIe x8 connector.
2	PCIe 2	Can be used to connect to another chassis.. Gen 2 compliant PCIe x8 connector.
3	Out Of Service	LED indicates the ASM is powering up, or has failed.
	CLOCK	External clock connections. SMB connectors with ESD suppression.
4	IN	Accepts an externally sourced timing input. Input range 10 MHz +/- 100 ppm, 5V peak to peak, AC coupled, 50 ohm terminated, 250mV minimum swing.
5	OUT	Extends the internal clock source to external instruments. 10 MHz +/- 100 ppm, 3.3V CMOS, 50 ohm output impedance.
	MULTIFRAME	Synchronizes timing signals with multiple daisy-chained chassis. 36-pin mini D connectors use accessory Agilent cables (Y1223A or Y1224A).
6	INPUT	Communicates to the next higher chassis. The highest chassis is referred to as the master chassis.
7	OUTPUT	Communicates to the next lower chassis. If this chassis is at the head of the chain, it becomes the master, using an internal or external clock to send timing signals to other chassis in the chain.
8	Ports	External bidirectional, programmable trigger connections.
	Port 1 - Port 6	Adjustable threshold input range -5V to +5V, 250 mV minimum swing.
9	ASM IP Reset	Resets the ASM LAN1/LAN2 ports to a DHCP assigned address (if available). If DHCP address not available, resets to the factory preset addresses: 169.254.1.1.
10	LAN 1, LAN 2	Connects the host PC to the chassis, RJ45 connector. Tri-rate 10/100/1000 Base-T, auto crossover.
		Amber Link/Activity LED, and Bicolor Speed LED (Amber = 1Gbps, Green = 100Mbps, Off = 10Mbps).
		An embedded system controller (M9036A) can access this port via the chassis backplane.
11	ASM Status	See table on the following page.

* The M9521A ASM is different than the Embedded System Module (ESM) used in the Agilent M9502A and M9505A AXIe chassis. They are not interchangeable.

M9521A Indicator LEDs

The M9521A ASM has several indicator LEDs on its front panel. In general, when the LEDs are solid green (not flashing), the monitored state or circuit is working normally. The following table indicates the various states (colors) of the ASM LEDs and their meaning:

M9521A ASM Status LED

Status LED State (color)	Description
off	ASM not receiving power. Chassis powered off.
solid amber	Internal power-on self test (POST) is running
flashing amber	Indicates POST failure
flashing green	PCIe startup delay while waiting for instrument modules to be activated. Front panel identification indicator, invoked by web page, IVI function call, or Soft Front Panel to identify specific ASM.
solid green	Shelf Manager & chassis working normally, power-on self tests passed, etc.
solid red	Indicates a serious problem. Connection to the chassis or ASM may not be available due to the nature of the problem, Service required.
M9521A ASM Out of Service (OOS)	
off	Normal operation
solid red	Red while modules being activated, then turns off. If stays red, indicated ASM failure.
M9521A ASM PCIe Link (2 LEDs, one for each connector)	
green	PCIe Link is functional
M9521A ASM Upstream	
amber	Identifies the upstream PCIe port

AXIe Instrument Modules

The chassis slots accept AXIe instrument modules. These may comprise one or more instruments for signal injection, data acquisition, and measurement. Install them in any available AXIe slot.

The drawing below illustrates the AXIe module's general layout, backplane connections and chassis fasteners, viewed from the top.

Module Rear (connectors to chassis backplane)

Space for Zone 3
Connector (not used)

Zone 2 Connector

Zone 1
Connector

Typical AXIe Instrument Module

Retaining Screw

Module Insertion/Extraction Handle
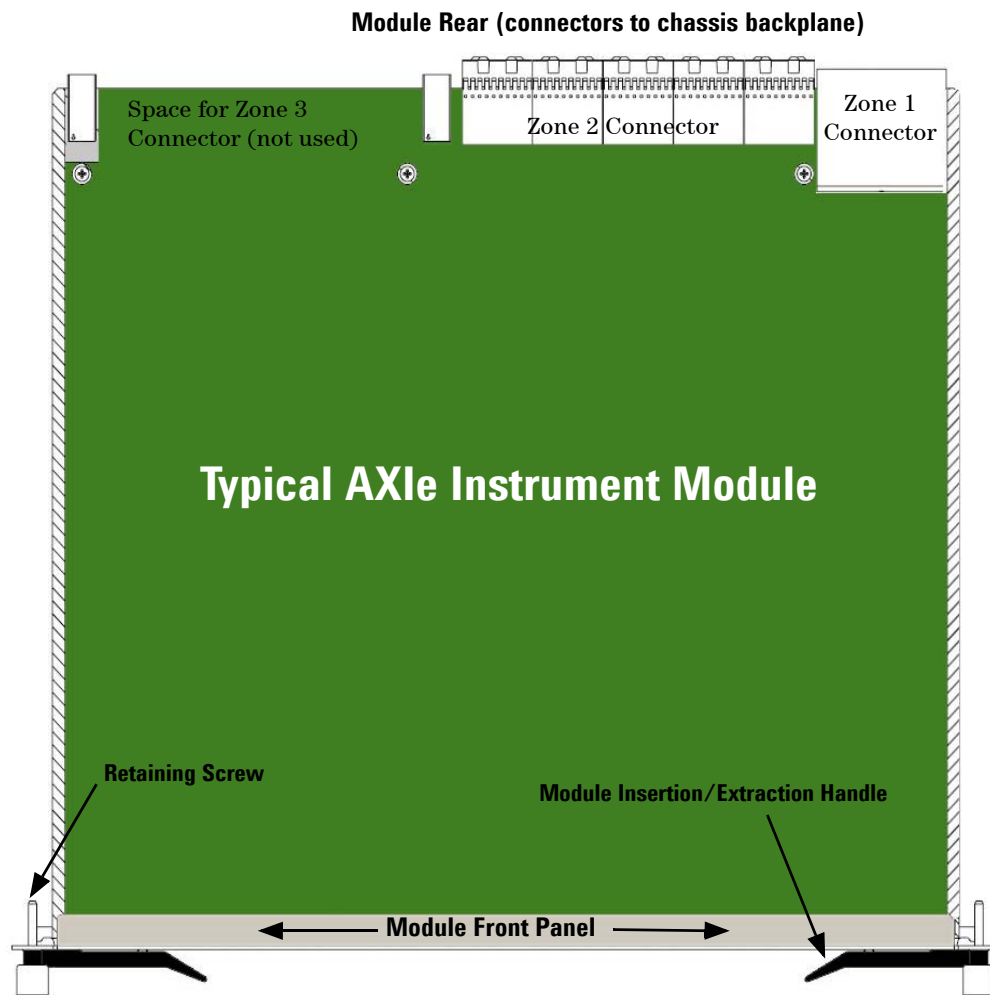
Module Front Panel

Test connections are made at the module's front panel. The front panel and backplane connectors will vary depending on the module.

ESD Precautions

CAUTION	Agilent's AXIe chassis and instrument modules are shipped in materials which prevent static electricity damage. These instruments should only be removed from the packaging in an anti-static area ensuring that correct anti-static precautions are taken. Store all modules in anti-static envelopes when not installed.
	You must wear an ESD wrist strap before installing or removing any part or electrical component.

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. 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 MΩ of isolation from ground.

An ESD wrist strap connector (4mm banana jack) is provided on the front of the M9514A chassis.
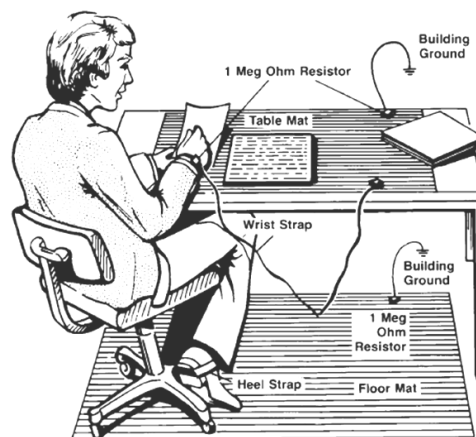
Chassis Power Overview

Circuit Breaker

The chassis circuit breakers are installed on the back panel. These circuit breakers are marked OFF (O) when open and ON (I) when closed:

Circuit Breaker Open (OFF)   **Circuit Breaker Closed (ON)**

CAUTION	Do not operate the chassis with one or two of the circuit breakers in the OFF position. All three breakers must be in the ON position for the chassis to operate at full capacity.

CAUTION	The Mains wiring and connectors shall be compatible with the connector used in the premise electrical system. Failure to ensure adequate earth grounding by not using the correct components may cause product damage and serious injury.

The INHIBIT switch

The method of powering up the chassis depends on the position of the INHIBIT switch on the chassis rear panel, which can be set to the DEF (DEFault) position or to the MAN (MANual) position. These two methods work as follows:

- INHIBIT switch in the DEF position — In this position, the front panel power push button is used to switch the chassis between ON and Standby—hence, this is known as the ON/Standby push button.

- INHIBIT switch in the MAN position — In this position, the Inhibit signal (pin 5 on the DB-9 connector) controls chassis power. The chassis is powered up by applying a logic high signal to the Inhibit signal. When the Inhibit pin (pin 5) is pulled low, the chassis is in Standby.

Use of the INHIBIT switch in the DEF position and the ON/Standby push button to power up the chassis is assumed unless otherwise noted. For information on using the Inhibit signal on the rear panel DB-9 connector to power the chassis up and down, please see *"Chassis Inhibit/Voltage Monitoring"* on page 95.

The RJ45 connectors are for multiple chassis power-up synchronization. Cables used for multiple chassis power-up synchronization purposes should not exceed 30m in length. Straight CAT5 or better cables recommended. Refer to Chapter 6, "MultiFrame Operation" for information on using these connectors.

CAUTION	The RJ45 connectors are for multiple chassis power-up synchronization. Do not connect LAN cables from your corporate LAN to these connectors.

On/Standby Button

OFF   STANDBY   ON
             (dimly lit)   (brightly lit)
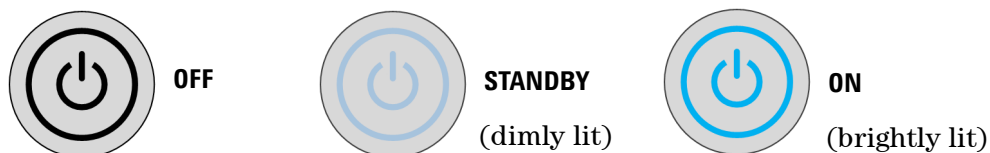
Power Modes

The chassis has three power modes:

OFF   With the power cord removed or the circuit breakers in the open position, the chassis is OFF.

STANDBY   With the power cord connected, the circuit breakers closed, the switch will have a dim glow to indicate power is available and the chassis is in Standby mode. Although no power is supplied to the ASM and installed modules when in Standby, the chassis is energized and consumes power. The power supply fans may operate in Standby mode, and the power supply LEDs will be on.

ON   With the power cord attached and circuit breakers closed, when the power button is pushed once, the chassis transitions to the ON state and the power button will be brightly lit. Power is supplied to the ASM and installed modules. Fans will operate as dictated by chassis thermal load. The three power supply status LEDs on the front panel should also be on.

Using the two RJ45 connectors on the rear panel of the chassis, the power button on one chassis will signal all interconnected chassis to either power up or power down. For detailed information, refer to Chapter 6, "MultiFrame Operation".

Powering Down   The power button cycles between fully lit and dimly lit as the chassis powers down.

WARNING	Hearing protection must be worn when working on or around the chassis when it is powered on. The airflow noise around the chassis can exceed 79 dB(A). This is outside the range that is normally considered safe (70 dB(A)). Over and above that level is considered hazardous and can result in permanent hearing damage.

Hardware Connections to the Host PC

CAUTION	Except where noted, connections between the external host controller and the chassis AXIe System Module (ASM) should be made with both the PC and chassis powered off.

For initial turn-on and testing, make a LAN-only connection to the chassis and ASM — this is the simplest connection and doesn't require installation of a PCIe adapter card in the host PC. The host PC can either be connected directly to the chassis and/or ASM with a crossover Gigabit Ethernet cable, or connected through your network with a straight Ethernet cable. The following diagram shows the basic connection.
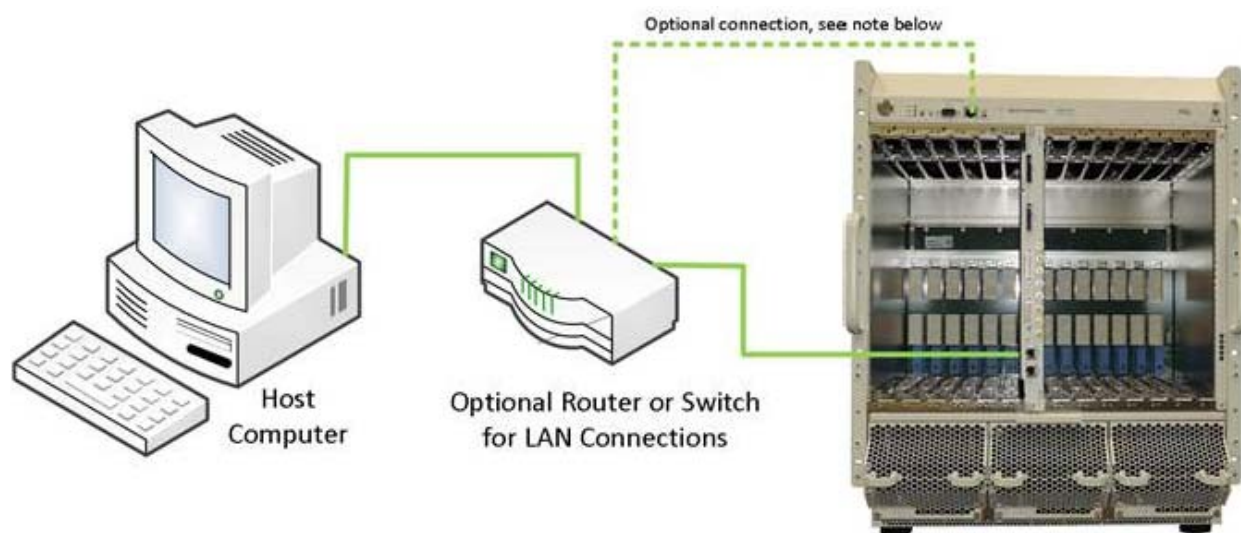
NOTE	The chassis LAN port and Shelf Manager LAN switch provide an access to the chassis Shelf Manager if a non-Agilent ASM is used that does not contain a LAN fabric. In this case, the chassis Shelf Manager is accessible via LAN 0. When using the Agilent M9521A ASM, the LAN 0 connector is not used and the Shelf Manager LAN switch should remain in the default ASM (right) position.

Chassis and Host Controller Power Cycling

The chassis and host controller must be powered up and down in the sequences described below. The procedure used depends on whether you have an external host controller or an embedded controller, as described below.

CAUTION	The chassis and host controller must be powered up and down in the correct order as in the procedures below. These procedures are overviews. For details regarding powering up the chassis, see "Powering Up the Chassis" on page 33. For details about powering down the chassis, see "Powering Down the Chassis" on page 36.

The procedures below are for routine power cycling, such as power cycling after updating the chassis or ASM firmware. If you are initially setting up the system, or are installing or removing modules, refer to the *M9514A Startup Guide* for safety and procedural information.

Powering Up with an External Host Controller

1 Power up the chassis first as described in detail in "Powering Up the Chassis" on page 33. This initiates the chassis power on self-test (POST). During self-test, the chassis STATUS LED will be amber. The chassis STATUS LED will blink green as all the modules power up, and then stay green continuously when the ASM and modules are ready. (Refer to the *Power-up/Power-down Sequence* graphic on page 35 for detailed power up information.)

2 After all installed modules have performed their initialization, power up the external host controller. (See your module documentation for module initialization information.)

NOTE	If you used a soft front panel to update the serial number of the chassis or ASM, since the serial number is part of the device hostname, you may have to update the instrument configuration in Connection Expert (part of the IO Libraries Suite). Refer to "Establishing PCIe and LAN Connectivity to the Chassis and ASM" on page 37 for a step-by-step procedure.

Powering Down with an External Host Controller

1 Save all of your work before shutting down the PC. Shut down the Windows operating system (click **Start > Shut down** on the PC) and wait until the PC powers down.

2 Power down the chassis using one of the two methods in "Powering Down the Chassis" on page 36.

Powering Up with an Embedded Host Controller

1 If you are using an embedded controller such as the Agilent M9536A, you can power up the chassis as described in detail in *"Powering Up the Chassis"* on page 33. This initiates the chassis power on self-test. During self-test, the chassis STATUS LED will be amber. The chassis STATUS LED will blink green as all the modules power up, and then stay green continuously when the ASM and modules are ready.

2 Wait until the Windows operating system boots and all installed modules have performed their initialization. (See your module documentation for module initialization information.)

Powering Down with an Embedded Host Controller

1 Save all of your work on the embedded host controller.

2 Power down the chassis using one of the two methods in *"Powering Down the Chassis"* on page 36.

Powering Up the Chassis

NOTE	When powering up a system with an external PC controller that has been powered down, you should always power up the chassis first, as described below. After successfully powering up the chassis, you can then power up the external controller.

Close all Three Circuit Breakers   Close the rear panel circuit breakers (ON position). The On/Standby Button should be dimly lit to indicate that AC power is available and the chassis is in Standby mode.

Press On/Standby Button   Press the chassis' On/Standby button. It should light when depressed. (Refer to the *Power-up/Power-down Sequence* graphic on page 35 for detailed power up information.)

The Status LEDs on the chassis and ASM cycle as follows:

1 Light off - with button in STANDBY mode
2 Green, blinking - for a few seconds after power on self-test (POST).
3 Green, steady - successful chassis power-up is complete.

NOTE	If the chassis On/Standby Button flashes continuously after turning on the chassis, press and hold the On/Standby Button for five seconds. If this does not resolve the issue, power down the chassis and refer to the *M9514A and M9521A Service Guide*.

If either the chassis or the ASM do not power up to a steady green Status LED, or either powers up to a steady red Status LED, the chassis or ASM has detected a failure. Immediately power down the chassis and refer to the *M9514A and M9521A Service Guide*.

CAUTION	The chassis and host PC must be powered up and down in the following sequence. The chassis should be powered up first, which initiates its built-in self-test. During self-test, the chassis STATUS LED will be amber. The chassis STATUS LED will blink green as all the modules power up, and then stay green continuously when the ASM and modules are ready. The external host PC should be turned on only after all installed modules have performed their initialization—see your module documentation for initialization information. An embedded controller such as the M9536A handles this sequence automatically.

In brief, the host PC must be off whenever the chassis is powered up or down. Because modules are not hot-swappable, the chassis must be powered down before modules are added or removed.

While the power sequencing shown above doesn't apply to an embedded controller (because an embedded controller and chassis are powered simultaneously), an embedded controller must also be restarted (after Windows starts) if the chassis configuration was changed in any way while the chassis and embedded controller were turned off.

Chassis, ASM, and External Host Controller Power-up/Power-down Sequence

1. Times are shown in seconds.

2. The times can vary based on the number of modules installed in the chassis and their activation/de-activation times.

Powers up chassis

IMPORTANT: Make sure you turn off the external host controller before you press the power button to power down the chassis

Starts power-down sequence

User presses power button

Chassis power (high = powered up)

Chassis awaits modules reporting they have deactivated, then chassis powers down.

Chassis ready

Chassis POST happens here.

Status LED flashes amber If POST fails

Chassis powering up

20 - 75

Chassis Status LED

30   4

Modules activated by the Shelf Manager

Performing self-test will turn off amber flashing caused by a POST failure.

ASM de-activated

ASM power (high = ASM powered up by Shelf Manager)

ASM ready

ASM POST happens here.

Status LED flashes amber If POST fails

ASM activated

ASM powering up

6 - 35

ASM Status LED

OOS light off

You can view the ASM web interface or bring up the ASM SFP here.

Performing self-test will turn off amber flashing caused by a POST failure.

Instrument modules (high = powered up)

See the user guide of your instrument modules for a description of their status LEDs.

OOS lights off

When the chassis Status LED ceases flashing green, you can turn on your PCIe-connected controller. You can also view the chassis web interface or bring up the chassis SFP.

Turn off the external host controller before powering-down the chassis.

External Host Controller (high = turned on by user)

Powering Down the Chassis

There are two chassis power-down modes:

- For routine power-down or to cycle power to the chassis, momentarily press the chassis On/Standby button. The power button flashes on/off several times. The system does a controlled shutdown of the embedded controller (if installed) and instrument modules and then shuts down the power supply. The front fan tray fans will gradually drop in speed to off, and the power supply unit (PSU) fans will gradually return to idle speed as the PSU cools. This is normal.

- If you press and hold the On/Standby button for more than five seconds, the system shuts down the power supply immediately.

CAUTION	For routine power-down, do not use the circuit breaker to turn the chassis off. Doing so interrupts power to the power supply fans, which could shorten the life of the PSU. Use the front panel On/Standby switch to power down the unit, and allow the PSU fans to return to idle before removing power from the chassis.

Once the chassis has cooled, you may isolate the chassis from AC power as needed. This is usually done by opening the circuit breakers.

Using the two RJ45 connectors on the rear panel of the chassis, the power button on one chassis will signal all interconnected chassis to either power up or power down. The power up process is as described above. but the power button signal originates from a remote chassis. For detailed information, refer to Chapter 6, "MultiFrame Operation".

Establishing PCIe and LAN Connectivity to the Chassis and ASM

It is possible to lose LAN connectivity to the chassis or ASM. This can happen after clicking the Reset User-Settable Memory button on the device's Web page, or whenever the device's serial number (part of the hostname) changes. In this situation, you will have to re-establish connectivity as described below.

To have Agilent Connection Expert search for LAN instruments, select the LAN (TCPIPn) interface in the Connection Expert Explorer Pane.
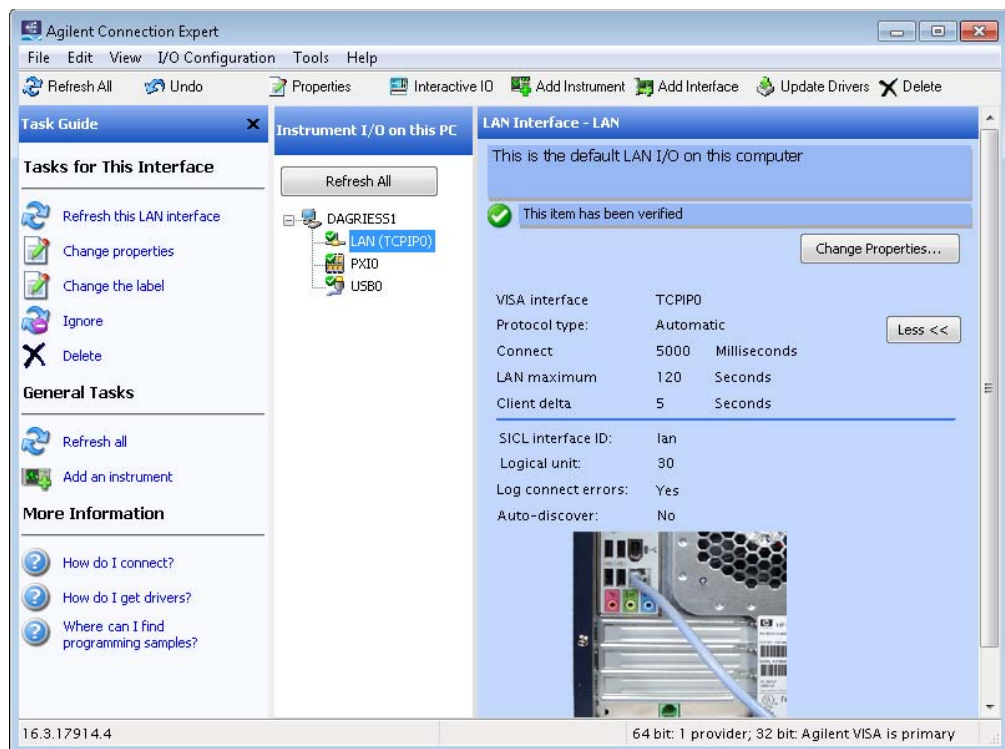
Click **Add Instrument** (from either Task Guide, the top menu bar or right click on the LAN TCPIPn) to search for instruments on your local subnet. This opens the Add LAN Instruments dialog (see below) with the **Auto Find** tab preselected.
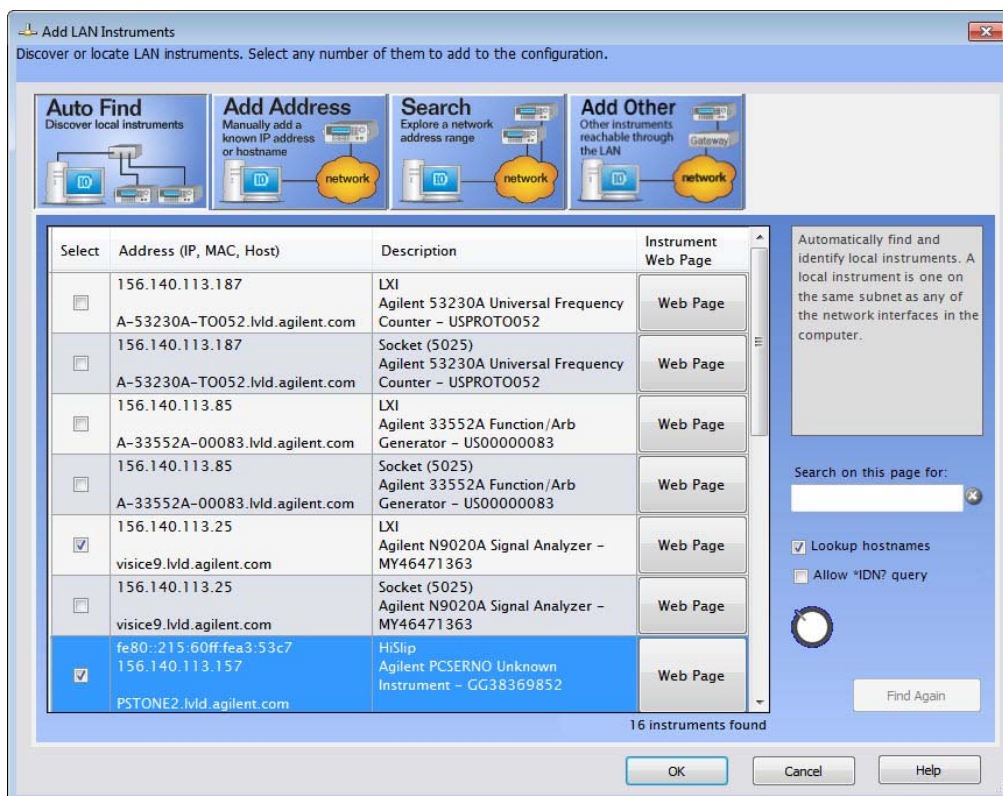
Click the Select check box for each instrument you want to include as part of your test system. Click the **OK** button to verify each selected instrument and add it to the Connection Expert Explorer Pane. Instrument properties are enumerated in the Connection Expert properties pane.

If Connection Expert Did Not Find your Instrument...

- You may have to cycle power on the external host controller for it to find the updated hostname.

- If all the instrument(s) you want to include are on the same local subnet as your PC, the Connection Expert **Auto Find** (default tab) should discover each instrument. If it did not find one or more instruments:

  - If instrument(s) are not on the same local subnet as the PC and you don't know the instrument IP address or the Hostname, use the **Search** tab.

  - If instrument(s) are not on the same local subnet as the PC and you know the instrument IP address or hostname, use the **Add Address** tab shown below. Select the **Use Hostname** or **Use IP Address** and enter the corresponding hostname or IP address. Be sure to select **Socket**, and click **OK**.

Refer to the Connection Expert help for more information on finding and adding LAN instruments.

Chassis Firmware, IVI Driver, and IO Libraries Matrix

The following table lists the various chassis firmware versions, IVI software versions, and IO Libraries versions shipped with the Agilent M9514A AXIe chassis and M9521A ASM.

	Approximate Shipment Date	Firmware Version	IVI Driver Version	IO Libraries Suite Minimum Version	IO Libraries Suite Version the Firmware or Drivers were Released with
M9514A Chassis:	March 2014	2.3.10	1.0.2.0	16.3 Update 2	16.3 Update 2
M9521A ASM:	March 2014	2.3.10	1.0.1.0	16.3 Update 2	16.3 Update 2

NOTE	Device firmware may change over time. To identify the device's firmware revision, use the device web page or Soft Front Panel.

To update firmware, IVI driver (including Soft Front Panel), and LabVIEW driver, and get the most up-to-date documentation, refer to the Agilent AXIe chassis or ASM web pages:

www.agilent.com/find/M9514A

or

www.agilent.com/find/M9521A

To update IO Libraries Suite, go to: www.agilent.com/find/iosuite

Always use the latest version of firmware, IVI and LabVIEW drivers, and IO Libraries Suite to get the best performance and latest features.

Updating Firmware

You can update a device's firmware from its soft front panel (SFP).

To open the M9514A Chassis SFP, from Windows click:

Start > All Programs > Agilent > AXIe Chassis (M9514) > AXIeC SFP

To open the M9521A ASM SFP, from Windows click:

Start > All Programs > Agilent > AXIe System Module (M9521A) > AXIeSM SFP

From either SFP, click **Utilities > Update Firmware...** and follow the instructions in the dialog boxes and the application help.

You can also run the soft front panels from the Installed Drivers tab of the instrument properties view in Agilent Connection Expert.
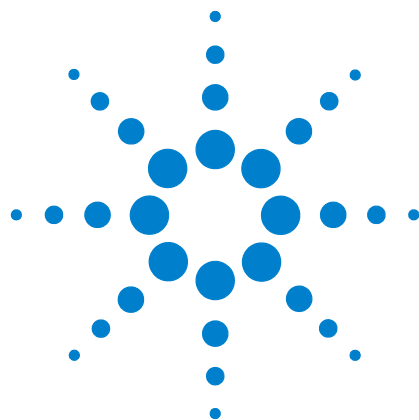
2

Module and Software Installation

This chapter begins where the *M9014A Startup Guide* leaves off, and provides the detailed procedures for module installation and removal and module software installation.

The *M9514A Startup Guide*, provided in print and on *Software and Product Information CD* with each chassis, includes a step-by-step procedure to connect the chassis to a host PC and establish basic LAN communication with the chassis using the built-in Web Interface. Agilent recommends you follow the Steps in the *Startup Guide* before proceeding. You may also obtain the latest *Startup Guide* at www.agilent.com/find/M9514A.

To verify basic chassis operation, it is not mandatory to install modules, mount the chassis, or interconnect to other chassis.

WARNING	Chassis exceeds 43 kg. Use a mechanical lift to lift the chassis. The chassis should be transported using a rolling cart. Do not lift the chassis by the handles on the front and rear of the chassis.

Agilent Technologies

Installing Modules

The AXIe chassis accept modules conforming to the single slot, 1U AXIe standard. These may include:

- AXIe instrument modules
- AXIe embedded controller module
- AXIe filler panels

> **CAUTION**
>
> **Static Electricity**—The components and connectors on modules are sensitive to static electricity. To minimize electrostatic damage, take the necessary anti-static precautions. Both chassis provide a grounding terminal, to which you can connect a wrist strap. To locate this terminal, see "M9514A AXIe 14-Slot Chassis at a Glance" on page 21.
>
> **Empty Slots**—Except for performing initial chassis verification or troubleshooting, do not operate the chassis with empty slots. Always insert a filler panel or an instrument module into empty slots. This is especially important for the slots on either side of an instrument module. This allows proper air flow and cooling, and provides EMI shielding for the chassis and installed components. Leaving slots empty can increase fan speed, raise ambient noise, overheat components, and shut down modules.
>
> **ASM**—The AXIe System Module is integral to the operation of the chassis. Except for troubleshooting purposes, do not remove the ASM.
>
> **Hot Swap**—AXIe does not explicitly support hot swap for instrument modules. Agilent recommends fully powering down the chassis before installing or removing modules
>
> **Embedded Controller Module**—Manually initiate a graceful shutdown of the controller operating system and power off the chassis before removing the module.

Removing Filler Panels

1 Power down the AXIe chassis (see "Chassis and Host Controller Power Cycling" on page 32).

2 Fully loosen the captive retaining screws on both sides of the filler panel.

> **CAUTION**
>
> Ensure you fully loosened the captive module retaining screws before trying to extract any module. If you attempt to pull the module out by the screws (for filler panels) or by using the extraction handles (other modules) with these screws still engaged, damage to the chassis or module could result.

3 Grasp the panel by the two retaining screws, and slide it out of the chassis.

Installing a Module

1 Power down the AXIe chassis (see "Chassis and Host Controller Power Cycling" on page 32).

2 Locate the (top and bottom) guide rails for each slot. The example below shows the guide rails in the chassis with all slots empty; typically one or more will be covered.

Spring guides center the module's PCB at the entry of the guide rail
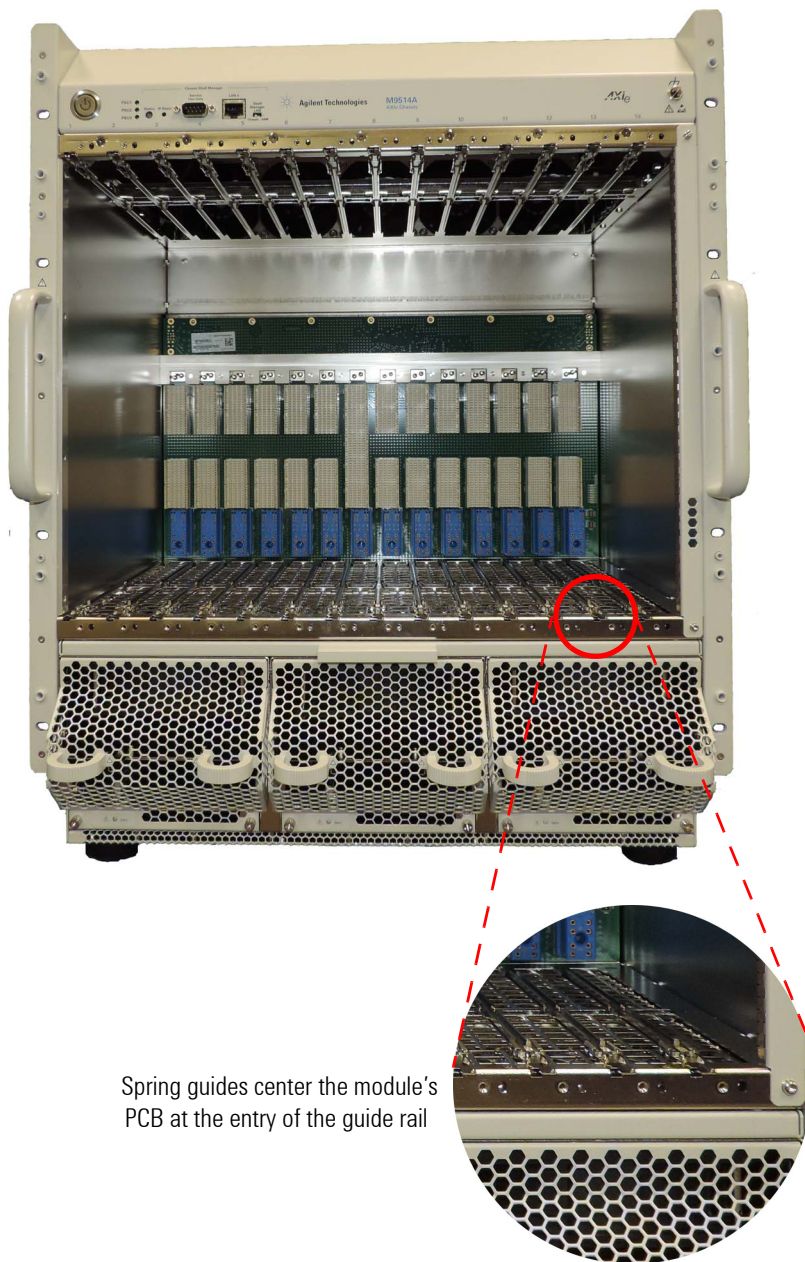
3 Align the module's circuit board with the chassis guide rails. If the module has metal plates covering the board, be sure to insert the circuit board and not the metal plates into the rails. Slide the board gently into the two rails. If the fit is tight, slide the board back out and recheck alignment.

4 Locate the insertion/extraction handles at each side of the module's front panel. Extend the ends of both handles, by pulling them inwards towards each other; the plastic handle end slides about 1 cm on the metal handle shaft. Then fully open the handles by pivoting them out towards you until they are perpendicular to the front panel. The left handle is shown below, from the top view, correctly extended.
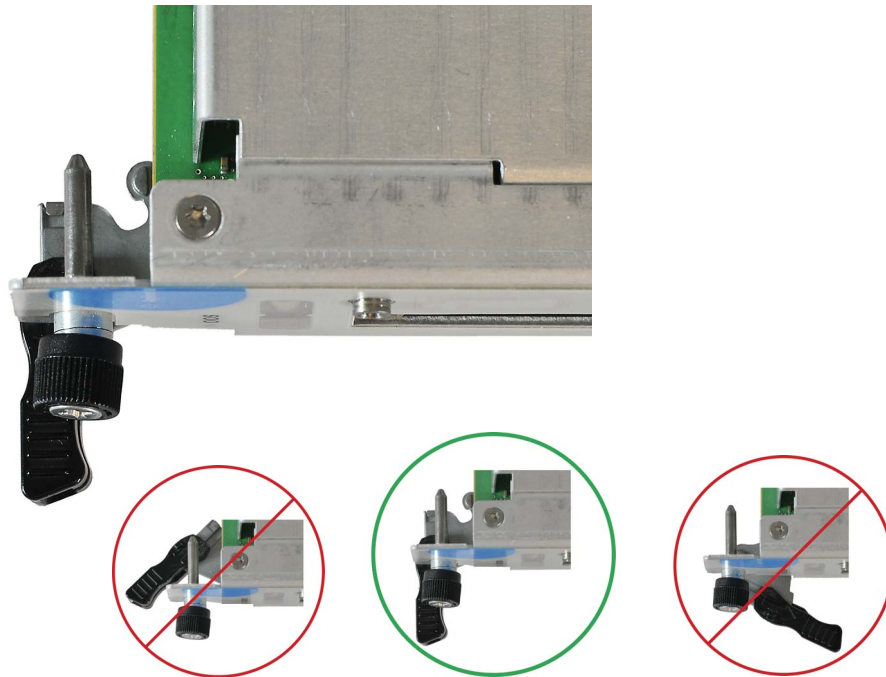
If either handle is misaligned, you will not be able to properly install the module.

5 Slide the module completely into the chassis. When the module's backplane connectors contact the chassis backplane, you will feel resistance and the two handles will begin to close toward each other. The module's faceplate will be about 1 cm from the chassis front panel.

6 Continue nudging the module faceplate gently but firmly with your thumbs, until the handles are pressed up against the chassis and the module's front panel lies flush with the chassis' front panel. This seats the module firmly in the chassis backplane. If necessary, gently press inward (toward the chassis) on the handles to ensure full insertion.

7 Tighten the captive retaining screws at both sides of the module.

CAUTION	Modules are grounded through the chassis. Tighten the module retaining screws to ensure a proper ground connection.

8 Retract the handle ends by sliding them outward on their metal shafts, away from each other, toward the chassis edge; this secures them out of the way of test connections.

9 Repeat steps 3 through 8 for additional modules, as needed. Ensure that each slot has an instrument module or filler panel installed.

10 Power up the AXIe chassis. Verify that the chassis fans are operating and free of obstructions that may restrict airflow.

Removing a Module

The instructions below apply to all module types. The AXIe System Module (ASM) has the same extraction handles and retaining screws as instrument modules. If you should ever have to remove the ASM, follow the instructions for instrument modules below.

1 Power down the AXIe chassis (see "Chassis and Host Controller Power Cycling" on page 32).

2 Fully loosen the captive retaining screws on both sides of the module.

<table>
<tr><td>**CAUTION**</td><td>Ensure you fully loosened the captive module retaining screws before trying to extract any module. If you attempt to pull the module out by the screws (for filler panels) or by using the extraction handles (other modules) with these screws still engaged, damage to the chassis or module could result.</td></tr>
</table>

3 For a filler panel, grasp the panel by the two captive retaining screws, and slide it out of the chassis.

For all other modules, locate the insertion/extraction handles at each side of the module's front panel. Extend the plastic ends of both handles by sliding them outward on their metal handle shafts, inwards towards each other.

4 Open the handles by pivoting them out towards you, away from the chassis. This is easiest to do with thumb and forefinger of both hands simultaneously. Place each thumb at the inside of the handle, forefinger outside the handle, and rotate the handles with your thumbs. When the handles are perpendicular with the chassis, stop. The module should now be unseated the module from the chassis backplane and its faceplate from the chassis front panel.

5 Grasp the levers to slide the module out of the chassis.

Setting Up a Host PC

Following the *M9514A Startup Guide* instructions, you should have selected a host PC, made physical connection to the chassis, and communicated with the chassis using its Web Interface. You may have then disconnected the host PC from the chassis in order to install modules or mount the chassis. Re-establish that connection, per the *Startup Guide*.

CAUTION	Do not enable the Microsoft Windows sleep mode on the host PC. The controller may not have proper chassis enumeration when it wakes up and unpredictable operation may result.

Installing Module Soft Front Panels and Device Drivers

Each installed module typically requires device drivers and control software. You need not install them to verify basic chassis operation, but would logically install them on the host PC at this time. For Agilent instrument modules, load each module's *Software and Product Information* CD into the optical drive of your PC and follow the prompts. For others, consult the module provider for software requirements and instructions. Note that you can also obtain Agilent drivers and control software from the Agilent website:

> www.agilent.com/find/M9514A

Verifying Operation with Modules Installed

In the *M9514A Startup Guide*, you should have verified basic power-on operation of the AXIe chassis and communication with the host PC. Subsequently, in this chapter you have installed instrument modules. Then you have reconnected the host PC, and loaded chassis and module software drivers.

You should now reverify that Agilent Connection Expert correctly communicates with the chassis and installed modules.

- Power up the chassis (solid green status light on the chassis and ASM).
- Reboot the host PC. This will allow the host PC's BIOS to recognize the PCIe devices in the chassis.
- You may need to run the appropriate Add Hardware process in Windows for the host PC's operating system to correctly recognize and enumerate modules on the PCIe bus.
- Establish chassis communication with Agilent Connection Expert.
- Agilent Connection Expert should recognize the installed modules, and they also should be listed on the Module Configuration Page in the chassis Web Interface.

- The Web Interface is covered in detail in Chapter 3.
- After driver installation is complete, restart your PC. The Ethernet Controller **Found New Hardware Dialog** should no longer appear.

The following graphic shows typical PCIe or LAN connections between an external host computer and the M9514A chassis with an M9521A ASM.
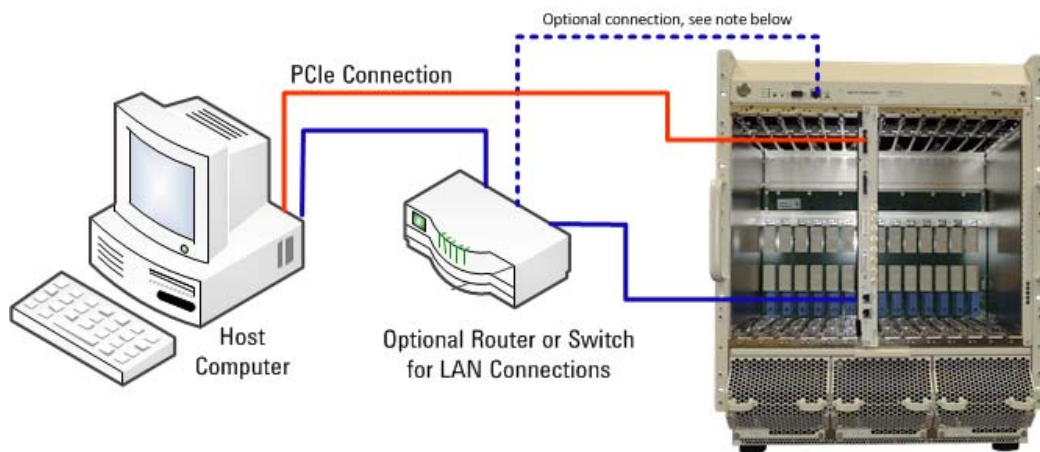
NOTE	The chassis LAN port and Shelf Manager LAN switch provide an access to the chassis Shelf Manager if a non-Agilent ASM is used that does not contain a LAN fabric. In this case, the chassis Shelf Manager is accessible via LAN 0. When using the Agilent M9521A ASM, the LAN 0 connection is not used and the Shelf Manager LAN switch should remain in the default **ASM** (right) position.

Using an Embedded Controller

An embedded controller, such as the Agilent M9536A may be installed in any slot in the chassis except for Slot 7 which is reserved for the ASM. However, to eliminate interference with the local bus used for E-Keying (if your AXIe modules use E-Keying), you should install the controller in one of the outside slots; e.g., 1 or 14 first, then 2 or 13, etc.

This section provides overall guidance on selecting and using the LAN ports. The controller uses the Agilent IO Libraries configuration file to keep track of all instrument connections. Any change to LAN connections after running Connection Expert (adding, removing, or changing LAN cable connections) may cause a change in LAN address and therefore cause Connection Expert to lose track of instruments. If your application programs rely on a specific IP address, these programs may cease to operate if you change LAN cable connections.

NOTE	Agilent's M9536A Embedded Controller must have BIOS AG16 or later. Earlier versions of the BIOS could not enumerate all of the slots in the M9514A AXIe chassis.

Using the M9536A Embedded Controller LAN Ports

If you installed an Agilent M9536A Embedded Controller in the Agilent M9514A AXIe chassis, there are a total of five LAN ports accessible on the front panels (refer to Figure 1). two on the M9536A controller, two on the M9521A AXIe System Module (ASM) and one on the chassis front panel (not used) .

Agilent M9536A
Controller
installed in slot 1

RJ 45 LAN
Connectors
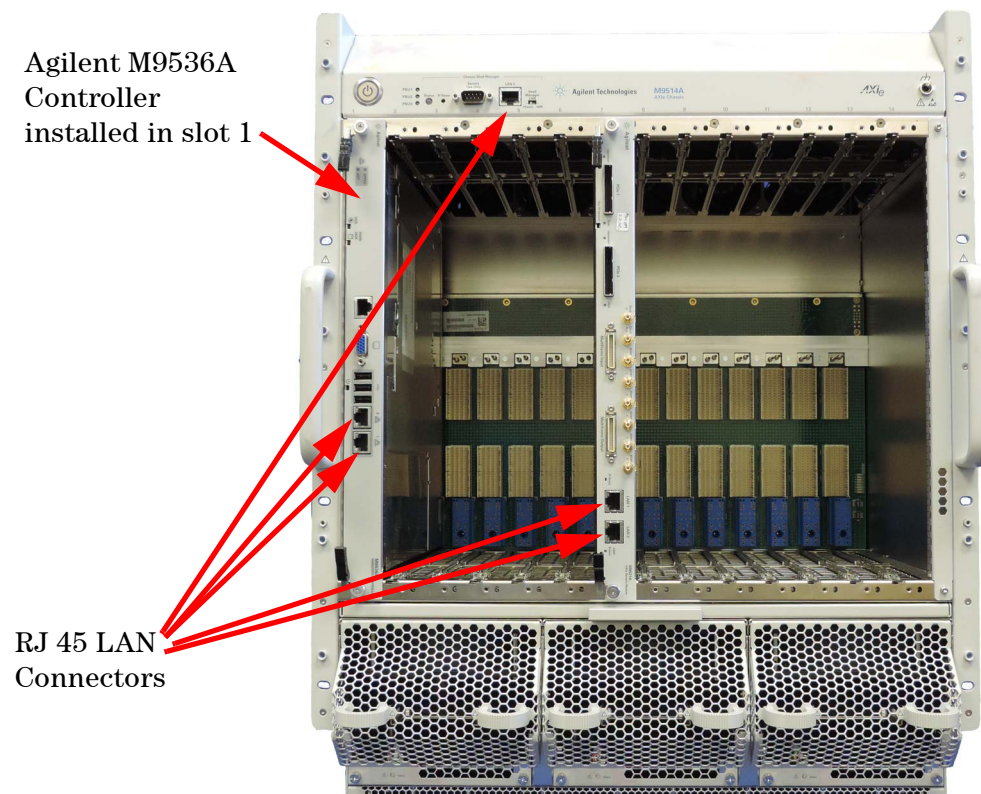
Figure 1   Embedded Controller, ASM, and chassis LAN ports

Windows Device Manager shows a total of four (5) individual Network Interface Cards (NICs) listed under the M9536A (see Figure 2). The Intel 82576 NICs are located in the M9536A, and the Intel 82580 NIC is located in the M9521A ASM.

CAUTION	Changing the LAN port connection or removing the LAN cable, may cause Agilent Connection Expert to lose track of LAN-enabled instruments. Reboot the AXIe chassis to restore the complete list of LAN-enabled instruments. Read the following for details.

Figure 2   NICs shown in Device Manager

Changes to the ASM PCIe or LAN connection are only detected as the ASM is powered up. Perform the following steps when you change either of these two connections:

1 Within Agilent Connection Expert, delete the LAN interfaces (right click on the interface then select **Delete**). This causes connection Expert to forget all instrument history.

2 Power down the AXIe chassis using the chassis power button.

3 Make the desired cabling change to the ASM PCIe and/or LAN connections.

4 Power up the AXIe chassis with the embedded controller.

5 Run Agilent Connection Expert and verify that the LAN interfaces are operating correctly and that Connection Expert finds the AXIe chassis.

NOTE	With Agilent IO Libraries 16.3 update 2 (and later versions) Agilent Connection Expert should automatically identify the AXIe chassis.

Cable Connection Recommendations

As a general rule, connect a network LAN cable to the ASM's LAN port and connect LXI instruments to the M9536A's LAN ports. While other configurations are viable, this configuration provides the fastest and most consistent reporting in Agilent Connection Expert. Refer to .

- Where you have the network and instruments connected when the chassis and controller first power on determines how quickly Agilent Connection Expert locates network instruments. If necessary, shut down the controller and chassis and reboot.

- If you move a LAN cable while chassis power is applied, Connection Expert may not find all of the instruments available on the network.

  For example, if the LAN cable is connected to the ASM when power is first applied to the chassis and subsequently moved to one of the two LAN ports on the controller (while the chassis is still powered on), Connection Expert may only find the M9536A controller and AXIe modules installed in the chassis. Shut down the controller and chassis and reboot to restore Connection Expert's ability to locate other network instruments.

- Connect external LAN-enabled instruments (LXI instruments) to the M9536A controller LAN ports. This allows Agilent Connection Expert to automatically find the instruments. These instruments will have a local LAN IP address or private network range.

  LXI instruments may be connected to the ASM's LAN port, but Connection Expert may not automatically find them when these instruments are not located on the same LAN subnet range. However, instruments may be added manually using Connection Expert's Add Address feature.

- If you are using an external LAN router or switch, cycling power on the chassis may cause the IP address of the chassis ASM and controller to change. Therefore you may want to set a static IP address. Refer to your particular network device's documentation for information on setting static IP addresses.

  With the Agilent M9536A Embedded Controller installed in the AXIe chassis, the x8 PCIe connection on the ASM module is disabled. However, the PCIe cable detect mechanism may reset the hardware when attaching a PCIe cable.

NOTE	The chassis LAN port and Shelf Manager LAN switch provide an access to the chassis Shelf Manager if a non-Agilent ASM is used that does not contain a LAN fabric. In this case, the chassis Shelf Manager is accessible via LAN 0. When using the Agilent M9521A ASM, the LAN 0 connection is not used and the Shelf Manager LAN switch should remain in the default ASM (right) position.
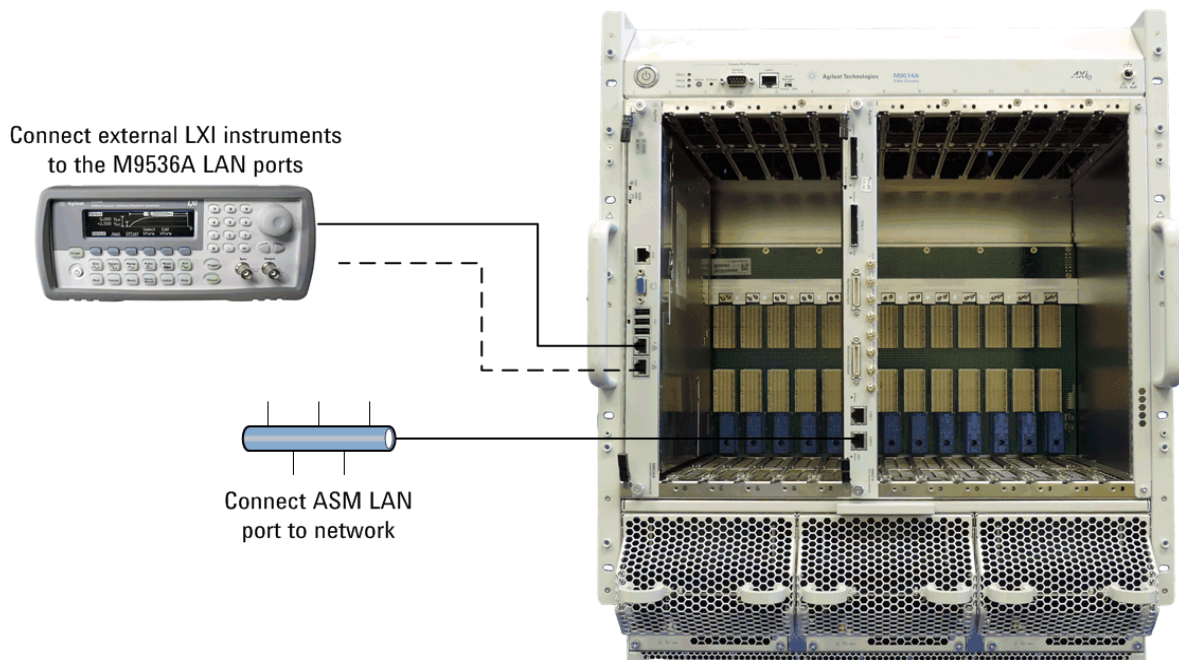
Figure 3   Recommended LAN Connections

Figure 3 shows the recommended LAN connections to the AXIe chassis/ASM and the M9536A. Note that you may need to manually add instrument IP addresses to Agilent Connection Expert.

Using an External Controller
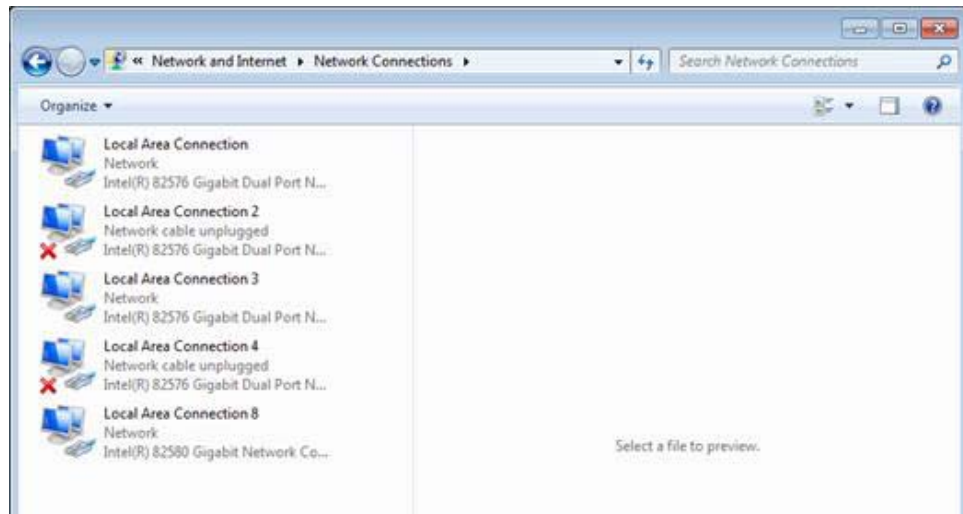
Changes to the ASM PCIe or LAN connection are only detected as the ASM is powered up. Perform the following steps when you change either of these two connections:

1   Within Agilent Connection Expert, delete the LAN interfaces (right click on the interface then select **Delete**). This causes connection Expert to forget all instrument history.

2   Turn off the external host controller.

3   Power down the AXIe chassis using the chassis power button.

4   Make the desired cabling change to the ASM PCIe and/or LAN connections.

5   Power up the AXIe chassis.

6   Power on the external host controller.

7   Run Agilent Connection Expert and verify that the LAN interfaces are operating correctly and that Connection Expert finds the AXIe chassis.
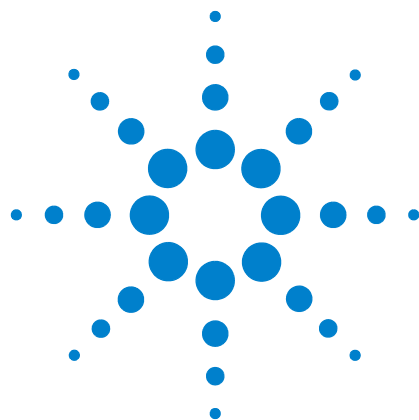
3

Navigating the Web Interfaces

This chapter provides a complete overview of the M9514A AXIe chassis and the M9521A ASM Web Interfaces, which allow for monitoring and configuration.

The Web Interface is stored in the chassis or ASM firmware, and may evolve in look and functionality as more recent versions of the firmware are developed. The examples in this manual reflect the firmware at time of product introduction.

Introduction

You can use the device's Web Interface or soft front panel (SFP) software to monitor and control the device. There are two separate SFPs and two web interfaces, one for the M9514A chassis and one for the M9521A ASM. Using the Web Interface requires only a browser on the host PC, whereas using the SFP requires installing the AXIe device software (which includes the SFP) on the host PC.

Launching the Web Interface

Like other Agilent web-enabled instruments, you can launch the web interface from any web browser using the chassis' or ASM's IP address (169.254.1.0 and 169.254.1.1, respectively).

NOTE	This section assumes Agilent IO Libraries Suite version 16.3 update 2 (or later) is installed. Earlier versions of IO Libraries Suite behaved differently. Always use the latest version of Agilent IO Libraries Suite.

NOTE	The chassis LAN port and Shelf Manager LAN switch provide an access to the chassis Shelf Manager if a non-Agilent ASM is used that does not contain a LAN fabric. In this case, the chassis Shelf Manager is accessible via LAN 0. When using the Agilent M9521A ASM, the LAN 0 connection is not used and the Shelf Manager LAN switch should remain in the default ASM (right) position.

Launch the Web Interface from Agilent Connection Expert

1 Open *Agilent Connection Expert* using one of these three methods:

- Click the IO control in your Windows taskbar (see below) and click Agilent Connection Expert.

- From the Windows Start menu, select **All Programs > Agilent IO Libraries Suite > Agilent Connection Expert** to launch the program.

- From a Command Prompt window, type:
```
<c>:\Program Files\Agilent\IO Libraries Suite\
AgilentConnectionExpert.exe
```

to launch the program.

The **Agilent Connection Expert** window displays.
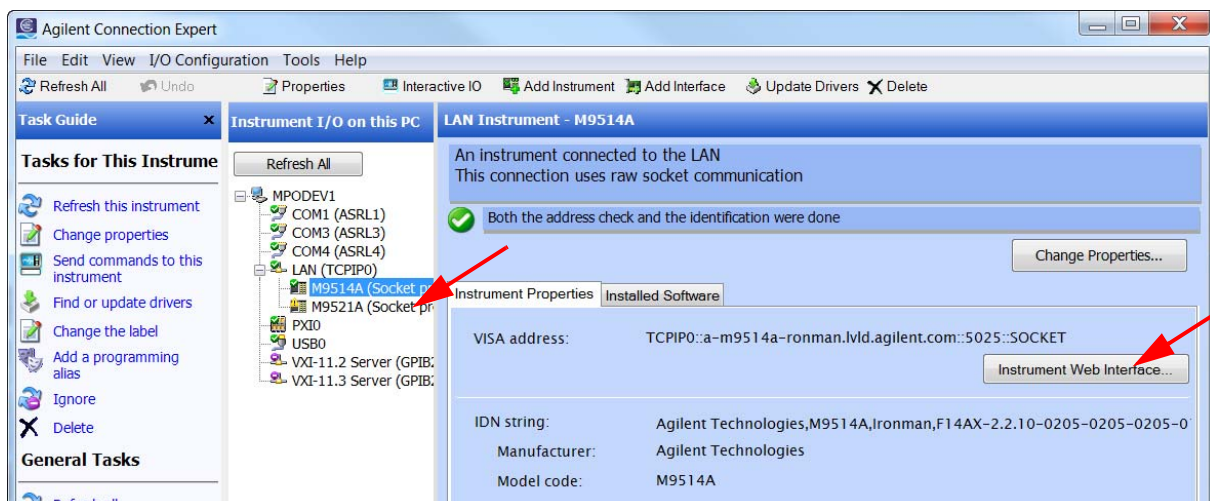
2 The **Instrument I/O on this PC** pane shows instrument connections on your PC. If connected through PCIe, both the chassis and ASM will appear under the PXI0 interface. If connected through LAN, both the chassis and ASM appear under the LAN interface.

3 To launch the Web Interface, select either the M9514A chassis or the M9521A ASM in Connection Expert. Then, click the Instrument Web Interface... button as shown above. The Web Interface will be displayed in a new window:

NOTE	If you have problems launching the chassis or ASM Web interface, check your browser's proxy settings. When Agilent Connection Expert launches a Web interface for a chassis, it hands off the **http://<address>** to the browser or dedicated web application. Therefore, it should not use a proxy.

Using the M9514A Web Interface

The five buttons at left are the Web Interface's menu. The following table provides a brief description of what you can do on each page.

Home Page - View General Information about the chassis, such as product identification, firmware version and LAN parameters.

LAN Configuration Page - View/change IP address, domain, and subnet. Display service discovery information and LAN status.

Module Configuration Page - View basic product and model information for instrument modules loaded in the chassis.

E-Keying Page - Shows the connection protocols each module has with other modules in the chassis over the backplane (read-only). E-keying permission occurs as modules activate during power on.

Chassis Health Page - Shows read-only diagnostic information on chassis fan speed, voltage rails, and temperature sensors. It also allows you to set a minimum chassis fan speed and provides a link to update chassis firmware

Chassis Fan Control Page -Displays the fan operating level for module cooling.

Help Page - General help topics and context-based help for the current page.

Home Page

The home page displays identifying information about your chassis and LAN connection, more if you click the Advanced Information (Advanced) button.

Clicking **Turn On Front Panel Identification Indicator** causes the chassis front panel STATUS light to flash steadily; use this to quickly identify which chassis you are communicating with.

Communication settings of your M9514A

Click the ⬛ button to display the communications settings:

The Communication page allows you to view network and LAN configuration parameters of the chassis. These parameters cannot be configured from this Web page. Refer to Agilent Connection Expert to reconfigure parameters.

LAN Configuration

•**IP Address Configuration**　This parameter shows the current IP address configuration. If it is set to Automatic, the IP Address, Subnet Mask, and Default Gateway were determined automatically, either from DHCP or, if a DHCP server was not found, from Dynamically Configured Link Local Addressing (Auto-IP). If it is set to Manual, the IP Address, Subnet Mask, and Default Gateway were set to the configured values.

•**IP Address**　This is the Internet Protocol (IP) address of the chassis. The IP address is used for TCP/IP communications with the chassis. The IP Address Configuration (above) indicates how the address was determined.

•**Subnet Mask**   This parameter is used to enable the chassis to determine if an IP Address is on the same local subnet as the chassis. When an address is on a different subnet, all packets must be sent to a gateway. The IP Address Configuration (above) indicates how the subnet mask was determined.

•**Default Gateway**   This is the IP address of the default gateway that allows the chassis to communicate with systems that are not on the local subnet. Packets which are destined for a device not on the local subnet, as determined by the subnet mask, are sent to the default gateway. The IP Address Configuration (above) indicates how the default gateway was determined.

•**DNS Server(s)**   This parameter shows the IP addresses of the Domain Name System (DNS) servers. The server provides a hostname for a given IP Address based on entries in its DNS lookup table. If the DNS Server Address Configuration was set to Automatic on the Modify Configuration page, then the DNS servers were obtained from the DHCP server.

•**Desired Hostname**   This parameter shows the desired hostname name for the chassis. This name is used as the NetBIOS name as well as the DNS name. Depending upon what type of servers that you have, you may be able to use this name to connect to the chassis.

•**Domain**   This parameter shows the Internet domain for the chassis.

•**Description**   This parameter shows a description of this chassis. This description appears on the Welcome Page.

- mDns Instrument Name is the name available to mDNS clients, such as Agilent Connection Expert.

- mDns Status is normally Active.

Refresh Button   Verifies and refreshes the displayed settings.

Reset User-Settable Memory

CAUTION	Clicking this button resets all user-settable, non-volatile memory - returning the chassis to its factory state. This will interrupt connectivity with the chassis, and will require re-establishing the LAN connectivity to the chassis. See "Establishing PCIe and LAN Connectivity to the Chassis and ASM" on page 37 for instructions on re-establishing connectivity.

Clicking the **Reset User-Settable Memory** button:

- Resets the LAN IP address to 169.254.1.0

- "Resets the fan Dynamic Minimum Fan Level and the Current Speed Level to 35 (the shelf manager may override this setting, depending on heat load).

Chassis Addressing

In its default configuration, when you make a LAN connection between host PC and chassis LAN connection, and then power-on the chassis, the following process happens:

1 The chassis, as client, seeks a Dynamic Host Configuration Protocol (DHCP) server to set the IP configuration. If, after 30 seconds, no DHCP address is provided, the chassis sets its default address to: 169.254.1.0

2 If you connected the chassis and PC to a corporate LAN, the network will provide the DHCP addresses.

3 If you made a direct LAN connection (physical LAN or implicit LAN connection through PCIe), the chassis reverts to a link-local address (a type of unicast address intended for local use, only).

Chassis Module Configuration Page

Click the 🖳 button to display the Chassis Module Configuration page. This page allows you to view the physical location and identifying information for recognized modules installed in the chassis, as well as the chassis frame and AXIe System Module. Scroll down to view power supply and fan tray details. This information is read-only, provided so that you may verify the chassis slot configuration.

M9514A | Products | Agilent

Agilent Technologies   M9514A AXIe 14 Slot Chassis

Chassis Module Configuration

Module Slot		Product Name	Description	
14		AXIe System Controller		
			Product Serial Number	TW52070510
			Revision	B1
			Manufacturer	Agilent Technologies
13		-empty-		
			Product Serial Number	
			Revision	
			Manufacturer	
12		-empty-		
			Product Serial Number	
			Revision	
			Manufacturer	
11		-empty-		
			Product Serial Number	
			Revision	
			Manufacturer	
10		-empty-		
			Product Serial Number	
			Revision	

Module E-Keying Configuration

Click [key icon] to display the E-Keying Configuration. E-Keying (short for Electronic Keying) is a process in which compatible matches over links between different modules are identified and enabled to be used. For more information on E-Keying refer to

In general, you do not need to understand how E-Keying works. The E-Keying process is handled by the chassis shelf manager. The following two figures illustrate the Module E-Keying Activity display in the Module Configuration Page.

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Agilent Technologies M9514A AXIe 14 Slot Chassis

Module E-Keying Configuration

This table describes the electronic keying link activity permitted by the shelf manager. A status of 'enabled' indicates an interface and associated link is permitted to be established. It does not indicate whether the link is alive and active. Modules may have many interfaces. A blank status indicates an interface is available, but not in use. Clicking on any heading will sort the table according to that column.

From Slot	To Slot	Status	Interface	Link Type	Extension	Group	Channel	Port
Backplane			AXIE Timing (0x02)	FCLK	(System slot output) (0x1)	0x00	1	1
Backplane			AXIE Timing (0x02)	CLK100	(System slot output) (0x1)	0x00	2	1
Backplane			AXIE Timing (0x02)	SYNC	(System slot output) (0x1)	0x00	3	1
Backplane			AXIE Timing (0x02)	FCLK	(Instrument slot input) (0x2)	0x00	4	1
Backplane			AXIE Timing (0x02)	CLK100	(Instrument slot input) (0x2)	0x00	5	1
Backplane			AXIE Timing (0x02)	SYNC	(Instrument slot input) (0x2)	0x00	6	1
Backplane			AXIE Timing (0x02)	FCLK	(Instrument slot input) (0x2)	0x00	7	1
Backplane			AXIE Timing (0x02)	CLK100	(Instrument slot input) (0x2)	0x00	8	1
Backplane			AXIE Timing (0x02)	SYNC	(Instrument slot input) (0x2)	0x00	9	1
Backplane			AXIE Timing (0x02)	FCLK	(Instrument slot input) (0x2)	0x00	10	1
Backplane			AXIE Timing (0x02)	CLK100	(Instrument slot input) (0x2)	0x00	11	1
Backplane			AXIE Timing (0x02)	SYNC	(Instrument slot input) (0x2)	0x00	12	1
Backplane			AXIE Timing (0x02)	FCLK	(Instrument slot input) (0x2)	0x00	13	1
Backplane			AXIE Timing	CLK100	(Instrument slot input)	0x00	14	1

In the following segment, note that the module in Slot 3 and the ASM have an Enabled status and use the AXIe Fabric (0x00). This indicates that the two modules have permission to communicate directly (E-Keying) over the AXIe backplane.

From Slot	To Slot	Status	Interface	Link Type	Extension	Group	Channel	Port	
3			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	1	1	
3			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	2	1	
3			Fabric (0x01)	PICMG 3.1 Ethernet Fabric	(1000BASE-BX)	0	1	1	
3			Fabric (0x01)	PICMG 3.1 Ethernet Fabric	(1000BASE-BX)	0	2	1	
3			Update Channel (0x02)	OEM GUID-based (0xf0)		0	1	1	
3	ASM	Enabled	AXIE Fabric (0x00)	PCI Express Fabric	(5 GT/s normal)	0	1	1,2	
3			AXIE Local Bus (0x01)	OEM GUID-based (0xf0)	(62-pair local bus)	0	1 (Left)	1	
3			AXIE Local Bus (0x01)	OEM GUID-based (0xf0)	(62-pair local bus)	0	2 (Right)	1	
3			AXIE Timing (0x02)	FCLK		0	1	1	
3			AXIE Timing (0x02)	CLK100		0	2	1	
3			AXIE Timing (0x02)	SYNC		0	3	1	
3			AXIE Timing (0x02)	STRIG		0	4	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(ShMC Cross-connect)	0	1	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	2	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	3	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	4	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	5	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	6	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	7	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	8	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	9	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	10	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	11	1	
ASM			Base (0x00)	PICMG 3.0 Base 10/100/1000 BASE-T	(10/100/1000 BASE-T)	0	12	1	

More information on AXIe E-Keying is available on the AXIe Consortium website: www.axiestandard.org.

Chassis Health Page

Click the [icon] button to display the Chassis Health page.

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Agilent Technologies   M9514A AXIe 14 Slot Chassis

Chassis Health

Sensors

Module Slot	Instrument	State	Sensor Readings					
14	AXIe System Controller	Active						
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical
	Nominal		6	Voltage	+1.5V DDR-CPU1	1.25 Volts	1.56 Volts	1.62 Volts
	Nominal		7	Voltage	+1.8V CPU1	1.66 Volts	1.82 Volts	1.95 Volts
	Nominal		10	Voltage	+5.0V	4.62 Volts	5.16 Volts	5.40 Volts
	Nominal		11	Voltage	+3.3V	3.05 Volts	3.34 Volts	3.57 Volts
	Nominal		12	Voltage	+12V	11.08 Volts	12.15 Volts	13.01 Volts
	Nominal		18	Temperature	LM75 SYS Temp	-5.00 degrees C	32.00 degrees C	75.00 degrees C
	Nominal		19	Temperature	CPU1 Temp		35.00 degrees C	80.00 degrees C
	Nominal		20	Temperature	CPU2 Temp		0.00 degrees C	80.00 degrees C
13	-empty-							
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical
12	-empty-							
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical
11	-empty-							
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical
10	-empty-							
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical
9	-empty-							
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical
8	-empty-							
	Status		ID	Type	Name	Lower Critical	Reading	Upper Critical

Sensor Readings

The Sensor Readings section provides information about the chassis voltage
and temperature sensors and any sensors located on the individual AXIe
modules. These module sensors are unique to the modules and should be
described in their respective user documentation. The graphic above shows
values for both temperature and voltage sensors on the AXIe System
Controller installed in Slot 14.

Alarm conditions appear in color. For example, an Upper Criticial condition appears as:

		ID	Type	Name	Lower Critical	Reading	Upper Critical
	Nominal	246	OEM reserved	PSU3 ALARM1		0x00 unspecified	
	Nominal	247	OEM reserved	PSU3 ALARM2		0x00 unspecified	
	Front Left Fan Tray	**Active**					
	Status	*ID*	*Type*	*Name*	*Lower Critical*	*Reading*	*Upper Critical*
	Upper Critical	2	Temperature	Front tray		29.00 degrees C	70.00 degrees C
	Nominal	3	OEM reserved	Timer Low		0xdf unspecified	
	Nominal	4	OEM reserved	Timer Middle		0x00 unspecified	
	Nominal	5	OEM reserved	Timer High		0x02 unspecified	

Click the help button on the web page for information on sensor alarms.

Configure Fan Control

Click ![icon] to display the Configure Fan Contol page:

The M9514A AXIe chassis contains:

- Three removable fan trays at the bottom on the front of the chassis (each fan tray has two fans) that pushes air into the chassis module cavity.

- A removable fan tray at the top of the rear of the chassis (contains two assemblies of five fans each) that pulls air out of the module cavity.

The net effect of the removable fan trays is to create a negative pressure in the module cavity and increase overall air flow performance and cooling in the module cavity.

For uniform cooling of the module cavity, the fan level setting adjusts all fans in the four removable fan trays. Using a range of 35 to 100 (percentage of maximum), you can manually set the minimum speed you want the fans to operate at — 35 means the minimum fan speed.

| NOTE | Regardless of where you set the minimum fan speed, if the temperature inside the AXIe chassis rises, the fans speed increases to provide additional cooling. The resolution of the Current Fan Level, as shown on the Chassis Health web page, is an approximation of the fan speed. |

The Configure Fan Control section of the Chassis Health Page has the following five fields:

Fan RPM Status   The chassis shelf manager continuously monitors fan speed in each of the removable fan trays, looking for possible indication that one or more fans are not turning. Nominal fan status represents a fan speed of approximately 2,000 RPM, higher when required by instrumentation load. Below that range, the shelf manager will report an alarm condition for that fan, attempt to increase fan speed and continue to monitor. Failure of one fan will not result in interruption of power to installed modules. The fan status conditions are listed in the following table.

Fan RPM Status	Fan Speed (RPM)	Shelf Manager Response
Nominal	2,000 or higher	Continue monitoring fan speed
Below Lower Non-Critical		Increase fan speed one step and continue monitoring
Below Lower Critical		Increase fan speed to maximum and continue monitoring
Below Lower Non-Recoverable		This usually indicates a fan has stopped turning; increase fan speed to maximum and continue monitoring

Cooling Status   The shelf manager continuously monitors reported module temperatures, looking for indication that one or more modules is outside its optimal temperature range. This range is specified by the module vendor, as are the thresholds for alarm conditions. Typically only high temperatures generate an alarm, although it is possible for a vendor to specify low temperature alarm levels as well.

In the event of a high temperature alarm from any module, the shelf manager responds by increasing chassis fan speed (in all removable fan trays) and continuing to monitor. If the Upper Non-Recoverable threshold is reached, the shelf manager requests the module to power down to its inactive state. Because this level is set by the module vendor, it may not indicate that the module has failed, only that continued operation is inadvisable until the module cools.

Cooling Status	Module Temp	Shelf Manager Response
Nominal		Continue monitoring module temperature
Above Upper Non-Critical		Increase fan speed one step and continue monitoring
Above Upper Critical	specified by module vendor	Increase fan speed to maximum and continue monitoring
Above Upper Non-Recoverable		Increase fan speed to maximum, deactivate that module and continue monitoring. This usually implies imminent module damage if operation continues;

Current Speed Level   This is the level the fans are currently operating at and is controlled by the Shelf Manager. It increases from a set minimum as needed to adjust for changes in chassis temperature. The range is from 35 to 100, where 35 is the slowest speed level and 100 is the highest speed level.

The Current Speed Level indicates an approximate percentage of maximum fan RPM. Therefore, a level of 40 indicates the fans are operating at approximately 40% of maximum RPM, and 100 indicates the fans are operating at 100% of maximum RPM. Note, the default/reset value is 40.

Dynamic Minimum Fan Level   This is the minimum fan level the shelf manager algorithm sets as it actively monitors the overall system temperature and temperature threshold events received from instrument modules. Over time, the algorithm adjusts this level towards the user-specified minimum fan level provided the cooling status remains at Normal.

Adjust Current Speed Level and Dynamic Minimum Fan Level   This user adjustable parameter actually sets both values. This level is kept in non-volatile RAM until you change it; cycling power to the chassis does not change the minimum fan level. Adjust the minimum fan level by entering a value in the field, or clicking the up/down arrows, and then clicking the **Apply** button.

Note that you can individually set the Current Speed Level and the Dynamic Minimum Fan Level using IVI commands. The Web UI (and the Soft Front Panel) binds these two together. Setting the Current Speed Level is always temporary because the Dynamic Minimum Fan Level algorithm continuously adjusts the fan speed towards a dynamic minimum when cooling conditions permit. For example, consider a situation where the chassis and installed modules require a fan speed of 50 to maintain proper cooling. If you attempt to manually set the Current Fan Speed to a lower value (40 for example) the algorithm overrides the setting and maintains the fan speed to provide adequate cooling. Conversely, if you manually set the fan speed to a higher value (65 for example), the algorithm sets that fan speed and does not change it unless additional cooling becomes required.

Of course, since the actual cooling requirements for the chassis and modules may continuously change, that actual fan Current Speed Level and the Dynamic Minimum Fan Speed will also change over time.

Controlling Fan Speed

You can set the *dynamic minimum fan level*, over a range from 35 to 100 as a percentage of maximum fan speed, by setting that level in the Adjust Current Speed Level and Dynamic Minimum Fan Level field and clicking the **Apply** button. This specifies the minimum level at which you want the chassis fans to run. The Shelf Manager will increase fan speed from that minimum—for all (three or six) chassis fans—if required by an alarm condition (low fan speed or high module temperature).

NOTE	If the minimum fan speed is changed using the Web Interface, the newly-set value will become the chassis power-on default value. This is unlike other parameters set using the Web Interface, which do not persist through a power cycle. For more detailed information on controlling the fans using the Web Interface, refer to "Configure Fan Control" on page 67.

The power supply (PSU) fans are controlled automatically, you cannot override them.

Example of Chassis Fan Speed

The following graph illustrates how the chassis fan speed operates. For simplicity, only one temperature event is shown; in reality, temperature events may be happening frequently causing the fan Current Speed Level to change and the Dynamic Minimum Fan Speed to gradually change.
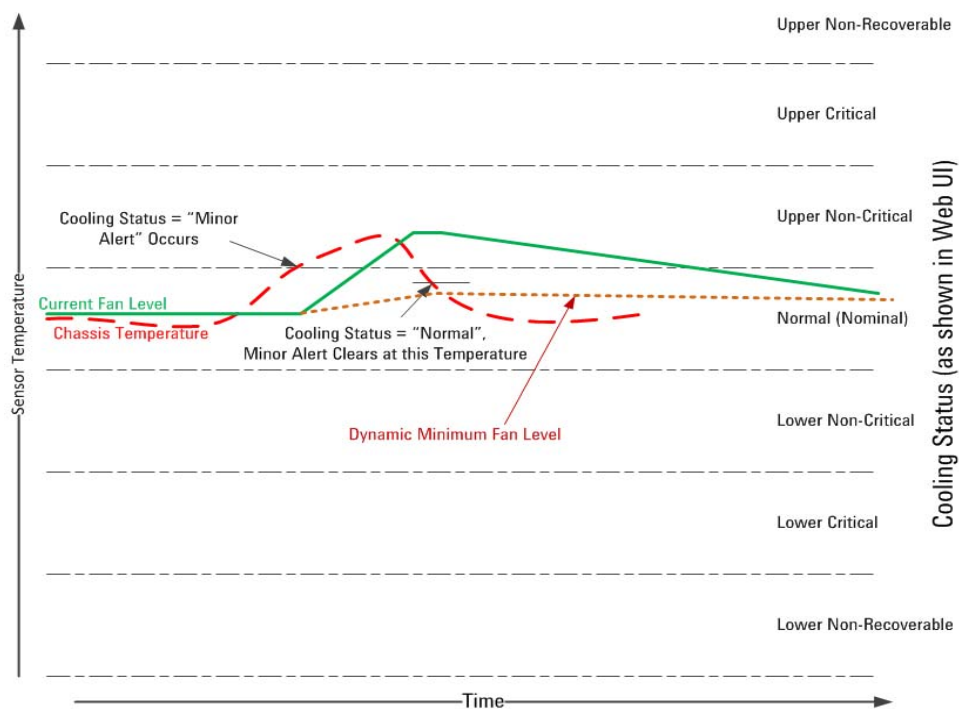
Assume at the beginning, the chassis is reporting a Nominal cooling status. The Dynamic Minimum Fan Level is approximately the same as the fan Current Speed Level. When one (or more) temperature sensors reports that a temperature has increased above its Nominal range and is now above its Upper Non-Critical threshold, a Minor Alert occurs on the cooling status. At this point, the chassis fan Current Speed Level begins ramping up to provide additional cooling. Note that the change is not instantaneous.

When the temperature sensors report that the temperature has dropped back into the Nominal range (because of hysteresis it is actually a few degrees below the Upper Non-Critical threshold), the chassis fan Current Speed Level begins to gradually slow down, compensating for the reduced heat load.

During this entire time, the Dynamic Minimum Fan Level algorithm is recalculating to provide a new minimum fan speed. As additional temperature events occur, and the Current Fan Level changes, the Dynamic Minimum Fan Level algorithm recalculates the minimum fan speed required to ensure optimal cooling in the chassis.

IVI-COM Programming

To set the Dynamic Minimum Level to 36:

IAgAXIeCFanTray.DynamicMinimumFanLevel = 36;

To set the current operating speed level of the fans to 36:

IAgAXIeCFanTray.CurrentSpeedLevel = 36;

IVI-C Programming:

To set the Dynamic Minimum Level

AgAXIeC_FanTraySetDynamicMinimumFanLevel Function

To set the current operating speed level:

AgAXIeC_FanTraySetCurrentSpeedLevel Function

Example Programs

The *AXIeCMonitor* example program demonstrates how to monitor threshold sensors. It lists all of the threshold sensors with their description, current value, and their threshold limits. The program then shows how to monitor a few select sensors and log their reading values to a file.

The *AXIeCFans* example program prints out the IVI names used to access the FanTray repeated capability. After listing out the names of all of the fan trays, the program then prints out the name and present setting of each item in each fan tray.

You can access MATLAB and Microsoft Visual Studio .NET example programs from the Windows Start menu by clicking:

Start > All Programs > Agilent IVI Drivers > AgAXIeSM AXIe System Module > AgAXIeSM Examples

Examples with *AXieSMTrigger* as part of the filename demonstrate how to route signals through the Crosspoint Switch and how to query to determine the input signals currently specified on a Crosspoint Switch output line.

IVI Driver Help

You can access the M9521A IVI driver help from the Windows Start menu by clicking:

Start > All Programs > Agilent IVI Drivers > AgAXIeSM AXIe System Module > AgAXIeSM Documentation

Using the M9521A Web Interface

The three buttons at left are the Web Interface's menu; at right is a brief description of what you can do on each page.

z

Home Page - View General Information about the chassis, such as product identification, firmware version and LAN parameters.

LAN Configuration Page - View/change IP address, domain, and subnet. Display service discovery information and LAN status.

Help Page - General help topics and context-based help for the current page.

Home Page

The home page displays identifying information about your ASM and LAN connection, more if you click the Advanced Information (Advanced) button.

Clicking **Turn On Front Panel Identification Indicator** causes the ASM front panel **STATUS** light to flash steadily; use this to quickly identify which ASM you are communicating with.

LAN Configuration Page

Click the [icon] button to display the Communication Settings page:

Agilent Technologies   **M9521A AXIe System Module (ASM)**

Communication settings of your M9521A

LAN Configuration

Parameter	Currently in use
IP Address Configuration:	Automatic
IP Address:	156.140.95.69
Subnet Mask:	255.255.248.0
Default Gateway:	156.140.88.1
DNS Server(s):	141.121.184.75 141.121.184.76
Desired Hostname:	A-M9521A-Pyton
Domain:	lvld.agilent.com
Description:	M9521A AXIe System Module (ASM)
mDns Instrument Name	Agilent M9521A AXIe System Module (ASM) - Pyton
mDns Status	Active

PCIe Configuration

Speed	PCIe Gen 2 Enabled (SW14.1 is on)
Fabric Revision	1.8
Host Slot	7

	Active Configuration:	New Configuration*:	
	PCIe 1 connector	PCIe 1 connector ▾	
	and wait [0]	and wait [0] [↓]	
	seconds	[↑] seconds	
PCIe Master	*CAUTION: Applying a new PCIe setting will only take effect after the next chassis power cycle. The **Auto** configuration (default) is recommended. With **Auto** selected, the ASM will select an embedded controller, if present, as the PCIe master -- for example, the M9536A AXIe Embedded Controller. If an embedded controller is not present, the ASM will look for an external PC controller on the ASM PCIe 1 connector to act as the PCIe master. If you want to have the PCIe master always be an external PC controller regardless of whether or not an embedded controller is installed, select the **PCIe 1 connector** setting. This setting forces the PCIe master to be an external PC controller connected to the ASM PCIe 1 connector. With this setting, if an external PC controller is not connected to the PCIe 1 connector, there will be no PCIe master. CAUTION: This setting may lead to confusion later if you subsequently install an embedded controller and expect it to automatically become the PCIe master. To achieve this, you'll need to select **Auto**. Note that the PCIe 2 connector on the ASM front panel is always configured as downstream facing to subordinate PCIe devices, and is not affected by this dialog.	[Apply New PCIe Settings] [Restore Factory Default]

[Refresh]

Reset User-Settable Memory
CAUTION: Pressing the button below will reset all user settable non-volatile memory, returning the ASM to its factory state. Doing this will interrupt connectivity with the ASM, and will require setting up the ASM as a new device. See "Establishing PCIe and LAN connectivity to the chassis and ASM" in the User Guide for more information.

[Reset User-Settable Memory]

The Communication page allows you to view network and LAN configuration parameters of the ASM. These parameters cannot be configured from this Web page. Refer to Agilent Connection Expert to reconfigure parameters.

LAN Configuration

•**IP Address Configuration**   This parameter shows the current IP address configuration. If it is set to Automatic, the IP Address, Subnet Mask, and Default Gateway were determined automatically, either from DHCP or, if a DHCP server was not found, from Dynamically Configured Link Local Addressing (Auto-IP). If it is set to Manual, the IP Address, Subnet Mask, and Default Gateway were set to the configured values.

•**IP Address**   This is the Internet Protocol (IP) address of the ASM. The IP address is used for TCP/IP communications with the ASM. The IP Address Configuration (above) indicates how the address was determined.

•**Subnet Mask**   This parameter is used to enable the ASM to determine if an IP Address is on the same local subnet as the ASM. When an address is on a different subnet, all packets must be sent to a gateway. The IP Address Configuration (above) indicates how the subnet mask was determined.

•**Default Gateway**   This is the IP address of the default gateway that allows the ASM to communicate with systems that are not on the local subnet. Packets which are destined for a device not on the local subnet, as determined by the subnet mask, are sent to the default gateway. The IP Address Configuration (above) indicates how the default gateway was determined.

•**DNS Server(s)**   This parameter shows the IP addresses of the Domain Name System (DNS) servers. The server provides a hostname for a given IP Address based on entries in its DNS lookup table. If the DNS Server Address Configuration was set to Automatic on the Modify Configuration page, then the DNS servers were obtained from the DHCP server.

•**Desired Hostname**   This parameter shows the desired hostname name for the ASM. This name is used as the NetBIOS name as well as the DNS name. Depending upon what type of servers that you have, you may be able to use this name to connect to the ASM.

•**Domain**   This parameter shows the Internet domain for the ASM.

•**Description**   This parameter shows a description of this ASM. This description appears on the Welcome Page.

• mDns Instrument Name is the name available to mDNS clients, such as Agilent Connection Expert.

• mDns Status is normally Active.

Refresh Button   Verifies and refreshes the displayed settings.

Reset User-Settable Memory

CAUTION	Clicking this button resets all user-settable, non-volatile memory - returning the ASM to its factory state. This will interrupt connectivity with the ASM, and will require re-establishing the LAN connectivitiy to the ASM. See *"Establishing PCIe and LAN Connectivity to the Chassis and ASM"* on page 37 for instructions on re-establishing connectivity.

Clicking the **Reset User-Settable Memory** button resets the LAN IP address to 169.254.1.1

About ASM Addressing

In its default configuration, when you make a LAN connection between host PC and ASM LAN connection, and then power-on the chassis, the following process happens:

1 The ASM, as client, seeks a Dynamic Host Configuration Protocol (DHCP) server to set the IP configuration. If, after 30 seconds, no DHCP address is provided, the ASM sets its default address to: 169.254.1.1

2 If you connected the ASM and PC to a corporate LAN, the network will provide the DHCP addresses.

3 If you made a direct LAN connection (physical LAN or implicit LAN connection through PCIe), the chassis reverts to a link-local address (a type of unicast address intended for local use, only).

PCIe Configuration

•**Speed**   This parameter shows the PCIe generation speed, either Gen 2 or Gen 1. This parameter is selectable by DIP switch 14 on the hardware. Default is Gen 2 which will automatically train to the correct speed between the ASM and external host controller. Some PC host BIOS may be incompatible operating at Gen 2, so this setting may be adjusted to operate only at Gen 1 in these special circumstances. This setting should not be changed unless there are PCIe connectivity issues.

•**Fabric Revision**   This field describes the eeprom revision for the PCIe fabric configuration, which may be referenced for support.

•**Host Slot**   This field reports the module slot acting as the PCIe host controller of the chassis. If no embedded host controllers are present, this slot reports the ASM (slot 7) as the PCIe connection interface to an external host controller.

•**PCIe Master**   The Active Configuration section displays the current PCIe upstream connection settings. New Configuration describes adjustments to be made upon the next power cycling of the chassis.

• **Active Configuration** -The PCIe Active Configuration section displays the current PCIe upstream connection settings in the **Active Configuration** field.

NOTE	Typically, you should *not* need to change the Active Configuration. Leave it set to **Auto** for the ASM to automatically select the appropriate configuration.

• **New Configuration** - The **New Configuration** field allows you to designate a PCIe Upstream Connection or designate an enumeration wait time.

The **Auto** configuration is recommended. With **Auto** selected, the ASM will select an embedded controller (such as the M9536A AXIe Embedded Controller), if present, as the PCIe master. If an embedded controller is not present, the ASM will look for an external PC controller on the ASM PCIe 1 connector to act as the PCIe master. The embedded host controller is chosen based on the following priority: slot 14, 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13. If none is found, the ASM in slot 7 uses PCIe Port 1 as the upstream facing connection to an external controller.

If you want to have the PCIe master *always* be an external PC controller regardless of whether or not an embedded controller is installed, select the **PCIe 1 connector** setting. This setting forces the PCIe master to be an external PC controller connected to the ASM PCIe 1 connector. With this setting, if an external PC controller is not connected to the PCIe 1 connector, there will be no PCIe master.

NOTE	If you use the **PCIe1 connector** setting, and later install an embedded controller, you will have to change the configuration to **Auto** for the embedded controller to be found and used.

•**Wait**   This parameter adds more time for modules to be ready for PCIe enumeration. Typically, you should not need to change the enumeration wait time. However, some AXIe instrument modules take longer to be ready for enumeration than the PXI link ready requirement of 100ms. Consequently, it is possible for some controllers (such as the Agilent M9536A Embedded Controller) to enumerate the chassis before all of the individual modules are ready and therefore not enumerate them. If you have a situation where Agilent Connection Expert and/or the Windows Device Manager consistently does not find specific instrument modules when the chassis powers up, increase the wait time (valid range is 0 to 60 seconds).

Apply New PCIe Settings button After selecting a new PCIe setting and/or wait time, click the Apply New PCIe Settings button.

Restore Factory Default button clicking this button returns the configuration to Auto and the Wait time to 0.

NOTE You must cycle chassis power for the new, or factory default, PCIe settings to take effect. See *"Chassis and Host Controller Power Cycling"* on page 32 for details on how to cycle chassis power.

NOTE The PCIe 2 connector on the ASM front panel is always configured as downstream facing to subordinate PCIe devices, and is not affected by this dialog.
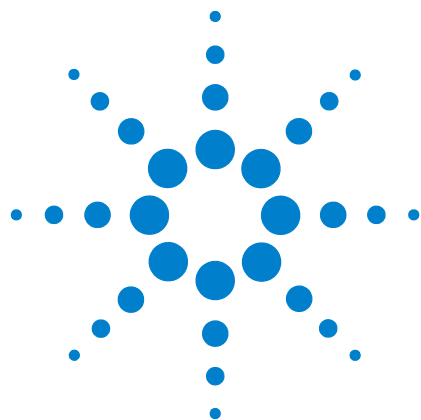
4
M9514A Chassis
Features and Functions

This chapter describes the key areas of the Agilent M9514A 14-slot AXIe chassis.

Agilent Technologies

Introduction

The diagram on the next page illustrates the relationship between the M9514A chassis and the M9521A ASM.

- The AXIe 14-slot chassis comprised of the AXIe module cavity, backplane, cooling fans, power supplies, etc.

- The Agilent M9521A AXIe System Module (ASM)[*] comprised of a single slot AXIe module that contains the clock functions, triggering routing crosspoint matrix (includes six external bidirectional ports), the upstream/downstream PCIe fabric switch and IO communication, and MultiFrame management.

The M9521A ASM must be installed in slot number seven (7) in the M9514A chassis in order to function as the system module.

Topics in this chapter describe the features and functions of the M9514A AXIe chassis. The M9521A ASM features and functions are described in detail in Chapter 5.

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[*] The M9521A ASM is different than the Embedded System Module (ESM) used in the Agilent M9502A and M9505A AXIe chassis. They are not interchangeable.

M9514 AXIe Chassis System

Agilent Connection Expert

Host PC

Agilent Connection Expert displays connection information separately for the chassis and for each module installed in the chassis.

Chassis or ASM Web Interface

Chassis or ASM Soft Front Panel SFP

The Web Interface uses either PCIe or LAN.

The SFP uses either PCIe or LAN.

Agilent M9514A AXIe Chassis

The PCIe x4 connections to each slot can only be accessed from the ASM PCIe interface. However, the internal LAN connections to each slot can be accessed from both the PCIe interface (through the Intel NIC and LAN Switch) and through the ASM LAN interface.

AXIe Modules may connect to the PCIe x4 interface and/or the Gb Ethernet interface. Refer to your module documentation for information on the interface(s) it uses.

PCIe x4 (Gen 2) to each slot

Internal LAN to each slot

Slot 14

Slot 10

Slot 9

Slot 8

ASM in Slot 7

ASM PCIe interface

PCIe cable (Gen 2)

PCIe ExpressCard Adapter (x1)
PCIe Desktop Adapter (x8)

PCIe Adapter

An application can use (open) one or both drivers.

Application program

Chassis Driver — AgAXIeC driver

AgAXIeSM driver — ASM Driver

In performing the Initialize() call for either driver, the application program specifies a VISA resource name. If only PCIe is connected, the resource name may appear like:

`"TCPIP0::169.254.1.0::5025::SOCKET"`

where 169.254.1.0 is an example private IP address. If only LAN is connected, the resource name may appear like:

`"TCPIP0::192.168.5.2::5025::SOCKET"`

where 192.168.5.2 is an example DHCP-assigned IP address.

LAN

Site LAN hub, router, or switch

LAN 1

LAN 2

PCIe Switch

Intel 82580 Network Interface Card (NIC)

LAN Switch

IPMB — Intelligent Platform Management Bus

Parallel and star trigger lines

ASM Manager
• ASM Web Interface
• Triggering
• ASM IO Interface for upstream/downstream PCIe Interface

Synchronization and Triggering

Slot 6

Slot 5

Slot 4

Slot 1

Chassis LAN interface

LAN 0

Chassis Shelf Manager
• Monitor/control fan speeds
• Monitor temperature sensors
• Monitor module sensors
• Chassis Web Interface

The slot PCIe interfaces cannot be accessed from the chassis LAN interface.

NOTES:

1. PCIe and LAN connectivity:

   A. If the chassis PCIe interface is connected and the chassis LAN interface isn't connected, the Intel 82580 NIC provides a means for the PC to access the LAN Switch – this provides PC access to the ASMManager as well as access to the Gb Ethernet connections to each slot.

   B. While the Intel NIC allows the host PC to use the PCIe interface to access the LAN Switch (and the devices connected to the LAN Switch), the reverse does not apply -- the PC cannot use the LAN interface and the Intel NIC to access the slot PCIe x4 interfaces..

2. PCIe Generation ("Gen") 1 peak speed is 2.5 Gb/s per lane. PCIe Gen 2 peak speed is 5.0 Gb/s per lane. Taking into account encoding and other overhead, maximum Gen 2 performance in MB/s and GB/s are as follows for x1, x4, x8:   **x1:** 500 MB/s   **x4:** 2 GB/s   **x8:** 4 GB/s

3. The PCIe Switch internal buffering allows the chassis to communicate to the host PC at 4 GB/s, and simultaneously communicate at 2 GB/s to each of two x4 module slots. Factoring in certain overheads, nominal data rates of 1.85 GB/s per slot can be achieved.

M9514A Chassis

Shelf Manager

The chassis shelf manager provides intelligent control of the M9514A including control of the chassis cooling fans and managing the chassis power-up sequence. This ensures there is sufficient power/cooling for each module.

The shelf manager performs these functions:

- Monitor and control chassis fan speed
- Monitor chassis backplane and cavity temperature
- Monitor module health, as provided by the module vendor (may include voltages and temperatures, fuse status, alarms and alarm setpoints)
- Chassis Web Interface (see "Using the M9514A Web Interface" on page 57)"
- Automatically and safely shut down power upon a fan tray or power supply unit (PSU) failure

You may monitor chassis behavior and make fan settings as explained below using the chassis Soft Front Panel or the *Web Interface* (**Chassis Health** page).

Chassis Backplane Description

The graphic on the next page shows a simplified block diagram of the M9514A chassis. Notice the following:

- Physical slot numbering begins at the left edge of the chassis and increments to the right. Logical slot numbers begin with the ASM in physical slot seven (7). To use and program the chassis, you only need to know the physical slot number; you do not need to know the logical slot numbers.

- The M9514A chassis has one dedicated slot for the AXIe System Module (ASM). That is physical slot number seven (7) in the center of the chassis.

- The AXIe backplane includes all of the following AXIe backplane lines:

  - Timing and triggering signals including: 100 MHz clock, 100 MHz PCIe clock (FCLK), point-to-point star trigger from the system slot (SYNC), bi-directional point-to-point star trigger (STRIG), and 12 signal parallel trigger bus (TRIG).
  - Distributed PCIe data fabric (Gen 2 x4 to each slot).
  - Distributed gigabit Ethernet LAN to each slot.

- 62-pair local bus for adjacent module signaling or data transfer (AXIe only requires 18 pairs).

- DC power rail (normally -45 to -53 VDC).

- Intelligent Platform Management Bus (IPMB) for chassis control, including module power-up.
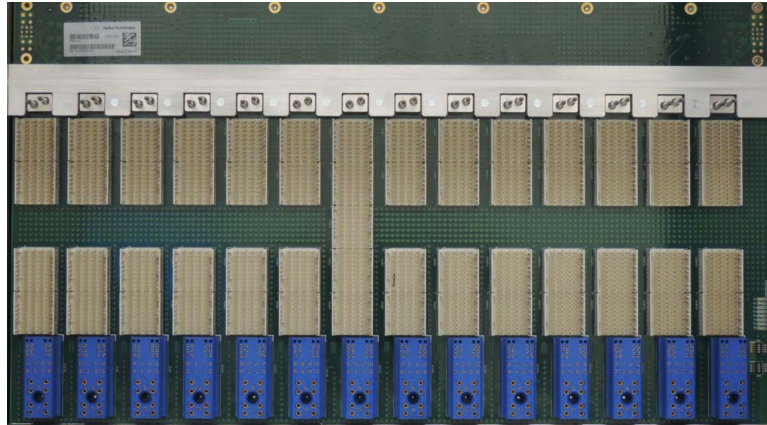
Figure 4   14-Slot AXIe Backplane in the M9514A
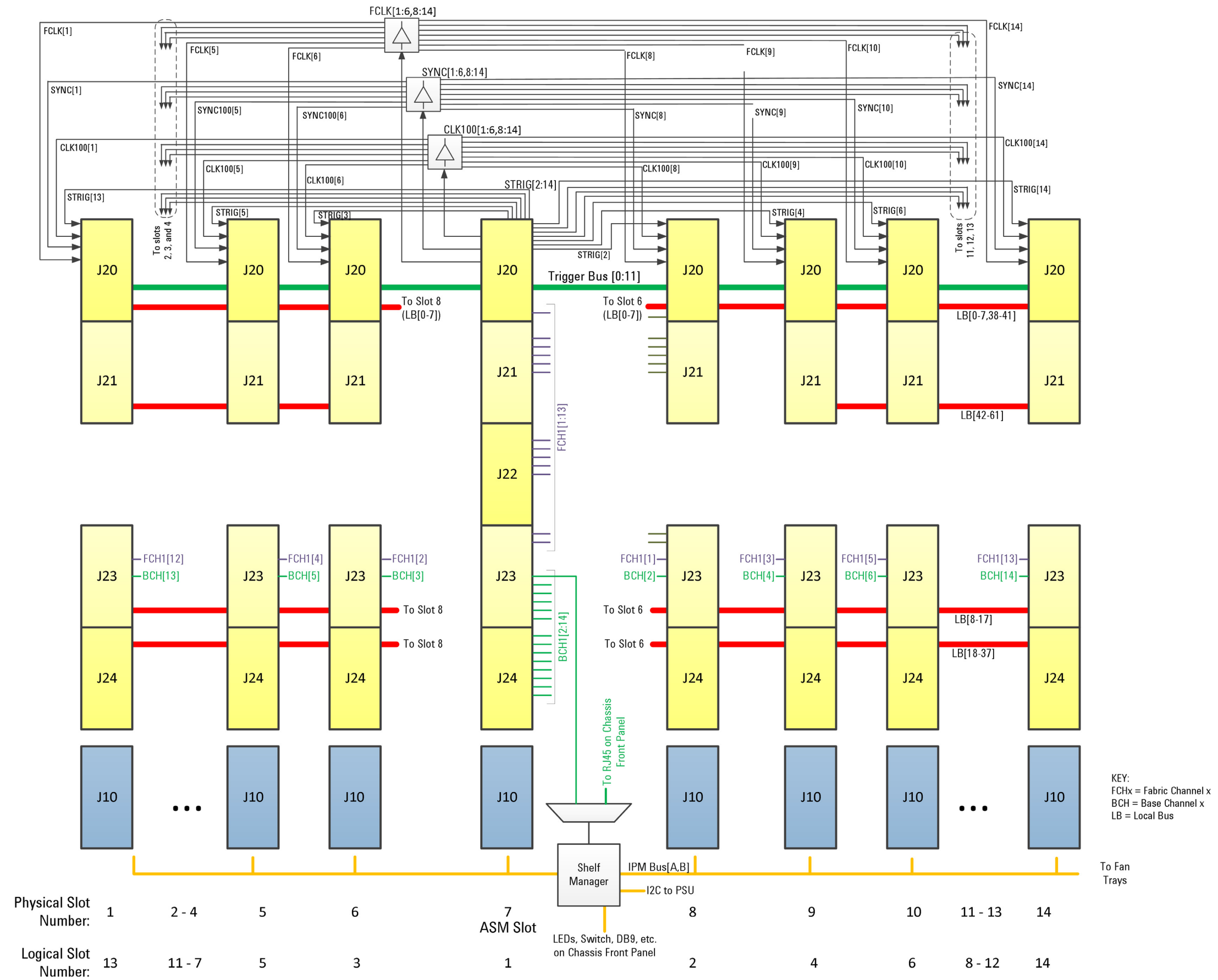
Air Filter Replacement

The chassis provides a replaceable air filter in the front of the chassis. It can be removed by pulling out on the air filter's handle. To re-install, push the air filter tray into the guide rails at each side of the chassis until the filter is all the way in.

NOTE	When installing the air filter, the filter element must be in the top position. For detailed information, refer to the M9514A and M9521A Service Manual.

Clean dust from the filter with a vacuum or with a damp cloth.

CAUTION	Do not wash the filter element or install the filter in the chassis if it is wet.

Fan Trays

The M9514A chassis has three interchangeable fan trays at the bottom in the front of the chassis and one fan tray at the top of the rear of the chassis. Each of the fan trays at the front of the chassis contain two radial fans to pull air through the air filter and force it up through the chassis cavity to cool the AXIe modules. The fan tray at the rear of the chassis pulls warm air from the chassis cavity and expels it through the rear. See "M9514A chassis airflow and air filter" on page 87.

For additional information on regulating fan speed, refer to "Controlling Fan Speed" on page 69 of this manual. Note that all fans operate together; that is, changing the speed of the fans changes the speed of all of the fans in the fan trays.

For detailed information on replacing the fan trays, refer to the M9514A Service Manual.

NOTE	The fan trays are not hot swappable. They should not be removed while the chassis is operating, overheating of installed AXIe modules may occur.

top rear fan tray   chassis air
exhaust

chassis
air filter

bottom fan
trays

cool air in
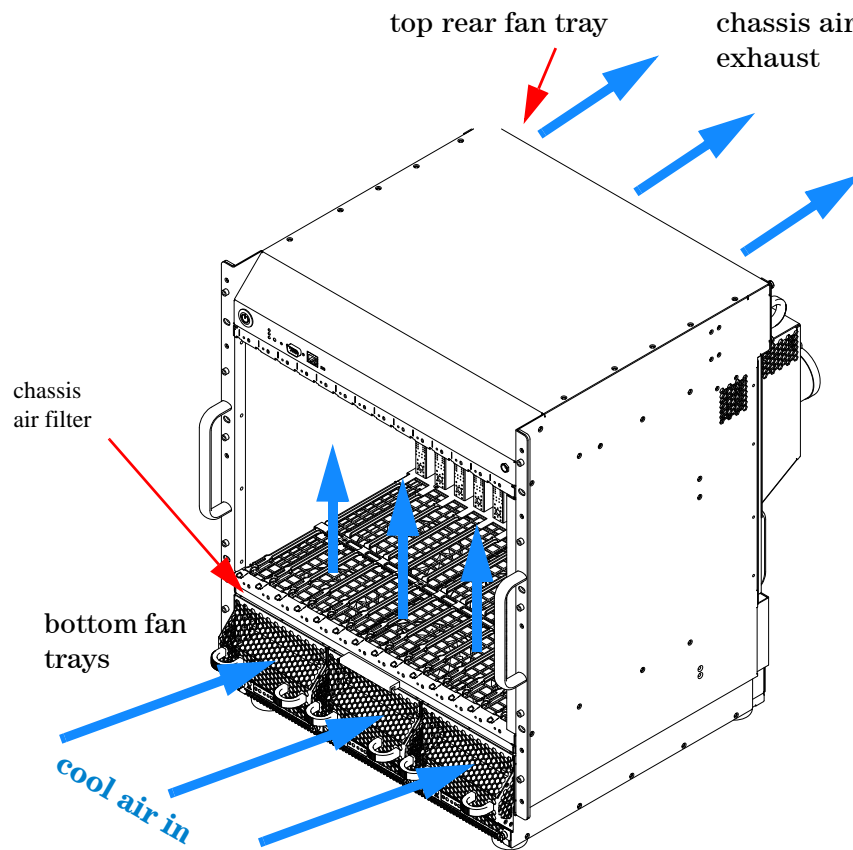
Figure 5   M9514A chassis airflow and air filter

Power Supply Units

The M9514A chassis has three independent Power Supply Units
(PSUs), installed inside of the chassis. These PSUs provide a nominal
-51.8 VDC for powering the AXIe modules as well as power for the ASM
shelf manager, etc. The following simplified diagram shows the
relationship between the PSUs and the rest of the M9514A chassis.
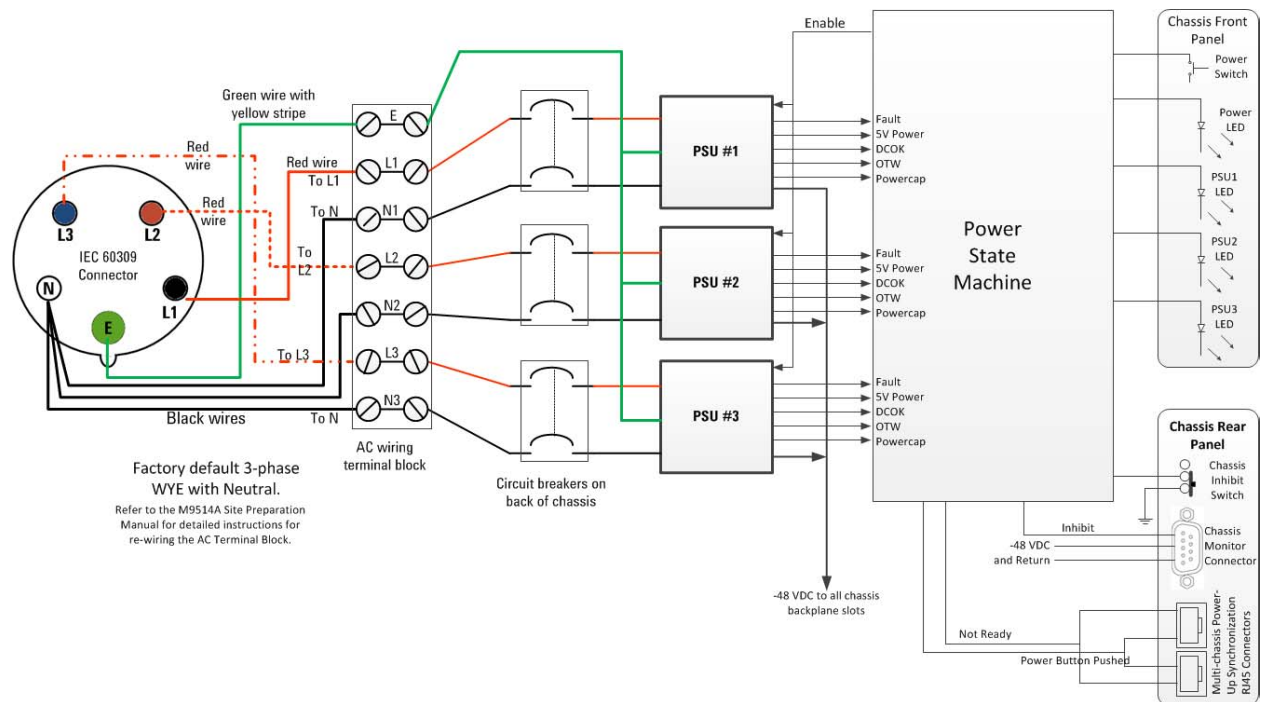
Figure 6   M9514A Simplified Power Supply Block Diagram

CAUTION	The RJ45 connectors on the back of the M9514A chassis are for multichassis power-up synchronization. Do not connect LAN cables to these connectors. Refer to Chapter 6, "MultiFrame Operation" for detailed information.

CAUTION	Do not operate the chassis with one or two of the circuit breakers in the OFF position. All three breakers must be in the ON position for the chassis to operate at full capacity.

The method of powering up the chassis depends on the position of the INHIBIT switch on the chassis rear panel, which can be set to the DEF (DEFault) position or to the MAN (MANual) position. These two methods work as follows:

• INHIBIT switch in the DEF position — In this position, the front panel power push button is used to switch the chassis between ON and Standby—hence, this is known as the ON/Standby push button.

- INHIBIT switch in the MAN position — In this position, the Inhibit signal (pin 5 on the DB-9 connector) controls chassis power. The chassis is powered up by applying a logic high signal to the Inhibit signal. When the Inhibit pin (pin 5) is pulled low, the chassis is in Standby.

Use of the INHIBIT switch in the DEF position and the ON/Standby push button to power up the chassis is assumed unless otherwise noted. For information on using the Inhibit signal on the rear panel DB-9 connector to power the chassis up and down, please see "Chassis Inhibit/Voltage Monitoring" on page 95.

The RJ45 connectors are for multichassis power-up synchronization. Do not connect LAN cables that connect to a network to these connectors. Refer to "Multiple Chassis Power-up and Power-down" on page 148 for information on using these connectors.

Chassis LAN Connector and LAN Switch

The chassis LAN port and Shelf Manager LAN switch provide an access to the chassis Shelf Manager if a non-Agilent ASM is used that does not contain a LAN fabric. In this case, the chassis Shelf Manager is accessible via LAN 0. When using the Agilent M9521A ASM, the LAN 0 connection is not used and the Shelf Manager LAN switch should remain in the default ASM (right) position.

Chassis IP Reset

The IP Reset button on the top front panel of the M9514A chassis resets the chassis Internet Protocol (IP) address to its factory default setting (169.254.1.0). This is useful when troubleshooting possible IP address problems, or when the IP address becomes lost or forgotten.

NOTE	Dot-notation addresses ("nnn.nnn.nnn.nnn" where "nnn" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

Service Use Only Connector

The DB-9 connector on the top front panel of the chassis labeled "**Service Use Only**" is for internal Agilent use only. There is no user diagnostic, troubleshooting, or service information available from this connector.

Chassis Self-Test

The chassis supports two types of self-test:

- Power-on self-test (POST)-- performed whenever the device is powered-on.
- User-initiated self-test -- initiated by you, either from the M9514A Soft Front Panel or programmatically using the SelfTest IVI call.

Each type of self-test runs a series of tests and any failure generates an error consisting of an error code and error message.

A single self-test error queue in the chassis holds both the power-on self-test errors and the user-initiated self-test errors. Power-on self-test error messages are identified by the "(POST)" prefix; user-initiated self-test messages do not have a prefix.

Running the user-initiated self-test (either from the soft front panel or programmatically) preserves any unread power-on test messages in the queue, but erases any other (user-initiated) unread messages before running the tests.

You can use the soft front panel or the IVI SelfTestErrorQuery call to view the errors.

When you open the soft front panel's Self-Test dialog box, any previous results are automatically displayed, preceded by the label "*Previous self-test results:*" If you then click the Run Self-Test button, the new self-test results are displayed below any previous results.

Chassis Self-Test IVI Driver Calls

IVI-COM:

IIviDriverUtility.SelfTest(TestResult,TestMessage); *(runs self-test, returns number of failures, passed or failed message)*

IAgAXIeCSystem.SelfTestErrorQuery(ErrorCode,TestMessage); *(reads each self test error code and message)*

IVI-C:

AgAXIeC_self_test Function *(runs self-test)*

AgAXIeC_SystemSelfTestErrorQuery Function *(reads error queue)*

Additional Features of the M9514A AXIe Chassis

Chassis Backplane LVDS Local Bus

The M9514A chassis backplane provides a *local bus* with 62 differential signaling pairs between each pair of adjacent instrument physical slots. This bus is the Low Voltage Differential Signaling or LVDS bus.

Availability of these signal lines to any module depends on vendor implementation of the Zone 2 connectors and related commands to manage signaling on the local bus. See "Chassis Backplane Connections" on page 162 for a look at these connectors.

The chassis provides these local bus pairs on Zone 2 backplane connectors P20-P24. Most instrument modules will load connector P20 to access the trigger and timing bus, and will load connector J23 in order to use the AXIe base and data fabrics. Connector J23 provides the first 22 local bus pairs from backplane to module.

Modules designed to take maximum advantage of the AXIe local bus load additional connectors (P24, P21) and expand the local bus up to 42 or 62 signals to each adjacent module slot. If P24 (or P24 and P21) are loaded on your module, the vendor is likely using the local bus.

Check with the module vendor for any instrument in your AXIe chassis to determine if it uses the AXIe local bus and what functionality that feature provides you.

Electronic Keying (E-Keying)

Electronic keying is one of several capabilities AXIe inherits from the AdvancedTCA architecture. Like ATCA, AXIe promotes a fabric independent (also known as fabric-agnostic) backplane with respect to local bus connectivity. Note that ATCA supports module hot swap, with AXIe it is optional. The M9514A does not support module hot swapping. It is only at chassis power-on that E-Keying compatibility is acknowledged.

AXIe modules may provide various communication protocols and hardware signaling that connect to pins on the backplane that link physically adjacent modules together. In general, the backplane itself does not provide internal buffering, so a link connection between two adjacent modules is simply a wired connection, either configured point to point or tied together on a common bus. This allows different modules in the system to establish their own link protocols provided a connection path exists.

This flexibility frees the chassis configuration from dictating signal levels and protocols involved with any particular link. However, this flexibility presents a challenge: how to know whether the endpoints of a link are compatible or not.

<table>
<tr><td>N O T E</td><td>If you have modules in your system that are E-Keying compatible, refer to the documentation provided with your modules for detailed installation information.</td></tr>
</table>

E-Keying is a process in which compatible matches over links between different modules are identified and enabled to be used. The E-Keying process is handled by the chassis shelf manager. Each module in the chassis runs an Intelligent Platform Manager Controller (IPMC). These IPMCs interface with the shelf manager and each other using the Intelligent Platform Management Bus (IPMB). IPMB is basically a side channel protocol built on top of I2C that connects all modules in a chassis together. See the figure below.
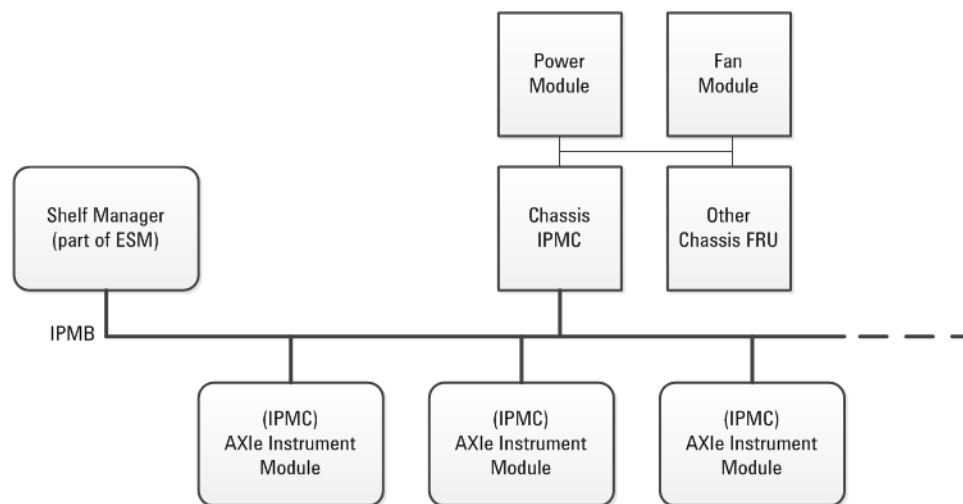
The shelf manager has two primary roles:

- Manage the inventory and infrastructure of a chassis by communicating with IPMCs in the chassis:
  - Power requirements of the modules and managing the power module
  - Chassis cooling control of the fan module.
  - Individual Field Replaceable Unit (FRU)[*] inventory located in non-volatile memory that tracks ATCA and AXIe attributes from each module
  - E-Keying interconnection resources among modules:

* A field replaceable unit is a part that may be removed from a system and exchanged with another part or returned to a factory for service Examples of FRUs may be a module card in a chassis slot, a fan tray, a power supply, and the chassis frame.

- Point-to-point (P2P) connections for base, fabric, and update channel interfaces. P2P connections are predominately what AXIe is concerned with.

- Bussed resources for clock and metallic test bus (in ATCA).

- External connectivity to a system manager, using an IPMI connection over Ethernet using a RMCP protocol.

E-Keying Process

When the chassis powers on, the first step the shelf manager does in point-to-point (P2P) E-Keying is read the backplane P2P connectivity records from the chassis modules. These connectivity records specify the P2P interconnections the backplane routes between specific slots and specific channels on each slot.

Next, for each module loaded in the chassis, the shelf manager reads each module's Field Replaceable Unit (FRU) table for the P2P connections that module makes to the backplane. The shelf manager builds up a connection inventory of all the potential links a particular module can implement. This list is later used to examine the potential logical links each module has to other modules. Each potential link end has a link descriptor that identifies the following information:

- P2P interface on the backplane and a channel number within that interface

- The ports on a given channel that are involved with this link. This may include sets of differential signal pairs.

- Finally, the link type which identifies the specification entity, such as PICMG 3.x, AXIe 1.0, or other specification that fully describes the link classification. The link type may also be an OEM-defined value using a 128-bit Globally Universal Identifier (GUID); each card may support up to 15 different GUIDs.

The shelf manager goes through the backplane connection possibilities, identifying each end of a P2P connection and searches for a compatible link descriptors. If a pair of ends match, such as both ends are PCIe Express x4, then the shelf manager issues a "Set Port State (enable)" command to each module for that link. For the matches that are not found, the shelf manager issues a "Set Port State (disable)" command to ensure that incompatible link connections are kept off.

As a final note, the shelf manager is truly agnostic about specific details of a link protocol. This permits new protocols to be added without modification to the chassis.

For additional information on E-Keying, refer to the AdvancedTCA specification (http://www.picmg.org) and the AXIe specification (http://www.axiestandard.org).

Chassis Inhibit/Voltage Monitoring

The method of powering up the chassis depends on the position of the INHIBIT rear panel switch, which can be set to the DEF (default) position or to the MAN (manual) position). These two methods work as follows:

- INHIBIT switch in the DEF position — In this position, the front panel power push button is used to switch the chassis between ON and Standby—hence, this push button is known as the ON/Standby push button.

- INHIBIT switch in the MAN position — In this position, the Inhibit signal (pin 5 on the rear panel DB-9 connector) controls chassis power. The chassis is powered up by applying a logic high signal to the Inhibit pin. When the Inhibit pin (pin 5) is pulled low, the chassis is in Standby.
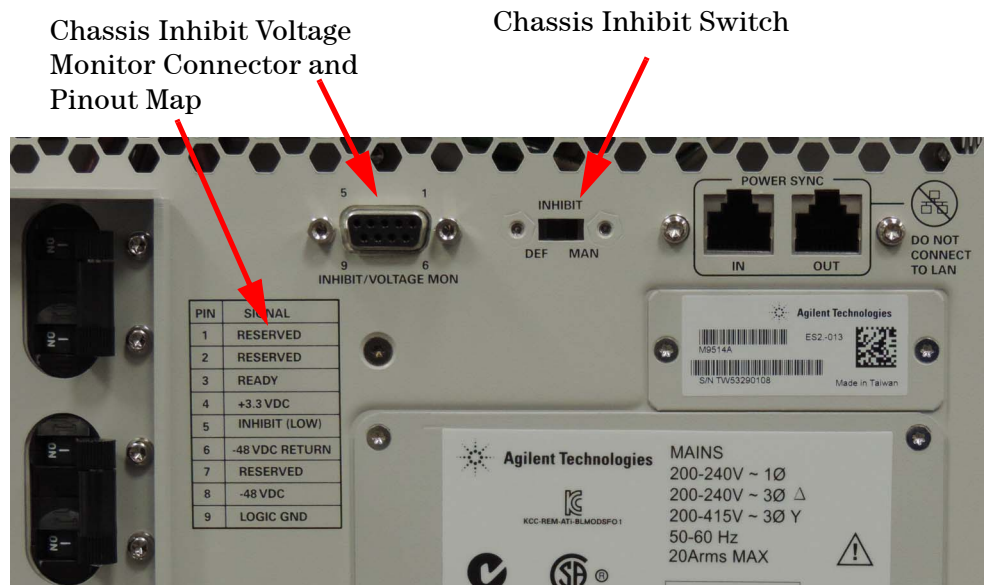
Figure 7   Chassis Inhibit Connector and Switch (chassis back panel)

Because there is an internal pullup resistor on the Inhibit signal, an open circuit (no signal connected) on the Inhibit signal will also turn on the power supply. This means that, if the INHIBIT switch is set to the MAN position and if no signal is connected to the Inhibit input signal, the chassis will power up as soon as AC power is applied.

| CAUTION | The PSUs contain no customer-serviceable parts such as fuses. If a PSU fails, it must be replaced as a complete unit. Replacement of the power supply is described in the *M9514A Service Manual*. |

5
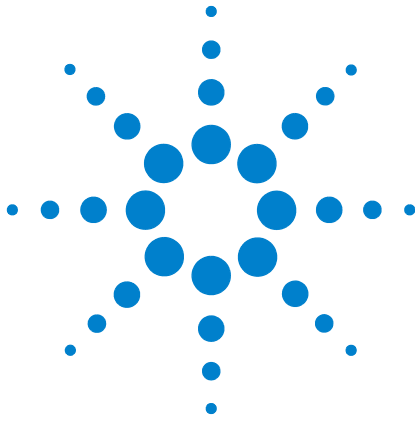
M9521A ASM
Features and Functions

This chapter describes the basic features of the M9521A ASM and describes how to use the Crosspoint Switch, timing, synchronization, triggering and signal routing using the ASM.

Note that MultiFrame is described in detail in Chapter 5, "MultiFrame Operation" on page 139.

M9521A AXIe System Module (ASM)

The ASM performs the following functions:

• Crosspoint Switch management for triggering, clock and sync signals

• Manages MultiFrame input/output

• Programmable front panel ports

• PCIe and LAN data transfer to/from AXIe modules installed in the chassis

• Multiple chassis interaction, data transfer, etc. This is described in detail in Chapter 6, "MultiFrame Operation".

ASM LAN Connectors

The ASM LAN ports provide access to the both the ASM Manager and chassis Shelf Manager. In general, you should use the ASM LAN ports for communication between the host controller and the M9521A ASM and M9514A AXIe chassis.

ASM IP Reset

The IP Reset button on the front panel of the M9521A ASM resets the ASM Internet Protocol (IP) address to its factory default setting (169.254.1.1). This is useful when troubleshooting possible IP address problems, or when the IP address becomes lost or forgotten.

NOTE	Dot-notation addresses ("nnn.nnn.nnn.nnn" where "nnn" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

ASM Self-Test

Similar to the chassis, the ASM supports two types of self-test:

- Power-on self-test (POST)-- performed whenever the device is powered-on.
- User-initiated self-test -- initiated by you, either from the M9514A Soft Front Panel or programmatically using the SelfTest IVI call.

Each type of self-test runs a series of tests and any failure generates an error consisting of an error code and error message.

A single self-test error queue in the chassis holds both the power-on self-test errors and the user-initiated self-test errors. Power-on self-test error messages are identified by the "(POST)" prefix; user-initiated self-test messages do not have a prefix.

Running the user-initiated self-test (either from the soft front panel or programmatically) preserves any unread power-on test messages in the queue, but erases any other (user-initiated) unread messages before running the tests.

You can use the soft front panel or the IVI SelfTestErrorQuery call to view the errors.

When you open the soft front panel's Self-Test dialog box, any previous results are automatically displayed, preceded by the label "*Previous self-test results:*" If you then click the Run Self-Test button, the new self-test results are displayed below any previous results.

ASM Self-Test IVI Driver Calls

IVI-COM:

IIviDriverUtility.SelfTest Method *(runs self-test, returns number of failures, passed or failed message)*

IAgAXIeSMSystem.SelfTestErrorQuery Method *(reads each self test error code and message)*

IVI-C:

AgAXIeSM_self_test Function *(runs self-test)*

AgAXIeSM_SystemSelfTestErrorQuery Function *(reads error queue)*

The ASM Power-On/Factory Default Configuration

As shipped from the factory, the trigger subsystem power-on default configuration is equal to the factory default configuration -- see the "Resetting the ASM" on page 100 for a description of the factory default configuration.

The power-on default configuration can be changed using the SaveAsPowerOnState method, which saves the current trigger subsystem configuration as the new power-on default configuration. To apply the power-on default configuration parameters that were saved using the SaveAsPowerOnState method, use the RecallPowerOnState method. The RecallPowerOnState method sets the following trigger subsystem parameters:

- All Crosspoint Switch connections
- Crosspoint Switch EdgeSeen latches
- Crosspoint Switch SetEdgesToLatch
- The contents of the Trigger Bus Output Enable Register
- The contents of the Trigger Bus Input and Output Invert Registers
- The contents of the Star Trigger Output Enable Register
- The contents of the Star Trigger Input and Output Invert Registers
- The Software Trigger State setting
- The TriggerRouting Status Input and Output EdgesToLatch
- The DriveType on all Ports
- The Input settings on all Ports
- The Output settings on all Ports
- The ExternalSignals Clock Out Enabled setting
- The ReferenceClock Source and SourceAuto settings
- The CLK100FeedbackEnabled setting
- The Sync settings: Backplane and MultiframeSyncAuto
- The Timing settings: Run and MultiframeRunAuto

NOTE	You can also set the above parameters using the SetState method and query them using the GetState method.

Resetting the ASM

The IVI-COM **IAgAXIeSM.ResetTriggerBus** method or the IVI-C **AgAXIeSM_ResetTriggerBus** function performs the following actions which places the chassis trigger subsystem to the factory default configuration:

- All Crosspoint Switch outputs are connected to the Static 0 (logic low) input.

- The TriggerRouting Status Input EdgeSeenLatches are set to 0 on all inputs.

- The TriggerRouting Status Input EdgesToLatch are set to 1 (rising edge) for all inputs.

- The TriggerRouting Status Output EdgeSeenLatches are set to 0 on all outputs.

- The TriggerRouting Status Output EdgesToLatch are set to 1 (rising edge) for all outputs.

- The Trigger Bus Output Enable Register is cleared, which disables the Trigger Bus Output drivers (all drivers are set to high impedance).

- The Trigger Bus Input Invert register is cleared, making all Trigger Bus inputs non-inverting.

- The Trigger Bus Output Invert register is cleared, making all Trigger Bus outputs non-inverting.

- The Star Trigger Output Enable Register is cleared, which disables the Star Trigger Output drivers (all drivers are set to high impedance).

- The Star Trigger Input Invert register is cleared, making all Star Trigger inputs non-inverting.

- The Star Trigger Output Invert register is cleared, making all Star Trigger outputs non-inverting.

- The SoftwareTriggerState property is set to False, which sets the SW_TRIG input signal to a logic low level.

- Each Port is set to: DriveType = Input, Input Threshold = 1.65 V, Input InvertEnabled = False, Input Impedance = 3000 Ohms, Input Mode = Pass Through, Output InvertEnabled = False, Output Mode = Pass Through.

- The ExternalSignals Clock Output Enabled property is set to False.

- The ReferenceClock SourceAuto property is set to True, which will cause automatic selection of the ReferenceClock Source.

- The CLK100FeedbackEnabled property is set to False.

- The Backplane sync (BP_SYNC) property is set to MultiFrame Output Sync (MO_SYNC).

- The MultiFrameSyncAuto property is set to True.

- The Run property is set to False and the MultiFrameRunAuto property is set to True.

As noted, the methods described above place the chassis in the factory default configuration. The other configuration of interest is the power-on default configuration. The power-on default configuration is applied after each chassis power cycle, and can also be applied programmatically using the RecallPowerOnState method -- see this method for more details.

If you use the SaveAsPowerOnState method to save a particular state for use as the power-on default configuration, but then want to change the power-on default configuration to be equal to the factory default configuration, perform the following two steps:

Execute this ResetTriggerBus method -- This will restore the trigger subsystem to the factory default configuration.

Execute the SaveAsPowerOnState method -- This will save the just-restored factory default configuration settings as the power-on default configuration. The newly-saved power-on default configuration can then be applied either by cycling the chassis power or by executing the RecallPowerOnState method.

Clock and Trigger Subsystem Diagram

The block diagram on page 104 shows the overall clock and trigger subsystem used in the M9521A ASM. Each subsection is described in detail on the following pages along with some suggestions for IVI-COM programming.

Block Diagram Details

An X on a crosspoint indicates a disallowed connection. For example, you cannot connect a PORT input to the same PORT output:
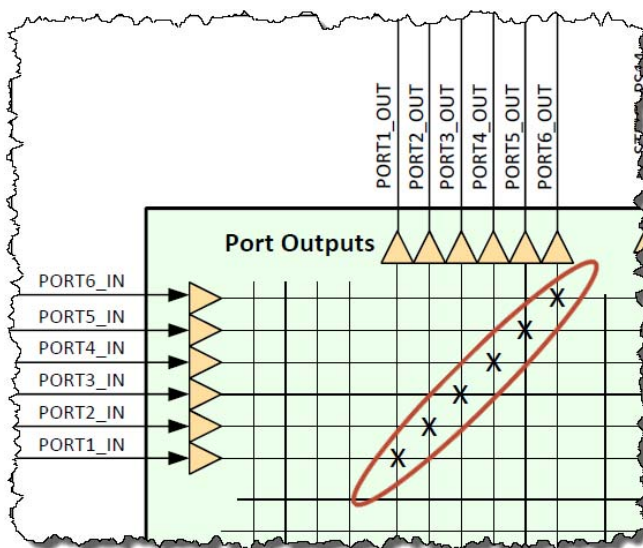
Star Trigger Bus and Trigger Bus inputs can be inverted. Inverting bus inputs are shown as a buffer superimposed over an inverter:
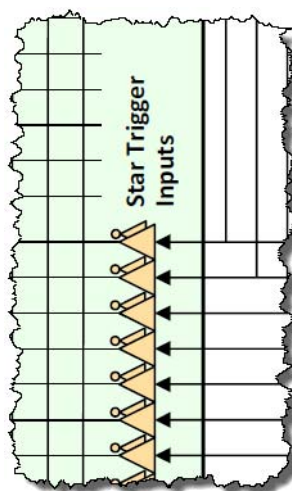
Star Trigger Bus and Trigger Bus outputs can be inverted and enabled or disabled. This is shown as:
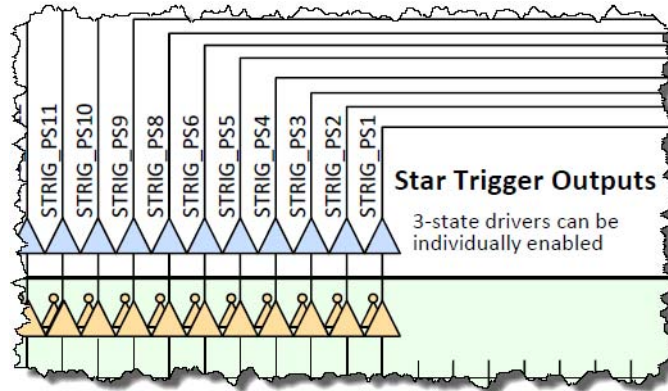
NOTE

The Ports 1 through 6 inputs and outputs can also be inverted. This is shown in the detailed Port 1 schematic on the top left of the block diagram.

The thick black border around the Crosspoint Switch in the diagram indicates where signal measurements (SignalValues or EdgeSeenLatches, for example) are made. See the IVI Driver Help for more information on signal measurements.

M9521A Clock and Trigger Subsystem
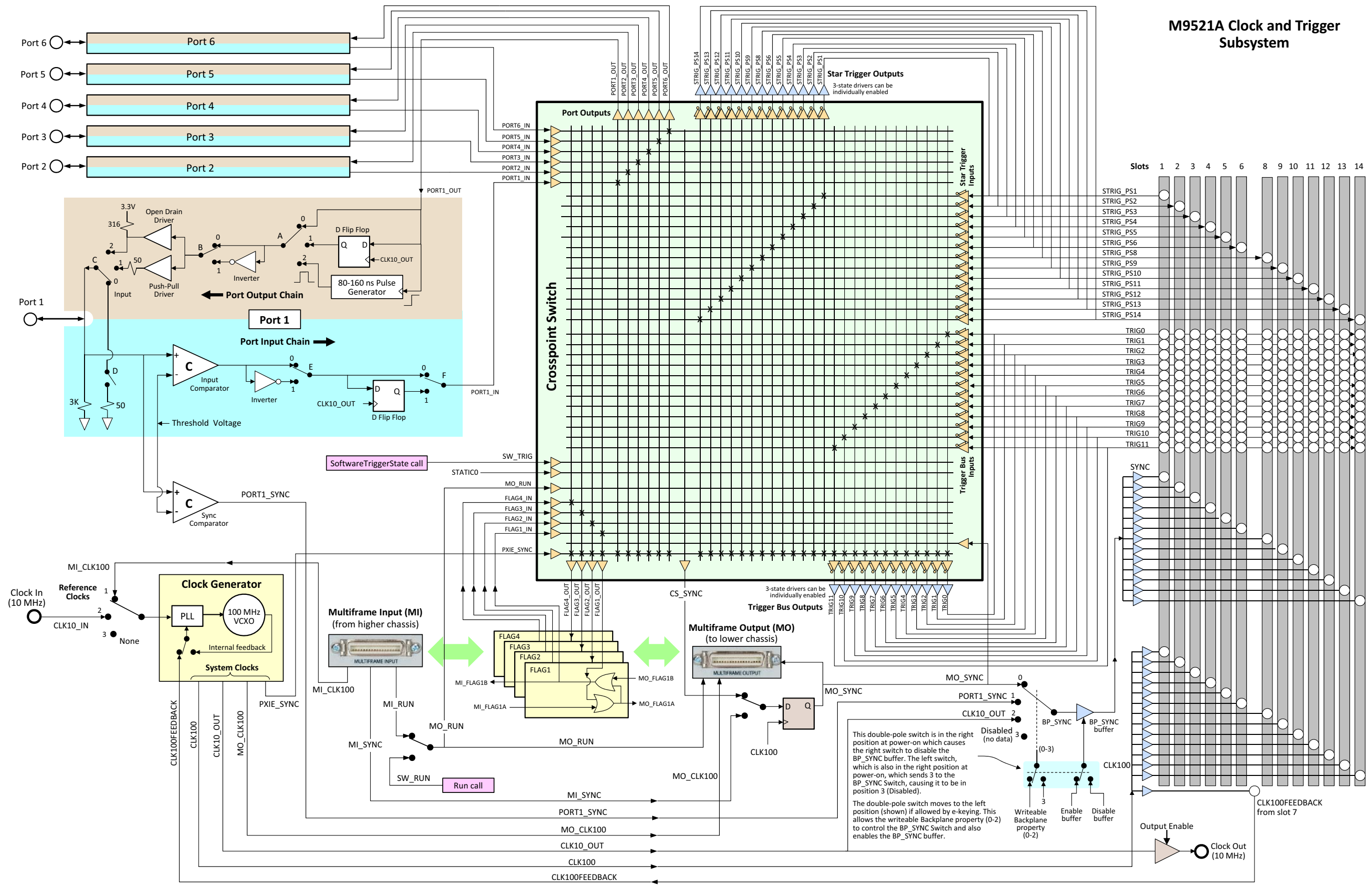
The Crosspoint Switch

The Crosspoint Switch, shown in the block diagram on , provides the flexibility of routing many signal events from the backplane, flags or external trigger to different destinations. You can choose to enable and assign any of the 40 the input *sources* for any or all of 36 signal *destinations* (trigger/timing resources). You can also source a logical 0 or 1 to force any destination low or high.

The M9521A Soft Front Panel is a good way to start learning about the Crosspoint Switch. This utility offers basic switch control and other basic M9521A operations, such as running self-test. The soft front panel is available from the Windows Start menu by clicking:

Start > All Programs > Agilent > AXIe System Module (M9521) > AXIeSM SFP

Connecting an Input to an Output in the Crosspoint Switch

This section describes how to programmatically connect one or more Crosspoint Switch inputs to an output. In the M9521A Soft Front Panel, this is shown symbolically as a "dot" connecting the desired input to the output. In the example diagram below, the dot shows the input signal PORT1_1N connected to the output signal PORT2_OUT.
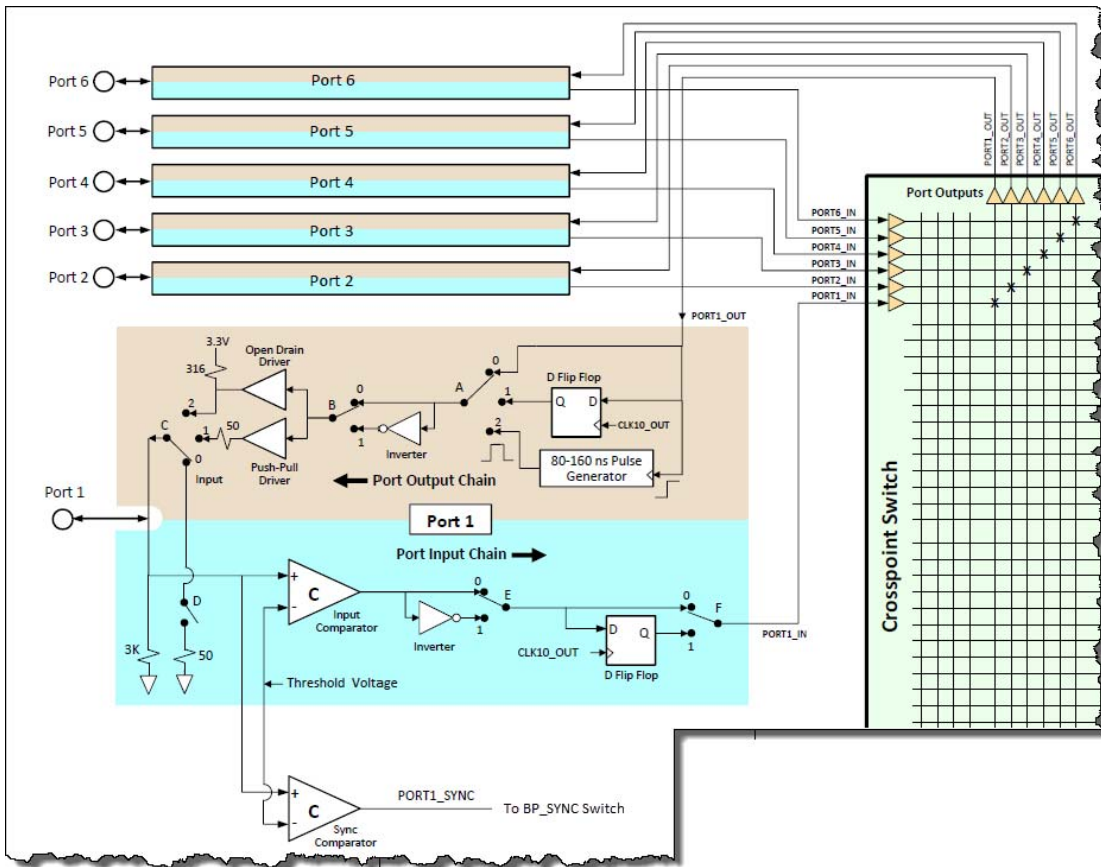
Figure 8   Port Input/Output Circuitry

The black dot in the above diagram indicates the connection between the input signal PORT1_1N connected to the output signal PORT2_OUT.

IVI Driver Examples - Crosspoint Switch

The IVI-COM and IVI-C driver calls for typical SFP settings are listed below.

Sample IVI-COM calls:

The IAgAXIeSM**TriggerRouting.SetCrosspointSwitch** method specifies which Crosspoint Switch input signals are connected to the specified Crosspoint Switch output signal. To handle the large number of input signals, the inputs are divided into two lists; InputList1 and InputList2. The IVI driver help (see "IVI Driver Help" on page 117) describes which input signals are in each list. This method has the general form:

```
SetCrosspointSwitch(
    OutputLine,
    InputList1,
    InputList2
    )
```

`OutputLine` specifies the output line being programmed. Defined by the AgAXIeSMOutEnum.

`InputList1` specifies the input signal(s) of the first list/group (Triggers and Star Triggers) that may be routed to an output signal line. Defined by AgAXIeSMInList1Enum.

`InputList2` specifies the input signal(s) of the second list/group (Ports, MultiFrame Flags, etc.) that may be routed to an output signal line. Defined by AgAXIeSMInList2Enum.

Enable Trigger Output or Star Trigger Output Methods   When dealing with Trigger or Star Trigger outputs, you must enable the output drivers after making Crosspoint Switch connections. The **IAgAXIeSMTriggerRouting.SetTriggerBusOutputEnableRegister** method enables the trigger bus output register. The **IAgAXIeSMTriggerRouting.SetStarTriggerOutputEnableRegister** method enables the trigger bus output register.

To connect STRIG_PS2 input (InputList1) to STRIG_PS12 output:

Use these enums:

> **AgAXIeSMOutStarTriggerSlot12** - *The STRIG_PS12 output signal.*

> **AgAXIeSMInList1StarTriggerSlot2** - *The STRIG_PS2 input signal.*

> **AgAXIeSMInList2None** - *Indicates there are no inputs specified from list 2*

Enable the STRIG_PS12 output:

> **IAgAXIeSMTriggerRouting.SetStarTriggerOutputEnableRegister(AgAX IeSMStarTriggerSlot12);**

To connect Port3_IN (InputList2) to PORT2_out:

Use these enums:

> **AgAXIeSMOutPort2** - *The PORT2_OUT output signal*

> **AgAXIeSMInList1None** - *Indicates there are no inputs specified from list 1*

> **AgAXIeSMInList2Port3** - *The PORT3_IN input signal*

To connect TRIG7 (InputList1) and SW_TRIG (InputList2) to the TRIG_5 output:

Use these enums:

> **AgAXIeSMOutTrigger5** - *The TRIG5 output signal*

> **AgAXIeSMInList1Trigger7** - *The TRIG7 input signal*

> **AgAXIeSMInList2SoftwareTrigger** - *The SW_TRIG input signal*

Enable the TRIG5 output:

> **IAgAXIeSMTriggerRouting.SetTriggerBusOutputEnableRegister(AgAX IeSMTriggerBus5);**

To connect multiple inputs to an output:

You can connect more than one Crosspoint Switch input to a Crosspoint Switch output. The multiple inputs are logically ORed to the output.

To combine the multiple inputs, you can add multiple enums. For example, the TRIG2 and TRIG4 inputs are in InputList1. To connect these inputs to STRIG_PS2 output, add the two list 1 enums:

> **AgAXIeSMOutStarTriggerSlot2** - *The STRIG_PS2 output signal*

> **AgAXIeSMInList1Trigger2 + AgAXIeSMInList1Trigger4** - *The sum of the TRIG2 and TRIG4 input signals*

> **AgAXIeSMInList2None** - *Indicates there are no inputs specified from list 2*

NOTE   You can also specify multiple inputs using the sum of the numerical values for InputList1 and/or InputList2. See Figure 9 on page 112 for the mappings and decimal equivalents of all inputs signals. For example, TRIG2 has a decimal value of 4, TRIG4 has a decimal value of 16. To connect these inputs to STRIG_PS2 output, the decimal sum of 20 is used in place of the list 1 enum.

Enable the STRIG_PS2 output:

> **IAgAXIeSMTriggerRouting.SetStarTriggerOutputEnableRegister(AgAX IeSMStarTriggerSlot2);**

As another example, the FLAG1 and FLAG4 inputs are in InputList2. To connect these inputs to PORT2_OUT:

> **AgAXIeSMOutPort2** - *The PORT2_OUT signal*

> **AgAXIeSMInList1None** - *Indicates there are no inputs specified from list 1*
>
> **AgAXIeSMInList2MultiFrameFlag1 + AgAXIeSMInList2MultiFrameFlag4** - *The sum of the FLAG1 and FLAG4 enums*

Or, you can use numeric equivalents. FLAG1 has a decimal value of 1 and FLAG4 has a decimal value of 8. To connect these inputs to PORT2_OUT, the decimal sum of 9 is used in place of the list 2 enum.

To set SW_TRIG line low, use this property:

IAgAXIeSMTriggerRouting.SoftwareTriggerState = False;

IVI-C functions and attributes:

The **AgAXIeSM_TriggerRoutingSetCrosspointSwitch** method specifies which Crosspoint Switch input signals are connected to the specified Crosspoint Switch output signal. To handle the large number of input signals, the inputs are divided into two lists; InputList1 and InputList2. The IVI driver help (click Help > Driver Help) describes which input signals are in each list. This method has the general form:

```
ViStatus AgAXIeSM_TriggerRoutingSetCrosspointSwitch(
    Vi, - The ViSession handle
    OutputLine,
    InputList1,
    InputList2
    );
```

`OutputLine` specifies the output line being programmed. Defined by the **AGAXIESM_VAL_OUT...** parameter.

`InputList1` specifies the input signal(s) of the first list/group (Triggers and Star Triggers) that may be routed to an output signal line. Defined by the **AGAXIESM_VAL_IN_LIST1...** parameter.

`InputList2` specifies the input signal(s) of the second list/group (Ports, MultiFrame Flags, etc.) that may be routed to an output signal line. Defined by the **AGAXIESM_VAL_IN_LIST2...** parameter.

Enable Trigger Output or Star Trigger Output Methods   When dealing with Trigger or Star Trigger outputs, you must enable the output drivers after making Crosspoint Switch connections. The **AgAXIeSM_TriggerRoutingSetTriggerBusOutputEnableRegister** function enables the trigger bus output register using the trigger bus output parameters listed below. The **AgAXIeSM_TriggerRoutingSetStarTriggerOutputEnableRegister** function enables the trigger bus output register using the trigger bus output parameters listed below.

To connect STRIG_PS2 input (InputList1) to STRIG_PS12 output:

Use these parameters:

AGAXIESM_VAL_OUT_STAR_TRIGGER_SLOT12 - *The STRIG_PS12 output signal*

AGAXIESM_VAL_IN_LIST1_STAR_TRIGGER_SLOT2 - *The STRIG_PS2 input signal*

AGAXIESM_VAL_IN_LIST2_NONE - *Indicates there are no inputs specified from list 2*

Enable the output with this function:

AgAXIeSM_TriggerRoutingSetStarTriggerOutputEnableRegister Function

With this parameter:

AGAXIESM_VAL_STAR_TRIGGER_SLOT12

To connect Port3_IN (InputList2) to PORT2_out, use these enums:

AGAXIESM_VAL_OUT_PORT2 - *The PORT2_OUT output signal*

A**GAXIESM_VAL_IN_LIST1_NONE** - *Indicates there are no inputs specified from list 1*

AGAXIESM_VAL_IN_LIST2_PORT3 - *The PORT3_IN input signal*

To connect TRIG7 (InputList1) and SW_TRIG (InputList2) to the TRIG_5 output, use these parameters:

AGAXIESM_VAL_OUT_TRIGGER5 - *The TRIG5 output signal*

AGAXIESM_VAL_IN_LIST1_TRIGGER7 - *The TRIG7 input signal*

AGAXIESM_VAL_IN_LIST2_SOFTWARE_TRIGGER - *The SW_TRIG input signal*

Enable the output with this function:

AgAXIeSM_TriggerRoutingSetTriggerBusOutputEnableRegister Function

With this parameter:

AGAXIESM_VAL_TRIGGER_BUS5

To connect multiple inputs to an output:

You can connect more than one Crosspoint Switch input to a Crosspoint Switch output. The multiple inputs are logically ORed to the output.

To combine the multiple inputs, you can add multiple enums. For example, the TRIG2 and TRIG4 inputs are in InputList1. To connect these inputs to STRIG_PS2 output, add the two list 1 enums:

AGAXIESM_VAL_OUT_STAR_TRIGGER_SLOT2 - *The STRIG_PS2 output signal*

AGAXIESM_VAL_IN_LIST1_TRIGGER2 +
AGAXIESM_VAL_IN_LIST1_TRIGGER4 - *The sum of the TRIG2 and TRIG4 input signal numeric values*

AGAXIESM_VAL_IN_LIST2_NONE - *Indicates there are no inputs specified from list 2*

NOTE	You can also specify multiple inputs using the sum of the numerical values for InputList1 and/or InputList2. See Figure 9 on page 112 for the mappings and decimal equivalents of all inputs signals. For example, TRIG2 has a decimal value of 4, TRIG4 has a decimal value of 16. To connect these inputs to STRIG_PS2 output, the decimal sum of 20 is used in place of the list 1 enum.

Enable the output with this function:

AgAXIeSM_TriggerRoutingSetStarTriggerOutputEnableRegister Function

With this parameter:

AGAXIESM_VAL_STAR_TRIGGER_SLOT2

As another example, the FLAG1 and FLAG4 inputs are in InputList2. To connect these inputs to PORT2_OUT:

AGAXIESM_VAL_OUT_PORT2 - *The PORT2_OUT signal.*

AGAXIESM_VAL_IN_LIST1_NONE - *Indicates there are no inputs specified from list 1*

AGAXIESM_VAL_IN_LIST2_MULTIFRAME_FLAG4 - *The sum of the FLAG1 and FLAG4 input signal numeric values.*

Or, you can use numeric equivalents. FLAG1 has a decimal value of 1 and FLAG4 has a decimal value of 8. To connect these inputs to PORT2_OUT, the decimal sum of 9 is used in place of the list 2 enum.

Input Signal Bit-Mapping

You can connect more than one Crosspoint Switch input to a particular Crosspoint Switch output. The multiple inputs are logically ORed to the output. To identify multiple input signals, a bit-mapping is used to assign a numeric value to each input signal. To handle the large number of input signals, the input signals are divided into two lists; *InputList1* and *InputList2*. You then specify the multiple inputs by specifying the sum of the numerical values for InputList1 and/or InputList2. The bit-mapping of each signal to the Crosspoint Switch and the decimal equivalents are shown below.

Decimal	Binary	Bit	List 2 Input Signal
2048	1000 00000000	Bit 11	PORT6_IN
1024	100 00000000	Bit 10	PORT5_IN
512	10 00000000	Bit 9	PORT4_IN
256	1 00000000	Bit 8	PORT3_IN
128	10000000	Bit 7	PORT2_IN
64	1000000	Bit 6	PORT1_IN

Crosspoint Switch

List 1 Input Signal	Bit	Binary	Decimal
STRIG_PS1	Bit 12	10000 00000000	4096
STRIG_PS2	Bit 13	100000 00000000	8192
STRIG_PS3	Bit 14	1000000 00000000	16384
STRIG_PS4	Bit 15	10000000 00000000	32768
STRIG_PS5	Bit 16	1 00000000 00000000	65536
STRIG_PS6	Bit 17	10 00000000 00000000	131072
STRIG_PS8	Bit 19	1000 00000000 00000000	524288
STRIG_PS9	Bit 20	10000 00000000 00000000	1048576
STRIG_PS10	Bit 21	100000 00000000 00000000	2097152
STRIG_PS11	Bit 22	1000000 00000000 00000000	4194304
STRIG_PS12	Bit 23	10000000 00000000 00000000	8388608
STRIG_PS13	Bit 24	1 00000000 00000000 00000000	16777216
STRIG_PS14	Bit 25	10 00000000 00000000 00000000	33554432
TRIG0	Bit 0	1	1
TRIG1	Bit 1	10	2
TRIG2	Bit 2	100	4
TRIG3	Bit 3	1000	8
TRIG4	Bit 4	10000	16
TRIG5	Bit 5	100000	32
TRIG6	Bit 6	1000000	64
TRIG7	Bit 7	10000000	128
TRIG8	Bit 8	1 00000000	256
TRIG9	Bit 9	10 00000000	512
TRIG10	Bit 10	100 00000000	1024
TRIG11	Bit 11	1000 00000000	2048

Decimal	Binary	Bit	List 2 Input Signal
4096	10000 00000000	Bit 12	SW_TRIG
16	10000	Bit 4	MO_RUN
8	1000	Bit 3	FLAG4_IN
4	100	Bit 2	FLAG3_IN
2	10	Bit 1	FLAG2_IN
1	1	Bit 0	FLAG1_IN
16384	1000000 00000000	Bit 14	PXIE_SYNC

List 2 Input Signal	Bit	Binary	Decimal
MO_SYNC	Bit 5	100000	32

Figure 9   Crosspoint Switch Input Signal Bit-Mapping

Enabling Outputs

As shown in the block diagram on page 104, the Star Trigger Outputs and Trigger Bus Outputs can be enabled or disabled. Each set of outputs has a 32-bit Output Enable Register. A 1 in this bit-mapped field indicates the associated output signal is enabled, a 0 in this field indicates the output signal is disabled (high impedance). The bit-mapping shown below:
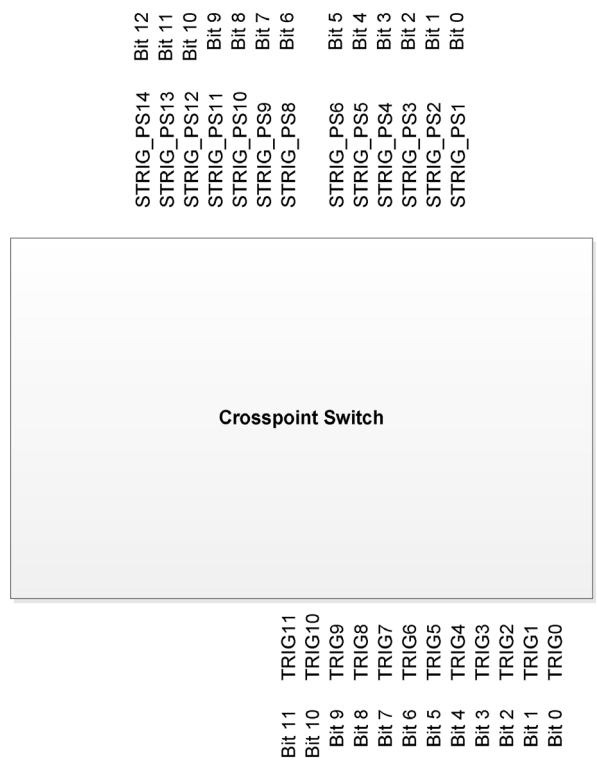
For example, to enable the STRIG-PS2 (Bit 0, decimal = 1) and the STRIG_PS4 (Bit 3, decimal = 8) outputs, use this IVI-COM method:

IAgAXIeSMTriggerRouting.SetStarTriggerOutputEnableRegister

or this IVI-C function:

AgAXIeSM_TriggerRoutingSetStarTriggerOutputEnableRegister

To set SW_TRIG line low, use this function:

AgAXIeSM_TriggerRoutingSetSoftwareTriggerState

Monitoring Crosspoint Switch Outputs

Each of the Crosspoint Switch outputs (see page 131) can be enabled and driven independently. An output must be enabled before it can be used as an output.

IVI-COM Programming   The GetCrosspointSwitch method returns the input signals connected to the specified output line of the Crosspoint Switch.

Monitoring Crosspoint Switch Inputs

Any of the Crosspoint Switch inputs (see page 130) can be assigned to any output, except that you cannot assign the same input as the output. The red X's on the Crosspoint Switch diagram indicate disallowed connections. For example, it is not allowed to connect PORT1_IN to PORT1_OUT; therefore, the connection is marked with a red X.

Multiple outputs may be driven from the same input, but each output may have only one input assigned.

The default input for all outputs is **"Static 0"**. If you don't specify the input signal for a specific output signal, the input signal will be logic 0 by default for that output signal.

IVI-COM Programming   The GetCrosspointSwitch method returns the input signals connected to the specified output line of the Crosspoint Switch.

OR-ing and AND-ing of Input Signals

When multiple Crosspoint Switch input signals are connected to a single output line, the signals are logically ORed together to produce the signal on that output line. That is, when *any* of the inputs are logic "1", the output will be logic "1". The truth table for a two-input OR gate is shown below.
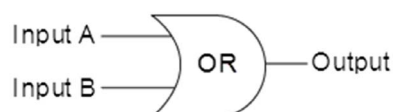
Input A	Input B	Output
0	0	0
1	0	1
0	1	1
1	1	1

By inverting both inputs and the output of an OR gate, the equivalent of an AND gate is achieved, even though the Crosspoint Switch is still performing an OR function internally. That is, when *all* inputs are logic "1", the output will be logic "1". The truth table for a two-input AND gate is shown below.
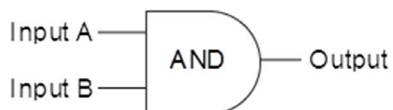
Input A	Input B	Output
0	0	0
1	0	0
0	1	0
1	1	1

The table below shows how inverting the inputs and outputs of an OR gate produces the truth table of an AND gate.

Inverted Input A	Inverted Input B	ORed Result	Inverted ORed Result
$\bar{0} = 1$	$\bar{0} = 1$	1	$\bar{1} = 0$
$\bar{1} = 0$	$\bar{0} = 1$	1	$\bar{1} = 0$
$\bar{0} = 1$	$\bar{1} = 0$	1	$\bar{1} = 0$
$\bar{1} = 0$	$\bar{1} = 0$	0	$\bar{0} = 1$

IVI-COM Driver Calls

Use **IAgAXIeSMTriggerRouting** and the methods described below to invert input and output lines.

Trigger and Star Trigger Input Inverting   The following input inverting methods write a 32-bit value to the Trigger or Star Trigger Input Invert Register. A 1 in this bit-mapped field indicates the associated Trigger or Star Trigger input signal is inverted as it enters the Crosspoint Switch, a 0 indicates the input signal is not inverted.

SetTriggerBusInputInvertRegister

SetStarTriggerInputInvertRegister

Trigger and Star Trigger Output Inverting   The following output inverting methods write a 32-bit value to the Trigger or Star Trigger Output Invert Register. A 1 in this bit-mapped field indicates the associated Trigger or Star Trigger output signal is inverted, a 0 in this field indicates the output signal is not inverted.

SetTriggerBusOutputInvertRegister

SetStarTriggerOutputInvertRegister

Port Input Inverting   The following method specifies the Port Input Chain settings (including inversion) of the selected Port with a single method call.

IAgAXIeSMPortInput.Configure Method

Port Output Inverting.   The following method specifies all of the settings on the selected Port Output Chain (including inversion) with a single method call. These settings will be used only when the DriveType is set to Push Pull Output or Open Drain Output.

IAgAXIeSMPortOutput.Configure Method

IVI-C Functions

Trigger and Star Trigger Input inverting   The following input inverting functions write a 32-bit value to the Trigger or Star Trigger Input Invert Register. A 1 in this bit-mapped field indicates the associated Trigger or Star Trigger input signal is inverted as it enters the Crosspoint Switch, a 0 indicates the input signal is not inverted.

AgAXIeSM_TriggerRoutingSetTriggerBusInputInvertRegister

AgAXIeSM_TriggerRoutingSetStarTriggerInputInvertRegister

Trigger and Star Trigger Output Inverting   The following output inverting functions write a 32-bit value to the Trigger or Star Trigger Output Invert Register. A 1 in this bit-mapped field indicates the associated Trigger or Star Trigger output signal is inverted, a 0 in this field indicates the output signal is not inverted.

AgAXIeSM_TriggerRoutingSetTriggerBusOutputInvertRegister

AgAXIeSM_TriggerRoutingSetStarTriggerOutputInvertRegister

Port Input Inverting   The following method specifies the Port Input Chain settings (including inversion) of the selected Port with a single method call.

AgAXIeSM_PortInputConfigure Function

Port Output Inverting.   The following method specifies all of the settings on the selected Port Output Chain (including inversion) with a single method call. These settings will be used only when the DriveType is set to Push Pull Output or Open Drain Output.

AgAXIeSM_PortOutputConfigure Function

Example Programs

You can access MATLAB, and Microsoft Visual Studio .NET example programs from the Windows Start menu by clicking:

Start > All Programs > Agilent IVI Drivers > AgAXIeSM AXIe System Module > AgAXIeSM Examples

Examples with *AXIeSMTrigger* as part of the filename demonstrate how to route signals through the Crosspoint Switch and how to query to determine the input signals currently specified on a Crosspoint Switch output line.

IVI Driver Help

You can access the M9521A IVI driver help from the Windows Start menu by clicking:

Start > All Programs > Agilent IVI Drivers > AgAXIeSM AXIe System Module > AgAXIeSM Documentation

Programmable Ports 1-6

Six programmable ports (Port 1 through Port 6) can bring external signals into the ASM, route signals out of the ASM, or both. Each port may be programmed as either an input, a traditional push-pull output or an open drain output which can both receive input and generate output. In the open drain output mode, the output driver is configured with a 316 Ω pull-up to 3.3 volts. Multiple ports in this mode may be bussed together.
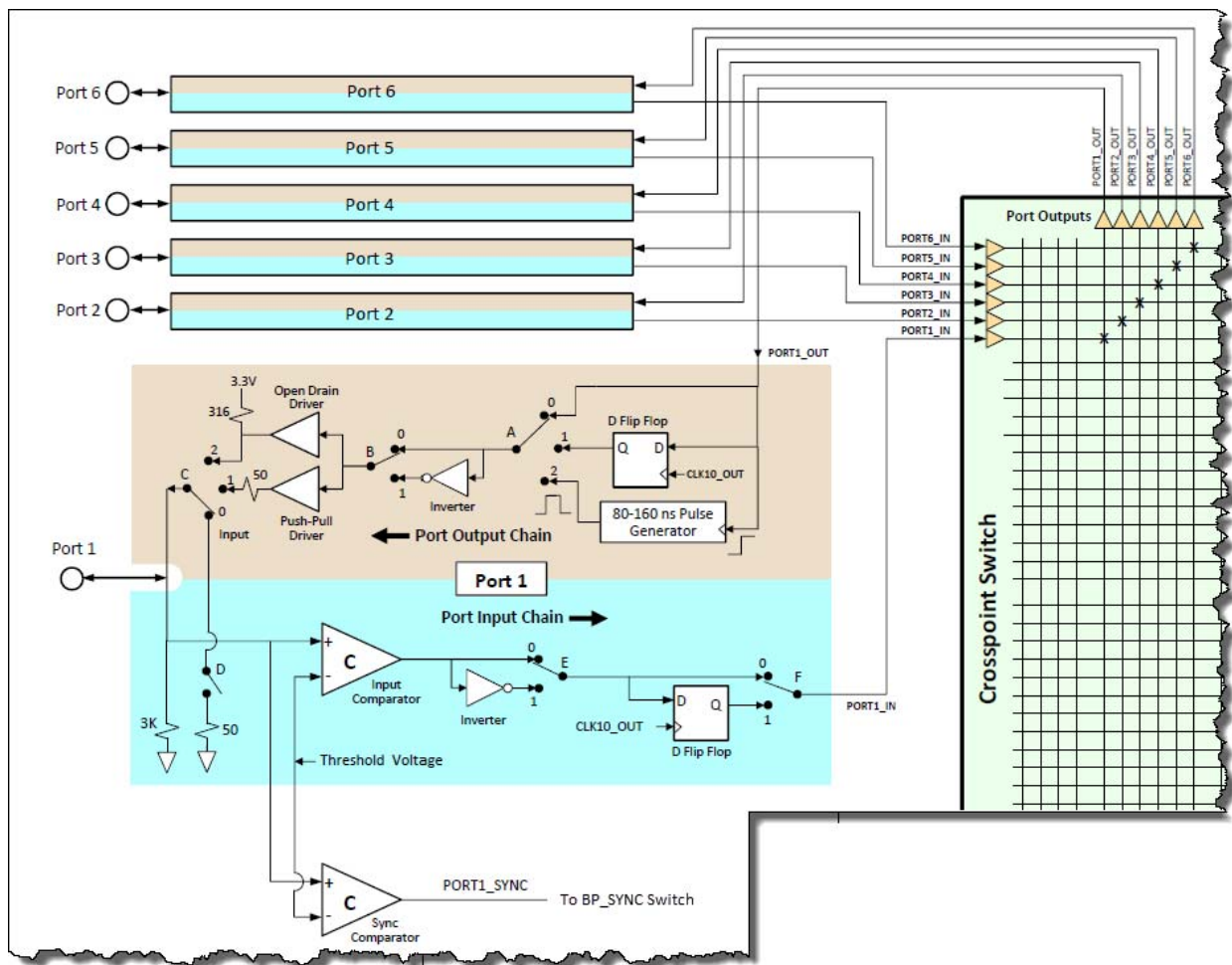
Figure 10   Port 1 Detail (other ports are identical except they do not have the Sync Comparator)

> **NOTE**   For a detailed explanation of port circuitry operation, see *IO Port Testing* in the *M9514A and M9521A Service Guide*

Reset Conditions

An ASM reset sets these default port conditions:

- DriveType = Input
- Input Threshold = 1.65 V
- Input InvertEnabled = False
- Input Impedance = 3000 Ohms
- Input Mode = Pass Through
- Output InvertEnabled = False
- Output Mode = Pass Through

Using the Ports as Inputs

When programmed as an input, you may specify:

- Termination impedance of 3000 Ω (default) or 50 Ω. This is shown symbolically as Switch D in Figure 10.
- A threshold voltage level (using an Input Comparator). If the signal is above the programmed threshold, the comparator outputs logic 1. Otherwise, the comparator outputs logic 0. Threshold range: -5.0 to +5.0 VDC in approximately 3 mV steps. Default is 1.65 V.
- Whether or not the input signal is inverted. This is shown symbolically as Switch E in Figure 10. Default: non-inverted.
- Whether or not the input signal is synchronized with the CLK10_OUT 10 MHz reference clock before going to the Crosspoint Switch. Synchronization is accomplished with the D Flip Flop shown in the diagram. Switch F in Figure 10, symbolically shows the selection of synchronized or not synchronized. Default: not synchronized.
- Additionally, the input signal on Port 1 only has the option to bypass the Input Comparator, Inverter, and D Flip Flop and connect directly to the chassis backplane SYNC line.

Using the Ports as Outputs

When programming a port as an output, you may specify:

- The port output state, whether the output is enabled or disabled. This is shown symbolically as Switch C in Figure 10. Default: port configured as input.
- Whether or not to invert the signal before outputting the signal. This is shown symbolically with an inverter and Switch B in Figure 10. Default: non-inverted.

- The source of the output signal from the Crosspoint Switch. Possible sources are: direct pass-through (no change to the signal), output clocked out by 10 MHz clock (SyncToClock), or generates a pulse on each rising edge of Crosspoint Switch output signal (PulseGeneration). These are shown symbolically as Switch A in Figure 10. Default: pass-through.

> **NOTE**   Multiple open drain ports, when bussed together, put their pull-up resistors in parallel. The overall pull-up resistance decreases making the pull-up weaker as more ports are bussed together. As the resistance of the paralleled ports lowers, the actual input threshold may change.

When the mode is PulseGeneration, a pulse is generated on each logic 0 to logic 1 transition (rising edge) of the associated Crosspoint Switch output signal. The width of the pulse cannot be changed, and will range from 80 to 160 ns. Note that the inversion optionally specified by the Invert parameter occurs after the generation of the pulse.

The pulse width may vary from 80 ns to 160 ns, and can change on a pulse-to-pulse basis. For example, one pulse might be 123 ns wide while the next pulse might be 151 ns wide while the subsequent pulse might be 84 ns wide. The duty cycle of the Pulse Generator output will be 8-16% if the Pulse Generator input has a frequency of 1 MHz (period of 1000 nS). This is because an 80 nS pulse in a period of 1000 nS represents an 8% duty cycle and an a 160 nS pulse in a period of 1000 nS represents an 16% duty cycle

The ResetTriggerBus method sets Output Mode to Pass-through (0).

PORT1_SYNC

PORT1_SYNC takes the input from the Port 1 SMB connector on the front panel of the ASM, or the output from the Port 1 Output Chain.

The IVI-COM I**AgAXIeSMPortInput.Threshold** property or the IVI-C **AgAXIeSM_PortInputSetThreshold** function sets the threshold voltage on the Port Input Chain comparator. If the input signal is above the threshold, the comparator outputs a logic 1. Otherwise, the comparator outputs a logic 0. Range: -5.0 to +5.0 VDC in approx. 3 mV steps. Default: 1.65 VDC.

IVI-COM Programming   Use the **IAgAXIeSMPort.DriveType** property to configure how the selected bi-directional Port will be driven. The supported drive types are Input, Push Pull Output and Open Drain Output. The Ports are always enabled, so changing DriveType will take effect immediately. Default: Input.

Use the **IAgAXIeSMPortOutput.Configure** method to specify all of the settings on the selected Port Output Chain with a single method call. These settings will be used only when the DriveType is set to Push Pull Output or Open Drain Output.

General Programming Information

The following table lists the symbolic switches and the generalized software call name used to program the ports. Refer to Figure 10 on page 118 for the switches and hardware.

Switch	Generalized Software Call Name	Default State
A	PortOutputMode	Passthrough,
A and B	PortOutputConfigure( )	Passthrough, non-inverted
B	PortOutputInvertEnabled	Non-inverted
C	PortDriveType	Input
D, E, and F	PortInputConfigure( )	3000 Ω, Non-inverted, Passthrough
D	PortInputImpedance	3000 Ω
E	PortInputInvertEnabled	Non-inverted
F	PortInputMode	Passthrough
(none)	PortInputThreshold	Input Comparator

IVI-COM Example Calls:

The following example IVI-COM calls select these Port 1 settings:

- Port Drive Type:
  - Input, 3 kOhm impedance
- Port Input Chain
  - Input threshold: 1.65 VDC (not inverted)
  - Mode: Pass through
- Port Output Chain
  - Output Inverted
  - Sync to Clock

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).DriveType = AgAXIeSMPortDriveTypeInput;

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).Input.Impedance = 3000;

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).Input.Threshold = 1.65;

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).Input.InvertEnabled = False;

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).Input.Mode = AgAXIeSMInputModePassThrough;

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).Output.InvertEnabled = True;

IAgAXIeSMExternalSignals.Ports.get_Item(Port1).Output.Mode = AgAXIeSMOutputModeSyncToClock;

IVI-C Example Calls

The following example IVI-C calls select these Port 1 settings:

- Port Drive Type:
    - Input, 3 kOhm impedance
- Port Input Chain
    - Input threshold: 1.65 VDC (not inverted)
    - Mode: Pass through
- Port Output Chain
    - Output Inverted
    - Sync to Clock

AgAXIeSM_GetPortName Function

AgAXIeSM_PortOutputConfigure Function (set impedance, threshold, invert enabled,input mode on the specified port)

AgAXIeSM_PortInputConfigure Function (set invert enabled,input mode on the specified port)

Example Programs

You can access MATLAB, and Microsoft Visual Studio .NET example programs from the Windows Start menu by clicking:

Start > All Programs > Agilent IVI Drivers > AgAXIeSM AXIe System Module > AgAXIeSM Examples

Examples with *AXIeSMPort_IO* as part of the filename demonstrate how to configure an I/O port as an input, push-pull output, or open drain output.

Timing, Synchronization and Triggering

The Agilent M9521A ASM with the M9514A chassis provides a rich set of triggering and timing options. These allow you to achieve time-aligned operation of multiple instruments installed in a single chassis or MultiFrame configuration (see "MultiFrame Operation" on page 139.

<table>
<tr><td>NOTE</td><td>MultiFrame, Agilent's method of interconnecting multiple chassis, is described in separate chapter, "MultiFrame Operation" on page 139. For this chapter, 'instruments in the chassis' includes all instrument modules in the single chassis or MultiFrame. If you are using only a single chassis, the MultiFrame references do not apply.</td></tr>
</table>

An example of time aligned operation would be starting and stopping some aspect of a test running on multiple instruments in the chassis. The time alignment of these operations can be:

- *Synchronous*: A single event (trigger signal or sync signal), initiated by an external trigger, flag, or other signal transition, triggers one or more instruments simultaneously.

- *Asynchronous:* Instruments operate independently, with their resulting data to be time-aligned post-collection in your analysis software. This requires data to be referenced to a common clock.

Moreover, there is capability to group instruments and perform such operations on several independent groups simultaneously. For example, instrument group A can be triggered from a 100MHz clock and instrument group B can receive an external trigger from an event transition in the test environment, while receiving the same clock signal to synchronize the two groups.
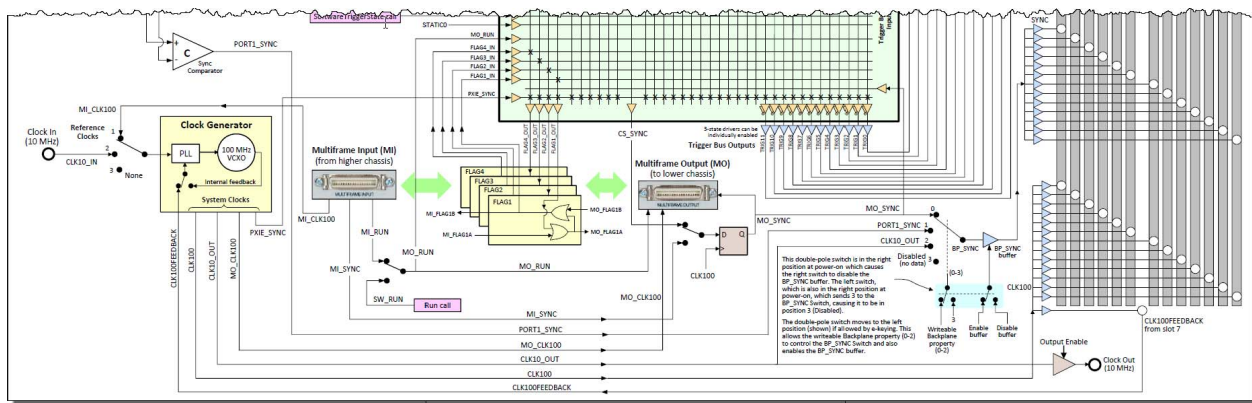
Figure 11   Synchronization and Timing Signals and Circuitry

The following table provides a brief description of the timing and synchronization interface signals:

FCLK	The 100 MHz PCIe Reference clock
CLK10_IN	10 MHz clock Input to the ASM front panel
CLK10_OUT	10 MHz clock Output from the ASM front panel
CLK100	The primary chassis clock. AXIe specifications require slot-to-slot skew to be less than 100 ps.
MI_CLK100	For MultiFrame, a 100 MHz clock from a higher chassis
MO_CLK100	For MultiFrame, a 100 MHz clock to a lower chassis
MI_RUN	For MultiFrame, a RUN signal from a higher chassis
MO_RUN	For MultiFrame, a RUN signal to a lower chassis
MI_SYNC	For MultiFrame, a Sync signal from a higher chassis
MO_SYNC	For MultiFrame, a Sync signal clock to a lower chassis
PORT1_SYNC	A sync signal from ASM Port 1
SYNC	The trigger/clock synchronization signal. Slot-to-slot skew must be less than 100 ps.
STRIG	Provides direct triggering between the ASM slot and each of the other instrument slots (no fanout). Skew must be less than 20 ps.

Timing

Clock Sources

These three clock signals are available:

- A local 100 MHz voltage controller crystal oscillator within the ASM. This provides the **CLK100** clock signal.
- **CLOCK IN:** A 10 MHz external reference clock applied at the ASM's front panel SMB connector.
- **MULTIFRAME INPUT CLK100:** An external reference clock from the MultiFrame Input (MI) higher chassis connector using Agilent's MultiFrame protocol (see Chapter 5).

Clock Outputs

The AXIe System Module (ASM) provides three clock outputs available for use by other AXIe instruments in the chassis or external instruments or devices under test.

- **CLK100:** Star distributed to all instrument slots.
- **CLOCK OUT:** Provided to the ASM's front panel SMB connector, as a 10 MHz external reference clock (3.3V CMOS, 50Ω). This is also shown as **CLK10_OUT** on the M9521A Clock and Trigger Subsystem diagram.
- **MULTIFRAME OUTPUT CLK100:** Distributed to additional (lower) chassis using Agilent's MultiFrame protocol (see Chapter 5). This is also shown as **MO_CLK100** on the M9521A Clock and Trigger Subsystem diagram.

To use CLOCK IN

You can connect a 10 MHz external reference clock source to drive the clock bus on any given chassis.

1 Provide a clock source at that ASMs's front panel SMB connector. The chassis will recognize a signal with these characteristics:
   - AC coupled, -5V to +5V input
   - 250 mV minimum swing
   - frequency 10 MHz ±100 ppm

2 In the default Auto mode (see "Auto Mode." on page 126), the chassis will automatically select CLOCK IN if sensed. If an ASM senses both CLOCK IN and MULTIFRAME INPUT CLK100, MULTIFRAME INPUT CLK100 has priority.

To use MultiFrame INPUT CLK100

In a MultiFrame system, the CLK100 signal sourced from the master chassis (MO_CLK100) drives the clock buses for all subordinate chassis. See Chapter 5 for details.

1   The MO_CLK100 signal is provided from the master to each subordinate chassis's MULTIFRAME INPUT (lower chassis) connector as MI_CLK100.

2   Each subordinate chassis automatically selects MI_CLK100 as its clock source if sensed.

To use CLK100

Regardless of source, the clock bus output CLK100 can be accessed by AXIe instruments via the backplane or MultiFrame connection.

1   AXIe modules installed in a given chassis may access CLK100 via the backplane.

2   If the module is in a subordinate chassis in a MultiFrame, its clock source is MI_CLK100.

To use CLOCK OUT

You can extend the clock bus output to *external instruments*. These are instruments which cannot access CLK100 from that chassis, either via the backplane or MultiFrame connection. They may be external to the AXIe chassis or chassis system.

The 10 MHz output is synchronous with the internal CLK100 signal.

Connect the external instrument's clock input to the ASM's front panel SMB **CLOCK OUT** connector.

IVI- COM Programming

Auto Mode.   When selected, the clock used by the Clock Generator is automatically selected from the available Reference Clocks. At power-on and in Auto mode, the AXIe System Module automatically selects the highest priority reference clock source present, using the following priority:

100 MHz MultiFrame In (highest priority)

10 MHz Clock In

None (lowest priority)

Automatic source selection continues after the power-on period. If a reference clock is connected (or disconnected) at any time, the system module will re-evaluate the available reference clocks and will again select the highest priority reference clock available. To select Auto mode:

> **IAgAXIeSMReferenceClock.SourceAuto = True;**

Manual Mode   To disable Auto mode, and select a specific clock source:

> **IAgAXIeSMReferenceClock.SourceAuto = False;**

This disables automatic mode, allowing a specific reference clock source to always be used, regardless of that source's position in the priority hierarchy. Once automatic selection is disabled, any subsequent connection of a higher priority source will be ignored, leaving the present source unchanged.

Select 100 MHz MultiFrame In:

> **IAgAXIeSMReferenceClock.Source(AgAXIeSMReferenceClockMultiFra me100MHz);**

Select 10 MHz Clock In:

> **IAgAXIeSMReferenceClock.Source(AgAXIeSMReferenceClockClockIn 10MHz);**

Select None:

> **IAgAXIeSMReferenceClock.Source(AgAXIeSMReferenceClockNone);**

Enable Clock Output   When enabled, the 10 MHz clock will be available on the ASM's front panel Clock Out connector. When cleared, the clock will not be available on the Clock Out connector.

Enable Clock Output:

> **IAgAXIeSMExternalSignals.ClockOutputEnabled(True);**

Disable Clock Output:

> **IAgAXIeSMExternalSignals.ClockOutputEnabled(False);**

IVI-C Programming

Enable/disable auto mode:

> **AGAXIESM_ATTR_REFERENCE_CLOCK_SOURCE_AUTO Attribute**

Select Reference Clock:

> **AgAXIeSM_ReferenceClockSetSource Function**

Select 100 MHz MultiFrame In, 10 MHz Clock In, or None:

> **AgAXIeSM_ReferenceClockSetSource Function**

Use one of these attributes:

> **AGAXIESM_VAL_REFERENCE_CLOCK_MULTIFRAME_100_MHZ**

> **AGAXIESM_VAL_REFERENCE_CLOCK_CLOCK_IN_10_MHZ**

> **AGAXIESM_VAL_REFERENCE_CLOCK_NONE**

AgAXIeSM_ExternalSignalsGetClockOutputEnabled Function (True, the clock will be available on Clock Out connector, False, the clock will not be available).

Synchronization

Refer to Figure 11 on page 124. The **SYNC** and **CLK100** backplane signals are a Low Voltage Differential Signaling (LVDS) star trigger and a star clock. **SYNC** provides an LVDS trigger signal, output at the next rising edge of **CLK100** after the source trigger is received. The **SYNC** and **CLK100** lines use identical fan out buffers and are trace length matched to operate as a pair, with the following characteristics:

- Point-to-point between the ASM (physical slot 7) and instrument slots (physical slots 1 through 6 and 8 through 14)
- Slot terminated with 100Ω differential resistor.

The backplane **SYNC** lines (also called BP_SYNC on the M9521A Clock and Timing Subsystem graphic) are sourced by either the MO_SYNC, PORT1_SYNC or CLK_OUT signals. The SYNC signal can be disabled causing SYNC to have no clocking. They are enabled by selecting either the MO_SYNC, PORT1_SYNC or CLK_OUT signals.

The backplane sync signal source can be reported as *Disabled* if operation of that setting is not allowed by e-keying. This situation is detected when the system module is powered on and most likely to happen if the system module is being used in a non-Agilent chassis.

Use When: For truly synchronous applications, **SYNC** allows you to trigger multiple instruments both simultaneously and in sync with the reference clock. It can also be used as a general asynchronous star trigger output line.

IVI-COM Programming

IAgAXIeSMSync.Backplane *Specifies the source of the backplane Sync signal (BP_SYNC)*

IAgAXIeSMBackplaneSyncMultiFrameOutputSync *Specifies the MultiFrame Output connector's Sync signal (MO_SYNC)*

IAgAXIeSMBackplaneSyncPort1Sync *Specifies the Port 1 connector's input signal (PORT1_SYNC)*

IAgAXIeSMBackplaneSyncCLK10 *Specifies the Internal 10 MHz clock signal*

IAgAXIeSMBackplaneSyncDisabled T*his is a READ ONLY state that indicates that the Backplane Sync has been disabled by EKeying*

IVI-C Programming

AgAXIeSM_SyncSetBackplane Function *Specifies the source of the backplane Sync signal (BP_SYNC)*

AGAXIESM_VAL_BACKPLANE_SYNC_MULTIFRAME_OUTPUT_SYNC *Specifies the MultiFrame Output connector's Sync signal (MO_SYNC)*

AGAXIESM_VAL_BACKPLANE_SYNC_PORT1_SYNC *Specifies the Port 1 connector's input signal (PORT1_SYNC)*

AGAXIESM_VAL_BACKPLANE_SYNC_CLK10 *Specifies the Internal 10 MHz clock signal (CLK10_OUT)*

AGAXIESM_VAL_BACKPLANE_SYNC_DISABLED *This is a READ ONLY state that indicates that the Backplane Sync has been disabled by EKeying*

Example Programs

Backplane sync examples for Microsoft Visual Studio and MATLAB are located in this directory path:

<drive>:\Program Files (x86)\IVI Foundation\IVI\Drivers\ AgAXIeSM\Examples

Examples with *AXIeSMSynchronization* in the file name, demonstrate how to route the 10 MHz clock (CLK10_OUT) signal, the MultiFrame Output Sync (MO_SYNC) signal, or the Port 1 Sync (PORT1_SYNC) signal to the Backplane Sync line.

MI_SYNC and MO_SYNC

MI_SYNC is sourced from a higher chassis through the MultiFrame Input (MI) connector. It can drive the **MO_SYNC** to lower chassis through the MultiFrame Output (MO) connector and ultimately the **SYNC** lines on the chassis backplane.

Use When: Use the **MI_SYNC** and **MO_SYNC** in MultiFrame configurations to synchronize instrument modules multiple chassis. Refer to Chapter 5.

IVI Programming

The IVI-COM **IAgAXIeSMSync.MultiFrameSyncAuto** property or the IVI-C **AGAXIESM_ATTR_SYNC_MULTIFRAME_SYNC_AUTO** attribute enables/disables automatic selection of which sync signal, MI_SYNC or CS_SYNC, will be routed to the MultiFrame Output Sync signal, MO_SYNC. The default is True, which enables automatic selection based on the presence of MultiFrame cabling.

When a MultiFrame cable is currently connected, or becomes connected, to the MultiFrame Input connector, the ASM automatically routes the MultiFrame Input connector's Sync signal to the Sync line of the MultiFrame Output connector (MO_SYNC).

If the MultiFrame cable is currently disconnected, or becomes disconnected, the ASM automatically routes the Crosspoint Switch Sync signal (CS_SYNC) to the MultiFrame Output connector's Sync line.

When MultiFrameSyncAuto is set to False, the MultiFrame cable is ignored, and the Crosspoint Switch Sync signal (CS_SYNC) is routed to the MultiFrame Output connector's Sync line (MO_SYNC).

In both cases above, the selected Sync signal is clocked by (edge aligned with) the system module's 100 MHz system clock during the routing to the MultiFrame Output connector's Sync line (MO_SYNC).

Triggering

This section introduces the AXIe chassis's trigger bus resources and some of the many ways you may use them. Any AXIe instrument can be triggered either:

- internally, based on its own automation or signals from DUT connected directly to it
- through an externally applied trigger.
- through the chassis backplane,

The AXIe chassis allows you to trigger instruments—singly, in groups, or all instruments in the chassis—from different signal sources.

Trigger Resources

The primary AXIe trigger resource is the Crosspoint Switch. It allows any trigger input to be connected to any trigger output.

Trigger Inputs   There are many inputs to the Crosspoint Switch. Any input can be connected to one or more trigger outputs. The inputs include:

- An external trigger (**TRIGGER IN**) applied at the ASM's front panel SMB connector

- Any of the 12 **TRIG** signals. As these lines are bidirectional, any AXIe module can source a trigger via the backplane using them.
- Any of the (two to five) **STRIG** signals. As these lines are bidirectional, any AXIe module can source a trigger via the backplane using them.
- Any of the four event Flag signals (**MULTIFRAME INPUT Flags 1 through 4**) from the lower chassis connector
- A MultiFrame SYNC signal (**MULTIFRAME INPUT SYNC**) from the lower chassis connector
- A MultiFrame **MO_RUN** Signal from the lower or upper chassis connector

Trigger Outputs   From the diagram, note that the ASM can output six types of trigger signal:

- From the chassis backplane
  - **TRIG**
  - **STRIG**
  - **SYNC**
- From the ASM front panel
  - **TRIGGER OUT** (SMB connector to any instrument)
  - **MultiFrame Out Flags** 1 through 4 (MultiFrame to upper chassis)
  - **MultiFrame Out SYNC** (MultiFrame connector to upper chassis)

TRIG Bus

The TRIG bus (TRIG[0,11]) is a set of 12 Multipoint Low Voltage Differential Signaling (MLVDS) signal pairs with the following characteristics representative for each pair:

- Multi-point and bidirectional to all slots plus the ASM
- Backplane terminated with 80Ω at each end

- Requires the instrument module to provide MLVDS buffers (blue lines)

TRIG Bus (one of 12 pairs)
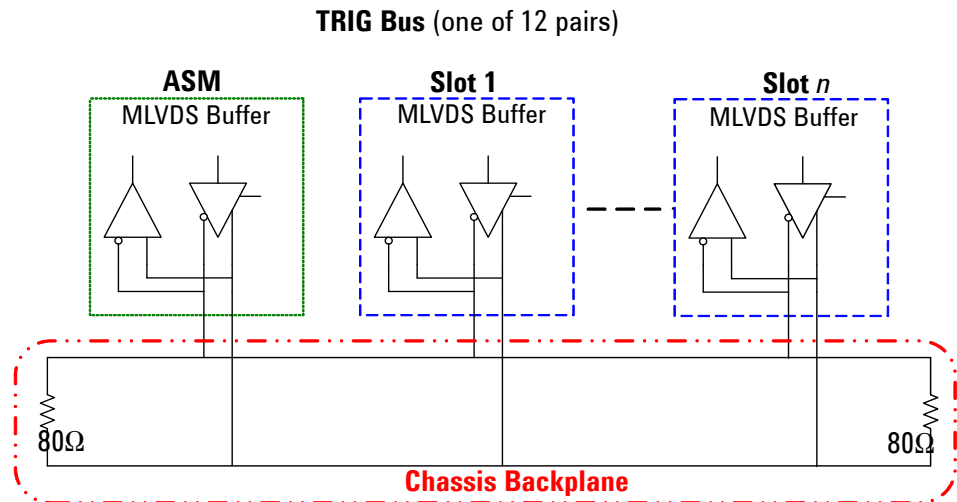
Each TRIG line (signal pair) is a parallel bus, with connections to all slots (ASM slot plus the instrument slots). Any instrument in the chassis can send or receive a trigger signal using any of these lines.

Use When: The TRIG bus's multipoint topology makes it fast and direct for module-to-module triggering.
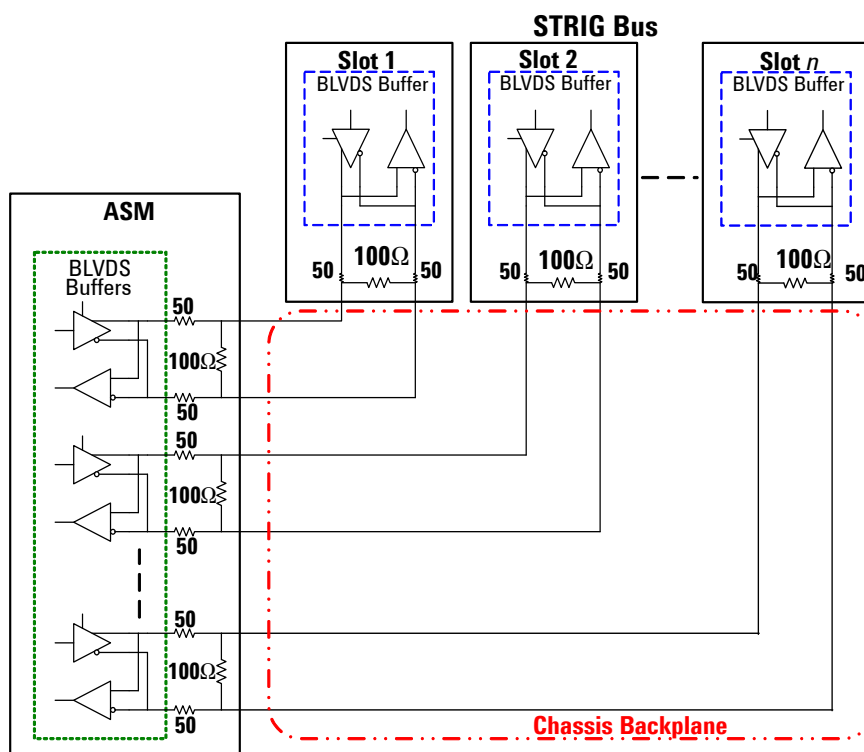
IVI Programming

Refer to "Connecting an Input to an Output in the Crosspoint Switch" on page 105 for details on using the STRIG inputs/outputs.

Star Trigger (STRIG) Lines

There are 13 STRIG lines -- STRIG_PS1 through STRIG_PS6 and STRIG_PS8 through STRIG_PS14; There is no STRIG_PS7 since this corresponds to the slot where the ASM is installed. STRIG:

- Allows the M9521A ASM to act as a master to trigger other modules in the chassis.

- Lines are bi-directional. Any module in the chassis can act as a trigger source or a trigger receiver.

- STRIG bus resources are allocated through E-Keying)

- The STRIG signal is a Bidirectional Low Voltage Differential Signaling (BLVDS) star trigger with the following characteristics:
  - Point-to-point and bidirectional between the ASM and instrument slots (physical slots 1 through 6 and 8 through 14).
  - Slot terminated with 100Ω differential and 50Ω series (optional).
  - All STRIG lines are trace length matched.

Use When: The STRIG bus's trace matched lines ensure the lowest skew when synchronously triggering multiple modules.

IVI Programming

Refer to "Connecting an Input to an Output in the Crosspoint Switch" on page 105 for details on using the STRIG inputs/outputs.

MO_RUN

MO_RUN is a software initiated signal that you can use to direct AXIe instrument modules to perform an action such as starting or stopping a measurement. MO_RUN is not defined in the AXIe architecture; it is a proprietary part of the Agilent Test Bus (ATB) architecture.

MO_RUN may be routed through the M9521A ASM crosspoint matrix to the Trigger bus lines or any other crosspoint signal outputs to send the software signal to one or more AXIe instruments.

MO_RUN is also part of the MultiFrame protocol. In a MultiFrame configuration, the Master chassis may initiate the MO_RUN signal to subordinate chassis, each having their own internal routing of the signal to instrument modules in the chassis. Only the Master chassis may pass along the MO_RUN signal to subordinate chassis or to the ASM Crosspoint Switch.

The MO_RUN signal:

- Initializes to 0 (de-asserts) at chassis power-on.

- A software application opens the ASM driver thereby implicitly de-asserting the MO_RUN signal.

IVI Programming

The **IVI-COM IAgAXIeSMTiming.MultiFrameRunAuto** property or the IVI-C **AgAXIeSM_TimingSetMultiframeRunAuto** function enables/disables automatic selection of which signal, MI_RUN or SW_RUN, is routed to the MultiFrame Output RUN signal, MO_RUN. MO_RUN also goes to the Crosspoint Switch. The default is True, which enables automatic selection based on MultiFrame cabling.

The default setting of MultiFrameRunAuto = True, has the following behaviors:

If a MultiFrame cable is presently (or becomes) connected to the MultiFrame Input connector, the control of the Run signal is given to a system module in a higher chassis. Normally the system module of the Master chassis would ultimately control the Run signal.

If the MultiFrame cable is presently (or becomes) disconnected from the MultiFrame Input connector, the system module will control the Run signal of its own (local) chassis.

PCIe and LAN Data Transfer

Data Channels

The ASM provides two paths for communication and data transfer through the AXIe chassis to and from installed modules:

Gb Ethernet: This is a star-distributed 1 Gb Ethernet:

• From the LAN switch in the ASM—the base channel hub—to each slot.

• From the LAN switch in the ASM to the RJ45 front panel LAN connection; 10/100/1000BASE-TX.

PCIe: This is the high speed primary data path:

• From the PCIe switch in the ASM—the fabric 1 hub—four lanes to each instrument slot through the backplane defined as PCIe x4.

• From the PCIe switch in the ASM to the PCIe x8 front panel connection.
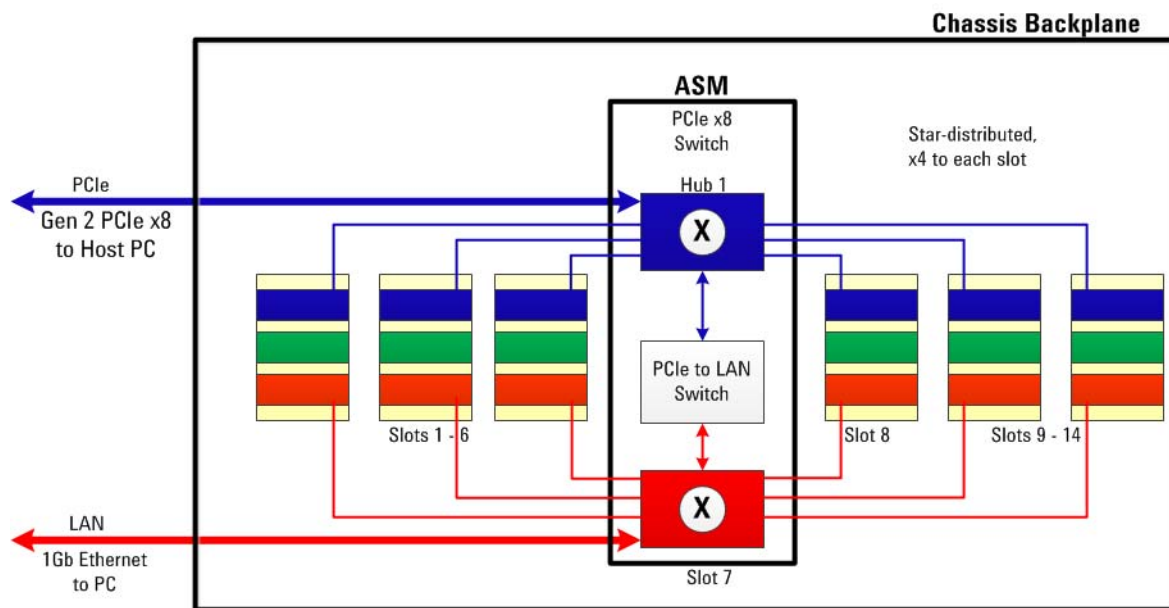
Maximizing Data Upload Speeds

The maximum data bandwidth to each slot is dictated by the x4 connection.

You will typically achieve higher PCIe data throughput to a external (desktop or rackmount) host PC than to an embedded controller.

- Using a high speed rackmount or desktop PC and a x8 cable, the primary data fabric uses a x8 connection between the ASM and the host PC. The ASM's PCIe switch can achieve Gen2 upload speeds when transferring data to the host from multiple modules simultaneously.

- If an embedded controller is installed in the chassis, that x8 connection is disabled; the controller uses its slot 1 backplane x4 link to the PCIe switch.

PCIe, LAN or Both?

You can establish communication between the chassis and host PC over either a LAN or a PCIe connection. In practice, the choice is usually driven by the interface(s) on your modules. For example, if you have a module with a x4 PCIe interface, you'll want to establish a PCIe connection to the chassis.

PCIe Connection Only You may connect the ASM to the host PC using only a PCIe cable. This will allow you to use both the base (LAN) channel and fabric 1 data channels.

Base channel communication between PC, ASM and any LAN capable installed instruments are made through the PCIe connection. A PCIe to LAN switch in the ASM manages the base channel communication to the slots; it is seen as a network interface device by Windows Device Manager.

LAN Connection Only You may connect ASM to host PC using only a LAN cable. You will have base channel communication only and significantly less data throughput that when using PCIe.

Hybrid Operation: You may connect both LAN and PCIe cables from ASM to host PC. This provides the most operational flexibility and some data throughput advantages over using only PCIe.

ASM IP Reset

The IP Reset button on the front panel of the M9521A ASM resets the ASM Internet Protocol (IP) address to its factory default setting (169.254.1.1). This is useful when troubleshooting possible IP address problems, or when the IP address becomes lost or forgotten.

6
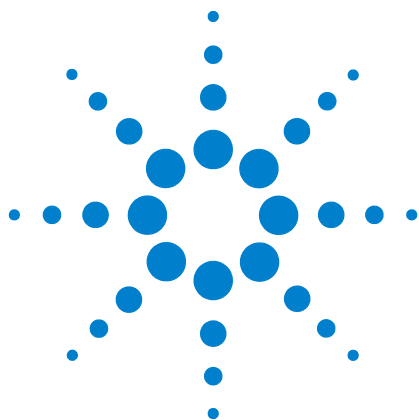
MultiFrame Operation

MultiFrame operation allows measurement modules in multiple AXIe chassis to be interconnected and appear as one integral instrument to the user. This chapter introduces basic multiple chassis connection and features, based on a simple combination of three M9514A chassis.

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How does a Multiple Chassis System Differ from a MultiFrame System?

In both multiple chassis and MultiFrame systems, all chassis are controlled by a single controller. The differences between the two system types are:

- In a multiple chassis system, the time base and triggering for each chassis operates independently from the other chassis. You can use this type of configuration to increase the number of chassis/modules that do not require a common time base or cross triggering between chassis. For more information, refer to Agilent's Multiple PXIe and AXIe Chassis Configuration tool. This tool is available on the *Software and Product Information CD* and on line at: www.agilent.com/find/pxie-multichassis.

- MultiFrame is an Agilent feature by which multiple instruments in two or more chassis are interconnected to appear as one integral instrument to the user. In a MultiFrame system, special cabling connects the time base and triggering of the master chassis to all daisy-chained slave chassis. These cables extend trigger and timing features to instruments not connected to the master chassis's backplane. You can use the MultiFrame configuration to increase the number of measurement modules utilizing a common time base or cross triggering.

Accordingly, there are two aspects of multiple chassis operation that need to be considered separately:

The first is the PCIe connectivity between the chassis and the host controller. This is handled via PCIe cabling between the ASM modules. In practice, the potential combinations of instruments which can share synchronization and triggering are numerous. The only practical limit to the number of chassis you can connect is determined by the number of PCIe slots your host computer can enumerate.

The second is the synchronization and timing of clock and trigger signals between the AXIe chassis. Use multiple chassis configurations to increase the number of measurement modules which use a common time base or cross triggering to achieve correlation. Use Agilent's MultiFrame cables (Y1223A or Y1224A) to extend trigger and timing features to instruments not connected to the master chassis's backplane. This aspect also includes power-on and power-down considerations.

Also:

- The host PC's BIOS must support enumeration of PCIe slots in the AXIe chassis; many computers are not capable of enumerating a sufficient number of PCIe slots to ensure that slots in all chassis are enumerated. Agilent maintains a document listing the integrated, rack mount, desktop and laptop computers that have been verified to properly enumerate PCIe devices in the AXIe chassis, entitled *PXI and AXIe Modular Instrumentation, Tested Computer List - Technical Note*. You can find this document at: www.agilent.com/find/axie-chassis.

- For the Agilent M9536A Embedded Controller, you must use BIOS AG16 or later.

- Always power up the last chassis in the series (subordinate 2 in the following diagrams), wait for its ASM's Status light to stop blinking, then turn on the next chassis in the series and wait for its Status light to stop blinking. Finally turn on the Master Chassis. Wait for its Status light to stop blinking before turning on the Host PC.

General Multiple Chassis Configurations

The following pages present three typical scenarios of multiple chassis operation. The first uses an external host controller and daisy-chained PCIe connectors from the Master chassis ASM to the subordinate chassis ASMs. The next two configurations demonstrate the use of an embedded controller such as the Agilent M9536A. All three example configurations show three M9514A chassis. Other combinations are possible such as one M9514A Master chassis to an Agilent M9505A 5-slot or M9502A 2-slot AXIe Subordinate chassis. The M9502A and M9505A chassis do not support daisy-chaining the PCIe connections.

| NOTE | To have all chassis shelf managers and ASM managers appear with unique IP addresses and found within the same subnet range, the LAN cable should also be daisy-chained. |

Cascaded Chassis with External Host Controller over PCIe

This first scenario is the most common; involving module control and data transfer via PCIe to the host computer.
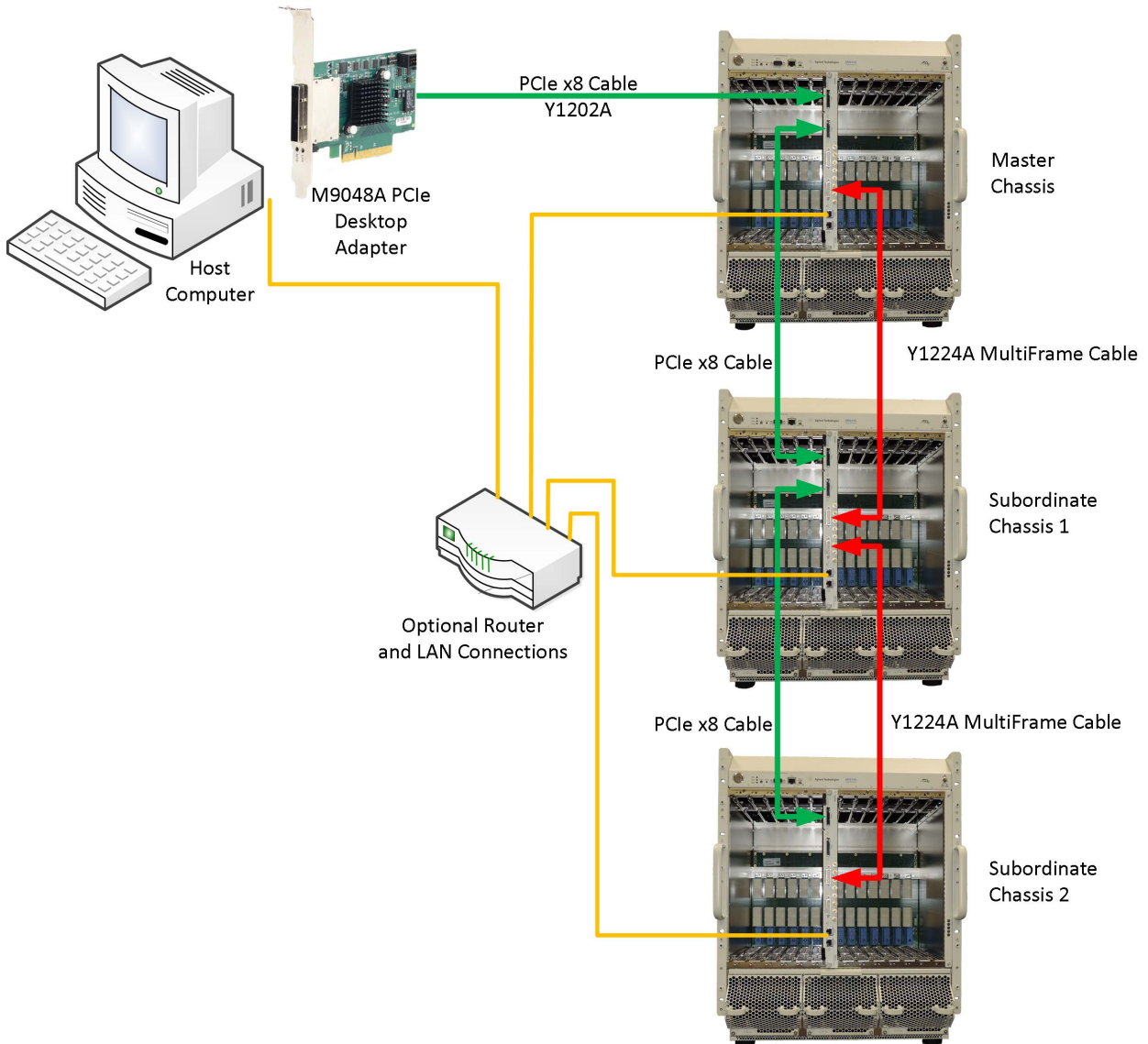
In this diagram, the green lines represent the daisy-chained PCIe cabling from the host controller to the first (or Master) chassis and then from the Master Chassis to the two subordinate chassis. Use Agilent's Y1202A cables. The red lines represent the MultiFrame cables (Y1223A or Y1224A). The router for LAN connection is optional; likewise a LAN connection between the chassis LAN port to the host PC is optional.

Cascaded Chassis with Embedded Controller (Agilent M9536A) – Scenario 1

This scenario is typical for using an embedded controller (such as the Agilent M9536A) in the Master Chassis to control the system.
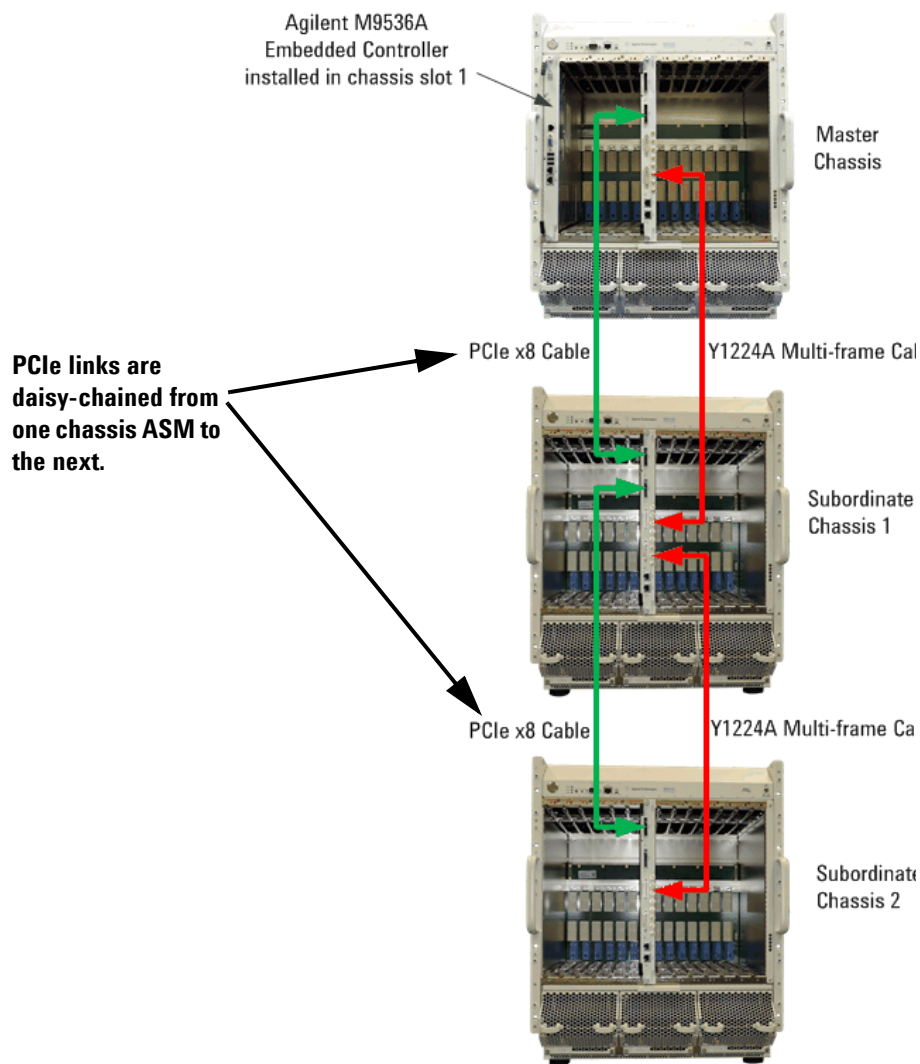
In this diagram, the green lines represent the PCIe cabling from the Master chassis first subordinate chassis and then to the second subordinate chassis. Use Agilent's Y1202A cable. The red lines represent the MultiFrame cables (Y1223A or Y1224A).

PCIe connectors from the Master chassis ASM to the subordinate chassis ASMs are daisy-chained.

Cascaded Chassis with Embedded Controller (Agilent M9536A) – Scenario 2

This scenario is also common for using an embedded controller (such as the Agilent M9536A) but is limited to three chassis.
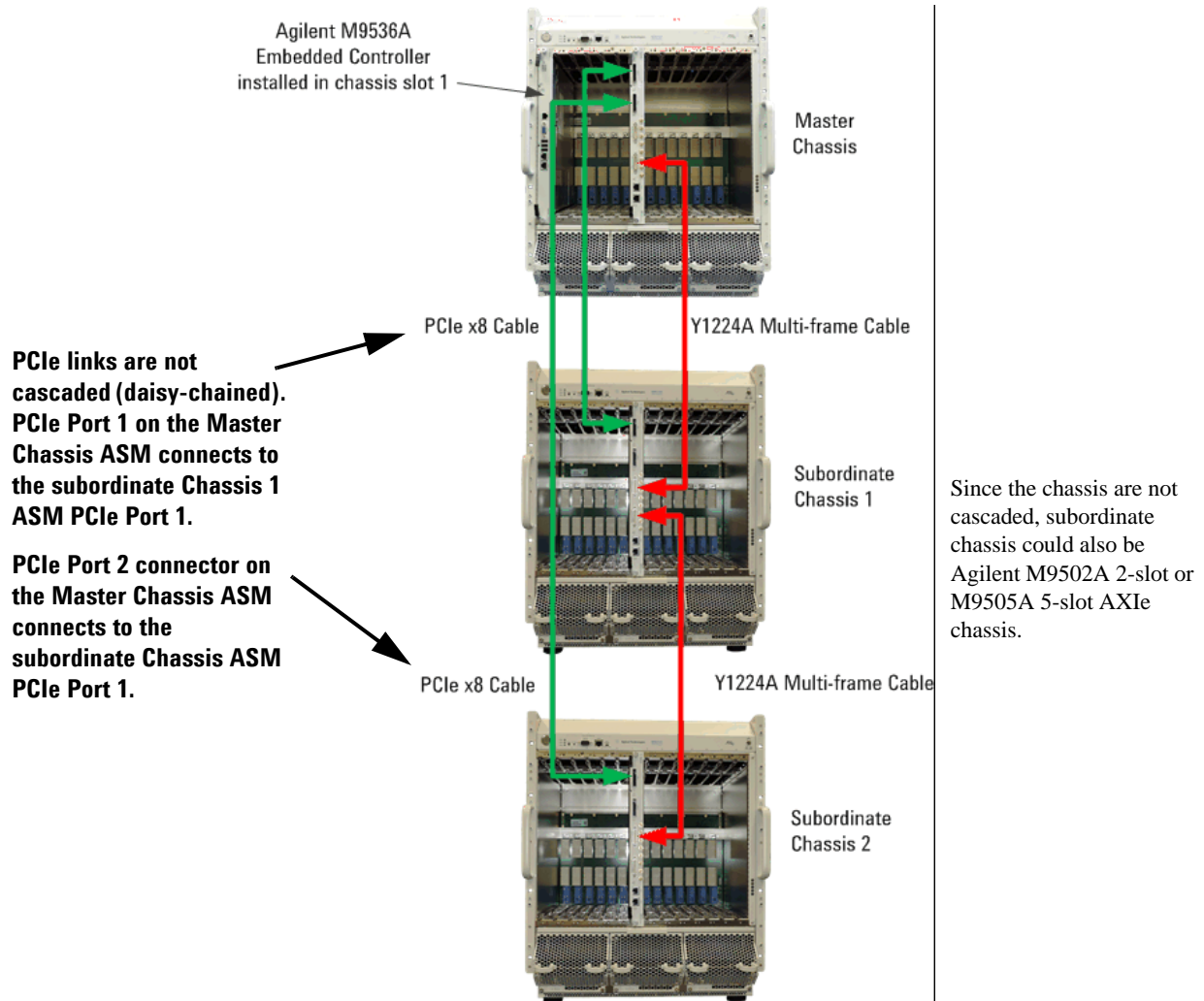
PCIe links are not cascaded (daisy-chained). PCIe Port 1 on the Master Chassis ASM connects to the subordinate Chassis 1 ASM PCIe Port 1.

PCIe Port 2 connector on the Master Chassis ASM connects to the subordinate Chassis ASM PCIe Port 1.

Since the chassis are not cascaded, subordinate chassis could also be Agilent M9502A 2-slot or M9505A 5-slot AXIe chassis.

The green lines represent the PCIe cabling from the Master chassis ASM to the two subordinate chassis. Use Agilent's Y1202A cable. The red lines represent the MultiFrame cables (Y1223A or Y1224A).

The PCIe Port 1 Connector on the Master Chassis ASM must be configured as an upstream port and connects to the subordinate Chassis 1 ASM Port 1 PCIe connector. The second PCIe connector on the Master Chassis ASM connects to the subordinate Chassis 2's ASM Port 1 PCIe connector.

MultiFrame Shared Features

All chassis (therefore all instruments) in a MultiFrame system share:

Clock Source   A common 100 MHz clock is sourced from the master chassis. The time offset for clock signals to traverse the cable and signal path between each pair of chassis is about 35 ns. The MultiFrame design calibrates this out, within about 600 ps of error.

Cross Synchronization   A common SYNC signal is sourced from the master chassis. The time offset for SYNC to traverse the cable and signal path between each pair of chassis is about 35 ns. The MultiFrame design calibrates this out, within about 600 ps of error.

Cross Triggering   Any instrument in the MultiFrame can source or receive a trigger, using any of the four Flag signals carried between chassis using the MultiFrame cables.

To Connect MultiFrame Chassis

Using an Agilent MultiFrame cable, connect the Master Chassis's MULTIFRAME OUTPUT port to the first subordinate chassis's MULTIFRAME INPUT port. Connect each succeeding subordinate chassis's MULTIFRAME OUTPUT port to the next subordinate chassis' the MULTIFRAME INPUT port.
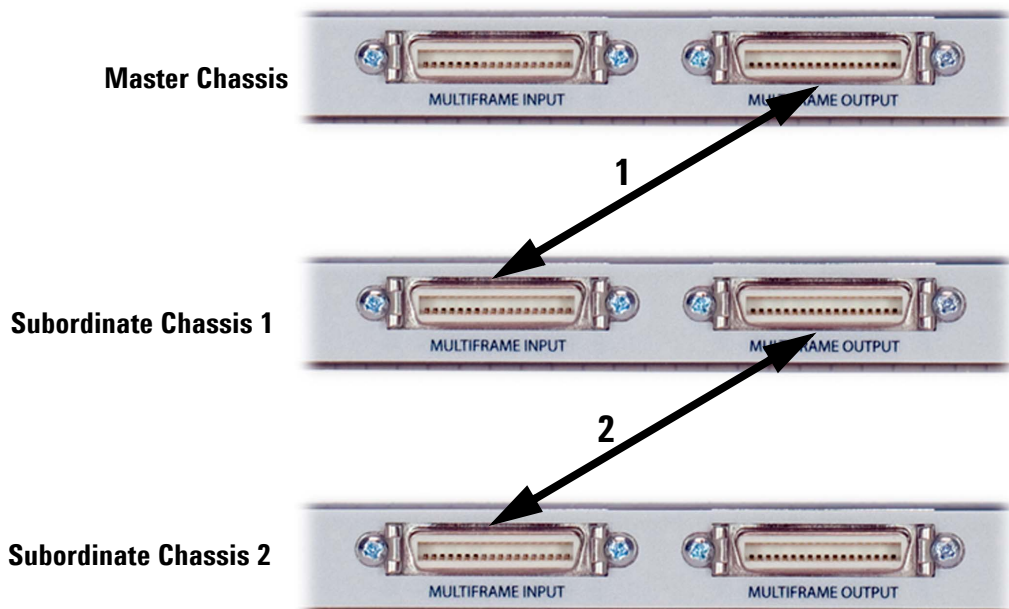
<table>
<tr><td>N O T E</td><td>MultiFrame cables [such as the Y1223A (0.5 m) or Y1224A (3 m)] can be hot plugged; that is, you do not need to cycle chassis power when connecting multiple chassis. The subordinate chassis detects the presence of the MultiFrame cable and automatically switches its clock source to the master chassis' clock output from the MultiFrame cable.</td></tr>
</table>

MultiFrame Synchronization

The following graphic shows the various MultiFrame flags and connectors and how they connect to the Crosspoint Switch.
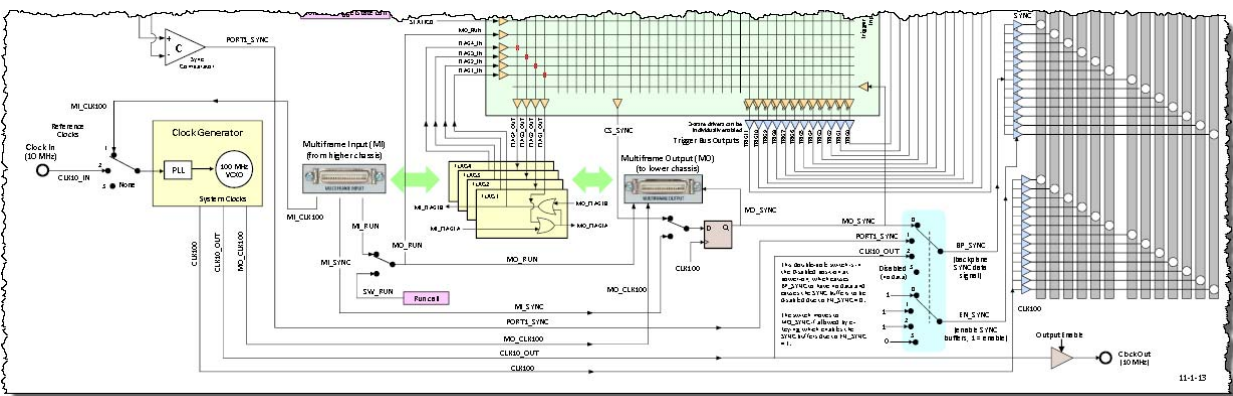
Figure 12

<table>
<tr><td>N O T E</td><td>On this diagram, an MI_ prefix (for example, MI_CLK100 or MI_FLAGn) indicateds a MultiFrame Input from a higher chassis. An MO_ prefix (such as MO_RUN or MO_CLK100) indicates a MultiFrame Output to a lower chassis.</td></tr>
</table>

MultiFrame Flags

Four BLVDS flag signals are provided on the MultiFrame cables. These flags can be distributed among any applications in a MultiFrame chassis that use asynchronous flagging.

A *flag* is an asynchronous pulse, which any instrument in any chassis can generate in response to a signal transition or program command.

Asynchronous flagging is accomplished by sending a flag and having the rest of the system act in a pre-configured way when it receives the flag. Any flag can be set or cleared (by assigning a static 1 or 0) or sourced, using the Web Interface.

The Flag lines are bidirectional. Any chassis can enable any of the four Flag lines as a trigger bus destination or specify a Flag as a trigger bus source; the MultiFrame logic will only allow one source per Flag in the MultiFrame.

Use When: The MultiFrame Flags provide for module to module signaling between modules in different chassis.

Separately, you will need to program other chassis how to respond to a received MultiFrame flag.

MultiFrame SYNC

A SYNC line is provided on the MultiFrame cables. This can be used to synchronously trigger any AXIe instruments in the MultiFrame.

To use MultiFrame SYNC as a Trigger Output

A SYNC signal output from the master chassis in the MultiFrame will be passed to the other chassis over the MultiFrame cable, as MultiFrame Sync.

To Output MultiFrame SYNC

The master chassis will output the SYNC signal over the MultiFrame cable. Only one chassis in the MultiFrame may be set to output on the shared SYNC line.

Multiple Chassis Power-up and Power-down

The power-up and power-down sequences in multiple chassis configurations are similar to a single chassis configuration. However, additional cabling is required for synchronized chassis power coordination. Two RJ-45 connectors on the chassis rear panel provide this coordination.
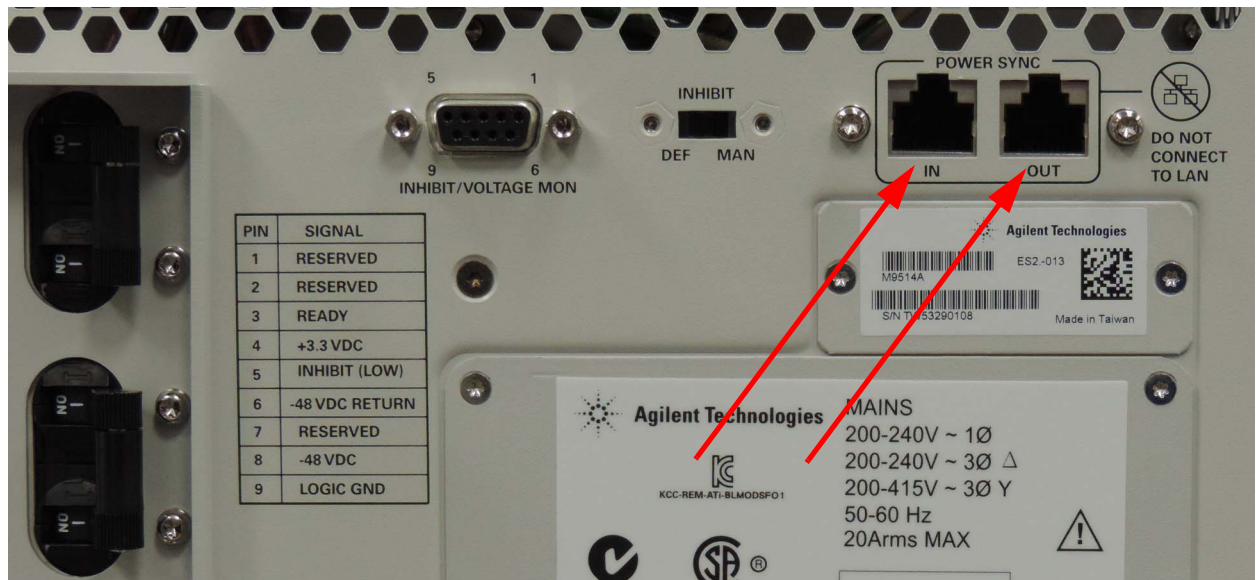

Figure 13   Rear panel RJ-45 power sync connectors

CAUTION	These RJ45 connectors are for multichassis power-up synchronization. Do not connect cables to a corporate or local LAN to these connectors.

The M9514A chassis may be connected in any order.

Power-Up

When connected by together via the RJ-45 connectors, the power button on any chassis may be used to power up the entire system.

The actual sequence is slightly different depending on whether an embedded controller (such as the Agilent M9536A) is used in the Master chassis or if an external host controller is used. If you are using an external host controller, it should be turned off until all chassis are powered on and their status lights are solid green.

1 Press the power button on any of the chassis connected together. The power control module in that chassis alerts the other chassis to power-on.

2 The other connected chassis automatically power-on. Each chassis asserts its "not ready signal" (part of the RJ45 connector) to the other chassis.

3 Each chassis ASM (shelf manager) determines if it is the Master chassis or a subordinate chassis. If either an embedded controller is found or the Port 1 PCIe connector is not connected to another chassis, it is the Master chassis; otherwise, the chassis is a subordinate chassis.

4 Each subordinate chassis deasserts its "not ready" signal once its modules are in their active mode. The Master chassis waits until each subordinate chassis is in the "ready" mode.

5 When the master chassis determines that each chassis in the system is ready, it waits the custom startup delay (see "PCIe Configuration" on page 77 (Wait setting).

6 If the Master chassis has an embedded controller (such as the M9536A), it then signals the controller to boot and enumerate all modules.

7 If an external host controller is used, wait until the status light on the Master chassis is solid green then power up the controller.

Figure 14 on page 150 shows how to connect multiple chassis using these connectors for remote power up/down. Cables used for multiple chassis power-up synchronization purposes should not exceed 30m in length. Straight CAT5 or better cables recommended.

Standard LAN cables
with RJ45 connectors
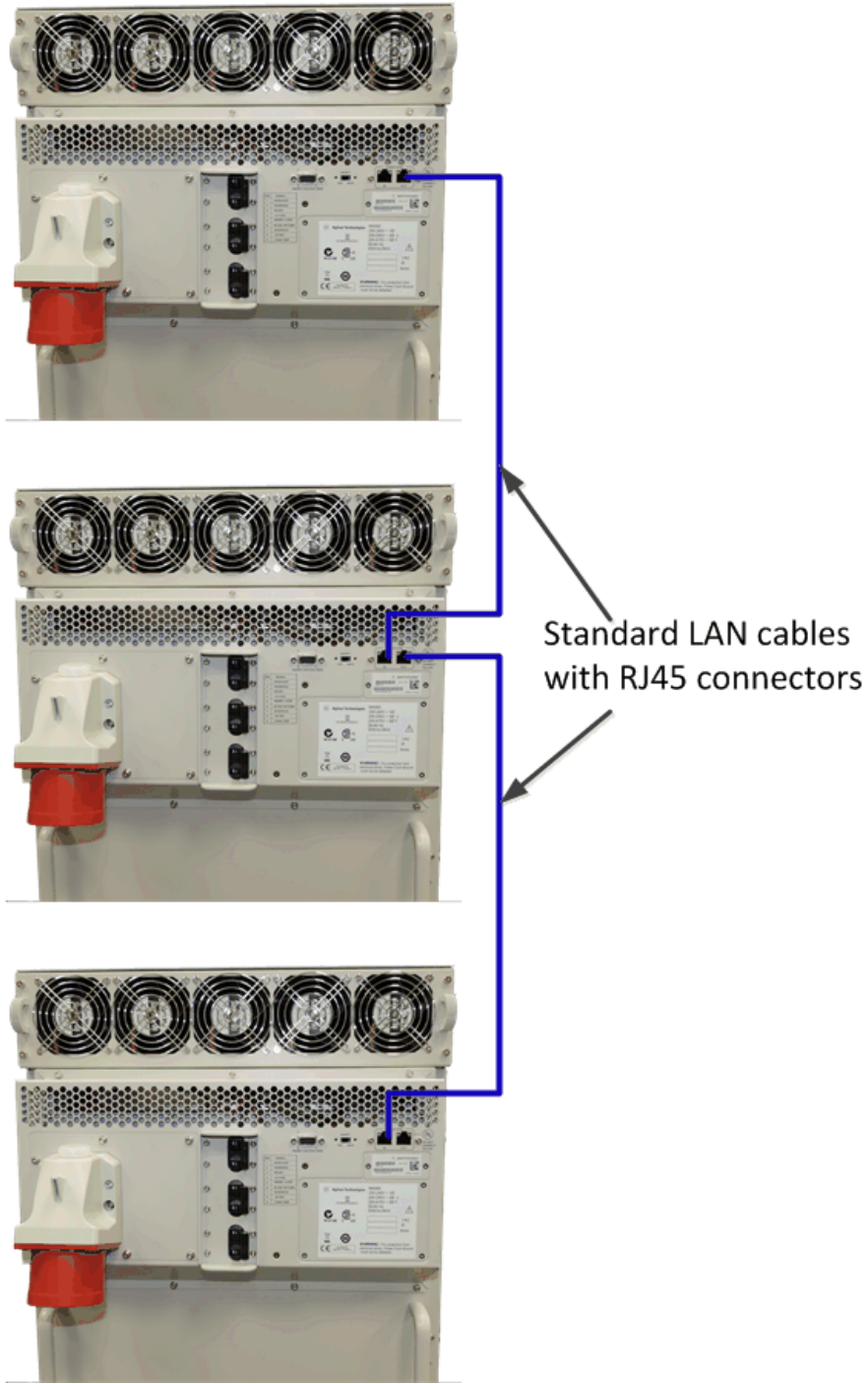
Figure 14   Remote Power Cabling

7
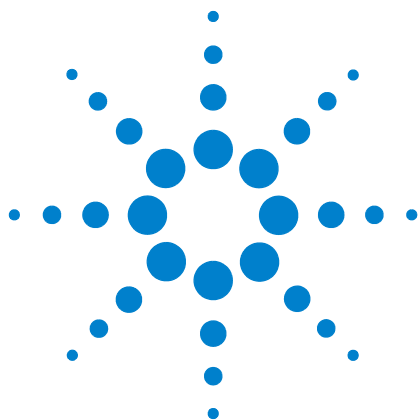
For Module Developers

This chapter provides a detailed look at the AXIe chassis backplane and connectors, provided as a quick reference for AXIe module developers. AXIe (ATCA eXtensions for Instrumentation) is a standard based on the Advanced Telecom Computing Architecture (ATCA or AdvancedTCA). There are three kinds of modules that can be used in an AXIe chassis:

- A System Module (such as the M9521A)
- An Instrument Hub Module
- An Instrument Module

The focus in this chapter is on AXIe 1.0 compliant instrument modules. Note that AXIe 1.0 states that Zone 3 connectors are not used.

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Module Types

The AXIe chassis provide several options for high speed, low voltage differential (LVDS signaling. Whether you can develop individual instrument modules or modular instrumentation sets, communication between modules may travel across the backplane.

Depending on your application, you have the flexibility create a variety of module types.

- **Instrument Module:** An instrument module can go in any slot and will typically use the AXIe trigger bus resources. It will not typically use the local bus unless it is part of an instrumentation set.

- **Instrumentation Sets:** AXIe provides the opportunity for you to create scalable, modular measurement and test systems which can occupy two or more chassis slots.

  - If you create a two-module instrumentation set intended to occupy adjacent slots, you can use up to 62 LVDS backplane local bus lines. This set could be designed to function in any two adjacent slots of the chassis. Refer to "Chassis Backplane LVDS Local Bus" on page 92 and "Electronic Keying (E-Keying)" on page 92.

  - You can also create instrumentation sets with up to five AXIe modules, and may implement backplane features and specify module placement as required.

ATCA and AXIe Requirements

Overview

The Agilent AXIe (ATCA eXtensions for Instrumentation) chassis backplanes used in the M9514A comply with the AXIe 1.0 Base Architecture Specification. This specification is based on AdvancedTCA (ATCA) architecture, expanded with several *eXtensions*, all of which will remain electrically compatible with standard ATCA modules. These modifications provide timing, triggering, local bus signaling and data transport features.

Agilent provides this chapter as a quick backplane reference for developers of AXIe instrument and instrument hub modules. It gives a brief explanation of how the chassis implements AXIe features, and provides signal connection pin assignments for module backplane connectors.

NOTE	This summary of AXIe requirements is <u>not</u> intended to replace the applicable module design standards, which specify mechanical, electrical, and logical interfaces between module and chassis. AXIe modules must comply with:

AXIe 1.0 Base Architecture Specification, available at http://www.axiestandard.org

AdvancedTCA PICMG 3.0 Specification, available at http://www.picmg.org

Most ATCA modules should be able to work in an AXIe environment. Conversely, developers should design AXIe modules to be compatible in an ATCA environment.

ATCA Requirements and Exceptions for AXIe 1.0

Mechanical   AXIe modules must meet all ATCA mechanical requirements for modules.

Exception: AXIe 1.0 chassis do not accommodate rear transition modules (RTM).

Hardware Platform (shelf) Management   AXIe modules must incorporate the ATCA hardware platform management features.

Exceptions:
- AXIe uses an intelligent platform bus (IPMB) for platform management communication between the intelligent FRUs (for example: shelf manager, module IPMC) in a chassis. This IPMB conforms to the ATCA requirements for IPMB-0, but with no IPMB redundancy.
- AXIe modules are not required to support the complete hot swap capabilities of ATCA. However, the module's FRUs are required to support all of the operational states required for ATCA front boards.

- AXIe modules are not required to have the handle switches that sense the module's insertion and impending removal from the chassis nor the blue hot-swap LEDs.

- AXIe modules do not implement ATCA electronic keying, metallic test bus, and ringing bus.

Power Distribution   Dual power supplies are connected in parallel to provide power to each slot. AXIe Modules must be able to operate over a range from –53 VDC to –45 VDC.

Data Transport   AXIe modules must comply with all ATCA requirements for Zone 2 base and fabric interfaces. Data transport is done through the Zone 2 connectors. All lines are differential pairs routed with 100Ω characteristic impedance on the backplane. Base channel interface communicates using the LAN protocol while the fabric interface runs on PCI Express (PCIe) or on proprietary serial protocols.

From the AXIe 1.0 specifications, here is a checklist of all the Zone 2 connections:

- 4 signal pairs for the base interface

- 16 signal pairs for the fabric interface in 2 channels of 8 pairs each

- 18, 42, or 62 local bus pairs

- 12 signal pairs for the AXIe Trigger bus

- 4 signal pairs for the timing interface (FCLK, CLK100, SYNC, and STRIG)

Exceptions:

- AXIe modules only implement a single base interface channel (LAN channel 1).

- AXIe modules may connect to data fabric channel 1 or channel 2, or both.

- Data fabric channel 1, if used by the AXIe module, must implement a PCIe connection, operated from the supplied 100MHz reference clock (FCLK).

- Data fabric channel 2, if used by the AXIe module, may implement proprietary protocols.

- AXIe modules may connect to any of the CLK100, SYNC or STRIG signal pairs, any of the 12 AXIe TRIG pairs, and any number of available pairs on either or both local bus ports.

Synchronization Clock   AXIe backplanes maintain the bused topology of most Synchronization Clock signals, and devices implement the same MLVDS signaling levels as ATCA. The following table provides a brief description of the timing interface signals:

Clock Signal	Description
FCLK	100 MHz PCIe Reference Clock
CLK100	Functions as the chassis clock. Slot-to-slot skew must be less than 100 ps.
SYNC	Trigger/clock synchronization signal. Slot-to-slot skew must be less than 100 ps.
STRIG	Direct connection for triggering between the system slot and instrument slots. LEss than 20 ps skew is allowed.

Exceptions:

• AXIe architecture expands the use of the ATCA Synchronization Clock Interface. The signals and connector pin assignments for AXIe modules differ from ATCA.

No Update Channel Interface

Exception:

• The AXIe architecture does not implement the ATCA Update Channel Interface. AXIe backplanes implement a single bused MLVDS topology for the signals connecting to those Zone 2 connector contacts, and devices implement different signaling schemes as defined in the AXIe specification. AXIe modules must implement electronic keying appropriate to prevent incompatible connections between AXIe and ATCA devices installed in either system environment.

AXIe Extensions to AdvancedTCA

AXIe expands the ATCA specification with several *eXtensions*, Zone 2 customizations which include:

- The AXIe *timing interface*, providing for specific clock distribution and signaling between the ASM and instrument slots 1 through 5. This interface includes timing resources SYNC, CLK100, and STRIG. See "The Crosspoint Switch" on page 105 for a complete functional description of these timing resources.

- A 12 pair MLVDS *trigger bus*, TRIG[0,11], bused across all slots (the ASM slot and instrument slots 1 through 5). See "The Crosspoint Switch" on page 105.

- A 62 pair *local bus* for signaling between adjacent instrument slots. See "Chassis Backplane LVDS Local Bus" on page 92.

- The *data transport fabric*, a dual star x4 PCIe gen2 interface:

  - Channel 1 connects the ASM slot in a star configuration to provide an x4 link to each instrument slot

  - Uses a distributed PCIe fabric reference clock (FCLK) driven from the ASM

  See "Chassis Backplane LVDS Local Bus" on page 92.

- AXIe chassis implement an extended set of electronic keying records to assure consistent use of AXIe-defined backplane fabrics and resources.

In the AXIe chassis, the ASM acts as logical slot 1 for base fabric signaling (LAN) and channel 1 data fabric signaling (PCIe) signaling in addition to shelf management.

Chassis Backplane Connections

The photo below reveals a small portion of the M9514A backplane, with modules removed from all slots. The backplane provides connectors P20, P21, P23, P24, and J10. P22 is only installed on slot 7 for the ASM.

A typical module connector layout is illustrated below the backplane photo, with the mating connectors J20 through J24 and P10.
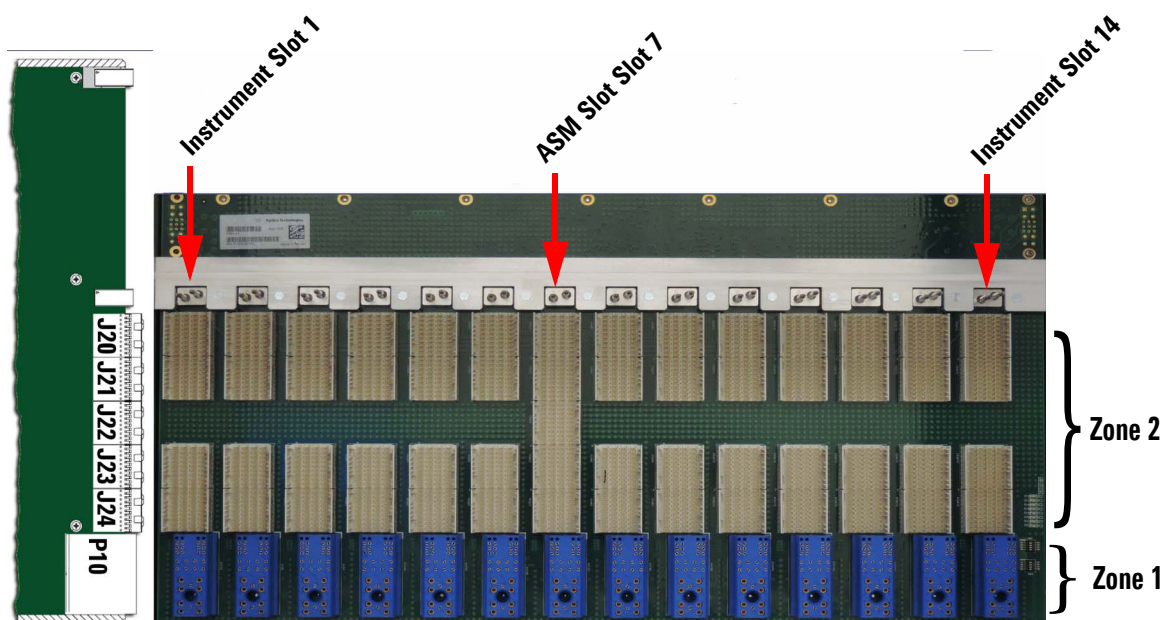
Module may implement all or none of J20-J24. P10 is required to power the module.

Zone 1 Connector Layout

The blue jack at far right in each slot is J10, the AXIe Zone 1 backplane connector. Through J10, the chassis distributes power feeds and provides shelf management. AXIe modules should be capable of operating normally from either feed, over a range from –53 VDC to –45 VDC. Your module must provide mating connector P10.

The photo below shows slot 1 from normal chassis orientation. The pin layout for J10 (all slots) is illustrated below the photo.

Zone 1 Backplane Connector J10

Hardware
Management

Unused
Contacts
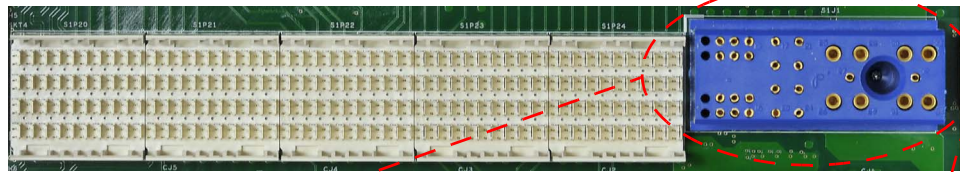
Power Supplies
and mating contacts
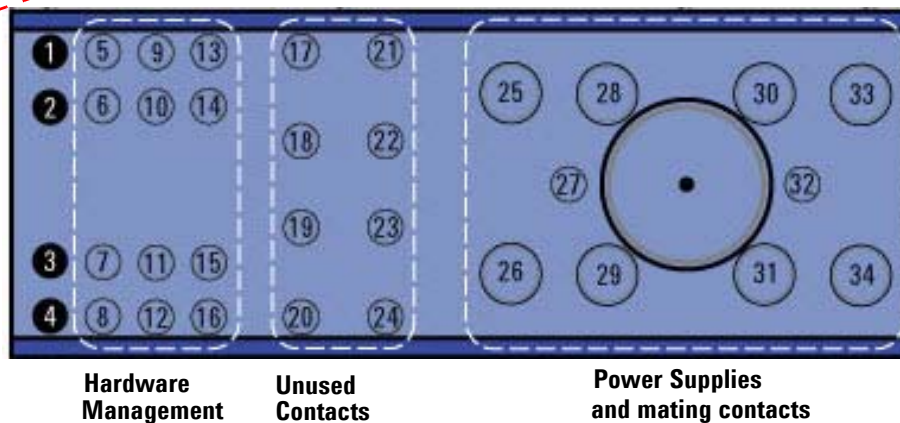
Zone 1 Connector Usage

Zone 1 provides these connections to each module slot:

• Dual redundant –48 VDC power supplies, per the ATCA specification.

• Hardware management circuits. including the Intelligent Platform Management Bus (IPMB) and Hardware Addressing (HA), per the ATCA specification.

• Metallic test and ringing generator buses are *not* provided in AXIe 1.0. Connector J10 will physically accommodate P10 pins 17-24 from a legacy ATCA module, but with no functionality.

Complete circuit definitions and design specifications can be found in the ATCA 3.0 base specification. Pin assignments are listed on the following page.

Zone 1 Pin Assignments

The Zone 1 pin assignments and circuit definitions for backplane connector J10 and module connector P10 are listed below:

Power Circuit Contacts for J10/P10

Contact Number	ATCA Designation	Description
25	SHELF_GND	Connection to Shelf Ground and safety ground
26	LOGIC_GND	Ground reference and return for Front Board-to-Front Board logic signals
27	ENABLE_B	Short pin for power sequencing, Feed B, tied to VRTN_B on backplanes
28	VRTN_A	–48 v return, Feed A
29	VRTN_A	–48 v return, Feed B
30	EARLY_A	–48 v input, Feed A pre-charge
31	EARLY_B	–48 v input, Feed B pre-charge
32	ENABLE_A	Short pin for power sequencing, Feed A, tied to VRTN_A on backplanes
33	–48V_A	–48 v input, Feed A, uses ENABLE_A to enable converters
34	–48V_B	–48 v input, Feed B, uses ENABLE_B to enable converters

Legacy ATCA Test Circuit Pins for J10/P10

Contact Number	ATCA Designation	Description
17	MT1_TIP	
18	MT2_TIP	
19	–RING_A	These backplane J10 contacts will physically accept pins from ATCA modules, but do not provide ATCA metallic test and ringing generator bus circuits.
20	–RING_B	
21	MT1_RING	
22	MT2_RING	
23	RRTN_A	
24	RRTN_B	

Hardware Management Circuit Contacts for J10/P10

Contact Number	ATCA Designation	Description
1-4		*Reserved, do not connect*
5	HA0	Hardware address bit 0
6	HA1	Hardware address bit 1
7	HA2	Hardware address bit 2
8	HA3	Hardware address bit 3
9	HA4	Hardware address bit 4
10	HA5	Hardware address bit 5
11	HA6	Hardware address bit 6
12	HA7/P	Hardware address bit 7 (odd parity bit)
13	SCL_A	IPMB clock, Port A
14	SDA_A	IPMB data, Port A
15	SCL_B	IPMB clock, Port B
16	SDA_B	IPMB data, Port B

Zone 2 Connector Layout

The Zone 2 connectors provide pins for up to 200 differential signaling pairs per slot (40 pairs per connector), although most slots and many modules will not feature all these connectors.

Zone 2 provides the signal connections for the data transport fabric and AXIe extensions, using P20 through P24; the white plugs in each instrument slot.

Each Zone 2 plug provides 40 differential signal contact pairs with ground in 10 columns, four pairs to a column. The pin layout for P20 (typical for all Zone 2 connectors) is illustrated below the slot photo.
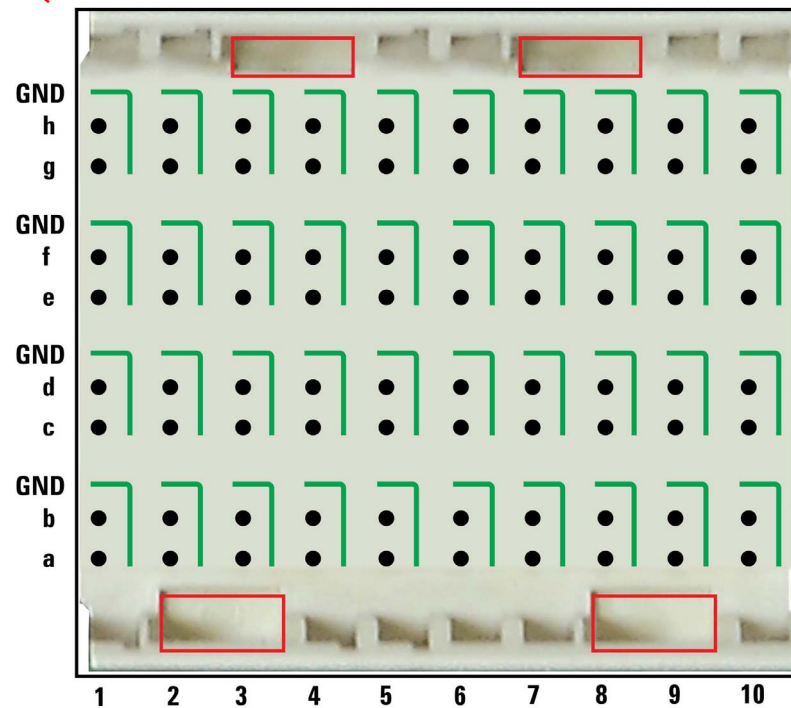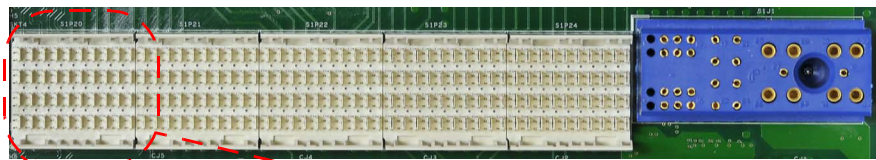
These plugs use male contacts; the mating module connectors J20 through J24 use female contacts. Note the areas shown with red boxes; these are for alignment/keying.

Zone 2 Connector Usage

Your module may implement any or none of the Zone 2 connectors. If you want:

- to use the AXIe trigger, timing, data, and local bus (22 pair) features in your module, load connectors J20 and J23.
- to expand the local bus up to 62 pair, load connectors J24 and J21.

The table below provides a locational map linking each AXIe Zone 2 interface type (function) with its backplane connectors

Interface Type	Interface	Number of Signal Pairs	Chassis Backplane Connector
Trigger Bus	TRIG[0,11]	12	P20
Timing Bus	STRIG, SYNC, CLK100 and FCLK	4	P20
Local Bus	pairs 0 through 7	8	P20
	pairs 8 through 17	10	P23
	pairs 18 through 37	20	P24
	pairs 38 through 41	4	P20
	pairs 42 through 61	20	P21
Base Channel		4	P23
Fabric Channel 1 (PCIe x4)	from ASM star hub	8	P23

Complete circuit definitions and design specifications can be found in the ATCA and AXIe specifications. Pin assignments are listed on the following page.

Zone 2 Pin Assignments

The Zone 2 pin assignments and circuit definitions for connector pairs P20/J20 through P24/J24 are listed below. For the local bus assignments:

- Pin designations beginning with LBL connect to the adjacent lower slot
- Pin designations beginning with LBR connect to the adjacent upper slot

P20/J20

Row	Interface	Instrument Slot 1-5 (Logical Slot 2-6)							
		ab		cd		ef		gh	
1	Trigger	TRIG[0]+	TRIG[0]–	TRIG[1]+	TRIG[1]–	TRIG[2]+	TRIG[2]–	TRIG[3]+	TRIG[3]–
2	Trigger	TRIG[4]+	TRIG[4]–	TRIG[5]+	TRIG[5]–	TRIG[6]+	TRIG[6]–	FCLK+	FCLK–
3	Trigger	TRIG[7]+	TRIG[7]–	TRIG[8]+	TRIG[8]–	TRIG[9]+	TRIG[9]–	TRIG[0]+	TRIG[0]–
4	Timing	TRIG[11]+	TRIG[11]–	STRIG+	STRIG–	SYNC100+	SYNC100–	CLK100+	CLK100–
5		LBL[0]+	LBL[0]–	LBL[1]+	LBL[1]–	LBR[0]+	LBR[0]–	LBR[1]+	LBR[1]–
6		LBL[2]+	LBL[2]–	LBL[3]+	LBL[3]–	LBR[2]+	LBR[2]–	LBR[3]+	LBR[3]–
7	Local Bus	LBL[4]+	LBL[4]–	LBL[5]+	LBL[5]–	LBR[4]+	LBR[4]–	LBR[5]+	LBR[5]–
8		LBL[6]+	LBL[6–	LBL[7]+	LBL[7]–	LBR[6]+	LBR[6–	LBR[7]+	LBR[7]–
9	Fabric	TX2[13]+	TX2[13]–	RX2[13]+	RX2[13]–	TX3[13]+	TX3[13]–	RX3[13]+	RX3[13]–
10	Channel 13	TX0[13]+	TX0[13]–	RX0[13]+	RX0[13]–	TX1[13]+	TX1[13]–	RX1[13]+	RX1[13]–

P21/J21

Row	Interface	Instrument Slot 1-5 (Logical Slot 2-6)							
		ab		cd		ef		gh	
1		LBL[42]+	LBL[42]–	LBL[43]+	LBL[43]–	LBR[42]+	LBR[42]–	LBR[43]+	LBR[43]–
2		LBL[44]+	LBL[44]–	LBL[45]+	LBL[45]–	LBR[44]+	LBR[44]–	LBR[45]+	LBR[45]–
3		LBL[46]+	LBL[46]–	LBL[47]+	LBL[47]–	LBR[46]+	LBR[46]–	LBR[47]+	LBR[47]–
4	Add for	LBL[48]+	LBL[48]–	LBL[49]+	LBL[49]–	LBR[48]+	LBR[48]–	LBR[49]+	LBR[49]–
5	62-Pair	LBL[50]+	LBL[50]–	LBL[51]+	LBL[51]–	LBR[50]+	LBR[50]–	LBR[51]+	LBR[51]–
6	Local Bus	LBL[52]+	LBL[52]–	LBL[53]+	LBL[53]–	LBR[52]+	LBR[52]–	LBR[53]+	LBR[53]–
7		LBL[54]+	LBL[54]–	LBL[55]+	LBL[55]–	LBR[54]+	LBR[54]–	LBR[55]+	LBR[55]–
8		LBL[56]+	LBL[56]–	LBL[57]+	LBL[57]–	LBR[56]+	LBR[56]–	LBR[57]+	LBR[57]–
9		LBL[58]+	LBL[58]–	LBL[59]+	LBL[59]–	LBR[58]+	LBR[58]–	LBR[59]+	LBR[59]–
10		LBL[60]+	LBL[60]–	LBL[61]+	LBL[61]–	LBR[60]+	LBR[60]–	LBR[61]+	LBR[61]–

P22 /J22 (Used only on the ASM Slot 7)

Row	Interface	ONLY in the ASM slot (Slot 7)							
		ab		cd		ef		gh	
1		NC	NC	NC	NC	NC	NC	NC	NC
2		NC	NC	NC	NC	NC	NC	NC	NC
3		NC	NC	NC	NC	NC	NC	NC	NC
4		NC	NC	NC	NC	NC	NC	NC	NC
5	Fabric Ch 2	TX2[5]+	TX2[5]–	RX2[5]+	RX2[5]–	TX3[5]+	TX3[5]–	RX3[5]+	RX3[5]–
6	*Hub to Slot 3*	TX0[5]+	TX0[5]–	RX0[5]+	RX0[5]–	TX1[5]+	TX1[5]–	RX1[5]+	RX1[5]–
7	Fabric Ch 2	TX2[4]+	TX2[4]–	RX2[4]+	RX2[4]–	TX3[4]+	TX3[4]–	RX3[4]+	RX3[4]–
8	*Hub to Slot 4*	TX0[4]+	TX2[4]–	RX0[4]+	RX0[4]–	TX1[4]+	TX1[4]–	RX1[4]+	RX1[4]–
9	Fabric Ch 2	TX2[3]+	TX2[3]–	RX2[3]+	RX2[3]–	TX3[3]+	TX3[3]–	RX3[3]+	RX3[3]–
10	*Hub to Slot 5*	TX0[3]+	TX0[3]–	RX0[3]+	RX0[3]–	TX1[3]+	TX1[3]–	RX1[3]+	RX1[3]–

P23/J23

Row	Interface	Instrument Slot 1-5 (Logical Slot 2-6)							
		ab		cd		ef		gh	
1	Fabric	TX2[2]+	TX2[2]–	RX2[2]+	RX2[2]–	TX3[2]+	TX3[2]–	RX3[2]+	RX3[2]–
2	Channel 2	TX0[2]+	TX0[2]–	RX0[2]+	RX0[2]–	TX1[2]+	TX1[2]–	RX1[2]+	RX1[2]–
3	Fabric	TX2[1]+	TX2[1]–	RX2[1]+	RX2[1]–	TX3[1]+	TX3[1]–	RX3[1]+	RX3[1]–
4	Channel 1	TX0[1]+	TX0[1]–	RX0[1]+	RX0[1]–	TX1[1]+	TX1[1]–	RX1[1]+	RX1[1]–
5	Base Channel 1	BI_DA1+ (Tx1+)	BI_DA1– (Tx1–)	BI_DB1+ (Rx1+)	BI_DB1– (Rx1–)	BI_DC1+	BI_DC1–	BI_DD1+	BI_DD1–
6		LBL[8]+	LBL[8]–	LBL[9]+	LBL[9]–	LBR[8]+	LBR[8]–	LBR[9]+	LBR[9]–
7		LBL[10]+	LBL[10]–	LBL[11]+	LBL[11]–	LBR[10]+	LBR[10]–	LBR[11]+	LBR[11]–
8	Local Bus	LBL[12]+	LBL[12–	LBL[13]+	LBL[13]–	LBR[12]+	LBR[12–	LBR[13]+	LBR[13]–
9		LBL[14]+	LBL[14]–	LBL[15]+	LBL[15]–	LBR[14]+	LBR[14]–	LBR[15]+	LBR[15]–
10		LBL[16]+	LBL[16]–	LBL[17]+	LBL[17]–	LBR[16]+	LBR[16]–	LBR[17]+	LBR[17]–

P24/J24

Row	Interface	Instrument Slot 1-5 (Logical Slot 2-6)							
		ab		cd		ef		gh	
1		LBL[18]+	LBL[18]–	LBL[19]+	LBL[19]–	LBR[18]+	LBR[18]–	LBR[19]+	LBR[19]–
2		LBL[20]+	LBL[20]–	LBL[21]+	LBL[21]–	LBR[20]+	LBR[20]–	LBR[21]+	LBR[21]–
3		LBL[22]+	LBL[22]–	LBL[23]+	LBL[23]–	LBR[22]+	LBR[22]–	LBR[23]+	LBR[23]–
4	Add for	LBL[24]+	LBL[24]–	LBL[25]+	LBL[25]–	LBR[24]+	LBR[24]–	LBR[25]+	LBR[25]–
5	42-Pair	LBL[26]+	LBL[26]–	LBL[27]+	LBL[27]–	LBR[26]+	LBR[26]–	LBR[27]+	LBR[27]–
6	Local Bus	LBL[28]+	LBL[28]–	LBL[29]+	LBL[29]–	LBR[28]+	LBR[28]–	LBR[29]+	LBR[29]–
7		LBL[30]+	LBL[30]–	LBL[31]+	LBL[31]–	LBR[30]+	LBR[30]–	LBR[31]+	LBR[31]–
8		LBL[32]+	LBL[32]–	LBL[33]+	LBL[33]–	LBR[32]+	LBR[32]–	LBR[33]+	LBR[33]–
9		LBL[34]+	LBL[34]–	LBL[35]+	LBL[35]–	LBR[34]+	LBR[34]–	LBR[35]+	LBR[35]–
10		LBL[36]+	LBL[36]–	LBL[37]+	LBL[37]–	LBR[36]+	LBR[36]–	LBR[37]+	LBR[37]–
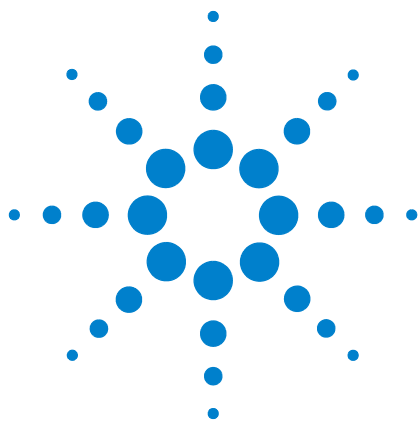
Glossary

Many of the terms in this manual and glossary are AXIe, ATCA or PICMG specific. Refer to the relevant specifications for more detail on these terms.

aDB-6100AX   Apple Desktop Bus (ADB) is an obsolete bit-serial computer bus for connecting low-speed devices (mouse, keyboard, etc.) to a computer.

ASM   AXIe System Module - the Agilent M9521A.

ATCA   Advanced Telecommunication Computing Architecture (also known as AdvancedTCA) is a PCI Industrial Computing Manufacturers Group (PICMG) specification. See AXIe below.

AXIe   AdvancedTCA eXtensions for Instrumentation is a platform for general purpose modular instrumentation. It is an open industry standard aimed at test equipment and instrumentation. It builds on the experience of VXIbus, PXI and LXI technologies.

Base Channel   Supports a 10/100/1000 Base-T LAN port on the backplane of the AXIe shelf. It is a dual star architecture.

BMC   Baseboard Management Controller

BMR-H8S   Board Management Reference design for AdvancedTCA

ESD   Electrostatic Discharge. See "ESD Precautions" on page 27

Fabric Channel   The Fabric interface runs on PCIe (or other proprietary serial protocols). It is intended to be the main data transport in the AXIe shelf manager.

FRU   Field Replaceable Unit. A unit (such as a module, fan tray, or power supply) that the user can replace in the field. Many FRUs are not hot swappable.

GbE   Gigabit Ethernet. Ethernet at a rate of 1 gigabit per second.

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GUID   globally unique identifier is a unique identifier number used in computer software.The term GUID also is used for Microsoft's implementation of the Universally Unique IDentifier (UUID). The value of a GUID is represented as a 32-character hexadecimal string, and is usually stored as a 128-bit integer

HPM   Hardware Platform Management. PICMG specification that defines an open mechanism to upgrade the resident management software and firmware.

IPMB   Intelligent Platform Management Bus. Based on the I^{2}C (also known as Inter IC, IIC or I2C) bus, the IPMB interface provide communication between components on a PC chassis; it is an internal chassis bus that also connects to the external chassis through a bridge chip.

IPMC   Intelligent Platform Management Controller. This is the controller that manages the modules and uses the IPMI over IPMB channels.

IPMI   Intelligent Platform Management Interface. It is used to monitor system health and manage the computer system.

KCS   Keyboard Style Controller

LPC   Low Pin count. An interface specification for legacy I/O. Allows legacy I/O of motherboard components, such a Super I/O chip, to migrate from the ISA/X bus to the new LPC interface while retaining software compatibility. It runs at the PCI 33MhZ clock making LPC much faster than the older ISA running with an 8MHz clock.

OEM   Original Equipment Manufacturer.

PCI   Peripheral Component Interface bus. A standard for connecting hardware in a computer.

PCI-E   PCI Express. Peripheral Component Interface Express (or PCIe) A standard to replace PCI.

PEC   Power Entry Control Module (same as PEM). Hardware module that controls the chassis power supplies.

PEM   Power Entry Module (same as PEC). Hardware module that controls the chassis power supplies.

PICMG   PCI Industrial Computer Manufacturers Group. PICMG is a consortium of hundreds of companies that develop open specifications for high performance telecommunications and industrial computing applications.

SATA   Serial ATA or Serial Advanced Technology Attachment. A computer bus interface for connecting host adapters to mass storage devices (hard drives, etc.) This standard is also known as EIDE.

SerDes   Serializer/Deserializer. Two blocks used in high speed communications to compensate for limited throughput. They convert data between serial and parallel interfaces.

Super I/O   A class of ICs that combines interfaces for a variety of low-bandwidth devices such as serial ports, keyboard and mouse, temperature and fan speed monitoring, etc.

TPM   Trusted Platform Module. An IC designed by the Trusted Computing Group (TCG) for storing passwords, encryption keys, digital certificates, etc.

UXGA   Abbreviation for **Ultra eXtended Graphics Array** referring to a standard monitor resolution of 1600×1200 pixels.

Glossary

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The Modular Tangram

The four-sided geometric symbol that appears in Agilent modular product literature is called a tangram. The goal of this seven-piece puzzle is to create shapes — from simple to complex. As with a tangram, the possibilities may seem infinite as you begin to create a new test system. With a set of clearly defined elements — architecture, hardware, software — Agilent can help you create the system you need, from simple to complex.

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