High Channel Count Test System Reference Architecture

Building High Channel (2,000+) Sensor-Based Measurement Systems with NI FlexLogger™ Software and NI CompactDAQ

Contents

High Channel Count Test Reference Architecture

This document provides guidance for designing scalable mechanical and sensor-based measurement systems using NI CompactDAQ hardware and FlexLogger application software. NI CompactDAQ systems are renowned for their modularity, flexibility, and precision, making them ideal for a wide range of testing applications. This guide is specifically tailored to help you create scalable system designs for three common types of tests: thermal, shock and vibration, and structural.

- **Thermal Testing**: This involves the thermal characterization of devices such as appliances or heaters. For example, measuring temperature distribution and heat dissipation in an appliance during operation helps in understanding its thermal performance and ensuring safety and efficiency. Examples of applications with higher channel counts include:
  - **Certification tests for heating appliances like ovens and ranges**
  - **Testbeds for smart building research**
  - **Regulatory tests for construction materials**

- **Shock and Vibration Testing**: This area is crucial for evaluating the durability and performance of devices under dynamic conditions. An example use case is testing a device on a vibration table to simulate real-world conditions and assess its resilience to shocks and vibrations. This is essential where components must withstand harsh environments. Application examples include:
  - Modal analysis on large structures like bridges
  - Noise, vibration, and harshness testing

- **Structural Testing**: Structural testing involves measuring the strain and stress on components to ensure their integrity and performance. For instance, monitoring the cylinder strain of a compressor tank during pressurization and depressurization cycles helps in understanding the material behavior and preventing failures. Examples of applications with higher channel counts include:
  - Static fatigue testing on aircraft/spacecraft structures and wind turbine blades
  - Strain analysis on civil structures such as bridges and modern building designs

Use this document to navigate the complexities of large-scale test system design for your specific testing requirements.

Section	Topics
Designing Systems Using the High Channel Count Test Reference Architecture	For users taking test requirements to design a test system: • Hardware and software overview • Guidance for selecting the hardware components for your test needs • Test system design implementation details
Commissioning a System from the Static Structural Test Reference Architecture	For users assembling the test system, wiring the system to the DUT, and installing and configuring the software: • Setting up the hardware • Configuring the software
Using the Static Data Viewer	For analysts: • Accessing the Static Data Viewer • Using the Static Data Viewer to view channel data, configure alarms, and access error reports
Creating a FlexLogger Project from an Excel Spreadsheet	For testbed developers and technicians: • Defining a FlexLogger project in an Excel spreadsheet • Setting up the worksheets in a spreadsheet • Importing a new FlexLogger project from a spreadsheet
Benchmarking a System Built from the High Channel Count Test Reference Architecture	For users interested in High Channel Count Test Reference Architecture system capabilities: System test results benchmarks

Designing Systems Using the High Channel Count Test Reference Architecture

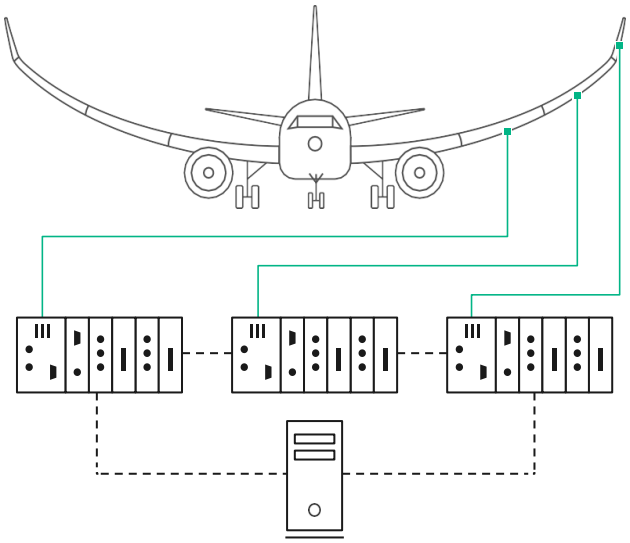
This section provides guidance for designing structural test systems that use NI hardware and the High Channel Count Test Reference Architecture design pattern. Use this to create a system schematic for your specific testing requirements.

High Channel Count Test Reference Architecture Overview

The High Channel Count Test Reference Architecture provides a pattern for designing systems that monitor and log responses from a variety of structures. The reference architecture is designed for short and long-term tests configured with up to 2,000 channels.

The High Channel Count Test Reference Architecture is a customizable modular design that uses the NI Network-based C Series platform. Network-based products enable the deployment of instrumentation over a large area which reduces the amount of sensor cabling that would otherwise be needed.

Figure 1. Example Structural Flex Test of Aircraft Wing



Other examples include:

- Large scale thermal tests for household appliances, materials testing and compliance labs
- Structural tests of wind turbine components including rotor blades and tower
- Research testbeds for modern civil structures including stadiums and bridges

Refer to ***Benchmarking a System Built from the High Channel Count Test Reference Architecture*** for more information about the specific hardware and software components used in the validated test system and performance benchmarks for various tests.

Note Your test requirements may not be easily satisfied by strict adherence to the design pattern described in this document. Deviations from the design pattern and the use of additional instrumentation is expected; however, consider the deviation when performing a trade analysis of your design.

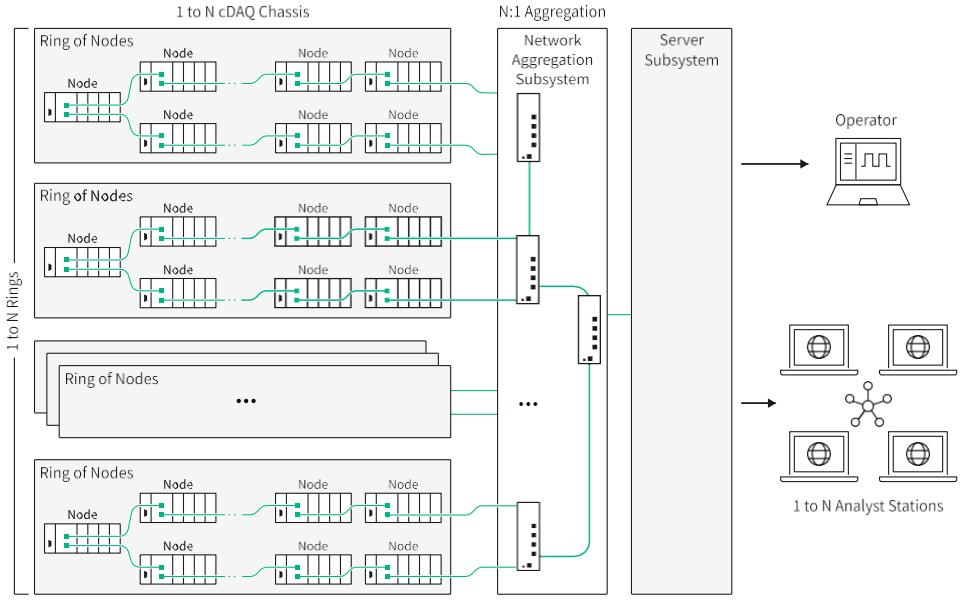
Related concepts:

- Benchmarking a System Built from the High Channel Count Test Reference Architecture

Hardware Overview

The High Channel Count Test Reference Architecture is fundamentally a design pattern that you can use to instantiate a family of high-channel-count test systems, ranging from dozens to thousands of channels.

Figure 3. High Channel Count Test Reference Architecture Hardware Overview



The High Channel Count Test Reference Architecture comprises a combination of NI instrumentation and additional third-party hardware components grouped into a pattern of ***nodes***, ***rings***, and ***subsystems***, further defined in the following sections.

Refer to ***Designing Your System*** for more information about choosing the hardware components for your test system needs.

Node

A ***node*** is a single cDAQ-9189 TSN-enabled Ethernet CompactDAQ chassis configured with up to eight C Series modules. The chassis serves as the foundation for all instrumentation in the test system and the modular design enables you to tailor the distribution and makeup of the channels in the system.

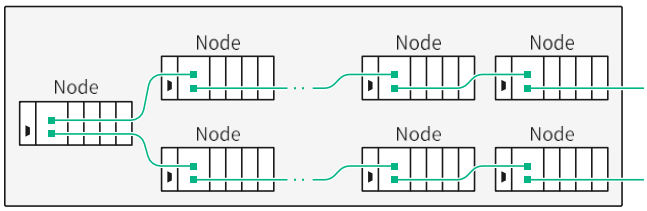
The reference architecture is intended for test systems composed of mostly quarter- bridge strain gauges; however, the design also supports thermocouple and voltage channel types. The reference architecture supports the following C Series modules:

- NI-9235 C Series Strain/Bridge Input Module
- NI-9236 C Series Strain/Bridge Input Module
- NI-9237 C Series Strain/Bridge (full/half/quarter) Input Module
- NI-9213 C Series Temperature Input Module
- NI-9234 C Series IEPE Acceleration/Vibration Input Module
- NI-9215 C Series Voltage Input Module

Ring

A ***ring*** is a network of nodes arranged in a ***ring topology***, as shown in the following figure. A ring topology introduces redundancy into the system design so that any single node or cable failure cannot cripple adjacent instrumentation.

Figure 4. Ring Topology



Note You can scale the design pattern for your test needs by expanding the number of nodes in each ring and number of rings in each test system.

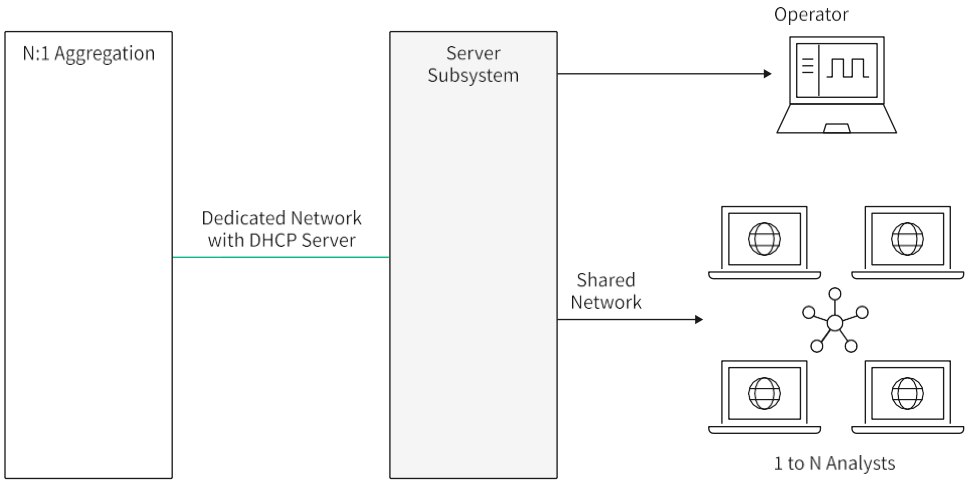
Network Aggregation Subsystem

The ***network aggregation subsystem*** aggregates all ring communication down to a single port using the cRIO-9805 Ethernet Switch Expansion Module for CompactRIO. The network aggregation subsystem can include as many Ethernet switches as are required to aggregate the ring count in your system. The Ethernet switches are arranged in a prescribed pattern depending on the amount of rings in your system design, as described in ***Aggregate Rings***.

Server Subsystem

The ***server subsystem*** has a server computer that receives all the aggregated Ethernet communication across a dedicated network, then sends the test data across a shared network to ***operators*** and ***analysts*** interested in monitoring the tests.

Figure 5. Detail View of Server Subsystem



Note All node IP Addresses must be assigned and managed by a DHCP server.

The server subsystem is responsible for test configuration and control and data logging. Refer to ***Software Overview*** for more information about the software components in the server subsystem.

- **Operator**—Responsible for running and configuring the test on the server computer. The operator primarily interacts with FlexLogger to configure all instrumentation and test parameters and control the test system.
- **Analyst**—Responsible for monitoring active test data and verifying the completeness and success of the test. The analyst primarily interacts with the Static Data Viewer web application on their ***analyst station*** to view relevant channels, configure local alarms, and add comments to the log file.

Related concepts:

- Aggregate Rings
- Software Overview

Related tasks:

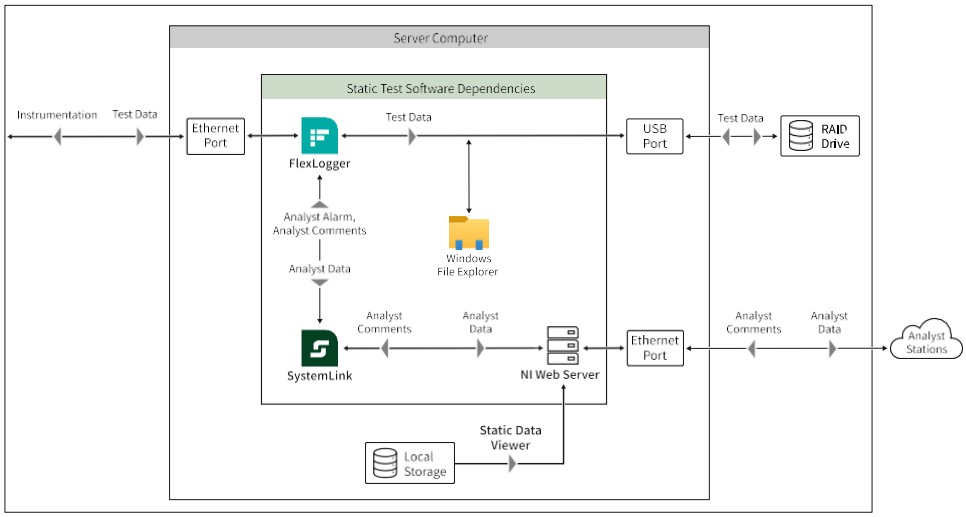
- Designing Your System

Software Overview

The server subsystem hosts the Static Test Software, which is responsible for acquiring, logging, and sending test data to analysts and operators monitoring the test.

The following figure depicts the software architecture of the server subsystem when used with a RAID drive.

Figure 6. Static Test Software Architecture



The High Channel Count Test Reference Architecture uses the following major software components.

- **FlexLogger**—Configures the test and instrumentation, logs data, visualizes channels, and sets events. FlexLogger allows you to import sensor configurations and provides an environment to manage and analyze test data during the test process.
- **Static Data Viewer** —Provides multiple test analysts a concurrent, personalized view into subsets of the test. Analysts can view test system health and live data of selected channels whenever an acquisition is active. The Static Data Viewer is a web-based application that enables numerous analysts to annotate log files and configure and set alarms on specific channels. The Static Data Viewer is accessible by any remote system with a web browser and access to the application.
- **NI Web Server**—Delivers the Static Data Viewer web application to remote analyst stations and responds to HTTP requests from the Static Data Viewer.
- **File Explorer**—Manages the log files created by FlexLogger. Use File Explorer to browse, move, and archive the test data.
- **SystemLink**—Provides communication between FlexLogger and the Static Data Viewer.

Designing Your System

Complete the following steps to implement the High Channel Count Test Reference Architecture design pattern for your specific test needs.

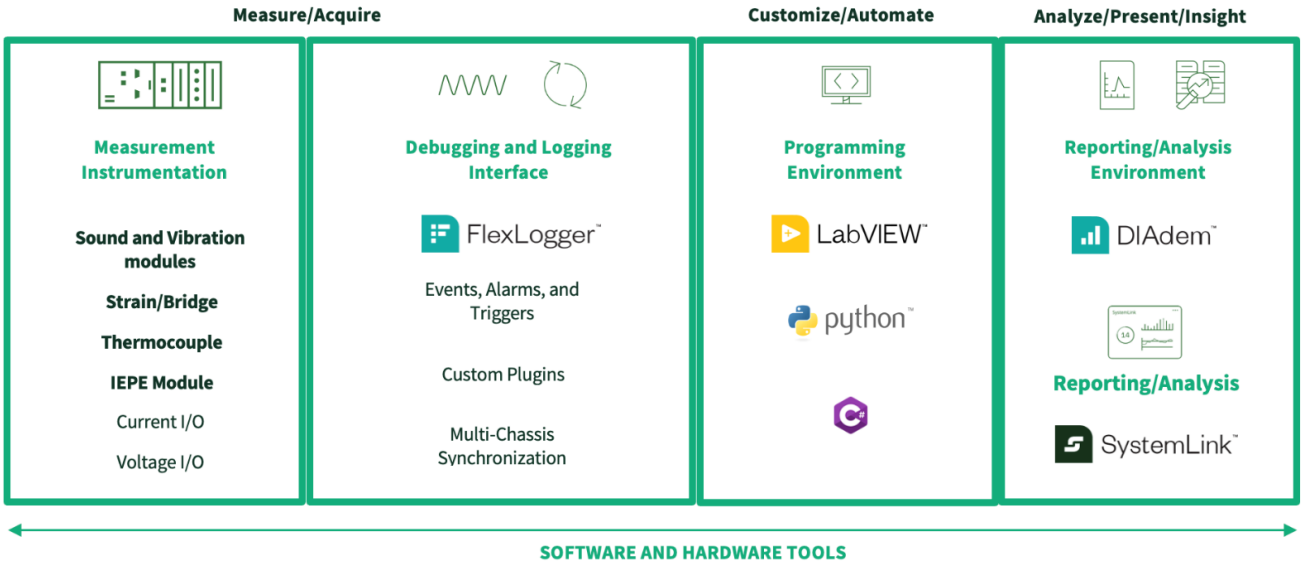
1. Map Your Sensor List to NI Instruments.
2. Group Modules Into Nodes.
3. Group Nodes Into Rings.
4. Aggregate Rings.
5. (Optional) Adjust Ring Sizes.
6. Select Power Supplies.
7. Select Network Cables.
8. Select Power Wiring.
9. Select Sensor Wires.
10. Select the Server Computer.
11. Select Storage Hardware.
12. Select Devices for Analyst Stations.

Customizing your System

A measurement server subsystem hosts the ***Measure/Acquire*** software components, which are responsible for acquiring, logging, and sending test data to analysts and operators monitoring the test. In some cases, custom applications may be hosted on the measurement subsystem to meet application-specific requirements.

The following figure depicts the software architecture components.

Figure 5. Scalable Measurement System Software Architecture



The Scalable Measurement System Architecture uses the following major software components.

- **NI-DAQmx** — Driver software used to communicate with and control NI data acquisition (DAQ) devices. It includes an extensive library of functions and VIs that can be called from application software such as LabVIEW, Python, C#, and others. NI-DAQmx simplifies the configuration of measurement tasks, channels, and timing, and provides tools for data logging, signal conditioning, and device synchronization.

- **NI FlexLogger** — Application software used to configure the test and instrumentation, log data, visualize channels, and set events. FlexLogger allows you to import sensor configurations and provides a basic environment to manage and analyze test data during the test process.

- **NI LabVIEW, Python, C#** — Development environments used to develop custom software components that may be required to address your user's unique workflow preferences.

- **File Explorer** — Software tool that manages the log files created by

FlexLogger. Use File Explorer to browse, move, and archive the test data.

- **NI DIAdem** — Application software that provides analysts with data inspection, visualization, analysis, and reporting tools. DIAdem allows analysts to search, index, manage and analyze test data after the test process.

- **NI SystemLink** — Provides communication between FlexLogger and enterprise test data management, reporting and analysis workflows.

Related concepts:

- Finding Documentation for Software Components

Map Your Sensor List to NI Instruments

Map your sensor list to the supported C Series modules in the following table

Table 1. Supported C Series Modules

Channel Type	Model	Description
Quarter-Bridge Strain	NI-9235	10 kS/s/channel, 120 Ω Quarter-Bridge Strain Gage, 8-Channel C Series Strain/Bridge Input Module
	NI-9236	10 kS/s/channel, 350 Ω, 8-Channel Quarter-Bridge Strain Gage, C Series Strain/Bridge Input Module
	NI-9237	50 kS/s/ch, Full-, Half-, or Quarter-Bridge Strain Gage, C Series Strain/Bridge Input Module
Thermocouple	NI-9213	16-Channel, 75 S/s Aggregate, ±78 mV C Series Temperature Input Module
Voltage	NI-9215	±10 V, 100 kS/s/ch, 16-Bit, Simultaneous Input, 4-Channel C Series Voltage Input Module
Accelerometer or Microphone	NI-9234	51.2 kS/s/ch, IEPE, ±5 V, C Series Sound and Vibration Input Module

Group Modules Into Nodes

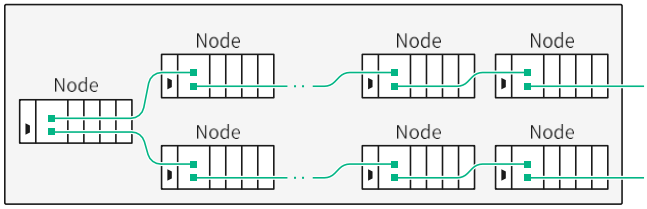
Group your C Series modules into nodes.

1. Arrange C Series modules into groups of up to eight and position them around the structure by optimizing total module count with the benefits of module proximity to the structure.
2. Assign each group of C Series modules to one cDAQ-9189 TSN-enabled Ethernet CompactDAQ chassis to complete a single node.

Group Nodes Into Rings

Arrange your nodes into rings, as shown in the following figure.

Figure 7. Ring Topology



Note The allowable distance between each node is equal to the maximum length of a CAT-5 cable (100 m).

The maximum number of nodes per ring is dependent on the amount of cRIO-9805 Ethernet switches needed to aggregate the system. The maximum ring sizes are also based on the total number of nodes in the system. Design your rings within the limits in the following table.

Total Nodes	Maximum Nodes
1 through 15	15
16 through 18	9
18 through 42	7

Note The maximum amount of nodes per ring reduces as total nodes in the system increase to account for the allowable amount of network hops in the TSN network. Refer to ***(Optional) Adjust Ring Sizes*** for more information.

Related concepts:

- (Optional) Adjust Ring Sizes

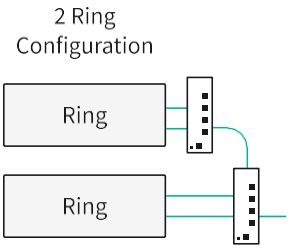
Aggregate Rings

Aggregate the list of rings to a single port.

The cRIO-9805 Ethernet switch can aggregate communication on up to three out of its four Ethernet ports. When arranging the cRIO-9805 switches, the two ports coming off of a ring must be connected to the same switch.

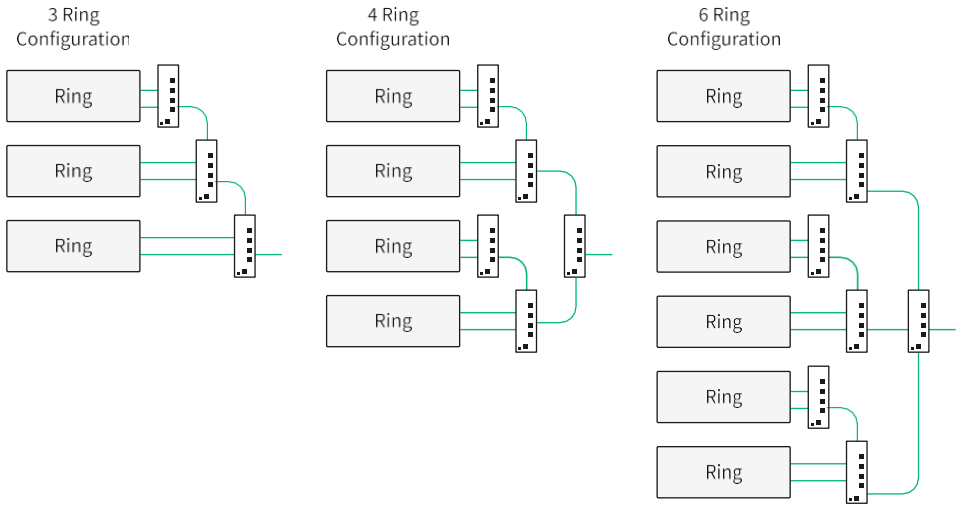
Divide your ring list into pairs and aggregate each pair together according to the pattern in the following figure.

Figure 8. Ring Pair Aggregation



An additional cRIO-9805 can aggregate up to three ring pairs, as shown in the following figure. Use this recursive pattern to group rings until all ring communication aggregates to a single network port.

Figure 9. Aggregation for Additional Ring Configurations

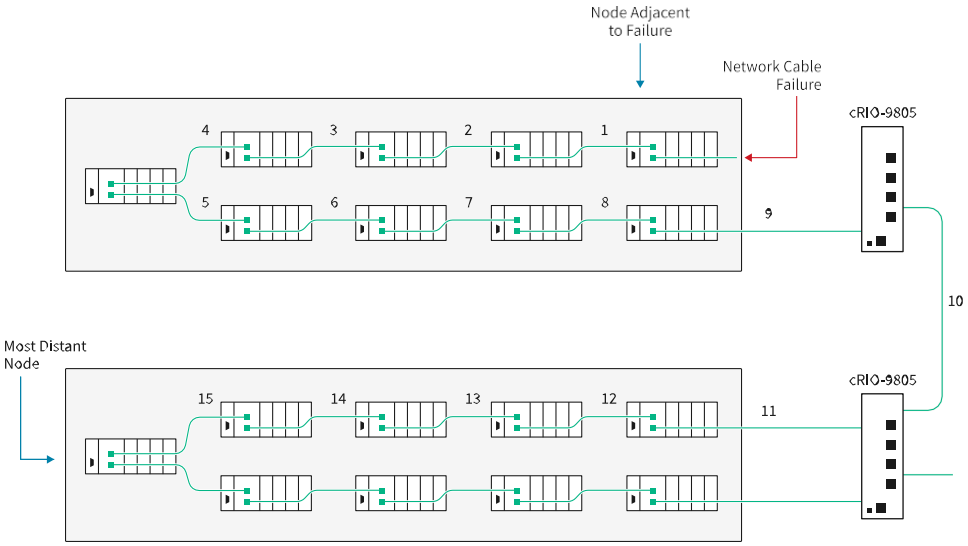


(Optional) Adjust Ring Sizes

You can adjust the ring sizes in your design so long as no two nodes are more than 15 hops apart.

The TSN network can tolerate a maximum number of 15 hops between any two nodes in the network. When a cable or node fails within a ring, the remaining nodes in the ring reconfigure into two line topologies (daisy chains). In a worst case scenario, a ring
of ***N*** nodes could reconfigure into a daisy chain of ***N*** nodes.

Figure 10. Network Hops Between Nodes After Network Cable Failure



Select Power Supplies

Select the power supplies for your nodes and the network aggregation subsystem. Each CompactDAQ chassis and Ethernet switch in your system needs its own DC power connection.

Instead of using the dedicated power supply that ships with these components, you can consolidate AC power conversion into larger power supplies that distribute their DC outputs to multiple components in the system.

Component Power Requirements

Refer to the following table to for the power requirements for the CompactDAQ chassis and Ethernet switch.

Table 2. Power Requirements

Model	Power Requirements
cDAQ-9189	16 W, 9 V to 30 V
cRIO-9805	5 W, 9 V to 30 V

Note The power requirement for the cDAQ-9189 includes maximum 1 W power load per slot across rated temperature. Quarter-bridge strain gauge modules can draw close to 1 W depending on the use case. Refer to documentation for each component to create more sophisticated power budgets.

Power Supply Options

Refer to the following table to determine the best power supply option for your specific system design.

Table 3. Supported Power Supplies

Model	Description
PS-14	24 VDC, 3.3 A, 80 W DIN-Mountable Industrial Power Supply
PS-15	24 VDC to 28 VDC, 5 A, 120 W, DIN-Mountable Industrial Power Supply
PS-16	24 VDC to 28 VDC, 10 A, 240 W, DIN-Mountable Industrial Power Supply

Note For example, a single PS-15 can comfortably power six fully loaded CompactDAQ chassis and one Ethernet switch, and the PS-16 can comfortably power 13 fully loaded CompactDAQ chassis and three Ethernet switches.

Related concepts:

- Finding Documentation for Hardware Components

Select Network Cables

Select the network cables needed for daisy chaining nodes and connecting rings to the Ethernet switches in the network aggregation subsystem.

NI offers the following CAT-5E Ethernet cables in various lengths.

Table 4. NI 8-Pin Male Ethernet to 8-Pin Male Ethernet, CAT-5E Ethernet Cables

NI Part Number	Length
151733-0R3	0.3 m
151733-01	1 m
151733-02	2 m
151733-05	5 m
151733-10	10 m

Select Power Wiring

Select the power wiring for the cDAQ-9189 chassis and Ethernet switches.

NI does not offer off-the-shelf cable assemblies for the CompactDAQ chassis or Ethernet switch. NI recommends using ferrules for stranded wires, and using the following wire gauge as defined in the specifications document for each model.

Table 5. Power Wire Gauges

Model	Wire Gauge
cDAQ-9189	24 AWG to 14 AWG
cRIO-9805	24 AWG to 16 AWG

Select Sensor Wires

Select the sensor wiring for the C Series modules.

NI does not offer off-the-shelf cable assemblies for sensors and recommends the following wire gauges as defined in the specifications document for each model.

Table 6. C Series Module Wire Gauges

Model	Connection	Wire Gauge
NI-9213	Spring Terminal	28 AWG to 18 AWG copper conductor wire
NI-9215	Screw Terminal	16 AWG to 14 AWG copper conductor wire
NI-9215	Spring Terminal	30 AWG to 12 AWG copper conductor wire
NI-9235	Spring Terminal	28 AWG to 18 AWG copper conductor wire
NI-9236	Spring Terminal	28 AWG to 18 AWG copper conductor wire
NI-9237	D-SUB	Build custom cable or use NI 9923 accessory with screw terminal wiring for 26 AWG to 16 AWG copper wire.
NI-9234	BNC	BNC Cables

Select the Server Computer

Select a server computer for the server subsystem that meets the following minimum requirements:

- Intel Xeon E-2286G CPU 4.0 GHz, 6-Core
- 64 GB RAM
- 1 TB SSD
- Gigabit Ethernet adapter (x2) (one dedicated for instrumentation network)
- Windows 10 64-bit
- DHCP server support or an external DHCP-enabled router

Select Storage Hardware

Select the storage hardware to store data logs from your tests.

Consider data throughput and test duration to choose storage hardware that is

appropriately sized for your system needs.

FlexLogger encodes all data into 8 byte data points, so 2,000 channels acquired at 100 S/s produces 1.6 MB/s of data.

Note NI recommends that you set the sample rate in FlexLogger to 100 S/s. When you select a value of other than 100 S/s, FlexLogger selects the minimum sample rate of the module. For example, the NI-9235 sample rate would be set to 793.651 S/s.

Refer to the following table for an example of how to determine the storage size needed for your system requirements.

Table 7. Example of Data Throughput for 2,000 Channels Acquired at 100 S/s

Data Throughput	Redundant Logging
1.6 MB/s	3.2 MB/s
6 GB/hr	12 GB/hr
140 GB/day	280 GB/day
1 TB/week	2 TB/week

Select Devices for Analyst Stations

Select the devices to use for analyst stations.

Consider the following recommendations to ensure the devices are compatible with the Static Data Viewer.

- **Multiple monitors**—The Static Data Viewer can pop-out into multiple browser tabs for a single test; users can configure channels and alarms in one tab while displaying waveforms in another.
- **Browser**—Google Chrome
- **Screen resolution**—1440 × 900 pixels

Commissioning a System from the High Channel Count Test Reference Architecture

The High Channel Count Test Reference Architecture provides a customizable solution for high-channel-count sensor measurement and test applications.

This section contains information that is necessary to set up and operate the components included in the reference architecture, including hardware installation and software configuration procedures.

Before You Begin

Complete the following tasks before you install, configure, or operate the components included in your system.

1. Ensure that you have a system design and schematic prepared per the instructions in ***Designing Systems Using the High Channel Count Test Reference Architecture***.
2. Review the safety and compliance documentation for each component in your system. Refer to ***Finding Documentation for Hardware Components*** for links to relevant documentation for the individual components in your system.

Related concepts:

- Finding Documentation for Hardware Components

Related reference:

- Designing Systems Using the High Channel Count Test Reference Architecture

Assembling System Components

Complete the following steps to assemble and install the hardware components included in your system design.

1. Mount the CompactDAQ chassis, Ethernet switches, and power supply.

Model	Where to Go
cDAQ-9189	***Mounting the cDAQ-9185/9189*** in the ***cDAQ-9185/9189 User Manual***
cRIO-9805	***Mounting the Expansion Module*** in the ***Expansion Module for CompactRIO User Manual***
PS-14	***Mounting Equipment*** and ***Mounting Orientation and Installation*** in the ***NI PS-14 Power Supply User Manual***
PS-15	***Mounting Equipment*** and ***Mounting Orientation and Installation*** in the ***NI PS-15 Power Supply User Manual***
PS-16	***Mounting Equipment*** and ***Mounting Orientation and Installation*** in the ***NI PS-16 Power Supply User Manual***

2. Ground the CompactDAQ chassis and Ethernet switches.

Model	Where to Go
cDAQ-9189	***Installing the cDAQ Chassis*** and ***Chassis Grounding Screw*** in the ***cDAQ-9185/9189 User Manual***
cRIO-9805	***Grounding the Expansion Module for CompactRIO*** in the ***Expansion Module for CompactRIO User Manual***

3. Install the C Series modules in the CompactDAQ chassis.

Model	Where to Go
cDAQ-9189	***Installing the cDAQ Chassis*** in the ***cDAQ-9185/9189 User Manual***

4. Install network cables according to your system design.
5. Install power cabling to all components.

Model	Where to Go
cDAQ-9189	***Wiring External Power to the cDAQ Chassis*** in the ***cDAQ-9185/9189 User Manual***
cRIO-9805	***Connecting the cRIO-9805 to an External Power Supply*** in the ***cRIO-9805 Getting Started***

6. Connect all sensor wiring to the C Series modules.

Model	Where to Go
NI-9213	***Connecting a Thermocouple*** in the ***NI-9213 Getting Started***
NI-9215	***NI-9215 Pinout*** in the ***NI-9215 Getting Started***
NI-9235	***Connecting a Quarter-Bridge Sensor*** in the ***NI-9235 Getting Started***
NI-9236	***Connecting a Quarter-Bridge Sensor*** in the ***NI-9236 Getting Started***

NI-9237	***NI-9237 Getting Started***
NI-9234	***NI-9234 Getting Started***

7. Visually inspect the LED indicators on the instrumentation to verify power.

Model	Where to Go
cDAQ-9189	***Getting Started with the cDAQ Chassis*** in the ***cDAQ-9185/9189 User Manual***
cRIO-9805	***Getting Started with the cRIO-9805***

Model	Where to Go
	the ***cRIO-9805 Getting Started***
PS-14	***DC On LED*** in the ***NI PS-14 Power Supply User Manual***
PS-15	***DC OK LED*** in the ***NI PS-15 Power Supply User Manual***
PS-16	***DC OK LED*** in the ***NI PS-16 Power Supply User Manual***

Related information:

- cDAQ-9189 User Manual
- Expansion Module for CompactRIO User Manual
- NI PS-14 Power Supply User Manual
- NI PS-15 Power Supply User Manual
- NI PS-16 Power Supply User Manual
- cRIO-9805 Getting Started
- NI-9213 Getting Started

- NI-9215 Getting Started
- NI-9235 Getting Started
- NI-9236 Getting Started
- NI-9237 Getting Started
- NI-9234 Getting Started

Installing Software

Refer to the ***Static Test Software Suite Readme*** for more information about installing and activating the software included in the Static Test Software.

1. Download Static Test Software on the server computer from `ni.com/ downloads`.
2. Install Static Test Software on the server computer following the installation prompts.

> **Note** During FlexLogger installation, ensure that **NI-DAQmx cDAQ Firmware** is selected for download in the ***Additional items you may wish to install page***. It is selected by default. Up-to-date cDAQ firmware is required for upgrading each cDAQ chassis in the system.

Related information:

- Static Test Software Suite Readme
- ni.com/downloads

Configuring Software for First Use

Complete the following steps to install and configure the software for first use.

1. Reserving cDAQ-9189 Chassis in MAX.
2. Upgrading cDAQ-9189 Chassis Firmware.
3. Configuring Your FlexLogger Project.

4. Configuring Static Data Viewer.

Reserving cDAQ-9189 Chassis in MAX

Complete the following steps to add cDAQ-9189 chassis to your software configuration.

1. Launch Measurement & Automation Explorer (NI MAX) from the server computer.
2. Right-click **Devices and Interfaces** and select **Find Network NI-DAQmx Devices**.
3. Click **Select All**, then select **Add Selected Devices**.
4. Verify that each C Series module is listed beneath the associated CompactDAQ chassis in your system.
5. To determine successful installation of the chassis, right click the chassis name listed under **Network Devices** and select **Self Test**.
   When the self-test finishes, a message indicates successful verification or if an error occurred.
6. If the chassis was not reserved automatically (indicated in MAX by the chassis icon with an X) after it was added (**Add Device**), you can reserve the chassis in MAX by expanding **Devices and Interfaces** » **Network Devices**, selecting the chassis, and clicking the **Reserve Chassis** button.
   The Override Reservation dialog box appears when you attempt to explicitly reserve a chassis. Agreeing to override the reservation forces the cDAQ chassis to be reserved by the current user.

Upgrading cDAQ-9189 Chassis Firmware

Complete the following steps to upgrade firmware for the cDAQ-9189 chassis in your system. You must upgrade the firmware for each individual chassis in your system.

1. Launch MAX.
2. Expand **Devices and Interfaces** and select your chassis under **Network Devices**.
3. On the System Settings tab, click **Update Firmware**.
   By default, the file dialog window opens to the location of the firmware files installed with the NI-DAQmx driver.
4. Select the firmware version and click **Open**.

Note NI recommends that you select firmware version 20.0 or later.

5. When the Update Firmware window appears, click **Begin Update**.

Configuring Your FlexLogger Project

Visit ***Creating a New Project*** in the ***FlexLogger Manual*** for information about configuring a project.

Tip When configuring your device channels in FlexLogger, you can apply the same configuration from a single channel to multiple channels. Select a single channel row and press <Ctrl-c> or right-click and select **Copy**, then select multiple channel rows and press <Ctrl-v> or right-click and select **Paste**. Alternatively, select all the channels that should share the same configuration, hover over any channel and click the **Configure** gear. Enter a root string in the **Name** field to auto-enumerate the channel name from the root string. Configure the channels and click **Done**.

Related information:

- Creating a New Project in the FlexLogger Manual

Configuring Static Data Viewer

After installing the Static Test Software, you must configure NI Web Server, SystemLink, and the Annotation for Static Data Viewer FlexLogger plugin to add support for the Static Data Viewer.

Complete the tasks in the following sections to configure NI Web Server security and authentication, SystemLink user roles and privileges, and FlexLogger annotation.

Configuring NI Web Server

1. Launch NI Web Server Configuration from the Start menu.

If this is your first time launching NI Web Server Configuration, a guided setup window appears. Click **Custom** to access the configuration options described in the following steps.

2. On the Remote tab, select the following settings:
   a. Under Remote Connections, select **Allow remote connections from any client**.
   b. Under Cross-Origin Resource Sharing (CORS) Settings, select **Disable CORS and block access from external content**.
3. On the HTTPS tab, choose whether to use a certificate from a certification authority, a self-signed certificate, or no certificate. Refer to ***Choosing an HTTPS Setting*** in the ***NI Web Server Manual*** for more information about each setting.

Note The Static Data Viewer has been validated with HTTP, and HTTPS with a self-signed certificate in Google Chrome.

To use HTTPS, you must obtain a certificate. For options on obtaining a certificate, refer to the ***Certificates*** section in the ***Security in NI Web Technology*** document. The certificate must be installed on NI Web Server. For self-signed certificates and some IT-signed certificates, clients must also import the certificate
to their device as part of a browser-specific process for trusting the certificate.

Tip To import a self-signed certificate to a client device using Google Chrome, open the browser settings and navigate to **Manage Certificates**. Import the self-signed certificate to **Trusted Root Certification Authorities**.

4. On the Authentication tab, select the following settings to specify how you want users to connect to the server.
   a. Select **Log in as users controlled by the web server** and set a password to create an admin account that is controlled by the NI Web Server.

> **Note** You can assign administrator privileges to additional accounts in SystemLink. Refer to ***Configuring SystemLink User Roles and Privileges*** for more information.

b. To configure settings for remote client access, refer to ***Choosing an Authentication Setting*** in the ***NI Web Server Manual*** and the ***SystemLink Operations Handbook***.

5. On the Applications tab, expand Static Data Viewer and select **users** next to Allows viewing the resource.
6. Click **Apply and restart** to save changes and restart the PC.
7. After restarting, launch NI Web Server Configuration.
8. On the Control tab, verify that the NI Web Server is running and enabled. If the NI Web Server is not running, select **Enable the web server**, **Start**, and **Apply and restart** on the Control tab.

Related tasks:

- Configuring SystemLink User Roles and Privileges

Related information:

- Choosing an HTTPS Setting in the NI Web Server Manual
- Security in NI Web Technology document
- Choosing an Authentication Setting in the NI Web Server Manual
- SystemLink Operations Handbook

Configuring SystemLink User Roles and Privileges

To use the Static Data Viewer, all users must have required SystemLink privileges. Complete the following steps to register users, define user roles, and assign privileges.

Note Only admins have access to make the following changes in SystemLink.

1. Launch the NI SystemLink Web Application from the Start menu. When logging in for the first time, use the admin credentials that you created in ***Configuring NI Web Server***.

   Tip You can also launch the application from the NI Web Server Configuration application by opening the Summary tab and clicking the **Running Server URI** link. This URL is referred to as the ***SystemLink URL***.

2. Click ⊞ to open the SystemLink navigator.
3. In **Access Control » Roles** tab, create a new role to define an analyst using the Static Data Viewer and specify the minimum required privileges for each feature listed in the following table. Refer to ***Configuring a Role and Privileges*** in the ***SystemLink Manual*** for more information about creating new user roles.

Applications and Services	Privileges
Alarms and Notifications	○ Enable the following Privileges: ▬ Acknowledge alarms ▬ Create tag alarm rules ▬ Delete alarms ▬ Delete tag alarm rules ▬ List and view alarms ▬ View details for strategies, groups, and email templates ▬ Read tag alarm rules ▬ Set and clear alarms ▬ Modify tag alarm rules
Messages	○ Set **Privilege Specificity** to * ○ Enable the following Privileges: ▬ Allow all privileges

Applications and Services	Privileges
Tags	○ Set **Privilege Specificity** to * ○ Enable the following Privileges: ▬ List tags and view tag value, history, properties, and keywords

Note It may take up to five minutes for privilege changes to take effect.

Related tasks:

- Configuring NI Web Server

Related information:

- Configuring a Role and Privileges in the SystemLink Manual

Registering Users in SystemLink

To enable client access to the Static Data Viewer, all clients must log in to SystemLink for the first time to register their user accounts and admins must assign the user accounts to the Default workspace.

Note The admin must send the SystemLink URL, described in ***Configuring SystemLink User Roles and Privileges***, to all clients before completing the following steps.

1. All clients must complete the following steps.
   a. Ensure that the client is either on the same network as the NI Web Server or a VPN.
   b. Open a web browser and enter the SystemLink URL provided by the admin.
   c. On the SystemLink login page, enter your Windows credentials associated with your organization.

   d. Notify the admin after successfully logging in.
2. Admins must complete the following steps.
   a. Launch the SystemLink Web Application.
   b. In **Access Control » Users**, verify that the client accounts appear as expected.
   c. In **Access Control » Workspaces**, assign users and roles to the Default workspace. Static Data Viewer is compatible only with the Default workspace. Assign analyst accounts to the role created in ***Configuring SystemLink User Roles and Privileges***. Refer to ***Assigning Users to Roles in a Workspace*** in the ***SystemLink Manual*** for more information.

> **Note** To assign the admin role to additional accounts, refer to ***Configuring a Role and Privileges*** in the ***SystemLink Manual***.

To verify client access to the Static Data Viewer, log in to SystemLink and click the Static Data Viewer.

> **Tip** Bookmark the SystemLink URL in your web browser for easy access.

Related tasks:

- Configuring SystemLink User Roles and Privileges

Related information:

- Assigning Users to Roles in a Workspace in the SystemLink Manual
- Configuring a Role and Privileges in the SystemLink Manual

Configuring SystemLink Tag Ingestion for High-Channel-Count Applications

1. Navigate to `C:\ProgramData\National Instruments\Skyline\ Config` and open `TagIngestion.json`.

> **Note** `ProgramData` may be a hidden folder on the system. To view hidden folders in Windows Explorer, select the **View** tab and enable **Hidden items** under Show/hide.

2. Add a key value pair `"Throttling.ValuesPerSecond" : 5000`.
3. Save the file.
4. Restart the server computer.

Configuring FlexLogger for Static Data Viewer

Complete the following steps to configure FlexLogger for use with the Static Data Viewer.

1. Open your test project in FlexLogger.
2. On the Channel Specification toolbar, select **Add channels** » **Plugin** and select **Annotation for Static Data Viewer**.
3. Click the **Configure** gear on the top right corner of the plugin header to open the plugin parameters configuration dialog.
4. Set **SystemLink Server URL** to the **Running Server URI** located at **NI Web Server** » **Summary**.
5. Set **SystemLink Username** and **SystemLink Password** to any credentials that have full privileges for SystemLink Messages.
6. Configure the FlexLogger project to publish channel data to SystemLink tags.
   a. In your configured FlexLogger project, go to **Project** » **Settings** and check the **Publish channels as local tags** checkbox.
   b. Restart FlexLogger.

Verifying System Configuration

Complete the steps in the following sections to ensure that all system components are configured correctly and the Static Data Viewer is ready for analyst use.

Before you complete the following steps, launch the following applications:

- Launch FlexLogger and open your configured project.

- Launch the Static Data Viewer from an analyst device and log in using analyst credentials.
- Launch SystemLink and log in as an admin. Open the SystemLink Alarm Utility from **Utilities** » **Alarms**.

Note Keep Static Data Viewer and SystemLink open in separate browser windows or different devices as you complete the verification steps.

Verifying FlexLogger Configuration

Complete the following steps to verify that your instrument is configured in FlexLogger and ready to perform a test.

1. Confirm that all the chassis used in your system appear in the Channel Specification pane.
2. For each channel, open the Channel Configuration pane and ensure the configuration parameters match the latest test plan.
3. In the Channel Specification pane, confirm that live data populates for each module in your system.

> **Note** On large systems, it can take several minutes for the TSN network to self-configure and for modules to begin acquiring data.

4. In the **Channel Specification** ribbon, confirm that the `SYNC` indicator appears green.
5. From the Channel Specification pane, select all the strain channels and perform a shunt calibration.
6. In the Logging Specification tab, ensure that you've entered the logging file path and segment parameter.

Verifying the Strain Gauge Connections

Complete the following steps to verify the connection between a strain gauge and a channel.

1. From the Channel Specification pane in FlexLogger, choose the channel you want to verify.
2. Perform a null offset operation on that channel.
3. Open the Channel Configuration pane for the channel and ensure that the live data reading shows approximately zero.
4. Go to your hardware setup and disconnect the strain gauge from the channel you just nulled.

5. From the Channel Configuration pane in FlexLogger, ensure that the live data reading shows the maximum signal range for the channel.

Verifying SystemLink Tag Functionality

Complete the following steps to validate that channel data from FlexLogger is publishing as SystemLink tags.

1. Log in to the Static Data Viewer with an analyst profile.
2. On the **Home** page, verify that the **Channel List** populates with all the channels in your configured FlexLogger project.
3. Select a handful of channels and verify that the **Data Table** displays the live data for all selected channels from the **Channel List**.

Verifying Alarm Rule Functionality

Complete the following steps to ensure that SystemLink receives the alarm rules created in the Static Data Viewer.

1. Create an alarm rule.

Application	Task
Static Data Viewer	In the **Data Table**, enter a value in the **HI Alarm** or **LO Alarm** field.
SystemLink Alarm Utility	a. Navigate to **Alarm Rules** » **Tags** to verify that an alarm rule tag appears for the channel with the configured alarm. b. Verify that the alarm rule is configured with an **Annotate Log File** notification.

2. Modify an alarm rule.

Application	Task
Static Data Viewer	In the **Data Table**, modify an alarm rule for a channel using any of the alarm rule configuration options in the **Data Table**.

SystemLink Alarm Utility	Navigate to **Alarm Rules** » **Tags** to verify that the changes appear in the alarm rule tag for the channel.

3. View all alarm rules.

Application	Task
Static Data Viewer	On the **Saved Alarm Rules** page, verify that all alarm rules appear.
SystemLink Alarm Utility	Navigate to **Alarm Rules** » **Tags** and ensure all expected alarm rules appear.

Note Each analyst can make their own rule for any given channel. There can be multiple alarm rules per channel if multiple analysts are using Static Data Viewer.

4. Delete alarm rules.

Application	Task
Static Data Viewer	On the **Saved Alarm Rules** page, select a channel from **Alarm Rules** and click **Delete**.
SystemLink Alarm Utility	Navigate to **Alarm Rules** » **Tags** and ensure the alarm rule does not appear.

Verifying Alarm Management Features

1. On the **Home** page of the Static Data Viewer, select a channel and set the **HI Alarm** level to a value that is less than the current live value.
2. Check the **Alarm Enabled** checkbox.
3. Ensure the alarm instance appears in the **Alarms** list.
4. Select the alarm from the **Alarms** list and click **Acknowledge Alarm**. The alarm instance should change from red to yellow once the alarm is acknowledged.
5. Uncheck the **Alarm Enabled** checkbox to disable the alarm.
6. In the **Alarms** list, select the alarm and click **Clear Alarm**. Verify that the alarm no longer appears in the list.

Verifying Saved Preferences

Complete the following steps to ensure that the Static Data Viewer retains saved preferences between analysts sessions.

1. On the **Home** page of the Static Data Viewer, take note of the selected channels and configured alarm settings.
2. Close the Static Data Viewer and reopen it.
3. Verify that all channels and configured alarm settings from the previous session appear as expected.

Verifying Log Annotations

1. In the configured FlexLogger project, click **Run** to start a test.
2. In the Static Data Viewer, write a comment in the **Note** field and click **Add Note to Log**.
3. Force an alarm instance by creating an alarm rule for a specific channel. Set **HI Alarm** to a level below the current live value and check **Alarm Enabled**.
4. In FlexLogger, click **Pause** to pause the test, then click **Resume**.
5. Double-click the log file in FlexLogger to open the file and view the data. Verify that the comment, alarm instance, and the pause and resume events are recorded in the log file.

After validating the Static Data Viewer, notify analysts that the Static Data Viewer is ready for use. Refer to ***Using the Static Data Viewer*** for more information about using the application.

Related reference:

- Using the Static Data Viewer

Using the Static Data Viewer

The Static Data Viewer is a web-based application that provides visual insights to live test data from structural test systems designed using the High Channel Count Test Reference Architecture.

Refer to this section for more information about using the Static Data Viewer, including tips and best practices.

Static Data Viewer Overview

The Static Data Viewer web application is accessible on any remote client that has access to the test system network. The Static Data Viewer provides a personalized view of live test data; log in with your credentials and make configurations that are automatically saved until the next time you log in. The Static Data Viewer is intended for multi-monitor viewing; open multiple browser tabs to view data from the same test.

The Static Data Viewer has the following key features:

- **Filter and Select Channels**—Filter and select the channels to view live data from the test.
- **Annotate Log Files**—Record your observations as notes that are added to the test log file.
- **Configure Alarms**—Configure alarms associated with a specific channel and user account to automatically annotate the log file when an alarm threshold is met.
- **View Live Test Data**—View live test values and visualize the data in customizable graph views.

Accessing the Static Data Viewer

You can access the Static Data Viewer using the SystemLink URL provided by the admin that configured the test system web server.

Tip Bookmark the URL to quickly access the Static Data Viewer.

If you are logging into the Static Data Viewer for the first time, you must complete the following steps to register your user account.

1. Ensure that the client is either on the same network as the test system network or a VPN.
2. Open a web browser and enter the SystemLink URL provided by the admin.

Note NI recommends using Google Chrome to open the Static Data Viewer. Browser plugins may interfere with browser performance when running the Static Data Viewer product.

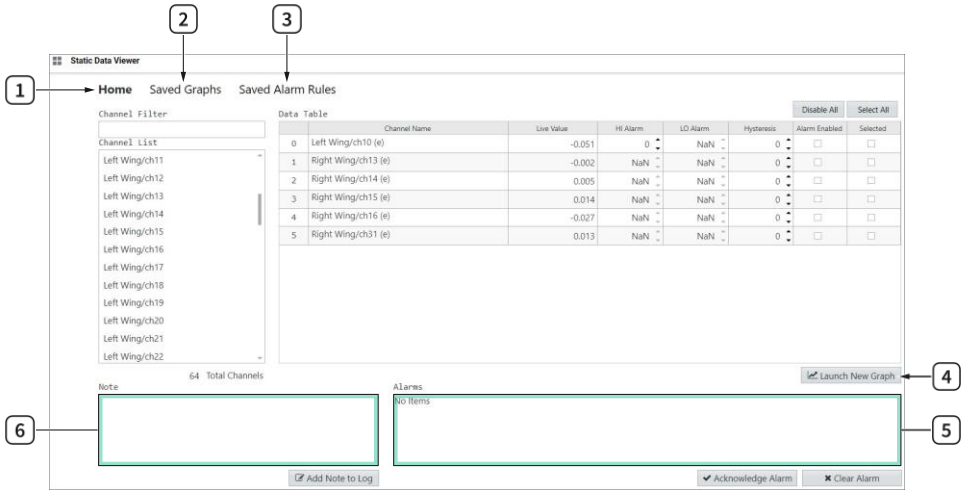
3. On the SystemLink login page, enter your Windows credentials associated with your organization.
4. Notify the admin after you log in.
5. Once the admin assigns the analyst role to your account, log in and begin using the Static Data Viewer.

Static Data Viewer Environment

The Static Data Viewer is hosted on the SystemLink Web Application.

Note Refer to ***Commissioning a System from the Static Structural Test Reference Architecture*** for more information about configuring the Static Data Viewer for first use.

Figure 11. Static Data Viewer Environment



1. Home
2. Saved Graphs
3. Saved Alarm Rules
4. Launch New Graph
5. Alarms
6. Note

Home

The **Home** page provides a full list of the channels that are configured in the test system. Use this page to select channels, configure alarm thresholds for specific channels, view alarms, and add notes to the log file. Refer to the following list for more information about each control on the **Home** page.

- **Channel Filter**—Search for the specific channel(s) that you are interested in viewing. The search filter is case sensitive.
- **Channel List**—Select the channel of interest from the **Channel List**. The total number of channels configured in the test system appear in the **Total Channels** field.
- **Data Table**—View expanded channel information on channels you selected from the **Channel List**. Use the controls in the **Data Table** to configure and enable alarms and view the live data for multiple channels, as outlined in ***Configuring Alarms*** and ***Viewing Channel Data***.

Launch New Graph

Open a graph in a separate browser tab to view the live values for specified channels in detail. Refer to ***Viewing Channel Data*** for more information.

Alarms

View alarm instances of a specific channel. If the alarm rules configured in the **Data Table** are met, an alarm is triggered and all alarm instances are displayed in the **Alarms** list until cleared. Clear the **Alarm Enabled** checkbox on a channel in the **Data**
Table to disable the alarm rule for that channel. Refer to ***Configuring Alarms*** for more information about clearing and acknowledging alarms.

Tip Press <Ctrl> to select multiple alarms from **Alarms** to launch or delete at the same time.

Note

Enter comments in the **Note** field. The comments are added to the test log file and include your username and a timestamp.

Tip The channel name is not automatically recorded in comments, so include the channel name in the comments as necessary.

Saved Graphs

The **Saved Graphs** page displays a list of all graphs that you launched from the **Home** page. Refer to the following list for more information about the controls on the **Saved Graphs** page.

- **Launch**—Click to open an existing graph in a new browser tab.
- **Delete**—Click to remove a graph.

Tip Press <Ctrl> to select multiple graphs from **Graphs** to launch or delete at the same time.

Saved Alarm Rules

The **Saved Alarm Rules** page displays all **Alarm Rules** that you have configured on the **Home** page and whether the alarm is enabled or disabled. Click **Delete** to delete and clear alarm rules for a specified channel. When you delete an alarm rule, the alarm values that you configured for the specific channel in the **Data Table** on the **Home** page return to the default settings.

Related concepts:

- Commissioning a System from the High Channel Count Test Reference Architecture

Related tasks:

- Configuring Alarms
- Viewing Channel Data

Configuring Alarms

Complete the following steps to configure alarms for channels.

1. On the **Home** page of the Static Data Viewer, select the channel(s) from the **Channel List**.
2. In the **Data Table**, specify a value for the **HI Alarm** (high) and/or **LO Alarm** (low) thresholds in the channel row for which you want to configure an alarm rule.

Note The default value for alarm rules is **NaN**, which indicates that an alarm rule does not exist for a channel regardless of the **Hysteresis** and **Alarm Enabled** fields.

3. Specify the **Hysteresis** value for the alarm threshold. Use hysteresis to reduce recurrent alarms on channels with fluctuating live values. The same hysteresis value is applied to both the **HI Alarm** and **LO Alarm** rules.

Alarm Example	Behavior
HI Alarm is set to `2` and	⬭ The alarm becomes active when the channel value is greater than the **HI Alarm** threshold.

Alarm Example	Behavior
Hysteresis is set to `1`	⬭ The alarm becomes inactive when the channel value passes below the **HI Alarm** threshold minus the **Hysteresis** value (2 - 1 = 1). The alarm becomes inactive (not cleared) when the channel value is 1 or lower.
LO Alarm is set to `0` and **Hysteresis** is set to `0.5`	⬭ The alarm becomes active when the channel value is less than the **LO Alarm** threshold. ⬭ The alarm becomes inactive when the channel value passes above the **LO Alarm** threshold plus the **Hysteresis** value (0 + 0.5 = 0.5). The alarm becomes inactive (not cleared) when the channel value is 0.5 or greater.

4. Select the **Alarm Enabled** checkbox to initiate the alarm rule evaluation.

> **Tip** Click **Disable All** to batch disable the configured alarms. To clear configured alarm values and return the values to default, you must delete the alarm rule from the **Saved Alarm Rules** page.

If an alarm threshold for a specific channel is met, the channel appears in the **Alarms** field. Click **Clear** to remove an alarm instance from the **Alarms** field. Refer to the following table for more information about alarm states.

Table 8. Alarm States

Alarm State	Description
Active (Red)	The alarm is active and has not been acknowledged.

Inactive (Clear)	The alarm for the channel is inactive.
Active (Yellow)	The alarm has been acknowledged. Click **Acknowledge Alarm** to acknowledge the alarm instance.

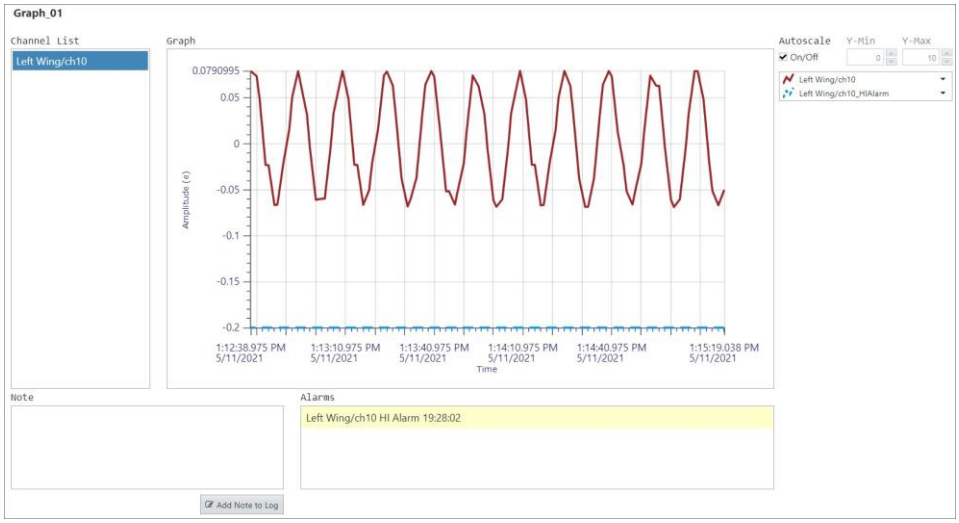
Viewing Channel Data

Complete the following steps to view live channel data.

1. On the **Home** page of the Static Data Viewer, view the **Live Values** of a specific channel in the **Data Table**.

2. To view the channel data as a graph, check the **Selected** checkbox on a channel or multiple channels to group, then click **Launch New Graph**. The graph for the specified channel launches in a new browser tab and is automatically saved to the **Saved Graphs** page.

   Figure 12. Live Graph Example



3. Use the **Autoscale On/Off** checkbox to change the size of the plot for your specific needs.
4. Use the graph legend to change plot properties.
5. View the list of **Alarms** and alarm states for the specific channels in the graph. You can acknowledge and clear alarms only from the **Alarms** list on the Home page.
6. Add a **Note** to annotate the log file.

7. Rename the graph title that appears above the **Channel List**. The graph name automatically updates in the **Graph List** on the **Saved Graphs** page.

Closing the browser tab automatically saves the launched graphs. You can access the saved graphs from the **Saved Graphs** page when you log back into the Static Data Viewer.

Error Reporting

All errors for the Static Data Viewer are reported in your web browser console. Static Data Viewer errors contain an error code and source message.

Tip You can open the Google Chrome Console in Developer Tools by pressing <Ctrl-Shift-i>.

Creating a FlexLogger Project from an Excel Spreadsheet

Use the FlexLogger Spreadsheet Importer command-line executable to create a FlexLogger project from an Excel spreadsheet.

The FlexLogger Spreadsheet Importer generally supports any hardware supported by FlexLogger, including following hardware typically deployed in high channel count test systems.

Chassis

- cDAQ-9185 (4-slot Ethernet chassis)
- cDAQ-9189 (8-slot Ethernet chassis)

Modules

- NI-9213 (Thermocouple)
- NI-9215 (±10V)
- NI-9235 (quarter-bridge strain)
- NI 9236 (quarter-bridge strain)
- NI 9237 (quarter-, half-, and full-bridge strain)
- NI 9234 (IEPE accelerometers and microphones)

Defining a FlexLogger Project in a Microsoft Excel Spreadsheet

Use a Microsoft Excel spreadsheet (.xlsx) to define and configure a FlexLogger project so you can import it into FlexLogger.

Complete the following steps to define your FlexLogger project in an Excel spreadsheet.

1. Create an Excel spreadsheet with the following worksheets:
    - Required:
        - Channel Mapping
    - Optional:

- Strain-Bridge
- Temperature-Thermocouple
- Voltage-Voltage
- Formulas
- Statistics
- Variables

You can find a FlexLogger Importer Spreadsheet template and a reference example spreadsheet in the ***Importing Structural Test Channel Information from MS Excel into FlexLogger*** document.

2. Set up the Strain-Bridge, Temperature-Thermocouple, and Voltage-Voltage worksheets with the appropriate columns. Refer to ***Strain-Bridge Worksheet***, ***Temperature-Thermocouple Worksheet***, and ***Voltage-Voltage Worksheet*** to learn about what to name the columns, which columns are required, and what values are allowed for each column.
3. Set up the Channel Mapping worksheet. Refer to ***Channel Mapping Worksheet*** to learn about what to name the columns, which columns are required, and what values are allowed for each column.
4. (Optional) If needed, set up the Formulas, Statistics, and Variables worksheets with the appropriate columns. Refer to ***Formulas Worksheet***, ***Statistics Worksheet***, and ***Variables Worksheet*** to learn about what to name the columns, which columns are required, and what values are allowed for each column.

Tip The FlexLogger CLI can take several minutes to run on a large spreadsheet.

NI recommends that you only configure a few channels in each of the worksheets first, then run the importer to ensure that they are properly configured, and only then complete the worksheet with all the required channels.

5. Save the file in .xlsx format.

Related reference:

- Strain-Bridge Worksheet
- Temperature-Thermocouple Worksheet
- Voltage-Voltage Worksheet
- Channel Mapping Worksheet
- Formulas Worksheet
- Statistics Worksheet
- Variables Worksheet

Related information:

- Importing Test Channel Information from MS Excel into FlexLogger document

Strain-Bridge Worksheet

Create the Strain-Bridge worksheet for the NI-9235 and NI-9236 modules in your system. Set up this worksheet with the columns described in the following table.

Table 9. Strain-Bridge Worksheet

Column Name	Column Type	Allowed Values
Channel Name	Required	String that does not contain the following characters: • , • ; • \ • @ • . Channel names must be unique.
Physical Unit	Optional	• Strain (ε) • Microstrain (με) When specifying Microstrain, use the "mu" (μ) symbol, not the "micro" (µ) symbol. They are both options from the Excel Insert Symbols dialog, and they look similar.
Signal Range	Optional	• Automatic • Manual (<Min

Column Name	Column Type	Allowed Values

		`Value>; <Max Value>)` Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Sensor Serial Number	Optional	String
Sensor Notes	Optional	String
Data Rate (Hz)	Optional	• `Slow (<Slow Value>)` • `Medium (<Medium Value>)` • `Fast (<Fast Value>)`
Gage Factor	Optional	Double
Alarm Value Change	Optional	• `Rises above value` • `Falls below value` • `Enters range` • `Leaves range`
Critical Alarm Enabled	Optional	• `TRUE` • `FALSE`
Critical Value	Optional	Number
Critical Range	Optional	`(<Min Value>; <Max Value>)` Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Critical Hysteresis	Optional	Number

Column Name	Column Type	Allowed Values
Warning Alarm Enabled	Optional	• TRUE • FALSE
Warning Value	Optional	Number
Warning Range	Optional	(<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Warning Hysteresis	Optional	Number

Temperature-Thermocouple Worksheet

Create the Temperature-Thermocouple worksheet for the NI-9213 modules in your system. Set up this worksheet with the columns described in the following table.

Table 10. Temperature-Thermocouple Worksheet

Column Name	Column Type	Allowed Values
Channel Name	Required	String that does not contain the following characters: • , • ; • \ • @ • . Channel names must be unique.

Physical Unit	Optional	• Degree Celsius (°C) • Degree Fahrenheit

Column Name	Column Type	Allowed Values
		(°F) • Kelvin (K)
Signal Range	Optional	• Automatic • Manual (<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Sensor Serial Number	Optional	String
Sensor Notes	Optional	String
Data Rate (Hz)	Optional	• Slow (<Slow Value>) • Medium (<Medium Value>) • Fast (<Fast Value>)
Linear Slope	Optional	Number
Linear Offset	Optional	Number
CJC Source	Optional	• Built-In • Constant
CJC Temperature	Optional	Double

Thermocouple Type	Optional	• B • E • J • K • N • R

Column Name	Column Type	Allowed Values
		• S • T
Alarm Value Change	Optional	• Rises above value • Falls below value • Enters range • Leaves range
Critical Alarm Enabled	Optional	• TRUE • FALSE
Critical Value	Optional	Number
Critical Range	Optional	(<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Critical Hysteresis	Optional	Number
Warning Alarm Enabled	Optional	• TRUE • FALSE

Warning Value	Optional	Number
Warning Range	Optional	`(<Min Value>; <Max Value>)` Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Warning Hysteresis	Optional	Number

Column Name	Column Type	Allowed Values
Filtering	Optional	• `Auto` • `None` • `High Resolution`

Voltage-Voltage Worksheet

Create the Voltage-Voltage worksheet for the NI-9213 and NI-9215 modules in your system. Set up this worksheet with the columns described in the following table.

Table 11. Voltage-Voltage Worksheet

Column Name	Column Type	Allowed Values
Channel Name	Required	String that does not contain the following characters: • `,` • `;` • `\` • `@` • `.` Channel names must be unique.

Physical Unit	Optional	• Kilovolt (kV) • Volt (V) • Millivolt (mV) • Microvolt (µV) When specifying Microstrain, use the "mu" (µ) symbol, not the "micro" (µ) symbol. They are both options from the Excel Insert Symbols dialog, and they look similar.

Column Name	Column Type	Allowed Values
Signal Range	Optional	• Automatic • Manual (<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Sensor Serial Number	Optional	String
Sensor Notes	Optional	String
Data Rate (Hz)	Optional	• Slow (<Slow Value>) • Medium (<Medium Value>) • Fast (<Fast Value>)
Scaling Type	Optional	• Linear • Sensitivity • Two Point

Linear Slope	Optional	Double Use when Scaling Type is set to `Linear`.
Linear Offset	Optional	Double Use when Scaling Type is set to `Linear`.
Sensitivity	Optional	Double Use when Scaling Type is set to `Sensitivity`.

Column Name	**Column Type**	**Allowed Values**
Sensitivity Offset	Optional	Double Use when Scaling Type is set to `Sensitivity`.
Two-point Physical 1	Optional	Double Use when Scaling Type is set to `Two Point`.
Two-point Electrical 1	Optional	Double Use when Scaling Type is set to `Two Point`.
Two-point Physical 2	Optional	Double Use when Scaling Type is set to `Two Point`.

Two-point Electrical 2	Optional	Double Use when Scaling Type is set to `Two Point`.
Alarm Value Change	Optional	• `Rises above value` • `Falls below value` • `Enters range` • `Leaves range`
Critical Alarm Enabled	Optional	• `TRUE` • `FALSE`
Critical Value	Optional	Number
Critical Range	Optional	`(<Min Value>; <Max Value>)`

Column Name	**Column Type**	**Allowed Values**
		Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Critical Hysteresis	Optional	Number
Warning Alarm Enabled	Optional	• `TRUE` • `FALSE`
Warning Value	Optional	Number

Warning Range	Optional	(<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Warning Hysteresis	Optional	Number

Channel Mapping Worksheet

For each channel you create on the Strain-Bridge, Temperature-Thermocouple, and Voltage-Voltage worksheets, create the hardware lookup on the Channel Mapping worksheet to specify the chassis/module to which you want to add the channel.

Note the following allowed values when setting up the Channel Mapping worksheet.

- Strain-Bridge channels can only be associated with the NI-9235, NI-9236, and NI-9237 modules.
- Temperature-Thermocouple channels can only be associated with the NI-9213 module.
- Voltage-Voltage channels can only be associated with the NI-9213 and NI-9215 modules.

Set up the Channel Mapping worksheet with the columns described in the following table.

Table 12. Channel Mapping Worksheet

Column Name	Column Type	Allowed Values
Channel Name	Required	Channel Name specified in the Strain-Bridge, Temperature-Thermocouple, or Voltage-Voltage worksheets.

Device Model	Required	• NI cDAQ-9189 • NI cDAQ-9185
Device Name	Required	Unique string, such as cDAQ1
Device Serial Number	Optional	Unique string that maps to the chassis serial number, such as 123ALPHA
Module Model	Required	• NI 9213 • NI 9215 • NI 9235 • NI 9236 • NI 9237 • NI 9234
Module Slot Number	Required	• Number between 1 and 8 that maps to the module slot position in the cDAQ-9189 • Number between 1 and 4 that maps to the module slot position in the cDAQ-9185
Channel Number	Required	• AI0 through AI15 for the NI-9213 • AI0 through AI3 for the NI-9215

Column Name	Column Type	Allowed Values
		• AI0 through AI7 for the NI-9235 and NI-9236

Formulas Worksheet

Set up the Formulas worksheet with the columns described in the following table.

Table 13. Formulas Worksheet

Column Name	Column Type	Allowed Values
Channel Name	Required	String that does not contain the following characters: • `,` • `;` • `\` • `@` • `.` Channel names must be unique.
Formula Type	Required	• `Arithmetic` • `Boolean`
Unit	Optional	String
Description	Optional	String
Formula	Required	Formula that references a Channel Name listed in the Channel Mapping worksheet between single quotation marks. Note that the single quotation mark is a special character in

Column Name	Column Type	Allowed Values
		Excel. To start the formula with a reference to a channel name, choose one of the following options: • Duplicate the single quotation mark: `''Channel 01' + 1` • Specify the entire formula as a string, starting with the equal sign: `="'Channel 01' + 1"`
Alarm Value Change	Optional	• `Rises above value` • `Falls below value` • `Enters range` • `Leaves range`
Critical Alarm Enabled	Optional	• `TRUE` • `FALSE`
Critical Value	Optional	Number
Critical Range	Optional	`(<Min Value>; <Max Value>)` Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Critical Hysteresis	Optional	Number

Warning Alarm Enabled	Optional	• TRUE • FALSE
Warning Value	Optional	Number

Column Name	Column Type	Allowed Values
Warning Range	Optional	(<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Warning Hysteresis	Optional	Number

Statistics Worksheet

Set up the Statistics worksheet with the columns described in the following table. Use Statistics channels to apply a filter or compute the mean or RMS of an existing channel.

Table 14. Statistics Worksheet

Column Name	Column Type	Allowed Values
Channel Name	Required	String that does not contain the following characters: • , • ; • \ • @ • . Channel names must be unique.

Statistics Type	Required	• `Filter` • `Mean` • `RMS`
Data Source	Required	Must be the name of a channel listed in the Channel Mapping spreadsheet.

Column Name	**Column Type**	**Allowed Values**
Description	Optional	String
Filter Type	Optional	• `Highpass` • `Lowpass`
Cutoff	Optional	Double Use when the value of column Statistics Type is `Filter`.
Block Size	Optional	Double, expressed in seconds Use when the value of column Statistics Type is `Mean` or `RMS`.
Alarm Value Change	Optional	• `Rises above value` • `Falls below value` • `Enters range` • `Leaves range`
Critical Alarm Enabled	Optional	• `TRUE` • `FALSE`
Critical Value	Optional	Double

Critical Range	Optional	(<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Critical Hysteresis	Optional	Number
Warning Alarm Enabled	Optional	• TRUE

Column Name	Column Type	Allowed Values
		• FALSE
Warning Value	Optional	Number
Warning Range	Optional	(<Min Value>; <Max Value>) Range is expressed in parenthesis, with the minimum and maximum double values separated by a semicolon.
Warning Hysteresis	Optional	Number

Variables Worksheet

Set up the Variables worksheet with the columns described in the following table to create variables.

Table 15. Variables Worksheet

Column Name	Column Type	Allowed Values

Channel Name	Required	String that does not contain the following characters: • , • ; • \ • @ • . Channel names must be unique.
Description	Optional	String
Value	Optional	Double
Unit	Optional	String

Configuring Software

Complete the following steps to install and configure the software for first use with a FlexLogger project created with the FlexLogger Spreadsheet Importer.

1. Verifying Spreadsheet Data in MAX
2. Reserving the cDAQ-9189 Chassis in MAX

Verifying Spreadsheet Data in MAX

Complete the following steps to verify and update the data entered in your spreadsheet.

1. Launch MAX from your server.
2. Right-click **Devices and Interfaces** and select **Find Network NI-DAQmx Devices**.
3. Click **Select All**, then select **Add Selected Devices**.
4. For each cDAQ chassis, right-click the chassis name listed under **Network Devices** and select the Settings tab.
5. Verify that the value for Model in MAX matches the value for Device Model in the Channel Mapping worksheet.

6. Update the Name in MAX to match the value for Device Name in the Channel Mapping worksheet.
7. Verify the Serial Number in MAX matches the value for Device Serial Number in the Channel Mapping worksheet.
8. For each module in each cDAQ chassis, do the following:
   a. Verify the Model in the MAX Settings tab matches the value for Module Model in the Channel Mapping worksheet.
   b. Verify the Slot Number in the MAX Settings tab in MAX matches the value for Module Slot Number in the Channel Mapping worksheet.

Reserving the cDAQ-9189 Chassis in MAX

Complete the following steps to add the cDAQ-9189 chassis to your software configuration.

1. Launch MAX from the server computer.
2. Right-click **Devices and Interfaces** and select **Find Network NI-DAQmx Devices**.
3. Click **Select All**, then select **Add Selected Devices**.
4. To determine successful installation of the chassis, right click the chassis name listed under **Network Devices** and select **Self Test**.
   When the self-test finishes, a message indicates successful verification or if an error occurred.
5. If the chassis was not reserved automatically (indicated in MAX by the chassis icon with an X) after it was added (**Add Device**), you can reserve the chassis in MAX by expanding **Devices and Interfaces** » **Network Devices**, selecting the chassis, and clicking the **Reserve Chassis** button.
   The Override Reservation dialog box appears when you attempt to explicitly reserve a chassis. Agreeing to override the reservation forces the cDAQ chassis to be reserved by the current user.

Importing a New Project

Import a project you defined in an Excel Spreadsheet into FlexLogger using the command-line interface.

Complete the following steps to import a project.

Before importing a new project, define the project in an Excel spreadsheet as described in ***Defining a FlexLogger Project in a Microsoft Excel Spreadsheet***.

1. Open a Command Prompt window.
2. Change the directory to the folder that contains the Spreadsheet Importer command-line executable, `C:\Program Files\National Instruments\ FlexLogger` using the cd command, `cd "C:\Program Files\National Instruments\FlexLogger"`
3. Run the following command: `.\flexloggercli.exe import -p "<ProjectName>" -f "<ProjectFolder>" -s "<ExcelSpreadsheetPath>"`
   The project file (.flxproj) is created in the project folder indicated in the command. The operation may take several minutes to complete, based on the size of the number of channels defined in the spreadsheet.

Open the generated FlexLogger project file by double-clicking the .flxproj file or opening the project within the FlexLogger application.

Related tasks:

- Defining a FlexLogger Project in a Microsoft Excel Spreadsheet

Commands and Command Options

The following tables summarize the FlexLogger Spreadsheet Importer commands and command options.

Table 16. FlexLogger Spreadsheet Importer Commands

Command	Description
`import`	Create a new project using the configuration you import from a spreadsheet.

Table 17. FlexLogger Spreadsheet Importer Command Options

Command Option	Description
`--project=VALUE`	Specify the name of the new project. Do not include the file extension in the name.
`-p VALUE`	
`--folder=VALUE`	Specify the location for the new project folder. The new project folder will have the same name as the new project.
`-f VALUE`	
`--spreadsheet=VALUE`	Specify the location of the spreadsheet you want to import.
`-s VALUE`	
`-o, --overwrite`	Include this optional parameter to indicate that any existing project with the same path should be overwritten by the imported project.

Benchmarking a System Built from the High Channel Count Test Reference Architecture

To create performance benchmarks for the High Channel Count Test Reference Architecture design pattern, NI built a physical test system according to the pattern and tested the system for viability and reliability, using the following tests.

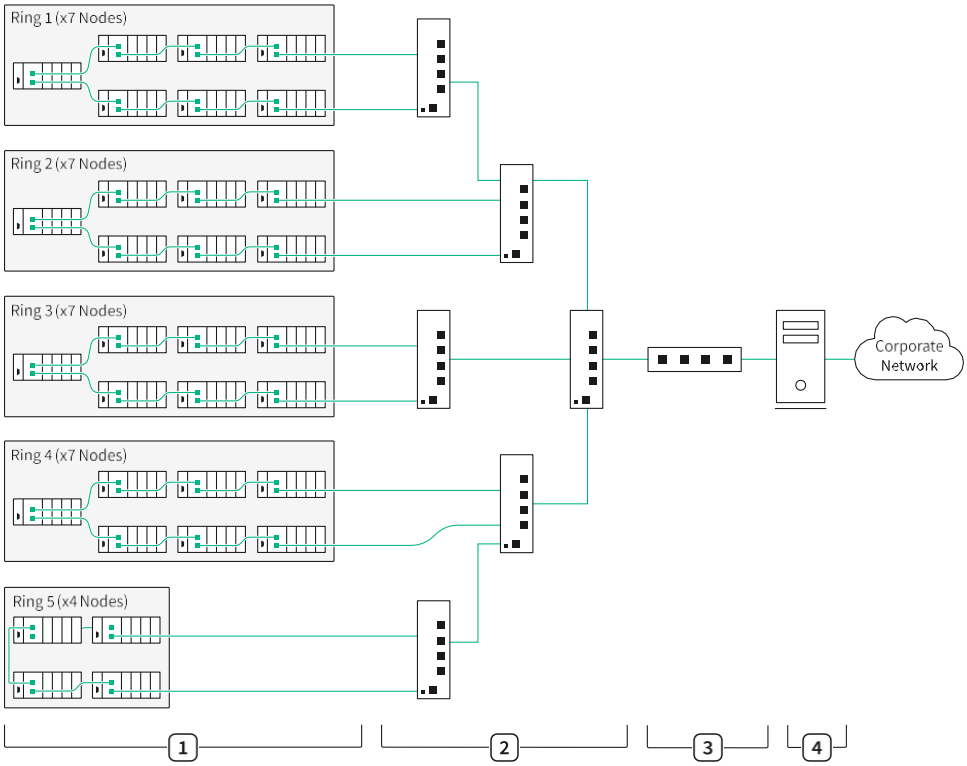
- **Long-Term Test Results**—Assessed the performance of the benchmark system when continuously logging data without producing errors.
- **Channel Count Parametrized Test Results**—Found the highest sample rates the benchmark system could achieve at different channel counts.
- **Shunt Calibration and Null Offset Test Results**—Assessed the time to complete a shunt calibration and null offset.

Use the results of the benchmark system tests as reference when building your own system from the High Channel Count Test Reference Architecture.

The High Channel Count Test Benchmark System

The following figure depicts the composition of the High Channel Count Test benchmark system built by NI.

Figure 13. Diagram of Benchmark System Built by NI



1. cDAQ-9189: 8-Slot, TSN-Enabled Ethernet CompactDAQ Chassis
2. cRIO-9805: 4-Port, 802.1AS Ethernet Switch Expansion Module for CompactRIO
3. Cisco RV340: Router
4. Lenovo ThinkStation P330 Tower Gen 2: Server Computer

Note To stress scalability and performance, NI configured the benchmark system with over 2,000 channels—the top-end channel count suggested in the Static Structural Test Reference Architecture.

The 32 cDAQ-9189 8-Slot chassis in the benchmark system are configured with a total of 256 modules and a channel composition that represents a common static structural test application.

Table 18. Channel Composition and Sample Rates for the Benchmark System Built by NI

Number and Type of Channels	Number of Modules	Module Models	Sample Rate
1,944 quarter-bridge strain gauges	243	NI-9235 and NI-9236	100 S/s
32 voltage channels	8	NI-9215	100 S/s
64 temperature channels	4	NI-9213	1 S/s

Conditions

The benchmark test results were found under the following conditions unless otherwise noted.

- Static Test Software Suite 1.2 installed
- Server computer: Lenovo ThinkStation P330 Tower Gen2
  - Intel Xeon E-2286G CPU 4.0 GHz, 6-Core
  - 64 GB RAM
  - 1 TB SSD
  - Gigabit Ethernet adapter (x2) (one dedicated for instrumentation network)
  - Windows 10 64-bit
- External RAID drive: Oyen Digital 4TB SSD MiniPro RAID v3 (2 TB, RAID 1 configuration)
- External DHCP-enabled router: Cisco RV340 router
- Google Chrome browser
- cDAQ-9189 chassis with cDAQ firmware version 20.0 installed (available through NI-DAQmx cDAQ Firmware 21.0)
- System components connected according to the High Channel Count Test Reference Architecture design pattern, as shown in the previous figure

Related information:

- Static Test Software Suite Download Page

Long-Term Test Results

The Long-Term Test assessed the performance of the benchmark system when continuously logging data without producing errors.

Conditions:

- 2-week test time
- 2,048 channel count
- 100 S/s sample rate for strain and voltage channels
- 1 S/s sample rate for thermocouple channels

Performance	
CPU usage	20% to 70%
Memory usage	15% to 30%, 2,000 MB to 6,000 MB
Network utility	17% to 18%
Storage utilization	
Total utilization	2.15 TB
Utilization by file type	337 technical data management streaming (TDMS) files at ~5.91 GB each 337 TDMS index files at ~620 MB each

Channel Count Parametrized Test Results

The Channel Count Parametrized Test found the highest sample rates the benchmark system could achieve at different channel counts. The highest sample rates, reported in the following section, were achieved for 30 minutes

without producing errors and within the following parameters:

- < 80% memory usage
- < 95% CPU usage
- < 80% network utility

Highest sample rates by channel count

2,048 channels	
Maximum sample rate	3 kS/s
CPU usage	36% to 50%
Memory usage	28% to 30%
Network utility	~22%
1,160 channels	
Maximum sample rate	10 kS/s (NI-9235 and NI-9236 have a maximum sample rate of 10 kS/s)
CPU usage	40% to 60%
Memory usage	34% to 40%
Network utility	~38%

448 channels	
Maximum sample rate	10 kS/s (NI-9235 and NI-9236 have a maximum sample rate of 10 kS/s)
CPU usage	20% to 50%
Memory usage	20% to 30%
Network Utility	~15%

Shunt Calibration and Null Offset Test Results

Time to complete shunt calibration on 1,944 channels	5 minutes
Time to complete null offset on 1,944 channels	5 minutes

High Channel Count Test Reference Architecture New Features and Changes

Learn about updates—including new features and behavior changes—introduced in each version of the High Channel Count Test Reference Architecture.

Related reference:

- High Channel Count Test Reference Architecture 1.2 New Features and Changes
- High Channel Count Test Reference Architecture 1.1 New Features and Changes

High Channel Count Test Reference Architecture 1.2 New Features and Changes

Introduced December 2021

Creating a FlexLogger Project from an Excel Spreadsheet

Added support to use the FlexLogger Spreadsheet Importer command-line executable to create a FlexLogger project from an Excel spreadsheet.

Related concepts:

- Creating a FlexLogger Project from an Excel Spreadsheet

High Channel Count Test Reference Architecture 1.1 New Features and Changes

Introduced September 2021

New Features

Initial version of the High Channel Count Test Reference Architecture provided support for the following high-channel-count measurement types:

- Strain-bridge input
- Thermocouple input
- Voltage input

Hardware Support

This version of the High Channel Count Test Reference Architecture provided support for the following products:

- cDAQ-9189
- cRIO-9805
- NI-9213
- NI-9215
- NI-9235
- NI-9236
- NI-9237
- NI-9234

Finding Documentation for Hardware Components

Use the following links to find documentation for the instrumentation used with the High Channel Count Test Reference Architecture, including getting started and specifications.

Table 19. Hardware Component Documentation

Model	Documentation Link
cDAQ-9189	cDAQ-9189 user documentation
cRIO-9805	cRIO-9805 user documentation
NI-9213	NI-9213 user documentation
NI-9215	NI-9215 user documentation
NI-9235	NI-9235 user documentation
NI-9236	NI-9236 user documentation
NI-9237	NI-9237 user documentation
NI-9234	NI-9234 user documentation
PS-14	PS-14 user documentation
PS-15	PS-15 user documentation
PS-16	PS-16 user documentation

NI
11500 N Mopac Expwy
Austin, TX 78759-3504