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High-Speed Bridge Module for Load/Pressure/Strain/Torque Measurements

NI 9237



- Built-in full- and half-bridge measurements
- 120 and 350 Ω quarter-bridge completion via NI 9944/45 accessory kits
- 24-bit resolution on four simultaneous inputs sampled at up to 50 kS/s/ch
- Compatible with TEDS sensors
- Up to 10 V programmable excitation
- Connection for external excitation supply for specific levels
- 1,000 Vrms transient isolation for safety
- RJ50 (10P10C) or D-Sub connector options

Overview

The NI 9237 simultaneous bridge module for NI C Series devices contains all the signal conditioning required to power and measure up to four bridge-based sensors simultaneously. It can perform offset/null as well as shunt calibration and remote sense, all of which increase the accuracy of strain and bridge measurements.

For connectivity, you can select from two versions of the module: RJ50 or a 37-pin D-Sub. The RJ50 version, also known as 10P10C, offers quick sensor connection because you can use it for sensor termination. When you need a custom quarter-bridge design, choose the D-Sub version, which does not have an accessory for quarter-bridge completion. You also can use it with standard NI or other D-Sub accessories when you need only full- or half-bridge measurements.

The NI 9944 and NI 9945 accessories with quarter-bridge sensors have a female RJ50 connector on one end and screw terminals on the other end. You can purchase these accessories with a kit of RJ50 cables (quantity 4).

For screw terminals without the quarter-bridge completion, purchase the NI 9949 and a kit of RJ50 cables (quantity 4). This setup exposes all 10 pins for each channel as screw terminals.

[Back to Top](#)

Requirements and Compatibility

OS Information

- Real-Time OS
- Windows

Driver Information

- NI-DAQmx
- NI-RIO

Software Compatibility

- ANSI C/C++
- LabVIEW
- LabWindows/CVI
- Measurement Studio
- SignalExpress
- Visual Basic
- Visual Studio
- Visual Studio .NET

[Back to Top](#)

Comparison Tables

Module	Channels	Max Sample Rate (kS/s/ch)	Resolution (bits)	Quarter-Bridge	Half and Full	Simultaneous
NI 9237	4	50	24	yes (120/350 Ω)	yes	yes
NI 9237 D-Sub	4	50	24	no	yes	yes
NI 9235	8	10	24	120 Ω	no	yes
NI 9236	8	10	24	350 Ω	no	yes

[Back to Top](#)

Application and Technology

High-Speed Simultaneous Sampling

Mechanical test applications that involve impact testing, high-speed machinery, or moving vehicles often require high-speed sample rates to capture the event at full speed. You need to separate analog-to-digital converter (ADC) circuitry to perform a time-synchronous measurement as the strain event propagates through the structure. When you use multiple NI 9237 modules in either an NI CompactDAQ or CompactRIO chassis, all modules and channels are synchronized through a single set of clocked signals in the chassis.

Programmable Excitation

The NI 9237 can output voltage excitation up to 10 V. For more specific excitation requirements, the NI 9237 has inputs for external excitation. See the product manual for more information on excitation.

TEDS Compatibility

IEEE 1451.4, also known as TEDS (transducer electronic data sheet), technology consists of a standardized set of templates for specific sensors that store information such as manufacturer, manufacture date, calibration data, sensor-specific setup data, and more. TEDS is typically implemented on the sensor side via an onboard EEPROM. With this, the sensor has all of the information needed for setup and calibration stored locally, so you no longer have to keep up with paper data sheets. On the instrumentation side, the measurement system must have the capability to read and understand the TEDS data from the sensor. The NI 9237 has the capability to read TEDS information for TEDS-enabled sensors.

C Series Compatibility

The NI C Series hardware family features more than 50 measurement modules and several chassis and carriers for deployment. With this variety of modules, you can mix and match measurements such as temperature, acceleration, flow, pressure, strain, acoustic, voltage, current, digital, and more to create a custom system. Install the modules in one of several carriers to create a single module USB, Ethernet, or Wi-Fi system, or combine them in chassis such as NI CompactDAQ and CompactRIO to create a mixed-measurement system with synchronized measurements. You can install up to eight modules in a simple, complete NI CompactDAQ USB data acquisition system to synchronize all of the analog output, analog input, and digital I/O from the modules. For a system without a PC, CompactRIO holds up to eight modules and features a built-in processor, RAM, and storage for an embedded data logger or control unit. For higher-speed control, CompactRIO chassis incorporate a field-programmable gate array (FPGA) that you can program with NI LabVIEW software to achieve silicone-speed processing on I/O data from C Series modules.

[Back to Top](#)

Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI 9237 Module Kits			
NI 9237 (RJ50)	779521-01	No accessories required.	
NI 9237 D-Sub	780264-01	No accessories required.	
RJ50 Cables for Use with NI 9237			
RJ50 to RJ50 cable kit (2 m, qty 4)	194612-02	No accessories required.	
RJ50 to RJ50 cable (10 m, qty 1)	194612-10	No accessories required.	
RJ50 to "pigtail wires" or "flying leads" (2 m, qty 4)	195950-02	No accessories required.	
RJ50 to "pigtail wires" or "flying leads" (10 m, qty 1)	195950-10	No accessories required.	
D-Sub Cables for Use with NI 9237 D-Sub			
37-pin D-Sub (M-F) shielded cable	778621-01	No accessories required.	
NI SH37F-Tajimi 37-pin D-Sub cable to connect to 7-pin male Tajimi connector (1 m, qty. 1)	199254-01	No accessories required.	
NI SH37F-Tajimi 37-pin D-Sub cable to connect to 7-pin male Tajimi connector (10 m, qty.1)	199254-10	No accessories required.	
External Excitation Connector			
Spare/replacement 4-position connector for external excitation on the NI 9237 (RJ50)	194611-01	No accessories required.	
D-Sub Terminal Blocks			
NI CB-37F-LP unshielded I/O connector block	779353-01	No accessories required.	
37-pin D-Sub to screw terminal connector block with horizontal DIN-rail mount	778673-01	No accessories required.	
37-pin D-Sub to screw terminal connector block with vertical DIN-rail mount	778672-01	No accessories required.	
RJ50 Connectivity Accessories			

NI 9949 - RJ50 to screw terminal adaptor (qty. 4) purchase with cable kit.	196809-01	No accessories required.
NI 9944 - Quarter-bridge completion accessory (120 Ohm, qty. 4) purchase with cable kit	194738-01	No accessories required.
NI 9945 - Quarter-bridge completion accessory (350 Ohm, qty. 4) purchase with cable kit	194739-01	No accessories required.

D-Sub Connector Kit

NI 9933 - creates custom cable for NI 9237 using D-Sub to screw terminal connection	779103-01	No accessories required.
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[Back to Top](#)

Software Recommendations

LabVIEW Professional Development System for Windows



- Advanced software tools for large project development
- Automatic code generation using DAQ Assistant and Instrument I/O Assistant
- Tight integration with a wide range of hardware
- Advanced measurement analysis and digital signal processing
- Open connectivity with DLLs, ActiveX, and .NET objects
- Capability to build DLLs, executables, and MSI installers

[Back to Top](#)

Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. To ensure the ongoing accuracy of your measurement hardware, NI offers basic or detailed recalibration service that provides ongoing ISO 9001 audit compliance and confidence in your measurements. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training in cities worldwide** - the most comprehensive hands-on training taught by engineers.
- **On-site training at your facility** - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
- **Training memberships** and training credits - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

[Back to Top](#)

Detailed Specifications

The following specifications are typical for the range –40 to 70 °C unless otherwise noted.

Input Characteristics	
Number of channels	4 analog input channels
Bridge completion	
Half and Full	Internal
Quarter	External
ADC resolution	24 bits
Type of ADC	Delta-Sigma (with analog prefiltering)
Sampling mode	Simultaneous
Internal master timebase (f_M)	
Frequency	12.8 MHz
Accuracy	±100 ppm max
Data rate range (f_s) using internal master timebase	
Minimum	1.613 kS/s
Maximum	50 kS/s
Data rate range (f_s) using external master timebase	
Minimum	390.625 S/s
Maximum	51.3 kS/s
Data rates ¹	$\frac{f_M \div 256}{n}, n = 1, 2, \dots, 31$
Typical input range	± 25 mV/V
Scaling coefficient	2.9802 nV/V per LSB
Overvoltage protection between any two pins	±30 V

Accuracy		
Measurement Conditions ²	Percent of Reading (Gain Error)	Percent of Range ³ (Offset Error)
Calibrated typ (25 °C, ±5 °C)	0.05%	0.05%
Calibrated max (– 40 to 70 °C)	0.20%	0.25%
Uncalibrated typ (25 °C, ±5 °C)	0.20%	0.1%
Uncalibrated max (– 40 to 70 °C)	0.60%	0.35%

Gain drift	10 ppm/°C max
Offset drift	
2.5 V excitation	0.6 µV/V per °C
3.3 V excitation	0.5 µV/V per °C
5 V excitation	0.3 µV/V per °C
10 V excitation	0.2 µV/V per °C

Channel-to-channel matching (calibrated)			
Input Signal Frequency (f_{in})	Gain		Phase
	Typical	Maximum	Maximum
0 to 1 kHz	0.15%	0.3%	$0.125^\circ/\text{kHz} \cdot f_{in}$
1 to 20 kHz	0.4%	1.1%	

Phase nonlinearity

$f_{in} = 0$ to 1 kHz	<0.001°
$f_{in} = 0$ to 20 kHz	±0.1°

Input delay

$38.4/f_s + 4.8 \mu\text{s}$

Passband

Frequency	$0.45 \cdot f_s$
Flatness	0.1 dB max

Stopband

Frequency	$0.55 \cdot f_s$
Rejection	100 dB

Alias-free bandwidth

$0.45 \cdot f_s$

Oversample rate

$64 \cdot f_s$

Rejection at oversample rate ⁴

$f_s = 10$ kS/s	60 dB @ 640 kHz
$f_s = 50$ kS/s	90 dB @ 3.2 MHz

Common-mode voltage, all signals to earth ground

±60 VDC

CMRR

Relative to earth ground ⁵ ($f_{in} = 0$ to 60 Hz)	140 dB
Relative to EX- ($f_{in} = 0$ to 1 kHz)	85 dB

SFDR (1 kHz, -60 dBFS)

106 dB

Total Harmonic Distortion (THD)

1 kHz, -20 dBFS	100 dB
8 kHz, -20 dBFS	90 dB

Input noise			
Excitation Voltage	Density (nV/V _{rms} per $\sqrt{1}$ Hz)	Total $f_{in} = 0$ to 25 kHz ($\mu\text{V/V}_{rms}$)	Total $f_{in} = 0$ to 1 kHz (nV/V _{rms})
2.5 V	8	1.3	250
3.3 V	6	1.0	190
5 V	4	0.6	130
10 V	2	0.3	65

Excitation noise	0.1 mV/V _{rms}
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Crosstalk

$f_{in} = 1$ kHz	110 dB
$f_{in} = 10$ kHz	100 dB

Excitation

Internal voltage	2.5 V, 3.3 V, 5.0 V, 10.0 V
Internal power	150 mW max
External voltage	2 V to 10 V

Shunt calibration	
Resistance	100 k Ω
Resistor accuracy	
25 °C	$\pm 110 \Omega$
–40 to 70 °C	$\pm 200 \Omega$
MTBF	603,359 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

 **Note** Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis

Active mode	740 mW max
Sleep mode	25 μ W max

Thermal dissipation (at 70 °C)

Active mode	740 mW max
Sleep mode	25 μ W max

Physical Characteristics

Weight	152 g (5.4 oz)
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Safety

If you need to clean the module, wipe it with a dry towel.

Safety Voltages

Connect only voltages that are within the following limits.

Between any two pins	± 30 V max
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Isolation

Channel-to-channel	None
Channel-to-earth ground	
Continuous	60 VDC, Measurement Category I
Withstand	1,000 V _{rms} , verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS ⁶ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

 **Caution** Do *not* connect the NI 9237 to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

 **Note** For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nC IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nC IIC T4
Europe (DEMKO)	EEx nC IIC T4

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326 (IEC 61326): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

 **Note** For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

 **Note** For EMC compliance, operate this device with shielded cables.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)



Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)	5 g _{rms} ¹ , 10 to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 to 500 Hz
Operating shock (IEC 60068-2-27)	30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	– 40 to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	– 40 to 85 °C
Ingress protection	IP 40
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing
Storage humidity (IEC 60068-2-56)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (IEC 60664)	2

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/wEEE.htm.

电子信息产品污染控制管理办法（中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Calibration

You can obtain the calibration certificate for this device at ni.com/calibration.

Calibration interval	1 year
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¹ The data rate must remain within the appropriate data rate range. Refer to the *Understanding Data Rates* section of the *NI 9237 Operating Instructions and Specifications* for more information.

² Before offset null or shunt calibration.

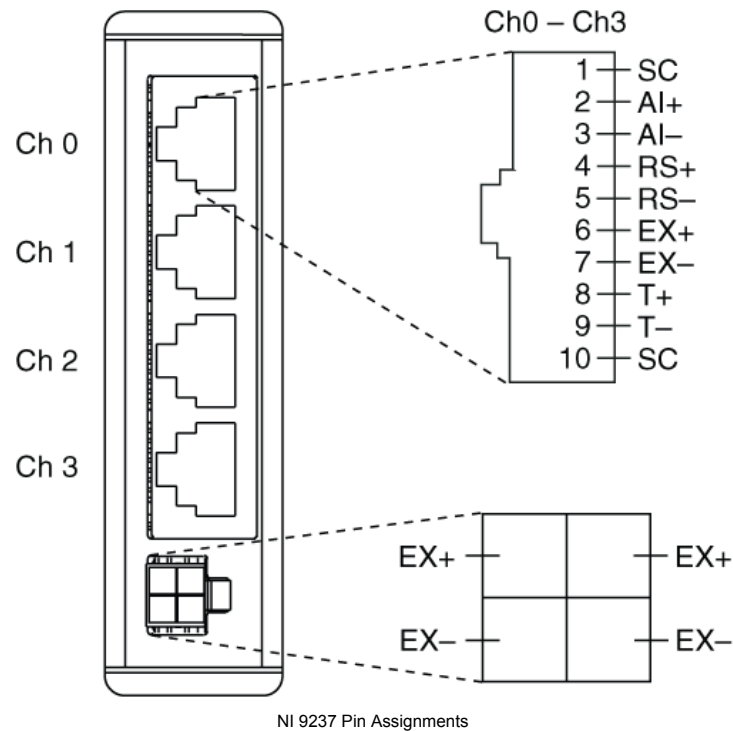
³ Range equals 25 mV/V.

⁴ Rejection by analog prefilter of signal frequencies at oversample rate.

⁵ Measured with a balanced cable. Shielded cables that are not twisted-pair may be significantly unbalanced. To improve the balance of shielded, twisted-pair cables, NI recommends twisting together the AI+/AI– pair, the RS+/RS– pair, and the EX+/EX– pair.

⁶ MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

Pinouts/Front Panel Connections



[Back to Top](#)

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