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Agilent E1529A, E1539A and E1422A

Strain Measurement System

Product Overview



Remote Strain Conditioning Unit for Stress and Fatigue Testing

- **32 channels of conditioning in a single rackmount unit**
- **Outputs for static-load or vibration measurements**
- **Simple, low-cost wiring using RJ-45 telecom connectors**
- **Locate up to 1000 feet from test system**
- **Up to 6144 static channels supported by a single-mainframe VXI system**

Agilent Technologies
Innovating the HP Way

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Compact strain conditioning with simple RJ-45 connectors reduces overall system cost

The Agilent E1529A is designed to simplify stress and fatigue testing for groups that test large mechanical products. It features built-in signal conditioning and multiplexed connections, which reduce overall system cost.

32 programmable channels in a single unit

By using the latest surface mount technology in circuit design, it has been possible to combine 32 channels of strain conditioning into a single 19-inch rackmount enclosure that is only 1¾ inches high. This includes programmability of individual strain bridge configuration and completion and an on-board calibration source.

Combined conditioning for static-load and vibration measurements

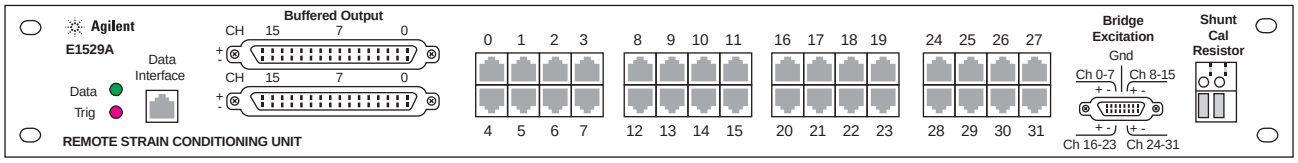
For slower speed measurements, the 32 channels have individual programmable filters and are connected to a 32:1 analog multiplexer. The multiplexer output can be connected to an external measuring device such as a scanning A/D converter for collecting static load data.

In addition, each channel of the E1529A has a wideband buffered output that can be connected to high-speed digitizers for measuring structural vibration levels. These signals are used for various forms of dynamic testing such as modal analysis.

Reduced cost for strain gage field wiring

Extensive testing by Agilent design engineers has resulted in the qualification of the standard RJ-45 telecom connector as the ideal low-cost connector for strain gages. Not

The Agilent E1529A front panel provides easy access to all essential inputs and outputs



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only are these connectors reliable, but low-cost construction of custom length cables is readily available. Reconfiguration or replacement of strain gage connections is as easy as connecting a telephone.

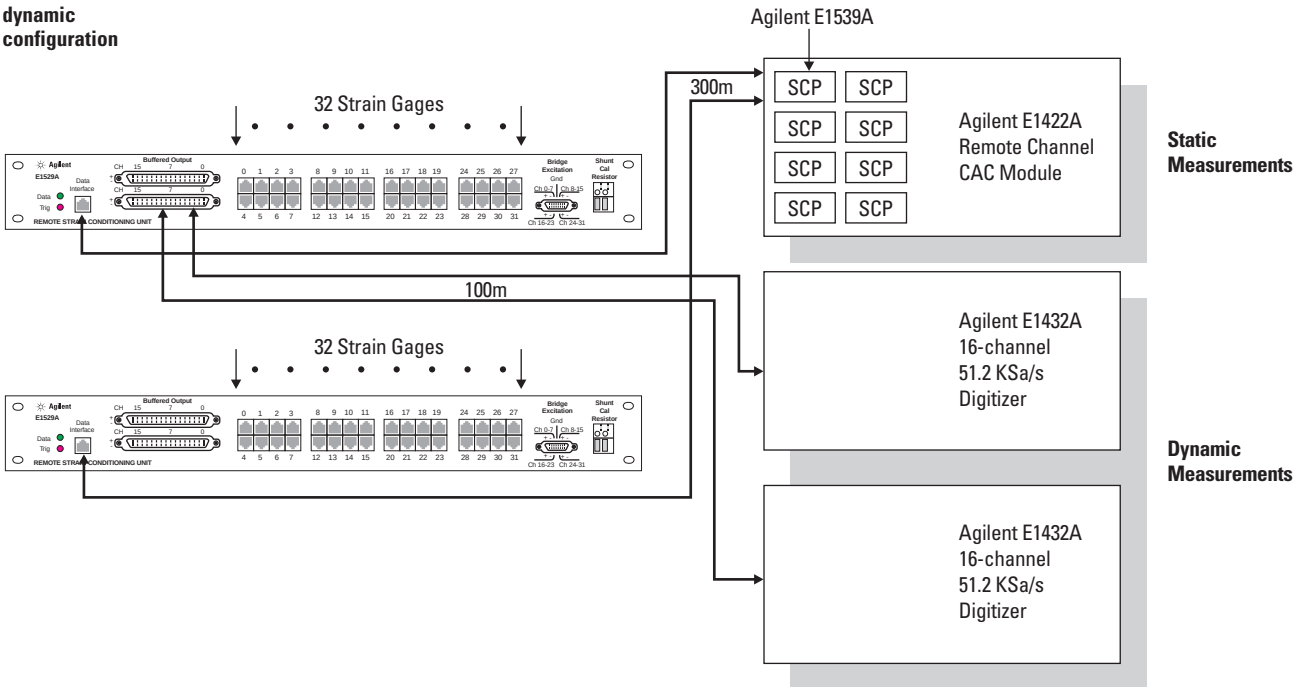
For static load testing, there is an additional benefit. The E1529A can be placed close to the 32 strain gages connected to it in order to minimize wire lengths. The single interface cable, which contains the multiplexer analog output and digital control lines, can be run up to 1000 feet (330 meters) to a measurement system located elsewhere. This effectively reduces the wiring costs by nearly 32:1 for large structure testing.

Complete measurement system in a standard architecture

Agilent provides a wide choice of measurement modules in the industry standard VXI architecture to complement the E1529A remote channel strain conditioning unit. For highest speed measurements, the E1433A digitizer plus DSP provides eight channels of individual 192 kSa/sec A/D complete with anti-aliasing filters. For medium speed measurements, the E1432A digitizer plus DSP provides 16 channels of individual 51.2 kSa/sec A/D complete with anti-aliasing filters. The E1433A and E1432A are both C-size VXI modules.

A C-size VXI card, the E1422A remote channel DAC module, provides the setup and configuration of the E1529A. This product also provides control of the E1529A multiplexer and digitizing of the analog signal with a 16-bit, 25 kSa/sec scanning A/D. The connection is provided with an interface daughter board called the E1539A remote channel SCP (signal conditioning plug-on). Other SCPs – up to eight on each E1422A – can be installed to provide I/O and various other analog, digital, and counter measurements.

Static and dynamic configuration



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Get results fast with high-level programming

Programming the E1529A is done through the E1422A remote channel DAC module, the E1539A remote channel SCP, and a powerful command set. Arbitrary measurement scans in any channel order or sequential scans with stated ranges are written in single program statements. This dramatically simplifies the programming task and greatly reduces development time.

High-level commands also let users quickly configure the bridge, list the parameters of the strain gage, input the excitation voltage, and initiate a scan that produces measurement results in engineering units. The programming language also can handle more difficult measurement and analysis situations. For example, users can write programs using unique constants for the mx+b linearization, or save raw bridge output voltages needed for post processing purposes.

The E1529A and E1422A have been designed to work together seamlessly. With comprehensive programming capabilities that match a wide range of user requirements, system development is fast and easy.

Up to 6144 channels in a single mainframe

For static load applications, full utilization of the E1422A can support up to 512 channels of strain measurements provided by sixteen E1529A remote strain conditioning units. Up to twelve E1422As can be installed in a 13-slot VXI mainframe, providing up to 6144 channels of strain measurements in a single system with a single I/O to the controlling computer.

There has never been a strain measurement solution as simple and elegant as the E1529A. Easy strain gage wiring and conditioning for both static load and vibration testing, and a choice of standard measurement modules, simplify the test engineer's job.



Tests verify RJ-45 connector reliability

The RJ-45 telecomm connector (and its four-pin relative, the RJ-11), has served the telecommunications industry reliably and inexpensively for many years. Even in tough environments, these connectors have performed reliably.

Because of its reliability, low cost, convenience, and ease of termination, Agilent has chosen the RJ-45 telecomm connector for use in the E1529A. To ensure that this connector meets the requirements of a strain measuring system, Agilent subjected the RJ-45 connector to several environmental tests.

Temperature: Cycling from 5 to 60 °C over a two-day period resulted in a thermo-electric shift of less than 10 microvolts (4 microstrain when using a 5-volt bridge excitation).

Humidity: During the five-day test at 95% R.H. and 40 °C, the variation in contact resistance was less than 2 milliohms for a 350 Ohm quarter bridge (2.8 microstrain of measurement shift).

Vibration: Testing was conducted with the interconnect cables loosely clamped, which maximized stress on the connector. The test conditions consisted of one hour of random, 0.2g vibration (5-500 Hz), 30 minutes of 2g swept sine with a five-minute dwell at each resonance, and 15 minutes of 2g random vibration (5-500 Hz). Total variation in contact resistance was less than 1.5 milliohms (2.1 microstrain).

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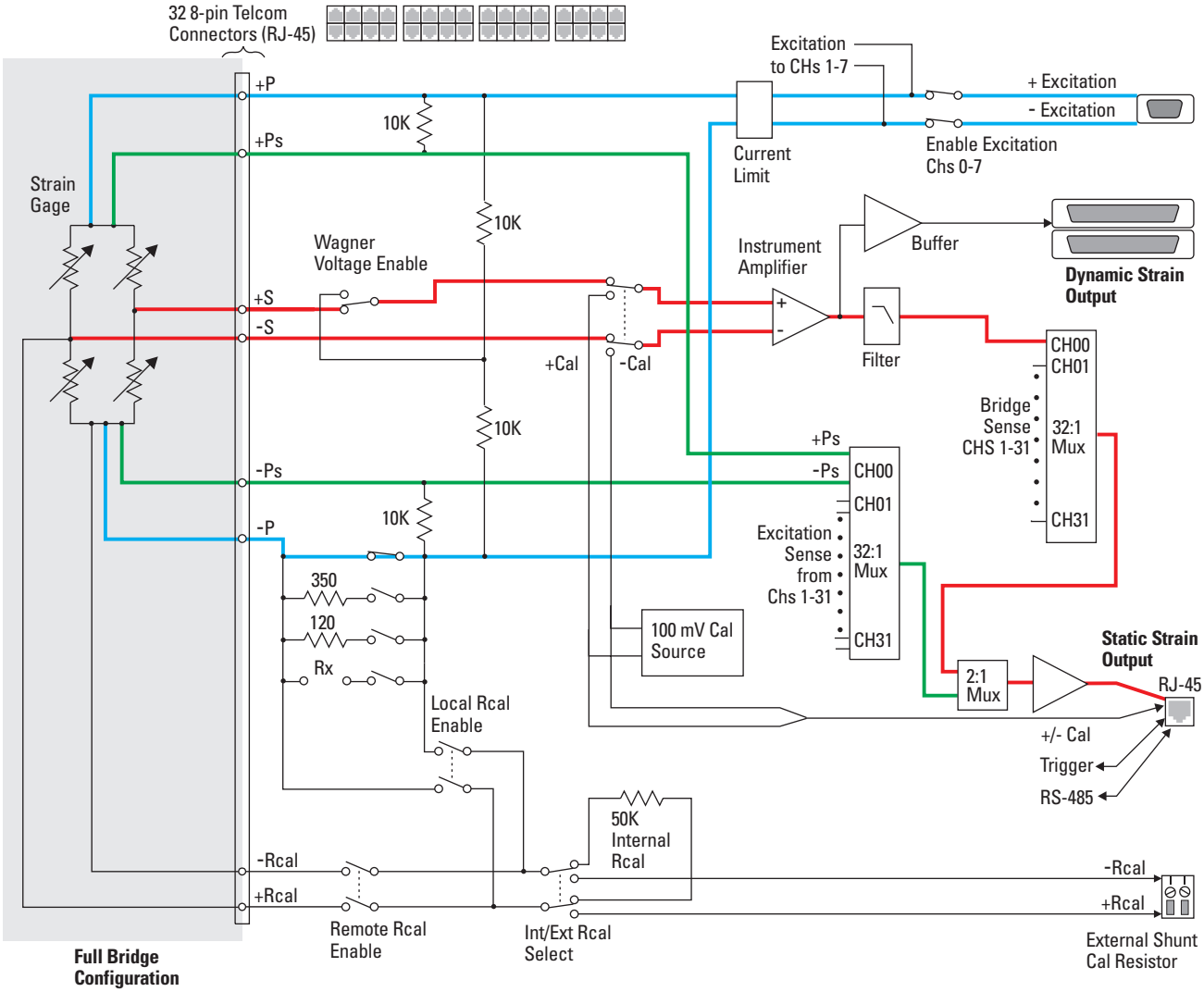
Flexible configurations meet a variety of needs

Tailoring a solution to the exact needs of the application is easy with the broad choice of available configurations in the E1529A. Users can programmatically select the appropriate bridge completion circuitry on a per-channel basis: full, half, quarter-120-Ohm, quarter-350-Ohm, and quarter-user-specified configurations. Programmable double-pole low-pass filters let users control system noise on a channel basis: 2, 10, 100 Hz, and 20 kHz (selectable in banks of eight). Each channel has a fixed gain of 32.

Other key attributes

- Static and dynamic outputs are buffered.
- Bridge excitation (user supplied in banks of eight) is measured per channel.
- Bridge excitation is current limit protected with resettable solid-state fuses.
- Built-in circuitry provides high common mode rejection.

Remote strain conditioning unit



Full Bridge Configuration

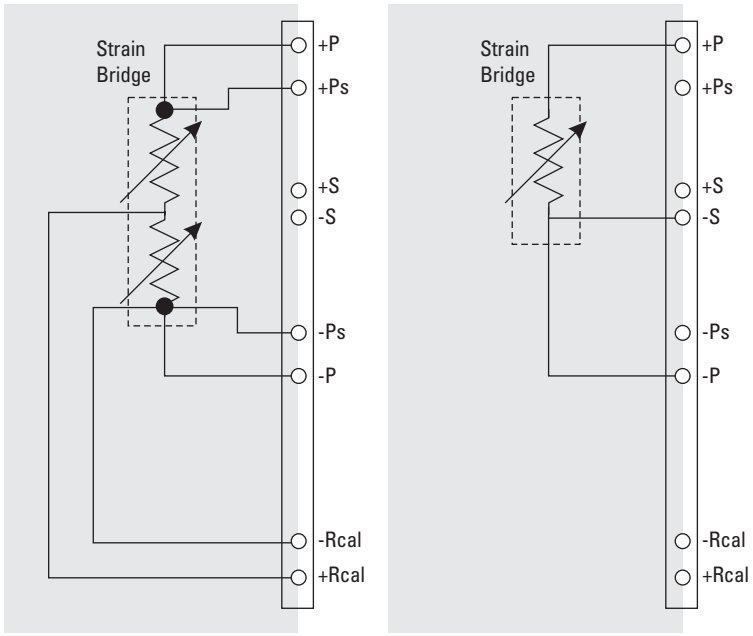
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On-board calibration ensures confidence

The E1529A employs several techniques to ensure highly reliable and accurate strain measurements. A stable internal reference source is applied to each channel to precisely determine the gain. To complete the gain calibration process, the reference voltage is also sent to the remote data acquisition system (via the RJ-45 connector-and-cable assembly) for precise measurement. Gain errors are recorded in memory for measurement compensation at run time. To further minimize error, the offset in each channel is measured by the system with the inputs to each amplifier grounded.

The traditional shunt calibration process is also available to ensure reliable bridge performance. Users may program the E1529A to select either the internal 50k Ohm shunt calibration resistor or an external user-selected resistor connected to the front-panel terminals.

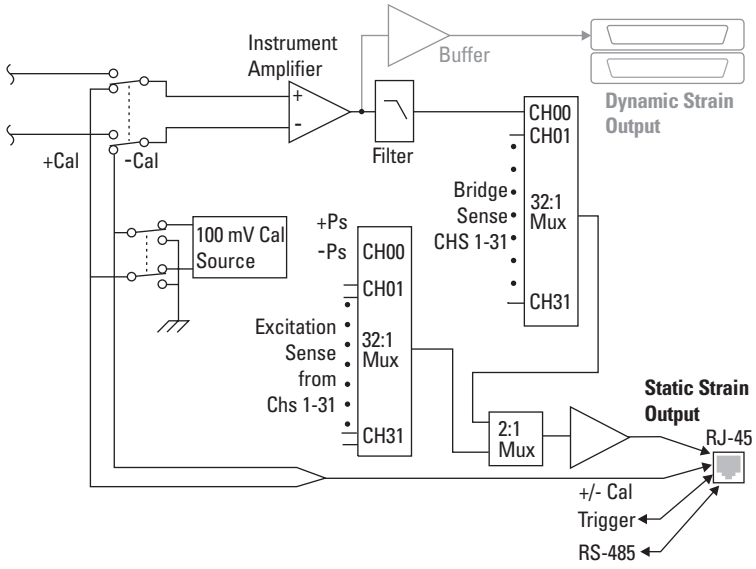
Programmable bridge completion circuitry



Half Bridge Configuration

Quarter Bridge Configuration

Internal calibration



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Versatile, low-cost wiring solutions

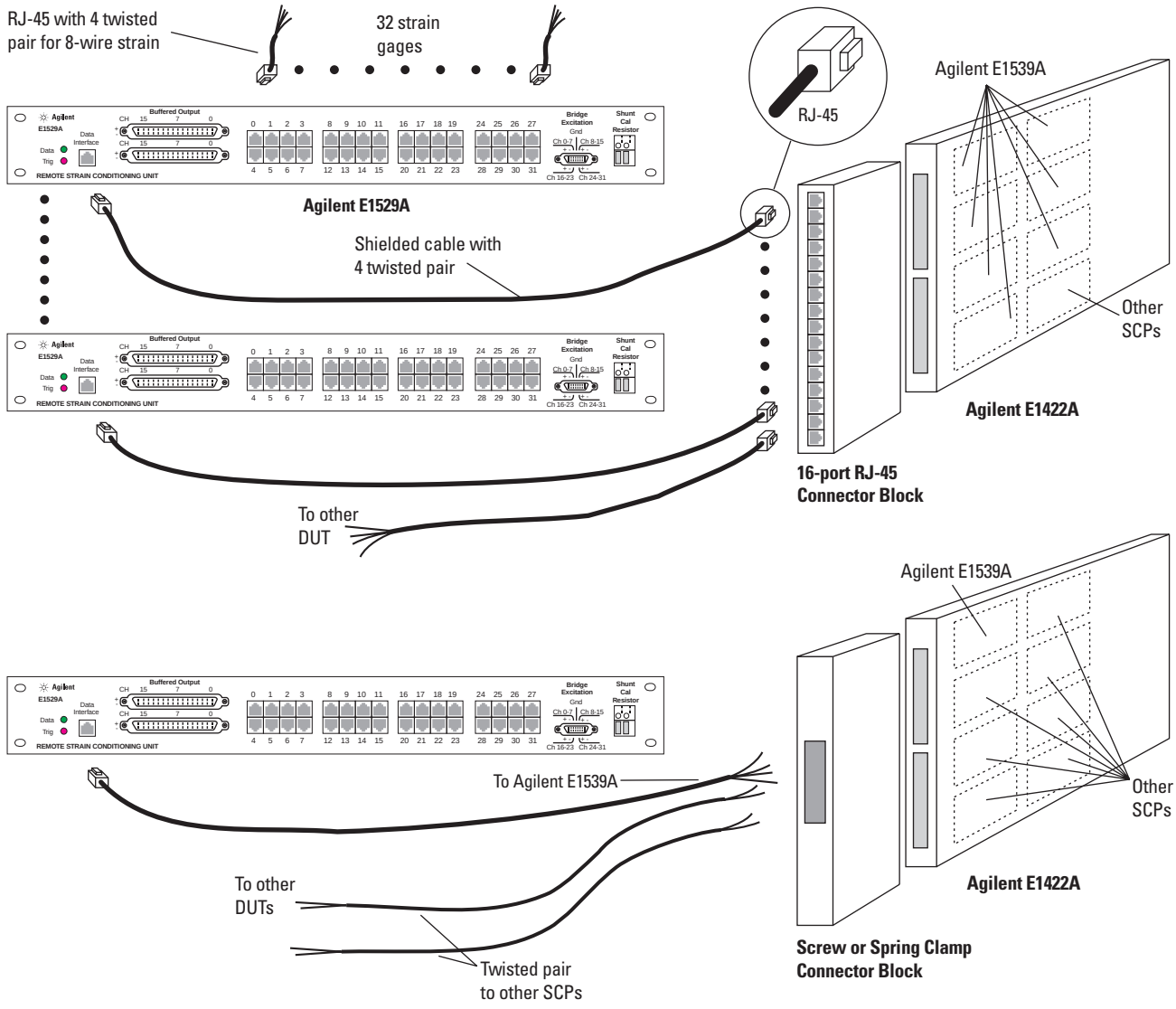
Systems wired with shielded cable and the RJ-45 telecom connector give the user a reliable and low-cost interconnecting solution for strain measurements. Inexpensive and readily available fastening tools let users quickly attach connectors to custom-made cables. This type of cable is used both for connecting strain gages to the E1529A strain-conditioning unit as well as for connecting the output of E1529A to the static measurement system.

For connecting strain gages, the shielded cable is terminated at one end with an RJ-45 connector. As shown in the figure, four twisted wire pairs provide eight strain gage connections.

For the interface between the E1529A and the E1422A, users have a choice of three E1422A accessories:

- 16-port RJ-45 connector block
- Screw terminal connector block
- Spring clamp connector block

Flexible wiring options



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These accessories attach to the front panel of the E1422A and provide signal routing to the SCPs inside.

The RJ-45 connector block is used for test setups having a large number of strain gages compared to the number of non-strain gage devices under test (DUTs). For this example, dual RJ-45 ended cables are used to connect the strain-conditioning unit to the 16-port RJ-45 connector block and E1422A. For cabling to other DUTs, the end opposite the RJ-45 connector remains free for connecting directly to the DUT. The four twisted wire pairs provide signal routing to four measurement channels.

Either the screw terminal or spring clamp connector blocks are used when the majority of test cabling connects to non-strain gage devices. In this case the instrument end of the RJ-45 cable remains free and its bare wires are fastened by screw terminals or spring clamps inside the connector block. Signals from this cable are routed to the E1539A SCP. Single twisted wire pairs are used to connect to other DUTs using other analog and digital input/output SCPs.

Measurement performance in the VXI standard architecture

Agilent's static and dynamic measurement equipment, available in the popular VXIbus industry standard, provides users some of the highest performance measurement capability available anywhere. Agilent's multichannel dynamic analyzers, the E1432A and E1433A, employ transducer signal conditioning, high-speed digitization, and alias protection. These analyzers also have on-board digital signal processing. The built-in DSP computes engineering units, does rapid data reduction, and calculates results directly in the time domain (peak and rms) or frequency domain (power spectra and FFTs). Because signal processing is built-in, the analyzer offloads the host computer, thus attaining the highest possible measurement throughput.

The E1422A is part of Agilent's family of scanning A/D VXI products. The E1422A, like its companion products, consists of a 64-channel multiplexer, 16-bit high-speed voltmeter, FIFO memory, auto calibration, and built-in controller. The E1422A is optimized for absolute DC accuracy and has 16-bit resolution at a sample rate of 25 kHz. Combined with on-the-fly auto-ranging, this provides 23 bits of measurement range. The scanning A/D works in conjunction with the E1539A remote channel SCP that provides the controlling interface to the E1529A and also routes the multiplexed strain bridge output to the multiplexer input of the E1422A. In addition to the E1529A, there is a large family of SCPs available to expand the measurement and control capability of the E1422A. These include a selection of gain, attenuator, and filter SCPs for analog signal conditioning, four-wire resistance, counter/totalizer, voltage and current D/As, digital I/O, and other SCPs for PID control.

Detailed information on these high-performance VXI products is available from Agilent. Please refer to the back page of this brochure for publication listings and Web addresses.

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Specifications

General	
Agilent E1529A outputs:	Single static output from 32:1 multiplexer 32 individually buffered dynamic outputs
Bridge completion:	120Ω, 350Ω and user installed, program selectable
Bridge configurations:	Full, half, and quarter
Remote operation:	330m (1000 ft) from multiiplexed output 100m (300 ft) from buffered outputs
Bridge excitation:	User-supplied excitation in 8-channel banks
Linearization:	Mx+b on all channels
Calibration:	Internal self-calibration source 50 kΩ and user-installed shunt calibration resistor, program selectable
Measurement rate:	25 kSa/s via multiplexed output, up to 196 kSa/s dynamic
Static (multiplexed) outputs:	
Gain (E1529A only) Gain (E1529A + E1422A) Resolution (1 LSB of E1422A)	32V per V 5000V per V 0.06 µV (subject to RMS noise limits)
Recommended measurement products:	Note: Companion products listed below are VXI-based. Twelve measurement module slots are typically available in systems using any one of Agilent's available 13-slot VXI mainframes.
Static strain measurements	E1422A Remote Channel DAC Module plus up to eight E1529A SCP
Dynamic strain measurements	E1432A 16-Chan 51.2 kSa/s Digitizer E1433A 8-Chan 196 kSa/s Digitizer

Bridge Specifications	
Completion resistors:	
Values	120/350Ω ± 0.05%, ±5 ppm/°C TC
Power	0.125W up to 125 °C
Shunt cal resistor:	50 kΩ ±0.1%, ±25 ppm/°C TC
Quarter bridge offset:	3 µstrain (±2 µV), ±4 °C of tare cal
Excitation sense:	
Gain accuracy	±0.01% of reading
Offset	<1 mV

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Strain Measurement

Measurement range (με) **(Quarter bridge, ±5V excitation)**	**Resolution (με)**	**RMS noise (με)**
±200,000		6.1 0.4
±50,000		1.5 0.4
±12,500		0.4 0.4
±3,125		0.1 0.4 (noise can be reduced by averaging)

System accuracy:	Note: After CAL routine, 1 hour warm-up, ±1 °C	
Voltage offset:	<2 µV	
Gain error:	<0.015% of reading	
RMS Noise:	<1 µV rms	
CMRR:	>100 dB, DC-10 MHz (common mode range ± 10V)	
Drift: Note: drift errors can be removed by running CAL routine	Offset drift Gain drift	<1 µV/°C <1 µV/month <30 ppm/°C

Dynamic outputs:

Gain:	32V per V ±0.1% of reading	
Offset:	<250 µV	
Bandwidth:	>100 kHz	
Equivalent input noise (E.I.N.):	<20 nV/$\sqrt{\text{Hz}}$	

Quarter Bridge Bending Errors: (5 V Excitation, GF=2)

με	**Error (με)**
-50,000	160
-40,000	90
-30,000	45
-20,000	20
-10,000	8
0	1
10,000	8
20,000	20
30,000	45
40,000	90
50,000	160

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Half Bridge Bending Errors: (5 V Excitation, GF=2)

με	Error (με)
-50,000	28
-40,000	23
-30,000	17
-20,000	12
-10,000	6
0	0.5
10,000	6
20,000	12
30,000	17
40,000	23
50,000	28

Full Bridge Bending Errors : (5 V Excitation, GF=2)

με	Error (με)
-50,000	28
-40,000	22
-30,000	17
-20,000	11
-10,000	6
0	0.3
10,000	6
20,000	11
30,000	17
40,000	22
50,000	28

Mechanical

Height:	4.45 cm (1.75 in)
Width:	49.53 cm (19.5 in)
Weight:	1.8 Kg (4 lbs)

Power Requirements

Line voltage:	90-264 Vac
Line frequency:	47-440 Hz
Input power:	8W

Environmental

Temperature:	-5 °C to +55 °C
Humidity:	5 to 85% R.H.
Altitude:	10,000 ft operating 30,000 ft non-operating

Warranty

Agilent E1529A:	1 year return to Agilent

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Ordering Information

Agilent E1529A*	32 Channel Remote Strain Conditioning Unit
Opt W01	Convert 3 yr. return to Agilent to 1 yr. onsite warranty
Opt W50	Convert 3 yr. return to Agilent to 5 yr. warranty
Agilent E1539A**	Remote Channel Signal Conditioning Plug-on
Agilent E1422A**	Remote Channel Multi-function DAC Module
Opt 001	16 Port RJ-45 Connector Block
Opt 011	Screw Terminal Connector Block
Opt 013	Spring Clamp Terminal Connector Block
Opt 0B0	Delete Manual
Opt W01	Convert 3 yr. return to Agilent to 1 yr. onsite warranty
Opt W50	Convert 3 yr. return to Agilent to 5 yr. warranty

* Note: The E1529A is shipped with a 3 meter (10 ft) cable with RJ-45 connectors on both ends. Cable and connector supplies and installation tools may be obtained from CABLENET Wiring Products, Inc., Englewood, CO 80112, (303) 799-0511.

** Note: One E1539A plug-on supports two E1529As and one E1422A supports up to eight E1539As. Refer to the E1422A Product Overview for details about this DAC module and its family of measurement and control plug-ons.

Related Agilent Literature

E1529A Specifications,
Pub. No. 5963-9650E

E1432A Technical Specifications,
Pub. No. 5965-7193E

E1432A/33A/34A Product Overview,
Pub. No. 5968-8729E

Test System and VXI Products Data Book,
Pub. No. 5968-7086E

On the Web, please go to
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Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

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