

VT1529B, VT1539A, and VT1422A

Strain, Voltage, and Temperature Measurement System



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



Remote Strain Conditioning and Voltage for Unit Stress and Fatigue Testing

Overview

The VXI Technology VT1529B Remote Strain Conditioning Unit simplifies stress and fatigue testing of large mechanical structures such as airframes and launch vehicles. The strain conditioning unit along with remotely-located data acquisition system provides high-quality static or dynamic strain measurements, voltage, and temperature*.

- Acquisition system provide high-quality static or dynamic strain measurements.
- Airframe structural and fatigue test
- Rocket and satellite structural test
- Wind tunnel flight load test

* Temperature measurements are made by connecting a VT1586A isothermal panel

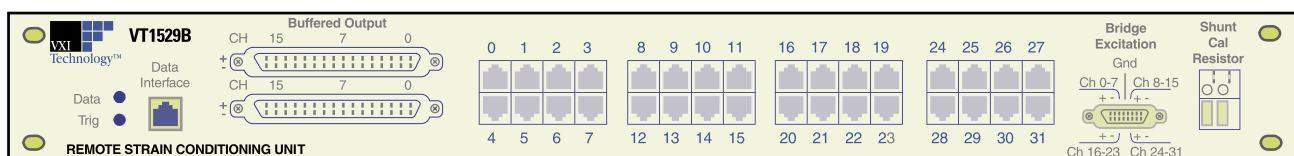
The VXI Technology VT1529B is designed to simplify stress and fatigue testing for groups that test large mechanical products. It features built-in signal conditioning and multiplexed connections, which reduce overall system cost.

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 the VT1422A for collecting static load data.

In addition, each channel of the VT1529B 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 VXI Technology design engineers has resulted in the qualification of the standard RJ-45 telecom connector as the ideal low-cost connector for strain gages. Not 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 VT1529B 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

VXI Technology provides a wide choice of measurement modules in the industry standard VXI architecture to complement the VT1529B remote channel strain conditioning unit. For highest speed measurements, the VT1433B digitizer plus DSP provides eight channels of individual 192 kSa/sec A/D complete with anti-aliasing filters. For medium speed measurements, the VT1432A digitizer plus DSP provides 16 channels of individual 51.2 kSa/sec A/D complete with anti-aliasing filters. The VT1433B and VT1432A are both C-size VXI modules.

The VT1422A remote channel DAC module, provides the setup and configuration of the VT1529B. This product also provides control of the VT1529B 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 VT1539A remote channel SCP (signal conditioning plug-on). Other SCPs – up to eight on each VT1422A – can be installed to provide I/O and various other analog, digital, and counter measurements.

Get results fast with high-level programming

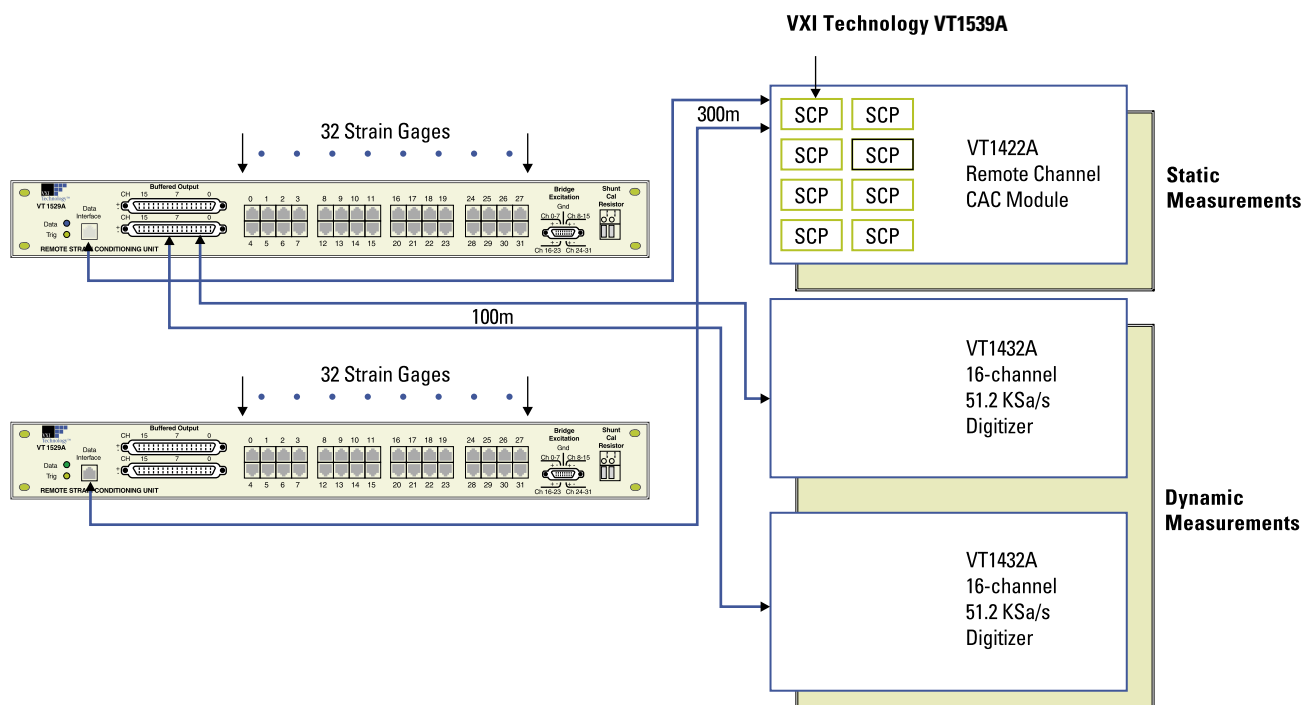
Programming the VT1529B is done through the VT1422A remote channel DAC module, the VT1539A remote channel SCP, and a powerful command set. Arbitrary measurement scans in any channel order or sequential scans with stated ranges are written in single program statements. This dramatically simplifies the 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 VT1529B and VT1422A 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 VT1422A can support up to 512 channels of strain measurements provided



by sixteen VT1529B remote strain conditioning units. Up to twelve VT1422As 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 VT1529B. 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 telecom 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, VXI Technology has chosen the RJ-45 telecom connector for use in the VT1529B. To ensure that this connector meets the requirements of a strain measuring system, the RJ-45 connector was subjected 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 mΩ for a 350Ω 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 mΩ (2.1 microstrain).

Tailoring a solution to the exact needs of the application is easy with the broad choice of available configurations in the VT1529B. 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.

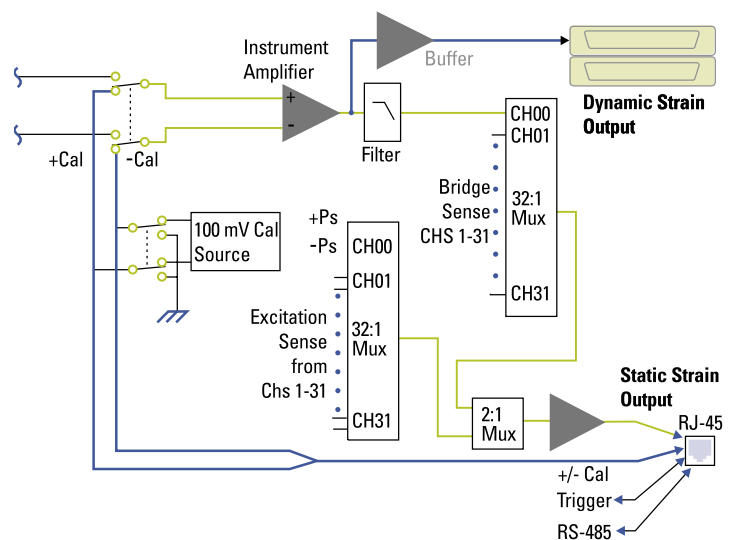
On-board calibration ensures confidence

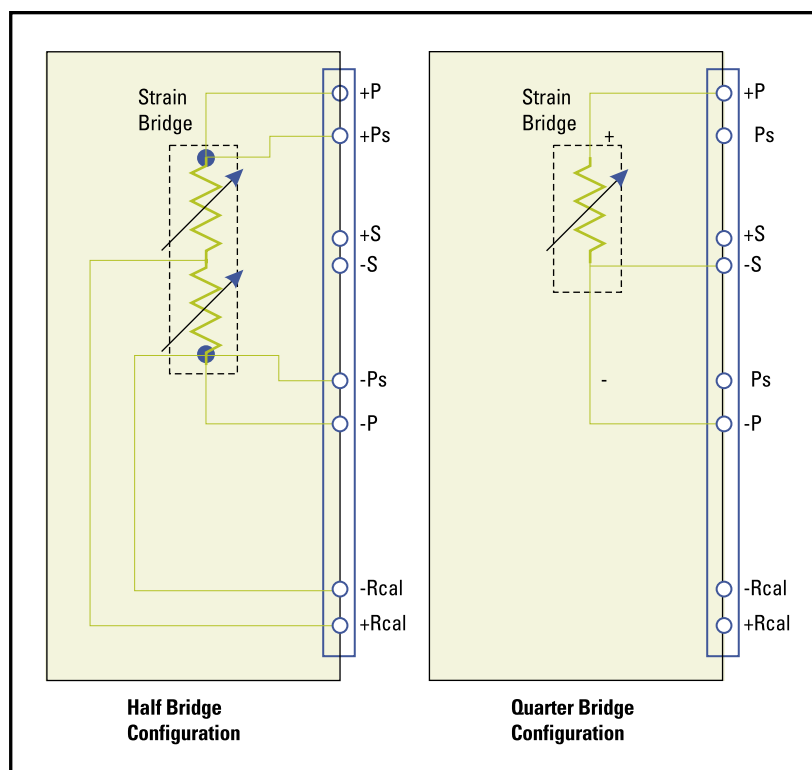
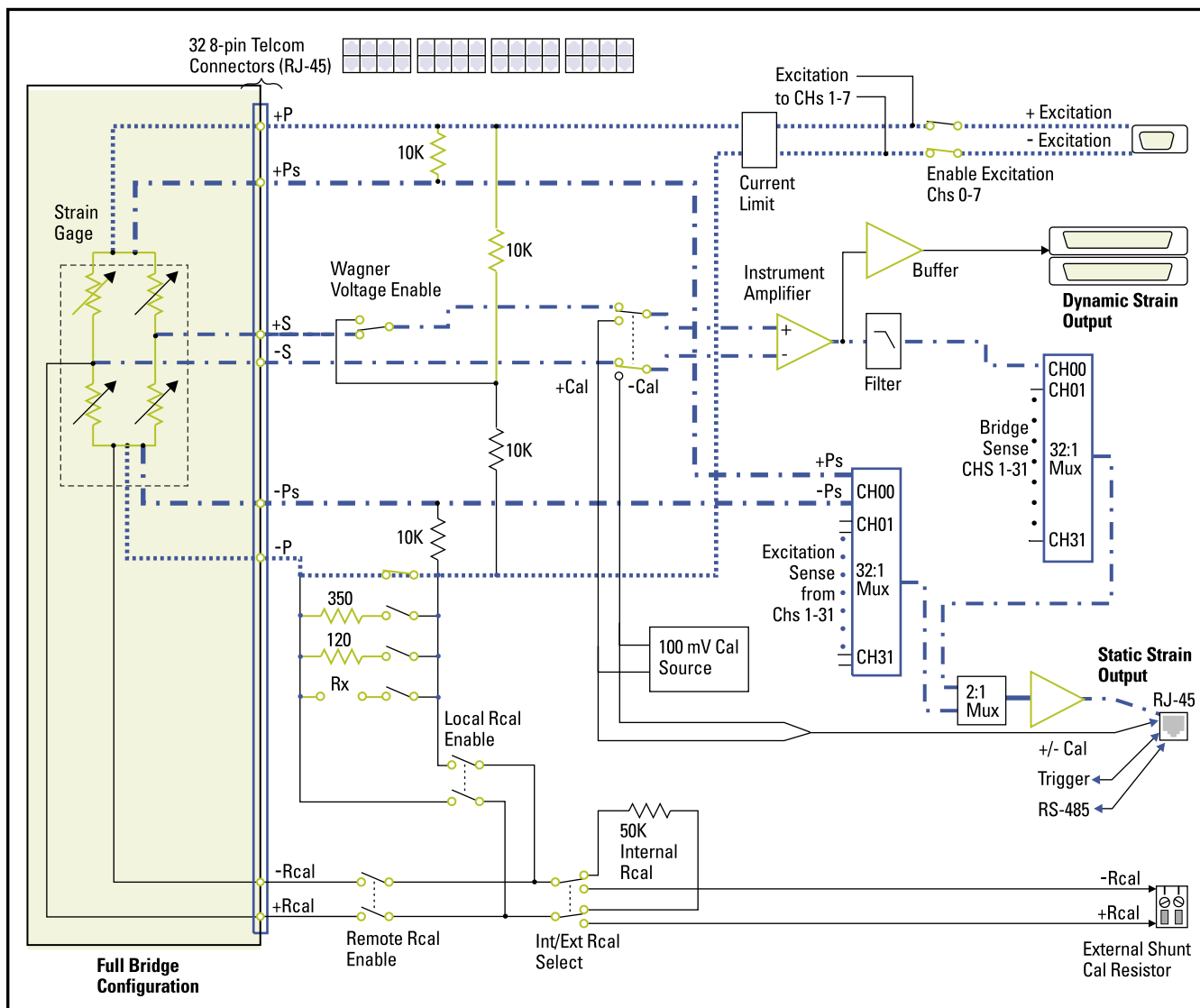
The VT1529B employs several techniques to ensure highly reliable and accurate strain measurements. A stable internal reference source is applied to each channel to precisely determine the gain. To complete the gain calibration process, the reference voltage is also sent to the remote data acquisition 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 VT1529B to select either the internal 50kΩ shunt calibration resistor or an external user-selected resistor connected to the front-panel terminals.

Versatile, low-cost wiring solutions

Systems wired with shielded cable and the RJ45 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 VT1529B strain-conditioning





unit as well as for connecting the output of VT1529B 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 VT1529B and the VT1422A, users have a choice of three VT1422A accessories:

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

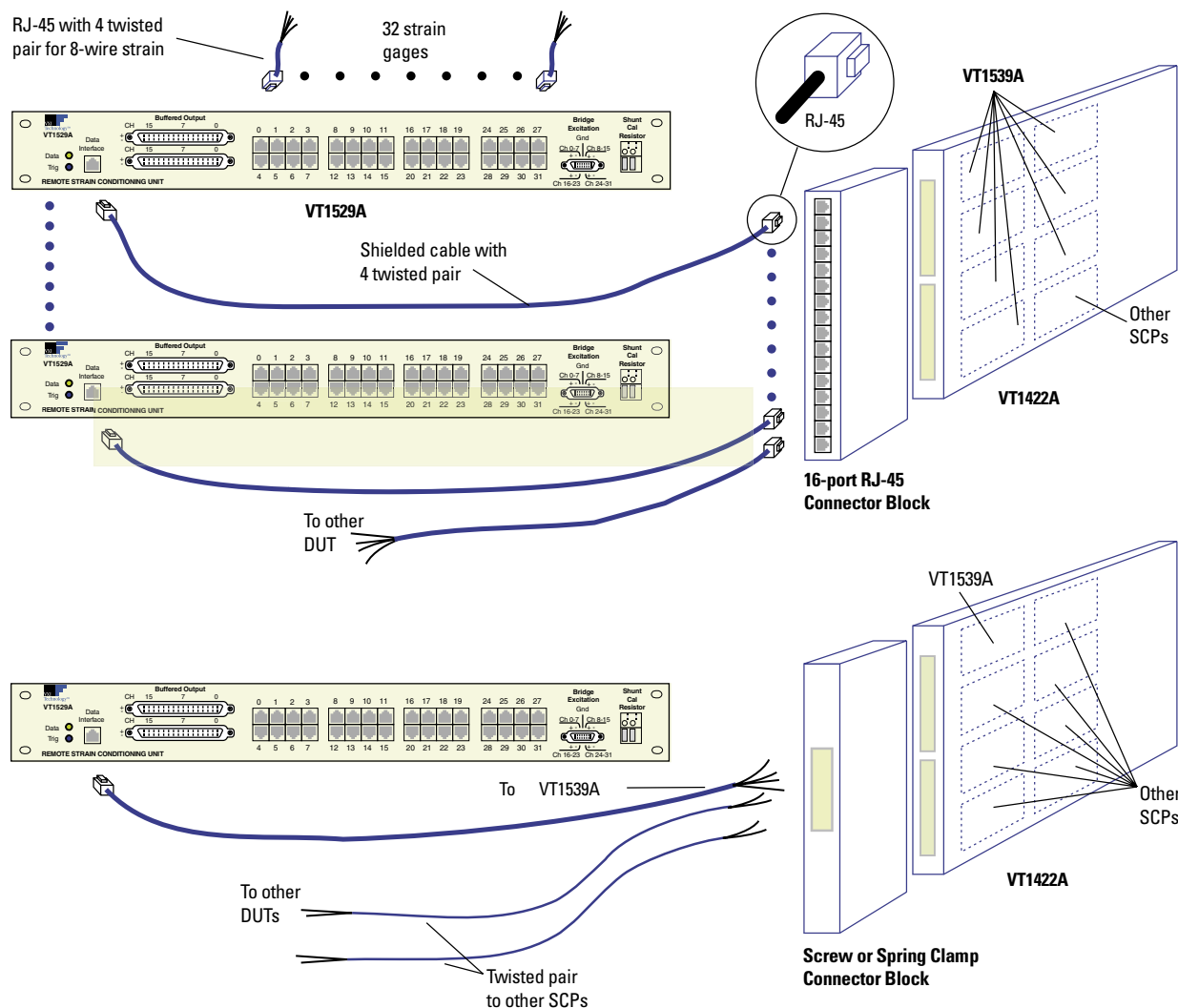
These accessories attach to the front panel of the VT1422A and provide signal routing to the SCPs inside.

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 VT1422A. 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 VT1539A 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

VXI Technology's static and dynamic measurement equipment, available in the popular VXIbus industry standard, provides users some of the highest performance measurement capability available anywhere. VXI Technology's multi-channel dynamic analyzers, the VT1432A and VT1433B, 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 VT1422A is part of VXI Technology's family of scanning A/D VXI products. The VT1422A, like its companion products, consists of a 64-channel multiplexer, 16-bit high-speed voltmeter, FIFO memory, auto calibration, and built-in controller. The VT1422A 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 VT1539A remote channel SCP that provides the controlling interface to the VT1529B and also routes the multiplexed strain bridge output to the multiplexer input of the VT1422A. In addition to the VT1529B, there is a large family of SCPs available to expand the measurement and control capability of the VT1422A. 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.

Specifications

VT1529B outputs: Single static output from 32:1 multiplexer. 32 individually buffered dynamic outputs

Bridge completion: 120 Ω , 350 Ω and user installed, program selectable

Bridge configurations: Full, half, and quarter

Remote operation: 330m(1000 ft.) from multiplexed 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 50k Ω 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 (VT1529B only) | 32V per V |
| Gain (VT1529B + VT1422A) | 5000V per V |
| Resolution (1 LSB of VT1422A) | 0.06 μ V (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 VXI Technology's available 13-slot VXI mainframes.

Static strain measurements:

| | |
|---------|--|
| VT1422A | Remote Channel DAC Module plus up to eight VT1539A SCP |
|---------|--|

Dynamic strain measurements:

| | |
|---------|---------------------------------|
| VT1432A | 16-Channel 51.2 kSa/s Digitizer |
| VT1433B | 8-Channel 196 kSa/s Digitizer |

Bridge Specifications

Completion resistors:

| | |
|--------|--|
| Values | 120 Ω /350 Ω \pm 0.05%, \pm 5 ppm/ $^{\circ}$ C TC |
| Power | 0.125W up to 125 $^{\circ}$ C |

Shunt cal resistor: 50 k Ω \pm 0.1%, \pm 25 ppm/ $^{\circ}$ C TC

Quarter bridge offset: 3 μ strain (\pm 2 μ V), \pm 4 $^{\circ}$ C of tare cal

Excitation sense:

| | |
|---------------|------------------------|
| Gain accuracy | \pm 0.01% of reading |
| Offset | <1 mV |

Strain Measurement

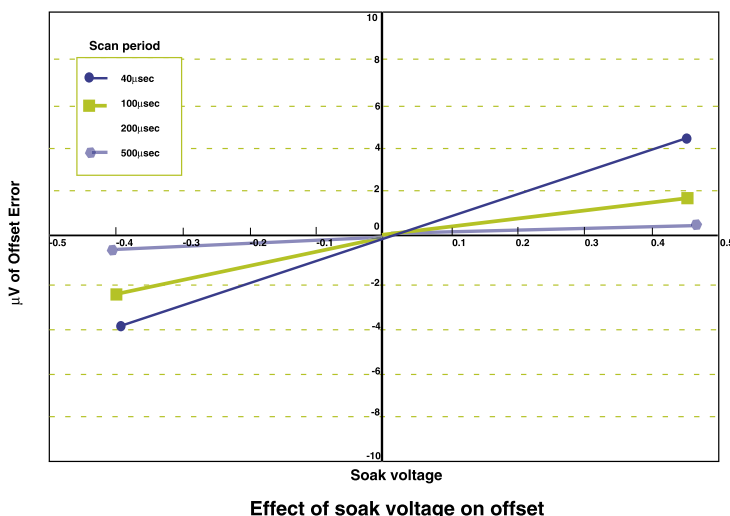
Measurement range ($\mu\epsilon$)

| (Quarter bridge, \pm 5V excitation) | Resolution ($\mu\epsilon$) | RMS noise ($\mu\epsilon$) |
|---------------------------------------|------------------------------|---|
| \pm 200,000 | 6.1 | 0.4 |
| \pm 50,000 | 1.5 | 0.4 |
| \pm 12,500 | 0.4 | 0.4 |
| \pm 3,125 | 0.1 | 0.4 (noise can be reduced by averaging) |

System accuracy: Note: After CAL routine, 1 hour warm-up, \pm 1 $^{\circ}$ C

Voltage offset: see figure 1

FIGURE 1



Effect of soak voltage on offset

Gain error: <0.015% of reading

RMS Noise: <1 μ V rms

CMRR: >100 dB, DC-10 MHz (common mode range \pm 10V)

Drift: Note: drift errors can be removed by running CAL routine

Gain drift: <30 ppm/°C
Offset drift: <1 µV/°C
<1 µV/month

Dynamic outputs:

Gain: 32V per V ±0.1% of reading

Offset: <250 µV

Bandwidth: >100 kHz

Equivalent input

noise (E.I.N.): <20 nV/√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 |

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 |

Voltage measurements

High level accuracy: 0.01%±0.5mV

High level drift: 0.001%/C±10µV/C

Low level accuracy: 0.015%±2µV(±10µVfor long term cable offsets)

Low level drift: .004%/C±1µV/C

Wagner resistors: 0.1%+25ppm/C

Voltage range: 0.5V for low level connection, 16V for high level input, balanced at chassis

Temperature Measurements

Thermocouple types: T.E.R.

Accuracy with 1% Completion Resistors: 0.33°C @ 25°C; 0.45°C @ 1000°C

Accuracy with 0.1% Completion Resistors: 0.08°C @ 25°C; 0.22°C @ 1000°C

With VT1586A isothermal panel: Add 0.3°C (temperature gradient & thermistor interchangeability)

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

Ordering Information

| | |
|-------------|--|
| VT1529B | 32-channel remote strain conditioning unit |
| VT1529B-001 | 16-channel dynamic output cable |
| VT1422A | Remote channel multifunction module |
| VT1422-001 | 16 port RJ-45 connector block |
| VT1422-011 | Screw terminal connector block |
| VT1422-013 | Spring clamp terminal block |
| VT1539A | Remote channel SCP |