VT1413C

64-channel Scanning A/D Converter

Features

- Comprehensive Signal Conditioning On Board
- Flexible Scanning/Auto Sequencing
- High-speed Data Transfers into Controller
- On-board Data Reduction and hi/low Limit Checking
- Signal Digitizing to 100 kHz Sampling Rate (*)

(* 100 kSa/s maximum sampling/scanning rate divided by the number of channels in the scan list, which can be 1 to 64.)

Overview

The VT1413C 64-channel Scanning A/D is a C-size, single slot, register-based VXI module. It is designed for high-performance data acquisition and computer-aided test applications. The key requirements of these applications are high-speed scanning, 16-bit resolution, high accuracy (0.01% of reading), 4 mV to 16 V full-scale input (60 V with VXI Technology VT1513A attenuator SCP), 64 kSample dual-ported FIFO buffer for fast data transfers, current value table for online monitoring, and automatic self-calibration. The available ranges are determined by the SCP used. An SCP is required for every input. Each SCP normally supplies input signal conditioning for eight (8) channels. See the individual SCP Data Sheet for more information.

The unique design of the analog subsystem provides a new level of density by combining a 16-bit A/D with a 64-channel differential FET multiplexer. Up to eight Signal Conditioning Plug-ons (SCPs), most with eight channels each, can be added to the VT1413C to provide additional capabilities (i.e., direct input, 10 Hz low-pass filtering, fixed gain/filter per channel, etc.).

Refer to the VXI Technology Website for instrument driver availability and downloading instructions, as well as for recent product updates, if applicable.

Multifunctional Measurement Capability

This module provides multifunction measurement capability within individual scans without any configuration re-programming. These include dc voltage, temperature, resistance, and strain.

Comprehensive Signal Conditioning On Board

A full range of signal conditioning is provided by optional Signal Conditioning Plug-on daughter boards (SCPs) that mount inside the VT1413C. Most SCPs buffer the signal to be measured and filter or amplify it before presenting it to the VT1413C's FET multiplexer and A/D converter. Other available SCPs provide more advanced functions such as sample-and-hold and strain bridge excitation and completion.

The SCPs supported by the VT1413C are:

Model No.	Description
VT1501A	8-channel Direct Input SCP
VT1502A	8-channel 7 Hz Low-pass Filter SCP
VT1503A	8-channel Programmable Filter and Gain SCP
VT1505A	8-channel Current Source SCP
VT1506A	8-channel 120 Ω Strain Completion & Excitation SCP
VT1507A	8-channel 350 Ω Strain Completion & Excitation SCP

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Model No.	Description
VT1508A	8-channel x16 Gain & 7 Hz Low-Pass Fixed Filter SCP
VT1509A	8-channel x64 Gain & 7 Hz Low-Pass Fixed Filter SCP
VT1510A	4-channel Sample & Hold Input SCP
VT1511A	4-channel Transient Strain SCP
VT1512A	8-channel 25 Low-Pass Hz Fixed Filter SCP
VT1513A	8-channel Divide-by-16 Fixed Attenuator & 7 Hz Low-pass Filter SCP
VT1518A	4-wire Resistance Measurement SCP

Refer to the information on each individual SCP for more details.

Flexible Scanning/Auto Sequencing

Measurement scans can be made in any channel order using any function on any channel, all at full speed, including auto-ranging. Up to four unique scan lists, each with up to 1,024 channel entries, can be stored in RAM and selected on the fly with a single software command. In addition, these scan lists can be automatically sequenced with a unique auto sequencing scan list. Lists can be sequenced so as to simplify the scanning of channels at different rates.

Other Features

High-speed Data Transfers into Controller

Data transfer speed has been greatly improved because multiple VT1413Cs can scan in parallel at full speed and then sequentially transfer data over the VXI backplane in D16 or D32 format at rates that match even the fastest embedded VXI computer. The data is transferred in computer-ready, IEEE-754, 32-bit floating-point real engineering unit format. Two on-board DSPs facilitate overall performance. The FIFO RAM is a dual-ported high-speed buffer that stores up to 64,000 samples until the controller is ready for efficient fast data transfer. For online monitoring, the Current Value Table RAM contains the most recently measured values for each channel in use. The CVT and FIFO RAMs can be accessed asynchronously.

On-board Data Reduction and Hi/Low Limit Checking

Averaging can be enabled on a scan basis to provide averaging for each channel over two to 256 samples in binary steps. The averaged data goes to both the CVT and the FIFO buffer. The maximum sample rate is 1.5 kSa/s per channel for 64 channels, although higher rates are possible with fewer channels. When averaging multiple channels in a scan list, scan list switching and auto-ranging are not allowed. This would distort the average. Individual high and low limits per channel can be downloaded to the VT1413C in engineering units format. If a limit is exceeded, an interrupt or trigger line can be pulled and the limit register can be read to determine the out-of-limit channel. A cumulative mode can be selected that holds the channel number of any out-of-limit reading since the last INIT command. The FIFO buffer can then be read to determine the actual out-of-limit readings.

Signal Digitizing

The VT1413C is suitable for digitizing of multichannel transient signals up to a 1 kHz sampling rate when used with the VT1510A 4-channel Sample & Hold Input SCP anti-aliasing filters. Digitizing higher frequency signals using the VT1501A 8-channel Direct Input SCP will require the use of external anti-aliasing filters. The scan trigger, either internally or externally generated, is used to initiate the channel samples controlled by the internal sample timer. The typical scan trigger jitter time is ±100 ps.

Signal Conditioning Plug-ons

A Signal Conditioning Plug-on (SCP) is a small daughter board that mounts on VXI Technology's VXI scanning measurement and control modules. These SCPs provide a number of input and output functions. Several include gain and filtered analog inputs for measuring electrical and sensor-based signals. Refer to the information on each individual SCP for more details.

Voltage Measurements

Use any of the following SCPs with the VT1413C to make voltage measurements: VT1501A, VT1502A, VT1503A, VT1508A, VT1509A, VT1512A, or VT1513A.

Temperature Measurements

Any of the input SCPs can be used to make temperature measurements with thermocouples, thermistors, or RTDs, but the VT1503A, VT1508A, VT1509A SCPs provide higher accuracy with thermocouples.

Resistance Measurements

Resistance is measured using the VT1505A 8-channel Current Source SCP and an input SCP or the VT1518A 4-wire Resistance Measurement SCP. Measurements are made by applying a dc current to the unknown and measuring the voltage drop across the unknown. The current source is provided through the VT1505A.

Static Strain Measurements

The VT1506A and VT1507A SCPs provide a convenient way to measure a few channels of static strain. When using the VT1506A/VT1507A for bridge completion, a second SCP is required to make the measurement connection. You can use the following SCPs for this type of static strain measurements:

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- **VT1503A 8-channel Programmable Filter/Gain SCP**
- **VT1506A 8-channel 120 Ω Strain Completion & Excitation SCP**
- **VT1507A 8-channel 350 Ω Strain Completion & Excitation SCP**
- **VT1508A 8-channel 7 Hz Fixed Filter & x16 Gain SCP**
- **VT1509A 8-channel 7 Hz Fixed Filter & x64 Gain SCP**

For applications requiring large channel counts of strain measurement, the EX1629 provides a more cost effective approach to static (and dynamic) strain measurements.

By using the latest surface mount technology in circuit design, it has been possible to combine 48 channels of strain conditioning into a single 19-inch rackmount enclosure that is only 1 ¾ inches high. This includes programmability of individual strain bridge configuration and completion, and an on-board calibration source.

Transient Measurements

When making higher speed measurements, a vital issue often is the time skew between channels. Ideally, in many applications, the sampled data is needed at essentially the same instant in time. The intrinsic design of the VT1413C provides scanning of 64 channels with maximum skew of 640 µs between the first and last channels, far less than most sampled data systems.

Transient Voltage Measurements

The VT1510A provides basic sample-and-hold capabilities on four channels. Six-pole Bessel filters provide alias and alias-based noise reduction while giving excellent transient response without overshoot or ringing. The VT1510A can be used in strain applications primarily where the bridge is external.

Transient Strain Measurements

The VT1511A and VT1521, double-wide SCPs, have all the capabilities of the VT1510A but add on-board bridge excitation and completion functions. The four direct input channels are used for monitoring the bridge excitation. A maximum of four SCPs (16 channels) can be installed on a VT1413C.

Automated Calibration for Better Measurements

The VT1413C offers superior calibration capabilities that provide more accurate measurements. Periodic calibration of the scanning A/D is accomplished by connecting an external voltage measurement standard (such as a highly accurate multimeter) to the inputs of the scanning A/D. This external standard first calibrates the on-board calibration source. Then built-in calibration routines use the on-board calibration source and on-board switching to calibrate the entire signal path from the scanning A/D's input, through the signal conditioning plug-ons (SCPs) and FET MUX, to the A/D itself. Subsequent daily or short-term calibrations of this same signal path can be quickly and automatically done using the internal calibration source to eliminate errors introduced by the signal path through the SCPs and FET MUX, or by ambient temperature changes. All 64 channels can be quickly and productively calibrated to assure continued high-accuracy measurements.

In addition to the calibration of the signal path within the scanning A/D, the VT1413C allows you to perform a "Tare Cal" to reduce the effects of voltage offsets and IR voltage drops in your signal wiring that is external to the scanning A/D. The Tare Cal uses an on-board D/A to eliminate these voltage offsets. By placing a short circuit across the signal or transducer being measured, the residual offset can be automatically measured and eliminated by the D/A. Tare Cal should not be used to eliminate the thermoelectric voltage of thermocouple wire on thermocouple channels.

Configuration

Twelve VT1413C modules may be used in a 13-slot, C-size mainframe for a total of 768 channels. A C-size configuration using MXIbus allows you to link together multiple mainframes on a single backplane for larger scanning A/D systems
Note: For field wiring, the use of shielded twisted pair wiring is highly recommended.

Timing Signals

Timing:	Scan-to-scan timing and sample-to-sample timing can be set independently.
Scan triggers:	Can be derived from a software command or a TTL level from other VXI modules, internal timer, or external hardware. Typical latency 17.5 µs.
Synchronization:	Multiple VT1413C modules can be synchronized at the same rate using the TTL trigger output from one VT1413C to trigger the others.
Alternate synchronization:	Multiple VT1413C modules can be synchronized at different integer-related rates using the scan timer/N mode and the TTL trigger output from one VT1413C module to trigger the others.

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64-channel Scanning A/D Converter

Scan Triggers

Internal: 100 µs to 6.5536 s

Resolution: 100 µs

Trigger count: 1 to 65535 or infinite

Sample Timer

Range: 10 µs to 32768 ms

Resolution: 0.5 µs

Measurement Specifications

The following specifications include the SCP and scanning A/D performance together as a unit. Accuracy is stated for a single sample. Averaging multiple samples will improve accuracy by reducing noise of the signal. The basic VT1413C scanning A/D has a full-scale range of ±16 V and five auto-ranging gains of x1, x4, x16, x64, and x256. An SCP must be used with each eight channel input block to provide input protection and signal conditioning. Refer to the information on each individual SCP for measurement specifications.

Measurement resolution: 16 bits (including sign)

Maximum reading rate: 100 kSa/s divided by the number of channels in the scan.

For example:
100k/64 = 1.56 k/Sa/s per channel
100k/16 = 6.25 k/Sa/s per channel

Memory: 64 kSa

Maximum input voltage: Normal mode plus common mode
Operating: ±16 V peak
Damage level: ±42 V peak

Maximum common mode voltage:
Operating: ±16 V peak
Damage level: ±42 V peak

SCP input impedance: 100 mΩ differential

Maximum tare cal offset: 62.5 mV range ±75% of full-scale other ranges ±25% of full-scale

Jitter
Phase jitter scan-to-scan: 80 ps rms
Phase jitter card-to-card: 41 ns peak 12 ns rms

Measurement Accuracy

Specifications are 90 days, 23 °C ± 1 °C, with *CAL done after a 1 hr warm-up and CAL:ZERO done within 5 minutes. Note: Beyond the 5 min limitation and CAL:ZERO not done, apply the following drift error: Drift = 10 µV/°C ÷ SCP gain, per °C change from CAL:ZERO temperature.

Accuracy Data

Measurement accuracy is dependent upon the SCP module used. Refer to the accuracy tables and graphs for the individual SCP to determine the overall measurement accuracy.

Many definitions of accuracy are possible. Here we use single-shot with 3 sigma noise. To calculate accuracy assuming temperature is held constant within ±1°C of the temperature at calibration, the following formula applies:

$$\text{Single Shot } 3\sigma = \pm(\sqrt{((\text{GainError})^2 + (\text{OffsetError})^2 + (3\sigma\text{noise})^2)})$$

Correcting for Temperature

To calculate accuracy over temperature range outside the ±1 °C range, results after *CAL are given by replacing each of the above error terms as follows:

Replace
$(\text{GainError})^2$
with
$(\text{GainError})^2 + (\text{GainTempco})^2$
Replace
$(\text{OffsetError})^2$
with
$(\text{OffsetError})^2 + (\text{OffsetTempco})^2$

Power Available for SCPs
±24 V: 1 A
5 V: 3.5 A

VT1413C

64-channel Scanning A/D Converter, C-Size

VXI Characteristics

VXI device type:	Register based
Data transfer bus:	A16/A24
Size:	C
Slots:	1
Connectors:	P1/2
Shared memory:	n/a
VXI buses:	TTL Trigger bus
Drivers:	VXI*plug&play* with Source Code

Instrument Drivers - See the VXI Technology Website www.vxitech.com for driver availability and downloading.

ACCESSORIES

73-0024-002, Option 011 Screw Terminal Connector Block

73-0024-003, Option 013 Spring Clamp Terminal Connector Block

73-0024-004, Option A3F Interface to Rackmount Terminal Panel

Ordering Information

VT1413C	Scanning A/D Converter, includes spring clamp terminal block
VT1413C-02	Scanning A/D Converter, includes screw connector terminal block
VT1413C-A3F	Interface to rackmount terminal panel
VT1501A	8-channel Direct Input SCP
VT1502A	8-channel 7 Hz Low-pass Filter SCP
VT1503A	8-channel Programmable Filter/Gain SCP
VT1505A	8-channel Current Source SCP
VT1506A	8-channel 120 Ω Strain Completion & Excitation SCP
VT1507A	8-channel 350 Ω Strain Completion & Excitation SCP
VT1508A	8-channel x16 Gain & 7 Hz Fixed Filter SCP
VT1509A	8-channel x64 Gain & 7 Hz Fixed Filter SCP
VT1510A	4-channel Sample & Hold Input SCP
VT1511A	4-channel Transient Strain SCP
VT1512A	8-channel 25 Hz Fixed Filter SCP
VT1513A	8-channel ÷ 16 Fixed Attenuator & 7 Hz Low-pass Filter SCP
VT1518A	4-wire Resistance Measurement SCP
VT1521	4-channel High-Speed Bridge SCP