ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *National Instruments SCXI-1315* at our website: ***Click HERE***

SCXI 8-Channel LVDT Input Module

NI SCXI-1540

- 8 channels
- Programmable input range per channel (0.05 to 6 V_{rms})
- Programmable 1 or 3 V_{rms} excitation per channel at 2.5, 3.3, 5, or 10 kHz
- Multichannel synchronization
- 333 kS/s maximum sampling rate (250 Hz output bandwidth)
- Autocalibration in case excitation required differs from level and frequency SCXI-1540 provides
- 4 or 5-wire connections
- Synchronization to external excitation frequency available
- Random scanning
- Lowpass filter (250 Hz)
- NI-DAQ driver software simplifies configuration, measurement, and scaling

Operating Systems
- Windows 2000/NT/XP

Recommended Software
- LabVIEW
- LabWindows/CVI
- Measurement Studio
- VI Logger

Driver Software
- NI-DAQ 7

Calibration Certificate Included

See page 21



Overview

The National Instruments SCXI-1540 8-channel linear variable differential transformers (LVDT) module provides the necessary conditioning to measure signals from transformer-based ratiometric position sensors, including LVDTs, rotary variable differential transformers (RVDTs), and resolvers. The NI SCXI-1540 offers both 4 and 5-wire connections for LVDTs and RVDTs. In addition, this module offers autocalibration without external hardware using NI-DAQ. As part of an SCXI system, you can scan the analog input channels of the SCXI-1540 along with other modules at rates up to 333 kS/s (3 µs per channel). Each of these modules can multiplex its signals into a single channel of the data acquisition (DAQ) device, and you can add modules to increase channel count. With random scanning capabilities, you select only the channels from which you want to acquire data.

Analog Input

Each of the eight analog inputs consists of an instrumentation amplifier, a variable gain stage, a demodulation circuit, and a lowpass filter. You can program each channel individually for a full-scale input within the range 0.05 to 6.0 V_{rms}. With 31 gain settings, you can obtain the full resolution of your DAQ device for any input range. The demodulation signal originates from the local oscillator for the 4-wire mode and originates from the input signal for the 5-wire mode. Each input is protected to ±30 V. The lowpass filter bandwidth on the output is set at 250 Hz.

Excitation

Each channel of the SCXI-1540 includes an AC voltage source for exciting LVDTs, RVDTs, and resolvers. You can set the excitation at 1 or 3 V_{rms} and at a frequency of 2.5, 3.3, 5, or 10 kHz. Each excitation output is protected with surge arrestors to prevent damage from accidental external voltages. Each channel also includes a provision for synchronizing its output to the excitation of another channel. Synchronization prevents the occurrence of beat signals between channels where cable crosstalk is a problem.

Calibration

You can autocalibrate the SCXI-1540 at anytime using a standard NI-DAQ function or LabVIEW VI. You need not disconnect sensor wiring to perform an autocalibration. The output is internally wrapped back to the input so that you can account for errors in both excitation and input circuitry. Correction constants from the autocalibration are stored in the EEPROMs located on each module. NI-DAQ driver software transparently uses these constants to correct for the gain and offset error of each channel.

Module	LVDTs	RVDTs	Resolvers
SCXI-1540	✓	✓	✓

Table 1. Signal Compatibility

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

SCXI 8-Channel LVDT Input Module

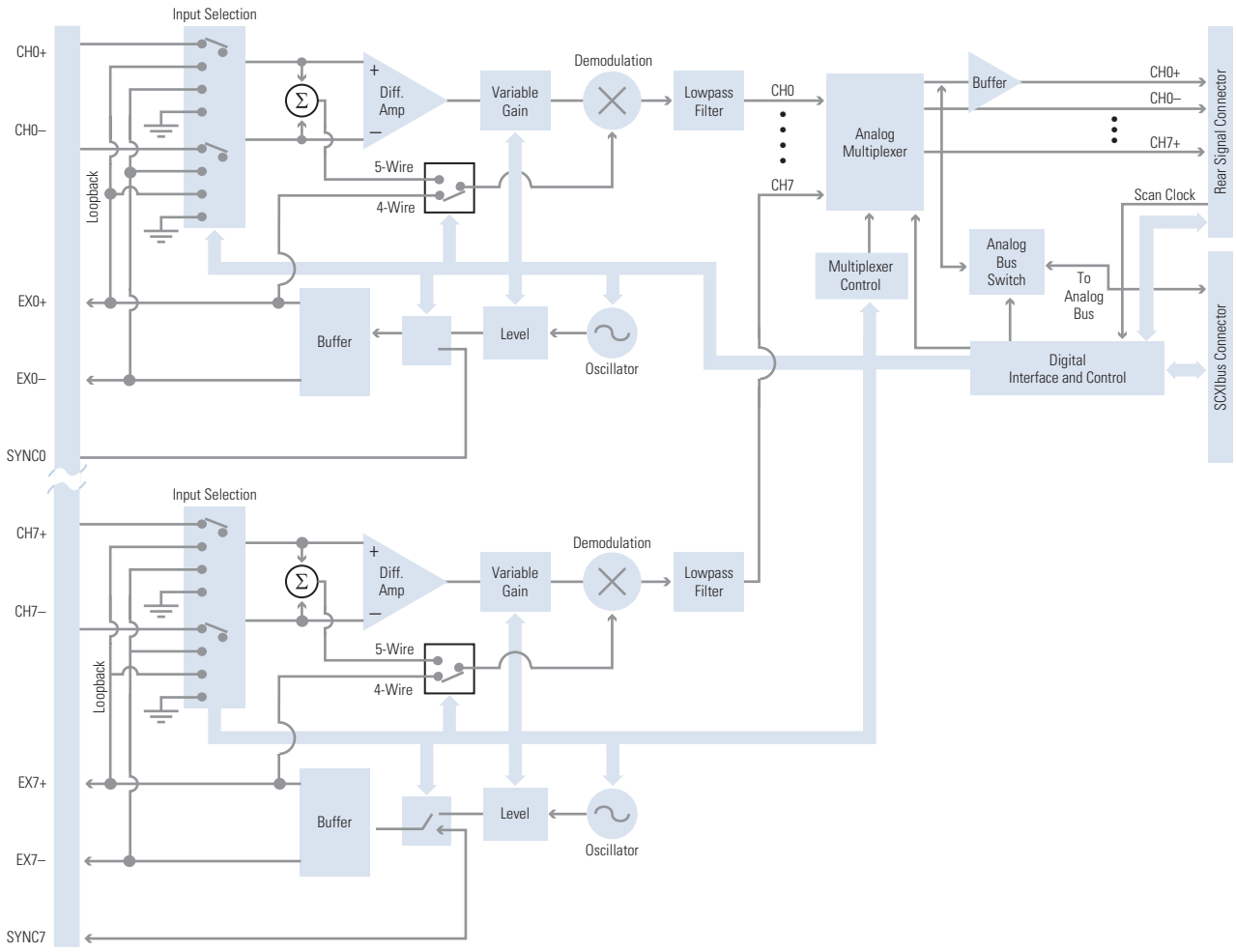


Figure 1. SCXI-1540 Block Diagram

Terminal Block	Part Number	Type	Compatible Modules	Page
SCXI-1315	777687-15	Screw terminals	SCXI-1540 front-mounting	329

Table1. Terminal Block Options for the SCXI-1540

Ordering Information

NI SCXI-1540 777966-40

For information on extended warranty and value-added services, see page 20.

BUY ONLINE!

Visit ni.com/info and enter scxi1540.

See page 276 to configure your complete SCXI system.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

SCXI 8-Channel LVDT Input Module

Specifications

These specifications are typical at 25 °C unless otherwise noted.

Absolute Accuracy

Input Range	Exitation Frequency (kHz)	Percent of Reading		Maximum Offset	System Noise (Peak, % of Full Scale)		Temperature Drift (%FSR/°C)	
		Typical	Maximum	Percent Full Scale	Single Pt.	100 Pt. Avg.	Gain Drift	Offset Drift
All input ranges	2.5	±0.2%	±0.5%	±0.05%	±0.03%	±0.01%	±0.03	±0.003
	3.3	±0.2%	±0.5%	±0.05%	±0.03%	±0.01%	±0.03	±0.003
	5	±0.2%	±0.5%	±0.05%	±0.03%	±0.01%	±0.03	±0.003
	10	±0.2%	±1.0%	±0.05%	±0.03%	±0.01%	±0.03	±0.003

One year specifications. Includes error added by 16-bit E Series MIO immediately after an E Series internal calibration. Absolute accuracy is (reading) x (% of reading) + FSR x (offset + system noise). If module temperature is beyond the range 15 to 35 °C, include the added term FSR x [(gain drift) x (reading) + offset] x T, where T is the absolute temperature difference between the module and 15 or 35 °C, whichever is smaller.

To calculate the absolute accuracy for the SCXI-1540, refer to page 194 or visit *ni.com/accuracy*

Input Range

Input range, gain, and required DAQ device limits

Input Range (V_{rms})	Gain Setting (VDC Out/V_{rms} In)	DAQ Device Input Limits (V)
6.00	0.80	±5.0
5.50	0.90	±5.0
5.00	1.00	±5.0
4.50	1.10	±5.0
4.00	1.25	±5.0
3.50	1.40	±5.0
3.00	1.60	±5.0
2.70	1.80	±5.0
2.50	2.00	±5.0
2.20	2.20	±5.0
2.00	2.50	±5.0
1.70	2.80	±5.0
1.50	3.20	±5.0
1.35	3.60	±5.0
1.25	4.00	±5.0
1.10	4.50	±5.0
1.00	5.00	±5.0
0.85	5.60	±5.0
0.75	6.30	±5.0
0.70	7.00	±5.0
0.62	8.00	±5.0
0.55	9.00	±5.0
0.50	10.00	±5.0
0.45	11.00	±5.0
0.40	12.50	±5.0
0.35	14.00	±5.0
0.31	16.00	±5.0
0.27	18.00	±5.0
0.25	20.00	±5.0
0.22	22.00	±5.0
0.20	25.00	±5.0
0.10	25.00	±2.5
0.05	25.00	±1.0

Input impedance ..... 100 k +2%
Frequency response ..... 250 Hz LPF, 4-pole butterworth
Input connections ..... 4 or 5-wire
Synchronization ..... Internal or external
Residual ripple and noise ..... < 0.1% peak of full scale
Nonlinearity ..... < 0.1% of full scale maximum
0.05% of full scale typical
Output range ..... ±5.0 V
Output offset drift ..... ±70 µV/°C maximum
Input gain ..... See input range
Input gain accuracy ..... ±2%[1]
Gain drift ..... ±300 ppm/°C maximum
Common-mode rejection ratio ..... > 60 dB maximum
75 dB typical
Maximum input working voltage ..... 6 V_{rms}
Overvoltage protection power on or off ..... 32 V_{rms}

Excitation

Frequency ..... 2.5 kHz ±10%
3.3 kHz ±10%
5.0 kHz ±10%
10.0 kHz ±10%

Level

Low setting ..... 3 V_{rms} ±5%[1]
High setting ..... 1 V_{rms} ±5%[1]
Minimum AC load impedance ..... 32 for 1 V_{rms} setting
95 for 3 V_{rms} setting

Control

The gain, excitation frequency, excitation level, connection type, and external synchronization (enable/disable) are set on a per-channel basis through software. There are no jumpers.

Physical

Dimensions ..... 3.0 by 17.2 by 20.3 cm
(1.2 by 6.9 by 8.0 in.)
Rear connector ..... 50-pin male ribbon cable
Front connector ..... 96-pin male DIN C

Environment

Operating temperature ..... 0 to 50 °C
Storage temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 90% noncondensing

Electromagnetic Compatibility

EMC emissions ..... Refer to the document supplied with the chassis for compliance with relevant directives.
EMI ..... FCC Class A compliant

[1]This is the error before correction in software. Input gain error, excitation level error, and output offset error are accounted for in the software correction coefficients stored in the onboard EEPROM. These constants are applied automatically when using LabVIEW or the NI-DAQ function SCXI_Scale. The specifications in the Absolute Accuracy Table indicate overall accuracy of the SCXI-1540, including the application of the software correction coefficients.

For a definition of specific terms, please visit *ni.com/glossary*.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Multifunction DAQ and SCXI Signal Conditioning Accuracy Specifications Overview

Every Measurement Counts

There is no room for error in your measurements. From sensor to software, your system must deliver accurate results. NI provides detailed specifications for our products so you do not have to guess how they will perform. Along with traditional data acquisition specifications, our E Series multifunction data acquisition (DAQ) devices and SCXI signal conditioning modules include accuracy tables to assist you in selecting the appropriate hardware for your application.

To calculate the accuracy of NI measurement products, visit ni.com/accuracy

Absolute Accuracy

Absolute accuracy is the specification you use to determine the overall maximum tolerance of your measurement. Absolute accuracy specifications apply only to successfully calibrated DAQ devices and SCXI modules. There are four components of an absolute accuracy specification:

- **Percent of Reading** – is a gain uncertainty factor that is multiplied by the actual input voltage for the measurement.
- **Offset** – is a constant value applied to all measurements.
- **System Noise** – is based on random noise and depends on the number of points averaged for each measurement (includes quantization error for DAQ devices).
- **Temperature Drift** – is based on variations in your ambient temperature.
- **Input Voltage** – the absolute magnitude of the voltage input for this calculation. The fullscale voltage is most commonly used.

Based on these components, the formula for calculating absolute accuracy is:

Absolute Accuracy = ±[(Input Voltage X % of Reading) + (Offset + System Noise + Temperature Drift)]

Absolute Accuracy RTI[1] = (Absolute Accuracy Input Voltage)
[1]RTI = relative to input

Temperature drift is already accounted for unless your ambient temperature is outside 15 to 35 °C. For instance, if your ambient temperature is at 45 °C, you must account for 10 °C of drift. This is calculated by:

Temperature Drift = Temperature Difference x % Drift per °C x Input Voltage

Absolute Accuracy for DAQ Devices

Absolute Device Accuracy at Full Scale is a calculation of absolute accuracy for DAQ devices for a specific voltage range using the maximum voltage within that range taken one year after calibration, the Accuracy Drift Reading, and the System Noise averaged value.

Below is the Absolute Accuracy at Full Scale calculation for the NI PCI-6052E DAQ device after one year using the ±10 V input range while averaging 100 samples of a 10 V input signal. In all the Absolute Accuracy at Full Scale calculations, we assume that the ambient temperature is between 15 and 35 °C. Using the Absolute Accuracy table on the next page, we see that that the calculation for the ±10 V input range for Absolute Accuracy at Full Scale yields 4.747 mV. This calculation is done using the parameters in the same row for one year Absolute Accuracy Reading, Offset and Noise + Quantization, as well as a value of 10 V for the input voltage value. You can then see that the calculation is as follows:

Absolute Accuracy = ±[(10 X 0.00037) + 947.0 µV + 87 µV] = ±4.747 mV

In many cases, it is helpful to calculate this value relative to the input (RTI). Therefore, you do not have to account for different input ranges at different stages of your system.

Absolute Acuracy RTI = (±0.004747/10) = ±0.0475%

The following example assumes the same conditions except that the ambient temperature is 40 °C. You can begin with the calculation above and add in the Drift calculation using the % Drift per °C from Table 2 on page 196.

Absolute Accuracy = 4.747 mV + ((40 – 35 °C) x 0.000006 /°C X 10 V) = ±5.047 mV

Absolute Acuracy RTI = (±0.005047/10) = ±0.0505%

Absolute Accuracy for SCXI Modules

Below is an example for calculating the absolute accuracy for the NI SCXI-1102 using the ±100 mV input range while averaging 100 samples of a 14 mV input signal. In this calculation, we assume the ambient temperature is between 15 and 35 °C, so Temperature Drift = 0. Using the accuracy table on page 313, you find the following numbers for the calculation:

Input Voltage = 0.014
% of Reading Max = 0.02% = 0.0002
Offset = 0.000025 V
System Noise = 0.000005 V

Absolute Accuracy = ±[(0.014 x 0.0002) + 0.000025 + 0.000005] V = ±32.8 µV

Absolute Accuracy RTI = ±(0.0000328 / 0.014) = ±0.234 %

The following example assumes the same conditions, except the ambient temperature is 40 °C. You can begin with the Absolute Accuracy calculation above and add in the Temperature Drift.

Absolute Accuracy = 32.8 µV + (0.014 x 0.000005 + 0.000001) x 5 = ±38.15 µV

Absolute Accuracy RTI = ±(0.00003815 / 0.014) = ±0.273 %

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Multifunction DAQ and SCXI Signal Conditioning Accuracy Specifications Overview

For both DAQ devices and SCXI modules, you should use the Single-Point System Noise specification from the accuracy tables when you are making single-point measurements. If you are averaging multiple points for each measurement, the value for System Noise changes. The Averaged System Noise in the accuracy tables assumes that you average 100 points per measurement. If you are averaging a different number of points, use the following equation to determine your Noise + Quantization:

$$\text{System Noise} = \text{Average System Noise from table} \times \sqrt{(100/\text{number of points})}$$

For example, if you are averaging 1,000 points per measurement with the PCI-6052E in the ±10 V (±100 mV for the SCXI-1102) input range, System Noise is determined by:

NI PCI-6052E**
System Noise= 87.0 0 µV x $\sqrt{(100/1000)}$ = 27.5 0 µV

NI SCXI-1102
System Noise= 5 µV x SQRT $\sqrt{(100/1000)}$ = 1.58 µV

**The System Noise specifications assume that dithering is disabled for single-point measurements and enabled for averaged measurements.

See page 21 or visit ni.com/calibration for more information on the importance of calibration on DAQ device accuracy.

Absolute System Accuracy

Absolute System Accuracy represents the end-to-end accuracy including the signal conditioning and DAQ device. Because absolute system accuracy includes components set for different input ranges, it is important to use Absolute Accuracy RTI numbers for each component.

$$\text{Total System Accuracy RTI} = \pm\text{SQRT}\,[(\text{Module Absolute Accuracy RTI})2 + (\text{DAQ Device Absolute Accuracy RTI})2]$$

The following example calculates the Absolute System Accuracy for the SCXI-1102 module and PCI-6052E DAQ board described in the first examples:

$$\text{Total System Accuracy RTI} = \pm\sqrt{[(0.00273)2 + (0.000505)2]} = \pm 0.278\%$$

Units of Measure

In many applications, you are measuring some physical phenomenon, such as temperature. To determine the absolute accuracy in terms of your unit of measure, you must perform three steps:

1. Convert a typical expected value from the unit of measure to voltage
2. Calculate absolute accuracy for that voltage
3. Convert absolute accuracy from voltage to the unit of measure

Note: it is important to use a typical measurement value in this process, because many conversion algorithms are not linearized. You may want to perform conversions for several different values in your probable range of inputs, rather than just the maximum and minimum values.

For an example calculation, we want to determine the absolute system accuracy of an NI SCXI-1102 system with a NI PCI-6052E, measuring a J-type thermocouple at 100 °C.

1. A J-type thermocouple at 100 °C generates 5.268 mV (from a standard conversion table or formula)
2. The absolute accuracy for the system at 5.268 mV is ±0.82%. This means the possible voltage reading is anywhere from 5.225 to 5.311 mV.
3. Using the same thermocouple conversion table, these values represent a temperature spread of 99.3 to 100.7 °C.

Therefore, the absolute system accuracy is ±0.7 °C at 100 °C.

Benchmarks

The calculations described above represent the maximum error you should receive from any given component in your system, and a method for determining the overall system error. However, you typically have much better accuracy values than what you obtain from these tables.

If you need an extremely accurate system, you can perform an end-to-end calibration of your system to reduce all system errors. However, you must calibrate this system with your particular input type over the full range of expected use. Accuracy depends on the quality and precision of your source.

We have performed some end-to-end calibrations for some typical configurations and achieved the results in Table 1:

To maintain your measurement accuracy, you must calibrate your measurement system at set intervals over time.

For a current list of SCXI signal conditioning products with calibration services, please visit ni.com/calibration

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Multifunction DAQ and SCXI Signal Conditioning Accuracy Specifications Overview

Module	Empirical Accuracy
SCXI-1102	±0.25 ˚C at 250 ˚C ±24 mV at 9.5 V
SCXI-1112	±0.21 ˚C at 300 ˚C
SCXI-1125	±2.2 mV at 2 V

Table 1. Possible Empirical Accuracy with System Calibration

		Absolute Accuracy							Relative Accuracy	
Nominal Range (V)		% of Reading			System Noise (mV)		Temp Drift	Absolute Accuracy	Resolution (µV)	
Positive FS	Negative FS	24 Hours	1 Year	Offset (µV)	Single Point	Averaged	(%/°C)	at Full Scale (mV)	Single Point	Averaged
10.0	-10.0	0.0354	0.0371	947.0	981.0	87.0	0.0006	4.747	1145.0	115.0
5.0	-5.0	0.0054	0.0071	476.0	491.0	43.5	0.0001	0.876	573.0	57.3
2.5	-2.5	0.0354	0.0371	241.0	245.0	21.7	0.0006	1.190	286.0	28.6
1.0	-1.0	0.0354	0.0371	99.2	98.1	8.7	0.0006	0.479	115.0	11.5
0.5	-0.5	0.0354	0.0371	52.1	56.2	5.0	0.0006	0.243	66.3	6.6
0.25	-0.25	0.0404	0.0421	28.6	32.8	3.0	0.0006	0.137	39.2	3.9
0.1	-0.1	0.0454	0.0471	14.4	22.4	2.1	0.0006	0.064	27.7	2.8
0.05	-0.05	0.0454	0.0471	9.7	19.9	1.9	0.0006	0.035	25.3	2.5
10.0	0.0	0.0054	0.0071	476.0	491.0	43.5	0.0001	1.232	573.0	57.3
5.0	0.0	0.0354	0.0371	241.0	245.0	21.7	0.0006	2.119	286.0	28.6
2.0	0.0	0.0354	0.0371	99.2	98.1	8.7	0.0006	0.850	115.0	11.5
1.0	0.0	0.0354	0.0371	52.1	56.2	5.0	0.0006	0.428	66.3	6.6
0.5	0.0	0.0404	0.0421	28.6	39.8	3.0	0.0006	0.242	48.2	3.9
0.2	0.0	0.0454	0.0471	14.4	22.4	2.1	0.0006	0.111	27.7	2.8
0.1	0.0	0.0454	0.0471	9.7	19.9	1.9	0.0006	0.059	25.3	2.5

Table 2. NI PCI-6052E Analog Input Accuracy Specifications

Note: Accuracies are valid for measurements following an internal (self) E Series calibration. Averaged numbers assume averaging of 100 single-channel readings. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature. One-year calibration interval recommended. The absolute accuracy at full scale calculations were performed for a maximum range input voltage (for example, 10 V for the ±10 V range) after one year, assuming 100 point averaging of data.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP