The *Black Stack* thermometer readout

- Reads SPRTs, RTDs, thermistors, and thermocouples
- Any configuration you like up to eight modules
- High-accuracy reference thermometer (to ± 0.0013 °C)
- Automates precision data acquisition

Hart's *Black Stack* thermometer has established itself as one of the most versatile, cost-effective, and accurate readouts in the world.

Nothing about this instrument says ordinary. Traditionally, thermometers were square boxes configured to do one particular job—such as read a calibrated PRT. However, if you also wanted to measure thermistors, you had to buy another instrument that could do this specific task. Some thermometers can do multiple jobs, but they're expensive, complex, and difficult to use. You're paying for functions you don't need and may never use. The *Black Stack* solves these problems and more.

The 1560 *Black Stack* can be any kind of thermometer you want it to be, and it works in three distinctive ways.

It's a reference thermometer with a NIST traceable calibration; it's an automated calibration system reading your reference probe and sensors you're testing; or it's a high-accuracy data acquisition system. And it does these functions better than any other thermometer currently on the market.

The *Stack* consists of up to eight different modules that fit together to do any type of thermometry you choose. You can buy all of them, or any combination of them, and change the *Stack* and its functions anytime you want. Each module stacks behind the preceding one, and when you add a module, the *Stack's* software automatically reconfigures itself to include all of the new functions supplied by that module. There's nothing to take apart. No boards need to be installed. There's no software to load, and nothing has to be calibrated. Just stack a new module onto the back of the previous modules and you're ready to use the *Black Stack* and all of its remarkable features.

Hart's 9935 Log*Ware* II makes the *Black Stack* an even more powerful data acquisition tool. Log*Ware* II provides graphical and statistical analysis of each channel you're measuring (up to 96 with the *Black Stack*). And with alarms that can be customized, delayed start times, and selectable logging intervals, Log*Ware* II turns the *Black Stack* into the most powerful temperature data acquisition tool on the market. (See page 101.)

The base unit

The *Stack* starts with a base module. It consists of two parts: a display with the main processor and a power supply. The base module supplies power, communication management, and software coordination for all of the other modules. It has the display, control buttons, and RS-232 port built-in.

Each base module can handle eight thermometer modules stacked behind it with a maximum of 96 sensor inputs. The base module never needs calibration and performs its own diagnostic self-test each time it powers up. The thermometer characteristics of each base module are defined by the thermometry modules stacked behind it.

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The modules

There are nine thermometry modules: an SPRT module, a high-temp PRT module, a PRT scanner module, a standards thermistor module, a thermocouple scanner module, a thermistor scanner module, a precision thermocouple module, and two 1000-ohm PRT modules.

Each module has its own processor and connects to the stack on a proprietary digital bus. Each retains its own calibration data and performs all analog measurement functions within the module.

Each module connects and disconnects easily from the Black Stack with just two screws.

SPRT module 2560

The SPRT module reads 10-ohm, 25-ohm, and 100-ohm four-wire RTDs, PRTs, and SPRTs with very high accuracy. It turns the *Stack* into a first-rate reference thermometer with an accuracy to ± 0.005 °C.

The 2560 has two input channels so you can collect data with two reference sensors, or you can do comparison calibrations of one sensor against a calibrated reference sensor.

Temperature conversion features include direct resistance measurement, ITS-90, W(T90), IPTS-68, Callendar-Van Dusen, or an RTD polynomial conversion. The user-changeable default values for the CVD conversion fit the 100-ohm, 0.00385 ALPHA sensor described by IEC-751.

The SPRT modules can be used one at a time or combined together in any combination for reading up to 16 different reference thermometers. If you stack an SPRT module with a scanner module, you can test multiple sensors against your reference. Unlike other competitive instruments, our PRT Scanner Module operates with or without the two-channel SPRT module. If you can think of a way to use a reference thermometer, you can do it with the *Stack*.

High-temp PRT module 2561

This module reads 2.5-ohm and 0.25-ohm four-wire HTPRTs and RTDs. The complete resistance range covers up to 5-ohm sensors with applications as high as 1200 °C. The temperature conversion features are the same as for the SPRT module, and like the SPRT module, the connectors are gold plated.

PRT scanner 2562

This module reads eight channels of two-, three-, or four-wire 100-ohm PRTs or RTDs. The accuracy is ± 0.01 °C at 0 °C for calibration of industrial sensors. The common industrial RTD can be read with the default values in the CVD temperature conversion for fast setup of industrial applications, or you can enter individual probe constants for higher accuracy data acquisition.

Standards thermistor module 2563

Special low-drift thermistors are becoming increasingly popular as reference probes in applications with modest temperature ranges up to 100 °C. This module has a temperature accuracy of ± 0.0013 °C at 0 °C with a resolution of 0.0001 °C.

The 2563 Thermistor Module has two input channels. It displays direct resistance in ohms or converts directly to a temperature readout using either the Steinhart-Hart equation or a higher-order polynomial.

Thermistor scanner module 2564

This module is usable with any type of thermistor but has eight channels instead of the two channels found on the Standards Thermistor Module and operates with or without the Standards Thermistor Module. This module's accuracy is ± 0.0025 °C at 0 °C for all eight channels.

The eight channels make the 2564 module an excellent data acquisition tool. It can be used in research work or for verification of biomedical equipment such as DNA sequencing apparatus.

Precision thermocouple module 2565

This precision thermocouple module reads any type of thermocouple, including type S platinum thermocouples and gold-platinum thermocouples for standards work. This two-channel module has internal reference junction compensation, or you can use an external source for even greater accuracy.

All the standard ANSI thermocouple types are preprogrammed; however, you can choose a conversion method and then enter the probe characteristics of your sensor, creating a system-calibrated channel. The 2565 module accepts up to three calibration points for error adjustment in the individual sensor.

A polynomial interpolation function calculates the points between your measurements.

Type R, type S, and gold-platinum conversions accept complete polynomial calibration coefficients. Additionally, a thermocouple conversion function calculates temperature by interpolating from a table. You enter the temperature in degrees C and the corresponding voltage for your specific sensor from 1 to 10 temperatures. Interpolation is performed between the entered points.

Thermocouple scanner module 2566

This module has 12 channels and reads K, J, T, S, R, B, E, and N thermocouples. (Support for C and U type thermocouples is available. Download the application note *Using Hart Readouts with Tungsten-Rhenium and other Thermocouples* from www.hartscientific.com.) Each channel can be set to read a different type of thermocouple. All temperature readings are performed in exactly the same manner as with the 2565 module.

The connectors on the scanner module are special dual connectors that accept both the common miniature and standard thermocouple connectors. If you want to use screw terminals, use the appropriately-sized connector with the hood removed.

1000-ohm PRT modules 2567 and 2568

For 1000-ohm PRTs, these modules provide all the same great features as the 2560 and 2562 Modules. The

The *Black Stack* thermometer readout

The Black Stack is the perfect foundation to build a totally automated calibration system with Hart heat sources and 9938 MET/TEMP II software (see page 97). No programming or system design nightmares.

two-channel 2567 Module has a resistance range of 0 to 4000 ohms and is accurate to ± 0.006 °C at 0 °C. The 2568 Module reads up to eight 1000-ohm PRTs and at 0 °C is accurate to ± 0.01 °C. Don't use an ohmmeter or multimeter to read your 1000-ohm PRTs when you can use a *Black Stack* loaded with convenient temperature functions.

Extended communications module 3560

Need more communications options? The 3560 module adds an IEEE-488 (GPIB) interface, a Centronics printer interface, and analog output via a DC signal (± 1.25 VDC).

Features common to all modules

The 1560 *Black Stack* is an incredible thermometer. You buy only the modules you need for the work you are doing. If your work changes, simply order the modules with the functions you need and slip them onto the back of the *Stack*. Your thermometer changes its software, display, and method of operation to match the new functions you've added.

Remember, you never have to open the case to add modules. There's no software to load. It's all automatic.

Each module stores its own calibration internally, so you can add or change modules without recalibrating the whole stack. Module calibration is digital and is performed manually through the base's front panel or over the RS-232 link. If your lab has the capability, you can calibrate modules yourself. If not, send them to us with or without your base unit and we'll recalibrate them. Hart calibrations are accredited.

The LCD screen has multiple methods of displaying data, including a graphical strip chart recorder. The graphical capability of the *Black Stack* makes testing temperature stability easier than ever. Vertical scaling and graph resolution are automatic.

The *Stack* has high-accuracy, two-channel capability or multi-channel functionality if you need it. Its memory stores the most recent 1000 readings, or you can send your data to your PC through the RS-232 port. Each data point is time and date stamped. An IEEE-488 port is optional.

With the *Black Stack* you can read data almost anyway you like—in ohms, millivolts, or temperature, according to your application and preference.

Remember, this thermometer's calibration is traceable to NIST. Its accuracy is as high as ± 0.0013 °C, depending on the module and sensor you're using.

Hey! Why did you make it look like that?!

We get asked this question a lot! There are several reasons for the shape of the *Black Stack*.

When we started the design process on the *Black Stack,* we wanted a unique instrument that was a true technological leap in thermometry. Incremental improvements are okay sometimes, but if you're going to lead the industry, you might as well go out and lead it.

Here are some of the design criteria we started with. The new thermometer had to be capable of transforming itself into any kind of thermometry instrument the customer wanted, and it had to do this without having to open the box, replace boards, or set up anything. All connections needed to be easily accessible from the front of the instrument, with no connectors on the front panel. The front panel had to be easy to read, with all features including programming done on the front panel, and the programming taking advantage of the graphical capability of the display. The software had to be as creative and as versatile as the instrument. It had to be easy to use and, if at all possible, even fun to use. And finally, it had to be very accurate.

The shape of the *Black Stack* facilitates the function and usability of the instrument. And it is unbelievably functional and fun to use.

The only way you'll truly understand what we're talking about is to get one and try it. Hundreds of customers, including many national standards labs, already have it!

The *Black Stack* thermometer readout

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Specifications

Model 1560 Base Unit

Power: 100 to 240 V ac, 50 or 60 Hz, nominal; Attachable Modules: up to 8; Display: 4.25 in x 2.25 in LCD graphics, LED backlight, adjustable contrast and brightness; Automatic Input Sequencing: 1 to 96 channels; Communications: RS-232; Non-volatile Memory: channel sequence, probe coefficients; Minimum Sample Time: 2 seconds.

Extended Communication Module 3560

The Extended Communication Module adds additional communication interface capability to the system. This module includes a GPIB (IEEE-488) interface, Centronics printer interface, and analog output. The GPIB interface connects the 1560 to a GPIB bus. GPIB can be used to control any function of the 1560 and read measurement data. The printer interface allows the 1560 to send measurement data directly to a printer. The analog output sources a DC signal (± 1.25 VDC) corresponding to the value of a measurement.

Resistance modules

Input Channels	Resistance Range	Basic Resistance Accuracy	Resistance Resolution	Temperature Range	Equivalent Temperature Accuracy†	Temperature Resolution	Excitation Current
SPRT Module 2560							
2	0 Ω to 400 Ω	± 20 ppm of reading (0.0005 Ω at 25 Ω, 0.002 Ω at 100 Ω)	0.0001 Ω	–260 °C to 962 °C	± 0.005 °C at 0 °C ± 0.007 °C at 100 °C	0.0001 °C	1.0 mA, 1.4 mA
High-Temp PRT Module 2561							
2	0 Ω to 25 Ω	± 50 ppm of reading (0.00013 Ω at 2.5 Ω)	0.00001 Ω	0 °C to 1200 °C	± 0.013 °C at 0 °C ± 0.018 °C at 100 °C	0.001 °C	3.0 mA, 5.0 mA
PRT Scanner 2562							
8	0 Ω to 400 Ω	± 40 ppm of reading (0.004 Ω at 100 Ω)	0.0001 Ω	–200 °C to 850 °C	± 0.01 °C at 0 °C ± 0.014 °C at 100 °C	0.0001 °C	1.0 mA, 1.4 mA
Standards Thermistor Module 2563							
2	0 Ω to 1 MΩ	± 50 ppm of reading (0.5 Ω at 10 KΩ)	0.1 Ω	–60 °C to 260 °C	± 0.0013 °C at 0 °C ± 0.0015 °C at 75 °C	0.0001 °C	2 µA, 10 µA
Thermistor Scanner 2564							
8	0 Ω to 1 MΩ	± 100 ppm of reading (1 Ω at 10 KΩ)	0.1 Ω	–60 °C to 260 °C	± 0.0025 °C at 0 °C ± 0.003 °C at 75 °C	0.0001 °C	2 µA, 10 µA
1000Ω PRT Module 2567							
2	0 Ω to 4 KΩ	± 25 ppm of reading (0.025 Ω at 1 KΩ)	0.001 Ω	–260 °C to 962 °C	± 0.006 °C at 0 °C ± 0.009 °C at 100 °C	0.0001 °C	1.0 mA, 1.4 mA
1000Ω PRT Scanner 2568							
8	0 Ω to 4 KΩ	± 40 ppm of reading (0.04 Ω at 1 KΩ)	0.001 Ω	–200 °C to 850 °C	± 0.01 °C at 0 °C ± 0.014 °C at 100 °C	0.0001 °C	0.1 mA, 0.05 mA

Thermocouple modules

Input Channels	Millivolt Range	Millivolt Accuracy	Millivolt Resolution	Temperature Accuracy,† Ext. CJC	Temperature Accuracy,† Int. CJC	Temperature Resolution
Precision Thermocouple Module 2565						
2	–10 to 100 mV	± 0.002 mV	0.0001 mV	± 0.05 °C	± 0.1 °C	0.001 °C
Thermocouple Scanner 2566						
12	–10 to 100 mV	± 0.004 mV	0.0001 mV	± 0.1 °C	± 0.3 °C	0.001 °C

†Temperature accuracy depends on probe type and temperature.

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Ordering Information

1560	*Black Stack* Readout Base Unit
2560	SPRT Module, 25 Ω and 100 Ω, 2-channel
2561	High-Temp PRT Module, 0.25 Ω to 5 Ω, 2-channel
2562	PRT Scanner Module, 8-channel
2563	Standards Thermistor Module, 2-channel
2564	Thermistor Scanner Module, 8-channel
2565	Precision Thermocouple Module, 2-channel
2566	Thermocouple Scanner Module, 12-channel
2567	SPRT Module, 1000 Ω, 2-channel
2568	PRT Scanner Module, 8-channel, 1000 Ω
3560	Extended Communications Module
9935-S	Log*Ware* II, Multi Channel, Single User
9935-M	Log*Ware* II, Multi Channel, Multi User
9302	Case (holds 1560 and up to five modules)

Probes

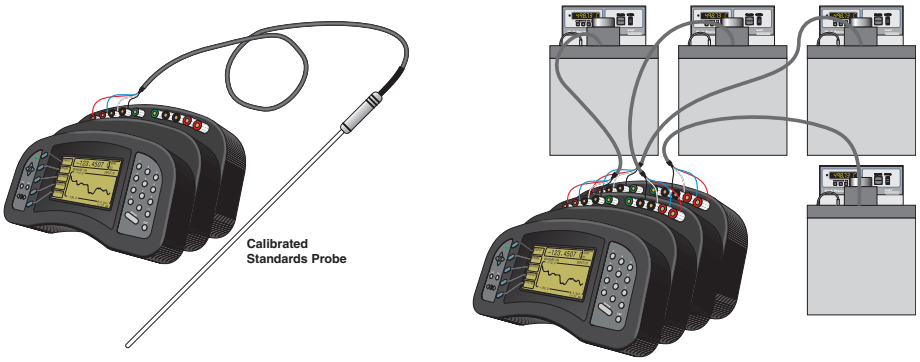
5610-6-X	Thermistor Probe (0.125 in dia x 6 in), 0 °C to 100 °C
5610-9-X	Thermistor Probe (0.125 in dia x 9 in), 0 °C to 100 °C
5642-X	Standards Thermistor Probe
5615-6-X	Secondary Standard PRT, (0.188 x 6.0 in), –200 to 300 °C
5615-9-X	Secondary Standard PRT, (0.188 x 9.0 in), –200 to 420 °C
5615-12-X	Secondary Standard PRT, (0.250 x 12.0 in), –200 to 420 °C
5626-12-X	Secondary Standard PRT (0.25 in dia x 12 in), 100 Ω, –200 °C to 661 °C
5628-12-X	Secondary Standard PRT (0.25 in dia x 12 in), 25 Ω, –200 °C to 661 °C
5628-15-X	Secondary Standard PRT (0.25 in dia x 15 in), 25 Ω, –200 °C to 661 °C

X = termination. Specify "B" (bare wire), "D" (5-pin DIN for Tweener Thermometers), "G" (gold pins), "I" (INFO-CON for 1521 or 1522 Handheld Thermometers), "J" (banana jacks), "L" (mini spade lugs), "M" (mini banana jacks), or "S" (spade lugs).

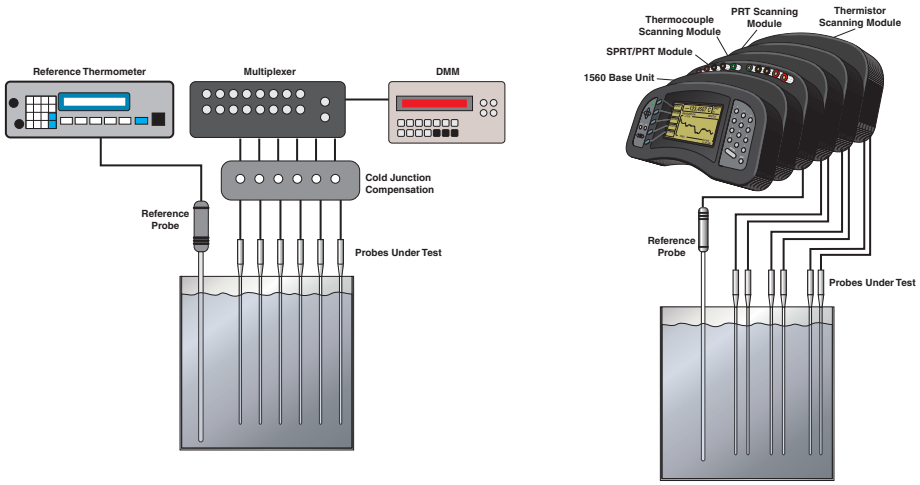
See pages 66 to 90 for more probes.

Spare connector kits

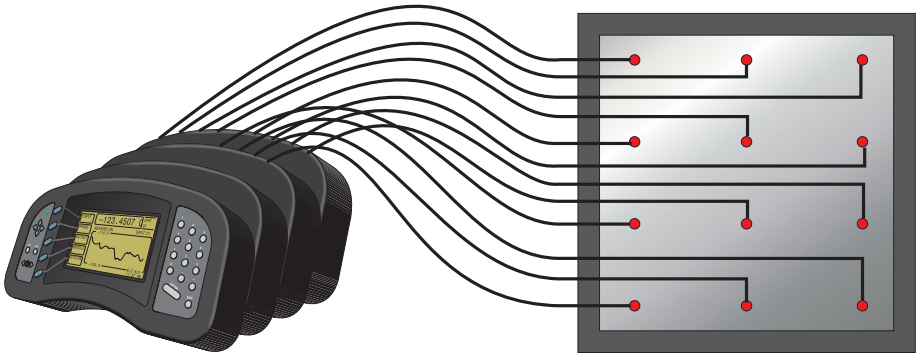
2380-X	Miniature Thermocouple Connector, 12 pcs. (X = TC type. Choose from K, T, J, E, R, S, N, or U)
2381-X	Standard Thermocouple Connector, 12 pcs. (X = TC type. Choose from K, T, J, E, R, S, N, or U)
2382	RTD/Thermistor Connector, 8 pcs. (Fits 2562, 2564, and 2568 modules)



The Black Stack as a High-Accuracy Reference Thermometer
Use the Black Stack with a calibrated standards probe. Using multiple modules, you can have one instrument read a standards probe in each bath or furnace in your lab.



The Black Stack as an Automated Calibration System
The 1560 reads sensors under calibration. Traditional techniques require a reference thermometer, digital multimeter, scanner, and cold junction compensation for thermocouples. With the Black Stack, one instrument does the whole job.



The Black Stack as a High-Accuracy Data Acquisition System
Use the 1560 in research work or critical production roles. With calibrated probes attached, the 1560 calibrates or verifies the performance of ovens, incubators, DNA sequencers, baths, or process equipment.