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INTRODUCTION

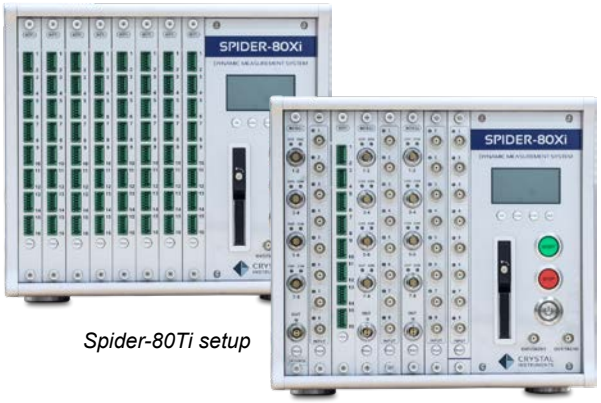
The Spider-80Ti is a front-end from the Spider-80Xi hardware platform that enables temperature measurement. Spider-80Ti supports temperature measurements from thermocouples and RTD (Resistance Temperature Detector) sensors.

Each Spider-80Ti front-end adds 16 temperature measurement channels to the Spider-80Xi system. A Spider-80Ti front-end is user-configurable to support either a PT100 RTD sensor or a k-type thermocouple. A combination of RTDs and thermocouples within the same Spider system is possible by combining the front-ends configured as RTDs and thermocouples.

Spider-80Ti is equipped with a 24-bit sigma-delta analog to digital converter (ADC) per channel to ensure highly accurate temperature measurements with any type of sensor. Together with the user-configurable non-linearity correction, the accuracy of the measurements is ensured over a wide range of temperature measurements.

The Spider-80Xi chassis can either be configured exclusively for temperature measurements using the Spider-80Ti front-end or can be configured for mixed signal data acquisition by combining the Spider-80Ti with the Spider-80Hi, Spider-80Ci, or Spider-80SGi. A Spider-80Xi chassis with 4 front-end slots or 8 front-end slots is available.

The efficient design of the Spider-80Xi chassis eliminates individual enclosures for each modular front-end to minimize the overall dimensions of the system. Its light weight makes it ideal for applications requiring portability and an efficient size without the need to exchange front-ends during operation.



Spider-80Ti setup

Multi-module setup

Multiple chassis consisting of Spider-80Ti front-ends or a combination of Spider-80Ti, Spider-80Hi, Spider-80Ci, or Spider-80SGi can be chained together to form a system with up to 1024 channels, all sampled simultaneously.

The Spider-80Xi system is equipped with powerful and flexible data acquisition functions. Users can initiate continuous time data recording or data recording triggered by user configurable events including pre-set run schedule, alarm limit trigger, input trigger, or digital input trigger. A high-performance removable 2.5-inch solid-state drive (SSD) is used as a storage media inside the Spider-80Xi. The default capacity of the SSD is 250 GB and is extendable up to 2 TB. When recorded, data will be written in the NTFS file format. Data is extracted from the SSD using Crystal Instruments PC software to transfer data to the PC, or the SSD can be physically removed and connected to another PC.

Terminology

Maximum and *minimum* specifications characterize the warranted performance of the instrument within the recommended calibration interval and under the stated operating conditions. These specifications are guaranteed by design.

Typical specifications would be met by the instrument within the recommended calibration interval at the specified operating conditions. These measurements are taken during production verification of the finalized engineering prototype. The performance of the instrument is not warranted.

All performance specifications are typical unless otherwise noted. These specifications are valid within the full operating temperature range. Accuracy specifications are valid within ±5 °C after calibrating the unit unless otherwise noted.

Selection of Temperature Sensors

The Spider-80Ti front-end supports the two widely used sensors, the PT100 RTD sensor and k-type thermocouples making it ideal for temperature measurements. Some of the key differences that aid in selecting a sensor for an application is listed below:

Sensor Type	RTD	Thermocouple
Temperature Range (typical)	-200 to 650°C	200 to 1750°C
Accuracy (typical)	0.1 to 1°C	0.5 to 5°C
Long-term Stability	Good	Variable
	Stable and repeatable	Drifts because of oxidation
Linearity	Fairly linear	Non-linear
Power Required	Constant voltage or current	Self-powered
Reference Junction	Not Required	Required
Response Time	Generally slow	Fast
	1 to 10s	0.10 to 1 s

Susceptibility to electrical noise	Less Susceptible	More Susceptible
Cost	High	Low

A majority of RTDs are designed for typically designed for measurements up to 500o C whereas thermocouples can operate at significantly higher and wider temperature ranges. Based on the table and measurement condition the appropriate sensor can be used. With two or more front-end modules both types of sensors can be used (one sensor type per module).

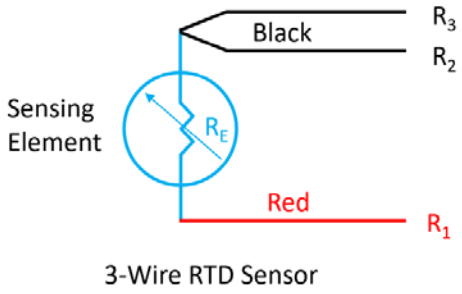
Environmental and General S80Xi Specifications

For details on Environmental and General Specifications of the Spider-80Xi system and chassis, refer to "Spider Front-End Hardware Specifications for Spider-80Xi Platform: Spider-80Hi, Spider-80Ci, Spider-80SGi, and Spider-80Ti"

Spider-80Ti with RTD Sensor

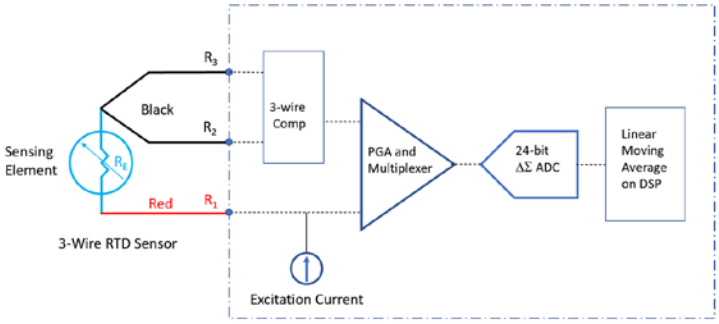
RTD Measurement Circuit

In the 3-Wire RTD sensor, two wires link the sensing element to the Spider-80Ti on one side of the sensing element, and one links it on its other side as shown in the picture below.



The Spider then calculates the compensation based on the following principle, if three identical type wires are used and their lengths are equal, then R1 = R2 = R3. By measuring the resistance through leads 1, 2, and the resistance element, a total system resistance is measured (R1 + R2 + RE).

If the resistance is also measured through leads 2 and 3 (R2 + R3), the resistance of only the lead wires is measured, and since all lead wire resistances are equal, subtracting this value (R2 + R3) from the total system resistance (R1 + R2 + RE) which eliminates any lead wire error, provides an accurate temperature measurement.



Each RTD channel is passed through a programable gain amplifier and then sampled by a 24-bit analog-to-digital converter (ADC). Finally, a user customizable moving linear average is applied to the measurements.

Spider-80Ti RTD Specifications

Number of Input Channels	16 channels per front-end Expandable up to 1024 channels
Connector Type	Six pins pluggable terminal blocks (Each block connects two input channels)
ADC	24-Bit Sigma - Delta
Temperature Measurement Range	-200°C to 850°C (-328°F to 1562°F)
Resistance Measurement Range	0 to 400 Ohm
RTD Excitation Current Source	10 µA to 1.5 mA programable source
Operating Temperature	-10°C to 55°C (14°F to 131°F)
Normal-mode Rejection Ratio (50/60 Hz)	105 dB
Common Mode Rejection Ratio (CMRR)	115 dB
Differential Input Impedance	2 MΩ
Channel-to-COM	±3 V
Sampling Rate	0.3125, 0.625, 1.25, 2.5… 512 S/sec (user selectable)
Average Number and Mode	Selectable moving linear average from 1 – 128

RTD Temperature Measurement Accuracy

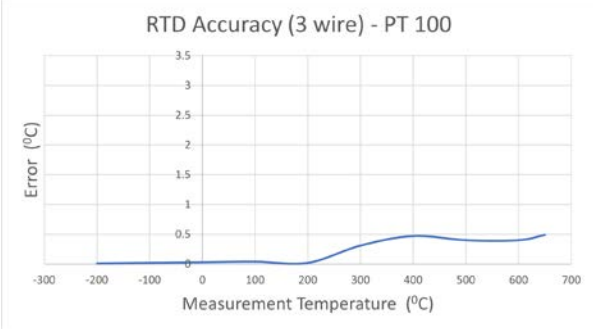
RTD Non-Linearity Correction

To provide high accuracy during measurements the Spider-80Ti directly implements the IEC 751 RTD equations. The user can use coefficient values as defined by the standard or specify custom coefficients. Having these customizable coefficients also allows the user to use RTD sensors with

different alpha values and greatly improves the accuracy of the measurements.

RTD Operating Measurement Accuracy

The following figures show errors for RTDs and thermocouples on the Spider-80Ti. The figures display the errors over a full temperature range at room temperature. The figures account for gain errors, offset errors, differential, and integral nonlinearity, quantization errors, noise errors, and lead wire resistance. The figures do not account for the accuracy of the sensor itself.

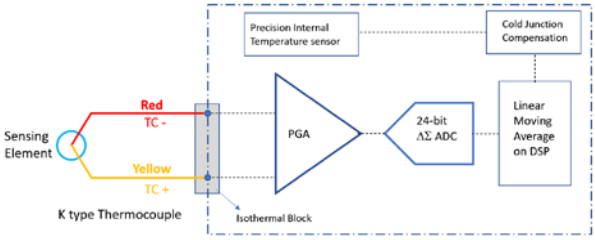


RTD Channel Gain and Offset Calibration

Gain and offset error may be introduced due to the source impedance of the sensor or other factors. Sensors with higher lead resistance may introduce significant errors. Spider-80Ti has a built-in function to perform gain correction and offset nulling for each individual channel to negate these errors.

Spider-80Ti with Thermocouples

Thermocouple Measurement Circuitry



Each thermocouple channel is passed through a programable gain amplifier and then sampled by a 24-bit analog-to-digital converter (ADC). Then the cold junction compensation and a user customizable moving linear average is applied to the measurements.

Cold Junction Compensation

Thermocouples have two junctions, namely the hot and cold junction. The hot junction is the measurement junction and is attached to the measurement point. In theory, the cold junction should be maintained at 0°C. Since this is not a practical solution because the cold junction is connected to an isothermal block, the temperature of the block is measured by a high precision internal temperature sensor. The thermoelectric voltage across the sensor is measured. The internal sensor measures the isothermal temperature, which is then converted to its corresponding voltage value. This value is used to offset the cold junction temperature to provide an accurate measurement.

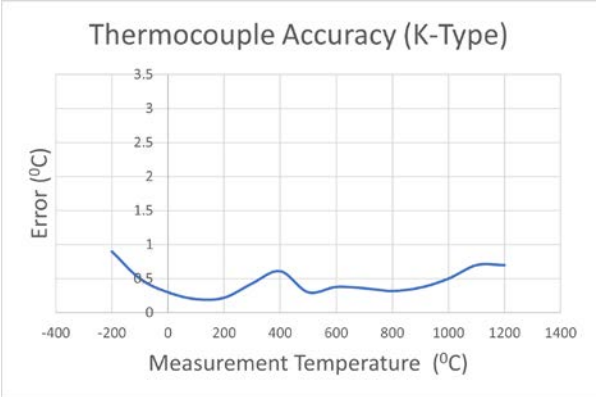
Spider-80Ti Thermocouple Specifications

Number of Input Channels	16 channels per front-end Expandable up to 1024 channels
Connector Type	Six pins pluggable terminal blocks (Each block connects two input channels)
ADC	24-Bit Sigma -Delta
Temperature Measurement Range	-250°C to 1350°C (NIST – K type)
Voltage Measurement Range	±80 mV
Operating Temperature	-10°C to 55°C (14°F to 131°F)
Cold Junction Compensation Accuracy	+/- 0.25°C (0°C to 70°C)
	+/- 0.75°C (-40°C to 70°C)
Normal-mode Rejection Ratio	105 dB
Common Mode Rejection Ratio (CMRR)	115 dB
Differential Input Impedance	2 MΩ
Channel-to-COM	±3 V
Sampling Rate	0.3125, 0.625, 1.25, 2.5 S/sec (user selectable)
Average Number and Mode	selectable moving linear average from 1 – 128

Thermocouple Temperature Measurement Accuracy

Thermocouple Operating Measurement Accuracy

The following figures show the errors for thermocouples on the Spider-80Ti. The figures display the maximum errors over a full temperature range and typical errors at room temperature. The figures account for gain errors, offset errors, differential and integral nonlinearity, quantization errors, noise errors, lead wire resistance, and cold-junction compensation errors. The figures do not account for the accuracy of the thermocouple itself.



Thermocouple Channel Gain and Offset Calibration

Gain and offset error may be introduced due to the source impedance of the sensor or other factors. Sensors with higher lead resistance may introduce significant errors. The Spider-80Ti has a built-in function to perform gain correction and offset nulling for each channel to negate these errors.

Multi-point Sensor Correction

The Spider-80Ti system allows the user to perform multi-point correction if the user has more precise values for the sensor. This data can be entered into the system to provide a linearized offset correction between the temperature breakpoints.

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