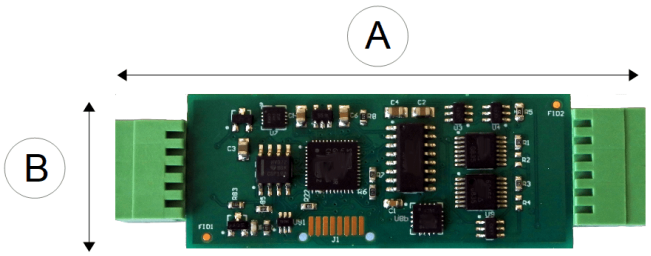
Strain Gauge Interface

Single Channel Strain Gauge / Load Cell SDI-12 and RS485 Interface Card

Last Updated Sept 1 2021

OEM Customised Product

Part Number : NP-1-STRAIN-24-SD85



Dimensions A = Length 75 mm B = 24 mm **Figure 1**

The NP-1-STRAIN-24-SD85 is an intelligent general purpose strain gauge interface card suitable for direct connection to strain gauges and load cells. The device can be connected to any suitable device supporting the SDI-12 network and is fully integrated into the free Keynes Controls Q-LOG Data Display and Recording Software..

The card has an SDI-12 and RS485 port which are User selectable using industry standard configuration commands.

The **NP-1-STRAIN-24-SD85** is User Programmable and can supply results in both raw or engineering unit format. A precision temperature sensor input is supplied for applications when compensation is required.

The sensor monitors the bridge excitation during the measurement and compensates automatically for any excitation variation during the data conversion process. The D0 and D1 commands can be User set to return any device parameter.

OEM Applications

The NP-1-STRAIN-24-SD85 PCB can be supplied customised for third party applications. Contact Keynes Controls for more details.

Sensor Port View looking into the Port

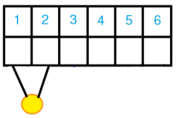


Fig 2

Pin-out Sensor Input Port

1 + Thermistor
2 - Thermistor
3 Gnd
4 + Vin
5 - Vin
6 Excitation

Network Port View looking into the Port

Fig 3

Pin-out Sensor Input Port

1 Gnd
2 +12
3 RS485 -
4 RS485 +
5 SDI-12

Temperature Measurement

.

The card supports the installation of type thermistor sensor input. The default calibration factors are factory set.

OEM Applications

This card can be modified for OEM applications. Contect Keynes Controls for further details.

Features

Support for 120 to 4 K Ohm Gauges
User Defined Parameter Strings D0 and D1.
External bridge completion
Precision Temperature Sensor - User Defined
User Programmable Scaling Factors
SDI-12 & RS485 Digital Communications
Extended SDI-12 Address Support: 0-9 , a-z
24 Bit ADC Analogue Input
Low Power - Minimised self heating effect
Engineering and Raw Data Values
Free Applications Software - Q-LOG Software
Multi-Variable Calibration Options
2.5 mm Pluggable Terminal Block Connection

The card has been designed for operation in harsh environments and still has the ability to be easily installed in the field.

No special installation tools or plugs are required simply since all signal and sensor cables simply push into the cable clamps mounted on the front and back of the unit.

Installation

Connect the NP-1-STRAIN-24-SD85 card as close as is practically possible to the sensor in order to minimise electrical noise. An optional IP-65 enclosure is available with this product.

Free Applications Software

The card is supplied with the Q-LOG application software. Q-LOG can be used for Configuration changes, Test Measurement and data Recording.

The Q-LOG software can be downloaded at:
http://keynes-controls.com/Download/QLogSetup50_21may2020.zip

Image is for marketing purposes only The supplied card may differ slightly from the image below.

A = Network Port **B = Sensor Port**

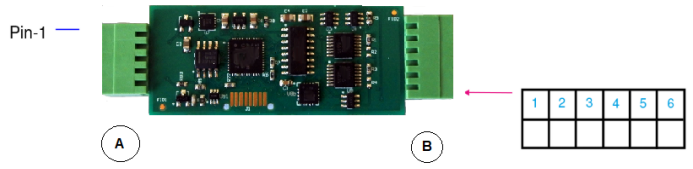
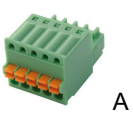


Figure 4

Cable Entry - Fast Connection

The NP-1-STRAIN-24-SD85 card uses the 2.5 mm pluggable terminal blocks to connect the sensor and network signals to the card.



A

5 Way Pluggable Terminal Block **Network Connection**

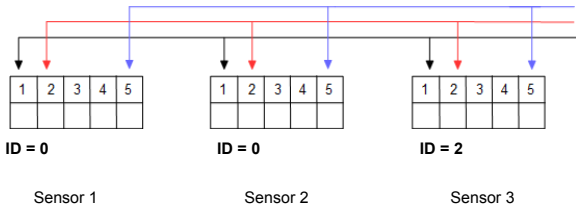
B

6 Way Pluggable Terminal Block **Sensor Connection**

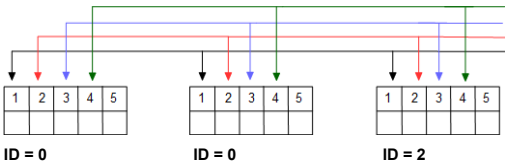
SDI-12 Network

Figure A below demonstrates how to connect multiple NP-1-STRAIN-24-SD85 cards on a SDI-12 digital network. Each card must have a unique ID number assigned (Address) in order to operate correctly. The SDI-12 network uses a simple three wire low speed application

Multiple Device SDI-12 Network Connection - Figure 7



Multiple Device RS485 Network Connection - Figure 8



Bridge Zero Offset Correction

The Single NP-1-STRAIN-24-SD85 sensor does not zero correct the bridge and assumes the User will correct the error in post processing of the data. Mean value correction of the measurements is used for bridge zero correction.

Temperature coefficient of Gage Factor (TCGF)

This is the change of sensitivity of the device to strain with change in temperature. This can be compensated for in the calibration equations but it is recommended to be post process corrected in any data analysis.

For the strain gauge:
aXCA0 - offset
aXCA1 - scale
Output = offset + (scale * reading) reading is in mV/V

For the temperature:
aXT1T0 - thermistor ref temperature (default 25 Deg C)
aXT1R0 - resistance reference (default 3 K Ohm)
aXT1ST0 - thermistor 'A' factor
aXT1ST1 - thermistor 'B' factor
aXT1ST2 - thermistor 'C' factor
aXT1ST3 - thermistor 'D' factor

General use:

0M! - start measurement

0D0! - retrieve results
gauge output, temperature, gauge mv/v

SDI12 Communications
1200 B, 7 Data, N Parity, 1 Stop

RS-485 Communications
1200 B, 7 Data, Even Parity, 1 Stop

Standard Formulae

Quarter Bridge

$$\varepsilon = \frac{4 \times C}{GF}$$

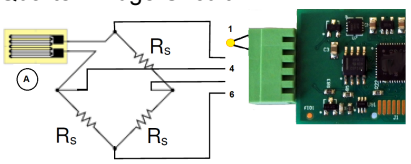
Half Bridge

$$\varepsilon = \frac{2 \times C}{GF}$$

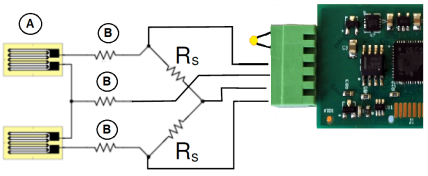
Full Bridge

$$\varepsilon = \frac{2 \times C}{GF}$$

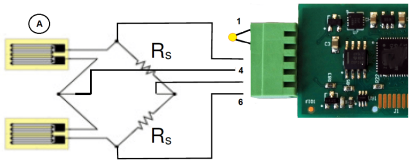
Quarter Bridge Circuit



3 Wire Half Bridge Circuit



Half Bridge Circuit



View looking into the sensor port. Fig 11

Parameters

A = Strain Gauge
B = Lead Resistance
C = Measurement
R_S = Bridge Resistor

Strain Calculation

$$\varepsilon = \frac{4 \times \text{Measurement}}{(GF).(N).E_x}$$

ε = Strain
E_x = Bridge Excitation
N = Number effective arms.
GF = Gauge Factor

Assign Return Order of the Measurements

aXCSTR0,ABC! where a = ID Number

D0 / D1 Output Parameters

A = Calibrated Output
B = Temperature Deg C
C = Raw Value mV/V
D = Raw Value mV
E = Bridge Excitation V

Output Parameters Order

The NP-1-STRAIN card supports individually configured output strings for the parameters D0 and D1. The Q-LOG Software can be used to select the order of the parameters that are returned by the card. Where D0 and D1 are the industry standard parameters.

Example: **2XCSTR0,ABC! Card with ID=2 will return Calibrated Output (A), Temperature Deg C) , Raw Value in mV/V (C)**

Example: **0XCSTR0,AEB! Card with ID=0 will return Calibrated Output (A), Bridge Excitation (E), Temperature Deg C**

The parameters order can be adjusted in the Card Configuration Window or directly using the 'Terminal' feature of the Q-LOG Software. Figure 16 shows the Device Configuration Window.

Multi Variable Calibration Options

The NP-1-Strain Card supports multi-variable calibration operations. When used with load cells then the card can be calibrated for load against temperature. This is a complex operation so contact Keynes Controls for support to carry out this operation.

Technical Specifications

Specifications are accurate at the time of publishing but can be changed without notice.

Power Supply	10 -18 V
Current	2 mA at acquisition 10 uA standby
Input Range	+/- 70 mV Other ranges on request
SDI-12 Port	1 x Port Version 1.03
Max update rate	1 sec
Cable Clamp Size	2.5 mm diameter
Bridge Excitation	0 - 4.5 V DC
Raw Value	Raw data mV/V
Engineering Value	micro-strain, mV/V User Defined
Range	User Defined, depends on sensor installed
Temp Sensor	Thermistor
Thermistor Type	3 K EC95 F type material 10K3A1 Betatherm
Calibration	Steinhart-Hart Set at manufacture
Accuracy	0.05 Deg -8 to 25 Deg C
Range	-30 to + 60 Deg
Units	Deg C mv/V, User Defined
RMS Noise (Typical values)	less than 1 uV/V less than 0.01 Deg C
PCB Dimension	
Length	75 mm
Width	24 mm
Max depth	10 mm
Cable Entry	1 m Screw terminal
Number Channels	1
Gauge Resistance	120 - 4K Ohm
Gauge Factor	User Defined
ADC	24 Bit

Q-LOG Results

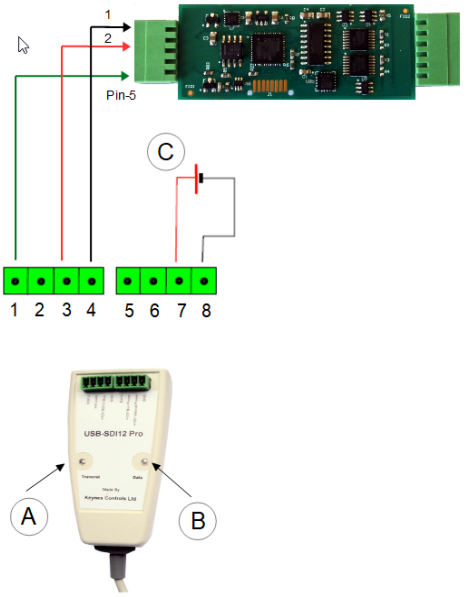
The Q-LOG software stores results into a text file using cell locations exactly like a spreadsheet. The results files uses a CSV (Comma Separated Variable) format...;

Connection to the USB-SDI12-Pro Media Converter

Figure 13 below shows how to connect the **NP-1-STRAIN-24-SD85** card to a SDI-12 media converter. The diagram shows the card connected to the Keynes Controls manufactured USB-SDI12-Pro media converter, and it can be connected to any similar device and is not not restricted to our own media converter.

The USB-SDI12-Pro media converter is used to connect an SDI-12 based intelligent sensor to a Windows PC. The USB-SDI12-Pro can power the card directly from the PC USB port without the requirement of an external power supply. This makes testing and configuration operations easy to undertake.

Figure 13



USB-SDI12-Pro	Pin	NP-1-STRAIN-24-SD85 Network Port	Pin
SDI-12 Data	1	Gnd / Ov	1
Not Used	2	+12 V	2
+12 V DC	3		3
Gnd / Ov	**4**		4
	5	SDI-12 Data	5

A = Transmit Status LED B = Data Status LED
C = External Power Supply Port.

For the strain gauge:

aXCA0 - offset
aXCA1 - scale
Output = offset + (scale * reading) reading is in mV/V

For the temperature:

aXT1T0 - thermistor ref temperature (default 25 celcius)
aXT1RE - resistance reference (default 3000)
aXT1ST0 - thermistor 'A' factor
aXT1ST1 - thermistor 'B' factor
aXT1ST2 - thermistor 'C' factor
aXT1ST3 - thermistor 'D' factor

Configuration

TheNP-1-STRAIN-24-SD85 interface is factory preset to operate with 3 K Ohm thermistor
The following command can be used to test theNP-1-STRAIN-24-SD85 sensor. See Figure 15.

Start measurement: **0M!** returns 012 - 1 sec response 3 values
0D0! returns 0+strain+temp+Raw Bridge mv/V

0XCA1,6.1435! - Write the Scale value 6.1345 to the card with ID=0.
0XCA0,520.06! - Write the offset value to the card.

2XT1T0,25! - write 25 Deg C reference temperature with card ID=2
2XT1RE,3000! - writes 3000 Ohms as resistance value temperature sensor T0

Youtube Demo Video - Device Configuration in Q-LOG

https://youtu.be/KEB3WZFfDX4

Application Software QLOG The Free Data Display and Configuration Software

The Q-LOG software can be used to make test measurements, configuration changes and display results and is free to download.

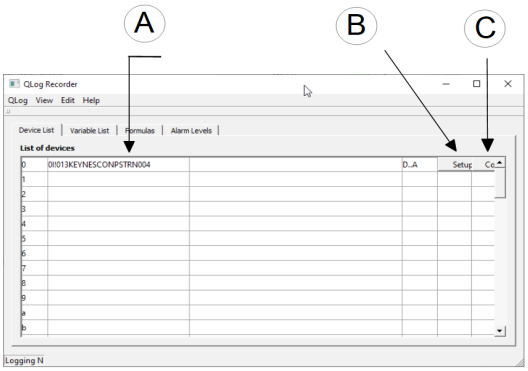


Figure 14

A = Identifier String **B = Setup Button**
C = Configure Button

Q-LOG is the free issue applications software supplied with this product. The software is used to Configure, make test measurements and display data.

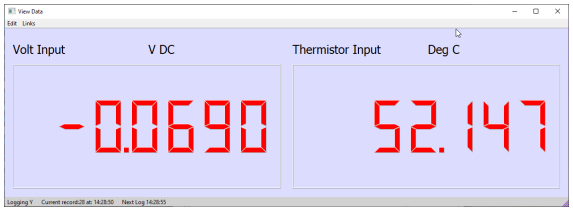
1. Ensure the card is connected to a suitable media converter.
2. Set the COMM port used by the media converter into Q-LOG. Use the 'Config' Window.
3. Scan the network and identify the card.

Select the 'Device **Setup**' tab to select the card type. The Window shown in Figure 15 will appear.

Select the **'Config Tab**' and the Sensor Configuration Window shown in Figure 16 will appear

Real-time Display

Real-time measurements can be displayed to a selection of panel meters and charts that are available in the Q-LOG software.



Use 'View' Tab from the main menu to select the Panel Meter display options.

Results File

Q-LOG stores measurement values in Comma Separated Variable text format enabling information to be easily imported into spreadsheet and data analysis packages.

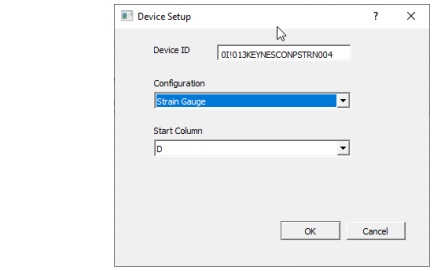


Figure 15

The 'Device Setup' Window is used to

1. Assign the start location for the measurements in the results file. Figure 15 shows Cell D as the first location for the storage of values in the text results file.

2. The **'Configuration**' list shows the User Defined parameters that are supported by this card.

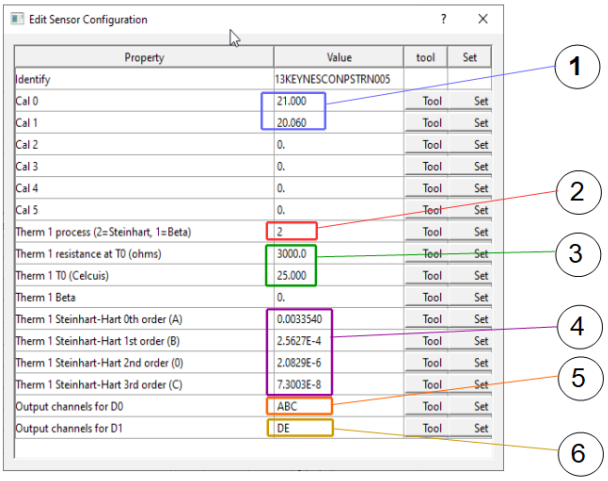


Figure 16

Q-LOG Device Configuration Window

Figure 16 shows the '**Sensor Configuration**' Window.

1 = Scale and Offset - Output in engineering units.

2 = Temperature Sensor Calibration Type Selection
1 = Beta 2 = Steinhart-Hart Factors.

3 = Temperature Sensor R0 and T0 Settings
Typically 3 K OHM at 25 Deg C (As shown)

4 = Steinhart-Hart Calibration factors
Recommended and most accurate calculation.

5 = D0 Return Parameters - User Selectable A/B/C/D/E

6 = D1 Return Parameters - User Selectable A/B/C/D/E

The parameter details are shown below.

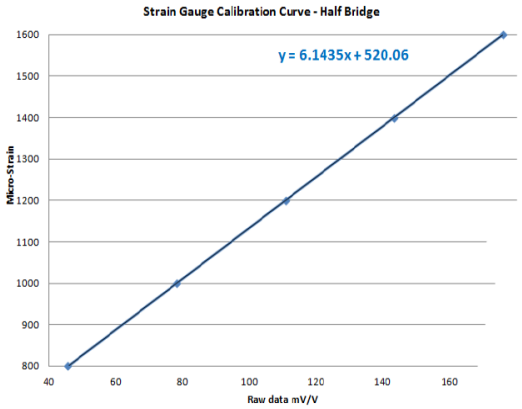
The card can return the parameters

A = Calibrated Output (Load/Strain) **B =** Temperature Deg C **C =** Raw value in mV/V
D = Raw value mV **E =** Raw Bridge Excitation Voltage

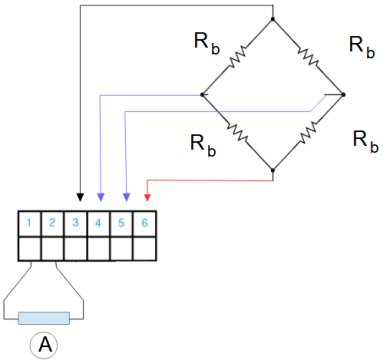
Configuration and Device Test Circuit

Command	Response	Description
aM!	a0tt3	3 values in time tt given by stats
aD0!	a+A/B/C/D/E + A/B/C/D/E + A/B/C/D/E	Up to 3 User Defined Parameters
aD1!	a+A/B/C/D/E + A/B/C/D/E + A/B/C/D/E	Up to 3 User Defined Parameters
aI!	aI!013KEYNESCONPSTRN005	Identification string

Sample Calibration Curve - Figure 17



Simple Test Circuit - Figure 18



R_b = Bridge Resistor - typically 120 to 1 K OHM
A = Precision Resistor
22K Ohm = -15.5 Deg C 4K7 Ohm = 15 Deg C 1 K Ohm = 52 Deg C

Table 3

Raw Data mV/V	Calibration Points microStrain
45.567	800
78.12175	1000
143.2313	1400
175.786	1600

The following data points were measured under test conditions using a strain gauge calibrator.Use a simple linear regression formula to determine the calibration curve used to convert measured values directly into engineering units.

Calibration Factor Calculations

Display the sample test data in a Microsoft Excel Scatter Chart.

Use the Trend Line format operations and select '**Linear**' and '**Display Equation on Chart**'. The equation shown is used to convert raw data into engineering units. The sample Scale and Offset values shown below have been calculated using the sample values shown in Table 3.

Sample Calibration Values

Calibration Offset : **Cal Offset = 520.06** Example 2AXCA0,520.06!
Calibrbration Scale : **Cal Scale = 6.1435** 2AXCA1,6.1435!

Test Circuit

Use the sample circuit to test the card and make sample measurements. The bridge resistance should be at least 350 Ohms. A 1K Ohm resistor is used to simulate a 3 K Ohm temperature sensor and will give a fixed temperature reading of approximately 50 Degree Celsius.

Default Steinhart-Hart Temperature Sensor Parameters are: **A** = 0.0033540 **B** = 2.5627E-4 **C** = 2.0829E-6 **D** = 7.3003E-8
Further details for configuring a media converter for use with Q-LOG can be seen at:

https://youtu.be/Brjgj9K8qaQ
The Youtube Video demonstrates the Keynes Controls USB media converter in operation.

https://youtu.be/XuMptEUERwc