KEYNES CONTROLS

Strain Gauge Interface - SDI12 Network

Single Channel Strain Gauge Interface - SDI-12 Device

OEM Customised Product

Last Updated: Nov 2014

Introduction

The **NP-STRAIN-1** is an intelligent general purpose strain gauge interface suitable for direct connection to strain gauges and load cells. The device connects to any suitable logger supports SDI-12 digital communications and is fully integrated into the free Keynes Controls Q-LOG data display and recording software.

The product is available as a stand-alone PCB for inclusion into 3rd party products or as a complete sensor complete with an enclosure.

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

The sensor monitors the bridge excitation during the measurement and compensates automatically for any excitation variation during the data conversion process.

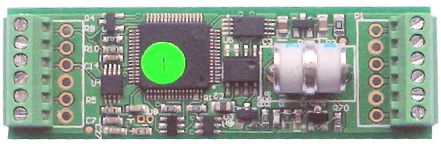
OEM Applications

The NP-Strain-1 PCB can be supplied customised for third party applications. The PCB can be changed to allow for screw hole PCB mounting, choice of termination and pre-set configurations.

Further Information

The **NP-STRAIN-1** strain can be used to provide force on a strain gauge based load cell using the following formula in Q-Log.

Fig-1



NP-STRAIN-1 circuit board

$$F = \frac{(e_o)(F_{fs})}{\left(\frac{mV}{V}\right)(E_x)}$$

F units Newton's

Point–slope form

$y - y_1 = m(x - x_1)$

Installation & Operation

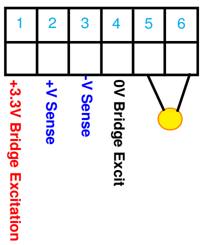
The installation and operation of the NP-Strain-1 sensor is straight forward.

Bridge Type

Connect the strain gauges and bridge completion resistors to the sensor input port, see Figures 7, 8 through 10 for sample wiring options.

Strain Gauge Port Pin-out

View looking into port



Network Connection

Connect the SDI-12 digital port on the sensor to the SDI-12 port on the USB-SDI12 media converter or SDI-12 port on a suitable data logger.

Default **ID = 0** unless specified on the sensor.

Physical Installation

Mount the NP-Strain-1 interface as close to the gauge/load cell is practical for minimum noise and optimum results

Wiring Diagram

The image opposite shows the wiring schematic for connection the NP-Strain-1 onto a SDI-12 network.

Features

Support for 120 to 1 K Ohm Gauges
Ensemble Average Measurements - Noise reduction
External bridge completion
Precision Temperature Sensor
User Programmable Scaling Factors
SDI-12 Digital Communications
Extended SDI-12 Address Support: 0-9 , a-z
16 Bit Precision ADC
Low Power - minimised self heating effect
Engineering and raw data values
Fully Integrated into Q-Log Software
Firmware upgrade facility

The image opposite shows both the NP-STRAIN-1 circuit board and the waterproof housing.

The sensor 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.

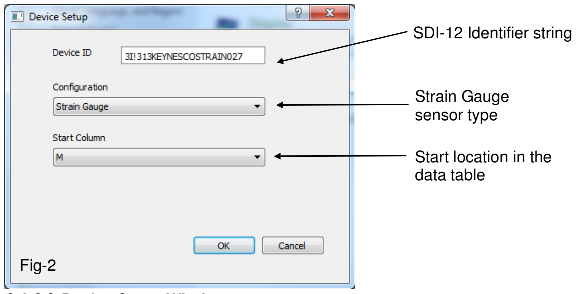


Fig-2

Q-LOG Device Setup Window

Download a copy of Q-Log

Further information at:

http://www.aquabat.net/QLOGFree/qlogv2.html

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

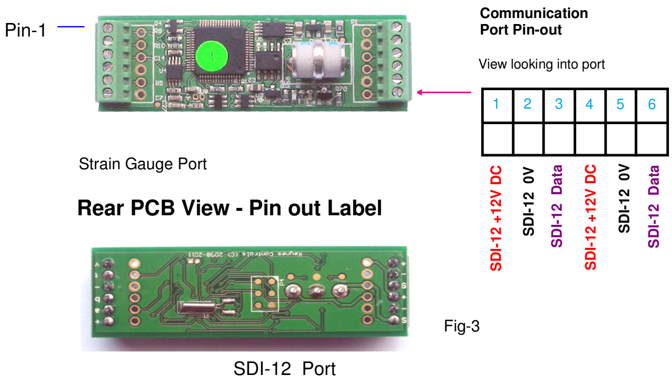


Fig-3

Network Connection Diagram

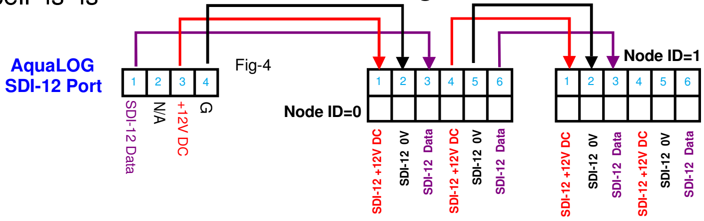


Fig-4

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	+/- 8mV Other ranges on request
SDI-12 Port	1 x Port Version 1.03
Max update rate	1 sec
Cable Clamp Size	2 mm diameter
Bridge Excitation	3.3 V DC - standard
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 10K 3A1 Betatherm
Calibration	Steinhart-Hart Built Pre-defined Set at manufacture
Accuracy	0.05 Deg -8 to 25 Deg C
Range	-30 to + 60 Deg
Units	Deg C / Deg F mv/V, User Defined
RMS Noise (Typical values)	less than 1 uV/V less than 0.01 Deg C
PCB Dimension	
Length	60 mm
Width	19.7 mm
Max depth	11.2 mm
Cable Entry	1 m Screw terminal
Number Channels	1
Gauge Resistance	120 - 1K Ohm
Gauge Factor	User Defined
ADC	16 Bit
Statistics	
Strain	Max, Min
Temp	Max, Min

Example AquaLOG SDI-12 Commands

[D] 0M! 0D0!	- get data ID=0 returns 2 values strain, temp
[F] 0M! 0D1!	- get Max Strain, temp values returns 4 values into cells F .. I
0MM1!	reset max strain for sensor ID=0

Part Numbers

NP-Strain-1-SDI-12	Strain gauge interface - SDI12 digital network option
NP-Strain-1-RS485	Strain gauge interface - RS-485 digital network option

Bridge Zero Offset Correction

The NP-Strain-1 sensor does not zero correct the bridge and assumes the User will correct the error in post processing of the data.

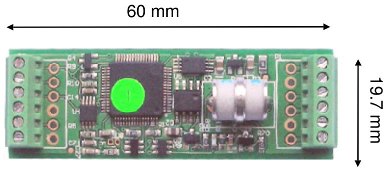
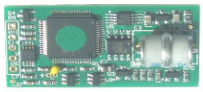


Fig-5

Physical Dimensions

Temperature coefficient of Gage Factor (TCGF)

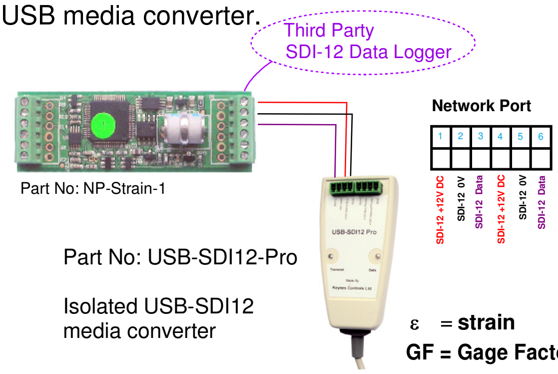
This is the change of sensitivity of the device to strain with change in temperature. This can be compensated for in the calibration equations but it is recommended to be post process corrected in any data analysis.



OEM Version PCB

PC / Laptop Data Acquisition Solutions

The image below shows a simple PC based strain gauge data acquisition application created using the NP-Strain interface cards and the Keynes Control USB media converter.



Strain Equations

The following equations are used by the NP-Strain-1 card to determine the measured strain.

Standard Formulae

$$\varepsilon = \frac{4 \cdot Reading}{GF}$$ **¼ bridge strain gage**

$$\varepsilon = \frac{2 \cdot Reading}{GF}$$ **½ bridge strain gage**

$$\varepsilon = \frac{Reading}{GF}$$ **Full bridge strain gage**

ε = strain
GF = Gage Factor

Default Configuration

The NP-Strain-1 interface uses the 3 K Ohm thermistor by default. The following command can be used to test the NP-Strain-1 sensor.

Start measurement:	0M!	returns 012	- 1 sec response 2 values
	0D0!	returns 0+strain+temp	

Bridge Circuit Options

The images below show how the different bridge options are connected to the NP_Strain-1 card.

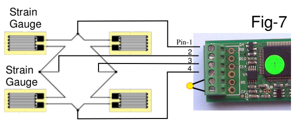


Fig-7

Example circuit shows a full (N=4) bridge strain gauge and thermistor

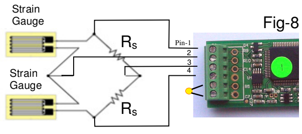


Fig-8

Example circuit shows a half (N=2) bridge strain gauge and thermistor.

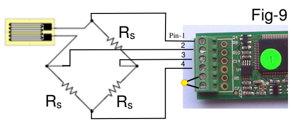


Fig-9

Example circuit shows a quarter (N=1) bridge strain gauge and thermistor.

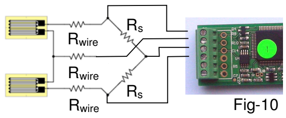


Fig-10

Example circuit shows a half bridge strain gauge (N=2) with 3 wire interface - reduces cable length effects.

Strain calculated using 1, 2 or 4 active arms

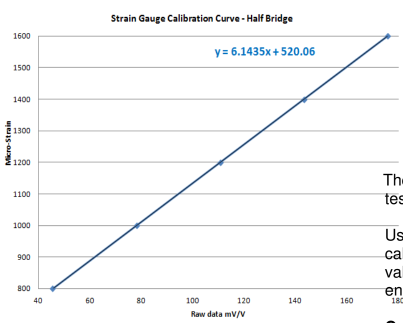
$$\varepsilon = \frac{4(e_o)}{(N)(GF)E_x}$$

N = 4 for full bridge
2 for half bridge
1 for quarter bridge

E_x = Bridge Excitation = 3.3 V
ε = strain
e_o = Output Voltage
N = Number of effective arms
GF = Gage Factor

Supported SDI-12 Commands

Command	Response	Description
aM!	a0tt2	2 values in time tt given by stats
aD0!	a+0.123+25.5	Strain and temperature values
aD1!	a+0.1299+0.1201+25.9+25.0	Statistical values max S, min S, max T, Min T
aI!	a13KEYNESCOPRESR001	Identification string
aXUTu!	au	Temperature units u=0 → Celsius, u=1 → Fahrenheit with read back
aXCn,xxxx	an,xxxx	Calibration data (No temp compensation - default) E = [0] + [1]*s with read back. s is in mV/V E is in micro-strain
aXFt,nn,xxxx!	at,nn,xxxx	Ensemble Averaging Command t → filter type (should be 0 - mean only) nn → number of filtered values 1 to 12 xxxx → interval between beasurment * 200ms
aXTHMT(0..1)	a+0/1	Thermistor type selection 0 → default = 3.3 K Material type F - Model EC95 1 → 10 K Ohm Model 10K3A1 Betatherm



Raw Data mV/V	Calibration Points micro-Strain
45.567	800
78.12175	1000
110.6765	1200
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 to determine 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.

A quadratic calibration equation can be used should this be proved suitable

Example Calibration Commands

aXC0,offset!   aXC1,scale!

Example - Using the sample test data above and Set calibration factors for device with ID = 3 to Scale = 6.1435 and offset = 520.06

SDI-12 Commands are 3XC1,6.1435! 3XC0,520.06!

Results are now in engineering units.

Output (Eng Units) = 6.1435. mV/ V_{in} + 520.06