Spider-80SG: Breakout Box Terminal Guide

Application Note 036

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Contents

A. Introduction

One of the most common inquiries we receive is regarding strain gage setup on the Spider-80SG. The Spider-80SG is designed to be used with strain gages, with the added advantage of utilizing the same intuitive interface from our EDM software platform. The connection to Spider-80SG breakout box is the final piece of the puzzle and it is a lot simpler than it looks.

The idea of having the breakout box is to provide users with flexibility to have multiple configuration types available to users. Depending on the application, users are free to choose whichever configuration suitable to their needs. We will explain a few primary configurations in this paper. To measure strain value, the resistance to be measured must be configured by a complete full-bridge circuit. By using the super-position technique, users will have the ability to complete a full-bridge circuit and select part of the equation to take measurement.

B. Hardware Connection

The breakout box is primarily comprised of the following pins: (Table 1 and Figure 1.1)

Positive and Negative Excitation sensing are used when the strain gage is located at a certain distance from the Spider, which results in a significant drop of the Excitation voltage that is fed to the Strain gage. In this case, a precise value of the excitation voltage is needed to measure strain accurately.

EXE + from the bridge needs to be connected to **SEN +** and **EXE –** from the bridge needs to be connected to the **SEN –** to measure the excitation voltage at the bridge.

Name	Description
EXC+	Positive Excitation (+2.5V/ +5V)
EXC-	Negative Excitation (-2.5V/-5V)
SEN+	Positive excitation sensing
SEN-	Negative excitation sensing
IN+	Positive input
IN-	Negative input
350	350 Ω terminal
120	120 Ω terminal
GND	Ground

Table 1

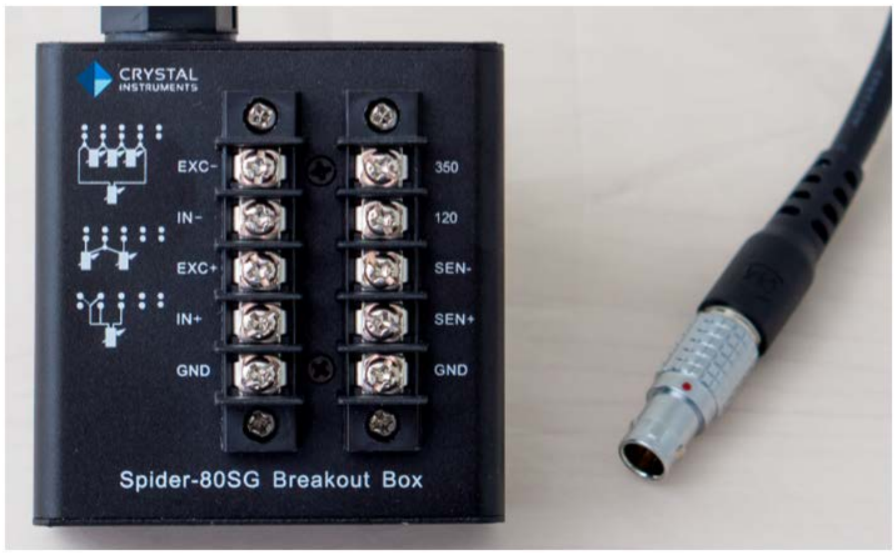

Figure 1.1

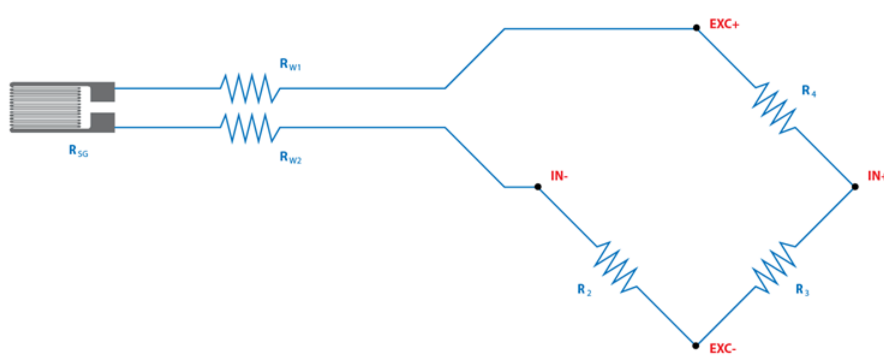

Figure 1.2

Strain gages usually include a 2 or 3-wire terminal. The 3-wire configuration consists of one cable attached to one terminal, and 2 remaining cables are attached to the second terminal. Strain Gages can be connected in the following five basic types of configurations:

(*For simplicity, we recommend configuration 1 and 2*)

1. **QUARTER BRIDGE TYPE I, 2-WIRE CONFIGURATION:** In this configuration, there is only one Strain Gage connected to measure the strain from the test object.

(Figure 1.2)

The strain gage is connected between the **EXC+** and **IN-** terminals as shown. The two terminals of the Strain Gage are interchangeable for this configuration.

Resistors $\mathbf{R_{W1}}$ and $\mathbf{R_{W2}}$ denote the wire resistances of the two wires originating from the strain gage and are connected to the Spider-80SG terminals.

Breakout Box Connections: (Table 2)

2. **QUARTER BRIDGE TYPE I, 3-WIRE CONFIGURATION**: Most Strain Gages have 3 wires (2 wires originating from one of the terminals and 1 wire from the other terminal), this is usually done to compensate for the resistance added by the wire.

One disadvantage of the Quarter Bridge Type I (2-Wire Configuration) is that the resistances caused by the lead wires from the terminals of the strain gage add a small additional value of resistance to the arm of the bridge to which it is connected to. For example, if a **120 Ω** strain gage is connected, the actual resistance would be $\mathbf{120 + R_{W1} + R_{W2}}$ **Ω**. The other internal resistor in the arm would be **120 Ω**, resulting in a slightly off-balance bridge. Since the strain gage works with very minute changes in the resistances, the value of $\mathbf{R_{W1} + R_{W2}}$, although small, can affect readings.

With the 3-wire configuration, as shown below, the third wire is connected in such a way that the wire resistance is added to both resistors of the arm. (Figure 1.3)

The third wire needs to be connected to a pin marked either **120 Ω** or **350 Ω** on the breakout box depending on the resistance of the connected strain gage

Strain Gage Terminals	Spider-80SG Break Out Box
Strain Gage Terminal 1	EXC+
Strain Gage Terminal 2	IN-

Table 2

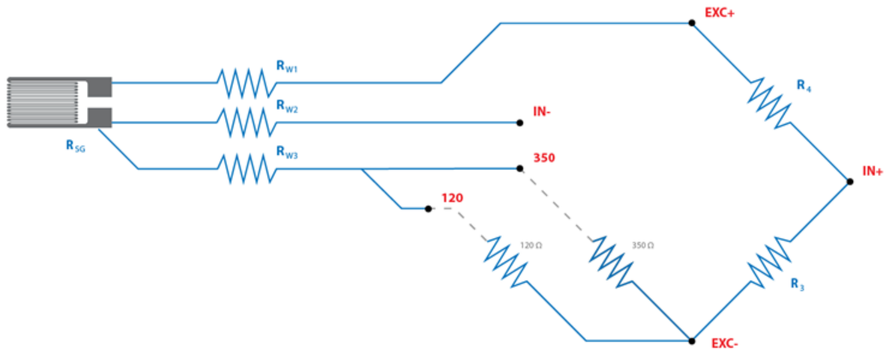

Figure 1.3

Strain Gage Terminals	Spider-80SG Break Out Box
Strain Gage Terminal 1	EXC+
Strain Gage Terminal 2	IN-
Strain Gage Terminal 2	120 Ω / 350 Ω

Table 3

Strain Gage Terminals	Spider-80SG Break Out Box
Strain Gage 1 Terminal 1	EXC+
Strain Gage 1 Terminal 2	IN-
Strain Gage 2 Terminal 1 *(Dummy / Passive)*	IN-
Strain Gage 2 Terminal 2 *(Dummy / Passive)*	EXC-

Table 4

It should be ensured that the terminal of the strain gage with 2 wires needs to be connected to **IN-** and **120/350Ω**. The other terminal of Strain gage with one wire should be connected to **EXC+**.

With the above configuration, assuming **120 Ω** strain gage is connected.

Resistance between **EXC+** and **IN-** =
$\mathbf{120\ \Omega + R_{W1} + R_{W2}}$

Resistance between **IN-** and **EXC -** =
120 Ω (Internal) $\mathbf{+ R_{W2} + R_{W3}}$

The resistances $\mathbf{R_{W1}}$, $\mathbf{R_{W2}}$, $\mathbf{R_{W3}}$ primarily depend on their length (as they are made of same material and operated at the same temperature), so when the length is ensured to be about the same, then $\mathbf{R_{W1} = R_{W2} = R_{W3}}$ making the above bridge, with 3-wire configuration, balanced. (Table 3)

3. **QUARTER BRIDGE TYPE II:** Quarter Bridge Type II is typically used for temperature compensation. Due to the changes in the temperature, the resistance of the strain gage will not be constant making the bridge out of balance even when there is no external strain applied.

To compensate for the changes in temperature, a second dummy strain gage is attached between **IN-** and **EXC-** similar to a Half Bridge configuration. However, the dummy strain gage does not measure strain of any kind and should not be connected to the object undergoing stress. As the dummy strain gage is placed in the same environment as the strain gage measuring strain, both strain gages are subject to the same temperature. Any change in the temperature would influence change the resistances of both strain gages equally and hence making the bridge balanced. (Table 4)

Each strain gage connected also has $\mathbf{R_{W1}}$ and $\mathbf{R_{W2}}$ associated with it making the bridge balanced.

4. **HALF BRIDGE:** For both Half Bridge Type I and Type II configurations, there are two active strain gages completing one arm of the bridge. (Table 5)

Strain Gage Terminals	Spider-80SG Break Out Box
Strain Gage 1 Terminal 1	EXC+
Strain Gage 1 Terminal 2	IN-
Strain Gage 2 Terminal 1	IN-
Strain Gage 2 Terminal 2	EXC-

Table 5

The other arm of the bridge in internal. Since, both strain gages are operated in the same environment with similar wire lengths, the bridge is balanced by default.

5. **FULL BRIDGE:** For both Full Bridge Type I and Type II configurations, all 4 resistors (strain gages) of the bridge are external. (Table 6)

Strain Gage Terminals	Spider-80SG Break Out Box
Strain Gage 1 Terminal 1	EXC+
Strain Gage 1 Terminal 2	IN-
Strain Gage 2 Terminal 1	IN-
Strain Gage 2 Terminal 2	EXC-
Strain Gage 3 Terminal 1	EXC-
Strain Gage 3 Terminal 2	IN+
Strain Gage 4 Terminal 1	IN+
Strain Gage 4 Terminal 2	EXC+

Table 6

C. Input Channel Table Setup

Test Configuration is similar to our standard DSA test setup. There are only a few items to look in Input Channels setup for the strain gage on Spider-80SG.

To set the input channel table, navigate to menu item **Setup > Input channels.** (Figure 2.1)

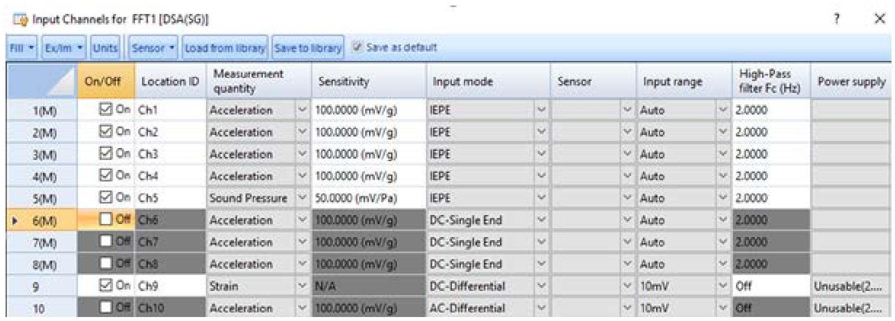

Figure 2.1

Set the required Measurement Quantity for Spider 80X channels and the Spider 80SG channels. For non-strain channels, set the Sensitivity and the Input mode. For Strain channels, set the Input range and then click on the tab **Strain Gage parameters** for further strain gage related settings.

Strain gage parameters are unique and are very different from your normal accelerometers. (Figure 2.2)

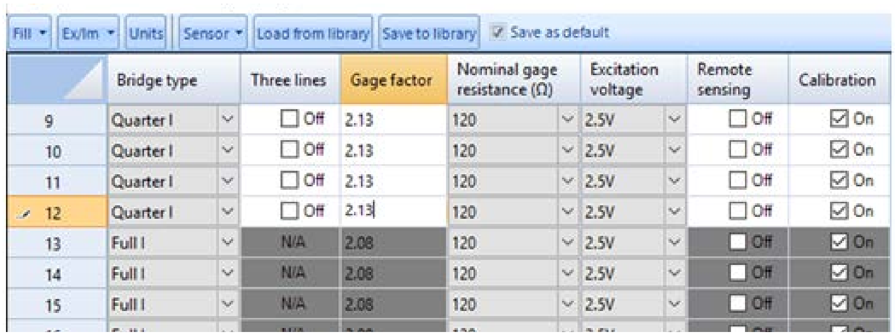

Figure 2.2

For the enabled channels, select **Bridge type** (depends on your configuration), **Nominal gage resistance** and the **Excitation voltage**. It is recommended to enable the Calibration at all times (Input channel must be calibrated before taking any measurements).

Enter the value of Gage factor depending on the type of strain gage being used.

Click on **OK** to complete the setup, and we are ready to take our measurements. Just be sure to calibrate and re-zero the strain gage before every measurement as standard practice for best data.

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