How to Select Bondable Resistors

BCM SENSOR bondable resistors are designed for purposes of the zero-offset adjustment, zero-temperature-drift compensation, span-temperature-drift compensation and span unification of the Wheatstone bridge circuit of sensors.

To fulfill these purposes, 4 different materials of metal foil (i.e., nickel, balco, copper and constantan) are available from which the bondable resistors can be made.

These materials are selected because of their TCR (temperature coefficient of resistance).

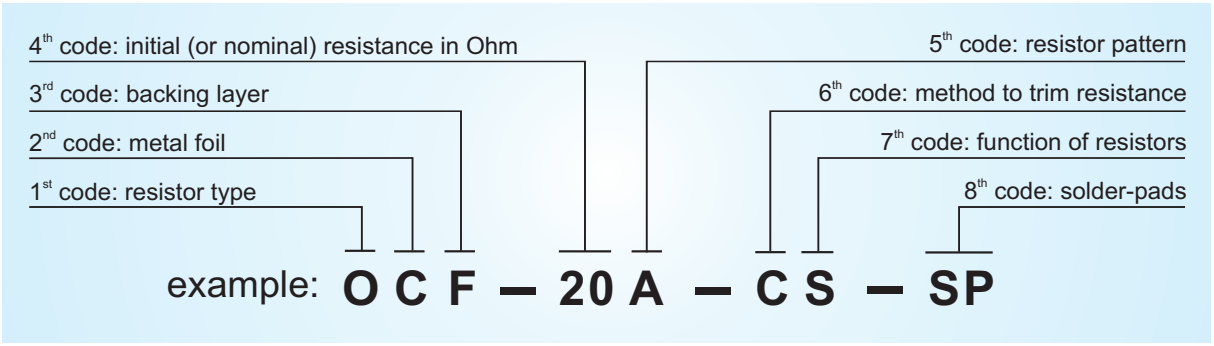
For the zero- and span-temperature-drift compensation, the nicke, balco and copper resistors are typically used due to their high TCR (TCR of nickel is 5500ppm/°C; TCR of balco is 4300ppm/°C; TCR of copper is 3900ppm/°C). While for the zero-offset adjustment and span unification, the constantan resistors are used as they have very low TCR (20ppm/°C).

For the purpose of the process as mentioned above, the resistance of the bondable resistors may need to be trimmed. Therefore, to provide you with different methods to trim the resistance, there are various patterns available for the bondable resistors, which can be found on their datasheet.

The ordering code system of bondable resistors and how-to-select will be explained in detail in this article.

3.3.1. Guidance of Ordering Code System of Bondable Resistors

The ordering code system shown below is meant to assist users to purchase the bondable resistors from BCM SENSOR. In the corresponding notes and the Explanation of Each Code below more advice is given.



1st code: resistor type – whether the grid of the resistor is encapsulated or not.

Two available resistor types are:
- E: encapsulated resistor, i.e., the resistor with an encapsulation layer;
- O: open-face resistor, i.e., the resistor without an encapsulation layer.

For the bondable resistors, the encapsulated type (E) is only available for the pattern A resistor with a fixed resistance (F as the 6th code) and the pattern M resistor of which resistance can be trimmed by short-circuit (S as the 6th code).

Industriepark Zone 4, Brechtsebaan 2
B-2900 Schoten-Antwerp, BELGIUM
Tel.: +32.3.238 64 69
Fax: +32.3.238 41 71
website: www.bcmsensor.com
email: info@bcmsensor.com

2nd code: metal foil – the foil of metal alloy from which the grid and solder pads of the resistors are made.

Four available types of metal foil are:
- B: balco alloy;
- C: constantan alloy;
- N: nickel;
- Q: copper.

The material of the metal foil will determine the function of the resistor. The balco (B), nickel (N) and copper (Q) have much higher temperature coefficient of their resistance than the constantan (C) does. Therefore, the balco (B), nickel (N) and copper (Q) resistors are for either zero-temperature-drift compensation or span-temperature-drift compensation, while the constantan (C) resistors are for either zero-offset adjustment or span unification.

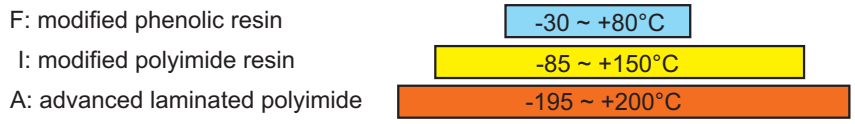
For details, please refer to the specifications on the datasheet of bondable resistors.

3rd code: backing layer material – the layer which carries the metal foil.

Three available types of backing layer (in short, backing) material are:
- F: modified phenolic resin;
- I: modified polyimide resin;
- A: advanced laminated polyimide.

Indicated below is the working temperature ranges of each backing layer (in short, backing) material which will determine the operating temperature range of the resistor. It is suggested that the backing material of the resistors shall correspond to the backing material of the strain gauges.

Working temperature of backing layer material:



4th code: nominal initial resistance (in Ohm) – the resistance measured from the solder pads of the resistors before trimming.

The nominal resistance refers to the designed resistance by BCM SENSOR. Therefore, for the resistors which can be trimmed by cutting (C), rubbing (R) or short-circuit (S), this code refers to their initial resistance.

The available resistances for the specific gauge patterns can be found on the datasheet.

5th code: resistor pattern – the pattern of the resistor design.

The resistor pattern will determine how to use the resistor, i.e., the 7th code of the ordering code.

The available resistor patterns can be found on the datasheet.

6th code: method to trim the resistance.

According to the way to trim the resistance, the resistors are grouped into the following four types:
- F: fixed resistance, i.e., the resistance cannot be trimmed;
- C: cutting, i.e., the resistance can be trimmed by cutting off the stripe(s) of the resistor grid;
- R: rubbing, i.e., the resistance can be trimmed by rubbing the resistor grid with a pencil eraser;
- S: short circuit, i.e., the resistance can be adjusted by shorting the resistor grid with a solder or a silver conductive compound.

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website: www.bcmsensor.com
email: info@bcmsensor.com

7th code: function of resistor – referring to the adjustment or compensation of the Wheatstone bridge circuit the resistor can be used for.

The four kinds of adjustment and compensation are:
- E: span-temperature-drift compensation or compensation for temperature effect on Young's modulus of the sensor body;
- S: span unification;
- T: zero-temperature-drift compensation;
- Z: zero-offset adjustment.

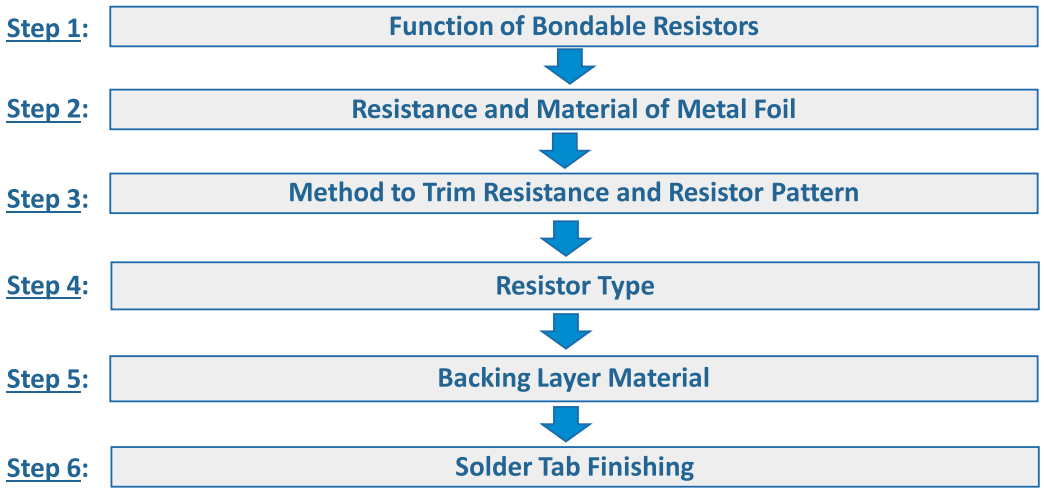
8th code: solder-pad finishing – the electrical interface of the resistor.

To ease the soldering and wiring on the bondable resistors, BCM SENSOR offers five types of solder-pad finishing for the resistors.

3.3.2. Selection Procedure of Bondable Resistors

In this chapter, a step-by-step selection procedure will be explained.

The following chart can assist users to map the steps to select the right bondable resistors. And the further explanation can be found below the chart.



Step 1: Determine the function of the bondable resistors.

The functions of bondable resistors are:
- E: span-temperature-drift compensation;
- S: span unification;
- T: zero-temperature-drift compensation;
- Z: zero-offset adjustment.

On Technical Questions page of BCM SENSOR website, one can find detailed info about these four kinds of adjustment and compensation.

Step 2: Decide about the resistance and the material of the metal foil according to the function of resistor in the application.

The candidates for the metal foil are partially determined by the function of the resistors as listed in Tab. 1 below. And in this table, one can also find the suggestion of how to decide about the resistance.

Industriepark Zone 4, Brechtsebaan 2
B-2900 Schoten-Antwerp, BELGIUM
Tel.: +32.3.238 64 69
Fax: +32.3.238 41 71
website: www.bcmsensor.com
email: info@bcmsensor.com

Tab. 1

Function of Bondable Resistors	Material of Metal Foil	How to Decide Resistance
zero-offset adjustment (Z)	constantan (C)	Refer to the technical note of Zero-Offset Adjustment.
zero-temperature-drift compensation (T)	balco (B), nickel (N), copper (Q)	Refer to the technical note of Zero-Temperature-Drift Compensation.
span-temperature-drift compensation (E)	balco (B), nickel (N)	Refer to the technical note of Span-Temperature-Drift Compensation.
span unification (S)	constantan (C)	Refer to the technical note of Span Unification.

Step 3: Decide how to trim the resistance of the bondable resistors and the resistor pattern.

Four available methods to trim the resistance of resistors are:
- F: fixed resistance, i.e., the resistance cannot be trimmed by the user.
- C: cutting, i.e., the resistance can be trimmed by cutting off the stripe(s) of the resistor grid.
- R: rubbing, i.e., the resistance can be trimmed by rubbing the resistor grid with a pencil eraser. This method is suitable for a fine adjustment of the resistance.
- S: short circuit, i.e., the resistance can be trimmed by shorting the parallel grid lines of the resistor with a suitable solder or conductive silver compound.

Listed in the table on the datasheet are the functions of bondable resistors versus the commonly used trimming-methods versus the suitable resistor patterns according to the experience of BCM SENSOR.

Step 4: Determine the resistor type (i.e., with or without encapsulation layer) according to the resistance trimming method.

The resistors with an encapsulation layer are only available for the pattern A resistor with a fixed resistance and the pattern M resistor of which resistance can be trimmed by short-circuit.

Step 5: Select the backing layer material to meet the required operating temperature range in the application.

The working temperature range of the bondable resistors has to correspond to that of the strain gauges.

Step 6: Select the solder tab finishing according to the installation requirements.

In sensor applications, the naked solder pad (SP) is the most commonly choice.

For further engineering advice on how to solder leads or wires onto karma gauges, one can contact BCM SENSOR.

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