Resistance Strain Gauge

I. General Information

Resistance strain gauge is a kind of sensitive element by using resistance-strain effect to transform the strain of specimen into resistance change. It is the most widely used strain test element. The load cells used in weighing and measuring field mainly include resistance strain gauge type load cells, capacitance type load cells, vibrating string type load cells and so on,more than 85% of them are resistance strain gauge type load cells.

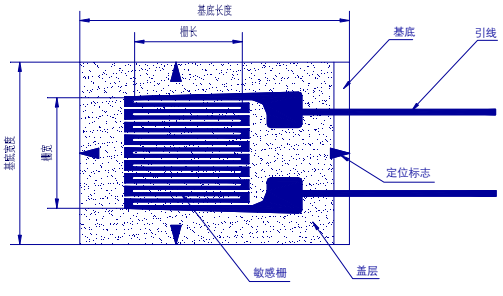
Jinan Jinzhong Electronic Scale Co., Ltd. has imported technology of resistance strain gauge from Japan, equipped various advanced equipments and devices such as vacuum heat treatment oven, automatic etching machine, temperature and pressure control curing machine, automatic exposure unit, measurement microscope, nitrogen protection welder, owns purifying equipment such as purifying drier, super-clean bench and pure water producer. All working sites are purified environments; key procedures are class 100 purified environments. Main materials and accessory materials use the products from famous foreign companies. Advanced equipment and producing environments, excellent raw materials, strict production procedures and perfect quality management ensure the high quality and consistent performance of resistance strain gauges.

The resistance strain gauges produced by our company has the advantages of long liability and good uniformity, the functions of creep and temperature self compensation, suitable for batch production of alloy steel, aluminum ally and stainless steel load cells with high accuracy, and for producing other load cells and force and strain measuring elements.

II. General Introduction of Resistance Strain Gauge

I) Structure of resistance strain gauge

The resistance strain gauge consists of the backing, sensitive grid, covering layer and lead wire, the typical structure of resistance strain gauge is shown in the following drawing:



II) Main operating characteristics of resistance strain gauge

1. Sensitive factor

On the strain gauge installed on the specimen, the ratio of the resistance relative change （△R／R） caused by axial stress and specimen surface axial strain （△L／L） caused by this stress is called as the sensitive factor of strain gauge. It can be expressed by the following equation:

$$K = \frac{\triangle R / R}{\triangle L / L}$$

2. Creep

In stable temperature conditions, when the installed strain gauge bears stable mechanic strain, the indicated strain quantity changing with time is called the creep of strain gauge.

The strain gauge that is used for producing load cell requires:

① Stable creep. The creep quantity of same type and batch of strain gauge shall be the same. The dispersion shall be small.

② Creep self-compensation function. The creep of different types and same series of strain gauge shall change from the small to the large so as to make convenience conduct the creep compensation for load cell.

The principle of strain gauge creep self-compensation: The elastic element of load cell normally uses the metal material. When the metal material generates strain after bearing stable external force, since it has the elastic lag effect, its strain will increase with the elapse of time and shows as the positive creep. Since the strain gauge backing and adhesive bonded on the elastic element of strain gauge have certain viscosity, the deformation of sensitive grid will decrease with the elapse of time and shows as negative creep. The result from above-mentioned two actions shows as positive or negative creep. The creep quantity of strain gauge can be adjusted by various methods such as changing the end side of sensitive grid, backing material and covering material. The strain gauges of same series can be produced as different numbers for selection according to the creep change so as to realize the purpose of compensating the creep of load cell, they are creep self-compensation strain gauges.

The principle of selecting creep self-compensation strain gauge for load cell is:

1. Select suitable structure of sensitive grid according to the force-bearing situations of elastic element and the size of strain area.

2. The smaller the capacity of load cell with the same material and structure, the more positive is the creep, and the more negative creep of strain gauge shall be selected.

3. Select the strain gauge with creep compensation number to bond on the load cell according to initial judgment.

4. Determine suitable type of strain gauge according to used creep compensation number of strain gauge and the final creep of load cell. The difference between two nearest creep numbers of strain gauges produced by our company is normally about 0.015%.

5. The creep will change after the strain gauge is affected with damp, so pay attention to damp-proof during store and operation.

6. The solidifying procedure and fixture can influence the creep; so pay attention to the stability of solidifying procedure and the periodical maintenance of solidifying fixture during using the strain gauges in batch.

3. Resistance of strain gauge

The resistance of strain gauge normally is: 120Ω, 350Ω, 1000Ω, 1500Ω, 2000Ω, 2500Ω. We also

can produce the strain gauge with any resistance between 0-3000Ω according to the requirements of users. The tolerance of resistance of same batch of strain gauge is normally ±0.5%, the tolerance of resistance of same packing of strain gauge is normally ±0.1%. The tolerance of strain gauges used on the same load cell shall be as small as possible so as to make convenience for zero compensation of load cell.

4. Heat output

For the strain gauge bonded on the specimen, under the conditions of not bearing external force, the indicated strain caused by the temperature change of environment is called heat output of strain gauge（ε_t） . The heat output of strain gauge is mainly caused by the following two parts: 1. The resistance temperature factor of sensitive grid material α; 2. Linear expansion factor of sensitive grid material（βe）and linear expansion factor of specimen material（βs）are different. It can be expressed by the following equation:

$$k\cdot\varepsilon_t=\alpha\cdot\triangle t + k\cdot(\beta s - \beta e)\cdot\triangle t$$

In the equation, k is the sensitive factor of strain gauge， △t is the temperature change. From above equation, adjusting the resistance temperature factor of sensitive grid material α to k· (βe -βs) can make the heat output of strain gaugeε_t=0 so as to realize the purpose that the output of strain gauge is not or little affected by the temperature. The strain gauge with this function is called **temperature self-compensation strain gauge**.

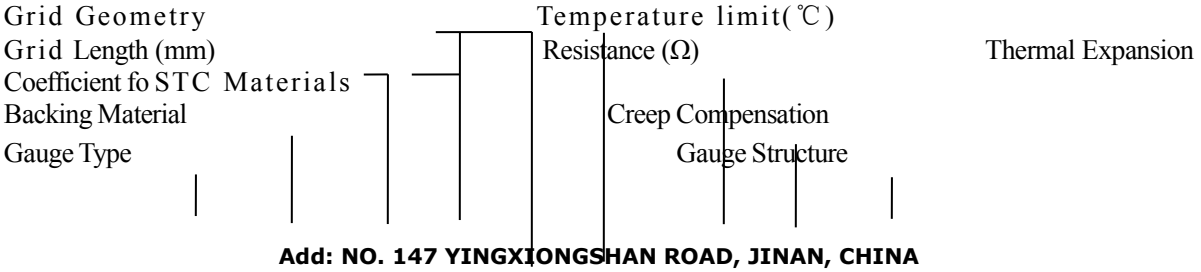
Manufacturers of strain gauges adjust the resistance temperature factor of sensitive grid material normally by using the method of vacuum heat treatment for sensitive grid material; therefore, vacuum heat treatment oven with high performance is the absolutely necessary equipment. The performance of vacuum heat treatment oven and heat treatment procedure are main factors that influence the quantity and dispersion of heat output of strain gauge. For the load cell, since the electrical bridge has the function of removing the temperature influence, the dispersion of heat output of strain gauge is the specification that shall be especially noticed.

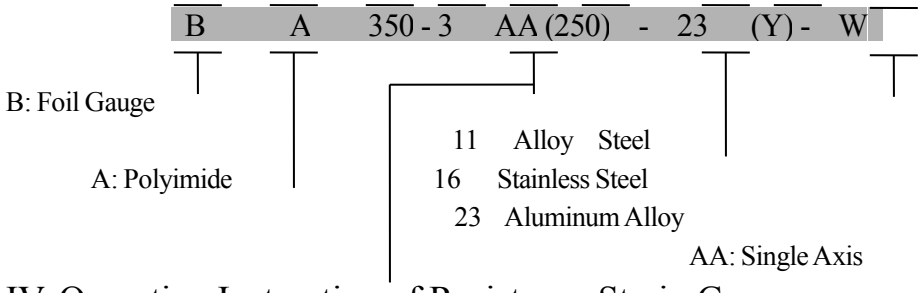
At present, normal elastic element materials of load cells are alloy steel, stainless steel and aluminum; their corresponding temperature self-compensation numbers are 11, 16 and 23. The materials shall have their linear expansion factors.

5. Sensitive factor change with the temperature

The sensitive factor of strain gauge is a constant in normal temperature, but it will change with the temperature change. The sensitive factor change with the temperature mainly relates with sensitive grid material, backing material and adhesive also affect it. The sensitive factor of constantan alloy will normally increase with the increase of temperature, about 1%/100℃. The change is basically linear within the range of operating temperature. The sensitive factor of karma alloy will normally decrease with the increase of temperature, about –0.7% - -1.3%/100℃, and it can be adjusted by heat treatment.

III. Strain Gauge Designation System





IV. Operation Instruction of Resistance Strain Gauge

1、 .The treatment of specimen surface

1) Specimen surface degreasing

Use organic solvent such as acetone, butyrone or ethanol absolute to clean the gauging area, the cleaning area shall be four times larger than gauging area.

2) Rough grinding

Use 160#-200# sand paper to grind the gauging area of strain gauge, the grinding trace shall be about 45 degree with the axis of strain gauge, and the trace shall be vertically intersected. Grind the area until no trace of machining tool can be seen. Then clean the sand and iron filings by soft cloth.

3) Finish grinding or sand blasting

Use 300#-400# sand paper to grind the gauging area of strain gauge, the grinding trace shall be about 45 degree with the axis of strain gauge, and the trace shall be vertically intersected. When the grinding trace is clear and uniform, clean the sand and iron filings by soft cloth (or use sand blasting machine to blast sand by use of 100#-250# emery).

4) Cleaning gauging area

Use organic solvent such as acetone, butyrone or ethanol absolute to clean the gauging area, the cleaning area shall be larger than two times of gauging area.

.2. Marking line

Use the marking needle to mark locating sign. Pay attention to the marking line shall not the range of gauging are, and the marking line can be seen by eye.

3. Bonding gauge

1) The selection of bonding gauge glue

Recommended type: M-BOND-610 produced by American MM company.

2) Measure the resistance of strain gauge and select the strain gauges with similar resistance to form the electric bridge.

3) Use a cotton stick to dip in organic solvent such as acetone to clean the bonding area of strain gauge.

4) Use a hairbrush to dip in M-BOND-610 glue and coat a thin coat on the surface of specimen, the

glue-coating area shall be slightly larger than the backing of strain gauge

5) Use the hair brush to brush the thin glue on the backing of strain gauge.

6) Bonging gauge

a) According to the marking line, bond the strain gauge on the bonding area, the axis of strain gauge shall be aligned with the marking line.

b) Use the polytetrafluoroethylene film to cover the strain gauge.

C) Use the index finger to press the center part of strain gauge vertically, roll it from inside to outside, and remove all air bubbles and residue glue.

4. Solidifying

In accordance with the solidifying conditions of glue, solidify and stabilize the strain gauge.

5. Check gauge bonding quality

a) Check whether there is any air bubble or impurity pellet under the strain gauge.

b) Check whether the resistance value and insulation resistance are normal.

c) Check whether the strain gauge deviates from the marked line

6. Lead out the lead wire

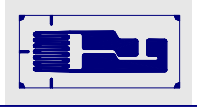
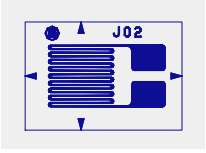
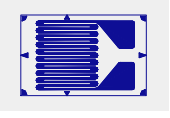
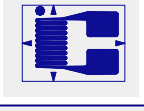
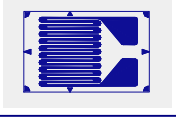
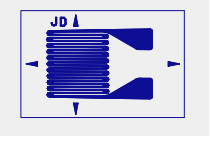
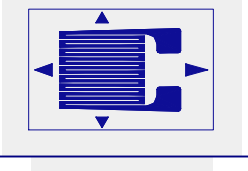
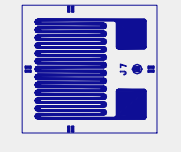
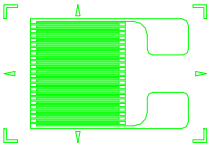
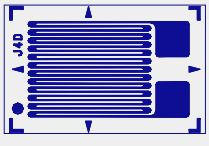
a) For the strain gauge with lead wire: Cut out the lead wire of strain gauge according to the required length, solder it on the connecting terminal after bending it, lead out the lead wire from the connecting terminal.

b)

For the strain gauge without lead wire: Remove the rubber layer and oxidation of 1/2 outer area of strain gauge, use the temperature control electric iron to solder the lead wire. Recommend using the lead wire with the section of less than 0.25 mm^2.

7. Strain gauge protection

Use suitable protection glue to conduct coating protection of strain gauge so as to avoid entering of humidity and erosive gases.

Model	Grid Size (L×W)	Base Size (L×W)	Appearance	Note
BA120-1AA-**	1.5×1.9	7.8×3.5		
BA120-2AA-**(2) BA120-2AA-**(4) BA120-2AA-**(6) BA120-2AA-**(8) BA120-2AA-**(10)	2.5×2.2	6×4		Creep Direction 2 ---- 10 - --- +
BA175-2AA-**	2×1.1	4×5.9		
BA350-1AA-**	1.3×2.2	5.1×3.5		
BA350-2AA-**	2.4×3	5.3×3.4		
BA350-2AA-**(NA) BA350-2AA-**(A) BA350-2AA-**(B) BA350-2AA-**(D) BA350-2AA-**(E) BA350-2AA-**(F)	2.0×2.6	7.3×4.5		Creep Direction NA-----F - +
BA350-3AA-**(W) BA350-3AA-**(X) BA350-3AA-**(Y)	3.0×3.1	7.2×4.9		Creep Direction W ---- Y + --- -
BA1000-3AA-**(A) BA1000-3AA-**(B) BA1000-3AA-**(D)				A ---- D + --- -
BA1000-3AA-**(7)	3.4×5.3	6.8×6.5		
BA700-3AA-**(23)	3.0×3.74	7.6×5.2		
BA2500-4AA-**(D) BA2500-4AA-**(E)	4.5×3.5	7.4×4.6		Creep Direction D ---- E - --- +

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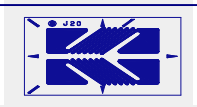
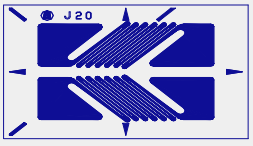
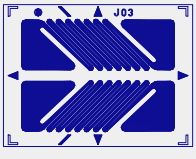
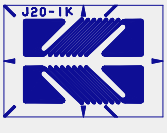
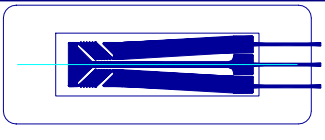
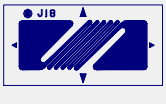
BA175-2HA-**(20)	1.9×1.3	5.2×7.4		
BA240-2HA-**(20)	1.9*1.6			
BA350-2HA-**(16) BA350-2HA-**(18) BA350-2HA-**(20) BA350-2HA-**(23)	2.0×1.6	7.9×5.3		Creep Direction 16 ---- 23 - --- +
BA350-2HA(180)-**(20) BA350-2HA(250)-**(20)	2.0×1.5	7.3×4.5		The highest temp. is 180℃、250℃
BA350-3HA-**(03) BA350-3HA-**(04) BA350-3HA-**(05) BA350-3HA-**(06) BA350-3HA-**(07) BA350-3HA-**(08) BA350-3HA-**(09) BA350-3HA-**(10) BA350-3HA-**(11) BA350-3HA-**(12)	3.0×2.5	9.8×7.2		Creep Direction 3 ---- 12 - --- +
BA1000-2HA-**(20)	2.0×1.6	7.4×5.3		
BA350-2HA-**(20)-1	2.0×2.6	20.8×6.4		
BA175-2HA-**(18)A	1.5×1.9	7.8×3.5		
BA350-2HA-**(18)A	2.0×1.6	7.6×2.8		
BA350-2HA-**(18)B	2.0×1.6	7.6×2.8		
BA1000-2.5HA-**(20)A	2.5×2.2	8.0×3.2		
BA1000-35JA-**	Φ35×1.5	Φ42.3		Double wire spiral grid Grid diameter Φ35

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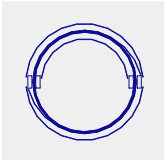
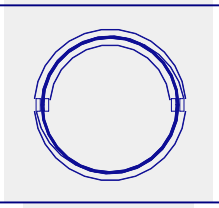
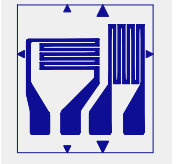
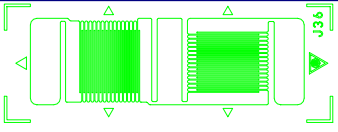
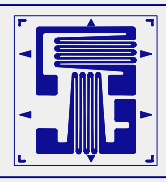
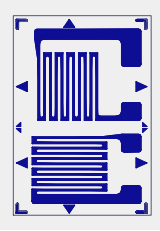
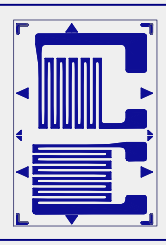
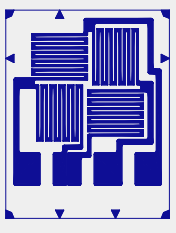
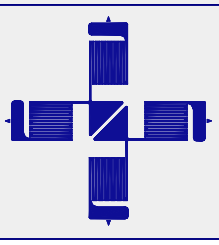
BA1000-50JA-**	Φ50×1.5	Φ57.3		Double wire spiral grid Grid diameter Φ50
BA1000-65JA-**	Φ65×1.5	Φ87.3		Double wire spiral grid Grid diameter Φ65
BA175-2BB-**	2.0×1.3	6.0×6.0		
BA350-3BB-**(23) BA350-3BB-**(36)	2.6×2.2	12.8×4.7		Creep Direction 23 ---- 36 - → +
BA600-6BB-**(W)	6.0×1.3	11.9×11.1		
BA1000-3BB-**(W)	3.0×3.0	6.1×10		
BA1000-3BB-**(W)	3.0×3.0	6.1×10		
BA700-3EB-**（W）	3.0×2.8	10×12.8		
BA350-2DD-**	2×3	16×16		Width between centers 8mm

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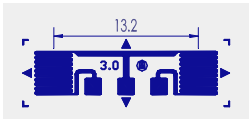
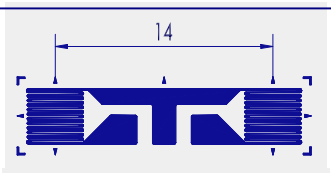
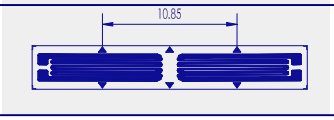
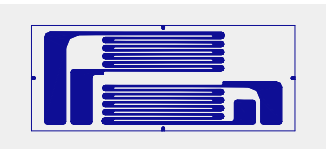
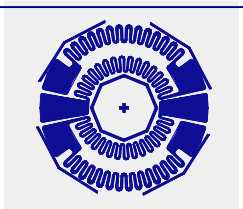
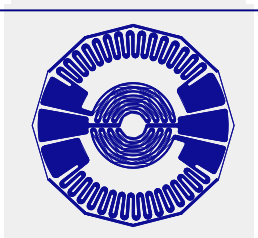
BA350-3GB-**(3)	3×4	7.8×3.5		
BA750-3GB-**(11)	3×3.5	19.2×5.2		
BA350-9GB-**	9×1.9	24.5×3.2		
BA350-4FB-**	4×1.4	10×4		
BA350-7KA-**		Φ7		
BA350-(8)KA-**		Φ8.5		
BA350-(10)KA-**		Φ10.2		
BA350-(18)KA-**		Φ18.8		

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