Strain Gauge-Catalogue

Strain Gauge and Bridge Balance Resistors

Represented by:

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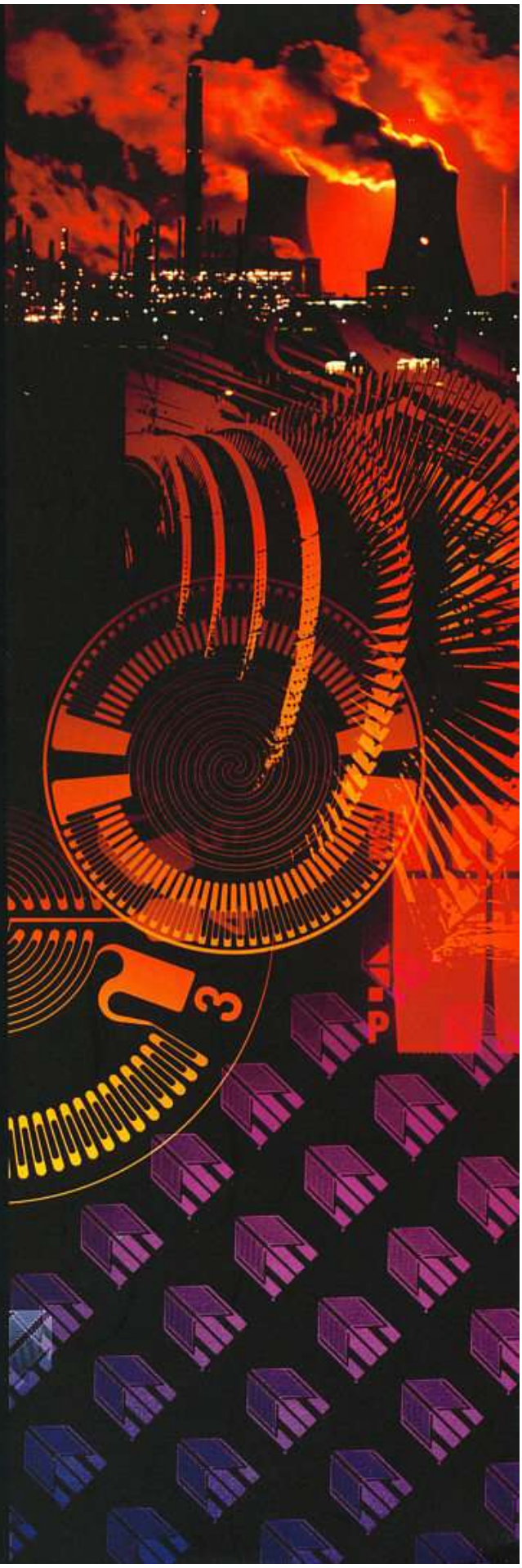
TSM

STRAIN GAUGES AND SENSORS



The Sensor Company

Welcome to our latest catalogue which outlines all TSM products, together with a range of services and accessories - designed to ensure you get the very best performance.

TSM have been designing and manufacturing strain gauges for over 30 years. The resultant experience and knowledge allows us to offer a unique service in strain measurement, which enables us to supply strain gauges for every application in stress analysis and transducer work.

All products are manufactured in our purpose built environmentally controlled units, using the latest photolithography processes and micromachining techniques. Every stage of design and manufacture of strain gauges conforms to EC and ISO 9001 standards.

As we control every aspect of manufacture, you can be sure of getting the right product you need - when you need it. We specialise in custom build to specific requirements, with the speed and flexibility you can expect from a vibrant, dynamic company.

Our philosophy is based on a partnership approach with our customers, by offering the very latest technology at sensible cost - backed up with full technical assistance that is always available. Let us share this philosophy with you.

Mr. Albert Ellison
Managing Director

Mr. Ellison who is the owner of the company is a Chartered Engineer with over 25 years experience in strain measurement and sensor technology. His vision is in seeking out the very latest developments in design, materials and technology and to offer these developments to the advantage of customers. He oversees and directs a number of research projects in partnership with several UK universities.

The Sensor Company

ADVANCED SENSOR TECHNOLOGY PRODUCTS

Mr.Sean Dobbins
General Manager

With a background in Finance and Postgraduate in Marketing, Mr. Dobbins runs the day to day management of the company and is your main contact for any enquiry or for specific applications assistance. He co-ordinates sales via a dedicated network of distributors in some 31 countries worldwide.

CONTENTS

Choosing the right Strain Gauge...

Careful selection is important in obtaining accurate and reliable strain measurement and achieving the best performance for specific applications. Choosing the right strain gauge will save time and money on installation costs. The following characteristics for consideration are:

- Strain sensitive alloy e.g. Constantan or Karma
- Backing material (carrier) e.g. Polyimide or Epoxy
- Gauge length/Gauge pattern
- Gauge resistance

Further requirements need to be considered such as :

- Accuracy and stability?
- Operating temperature range?
- Length of test duration and cyclic endurance?
- Type of strain measurement (static, dynamic, etc)?

TSM will be happy to advise on all aspects to ensure you have the right product

Despite the large number and types of strain gauges, the process of selection can be reduced to a few basic steps, which are:

1. Gauge length
2. Gauge pattern & resistance
3. Option (if any)
4. STC (Self Temperature Compensation) number

Gauge Length:

Gauge length is the length of the gauge grid which is sensitive to strain and which measures the average strain over the area of the grid. If an average value is required, for example on a nonhomogeneous material like cement, then a long strain gauge should be utilised. For homogeneous materials, the length of the gauge is determined by the available space, ease of handling and application; and grid area considerations for heat dissipation. TSM offer gauge lengths from 1mm to 200mm.

Gauge Pattern & Resistance:

The suitability of a strain gauge pattern for a specific application will be dependent on the gauge resistance and the type of stress analysis required. Gauge resistances are typically 120 ohms, 350 ohms, and 1000 ohms. Higher resistance gauges can use higher bridge voltages, generate higher output signals, and reduce heat generation rates and leadwire effects. Single grid gauges are used in circumstances where uni-axial stress states exist and the principle axes are known. Two element grids are used in a bi-axial state where the principle axes are known and three element grids are used in a bi-axial stress state where the principle axes are unknown.

Options:

TSM offer the following options for all strain gauges that are manufactured:

(a) Leadwire attachment - normally up to 50mm using plain or enamel insulated copper wire (Leadwire lengths can be increased/decreased to suit customer's application)

(b) Encapsulation only - Polyimide laminate generally 25-50 micron thick

(c) Leadwire attachment and Encapsulation

Self Temperature Compensation Number (S.T.C.)

Constantan alloy gauges are available with various STC numbers which match the thermal coefficients of expansion of the test material in ppm/degree C. These variations are available for mild steel, stainless steel, aluminium and ceramic.

Figure 1.

Notes on Types of Foil

Constantan Alloy:

This is the most widely used and has a relatively high strain sensitivity (or gauge factor), whilst being insensitive to strain level and temperature. Constantan has a long fatigue life, elongation capability and can be processed for self temperature compensation. All batches of TSM foil which have been self temperature compensated are tested and their thermal output curve plotted and approved, prior to the commencement of production. See Fig. 1.

Karma Alloy/Nickel Chromium:

Karma resistance alloy has a high electrical resistivity and low temperature coefficient of resistivity compared to Constantan, providing a wide temperature compensation range and having excellent stability and fatigue characteristics. Karma also allows higher gauge resistances to be achieved.

Foil Backing:

Plastic backing or carrier for the strain gauges. It provides electrical insulation between the metal foil and the test subject. There are two basic types:

Epoxy Backing – for temperature up to 120 degrees C.
Polyimide Backing – for temperatures up to 230 degrees C.

TSM can provide full details and guidance in the selection to suit your requirements.

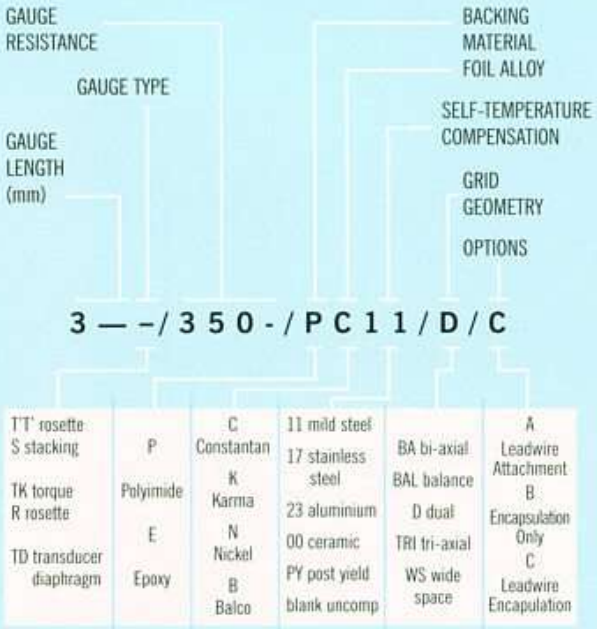
Ordering Information

All basic designs have integral foil solder tabs provided for lead attachments. Most of the configurations are also available with leadwire attachment and encapsulation options. After determining the desired foil type and backing material, choose a gauge with the appropriate size, grid pattern, tab geometry and gauge resistance from the charts given on the following pages. It will then be necessary to determine the temperature compensation required and any options desired.

The charts show the code designation. Simply select the specifications and options by the codes and numbers shown. Remember – our engineers are on hand to provide every assistance to help you with the right selection to suit your needs. We are just a phone call away! Tel +44 1265 55734 or Fax. +44 1265 58195.

Foil Strain Gauges Coding System

Availability: Supplied in packets of 5 or 10 matched gauges.
Specification: Gauge Factor range 2.00 - 2.20. Gauge factor variation with in batch ±1%
Resistance variation ±0.15% of nominal value on most gauge configurations.



CODING SYSTEM

Availability: Supplied in packets of 5 or 10
Specification: Resistance Variation ±1% of nominal resistance value.

Certificate No. 957388

Qualified for design & manufacture of Strain Gauges

Further Technical Points...

Zero Drift:

Drift is a gradual change in gauge zero strain resistance with time. Drift is always present, but can be minimised if the gauges are well matched and carefully selected. To ensure minimum zero drift, TSM gauges are manufactured from foil with very low temperature compensation spread. To ensure consistent performance, installation of all new gauges should be temperature cycled at least three times, prior to taking measurements to minimise zero drift.

Creep:

Creep is the change in gauge output over time under a constant strain. This output is reversed on the removal of the load. All TSM strain gauges are designed to have minimum creep. However, for precision requirements, creep can be a vital factor such as in electronic weighing. Gauges can be modified to match any characteristics of the customers transducer, to produce a creep performance within European standards.
Many factors can influence creep. These include the transducer body material, temperature, type and thickness of adhesive, type and thickness of backing material, encapsulation and the geometry of the strain gauge design. Even when the gauges have been carefully manufactured, if an alternate batch is specified, it may be necessary to make adjustments.

Hysteresis:

Hysteresis of a strain gauge is the difference in the measured values for rising and falling strain loading or temperature. Hysteresis becomes smaller after a number of load/temperature cycles, therefore it is recommended that installations are load and temperature cycled at least three times before experimental results are taken.

Errors:

Every strain measurement will unavoidably have measurement error and the knowledge of possible sources of error will enable counter measures to be taken. These may occur for example, in the change of resistance of the gauge with temperature. Other factors must be considered such as zero drift, creep, hysteresis, inadequate insulation, cable, chemical effects and change in gauge factor with temperature.

Gauge Factor:

Gauge Factor is a measure of the strain gauge's sensitivity and is expressed as the ratio of the relative change of resistance to applied strain. TSM measure and indicate the gauge factor for every batch of strain gauges produced, using special calibration equipment.

Temperature Compensation:

Uncompensated Constantan alloy gauges are suitable for use at ambient temperature only. Compensation for temperature changes may be achieved by the use of an active gauge and dummy gauge from the same production batch, being bonded onto a test specimen, both exposed to the same temperature, with the dummy gauge being positioned in such a way that it will not be strained under test. Self-Temperature Compensation gauges are made from Constantan which has been carefully selected and heat treated to exhibit the thermal expansion coefficients of the test specimen. This is the most widely used temperature compensation method for stress analysis and transducer applications.

CHECKLIST

Factors Affecting Strain Gauge Selection

Gauge Length	❑ maximum strain area
	❑ accuracy & stability
	❑ heat dissipation
	❑ installation restrictions
	❑ cyclic endurance
Gauge Pattern & Resistance	❑ heat dissipation
	❑ leadwire effects
	❑ stress state
	❑ strain gradients
	❑ installation restrictions
	❑ operating temperature
	❑ method of strain measurement
	❑ accuracy
	❑ signal to noise ratio
Options	❑ ease of soldering
	❑ environmental protection
	❑ type of strain measurement
S.T.C. Number	❑ test material
	❑ temperature range

Certificate No. 957388

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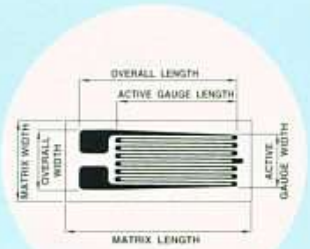
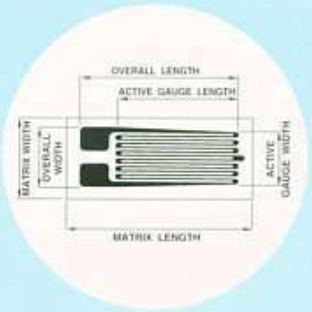
Linear Strain Gauges

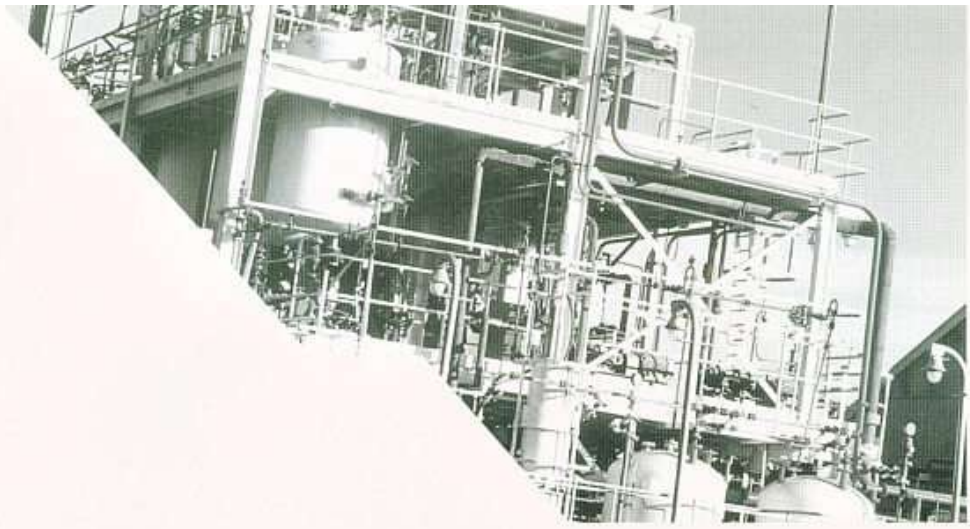


Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
1/120 	120 ± 0.15%	1/120/PC 1/120/EC	1.00	1.30	2.30	1.30	4.90	2.90
2/120 	120 ± 0.15%	2/120/PC 2/120/EC	1.50	1.26	3.20	2.10	5.50	4.00
2N/120 	120 ± 0.15%	2N//120/PC 2N//120/EC	2.00	1.30	3.70	1.30	4.80	3.50
2/350 	350 ± 0.15%	2/350/PC 2/350/EC	1.50	4.60	5.10	4.60	7.00	7.00
A2/350 	350 ± 0.15%	A2/350/PC A2/350/EC	1.50	2.50	3.80	2.50	7.10	5.60
2N/750 	750 ± 0.15%	2N/750/PC 2N/750/EC	1.50	1.70	5.10	1.70	8.00	3.80
3/120 	120 ± 0.15%	3/120/PC 3/120/EC	2.90	1.50	4.50	1.70	8.00	4.00
3/350 	350 ± 0.15%	3/350/PC 3/350/EC	2.80	1.60	4.70	1.80	6.00	4.00

Linear Strain Gauges

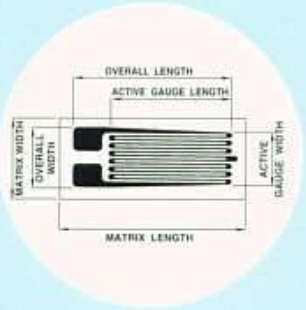


Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
3S/350 	350 ± 0.15%	3S/350/PC 3S/350/EC	3.10	1.70	5.60	1.70	8.00	4.50
PP/350 	350 ± 0.15%	PP/350/PC PP/350/EC	3.10	3.10	6.30	3.10	10.00	5.50
3/1000 	1000 ± 0.15%	3/1000/PC 3/1000/EC	3.00	2.90	6.00	3.10	10.20	9.80
4/120 	120 ± 0.15%	4/120/PC 4/120/EC	3.10	2.20	6.40	2.40	12.50	6.00
5/120 	120 ± 0.15%	5/120/PC 5/120/EC	5.00	2.00	7.60	2.00	10.00	4.60
6/350 	350 ± 0.15%	6/350/PC 6/350/EC	4.70	4.60	9.90	4.60	14.50	9.30
7/60 	60 ± 0.15%	7/60/PC 7/60/EC	5.70	2.70	8.50	3.20	12.50	6.00
7/100 	100 ± 0.15%	7/100/PC 7/100/EC	5.70	2.70	8.50	3.20	12.50	6.00

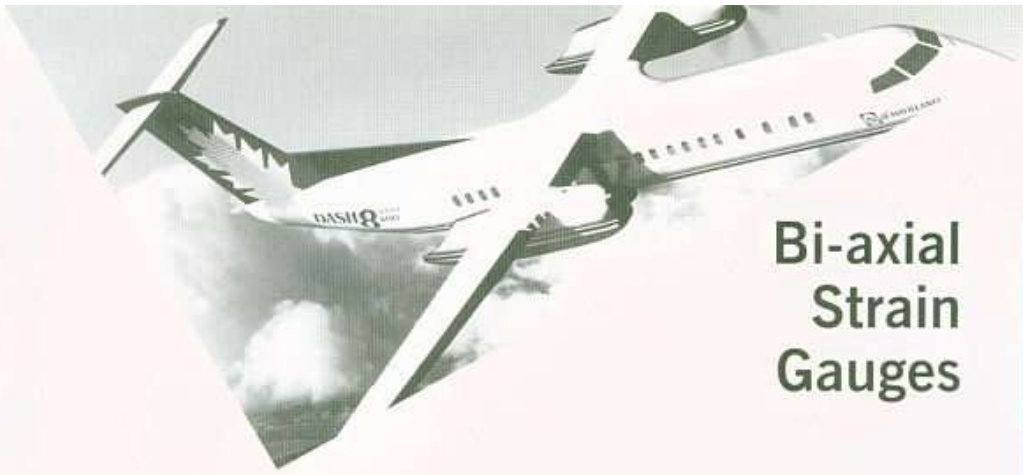


Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
7/120 	120 ± 0.15%	7/120/PC 7/120/EC	5.60	3.90	8.60	4.40	11.00	7.90
7N/120 	120 ± 0.15%	7N/120/PC 7N/120/EC	5.70	2.70	8.50	3.20	12.50	6.00
7/1000 	1000 ± 0.15%	7/1000/PC 7/1000/EC	6.40	3.80	10.00	4.00	12.00	6.00
8/350 	350 ± 0.15%	8/350/PC 8/350/EC	6.30	3.30	10.50	3.70	14.00	8.00
10/120 	120 ± 0.15%	10/120/PC 10/120/EC	10.00	3.20	13.40	3.20	16.40	6.50
13/350 	350 ± 0.15%	13/350/PC 13/350/EC	12.70	4.80	18.90	5.70	22.90	10.10
13/600 	600 ± 0.15%	13/600/PC 13/600/EC	11.20	5.00	17.40	5.50	20.00	10.00
13/1000 	1000 ± 0.15%	13/1000/PC 13/1000/EC	12.90	5.60	19.20	6.50	24.00	12.00

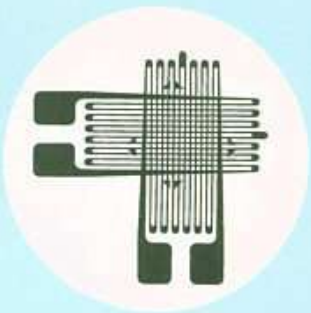
Linear Strain Gauges



Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
20/120	120 ± 0.15%	20/120/PC 20/120/EC	20.00	5.40	24.50	5.40	29.10	9.10
20/350	350 ± 0.15%	20/350/PC 20/350/EC	19.00	4.40	24.50	4.70	28.20	8.70
30/120	120 ± 0.15%	30/120/PC 30/120/EC	30.00	5.50	36.00	5.50	40.80	10.40
33/350	350 ± 0.15%	33/350/PC 33/350/EC	31.00	7.50	39.00	8.00	43.10	12.50
50/120	120 ± 0.15%	50/120/PC 50/120/EC	50.00	3.70	55.00	4.50	60.00	9.50
100/240	240 ± 0.15%	100/240/PC 100/240/EC	100.00	4.00	105.00	4.50	115.00	10.00
150/240	240 ± 0.15%	150/240/PC 150/240/EC	150.00	6.00	158.00	7.00	168.00	18.00
200/240	240 ± 0.15%	200/240/PC 200/240/EC	200.00	7.50	209.00	9.00	220.00	20.00

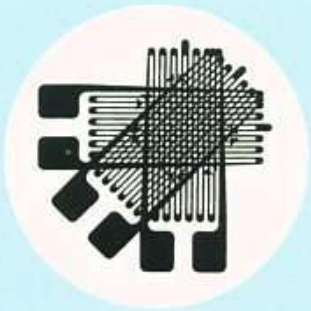


Bi-axial Strain Gauges



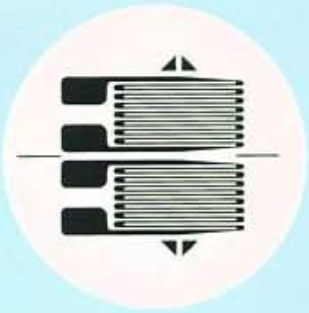
Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
2N/120/WS stacked	120 ± 0.15% each element	2N/120/PC/WS 2N/120/EC/WS	2.00 each	1.30 each	3.70 each	1.30 each	6.50	6.00
2/350/BA	350 ± 0.15% each element	2/350/PC/BA 2/350/EC/BA	1.60 each	2.00 each	3.30 each	5.00 each	7.50	8.00
3/350/BA	350 ± 0.15% each element	3/350/PC/BA 3/350/EC/BA	3.20 each	3.75 each	5.40 each	3.75 each	7.00	10.00
3/350/WS stacked	350 ± 0.15% each element	3/350/PC/WS 3/350/EC/WS	2.80 each	1.60 each	4.70 each	1.80 each	6.00	6.00
3/350/BAL	350 ± 0.15% each element	3/350/BAL/PC 3/350/BAL/EC	1.80 2.80	3.00 2.00	10.00	6.50	12.00	8.50
3T/350	350 ± 0.15% each element	3T/350/PC 3T/350/EC	2.50	3.00	10.00	4.40	12.00	5.20
4/350/BA	350 ± 0.15% each element	4/350/PC/BA 4/350/EC/BA	3.5/1.5	4.40	7.10	4.20	6.00	9.00
7N/120/WS stacked	120 ± 0.15% each element	7N/120/PC/WS 7N/120/EC/WS	5.70	2.70	8.50	3.20	10.00	10.00
8/350/WS stacked	350 ± 0.15% each element	8/350/PC/WS 8/350/EC/WS	6.30	3.30	10.50	3.70	13.00	13.00

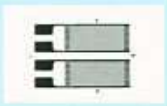
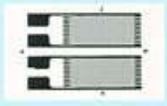
Tri-axial Strain Gauges

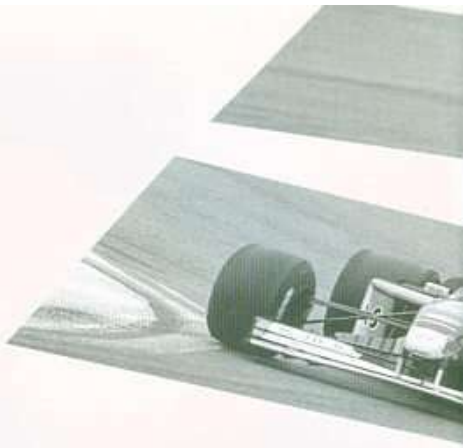


Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
2N/120/TRI stacked	120 ± 0.15% each element	2N/120/PC/TRI 2N/120/EC/TRI	2.00 each	1.30 each	3.70 each	1.30 each	6.50	6.00
3/350/TRI stacked	350 ± 0.15% each element	3/350/PC/TRI 3/350/EC/TRI	3.20 each	3.80 each	5.40 each	3.80 each	6.00	6.00
4/350/A	350 ± 0.15% each element	4/350/A/PC 4/350/A/EC	4.00	2.00	8.00	2.00	15.00	10.00
4/350/B	350 ± 0.15% each element	4/350/B/PC 4/350/B/EC	4.00	2.00	8.00	2.00	10.00	5.00
7N/120/TRI stacked	120 ± 0.15% each element	7N/120/PC/TRI 7N/120/EC/TRI	5.70 each	2.70 each	8.50 each	3.20 each	10.50	11.50
8/350/TRI stacked	350 ± 0.15% each element	8/350/PC/TRI 8/350/EC/TRI	6.30 each	3.30 each	10.50 each	3.70 each	12.50	13.00

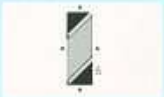
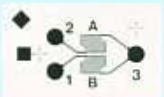
Dual Element Strain Gauges

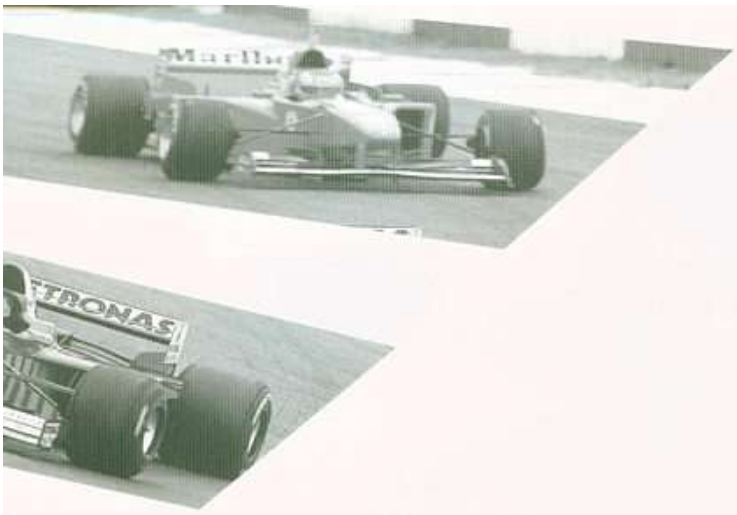


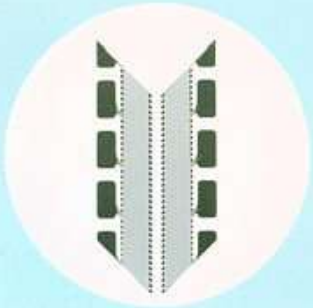
Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
2/1000/D 	1000 ± 0.15% each element	2/1000/PC/D 2/1000/EC/D	2.10	3.00 each	4.50	6.40	9.00	10.00
3S/350/D 	350 ± 0.15% each element	3S/350/PC/D 3S/350/EC/D	3.10	1.70 each	5.60	3.70	7.00	6.00
3/1000/D 	1000 ± 0.15% each element	3/1000/PC/D 3/1000/EC/D	3.00	2.80 each	6.00	6.40	10.00	10.00
6/350/D 	350 ± 0.15% each element	6/350/PC/D 6/350/EC/D	5.20	3.10 each	8.40	7.30	14.00	11.00
7N/350/D 	350 ± 0.15% each element	7N/350/PC/D 7N/350/EC/D	6.30	2.80 each	9.20	6.10	12.50	9.50
7/1000/D 	1000 ± 0.15% each element	7/1000/PC/D 7/1000/EC/D	6.40	3.00 each	10.00	6.70	13.00	11.00
7/2250/D 	2250 ± 0.15% each element	7/2250/PC/D 7/2250/EC/D	6.40	6.40 each	10.00	6.50	12.00	8.50
8/350/D 	350 ± 0.15% each element	8/350/PC/D 8/350/EC/D	6.60	3.40 each	10.00	7.70	13.60	9.70



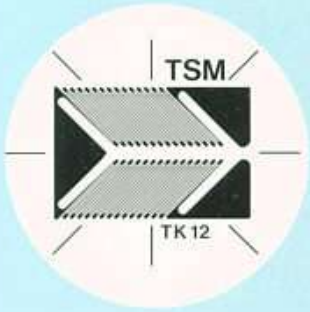
Torque/Shear Strain Gauges

Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
TK4/175 	175 ± 0.15%	TK4/175/PC TK4/175/EC	2.15	2.65	5.65	2.00	7.50	3.50
TK4/350 	350 ± 0.15%	TK4/350/PC TK4/350/EC	2.15	2.65	5.65	2.00	7.50	3.50
TK5/175 	175 ± 0.15%	TK5/175/PC TK5/175/EC	3.00	3.15	7.60	2.60	10.00	5.50
TK5/350 	350 ± 0.15%	TK5/350/PC TK5/350/EC	3.00	3.15	7.60	2.60	10.00	5.50
TK6/350 	350 ± 0.15%	TK6/350/PC TK6/350/EC	2.40 each	3.10	11.30	2.00	14.00	4.50
TK7/350 	350 ± 0.15%	TK7/350/PC TK7/350/EC	2.20 each	2.90	14.20	7.50	20.80	10.00





Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
TK9/50 ONE PAIR	50 ± 0.15% each section	TK9/50/PC One Pair TK9/50/EC One Pair	3.70	5.30	6.00	9.50	13.00	13.00
TK9/60 ONE PAIR	60 ± 0.15% each section	TK9/60/PC One Pair TK9/60/EC One Pair	3.70	5.30	6.00	9.50	13.00	13.00
TK9/50 TWO PAIR	100 ± 0.15% each half	TK9/50/PC Two Pair TK9/50/EC Two Pair	8.40	5.30	10.70	9.50	17.00	13.00
TK9/50 FOUR PAIR	200 ± 0.15% each half	TK9/50/PC Four Pair TK9/50/EC Four Pair	18.20	5.30	20.50	9.50	26.50	13.00
TK9/50 SIX PAIR	300 ± 0.15% each half	TK9/50/PC Six Pair TK9/50/EC Six Pair	27.20	5.30	29.50	9.50	36.00	13.00
TK9/50 TEN PAIR	500 ± 0.15% each half	TK9/50/PC Ten Pair TK9/50/EC Ten Pair	46.00	5.30	48.30	9.50	56.00	13.00



Torque/Shear Strain Gauges

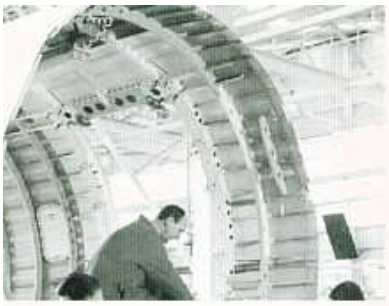
Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
TK10/350 	350 ± 0.15%	TK10/350/PC TK10/350/EC	3.30	2.90	8.10	5.70	13.00	10.00
TK11/350 	350 ± 0.15%	TK11/350/PC TK11/350/EC	3.10	2.70	8.80	5.70	12.00	8.50
TK12/350 	350 ± 0.15%	TK12/350/PC TK12/350/EC	1.70	2.80	4.70	3.20	10.00	7.00
TK14/350 	350 ± 0.15%	TK14/350/PC TK14/350/EC	2.40	3.60	6.30	4.40	10.00	8.00
TK14V/350 	350 ± 0.15%	TK14V/350/PC TK14V/350/EC	2.60	3.60	6.30	4.10	10.00	8.00
TK16/1000 	1000 ± 0.15%	TK16/1000/PC TK16/1000/EC	3.10	2.80	8.00	6.30	10.50	9.50
TK17/350 	350 ± 0.15%	TK17/350/PC TK17/350/EC	3.20	3.40	9.50	7.30	10.50	8.40
TK18/350 	350 ± 0.15%	TK18/350/PC TK18/350/EC	3.70	4.70	10.70	6.20	11.60	7.20

Circular Diaphragm Strain Gauges

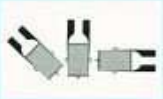
Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm			
			Maximum Grid Diameter	Circular Matrix	Square Matrix	Diaphragm Minimum Diameter
13/200	200 ± 0.75%	13/CD/200/PC 13/CD/200/EC	13.00	13.50	19.50	13.70
20/240	240 ± 0.75%	20/CD/240/PC 20/CD/240/EC	19.30	20.00	23.00	20.20
20/1000	1000 ± 0.75%	20/CD/1000/PC 20/CD/1000/EC	19.50	20.00	21.00	20.20
D12/350	350 ± 0.75%	D12/350/PC D12/350/EC	10.90	11.90	15.00	12.10
CD3/350	350 ± 0.75%	CD3/350/PC CD3/350/EC	9.30	10.30	11.50	10.50
CD4E/350	350 ± 0.75%	CD4E/350/PC CD4E/350/EC	9.90	10.20	11.00	10.40

Half and Full Bridge Strain Gauges

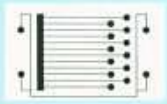
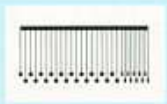
Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
TD1/1000 	1000 ± 0.2%	TD1/1000/PC TD1/1000/EC	1.50	3.70	12.70	12.00	15.50	14.50
TD2/1000 	1000 ± 0.2%	TD2/1000/PC TD2/1000/EC	1.50	3.70	13.80	12.00	16.00	14.50
TD3/350 	350 ± 0.2%	TD3/350/PC TD3/350/EC	2.40	2.60	9.90	7.50	11.90	8.50
TD4/1000 	1000 ± 0.2%	TD4/1000/PC TD4/1000/EC	2.60	2.60	9.90	7.50	11.90	8.50
TD5/350 	350 ± 0.2%	TD5/350/PC TD5/350/EC	1.50	3.70	16.70	16.70	19.50	19.50
TD6/1000 	1000 ± 0.2%	TD6/1000/PC TD6/1000/EC	1.50	3.70	16.70	16.70	19.50	19.50
2/1000/HB 	1000 ± 0.2% each element	2/1000/PC/HB 2/1000/EC/HB	2.10	2.70 each	4.70	6.40	6.80	7.30
7/350/SR 	350 ± 15% each element	7/350/PC/SR 7/350/EC/SR	Maximum gauge diameter 3.5mm		10.00	3.50	12.00	5.50
7/1000/SR 	1000 ± 15% each element	7/1000/PC/SR 7/1000/EC/SR	Maximum gauge diameter 3.5mm		10.00	3.50	12.00	5.50



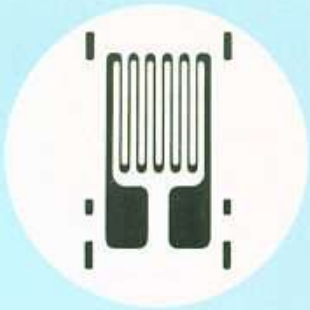
Rosette Type Strain Gauges

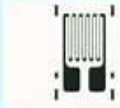
Gauge Pattern	Resistance in OHMS	Gauge Types Available	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
R3/120/120 	120 ± 0.15% each section	R3/120/120/PC R3/120/120/EC	3.00	2.20	14.00	14.00	16.00	16.00
R3/120/350 	350 ± 0.15% each section	R3/120/350/PC R3/120/350/EC	3.00	2.20	14.00	14.00	16.00	16.00
R3/135.90/120 	120 ± 0.15% each section	R3/135.90/120/PC R3/135.90/120/EC	3.00	2.20	14.00	14.00	16.00	16.00
R3/135.90/350 	350 ± 0.15% each section	R3/135.90/350/PC R3/135.90/350/EC	3.00	2.20	14.00	14.00	16.00	16.00
R4/120 	120 ± 0.15% each section	R4/120/PC R4/120/EC	3.20	2.20	16.00	6.50	20.00	12.00
R6/135.90 /120 	120 ± 0.15% each section	R6/135.90/120/PC R6/135.90/120/EC	1.40	1.50	9.00	9.10	11.10	11.20
S13/120 	120 ± 0.15% each section	S13/120/PC S13/120/EC	13.00	5.00	24.50	24.50	27.00	27.00

Crack Propagation Gauges

Gauge Pattern	Number of Limbs	Gauge Types Available	Dimensions in mm			
			Overall Length	Overall Width	Matrix Length	Matrix Width
CPG 1 	12 limbs	CPG 1	52.50	33.40	85.00	45.00
CPG 2 	11 limbs	CPG 2	34.60	25.80	40.00	31.00
CPG 3 	40 limbs	CPG 3	30.50	51.10	32.50	54.00
CPG 4 	30 limbs	CPG 4	33.20	72.40	38.00	79.00
CPG 5 	19 limbs	CPG 5	23.50	23.20	28.50	28.50
CPG 6	5 limbs	CPG 6	160.80	10.40	183.50	16.00
CPG 7	1 limb	CPG 7	77.00	2.00	81.00	4.00
BG 1 	1 limb	BG 1	31.00	5.30	36.00	10.40

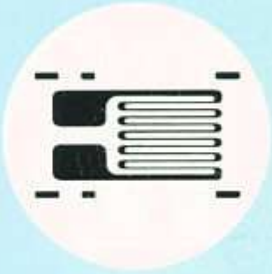
Temperature Compensation Resistors



Resistor Pattern	Resistance in OHMS	Resistor Types	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
Nickel 5mm 	13	5/13/PN	4.78	4.93	6.50	5.00	9.94	8.43
	15	5/15/PN	4.78	4.93	6.50	5.00	9.94	8.43
	17	5/17/PN	4.78	4.93	6.50	5.00	9.94	8.43
	20	5/20/PN	4.76	4.90	6.54	5.10	9.95	8.46
	22	5/22/PN	4.76	4.90	6.54	5.10	9.95	8.46
	24	5/24/PN	4.76	4.90	6.54	5.10	9.95	8.46
	34	5/34/PN	4.83	4.92	6.50	5.00	9.90	8.40
	35	5/35/PN	4.83	4.92	6.50	5.00	9.90	8.40
	36	5/36/PN	4.83	4.92	6.50	5.00	9.90	8.40
	38	5/38/PN	4.83	4.92	6.50	5.00	9.90	8.40
	40	5/40/PN	3.16	2.97	6.00	3.20	7.28	4.48
	42	5/42/PN	3.16	2.97	6.00	3.20	7.28	4.48
	44	5/44/PN	3.16	2.97	6.00	3.20	7.28	4.48
	46	5/46/PN	3.16	2.97	6.00	3.20	7.28	4.48
	48	5/48/PN	3.16	2.97	6.00	3.20	7.28	4.48
Nickel 9mm 	22	9/22/PN	6.13	5.00	8.54	5.12	11.54	8.12
	23	9/23/PN	6.13	5.00	8.54	5.12	11.54	8.12
	24	9/24/PN	6.13	5.00	8.54	5.12	11.54	8.12
	25	9/25/PN	6.13	5.00	8.54	5.12	11.54	8.12
	26	9/26/PN	6.13	5.00	8.54	5.12	11.54	8.12
	34	9/34/PN	6.16	5.10	8.51	5.81	11.51	8.81
	35	9/35/PN	6.16	5.10	8.51	5.81	11.51	8.81
	36	9/36/PN	6.16	5.10	8.51	5.81	11.51	8.81
	37	9/37/PN	6.16	5.10	8.51	5.81	11.51	8.81
	38	9/38/PN	6.16	5.10	8.51	5.81	11.51	8.81

11

Bridge Balance Resistors & Bondable Terminals



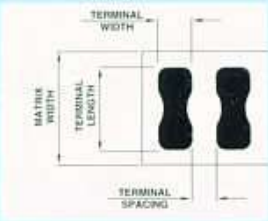
Balco

Resistor Pattern	Resistance in OHMS	Resistor types	Dimensions in mm					
			Active Gauge Length	Active Gauge Width	Overall Length	Overall Width	Matrix Length	Matrix Width
	17	5/17/PB	3.10	2.70	6.00	3.20	7.20	4.5
	18	5/18/PB	3.10	2.70	6.00	3.20	7.20	4.5
	19	5/19/PB	3.10	2.70	6.00	3.20	7.20	4.5
	20	5/20/PB	3.10	2.70	6.00	3.20	7.20	4.5
	21	5/21/PB	3.10	2.70	6.00	3.20	7.20	4.5
	22	5/22/PB	3.10	2.70	6.00	3.20	7.20	4.5
	23	5/23/PB	3.10	2.70	6.00	3.20	7.20	4.5
	24	5/24/PB	3.10	2.70	6.00	3.20	7.20	4.5
	28	5/28/PB	3.10	2.70	6.00	3.20	7.20	4.5
	30	5/30/PB	3.10	2.70	6.00	3.20	7.20	4.5
	32	5/32/PB	3.10	2.70	6.00	3.20	7.20	4.5

Apex Resistor

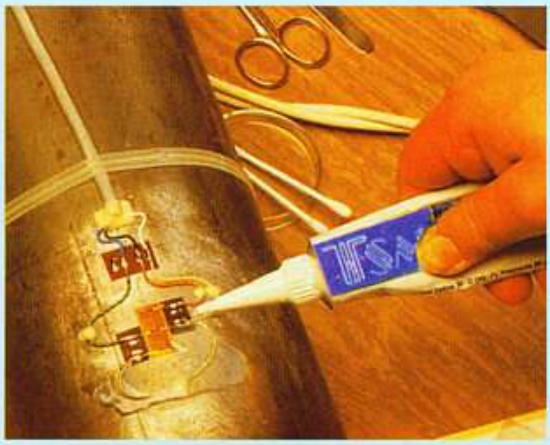
Resistance in OHMS	Resistor types	Active Gauge Length	Active Gauge Width	Overall Length	Overall Width
0.8 to 4.5 ± 15%	APEX - C (CONSTANTAN)	8.00	4.50	10.00	6.50
0.7 to 3.5 ± 15%	APEX - B (BALCO)	8.00	4.50	10.00	6.50

Bondable Terminals



Part Number	Size Not to Scale	Terminal Length	Terminal Width	Terminal Spacing	Matrix Width	Quantity per pack
SBT - 1		1.61	0.65	0.46	10.10	70 STRIPS
SBT - 2		2.38	0.96	0.64	16.35	60 STRIPS
SBT - 3		3.17	1.29	0.67	21.79	50 STRIPS
SBT - 4		4.78	1.97	1.32	32.67	40 STRIPS
SBT - 5		6.36	2.58	1.77	43.87	30 STRIPS
SBT - 6		9.53	3.95	2.68	65.50	20 STRIPS

Preparation & Installation



6 steps to successful Strain Gauge Installation

1. Surface Preparation
2. Adhesive Selection
3. Gauge Handling & Bonding
4. Leadwire Attachment
5. Protective Coating Application
6. Gauge Testing

Certificate No. 957388

Qualified for design & manufacture of Strain Gauges

1 SURFACE PREPARATION

For consistent high quality strain gauge bonding, it is essential that the following cleanliness procedures are followed:

(1) Degrease with TSM Surface Cleaner using rags or cottonbuds
(2) Surface abrade with coarse grade emery paper followed by abrading with fine 400 grade emery.
(3) Wet abrade with fine 400 grade emery and TSM Conditioner, then wipe dry.
(4) Gauge location layout lines should be marked not scribed onto surface.
(5) Rub the surface with a cotton bud, soaked in TSM Conditioner, until you reach the stage when a clean bud remains untarnished, then wipe dry.
(6) Neutralise with TSM Neutraliser applied with a cotton bud and wipe dry from centre of the preparation area outwards, to avoid contamination.

It is preferable to install the gauge within 20 minutes of completing the surface preparation.

2 ADHESIVE SELECTION

It is important to choose the right adhesive for your application and operating temperature. TSM offer a wide range which is listed on the back of the "TSM Adhesive Kit" datasheet and on Page 23 of the catalogue, or call our technical sales department on +44 1265 55734.

3 GAUGE HANDLING & BONDING

Tweezers should be used at all times for handling strain gauges, working areas should be clean glass surfaces to avoid contamination. The gauge and solder terminals, if required, can be located with the aid of tape suitable for the curing temperature, the chosen adhesive applied and the installation clamped and cured as directed in the "Adhesive Kit" datasheet. In addition TSM offer their own in-house comprehensive bonding service. See page 23.

4 LEADWIRE ATTACHMENT

Instrument wire and/or leadwire can now be attached to the bonded installation. For full instructions and materials please call our technical sales department on +44 1265 55734.

5 PROTECTIVE COATING APPLICATION

It is important to protect the gauge area as soon as possible after installation from: water, chemicals, contamination and mechanical damage. Depending on the application and operating temperature TSM offer Polyimide encapsulated gauges or TSM400 water/mechanical protection in the form of a 2 part Polysulphide cured epoxy.

6 GAUGE TESTING

Finally, it is important following the installation process that the strain gauge reads the nominal resistance and is electrically insulated from ground.

Adhesives & Bonding Service

TSM Adhesive Kits are designed for trouble-free preparation and bonding of strain gauges to most surfaces. TSM adhesives are also specially formulated for optimum performance under the recommended environmental conditions and are packaged to provide the user with maximum control in mixing and application. Each adhesive is dated to ensure freshness of contents and is supplied with detailed instructions for proper handling.

It should be noted that conventional industrial and consumer adhesives are not generally suitable for bonding strain gauges.

Most strain gauge adhesives are heat curing, two part epoxy resin and hardener, such as TSM 300 Cement. This adhesive can be used to bond both epoxy and polyimide gauges. Full details are given in the "TSM300 Adhesives Kit" datasheet.

TSM adhesives available are:

TSM 100 CEMENT:	Cyanoacrylate Instant Adhesive up to 70°C.
TSM 200 CEMENT:	A single mix, heat curing adhesive suitable up to 150°C.
TSM 300 CEMENT:	A two component, heat curing adhesive suitable up to 230°C.
TSM 600 CEMENT:	A two component, room temperature curing adhesive up to 50°C.

Bonding Service

TSM offer a comprehensive Bonding Service to ensure trouble free installation of strain gauges. Because many customers conduct their own installation and bonding, TSM offer ongoing support, guidance and training plus .....

- In-house clean areas dedicated to the bonding of strain gauges for pressure transducers, load cells, medical electronics, and stress analysis test samples
- On site strain gauging teams who specialise in structural stress analysis, e.g. for aerospace, automotive and OEM applications
- Bespoke design service for special gauging applications

Bonding Accessories:

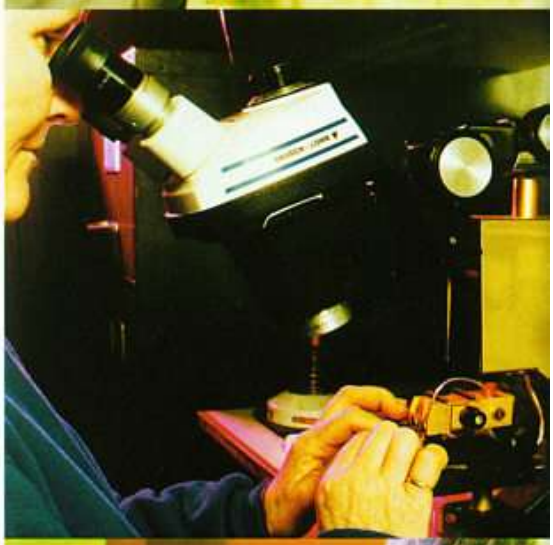
TSM offer a wide range of quality accessories to ensure optimum results for preparation, bonding and coating of strain gauges:

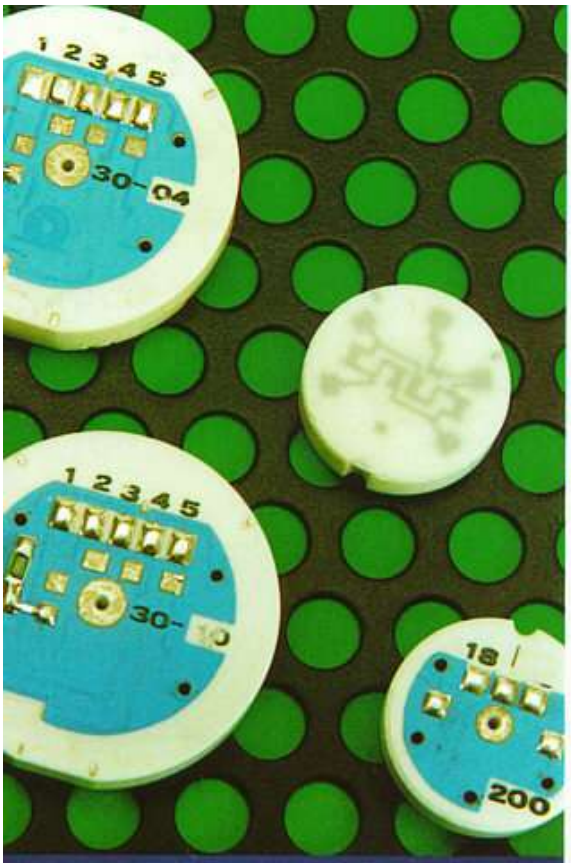
Abrasive Paper Grades 100 - 400/ Cotton Buds
TSM Solvent Cleaner/Conditioner/ Rosin Solvent and Neutraliser
Silicone Rubber Strips, PTFE and Polyester tape
Spring Clamps/Application Tools
Solder/Soldering Irons/Bondable Terminals
Selection of Wires and Attachments/Wiring Tools

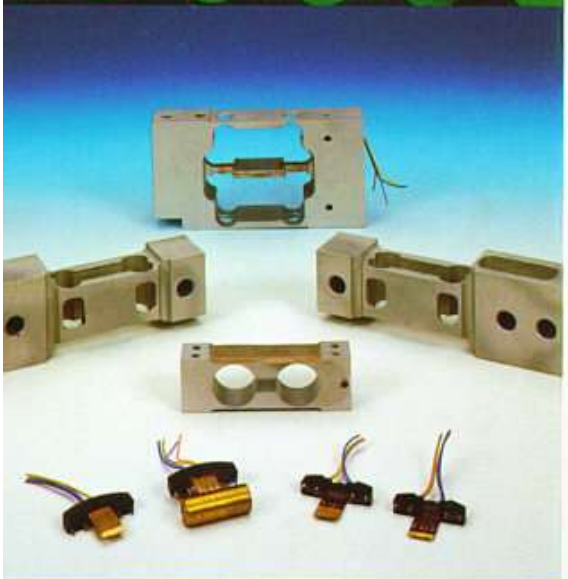
Strain Gauge Kits:

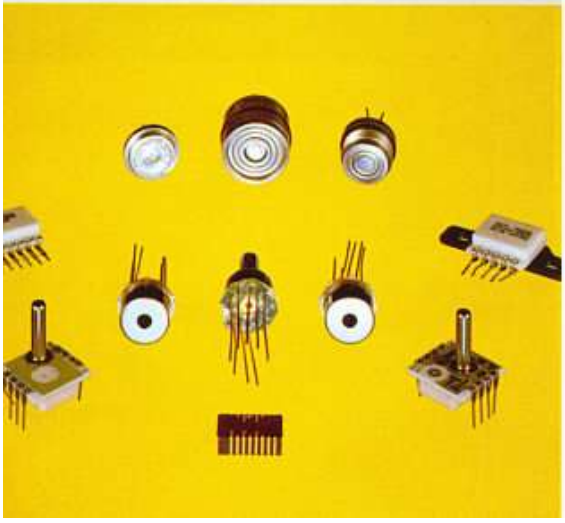
Fully equipped Kits contain everything you need for applying strain gauges - whether you are experienced or new to this discipline, we can provide the right materials to suit your needs.

Type 5370K	-	Students Strain Gauge Kit
Type 5370M	-	Strain Gauge Adhesive Kit
Type 5370N	-	Strain Gauge Tool and Adhesive Kit.









Ceramic & Silicon Pressure Sensors & Load Cells

CERAMIC PRESSURE SENSORS

The Type PT18 and PC30 Ceramic pressure sensors offer outstanding chemical, corrosion and abrasion resistance and are available in standard pressure ranges from 0-1 bar to 0-600 bar. Manufactured from high purity AL$_2$O$_3$ Alumina, the diaphragm material offers extraordinary resistance and performance:

- Outstanding long term stability
- Excellent repeatability with practically no hysteresis
- Ranges 0 - 1 bar to 0 - 600 bar gauge and absolute reference

The PT18(mm) and PC30(mm) sensors present a self-contained hermetically sealed pressure measuring capsule, ready for installation into pressure transducers or as a stand alone pressure sensor. A range of add-on circuits are available to convert the millivolt output signal to most industrial standard outputs.

TSM can provide additional guidance in the installation to help ensure maximum performance and long service life. For further information and prices, call the sales team on +44 1265 55734 for details.

LOAD CELLS/TRANSDUCERS/SPECIAL PURPOSE SENSORS

TSM provide a comprehensive bonding and circuit completion service to both low and high volume manufacturers of load cells and transducers. All TSM load cells have the advantage of using quality strain gauges that can be specially configured in house. We supply to a wide range of weighing equipment and transducer companies for many different industries and have many years experience in a wide range of applications. Why not fax your application requirements to us today on +44 1265 58195. We will be pleased to help.

SILICON PRESSURE SENSORS & ACCELEROMETERS

TSM also offer miniature pressure sensors, manufactured from combining precise silicon etching (micromachining) and wafer lamination (anodic or fusion bonding) with circuit processing techniques such as photolithography, diffusion and thin film deposition.

The high reliability, long term stability and low cost of micromachining sensors make them ideal for applications such as blood pressure transducers, gas and liquid flow measurement and control. TSM have an uncompromising commitment to supplying high quality, advanced technology pressure sensors, accelerometers and custom micromachined devices.

The unique combination of advanced design techniques, state-of-the-art fabrication technology, backed up with expert advice and wide availability has made TSM the preferred supplier for many of today's leading companies.

Our technical sales department will be pleased to advise on the right solution for your need.

Quality by Design

OUR COMMITMENT TO YOU

Stringent quality control and inspection is exercised at every stage in the manufacture of all TSM gauges. All materials used are rigorously tested to our own exacting requirements before approval is given for use in manufacture. All processes conform to ISO 9001 and Mil-I-45208 accreditation. You can be sure of our commitment to ensure complete satisfaction.

QUALITY BY DESIGN

TSM offers a complete design service by qualified engineers using the latest CAD technology. Together with latest photolithography and micromachining facilities, we can assist in every aspect from concept to completion for your foil strain gauge - sensor requirement, cost effectively.

WHAT ABOUT PRICES?

Because we control all processes and manufacture in-house, we can control our costs and pass these savings on to you. Our prices are very competitive and we can offer discounts for quantity orders. To find out more, why not call our sales team - and put us to the test?

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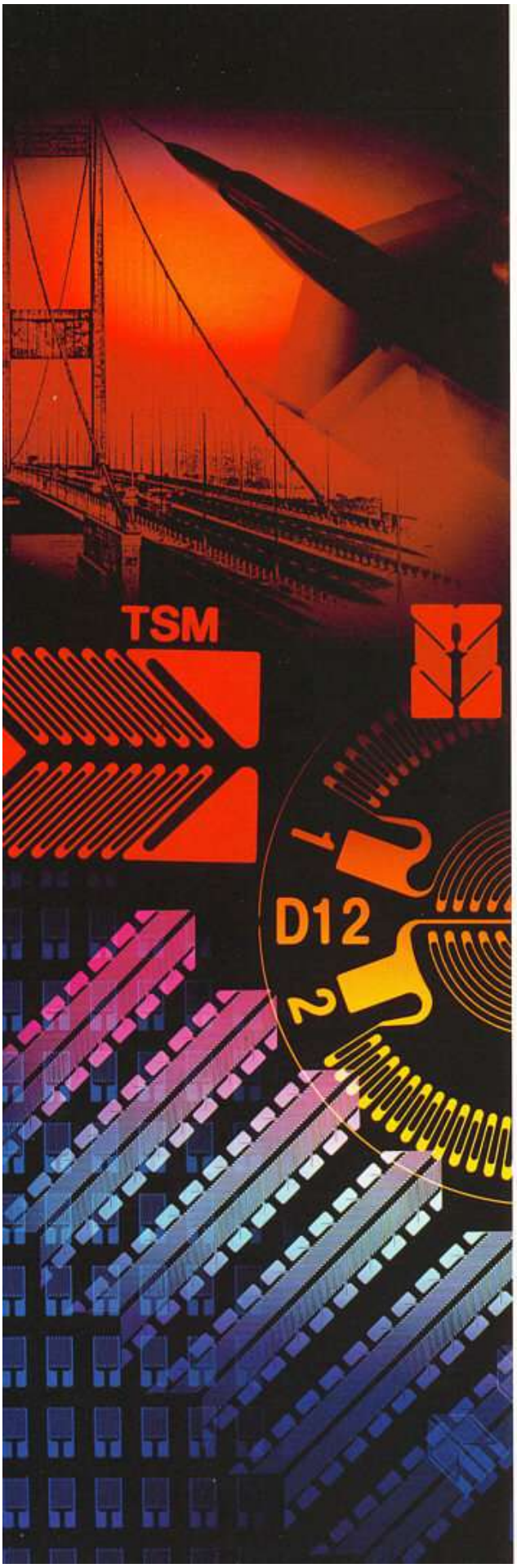
Applications in action of TSM Strain Gauges & Sensors

Certificate No. 957388



Product Range

- Linear Strain Gauges.
- Torque Strain Gauges.
- Full Bridge (Linear/Circular).
- Crack Propagation.
- Custom Designed Strain Gauges
- Adhesives.
- Bonding Service.
- Sensor Modules for Pressure, Force, Torque, Vibration and Temperature.
- Thin Film, Foil and Semiconductor Micro-machining.

Agents throughout the world. Call us for details of your nearest representative.

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