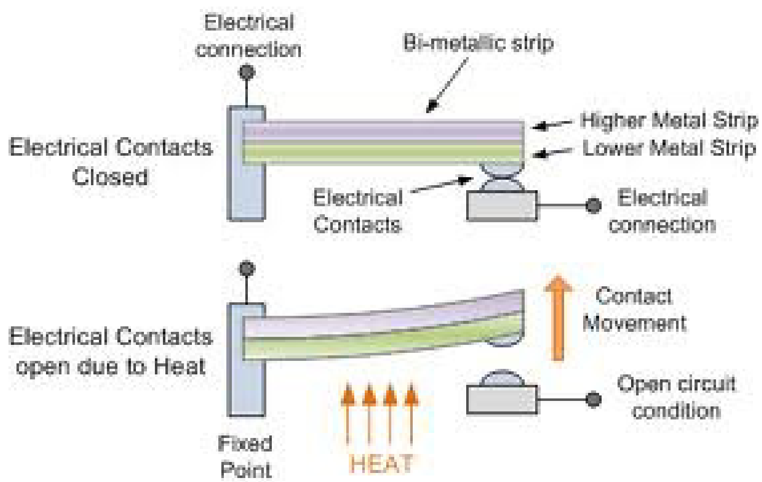
BIMETALS



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THERMOSTATIC BIMETALS

1 **THERMOSTATIC BIMETALS,** are temperature sensitive materials generally consisting of two layers of alloy strips having different coefficients of thermal expansion, bonded together into a composite strip. A flat strip of bimetal will assume a curvature on heating and upon cooling it will become flat again, so the effect is of reversible nature. The alloy having **L**ower coefficient of thermal **E**xpansion (L.E.) becomes concave and alloy having **H**igher coefficient of thermal **E**xpansion (H.E.) becomes convex upon heating. These alloys mainly consist of Nickel alloys e.g. Fe-Ni-Mn, Mn-Cu-Ni, Fe-Ni-Cr and Fe-Ni which are bonded into varying thickness ratios to obtain different grades.

2 **SENSITIVITY** is most important characteristic of a bimetal and it means "change of curvature with respect to temperature change" (also referred as Bending). Its value is intrinsic and mainly dependent on difference between coefficients of thermal expansions of H.E. and L.E. alloys. Its' value is mostly derived by measuring deflection of bimetal with respect to temperature change, by any of following standards.

THERMOSTATIC BIMETAL STANDARDS

i) BEAM method: Bimetal is freely supported at both ends and deflection is measured in the center. Owing to uniform stress distribution the Beam method is considered comparatively superior and accurate.

Sensitivity term	Temp	Symbol	Standard
Specific Thermal Curvature	"K	k	DIN 1715-1983
Flexivity	"F	f	ASTM B106-1990

ii) CANTILEVER method: Bimetal is fixed at one end only and deflection is measured at the other end, which is free to deflect. It is considered less accurate but is of more practical use.

Sensitivity term	Temp	Symbol	Standard
Specific Thermal Deflection	"C	a	DIN 1715-1963
Curvature Coefficient	"C	c	JIS 2530-1993

Comparison between these derived values of Sensitivity

$$a=c=0.53k=0.53x1.8f$$

3 **RESISTIVITY** is the other important characteristic of Bimetal and is material dependent. Sometimes a third layer of Cu or Ni is inserted in between HE & LE alloys to obtain a desired value of Electrical Resistivity. When Bimetal is made to deflect by self heating effect i.e. by passing the electrical current through it, its Electrical Resistance becomes very important. Resistance is measured at 20 deg C, by a suitable apparatus say a Kelvin Bridge & value of resistivity is calculated therefrom.

4 **HARDNESS:** Nickel alloys have high yield point and these cannot be hardened through normal heat treatment, therefore Bimetals are strengthened by giving about 25~30% reduction at the final stage of cold rolling. By varying cold reduction from 10 to 80% at final stage, different hardness values can be achieved. However Standard values normally vary around 200-250 HV

5 STRESS RELIEVING

During various manufacturing processes like Bonding, Cold Rolling, Slitting, Flattening & during components making, undesirable stresses develop and get locked into the bimetal. In order to get a consistent performance, these stresses need to be relieved (or rather re-distributed evenly). This is achieved by a heat stablizing process which is to be performed on final components only, but not on the strip.

The temperature of the components is slowly raised from room temperature to about 250/350 deg C depending upon the grade and the temp. is maintained for about 2 hours. Thereafter components are allowed to slowly cool to room temperature. This process may be carried in an inert atmosphere like cracked Ammonia, to prevent oxidization of components During this process each component is to be kept in a free to deflect position. Please note that this process is not an annealing process and it does not change the hardness of bimetal.

6 Grade Designations & Marking

We are generally producing 12 most frequently used grades, as given in this brochure. However, other grades may also be made available after mutual consultations and agreement.

Our grades are so designated that initial three digits indicate the Specific Deflection value while last three digits indicate the Resistivity value of the Bimetal. For Example:

155Z078 indicates Specific deflection value as 15.5 and Resistivity value as 0.78
135Z006 indicates Specific deflection value as 13.6 and Resistivity value as 0.06

The grades are chemically etched on either HE or LE side. It helps to identify its characteristic values as per our catalogue. Also, since a bimetal deflects in one direction only therefore it also helps to identify HE or LE alloy side.

7 List of Sizes, available of ZODIAC Bimetals

Thickness Range: 0.10mm to 1.5mm
Width Range: 1.60mm to 73mm
Tolerances: As per DIN standard DIN 1715-1983

8 Equivalency with other manufacturers grades:

For all practical purposes an equivalent replacement may be selected by comparing technical features like sensitivity, resistivity value etc over useful deflection range. Comparing the exactness of chemical composition of component alloys is not necessary.

9 Tolerances and delivery dimensions

i) *Tolerances on Specific Thermal Curvature:* The specific curvature of Thermostatic Bimetal is maintained within tolerance range of +/- 5%, on the values, measured as per DIN 1715.

ii) *Tolerances on Elect. Resistivity*: The specific electrical resistance is kept within tolerance range as given under. These tolerances are important, only in the case of direct passage of electrical current through the Thermostatic bimetal part.

Tolerance % on Resistivity

Thermostatic Bimetal Grades

155Z078, 135Z080, 115Z070	+/-4%
140Z140, 200Z110, 150Z055, 150Z050, 145Z045, 145Z035, 135Z025	+/-5%
150Z019, 115Z009, 60Z021	+/-6%
150Z017, 150Z015, 150Z011	+/-7%
135Z006, 130Z003, 200Z010, 180Z005	+/-10%

iii) *Tolerances on Thickness and Width:* Our standard dimensional tolerances are satisfactory for the manufacture of most bimetal parts. However, closer tolerances if necessary can be maintained, after special agreement, at extra cost.. If the customer gives no special instructions, we maintain the following tolerances.

Thickness tolerances

Strip thickness 0.10~0.20mm = +/-0.007mm
0.20~0.40mm = +/-0.010mm
0.40~2.50mm = +/-2.5%

Width tolerances

←----------------------------W I D T H (mm) ----------------------------------→

Thickness (mm)	1.5 ~ 4	4 ~20	20 ~40	40 ~70
0.1 ~ 0.4	+0.10	+/- 0.05	+/- 0.05	+/- 0.07
0.4 ~ 0.8	+0.14	+/- 0.07	+/- 0.07	+/- 0.10
0.8 ~ 1.6		+/- 0.10	+/- 0.12	+/- 0.15

10 Component Processing

i) **Shape:** The effect of Bimetal components' width on the deflection value is difficult to estimate. However as long as the width is not more than about 10% of the effective length, its influence can be neglected. With larger widths it must be borne in mind, that the bimetal will in fact, try to curve into spherical shell shape. However in the case of pure elastic stress this is possible only within very narrow limits. Because of this, with continued heating the spherical shell shape transforms readily into that of cylindrical shape, the curvature parallel to the axis of the cylinder is then complicated internal stress field arises

To avoid this, the working portions of bimetals are kept narrow by cutting or punching of slots,. The maximum width should generally not be greater than 15% of the working length. The width/thickness ratio is also important; in normal circumstances it should not exceed 20:1.

Circular thermostatic bimetal discs represent an exceptional case. These usually have sufficient thickness for good reproducibility so that the deflection per disc is small and the effects described above are unimportant. By stacking discs arranged in the same or in opposite senses or combination of the two possibilities the total force or the total deflection can in fact be adjusted within wide limits (stack of discs).

Thermostatic Bimetal is produced in the form of strips from which bimetal parts are either cut or punched out. It is of some consequence here whether the working length of the parts arranged parallel or the right angles to the direction of rolling of the strip; in the latter case a 1~2% less deflection is expected than when working length and rolling direction are parallel.

Thermostatic bimetals are provided with markings on the surface of the active component. It often happens however with punched parts that the markings has subsequently to be removed or is obscured be electrodeposited layers. In order that punched parts can be fitted the correct side up it is strongly recommended that some measure of asymmetry in their shape be provided, which is most simply done by chamfering an edge. Embossed markings are retained through successive working processes, but with very small pieces their legibility may become poor; deliberate asymmetry is better and simpler.

ii) **Forming:** For sharp bends it is important to note that material fractures are more likely to occur if the bending edge is parallel rather than perpendicular to the direction of rolling. The inside bending radius should not be less than the strip thickness and it is advisable to reach agreement on the hardness of the thermostatic bimetal, as this is governed by the magnitude of the final deformation.

Winding of spirals or helices like forming of bimetal parts takes place at room temperature. Under some conditions a rise in temperature occurs during forming operations so that parts no longer possess quite the desired form after cooling. It should be noted that with subsequent artificial ageing it is possible to reverse a small part of previously effected deformation.

iii) **Fixing:** The proper mounting bimetal components is important if they are to function satisfactorily. Fixing of bimetal elements is conveniently carried out by spot welding, and in appropriate circumstances by riveting, bolting, or even by soft soldering. Brazing or torch welding are out of the question for fixing as too high temperatures arise which would cause softening of the bimetal.

The cutting of threads is also possible, if bimetal with sufficient thickness is used. The hardness of the material in some cases, however, causes considerable tool wear. If the material is too thin to accommodate a sufficient number of threads, threaded bushes can be inserted.

When there is a risk of corrosion, care should be taken that bimetal does not form a voltaic cell with the support or means of fixture i.e. rivet or bolt. When spot welding, which is possible with all bimetal grades, excessive heating should be avoided; the softening areas should be confined to the actual welding point to prevent plastic deformation of the bimetal at the fixing point. Thorough degreasing of the parts is necessary before spot welding. With ZODIAC 200Z110 & 140Z140, spot welding should proceed from the passive side.

iv) **Corrosion protection**: Thermostatic Bimetal consisting of the nickel-iron alloys in fact corrode more slowly in a moist atmosphere than iron, but they are not rust resistant. In contact with water corrosive attack soon begins, particularly if the water is fairly warm or if it is not neutral, but weakly acid or basic. Not only is a gradual erosion of material from the surface observed, but also the stress corrosion effect also frequently occurs, when as a result of simultaneous corrosive attack and elastic deformation the structure becomes increasingly riddled with cracks.

Where there is a risk of rusting, surface protection is always advisable. Metal coats are the first choice for surface protection, and they are best electro-deposited; nickel, tin, silver, lead, zinc, cadmium and chromium are among the most commonly used protective coats. It is essential that the coatings are soft, free from pores and impervious as only then can they provide adequate corrosion protection. If these layers are sufficiently thin compared with the thickness of the bimetal, the thermal deflection is not materially affected. As a guide we may take it that the thickness of the protective coat should not exceed 0.015mm on each side. This means for a 1 mm thick strip an increase in thickness of 3% and, correspondingly, a reduction of the deflection by about the same amount. When very high precision is required, efforts will naturally be made to keep the coating thin as possible, while at the same time maintaining its protective action.

With temperatures of application up to 100 degree C a thin plastic coating having adequate resilience is also feasible.

Because of the cut edges bimetals with previously electroplated protective coats are not completely resistant. Good corrosion protection is assured only if finished parts are covered with the coating in such a way that all cut edges are protected.

For use in water combinations of two different protective layers have performed well; for example, nickel and cadmium, nickel and tin, tin and zinc. The nature and thickness of the coating to be plated depend on the type of corrosion attacks expected.

When bimetals are only superficially protected and protective layer is damaged, an attack invariably follows which because of mechanical stresses present in the bimetal usually leads to stress corrosion and hence to destruction of the bimetal.

Technical Characteristics for BIMETALS						
ZODIAC	Specific Thermal Curvature 20°C to 130°C	Electrical Resistivity @20 °C	Useful deflection range	Specific Deflection Thermal 20°C to 130°C	Linearity Range	Maximum Operating temprature
	10^{-6} / °C	**Ω mm² /m**	**°C**	**10^{-6} / °C**	**°C**	**°C**
140Z140	28.4 ±5%	1.40 ± 5%	-50 to 250	14.9 ±5%	-20ºC+200	350
200Z110	39.0 ±5%	1.10 ± 5%	-50 to 250	20.8 ±5%	-20ºC+200	350
200Z010	37.8 ±5%	0.10 ±10%	-50 to 250	20.0 ±5%	-20ºC+200	350
180Z005	33.8 ±5%	0.05 ±10%	-50 to 250	18.0 ±5%	-20ºC+200	350
135Z080	26.4 ±5%	0.80 ± 4%	-50 to 350	13.5 ±5%	-20ºC+175	450
155Z078	28.5 ±5%	0.78 ± 4%	-50 to 350	15.5 ±5%	-20ºC+200	450
150Z055	28.2 ±5%	0.55 ± 5%	-50 to 350	15.0 ±5%	-20ºC+200	450
150Z050	28.0 ±5%	0.50 ± 5%	-50 to 350	15.0 ±5%	-20ºC+200	450
145Z045	27.7 ±5%	0.45 ± 5%	-50 to 350	14.9 ±5%	-20ºC+200	450
145Z035	27.4 ±5%	0.35 ± 5%	-50 to 350	14.8 ±5%	-20ºC+200	450
140Z025	26.1 ±5%	0.25 ± 5%	-50 to 350	14.0 ±5%	-20ºC+200	450
150Z019	28.0 ±5%	0.19 ± 6%	-50 to 250	15.0 ±5%	-20ºC+200	400
150Z017	28.0 ±5%	0.17 ± 7%	-50 to 250	15.0 ±5%	-20ºC+200	400
150Z015	27.8 ±5%	0.15 ± 7%	-50 to 250	15.0 ±5%	-20ºC+200	400
150Z011	27.8 ±5%	0.11 ± 7%	-50 to 250	15.0 ±5%	-20ºC+200	400
135Z006	26.6 ±5%	0.06 ±10%	-50 to 250	13.6 ±5%	-20ºC+200	400
130Z003	24.5 ±5%	0.03 ±10%	-50 to 250	13.2 ±5%	-20ºC+200	350
115Z070	22.0 ±5%	0.70 ± 4%	-50 to 400	11.7 ±5%	-20ºC+380	450
115Z009	21.6 ±5%	0.09 ± 6%	-50 to 400	11.5 ±5%	-20ºC+380	400
60Z021	11.3 ±5%	0.21 ± 6%	-50 to 450	6.0 ±5%	-20ºC+450	450

Please ask for more details on technical characteristics, if required.

Updated on 31-Jul-2021

Equivalency with international standards and other manufacturers									
ZODIAC	**DIN 1715**	**ASTM B388**	**JIS C2530**	A	B	C	D	E	F
140Z140		TM8	TM1	P850R	BR-2	140/140	140SP	140R140	721-140
200Z110	TB20110	TM2	TM1	P675R	BR-1	208/110	108SP	200R110	721-112
200Z010		TM34		P60R		208/10	11SP	200R10	721Cu11
180Z005				P30R		175/05	5SP	180R05	721Cu5
135Z080		TM1	TM2	B1	BL-5	140/80	R80	135	223-1
155Z078	TB1577A	TM29	TM2	LA1	BL-2	155/78	AS	155	206-1
150Z055	TB1555			B350R	TR-55	150/55	AS55	155R55	206Ni55
150Z050		TM15		B300R	TR-50	-	-	145R50	223Ni50
145Z045	TB1445			B250R	TR-45	150/45	-	145R45	206Ni45
145Z035	TB1435	TM13	TM6	B200R	TR-35	148/35	AS35	145R35	206Ni35
140Z025	TB1425		TM6	B150R	TR-25	140/25	AS25	135R25	206Ni25
150Z019		TM9	TM5A	F125R		150/19	-	145R19	206Cu19
150Z017			TM5A	F100R		150/17	-	145R17	206Cu17
150Z015			TM5A	F90R		150/15	-	145R15	206Cu15
150Z011	TB1511	TM27	TM5A	F70R	TRC-12	150/11	AS11	145R10	206Cu11
135Z006			TM5A	F35R		130/06	AS6	135R05	206Cu6
130Z003		TM24		F20R		130/03	-	130R03	223Cu3
115Z070	TB1170A	TM6		B3	BH-2	115/70	BS	115	206-3
115Z009	TB1109			LA55R30		115/09	BS9	115R09	206Cu09
60Z021				-	-	-	-	60	-

Thermostatic Bimetal - Properties		
Grade		**140Z140**
Alloys : HE/LE		Mn-Ni-Cu / Ni36Fe
Sp. Thermal Deflection 20-130 °C		14.9×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		28.4×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		1.40 Ω mm^2/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		350 °C
Standard Hardness HV	HE LE	180 ~ 260 190 ~ 230
Density @20 °C		7.5 gm/cm^3
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		130 kN/mm^2
Thermal Conductivity @20 °C		0.04 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/°C

Thermostatic Bimetal - Properties		
Grade		**200Z110**
Alloys : HE/LE		Mn-Ni-Cu / Ni36Fe
Sp. Thermal Deflection 20-130 °C		20.8×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		39.0×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		1.10 Ω mm^2/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		350 °C
Standard Hardness HV	HE LE	180 ~ 260 190 ~ 230
Density @20 °C		7.7 gm/cm^3
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		145 kN/mm^2
Thermal Conductivity @20 °C		0.06 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/°C

Thermostatic Bimetal - Properties		
Grade		**200Z010**
Alloys : HE/LE Shunt		Mn-Ni-Cu / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		$20.0x10^{-6}$/ °C +/- 5%
Sp Thermal Curvature		$37.8x10^{-6}$/ °C +/- 5%
Elect. Resistivity @20 °C		0.10 Ωmm²/m +/-10%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		350 °C
Standard Hardness HV	HE LE	180 ~ 260 190 ~ 230
Density @20 °C		7.9 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		145 kN/mm²
Thermal Conductivity @20 °C		0.72 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/°C

Thermostatic Bimetal - Properties		
Grade		**180Z005**
Alloys : HE/LE Shunt		Mn-Ni-Cu / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		18.0x10-6/ °C +/- 5%
Sp Thermal Curvature		33.8x10-6/ °C +/- 5%
Elect. Resistivity @20 °C		0.05 Ωmm2/m +/-10%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		350 °C
Standard Hardness HV	HE LE	180 ~ 260 190 ~ 230
Density @20 °C		8.2 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		145 kN/mm²
Thermal Conductivity @20 °C		1.44 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/°C

Thermostatic Bimetal - Properties

Grade	**135Z080**
Alloys : HE/LE	Ni-Cr-Fe / Ni36Fe
Sp. Thermal Deflection 20-130 °C	13.5×10^{-6}/ °C +/- 5%
Sp Thermal Curvature	26.4×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C	0.80 Ω mm^2/m +/- 4%
Linearity Range	(-)20 to +175 °C
Useful Temp. Range	(-)50 to +350 °C
Max. Application Temp	450 °C
Standard Hardness HV	HE 220 ~ 260 LE 210 ~ 250
Density @20 °C	8.1 gm/cm^3
Recommended Heat Treatment	2 Hours @ 350 °C
Modulus of Elasticity @20 °C	170 kN/mm^2
Thermal Conductivity @20 °C	0.12 W/cm °C
Specific Heat @20 °C	0.46 Joules/g/°C

Thermostatic Bimetal - Properties		
Grade		**155Z078**
Alloys : HE/LE		Ni-Mn-Fe / Ni36Fe
Sp. Thermal Deflection 20-130 °C		15.5×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		28.5×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.78 Ω mm^2/m +/- 4%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.1 gm/cm^3
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm^2
Thermal Conductivity @20 °C		0.12 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**155Z055**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Ni
Sp. Thermal Deflection 20-130 °C		$15.0x10^{-6}$/ °C +/- 5%
Sp Thermal Curvature		$28.2x10^{-6}$/ °C +/- 5%
Elect. Resistivity @20 °C		0.55 Ώ mm^2/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.2 gm/cm^3
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm^2
Thermal Conductivity @20 °C		0.16 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties

Grade		**150Z050**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Ni
Sp. Thermal Deflection 20-130 °C		15.0×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		28.0×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.50 Ω mm²/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.2 gm/cm³
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.16 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**145Z045**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Ni
Sp. Thermal Deflection 20-130 °C		14.9×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		27.7×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.45 Ω mm^2/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.3 gm/cm^3
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm^2
Thermal Conductivity @20 °C		0.18 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties

Grade		**145Z035**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Ni
Sp. Thermal Deflection 20-130 °C		14.8×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		27.4×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.35 Ω mm²/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.2 gm/cm³
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.22 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**135Z025**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Ni
Sp. Thermal Deflection 20-130 °C		14.0x10^{-6}/ °C +/- 5%
Sp Thermal Curvature		26.1x10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.25 Ω mm²/m +/- 5%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.3 gm/cm³
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.28 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**150Z019**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		$15.0\text{x}10^{-6}$/ °C +/- 5%
Sp Thermal Curvature		$28.0\text{x}10^{-6}$/ °C +/- 5%
Elect. Resistivity @20 °C		0.19 Ω mm²/m +/- 6%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		400 °C
Standard Hardness HV	HE LE	200 ~ 240 190 ~ 220
Density @20 °C		8.2 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.42 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties

Grade		**150Z017**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		$15.0x10^{-6}$/ °C +/- 5%
Sp Thermal Curvature		$28.0x10^{-6}$/ °C +/- 5%
Elect. Resistivity @20 °C		0.17 Ώ mm²/m +/- 7%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		400 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.2 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.46 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**150Z015**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		15.0×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		27.8×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.15 Ω mm^2/m +/- 7%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		400 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.2 gm/cm^3
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		170 kN/mm^2
Thermal Conductivity @20 °C		0.48 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**150Z011**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		15.0×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		27.8×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.11 Ώ mm²/m +/- 7%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		400 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.3 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.65 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties

Grade		**135Z006**
Alloys : HE/LE Shunt		Ni-Cr-Fe / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		13.6×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		26.6×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.06 Ωmm²/m +/-10%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		400 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.4 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		160 kN/mm²
Thermal Conductivity @20 °C		1.25 W/cm °C
Specific Heat @20 °C		0.42 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**130Z003**
Alloys : HE/LE Shunt		Ni-Cr-Fe / Ni36Fe Cu
Sp. Thermal Deflection 20-130 °C		$13.2x10^{-6}$/ °C +/- 5%
Sp Thermal Curvature		$24.5x10^{-6}$/ °C +/- 5%
Elect. Resistivity @20 °C		0.03 Ώmm²/m +/-10%
Linearity Range		(-)20 to +200 °C
Useful Temp. Range		(-)50 to +250 °C
Max. Application Temp		350 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.60 gm/cm³
Recommended Heat Treatment		2 Hours @ 250 °C
Modulus of Elasticity @20 °C		140 kN/mm²
Thermal Conductivity @20 °C		2.24 W/cm °C
Specific Heat @20 °C		0.40 Joules/g/ °C

Thermostatic Bimetal - Properties

Grade		**115Z070**
Alloys : HE/LE		Ni-Mn-Fe / Ni42Fe
Sp. Thermal Deflection 20-130 °C		11.7×10^{-6}/ °C +/- 5%
Sp Thermal Curvature		22.0×10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.70 Ω mm^2/m +/- 4%
Linearity Range		(-)20 to +380 °C
Useful Temp. Range		(-)50 to +450 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE	200 ~ 260
	LE	190 ~ 250
Density @20 °C		8.1 gm/cm^3
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		170 kN/mm sq
Thermal Conductivity @20 °C		0.13 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

Thermostatic Bimetal - Properties		
Grade		**115Z009**
Alloys : HE/LE Shunt		Ni-Mn-Fe / Ni42Fe Cu
Sp. Thermal Deflection 20-130 °C		11.5x10^{-6}/ °C +/- 5%
Sp Thermal Curvature		21.6x10^{-6}/ °C +/- 5%
Elect. Resistivity @20 °C		0.09 Ω mm²/m +/- 6%
Linearity Range		(-)20 to +350 °C
Useful Temp. Range		(-)50 to +350 °C
Max. Application Temp		400 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.2 gm/cm³
Recommended Heat Treatment		2 Hours @ 300 °C
Modulus of Elasticity @20 °C		170 kN/mm²
Thermal Conductivity @20 °C		0.88 W/cm °C
Specific Heat @20 °C		0.43 Joules/g/ °C

Thermostatic Bimetal - Properties

Grade		**60Z021**
Alloys : HE/LE		Ni-Mn-Fe / Steel
Sp. Thermal Deflection 20-130 °C		$6.0x10^{-6}$/ °C +/- 5%
Sp Thermal Curvature		$11.3x10^{-6}$/ °C +/- 5%
Elect. Resistivity @20 °C		0.21 Ω mm²/m +/- 6%
Linearity Range		(-)20 to +450 °C
Useful Temp. Range		(-)20 to +450 °C
Max. Application Temp		450 °C
Standard Hardness HV	HE LE	200 ~ 260 190 ~ 250
Density @20 °C		8.0 gm/cm³
Recommended Heat Treatment		2 Hours @ 350 °C
Modulus of Elasticity @20 °C		190 kN/mm sq
Thermal Conductivity @20 °C		0.44 W/cm °C
Specific Heat @20 °C		0.46 Joules/g/ °C

WEIGHT & MEASURES CONVERSION FACTORS

To change			To change back		
From	to	Multiply by	From	to	Multiply by
Length			**Length**		
Mm	in	0.0394	In	mm	25.40
Cm	in	0.3937	In	cm	2.54
Cm	ft	0.0328	Ft	cm	30.48
In	m	0.0254	M	in	39.37

Area			**Area**		
Cir mils	sq in	0.0000007854	sq in	Cir mils	1273240
Cir mils	sq mils	0.7854	sq mils	Cir mils	1.2732
Cir mils	sq mm	0.0005066	sq mm	Cir mils	1973.51
sq mm	sq in	0.00155	sq in	sq mm	645.16
sq mils	sq in	0.000001	sq in	sq mils	1000000
sq cm	sq in	0.155	sq in	sq cm	6.4516

Volume			**Volume**		
cu cm	cu in	0.06102	cu in	cu cm	16.387

Power			**Power**		
Watts	hp	0.001341	Hp	watts	746
BTU per hr	hp	0.000393	Hp	BTU per hr	2545

Energy			**Energy**		
Ergs	joules	0.0000001	Joules	ergs	1,00,00,000
Joules	gram-calories	0.2388	gram-calories	joules	4.186
Joules	kg-m	0.10198	kg-m	joules	9.8117
Joules	ft-lbs	0.7375	ft-lbs	joules	1.356
ft-lbs	kg-m	0.1383	kg-m	ft-lbs	7.233
gram-calories	BTU	0.003968	BTU	gram-calories	252
Joules	BTU	0.000947	BTU	joules	1055
ft-lbs	BTU	0.001285	BTU	ft-lbs	778
BTU	watt-hrs	0.293	watt-hrs	BTU	3.416

Weights			**Weights**		
oz (troy)	grams	31.11	Grams	oz (troy)	0.03214
lbs (avdp)	grams	453.59	Grams	lbs (avdp)	0.002205
oz (troy)	lbs (avdp)	0.0686	lbs (avdp)	oz (troy)	14.58

Density grams cu cm	lbs (avdp) cu in	0.03613	**Density** lbs (avdp) cu in	grams cu cm	27.68
Electrical resistivity ohms cir mil/ft	ohms sq mil/ft	0.7854	**Electrical resistivity** ohms sq mil/ft	ohms cir mil/ft	1.273
ohms cir mil/ft	ohms mm² m	0.001662	ohms mm² m	ohms cir mil/ft	601.68
Flexivity Flexivity	specific deflection	0.954	**Flexivity** specific deflection	Flexivity	1.048
Modulus of Elasticity lbs sq in	N/mm²	0.006895	**Modulus of Elasticity** N/mm²	lbs sq in	145.04

CONVERSION TABLES

METRIC AND DECIMAL EQUIVALENTS OF COMMON FRACTIONS

Fraction of an inch	Decimals of an inch	Millimeters
1/64	0.0156	0.397
1/32	0.0313	0.794
3/64	0.0469	1.191
1/16	0.0625	1.588
5/64	0.0781	1.984
3/32	0.0938	2.381
7/64	0.1094	2.778
1/8	0.1250	3.175
9/64	0.1406	3.572
5/32	0.1563	3.969
11/64	0.1719	4.366
3/16	0.1875	4.763
13/64	0.2031	5.159
7/32	0.2188	5.556
15/64	0.2344	5.953
1/4	0.2500	6.350
17/64	0.2656	6.747
9/32	0.2813	7.144
19/64	0.2969	7.541
5/16	0.3125	7.938
21/64	0.3281	8.334
11/32	0.3438	8.731
23/64	0.3594	9.128
3/8	0.3750	9.525
25/64	0.3906	9.922
13/32	0.4063	10.319
27/64	0.4219	10.716
7/16	0.4375	11.113
29/64	0.4531	11.509
15/32	0.4688	11.906
31/64	0.4844	12.303
1/2	0.5000	12.700

CONVERSION TABLES

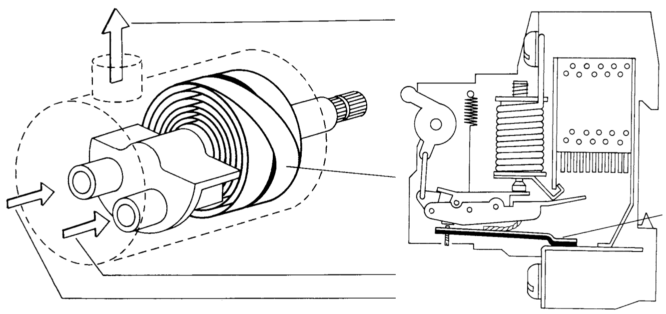
METRIC AND DECIMAL EQUIVALENTS OF COMMON FRACTIONS

Fraction of an inch	Decimals of an inch	Millimeters
33/64	0.5156	13.097
17/32	0.5313	13.494
35/64	0.5469	13.891
9/16	0.5625	14.288
37/64	0.5781	14.684
19/32	0.5938	15.081
39/64	0.6094	15.478
5/8	0.6250	15.875
41/64	0.6406	16.272
21/32	0.6563	16.669
43/64	0.6719	17.066
11/16	0.6875	17.463
45/64	0.7031	17.859
23/32	0.7188	18.256
47/64	0.7344	18.653
3/4	0.7500	19.050
49/64	0.7656	19.447
25/32	0.7813	19.844
51/64	0.7969	20.241
13/16	0.8125	20.638
53/64	0.8281	21.034
27/32	0.8438	21.431
55/64	0.8594	21.828
7/8	0.8750	22.225
57/64	0.8906	22.622
29/32	0.9063	23.019
59/64	0.9219	23.416
15/16	0.9375	23.813
61/64	0.9531	24.209
31/32	0.9688	24.606
63/64	0.9844	25.003
1	1.0000	25.400

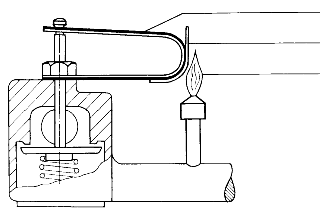
Applications

Thermostatic Bimetals have a wide range of applications other than microelectronics. They are used to control or limit temperature-dependent variables by means of a relatively simple design. Their easy handling as well as their high reliability and low costs are the decisive advantages for their application in:

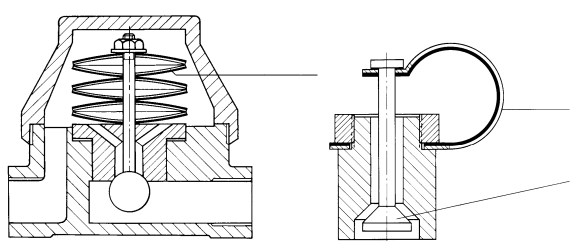
- Safety Devices
- Exhaust gas valves.
- Fire detectors.
- Hot water mixers



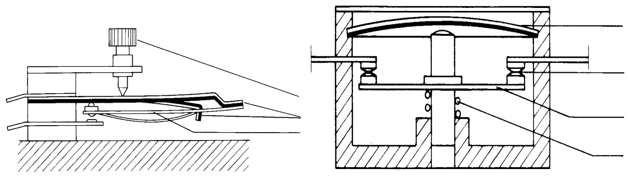
- Flame protection of gas burners.



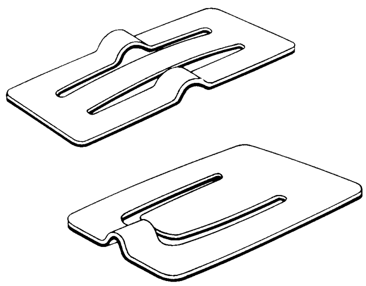
- Steam traps.



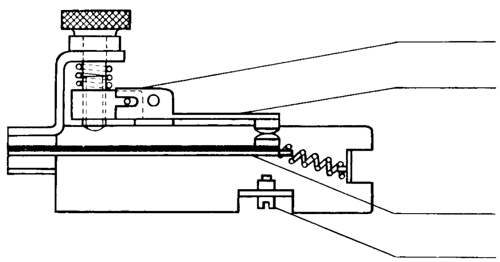
- Adjustable thermostat with snap action and small temperature differential
- Thermostat with snap action bimetal disc for rapid contact breaking



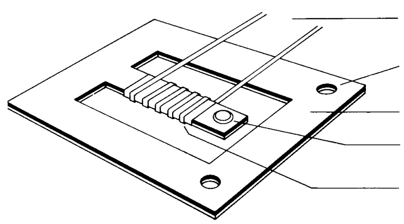
- Gas regulators
- Snap action bimetal



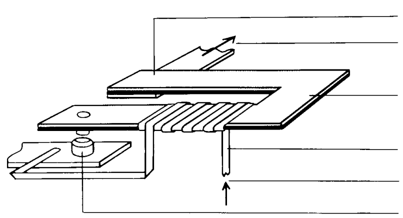
- Thermostat with snap action bimetal



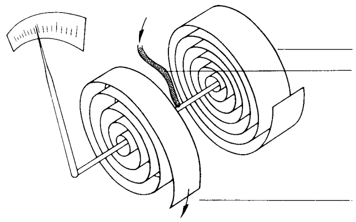
- Power controller with ambient temperature compensation



- Current and voltage regulators

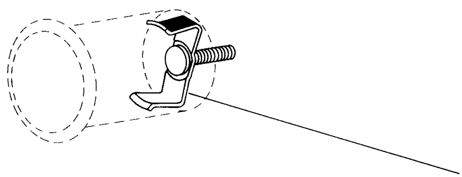


- Ambient temperature compensated ammeter



Automotive Industry

- Automatic starters.
- Brake-power controllers.
- Cigarette lighters.



- Radiator fan switches.
- Fuel level Guage.

Instrumentation and Control

- Clock and timer units.
- Temperature compensation.
- Temperature guages.
- Thermometers.