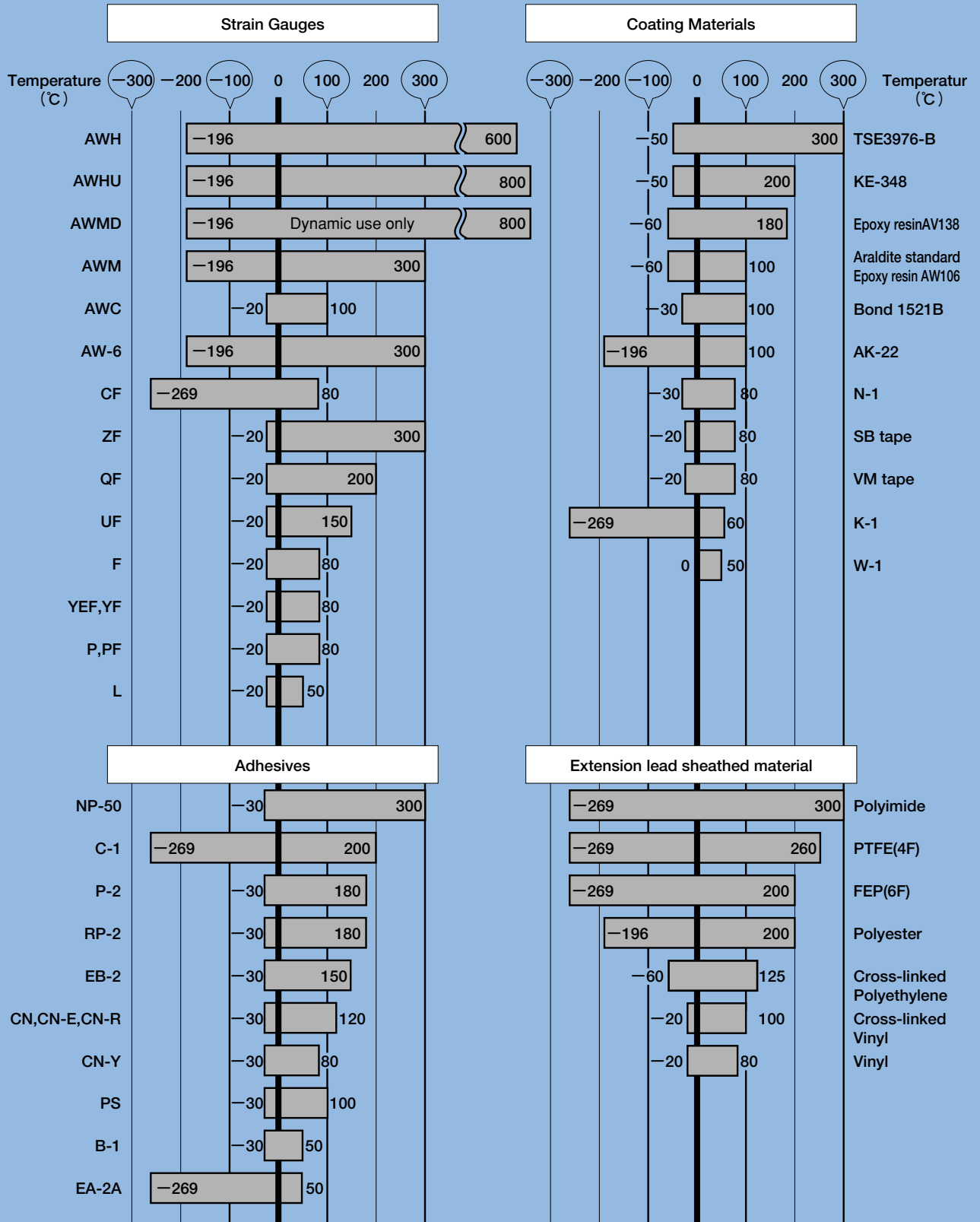


TML STRAIN GAUGES SELECTION

1. Measuring purpose

Material	Purpose	Operating temperature	Gauge series	Bonding adhesive	Coating materials	Extension wire
Metal Mild steel (ferritic) Stainless steel Copper alloy Aluminium Other metals	General purpose	Room temperature (-20~+80°C)	F /PF	CN/P-2 EB-2	W-1/N-1 SB tape	Vinyl/Enamel
		High temperature (-20~+150°C)	UF	CN/EB-2 NP-50	W-1/N-1 SB tape	Vinyl/FEP(6F)
		High temperature (-20~+200°C)	QF	C-1 NP-50	KE-348	FEP (6 F) PTFE (4 F)
		High temperature (-20~+300°C)	ZF	C-1 NP-50	TSE3976-B	PTFE (4 F)
		High temperature (-196~+300°C)	A W-6 A WM	Spot welding	Contact TML	PTFE (4 F) MI cable
		Dynamic use only High temperature (-196~+800°C)	AWMD	Spot welding	Contact TML	MI cable
		Static/Dynamic use High temperature (-196~+800°C)	AWHU	Spot welding	Contact TML	MI cable
		High temperature (-20~+650°C)	AWH	Spot welding	Contact TML	MI cable
		Cryogenic temperature (-269~+80°C)	CF	EA-2A/C-1	K-1	FEP (6 F) PTFE (4 F)
	Long-term	Room temperature (-20~+80°C)	FTP	CN/EB-2	Bond 1521 B W-1 SB tape	Cabtyre cable
			ZF	CN/C-1 NP-50		Vinyl Cross-linked vinyl PTFE (4 F)
			AW-6	Spot welding		
	Stress concentration	Room temperature (-20~+80°C)	FXV/FYV FBXV/FBYV CCFX/CCFYX	CN/P-2 EB-2	W-1 SB tape	Vinyl
		High temperature (-20~+200°C)	QFXV/QFYV QFBXV/QFBYV	C-1 NP-50	KE-348	FEP (6 F)
	Residual stress	Room temperature (-20~+80°C)	FRS FRAS	CN/P-2 EB-2	W-1 SB tape	Vinyl
	Torque	Room temperature (-20~+80°C)	FCT	CN/P-2 EB-2	W-1 SB tape	Vinyl
		High temperature (-20~+200°C)	QFCT	NP-50 C-1	KE-348	FEP (6 F)
	Shearing strain	High temperature (-20~+200°C)	QFLT	NP-50 C-1	KE-348	Vinyl
	Bending strain	High temperature (-10~+70°C)	DD	CN/P-2	* * * *	Vinyl
	Bolt axis	High temperature (-10~+80°C)	BTM	A-2	* * * *	Vinyl
Large strains (Elongation)	Room temperature (-20~+80°C)	YEF YF	CN/CN-Y	SB tape	Vinyl	
Metal Concrete	Magnetic field	Room temperature (-20~+80°C)	MF	CN/CN-E RP-2	W-1 SB tape	Twisted vinyl Shielded vinyl
Concrete Mortar	Surface strain	Room temperature (-20~+80°C)	P PF	CN-E RP-2	W-1 SB tape	Vinyl
		Long-term use/Room-temp. (-20~+80°C)	FLM WFLM	PS		
	Inner strain	Room temperature (-20~+60°C)	PM PMF	Embedment	* * * *	Vinyl
Plastics	General purpose	Room temperature (-20~+80°C)	GF	CN	W-1/N-1 SB tape	Vinyl
Composite	General purpose	High temperature (-20~+200°C)	BF	CN NP-50	W-1 KE-348	Vinyl
Wood Gypsum	General purpose	Room temperature (-20~+80°C)	LF	CN-E	W-1	Vinyl
Wood	General purpose	Long-term use/Room-temp. (-20~+80°C)	PFLW/PLW	PS	W-1, N-1 SB tape	Vinyl
General	Temperature	-20~+200°C	TF	CN/C-1 NP-50	W-1 SB tape	Vinyl

2. OPERATIONAL TEMPERATURES



TML STRAIN GAUGES SELECTION

3. Strain Gauge Characteristics

Gauge series	Applicable specimen	Applicable thermal expansion (ppm/°C)	Operational temperature (°C)		Bonding adhesive	Materials		Strain limit (×10 ⁻⁶ strain)	
			Normal	Compensation		Backing	Element		
F Leadwire-integrated F	Metal, Glass, Ceramics	8, 11, 17,23	-20~+80	+10~+80	CN/P-2/ EB-2	Epoxy	Cu-Ni	3% (30000)	
WF	Metal, Glass, Ceramics	11, 17, 23	0~+80	+10~+80	CN/P-2	Epoxy	Cu-Ni	3% (30000)	
Temperature-integrated FLA-T	Metal, Glass, Ceramics	11, 17, 23	-30~+80	+10~+80	CN/P-2	Epoxy Polyimide	Cu-Ni Ni-Cr	3% 1%	
UF Leadwire-integrated UF	Metal	11, 17, 23	-20~+150	+10~+100	CN, NP-50, EB-2	Polyimide- Amide	Cu-Ni	3% (30000)	
QF (High temperature)	Metal, Ceramics	11	-20~+200	+10~+100	CN, NP-50, C-1	Polyimide	Cu-Ni	3% (30000)	
ZF (High temperature)	Metal, Ceramics	11	-20~+300	+10~+100	CN, NP-50, C-1	Polyimide	Ni-Cr	1% (10000)	
CF (Cryogenic temperature)	Metal, Ceramics	11, 17, 23	-269~+80	-196~+80	CN, EA-2A, C-1	Epoxy	Special alloy	1% (10000)	
AW	AWM	Metal	11, 17	-196~+300	RT~+300	Spot welding	SUS304	Special alloy	1% (10000)
	AWMD	Metal	****	-196~+800	****	Spot welding	Inconel	Special alloy	1% (10000)
	AWH	Metal	Adjustable	-196~+650	RT~+600	Spot welding	SUS321 Inconel	Special alloy	0.6% (6000)
	AWHU	Metal	Inconel 600	-196~+800	RT~+800	Spot welding	Inconel	Special alloy	0.6% (6000)
	AW-6	Metal	11	-196~+300	+10~+100	Spot welding	SUS304	Special alloy	0.5% (5000)
	AWC	Metal	11	-20~+100	+10~+100	Spot welding	SUS304	Special alloy	0.5% (5000)
P Leadwire-integrated P	Concrete, Mortar	11	-20~+80	+10~+80	CN-E, RP-2	Polyester	Cu-Ni	2% (20000)	
PF Leadwire-integrated PF	Metal, Mortar	11	-20~+80	+10~+80	CN, RP-2	Polyester	Cu-Ni	2% (20000)	
FLM/WFLM	Concrete, Mortar	11	-20~+80	+10~+80	PS	SUS 304	Ni -Cr	0.5% (5000)	
PM/PMF	Concrete, Mortar	****	-20~+60	****	Embedment	Acrylic, Special plastics	Cu-Ni	2% (20000)	
GF	Plastics	50,70	-20~+80	+10~+80	CN	Epoxy	Cu-Ni	3% (30000)	
LF	Wood, Gypsum	11	-20~+80	+10~+80	CN-E	Epoxy	Cu-Ni	3% (30000)	
PFLW/PLW	Wood	11	-20~+80	+10~+80	PS	Polyester	Cu-Ni	2% (20000)	
BF	Composite materials	3, 5, 8	-20~+200	+10~+80	CN, NP-50	Polyimide	Cu-Ni	3% (30000)	
MF	Metal, Concrete	****	-20~+80	****	CN, CN-E, RP-2	Epoxy	Ni-Cr	1% (10000)	
YEF	Metal	****	-20~+80	****	CN, CN-Y	Special plastics	Cu-Ni	10~15%	
YF	Metal	****	-20~+80	****	CN, CN-Y	Special plastics	Cu-Ni	15~20%	
BTM	Bolt M10 or larger	****	-10~+80	****	A-2	Special plastics	Cu-Ni	0.5% (5000)	
DD	Metal	****	-10~+70	****	CN, P-2	Acrylic	Cu-Ni	0.15% (1500)	
FAC Crack gauge	Metal, Concrete	****	-20~+80	****	CN, RP-2	Epoxy	Cu-Ni	****	
FTP Protector gauge	Metal	11	-20~+80	+10~+80	CN, EB-2	Epoxy	Cu-Ni	3% (30000)	
SF Stress gauge	Metal	11, 17, 23	-20~+200	+10~+100	CN, NP-50, C-1	Polyimide	Cu-Ni	****	
Transducer-specific	General	****	-20~+200	****	CN, NP-50, C-1	Epoxy Polyimide	Cu-Ni, Ni-Cr	****	
TF Temperature gauge	Metal	11, 17, 23	-20~+200	+10~+80	C-1	Polyimide	Ni alloy	****	

N.B. Fatigue life is measured at room temperature. Strain level : ±1500×10⁻⁶ strain 15Hz ⊙: ±1000×10⁻⁶ strain 15Hz

	Fatigue life at room temperature	Applications	Page
	1×10 ⁶	The F series employs specially controlled alloy foils which are 0.003 to 0.007-mm thick. The grid is precision-etched by the most advanced processes available, and employs an extremely thin epoxy backing. Leadwire-integrated F series has a pre-attached vinyl leadwire to F series. 2-wire and 3-wire parallel are available.	23
	1×10 ⁶	This gauge eliminates the need for a moistureproof coating, which is sometimes troublesome in field test. The gauge has a vinyl lead wire and the entire gauge and leadwire junction have been fully overcoated with a transparent and flexible epoxy resin. Perfect waterproofing can be achieved by merely bonding the gauge with CN or P-2 bonding adhesive.	32
	1×10 ⁶	This gauge includes temperature sensor to measure both strain and temperature simultaneously. The FLA-T identical to the F series has T-thermocouple.	33
	1×10 ⁶	The operational temperature range of this general-purpose gauge series extends to 150°C. The gauges are temperature compensated for mild steel, stainless steel and aluminium. The gauge backing is colour-coded according to the temperature compensated material type in the same method as for the F. The gauge with a pre-attached vinyl leadwire is available.	34
	1×10 ⁶	The QF series have a polyimide carrier backing for excellent performance at high temperature of 200°C. It offers a small gauge length of 0.2 or 0.4mm, for use as a stress concentration measurement gauge or shear stress measurement gauge.	37
	1×10 ⁶	The ZF series have a polyimide carrier backing for excellent performance at high temperature of 300°C. Owing to the use of Ni-Cr alloy and special grid design for the strain sensing element, creep characteristics in high temperature have been much improved.	39
	1×10 ⁶	This epoxy-backed foil gauge is designed for measuring under cryogenic conditions. The specially selected and heat-treated sensing foil shows very small zero shift under cryogenic temperatures compared with conventional gauges.	40
	◎1×10 ⁶	The AWM is a spot-weldable strain gauge with Quarter bridge with 3-wire system. As the element is hermetically sealed, the gauge withstand upto 300°C and in harsh environment for strain measurement.	41
	◎1×10 ⁶	The AWMD is a spot-weldable strain gauge withstand upto 800°C for only dynamic strain measurement. It has a standard high-pass filter with full bridge configuration to eliminate unexpected low frequency influence.	42
	◎1×10 ⁶	The AW-8 is a spot-weldable strain gauge withstand upto 600°C for static measurement or upto 650°C for dynamic measurement. The backing material is available in Inconel 600 or SUS321 which should be selected according to the test specimen.	43
	◎1×10 ⁶	The AWHU is a spot-weldable strain gauge withstand upto 800°C for both static and dynamic measurement. Although it has a half bridge configuration, the measurement is made by full bridge using the supplied temperature compensation circuit board.	43
	◎1×10 ⁶	The AW-6 with quarter bridge with 3-wire system is suited for strain measurement in high temperature upto 300°C, for measurement of specimen to which adhesive is not applicable or for long term measurement.	44
	◎1×10 ⁶	The AWC-8B is fully encapsulated in a stainless steel tube with quarter bridge with 3-wire system. It enables a long term strain measurement in harsh environment.	44
	◎1×10 ⁵	This gauge is a standard wire strain gauge with a transparent plastic backing impregnated with a polyester resin. It offers several remarkable features such as excellent electrical insulation, easy and accurate installation, and quick setting. Gauge lengths are available with 60, 90 and 120mm, making it well suited to the measurement of concrete strain.	45
	1×10 ⁶	This is a foil strain gauge with the same transparent plastic backing as that of the P series gauges. Electrical insulation is excellent, and installation is very easy. It is especially recommended for mortar measurement.	46
	◎1×10 ⁵	This gauge is designed for strain measurement on concrete surfaces. It has a thin stainless-steel backing which prevents the penetration of moisture from the reverse side. It provides good electrical insulation to the concrete surface. The WFLM gauge has a moistureproof overcoating and integral lead in addition to stainless steel backing.	47
	* * * *	This gauge has been specially designed for measuring interior strain in concrete, mortar under a loading test. The PM is sealed between thin resin plates, and the PMF employs super engineering plastics capable of superior waterproofing characteristics. For long period measurement, the Strain Transducer KM is preferable.	48
	1×10 ⁶	This is a foil strain gauge which is designed for materials with low elastic modulus, such as plastics, and is specially configured to minimize the effect of gauge tightening. Self-temperature compensation is available for materials with thermal expansion of 50 and 70ppm/°C.	49
	1×10 ⁶	This gauge is specially designed for materials having a low elastic modulus such as wood or gypsum. It consists of a foil-etched gauge with an epoxy carrier backing, and it is self-temperature compensated with 11ppm/°C.	50
	◎1×10 ⁶	This gauge has a thin metal backing for a long term measurement on woods, not affected by moisture contained in wood. The gauge is bonded with PS adhesive.	50
	1×10 ⁶	This gauge employs a special grid pattern to minimize the effect of gauge tightening on composite materials. Self-temperature compensation is available with a thermal expansion values of 3, 5 or 8ppm/°C.	50
	1×10 ⁶	Consisting two identical grids, this gauge is designed to cancel noise voltage for strain measurement in a magnetic environment. By using a specially configured element pattern, the gauge circuit minimizes electromagnetic effects.	51
	5×10 ⁵	This gauge features a special plastic carrier base capable of withstanding extreme elongation upto 15% without creeping or cracking. Cycle measurement under elastic behaviour (approx. ±1500×10 ⁻⁶) strain is available same as general gauge.	52
	* * * *	This gauge features a special plastic carrier base capable of withstanding extreme elongation upto 20% without creeping or cracking.	53
	* * * *	The BTM is designed to measure the tensile force of bolts. To install, simply insert the gauge together with A-2 bonding adhesive into a pre-drilled hole in the bolt head. This unique method ensures that the gauge will not be damaged.	54
	◎1×10 ⁵	The DD is specially designed to separately measure bending and tensile stress by simply bonding the gauge to one side of a plate or beam. It works on the assumption that strain distribution in the section of the specimen which is subjected to both stress is linear.	55
	* * * *	The FAC-20 is designed to measure the progress (length) of a crack and its rate of growth to a pre-determined location on a test specimen for which metal fatigue monitoring is required. Adaptor CGA-120A is required between the gauge and the strainmeter.	55
	◎1×10 ⁶	The FTP was developed for rapid, on-site strain measurements without the need to connect the leadwire or apply waterproofing or mechanical protection. It is sealed in epoxy resin, housed in a light but rigid plastic case, and comes with a 5-meter long integral wire.	56
	1×10 ⁶	The SF is a foil strain gauge with a polyimide backing and measures stress in the optional direction in a plane stress field. It detects stress in the gauge axial direction regarding the shearing strain.	56
	1×10 ⁶	This range of strain gauges is lined up for strain gauge-type transducers such as force transducers, pressure transducers, torque transducers, etc.	57
	* * * *	The TF is a series of resistance type temperature sensors(resistance thermometers) and is a bonded type like strain gauges.	59