Linear Strain Gauges for Bending Beam Force Transducers

Description

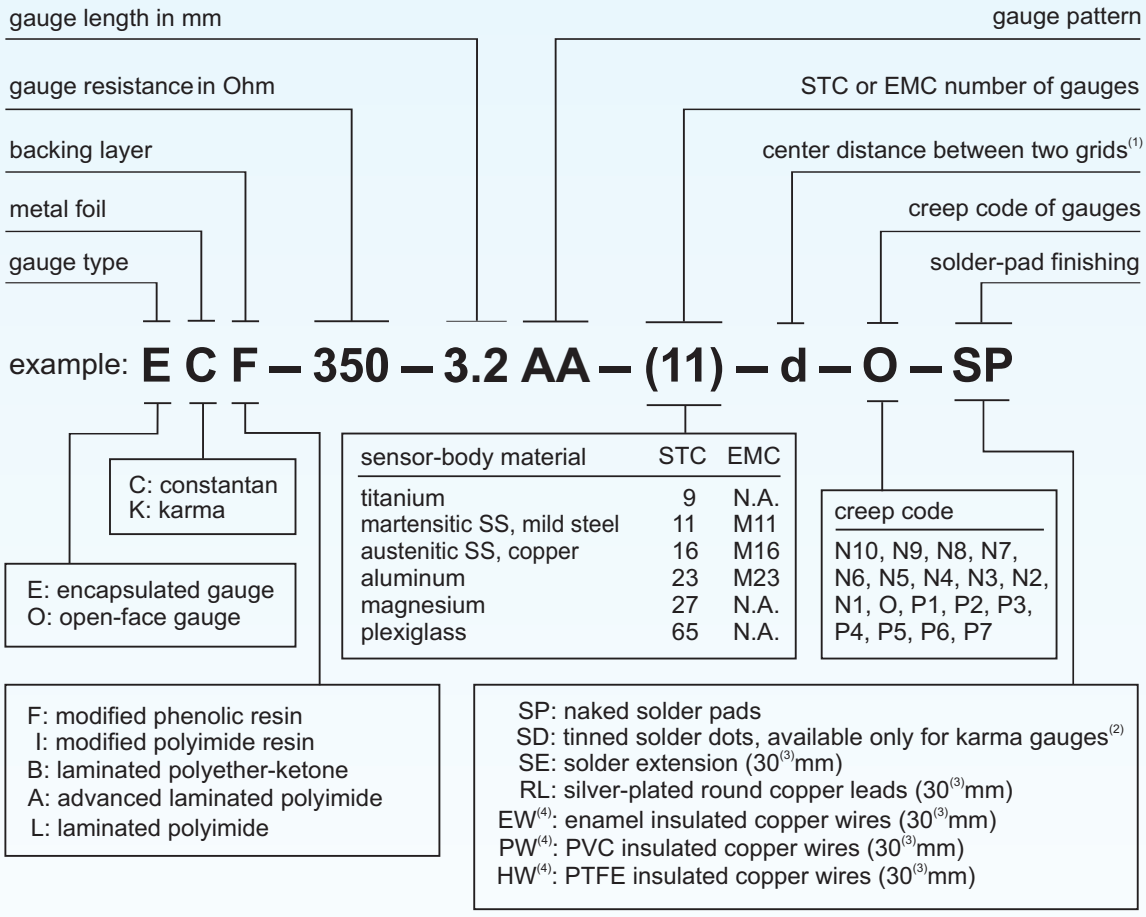
BCM SENSOR linear strain gauges are specially developed for manufacturing precision force transducers which employ bending beam working principle. For the purpose of this specific application, the linear strain gauges are temperature and creep compensated, and they can be either encapsulated or open-face according to the requirement.

The karma gauges can be manufactured with effective modulus compensation (EMC). The EMC gauges are mostly for manufacturing low-cost force transducers, because with the EMC gauges the manufacturers can eliminate the use of compensation resistors and achieve the sensitivity compensation.

For creep compensation, there are 18 creep codes: “N10, N9, N8, ..., O, ..., P5, P6, P7". The “N10” is the most negative creep code, while the “P7" is the most positive one. The “O” stands for a moderate creep code. For a specific strain gauge, please find its available creep code below its dimensions at the “Option *9" on the following pages. For customized creep code, consult BCM SENSOR.

For more information on self-temperature compensation (STC), creep compensation, and EMC of strain gauges, please refer to the corresponding articles respectively on the website of BCM SENSOR.

Ordering Information



Notes: (1) This code is only applicable to either the half- or full-bridge SG.

(2) It is recommended to select this option, if one wants to use the karma gauges and has no any experience having soldered leads or wires onto the karma gauges.

(3) 30mm is a standard length. The customized length is available on request.

(4) Working temperature ranges of the wires:
EW: -40 ~ +150°C; PW: -40 ~ +105°C; HW: -80 ~ +250°C.

Industriepark Zone 4, Brechtsebaan 2
B-2900 Schoten - Antwerpen, BELGIUM

Tel.: +32-3-238 6469
Fax: +32-3-238 4171

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

Linear Strain Gauges for Bending Beam Force Transducers

Specifications

Parameters	Specifications / Description				
series	ECF-series	ECI-series	ECB-series	ECA-series	ECL-series
features and suitable applications	most widely used in commercial applications	wide working temperature range, popular for normal industrial, automotive and military applications.	high strain limit, suitable for normal industrial and automotive applications	widest working temperature range, suitable for high temperature or cryogenic applications	suitable for normal industrial and military applications
metal foil	constantan alloy	constantan alloy	constantan alloy	constantan alloy	constantan alloy
foil thickness (μm)	5±1	5±1	5±1	5±1	5±1
backing layer	modified phenolic resin	modified polyimide resin	laminated polyether-ketone	advanced laminated polyimide	laminated polyimide
backing thickness (μm)	50±5	30±3	25±3	25±3	25±3
encapsulation layer	phenolic resin	phenolic resin	polyether-ketone	polyimide	polyimide
encapsulation thickness (μm)	17.5±2.5	17.5±2.5	12.5±2.5	12.5±2.5	17.5±2.5
nominal resistance (Ω)	350, 700, 1000	350, 700, 1000	350, 700, 1000	350, 700, 1000	350, 700, 1000
resistance tolerance (%)*	down to ±0.3	down to ±0.3	down to ±0.3	down to ±0.3	down to ±0.3
dispersion of resistance in one package (%)*	down to ±0.1	down to ±0.1	down to ±0.1	down to ±0.1	down to ±0.1
gauge factor	2.1	2.1	2.1	2.1	2.1
tolerance of gauge factor	±0.1	±0.1	±0.1	±0.1	±0.1
dispersion of gauge factor in one production lot (%)	±1	±1	±1	±1	±1
max. working strain (με)	±5,000	±5,000	±5,000	±5,000	±5,000
strain limit (με)	±30,000	±30,000	±30,000	±30,000	±30,000
fatigue life (load cycle)**	10^7	10^7	10^7	10^7	10^7
radius of curved surface for gauge bonding	≥3mm	≥3mm	≥3mm	≥3mm	≥3mm
STC codes	9, 11, 16, 23, 27, 65	9, 11, 16, 23, 27, 65	11, 16, 23	11, 16, 23	11, 16, 23
creep compensation***	Refer to Section 5.8.				
working temp. range (°C)	-30 ~ +80	-85 ~ +150	-45 ~ +150	-195 ~ +200	-55 ~ +150
max. temperature (°C) for dynamic applications up to two hours	100	170	170	220	170
thermal output	+370με over the temp. range of -50 ~ +25°C; -150με over +25 ~ +125°C; +200με over +125 ~ +200°C				
max. working current	Refer to ****	Refer to ****	Refer to ****	Refer to ****	Refer to ****

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Notes:

(*): The tolerance and dispersion of the gauge resistance is influenced by both the level of resistance and the gauge pattern. The specific tolerance and dispersion can be found in Selection Chart for the specific gauge pattern of metal foil strain gauges (SG).

(**): The fatigue life of metal foil SG was tested by tensile strain. The number of cycles of fatigue life of metal foil SG was tested and obtained when the tensile strain level was set at 1000με. The lower the tested strain level, the more cycles or longer fatigue life of the metal foil SG under test. When the tested strain level is lower than 200με, the metal foil SG under test may have much longer fatigue life.

(***): The available creep codes can be found in Selection Chart for the specific gauge pattern of metal foil SG.

(****): The maximum working current of SG is determined by the heat dissipation of SG. The heat dissipation of SG depends on the quality of bonding process (gluing and curing), the quality of sensor body material, and profile of the sensor body. For a given SG resistance, the maximum excitation voltage of sensors is determined by the maximum working current of the SG. If there is a sufficient heat dissipation channel underneath the SG, the maximum excitation voltage may be set to 12Vdc crossing the Wheatstone bridge circuit of the SG of 350Ω resistance, to keep the working temperature of the Wheatstone bridge circuit within the compensated temperature range of the sensor. Nevertheless, if the heat dissipation channel is not sufficient to dissipate the heat, due to the limit of dimension or profile of sensor body, the heat which is created by the working current may cause a localized increase of temperature in the Wheatstone bridge circuit. To keep the working temperature of the Wheatstone bridge circuit within the compensated temperature range of the sensor, it is recommended to lower the maximum excitation voltage e.g., not higher than 10Vdc crossing the Wheatstone bridge circuit of the SG of 350Ω resistance.

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Parameters	Specifications / Description			
series	EKF-series	EKI-series	EKA-series	EKL-series
features and suitable applications	available with various STC and EMC codes; for commercial applications requiring high resistance or effective modulus compensation	wide working temperature range with various STC and EMC codes; suitable for normal industrial, automotive and military applications which require high resistance or effective modulus compensation	widest working temperature range; suitable for high temperature or cryogenic applications which require high resistance	suitable for normal industrial and military applications which require high resistance and effective modulus compensation
metal foil	karma alloy	karma alloy	karma alloy	karma alloy
foil thickness (μm)	5±1	5±1	5±1	5±1
backing layer	modified phenolic resin	modified polyimide resin	advanced laminated polyimide	laminated polyimide
backing thickness (μm)	50±5	30±3	25±3	25±3
encapsulation layer	phenolic resin	phenolic resin	polyimide	polyimide
encapsulation thickness (μm)	17.5±2.5	17.5±2.5	12.5±2.5	17.5±2.5
nominal resistance (Ω)	350, 700, 1000, 2000, 5000	350, 700, 1000, 2000, 5000	350, 700, 1000, 2000, 5000	350, 700, 1000, 2000, 5000
tolerance of resistance (%,*)	down to ±0.3	down to ±0.3	down to ±0.3	down to ±0.3
dispersion of resistance in one package (%,*)	down to ±0.1	down to ±0.1	down to ±0.1	down to ±0.1
gauge factor	2.03	2.03	2.03	2.03
tolerance of gauge factor	±0.17	±0.17	±0.17	±0.17
dispersion of gauge factor in one production lot (%)	±1	±1	±1	±1
max. working strain (με)	±5,000	±5,000	±5,000	±5,000
strain limit (με)	+15,000/-20,000	+15,000/-20,000	+15,000/-20,000	+15,000/-20,000
fatigue life (load cycle,**)	10^7	10^7	10^7	10^7
radius of curved surface for gauge bonding	≥3mm	≥3mm	≥3mm	≥3mm
STC codes	9, 11, 16, 23, 27, 65	9, 11, 16, 23, 27, 65	11, 16, 23	11, 16, 23
EMC codes	M11, M16, M23	M23	NA	M11, M16, M23
creep compensation (***)	Refer to Section 5.8.	Refer to Section 5.8.	Refer to Section 5.8.	Refer to Section 5.8.
working temp. range (°C)	-30 ~ +80	-85 ~ +150	-195 ~ +200	-55 ~ +150
max. temperature (°C) for dynamic applications up to two hours	100	170	220	170
thermal output		+200με over the temp. range of -50 ~ +25°C +100με over the temp. range of +25 ~ +125°C -50με over the temp. range of +125 ~ +200°C		
max. working current	Refer to ****	Refer to ****	Refer to ****	Refer to ****

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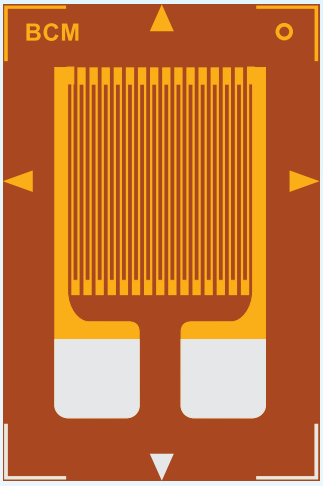
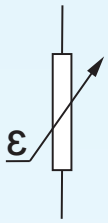
Selection Chart

1. Single-Grid Linear Gauges

Pattern: **AA**



schematic diagram



(ε: strain)

equivalent circuit

Application		for bending beam
Tolerance of Resistance		±0.3%
Dispersion of Resistance in 1 Package		±0.1%
Gauge Factor	constantan	2.1±0.1
	karma	2.03±0.17
Dispersion of Gauge Factor per Production Lot		±1%
5 Types of Backing Material (F.I.B.A.L.) vs Gauge Working Temperature Range	F: modified phenolic resin	-30 ~ +80°C
	I: modified polyimide resin	-85 ~ +150°C
	B: laminated polyether-ketone	-45 ~ +150°C
	A: advanced laminated polyimide	-195 ~ +200°C
	L: laminated polyimide	-55 ~ +150°C

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R (Ω) Nominal Resistance	Gauge Length mm (inch)	Grid Width mm (inch)	Backing Dimensions L x W, mm (inch)	Ordering Code Format / Variants	# Backing Material	STC or EMC	& Creep Code	^ Solder-Pad Finishings
175	0.5 (0.020)	1.4 (0.055)	3.8 x 2.6 (0.150 x 0.102)	EK#-R-0.5AA-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	SP, SD(3), SE, RL, EW, PW, HW
175				EK#-R-0.5AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
350(1)	0.8 (0.031)	1.4 (0.055)	3.1 x 2.6 (0.122 x 0.102)	EK#-R-0.8AA-(STC)-&-^	F, I, A, L	11, 16, 23	O, P3, P4	SP, SD(3), SE, RL, EW, PW, HW
350(1)				EK#-R-0.8AA-(EMC)-&-^	F, L	M11, M16, M23	O, P3, P4	
350(1)	1.1 (0.043)	1.0 (0.039)	2.9 x 2.0 (0.114 x 0.079)	EK#-R-1.1AA-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	SP, SD(3), SE, RL, EW, PW, HW
350(1)				EK#-R-1.1AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
175	1.5 (0.059)	2.6 (0.102)	4.6 x 3.6 (0.181 x 0.142)	EC#-R-1.5AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	P3(2)	SP, SD(3), SE, RL, EW, PW, HW
175				EK#-R-1.5AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
350				EC#-R-1.5AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	N10, N9, N8, N7, N6, N5, N4, N3, N2, N1, O, P1, P2, P3, P4, P6	
350				EK#-R-1.5AA-(EMC)-&-^	F, L	M11, M16, M23		
700(1), 1000				EK#-R-1.5AA-(STC)-&-^	F, I, A, L	11, 16, 23	N7, N5, O	
				EK#-R-1.5AA-(EMC)-&-^	F, L	M11, M16, M23	N7, N5, O	
350(1), 700	2.5 (0.098)	3.3 (0.130)	6.5 x 4.5 (0.256 x 0.177)	EC#-R-2.5AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	N10, N9, N8, N7, N6, N5, N4, N3, N2, N1, O, P1, P2, P3, P4, P6, P7	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-2.5AA-(EMC)-&-^	F, L	M11, M16, M23		
1000(1)				EK#-R-2.5AA-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	
1000(1)				EK#-R-2.5AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
350(1), 700	3.2 (0.126)	3.1 (0.122)	7.4 x 4.4 (0.291 x 0.173)	EC#-R-3.2AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	N7, N6, N5, N4, N3, N2, N1, O, P1, P2, P3, P4, P5, P6, P7	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-3.2AA-(EMC)-&-^	F, L	M11, M16, M23		
1000(1), 2000, 3000				EK#-R-3.2AA-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	
				EK#-R-3.2AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
1000(1)	3.2 (0.126)	4.6 (0.181)	6.7 x 5.8 (0.264 x 0.228)	EC#-R-3.2AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	O(2)	SP, SD(3), SE, RL, EW, PW, HW
5000(1)				EK#-R-3.2AA-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	
5000(1)				EK#-R-3.2AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
350(1), 700, 1000	4.2 (0.165)	4.4 (0.173)	8.5 x 5.6 (0.335 x 0.220)	EC#-R-4.2AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	O(2)	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-4.2AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
2000(1), 3000(4), 5000(4)				EK#-R-4.2AA-(STC)-&-^	F, I, A, L	11, 16, 23	O, P4	
				EK#-R-4.2AA-(EMC)-&-^	F, L	M11, M16, M23	O, P4	
350(1), 700, 1000	6.1 (0.240)	3.1 (0.122)	10.5 x 5.5 (0.413 x 0.217)	EC#-R-6.1AA-(STC)-&-^	F, I, B, A, L	11, 16, 23	P2, O, N3	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-6.1AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
2000(1), 3000, 6000(4)				EK#-R-6.1AA-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	
				EK#-R-6.1AA-(EMC)-&-^	F, L	M11, M16, M23	O(2)	

Notes: (1) Lower resistances are available for large-volume orders.
(2) Other creep codes are available for large-volume orders.
(3) Only necessary to select if one wants to use the karma gauges.
(4) Not available with backing material A.

Industriepark Zone 4, Brechtsebaan 2
B-2900 Schoten - Antwerpen, BELGIUM

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Fax: +32-3-238 4171

website: www.bcmsensor.com
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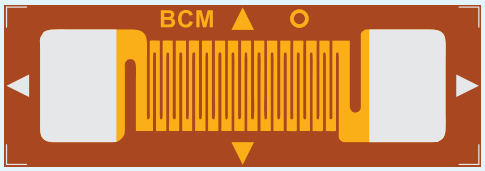
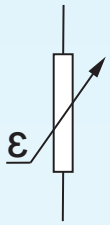
Pattern: **AA(B)**



schematic diagram



(ε: strain)

equivalent circuit

Application		for bending beam
Tolerance of Resistance		±0.3%
Dispersion of Resistance in 1 Package		±0.1%
Gauge Factor	constantan	2.1±0.1
	karma	2.03±0.17
Dispersion of Gauge Factor per Production Lot		±1%
5 Types of Backing Material (F.I.B.A.L.) vs Gauge Working Temperature Range	F: modified phenolic resin	-30 ~ +80°C
	I: modified polyimide resin	-85 ~ +150°C
	B: laminated polyether-ketone	-45 ~ +150°C
	A: advanced laminated polyimide	-195 ~ +200°C
	L: laminated polyimide	-55 ~ +150°C

R (Ω) Nominal Resistance	Gauge Length mm (inch)	Grid Width mm (inch)	Backing Dimensions L x W, mm (inch)	Ordering Code Format / Variants	# Backing Material	STC or EMC	& Creep Code	^ Solder-Pad Finishings
350(1)	0.6 (0.024)	1.9 (0.075)	1.4 x 4.2 (0.055 x 0.165)	EK#-R-0.6AA(B)-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-0.6AA(B)-(EMC)-&-^	F, L	M11, M16, M23	O(2)	

Notes: (1) Lower resistances are available for large-volume orders.
(2) Other creep codes are available for large-volume orders.
(3) Only necessary to select if one wants to use the karma gauges.

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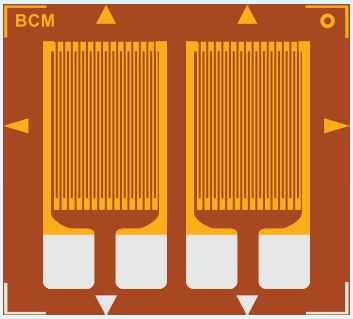
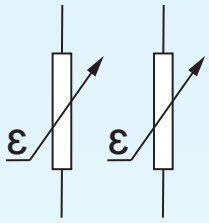
2. Dual-Grid Linear Gauges

Pattern: **FB**



schematic diagram



(ε: strain)

equivalent circuit

Application		for bending beam
Tolerance of Resistance		±0.3%
Dispersion of Resistance in 1 Package		±0.1%
Max. Difference of Resistance over Two Grids		±0.1%
Gauge Factor	constantan	2.1±0.1
	karma	2.03±0.17
Dispersion of Gauge Factor per Production Lot		±1%
5 Types of Backing Material (F.I.B.A.L.) vs Gauge Working Temperature Range	F: modified phenolic resin	-30 ~ +80°C
	I: modified polyimide resin	-85 ~ +150°C
	B: laminated polyether-ketone	-45 ~ +150°C
	A: advanced laminated polyimide	-195 ~ +200°C
	L: laminated polyimide	-55 ~ +150°C

R (Ω) Nominal Resistance	Gauge Length mm (inch)	Grid Width mm (inch)	Backing Dimensions L x W, mm (inch)	Ordering Code Format / Variants	# Backing Material	STC or EMC	& Creep Code	^ Solder-Pad Finishings
350(1)	2.1 (0.083)	2.8 (0.110)	6.4 x 7.6 (0.252 x 0.299)	EC#-R-2.1FB-(STC)-&-^	F, I, B, A, L	11, 16, 23	N3, O(2)	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-2.1FB-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
700(1), 1000				EK#-R-2.1FB-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	
				EK#-R-2.1FB-(EMC)-&-^	F, L	M11, M16, M23	O(2)	
350(1)	3.2 (0.130)	2.8 (0.110)	7.4 x 7.4 (0.291 x 0.291)	EC#-R-3.2FB-(STC)-&-^	F, I, B, A, L	11, 16, 23	N10, N9, N8, N7, N6, N5, N4, N3, N2, N1, O, P1, P2, P3, P4, P6, P7	SP, SD(3), SE, RL, EW, PW, HW
				EK#-R-3.2FB-(EMC)-&-^	F, L	M11, M16, M23		
700(1), 1000				EK#-R-3.2FB-(STC)-&-^	F, I, A, L	11, 16, 23	O(2)	
				EK#-R-3.2FB-(EMC)-&-^	F, L	M11, M16, M23	O(2)	

Notes: (1) Lower resistances are available for large-volume orders.
(2) Other creep codes are available for large-volume orders.
(3) Only necessary to select if one wants to use the karma gauges.

The listed specifications and dimensions are subject to change without prior notice.

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