Special Use Sensors—Crack Detection Sensors

CD-Series Crack Detection Gages are designed to provide a convenient, economical method of indicating the presence of a crack, or indicating when a crack has progressed to a predetermined location on a test part or structure. By employing several CD gages, it is also possible to monitor the rate of crack growth; however, Crack Propagation Gages would normally be selected for that purpose.

In some applications, thin copper wires bonded to the test structure are used to provide a low-cost method of detecting crack initiation or propagation. Because of the behavior of copper wire, however, this method suffers from two limitations: (a) the crack tip may progress considerably beyond the wire without breaking the strand, and (b) in areas of high cyclic strains, the wire may fail in fatigue without crack initiation in the specimen. CD-Series Crack Detection Gages are designed to overcome both of these limitations.

CD-Series gages consist of a single strand of high-endurance alloy. A crack propagating beneath the gage will induce local fracture of the sensing strand and open the electrical circuit. When the CD gage is installed at critical locations on a test part or structure and used as a sensing element in a control system, the signal can serve to alter a test sequence or to alert an operator to incipient component failure.

CONSTRUCTION

Two gage constructions are currently available:

The CD-02 is made of beryllium copper alloy laminated to polyimide, and offers a low-resistance sensing element. Select the CD-02 type for maximum conformability to irregular surfaces and ease of soldering, when greatest fatigue life is not required.

The CD-23 type is constructed of isoelastic alloy laminated to a glass-fiber-reinforced backing for applications where the highest endurance is required. The superior fatigue life of the isoelastic alloy allows the CD-23 to be used in high cyclic strain fields without premature failure, while maintaining high sensitivity to crack formation under the gage. This gage is less conformable than the CD-02 and requires use of SS-Flux for tinning of solder tabs for leadwire attachment.

Crack Detection Gages are available with various strand lengths; from 0.4 in (10 mm) for applications where space is limited, to 2.0 in (50 mm) for use where the direction of crack propagation, or the point of crack initiation, is uncertain.

Resistance of the CD Series is nominally 0.05Ω/mm of active strand length for beryllium copper and 1Ω/mm for isoelastic gages.

The normal operating temperature range is –320° to +250°F (–195° to +120°C).

ADHESIVES

Conventional strain gage adhesives are suitable for bonding CD-Series gages. M-Bond 600, 610, or 43-B are preferred for excellent performance over the widest operating temperature range. However, M-Bond AE-10 and AE-15 are also suitable where in-service temperatures will not exceed +200°F (+95°C). M-Bond 200 is satisfactory for fast installation, but should not be used for long-term testing.

PROTECTIVE COATINGS

Corrosion, which can cause premature filament failure, is greatly accelerated in the presence of high cyclic strain fields. For long-term use, it is essential to protect the crack detection gage from atmospheric corrosion and other contamination.

M-Bond 43-B is an excellent protective coating when the bonding adhesive, leadwire insulation and solder can tolerate the cure temperature. If lower cure temperatures are necessary, M-Bond AE-10 and AE-15 are recommended. When in-service environmental conditions are not extreme, a softer coating may prove perfectly adequate. Either 3140 RTV or M-Coat D would be a good choice in these instances.

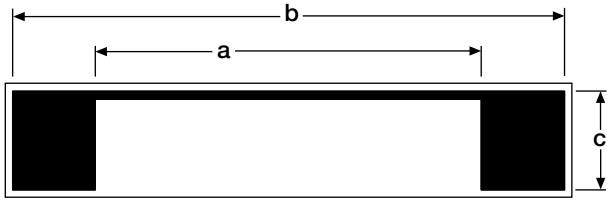
For repetitive use on identical structural shapes, special patterns may be designed to fit the expected crack formation area. Contact our Applications Engineering Department for details.

Special Use Sensors—Crack Detection Sensors

CD-SERIES GAGE DESIGNATION

C D – 2 3 – 1 5 A

- **GEOMETRY** (tabs as shown)
- **LENGTH OF ACTIVE LINE IN MILLIMETERS**
- **MATERIAL AND CONSTRUCTION:**
  - 02 = 0.0005 in (0.013 mm) beryllium copper laminated to 0.001 in (0.025 mm) polyimide backing
  - 23 = 0.00025 in (0.006 mm) isoelastic alloy laminated to 0.0008 in (0.020 mm) glass-fiber-reinforced backing
- **CRACK DETECTION GAGE** (single strand)



GAGE DESIGNATION	DIMENSIONS (inch / millimeter)				
Pb-free RoHS COMPLIANT	a	b	c	LENGTH	WIDTH
CD-02-10A CD-23-10A	0.40	0.56	0.10	0.60	0.13
	10.2	14.2	2.5	15.2	3.2
CD-02-15A CD-23-15A	0.60	0.76	0.10	0.80	0.13
	15.2	19.3	2.5	20.3	3.2
CD-02-20A CD-23-20A	0.80	0.96	0.10	1.00	0.13
	20.3	24.4	2.5	25.4	3.2
CD-02-25A CD-23-25A	1.00	1.16	0.10	1.20	0.13
	25.4	29.5	2.5	30.5	3.2
CD-02-50A CD-23-50A	2.00	2.16	0.10	2.22	0.13
	50.8	54.9	2.5	56.4	3.2

Special Use Sensors—Crack Propagation Sensors

Crack Propagation Gages provide a convenient method for indicating rate of crack propagation in a test part or structure. The CPA, CPB, and CPC patterns consist of a number of resistor strands connected in parallel. When bonded to a structure, progression of a surface crack through the gage pattern causes successive open-circuiting of the strands, resulting in an increase in total resistance. The CPA pattern incorporates 20 resistor strands; the CPB, with the same basic configuration, incorporates ten. Both series produce stepped increases in resistance with successive open-circuiting as indicated in the charts below. In applications where space permits, the CPC pattern may be preferred because of greater uniformity of increases in total resistance with successive strand fractures.

The resistor strands of the CPD pattern operate independently, each producing an open circuit when fractured. This type of gage allows the user to electrically predetermine a specific point in the fracturing process at which the instrumentation will perform some type of altering function.

GAGE CHARACTERISTICS

Crack Propagation Gages have a nominal gage thickness of only 0.0017 in (0.043 mm). The high-endurance K-alloy foil grid has a single cycle strain range of up to ±1.5% with a fatigue life of greater than 10^7 cycles at ±2000 microstrain. The standard backing is a glass-fiber-reinforced epoxy matrix. These gages are useful through the temperature range of –452°F (–269°C) to over +450°F (+230°C).

Since exact self-temperature compensation is unnecessary in crack propagation studies, all of these gages are supplied in 09 S-T-C.

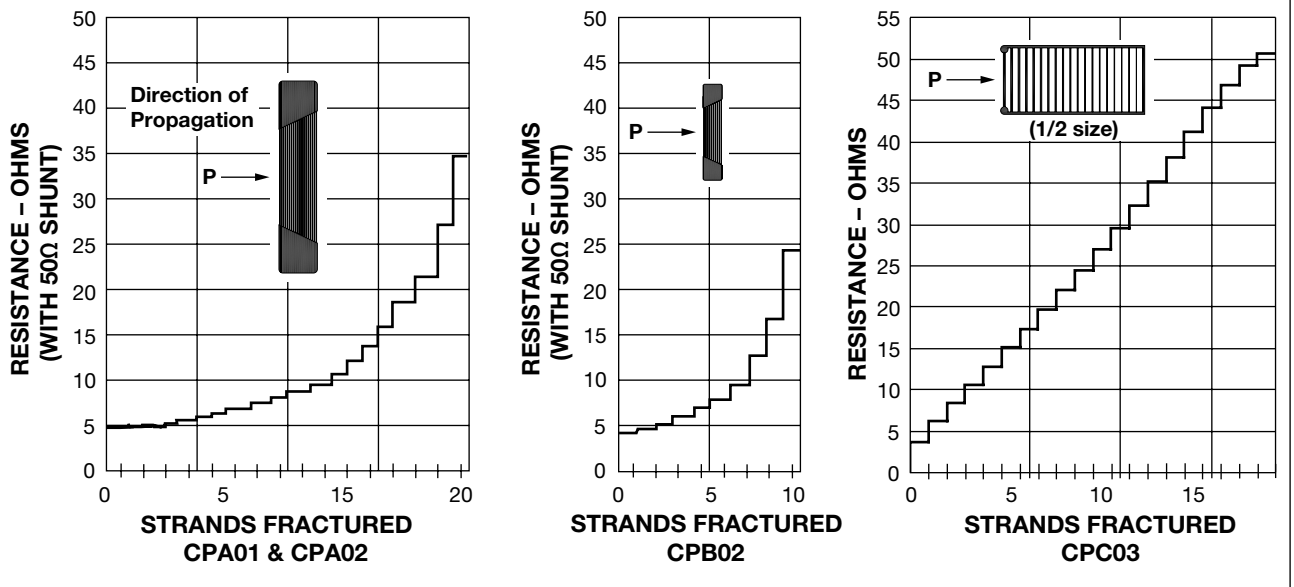
Crack Propagation Gages feature small copper pads on the tabs for ease of soldering.

ADHESIVES AND PROTECTIVE COATINGS

Crack Propagation Gages should be installed with a solvent-thinned adhesive incorporating a cure temperature of at least +300°F (+150°C). M-Bond 600 or 610 adhesives are recommended for use over the widest temperature range. Handling tape should not be applied over the grid or soldering tabs during installation. Room-temperature-curing adhesives are not recommended for use with Crack Propagation Gages.

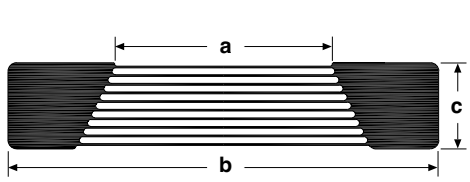
Protective coating selection considerations are similar to those for CD-Series Crack Detection Gages. Refer to appropriate datasheet for protective coating recommendations.

GAGE RESISTANCE CHARTS—See circuitry on following page

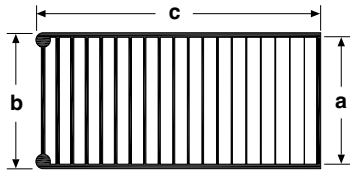


Crack Propagation Patterns

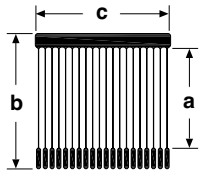
Special Use Sensors—Crack Propagation Sensors



CPA, CPB



CPC



CPD

GAGE DESIGNATION AND DESIGNATION (Pb-free RoHS COMPLIANT)	NOMINAL RESISTANCE IN OHMS	DIMENSIONS (inch / millimeter)				
		a	b	c	MATRIX Length	MATRIX Width
TK-09-CPB02-005/DP	5	0.25	0.50	0.10	0.56	0.16
		6.4	12.7	2.5	14.2	4.1
		Ten grid lines—0.010 in (0.25 mm) between centerlines.				
TK-09-CPA01-005/DP	5	0.50	1.00	0.20	1.08	0.28
		12.7	25.4	5.1	27.4	7.1
		Twenty grid lines—0.010 in (0.25 mm) between centerlines.				
TK-09-CPA02-005/DP	5	1.00	2.00	0.40	2.08	0.48
		25.4	50.8	10.2	52.8	12.2
		Twenty grid lines—0.020 in (0.51 mm) between centerlines.				
TK-09-CPC03-003/DP	3	0.70	0.75	1.57	0.80	1.62
		17.8	19.1	39.9	20.3	41.1
		Twenty grid lines—0.080 in (2.03 mm) between centerlines.				
TK-09-CPD01-NRA/DP	110	0.75	1.00	1.00	1.11	1.11
		19.1	25.4	25.4	28.1	28.1
		Twenty grid lines—0.050 in (1.27 mm) between centerlines.				

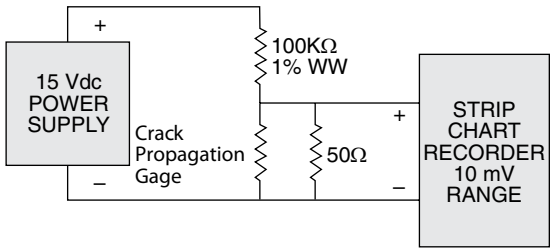
CIRCUITRY

CPA, CPB, AND CPC PATTERNS

An ohmmeter with milliohm sensitivity is a suitable readout instrument. Alternately, a strip chart recorder, connected in the manner shown at right, can be used to obtain a step curve of strands broken versus time.

CPD PATTERN

Low voltage instrumentation can be employed to shut off a motor, sound an alarm, or trigger some other type of alerting function.



Conventional strain gage instrumentation is not readily adaptable for use with Crack Propagaton Gages.