

## Technical Data

### OPTIONAL FEATURES

Micro-Measurements offers a wide selection of optional features for its general-purpose strain gages and special-purpose sensors. The addition of options to the basic gage construction usually increases the cost, but this is generally offset by the benefits. Examples are:

- Significant reduction of installation time and costs.
- Reduction of the skill level necessary to make dependable installations.
- Increased reliability of applications.

- Simplified installation of sensors in difficult locations on components or in the field.
- Increased protection, both in handling during installation and shielding from the test environment.
- Achievement of special performance characteristics.

Availability of each option varies with gage series and pattern. Standard options are noted for each sensor in the product listing.

Shown below is a summary of the optional features offered. Detailed descriptions will be found on the following pages.

### STANDARD OPTIONS

The optional features shown below are considered standard when they are listed with the gage series and pattern in the strain gage product datasheets. If the option

desired is not listed, it may be available as a special order. Please contact our Applications Engineering Department for specific information.

STANDARD OPTION <sup>1</sup>	BRIEF DESCRIPTION	AVAILABLE ON GAGE SERIES
<b>W</b>	Integral Terminals and Encapsulation	As shown in the individual strain gage datasheet
<b>E</b>	Encapsulation with Exposed Tabs	
<b>SE</b>	Solder Dots and Encapsulation	
<b>L</b>	Preattached Leads	
<b>LE</b>	Preattached Leads and Encapsulation	
<b>P</b>	Preattached Leadwire Cables and Encapsulation	
<b>P2</b>	Preattached Leadwire Cables for CEA-Series Gages	
SP20	Increases solid-copper jumper wire length to 20 in.	C2A
SP35	10 feet of preattached 30 AWG, twisted, etched Teflon® leadwires	CEA, WK
R	Individually Furnished Resistance Value	Special order required
S	Solder Dots	
W3	Special Terminals	

**Note 1:** Products with designations and options shown in **bold** are not RoHS compliant.

### SPECIAL OPTIONS

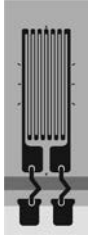
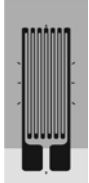
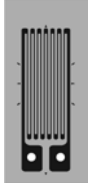
The following applies:

1. Availability will depend on the specific gage series and pattern.
2. A quotation is required and can be requested from our Customer Service Department.
3. A minimum order quantity may be required.
4. Whenever more than one Special Option is required, a custom part number will be assigned to the gage/option combination.

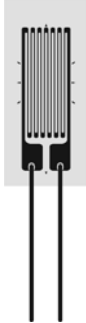
OPTION	BRIEF DESCRIPTION	AVAILABLE ON GAGE SERIES
SP11-14	Single Batch of Foil per Order	All
SP21-24	'Modulus-Compensating' Foil	EK, WK, SK, S2K
SP30	Round Ni-Clad Copper Leads	EA, WA, ED, WD, EK, WK, EP
SP60	Special Encapsulation	Only on Manganin Gages
SP61	Preattached Leads and Encapsulation	N2A, N2P

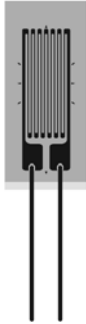
## Technical Data

### STANDARD OPTION DESCRIPTIONS

OPTION W	SERIES AVAILABILITY: EA, EP, WA, ED, WD, EK, WK	
<p><b>General Description:</b> This option provides encapsulation, and thin, printed circuit terminals at the tab end of the gage. Beryllium copper jumpers connect the terminals to the gage tabs. The terminals are 0.0014 in (0.036 mm) thick copper on polyimide backing nominally 0.0015 in (0.038 mm) thick. Option W gages are rugged and well protected, and permit the direct attachment of larger leadwires than would be possible with open-faced gages. This option is primarily used on EA-Series gages for general-purpose applications. <b>Solder:</b> +430°F (+220°C) tin-silver alloy solder joints on E-backed gages, +570°F (+300°C) lead-tin-silver alloy solder joints on W-backed gages. <b>Temperature Limit:</b> +350°F (+175°C) for E-backed gages, +450°F (+230°C) for W-backed gages. <b>Grid Protection:</b> Entire grid and part of terminals are encapsulated with polyimide. <b>Fatigue Life:</b> Some loss in fatigue life unless strain levels at the terminal location are below <math>\pm 1000\mu\epsilon</math>. <b>Size:</b> Option W extends from the soldering tab end of the gages and thereby increases gage size. With some patterns, width is slightly greater. <b>Strain Range:</b> With some gage series, notably E-backed gages, strain range will be reduced. This effect is greatest with EP gages, and Option W should be avoided with them if possible. <b>Flexibility:</b> Option W adds encapsulation, making gages slightly thicker and stiffer. Conformance to curved surfaces will be somewhat reduced. In the terminal area itself, stiffness is markedly increased. <b>Resistance Tolerance:</b> On E-backed gages, resistance tolerance is normally doubled.</p>		
OPTION E	SERIES AVAILABILITY: EA, ED, EK, EP	
<p><b>General Description:</b> Option E consists of a protective encapsulation of polyimide film approximately 0.001 in (0.025 mm) thick. This provides ruggedness and excellent grid protection, with little sacrifice in flexibility. Soldering is greatly simplified since the solder is prevented from tinning any more of the gage tab than is deliberately exposed for lead attachment. Option E protects the grid from fingerprints and other contaminating agents during installation and, therefore, contributes significantly to long-term gage stability. Heavier leads may be attached directly to the gage tabs for simple static load tests. Supplementary protective coatings should still be applied after lead attachment in most cases. <b>Temperature Limit:</b> No degradation. <b>Grid Protection:</b> Entire grid and part of tabs are encapsulated. <b>Fatigue Life:</b> When gages are properly wired with small jumpers, maximum endurance is easily obtained. <b>Size:</b> Gage size is not affected. <b>Strain Range:</b> Strain range of gages will be reduced because the additional reinforcement of the polyimide encapsulation can cause bond failure before the gage reaches its full strain capability. <b>Flexibility:</b> Option E gages are almost as conformable on curved surfaces as open-faced gages, since no internal leads or solder are present at the time of installation. <b>Resistance Tolerance:</b> Resistance tolerance is normally doubled when Option E is selected.</p>		
OPTION SE	SERIES AVAILABILITY: EA, ED, EK, EP	
<p><b>General Description:</b> Option SE is the combination of solder dots on the gage tabs with a 0.001 in (0.025 mm) polyimide encapsulation layer that covers the entire gage. The encapsulation is removed over the solder dots providing access for lead attachment. These gages are very flexible, and well protected from handling damage during installation. Option SE is primarily intended for small gages that must be installed in restricted areas, since leadwires can be routed to the exposed solder dots from any direction. The option does not increase overall gage dimensions, so the matrix may be field-trimmed very close to the actual pattern size. Option SE is sometimes useful on miniature transducers of medium- or low-accuracy class, or in stress analysis work on miniature parts. <b>Solder:</b> +570°F (+300°C) lead-tin-silver alloy. To prevent loss of long-term stability, gages with Option SE must be soldered with noncorrosive (rosin) flux, and all flux residue should be carefully removed with M-LINE Rosin Solvent after wiring. Protective coatings should then be used. <b>Temperature Limit:</b> No degradation. <b>Grid Protection:</b> Entire gage is encapsulated. <b>Fatigue Life:</b> When gages are properly wired with small jumpers, maximum endurance is easily obtained. <b>Size:</b> Gage size is not affected. <b>Strain Range:</b> Strain range of gages will be reduced because the additional reinforcement of the polyimide encapsulation can cause bond failure before the gage reaches its full strain capability. <b>Flexibility:</b> Option SE gages are almost as conformable on curved surfaces as open-faced gages. <b>Resistance Tolerance:</b> Resistance tolerance is normally doubled when Option SE is selected.</p>		

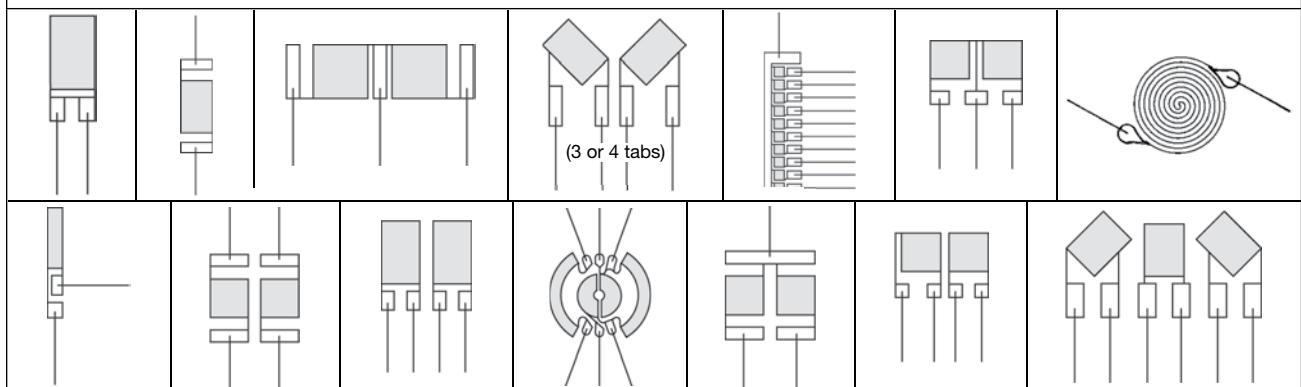
## Technical Data

OPTION L	SERIES AVAILABILITY: EA, ED, EK, EP	
<p><b>General Description:</b> Option L is the addition of soft copper lead ribbons to open-faced polyimide-backed gages. The use of this type of ribbon results in a thinner and more conformable gage than would be the case with round wires of equivalent cross section. At the same time, the ribbon is so designed that it forms almost as readily in any desired direction. <b>Leads:</b> Nominal ribbon size for most gages is 0.012 wide x 0.004 in thick (0.30 x 0.10 mm). Leads are approximately 0.8 in (20 mm) long. <b>Solder:</b> +430°F (+220°C) tin-silver alloy. <b>Temperature Limit:</b> +400°F (+200°C). <b>Fatigue Life:</b> Fatigue life will normally be degraded by Option L. This occurs primarily because the copper ribbon has limited cyclic endurance. When it is possible to carefully dress the leads so that they are not bonded in a high strain field, the performance limitation will not apply. Option L is not often recommended for very high endurance gages such as the ED Series. <b>Size:</b> Matrix size is unchanged. <b>Strain Range:</b> Strain range will usually be reduced by the addition of Option L. <b>Flexibility:</b> Gages with Option L are not as conformable as standard gages. <b>Resistance Tolerance:</b> Not affected.</p>		


OPTION LE	SERIES AVAILABILITY: EA, ED, EK, EP	
<p><b>General Description:</b> This option provides the same conformable soft copper lead ribbons as used in Option L, but with the addition of a 0.001 in (0.025 mm) thick encapsulation layer of polyimide film. The encapsulation layer provides excellent protection for the gage during handling and installation. It also contributes greatly to environmental protection, though supplementary coatings are still recommended for field use. Gages with Option LE will normally show better long-term stability than open-faced gages which are “waterproofed” only after installation. A good part of the reason for this is that the encapsulation layer prevents contamination of the grid surface from fingerprints or other agents during handling and installation. The presence of such contaminants will cause some loss in gage stability, even though the gage is subsequently coated with protective compounds. <b>Leads:</b> Nominal ribbon size for most gages is 0.012 wide x 0.004 in thick (0.30 x 0.10 mm) copper ribbons. Leads are approximately 0.8 in (20 mm) long. <b>Solder:</b> +430°F (+220°C) tin-silver alloy. <b>Temperature Limit:</b> +400°F (+200°C). <b>Grid Protection:</b> Entire gage is encapsulated. A short extension of the backing is left uncovered at the leadwire end to prevent contact between the leadwires and the specimen surface. <b>Fatigue Life:</b> Fatigue life will normally be degraded by Option LE. This occurs primarily because the copper ribbon has limited cyclic endurance. Option LE is not often recommended for very high endurance gages such as the ED Series. <b>Size:</b> Matrix size is unchanged. <b>Strain Range:</b> Strain range will usually be reduced by the addition of Option LE. <b>Flexibility:</b> Gages with Option LE are not as conformable as standard gages. <b>Resistance Tolerance:</b> Resistance tolerance is normally doubled by the addition of Option LE.</p>		

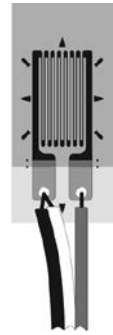
### LEADWIRE ORIENTATION FOR OPTIONS L AND LE

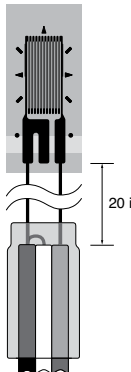
These illustrations show the standard orientation of leadwires relative to the gage pattern geometry for Options L and LE. The general rule is that the leads are parallel to the longest dimension of the pattern. The illustrations also apply to leadwire orientation for WA-, WK- and WD-Series gages, when the pattern shown is available in one of these series.



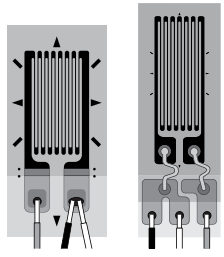
## Technical Data

OPTION P	SERIES AVAILABILITY: EA, N2A	
<p><b>General Description:</b> Option P is the addition of preattached leadwire cables to many patterns of EA Series strain gages. Encapsulation seals small “jumper” leadwires at gage end, and cable insulation protects solder joints at cable end. Option P virtually eliminates need for soldering during gage installation. <b>Leads:</b> A pair of 1 in (25 mm) <i>M-LINE</i> 134-AWP (solid copper, polyurethane enamel) single conductor “jumper” leadwires. <b>Cable:</b> 10 ft (3.1 m) of color-coded, flat, three-conductor 26-gauge (0.404 mm dia.), stranded, tinned copper with vinyl insulation (similar to M-LINE 326-DFV). Solder: +430°F (+220°C) tin-silver alloy solder joints, “jumper” to gage. Cable conductors and “jumpers” joined with +361°F solder beneath cable insulation. Exposed leadwires on unattached end of cable are pretinned for ease of hookup. <b>Temperature Limit:</b> –60° to +180°F (–50° to +80°C); limited by vinyl insulation on cable. <b>Grid Encapsulation:</b> Entire grid and tabs are encapsulated. <b>Fatigue Life:</b> Fatigue life will normally be degraded by Option P, primarily because the copper “jumper” wires have limited cyclic endurance. <b>Pattern Availability:</b> Most EA-Series single-grid patterns that are 0.062 in (1.5 mm) or greater gage length, with parallel solder tabs on one end of the grid, and suitable for encapsulation. (Consult our Applications Engineering Department for availability of Option P on other gage series/patterns, and for nonstandard cable lengths.) <b>Size:</b> Matrix size is unchanged. <b>Strain Range:</b> Strain range will usually be reduced by the addition of Option P. <b>Flexibility:</b> E-backed gages with Option P are not as conformable as standard gages. <b>Resistance Considerations:</b> Each conductor of the cable has a nominal resistance of 0.04 ohm/ft (0.13 ohm/m). Gage resistance is measured at gage tabs. <b>Gage Factor:</b> Gage factor is determined for gages without preattached cable. <b>Resistance Tolerance:</b> Resistance tolerance is normally ±0.5% for single-element gages, and ±0.6% for multiple-grid gages.</p>		

OPTION P2	SERIES AVAILABILITY: CEA	
<p><b>General Description:</b> Option P2 is the addition of preattached leadwire cables to CEA-Series strain gages. Option P2 virtually eliminates need for soldering during gage installation. <b>Cable:</b> 10 ft (3.1 m) of color-coded, flat, three-conductor 30-gauge (0.255 mm), stranded, tinned copper with vinyl insulation (similar to <i>M-LINE</i> 330-DFV). Solder: +361°F (+180°C) tin-lead alloy solder joints. Exposed leadwires on unattached end of cable are pretinned for ease of hookup. <b>Temperature Limit:</b> –60° to +180°F (–50° to +80°C); limited by vinyl insulation on cable. <b>Grid Encapsulation:</b> Entire grid is encapsulated. (Solder tabs are not encapsulated.) <b>Fatigue Life:</b> Fatigue life will normally be unchanged by Option P2. <b>Pattern Availability:</b> Most CEA-Series single- and multiple-grid patterns. <b>Size:</b> Matrix size is unchanged. <b>Strain Range:</b> Standard for CEA-Series gages. <b>Flexibility:</b> No appreciable increase in stiffness. <b>Resistance Considerations:</b> Each conductor of the cable has a nominal resistance of 0.1 ohm/ft (0.35 ohm/m). Gage resistance is measured at gage tabs. <b>Gage Factor:</b> Gage factor is determined for gages without preattached cable. <b>Resistance Tolerance:</b> Not affected.</p>		

OPTION SP20	SERIES AVAILABILITY: C2A	
<p><b>General Description:</b> This option provides pre-attached instrument cables which have been optimized for Printed Circuit Board (PCB) testing. The jumper wire between gage and instrument cable is the same 34 AWG single conductor, polyurethane insulated copper wire as the standard C2A-Series gages, but the length has been increased with this option to 20 in (0.5 m). This length of wire permits ease of routing the wires on the PCB and through the seal on vacuum test fixtures. The jumper wire transitions to the C2A-Series standard 10-ft (3-m) 26-AWG stranded instrument cable. On multi-grid strain gages, the instrument cable is numbered to match the grid numbering to which the cable is attached. This option does not change any other specifications of the standard C2A-Series. <b>Temperature range:</b> –60°F to +180°F (–50°C to +80°C).</p>		

## Technical Data

OPTION SP35	SERIES AVAILABILITY: CEA, WK	
<p><b>General Description:</b> Option SP35 provides 10 feet of 30 AWG, twisted, etched Teflon® leadwires (330-FTE) preattached to applicable CEA and WK series gages. This allows for a higher temperature rating compared to similar vinyl insulated preattached leaded gages (Option P, Option P2 and C2A series). CEA series gages will use our +430°F (+220°C) tin-silver alloy solder joints. WK series gages will have the standard Option W or W3 added as appropriate for the gage geometry (see Option W or W3 specifications), and will use our +450°F (+232°C) tin-alloy solder. <b>Temperature Limit:</b> +350°F (+177°C) for CEA gages, +400°F (+204°C) for WK gages. <b>Grid Protection:</b> Both the CEA and WK versions have an encapsulating layer over the grids. This helps to protect the sensing grids during the installation. <b>Fatigue Life:</b> The fatigue life will be the same as standard CEA series fatigue tables. While the WK series is slightly reduced (same as adding option W to the WK series gages). <b>Size:</b> The CEA versions will have the same dimensions as the parent gage. The WK versions with the option W will add to the matrix length dimension of the parent gage (varies slightly by pattern). <b>Strain Range:</b> CEA and WK with Option W strain range should be unaffected. <b>Flexibility:</b> The flexibility will be slightly affected by the Teflon as it is stiffer than a typical vinyl insulated wire of the same AWG. <b>Resistance Tolerance:</b> The resistance tolerance is increased to ±0.5% for planar gages and ±0.6% for stacked gages.</p>		 <p>CEA WK</p>

OPTION R	SERIES AVAILABILITY: ALL	
<p>The resistance of each gage is separately measured with an accurate digital ohmmeter and the exact value is recorded on the transparent folder that contains the gage. Resistance is given to the nearest 0.01 ohm, and the overall absolute accuracy is ±0.05% or better for gages of 60-ohm or greater resistance; thus allowing the user to select gages very closely matched in resistance from the total group of gages purchased. The necessary order quantity can be estimated for any matching requirements by assuming an even distribution of resistance values through the tolerance band, which is unchanged. Note: This feature is less effective for open-faced gages without leadwires or solder dots because of the uncertainty in leadwire position on the tabs with user-installed leadwires.</p>		

OPTION S	SERIES AVAILABILITY: EA, ED, EP	
<p>Precisely formed hemispherical solder dots are installed in the center of each solder tab. This feature facilitates soldering by providing a pretinned area for lead attachment. A film of adhesive or appropriate protective coating is normally applied over the gage before soldering, and this prevents the solder from spreading on the tab when leads are reinstalled. After the top coating has been cured, the solder dot is easily exposed for soldering by scraping with a scalpel or by simply post-tinning. Solder used for the dots is +570°F (+300°C) lead-tin-silver alloy. Dot diameter varies somewhat with tab size but is usually about 0.02 in (0.5 mm). Temperature limit for this feature is +500°F (+260°C). Because the solder dots result in much greater soldering uniformity, the variable fatigue life factor, which results from excessive solder on the gage tabs, is eliminated. Solder dots are small and interfere very little with flexibility and conformability of strain gages.</p>		

OPTION W3	SERIES AVAILABILITY: EA, EP, WA, ED, EK, WK	
<p>This feature is identical to Standard Catalog Option W, except that the printed circuit wiring terminals have three solder pads, two of which are electrically common. These terminals facilitate the connection of three-conductor cable for single active gage circuits using the three-wire lead system. Many of the gage patterns which are marked as available with Option W in the General-Purpose Strain Gage Listings are available with three-pad terminals.</p>		

## Technical Data

### SPECIAL OPTION DESCRIPTIONS

OPTIONS SP11, 12, 13, 14	SERIES AVAILABILITY: ALL
<p>These options specify that all sensors are supplied from a single process batch and lot of foil. They are primarily used to obtain the closest possible matching of performance characteristics from a large group of gages.</p> <p>SP11: One sensor type from a single batch of processed foil            SP12: Two sensor types from a single batch of processed foil            SP13: Three sensor types from a single batch of processed foil            SP14: Four sensor types from a single batch of processed foil</p>	

OPTIONS SP21, 22, 23, 24		SERIES AVAILABILITY: EK, WK, SK, S2K		
This option series provides strain gages with 'Modulus Compensation' features through use of specially modified lots of K alloy. The 'Mod-Comp' match will be quite close for the materials specified, although thermal output characteristics may not be ideal.				
When force-responsive type transducers are manufactured from the metals listed, and the appropriate Special Option gages are used, the result is a transducer which demonstrates very little span change with temperature.	NOMINAL GAGE FACTOR SLOPE			
	Option	%/100°F	%/100°C	For Use On
	SP21	-1.50	-2.70	Stainless Steels
	SP22	-2.35	-4.25	Aluminum
	SP23	-1.25	-2.25	Tool Steels
	SP24	-1.35	-2.45	Tool Steels

OPTION SP30	SERIES AVAILABILITY: EA, WA, ED, WD, EK, WK, EP
<p><b>General Description:</b> This option consists of special leadwires, either added to open-faced gages, or substituted for lead ribbons on WA-, WK-, or WD-Series gages. The wire is very formable, and may be spot-welded or soldered to main leadwires. The primary advantages are easy handling and excellent resistance to oxidation at the highest temperatures the gages can withstand. <b>Leads:</b> 0.8 in (20 mm) long nickel-clad copper wires 0.005 in (0.13 mm) diameter. For some gage types, usually small patterns, wire size must be reduced to 0.0035 in (0.09 mm) diameter. <b>Solder:</b> EA-, ED-, EK-, EP-Series gages: +430°F (+220°C) tin-silver alloy; WA-Series gages: +570°F (+300°C) lead-tin-silver alloy; WK- and WD-Series gages: +770°F (+410°C) solder. <b>Temperature Limit:</b> E-backed gages: +400°F (+200°C); WA-Series gages: +500°F (+260°C); WKand WD-Series gages: +750°F (+400°C). <b>Fatigue Life:</b> Fatigue life will normally be degraded by Option SP30. This occurs primarily because the copper wire has limited cyclic endurance. Option SP30 should therefore not be used when best fatigue life is required, unless the tab area of the gage is in a low strain area (<math>\pm 1000\mu\epsilon</math> or less). Loss of cyclic endurance is experienced particularly with WA-, WK-, and WD-Series gages. <b>Size:</b> Matrix size is unchanged. On W-backed gages, SP30 leads are substituted for the normal beryllium copper ribbon leads. One wire lead per tab is supplied. <b>Strain Range:</b> Option SP30 normally reduces the strain range of E-backed gages but does not similarly affect W-backed gages. <b>Flexibility:</b> E-backed gages with SP30 leads are not as conformable as standard gages. W-backed gages are not affected. <b>Resistance Tolerance:</b> Not affected.</p>	

OPTION SP60	SERIES AVAILABILITY: ONLY ON MANGANIN GAGES
<p>SP60 is an encapsulation option available for L-backed manganin gages. The end of each tab includes a thin copper coating that is left exposed for lead attachment.</p>	



## Technical Data

OPTION SP61	SERIES AVAILABILITY: N2A, N2P
<p><b>General Description:</b> This option provides conformable, soft copper lead ribbons and a 0.0005 in (0.013 mm) thick encapsulation layer of polyimide film. The encapsulation layer provides excellent protection for the gage during handling and installation. It also contributes greatly to environmental protection, though supplementary coatings are still recommended for field use. Gages with Option SP61 will normally show better long-term stability than open-faced gages which are “waterproofed” only after installation. A good part of the reason for this is that the encapsulation layer prevents contamination of the grid surface from fingerprints or other agents during handling and installation. The presence of such contaminants will cause some loss in gage stability, even though the gage is subsequently coated with protective compounds. <b>Leads:</b> 0.010 wide x 0.002 in thick (0.25 x 0.05 mm) soft copper ribbons. Leads are approximately 0.8 in (20 mm) long. <b>Solder:</b> +430°F (+220°C) tin-silver alloy. The solder is confined to small, well-defined areas at the end of each ribbon. <b>Temperature Limit:</b> +400°F (+200°C). <b>Grid Protection:</b> Entire gage is encapsulated. A short extension of the backing is left uncovered at the leadwire end to prevent contact between the leadwires and the specimen surface. <b>Size:</b> Matrix size is unchanged. <b>Strain Range:</b> Strain range will usually be reduced by the addition of Option SP61. <b>Flexibility:</b> Gages with Option SP61 are not as conformable as standard gages. <b>Resistance Tolerance:</b> Resistance tolerance is normally doubled by the addition of Option SP61.</p>	

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