Technical Data

GAGE SERIES

All Vishay Micro-Measurements strain gages incorporate precision foil grids mounted on organic backing materials. The strain-sensing alloys and backing materials cannot be arbitrarily combined in specifying a gage type. Instead, a selection must be made from among the available gage systems, or series, where each series generally incorporates special design or construction features, as well as a specific combination of alloy and backing material.

Descriptions of all standard gage series are given on the following pages, along with performance specifications and application notes. The information includes, in each case, the alloy and backing combination employed, as well as the principal construction features common to the series. The allowable strain range is specified, and operating temperature ranges are recommended for different types of applications.

The plots of cyclic strain level versus number of cycles shown for each series represent general guidelines for the nominal fatigue characteristics. This data is a function of gage size with the upper curve indicative of larger gage patterns, and the lower curve of smaller gage patterns. Since the fatigue life of a strain gage is subject to special interpretation, reference should be made to Vishay Micro-Measurements Tech Note TN-508, Fatigue Characteristics of Vishay Micro-Measurements Strain Gages, for a full understanding of the plotted data.

The fatigue curves on the following pages correspond to fully reversed strain levels. They can also be applied, approximately, to unidirectional strains and to combinations of mean and variable strains by derating the peak-to-peak amplitude by 10%. As an example, a fully reversed strain range of ±1500με is approximately equivalent in gage fatigue damage to strain levels of:

0 to +2700με

0 to –2700με

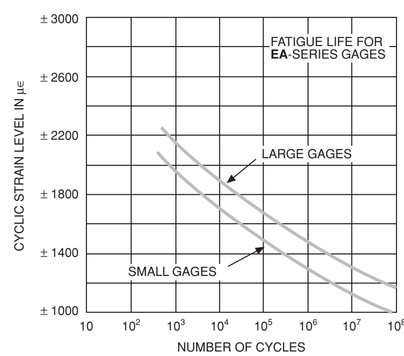
–200 to +2500με

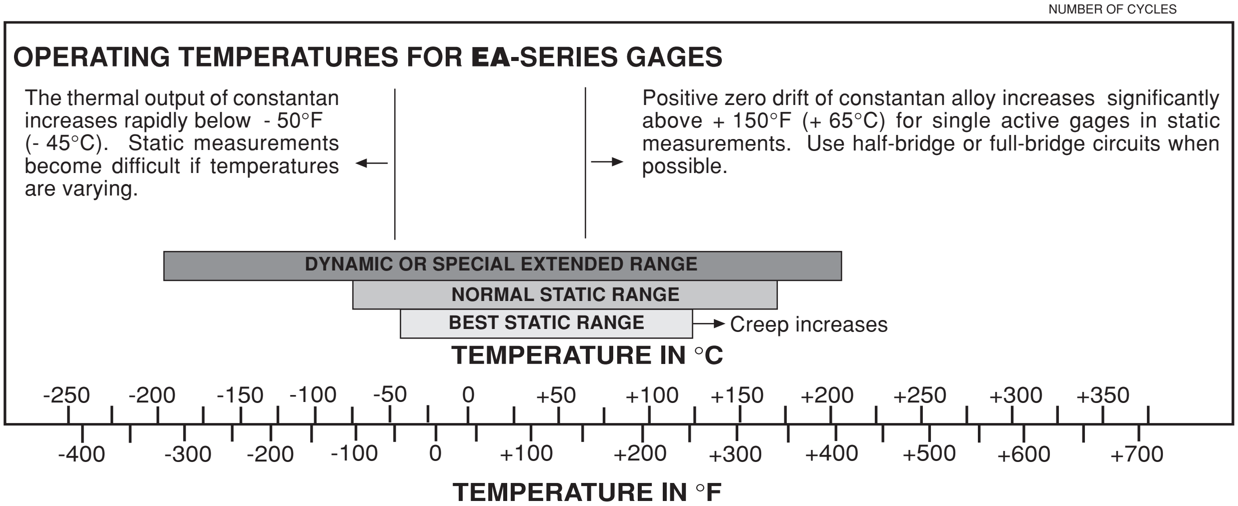
However, a mean strain which increases in the tensile direction during cycling will lead to much earlier failure.

It must be noted that all performance specifications for strain gages are nominal, since the behavior of a particular gage may be modified by installation or application circumstances. Moreover, the specifications apply primarily to gages of 0.125 in (3 mm) gage length and larger, and without optional features, unless otherwise indicated.

EA Series

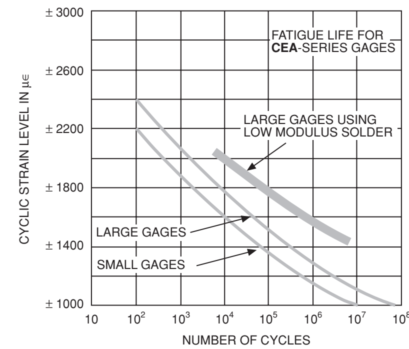
EA-Series constantan gages are widely used in general-purpose experimental stress analysis applications. The basic gage is of open-faced construction on a 0.001 in (0.025 mm) tough, flexible cast polyimide backing. The strength and heat resistance of this backing provide excellent handling and performance qualities. This series is available in the widest range of patterns and will usually be the lowest in cost for a particular pattern design. A large number of options may be obtained for EA-Series gages, covering various forms of lead attachment and protective encapsulation. The backing is treated for strong bond formation with all standard strain gage adhesives. Strain limits are approximately ±5% for gages of 1/8 in (3 mm) or greater gage length and ± 3% for smaller sizes.





CEA Series

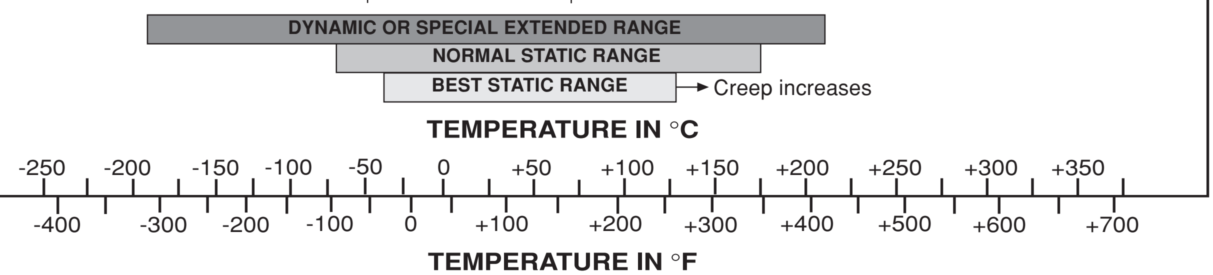
CEA-Series gages are the most widely accepted for use in general-purpose experimental stress analysis applications in the world today. These polyimide encapsulated constantan gages feature large, rugged, copper-coated tabs. This construction provides optimum capability for attaching leadwires directly to the tabs, eliminating the need for separate terminals. In most applications, the CEA Series is preferred over the EA Series with options such as E, L, LE and W. Nominal single-plane gage thickness is 0.0027 in (0.069 mm); stacked rosettes, 0.0039 in (0.099 mm). The extremely tough but flexible cast polyimide carrier can be contoured to almost any radius. Strain limits are approximately ±5% (50 000µ∊) for gage lengths 1/8 in (3 mm) or greater, and ±3% for smaller sizes.



OPERATING TEMPERATURES FOR CEA-SERIES GAGES

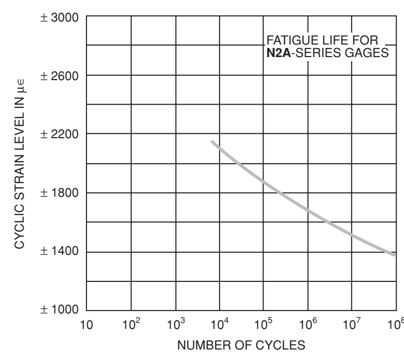
The thermal output of constantan increases rapidly below -50°F (-45°C). Static measurements become difficult if temperatures are varying.

Positive zero drift of constantan alloy increases significantly above +150°F (+65°C) for single active gages in static measurements. Use half-bridge or full-bridge circuits when possible. Stacked rosettes are limited to a maximum operating temperature of + 150°F (+65°C).



N2A Series

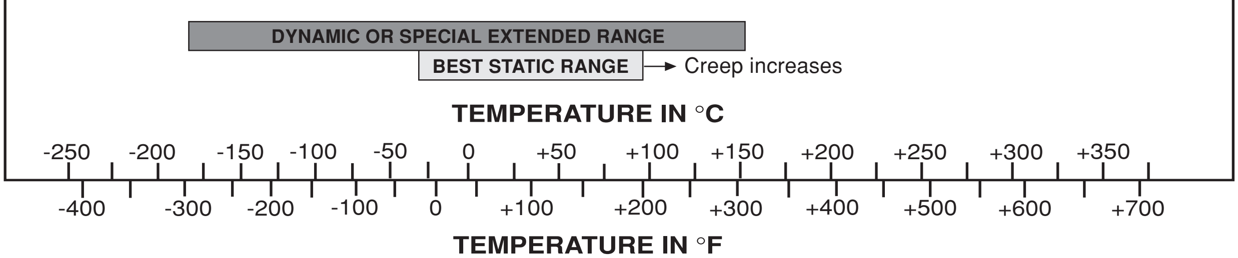
N2A-Series gages are open-faced constantan on a special, thin, laminated polyimide backing. The backing is very flexible and tough. Backing thickness is approximately 0.0008 in (0.020 mm), and the backing has been specially treated for optimum bond formation. The N2A Series has an elongation capability of approximately ±3%. These gages are intended for use in elastic strain fields. This series is primarily available for certain large gage patterns because its flatness eases handling.



OPERATING TEMPERATURES FOR N2A-SERIES GAGES

The thermal output of constantan increases rapidly below -50°F (-45°C). Static measurements become difficult if temperatures are varying.

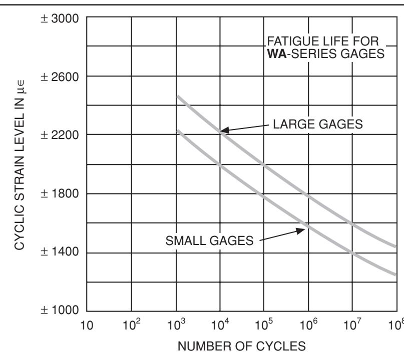
Positive zero drift of constantan alloy increases significantly above +150°F (+65°C) for single active gages in static measurements. Use half-bridge or full-bridge circuits when possible.



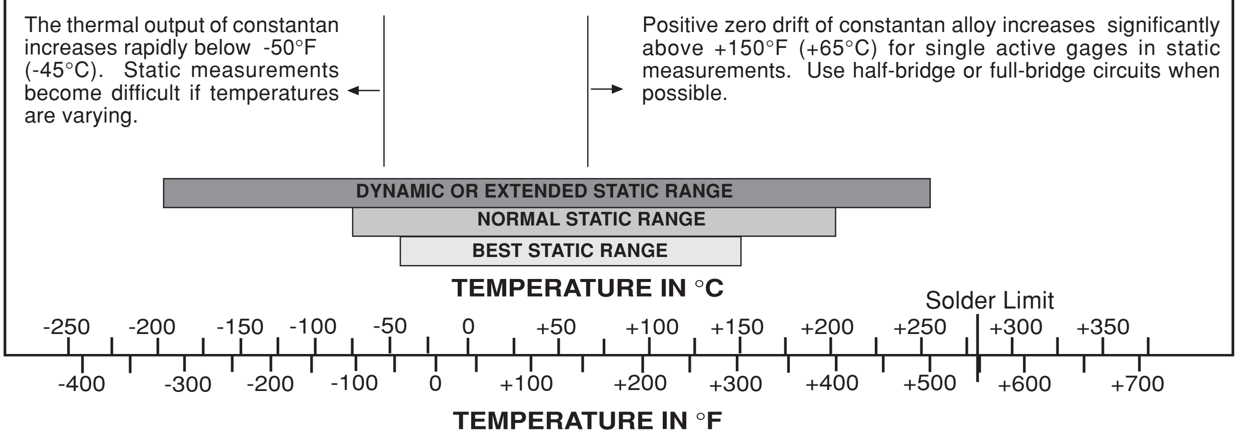
Technical Data

WA Series

WA-Series gages are fully encapsulated constantan, equipped with integral, high-endurance beryllium copper leadwires. The backing and encapsulation matrix consists of a high-temperature epoxy-phenolic resin system reinforced with glass fibers. Overall gage thickness is approximately 0.0028 in (0.071 mm). The WA construction provides a gage that is strong and easy to handle, though not as flexible as the EA type. The backing is treated for strong bond formation with all standard strain gage adhesives. The strain range is limited to approximately ±1 to 2% by the hard, creep-resistant matrix. WA-Series gages are primarily intended for high accuracy measurements over wider temperature ranges and in more difficult environments than other forms of constantan gages. Option W is available on some WA-Series gages, but will restrict the fatigue life to some extent. Heat-curing adhesives such as M-Bond 600 or 610 are recommended when full-temperature-range capabilities are required.

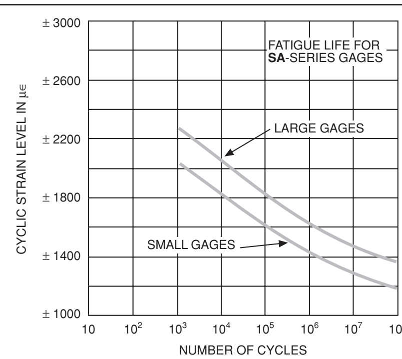


OPERATING TEMPERATURES FOR WA-SERIES GAGES

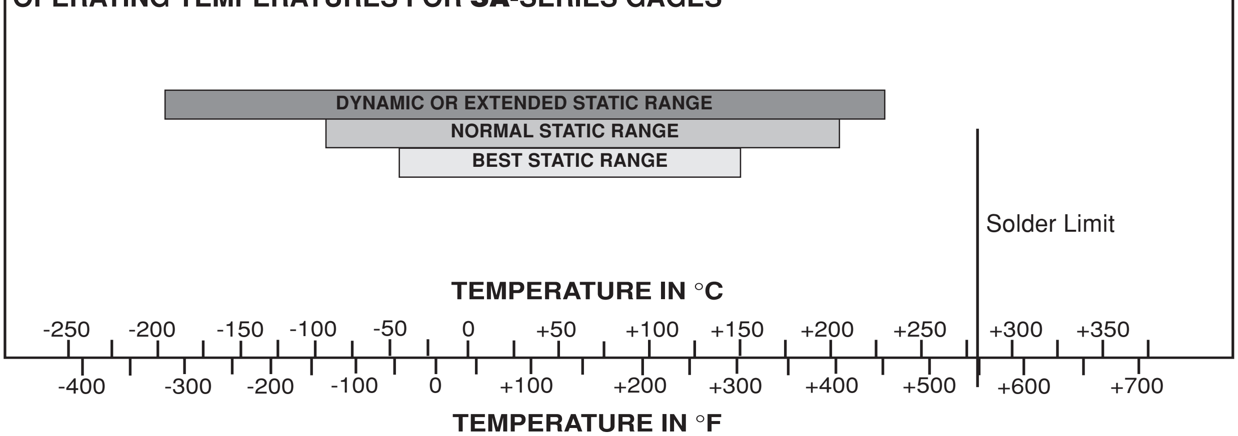


SA Series

SA-Series gages are fully encapsulated constantan similar to WA-Series gages, but with solder dots instead of leadwires. The matrix is somewhat thinner than the WA type, with an overall gage thickness of approximately 0.002 in (0.05 mm). The solder is a lead-tin-silver alloy which melts at approximately +570°F (+300°C). These gages are typically used in stress analysis applications when mounting space is restricted. The solder dot connections permit small jumper wires to be attached from any direction, and the matrix can be field-trimmed very close to the pattern since no integral leadwires are involved. Because of the exposed solder dots, SA-Series gages are not as well protected in extreme environments as the WA type. The WA Series is superior in maximum temperature capability and fatigue life. No leadwire options are available in this series. Strain limits are approximately ±1 to 2%. Heat-curing adhesives such as M-Bond 600 or 610 are recommended for full-range performance.



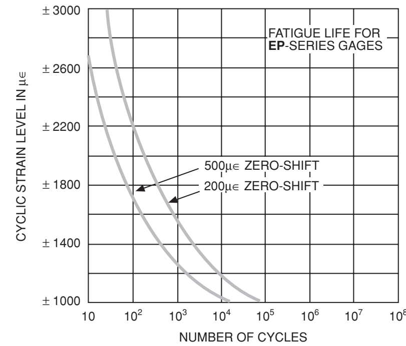
OPERATING TEMPERATURES FOR SA-SERIES GAGES



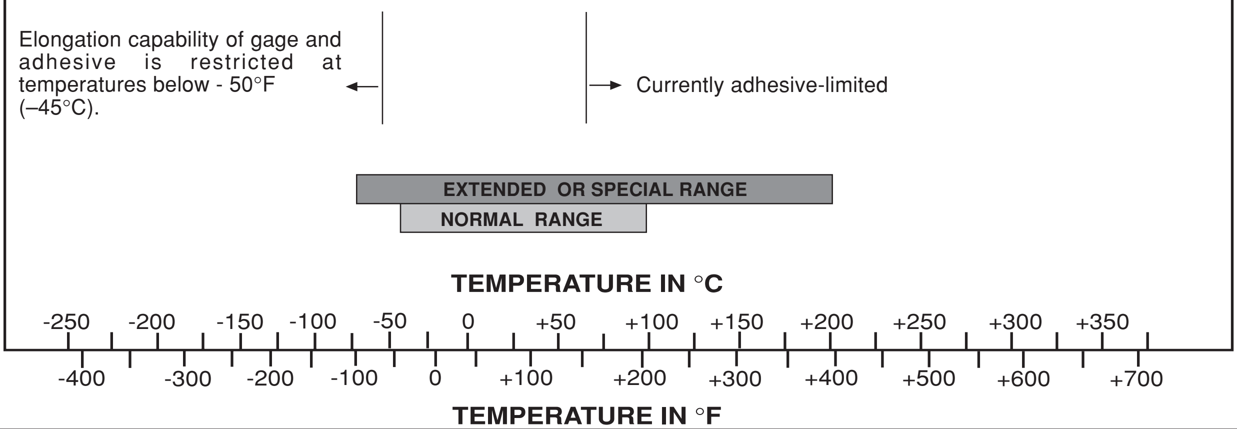
Technical Data

EP Series

EP-Series gages are specifically designed for use in the measurement of large strains, >3-5%. The basic gage is of open-faced construction on a 0.001 in (0.025 mm) tough, flexible, high-elongation cast polyimide backing. The sensing grid is a special grade of fully annealed constantan foil for maximum ductility. This gage series is available in 08 and 40 compensations, for use on metals and plastic, respectively. Exact values of self-temperature compensation are usually not important in post-yield work because the thermal output error is very small compared to the large strain levels being measured. Strain limits for EP-Series gages are approximately ±20% for gages of 1/8 in (3 mm) or greater gage length, and ±10% for smaller sizes. Optional features generally degrade elongation capabilities. EP-Series gages can be obtained on special order with all options offered on the equivalent EA-Series pattern. M-Bond A-12 adhesive is recommended for full elongation capability.

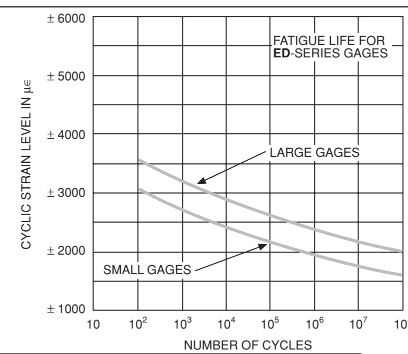


OPERATING TEMPERATURES FOR EP-SERIES GAGES

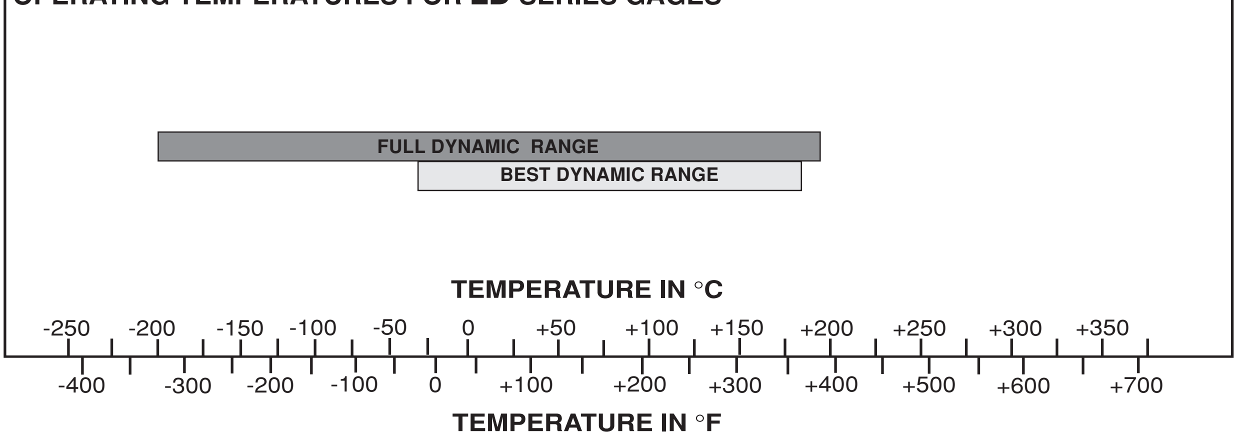


ED Series

ED-Series gages are used in general-purpose dynamic-only strain measurement. They are open-faced construction on a thin, 0.001 in (0.025 mm), tough, flexible cast polyimide backing. The isoelastic grid alloy has a high strain sensitivity, and gage factor is approximately 3.2. The extremely high temperature coefficient of resistance [thermal output of approximately 80$\mu\epsilon$/°F (145$\mu\epsilon$/°C)] does not normally permit static measurements to be made with isoelastic gages. The outstanding features of the ED Series are excellent handling properties, high flexibility, good fatigue life, and relatively low cost. A wide range of options is available, covering various forms of lead attachment and protective encapsulation. Leadwires must be handled and installed with care to avoid reduction in fatigue life. All isoelastic gages tend to generate error signals in magnetic fields, since the alloy is both magnetic and magnetostrictive. Strain limits for ED gages are approximately ±1%, but increasing nonlinearity above ±5000$\mu\epsilon$ normally restricts this type of gage to measurement of dynamic, elastic strain levels.



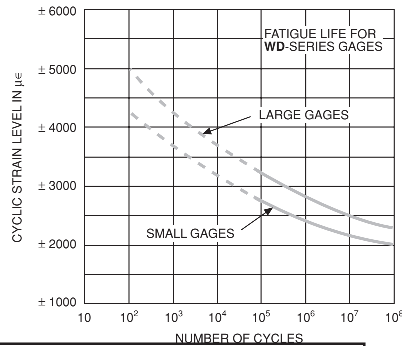
OPERATING TEMPERATURES FOR ED-SERIES GAGES

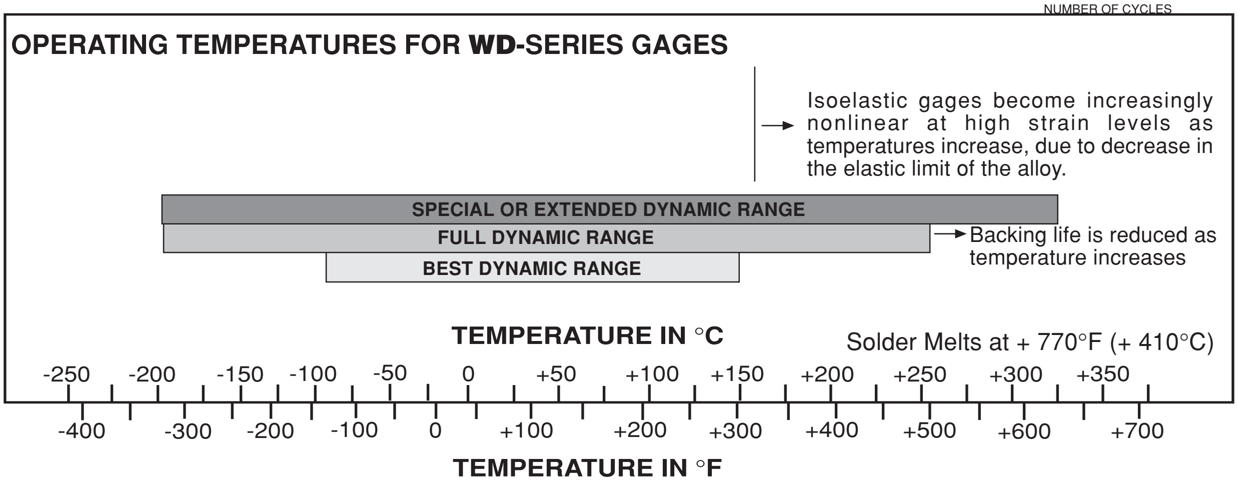


Technical Data

WD Series

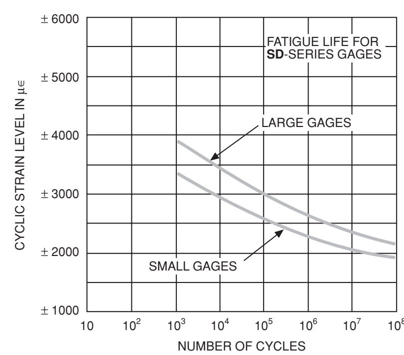
WD-Series gages are fully encapsulated isoelastic alloy with integral, high-endurance beryllium copper leadwires. The matrix is a high-temperature epoxy-phenolic resin system reinforced with glass fibers. Overall gage thickness is approximately 0.0028 in (0.071 mm). These gages are excellent in dynamic strain measurement over wide temperature ranges. The WD Series is considerably less flexible than the ED type, but is useful over a wider temperature range and in more severe environments. The encapsulation matrix and integral high-endurance leadwires provide higher fatigue life than ED-Series gages. No standard options are available. Strain limits for WD-Series gages are approximately ±5000με. Heat-curing adhesives such as M-Bond 600 or 610 will provide best overall performance.

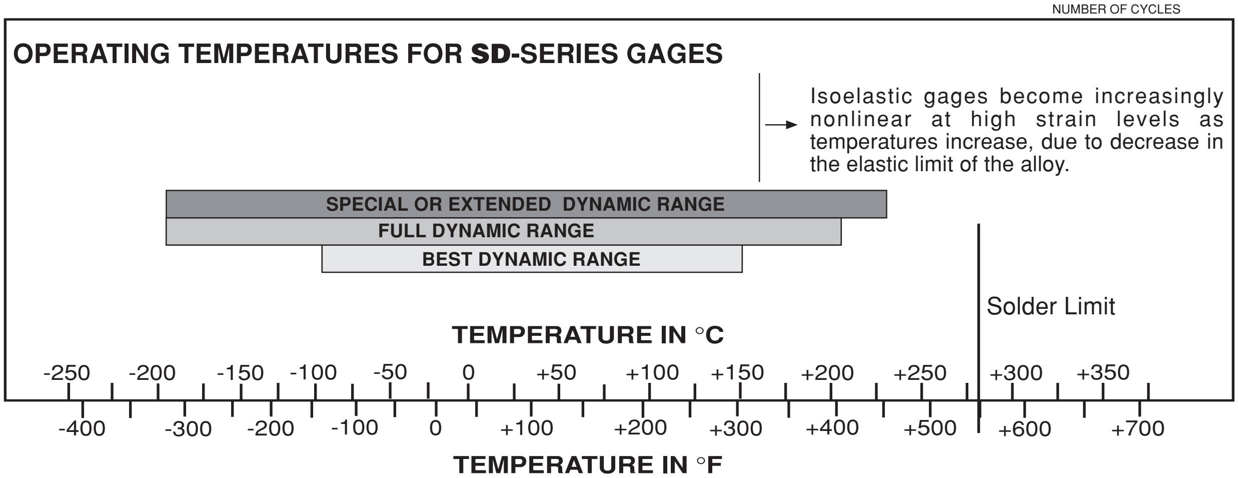




SD Series

SD-Series gages are fully encapsulated isoelastic alloy similar to WD-Series gages, but with solder dots instead of leadwires. The matrix is somewhat thinner than the WD type, with an overall thickness of approximately 0.002 in (0.05 mm). The solder is a lead-tin-silver alloy which melts at +570°F (+300°C). The SD Series is primarily used over the WD type when the matrix must be trimmed very close to the gage pattern because of restricted mounting space. There are no integral leadwires to restrict trimming of the lower edge of the matrix, and attachment wires can be routed to the solder dot tabs from any direction. Both maximum operating temperature and fatigue life are somewhat lower than in the WD Series because of the exposed solder dots. Strain limits are approximately ±1%, but nonlinearity becomes increasingly severe above ±5000με. Heat-curing adhesives such as M-Bond 600 or 610 will provide best overall performance.

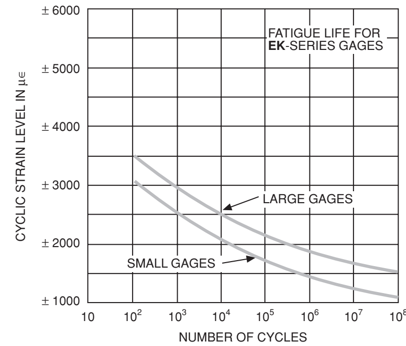




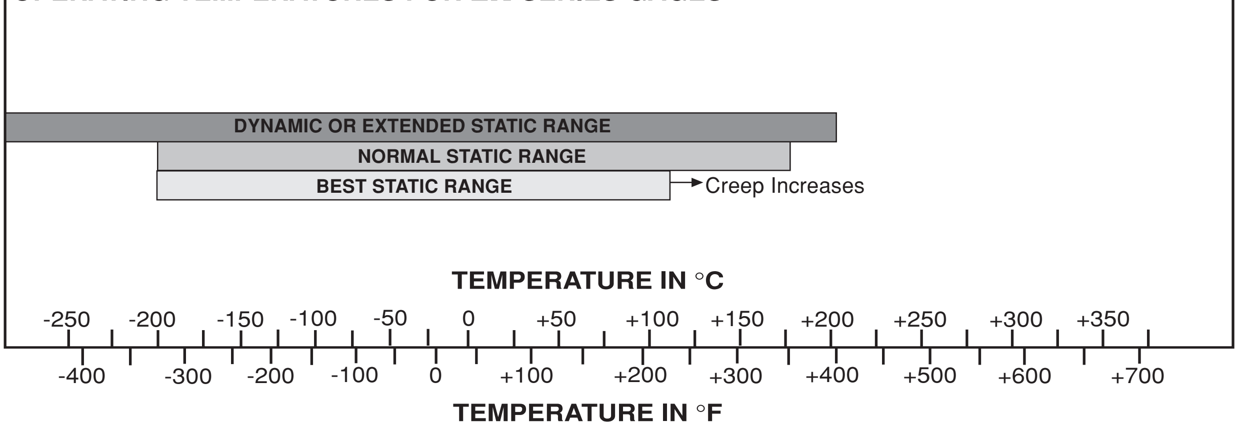
Technical Data

EK Series

EK-Series gages are K alloy, often employed in general-purpose testing where higher resistances and grid stability are required, particularly at elevated temperatures. They are normally selected for applications where reinforced laminate-backed gages lack sufficient flexibility. EK gages are of open-faced construction on a 0.001 in (0.025 mm) tough, flexible cast polyimide backing. The strong, heat-resistant backing provides excellent handling and performance qualities, and is treated for good bond formation with all standard strain gage adhesives. Heat-curing adhesives such as M-Bond 610 are recommended for full-temperature-range capabilities. Strain limits for this series are approximately ±1.5%. EK gages are often selected instead of EA gages for improved fatigue life. However, when maximum fatigue life is required, reinforced laminate-backed K-alloy gages are recommended. Soldering to K-alloy is difficult, and duplex copper pads or dots are included as a standard feature. Most options available on EA-Series gages are offered with EK gages, but performance may be degraded.

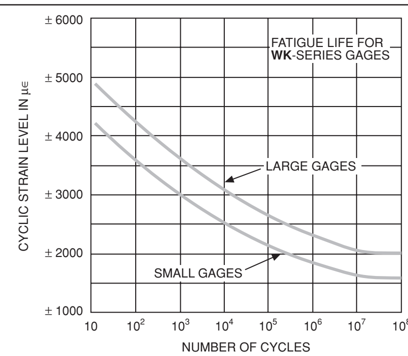


OPERATING TEMPERATURES FOR EK-SERIES GAGES

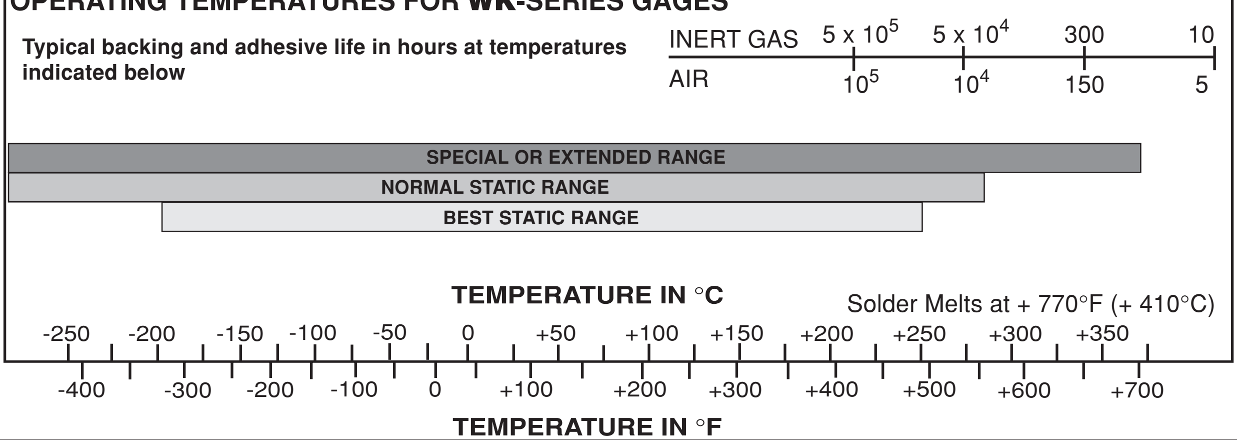


WK Series

WK-Series gages are fully encapsulated K alloy, equipped with integral, high-endurance beryllium copper leadwires. The matrix is a high-temperature epoxy-phenolic resin system reinforced with glass fibers. Overall gage thickness is approximately 0.0028 in (0.071 mm). WK-Series gages have the widest temperature range and most extensive environmental capability of any general purpose strain gage of the self-temperature-compensated type. Option W is available on many pattern designs, but will lower the excellent cyclic endurance and maximum operating temperature of the basic WK gage. Elevated temperature drift of these gages is very low to +600°F (+315°C), and the main restriction at high temperatures is the limited life of the backing and adhesive due to oxidation and sublimation. Strain limits for WK gages are approximately ±1.5%. High temperature adhesives such as M-Bond 610 are required for full-range performance.



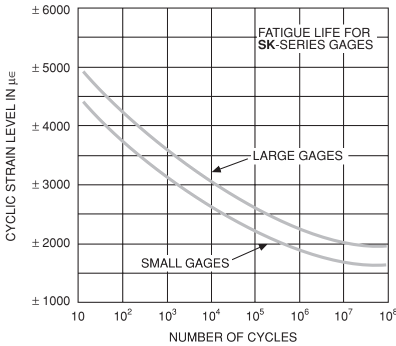
OPERATING TEMPERATURES FOR WK-SERIES GAGES

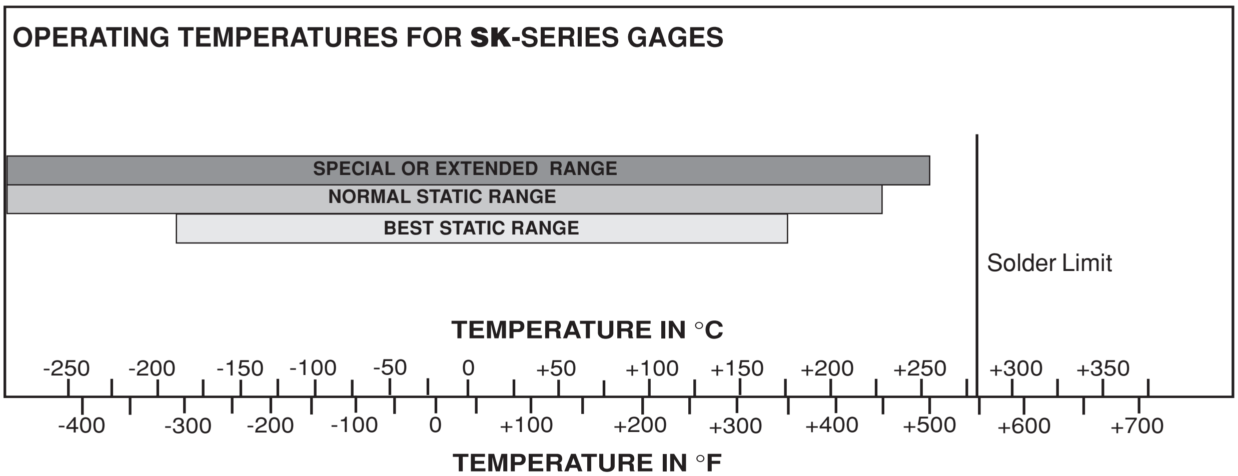


Technical Data

SK Series

SK-Series gages are fully encapsulated similar to the WK-Series gages, but with solder dots instead of leadwires. The matrix is somewhat thinner than the WK type, with an overall thickness of approximately 0.002 in (0.05 mm). The solder is a lead-tin-silver alloy which melts at approximately +570°F (+300°C). SK gages are primarily used when mounting space is restricted. Performance is equivalent to the WK type, but over a lower temperature range. Fatigue life of the SK Series is equivalent to the WK type, but more care is required during leadwire attachment to avoid gage damage. The absence of integral leadwires allows SK gages to be field-trimmed very close to the pattern size. No leadwire options are available. Strain limits are approximately ±1.5%. Heat-curing adhesives such as M-Bond 610 will provide best overall performance.





S2K Series

S2K-Series gages are fully encapsulated K alloy, equipped with large integral solder pads. The backing and encapsulation are 0.001 in (0.025 mm) thick laminated high-performance polyimide. The overlay fully encapsulates the grid and solder tabs. Large [0.030 in (0.75 mm)] diameter solder pads are provided for ease of leadwire attachment. Overall gage thickness is approximately 0.0025 in (0.065 mm) and the backing has been specially treated for optimum bond formation. M-Bond 43-B is recommended for S2K-Series gages if a cure temperature of +350°F (+175°C) is possible. Alternatively, M-Bond AE-10/15, M-Bond 200, or M-Bond 600/610 may be used. The S2K Series has an elongation capability exceeding ±1.5%. Designed primarily for use on composites, these gages are normally produced in larger patterns and higher resistances.