

## Introduction and Designation System

Micro-Measurements manufactures a variety of fixed, adjustable, and combination bondable resistors for use in many applications where precise resistance is required. Appropriate patterns are available in both low and high temperature-coefficient-of-resistance types. Widest use is in transducer bridge circuits to compensate for small temperature-induced errors and to adjust bridge-balance output.<sup>1</sup> Figure 1 (on the facing page) shows a typical application.

Various foil types, sizes, and patterns are available, allowing selection of the optimum resistor for specific applications. Resistors are normally produced open-faced on the flexible E or N2 polyimide backings. The recommended temperature range is 0° to +350°F [-20° to +175°C] for the E type and 0° to +300°F [-20° to +150°C] for the N2. Standard packaging for bondable resistors is 50 per package.

### TEMPERATURE-COMPENSATED RESISTORS

Temperature-compensated A alloy and K alloy are available in several resistor patterns. They are normally stocked in both 06 S-T-C for steel and 13 S-T-C for aluminum. Due to the difficulty of directly soldering to K alloy, all N2K resistors are supplied with a copper soldering pad (DP) on each tab.

### TEMPERATURE-SENSITIVE RESISTORS

Three different foil materials are available to fit a variety of compensation requirements.

**Nickel** — Pure nickel has the highest resistance-versus-temperature sensitivity of the three available foil types and is normally selected for span-versus-temperature compensation. It can be ordered as a fixed resistance value (A Pattern) or adjustable (B Pattern). The temperature coefficient of resistance (TCR) for nickel is +0.33%/°F [+0.59%/°C] over a temperature range of +50° to +150°F [+10° to +65°C].

**Balco**<sup>®</sup> — Although having a slightly lower TCR than nickel, Balco has a higher resistivity, which makes higher resistance values more easily obtained. It also has some price advantage over nickel. The TCR for Balco is +0.24%/°F [+0.43%/°C] over a temperature range of +50° to +150°F [+10° to +65°C].

**Note:** Since resistance-versus-temperature for nickel and Balco is not a linear function, values are given as chord slopes over the specified temperature range.

**Copper** — Pure copper has the lowest TCR of the three materials and also very low resistivity. This makes it ideal for minor adjustments when used in a corner compensation approach (see Fig. 1). Copper also has a more linear TCR than either Balco or nickel. When used for span-versus-temperature correction, copper can produce a more

linear span compensation in some transducer designs. Copper TCR is +0.22%/°F [+0.40%/°C].

### RESISTANCE TOLERANCES

A-Pattern resistors have fixed values (selected by the user) and are supplied with tight tolerances. With adjustable types, it is impractical to supply precise values. Most resistors will be within  $\pm 20\%$  of the specified nominal values, but occasionally resistances will fall outside that range. The various cutting steps will follow the same trend.

### RECOMMENDED ADHESIVES

M-Bond 610, M-Bond 43-B or M-Bond 450 adhesive should be used for operation over the widest temperature range. Other standard strain gage adhesives are acceptable within their recommended temperature limits. The special backing treatment used permits good bond formation with all strain gage adhesives except the solvent-evaporation-setting type. Resistors should be mounted in areas of low strain (preferably less than 500 $\mu\epsilon$ ) and on relatively flat surfaces. If possible, grids should be aligned with the direction of lowest strain.

### INSTALLATION AND WIRING

All resistor patterns should be bonded to the mounting surface before adjustment or use. Prepare the specimen surface and install the resistor using standard strain gage materials and techniques. Install leadwires, and solder to the attachment tabs with an appropriate solder.

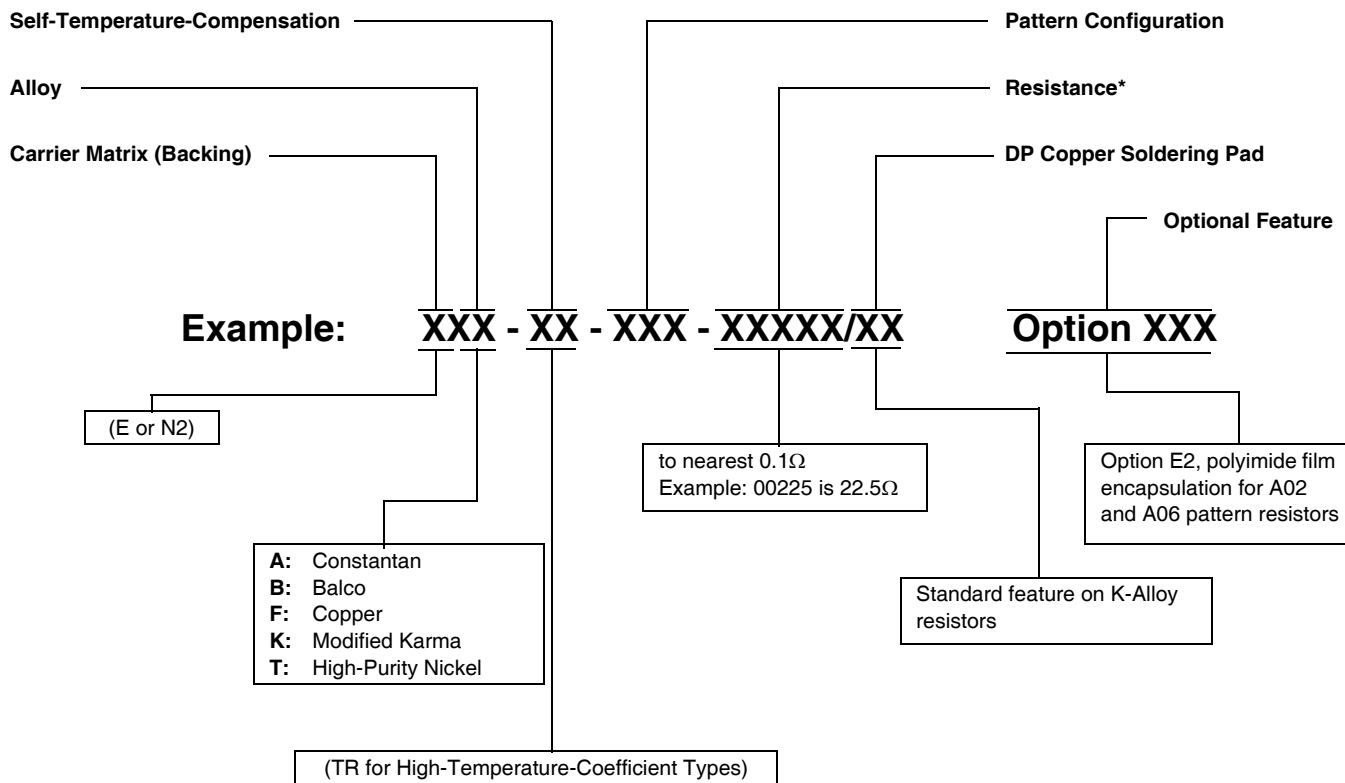
After thorough flux removal, blot with clean sponges, and allow the surface of the resistor to dry completely. Attach leadwires to an appropriate resistance-measuring instrument and adjust the resistor as described in "Adjustment Instructions" until the desired resistance is achieved.

### PROTECTIVE COATINGS

For maximum long-term stability, coat the adjusted resistors with a hard, heat-curing material such as Micro-Measurements M-Bond 610, 43-B, or 450. Satisfactory results may be obtained with appropriate air-drying coatings.

<sup>1</sup> "Strain Gage Based Transducers — Their Design and Construction." Available from Micro-Measurements  
Balco is a registered trademark of W.B. Driver Company.

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\*Note: It is impossible to guarantee initial or final resistance on adjustable resistor types. Most resistors will be within ± 20% of the nominal values given.

**FIG. 1 BRIDGE CIRCUIT WITH TYPICAL COMPENSATION RESISTORS.**

