Silver Soldering Technique for Attachment of Leads to Strain Gages

Introduction

To avoid excessive reduction in mechanical strength, conventional soft solders are generally limited to maximum operating temperatures of approximately 50°F (*30°C*) below the solder melting point. The highest melting temperature for easy-to-handle soft solders is in the +570° to +585°F (*+300° to +310°C*) range, thus limiting the operating temperature range to +520° to +535°F (*+270° to +280°C*). Vishay Micro-Measurements Solder 570-28R is a soft solder within this range.

Environmental applications that exceed these operating temperatures require other lead attachment techniques. Resistance soldering, spot welding, and flame welding are common alternatives. This Application Note is restricted to the resistance soldering technique with silver solder paste. For practical demonstration purposes, the WK-Series strain gage has been selected.

The soldering unit recommended for this application is the WRS-1 Resistance Soldering Unit (see Vishay Micro-Measurements Strain Gage Accessories Data Book) which features a continuously variable power control, tweezer-type electrodes, and a foot-actuated energizing switch. The silver solder powder is in a flux suspension, and the melting temperature is approximately +1240°F (*+670°C*).

All accessory items referred to in this Application Note are described in detail in the accessories data book.

Figure 1 shows a WK-Series strain gage installation, properly bonded and cured, in preparation for attachment of leadwires by the silver soldering technique.

Strain Gage Selection

The WK-Series strain gage used in the application is one of few organic-carrier gages capable of operating above +525°F (*+275°C*) for extended periods. Standard leads are beryllium copper. Nickel-clad copper leads (Option SP30) are also available, and recommended for continuous high-temperature operation.

Bonding

M-Bond 600 or 610 is the strain gage adhesive generally recommended for high operating temperatures. An insulating layer, sufficient to prevent contact of any bare leads with the specimen surface, must be bonded to the specimen adjacent to the strain gage. This layer is ordinarily bonded at the same time as the strain gage, using the same techniques. Bonding instructions are detailed in Vishay Micro-Measurements Instruction Bulletin B-130.

Fiberglass cloth (untreated), tissue glass, or a layer of Kapton® film are commonly used surface insulators. To provide an optimum bond, both sides of Kapton film must be lightly abraded to remove the glossy surface.

Lead Preparation

Step 1

Carefully lift the gage lead ribbons from the surface of the insulating material by laying the wooden handle of a cotton-tipped applicator firmly across the gage at the lead exit point, grasping each lead with tweezers, and raising the lead at a shallow angle (Figure 2). Avoid introducing kinks or sharp corners. While maintaining pressure with the applicator stick, gently stroke the leads from the gage toward the free ends with a pencil eraser to remove any adhesive and/or oxidation.

Step 2

For static test measurements, cut three equal lengths of nickel-clad solid copper leadwire with fiberglass insulation, such as 126-GWF [AWG No. 26 (0.016 in, or *0.4 mm*, dia.)].

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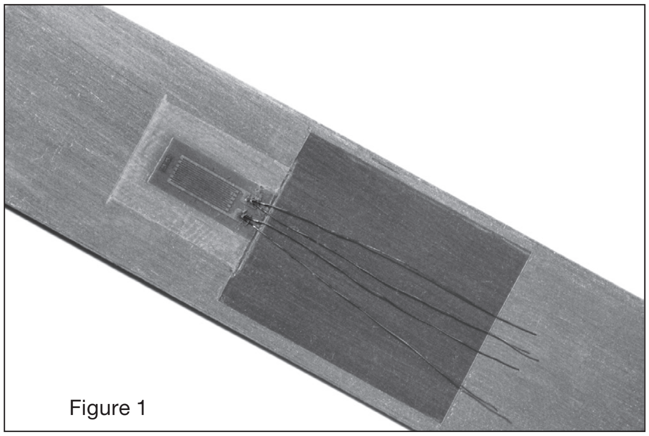

Figure 1

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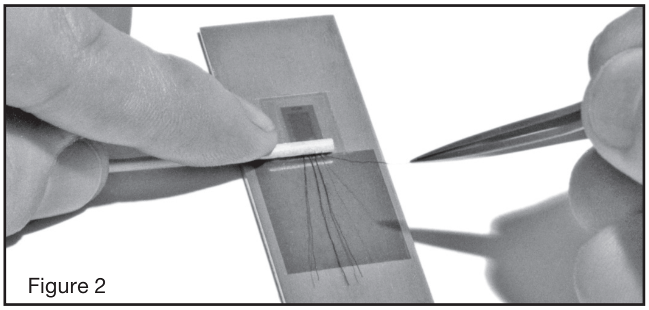
Figure 2

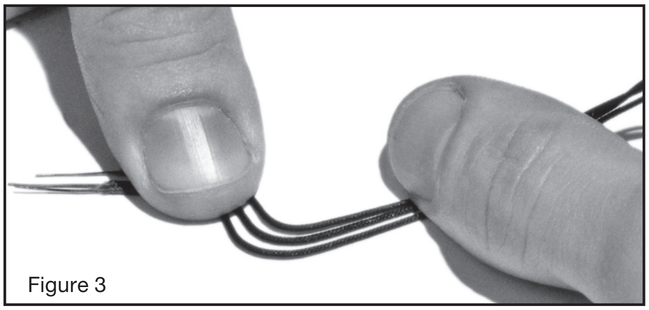
Figure 3

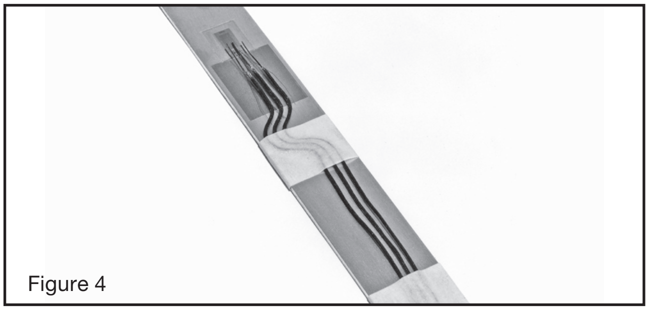
Figure 4

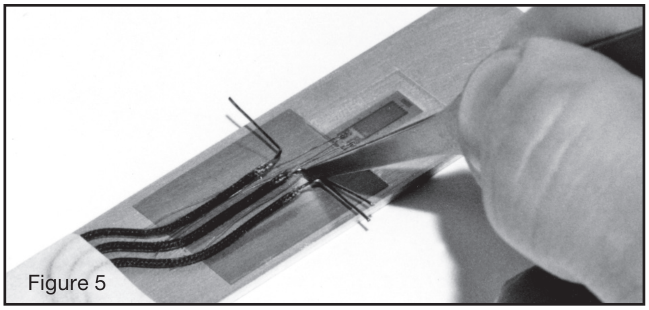
Figure 5

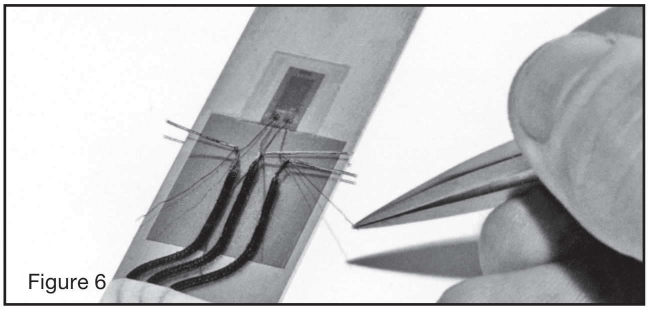
Figure 6

Step 3

Flame-burnish 1 in (*25 mm*) of the leadwire ends with a match to prevent fraying of the fiberglass.

Step 4

Strip approximately 0.75 in (*20 mm*) of insulation from the end of each leadwire being careful not to nick the conductors. Clean the stripped ends with a pencil eraser to remove any oxidation.

Step 5

Press these ends firmly against any flat surface and form a C-shaped loop 1 to 2 in (*25 to 50 mm*) from the stripped end (Figure 3). This loop technique will prevent any twisting or rolling of the leadwires during attachment to the gage leads.

Step 6

Anchor the leadwires to the specimen surface with PDT-1 Drafting Tape as in Figure 4; raise the ends off the surface for convenient attachment to gage leads.

Step 7

Bend the stripped leadwires at right angles, 0.25 in (*6 mm*) from the end of the insulation (Figure 5).

Step 8

Grasp the end of the gage lead with sharp-pointed tweezers and wrap once around the instrument leadwire at the formed right angle. Pull with sufficient force to tightly form the gage lead around the instrument leadwire (Figure 6). To prevent damage to the gage, it is advisable to press the wooden handle of a cotton-tipped applicator across the gage at the lead exit point as shown in Figure 2 (Step 1).

Silver Soldering Technique

Step 1

Thoroughly mix the silver-solder paste in the jar in which it is supplied. The consistency should be that of a thin mortar. If the paste is too dry, add only a few drops of water and stir. *Be careful not to over-thin the paste.* Keep tightly capped when not in use.

Step 2

Slip a small piece of paper under the leadwires and over the insulating layer to protect the insulation from contamination during the silver soldering process.

Step 3

Apply a small amount of paste to each solder joint location with a dental probe, working the solder into the joints, as shown in Figure 7. Restrict the paste to the joints only; *do*

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not allow paste to wet the lead ends. If available, a 3X to 5X magnifier is helpful.

Step 4

Connect the tweezer electrode cable and footswitch to the WRS-1 power control. Inspect the tweezers; if the point at which the electrodes close together is not clean, lightly abrade with 400-grit silicon-carbide paper. *Always keep electrodes clean.*

Step 5

Adjust the power control to about 90%. Firmly grasp the instrument leadwire with the electrodes, approximately 0.062-in (*1.5 mm*) from the end (Figure 8). If available, a 3X to 5X magnifier is helpful.

Step 6

Energize the unit by pressing the footswitch. If the solder pool does not begin to steam and bubble, reclean the tweezers. The actual flow of solder will not begin until the water has boiled away.

When the solder joint has formed, quickly remove the tweezers and then release the footswitch, in that order, to minimize the chance of welding the electrodes to the leadwire.

Flux Removal

Remove the glass-like flux produced by the soldering operation as follows:

Step 1

Apply a small amount of *M-Prep* Conditioner A to soften the flux, and lightly brush the softened material away with a camel-hair or other soft brush. [Warming the Conditioner A to +120°F (*+50°C*) before applying will accelerate this process.] Inspect the joint and repeat as necessary until the solder is shiny in appearance.

Step 2

Flood the area with *M-Prep* Neutralizer 5A and blot dry with tissue or a gauze sponge. Remove the protective paper between the leads and insulation.

Cable Anchoring

Step 1

Clip off the excess gage leads and instrument leadwires at the solder joint, and remove the drafting tape.

Step 2

Carefully form the leadwires flat against the surface and hold in place with Mylar tape or wire. Secure with tape as shown in Figure 9.

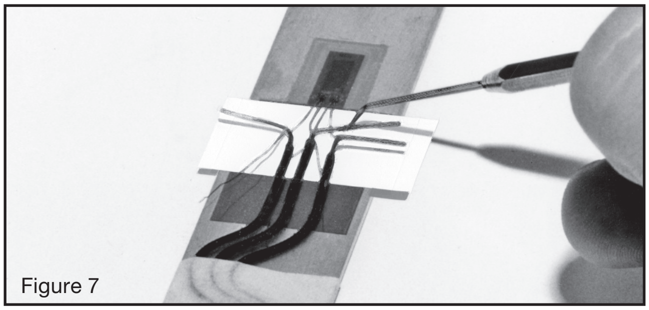

Figure 7

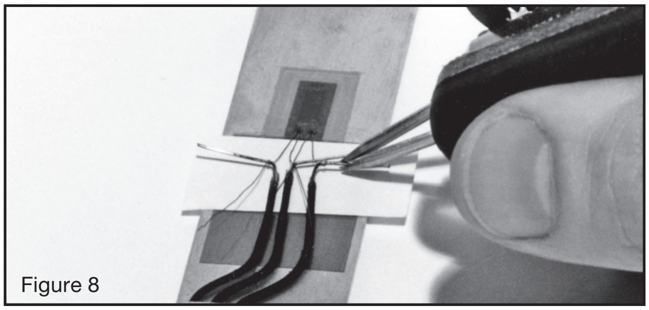

Figure 8

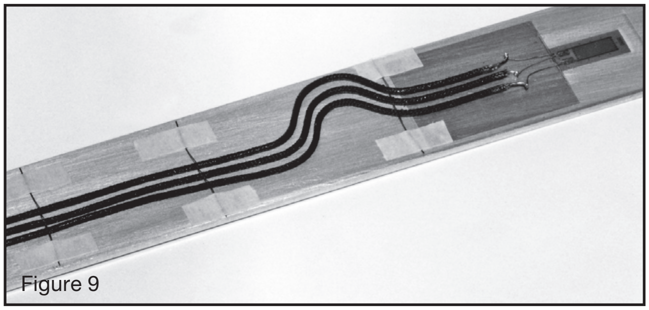

Figure 9

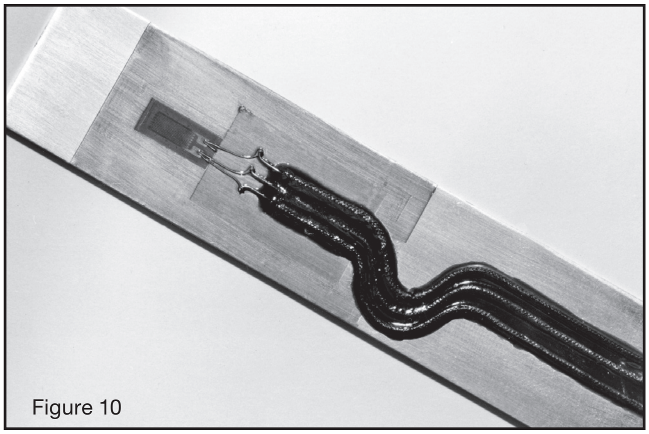

Figure 10

Step 3

Apply an anchor coat of RTV-3145 or M-Bond GA-61 to the leadwires, avoiding contact with the securing tape or wire. Cure sufficiently to secure the leadwires in position.

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The same coating selected to anchor the leadwires can be extended to cover the gage.

Step 4

Remove the securing tape or wire, fill in the uncoated areas, and complete the curing process.

Figure 10 is representative of a completed, protected, and cured installation.

Caution: All these materials have a limited life, dependent upon time, temperature, and exposure to oxidizing atmospheres. For further information, contact our Applications Engineering Department.