

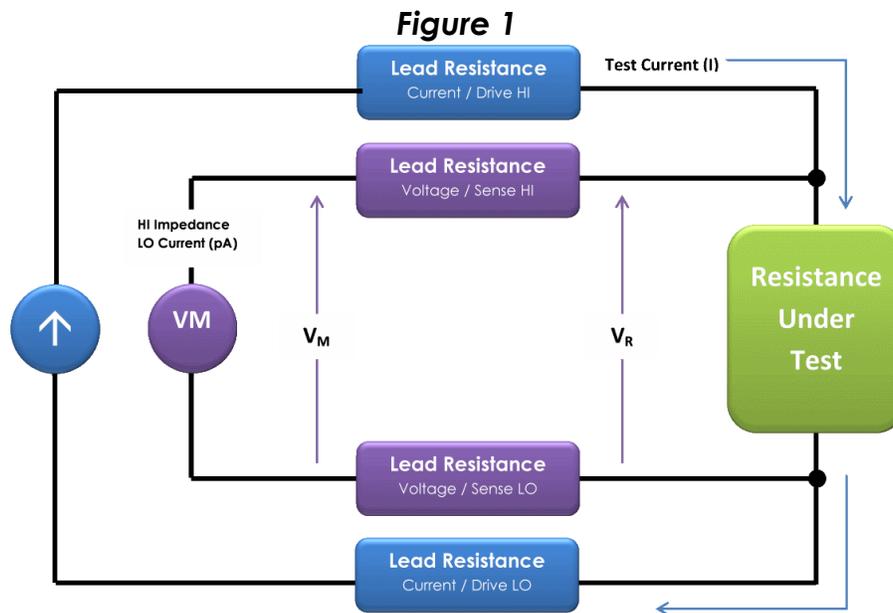
TEGAM Resistance Probes and Test Leads for Bond Meters

Introduction

Probes and test leads are an integral part of any resistance measuring system. Acting as the interface between the device under test (DUT) and the measuring instrument, resistance measuring probes and test leads must be engineered to the highest electrical standards while still being able to withstand daily, and often rigorous, use. Precision resistance measurements present the added challenge of requiring four-wire Kelvin measurements further complicating the probe design.

Four-Wire Resistance Measurements

The resistance of the wire used to construct the leads can significantly affect measurement accuracy. For example, 18-gauge test leads have a resistance of 0.006 ohms per foot per lead, or 0.012 ohms per foot per lead pair. Further, the resistive temperature coefficient of copper wire is 0.393% / °C. When measuring resistances in the milliohm or micro-ohm ranges, these factors will cause significant measurement errors if not compensated for. Simple two-wire measuring devices attempt to offset lead resistance by shorting the leads together and electrically or mathematically compensating for the residual resistance. However, this method is cumbersome, subject to user error, and does not account for temperature coefficient of the test leads.



V_R = Voltage across Resistance Under Test, and V_M = Voltage measured at voltmeter.

Because the sense current is minimal, any voltage drop due to lead resistance across the sense leads is negligible. Since $V_M = V_R$, the Resistance Under Test = I / V_M .

Figure 1 - Electrical Representation of a typical Four-Wire Kelvin Measurement

Kelvin test leads minimize these errors by using four wires to make the resistance measurement, as shown in Figure 1. In a Kelvin measurement, two wires apply a known current (typically called the “drive” leads) to the DUT. A second pair of wires (called the “sense” leads) is used to measure the resultant voltage drop across the DUT with a voltmeter. Since the voltmeter draws minimal current, any voltage drop in the sense leads is negligible. Using Ohm’s Law, the DUT resistance can then be calculated by dividing the measured voltage by the known current, providing an accurate resistance measurement.

TEGAM Kelvin Probes for Bond Meters

TEGAM’s line of bond meter probes and test leads has been engineered for high precision, reliable resistance measurements. Most of our probes are compatible across the range of TEGAM bond meters, and many are compatible with other manufacturers’ bond meters as well. Probe and test lead terminations can often be customized to connect to non-TEGAM bond meters, or for specific applications. TEGAM also manufactures probe sets for applications which require intrinsically safe bond meters such as aircraft fuel tank testing. TEGAM’s bond meters and bond meter probes are used by military and governmental organizations, research groups, and manufacturers around the globe for many applications, including:

- Materials testing (surface and bulk resistivity)
- Aircraft bonds¹
- Contact resistance and switch resistivity
- Bus and cable joints
- Integrity of weldments
- Transformer and winding resistance
- Rail and pipe bonds
- Wire resistance
- Antenna and lightning conductor bonds
- Power lineman bucket truck bond tests
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BKP, MKP, and MCP Kelvin Probes

TEGAM’s BKP-10 and MKP-6 Kelvin Probes are designed to be easy to use and versatile, while still maintaining the highest standards of measurement integrity. Both probe sets are terminated with $\frac{3}{4}$ ” spaced dual banana plugs allowing the probes to be used with most of TEGAM’s bond meters, and many bond meters made by other manufacturers as well. The measurement probes utilize a two pin per probe configuration, which can be customized with a variety of pin sizes and styles. The TEGAM MCP-6 is similar to the MKP-6, except it uses a coaxial pin configuration that is ideal for smaller DUTs. Specifications for each probe set are shown in Figure 3.

¹ For more information about aircraft bond testing and TEGAM’s line of Kelvin probes, please see “Application Note 109: Testing Aircraft Electrical Bonds Ensures Safety and Reliability, Improves System Performance,” available at www.tegam.com.

Figure 3

BKP-10 Kelvin Probe



Pin Spacing:	0.19" (4.8 mm)
Pin Diameter:	0.110" – 0.156" (2.79 mm – 3.96 mm)
Cable Length:	10' (3.0 m)
Max Voltage:	42 V
Max Current:	2 A

MKP-6 Kelvin Probe

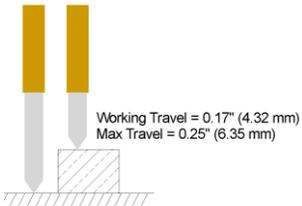
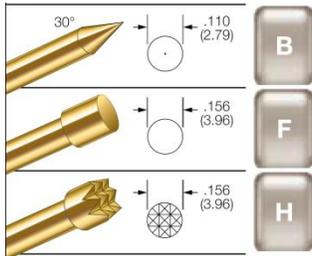
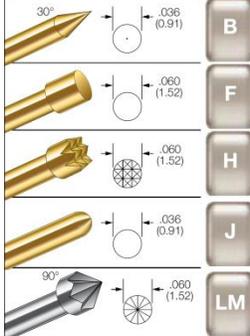


Pin Spacing:	0.11" (2.8 mm)
Pin Diameter:	0.036" – 0.060" (0.91 mm – 1.52 mm)
Cable Length:	6' (1.8 m)
Max Voltage:	42 V
Max Current:	2 A

MCP-6 Coaxial Kelvin Probe



Diameter	
Inner Pin:	0.016" (0.4 mm)
Outer Pin:	0.060" (1.5 mm)
Cable Length:	6' (1.8 m)
Max Voltage:	42 V
Max Current:	2 A

<p>BKP-10/MKP-6 Pin Travel</p> 	<p>BKP-10 Pin Options</p> 	<p>MKP-6 Pin Options</p> 
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HTP-100 and HTP-101A Pistol Grip Kelvin Probes

The TEGAM HTP-100 and HTP-101A Pistol Grip Kelvin Probes are designed for tough duty applications where metal components and surfaces need to be tested for bonding. They are molded with impact resistant material that will stand up to the rigors of daily use. The probe pins are made of hardened stainless steel, and rotate when pressed onto the DUT to help ensure positive contact with the measurement surface even when penetrating paint or other surface coverings. The probe wires are 8 feet (2.4 meters) long and are terminated with color-coded spade lugs. The HTP-100 probes are suitable for use with most of TEGAM's bond meters, while the HTP-101A probes are molded from an intrinsically static-dissipative polycarbonate/ABS resin and specifically designed for use with the TEGAM R1L-E2A Intrinsically Safe Bond Meter.



Pin Spacing:	0.5" (12.7 mm)
Pin Diameter:	0.156" (3.96 mm)
Cable Length:	8' (2.4 m)
TEGAM Compatibility:	
HTP-100	R1L-B / BR / BR1 / D1
HTP-101A	R1L-E2A ²

SKP-8 Kelvin Probes

For intrinsically safe measurements in spaces too small for the HTP-101A Pistol Grip Probes, TEGAM designed the SKP-8 Kelvin Probes. Made from the same static-dissipative material as the HTP-101A Probes, the SKP-8 Probes are excellent for making 4-wire surface resistance measurements on films and other metallic surfaces where penetration of paint or rust layers is not required. The probe tips are interchangeable and compatible with the full line of BKP-10 probe tips. Similar to the HTP-101A, the leads are 8 feet (2.4 meters) long and terminated with color-coded spade lugs.



Pin Spacing:	0.19" (4.8 mm)
Pin Diameter:	0.110" – 0.156" (2.79 mm – 3.96 mm)
Cable Length:	8' (2.4 m)
TEGAM Compatibility:	
	R1L-E2A ²

² The TEGAM HTP-101A Pistol Grip Probes and SKP-8 Kelvin Probes are ATEX, UL, and CSA certified as intrinsically safe when used with the TEGAM R1L-E2A Intrinsically Safe Bond Meter. If used with any other TEGAM bond meter, or bond meters made by other manufacturers, neither probe set is certified as intrinsically safe and should not be used for applications that require intrinsically safe equipment.

Kelvin Clip Leads

TEGAM provides additional options for making bond meter measurements. The KTL-100 Kelvin Clip Leads and KAK-1M Kelvin Alligator Leads both provide a solid 4-wire Kelvin connection, and are made of gold-plated brass, ensuring a high quality electrical connection to the DUT. For larger DUTs, the HKC-100 Large Kelvin Leads are an excellent choice, providing a secure connection to DUTs up to 1.78 inches. The KTL-100 and HKC-100 test lead sets are terminated with dual banana leads, and the KAK-1M with four single banana leads. All three are compatible with most TEGAM bond meters, and many bond meters made by other manufacturers as well. See Figure 4 for details about TEGAM’s Kelvin Clip Leads.

Figure 4

KTL-100 Kelvin Clip Leads



Lead Length: 7' (2.1 m)

Max Jaw Opening: 0.6875" (17.5 mm)

KAK-1M Kelvin Alligator Leads



Lead Length: 4' (1.2 m)

Max Jaw Opening: 0.8070" (20.5 mm)

HKC-100 Large Kelvin Leads



Lead Length: 8' (2.4 m)

Max Jaw Opening: 1.78" (45 mm)

Compatibility

TEGAM's line of bond meter probes and test leads have been designed to provide accurate and reliable low-resistance measurements in a wide variety of applications. They also incorporate industry-standard terminations, making them compatible across the TEGAM series of bond meters and with many commonly available bond meters made by other manufacturers.

TEGAM Resistance Probes and Leads Compatibility

Probe	Type	Connector	Length (feet)	R1L-B	R1L-BR	R1L-BR1	R1L-D1	R1L-E2A
BKP-10	Big Kelvin Probe	Dual Banana – ¼" Spacing	10	●	●	●	●	
HKC-100	Large Alligator Kelvin	Dual Banana – ¼" Spacing	8	●	●	●	●	
HTP-100	Pistol Grip Kelvin	Spade Lugs	8	●	●	●	●	
KAK-1M	Kelvin Alligator	Banana	4	●	●	●	●	
KTL-100	Kelvin Clip	Dual Banana – ¼" Spacing	7	●	●	●	●	
MCP-6	Kelvin Coaxial Probe	Dual Banana – ¼" Spacing	6	●	●	●	●	
MKP-6	Kelvin Probe	Dual Banana – ¼" Spacing	6	●	●	●	●	
HTP-101A	Pistol Grip Kelvin	Spade Lugs	8					●
SKP-8	Kelvin Probe	Spade Lugs	8					●

● - Optional

● - Included with Purchase

TEGAM has been working to meet the challenges of precision resistance measurement for over 25 years. With its line of microohmmeters, bond meters, and Kelvin measurement probes, TEGAM has developed a comprehensive resistance measurement product line versatile enough to be used in many different applications while meeting the most stringent measurement requirements. Several of TEGAM's most widely implemented electrical bond meters are show in Figure 5 below, and our full product line can be seen at www.tegam.com.

Figure 5
R1L-BR1



Intrinsically Safe Bond Meter for All Phases of Aircraft Maintenance



Field-proven for Bond Testing Rotary Wing Aircraft

R1L-D1



Portable, High-accuracy Microohmmeter and RTD Monitor

Figure 5 – TEGAM’s line of bond meters and microohmmeters provide engineers and maintenance personnel easy-to-use bond testing and low-resistance measurement solutions that provide superior accuracy. Many of TEGAM’s Resistance Probes and Test Leads are compatible with multiple TEGAM products, as well as bond meters and microohmmeters made by other manufacturers.

For further information or questions concerning TEGAM’s Kelvin probes and test leads, compatibility with particular bond meters, or TEGAM’s full line of bond testing, RF, temperature, and other measurement products, please visit www.tegam.com or call 800-666-1010.