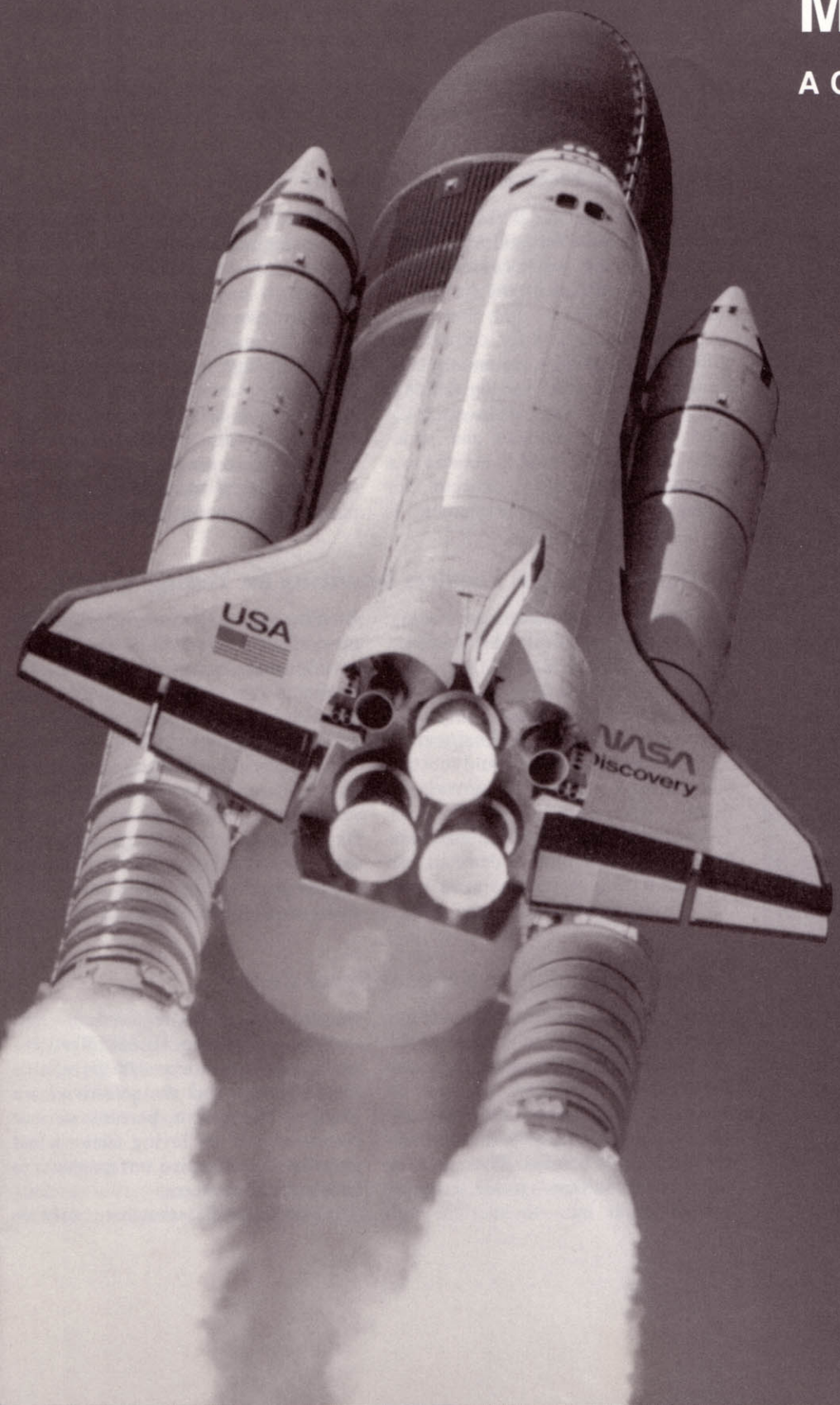
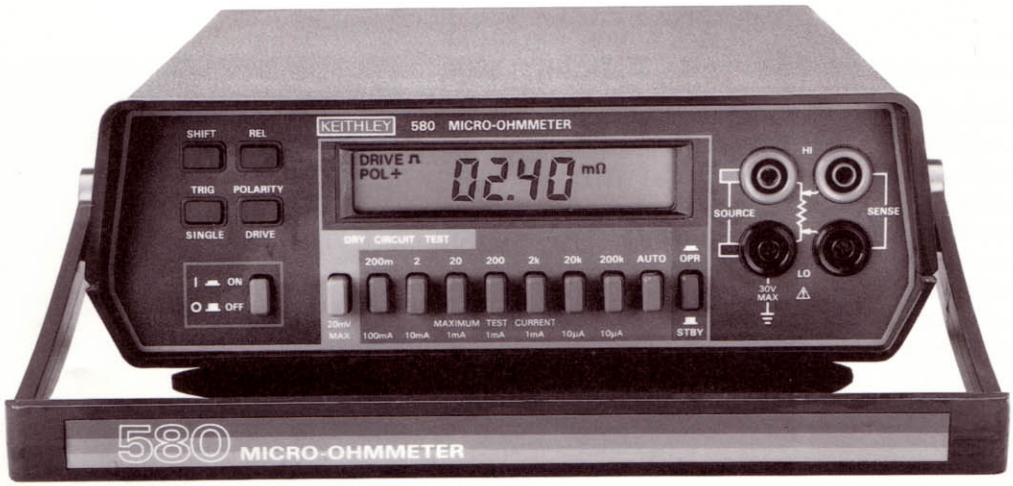
Aerospace Bonding Measurements

A Case History



KEITHLEY

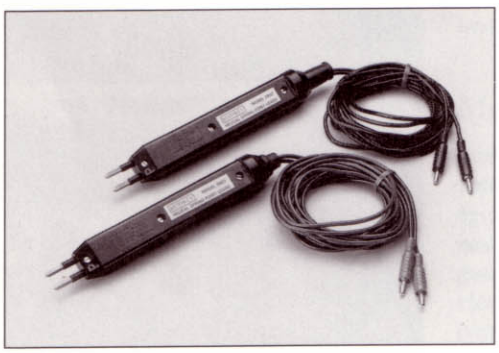


The Model 580 Micro-ohmmeter is a versatile unit that meets the needs of many demanding applications. If your applications extend beyond bonding measurements, consider these other 580 capabilities:

- Three sets of test leads
- Dry circuit test mode with 20mV source
- DC or pulsed test current
- Optional IEEE-488 interface

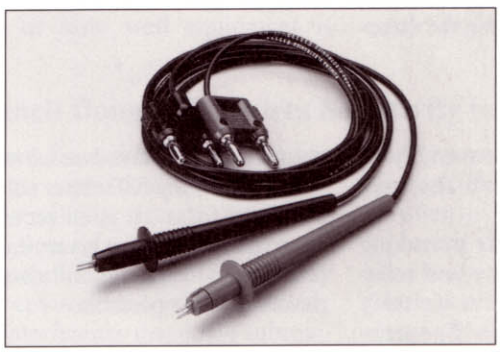
A new **Model 580-1** has been designed specifically for bonding measurements. This unit is the same as the Model 580, except the test leads and carrying pouch are not included. Select one or both of the test leads below for accurate and reliable bonding resistance measurements.

Bonding Test Leads (optional)



5807-7 Test Leads

- 2 rotating test probes
- 0.45-in. spacing between probes
- 7 ft. cable length



5805 Kelvin Probes

- 2 spring loaded test probes
- 0.1-in. spacing between probes
- 36 in. cable length

KEITHLEY

Keithley Instruments Division / Keithley Instruments, Inc.
28775 Aurora Road / Cleveland, Ohio 44139 / U.S.A. / (216) 248-0400 / Telex: 98-5469 / Telefax: 248-6168

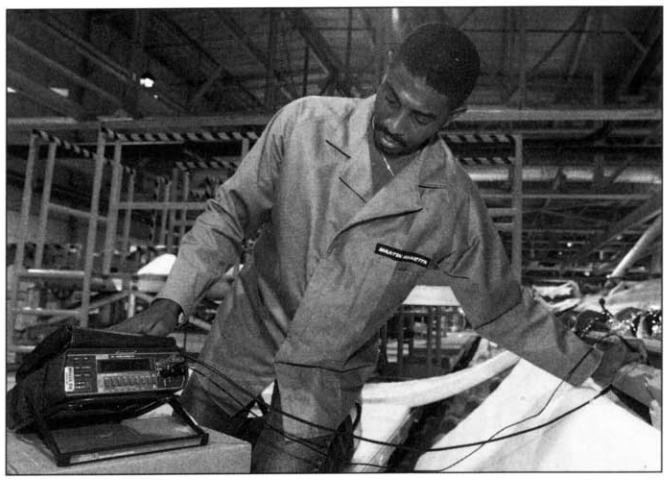
WEST GERMANY: **Keithley Instruments GmbH** / Heiglhofstr. 5 / München 70 / 089-71002-0 / Telex: 52-12160 / Telefax: 089-7100259
GREAT BRITAIN: **Keithley Instruments, Ltd.** / 1 Boulton Road / Reading, Berkshire RG 2 ONL / 0734-861287 / Telex: 847 047 / Telefax: 0734-863665
FRANCE: **Keithley Instruments SARL** / 3 Allée des Garays / B.P. 60 / 91124 Palaiseau / Z.I. / 1-6-0115 155 / Telex: 600 933 / Telefax: 1-6-0117726
NETHERLANDS: **Keithley Instruments BV** / Avelingen West 49/4202 MS Gorinchem / P.O. Box 559/4200 AN Gorinchem / 01830-35333 / Telex: 24 684 / Telefax: 01830-30821
SWITZERLAND: **Keithley Instruments SA** / Kriesbachstr. 4 / 8600 Dübendorf / 01-821-9444 / Telex: 828 472 / Telefax: 0222-315366
AUSTRIA: **Keithley Instruments GesmbH** / Rosenhügelstrasse 12 / A-1120 Vienna / (0222) 84 65 48 / Telex: 131677 / Telefax: (0222) 84 35 97
ITALY: **Keithley Instruments SRL** / Viale S. Gimignano 4/A / 20146 Milano / 02-4120360 or 02-4156540 / Telefax: 02-4121249

No. 580CH
68930KCG

falsely indicating low, acceptable resistance values. The false indication resulted from the meter characteristic of indicating a repeatable mid-scale reading when one of the four meter leads in the Kelvin probes failed to make contact with the component under test. Our work demands high standards of accuracy, and we decided to switch to the Keithley Instruments Model 580 Micro-ohmmeter.

For our testing, we require less than 2.5 milliohms of resistance, which is a relatively simple measurement to make with Keithley's micro-ohmmeter. The Model 580 was found to be immune to the other meter's failure mode. The Kelvin probes provide a good, clean contact to ensure reliable, repeatable measurements.

By David Broussard, Sr. Test Engineer
Ben Schubert, Manufacturing Engineer
Martin Marietta



much more accurate, and it's easier for our people to use. In the past, with analog meters, it was necessary for us to zero out the instrument each time we used it. That's not required, of course, with the 580's digital readout.

For us, the Keithley 580 micro-ohmmeter functions just like a stethoscope for a doctor. When engineers in other LTV departments call us for help in identifying sources of electrical noise, we grab the 580 and take it to the site. We check for bonding throughout the structure, identify if paint is interfering with the connection between surfaces and locate areas where the bond can be improved. For us, the 580 is an excellent diagnostic tool.

By Phil Moscko, Lead Engineer
LTV Missiles and Electronics
RF Systems Group

ohms or less between the assembly or harness shield to the aircraft frame or ground point.

We had a lot of difficulty in making this measurement accurately and reliably before we began using the Keithley Model 580 micro-ohmmeters. The problem for us is common in the aerospace industry—most probes do not provide a good, strong contact to the irregular surfaces we must test. In addition, most DMMs are not capable of making a measurement in that extremely sensitive measurement range—less than 2.5 milliohms.

The Keithley 580 meter solved these problems for us. It is an accurate, high speed instrument that is very easy for our technicians to operate, and a battery pack makes the unit portable.

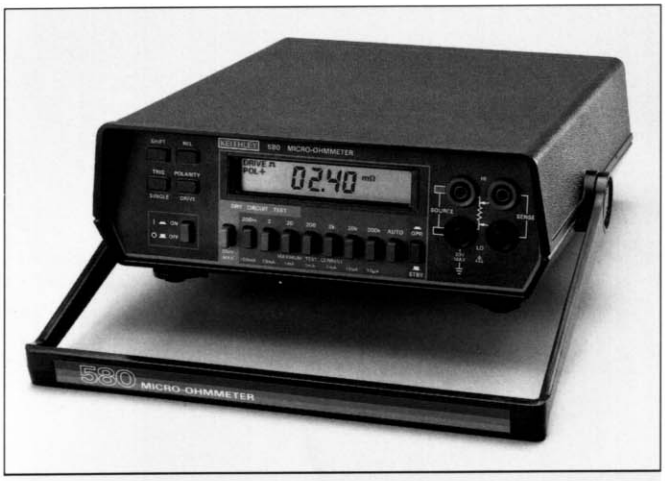
By Ed Nida
General Foreman, Inspection
McDonnell Douglas, MCAIR Division

more than 2.5 milliohms of resistance, and the Keithley meter has no problems in making this measurement without erratic readings. In fact, it's 1000 times more sensitive than the meter we previously used.

Training our people to take bonding readings is very easy, because the 580 is so simple to operate. The Keithley 580 allows us to make immediate measurements much more quickly than we were able to do with other meters.

By Marvin E. Banks Jr.
Materials and Process Engineer
McDonnell Douglas
Kennedy Space Center

These case histories are of the Model 580 in precise bonding applications.



580 Micro-ohmmeter:

A Sensitive Unit for Demanding Applications

The aerospace industry demands special standards of reliability. In bonding applications, many specifications call for the electrical resistance between two joined metals to be less than a few milliohms. It's a common measurement in the aerospace industry that at times can cause some uncommon problems.

Digital multimeters or micro-ohmmeters can be used to make these precise measurements. However, DMMs are too expensive, not sensitive enough, or just plain inefficient for such a precise measurement of low resistance.

Micro-ohmmeters have the sensitivity required, but some units can present other problems when making these measurements. For example, some meters will give an on-scale reading, even if all four of the meter's bonding probes are not making good contact with the surface under test. Many of these bonds, when tested again, should have failed the initial test, although the instrument indicated it passed.

This problem can be avoided by using Keithley's Model 580 Micro-ohmmeter. Designed for accurate bonding resistance measurements, the 580 offers 10μΩ sensitivity and 4 1/2-digit resolution to function as a convenient, reliable instrument. And, importantly for the aerospace industry, the 580 has been designed to prevent on-scale readings unless all four of its probes are making good contact.

The Model 580 Micro-ohmmeter features an optional battery pack that makes the unit portable for on-site field or factory applications. Resistance measurements can be made from 10μΩ to 200kΩ. Accuracy is 0.04% of reading, and settling time is less than one second. *At a reading of 2.5mΩ, the accuracy is ± 21μΩ.* Other important features include:

- 4-wire configuration (2 sense, 2 source)
- Automatic compensation for thermal emfs
- Digital calibration
- Tilt handle
- Test leads for bonding applications (optional)

Call your local Keithley Representative, or our Applications Department at **(800) 552-1115** for more information about the Model 580 Micro-ohmmeter, the instrument that meets the demanding test requirements of the aerospace industry.

KEITHLEY

Expect more. Expect Keithley.

Space Shuttle Testing at Martin Marietta

In our department, we work with the external fuel tanks of the Space Shuttle. In this role, we conduct a number of tests to ensure that the external tanks are shielded from the electrical effects that could result from lightning, nearby radio transmissions and electromagnetic interference. If a problem is found, we isolate its causes and coordinate whatever corrective steps are required to solve it.

Much of our work is focused on electrical bond jumpers—short strips of copper wire that extend from one structure to another. These bond jumpers ensure a good electrical connection across nonconductive joints, thereby establishing a continuous electrical connection between these structures. If they're not properly grounded, lightning or electrical noise could cause several problems, such as arcing, structural damage or damage to protected circuits.

We recently had a problem with a bonding meter from another manufacturer that was found to be capable of

LTV Checks Electrical Bond on Army Missiles

My work here at LTV focuses on electromagnetic effects—EMI, EMC, radiation effects, and electromagnetic pulse. It's a vital task for the Army missiles we help develop.

We frequently test for compliance with MIL-B-5087B, a commonly used bonding specification for the military. Specifically, we examine the electrical bond between equipment and structures—how well a braid is bonded to a backshell (clamp) on a connector, for instance, or how well equipment is bonded to the metal structure it's mounted on. Our requirements stipulate that there can be no more than 2.5 milliohms of resistance.

Before we purchased the Keithley Model 580 micro-ohmmeter, we used to use an analog meter made by another company. However, we found the Keithley meter solved several problems for us. It's much more portable, and its leads are designed so we can maneuver them into tight places that we weren't able to reach with our previous equipment. It's

McDonnell Douglas Requires Sensitivity for Testing Aircraft

Electronics and avionics have become increasingly sophisticated and complex in today's military aircraft. While this adds significantly to weapons and navigation capabilities, it creates a very noisy electrical environment, with inductively coupled interference that could substantially affect a system's performance in flight.

Obviously, areas in which this interference will occur must be detected, and MCAIR testing procedures must identify those interference-prone areas. Bonding measurements are stipulated in most industry contracts, so manufacturers often make resistance measurements to ensure that a satisfactory electrical bond has been made. Our EMI test specifications are very stringent. Depending on the class of bond, e.g. lightning protection, current return, static discharge, etc., the maximum acceptable resistance for a given joint varies from less than 2.5 milliohms to 1.0 ohm. For MCAIR, we require bonding for wiring or components to exhibit a resistance of 2.5 milli-

Aerospace Bonding at Kennedy Space Center

The aerospace bonding measurements we conduct here are in support of the satellites, interplanetary probes, Spacelab and all scientific payloads that travel on the shuttle. We conduct a series of resistance checks to ensure that the surfaces are electrically bonded. There can be nothing on the surface—grease, dirt, paint contamination, etc.—to interfere with the electrical contact required.

We use a Keithley Model 580 micro-ohmmeter to provide us with the reliable measurements and the sensitivity we require. Ninety-five percent of our measurements are faying tests—a test on a flat or conductive surface that's to be bonded to another.

Our tests stipulate that there can be no