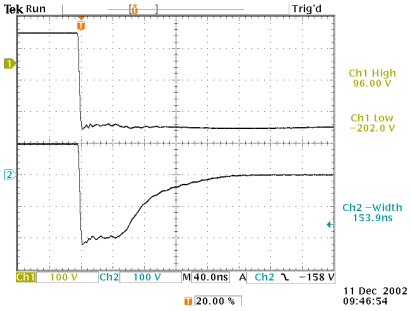
AVR-EB SERIES

t_{RR} & t_{FR} TEST GENERATORS FOR DIODE SWITCHING TIME TESTS INCLUDING METHODS 4031.1 & 4026.2

GPIB IEEE-488



Top: AVR-EB4-B output. (100V/div, 40 ns/div)
Bottom: Reverse recovery of 1N4937 rectifier (+2A, -4A)

- Ideal for diode switching time tests (t_{RR}, t_{FR})
- Models for forward and reverse recovery testing
- MIL-STD-750E Method 4026.3
- MIL-STD-750E Method 4031.4 Conditions A and B
- Customized test jigs available
- IEEE-488.2 GPIB and RS-232 interfaces included

AVR-EB Series

The AVR-EB series was designed for MIL-STD-750E diode switching time tests, including Method 4026.3 forward recovery time tests and Method 4031.4 reverse recovery time tests (Conditions A and B1-B4). Avtech can also provide test systems for MIL-STD-750E Method 4031.4 Test Condition D, where a ramped current with adjustable di/dt is used. See http://www.avtechpulse.com/semiconductor/avr-cd1.

Method 4031.4 Condition B Reverse Recovery Tests

Models AVR-EB4-B, AVR-EB5-B and AVR-EB7-B are provided for Condition B reverse recovery tests of MIL-STD-750E Method 4031.4. The AVR-EB4-B is intended for reverse recovery testing of high-speed power rectifiers. The similar AVR-EB5-B is intended for more specialized reverse recovery testing of long-lifetime high-voltage PIN diodes, and the AVR-EB7-B is intended for low-current small-signal diodes.

The AVR-EB2A-B is intended for Method 4031.4 Condition A reverse recovery tests of low current switching diodes.

Models AVR-EBF6-B and AVR-EBF8-B are intended for Method 4026.3 forward recovery tests.

For reverse-recovery tests of high-speeds rectifiers, the AVR-EB4-B generates a forward-bias pulse of up to +100V/+2A, which is then immediately followed by a reverse-bias pulse of up to -200V/-4A. The forward and reverse amplitudes and pulse widths are independently variable. The forward-to-reverse switching time is < 4.5 ns (10%-90%).

The current waveforms generated by this instrument are suitable for MIL-STD-750E Method 4031.4 Test Condition B tests. In the terminology of this standard, V3 = 0 to +200V, V4 = 0 to -200V, RF = 50 Ohms, R4 = 50 Ohms, and RR ≈ 0. These values differ from the values suggested in the standard, but the use of 50 Ohm resistances allows common coaxial cabling to be used for flexible connection arrangement, and greatly reduces the $\tau = L / R$ time constants that plague measurement systems based on the suggested values. As a result, the measurements are more accurate and more repeatable. (For additional information about the rationale behind the approach, please refer to Avtech Technical Brief 15, "A Comparison of Reverse Recovery Measurement Systems", available at http://www.avtechpulse.com/appnote.) The values of I_F, I_{RM}, and $i_{R(REC)}$ produced by this instrument are suitable for the MIL-STD-750E Method 4031.4 Test Conditions B1-B4. (B4 is not recommended by Avtech, however, because the high I_{RM} / $i_{R(REC)}$ ratio will make the results more sensitive to parasitic effects.) See the online manual for a selection of typical waveforms obtained with different diode types.

Standard AVR-EB4-B models include one AVX-TRR-MIX diode test jig. The instrument mainframe is connected to the test jig using one coaxial cable and one DB-9 control cable. This test jig contains a variety of pin sockets, which may be used to hold the diode device under test (DUT). The test jig has a hinged lid, which must be fully closed to protect the user from high voltages. The output will be automatically disabled if the lid is left open. The standard AVX-TRR-MIX test jig will accommodate TO-220AC (2 lead) packages, DO-style packages with (leads bent at 90°), and standard and reverse-polarity TO-3 packages. The AVR-EB4-B may also be provided with different or additional a customized test jigs, to meet particular customer package requirements. The standard test jig may be replaced with one that accepts DO-41 and Type E axial packages without the need for lead-bending by specifying the -ANB option. (This jig can also be ordered separately as model AVX-TRR-ANB.)

The breakdown voltage of diodes tested by the AVR-EB4-B must exceed I_{RM} x 50Ω. For instance, for tests with I_{RM} = -1A, V_{BR} must exceed 50V.

The AVR-EB5-B is also similar, except that it is intended for use with diodes which have much longer recovery times (hundreds of microseconds), such as high-voltage PIN diodes. The switching times are slower than for the AVR-EB4-B, and the forward bias current is programmable in the range of +10 mA to +4A. In contrast to the AVR-EB4-B, the forward pulse is programmed in terms of the desired current (+10 mA to +4), rather than the applied voltage. The internal output impedance auto-ranges to achieve the desired current amplitude.

Model AVR-EB7-B is optimized for lower-current small-signal diodes (10 - 200 mA). The switching time is < 2.5 ns.

Method 4031.4 Condition A Reverse Recovery Tests

The above models are used for Condition B tests outlined in MIL-STD-750E Method 4031.4. Model AVR-EB2A-B is for Condition A tests, which use a slightly different test arrangement more suited for low-current small-signal diodes (10 - 100 mA). The switching time of the pulse generator is less than 300 ps (but the inductance of the device under test and the test jig typically increase the measured transition times to 700 ps, approximately).

Method 4026.3 Forward Reverse Recovery Tests

Model AVR-EBF6-B is intended for forward recovery tests, as per MIL-STD-750E Method 4026.3. This pulse generator provides a +5V to +50V output amplitude, with 50 Ohm output impedance (for back-matching) to drive 50 Ohm load impedances. Forward currents as high as +1A can be obtained. The mainframe output rise time is < 5 ns (10%-90%). An accessory coaxial rise time filter should be connected to the output to provide the rise time required for the test – typically 8, 10, or 12 ns (10%-90%). The 10 ns filter is included as a standard accessory, and the 8 and 12 ns filters are available as options. The pulse width is adjustable over the range of 200 ns to 10 us. Standard AVR-EBF6-B models include one AVX-TFR-MIX diode test jig. The instrument mainframe is connected to the test jig using one coaxial cable and one DB-9 control cable. The standard test jig contains a variety of pin sockets, which may be used to hold the diode device under test (DUT). The test jig has a hinged lid, which

must be fully closed to protect the user from high voltages. The output will be disabled if the lid is left open. The standard AVX-TFR-MIX test jig will accommodate DO-41 packages, the Microsemi axial "E" package, DO-201AD, TO-220AC and similar packages. Lead bending is required for axial packages. The AVR-EBF6-B may also be provided with different or additional a customized test jigs, to meet particular requirements. Different rise times can also be provided.

Model AVR-EBF8-B is similar, except it provides faster switching times (< 400 p, and no filters are used) and lower test currents (to 200 mA). It is intended for very-high-speed signal diodes.

Other Tests

Avtech can also provide test systems other tests. Contact the factory (*info@avtechpulse.com*) with your requirements.

Model AVR-CD1-B is available for MIL-STD-750E Method 4031.4 Test Condition D, where a ramped current with adjustable di/dt is used.

See *http://www.avtechpulse.com/semiconductor/avr-cd1* for details.

Test Jigs

The test jigs supplied with all models are specially designed to minimize the effects of parasitic inductance as well as transmission line reflections. This helps improve the accuracy and repeatability of the tests.

Other

All models are controlled by a front-panel keypad, adjust knob, and LCD display, or by programming commands sent via the included IEEE-488.2 GPIB and RS-232 ports.

Several relevant application notes are available on the Avtech web site, at http://www.avtechpulse.com/appnote. See application notes TB9, TB15, and TB16 in particular.

More Information

The operating manuals for most instruments are available for download from their online product pages, available at http://www.avtechpuls.ecom/semiconductor. These manuals contain a wealth of information, including actual test results.

GPIB IEEE-488

SPECIFICATIONS AVR-EB SERIES

Model[1]:	AVR-EB4-B		AVR-EB5-B		AVR-EB7-B		AVR-EB2A-B		AVR-EBF6-B	AVR-EBF8-B
Recovery type:	Reverse recovery		Reverse recovery		Reverse recovery		Reverse recovery		Forward recovery	Forward recovery
Intended application:	High-speed rectifiers		Long-lifetime PIN diodes		High-speed small-signal diodes		High-speed small-signal diodes		High-speed rectifiers	Very high-speed small-signal diodes
Basic waveform:	A positive pulse followed immediately by a negative pulse		A positive pulse followed immediately by a negative pulse		A positive pulse interrupted by a negative pulse		Positive DC interrupted by a negative pulse		A positive pulse	A positive pulse
Pulse polarity:	-	+	-	+	-	+	DC	-	+	+
Voltage output[2,5,7]: (to R_L = 50Ω)	-2V to -200V	+5V to +100V	-2V to -200V	N/A	-0.2V to -20V	+0.1V to +10V	+1V to +100V	-1V to -24V	+2.5V to +50V	+2.5V to +12.5V
Corresponding diode current[2,5] (approx., depends on V_{DIODE}):	-40 mA to -4A	+100 mA to +2A	-40 mA to -4A	+10 mA to +4A	-10 mA to -200 mA	+10 mA to +200 mA	+10 mA to +100 mA	-10 mA to -100 mA	+50 mA to +1A	+50 mA to +200 mA
Pulse width (FWHM):	2 us - 20 us		0.2 ms to 1 ms		200 ns	500 ns[9]	DC	200 ns	200 ns to 10 us[8]	100 ns
Maximum duty cycle:	N/A		0.25%		N/A		N/A		N/A	N/A
Rise time: (10%-90%)	< 4.5 ns	< 1 us	< 50 ns	< 1 us	< 2.5ns[10]	< 20 ns	< 300 ps (without test jig), and typically 700 ps[11] with jig and DUT installed.		No filter < 5 ns. Standard filter[4]: 10 ns Optional filters[4]: 8 ns, 12 ns, 20 ns	< 400 ps (without test jig), and typically 700 ps[11] with jig and DUT installed.
Output impedance during pulse (inside the mainframe):	≤ 2 Ohm	50 Ohms	≤ 2 Ohm	varies	50 Ohms		50 Ohms		50 Ohms	50 Ohms
Maximum PRF:	100 Hz		10 Hz		5 kHz		10 kHz		100 Hz	5 kHz
Delay:	Follows + pulse	0 to ±1s, variable	Follows + pulse	0 to ±1s, variable	500 ns after start of +pulse[6]	0 to ±1s, variable	0 to ±1s, variable		0 to ±1s, variable	0 to ±1s, variable
Included test jig[3]:	See tables on next page.									
Connectors:	BNC on mainframe, SMA on jigs									
GPIB & RS-232:	Standard on -B units. See http://www.avtechpulse.com/gpib for details.									
Trigger required:	Ext trig mode: + 5 Volts, 10 ns or wider (TTL)									
Gate input	Active high or low, switchable. Suppresses triggering when active.									
Power requirements:	100 - 240 Volts, 50 - 60 Hz									
Dimensions:	H x W x D: 100 mm x 430 mm x 375 mm (3.9" x 17" x 14.8")									
Chassis material:	cast aluminum frame and handles, blue vinyl on aluminum cover plates									
Temperature range:	+5°C to +40°C									

1) -B suffix indicates IEEE-488.2 GPIB and RS-232 control of amplitude, pulse width, PRF and delay (see http://www.avtechpulse.com/gpib).
2) For operation at amplitudes of less than 10% of full-scale, best results will be obtained by setting the amplitude near full-scale and using external attenuators on the output.
3) Customized jigs available upon request.
4) The 10 ns (10%-90%) rise time filter is included as a standard feature. To add an 8 ns filter, add the -F8NS option to the model number. To add a 12 ns filter, add the -F12NS option to the model number. To add a 20 ns filter, add the -F20NS option to the model number. The rise time filter rise time accuracy is ±20%.
5) The amplitude settings should not be relied upon for any degree of accuracy, because the dynamics of the device under test can affect the actual generated waveforms. Amplitude settings should always be verified by oscilloscope measurements.
6) Thus the diode must come to forward steady-state within 500 ns.
7) The diode must have a breakdown voltage exceeding these amplitude limits. Contact Avtech for special arrangements if $I_{MAX} \times 50\Omega > V_{BR}$.
8) Maximum pulse width is reduced to 500 ns for units with the -DIPFP option.
9) The full forward pulse width is 2 us, but the reverse pulse is super-imposed on the forward pulse 500 ns after the start of the forward pulse.
10) Increases to 4.5 ns for units with the -DIPFP option, due to the switching relay inductance.
11) Depends on the parasitic inductance of the DUT and its leads.

Test Jigs for “Condition B” Reverse Recovery Tests (AVR-EB4-B, AVR-EB5-B, AVR-EB7-B)

Option Code	Included Jig	Description
	AVX-TRR-MIX	Standard jig, if an optional jig is not specified. Includes a mix of pin sockets. Will accept TO-220AC (2 lead) packages, DO-style packages[3] (DO-15, DO-35, DO-41, DO-201AD, etc.) with leads bent at 90°, and standard and reverse-polarity TO-3 packages. Lead bending is required for axial packages.
-ANB	AVX-TRR-ANB	Optional “axial no bend” jig. Accepts will accept DO-41 packages (0.205" x 0.107" body, max) and Microsemi Axial Type E packages (0.185" x 0.135" body, max). Unlike the standard jig, bending is NOT required to insert these packages. This jig will not accept any other type of package.
-MELF	AVX-TRR-MELF	Optional MELF jig. Accepts most common MELF and SQMELF packages. Uses two opposing spring pins, which much be pulled back using tweezers while maneuvering the DUT into position.
-SQMELF	AVX-TRR-SQMELF	Optional square MELF jig. Accepts Microsemi Type A (D-5A) and Microsemi Type E (D-5B) “square MELF” packages. It also accepts Microsemi Type B (D-5D) and Microsemi Type G (D-5C) packages, although the fit is less optimal. Easier to use (tweezers are not required to open the device holder), but less flexible, than the -MELF option.
-DIPFP	AVX-TRR-DIPFP	Optional military-style DIP / flat-pack jig. Accepts DIP packages with up to 16 pins (width = 0.3”, pitch = 0.1”). A flat-pack-to-DIP adapter is provided to accept mil-style flat-packs with up to 16 pins (width < 0.27”, pitch = 0.050”). The instrument can be programmed to switch the input and output signals to any pair of pins on the device under test, using a system of internal relays. This is not available as a separate part number. It must be ordered as an option when ordering the AVR-EB-series instrument.
-AR1	AVX-TRR-AR1	Optional axial / square MELF jig with customized Aries 9890-122-23 socket. Accepts: 1. Microsemi "Type E" axial packages (used in the 1N5418 and other devices) 2. Generic DO-41 packages (used in the 1N5819 and other devices) 3. Microsemi Type A square MELF, also called D-5A (for example, 1N5806US) 4. Microsemi Type B square MELF, also called D-5D (for example, 1N6701US) 5. Microsemi Type E square MELF, also called D-5B (for example, 1N5811US)
-STUD	AVX-TRR-STUD	Optional stud jig. Accepts DO-4 and DO-5 stud packages.

Test Jigs for “Condition A” Reverse Recovery Tests (AVR-EB2A-B)

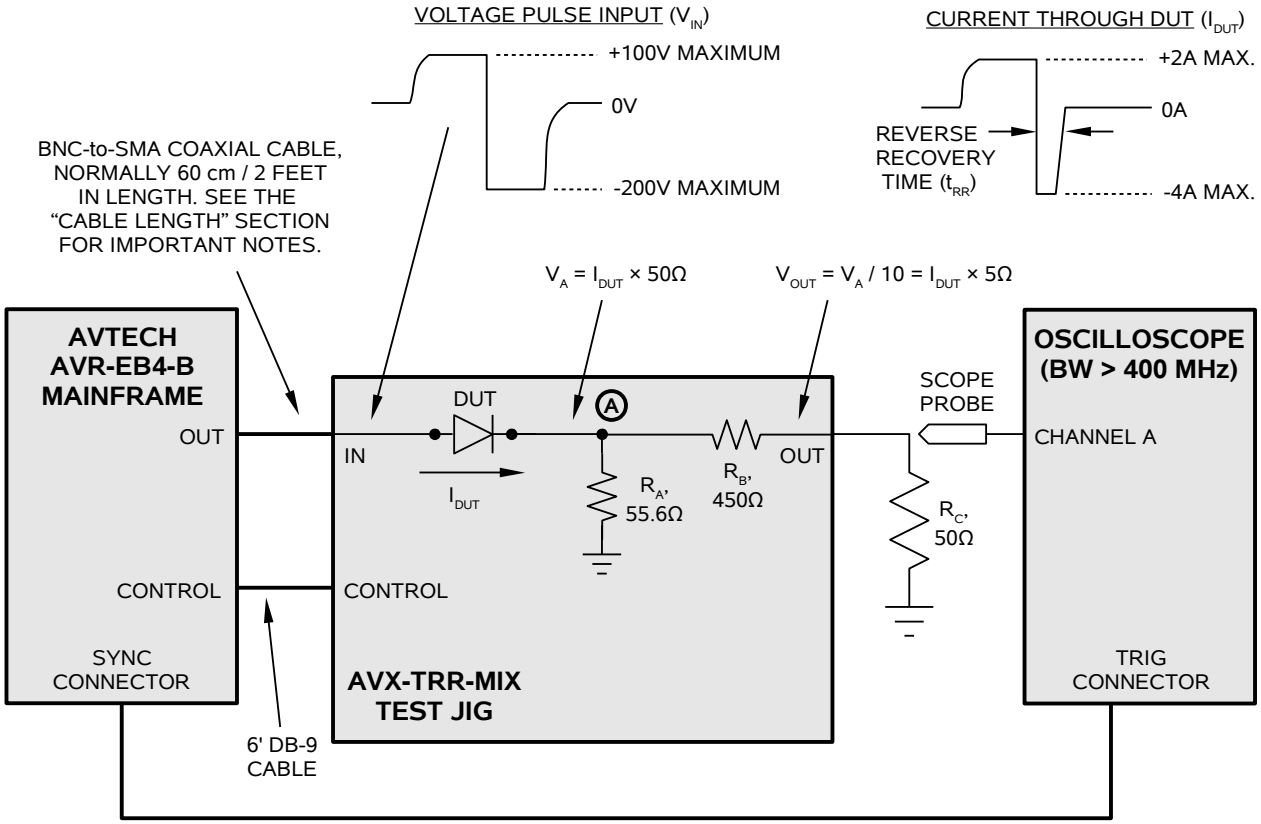
Option Code	Included Jig	Description
	AVX-CA-AR1	Standard jig with customized Aries 9890-122-23 socket. Accepts: 1. Microsemi "Type E" axial packages (used in the 1N5418 and other devices) 2. Generic DO-41 packages (used in the 1N5819 and other devices) 3. Microsemi Type A square MELF, also called D-5A (for example, 1N5806US) 4. Microsemi Type B square MELF, also called D-5D (for example, 1N6701US) 5. Microsemi Type E square MELF, also called D-5B (for example, 1N5811US)

Test Jigs for Forward Recovery Tests (AVR-EBF6, AVR-EBF8-B)

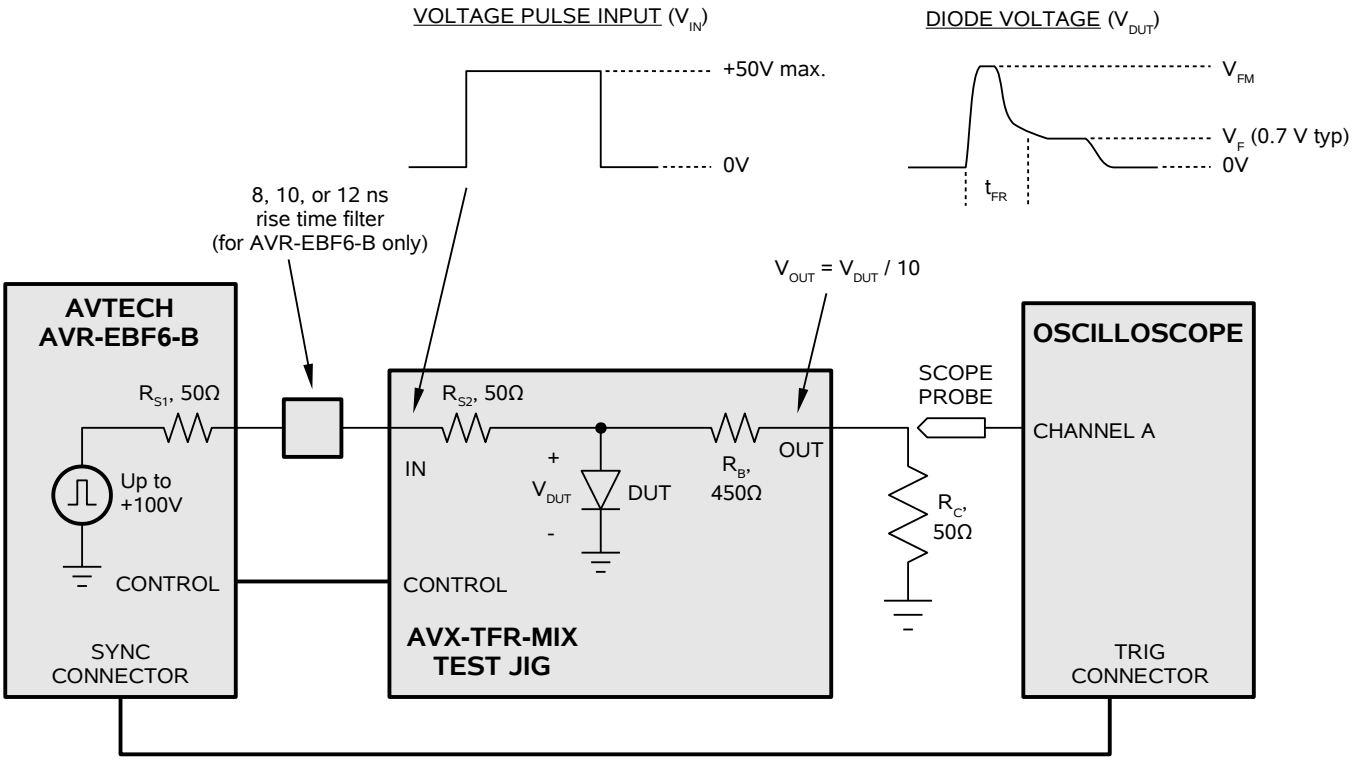
Option Code	Included Jig	Description
	AVX-TFR-MIX	Standard jig, if an optional jig is not specified. Includes a mix of pin sockets. Will accept TO-220AC (2 lead) packages, DO-style packages[3] (DO-15, DO-35, DO-41, DO-201AD, etc.) with leads bent at 90°, and standard and reverse-polarity TO-3 packages. Lead bending is required for axial packages.
-ANB	AVX-TFR-ANB	Optional “axial no bend” jig. Accepts will accept DO-41 packages (0.205" x 0.107" body, max) and Microsemi Axial Type E packages (0.185" x 0.135" body, max). Unlike the standard jig, bending is NOT required to insert these packages. This jig will not accept any other type of package.
-MELF	AVX-TRR-MELF	Optional MELF jig. Accepts most common MELF and SQMELF packages. Uses two opposing spring pins, which much be pulled back using tweezers while maneuvering the DUT into position.
-SQMELF	AVX-TFR-SQMELF	Optional square MELF jig. Accepts Microsemi Type A (D-5A) and Microsemi Type E (D-5B) “square MELF” packages. It also accepts Microsemi Type B (D-5D) and Microsemi Type G (D-5C) packages, although the fit is less optimal. Easier to use (tweezers are not required to open the device holder), but less flexible, than the -MELF option.
-DIPFP	AVX-TFR-DIPFP	Optional military-style DIP / flat-pack jig. Accepts DIP packages with up to 16 pins (width = 0.3”, pitch = 0.1”). A flat-pack-to-DIP adapter is provided to accept mil-style flat-packs with up to 16 pins (width < 0.27”, pitch = 0.050”). The instrument can be programmed to switch the input and output signals to any pair of pins on the device under test, using a system of internal relays. This is not available as a separate part number. It must be ordered as an option when ordering the AVR-EB-series instrument.
-AR1	AVX-TFR-AR1	Optional axial / square MELF jig with customized Aries 9890-122-23 socket. Accepts: 1. Microsemi "Type E" axial packages (used in the 1N5418 and other devices) 2. Generic DO-41 packages (used in the 1N5819 and other devices) 3. Microsemi Type A square MELF, also called D-5A (for example, 1N5806US) 4. Microsemi Type B square MELF, also called D-5D (for example, 1N6701US) 5. Microsemi Type E square MELF, also called D-5B (for example, 1N5811US)
-STUD	AVX-TFR-STUD	Optional stud jig. Accepts DO-4 and DO-5 stud packages.

NOTE: *All of the above jigs are suitable for light research and development use. Consult Avtech (info@avtechpulse.com) regarding the suitability of particular jigs for heavy production use.*

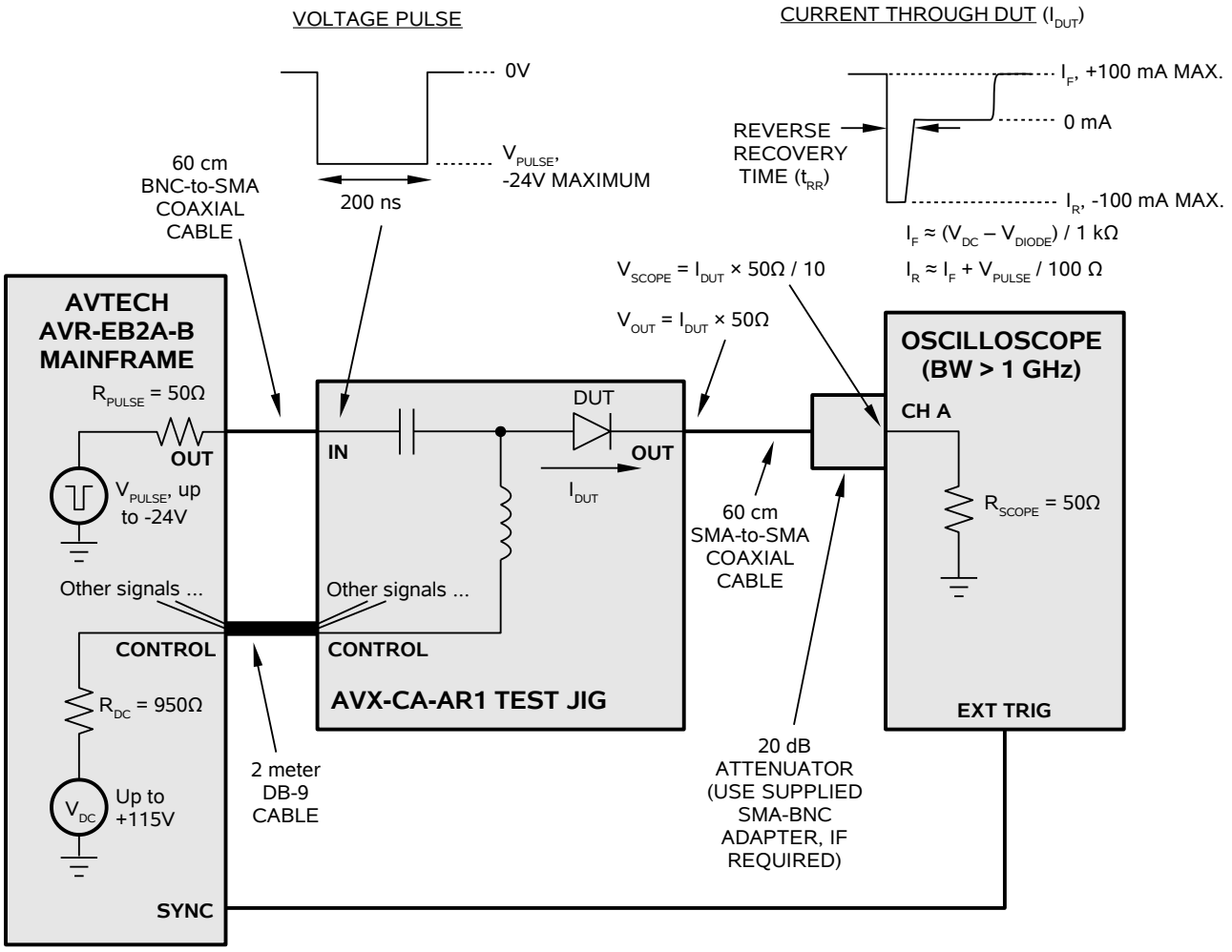
Typical Test Arrangement – "Condition B" Reverse Recovery Tests



Typical Test Arrangement – Forward Recovery Tests



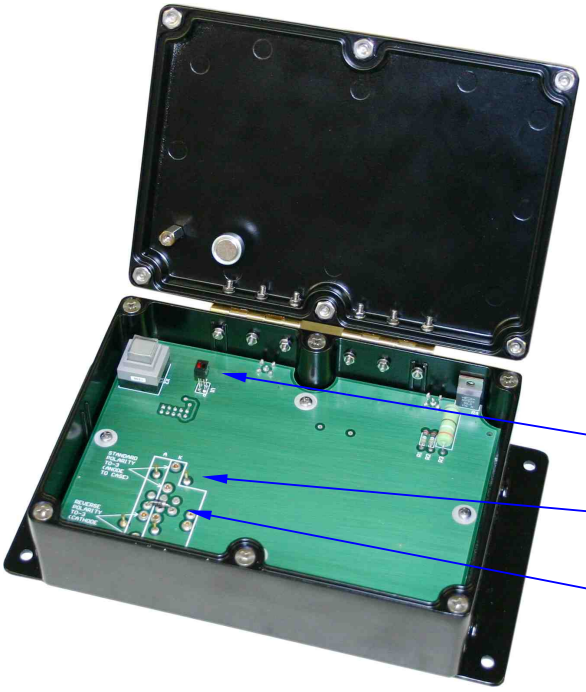
Typical Test Arrangement – "Condition A" Reverse Recovery Tests



INSTRUMENT MAINFRAME

TEST JIGS

The standard AVR-EB4-B, AVR-EB5-B, and AVR-EB7-B models include the AVX-TRR-MIX test jig, shown below. (The AVX-TFR-MIX jig for forward recovery tests is similar.)



The input, output, and control cables connect to the rear, shown below:

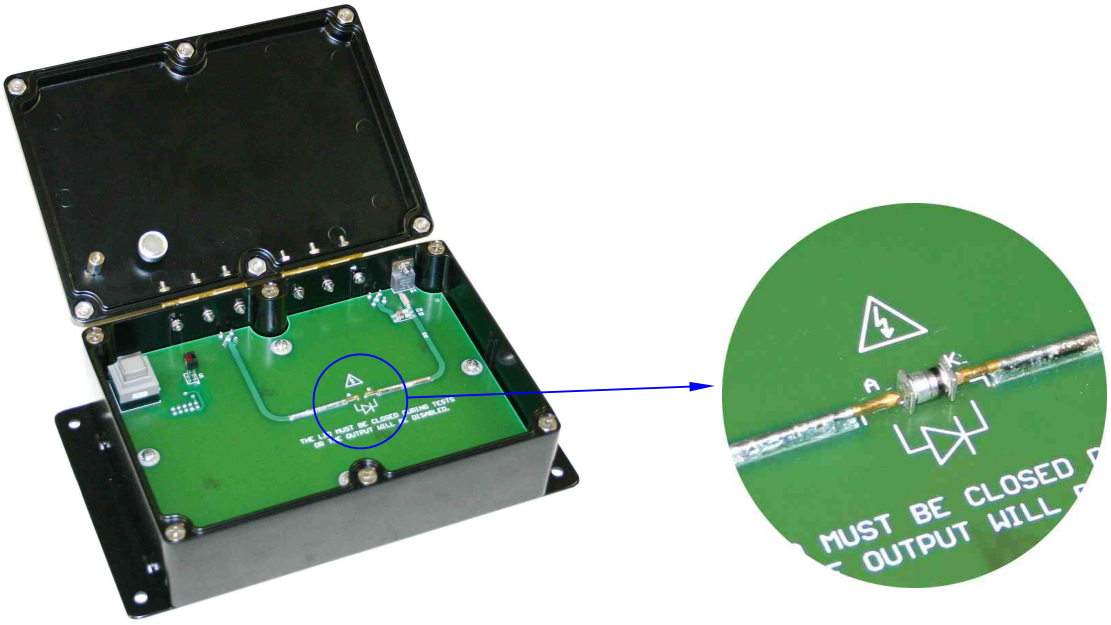
Safety interlocks

Pin sockets, to accommodate a range of leaded devices (DO-41, TO-220, TO-3, etc).

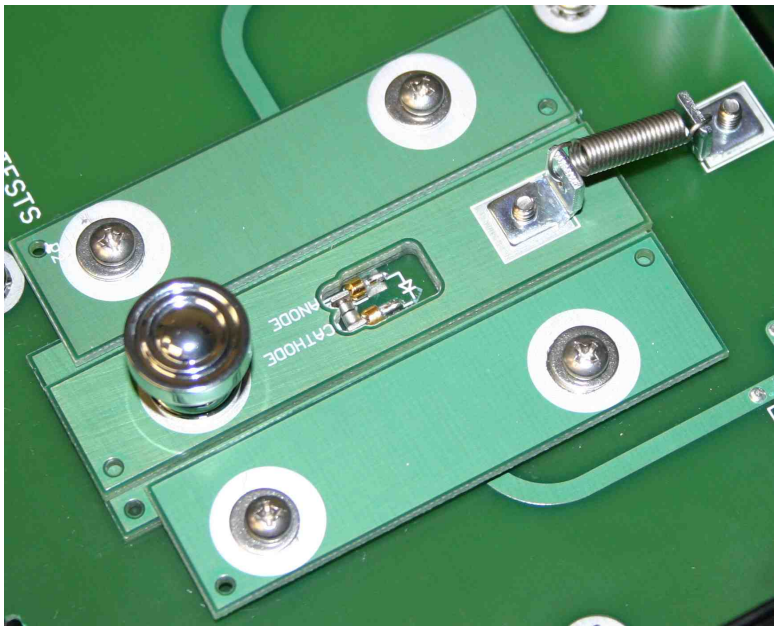
An installed device under test. DO-41 package.

Each test jig is specially designed to minimize the parasitic inductance that can distort results, while maintaining ease of use.

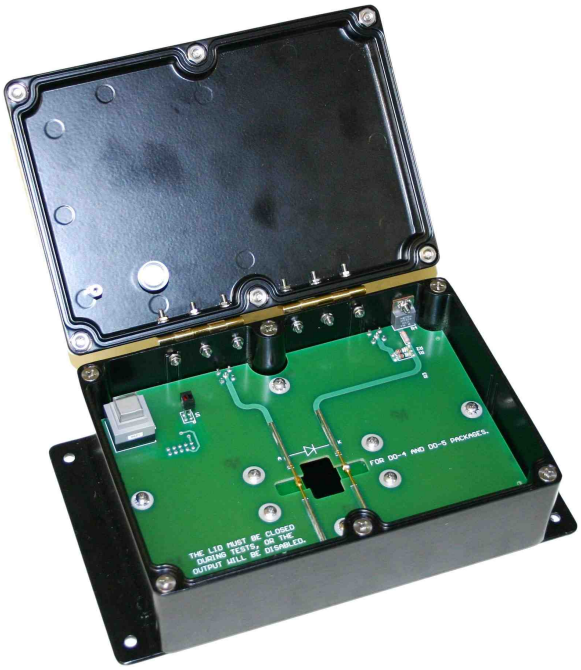
Specialized test jigs can be provided. For instance, the “-MELF” jigs accommodates surface-mount MELF packages, using simple spring-loaded contact pins:

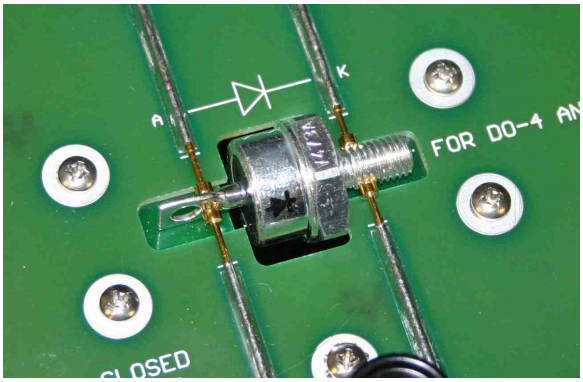


The -SQMELF jigs also accept square MELF devices, but have an easier-to-use sliding device holder:

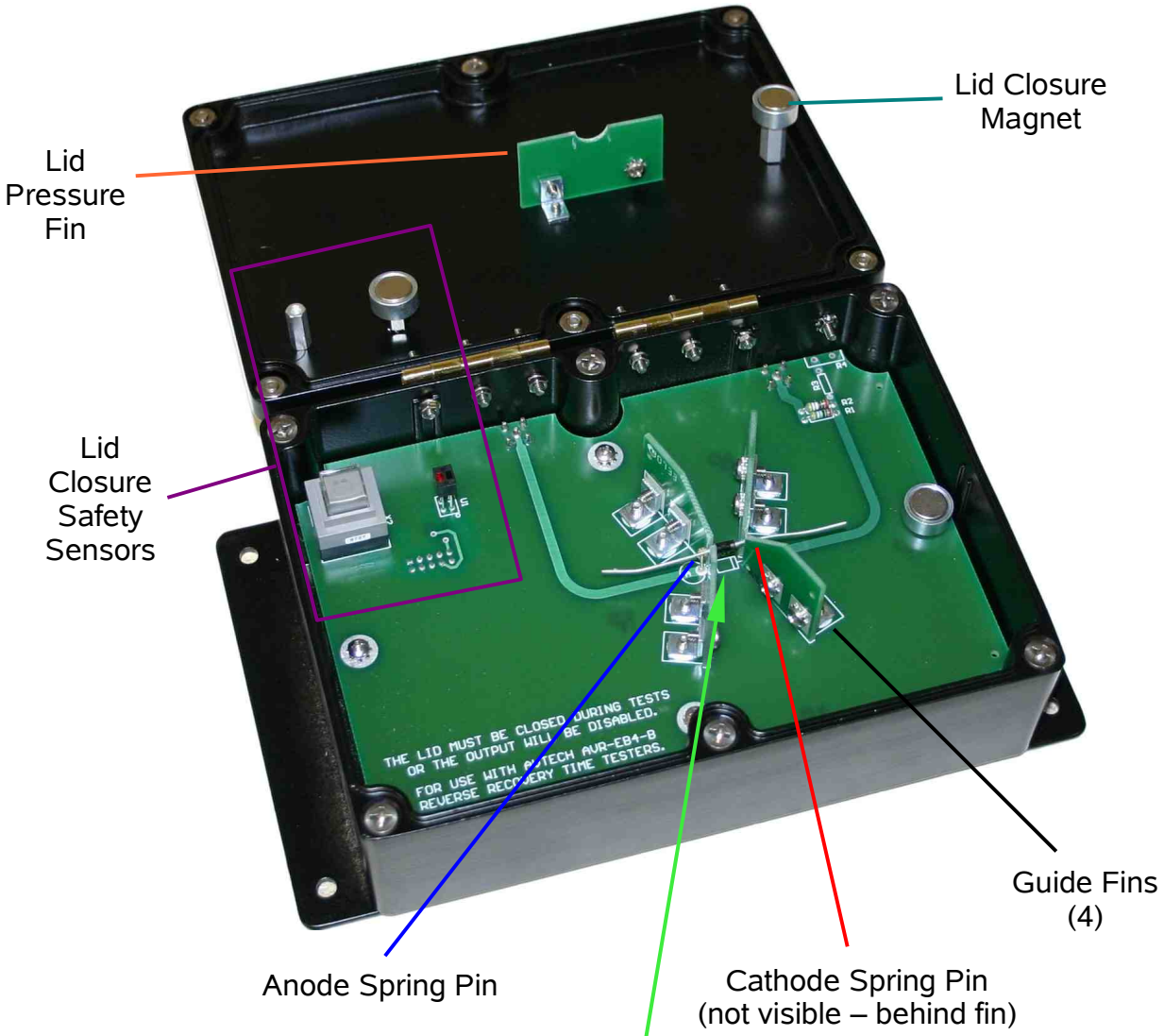


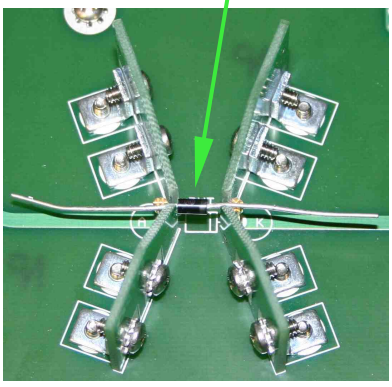
The “-STUD” test jigs accept DO-4 and DO-5 stud packages:



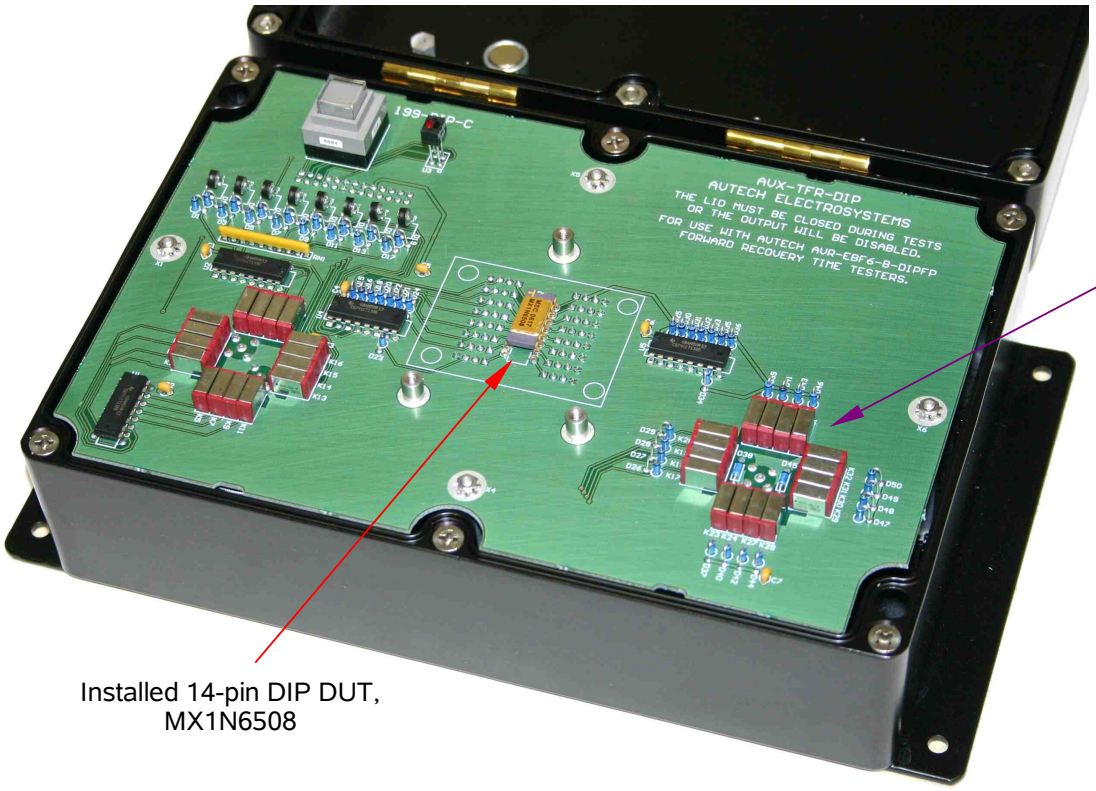


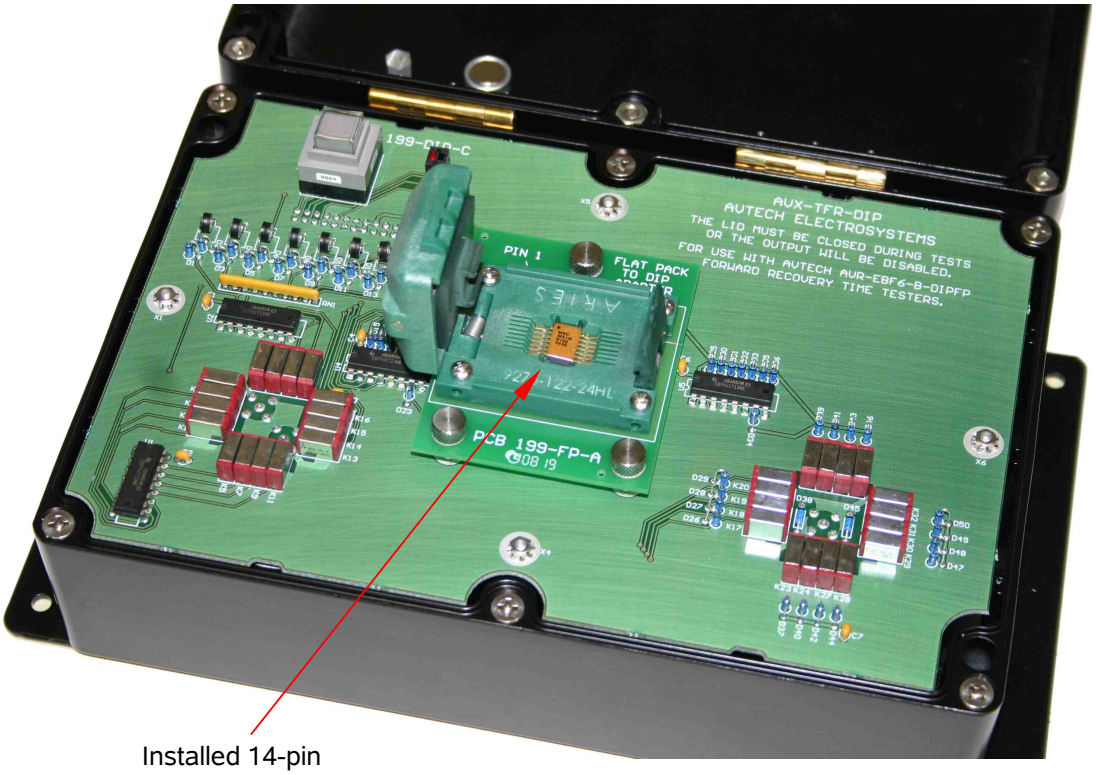
The “-ANB” jigs are intended for applications where axial devices must be tested, but lead bending is undesirable:



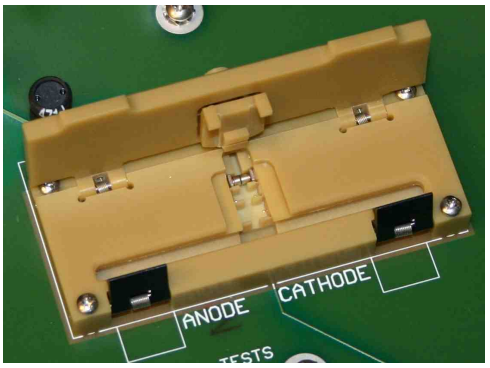


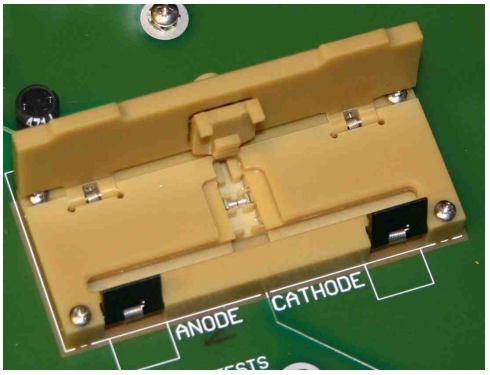
The “-DIPFP” jigs are intended for testing diode arrays in DIP packages and military-style flat packs. These jigs must be ordered with the AVR-EB-series instrument, because they require additional circuitry to support the routing of signals to the various possible pins.

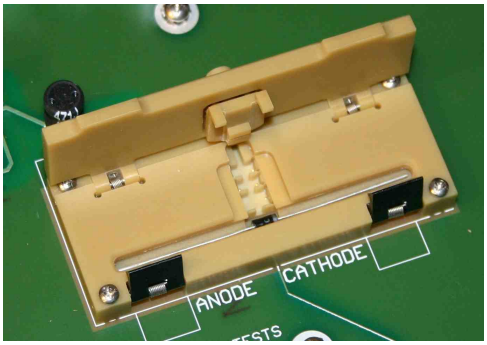


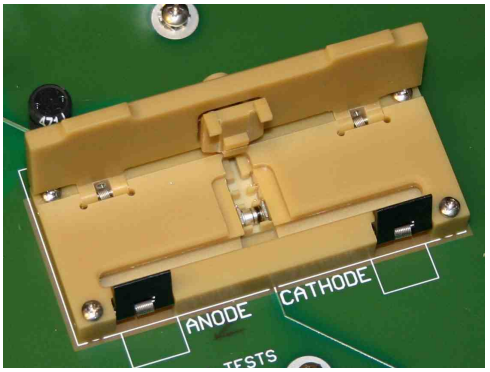


The “-AR1” jigs included a customized Aries Electronics (http://www.arieselec.com/) model 9890-122-23 socket, which accepts a variety of axial and SQMELF package types. It is best suited for light R&D use.









The various test jigs listed above have been developed in response to particular customer requirements. Other test jigs can be provided upon request. Contact Avtech (info@avtechpulse.com) with your special test requirements!