INSTRUCTIONS

MODEL AVR-EB3-B

0 TO ±100V (0 to ±1A) PULSE GENERATOR
FOR MIL-STD-750C METHOD
4031.1 AND 4026.2 T_{RR} AND T_{FR} TESTS

SERIAL NUMBER: ____________

WARRANTY

Avtech Electrosystems Ltd. warrants products of its manufacture to be free from defects in material and workmanship under conditions of normal use. If, within one year after delivery to the original owner, and after prepaid return by the original owner, this Avtech product is found to be defective, Avtech shall at its option repair or replace said defective item. This warranty does not apply to units which have been dissembled, modified or subjected to conditions exceeding the applicable specifications or ratings. This warranty is the extent of the obligation assumed by Avtech with respect to this product and no other warranty or guarantee is either expressed or implied.

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Manual Reference: /fileserver1/officefiles/instructword/avr-eb/avr-eb3/AVR-EB3-B, edition 1.doc, created October 3, 2001

INTRODUCTION

The AVR-EB-C series was specifically designed to provide the diode switching time test waveforms specified in MIL-STD-750C, Methods 4031.1 and 4026.2 for T_{RR} and T_{FR}. This instrument units generates two pulsed outputs (a positive turn-on waveform and a negative turn-off waveform) and provides the necessary variable delay between the two outputs. The two outputs may also be used separately for other applications.

One output generates amplitudes of 0 to +100V, and a second output generates amplitudes of 0 to -100V. When used in junction with an appropriate test jig, the model AVR-EB3-B can provide diode test currents as high as 1.0 Ampere. The negative output has a rise time of less than 1 ns, which allows the testing of ultra-fast diodes. (This rise time can be increased to 5 ns, if necessary, by means of a rear-panel switch.) The positive output has a rise time of less than 5 ns.

The AVR-EB3-B can be triggered internally, or triggered or gated by an external source. A front-panel pushbutton can also be used to trigger the instrument.

The AVR-EB3-B features front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40-character backlit LCD display of the output amplitude, polarity, pulse width, pulse repetition frequency, source resistance and delay. The instrument includes memory to store up to four complete instrument setups. The operator may use the front panel or the computer interface to store a complete “snapshot” of all key instrument settings, and recall this setup at a later time.

SPECIFICATIONS

Model:	AVR-EB3-B	
GPIB & RS-232 control:	Standard	
Channel:	1	2
Output amplitude:	0 to -100V	0 to +100V
Diode current max (Amp):	- 1.0	+ 1.0
Pulse width:	0.1 to 5.0 us	0.1 to 5.0 us
Rise, fall time:	1.0 ns (can be increased to 5 ns by means of a rear-panel switch)	5.0 ns
Source Impedance (Ohms):	50	$\leq$ 2
PRF:	5 Hz to 5 kHz	
Delay:	0 to 5 us (channel 1 to channel 2)	
Connectors:	BNC	
Prime power:	120/240 V, 50-60 Hz	
Jitter (Ext trig in to pulse out):	$\pm$ 100 ps $\pm$ 0.03% of sync delay	
External Trigger:	+5 Volt, 50 ns or wider (TTL)	
Sync output:	+3 Volts, 200 ns, will drive 50 Ohm loads	
Gated operation:	sync or async, active high or low, switchable	
Power requirements:	120/240 Volts (switchable) 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	
Mounting:	Any	
Temperature range:	+15° to +40° C	

INSTALLATION

VISUAL CHECK

After unpacking the instrument, examine to ensure that it has not been damaged in shipment. Visually inspect all connectors, knobs, liquid crystal displays (LCDs), and the handles. Confirm that a power cord, a GPIB cable, and two instrumentation manuals (this manual and the “OP1B Interface Programming Manual”) are with the instrument. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

PLUGGING IN THE INSTRUMENT

Examine the rear of the instrument. There will be a male power receptacle, a fuse holder and the edge of the power selector card visible. Confirm that the power selector card is in the correct orientation.

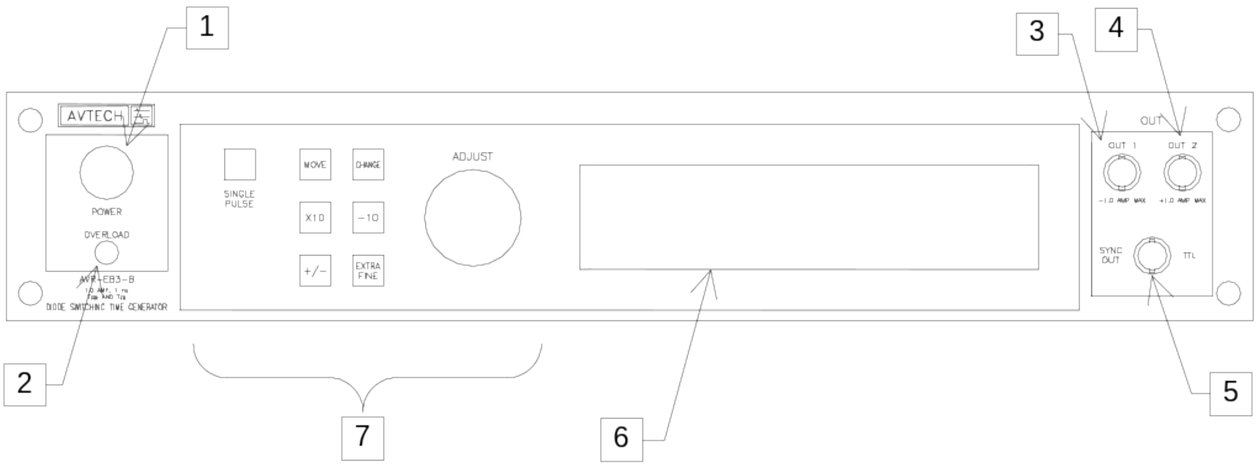
For AC line voltages of 110-120V, the power selector card should be installed so that the “120” marking is visible from the rear of the instrument.

For AC line voltages of 220-240V, the power selector card should be installed so that the “240” marking is visible from the rear of the instrument.

If it is not set for the proper voltage, remove the fuse and then grasp the card with a pair of pliers and remove it. Rotate horizontally through 180 degrees. Reinstall the card and the correct fuse.

In the 120V setting, a 1.0A slow blow fuse is required. In the 240V setting, a 0.5A slow blow fuse is required.

FRONT PANEL CONTROLS



1. POWER Switch. The POWER push button switch applies AC prime power to the primaries of the transformer, turning the instrument on. The push button lamp is connected to the internal +15V DC supply.

2. OVERLOAD. The AVR-EB3-B is protected in its internal software against conflicting or dangerous settings. As an additional protective measure, an automatic overload circuit exists, which controls the front panel overload light. If the unit is overloaded (by operating at an exceedingly high duty cycle or by operating into a very low impedance), the protective circuit will turn the output of the instrument OFF and turn the indicator light ON. The light will stay ON (i.e. output OFF) for about 5 seconds after which the instrument will attempt to turn ON (i.e. light OFF) for about 1 second. If the overload condition persists, the instrument will turn OFF again (i.e. light ON) for another 5 seconds. If the overload condition has been removed, the instrument will turn on and resume normal operation.

   This overload indicator may come one riefly at startup. This is not a cause for concern.

3. OUT 1 CONNECTOR. This BNC connector provides the negative output signal. The amplitude of this output can be varied from 0 to -100V.

4. OUT 2 CONNECTOR. This BNC connector provides the positive output signal. The amplitude of this output can be varied from 0 to +100V.

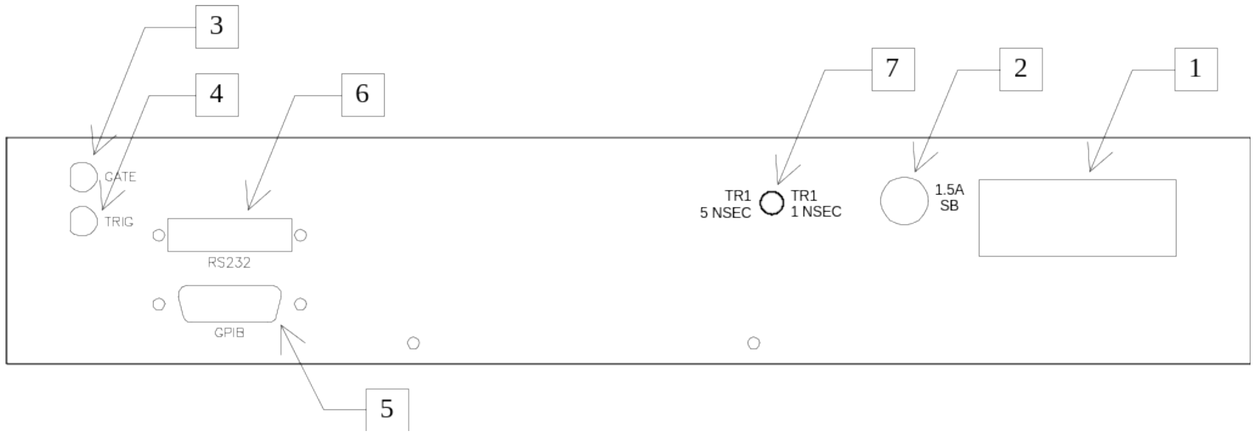
5. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads (or lags) the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to R_L > 1K with a pulse width of approximately 50 ns.

6. LIQUID CRYSTAL DISPLAY (LCD). This LCD is used in conjunction with the keypad to change the instrument settings. Normally, the main menu is displayed, which lists the key adjustable parameters and their current values. The "OP1B Interface Programming Manual" describes the menus and submenus in detail.

7. KEYPAD.

Control Name	Function
MOVE	This moves the arrow pointer on the display.
CHANGE	This is used to enter the submenu, or to select the operating mode, pointed to by the arrow pointer.
×10	If one of the adjustable numeric parameters is displayed, this increases the setting by a factor of ten.
÷10	If one of the adjustable numeric parameters is displayed, this decreases the setting by a factor of ten.
+/-	If one of the adjustable numeric parameters is displayed, and this parameter can be both positive or negative, this changes the sign of the parameter.
EXTRA FINE	This changes the step size of the ADJUST knob. In the extra-fine mode, the step size is twenty times finer than in the normal mode. This button switches between the two step sizes.
ADJUST	This large knob adjusts the value of any displayed numeric adjustable values, such as frequency, pulse width, etc. The adjust step size is set by the "EXTRA FINE" button. When the main menu is displayed, this knob can be used to move the arrow pointer.

REAR PANEL CONTROLS



1. AC POWER INPUT. A three-pronged recessed male connector is provided on the back panel for AC power connection to the instrument. Also contained in this assembly is a slow-blow fuse and a removable card that can be removed and repositioned to switch between 120V AC in and 240V AC in.

   For AC line voltages of 110-120V, the power selector card should be installed so that the “120” marking is visible from the rear of the instrument.

   For AC line voltages of 220-240V, the power selector card should be installed so that the “240” marking is visible from the rear of the instrument.

   If it is not set for the proper voltage, remove the fuse and then grasp the card with a pair of pliers and remove it. Rotate horizontally through 180 degrees. Reinstall the card and the correct fuse.

   In the 120V setting, a 1.0A slow blow fuse is required. In the 240V setting, a 0.5A slow blow fuse is required.

2. 1.5A SB. This fuse protects the output stage if the output duty cycle rating is exceeded.

3. GATE. This TTL-level (0 and +5V) logic input can be used to gate the triggering of the instrument. This input can be either active high or active low, depending on the front panel settings or programming commands. (The instrument triggers normally when this input is unconnected).

4. TRIG. This TTL-level (0 and +5V) logic input can be used to trigger the instrument, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input. The instrument can also be set such that the output pulse width tracks the pulse width on this input, or the output pulse width can be set independently.

5. GPIB Connector. A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “OP1B Interface Programming Manual” for more details on GPIB control.

6. RS-232 Connector. A standard serial cable with a 25-pin male connector can be attached to this connector to allow the instrument to be computer-controlled. See the “OP1B Interface Programming Manual” for more details on RS-232 control.

7. Channel 1 Rise Time Switch. Normally, the rise time of the Channel 1 output is 1 ns. However, the rise time can be increased to 5 ns by setting this switch to the “5 NSEC” position.

GENERAL INFORMATION

BASIC PULSE CONTROL, WITHOUT TEST JIG

This instrument can be triggered by its own internal clock or by an external TTL trigger signal. In either case, three output channels respond to the trigger: OUT 1, OUT 2 and SYNC. The OUT 1 channel is a negative amplitude signal that may either drive a 50 Ohm load, or the test jig described later. Its amplitude and pulse width are variable. The OUT 2 channel is a positive amplitude signal that may either drive a 50 Ohm load, or the test jig described later. Its amplitude and pulse width are also variable. The SYNC pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems. When the delay is set to a positive value the SYNC pulse precedes the OUT pulse. When the delay is set to a negative value the SYNC pulse follows the OUT pulse.

These pulses are illustrated below, assuming internal triggering and a positive delay:

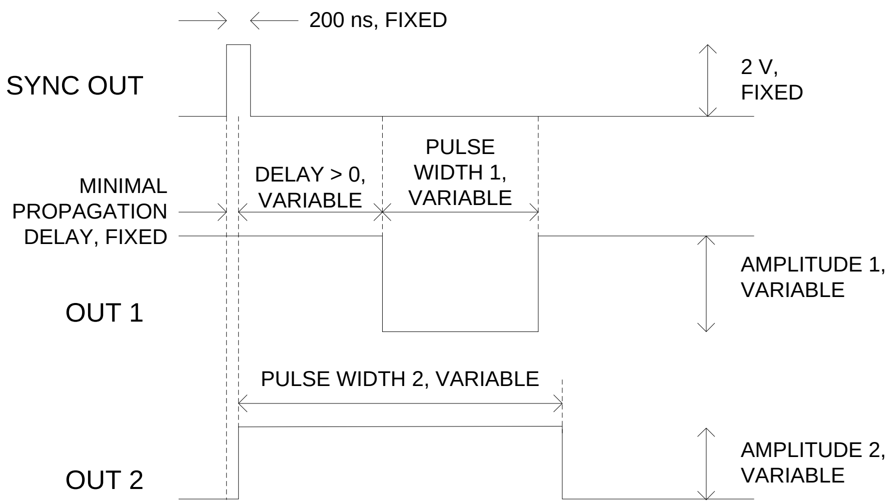


Figure A

If the delay is negative, the order of the SYNC and OUT pulses is reversed:

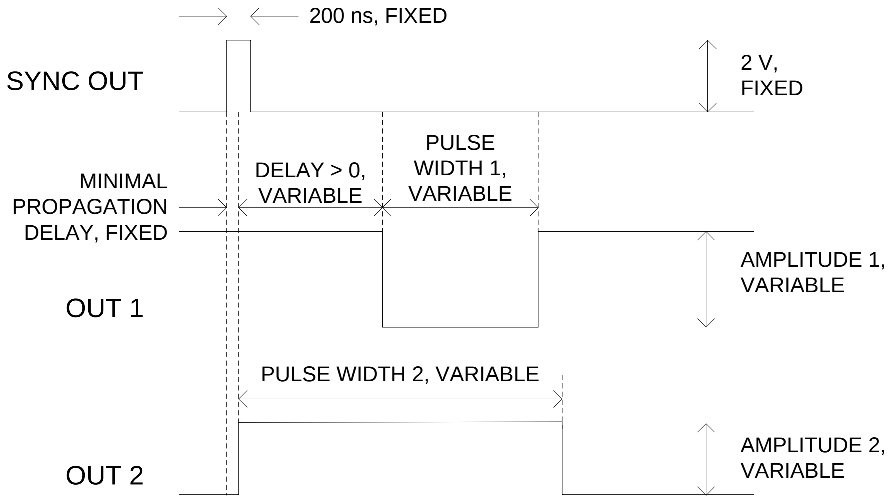


Figure B

The next figure illustrates the relationship between the signals when an external TTL-level trigger is used:

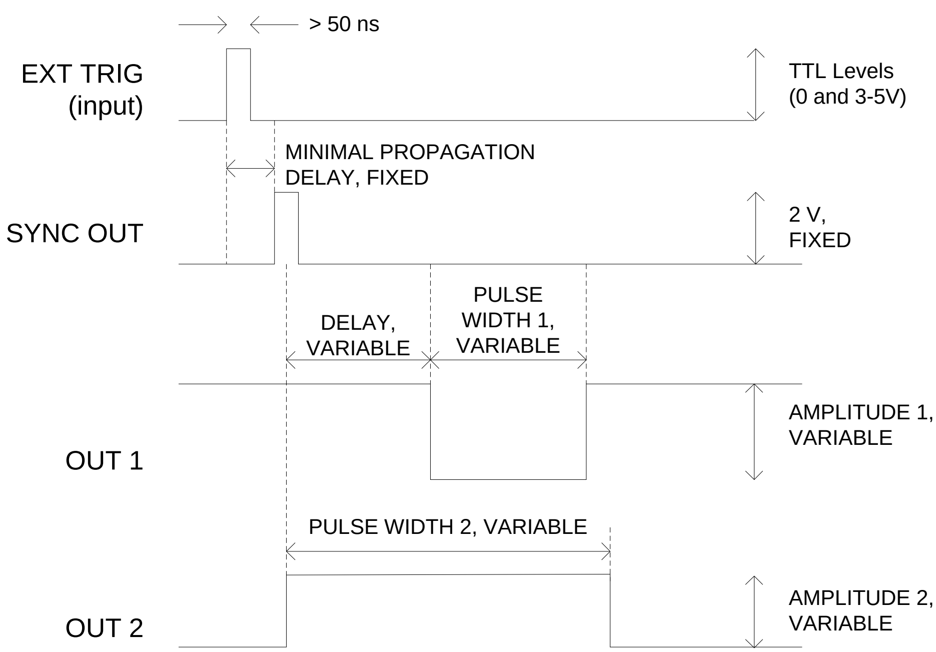


Figure C

The delay, pulse width, and frequency (when in the internal mode), of the OUT pulse can be varied with front panel controls or via the GPIB or RS-232 computer interfaces.

TRIGGER MODES

This instrument has four trigger modes:

- Internal Trigger: the instrument controls the trigger frequency, and generates the clock internally.
- External Trigger: the instrument is triggered by an external TTL-level clock on the back-panel TRIG connector.
- Manual Trigger: the instrument is triggered by the front-panel “SINGLE PULSE” pushbutton.
- Hold Trigger: the instrument is set to not trigger at all.

These modes can be selected using the front panel trigger menu, or by using the appropriate programming commands. (See the “OP1B Interface Programming Manual” for more details.)

PULSE WIDTH MODES

This instrument has two pulse width modes:

- Normal: the instrument controls the output pulse width.
- $PW_{IN}=PW_{OUT}$: the output pulse width equals the pulse width of the trigger signal on the “TRIG” connector. The instrument must be in the external trigger mode.

These modes can be selected using the front panel pulse width menu, or by using the appropriate programming commands. (See the “OP1B Interface Programming Manual” for more details.)

GATING MODES

Triggering can be suppressed by a TTL-level signal on the rear-panel GATE connector. The instrument can be set to stop triggering when this input high or low, using the front-panel gate menu or the appropriate programming commands. This input can also be set to act synchronously or asynchronously. When set to asynchronous mode, the GATE will disable the output immediately. Output pulses may be truncated. When set to synchronous mode, the output will complete the full pulse width if the output is high, and then stop triggering. No pulses are truncated in this mode.

USING THE TEST JIGS - FORWARD RECOVERY TESTS

Although the AVR-EB3-B can be used as a two-channel 50Ω pulse generator, the two outputs are normally used together to drive special-purpose test jigs. These test jigs are used to perform the MIL-STD-750C Methods 4031.1 and 4026.2 diode recovery tests.

PERFORMING METHOD 4026.2 FORWARD RECOVERY TESTS

When performing Method 4026.2 tests, the basic approach is to pulse a series combination of a resistor and the device under test with a positive voltage. (A shunt resistor is added to provide proper transmission line termination.) The basic setup is shown below, when used with a sampling oscilloscope:

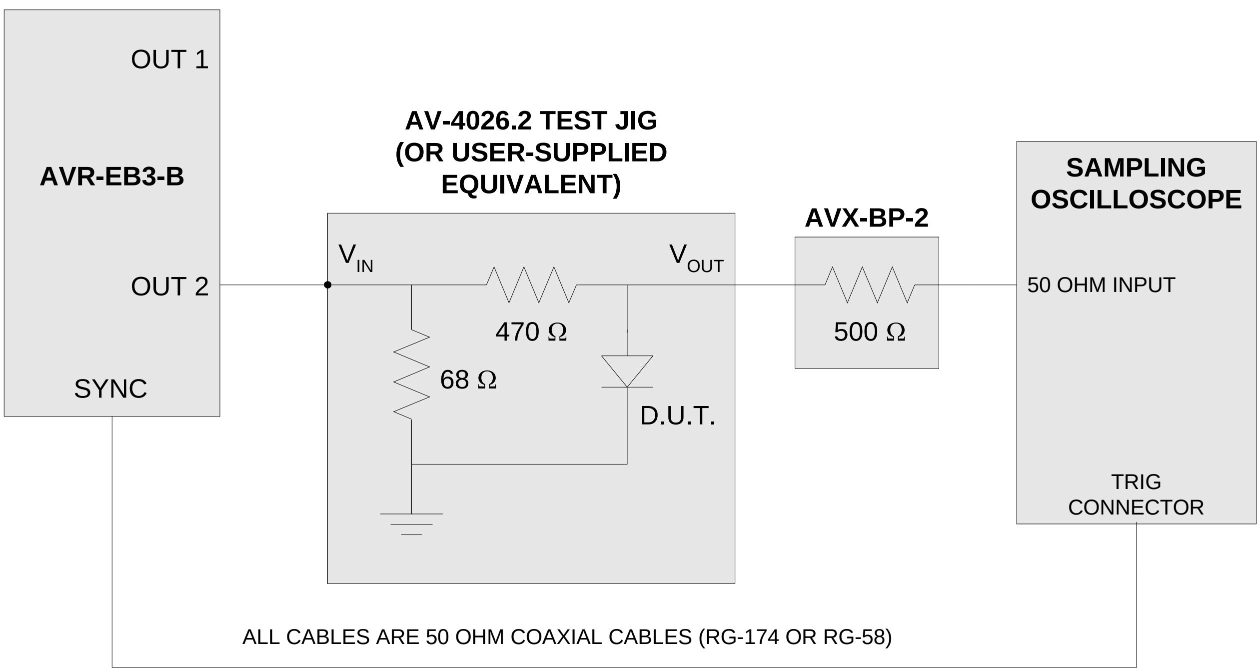


Figure D

The AVX-BP-2 is included to boost the apparent input impedance of the oscilloscope. (According to the 4026.2 specification, the impedance of the measuring device must be greater than 20 V_F/I_F, which for a typical diode with 0.7V forward voltage, tested at 50 mA, would be $20 \times 0.7 / 0.05 = 280\ \Omega$. Thus, the 50 Ω input impedance of a typical sampling oscilloscope is too low.) Alternatively, if the diode recovery time is relatively slow, a real-time oscilloscope may be used instead, in which case the following connections should be used:

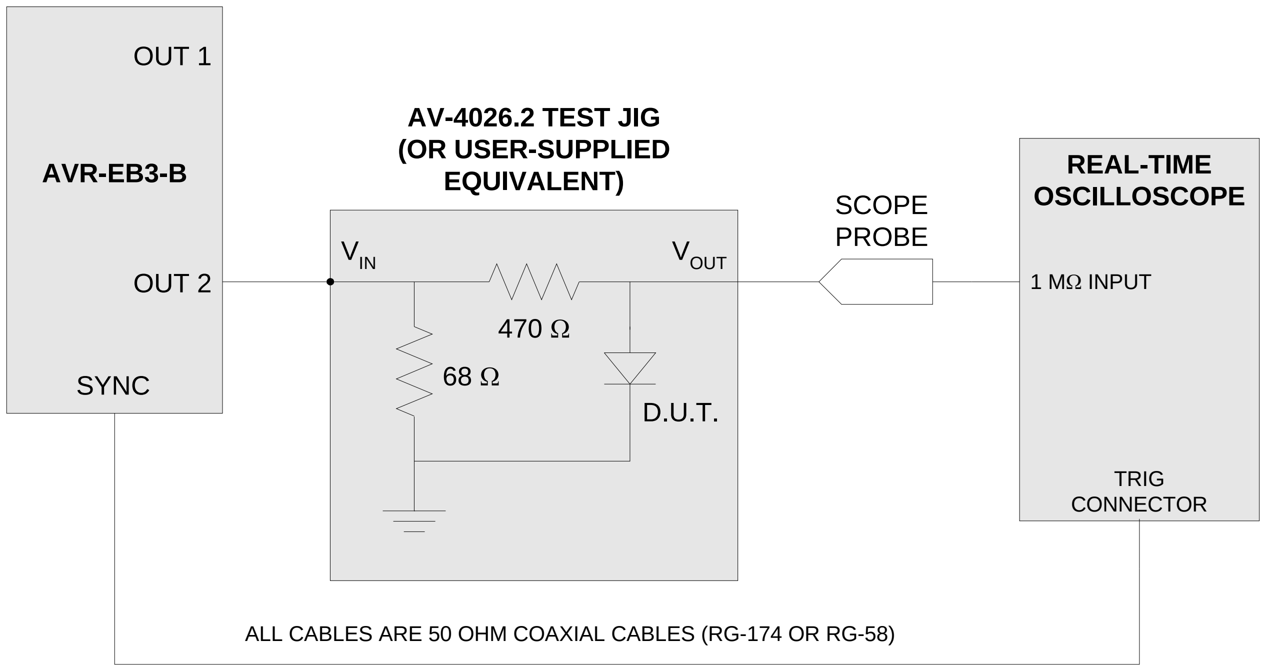


Figure E

The resulting waveforms are illustrated below:

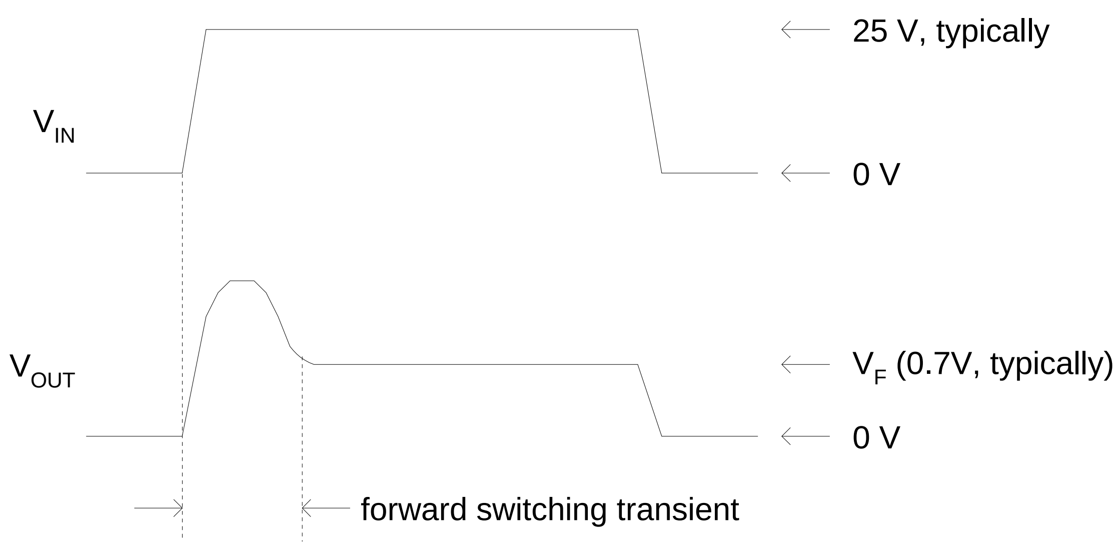


Figure F

The necessary OUT 2 amplitude, V_{IN}, needed to generate a given forward current, I_F, can be calculated using: $V_{IN} = V_F + I_F \times 470\Omega$, where V_F is the typical forward voltage drop across the diode. If higher currents are required, the 470Ω resistor can be decreased.

<u>EXAMPLE PROCEDURE - FORWARD RECOVERY TEST WITH A 1N4150 DIODE</u>

1) For this example, connect the pulser and test jig as shown in Figure D. Insert the 1N4150 diode in the D.U.T. socket.

2) Set the AVR-EB3-B to trigger at 5 kHz.

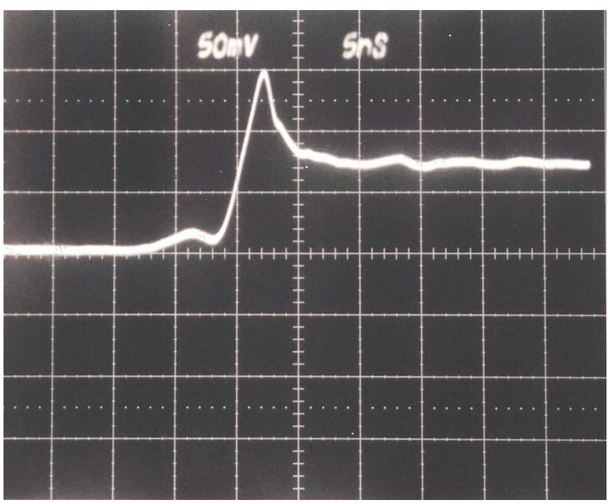
3) Set PW2 at 1 us.

4) Set the OUT2 amplitude to +25V. (This will produce approximately +50 mA of forward current.)

5) Set the outputs to “ON”, using the “Output” menu.

6) Set the sampling oscilloscope time base to 5 ns/div, and the vertical scale to 50 mV/div. (The AVX-BP-2 attenuates the signal by a factor of 11, so the actual vertical scale will be 0.55 V/div.) Adjust the oscilloscope controls as required to center the waveform on the display.

7) The oscilloscope should show a waveform similar to that shown below:



0.55 V/div, 5 ns/div

It can be observed that the forward recovery time of the 1N4150 diode is approximately 6 ns, in this example.

USING THE TEST JIGS - FORWARD RECOVERY TESTS

The MIL-STD-750C Methods 4031.1 reverse recovery test require more skill to perform than the 4026.2 tests, because two separate signals are combined to test the diode.

PERFORMING METHOD 4031.1 REVERSE RECOVERY TESTS

When performing Method 4031.1 reverse recovery tests on ultra-fast switching diodes with recovery times on the order of several tens of nanoseconds, it is necessary to use a high-speed sampling oscilloscope, as shown in Figure G:

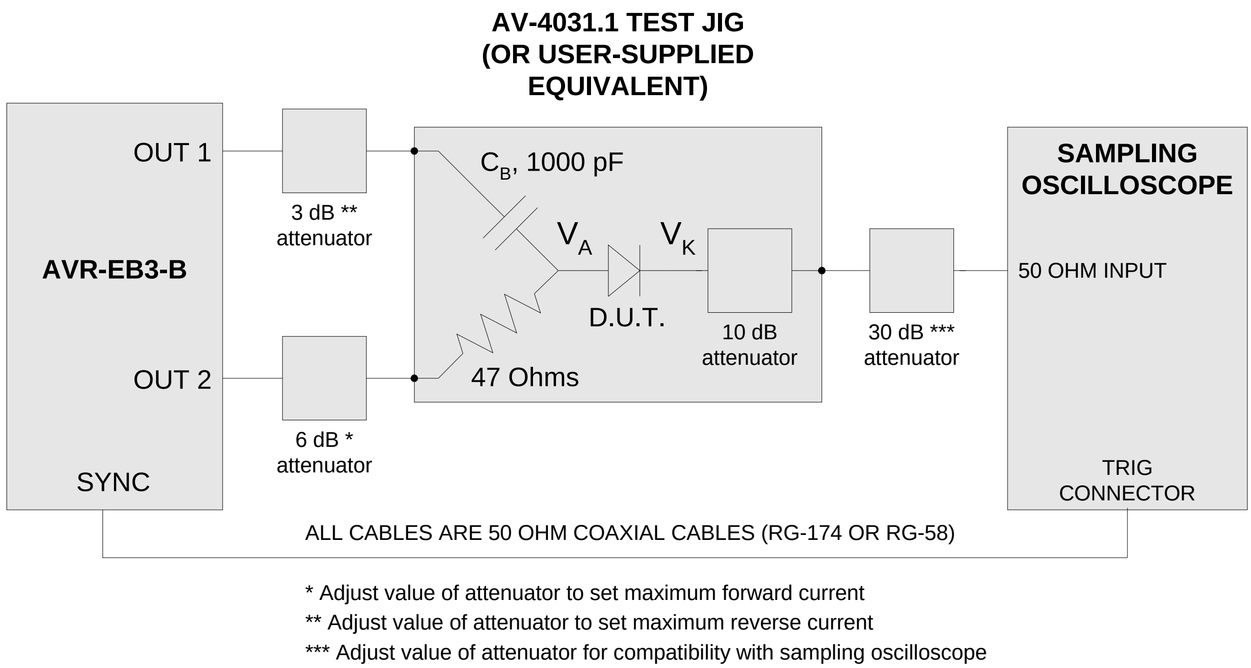


Figure G

For diodes with longer recovery times (> 100 ns), it is practical and more convenient to use a real-time oscilloscope, as shown in Figure H:

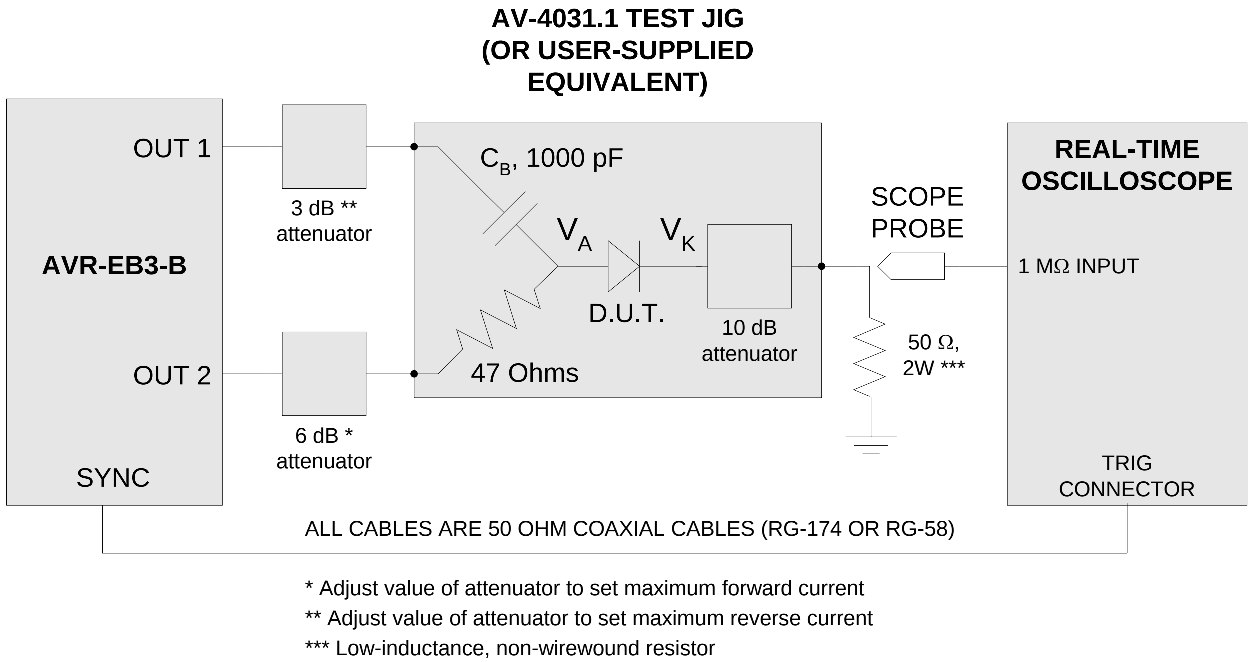


Figure H

When performing Method 4031.1 tests, the basic approach is to combine a wide positive pulse from the OUT 2 output with a narrower, delayed negative pulse from the OUT 1 output. The magnitude of the OUT 2 pulse must be larger than the magnitude of the OUT 1 pulse, to send the diode into reverse bias. The (simplified) resulting waveforms are illustrated below:

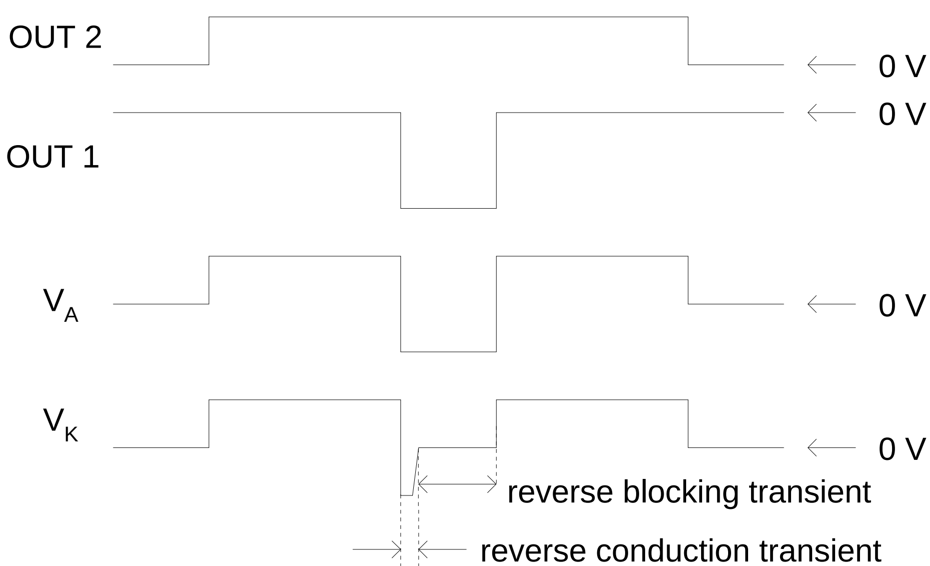


Figure I

Because of the finite value of the coupling capacitor C_B, the actual waveforms will display some AC-coupling effects (rounding and decay):

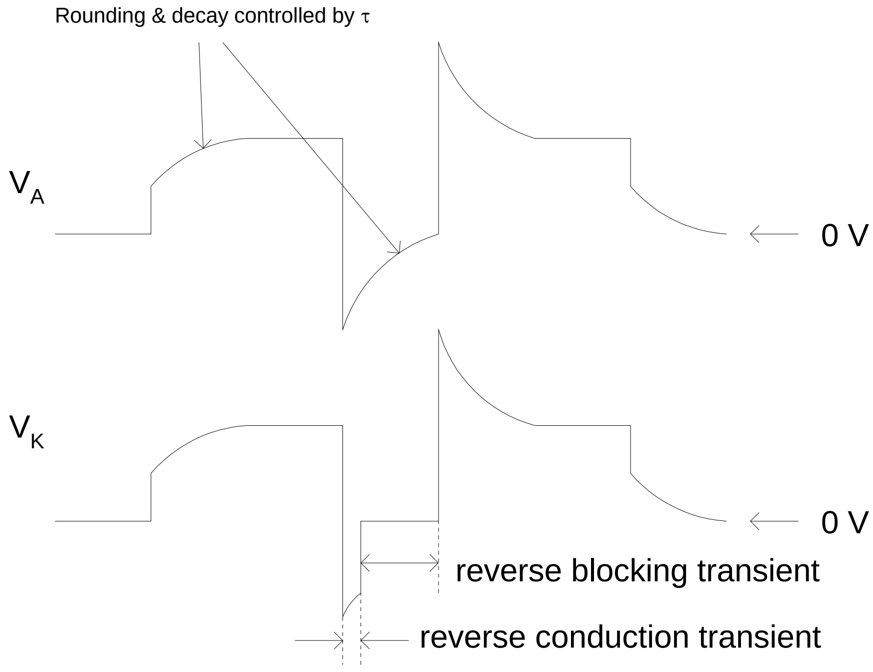


Figure J

The time constant of the rounding and decay is in the order of $\tau = 50\Omega \times C_B$. For instance, if C_B = 1000 pF, the time constant τ is approximately 50 ns. The negative-going pulse should be delayed at least 3τ relative to the start of the positive-going pulse. Also, τ should be several times larger than the expected duration of reverse conduction transient. If τ is too small, the negative-going pulse will decay before the reverse conduction transient has finished, and no reverse-blocking transient will be observed. This will yield incorrect measurements.

As supplied, the test jig has C_B = 1000 pF. This is appropriate for rectifiers with ultra-fast recovery times, of several tens of nanoseconds. The capacitor must be increased for diodes with longer recovery times.

The OUT1 channel can produce up to -100V, and the OUT2 channel can generate amplitudes up to +100V. For optimum waveforms, these outputs should be operated near these maximum values, and attenuators should be added to lower the peak currents generated in the D.U.T. The tables below suggest appropriate attenuator values:

OUT 1 Amplitude	Attenuator Value	Resulting Forward Diode Current*
+100 V	0 dB	2.0 A
+50 V		1.0 A
+100 V	3 dB	0.8 A
+50V		0.4 A
+100 V	6 dB	0.6 A
+50 V		0.3 A
+100 V	10 dB	0.4 A
+50V		0.2 A

*a forward diode voltage of 0.7V has been assumed for the calculations.

The corresponding currents for the OUT 2 channel are listed below:

OUT 2 Amplitude	Attenuator Value	Resulting Current Pulse**
-100 V	0 dB	-2.0 A
-50 V		-1.0 A
-100 V	3 dB	-1.4 A
-50V		-0.7 A
-100 V	6 dB	-1.0 A
-50 V		-0.5 A
-100 V	10 dB	-0.6 A
-50V		-0.3 A

** actual currents may be lower, depending on the diode dynamics.

The OUT 2 amplitude must be large enough to overcome the forward current, and send the diode into reverse conduction. For instance, if OUT 1 is used to generate a 400 mA forward current, and a -400 mA reverse current is desired, then OUT 2 must be set such that a -800 mA pulse is generated.

EXAMPLE PROCEDURE - REVERSE RECOVERY TEST WITH A 1N4150 DIODE

This example procedure shows results obtained with an ultra-fast, medium current switching diode, the 1N4150. Due to the ultra-fast nature of the diode, a sampling oscilloscope must be used.

1. For this example, connect the pulser, test jig, and sampling oscilloscope as shown in Figure G, using the attenuator values shown in the diagram. Insert the 1N4150 diode in the D.U.T. socket.

   NOTE: Channel 1 of the AVR-EB3-B provides an extremely fast rise time of $\leq$1ns. Consequently, the test jig (whether Avtech-supplied or user-supplied) must be extremely broadband or the pulse rise time will be degraded and severe ringing may be observed. It is recommended that the test jig be constructed on microstrip, employing high quality SMA connectors, microwave capacitors and resistors, and that lead lengths be kept less than 0.2 cm.

2. Set the AVR-EB3-B to trigger at 5 kHz.

3. Set PW2 at 1 us, and PW1 at 100 ns.

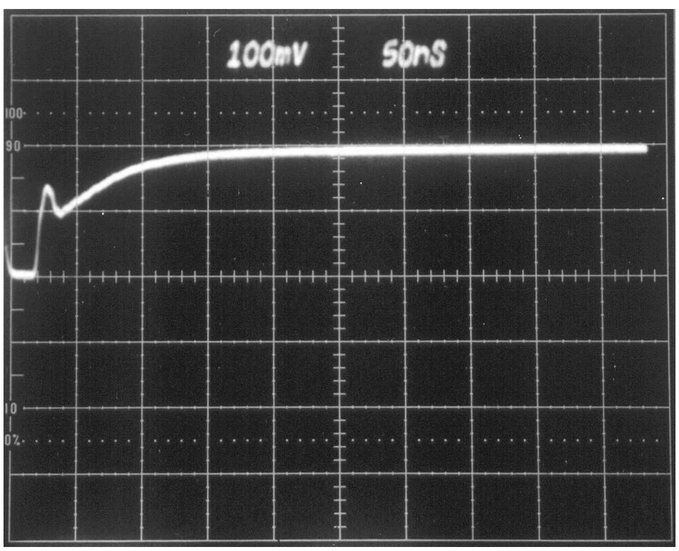
4. Set the delay to +250 ns.

5. Set the OUT2 amplitude to +65V. (This will produce approximately +400 mA of forward current.)

6. Set the outputs to “ON”, using the “Output” menu.

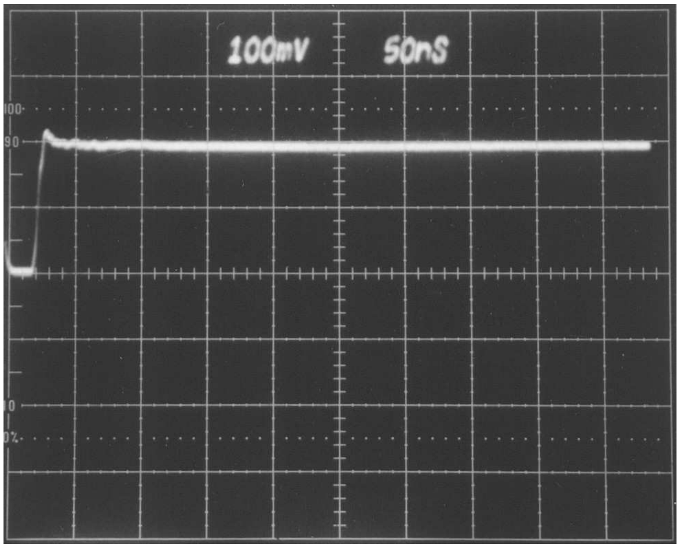
7. Set the sampling oscilloscope time base to 50 ns/div, and the vertical scale to 100 mV/div. (With 40 dB of attenuation on the test jig output and the oscilloscope input, the actual vertical scale will be 10V/div, or 200 mA/div.) Adjust the oscilloscope controls as required to center the waveform on the display.

8. The oscilloscope should show a waveform similar to that shown below:



200 mA/div, 50 ns/div

Note that the coupling of OUT 2 to OUT 1 results in the increase of the rise time of OUT 2 to more than 5ns. This is entirely due to C_B in the test jig. For this reason, C_B should be limited to 1000 pF. If OUT 1 and its associated attenuator are temporarily disconnected, the fast rise time waveform shown below would be obtained:

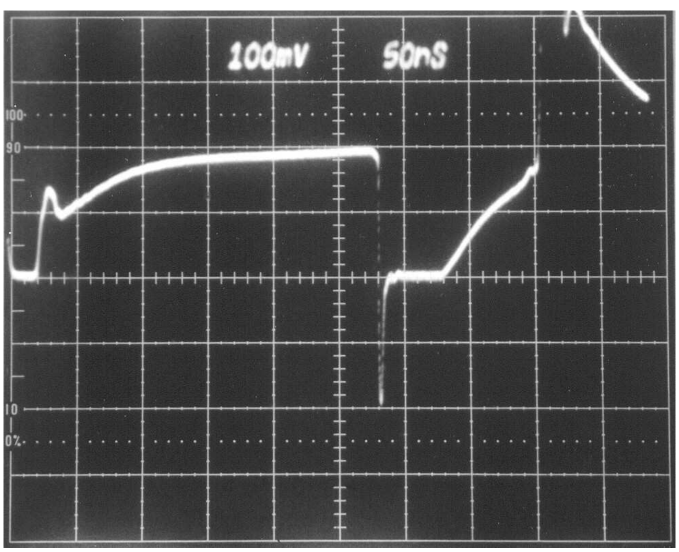


200 mA/div, 50 ns/div

Leave OUT 1 and its attenuator connected.

Adjust the OUT 2 amplitude as required until the observed waveform is 2 divisions (400 mA) tall.

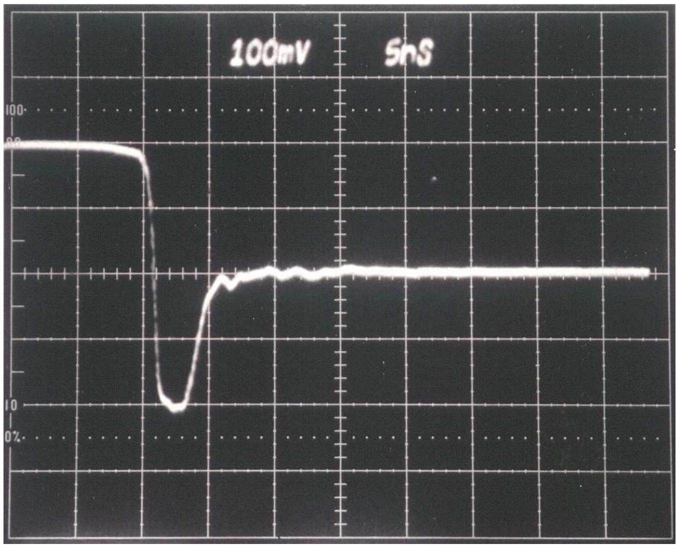
9. Set OUT 2 to -75V. The observed waveform should be as shown below:



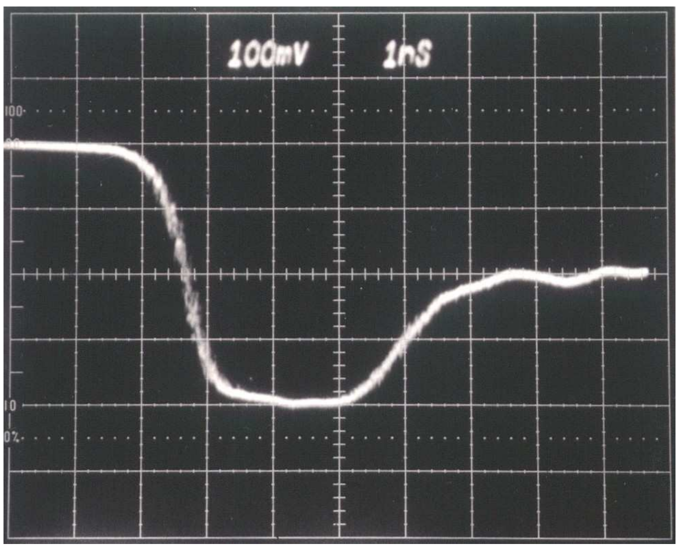
200 mA/div, 50 ns/div

Adjust the amplitude until the narrow negative spike extends two divisions below the zero level (i.e., -400 mA).

10. Adjust the oscilloscope time base to 5 ns/div or 1 ns/div, and adjust the oscilloscope controls to examine the negative spike. The expected waveforms are shown below:



200 mA/div, 5 ns/div



200 mA/div, 1 ns/div

The fast 1 ns switching time of the OUT 2 output is clearly shown in the photo above. The reverse recovery time of the 1N4150 diode is approximately 3 ns, in this example.

EXAMPLE PROCEDURE - REVERSE RECOVERY TEST WITH A 1N4937 DIODE

This example procedure shows results obtained with a moderately fast, high current switching diode, the 1N4937. Since the rated recovery time is greater than 100 ns, a real-time oscilloscope will be used. Also, the capacitor C_B must be increased from 1000 pF to approximately 12500 pF, by soldering additional capacitance on the test jig.

1. For this example, connect the pulser, test jig, and real-time oscilloscope as shown in Figure H, omitting the attenuators (i.e., 0 dB of attenuation will be

used). Insert the 1N4937 diode in the D.U.T. socket.

2. With the instrument turned off, solder additional capacitance across C_B, to raise the total capacitance to approximately 12500 pF.

3. Turn on the instrument. Set the AVR-EB3-B to trigger at 100 Hz.

4. Set PW1 at 500 ns, and PW2 at 5 us.

5. Set the delay to +2 us.

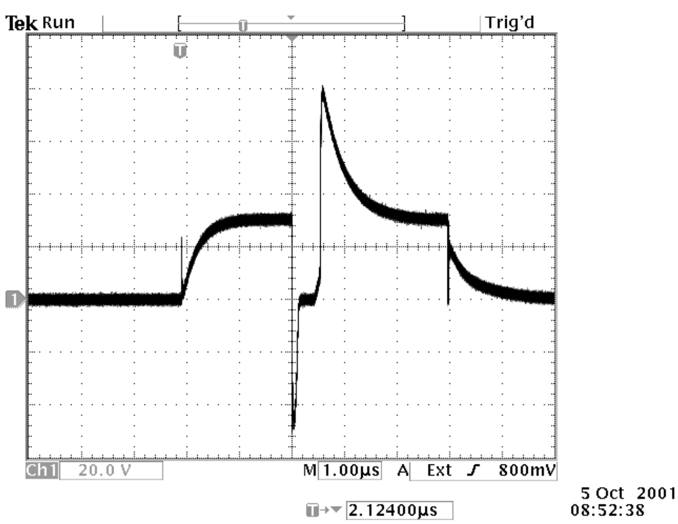
6. Set the OUT1 amplitude to -100V.

7. Set the OUT2 amplitude to +60V. (This will produce approximately +600 mA of forward current.)

8. Set the outputs to "ON", using the "Output" menu.

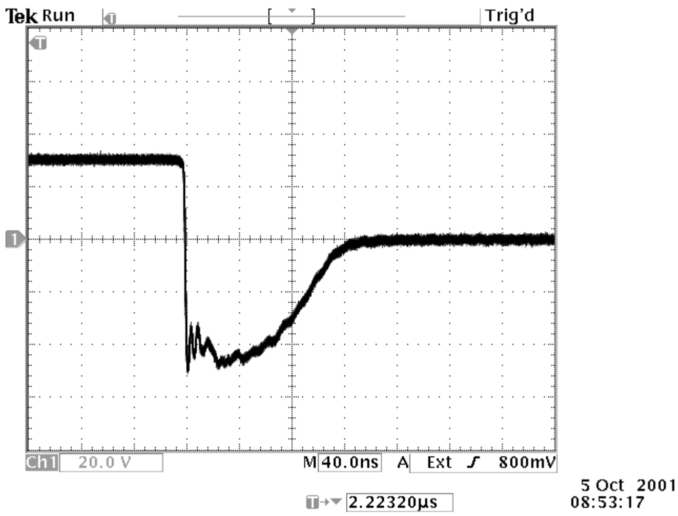
9. Set the real-time oscilloscope time base to 1 us/div, and the vertical scale to 20 V/div. (Since the probe is attached across a 50Ω load, the vertical scale also corresponds to 400 mA/div.) Adjust the oscilloscope controls as required to center the waveform on the display.

10. The oscilloscope should show a waveform similar to that shown below:



20 V/div (400 mA/div), 1 us/div

11. Adjust the oscilloscope time base to 40 ns/div and adjust the oscilloscope delay controls to examine the negative spike. The expected waveforms are shown below:



20 V/div (400 mA/div), 40 ns/div

The reverse recovery time of the 1N4937 diode is approximately 120 ns, in this example. As can be seen from the above photo, the forward current used is approximately +600 mA, and the reverse current is approximately -1A.

RISE TIME CONTROL FOR CHANNEL 1

The rise time of Channel 1 is normally 1 ns. For some applications, this may be excessively fast. The rise time of this output may be increased to 5 ns by setting the rear-panel “TR1” switch to the “5 NSEC” position, instead of the normal “1 NSEC” position.

If longer rise times are desired, they may be obtained by setting the rear-panel “TR1” switch to the “5 NSEC” position and adding a shunt capacitance between the Channel 1 input of the test jig and ground. (That is, immediately before capacitor C_B). For this technique to work, an attenuator must be placed between the mainframe OUT 1 output and the test jig input, so that the source impedance seen by the shunt capacitor is 50 Ohms.

The approximately increase in the rise time may be estimated using $\Delta t_R = 50\Omega \times C_{SHUNT}$. For instance, adding 200 pF will increase the rise time by 10 ns.

MECHANICAL INFORMATION

TOP COVER REMOVAL

The interior of the instrument may be accessed by removing the four Phillips screws on the top panel. With the four screws removed, the top cover may be slid back (and off).

RACK MOUNTING

A rack mounting kit is available. The -R5 rack mount kit may be installed after first removing the one Phillips screw on the side panel adjacent to the front handle.

ELECTROMAGNETIC INTERFERENCE

To prevent electromagnetic interference with other equipment, all used outputs should be connected to shielded 50Ω loads using shielded 50Ω coaxial cables. Unused outputs should be terminated with shielded 50Ω BNC terminators or with shielded BNC dust caps, to prevent unintentional electromagnetic radiation. All cords and cables should be less than 3m in length.

OPERATIONAL CHECK

This section describes a sequence to confirm the basic operation of the instrument. It should be performed after receiving the instrument. It is a useful learning exercise as well.

Before proceeding with this procedure, finish reading this instruction manual thoroughly. Then read the “Local Control” section of the “OP1B Interface Programming Manual” thoroughly. The “Local Control” section describes the front panel controls used in this operational check - in particular, the MOVE, CHANGE, and ADJUST controls.

1. Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Connect a 2W (or higher), low-inductance (not wirewound) 50Ω load to the OUT 1 connector and place the scope probe across this load. Do the same with a second load and probe to the OUT 2 connector. Set the oscilloscope to trigger externally with the vertical setting at 50 Volts/div and the horizontal setting at 100 ns/div.

   The oscilloscope should have a bandwidth of at least 500 MHz.

2. Turn on the AVR-EB3-B. The main menu will appear on the LCD.

3. To set the AVR-EB3-B to trigger from the internal clock at a PRF of 5 kHz:

   a) The arrow pointer should be pointing at the frequency menu item. If it is not, press the MOVE button until it is.

   b) Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 5 kHz.

   c) The arrow pointer should be pointing at the “Internal” choice. If it is not, press MOVE until it is.

   d) Press CHANGE to return to the main menu.

4. To set the delay to 100 ns:

   a) Press the MOVE button until the arrow pointer is pointing at the delay menu item.

   b) Press the CHANGE button. The delay submenu will appear. Rotate the ADJUST knob until the delay is set at 100 ns.

c) The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.

d) Press CHANGE to return to the main menu.

5. To set the Channel 1 pulse width to 150 ns:

   a) Press the MOVE button until the arrow pointer is pointing at the "PW1" menu item.

   b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 150 ns.

   c) The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.

   d) Press CHANGE to return to the main menu.

6. To set the Channel 2 pulse width to 250 ns:

   a) Press the MOVE button until the arrow pointer is pointing at the "PW2" menu item.

   b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 250 ns.

   c) The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.

   d) Press CHANGE to return to the main menu.

7. At this point, nothing should appear on the oscilloscope.

8. To enable the output:

   a) Press the MOVE button until the arrow pointer is pointing at the output menu item.

   b) Press the CHANGE button. The output submenu will appear.

   c) Press MOVE until the arrow pointer is pointing at the “ON” choice.

   d) Press CHANGE to return to the main menu.

9. To change the Channel 1 output amplitude:

a) Press the MOVE button until the arrow pointer is pointing at the "AMP1" menu item.

b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at -100V.

c) Observe the oscilloscope. You should see 150 ns wide, -100V pulses. Due to the fast rise time of this output, some ringing may be observed. This is due to limitations of the oscilloscope, not the pulser. A high-bandwidth sampling oscilloscope may be used to confirm this, if desired.

d) Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary. Return it to -100V.

e) Press CHANGE to return to the main menu.

10. To change the Channel 2 output amplitude:

a) Press the MOVE button until the arrow pointer is pointing at the "AMP2" menu item.

b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at +100V.

c) Observe the oscilloscope. You should see 250 ns wide, 100V pulses.

d) Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary.

e) Press CHANGE to return to the main menu.

11. Try varying the pulse width, by repeating step (6). As you rotate the ADJUST knob, the pulse width on the oscilloscope will change. It should agree with the displayed value.

This completes the operational check.

PROGRAMMING YOUR PULSE GENERATOR

KEY PROGRAMMING COMMANDS

The “OP1B Interface Programming Manual” describes in detail how to connect the pulse generator to your computer, and the programming commands themselves. A large number of commands are available; however, normally you will only need a few of these. Here is a basic sample sequence of commands that might be sent to the instrument after power-up:

*rst	(resets the instrument)
trigger:source internal	(selects internal triggering)
frequency 1000 Hz	(sets the frequency to 1000 Hz)
pulse:width1 1 us	(sets the channel 1 pulse width to 1 us)
pulse:width2 2 us	(sets the channel 2 pulse width to 2 us)
pulse:delay 1 us	(sets the inter-channel delay to 1 us)
volt:ampl1 -50	(sets the channel 1 amplitude to -50 V)
volt:ampl2 +75	(sets the channel 2 amplitude to +75 V)
output on	(turns on the output)

For triggering a single event, this sequence would be more appropriate:

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width1 1 us	(sets the channel 1 pulse width to 1 us)
pulse:width2 2 us	(sets the channel 2 pulse width to 2 us)
pulse:delay 1 us	(sets the inter-channel delay to 1 us)
output on	(turns on the output)
volt:ampl1 -50	(sets the channel 1 amplitude to -50 V)
volt:ampl2 +75	(sets the channel 2 amplitude to +75 V)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

To set the instrument to trigger from an external TTL signal applied to the rear-panel TRIg connector, use:

*rst	(resets the instrument)
trigger:source external	(selects internal triggering)
pulse:width1 1 us	(sets the channel 1 pulse width to 1 us)
pulse:width2 2 us	(sets the channel 2 pulse width to 2 us)
pulse:delay 1 us	(sets the inter-channel delay to 1 us)
volt:ampl1 -50	(sets the channel 1 amplitude to -50 V)

volt:ampl2 +75	(sets the channel 2 amplitude to +75 V)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

ALL PROGRAMMING COMMANDS

For more advanced programmers, a complete list of the available commands is given below. These commands are described in detail in the “OP1B Interface Programming Manual”. (Note: this manual also includes some commands that are not implemented in this instrument. They can be ignored.)

Keyword	Parameter	Notes
LOCAL		
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW | FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DCYCle	<numeric value>	
:HOLD	WIDTh | DCYCle	
:DELay	<numeric value>	
:GATE		
:TYPE	ASYNC | SYNC	
:LEVel	HIgh | LOw	
[SOURce]:		
:VOLTage		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value>	
:PROTection		
:TRIPped?		[query only]
STATUS:		
:OPERation		
:[EVENt]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
:QUEStionable		
:[EVENt]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
SYSTem:		
:COMMunicate		

```
          :GPIB
               :ADDRess                   <numeric value>
          :SERial
               :CONTrol
                    :RTS                  ON | IBFull | RFR
               :[RECeive]
                    :BAUD                 1200 | 2400 | 4800 | 9600
                    :BITS                 7 | 8
                    :ECHO                 <boolean value>
                    :PARity
                         :[TYPE]          EVEN | ODD | NONE
                    :SBITS                1 | 2
     :ERRor
          :[NEXT]?                                             [query only]
          :COUNT?                                              [query only]
     :VERSion?                                                 [query only]
TRIGger:
     :SOURce                              INTernal | EXTernal | MANual | HOLD | IMMediate
*CLS                                                           [no query form]
*ESE                                      <numeric value>
*ESR?                                                          [query only]
*IDN?                                                          [query only]
*OPC
*SAV                                      0 | 1 | 2 | 3        [no query form]
*RCL                                      0 | 1 | 2 | 3        [no query form]
*RST                                                           [no query form]
*SRE                                      <numeric value>
*STB?                                                          [query only]
*TST?                                                          [query only]
*WAI                                                           [no query form]
```

PERFORMANCE CHECK SHEET