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INSTRUCTIONS

MODEL AV-155C-B

0 to 2 A AMPLITUDE, 0 to 500 mA OFFSET,
0 to 4V COMPLIANCE, 50 ns RISE TIME

PULSED CONSTANT CURRENT GENERATOR

WITH IEEE 488.2 AND RS-232 CONTROL

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 disassembled, 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: /filesserver1/officefiles/instructword/av-155/AV-155C-B,edition3.sxw.
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INTRODUCTION

The Model AV-155C-B pulsed constant current generator is capable of producing pulses with amplitudes as high as ± 2 A into load voltages up to ± 4 V, with 50 ns rise and fall times. A DC offset in the range of 0 to ± 500 mA may be added to the pulse output.

The internal trigger source can be used to trigger the instrument at frequencies between 1 Hz and 1 MHz. An external TTL trigger pulse, a front-panel pushbutton, and a computer can also be used to trigger the instrument.

The external trigger function offers considerable flexibility. Several modes are available:

- Voltage-to-current amplifier mode. In this case, the output signal $I_{OUT} \approx V_{AMP} \times 500$ mA/V, and the output current waveform tracks the input voltage waveform. The output follows the input by a minimal fixed delay.
- $PW_{OUT} = PW_{IN}$ mode. The output pulse width tracks the input pulse width, but the amplitude is controlled by the front panel settings (or by programming commands). The output follows the input by a minimal fixed delay. The external trigger is TTL-level.
- Normal external trigger mode. The output pulse width and amplitude are controlled by the front panel settings (or by programming commands). The output follows the input by a programmable delay. The external trigger is TTL-level.
- For instruments with the “-EA” option, the output amplitude can be set to track a DC voltage (0 to 10V full-scale) present on the rear-panel “AMP” connector.

The Model AV-155C-B pulse generator is a current pulser. The current amplitude is largely independent of the load voltage. For proper operation, the load voltage ($V_{LOAD} = I_{LOAD} \times R_{LOAD}$) must lie in the range of 0 to ± 4 V.

The AV-155C-B features front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40 character back-lit LCD display of the output amplitude, pulse width, pulse repetition frequency, 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:	AV-155C-B
Amplitude ^{1,2} Pulse: DC offset: Peak:	0 to ±2.0 A 0 to ±500 mA 0 to ±2.5 A
Pulse width:	100 ns to 1 sec
Pulse repetition frequency (PRF): Internal trigger: External trigger:	1 Hz to 1 MHz 0 Hz to 1 MHz
Duty cycle (maximum): Internal trigger: External trigger:	90% 100%
Rise time ³ :	± 50 ns
Fall time ³ :	± 50 ns
Polarity:	Switchable, + or -.
Output current regulation:	± 1 % load voltage change from 0 V to 4 V
Compliance voltage:	-4 to +4 Volts
Overshoot ³ :	± 5%
GPIO and RS-232 control ⁴ :	Standard on -B units.
LabView drivers:	Check http://www.avtechpulse.com/labview for availability and downloads
Jitter: (Ext trig in to pulse out)	< ± 100 ps ± 0.03% of sync delay
Trigger required: (External trigger mode A) ⁵	$V_{IN} = \frac{I_{OUT}}{K_3}$, $K_3 = 0.5 \frac{\text{Amps}}{\text{Volt}}$
Trigger required (External trigger modes B and C) ⁶ :	TTL, PW > 50 ns
Sync delay:	Variable, 0 to ±1 ms (sync out to pulse out)
Sync output:	+3 Volts, 50 ns, will drive 50 Ohm loads
Gate input:	Synchronous or asynchronous, active high or low, switchable. Suppresses triggering when active.
Monitor output:	Back-panel SMA connector provides (to 50 Ohm) a coincident replica of the diode current.
Connectors: Out: Monitor: Trig, Sync, Gate:	Rear-panel socket designed to mate to supplied AV-LZ and RG174 cables. SMA BNC
Supplied low-impedance cable: (characteristic impedance, length):	AV-LZ1 (1 Ohm, 1 meter). One end mates to the rear-panel OUT socket, and the other end is terminated with microstrip board with solder pads ⁷ .
Supplied 50Ω output cable:	RG174 coaxial cable, 15 cm. One end mates to pulser, other end terminated with SMA connector.
Power requirement:	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:	Anodized aluminum, with blue plastic trim
Mounting:	Any
Temperature range:	+10°C to +40°C

1) For analog electronic control of amplitude or DC offset, suffix the model number with -EA or -EO. Electronic control units also include standard front-panel controls.

2) Minimum useful amplitude is 5% of full-scale.

3) Valid when using the supplied AV-LZ line to connect to a matched load (i.e., load impedance equals AV-LZ characteristic impedance), at amplitudes greater than 5% of full-scale. Rise and fall times will increase for higher impedance loads, and at amplitudes below 5% of rated maximum. Rise and falls times are measured between 20% and 80% amplitude transition points.

4) -B suffix indicates IEEE-488.2 GPIO and RS-232 control of amplitude, DC bias, pulse width, PRF and delay. (See page 8).

5) $R_N \geq 500\Omega$.

6) $R_N \geq 1k\Omega$.

7) To specify socket mounting, add suffix -S5 to the model number and describe the diode package type (e.g. TO-18) and the required pin connections (e.g. anode, cathode, ground, etc.). See page 75 for readily available package mounting. Contact Avtech for special or different packages.

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, two instrumentation manuals (this manual and the "Programming Manual for -B Instruments"), a 6" RG-174 output cable, and an AV-LZ1 output cable 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.

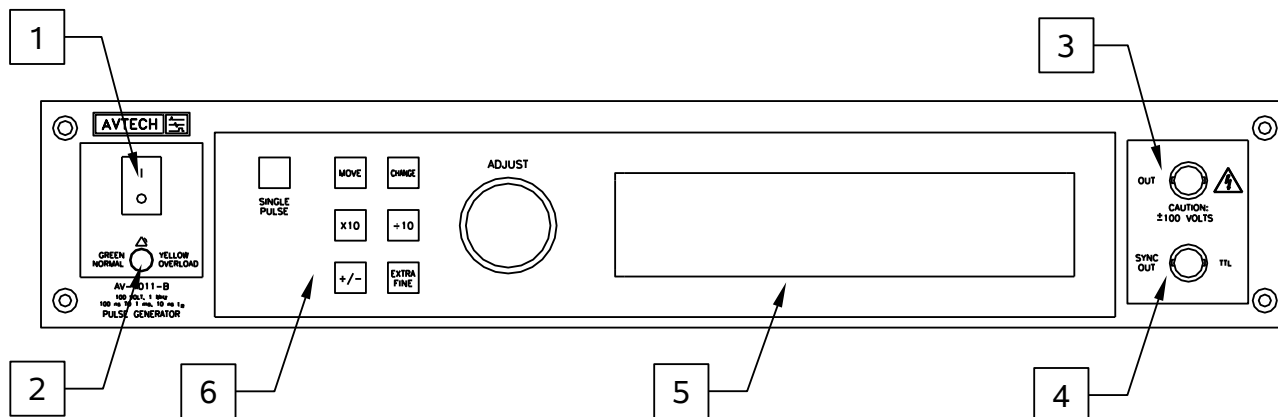
For AC line voltages of 110-120V, the power selector card should be installed so that the "120" marking is visible from the rear of the instrument, as shown below:

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, as shown below:

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 1.5A slow blow fuse is required. In the 240V setting, a 0.75A 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 (#382 type) is connected to the +15V DC supply.
2. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. The sync output has an approximate amplitude of +3 Volts to $R_L > 1 \text{ k}\Omega$ with a pulse width of approximately 50 ns.
3. 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 "Programming Manual for -B Instruments" describes the menus and submenus in detail.
4. KEYPAD.

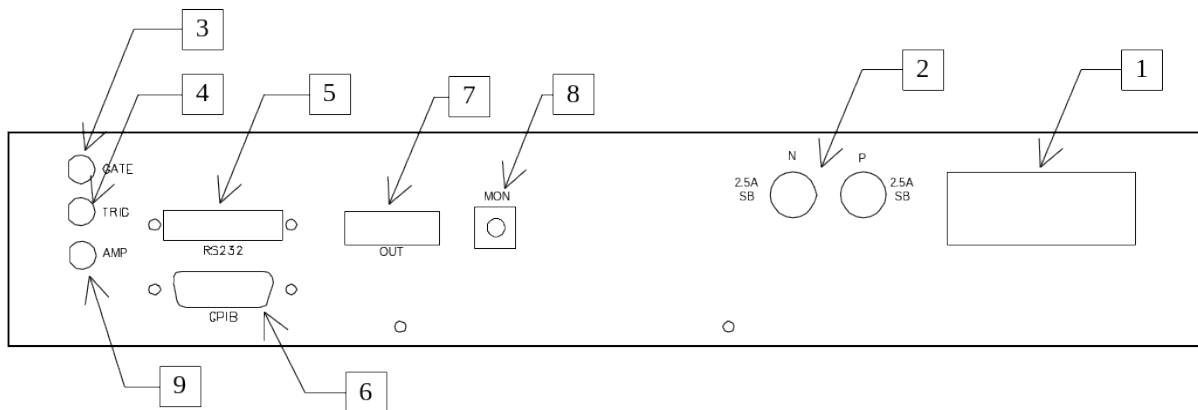
Control Name	Function
MOVE	This moves the arrow pointer on the display.
CHANGE	This is used to enter the submenu, or to select the operating mode, pointed to by the arrow pointer.
×10	If one of the adjustable numeric parameters is displayed, this increases the setting by a factor of ten.
÷10	If one of 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 1.5A slow blow fuse and a removable card that can be removed and repositioned to switch between 120V AC in and 240V AC in.
2. **2.5A SB.** These fuses protect the internal DC power supplies.
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 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 output pulse width can be set to track the pulse width on this input. This is the “EW” option.)
5. **GPIB Connector.** A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B Instruments” 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 “Programming Manual for -B Instruments” for more details on RS-232 control.
7. **OUT.** This is the main output. The LZ1 transmission line or the RG174 transmission line plugs into this socket. The upper side of the socket (“UP”) is the signal line. The lower side (“DOWN”) is connected to ground.
8. **MON.** This is a current monitor output. This output provides a voltage waveform that is proportional to the current waveform on the output. The monitor relationship is: $V_{MON} = I_{OUT} \times 1\Omega$, for a load of $> 1\text{ k}\Omega$. (The monitor output can also drive a 50Ω load, but the output voltage will be reduced by a factor of 2. This output is short-circuit protected.)

9. AMP Connector. When the amplitude is set to the "EXT AMPLIFY" mode (i.e., the instrument is in the voltage-to-current converter mode), the output current is approximately equal to $I_{OUT} = V_{AMP} \times 0.5 \text{ A/V}$, where V_{AMP} is the signal on this connector.

(For units with the -EA option:) When the amplitude is set to the "EXT CONTROL" mode, the output current is amplitude is controlled by the DC voltage on this connector, with 0V corresponding to zero output, and 10V corresponding to full-scale output.

GENERAL INFORMATION

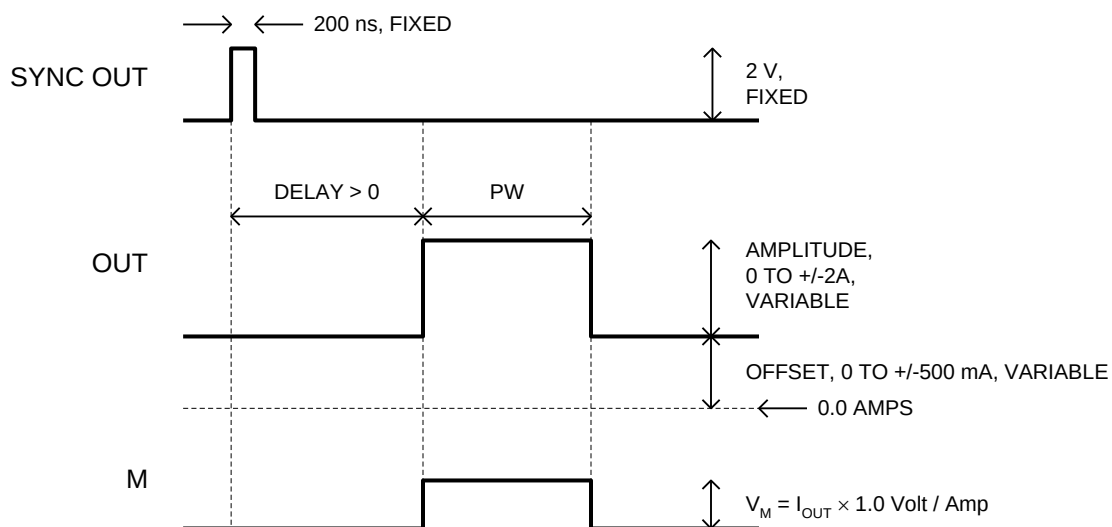
BASIC PULSE CONTROL

This instrument can be triggered by several sources - its own internal clock, an external TTL trigger signal, the front-panel "SINGLE PULSE" pushbutton, or by a computer-generated command. In any case, three output channels respond to the trigger: OUT, SYNC, and MON. The OUT channel is the signal that is applied to the load. Its amplitude and pulse width are 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. The MON output is a voltage waveform that is proportional to the current waveform on OUT. $V_{MON} = I_{OUT} \times 1\Omega$, for monitor loads of $> 1\text{ k}\Omega$.

The different trigger modes are detailed below. In all cases, positive amplitude and offset is assumed.

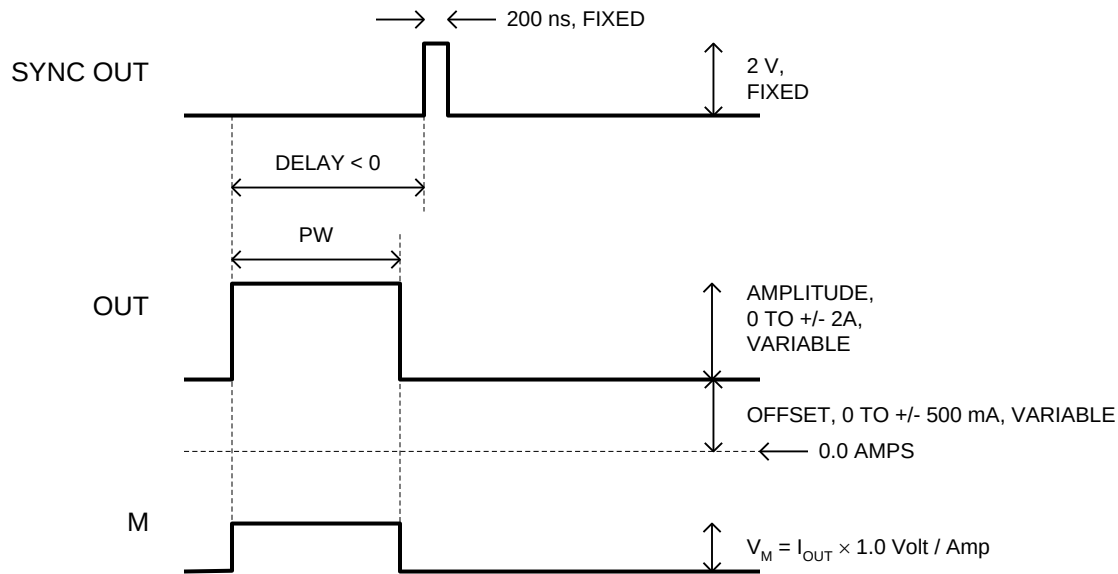
Internal Triggering

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



Basic Output Pulses for Delay > 0

The order of the output pulses is reversed for negative delays:

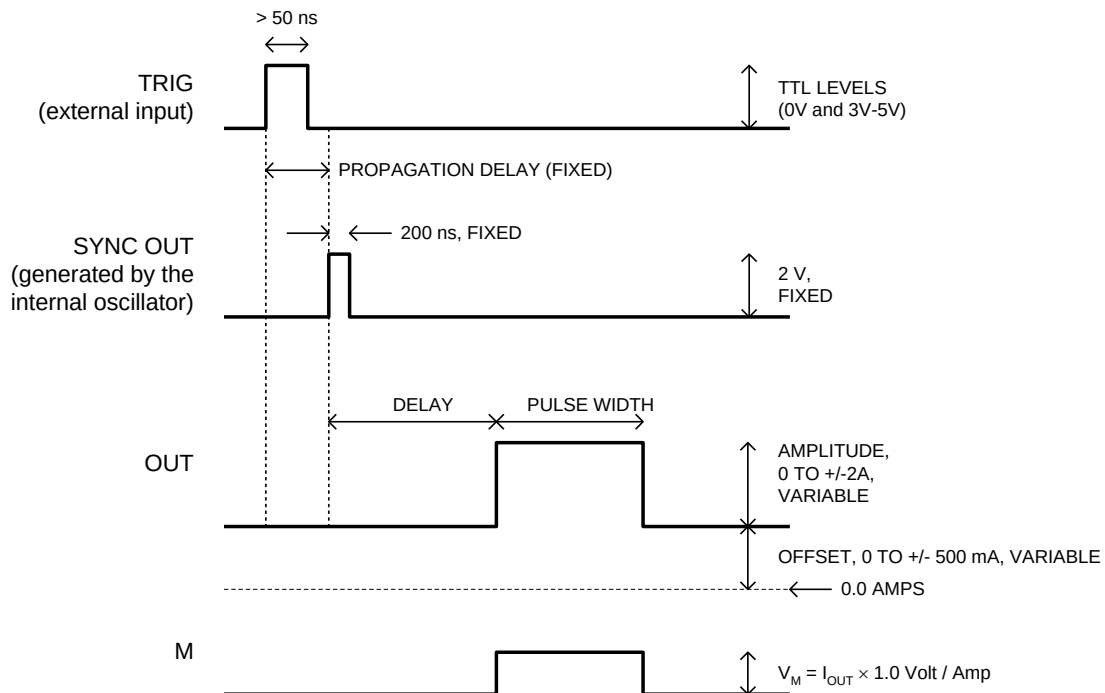


Basic Output Pulses for Delay < 0

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

External Triggering, with Normal PW and Amplitude Modes

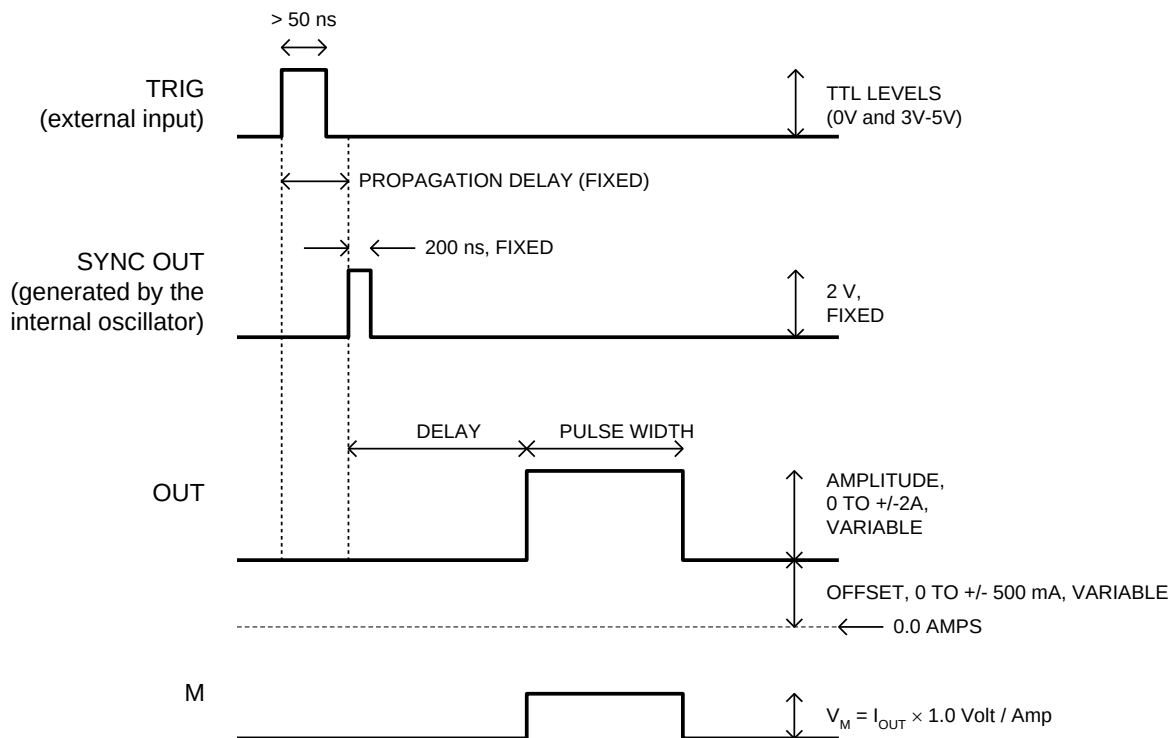
When the triggering is set to external mode, and the pulse width and amplitude modes are set to “normal” (i.e., the front-panel display reads “EXT TRIG”, “PW:??ns”, and “AMP:??mA”, where “??” means a number), a TTL-level pulse on the TRIG input will trigger the pulse generator, as shown below:



In this mode, the delay, pulse width, and amplitude of the OUT pulse can be varied with front panel controls or via the GPIB or RS-232 computer interfaces.

External Triggering, with $PW_{IN}=PW_{OUT}$ mode and Normal Amplitude Mode

When the triggering is set to external mode, the amplitude mode is set to “normal”, and the “ $PW_{IN}=PW_{OUT}$ ” pulse width mode is used, (i.e., the front-panel display reads “EXT TRIG”, “PW IN=OUT”, and “AMP:??mA”, where “??” is a number) a TTL-level pulse on the TRIG input will trigger the pulse generator, as shown below:



In this mode, the output pulse width is approximately equal to the pulse width of the TTL-level trigger pulse on the TRIG input. The output pulse is generated after a short propagation delay. The delay is not variable. The amplitude of the OUT pulse can be varied with front panel controls or via the GPIB or RS-232 computer interfaces.

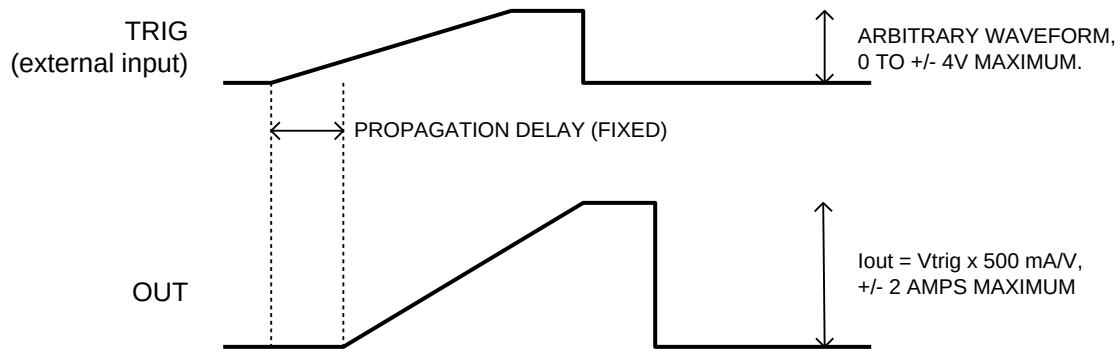
External Amplitude Mode (requires “-EA” option)

In any of the previously mentioned modes, the amplitude can be set to track a 0 to +10V DC voltage present on the AMP connector. (In this mode, the front-panel display reads “AMP:EXT”.) The pulse width, delay, frequency, and triggering are controlled as described above.

The output polarity remains at its last setting before the amplitude is switched to the external amplitude mode.

Amplifier Mode (Voltage-to-Current Converter)

When the triggering is set to amplifier mode (i.e., the front-panel display reads “EXT AMPLIFY”), the instrument acts as a fixed-gain voltage-to-current amplifier, and the output current is: $I_{OUT} = V_{AMP} \times 500 \text{ mA/V}$, where V_{AMP} is the voltage waveform on the AMP connector. This is illustrated below:



For -PN units, the output polarity remains at its last setting before the amplitude is switched to the amplify mode.

In this mode, the output pulse width and amplitude are determined by the signal on the AMP connector. The SYNC output is not useful in this mode.

TRIGGER SOURCES

This instrument has several possible trigger sources:

- Internal Trigger: the instrument controls the trigger frequency, and generates the clock internally.
- External Trigger: the instrument is triggered by an external TTL-level signal on the back-panel TRIG connector. As noted in the previous section, the exact function of this trigger is determined by the amplitude and pulse width mode settings.
- External Amplifier Mode Trigger: the instrument is triggered by an analog signal on the back-panel AMP 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 “Programming Manual for -B Instruments” for more details.)

When being controlled by a computer, there is a additional trigger mode:

- Immediate Trigger: generates a single trigger event. This is the computer-control equivalent of pressing the front-panel “SINGLE PULSE” pushbutton.

GATING MODES

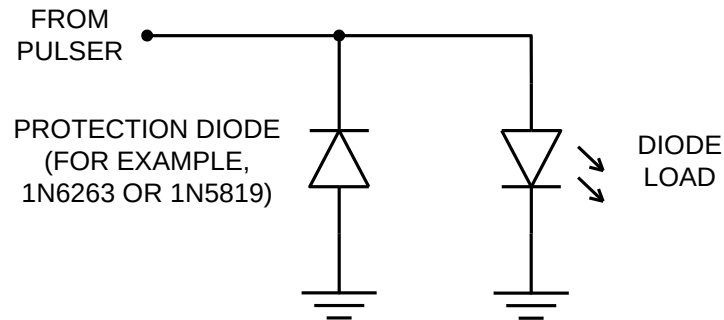
Triggering can be suppressed by a TTL-level signal on the rear-panel GATE connector. The instrument can be set to stop triggering when this input high or low, using the front-panel gate menu or the appropriate programming commands.

This gate signal acts synchronously - i.e., when gated, the output will complete the full pulse width if the output is high, and then stop triggering. No pulses are truncated in this mode.

LOAD PROTECTION

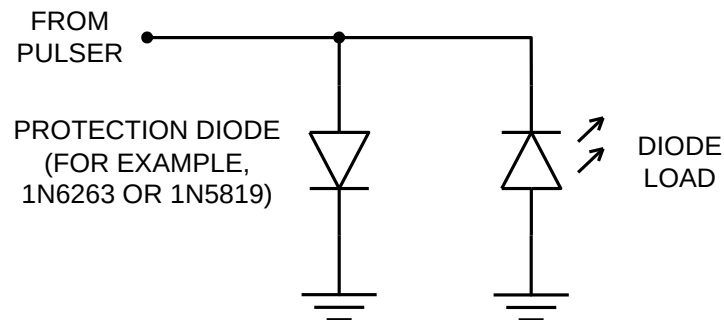
PROTECTING DIODE LOADS

It is possible for a small offset current to be generated on the output, if the trimpots (see the “Calibration Adjustments” section) are not correctly adjusted. This can lead to the development of a negative voltage on a diode load. If the diode breakdown voltage is less than 15V, breakdown can occur. If your load is sensitive to this, the load should be protected by adding a low-capacitance shunt Schottky diode, as illustrated below:



The previous diagram assumes that the diode is to be driven with a positive current. This circuit will prevent the output voltage going below approximately -0.5V.

The equivalent circuit for negative output currents is shown below:



NEVER APPLY AN EXTERNAL VOLTAGE TO THE OUTPUT

Externally generated potentials must never be applied to the output.

LENZ'S LAW AND INDUCTIVE VOLTAGE SPIKES

This instrument is designed to pulse resistive and diode loads and will exhibit a large output spike when used to drive a load with significant inductance (as predicted by LENZ'S LAW). For this reason the load should be connected to the output using low inductance leads (as short as possible and as heavy a gauge as possible).

The voltage developed across an inductance L (in Henries), when the current is changing at a rate given by di_{LOAD} / dt (in Amps/sec), is: $V_{SPIKE} = L di_{LOAD} / dt$.

ATTACHING AND DETACHING LOADS

To avoid damaging the loads connected to main outputs, the loads should only be connected to or removed from the instrument when:

- the instrument is off
- the instrument is on, but the "STANDBY/OPERATE" switch is in the STANDBY position.

Do not connect loads when the instrument is on and the outputs are turned on. This can cause sparking.

CHANGING PARAMETERS WHEN A LOAD IS ATTACHED

If your load is easily damaged, reduce the amplitude and offset settings to zero, and switch the instrument to STANDBY mode before changing the timing parameters, especially if you need to change a timing range setting. This protects the loads from possible short transient effects.

OPEN AND SHORT CIRCUITS

The AV-155C-B will operate properly into a short circuit to ground. Operation into an open circuit will not damage the instrument in any way.

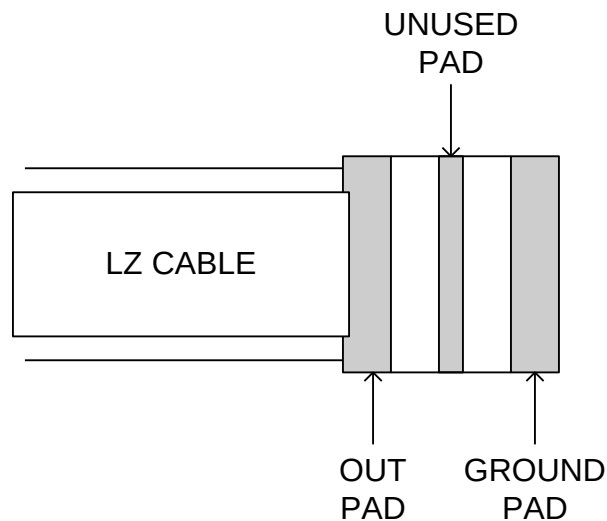
CONNECTING THE LOAD FOR OPTIMUM PERFORMANCE

This instrument is supplied with two types of output cables, which can be plugged in the the OUT socket on the rear panel:

- The LZ1 flexible flat transmission line, which has a 1Ω characteristic impedance (Z_0).
- A 6" RG174 coaxial transmission line, which has a 50Ω characteristic impedance (Z_0).

For both cables, the end that plugs into the rear panel is marked with an "UP" side and a "DOWN" side. (The UP side is the signal output, and the DOWN side is ground.)

The LZ1 transmission line is terminated with a small circuit board, as shown below:



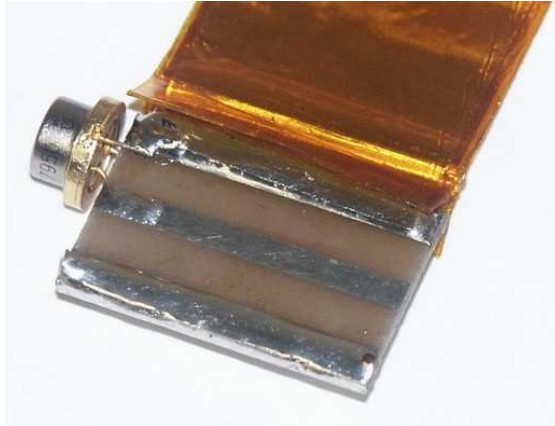
To obtain the very best waveform, it is important that the characteristic impedance of the transmission line used to connect the load to the pulser be well matched to the load impedance. This will minimize transmission line reflections.

Thus, when connecting to a low-impedance load, like a laser diode, the LZ1 line will provide the best performance. However, the LZ1 line may be physically awkward to use. If increased rise time or waveform ringing can be tolerated, the 6" length of RG-174 cable may be used instead.

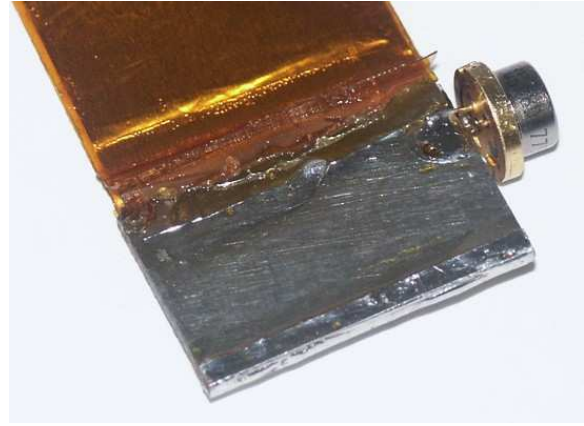
For more information regarding connection methods, see "Technical Brief No. 1 - How to Connect Loads to your Pulsed Constant Current Generator for Optimum Performance", online at <http://www.avtechpulse.com/appnote>.

EXAMPLE – ATTACHING A DIODE LOAD

The two photos below show a laser diode soldered between the top-side out pad and the bottom-side ground plane:



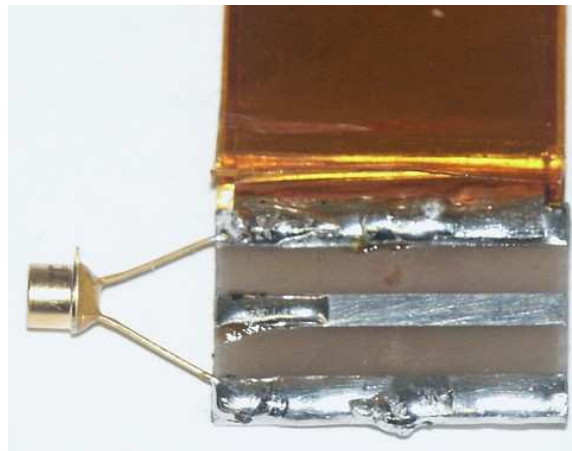
Top View – The diode anode is soldered to the OUT pad.



Bottom View – The diode cathode is soldered to the ground plane.

The arrangement shown above will produce best results if the resistance of the diode is approximately equal to the characteristic impedance of the transmission line. If the diode resistance is lower, then a series resistor should be installed. This is illustrated in the next section.

For maximum performance, the lead lengths are as short as possible. The photo below, in contrast, shows the wrong way to connect a diode load:



Wrong Way To Connect a Diode. The leads are too long!

In the above photo, approximately 1 inch of lead length is present in the circuit. The inductance of such leads is approximately 10 nH / inch. This may add significant distortion to the waveform, which can be estimated using Lenz's Law ($V = L di/dt$). See the “LENZ'S LAW AND INDUCTIVE VOLTAGE SPIKES” section for more details.

EXAMPLE – ATTACHING A DIODE LOAD WITH A SERIES RESISTOR

As noted above, it may be desirable to add a resistance in series with a diode load. (This is required on voltage pulsers, but optional on current pulsers.) This can be conveniently implemented by using the unconnected middle pad as a connection point, as shown in the photo below:



In this set-up, one end of the resistor has been soldered to the OUT pad. The other end is soldered to the anode of the diode. The diode cathode is soldered to ground.

See the “SUGGESTED RESISTORS” section for more about appropriate resistors.

EXAMPLE – TWO WAYS OF MEASURING CURRENT

The photo below shows a resistive load installed between the top-side OUT and GND pads. Also, two methods of measuring the current are shown.



On the right side of the photo, an oscilloscope probe (and ground clip) are connected across the resistor. The current waveform can be calculated from the observed voltage waveform using Ohm's Law. However, the parasitic inductance of the resistor can distort the waveform slightly. For some applications, a current probe may yield better measurements.

On the left side of the photo, an Integrated Sensor Technologies (<http://www.isensortech.com/>) model 711 current probe is shown. A short length of the resistor lead has been fed through the donut-shaped probe. The other end of the probe is connected to an oscilloscope. The waveform observed on the oscilloscope is proportional to the current measured by the probe.

SUGGESTED RESISTORS

Avtech recommends two types of resistors for use in medium-current pulsed applications.

The RCD RSF1A and RSF2B series of low-inductance 1W and 2W resistors are well-suited for low-to-medium current applications. They are available with resistances as low as 0.1 Ohms. The RSF1A is relatively small, physically. See <http://www.rcd-comp.com/> for more information.

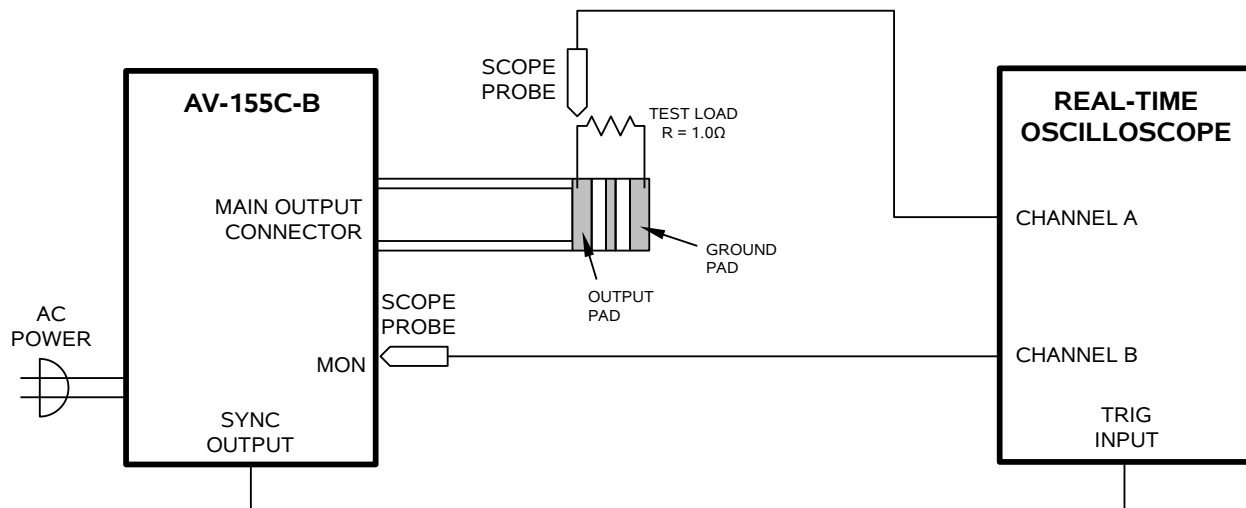
The Ohmite OX and OY series of low-inductance 1W and 2W resistors are well-suited for medium-to-high current applications. They are extremely rugged, and are less prone to fail when abused, compared to the RSF1A and RSF2B series. However, they are larger in size. See <http://www.ohmite.com/> for more information. These resistors are readily available from Digi-Key (<http://www.digikey.com/>).

It is generally advisable to connect several resistors in parallel to achieve a low resistance, because this has the added benefit of also lowering the total effective inductance.

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 “Programming Manual for -B Instruments” thoroughly. The “Local Control” section describes the front panel controls used in this operational check - in particular, the MOVE, CHANGE, and ADJUST controls.



Basic Test Arrangement

1. Insert a 1Ω test load between the signal out and ground pads on the LZ1 circuit board. Alternatively, the connectorized 1 Ohm test load and the RG174 cable may be used. The output waveform will show more distortion in this case, due to the impedance mismatch.
2. Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Set the oscilloscope to trigger externally.
3. Connect one oscilloscope probe (channel A) to the signal side of the test load. Connect the other probe to the MON output (on the rear panel). On the oscilloscope, set the channel A vertical scale to 5 V/div, the channel B vertical scale to 1 V/div, and the horizontal scale to 200 ns/div.
4. Turn on the AV-155C-B. The main menu will appear on the LCD.
5. To set the AV-155C-B to trigger from the internal clock at a PRF of 10 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 10 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.
6. 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) Press CHANGE to return to the main menu.
7. To set the OUT pulse width to 500 ns:
- a) Press the MOVE button until the arrow pointer is pointing at the “PW” menu item.
 - b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 500 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.
8. At this point, nothing should appear on the oscilloscope.
9. 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.
10. To change the OUT 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 2 A.
- c) Observe the oscilloscope. You should see 500 ns wide, 2V pulses (i.e., $2A \times 1\Omega = 2V$) on the probe connected to the main output. The other probe, connected to the MON monitor output, should also show 500 ns, 2V pulses (i.e. $2A \times 1\Omega$).
- d) Press CHANGE to return to the main menu.

11. Try varying the pulse width, by repeating step (7). As you rotate the ADJUST knob, the pulse width on the oscilloscope will change. It should agree with the displayed value.

12. This completes the operational check.

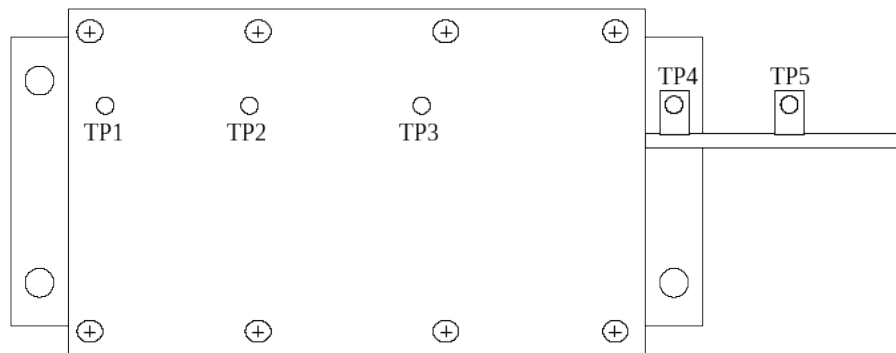
If additional assistance is required:

Tel: (613) 226-5772,
Fax: (613) 226-2802
Email: info@avtechpulse.com

CALIBRATION ADJUSTMENTS - INTERNAL TRIMPOTS

The output module has five trimming potentiometers ("trimpots") that can be used to adjust the performance of the output. These trimpots are preset at the factory and should not normally require adjusting after delivery. These controls can be accessed by removing the top panel of the instrument, and by locating the output-stage module. It is near the rear of the instrument.

The locations of the trimpots (designated TP1-TP5) are shown below. All should be accessible through any heatsinking.



Location of Trimpots

These trimpots can be used to adjust or calibrate the followings properties:

- Current offsets on the main outputs.
- Voltage offsets on the monitor outputs.
- Monitor calibration.
- Output impedance.

NULLING CONSTANT CURRENT OFFSETS

If a small constant current offset is observed on one of the main outputs, TP2 can be rotated to reduce it to zero. Note that the output stage is incapable of generating a negative current, due to the presence of a diode in series with the output.

NULLING AMPLITUDE-DEPENDENT CURRENT OFFSETS

If a small amplitude-dependent current offset is observed on one of the main outputs, TP1 can be rotated to null it out. Rotate TP1 while adjusting the output amplitude from the front panel, until the offset does not vary with amplitude.

NULLING CONSTANT MONITOR OFFSETS

If a small constant voltage offset is observed on one of the monitor outputs, TP5 can be rotated to reduce it to zero.

ADJUSTING OUTPUT IMPEDANCE

Ideally, the outputs of the pulsed current sources should be independent of the output voltages, within the 0 to $\pm 4\text{V}$ compliance voltage range. This condition represents infinite output impedance. If a load voltage/output current dependence is present, the output impedance needs to be adjusted.

To adjust the output impedance, connect a 1Ω load to the output to be adjusted. Set the output amplitude to 2A and observe the load voltage on an oscilloscope. The load voltage should have an amplitude of approximately 2V (i.e. $2\text{A} \times 1\Omega = 2\text{V}$). Note the exact value. Now replace the 1Ω load with a 0.5Ω load. The load voltage should fall by to approximately 1V (i.e. $2\text{A} \times 0.5\Omega = 1\text{V}$). Note the exact value. If the second voltage is not exactly one-half of the first voltage, adjust TP3 and repeat *both* measurements (1Ω and 0.5Ω) again. Repeat as required.

ADJUSTING MONITOR CALIBRATION

Just as the current amplitude of the main outputs can exhibit a load-voltage dependence, the voltage amplitude of the current monitors can also exhibit such a dependence if not adjusted properly.

To null out the monitor load voltage dependence, connect a 1Ω load to the main output. Set the output amplitude to 2A and observe the monitor voltage on an oscilloscope. The monitor voltage should have an amplitude of approximately 2V. Note the exact value. Now replace the 1Ω load with a 0.5Ω load. The monitor voltage should not change, since the current amplitude has not changed. Note the exact value. If the second voltage is not exactly equal to the first voltage, adjust TP4 and repeat *both* measurements (1Ω and 0.5Ω) again. Repeat as required.

CALIBRATION ADJUSTMENTS - SOFTWARE PROCEDURES

ADJUSTING AMPLITUDE ACCURACY

If it is found that the output amplitude setting (as set by the front-panel controls or programming commands) does not agree exactly with measured values of amplitude (i.e., by examining the output on an oscilloscope), the amplitude calibration can be updated using software commands.

The following procedure is suggested:

- 1) Connect a precision resistive load to the output. (As an example, suppose 1.0Ω is used.)
- 2) Connect the pulse generator to a computer using the GPIB or RS232 ports.
- 3) Turn on the pulse generator, and set the time controls (frequency, delay, pulse width) to typical values.
- 4) Turn on the outputs.
- 5) Set the output amplitude to its maximum value (2A).
- 6) Observe the voltage across the load. (Continuing the 1.0Ω example, suppose that 1.9V is observed.) From this, calculate the measured current (1.9A).
- 7) Send one of the following commands to the instrument via the computer interface:
 - `diag:ampl:cal 1.9A`

The internal software compares the supplied measured value to the programmed value, and adjusts the internal calibration data to null out any differences.

- 8) Observe the voltage across the load again. The amplitude setting should now agree with the measured value.

The same procedure can be performed for the offset function, except that the “diag:offset:cal” command is used.

PROGRAMMING YOUR PULSE GENERATOR

KEY PROGRAMMING COMMANDS

The “Programming Manual for -B Instruments” 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, using the internal trigger source:

```
*rst                (resets the instrument)
trigger:source internal (selects internal triggering)
frequency 1 kHz      (sets the frequency to 1 kHz)
pulse:width 100 ns   (sets the pulse width to 100 ns)
pulse:delay 200 ns   (sets the delay to 200 ns)
output on            (turns on the output)
source:current 100mA (sets the amplitude to 0.1 amperes)
source:current:low 100mA (sets the offset to 100 mA)
```

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

```
*rst                (resets the instrument)
trigger:source hold  (turns off all triggering)
pulse:width 100 ns   (sets the pulse width to 100 ns)
output on            (turns on the output)
source:current 100mA (sets the amplitude to 0.1 amperes)
source:current:low 100mA (sets the offset to 100 mA)
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 output pulse width to track the trigger pulse width in external mode, use:

```
*rst                (resets the instrument)
trigger:source external (selects external triggering)
pulse:width in        (PWOUT = PWIN)
output on            (turns on the output)
source:current 100mA  (sets the amplitude to 0.1 amperes)
source:current:low 100mA (sets the offset to 100 mA)
```

To set the instrument to work as an amplifier (i.e., $I_{OUT} = V_{TRIG} \times 500 \text{ mA/V}$), use:

```
*rst                (resets the instrument)
output on           (turns on the output)
source:current amplify (switches to amplifier mode)
```

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 “Programming Manual for -B Instruments”. (Note: that manual also includes some commands that are not implemented in this instrument. They can be ignored.)


<u>Keyword</u>	<u>Parameter</u>	<u>Notes</u>
DIAGnostic:		
:AMPLitude		
:CALibration	<numeric value>	[no query form]
:OFFSet		
:CALibration	<numeric value>	[no query form]
LOCAL		
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW FIXed]	<numeric value>	
[SOURce]:		
:CURRent		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value> EXT AMPLify	
:LOW	<numeric value>	
:PROTection		
:TRIPped?		[query only]
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value> IN	
:DCYCLe	<numeric value>	
:HOLD	WIDTh DCYCLe	
:DELay	<numeric value>	
:GATE		
:LEVel	High Low	
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		
:ADDRes	<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]


MECHANICAL INFORMATION

TOP COVER REMOVAL

If necessary, 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).

 Always disconnect the power cord and allow the instrument to sit unpowered for 10 minutes before opening the instrument. This will allow any internal stored charge to discharge.

There are no user-adjustable internal circuits. For repairs other than fuse replacement, please contact Avtech (info@avtechpulse.com) to arrange for the instrument to be returned to the factory for repair. Service is to be performed solely by qualified service personnel.

 Caution: High voltages are present inside the instrument during normal operation. Do not operate the instrument with the cover removed.

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 loads using shielded coaxial cables. Unused outputs should be terminated with shielded coaxial terminators or with shielded coaxial dust caps, to prevent unintentional electromagnetic radiation. All cords and cables should be less than 3m in length.

MAINTENANCE

REGULAR MAINTENANCE

This instrument does not require any regular maintenance.

On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

CLEANING

If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

PERFORMANCE CHECK SHEET