# INSTRUCTIONS

MODEL AVOZ-A3-UTC-B

DUAL CHANNEL, 100 & 200 AMP
LASER DIODE DRIVER
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 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.

## TECHNICAL SUPPORT

Phone: 613-226-5772 or 1-800-265-6681
Fax: 613-226-2802 or 1-800-561-1970

E-mail: info@avtechpulse.com
World Wide Web: http://www.avtechpulse.com

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# INTRODUCTION

The dual-channel Model AVOZ-A3-UTC-B pulse generator is designed for pulsing laser diode and other low impedance loads with rectangular pulses.

Channel 1 will generate amplitudes as high as 60V into 0.3Ω (i.e. 200 Amps) with 100 ns rise and fall times. The pulse width is variable from 100 ns to 2 us.

Channel 2 will generate amplitudes as high as 30V into 0.3Ω (i.e. 100 Amps) with 30 ns rise and fall times. The pulse width is variable from 30 ns to 2 us.

The instrument may be triggered internally or externally. When triggered internally, both channels share a common trigger, which may be the internal 1 Hz to 500 Hz variable oscillator, the front-panel pushbutton, or a computer command. The pulse width is set by the front-panel controls.

When triggered externally, each channel is triggered by TTL-level pulses on separate input connectors. The two channels trigger completely independently. In this mode, the output pulse width tracks the trigger input pulse width. The pulse width is not set by the front-panel controls.

The Model AVOZ-A3-UTC-B pulse generator is a voltage pulser. The current amplitude is determined by Ohm's Law. That is, the current is the output voltage divided by the load resistance. The load resistance should be approximately 0.3Ω to attain a peak currents of 200 A and 100 A. The loads can be connected to the pulse generator using the convenient LZ1 flexible flat transmission line, which has a 1Ω characteristic impedance ($Z_0$), and is terminated with a small circuit board.

The AVOZ-A3-UTC-B can be controlled from the front panel, or via a computer connected to the IEEE 488.2-compliant GPIB port, or the RS-232 serial port.

# ORIGINAL QUOTATION

January 4, 2001

Dear Taito,

1) At long last we are able to quote as follows:

| | | |
|---|---|---|
| Quote No: | 10194 | |
| Model Designation: | AVOZ-A3-UTC-B | |
| No. of Channels: | Two | |
| | Channel 1 | Channel 2 |
| Amplitude: | 0 to +60 Volts<br>To RL >/- 0.3 Ohms<br>(200 Amps max)<br>GPIB Control | 0 to +30 Volts<br>To RL >/- 0.3 Ohms<br>(100 Amps max)<br>GPIB Control |
| Pulse Width: | 100 ns to 2 us<br>GPIB Control or<br>PWin = PWout Mode | 30 ns to 2 us<br>GPIB Control or<br>PWin = PWout Mode |
| Rise, Fall Time: | </- 100 ns | </- 30 ns |
| PRF: | 500 Hz<br>GPIB Control or<br>EXT TRIG Control | 500 Hz<br>GPIB Control or<br>EXT TRIG Control |
| Pulse Sequence: | 1 to 3 pulses per burst<br>(in PWin = PWout EXT Mode) | 1 to 3 pulses per burst<br>(in PWin = PWout EXT Mode) |
| Delay Between Pulses: | 100 ns to 500 us<br>(in PWin = PWout EXT Mode) | 30 ns to 500 us<br>(in PWin = PWout EXT Mode) |
| Channel 2 to Channel 1 Relative Delay: (GPIB Mode) | 0 to 10 us | |
| GPIB Control: | Yes. Please see Page 8, Cat. No. 10. The output parameters can be varied using the front panel key pad and endless turn control. (see attached Front Panel drawing) | |
| Chassis Size: | 3.9" x 17" x 17" | |
| Output Cables: | AV-LZ1 (detachable, 1-meter, see attached Rear Panel drawing) | |
| Price: | $10,980.00 US, EXWORKS: Ottawa, Canada | |

Delivery: 60-90 days, after receipt of order

2) I again apologize for the endless delays and I hope the above quote accurately reflects your wishes. Please contact me again if you require any clarifications or modifications.

Regards,

Dr. Walter Chudobiak
Chief Engineer

# 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.

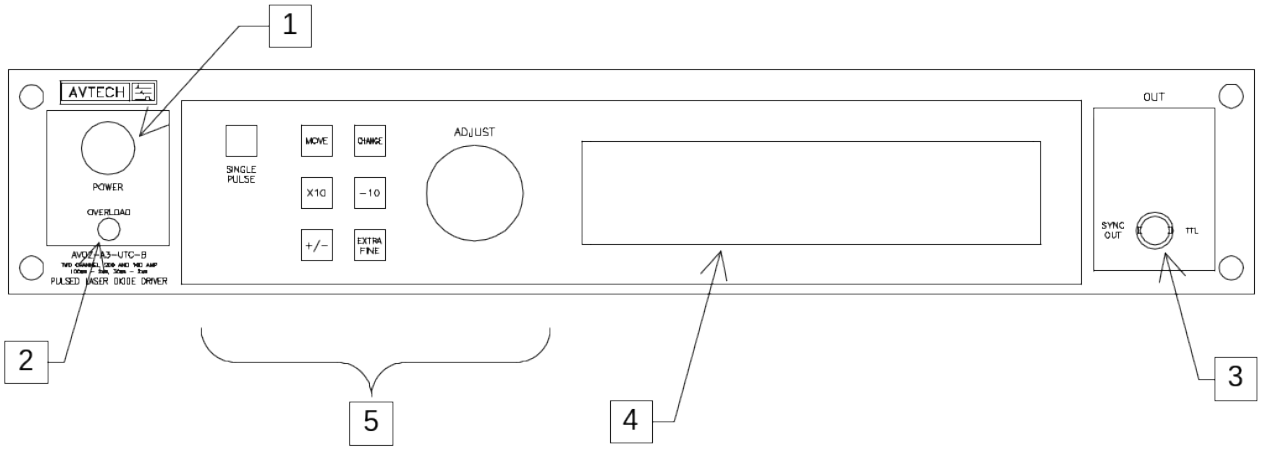
For AC line voltages of 110-120V, the power selector card should be installed so that the “120” marking is visible from the rear of the instrument.

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 (#382 type) is connected to the +15V DC supply.

2. OVERLOAD. This instrument 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 internal power supply is overloaded due to improper operation, 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.

   The overload indicator may come on briefly at startup. This is not a cause for concern.

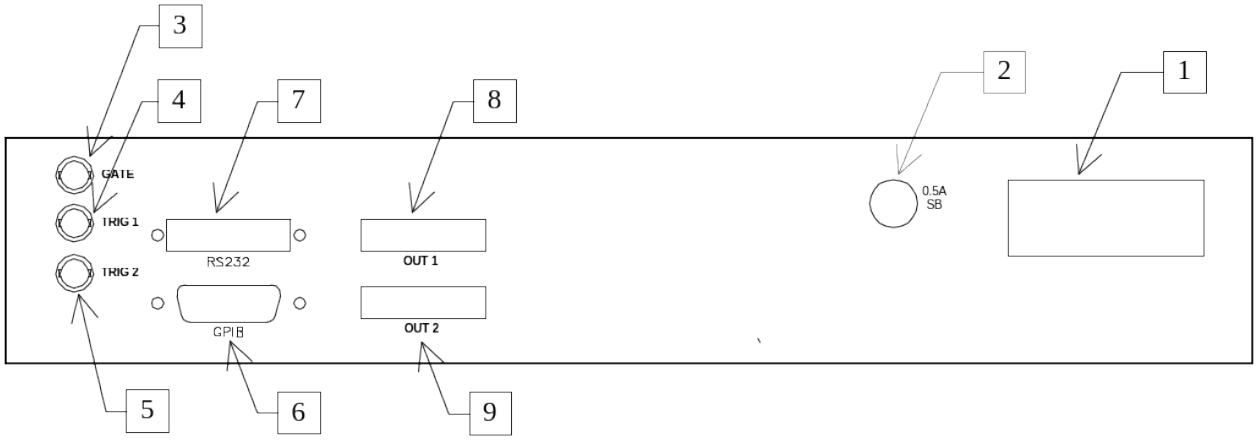
3. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads, or lags, the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to $R_L$ > 1kΩ with a pulse width of approximately 200 ns.

4. 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.

5. 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.<br><br>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 1.0A slow blow fuse and a removable card that can be removed and repositioned to switch between 120V AC in and 240V AC in.

2. DC FUSE. This slow-blow fuse protects 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 1. This TTL-level (0 and +5V) logic input can be used to trigger Channel 1, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input.

5. TRIG 2. This TTL-level (0 and +5V) logic input can be used to trigger Channel 2, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input.

6. 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.

   Depending on the cabling used, the GPIB cable may block easy access to the “OUT2” connector. A GPIB extender adapter has been provided to move the GPIB cable away from the rear-panel, if necessary.

7. 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.

8. OUT 1. This is the Channel 1 output. The LZ1 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.

9. OUT 2. This is the Channel 2 output. The LZ1 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.

# GENERAL INFORMATION - PULSE GENERATOR TIMING

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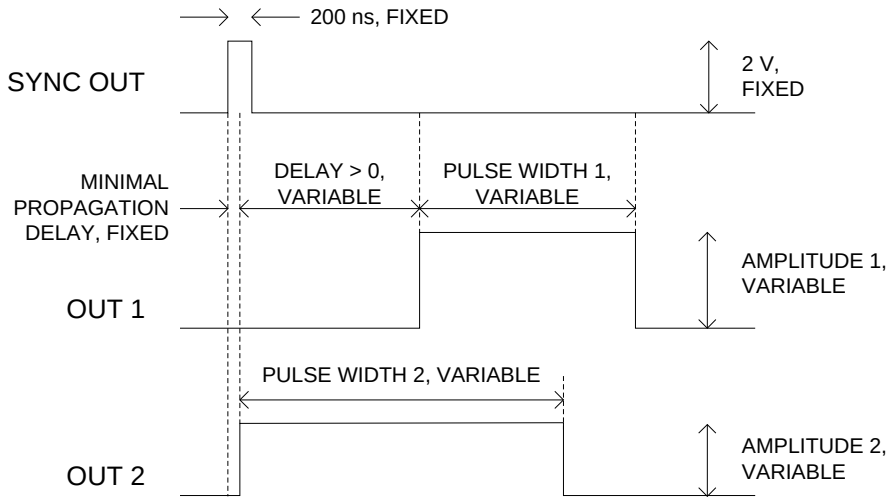
## BASIC PULSE CONTROL - INTERNAL TRIGGERING

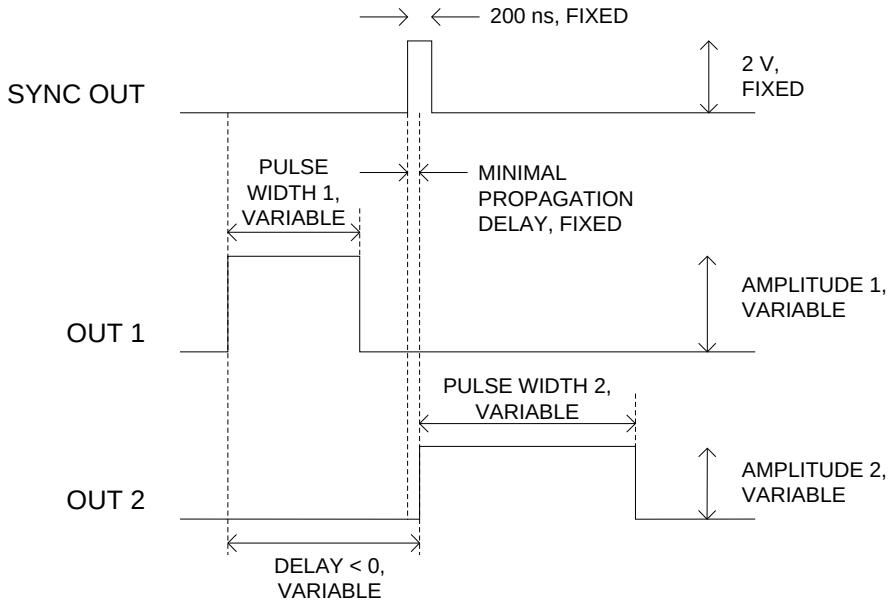
When the instrument is set to trigger internally, three output channels respond to the trigger: OUT 1, OUT 2 and SYNC. The OUT 1 and OUT 2 channels are the signals that are applied to the devices under test. Their amplitude, pulse width, and relative delay are variable. The SYNC pulse is a fixed-width 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.

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:

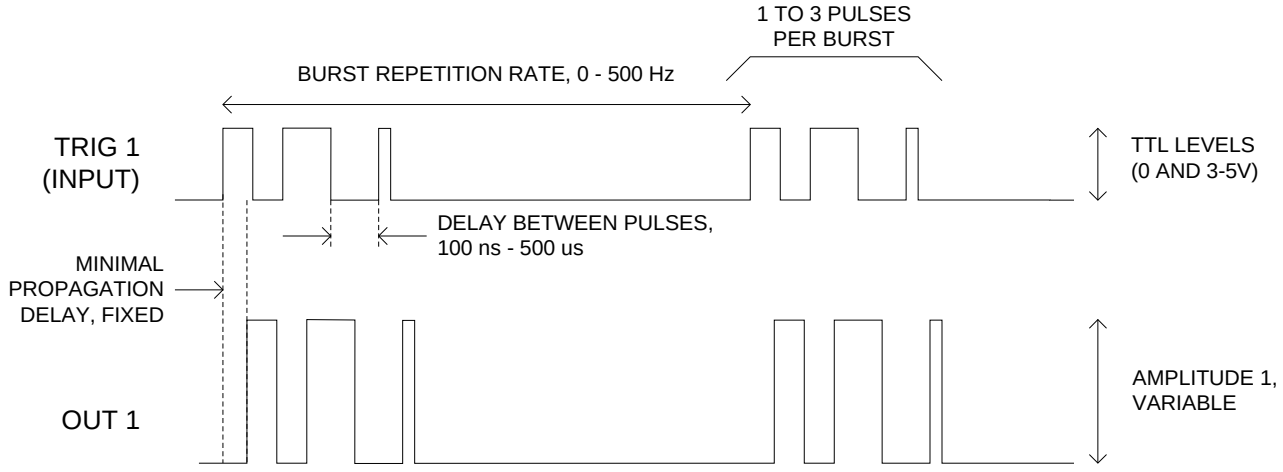



*Basic Output Pulses for Delay < 0*

## BASIC PULSE CONTROL - EXTERNAL TRIGGERING

Operation in the external trigger mode is significantly different than in the internal mode. In the external trigger mode, the each of the two output channels has a separate trigger input. These inputs do not need to be synchronized with each other (although they can be). The output pulse width is approximately equal to the input pulse width, on a pulse-by-pulse basis.

The input trigger may consists of bursts of 1 to 3 pulses, at burst repetition rates of up to 500 Hz. The minimum spacing between the pulses in the burst is shown below.



The Channel 2 timing is similar, except that the “DELAY BETWEEN PULSES” can vary from 30 ns to 500 us.

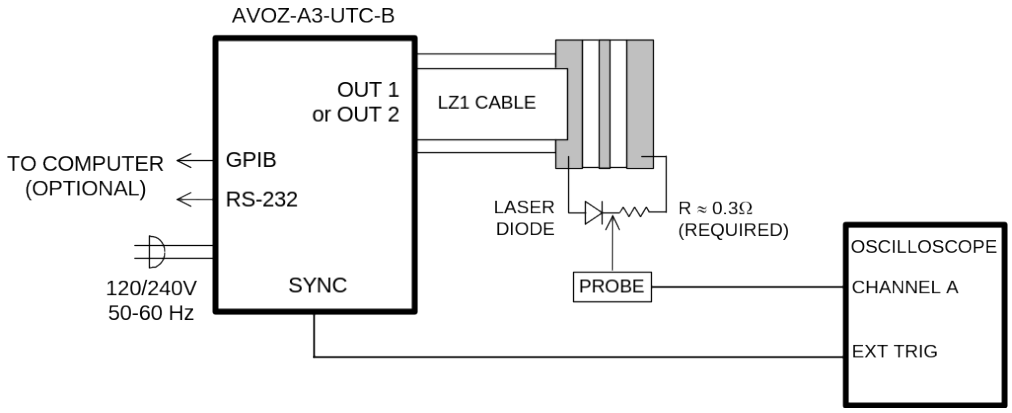
The SYNC output is not used in this mode.

## GATING MODES

When triggering internally, the triggering of Channel 1 can be suppressed by a TTL-level signal on the rear-panel GATE onnector. 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.

# GENERAL INFORMATION - OPERATING INTO A LOAD

## BASIC TEST ARRANGEMENT




The equipment should be connected in the general fashion shown above. Since the AVOZ unit provides an output pulse rise time as low as 30 ns a fast oscilloscope (at least 100 MHz) should be used to display the waveform.

Proper choice of test resistance is important. It is essential that the resistive test load be low-inductance. (Wirewound resistors are not acceptable, unless many are connected together in parallel.) The power dissipated in the resistor is given by

$$P_{AVERAGE} = I^2 \times R \times \frac{PW}{T}, \quad P_{PEAK} = I^2 \times R$$

where “I” is the current, “R” is the resistance, “PW” is the pulse width, and “T” is the pulse period (1/frequency). The power rating of the resistance should exceed this average power rating by a large margin. Beware that some low-value resistors exhibit a significant temperature-dependence, even when the average power dissipated is below the resistor’s power rating. This is particularly true if the peak power exceeds the resistor’s power rating.

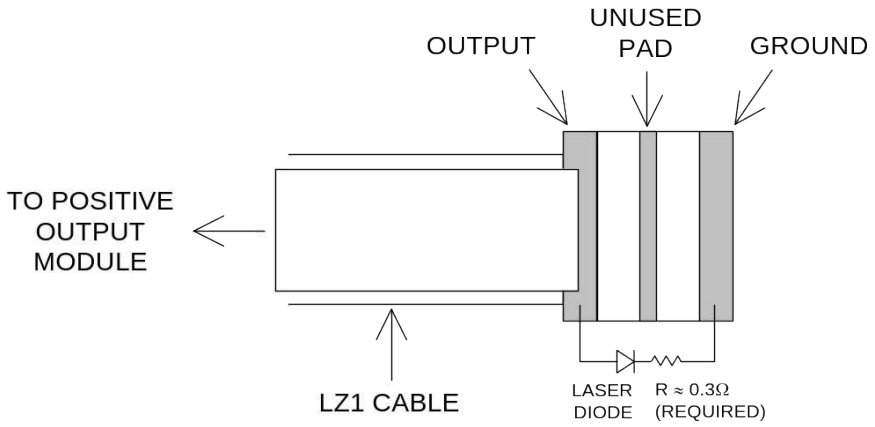
## CONNECTING THE LOAD

The loads can be connected to the LZ1 flexible flat transmission line, which has a 1Ω characteristic impedance ($Z_0$), and is terminated with a small circuit board.

The diode load and a non-inductive load resistor should be solder connected to the end of the line as shown below (using extremely short lead lengths (eg. 0.2 cm) so as to reduce inductance). The series combination of the laser diode and the load resistor $R_L$ should present 0.3Ω to the end of the line. The instrument generates up to 30 or 60

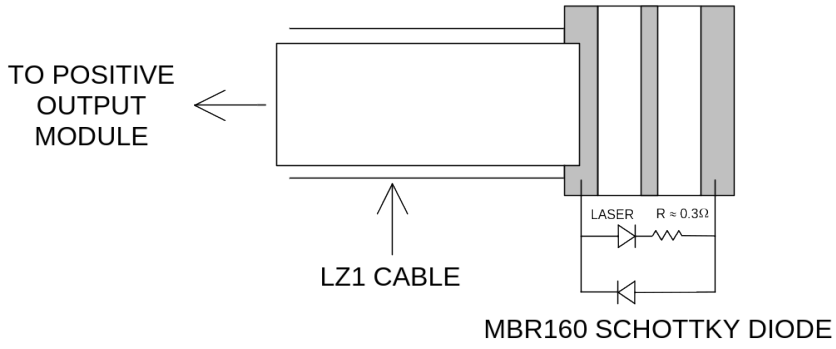
Volts to provide a peak load current of 100 or 200 Amperes. For many diodes, a load resistor 0.3Ω may be selected as a first choice. An ultra fast rectifier diode (eg. MBR160) may be placed across the laser diode to protect against reverse transients. Note that the net load resistance may be higher than 0.3Ω but in this case the peak current will be less than the rated value.

The end of the LZ1 line is illustrated below:




In the above diagram, the diode is oriented for positive current flow. Reverse the diode for negative operation.

The next diagram shows how ultrafast rectifier diodes may be added to protect the laser diode:




## AMPLITUDE CONTROL

The Model AVOZ-A3-UTC-B pulse generator is a voltage pulser. The current amplitude is determined by Ohm's Law. That is, the current is the output voltage divided by the load resistance.

More specifically, $I_{OUT} = \frac{V_{SETTING} - V_{DIODE}}{R}$,

where $V_{SETTING}$ is the set amplitude, $V_{DIODE}$ is the diode voltage, and R is the series resistance (including any series resistance in the diode itself). R is normally 0.3Ω; it should not be smaller than this.

## CURRENT MEASUREMENT

Measuring current is more difficult than measuring voltage. There are two basic approaches to measuring pulsed current:

1. Monitor the voltage across the resistor connected in series with the load, and calculate the current using Ohm's Law. To minimize inductance, it is usually wise to connect several resistors in parallel. Beware that wirewound resistors usually have far too much inductance to be useful as current-sensing resistors.

2. Use a current transformer (such as the Pearson Model 410, see www.pearsonelectronics.com for details). The output voltage of the transformer is proportional to the sensed current. However, the lead length necessary to connect the transformer may degrade the current rise time.

## 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: $V_{SPIKE} = L\frac{dI_{LOAD}}{dt}$.

## 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. Do not connect loads when the instrument is on and the output amplitude is not zero. This can cause sparking.

# START-UP CHECK-LIST FOR LOCAL CONTROL

1) Insert a 0.3Ω test load between the signal out and ground pads on the LZ1 circuit board. Insert the other end of the LZ1 cable into the OUT 1 connector on the rear panel.

2) Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Set the oscilloscope to trigger externally.

3) Connect an oscilloscope probe (channel A) to the signal side of the test load. On the oscilloscope, set the channel A vertical scale to 10 V/div, and the horizontal scale to 200 ns/div.

4) Turn on the instrument. The main menu will appear on the LCD.

5) To set the instrument to trigger from the internal clock at a PRF of 500 Hz:

   - The arrow pointer should be pointing at the frequency menu item. If it is not, press the MOVE button until it is.
   - Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 500 Hz.
   - The arrow pointer should be pointing at the “Internal” choice. If it is not, press MOVE until it is.
   - Press CHANGE to return to the main menu.

6) To set the delay to 100 ns:

   - Press the MOVE button until the arrow pointer is pointing at the delay menu item.
   - Press the CHANGE button. The delay submenu will appear. Rotate the ADJUST knob until the delay is set at 100 ns.
   - Press CHANGE to return to the main menu.

7) To set the OUT 1 pulse width to 500 ns:

   - Press the MOVE button until the arrow pointer is pointing at the “PW1” menu item.

- Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 500 ns.
- The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.
- Press CHANGE to return to the main menu.

8) At this point, nothing should appear on the oscilloscope.

9) To enable the output:

- Press the MOVE button until the arrow pointer is pointing at the output menu item.
- Press the CHANGE button. The output submenu will appear.
- Press MOVE until the arrow pointer is pointing at the “ON” choice.
- Press CHANGE to return to the main menu.

10) To change the OUT output amplitude:

- Press the MOVE button until the arrow pointer is pointing at the AMP1 menu item.
- Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at 30 V.
- Observe the oscilloscope. You should see 500 ns wide, 30V pulses on the probe connected to the main output.
- 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) Repeat steps 1-11 with the LZ1 cable connected to the OUT 2 connector.

13) This completes the operational check.

If additional assistance is required:

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

# MECHANICAL INFORMATION

## TOP COVER REMOVAL

The top cover of the instrument may be removed by removing the four Phillips screws on the top panel. With these four screws removed, the top panel may be slid off by pulling it towards the rear.

## 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.

# 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 10 Hz | (sets the frequency to 10 Hz) |
| pulse:width1 200 ns | (sets the Channel 1 pulse width to 200 ns) |
| pulse:width2 400 ns | (sets the Channel 2 pulse width to 400 ns) |
| pulse:delay 1 us | (sets the delay to 1 us) |
| output on | (turns on the output) |
| source:volt1 15V | (sets the Channel 1 voltage amplitude to 15 Volts) |
| source:volt2 25V | (sets the Channel 2 voltage amplitude to 25 Volts) |

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

| | |
|---|---|
| *rst | (resets the instrument) |
| trigger:source hold | (turns off all triggering) |
| pulse:width1 200 ns | (sets the Channel 1 pulse width to 200 ns) |
| pulse:width2 400 ns | (sets the Channel 2 pulse width to 400 ns) |
| output on | (turns on the output) |
| source:volt1 15V | (sets the Channel 1 voltage amplitude to 15 Volts) |
| source:volt2 25V | (sets the Channel 2 voltage amplitude to 25 Volts) |
| 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 external TTL signals applied to the rear-panel TRIG 1 and TRIG 2 connectors, use:

| | |
|---|---|
| *rst | (resets the instrument) |
| trigger:source external | (selects internal triggering) |
| source:volt1 15V | (sets the Channel 1 voltage amplitude to 15 Volts) |
| source:volt2 25V | (sets the Channel 2 voltage amplitude to 25 Volts) |
| 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 |
|---|---|---|
| DIAGnostic: | | |
| :AMPLitude | | |
| :CALibration: | <numeric value> | [no query form] |
| LOCAL | | |
| MEASure: | | |
| :AMPLitude? | | [query only] |
| OUTPut: | | |
| :[STATe] | <boolean value> | |
| :PROTection | | |
| :TRIPped? | | [query only] |
| REMOTE | | |
| [SOURce]: | | |
| :FREQuency | | |
| [:CW \| FIXed] | <numeric value> | |
| [SOURce]: | | |
| :VOLTage | | |
| [:LEVel] | | |
| [:IMMediate] | | |
| [:AMPLitude] | <numeric value> | |
| :PROTection | | |
| :TRIPped? | | [query only] |
| [SOURce]: | | |
| :PULSe | | |
| :PERiod | <numeric value> | |
| :WIDTh | <numeric value> | |
| :DCYCle | <numeric value> | |
| :HOLD | WIDTh \| DCYCle | |
| :DELay | <numeric value> | |
| :GATE | | |
| :TYPE | ASYNC \| SYNC | |
| :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 | | |
| :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] |

Information on timing and amplitude calibration procedures is available at http://www.avtechpulse.com/appnote/.

PERFORMANCE CHECK SHEET