# INSTRUCTIONS

MODEL AVG-3B-B

0 TO 450 Volts, 20 kHz IMPULSE 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 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

TABLE OF CONTENTS

***PERFORMANCE CHECK SHEET_____25***

Manual Reference: /fileserver1/officefiles/instructword/avg/OBS/AVG-3B-B,edition1.doc, created August 22, 2002

## INTRODUCTION

The AVG-3B-B is a high performance, GPIB and RS232-equipped instrument capable of generating 0 to 450V at repetition rates up to 20 kHz into 50 Ω loads. The pulse width is fixed at ≤ 2 ns (measured at 20% rise time). The AVG-3B-B includes an internal trigger source, but it can also be triggered or gated by an external source. A front-panel pushbutton can also be used to trigger the instrument. The output pulse width can be set to follow an input trigger pulse width.

The output voltage polarity depends on the model number:

| | |
|---|---|
| "-P" units: | 0 to +450 Volts |
| "-N" units: | 0 to -450 Volts |
| "-PN" units: | 0 to ±450 Volts |

The AVG-3B-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, 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.

## AVAILABLE OPTIONS

| | |
|---|---|
| -EA Option: | The amplitude can be controlled by an externally generated 0 to +10V analog control voltage. |
| "-M" Option: | a monitor output is provided. |
| "-OS" Option: | an externally generated DC offset can be added to the output. |

## HIGH-VOLTAGE PRECAUTIONS

**CAUTION:** This instrument provides output voltages as high as 450 Volts, so extreme caution must be employed when using this instrument. The instrument should only be used by individuals who are thoroughly skilled in high voltage laboratory techniques. The following precautions should always be observed:

1) Keep exposed high-voltage wiring to an absolute minimum.

2) Wherever possible, use shielded connectors and cabling.

3) Connect and disconnect loads and cables only when the amplifier is turned off.

4) Consider using attenuators to reduce observed signals to lower and safer voltages.

5) Keep in mind that all cables, connectors, oscilloscope probes, and loads must have an appropriate voltage rating.

Do not attempt any repairs on the instrument, beyond the fuse replacement procedures described in this manual. Contact Avtech technical support (see page 2 for contact information) if the instrument requires servicing.

# SPECIFICATIONS

| | |
|---|---|
| Model: | AVG-3B-B[2] |
| Amplitude[3]: | 0 - 450 V (50 Ω load) |
| Pulse width: | ≤ 2 ns (at 20% rise time) |
| Rise time: | ≤ 0.8 ns |
| Fall time: | ≤ 0.8 ns |
| PRF: | 0 to 20 kHz |
| Polarity[5]: | Positive or negative or both (specify) |
| GPIB and RS-232 control[2]: | Standard on -B units. Not available on -C units or modules. |
| LabView Drivers: | -B units only: check http://www.avtechpulse.com/labview for availability and downloads |
| Propagation delay: | ≤ 50 ns (Ext trig in to pulse out) |
| Jitter: | ± 100 ps (Ext trig in to pulse out) |
| DC offset: | Optional[6]: Apply required DC offset (± 50 Volts, 250 mA max) to back-panel solder terminals |
| Trigger required: | Modules, and -C & -B external trigger mode: +5 Volts, 50 to 500 ns (TTL) |
| Sync delay: | Sync out to pulse out, -C and -B units only: Variable 0 to 200 ns |
| Sync out: | + 3 Volts, 200 ns, will drive 50 Ohm loads (-B and -C units only) |
| Gate input: | Active high or low, switchable. Suppresses triggering when active. (-B units only) |
| Monitor output: | Optional[7]: Provides a 20 dB attenuated coincident replica of main output |
| Connectors: | -C & -B: Out: SMA, Trig, Sync, Gate (-B only): BNC<br>Modules: Out: SMA, In: SMA, Power: Solder terminal |
| Dimensions: (H x W x D) | -B units: 100 mm x 430 mm x 375 mm (3.9" x 17" x 14.8"). See Style G1, page 113.<br>-C units: 100 mm x 215 mm x 375 mm (3.9" x 8.5" x 14.8"). See Style E1, page 113.<br>Modules: 43 mm x 76 mm x 152 mm (1.7" x 3.0" x 6.0"). See Style A1, page 113. |
| Power: | -C & -B: 120/240 Volts (switchable) 50 - 60 Hz,<br>Modules: +15 Volts, 200 mA |
| Other: | For chassis material, mounting, and temperature range, see the AVM Data sheet, page 18. |

1) -C suffix indicates stand-alone lab instrument with internal clock and line powering. No suffix indicates miniature module requiring DC power and external trigger.
2) -B suffix indicates IEEE-488.2 GPIB and RS-232 control of amplitude, pulse width, PRF and delay.
3) For electronic control (0 to + 10 V) of amplitude, suffix the model number with -EA. Electronic control units also include standard front-panel one-turn controls.
4) For the shorter pulse width option, add the suffix -T2.
5) Indicate desired polarity by suffixing model number with -P or -N (i.e. positive or negative) or -PN for the dual polarity option. (-PN available only on -B and -C units). AVX-1 transformer may be used to invert polarity.
6) For DC offset option suffix model number with -OS.
7) For monitor option add suffix -M.

# 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.

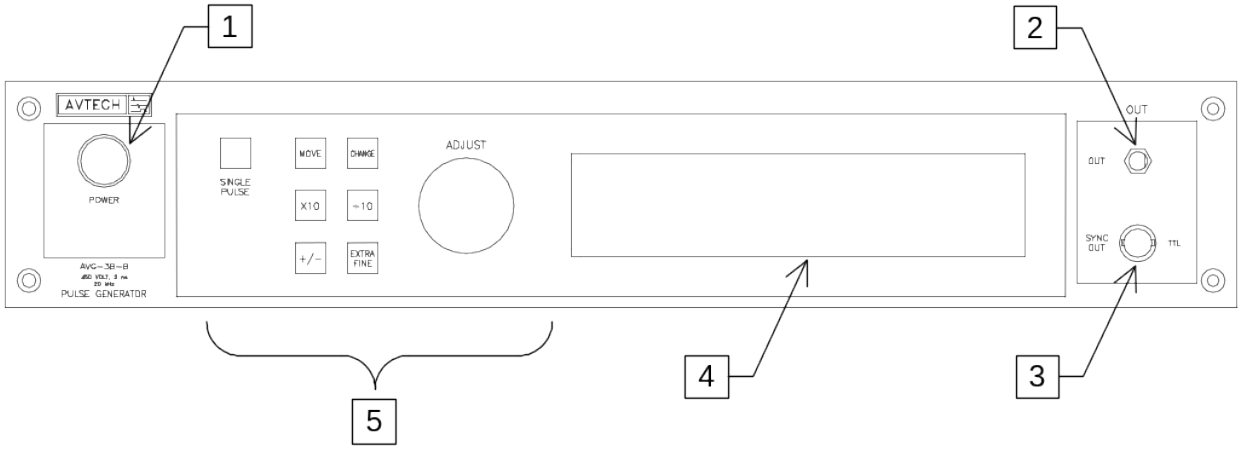
For AC line voltages of 110-120V, the power selector card should be installed so that the “120” marking is visible from the rear of the instrument, as shown below:

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 1.0 slow blow fuse is required. In the 240V setting, a 0.5 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. OUT CONNECTOR. This SMA-type connector provides the output to a 50Ω (or higher) load.

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 $R_L$ > 1K with a pulse width of approximately 200 ns.

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.<br><br>When the main menu is displayed, this knob can be used to move the arrow pointer. |

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.

## 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. See the “Installation” section for more details.

2. 0.5A SB. This fuse protects the output stage.

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). When set to active high mode, this input is pulled-down to ground by a 1 kΩ resistor. When set to active low mode, this input is pulled-up to +5V by a 1 kΩ resistor.

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 input impedance of this input is 1 kΩ. (Depending on the

length of cable attached to this input, and the source driving it, it may be desirable to add a coaxial 50 Ohm terminator to this input to provide a proper transmission line termination. The Pasternack (www.pasternack.com) PE6008-50 BNC feed-thru 50 Ohm terminator is suggested for this purpose.)

5. AMP. (For units with -EA option only.) The output amplitude can be set to track the DC voltage on this input. This input voltage may range between 0 and +10 Volts, which corresponds to minimum and maximum output amplitudes, respectively. (In normal operation, the output amplitude is set by the front-panel controls or via the computer interface.)

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.

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.

# GENERAL INFORMATION

## BASIC PULSE CONTROL

This instrument can be triggered by its own internal clock or by an external TTL trigger signal. In either case, two output channels respond to the trigger: OUT and SYNC. 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.

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

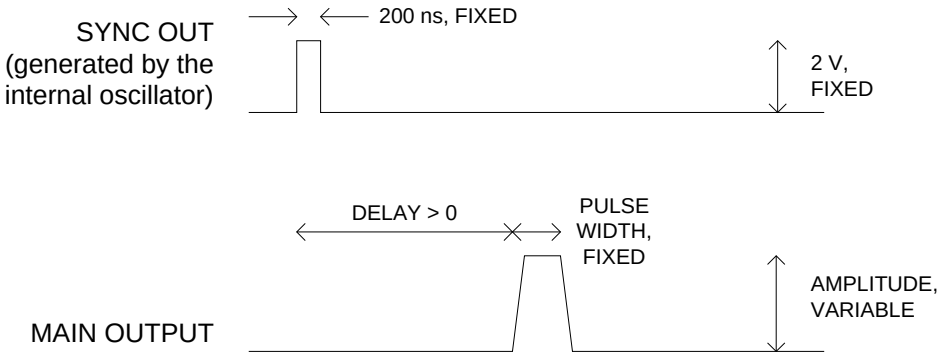



*Figure A*

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

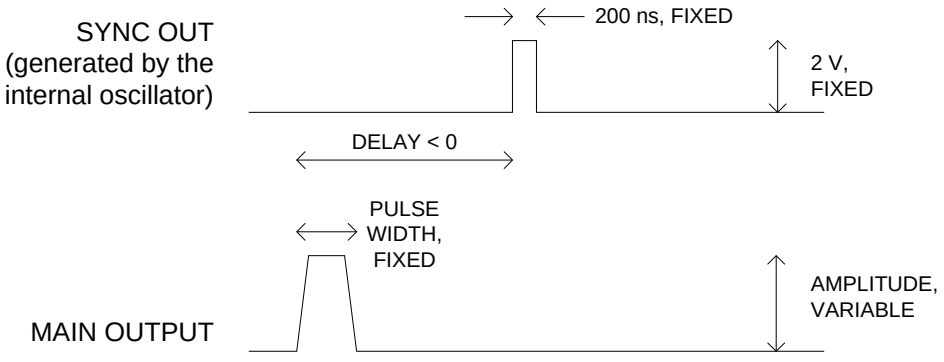



*Figure B*

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

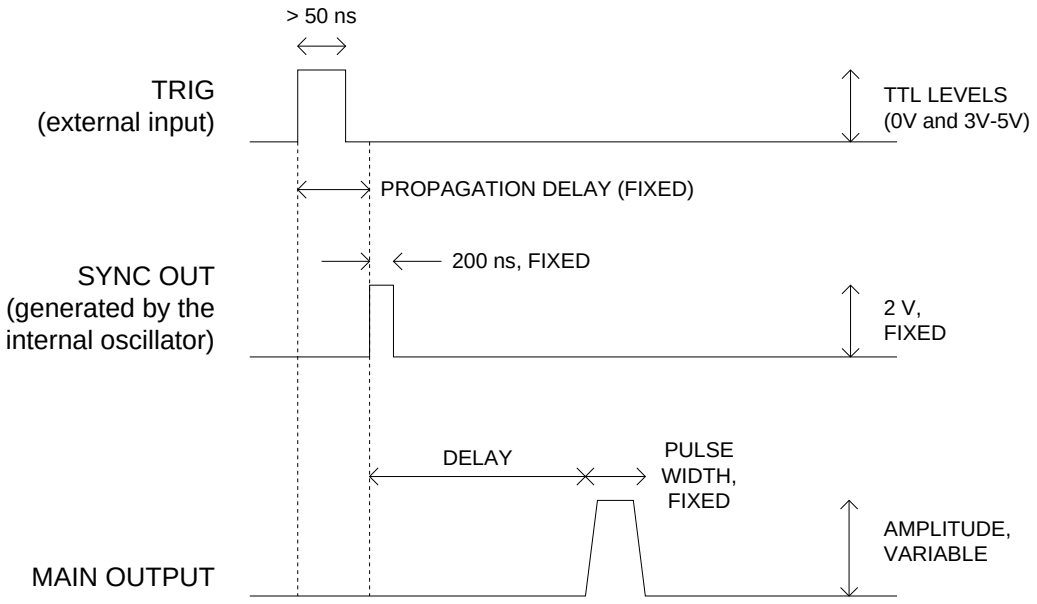



*Figure C*

As before, if the delay is negative, the order of the SYNC and OUT pulses is reversed.

## 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.)

## 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. When gated, the output will complete the full pulse width if the output is high, and then stop triggering. Pulses are not truncated.

## 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.

## 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.

## 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).

**CAUTION!** Extreme caution should be followed when using this instrument as it generates output pulse amplitudes as high as 450 Volts. DC potentials as high as 500 Volts are generated internally. It is therefore highly recommended that the unit be returned to Avtech for all repairs beyond the replacement of the AC line fuse or the DC rear-panel fuse.

# AVAILABLE OPTIONS

## ELECTRONIC AMPLITUDE CONTROL, "-EA" OPTION

The output amplitude can be set to track the voltage on this input. Zero Volts in corresponds to zero amplitude output, and +10V in corresponds to maximum amplitude out. This mode is activated by selecting "Ext Control" on the front-panel amplitude menu, or with the "source:voltage external" command. The polarity remains at its last setting.

## -M OPTION

This option provides a monitor output, which is an attenuated replica of the main output. The monitor is connected to the main output through a 470 Ohm resistor, which results in an attenuation of approximately 20 dB (i.e., ÷10) when the monitor output is terminated with a 50 Ohm load.

For models with the “-OS” option, the monitor output does not include the effect of the added offset.

The monitor output should be terminated with a 50 Ohm load.

## -OS OPTION

This option allows an externally generated DC offset to be added to the output. The desired DC offset is applied to the back panel OS terminal, which is connected to the output centre conductor trhough a high-quality RF inductor.  Do not exceed 50V, 250 mA.

# PROTECTING YOUR INSTRUMENT

## TURN OFF INSTRUMENT WHEN NOT IN USE

The lifetime of the switching elements in the pulse generator module is proportional to the running time of the instrument. For this reason the prime power to the instrument should be turned off when the instrument is not in use. In the case of failure, the switching elements are easily replaced following the procedure described in a following section.

## DO NOT EXCEED 20 kHz

The output stage may be damaged if triggered by an external signal at a pulse repetition frequency greater than 20 kHz.

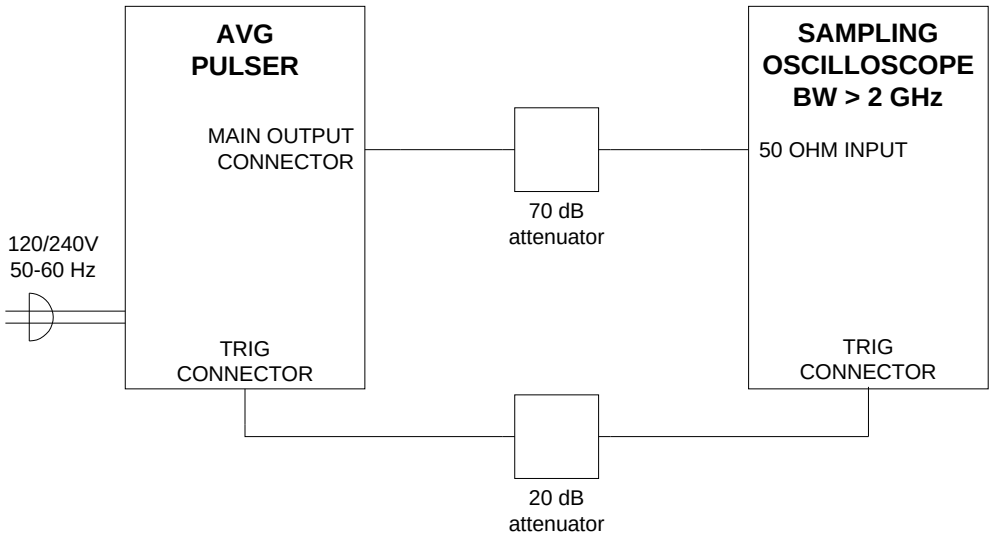
## USE A 50Ω LOAD

The output stage may be damaged if the output is not terminated into a 50Ω load.

# 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.




*BASIC TEST ARRANGEMENT*

1. Connect the pulse generator to a sampling oscilloscope as shown above. Note that:

   a) The use of 70 dB attenuator at the sampling scope vertical input channel will insure a peak input signal to the sampling scope of less than 1 Volt. WARNING: This model may provide a peak output power in excess of 4 kW. The peak power rating of the attenuator must exceed this limit. Factory tests are conducted using a Midwest Microwave model ATT-0527-20-SMA-07 attenuator.

   b) The TRIG output channel provides TTL level signals (approximately 0 and +3V). To avoid overdriving the TRIG input channel of some scopes, a 20 dB attenuator should be placed at the input to the scope trigger channel.

c) The bandwidth capability of components and instruments used to display the pulse generator output signal (attenuators, cables, connectors, etc.) should exceed 2 GHz.

d) Set the oscilloscope to trigger externally with the vertical setting at 100 mV/div and the horizontal setting at 50 ns/div.

2. Turn on the AVG-3B-B. The main menu will appear on the LCD.

3. To set the AVG-3B-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.

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. (Note that it may be necessary to adjust the delay setting within a $\pm$5ns range to obtain optimum jitter performance, as the jitter has a slight periodic delay dependency.)

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

6. 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.

7. To change the output amplitude:

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

b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at +400V (or -400V for "-N" models).

c) Observe the oscilloscope. You should see 2 ns wide, 400V pulses. If you do not, you may need to adjust the delay setting to a value more compatible with your sampling oscilloscope. Repeat step 4 if required. You may also need to adjust the sampling scope controls.

d) Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary. Return it to 400V.

e) ("-PN" units only) Press the +/- button on the front panel. The amplitude as seen on the oscilloscope should flip polarity, to -400V.

f) Press CHANGE to return to the main menu.

This completes the operational check.

# PROGRAMMING YOUR IMPULSE GENERATOR

## KEY PROGRAMMING COMMANDS

The “OP1B Interface Programming Manual” describes in detail how to connect the impulse 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:delay 100 ns | (sets the delay to 100 ns) |
| volt 200 | (sets the amplitude to 200 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:delay 100 ns | (sets the delay to 100 ns) |
| output on | (turns on the output) |
| volt 200 | (sets the amplitude to 200 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:delay 100 ns | (sets the delay to 100 ns) |
| volt 200 | (sets the amplitude to 200 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> | |
| :DCYCle | <numeric value> | |
| :HOLD | WIDTh \| DCYCle | |
| :DELay | <numeric value> | |
| :GATE | | |
| :TYPE | ASYNC \| SYNC | |
| :LEVel | HIgh \| LOw | |
| [SOURce]: | | |
| :VOLTage | | |
| [:LEVel] | | |
| [:IMMediate] | | |
| [:AMPLitude] | <numeric value> \| EXTernal | |
| :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