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SINCE 1975

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## INSTRUCTIONS

MODEL AVL-3AH-C

0 TO 450 VOLTS, 5 kHz, 5 TO 100 ns

HIGH SPEED PULSE GENERATOR

WITH 1 ns RISE TIME, 4 ns FALL TIME

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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## TABLE OF CONTENTS

<b>WARRANTY.....</b>	<b>2</b>
<b>TECHNICAL SUPPORT.....</b>	<b>2</b>
<b>TABLE OF CONTENTS.....</b>	<b>3</b>
<b>INTRODUCTION.....</b>	<b>4</b>
<b>AVAILABLE OPTIONS.....</b>	<b>4</b>
<b>SPECIFICATIONS.....</b>	<b>5</b>
<b>INSTALLATION.....</b>	<b>6</b>
<b>VISUAL CHECK.....</b>	<b>6</b>
<b>PLUGGING IN THE INSTRUMENT.....</b>	<b>6</b>
<b>FRONT PANEL CONTROLS.....</b>	<b>8</b>
<b>REAR PANEL CONTROLS.....</b>	<b>10</b>
<b>GENERAL INFORMATION.....</b>	<b>11</b>
<b>BASIC TEST ARRANGEMENT.....</b>	<b>11</b>
<b>BASIC PULSE CONTROL.....</b>	<b>11</b>
<b>OBTAINING A RECTANGULAR PULSE.....</b>	<b>13</b>
<b>AMPLITUDE INTERACTION.....</b>	<b>13</b>
<b>AMPLITUDE DYNAMIC RANGE.....</b>	<b>13</b>
<b>OPERATIONAL CHECK.....</b>	<b>14</b>
<b>MINIMIZING WAVEFORM DISTORTIONS.....</b>	<b>16</b>
<b>USE 50Ω TRANSMISSION LINES AND LOADS.....</b>	<b>16</b>
<b>USE LOW-INDUCTANCE LOADS.....</b>	<b>16</b>
<b>PREVENTING DAMAGE.....</b>	<b>16</b>
<b>MECHANICAL INFORMATION.....</b>	<b>17</b>
<b>TOP COVER REMOVAL.....</b>	<b>17</b>
<b>ELECTROMAGNETIC INTERFERENCE.....</b>	<b>17</b>
<b>MAINTENANCE.....</b>	<b>18</b>
<b>REGULAR MAINTENANCE.....</b>	<b>18</b>
<b>CLEANING.....</b>	<b>18</b>
<b>PERFORMANCE CHECK SHEET.....</b>	<b>19</b>

## INTRODUCTION

The AVL-3AH-C is a high performance instrument capable of generating up to 450V into 50Ω loads at repetition rates up to 5 kHz. The rise time is less than 2 ns, and the fall time is less than 4 ns.

Instruments with the "-P" model suffix can generate 0 to +450V, whereas instruments with the "-N" model suffix can generate 0 to -450V. Instruments with the "-PN" suffix can generate both polarities.

The output is designed to drive 50Ω loads. (A 50Ω load is required for proper operation.) The output is AC-coupled.

This instrument is intended for use in research and development laboratories.

## AVAILABLE OPTIONS

The AVL-3AH-C is available with several options:

- M Option: a monitor output is provided.
- OS Option: an externally generated DC offset can be added to the output.
- T Option: allows the rise time to be varied up to 10 ns, in 1 ns increments.
- TN Option: reduces the propagation delay to 100 ns.

## SPECIFICATIONS

Model:	AVL-3AH-C <sup>1</sup>
Amplitude <sup>2,3</sup> : (50 Ohm load)	0 to 450 Volts
Rise time <sup>4</sup> (20%-80%):	< 1 ns
Fall time (80%-20%):	< 4 ns
Pulse width:	5 to 100 ns
PRF:	0 to 5 kHz
Polarity <sup>5</sup> :	Positive (For negative output see Note 5.)
Propagation delay:	< 350 ns standard (100 ns optional <sup>6</sup> ). (Ext trig in to pulse out)
Jitter:	± 100 ps (Ext trig in to pulse out)
DC offset or bias insertion:	Option available. Apply required DC offset or bias in the range of ± 50 Volts, (250 mA max) to back panel solder terminal. See note 7.
Trigger required:	Ext trig mode: + 5 Volt, 50 to 500 ns (TTL)
Sync delay:	Sync out to pulse out: Variable 0 to 200 ns
Sync output:	+2 Volts, 200 ns, will drive 50 Ohm loads
Monitor output option <sup>8</sup> :	Provides a 20 dB attenuated coincident replica of main output
Connectors:	Out: SMA, Trig: BNC, Monitor: SMA
Dimensions (H x W x D):	100 x 430 x 375 mm (3.9" x 17" x 14.8")
Power requirements:	120/240 Volts (switchable) 50-60 Hz
Temperature range:	+10°C to +40°C
Chassis material:	Cast aluminum frame & handles, blue vinyl on aluminum cover plates
Mounting:	Any

- 1) -C suffix indicates stand-alone lab instrument with internal clock and line powering. (See page 112 for additional details of the basic instrument formats).
- 2) For electronic control (0 to +10V) of amplitude, suffix model number with -EA. Electronic control units also include the standard front-panel one-turn controls. Available for AVL-3B-C only.
- 3) For operation at amplitudes of less than 10% of full-scale, best results will be obtained by setting the amplitude near full-scale and using external attenuators on the output.
- 4) For rise time variable up to 10 ns in ns increments via a ten-position switch suffix model number with -T. Not available for AVL-3A-C.
- 5) To obtain a negative output use Models AVX-1 or AVX-3 inverting transformer.
- 6) For 100 ns propagation delay option, add suffix -TN. Not available for AVL-3A-C.
- 7) For DC offset option suffix model number with -OS.
- 8) For monitor option add suffix -M.

## INSTALLATION

### VISUAL CHECK

After unpacking the instrument mainframe and the transformer module, examine to ensure that they have not been damaged in shipment. Visually inspect all connectors, knobs, and handles. Confirm that a power cord and an instrumentation manual (this 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:



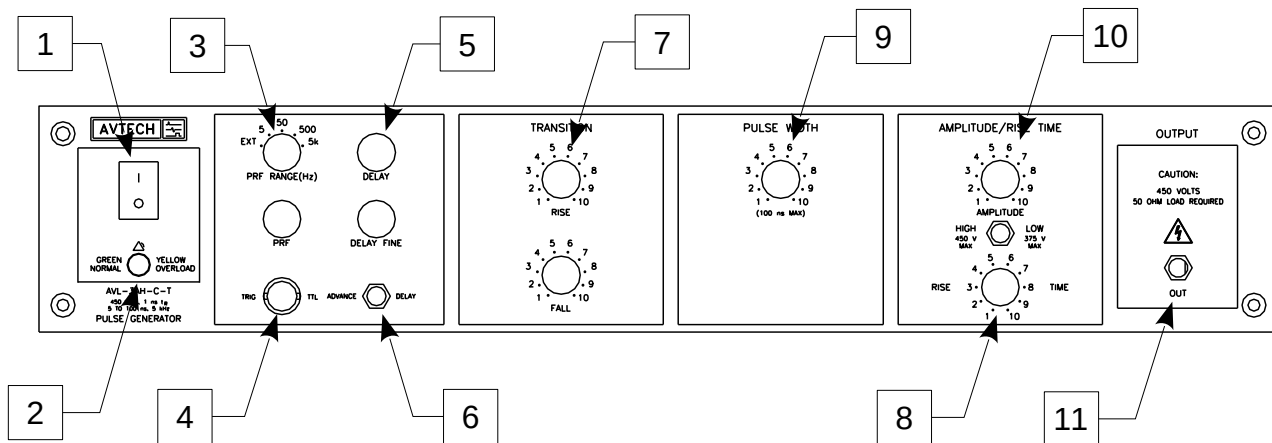
For AC line voltages of 220-240V, the power selector card should be installed so that the “240” marking is visible from the rear of the instrument, as shown below:



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 0.5A slow blow fuse is required. In the 240V setting, a 0.25A slow blow fuse is required.

## FRONT PANEL CONTROLS



- 1) **POWER Switch.** This is the main power switch. When turning the instrument on, there may be a delay of several seconds before the instrument appears to respond.
- 2) **OVERLOAD Indicator.** When the instrument is powered, this indicator is normally green, indicating normal operation. If this indicator is yellow, an internal automatic overload protection circuit has been tripped. If the unit is overloaded (by operating at an exceedingly high duty cycle or by operating into a very low impedance), the protective circuit will disable the output of the instrument and turn the indicator light yellow. The light will stay yellow (i.e. output disabled) for about 5 seconds after which the instrument will attempt to re-enable the output (i.e. light green) for about 1 second. If the overload condition persists, the output will be disabled again (i.e. light yellow) for another 5 seconds. If the overload condition has been removed, the instrument will resume normal operation.

This overload indicator may flash yellow briefly at start-up. This is not a cause for concern.

- 3) **PRF Range Switch.** This switch sets the pulse repetition frequency (PRF) range of the internal oscillator. The marked value of each position is the upper limit of the 10:1 range, approximately. The vernier dial directly below the switch varies the PRF within the set range.

If this switch is set to the "EXT" position, the instrument is triggered by a signal applied to the TRIG connector, rather than by the internal oscillator.

- 4) **TRIG Connector.** When the PRF Range Switch is set to "EXT", the instrument is triggered by a TTL pulse applied to this connector. The pulse must be at least 50 ns wide.

When the PRF Range Switch is set to one of the four internal oscillator ranges, this



connector is an output, which supplies a 2V, 200 ns wide pulse for each trigger event. This output may be used to trigger oscilloscopes or other equipment.

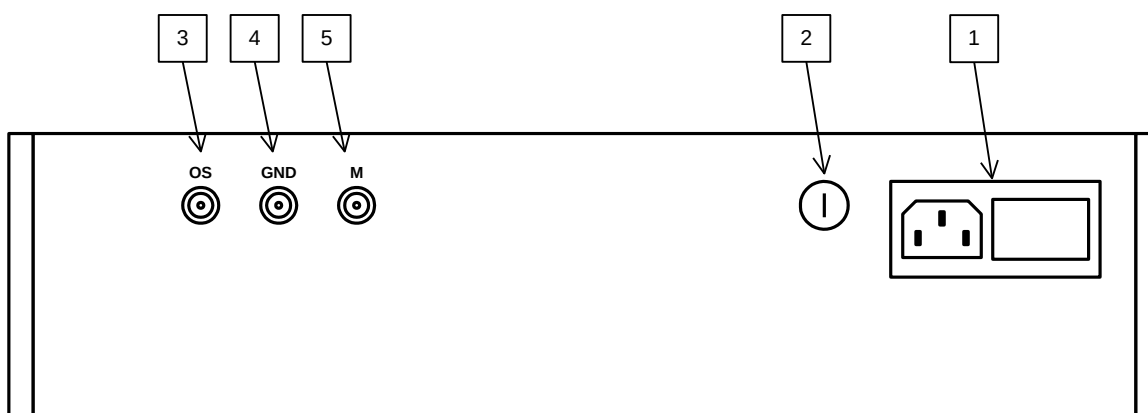
- 5) Delay Controls. When the PRF Range Switch is set to one of the four internal oscillator ranges, the main output is advanced or delayed relative to the TRIG output pulse (item 3). The delay is variable up to 200 ns, approximately, using the DELAY and DELAY FINE dials.
- 6) Advance/Delay Switch. When the PRF Range Switch is set to one of the four internal oscillator ranges, this switch determines whether the TRIG output precedes the main output (ADVANCE mode), or whether the TRIG output occur after the main output (DELAY mode).
- 7) TRANSITION RISE and TRANSITION FALL Controls. The one-turn TRANSITION RISE control adjusts the shape of the leading edge of the output waveform. This control must be adjusted to minimize the rise time after the pulse width has been adjusted. The instrument may require an initial warm-up time of several minutes before the leading edge waveform stabilizes.

The one-turn TRANSITION FALL control adjusts the shape of the falling edge of the output waveform. The control must be adjusted to minimize the fall time after the pulse width has been adjusted.

- 8) Rise Time Control. (For units with the -T option only.) This ten-position switch allows the rise time to be varied up to 10 ns, in 1 ns increments. (The TRANSITION RISE and TRANSITION FALL controls still need adjusted to be used to generate the optimal rectangular waveform.)
- 9) Pulse Width Control. This dial controls the pulse width.
- 10) Amplitude Control. The output pulse amplitude is controlled by means of the one-turn dial (AMP) and the HIGH-LOW switch below the dial. With the switch in the HIGH position, the output amplitude is variable over the range of 100 to 450 Volts while in the LOW position the output amplitude is variable over the range of about 0 to 320 Volts.
- 11) OUT Connector. This connector provides the main output signal, into load impedances of 50Ω.

⚠ Caution: Voltages as high as ±450V may be present on the center conductor of this output connector. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

## 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.

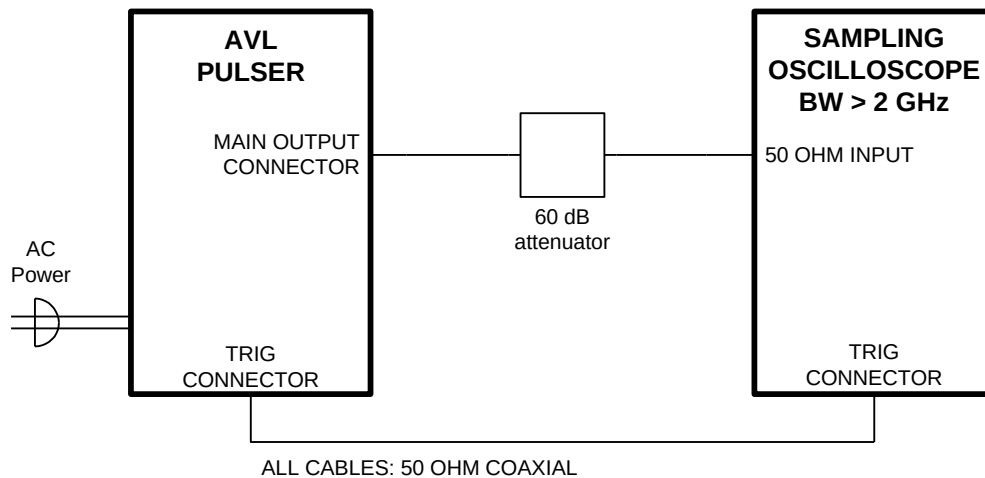
In the 120V setting, a 0.5A slow blow fuse is required. In the 240V setting, a 0.25A slow blow fuse is required. See the “Installation” section for more details.

- 2) 0.5A SB. This fuse protects the internal high-voltage DC power supply.
- 3) OS INPUT CONNECTOR. (Present on units with -os option only.) A DC offset in the range of  $\pm 50V$  (250 mA max) may be applied to this solder terminal. The DC offset will appear on the output. When this feature is not used, the OS input should be connected to ground (using the adjacent GND connector). This is especially important when driving loads containing a diode.
- 4) GND CONNECTOR. (Present on units with -os option only.) This solder terminal is connected to ground. It may be used to ground the OS input connector.
- 5) M OUTPUT CONNECTOR. (Present on units with -M option only.) This SMA connector output provides a 20 dB attenuated coincident replica of main output, for monitoring purposes.

## GENERAL INFORMATION

### BASIC TEST ARRANGEMENT

The AVL-3AH-C should be tested with a sampling oscilloscope with a bandwidth of at least 2 GHz to properly observe the high-speed waveform. A typical test arrangement is shown below:



The attenuators are required to prevent damage to the sampling oscilloscope. A 60 dB attenuator with sufficient voltage rating should be used on the main output.

### BASIC PULSE CONTROL

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

- OUT. This is the main output. The maximum output voltage is 450V.
- TRIG. The TRIG pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems.

When the ADVANCE/DELAY switch is set to “ADVANCE”, the TRIG output precedes the main output. These pulses are illustrated below:

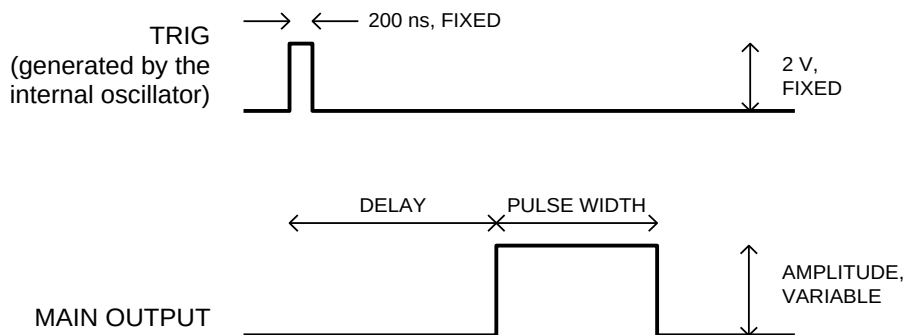
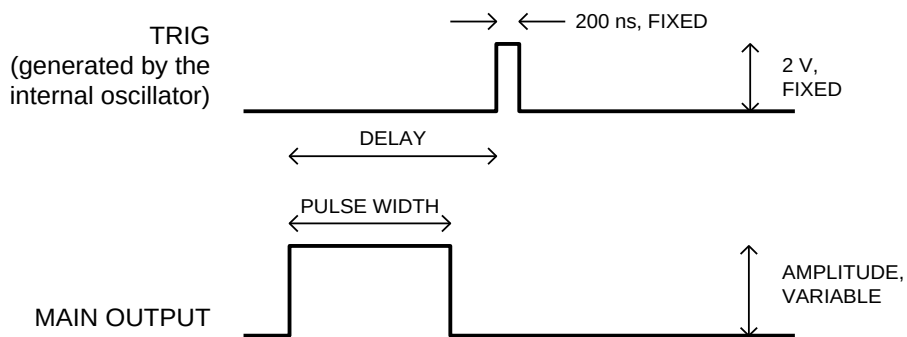
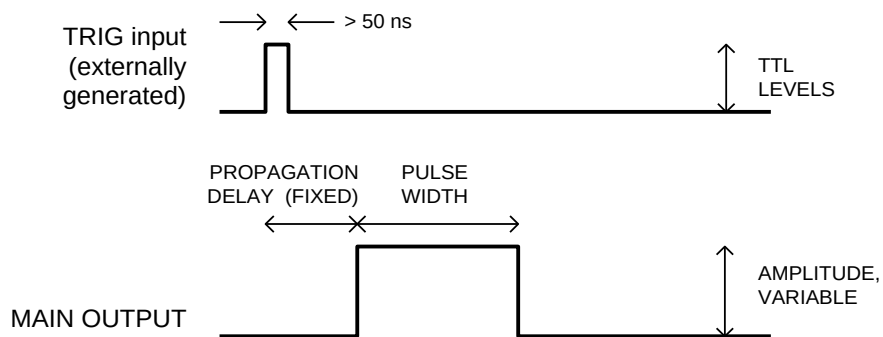


Figure A

When the ADVANCE/DELAY switch is set to "DELAY", the TRIG output occurs after the main output. This illustrated below:



When triggered externally, the TRIG connector acts as an input. The delay controls do not function in this mode. This illustrated below:



## OBTAINING A RECTANGULAR PULSE

The one-turn TRANSITION RISE control adjusts the shape of the leading edge of the output waveform. This control must be adjusted to minimize the rise time after the pulse width has been adjusted. The instrument may require an initial warm-up time of several minutes before the leading edge waveform stabilizes.

The one-turn TRANSITION FALL control adjusts the shape of the falling edge of the output waveform. The control must be adjusted to minimize the fall time after the pulse width has been adjusted.

## AMPLITUDE INTERACTION

Some properties of the output pulse may change as a function of the amplitude setting. For some demanding applications, it may be desirable to use a combination of external attenuators and the amplitude pot to achieve the desired output amplitude.

## AMPLITUDE DYNAMIC RANGE

Avtech high-speed pulse generators are optimized to operate near their maximum rated amplitude. Generally, operation below 20% of the maximum rated amplitude is not recommended. To generate pulses below this level, the pulse generator should be operated near its maximum rated amplitude, and one or more coaxial attenuators should be connected to the output.

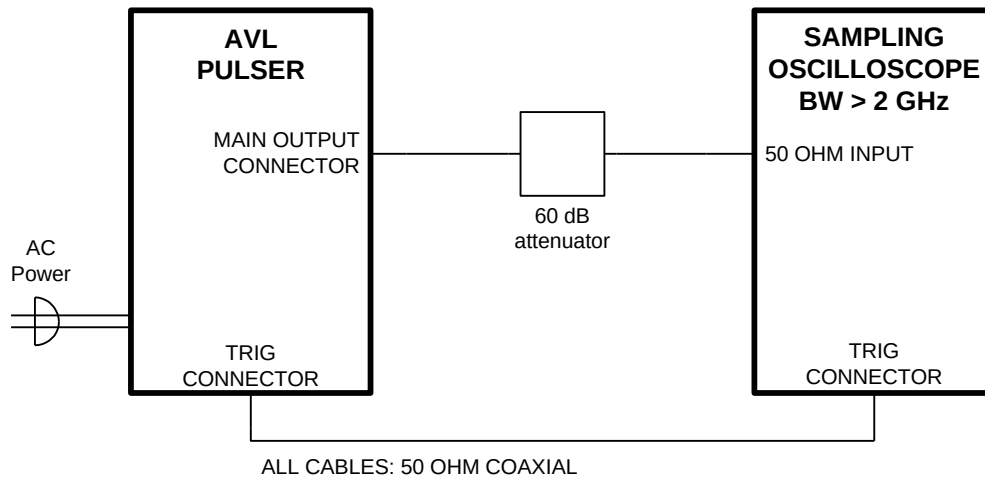
Avtech suggest the Midwest Microwave ATT-0527-XX-SMA-07 family of fixed 12 GHz, 20 Watt attenuators for use with the AVL series.

For more information, please see the Avtech application note “How Can I Extend the Amplitude Range to Low Levels?” at <http://www.avtechpulse.com/appnote/techbrief11/>.

## 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.



### *BASIC TEST ARRANGEMENT*

1. Connect the pulse generator to a sampling oscilloscope as shown above. Leave the pulse generator turned off for now. Note that:
  - a) The use of 60 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 2 kW. The peak power rating of the attenuator must exceed this limit. Factory tests are conducted using Midwest Microwave model ATT-0527-20-SMA-07 attenuators.
  - 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 might be needed 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 20 ns/div.

2. Set the ADVANCE / DELAY switch to “ADVANCE”. Set the upper delay dial to mid-range.
3. Set the PRF RANGE switch to 5 kHz. Rotate the PRF fine control to mid-range.
4. For units with the -T option, set the RISE TIME switch (not the TRANSITION RISE control) to the minimum position (i.e., “1”).
5. Set the amplitude HIGH / LOW switch to low. Rotate the amplitude fine control to fully-clockwise.
6. Set the PULSE WIDTH control to mid-range.
7. Observe the oscilloscope. You should see 50 ns wide, 300V pulses, approximately. If you do not, you may need to adjust the delay setting to a value more compatible with your sampling oscilloscope.
8. Adjust the TRANSITION RISE control and observe the effect on the rising edge of the waveform. Adjust it to obtain the fastest rise time.
9. Adjust the TRANSITION FALL control and observe the effect on the falling edge of the waveform. Adjust it to obtain the fastest rise time.
10. This completes the operational check.

## MINIMIZING WAVEFORM DISTORTIONS

### USE 50Ω TRANSMISSION LINES AND LOADS

Connect the load to the pulse generator with 50Ω transmission lines (e.g. RG-58 or RG-174 cable).

This instrument requires a 50Ω load for proper operation. It will not properly drive a high-impedance load. The output stage will be damaged if it is operated into an open circuit (or any other high impedance). Failures due to improper output loading are not covered by the warranty.

### USE LOW-INDUCTANCE LOADS

Lenz's Law predicts that for an inductive voltage spike will be generated when the current through an inductance changes. Specifically,  $V_{\text{SPIKE}} = L \times dI_{\text{LOAD}}/dt$ , where L is the inductance,  $I_{\text{LOAD}}$  is the load current change, and t is time. For this reason, it is important to keep any parasitic in the load low. This means keeping wiring short, and using low inductance components. In particular, wire-wound resistors should be avoided.

## PREVENTING DAMAGE

The AVL-3AH-C may fail if triggered at a PRF greater than 5 kHz.

This unit is designed to operate into a load impedance of 50 Ohms and the output stage will be damaged if it is operated into an open circuit (or any other high impedance). Failures due to improper output loading are not covered by the warranty.

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.



## 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 before opening the instrument.

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.

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

### 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 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.

### 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