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SINCE 1975

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## INSTRUCTIONS

MODEL AVN-4-C

50 MHz TO 250 MHz

HIGH SPEED PULSE GENERATOR

WITH 150 ps RISE & FALL TIMES

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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## INTRODUCTION

The AVN-4-C pulse generator is a high performance instrument capable of operating at pulse repetition frequencies from 50 MHz to 250 MHz, with 150 ps rise and fall times. The pulse width is variable from 0.3 to 1.0 ns. The maximum amplitude is 20V for repetition rates up to 100 MHz, falling to 15V at 150 MHz, and 5V at 250 MHz.

Instruments with the "-P" model suffix can generate positive amplitudes, whereas instruments with the "-N" model suffix can generate negative amplitudes.

Instruments with the "-P-PN" suffix generate positive amplitudes at the main output, and are supplied with an inverting transformer that can be installed on the output to generate a negative signal.

Instruments with the "-N-PN" suffix generate negative amplitudes at the main output, and are supplied with an inverting transformer that can be installed on the output to generate a positive signal.

The output is designed to drive 50 $\Omega$  loads. (A 50 $\Omega$  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 AVN-4-C is available with several options:

"-OT" Option: an internally generated DC offset can be added to the output.

"-M" Option: a monitor output is provided.

## SPECIFICATIONS

Model:	AVN-4-C <sup>1</sup>
Amplitude: (50 Ohm load)	0 to 20V at ≤100 MHz, falling to 0 to 15V at 150 MHz, and 0 to 5 V at 250 MHz
Pulse width:	Variable 0.3 to 1.0 ns
PRF:	50 MHz to 250 MHz
Rise time:	≤ 150 ps
Fall time:	≤ 150 ps
Polarity <sup>2</sup> :	Positive or negative or both (specify)
Propagation delay:	≤ 5 ns (Ext trig in to pulse out)
Jitter:	± 15 ps (Ext trig in to pulse out)
DC offset or bias insertion <sup>3</sup> :	Apply required DC offset to back panel solder terminals (+/- 50 Volts, 250 mA max)
Trigger required:	ext trig mode: 0.3 V RMS sine wave or 50% duty cycle square wave
Sync output:	50 mV square wave
Monitor output option <sup>4</sup> :	Provides a 20 dB attenuated coincident replica of main output
Connectors:	Out: SMA, Trig: BNC, Sync: BNC, Monitor: SMA
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

- 1) -C suffix indicates stand-alone lab instrument with internal clock and line powering.
- 2) Indicate desired polarity by suffixing the model number with -P or -N (i.e. positive or negative) or -P-PN or -N-PN for dual polarity option where the suffix preceding -PN indicates the polarity at the mainframe output port. (-PN not available on modules).
- 3) For internally generated DC offset option (0 to +/- 5 V, one-turn control) add suffix -OT to the model number. Not available on modules.
- 4) For monitor option add suffix -M. Not available on modules.

EC DECLARATION OF CONFORMITY

We

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declare that this pulse generator meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance pertains to the following specifications as listed in the official Journal of the European Communities:

EN 50081-1 Emission

EN 50082-1 Immunity

and that this pulse generator meets the intent of the Low Voltage Directive 72/23/EEC as amended by 93/68/EEC. Compliance pertains to the following specifications as listed in the official Journal of the European Communities:

EN 61010-1:2001 Safety requirements for electrical equipment for measurement, control, and laboratory use



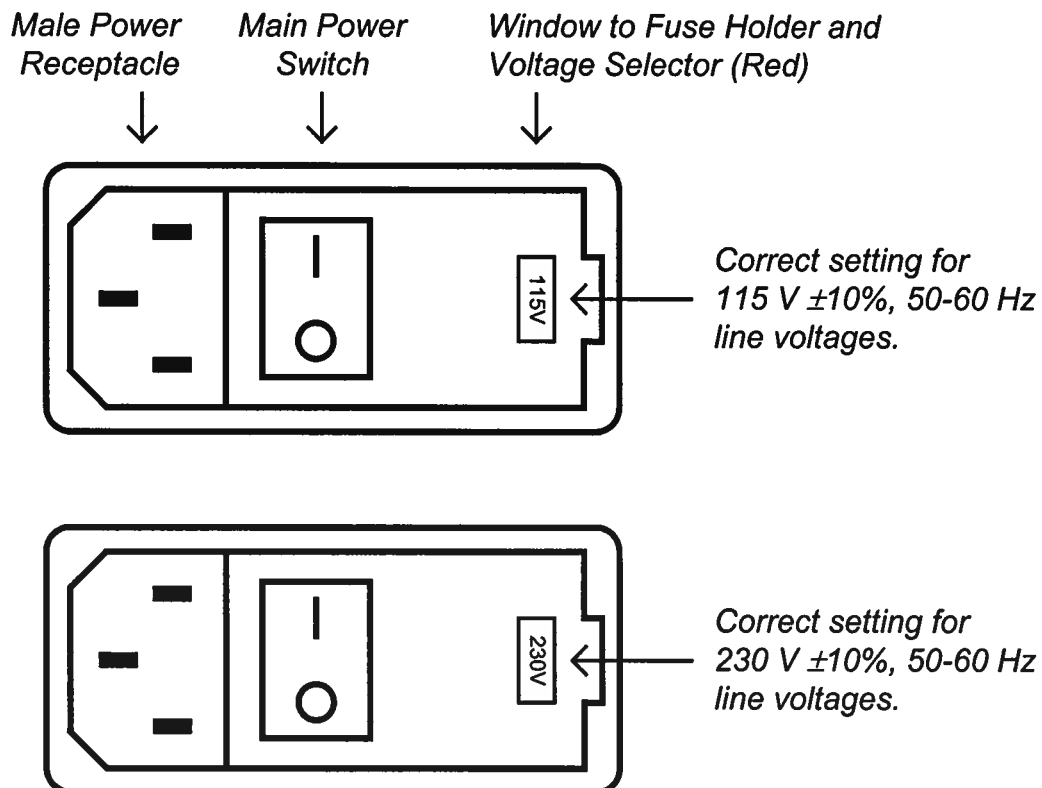
## INSTALLATION

### VISUAL CHECK

After unpacking the instrument, examine to ensure that it has not been damaged in shipment. Visually inspect all connectors, knobs, and handles. Confirm that a power cord is with the instrument. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

### LINE VOLTAGE SELECTION

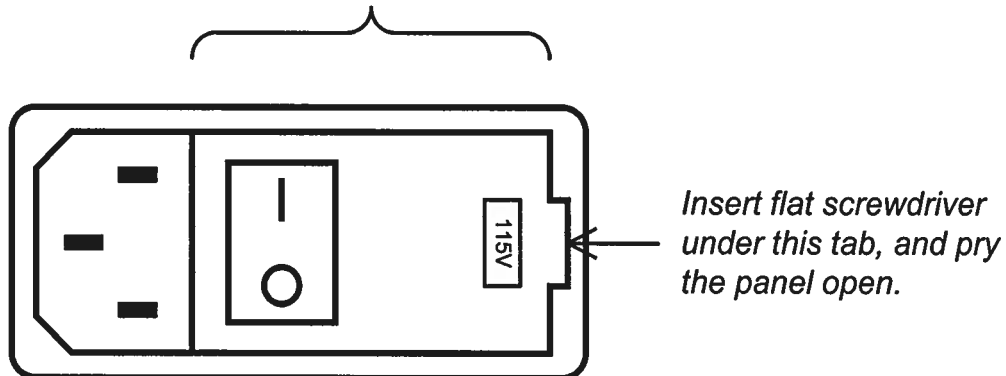
Examine the rear of the instrument. There will be a power-entry module consisting of a male power receptacle, the main power switch, and a fuse holder / voltage selector. Confirm that the voltage selector is in the correct orientation. For AC line voltages of  $115\text{V} \pm 10\%$ , 50 - 60 Hz, the power selector card should be installed so that the "115" marking is visible from the rear of the instrument. For AC line voltages of  $230\text{V} \pm 10\%$ , 50 - 60 Hz, the power selector card should be installed so that the "230" marking is visible from the rear of the instrument. The two possible settings are shown below:



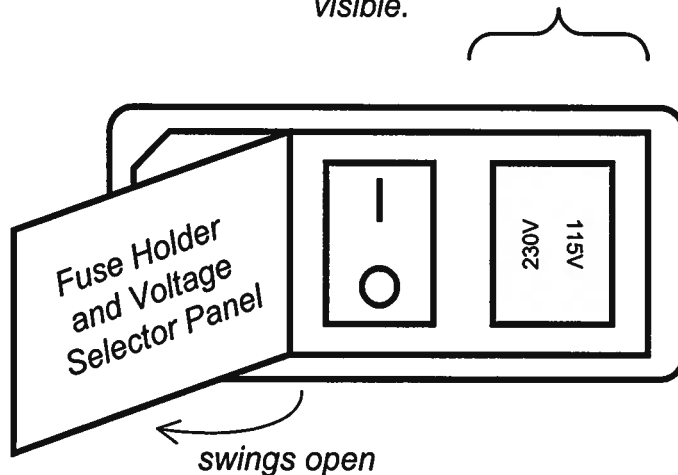
If the voltage selector is not set for to proper voltage, use a small flat-head screwdriver to pry open the voltage selector panel, as shown below:



*Fuse Holder and Voltage Selector Panel.*



*Fuse Holder and Voltage Selector.  
After opening the panel, the red plastic  
fuse holder and voltage selector will be  
visible.*



Once the panel is open, the red fuse holder / voltage selector should be visible. To change the voltage setting, pull out the red fuse holder / voltage selector and rotate it so that the proper voltage marking will shown through the panel window. Re-install the red fuse holder / voltage selector, and close the panel.

### CONNECTION TO THE POWER SUPPLY

An IEC-320 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket. The other end of the detachable power cord plugs into the local mains supply. Use only the cable supplied with the instrument. The mains supply must be earthed, and the cable used to connect the

instrument to the mains supply must provide an earth connection. (The supplied cable does this.)

### POWER RATINGS

This instrument is intended to operate from 115 / 230 V  $\pm$  10%, 50-60 Hz. The maximum power consumption is 57 W. This instrument is an "Installation Category II" instrument, intended for operation from a normal single-phase supply.

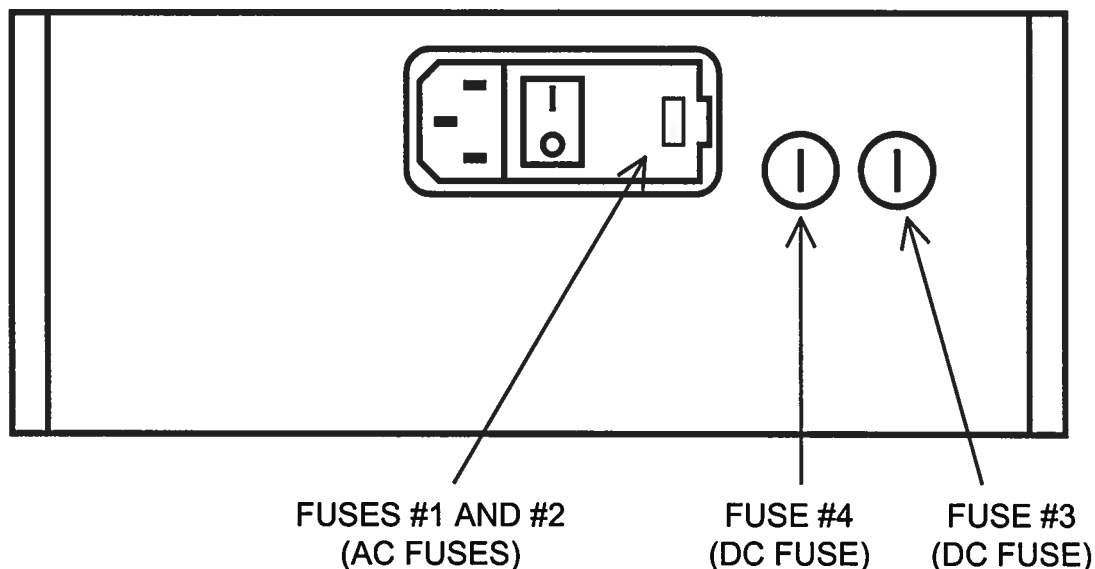
### ENVIRONMENTAL CONDITIONS

This instrument is intended for use under the following conditions:

- a) indoor use;
- b) altitude up to 2 000 m;
- c) temperature 5 °C to 40 °C;
- d) maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
- e) Mains supply voltage fluctuations up to  $\pm$ 10 % of the nominal voltage;
- f) no pollution or only dry, non-conductive pollution.

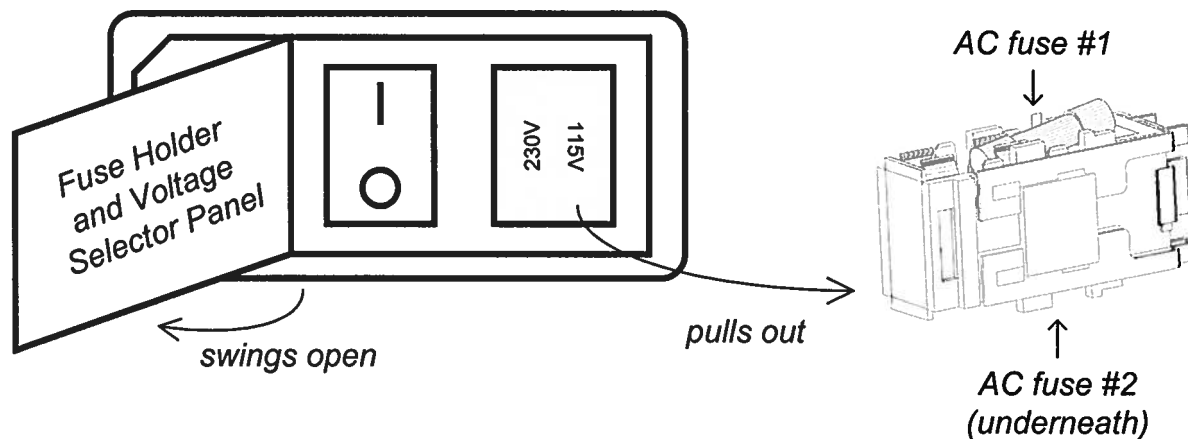
## FUSES

This instrument contains four fuses. All are accessible from the rear-panel. Two protect the AC prime power input, and two protect the internal DC power supplies. The locations of the fuses on the rear panel are shown in the figure below:



### AC FUSE REPLACEMENT

The red fuse holder / voltage selector described in the previous section contains two fuses. One protects the AC "Line" input, and one protects the AC "Neutral" input. To replace the AC fuses, pull out the red fuse holder / voltage selector (as described in the previous section). The location of the two identical 5 mm x 20 mm fuses is shown below:



## DC FUSE REPLACEMENT

The DC fuses may be replaced by inserting the tip of a flat-head screwdriver into the fuseholder slot, and rotating the slot counter-clockwise. The fuse and its carrier will then pop out.

## FUSE RATINGS

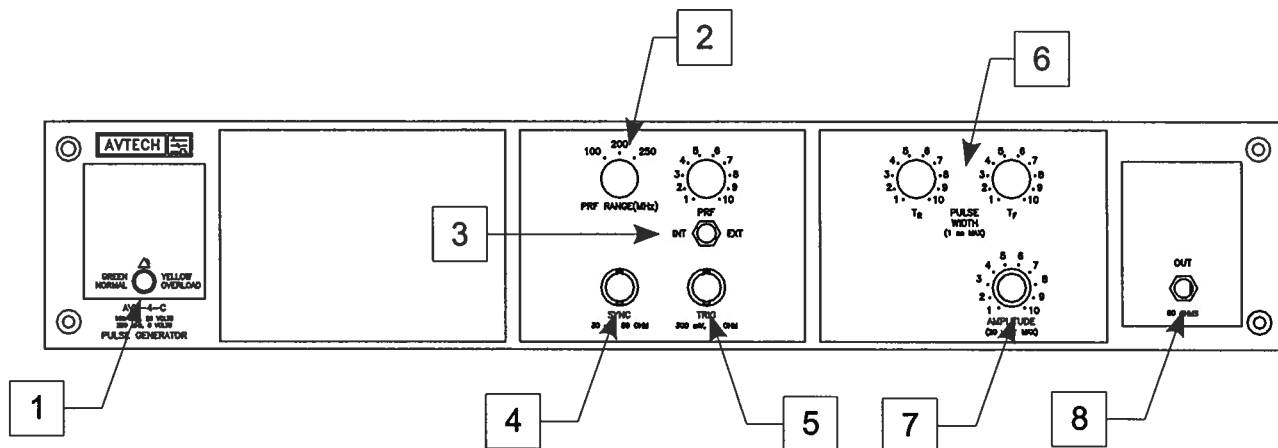
The following table lists the required fuses:

Fuse	Mains Voltage	Rating	Case Size	Manufacturer's Part Number (Wickmann)	Distributor's Part Number (Digi-Key)
#1 (AC)	115 V	0.5A, 250V, Time-Delay	5 x 20 mm	1950500000	WK5041-ND
	230 V	0.25A, 250V, Time-Delay	5 x 20 mm	1950250000	WK5035-ND
#2 (AC)	115 V	0.5A, 250V, Time-Delay	5 x 20 mm	1950500000	WK5041-ND
	230 V	0.25A, 250V, Time-Delay	5 x 20 mm	1950250000	WK5035-ND
#3 (DC)	115/230V	1.6A, 250V, Time-Delay	5 x 20 mm	1951160000	WK5053-ND
#4 (DC)	115/230V	1.0A, 250V, Time-Delay	5 x 20 mm	1951100000	WK5048-ND

The fuse manufacturer is Wickmann (<http://www.wickmann.com/>).

Replacement fuses may be easily obtained from Digi-Key (<http://www.digikey.com/>) and other distributors.

## FRONT PANEL CONTROLS



1. **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.

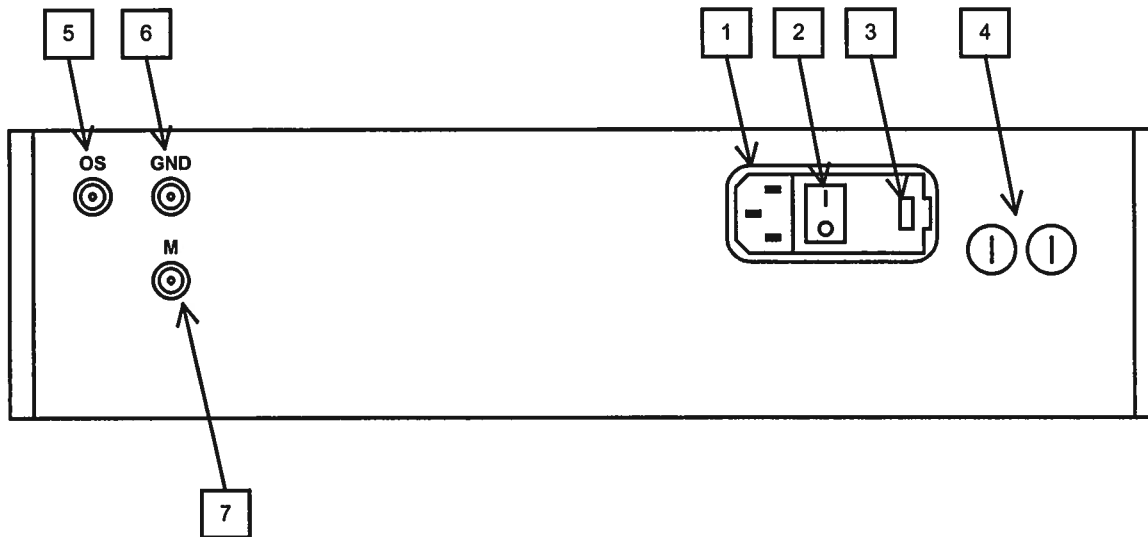
2. **PRF Range Switch.** This switch sets the pulse repetition frequency (PRF) range of the internal oscillator. The marked value of each position is the upper limit of the range, approximately. The vernier dial directly to the right of the switch varies the PRF within the set range.

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.

3. **INT / EXT Switch.** When this switch is in the INT position, the instrument is triggered by the internal oscillator, whose repetition frequency is controlled by item (2). When this switch is in the EXT position, the instrument requires a 0.3 V RMS sine wave applied at the TRIG input in order to trigger the output stages. In this mode the oscilloscope time base must be triggered by the external trigger source.

4. SYNC Output. This output is approximately coincident with the main output and may be used to trigger a sampling scope time base. The output is a 50 mV sine wave capable of driving a 50 Ohm load.
5. TRIG Input. The external trigger signal is applied at this input when the EXT-INT toggle switch is in the EXT position. See item (4).
6. TR-TF Controls. These two one-turn controls vary the output pulse width and pulse shape. TR controls the leading edge of the pulse while TF controls the falling edge. Clockwise rotation of TR and TF increases the output pulse width. See the "General Operating Notes" section for more details.
7. AMP Control. This dial varies the output pulse amplitude from zero to maximum output.
8. OUT Connector. This SMA connector provides the main output to a 50 Ohm load.

## REAR PANEL CONTROLS

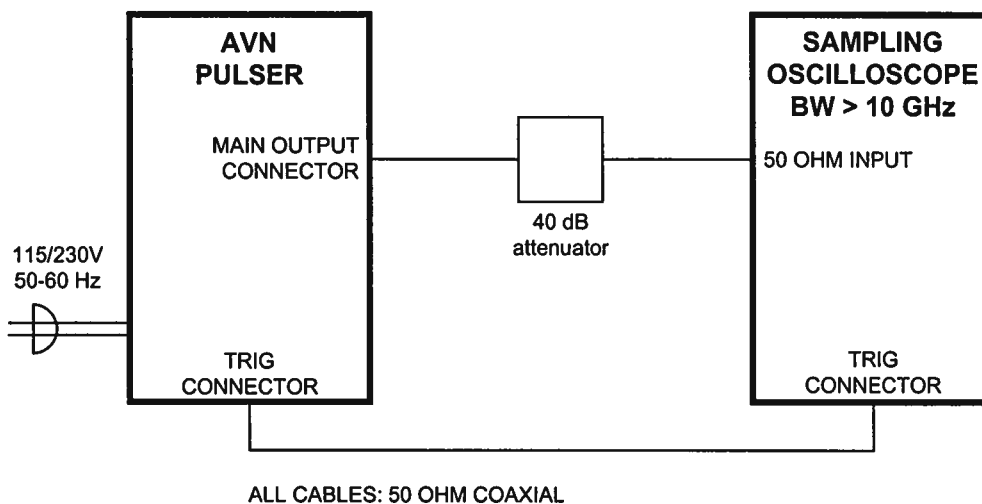


1. **AC POWER INPUT.** An IEC-320 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket.
2. **POWER SWITCH.** This is the main power switch. The instrument should be positioned so that the switch is accessible.
3. **FUSE HOLDER / VOLTAGE SELECTOR.** This red plastic module must be installed so that the marked voltage equals the AC line voltage. This module also contains two fuses that protect the AC inputs. Please see the "LINE VOLTAGE SELECTION" and "FUSES" sections of this manual for more information.
4. **DC FUSES.** These two fuses protect the internal DC power supplies. Please see the "FUSES" sections of this manual for more information.
5. **OS INPUT CONNECTOR.** A DC offset in the range of  $\pm 50\text{V}$  (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.
6. **GND CONNECTOR.** This solder terminal is connected to ground. It may be used to ground the OS input connector.
7. **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 AVN-4-C should be tested with a sampling oscilloscope with a bandwidth of at least 10 GHz to properly observe the high-speed waveform. A typical test arrangement is shown below:



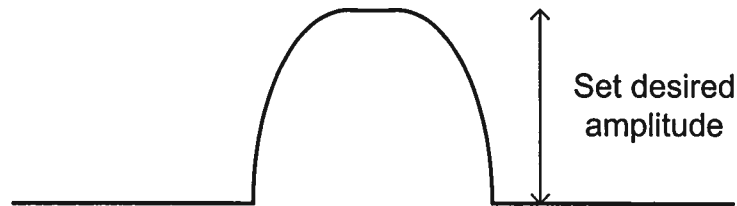
The attenuators are required to prevent damage to the sampling oscilloscope. A 40 dB attenuator with sufficient voltage rating should be used on the main output.

### GENERAL OPERATING NOTES

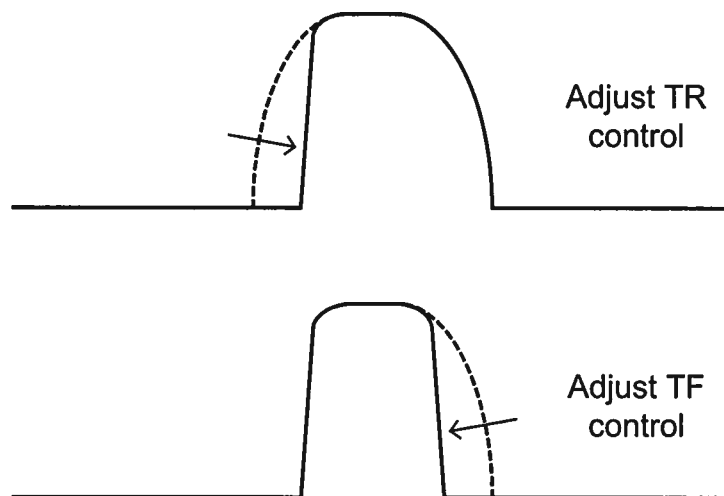
- 1) The bandwidth capability of components and instruments used to display the pulse generator output signal (attenuators, cables, connectors, etc.) should exceed 10 GHz.
- 2) The use of 40 dB attenuator at the sampling scope vertical input channel will insure a peak input signal to the sampling scope of less than 1 Volt.
- 3) The SYNC output provides a 50 mV sine wave (to 50 Ohms).
- 4) To obtain a stable output display the PRF and PRF FINE controls on the front panel should be set mid-range. The front panel TRIG toggle switch should be in the INT position. The scope triggering controls are then adjusted to obtain a stable output.
- 5) The output pulse shape is determined by the two front panel controls TR and TF. TR controls the leading edge of the pulse while TF controls the falling edge. Clockwise rotation of TR and TF increases the output pulse width. Initially rotate



the TF pot fully clockwise and set the TR pot at mid-range. The output amplitude is controlled by the front panel AMP control and by the input signal level. Initially the AMP control should be set maximum clockwise. The CRT display will resemble the following:



- 6) Having obtained a display of the form shown above, the desired pulse width is then obtained by adjusting the two front panel pots TR and TF. Rotate TR counter clockwise from the position set earlier until a sharp 150 ps leading edge is observed. Then rotate TF counterclockwise until the desired pulse width and fall time are obtained.



- 7) Further iterative adjustments of TR and TF will be necessary to simultaneously obtain the lowest rise time, lowest fall time, the desired pulse width, and pulse top shape, and low spurious signal level. In addition some additional adjustment of signal level may be necessary to obtain the desired amplitude. If the input frequency is then changed it will be necessary to readjust AMP, TR and TF to establish the required pulse shape. Following the above sequence it is possible to generate output pulses having amplitudes of at least 20, 15 and 5 Volts with pulse repetition frequencies in the range of 50 to 100 MHz, 150 and 250 MHz, respectively.

**WARNING:** Do not operate below 50 MHz as failure may result. Also, do not

exceed 20 Volts out (for frequencies of less than 100 MHz) as this too may result in failure. Failures due to operating at output signals higher than 20 Volts are not covered by the warranty.

- 8) To trigger externally, set the INT-EXT switch to EXT and connect a sine wave generator to the TRIG connector. The output PRF will equal the sine wave PRF. The sine wave amplitude should be set at 0.3 VRMS.
- 9) To DC offset the output pulse connect a DC power supply set to required DC offset value to the back panel terminals marked OS. The maximum attainable DC offset voltage is  $\pm 50$  Volts (for units without the OT option only).

## MINIMIZING WAVEFORM DISTORTIONS

### USE 50 OHM 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 AVN-4-C may fail if triggered at a PRF greater than 250 MHz.

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.

## OPTIONS

The AVN-4-C is available with these options:

### -OT OPTION

This option allows an internally generated DC offset to be added to the output. The output DC offset is variable from +5 to -5 Volts by means of the front-panel one-turn OFFSET control. The offset control may be turned off by means a the rear panel ON-OFF OFFSET switch.

### -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.,  $\div 10$ ) when the monitor output is terminated with a 50 Ohm load.

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


## 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 BNC terminators or with shielded BNC 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.

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