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NANOSECOND WAVEFORM ELECTRONICS  
SINCE 1975

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BOX 5120, LCD MERIVALE  
OTTAWA, ONTARIO  
CANADA K2C 3H4

## INSTRUCTIONS

MODEL AV-156A-B

0 to +5 AMP, 20% DUTY, 4 us RISE TIME

MODEL AV-156G-B

0 to +10 AMP, 10% DUTY, 4 us RISE TIME

PULSED CONSTANT CURRENT GENERATORS

WITH IEEE 488.2 AND RS-232 CONTROL

SERIAL NUMBER: \_\_\_\_\_

### WARRANTY

Avtech Electrosystems Ltd. warrants products of its manufacture to be free from defects in material and workmanship under conditions of normal use. If, within one year after delivery to the original owner, and after prepaid return by the original owner, this Avtech product is found to be defective, Avtech shall at its option repair or replace said defective item. This warranty does not apply to units which have been disassembled, modified or subjected to conditions exceeding the applicable specifications or ratings. This warranty is the extent of the obligation assumed by Avtech with respect to this product and no other warranty or guarantee is either expressed or implied.

### TECHNICAL SUPPORT

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## INTRODUCTION

The Model AV-156A-B pulsed constant current generator is capable of producing rectangular pulses with amplitudes as high as +5 Amperes, with < 4 us rise and fall times. The internal trigger source can be used to trigger the instrument at frequencies between 1 Hz and 10 kHz. An external TTL trigger pulse, a front-panel pushbutton, and a computer can also be used to trigger the instrument. The pulse width is variable from 10 us to 10 ms (or 100 ms with the -PW option). The maximum duty cycle is 20%.

The AV-156G-B is similar in all respects, except that the maximum amplitude is +10 Amps, and the maximum duty cycle is 10%.

The AV-156A-B and AV-156G-B pulse generators are current pulsers. The current amplitude is largely independent of the load voltage. For proper operation, the load voltage ( $V_{LOAD} = I_{LOAD} \times R_{LOAD}$ ) must lie in the range of 0 to +15V (or 0 to +25V for units with the -HC option).

These models feature front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40 character back-lit LCD display of the output amplitude, pulse width, pulse repetition frequency, and delay. The instrument includes memory to store up to four complete instrument setups. The operator may use the front panel or the computer interface to store a complete "snapshot" of all key instrument settings, and recall this setup at a later time.

This instrument is intended for use in research, development, test and calibration laboratories by qualified personnel.

### AVAILABLE OPTIONS

- HC Option: This extends the maximum compliance voltage from +15V to +25V.
- R5 Option: Rack-mount kit.
- RP Option: This option adds a second output connector, located on the rear-panel. This rear-panel connector and the standard front-panel output connector are wired to the same point internally.
- OT Option: This option allows the addition of a 0 to +500 mA DC offset to the output. (The total sum of the offset plus the amplitude can not exceed the maximum amplitude rating. That is, the amplitude and offset can not both be set to their maximum settings at the same time.)
- VI Option: This option adds a “voltage-to-current” amplifier mode of operation. When enabled, this allows the output current to track the voltage waveform applied to a rear-panel input connector. The relationship is:  
  
AV-156A-B-VI:  $I_{OUT} \approx V_{IN} \times 0.5 \text{ Volt / Amp.}$   
AV-156G-B-VI:  $I_{OUT} \approx V_{IN} \times 1.0 \text{ Volt / Amp.}$
- TNT Option: Adds a rear-panel Ethernet connector, providing Telnet-based remote control from a network.
- BR Option: This optional feature allows a burst of 1-500 pulses to be generated in response to each trigger event.
- PW Option: This option extends the maximum pulse width from 10 ms to 100 ms.

## SPECIFICATIONS

Model:	AV-156A-B	AV-156G-B
Amplitude:	0.01 - 5.0 A	0.01 - 10 A
Number of output channels:	One	
Pulse width (FWHM):	10 us to 10 ms Optional <sup>9</sup> : 10 us to 100 ms	
Max. pulse repetition freq:	10 kHz	
Max. duty cycle:	20%	10%
Rise & fall time <sup>1</sup> (20%-80%):	< 4 us	
Load configuration:	Referenced to ground.	
Polarity:	Positive - sources current.	
Output current regulation:	< 2 % load voltage change from 0 Volts to maximum rated voltage	
Load voltage range:	Standard: 0 to +15V With -HC option <sup>2</sup> : 0 to +25V	
Voltage-to-current amplifier mode:	With -VI option <sup>3</sup> : I <sub>OUT</sub> waveform tracks V <sub>IN</sub> waveform. +10V full-scale. Average current 1A maximum.	
DC offset / bias option <sup>8</sup> :	0.01 - 0.5 A (optional feature <sup>8</sup> )	
Overshoot <sup>4</sup> :	< 10 %	
Jitter:	< ± 200 ps ± 0.03% of sync delay (Ext trig in to pulse out)	
Trigger required:	External trigger mode: TTL, PW > 50 ns	
Sync delay:	0 to ±1.0 seconds (Sync out to pulse out)	
Sync output:	+3 Volts, 100 ns, will drive 50 Ohm loads	
Amplitude accuracy <sup>1,5</sup> :	± 3 mA ± 3%	
Frequency accuracy <sup>5</sup> :	± 3%	
Pulse width accuracy <sup>1,5</sup> :	± 1 us ± 3%	
Sync delay accuracy <sup>1,5</sup> :	± 1 us ± 3%	
Gate input:	Active high or low, switchable. Suppresses triggering when active.	
Monitor output:	Back-panel BNC connector provides a coincident replica of the output current.	
Connectors, main output:	BNC, front-panel <sup>6</sup>	
Connectors, other:	Sync output: BNC, front-panel. Gate, Ext Trig, Monitor: BNC, rear-panel	
GPIB and RS-232 control:	Standard feature. See page See <a href="http://www.avtechpulse.com/gpib">http://www.avtechpulse.com/gpib</a> for details.	
LabView Drivers:	Check <a href="http://www.avtechpulse.com/labview">http://www.avtechpulse.com/labview</a> for availability and downloads	
Telnet / Ethernet control <sup>7</sup> :	Optional. See <a href="http://www.avtechpulse.com/options/tnt">http://www.avtechpulse.com/options/tnt</a> for details.	
Power requirements:	100 - 240 Volts, 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:	cast aluminum frame & handles, blue vinyl on aluminum cover plates	
Temperature range:	+5°C to +40°C	

- 1) Valid when driving a load impedance that is between zero Ohms and the impedance given by (Maximum Compliance Voltage) / (Maximum Rated Current). For load impedances higher than this value, de-rate the rise and fall times proportionally.
- 2) To specify the high compliance voltage option, add the suffix -HC to the model number.
- 3) To specify the voltage-to-current amplifier mode option, add the suffix -VI to the model number.
- 4) Valid for amplitudes greater than 5% of the full-scale value, into non-inductive loads.
- 5) At room temperature, when operating into a resistive load.
- 6) To add a duplicate main output connector on the rear panel, add the suffix -RP to the model number.
- 7) Add the suffix -TNT to the model number to specify the Telnet / Ethernet control option.
- 8) Add the suffix -OT to the model number to specify the DC offset option. The total sum of the offset plus the amplitude can not exceed the maximum amplitude rating. That is, the amplitude and offset can not both be set to their maximum settings at the same time.
- 9) Add the suffix -PW to the model number to specify the wider pulse width range.

## REGULATORY NOTES

### FCC PART 18

This device complies with part 18 of the FCC rules for non-consumer industrial, scientific and medical (ISM) equipment.

This instrument is enclosed in a rugged metal chassis and uses a filtered power entry module. The main output signal is provided on a shielded connector that is intended to be used with shielded coaxial cabling and a shielded load. Under these conditions, the interference potential of this instrument is low.

If interference is observed, check that appropriate well-shielded cabling is used on the output connectors. Contact Avtech ([info@avtechpulse.com](mailto:info@avtechpulse.com)) for advice if you are unsure of the most appropriate cabling. Also, check that your load is adequately shielded. It may be necessary to enclose the load in a metal enclosure.

If any of the connectors on the instrument are unused, they should be covered with shielded metal "dust caps" to reduce the interference potential.

This instrument does not normally require regular maintenance to minimize interference potential. However, if loose hardware or connectors are noted, they should be tightened. Contact Avtech ([info@avtechpulse.com](mailto:info@avtechpulse.com)) if you require assistance.

### EC DECLARATION OF CONFORMITY



We                      Avtech Electrosystems Ltd.  
                             P.O. Box 5120, LCD Merivale  
                             Ottawa, Ontario  
                             Canada K2C 3H4

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

#### DIRECTIVE 2002/95/EC (RoHS)

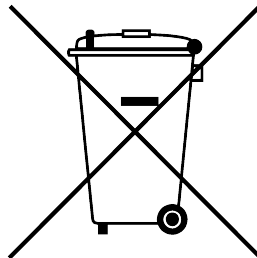
This instrument is exempt from Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the use of certain Hazardous Substances (RoHS) in electrical and electronic equipment. Specifically, Avtech instruments are considered "Monitoring and control instruments" (Category 9) as defined in Annex 1A of Directive 2002/96/EC. The Directive 2002/95/EC only applies to Directive 2002/96/EC categories 1-7 and 10, as stated in the "Article 2 - Scope" section of Directive 2002/95/EC.

#### DIRECTIVE 2002/96/EC (WEEE)

European customers who have purchased this equipment directly from Avtech will have completed a "WEEE Responsibility Agreement" form, accepting responsibility for WEEE compliance (as mandated in Directive 2002/96/EC of the European Union and local laws) on behalf of the customer, as provided for under Article 9 of Directive 2002/96/EC.

Customers who have purchased Avtech equipment through local representatives should consult with the representative to determine who has responsibility for WEEE compliance. Normally, such responsibilities will lie with the representative, unless other arrangements (under Article 9) have been made.

Requirements for WEEE compliance may include registration of products with local governments, reporting of recycling activities to local governments, and financing of recycling activities.



## 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 “Programming Manual for -B Instruments”) are with the instrument. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

### POWER RATINGS


This instrument is intended to operate from 100 - 240 V, 50 - 60 Hz.

The maximum power consumption is 90 Watts. Please see the “FUSES” section for information about the appropriate AC and DC fuses.

This instrument is an “Installation Category II” instrument, intended for operation from a normal single-phase supply.

### 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 cord used to connect the instrument to the mains supply must provide an earth connection. (The supplied cord does this.)

 Warning: Failure to use a grounded outlet may result in injury or death due to electric shock. This product uses a power cord with a ground connection. It must be connected to a properly grounded outlet. The instrument chassis is connected to the ground wire in the power cord.

The table below describes the power cord that is normally supplied with this instrument, depending on the destination region:

Destination Region	Description	Option	Manufacturer	Part Number
United Kingdom, Hong Kong, Singapore, Malaysia	BS 1363, 230V, 50 Hz	-AC00	Qualtek <sup>1</sup>	370001-E01
Australia, New Zealand	AS 3112:2000, 230-240V, 50 Hz	-AC01	Qualtek <sup>1</sup>	374003-A01
Continental Europe, Korea, Indonesia, Russia	European CEE 7/7 "Schuko" 230V, 50 Hz	-AC02	Qualtek <sup>1</sup>	364002-D01
North America, Taiwan	NEMA 5-15, 120V, 60 Hz	-AC03	Qualtek <sup>1</sup>	312007-01
Switzerland	SEV 1011, 230V, 50 Hz	-AC06	Qualtek <sup>1</sup>	378001-E01
South Africa, India	SABS 164-1, 220-250V, 50 Hz	-AC17	Volex <sup>2</sup>	2131H 10 C3
Japan	JIS 8303, 100V, 50-60 Hz	-AC18	Qualtek <sup>1</sup>	397002-01
Israel	SI 32, 220V, 50 Hz	-AC19	Qualtek <sup>1</sup>	398001-01
China	GB 1002-1, 220V, 50 Hz	-AC22	Volex <sup>2</sup>	2137H 10 C3

## PROTECTION FROM ELECTRIC SHOCK

 Operators of this instrument must be protected from electric shock at all times. The owner must ensure that operators are prevented access and/or are insulated from every connection point. In some cases, connections must be exposed to potential human contact. Operators must be trained to protect themselves from the risk of electric shock. This instrument is intended for use by qualified personnel who recognize shock hazards and are familiar with safety precautions required to avoid possibly injury. In particular, operators should:

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 instrument is turned off.
4. Keep in mind that all cables, connectors, oscilloscope probes, and loads must have an appropriate voltage rating.
5. 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. Service is to be performed solely by qualified service personnel.

## ENVIRONMENTAL CONDITIONS

This instrument is intended for use under the following conditions:

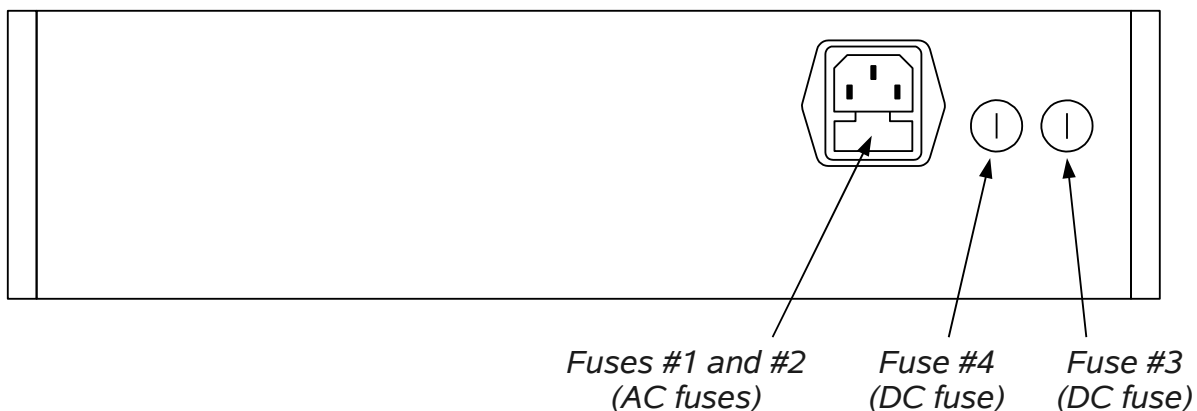
1. indoor use;
2. altitude up to 2 000 m;
3. temperature 5 °C to 40 °C;
4. maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
5. Mains supply voltage fluctuations up to  $\pm 10$  % of the nominal voltage;
6. no pollution or only dry, non-conductive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

## LABVIEW DRIVERS

A LabVIEW driver for this instrument is available for download on the Avtech web site, at <http://www.avtechpulse.com/labview>. A copy is also available in National Instruments' Instrument Driver Library at <http://www.natinst.com/>.

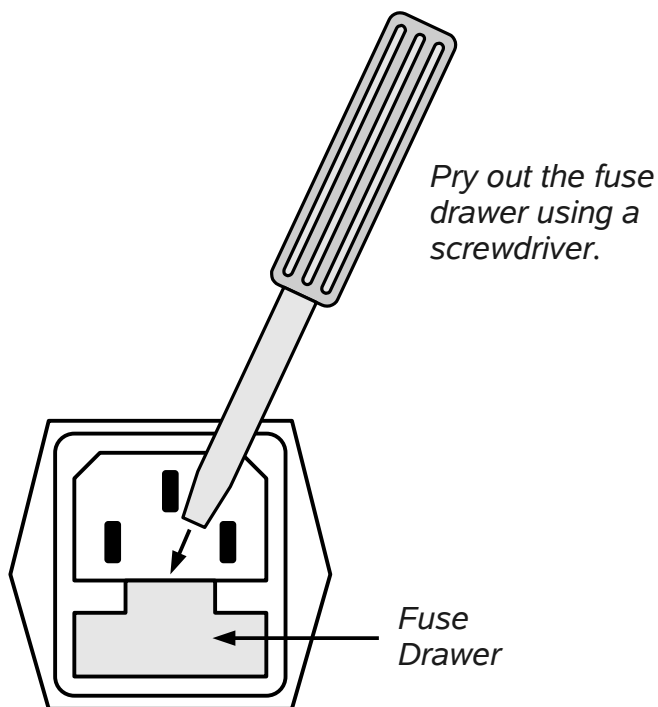
## FUSES

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

To physically access the AC fuses, the power cord must be detached from the rear panel of the instrument. The fuse drawer may then be extracted using a small flat-head screwdriver, as shown below:



## DC FUSE REPLACEMENT

The DC fuses may be replaced by inserting the tip of a flat-head screwdriver into the fuse holder 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 for the AV-156A-B:

Fuses	Nominal Mains Voltage	Rating	Case Size	Recommended Replacement Part	
				Littelfuse Part Number	Digi-Key Stock Number
#1, #2 (AC)	115 V	0.8A, 250V, Time-Delay	5×20 mm	0218.800HXP	F2418-ND
	230 V	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND
#3 (DC)	N/A	2.0A, 250V, Time-Delay	5×20 mm	0218002.HXP	F2420-ND
#4 (DC)	N/A	1.6A, 250V, Time-Delay	5×20 mm	021801.6HXP	F2424-ND

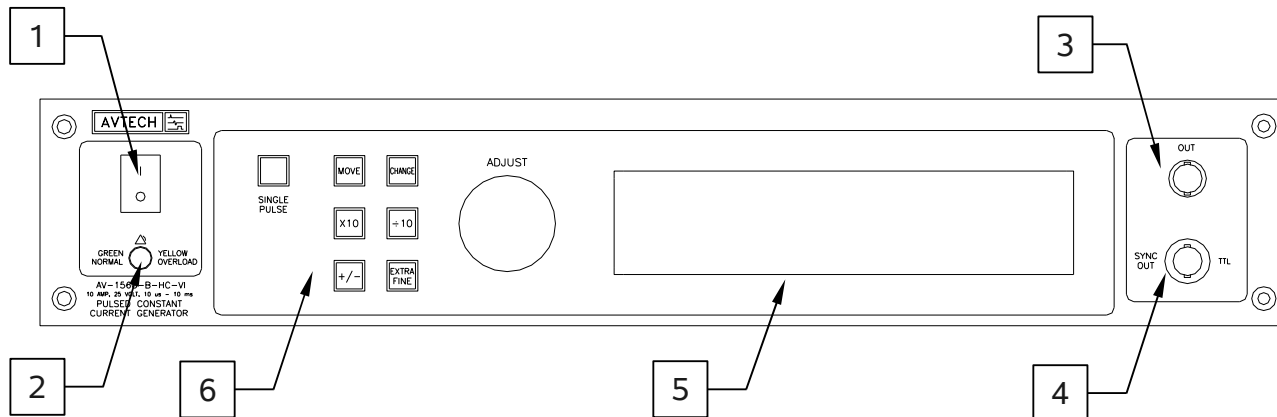
The following table lists the required fuses for the AV-156G-B:

Fuses	Nominal Mains Voltage	Rating	Case Size	Recommended Replacement Part	
				Littelfuse Part Number	Digi-Key Stock Number
#1, #2 (AC)	115 V	0.8A, 250V, Time-Delay	5×20 mm	0218.800HXP	F2418-ND
	230 V	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND
#3 (DC)	N/A	2.5A, 250V, Time-Delay	5×20 mm	021802.5HXP	F2427-ND
#4 (DC)	N/A	2.0A, 250V, Time-Delay	5×20 mm	0218002.HXP	F2420-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) 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.

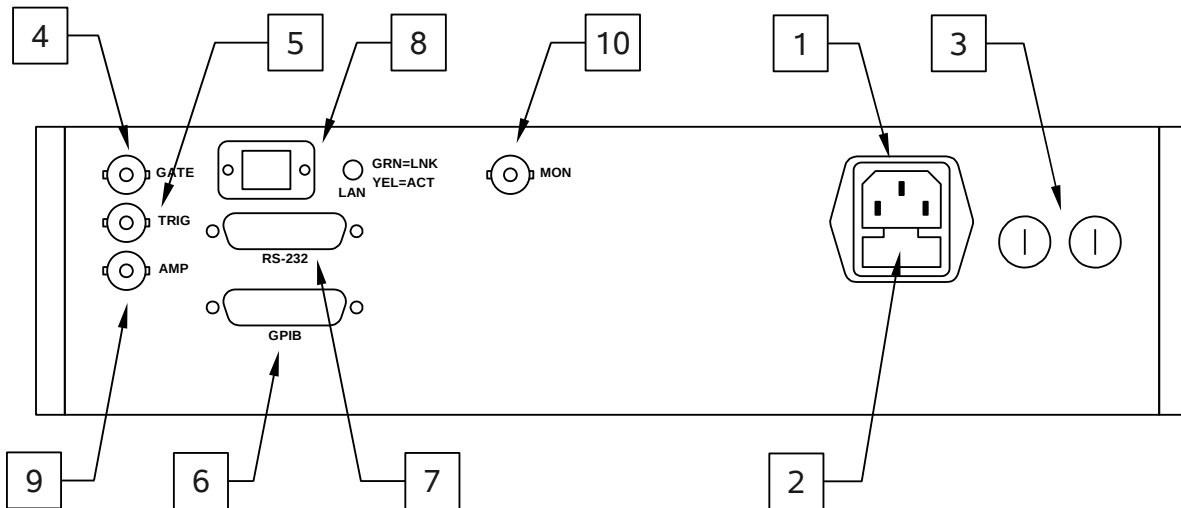
Note that the output stage will safely withstand a short-circuited load condition.

- 3) OUT CONNECTOR. This BNC connector provides the main output signal. (Models with the -RP option will also have an output connector on the rear-panel. Both connectors are wired to the same point internally, and may be used interchangeably).
- 4) 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  $R_L > 50\Omega$  with a pulse width of approximately 100 ns.
- 5) LIQUID CRYSTAL DISPLAY (LCD). This LCD is used in conjunction with the keypad to change the instrument settings. Normally, the main menu is displayed, which lists the key adjustable parameters and their current values. The "Programming Manual for -B Instruments" describes the menus and submenus in detail.

6) KEYPAD.

Control Name	Function
MOVE	This moves the arrow pointer on the display.
CHANGE	This is used to enter the submenu, or to select the operating mode, pointed to by the arrow pointer.
×10	If one of the adjustable numeric parameters is displayed, this increases the setting by a factor of ten.
÷10	If one of the adjustable numeric parameters is displayed, this decreases the setting by a factor of ten.
+/-	If one of the adjustable numeric parameters is displayed, and this parameter can be both positive or negative, this changes the sign of the parameter.
EXTRA FINE	This changes the step size of the ADJUST knob. In the extra-fine mode, the step size is twenty times finer than in the normal mode. This button switches between the two step sizes.
ADJUST	This large knob adjusts the value of any displayed numeric adjustable values, such as frequency, pulse width, etc. The adjust step size is set by the "EXTRA FINE" button.  When the main menu is displayed, this knob can be used to move the arrow pointer.

## REAR PANEL CONTROLS



1. **AC POWER INPUT.** An IEC-320 C14 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. **AC FUSE DRAWER.** The two fuses that protect the AC input are located in this drawer. Please see the “FUSES” section of this manual for more information.
3. **DC FUSES.** These two fuses protect the internal DC power supplies. Please see the “FUSES” sections of this manual for more information.
4. **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 k $\Omega$  resistor. When set to active low mode, this input is pulled-up to +5V by a 1 k $\Omega$  resistor.
5. **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 k $\Omega$ . (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](http://www.pasternack.com)) PE6008-50 BNC feed-thru 50 Ohm terminator is suggested for this purpose.)

When triggering externally, the instrument can be set such that the output pulse width tracks the pulse width on this input, or the output pulse width can be set independently.

6. **GPIB Connector.** A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B

Instruments” for more details on GPIB control.

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 “Programming Manual for -B Instruments” for more details on RS-232 control.
8. LAN Connector and Indicator. (Optional feature. Present on -TNT units only.) The -TNT option "Internet-enables" Avtech pulse generators by adding this standard Ethernet port to the rear panel, in addition to the IEEE-488.2 GPIB and RS-232 ports normally found on "-B" units. Commands are sent using the standard Telnet protocol. The SCPI-compliant command set is the same as that used for GPIB and RS-232 control. The -TNT option uses the Dynamic Host Configuration Protocol (DHCP) to obtain its network address. A DHCP server must be present on the local network for the -TNT option to operate properly.
9. AMP Connector. (Optional feature. -VI units only.) When the instrument is operated in the “voltage-to-current” amplifier mode of operation, the output current will track the voltage waveform applied to this input connector. The relationship is:

$$\begin{aligned} \text{AV-156A-B-VI: } I_{\text{OUT}} &\approx V_{\text{IN}} \times 0.5 \text{ Volt / Amp.} \\ \text{AV-156G-B-VI: } I_{\text{OUT}} &\approx V_{\text{IN}} \times 1.0 \text{ Volt / Amp.} \end{aligned}$$

10. MON Connector. This is a current monitor output. This output provides a voltage waveform that is proportional to the current waveform on the main output. The monitor relationship is:

$$V_{\text{MON}} = I_{\text{OUT}} \times 1.0 \text{ Volt / Amp,}$$

for a load of  $> 1 \text{ k}\Omega$ . (The monitor output can also drive a  $50\Omega$  load, but the output voltage will be reduced by a factor of two. This output is short-circuit protected.)

Depending on the combination of options ordered, the positions of the rear-panel connectors may be somewhat different than shown in the figure above.

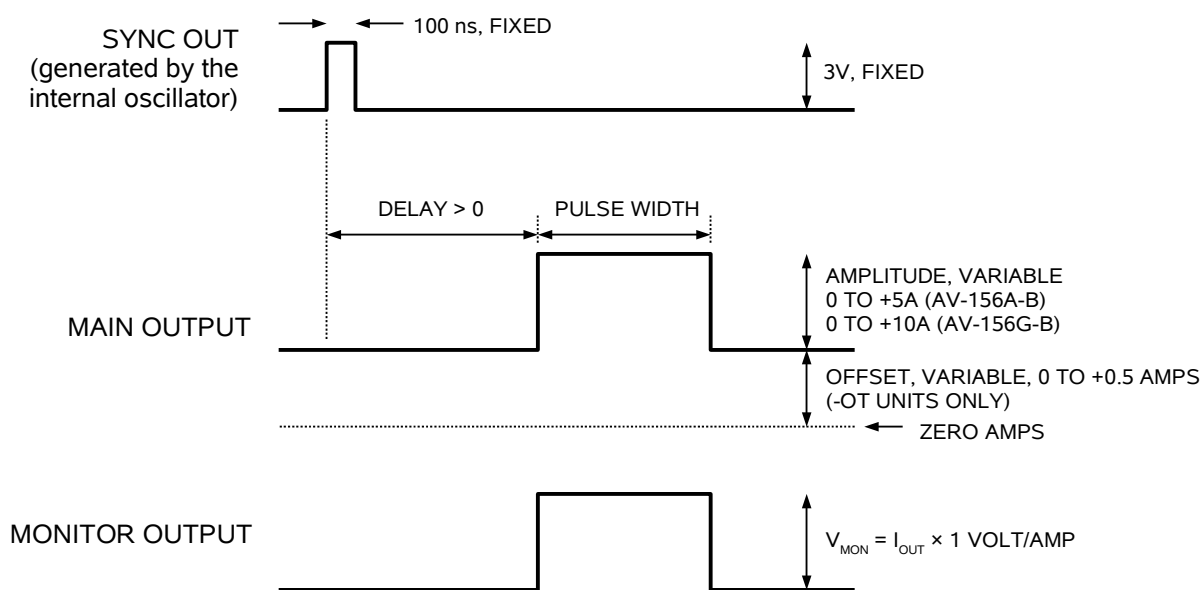
## GENERAL INFORMATION

### BASIC PULSE CONTROL

This instrument can be triggered by several sources - its own internal clock, an external TTL trigger signal, the front-panel "SINGLE PULSE" pushbutton, or by a computer-generated command. In any case, three output channels respond to the trigger: OUT, SYNC, and M. OUT is the signal that is applied to the device under test. 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. The SYNC pulse serves as a reference point for the delay setting of the OUT pulse. The M output is a voltage waveform that is proportional to the current waveform on OUT.  $V_{MON} = I_{OUT} \times 1.0$  Volt / Amp for monitor loads of  $> 1 \text{ k}\Omega$ .

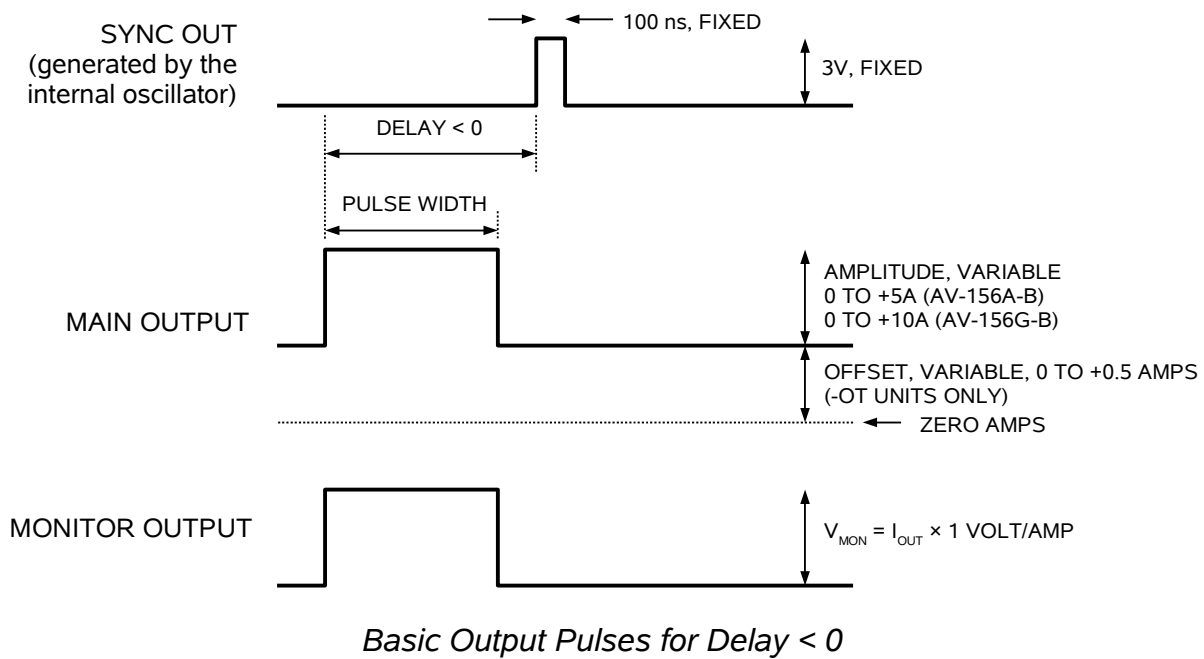
When the delay is set to a positive value the SYNC pulse precedes the OUT pulse. This order is reversed for negative delays.

These pulses are illustrated below for a positive delay:



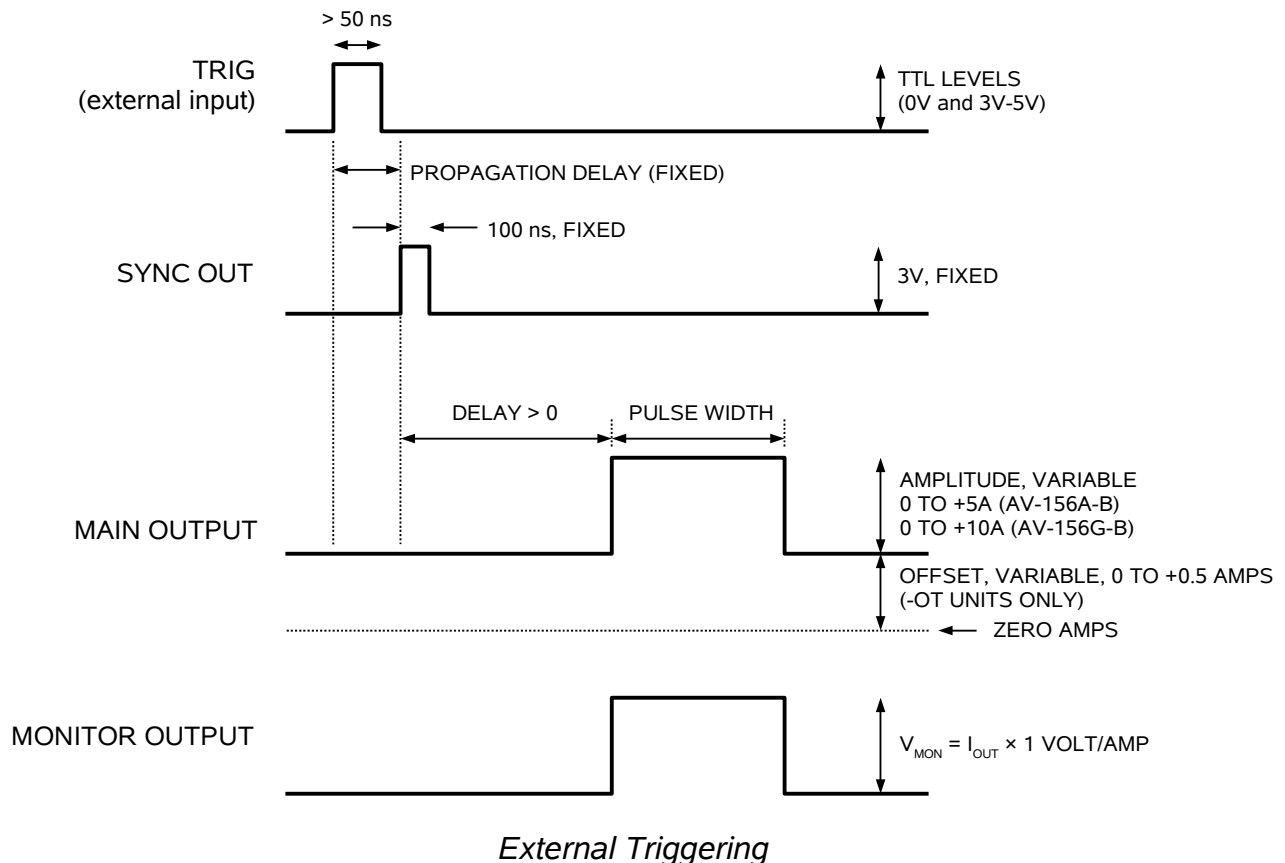
*Basic Output Pulses for Delay > 0*

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



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

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



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

### MONITOR CIRCUIT

As noted in the previous section, a current monitor output is available. The current monitor output also measures peak amplitude of the most recent pulse, in amperes, and displays it on the front panel LCD. (If a DC offset is present, the peak current will be the sum of the amplitude and the offset.)

The LCD does not display the correct measurement if the instrument is operated in the “voltage-to-current” amplifier mode available on units with the -VI option. The rear-panel current monitor output is accurate in this mode, however.

### TRIGGER MODES

This instrument has four front-panel 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 “Programming Manual for -B Instruments” for more details.)

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

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

### GATING MODES

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

### AVOID EXCESS POWER DISSIPATION

To prolong the life of the output stages of the instrument, the internal power dissipation should be minimized whenever practical. The power dissipated in the output stage can be calculated using:

$$P_{DISS} = (24 \text{ Volts} - V_{LOAD}) \times I_{PEAK} \times \text{Duty Cycle}$$

or, for -HC units:

$$P_{DISS} = (36 \text{ Volts} - V_{LOAD}) \times I_{PEAK} \times \text{Duty Cycle}$$

To minimize power dissipation, keep the current amplitude and duty cycle as low as practical. Operation into larger load resistance is preferred over operation into a low load resistance, since  $V_{LOAD} = I_{PEAK} \times R_{LOAD}$ .

### AMPLIFIER MODE (-VI OPTION)

The -VI option adds a “voltage-to-current” amplifier mode of operation. When enabled, this allows the output current to track the voltage waveform applied to a rear-panel input connector. The relationship is:

$$\begin{aligned} \text{AV-156A-B-VI: } I_{OUT} &\approx V_{IN} \times 0.5 \text{ Volt / Amp} \\ \text{AV-156G-B-VI: } I_{OUT} &\approx V_{IN} \times 1.0 \text{ Volt / Amp} \end{aligned}$$

This mode may be enabled using the front panel by entering the amplitude menu and selecting the “amplify” mode.

This mode may be enabled by computer command by sending this command:

```
source:current amplify
```

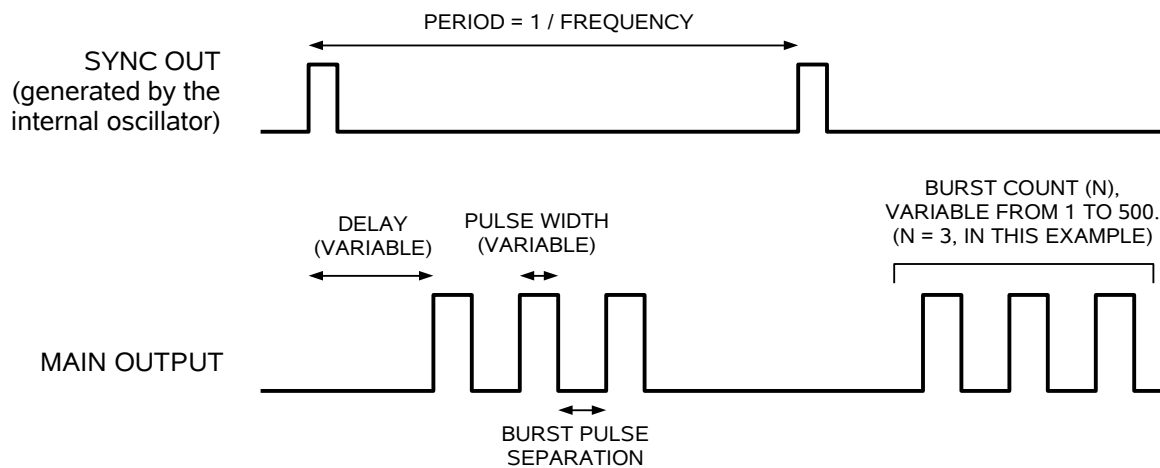
The LCD does not display the correct measurement if the instrument is operated in the “voltage-to-current” amplifier mode available on units with the -VI option. The rear-panel current monitor output is accurate in this mode, however.

### BURST GENERATION (-BR OPTION)

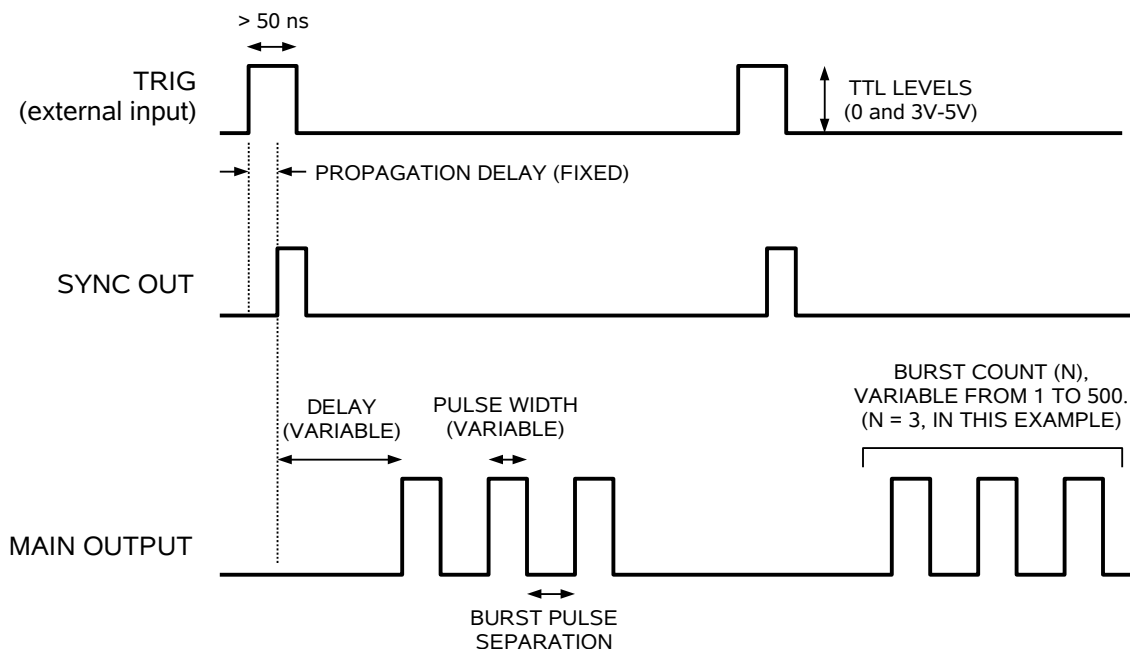
The waveforms given above assume that a single output pulse is generated for each trigger event (regardless of the source). However, when the burst mode feature is used on units with the -BR option, the instrument can generate 1-500 pulses for each individual trigger event. The number of output pulses in each burst can be adjusted from 1 to 500 using the front-panel controls (using the “N” menu), or by a computer command. The time between pulses (i.e., from the falling edge of one pulse to the rising

edge of the next pulse) can also varied from 100 us to 1.0 seconds from the front panel (using the “BUR” menu), or by computer command.

The figure below shows burst mode operation (i.e.,  $N > 1$ ) used with internal triggering:



The figure below shows burst mode operation used with external triggering:



The burst mode may also be used with the front-panel “Single Pulse” pushbutton as a trigger source. (Pressing the pushbutton will actually generate a single burst, rather than a single pulse, in this mode.) Computer commands can also trigger a burst.

To control the burst count and timing from the front-panel, use the “N” and “BUR” menus. To control them using computer commands, use the `SOURce:PULSe:COUNT` and `SOURce:PULSe:SEPARation` commands, as described in the programming manual.

The pulse spacing is constrained by several factors:

1. The maximum PRF limitation of the instrument applies within the burst. That is, timing between two consecutive leading edges must lie between a minimum of  $1/\text{PRF}_{\text{MAX}}$  and a maximum of 1.0 seconds, where  $\text{PRF}_{\text{MAX}}$  is the maximum pulse repetition frequency specification for the instrument.

For this instrument, the maximum PRF for the instrument is 10 kHz, so the time between two leading edges within the burst may not be smaller than 100 microseconds. The total number of pulses per second (i.e., Trigger Frequency x Burst Count) must also be less than 10 kHz.

2. The maximum duty cycle limitation of the instrument can not be exceeded inside the burst. Within the burst, the duty cycle may be calculated using  $\text{DC}_{\text{BURST}} = 100\% \times \text{Pulse Width} / (\text{Pulse Width} + \text{Pulse Separation})$ . The total average duty cycle is equal to  $\text{DC}_{\text{AVG}} = 100\% \times \text{Pulse Width} \times \text{Burst Count} \times \text{Trigger Frequency}$ . Both  $\text{DC}_{\text{BURST}}$  and  $\text{DC}_{\text{AVG}}$  must be less than the rated maximum duty cycle of the instrument.

The maximum duty cycle is 20% for the AV-156A-B and 10% for the AV-156G-B.

#### APPLICATION NOTES, LABVIEW DRIVERS

Application notes and LabView drivers are available on the Avtech web site, at <http://www.avtechpulse.com/appnote>.

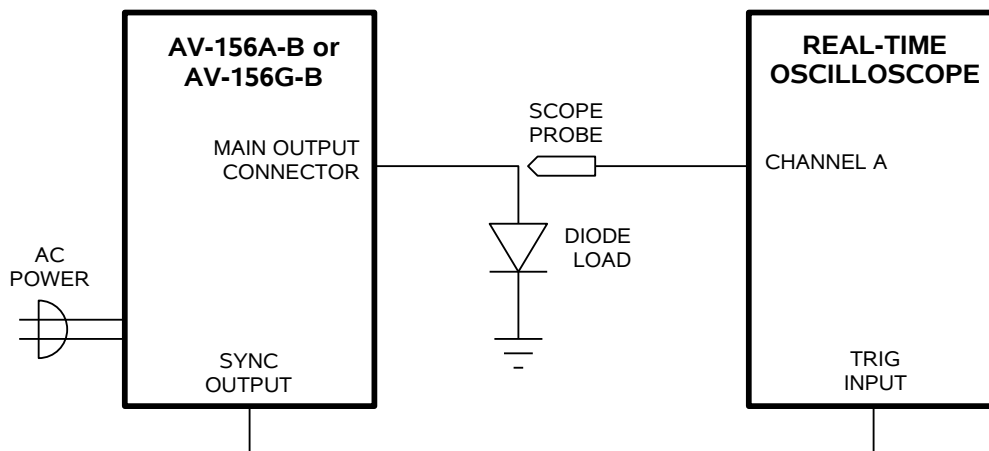
#### MANUAL FEEDBACK

Please report any errors or omissions in this manual, or suggestions for improvement, to [info@avtechpulse.com](mailto:info@avtechpulse.com). Thanks!

## LOAD PROTECTION

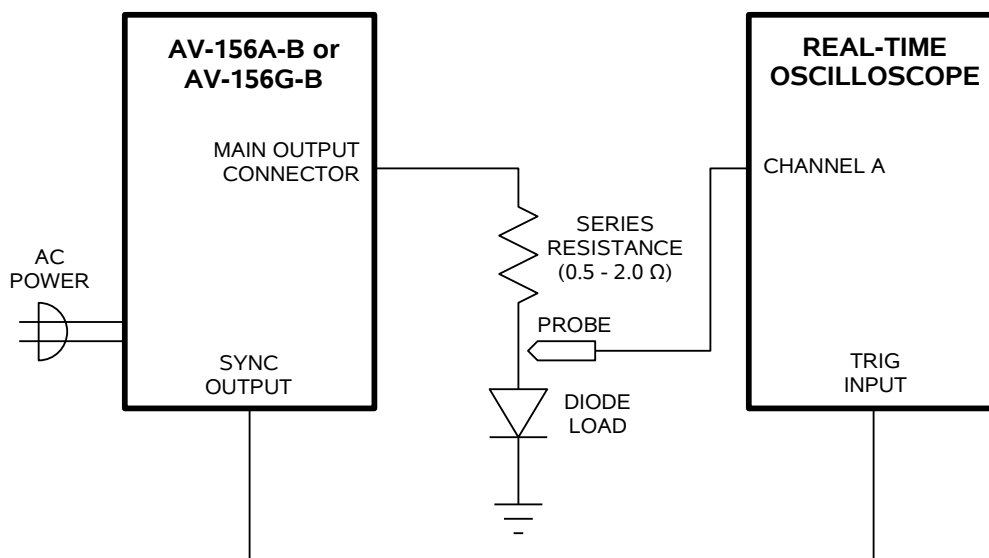
### DRIVING DIODE LOADS

When driving laser diode loads (or any other diode load), the anode should be connected to the output of the instrument, and the cathode should be connected to ground. This is illustrated below:



Reversing this connection may cause the diode to breakdown, possibly damaging it.

For diode loads, a better waveform (with less ringing) will normally be obtained if a small resistance ( $0.5 \Omega$  -  $2 \Omega$  typically) is added in the series with the diode. (The resistance must be small enough that the maximum load voltage rating of 15V, or 25V for -HC units, is not exceeded.) The extra resistance slows down the output voltage waveform slightly, allowing the output circuit to better control the signal. This arrangement is shown below:



## 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:  $V_{SPIKE} = L \times di_{LOAD}/dt$ .


## OUTPUT ON/OFF

The main outputs may be switched on and off using the front-panel controls or via programming commands. When the output is set "OFF", the main outputs are short-circuited to ground with a relay, and the trigger source is removed from the output stage.

## ATTACHING AND DETACHING LOADS

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

- the instrument is off
- the instrument is on, but the outputs are turned off (i.e. the LCD display reads "OUTPUT OFF")

 **Do not** connect loads when the instrument is on and the outputs are turned on. This can cause mild sparking and unexpected current surges.

## CHANGING PARAMETERS WHEN A LOAD IS ATTACHED

If your load is easily damaged, the outputs should be turned off when changing the trigger source, frequency, pulse width, or other pulse parameters. This protects the loads from possible short transient effects.

## OPEN AND SHORT CIRCUITS

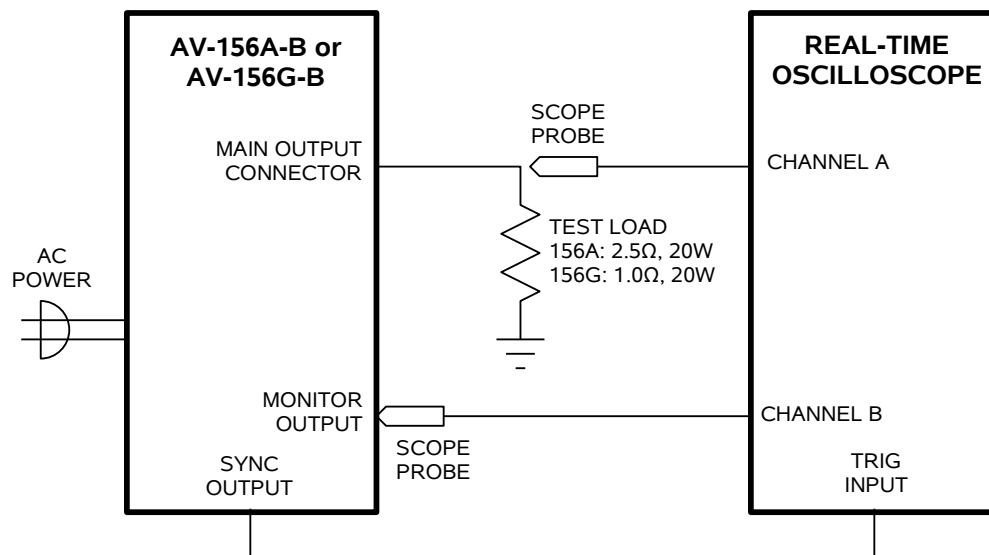
The AV-156A-B and the AV-156G-B will operate properly into a short circuit to ground.

Operation into an open circuit will not damage the instrument in any way, although the monitor circuit may not give the correct reading (which should be zero).

## OPERATIONAL CHECK

This section describes a sequence to confirm the basic operation of the instrument. It should be performed after receiving the instrument. It is a useful learning exercise as well.

Before proceeding with this procedure, finish reading this instruction manual thoroughly. Then read the “Local Control” section of the “Programming Manual for -B Instruments” thoroughly. The “Local Control” section describes the front panel controls used in this operational check - in particular, the MOVE, CHANGE, and ADJUST controls.



*Basic Test Arrangement*

1. Connect a 20W test load (2.5 Ohms for the AV-156A-B, 1.0 Ohms for the AV-156G-B) between the OUT connector and ground.
2. Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Set the oscilloscope to trigger externally.
3. Connect one oscilloscope probe (channel A) to the OUT load. Connect the other probe to the M output (on the rear panel). On the oscilloscope, set the channel A vertical scale to 5 V/div, the channel B vertical scale to 2 V/div, and the horizontal scale to 50 us/div.
4. Turn on the AV-156A-B. The instrument will execute a warm-up sequence during which time the internal capacitor banks are charged. Wait for this sequence to complete. After this delay, the main menu will appear on the LCD.
5. To set the AV-156A-B to trigger from the internal clock at a PRF of 100 Hz:

- 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 100 Hz.
  - c) The arrow pointer should be pointing at the “Internal” choice. If it is not, press MOVE until it is.
  - d) Press CHANGE to return to the main menu.
6. To set the delay to 50 us:
- 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 50 us.
  - c) Press CHANGE to return to the main menu.
7. To set the OUT pulse width to 100 us:
- a) Press the MOVE button until the arrow pointer is pointing at the “PW” menu item.
  - b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 100 us.
  - c) The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.
  - d) Press CHANGE to return to the main menu.
8. At this point, nothing should appear on the oscilloscope.
9. To enable the output:
- a) Press the MOVE button until the arrow pointer is pointing at the output menu item.
  - b) Press the CHANGE button. The output submenu will appear.
  - c) Press MOVE until the arrow pointer is pointing at the “ON” choice.
  - d) Press CHANGE to return to the main menu.
10. To change the OUT output amplitude:
- a) Press the MOVE button until the arrow pointer is pointing at the AMP menu item.

- b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at 5A.
- c) Observe the oscilloscope.

For the AV-156A-B, you should see 100 us wide, 12.5V pulses (i.e.,  $5A \times 2.5\Omega = 12.5V$ ) on the probe connected to the OUT main output. The other probe, connected to the M monitor output, should show 100 us, 5V pulses (i.e.  $5A \times 1V/A$ ).

For the AV-156G-B, you should see 100 us wide, 5V pulses (i.e.,  $5A \times 1.0\Omega = 5V$ ) on the probe connected to the OUT main output. The other probe, connected to the M monitor output, should show 100 us, 5V pulses (i.e.  $5A \times 1V/A$ ).

- d) Press CHANGE to return to the main menu.

#### 11. To change the OUT output offset:

- a) Press the MOVE button until the arrow pointer is pointing at the OS menu item.
- b) Press the CHANGE button. The offset submenu will appear. Rotate the ADJUST knob until the offset is set at 200 mA.
- c) Observe the oscilloscope. For the AV-156A-B, the main output pulse should shift upwards by 500 mV (i.e.,  $200\text{ mA} \times 2.5\Omega = 500\text{ mV}$ ). For the AV-156G-B, the main output pulse should shift upwards by 200 mV (i.e.,  $200\text{ mA} \times 1.0\Omega = 200\text{ mV}$ ).
- d) Press CHANGE to return to the main menu.

#### 12. 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.

#### 13. This completes the operational check.

## CALIBRATION PROCEDURES

All calibration procedures are performed in software. There are no user-adjustable trim pots inside the instrument.

To calibrate the timebase, please see the Avtech Technical Brief 4, "How Can I Calibrate the Timebase of my Avtech Pulse Generator?" on the web at <http://www.avtechpulse.com/appnote/techbrief4/> for more information and sample LabView drivers.

To calibrate the amplitude and offset, please see the Avtech Technical Brief 5, "How Can I Calibrate the Amplitude and Offset of my Pulse Generator?" on the web at <http://www.avtechpulse.com/appnote/techbrief5/> for more information.

## PROGRAMMING YOUR PULSE GENERATOR

### KEY PROGRAMMING COMMANDS

The “Programming Manual for -B Instruments” describes in detail how to connect the pulse generator to your computer, and the programming commands themselves. A large number of commands are available; however, normally you will only need a few of these. Here is a basic sample sequence of commands that might be sent to the instrument after power-up, using the internal trigger source:

*rst	(resets the instrument)
trigger:source internal	(selects internal triggering)
frequency 1 Hz	(sets the frequency to 1 Hz)
pulse:width 1 ms	(sets the pulse width to 1 ms)
pulse:delay 10 ms	(sets the delay to 10 ms)
output on	(turns on the output)
source:current 2 A	(sets the current amplitude to 2 amperes)
source:current:low 0.2 A	(sets the DC offset to 0.2 amperes)
measure:amplitude?	(this returns the peak current, in amperes, as measured by the monitor circuit)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width 1 ms	(sets the pulse width to 1 ms)
pulse:delay 10 ms	(sets the delay to 10 ms)
output on	(turns on the output)
source:current 2 A	(sets the current amplitude to 2 amperes)
source:current:low 0.2 A	(sets the DC offset to 0.2 amperes)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off both outputs)

These commands will satisfy 90% of your programming needs.

### ALL PROGRAMMING COMMANDS

For more advanced programmers, a complete list of the available commands is given below. These commands are described in detail in the “Programming Manual for -B Instruments”. (Note: this manual also includes some commands that are not implemented in this instrument. They can be ignored.)

<u>Keyword</u>	<u>Parameter</u>	<u>Notes</u>
DIAGnostic:		
:AMPLitude		
:CALibration		


:POINT	<numeric value> <numeric value>	
:MONitor		
:CALibration	<numeric value>	[no query form]
:STEP	<numeric value>	
:OFFSet		
:CALibration		
:POINT	<numeric value> <numeric value>	
LOCAL		
MEASure:		
:AMPLitude?		[query only]
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW   FIXed]	<numeric value>	
[SOURce]:		
:CURRent		
[:LEVe]		
[:IMMediate]		
[:AMPLitude]	<numeric value>   AMPLify	
:LOW	<numeric value>	
:PROTection		
:TRIPped?		[query only]
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DCYCLE	<numeric value>	
:HOLD	WIDTh   DCYCLE	
:DELay	<numeric value>	
:GATE		
:LEVe	High   LOw	
:TYPE	ASYNc   SYNc	
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	[no query form]
*CLS		
*ESE	<numeric value>	
*ESR?		[query only]
*IDN?		[query only]
*OPC		
*SAV	0   1   2   3	[no query form]
*RCL	0   1   2   3	[no query form]
*RST		[no query form]
*SRE	<numeric value>	
*STB?		[query only]
*TST?		[query only]
*WAI		[no query form]


## MECHANICAL INFORMATION

### TOP COVER REMOVAL

If necessary, the interior of the instrument may be accessed by removing the four Phillips screws on the top panel. With the four screws removed, the top cover may be slid back (and off).

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

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

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

### RACK MOUNTING

A rack mounting kit is available. The -R5 rack mount kit may be installed after first removing the one Phillips screw on the side panel adjacent to the front handle.

### ELECTROMAGNETIC INTERFERENCE

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

## MAINTENANCE

### REGULAR MAINTENANCE

This instrument does not require any regular maintenance.

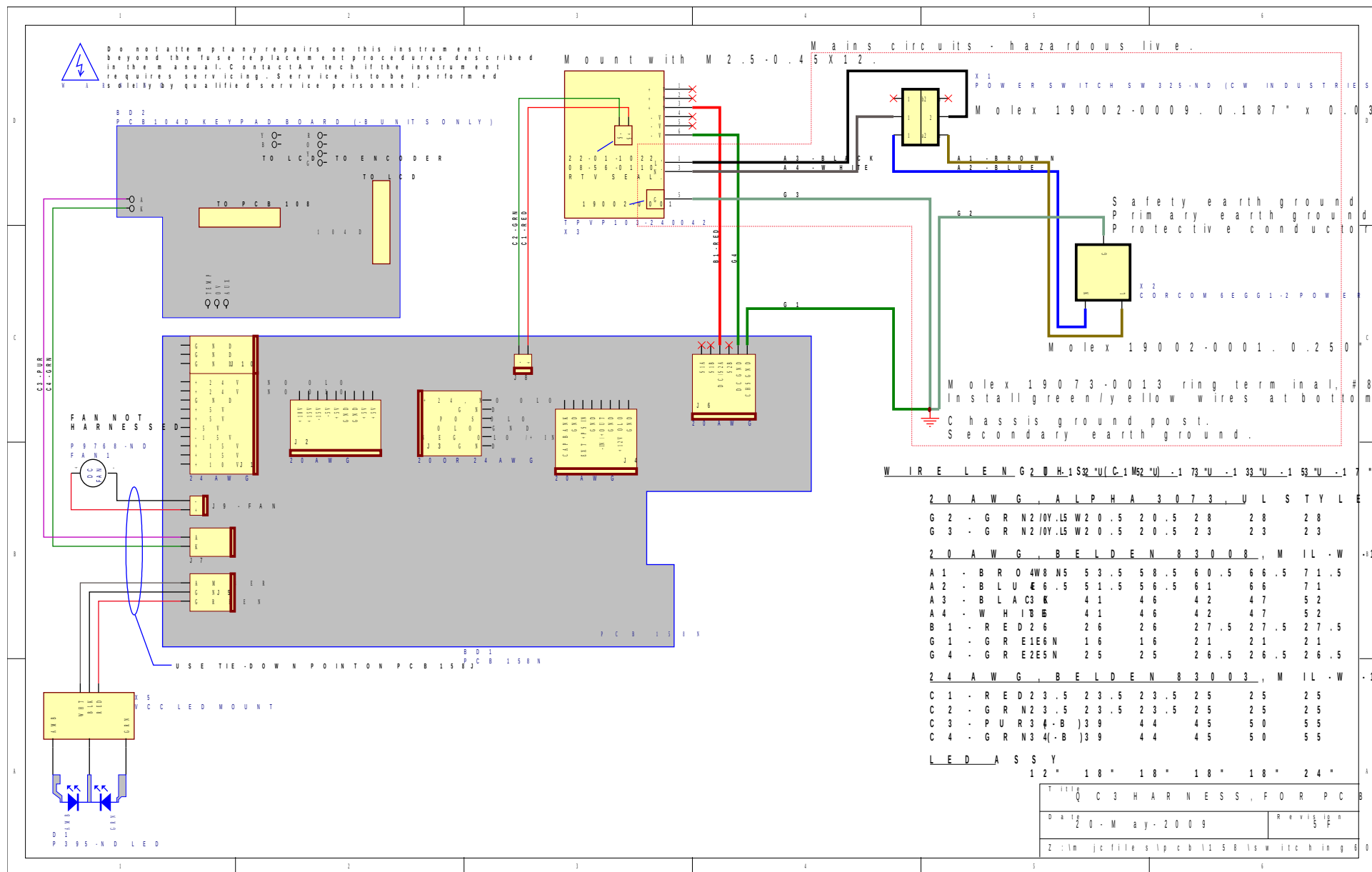
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

### CLEANING

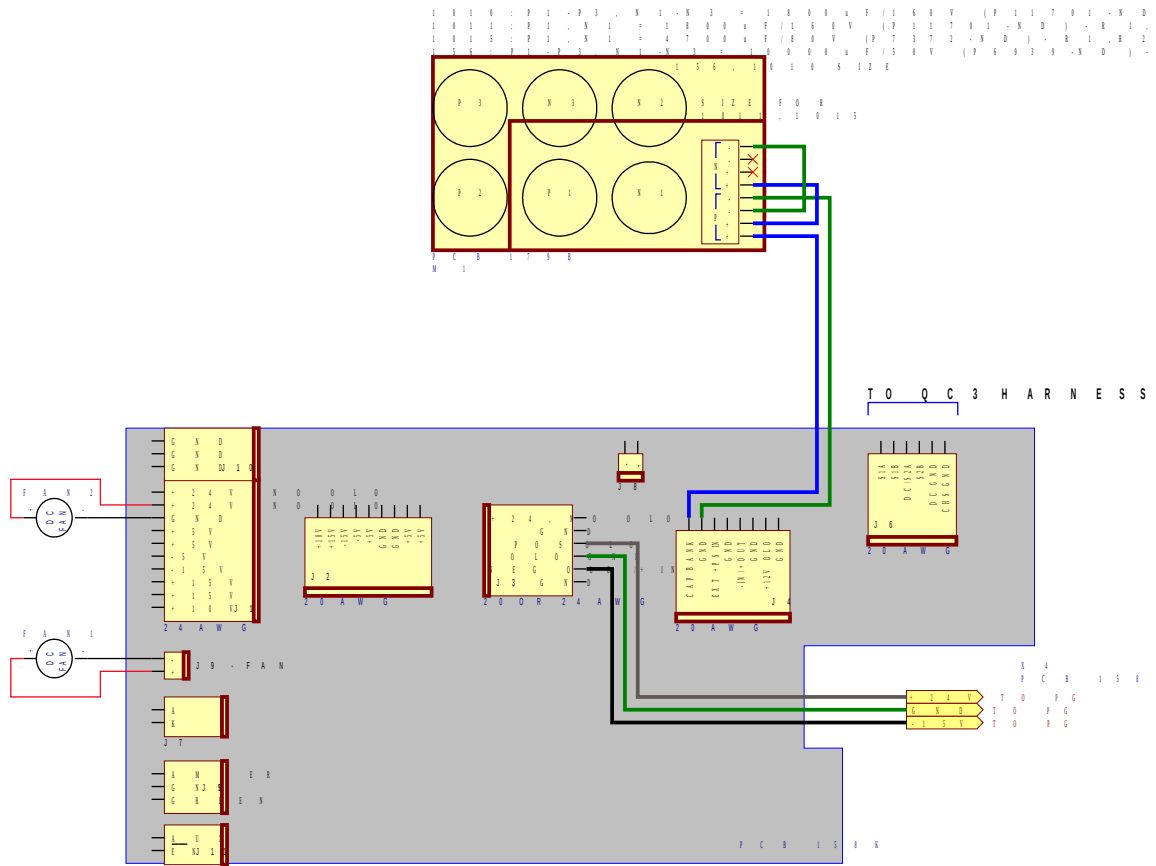
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

# WIRING DIAGRAMS

## WIRING OF AC POWER (AV-156A-B), 1/2



# WIRING OF AC POWER, 2/2 (AV-156A-B)

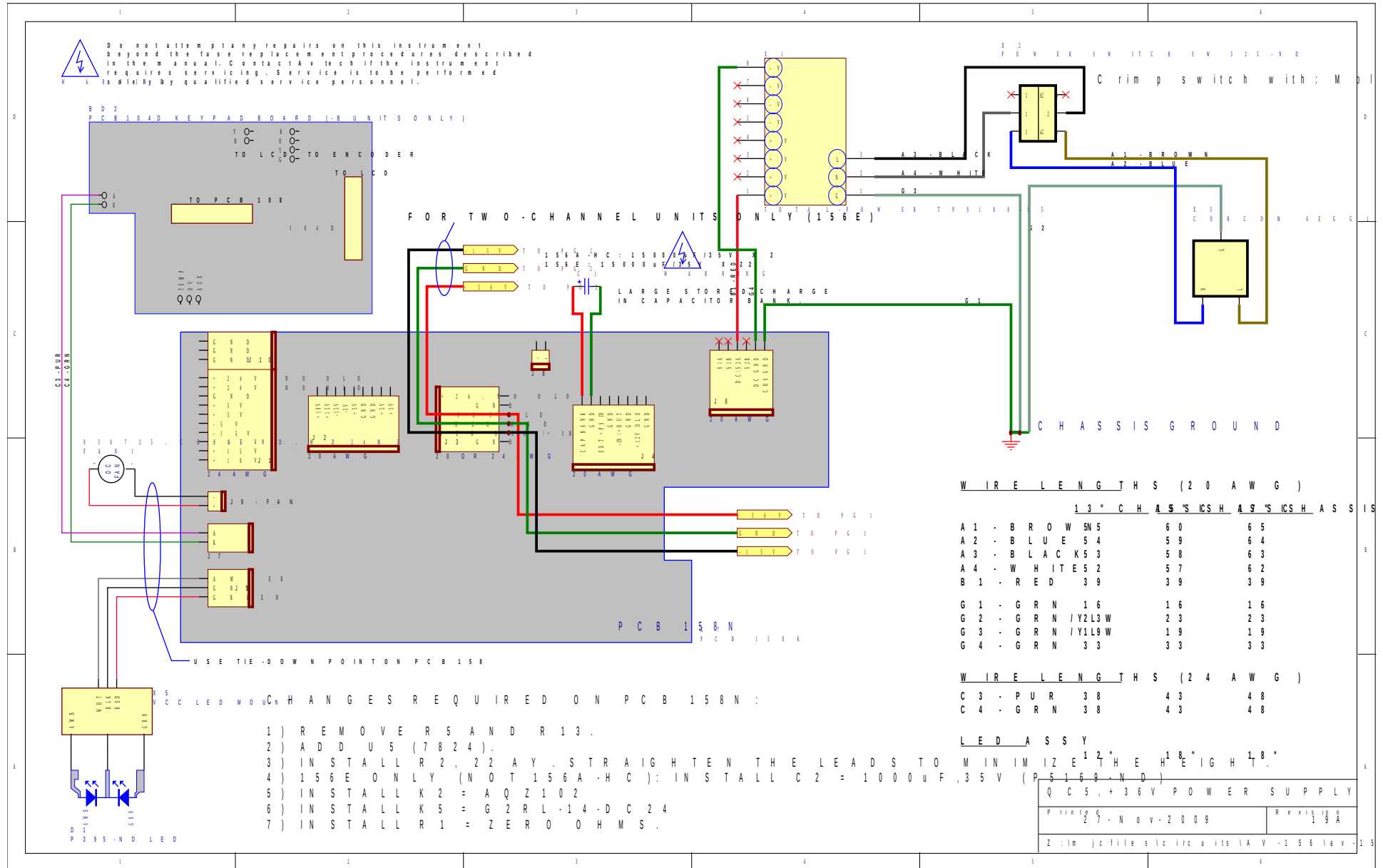


COMPONENT CHANGES ARE REQUIRED ON THE PCB 158K :

- 1) INSTALL R 1 = ZERO OHMS
- 2) INSTALL K 2 = A Q Z 1 0 2
- 3) REMOVE R 1 3
- 4) INSTALL R 2 = 2 2 A Y (STRAIGHTEN LEADS)
- 5) INSTALL L K 5 = G 2 R L -14 -D C 2 4

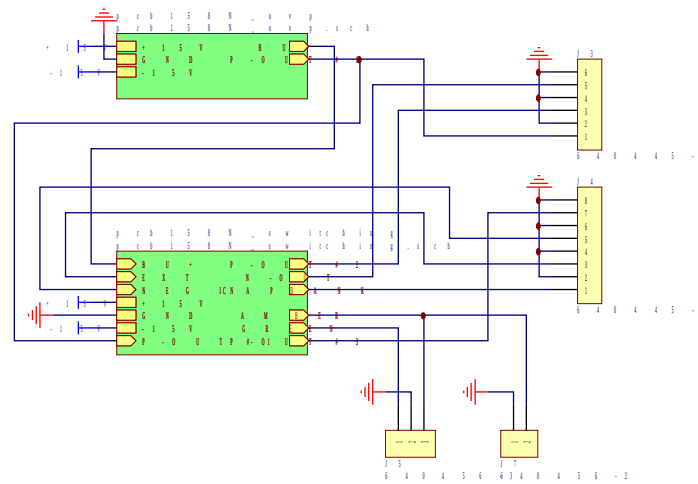
+ 24V PS FOR 156A, 156G	
PRINTED 27-NOV-2009	REVISION 2007
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# WIRING OF AC POWER (AV-156A-B-HC)



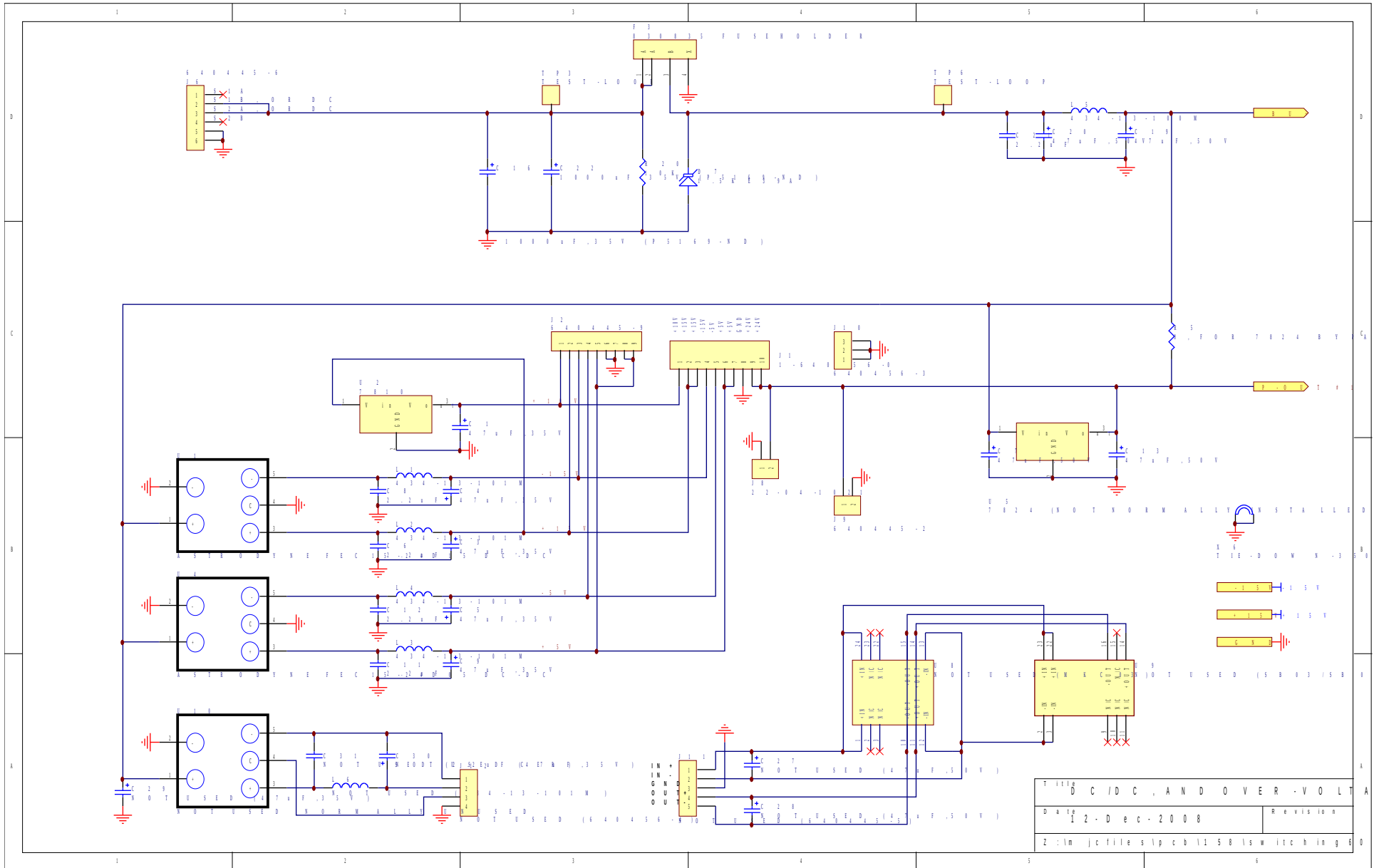


# PCB 158N - LOW VOLTAGE POWER SUPPLY, 1/3



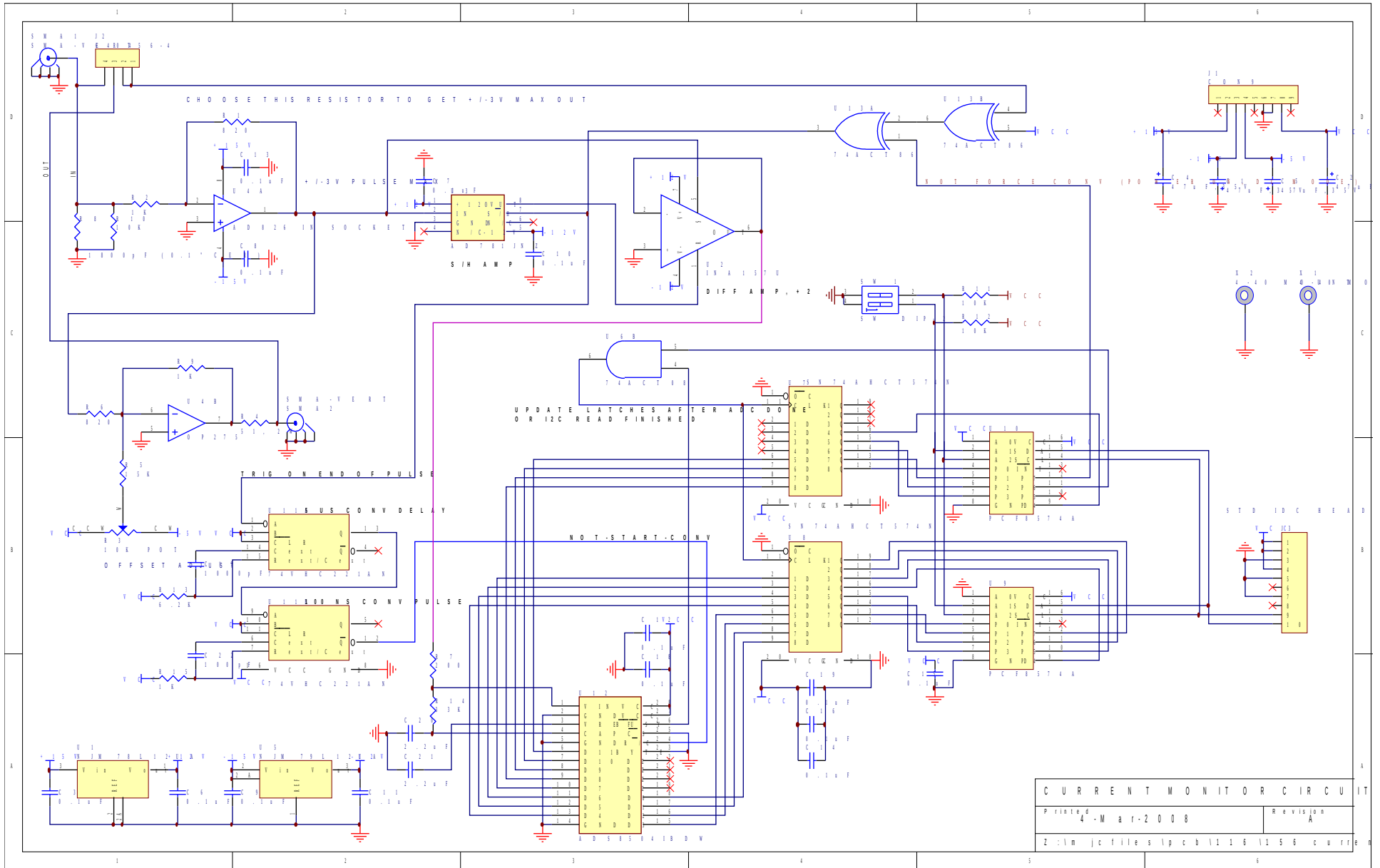
Title		LOW VOLTAGE DC / DC PD
Date	12-Dec-2008	Revision
Z:\im\jctiles\pcb\158\iswitching\9		

# PCB 158N - LOW VOLTAGE POWER SUPPLY, 2/3





# PCB 116C - CURRENT MONITOR BOARD



CURRENT MONITOR CIRCUIT  
 Printed 4-Mar-2008 Revision A  
 Z:\m\jc\files\lpcb\116\1156\cui16





PERFORMANCE CHECK SHEET