



AVTECH ELECTROSYSTEMS LTD.

NANOSECOND WAVEFORM ELECTRONICS  
SINCE 1975

P.O. BOX 265  
OGDENSBURG, NY  
U.S.A. 13669-0265

TEL: 888-670-8729 (USA & Canada) or +1-613-226-5772 (Intl)  
FAX: 800-561-1970 (USA & Canada) or +1-613-226-2802 (Intl)

info@avtechpulse.com - <http://www.avtechpulse.com/>

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

## INSTRUCTIONS

MODEL AVRK-4-B

0 TO 750 VOLTS, 6 ns RISE TIME

HIGH PERFORMANCE PULSE GENERATOR

WITH IEEE 488.2 AND RS-232 CONTROL

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

### WARRANTY

Avtech Electrosystems Ltd. warrants products of its manufacture to be free from defects in material and workmanship under conditions of normal use. If, within one year after delivery to the original owner, and after prepaid return by the original owner, this Avtech product is found to be defective, Avtech shall at its option repair or replace said defective item. This warranty does not apply to units which have been 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

Phone: 888-670-8729 (USA & Canada) or +1-613-226-5772 (Intl)

Fax: 800-561-1970 (USA & Canada) or +1-613-226-2802 (Intl)

E-mail: [info@avtechpulse.com](mailto:info@avtechpulse.com)

World Wide Web: <http://www.avtechpulse.com>

## 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>5</b>
<b>AVAILABLE OPTIONS.....</b>	<b>6</b>
<b>HIGH-VOLTAGE PRECAUTIONS.....</b>	<b>7</b>
<b>SPECIFICATIONS.....</b>	<b>8</b>
<b>EUROPEAN REGULATORY NOTES.....</b>	<b>10</b>
<b>EC DECLARATION OF CONFORMITY.....</b>	<b>10</b>
<b>DIRECTIVE 2002/95/EC (RoHS).....</b>	<b>10</b>
<b>DIRECTIVE 2002/96/EC (WEEE).....</b>	<b>10</b>
<b>INSTALLATION.....</b>	<b>12</b>
<b>VISUAL CHECK.....</b>	<b>12</b>
<b>POWER RATINGS.....</b>	<b>12</b>
<b>CONNECTION TO THE POWER SUPPLY.....</b>	<b>12</b>
<b>PROTECTION FROM ELECTRIC SHOCK.....</b>	<b>13</b>
<b>ENVIRONMENTAL CONDITIONS.....</b>	<b>13</b>
<b>LABVIEW DRIVERS.....</b>	<b>14</b>
<b>FUSES.....</b>	<b>15</b>
<b>AC FUSE REPLACEMENT.....</b>	<b>15</b>
<b>DC FUSE REPLACEMENT.....</b>	<b>16</b>
<b>FUSE RATINGS.....</b>	<b>16</b>
<b>FRONT PANEL CONTROLS.....</b>	<b>17</b>
<b>REAR PANEL CONTROLS.....</b>	<b>19</b>
<b>GENERAL INFORMATION.....</b>	<b>21</b>
<b>BASIC PULSE CONTROL.....</b>	<b>21</b>
<b>TRIGGER MODES.....</b>	<b>22</b>
<b>GATING MODES.....</b>	<b>23</b>
<b>AMPLITUDE CONTROL.....</b>	<b>23</b>
<b>AMPLITUDE DYNAMIC RANGE.....</b>	<b>23</b>
<b>CONNECTING TO PLATE LOADS.....</b>	<b>24</b>
<b>PROTECTING YOUR INSTRUMENT.....</b>	<b>25</b>
<b>TURN OFF INSTRUMENT WHEN NOT IN USE.....</b>	<b>25</b>

DO NOT EXCEED 10 kHz.....	25
USE A 50 OHM LOAD.....	25
<b>OPERATIONAL CHECK.....</b>	<b>26</b>
<b>PROGRAMMING YOUR PULSE GENERATOR.....</b>	<b>29</b>
KEY PROGRAMMING COMMANDS.....	29
ALL PROGRAMMING COMMANDS.....	30
<b>MECHANICAL INFORMATION.....</b>	<b>32</b>
TOP COVER REMOVAL.....	32
RACK MOUNTING.....	32
ELECTROMAGNETIC INTERFERENCE.....	32
<b>MAINTENANCE.....</b>	<b>33</b>
REGULAR MAINTENANCE.....	33
CLEANING.....	33
<b>WIRING DIAGRAMS.....</b>	<b>34</b>
WIRING OF AC POWER, 1/2.....	34
WIRING OF AC POWER, 2/2.....	35
PCB 158M - LOW VOLTAGE POWER SUPPLY, 1/3.....	36
PCB 158M - LOW VOLTAGE POWER SUPPLY, 2/3.....	37
PCB 158M - LOW VOLTAGE POWER SUPPLY, 3/3.....	38
PCB 170B - HIGH-VOLTAGE POWER SUPPLY.....	39
PCB 183A-S AND 183A-P CAPACITOR BANKS.....	40
MAIN WIRING.....	41
<b>PERFORMANCE CHECKSHEET.....</b>	<b>42</b>

## INTRODUCTION

The AVRK-4-B is a high performance, GPIB and RS232-equipped instrument capable of generating narrow high-voltage pulses into 50 $\Omega$  loads.

The pulse width is adjustable from < 6 ns to > 20 ns. The repetition rate may be as high as 10 kHz.

Amplitudes as high as 750V may be produced at the widest pulse widths (12 – 20 ns). The maximum available amplitude falls to 700V for pulse widths of 9-12 ns, and to 550V for pulse widths of 6-9 ns.

The rise time (20%-80%) is less than 6 ns for all pulse widths.

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

The AVRK-4-B is a highly flexible instrument. Aside from the internal trigger source, it can also be triggered or gated by external TTL-level signals. A front-panel pushbutton or a computer command can also be used to trigger the instrument.

The AVRK-4-B features 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

The AVRK-4-B is available with several options:

-OS Option: an externally generated DC offset ( $\pm 50$  Volts, 250 mA DC maximum) can be added to the output.


-OSHV Option: an externally generated DC offset ( $\pm 1500$  Volts, 1.5 mA DC maximum) can be added to the output.

-EA Option: the amplitude can be controlled by an externally generated 0 to +10V analog control voltage.

-R5 Option: This is the optional rack-mounting kit. The R5 rack-mount kit may also be ordered separately.

-TNT Option: Adds a rear-panel Ethernet connector, providing Telnet or Web-based remote control from a network.

## HIGH-VOLTAGE PRECAUTIONS

 **CAUTION:** This instrument provides output voltages as high as 750 Volts under normal operating conditions, and generates > 800V internally, so extreme caution must be employed when using this instrument. The instrument should only be used by individuals who are thoroughly skilled in high voltage laboratory techniques. The following precautions should always be observed:

1. Keep exposed high-voltage wiring to an absolute minimum.
2. Wherever possible, use shielded connectors and cabling.
3. Connect and disconnect loads and cables only when the amplifier is turned off.
4. Keep in mind that all cables, connectors, oscilloscope probes, and loads must have an appropriate voltage rating.

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

## SPECIFICATIONS

Model:	AVRK-4-B <sup>1</sup>
Amplitude <sup>2,3</sup> : (50Ω load)	0 to >550V at PW = 6-9 ns >700V at PW = 9-12 ns >750V at PW = 12-20 ns
Rise time (20%-80%):	≤ 6 ns
Fall time (80%-20%):	≤ 6 ns at PW = 6-9 ns ≤ 9 ns at PW = 9-12 ns ≤ 12 ns at PW = 12-20 ns
Pulse width (FWHM):	6 – 20 ns
PRF:	0 to 10 kHz
Required load impedance:	50 Ohms <sup>9</sup>
Output impedance <sup>4</sup> :	Low (much less than 50 Ohms)
Polarity <sup>5</sup> :	Positive or negative (specify <sup>4</sup> )
Propagation delay:	≤ 150 ns (Ext trig in to pulse out)
Jitter:	± 100 ps ± 0.03% of sync delay (Ext trig in to pulse out)
DC offset:	-OS option <sup>7</sup> : Apply required DC offset (± 50 Volts, 250 mA DC max) to rear-panel solder terminals -OSHV option <sup>8</sup> : Apply required DC offset (± 1500 Volts, 1.5 mA DC max) to rear-panel Type N connector.
Trigger required: (external trigger mode)	+ 5 Volts, 50 ns or wider (TTL)
Sync delay:	Variable, 0 to ± 1 seconds
Sync output:	+3 Volts, 100 ns, will drive 50 Ohm loads
Gate input:	Synchronous or asynchronous, active high or low, switchable. Suppresses triggering when active.
Monitor output:	Included <sup>8</sup> . Provides a 20 dB attenuated coincident replica of main output
Connectors:	BNC <sup>8</sup>
GPiB and RS-232 control <sup>1</sup> :	Standard on -B units.
Telnet / Ethernet control <sup>4</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")
Rack-mount kit:	Optional. Add -R5 to the model number.
Temperature range:	+5°C to +40°C

- 1) -B suffix indicates IEEE-488.2 GPiB and RS-232 control of amplitude, pulse width, PRF and delay. (See <http://www.avtechpulse.com/gpib>).
- 2) For operation at amplitudes of less than 20% of full-scale, best results will be obtained by setting the amplitude near full-scale and using external attenuators on the output.
- 3) For analog electronic control (0 to +10V) of amplitude, suffix model number with -EA. Electronic control units also include the standard front-panel controls.
- 4) Indicate desired polarity by suffixing model number with -P or -N (i.e. positive or negative).
- 5) This is the input in series with the output, internally. Since the output impedance is not 50 Ohms, the load impedance must be 50 Ohms, or transmission line reflections will occur.
- 6) Add the suffix -TNT to the model number to specify the Telnet / Ethernet control option.
- 7) For DC offset option suffix model number with -OS.
- 8) Units with the -OSHV option will have a Type N output connector, instead of SMA. The DC load impedance must be greater than 1 Megohm. (Note that the high-frequency load impedance must be 50 Ohms. For high impedance loads, such as microchannel plates, this can be achieved by shunting the input to the load with a series combination of a 50 Ohm resistor and a high-voltage capacitor.) The monitor output (-M option) would not include the DC component; it would include only the pulse component.
- 9) A 50 Ohm load is required. Other loads may damage the instrument. Consult Avtech ([info@avtechpulse.com](mailto:info@avtechpulse.com)) if you need to drive other load impedances.





## EUROPEAN REGULATORY NOTES

### 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.

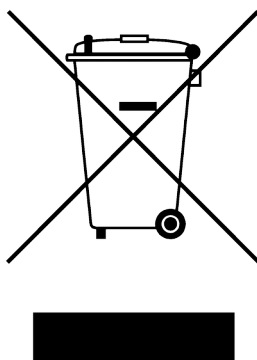
### DIRECTIVE 2002/96/EC (WEEE)

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	Manufacturer	Part Number
Continental Europe	European CEE 7/7 "Schuko" 230V, 50Hz	Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> )	319004-T01
United Kingdom	BS 1363, 230V, 50Hz	Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> )	370001-E01
Switzerland	SEV 1011, 2 30V, 50Hz	Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )	2102H-C3-10
Israel	SI 32, 220V, 50Hz	Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )	2115H-C3-10
North America, and all other areas	NEMA 5-15, 120V, 60 Hz	Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> )	312007-01

### 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:

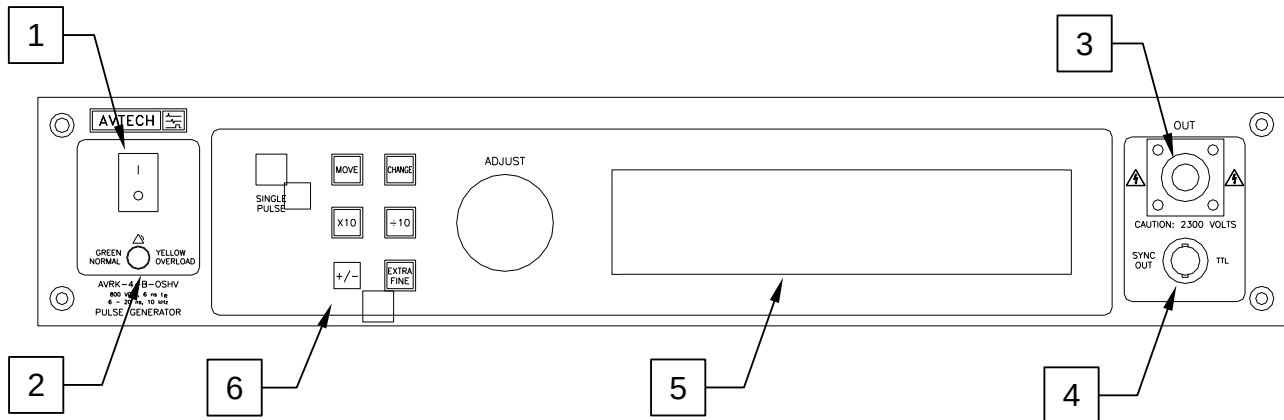
Fuses	Nominal Mains Voltage	Rating	Case Size	Recommended Replacement Part	
				Littelfuse Part Number	Digi-Key Stock Number
#1, #2 (AC)	115 V	0.8A, 250V, Time-Delay	5×20 mm	0218.800HXP	F2418-ND
	230 V	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND
#3 (DC)	N/A	2.5A, 250V, Time-Delay	5×20 mm	021802.5HXP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

The recommended fuse manufacturer is Littelfuse (<http://www.littelfuse.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 circuit can withstand an infinite VSWR on the output port but is intended for operation with 50Ω loads.

3. **OUT CONNECTOR**. This BNC connector provides the main output signal, into load impedances of 50Ω. (Units with the -OSHV option will have a Type N connector instead, to support the higher average output voltages.)

 **Caution:** Pulsed voltages as high as ±750V 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.

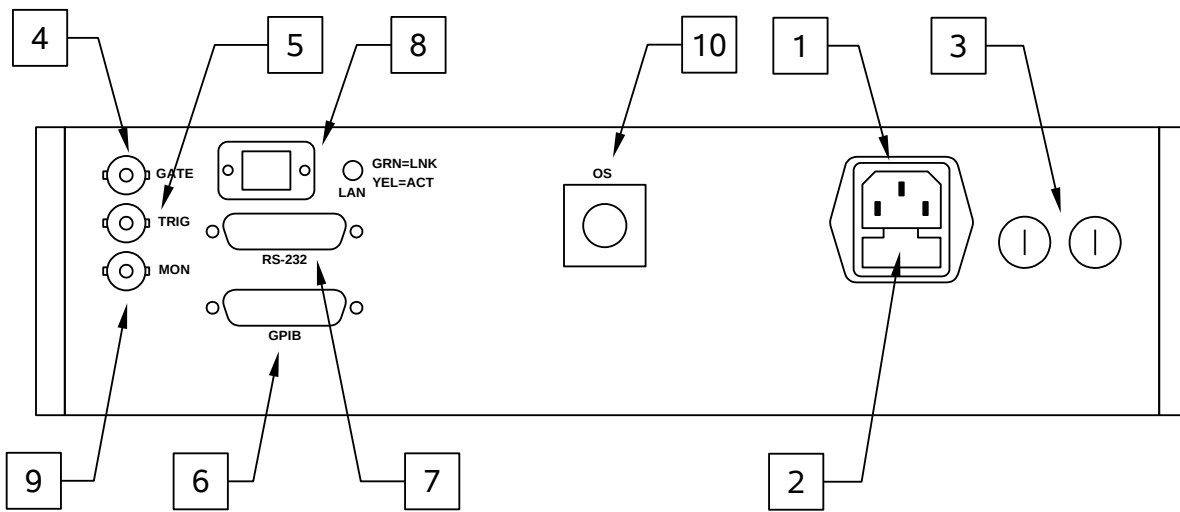
 **Caution:** DC voltages as high as ±1500V may be present on the center conductor of this output connector if the -OSHV option has been ordered. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to

ensure that the center conductor is not exposed.

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  $R_L > 1k\Omega$  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.)
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 may be sent using the standard Telnet protocol, or using a web browser. 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. MON Connector. The monitor output provides an attenuated replica (-20 dB down, or  $\pm 10$ ) of the pulse voltage on the main output. The monitor output is designed to operate into a 50 Ohm load. (On units with the -OSHV option, this output does not include the effect of the applied DC offset.)
10. OS Connector. (Optional feature. Present on "-OS" units only.) The desired DC offset is applied to this connector. Internally, it is connected to the output centre conductor via a high quality RF inductor. Do not exceed  $\pm 50V$ , 250 mA. When not used, the OS input should be connected to ground.

*or*

OS Connector. (Optional feature. Present on "-OSHV" units only.) The desired DC offset is applied to this connector. Internally, it is connected to the output centre conductor via a high quality RF inductor. Do not exceed  $\pm 1500V$ , 1.5 mA. When not used, the OS input should be connected to ground.

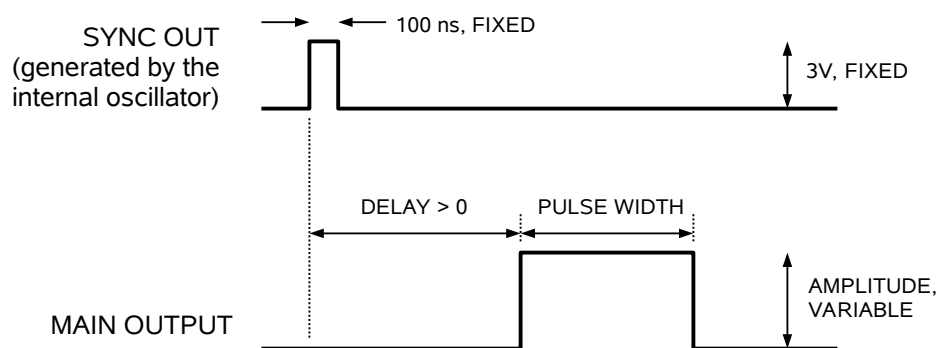
## GENERAL INFORMATION

### BASIC PULSE CONTROL

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

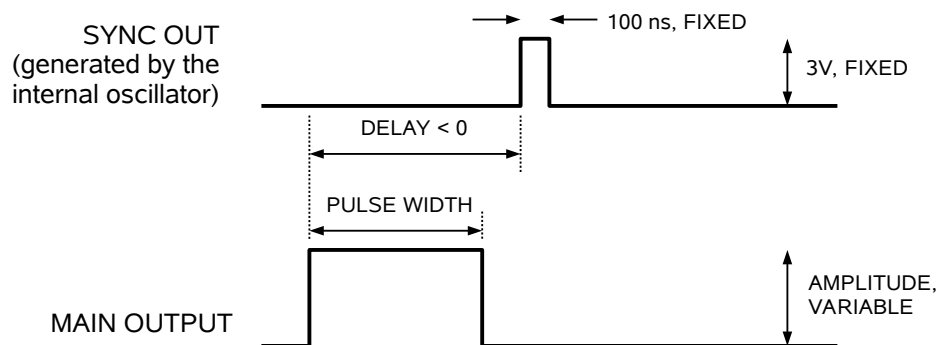
- OUT. This is the main output. The maximum output voltage is 750V.
- SYNC. The SYNC pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems. When the delay is set to a positive value the SYNC pulse precedes the OUT pulse. When the delay is set to a negative value the SYNC pulse follows the OUT pulse.

These pulses are illustrated below, assuming internal triggering and a positive delay. All waveforms are shown with positive amplitudes.



*Figure A*

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



*Figure B*

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

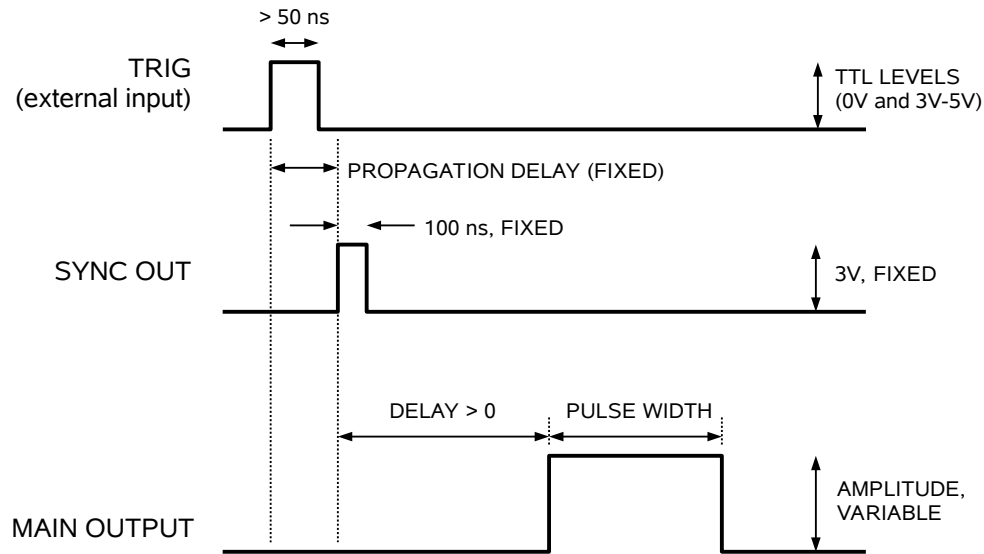


Figure C

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

In general, 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.

### TRIGGER MODES

This instrument has four trigger modes:

- Internal Trigger: the instrument controls the trigger frequency, and generates the clock internally.
- External Trigger: the instrument is triggered by an external TTL-level clock on the back-panel TRIG connector.
- Manual Trigger: the instrument is triggered by the front-panel "SINGLE PULSE" pushbutton.
- Hold Trigger: the instrument is set to not trigger at all.

These modes can be selected using the front panel trigger menu, or by using the appropriate programming commands. (See the "Programming Manual for -B Instruments" for more details.)

WARNING: The output stage may be damaged if triggered by an external signal at a pulse repetition frequency greater than 5 kHz.

### GATING MODES

Triggering can be suppressed by a TTL-level signal on the rear-panel GATE connector. The instrument can be set to stop triggering when this input high or low, using the front-panel gate menu or the appropriate programming commands. When gated, the output will complete the full pulse width if the output is high, and then stop triggering. Pulses are not truncated.

### AMPLITUDE CONTROL

The output amplitude varies with the set pulse width. The programmed amplitude is most accurate for the 12 – 20 ns pulse width range. At lower pulse widths, the output amplitude will actually be somewhat less than the programmed value.

If the amplitude is set to its nominal maximum of 750V, the actual output amplitude should be > 750V for pulse widths of 12 - 20 ns, > 700V for pulse widths of 9 - 12 ns, and > 550V for pulse widths of 6 - 9 ns.

The output amplitude may also vary slightly with the programmed frequency.

The user can non-invasively measure the output amplitude by attaching a high-quality 50 Ohm load to the rear-panel monitor output connector. The output waveform on this BNC connector is one-tenth of the output voltage on the main output connector.

### 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 AVRK-4-B.

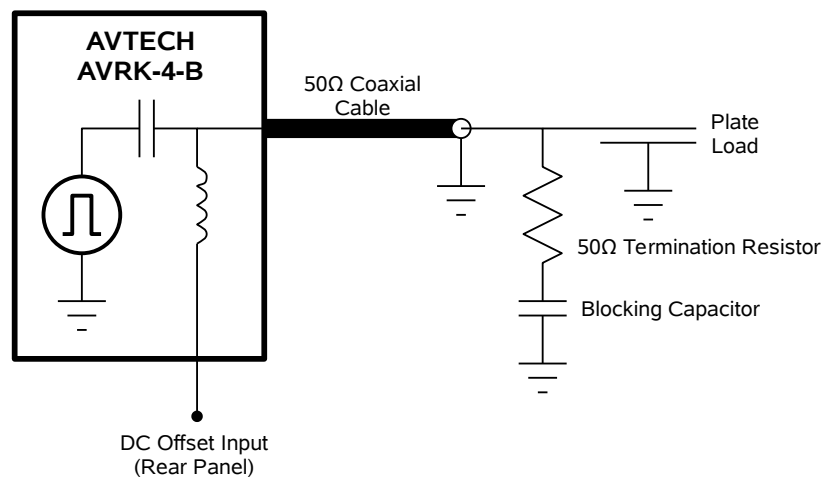
For more information, please see the Avtech application note “How Can I Extend the Amplitude Range to Low Levels?” at <http://www.avtechpulse.com/appnote/techbrief11/>.

## CONNECTING TO PLATE LOADS

The AVRK-4-B is designed to drive 50 Ohm loads, and requires a 50 Ohm load.

It is possible to drive high-impedance loads (“plate loads”), but some additional circuit elements must be added to properly terminate the high-speed pulses from the AVRK-4-B with 50 Ohms, while maintaining the ability to add a DC offset to the plate load. Normally, a large DC offset can not be applied directly to a 50 Ohm load, or it will overheat.

The suggested arrangement is shown below:



In this arrangement, a DC blocking capacitor is added in series with the 50 Ohm termination resistor, so that the high-frequency pulse “sees” a 50 Ohm load, but the DC offset “sees” an open circuit.

The user should note the following:

1. The blocking capacitor should be  $\geq 0.01 \mu\text{F}$ , with a breakdown voltage  $\geq 1500\text{V}$ .
2. The termination resistor is 50 Ohms, with a breakdown voltage  $\geq 750\text{V}$ . A non-inductive resistor (carbon composition or ceramic composition are ideal) with an average power rating of  $> 1 \text{ Watt}$  should be used.
3. All leads lengths should be kept  $< 5 \text{ mm}$  (as short as possible!).
4. The capacitance of the plate load will degrade the output pulse amplitude. A 30 pF parasitic capacitance will reduce amplitude by  $\sim 10\%$ , for example.



## PROTECTING YOUR INSTRUMENT

### TURN OFF INSTRUMENT WHEN NOT IN USE

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

### DO NOT EXCEED 10 kHz

The output stage may be damaged if triggered by an external signal at a pulse repetition frequency greater than 10 kHz.

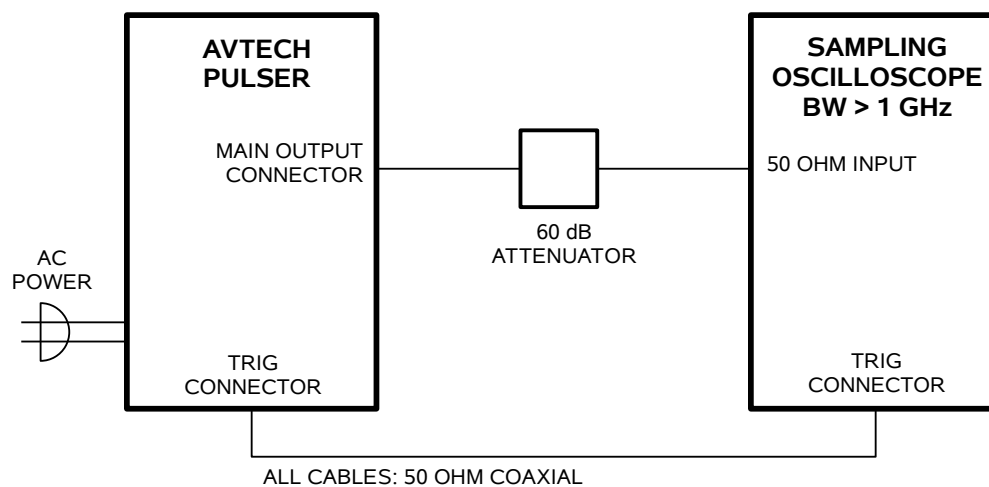
### USE A 50 OHM LOAD

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

## OPERATIONAL CHECK

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

Before proceeding with this procedure, finish reading this instruction manual thoroughly. Then read the “Local Control” section of the “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 the pulse generator to a sampling oscilloscope as shown above. 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 11.3 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 should be placed at the input to the scope trigger channel.
  - c) The bandwidth capability of components and instruments used to display the pulse generator output signal (attenuators, cables, connectors, etc.) should exceed 1 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. Turn on the AVRK-4-B. The main menu will appear on the LCD.
  3. To set the AVRK-4-B to trigger from the internal clock at a PRF of 5 kHz:
    - a) The arrow pointer should be pointing at the frequency menu item. If it is not, press the MOVE button until it is.
    - b) Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 5 kHz.
    - c) The arrow pointer should be pointing at the “Internal” choice. If it is not, press MOVE until it is.
    - d) Press CHANGE to return to the main menu.
  4. To set the delay to 100 ns:
    - a) Press the MOVE button until the arrow pointer is pointing at the delay menu item.
    - b) Press the CHANGE button. The delay submenu will appear. Rotate the ADJUST knob until the delay is set at 100 ns.
    - c) The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.
    - d) Press CHANGE to return to the main menu.
  5. To set the pulse width to 12 ns:
    - a) Press the MOVE button until the arrow pointer is pointing at the pulse width menu item.
    - b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 12 ns.
    - 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.
  6. At this point, nothing should appear on the oscilloscope.
  7. 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.
8. To change the output amplitude:
- a) Press the MOVE button until the arrow pointer is pointing at the amplitude menu item.
  - b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at +750V (or -750V for "-N" models).
  - c) Observe the oscilloscope. You should see 12 ns wide, 750V pulses. If you do not, you may need to adjust the delay setting to a value more compatible with your sampling oscilloscope. Repeat step 4 if required. You may also need to adjust the sampling scope controls.
  - d) Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary. Return it to 200V.
  - e) Press CHANGE to return to the main menu.
9. Try varying the pulse width, by repeating step (5). As you rotate the ADJUST knob, the pulse width on the oscilloscope will change. It should agree with the displayed value.

This completes the operational check.

## 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:

*rst	(resets the instrument)
trigger:source internal	(selects internal triggering)
frequency 1000 Hz	(sets the frequency to 1000 Hz)
pulse:width 50 ns	(sets the pulse width to 50 ns)
pulse:delay 20 ns	(sets the delay to 20 ns)
volt:ampl 250	(sets the amplitude to +250 V)
	("-N" units should use "volt:ampl -250)
output on	(turns on the output)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width 50 ns	(sets the pulse width to 50 ns)
output on	(turns on the output)
volt:ampl 250	(sets the amplitude to +250 V)
	("-N" units should use "volt:ampl -250)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

To set the instrument to trigger from an external TTL signal applied to the rear-panel TRIG connector, use:

*rst	(resets the instrument)
trigger:source external	(selects external triggering)
pulse:width 50 ns	(sets the pulse width to 50 ns)
pulse:delay 1 us	(sets the delay to 1 us)
volt:ampl 250	(sets the amplitude to +250 V)
	("-N" units should use "volt:ampl -250)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

## ALL PROGRAMMING COMMANDS

For more advanced programmers, a complete list of the available commands is given below. These commands are described in detail in the “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>
LOCAL		
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW   FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DCYClE	<numeric value>	
:HOLD	WIDTh   DCYClE	
:DELay	<numeric value>	
:GATE		
:TYPE	ASYNc   SYNc	
:LEVel	HIgh   LOw	
[SOURce]:		
:VOLTage		
[:LEVel]		
[:IMMEdiate]		
[:AMPLitude]	<numeric value>   EXTernal	
:PROTection		
:TRIPped?		[query only]
STATUS:		
:OPERation		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
:QUEStionable		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
SYSTEM:		
:COMMunicate		
:GPIB		
:ADDReSS	<numeric value>	
:SERial		
:CONTRol		
:RTS	ON   IBFull   RFR	
:[RECeive]		
:BAUD	1200   2400   4800   9600	
:BITS	7   8	
:ECHO	<boolean value>	
:PARity		

	: [TYPE]	EVEN   ODD   NONE	
	: SBITS	1   2	
:ERRor			
:[NEXT]?			[query only]
:COUNT?			[query only]
:VERSion?			[query only]
TRIGger:			
:SOURce		INTernal   EXTernal   MANual   HOLD   IMMEDIATE	
*CLS			[no query form]
*ESE		<numeric value>	
*ESR?			[query only]
*IDN?			[query only]
*OPC			
*SAV		0   1   2   3	[no query form]
*RCL		0   1   2   3	[no query form]
*RST			[no query form]
*SRE		<numeric value>	
*STB?			[query only]
*TST?			[query only]
*WAI			[no query form]

## 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.

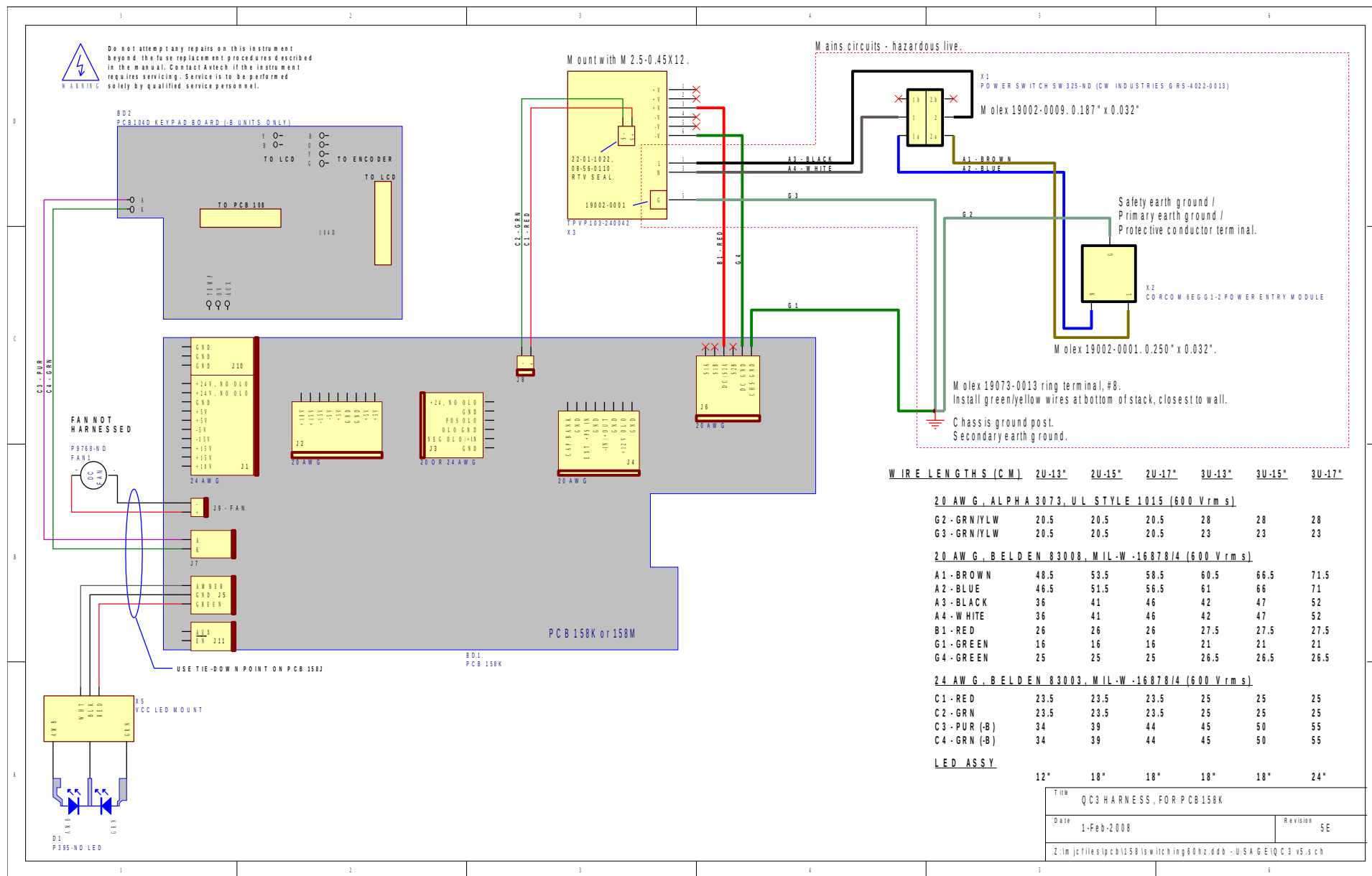
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

### 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

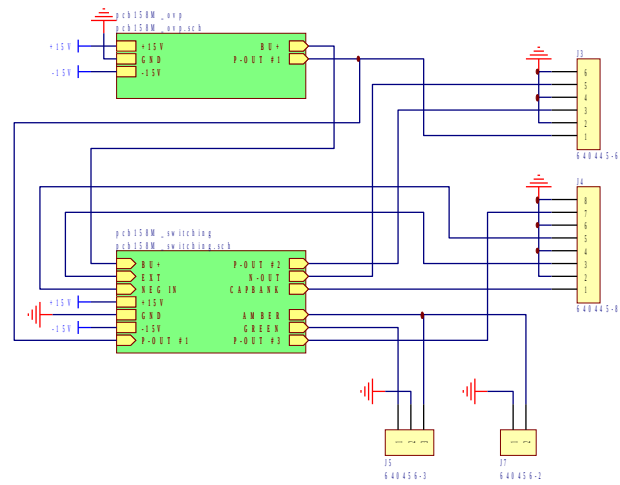
## WIRING OF AC POWER, 1/2



Title: QCS HARNESS, FOR PCB158K	
Date: 1-Feb-2008	Revision: SE
Z:\im\jctiles\lpc\cb1158\lsw\litching\60hz\ddb - U.S.A.GE\IQ C3 v5.sch	

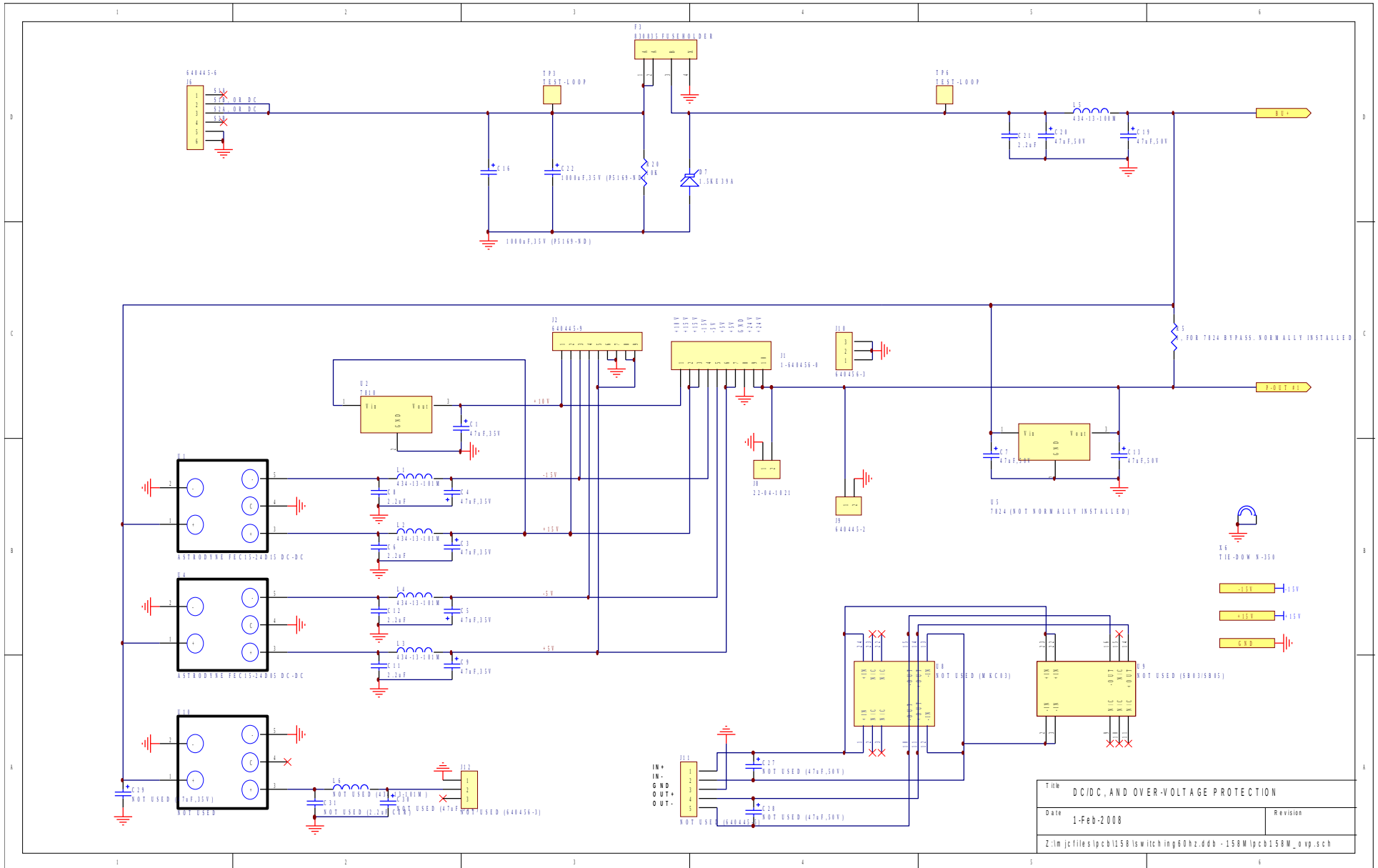


# PCB 158M - LOW VOLTAGE POWER SUPPLY, 1/3



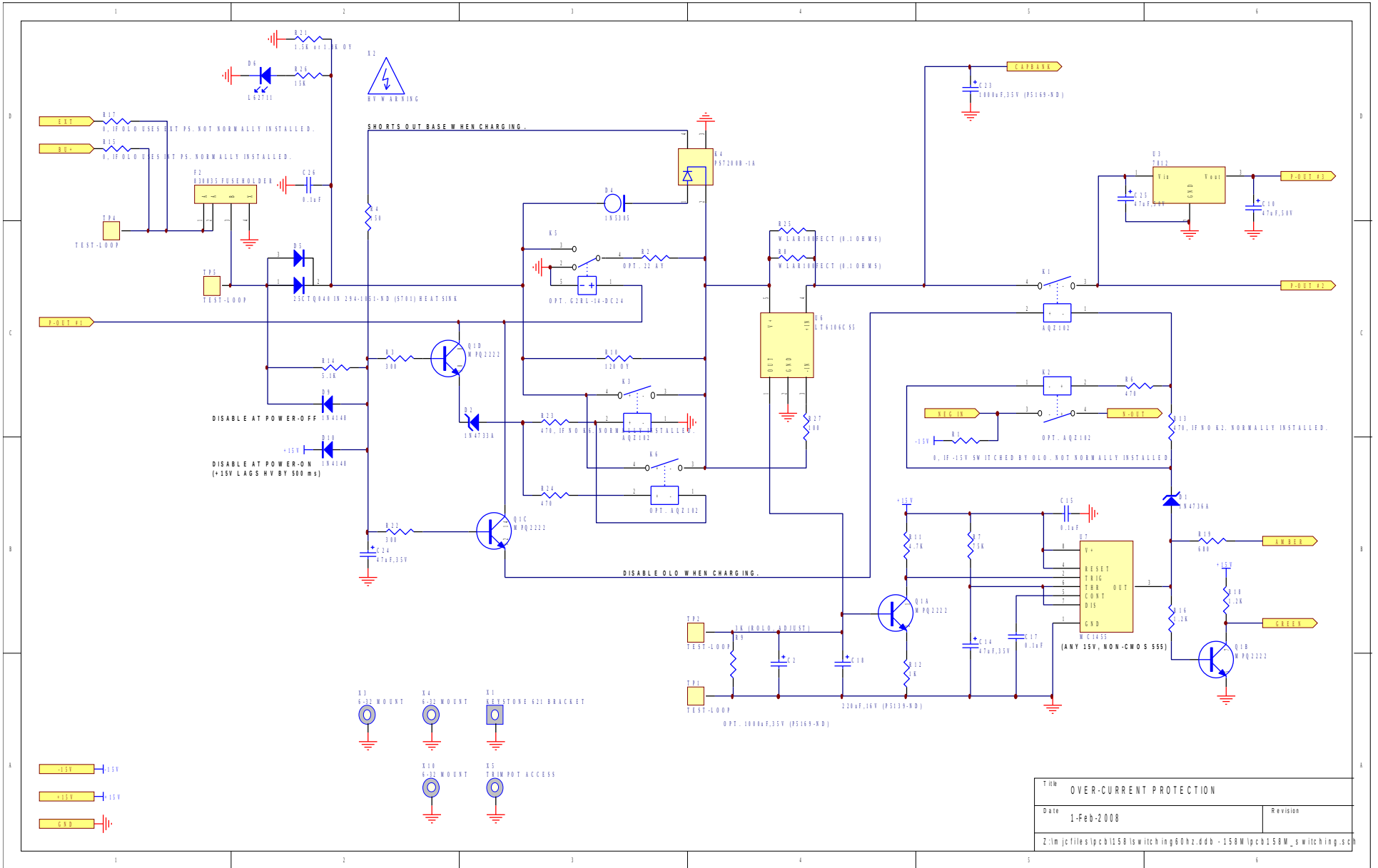
Title		LOW VOLTAGE DC/DC POWER SUPPLY
Date	1-Feb-2008	Revision
Z:\lm\jc\files\ipc\b1158\low\litch\ing60hz.dbb - 158M\ipc\b158M.sch		

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

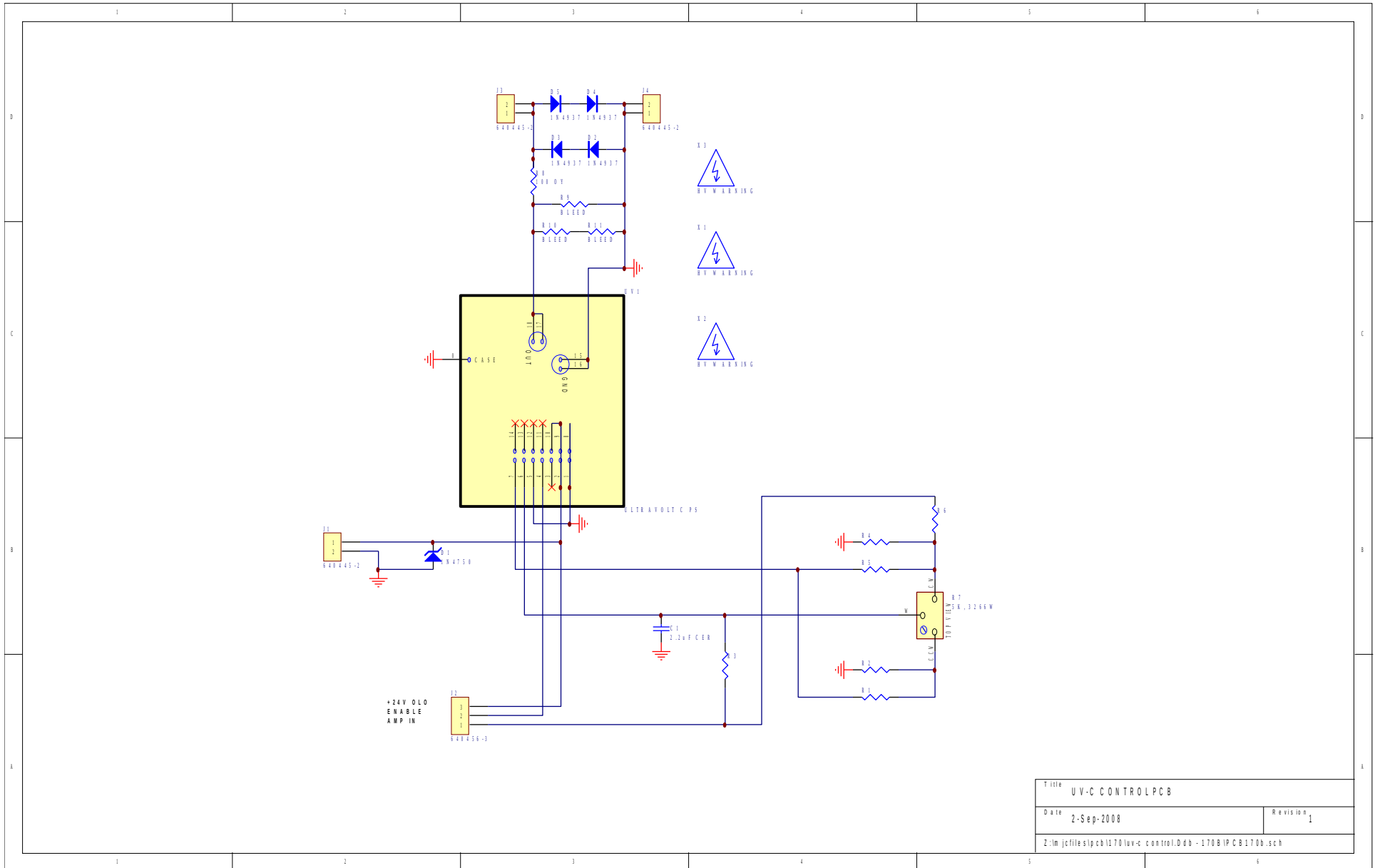


TITLE		
DC/DC, AND OVER-VOLTAGE PROTECTION		
Date	1-Feb-2008	Revision
Z:\lm\jc\files\lpcb158\lsw\litch\img60hz.ddb - 158M\lpcb158M_o_vp.sch		

# PCB 158M - LOW VOLTAGE POWER SUPPLY, 3/3

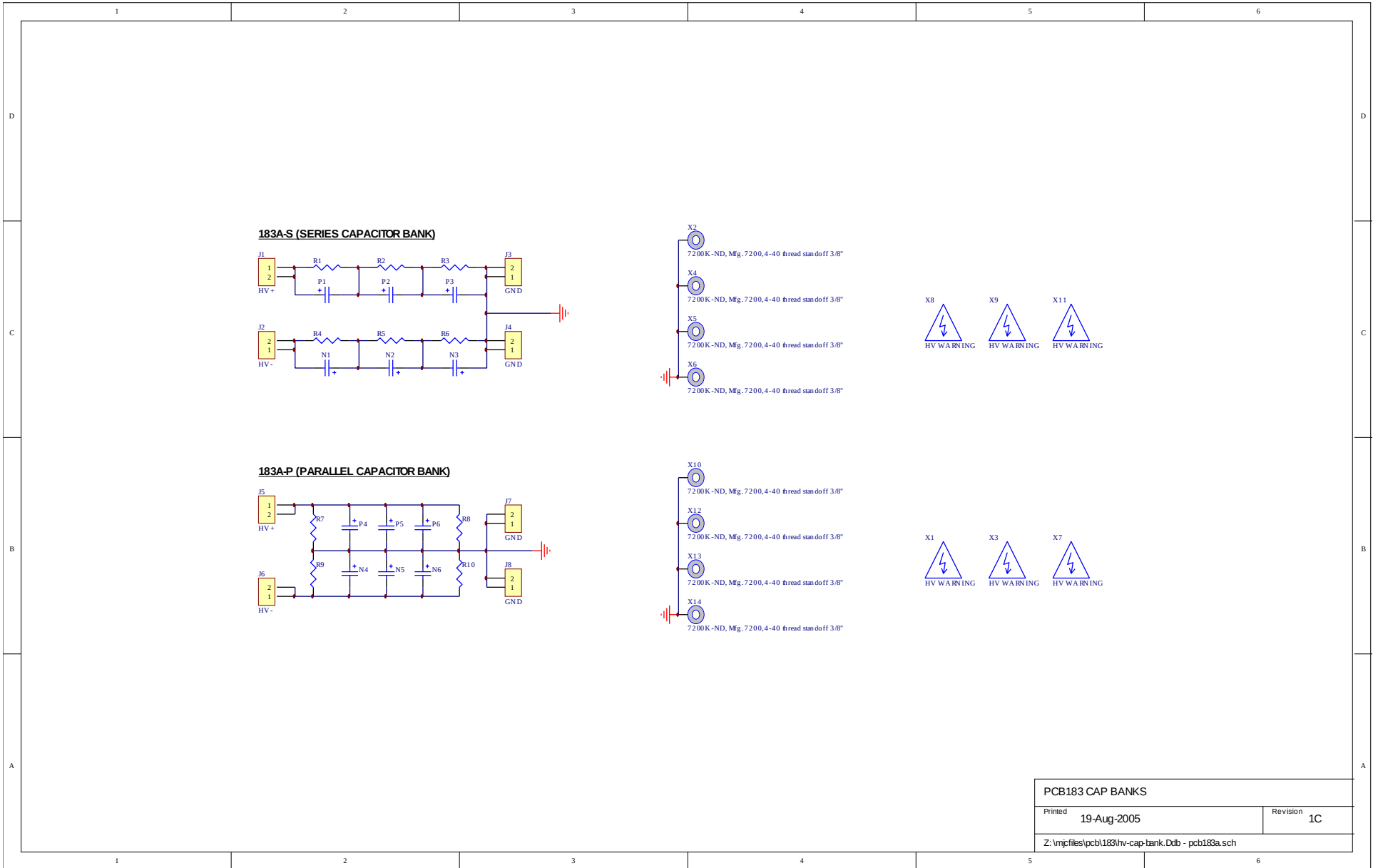


# PCB 170B - HIGH-VOLTAGE POWER SUPPLY



Title UV-C CONTROL PCB	
Date 2-Sep-2008	Revision 1
Z:\m\jcf\files\pcb\170\uv-c control.dwg - 170B\PCB170B.sch	

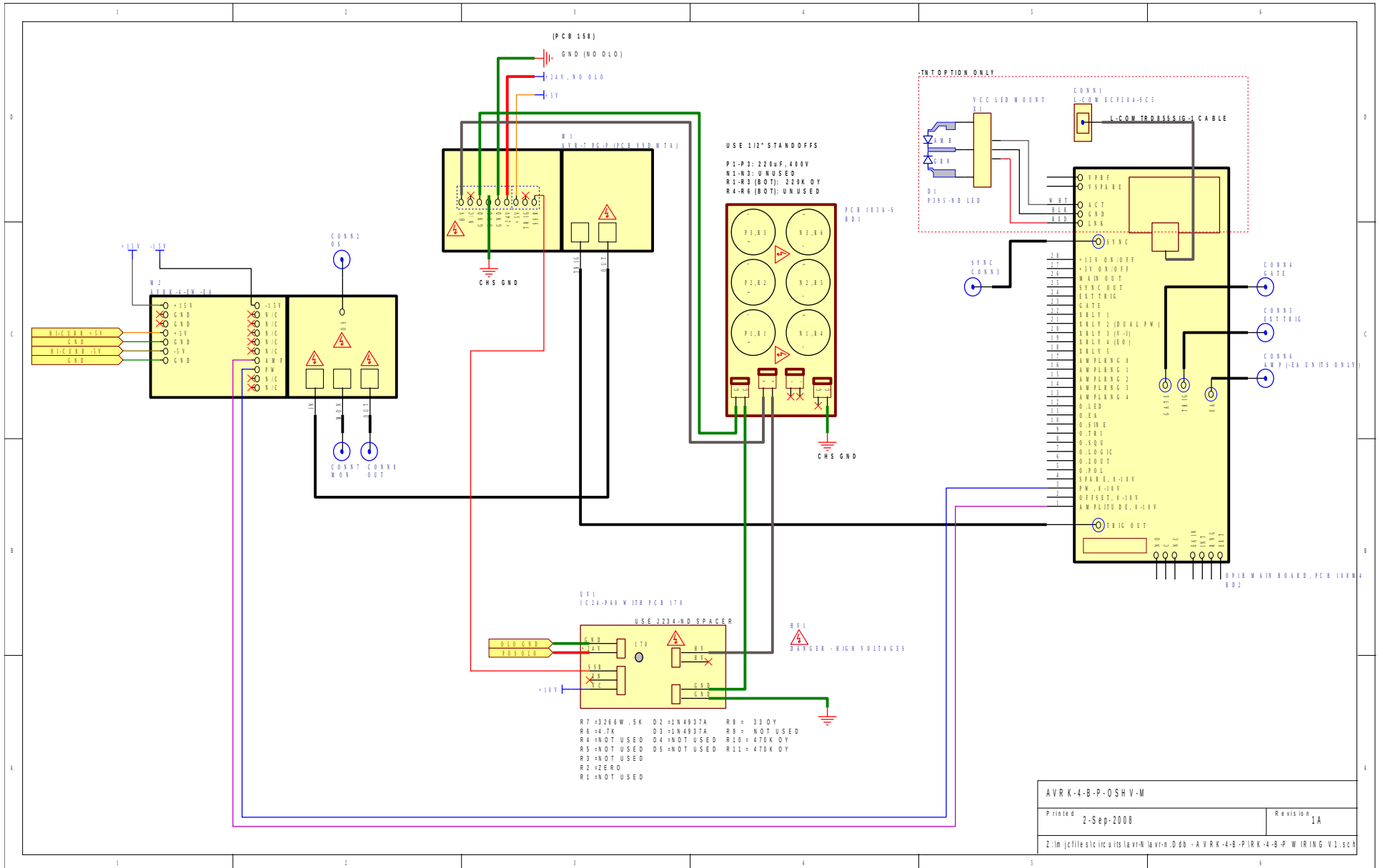
# PCB 183A-S AND 183A-P CAPACITOR BANKS



PCB183 CAP BANKS	
Printed 19-Aug-2005	Revision 1C
Z:\mprojfiles\pcb183\hv-cap-bank.Dtb - pcb183a.sch	



# MAIN WIRING



PERFORMANCE CHECKSHEET