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NANOSECOND WAVEFORM ELECTRONICS
SINCE 1975

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BOX 5120, LCD MERIVALE
OTTAWA, ONTARIO
CANADA K2C 3H5

INSTRUCTIONS

MODEL AVG-4C-C

150 to 920 VOLTS, 10 kHz

HIGH SPEED IMPULSE GENERATOR

WITH < 8 ns PULSE WIDTH

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 +1-613-686-6675 (International)

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Manual Reference: /files/server1/officefiles/instructword/avg/AVG-4C-C,edition5.odt.
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INTRODUCTION

The AVG-4C-C is a high performance instrument capable of generating up to 920V into 50 Ω loads at repetition rates up to 10 kHz. The pulse width is nominally < 8 ns, but it can be adjusted over a narrow range.

The amplitude is adjustable from $\leq 150\text{V}$ to $\geq 920\text{V}$. Instruments with the "-P" model suffix can generate positive amplitudes, whereas instruments with the "-N" model suffix can generate only negative. Instruments with the "-PN" suffix can generate both polarities. (The maximum amplitude available for negative impulses is 10% less than that for positive ones, due to the loss in the internal inverting transformer.)

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

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

SPECIFICATIONS

Model:	AVG-4C-C ¹
Amplitude ^{3,4,11} : (50 Ω load ¹⁰)	150-920 V ¹²
Pulse width: (at 20% rise time)	≤ 8 ns
Rise time: (20%-80%)	≤ 2.5 ns
Fall time: (80%-20%)	≤ 4 ns
PRF:	0 to 10 kHz
Polarity ⁵ :	Positive or negative or both (specify)
Propagation delay:	≤ 50 ns (Ext trig in to pulse out)
Jitter:	± 100 ps (Ext trig in to pulse out)
DC offset:	-OS option ⁶ : Apply required DC offset (± 50 Volts, 250 mA DC max) to rear-panel solder terminals
Trigger required:	External trigger mode: +5 Volts, 50 to 500 ns (TTL)
Sync delay:	Sync out to pulse out: Variable 0 to 200 ns
Sync out:	+ 3 Volts, 200 ns, will drive 50 Ohm loads
Monitor output:	Optional ⁷ : Provides a 20 dB attenuated coincident replica of main output
Connectors:	Out: SMA ⁹ , Trig: BNC
Dimensions (H x W x D):	100 mm x 430 mm x 375 mm (3.9" x 17" x 14.8").
Power:	100 – 240 Volts, 50 – 60 Hz
Chassis material:	Cast aluminum frame & handles, blue vinyl on aluminum cover plates
Mounting:	Any
Temp. range:	+5°C to +40°C

- 1) -C suffix indicates stand-alone lab instrument with internal clock and line powering. No suffix indicates miniature module requiring DC power and external trigger.
- 2) -B suffix indicates IEEE-488.2 GPIB and RS-232 control of amplitude, pulse width, PRF and delay (see <http://www.avtechpulse.com/gpib>).
- 3) 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.
- 4) For electronic control (0 to + 10 V) of amplitude, suffix the model number with -EA. Electronic control units also include standard front-panel one-turn controls. The -EA option will cause the maximum available output amplitude to be reduced by 10%, due to the loss that the additional circuitry introduces.
- 5) Indicate desired polarity by suffixing model number with -P or -N (i.e. positive or negative) or -PN for the dual polarity option. (-PN available only on -B and -C units). AVX-1 transformer may be used to invert polarity.
- 6) For DC offset option suffix model number with -OS.
- 7) For monitor option add suffix -M.
- 8) Falls to 180V for PRF above 10 kHz.
- 9) Units with the -OSHV option will have a Type N output connector, instead of SMA. Not available on modules. 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.
- 10) A 50 Ohm load is required. Other loads may damage the instrument. Consult Avtech (info@avtechpulse.com) if you need to drive other load impedances.
- 11) Maximum amplitudes are for positive outputs only. The maximum negative amplitude for -N and -PN units will be approximately 10% lower, due to the use of an internal inverting transformer.
- 12) The maximum available output amplitude will decrease by 10% for pulse repetition frequencies above 5 kHz.

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 (where applicable). 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) 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) if you require assistance.

EC DECLARATION OF CONFORMITY



We Avtech Electrosystems Ltd.
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 Ottawa, Ontario
 Canada K2C 3H5

declare that this pulse generator meets the intent of Directive 2004/108/EG 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.



AC POWER SUPPLY REGULATORY NOTES

This instrument converts the AC input power to the +24V DC voltage that powers the internal circuitry of this instrument using a Tamura AAD130SD-60-A switching power supply. According to the manufacturer, the Tamura AAD130SD-60-A has the following certifications:

UL60950-1
IEC60950 -1
CSA C22.2 No. 60950- 1
EN60950 -1

and is compliant with:

EN61000-3-2
EN61000-4-2 Level 2
EN61000-4-2 Level 3 (Air Only)
EN61000-4-4 Level 3
EN61000-4-5 Level 3
EN61000-4-11
CISPR 11 and 22 FCC Part 15 Class B (conducted)

INSTALLATION

VISUAL CHECK

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

POWER RATINGS


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

The maximum power consumption is 57 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	370001-E01
Australia, New Zealand	AS 3112:2000, 230-240V, 50 Hz	-AC01	Qualtek	374003-A01
Continental Europe, Korea, Indonesia, Russia	European CEE 7/7 "Schuko" 230V, 50 Hz	-AC02	Qualtek	364002-D01
North America, Taiwan	NEMA 5-15, 120V, 60 Hz	-AC03	Qualtek	312007-01
Switzerland	SEV 1011, 230V, 50 Hz	-AC06	Qualtek	378001-E01
South Africa, India	SABS 164-1, 220-250V, 50 Hz	-AC17	Volex	2131H 10 C3
Japan	JIS 8303, 100V, 50-60 Hz	-AC18	Qualtek	397002-01
Israel	SI 32, 220V, 50 Hz	-AC19	Qualtek	398001-01
China	GB 1002-1, 220V, 50 Hz	-AC22	Volex	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 ± 10 % of the nominal voltage;
6. no pollution or only dry, non-conductive pollution.

FUSES

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



AC FUSE REPLACEMENT

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

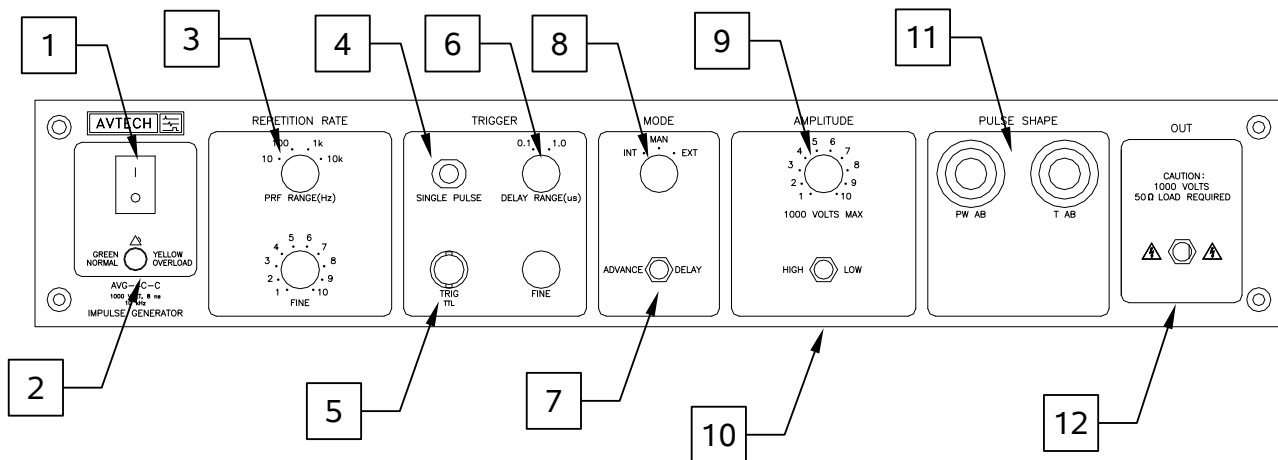
The following table lists the required fuses:

Fuses	Nominal Mains Voltage	Rating	Case Size	Recommended Replacement Part	
				Littelfuse Part Number	Digi-Key Stock Number
#1, #2 (AC)	100-240V	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND
#3 (DC)	N/A	2A, 250V, Time-Delay	5×20 mm	0218002.HXP	F2420-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.
3. PRF Range Switch and Vernier. This switch sets the pulse repetition frequency (PRF) range of the internal oscillator. The marked value of each position is the upper limit of the range, approximately. The vernier dial directly below the switch varies the PRF within the set range.
4. SINGLE PULSE Push Button. The "SINGLE PULSE" push button will trigger the instrument manually for one cycle of output, when the "MODE" switch is in the "MAN" position. Otherwise, the push button has no effect.
5. TRIG Connector. When the "MODE" switch is in the "EXT" position, this connector is an input. The external trigger (50 ns or wider, TTL levels) is applied to this connector.

When operating in the "INT" mode, this connector is an output. A SYNC output is generated on this connector, to synchronize oscilloscopes or other measurement systems.

6. Delay Range Switch and Vernier. This switch and one-turn dial sets the delay between the main output and the TRIG output. The marked value of each switch position is the upper limit of the range, approximately. The vernier dial directly below the switch varies the delay within the set range.
7. ADVANCE/DELAY Switch. With this switch in the DELAY position, the leading edge of the output pulse precedes the leading edge of the TRIG output. When in the ADVANCE position, the leading edge of the TRIG output precedes the leading edge of the main output.
8. MODE Switch. In the "INT" position the instrument is internally triggered and the TRIG connector provides a SYNC output which allows one to trigger other instruments, such as oscilloscopes.

In the "MAN" position a single pulse can be generated by pressing the "SINGLE PULSE" push button. The TRIG connector is not used in this mode.

In the "EXT" position the instrument is triggered by a TTL-level pulse on the TRIG connector. The output parameters (pulse width, delay, and amplitude) are determined by the front panel settings.

9. AMPLITUDE Controls. The output amplitude is controlled by this one-turn dial. It may be necessary to adjust the "PULSE SHAPE" controls (item 11) in conjunction with this control, to obtain the best waveform.
10. POLARITY POS/NEG Switch. (Present on units with -PN option only.) This switch controls the output polarity (positive or negative) on dual-polarity units.
11. PULSE SHAPE Controls. The AVG-4C-C output stage consists of two separate pulse generator circuits, whose outputs are combined to generate the main output impulse. The "PW AB" dial controls the pulse widths of the two components, and the "T AB" dial controls the delay between the two components. Normally, "PW AB" is set fully clockwise, and "T AB" is set mid-range. These controls should be adjusted to obtain the optimal waveshape (i.e., pulse width and amplitude) for your application. It may be necessary to adjust the "AMPLITUDE" control (item 9) in conjunction with these controls, to obtain the best waveform.

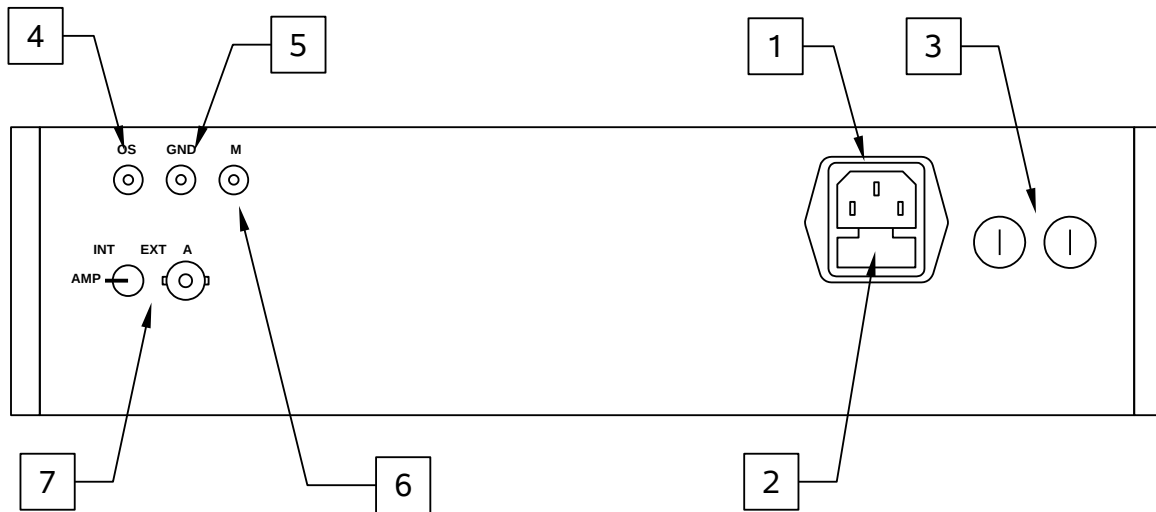
It may be necessary to re-adjust the controls if the pulse repetition frequency is changed.

12. OUT CONNECTOR. This SMA connector provides the main output signal, into load impedances of 50 Ohms.

 Caution: Voltages as high as $\pm 920\text{V}$ may be present on the center conductor of

this output connector. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

REAR PANEL CONTROLS

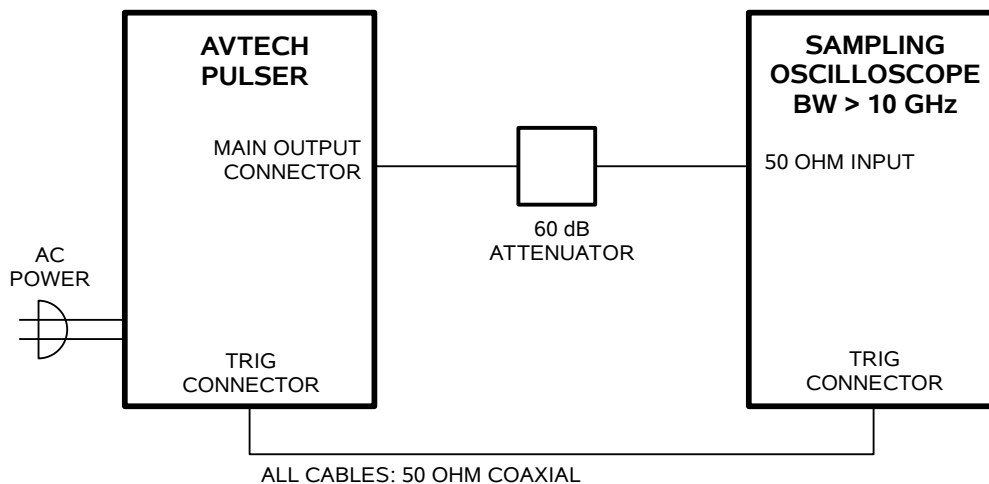


1. AC POWER INPUT. An IEC-320 C14 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket.
2. AC FUSE DRAWER. The two fuses that protect the AC input are 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. OS INPUT CONNECTOR. (Present on units with -OS option only.) A DC offset in the range of $\pm 50\text{V}$ (250 mA max) may be applied to this solder terminal. The DC offset will appear on the output. When this feature is not used, the OS input should be connected to ground (using the adjacent GND connector). This is especially important when driving loads containing a diode.
5. GND CONNECTOR. (Present on units with -OS option only.) This solder terminal is connected to ground. It may be used to ground the OS input connector.
6. M OUTPUT CONNECTOR. (Present on units with -M option only.) This SMA connector is connected to the main output through a 470 Ohm resistor. When this output is used, it must be terminated with a 50 Ohm resistance. This will provide an monitor signal that is a -20 dB replica of the main output signal, approximately.
7. AMP SWITCH & INPUT. (Present on units with -EA option only.) To control the output amplitude with an external voltage, set the rear-panel switch to the “EXT” position and apply 0 to +10V to the adjacent connector ($R_{IN} \geq 10\text{k}\Omega$).

GENERAL INFORMATION

BASIC TEST ARRANGEMENT

The AVG-4C-C should be tested with a sampling oscilloscope with a bandwidth of at least 2 GHz to properly observe the high-speed waveform. A typical test arrangement is shown below:



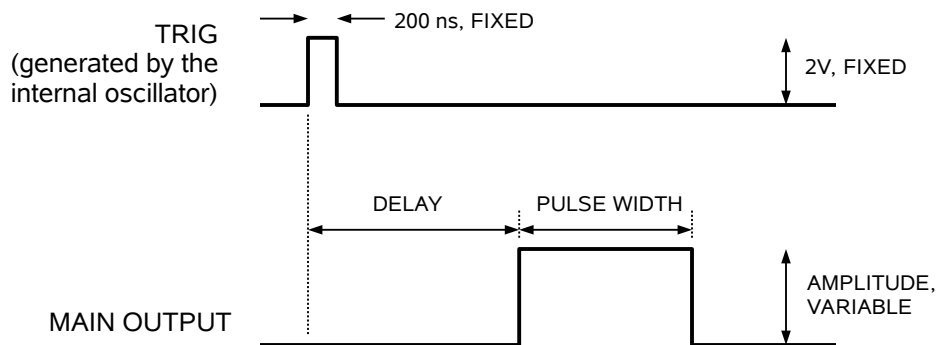
⚠ The attenuators are required to prevent damage to the sampling oscilloscope. A 60 dB attenuator (or higher) with an unusually high voltage rating should be used on the main output.

BASIC PULSE CONTROL

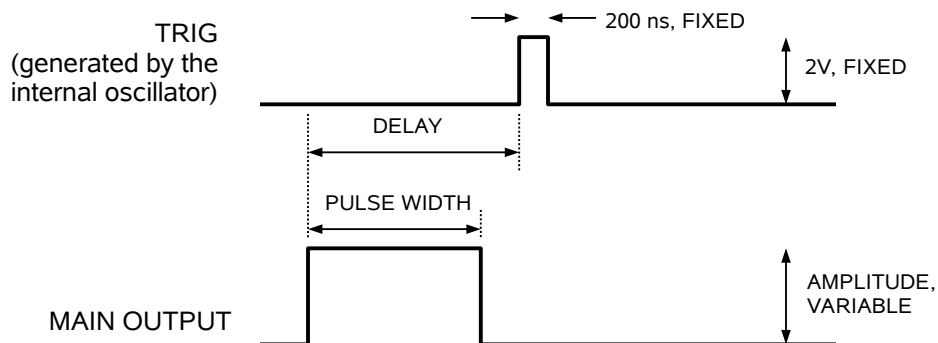
This instrument can be triggered by its own internal clock or by an external TTL trigger signal. When triggered internally, two mainframe output channels respond to the trigger: OUT and SYNC.

- OUT. This is the main output. The maximum output voltage is 920V.
- TRIG. The TRIG pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems.

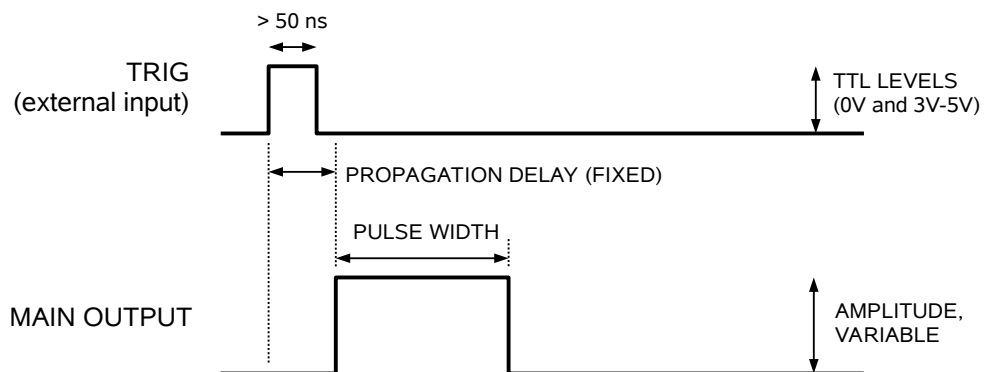
When the ADVANCE/DELAY switch is set to “ADVANCE”, the TRIG output precedes the main output. These pulses are illustrated below:



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



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




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.

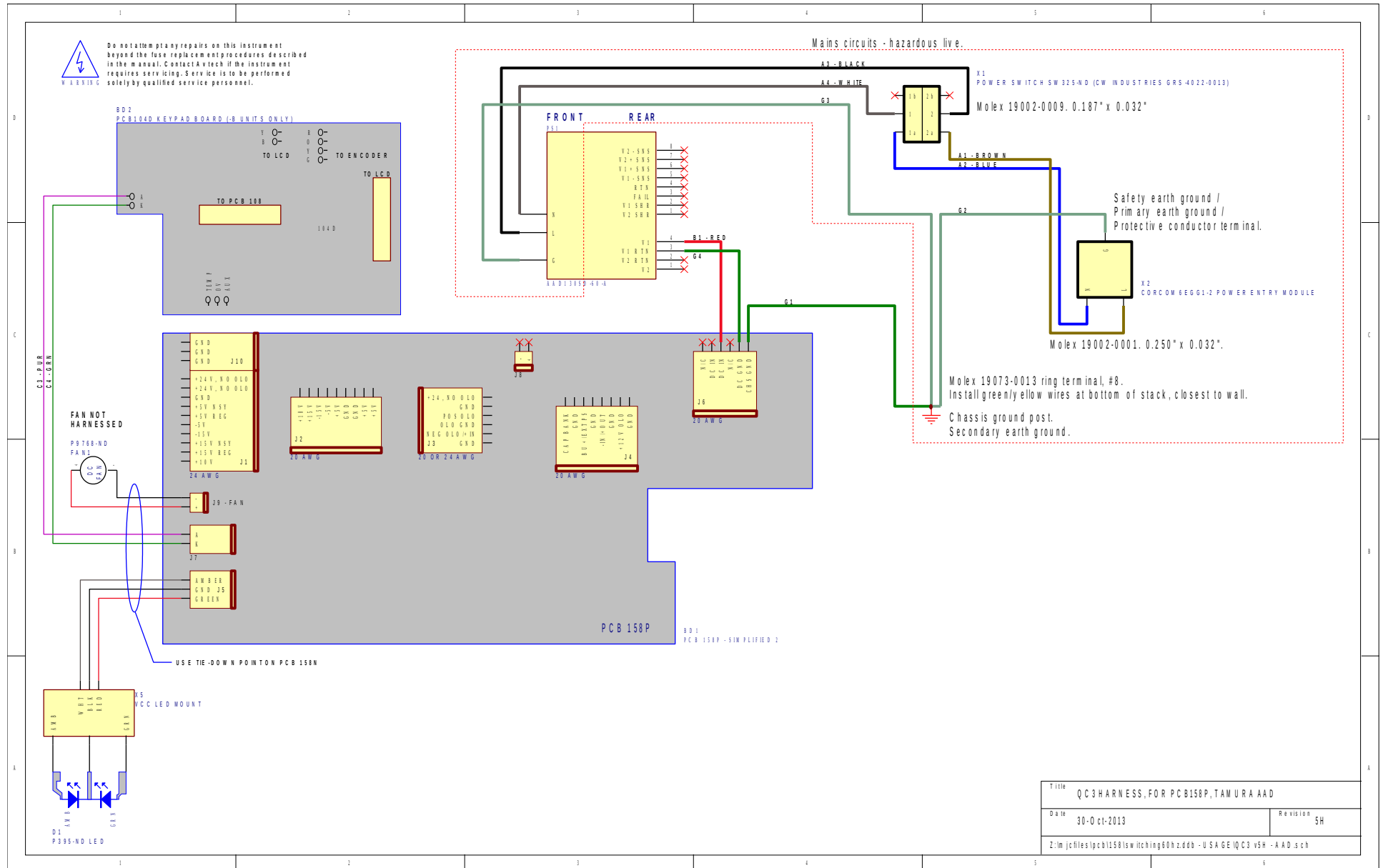
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

CLEANING

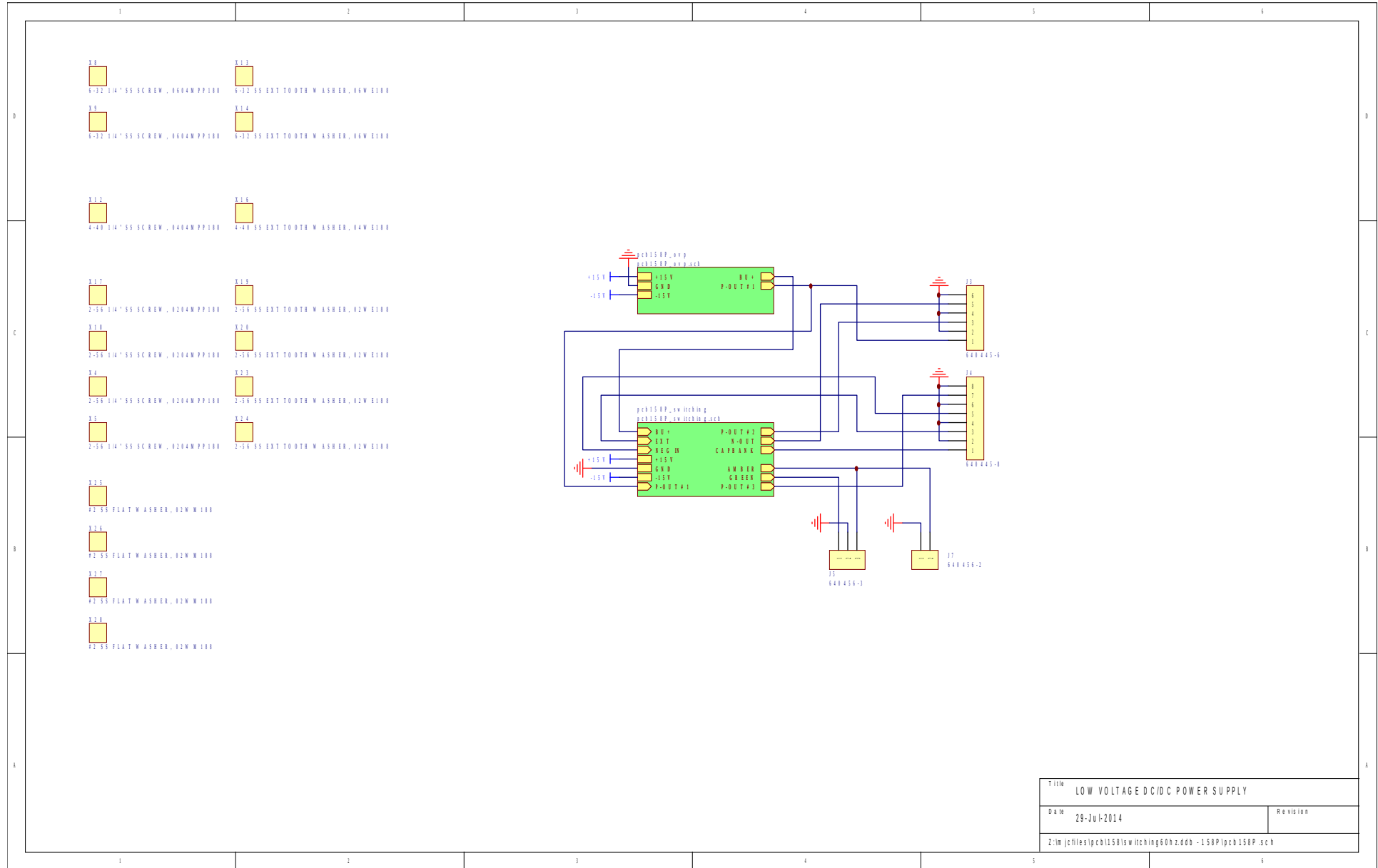
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

WIRING DIAGRAMS

WIRING OF AC POWER

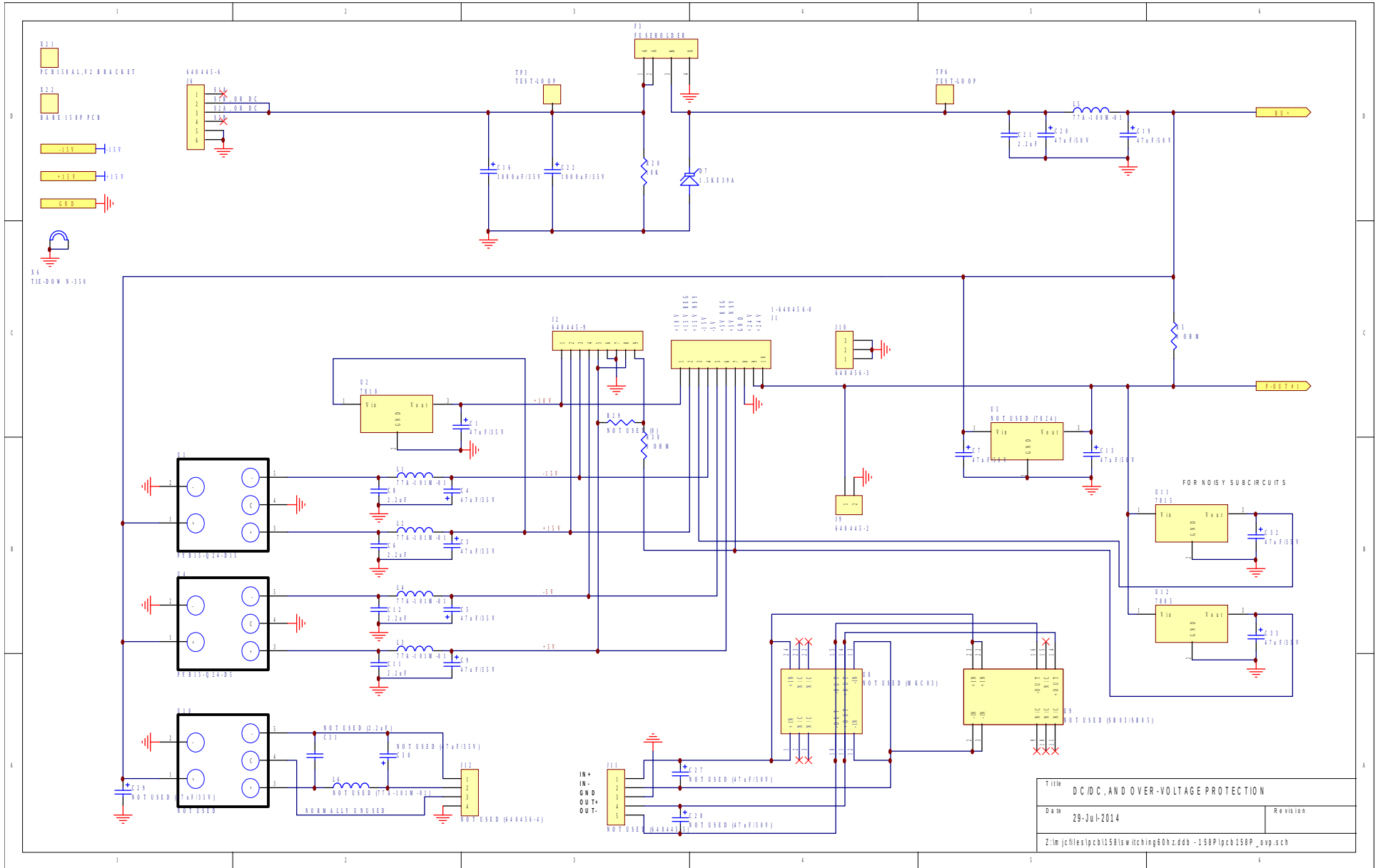


PCB 158P - LOW VOLTAGE POWER SUPPLY, 1/3



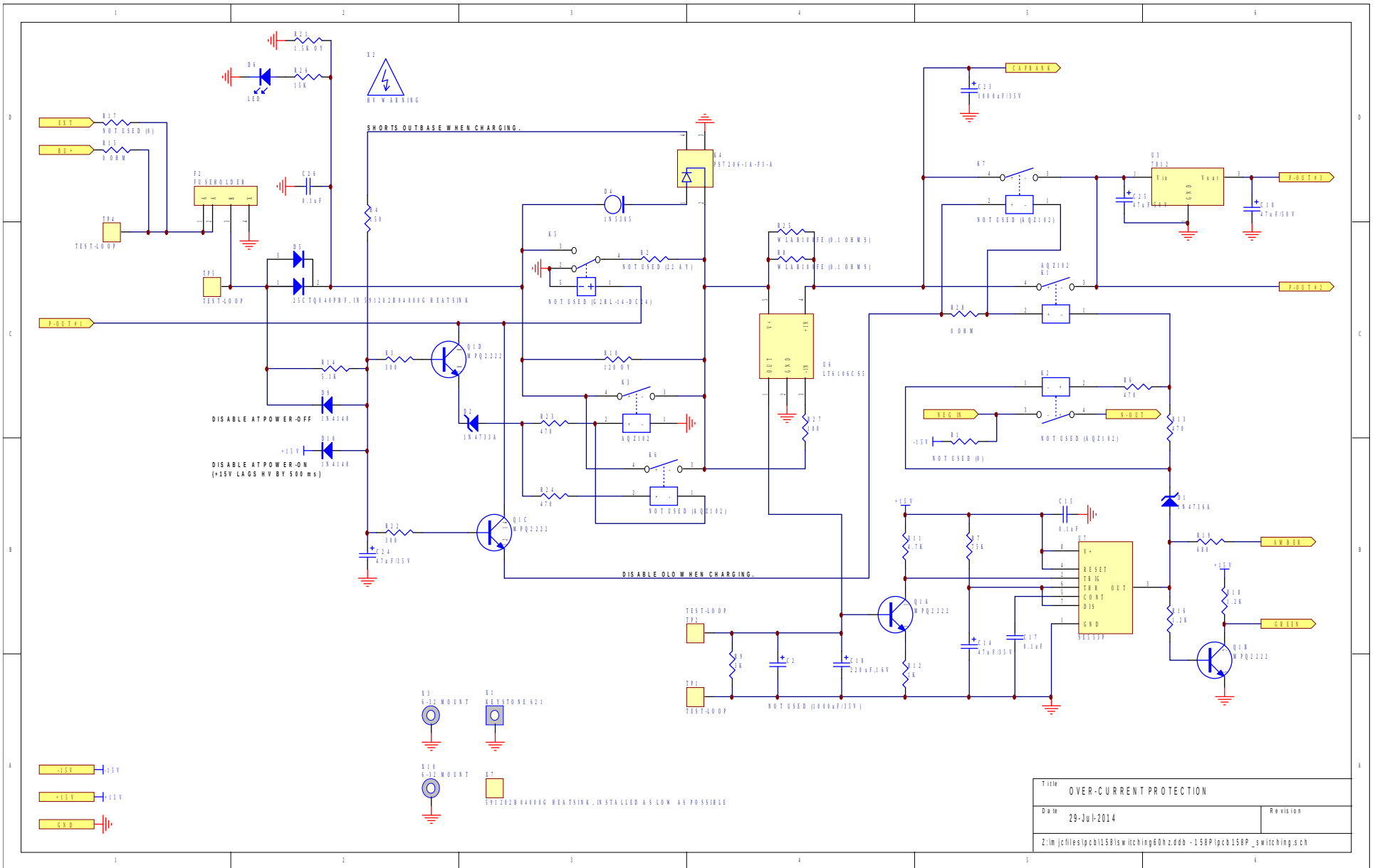
Title LOW VOLTAGE DC/DC POWER SUPPLY	
Date 29-JUL-2014	Revision
Z:\m\jcf\files\pcb158\sw\hching60hz.ddb - 158P\pcb 158P.sch	

PCB 158P - LOW VOLTAGE POWER SUPPLY, 2/3



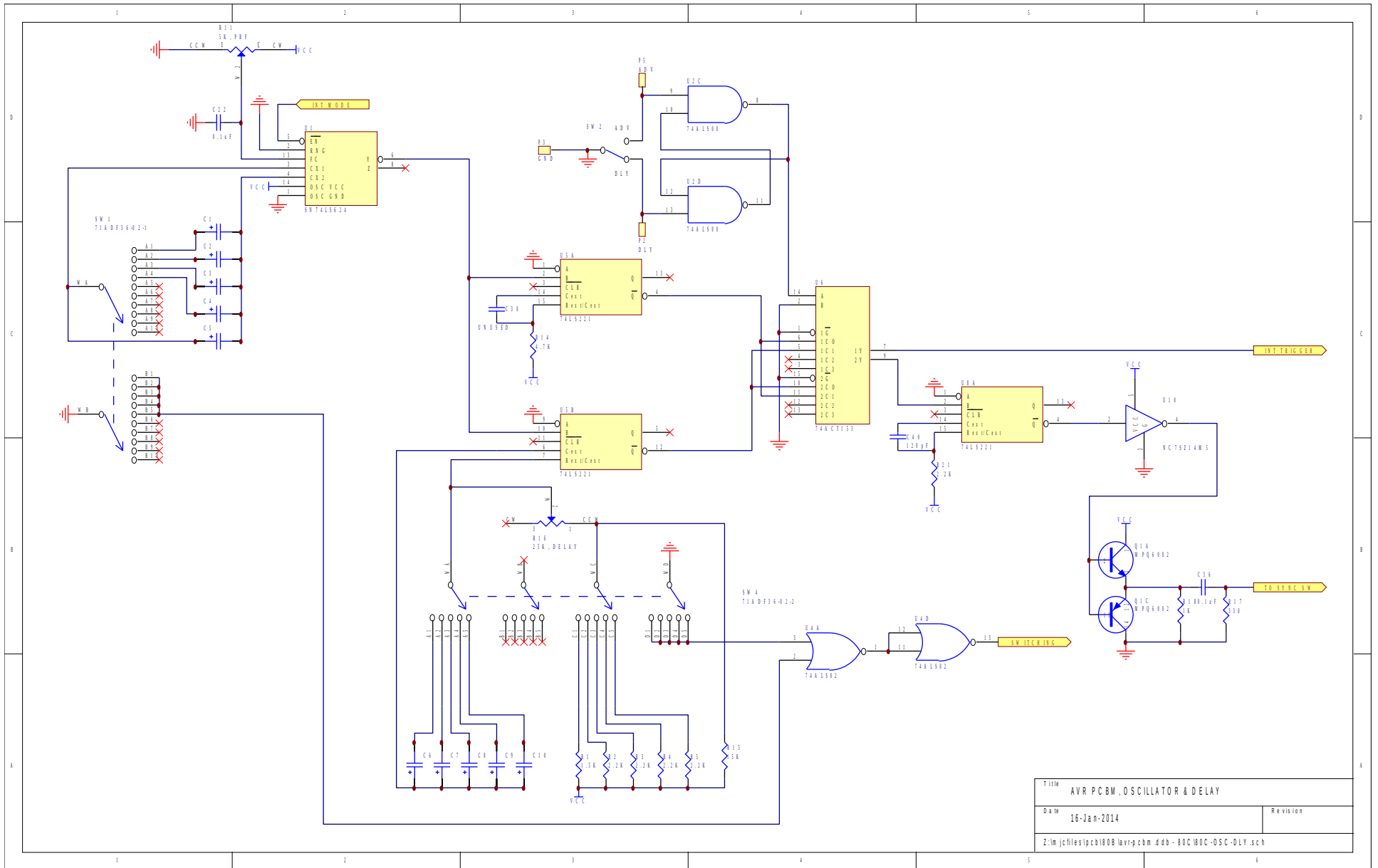
Title DC/DC, AND OVER-VOLTAGE PROTECTION	
Date 29-JUL-2014	Revision
Z:\m\jcf\files\pcb158\isw\hching60hz.ddd - 158P\pcb158P_exp.sch	

PCB 158P - LOW VOLTAGE POWER SUPPLY, 3/3



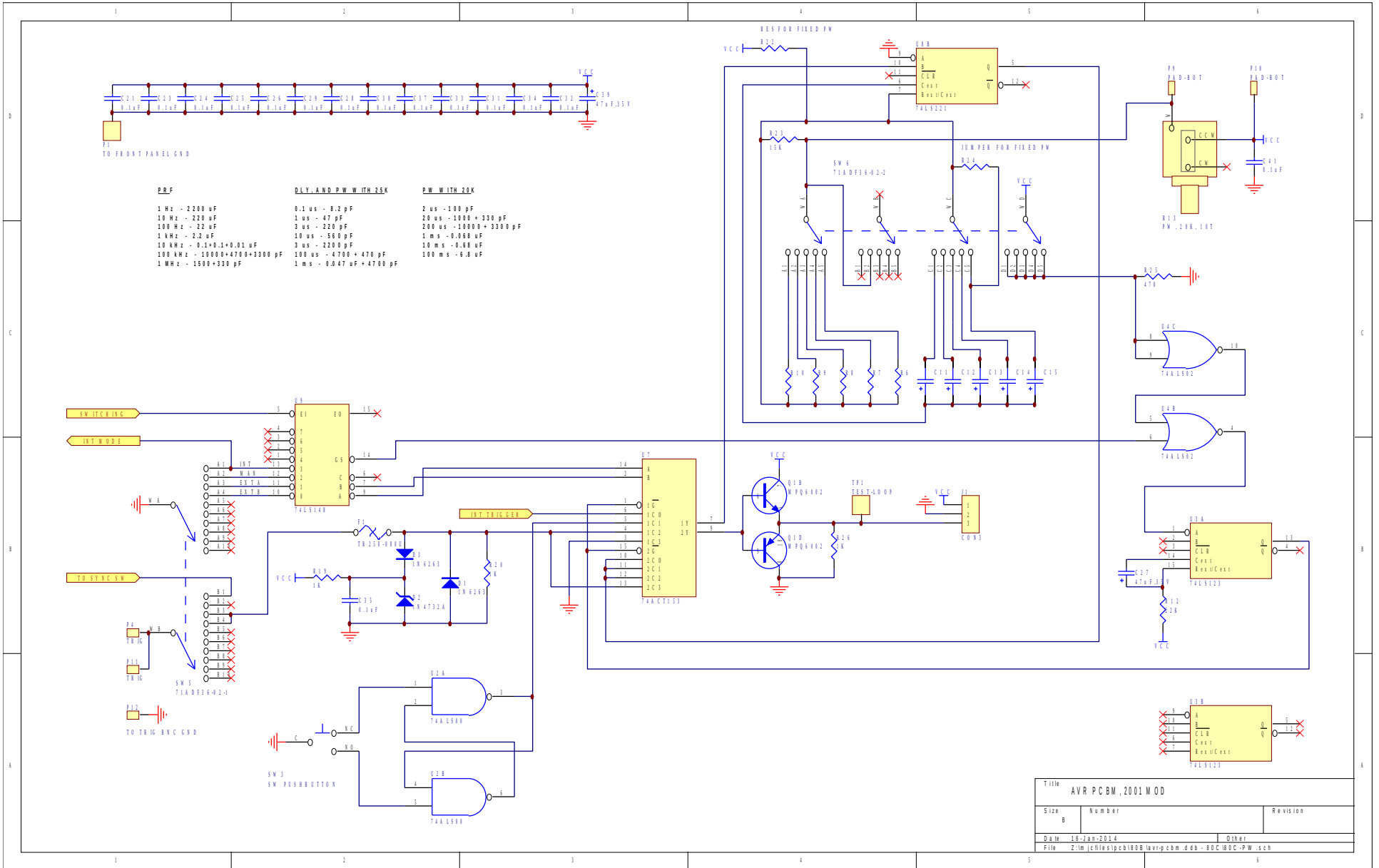
Title OVER-CURRENT PROTECTION	
Date 29-JUL-2014	Revision
Z:\m\jcf\files\pcb158\sw\hchng60hz.ddb - 158P\pcb 158P_sw\switching.sch	

PCB 80C - TIMING BOARD (1/2)



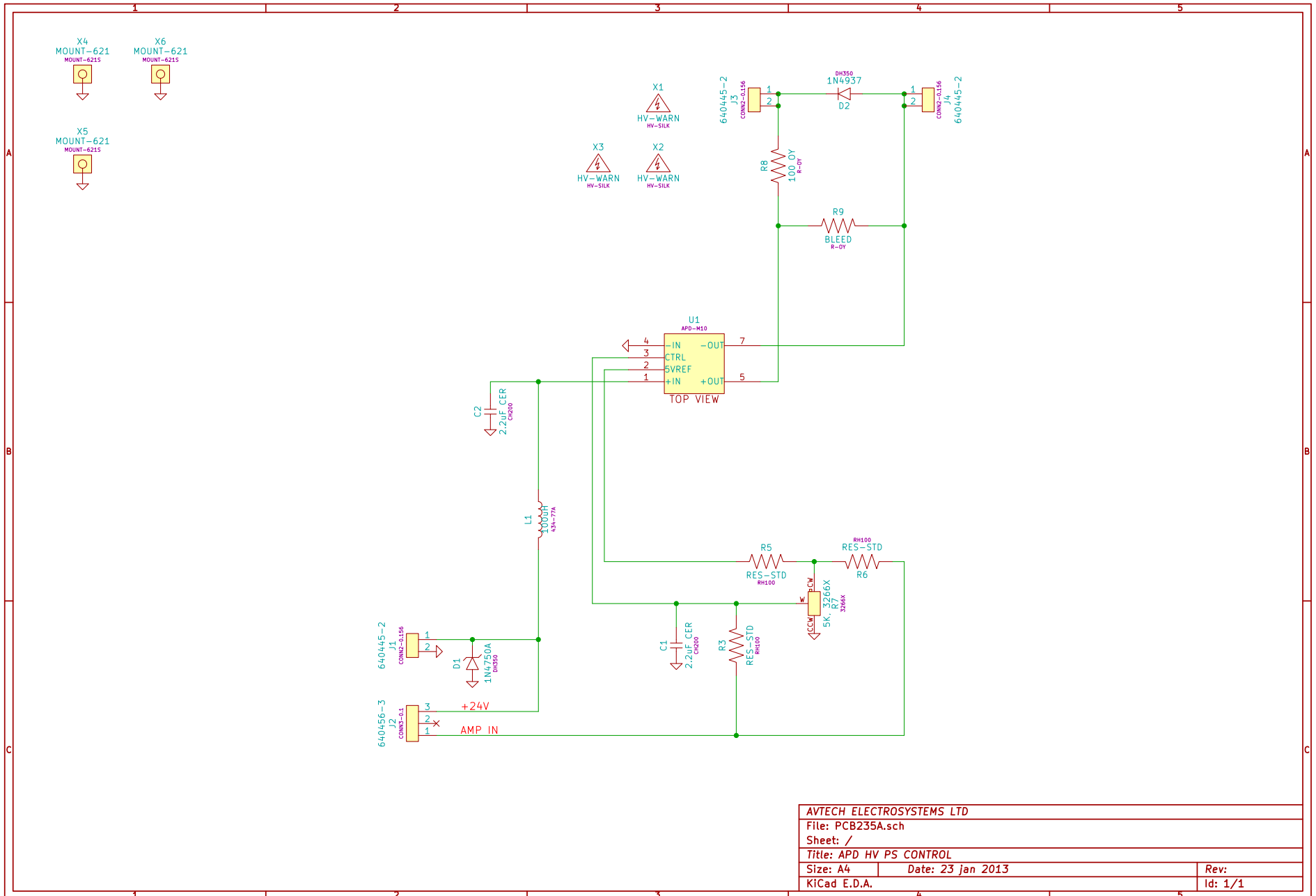
Title		AVR PCB M, OSCILLATOR & DELAY
Date	16-Jan-2014	Revision
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PCB 80C - TIMING BOARD (2/2)



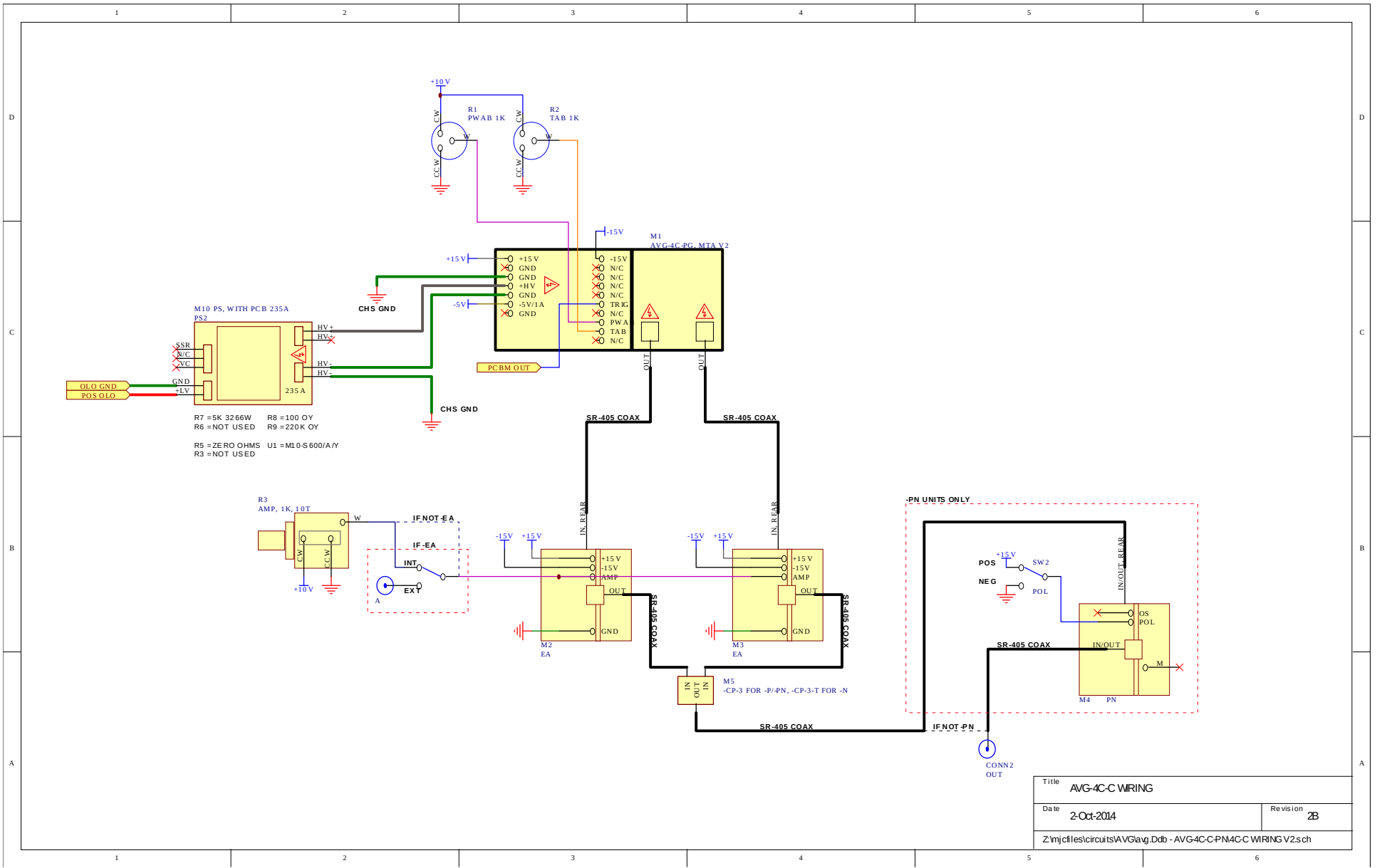
Title			AVR PCB M. 2001 MOD
Size	Number	Revision	
B			
Date	16-Jan-2014	Other	
File	Z:\m\c\files\pcb1008\avr-pcbm.dbb	80C100C-PW.sch	

PCB 235A - HIGH VOLTAGE DC POWER SUPPLY



AVTECH ELECTROSYSTEMS LTD		
File: PCB235A.sch		
Sheet: /		
Title: APD HV PS CONTROL		
Size: A4	Date: 23 Jan 2013	Rev:
KiCad E.D.A.		Id: 1/1

MAIN WIRING



Title AV-G-4C-WIRING	
Date 2-Oct-2014	Revision 2B
Z:\mjcf\res\circuits\AVG\avg.Ddb - AV-G-4C-PN\4C-WIRING V2.sch	

PERFORMANCE CHECK SHEET