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NANOSECOND WAVEFORM ELECTRONICS
SINCE 1975

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OTTAWA, ONTARIO
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INSTRUCTIONS

MODEL AVN-W1-C-P-QTKA

5 - 50 MHz, 5 VOLT

HIGH SPEED PULSE GENERATOR

WITH 200 ps RISE TIMES

SERIAL NUMBER: _____

WARRANTY

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

TECHNICAL SUPPORT

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INTRODUCTION

The AVN-W1-C-P-QTKA pulse generator is a high performance instrument capable of operating at pulse repetition frequencies from 5 MHz to 50 MHz, with 200 ps rise times and 300 ps fall times. The pulse width is variable from 0.5 to 5 ns. The maximum amplitude is 5V.

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

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

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

The output is designed to drive 50 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.

AVAILABLE OPTIONS

The AVN-W1-C-P-QTKA is available with several options:

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

-M Option: a monitor output is provided.

SPECIFICATIONS

Model:	AVN-W1-C-P-QTKA ¹
Maximum amplitude ² : (50Ω load required ⁶)	5V
Pulse width (FWHM):	0.5 - 5 ns ⁵
PRF:	5 - 50 MHz
Rise time (20%-80%):	200 ps
Fall time (20%-80%):	300 ps
Polarity ³ :	Positive or negative or both (specify)
Propagation delay:	≤ 5 ns (Ext trig in to pulse out)
Jitter:	± 15 ps (Ext trig in to pulse out)
DC offset ⁴ :	Apply required DC offset to back panel solder terminals (± 50 Volts, 250 mA max)
Trigger required:	External trigger mode: ECL-logic-level (LOW = -1.6V, HIGH = -0.8V) square wave with 50% duty cycle. The trigger input is terminated by 50 Ohms to -2V internally.
Sync output:	400 mV square wave, AC-coupled. Must be terminated with 50 Ohms to ground.
Monitor output:	Provides a 20 dB attenuated coincident replica of main output
Connectors:	Out, Monitor: SMA Trig, Sync: BNC
Power requirements:	100 - 240 Volts, 50 - 60 Hz
Dimensions:	(H x W x D) 100 x 430 x 375 mm (3.9" x 17" x 14.8")
Chassis material:	Anodized aluminum, with blue plastic trim.
Temperature range:	+5°C to +40°C

- 1) -C suffix indicates stand-alone lab instrument with internal clock and line powering. (See <http://www.avtechpulse.com/formats> for details of the basic instrument formats).
- 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) Indicate desired polarity by suffixing the model number with -P or -N (i.e. positive or negative) or -P-PN or -N-PN for dual polarity option where the suffix preceding -PN indicates the polarity at the mainframe output port.
- 4) For internally generated DC offset option (0 to ±5 V, one-turn control) add suffix -OT to the model number.
- 5) For the AVN-W1-C-P-QTKA, the minimum PW increases to 2 ns if the PRF is < 10 MHz and the amplitude is > 15V. Maximum PW decreases to 3 ns if the PRF is > 40 MHz.
- 6) 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.

EUROPEAN REGULATORY NOTES

EC DECLARATION OF CONFORMITY

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

EN 50081-1 Emission

EN 50082-1 Immunity

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

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



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.

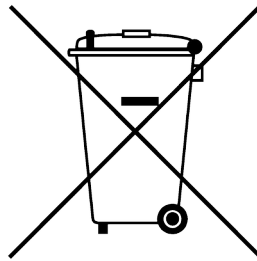
DIRECTIVE 2002/96/EC (WEEE)

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, and handles. Confirm that a power cord is with the instrument. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

POWER RATINGS


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

The maximum power consumption is 74 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 (http://www.qualtekusa.com)	319004-T01
United Kingdom	BS 1363, 230V, 50Hz	Qualtek (http://www.qualtekusa.com)	370001-E01
Switzerland	SEV 1011, 2 30V, 50Hz	Volex (http://www.volex.com)	2102H-C3-10
Israel	SI 32, 220V, 50Hz	Volex (http://www.volex.com)	2115H-C3-10
North America, and all other areas	NEMA 5-15, 120V, 60 Hz	Qualtek (http://www.qualtekusa.com)	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 ± 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

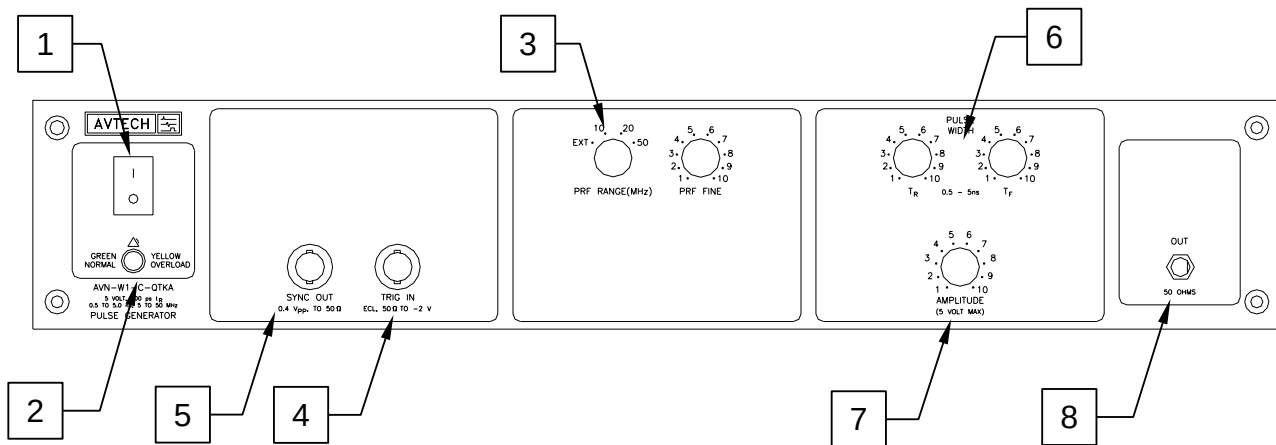
The following table lists the required fuses:

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	1.6A, 250V, Time-Delay	5×20 mm	021801.6HXP	F2424-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. 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 2:1 range, approximately. The vernier dial beside the switch varies the PRF within the set range.

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

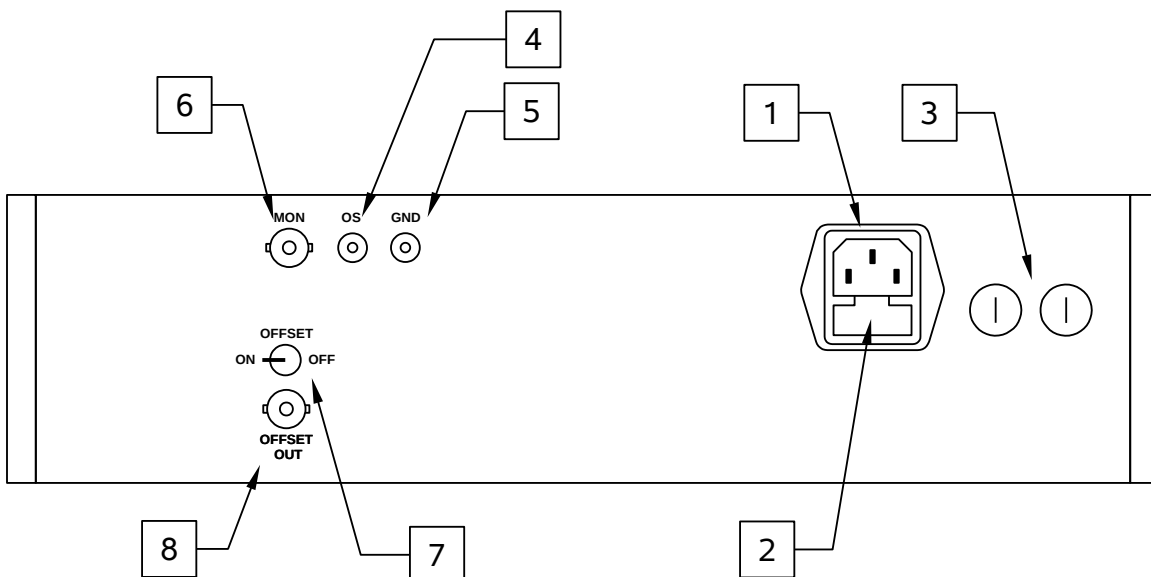
- 4) TRIG Connector. When the PRF Range Switch is set to “EXT”, the instrument is triggered by an ECL-level (LOW = -1.6V, HIGH = -0.8V) square wave (50% duty cycle) applied to this connector. This input is terminated internally with 50 Ohms to -2V.

- 5) SYNC Connector. This output may be used to trigger oscilloscopes or other equipment. It is active in both the internal and external trigger modes. This output provides an AC-coupled 400 mV (peak-to-peak) square wave with the same pulse repetition frequency as the main output.
- 6) Pulse Width Control. These two one-turn controls vary the output pulse width and pulse shape. TR controls the leading edge of the pulse while TF controls the falling edge. Clockwise rotation of TR and TF increases the output pulse width. See the “General Operating Notes” section for more details.
- 7) Amplitude Control. This dial controls the amplitude.
- 8) OUT Connector. This SMA connector provides the main output to a 50 Ohm load.

Optional controls (not shown in the diagram):

OFFSET Control. (Present units with the -OT option only.) This controls the DC offset added to the output, in the range of -5V to +5V. The rear-panel OT On/Off switch must be in the “On” position for this function to be enabled.

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. (For units without the -OT option.) 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.

When using an inverting transformer on the output, the DC offset should be applied to the transformer's offset input, and not this connector.

5. GND CONNECTOR. (For units without the -OT option.) This solder terminal is connected to ground. It may be used to ground the OS input connector.
6. M OUTPUT CONNECTOR. This SMA connector output provides a 20 dB attenuated coincident replica of main output, for monitoring purposes.

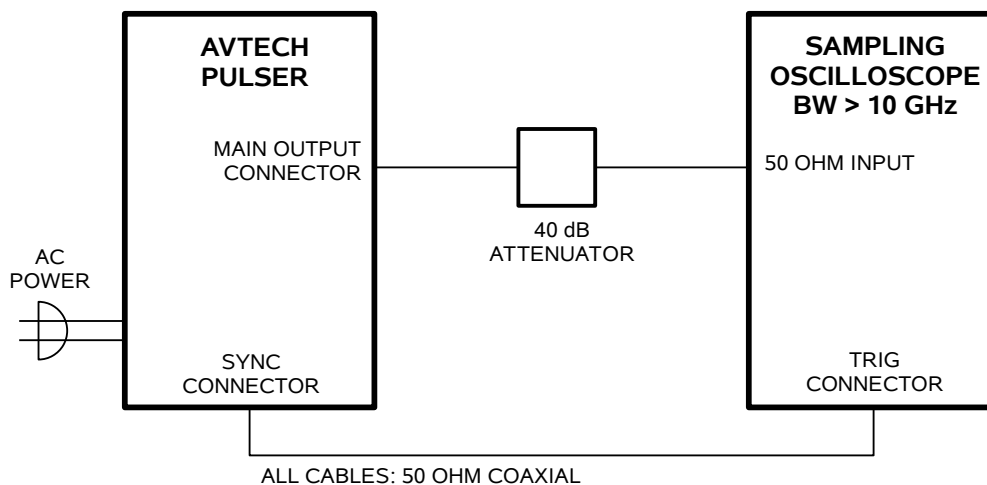
7. OT ON/OFF SWITCH. (Present on units with -OT option only.) This switch enables or disables the front-panel offset dial and the associated internal offset generation circuitry.
8. OT OUT CONNECTOR. (Present on units with -OT option only.) This BNC connector provides access to the internally-generated DC offset voltage when the OT ON/OFF switch is set to "ON".

To add an internally-generated offset to inverted pulses on AVN units with the dual polarity option (-PN), connect the "OFFSET OUT" BNC terminal to the DC terminal of the AVX-2-T inverting transformer (see the "POLARITY INVERSION" sections in this manual for further details).

GENERAL INFORMATION

BASIC TEST ARRANGEMENT

The AVN-W1-C-P-QTKA should be tested with a sampling oscilloscope with a bandwidth of at least 10 GHz to properly observe the high-speed waveform. A typical test arrangement is shown below:

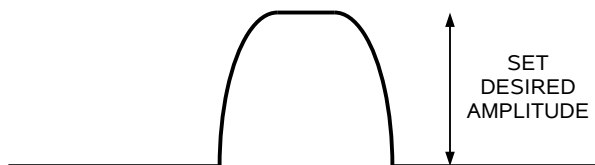


The attenuators are required to prevent damage to the sampling oscilloscope. A 40 dB attenuator with sufficient voltage rating should be used on the main output.

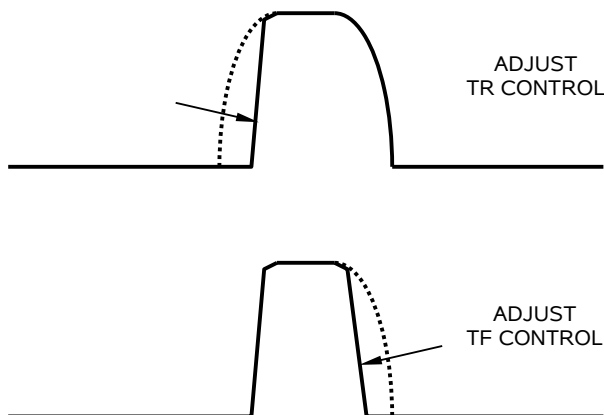
The SYNC output provides a 400 mV square wave (to 50 Ohms), and should be used to trigger the oscilloscope.

CONTROLLING THE PULSE SHAPE

The output pulse shape is determined by the two front panel controls TR and TF. TR controls the leading edge of the pulse while TF controls the falling edge. Clockwise rotation of TR and TF increases the output pulse width. Initially rotate the TF pot fully clockwise and set the TR pot at mid-range. The output amplitude is controlled by the front panel AMP control and by the input signal level. Initially the AMP control should be set mid-range. The oscilloscope display will resemble the following:



Having obtained a display of the form shown above, the desired pulse width is then obtained by adjusting the two front panel pots TR and TF. Rotate TR counter clockwise from the position set earlier until a sharp 100 ps leading edge is observed. Then rotate TF counterclockwise until the desired pulse width and fall time are obtained.



Further iterative adjustments of TR and TF will be necessary to simultaneously obtain the lowest rise time, lowest fall time, the desired pulse width, and pulse top shape, and low spurious signal level. In addition some additional adjustment of signal level may be necessary to obtain the desired amplitude. If the input frequency is then changed it will be necessary to readjust AMP, TR and TF to establish the required pulse shape.

To trigger externally, set the PRF Range Switch to "EXT". In this mode, the instrument is triggered by an ECL-level (LOW = -1.6V, HIGH = -0.8V) square wave (50% duty cycle) applied to the TRIG input connector. This input is terminated internally with 50 Ohms to -2V.

AMPLITUDE INTERACTION

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

POLARITY INVERSION

Instruments with the "-P-PN" suffix generate 0 to +5V at the main output, and are supplied with an AVX-2 inverting transformer that can be installed on the mainframe output. A negative pulse is then obtained at the out port of the AVX-2 module.

Instruments with the "-N-PN" suffix generate 0 to -5V at the main output, and are supplied with an AVX-2 inverting transformer that can be installed on the mainframe output. A positive pulse is then obtained at the out port of the AVX-2 module.

When using the transformer with dual-polarity models, the external offset must be added to the DC terminal of the inverting transformer. Do not apply the offset to the rear-panel offset terminal on the mainframe. For units with the OT or EO options, connect a lead from the rear panel OS OUT connector to the DC terminal of the AVX-2-T unit. The DC offset at the output of the AVX-2-T unit is then controlled by the front-panel offset control.

OPERATION AT LOW AMPLITUDES

This instrument will generate the best waveforms when operated near maximum amplitude. If amplitudes less than 1/3 of the full-scale value are desired, better results will be obtained if the pulse generator is operated at a higher amplitude, and an attenuator is connected to the output. Avtech recommends the ATT-0527-XX-SMA-07 series of 12 GHz 20 Watt coaxial attenuators from Midwest Microwave, <http://www.midwestmicrowave.com/>. (The "XX" in the part number is replaced with the numeric attenuation value in dB).

OSCILLOSCOPE SELECTION AND BANDWIDTH ISSUES

To observe a signal with a rise time of t_R , the bandwidth of the oscilloscope must exceed $1/t_R$. For the AVN-W1-C-P-QTKA, $1/t_R = 1 / 200 \text{ ps} = 5 \text{ GHz}$. For best results, the bandwidth of the oscilloscope (and any attenuators and cables used in the measurement system) should exceed 10 GHz.

Most oscilloscopes with suitable bandwidth are "sampling" oscilloscopes, which are more specialized in nature than slower conventional "real-time" oscilloscopes. Most sampling oscilloscopes have a very limited input voltage range ($\pm 1\text{V}$, for example). It is essential in these cases to use high-bandwidth attenuators on the input of the oscilloscope, to avoid over-driving or damaging the oscilloscope.

If a high-bandwidth sampling oscilloscope is not available, a slower real-time oscilloscope can be used, but the rising and falling edges will not be accurately displayed. Significant overshoot and ringing will be observed as a result of the oscilloscope's limited bandwidth. (Contrary to some user's expectations, low-bandwidth oscilloscopes do not "round off" the signal like a classic low-pass filter.) These are measurement artifacts, and are not normally present on the actual output.

MINIMIZING WAVEFORM DISTORTIONS

USE 50 OHM TRANSMISSION LINES AND LOADS

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

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

USE LOW-INDUCTANCE LOADS

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

PREVENTING DAMAGE

The AVN-W1-C-P-QTKA may fail if triggered at a PRF greater than 50 MHz, or less than 5 MHz.

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

The lifetime of the switching elements in the pulse generator module is proportional to the running time of the instrument. For this reason the prime power to the instrument should be turned off when the instrument is not in use.

The instrument contains thermal sensors to detect overheating of the output stage. If the output stage becomes too hot, an alarm will sound and the output triggering will stop until the temperature has decreased sufficiently. If the alarm is sounded, the user should turn off the instrument for 10 minutes to allow it to cool thoroughly.

OPTIONS

The AVN-W1-C-P-QTKA is available with these options:

-OT OPTION

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

-M OPTION


This option provides a monitor output, which is an attenuated replica of the main output. The monitor is connected to the main output through a 470 Ohm resistor, which results in an attenuation of approximately 20 dB (i.e., $\div 10$) when the monitor output is terminated with a 50 Ohm load.

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


MECHANICAL INFORMATION

TOP COVER REMOVAL

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

 Always disconnect the power cord 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.

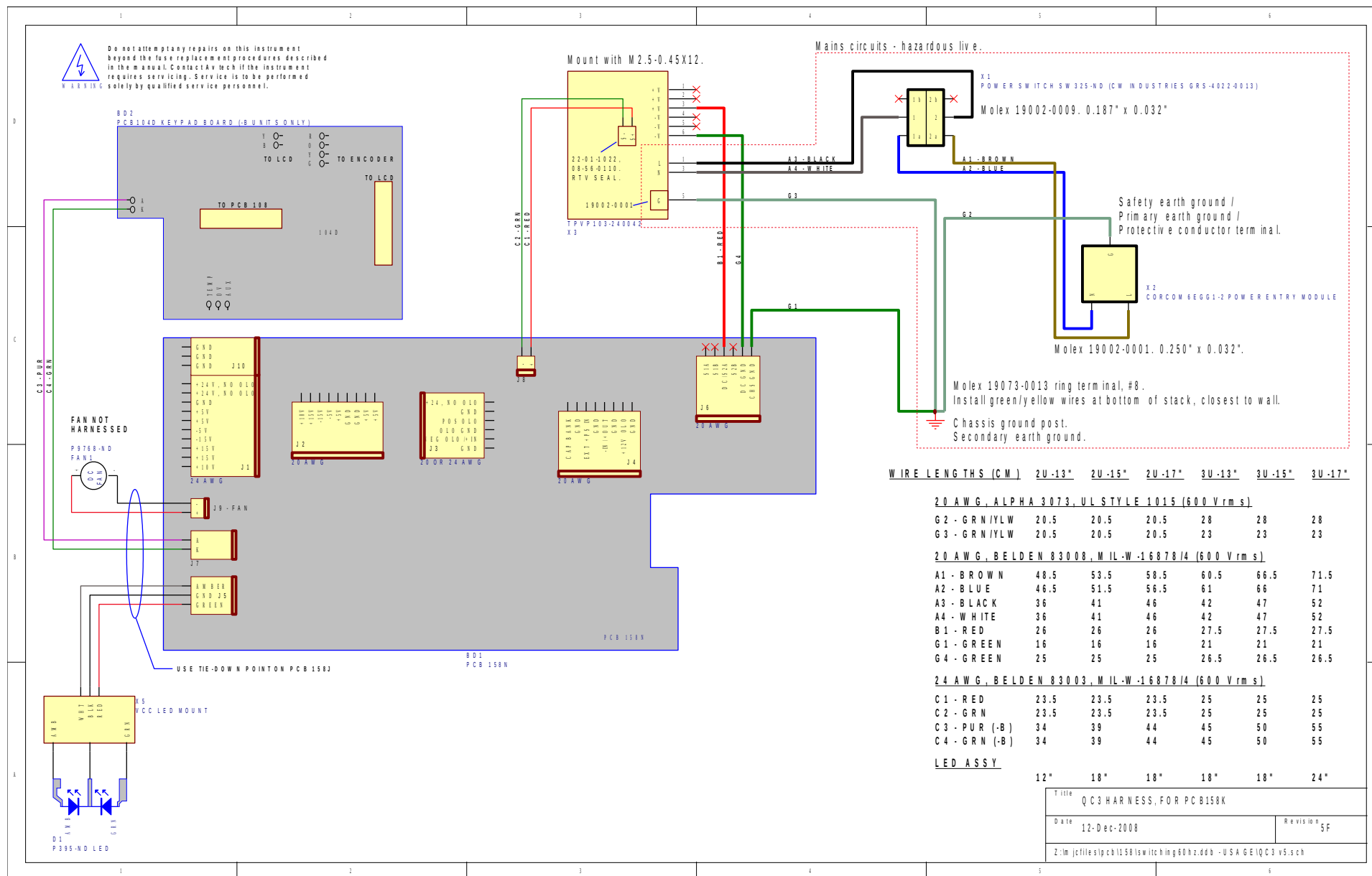
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

CLEANING

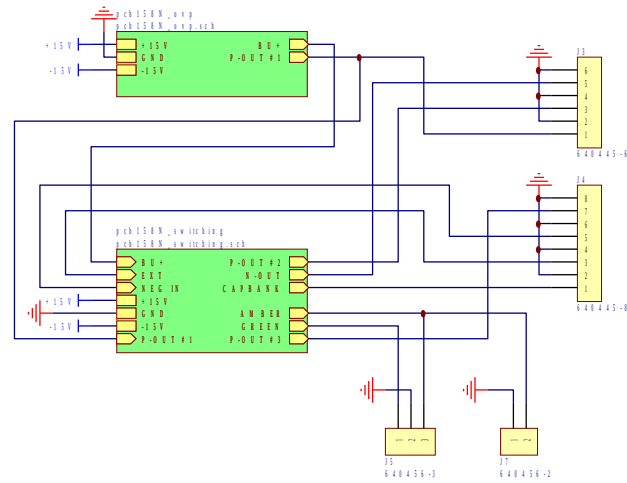
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

WIRING DIAGRAMS

WIRING OF AC POWER

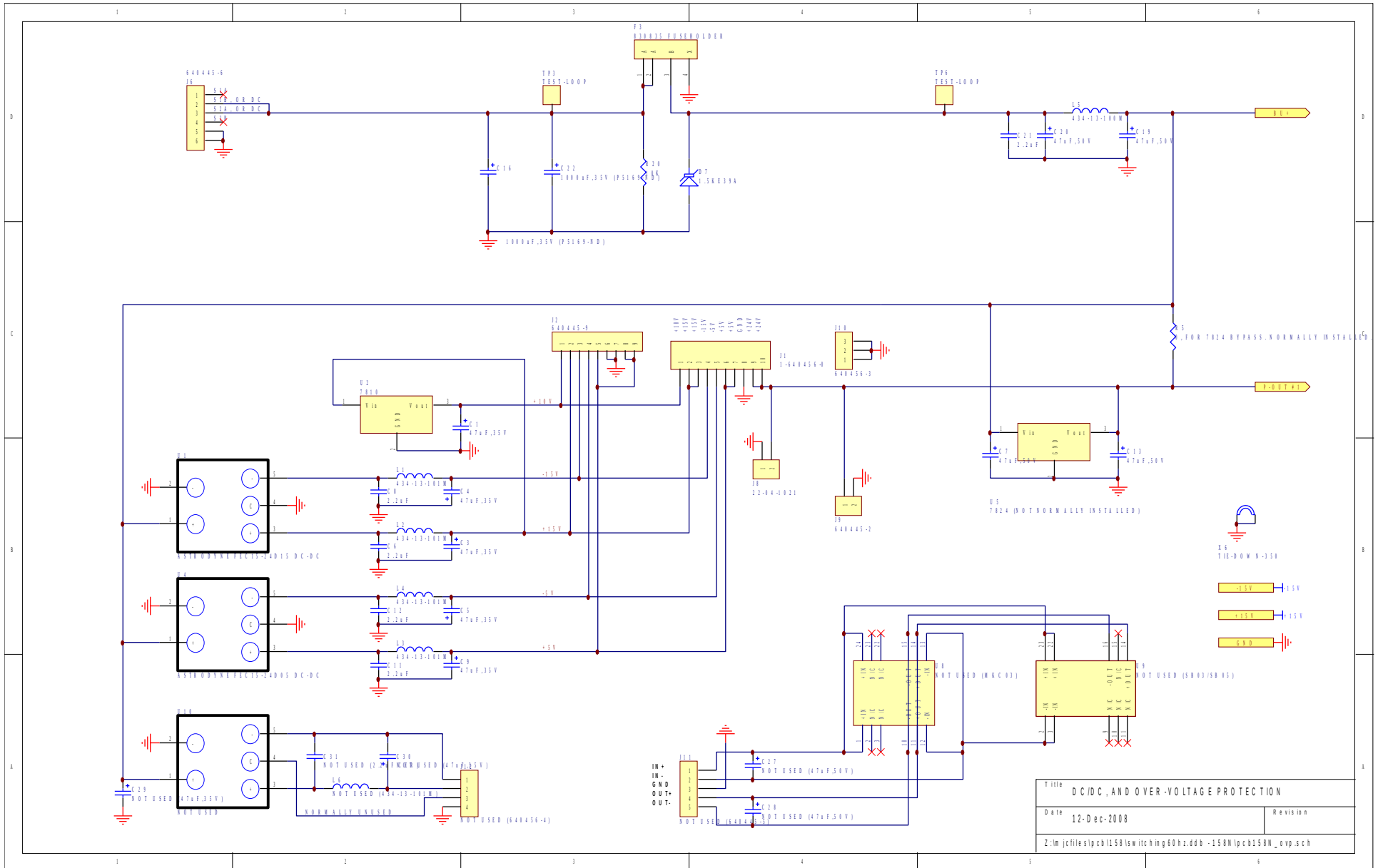


PCB 158N - LOW VOLTAGE POWER SUPPLY, 1/3

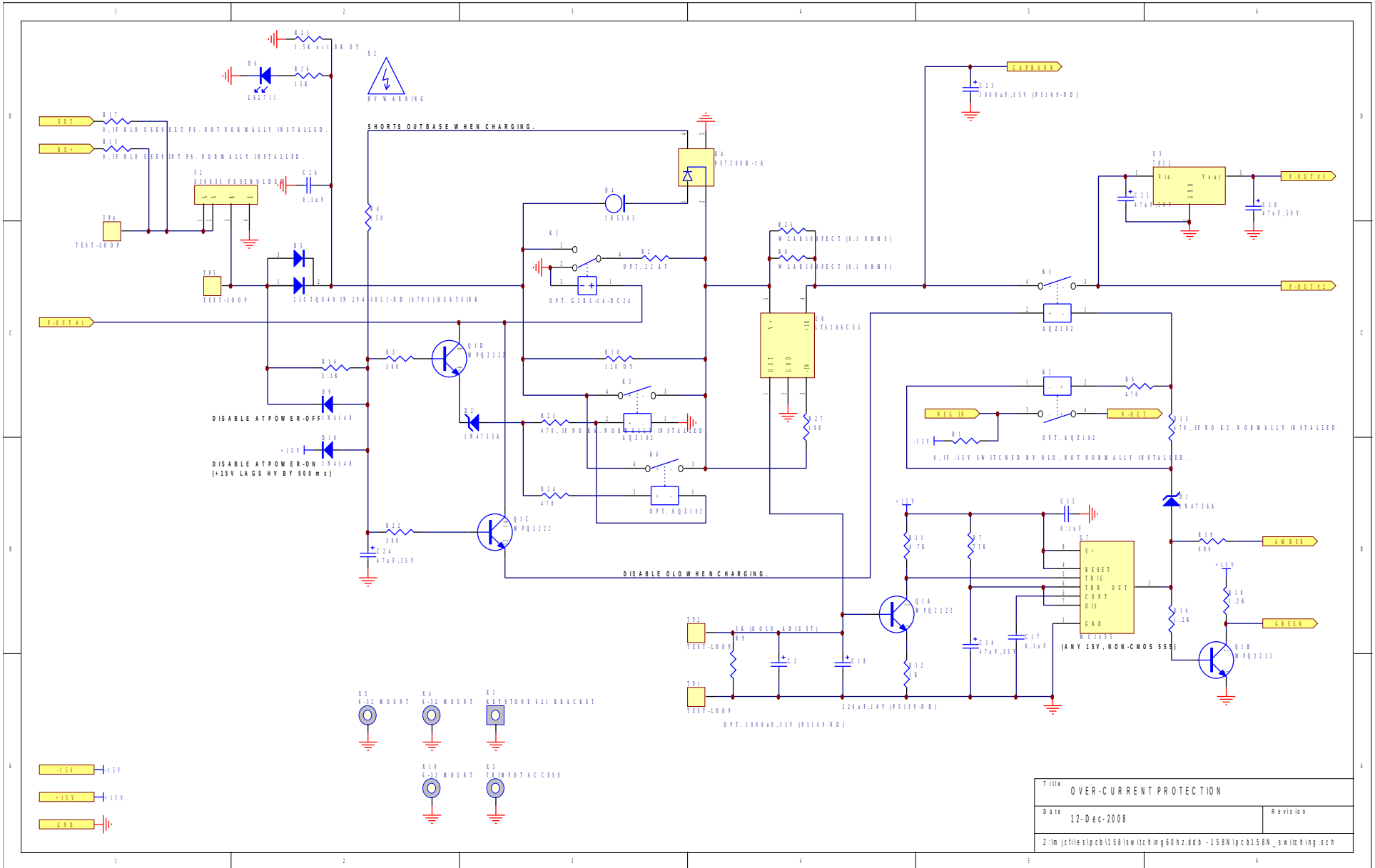


Title		LOW VOLTAGE DC/DC POWER SUPPLY
Date	12-Dec-2008	Revision
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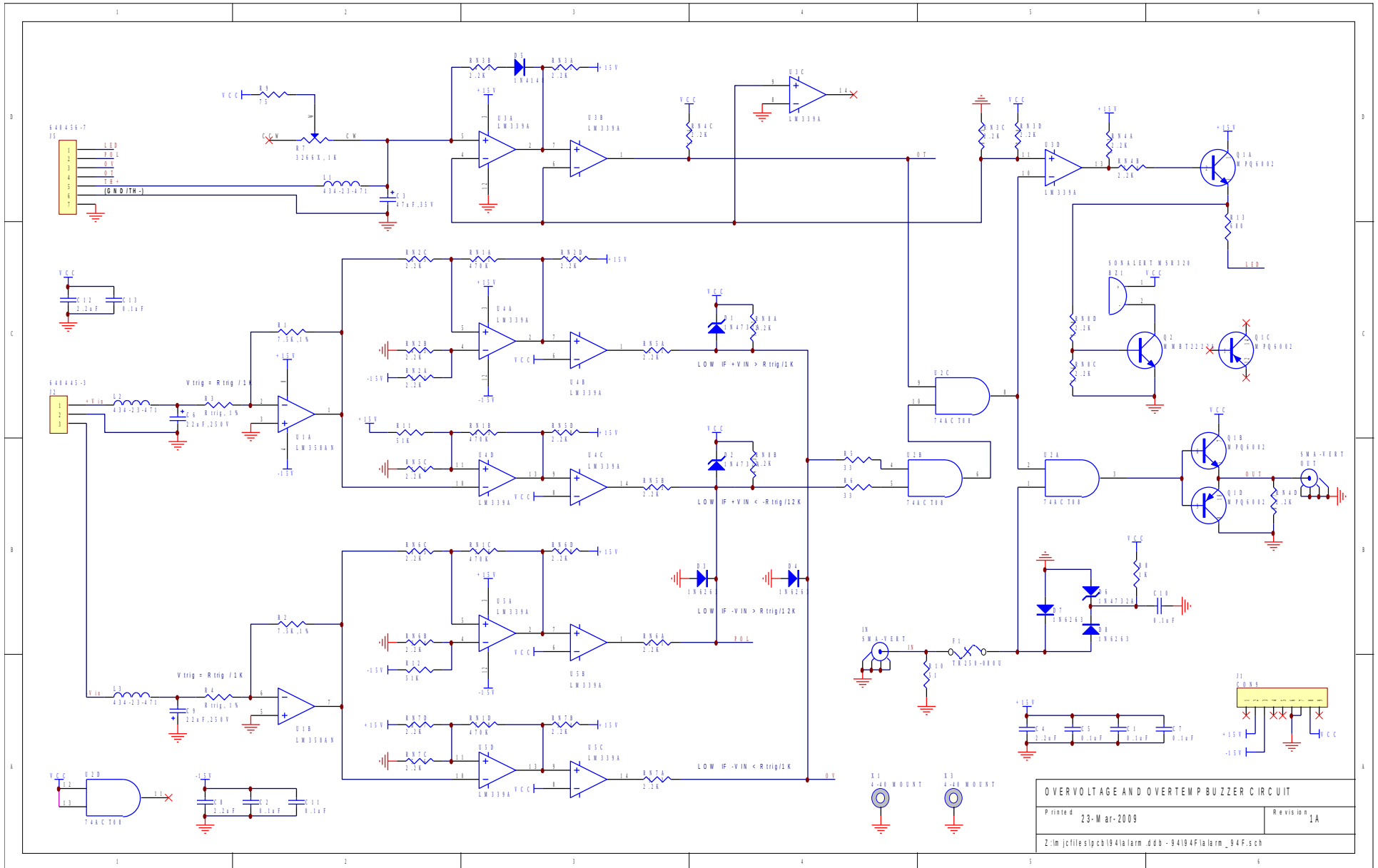
PCB 158N - LOW VOLTAGE POWER SUPPLY, 2/3



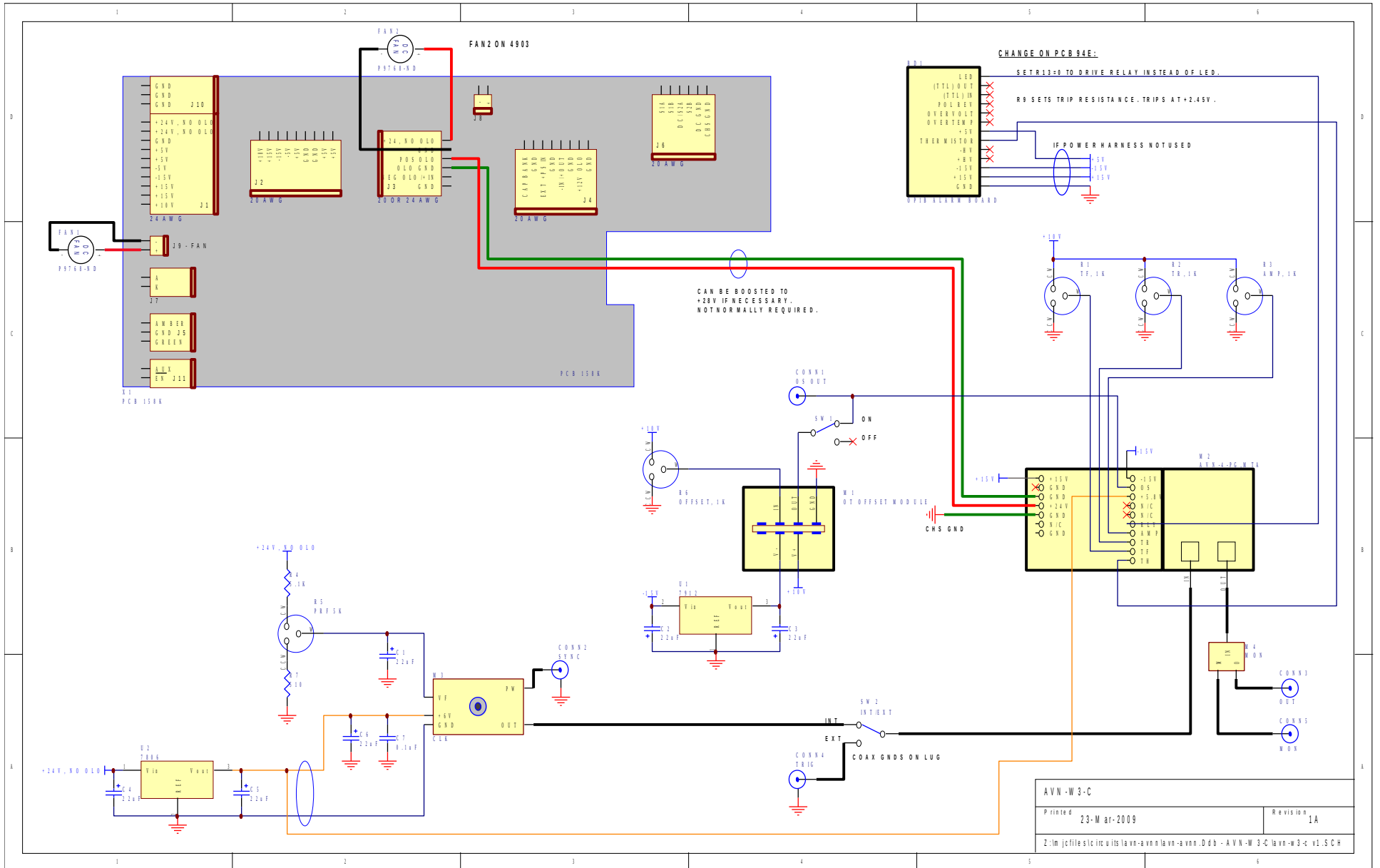
PCB 158N - LOW VOLTAGE POWER SUPPLY, 3/3



PCB 94F - ALARM BOARD



MAIN WIRING



PERFORMANCE CHECK SHEET