AVTECH ELECTROSYSTEMS LTD.
NANOSECOND WAVEFORM ELECTRONICS
SINCE 1975

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BOX 5120, LCD MERIVALE
OTTAWA, CANADA K2C3H5

INSTRUCTIONS

MODEL AVR-D3-B

UP TO ±250 VOLTS, ±5 AMP

BIPOLAR TRANSISTOR

SEMICONDUCTOR TEST PULSER

WITH IEEE 488.2 / RS-232 / ETHERNET CONTROL

SERIAL NUMBER: 14117

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 dissembled, 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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TABLE OF CONTENTS

WARRANTY.....2
TECHNICAL SUPPORT.....2
TABLE OF CONTENTS.....3
INTRODUCTION.....5
SPECIFICATIONS.....7
REGULATORY NOTES.....9
FCC PART 18.....9
EC DECLARATION OF CONFORMITY.....9
DIRECTIVE 2011/65/EU (RoHS).....10
DIRECTIVE 2002/96/EC (WEEE).....10
FIRMWARE LICENSING.....11
INSTALLATION.....12
VISUAL CHECK.....12
POWER RATINGS.....12
CONNECTION TO THE POWER SUPPLY.....12
PROTECTION FROM ELECTRIC SHOCK.....13
ENVIRONMENTAL CONDITIONS.....14
LABVIEW DRIVERS.....14
FUSES.....15
AC FUSE REPLACEMENT.....15
DC FUSE REPLACEMENT.....16
FUSE RATINGS.....16
FRONT PANEL CONTROLS.....17
REAR PANEL CONTROLS.....19
GENERAL INFORMATION.....21
BASIC PULSE CONTROL.....21
TRIGGER MODES.....22
GATING MODES.....23
MINIMIZING WAVEFORM DISTORTIONS.....24
USE 50 OHM TRANSMISSION LINES.....24
USE LOW-INDUCTANCE LOADS.....24
TYPICAL USAGE AND WAVEFORMS.....25

TURN-ON TEST **25**
TURN-OFF TEST **26**
IMPEDANCE NOTES **28**
TRANSITION TIME NOTES **28**
PROGRAMMING YOUR PULSE GENERATOR ***29***
KEY PROGRAMMING COMMANDS **29**
ALL PROGRAMMING COMMANDS **30**
OTHER INFORMATION ***32***
APPLICATION NOTES **32**
MANUAL FEEDBACK **32**
MECHANICAL INFORMATION ***33***
TOP COVER REMOVAL **33**
RACK MOUNTING **33**
ELECTROMAGNETIC INTERFERENCE **33**
MAINTENANCE ***34***
REGULAR MAINTENANCE **34**
CLEANING **34**
WIRING DIAGRAMS ***35***
WIRING OF AC POWER **35**
PCB 158R5 - LOW VOLTAGE POWER SUPPLY **36**
PCB 168C - HIGH-VOLTAGE POWER SUPPLY **37**
PCB 228C - NEGATIVE UV CONTROL PCB **38**
PCB 241C - DUAL PW PCB **39**
PCB 335A - DUAL TRIGGER ENCODER **40**
PCB 104G - KEYPAD / DISPLAY BOARD **41**
MAIN WIRING **42**
PERFORMANCE CHECK SHEET ***43***

Manual Reference: /fileserver1/officefiles/instructword/avr-d3/AVR-D3-B,ed2.odt.
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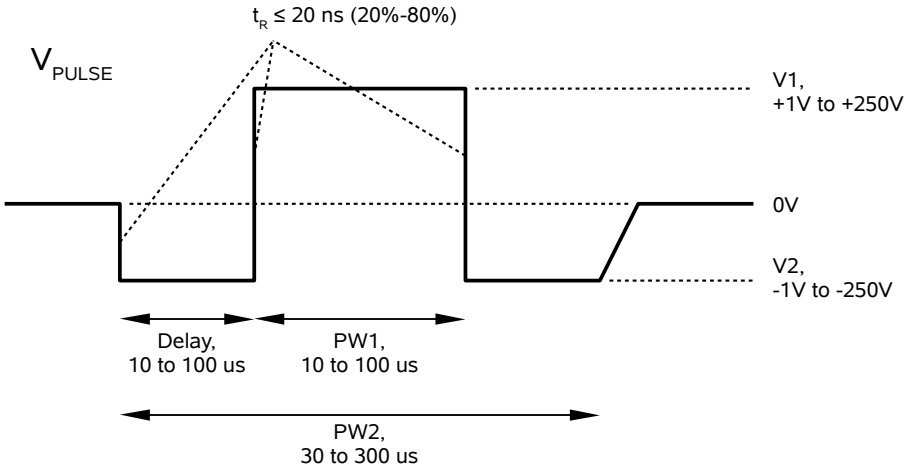
INTRODUCTION

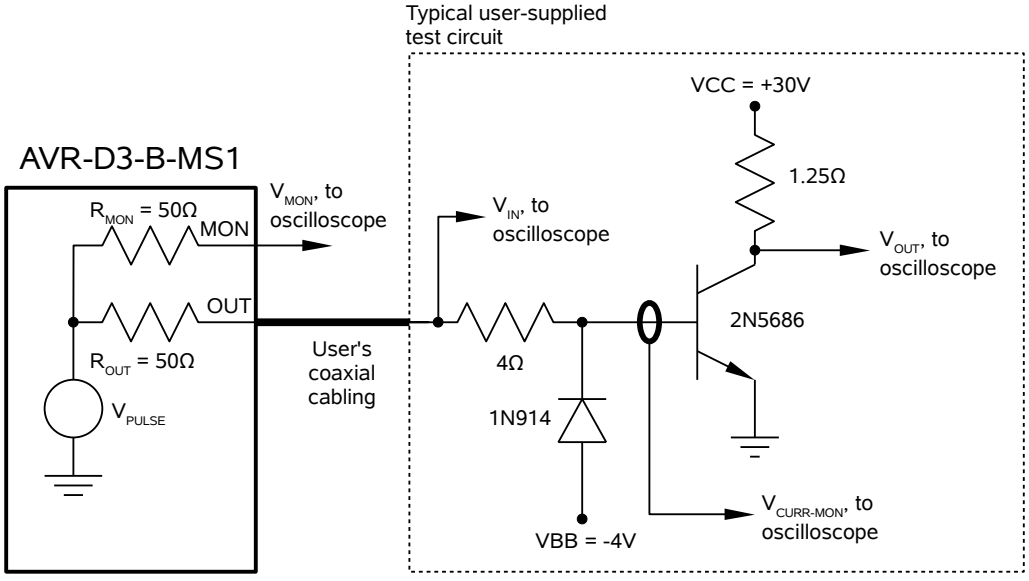
The AVR-D3-B is a high performance, GPIB and RS232-equipped instrument capable of generating the bipolar waveform shown below:



In the waveform shown above, a wide negative pulse (with pulse width PW2 and amplitude -V2) is interrupted by a shorter positive pulse (PW1, +V1). The three highlighted transition have switching times of 20 ns or less. (The final transition to ground is slower).

This waveform allows both turn-on and turn-off transitions to be tested, without biasing the devices with thermally-troublesome DC currents.

The main output is normally connected to a user-supplied test circuit, similar to that shown below:



A 50 Ohm output impedance exists between the internal pulse generator circuit and the output connector on the front panel of the instrument.

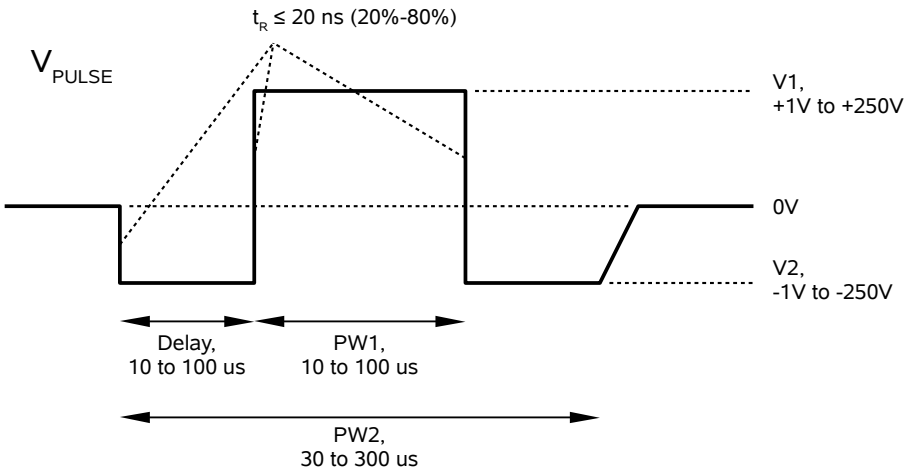
A monitor output (“MON”) is provided as well, for monitoring the internal pulse waveform. It can be used to sense the voltage drop across the main output resistance, thus providing a measure of the actual output current. However, the user of a dedicated current transformer or current probe is normally recommended for current sensing.

The AVR-D3-B features front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40-character backlit 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.

The instrument is protected against overload conditions (such as short circuits) by an automatic control circuit. An internal power supply monitor removes the power to the output stage for five seconds if an average power overload exists. After that time, the unit operates normally for one second, and if the overload condition persists, the power is cut again. This cycle repeats until the overload is removed.

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

SPECIFICATIONS



Model[1]:	AVR-D3-B
V1 amplitude:	+1V to +250V
V2 amplitude:	-1V to -250V
PW1 pulse width:	10 to 100 us
PW2 pulse width:	30 to 300 us
Output impedance (R_{OUT}):	50 Ohms
Maximum output current:	±250V / R_{OUT} = ±5 Amps
Maximum power dissipated internally, in R_{OUT}:	$(5A)^2 \times 50\Omega \times 300$ us × 10 Hz = 3.75 W
Switching time (t_R):	≤ 20 ns (20%-80%), as measured at the "MON" connector. The switching times at the "OUT" connector may be slower due to the effective of R_{OUT} and and the cabling / circuit capacitance (C_{LOAD}). The time constant of any degradation will be given by $\tau = R_{OUT} \times C_{LOAD}$. This switching time ($t_R$) applies to the three transitions noted in the waveform above. The fourth transition will be much slower.
Pulse repetition frequency	1 Hz to 10 Hz, adjustable, or single-shot.
Supplied test jigs:	None (user-supplied)
Propagation delay:	≤ 150 ns (Ext trig in to pulse out)
Jitter:	± 100 ps ± 0.03% of sync delay (Ext trig in to pulse out)
Trigger required:	External trigger mode: TTL, 50 ns or wider
Sync delay:	Variable 0 to ± 1 second (sync out to pulse out)
Sync output:	+3 Volts, 100 ns, will drive 50 Ohm loads
Gated operation:	Active high or low, switchable.
Connectors:	Out, Trig, Sync, Gate: BNC
GPIB & RS-232 control[1]:	Standard feature on all -B units.
LabView drivers:	Available for download at http://www.avtechpulse.com/labview.
Ethernet port, for remote	Included. Recommended as a modern alternative to GPIB / RS-232.

control using VXI-11.3, ssh, telnet, & web:	See http://www.avtechpulse.com/options/vxi for details.
Settings resolution:	The resolution of the timing parameters varies, but is always better than 0.15% of the set value. The amplitude resolution is typically 0.02% of the maximum amplitude.
Settings accuracy:	Typically ± 3% (plus ±1V or ± 2 ns) after 10 minute warmup. For high-accuracy applications requiring traceable calibration, verify the output parameters with a calibrated oscilloscope[2].
Power requirements:	100 - 240 Volts, 50 - 60 Hz
Dimensions:	100 mm x 430 mm x 375 mm (3.9" x 17" x 14.8")
Chassis material:	Cast aluminum frame and handles, blue vinyl on aluminum cover plates
Mounting:	Any. Add -R5 to the model number to add a rack-mount kit.
Temperature range:	+5°C to +40°C

1) -B suffix indicates IEEE-488.2 GPIB and RS-232 control of amplitude and frequency. See http://www.avtechpulse.com/gpib for details.
2) These instruments are provided with a basic calibration checksheet, showing a selection of measured output parameters. These measurements are performed with equipment that is calibrated on a regular basis by a third-party ISO/IEC 17025:2005 accredited calibration laboratory. However, Avtech itself does not claim any accreditation. For applications requiring traceable performance, use a calibrated measurement system rather than relying on the accuracy of the pulse generator settings.

REGULATORY NOTES

FCC PART 18

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

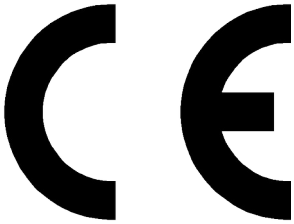
This instrument is enclosed in a rugged metal chassis and uses a filtered power entry module (where applicable). The main output signal is provided on a shielded connector that is intended to be used with shielded coaxial cabling and a shielded load. Under these conditions, the interference potential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



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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 2006/95/EC. 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 2011/65/EU (RoHS)

We Avtech Electrosystems Ltd.
P.O. Box 5120, LCD Merivale
Ottawa, Ontario
Canada K2C 3H5

declare that, to the best of our knowledge, all electrical and electronic equipment (EEE) sold by the company are in compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (also known as “RoHS Recast”). In addition, this declaration of conformity is issued under the sole responsibility of Avtech Electrosystems Ltd. Specifically, products manufactured do not contain the substances listed in the table below in concentrations greater than the listed maximum value.

Material/Substance	*Threshold level*
Lead (Pb)	< 1000 ppm (0.1% by mass)
Mercury (Hg)	< 1000 ppm (0.1% by mass)
Hexavalent Chromium (Cr6+)	< 1000 ppm (0.1% by mass)
Polybrominated Biphenyls (PBB)	< 1000 ppm (0.1% by mass)
Polybrominated Diphenyl ethers (PBDE)	< 1000 ppm (0.1% by mass)
Cadmium (Cd)	< 100 ppm (0.01% by mass)
Bis(2-ethylhexyl) phthalate (DEHP)	< 1000 ppm (0.1% by mass)
Butyl benzyl phthalate (BBP)	< 1000 ppm (0.1% by mass)
Dibutyl phthalate (DBP)	< 1000 ppm (0.1% by mass)
Diisobutyl phthalate (DIBP)	< 1000 ppm (0.1% by mass)

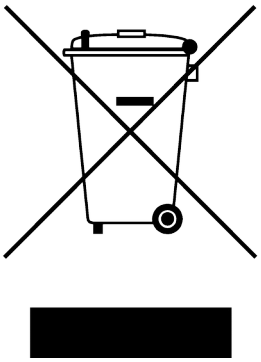
DIRECTIVE 2002/96/EC (WEEE)

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 with 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.



FIRMWARE LICENSING

Instruments with firmware versions 5.00 or higher use open-source software internally. Some of this software requires that the source code be made available to the user as a condition of its licensing. This source code is available upon request (contact info@avtechpulse.com).

Earlier firmware versions do not contain any open source software.

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 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 / 2099-1, 220V, 50 Hz	-AC22	Qualtek	399012-01

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:

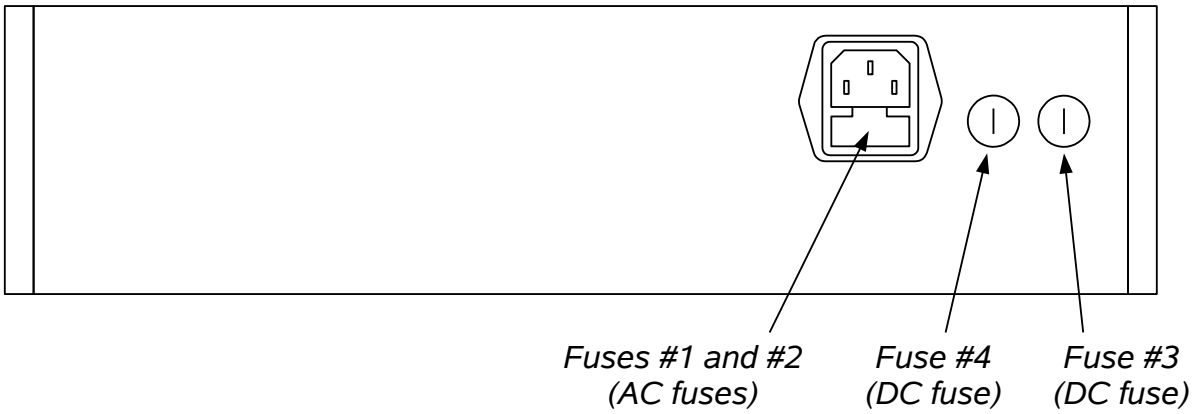
1. indoor use;
2. altitude up to 2 000 m;
3. temperature 5 °C to 40 °C;
4. maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
5. Mains supply voltage fluctuations up to ±10 % of the nominal voltage;
6. no pollution or only dry, non-conductive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

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/.

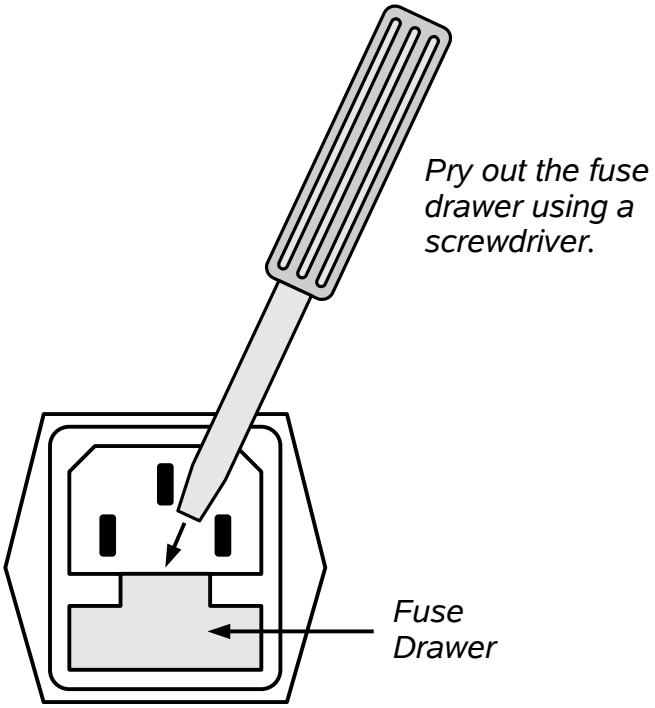
FUSES

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

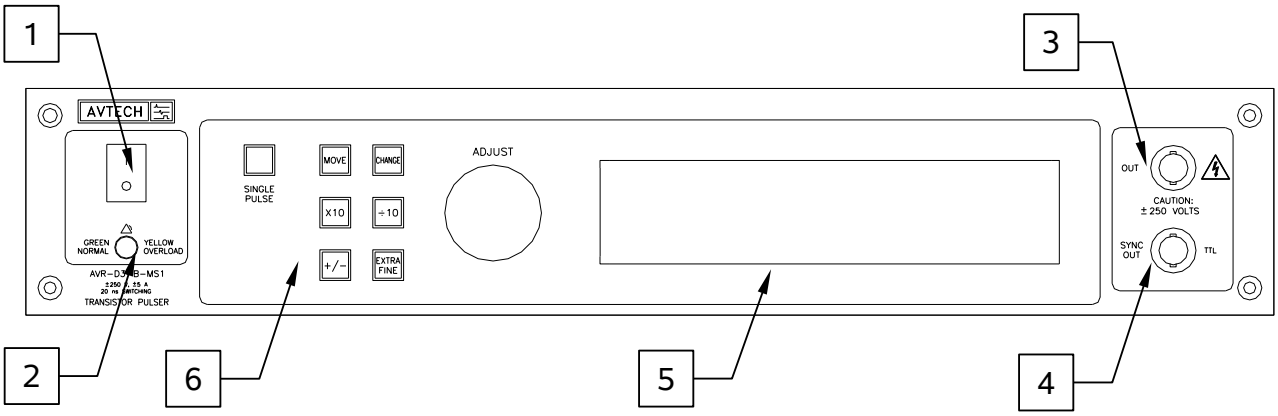
The following table lists the required fuses:

Fuses	Nominal Mains Voltage	Rating	Case Size	Recommended Replacement Part	
				Littelfuse Part Number	Digi-Key Stock Number
#1, #2 (AC)	100-240V	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND
#3 (DC)	N/A	1.0A, 250V, Time-Delay	5×20 mm	0218001.HXP	F2419-ND
#4 (DC)	N/A	1.6A, 250V, Time-Delay	5×20 mm	021801.6HXP	F2424-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 is normally a delay of 10 seconds before anything is shown on the main display, as the internal operating system boots up.

   If the main menu does not appear after 30 seconds, turn off the instrument and leave it off for at least 60 seconds before applying power again.

2. OVERLOAD Indicator. When the instrument is powered, this indicator is normally green, indicating normal operation. If this indicator is yellow, an internal automatic overload protection circuit has been tripped. If the unit is overloaded (by operating at an exceedingly high duty cycle or by operating into a very low impedance), the protective circuit will disable the output of the instrument and turn the indicator light yellow. The light will stay yellow (i.e. output disabled) for about 5 seconds after which the instrument will attempt to re-enable the output (i.e. light green) for about 1 second. If the overload condition persists, the output will be disabled again (i.e. light yellow) for another 5 seconds. If the overload condition has been removed, the instrument will resume normal operation.

   This overload indicator may flash yellow briefly at start-up. This is not a cause for concern.

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

3. OUT CONNECTOR. This BNC connector provides the main output signal, into load impedances of 0Ω or higher.

   ⚠ Caution: Voltages as high as ±250V 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.

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

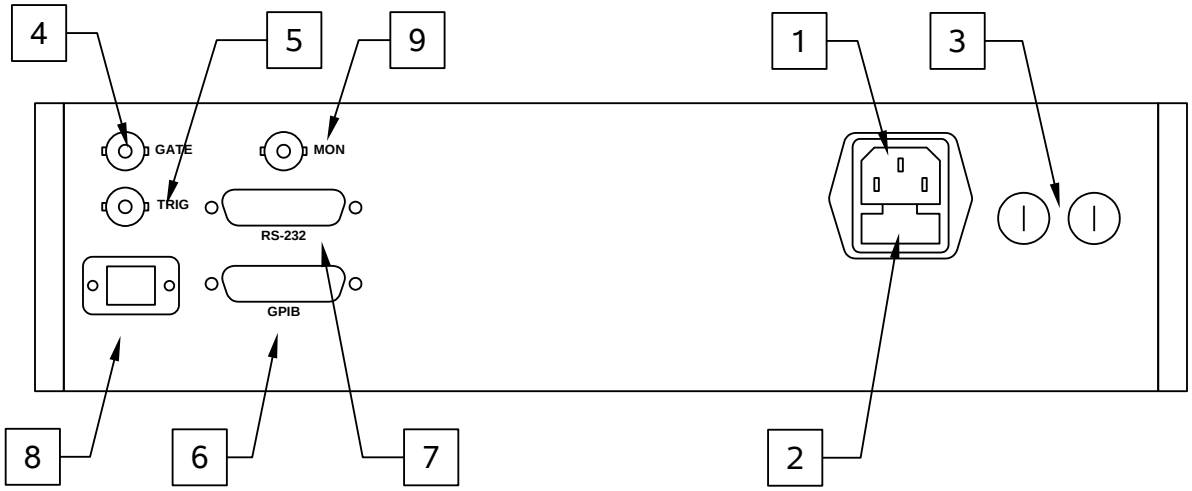
of +3 Volts to R_L > 50Ω with a pulse width of approximately 100 ns.

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



Note: some connectors may be in different positions than shown above, depending on the exact combination of options ordered.

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 kΩ resistor. When set to active low mode, this input is pulled-up to +5V by a 1 kΩ 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 kΩ. (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) 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. A user name (“admin”) and a password (“default”, as shipped from the factory) are required when logging into a serial terminal session. The internal controller attempts to auto-sense the parity setting. It may be necessary to send a few return characters before attempting a login in order to provide enough data to allow this auto-sensing to work. (A standard Linux “agetty” process is used to implement serial control internally.) See the “Programming Manual for -B Instruments” for more details on RS-232 control.

8. Network Connector. This Ethernet connector allows the instrument to be remotely controlled using the VXI-11.3, ssh (secure shell), telnet, and http (web) protocols. See the “Programming Manual for -B Instruments” for more details.

9. MON Connector. This output may be used to sense the voltage drop across the main output resistance, thus providing a measure of the actual output current. It is connected to the internal pulse generator (V_{PULSE}) through a 50Ω resistance. The MON output should operate into a load impedance of 50Ω or higher. If a 50Ω load is used, note that a 2:1 voltage divider effect will occur. If this output is not used, it should be covered with a metal BNC dust cap, to prevent interference with other equipment.

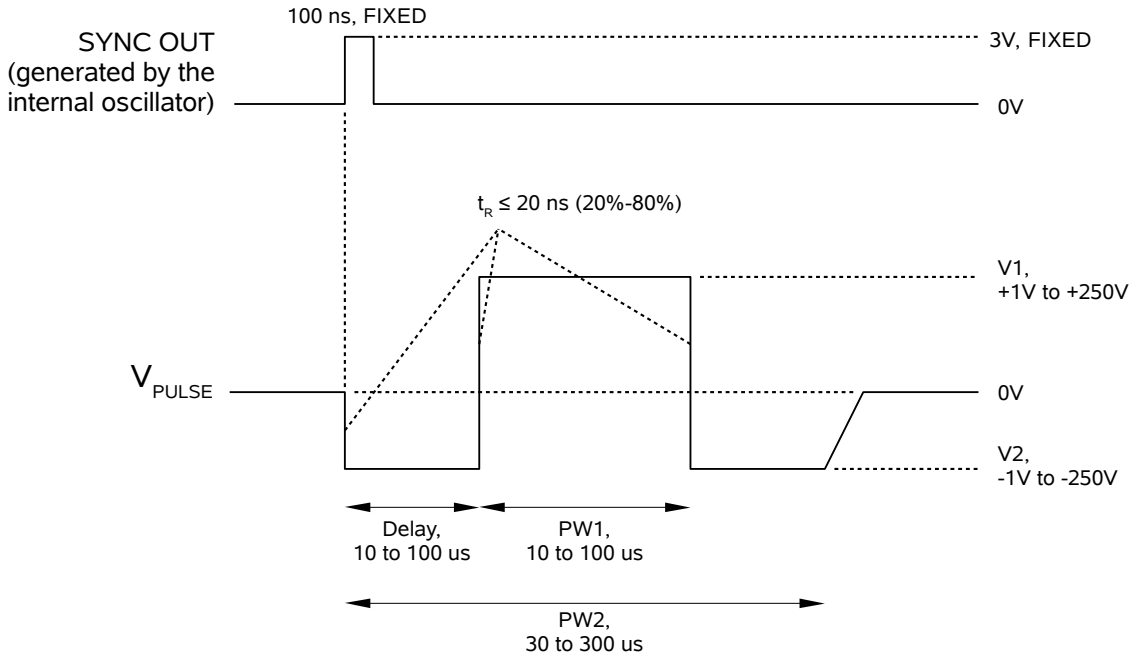
   ⚠ Caution: Voltages as high as ±250V may be present on the center conductor of this output connector. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

GENERAL INFORMATION

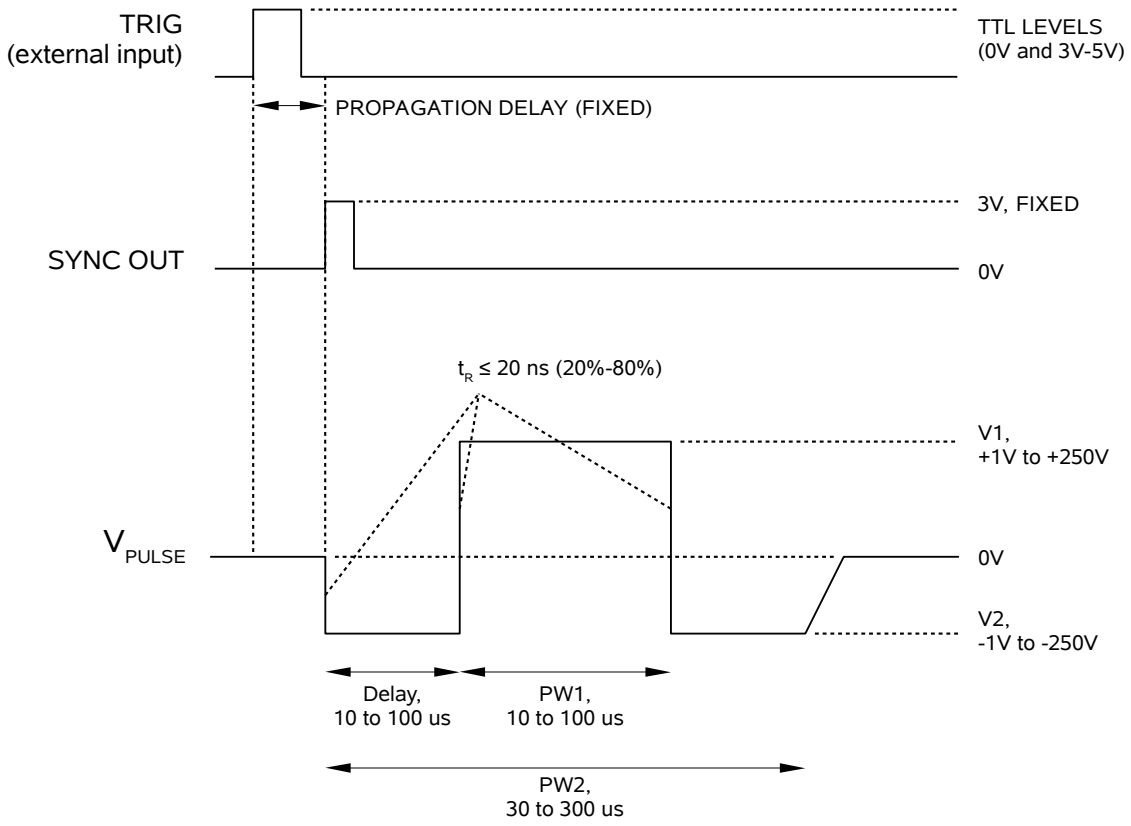
BASIC PULSE CONTROL

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. The OUT channel is the signal that is applied to the load. Its amplitude and pulse width are variable. The SYNC pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems. 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, with internal triggering:



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



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.)

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.

MINIMIZING WAVEFORM DISTORTIONS

USE 50 OHM TRANSMISSION LINES

Connect the load to the pulse generator with 50Ω transmission lines (e.g. RG-58 or RG-174 cable). If possible, use a 50Ω load. If the actual device under test has a high impedance, consider adding a 50Ω termination in parallel with the load to properly terminate the transmission line.

The 50Ω output impedance present in the AVR-D3-B will “back-match” the transmission line, resulting in improved performance.

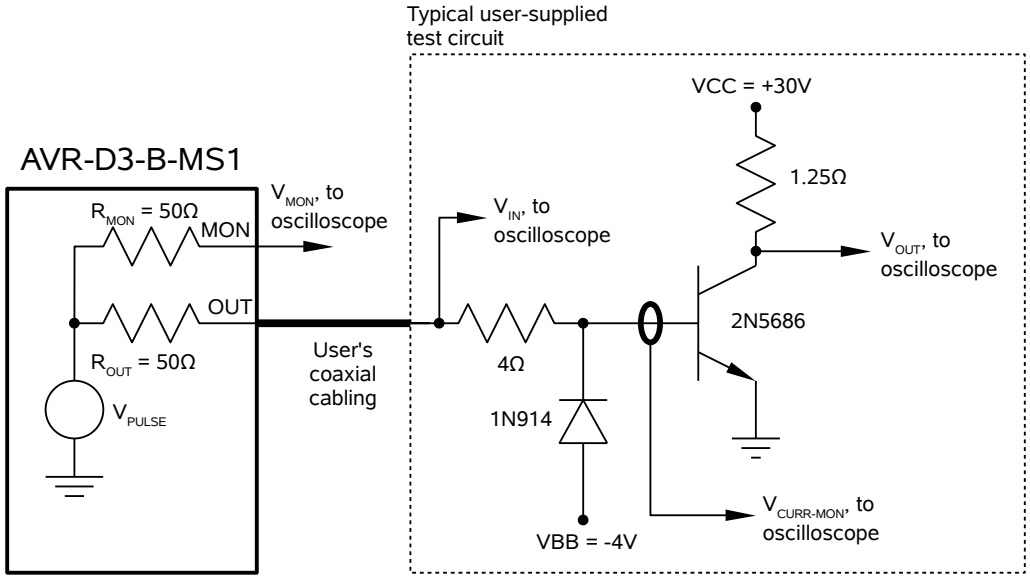
USE LOW-INDUCTANCE LOADS

Lenz’s Law predicts that for an inductive voltage spike will be generated when the current through an inductance changes. Specifically, $V_{SPIKE} = L \times dI_{LOAD}/dt$, 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.

TYPICAL USAGE AND WAVEFORMS

The AVR-D3-B generates high-voltage, high-current waveforms that are suitable for a number of transistor turn-on time, turn-off time, and storage time tests.

The setup shown below is appropriate for testing the 2N5686 NPN transistor, based on the MIL-PRF-19500/464G specification. (Note that Figure 2 of MIL-PRF-19500/464G apparently has an error where it specifies VBB = 4.0V. It should actually be negative, i.e., -4.0V).



TURN-ON TEST

Table 1 of MIL-PRF-19500/464G specifies that the turn-on tests should be performed with a forward base current of +2.5A. This corresponds to a V1 setting for V_{PULSE} of:

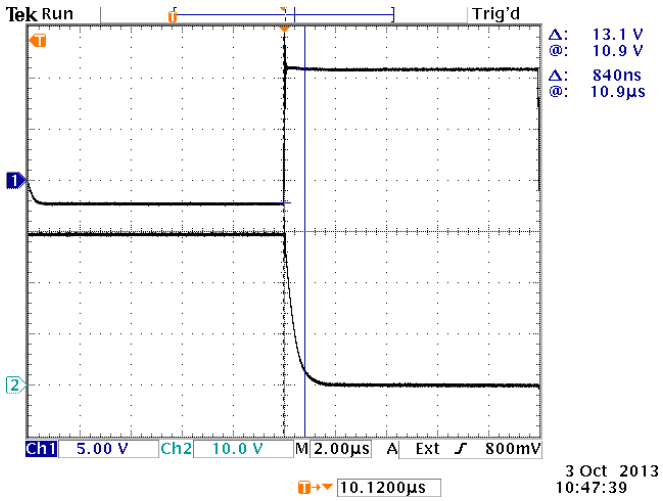
$$V1 \approx (R_{OUT} + 4\Omega) \times 2.5A + 0.7V = +135.7V$$

Under these conditions, the voltage at V_{IN} will be approximately:

$$V_{IN} \approx (4\Omega \times 2.5A) + 0.7V = +10.7V$$

Before the turn-on state, the input to the biased-off transistor is specified to be -2V in Figure 2 of MIL-PRF-19500/464G. Thus we set V2 = -2V on the AVR-D3-B. Since no current flows in the reverse state in this test, there is no voltage drop.

With the PRF set to 10 Hz, PW1 set to 10 us, PW2 set to 30 us, and a 10 us delay setting, the following waveforms are obtained for V_{IN} and V_{OUT} (as defined in the diagram above):



The top waveform shows V_{IN} swinging from -2V to +10.7V, approximately.

The bottom waveform shows the collector voltage falling from +30V to 0V with a 10%-90% transition time of 840 ns. This is t_{ON}, the turn-on time. MIL-PRF-19500/464G specifies t_{ON} to be 1.5 us or less, so this particular device meets the test requirements.

An On Semi 2N5686G (datecode BM1129) transistor was used for this test.

TURN-OFF TEST

As with the turn-on test, Table 1 of MIL-PRF-19500/464G specifies that the turn-off tests should be performed with a forward base current of +2.5A. This corresponds to a V1 setting for V_{PULSE} of:

$$V1 \approx (R_{OUT} + 4\Omega) \times 2.5A + 0.7V = +135.7V$$

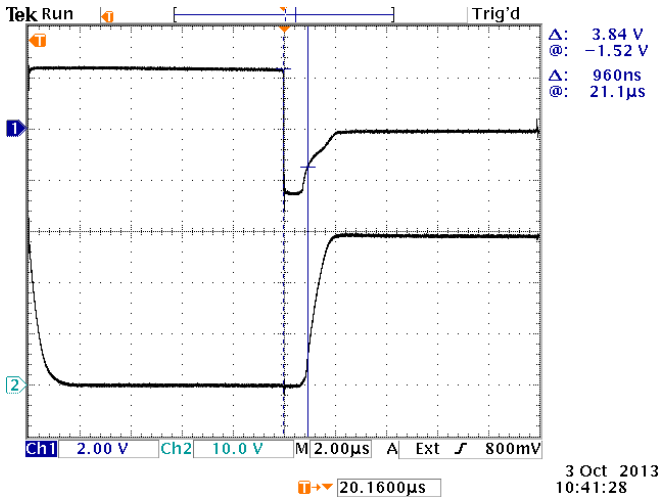
Under these conditions, the voltage at V_{IN} will be approximately:

$$V_{IN} \approx (4\Omega \times 2.5A) + 0.7V = +10.7V$$

The reverse base current is specified to be -2.5A for the turn-off test. This corresponds to a V2 setting for V_{PULSE} of:

$$V2 \approx (R_{OUT} + 4\Omega) \times -2.5A = -135V$$

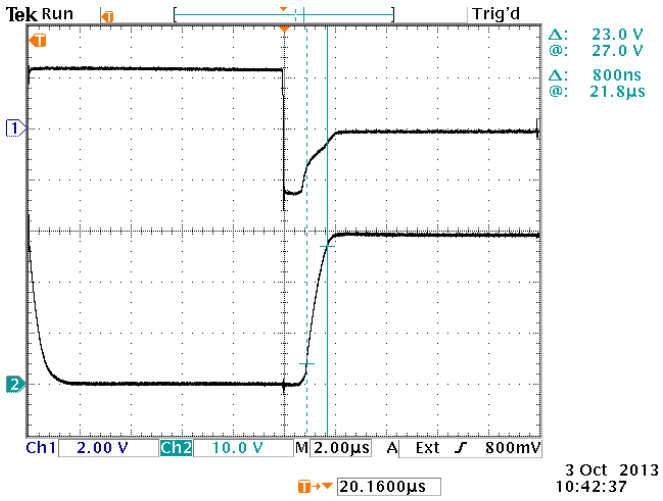
With the PRF set to 10 Hz, PW1 set to 10 us, PW2 set to 30 us, and a 10 us delay setting, the following waveforms are obtained for $V_{CURR\text{-}MON}$ and V_{OUT}:



The top waveform shows the output of a current probe on the base ($V_{CURR-MON}$, scaled at 1V/A) swinging from +2.5A to -2.5A, approximately.

The bottom waveform shows the collector voltage starting to rise to 10% of its final value after a delay of 960 ns. This is t_S, the storage time. MIL-PRF-19500/464G specifies t_S to be 2.0 us or less, so this particular device meets the test requirements.

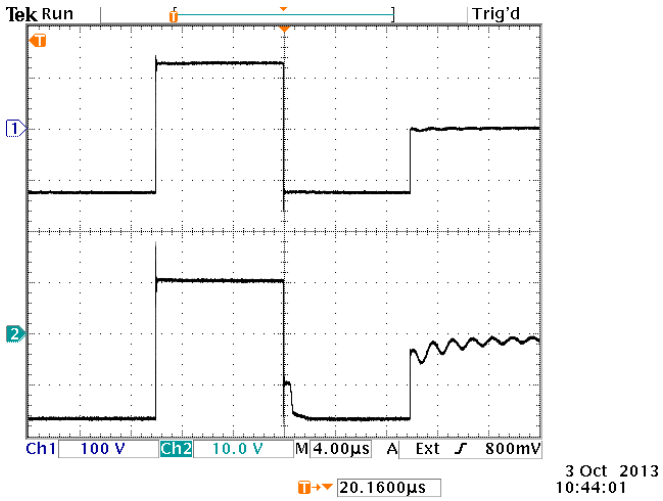
The photo below is the same, except that the cursors measure the collector 10%-90% rise time, corresponding to the turn-off time (t_{OFF}):



t_{OFF} is measured as 800 ns. MIL-PRF-19500/464G specifies t_{OFF} to be 3.0 us or less, so this particular device meets the test requirements.

An On Semi 2N5686G (datecode BM1129) transistor was used for this test.

The waveform below shows the VMON and VIN waveforms that correspond to the last two photos:



V_{MON} shows that the pulser is generating a fast-switching pulse.

V_{IN} shows a "bump" in the waveform on the + to – transition, due to the effect of the storage time and the 50Ω output impedance of the pulser. This is not a concern, as $V_{CURR-MON}$ shows that the desired current is in fact obtained (-2.5A).

IMPEDANCE NOTES

The "bump" in the waveform noted above might be avoided if the pulse generator had a low output impedance. However, some tests explicitly require a 50 Ohm output impedance in the pulse generator (such as MIL-PRF-19500/498E, MIL-S-19500/537).

MIL-PRF-19500/464G does not specify a particular output impedance. The tests above show the 50Ω output impedance produces good results with MIL-PRF-19500/464G.

Some tests call for a 51Ω resistance to ground to be added at V_{IN}. This may help suppress any observed transmission line ringing when the transistor switches off (becoming an open circuit, mismatching the transmission line).

TRANSITION TIME NOTES

The internal pulse generator has a 20%-80% switching time of 20 ns or less. The transitions times observed at V_{IN} may be higher, due to the RC time constant effect of R_{OUT} and any parasitic capacitance in the user's cabling.

Some tests call for extremely fast switching times (< 2ns for MIL-PRF-19500/498E). However, this is not truly necessary, because the parameters being tested are measured on the scale of microseconds. A 20 ns switching time will not affect the measurements in any meaningful way.

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:delay 10 us       (sets the delay to 10 us)
pulse:width1 10 us      (sets the positive pulse width to 10 us)
pulse:width2 30 us      (sets the negative pulse width to 30 us)
volt:ampl1 +100         (sets the positive pulse amplitude to +100 V)
volt:ampl2 -200         (sets the negative pulse amplitude to -200 V)
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)
output on               (turns on the output)
pulse:delay 10 us       (sets the delay to 10 us)
pulse:width1 10 us      (sets the positive pulse width to 10 us)
pulse:width2 30 us      (sets the negative pulse width to 30 us)
volt:ampl1 +100         (sets the positive pulse amplitude to +100 V)
volt:ampl2 -200         (sets the negative pulse amplitude to -200 V)
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 internal triggering)
pulse:delay 10 us       (sets the delay to 10 us)
pulse:width1 10 us      (sets the positive pulse width to 10 us)
pulse:width2 30 us      (sets the negative pulse width to 30 us)
volt:ampl1 +100         (sets the positive pulse amplitude to +100 V)
volt:ampl2 -200         (sets the negative pulse amplitude to -200 V)
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.)

Keyword	Parameter	Notes
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
[SOURce]:		
:FREQuency		
[:CW | FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DELay	<numeric value>	
:GATE		
:LEVel	HIgh | LOw	
[SOURce]:		
:VOLTage		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value>	
: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 | 19200 | 38400 | 57600 | 115200	
: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]

OTHER INFORMATION

APPLICATION NOTES

Application notes are available on the Avtech web site, at http://www.avtechpulse.com/appnote.

MANUAL FEEDBACK

Please report any errors or omissions in this manual, or suggestions for improvement, to info@avtechpulse.com. Thanks!

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.

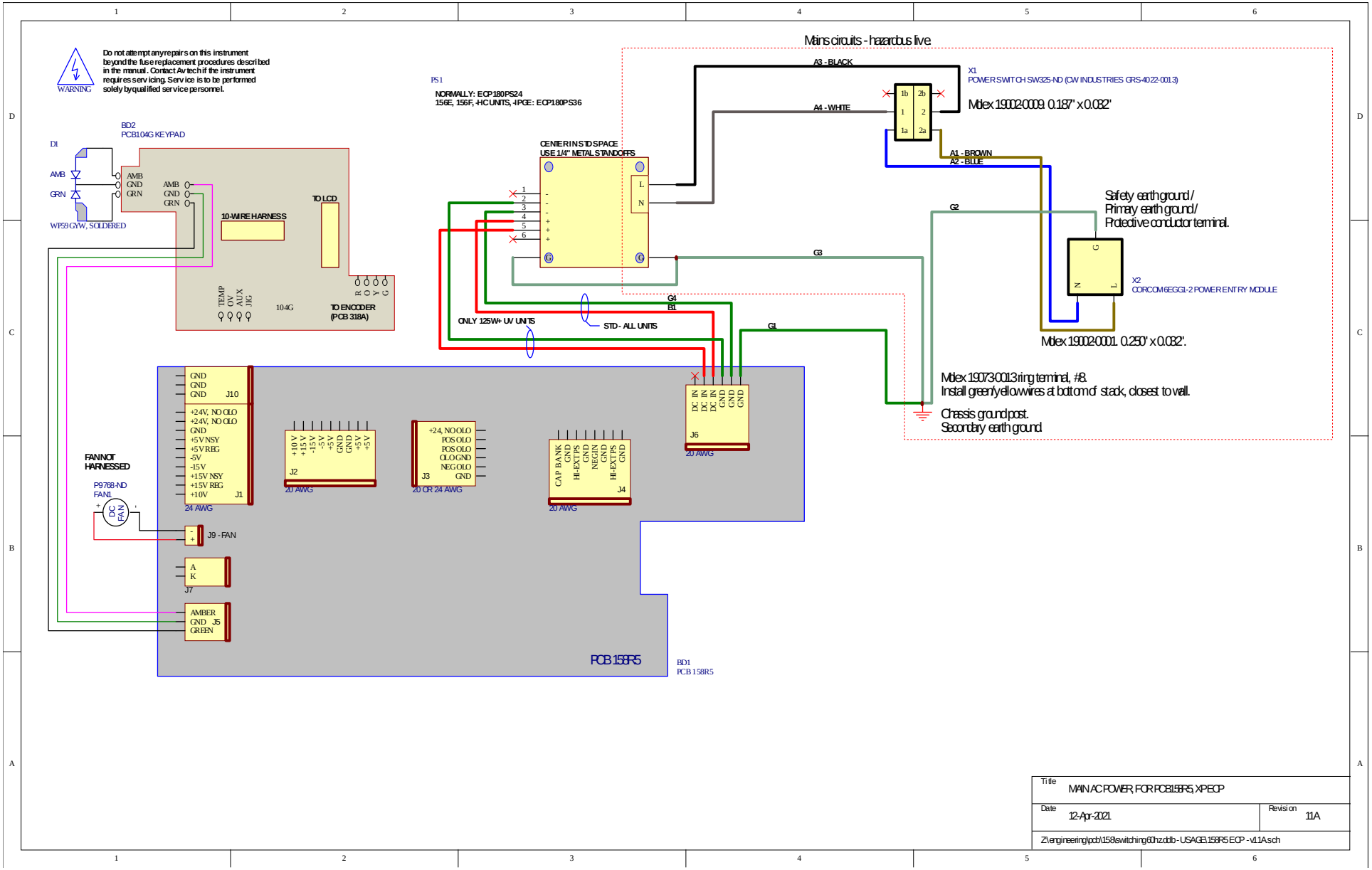
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

CLEANING

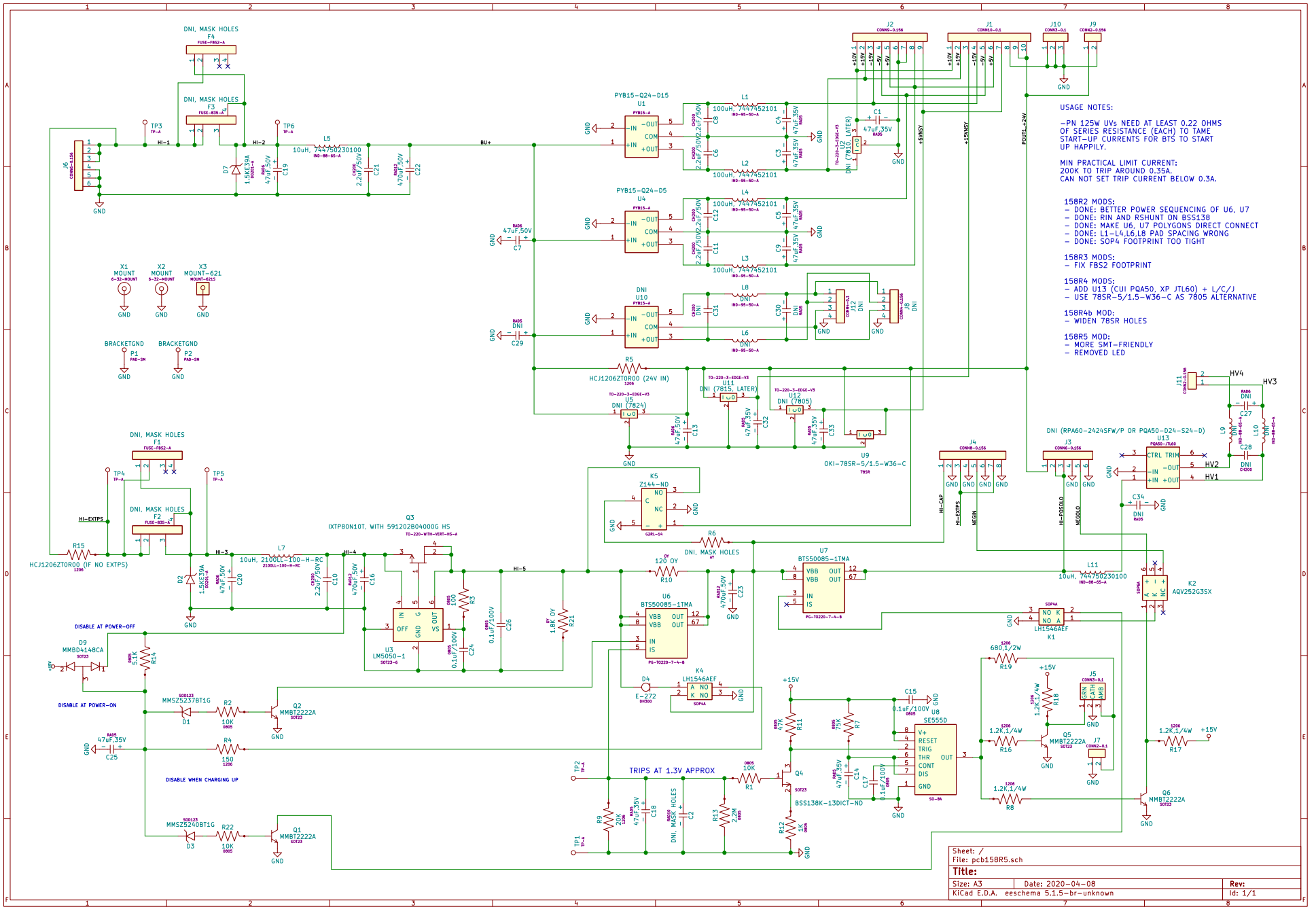
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

WIRING DIAGRAMS

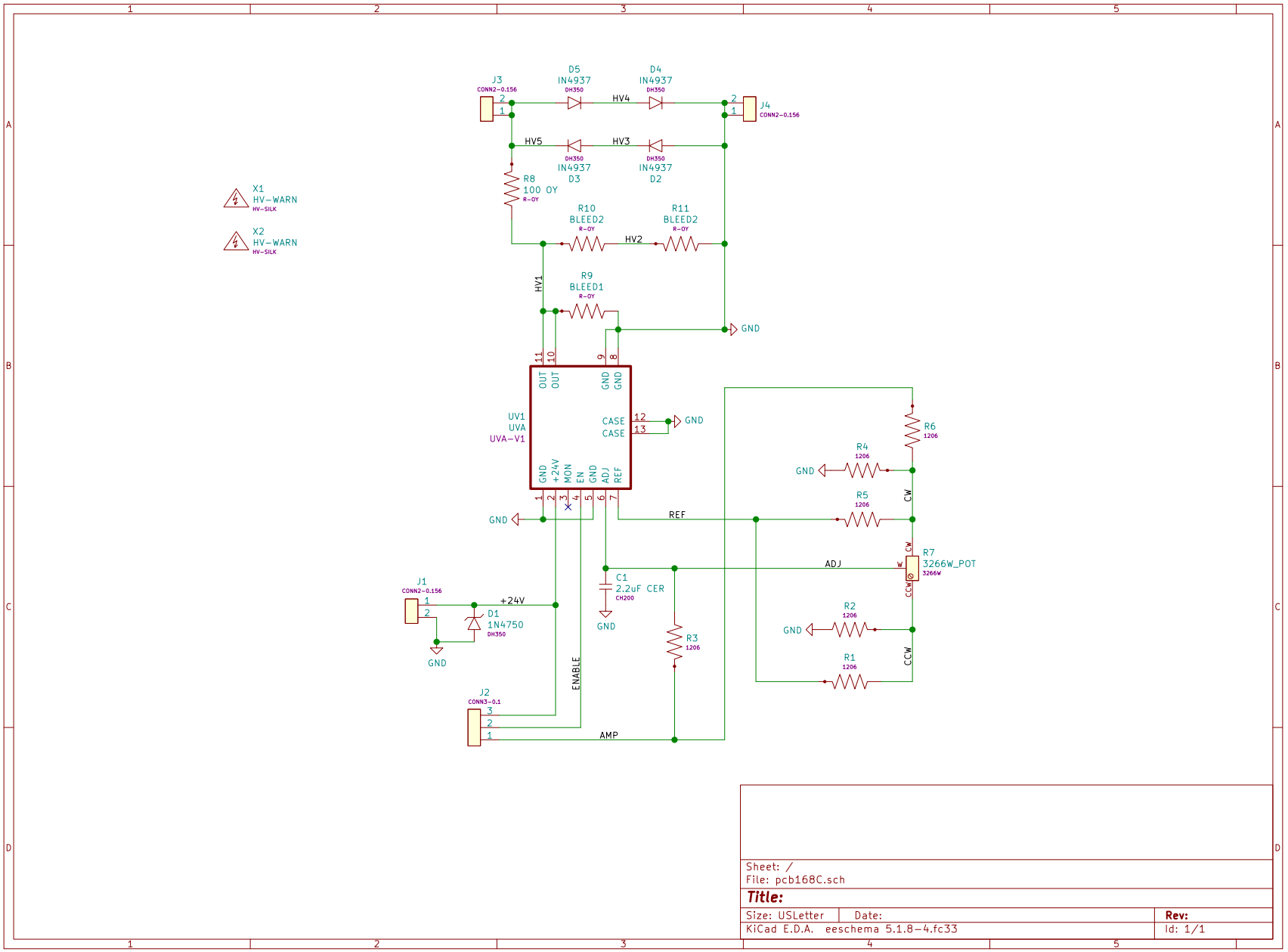
WIRING OF AC POWER



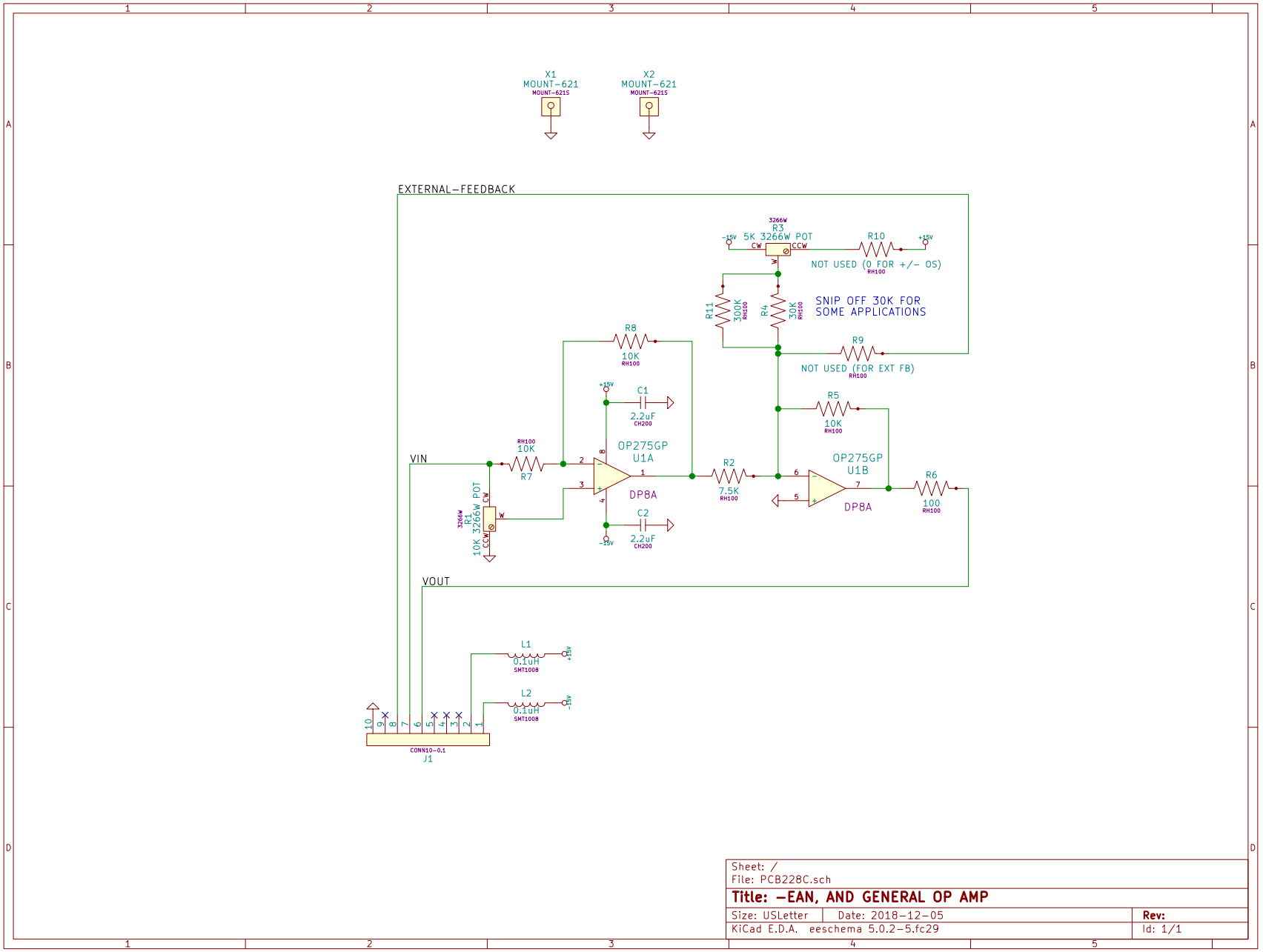
PCB 158R5 - LOW VOLTAGE POWER SUPPLY



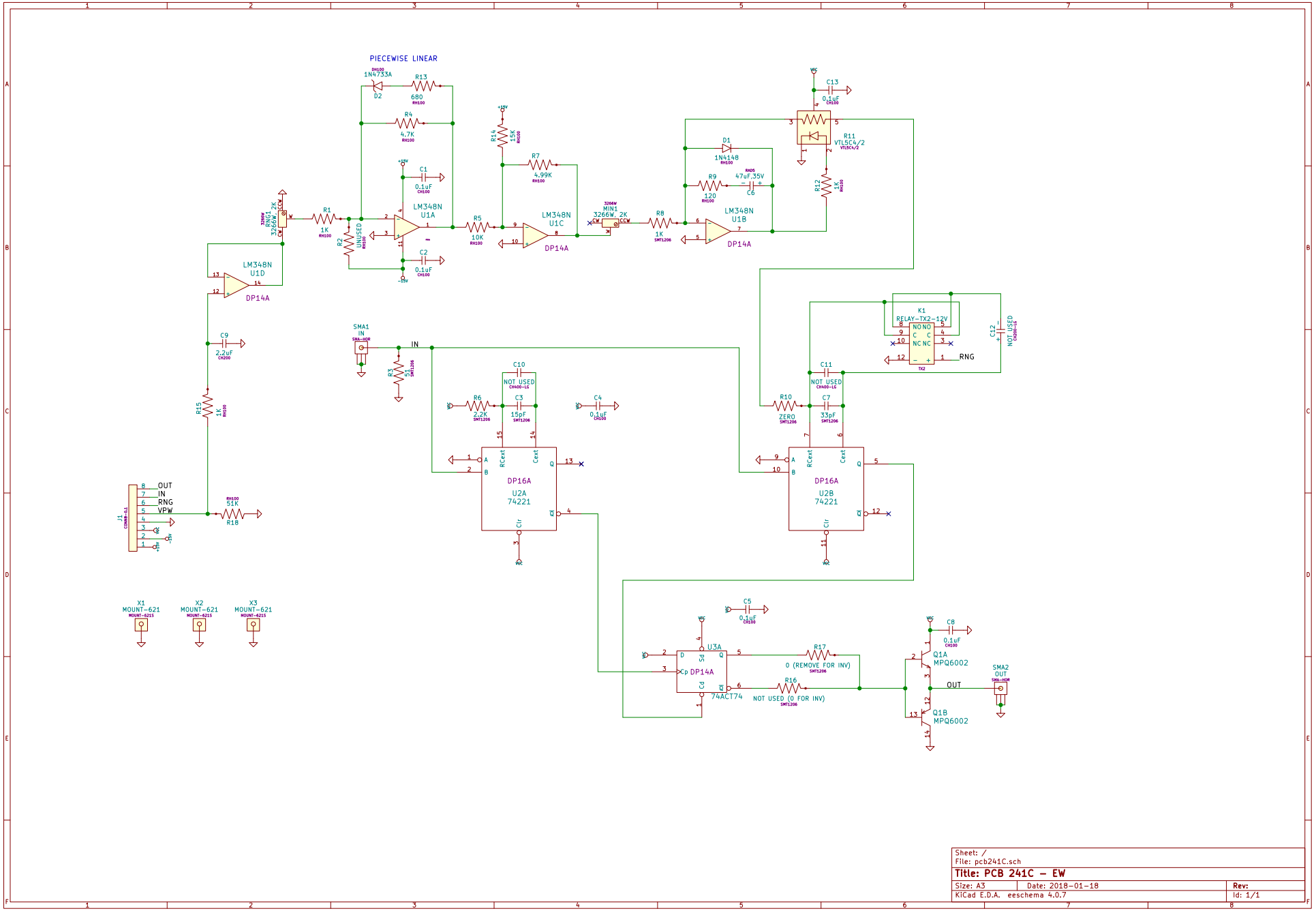
PCB 168C - HIGH-VOLTAGE POWER SUPPLY



PCB 228C - NEGATIVE UV CONTROL PCB

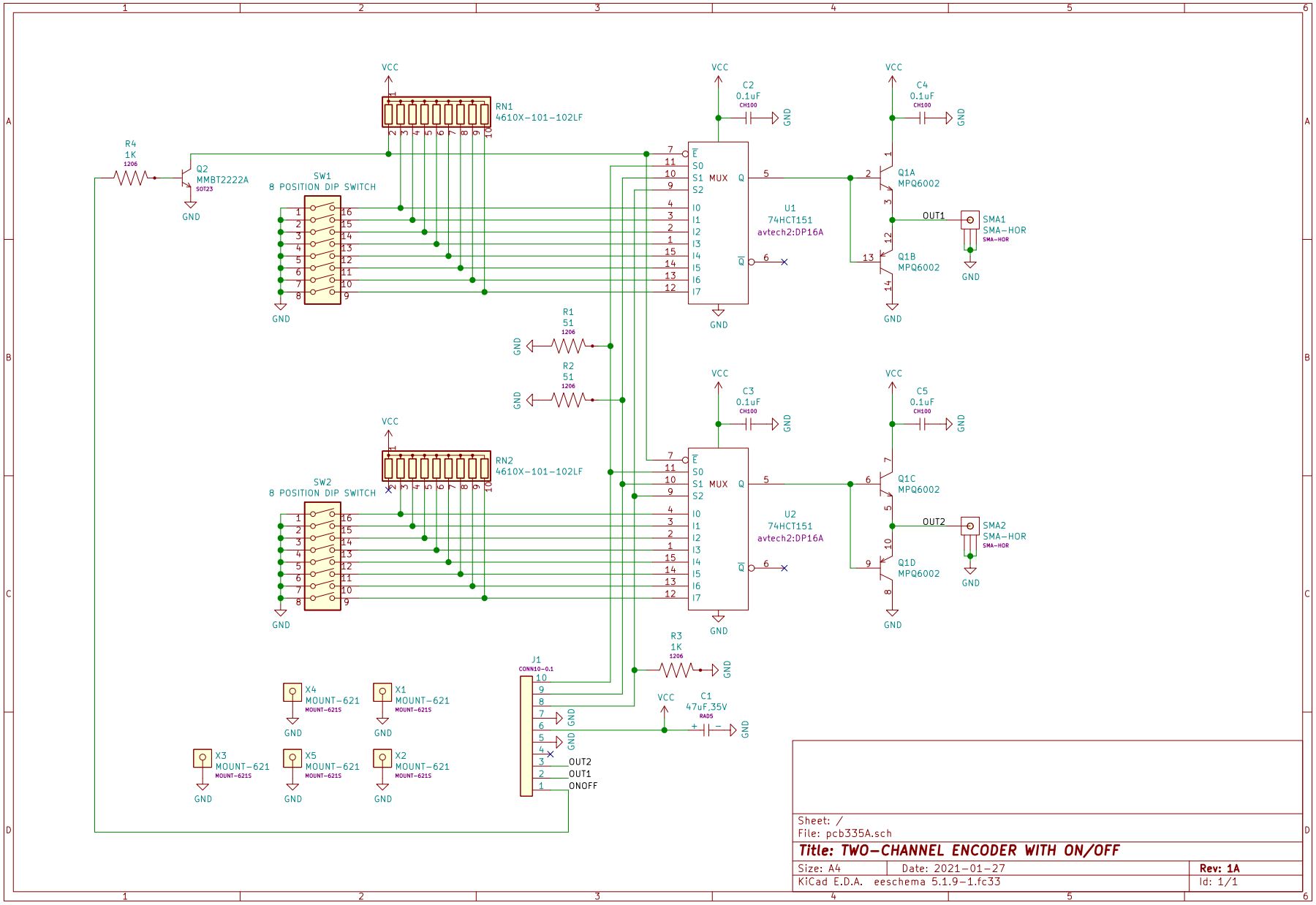


PCB 241C - DUAL PW PCB

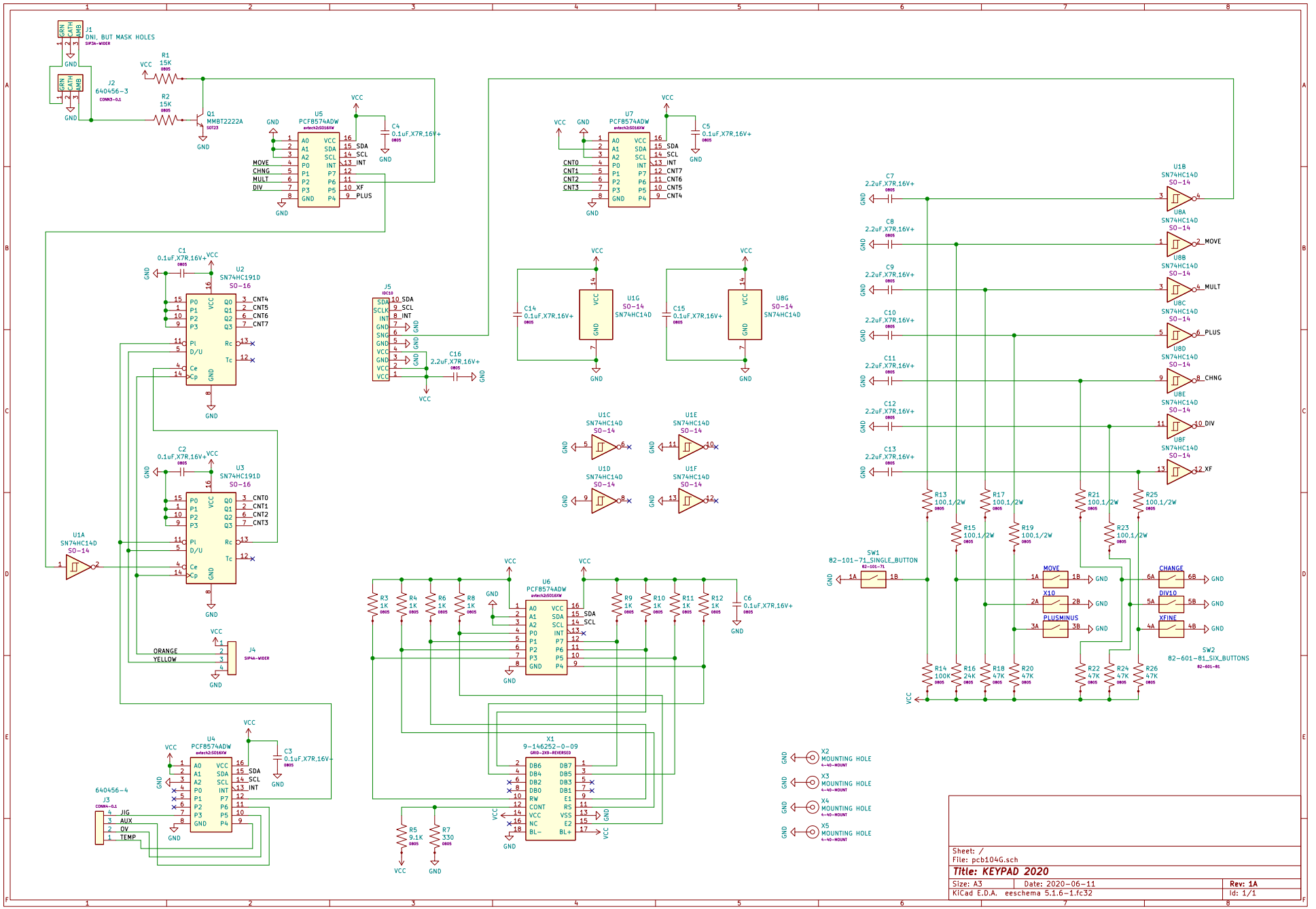


Sheet: /	
File: pcb241C.sch	
Title: PCB 241C – EW	
Size: A3	Date: 2018-01-18
KiCad E.D.A. eeschema 4.0.7	Id: 1/1

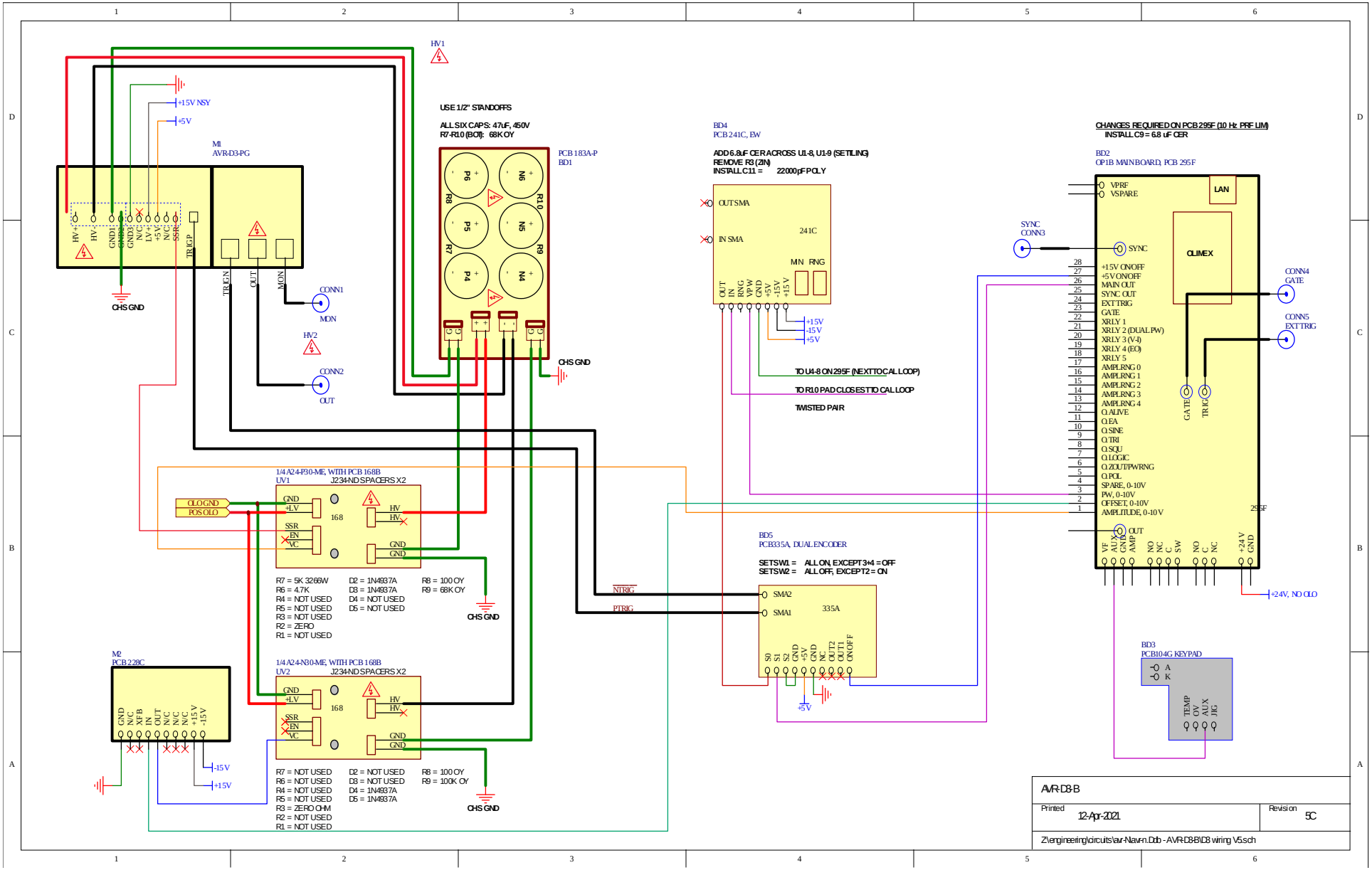
PCB 335A - DUAL TRIGGER ENCODER



PCB 104G - KEYPAD / DISPLAY BOARD



MAIN WIRING


HV1
+15V NSY
+5V
M1
AVR-D3-PG
CHS GND
TRIGN
OUT
MON
CONN1
MON
HV2
CONN2
OUT
USE 1/2" STANDOFFS
ALL SIX CAPS: 47uF, 450V
R7-R10 (BOT): 68K OY
PCB 183A-P
BD1
P6
N6
P5
N5
P4
N4
R8
R10
R7
R9
CHS GND
BD4
PCB 241C, EW
ADD 6.8uF CER ACROSS U1-8, U1-9 (SETTLING)
REMOVE R3 (ZIN)
INSTALL C11 = 22000pF POLY
OUT SMA
IN SMA
241C
MIN RNG
+15V
-15V
+5V
TO U4-8 ON 295F (NEXT TO CAL LOOP)
TO R10 PAD CLOSEST TO CAL LOOP
TWISTED PAIR
CHANGES REQUIRED ON PCB 295F (10 Hz PRF LIM)
INSTALL C9 = 6.8 uF CER
BD2
OP1B MAINBOARD, PCB 295F
VPRF
VSPARE
LAN
SYNC
CONN3
SYNC
CLIMEX
+15V ON/OFF
+5V ON/OFF
MAIN OUT
SYNC OUT
EXT TRIG
GATE
XRLY 1
XRLY 2 (DUAL PW)
XRLY 3 (V-I)
XRLY 4 (EO)
XRLY 5
AMPLRNG 0
AMPLRNG 1
AMPLRNG 2
AMPLRNG 3
AMPLRNG 4
O.ALIVE
O.EA
O.SINE
O.TRI
O.SQU
O.LOGIC
O.ZOUT/PWRNG
O.POL
SPARE, 0-10V
PW, 0-10V
OFFSET, 0-10V
AMPLITUDE, 0-10 V
295F
CONN4
GATE
CONN5
EXT TRIG
GATE
TRIG
+24V, NO CLO
1/4 A24-P30-ME, WITH PCB 168B
UV1
J234-ND SPACERS X2
OLO GND
POS OLO
GND
+LV
168
SSR
EN
VC
HV
HV
GND
GND
R7 = 5K 3266W
R6 = 4.7K
R4 = NOT USED
R5 = NOT USED
R3 = NOT USED
R2 = ZERO
R1 = NOT USED
D2 = 1N4937A
D3 = 1N4937A
D4 = NOT USED
D5 = NOT USED
R8 = 100 OY
R9 = 68K OY
CHS GND
1/4 A24-N30-ME, WITH PCB 168B
UV2
J234-ND SPACERS X2
R7 = NOT USED
R6 = NOT USED
R4 = NOT USED
R5 = NOT USED
R3 = ZERO OHM
R2 = NOT USED
R1 = NOT USED
D2 = NOT USED
D3 = NOT USED
D4 = 1N4937A
D5 = 1N4937A
R8 = 100 OY
R9 = 100K OY
CHS GND
M2
PCB 228C
GND
N/C
XFB
IN
OUT
-15V
+15V
NTRIG
PTRIG
BD5
PCB335A, DUAL ENCODER
SETSW1 = ALL ON, EXCEPT 3+4 = OFF
SETSW2 = ALL OFF, EXCEPT 2 = ON
SMA2
SMA1
335A
S0
S1
S2
GND
+5V
GND
NC
OUT2
OUT1
ON/OFF
BD3
PCB104G KEYPAD
A
K
TEMP
0V
AUX
JIG
AVR-D3-B
Printed
12-Apr-2021
Revision
5C
Z:\engineering\circuits\avr-Navn.Ddb - AVR-D3-B\D3 wiring V5.sch

PERFORMANCE CHECK SHEET