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NANOSECOND WAVEFORM ELECTRONICS
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INSTRUCTIONS

MODEL AV-106A-B

30 AMP, 30 VOLT, 50 ns RISE TIME

LASER DIODE DRIVER

WITH IEEE 488.2 AND RS-232 CONTROL

SERIAL NUMBER: 14172

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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TABLE OF CONTENTS

WARRANTY.....	2
TECHNICAL SUPPORT.....	2
TABLE OF CONTENTS.....	3
INTRODUCTION.....	5
SPECIFICATIONS.....	6
REGULATORY NOTES.....	7
FCC PART 18.....	7
EC DECLARATION OF CONFORMITY.....	7
DIRECTIVE 2011/65/EU (RoHS).....	8
DIRECTIVE 2002/96/EC (WEEE).....	8
FIRMWARE LICENSING.....	9
INSTALLATION.....	10
VISUAL CHECK.....	10
POWER RATINGS.....	10
CONNECTION TO THE POWER SUPPLY.....	10
PROTECTION FROM ELECTRIC SHOCK.....	11
ENVIRONMENTAL CONDITIONS.....	12
LABVIEW DRIVERS.....	12
FUSES.....	13
AC FUSE REPLACEMENT.....	13
DC FUSE REPLACEMENT.....	14
FUSE RATINGS.....	14
FRONT PANEL CONTROLS.....	15
REAR PANEL CONTROLS.....	17
GENERAL INFORMATION - PULSE GENERATOR TIMING.....	20
BASIC PULSE CONTROL.....	20
TRIGGER MODES.....	21
GATING MODES.....	21
GENERAL INFORMATION - OPERATING INTO A LOAD.....	23
AMPLITUDE CONTROL.....	23
OUTPUT CONNECTIONS.....	23
USING THE SUPPLIED TEST LOAD (AV-CTL1-ENC).....	23
TEST ARRANGEMENT.....	25

LENZ'S LAW AND INDUCTIVE VOLTAGE SPIKES.....	25
CURRENT MEASUREMENT.....	26
MONITOR OUTPUTS.....	26
POLARITY CONTROL.....	27
START-UP CHECK-LIST FOR LOCAL CONTROL.....	28
CALIBRATION ADJUSTMENTS - SOFTWARE PROCEDURES.....	30
ADJUSTING AMPLITUDE ACCURACY.....	30
PROGRAMMING YOUR PULSE GENERATOR.....	31
KEY PROGRAMMING COMMANDS.....	31
ALL PROGRAMMING COMMANDS.....	32
MECHANICAL INFORMATION.....	34
TOP COVER REMOVAL.....	34
RACK MOUNTING.....	34
ELECTROMAGNETIC INTERFERENCE.....	34
MAINTENANCE.....	35
REGULAR MAINTENANCE.....	35
CLEANING.....	35
WIRING DIAGRAMS.....	36
WIRING OF AC POWER.....	36
PCB 158R5 - LOW VOLTAGE POWER SUPPLY.....	37
PCB 235C - HIGH VOLTAGE DC POWER SUPPLY.....	38
PCB 104G - KEYPAD / DISPLAY BOARD.....	39
MAIN WIRING.....	40
PERFORMANCE CHECK SHEET.....	41

INTRODUCTION

The Model AV-106A-B pulse generator is designed for pulsing laser diode and other low impedance loads with rectangular pulses as high as 30 Amperes into load voltages up to 30V, with 50 ns rise and fall times. The pulse repetition frequency can vary from 1 Hz to 1 kHz, and pulse widths can vary from 0.5 to 50 μ s. The current and voltage polarities depend on the model number:

-P units: 0 to +30 A amplitude, 0 to +30V compliance

-N units: 0 to -30 A amplitude, 0 to -30V compliance

-PN units: 0 to \pm 30 A amplitude, 0 to +30V compliance for positive output, and 0 to -30V compliance for negative output.

The Model AV-106A-B pulse generator is a current pulser. The current amplitude is largely independent of the load voltage. The load voltage must not exceed 30V.

The loads can be connected to the pulse generator using the convenient AV-CLZ1-100 transmission line cable assembly, which has a 1 Ω characteristic impedance (Z_0), and is terminated with a DB-37 male connector. A sample connectorized test load is provided.

The AV-106A-B can be controlled from the front panel, or via a computer connected to the IEEE 488.2-compliant GPIB port, or the RS-232 serial port.

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

SPECIFICATIONS

Model ¹ :	AV-106A-B
Amplitude ² :	1 to 30 A
Load voltage range:	0 to 30 Volts
Pulse width (FWHM):	0.5 to 50 us
Rise & fall times (20%-80%) ⁶ :	≤ 50 ns
Maximum PRF:	1 kHz
Duty cycle: (max)	0.25%
Output impedance:	≥ 50 Ohms
Output regulation:	≤ ±5% change in current for a load voltage change from 0 V to max. rated load voltage
Polarity ³ :	Specify - Positive or negative or both. Dual polarity not available on AV-106F-B.
GPIO & RS-232 control ¹ :	Standard on -B units.
LabView drivers:	Check http://www.avtechpulse.com/labview for availability and downloads
Ethernet port, for remote control using VXI-11.3, ssh, telnet, & web:	Included. Recommended as a modern alternative to GPIO / RS-232. See http://www.avtechpulse.com/options/vxi for details.
Settings resolution:	The resolution of the timing parameters (pulse width, delay, period) varies, but is always better than 0.15% of (set value + 20 ns). The amplitude resolution is < 0.1% of the maximum amplitude.
Settings accuracy:	Typically ± 3% of setting (plus ± 1% of maximum, for amplitude) after a 10 minute warmup. For high-accuracy applications requiring traceable calibration, verify the output parameters with a calibrated oscilloscope ⁴ .
Propagation delay (Jitter):	≤ 100 ns, (± 100 ps ± 0.03% of sync delay, Ext trig in to pulse out)
Trigger modes:	Internal trigger, external trigger (TTL level pulse, > 10 ns, 1 kΩ input impedance), front-panel "Single Pulse" pushbutton, or single pulse trigger via computer command
Variable delay:	Sync to main out: 0 to 1.0 seconds, for all trigger modes (including external trigger).
Sync output:	+3 Volts, > 50 ns, will drive 50 Ohm loads
Gate input:	Sync or async, active high or low, switchable. Suppresses triggering when active.
Monitor output:	Provides an attenuated coincident replica of output current pulse.
Supplied output transmission line:	Detachable high-current transmission line cable assembly. See http://www.avtechpulse.com/transmission for details.
Part number, length, Z ₀ :	AV-CLZ1-100 (see http://www.avtechpulse.com/transmission/av-clz1), 1 Ω, 100 cm
Output connection:	End of cable: DB-37 male. Pins 1-19 = signal, pins 20-37 = ground.
Supplied test load ⁵ :	AV-CTL1-ENC. See http://www.avtechpulse.com/accessories/av-ctl1 for details.
Connectors (other):	Trig, Sync, Gate, Monitor: BNC
Power requirements:	100 - 240 Volts, 50 - 60 Hz
Dimensions:	100 x 430 x 375 mm (3.9" x 17" x 14.8")
Temperature range:	+5°C to +40°C

1) -B suffix indicates IEEE-488.2 GPIO and RS-232 control of amplitude, pulse width, PRF and delay (see <http://www.avtechpulse.com/gpio> for details).

2) The minimum useful amplitude is 3% of the maximum amplitude.

3) Indicate desired polarity by suffixing the model number with -P or -N (i.e. positive or negative) or -PN for dual polarity option.

4) 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.

5) The supplied test load is for low-duty-cycle basic operational tests only. The power rating of the load is 5 Watts. It may not be capable of supporting the instrument's full maximum average output power. See <http://www.avtechpulse.com/accessories/> for details about the AV-CTL series of test loads.

6) Valid for a resistive (and non-inductive) load installed at the end of the supplied output cable (at the output connector for the AV-106F-B), with a load impedance of (maximum allowed load voltage) ÷ (maximum allowed current amplitude). For lower resistances and/or more inductive loads, the rise and fall times may increase as governed by the L/R time constant, where L is the parasitic inductance of any cabling and load, and R is the load resistance.

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.
 P.O. Box 5120, LCD Merivale
 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.
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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.

<i>Material/Substance</i>	<i>Threshold level</i>
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 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.



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. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

Confirm that the following items are present:

- The mainframe (i.e., the main instrument chassis)
- A power cord
- A GPIB cable
- An AV-CTL1-ENC test load
- An AV-CLZ1-100 transmission line cable assembly
- Two instrumentation manuals (this manual and the “Programming Manual for -B Instruments”) are with 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

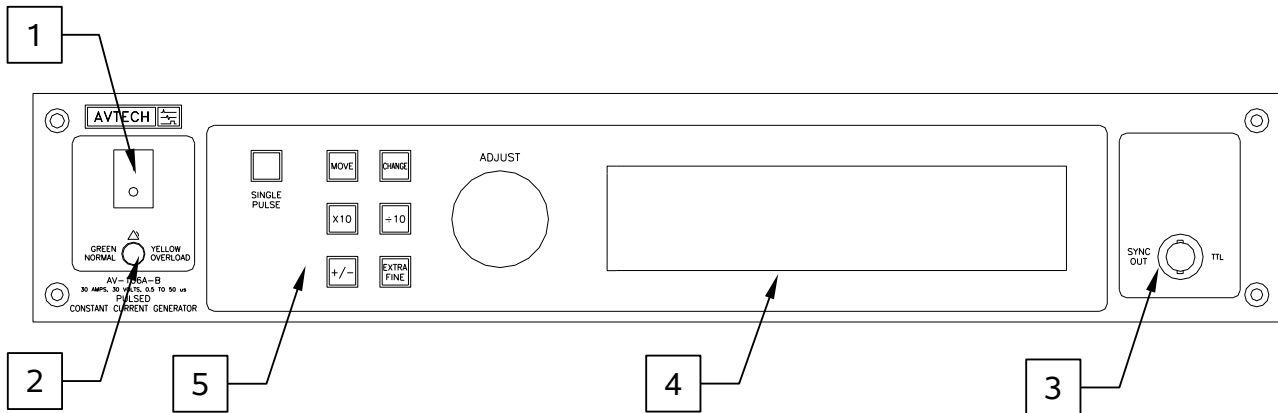
The following table lists the required fuses for standard models:

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	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 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.

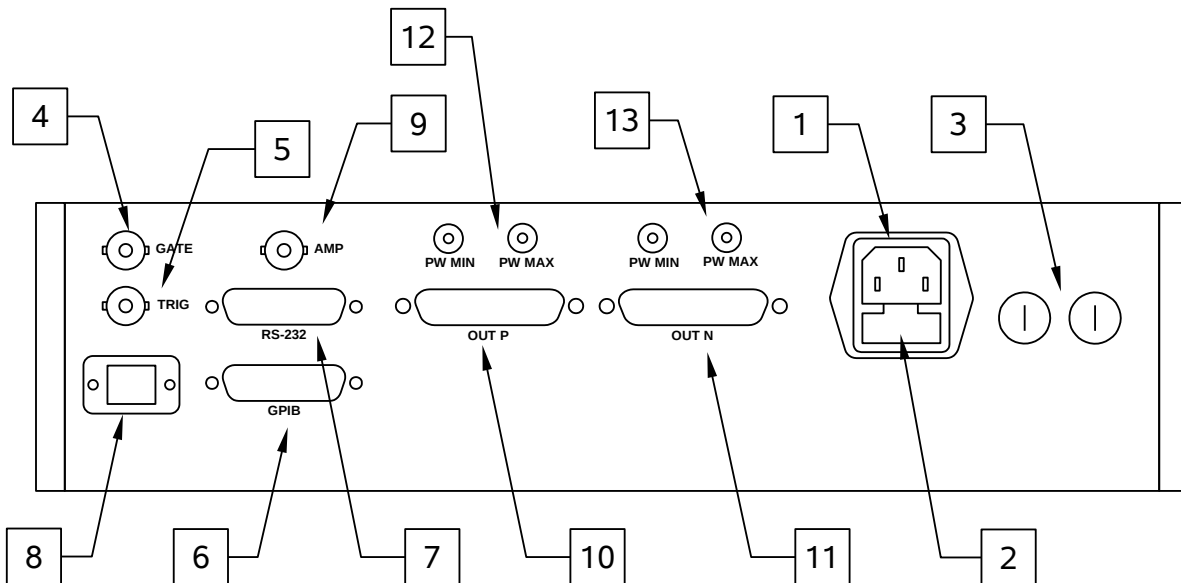
This overload indicator may flash yellow briefly at start-up. This is not a cause for concern.

3. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads (or lags) the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to $R_L > 50\Omega$ with a pulse width of approximately 100 ns.
4. 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.

5. KEYPAD.

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

REAR PANEL CONTROLS



1. AC POWER INPUT. An IEC-320 C14 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket.
2. AC FUSE DRAWER. The two fuses that protect the AC input are located in this drawer. Please see the “FUSES” section of this manual for more information.
3. DC FUSES. These two fuses protect the internal DC power supplies. Please see the “FUSES” sections of this manual for more information.
4. GATE. This TTL-level (0 and +5V) logic input can be used to gate the triggering of the instrument. This input can be either active high or active low, depending on the front panel settings or programming commands. (The instrument triggers normally when this input is unconnected). When set to active high mode, this input is pulled-down to ground by a 1 k Ω resistor. When set to active low mode, this input is pulled-up to +5V by a 1 k Ω resistor.
5. TRIG. This TTL-level (0 and +5V) logic input can be used to trigger the instrument, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input. The input impedance of this input is 1 k Ω . (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.)

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

independently.

6. GPIB Connector. A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B Instruments” for more details on GPIB control.
7. RS-232 Connector. A standard serial cable with a 25-pin male connector can be attached to this connector to allow the instrument to be computer-controlled. 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. (Optional feature. Active on -VXI units only.) 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. AMP Connector. Not used.
10. OUT P. This is the main positive output, present on “-P” and “-PN” units. It is only active when the amplitude is set to a positive value. The AV-CLZ1-100 transmission line plugs into this DB-37 female connector. Pins 1-19 (the upper row) are connected to the signal out, and pins 20-37 (the lower row) are connected to ground.
11. OUT N. This is the main negative output, present on “-N” and “-PN” units. It is only active when the amplitude is set to a negative value. The AV-CLZ1-100 transmission line plugs into this DB-37 female connector. Pins 1-19 (the upper row) are connected to the signal out, and pins 20-37 (the lower row) are connected to ground.
12. MON P. These are the current monitor outputs for the OUT P signal. The monitor output voltage (V_M) is related to the load current (I_L) by:

$$V_M \approx I_L \times 0.1 \text{ Volt/Amp, approximately}$$

when operating into 50 Ohms. Two outputs are provided to cover narrow pulse width operation and wide pulse width operation (different current transformers are used internally.) The “MIN PW” output is use to pulse widths of 15 us or less. The “MAX PW” output covers the full pulse width range, but tends to introduce excess overshoot on the first ~ 1 us of the pulse.

13. MON N. These are the current monitor outputs for the OUT N signal. The monitor output voltage (V_M) is related to the load current (I_L) by:

$$V_M \approx I_L \times 0.1 \text{ Volt/Amp, approximately}$$

when operating into 50 Ohms. Two outputs are provided to cover narrow pulse width operation and wide pulse width operation (different current transformers are used internally.) The “MIN PW” output is use to pulse widths of 15 us or less. The “MAX PW” output covers the full pulse width range, but tends to introduce excess overshoot on the first ~ 1 us of the pulse.

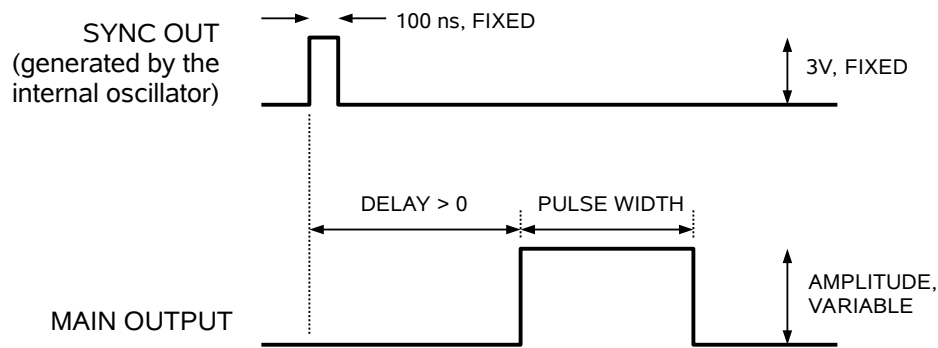
GENERAL INFORMATION - PULSE GENERATOR TIMING

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 device under test. Its amplitude and pulse width are variable. The SYNC pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems. When the delay is set to a positive value the SYNC pulse precedes the OUT pulse.

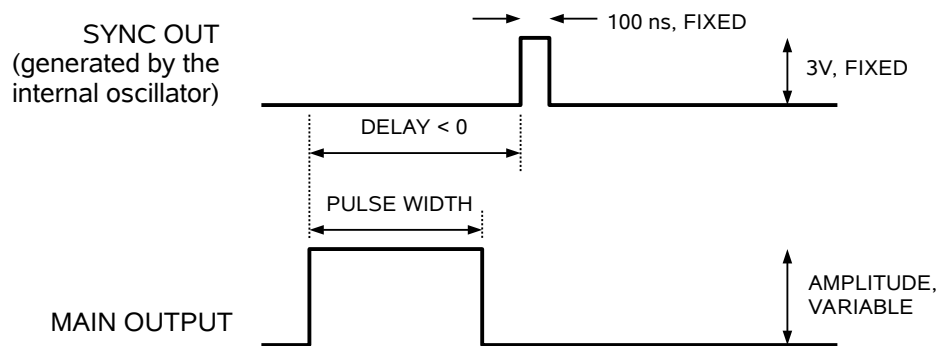
In the diagrams below, positive amplitude is assumed. (For “-N” units, the output waveforms are inverted in polarity.)

These pulses are illustrated below for a positive delay, and internal triggering:



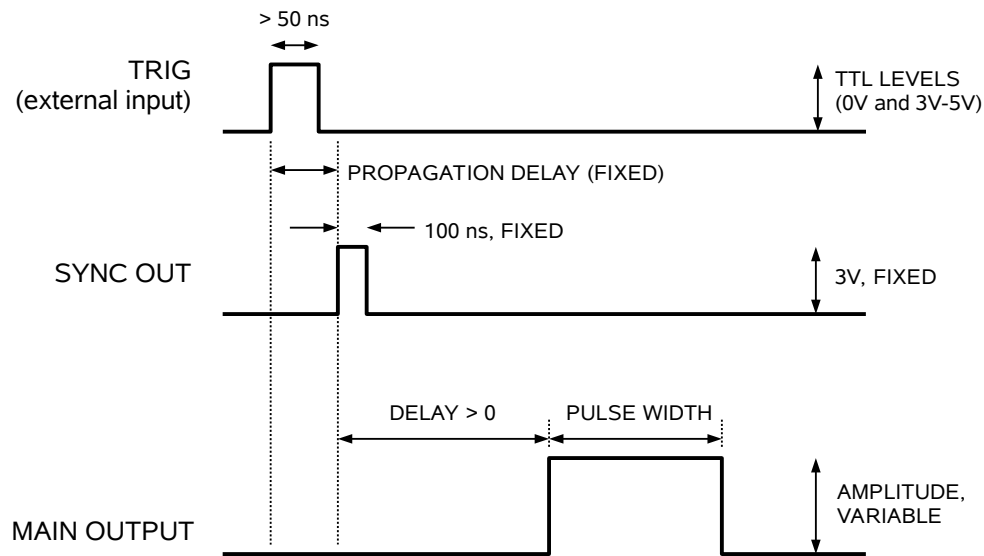
Basic Output Pulses for Delay > 0

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



Basic Output Pulses for Delay < 0

When the triggering is set to external mode, a TTL-level pulse on the TRIG input will trigger the pulse generator, as shown below:



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

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. This input can also be set to act synchronously or asynchronously. When set to asynchronous mode, the GATE will disable the output immediately. Output pulses may be truncated. When set to

synchronous mode, the output will complete the full pulse width if the output is high, and then stop triggering. No pulses are truncated in this mode.

GENERAL INFORMATION - OPERATING INTO A LOAD

AMPLITUDE CONTROL

The AV-106A-B is a pulsed constant current source. The output current is largely independent of the load voltage (as long as the load voltage remains within the specified 0 to 100V range).

The instrument will function properly into short circuits and diode loads. For optimal waveform shape, however, it may be beneficial to add a small resistance to the load ($\sim 1\Omega$), to better match the load impedance to the cable characteristic impedance.

OUTPUT CONNECTIONS

The main output is provided on a rear-panel DB-37 female connector. Pins 1-19 of this connector (the upper row) are connected to the signal out, and pins 20-37 (the lower row) are connected to ground.

An AV-CLZ1-100 transmission line is supplied with the instrument. One end plugs into the rear-panel connector. The other end is terminated with a DB-37 male connector. Pins 1-19 of this connector (the upper row) are connected to the signal out, and pins 20-37 (the lower row) are connected to ground. The cable is reversible - either end can be plugged into the rear panel. This cable can be ordered separately, as model AV-CLZ1-100. (Lengths longer than 100 cm are also available - see <http://www.avtechpulse.com/transmission/av-clz1> for details.)

The user may connect a load to the end of the AV-CLZ1-100 transmission line using a load that has a DB-37 female connector. To construct your own connectorized load, consider using a Norcomp 172-037-201-001 DB-37 female connector with solder cup pins. This is readily available from Digi-Key (<http://www.digikey.com>, stock number 137F-ND). Care must be taken to construct the connectorized test load to conform to local safety standards. Pins 1-19 should be connected together to provide the signal output, and pins 20-37 should be connected together to provide the ground.

It may be simpler to modify the supplied test load. The supplied test load has this connector pre-installed, and a safety enclosure is provided. This test load is described in the next section.

USING THE SUPPLIED TEST LOAD (AV-CTL1-ENC)

The supplied test load consists of a DB-37 female connector mounted on the lid of a small aluminum box chassis. Inside the chassis, an 8 mm by 50 mm circuit board is sandwiched between the two rows of solder cups on the rear of the connector. Four Ohmite OY-series 3.9 Ohm resistors are connected in parallel between the two rows of solder cups. This provides a total resistance of $3.9\Omega / 4 \approx 1.0\Omega$.

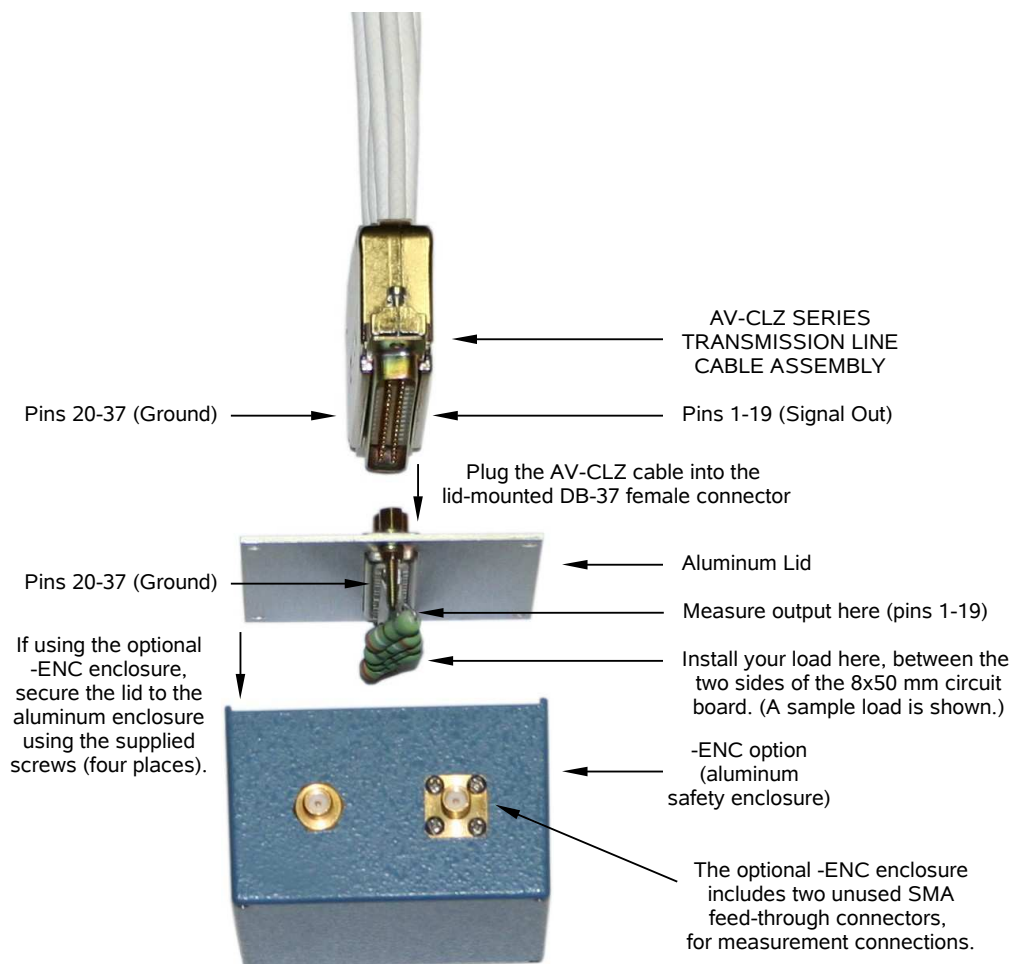
Two unused SMA connectors are provided for making connections through the chassis wall, if desired. A 5/16" hole, plugged with a screw is also provided. The screw may be removed to provide an access hole to the interior of the chassis.

For safety reasons, the lid should be installed on the aluminum chassis so that users can not physically touch the load.

The test load has a maximum power dissipation rating of 5 Watts. Take care not exceed this!

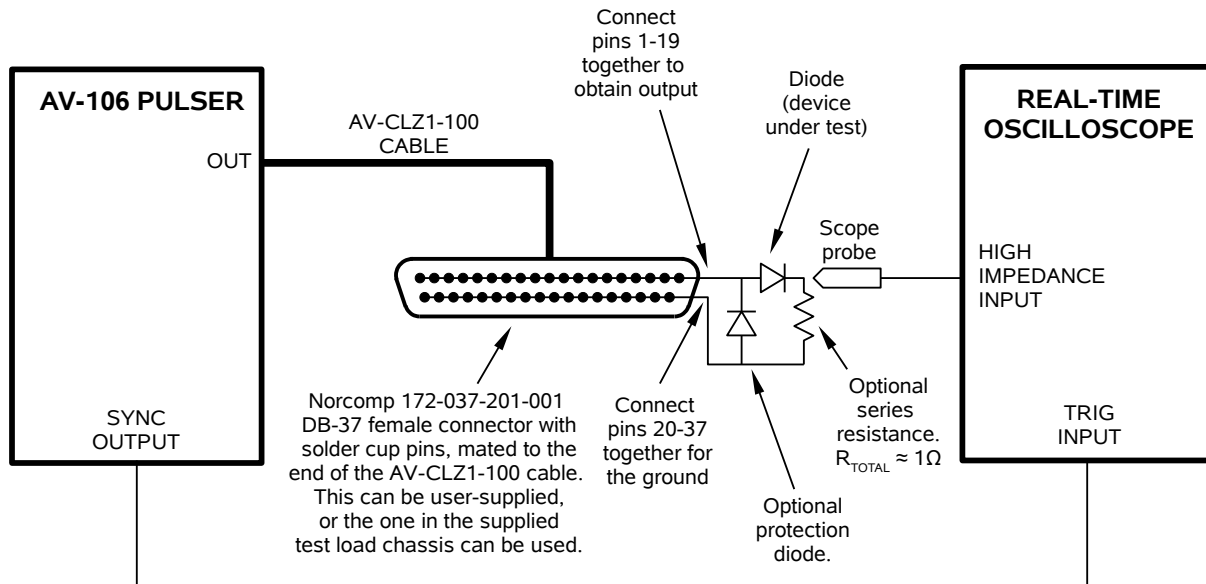
This test load can be ordered separately, as model AV-CTL1-ENC. It can also be ordered with no resistors installed, as model AV-CTLX-ENC.

The basic mechanical connection scheme for the AV-CTL1-ENC is shown below:



TEST ARRANGEMENT

The basic test arrangement is shown below:



NOTE: BOTH DIODES ARE SHOWN ORIENTED FOR A POSITIVE OUTPUT. REVERSE BOTH DIODES FOR NEGATIVE OPERATION.

There are several key points to note. As explained above, a resistance can optionally be added in series with the diode load, to provide transmission line matching. This resistance may also be used to monitor the current through the diode. If connected as shown above, the resistor voltage displayed on the oscilloscope is directly proportional to the diode current. It is essential the low-inductance resistors be used. Several non-inductive, medium power resistors should be used in parallel (for instance, four 3.9 Ohm 2W resistors). The Ohmite OY series (www.ohmite.com) or the RCD RSF2B series (www.rcd-comp.com) are appropriate.

It is also recommended that a low-capacitance, high-voltage, ultra-fast Schottky rectifier diode be connected for reverse-bias protection, especially for sensitive or costly devices under test. The STMicroelectronics (www.st.com) STPS3150 is an example of a suitable diode. Note, however, that the capacitance added by the protection diode may degrade the output rise time slightly.

LENZ'S LAW AND INDUCTIVE VOLTAGE SPIKES

This instrument is designed to pulse resistive and diode loads and will exhibit a large output spike when used to drive a load with significant inductance (as predicted by LENZ'S LAW). For this reason the load should be connected to the output using low inductance leads (as short as possible and as heavy a gauge as possible).

The voltage developed across an inductance L (in Henries), when the current is changing at a rate given by di_{LOAD}/dt (in Amps/sec), is: $V_{SPIKE} = L \times di_{LOAD}/dt$.

For this reason, the length of leads used to connect the load to the circuit board should be kept extremely short (< 0.5 cm).

CURRENT MEASUREMENT

Measuring current is more difficult than measuring voltage. There are three basic approaches to measuring pulsed current:

- 1) Rely on the accuracy of the amplitude setting (typically 3%), as displayed on the LCD display.
- 2) Use a high-performance current transformer, such as a Pearson 2878. The output voltage of the transformer is proportional to the sensed current. The Pearson 2878 is useful for pulse widths up to 200 us. The Pearson 410 will operate at pulse widths up to 1 ms, but the 2878 is preferred since it is physically smaller, and requires a shorter lead length. This reduces the added inductance in the load circuit, and thus minimizes inductive waveform distortions. (See the "Load Protection" section for more information on inductive distortions.)
- 3) Use a low-resistance, low-inductance, current-sensing resistor connected in series with the load. To minimize inductance, it is usually wise to connect several resistors in parallel. Beware that wirewound resistors usually have far too much inductance to be useful as current-sensing resistors.
- 4) Use the built-in current monitor. This feature provides a rear-panel output connector, whose voltage waveform is proportional to the current waveform on the main output. However, this current monitor is not calibrated. The rise and fall times are also somewhat slower than the actual output signal.

MONITOR OUTPUTS

The monitor output connectors are provided on the rear panel. When used, the monitor outputs should be terminated with 50 Ohm loads. Single polarity instruments will have two monitor outputs. Dual-polarity (-PN) units will have four monitor outputs.

The monitor output voltage (V_M) is related to the load current (I_L) by:

$$V_M \approx I_L \times 0.1 \text{ Volt/Amp, approximately}$$

when operating into 50 Ohms. Two outputs are provided for each polarity to cover narrow pulse width operation and wide pulse width operation (different current transformers are used internally.) The "MIN PW" output is use to pulse widths of 15 us

or less. The “MAX PW” output covers the full pulse width range, but tends to introduce excess overshoot on the first ~ 1 μ s of the pulse.

POLARITY CONTROL

Dual-polarity units have two output connectors, one for positive operation, and one for negative operation.

The output cable should never be moved between these two connectors when the output is “on”. The output should be “off”. Best practice is to turn the instrument off before moving the output cable.

The amplitude must be set to the correct polarity using the front-panel amplitude menu (and the +/- button), or by computer command (e.g., curr -10A).

START-UP CHECK-LIST FOR LOCAL CONTROL

1. Connect the supplied test load (AV-CTL1-ENC) to the rear-panel of the mainframe, using the AV-CLZ1-100 cable.
2. Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Set the oscilloscope to trigger externally.
3. Connect an oscilloscope probe to the signal side of the resistors in the test load. It may be necessary to connect the probe using the SMA feed-throughs on the test load enclosure. On the oscilloscope, set the channel A vertical scale to 10 V/div, and the horizontal scale to 10 us/div. (A 50 Ohm measurement system, without a high impedance probe, can also be used if desired. This may be more mechanically convenient. See the "TEST ARRANGEMENT" section for details.)
4. Turn on the instrument. The main menu will appear on the LCD.
5. To set the instrument to trigger from the internal clock at a PRF of 100 Hz:
 - a) The arrow pointer should be pointing at the frequency menu item. If it is not, press the MOVE button until it is.
 - b) Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 100 Hz.
 - c) The arrow pointer should be pointing at the "Internal" choice. If it is not, press MOVE until it is.
 - d) Press CHANGE to return to the main menu.
6. To set the delay to 100 ns:
 - a) Press the MOVE button until the arrow pointer is pointing at the delay menu item.
 - b) Press the CHANGE button. The delay submenu will appear. Rotate the ADJUST knob until the delay is set at 100 ns.
 - c) Press CHANGE to return to the main menu.
7. To set the OUT pulse width to 50 us:
 - a) Press the MOVE button until the arrow pointer is pointing at the "PW" menu item.

- b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 50 us.
 - c) The arrow pointer should be pointing at the "Normal" choice. If it is not, press MOVE until it is.
 - d) Press CHANGE to return to the main menu.
8. At this point, nothing should appear on the oscilloscope.
9. To enable the output:
 - a) Press the MOVE button until the arrow pointer is pointing at the output menu item.
 - b) Press the CHANGE button. The output submenu will appear.
 - c) Press MOVE until the arrow pointer is pointing at the "ON" choice.
 - d) Press CHANGE to return to the main menu.
10. To change the OUT output amplitude:
 - a) Press the MOVE button until the arrow pointer is pointing at the AMP menu item.
 - b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at 30 A (or -30 A for "-N" units).
 - c) Observe the oscilloscope. You should see 50 us wide, 30 V / 30 A pulses on the probe connected to the main output.
 - d) Press CHANGE to return to the main menu.
11. Try varying the pulse width, by repeating step (7). As you rotate the ADJUST knob, the pulse width on the oscilloscope will change. It should agree with the displayed value.
12. This completes the operational check.

CALIBRATION ADJUSTMENTS - SOFTWARE PROCEDURES

ADJUSTING AMPLITUDE ACCURACY

The AV-106A-B has two amplitude ranges: 0 to 4A, and 4A to 30A, approximately. The calibration of each range can be adjusted by a few percent if necessary.

If it is found that the output amplitude settings (as set by the front-panel controls or programming commands) do not agree exactly with measured values of amplitude (i.e., by examining the output on an oscilloscope) in one of these ranges, the amplitude calibration can be updated using software commands.

The following procedure is suggested:

1. Connect a precision, high-power resistive load to the output. (As an example, suppose 1 Ω is used.)
2. Connect the pulse generator to a computer using the GPIB or RS232 ports.
3. Turn on the pulse generator, and set the time controls (frequency, delay, pulse width) to typical values.
4. Turn on the outputs.
5. Set the output amplitude to 80% of the maximum current for that range. For instance, if the 0 to 30A range requires calibration, set the amplitude to 24A.
6. Observe the voltage across the load. (Using the 1 Ω example, suppose that 25V is observed.) From this, calculate the measured current (25 A in this example).
7. Send the measured value to the instrument using the following command:

```
diag:ampl:cal 25 A
```

The internal software compares the supplied measured value to the programmed value, and adjusts the internal calibration data to null out any differences.

8. Observe the voltage across the load again. The amplitude setting should now agree with the measured value.

Information on more extensive timing and amplitude calibration procedures is available at <http://www.avtechpulse.com/appnote/>.

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 10 Hz	(sets the frequency to 10 Hz)
pulse:width 5 us	(sets the pulse width to 5 us)
pulse:delay 200 ns	(sets the delay to 200 ns)
output on	(turns on the output)
source:current 17 A	(sets the current amplitude to 17 amperes)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width 5 us	(sets the pulse width to 5 us)
output on	(turns on the output)
source:current 17 A	(sets the current amplitude to 17 amperes)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

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

*rst	(resets the instrument)
trigger:source external	(selects external triggering)
pulse:width 5 us	(sets the pulse width to 5 us)
pulse:delay 200 ns	(sets the delay to 200 ns)
source:current 17 A	(sets the current amplitude to 17 amperes)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

ALL PROGRAMMING COMMANDS

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

<u>Keyword</u>	<u>Parameter</u>	<u>Notes</u>
DIAGnostic:		
:AMPLitude		
:CALibration:	<numeric value>	[no query form]
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
[SOURce]:		
:FREQuency		
[:CW FIXed]	<numeric value>	
[SOURce]:		
:CURRent		
[:LEVEl]		
[:IMMediate]		
[:AMPLitude]	<numeric value>	
:PROTection		
:TRIPped?		[query only]
[SOURce]:		
:PULSE		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DCYCLE	<numeric value>	
:HOLD	WIDTh DCYCLE	
:DELay	<numeric value>	
:GATE		
:TYPE	ASync SYNC	
:LEVEl	HIGH LOW	
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]

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.

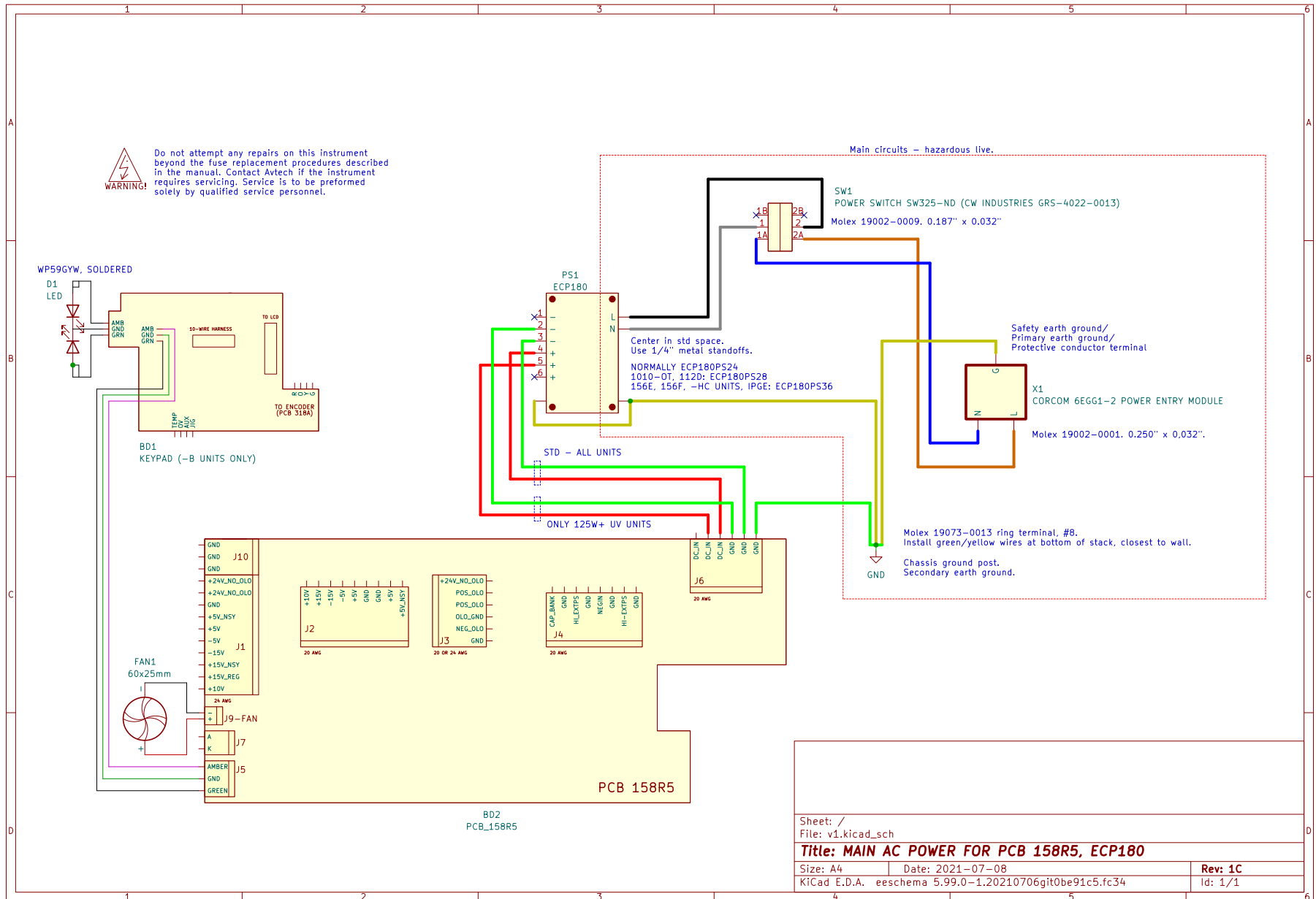
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

CLEANING

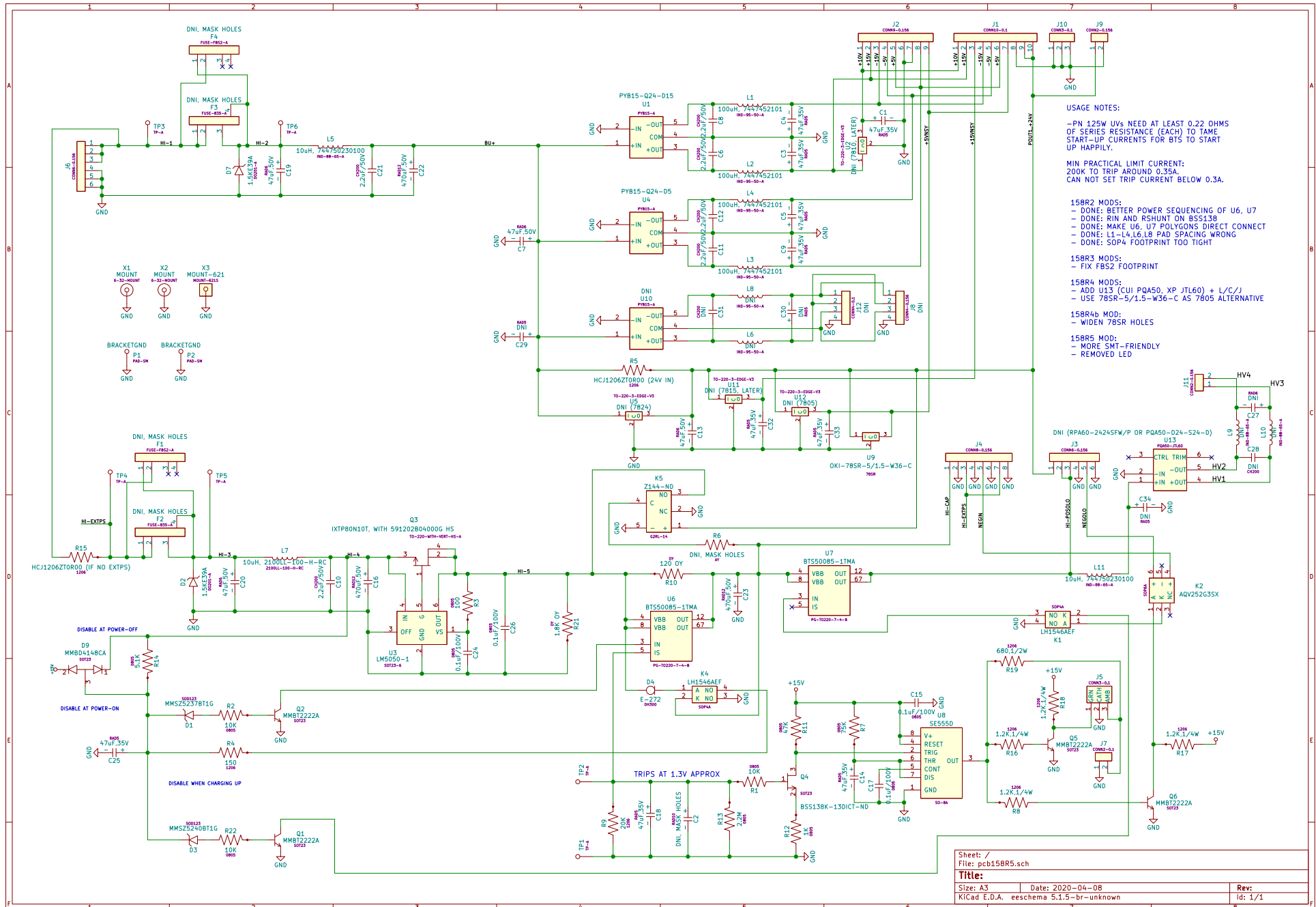
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

WIRING DIAGRAMS

WIRING OF AC POWER

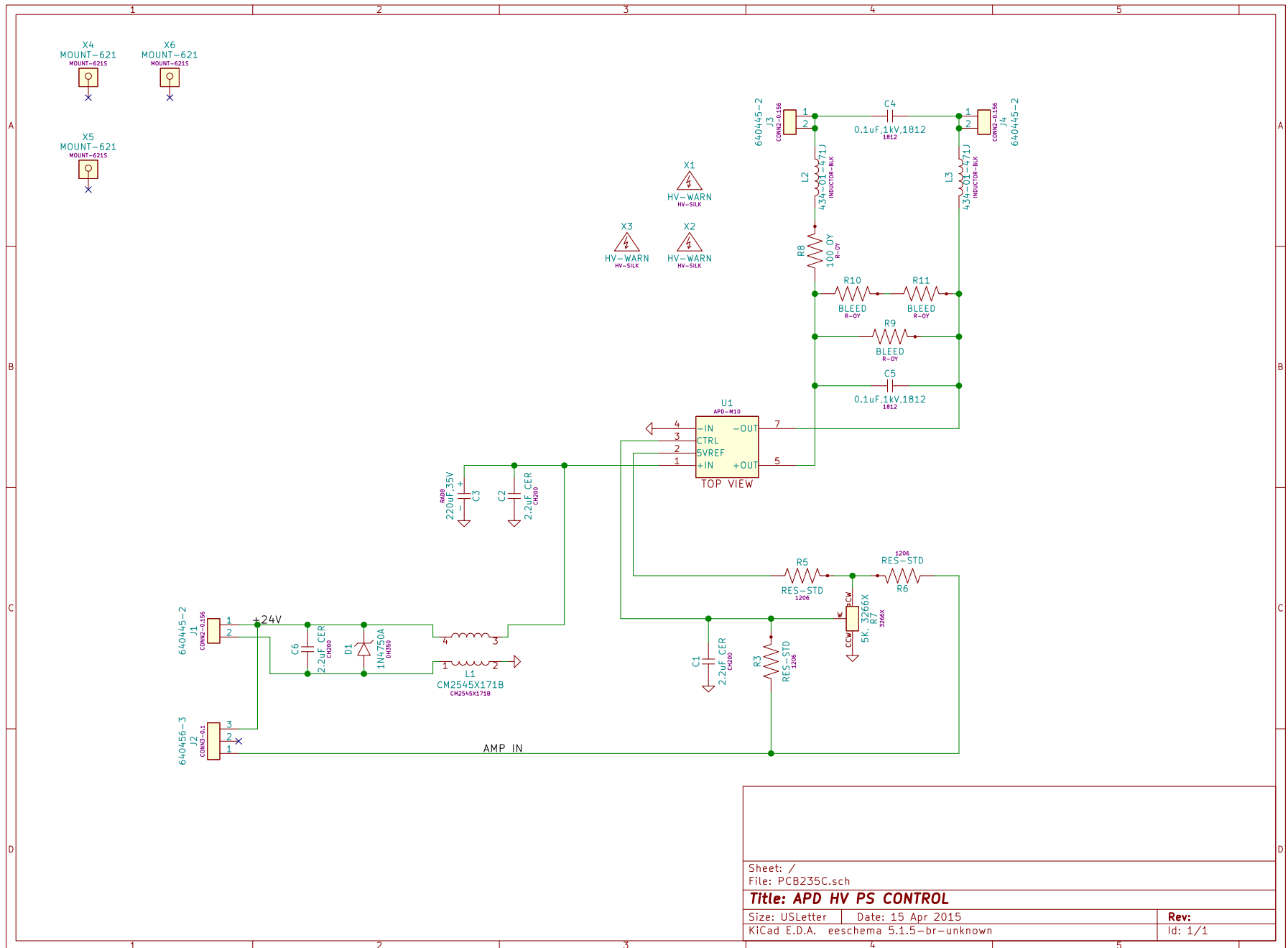


PCB 158R5 - LOW VOLTAGE POWER SUPPLY

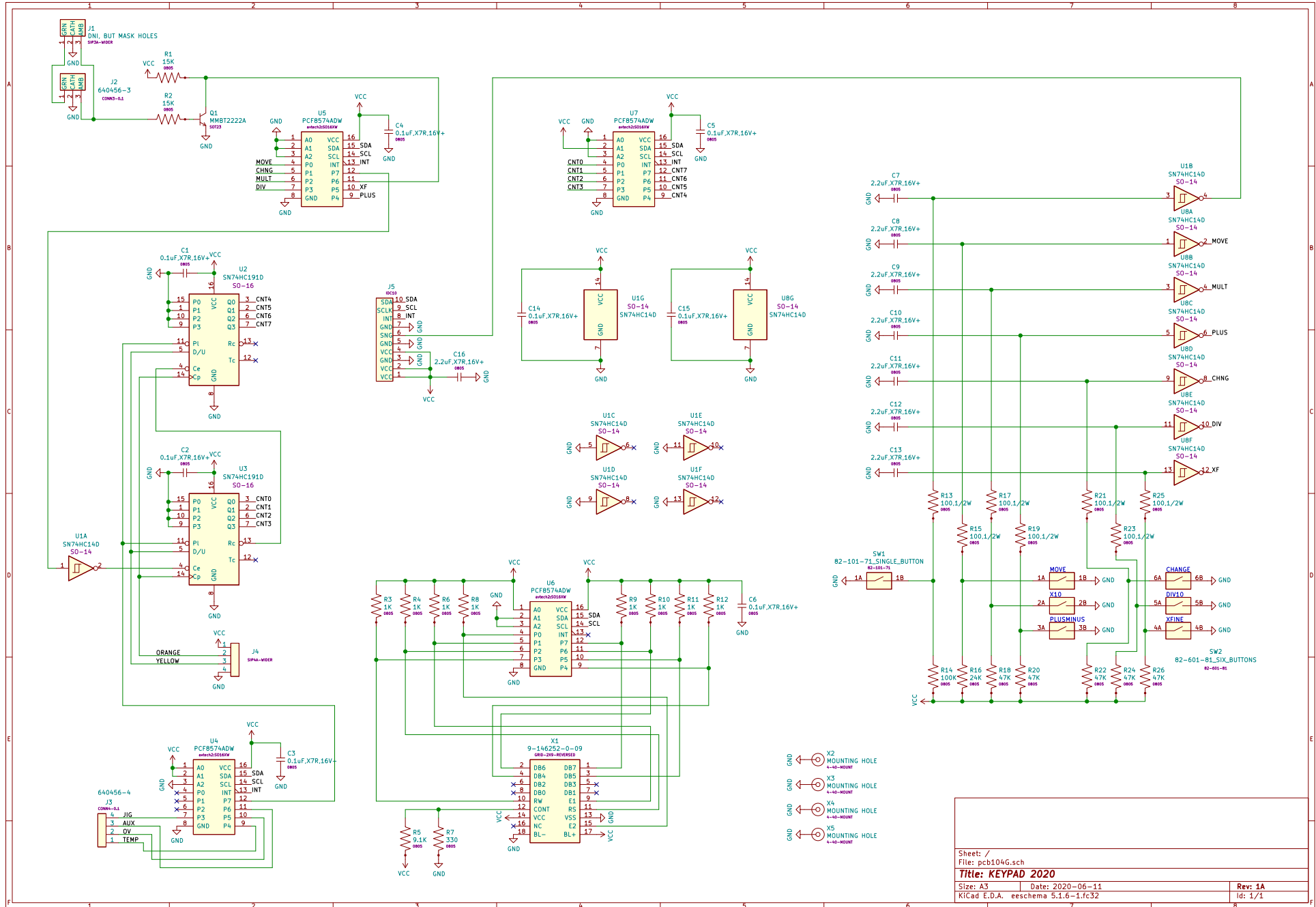


- USAGE NOTES:**
- PN 125W UVs NEED AT LEAST 0.22 OHMS OF SERIES RESISTANCE (EACH) TO TAME START-UP CURRENTS FOR BITS TO START UP HAPPILY.
 - MIN PRACTICAL LIMIT CURRENT: 200K TO TRIP AROUND 0.35A. CAN NOT SET TRIP CURRENT BELOW 0.3A.
- 158R2 MODS:**
- DONE: BETTER POWER SEQUENCING OF U6, U7
 - DONE: RIN AND RSHUNT ON B55138
 - DONE: MAKE U6, U7 POLYGONS DIRECT CONNECT
 - DONE: L1-L4, L6, L8 PAD SPACING WRONG
 - DONE: SOP4 FOOTPRINT TOO TIGHT
- 158R3 MODS:**
- FIX FB52 FOOTPRINT
- 158R4 MODS:**
- ADD U13 (CUI PQA50, XP JTL60) + L/C/J
 - USE 785R-5/1.5-W36-C AS 7805 ALTERNATIVE
- 158R4b MOD:**
- WIDEN 785R HOLES
- 158R5 MOD:**
- MORE SMT-FRIENDLY
 - REMOVED LED

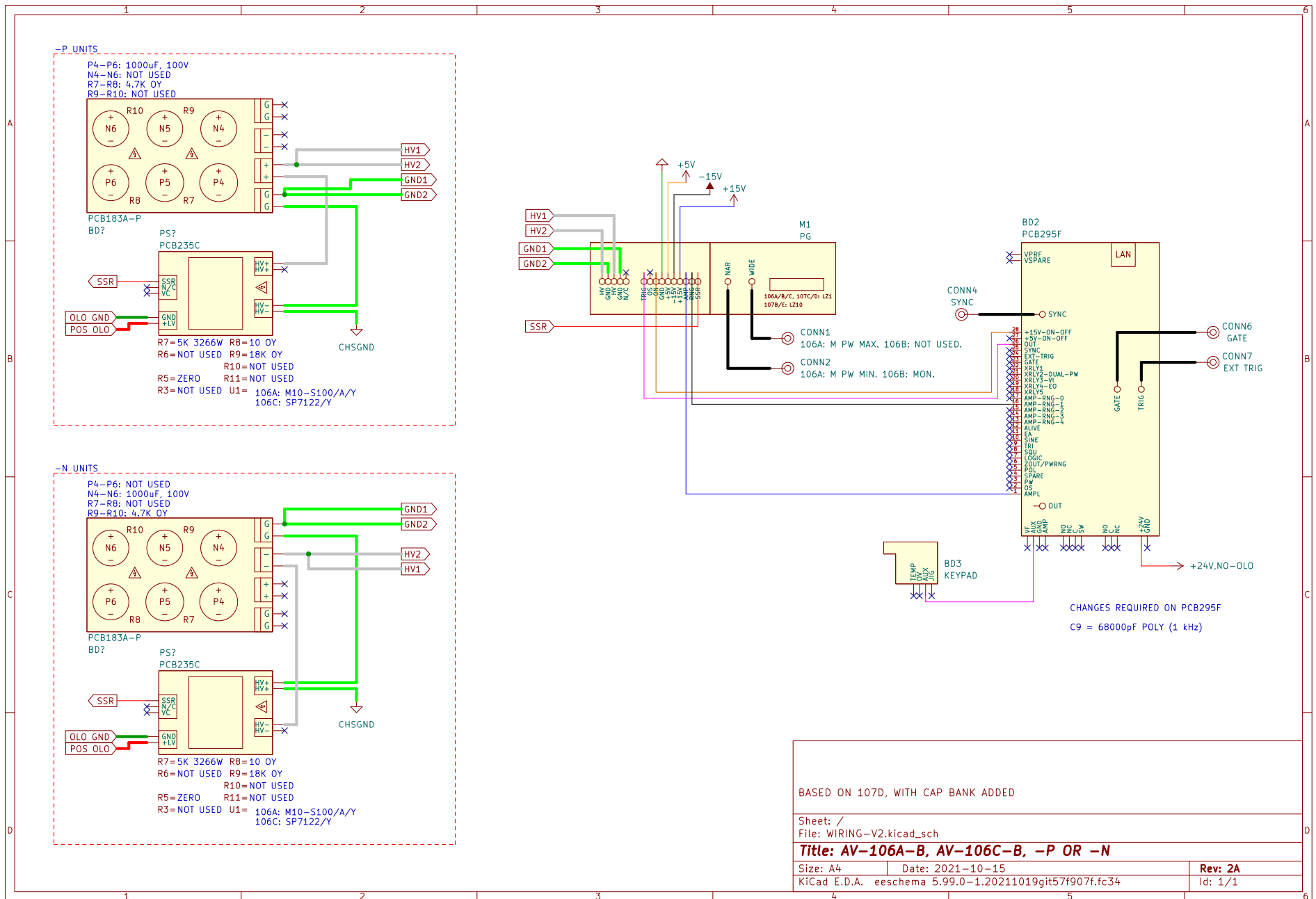
PCB 235C - HIGH VOLTAGE DC POWER SUPPLY



PCB 104G - KEYPAD / DISPLAY BOARD



MAIN WIRING



BASED ON 107D, WITH CAP BANK ADDED

Sheet: /
File: WIRING-V2.kicad_sch

Title: AV-106A-B, AV-106C-B, -P OR -N

Size: A4 Date: 2021-10-15

Rev: 2A

KiCad E.D.A. eeschema 5.99.0-1.20211019git57f907f.fc34

Id: 1/1

PERFORMANCE CHECK SHEET