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SINCE 1975

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## INSTRUCTIONS

MODEL AV-106A-B

0 to 30 AMP, 0 to 30 V, 50 ns RISE TIME  
LASER DIODE DRIVER  
WITH IEEE 488.2 AND RS-232 CONTROL

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

### WARRANTY

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

### TECHNICAL SUPPORT

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Manual Reference: /files/officefiles/instructword/av-106/AV-106A-B,edition3.odt.

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## 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 1000 Hz, and pulse widths can vary from 500 ns to 50 us. 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  $1\Omega$  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 <sup>1</sup> :                     | AV-106A-B   |
| Amplitude <sup>2,3</sup> :               | 0 to 30 Amperes   |
| Load voltage range:                      | 0 to 30 Volts   |
| Pulse width:                             | 0.5 to 50 us  |
| Rise time, fall time:                    | ≤ 50 ns   |
| PRF:                                     | 0 to 1 kHz  |
| Duty cycle: (max)                        | 0.25%   |
| Output impedance:                        | ≥ 50 Ohms   |
| Output regulation:                       | ≤ ±5% change in current for a load voltage change from 0 Volts to maximum rated load voltage  |
| Polarity <sup>4</sup> :                  | Positive or negative or both (specify)  |
| GPIB & RS-232 control <sup>1</sup> :     | Standard on -B units.   |
| LabView drivers:                         | Check <a href="http://www.avtechpulse.com/labview">http://www.avtechpulse.com/labview</a> for availability and downloads  |
| Controls:                                | Keypad and adjust knob, and GPIB / RS-232 control.  |
| Telnet / Ethernet control:               | Optional <sup>5</sup> .<br>See <a href="http://www.avtechpulse.com/options/tnt">http://www.avtechpulse.com/options/tnt</a> for details.                                     |
| Propagation delay (Jitter):              | ≤ 100 ns, (± 100 ps ± 0.03% of sync delay, Ext trig in to pulse out)  |
| Ext. trigger in:                         | Mode A: + 5 Volts, 50 ns or wider (TTL),<br>Mode B: + 5 Volts, PW <sub>IN</sub> = PW <sub>OUT</sub> (TTL)   |
| Sync to pulse out delay:                 | 0 to ± 1 second   |
| Sync output:                             | + 3 Volt, 200 ns, will drive 50 Ohm loads   |
| Gate input:                              | Synchronous or asynchronous, active high or low, switchable.<br>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.<br>See <a href="http://www.avtechpulse.com/transmission">http://www.avtechpulse.com/transmission</a> for details. |
| Part number:<br>length, Z <sub>0</sub> : | AV-CLZ1-100 (see <a href="http://www.avtechpulse.com/transmission/av-clz1">http://www.avtechpulse.com/transmission/av-clz1</a> )<br>1 Ω, 100 cm                             |
| Output connection:                       | End of cable: DB-37 male. Pins 1-19 = signal, pins 20-37 = ground.  |
| Supplied test load <sup>6</sup> :        | AV-CTL1-ENC.<br>See <a href="http://www.avtechpulse.com/accessories/av-ctl1">http://www.avtechpulse.com/accessories/av-ctl1</a> 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 GPIB and RS-232 control of amplitude, pulse width, PRF and delay (see <http://www.avtechpulse.com/gpib> for details).
- 2) For analog electronic control (0 to + 10 V) of amplitude, suffix model the model number with -EA. Electronic control units also include standard front-panel controls and computer control capability.
- 3) The minimum useful amplitude is 3% of the maximum amplitude.
- 4) Indicate desired polarity by suffixing the model number with -P or -N (i.e. positive or negative) or -PN for dual polarity option.
- 5) Add the suffix -TNT to the model number to specify the Telnet / Ethernet control option.
- 6) 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.

## EUROPEAN REGULATORY NOTES

### EC DECLARATION OF CONFORMITY

We Avtech Electrosystems Ltd.  
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Ottawa, Ontario  
Canada K2C 3H4

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

EN 50081-1 Emission

EN 50082-1 Immunity

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

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



### DIRECTIVE 2002/95/EC (RoHS)

This instrument is exempt from Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the use of certain Hazardous Substances (RoHS) in electrical and electronic equipment. Specifically, Avtech instruments are considered "Monitoring and control instruments" (Category 9) as defined in Annex 1A of Directive 2002/96/EC. The Directive 2002/95/EC only applies to Directive 2002/96/EC categories 1-7 and 10, as stated in the "Article 2 - Scope" section of Directive 2002/95/EC.

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

European customers who have purchased this equipment directly from Avtech will have completed a "WEEE Responsibility Agreement" form, accepting responsibility for WEEE

compliance (as mandated in Directive 2002/96/EC of the European Union and local laws) on behalf of the customer, as provided for under Article 9 of Directive 2002/96/EC.

Customers who have purchased Avtech equipment through local representatives should consult with the representative to determine who has responsibility for WEEE compliance. Normally, such responsibilities will lie with the representative, unless other arrangements (under Article 9) have been made.

Requirements for WEEE compliance may include registration of products with local governments, reporting of recycling activities to local governments, and financing of recycling activities.





## INSTALLATION

### VISUAL CHECK

After unpacking the instrument, examine to ensure that it has not been damaged in shipment. Visually inspect all connectors, knobs, liquid crystal displays (LCDs), and the handles. 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                             | Manufacturer  | Part Number  |
|---------------------------------------|---|---|--------------|
| Continental Europe                    | European CEE 7/7<br>"Schuko" 230V, 50Hz | Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )             | 17850-C3-326 |
|                                       |   | Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> ) | 319004-T01   |
| United Kingdom                        | BS 1363,<br>230V, 50Hz                  | Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> ) | 370001-E01   |
| Switzerland                           | SEV 1011, 2<br>30V, 50Hz                | Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )             | 2102H-C3-10  |
| Israel                                | SI 32,<br>220V, 50Hz                    | Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )             | 2115H-C3-10  |
| North America,<br>and all other areas | NEMA 5-15,<br>120V, 60 Hz               | Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> ) | 312007-01    |

### PROTECTION FROM ELECTRIC SHOCK

 Operators of this instrument must be protected from electric shock at all times. The owner must ensure that operators are prevented access and/or are insulated from every connection point. In some cases, connections must be exposed to potential human contact. Operators must be trained to protect themselves from the risk of electric shock. This instrument is intended for use by qualified personnel who recognize shock hazards and are familiar with safety precautions required to avoid possibly injury. In particular, operators should:

1. Keep exposed high-voltage wiring to an absolute minimum.
2. Wherever possible, use shielded connectors and cabling.
3. Connect and disconnect loads and cables only when the instrument is turned off.
4. Keep in mind that all cables, connectors, oscilloscope probes, and loads must have an appropriate voltage rating.
5. Do not attempt any repairs on the instrument, beyond the fuse replacement procedures described in this manual. Contact Avtech technical support (see page 2 for contact information) if the instrument requires servicing. Service is to be performed solely by qualified service personnel.

### ENVIRONMENTAL CONDITIONS

This instrument is intended for use under the following conditions:

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

### LABVIEW DRIVERS

A LabVIEW driver for this instrument is available for download on the Avtech web site, at <http://www.avtechpulse.com/labview>. A copy is also available in National Instruments' Instrument Driver Library at <http://www.natinst.com/>.

## FUSES

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



### AC FUSE REPLACEMENT

To physically access the AC fuses, the power cord must be detached from the rear panel of the instrument. The fuse drawer may then be extracted using a small flat-head screwdriver, as shown below:



## DC FUSE REPLACEMENT

The DC fuses may be replaced by inserting the tip of a flat-head screwdriver into the fuse holder slot, and rotating the slot counter-clockwise. The fuse and its carrier will then pop out.

## FUSE RATINGS

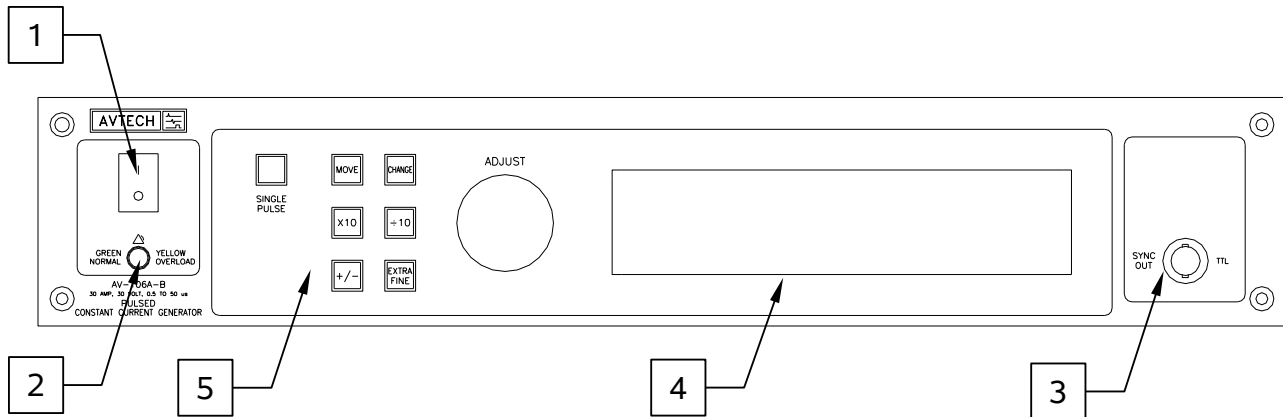
The following table lists the required fuses:

| Fuses       | Nominal Mains Voltage | Rating                 | Case Size | Recommended Replacement Part |                       |
|-------------|-----------------------|------------------------|-----------|------------------------------|-----------------------|
|             |                       |                        |           | Littelfuse Part Number       | Digi-Key Stock Number |
| #1, #2 (AC) | 100-240V              | 0.5A, 250V, Time-Delay | 5×20 mm   | 0218.500HXP                  | F2416-ND              |
| #3 (DC)     | N/A                   | 1.6A, 250V, Time-Delay | 5×20 mm   | 021801.6HXP                  | F2424-ND              |
| #4 (DC)     | N/A                   | 0.5A, 250V, Time-Delay | 5×20 mm   | 0218.500HXP                  | F2416-ND              |

The recommended fuse manufacturer is Littelfuse (<http://www.littelfuse.com>).

Replacement fuses may be easily obtained from Digi-Key (<http://www.digikey.com>) and other distributors.

## FRONT PANEL CONTROLS



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

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

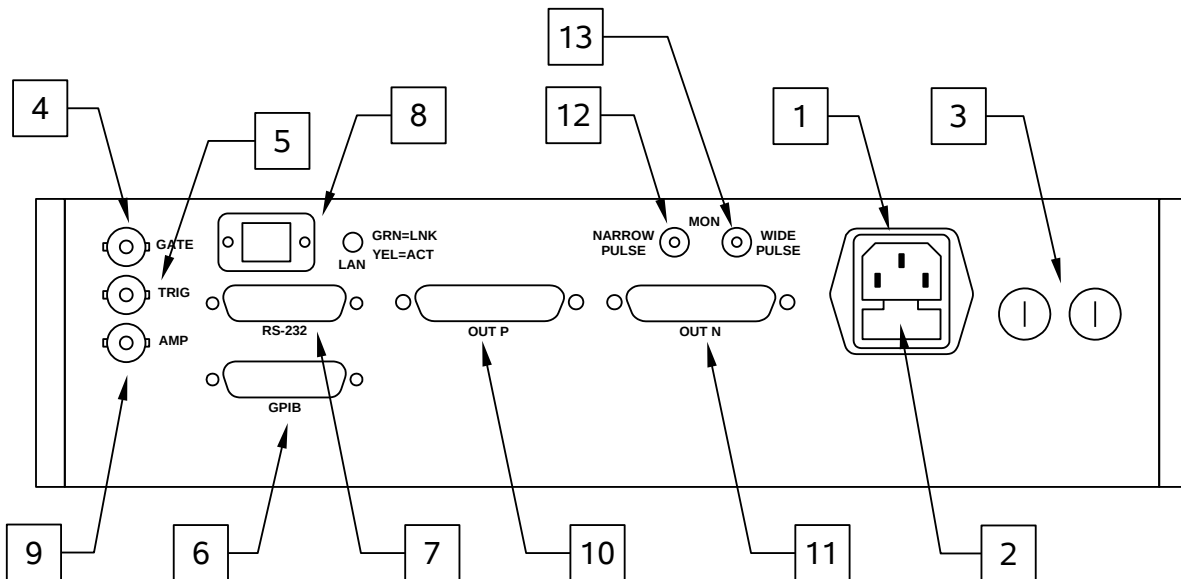
Note that the output stage will safely withstand a short-circuited load condition.

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.<br><br>When the main menu is displayed, this knob can be used to move the arrow pointer. |

## REAR PANEL CONTROLS



1. AC POWER INPUT. An IEC-320 C14 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket.
2. AC FUSE DRAWER. The two fuses that protect the AC input are located in this drawer. Please see the “FUSES” section of this manual for more information.
3. DC FUSES. These two fuses protect the internal DC power supplies. Please see the “FUSES” sections of this manual for more information.
4. GATE. This TTL-level (0 and +5V) logic input can be used to gate the triggering of the instrument. This input can be either active high or active low, depending on the front panel settings or programming commands. (The instrument triggers normally when this input is unconnected). When set to active high mode, this input is pulled-down to ground by a 1 k $\Omega$  resistor. When set to active low mode, this input is pulled-up to +5V by a 1 k $\Omega$  resistor.
5. TRIG. This TTL-level (0 and +5V) logic input can be used to trigger the instrument, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input. The input impedance of this input is 1 k $\Omega$ . (Depending on the length of cable attached to this input, and the source driving it, it may be desirable to add a coaxial 50 Ohm terminator to this input to provide a proper transmission line termination. The Pasternack ([www.pasternack.com](http://www.pasternack.com)) PE6008-50 BNC feed-thru 50 Ohm terminator is suggested for this purpose.)

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. See the “Programming Manual for -B Instruments” for more details on RS-232 control.
8. LAN Connector and Indicator. (Optional feature. Present on -TNT units only.) The -TNT option "Internet-enables" Avtech pulse generators by adding this standard Ethernet port to the rear panel, in addition to the IEEE-488.2 GPIB and RS-232 ports normally found on "-B" units. Commands may be sent using the standard Telnet protocol, or using a web browser. The SCPI-compliant command set is the same as that used for GPIB and RS-232 control. The -TNT option uses the Dynamic Host Configuration Protocol (DHCP) to obtain its network address. A DHCP server must be present on the local network for the -TNT option to operate properly.
9. AMP Connector. (Active on units with the -EA option only.) The output amplitude can be set to track the voltage on this input. Zero Volts in corresponds to zero amplitude output, and +10V in corresponds to maximum amplitude out. This mode is activated by selecting "Ext Control" on the front-panel amplitude menu, or with the "source:voltage external" command.
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 – NARROW PULSE. The “NARROW PULSE” monitor output connector is the output of an AC-coupled current transformer. It is only useful for pulse widths of 3 us or less. At wider pulse widths, the transformer will saturate and the monitor output will cease to be accurate. This monitor output accurately reproduces the rising edge of the current pulse. The monitor output voltage( $V_M$ ) is related to the load current ( $I_L$ ) by:

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

This output must be terminated with a 50 Ohm load when used.

13. MON – WIDE PULSE. The “WIDE PULSE” monitor output connector is the output of an DC-coupled differential amplifier monitoring the current through a small resistance in series with the output. It is only useful for pulse widths of 3 us or wider. At narrower pulse widths, inductive artifacts (“spikes”) on the rising and falling edges distort the measurement too much. This monitor output does not accurately reproduce the rising edge of the current pulse. The monitor output voltage ( $V_M$ ) is related to the load current ( $I_L$ ) by:

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

This output must be terminated with a 50 Ohm load when used.

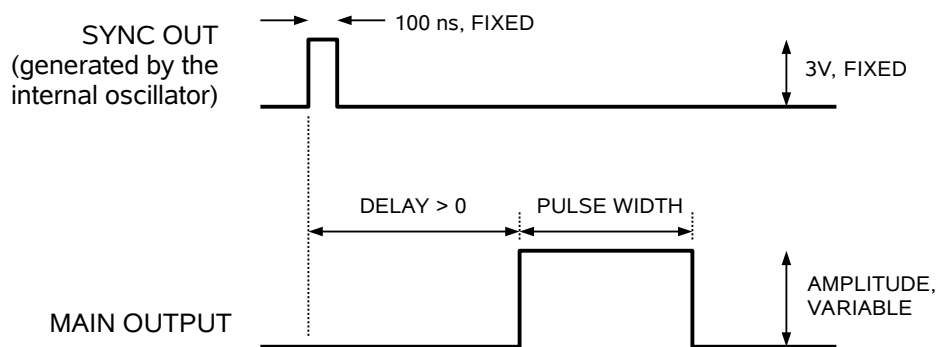
## GENERAL INFORMATION - PULSE GENERATOR TIMING

### 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.

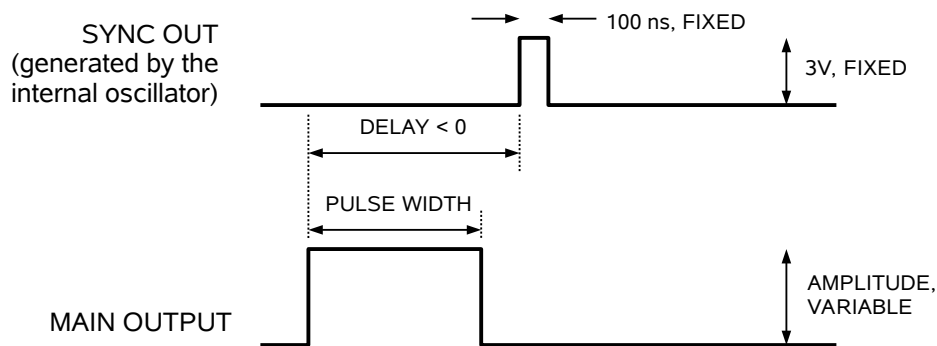
In the diagrams below, positive amplitude is assumed. (For “-N” units, the output waveforms are inverted in polarity.)

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



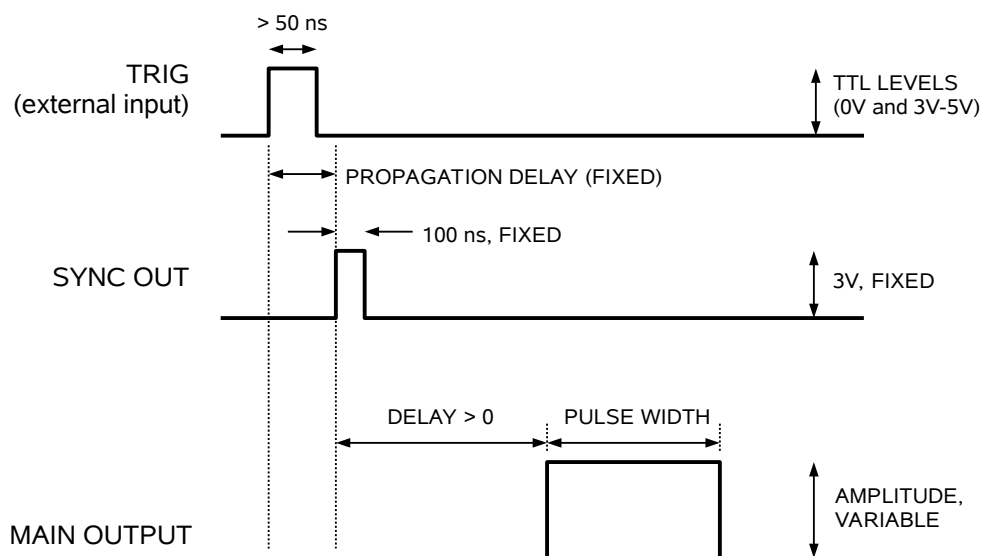
*Basic Output Pulses for Delay > 0*

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

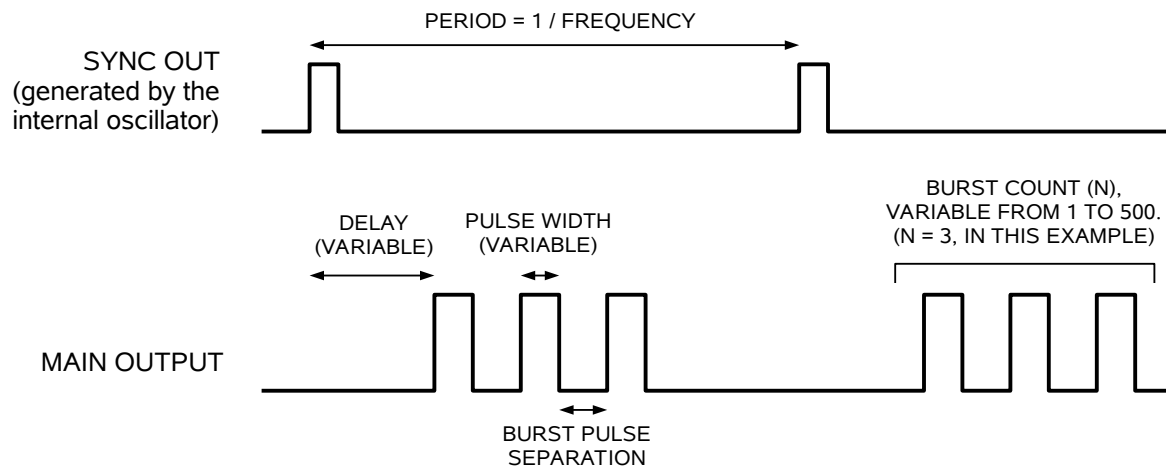
Triggering can be suppressed by a TTL-level signal on the rear-panel GATE connector. The instrument can be set to stop triggering when this input high or low, using the front-panel gate menu or the appropriate programming commands. This input can also be set to act synchronously or asynchronously. When 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.

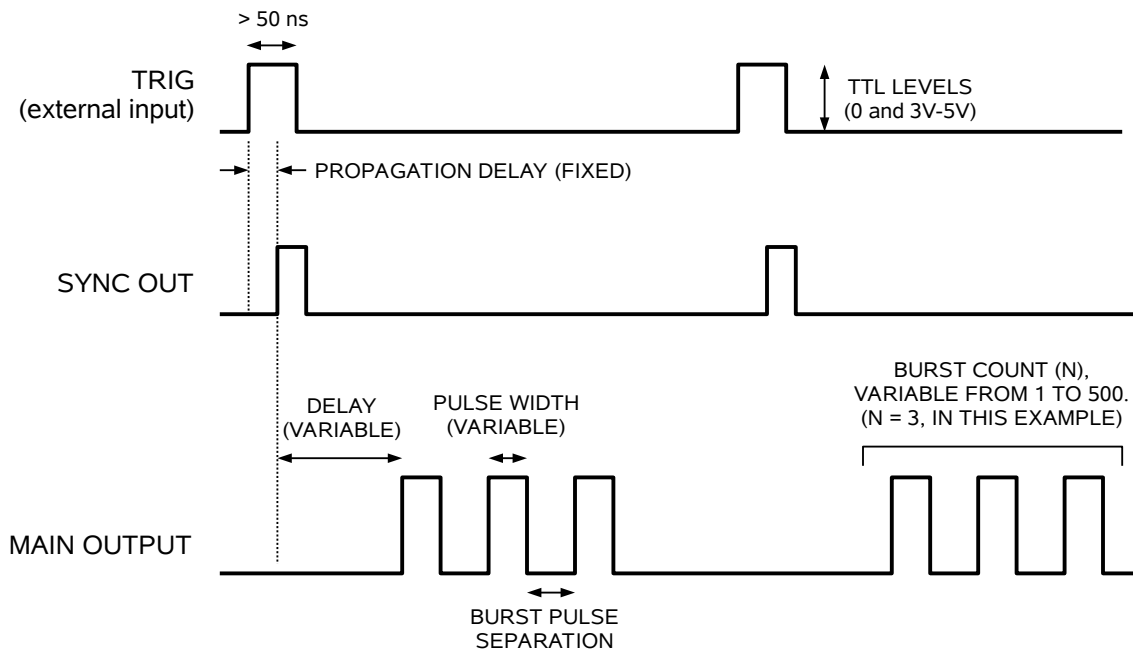
### BURST GENERATION (-BR OPTION)

The waveforms given above assume that a single output pulse is generated for each trigger event (regardless of the source). However, when the burst mode feature is used on units with the -BR option, the instrument can generate 1-500 pulses for each individual trigger event. The number of output pulses in each burst can be adjusted from 1 to 500 using the front-panel controls (using the “N” menu), or by a computer command. The time between pulses (i.e., from the falling edge of one pulse to the rising edge of the next pulse) can also be varied from 1 ms to 1.0 seconds from the front panel (using the “BUR” menu), or by computer command.

The figure below shows burst mode operation (i.e.,  $N > 1$ ) used with internal triggering:



The figure below shows burst mode operation used with external triggering:



The burst mode may also be used with the front-panel “Single Pulse” pushbutton as a trigger source. (Pressing the pushbutton will actually generate a single burst, rather than a single pulse, in this mode.) Computer commands can also trigger a burst.

To control the burst count and timing from the front-panel, use the “N” and “BUR” menus. To control them using computer commands, use the `SOURce:PULSe:COUNT` and `SOURce:PULSe:SEPARation` commands, as described in the programming manual.

The pulse spacing is constrained by several factors:

1. The maximum PRF limitation of the instrument applies within the burst. That is, timing between two consecutive leading edges must lie between a minimum of  $1/\text{PRF}_{\text{MAX}}$  and a maximum of 1.0 seconds, where  $\text{PRF}_{\text{MAX}}$  is the maximum pulse repetition frequency specification for the instrument.

For this instrument, the maximum PRF for the instrument is 1 kHz, so the time between two leading edges within the burst may not be smaller than 1.0 milliseconds. The total number of pulses per second (i.e., Trigger Frequency x Burst Count) must also be less than 1 kHz.

2. The maximum duty cycle limitation of the instrument can not be exceeded inside the burst. Within the burst, the duty cycle may be calculated using  $\text{DC}_{\text{BURST}} = 100\% \times \text{Pulse Width} / (\text{Pulse Width} + \text{Pulse Separation})$ . The total average duty cycle is equal to  $\text{DC}_{\text{AVG}} = 100\% \times \text{Pulse Width} \times \text{Burst Count} \times \text{Trigger Frequency}$ . Both  $\text{DC}_{\text{BURST}}$  and  $\text{DC}_{\text{AVG}}$  must be less than the rated maximum duty cycle of the instrument.

For this instrument, the maximum duty cycle is 0.25%.

## 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 30V 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  $3.9\Omega / 4 \approx 1.0\Omega$ .

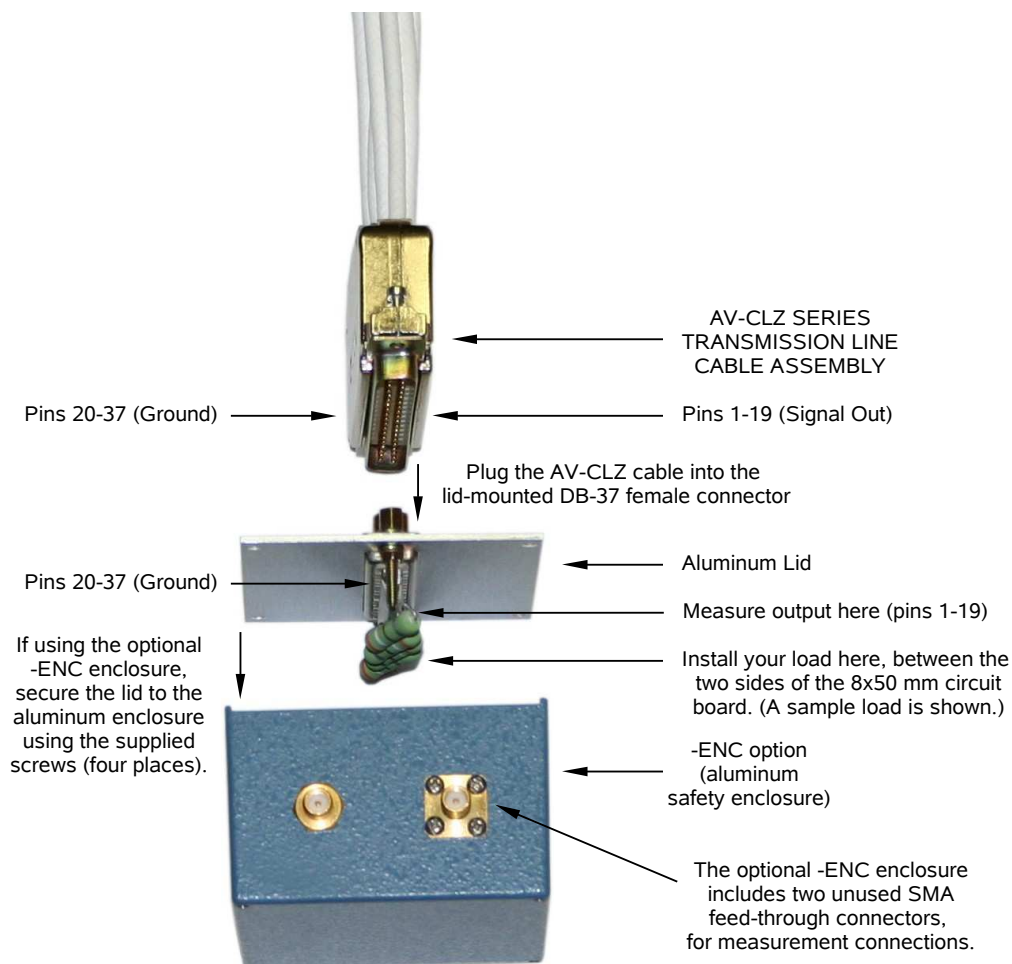
Two unused SMA connectors are provided for making connections through the chassis wall, if desired. A 5/16" hole, plugged with a screw is also provided. The screw may be removed to provide an access hole to the interior of the chassis.

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.

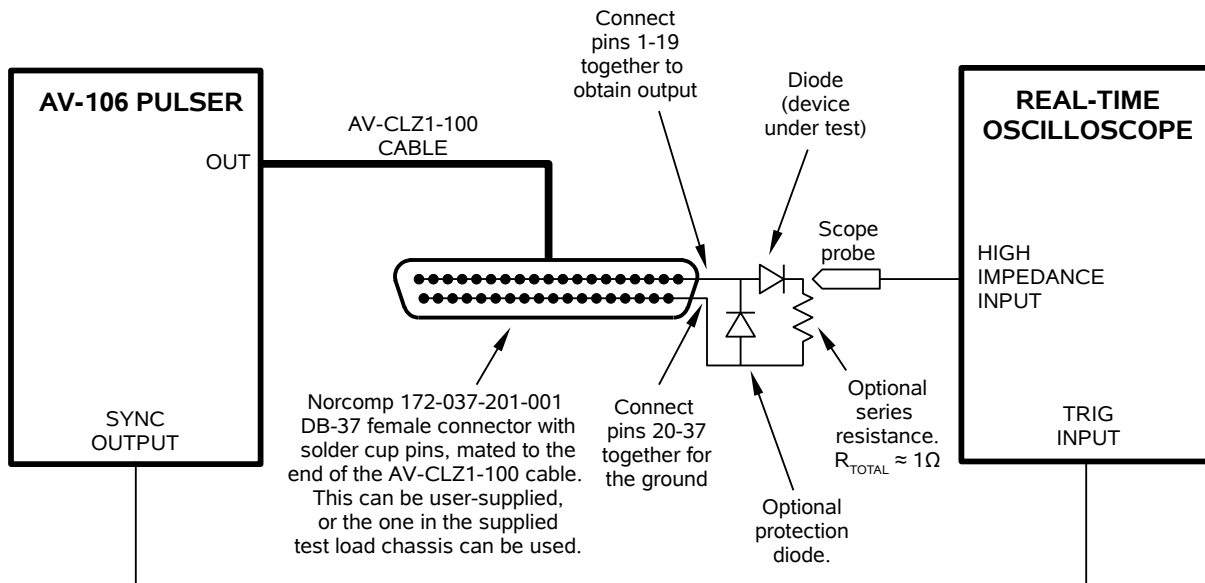
The basic mechanical connection scheme for the AV-CTL1-ENC is shown below:





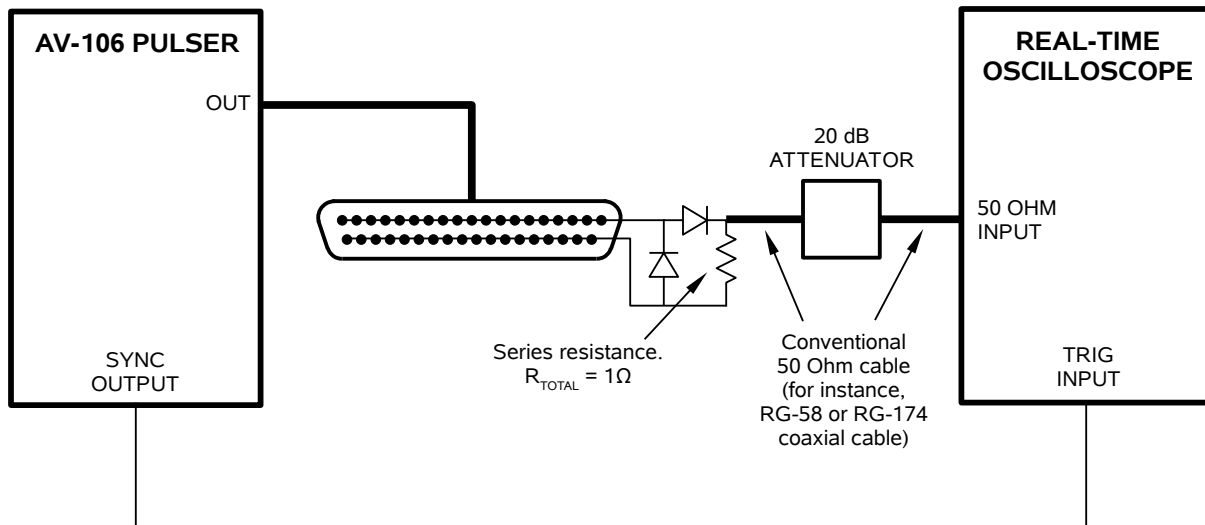
## TEST ARRANGEMENT

The basic test arrangement is shown below:



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

The diagram above shows how high-impedance oscilloscope probe can be used to observe the waveform. However, since the load impedance is so low (1 Ohm), a 50 Ohm measurement system like that shown in the diagram below can also be used to observe the load waveform. An attenuator should be used to avoid damaging the oscilloscope input, since the load voltage can be as high as 30V. (Two SMA connectors are present in the AV-CTL1-ENC test load, and either can be used to connect the 50 Ohm coaxial cables through the chassis wall.)



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](http://www.ohmite.com)) or the RCD RSF2B series ([www.rcd-comp.com](http://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 APT ([www.advancedpower.com](http://www.advancedpower.com)) APT15S20K 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 5%), 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  $\mu$ s. 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 "-M" current monitor. This optional feature provides a rear-panel output connector, whose voltage waveform is proportional to the current waveform on the main output.

## MONITOR OUTPUTS

The monitor output connectors are provided on the rear panel. When used, the monitor outputs should be terminated with 50 Ohm loads.

The "NARROW PULSE" monitor output connector is the output of an AC-coupled current transformer. It is only useful for pulse widths of 3  $\mu$ s or less. At wider pulse widths, the transformer will saturate and the monitor output will cease to be accurate. This monitor output accurately reproduces the rising edge of the current pulse.

The "WIDE PULSE" monitor output connector is the output of a DC-coupled differential amplifier monitoring the current through a small resistance in series with the output. It is only useful for pulse widths of 3  $\mu$ s or wider. At narrower pulse widths, inductive artifacts ("spikes") on the rising and falling edges distort the measurement too much.

For both outputs, the monitor output voltage ( $V_M$ ) is related to the load current ( $I_L$ ) by:

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

These ratios are only valid when the monitor output is terminated with a 50 Ohm load.

### 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  $1\Omega$  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  $1\Omega$  example, suppose that 24.6V is observed.) From this, calculate the measured current (24.6 A in this example).
7. Send the measured value to the instrument using the following command:

```
diag:ampl:cal 24.6 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 500 ns      | (sets the pulse width to 500 ns)           |
| 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 500 ns       | (sets the pulse width to 500 ns)                  |
| 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 500 ns      | (sets the pulse width to 500 ns)           |
| 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]                  |
| LOCAL          |                   |                                  |
| OUTPut:        |                   |                                  |
| :[STATe]       | <boolean value>   |                                  |
| :PROTection    |                   |                                  |
| :TRIPped?      |                   | [query only]                     |
| REMOTE         |                   |                                  |
| [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          |                   |                                  |
| :ADDRes        | <numeric value>   |                                  |
| :SERial        |                   |                                  |
| :CONTRol       |                   |                                  |
| :RTS           | ON   IBFull   RFR |                                  |
| :[RECeive]     |                   |                                  |




|           |   |                 |
|-----------|---|-----------------|
| :BAUD     | 1200   2400   4800   9600                       |                 |
| :BITS     | 7   8   |                 |
| :ECHO     | <boolean value>                                 |                 |
| :PARity   |   |                 |
| :[TYPE]   | EVEN   ODD   NONE                               |                 |
| :SBITS    | 1   2   |                 |
| :ERRor    |   |                 |
| :[NEXT]?  |   | [query only]    |
| :COUNT?   |   | [query only]    |
| :VERSion? |   | [query only]    |
| TRIGger:  |   |                 |
| :SOURce   | INTernal   EXTernal   MANual   HOLD   IMMEDIATE |                 |
| *CLS      |   | [no query form] |
| *ESE      | <numeric value>                                 |                 |
| *ESR?     |   | [query only]    |
| *IDN?     |   | [query only]    |
| *OPC      |   |                 |
| *SAV      | 0   1   2   3                                   | [no query form] |
| *RCL      | 0   1   2   3                                   | [no query form] |
| *RST      |   | [no query form] |
| *SRE      | <numeric value>                                 |                 |
| *STB?     |   | [query only]    |
| *TST?     |   | [query only]    |
| *WAI      |   | [no query form] |


## MECHANICAL INFORMATION

### TOP COVER REMOVAL

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

 Always disconnect the power cord and allow the instrument to sit unpowered for 10 minutes before opening the instrument. This will allow any internal stored charge to discharge.

There are no user-adjustable internal circuits. For repairs other than fuse replacement, please contact Avtech (info@avtechpulse.com) to arrange for the instrument to be returned to the factory for repair. Service is to be performed solely by qualified service personnel.

 Caution: High voltages are present inside the instrument during normal operation. Do not operate the instrument with the cover removed.

### RACK MOUNTING

A rack mounting kit is available. The -R5 rack mount kit may be installed after first removing the one Phillips screw on the side panel adjacent to the front handle.

### ELECTROMAGNETIC INTERFERENCE

To prevent electromagnetic interference with other equipment, all used outputs should be connected to shielded loads using shielded coaxial cables. Unused outputs should be terminated with shielded coaxial terminators or with shielded coaxial dust caps, to prevent unintentional electromagnetic radiation. All cords and cables should be less than 3m in length.

## MAINTENANCE

### REGULAR MAINTENANCE

This instrument does not require any regular maintenance.

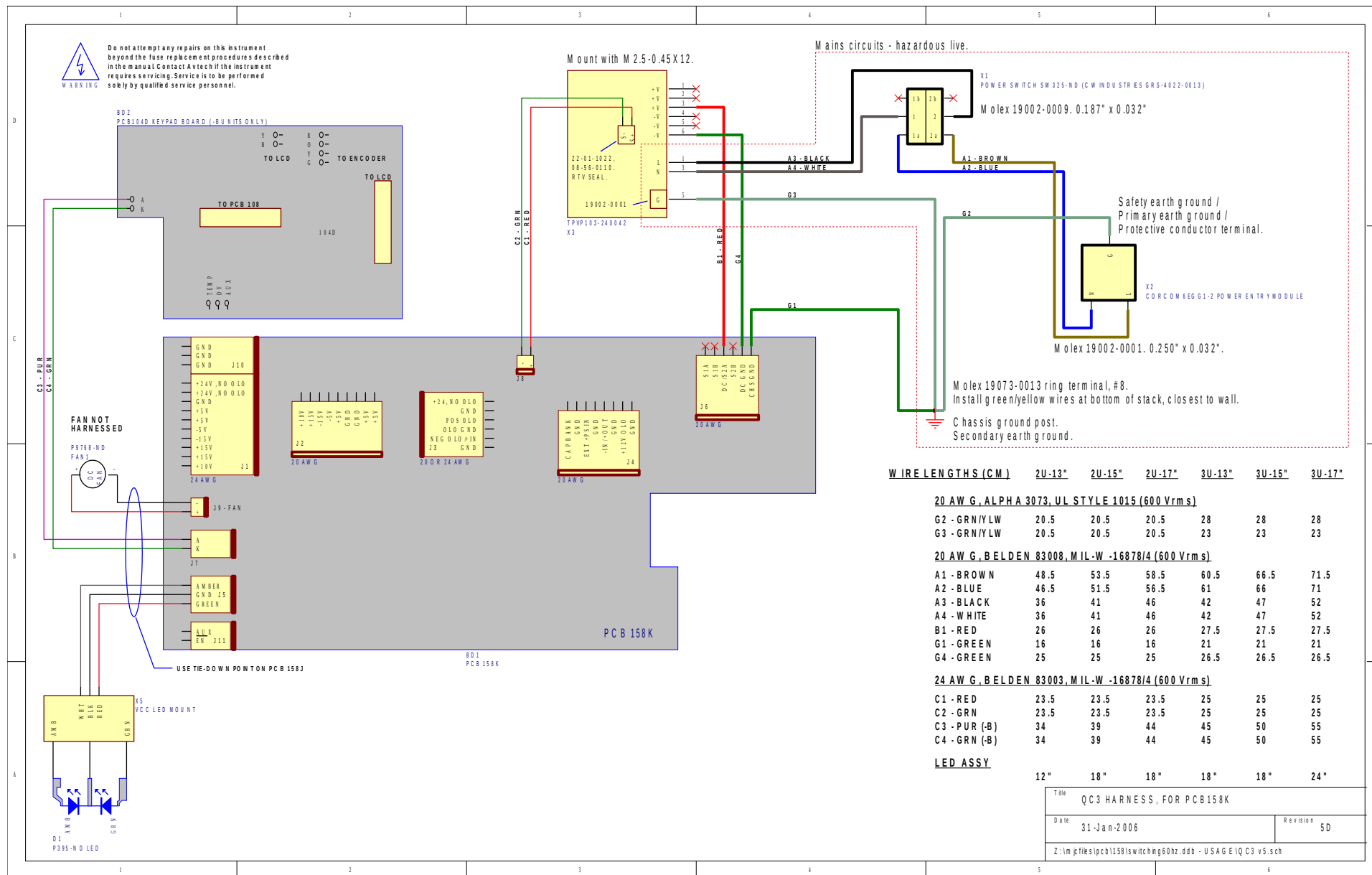
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

### CLEANING

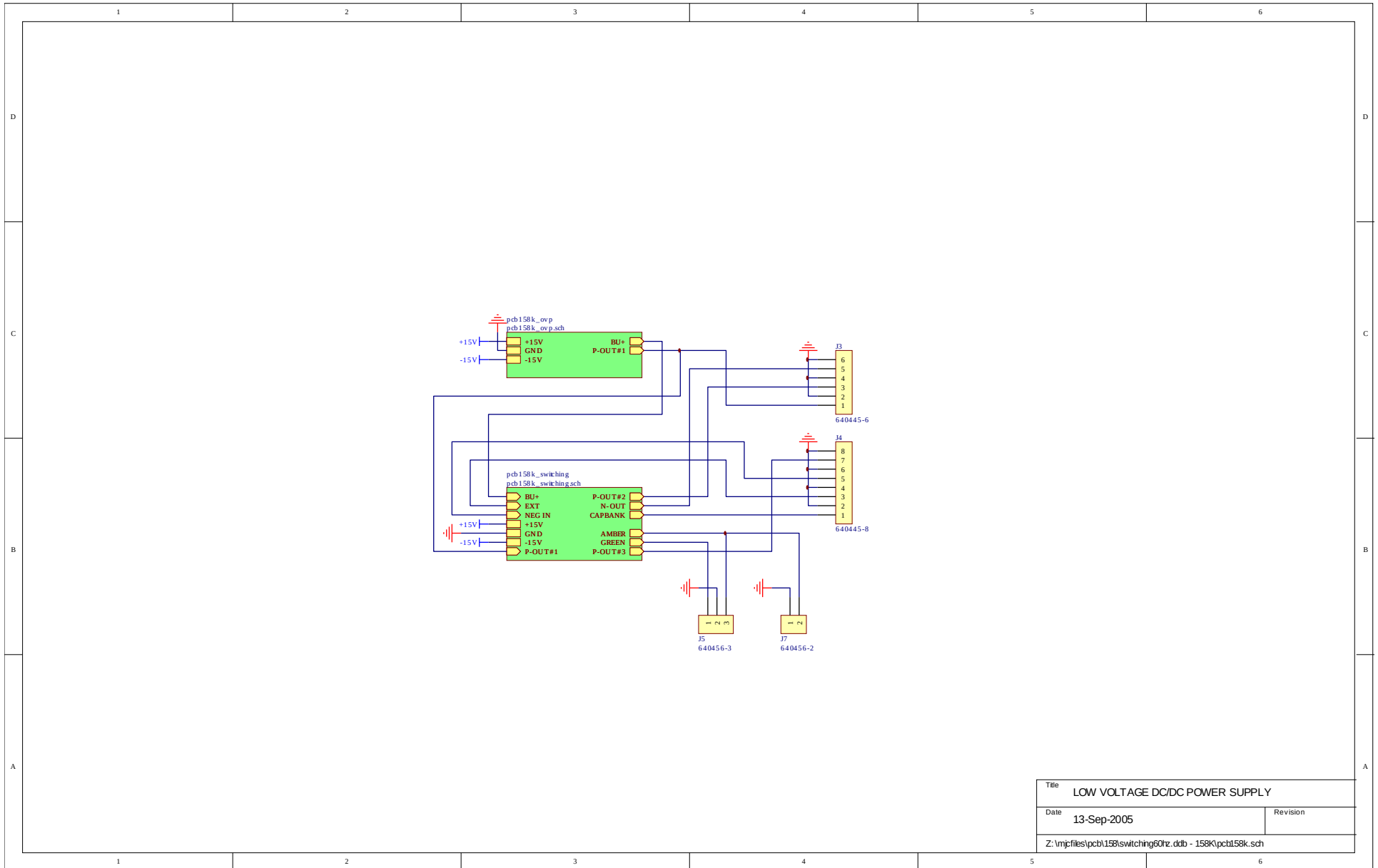
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

# WIRING DIAGRAMS

## WIRING OF AC POWER

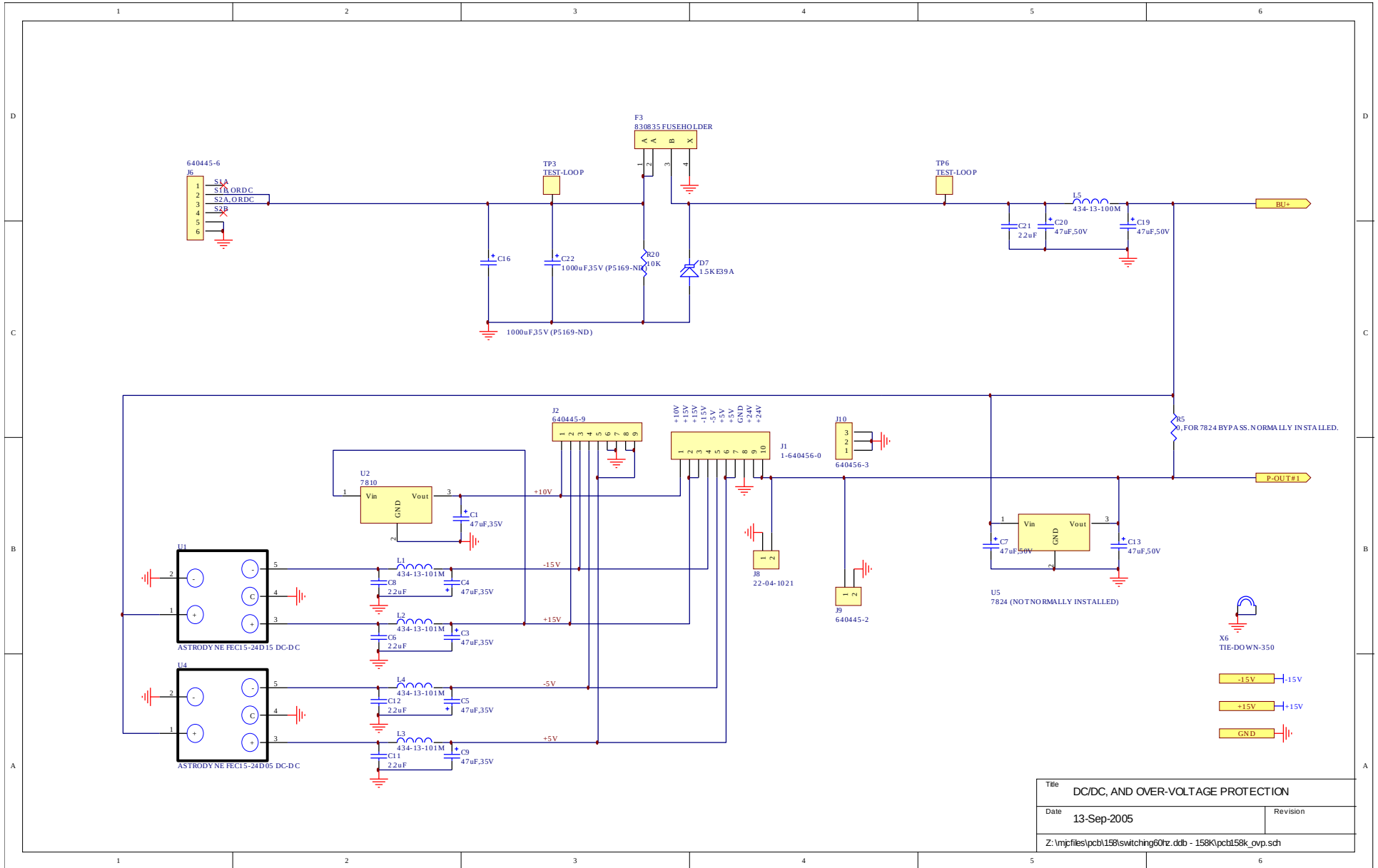


# PCB 158K - LOW VOLTAGE POWER SUPPLY, 1/3

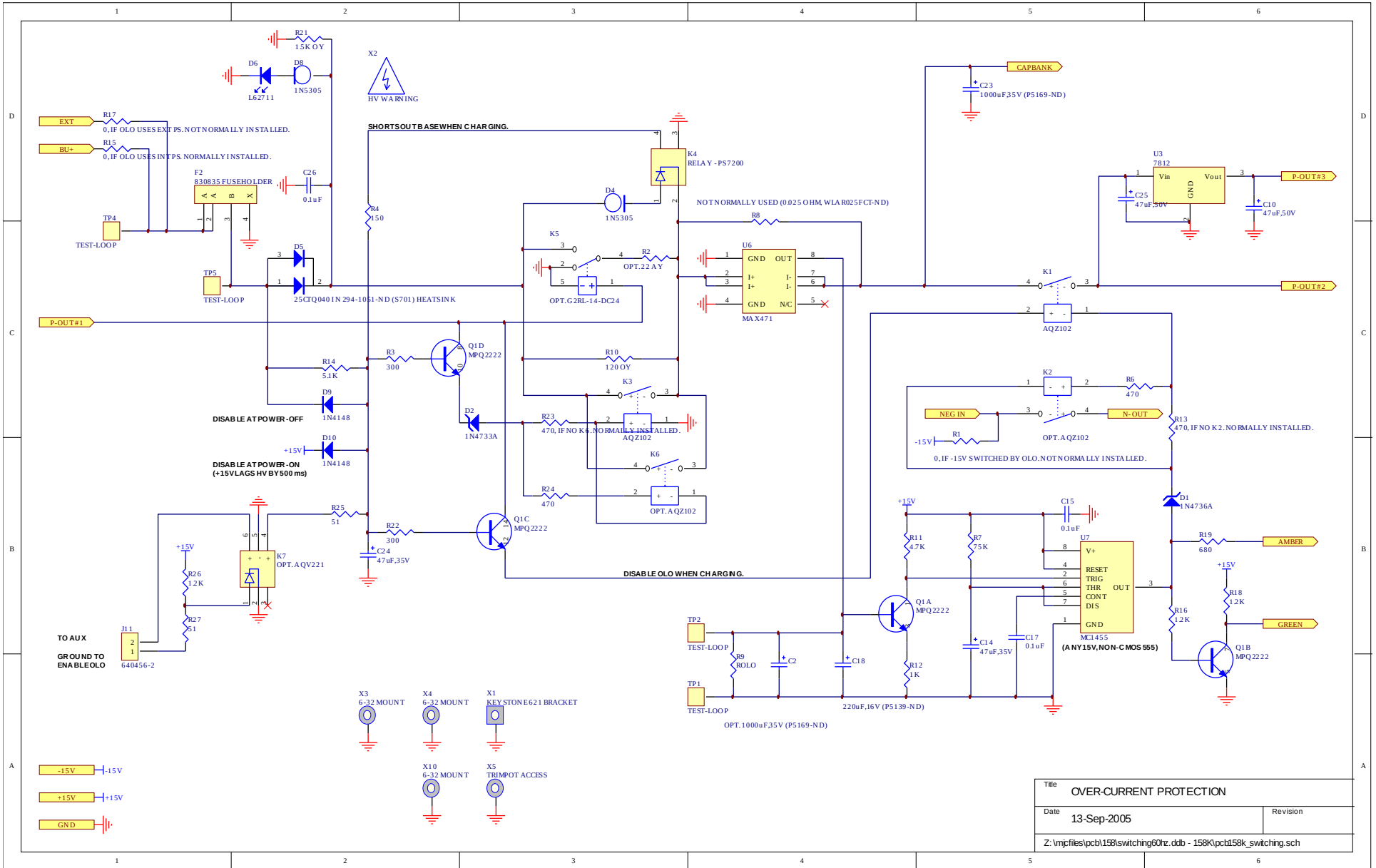


|   |             |                                |
|---|-------------|--------------------------------|
| Title   |             | LOW VOLTAGE DC/DC POWER SUPPLY |
| Date  | 13-Sep-2005 | Revision                       |
| Z:\mpjfiles\pcb158\switching01rz.ddb - 158K\pcb158k.sch |             |                                |

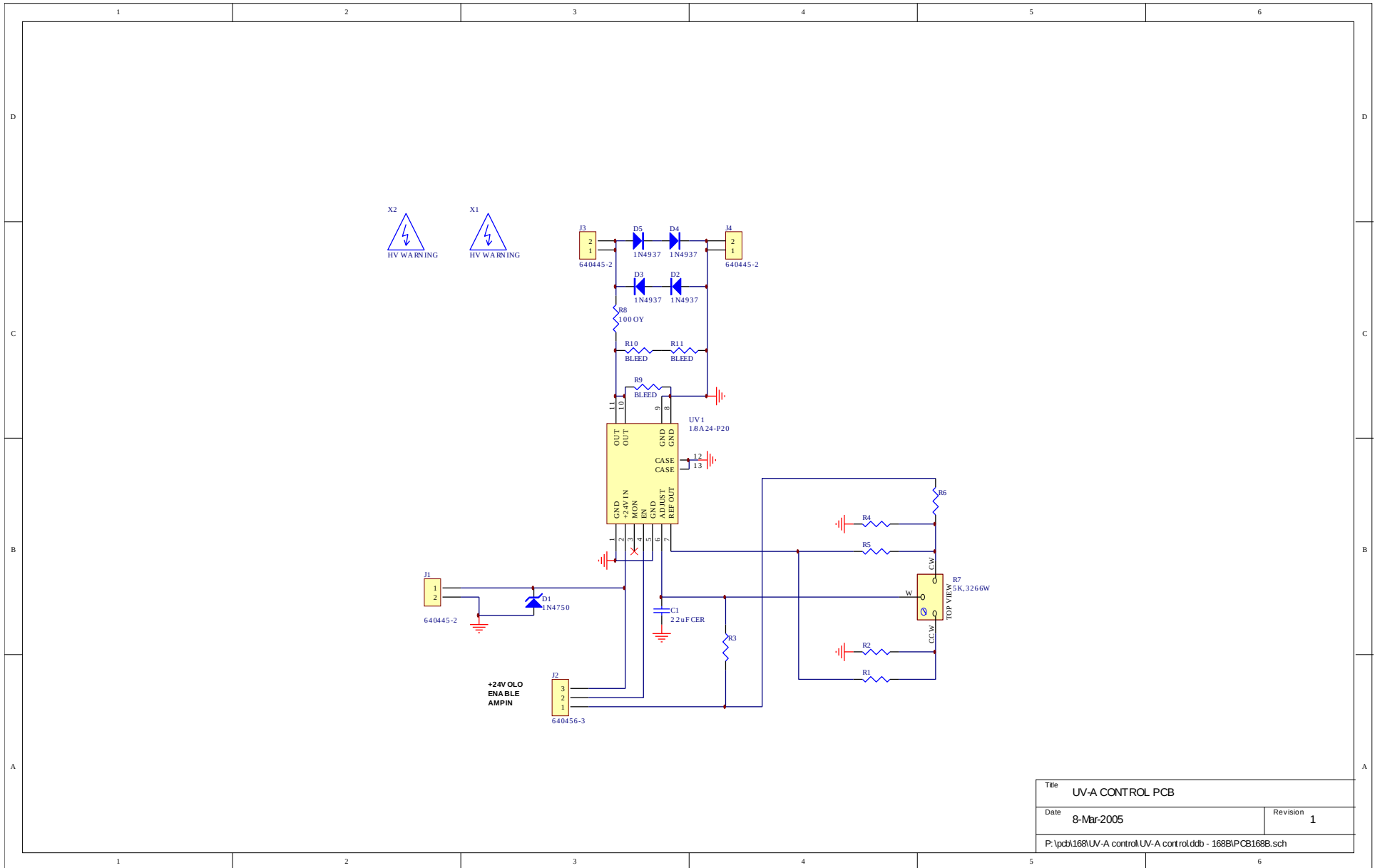
# PCB 158K - LOW VOLTAGE POWER SUPPLY, 2/3



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



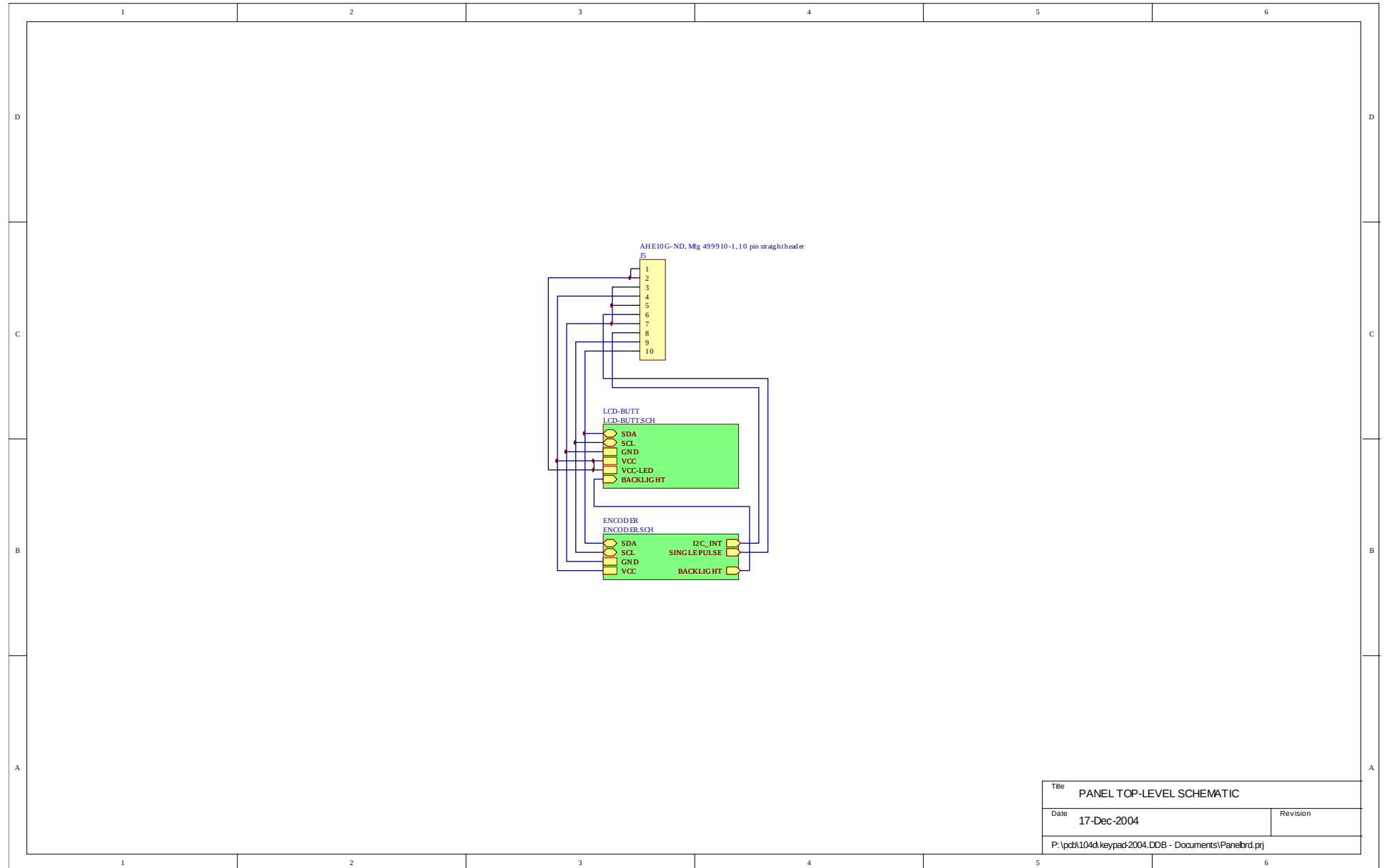
# PCB 168B - HIGH VOLTAGE DC POWER SUPPLY



|   |            |
|---|------------|
| Title UV-A CONTROL PCB                                      |            |
| Date 8-Mar-2005   | Revision 1 |
| P:\pcb\168\UV-A control\UV-A control.dtb - 168B\PCB168B.sch |            |

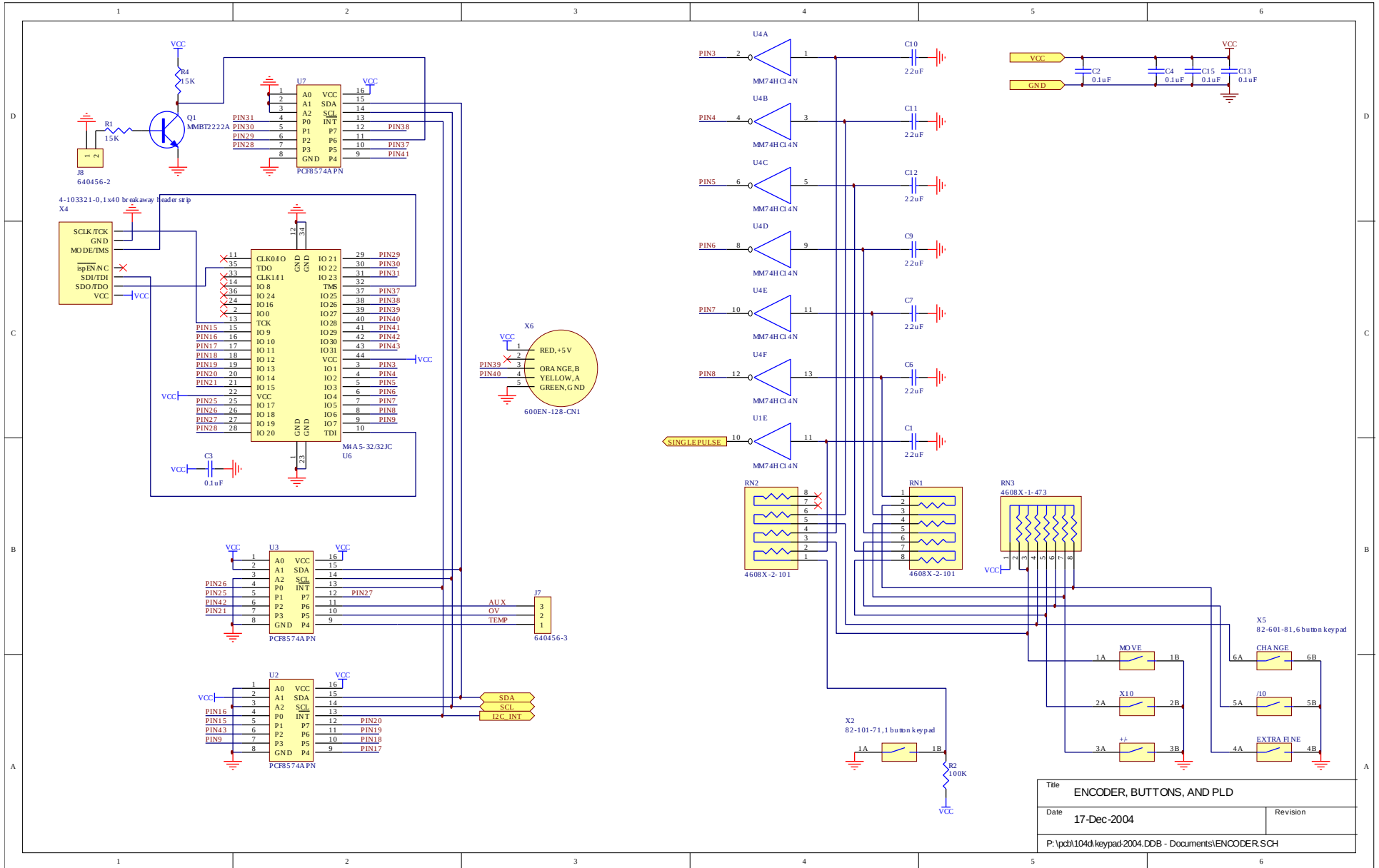


# PCB 104D - KEYPAD / DISPLAY BOARD, 1/3

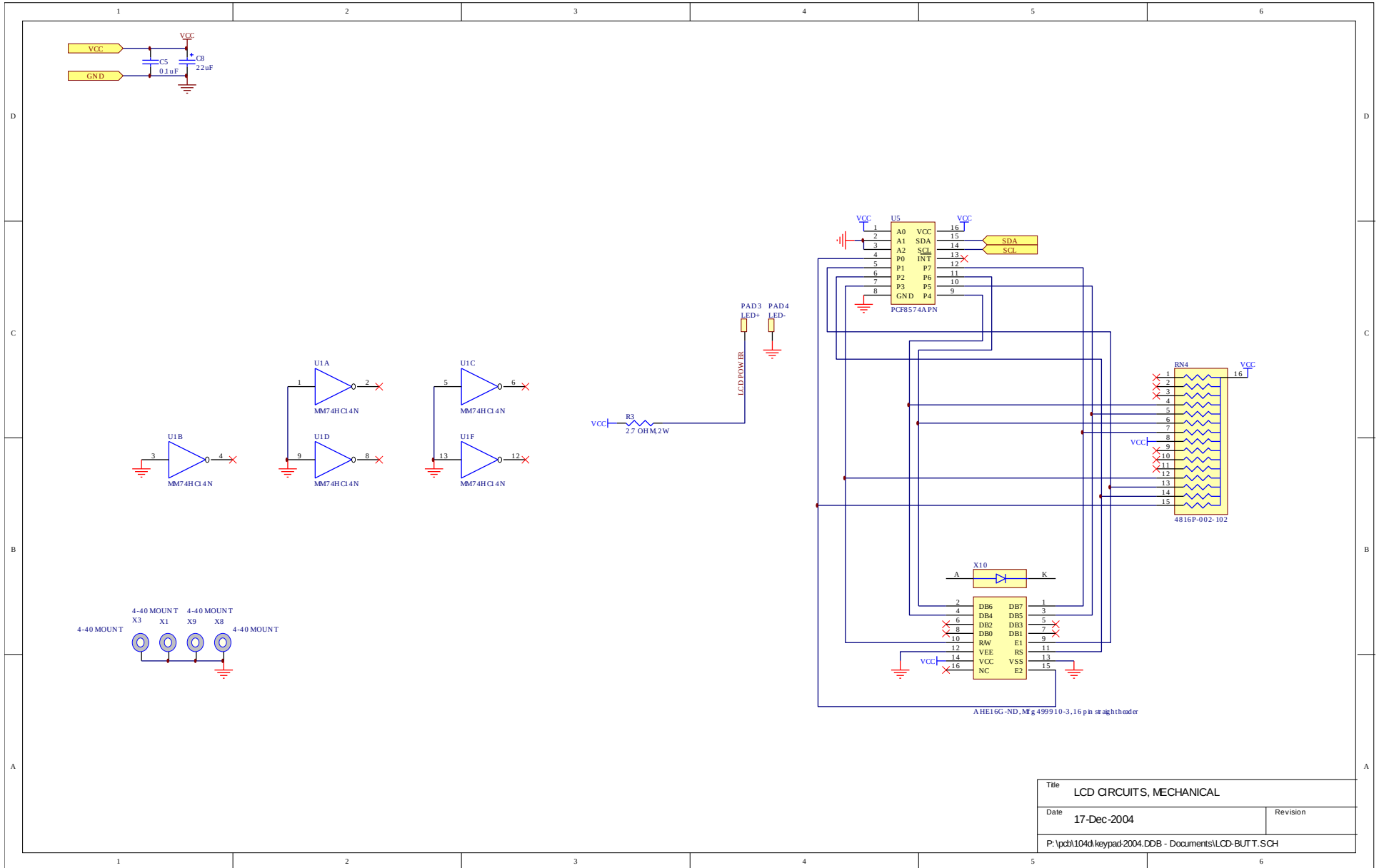


|  |                           |          |
|--|---------------------------|----------|
| Title  | PANEL TOP-LEVEL SCHEMATIC |          |
| Date   | 17-Dec-2004               | Revision |
| P:\pcb\104d\keypad\2004.DDB - Documents\Panelbrd.prj |                           |          |

# PCB 104D - KEYPAD / DISPLAY BOARD, 2/3



# PCB 104D - KEYPAD / DISPLAY BOARD, 3/3



|  |             |                          |  |
|--|-------------|--------------------------|--|
| Title  |             | LCD CIRCUITS, MECHANICAL |  |
| Date   | 17-Dec-2004 | Revision                 |  |
| P:\pcb\104d\keypad\2004.DDB - Documents\LCD-BUTT.SCH |             |                          |  |



PERFORMANCE CHECK SHEET