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## INSTRUCTIONS

MODEL AVR-EB4-B

+2A / -4A REVERSE RECOVERY  
MEASUREMENT SYSTEM  
WITH 3 ns SWITCHING TIME

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.

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Manual Reference: /files/server1/officefiles/instructword/avr-eb/avr-eb4/AVR-EB4-B,ed1.odt.

Last modified February 29, 2024.

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## INTRODUCTION

The AVR-EB4-B is a high performance, GPIB and RS232-equipped instrument capable of generating a +100V / -200V "monocycle" waveform into a 50 Ohm resistance. Normally, a diode will be placed in series with this resistance, allowing diode currents of up to +2A and -4A to be generated.

More specifically, the AVR-EB4-B mainframe generates a 2-20 us wide forward-bias pulse with amplitude adjustable up to +100V/+2A, which is immediately followed by a 2-20 us wide reverse-bias pulse with amplitude up to -200V/-4A. The forward and reverse amplitudes and pulse widths are independently variable.

A diode test jig is provided. The instrument mainframe is connected to the test jig using one coaxial cable and one DB-9 control cable. The test jig contains a variety of pin sockets and posts, which may be used to hold the diode device under test (DUT). The test jig has a hinged lid, which must be fully closed to protect the user from high voltages. The output will be automatically disabled if the lid is left open.

The diode-under-test is connected in series with a 50 Ohm resistance present on the test jig. In order to achieve the full +2A / -4A amplitude, the diode resistance (dV/dI at high currents) must be much less than 50 Ohms (i.e., 5 Ohms or lower).

One end of the 50 Ohm resistance is connected to ground, and access to the other end is provided through an SMA connector. This output should be terminated with 50 Ohms, and connected to a high-bandwidth (> 400 MHz) oscilloscope. The voltage across this resistance is directly proportional to the current through the diode. By observing the current waveform through the diode, the reverse recovery time may be determined.

While the provided test jig is intended to be flexible and easy to use, users can also develop their own test jigs easily.

The AVR-EB4-B includes an internal trigger source, but it can also be triggered or gated by an external source. A front-panel pushbutton can also be used to trigger the instrument.

The AVR-EB4-B features front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40-character backlit LCD display of the output amplitude, pulse repetition frequency, and delay. The instrument includes memory to store up to four complete instrument setups. The operator may use the front panel or the computer interface to store a complete "snapshot" of all key instrument settings, and recall this setup at a later time.

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

## SPECIFICATIONS

Model:	AVR-EB4-B	
Pulse polarity:	-	+
Voltage output <sup>1</sup> (to 50Ω):	0 to -200V	0 to +100V
Diode current, maximum:	-4A	+2A
Pulse width:	2 to 20 us	2 to 20 us
Rise time:	< 3 ns	< 1 us
Source impedance:	≤ 2 Ohm	50 Ohms
PRF:        internal trigger: external trigger:	1 Hz to 100 Hz 0 Hz to 100 Hz	
Delay:	auto-aligned with positive falling edge	Variable, 0 - 1 second
Number of outputs:	One. A composite waveform is generated on the main output.	
Mainframe connectors:	BNC	
GPIB and RS-232 control:	Standard on -B units. See <a href="http://www.avtechpulse.com/gpib">http://www.avtechpulse.com/gpib</a> for details.	
Trigger required:	Ext trig mode: + 5 Volts, 10 ns or wider (TTL)	
Gate input:	Active high or low, switchable. Suppresses triggering when active.	
Power requirements:	100 - 240 Volts, 50 - 60 Hz	
Dimensions: (H x W x D)	100 mm x 430 mm x 375 mm (3.9" x 17" x 14.8")	
Chassis material:	cast aluminum frame and handles, blue vinyl on aluminum cover plates	
Mounting:	Any	
Temperature range:	+5°C to +40°C	

1) For operation at amplitudes of less than 10% of full-scale, best results will be obtained by setting the amplitude near full-scale and using external attenuators on the output(s).

## EUROPEAN REGULATORY NOTES

### EC DECLARATION OF CONFORMITY

We

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

EN 50081-1 Emission

EN 50082-1 Immunity

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

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



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

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

## 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.

The following items should be with the instrument:

- 1) A power cord.
- 2) A GPIB cable
- 3) Two instrumentation manuals (this manual and the "Programming Manual for -B Instruments").
- 4) One test jig (labeled "TRR C").
- 5) A 6' (200 cm) length of BNC-to-BNC coaxial cable.
- 6) A 6' (200 cm) DB-9 control cable.

### POWER RATINGS


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

The maximum power consumption is 74 Watts. Please see the "FUSES" section for information about the appropriate AC and DC fuses.

This instrument is an "Installation Category II" instrument, intended for operation from a normal single-phase supply.

### CONNECTION TO THE POWER SUPPLY

An IEC-320 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket. The other end of the detachable power cord plugs into the local mains supply. Use only the cable supplied with the instrument. The mains supply must be earthed, and the cord used to connect the instrument to the mains supply must provide an earth connection. (The supplied cord does this.)


 Warning: Failure to use a grounded outlet may result in injury or death due to electric shock. This product uses a power cord with a ground connection. It must be connected to a properly grounded outlet. The instrument chassis is connected to the ground wire in the power cord.



The table below describes the power cord that is normally supplied with this instrument, depending on the destination region:

Destination Region	Description	Manufacturer	Part Number
Continental Europe	European CEE 7/7 "Schuko" 230V, 50Hz	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, 230V, 50Hz	Qualtek ( <a href="http://www.qualtekusa.com">http://www.qualtekusa.com</a> )	370001-E01
Switzerland	SEV 1011, 2 30V, 50Hz	Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )	2102H-C3-10
Israel	SI 32, 220V, 50Hz	Volex ( <a href="http://www.volex.com">http://www.volex.com</a> )	2115H-C3-10
North America, and all other areas	NEMA 5-15, 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.

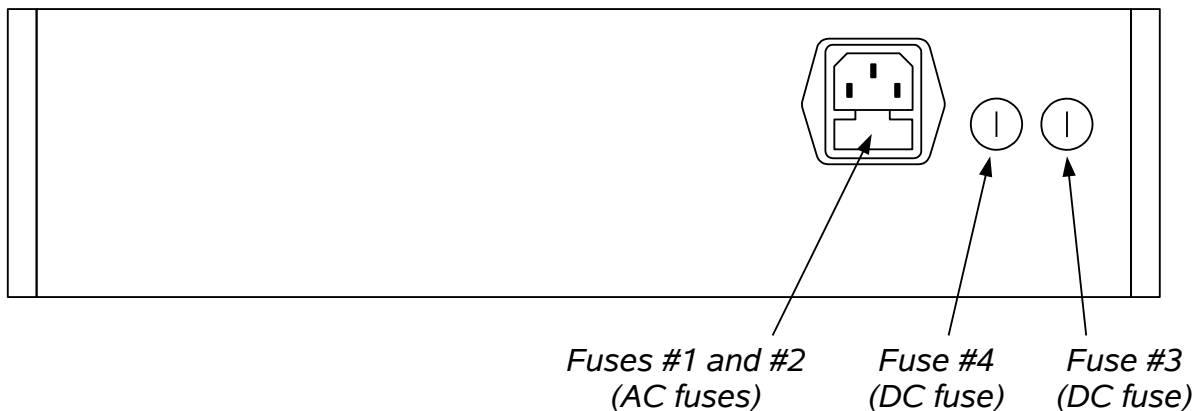
## ENVIRONMENTAL CONDITIONS

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.

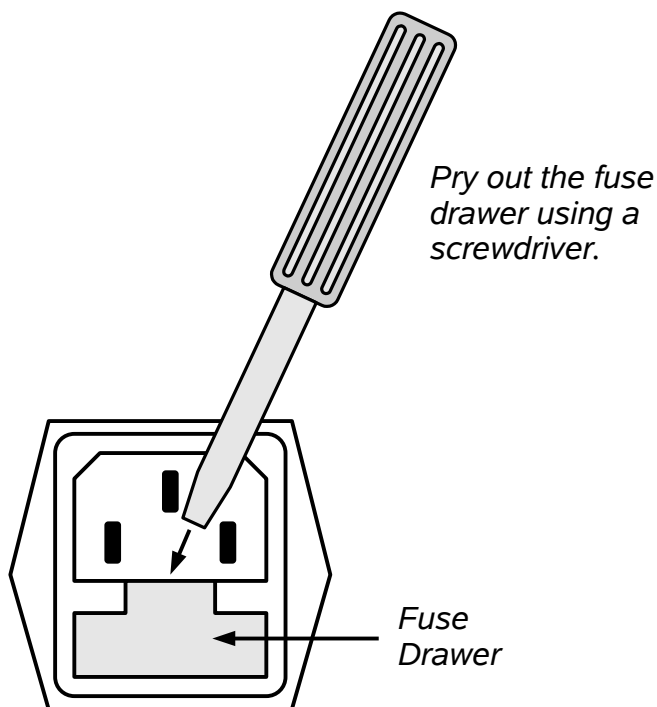
## FUSES

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

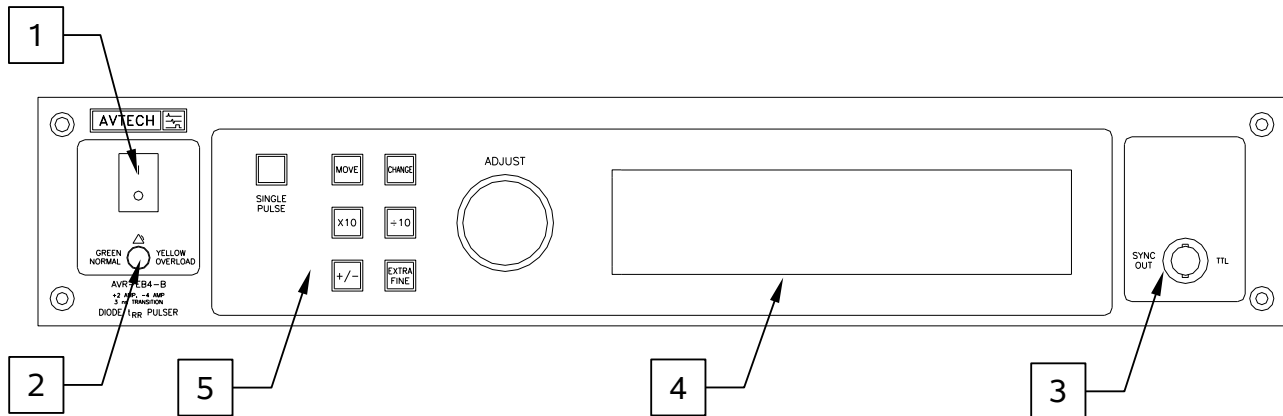
The following table lists the required fuses:

Fuses	Nominal Mains Voltage	Rating	Case Size	Manufacturer's Part Number (Wickmann)	Distributor's Part Number (Digi-Key)
#1, #2 (AC)	100-240V	0.5A, 250V, Time-Delay	5×20 mm	1950500000	WK5041-ND
#3 (DC)	N/A	1.6A, 250V, Time-Delay	5×20 mm	1951160000	WK5053-ND
#4 (DC)	N/A	0.5A, 250V, Time-Delay	5×20 mm	1950500000	WK5041-ND

The fuse manufacturer is Wickmann (<http://www.wickmann.com/>).

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

## FRONT PANEL CONTROLS



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

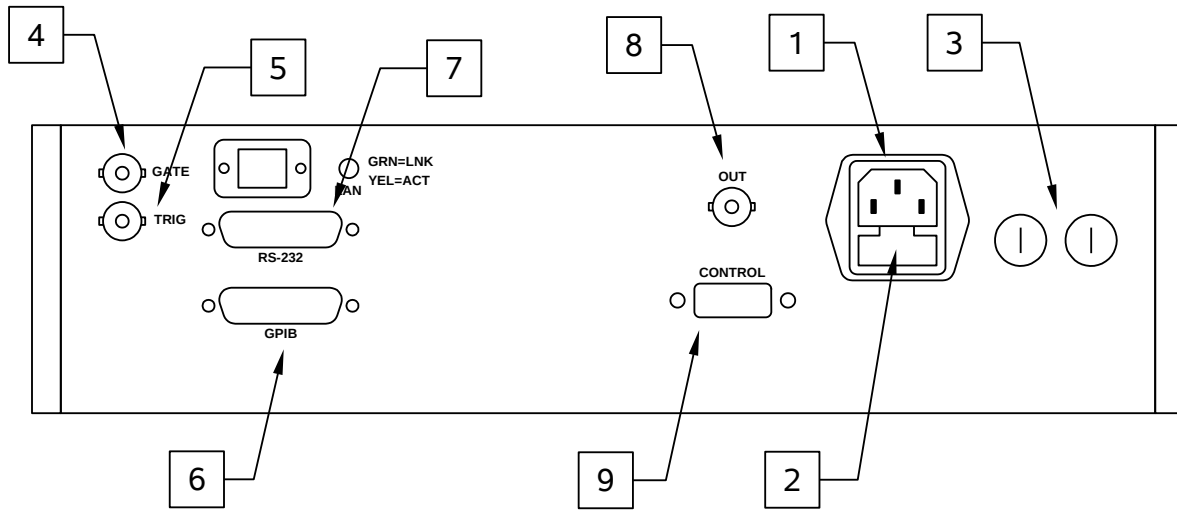
This overload indicator may flash yellow briefly at start-up. This is not a cause for concern.

3. 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 $\Omega$  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.)
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. PULSE OUT CONNECTOR. This BNC connector provides the pulse output signal to the test jig. This output should be connected to the corresponding input on the test jig using the supplied BNC-to-BNC coaxial cable.

 Caution: Voltages as high as 200V may be present on the center conductor of this output connector. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

9. CONTROL Connector. This DB-9 female connector should be connected to the corresponding connector on the test jig using the supplied DB-9 cable. This cable contains the safety interlock signals that ensure that the test jig lid is closed. The pinout is as follows:

Pin 1 - To test jig switch 1.

Pin 2 - To test jig switch 2.

Pin 5 - Ground.

Pin 6 - To test jig switch 1.

Pin 7 - To test jig switch 2.

Pin 9 - Safety sensor power supply (+15V through 680 Ohms).

When the test jig lid is safely closed, Pin 1 is shorted to Pin 6, and Pin 2 is shorted to Pin 7.



## TIMING CONTROL

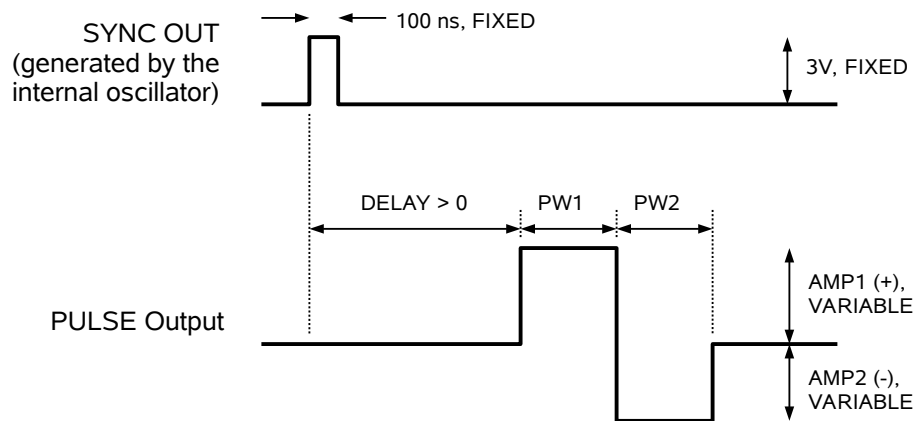
### BASIC TIMING CONTROL

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: PULSE and SYNC.

The PULSE output is a bipolar signal that may either drive a 50 Ohm load, or the test jig described later. The positive and negative amplitudes are adjustable. The pulse widths are variable over a 2-20 us range.

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 PULSE output. When the delay is set to a negative value the SYNC pulse follows the PULSE output.

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



*Figure A*

If the delay is negative, the order of the SYNC and PULSE outputs is reversed:

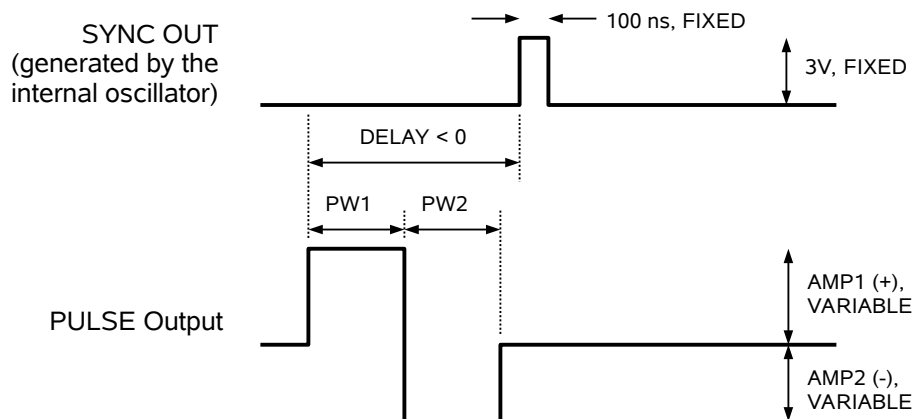


Figure B

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

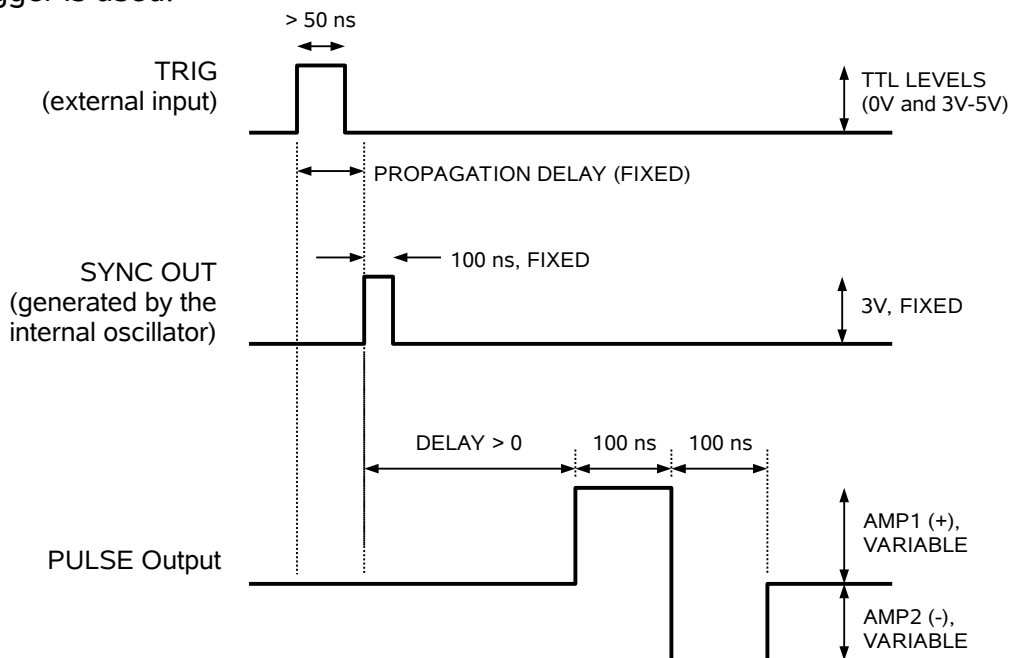


Figure C

As before, if the delay is negative, the order of the SYNC and PULSE outputs is reversed.

The delay and frequency (when in the internal mode) of the PULSE output can be varied with front panel controls or via the GPIB or RS-232 computer interfaces.

## TRIGGER MODES

This instrument has four trigger modes:

- Internal Trigger: the instrument controls the trigger frequency, and generates the clock internally.
- External Trigger: the instrument is triggered by an external TTL-level clock on the back-panel TRIG connector.
- Manual Trigger: the instrument is triggered by the front-panel “SINGLE PULSE” pushbutton.
- Hold Trigger: the instrument is set to not trigger at all.

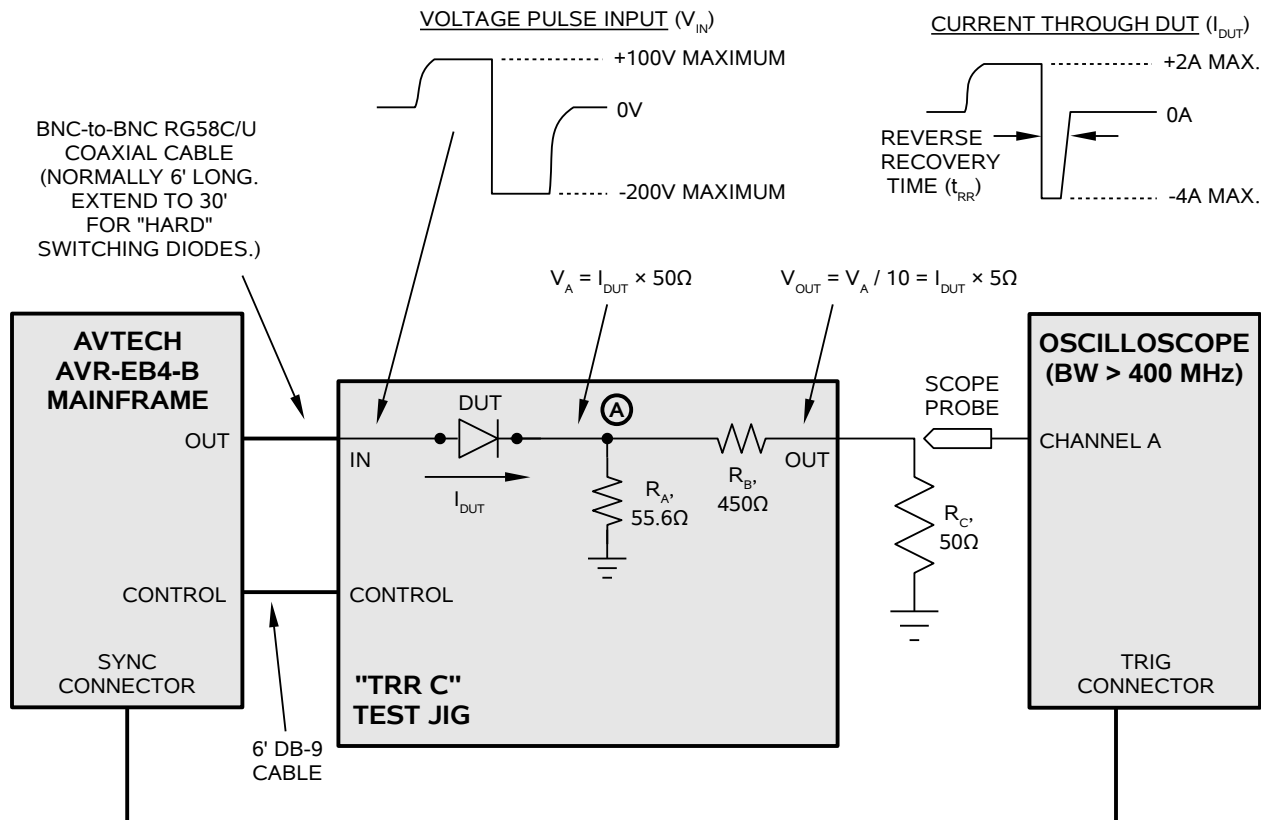
These modes can be selected using the front panel trigger menu, or by using the appropriate programming commands. (See the “Programming Manual for -B Instruments” for more details.)

## GATING MODES

Triggering can be suppressed by a TTL-level signal on the rear-panel GATE connector. The instrument can be set to stop triggering when this input high or low, using the front-panel gate menu or the appropriate programming commands. When gated, the output will complete the full pulse width if the output is high, and then stop triggering. Pulses are not truncated.

## BASIC AMPLITUDE CONTROL

The basic test arrangement for the AVR-EB4-B is shown in the figure below. The PULSE output on the instrument mainframe is connected to the PULSE input on the test jig (part number "TRR C") using the supplied BNC-to-BNC coaxial cable, and the control cable is connected using the supplied DB-9 cable.



A 50 Ohm resistance ( $R_C$  in the diagram above) must be connected to ground on the output. This can be a discrete resistor, a feed-through terminator, or the input impedance of an oscilloscope. If a high-speed sampling oscilloscope is used, the input should be protected by adding attenuator on the input.

The total effective resistance of resistors  $R_A$ ,  $R_B$ , and  $R_C$  in the diagram above is 50 Ohms. Thus, the voltage at point "A" is simply given by:

$$V_A = I_{DUT} \times 50\Omega$$

where  $I_{DUT}$  is the current through the device under test. A 450 Ohm resistance ( $R_B$ ) is present in series with the measurement output. When a 50 Ohm resistance ( $R_C$ ) is installed on the output (by the user), the output voltage will be one-tenth of  $V_A$  due to the resistor-divider effect. That is:

$$V_{OUT} = V_A / 10 = I_{DUT} \times 5\Omega$$

This is the key equation for relating the observed voltage waveform to the DUT current.

### SETTING THE AMPLITUDE LEVELS

The amplitude of the positive and negative portions of the PULSE waveform may be set from the front panel of the instrument, or by computer command. These settings are expressed in terms of the voltage present on the test jig input.

The positive voltage ("AMP1" on the front panel display) is related to the forward diode current by:

$$I_{FORWARD} \approx (AMP1 - V_F) / (50\Omega + R_{DIODE-FORWARD})$$

where  $V_F$  is the forward voltage drop of the diode (typically 0.7V for the classic silicon PN junction diode, and usually somewhat lower for a Schottky diode), and  $R_{DIODE-FORWARD}$  is the effective resistance of the diode under forward bias.

The negative voltage ("AMP2" on the front panel display) is related to the reverse diode current by:

$$I_{REVERSE} \approx AMP2 / (50\Omega + R_{DIODE-REVERSE}).$$

Where  $R_{DIODE-REVERSE}$  is the effective resistance of the diode under reverse bias.

It is important to note that  $R_{DIODE-FORWARD}$  and  $R_{DIODE-REVERSE}$  are not the same, and that they may change during the transient. Furthermore, depending on the design of the diode under test, it is possible that  $R_{DIODE-REVERSE}$  may be so high that it is impossible to achieve the full 4 Amps of reverse current. (The ideal diode would of course have  $R_{DIODE-REVERSE} = \infty$ ).

Most test procedures for measuring recovery time will use a particular ratio of forward to reverse currents - for example,  $I_{REVERSE} / I_{FORWARD} = 2$ .

Some Schottky diodes have negligible amounts of stored charge resulting from the forward bias, compared to non-Schottky devices. For these Schottky diodes, the reverse transient will be governed by the capacitance of the device, and the reverse transient may be largely unaffected by the amplitude of the forward transient. (In other words, the  $I_{REVERSE} / I_{FORWARD}$  ratio is irrelevant). The capacitance may be so small that it becomes impossible to obtain the full -4 Amps of reverse current.

Normally, the forward and reverse amplitudes should be set near the maximum values (+100V, -200V). Performance may degrade if the amplitudes are set lower than 10% of the maximum values.

### AMPLITUDE ACCURACY

Due to the variations in  $V_F$  and  $R_{\text{DIODE-FORWARD}}$  and  $R_{\text{DIODE-REVERSE}}$  as a function of operating conditions, the AMP1 and AMP2 settings *should not be relied upon for any degree of accuracy*. Instead the voltage at the OUT terminal on the test jig should be monitored with a calibrated oscilloscope. As mentioned above,  $I_{\text{DUT}} = V / 5\Omega$ .


$R_A$ ,  $R_B$ , and  $R_C$  can all be measured directly on the test jig (with the test jig disconnected) to determine calibrated relationships, if desired.


### INCORRECT ORIENTATION

The instrument and the DUT will not be damaged if the diode is installed with the incorrect orientation (i.e., with the anode and cathode reversed). However, incorrect waveforms will be generated,

### ACCESSIBLE VOLTAGES

The mainframe provides pulsed voltages of up to 200V to the test jig. For this reason, the output is automatically disabled when the test jig lid is open. The lid must be closed to obtain measurements.

 Shielded cabling should be used for all connections to the "IN" and "OUT" terminals on the test jig, and the "OUT" connector on the mainframe.

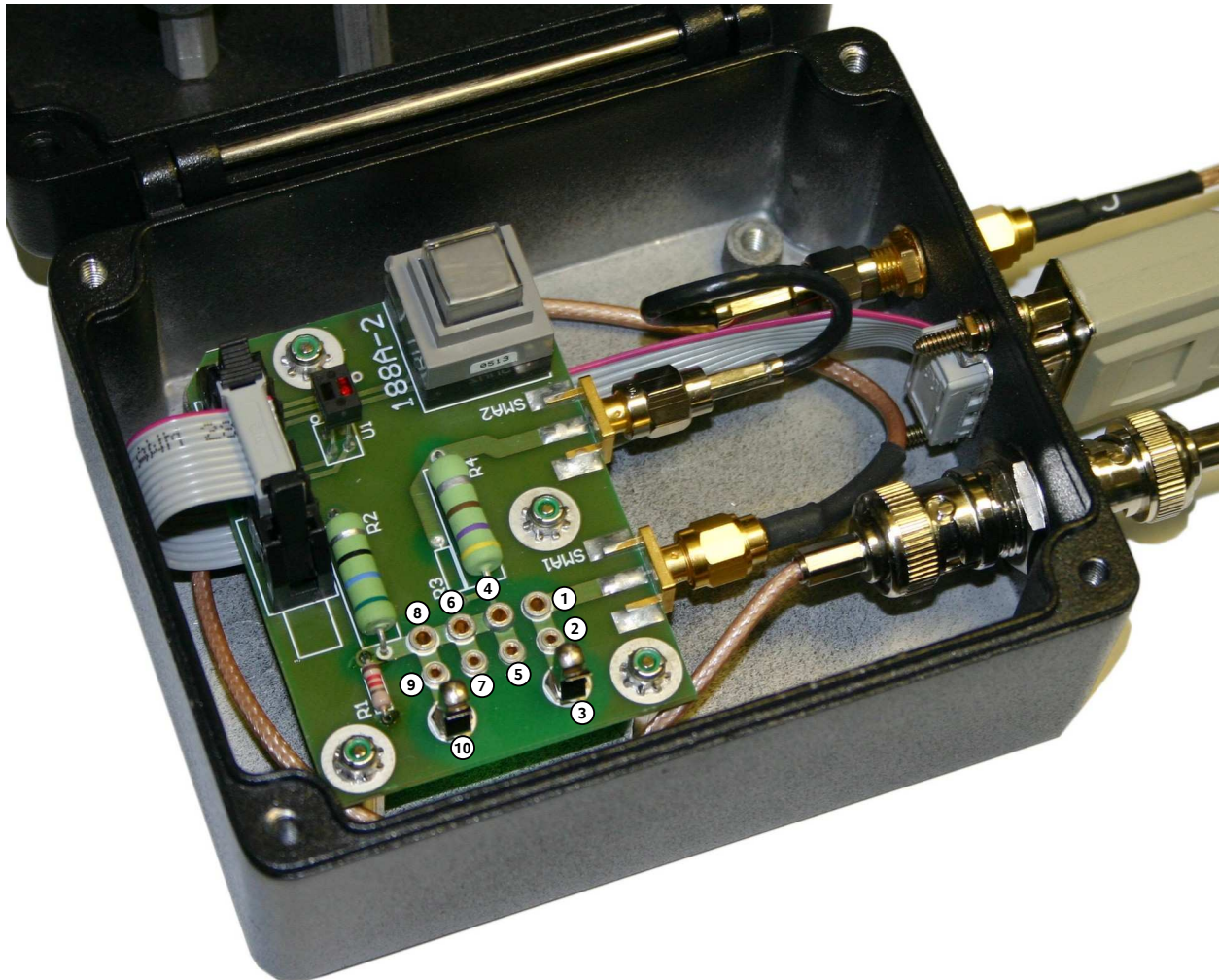
 When used properly (with  $R_C = 50 \text{ Ohms}$ ), the maximum voltage on the OUT terminal will be 20V, approximately. However, if  $R_C$  is not connected, the maximum voltage will at the OUT terminal may be as high as 200V.

## TEST JIG MECHANICAL ASPECTS

One "TRR C" test jig is supplied with the mainframe.

### TRR C TEST JIG

The TRR C test jig accepts a range of through-hole and axial devices, using pin sockets and spring-clip posts. It is intended for use with diodes in DO-41, TO-220 or DO-204AR or similar packages. A photo of the pad/post arrangement is shown below. Pins 1-3 are connected together, and one of them should be connected to the anode of the device. Pins 4-10 are connected together, and should be connected to the cathode of the device. (3 and 10 are post clips, rather than pin sockets).



The resistors R1 and R2 in the test jig are in parallel, and form the resistance  $R_A$  (nominally  $55.6\Omega$ ) previously described in the "BASIC AMPLITUDE CONTROL" section.

The resistors R3 and R4 in the test jig are in parallel, and form the resistance  $R_B$  (nominally  $450\Omega$ ).

U1 is an optical sensor which disables the output when the lid is open. A pushbutton switch is also present that serves the same function.

The instrument and the DUT will not be damaged if the diode is installed with the incorrect orientation (i.e., with the anode and cathode reversed). However, incorrect waveforms will be generated.

### CABLE LENGTHS

Normally the test jig is connected to the mainframe use a 6-foot-long DB-9 control cable, and a 6-foot-long RG-58C/U coaxial cable.

Under certain circumstances, reflections may occur on the coaxial cable that distort the measured waveform. This occurs for diodes where the reverse transient ends very abruptly. This phenomenon is discussed further in the "Typical Results" section. For these diodes, the length of the coaxial cable should be increased to 30 feet, so that the reflections occur well after the switching transients of interest. BNC-to-BNC RG-58C/U cables of arbitrary length can be easily ordered with next day delivery from Pasternack (<http://www.pasternack.com>). Specify Pasternack part number PE3067-XXX, where "XXX" is the desired length in inches.

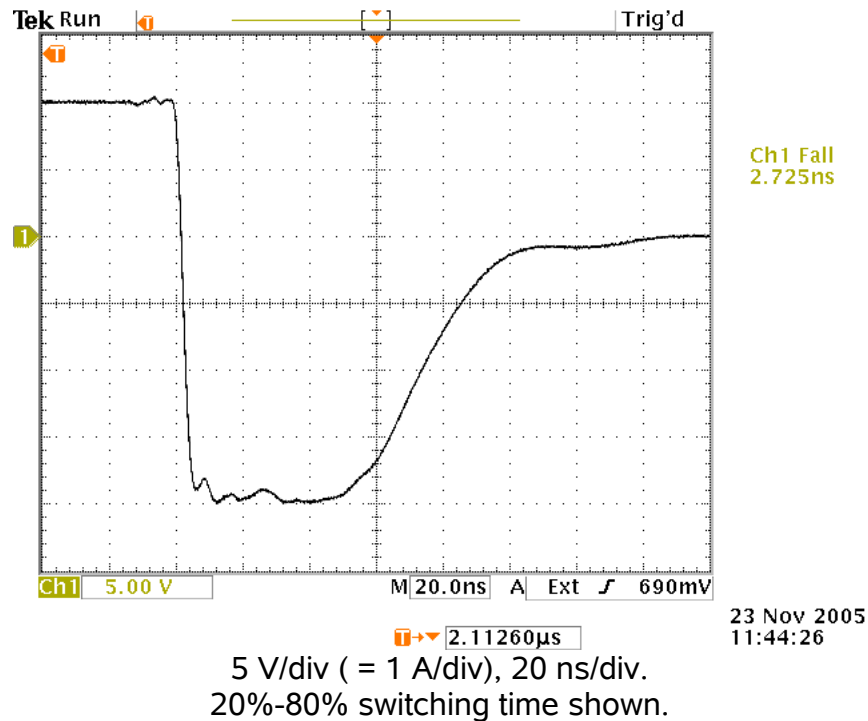


## TYPICAL RESULTS

Obtaining meaningful results with the AVR-EB4-B requires care, experience, and an understanding of diode transient behavior and the impact of inductive and capacitive parasitics. To assist the user, typical results for commercially available diodes are provided below. The user should be able to reliably duplicate these results.

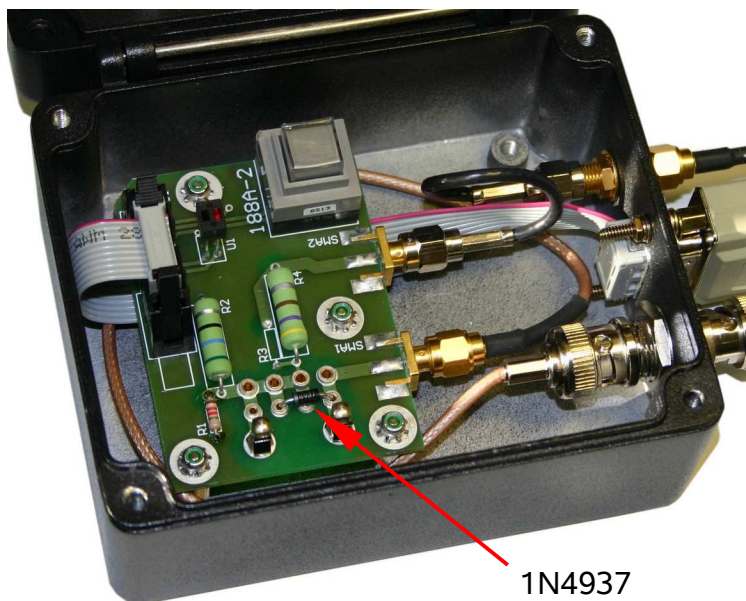
### 1N4937 RESULTS

The On Semiconductor 1N4937 is a 1A, 600V DO-41 fast-recovery rectifier. With the amplitudes set to +100V and -200V, the following reverse recovery waveform is obtained at the test jig "OUT" terminal:



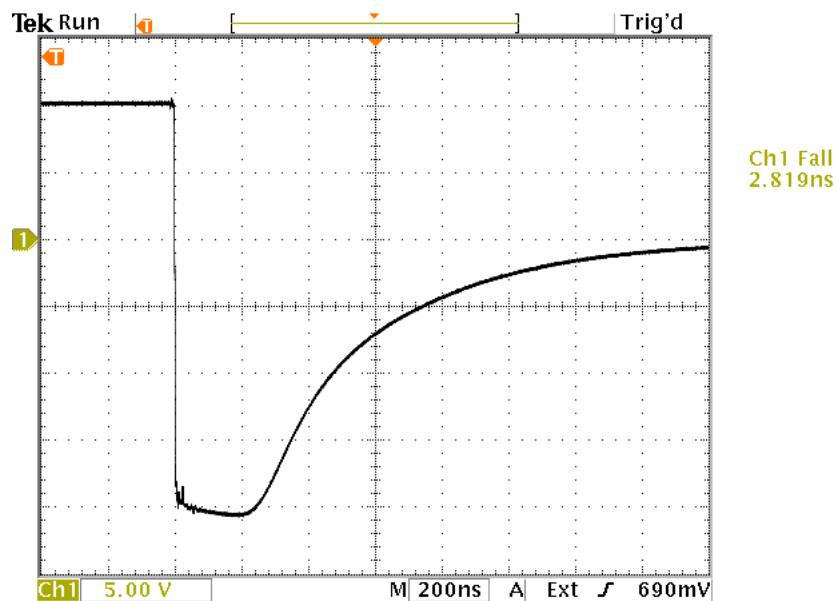
The above waveform shows the transition from a forward current of +2A to a reverse current of -4A. The reverse transient lasts for approximately 100 ns under these conditions.

For this test, the 1N4937 was installed with the anode in Pin 2 of the test jig, and the cathode in Pin 7, as shown below:



## 1N4004 RESULTS

The generic 1N4004 is a very slow 1A, 400V DO-41 fast-recovery rectifier. With the amplitudes set to +100V and -200V, the following reverse recovery waveform is obtained at the test jig "OUT" terminal:



4.04600μs

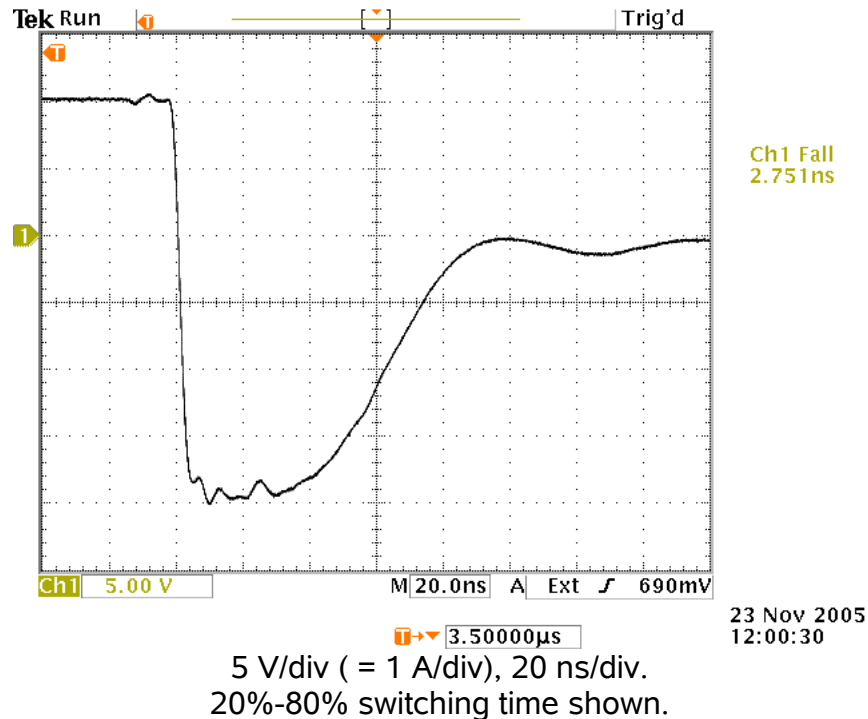
5 V/div (= 1 A/div), 200 ns/div.  
20%-80% switching time shown.

23 Nov 2005  
11:59:26

The above waveform shows the transition from a forward current of +2A to a reverse current of -4A. The reverse transient duration exceeds 1 us under these conditions.

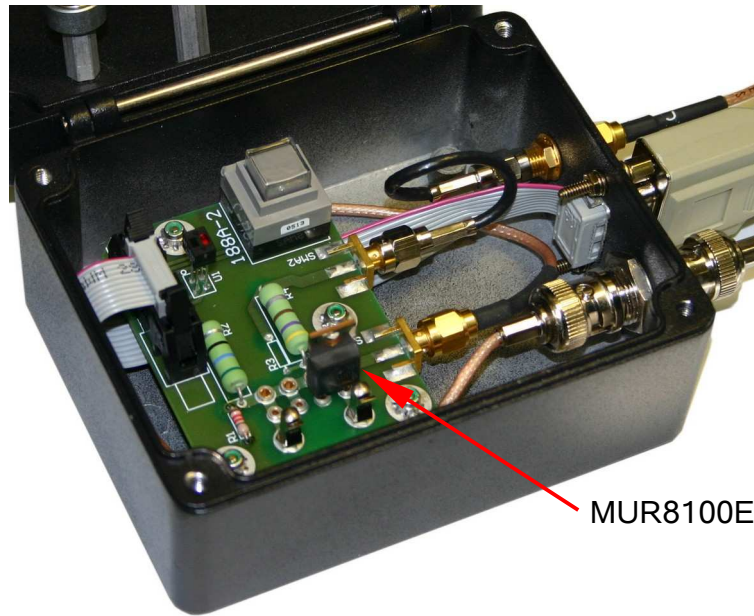
### MUR8100E RESULTS

The On Semiconductor MUR8100E is a 8A, 1000V TO-220 ultrafast rectifier. With the amplitudes set to +100V and -200V, the following reverse recovery waveform is obtained at the test jig "OUT" terminal:



The above waveform shows the transition from a forward current of +2A to a reverse current of -4A. The reverse transient lasts for approximately 90 ns under these conditions.

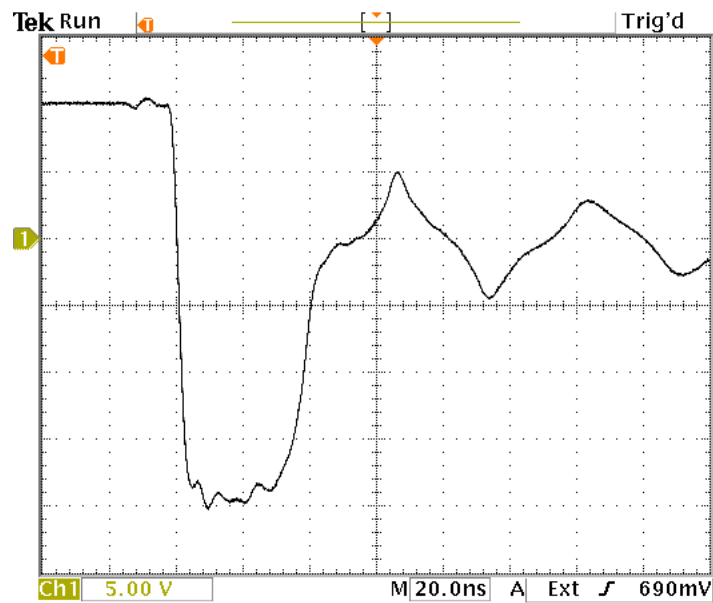
For this test, the MUR8100E was installed with the anode in Pin 2 of the test jig, and the cathode in Pin 5, as shown below:



MUR8100E

## RUS460 RESULTS

The EDI RUS460 is a 5A, 600V DO-204AR ultrafast rectifier. With the amplitudes set to +100V and -200V, the following reverse recovery waveform is obtained at the test jig "OUT" terminal:

Ch1 Fall  
2.807ns

2.80200µs

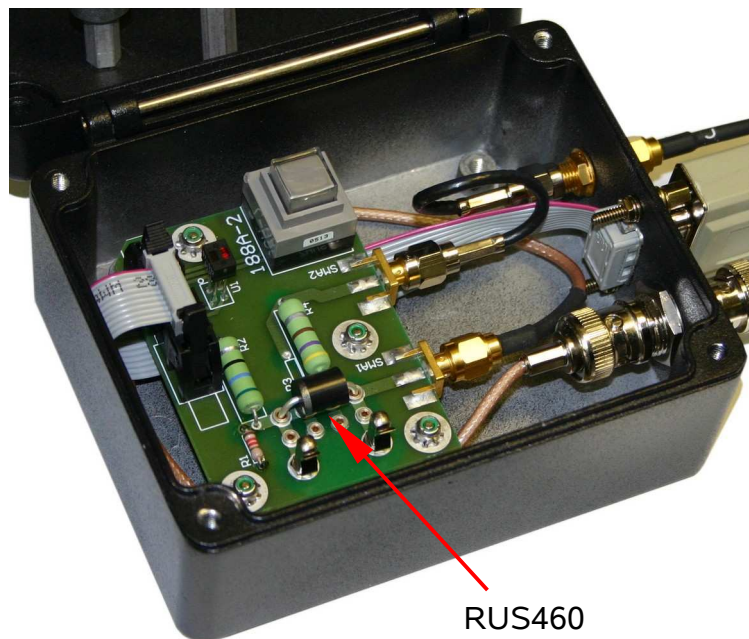
5 V/div (= 1 A/div), 20 ns/div.  
20%-80% switching time shown.

23 Nov 2005  
11:55:10

The above waveform shows the transition from a forward current of +2A to a reverse current of -4A. The reverse transient lasts for approximately 40 ns under these conditions, and then ends rather abruptly. This abrupt termination of the reverse transient is somewhat unusual, and is referred to as a "hard" or "step" transient. Most modern diodes are optimized to provide a "soft" transient, with a more gradual decay of the reverse current from its peak value to zero.

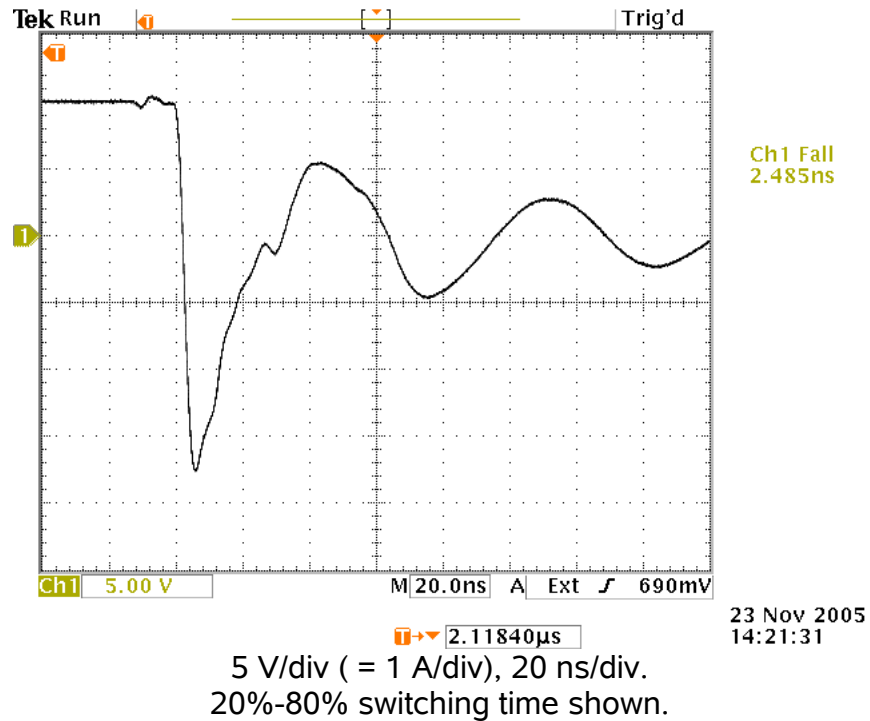
The fast switching time of the hard transient causes transmission line reflections to occur. These reflections repeat in an exponential decay pattern, until they are no longer detectable. The time between reflections is governed by the length of coaxial cabling (normally 6 feet) connecting the mainframe to the output module. These reflections can normally be ignored, since they occur after the end of the "interesting" part of the transient where measurements are made. The coaxial cable can be extended to move the reflection away from the switching transient - this is discussed in detail in the next section ("CSD10120 Results").

For this test, the RUS460 was installed with the anode in Pin 1 of the test jig, and the cathode in Pin 8, as shown below:

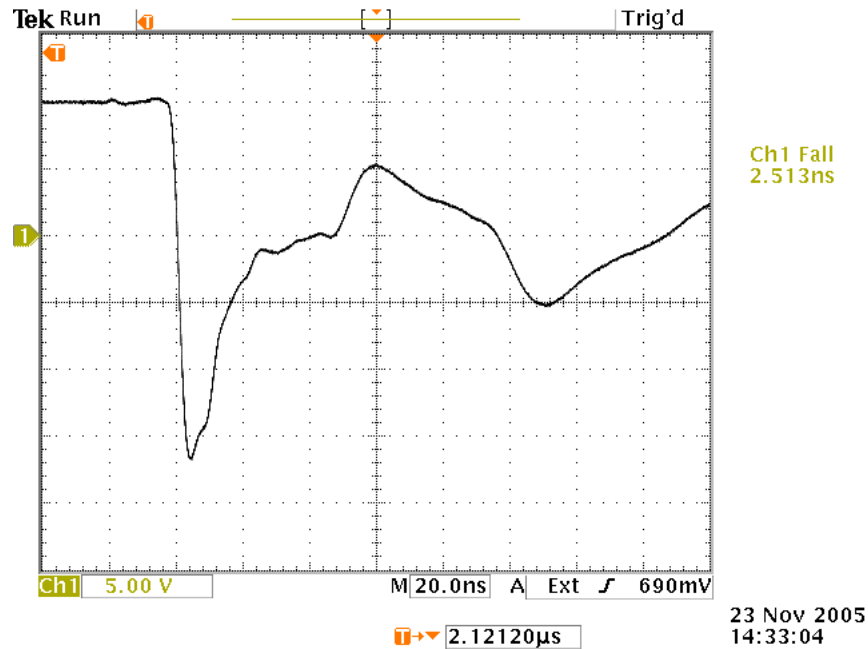


### CSD10120 RESULTS

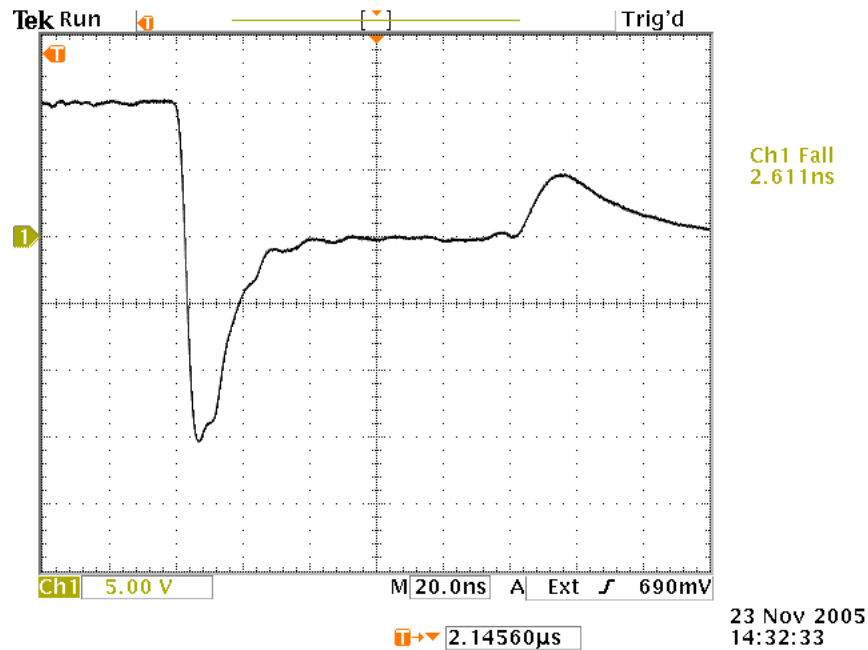
The Cree CSD10120 is a state-of-the-art 1200 Volt, 10 Amp TO-220-packaged Silicon Carbide Schottky diode, promoted as a "Zero Recovery Rectifier". The waveform below shows the results obtained with the CSD10120 diode installed in the TRR C test jig:



The above waveform shows the transition from a forward current of +2A to a reverse current of -3.5A. The diode does not reach the full -4A peak current, in fact. The very fast transient last less than 20 ns, and triggers a series of reflections on the cabling after the termination of the transient. In cases such as these it may be unclear where the reverse transient ends and where the reflections begin. To separate the two effects it may be beneficial to use a longer length of coaxial cable between the mainframe and the test jig. The waveform below shows the results for the same test, but with the 6 foot cable replaced by a 12 foot cable:

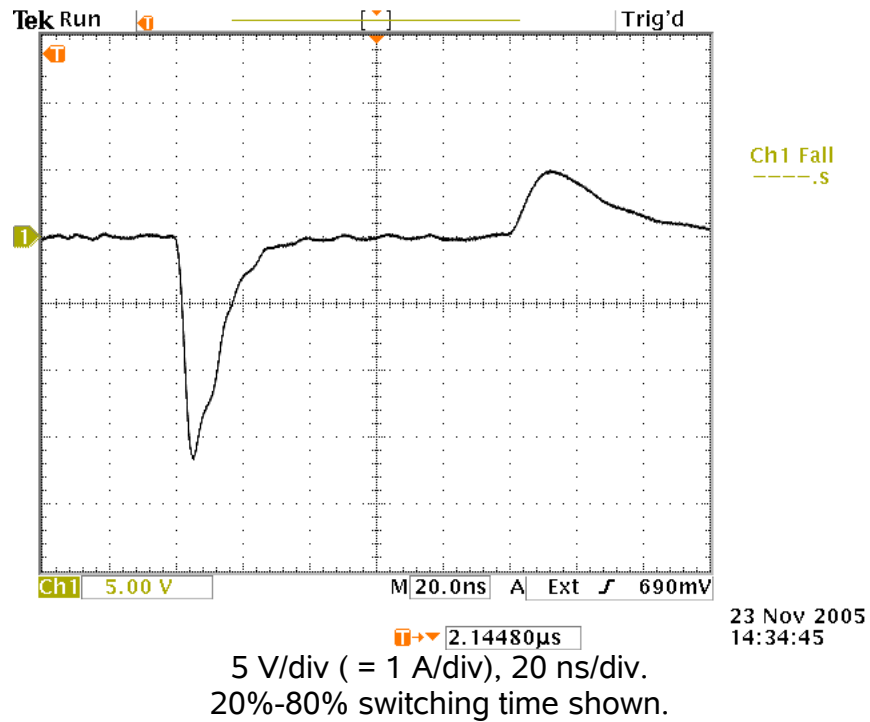


In this waveform, the extra cable length allows the reverse transient to fall to zero completely before the reflections occur. If the cable length is increased even more, to 28 feet, further separation is achieved:



If diodes with very abrupt reverse recovery transients are to be tested, the cable length should be extended to approximately 30 feet. Use the heavier RG-58C/U coaxial cable rather than the lighter RG174A/U type, to avoid resistive losses. BNC-to-BNC RG-58C/U cables of arbitrary length can be easily ordered with next day delivery from Pasternack (<http://www.pasternack.com>). Specify Pasternack part number PE3067-XXX, where "XXX" is the desired length in inches.

Unlike most conventional diodes, the CSD10120 reverse recovery transient is dominated by the capacitance of the device, rather than by minority carrier charge storage. This can be seen by reducing the forward bias current to zero, as shown below:



The above waveform shows the transition from a forward current of +0A to a reverse current of -3.5A, approximately. The reverse transient is nearly unchanged, relative to the case when the forward current was +2A! The CSD10120 datasheet says "this is a majority carrier diode, so there is no reverse recovery charge", and the results above largely support this.



## PROGRAMMING YOUR PULSE GENERATOR

### KEY PROGRAMMING COMMANDS

The “Programming Manual for -B Instruments” describes in detail how to connect the pulse generator to your computer, and the programming commands themselves. A large number of commands are available; however, normally you will only need a few of these. Here is a basic sample sequence of commands that might be sent to the instrument after power-up:

*rst	(resets the instrument)
trigger:source internal	(selects internal triggering)
frequency 1000 Hz	(sets the frequency to 1000 Hz)
pulse:delay 1 us	(sets the delay to 1 us)
pulse:width1 10 us	(sets the positive pulse width to 10 us)
pulse:width2 5 us	(sets the negative pulse width to 5 us)
volt:ampl1 +100	(sets the positive pulse amplitude to +100 V)
volt:ampl2 -200	(sets the negative pulse amplitude to -200 V)
output on	(turns on the output)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
output on	(turns on the output)
pulse:delay 1 us	(sets the delay to 1 us)
pulse:width1 10 us	(sets the positive pulse width to 10 us)
pulse:width2 5 us	(sets the negative pulse width to 5 us)
volt:ampl1 +100	(sets the positive pulse amplitude to +100 V)
volt:ampl2 -200	(sets the negative pulse amplitude to -200 V)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

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

*rst	(resets the instrument)
trigger:source external	(selects external triggering)
pulse:delay 1 us	(sets the delay to 1 us)
pulse:width1 10 us	(sets the positive pulse width to 10 us)
pulse:width2 5 us	(sets the negative pulse width to 5 us)
volt:ampl1 +100	(sets the positive pulse amplitude to +100 V)
volt:ampl2 -200	(sets the negative pulse amplitude to -200 V)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

## ALL PROGRAMMING COMMANDS

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


<u>Keyword</u>	<u>Parameter</u>	<u>Notes</u>
LOCAL		
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW   FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DELay	<numeric value>	
:GATE		
:LEVel	High   LOw	
[SOURce]:		
:VOLTage		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value>	
:PROTection		
:TRIPped?		[query only]
STATUS:		
:OPERation		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
:QUEStionable		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
SYSTEM:		
:COMMunicate		
:GPIB		
:ADDReSS	<numeric value>	
:SERial		
:CONTRol		
:RTS	ON   IBFull   RFR	
:[RECeive]		
:BAUD	1200   2400   4800   9600	

: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.

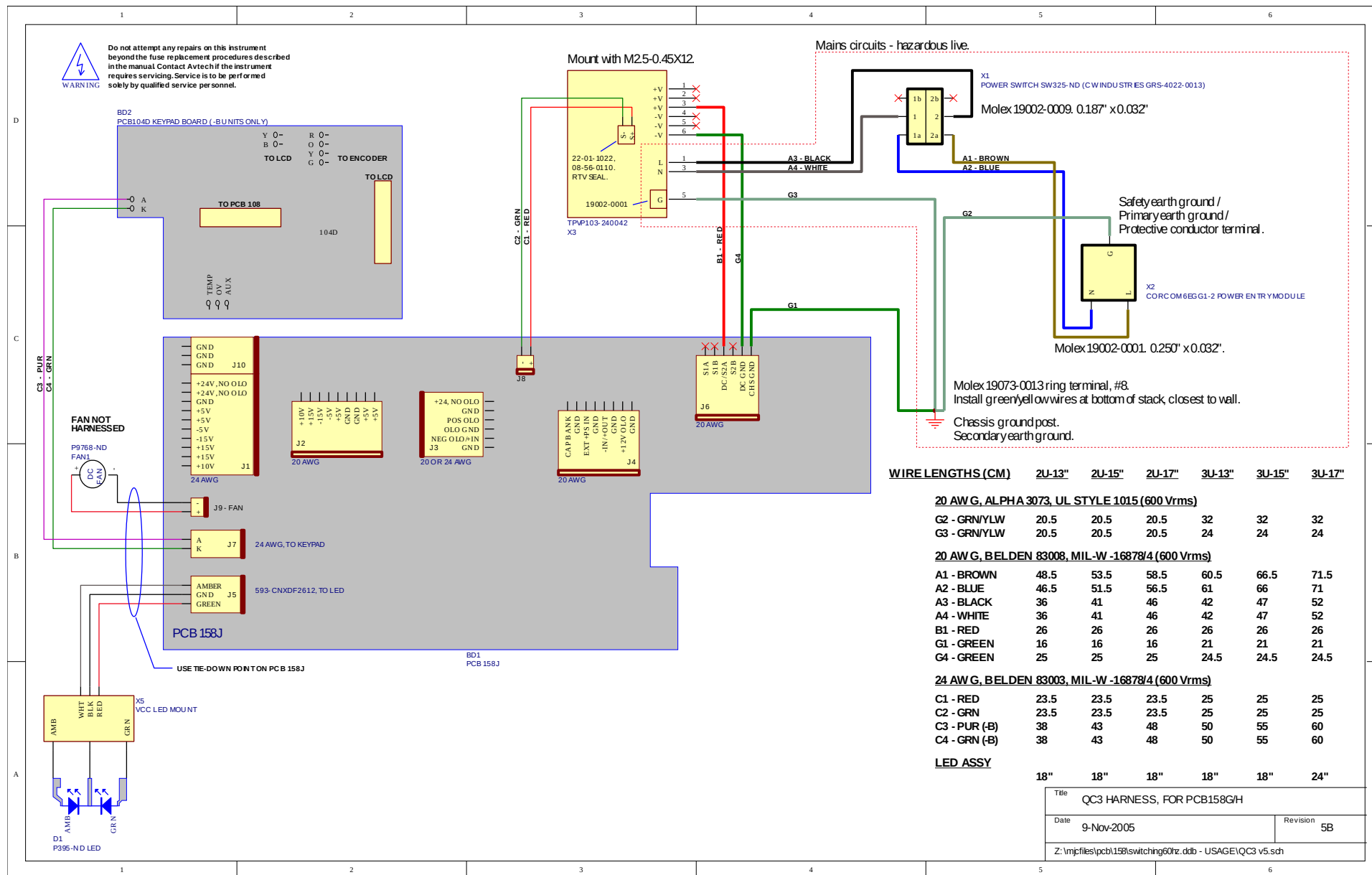
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

### CLEANING

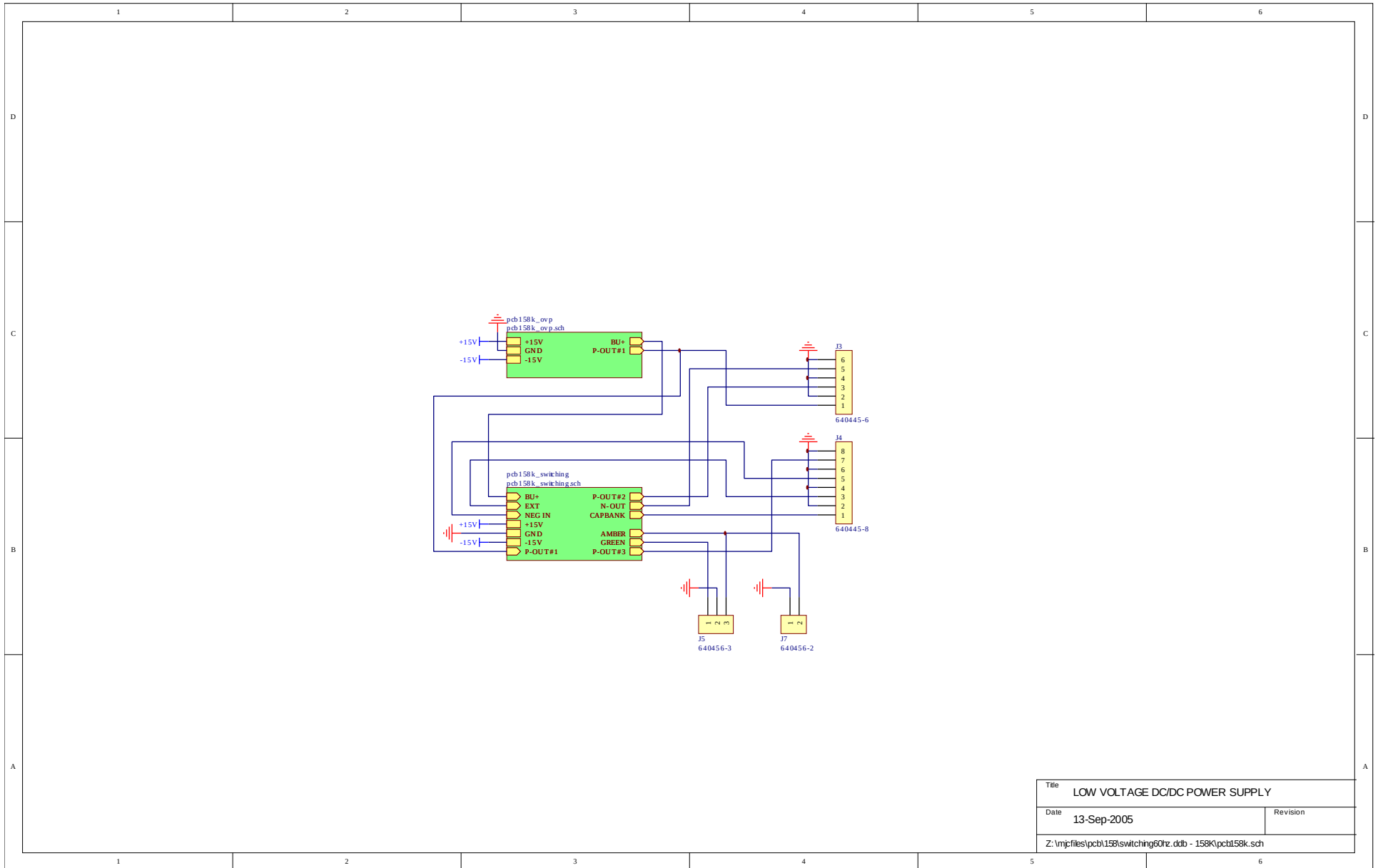
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

# WIRING DIAGRAMS

## WIRING OF AC POWER

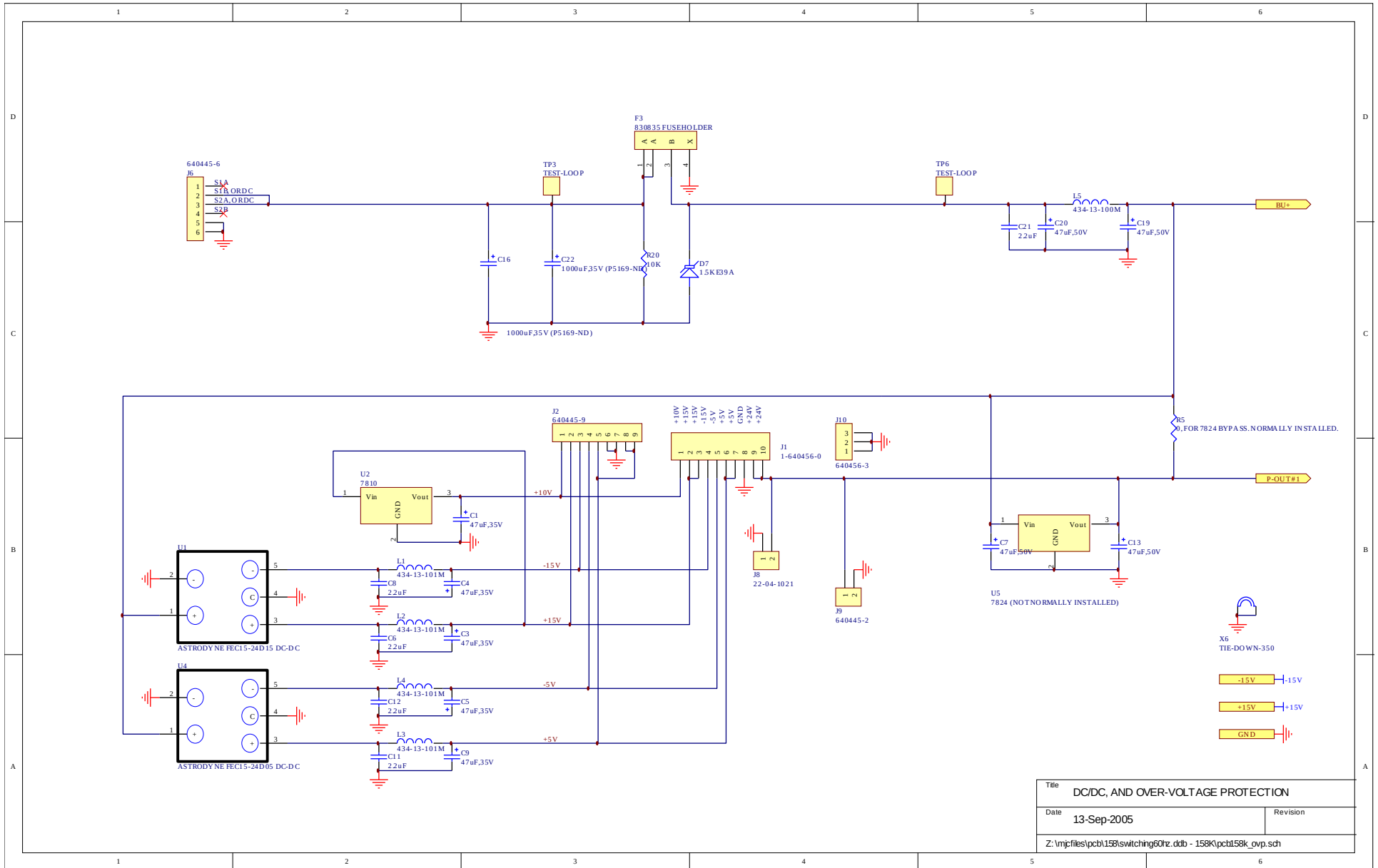


# PCB 158K - LOW VOLTAGE POWER SUPPLY, 1/3



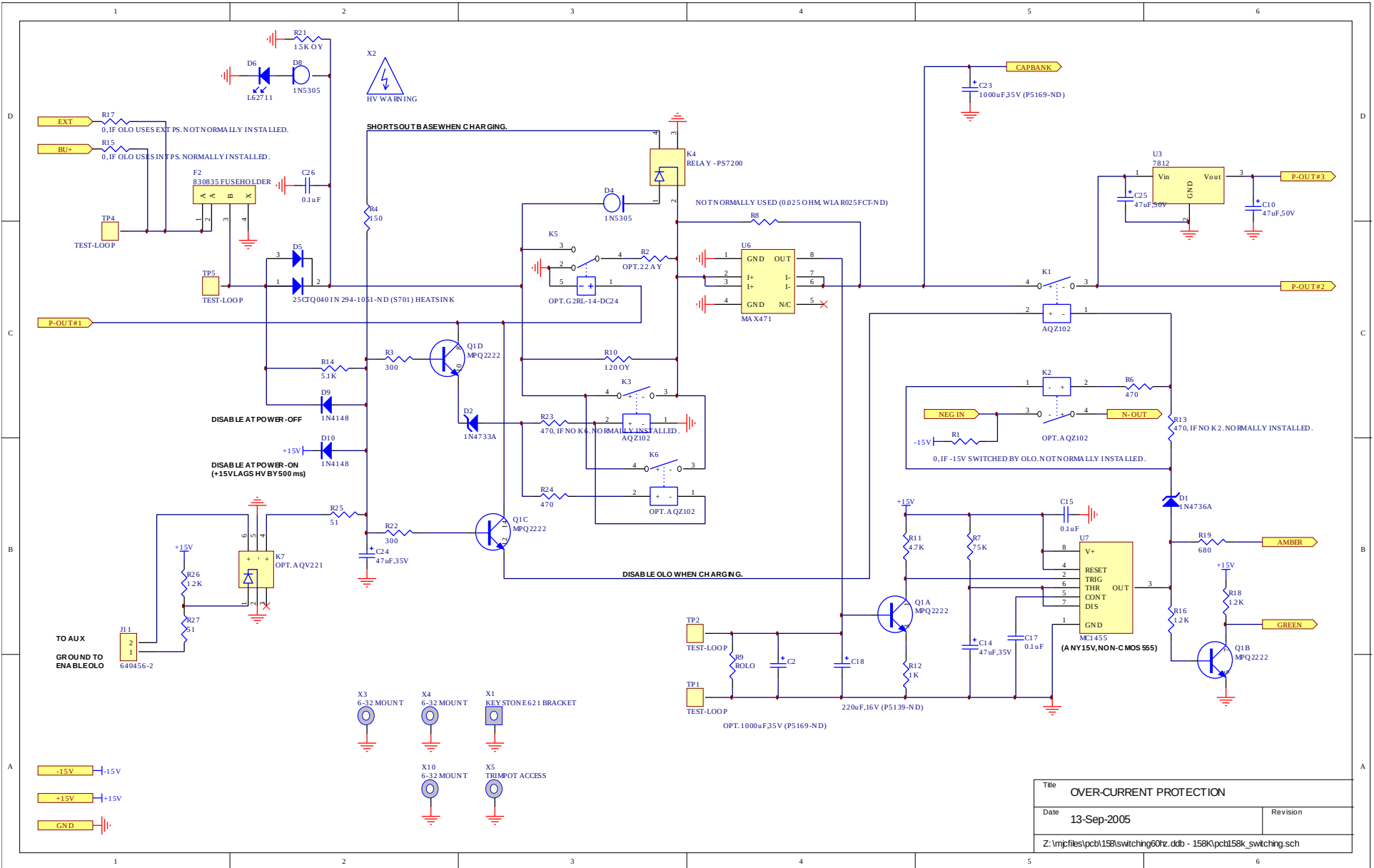
Title	LOW VOLTAGE DC/DC POWER SUPPLY	
Date	13-Sep-2005	Revision
Z:\mpjfiles\pcb158\switching01rz.ddb - 158K\pcb158k.sch		

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

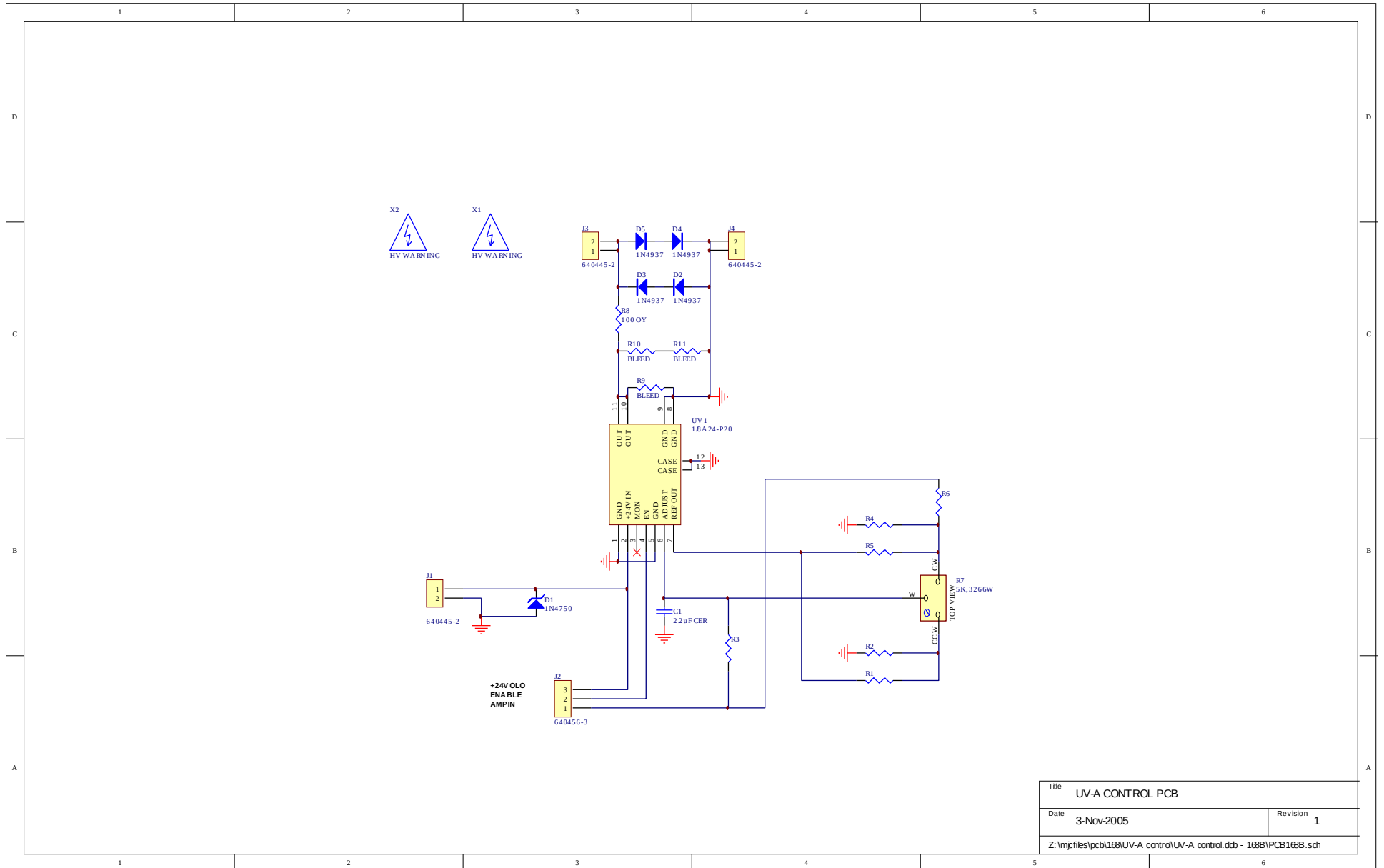




# PCB 158K - LOW VOLTAGE POWER SUPPLY, 3/3

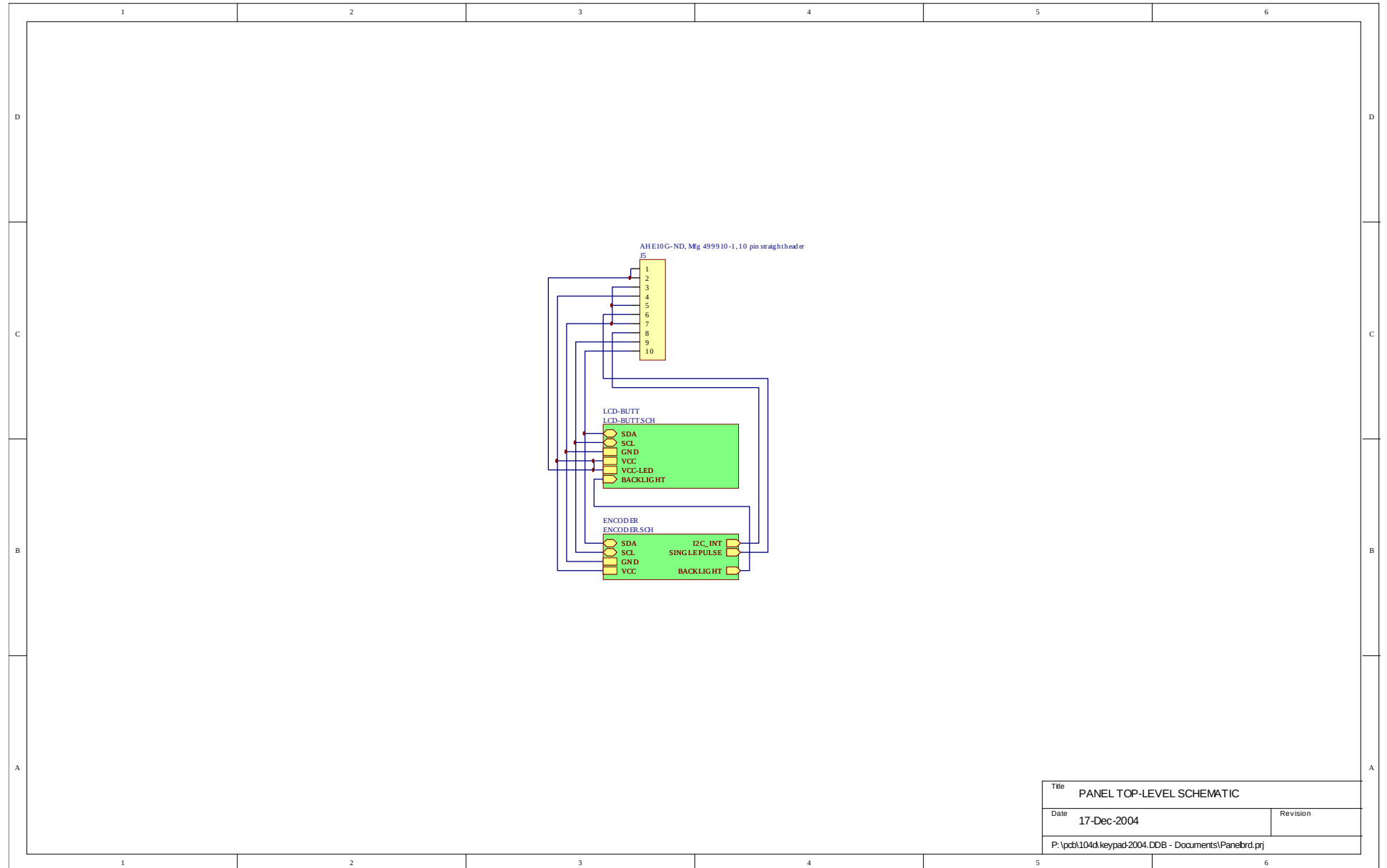


# PCB 168B - HIGH VOLTAGE DC POWER SUPPLY



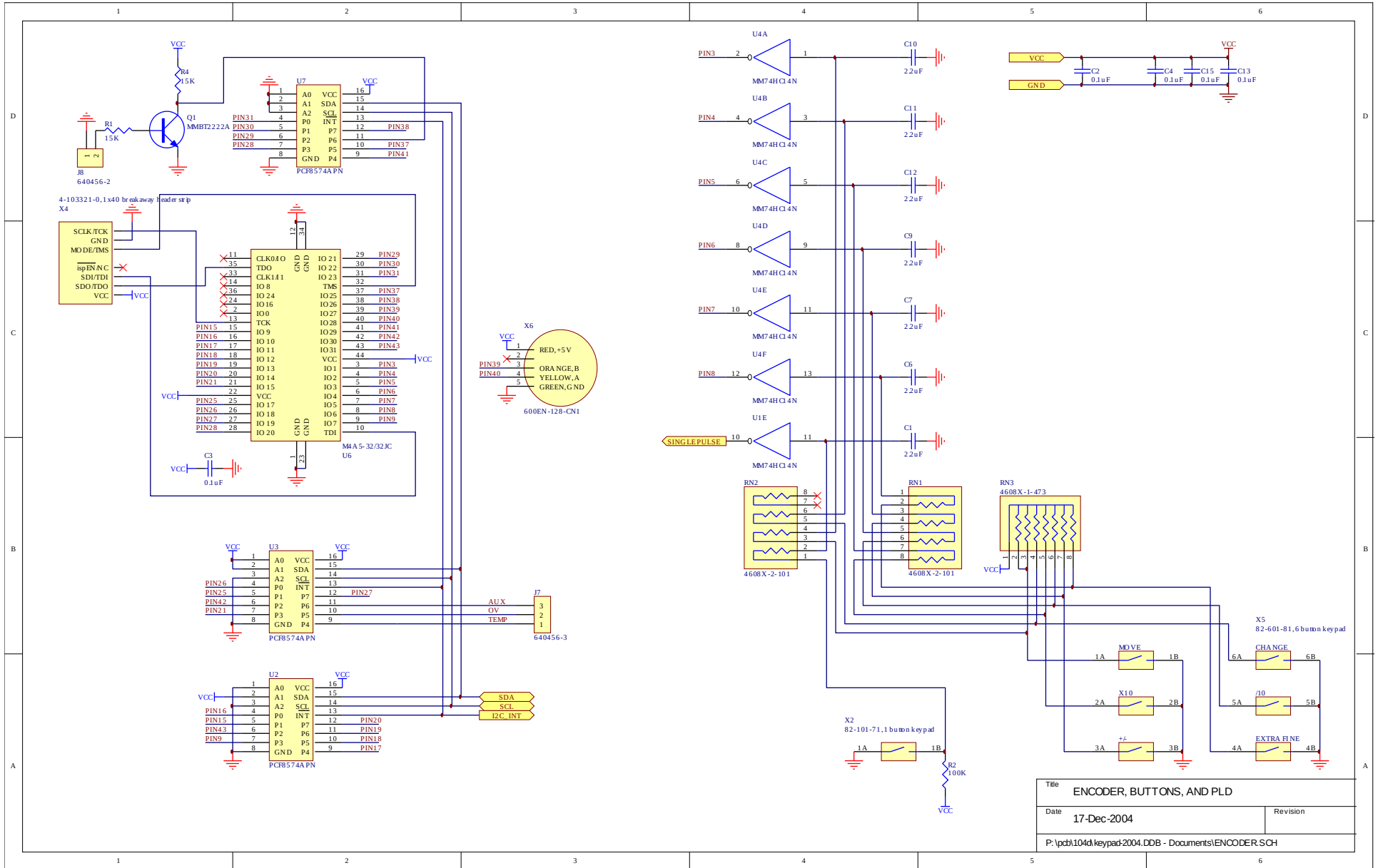
Title		UV-A CONTROL PCB
Date	3-Nov-2005	Revision 1
Z:\mpjfiles\pcb168\UV-A control\UV-A control.ddb - 168B\PCB168B.sch		

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

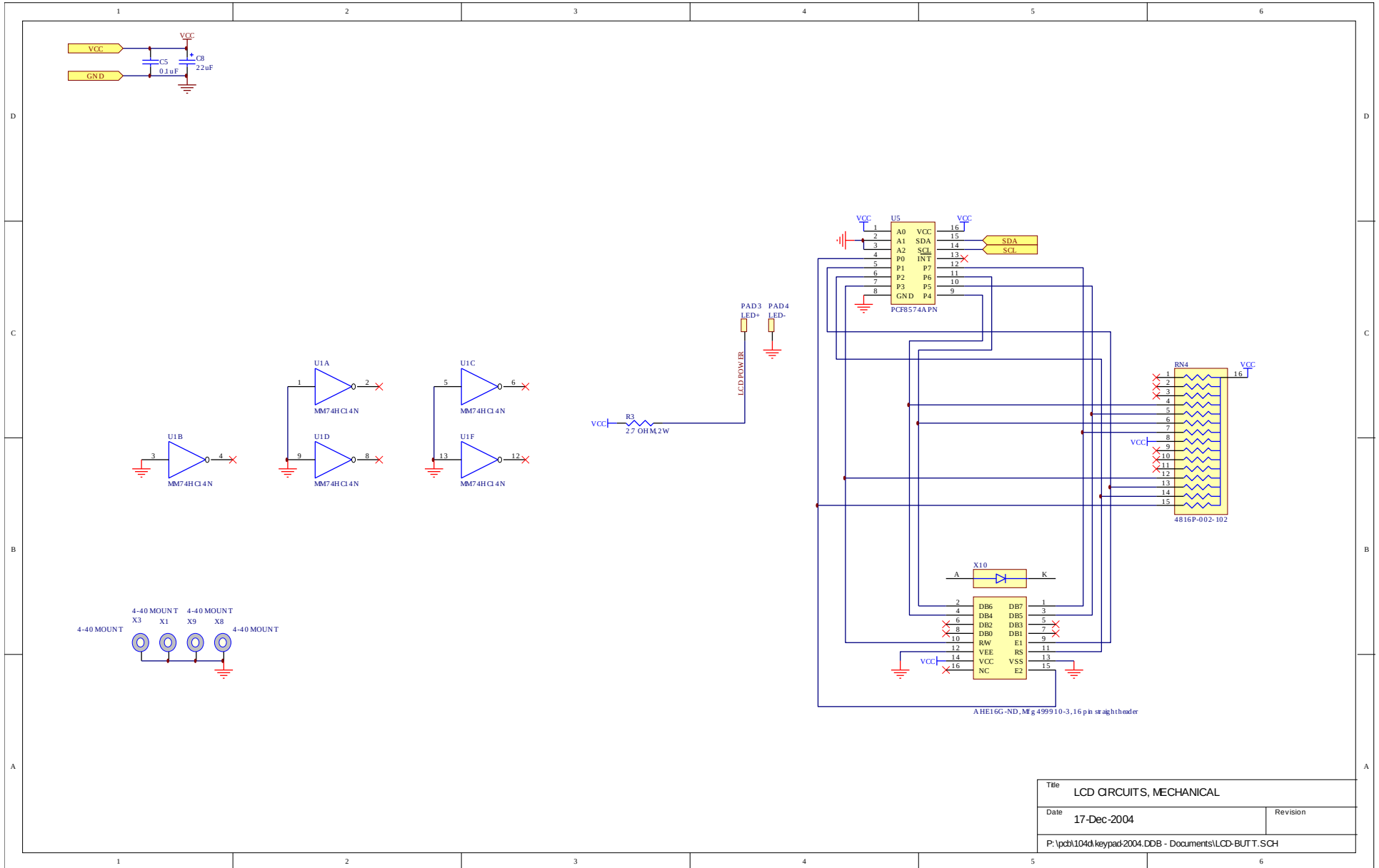


Title		PANEL TOP-LEVEL SCHEMATIC	
Date	17-Dec-2004	Revision	
P:\pcb\104d\keypad\2004.DDB - Documents\Panelbrd.prj			

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

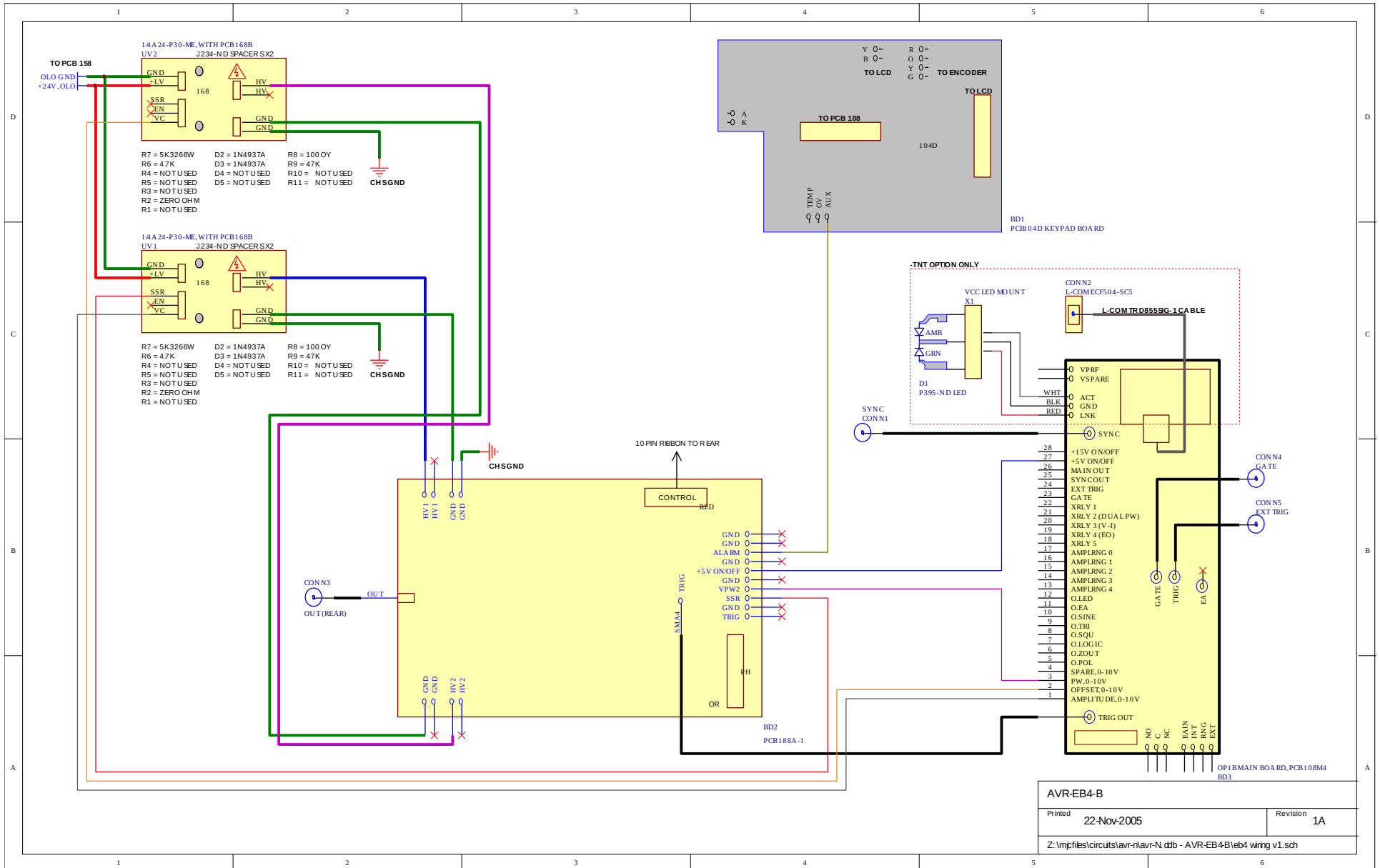


# PCB 104D - KEYPAD / DISPLAY BOARD, 3/3

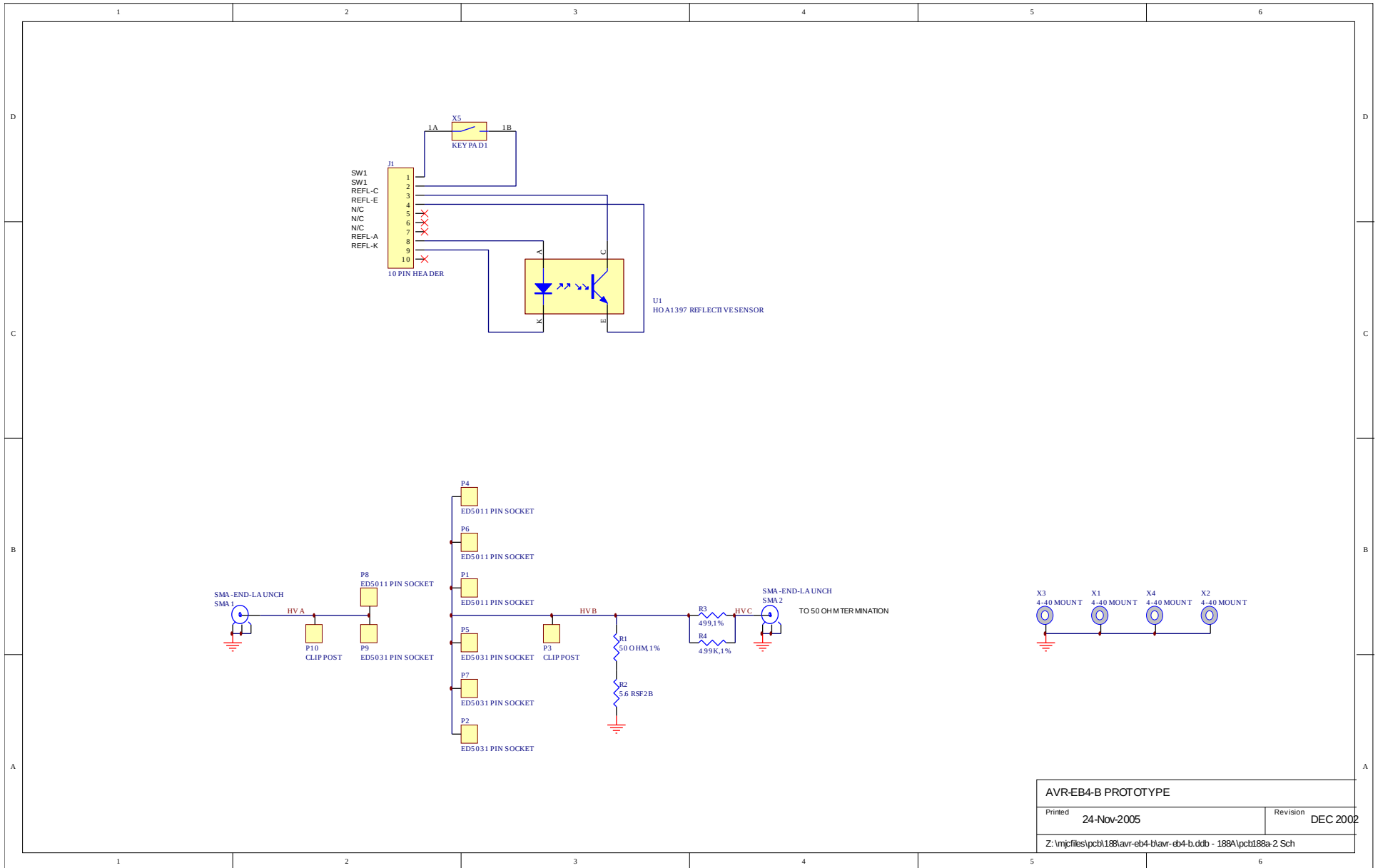


Title		LCD CIRCUITS, MECHANICAL	
Date	17-Dec-2004	Revision	
P:\pcb\104d\keypad2004.DDB - Documents\LCD-BUTT.SCH			

# MAIN WIRING



# TEST JIG WIRING



AVR-EB4-B PROTOTYPE	
Printed 24-Nov-2005	Revision DEC 2002
Z:\mprojfiles\pctl188\avr-eb4-blavr-eb4-b.ddb - 188A\pctl188a-2 Sch	

PERFORMANCE CHECK SHEET