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SINCE 1975

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BOX 5120, LCD MERIVALE
OTTAWA, ONTARIO
CANADA K2C 3H5

INSTRUCTIONS

MODEL AVR-CD1-B
REVERSE RECOVERY TIME TESTER
WITH ADJUSTABLE di/dt
OF 20 – 200 A/us

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-cd1/AVR-CD1-B,ed6.odt.
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INTRODUCTION

The AVR-CD1-B is a high performance, GPIB and RS232-equipped instrument intended for reverse recovery time testing of diodes and other semiconductor devices.

The AVR-CD1-B will apply a 2 us wide forward bias pulse with an adjustable amplitude of +0.1A to +10A to a device under test (DUT). At the end of that pulse, the current ramps downward at an adjustable rate of < 20 to > 200 A/us until the diode stops conducting. The maximum specified ramp duration is 1 us, and the maximum allowed reverse current is -20A.

The current waveforms generated by this instrument are suitable for MIL-STD-750E Method 4031.4 Test Condition D tests. (Avtech can also provide separate test systems for Condition B tests). All standard conditions of this method (conditions D1-D6) can be accommodated.

Standard AVR-CD1-B models include one AVX-CD1-MIX diode test jig. The instrument mainframe is connected to the test jig using a DB-25 control cable. The standard test jig contains a variety of pin sockets and posts, which may be used to hold the diode device under test (DUT). This jig will accept TO-220AC (2 lead) packages and most axial packages, if the leads are bent. The jig will also accept a variety of specialized daughterboards, which can be used to hold MELF or unbent axial devices. Customized daughterboards can be provided.

The output signal is provided on a BNC connector on the test jig. This output should be terminated with 50 Ohms (a suitable terminator is provided with the instrument), and connected to a user-supplied high-bandwidth (≥ 300 MHz) oscilloscope. The output signal is generated by a Tektronix CT2 current transformer in series with the DUT, and the voltage it generates is directly proportional to the current through the diode (1 Volt per Amp, nominally). By observing the current waveform through the diode, the reverse recovery time may be determined.

The AVR-CD1-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-CD1-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-CD1-B
Intended application:	Reverse recovery time tests, as per MIL-STD-750E Method 4031.4 Test Condition D1-D6.
Basic waveform:	A positive current pulse followed immediately by a negative-going current ramp
Positive current duration:	2 us
Positive current amplitude:	+0.1A to +10A, adjustable (typical accuracy ¹ : greater of ± 5% or ± 20 mA)
Negative-going ramp rate:	< 20 to > 200 A/us, adjustable (± 10% typical accuracy ¹)
Maximum reverse current:	-20A
Maximum ramp duration:	1 us
Maximum PRF:	100 Hz
Delay:	0 to ± 1 second, adjustable
Supplied test jig ⁴ :	Model AVX-CD1-MIX. Includes pin sockets for TO-220AC (2 lead) packages, and DO-style packages ³ with leads bent at 90°.
Jig daughterboards:	-AANB option: Adds a daughterboard to accept DO-41 and similar axial packages, without lead bending. -SQMELF option: Adds a daughterboard to accept common MELF and SQMELF packages. Others are available upon request.
Mainframe to jig cable:	DB-25 male/male straight-through.
Mainframe connectors:	TRIG, SYNC, GATE: BNC female
Jig output connector:	BNC female.
Output waveform:	When the output is terminated with the provided 50 Ohm terminator, the output voltage is proportional to the DUT current: $V_{OUT} = I_{DUT} \times 1 \text{ Volt / Amp,}$ The output is generated internally by an integrated Tektronix CT2 current transformer (bandwidth 1.2 kHz to 200 MHz).
GPIB and RS-232 control:	Standard on -B units. See http://www.avtechpulse.com/gpib for details.
LabView driver:	Check http://www.avtechpulse.com/labview for availability and downloads
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
Temperature range:	+5°C to +40°C

1) The amplitude settings should not be relied upon for any degree of accuracy, because the dynamics of the device under test can affect the actual generated waveforms. Amplitude settings should always be verified by oscilloscope measurements.

REGULATORY NOTES

FCC PART 18

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

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

If interference is observed, check that appropriate well-shielded cabling is used on the output connectors. Contact Avtech (info@avtechpulse.com) for advice if you are unsure of the most appropriate cabling. Also, check that your load is adequately shielded. It may be necessary to enclose the load in a metal enclosure.

If any of the connectors on the instrument are unused, they should be covered with shielded metal "dust caps" to reduce the interference potential.

This instrument does not normally require regular maintenance to minimize interference potential. However, if loose hardware or connectors are noted, they should be tightened. Contact Avtech (info@avtechpulse.com) if you require assistance.

EC DECLARATION OF CONFORMITY



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

declare that this pulse generator meets the intent of Directive 2004/108/EG for Electromagnetic Compatibility. Compliance pertains to the following specifications as listed in the official Journal of the European Communities:

EN 50081-1 Emission

EN 50082-1 Immunity

and that this pulse generator meets the intent of the Low Voltage Directive 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.



AC POWER SUPPLY REGULATORY NOTES

This instrument converts the AC input power to the +24V DC voltage that powers the internal circuitry of this instrument using a Tamura AAD130SD-60-A switching power supply. According to the manufacturer, the Tamura AAD130SD-60-A has the following certifications:

UL60950-1
IEC60950 -1
CSA C22.2 No. 60950- 1
EN60950 -1

and is compliant with:

EN61000-3-2
EN61000-4-2 Level 2
EN61000-4-2 Level 3 (Air Only)
EN61000-4-4 Level 3
EN61000-4-5 Level 3
EN61000-4-11
CISPR 11 and 22 FCC Part 15 Class B (conducted)

FIRMWARE LICENSING

Instruments with firmware versions 5.00 or higher use open-source software internally. Some of this software requires that the source code be made available to the user as a condition of its licensing. This source code is distributed on the device itself. To access it, log in as user “source” with password “source”. The source files are provided in this user's home directory, and are accessible using standard viewing and file transfer tools (such as vim, sz, and scp).

Earlier firmware versions do not contain any open source software.

INSTALLATION

VISUAL CHECK

After unpacking the instrument, examine to ensure that it has not been damaged in shipment. Visually inspect all connectors, knobs, liquid crystal displays (LCDs), and the handles. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

The following items should be with the instrument:

- 1) One AVR-CD1-B mainframe
- 2) One 6 ft / 2m DB25 control cable
- 3) One 5 ft / 1.5m BNC-to-BNC coaxial cable
- 4) One BNC feed-through 50 Ohm terminator
- 5) One AVX-CD1-MIX test jig
- 6) One standard GPIB cable, 2m length
- 7) One AC Power Cord
- 8) One Programming Manual for "-B" Instruments
- 9) One AVR-CD1-B Instruction Manual
- 10) One AVX-CD1-SQMELF daughterboard (PCB 209B.2), for units with the -SQMELF option.
- 11) One AVX-CD1-AANB daughterboard (PCB 209B.3), for units with the -AANB option.
- 12) One AVX-CD1-DO4 daughterboard, for units with the -DO4 option.
- 13) One AVX-CD1-DO5 daughterboard, for units with the -DO5 option.

POWER RATINGS

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


The maximum power consumption is 57 Watts. Please see the "FUSES" section for information about the appropriate AC and DC fuses.

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

CONNECTION TO THE POWER SUPPLY

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


instrument to the mains supply must provide an earth connection. (The supplied cord does this.)

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

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

Destination Region	Description	Option	Manufacturer	Part Number
United Kingdom, Hong Kong, Singapore, Malaysia	BS 1363, 230V, 50 Hz	-AC00	Qualtek	370001-E01
Australia, New Zealand	AS 3112:2000, 230-240V, 50 Hz	-AC01	Qualtek	374003-A01
Continental Europe, Korea, Indonesia, Russia	European CEE 7/7 "Schuko" 230V, 50 Hz	-AC02	Qualtek	364002-D01
North America, Taiwan	NEMA 5-15, 120V, 60 Hz	-AC03	Qualtek	312007-01
Switzerland	SEV 1011, 230V, 50 Hz	-AC06	Qualtek	378001-E01
South Africa, India	SABS 164-1, 220-250V, 50 Hz	-AC17	Volex	2131H 10 C3
Japan	JIS 8303, 100V, 50-60 Hz	-AC18	Qualtek	397002-01
Israel	SI 32, 220V, 50 Hz	-AC19	Qualtek	398001-01
China	GB 1002-1, 220V, 50 Hz	-AC22	Volex	2137H 10 C3

PROTECTION FROM ELECTRIC SHOCK

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

1. Keep exposed high-voltage wiring to an absolute minimum.

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

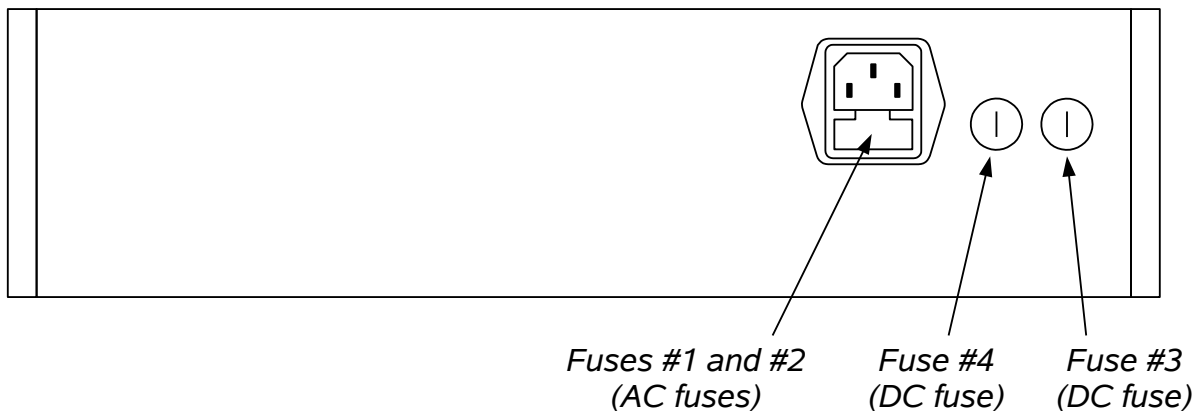
ENVIRONMENTAL CONDITIONS

This instrument is intended for use under the following conditions:

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

FUSES

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



AC FUSE REPLACEMENT

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



DC FUSE REPLACEMENT

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

FUSE RATINGS

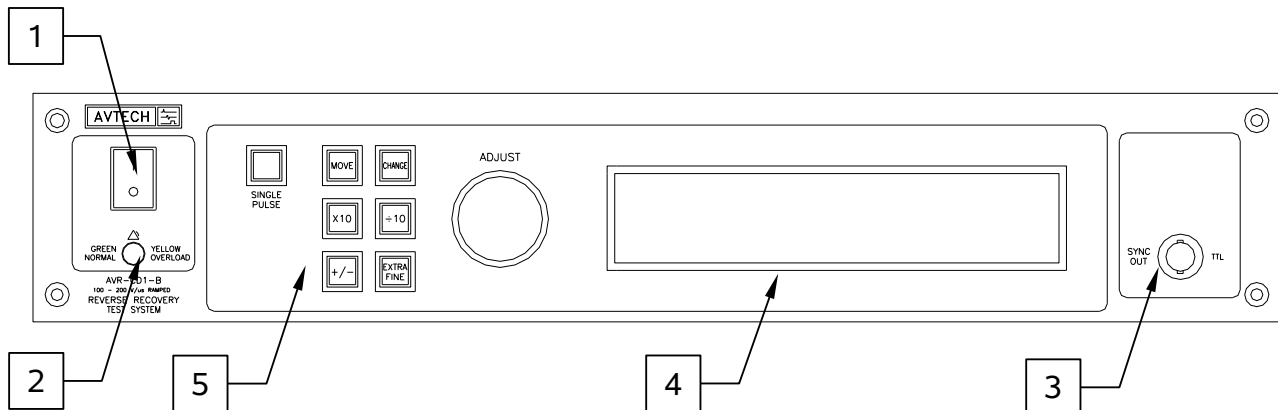
The following table lists the required fuses:

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

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

Allow 30 seconds before re-powering an instrument that has been switched off. If the power is switched more frequently than that, the turn-on delay may be longer (up to 20 seconds) as the internal software performs filesystem checks.

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

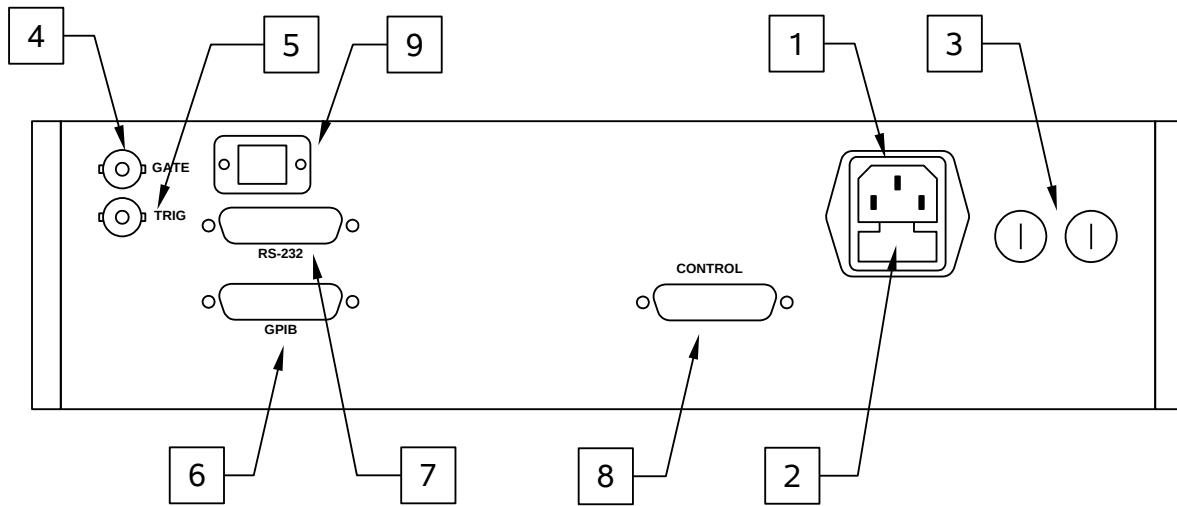
This overload indicator may flash yellow briefly at start-up. This is not a cause for concern.

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

4. LIQUID CRYSTAL DISPLAY (LCD). This LCD is used in conjunction with the keypad to change the instrument settings. Normally, the main menu is displayed, which lists the key adjustable parameters and their current values. The "Programming Manual for -B Instruments" describes the menus and submenus in detail.
5. KEYPAD.

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

REAR PANEL CONTROLS



1. AC POWER INPUT. An IEC-320 C14 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket.
2. AC FUSE DRAWER. The two fuses that protect the AC input are located in this drawer. Please see the “FUSES” section of this manual for more information.
3. DC FUSES. These two fuses protect the internal DC power supplies. Please see the “FUSES” sections of this manual for more information.
4. GATE. This TTL-level (0 and +5V) logic input can be used to gate the triggering of the instrument. This input can be either active high or active low, depending on the front panel settings or programming commands. (The instrument triggers normally when this input is unconnected). When set to active high mode, this input is pulled-down to ground by a 1 k Ω resistor. When set to active low mode, this input is pulled-up to +5V by a 1 k Ω resistor.
5. TRIG. This TTL-level (0 and +5V) logic input can be used to trigger the instrument, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input. The input impedance of this input is 1 k Ω . (Depending on the length of cable attached to this input, and the source driving it, it may be desirable to add a coaxial 50 Ohm terminator to this input to provide a proper transmission line termination. The Pasternack (www.pasternack.com) PE6008-50 BNC feed-thru 50 Ohm terminator is suggested for this purpose.)
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. CONTROL Connector. This DB-25 female connector must be connected to the corresponding connector on the test jig using the supplied DB-25 male/male straight-through cable. Do not connect or disconnect the cabling while the instrument is powered.
9. Network Connector. (Optional feature. Present on -VXI units only.) This Ethernet connector allows the instrument to be remotely controlled using the VXI-11.3, ssh (secure shell), telnet, and http (web) protocols. See the “Programming Manual for -B Instruments” for more details.

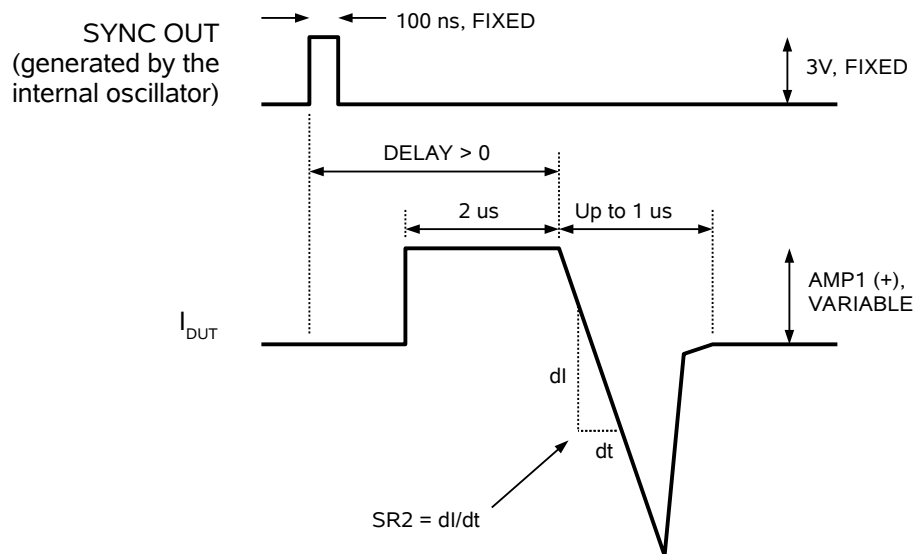
BASIC CONTROLS

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: the main output (I_{DUT} , the current through the DUT) and the SYNC output.

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:



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.

BASIC AMPLITUDE CONTROL

There are three amplitudes that must be set from the front panel or by computer commands.

AMP1 is the amplitude of the forward current pulse. It may be set anywhere between +0.1 and +10 Amps. This may be adjusted from the AMP1 menu of the front panel display, or using a command like "sour:curr1 +5A".

AMP2 is the DC bias voltage applied to the source of the ramp transistor. This may be adjusted from 0 to -80V, but it should always be set as negative as possible. That is, always set it at -80V, unless this exceeds the DUT's breakdown voltage. This may be adjusted from the AMP2 menu of the front panel display, or using a command like "sour:volt2 -80V". (We suggest setting this at -80V, even if the test specification normally calls for a reduced voltage.)

SR2 is the "slew rate" of the negative-going ramp. The specified range is 20 A/us to 200 A/us, but it may actually be set anywhere between 15 A/us and 250 A/us. This may be adjusted from the SR2 menu of the front panel display, or using a command like "sour:curr:slew2 150 A/us".

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.

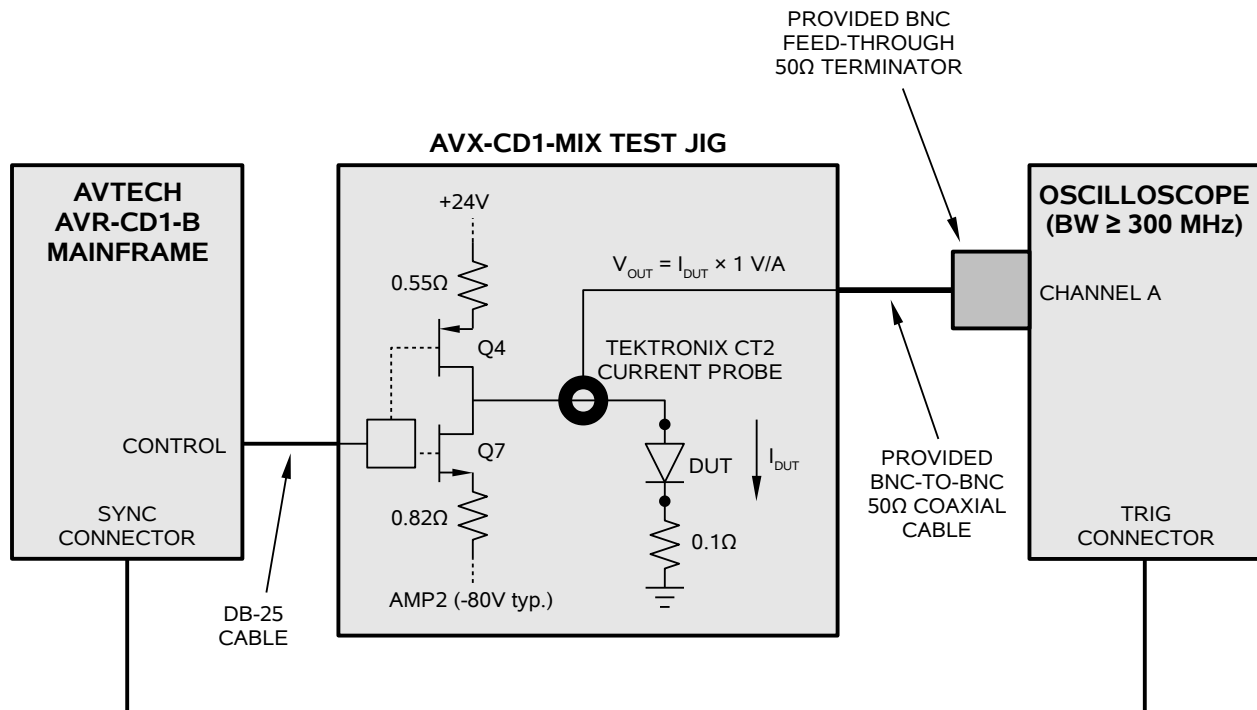
These modes can be selected using the front panel trigger menu, or by using the appropriate programming commands. (See the "Programming Manual for -B Instruments" for more details.)

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 TEST ARRANGEMENT

The basic test arrangement for the AVR-CD1-B is shown in the figure below. The mainframe is connected to the test jig using the supplied DB-25 control cable, and the test jig is connected to the user-provided oscilloscope with the supplied BNC-to-BNC cable and feed-through terminator. The oscilloscope input impedance should be high (≥ 1 Megohm).



The embedded Tektronix CT2 current probe monitors the current through the DUT, and provides the output signal.

CT2 CURRENT PROBE

The CT2 current probe generates the output waveform, using the ratio of $V_{OUT} = I_{DUT} \times 1 \text{ V/A}$. The nominal accuracy of the CT2 is 3%. However, the CT2 is an AC-coupled device (a transformer), so the output may waveform may droop by several percent during the 2 μ s forward bias time. This is normal.

Also, as an AC-coupled device, the oscilloscope waveform may shift slightly in the amplitude axis so that the average output over time is zero. This is normal, but may lead to some confusion, if it appears that a small DC current is flowing when the device should be fully turned off. This is a measurement artifact, and not a “real” DC current.

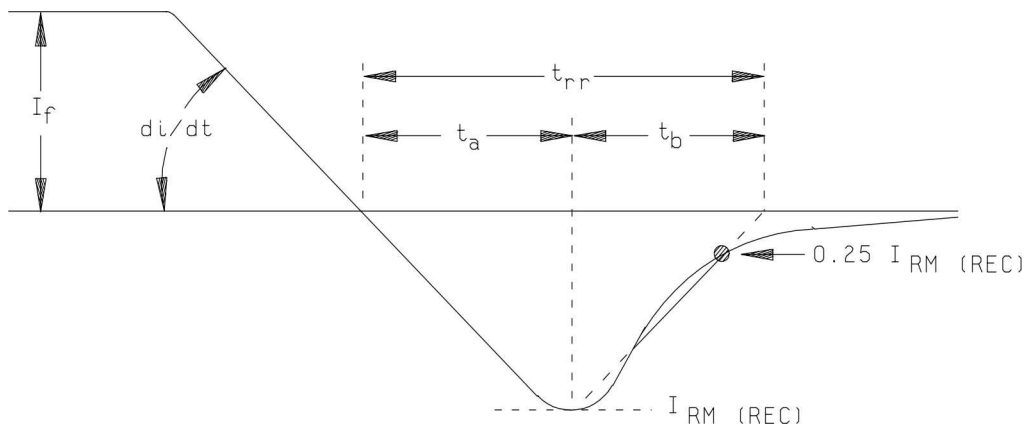
A 0.1 Ohm resistance (actually composed of four 0.4 Ohm resistors in parallel) is also present in the circuit, and can be used as a DC-coupled current-sensing output if the user prefers. An SMA connector providing this output is installed on the bottom side of the jig PCB. It is possible to disconnect the CT2 from the OUT BNC internally, by removing the SMB-to-BNC cable. An SMA-to-BNC cable can then be connected from the SMA connector to the OUT BNC connector. To access the underside of the PCB, remove the four nuts on the top side of the PCB (one near the midpoint of each edge), and gently pull the PCB upwards.

SAFETY INTERLOCK

The mainframe provides DC voltages of up to 80V 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.

MEASUREMENT THEORY

The figure below, taken from MIL-STD-750E Method 4031.4 Test Condition D, shows the basic definitions for Condition D measurements:



I_f is the same as “AMP1” on the front panel.

di/dt is the same as “SR2” on the front panel.

t_{rr} , t_a , t_b , and $I_{RM(REC)}$ are measured by the user on the attached oscilloscope.

DIFFERENCES BETWEEN TESTERS

Often reverse recovery time measurements must be compared between users at different sites, possibly with different equipment.

The t_a measurement should be reasonably consistent across different test systems.

The t_b measurement (and thus t_{RR}) may be more variable. During the “ t_b ” time, the diode has stopped conducting, and acts primarily as a capacitance in the test circuit. The test circuit will then look like a classic RLC (resistor-inductor-capacitor) series circuit, where R is composed of the 0.1 and 0.82 Ohm resistances shown in the “Basic Test Arrangement” figure, L is the parasitic inductance of the diode and the PCB traces, and C is the reverse-bias capacitance of the diode. t_b will be largely determined by the R and L values, which are tester-dependent.

For this reason, it is best to compare on the basis of t_a , if possible, because it is mostly device-dependent.

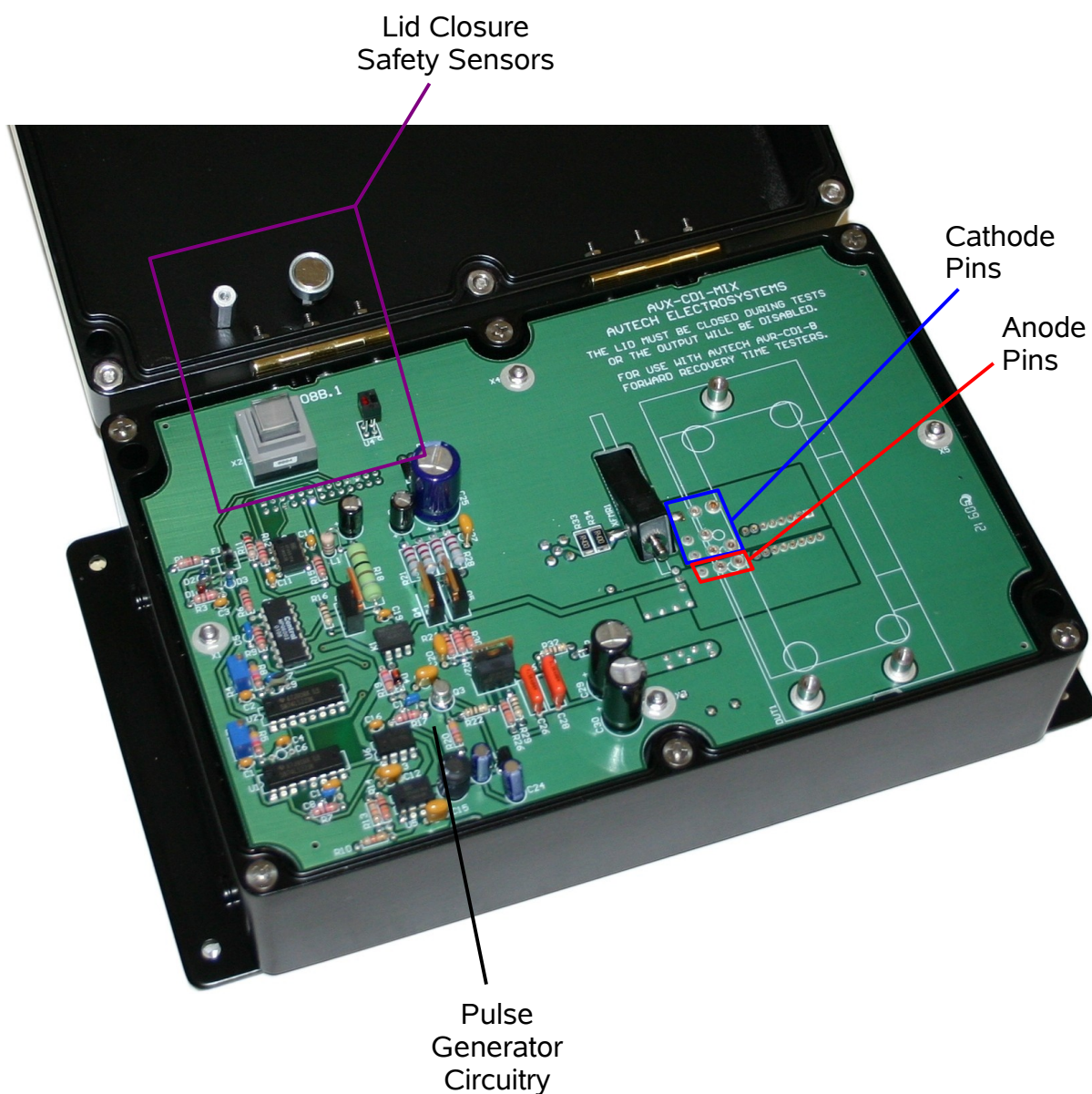
t_b , t_{RR} , and the “recovery softness factor (RSF)” of t_b/t_a are more circuit-dependent than device-dependent.

STANDARD TEST JIG MECHANICAL ASPECTS

One AVX-CD1-MIX test jig is normally supplied with the mainframe, unless the customer has requested a different or additional test jigs.

AVX-CD1-MIX TEST JIG

The AVX-CD1-MIX test jig directly accepts a range of through-hole and axial devices, using pin sockets and spring-loaded pins. It is intended for use with diodes in DO-41, TO-220, DO-204AR, or similar packages. A photo of the arrangement is shown below:

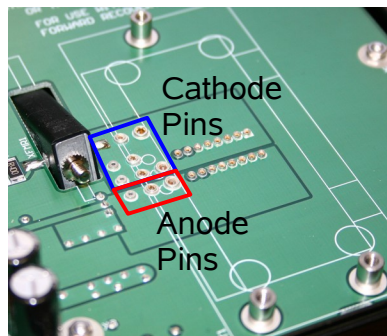


The instrument and the DUT will not be damaged if the diode is installed with the incorrect orientation (i.e., with the anode and cathode reversed). However, incorrect waveforms will be generated.

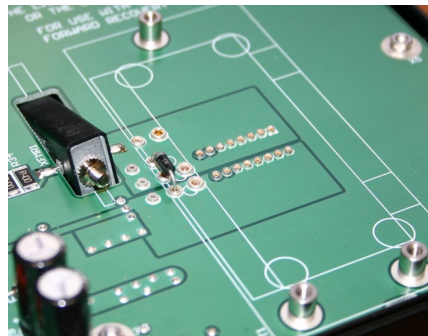
The procedure for inserting most axial and TO-220 packages is straightforward. Simply insert the DUT between one of the Anode pin sockets (in the red area above) and one of the Cathode sockets (in the blue area above). Select the sockets with the most appropriate hole size, and try to minimize all lead lengths, to minimize parasitic inductance.

Several actual installed devices are shown below:

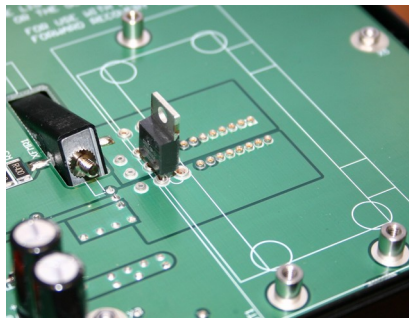
No DUT Installed



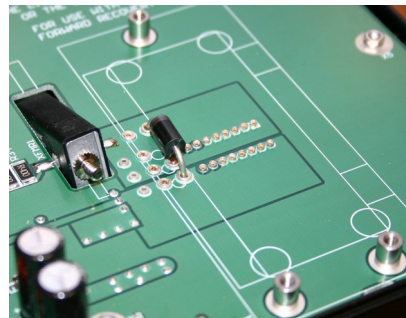
DO-41 DUT Installed



TO-220AC DUT Installed



DO-204AR DUT Installed



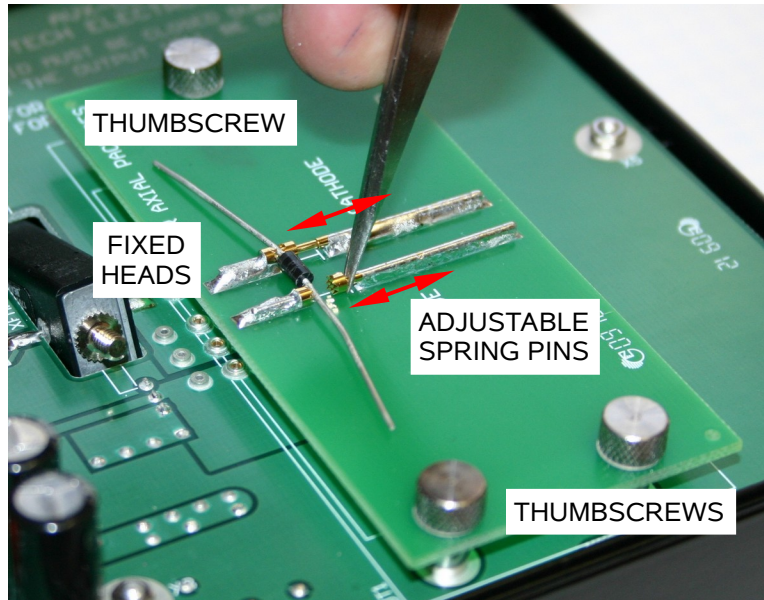
USING A DAUGHTERBOARD

Depending on the exact configuration ordered, the AVR-CD1-B may include several daughterboards to accommodate other packaging styles. The daughterboards plug into the 16-pin-DIP socket to the right of the normal DUT area, and are secured with three thumbscrews.

To install a daughterboard, carefully align the daughterboard so that the 16 pins on the bottom side align with the 16-pin socket on the main jig PCB. The three holes for the thumbscrews should also align with the threaded posts on the main jig PCB.

AVX-CD1-AANB DAUGHTERBOARD

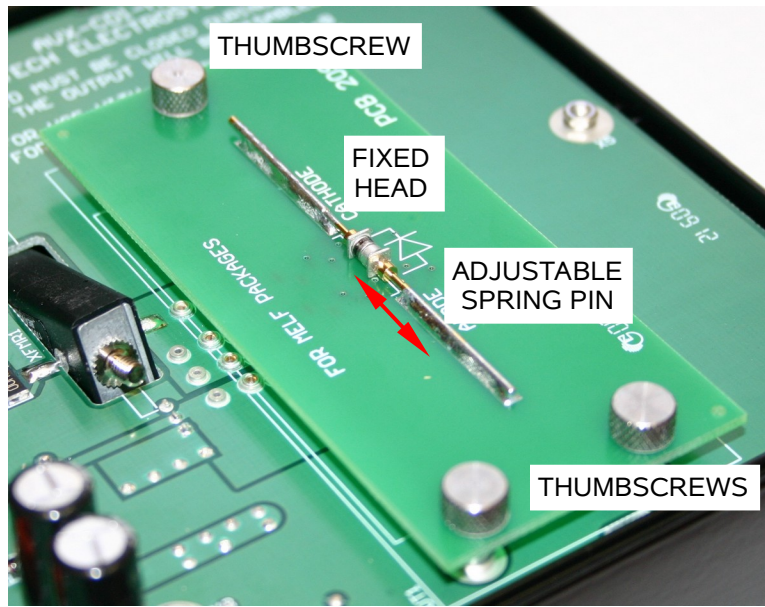
An installed AVX-CD1-AANB test jig is shown below, with a DO-41 packaged DUT installed:



To install a DUT, use tweezers to pull back the anode adjustable spring pin. Insert the anode between the serrated head of this spring pin and the fixed head opposite it. Then do the same for the cathode spring pin.

AVX-CD1-SQMELF DAUGHTERBOARD

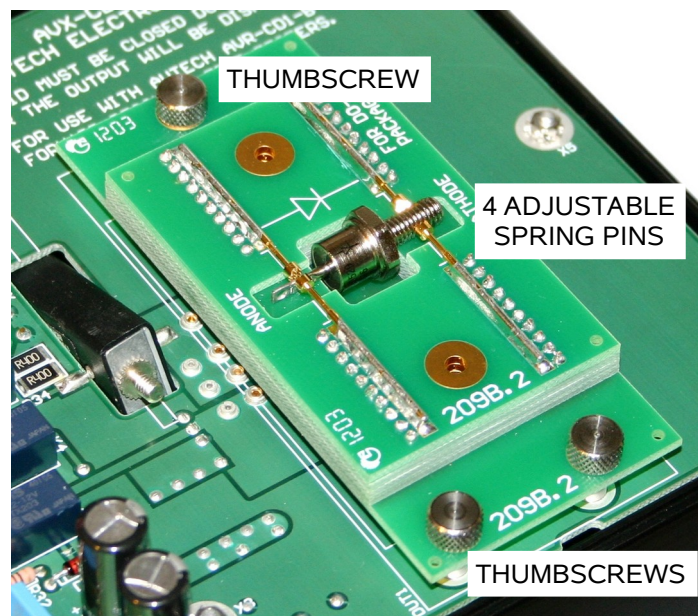
An installed AVX-CD1-SQMELF test jig is shown below, with a square-MELF DUT installed:



To install a DUT, use tweezers to pull back the anode adjustable spring pin. Insert the anode between the serrated head of this spring pin and the fixed head opposite it.

AVX-CD1-DO4 AND AVX-CD1-DO5 DAUGHTERBOARDS

The AVX-CD1-DO4 and AVX-CD1-DO5 daughterboards accept DO-4 and DO-5 stud packages, respectively. An example is shown below. The photo below shows a DO-4 diode (Microsemi 1N5816JAN) installed between the four spring-loaded contacts (two for the anode end, and two for the cathode end):



To install the diode, spread apart one pair of spring pins with tweezers, and insert one end of the diode. Repeat on the other end.

OTHER DAUGHTERBOARDS AND REPLACEMENT PARTS

Other daughterboards are available upon request.

The thumbscrews are Keystone Electronics (<http://www.keyelco.com>) model 2400.

The spring pins are Test Connections, Inc. (<http://www.tciinfo.com>) model 70-3H.

The bottom-side SMT DIP pins are Mill-Max (<http://www.mill-max.com>) model 350-10-164-00-106000.

TEST JIG CONNECTORS

The IN, OUT, and CONTROL connectors are on the rear of the jig, below the hinges:

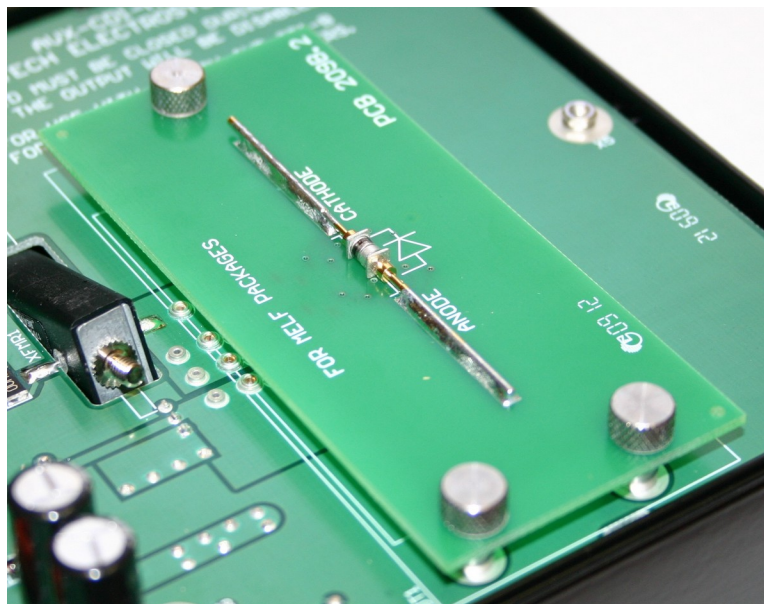


TYPICAL RESULTS

Obtaining meaningful results with the AVR-CD1-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 are provided below. The user should be able to reliably duplicate these results.

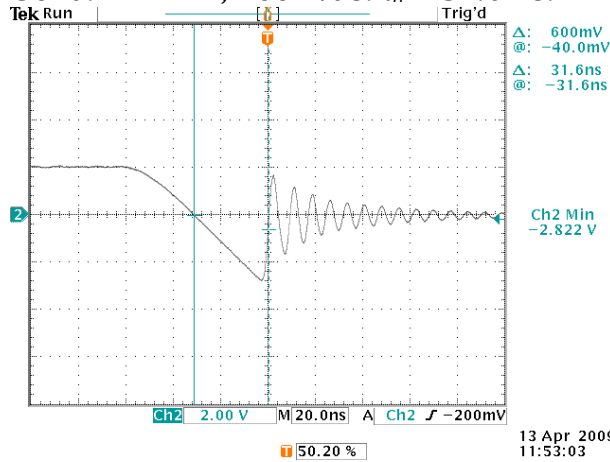
MQ1N5811US RESULTS

A Microsemi MQ1N5811US diode was tested. The MQ1N5811US is packaged in the Microsemi Package “E”, or “D-5B”, square MELF. The installed DUT is shown below:

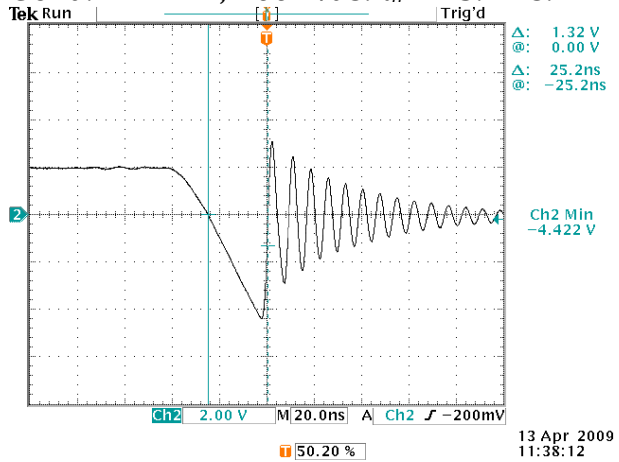


This device was tested at forward currents of 2, 6, and 10 Amps, at 100 and 200 A/us (which corresponds to conditions D1-D6 of MIL-STD-750E Method 4031.4). The results are shown below:

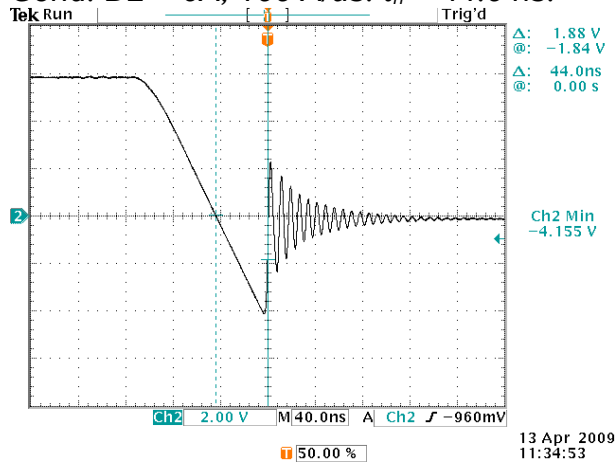
Cond. D1 – 2A, 100 A/us. $t_{rr} = 31.6$ ns.



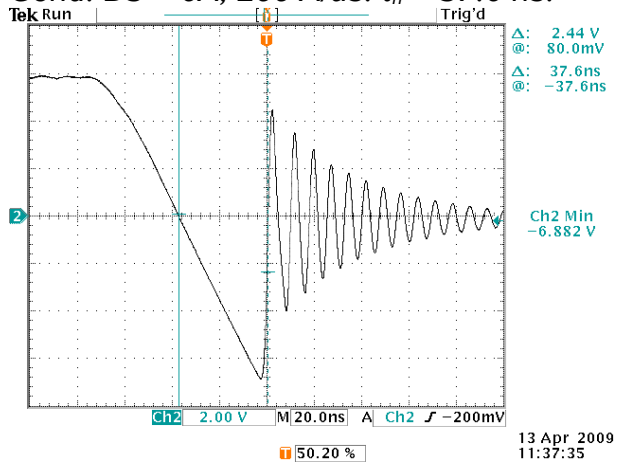
Cond. D4 – 2A, 200 A/us. $t_{rr} = 25.2$ ns.



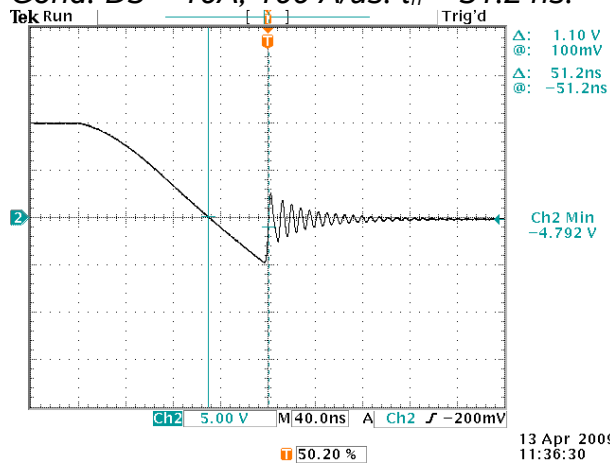
Cond. D2 – 6A, 100 A/us. $t_{rr} = 44.0$ ns.



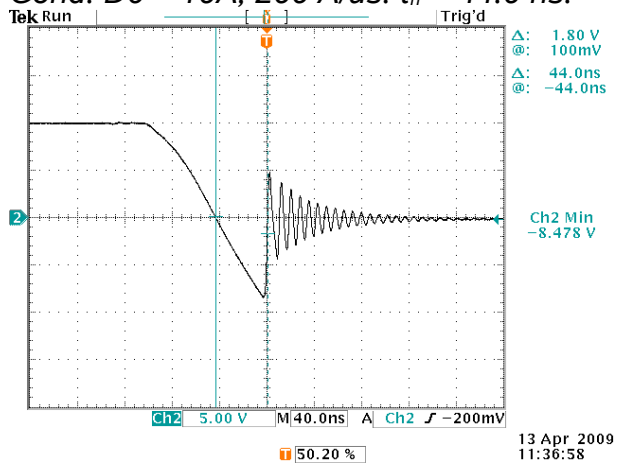
Cond. D5 – 6A, 200 A/us. $t_{rr} = 37.6$ ns.



Cond. D3 – 10A, 100 A/us. $t_{rr} = 51.2$ ns.



Cond. D6 – 10A, 200 A/us. $t_{rr} = 44.0$ ns.

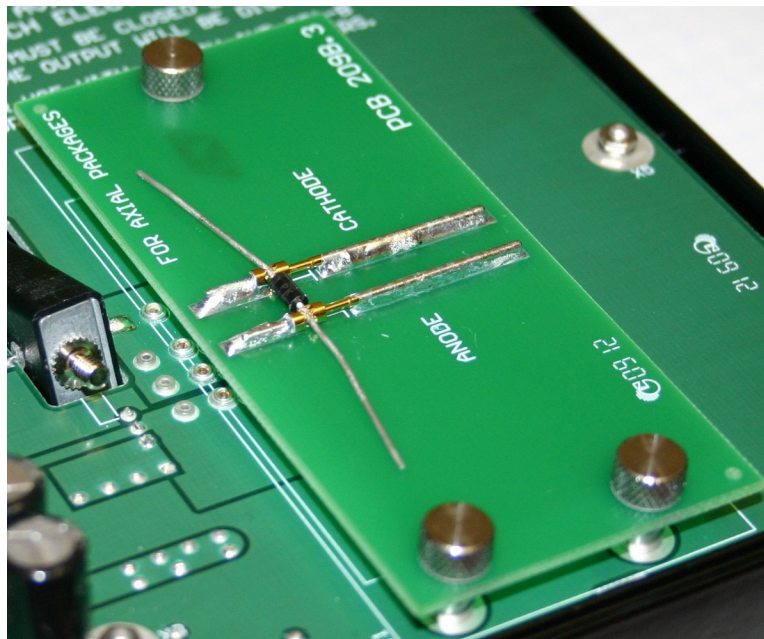


The measurements were taken using a Tektronix TDS3052B oscilloscope.

The waveforms exhibit a very sharp turn-off. That is, $t_a \gg t_b$. The short t_b time causes the RLC circuit in the test jig to ring. This is not unexpected or problematic. However, the user should take care to ensure that such ringing does not “confuse” any automated measurements made from the oscilloscope.

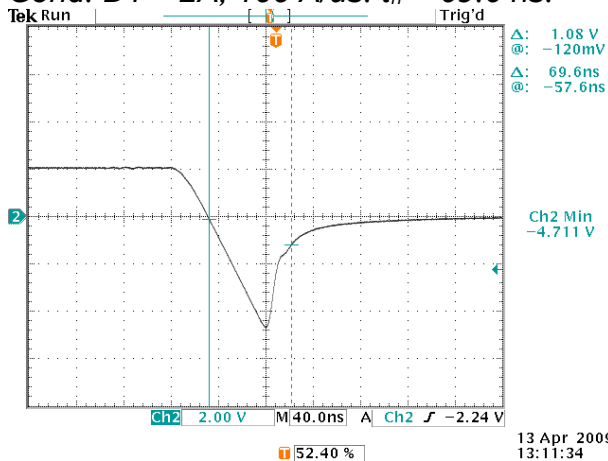
1N4937 RESULTS

An On Semi 1N4937 diode was tested. The 1N4937 is packaged in the DO-41 axial package. The installed DUT is shown below:

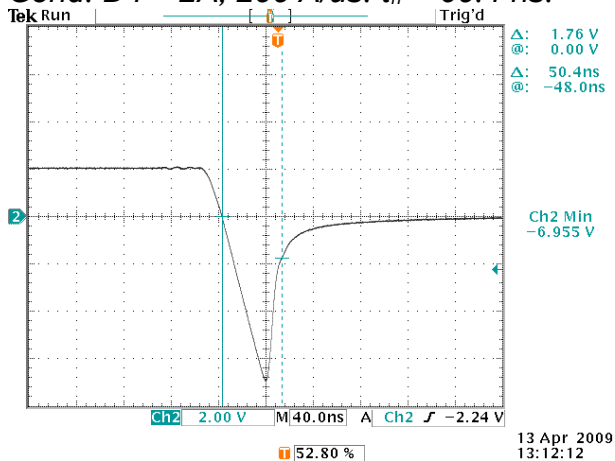


This device was tested at forward currents of 2, 6, and 10 Amps, at 100 and 200 A/us (which corresponds to conditions D1-D6 of MIL-STD-750E Method 4031.4). The results are shown below:

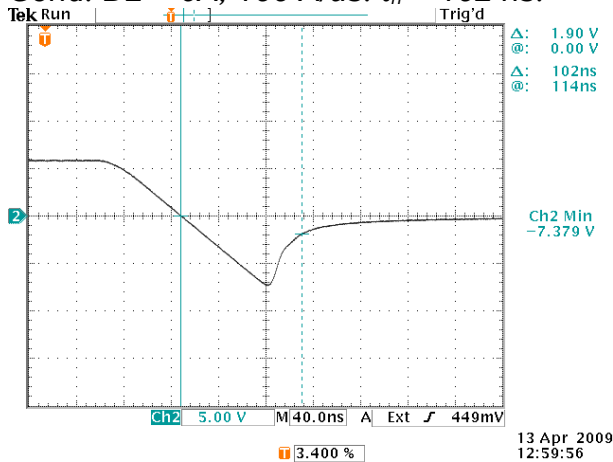
Cond. D1 – 2A, 100 A/us. $t_{rr} = 69.6$ ns.



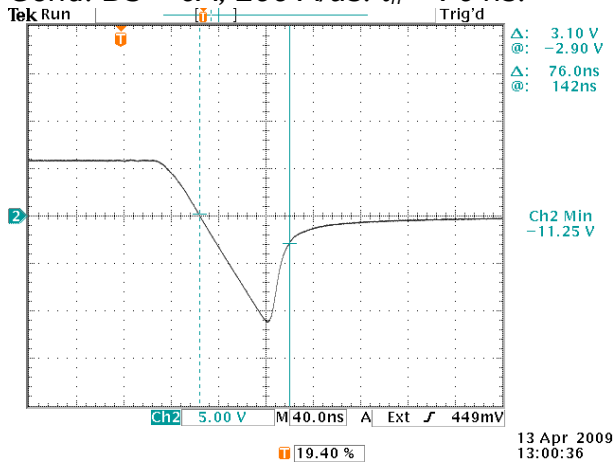
Cond. D4 – 2A, 200 A/us. $t_{rr} = 60.4$ ns.



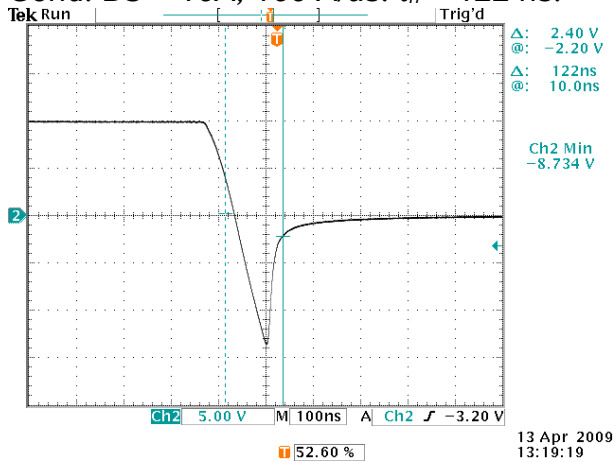
Cond. D2 – 6A, 100 A/us. $t_{rr} = 102$ ns.



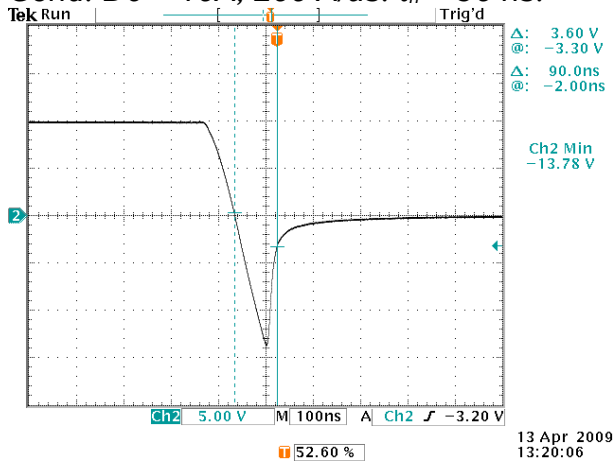
Cond. D5 – 6A, 200 A/us. $t_{rr} = 76$ ns.



Cond. D3 – 10A, 100 A/us. $t_{rr} = 122$ ns.



Cond. D6 – 10A, 200 A/us. $t_{rr} = 90$ ns.



The measurements were taken using a Tektronix TDS3052B oscilloscope. Unlike the MQ1N5811US, these waveforms do not exhibit a very sharp turn-off, and no ringing is observed.

TROUBLESHOOTING

If you obtain “strange” output waveforms, or unexpected values of t_{RR} , keep these points in mind:

- 1) The test jig output *must* be terminated with 50 Ohms. Use the supplied terminator, and make sure the oscilloscope input impedance is high.
- 2) Keep device lead lengths as short as possible, to minimize parasitic inductance.
- 3) The test jig lid must be closed, or the pulser output will be disabled.
- 4) Remember that you need to set 3 amplitude values (AMP1, AMP2, and SR2). AMP2 should not be zero - it should normally be -80V.

For technical support, contact info@avtechpulse.com. Sample waveforms and digital photos of your setup are always helpful!

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 100 Hz)
sour:curr1 +2A       (sets the forward current to +2A)
sour:curr:slew2 200A/us (sets the forward current to 200 A/us)
sour:volt2 -80       (sets the negative bias to -80V)
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)
sour:curr1 +2A       (sets the forward current to +2A)
sour:curr:slew2 200A/us (sets the forward current to 200 A/us)
sour:volt2 -80       (sets the negative bias to -80V)
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 TRlg connector, use:

```
*rst                (resets the instrument)
trigger:source external (selects external triggering)
sour:curr1 +2A       (sets the forward current to +2A)
sour:curr:slew2 200A/us (sets the forward current to 200 A/us)
sour:volt2 -80       (sets the negative bias to -80V)
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]:		
:CURRent		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value>	
:PROTection		
:TRIPped?		[query only]
:SLEW	<numeric value>	
: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

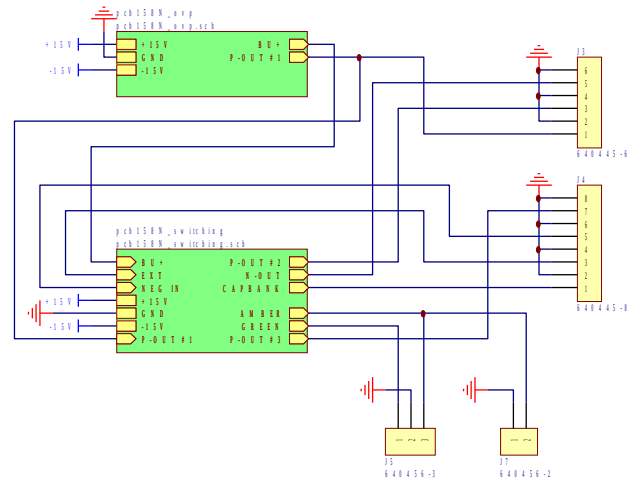
This instrument does not require any regular maintenance.

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

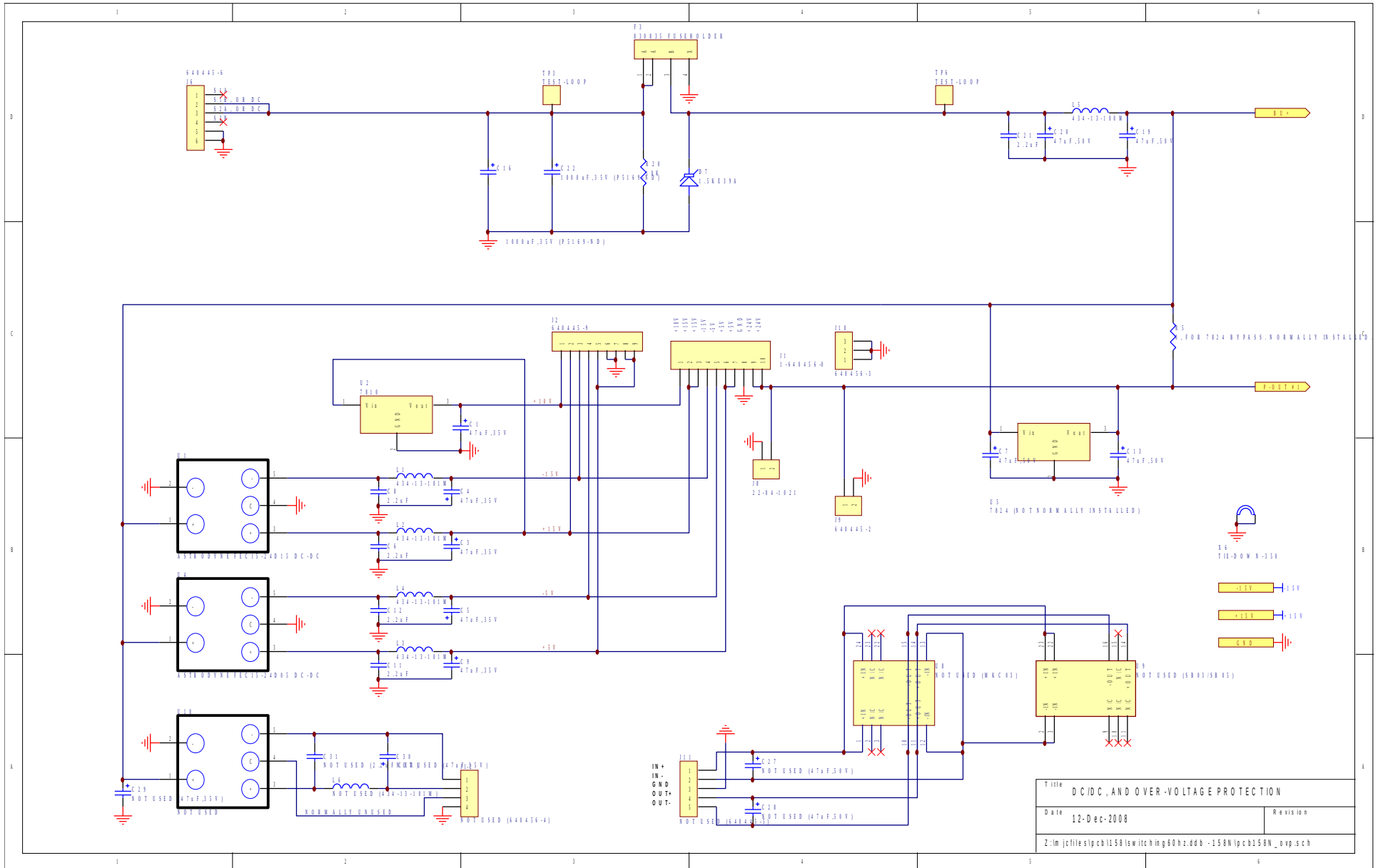
If desired, the interior of the instrument may be cleaned using compressed air to dislodge any accumulated dust. (See the “TOP COVER REMOVAL” section for instructions on accessing the interior.) No other cleaning is recommended.

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

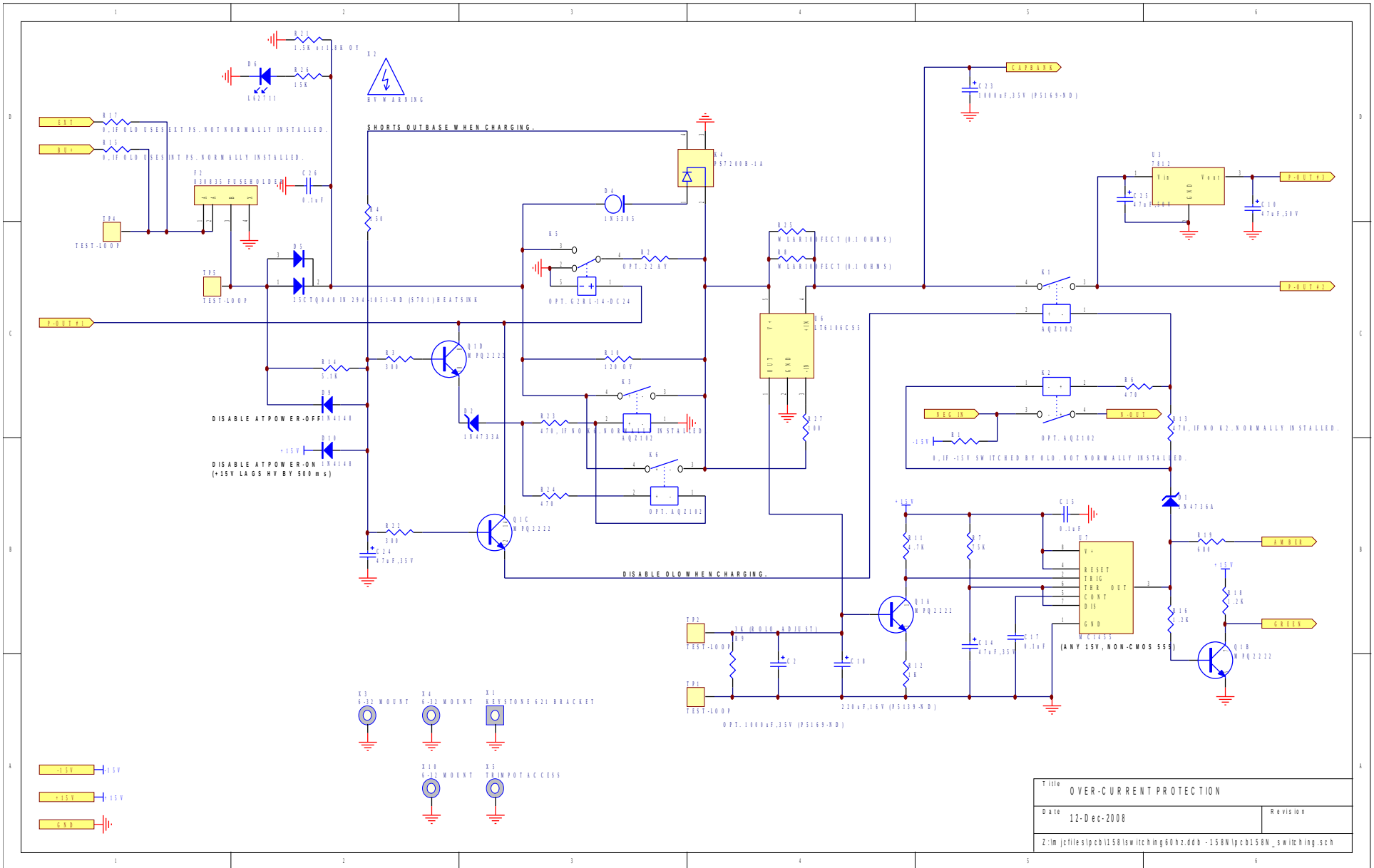


Title		LOW VOLTAGE DC/DC POWER SUPPLY
Date	12-Dec-2008	Revision
Z:\m\jcf\files\pcb\158\switching\60hz.ddb - 158N\pcb158N.sch		

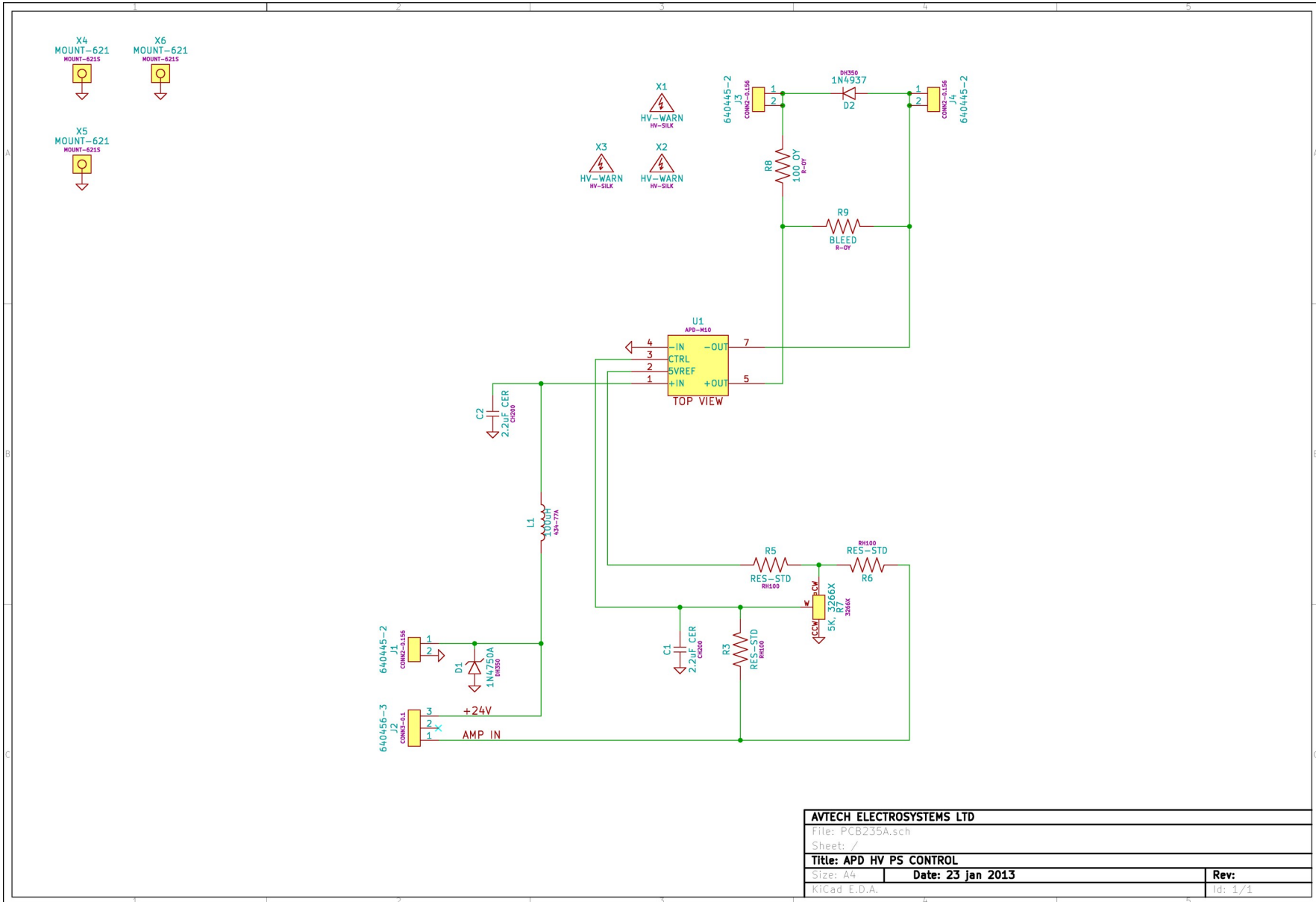
PCB 158N - LOW VOLTAGE POWER SUPPLY, 2/3



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

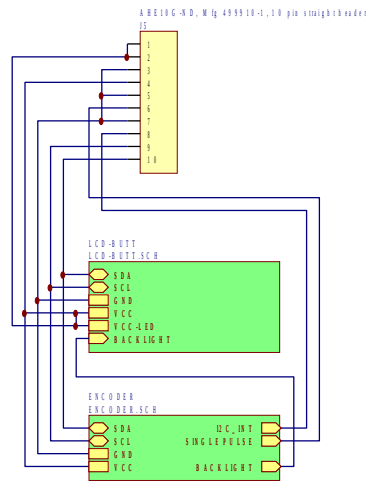


PCB 235A - HIGH VOLTAGE DC POWER SUPPLY



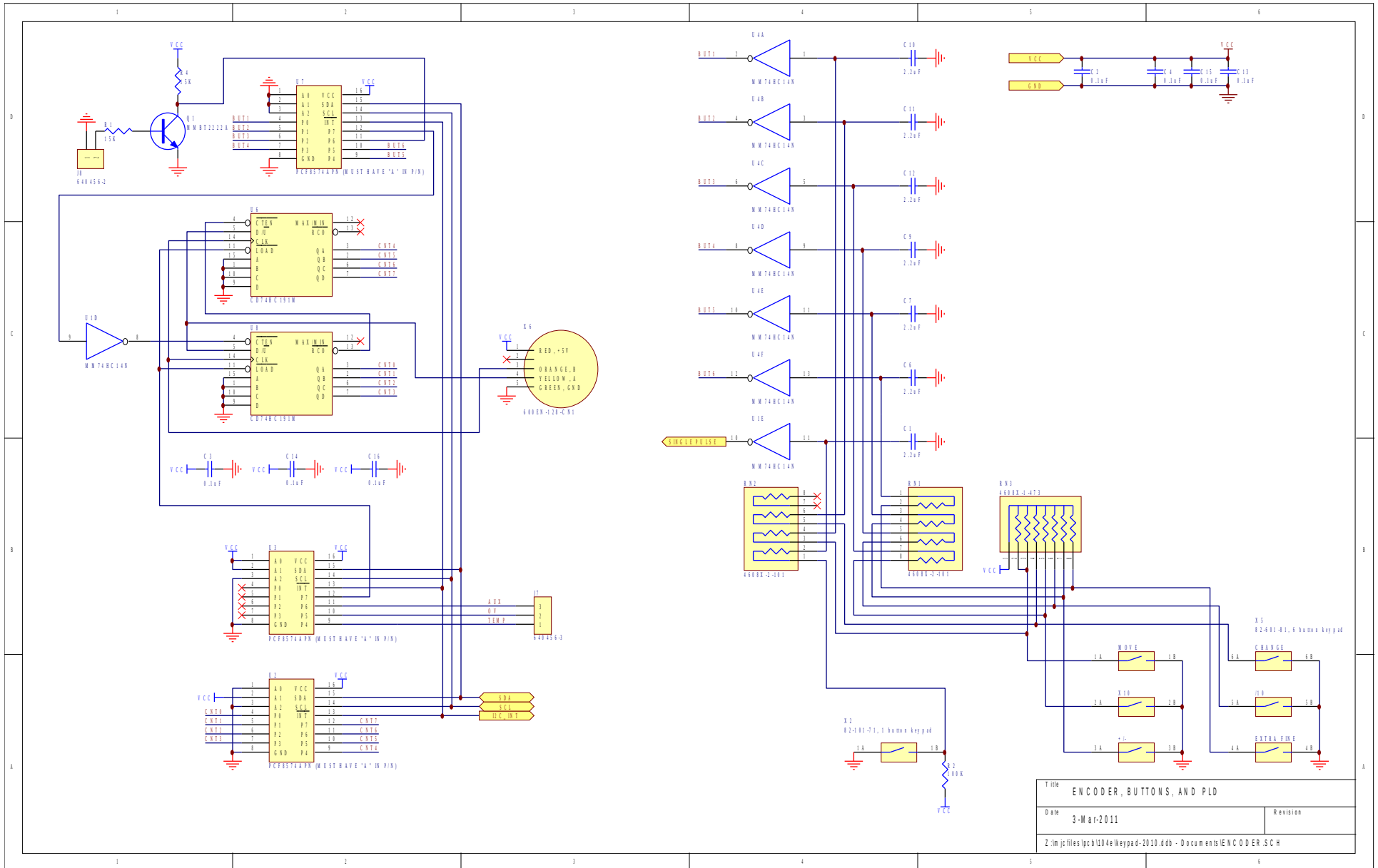
AVTECH ELECTROSYSTEMS LTD	
File: PCB235A.sch	
Sheet: /	
Title: APD HV PS CONTROL	
Size: A4	Date: 23 Jan 2013
KiCad: E.D.A.	Rev: Id: 1/1

PCB 104E - KEYPAD / DISPLAY BOARD, 1/3



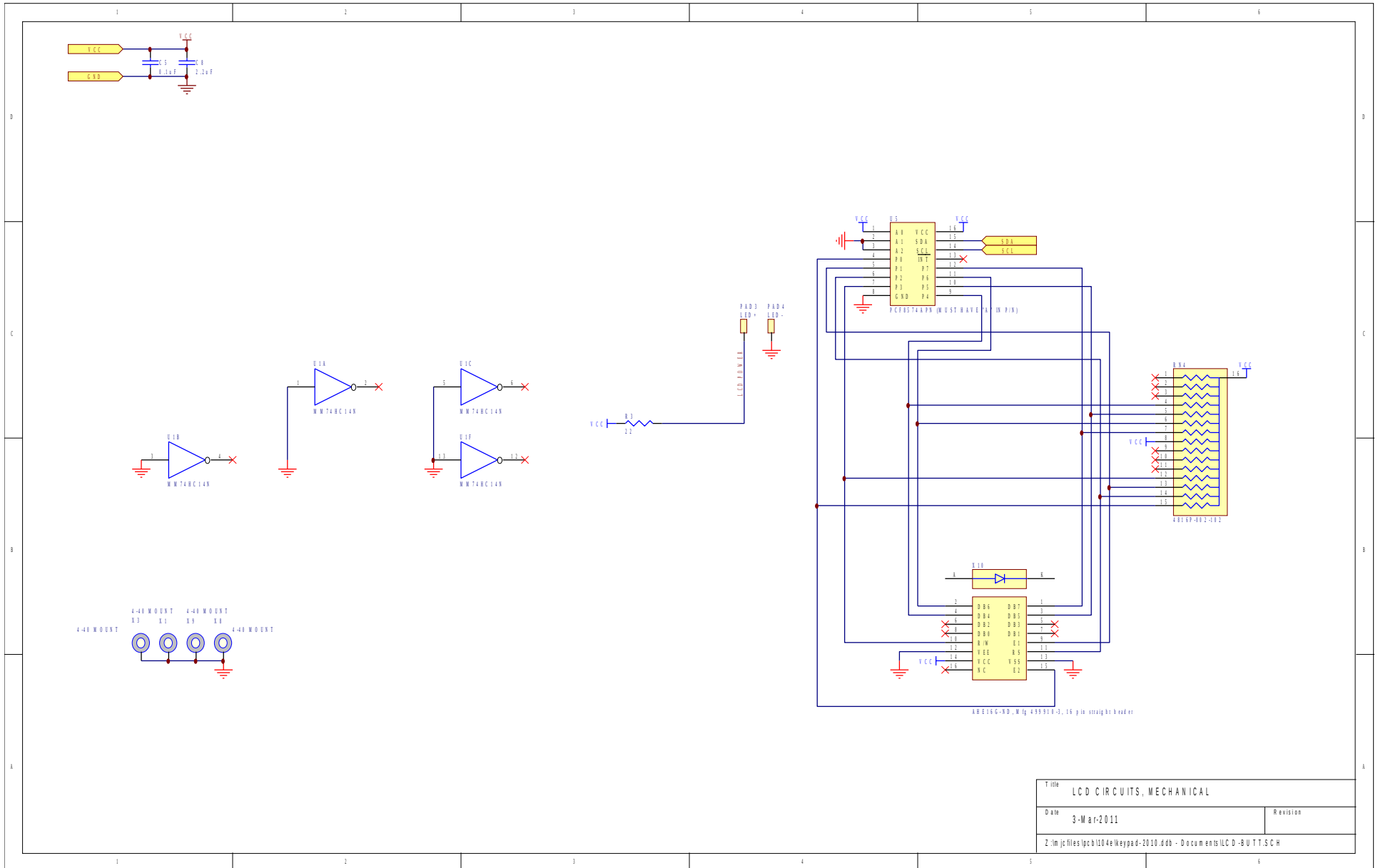
Title		PANEL TOP-LEVEL SCHEMATIC	
Date	3-Mar-2011	Revision	
Z:\m\j\files\pcb\104e\keypad-2010.ddb - Documents\Panel\rd.pjt			

PCB 104E - KEYPAD / DISPLAY BOARD, 2/3



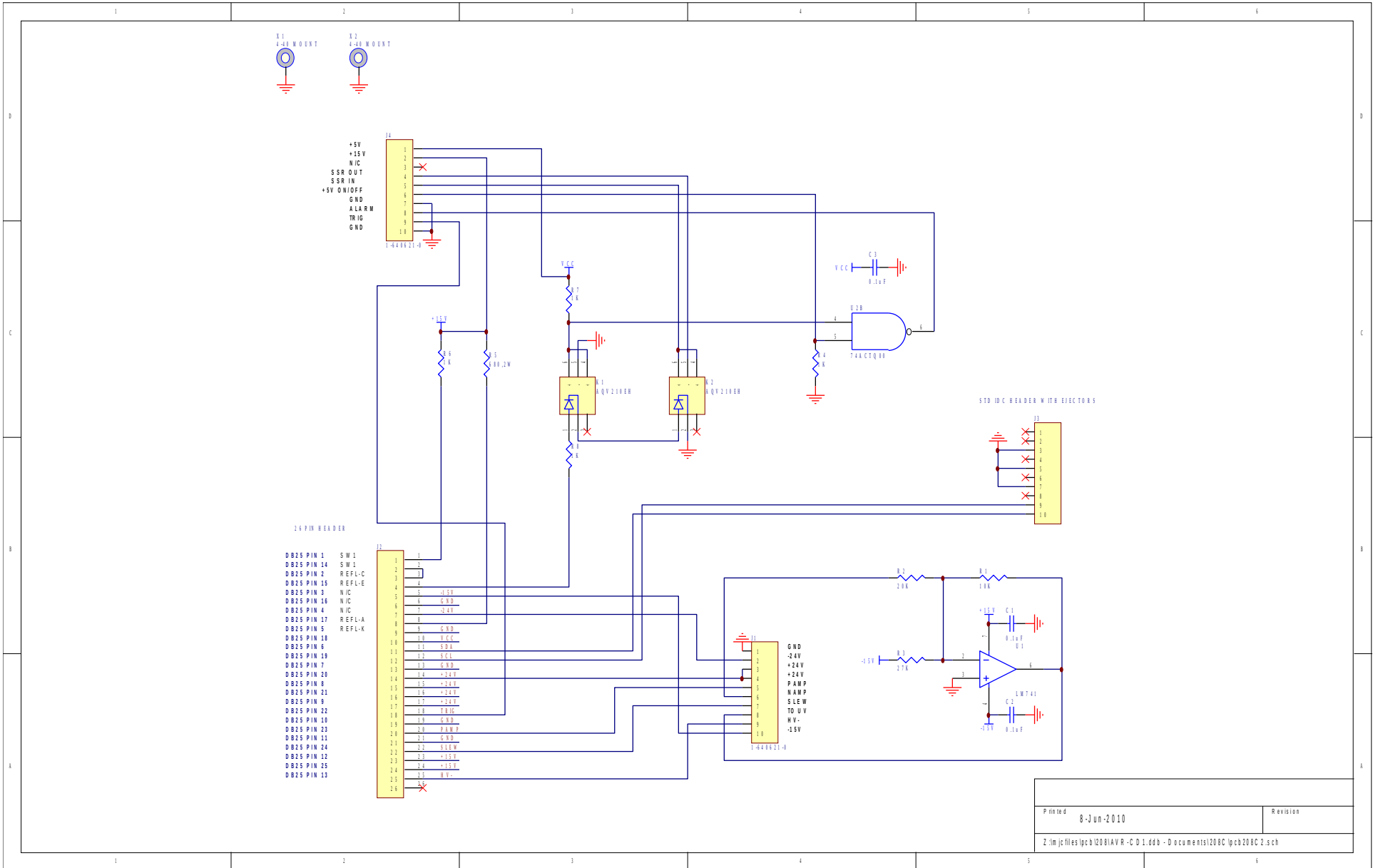
Title		ENCODER, BUTTONS, AND PLD
Date	3-Mar-2011	Revision
Z:\m\j\files\pcb\104e\keypad-2010.ddb - Documents\ENCODER.SCH		

PCB 104E - KEYPAD / DISPLAY BOARD, 3/3



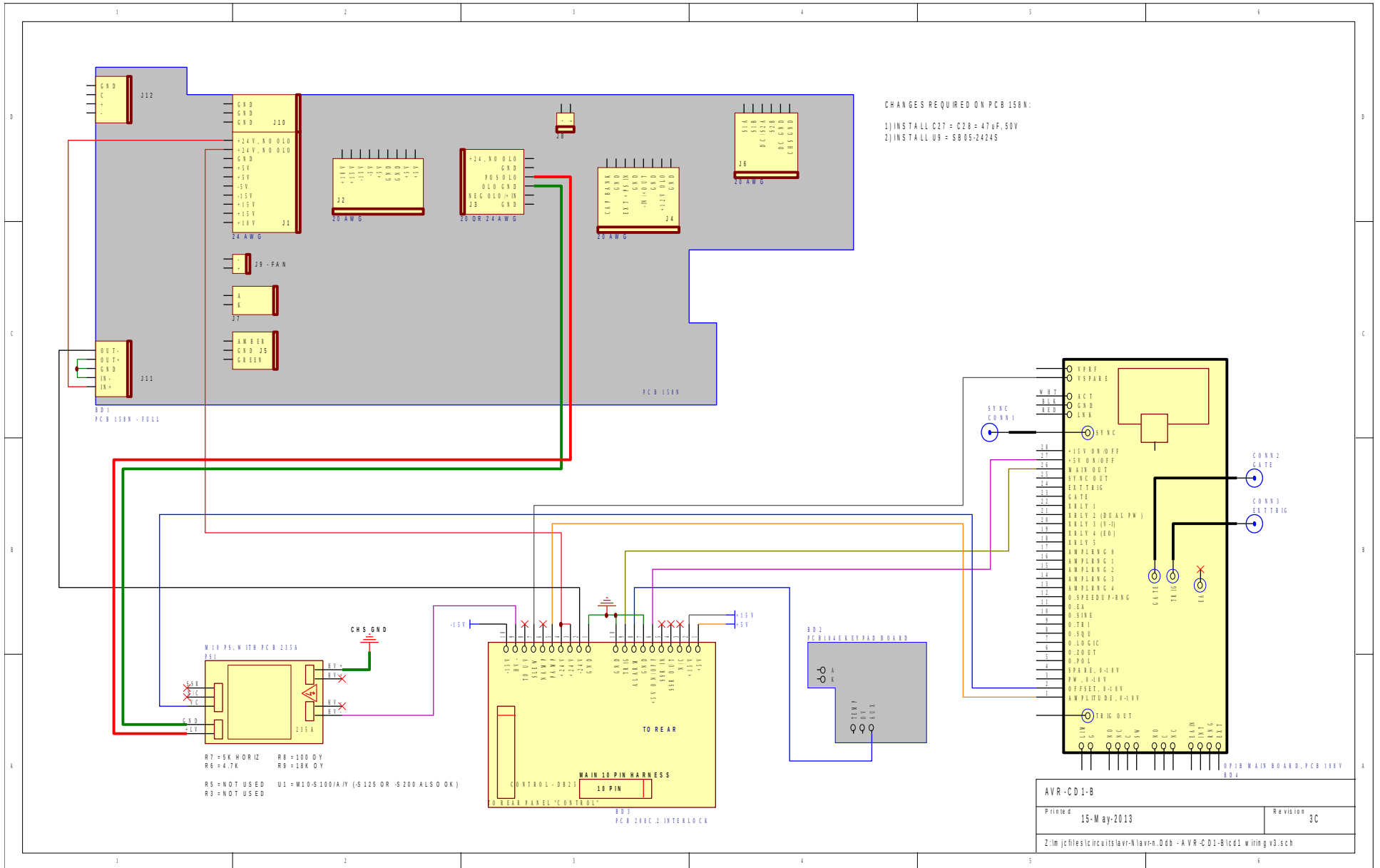
Title LCD CIRCUITS, MECHANICAL	
Date 3-Mar-2011	Revision
Z:\m\j\files\pcb\104e\keypad-2010.ddb - Documents\LCD-BUTTON.SCH	

PCB 208C.2 – MAINFRAME TO JIG INTERFACE

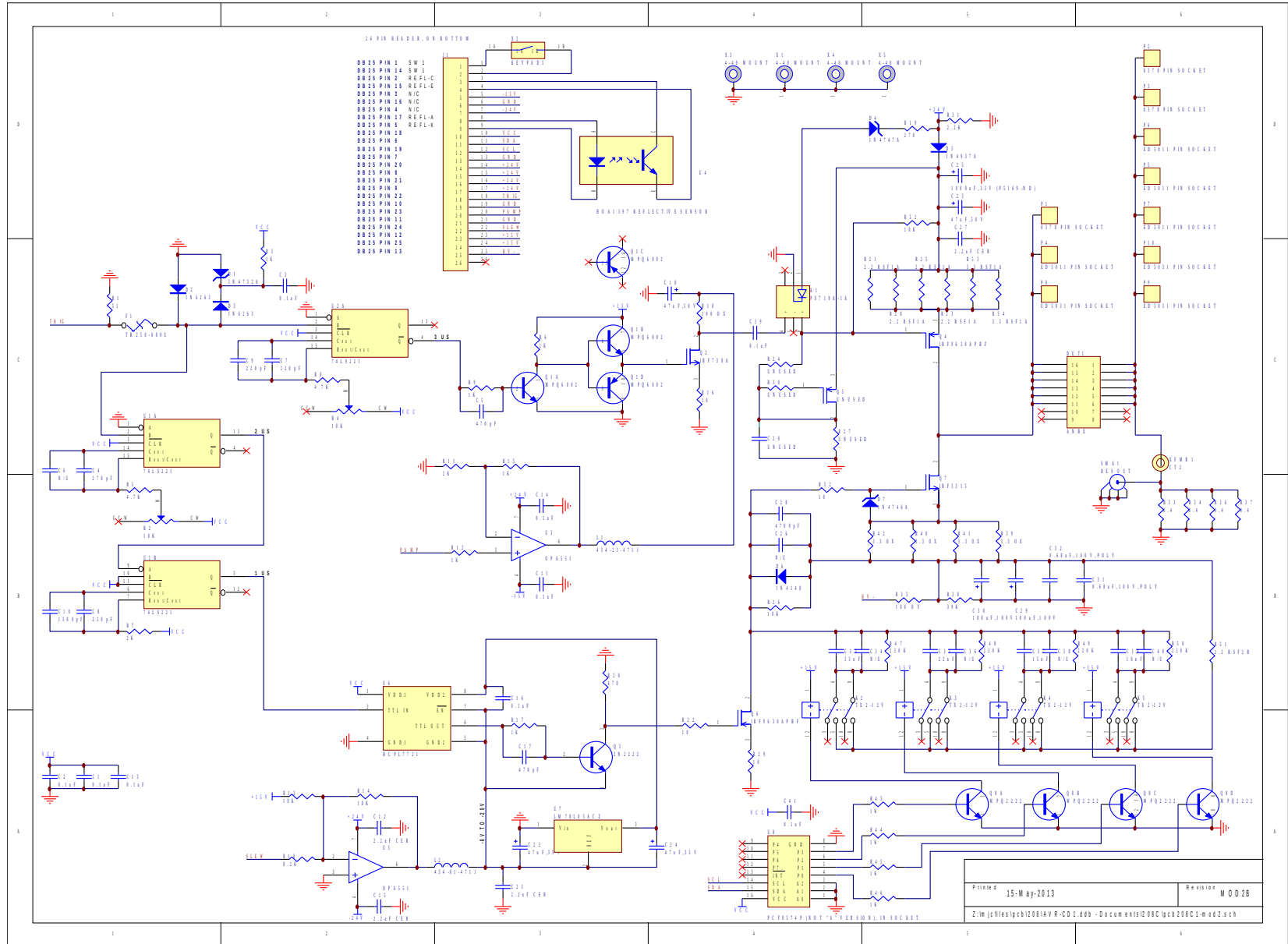


Printed	8-Jun-2010	Revision
Z:\m\jcs\files\pcb\2081AVR-C\01.dbb - Documents\208C\pcb\208C.2.sch		

MAIN WIRING



STANDARD TEST JIG WIRING (AVX-CD1-MIX)



Pin#	15-May-2013	Revision	M 0 D 2 B
Z:\m\j\files\pcb\208\AVR-CD1.ddb - Documents\208\pcb\208C1-m.d2.sch			

PERFORMANCE CHECK SHEET