AVTECH ELECTROSYSTEMS LTD.

NANOSECOND WAVEFORM ELECTRONICS
SINCE 1975

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BOX 5120, LCD MERIVALE
OTTAWA, ONTARIO
CANADA K2C 3H4

INSTRUCTIONS

MODEL AVRQ-3-B-SIA

± 1 kV and ± 1.5 kV AMPLITUDE,

25 ns to 250 ns ADJUSTABLE RISE TIME,

PULSE GENERATORS FOR

COMMON MODE TRANSIENT IMMUNITY (CMTI) TESTS

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 dissembled, modified or subjected to conditions exceeding the applicable specifications or ratings. This warranty is the extent of the obligation assumed by Avtech with respect to this product and no other warranty or guarantee is either expressed or implied.

TECHNICAL SUPPORT

Phone: 888-670-8729 (USA & Canada) or +1-613-686-6675 (International)
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Manual Reference: /fileserver1/officefiles/instructword/avrq/obs/AVRQ-3-B-SIA,edition1.odt.
Last modified February 29, 2024.

INTRODUCTION

The AVRQ-3-B-SIA is designed to test the common mode transient immunity (CMTI) of opto-couplers. It is primarily intended to test “voltage-drive” opto-couplers (that is, those that use 3-5V logic levels on the input side), although it also has provision to test “current-drive” opto-couplers (where the input LED is driven directly, via the anode and cathode).

The AVRQ-3-B-SIA provides accepts user-supplied plug-in daughterboards to accommodate the device under test. The AVRQ-3-B-SIA is supplied with one (installed) sample plug-in daughterboard, which has a Silicon Laboratories Si8421BB dual-channel opto-coupler installed. The “A1-B1” channel is wired for tests. Sample test results for this device are included later in this manual.

A high-voltage pulse is applied to the floating input-side “ground” (GND1) of the DUT. The output-side ground (GND2) is connected to the instrument chassis earth ground. The device-under-test daughterboard area is accessed from the rear-panel, through a hinged door. The high-voltage outputs are disabled when the door is open. (This may be mechanically awkward, but it is the only practical arrangement that keeps signal distances extremely short, which is necessary for the performance levels of the AVRQ-3-B-SIA.)

The high-voltage pulse amplitude (HV) may be set at -1.5 kV, -1.0 kV, +1.0 kV or +1.5 kV. This is the “AMP1” setting shown on the front panel. It may be set from the front-panel, or by using a command of the form “volt1 +1000”.

For voltage-drive DUTs, the input-side VCC1 voltage may be varied from +3.0V to +5.0V DC. This is the “AMP3” setting shown on the front panel. It may be set from the front-panel, or by using a command of the form “volt3 +5.0”.

For voltage-drive DUTs, the output-side VCC2 voltage may be varied from +3.0V to +24.0V DC. This is the “AMP4” setting shown on the front panel. It may be set from the front-panel, or by using a command of the form “volt4 +5.0”.

For voltage-drive DUTs, the input-side logic voltage (A1) may be switched between 0 and VCC1. This is the “AMP5” setting shown on the front panel. It may be set from the front-panel, or by using a command of the form “volt5 +5.0”.

For current-drive DUTs, the input-side LED bias current (IBIAS) may be varied from 1 mA to 16 mA, or set at zero. This is the “AMP2” setting shown on the front panel. It may be set from the front-panel, or by using a command of the form “curr2 10 mA”.

If AMP3/VCC1 is set > 0, AMP2/IBIAS is automatically set to zero, and vice versa.

The rise time (measured 10%-90%) of the high-voltage pulse may be varied over the range of < 25 ns to > 250 ns. This is the “TR” setting shown on the front panel. It may be set from the front-panel, or by using a command of the form “pulse:transition 50 ns”.

The rise time control is NOT calibrated, since it is strongly influenced by device capacitance and other parasitic effects. The actual rise time must be measured by the user, and it may differ significantly from the set value. The set rise time corresponds approximately to the output rise time at -1.5 kV or +1.5 kV. At -1 kV and + 1 kV, the actually output rise time will be approximately 33% smaller than the set rise time.

A non-adjustable 5 kilohm pull-up (to VCC2) resistance is provided on the output side of the DUT. The user may use this pull-up, if desired, by wiring the daughterboard appropriately. It is not necessary to use it. The pull-up resistance is displayed on the front panel, but it is not actually adjustable in the AVRQ-3-B-SIA.

The high-voltage pulse and the logic output of the DUT must be measured by the user, using suitable high-impedance oscilloscope probes. Coaxial cabling should not be used. Normally, the user will decrease the rise time of the high voltage pulse until logic-level “glitches” are observed on the logic output.

The AVRQ-3-B-SIA 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 rise time, pulse width, pulse delay, and pulse repetition frequency. 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.

HIGH-VOLTAGE PRECAUTIONS

⚠ **CAUTION:** This instrument provides output voltages as high as 1500 Volts under normal operating conditions, and generates up to 1600V internally, so extreme caution must be employed when using this instrument. The instrument should only be used by individuals who are thoroughly skilled in high voltage laboratory techniques. The following precautions should always be observed:

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.

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.

SPECIFICATIONS

Model:	AVRQ-3-B-SIA
GPIB and RS-232 control:	Yes
HV Pulse Amplitude:	-1500V, -1000V, +1000V, or +1500V (+/- 5%)
VCC1 Amplitude:	+3.0V to +5.0V DC
VCC2 Amplitude:	+3.0V to +24.0V DC
LED Bias:	0 mA, or 1 mA to 16 mA
Logic pull-up:	5000 Ohms
Leading edge rise time[2]: (10% - 90%):	< 25 ns to > 250 ns, variable. (Refers to the leading edge, which swings from 0 to -2000V).
Leading edge shape:	Linear, approximately. See the “Typical Waveforms” section of this manual.
Trailing edge fall time: (90% - 10%):	At least ten times greater than the rise time.
Trailing edge shape:	Exponential decay, approximately. See the “Typical Waveforms” section of this manual.
Pulse width:	1 us (measured between the start of the leading edge and the start of the falling edge)
PRF:	Internal trigger: 1 to 10 Hz External trigger: 0 to 10 Hz
Output protection:	Short-circuit protected.
Output enable timer:	The output is disabled automatically after 90 seconds of inactivity (i.e., unchanged pulse settings).
Propagation delay:	≤ 200 ns (Ext trig in to start of output pulse)
Jitter (Ext trig in to pulse out):	± 200 ps ± 0.03% of sync delay
Trigger required (ext trig mode):	TTL levels (0 and +3V to +5V), 50 ns or wider
Sync delay:	Variable 0 to ± 1.0 seconds
Sync output:	TTL levels (0 and +3V to +5V), 100 ns, will drive 50 Ohm loads
Gate input:	Synchronous, active high or low, switchable. Suppresses triggering when active.
Connectors:	LOGIC OUT: BNC, rear panel. DIFF PROBE: two-pin 0.1” header HV PULSE: BNC, rear panel. Trig, Gate: BNC, rear-panel. Sync: BNC, front-panel.
Power requirements:	100 - 240 Volts, 50 - 60 Hz
Dimensions: (H x W x D)	145 mm x 430 mm x 475 mm (5.7” x 17” x 18.8”)
Chassis material:	cast aluminum frame and handles, blue vinyl on aluminum cover plates
Temperature range:	+5°C to +40°C

ORIGINAL QUOTATION

Date: Mon, 09 Nov 2009 12:54:35 -0500
From: Avtech Sales
To: XXXXX
Subject: Re: cmti tester AVRQ-3-B

XXXXX,

Following your recent inquiry, I am pleased to quote as follows:

Quote number: 15004

Model number: AVRQ-3-B-SIA

Description: Customized High Voltage Pulser with IEEE-488.2 GPIB and RS-232 Computer Control Ports

Output socket**: A pin socket array will be provided, centered in 1.2" x 2.1" of floor space, with > 1.5" of height clearance. One daughterboard will be provided, with a ZIF socket suitable for testing a DIP sample device provided by XXXXX*. Users can create their own daughterboards to mate to other sockets and package types.

Input drive: Current-drive (0, or +1 to +16 mA adjustable) or voltage-drive (Vccin = +3V to +5V, adjustable, with the logic input switchable between 0 and Vccin).

Vccout power supply: +3V to +24V, adjustable

Logic output pull-up resistance: none (for use with CMOS output stages)

Other: as per the standard AVRQ-3-B, described at http://www.avtechpulse.com/medium/avrq-3

PDF datasheet: http://www.avtechpulse.com/catalog/page_new_cat11_avrq_rev5.pdf

Price: $XXXXX US each, DDU (Delivered Duty Unpaid). Includes the cost of shipping and insurance, but excludes customs duties, taxes, and other import fees. Shipments are from Canada, and are normally duty-free.

Quote valid for: 8 weeks

Estimated delivery: 12 weeks after receipt of order.

End Use Statement: An "End Use Statement - Low Speed Models" form must be completed when ordering, to determine if any special export control regulations apply. We can not process your order without this information. The necessary form is attached (in PDF format), and is also available at: http://www.avtechpulse.com/end-use/EndUseStatement,LowSpeed,v6.pdf

* Note: XXXXX should provide us with sample DIP devices, so that the instrument may be tested with them. If sample devices are not available, we can test the instrument with 2-3 sample DIP devices from other manufacturers, if they are available readily through Digi-Key. Please specify.

Please call or email me if I can be of further assistance.

Thank you for your interest in our products!

Regards,

Dr. Michael J. Chudobiak
Chief Engineer

--- Avtech Electrosystems Ltd. ---------- since 1975 ---

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*** NOTE: SOIC sample devices were provided the user. After consulting with the client, the provided daughterboard has been changed to one with the SOIC device soldered on. A ZIF DIP socketed daughterboard is not to be provided.*

REGULATORY NOTES

FCC PART 18

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

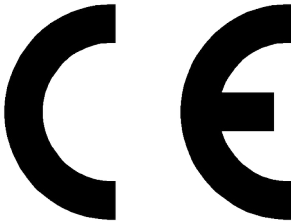
This instrument is enclosed in a rugged metal chassis and uses a filtered power entry module. The main output signal is provided on a shielded connector that is intended to be used with shielded coaxial cabling and a shielded load. Under these conditions, the interference potential of this instrument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

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

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

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

EC DECLARATION OF CONFORMITY



We Avtech Electrosystems Ltd.
P.O. Box 5120, LCD Merivale
Ottawa, Ontario
Canada K2C 3H4

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

EN 50081-1 Emission

EN 50082-1 Immunity

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

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

DIRECTIVE 2002/95/EC (RoHS)

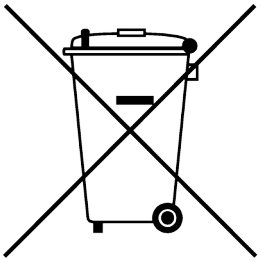
This instrument is exempt from Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the use of certain Hazardous Substances (RoHS) in electrical and electronic equipment. Specifically, Avtech instruments are considered "Monitoring and control instruments"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

DIRECTIVE 2002/96/EC (WEEE)

European customers who have purchased this equipment directly from Avtech will have completed a “WEEE Responsibility Agreement” form, accepting responsibility for WEEE compliance (as mandated in Directive 2002/96/EC of the European Union and local laws) on behalf of the customer, as provided for under Article 9 of Directive 2002/96/EC.

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

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



INSTALLATION

VISUAL CHECK

After unpacking the instrument, examine to ensure that it has not been damaged in shipment. Visually inspect all connectors, knobs, liquid crystal displays (LCDs), and the handles. Confirm that a power cord, a GPIB cable, and two instrumentation manuals (this manual and the “Programming Manual for -B Instruments”) are with the instrument. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

POWER RATINGS

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

The maximum power consumption is 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	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.

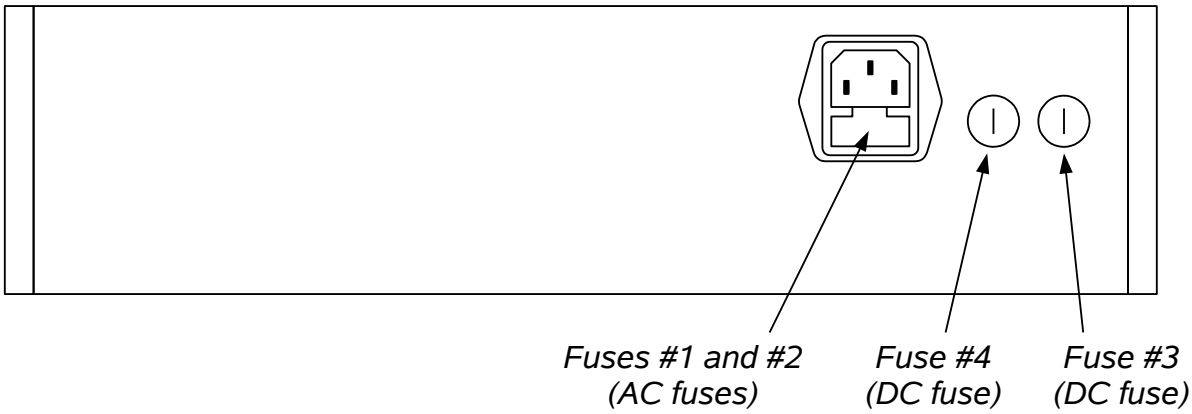
ENVIRONMENTAL CONDITIONS

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.

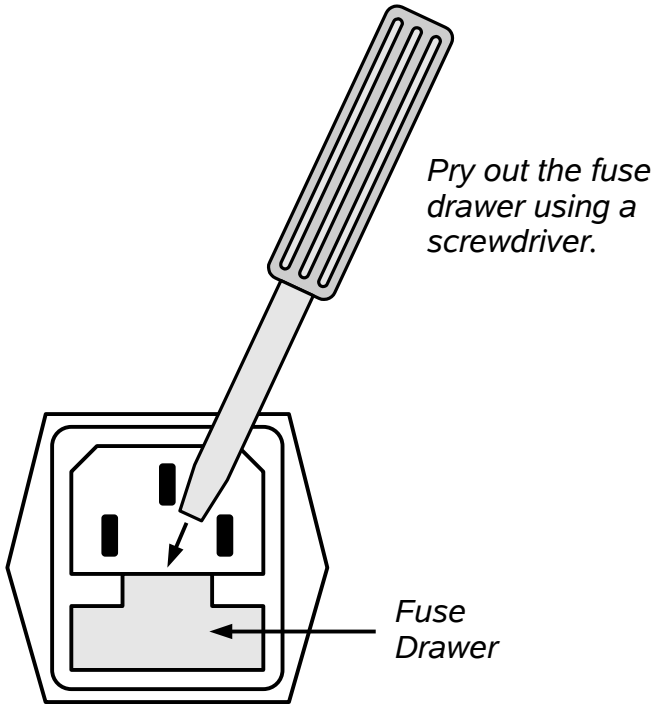
FUSES

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

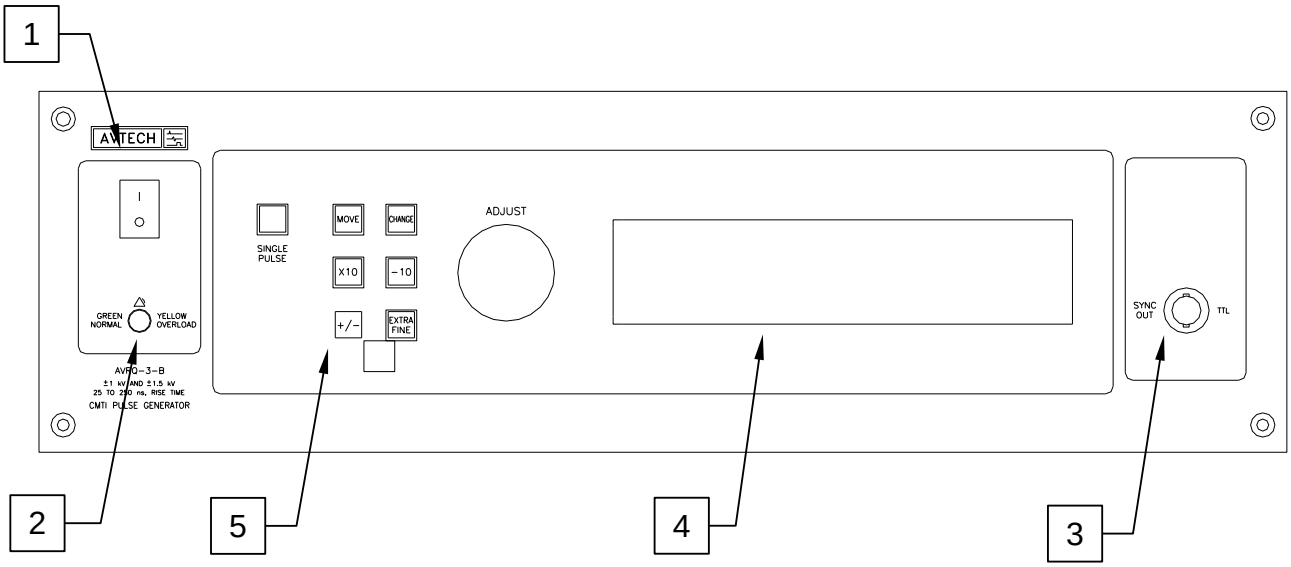
The following table lists the required fuses:

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	1.6A, 250V, Time-Delay	5×20 mm	021801.6HXP	F2424-ND
#4 (DC)	N/A	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND

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

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

FRONT PANEL CONTROLS



1. POWER Switch. This is the main power switch. When turning the instrument on, there may be a delay of several seconds before the instrument appears to respond.

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

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

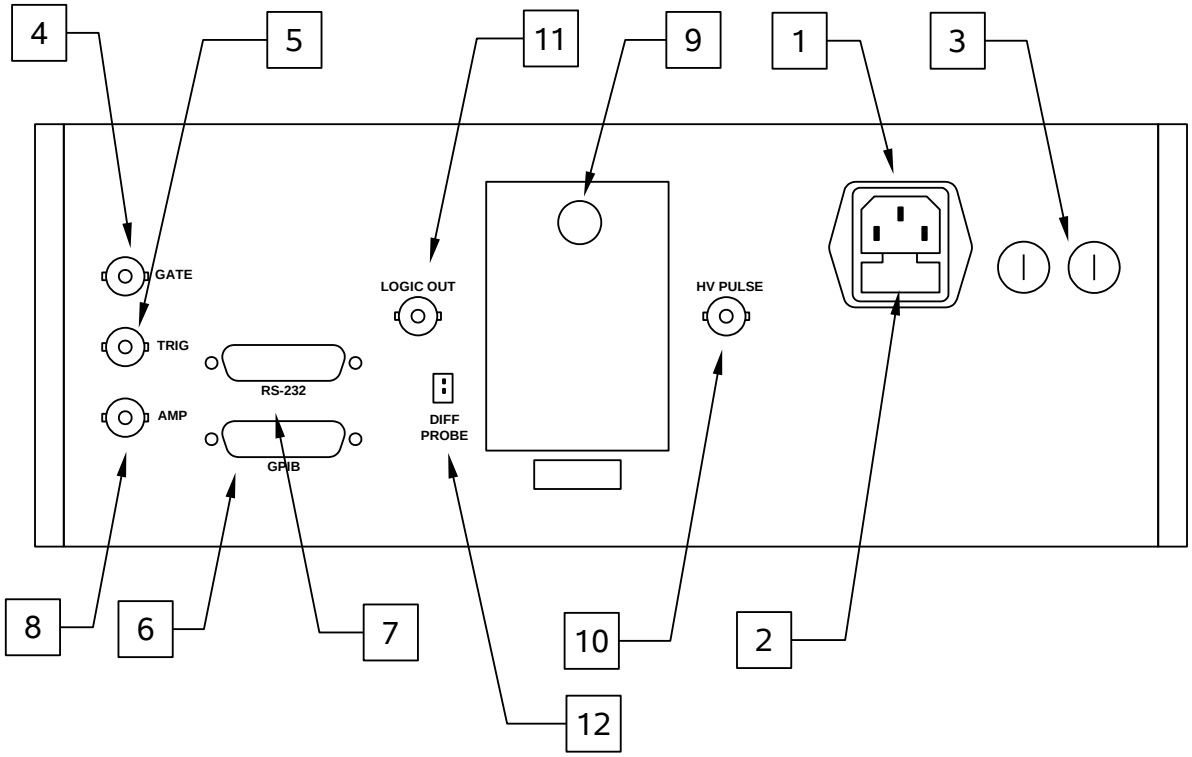
3. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads (or lags) the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to R_L > 1 kΩ with a pulse width of approximately 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 kΩ resistor. When set to active low mode, this input is pulled-up to +5V by a 1 kΩ resistor.

5. TRIG. This TTL-level (0 and +5V) logic input can be used to trigger the instrument, if the instrument is set to triggering externally. The instrument triggers on the rising edge of this input. The input impedance of this input is 1 kΩ. (Depending on the length of cable attached to this input, and the source driving it, it may be desirable to add a coaxial 50 Ohm terminator to this input to provide a proper transmission line termination. The Pasternack (www.pasternack.com) PE6008-50 BNC feed-thru 50

Ohm terminator is suggested for this purpose.)

6. GPIB Connector. A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B Instruments” for more details on GPIB control.

7. RS-232 Connector. A standard serial cable with a 25-pin male connector can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B Instruments” for more details on RS-232 control.

8. AMP Connector. Not used. No internal connection.

9. DUT Door. This is the door that provides access to the DUT area. To open it, pull on the chrome knob. When closed, the door is held latched in place magnetically.

   The high voltage output is automatically disabled when the DUT door is opened. The door must be closed during tests.

10. HV PULSE CONNECTOR. The BNC connector provides access to the high voltage (±1 kV or ±1.5 kV) pulse that is applied to the DUT, for monitoring purposes. This signal must be observed on an oscilloscope to accurately measure the dV/dt rate of the high voltage pulse.

    A Tektronix P5100 high-voltage probe with the 013-0291-00 probe-tip-to-BNC adapter should be used to connect to this output.

    ⚠ CAUTION: Voltages as high as 1.5 kV may be present on the center conductor of this output connector. Avoid touching this conductor. Connect to this connector using a Tektronix P5100 high-voltage probe with the 013-0291-00 probe-tip-to-BNC adapter, to ensure that the center conductor is not exposed.

    ⚠ DO NOT CONNECT THIS OUTPUT DIRECTLY TO AN OSCILLOSCOPE. The oscilloscope will be damaged by the high voltages. Use a Tektronix P5100 high-voltage probe with the 013-0291-00 probe-tip-to-BNC adapter.

    ⚠ DO NOT CONNECT COAXIAL CABLING TO THIS OUTPUT. The capacitance of the cabling will reduce the dV/dt rates noticeably.

11. LOGIC OUT Connector. This BNC connector connects internally to the logic output of the DUT. This is the output that is monitored for “glitches” caused by high dV/dt rates on the common mode voltage. An oscilloscope probe with a probe-tip-to-BNC adapter should be connected to this output. (The Tektronix P6139A low-voltage probe with the 013-0254-00 probe-tip-to-BNC adapter may be suitable).

    ⚠ DO NOT CONNECT COAXIAL CABLING TO THIS OUTPUT. The capacitance of the cabling will distort the measurements.

The DIFF PROBE output can be used instead of the LOGIC OUT connector, if desired. They are both connected to the same point internally.

12. DIFF OUT Connector. The LOGIC OUT connector described above is referenced to chassis ground. This can cause some ringing on the output. The ringing will not normally confuse a human operator, but it may confused automatic measurement systems.

    To avoid this problem, the two-pin DIFF OUT connector is provided. It will mate to the Tektronix P6246 differential probe. This will normally provide slightly “cleaner” output signals than the LOGIC OUT connector, since the ground noise will be subtracted from the signal output. When using the differential probe, install the probe so that the “-” side is on the top, and the “+” side is on the bottom.

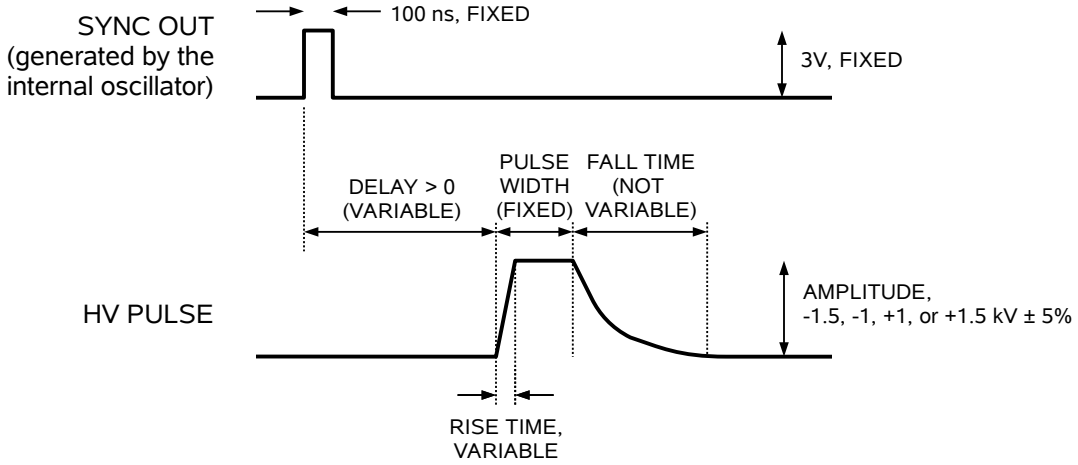
    The use of the DIFF OUT connector is optional.

GENERAL INFORMATION

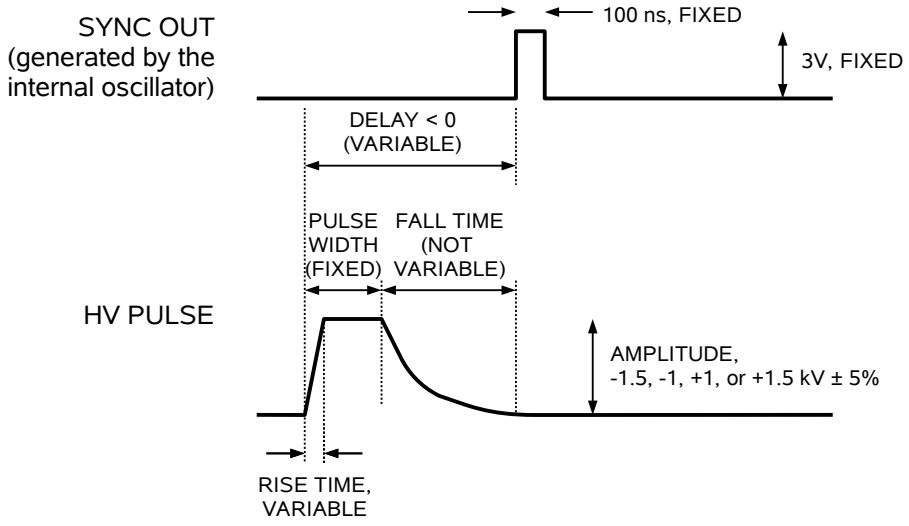
BASIC PULSE CONTROL

This instrument can be triggered by its own internal clock or by an external TTL trigger signal. In either case, two output channels respond to the trigger: HV PULSE and SYNC. The HV PULSE channel is the signal that is applied to the DUT. Its amplitude is variable. The SYNC pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems. When the delay is set to a positive value the SYNC pulse precedes the HV PULSE pulse. When the delay is set to a negative value the SYNC pulse follows the HV PULSE pulse.

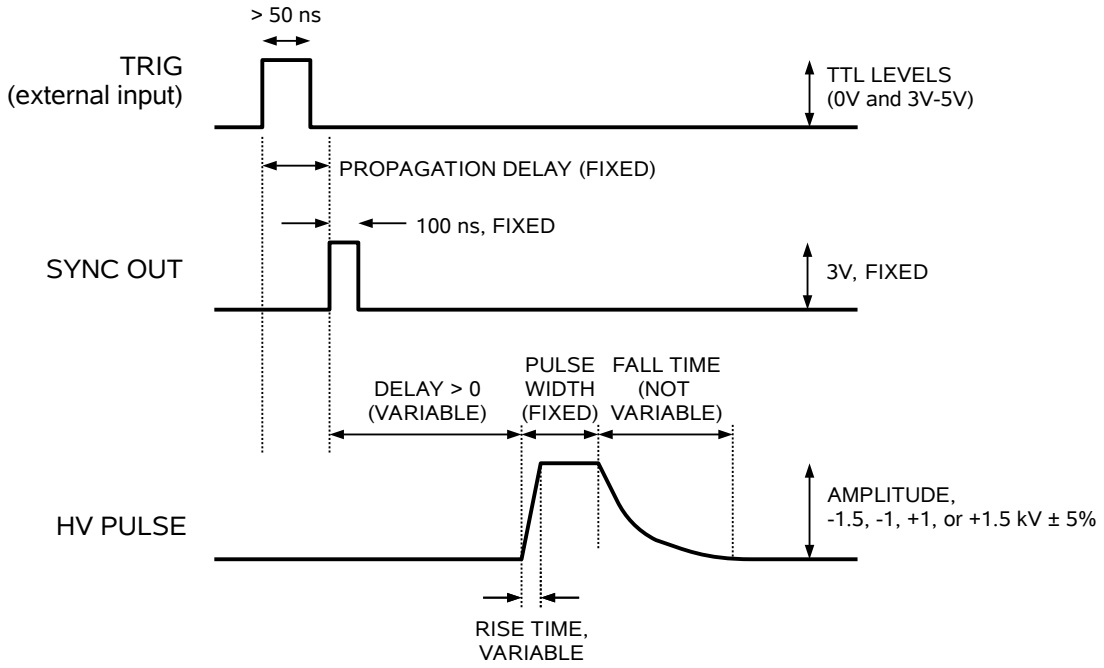
These pulses are illustrated below, assuming internal triggering, a positive delay, and positive amplitude:



If the delay is negative, the order of the SYNC and OUT pulses is reversed:



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



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

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

TRIGGER MODES

This instrument has four trigger modes:

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

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

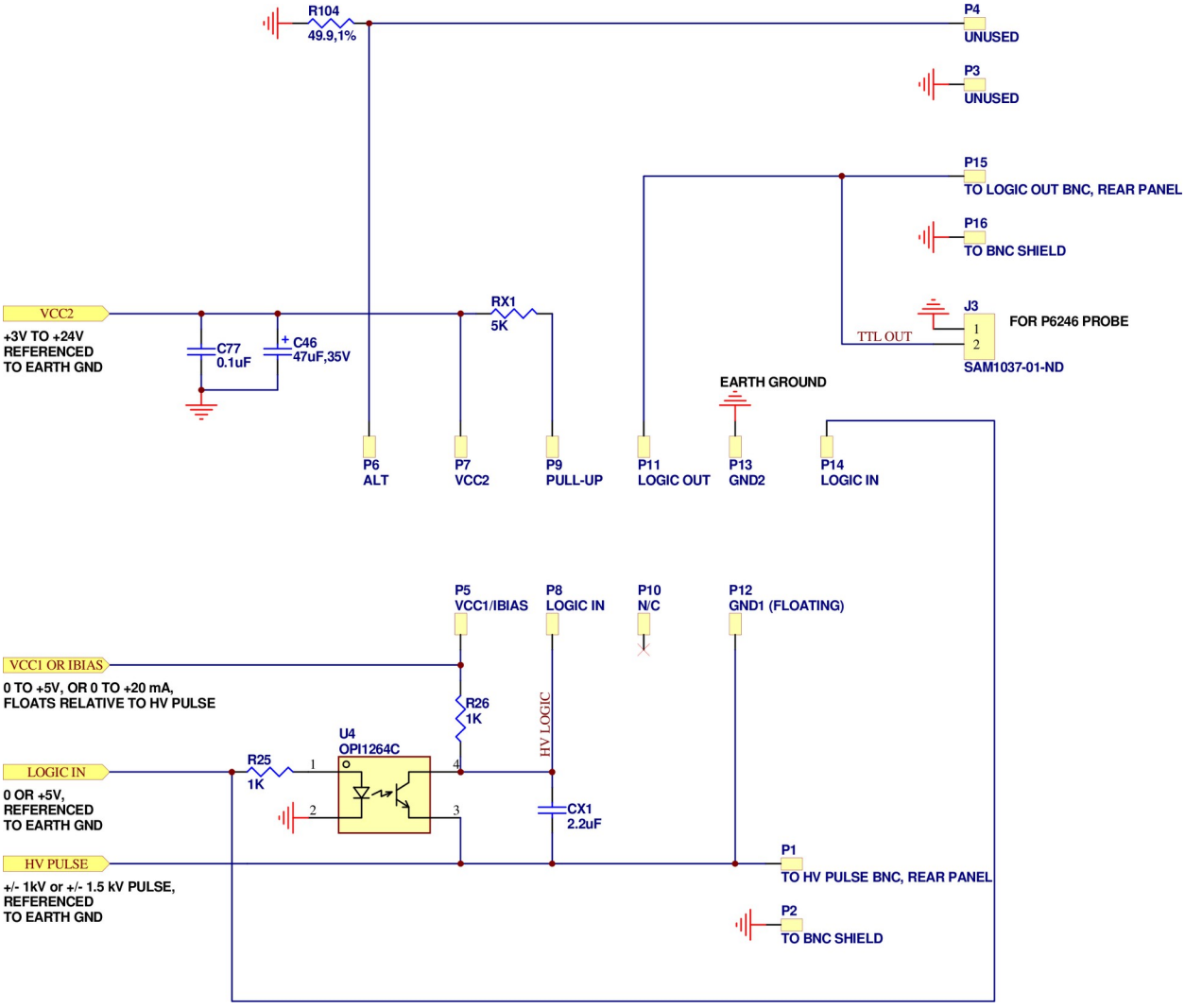
GATING MODES

Triggering can be suppressed by a TTL-level signal on the rear-panel GATE connector. The instrument can be set to stop triggering when this input high or low, using the front-panel gate menu or the appropriate programming commands. This input can also be set to act synchronously or asynchronously. When set to asynchronous mode, the GATE will disable the output immediately. Output pulses may be truncated. When set to synchronous mode, the output will complete the full pulse width if the output is high, and then stop triggering. No pulses are truncated in this mode.

DUT INSTALLATION

DAUGHTERBOARD PINOUT

The DUT installation area is accessed from the rear-panel door. Inside this area, two rows of pin sockets are provided, which mate to a user-supplied daughterboard (or the sample board provided by Avtech). One row has 6 pin sockets, on the output ground-referenced side of the DUT. The other row has 4 pin sockets, on the floating HV-pulsed input side of the DUT. The functions of these pins are shown schematically below:



Output row, ground-referenced	P6	ALT	Not used.
	P7	VCC2	A voltage of +3 to +24V is applied to the output side VCC2 of the DUT.
	P9	PULL-UP	If desired, the user may connect this pin socket to P11, to provide a pull-up function. This pin may be left unconnected.
	P11	LOGIC OUT	This is the logic output signal of the DUT. It must be observed by the user.
	P13	EARTH GND	This is the output-side ground of the DUT. It is connected to earth ground.
	P14	LOGIC IN	This pin is not used in the AVRQ-3-B-SIA. Leave it unconnected.
Input row, floating on HV PULSE	P5	VCC1/IBIAS	This pin provides power to voltage-drive DUTS (VCC2). For current-drive DUTs, this provide the bias current to the LED anode.
	P8	LOGIC IN	This pin provides the floating logic input to voltage-drive DUTs. The user should shunt this signal with 2.2 uF to P12, the floating ground, best performance.
	P10	N/C	Not used, no connection.
	P12	FLOATING GND	This pin must be connected to the input-side GND of a voltage-drive DUT, or the LED cathode of a current-drive DUT. The HV pulse is applied to this pin.

DAUGHTERBOARD REQUIREMENTS

The daughterboard that plugs into the pin sockets must:

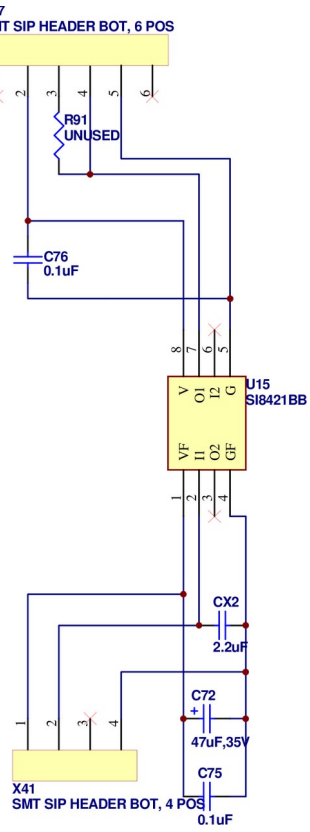
1. Provide a 0.1 uF decoupling capacitor between P7 / VCC2 and P13 / GND2, for all devices.

2. Provide a 0.1 uF and a 47 uF decoupling capacitor in parallel between P5 / VCC1 and P12 / GND2, for voltage-drive DUTs.

3. Provide a 2.2 uF decoupling capacitor in parallel between P8 / LOGIC IN and P12 / GND2, for voltage-drive DUTs.

4. Must connect the DUT to the appropriate power supplies, grounds, and I/Os. The user will need to ensure that enable/disable pins on the DUT are appropriately configured.

The sample daughterboard provided by Avtech has this pinout:

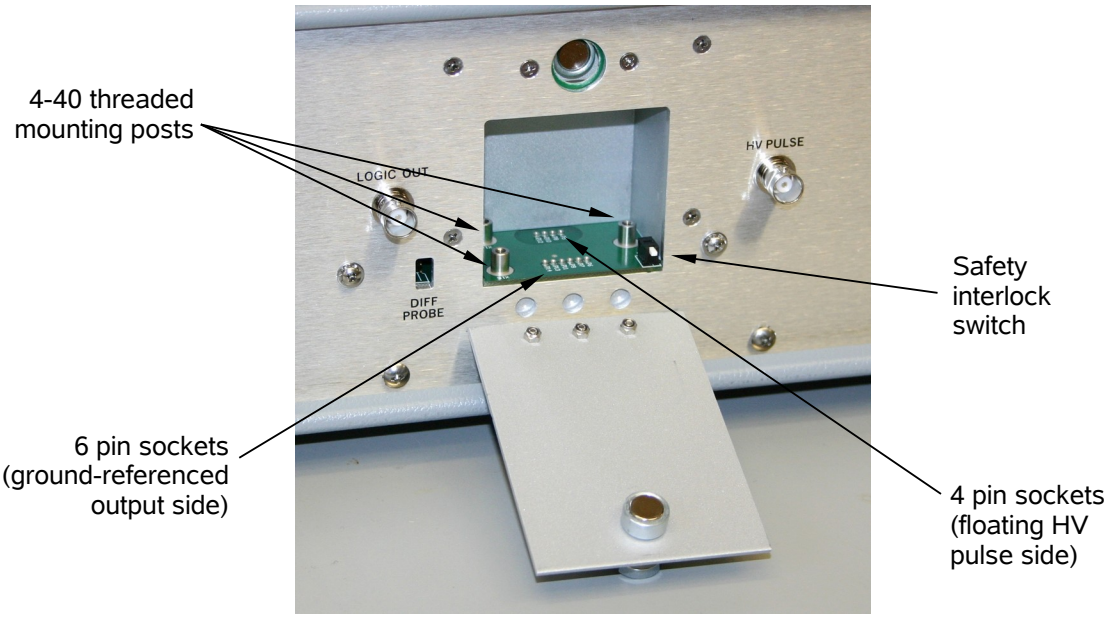


The Si8421BB is soldered on (not socketed).

INSTALLING THE DAUGHTERBOARD

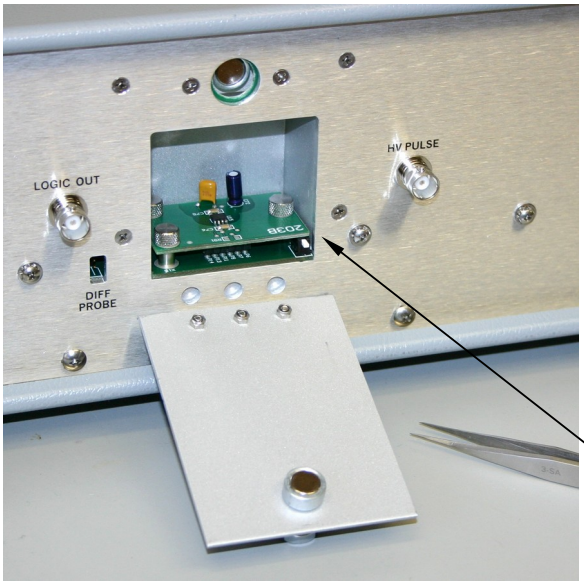
When shipped from the factory, the AVRQ-3-B-SIA will have a sample daughterboard installed.

The DUT area is located on the rear panel, behind the hinged door:



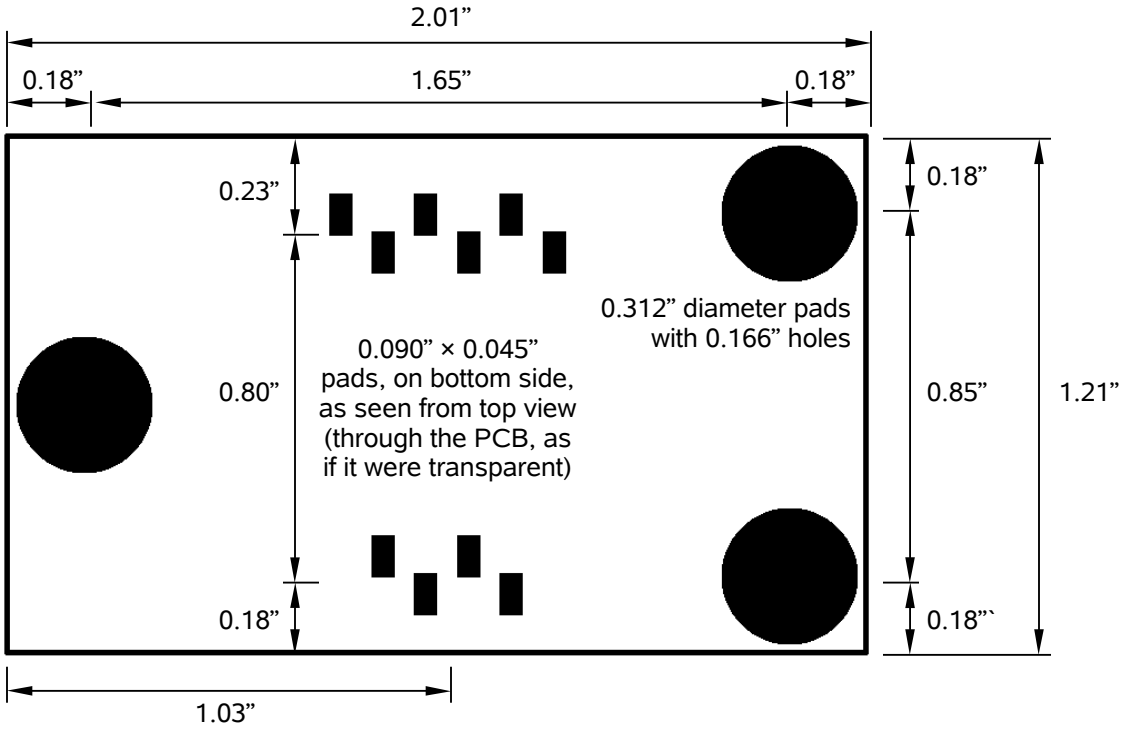
The outputs are automatically disabled when the DUT door is open (as sensed by the safety interlock switch).

To install a different daughterboard, unscrew the three screws that secure the board to the three mounting posts, and gently pull the board upwards, out of the pin sockets. Insert the new PCB by carefully aligning the bottom-side pins with the ten matching pin sockets. Gently push the new board down into the pin sockets. Secure the board with the three 4-40 thumbscrews. A tweezer should be used to guide the thumbscrews into position. Do not over tighten the screws.



DAUGTHERBOARD MECHANICAL ASPECTS

The sample daughterboard provided by Avtech uses bottom-side surface-mounted pin strips to mate to the pin sockets. These are portions of a Mill-Max 350-10-164-00-106000 64-position pin strip, available from Mouser (www.mouser.com, Mouser stock number 575-640006). The general arrangement is shown below:



In the above mechanical drawing, the DUT would be mounted on the top side. The pads shown for the pin strips are on the bottom side, shown through the PCB (in the same way that most PCB layout programs show the layers).

DAUGTHERBOARD ELECTRICAL ASPECTS

Aside from the pinout requirements noted above, there are a few special concerns regarding electrical layout of the daughterboard:

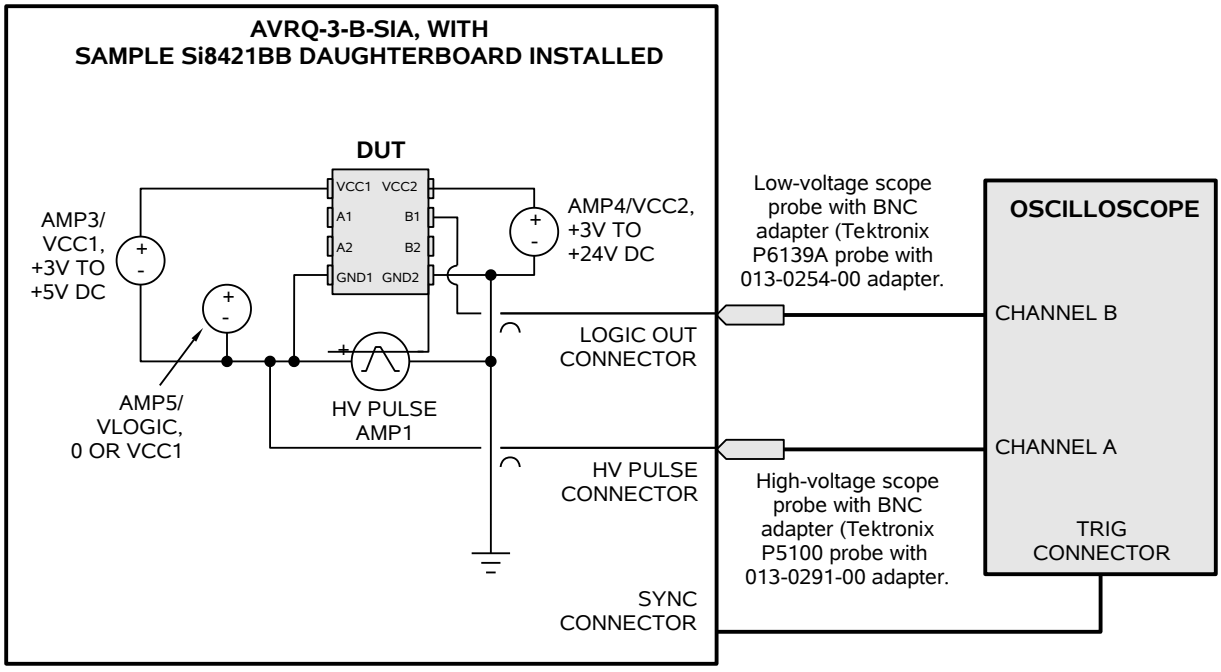
1. The HV side (the 4 pins sockets) pulse to a maximum voltage of 1.5 kV. These circuits need to be widely spaced from the circuits on the ground-reference side (the 6 pin sockets), for both safety reasons and to minimize interference issues.

2. Some optocouplers are extremely sensitive to parasitic signals capacitively coupled to “unused” pins. For instance, pin 3 of the HCPL-7721 optocoupler is not normally used, but it is nonetheless connected to the anode of the internal LED! This pin needs to be isolated as much as possible. dV/dt performance is

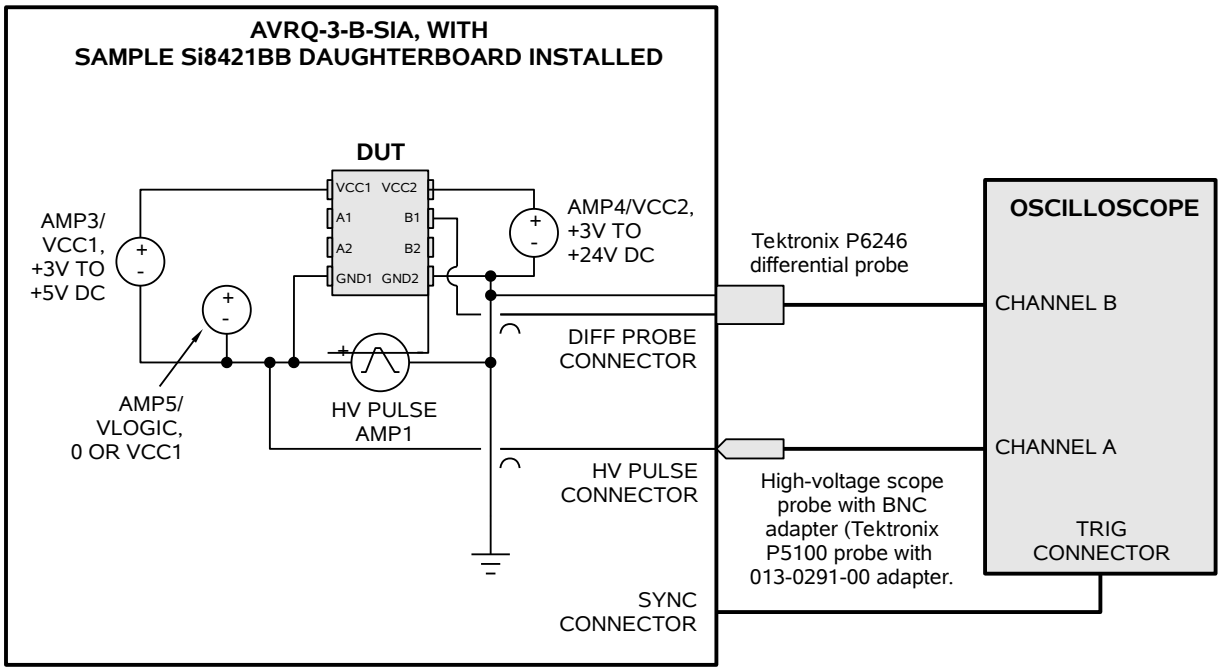
noticeably improved, in fact, if this pin is snipped off entirely! Other optocouplers may have similar unexpected interference issues that need to be thought out.

BASIC TEST ARRANGEMENT

The figure below shows basic test arrangement for the AVRQ-3-B-SIA, when the single-ended LOGIC OUT output is used, is shown below:



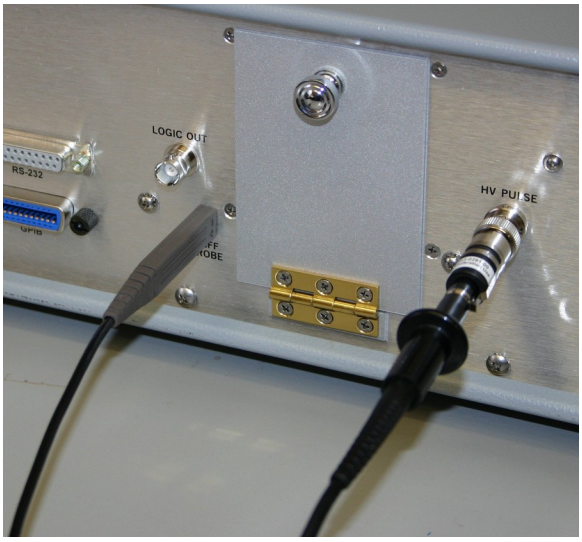
Alternatively, a differential probe may be used to monitor the logic output, giving a slightly different arrangement:



Coaxial cabling should only be used to connect the AVRQ-3-B-SIA SYNC output to the oscilloscope trigger input. It should not be used anywhere else in the test system. The HV PULSE and LOGIC OUT / DIFF PROBE outputs should be measured using oscilloscope probes, without intervening cabling.

⚠ Caution: The HV PULSE oscilloscope probe must be rated for operation at 1.5 kV (pulsed) or higher. Factory tests are conducted using a Tektronix P5100 probe, which has a 2.5 kV peak rating and a 1000:1 division ratio. (Remember to adjust the compensation of the probe to match your oscilloscope input.)

With the Tektronix P5100 high-voltage probe with the 013-0291-00 adapter and the Tektronix P6246 differential probe installed, the rear panel will look like:



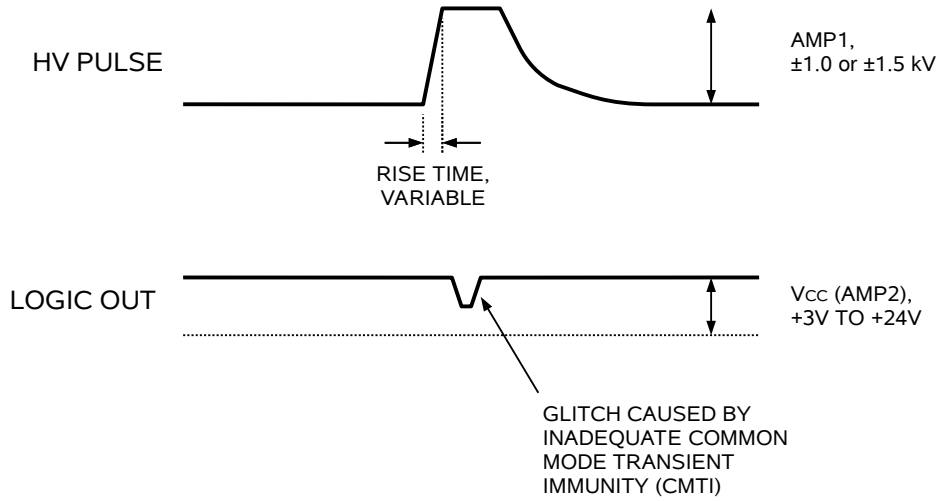
When using the differential probe, install the probe so that the “-” side is on the top, and the “+” side is on the bottom.

TYPICAL WAVEFORMS

BASIC THEORY

The instrument will normally be set to test the DUT four times – with a + HV pulse and a logic HIGH input, with a + HV pulse and a logic LOW input, with a - HV pulse and a logic HIGH input, and with a - HV pulse and a logic LOW input.

For all tests, the rise time should be set to its maximum value, and then decreased until a glitch is observed on the output:

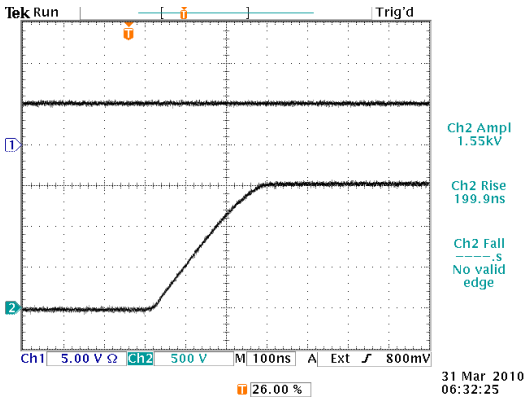


For logic-HIGH output conditions, the user must watch for a glitch to logic-LOW (as shown above).

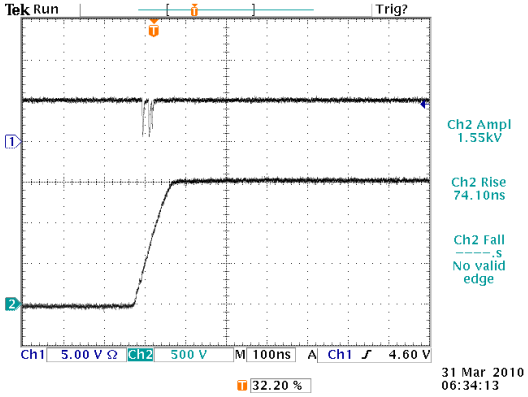
For logic-LOW output conditions, the user must watch for a glitch to logic-HIGH.

Si8421BB, +1.5 kV, LOGIC HIGH

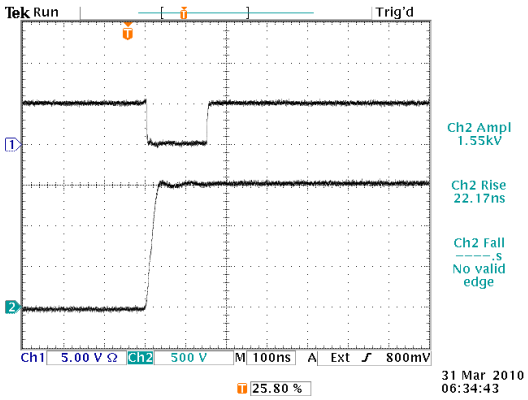
With the sample daughterboard installed, AMP1 (HV PULSE) = +1.5 kV, AMP3 (VCC1) = AMP4 (VCC2) = AMP5 (VLOGIC) = +5V, the following waveforms were obtained:



Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Normal operation with rise time ~ 200 ns



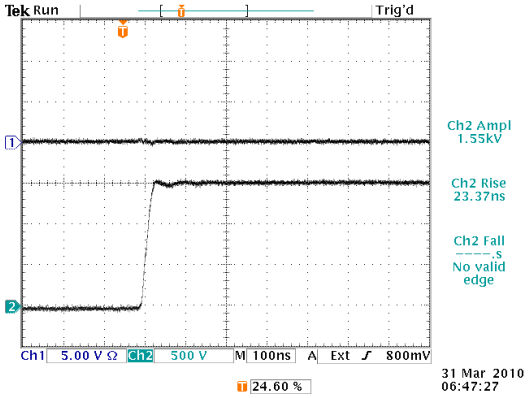
Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Glitches start at rise time = 74.1 ns, or dV/dt = 16.2 kV/us.



Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Major glitch at minimum rise time.

Si8421BB, +1.5 kV, LOGIC LOW

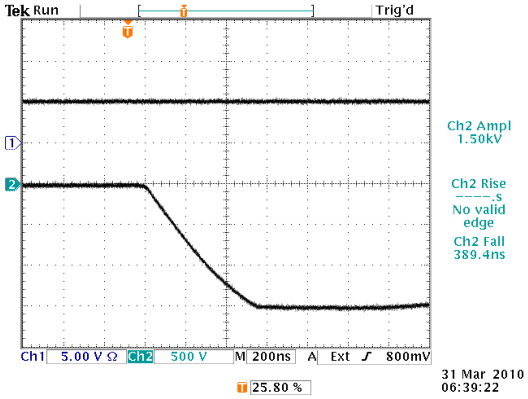
With the sample daughterboard installed, AMP1 (HV PULSE) = +1.5 kV, AMP3 (VCC1) = AMP4 (VCC2) = +5V and AMP5 (VLOGIC) = 0, the following waveforms were obtained:



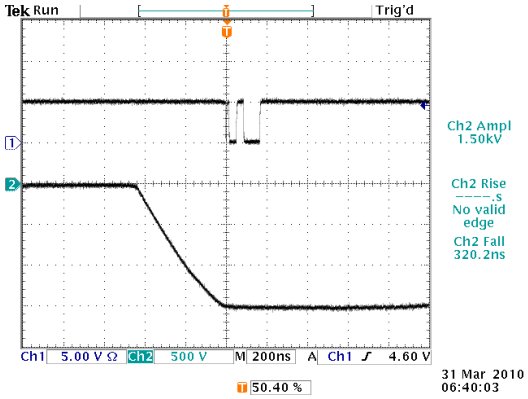
Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Normal operation even at minimum rise time.

Si8421BB, -1.5 kV, LOGIC HIGH

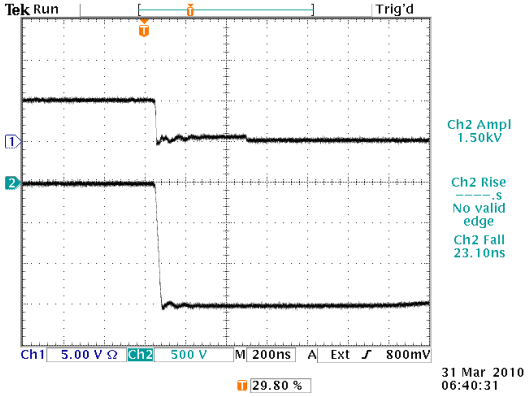
With the sample daughterboard installed, AMP1 (HV PULSE) = -1.5 kV, AMP3 (VCC1) = AMP4 (VCC2) = AMP5 (VLOGIC) = +5V, the following waveforms were obtained:



Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Normal operation with rise time ~ 400 ns



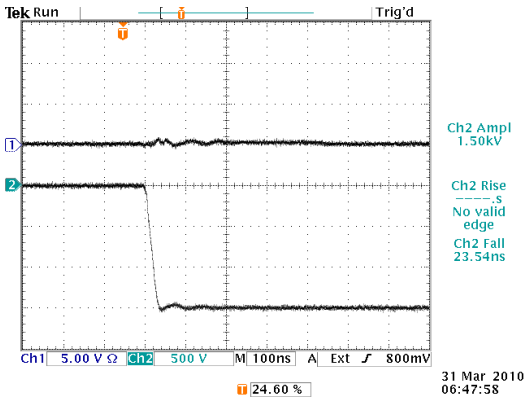
Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Glitches start at rise time = 320.2 ns, or dV/dt = 3.7 kV/us.



Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Major glitch at minimum rise time.

Si8421BB, -1.5 kV, LOGIC LOW

With the sample daughterboard installed, AMP1 (HV PULSE) = -1.5 kV, AMP3 (VCC1) = AMP4 (VCC2) = +5V and AMP5 (VLOGIC) = 0, the following waveforms were obtained:



Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Normal operation even at minimum rise time.

Si8421BB SUMMARY

Based on the above results, the tested device appears to work well if the logic level is low. With the logic level high, glitches start at 16.2 kV/us for a positive HV pulse, and as low as 3.7 kV/us with a negative HV pulse.

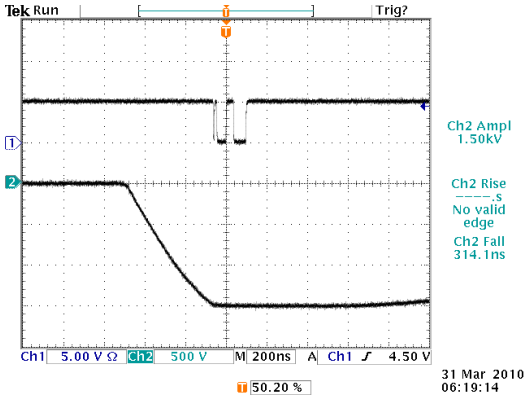
FURTHER VERIFICATION

It is virtually impossible to measure the VCC1 and VLOGIC signals when the HV pulse is active. Differential oscilloscope probes are not able to accurately reproduce these waveforms, subtracting the effects of the HV pulse, due to the very high dV/dt rates. That is, just as it is difficult to manufacture a digital optocoupler that operates well under these conditions, it is even harder to design an analog differential oscilloscope probe.

If a DUT is not performing as well as expected, the user may wish to confirm that the instrument is not to blame due to glitches on VCC1 and VLOGIC. It is not possible to confirm this directly. However, a daughterboard can be modified to disconnect the VCC1 and VLOGIC signals generated by the AVRQ-3-B-SIA, replacing them with DC voltages generated by a battery and a voltage regulator.

For example, to confirm the above Si8421BB results, a daughterboard was modified so that a 9V battery powered a 78L05 regulator, which provided a floating +5V power supply to the VCC1 pin of the Si8421BB. The logic input (A1) was then jumpered to either this +5V level, or the floating ground pin (GND1).

Under these conditions, nearly identical results were obtained. For example, the poor performance with AMP1 (HV PULSE) = -1.5 kV, VCC2 = +5V was replicated, with VCC1 generated by the battery and 78L05 (+5V), and the logic input jumpered to VCC1:



Top: Logic Out, 5V/div.
Bottom: HV Pulse, 500 V/div.
Glitches start at rise time = 314.1 ns, or dV/dt = 3.8 kV/us.

All of the earlier tests were repeated using the battery arrangement, and the results were essentially identical to the earlier tests.

SAFETY CONCERNS

TURN OUTPUT OFF BEFORE ACCESSING DUT

Always turn the output off before opening the rear-panel DUT door, using the front panel menu or by computer command (“output off”).

If you do not disable the output first, the output will be automatically disabled by a sensor on the DUT door when it is opened. However, the user should not rely on this for safety purposes.

Always check that the front panel indicates that the output is “off” before touching the DUT ZIF socket.

AUTOMATIC TIMEOUT

The output is disabled automatically after 90 seconds of inactivity (i.e., unchanged pulse settings). The timer resets each time a pulse parameter (amplitude, rise time, etc) is changed.

OVERLOAD INDICATOR

The front-panel “overload” indicator should always glow green, and never amber (except briefly when the instrument is first turned on).

If the overload indicator becomes active (amber), stop using the instrument immediately.

OPERATIONAL CHECK

This section describes a sequence to confirm the basic operation of the instrument. It should be performed after receiving the instrument. It is a useful learning exercise as well.

Before proceeding with this procedure, finish reading this instruction manual thoroughly. Then read the “Local Control” section of the “Programming Manual for -B Instruments” thoroughly. The “Local Control” section describes the front panel controls used in this operational check - in particular, the MOVE, CHANGE, and ADJUST controls.

1. Connect the pulser, the load, and the oscilloscope as described in the preceding “Basic Test Arrangement” section. Install a DUT.

   ⚠ Confirm that the scope probe, test load, cables, and any adapters used are rated for 1.5 kV pulsed operation.

2. Turn on the AVRQ-3-B-SIA. The main menu will appear on the LCD.

3. To set the AVRQ-3-B-SIA to trigger from the internal clock at a PRF of 10 Hz:

   a) The arrow pointer should be pointing at the frequency menu item. If it is not, press the MOVE button until it is.

   b) Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 10 Hz.

   c) The arrow pointer should be pointing at the “Internal” choice. If it is not, press MOVE until it is.

   d) Press CHANGE to return to the main menu.

4. To set the delay to 50 ns:

   a) Press the MOVE button until the arrow pointer is pointing at the delay menu item.

   b) Press the CHANGE button. The delay submenu will appear. Rotate the ADJUST knob until the delay is set at 50 ns.

   c) The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.

   d) Press CHANGE to return to the main menu.

5. To set the rise time to 100 ns:

    a) Press the MOVE button until the arrow pointer is pointing at the rise time menu item.

    b) Press the CHANGE button. The rise time submenu will appear. Rotate the ADJUST knob until it is set at 100 ns.

    c) Press CHANGE to return to the main menu.

6. To set the HV PULSE amplitude to +1.5 kV:

    a) Press the MOVE button until the arrow pointer is pointing at the AMP1 menu item.

    b) Press the CHANGE button. The submenu will appear. Rotate the ADJUST knob until it is set at + 1.5 kV.

    c) Press CHANGE to return to the main menu.

7. To set the VCC1 amplitude to +5V:

    a) Press the MOVE button until the arrow pointer is pointing at the AMP3 menu item.

    b) Press the CHANGE button. The submenu will appear. Rotate the ADJUST knob until it is set at +5V.

    c) Press CHANGE to return to the main menu.

8. To set the VCC2 amplitude to +5V:

    a) Press the MOVE button until the arrow pointer is pointing at the AMP4 menu item.

    b) Press the CHANGE button. The submenu will appear. Rotate the ADJUST knob until it is set at +5V.

    c) Press CHANGE to return to the main menu.

9. To set the VLOGIC amplitude to +5V:

    a) Press the MOVE button until the arrow pointer is pointing at the AMP5 menu item.

    b) Press the CHANGE button. The submenu will appear. Rotate the ADJUST knob until it is set at +5V.

c) Press CHANGE to return to the main menu.

10. At this point, nothing should appear on the oscilloscope.

11. To enable the output:

    a) Press the MOVE button until the arrow pointer is pointing at the output menu item.

    b) Press the CHANGE button. The output submenu will appear.

    c) Press MOVE until the arrow pointer is pointing at the “ON” choice.

    d) Observe the oscilloscope. You should see +1.5 kV pulses with 100 ns rise time, approximately.

    e) Press CHANGE to return to the main menu.

12. Try varying the rise time, by repeating step (5). As you rotate the ADJUST knob, the rise time on the oscilloscope will change.

13. 90 seconds after the last parameter change, the instrument will automatically shut the output off. Confirm that this occurs.

This completes the operational check.

PROTECTING YOUR INSTRUMENT

USE HIGH-VOLTAGE CABLES, CONNECTORS, AND PROBES

⚠ Confirm that the scope probe, test load, cables, and any adapters used are rated for 2 kV pulsed operation.

SHORT-CIRCUIT PROTECTION

The output will withstand temporary short-circuit conditions. However, short-circuit conditions should not be allowed to persist longer than 10 seconds, or the stress on the components will shorten the circuit lifetime.

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 before opening the instrument.

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.

⚠ Caution: High voltages (over 1500V) are present inside the instrument during normal operation. Do not operate the instrument with the cover removed.

⚠ Caution: Do not remove the internal aluminum lid. It shields certain very-high-voltage areas.

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.

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.

PROGRAMMING YOUR PULSE GENERATOR

KEY PROGRAMMING COMMANDS

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

*rst	(resets the instrument)
trigger:source internal	(selects internal triggering)
frequency 10 Hz	(sets the frequency to 10 Hz)
pulse:transition 50 ns	(sets the rise time to 50 ns)
pulse:delay 1 us	(sets the delay to 100 ns)
volt1 +1 kV	(sets the HV PULSE amplitude to +1 kV)
curr2 0	(disables the current-drive mode)
volt3 5.0	(sets VCC1 to +5.0V)
volt4 5.0	(sets VCC2 to +5.0V)
volt5 5.0	(sets VLOGIC to +5.0V)
output on	(turns on the output)

The output will turn off automatically 90 seconds later, if no further commands are sent before then.

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:transition 50 ns	(sets the rise time to 1 us)
volt1 +1 kV	(sets the HV PULSE amplitude to +1 kV)
curr2 0	(disables the current-drive mode)
volt3 5.0	(sets VCC1 to +5.0V)
volt4 5.0	(sets VCC2 to +5.0V)
volt5 5.0	(sets VLOGIC to +5.0V)
output on	(turns on the output)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

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

*rst	(resets the instrument)
trigger:source external	(selects internal triggering)
pulse:transition 50 ns	(sets the rise time to 50 ns)

pulse:delay 1 us	(sets the delay to 100 ns)
volt1 +1 kV	(sets the HV PULSE amplitude to +1 kV)
curr2 0	(disables the current-drive mode)
volt3 5.0	(sets VCC1 to +5.0V)
volt4 5.0	(sets VCC2 to +5.0V)
volt5 5.0	(sets VLOGIC to +5.0V)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

ALL PROGRAMMING COMMANDS

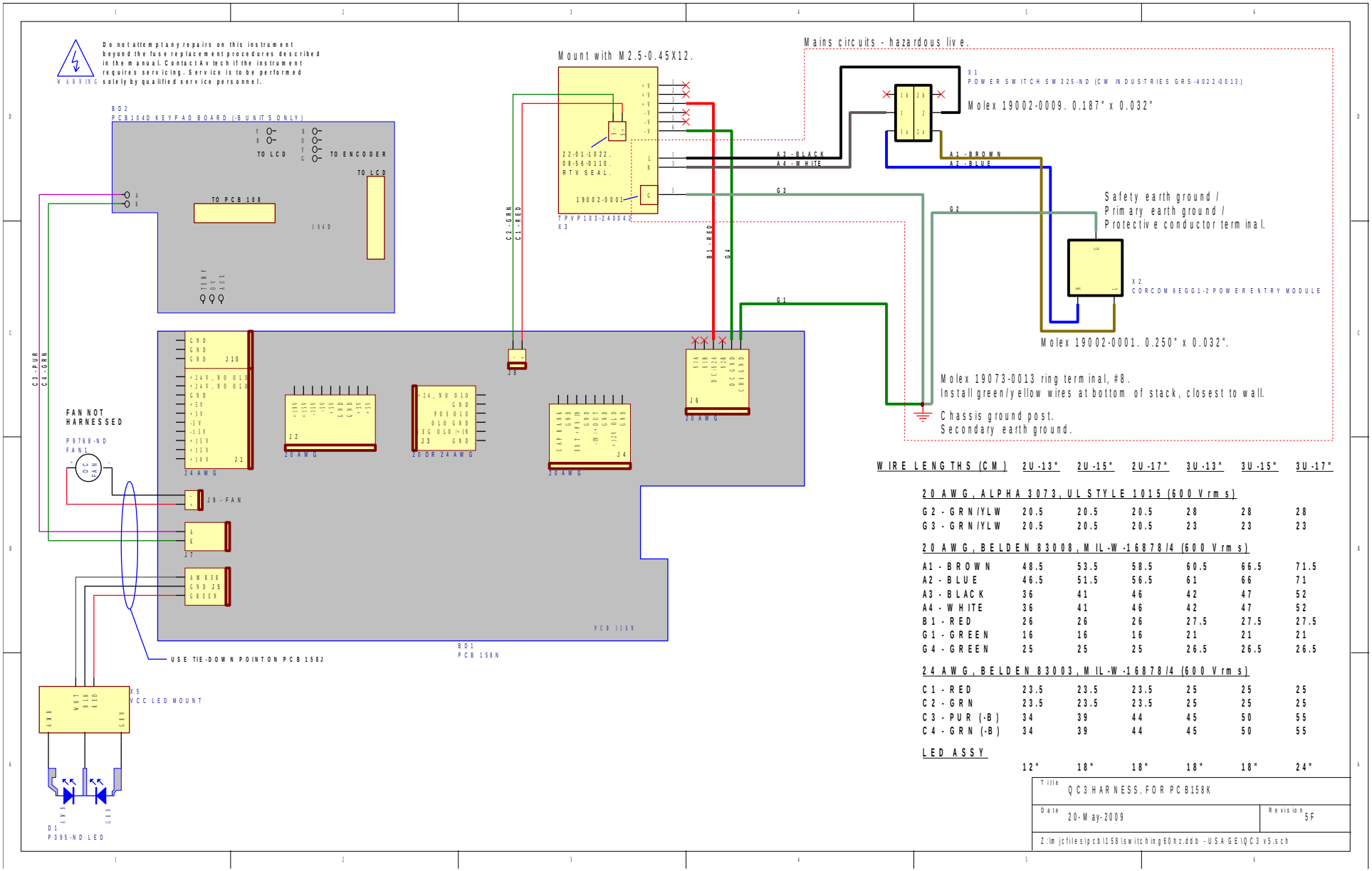
For more advanced programmers, a complete list of the available commands is given below. These commands are described in detail in the “Programming Manual for -B Instruments”. (Note: this manual also includes some commands that are not implemented in this instrument. They can be ignored.)

Keyword	Parameter	Notes
LOCAL		
OUTPut:		
:[STATe]	<boolean value>	
:LOAD	<numeric value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW | FIXed]	<numeric value>	
[SOURce]:		
:CURRent	<numeric value>	
:PULSe		
:PERiod	<numeric value>	
:HOLD	WIDTh | DCYCle	
:DELay	<numeric value>	
:GATE		
:TYPE	ASYNC | SYNC	
:LEVel	HIgh | LOw	
:TRANsition		
:[LEADing]	<numeric value>	
:VOLTage		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value> | EXTernal	
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]

WIRING DIAGRAMS

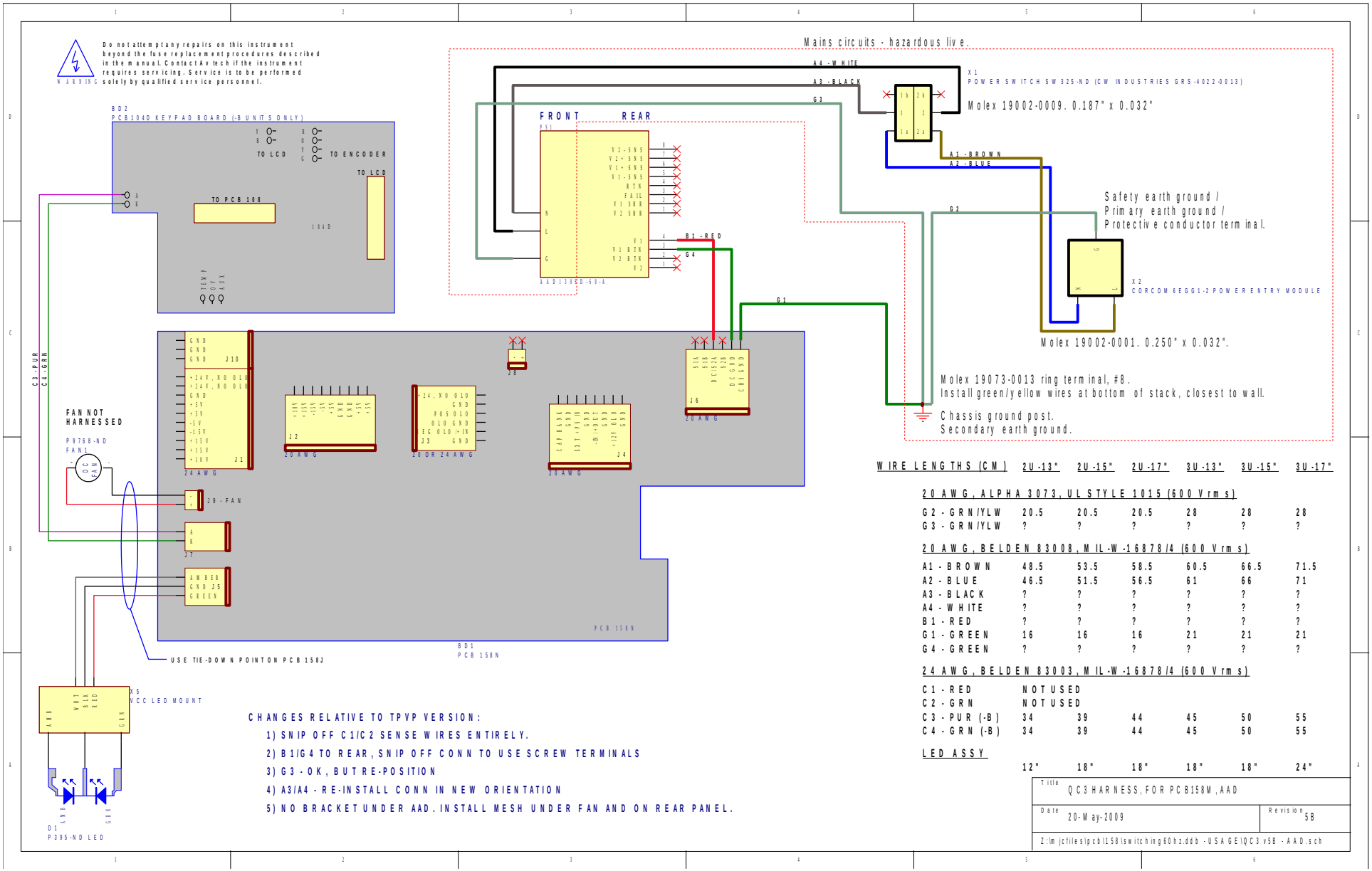
WIRING OF AC POWER, STYLE 1



WIRE LENGTHS (CM)	2U-13"	2U-15"	2U-17"	3U-13"	3U-15"	3U-17"
20 AWG, ALPHA 3073, UL STYLE 1015 (600 Vrms)						
G2 - GRN/YLW	20.5	20.5	20.5	28	28	28
G3 - GRN/YLW	20.5	20.5	20.5	23	23	23
20 AWG, BELDEN 83008, MIL-W-16878/4 (600 Vrms)						
A1 - BROWN	48.5	53.5	58.5	60.5	66.5	71.5
A2 - BLUE	46.5	51.5	56.5	61	66	71
A3 - BLACK	36	41	46	42	47	52
A4 - WHITE	36	41	46	42	47	52
B1 - RED	26	26	26	27.5	27.5	27.5
G1 - GREEN	16	16	16	21	21	21
G4 - GREEN	25	25	25	26.5	26.5	26.5
24 AWG, BELDEN 83003, MIL-W-16878/4 (600 Vrms)						
C1 - RED	23.5	23.5	23.5	25	25	25
C2 - GRN	23.5	23.5	23.5	25	25	25
C3 - PUR (-B)	34	39	44	45	50	55
C4 - GRN (-B)	34	39	44	45	50	55
LED ASSY	12"	18"	18"	18"	18"	24"

Title	QC3 HARNESS, FOR PCB158K
Date	20-May-2009
Revision	5F
	Z:\mjcfiles\pcb\158\switching60hz.ddb - USAGE\QC3 v5.sch

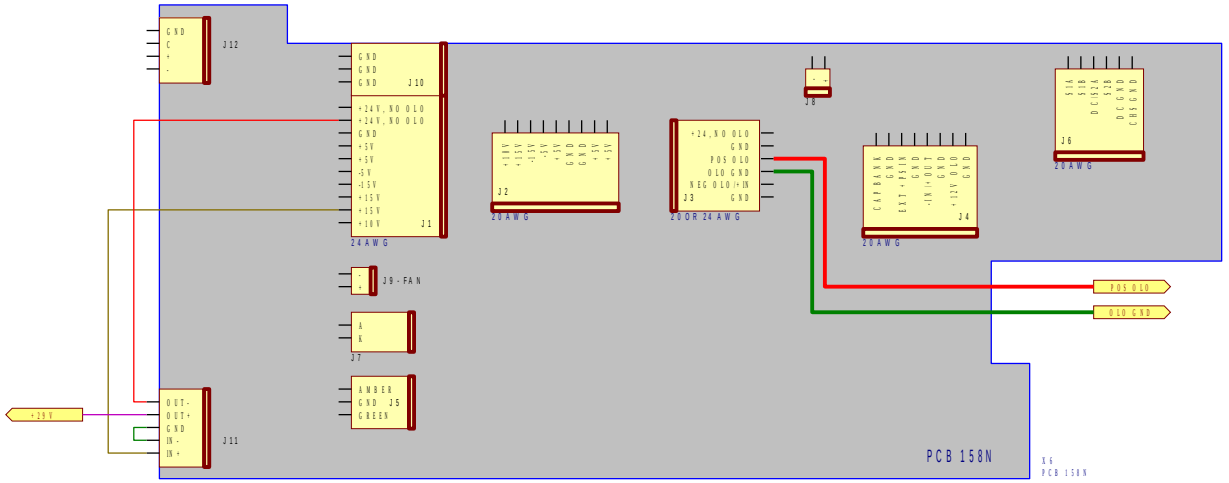
WIRING OF AC POWER, STYLE 2



WIRE LENGTHS (CM)	2U-13"	2U-15"	2U-17"	3U-13"	3U-15"	3U-17"
20 AWG, ALPHA 3073, UL STYLE 1015 (600 Vrms)						
G2 - GRN/YLW	20.5	20.5	20.5	28	28	28
G3 - GRN/YLW	?	?	?	?	?	?
20 AWG, BELDEN 83008, MIL-W-16878/4 (600 Vrms)						
A1 - BROWN	48.5	53.5	58.5	60.5	66.5	71.5
A2 - BLUE	46.5	51.5	56.5	61	66	71
A3 - BLACK	?	?	?	?	?	?
A4 - WHITE	?	?	?	?	?	?
B1 - RED	?	?	?	?	?	?
G1 - GREEN	16	16	16	21	21	21
G4 - GREEN	?	?	?	?	?	?
24 AWG, BELDEN 83003, MIL-W-16878/4 (600 Vrms)						
C1 - RED	NOT USED					
C2 - GRN	NOT USED					
C3 - PUR (-B)	34	39	44	45	50	55
C4 - GRN (-B)	34	39	44	45	50	55
LED ASSY						
	12"	18"	18"	18"	18"	24"

Title	QC3 HARNESS, FOR PCB158M, AAD
Date	20-May-2009
Revision	5B
	Z:\mjcfiles\pcb158\switching60hz.ddb - USAGE\QC3v5B - AAD.sch

ADDITIONAL DC POWER WIRING

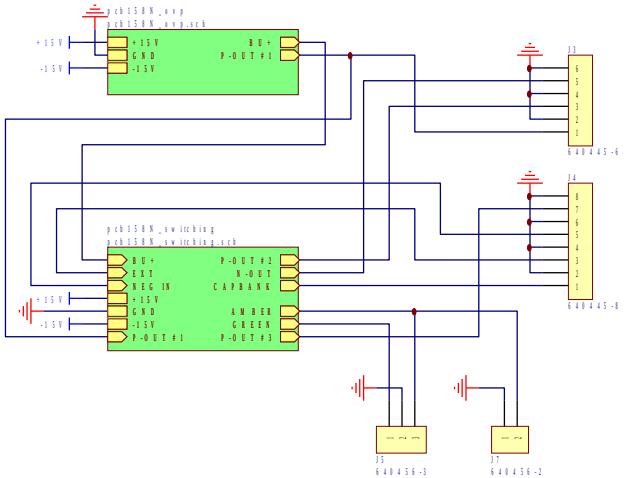


CHANGES REQUIRED ON PCB 158N:

1) INSTALL U8 = MKC03-12S-05
2) INSTALL C27 = C28 = 47uF, 50V
3) INSTALL J11 = 640445-5

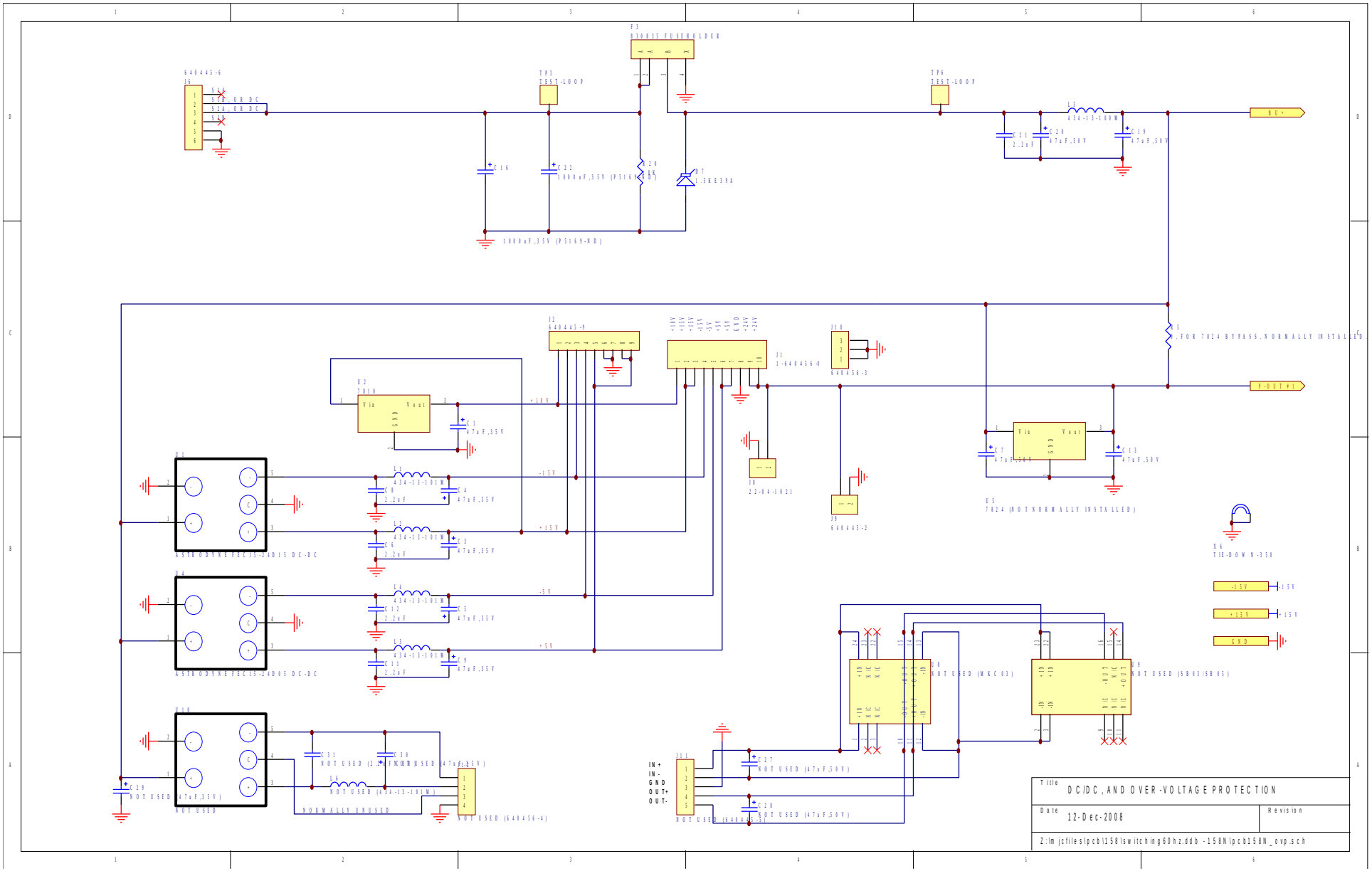
AVRQ-3-B PS	
Printed 31-Mar-2010	Revision 3A
Z:\mjc files\circuits\avr-N\avr-N.ddb - AVRQ-3-B\AVRQ-3PS V3.sch	

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

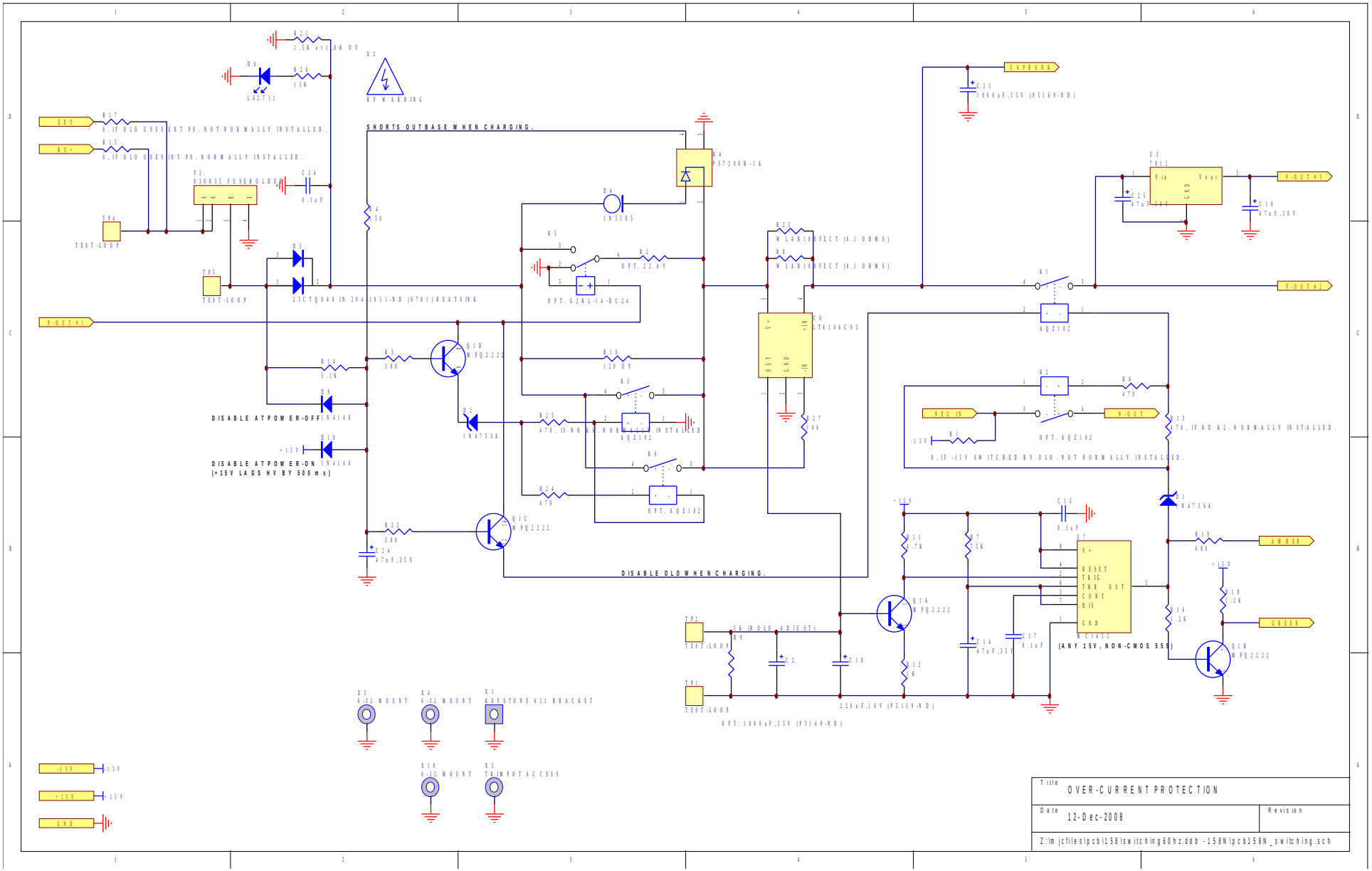


Title	LOW VOLTAGE DC/DC POWER SUPPLY
Date	12-Dec-2008
Revision	
Z:\mjcfiles\pcb158\switching60hz.ddb - 158N\pcb158N.sch	

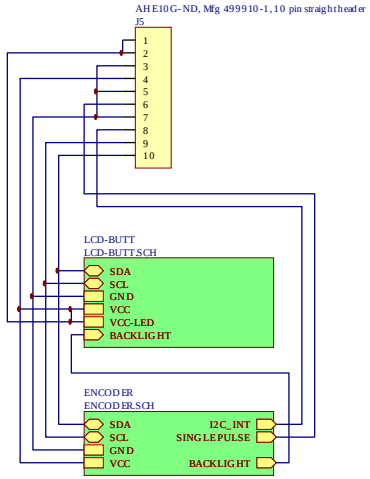
PCB 158N - LOW VOLTAGE POWER SUPPLY, 2/3



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

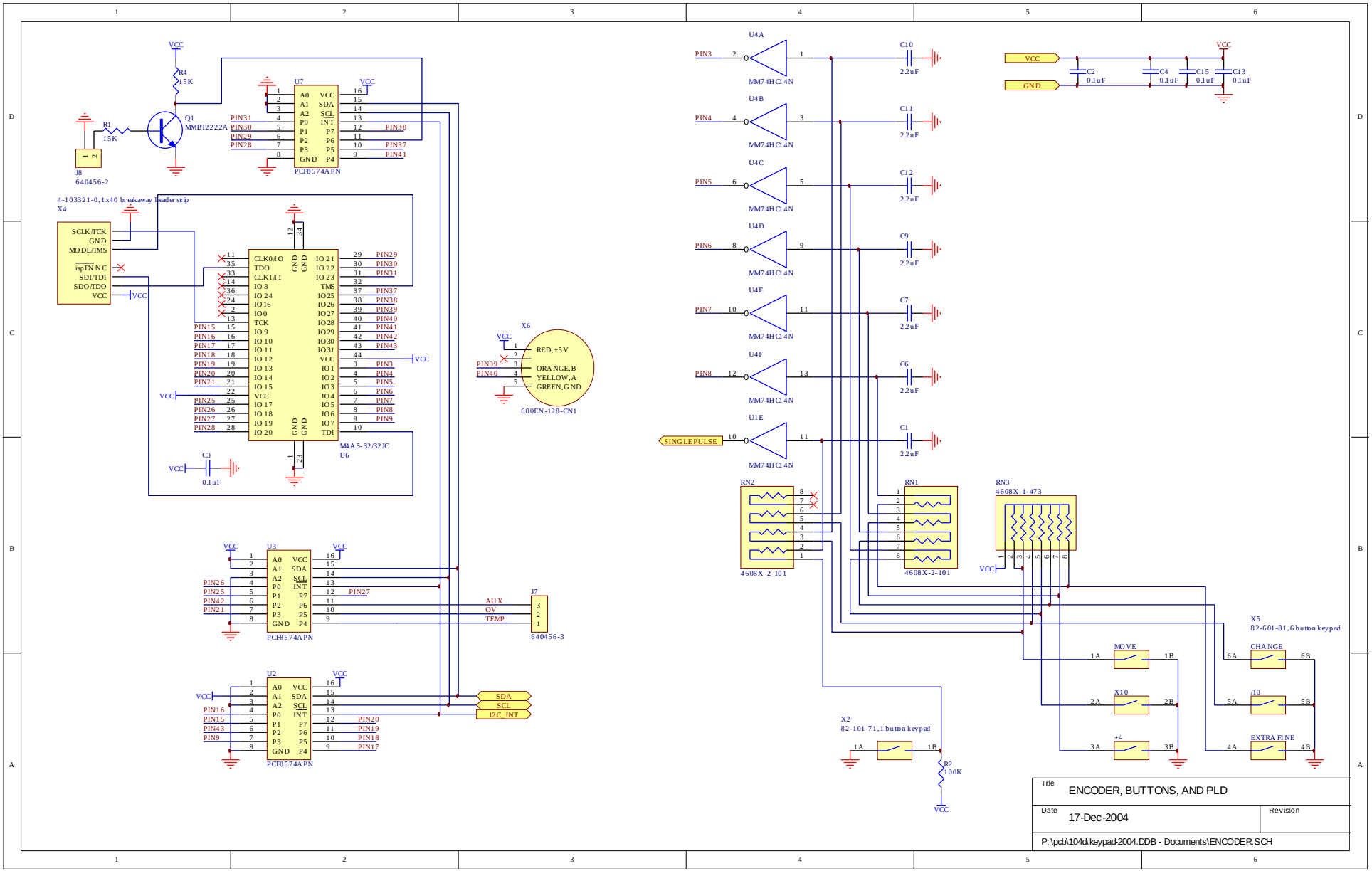


PCB 104D - KEYPAD / DISPLAY BOARD, 1/3

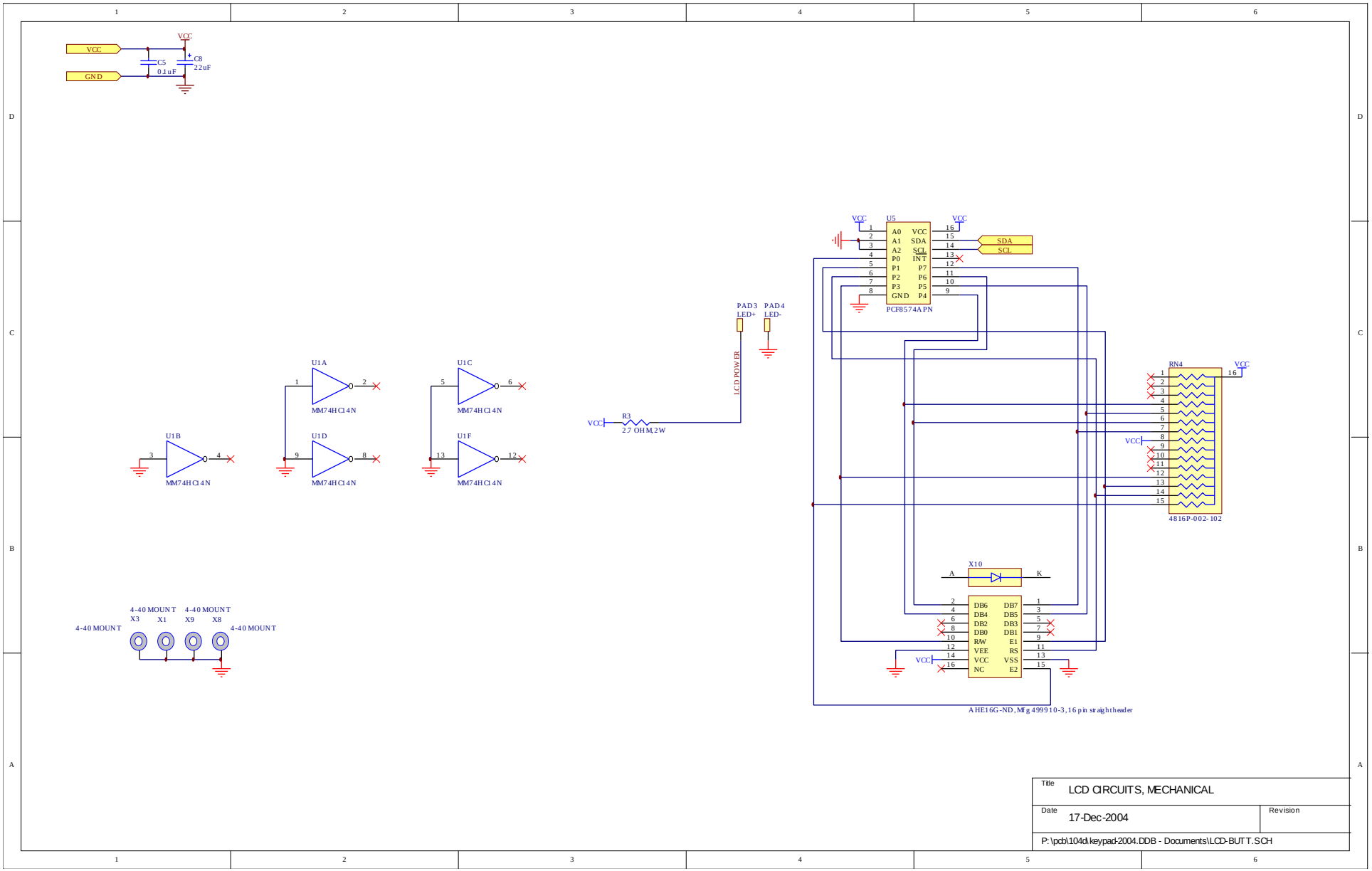


Title	PANEL TOP-LEVEL SCHEMATIC
Date	17-Dec-2004
Revision	
P:\pcb\104d\keypad-2004.DDB - Documents\Panelbrd.prj	

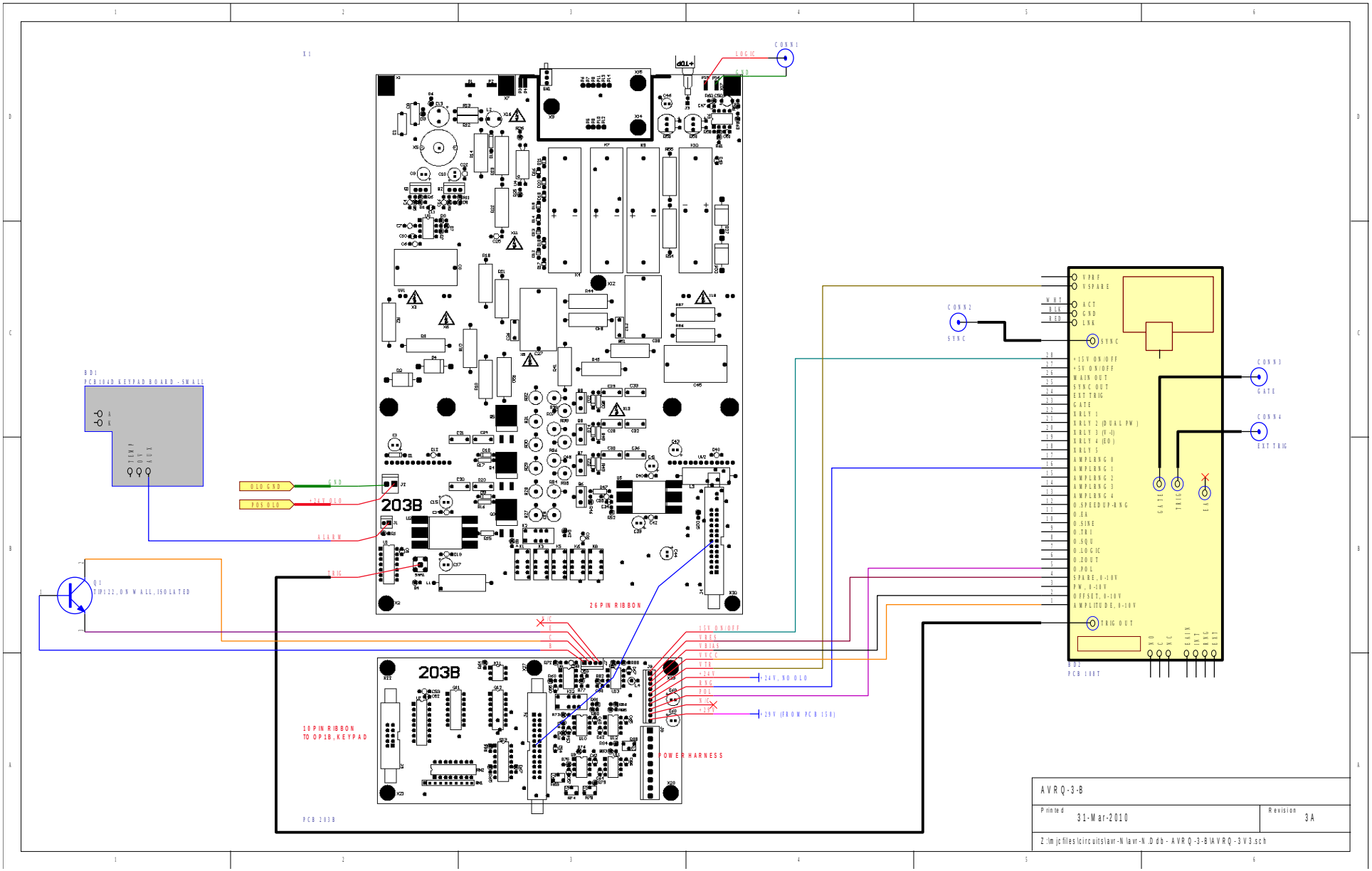
PCB 104D - KEYPAD / DISPLAY BOARD, 2/3



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



MAIN WIRING


CONN1
LOGIC
GND
203B
26 PIN RIBBON
10 PIN RIBBON
TO OP1B, KEYPAD
POWER HARNESS
PCB 203B
OLO GND
POS OLO
ALARM
TRIG
+24V OLO
+24V, NO OLO
+29V (FROM PCB 158)
CONN2
SYNC
CONN3
GATE
CONN4
EXT TRIG
TRIG OUT
AVRQ-3-B
Printed
31-Mar-2010
Revision
3A
Z:\mjc files\circuits\avr-N\avr-N.ddb - AVRQ-3-B\AVRQ-3V3.sch

PERFORMANCE CHECK SHEET