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NANOSECOND WAVEFORM ELECTRONICS  
SINCE 1975

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

## INSTRUCTIONS

MODEL AVR-G1-B-P-EMRA-R5-RP-IM

0 TO 240 Volts, 10 kHz

PULSE GENERATOR WITH

IEEE 488.2 AND RS-232 CONTROL

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

### WARRANTY

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

### TECHNICAL SUPPORT

Phone: 888-670-8729 (USA & Canada) or +1-613-226-5772 (Intl)

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Manual Reference: /files/server1/officefiles/instructword/avr-g/AVR-G1-B-P-EMRA-RP-IM,edition2.odt.

Last modified February 29, 2024.

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## INTRODUCTION

The AVR-G1-B-P-EMRA-R5-RP-IM is a customized high performance, GPIB and RS232-equipped instrument capable of generating 0 to +240V at repetition rates up to 10 kHz into resistive loads of 1.6 k $\Omega$  or higher, with a capacitance of up to 900 pF. The pulse width is variable from 3  $\mu$ s to 30  $\mu$ s, and the duty cycle may be as high as 30%. The rise time is < 10 ns into a resistive load, and the fall time is < 20 ns.

This instrument includes a current monitor. The monitor circuit samples the output current at the end of the pulse, and reports it on the front panel LCD. The value may also be queried remotely using the “meas:ampl?” command. The current monitor circuit also provides a rear-panel “M” BNC connector. The voltage waveform on this connector is proportional to the output current ( $V_M = I_{OUT} \times 2V / 100 \text{ mA}$ ), for currents of up to 250 mA. The voltage waveform is pulsed, similar to the main output. It is not a DC output.

The AVR-G1-B-P-EMRA-R5-RP-IM 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 output pulse width can be set to follow an input trigger pulse width.

The AVR-G1-B-P-EMRA-R5-RP-IM 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 width, 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.

The instrument is protected against overload conditions (such as short circuits) by an automatic control circuit. An internal power supply monitor removes the power to the output stage for five seconds if an average power overload exists. After that time, the unit operates normally for one second, and if the overload condition persists, the power is cut again. This cycle repeats until the overload is removed.

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

## INCLUDED OPTIONS

- R5 Option: Rack-mount kit.
- RP Option: The output is on the rear panel, instead of on the front panel.
- IM Option: Provides a digital current monitor circuit, as well as an analog current monitor waveform ( $V_M = I_{OUT} \times 2V / 100 \text{ mA}$ ).

## SPECIFICATIONS

Model:	AVR-G1-B-P-EMRA-R5-RP-IM <sup>1</sup>
Amplitude:	0 to +240 Volts
Pulse width (FWHM) <sup>2</sup> :	3 us to 30 us
Load impedance:	≥ 1.6 kΩ, ≤ 900 pF. 150 mA maximum output current.
Output impedance:	50 Ω (i.e., internal resistance in series with the output).
Rise time (20%-80%):	≤ 10 ns, into a resistive load
Fall time (80%-20%):	≤ 20 ns, into a resistive load
PRF:	1 Hz to 10 kHz
Duty cycle:	30% maximum
Polarity:	Positive
GPIB and RS-232 control <sup>1</sup> :	Standard on -B units
LabView Drivers:	Check <a href="http://www.avtechpulse.com/labview">http://www.avtechpulse.com/labview</a> for availability and downloads
Propagation delay:	≤ 100 ns (Ext trig in to pulse out)
Jitter (Ext trig in to pulse out):	± 100 ps ± 0.03% of sync delay
Trigger required: (External trigger modes)	Mode A: + 5 Volt, > 50 ns (TTL) Mode B: + 5 Volt, PW <sub>IN</sub> = PW <sub>OUT</sub> (TTL)
Sync delay:	Variable, 0 to ± 1 second
Sync output:	+ 3 Volts, 100 ns, will drive 50 Ohm loads
Gate input:	Synchronous or asynchronous, active high or low, switchable. Suppresses triggering when active.
Monitor output:	Provides an internal current monitor circuit whose measurements are displayed on the front panel and can be queried digitally through the GPIB / RS-232 ports. The current monitor will sense the output current at the end of the pulse. Currents in the range of 0 to 250 mA can be measured properly. (Higher currents will not damage the monitor, but they will not be reported properly.) Measurement accuracy: +/- 10%.
Connectors:	SYNC: BNC, front panel All others: BNC, rear panel
Power requirements:	100 - 240 Volts, 50 - 60 Hz
Dimensions (H x W x D):	100 mm x 430 mm x 375 mm (3.9" x 17" x 14.8")
Chassis material:	cast aluminum frame and handles, blue vinyl on aluminum cover plates
Mounting:	Any. Add the suffix -R5 to the model number to include a rack-mount kit.
Temperature range:	+5°C to +40°C

1) -B suffix indicates IEEE-488.2 GPIB and RS-232 control of amplitude, pulse width or duty cycle (as appropriate), pulse repetition frequency, and delay (See <http://www.avtechpulse.com/gpib>).

2) When triggered externally, the pulse width can be set by the pulse instrument controls, or it may be set to track the input trigger pulse width.

## ORIGINAL QUOTATION

Date: Thu, 27 Sep 2007 12:55:50 -0400  
From: Avtech Sales  
Subject: AVR-G1-B-P-EMRA-R5 Modification

XXXXX,

Following our telephone conversation yesterday, I have quoted below on a modification to the existing AVR-G1-B-P-EMRA-R5 units that would allow the current monitor to be read remotely by the GPIB / RS-232 interfaces, rather than providing a DC output that needs to be measured by another instrument.

Also, as I mentioned, XXXXX XXXXX requested that the OUT connector be moved to the rear panel. This quote includes that change, and I have copied this email to him as well.

I have also quoted on a second version, which includes an output voltage monitor, as requested.

I am pleased to quote as follows:

Quote number: 13998.01

Description: Convert the AVR-G1-B-P-EMRA-R5 into an AVR-G1-B-P-EMRA-R5-RP-IM

Task 1: Add the -RP option to the AVR-G1-B-P-EMRA-R5. This moves the main OUT connector from the front panel to the rear panel. (The SYNC output remains on the front panel.)

Task 2: Add the -IM option to the AVR-G1-B-P-EMRA-R5. This will remove the existing rear-panel "M" monitor analog output connector, and replace it with an internal current monitor circuit whose measurements are displayed on the front panel and can be queried digitally through the GPIB / RS-232 ports. The current monitor will sense the output current at the end of the pulse. (This is slightly different than the existing design, which senses it at 2-3 us into the pulse.) Currents in the range of 0 to 250 mA can be measured properly. (Higher currents will not damage the monitor, but they will not be reported properly.) Measurement accuracy: +/- 10%.

Price: \$XXXXX US, FOB destination.

Time to complete: 1-2 week at the factory.

Quote number: 13998.02

Description: Convert the AVR-G1-B-P-EMRA-R5 into an AVR-G1-B-P-EMRA-R5-RP-IM-VM

Task 1: Add the -RP option to the AVR-G1-B-P-EMRA-R5. This moves the main OUT connector from the front panel to the rear panel. (The SYNC output remains on the front panel.)

Task 2: Add the -IM option to the AVR-G1-B-P-EMRA-R5. This will remove the existing rear-panel "M" monitor analog output connector, and replace it with an internal current monitor circuit whose measurements are displayed on the front panel and can be queried digitally through the GPIB / RS-232 ports. The current monitor will sense the output current at the end of the pulse. (This is slightly different than the existing design, which senses it at 2-3 us into the pulse.) Currents in the range of 0 to 250 mA can be measured properly. (Higher currents will not damage the monitor, but they will not be reported properly.) Measurement accuracy: +/- 10%.

Task 3: Add the -VM option to the AVR-G1-B-P-EMRA-R5. This adds an internal voltage monitor circuit whose measurements are displayed on the front panel and can be queried digitally through the GPIB / RS-232 ports. The voltage monitor will sense the output voltage at the end of the pulse. Measurement accuracy: +/- 3%.

Price: \$XXXXX US, FOB destination.

Time to complete: 1-2 week at the factory.

To proceed with modification, please return the pulser via prepaid shipping to the following address:

Avtech Electrosystems Ltd.  
C/O Strader-Ferris International  
808 Commerce Park Drive  
Ogdensburg, NY 13669

Tel: (315)394-0051 (Strader-Ferris Intl)

Please package the instrument very carefully! Damage incurred during shipping may increase the repair cost.

The RMA number is the same as the instrument serial number (11824, 11850, or 11851). Avtech will require either a Purchase Order Number or a credit card number (American Express, MasterCard or Visa) to cover the cost of the modification.

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

Regards,  
Dr. Michael J. Chudobiak  
Chief Engineer

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

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Monocycle Generators - Impulse Generators - Pulse Amplifiers  
Current Pulsers - Function Generators - Frequency Dividers - and more!

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## EUROPEAN REGULATORY NOTES

### 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 will lie with the representative, unless other arrangements (under Article 9) have been made.

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



## INSTALLATION

### VISUAL CHECK

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

### PROTECTION FROM ELECTRIC SHOCK

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

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

### ENVIRONMENTAL CONDITIONS

This instrument is intended for use under the following conditions:

1. indoor use;
2. altitude up to 2 000 m;
3. temperature 5 °C to 40 °C;

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

### LABVIEW DRIVERS

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

## FUSES

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



### AC FUSE REPLACEMENT

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



## DC FUSE REPLACEMENT

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

## FUSE RATINGS

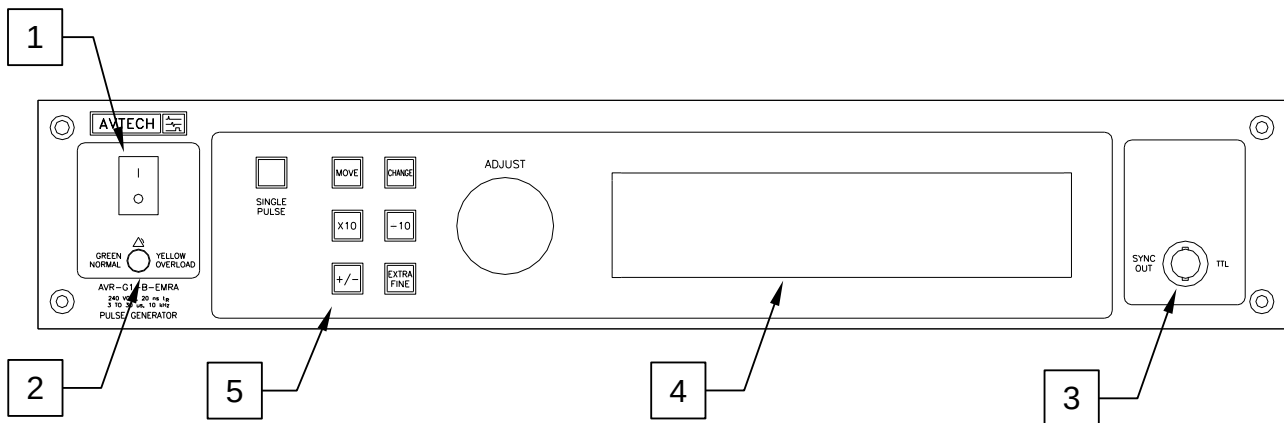
The following table lists the required fuses:

Fuses	Nominal Mains Voltage	Rating	Case Size	Recommended Replacement Part	
				Littelfuse Part Number	Digi-Key Stock Number
#1, #2 (AC)	100-240V	0.5A, 250V, Time-Delay	5×20 mm	0218.500HXP	F2416-ND
#3 (DC)	N/A	1.6A, 250V, Time-Delay	5×20 mm	021801.6HXP	F2424-ND
#4 (DC)	N/A	0.8A, 250V, Time-Delay	5×20 mm	0218.800HXP	F2418-ND

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

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

## FRONT PANEL CONTROLS



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

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

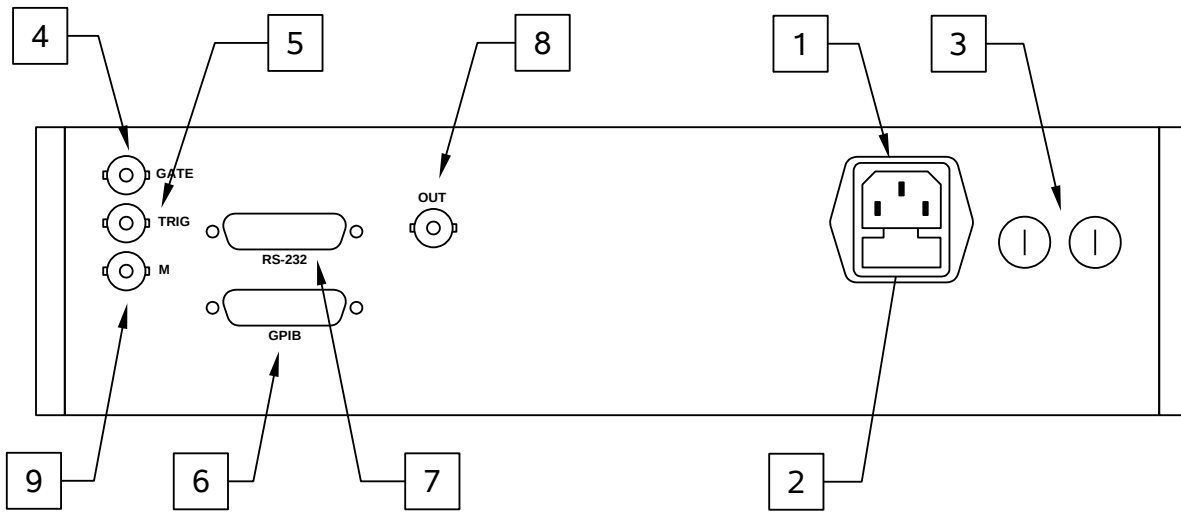
3. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads (or lags) the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to  $R_L > 50\Omega$  with a pulse width of approximately 100 ns.
4. LIQUID CRYSTAL DISPLAY (LCD). This LCD is used in conjunction with the keypad to change the instrument settings. Normally, the main menu is displayed, which lists the key adjustable parameters and their current values. The "Programming Manual for -B Instruments" describes the menus and submenus in detail.



5. KEYPAD.

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

## REAR PANEL CONTROLS



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

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

6. GPIB Connector. A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B Instruments” for more details on GPIB control.
7. RS-232 Connector. A standard serial cable with a 25-pin male connector can be attached to this connector to allow the instrument to be computer-controlled. See the “Programming Manual for -B Instruments” for more details on RS-232 control.
8. OUT CONNECTOR. This connector provides the output to a 1.6 k $\Omega$  (or higher) load, with a load capacitance of 900 pF or less.



Caution: Voltages as high as +240V may be present on the center conductor of this output connector. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

9. M Connector. The voltage waveform on this connector is proportional to the output current ( $V_M = I_{OUT} \times 2V / 100 \text{ mA}$ ), for currents of up to 250 mA. The voltage waveform is pulsed, similar to the main output. It is not a DC output. This output is intended to drive high impedance (> 10 k $\Omega$ ) loads, such as an oscilloscope probe. It can drive 50 $\Omega$  loads, but the output voltage will be reduced by a factor of two, approximately. The output accuracy is  $\pm 10\%$ . The DC component of the waveform varies as a function of duty cycle and other parameters, and should be ignored. The pulse amplitude (peak-to-peak) should be measured instead.

## 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: OUT and SYNC. The OUT channel is the signal that is applied to the load. Its amplitude and pulse width are variable. The SYNC pulse is a fixed-width TTL-level reference pulse used to trigger oscilloscopes or other measurement systems. When the delay is set to a positive value the SYNC pulse precedes the OUT pulse. When the delay is set to a negative value the SYNC pulse follows the OUT pulse.

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



*Figure A*

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



*Figure B*

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



Figure C

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

The last figure illustrates the relationship between the signal when an external TTL-level trigger is used in the  $PW_{IN}=PW_{OUT}$  mode. In this case, the output pulse width equals the external trigger's pulse width (approximately), and the delay circuit is bypassed:



Figure D

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.)

### PULSE WIDTH MODES

This instrument has two pulse width modes:

- Normal: the instrument controls the output pulse width.
- $PW_{IN}=PW_{OUT}$ : the output pulse width equals the pulse width of the trigger signal on the “TRIG” connector. The instrument must be in the external trigger mode.

These modes can be selected using the front panel pulse width 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.

### OUTPUT IMPEDANCE

The AVR-G1-B-P-EMRA-R5-RP-IM has an output impedance (i.e., an internal resistance in series with the output) of 50 Ohms, to provide transmission line back-matching and short-circuit protection.

If the load is capacitive, the RC time constant of the output impedance and the capacitive load will tend to degrade the rise and fall times.

### CURRENT MONITOR

This instrument includes a current monitor, for measuring output currents of up to 250 mA. The monitor circuit samples the output current at the end of the pulse, and reports it on the front panel LCD. The value may also be queried remotely using the “meas:ampl?” command.

The current monitor circuit also provides a rear-panel “M” BNC connector. The voltage waveform on this connector is proportional to the output current ( $V_M = I_{OUT} \times 2V / 100 \text{ mA}$ ), for currents of up to 250 mA. The voltage waveform is pulsed, similar to the main output. It is not a DC output. This output is intended to drive high impedance (> 10 k $\Omega$ ) loads, such as an oscilloscope probe. It can drive 50 $\Omega$  loads, but the output voltage will be reduced by a factor of two, approximately. The DC component of the waveform varies as a function of duty cycle and other parameters, and should be ignored. The pulse amplitude (peak-to-peak) should be measured instead.

### PREVENTING OUTPUT STAGE FAILURE

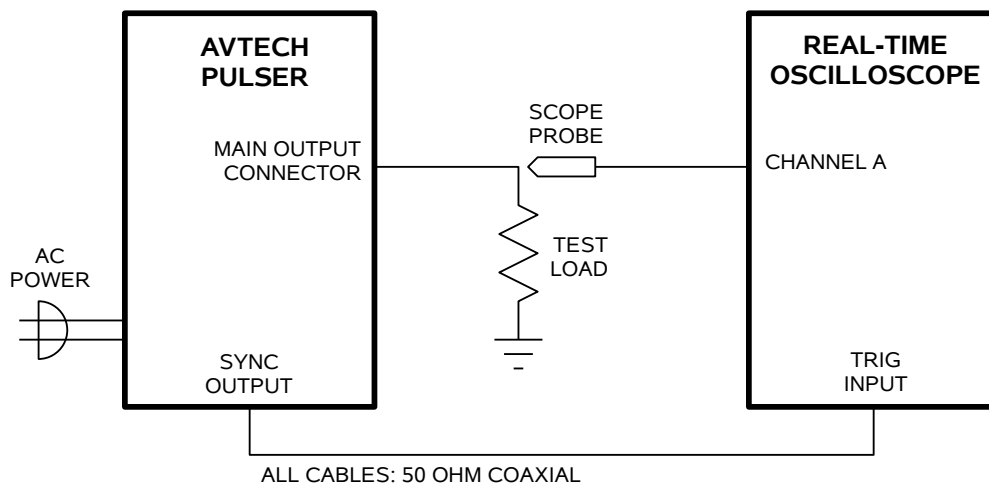
The output stage is protected against overload conditions by an overload circuit and fuses on the main frame back panel. However, the output switching elements may fail if the unit is triggered at a PRF exceeding 10 kHz or at duty cycles resulting in an average output power in excess of 11 Watts. Heating and subsequent possible failure of the output stage is reduced if the following action is taken where possible:

- PRF is kept to a minimum, i.e. operate in a low PRF range when possible rather than in a high PRF range.
- Keep the output pulse width to a minimum.
- Never apply an externally generated voltage to the output port.

## 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 read 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 a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Connect a 11W (or higher) 1.6 kΩ load to the OUT connector and place the scope probe across this load. The load resistor must have a voltage rating of at least 240V. The power dissipated in the resistor is given by

$$P = (V^2 / R) \times (PW / T) = (V^2 / R) \times PW \times f$$

where “V” is the output voltage, “R” is the load resistance, “PW” is the pulse width, and “T” is the pulse period (1/frequency), and “f” is the frequency.

2. Set the oscilloscope to trigger externally with the vertical setting at 50 Volts/div and the horizontal setting at 1 us/div. Be sure that your oscilloscope and probe setup can handle the maximum amplitude of 240V. The load resistor should be rated for at least 240V of voltage and 20W of power.
3. Turn on the AVR-G1-B-P-EMRA-R5-RP-IM. The main menu will appear on the LCD.



4. To set the AVR-G1-B-P-EMRA-R5-RP-IM to trigger from the internal clock at a PRF of 1 kHz:
  - The arrow pointer should be pointing at the frequency menu item. If it is not, press the MOVE button until it is.
  - Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 1 kHz.
  - The arrow pointer should be pointing at the “Internal” choice. If it is not, press MOVE until it is.
  - Press CHANGE to return to the main menu.
5. To set the delay to 1 us:
  - Press the MOVE button until the arrow pointer is pointing at the delay menu item.
  - Press the CHANGE button. The delay submenu will appear. Rotate the ADJUST knob until the delay is set at 1 us.
  - The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.
  - Press CHANGE to return to the main menu.
6. To set the pulse width to 5 us:
  - Press the MOVE button until the arrow pointer is pointing at the pulse width menu item.
  - Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 5 us.
  - The arrow pointer should be pointing at the “Normal” choice. If it is not, press MOVE until it is.
  - Press CHANGE to return to the main menu.
7. At this point, nothing should appear on the oscilloscope.
8. To enable the output:
  - Press the MOVE button until the arrow pointer is pointing at the output menu item.

- Press the CHANGE button. The output submenu will appear.
  - Press MOVE until the arrow pointer is pointing at the “ON” choice.
  - Press CHANGE to return to the main menu.
9. To change the output amplitude:
- Press the MOVE button until the arrow pointer is pointing at the amplitude menu item.
  - Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at +240V.
  - Observe the oscilloscope. You should see 5 us wide, 240V pulses.
  - Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary.
  - Press CHANGE to return to the main menu.
10. Repeat step 9, but set the amplitude to zero.
11. This completes the operational check.

## PROGRAMMING YOUR PULSE GENERATOR

### KEY PROGRAMMING COMMANDS

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

*rst	(resets the instrument)
trigger:source internal	(selects internal triggering)
frequency 1000 Hz	(sets the frequency to 1000 Hz)
pulse:width 5 us	(sets the pulse width to 5 us)
pulse:delay 2 us	(sets the delay to 2 us)
volt 240	(sets the amplitude to 240 V)
output on	(turns on the output)
measure:amplitude?	(this returns the peak current, in amperes, as measured by the monitor circuit)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width 5 us	(sets the pulse width to 5 us)
pulse:delay 2 us	(sets the delay to 2 us)
output on	(turns on the output)
volt 240	(sets the amplitude to 240 V)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
measure:amplitude?	(this returns the peak current, in amperes, as measured by the monitor circuit)
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:width 5 us	(sets the pulse width to 5 us)
pulse:delay 2 us	(sets the delay to 2 us)
volt 240	(sets the amplitude to 240 V)
output on	(turns on the output)
measure:amplitude?	(this returns the peak current, in amperes, as measured by the monitor circuit)

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		
MEASure:		
:AMPLitude?		[query only]
OUTPut:		
:[STATE]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
REMOTE		
[SOURce]:		
:FREQuency		
[:CW   FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>   EXTeRnal	
:DCYCLE	<numeric value>	
:HOLD	WIDTh   DCYCLE	
:DELay	<numeric value>	
:GATE		
:TYPE	ASYNc   SYNc	
:LEVel	HIGH   LOW	
[SOURce]:		
:VOLTage		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value>   EXTeRnal	
:PROTection		
:TRIPped?		[query only]
STATUS:		
:OPERation		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
:QUEStionable		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
SYSTem:		
:COMMunicate		
:GPIB		
:ADDReSS	<numeric value>	
:SERial		
:CONTRol		
:RTS	ON   IBFull   RFR	

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


## MECHANICAL INFORMATION

### TOP COVER REMOVAL

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

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

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

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

### RACK MOUNTING

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

### ELECTROMAGNETIC INTERFERENCE

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

## MAINTENANCE

### REGULAR MAINTENANCE

This instrument does not require any regular maintenance.

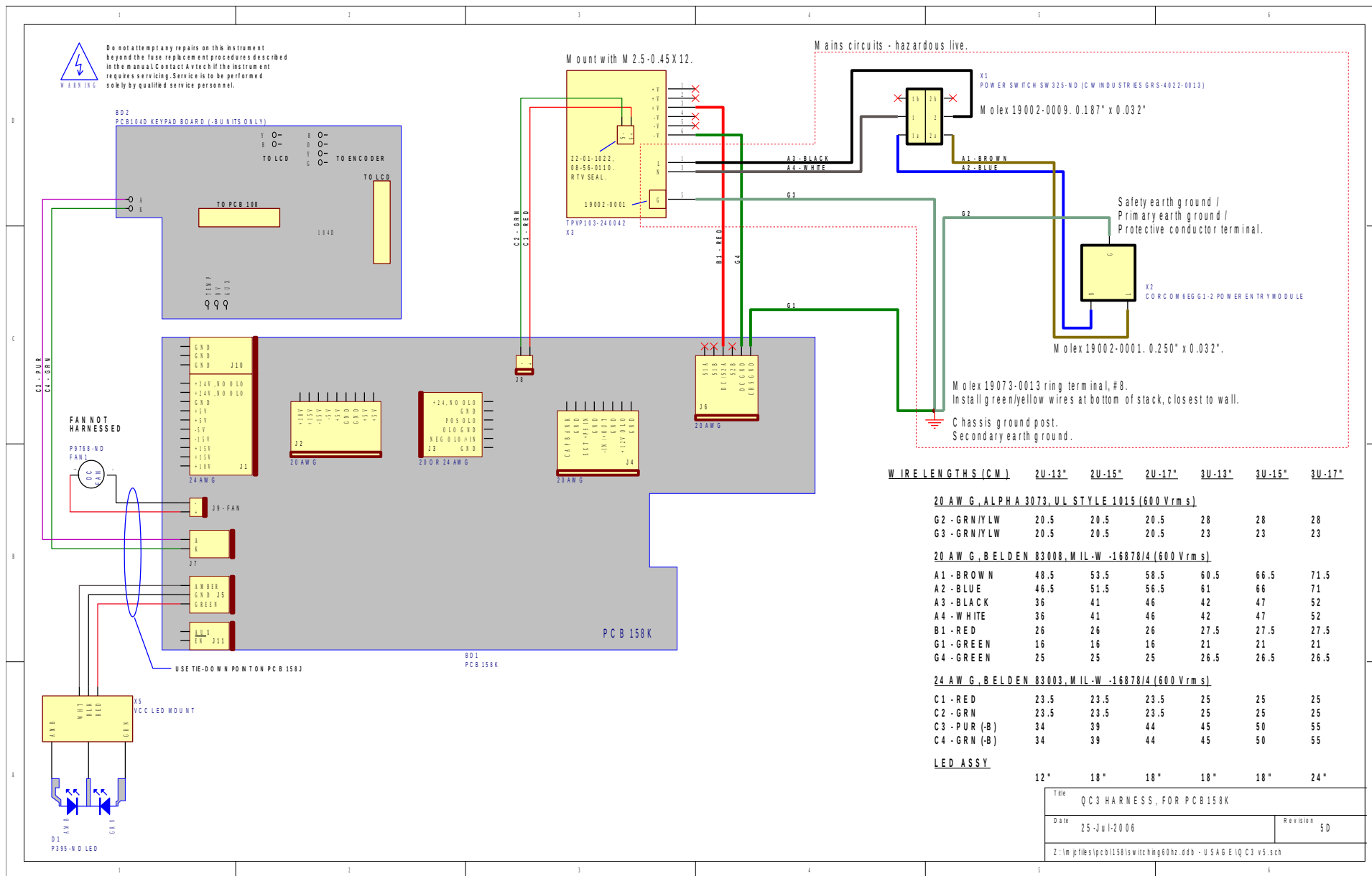
On occasion, one or more of the four rear-panel fuses may require replacement. All fuses can be accessed from the rear panel. See the “FUSES” section for details.

### CLEANING

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

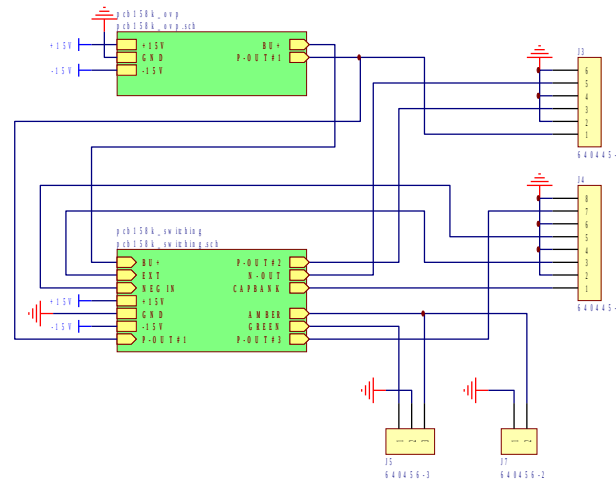
# WIRING DIAGRAMS

## WIRING OF AC POWER



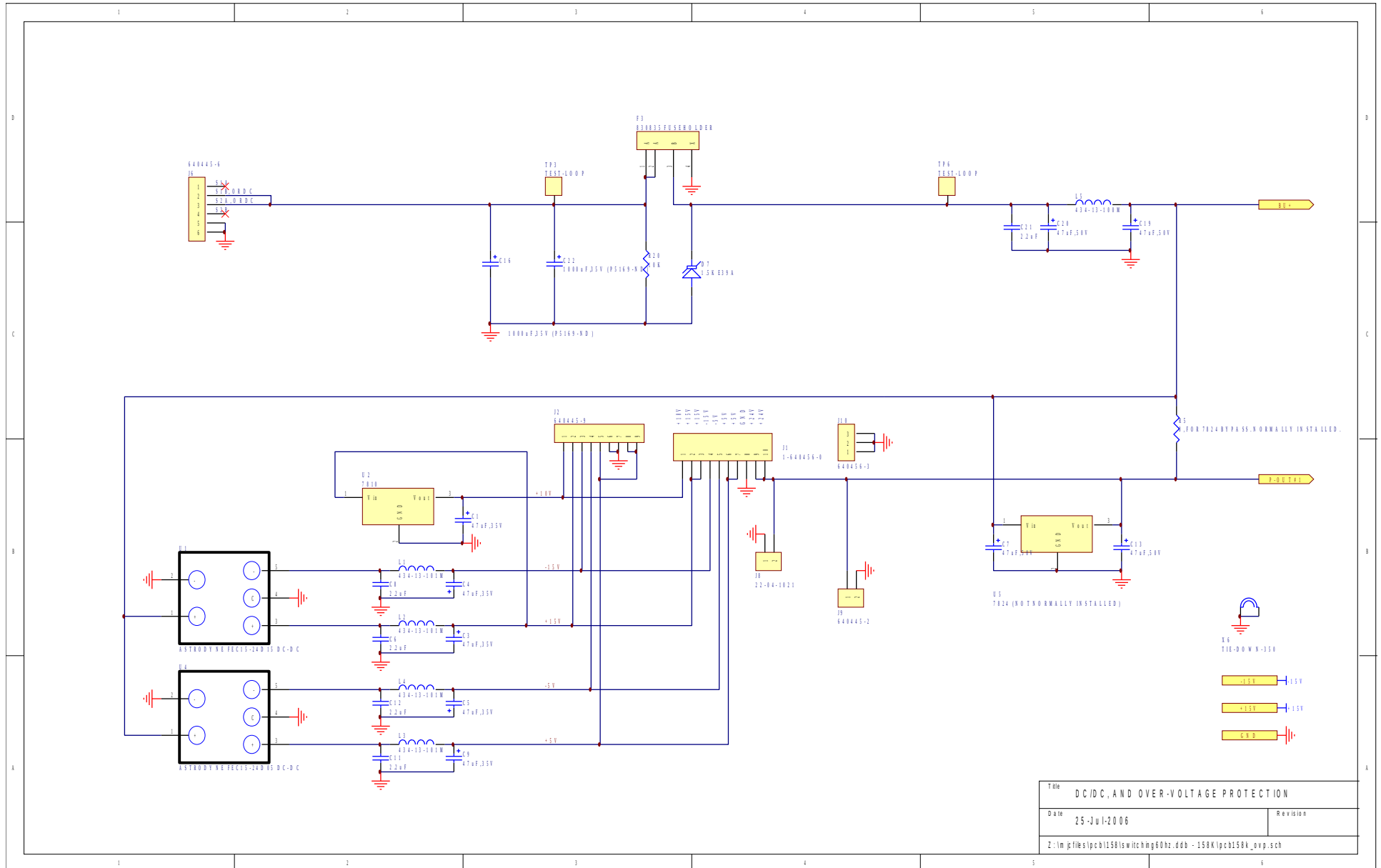


# PCB 158K - LOW VOLTAGE DC POWER SUPPLY, 1/3

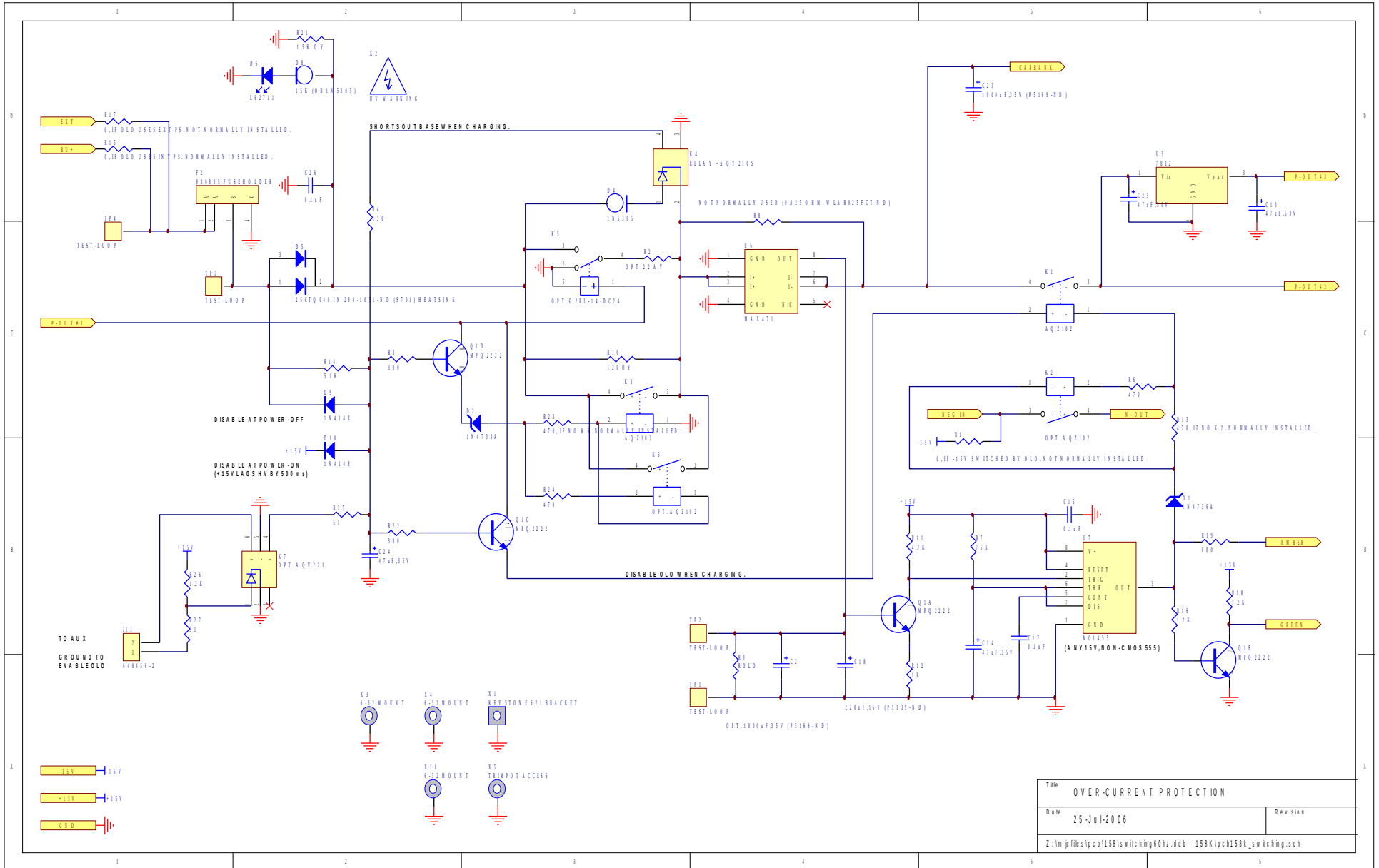


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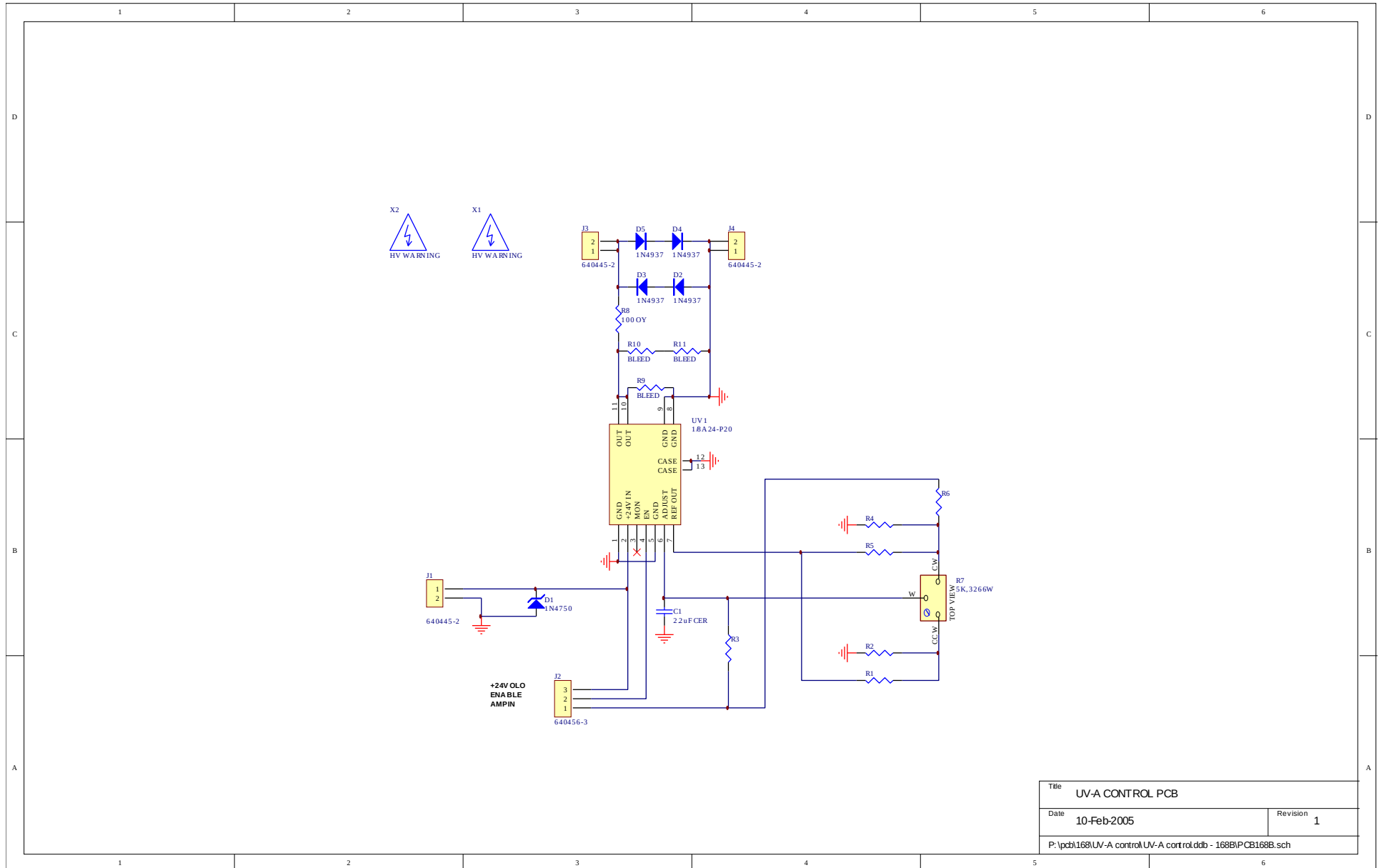
# PCB 158K - LOW VOLTAGE DC POWER SUPPLY, 2/3



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



# PCB 168B - HIGH VOLTAGE DC POWER SUPPLY



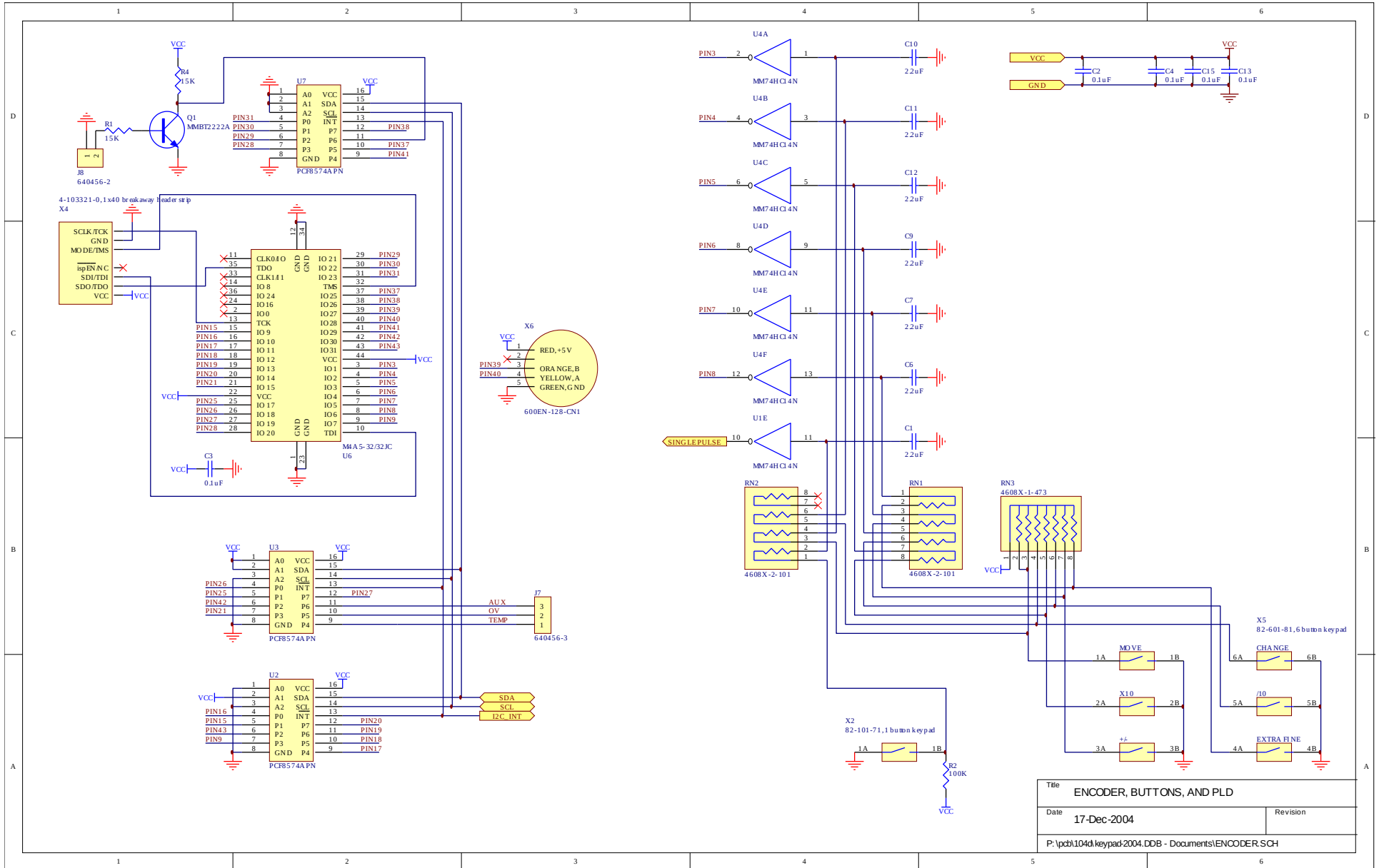
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Date 10-Feb-2005	Revision 1
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# PCB 104D - KEYPAD / DISPLAY BOARD, 1/3

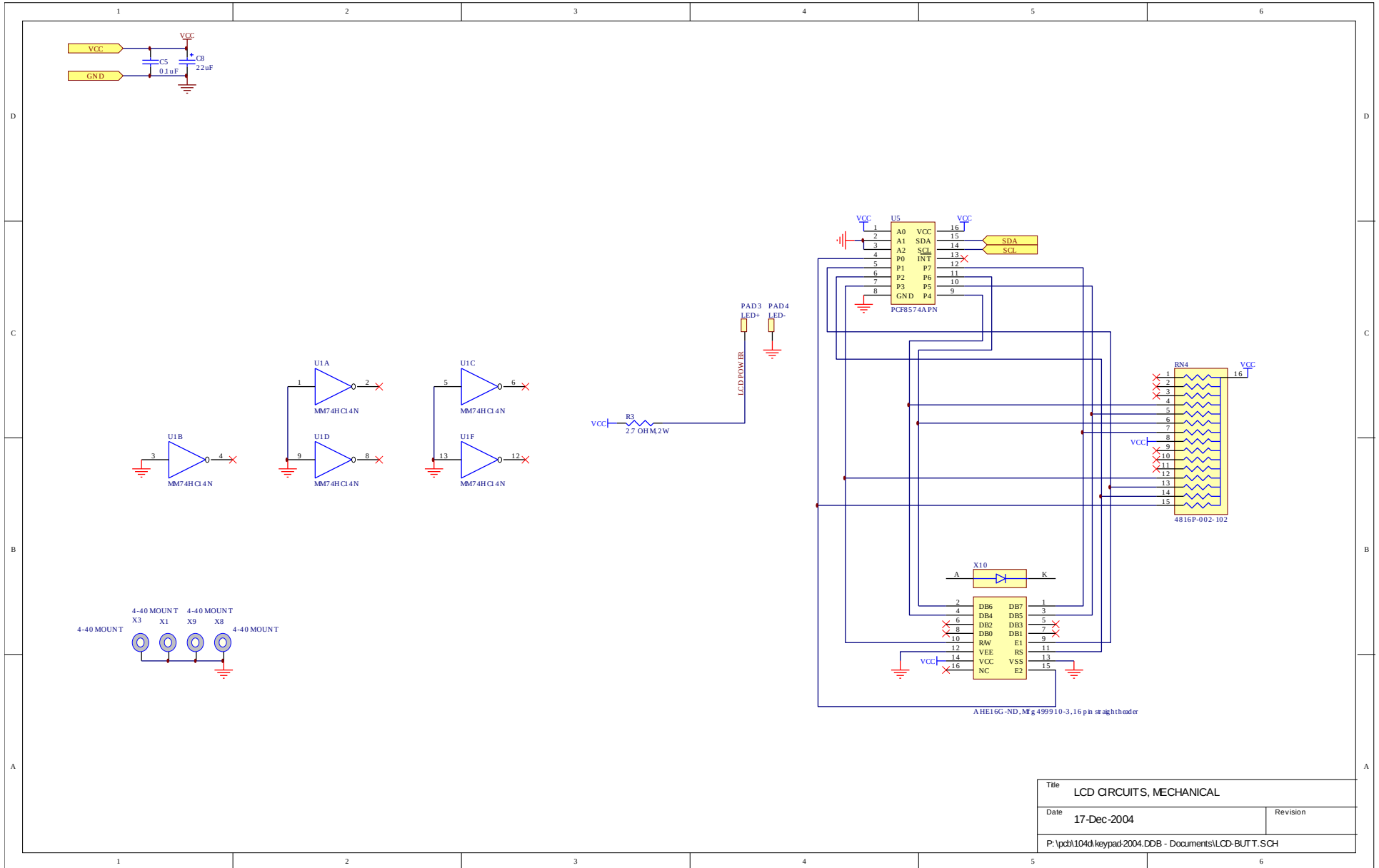


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Date	17-Dec-2004	Revision
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# PCB 104D - KEYPAD / DISPLAY BOARD, 2/3

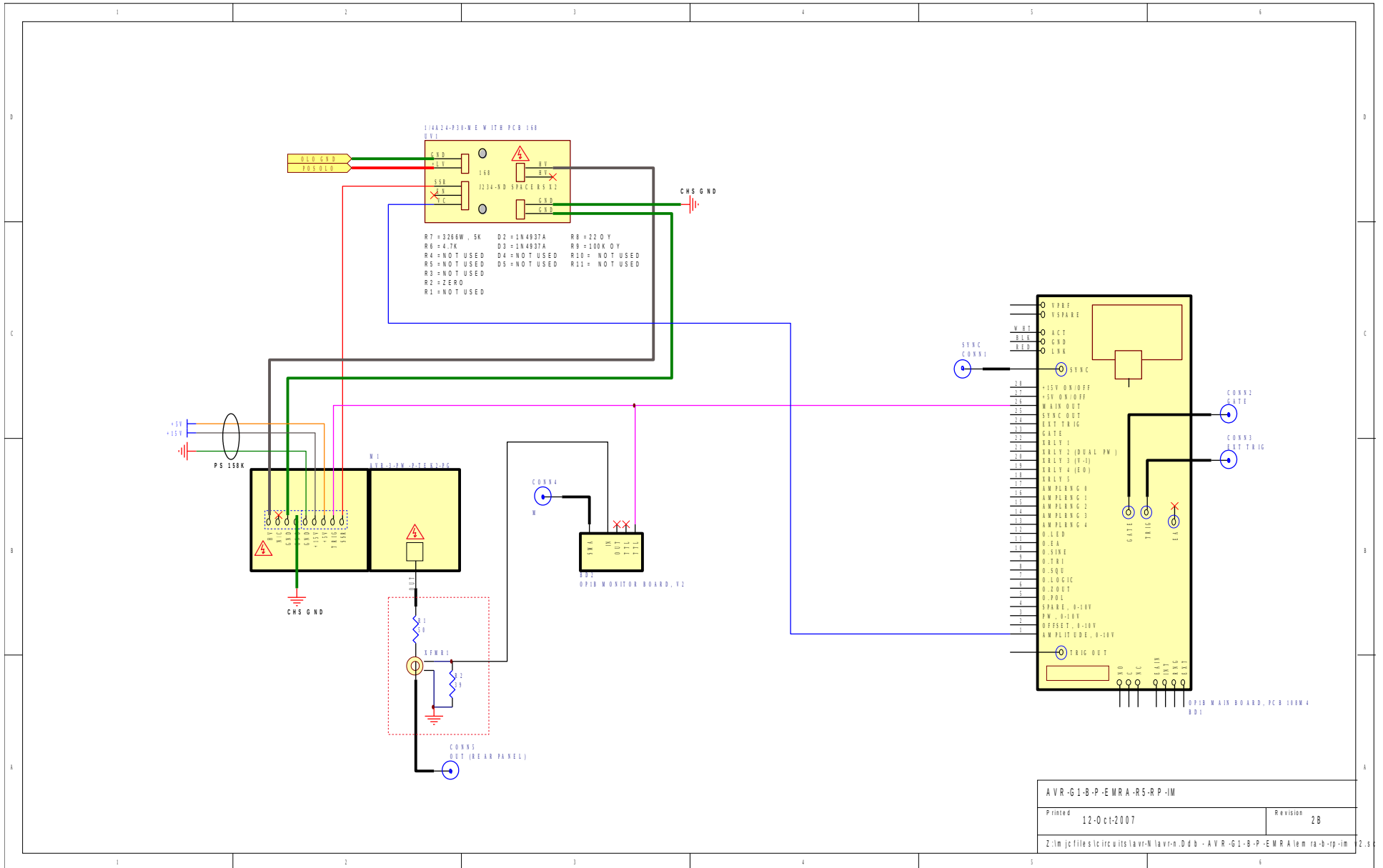


# PCB 104D - KEYPAD / DISPLAY BOARD, 3/3



Title		LCD CIRCUITS, MECHANICAL	
Date	17-Dec-2004	Revision	
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# MAIN WIRING



AVR-G1-B-P-EMRA-R5-RP-IM	
Printed	12-Oct-2007
Revision	28
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PERFORMANCE CHECK SHEET