AVTECH ELECTROSYSTEMS LTD.
NANOSECOND WAVEFORM ELECTRONICS
SINCE 1975

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INSTRUCTIONS

MODEL AVL-5-B

450 VOLT / 5 NS RISE TIME (STD)

400 VOLT / 2.5 NS RISE TIME (OPT)

8 ns TO 100 ns PULSE WIDTH

PULSE GENERATOR

WITH IEEE 488.2 / RS-232 / ETHERNET CONTROL

SERIAL NUMBER: 14550

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

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Manual Reference: /fileserver1/officefiles/instructword/avl/AVL-5-B,sn14550.odt.
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INTRODUCTION

The AVL-5-B is a high performance, GPIB and RS232-equipped instrument capable of generating up to 450V into 50Ω loads at repetition rates up to 2 kHz. The output pulse width is variable from 8 to 100 ns, and the sync delay is variable up to 1 second. The rise time is fixed at less than 5 ns.

Instruments with the "-P" model suffix can generate up to +450V, whereas instruments with the "-N" model suffix can generate up to -450V. Instruments with the "-PN" suffix can generate both polarities.

Models with the -TR option have faster rise times (< 2.5 ns, 20%-80%), with a slightly reduced maximum amplitude (400V).

The AVL-5-B is a highly flexible instrument. Aside from the internal trigger source, it can also be triggered or gated by external TTL-level signals. A front-panel pushbutton or a computer command can also be used to trigger the instrument.

The AVL-5-B features front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40 character back-lit 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.

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 450 Volts under normal operating conditions, and generates > 1000V 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 amplifier 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[1]:	AVL-5-B	AVL-5-B-TR
Maximum amplitude[2]: (50Ω load required[7])	450 V	400 V
Rise time (20%-80%):	≤ 5 ns	≤ 2.5 ns
Fall time (80%-20%):	≤ 5 ns	
Pulse width (FWHM):	8 - 100 ns	
PRF:	0 to 2 kHz	
Polarity[3]:	Positive or negative or both (specify)	
Jitter:	± 100 ps ± 0.03% of sync delay (Ext trig in to pulse out)	
GPIB & RS-232 control[1]:	Standard on -B units.	
LabView drivers:	Check http://www.avtechpulse.com/labview for availability and downloads	
Ethernet port, for remote control using VXI-11.3, ssh, telnet, & web:	Included. Recommended as a modern alternative to GPIB / RS-232. See http://www.avtechpulse.com/options/vxi for details.	
Settings resolution:	The resolution of the timing parameters (pulse width, delay, period) varies, but is always better than 0.15% of (|set value| + 20 ns). The amplitude resolution is < 0.1% of the maximum amplitude.	
Settings accuracy:	Typically ± 4% (± 2 ns or ± 4% of max. amplitude) after 10 minute warmup. For high-accuracy applications requiring traceable calibration, verify the output parameters with a calibrated oscilloscope.	
DC offset or bias insertion[4]:	Option available. Apply required DC offset or bias in the range of ± 50 Volts (250 mA max) to back panel solder terminal.	
Trigger modes:	Internal trigger, external trigger (TTL level pulse, > 10 ns, 1 kΩ input impedance), front-panel “Single Pulse” pushbutton, or single pulse trigger via computer command.	
Variable delay[5]:	Sync to main out: 0 to 1.0 seconds, for all trigger modes (including external trigger).	
Sync output:	> +3 Volts, > 50 ns, will drive 50 Ohm loads	
Propagation delay:	≤ 350 ns (Ext trig in to pulse out)	
Gate input:	Synchronous. Active high or low, switchable. Suppresses triggering when active.	
Monitor output option[6]:	Provides a 20 dB attenuated coincident replica of the main output	
Connectors:	BNC	
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 & handles, blue vinyl on aluminum cover plates	
Mounting:	Any	
Temperature range:	+5°C to +40°C	

1) -B suffix indicates IEEE-488.2 GPIB and RS-232 control of amplitude, pulse width, PRF and delay (see http://www.avtechpulse.com/gpib).
2) For operation at amplitudes of less than 20% of full-scale, best results will be obtained by setting the amplitude near full-scale and using external attenuators on the output.
3) Indicate desired polarity by suffixing model number with -P or -N (i.e. positive or negative) or -PN for dual polarity option. Polarity reversal is achieved via keypad or computer control.
4) For DC offset option suffix model number with -OS.
5) Delay must be less than the period (1 / PRF).
6) For monitor option add suffix -M. The monitor, when used, will load down the main output slightly, causing a 10% drop in the maximum main output amplitude.
7) A 50 Ohm load is required. Other loads may damage the instrument. Consult Avtech (info@avtechpulse.com) if you need to drive other load impedances.

REGULATORY NOTES

FCC PART 18

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

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

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

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

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

EC DECLARATION OF CONFORMITY

We Avtech Electrosystems Ltd.
P.O. Box 5120, LCD Merivale
Ottawa, Ontario
Canada K2C 3H5

declare that this pulse generator meets the intent of Directive 2014/30/EU 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 2014/35/EU. Compliance pertains to the following specifications as listed in the official Journal of the European Communities:

EN 61010-1:2010+A1:2019, Safety requirements for electrical equipment for measurement, control, and laboratory use

DIRECTIVE 2011/65/EU (RoHS)

We Avtech Electrosystems Ltd.
P.O. Box 5120, LCD Merivale
Ottawa, Ontario
Canada K2C 3H5

declare that, to the best of our knowledge, all electrical and electronic equipment (EEE) sold by the company are in compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (also known as “RoHS Recast”). In addition, this declaration of conformity is issued under the sole responsibility of Avtech Electrosystems Ltd. Specifically, products manufactured do not contain the substances listed in the table below in concentrations greater than the listed maximum value.

Material/Substance	*Threshold level*
Lead (Pb)	< 1000 ppm (0.1% by mass)
Mercury (Hg)	< 1000 ppm (0.1% by mass)
Hexavalent Chromium (Cr6+)	< 1000 ppm (0.1% by mass)
Polybrominated Biphenyls (PBB)	< 1000 ppm (0.1% by mass)
Polybrominated Diphenyl ethers (PBDE)	< 1000 ppm (0.1% by mass)
Cadmium (Cd)	< 100 ppm (0.01% by mass)
Bis(2-ethylhexyl) phthalate (DEHP)	< 1000 ppm (0.1% by mass)
Butyl benzyl phthalate (BBP)	< 1000 ppm (0.1% by mass)
Dibutyl phthalate (DBP)	< 1000 ppm (0.1% by mass)
Diisobutyl phthalate (DIBP)	< 1000 ppm (0.1% by mass)

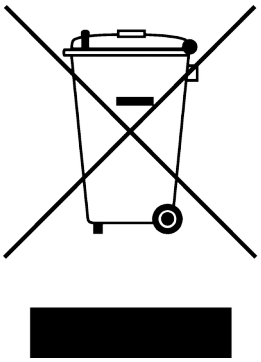
DIRECTIVE 2002/96/EC (WEEE)

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.



FIRMWARE LICENSING

This instrument uses open-source software internally, and is built on a Fedora Linux operating system.

Some of this software requires that the source code be made available to the user as a condition of its licensing. The source code for programs used by Fedora is freely available at https://src.fedoraproject.org/.

The source code for modifications implemented by Avtech, and for Avtech-specific programs, is available at https://www.avtechpulse.com/cgit/Instrument.git/.

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 57 Watts. Please see the “FUSES” section for information about the appropriate AC and DC fuses.

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

CONNECTION TO THE POWER SUPPLY

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

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

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

Destination Region	Description	Option	Manufacturer	Part Number
United Kingdom, Hong Kong, Singapore, Malaysia	BS 1363, 230V, 50 Hz	-AC00	Qualtek	370001-E01
Australia, New Zealand	AS 3112:2000, 230-240V, 50 Hz	-AC01	Qualtek	374003-A01
Continental Europe, Korea, Indonesia, Russia	European CEE 7/7 “Schuko” 230V, 50 Hz	-AC02	Qualtek	364002-D01
North America, Taiwan	NEMA 5-15, 120V, 60 Hz	-AC03	Qualtek	312007-01
Switzerland	SEV 1011, 230V, 50 Hz	-AC06	Qualtek	378001-E01
South Africa, India	SABS 164-1, 220-250V, 50 Hz	-AC17	Volex	2131H 10 C3
Japan	JIS 8303, 100V, 50-60 Hz	-AC18	Qualtek	397002-01
Israel	SI 32, 220V, 50 Hz	-AC19	Qualtek	398001-01
China	GB 1002-1 / 2099-1, 220V, 50 Hz	-AC22	Qualtek	399012-01

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:

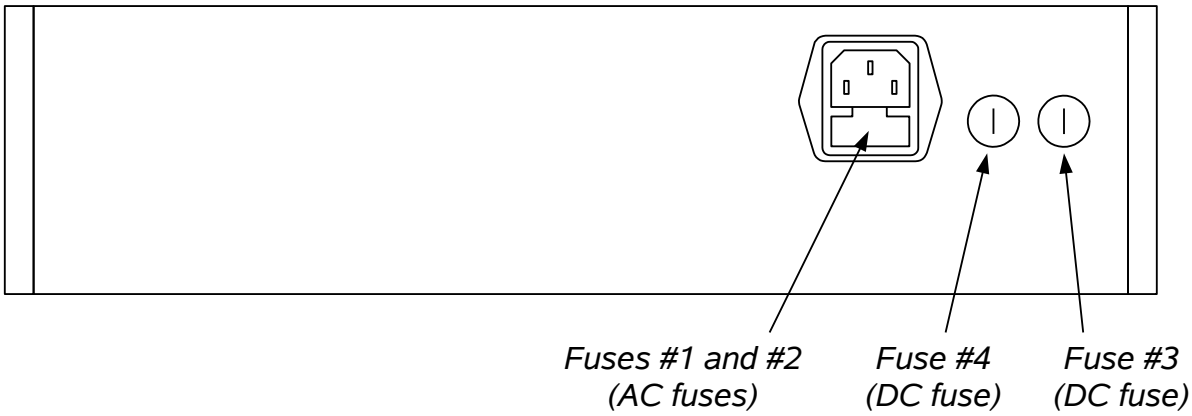
1. indoor use;
2. altitude up to 2 000 m;
3. temperature 5 °C to 40 °C;
4. maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
5. Mains supply voltage fluctuations up to ±10 % of the nominal voltage;
6. no pollution or only dry, non-conductive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

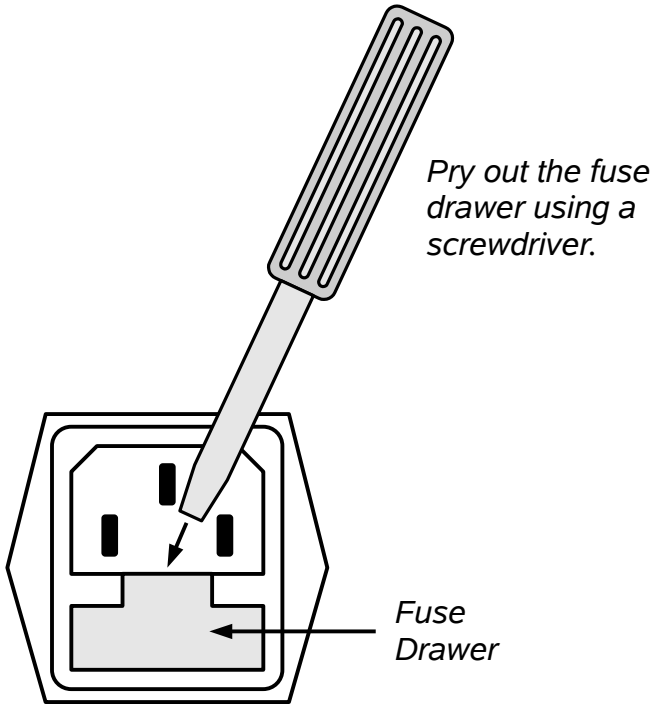
FUSES

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

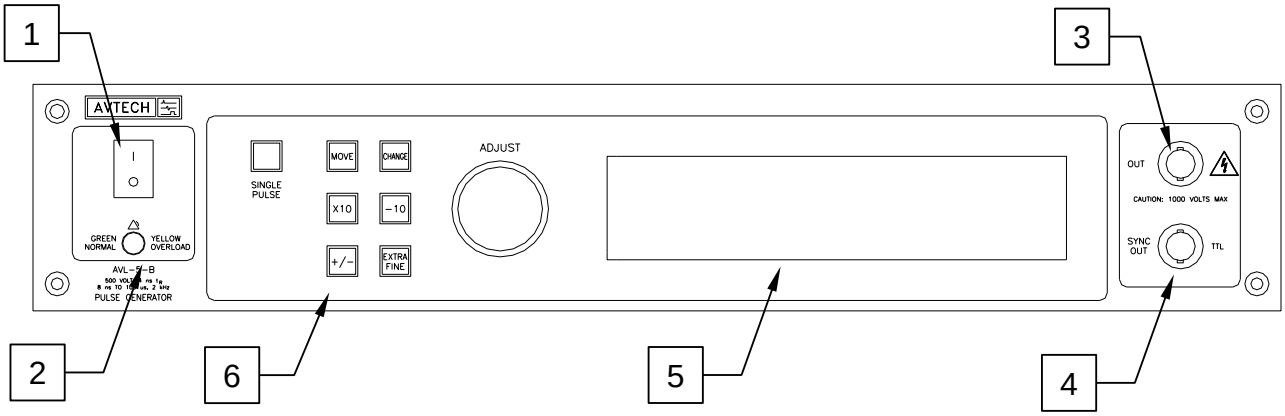
The following table lists the required fuses:

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	1.0A, 250V, Time-Delay	5×20 mm	0218001.HXP	F2419-ND
#4 (DC)	N/A	1.0A, 250V, Time-Delay	5×20 mm	0218001.HXP	F2419-ND

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

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

FRONT PANEL CONTROLS



1. POWER Switch. This is the main power switch. When turning the instrument on, there is normally a delay of 10 seconds before anything is shown on the main display, as the internal operating system boots up.

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. OUT CONNECTOR. This BNC connector provides the main output signal, into load impedances of 50Ω.

   ⚠ Caution: Voltages as high as 450V may be present on the center conductor of this output connector during normal operation, and the voltage may rise to > 1 kV if the output is open-circuited. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

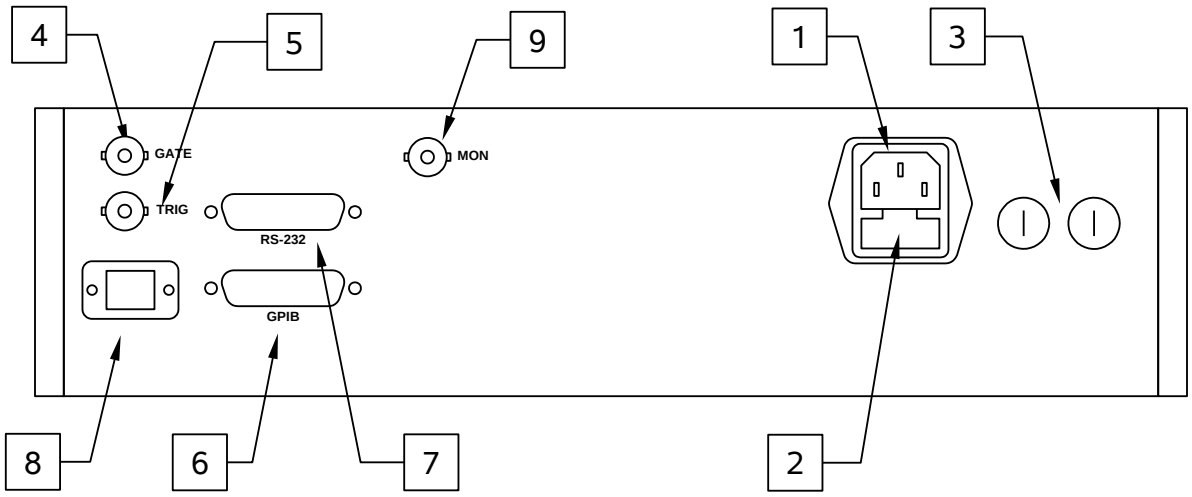
4. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads (or lags) the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to R_L > 1 kΩ with a pulse width of approximately 100 ns.

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.

6. 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.

REAR PANEL CONTROLS



Note: some connectors may be in different positions than shown above, depending on the exact combination of options ordered.

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. A user name (“admin”) and a password (“default”, as shipped from the factory) are required when logging into a serial terminal session. The internal controller attempts to auto-sense the parity setting. It may be necessary to send a few return characters before attempting a login in order to provide enough data to allow this auto-sensing to work. (A standard Linux “agetty” process is used to implement serial control internally.) See the “Programming Manual for -B Instruments” for more details on RS-232 control.

8. Network Connector. This Ethernet connector allows the instrument to be remotely controlled using the VXI-11.3, ssh (secure shell), telnet, and http (web) protocols. See the “Programming Manual for -B Instruments” for more details.

9. MON Connector. (Optional feature. Present on "-M" units only.) The monitor output provides an attenuated replica (÷10) of the voltage on the main output. The monitor output is designed to operate into a 50 Ohm load, if used.

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, positive delay, and a positive output amplitude:

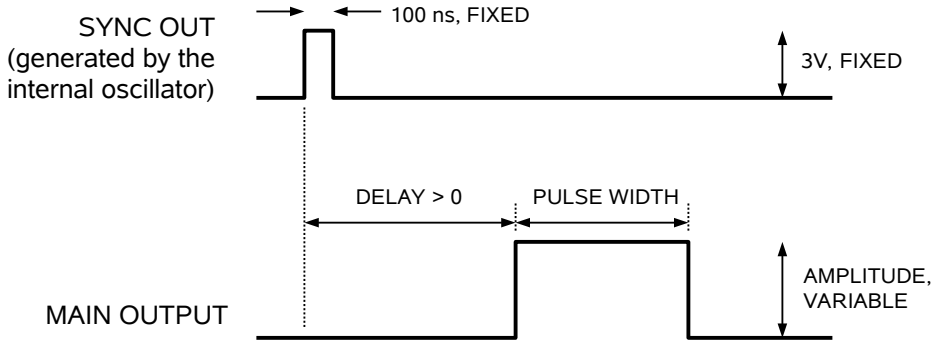


Figure A

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

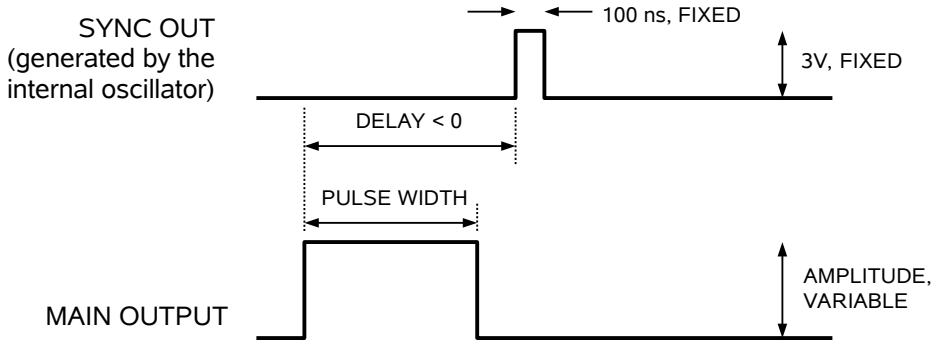


Figure B

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

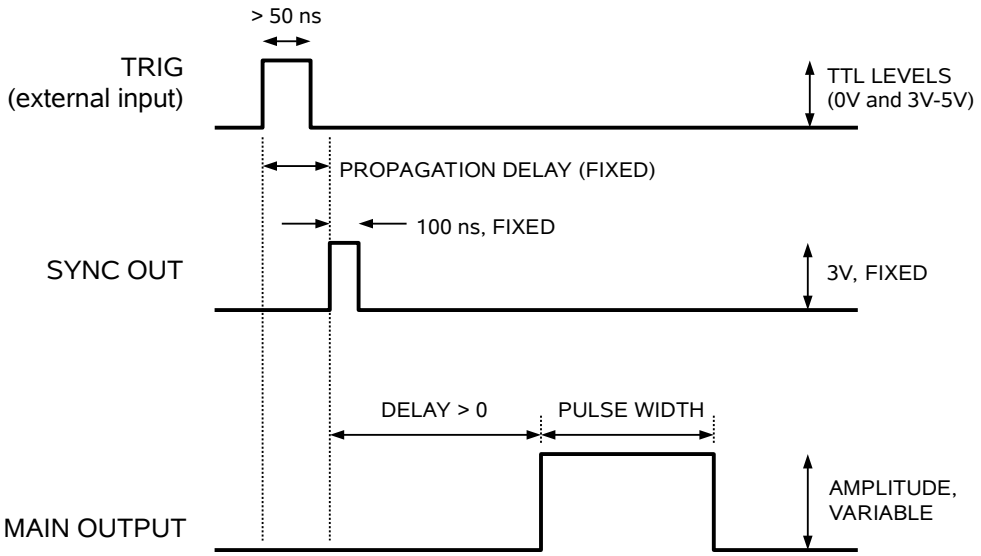


Figure C

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

The 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. When gated, the output will complete the full pulse width if the output is high, and then stop triggering. Pulses are not truncated.

OUTPUT IMPEDANCE

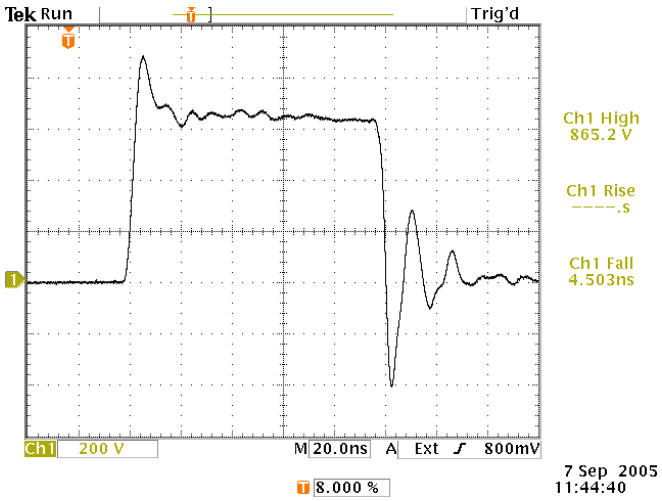
The output impedance (i.e., the apparent resistance in series with the output internally) during the pulse is approximately 50 Ohms. Between pulses, the output impedance is much lower (i.e., closer to zero) as the output is pulled to ground.

The 50 Ohm output impedance provides transmission line "back-matching". That is, reflections from an improperly termination transmission line will tend to be absorbed by the pulser. This back-matching is only active during the pulse. Between pulses, the output impedance falls and back-matching no longer occurs.

This instrument is specified for use with (and has been characterized and tested with) 50 Ohm loads, but the 50 Ohm output impedance makes it reasonably tolerant of other load conditions. In principle, the output can be used to drive any resistive load between 0 and ∞ Ohms. However, failure when driving non-50-Ohm loads is *not* covered under the warranty - so proceed at your own risk.

⚠ When operating into an open circuit (∞ Ω), the peak output voltage may be as high as 1 kV. Make sure that any connected accessories, cables, loads, probes, and test equipment have suitable voltage ratings.

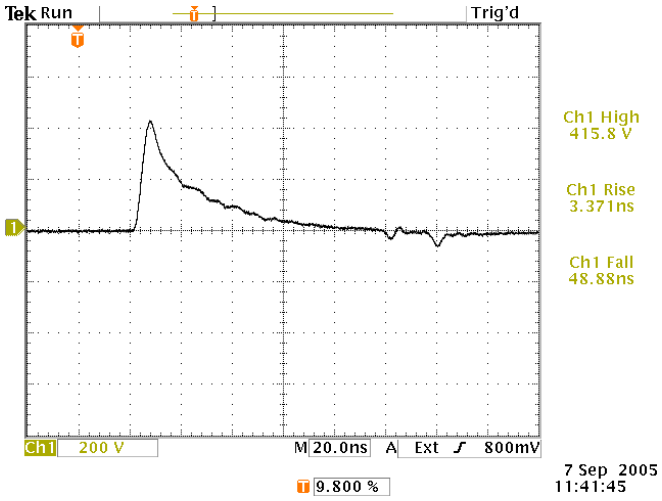
A typical waveform into a 220 Ohm load is shown below. The ringing is caused by the impedance mismatches. The 220 Ohm resistor is installed on a BNC-to-binding-post adapter (Pomona 1296) installed directly on the output connector.



200 V/div, 20 ns/div.
Settings: 10 Hz, 100 ns PW, +450V amplitude. 220 Ohm load.

SHORT CIRCUIT PROTECTION

The AVL-5-B will withstand short circuits to ground on the output. The photo below shows the output voltage on a 50 Ohm load which has been short circuited with a 12 inch length of mini-grabber patch cord (Pomona 3781-12-2). The non-zero inductance of the cord prevents allows an output voltage to develop, briefly.



200 V/div, 20 ns/div.
Settings: 10 Hz, 100 ns PW, +450V amplitude. Short-circuited load.

MINIMIZING WAVEFORM DISTORTIONS

USE 50 OHM TRANSMISSION LINES

Connect the load to the pulse generator with 50Ω coaxial transmission lines. See the "What Coaxial Cable Should I Use?" application note at http://www.avtechpulse.com/appnote/techbrief6/ for a listing of different possible types of coaxial cable.

USE LOW-INDUCTANCE LOADS

Lenz's Law predicts that for an inductive voltage spike will be generated when the current through an inductance changes. Specifically, $V_{SPIKE} = L \times dI_{LOAD}/dt$, where L is the inductance, I_{LOAD} is the load current change, and t is time. For this reason, it is important to keep any parasitic in the load low. This means keeping wiring short, and using low inductance components. In particular, wire-wound resistors should be avoided.

The Ohmite OY series (www.ohmite.com) of ceramic composition resistors are highly recommended for low-inductance pulsed applications. Note that you may need to use several resistors connected in series and/or parallel to achieve appropriate power and voltage capability.

PROTECTING YOUR INSTRUMENT

TURN OFF INSTRUMENT WHEN NOT IN USE

The lifetime of the switching elements in the pulse generator module is proportional to the running time of the instrument. For this reason the prime power to the instrument should be turned off when the instrument is not in use. In the case of failure, the switching elements are easily replaced following the procedure described in a following section.

DO NOT EXCEED 2 kHz

The output stage may be damaged if triggered by an external signal at a pulse repetition frequency greater than 2 kHz.

REDUCE AMPLITUDE AND FREQUENCY WHEN POSSIBLE

The heat dissipated in the output switching circuits is directly proportional to the pulse repetition frequency (PRF), and to the square of the output amplitude (V^2). The instrument lifetime will be prolonged by reducing frequency and amplitude when practical.

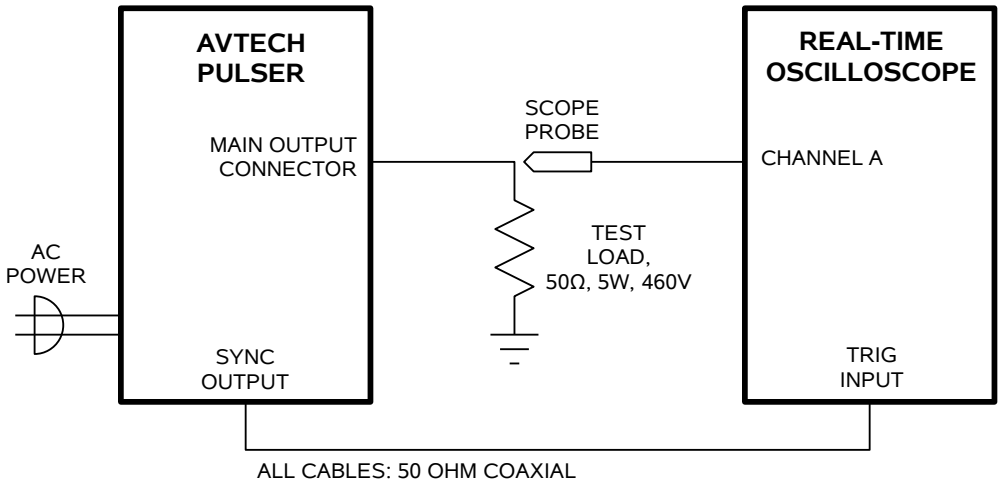
USE A 50 OHM LOAD

This instrument is designed for use with a 50 Ohm load. It may be possible to use the instrument with other loads, but damage caused under such conditions is not covered by the warranty. See the "Output Impedance" section of this manual for more information.

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 a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Connect a 5W (or higher) 50Ω load with a voltage rating > 460V to the OUT connector and place the scope probe across this load. Set the oscilloscope to trigger externally with the vertical setting at 100 Volts/div and the horizontal setting at 50 ns/div.

   ⚠ Confirm that the scope probe and the test load are rated for 450V pulses.

   ⚠ Note that many high-voltage probes have limited bandwidth ratings, and may distort the signal slightly. In particular, the rise and fall time measurements may be higher than expected, and some ringing may be seen on the waveform.

2. Turn on the AVL-5-B. The main menu will appear on the LCD.

3. To set the AVL-5-B to trigger from the internal clock at a PRF of 100 Hz:

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

b) Press the CHANGE button. The frequency submenu will appear. Rotate the ADJUST knob until the frequency is set at 100 Hz.

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

d) Press CHANGE to return to the main menu.

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 pulse width to 50 ns:

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

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

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

7. To enable the output:

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

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

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

d) Press CHANGE to return to the main menu.

8. To change the output amplitude:

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

    b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at 200V.

    c) Observe the oscilloscope. You should see 50 ns wide, 200V pulses.

    d) Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary. Set it at 450V.

    e) Press CHANGE to return to the main menu.

9. Try varying the pulse width, by repeating step (5). As you rotate the ADJUST knob, the pulse width on the oscilloscope will change. It should agree with the displayed value.

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 50 ns	(sets the pulse width to 50 ns)
pulse:delay 1 us	(sets the delay to 1 us)
volt 250	(sets the amplitude to +250 V)
output on	(turns on the output)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width 50 ns	(sets the pulse width to 50 ns)
output on	(turns on the output)
volt:ampl +250	(sets the amplitude to +250 V)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

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

*rst	(resets the instrument)
trigger:source external	(selects internal triggering)
pulse:width 50 ns	(sets the pulse width to 50 ns)
pulse:delay 1 us	(sets the delay to 1 us)
volt:ampl 190V	(sets the amplitude to +190 V)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

ALL PROGRAMMING COMMANDS

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

Keyword	Parameter	Notes
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
[SOURce]:		
:FREQuency		
[:CW | FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
: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 | 19200 | 38400 | 57600 | 115200	
: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.

TRIGGER DAMAGE

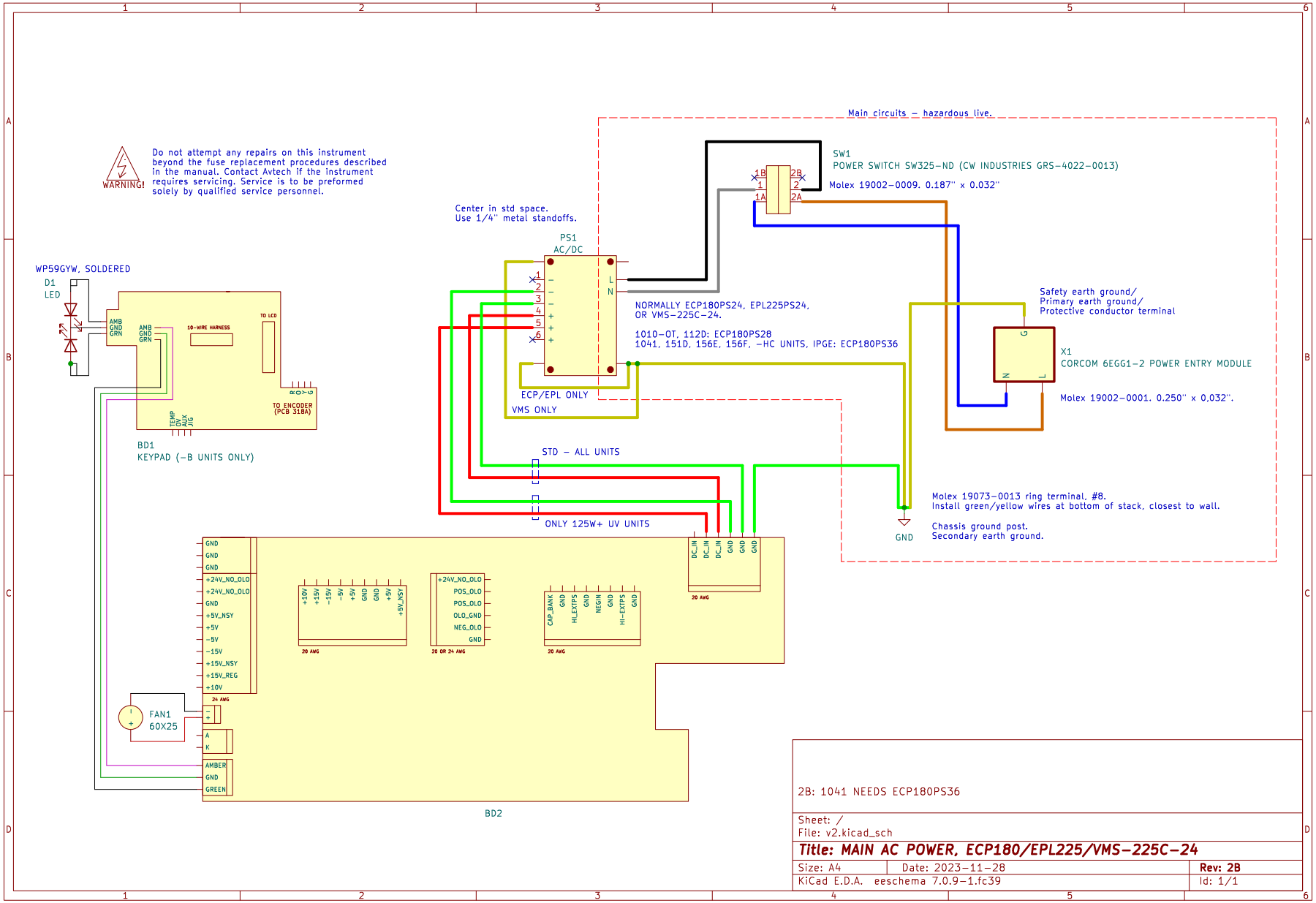
The rear-panel TRIG input, used in the external trigger mode, is protected by a diode clamping circuit. However, the protection circuit is not foolproof, and it is possible for a grossly excessive signal to damage the trigger circuitry on the main timing control board (the 4×10 inch board on the right side of the instrument).

The IC that is most likely to fail under these conditions is installed in a socket. It is a standard TTL IC in a 16-pin plastic DIP package, model 74F151 or equivalent.

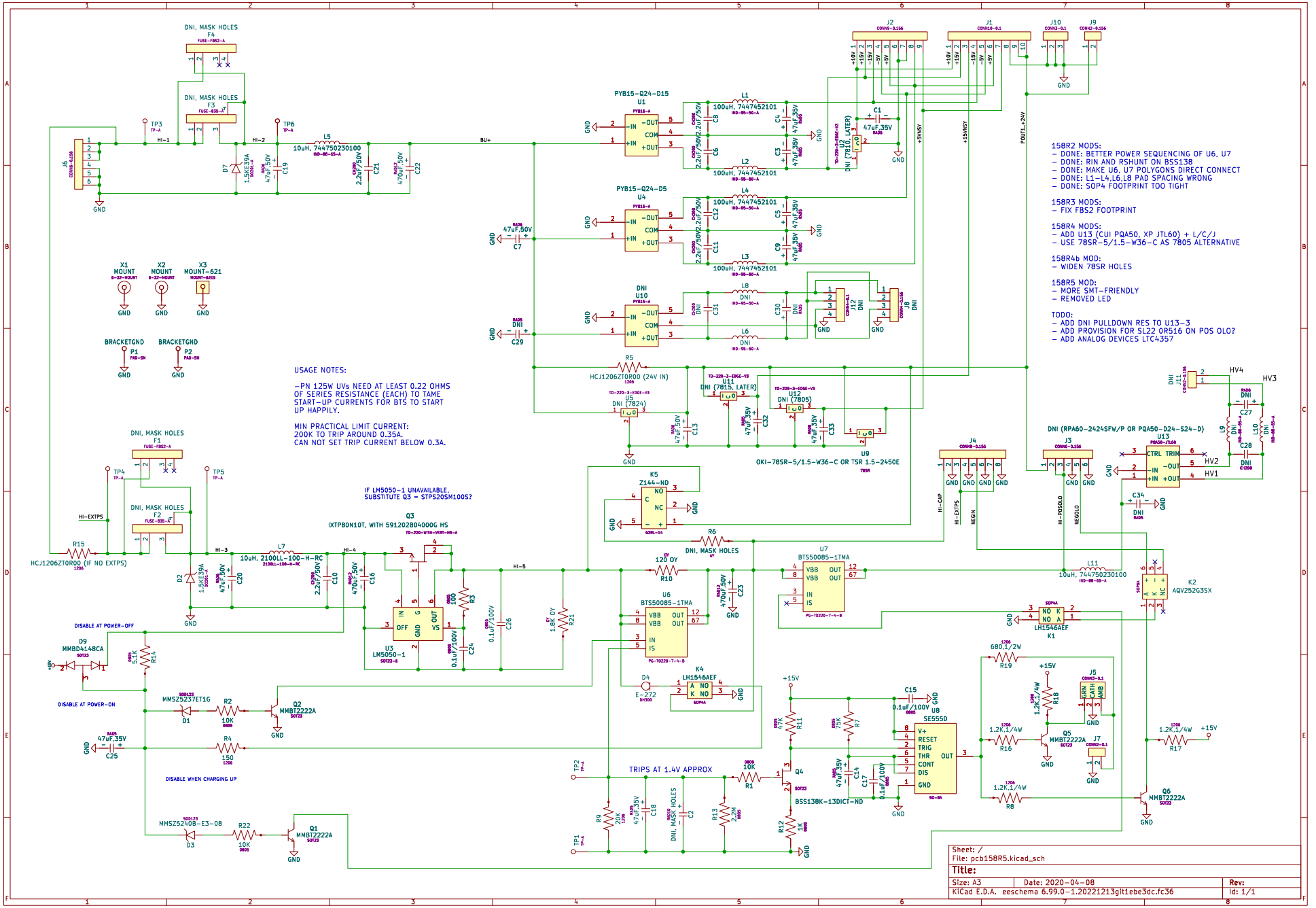
If you suspect that this IC has been damaged, turn off the power and replace this IC. It may be replaced by a 74F151, 74LS151, 74ALS151, or 74HCT151.

WIRING DIAGRAMS

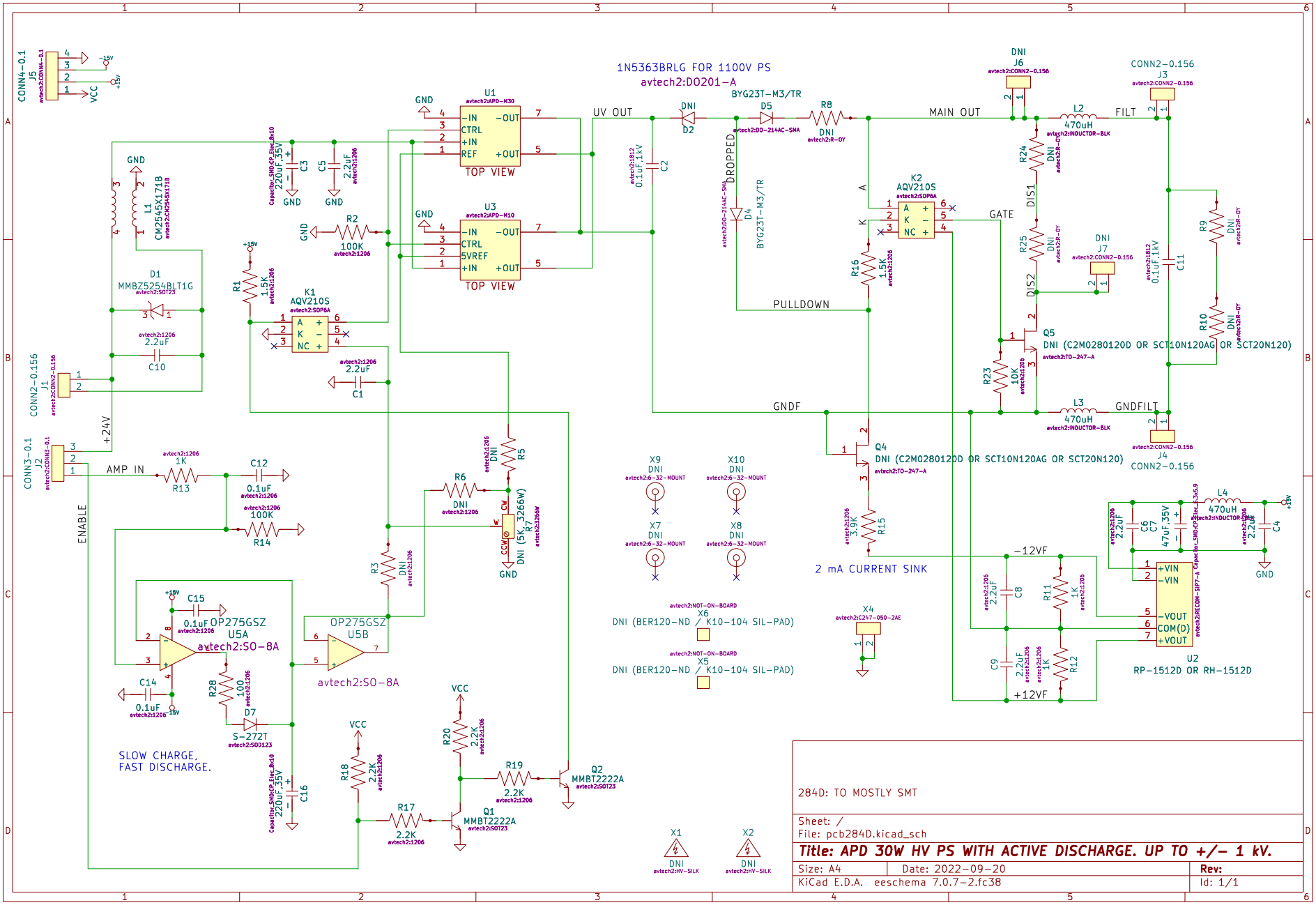
WIRING OF AC POWER



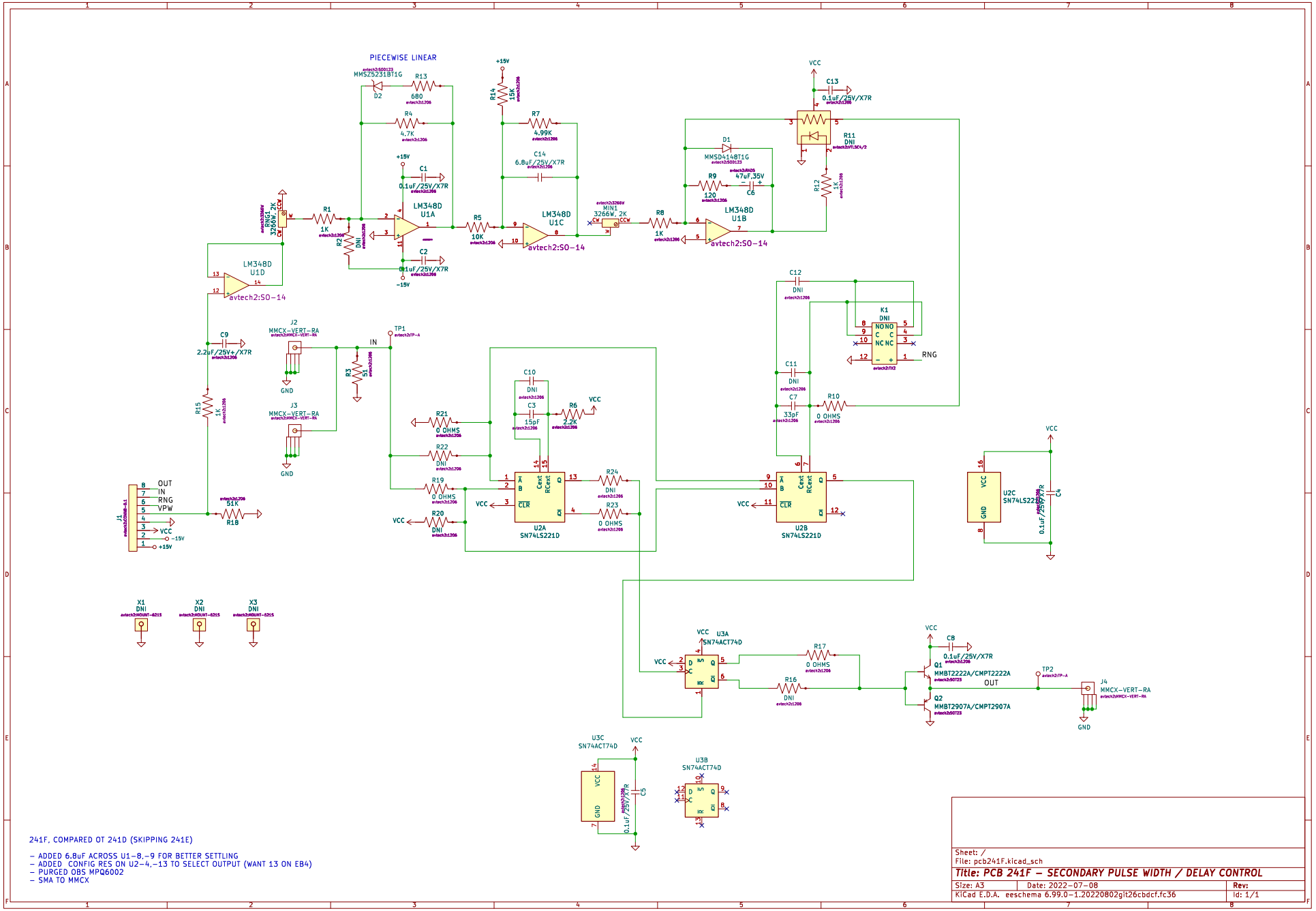
PCB 158R5 - LOW VOLTAGE POWER SUPPLY



PCB 284D - HIGH-VOLTAGE POWER SUPPLY

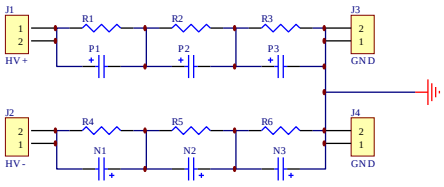


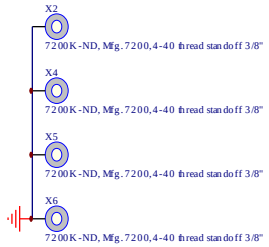
PCB 241F - SYNC DELAY



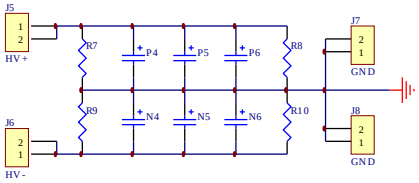
PCB 183A-S AND 183A-P CAPACITOR BANKS

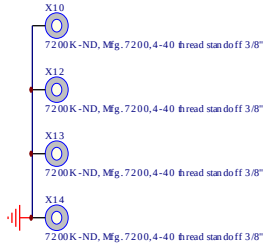
183A-S (SERIES CAPACITOR BANK)





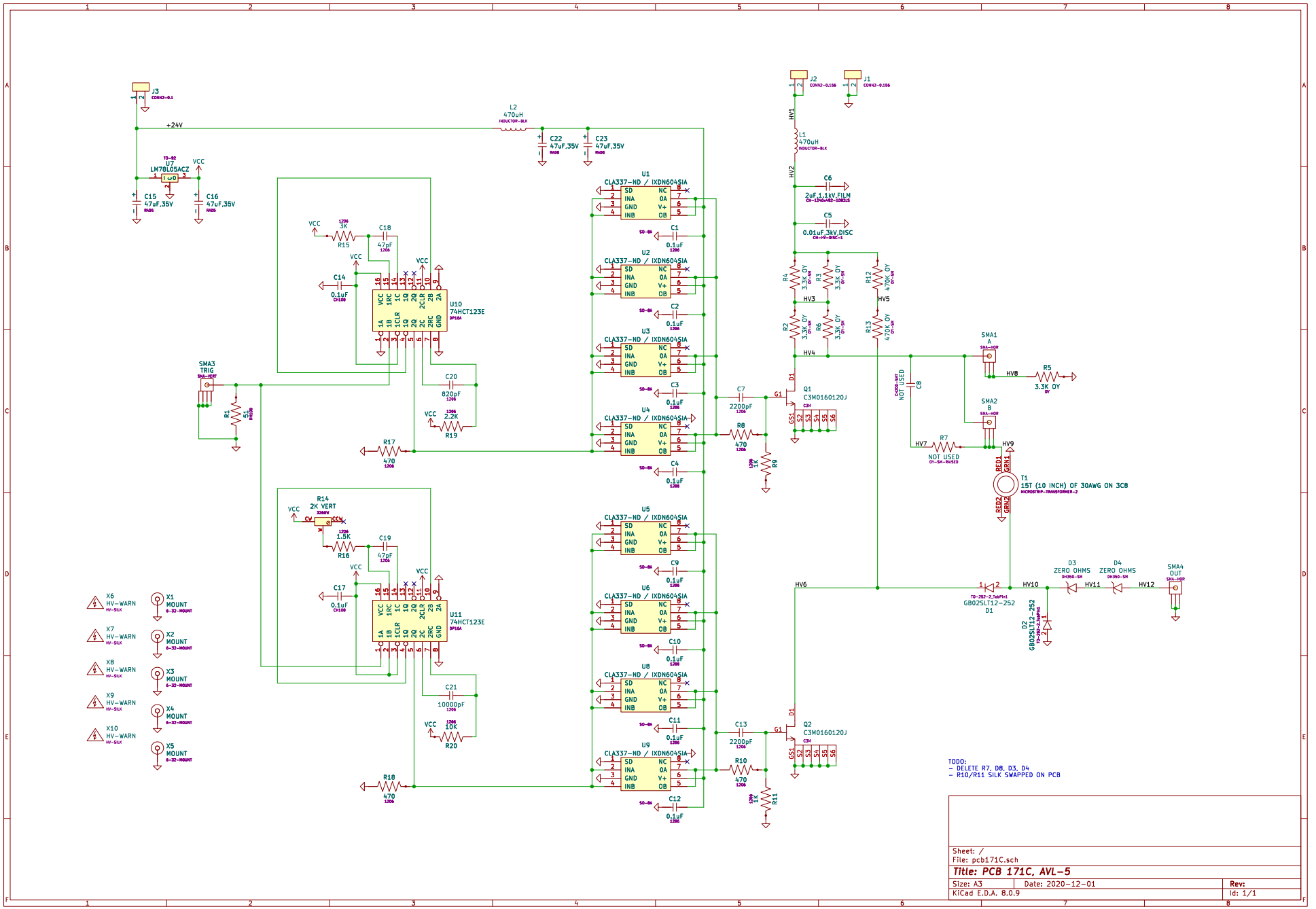
183A-P (PARALLEL CAPACITOR BANK)



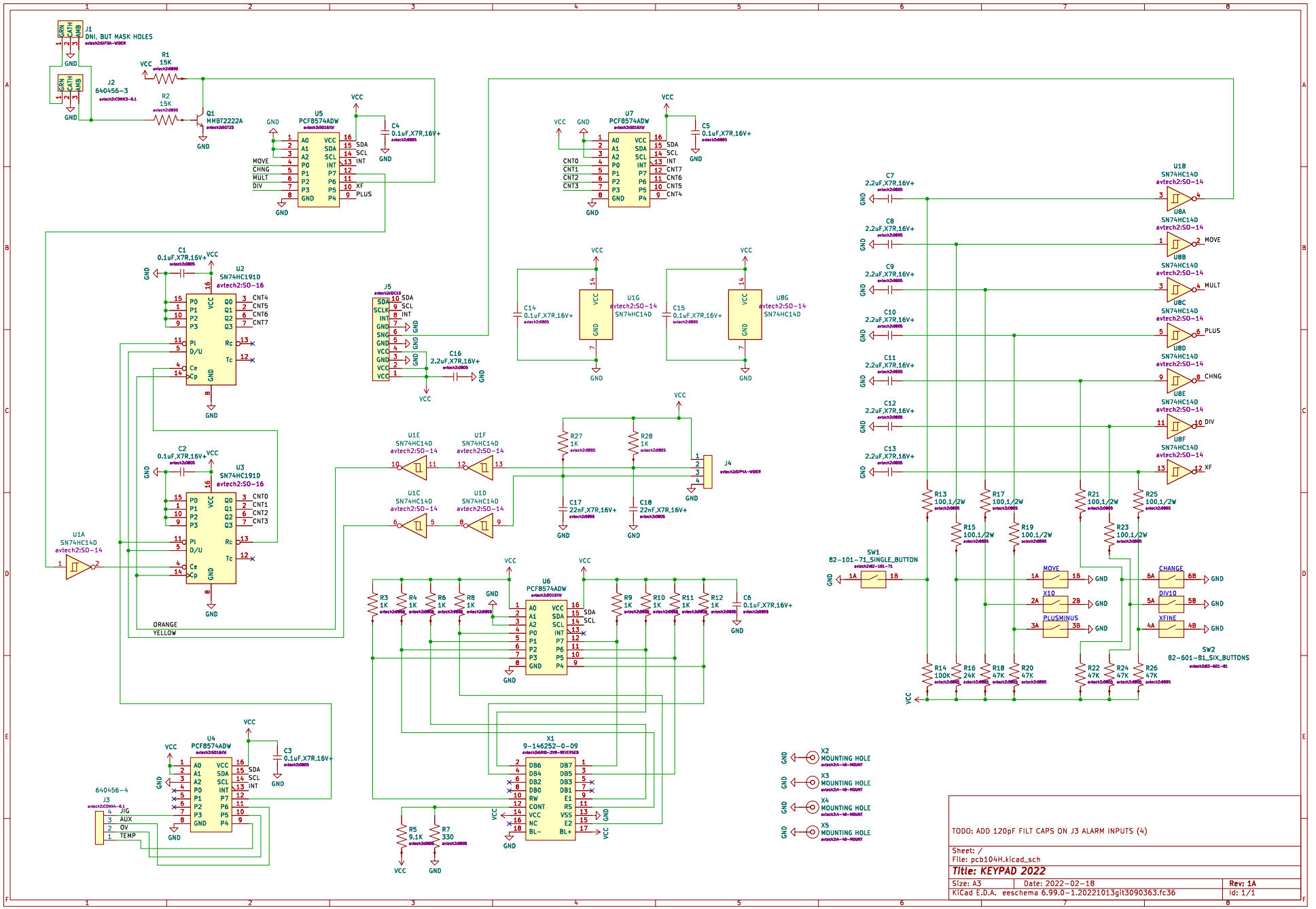


PCB183 CAP BANKS	
Printed 19-Aug-2005	Revision 1C
Z:\mjcfiles\pcb\183\hv-cap-bank.Ddb - pcb183a.sch	

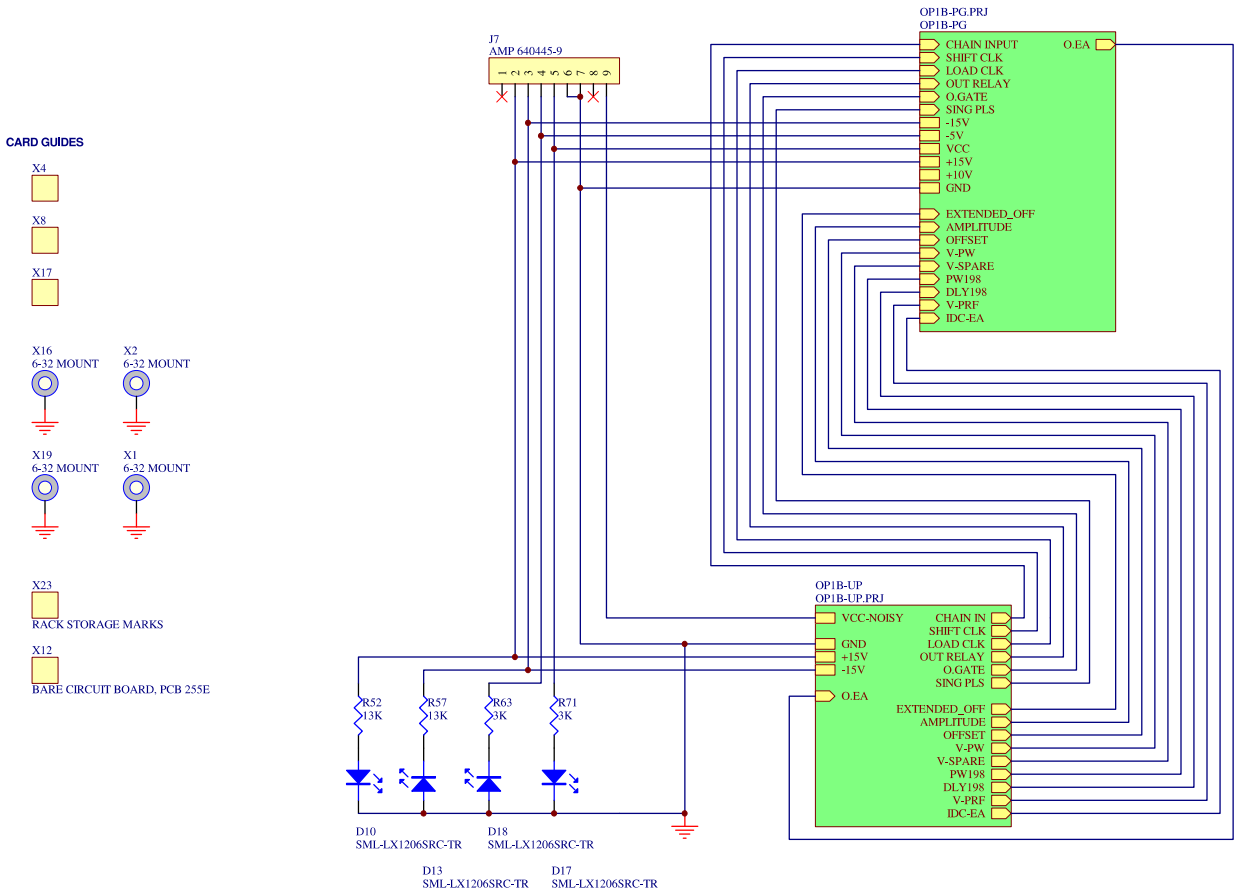
PCB 171C - MAIN PULSER



PCB 104H - KEYPAD / DISPLAY BOARD



PCB 295G - MAIN CONTROL BOARD, 1 OF 13, TOP-LEVEL



MAIN BOARD TOP-LEVEL SCHEMATIC	
Printed 16-Dec-2024	Revision
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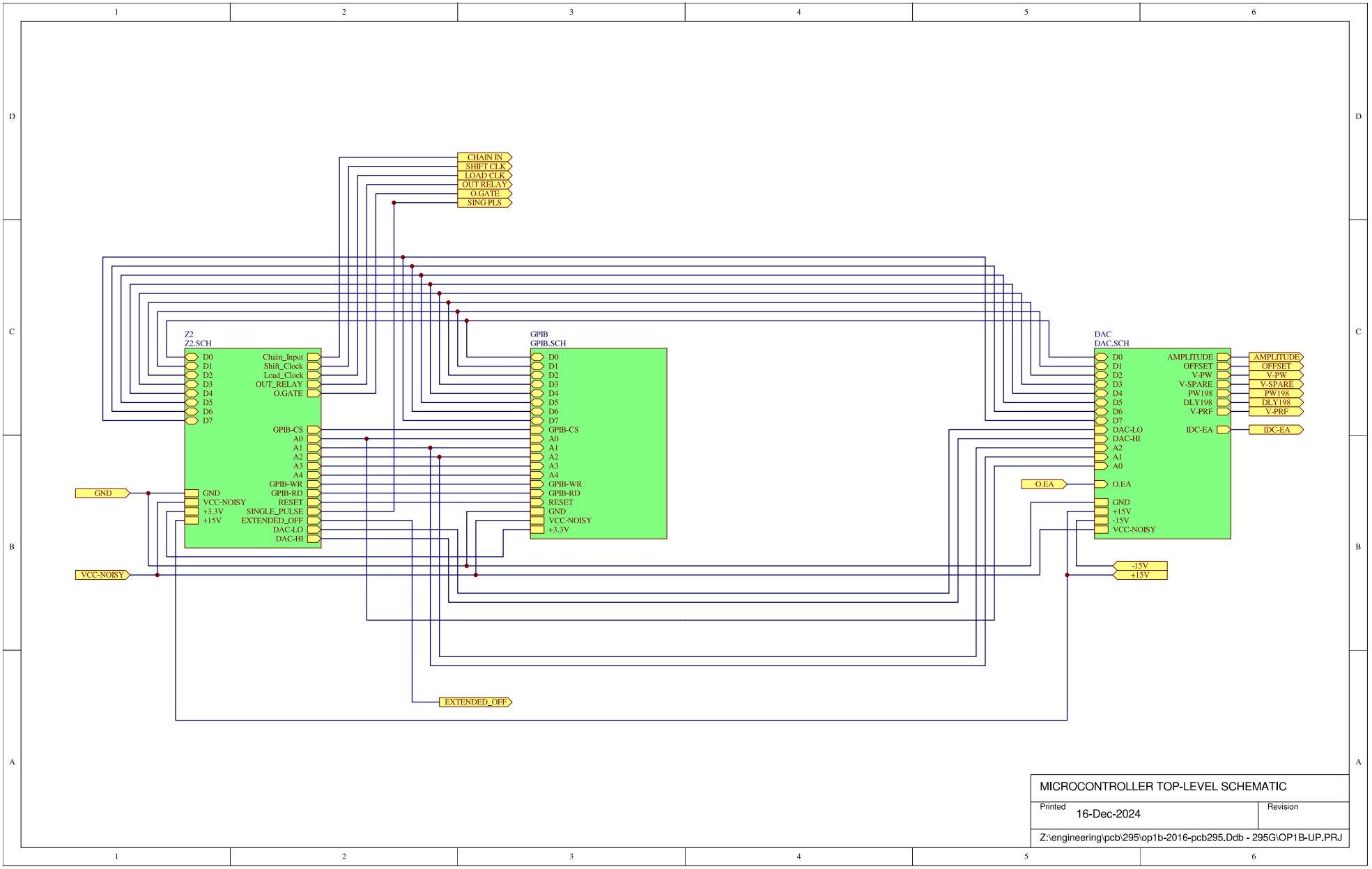
PCB 295G - MAIN CONTROL BOARD, 2 OF 13, MICROCONTROLLER TOP-LEVEL



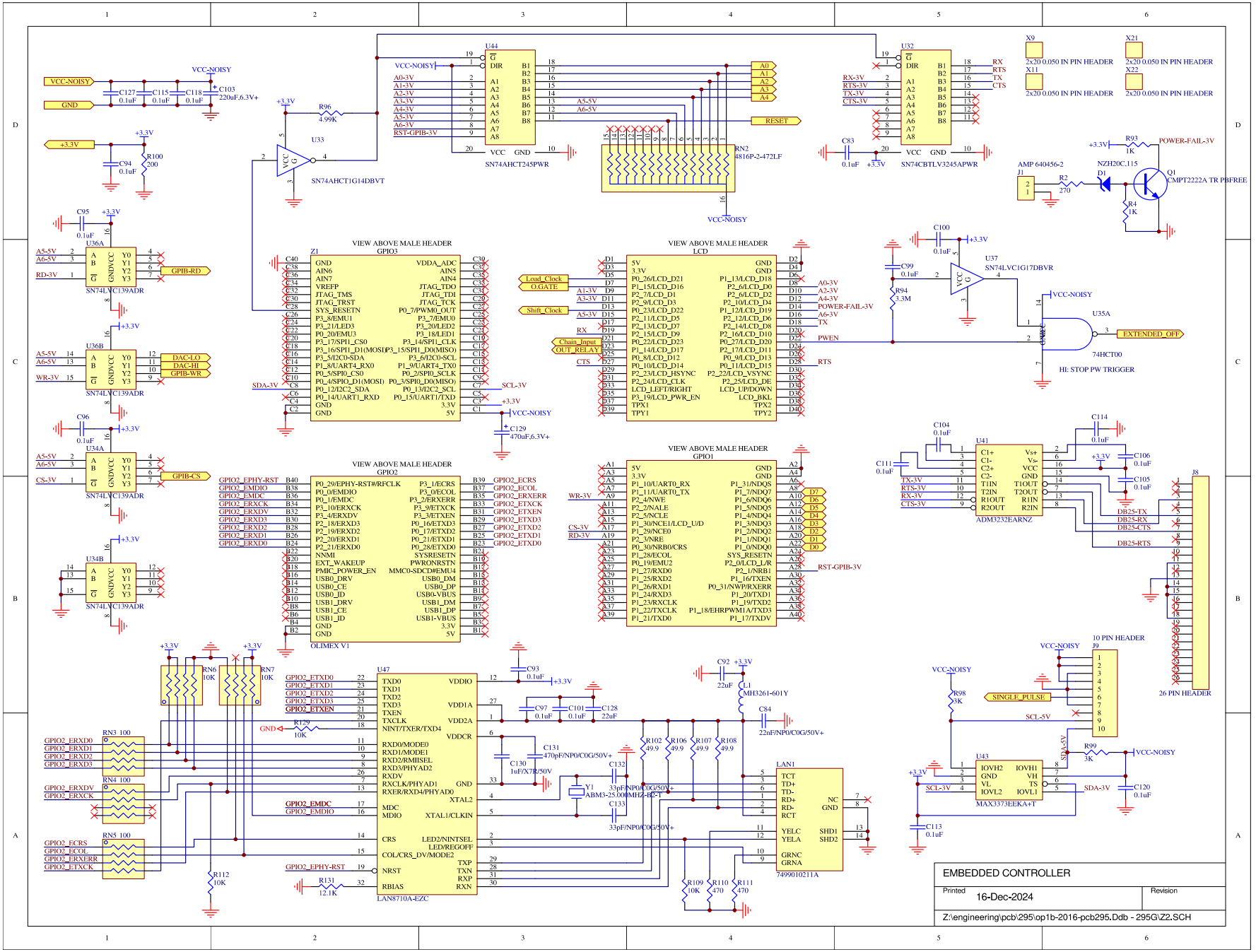
MICROCONTROLLER TOP-LEVEL SCHEMATIC

Printed 16-Dec-2024

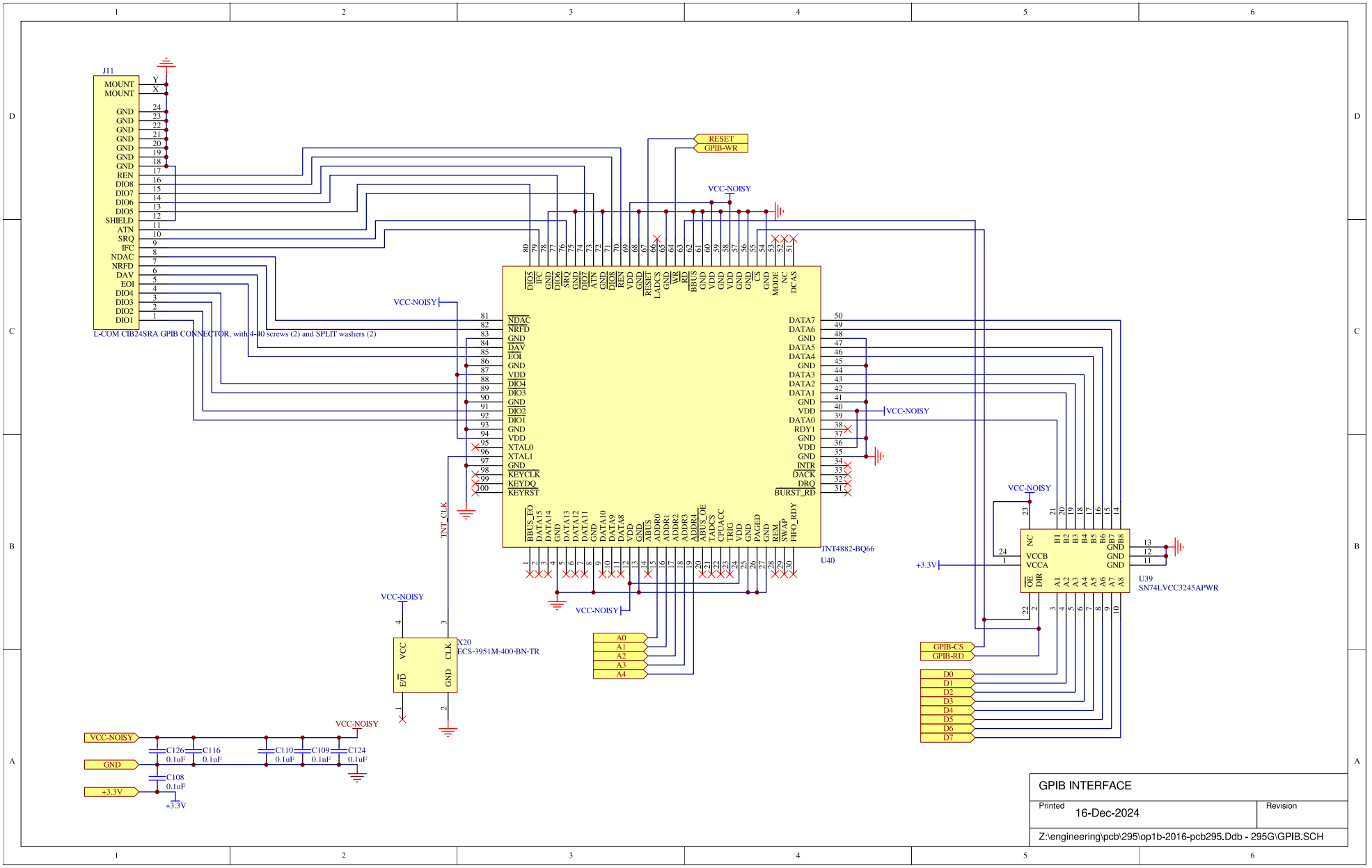
Revision

Z:\engineering\pcb\295\op1b-2016-pcb295.Ddb - 295G\OP1B-UP.PRJ

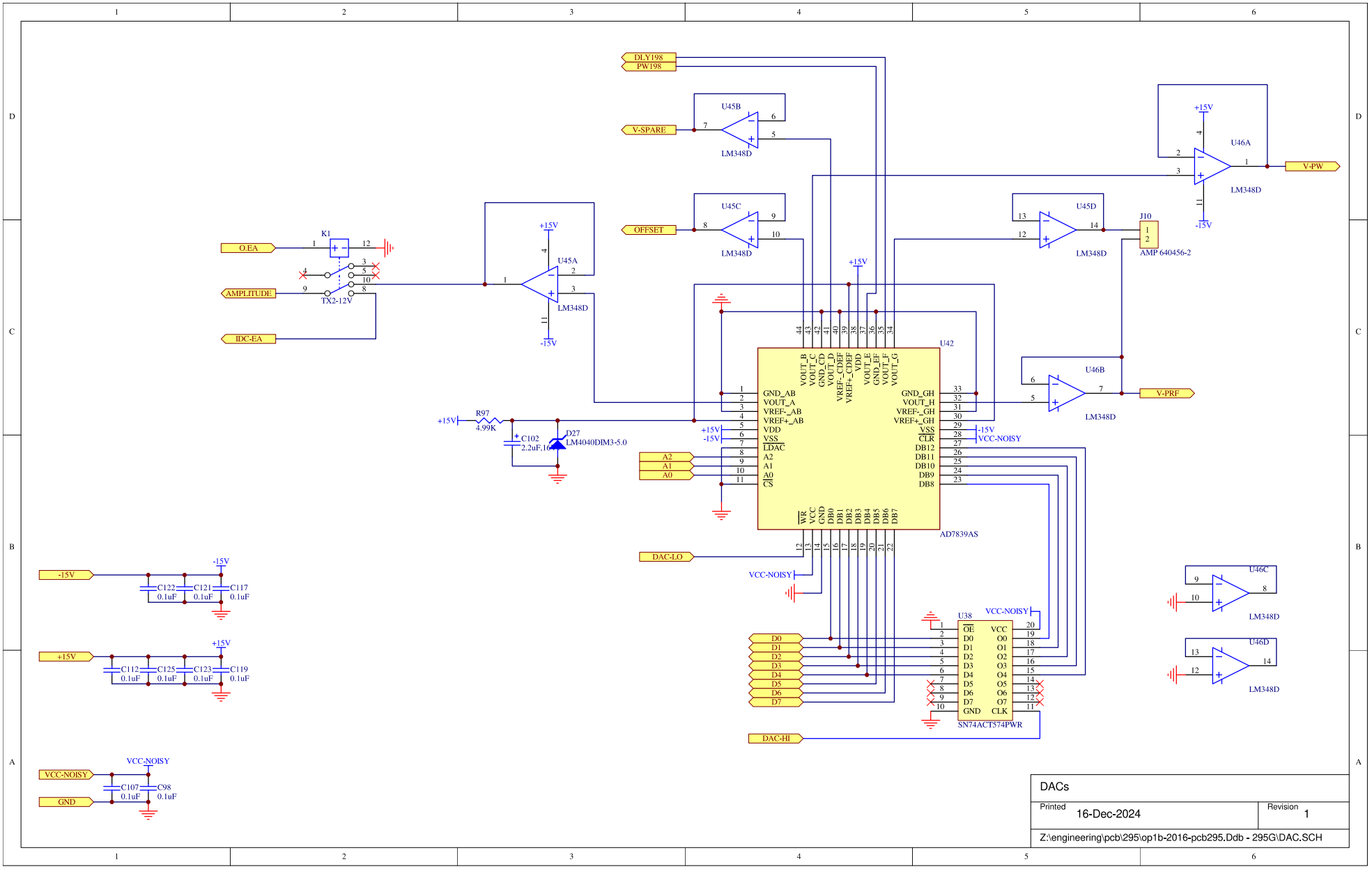
PCB 295G - MAIN CONTROL BOARD, 3 OF 13, EMBEDDED CONTROLLER



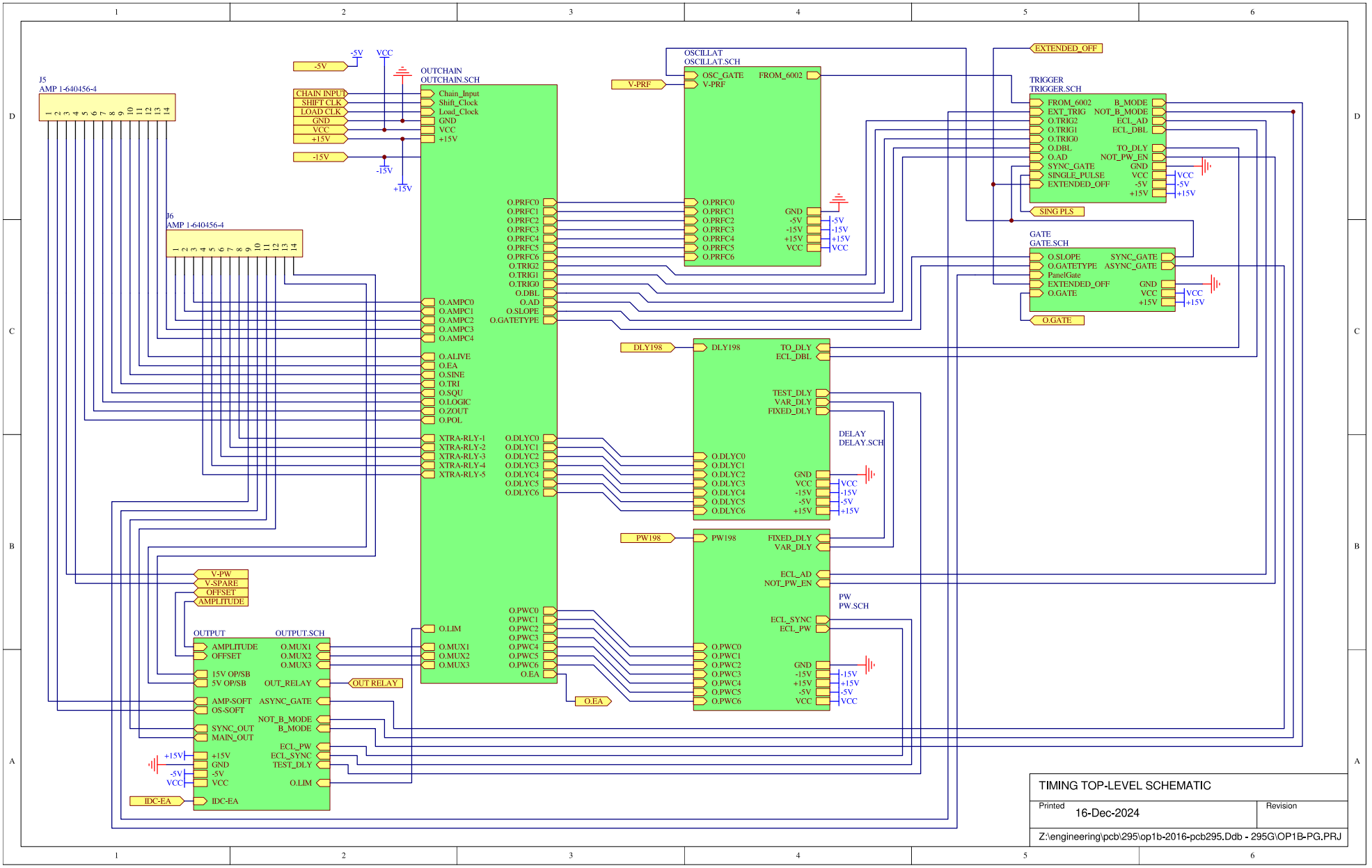
PCB 295G - MAIN CONTROL BOARD, 4 OF 13, GPIB INTERFACE



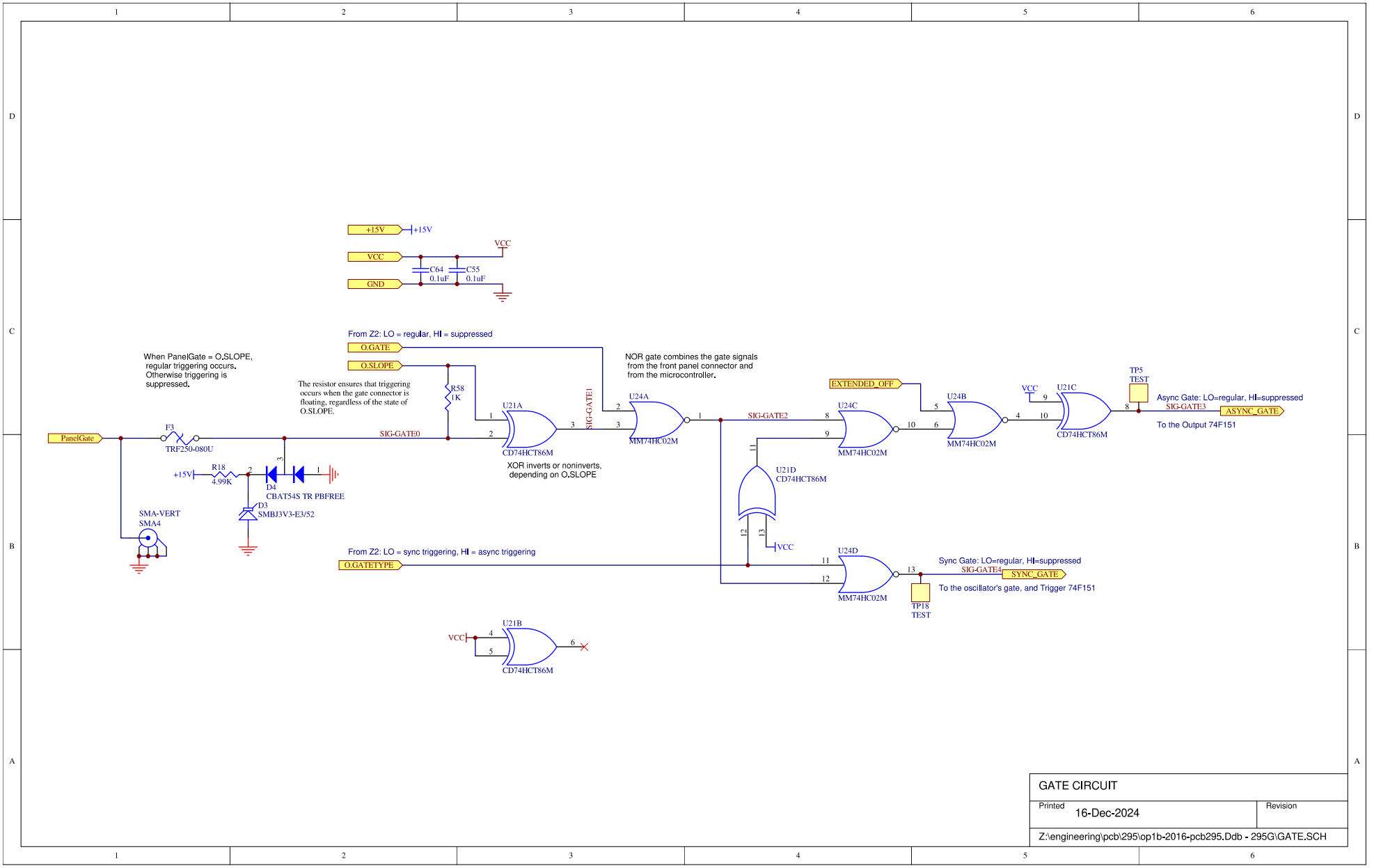
PCB 295G - MAIN CONTROL BOARD, 5 OF 13, DACs



PCB 295G - MAIN CONTROL BOARD, 6 OF 13, TIMING TOP-LEVEL



PCB 295G - MAIN CONTROL BOARD, 7 OF 13, GATE CIRCUIT



GATE CIRCUIT	
Printed 16-Dec-2024	Revision
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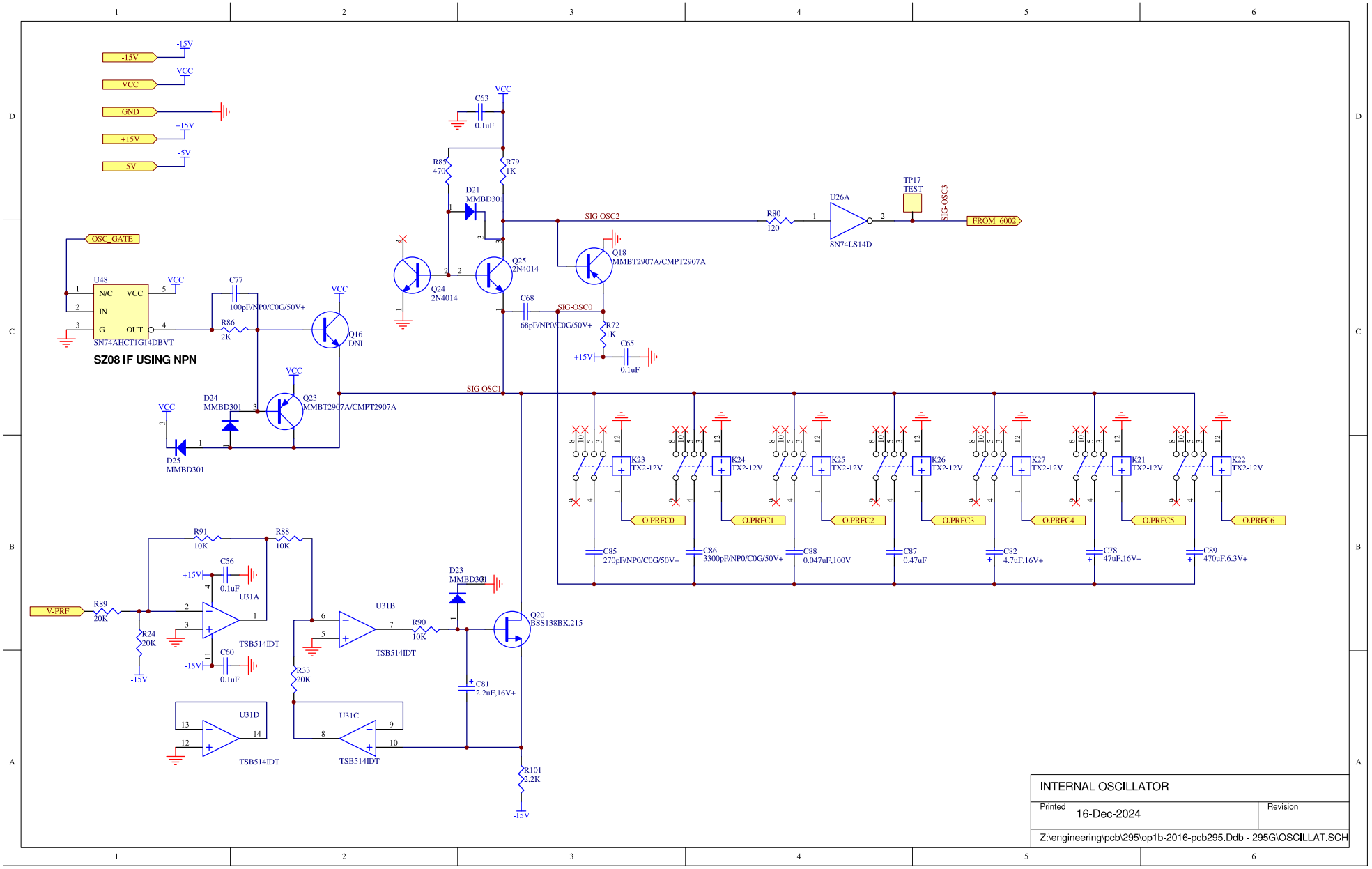
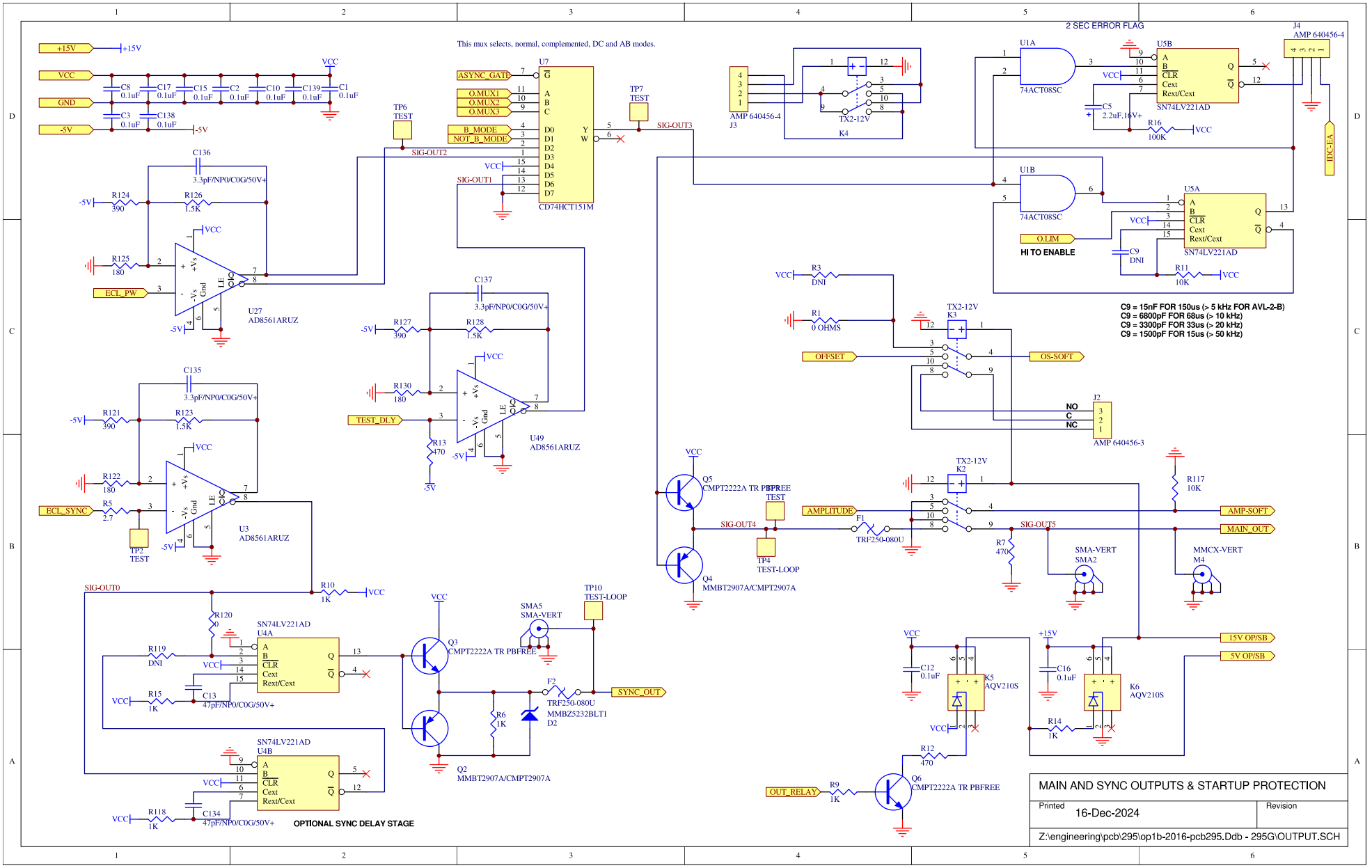
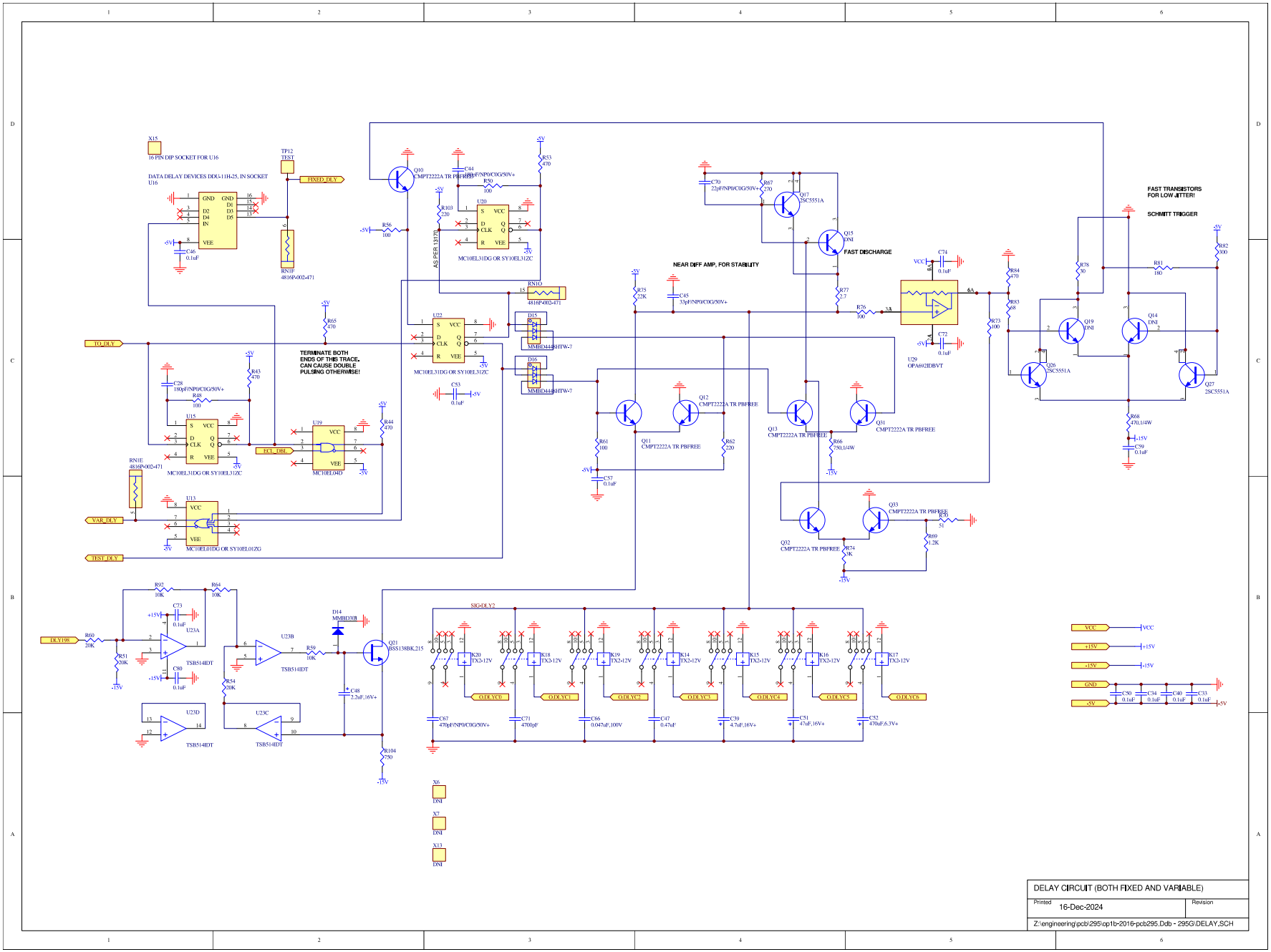
PCB 295G - MAIN CONTROL BOARD, 8 OF 13, OSCILLATOR



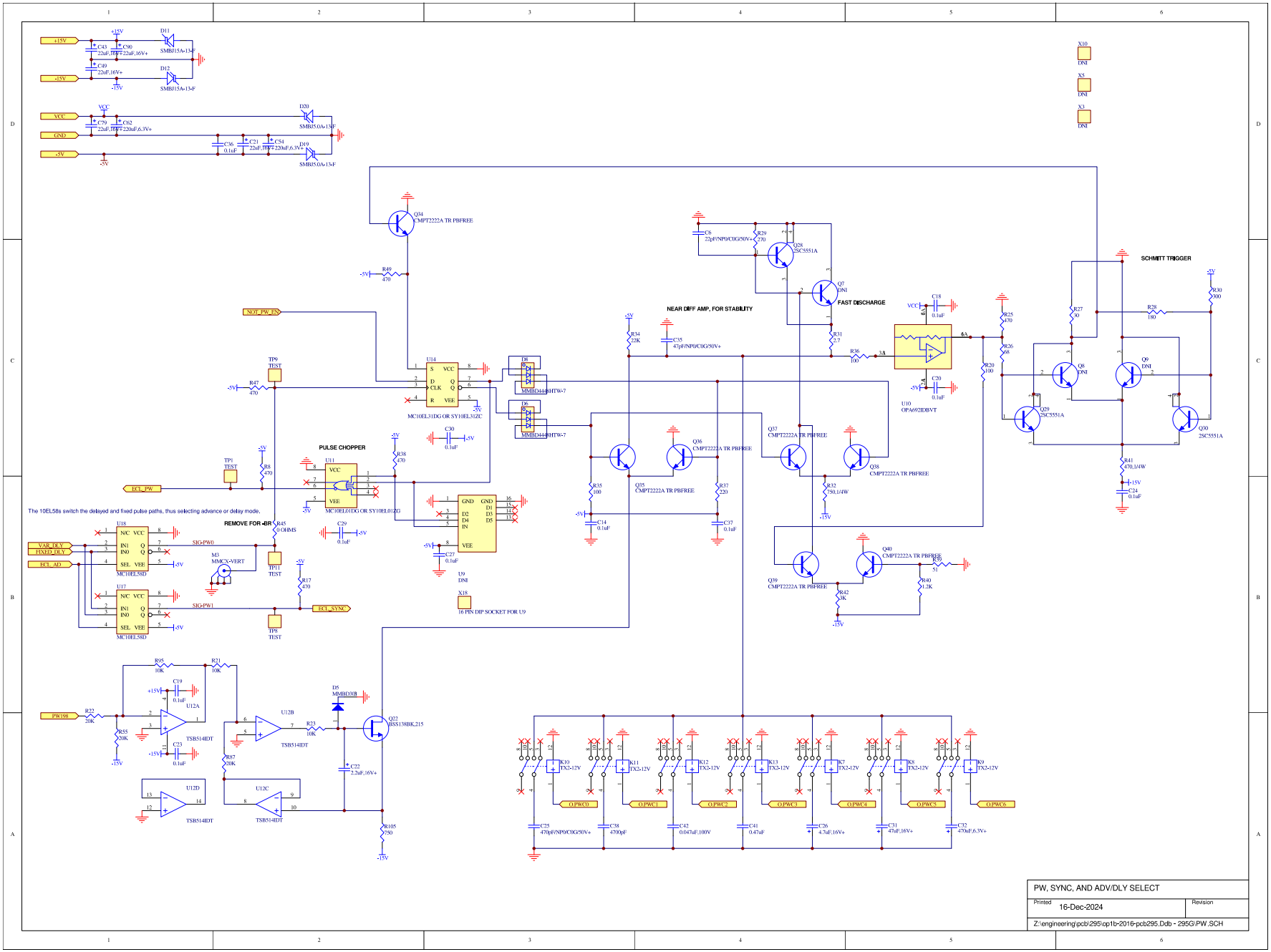
PCB 295G - MAIN CONTROL BOARD, 9 OF 13, TTL OUTPUTS



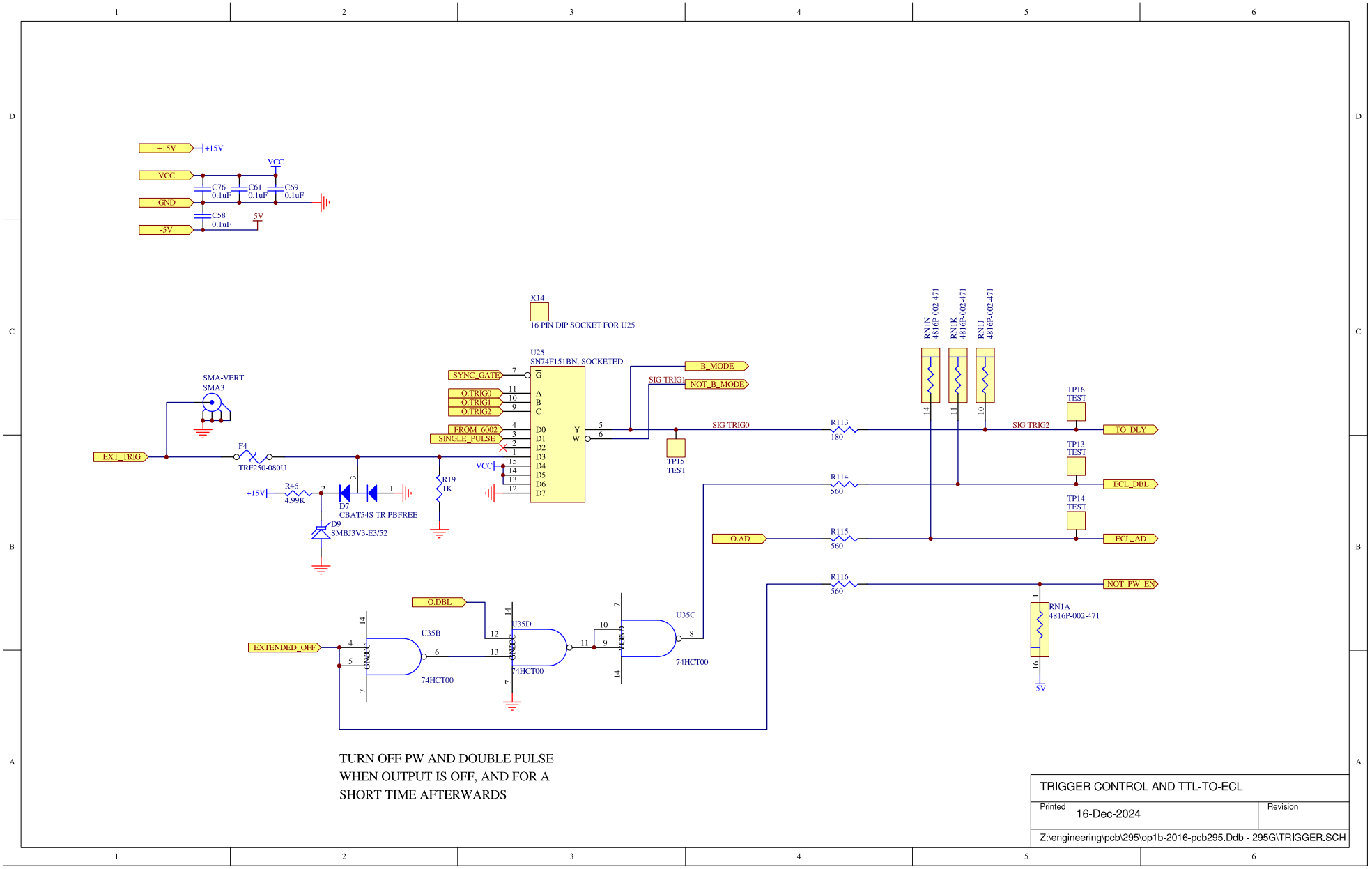
PCB 295G - MAIN CONTROL BOARD, 10 OF 13, DELAY CIRCUITS



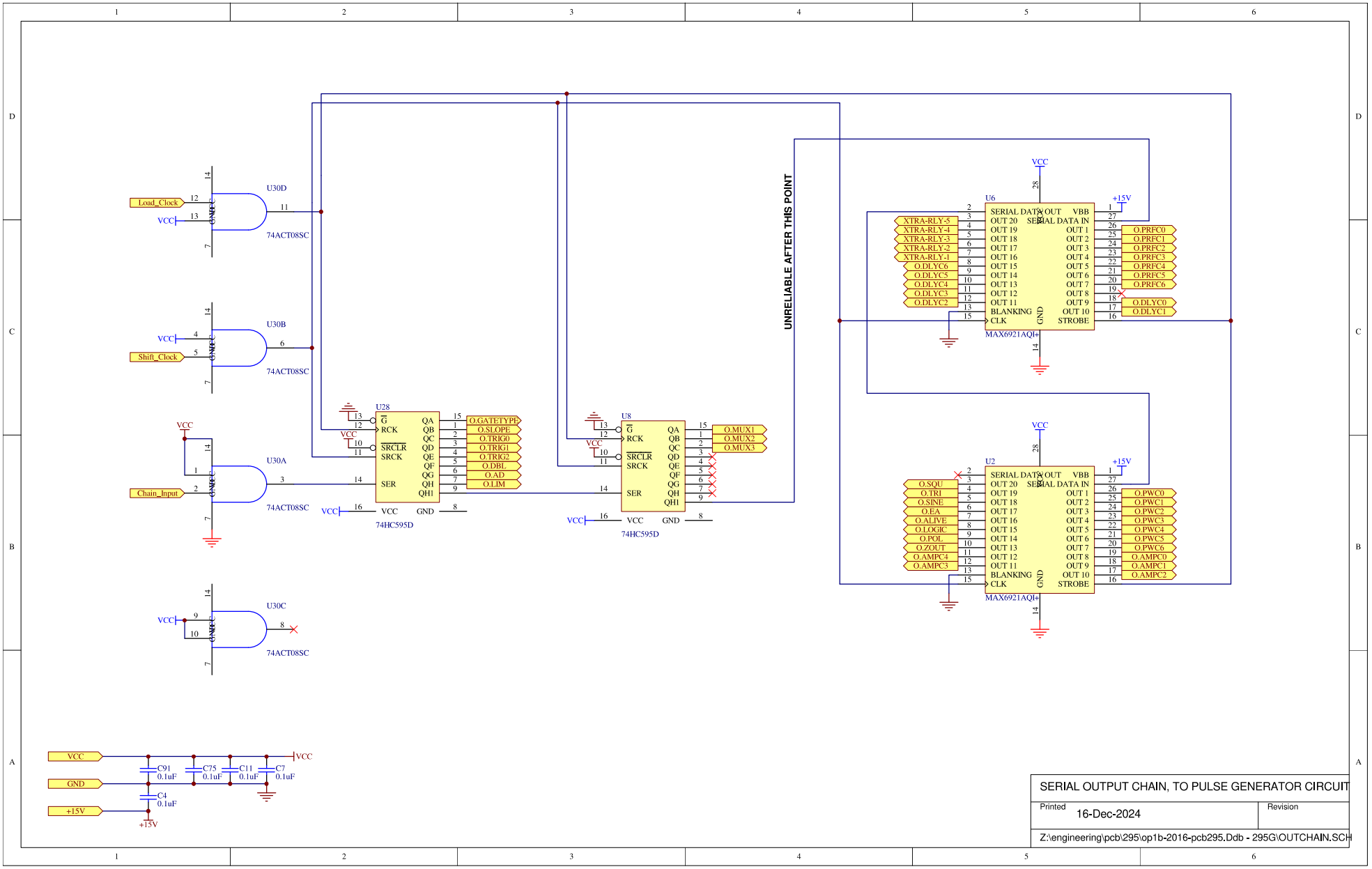
PCB 295G - MAIN CONTROL BOARD, 11 OF 13, PULSE WIDTH CIRCUIT



PCB 295G - MAIN CONTROL BOARD, 12 OF 13, TRIGGER SELECT



PCB 295G - MAIN CONTROL BOARD, 13 OF 13, SHIFT REGISTERS

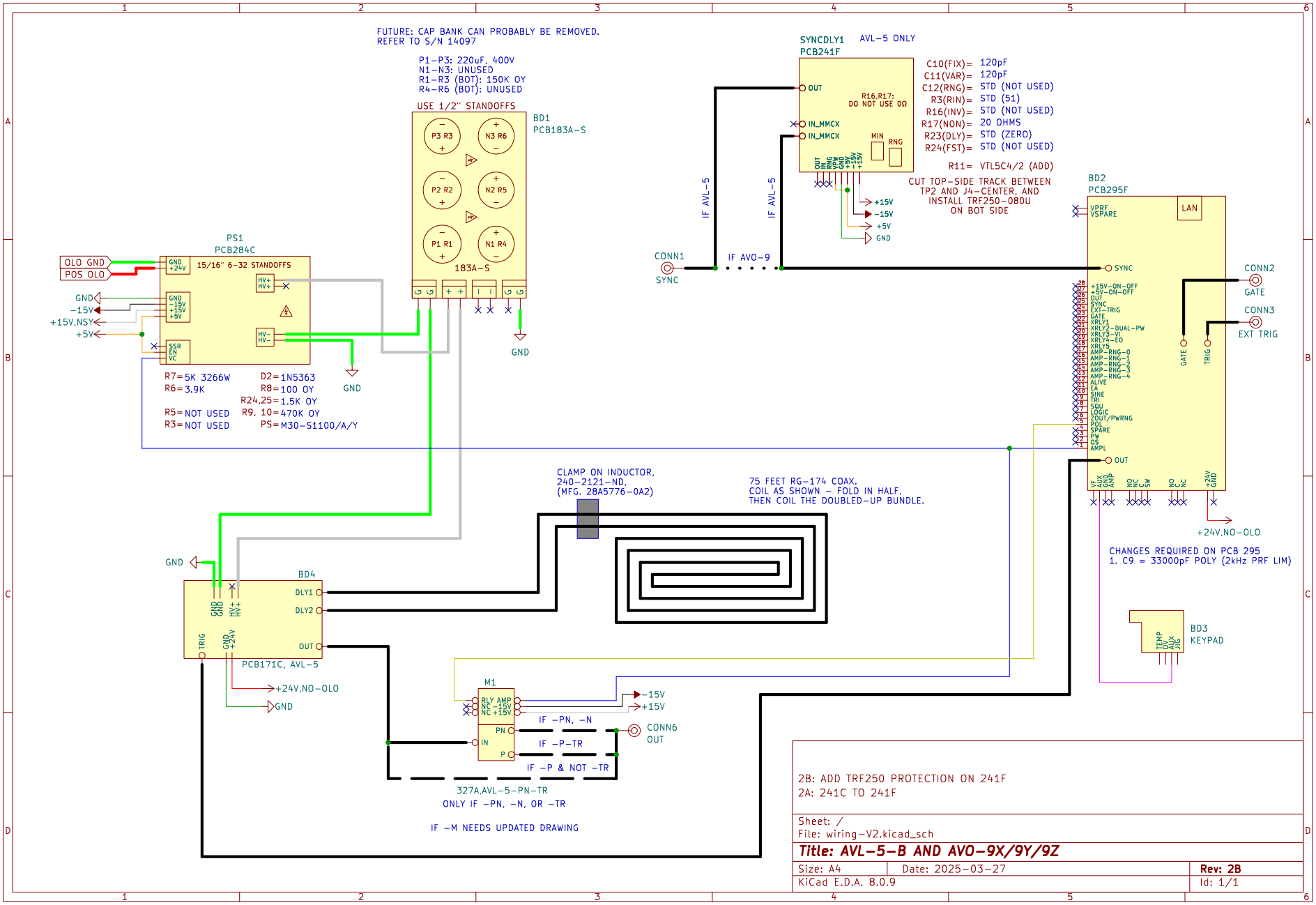


SERIAL OUTPUT CHAIN, TO PULSE GENERATOR CIRCUIT

Printed	Revision
16-Dec-2024	

Z:\engineering\pcb\295\op1b-2016-pcb295.Ddb - 295G\OUTCHAIN.SCH

MAIN WIRING


FUTURE: CAP BANK CAN PROBABLY BE REMOVED.
REFER TO S/N 14097
P1-P3: 220uF, 400V
N1-N3: UNUSED
R1-R3 (BOT): 150K OY
R4-R6 (BOT): UNUSED
USE 1/2" STANDOFFS
BD1
PCB183A-S
183A-S
SYNCDLY1
PCB241F
AVL-5 ONLY
C10(FIX)= 120pF
C11(VAR)= 120pF
C12(RNG)= STD (NOT USED)
R3(RIN)= STD (51)
R16(INV)= STD (NOT USED)
R17(NON)= 20 OHMS
R23(DLY)= STD (ZERO)
R24(FST)= STD (NOT USED)
R11= VTL5C4/2 (ADD)
R16,R17: DO NOT USE 0Ω
CUT TOP-SIDE TRACK BETWEEN TP2 AND J4-CENTER, AND INSTALL TRF250-080U ON BOT SIDE
IF AVL-5
IF AVL-5
CONN1
SYNC
IF AVO-9
BD2
PCB295F
LAN
CONN2
GATE
CONN3
EXT TRIG
PS1
PCB284C
15/16" 6-32 STANDOFFS
OLO GND
POS OLO
GND
-15V
+15V,NSY
+5V
R7= 5K 3266W
R6= 3.9K
R5= NOT USED
R3= NOT USED
D2= 1N5363
R8= 100 OY
R24,25= 1.5K OY
R9, 10= 470K OY
PS= M30-S1100/A/Y
CLAMP ON INDUCTOR,
240-2121-ND,
(MFG, 28A5776-0A2)
75 FEET RG-174 COAX.
COIL AS SHOWN - FOLD IN HALF,
THEN COIL THE DOUBLED-UP BUNDLE.
BD4
PCB171C, AVL-5
+24V,NO-OLO
CHANGES REQUIRED ON PCB 295
1. C9 = 33000pF POLY (2kHz PRF LIM)
BD3
KEYPAD
M1
CONN6
OUT
IF -PN, -N
IF -P-TR
IF -P & NOT -TR
327A,AVL-5-PN-TR
ONLY IF -PN, -N, OR -TR
IF -M NEEDS UPDATED DRAWING
2B: ADD TRF250 PROTECTION ON 241F
2A: 241C TO 241F
Sheet: /
File: wiring-V2.kicad_sch
Title: AVL-5-B AND AVO-9X/9Y/9Z
Size: A4
Date: 2025-03-27
Rev: 2B
KiCad E.D.A. 8.0.9
Id: 1/1

PERFORMANCE CHECK SHEET