INSTRUCTIONS

MODEL AVR-7B-B-P-QTKA

0 TO 700 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 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/avr-7/AVR-7B-B-P-QTKA.DOC, created April 8, 2002

INTRODUCTION

The AVR-7B-B-P-QTKA is a high performance, GPIB and RS232-equipped instrument capable of generating 0 to +700V at repetition rates up to 10 kHz into ≥50 Ω loads. The pulse width is variable from 100 ns to 1 second, and the average output power may be as high as 50W. Rise and fall times are fixed at less than 50 ns. The AVR-7B-B-P-QTKA 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-7B-B-P-QTKA 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.

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.

CAUTION! EXTREME CAUTION SHOULD BE FOLLOWED WHEN USING THIS INSTRUMENT AS IT GENERATES OUTPUT PULSE AMPLITUDES AS HIGH AS 700 VOLTS. DC POTENTIALS AS HIGH AS 750 VOLTS ARE EMPLOYED IN THE GENERATION OF THE 700 VOLT PULSE SO EXTREME CAUTION MUST BE EMPLOYED WHEN REPAIRING THIS INSTRUMENT. IT IS THEREFORE HIGHLY RECOMMENDED THAT THE UNIT BE RETURNED TO AVTECH FOR ALL REPAIRS BEYOND THE REPLACEMENT OF THE 1.5 AMP LINE FUSE OR THE 3.0 AMP SB REAR PANEL FUSE.

SPECIFICATIONS

Model:	AVR-7B-B-P-QTKA
Amplitude:	0 to +700 Volts, to $R_L \geq 50$ Ohms
Rise time:	≤ 50 ns
Fall time:	≤ 50 ns
Pulse width:	100 ns to 1 second
PRF:	1 Hz to 10 kHz
Duty cycle (maximum):	0.5%
Average power out (maximum):	50 W
Computer control:	GPIB and RS-232 interfaces included
Propagation delay:	≤ 100 ns (Ext trig in to pulse out)
Jitter:	± 100 ps (Ext trig in to pulse out)
Trigger required:	Internal Mode: +5 Volt, 50 ns or wider (TTL) External Mode: +5 Volt, $PW_{IN} = PW_{OUT}$ (TTL)
Sync delay:	Sync out to pulse out: Variable 0 to ± 1 s
Sync output:	+ 3 Volts, 200 ns, will drive 50 Ohm loads
Connectors:	Out: N type, Trig: BNC, Sync: BNC, Gate: BNC
Power, AC:	120/240 Volts (switchable) 50 - 60 Hz
Dimensions:	Mainframe: 100 mm x 430 mm x 375 mm (3.9” x 17” x 14.8”)
Chassis material:	Anodized aluminum, with blue plastic trim
Mounting:	Any
Temperature range:	+ 15° to + 40° C

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 "OP1B Interface Programming Manual") are with the instrument. If the instrument has been damaged, file a claim immediately with the company that transported the instrument.

PLUGGING IN THE INSTRUMENT

Examine the rear of the instrument. There will be a male power receptacle, a fuse holder and the edge of the power selector card visible. Confirm that the power selector card is in the correct orientation.

For AC line voltages of 110-120V, the power selector card should be installed so that the "120" marking is visible from the rear of the instrument, as shown below:

For AC line voltages of 220-240V, the power selector card should be installed so that the "240" marking is visible from the rear of the instrument, as shown below:

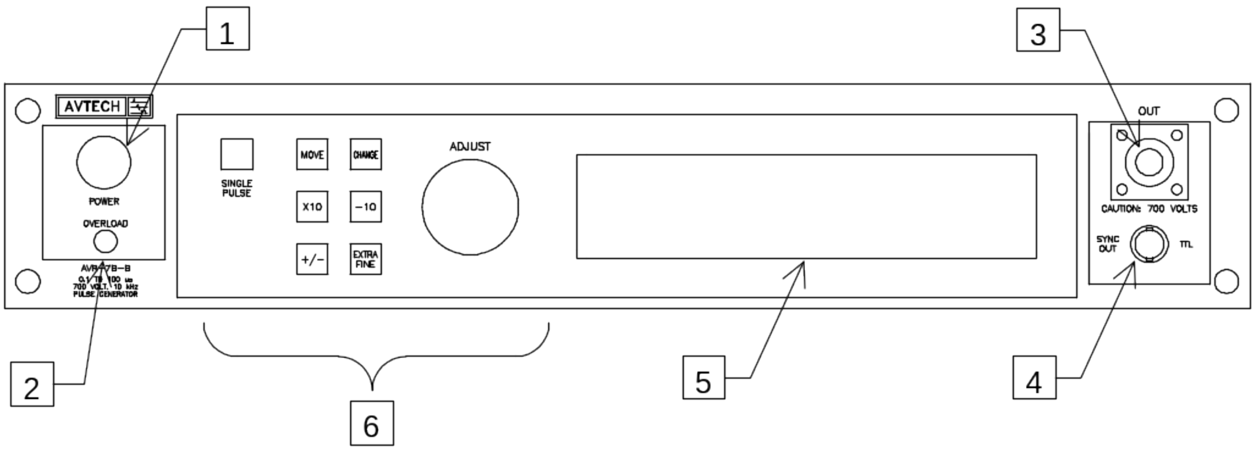
If it is not set for the proper voltage, remove the fuse and then grasp the card with a pair of pliers and remove it. Rotate horizontally through 180 degrees. Reinstall the card and the correct fuse.

In the 120V setting, a 1.5A slow blow fuse is required. In the 240V setting, a 0.75A slow blow fuse is required.

LABVIEW DRIVERS

A LabVIEW driver for the AVR-7B-B series 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/.

FRONT PANEL CONTROLS



1. POWER Switch. The POWER push button switch applies AC prime power to the primaries of the transformer, turning the instrument on. The push button lamp (#382 type) is connected to the +15V DC supply.

2. OVERLOAD. The AVR-7B-B-P-QTKA is protected in its internal software against conflicting or dangerous settings. As an additional protective measure, an automatic overload circuit exists, which controls the front panel overload light. 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 turn the output of the instrument OFF and turn the indicator light ON. The light will stay ON (i.e. output OFF) for about 5 seconds after which the instrument will attempt to turn ON (i.e. light OFF) for about 1 second. If the overload condition persists, the instrument will turn OFF again (i.e. light ON) for another 5 seconds. If the overload condition has been removed, the instrument will turn on and resume normal operation.

   This overload indicator is only likely to come on in three situations:

   - Briefly at start-up. This is not a cause for concern.
   - When suddenly changing the amplitude by a large amount. In this case, wait for the overload condition to clear, and re-enable the output if required.
   - When a low-impedance load (R_L < 50Ω), or a short-circuit, is connected to the output. In this case, turn off the instrument and connect the proper load.
   - When the average output power exceeds 50W. In this case, reduce the amplitude or duty cycle, or increase the load impedance.

Note that the output stage will safely withstand a short-circuited load condition.

3. OUT CONNECTOR. This N-type connector provides the output to a 50Ω (or higher) load.

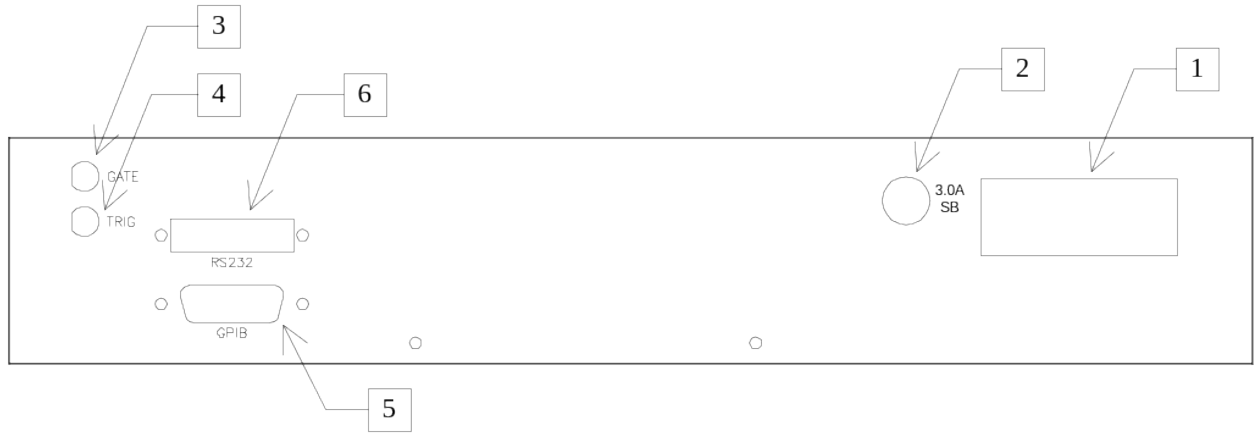
4. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads, or lags, the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to R_L > 1K with a pulse width of approximately 200 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 “OP1B Interface Programming Manual” describes the menus and submenus in detail.

REAR PANEL CONTROLS



1. AC POWER INPUT. A three-pronged recessed male connector is provided on the back panel for AC power connection to the instrument. Also contained in this assembly are a slow-blow fuse and a removable card that can be removed and repositioned to switch between 120V AC in and 240V AC in.

   For AC line voltages of 110-120V, the power selector card should be installed so that the “120” marking is visible from the rear of the instrument.

   For AC line voltages of 220-240V, the power selector card should be installed so that the “240” marking is visible from the rear of the instrument.

   If it is not set for the proper voltage, remove the fuse and then grasp the card with a pair of pliers and remove it. Rotate horizontally through 180 degrees. Reinstall the card and the correct fuse.

   In the 120V setting, a 1.5A slow blow fuse is required. In the 240V setting, a 0.75A slow blow fuse is required.

2. 3.0A SB. This fuse protects the output stage.

3. 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.

4. 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.)

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.

5. GPIB Connector. A standard GPIB cable can be attached to this connector to allow the instrument to be computer-controlled. See the “OP1B Interface Programming Manual” for more details on GPIB control.

6. 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 “OP1B Interface Programming Manual” for more details on RS-232 control.

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:

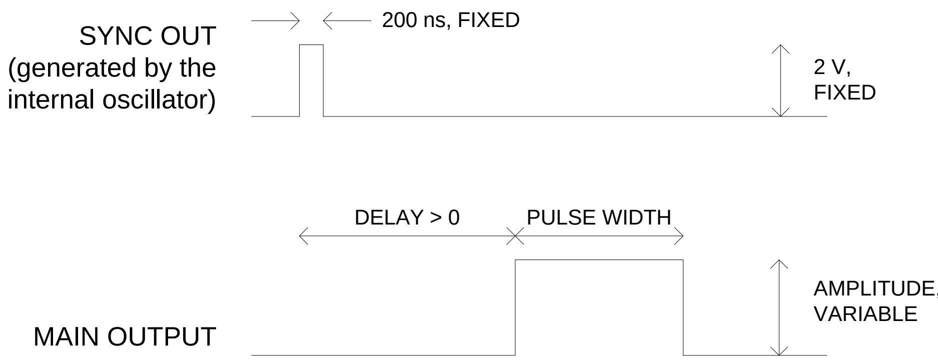


Figure A

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

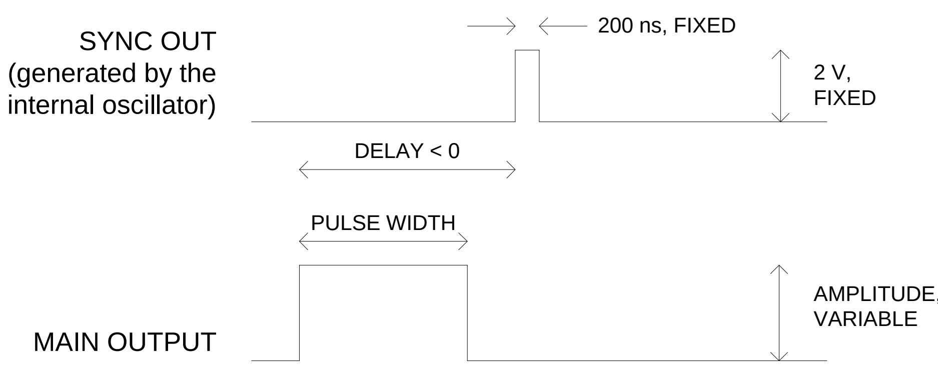


Figure B

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

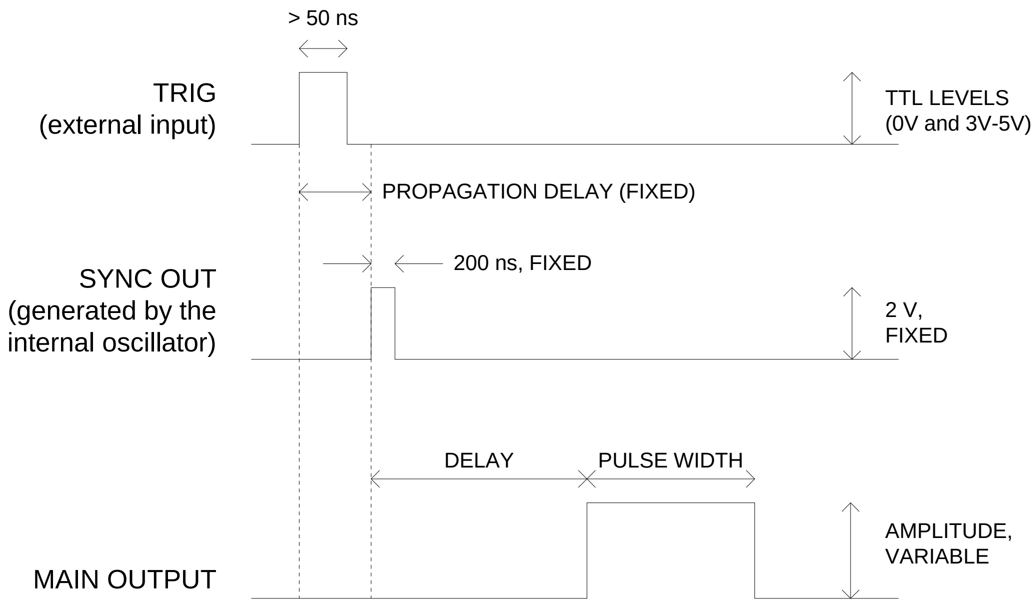


Figure C

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:

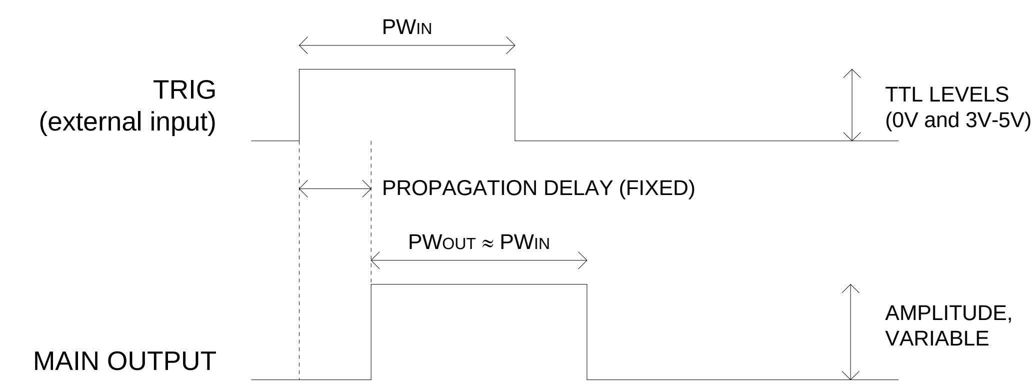


Figure D

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 “OP1B Interface Programming Manual” 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 “OP1B Interface Programming Manual” for more details.)

AVERAGE POWER CONSIDERATIONS

The AVR-7B-B-P-QTKA can produce pulse widths to 1 second, amplitudes to +700V, and can operate into loads as low as 50Ω. However, the maximum average power rating is 50W, which means that these conditions cannot occur simultaneously (e.g., a +700V pulse into 50 Ohms represents 9800W of peak power). When operating at maximum pulse width and maximum amplitude, or at maximum duty cycle and maximum amplitude, the load should be 9.8 kΩ or greater (that is, $(700V)^2 \div 50W = 9.8$ kΩ).

If the average output power exceeds 50W, the internal overload protection circuitry will be activated, which will disable the output temporarily.

See the “PULSED RESISTOR TESTS” section 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-7B-B-P-QTKA features an output impedance of the order of several Ohms (rather than 50 Ohms). The following consequences of this feature should be noted:

- When used to switch some semiconductor devices (eg. bipolar and VMOS power transistors), the AVR unit will yield much faster switching times than those provided by 50 Ohm pulse generators.

- The AVR unit will safely operate in to load impedances in the range of 50 Ohms to an open circuit. However, the fall time may degrade for load impedances higher than fifty Ohms.

- The AVR unit may be effectively converted to a fifty Ohm output impedance generator by placing a fifty Ohm carbon composition resistor in series with the output of the unit and the load. The maximum available load voltage will then decrease to 350 Volts (from 700 Volts).

PREVENTING OUTPUT STAGE FAILURE

The output stage is protected against overload condition by the overload module and a 3.0 A slow blow fuse 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 50 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 PW to a minimum.
- Never apply an externally generated voltage to the output port.

TOP COVER REMOVAL

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).

ELECTROMAGNETIC INTERFERENCE

To prevent electromagnetic interference with other equipment, all used outputs should be connected to shielded 50Ω loads using shielded 50Ω coaxial cables. Unused outputs should be terminated with shielded 50Ω BNC terminators or with shielded BNC dust caps, to prevent unintentional electromagnetic radiation. All cords and cables should be less than 3m in length.

RACK MOUNTING

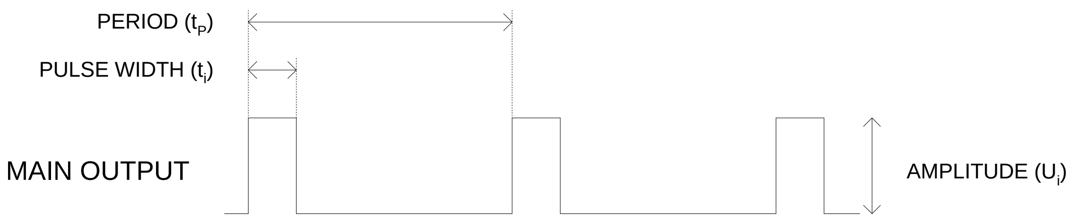
A rack mounting kit is available. The -R5 rack mount kit may be installed after first removing the one Phillips screw on the side panel adjacent to the front handle.

PULSED RESISTOR TESTS

AVR-7B-B-P-QTKA is useful for many applications, including testing resistors. This section includes operating suggestion specific to resistor testing.

PULSE GENERATOR POWER LIMITS, IN CONTINUOUS PULSE MODE

Some resistor test protocols call for a continuous (i.e., repetitive) series of rectangular pulses, as illustrated below:



The AVR-7B-B-P-QTKA can generate this waveform, within these ranges:

Amplitude, U_i:	0 to +700 Volts
Period, t_P:	100 us to 1 second
Pulse width, t_i:	100 ns to 1 second*
t_P/t_i:	$\geq$ 200
Load Resistance, R:	$\geq 50\ \Omega$

(* In practice, this is limited to 5 ms, due to the 0.5% duty cycle limitation. Use the single pulse mode for wider pulses.)

Also, the average pulse load, P_{AVG}, must remain below 50W. That is,

$$P_{AVG} = \frac{U_i^2 \cdot t_i}{R \cdot t_P} \qquad \text{(eq. 1)}$$

$$P_{AVG} \leq 50\, Watts$$

If the amplitude and timing sets cause P_{AVG} to exceed 50W, the instrument's overload protection circuitry will be activated.

The peak power can also be calculated from:

$$\hat{P}_{\max} = \frac{U_i^2}{R} \qquad \text{(eq. 2)}$$

The maximum period t_P the can be produced by the internal trigger oscillator is 1.0 second. The AVR-7B-B-P-QTKA can be triggered at slower rates, if operated in the external trigger mode. For very slow trigger rates (t_P > 1.0 seconds), the AVR-7B-B-P-QTKA is governed by the equations given in “SINGLE PULSE TESTING” section, rather than the equations given above.

If the load resistance, duty cycle, and period are kept within the rated values (i.e., R ≥ 50 Ohms, $t_P/t_i \geq 200$, t_P between 100 us and 1.0 seconds), the average power rating will never be exceeded regardless of the amplitude setting. In other words, in the worst case scenario,

$$P_{AVG} = \frac{U_i^2}{R} \cdot \frac{t_i}{t_P}$$

$$P_{AVG} = \frac{(700V)^2}{50 Ohms} \cdot \frac{1}{200} \qquad \text{(eq. 3)}$$

$$P_{AVG} = 49\,W$$

When trigger externally, it is the user’s responsibility to ensure that t_P/t_i is ≥ 200.

PULSE GENERATOR POWER LIMITS, IN SINGLE PULSE MODE

Single pulse testing is similar to continuous pulse testing, expect that the period (t_P) is effectively infinite ($t_P \rightarrow \infty$). Much wider pulse widths (up to 1 second) can be obtained in the single pulse mode than in the continuous pulse mode, because the duty cycle restriction does not apply.

In this mode, the AVR-7B-B-P-QTKA can be operated over these ranges:

Amplitude, U_i:	0 to +700 Volts
Pulse width, t_i:	100 ns to 1 second
Load Resistance, R:	≥ 50 Ω

The internal overload protection circuit monitors the average power consumed over a 1 second interval (approximately), so the average power over a 1 second interval must remain below 50W. That is,

$$P_{AVG} = \frac{U_i^2 \cdot t_i}{R \cdot (1.0 \sec)} \qquad \text{(eq. 4)}$$

$$P_{AVG} \leq 50\,Watts$$

The maximum pulse width that can be generated for a given amplitude in single pulse mode can be calculated from the equation above. For instance, the maximum duration of a +700V pulse that can be generated into a 100 Ohm load is given by:

$$50W \geq \frac{(700V)^2 \cdot t_i}{100Ohms \cdot (1.0\sec)}$$
$$t_i \leq 10.2\ ms$$
(eq. 5)

Pulse widths longer than this may cause the overload protection circuitry to activate.

The peak power can also be calculated from:

$$\hat{P}_{\max} = \frac{U_i^2}{R}$$
(eq. 6)

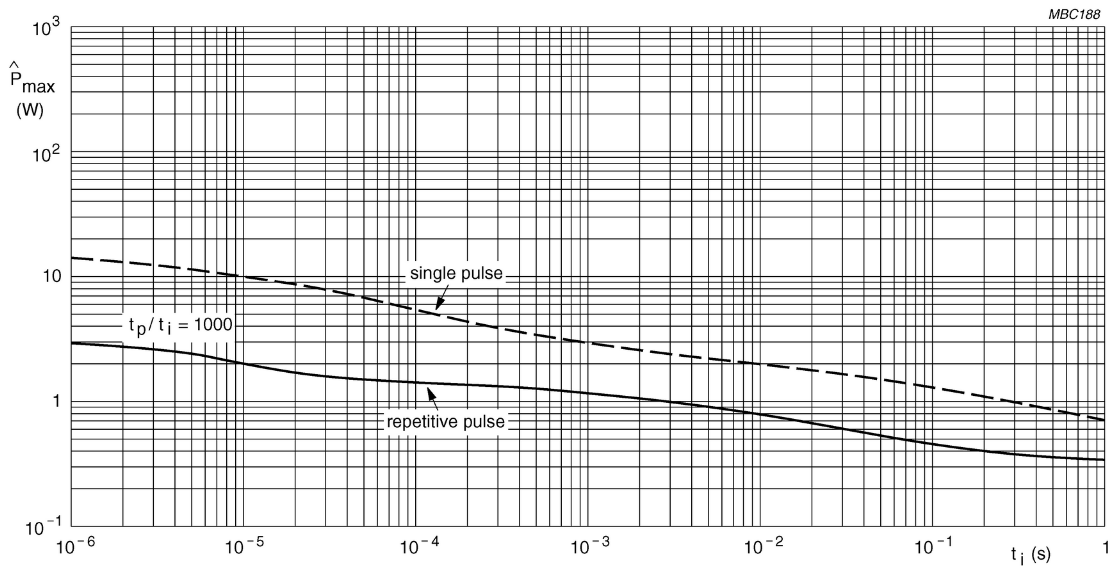
RESISTOR LIMITATIONS

The equations above describe the power limitations of the AVR-7B-B-P-QTKA. The resistors under test will have different power and voltage limitations. The resistors may have much lower peak power, average power, and peak voltage handling capability than the AVR-7B-B-P-QTKA.

For instance, the following graphs are provided in a Phycomp datasheet for the RC02(G) 1206 size resistors. Figure 11 relates the maximum peak power (calculated using equations 2 or 6) to the pulse width. The dashed curve is for single pulse operation, and the solid curve is for continuous pulsing with t_P/t_i = 1000.

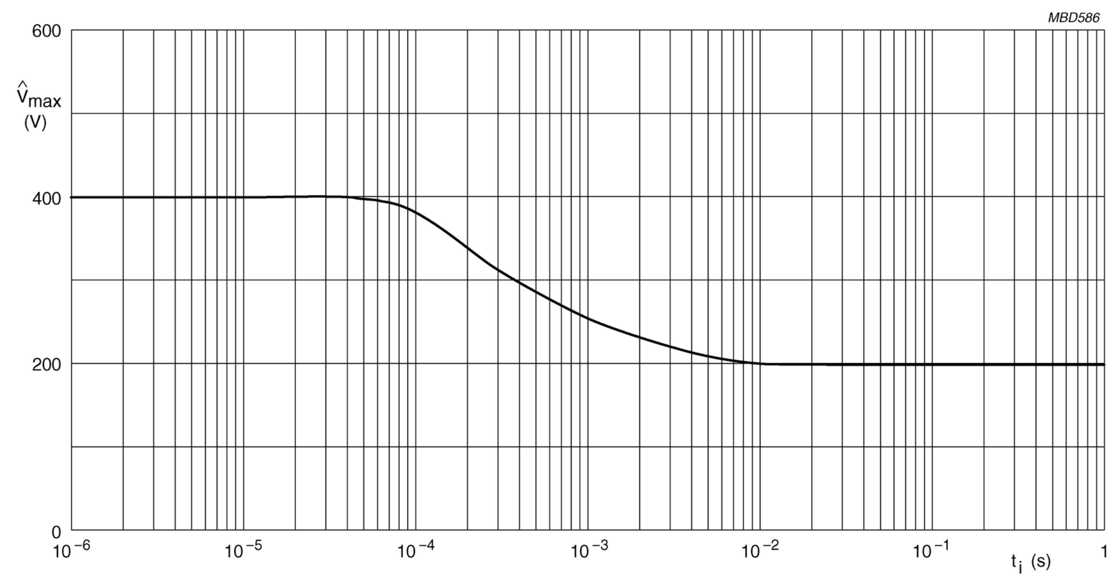
Figure 12 shows the maximum peak voltage (V_{MAX}, or U_i) as a function of pulse width. It is applicable to both modes of operation.

As an example, consider a 4.7 kΩ resistor, operating at a pulse width of 10us. Figure 11 indicates that the maximum allowed peak power in single pulse mode is 10W, and in the continuous mode with t_P/t_i = 1000 it is 2W. Using equation 2 or 6 shows that the maximum amplitude in single pulse mode is then 216.8V, and in the continuous mode it is 97.0V. Figure 12 indicates that the maximum allowed voltage is 400V, which is this case is not the limiting factor.



RC02G

Fig.11 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.



RC02

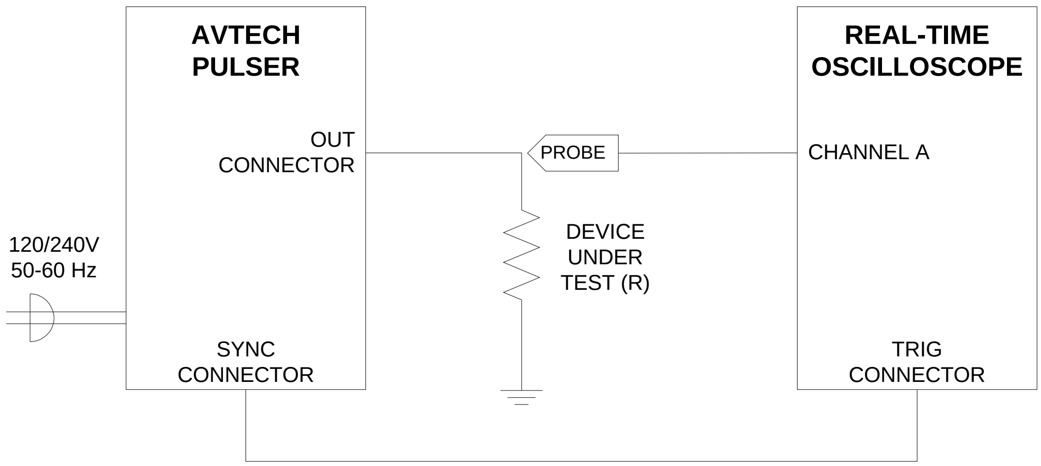
Fig.12 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

The resistor may be destroyed if these limits are exceeded.

If a resistor does fail by going open circuit, the pulse generator will continue to operate normally, producing the set amplitude and timing. If a resistor fails by going short circuit, the pulse generator short-circuit protection circuitry will act to disable the output. Short circuit failures should be avoided. Prolonged short circuits may damage the pulse generator.

CONNECTING THE DEVICE UNDER TEST

The AVR-7B-B-P-QTKA should normally be connected as shown in the figure below.



Be sure that your oscilloscope and probe setup can handle the maximum amplitude of 700V. A high-voltage attenuator might be necessary to avoid damaging the probe and oscilloscope.

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.

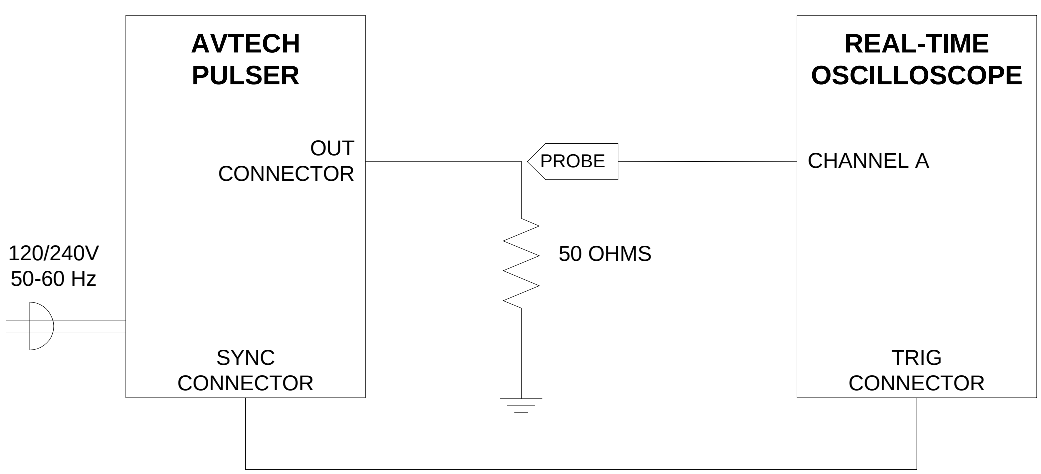
Before proceeding with this procedure, finish read this instruction manual thoroughly. Then read the “Local Control” section of the “OP1B Interface Programming Manual” thoroughly. The “Local Control” section describes the front panel controls used in this operational check - in particular, the MOVE, CHANGE, and ADJUST controls.

1. Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Connect a 50W (or higher) 50Ω load to the OUT connector and place the scope probe across this load. The load resistor <u>must</u> have a voltage rating of at least 700V. The power dissipated in the resistor is given by

   $$P = \frac{V^2}{R} \times \frac{PW}{T} = \frac{V^2}{R} \times PW \times f ,$$

   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 100 Volts/div and the horizontal setting at 1 μs/div. Be sure that your oscilloscope and probe setup can handle the maximum amplitude of 700V. A high-voltage attenuator might be necessary to avoid damaging the probe and oscilloscope.



The 50Ω load resistor should be rated for at least 700V of voltage and 50W of average power.

3. Turn on the AVR-7B-B-P-QTKA. The main menu will appear on the LCD.

4. To set the AVR-7B-B-P-QTKA 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 μs:

   - 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 μs.

   - 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 1 μs:

   - 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 1 μs.

   - 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 +200V.
   - Observe the oscilloscope. You should see 1 μs wide, 200V pulses.
   - Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary.
   - Reduce the amplitude to 50V using the adjust knob.
   - 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 "OP1B Interface Programming Manual" 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 1 us	(sets the pulse width to 1 us)
pulse:delay 2 us	(sets the delay to 2 us)
volt 200	(sets the amplitude to 200 V)
output on	(turns on the output)

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

*rst	(resets the instrument)
trigger:source hold	(turns off all triggering)
pulse:width 1 us	(sets the pulse width to 1 us)
pulse:delay 2 us	(sets the delay to 2 us)
output on	(turns on the output)
volt 200	(sets the amplitude to 200 V)
trigger:source immediate	(generates a single non-repetitive trigger event)
trigger:source hold	(turns off all triggering)
output off	(turns off the output)

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

*rst	(resets the instrument)
trigger:source external	(selects internal triggering)
pulse:width 1 us	(sets the pulse width to 1 us)
pulse:delay 2 us	(sets the delay to 2 us)
volt 200	(sets the amplitude to 200 V)
output on	(turns on the output)

These commands will satisfy 90% of your programming needs.

ALL PROGRAMMING COMMANDS

For more advanced programmers, a complete list of the available commands is given below. These commands are described in detail in the “OP1B Interface Programming Manual”. (Note: this manual also includes some commands that are not implemented in this instrument. They can be ignored.)

<table>
<tr><th>Keyword</th><th>Parameter</th><th>Notes</th></tr>
<tr><td>LOCAL</td><td></td><td></td></tr>
<tr><td>OUTPut:</td><td></td><td></td></tr>
<tr><td>   :[STATe]</td><td><boolean value></td><td></td></tr>
<tr><td>   :PROTection</td><td></td><td></td></tr>
<tr><td>   :TRIPped?</td><td></td><td>[query only]</td></tr>
<tr><td>REMOTE</td><td></td><td></td></tr>
<tr><td>[SOURce]:</td><td></td><td></td></tr>
<tr><td>   :FREQuency</td><td></td><td></td></tr>
<tr><td>   [:CW | FIXed]</td><td><numeric value></td><td></td></tr>
<tr><td>[SOURce]:</td><td></td><td></td></tr>
<tr><td>   :PULSe</td><td></td><td></td></tr>
<tr><td>   :PERiod</td><td><numeric value></td><td></td></tr>
<tr><td>   :WIDTh</td><td><numeric value> | EXTernal</td><td></td></tr>
<tr><td>   :DCYCle</td><td><numeric value></td><td></td></tr>
<tr><td>   :HOLD</td><td>WIDTh | DCYCle</td><td></td></tr>
<tr><td>   :DELay</td><td><numeric value></td><td></td></tr>
<tr><td>   :GATE</td><td></td><td></td></tr>
<tr><td>   :TYPE</td><td>ASYNC | SYNC</td><td></td></tr>
<tr><td>   :LEVel</td><td>HIgh | LOw</td><td></td></tr>
<tr><td>[SOURce]:</td><td></td><td></td></tr>
<tr><td>   :VOLTage</td><td></td><td></td></tr>
<tr><td>   [:LEVel]</td><td></td><td></td></tr>
<tr><td>   [:IMMediate]</td><td></td><td></td></tr>
<tr><td>   [:AMPLitude]</td><td><numeric value> | EXTernal</td><td></td></tr>
<tr><td>   :PROTection</td><td></td><td></td></tr>
<tr><td>   :TRIPped?</td><td></td><td>[query only]</td></tr>
<tr><td>STATUS:</td><td></td><td></td></tr>
<tr><td>   :OPERation</td><td></td><td></td></tr>
<tr><td>   :[EVENt]?</td><td></td><td>[query only, always returns "0"]</td></tr>
<tr><td>   :CONDition?</td><td></td><td>[query only, always returns "0"]</td></tr>
<tr><td>   :ENABle</td><td><numeric value></td><td>[implemented but not useful]</td></tr>
<tr><td>   :QUEStionable</td><td></td><td></td></tr>
<tr><td>   :[EVENt]?</td><td></td><td>[query only, always returns "0"]</td></tr>
<tr><td>   :CONDition?</td><td></td><td>[query only, always returns "0"]</td></tr>
<tr><td>   :ENABle</td><td><numeric value></td><td>[implemented but not useful]</td></tr>
<tr><td>SYSTem:</td><td></td><td></td></tr>
<tr><td>   :COMMunicate</td><td></td><td></td></tr>
<tr><td>   :GPIB</td><td></td><td></td></tr>
<tr><td>   :ADDRess</td><td><numeric value></td><td></td></tr>
<tr><td>   :SERial</td><td></td><td></td></tr>
<tr><td>   :CONTrol</td><td></td><td></td></tr>
<tr><td>   :RTS</td><td>ON | IBFull | RFR</td><td></td></tr>
<tr><td>   :[RECeive]</td><td></td><td></td></tr>
<tr><td>   :BAUD</td><td>1200 | 2400 | 4800 | 9600</td><td></td></tr>
<tr><td>   :BITS</td><td>7 | 8</td><td></td></tr>
</table>

: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]

PERFORMANCE CHECK SHEET