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INSTRUCTIONS

MODEL AVRQ-2-B

-2000 VOLTS INTO 40 pF,
50 ns to 500 ns RISE TIME
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.

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Manual Reference: /fileserver1/officefiles/instructword/avrq/obs/AVRQ-2-B,edition1.sxw.
Last modified February 29, 2024.

INTRODUCTION

The AVRQ-2-B generates a -2000 V pulse into capacitive loads of up to 40 pF. The 10%-90% rise time of the leading edge is variable from < 50 ns to > 500 ns. Approximately 1 microsecond after the start of the leading transition, the voltage starts to decay back to zero. The fall time of this decay is at least ten times greater than the rise time of the leading edge. The pulse repetition frequency is adjustable from 1 Hz to 10 Hz, using the front panel controls or by computer command. This instrument may also be triggered by an external TTL trigger pulse (10 Hz maximum), by a computer command, or by a front-panel pushbutton.

The AVRQ-2-B features front panel keyboard and adjust knob control of the output pulse parameters along with a four line by 40-character backlit LCD display of the rise time, pulse width, pulse delay, and pulse repetition frequency. The instrument includes memory to store up to four complete instrument setups. The operator may use the front panel or the computer interface to store a complete "snapshot" of all key instrument settings, and recall this setup at a later time.

This instrument is intended for use in research and development laboratories.

HIGH-VOLTAGE PRECAUTIONS

⚠ **CAUTION:** This instrument provides output voltages as high as 2000 Volts under normal operating conditions, and generates > 2000V 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:	AVRQ-2-B[1]
GPIB and RS-232 control:	Yes.
Amplitude:	-2000V, +/- 5%
Load resistance:	> 10 Megohms
Load capacitance:	≈ 40 pF total, including cabling. (Note that typical coaxial cabling has a capacitance of 30 pF/foot)
Leading edge rise time[2]: (10% - 90%):	< 50 ns to > 500 ns, variable. (Refers to the leading edge, which swings from 0 to -2000V).
Leading edge shape:	Linear, approximately. See the "Typical Waveforms" section of this manual.
Trailing edge fall time: (90% - 10%):	At least ten times greater than the rise time. (Refers to the trailing edge, which swings from -2000V to 0V)
Trailing edge shape:	Exponential decay, approximately. See the "Typical Waveforms" section of this manual.
Pulse width:	1 us (measured between the start of the leading edge and the start of the falling edge)
PRF:	Internal trigger: 1 to 10 Hz External trigger: 0 to 10 Hz
Output protection:	Short-circuit protected.
Output enable timer:	The output will only remain active for 90 seconds after being enabled from the front panel or by computer command. After that time, the output will be disabled. The output must be re-enabled from the front panel or by computer command for the next test sequence.
Propagation delay:	≤ 200 ns (Ext trig in to start of output pulse)
Jitter (Ext trig in to pulse out):	± 200 ps ± 0.03% of sync delay
Trigger required (ext trig mode):	TTL levels (0 and +3V to +5V), 50 ns or wider
Sync delay:	Variable 0 to ± 1.0 seconds
Sync output:	TTL levels (0 and +3V to +5V), 100 ns, will drive 50 Ohm loads
Gate input:	Synchronous, active high or low, switchable. Suppresses triggering when active.
Connectors:	Out: SHV (rear-panel) Trig, Sync, Gate: BNC (rear-panel)
Power requirements:	100 - 240 Volts, 50 - 60 Hz
Dimensions: (H x W x D)	100 mm x 430 mm x 475 mm (3.9" x 17" x 18.8")
Chassis material:	cast aluminum frame and handles, blue vinyl on aluminum cover plates
Temperature range:	+5°C to +40°C

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) Valid into a 40 pF load. The rise time is affected by the load capacitance. As such, a high-voltage high-bandwidth oscilloscope probe such as the Tektronix P5100 should always be used to verify the actual output rise time, rather than relying on the programmed value.

EC DECLARATION OF CONFORMITY

We

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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

CE

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

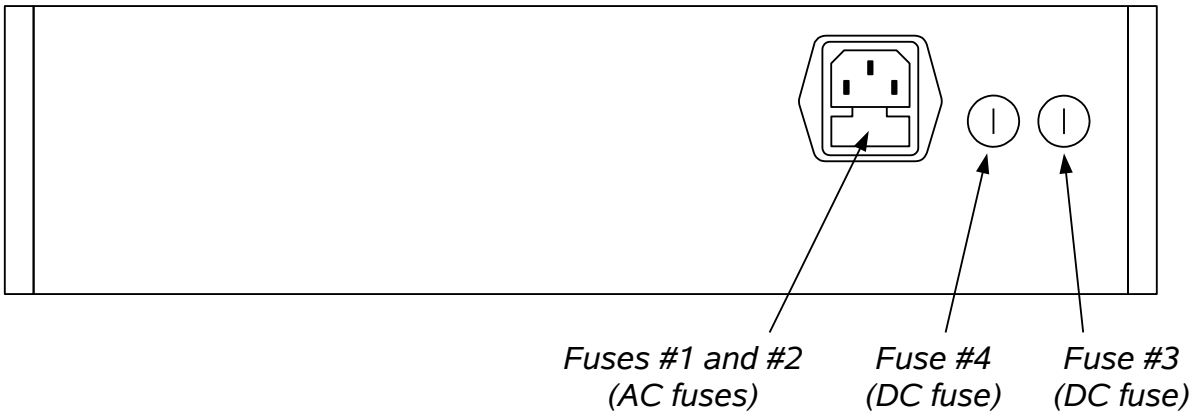
ENVIRONMENTAL CONDITIONS

This instrument is intended for use under the following conditions:

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

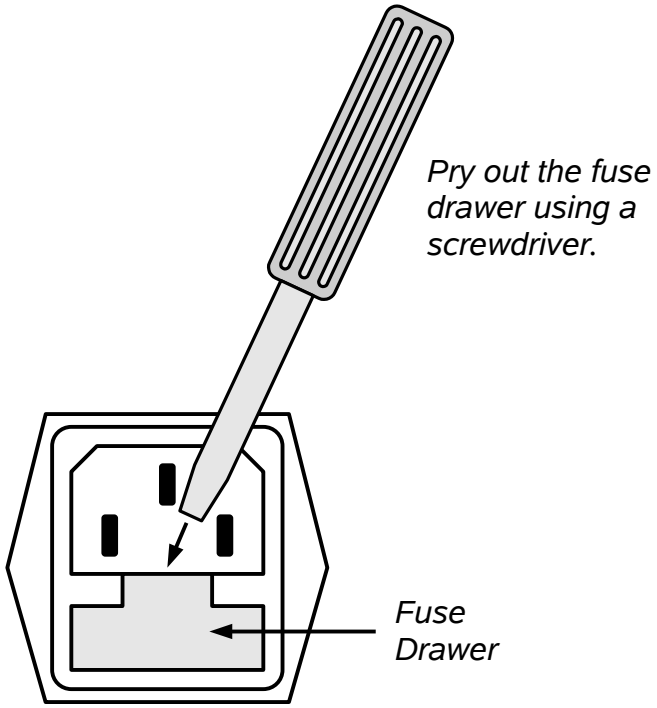
FUSES

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



AC FUSE REPLACEMENT

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



DC FUSE REPLACEMENT

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

FUSE RATINGS

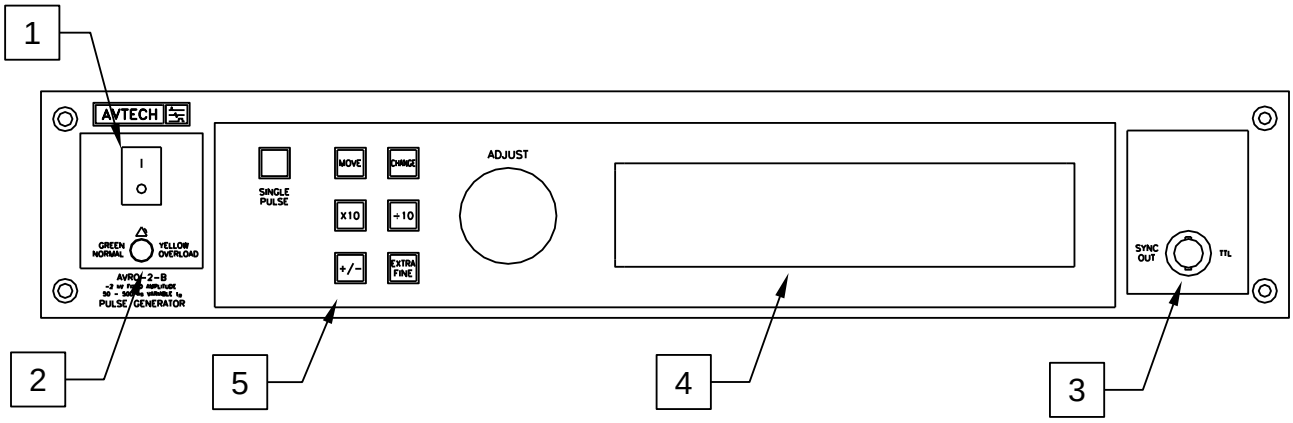
The following table lists the required fuses:

Fuses	Nominal Mains Voltage	Rating	Case Size	Manufacturer's Part Number (Wickmann)	Distributor's Part Number (Digi-Key)
#1, #2 (AC)	100-240V	0.5A, 250V, Time-Delay	5×20 mm	1950500000	WK5041-ND
#3 (DC)	N/A	1.6A, 250V, Time-Delay	5×20 mm	1951160000	WK5053-ND
#4 (DC)	N/A	0.5A, 250V, Time-Delay	5×20 mm	1950500000	WK5041-ND

The fuse manufacturer is Wickmann (http://www.wickmann.com/).

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

FRONT PANEL CONTROLS



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

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

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

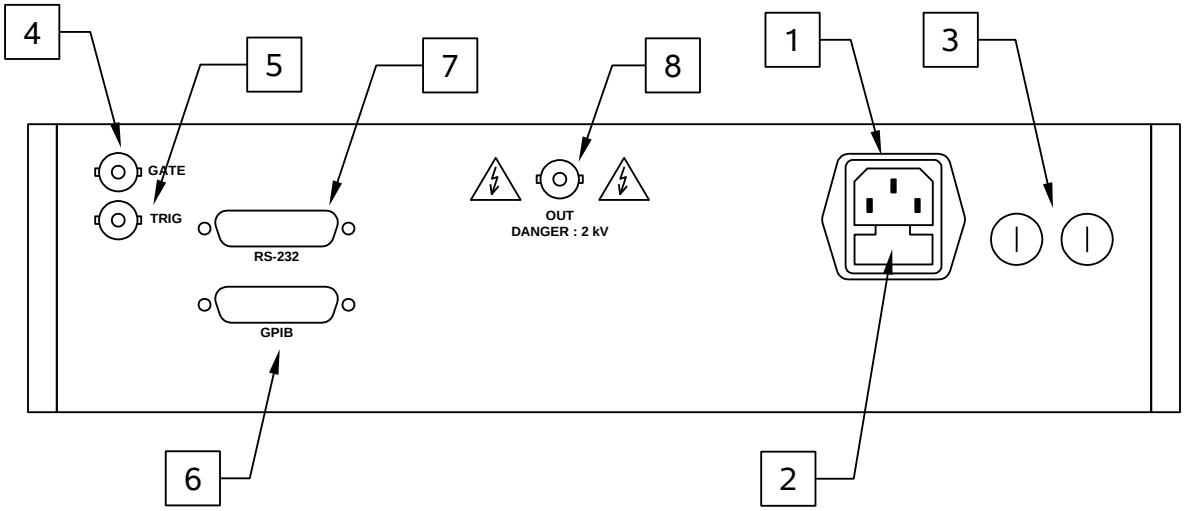
3. SYNC OUT. This connector supplies a SYNC output that can be used to trigger other equipment, particularly oscilloscopes. This signal leads (or lags) the main output by a duration set by the "DELAY" controls and has an approximate amplitude of +3 Volts to R_L > 1 kΩ with a pulse width of approximately 200 ns.

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

5. KEYPAD.

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

REAR PANEL CONTROLS



1. AC POWER INPUT. An IEC-320 C14 three-pronged recessed male socket is provided on the back panel for AC power connection to the instrument. One end of the detachable power cord that is supplied with the instrument plugs into this socket.

2. AC FUSE DRAWER. The two fuses that protect the AC input are located in this drawer. Please see the “FUSES” section of this manual for more information.

3. DC FUSES. These two fuses protect the internal DC power supplies. Please see the “FUSES” sections of this manual for more information.

4. GATE. This TTL-level (0 and +5V) logic input can be used to gate the triggering of the instrument. This input can be either active high or active low, depending on the front panel settings or programming commands. (The instrument triggers normally when this input is unconnected). When set to active high mode, this input is pulled-down to ground by a 1 kΩ resistor. When set to active low mode, this input is pulled-up to +5V by a 1 kΩ resistor.

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

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

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

8. OUT CONNECTOR. This SHV connector provides the main output signal, into load resistances of > 10 MΩ, and capacitances of up to 40 pF. (If the load capacitance is significantly less than 40 pF, some capacitance may need to be added to the device under test to achieve the full rise time adjustment range.)

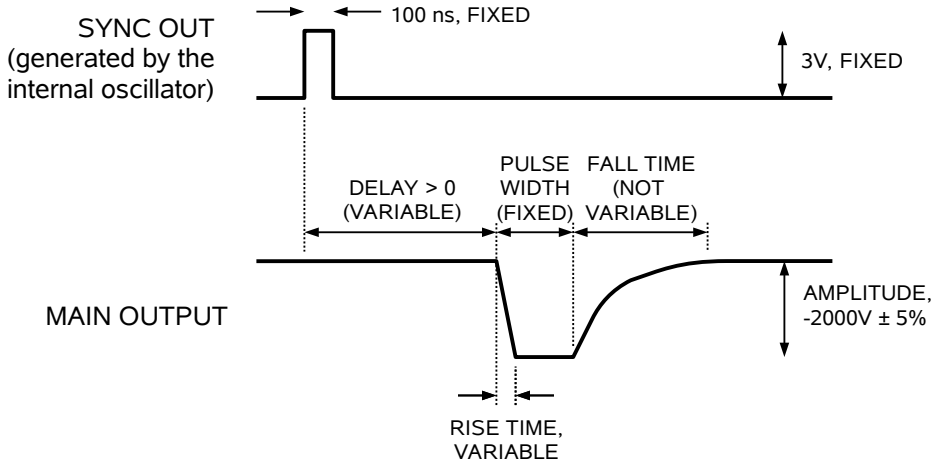
   ⚠ Caution: Voltages as high as 2000V may be present on the center conductor of this output connector. Avoid touching this conductor. Connect to this connector using standard coaxial cable, to ensure that the center conductor is not exposed.

GENERAL INFORMATION

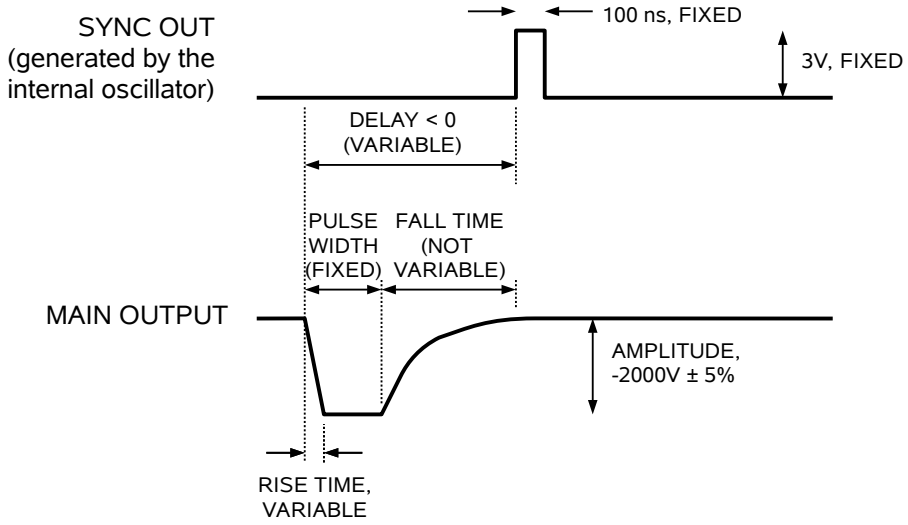
BASIC PULSE CONTROL

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.

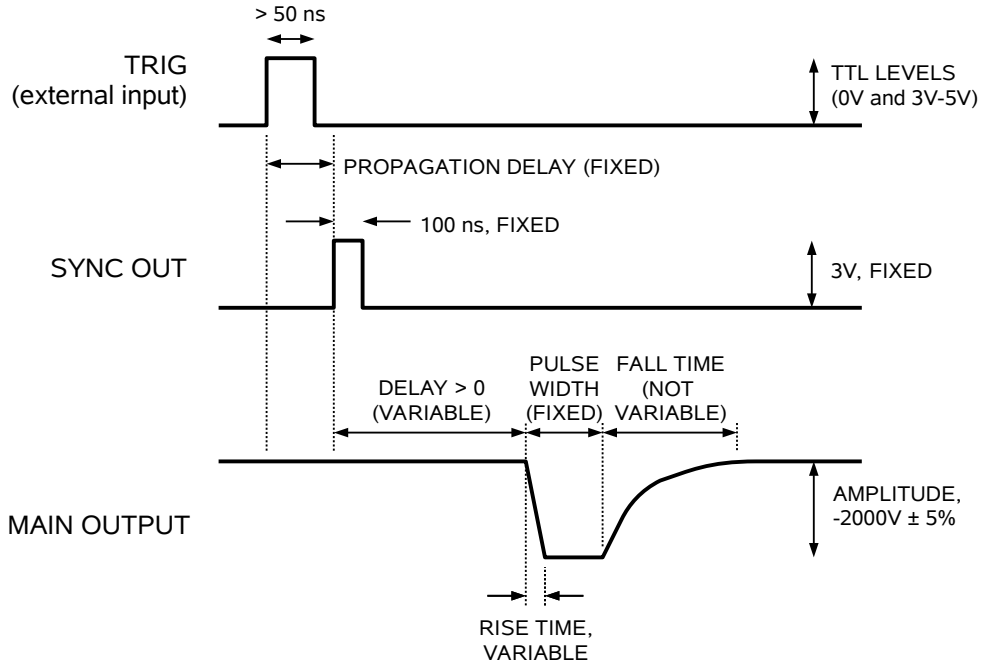
These pulses are illustrated below, assuming internal triggering and a positive delay:



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



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



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

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

TRIGGER MODES

This instrument has four trigger modes:

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

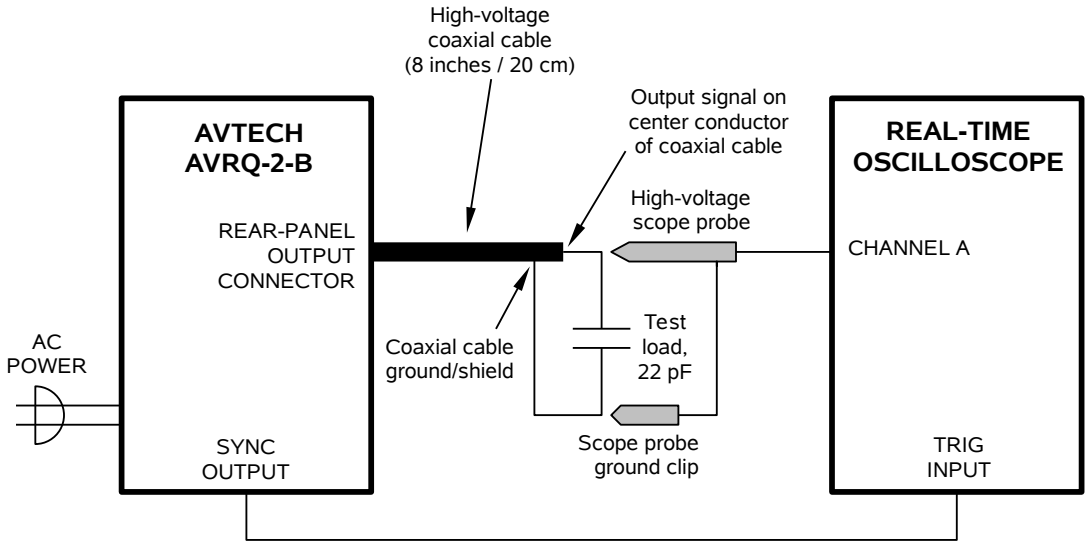
These modes can be selected using the front panel trigger menu, or by using the appropriate programming commands. (See the “Programming Manual for -B Instruments” for more details.)

GATING MODES

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

BASIC TEST ARRANGEMENT

The figure below shows how the AVRQ-2-B is tested at the factory:



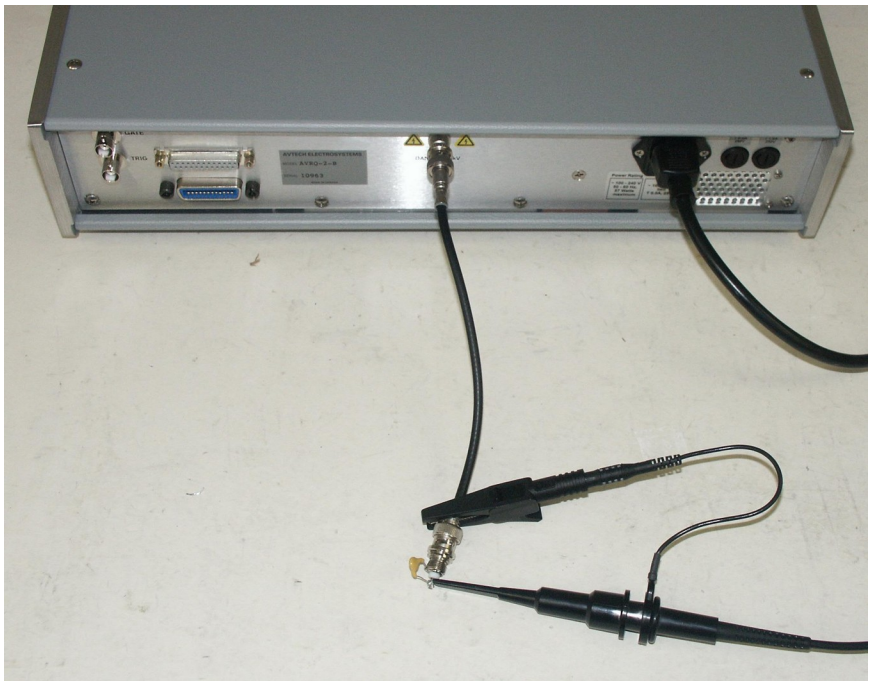
The AVRQ-2-B requires a load of approximately 40 pF in to obtain the expected rise time adjustment range. In the figure above, this is achieved by using an 8" length of coaxial cable (≈ 2.5 pF / inch, ≈ 20 pF total) and a 22 pF capacitor.

⚠ Caution: The load capacitor must be rated for operation at 2 kV or higher. Factory tests are conducted using a 3 kV, 22 pF Panasonic ECC-D2F220JGE capacitor, available from Digi-Key (http://www.digikey.com, stock number P10832-ND).

⚠ Caution: The oscilloscope probe must be rated for operation at 2 kV (pulsed) or higher. Factory tests are conducted using a Tektronix P5100 prove, which has a 2.5 kV peak rating and a 1000:1 division ratio. (Remember to adjust the compensation of the probe to match your oscilloscope input.)

⚠ Caution: Any connectors and cables used on the output must be able to withstand a 2 kV pulse. The common RG58C/U cable has an RMS voltage rating of 1900V (1900V RMS = 2687V peak), and should be adequate. The use of RG174A/U, another common cable type, is not recommended due to its lower rating (1500V RMS) and smaller diameter. For an extra large safety margin, consider the use of RG214/U cable (5000V RMS). See http://www.avtechpulse.com/appnote/techbrief6/ for more cabling information.

The photos below show how the diagram above is actually implemented for factory tests:



The photo above shows the Tektronix P5100 probe (with the signal probe at the bottom, and the ground clip at the top), and the yellow 22 pF capacitor. An 8” length of SHV-to-BNC cable has been used. The capacitor is soldered to a BNC-to-solder-terminal adapter. (Other cable/connector arrangements might be more practical. For instance, consider using the Pasternack PE3815-8 or PE3117-8 SHV-to-SHV cables

with the PE4239, PE4499, PE4500, or PE4501 SHV-to-solder-terminal adapters. See http://www.pasternack.com for more information.)

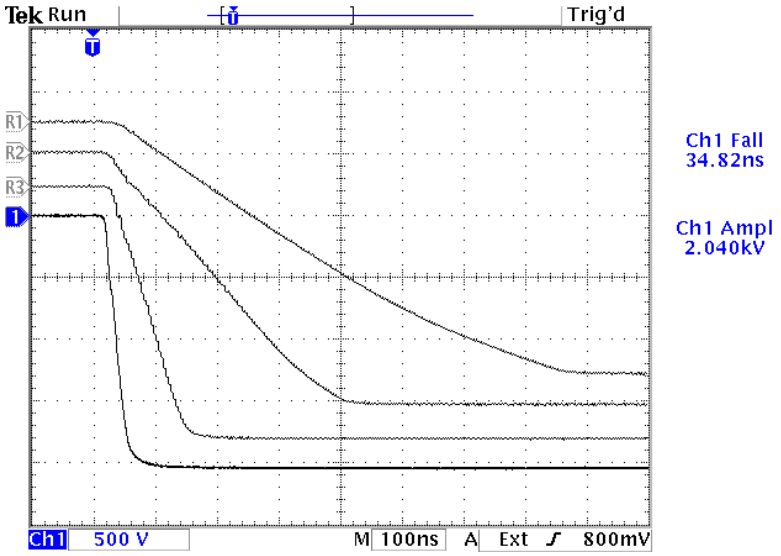
It is very important that the oscilloscope ground clip be connected to a ground point very close to the load. Otherwise, unusual oscillations and distortions may appear on the measurements.

OUTPUT CABLE LENGTHS

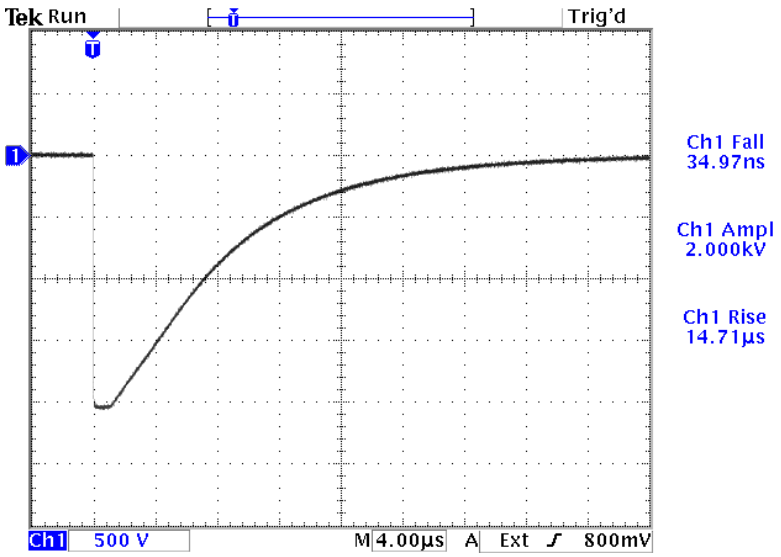
The AVRQ-2-B requires a load capacitance of 40 pF to operate properly. This includes any capacitance contributed by the device under test and any cabling. Since most coaxial cabling adds capacitance at a rate of 30 pF / foot, cable lengths can not be any longer than 15 inches (38 cm). Factory tests are conducted using an 8 inch length of cable.

TYPICAL WAVEFORMS

The photo below shows the leading edge of four waveforms obtained using four different rise time settings. The test arrangement shown in the preceding section was used. The scale is 500 V/div and 100 ns/div.



The photo below shows the output on a longer time scale, showing both the leading/rising and trailing/falling edges. The rise time was set to the minimum value. The scale is 500 V/div and 4 us/div.



OPERATIONAL CHECK

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

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

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

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

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

3. To set the AVRQ-2-B to trigger from the internal clock at a PRF of 10 Hz:

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

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

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

   d) Press CHANGE to return to the main menu.

4. To set the delay to 50 ns:

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

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

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

   d) Press CHANGE to return to the main menu.

5. To set the rise time to 100 ns:

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

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

    c) 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) Observe the oscilloscope. You should see - 2kV pulses with 100 ns rise time.

    e) Press CHANGE to return to the main menu.

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

9. 90 seconds after the output is turned on, the instrument will automatically shut the output off. Confirm that this occurs.

This completes the operational check.

PROTECTING YOUR INSTRUMENT

USE HIGH-VOLTAGE CABLES, CONNECTORS, AND PROBES

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

SHORT-CIRCUIT PROTECTION

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

MECHANICAL INFORMATION

TOP COVER REMOVAL

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

Always disconnect the power cord before opening the instrument.

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

⚠ Caution: High voltages (over 2000V) are present inside the instrument during normal operation. Do not operate the instrument with the cover removed.

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

RACK MOUNTING

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

MAINTENANCE

REGULAR MAINTENANCE

This instrument does not require any regular maintenance.

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

CLEANING

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

PROGRAMMING YOUR PULSE GENERATOR

KEY PROGRAMMING COMMANDS

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

```
*rst                        (resets the instrument)
trigger:source internal     (selects internal triggering)
frequency 10 Hz         (sets the frequency to 10 Hz)
pulse:transition 50 ns      (sets the rise time to 1 us)
pulse:delay 1 us            (sets the delay to 1 us)
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:transition 50 ns      (sets the rise time to 1 us)
output on                   (turns on the output)
trigger:source immediate    (generates a single non-repetitive trigger event)
trigger:source hold         (turns off all triggering)
output off                  (turns off the output)
```

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

```
*rst                        (resets the instrument)
trigger:source external     (selects internal triggering)
pulse:transition 50 ns      (sets the rise time to 1 us)
pulse:delay 1 us            (sets the delay to 1 us)
output on                   (turns on the output)
```

These commands will satisfy 90% of your programming needs.

ALL PROGRAMMING COMMANDS

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

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

PERFORMANCE CHECK SHEET