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## INSTRUCTIONS

MODEL AVR-D2-B

MIL-S-19500 SWITCHING TIME TEST  
PULSE GENERATOR  
WITH IEEE 488.2 AND RS-232 CONTROL

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

### WARRANTY

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## INTRODUCTION

Model AVR-D2-B is specifically designed to perform MIL-S-19500 switching time tests, but it is also useful as a high-speed medium-voltage general-purpose laboratory pulse generator. The main output (channel 1) provides a 0 to  $\pm 30$  Volt pulse and the width is variable from 200 ns to 20  $\mu$ s. A second output (channel 2) provides a  $\pm 2$  Volt, 15 ns wide pulse. The rise and fall times for both outputs are less than 1 ns and both outputs have a  $50\Omega$  source impedance. Both outputs require a  $50\Omega$  load. A variable DC offset of 0 to  $\pm 15$  Volts is available on the channel 1 output while a  $\pm 1.0$  Volt DC offset is available on the channel 2 output.

The AVR-D2-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 AVR-D2-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.

### SPECIFICATIONS

Model:	AVR-D2-B
GPIB & RS-232 control:	Included
Amplitude: Channel 1: (50 $\Omega$ load) Channel 2:	0 to $\pm$ 30 Volts $\pm$ 2 Volts
Pulse width: Channel 1: Channel 2:	0.2 to 20 $\mu$ s 15 ns
Rise time, fall time:	< 1 ns
PRF:	0 to 50 kHz
Duty Cycle (max):	10% PW $\leq$ 2 $\mu$ s: 0 to 50 kHz PW = 20 $\mu$ s: 0 to 5 kHz
Polarity:	Positive and negative
DC offset: Channel 1: Channel 2:	0 to $\pm$ 15 Volts 0 to $\pm$ 1.0 Volts
Sync Output:	+ 5 Volt, 200 ns
Sync delay: (sync out to pulse out):	0 to 20 $\mu$ s
Trigger required: (Ext trig. mode)	+ 5 Volt, $\geq$ 10 ns
Propagation delay: (Ext trig in to pulse out)	< 100 ns
Jitter: (Ext trig in to pulse out)	< $\pm$ 100ps $\pm$ 0.015% sync delay
Connectors: Out, Trig, Sync	BNC
Power requirement:	120/240 V, 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
Temperature range:	+ 10° to + 40° C

## INSTALLATION

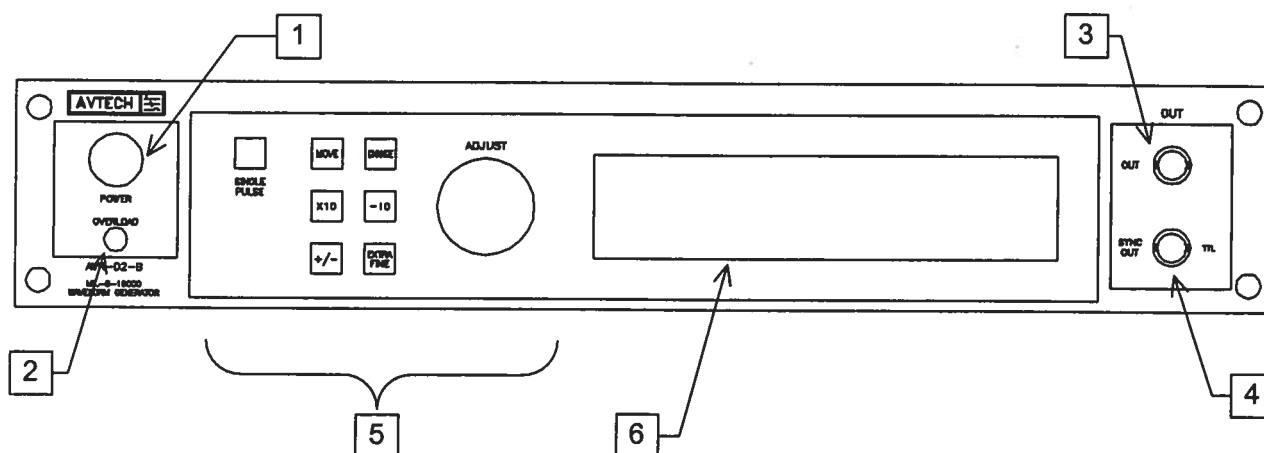
### VISUAL CHECK

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 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 is in the correct orientation - it should be marked either 120 or 240, indicating whether it expects 120V AC or 240V AC. 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 1.0A slow blow fuse is required. In the 240V setting, a 1/2A slow blow fuse is required.

## 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 internal +15V DC supply.
2. **OVERLOAD.** The AVR-D2-B 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 may come on briefly at startup. This is not a cause for concern.

3. **OUT CONNECTOR.** This BNC connector provides the output signal, into load impedances of 50Ω. This instrument has two channels internally (channels 1 and 2), but only one is supplied to the OUT connector at a time, depending on the front-panel settings, or computer commands. CAUTION: Channel 1 may be damaged if operated into an open-circuited or short-circuited 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

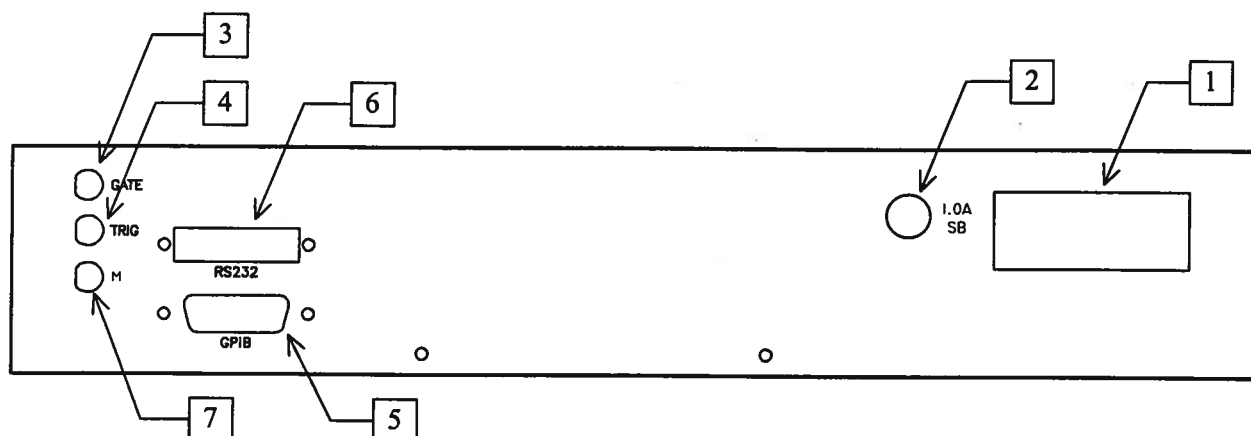
of +3 Volts to  $R_L > 1k\Omega$  with a pulse width of approximately 200 ns.

5. 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.
6. 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.** A three-pronged recessed male connector is provided on the back panel for AC power connection to the instrument. Also contained in this assembly is a 1.0A slow blow fuse and a removable card that can be removed and repositioned to switch between 120V AC in and 240V AC in.
2. **1.0A SB.** This fuse protects the DC power supply to 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).
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 instrument can also 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.
7. **M Connector.** The monitor output provides an attenuated replica (20 dB down) of the voltage on the output connector. The monitor output is designed to operate into a 50 Ohm load.

## GENERAL INFORMATION

### BASIC PULSE CONTROL

This instrument can generate two types of waveforms, designated Channel 1 and Channel 2, on the main output. These two channels share a common output connector, and only one is active at a time. The general characteristics of the two channels are as follows:

- Channel 1:
  - Amplitude continuously variable from -30V to +30V (requires a 50 $\Omega$  load)
  - Offset continuously variable from -15V to +15V
  - Pulse width continuously variable from 0.2 to 20  $\mu$ s
- Channel 2:
  - Amplitude of either -2V or +2V (not continuously variable)
  - Offset continuously variable from -1V to +1V
  - Pulse width fixed at 15 ns

When Channel 1 is active, the main menu on the front panel LCD will display "Active:CH1". When Channel 2 is active, the main menu on the front panel LCD will display "Active:CH2".

Regardless of the channel used, this instrument can be triggered by its own internal clock or by an external TTL trigger signal. In either case, two signals respond to the trigger: OUT and SYNC.

- OUT. This is the main output. The Channel 1 or Channel 2 waveform is generated on this output.
- SYNC. 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:

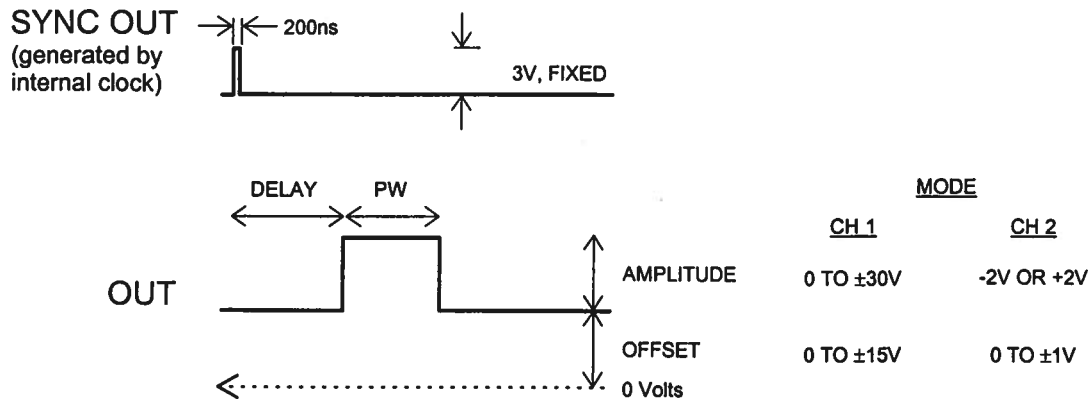


Figure A

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

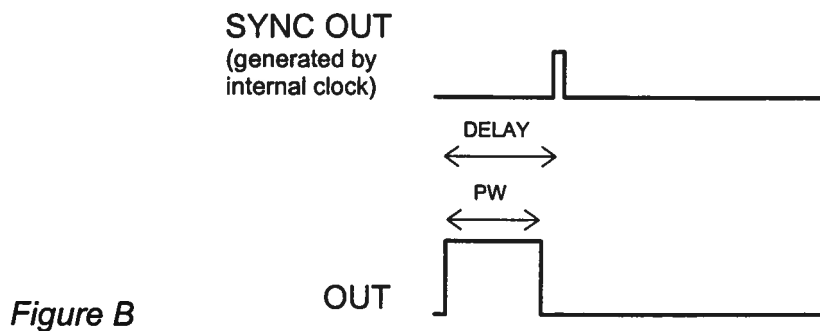


Figure B

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

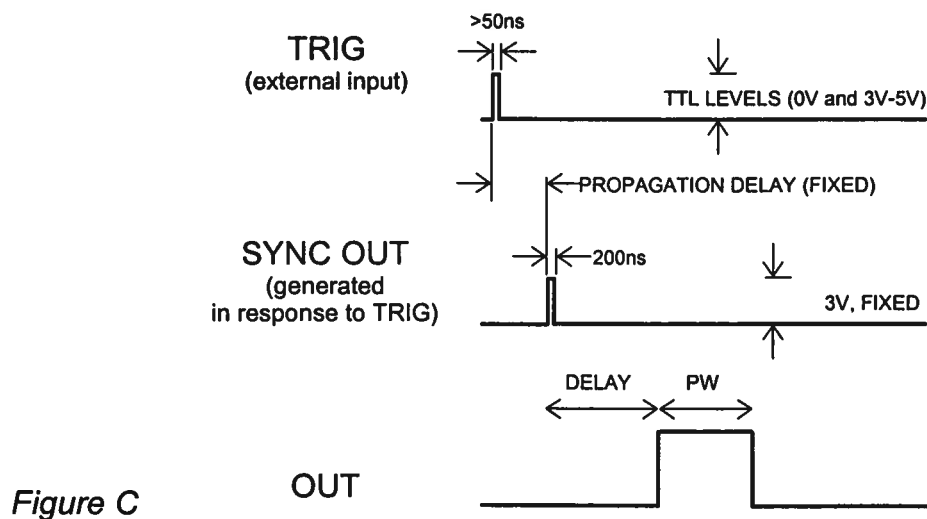


Figure C

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

In general, 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.)

**WARNING:** The output stage may be damaged if triggered by an external signal at a pulse repetition frequency greater than 5 kHz.

## 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.

## 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.

## PROTECTING YOUR INSTRUMENT AND YOUR LOAD

### DO NOT EXCEED 10% DUTY CYCLE

When triggering internally, the instrument will automatically prohibit conflicting settings. However, when triggering externally the user must take care to ensure that the output duty cycle for the channel 1 output must not exceed 10%, or the output stage may be damaged. For example, at the maximum pulse width of 20  $\mu\text{s}$ , the PRF must not exceed 5 kHz. For pulse width of 2  $\mu\text{s}$  or less the PRF may be as high as 50 kHz.

Note that the programmed value of the DC offset is accurate to at least 1% for duty cycles of less than 1% but this accuracy will degrade significantly as the duty cycle approaches 10% and as the pulse amplitude approaches 30 Volts.

### USE 50 $\Omega$ TERMINATIONS

Both channels 1 and 2 are designed to operate into 50 Ohms so the switching time test circuit should present an input resistance of this magnitude. Note that AVTECH can supply some test jigs. Call AVTECH for more information. Caution: Channel 1 may be damaged if operated into an open-circuited or short-circuited load or if an externally generated potential (DC or pulse) is applied to the output. The input to the test circuit must include a series DC blocking capacitor if DC potential (or Bias levels) exists in the input to the test circuit. In addition to possible damage, the internally generated DC offsets will be in error if externally generated DC bias levels appear at the input to the test load.

### CONSIDER THE POWER DISSIPATION

At maximum duty cycle, Channel 1 will provide nearly 2 Watts average power so the test circuit must be capable of dissipating this power.

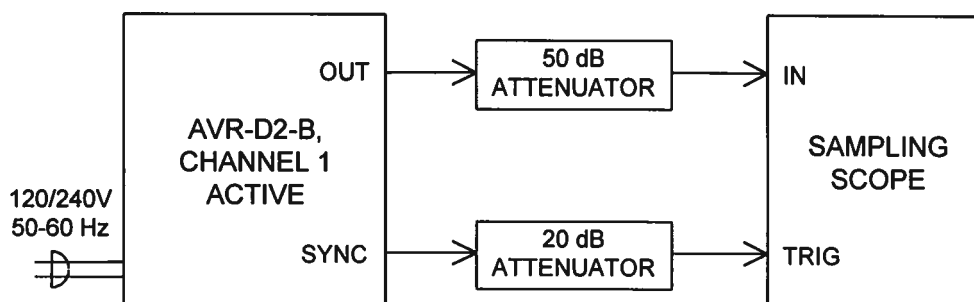
The DC offset on Channel 1 will provide up to 4.5 Watts to a DC load of 50 Ohms. It may be necessary to place DC blocking capacitors in the test circuit to limit the DC power dissipation.

An audible hum may be evident when the DC offset is set near maximum for Channel 1 and the output pulse width is near maximum. This hum is normal.

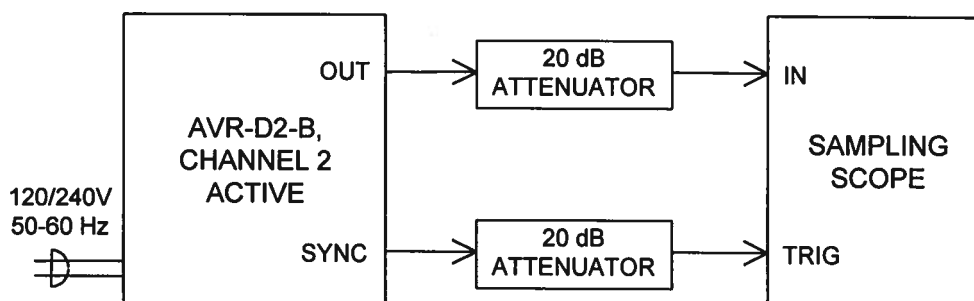
## OPERATIONAL CHECK

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 "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.



*BASIC TEST ARRANGEMENT FOR TESTING CHANNEL 1*



*BASIC TEST ARRANGEMENT FOR TESTING CHANNEL 2*

Connect the pulse generator to a sampling oscilloscope as shown above in the "Basic Test Arrangement For Testing Channel 1" figure. Note that:

- a) The use of 50 dB attenuator (for channel 1, but 20 dB for channel 2) at the scope vertical input channel will insure a peak input signal to the scope of less than 1 Volt (necessary only if sampling scope used). If a high impedance real

when operating. Note that AVTECH can supply some test jigs. Call for further information.

- b) The SYNC output channel provides TTL level signals (approximately 0 and +3V). To avoid overdriving the TRIG input channel of some scopes, a 20 dB attenuator should be placed at the input to the scope trigger channel.
  - c) The bandwidth capability of components and instruments used to display the pulse generator output signal (attenuators, cables, connectors, etc.) should exceed 1 GHz.
2. Turn on the AVR-D2-B. The main menu will appear on the LCD.
  3. To set the AVR-D2-B to generate the Channel 1 waveform on the output connector:
    - a) Press the MOVE button until the arrow pointer is pointing at the "Active" menu item.
    - b) Press the CHANGE button. The active channel submenu will appear.
    - c) The arrow pointer should be pointing at the "Channel 1" choice. If it is not, press MOVE until it is.
    - d) Press CHANGE to return to the main menu.
  4. To set the AVR-D2-B to trigger from the internal clock at a PRF of 2 kHz:
    - 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 2 kHz.
    - 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.
  5. To set the delay to 100 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 100 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. To set the Channel 1 pulse width to 500 ns:
  - a) Press the MOVE button until the arrow pointer is pointing at the PW1 menu item.
  - b) Press the CHANGE button. The pulse width submenu will appear. Rotate the ADJUST knob until the pulse width is set at 500 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.
7. At this point, nothing should appear on the oscilloscope.
8. To change the output amplitude:
  - a) Press the MOVE button until the arrow pointer is pointing at the AMP1 menu item.
  - b) Press the CHANGE button. The amplitude submenu will appear. Rotate the ADJUST knob until the amplitude is set at +20V.
  - c) Observe the oscilloscope. You should see 500 ns wide, +20V pulses. If you do not, you may need to adjust the delay setting to a value more compatible with your sampling oscilloscope. Repeat step 5 if required. You may also need to adjust the sampling scope controls.
  - d) Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary. Return it to +20V.
  - e) Press the +/- button on the front panel. The amplitude as seen on the oscilloscope should flip polarity, to -20V.
  - f) Press CHANGE to return to the main menu.
9. Try varying the pulse width, by repeating step (6). As you rotate the ADJUST knob, the pulse width on the oscilloscope will change. It should agree with the displayed value.

10. To set the AVR-D2-B to generate the Channel 2 waveform on the output connector:
  - a) Press the MOVE button until the arrow pointer is pointing at the "Active" menu item.
  - b) Press the CHANGE button. The active channel submenu will appear.
  - c) Press the MOVE button until the arrow pointer is pointing at the "Channel 2" menu item.
  - d) Press CHANGE to return to the main menu.
  - e) Observe the oscilloscope. You should see 15 ns wide, -2V pulses. If you do not, you may need to adjust the delay setting to a value more compatible with your sampling oscilloscope. Repeat step 5 if required. You may also need to adjust the sampling scope controls.

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)
route:close (@1)    (selects the Channel 1 output waveform)
frequency 1000 Hz  (sets the frequency to 1000 Hz)
pulse:width1 500 ns (sets the channel 1 pulse width to 500 ns)
pulse:delay 20 ns  (sets the delay to 20 ns)
volt:ampl1 -20     (sets the channel 1 amplitude to -20 V)
volt:low1 -2V     (sets the channel 1 offset to -2 V)
volt:ampl2 -2V    (sets the channel 2 amplitude to -2 V)
volt:low2 +1V     (sets the channel 2 offset to +1 V)
(...perform your tests using the channel 1 output....)
route:close (@2)  (selects the Channel 2 output waveform)
(...perform your tests using the channel 2 output....)
```

These commands will satisfy 90% of your programming needs.

Note that the pulse width, amplitude and offset commands require that a channel number be added to the end of the command header. If no channel number is added, Channel 1 is assumed.

### 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.)

<u>Keyword</u>	<u>Parameter</u>	<u>Notes</u>
LOCAL		
REMOTE		
[ROUTe]:		
:CLOSe	<channel list>	
[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	SYNC	
:LEVel	High   LOw	
[SOURCE]:		
:VOLTage		
[:LEVel]		
[:IMMediate]		
[:AMPLitude]	<numeric value>	
:LOW	<numeric value>	
:PROTection		
:TRIPped?		[query only]
STATUS:		
:OPERation		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
:QUESTionable		
:[EVENT]?		[query only, always returns "0"]
:CONDition?		[query only, always returns "0"]
:ENABle	<numeric value>	[implemented but not useful]
SYSTEM:		
:COMMunicate		
:GPIB		
:ADDRess	<numeric value>	
:SERial		
:CONTRol		
:RTS	ON   IBFull   RFR	
:[RECeive]		
:BAUD	1200   2400   4800   9600	
:BITS	7   8	
:ECHO	<boolean value>	
:PARity		
:[TYPE]	EVEN   ODD   NONE	
:SBITS	1   2	
:ERRor		
:[NEXT]?		[query only]
:COUNT?		[query only]
:VERSion?		[query only]
TRIGger:		
:SOURce	INTernal   EXTernal   MANual   HOLD   IMMEDIATE	
*CLS		[no query form]
*ESE	<numeric value>	
*ESR?		[query only]
*IDN?		[query only]
*OPC		
*SAV	0   1   2   3	[no query form]
*RCL	0   1   2   3	[no query form]
*RST		[no query form]
*SRE	<numeric value>	

\*STB?  
\*TST?  
\*WAI

[query only]  
[query only]  
[no query form]

## REPAIR PROCEDURES

### SYSTEM DESCRIPTION AND REPAIR PROCEDURE

The AVR-D2-C consists of the following basic modules:

- 1) AVR-D2-PG1 pulse generator modules (-P and -N)
- 2) AVR-D2-PG2 pulse generator module
- 3) AVR-D2-PS-PN power supply and bias module
- 4) AVR-D2-OT offset module
- 5) AVR-D2-PS-24 power supply module
- 6) AVR-D2-RLY relay module
- 7) AVR-D2-RSM-2D coaxial relays
- 8) OP1B computer control and pulse generator board
- 9) OP1B-PS 60 Hz power supply board

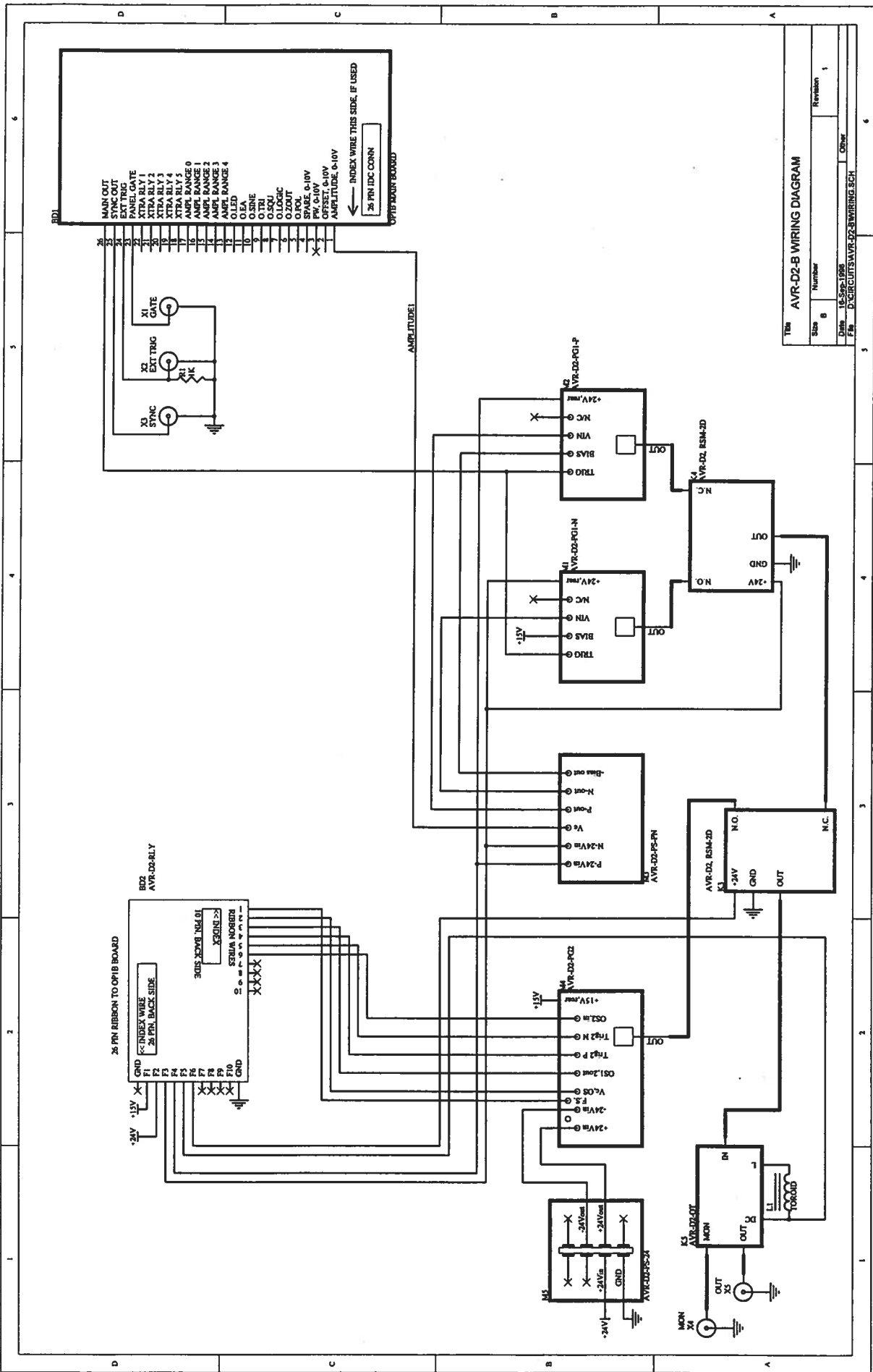
The modules are interconnected as shown in the attached schematic. The OP1B board controls the output PRF and the relative delay between the main output and the SYNC outputs. The PG pulse generator modules generate the output pulse.

In the event of an instrument malfunction, it is most likely that the rear panel 1.0A SB fuse or some of the output switching elements (SL5T) may have failed due to an output short circuit condition or to a high duty cycle condition. The switching elements may be accessed by removing the cover plates on the bottom side of the instrument. **NOTE:** First turn off the prime power. The elements may be removed from their sockets by means of a needle nosed pliers. The SL5T is a selected VMOS power transistor in a TO 220 packages and may be checked on a curve tracer. If defective, replacement units should be ordered directly from Avtech. When replacing the SL5T switching elements, take care to insure that the short lead (of the three leads) is adjacent to the black dot on the chassis. If the switching elements are not defective, then the four Phillips screws on the back panel should be removed. The top cover may then be slid off and operation of the clock and power supply modules should be checked.

The OP1B board is functioning properly if:

- A) a TTL-level signal, with a pulse width equal to the Channel 1 pulse width setting is observed on finger 26 of the board. (The fingers are located near the front of the instrument, to the left.)
- B) The PRF of the TTL signal on finger 26 can be varied over the range of 1 Hz to 50 kHz using the PRF controls.
- C) The relative delay between the finger 26 and 25 outputs can be varied by at least 20  $\mu$ s by the DELAY controls.

The instrument must be returned to Avtech for repair or replacement if the above conditions are not observed.



**AVR-D2-B WIRING DIAGRAM**

Size	6	Number	1
Date	11-25-78	Other	
File	D:\CIRCUITS\AVR-D2-B\WIRING.SCH		