INSTRUCTIONS

MODEL AV-1021-B-JDSU1

0 TO +25 VOLTS, 5 MHz
GENERAL PURPOSE LAB 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

Phone: 613-226-5772 or 1-800-265-6681
Fax: 613-226-2802 or 1-800-561-1970

E-mail: info@avtechpulse.com
World Wide Web: http://www.avtechpulse.com

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INTRODUCTION

The AV-1021-B-JDSU1 is a high performance, GPIB and RS232-equipped instrument capable of generating 0 to +25 Volts into 50Ω loads, with DC offsets of 0 to +10V, at repetition rates up to 5 MHz. Pulse width and delay are variable up to 500 ms. Rise and fall times are fixed at less than 50 ns.

The AV-1021-B-JDSU1 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. In the external trigger mode, the output pulse width can be set by the pulse generator, or it can be set to follow the input trigger's pulse width. The AV-1021-B-JDSU1 can generate single or double pulse outputs.

The AV-1021-B-JDSU1 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, polarity, pulse width, pulse repetition frequency, source resistance 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:	AV-1021-B-JDSU1
GPIB and RS-232 control[1]:	Included
No. of channels out:	One, plus logic and logic-complement outputs
Amplitude (to 50 Ohms):	Main out: 0 to +25V TTL levels: 0 and +5V ECL levels: -0.8V and -1.6V
PRF:	1 Hz to 5 MHz
Pulse width:	100 ns to 0.5 sec
Rise time, fall time:	Main: ≤ 50 ns, TTL: 5 ns, ECL: 2 ns
DC offset:	0 to +10 V (total output not to exceed +25V)
Source impedance Z_{OUT} (main output):	2Ω
Polarity (main output):	Positive
Duty cycle (max):	50%
Trigger required (Ext trig mode):	+ 5 Volts, ≥ 4 ns TTL
Trigger required (Gate in):	TTL, synchronous or asynchronous, active high or low
Delay jitter:	≤ ±35ps ±0.015% RMS (sync out to pulse out)
Delay:	0 to ±0.5 sec (sync out to pulse out)
Sync output:	+2 Volts, 50 ns, will drive 50 Ohm loads
Single pulse mode:	manual front-panel push button or computer command
Double pulse mode:	yes
Signal connectors:	BNC
Power requirement:	120/240 Volts (switchable) 50 - 60 Hz (30 Watts)
Dimensions, Weight, Chassis:	100 × 215 × 315 mm (3.9" × 8.5" × 14.8"), 4.5 kg (10 lbs), anodized aluminum with blue-gray plastic trim
Mounting & Temperature range:	Any, +10° C 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
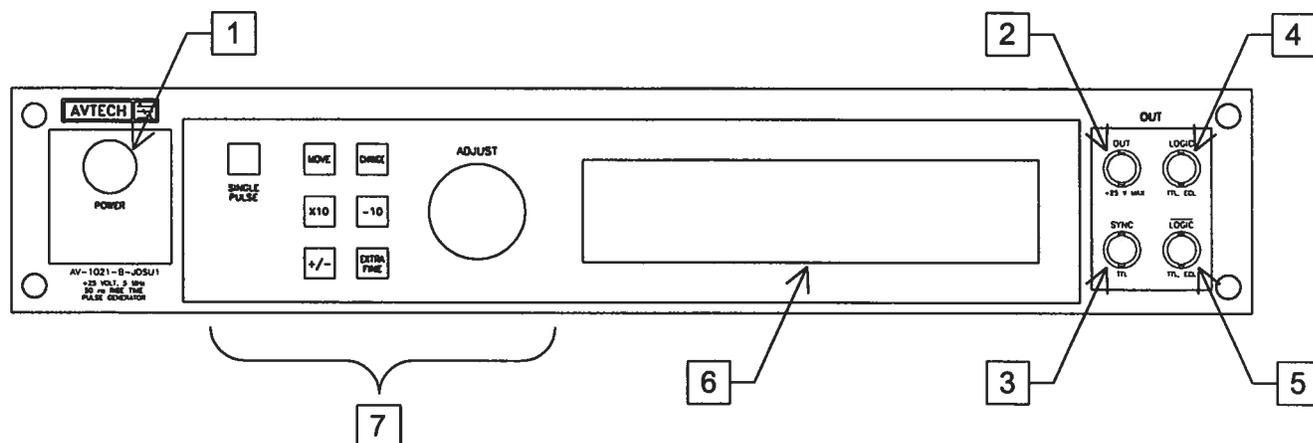
1. <u>POWER Switch</u>. The POWER push button switch applies AC prime power to the primaries of the transformer, turning the instrument on. The push button lamp (#382 type) is connected to the internal +15V DC supply.

2. <u>OUT CONNECTOR</u>. This BNC connector provides the main output signal, into load impedances of 50Ω or higher. It can generate voltages of up to +25V.

3. <u>SYNC OUT</u>. 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 50 ns.

4. <u>LOGIC Output</u>. The signal on this output has approximately the timing parameters as the main output (i.e. frequency, pulse width, and delay) but the amplitude is fixed at either TTL logic levels (0 and +5V, approximately) or ECL logic levels (-1.6V and -0.8V, approximately), depending on the settings. When using this output, it is recommended that it be terminated with a 50Ω load.

5. <u>LOGIC-Complement Output</u>. The signal on this output is the logical complement of the signal on the LOGIC output (item 4). That is, the high and low logic levels are reversed.

6. <u>LIQUID CRYSTAL DISPLAY (LCD)</u>. 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.

7. <u>KEYPAD</u>.

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
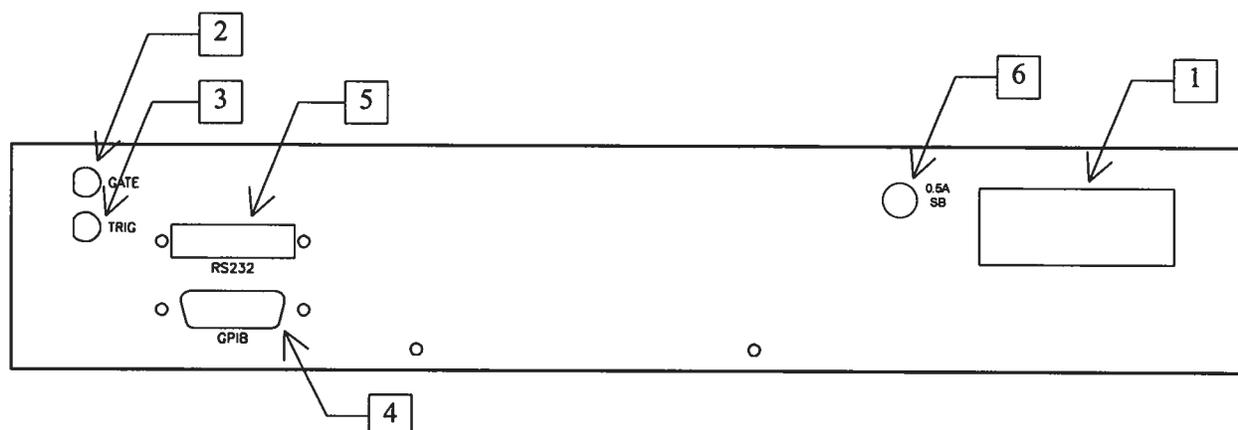
1. AC POWER INPUT. A three-pronged recessed male connector is provided on the back panel for AC power connection to the instrument. Also contained in this assembly is a 1.0A slow blow fuse and a removable card that can be removed and repositioned to switch between 120V AC in and 240V AC in.

2. 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).

3. 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.

4. 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.

5. 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.

6. DC FUSE. This 0.5A slow-blow fuse protects the internal DC power supply.

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, four output channels respond to the trigger: OUT, SYNC, LOGIC, and LOGIC-Complement.

- OUT. This is the main output. The pulse width, amplitude, and offset are all adjustable. The maximum output voltage is +25V.

- 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.

- LOGIC. The signal on this output has approximately the timing parameters as the main output (i.e. frequency, pulse width, and delay) but the amplitude is fixed at either TTL logic levels (0 and +5V, approximately) or ECL logic levels (-1.6V and -0.8V, approximately), depending on the settings. When using this output, it is recommended that it be terminated with a 50Ω load.

- LOGIC-Complement Output. The signal on this output is the logical complement of the signal on the LOGIC output. That is, the high and low logic levels are reversed.

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

SYNC OUT
(generated by
internal clock)

50ns

3V, FIXED

DELAY   PW   AMPLITUDE, 0 to +25V

OUT   OFFSET, 0 to +10V

0V

LOGIC   5V (TTL) or -0.8V (ECL)

0V (TTL) or -1.6V (ECL)

$\overline{\text{LOGIC}}$ 5V (TTL) or -0.8V (ECL)

0V (TTL) or -1.6V (ECL)

Figure A

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

SYNC OUT
(generated by
internal clock)

50ns

3V, FIXED

DELAY

PW

OUT

LOGIC   5V (TTL) or -0.8V (ECL)

0V (TTL) or -1.6V (ECL)

$\overline{\text{LOGIC}}$ 5V (TTL) or -0.8V (ECL)

0V (TTL) or -1.6V (ECL)
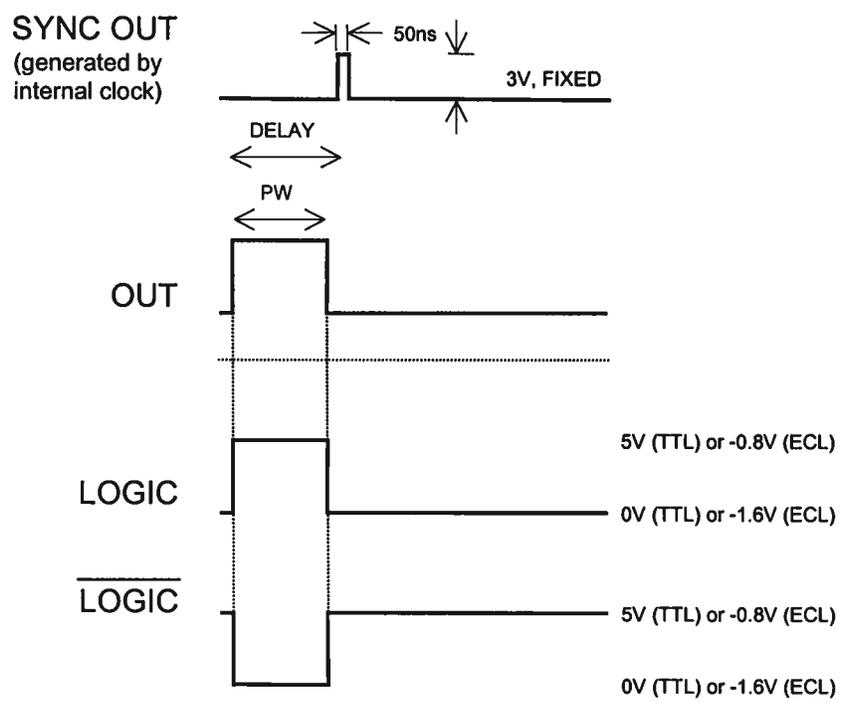
Figure B

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

TRIG
(external input)

>50ns

TTL LEVELS (0V and 3V-5V)

PROPAGATION DELAY (FIXED)

SYNC OUT
(generated
in response to TRIG)

50ns

3V, FIXED

DELAY   PW

OUT

LOGIC
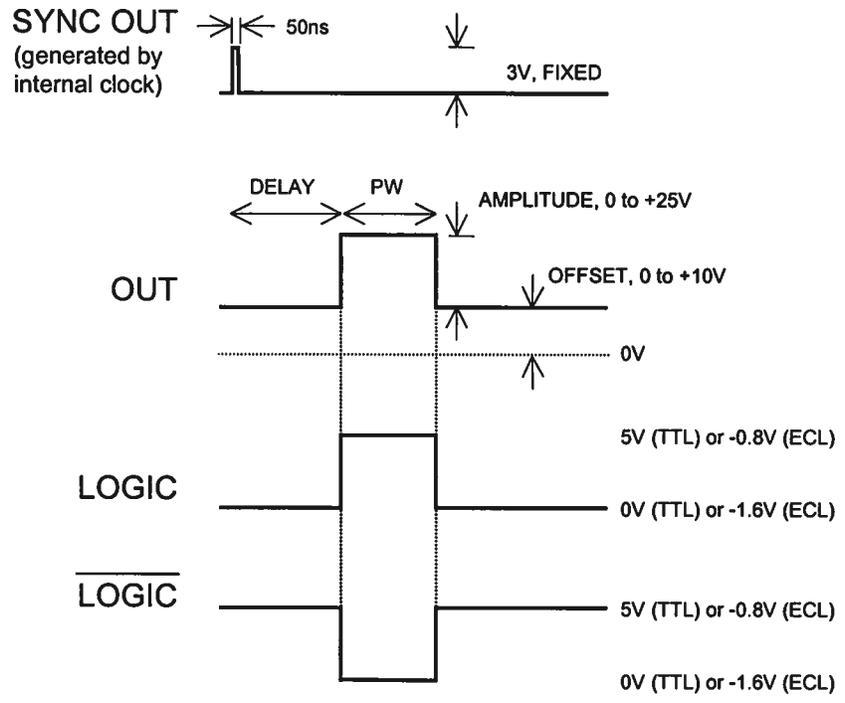
$\overline{\text{LOGIC}}$

Figure C

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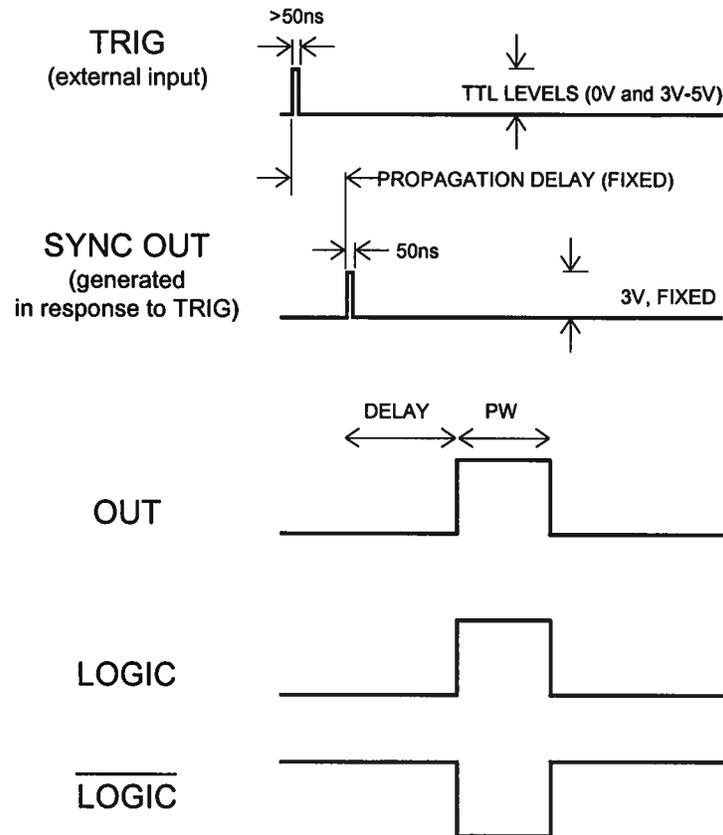
The last figure illustrates the relationship between the signal when an external TTL-level trigger is used in the $PW_{IN}=PW_{OUT}$ mode. In this case, the output pulse width equals the external trigger's pulse width (approximately), and the delay circuit is bypassed:
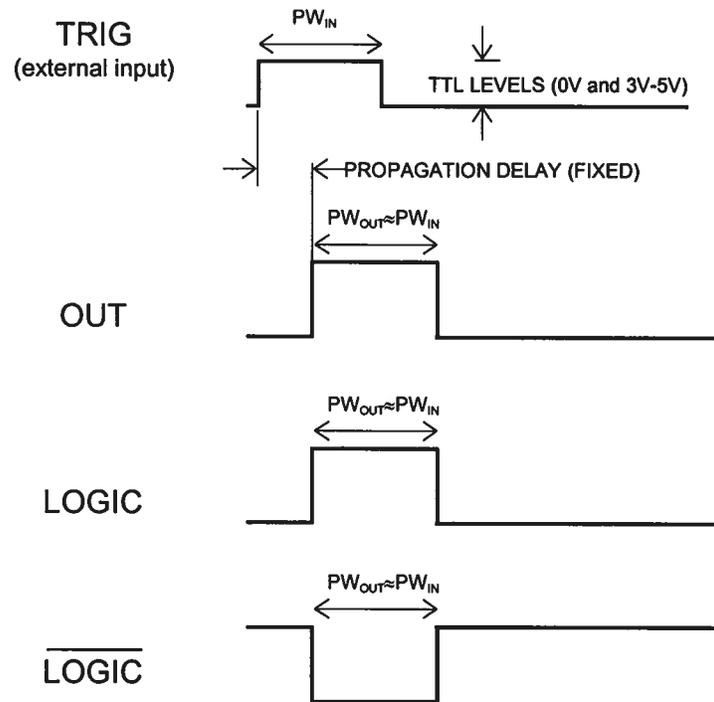
Figure D

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.)

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.

+10V, 10 ns RISE TIME OPERATION

The output power stage on this instrument can be bypassed to yield a 0 to +10V, 10 ns rise time pulser (similar to the standard AV-1021-B). To bypass the output stage, remove the top cover (see below) and disconnected the two RG-174 cables from the PG-JDSU1 module. The two cables should be connected together using an SMA sex changer adapter. Secure the cables such that the exposed cable shielding does not contact any active circuits.

Note that the output amplitude and offset will be 2.5 times lower than the settings displayed on the front panel.

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.

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.

1. Connect a cable from the SYNC OUT connector to the TRIG input of an oscilloscope. Connect a 2W (or higher), low-inductance (not wirewound) 50Ω load to the OUT connector and place the scope probe across this load. Set the oscilloscope to trigger externally with the vertical setting at 5 Volts/div and the horizontal setting at 100 ns/div.

2. Turn on the AV-1021-B-JDSU1. The main menu will appear on the LCD.

3. To set the AV-1021-B-JDSU1 to trigger from the internal clock at a PRF of 1 MHz:

   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 1 MHz.

   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 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.

5.   To set the pulse width to 150 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 150 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 25V.

    c)   Observe the oscilloscope. You should see 150 ns wide, 25V pulses.

    d)   Rotate the ADJUST knob. The amplitude as seen on the oscilloscope should vary. Return it to +15V.

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.

10. To add a DC offset:

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

   b) Press the CHANGE button. The offset submenu will appear. Rotate the ADJUST knob until the offset is set at 5V.

   c) Observe the oscilloscope. You should see 150 ns wide pulses, swinging between +5V and +20V.

   d) Press CHANGE to return to the main menu.

11. To set the logic outputs to TTL operation:

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

   b) The arrow pointer should be pointing at the "TTL level" choice. If it is not, press MOVE until it is.

   c) Press CHANGE to return to the main menu.

12. Move the 50Ω load from the OUT connector to the LOGIC connector. Observe the waveform. You should see 150 ns wide pulses, swinging between 0 and +5V (approximately).

13. To set the logic outputs to ECL operation:

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

   b) Press MOVE until the arrow pointer is pointing at the "ECL level" choice.

   c) Press CHANGE to return to the main menu.

14. Observe the waveform. You should see 150 ns wide pulses, swinging between -1.6V and -0.8V (approximately).

This completes the operational check.

CALIBRATION ADJUSTMENTS

The AV-1021-B-JDSU1 output stage has several user-accessible trimpots to null out undesired voltage offsets, and to calibrate the amplitude and DC offset settings. To access these trimpots, remove the top cover of the instrument, as described in the "Top Cover Removal" section. All of the trimpots are located on the 4" × 6", 10 cm × 15 cm board near the front of the board. The trimpot locations are illustrated below:
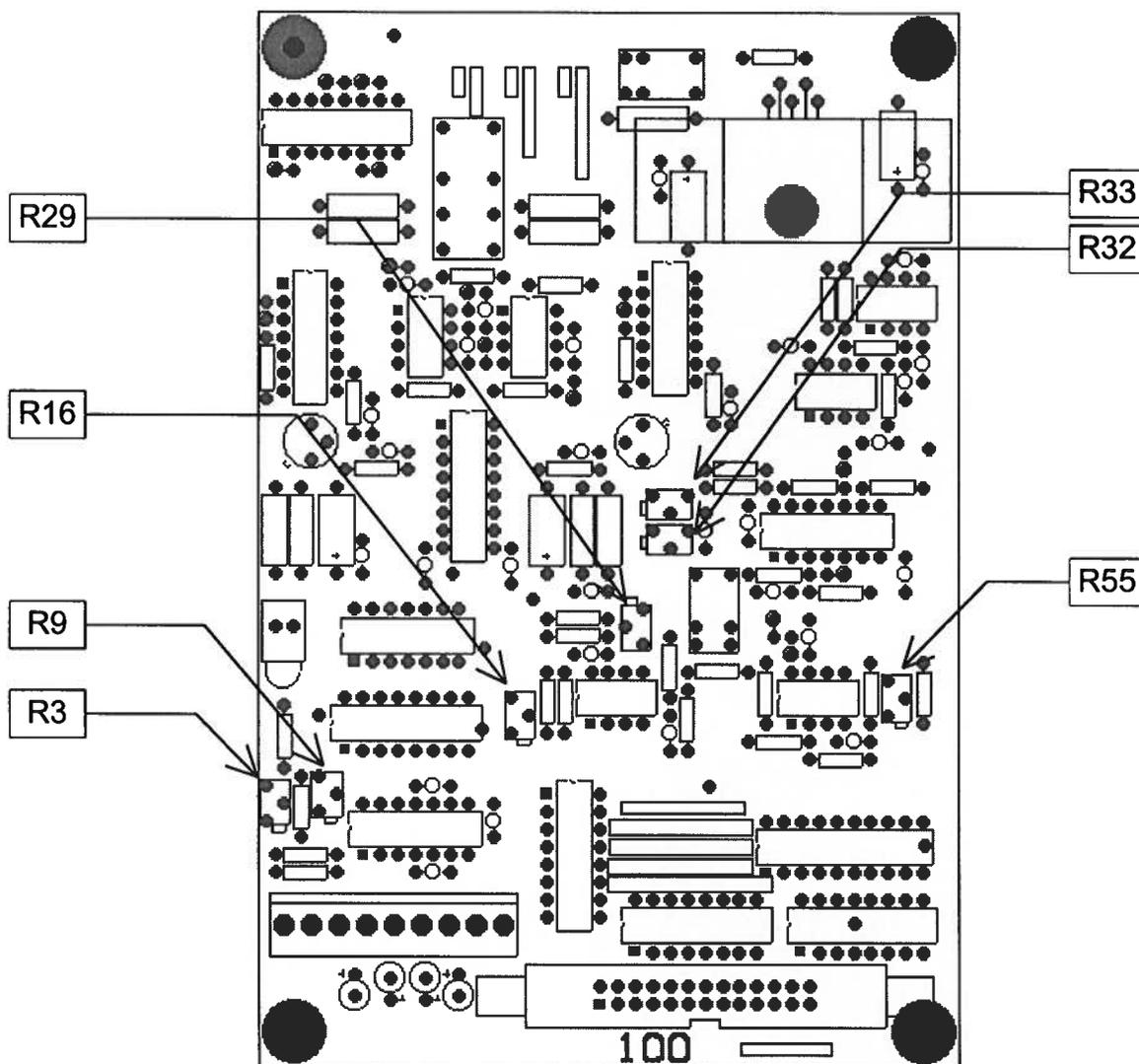
The general calibration procedure follows:

1) Turn on the instrument. Set the frequency to 10 kHz, and the pulse width to 10 μs. Turn on the output.

2) Set the amplitude and offset to zero. Null any observed offset to zero by adjusting R33.

3) Set amplitude to +10V. Null any observed offset to zero with R55.

4) Adjust R9 until observed amplitude is exactly +10V.

5) Set amplitude to +0.1V. Adjust R3 until the observed amplitude is exactly +0.1V.

6) Repeat the last two steps until no further adjustment is required.

This completes the calibration procedure.

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 10 us	(sets the pulse width to 10 us)
pulse:delay 1 us	(sets the delay to 1 us)
output:type TTL	(sets the logic outputs to TTL mode)
volt:ampl 5	(sets the amplitude to 5 V)
volt:low +2	(sets the DC offset to 2 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 100 ns	(sets the pulse width to 100 ns)
output on	(turns on the output)
volt:ampl 5	(sets the amplitude to 5 V)
volt:low +2	(sets the DC offset to 2 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 10 us	(sets the pulse width to 10 us)
pulse:delay 1 us	(sets the delay to 1 us)
output:type TTL	(sets the logic outputs to TTL mode)
volt:ampl 5	(sets the amplitude to 5 V)
volt:low 2	(sets the DC offset to 2 V)
output on	(turns on the output)

In the above example, the pulse width of the output was set by a programming command. To set the output pulse width to track the trigger pulse width in external mode, use:

*rst	(resets the instrument)
trigger:source external	(selects internal triggering)
pulse:width in	($PW_{OUT} = PW_{IN}$)
output:type TTL	(sets the logic outputs to TTL mode)
volt:ampl 15	(sets the amplitude to 15 V)
volt:low 10	(sets the DC offset to 10 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.)

Keyword	Parameter	Notes
DIAGnostic:		
:AMPLitude		
:CALibration	<numeric value>	[no query form]
:OFFSet		
:CALibration	<numeric value>	[no query form]
LOCAL		
OUTPut:		
:[STATe]	<boolean value>	
:PROTection		
:TRIPped?		[query only]
:TYPE	TTL | ECL	
REMOTE		
[SOURce]:		
:FREQuency		
[:CW | FIXed]	<numeric value>	
[SOURce]:		
:PULSe		
:PERiod	<numeric value>	
:WIDTh	<numeric value>	
:DCYCle	<numeric value>	
:HOLD	WIDTh | DCYCle	
:DELay	<numeric value>	

```
        :DOUBle
            [:STATE]            <boolean value>
            :DELay             <numeric value>
        :GATE
            :TYPE              ASYNC | 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?                                                    [query only]
*TST?                                                    [query only]
```

*WAI   [no query form]

PERFORMANCE CHECK SHEET