

List of Avtech products which include the OP-1 option.

The available command acronyms, outputs, units and range of acceptable values are:

Acronym	Output	Units	Range	Decades

1. AVL-AV-C (E/D 101 Rev 1, May 95, s144, sw3)				
V	Voltage amplitude	Volts	0 to 250	
R	Repetition rate	Hertz	5 to 5000	3
W	Width of pulse	nano-sec	10 to 100	1
D	Delay (trigger)	nano-sec	25 to 250	1
A	Advance (trigger)	nano-sec	25 to 250	1
2. AVL-2C (E/D 101 Rev 2, Jun 95, s147, sw2)				
V	Voltage amplitude	Volts	0 to 350	
R	Repetition rate	Hertz	5 to 5000	3
W	Width of pulse	micro-sec	5 to 500	2
D	Delay (trigger)	nano-sec	20 to 200	1
A	Advance (trigger)	nano-sec	20 to 200	1
3. AVO-5D (E/D 101 Rev 3, Jul 95, s148, sw4)				
I	I (current) amplitude	Amps	0 to 30	
R	Repetition rate	Hertz	3 to 300	2
W	Width of pulse	micro-sec	0.05 to 5	2
D	Delay (trigger)	micro-sec	0.05 to 5	2
A	Advance (trigger)	micro-sec	0.05 to 5	2
4,5. AV-1011-C (E/D 101 Rev 4 and 5, Qty 2 delivered, Feb 96, s155) and (Rev 21, Feb /97, S178, sw1-old-00f)				
V	Voltage amplitude	Volts	0 to 100	
R	Repetition rate	Hertz	100 to 1000000	4
W	Width of pulse	micro-sec	0.1 to 100	3
D	Delay (trigger)	micro-sec	0.1 to 100	3
A	Advance (trigger)	micro-sec	0.1 to 100	3
6. AV-6C1-C (E/D 101 Rev 6, Feb 96, s155, sw6)				
I	(current) amplitude	Amps	0 to 5	
R	Repetition rate	Hertz	1 to 10000	4
W	Width of pulse	micro-sec	0.05 to 50	3
D	Delay (trigger)	micro-sec	0.05 to 50	3
A	Advance (trigger)	micro-sec	0.05 to 50	3
7. AVO-7F-C-PN (E/D 101 Rev 7, Mar 96, s158, sw5)				
I	I (current) amplitude	Amps	0 to 5	
R	Repetition rate	Hertz	1 to 1000	3
W	Width of pulse	micro-sec	1 to 1000	3
D	Delay (trigger)	micro-sec	1 to 1000	3
A	Advance (trigger)	micro-sec	1 to 1000	3

Product List, Avtech OP-1 Option

List of Avtech products which include the OP-1 option, continued.

The available command acronyms, outputs, units and range of acceptable values are:

Acronym	Output	Units	Range	Decades

8. AVRH-2-C-PN-OP1 (E/D 101 Rev 8, May 96, s160, sw7)				
V	Voltage amplitude	Volts	0 to 2000	
R	Repetition rate	Hertz	1 to 1000	3
W	Width of pulse	nano-sec	250 to 2500	1
D	Delay (trigger)	nano-sec	25 to 2500	3
A	Advance (trigger)	nano-sec	25 to 2500	3
P	Polarity		+ or -	
9. AVO-2C-BE02B-R5-P (E/D 101 Rev 9, Jul 96, s164, sw9)				
I	I (current amplitude)	amps	0 to 2	
R	Repetition rate	Hertz	2 to 20000	4
D	Delay (trigger)	nano-sec	25 to 250	1
A	Advance (trigger)	nano-sec	25 to 250	1
S	Single pulse			
10. AVR-3-PW-C-OP1 (E/D 101 Rev 10, Jul 96, s164, sw0)				
V	Voltage amplitude	Volts	0 to 200	
R	Repetition rate	Hertz	1 to 10000	4
W	Width of pulse	micro-sec	0.1 to 100	3
D	Delay (trigger)	micro-sec	0.1 to 100	3
A	Advance (trigger)	micro-sec	0.1 to 100	3
11. AVR-4B-PW-C-OP1 (E/D 101 Rev 11, Jul 96, s164, sw8)				
V	Voltage amplitude	Volts	0 to 400	
R	Repetition rate	Hertz	1 to 10000	4
W	Width of pulse	micro-sec	0.1 to 100	3
D	Delay (trigger)	micro-sec	0.1 to 100	3
A	Advance (trigger)	micro-sec	0.1 to 100	3
12. AVO-2C-BE03-R5-P				
(Rev 12, Oct 96-s168; Rev 15,16, Jan 97 -s173 & Rev 17,18,19 feb 97 -s176, sw10)				
I	I (current amplitude)	amps	0 to 2	
R	Repetition rate	Hertz	2 to 20000	4
D	Delay (trigger)	nano-sec	25 to 250	1
A	Advance (trigger)	nano-sec	25 to 250	1
13. AVO-2W-C (E/D 101 Rev 13, Dec 2/96, s170, sw 11)				
I	I (current amplitude)	amps	0 to 10	
R	Repetition rate	Hertz	20 to 20000	3
D	Delay (trigger)	nano-sec	25 to 250	1
A	Advance (trigger)	nano-sec	25 to 250	1
W	Width of pulse	nano-sec	3 to 50	1

Product List, Avtech OP-1 Option

List of Avtech products which include the OP-1 option, continued.

The available command acronyms, outputs, units and range of acceptable values are:

Acronym	Output	Units	Range	Decades

14. AV-108B-3-C-SLIB		(ED-101, Rev 13B, Dec 16, 96, s171, sw12)		
I	I (current) amplitude	amps	0 to 200	
R	Repetition rate	Hertz	1 to 10000	4
D	Delay (trigger)	milli-sec	0.01 to 10	3
A	Advance (trigger)	milli-sec	0.01 to 10	3
W	Width of pulse	milli-sec	0.01 to 10	3
15. AV-6C-C-F1		(E/D 101 Rev 14, Jan 12/97, s173, sw13)		
I	I (current) amplitude	amps	0 to 5	
R	Repetition rate	Hertz	1 to 10000	4
D	Delay (trigger)	micro-sec	0.05 to 5	2
A	Advance (trigger)	micro-sec	0.05 to 5	2
W	Width of pulse	micro-sec	0.05 to 5	2
16. AV155C-C-P		(E/D 101 Rev 24, Feb 25/97, s177, sw14), (formerly Rev 20)		
I	I (current) amplitude	Amps	0 to 2	
R	Repetition rate	Hertz	100 to 1000000	4
W	Width of pulse	micro-sec	0.1 to 10	2
D	Delay (trigger)	micro-sec	0.1 to 10	2
A	Advance (trigger)	micro-sec	0.1 to 10	2
17. AV-108B-3-C		(ED-101, Rev 22 and Rev 23, Mar 4/97, s178, sw15)		
I	I (current amplitude)	amps	0 to 200	
R	Repetition rate	Hertz	0.1 to 1000	4
D	Delay (trigger)	milli-sec	0.01 to 1	2
A	Advance (trigger)	milli-sec	0.01 to 1	2
18. AV-1011-C-Mod		(ED101 Rev 21A & Rev 25, Qty 2 del'd, Mar 26/97, s179, sw1)		
V	Voltage amplitude	Volts	0 to 100	
R	Repetition rate	Hertz	100 to 1000000	4
W	Width of pulse	micro-sec	0.1 to 1000	4
D	Delay (trigger)	micro-sec	0.1 to 100	3
A	Advance (trigger)	micro-sec	0.1 to 100	3

OP-1 Operating Instructions

1.0 Introduction

This section describes how to use the OP-1 GPIB Bus Listener interface for remote computer control of the Avtech pulse generator, by means of the IEEE 488 General Purpose Interface Bus (GPIB).

The available commands and their structure, a typical command sequence and a sample program are included.

In addition, possible methods of incorporating remote duty cycle limit checking and instructions on how to change the GPIB address are provided

2.0 Interface to the GPIB

The IEEE 488 compatible Bus functions available to the user for GPIB control are as follows: The listed functions define a Bus Listener capability:

- SH0, AH1, T0, TE0, L2, LE0, SR0, RLO, PP0, DC1, DT0, C0.

2.1 Available Commands

The OP-1 GPIB user interface is designed to be used to remotely program the Avtech pulse generator to control the pulse repetition rate, pulse width, pulse amplitude and delayed (or advanced) trigger output.

The available command acronyms, outputs, units and range of acceptable values for the AV155C-C-P generator are defined in the table below:

Acronym	Output	Units	Range	Decades
I	I (current) amplitude	Amps	0 to 2	
R	Repetition rate	Hertz	100 to 1000000	4
W	Width of pulse	micro-sec	0.1 to 10	2
D	Delay (trigger)	micro-sec	0.1 to 10	2
A	Advance (trigger)	micro-sec	0.1 to 10	2

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2.2 Command Interpretation

The command may utilize the defined single letter acronym, or may be expanded to a longer word to make the control program easier to understand. This is because letters following the defined acronym letter are ignored. For example, a command of "I=0.2" will cause exactly the same result if the command is sent as "I (current) level of output pulse = 0.2". However, it is mandatory that the first letter of each command be one of the five defined acronyms.

Acronyms are case insensitive, for example, "R" or "r" are the same.

The number following the acronym letter may be any number in the range specified, however, the number of significant digits are limited to one part in 255 (for 8 bits of output resolution). For example, rep rate values of 128.2, 128.3 or 128.2145 will all result in the same output. (Note that output resolution and accuracy are not necessarily the same).

Leading or trailing zeros in numbers will be ignored.

Numbers expressed in "exponential" format will NOT be interpreted correctly. For example, 3e+2 will be interpreted as 3, not as 300.

The range of the specified values must be as specified for the equipment. Numbers outside the range will be ignored.

If desired, trailing text may be added to make the control program easier to understand, since it will be ignored. For example, a command of "delay=2" will result in the same output as the command "delay = 2 microseconds".

The term "Delay" is used to specify the duration of the delay between the trigger output pulse and the occurrence of the actual output pulse. The term "Advance" similarly refers to the amount of time the trigger pulse will occur prior to the output pulse.

If an invalid command is sent, the unit will ignore the command and the previous value will remain unchanged. If an "out-of-range" value is sent, the unit will also ignore the command.

2.3 Typical Command Sequence Interpretation

Assume the following commands are sent using the computer, using the appropriate command structure as specified for the user's GPIB controller. Note that the default GPIB address is eight.

R=100

I= 1

A=1

W=2

OP-1 Operating Instructions

For example, for a GPIB controller from National Instruments, the following set of commands would be sent:

```
ibwrt "r=100"  
ibwrt "i=1"  
ibwrt "a=1"  
ibwrt "w=2"
```

This command sequence will cause the generator to produce an output pulse of width 2 micro-sec and an amplitude of 1 amp peak, repeated at a rate of 100 pulses per second. An oscilloscope attached to the generator output will confirm the result. If the generator output trigger port is used, it will be noted that each output pulse will occur 1 micro-sec after the trigger pulse occurs.

2.4 Sample Program

To illustrate the remote control process by means of the GPIB, a sample program written in BASIC is provided. While this example is prepared for use with the B&C MicroSystems PC488 circuit card, the general principles of control apply to any IEEE 488 GPIB Controller.

```
"TEST of Pulser Controller  
OPEN "PC488" FOR OUTPUT AS #1  
PRINT #1, "ABORT"  
PRINT #1, "CLEAR"  
PRINT #1, "OUTPUT 8;I", 1  
PRINT #1, "OUTPUT 8;R", 100  
PRINT #1, "OUTPUT 8;A", 1  
PRINT #1, "OUTPUT 8;W", 2  
END
```

3.0 Duty Cycle Limits

Typically, Avtech pulse generators are limited to a maximum duty cycle because of thermal constraints, where duty cycle is the ratio of Pulse Width to the reciprocal of the Repetition Rate (i.e.; R times W). Although the generator contains automatic protection against an excessive duty cycle, whenever this protection is activated, the output is inhibited. Therefore, it may be desirable to have the control computer calculate the duty ratio, then generate a warning message to the operator whenever the limits are exceeded (preferably prior to actually sending the command sequence).

This message could caution the user either to reduce the repetition rate or the pulse width, to avoid thermal overload.

While this calculation is not mandatory, it could avoid the annoyance of automatic inhibiting of the generator output.

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4.0 Changing the Unit GPIB Address

Since the GPIB data bus address for the pulse generator has been preset to "8" in the factory, commands are required to be sent to this address. However, the user may wish to change the address to any address in the allowed range of 0 to 30. This address may be easily changed by re-setting the GPIB address switch on the GPIB Interface board located inside the pulse generator chassis.

The address is set by means of a five position "Dipswitch " located on the top of a small circuit card located inside the enclosure near the top rear. The switch may observed to be set to the default address by noting that the Dipswitch position 4 is set in the OFF position, defining a binary address of 8.

The switch setting is calculated as the sum of the switch weights in the OFF position, calculated as follows: (a switch in the ON position it has a weight of zero):

Switch Number	OFF Weight
1	1
2	2
3	4
4	8
5	16

For example, a switch with positions 1, 4 and 5 set to OFF will result in an address setting of 25 (16 plus 8 plus 1 = 25).

5.0 Trouble-Shooting Aid

In the event that difficulties are encountered communicating via the GPIB interface, two auxiliary communications status indicators have been included on the GPIB interface circuit card. These status indicators are small LED lamps, one which flashes briefly whenever a properly addressed command is received. The second LED will light whenever an out-of-range value or invalid command is received, and will remain lit until a valid command with a valid in-range value is subsequently received.

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2.0 Interface to the GPIB

The IEEE 488 compatible Bus functions available to the user for GPIB control are as follows: The listed functions define a Bus Listener capability:

- SH0, AH1, T0, TE0, L2, LE0, SR0, RL0, PP0, DC1, DT0, C0.

2.1 Available Commands

The OP-1 GPIB user interface is designed to be used to remotely program the Avtech pulse generator to control the pulse repetition rate, pulse width, pulse amplitude and delayed (or advanced) trigger output.

The available command acronyms, outputs, units and range of acceptable values for the AV-108B-3-C generator are defined in the table below:

Acronym	Output	Units	Range	Decades
I	I (current amplitude)	amps	0 to 200	
R	Repetition rate	Hertz	0.1 to 1000	4
D	Delay (trigger)	milli-sec	0.01 to 1	2
A	Advance (trigger)	milli-sec	0.01 to 1	2

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2.2 Command Interpretation

The command may utilize the defined single letter acronym, or may be expanded to a longer word to make the control program easier to understand. This is because letters following the defined acronym letter are ignored. For example, a command of "I=0.2" will cause exactly the same result if the command is sent as "I (current) level of output pulse = 0.2". However, it is mandatory that the first letter of each command be one of the five defined acronyms.

Acronyms are case insensitive, for example, "R" or "r" are the same.

The number following the acronym letter may be any number in the range specified, however, the number of significant digits are limited to one part in 255 (for 8 bits of output resolution). For example, rep rate values of 128.2, 128.3 or 128.2145 will all result in the same output. (Note that output resolution and accuracy are not necessarily the same).

Leading or trailing zeros in numbers will be ignored.

Numbers expressed in "exponential" format will NOT be interpreted correctly. For example, 3e+2 will be interpreted as 3, not as 300.

The range of the specified values must be as specified for the equipment. Numbers outside the range will be ignored.

If desired, trailing text may be added to make the control program easier to understand, since it will be ignored. For example, a command of "delay=0.2" will result in the same output as the command "delay = 0.2 milli-seconds".

The term "Delay" is used to specify the duration of the delay between the trigger output pulse and the occurrence of the actual output pulse. The term "Advance" similarly refers to the amount of time the trigger pulse will occur prior to the output pulse.

If an invalid command is sent, the unit will ignore the command and the previous value will remain unchanged. If an "out-of-range" value is sent, the unit will also ignore the command.

2.3 Typical Command Sequence Interpretation

Assume the following commands are sent using the computer, using the appropriate command structure as specified for the user's GPIB controller. Note that the default GPIB address is eight.

```
R=100  
I= 1  
A=0.1  
W=0.2
```

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For example, for a GPIB controller from National Instruments, the following set of commands would be sent:

```
ibwrt "r=100"  
ibwrt "i=1"  
ibwrt "a=0.1"  
ibwrt "w=0.2"
```

This command sequence will cause the generator to produce an output pulse of width 0.2 milli-sec and an amplitude of 1 amp peak, repeated at a rate of 100 pulses per second. An oscilloscope attached to the generator output will confirm the result. If the generator output trigger port is used, it will be noted that each output pulse will occur 0.1 milli-sec after the trigger pulse occurs.

2.4 Sample Program

To illustrate the remote control process by means of the GPIB, a sample program written in BASIC is provided. While this example is prepared for use with the B&C MicroSystems PC488 circuit card, the general principles of control apply to any IEEE 488 GPIB Controller.

```
'TEST of Pulser Controller  
OPEN "PC488" FOR OUTPUT AS #1  
PRINT #1, "ABORT"  
PRINT #1, "CLEAR"  
PRINT #1, "OUTPUT 8;I", 1  
PRINT #1, "OUTPUT 8;R", 100  
PRINT #1, "OUTPUT 8;A", 0.1  
PRINT #1, "OUTPUT 8;W", 0.2  
END
```

3.0 Duty Cycle Limits

Typically, Avtech pulse generators are limited to a maximum duty cycle because of thermal constraints, where duty cycle is the ratio of Pulse Width to the reciprocal of the Repetition Rate (i.e.; R times W). Although the generator contains automatic protection against an excessive duty cycle, whenever this protection is activated, the output is inhibited. Therefore, it may be desirable to have the control computer calculate the duty ratio, then generate a warning message to the operator whenever the limits are exceeded (preferably prior to actually sending the command sequence).

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The switch setting is calculated as the sum of the switch weights in the OFF position, calculated as follows: (a switch in the ON position it has a weight of zero):

Switch Number	OFF Weight
1	1
2	2
3	4
4	8
5	16

For example, a switch with positions 1, 4 and 5 set to OFF will result in an address setting of 25 (16 plus 8 plus 1 = 25).

5.0 Trouble-Shooting Aid

In the event that difficulties are encountered communicating via the GPIB interface, two auxiliary communications status indicators have been included on the GPIB interface circuit card. These status indicators are small LED lamps, one which flashes briefly whenever a properly addressed command is received. The second LED will light whenever an out-of-range value or invalid command is received, and will remain lit until a valid command with a valid in-range value is subsequently received.