1.0 Introduction

This application note describes how to use the Eildan Model E/D-101 GPIB Interface Card Assembly for remote computer control of the Avtech product line of pulse generators, by means of the IEEE 488 General Purpose Interface Bus (GPIB). Commands sent from a computer with an IEEE 488 Controller Card can be used to change the outputs of the generator. The Avtech Model AVR-3 pulse generator is used as a typical example.

This application note describes the available commands and their structure, supplies a typical command sequence and provides a sample program. In addition, suggestions are made on how to incorporate remote duty cycle limit checking and how to change the GPIB address of the control interface to the pulse generator if required.

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 listen-only capability:
- SH0, AH1, T0, TE0, L2, LE0, SR0, RL0, PP0, DC1, DT0, C0.

2.1 Available Commands

The GPIB user interface can be used to program the Avtech generator to remotely control pulse repetition rate, pulse width, pulse amplitude and delayed (or advanced) trigger outputs. The available command acronyms, suggested outputs, typical range of acceptable values and suggested units for the AVR-3 equipment are:

Acronym	Typ. Output	Typical Units	Typical Range	Max Decades
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

Each pulse generator provides a slight variation in the actual range of programmable values, however the acronyms remain the same. (One exception is for generators providing current amplitude control, where the acronym "I" is used instead of "V"). See the specification provided with each Avtech unit to determine the available range of command values.

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 "V 70.2" will result in exactly the same result if the command is sent as "Voltage of output pulse = 70.2". 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, amplitude values of 12.82, 12.83 or 12.82145 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+3 will be interpreted as 3, not as 3000.

The range of the specified values must be as specified for the equipment. Numbers outside the range will be ignored. The suggested units are those selected for the Avtech AVR-3 generator.

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 "width =177" will result in the same output as the command " width = 177 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=1000
        W=3
        V= 30
        A=1

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

```
ibwrt "r=1000"
ibwrt "w=3"
ibwrt "v=30"
ibwrt "a=1"
```

This command sequence will cause the generator to produce a series of output pulses of width 3 micro-sec and an amplitude of 30 volts peak, repeated at a rate of 1000 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 be delayed 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 should 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;V", 30
PRINT #1, "OUTPUT 8;W", 3
PRINT #1, "OUTPUT 8;R", 1000
PRINT #1, "OUTPUT 8;A", 1
END
```

3.0 Duty Cycle Limits

Typically, the Avtech pulse generators are limited, because of thermal constraints, to a maximum duty cycle, where duty cycle is the ratio of Pulse Width to the reciprocal of the Repetition Rate (i.e.; $R*W$). Although the generator contains automatic protection against an excessive duty cycle, whenever this protection is activated, the output is inhibited. Therefore, it is 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 sending the command sequence.

This message should 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.

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

The address is set by means of a five position "Dipswitch " located on the top of the circuit card assembly.. The switch may observed to be set to the default address by noting that the Dipswitch position 4 is in the OFF position, defining a binary value 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).

6.0 Trouble-Shooting Aid

To aid in resolving any difficulties encountered communicating via the GPIB interface, two auxiliary communications status indicators have been included on the GPIB interface 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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