Sigtrona APG1780DA

(Rev. r0.7, June 18, 2025)

Digitally Adjustable Picosecond Pulse Generator

Features

- Digitally adjustable pulse width: 17 ps to 80 ps in 3 ps increments
- Trigger rate beyond 2 GHz
- USB powered operation, external power optional, draws only 3.2 W
- Pulse width and trigger level adjustable via either USB or frontpanel
- Trigger input options: Single-ended or differential, with adjustable hysteresis, accepts NECL, PECL, CML, LVDS,...
- Two complementary 2.4 mm outputs
- DC coupled input and outputs
- Internal trigger generator 1 Hz to 72 MHz
- Compact size: $50 \times 60 \times 18$ mm

Typical Applications

- Optical pulse modulation via electro-optic modulation (EOM)
- Response function characterization of high bandwidth analog systems
- Automated test equipment (ATE)

General Description

The Sigtrona APG1780DA is a digitally adjustable electronic pulse generator capable of producing output pulses ranging from 17 to 80 ps. The pulse trigger input accepts features a configurable trigger level and hysteresis enabling reliable triggering on any high-speed logic signal within a ± 3 V range. An alternative variant called APG1780DA-DIFF provides a differential trigger input leveraging lower jitter and higher noise immunity of differential signals and eliminiating the need to adjust a trigger level. The APG1780DA can be either used as a standalone device operated from the frontpanel or it can be remotely controlled over a USB interface.

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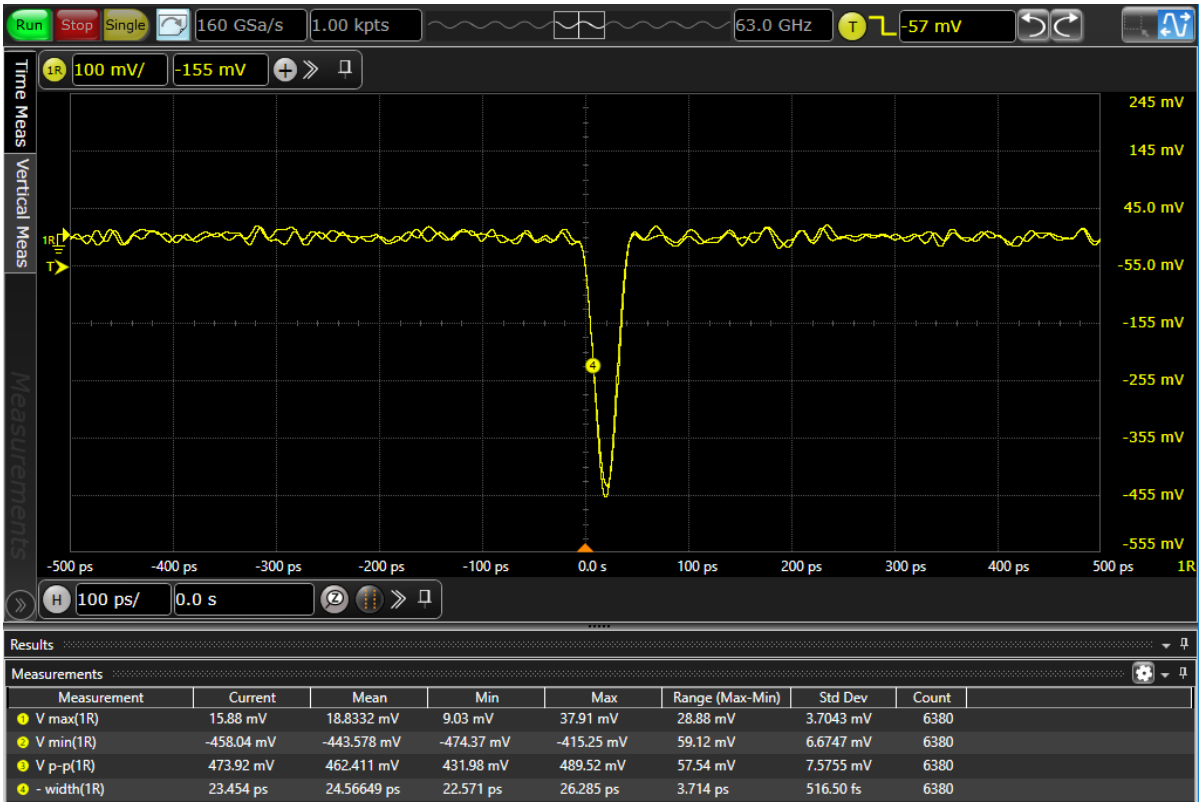
1 Specifications

1.1 Electrical and Environmental Characteristics

Parameter	Conditions	Min	Typ	Max	Units
DC Characteristics					
Supply Voltage (V_S)[1]	External DC input	4.8	12	14	V
	USB powered	4.6	5	14	V
Supply Current	$V_S = 5$ V, 72 MHz pulse rate		610		mA
	$V_S = 12$ V, 72 MHz pulse rate		250		mA
	$V_S = 5$ V, standby mode		TBD		mA
Single-Ended Trigger Input					
Input Impedance			50		Ω
Input Voltage Range	Trigger level adjustment range	−3		+3	V
	Absolute maximum rating	−5		+5	V
Trigger Frequency		0		> 2	GHz
Differential Trigger Input					
Input Impedance			100		Ω_{diff}
Input Common Mode Voltage Range		−3		+3	V
Input Differential Voltage Range		−1		+1	V_{diff}
Trigger Frequency		0		> 2	GHz
Pulse Output					
Pulse Width	Adjutable in steps of 3 ps	17		> 80	ps
Pulse Amplitude	Pulse width 25 ps, into 50 Ω	400	450		mV_{pp}
	Pulse width 20 ps, into 50 Ω	250	300		mV_{pp}
	Pulse width 17 ps, into 50 Ω	100	175		mV_{pp}
Trigger Delay			TBD		ps
Environmental Characteristics					
Thermal dissipation	Not in standby		3.0	3.5	W
Operating Ambient Temperature[2]	non-condensing	−20		+50	°C
Operating Internal Temperature[2]	non-condensing			+70	°C
Storage Temperature	non-condensing	−20		+100	°C
Weight			75		g

[1] When both power sources are present and the power source mode is "auto" and the external power is in the range $V_{\text{USB}} + 0.2\,\text{V} \leq V_{\text{ext}} \leq V_{\text{USB}} + 0.8\,\text{V}$, then oscillation can occur. Avoid that constellation.

[2] Sufficient cooling needs to be provided to keep the internal temperature below 70°C; see the command `:health? temp`.

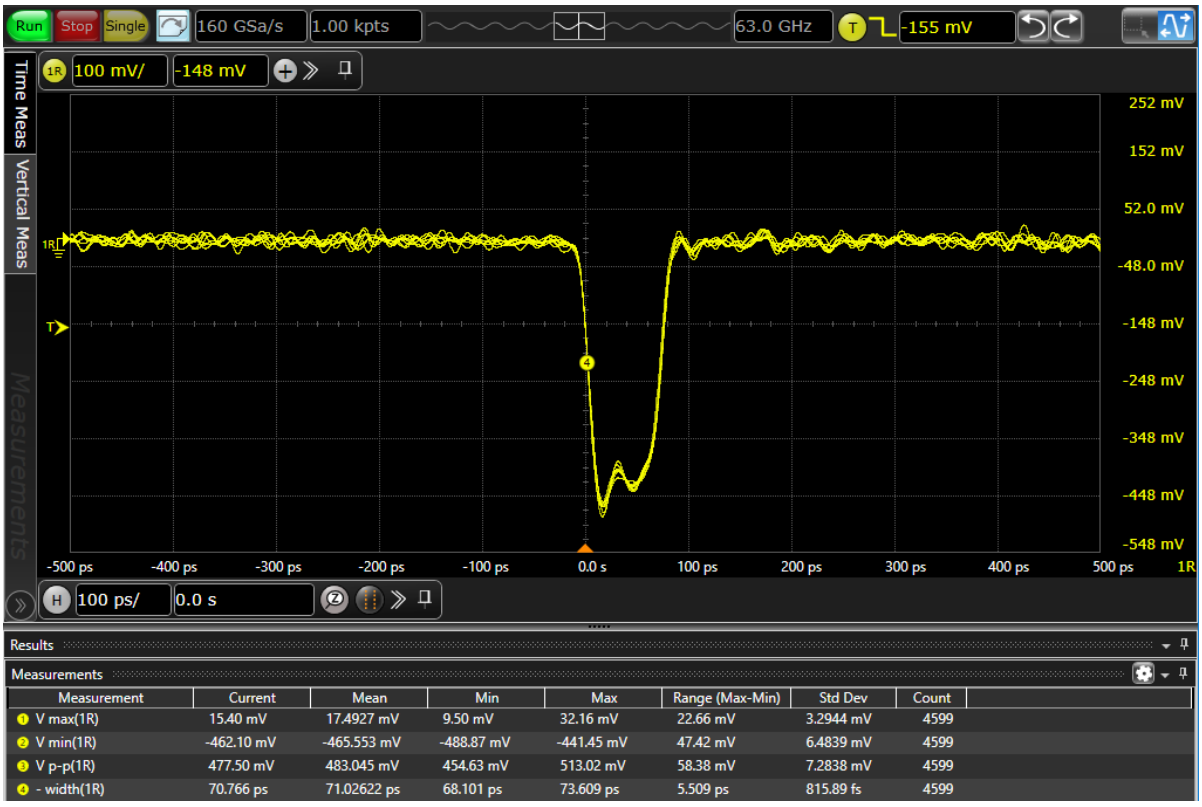


The image above shows a negative pulse width of 24.5 ps and an amplitude close to 400 mV.

Reducing the pulse width below 25 ps also reduces the amplitude: 19 ps pulse, amplitude 300 mV.

Measurement	Current	Mean	Min	Max	Range (Max-Min)	Std Dev	Count
V max(1R)	13.055 mV	12.0267 mV	5.836 mV	21.380 mV	15.544 mV	2.02943 mV	5959
V min(1R)	-174.742 mV	-184.179 mV	-210.942 mV	-168.683 mV	42.260 mV	5.30183 mV	5959
V p-p(1R)	187.797 mV	196.205 mV	179.261 mV	223.523 mV	44.262 mV	5.76830 mV	5959
- width(1R)	18.752 ps	17.24302 ps	15.658 ps	19.525 ps	3.867 ps	458.74 fs	5959

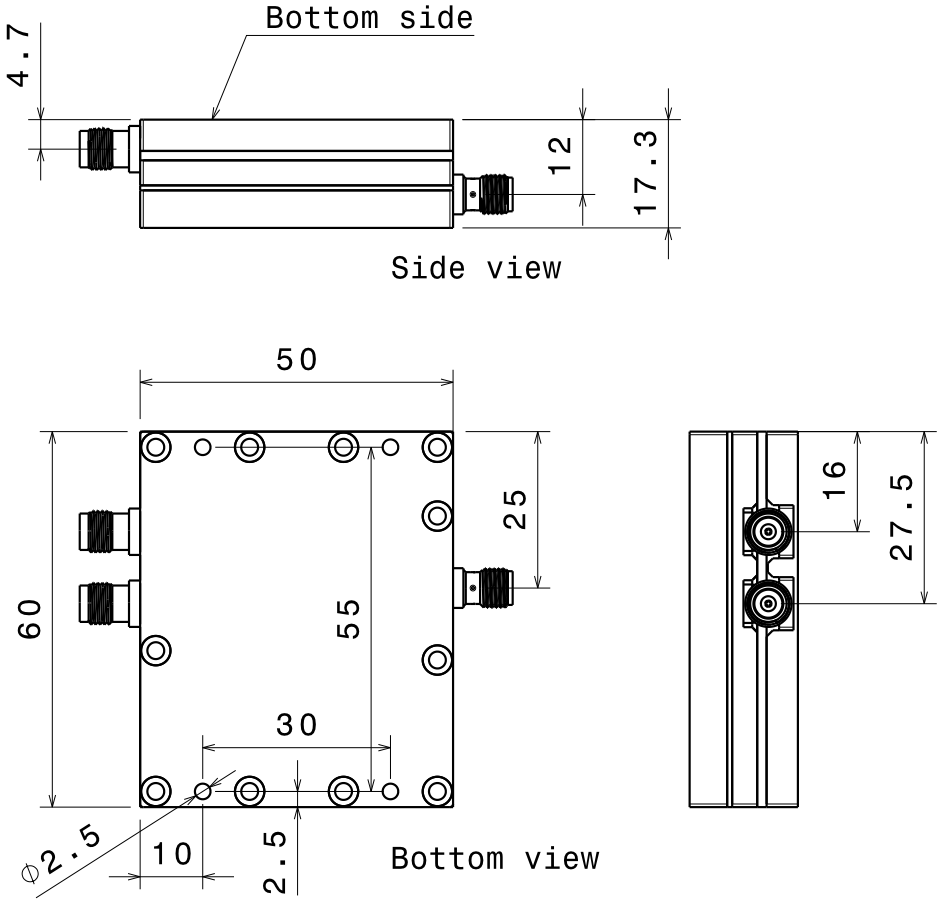
Even shorter pulse: 17 ps with 175 mV amplitude.



Measurement	Current	Mean	Min	Max	Range (Max-Min)	Std Dev	Count
V max(1R)	15.40 mV	17.4927 mV	9.50 mV	32.16 mV	22.66 mV	3.2944 mV	4599
V min(1R)	-462.10 mV	-465.553 mV	-488.87 mV	-441.45 mV	47.42 mV	6.4839 mV	4599
V p-p(1R)	477.50 mV	483.045 mV	454.63 mV	513.02 mV	58.38 mV	7.2838 mV	4599
- width(1R)	70.766 ps	71.02622 ps	68.101 ps	73.609 ps	5.509 ps	815.89 fs	4599

Longer pulses have a “flat top”: 71 ps pulse width, amplitude > 400 mV.

1.2 Mechanical Dimensions



All dimensions in mm. The drawing shows the single-ended input variant (SMA plug). The differential input variant has a non-protruding SATA connector at the place where the SMA input connector is shown.

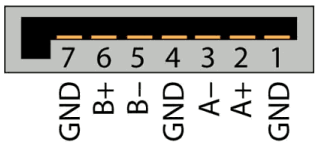
The APG1780 has 4 mount holes on the bottom for metric M 2.5 mm screws in a 55×30 mm pattern as shown above. These screws can penetrate 5 mm into the metal case.

1.3 Variants and Order Codes

There are two variants: The **APG1780DA-SMA** *has a single-ended 50 Ω terminated SMA input (left) and the* **APG1780DA-DIFF** *has a differential input using a SATA connector. The differential input triggers on the zero crossing and hence does not provide means for adjusting a trigger level.*

The APG1780DA is available in the following variants:

- **APG1780DA-SMA**: Single-ended trigger input via an SMA female connector. The input is DC coupled and internally terminated with 50 Ω.
- **APG1780DA-DIFF**: Differential trigger input via an SATA connector, using pins A+, A−. The input is DC coupled and internally terminated with $100\,\Omega_{\text{diff}}$.
  The pins B+, B− are unused but a factory modification to use the B pins instead of the A pins is available upon request. A factory modification to terminate each input with 50 Ω to ground instead of $100\,\Omega_{\text{diff}}$ is also available on request.



SATA pinout when looking at the APG1780.

2 Connections and Frontpanel Operation

The basic functionaliy of the Sigtrona APG1780 is available from the front panel and no USB connection is required. Howver, the pulse generator can also be controlled remotely by sending commands over the USB connection.

2.1 Power Source

The Sigtrona APG1780 can be fully USB powered. It has a USB-C plug and can be operated e.g. by use of a USB A-C cable. Note that a standard USB 2.0 powered peripheral may only draw 500 mA at 5 V and the APG1780 will typically draw sligtly more than this, but it will usually still work in a USB powered fashion.

Alternatively, the APG1780 can also be externally powered by providing between 5 and 12 V via the 2-pin JST PH series power connector.

If both power sources are available, the device will automatically choose the one with the higher voltage. See also the `:power_src` USB command.

2.2 Trigger Input

The Sigtrona APG1780 comes in two variants, either with single-ended or with differential trigger input.

The single-ended input is an SMA female plug with internal 50 Ω termination. A rising edge input that crosses the adjustable trigger level voltage generates a pulse.

The differential input is an SATA type connector with internal termination 100 Ω (differential). The differential input does not have an adjustable trigger level; instead a pulse is generated when the differential input voltage performs a positive zero transition. The differential input is fully compatible with most high speed signal levels including NECL, PECL, LVDS, CML and others as long as the common mode voltage range and the differential voltage are within the limits given in the electrical characteristics.

2.3 Pulse Outputs

The Sigtrona APG1780 has two 2.4 mm-type pulse output connectors. Both outputs are DC coupled and have matched timing.

The `Out+` connector produces a positive voltage pulse that sits on a negative DC offset voltage of −450 mV.

At the `Out-` connector, a negative voltage pulse is generated that has no offset voltage.

2.4 Frontpanel Operation

Top view of the frontpanel elements. The differential input version looks identical except it lacks the trigger level adjustment. The outputs are 2.4 mm coaxial connectors. The device can be USB powered; the power connector on the left top is optional.

The frontpanel elements allow the following operations:

- **Setting the pulse width:** The 5 DIP switches allow you to specify the pulse width in 32 steps. They are interpreted as a binary figure with the most significant bit on the left side (marked "1"). Flipping the a switch up increases the pulse width. The pulse width defaults to DIP switch upon power-up but can also be controlled remotely via the USB by use of the commands `:mode` and `:pulse_len`.
- **Setting the trigger level:** The left control dial sets the trigger level in a range of approx. ±3 V. This control is only available for pulse generators with single ended input (e.g. SMA plug) and not available for differential inputs. This can also be set remotely via the command `:trig_level`.
- **Setting the trigger hysteresis:** The trigger hysteresis can be set by right control dial with a range of about 0 to 70 mV. A higher hysteresis avoids spurious triggering from noise on the trigger signal.

There are 3 indicator LEDs on the frontpanel:

- **Power:** This green LED blinks when the device is operational. A 50% duty cycle 1 Hz signal indicates normal operation while a a short flash every 2 seconds indicates power-down mode (see command `:power`).
- **Remote:** This orange LED is active when either the pulse width or the trigger level is controlled remotely via the USB and not controlled by the frontpanel elements. (See commands `:mode`, `:pulse_len`, `:trig_level`)
- **Trigger:** This yellow LED indicates when the pulse genrator is triggered, either internally or externally, and produces pulses. Note that due to a hardware limitation, at certain narrow trigger frequencies above 100 MHz, it might be off despite triggers being accepted.

2.5 Cooling

The APG1780 dissipates about 3 W electrical power which has to be removed from the system. It is therefore recommended to firmly attach the bottom side of the aluminum casing to a heat sink or larg enough metal structure.

You can monitor the temperature of the APG1780 using the USB command `:health? temp`. The hottest part inside is the high speed pulse generator which should be limited to +70°C. If the `:health?` command does not report that temperature, extrapolate it by taking the microcontroller temperature and adding FIXME:TBD.

3 Remote Control via USB

3.1 USB Virtual COM Port (VCP)

When connecting the Sigtrona APG1780 to a USB host, it registers itself as a USB virtual COM port (VCP) using the CDC ACM interface with a product ID of 0x5740 and a vendor ID of 0x0483. It will automatically show up as a virtual serial port under current operating systems. Linux will typically recognize it as `/dev/ttyACM`x, Windows as `COM`x.

Under Linux, the following `udev` rule can be used to create a symlink named `/dev/ttyAPG` to the last plugged in device:

```
ATTRS{idVendor}=="0483", ATTRS{idProduct}=="5740", ATTRS{product}=="APG* Pulse Generator",
SUBSYSTEM=="tty", SYMLINK+="ttyAPG"
```

After storing the rule in a file in `/etc/udev/rules.d`, call

```
sudo udevadm control --reload
```

and re-plug the USB cable. The pulse genrator will now consistently show up as `/dev/ttyAPG`.

The virtual COM port does not require any of the traditional COM port settings such as baud rate, number of stop bits or parity. However, local echo has to be disabled on the host side to avoid that the device reads back echoed responses and generates errors. Under Linux use this call to configure the port:

```
stty -echo -icrnl igncr < /dev/ttyACMx
```

This disables local echo and ignores the CR character.

3.2 Communication Prototcol

The APG1780 accepts text based commands. Each command starts with a colon ':' and needs to be terminated by a CR or LF character (they are both threated equally). Apart from commands to set parameters, there are also query commands to read back status information from the device. Those query commands end with a question mark '?'. Examples:

```
:mode usb
:trig_level 2200
:trig_level?
```

Responses are single or multiple lines terminated by a CR+LR combination. Each line starts with either `OK` or `ERR`, indicating success or failure, followed by an optional value. After that, a hash sign `#` and a human-readable part can be added. Examples for responses:

```
OK: 2200 # Ext. trigger level 2200
OK: Restarting...
ERR # Value out of range 0 ... 31.
```

This format is deliberately chosen to ease parsing in automatic script talking to the APG1780. Error checking in automated scripts can ignore everything after the hash sign or decide to present it to the end user. Only a few commands deviate from this syntax such as the `:help` and `:status?` commands.

3.3 USB Command Description

```
:mode {dip|usb}
:mode?
```

Specify if the pulse width be set via USB or via DIP switches on the frontpanel. The power-up default is DIP switches. If set to USB, the orange LED "remote" will be on. If USB mode is active, the pulse width is set via command :pulse_len.

```
:pulse_len {0...31}
:pulse_len?
```

Set the pulse width if the mode is set to USB, ineffective if the mode is set for DIP switches.

The query command can be used to read back the actual pulse width which is the one set by DIP switches if the mode is set to DIP.

```
:trig_level {-1...4095}
:trig_level?
```

Set the trigger level. This is only available for single-ended input (e.g. SMA input) and not for differential inputs. The special value −1 is the power-up default and denotes that the frontpanel dial will be used to set the trigger level.

The value range 0...4095 will set the trigger level via USB and corresponds to a voltage range of approx −3...+3 V. The orange "remote" LED will be on in this case.

```
:triggered?
```

Query if a recent trigger occurred (less than 1 second ago). This is similar to the frontpanel trigger LED.

Due to a hardware limitation, there are certain trigger frequencies beyond approx. 100 MHz where the triggered status can report no triggers seen even though the device is being triggered.

```
:trig_freq?
```

Query the observed trigger frequency in Hz. This is generally reliable from at least 10 Hz to appox. 80 MHz. Outside that range the reported trigger frequency can show erraneous values.

```
:int_trig {0...72000000}
:int_trig?
```

Values larger than 0 enable the internal trigger generator and specify the internal trigger frequency in Hz. Use value 0 to disable. The internal trigger is generated by dividing down an internal 72 MHz clock and hence not all values in the range 1 Hz to 72 MHz are available. When issuing this command, the actual trigger frequency is reported back.

This is mainly useful for testing.

Note that the internal trigger generator is simply AC coupled onto the input, so any external trigger

signal attached will interfere with the internally generated trigger signal. Therefore, only use the internal trigger when the external trigger signal is removed.

Note also, that when activating the internal trigger, the trigger level will be set to a suitable value (e.g. 2060, depending on the hardware).

Starting with firmware rev. 0.7a, the "remote" LED indicates when the internal trigger generator is activated.

```
:power_src {auto|ext}
:power_src?
```

The Sigtrona APG1780DA can be operated from USB power as well as from an externally supplied 5 to 12 V source.

By default, the source with the higher voltage will be chosen automatically. This is what the setting `auto` does.

In some applications, it may be desirable to make the pulse generator draw its power from an externally supplied 5 V source to not load the USB power. In this case, using `ext` forces the use of the external power supply. In this case, if the external power drops, the pulse generator will reset.

Note: Avoid external voltage slightly higher than USB voltage in "auto" mode

When both power sources are present and the power source mode is `auto` and the external power is in the range $V_{\text{USB}} + 0.2\,\text{V} \leq V_{\text{ext}} \leq V_{\text{USB}} + 0.8\,\text{V}$, then oscillation can occur. Avoid that constellation. With a 5 V USB power, either use 5 V external and force power mode `ext` or use at least 6 V external voltage when using `auto` mode.

```
:power {on|stby}
:power?
```

This command allows to set the pulse generator into a lower power standby state. In this state, no pulses are generated but the USB communication is still active.

This command is only available if the hardware revision supports it.

```
:health?  {temp|sup}
```

Query the health status.

With the `temp` argument, it will report back the microcontroller temperature in degrees Celsius. If available, the high speed pulse hardware temperature will also be reported as a second number.

Use argument `sup` to query the measured internally generated supply voltages on the 4 main supply rails which are reported in the following order: −3.3 V, +3.3 V, −5 V, +5 V.

This command requires firmware version 0.7 or higher; older versions show the health information only via the `:status?` command.

```
:status?
```

The response to this command is a lengthy human-readable status response. It is not meant to be parsed by automated scripts and the format of the messages may change.

A status report may look like this:

```
# Sigtrona Adjustable Pulse Generator APG1780DA 0.7a
# Trigger level: -1 (unavail due to diff. input)
# Trigger input: 0 Hz (measured; reliable up to 80 MHz)
# Internal trigger: inactive (set to 0 Hz, actual 0 Hz)
# Triggered within the last 1000 ms: NO; Pin level: HIGH
# Pulse length: DIP 0, USB 15; currently in DIP mode
# Power: Source: AUTO USB, PGOOD: YES, Standby: NO
# Supply voltages: (-/+3.3V; -/+5V): -3361, 3288; -4843, 4961 mV
# Ref voltage: 1221 mV (cal: 1229 mV)
# UC temperature: 45.5 degC (raw: 1660, cal: 1747 - 1300)
# Raw ADC values: 2668, 2040; 2047, 3078; 1516; T 1660
# Uptime: 9.221 s (modulo 49.7 days)
# HW options: [DiffIn] Board rev: 0/0 (0x0001)
```

```
:help
:help?
```

Displays a human-readable summary of available USB commands.

```
:version?
```

Reports the firmware date and version.

```
:reset
```

This re-starts the microcontroller inside the pulse generator. A re-start will cause an USB disconnect/reconnect and will revert all settings back to power-on defaults.

```
:dfuboot!
```

This command is used for firmware upgrades.

After executing this command, the STM32 microcontroller inside the pulse generator will enter its built-in DFU boot loader mode. In this mode, it will show up as an USB device with vendor ID 0x0483 and a product ID of 0xdf11. The product and vendor strings are "`STM32 BOOTLOADER`" and "`STMicroelectronics`", respectively.

3.4 Firmware Update

To update the firmware in the pulse generator follow the following steps. It is important that the device is not un-plugged from USB during the whole process.

1. Obtain fimrware file from Sigtrona. This will typically be a `.bin` file with a size between 40 and 64 kbytes.
2. Obtain the `dfu-util` program. This program is cross-platform and many Linux distributions will have packages ready to install which can be used. Windows, Mac and Linux users without packages can obtain the program from the following web page:
   https://dfu-util.sourceforge.net/

3. Send via USB the command `:dfuboot!` to the APG1780. The firmware will respond with `OK # Entering DFU boot loader...`

4. Observe the newly created USB device with a vendor:product ID of `0483:df11`. This indicates the device is in bootloader mode.

5. Perform the firmware update via the `dfu-util` program. Open up a terminal and execute the following command:
   `dfu-util -v -a 0 -s "0x08000000:leave" -R -D pulsegen.bin`
   Depending on the user rights, you might need to run this as root or Administrator. (Linux: Use `sudo`, i.e. run: `sudo dfu-util -v -a...`)

6. Verify the firmware is updated by issuing the `:version?` command.