MODEL 4016

< 5 PICOSECOND PULSE GENERATOR

Features:

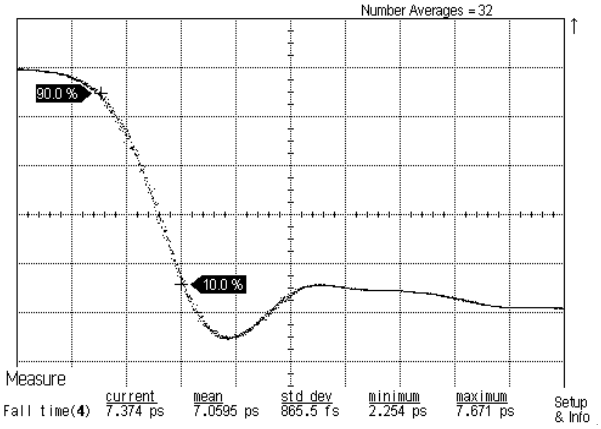
- **< 5 ps Falltime**
- **-5 V Pulse Amplitude**
- **Adjustable Repetition Rate**
- **Internally or Externally Triggered**

Applications:

- **Very high resolution TDR and TDT measurements**
- **Risetime standard for testing oscilloscopes**
- **Impulse or step response testing of semiconductors, components, networks, etc.**
- **Impulse Ultra-WideBand (UWB) RADAR**

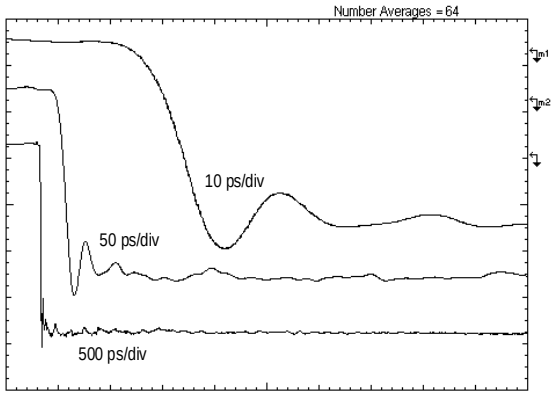
The Model 4016 Pulse Generator produces an ultra-fast pulse of -5 V with less than 5 ps falltime into an AC or DC coupled 50Ω load. The <5 ps, -5 V pulse is generated in a small external pulse head that is attached to the main unit via a coaxial cable. This allows the pulse head to be directly connected where it is needed, eliminating the risetime slowing effects of interconnecting coaxial cables. A 2 V, 18 ps impulse can also be generated with the 4016 by attaching the optional Model 5208 Impulse Forming Network to the pulse head output. If two 5208s are connected in cascade, a 1.3 V, 12.5 GHz monocycle will result.

Typical Step Pulse Data



Measured on PSPL 100 GHz Sampling System

5 ps/div, 1 V/div. Measured falltime is 7.4 ps. The system risetime, including contributions from the sampler, adapter, attenuator, and averaged jitter, is 6.7 ps. Deconvolved falltime of the 4016 is 3 ps (see note [2] on page 3).



Measured on Agilent 50 GHz Sampling System

1 V/div. Measured falltime is 10.8 ps. The system risetime, including contributions from the sampler, attenuator, and averaged jitter, is 11.3 ps. The system risetime is too slow to meaningfully deconvolve the falltime of the 4016 (see note [2] on page 3).

Step Pulse Parameters [1, 2]	
Waveform	5 ns step pulse followed by 10 ns exponential decay
Falltime (10% - 90%)	5 ps max.
Amplitude	5 V, ±0.5 V max. variation
Polarity	Negative
Baseline	0 V
Step Duration	5 ns
Risetime (90% - 10%)	20 ns
Precursor	±2%
Overshoot	10%
Perturbations	±7%, t < 1 ns
Flatness	±2%, t > 1 ns
Spurious Pulses	±10%, t = 11 ns
Impedance	50 Ω

Impulse Parameters [1, 3]	
Waveform	Impulse
Amplitude	2 V
Baseline	0 V
Polarity	Negative
Duration (FWHM)	18 ps
Falltime (10% - 90%)	13 ps
Risetime (90% - 10%)	10 ps
Perturbations	+25%, t = 30 ps ±7%, t < 1 ns
Baseline Flatness	±2%, t > 1 ns
Spurious Pulses	±5%, t = 11 ns

Trigger Output	
Impedance	50 Ω
Amplitude	2.3 V
Duration	80 ns
Risetime	900 ps
Note: Not functional with ext. trigger	

External Trigger Input	
Impedance	50 Ω, DC
Coupling	AC
Slope	Positive
Amplitude	200 mV to 1 V
Signal Type	Pulse only. Works with 200 mV TDR, ECL or TTL
Risetime	< 3 ns max.
Input Repetition Rate	500 kHz max.
Max. Input	1 Vpp pulse, ±5 V DC max.
Kickout Pulse	0.5 Vpp

General Timing	
Rep. Rate	500 KHz to 1 Hz, adjustable in 6 ranges with 10:1 vernier. Also single pulse and external trigger input.
Delay	60 ns with int. rep. rate. 14 ns with ext. trigger
Jitter (rms)	< 1 ps, 1.5 ps max.

General Specifications	
Connectors	Front panel: SMA External pulse head: input 2.92 mm; output available in 2.4 mm or 1.85 mm
Controls	Power, Load Coupling [4], Rep. Rate and Vernier
AC Power	100, 117, 200 or 230 V AC, 50/60 Hz, 15 VA (60 Hz)
Operating Environment	Indoors, 0 C to 50 C, < 80%RH
Safety Certifications	Conforms to EN-061010-1 (CE mark) UL-1244 and IEC-348. Safety class I. For lab use only by qualified personnel
EMI Certifications	Conforms to EU Directive 89/336/EEC EN55011 and EN50082-1, CE mark
Calibration	Test report with waveforms included. NPL/NIST-traceable.
Warranty	One year. See Terms and Conditions of Sale for details. Exception: 30-day, one-time limited warranty on static-sensitive internal and external pulse heads.
Accessories Included	PSPL external pulse head, SMA cable, power cord, and instruction manual.
Dimensions	3.8" x 8.4" x 10.3" (9.7 x 21.3 x 26.2 cm)
Weight	8 lbs (3.6 kg), 11 lbs (5 kg) shipping

Ordering Information	
Model Number	**Description**
4016-215	Pulse Generator, 2.4 mm Output
4016-307	Pulse Generator, 1.85 mm Output
Recommended Accessories	
Model Number	**Description**
5208	Impulse Forming Network
5510V-302-20dB	20dB Attenuator, V Connector
5510V-302-10dB	10dB Attenuator, V Connector
5510V-302-6dB	6dB Attenuator, V Connector
5510V-302-3dB	3dB Attenuator, V Connector
5510-110-10dB	10dB Attenuator, SMA
5350-201	Resistive Power Divider, 2.4 mm

Notes:

[1] These are typical performance parameters. Only the falltime and pulse amplitude are guaranteed to meet max/min limits. All other parameters are typical values only.

[2] Since the risetime of the Agilent 50 GHz system is too slow for accurate quantitative characterization of the 4016 falltime, a further measurement on one unit was made using a PSPL 100 GHz bandwidth sampler.

The PSPL 100 GHz sampler system risetime is calculated using the root sum of squares (RSS) approximation.

$$Tr(system) = [\ T_r^2(sampler) + T_r^2(1.0mm/1.85mm\ adapter) + T_r^2(attenuator) + T_r^2(averaged\ jitter)\ ]^{1/2}$$

$$= [\ (3.5\ ps)^2 + (2.0\ ps)^2 + (4.6\ ps)^2 + (2.8\ ps)^2\ ]^{1/2} = 6.7\ ps$$

Using the Root-Sum-of-Squares (RSS) approximation to extract the 4016 risetime from the measured risetime gives:

$$T_f(4016) = [\ T_f^2(measured) - T_r^2(system)\ ]^{1/2} = [\ (7.4)^2 - (6.7)^2\ ]^{1/2} = 3.1\ ps$$

Another even more conservative approach to using the risetime as displayed in the figure on page 1 is to use the top of the overshoot as the 100% level. This is considered by some to be more accurate for use with RSS approximations. In this case, the measured risetime is 8.0 ps, resulting in a 4016 risetime of 4.4 ps.

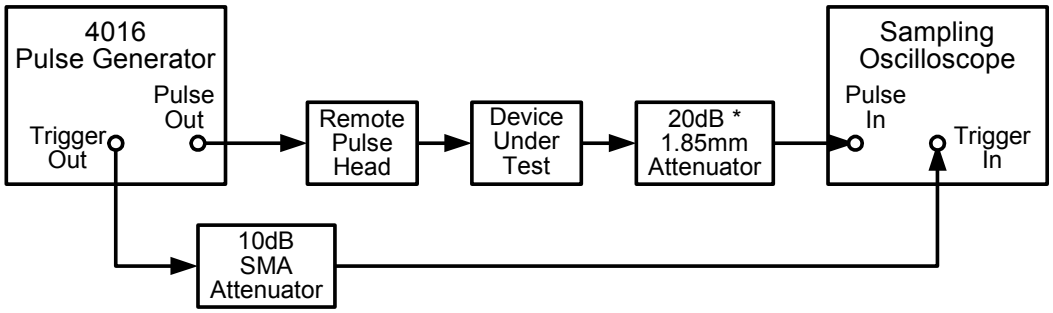
The same 4016 unit was measured using an Agilent 50 GHz scope. In this case, contributors to the system risetime include the scope (9.8 ps), attenuator (4.6 ps), and the averaged jitter (3.4 ps), for a total system risetime of 11.3 ps. The measured falltime was 10.8 ps. It is possible for the measured falltime to be faster than the scope due to overshoot on the signal. For production falltime verification of 4016 pulse generators, PSPL will guarantee that the 4016 falltime as measured on a 50 GHz Agilent scope is < 10.8 ps.

[3] These results were achieved with a Model 5208 Impulse Forming Network (may be purchased as an added accessory). These are typical performance parameters. Duration, risetime, and falltime are measured values, they are not deconvolved.

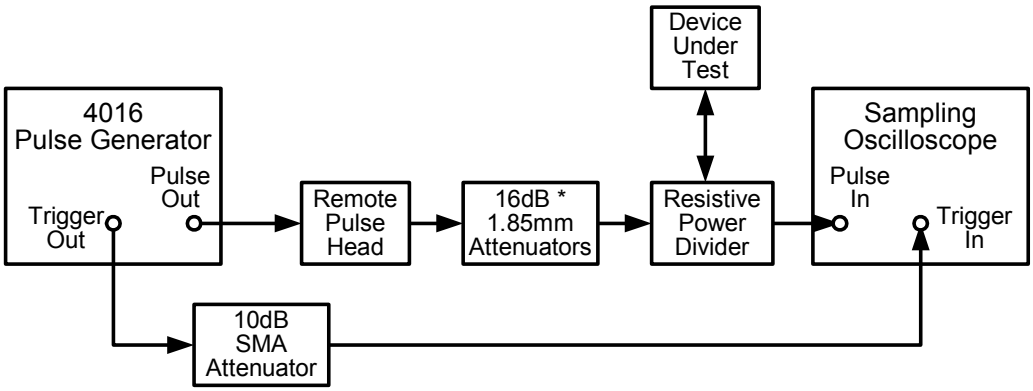
[4] The 4016 can be driven into either an AC or DC coupled 50Ω load. The "Load Coupling" switch on the front panel needs to be set appropriately. Each unit is calibrated using a DC coupled 50Ω load; however, similar performance can be expected when driving an AC coupled 50Ω load.

[5] CAUTION: The semiconductors in the external and internal pulse heads are fragile and susceptible to damage by static discharge. Use care when handling them. Always discharge cables and loads prior to connecting. These pulse heads can be damaged if an external voltage is applied. Since these items are subject to damage by the user, they have a limited 30 day warranty. If a DC voltage is present in the external circuit, use a DC blocking capacitor (for example, PSPL Model 5509-205-224) on the output of the external pulse head.

Example TDT and TDR Set-Ups:



Time Domain Transmission (TDT) Test Setup



Time Domain Reflectometry (TDR) Test Setup

* Note: To obtain the desired signal amplitude, attenuators may be placed before and/or after the Device Under Test.

Note: Please see Ordering Information for PSPL recommended accessories.