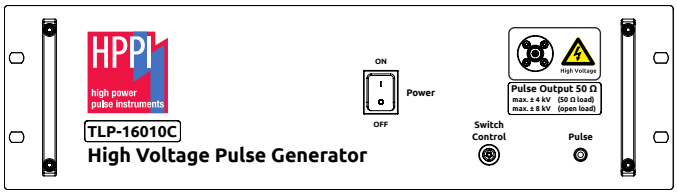
High Voltage Pulse Generator TLP-16010C

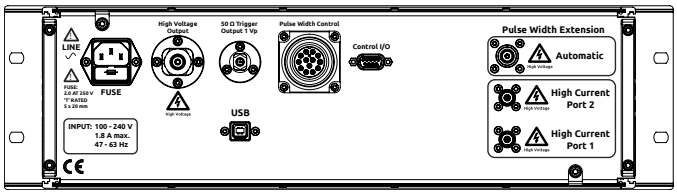
Advanced TLP/HMM/HBM Solutions

1 Features

- ±4 kV into 50 Ω
- ±160 A into short circuit
- 320 kW into 50 Ω
- Pulse output: high voltage TNC connector
- 6 digital programmable pulse rise times in the ranges:
  - 0.2 ns to 50 ns from 0 A to 40 A (40 A mode)
  - 1 ns to 50 ns from 0 A to 120 A (160 A mode)
  - 1 ns from >120 A to 160 A (160 A mode)
- High speed 50 Ω trigger output for oscilloscopes (synchronous to high voltage pulse output)
- 8 programmable pulse widths: 1 ns to 100 ns (40 A mode), 1 built-in pulse width: 100 ns (160 A mode)
- The optional pulse width extender TLP-3011C enables pulse width up to 1.6 µs in 68 digital programmable steps (0 A to 40 A, 40 A mode)
- Optional external pulse width extensions from 5 ns to 500 ns (0 A to 160 A, 160 A mode) using the external pulse width extender TLP-16012A
- Built-in pulse reflection suppression
- Fast measurement time, typically less than 0.2 s per pulse including one-point DC measurement between pulses
- Efficient software for system control and waveform data management
- The software can control automatic probers for fast measurements of complete wafers
- Combines TLP-16010A and TLP-4010C in one system
- Can be operated together with TLP-16012A and TLP-3011C pulse width extenders
- Integrated interlock safety shut-down
- Industrial isolated and EMI/ESD protected USB control interface



(a) TLP-16010C high voltage pulse generator front side view



(b) TLP-16010C high voltage pulse generator rear side view

Figure 1: TLP-16010C overview

2 Specifications

The high voltage pulse generator TLP-16010C combines the performance of the TLP-16010A, TLP-12010C and TLP-4010C pulse generator.

It offers advanced features intended for the characterization of semiconductor devices, discrete components, such as TVS, varistors, capacitors, gas tubes, circuits and systems in the high power time domain. It includes high current I-V characteristics in pulsed operation mode, turn-on/off transient characteristics of the device, breakdown effects, charge recovery effects e.g. reverse recovery, Safe-Operating-Area (SOA) and ESD measurements in general.

The TLP-16010C, Fig. 1, has 8 programmable pulse widths 1 ns to 100 ns (0 A to 40 A) and 1 built-in pulse width 100 ns for currents 0 A to 160 A.

Since the TLP-16010C in the current regime up to 160 A is limited to just one single pulse width the TLP-16012A pulse width extender may be considered. With this optional extender additional pulse width of 5, 10, 50, 100, 200 and 500 ns for example can be generated. In contrast to the TLP-4010C the selection of pulse width is done manually. Using the optional pulse width extender TLP-3011C the pulse width can be increased automatically up to 1.6 µs in 68 digital programmable steps from 0 A to 40 A. The TLP-16010C can be combined and operated together with the TLP-16012A and TLP-3011C extenders.

The DUT switch , shown in the measurement setup Fig. 2 to Fig. 4, automatically connects the DUT to the pulse generator or to the source meter unit (SMU) for DC measurements.

The advanced current sensor CS-0V5-TNC, with 150 ps rise-time, can be used up to e.g. 160 A at 100 ns pulse width, 120 A at 580 ns pulse width or 100 A at 700 ns pulse width, according it's Amp x Second rating of 70 A µs, respectively.

The system has been optimized for highly flexible fast software remote control. The highly efficient TLP software offers best-in-class measurement speed with up to 5 pulses/s, depending on scope and SMU data transfer speed, with one DC spot measurement after every pulse. The software is compatible with all HPPI equipment and offers seamless control and enhanced features like 4 graphic plots with transient waveforms, DC and I-V data, as well as the I-V data in tabular form. Up to five different data sets can be loaded simultaneously for a direct comparison of devices.

Data plots can be copied to the Windows® clipboard and conveniently pasted in other applications. The software offers accurate TLP full system calibration using zener-diodes and resistors as reference.

For compliance with laboratory safety regulations an interlock shut-down function has been integrated according: https://www.hppi.de/files/Interlock_Safety_Shutdown.pdf

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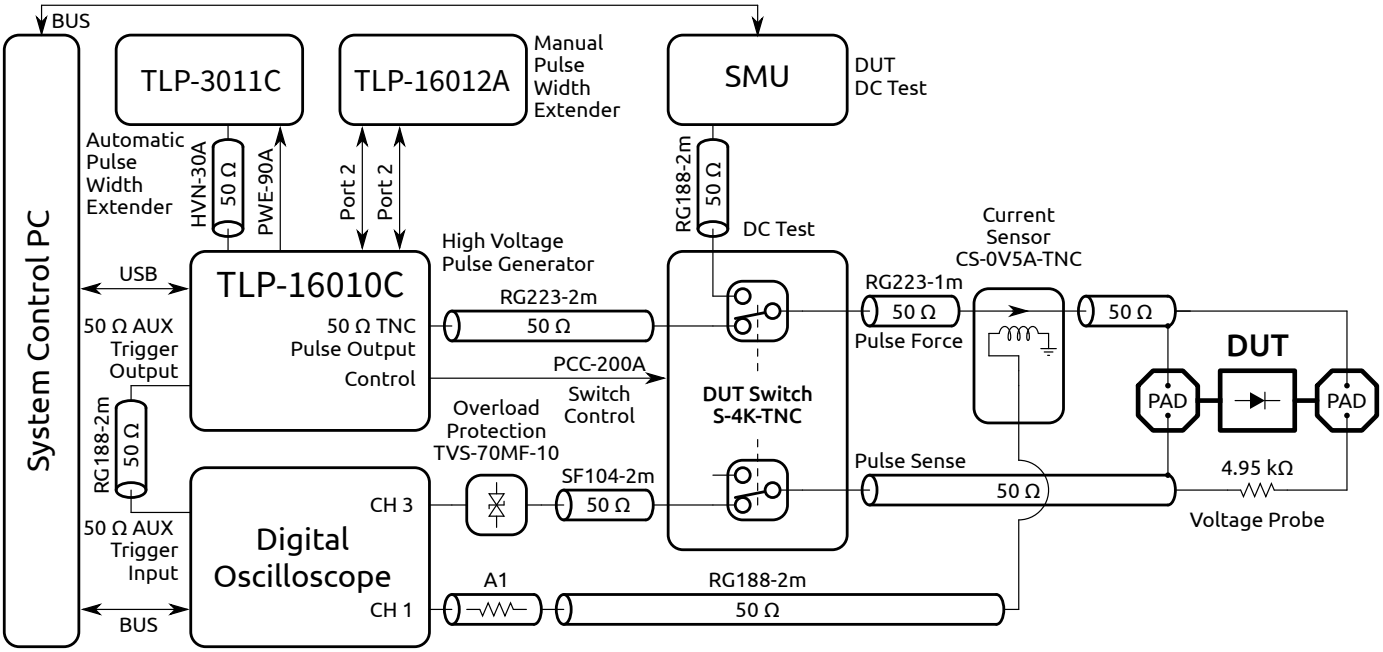

Figure 2: TLP-16010C Kelvin-based wafer-level test setup

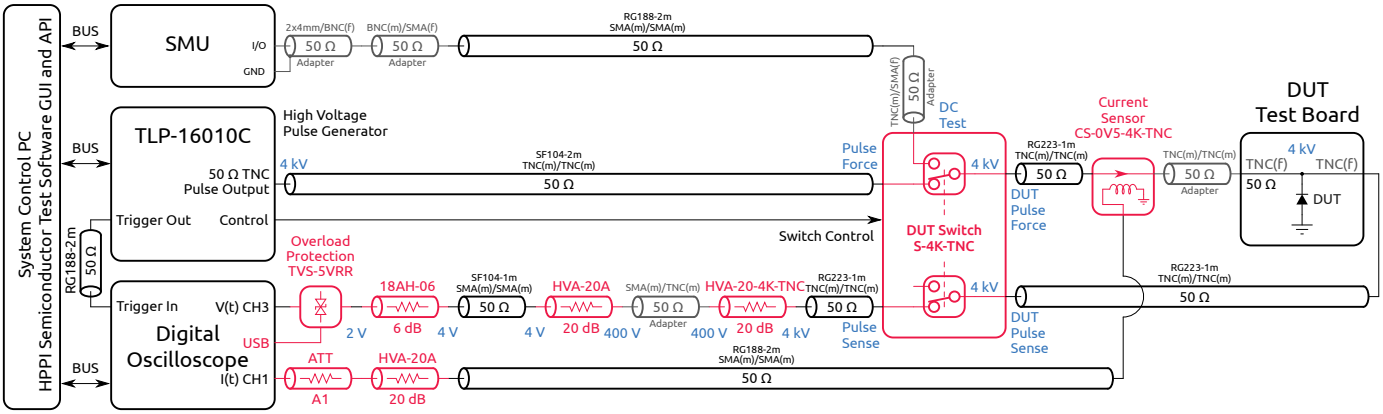

Figure 3: TLP-16010C 50 Ω through testboard setup

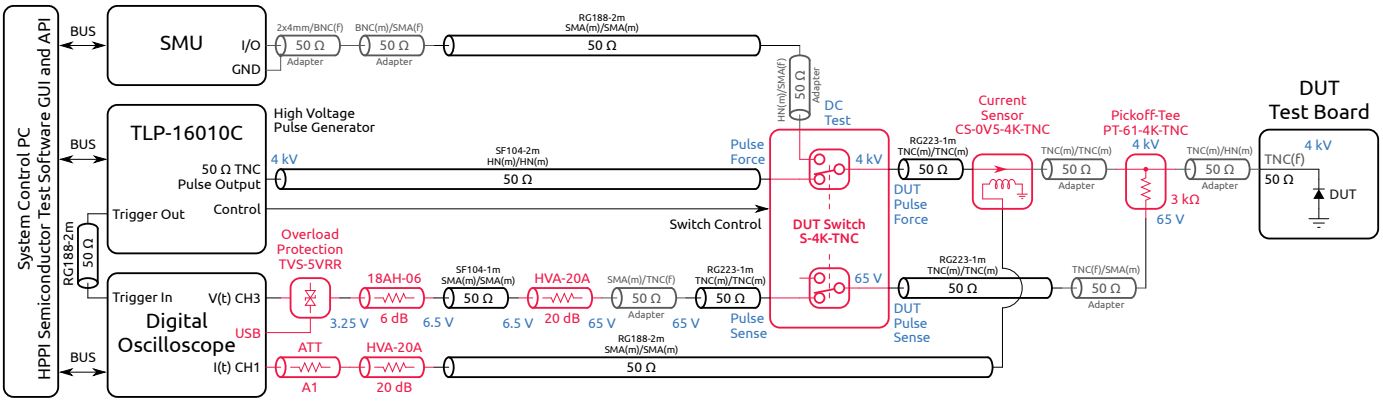

Figure 4: TLP-16010C single-ended testboard setup

High Voltage Pulse Generator TLP-16010C

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Parameter	Symbol	Limit Values			Unit	Remarks
		Min.	Typ.	Max.		
Output voltage (open load)	$V_{out,\infty}$	−4		+4	kV	into open load[1]
Output voltage (50 Ω)	$V_{out,50\Omega}$	−4		+4	kV	into 50 Ω[2]
Peak pulse output power (50 Ω)	$P_{out,50\Omega}$		320		kW	into 50 Ω[3]
Minimum output voltage step size	V_{Δ}		0.1		V	Programmable
Maximum output current (short circuit)	$I_{out,0}$	−160		+160	A	into short circuit
Maximum output current (50 Ω)	$I_{out,50\Omega}$	−80		+80	A	into 50 Ω
Max. HMM first peak output current	$I_{HMM,peak}$	−160		+160	A	Short circuit DUT, 50 Ω HMM
Max. HMM broad peak output current	$I_{HMM,30ns}$	−85		+85	A	Short circuit DUT, 50 Ω HMM, equivalent to ±43 kV IEC 61000-4-2 (330 Ω, 150 pF)
Pulse repetition frequency	f_p		5	10	Hz	State dependent
Pulse width in 160 A mode	$t_{p,160A}$		100		ns	One fixed pulse width
Pulse width in 160 A mode using pulse width extender TLP-16012A (optional)	$t_{p,160A}$		5	500	ns	5/10/50/100/200/500 ns manual selectable with TLP-16012A
Pulse width in 40 A mode	$t_{p,40A}$		1	100	ns	8 programmable steps: 1/2.5/5/10/25/50/75/100 ns
Pulse width in 40 A mode using pulse width extender TLP-3011C (optional)	$t_{p,40A}$		125	1600	ns	68 programmable steps: 125 ns to 1600 ns in 25 ns steps
Output pulse rise time 0 A to 40 A (40 A mode)	$t_{r,40A}$	0.2		50	ns	6 programmable steps, out of: 0.2/0.3/0.6/1/2/5/10/20/50 ns custom selectable[4]
Output pulse rise time 0 A to 120 A (160 A mode)	$t_{r,120A}$	1		50	ns	6 programmable steps, out of: 1/2/5/10/20/50 ns[5]
Output pulse rise time >120 A to 160 A (160 A mode)	$t_{r,160A}$		1		ns	Fixed. The control and conditional check will be handled automatically by the GUI/API software and firmware of the pulse generator.
Digital control interface	-	USB			-	Industrial isolated and EMI/ESD protected USB 2.0 interface
AC line voltage range	V_{AC}	100		240	V	47 Hz to 63 Hz, max. 1.8 A
Dimensions TLP-16010C (W x H x D)	D_{16010C}	428 (482.6) x 132.5 x 485			mm^3	428 mm body, 482.6 mm rack flange
Weight TLP-16010C	W_{16010C}		22		kg	Excluding accessories
Software support of digital oscilloscopes	All models from Keysight, LeCroy, Tektronix, Iwatsu. New models will be added on request.					
Software support of SMU source meters	Keithley 24xx/26xx series SMU, Keithely 230 voltage source, Agilent B2900A, Iwatsu. New models will be added on request. 5 SMUs can be controlled by the system: 1 leakage measurement SMU and 4 independent bias SMU.					
Supported automatic probe stations	All Suss, Cascade, Signatone, MPI probe stations.					
Supported PC operating system	Microsoft Windows 10, 11, 64-bit (required).					
Integrated interlock safety shut-down (optional)	https://www.hppi.de/files/Interlock_Safety_Shutdown.pdf					

[1] The open load output voltage should not exceed this limit. The TLP-16010C must not operated at maximum voltage at open load condition.
[2] Limited by the breakdown voltage of the DUT connectors.
[3] Limited by the breakdown voltage and the thermal capability (pulse width) of the DUT connectors.
[4] 1 ns rise time of the 160 A mode must be part of the custom selected set of rise times. Other rise time values on request.
[5] In the range from 0 A to 120 A all above mentioned rise times of the 40 A mode ≥1 ns can be used. In the range >120 A to 160 A only 1 ns rise time is possible. The control and conditional check will be handled automatically by the GUI/API software and firmware of the pulse generator.

Table 1: TLP-16010C specifications

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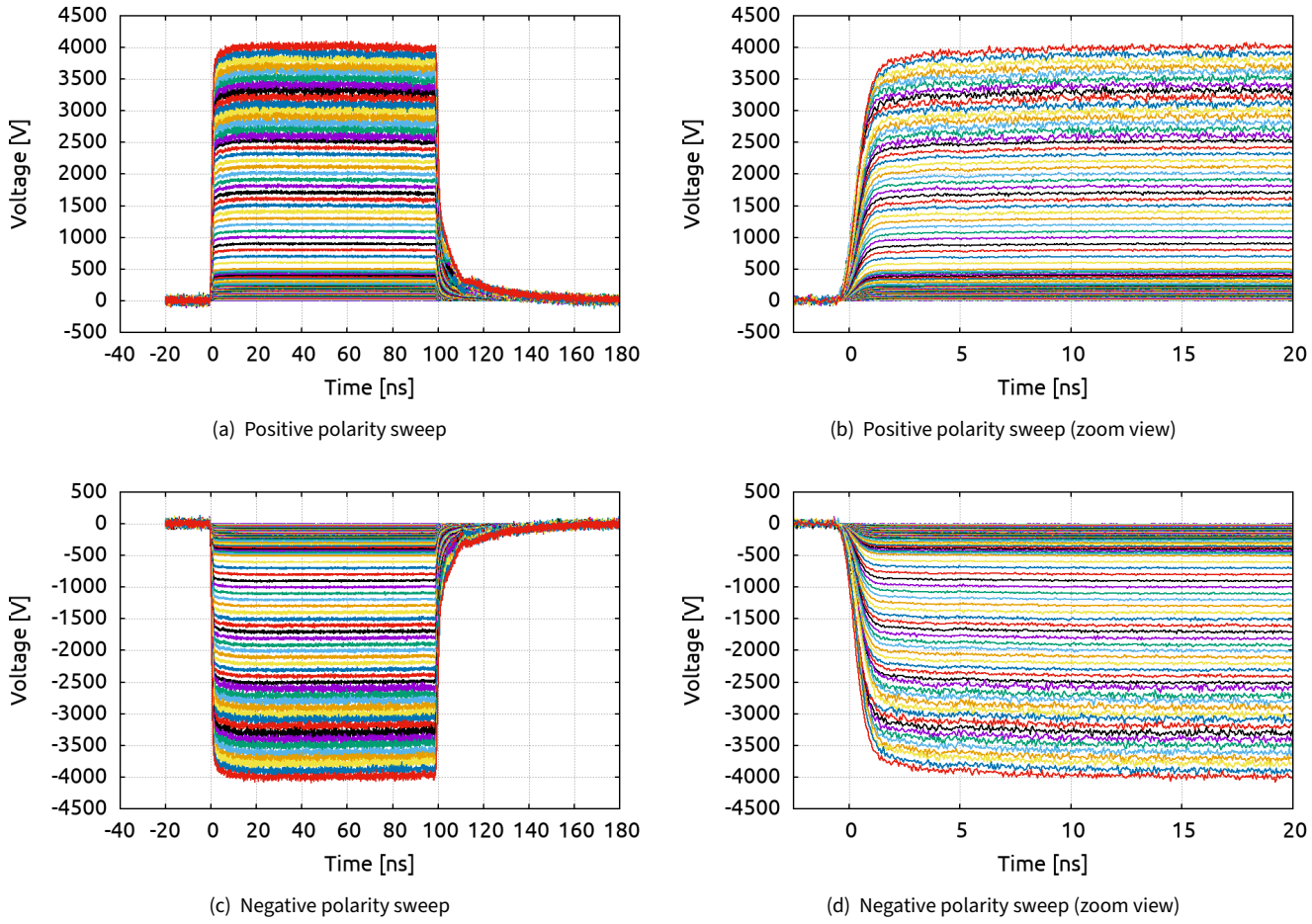


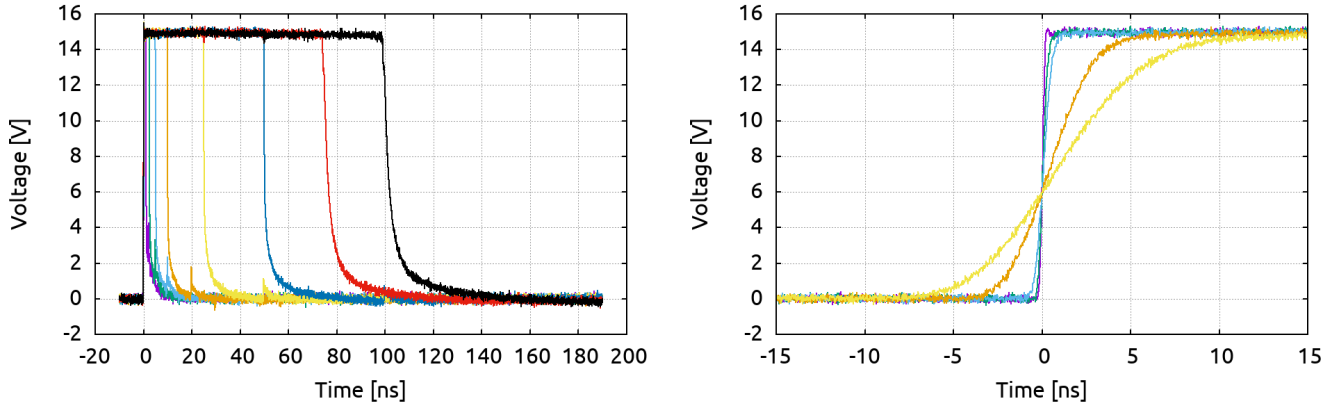
(a) Positive polarity sweep

(b) Positive polarity sweep (zoom view)

(c) Negative polarity sweep

(d) Negative polarity sweep (zoom view)

Figure 5: Measured output voltage (160 A mode, 1 ns rise time, 100 ns pulse width)



(a) Software programmable pulse width (example)

(b) Software programmable rise time (example)

Figure 6: Measured output voltage (40 A mode, different pulse width and rise time)

2.1 Pulse Generator Life-Time

The life-time of a high voltage pulse generator is depending on the operating parameters, such as pulse voltage, pulse width setting and total pulse count. In general, the life-time can be increased if the maximum ratings of the pulse generator are not exceeded.

2.1.1 Definition of the Pulse Voltage V_P

In general, the output voltage of the pulse generator at the load is not known, because it is dependent on the actual load impedance. Just 50 Ω output load impedance is a well defined case.

In contrast to the output voltage the internal pulse voltage V_P of the pulse source (Fig. 7) is well known. Therefore, V_P is always referred by the control software and manuals as the value of the pulse amplitude. The output voltage at the load is then dependent on the load impedance. Example: If 8000 V pulse voltage V_P is set by the software, and the output of the pulse generator is terminated with 50 Ω, then the output voltage across the 50 Ω load resistor will result to $V_P/2$ = 4000 V.

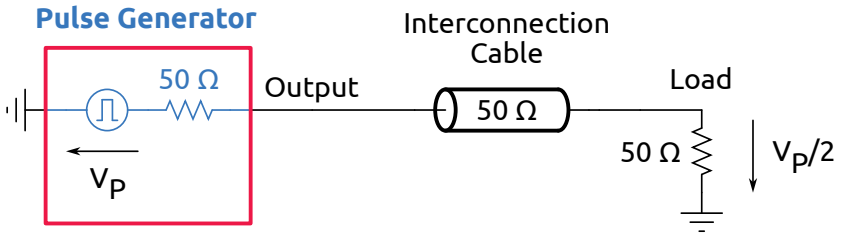


Figure 7: Definition of the pulse voltage V_P

2.1.2 Maximum Ratings

Depending on the pulse width, the pulse voltage V_P should not exceed the limits as shown in Fig. 8.

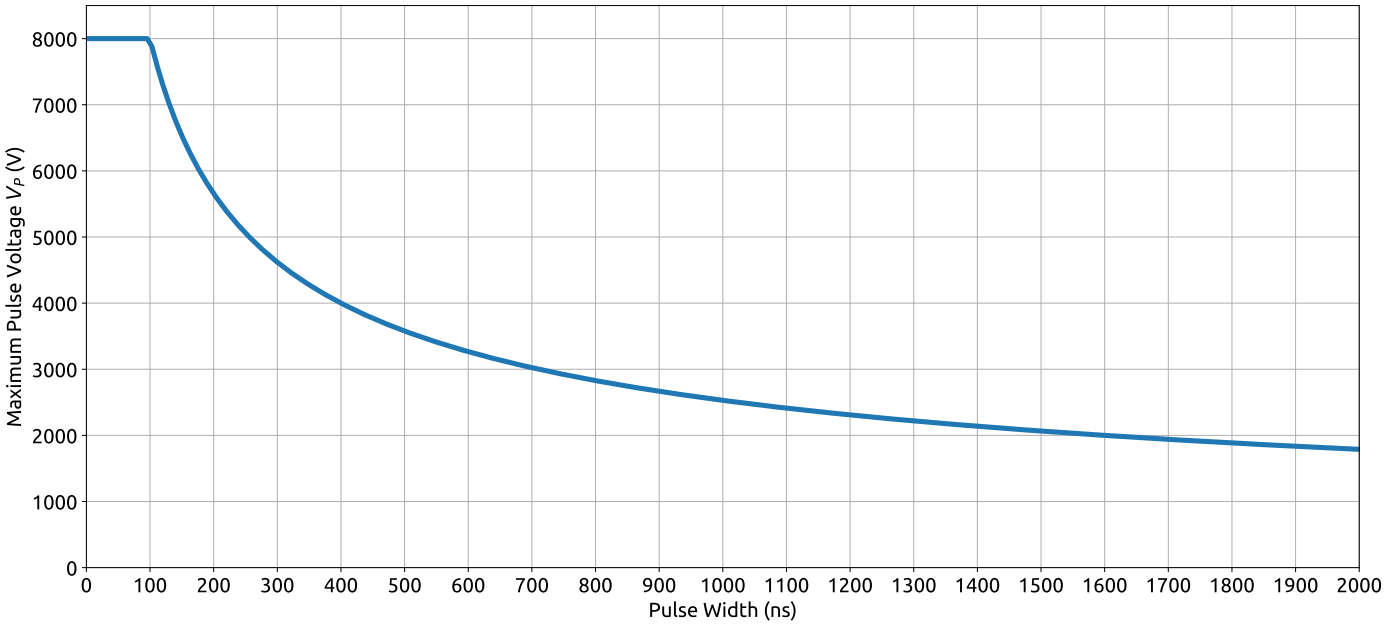


Figure 8: TLP-16010C recommended maximum ratings of the operating pulse voltage V_P versus pulse width

3 Ordering Information

Pos.	Description	Part No.
01	High voltage pulse generator TLP-16010C including accessories, software and manuals	TLP-16010C
02	Optional 40 A automatic pulse width extender TLP-3011C with 125 µs to 1.6 µs in 68 programmable steps	TLP-3011C
03	Optional 160 A pulse width extender TLP-16012A with 6 manual selectable built-in pulse width: 5, 10, 50, 100, 200, 500 ns (optional up to 1 µs on request)	TLP-16012A
04	Precision Picoprobe® Micropositioner Kit PHD-3001A, customizable for various micromanipulators	PHD-3001A

General

The product data contained in this data-sheet is exclusively intended for technically trained staff. You and your technical departments will have to evaluate the suitability of the product for the intended application and the completeness of the product data with respect to such application. Our products are solely intended to be commercially used internally and should not be sold to consumers. This data-sheet is describing the specifications of our products for which a warranty is being granted by HPPI GmbH. Any such warranty is granted exclusively pursuant the terms and conditions of the respective supply agreement. There will be no guarantee of any kind for the product and its specifications. For further information on technology, specific applications of our product, delivery terms, conditions and prices please contact HPPI:

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