

# Keysight PD1000A

## Power Device Measurement System for Advanced Modeling

### Introduction

The hybrid-electric and electric vehicle (HEV/EV) market is growing rapidly. Increasing vehicle electrification in the automotive market brings with it new challenges in design and manufacturing. Many HEV and EV manufacturers are migrating their power-conversion designs to wide bandgap (WBG) devices, such as Silicon-Carbide (SiC) and Gallium-Nitride (GaN), to achieve higher efficiency (extended range) and higher power in smaller, lighter, and cooler (less heat) packages. However, there are significant concerns about making sure these new designs are reliable and safe.



Only Keysight's power device measurement system for advanced modeling allows you to eliminate design cycles by creating real-world models resulting in simulations you can trust.

## For wide bandgap devices, traditional tools don't work

Relying on traditional semiconductor time-domain analysis tools and simple lumped-sum models for circuit simulation will not produce reliable, real-world results for WBG devices. While WBG switching frequencies may only be in the hundreds of kHz, what designers might not realize is WBG device's edge (on/off) speeds are can be can be ten to one hundred times faster than traditional silicon devices and result in frequency components in the 100s of MHz. Traditional semiconductor models do not contain the device's parasitic characteristics, which react to these high frequencies, and therefore cannot accurately predict conditions that are key to the safety and reliability of the circuit. A few examples of such conditions are in-rush currents, overshoots, ringing, and switching times. Without these conditions properly modeled, results may have inaccurate power estimates, undiscovered EMC issues, reliability issues if device margins are not met, or even a non-functional prototype. All these result in increased development time, costs, and potential loss of market opportunity.

## Keysight's Solution

Keysight is partnering with industry leaders in the HEV/EV power-conversion market to help them transition smoothly towards the use of WBG devices in their designs. As a result of these relationships, Keysight has developed a state-of-the-art modeling suite of power circuit simulator tools that allow WBG device designers to easily create models never before possible. The test suite, which consists of curve-tracing, s-parameter, and double-pulse tester hardware, takes measurements from actual WBG devices and uses advanced modeling software to build sophisticated WBG device models that are exclusive to Keysight. These models can then be used in Keysight's Electronic Design Automation (EDA) software to simulate and analyze the effects that high frequency components have on the reliability and EMI of the design. Changes in design can be made before the first prototype, saving time and costs by eliminating unnecessary design cycles.

Contact Keysight today to learn more: [www.keysight.com/find/PD1000A](http://www.keysight.com/find/PD1000A)

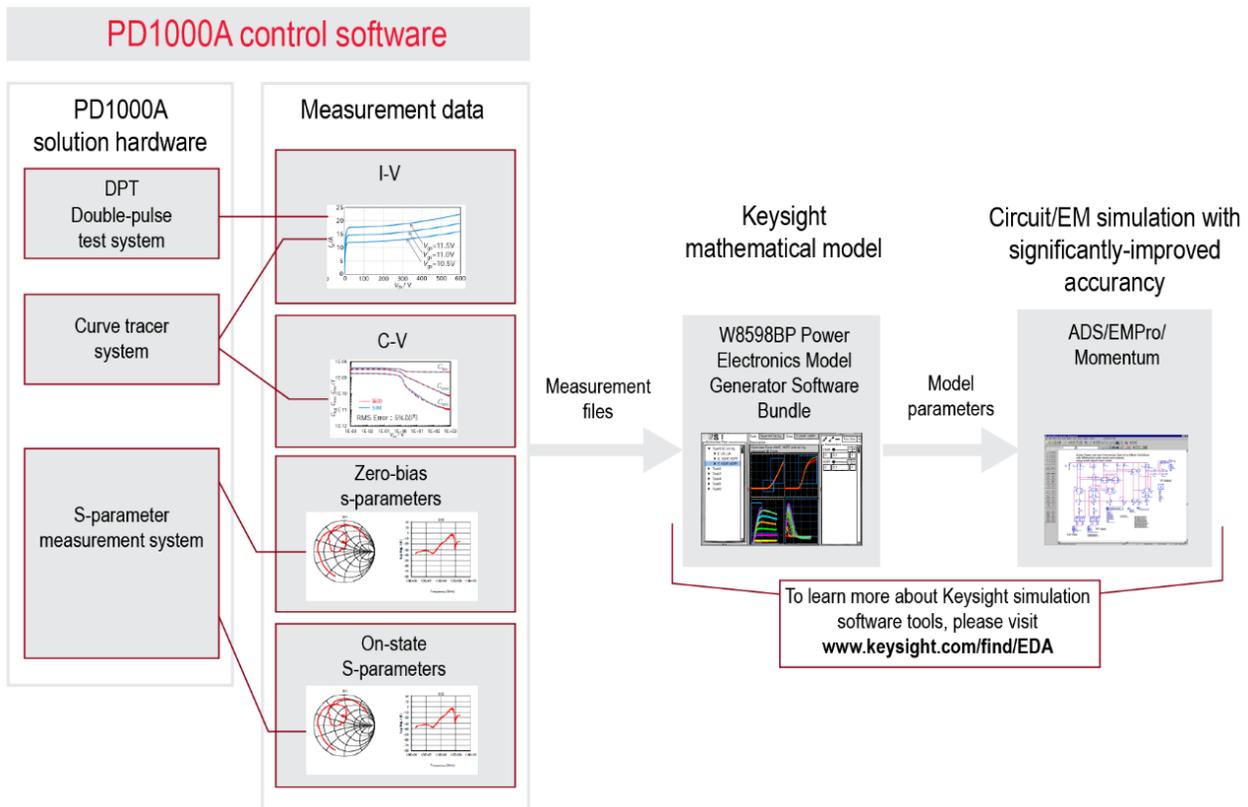
## Key features of the PD1000A Power Device Measurement System for Advanced Modeling

- Easily create models you can trust for any WBG device with real measurements, right on your bench\*
- Exclusive WBG device modeling that results in accurate simulations of EMI, in-rush, overshoots, switching time, etc.
- Causes of EM noise can be identified easily in simulation, before design is finalized
- Complete, one-vendor solution of hardware, software, consulting and support services worldwide

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\* Or send the part to Keysight and we'll create the models for you. Inquire about Keysight's PD1000A Measurement Service.

## How the PD1000A creates superior models



The PD1000A Power Device Measurement System for Advanced Modeling consists of three subsystems, all controlled by the PD1000A System Control Software:

- Curve Tracer System (based on the B1506A and accessories)
  - The curve tracer system provides I-V and CV measurements. They “teach” the model how the device will react under specific current and voltage conditions.
- S-Parameter Measurement System (based on the EN5080A, B2902A, and accessories)
  - The s-parameter measurement system measures the frequency response of the device under zero-bias (off) and biased (on) conditions. This “teaches” the model how the device will react in the frequency domain.
- Double-Pulse Test System
  - The DPT also covers characterization and parameter extraction, such as switching, reverse recovery, gate charge, switching locus, and many other parameters. These measurements add another level of accuracy to the model.

The control software automates almost all of the measurement process and creates files that can be loaded into the Keysight W8598BP Power Electronics Model Generator Software Bundle (PEMG). Once loaded into the PEMG, the user can choose from four different WBG models. The PEMG will create the model using the measurements and the modeling formula chosen. The model can then be used in Keysight’s Advanced Design System, EMPro, and Momentum for precise, real-world simulation. To learn more about Keysight’s simulation software tools, please visit [www.keysight.com/find/EDA](http://www.keysight.com/find/EDA).

## Overview of specifications and characteristics

### Curve Tracer System

This is an abbreviated list of specifications and/or characteristics. For the full list, please see: B1506A Power Device Analyzer for Circuit Design – Data Sheet, Literature number 5991-4441.



<http://literature.cdn.keysight.com/litweb/pdf/5991-4441EN.pdf>

### Key Specifications of B1506A

			B1506A-H21	B1506A-H51	B1506A-H71	
Collector/ Drain channel	Maximum output	Voltage	±3000 V	±3000 V	±3000 V	
		Current	Pulsed	±20 A	±500 A	±1500 A
			DC	±1 A	±100 mA	
	Minimum Resolution (Source)	Voltage	200 nV	25 µV		
		Current	100 fA	100 fA		
	Minimum Resolution (Measurement)	Voltage	200 nV	500 nV		
Current		10 fA	10 fA			
Gate channel	Maximum output	Voltage		±100 V		
		Current	Pulsed		±1 A	
			DC		±100 mA	
	Minimum Resolution (Source)	Voltage		200 nV		
		Current		500 fA		
	Minimum Resolution (Measurement)	Voltage		200 nV		
Current			10 fA			
Capacitance measurement (H21/H51/H7 1 only)	Max bias	Gate		±100 V		
		Collector/Drain		±3000 V		
	Frequency range			1 kHz to 1 MHz		
	Capacitance range			100 fF to 1µF		

## S-Parameter Measurement System

This is an abbreviated list of specifications and/or characteristics. For the full list, please see the Keysight E5080A ENA Vector Network Analyzer – Data Sheet, literature number 5992-0291.

<http://literature.cdn.keysight.com/litweb/pdf/5992-0291EN.pdf>



### Key Specification of E5080A (Uncorrected)

User correction: OFF, system error correction: ON

Description	Specification					
	9 k to 50 kHz	50 k to 300 kHz	300 k to 3 GHz	3 G to 6 GHz	6 G to 8.5 GHz	8.5 G to 9 GHz
Directivity	20	20	25	20	15	15
Source match	20	20	25	20	15	15
Load match	8	12	17	12	10	8

Description	Typical					
	9 k to 50 kHz	50 k to 300 kHz	300 k to 3 GHz	3 G to 6 GHz	6 G to 8.5 GHz	8.5 G to 9 GHz
Directivity	40	40	40	35	35	35
Source match	40	40	40	35	35	35
Load match	12	18	20	20	16	14
Transmission tracking	± 0.1	± 0.1	± 0.1	± 0.1	± 0.2	± 0.2
Reflection tracking	± 0.1	± 0.1	± 0.1	± 0.1	± 0.2	± 0.2

Description	Typical				
	9 k to 100 kHz	100 k to 50 MHz	50 M to 6 GHz	6 G to 8.5 GHz	8.5 G to 9 GHz
Crosstalk	132	141	147	140	130

This is an abbreviated list of characteristics. For the full list of characteristics, please see the Keysight B2900A Series Precision Source/Measure Unit – Data Sheet, literature number 5990-7009.

<http://literature.cdn.keysight.com/litweb/pdf/5990-7009EN.pdf>

### Key Specifications of B2902A

	Max voltage	Max current
DC or pulsed	210 V	0.105 A
	21 V	1.515 A
	6 V	3.03 A
Pulsed only	200 V	1.515 A
	6 V	10.5 A



## Bias Tee

Parameter	Typical
Impedance	50 $\Omega$
Maximum Voltage	$\pm 42$ V
Maximum Current	5 A
Resistance (bias input to RF port)	70 m $\Omega$
Frequency Range	50 kHz to 3 GHz (typical)
Rise Time	100 pS (typical)
Environmental Temperature	23°C $\pm$ 5°C with less than 1°C deviation from the calibration temperature
Capacitance (RF port 1 to port 2)	0.15 $\mu$ F
Inductance	185 $\mu$ H
RF Connectors	SMA female to ENA, SMA male to Test Fixture
DC Connectors	4 mm jack (banana jacks)

## Double-Pulse Test System

This is an abbreviated list of specifications and/or characteristics. For the full list, please see the Keysight PD1500A Dynamic Power Device Analyzer/Double Pulse Teste – Data Sheet, literature number 5992-3942.

<http://literature.cdn.keysight.com/litweb/pdf/5992-3942EN.pdf>



## Key Specifications for 1.2 kV / 200 A system

Category	Type			Item	Specification
Electrical	General			Sample Rate	10 Gsa/s
				Sampling Accuracy	12 ppb + 75 ppb/year
				Deskew Accuracy	200 ps (estimated)
	Drain/Collector Channel	DC	Source	Max. Voltage	1200 V
				Max Current	200 A
				Min Voltage	50 V
				Min Current	10 A
	Gate	DC	Source	High Level Max Voltage	29 V
				High Level Min Voltage	12 V
				Low Level Max Voltage	0 V
				Low Level Min Voltage	-10 V
				AC	
	DUT				MOSFET, IGBT
			Silicon and SiC		
			TO-247 (3pin), D2PAK7		
			Temperature	Room temperature (20 C to 30 C) to 150 C	

## PD1000A Accessories

### Curve Tracer System

- inTEST HP289-PM automated high temperature thermal platform – Hot plate for Keysight B1506A Analyzer
  - Data Sheet:  
[http://www.intestthermal.com/pdfs/Thermal\\_ds/Hot\\_Plate\\_Power\\_Device\\_Analyzer.pdf](http://www.intestthermal.com/pdfs/Thermal_ds/Hot_Plate_Power_Device_Analyzer.pdf)
  - The HP289-PM is a temperature-controlled platform designed to integrate with the Keysight B1506A power device analyzer. The platform permits automated control of plate temperature, from enclosure ambient to 250°C, for characterization of power devices such as IGBTs and MOSFETs.
- Option GTW LAN/GPIB/USB Gateway
  - Required to control the inTEST hot plate via LAN
- Options GP0 - GP8 GPIB Cables (see How to Order for details)
  - Required to connect the LAN/GPIB/USB Gateway to the hot plate

### S-Parameter Measurement System

- Option SPK S-Parameter Accessories Kit
  - The accessories kit includes:
    - Two Bias-Tees (Left & Right)
    - Three test fixtures (TO-220, TO-247, and SMD transistor packages)
    - Cables: coaxial and banana
    - Torque wrench
    - Carrying case
- PD1010A-License for S-Parameter Measurement Control in PD1000A Control
  - After the built-in, 30-day free trial, a license is required to perform s-parameter measurements with the PD1000A Control Software

### Double Pulse Test Measurement System

- PD1020A License for Double Pulse Test Measurement Control in PD1000A Control Software
- After the built-in, 30-day free trial, a license is required to perform DPT measurements with the PD1000A Control Software

## How to Order

How to order your PD1000A Power Device Measurement System for Advanced Modeling

### Power Device Curve Tracer System

For a complete curve tracer system, order one option 100 - 106, one inTEST thermal platform (hot plate), one option GTW, and one option GP0 - GP8.

### Curve Tracer Options

Option	Description
101	Power Device Analyzer/Curve Tracer, 20 A/3 kV/C-V/Gate Charge/Thermal Fixture Package, 50 Hz Line Frequency
102	Power Device Analyzer/Curve Tracer, 20 A/3 kV/C-V/Gate Charge/Thermal Fixture Package, 60 Hz Line Frequency
103	Power Device Analyzer/Curve Tracer, 500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package, 50 Hz Line Frequency
104	Power Device Analyzer/Curve Tracer, 500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package, 60 Hz Line Frequency
105	Power Device Analyzer/Curve Tracer, 1500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package, 50 Hz Line Frequency
106	Power Device Analyzer/Curve Tracer, 1500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package, 60 Hz Line Frequency

### Hot Plate Options

Option	Description
inTEST Model # HP289-PM	***MUST BE ORDERED DIRECTLY FROM inTEST; contact sales@intestthermal.com*** Temperature controlled platform designed to integrate with the Keysight B1505A and B1506A Power Device Analyzer (GPIB controlled)
GTW	LAN/GPIB/USB Gateway (for control of inTEST hot plate via LAN-to-GPIB)
GP0	GPIB Cable, 0.5 meter
GP1	GPIB Cable, 1 meter
GP2	GPIB Cable, 2 meter
GP4	GPIB Cable, 4 meter
GP6	GPIB Cable, 6 meter
GP8	GPIB Cable, 8 meter

## Power Device S-Parameter Measurement System

For a complete s-parameter measurement system, order one option 201 – 202, one option 301 – 302, one option SPK, and one PD1010A

### Network Analyzer Options

Option	Description
201	ENA Vector Network Analyzer; 2-port test set, 9 kHz to 4.5 GHz with bias tees with Options 245, 019, and UNQ
202	ENA Vector Network Analyzer; 2-port test set, 9 kHz to 4.5 GHz with bias tees with Options 245, 019, UNQ, 810, 820, and A6J

### Bias Power Supply Options

Option	Description
301	Precision Source/Measure Unit, 2ch, 100fA resolution, 210V, 3A DC/10.5A pulse
302	Precision Source/Measure Unit, 2ch, 100fA resolution, 210V, 3A DC/10.5A pulse with Option A6J

### S-Parameter Measurement Accessories

Option	Description
PD1010A	License for S-Parameter Measurement Control in PD1000A Control Software
SPK	Power Device Modeling S-Parameter Measurement System Accessories Kit

## Power Device Double Pulse Test Measurement System

For a complete DPT measurement system, order one of each of the options below.

Option	Description
400	DSOS104A, DPT Oscilloscope with accessories
450	Oscilloscope protection probe
500	1.2kV high-voltage power supply with accessories
530	33512B, DPT Function generator with accessories
600	Auto calibration basic pack
800	DPT Rack & Safety Enclosure with accessories
805	DPT Fixture for Si/SiC modular system
821	DUT board for TO-247 (3 pin)
822	DUT board for D2PAK7
870	Basic gate driver for Si/SiC
890	Clamp circuit for Si/SiC
PD1020A	License for Double Pulse Test Measurement Control in PD1000A Control Software

## Power Cord Options

When ordering options 101 - 106, 201, or 301, choose one of the following power cord options. You will receive the appropriate power cords for all ordered options.

Option	Description
900	Power Cord, UK, Singapore, Malaysia, Hong Kong
901	Power Cord, Australia and New Zealand
902	Power Cord, Continental Europe, Indonesia, Korea and Vietnam
903	Power Cord, United States and Canada (125V)
904	Power Cord, United States and Canada (250V)
906	Power Cord, Switzerland
912	Power Cord, Denmark
917	Power Cord, India
918	Power Cord, Japan (100V)
919	Power Cord, Israel
920	Power Cord, Argentina
921	Power Cord, Chile
922	Power Cord, People's Republic of China
923	Power Cord, South Africa
927	Power Cord, Thailand and Philippines
929	Power Cord, Japan (250V)
930	Power Cord, Brazil
931	Power Cord, Taiwan
932	Power Cord, Cambodia

## PD1000A Measurements Service

*Not interested in owning your own PD1000A solution?*

*Contact Keysight to learn more about our PD1000A Measurement Service*

Learn more at: [www.keysight.com](http://www.keysight.com)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

