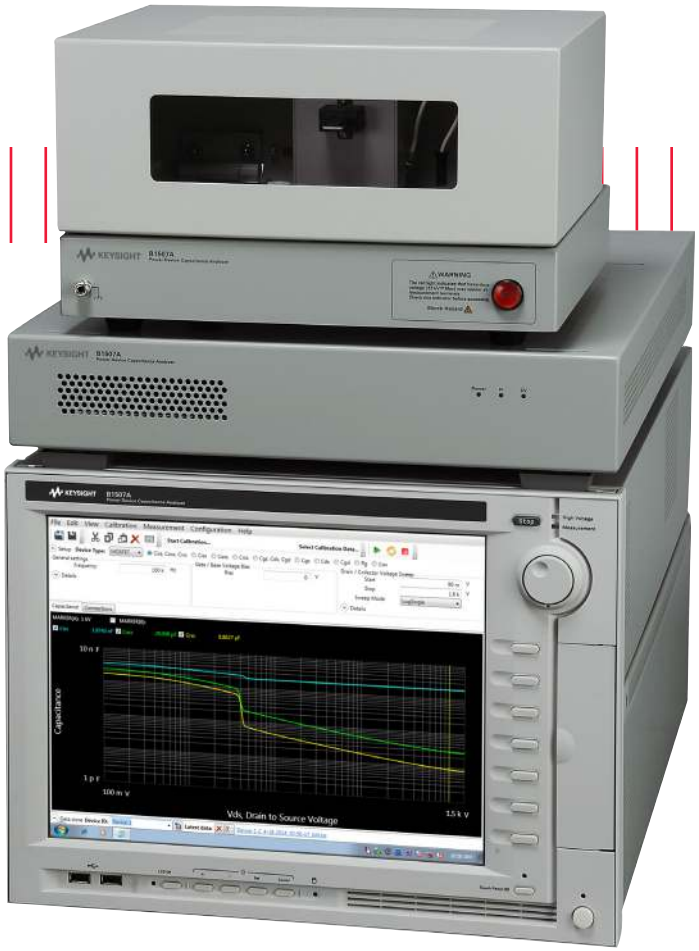
Keysight Technologies
B1507A Power Device Capacitance Analyzer

Automatically evaluate all power device capacitance parameters (including Ciss, Coss, Crss, and Rg) under a wide range of operating voltages

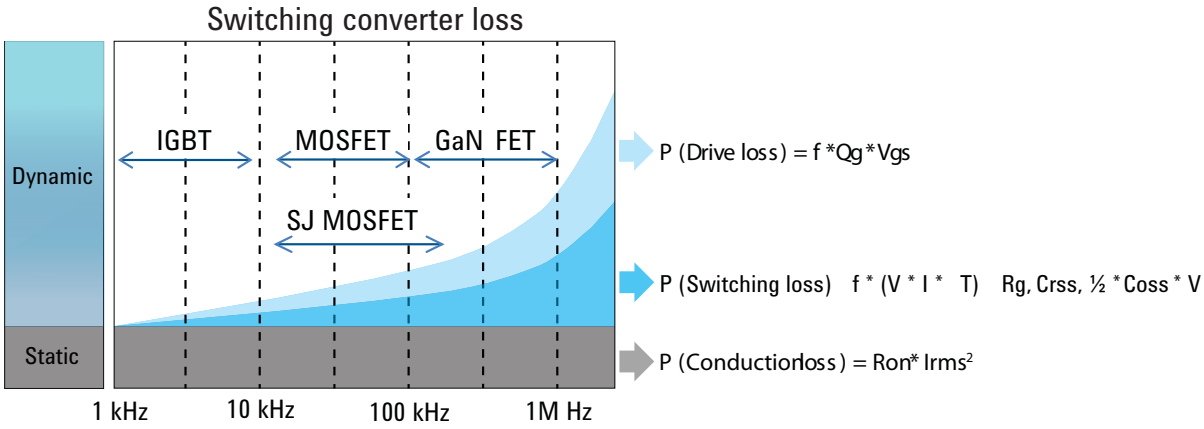


KEYSIGHT TECHNOLOGIES

Crucial issues facing the power electronics industry

Do you understand the full impact of device capacitance on increasing switching power supply frequencies?

In general, higher switching frequencies allow power electronics circuits to be physically smaller and take up less area. However, as frequency increases the device on-resistance (Ron) becomes less important, and switching loss and driving loss become the dominant factors that determine overall circuit power loss. A power device's capacitance characteristics (which are non-linear) are key parameters that help determine both switching and driving losses. Reverse transfer capacitance (Crss) and gate resistance (Rg) determine the switching speed, while the input capacitance (Ciss) determines the gate driving condition. In addition, the output capacitance (Coss) is also a key parameter in determining the switching loss for a resonant converter. Therefore, it has become more important than ever to accurately evaluate these parameters when designing power conversion circuits.



Do you worry about unknowingly using faulty power devices in your products?

As the occurrence of counterfeit and substandard power devices has become more common, the chance of accidentally using one or more of these devices in a power circuit has also increased.

Only checking current-voltage (IV) characteristics such as on-resistance (Ron) is not sufficient to screen out substandard devices. In fact, some devices have been intentionally manufactured with short channel widths to give them low Ron values. However, since capacitance is inversely proportional to channel width, these same devices have large and out-of-spec values for Crss. This means that when used in a circuit, these faulty devices will exhibit high levels of switching loss. For this reason, it is critical to measure device capacitance to prevent the use of defective power devices in your circuits.

The Keysight B1507A meets the challenges of power device capacitance evaluation

With the increasing use of power devices fabricated from emerging new materials such as SiC and GaN, switching power supplies are operating at increasingly higher frequencies. This makes accurate device capacitance characterization more important than ever before. The B1507A Power Device Capacitance Analyzer meets this need, providing a complete solution for the evaluation of power device capacitance (such as input, output, and reverse transfer capacitances). The B1507A can help power device development engineers maximize product value and performance by revealing detailed device characteristics. It can also help power electronic circuit designers maximize their products' value by helping them to select the optimal power devices for their applications. The B1507A's intuitive GUI allows you to automatically measure all capacitances under a wide range of operating voltages. In addition, it makes it easy to switch back and forth between leakage tests (to verify the device is not damaged) and capacitance measurements without having to do any recabling.

Features	Benefits
– Measure transistor input, output and reverse transfer capacitances (Ciss, Coss, Crss, Cies, Coes, Cres) at high bias voltages – Measure independent terminal capacitances (Cgs, Cgd, Cds, Cge, Cgc, Cce) – Measure capacitances for normally-on devices such as SiC JFET or GaN FET – Measure internal gate resistance (Rg) – Continuous capacitance measurement as the gate voltage varies from negative to positive – Easy to switch back and forth between leakage tests and capacitance measurements – Wide operation voltage bias up to +/-3 kV – Easy to use and fully automated measurement	– Improved circuit performance through optimal power device selection – Optimized (sufficient & efficient) circuit operating margins – Reduced form factors – Lower power losses – Higher reliability through screening of faulty devices – Reduced product costs – Optimized power device value through junction capacitance minimization – Maximized productivity via faster development cycles – Quick device trouble shooting

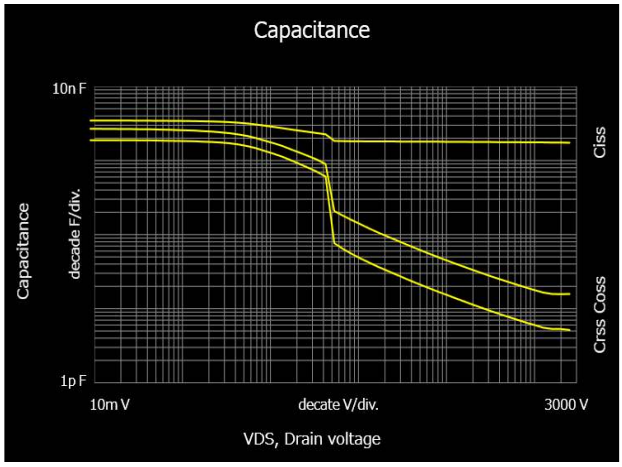
Measure device junction capacitances accurately and automatically

Measure capacitance at DC biases of up to 3 kV

The drain or collector terminal of a power device is often exposed to high voltages when it is off, which determines the value of its junction capacitances at the moment it turns on. Therefore, understanding how device capacitance changes with applied voltage is very important for power electronics circuit designers. Knowing the true value of device capacitance at a specific voltage and the calculated voltage the device will experience in a circuit allows you to select a power device with the lowest loss.

Measuring capacitance at high voltage biases is not easy. It requires both a good understanding of capacitance measurement theory as well as practical knowledge on how to connect the device and other necessary components (such as DC blocking capacitors and AC blocking resistors) correctly. In addition, since potentially lethal voltages are involved it requires a test setup that prevents the user from touching any high voltage nodes.

The B1507A meets all of these requirements. It can accurately and safely evaluate the junction capacitance voltage dependency of devices at up to 3 kV of DC bias. It can also compensate for the parasitic elements that affect cables and fixturing to produce reliable capacitance measurements.



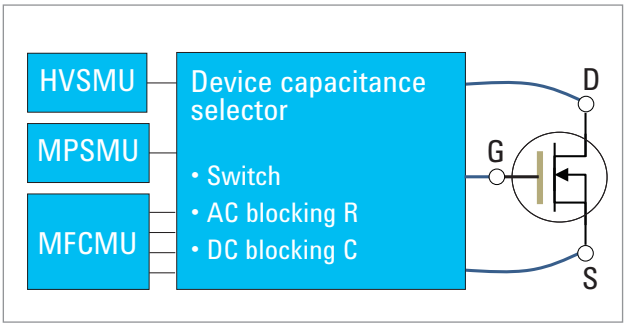
Ciss, Coss and Crss vs. drain voltage

Fully automated Ciss, Coss , Crss and Rg measurement

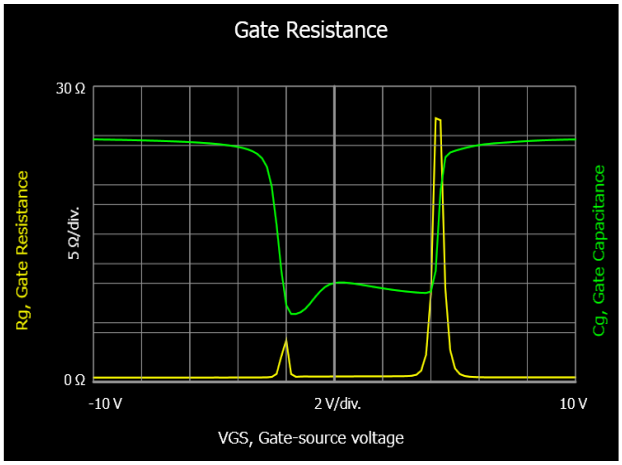
Measuring Ciss, Coss and Crss on a three-terminal power device is a tedious process. Each capacitance measurement requires a different connection scheme and some require additional external components. Moreover, any wiring mistakes with the AC guard, DC blocking capacitor or AC blocking resistor will result in an incorrect measurement.

The B1507A eliminates these concerns by automating the process to determine the drain or collector voltage dependencies of the input, output and reverse transfer capacitances.

Gate resistance is another important parameter for circuit designers, since it impacts device operation speed and switching loss. The B1507A can automatically extract device gate resistance (Rg) when it performs capacitance measurement, thereby eliminating the need for additional complicated data analysis.



Capacitance selector supports fully automated Ciss, Coss and Crss measurement



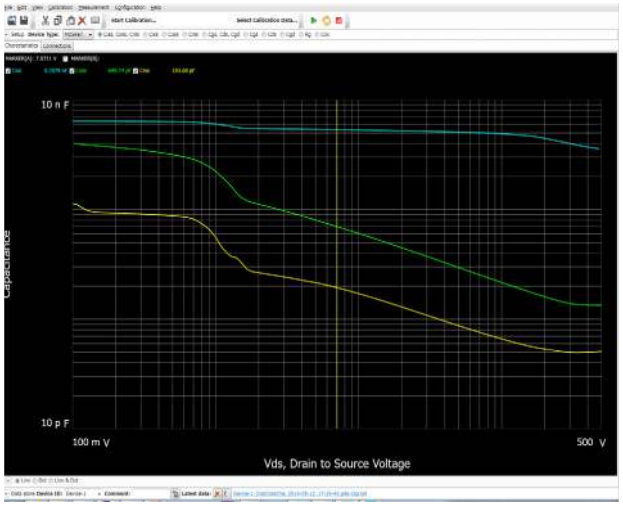
Gate resistance (Rg) and Ciss vs. gate voltage

Extensive range of capabilities meets both current and future capacitance measurement needs

Easily measure normally-on device capacitances

The faster switching frequencies and higher operating temperatures of normally-on power devices such as GaN FETs and SiC JFETs have made their use in power circuits more common. Due to their higher operating frequencies, it is extremely important to understand and characterize the capacitance characteristics of these normally-on devices so as to minimize switching losses. However, measuring the capacitance characteristics of a normally-on device adds an additional level of complexity, since the device under test needs to be biased off with a negative effective gate voltage during the capacitance measurements. This consideration also has to be integrated with all of the standard issues around making capacitance measurements on three-terminal power devices (AC guard connection, DC blocking capacitor, AC blocking resistor, etc.).

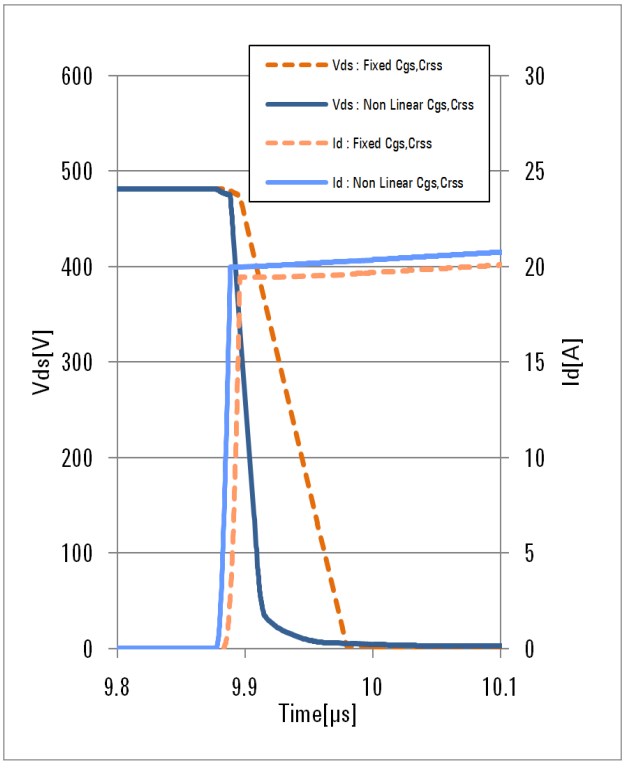
The B1507A's integrated capacitance selector and easy-to-use software eliminate the need to worry about all of these issues, allowing you to quickly and efficiently measure the capacitance characteristics of a normally-on device.



Ciss, Coss and Crss vs. drain voltage on normally-on devices

Obtain accurate models for switching waveform simulations

For power electronics circuit designers, circuit simulators such as SPICE are an essential tool. Accurate circuit simulations can significantly reduce costs by reducing development cycles and prototyping. However, until now acquiring an accurate model of power device non-linear capacitance characteristics has not been possible since no equipment existed that could perform the necessary high voltage capacitance measurements. The B1507A meets this need by providing precise values for Crss, Ciss and Rg, which are essential for accurate power circuit simulations. The switching characteristics on the right show simulation results using Crss, Ciss and Rg modeling data obtained with the B1507A.

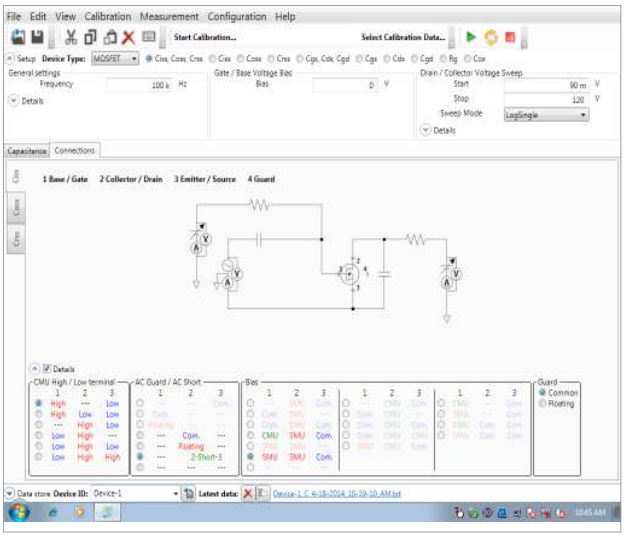


Simulation example: Switching waveforms with & without CV and Rg data

Achieve accurate results immediately without the need for training or measurement expertise

Intuitive user interface and simplified cabling connections eliminate the need for product training

The B1507A has a unique software interface that simplifies power device capacitance evaluation. . The B1507A is also supplied with a library of test setups for common devices such as MOSFETs and IGBTs, which allows you to unpack the instrument and start measuring device capacitances immediately. Moreover, it is easy to customize the furnished setups as well as to create new ones from scratch if needed. The B1507A also provides a fool-proof test socket for three-pin power devices that can additionally be used with an insulated pad to test larger devices (such as power modules). All of these B1507A features combine to create an easy-to-use solution that does not require any product training and that greatly minimizes the chance of operator error.



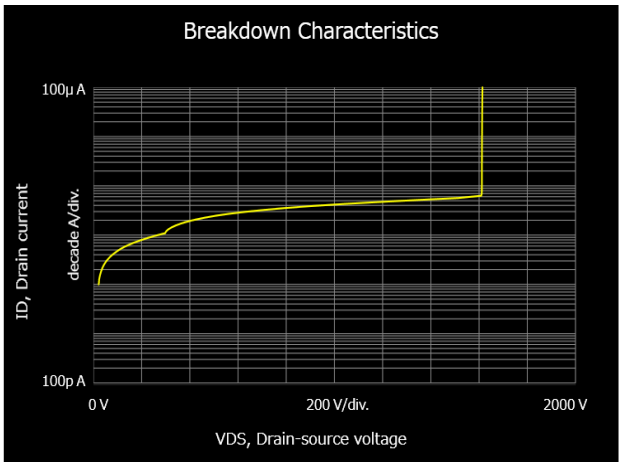
The B1507A's intuitive CV characterization software provides complete device CV characteristics in a few simple steps

Ability to easily switch between leakage and capacitance testing accelerates device development cycles

When evaluating device reliability, it is frequently necessary to measure junction leakage currents and/or breakdown voltage both before and after making junction capacitances measurements to insure that the DUT has not been damaged. This procedure is especially important for device manufacturers developing a new power device and for device users screening parts for counterfeit or substandard devices.

The B1507A meets all of these needs by providing a quick and easy way to make capacitance and leakage measurement without changing any cable connections. This results in faster development cycles for power device designers and quicker device selection for power circuit designers.

Simplified DUT connections eliminates errors



Accurate blocking characteristics up to 3 kV

Key specifications and ordering guide

Capacitance measurement	**Max bias**	**Gate**		**±100 V**
		Collector/Drain		±3000 V
	Frequency range			1 kHz to 1 MHz
	Capacitance range			10 fF to 1µF
Collector/ Drain channel	**Max output**	**Voltage**		**±3000 V**
		Current	DC	±8 A
	Source	Min. resolution	Voltage	200 µV
			Current	100 fA
	Measurement	Min. resolution	Voltage	200 µV
			Current	100 fA
Gate channel	**Max output**	**Voltage**		**±100 V**
		Current	DC	±100 mA
	Source	Min. resolution	Voltage	25 µV
			Current	500 fA
	Measurement	Min. resolution	Voltage	0.5 µV
			Current	10 fA

Characteristics[1]	**Category**	**Parameters**
Capacitance characteristics	Device Capacitance	Ciss, Coss, Coss_eff, Cgs, Cgd, Cds, Cies, Coes, Cres
	Gate Resistance	Rg
Static characteristics	Gate leakage current	Igss, Iges
	Output leakage current	Idss, Ices
	Breakdown voltage	BVds, BVces
	Threshold voltage	V(th),Vge(th)

1. Target device: MOSFET, IGBT, Diode / Device type: Package, Module, Wafer

Ordering Information

Model number	**Option**	**Description**
B1507A		**Power Device Capacitance Analyzer**
	Power line frequency	
	050	50 Hz Line Frequency
	060	60 Hz Line Frequency
	Documentation	
	ABA	English User's Guide
	ABJ	Japanese User's Guide
	Calibration	
	UK6	Commercial calibration certificate with test data
	A6J	ANSI Z540-1-1994 Calibration
	Drive option	
	DR1	Replace A Built-in DVD-R Drive With A Read-only DVD Drive
B1506AU		**Upgrade kit for B1507A**
	Accessories	
	F10	3-pin Inline Package Socket Module

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