

Keysight Technologies

Reducing Device-Failure Risk  
with a Black-Box Recorder

Application Note



## Introduction

Protecting against damage in test for aerospace/defense and automotive devices -- or any devices that are time consuming and costly to replace -- is essential to meeting delivery and budget objectives. When the risk of device failure is of significant concern, test planning should include strategies and equipment that can help you reduce the risk.

Even after planning carefully, taking extensive precautions, and executing a test plan step by step, DUTs may still fail. DUTs may fail for a variety of reasons beyond DUT flaws, among them human error, test equipment failure, and controller failure. When a failure occurs, you need to identify and understand the failure mechanism to avoid a repeat. Better still is to detect conditions that can lead to DUT failure and to act to prevent damage. The Keysight Technologies, Inc. N7908A black-box recorder (BBR) can provide the necessary functionality. As in commercial aviation, and increasingly in automobiles and other high-value equipment, a BBR can provide critical failure-mode insight and can play an important role in test strategy development aimed at reducing the risk of failure. You can gain insight about the operation and health of a DUT from examining the power source output and status data captured during a test cycle. The N7908A BBR is a user-installable accessory available for the Keysight Advanced Power System N6900 and N7900 Series DC power supplies.

### **Keysight black-box recorder**

The Keysight BBR runs in the background to continuously log the power supply's measured parameters and various other events. Logging starts automatically when the unit is turned on. Logging does not interfere with any source or measurement features of the power supply. It never stops, and data is preserved after a power cycle. Data logging can be performed every 10 ms or every 100 ms. At the 10-ms logging rate, you can log 24 hours of continuous data, and at the 100-ms rate, you can log 240 hours of data. Recorded measurements include average, minimum, and maximum voltage, current, and power. Logged events include system status bits that might affect sourcing, two user-defined status bits, front-panel keys pressed, SCPI command received, and trigger events.

## Examining and analyzing recorder data to understand DUT failures

BBR data can help you analyze DUT failures by providing time-stamped records of events and measurements of voltage, current, and power levels, as well as power-supply status -- both leading up to the point of DUT or test-equipment failure and after the failure. When the BBR clock is synchronized with the test-system controller and events external to the power source are also recorded and time stamped, examining and analyzing the data may provide a crucial link that can help you reconstruct the problem and determine the failure mechanism. Voltage, current and power data coupled with power supply status captured every 10 or 100 ms compared with expected values and conditions can help you discover if a failure was the result of a test configuration error, test equipment malfunction, or an isolated DUT failure. When a failure is not caused by test error or equipment malfunction, BBR data such as higher- or lower-than-expected voltage, current or power as well as short duration surges may help to uncover DUT flaws.

When a DUT fails or an unexpected event occurs during test, you can examine BBR voltage, current, and power entries along with a broad array of status bits for anomalous values and conditions. In addition to power-source output measurements, the BBR can record 31 status/event items. Recorded status states range from power-supply output operating mode to power-supply programming to fault conditions to user-defined status events (see Figure 2). You can view up to 12 user-selectable status items with the Power Assistant software (see Figure 1). Figure 1 shows the PC-based Keysight N7906A Power Assistant software interface to the BBR. To facilitate a review of BBR data while testing is in progress, you can use the software to capture and view snapshots with a specified time range.

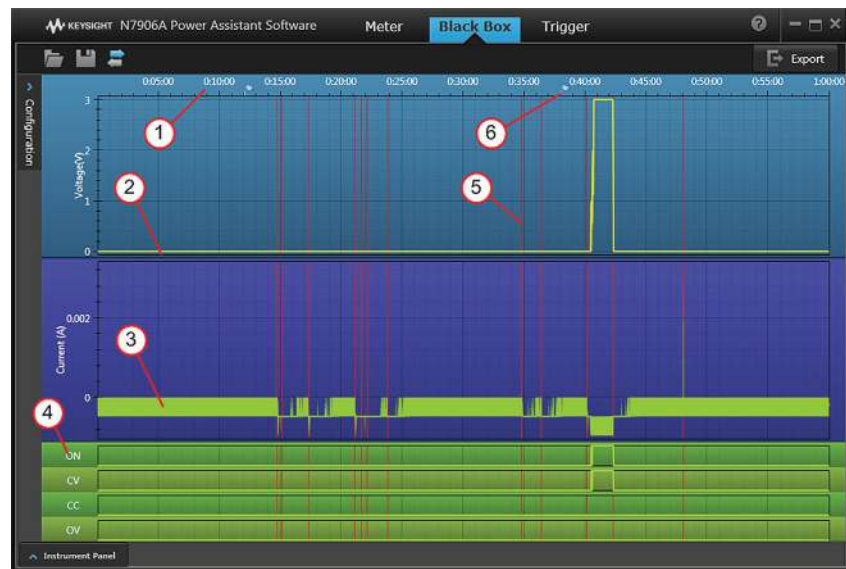


Figure 1: Keysight N7906A Power Assistant software interface to the BBR

1. The area on top of the display indicates the total time period of the snapshot.
2. The yellow line is the output voltage.
3. The green line is the output current.
4. The green portion of the window displays the status states.
5. The vertical red lines indicate when power was cycled on or off.
6. The pale blue dots on the timeline indicate where a user-defined message was placed into the log.

## Using BBR capability to establish and execute DUT test strategy

When it is critical that a test strategy includes a measured approach to the application of power and loading on a DUT, the BBR can provide a useful record of events for each stage of testing. When test-result expectations are not fully determined or understood prior to test execution, you may need to use a cautious, incremental test approach to confirm the DUT is operating within a safe range in each stage. For DUTs early in the development cycle, test-result expectations may be preliminary. For DUTs in final stages of development, test-result expectations will generally be firm. For either situation, the examination of BBR data for appropriate or inappropriate source output levels or surges of current, voltage and power and power supply status for each test stage may help you determine if testing should continue, or if you need to modify the test or the DUT before proceeding.

For some DUTs, testing involves the application of a range of voltages and a range of loads. Here, too, the BBR can be helpful and can provide useful information as you adjust test conditions. In some cases, the testing of a multifaceted, multisubsystem DUT must be done on a subsystem-by-subsystem basis, the results of which become a determining factor for continuing on to each additional subsystem. For some subsystems or for an entire DUT, it may be advisable to apply power to and/or loading on the DUT in measured increments. Recorded power supply status and output levels during each incremental test may help you determine the response of the DUT to additional changes in DUT stimulation and loading. Examining the data may provide insight into device performance and whether moving to higher stress levels of testing is appropriate.

## Using BBR data to augment quality assurance measures

When a DUT is a finished product you intend to deliver to an end customer, quality assurance plays an important role in ensuring product performance and life, and is most critical when the product, such as a satellite, cannot be serviced once deployed. Inappropriate and unexpected stress levels may not cause immediate DUT failure, but may cause or contribute to the weakening of components in the DUT, potentially leading to early failure. You can examine BBR recordings for anomalies to help verify that a DUT was operated within safe parameters. For example, some devices require multiple bias voltages that must be applied and removed in a specific order. Deviation may result in immediate failure, but worse would be an undetected misapplication of voltage resulting in a potentially shortened product life. Other potentially product-life-shortening events could result from operator error, test-equipment malfunction or software glitches. The BBR records test-system conditions that affect power-source status and output levels.

Status /event	Description	Status /event	Description	Status /event	Description
CV	Regulating in CV mode (voltage priority only)	Trans Active	A Step or List transient is active	USTAT2	User-defined status 2
LIM+	Output is in +current limit in voltage priority Output is in +voltage limit in current priority	VPRI	Instrument is set to voltage priority mode	CP—	Negative over-power protection tripped
IPK	Output is in positive peak current	CP+	Positive over-power protection tripped	CSF	Current sharing fault has occurred
IPK-	Output is in negative peak current	CC	Regulating in CC mode (current priority only)	PCHG	Programming DAC setting has changed
UNR	Output is unregulated	LIM—	Output is in –current limit in voltage priority Output is in –voltage limit in current priority	OT	Over-temperature protection tripped
OC	Over-current protection tripped	SF	Sense fault has been detected	WDOG	Watchdog timer protection tripped
OV	Over-voltage protection tripped	OV—	Negative over-voltage protection tripped	FPKEY	Front panel key was pressed
PF	Power-fail protection tripped	PD OT	Power Dissipator over-temperature tripped	SCPI	SCPI command or query received
INH	Output is inhibited by an external signal	PDP2	Power Dissipator on power supply connector P2 operating normally	EVENT	A BBR:EVENT command was received
OFF	Output state is off	PDP4	Power Dissipator on power supply connector P4 operating normally		
ON	Output state is on	USTAT1	User-defined status 1		

Figure 2: Status and events captured by the Keysight black-box recorder

## Conclusion

A BBR can give you critical insight into DUT failures and can help you develop an effective test strategy for reducing the risk of failure. You can gain insight about the operation and health of a DUT from examining the power-source output and status data captured during a test cycle with the N7908A BBR for the Keysight Advanced Power System N6900 and N7900 Series DC power supplies.

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