The DL850^{TM}—The Ideal ScopeCorder for Developing Energy-Saving Devices

Yokogawa Meter & Instruments Corporation
General Purpose Test & Measurement Gr. Development & Engineering Dept.
Etsurou Nakayama

1. Introduction

With increased concern in recent years about saving energy, continual improvements are being made in energy efficiency. With inverters, for example, continual increases in efficiency means power devices are becoming faster and higher in voltage. And as typified by automobile electronics, multiple CPUs are being utilized for finer control and more advanced functionality. R&D laboratories devoted to such products increasingly require isolated high withstand voltage measurements at higher sampling rates, as well as the ability to simultaneously measure greater numbers of signals for longer periods of time.

Against this background we position the DL850 ScopeCorder (see figure 1), a plug-in module–type signal waveform recording and measurement instrument. Following in the conceptual footsteps of its predecessor (the DL750) in terms of size and diversity of plug-in modules, we have dramatically improved its basic performance characteristics. It is further supported with four new modules offering even greater measurement flexibility.

Figure 1.　Overview of the DL850

2. Overview

The DL850 is a waveform recording and measurement instrument with eight module input slots. Users can mix and match any of fifteen modules best suited to the circuit under test and connect a variety of sensors directly to the inputs for measurements of physical quantities.

The DL850’s basic performance characteristics include high-speed sampling (100 MS/s), long memory (2 Gpts), and voltage measurements on up to 128 channels. Thus, it enables measurement over long durations at high-speed sampling on multiple channels—all on a single unit. Comparing with our previous model (the DL750), the DL850 samples ten time faster, holds twice the memory, and offers eight times the number of channels. And while offering 100 MS/s of high-speed sampling, the 100 MS/s Voltage Measurement Module also empowers engineers with high precision (12-bit A/D resolution) and high isolation withstand voltage (1 kVrms).

Two proprietary development technologies were employed in the creation of this product. The first is "isoPRO®" isolated data transfer technology to support high withstand voltage and high-speed sampling. The second is our very own "GigazoomEngine2" signal processing system for high-speed multichannel sampling.

In this document we focus on these two proprietary technologies and introduce the DL850's distinctive high-speed sampling and multichannel measurement functionality.

3. Characteristic Functions

3. 1 isoPRO® Technology

Inverter switching devices are becoming higher in speed and withstand voltage, and operating voltages are also rising. Thus for inverter evaluation, engineers naturally require waveform measuring instruments with high-speed sampling, but also with high withstand voltage. The high-speed isolation module offers high-speed data acquisition with a 100 MS/s sample rate, 12-bit AD resolution, and 20 MHz analog bandwidth, coupled with isoPRO® technology for high voltage (1 kV) isolation performance. isoPRO® technology employs a system whereby digital data is converted to optical using a semiconductor laser diode, and the data is transferred via optical fiber to the instrument. A diagram of this system is shown in figure 2. As the data transfer rate of the semiconductor laser diode is extremely high, large amounts of data can be transferred on a single device, and as a result the area of isolation has become very small. Also, due to the fact that optical fiber itself is an insulator, and that the distance of signal transfer along the optical fiber is of a sufficient distance for the requirement of insulation, an insulating distance between the signal input and the main unit is provided even at a high voltage of 1 kV. Owing to isoPRO® technology, we can package two channels of 100 MS/s, 1 kV high withstand voltage isolation measurement circuits in a compact module of approximately 100 × 200 mm. Noise rejection is also high, again because of the isolation from the optics.

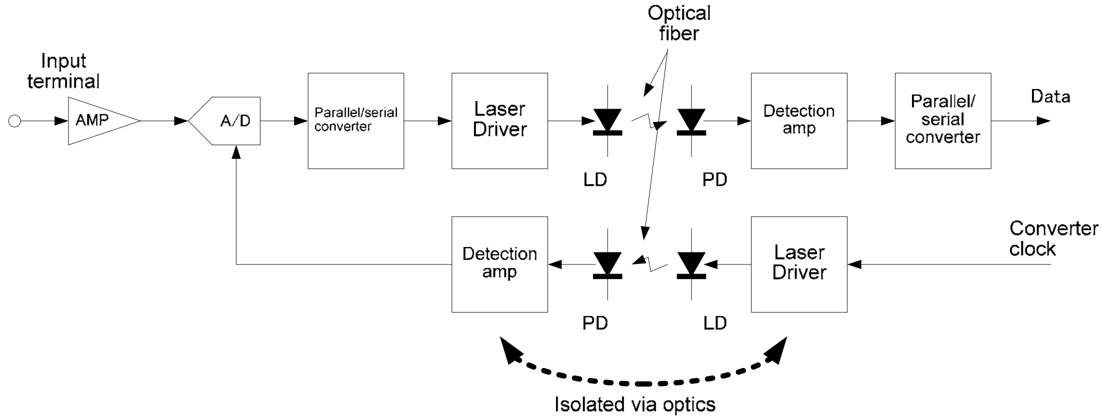


Figure 2.　Principles of isoPRO® technology

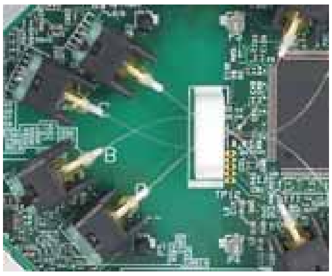
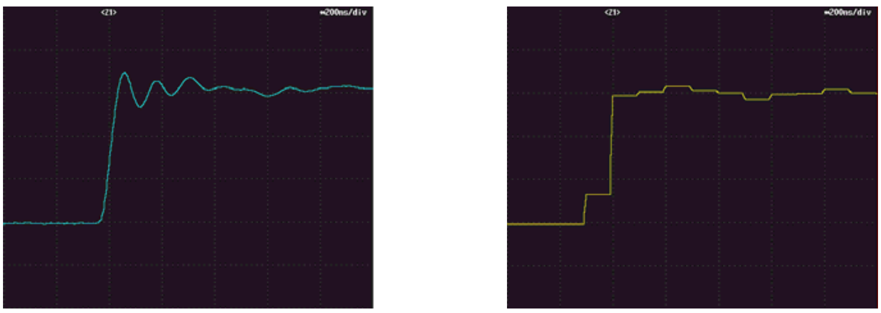


Figure 3.　isoPRO® technology

Figure 4 shows a pulse waveform of an inverter signal using this module. On the left is the measured result at 100 MS/s, and on the right is the result using the predecessor 10 MS/s module. You can see that measurements with the 100 MS/s High-Speed Isolation Module provide more pulse details.



100 MS/s High-Speed Isolation Module　　10 MS/s High-Speed Isolation Module

Figure 4. Comparison of measured waveforms

3. 2 Noise Rejection

Because the high voltage of inverters is switched at high speed, noise necessarily is introduced along the path of measurement.

The structure of the DL850 module shown below offers high noise rejection. The module enclosure includes shielding that constitutes the electrical potential of the case, and external noise is initially absorbed by this shield. Next, the measurement circuit area is shielded at measurement circuit GND potential, and is furthermore structured to hinder the propagation of noise (figure 5). With regard to the measurement circuit area's shielding in particular, the adjustment hole is sealed during assembly. In the 10 MS/s High-Speed Isolation Module, this double shielding achieves a high CMRR of approximately 90 dB at 10 kHz (figure 7). Also, when the module is inserted into the main unit, its case potential shielding is introduced between the neighboring channels. Thus, even if high voltage enters one of the channels, it is difficult for it to affect the other neighboring channel (figure 6).

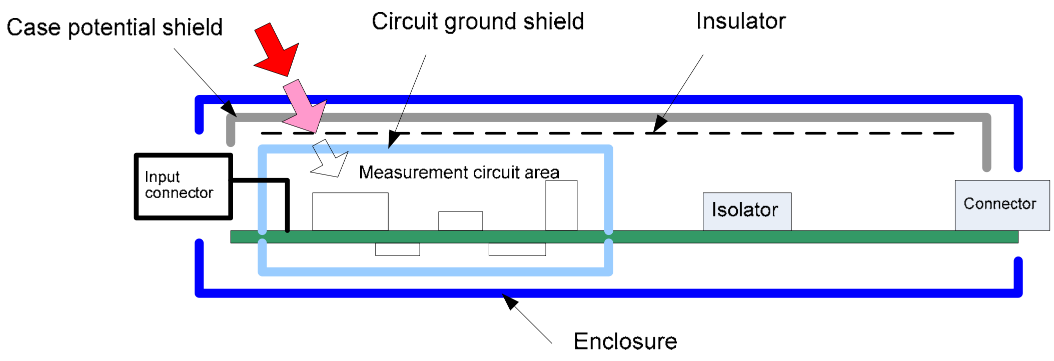


Figure 5. Module shield structure

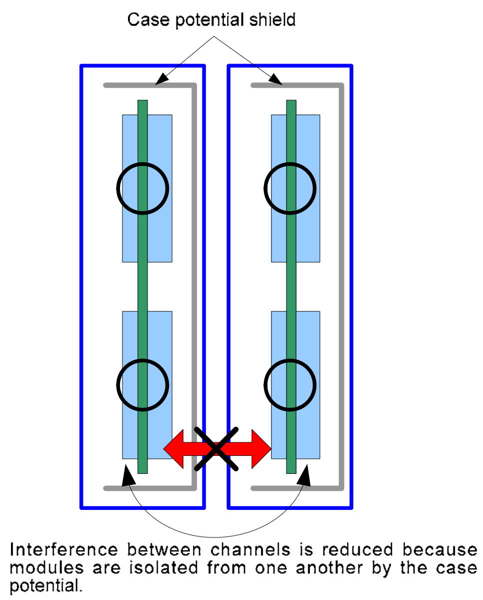


Figure 6. Shielding between modules

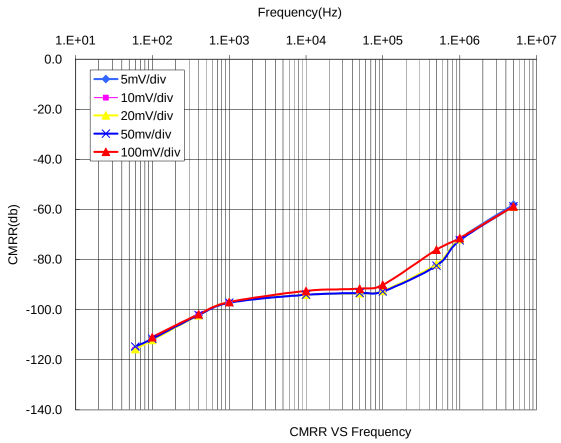


Figure 7.　10 MS/s High-Speed Isolation Module CMRR characteristics

Figure 8 shows an example of an inverter waveform measurement. You can see that noise has no effect, and the waveform is measured accurately.

Figure 8.　Inverter waveform measurement example

3. 3　GigazoomEngine®2 High-Speed Display Function

When speaking of inverters for industrial equipment, advances in switching devices have made those devices faster and higher in carrier frequency. As a result, higher speed sampling of switching and output waveforms has become necessary for inverter evaluation. And because it is also necessary to measure how inverter operating conditions change with fluctuations in system load conditions over long periods of time, there is a tendency for the amounts of data per measurement to be larger than before. The evaluation test cycle is a repetition of the following processes: Evaluation -> Data verification -> Change of conditions -> Evaluation. Therefore to reduce cycle times and raise efficiency, it is crucial to shorten the time required for data verification.

To meet this requirement, we have developed the GigazoomEngine®2 high-speed data processing system for the DL850 that uses a proprietary data processing algorithm for high-speed sampling and multichannel measurements. While saving data to acquisition memory, the GigazoomEngine®2 creates waveform display data and saves it to waveform display memory in real time. Because waveform display data is already prepared when data acquisition is completed, it is not necessary to read out and process data in the acquisition memory for display—display is made instantaneous by using the data in the waveform display memory. Also, with the independently functioning dedicated waveform generation hardware, data from acquisition memory or waveform display memory is read regardless of whether it has finished loading, making it is possible to reprocess the waveform display data according to the display zoom factor. Therefore, even during acquisition of data into the 2 Gpts of long memory, you can instantly display waveforms in two screens at any zoom factor. The functions of the GigazoomEngine®2 reduce the time required for data verification within the evaluation test cycle. Figure 9 shows a block diagram of the GigazooomEngine®2.

Note that dedicated zoom and position knobs have been provided to improve the waveform confirmation process (figure 11). Dedicated knobs make it easy to check waveform details by enabling you to directly zoom in and out of waveforms regardless of whether measurement is completed or not.

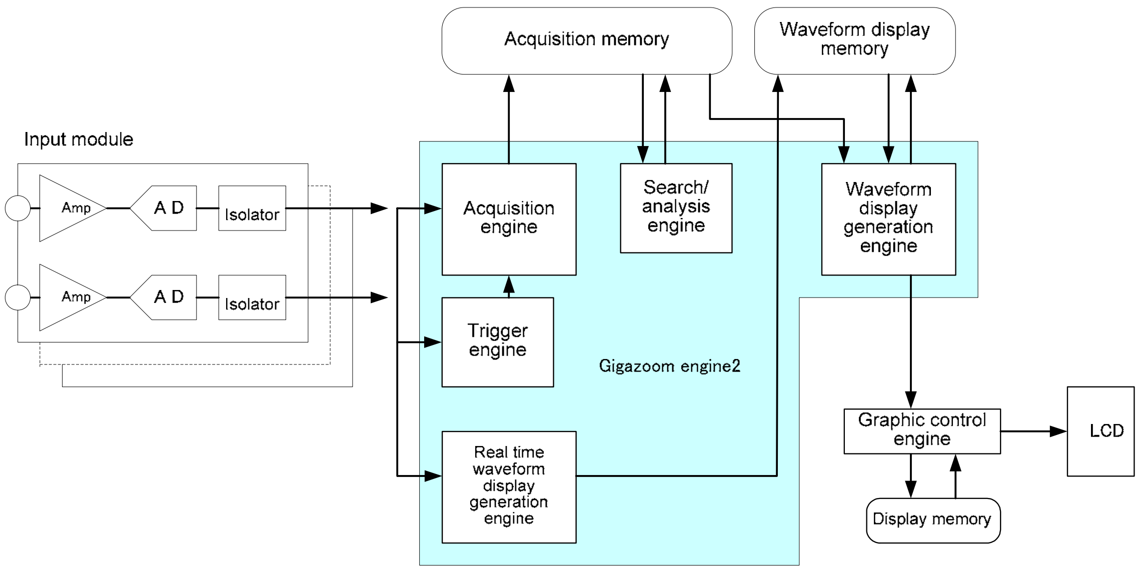


Figure 9 GigazoomEngine®2 block diagram

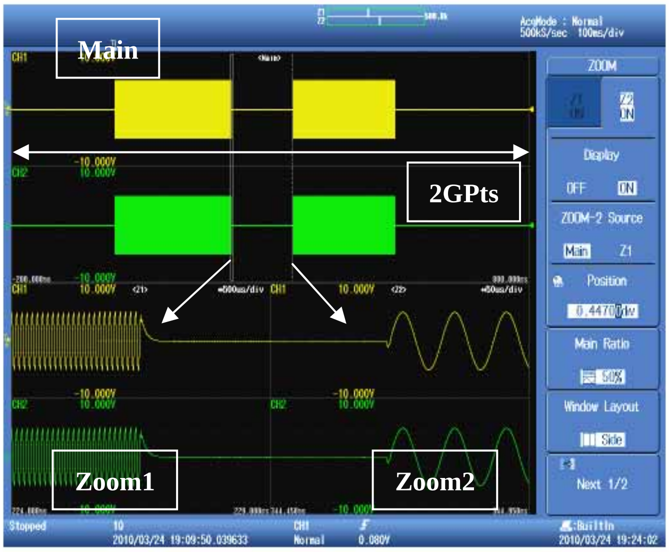


Figure 10 Example of a zoomed waveform

Figure 11 Independent zoom knobs

3. 4 High-Speed Real Time Recording Function

Product reliability or durability testing requires monitoring and saving of data over long periods of time. The DL850 can continuously write sampling data to hard disk at 100 kS/s on sixteen channels simultaneously. There are two problems involved when writing data continuously to hard disk. The first problem relates to long duration recording. The amount of data can reach dozens of gigabytes, and when attempting to confirm and display the acquired waveform data, the efficiency of data confirmation is quite poor because even a high performance PC will take a long time just for file access and generation of display data. The second problem relates to simultaneity of operations. To improve data processing and evaluation efficiency, during evaluation one must load data acquired to hard disk on the PC for analysis without halting data acquisition.

The first problem is solved by applying the functionality of the GigazoomEngine®2 to hard disk recording. Namely, even during hard disk recording the GigazoomEngine®2 simultaneously generates waveform display data and saves it to acquisition memory. This waveform display data is used during data acquisition for rapid display. When data acquisition is finished, the display data is saved to a file at the same time. If the waveform data is transferred to a PC it can be used by the Xviewer program for instant display regardless of data length.

Next, transfer of data during data acquisition is supported by dividing data files into small increments and saving them. If measured data is continuously written to hard disk as a single file, the number of data in the file cannot be determined until measurement is complete. If the file is transferred to a PC during acquisition under such circumstances, data number mismatches can occur, or worse, the file can become corrupted resulting in data loss. The DL850 divides and saves data files as they reach a certain size, and only the completely saved divisions are transferred to the PC, thus ensuring no loss of data. When accessing data from Xviewer, the divided files are recognized as a single file, with no need to be aware that they have been divided.

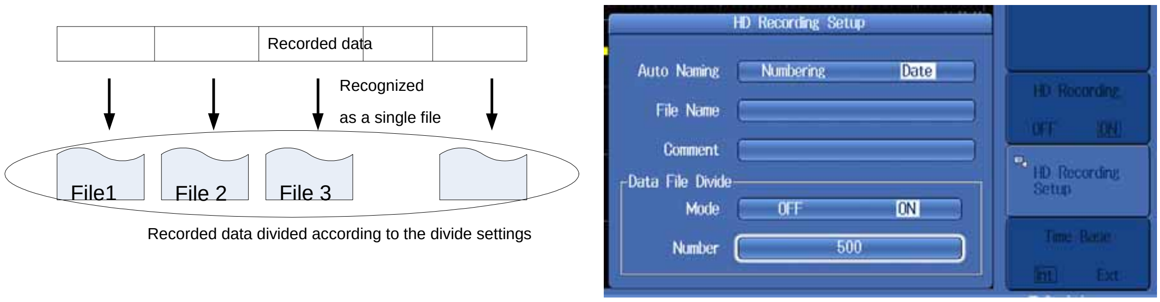


Figure 12　File divide settings

3. 5　CAN Bus Monitor

Electronics play an indispensable role in providing comfort, safety, climate, and reliability for today's automobiles. In cars with advanced electronics there are greater numbers of sensors and actuators, which in turn means a greater number of signals that must be measured simultaneously in order to evaluate the overall system. There are also many ECUs,(Electric Control Units) and the CAN bus is used for cooperative control between them. Speed, engine RPM, various temperatures and other information about the car body, the ON/OFF states of every switch, and other control data is flowing on the CAN bus. If the CAN bus data can be saved as-is on a measuring instrument, speed, engine RPM, and other data can be measured without additional sensors.

A single CAN bus monitor module has two ports that allow you to measure data on separate CAN busses. Each CAN bus port can monitor up to sixteen signals simultaneously. With the CAN bus monitor module, data at any bit of a packet of a specified ID can be extracted, resampled, scaled, saved as time series data, and waveform-displayed (figure 13). By using the CAN bus monitor module, data on the CAN bus and analog signals acquired directly from sensors can be displayed on a single screen and time axis for comparison, thus enabling easy validation of CAN bus–based systems.

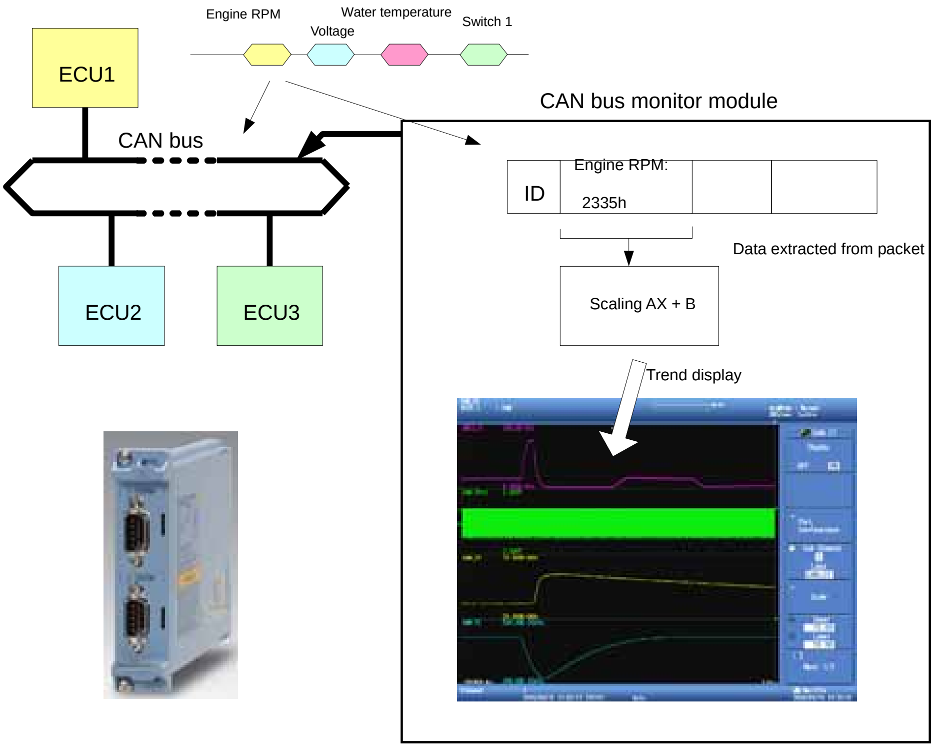


Figure 13　Principle of CAN bus monitoring

3. 6　Multichannel Measurement

The 16 CH Voltage Module includes a scanner function that enables you to measure by time division according to the number of input channels, as well as phenomena of anywhere from DC to several hundreds of hertz on multiple channels. Figure 14 shows a block diagram of the scanner module. Each channel has a gain amp and filter, and measurements can be taken on each channel at the optimal range for the signal level. A scanning switch resides between the filter and A/D converter, and by measuring while switching at high-speed, high-speed sampling of 10 kS/s (with sixteen channels) or 200 kS/s (with one channel) is possible.

With the 16-Bit Logic Module, sixteen relay and sequence states can be measured on a single module simultaneously.

With the GigazoomEngine2®, multichannel sampling and high-speed simultaneous display are possible even during multichannel measurement, as is observation on up to 128 channels.

The DL850 uses a 1024 × 768 dot high resolution LCD, as well as a “display group” to maintain waveform visibility even during multichannel measurement. With the display group, channels that you wish to display simultaneously are specified in advance, and you can instantly switch the display between the items you wish to check. This makes is easy to check waveforms of interest only on channels you wish to compare.

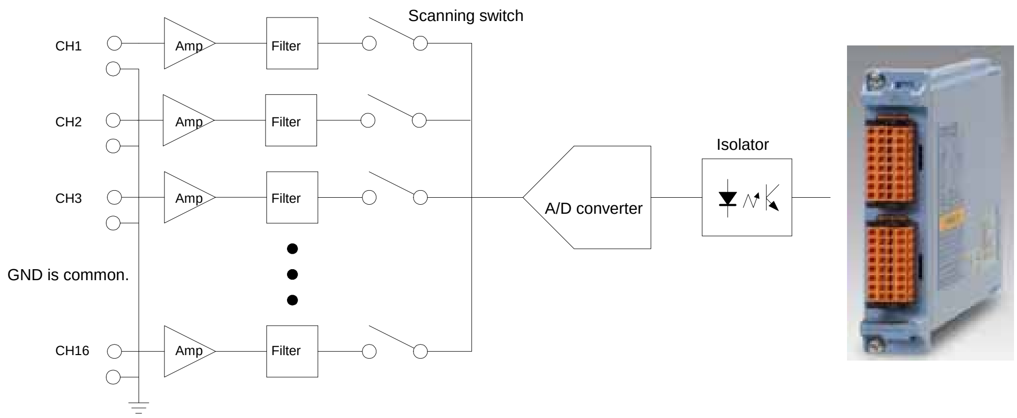


Figure 14　Structure of the 16-CH Voltage Module

Waveforms of interest can be grouped for display

Figure 15　Example of multichannel display

4. Closing

The DL850 achieves high-speed sampling (100 MS/s), high withstand voltage isolation (1 kV), multichannel measurement (max. 128 ch), and long duration measurement (max. 2 Gpts) on a single unit. Since users can mix and match modules to best suit the application, this single measuring instrument can adapt flexibly to any measurement challenge. Also, with its high-speed data processing technology including the GigazoomEngine®2, engineers will save time and money on confirmation and analysis of measured data. We hope we have demonstrated how the DL850 can take engineers to a new level of efficiency in the development of everything from green devices to complex advanced systems.