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LABORATORY-CLASS MEASUREMENTS IN A FIELD-PORTABLE FORMAT

No electrical engineer likes to hear that a product they worked on is subject to a recall for a defect or worse an operational safety issue. However, it's becoming more common as our products contain increasing amounts of embedded hardware and software than ever before. Our media is populated with stories about recalls, whether it's an automotive manufacturer recalling a vehicle with a defective accelerator or emissions, a smartphone manufacturer with an overheating or melting battery or a whitegoods manufacturer who has a fault in a microwave, oven or washer-dryer.

It is estimated that in 2015, the last year for which statistics are available, that 83million (Ref. 1) vehicle recall events were recorded in the US alone by the NHTSA. The cost to the automotive manufacturers was an estimated $6.9bn. Of the 83million, 56% were attributed to manufacturing faults and flaws, and 19.8% were attributed to design issues. More recently, Samsung's market value suffered by many billions of dollars when a number of its Note 7 phones caught fire shortly after launch, and shipments had to be suspended.

When this happens the product is usually returned to the laboratory to be examined to discover the root cause of the issue and for it to be rectified. However, in some instances it's better to get out into the field to understand the exact circumstances when the problem occurs: vehicles and large appliances are a good example. The reason behind this is that the exact conditions when the issue arises may not be easy to replicate in the lab which is often clean, sterile with conditioned power supplies.

REPRODUCING THE PATH TO FAILURE

Therefore, engineers are challenged in two areas. Firstly, the detection of the exact conditions in which the fault/error occurs. What worked in the laboratory, and test environment, is no longer doing so: and what's going wrong needs to be identified quickly so a remedy can be implemented.

Secondly, once a remedy to the design and possibly manufacturing process has been implemented the product will need to be tested again. As before, because the original issue was discovered and characterised in the field, final QA also has to be done in the field.

One issue in these scenarios is that the circuitry may be working to very precise parameters and minimal tolerances: it requires laboratory-class sensitivity in measurements to be able to detect the slightest variations in any performance characteristic. Trying to take that type of equipment into the field is problematic for a number of reasons; size of the equipment, weight, power consumption and the number of pieces of equipment needed.

Today, there are a number of test and measurement products that can meet some of the requirements, but not all. They can be handheld and/or battery powered but don't have the capacity to record data needed for analysis; they may have a limited number of test modules and lastly they are not accurate enough to pick up the smallest condition variations.

This has given rise, as seen from test manufacturer Yokogawa, to increasing demand for a combination instrument, which is portable; and capable of performing oscilloscope type measurements; while recording over long periods of time. Until now engineers would have to take two lower-specification item with them into the field and then struggle with completing the testing regime required and replicating the laboratory testing conditions. The company's reaction comes in the form of its DL350 'ScopeCorder', which combines features of a general-purpose oscilloscope and those of a high-performance data acquisition recorder in a single, portable instrument. Unlike alternative portable measuring solutions such as portable oscilloscopes and combined oscilloscope/multimeters, the instrument provides high levels of precision and accuracy in field measurements; isolated inputs for measurements at high voltage levels; and long-memory capabilities that allow long-term recording for many hours or even days.

MODULAR MEASUREMENT SET

A key feature of the configuration, which is not offered by other portable instruments, is its plug-in modularity, which allows it to be configured to suit a variety of user applications. This flexible input capability is achieved by incorporating two slots which are populated with any of 18 different types of user-swappable input modules.

Based on an A4-sized chassis, it weighs 2.6 kg excluding battery and under 4 kg when populated with a battery and 2 x 4 channel modules. The built-in rechargeable battery provides three hours of continuous operation which, when combined with either mains or 10-30 VDC power, provides the DL350 with a reliable power supply and the user with confidence in recording for tests that are difficult or expensive to repeat.

ANALOGUE RECORDING WITH BUS TRAFFIC DECODE

An example for an automotive engineer might be the challenge of combining measurements of electrical signals, physical parameters indicated by onboard sensors, together with CAN bus, LIN bus or SENT data transmitted by the powertrain management (Figure 1). This need is met by combining high-speed isolation and CAN bus modules, to assemble an optimum tool to measure electric/hybrid vehicle drive train efficiency and performance. It will measure the fluctuation of the input/output

voltage of the drive train inverter, trend speed, accelerating and braking rates, as translated by CAN communications, simultaneously and continuously for up to 2.5 hours at a sample rate of 200 ksamples/sec. Adding an optional GPS unit can add co-ordinate information to correlate test-track location and measurement data.

Figure 1 *Display and recording of decoded bus traffic*

A further option is measuring four isolated 16-bit voltage inputs at speeds of 1 Msample/sec alongside 16 temperatures or two separate CAN or LIN buses each containing 60 signals. The "CAN Monitor" function enables monitoring of CAN frame data as trends. The trends are displayed as waveforms, and can be compared with other analogue waveforms. Waveforms obtained from the signals in the CAN or LIN-Bus data can also be used as the physical value trigger source. Changing a single module enables measurement at 100 Msample/sec with 12 bit resolution and 1 kV of isolation. While there are logic inputs always available, additional inputs can be added with a discrete logic module. Up to 5 Gpoints of data per channel can be recorded directly to an SD card, which means that data can be continuously recorded up to 50 days.

Using the unit in the field it is possible to reduce time spent on fault-finding or transient analysis because it is possible to directly visualise the disturbing event on a signal. The key question here is how to determine whether there is a transient event. Having the possibility to set multiple types of triggers on multiple channels provides the power to investigate what causes a particular transient event. Moreover, the availability of large acquisition memory, and thus the ability to measure over longer time periods, helps the analysis of the effect of such an event on other parts of the application by investigating other measurement channels' behaviour after the trigger event. The instrument has a broad combination of basic and enhanced triggers. A feature called "action on trigger" allows the user to leave a ScopeCorder unattended and automatically save the waveform to a file or send an email for notification of a trigger event.

To assist with the isolation and analysis of the data captured, in scope mode, the DL350 automatically divides the available acquisition memory in up to 1,000 "history waveforms". All history records are accessible and can be displayed immediately after any measurement has stopped. This allows for any abnormal phenomenon, which usually would have disappeared after a trigger is activated, to be analysed. The DL350 can then use this 'history' information to calculate the parameters of the waveform and then statistically provide a measurement of how the captured waveforms vary for each trigger.

POWER WAVEFORM QUALITY – AND HISTORY

Power engineers can use the unit to evaluate single and 3-phase systems. For fundamental waveforms of 50 or 60 Hz, up to 40 harmonic orders can be analysed. Alternatively, it is possible to use the suite of FFT functions to perform full frequency analysis. Engineers have the choice of a simple level trigger or enhanced triggers on such things as pulse width, waveform period and across multiple channels. For example, the wave window trigger is suited to AC power-line monitoring, and enables voltage sags, surges, spikes, phase shifts or drop-outs to be easily captured (available for 40 to 1000 Hz waveforms).

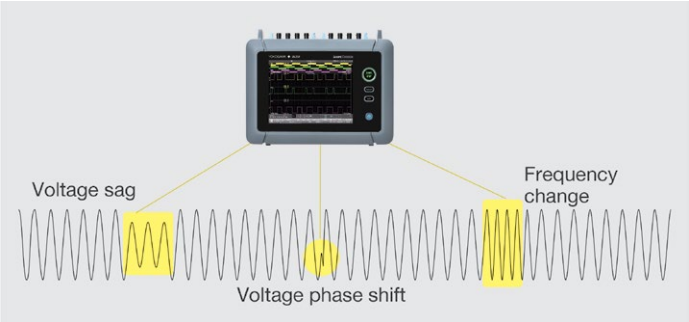

Figure 2 *Waveform defects of various types can be triggered on, and recorded*

This lightweight portable instrument provides operating compatibility with its bigger laboratory family member and can share many modules and functions, preserving the investment in training and equipment, which means engineers will have a familiar tool when going out into the field. Engineers can now see what precisely happens to systems in the field in a production environment rather than trying to simulate/emulate conditions in the laboratory or to build complex test rigs into development "mule" vehicles to understand issues and find real performance improvements.

Field	Application purpose	Measurement item		User advantages
		Slot 1	Slot 2	
EV (electric vehicle)	Evaluation of battery voltage fluctuation while driving	Battery voltage	CAN communication data	Small size, battery drive, synchronization with GPS* position and time data
Power tool	Evaluation of practical behavior	Battery voltage, motor rotation pulse	Tool vibration	Small size, battery drive, complex measurement of voltage and vibration
Field device	Maintenance of ultrasonic-type vortex flow meter	Sensor receiving wave, receiving pulse	Gate signal	Small size, 2-way power source, long-term monitoring with long memory
Factory/plant	Power quality monitoring	AC power, voltage, current	Auxiliary power source monitor	Small, portable, window trigger (instantaneous power failure, sag detection)
Steel making Paper making	Rolling process monitoring	Thickness gauge monitor	Temperature	High noise immunity, external clock (roller) synchronization

*Release pending in the EU and Korea. Contact your local sales office for further details.

Table 1 *Aspects of the instrument's feature set appropriate to a range of industries*

Combining portability, functionality and operability, the unit can be operated exactly as is an oscilloscope, or recorder, and the touch screen makes it simple to access the advanced measurement and analysis functions for use by anyone, anywhere.

REFERENCE

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