ROWTEST ROTOR WINDING RSO REFLECTOMETER TDR200

LOW VOLTAGE RSO TEST UNIT FOR DETECTING WINDING FAULTS IN POWER PLANT ALTERNATOR ROTORS

THE ROWTEST TDR200 Rotor Winding RSO Reflectometer

The **Rowtest TDR200 Rotor RSO Reflectometer** allows inter-turn and earth faults in the rotor windings of large electrical turbo-generators to be detected and located by a simple, rapid and safe **RSO** (Recurrent Surge Oscilloscope) low voltage test. Typical applications include the routine testing of generators by power Utilities and the monitoring by manufacturers and repairers of rotor windings during their initial fabrication and subsequent repairs.

The test can be carried out with the unexcited rotor winding stationary or at speed and is therefore particularly useful for detecting and locating faults which are speed-dependent. The Reflectometer can be left permanently connected to the rotor winding during re-insulation work, so that any defects are immediately apparent.

The equipment is easy to use and the adjustment of the controls is non-critical, making it almost impossible to produce erroneous results due to maladjustment. The test should ideally be carried out on a routine basis so that any winding deterioration can be detected and correlated with other effects such as increased excitation current or mechanical vibration.

The TDR200 contains an internal rechargable battery for use where mains supplies are not available. and is controlled by and displays the rotor waveforms directly on a **Notebook PC** (included). The reflectometer is supplied in a custom padded transit bag, complete with a full set of accessories, including connecting leads, contact magnets, instruction manuals and a demonstration **Delay Line.** This simulates a rotor winding and can be used to check and demonstrate the operation of the Reflectometer.

PRINCIPLE OF OPERATION OF THE RSO TEST

The RSO test for detecting winding faults in turbo-generator rotor windings was first described by A E Grant of the UK CEGB in 1972. A DC voltage step is applied to each end of the rotor winding in turn. Each reflected wave at the input ends of the winding, are monitored and displayed on an oscilloscope screen. As the half-windings in a rotor are identical, the two waveforms monitored at each end of the rotor will also be identical for a healthy winding.

Figure. 1 shows the two superimposed waveforms for a typical fault free winding as viewed on a conventional analogue oscilloscope using Grant's method. A winding with a fault will cause different voltages to be monitored at the two ends and Figure 2 shows a typical oscilloscope display for a winding with an inter-turn fault.

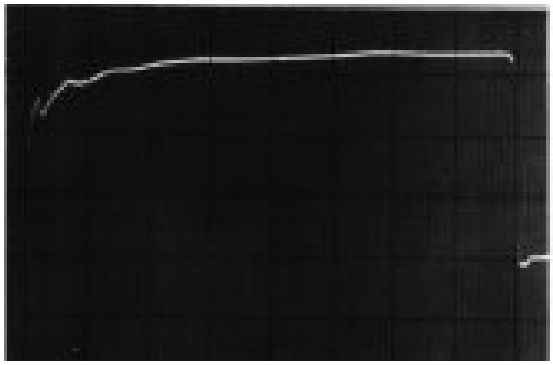


Figure 1. Waveforms for fault-free rotor

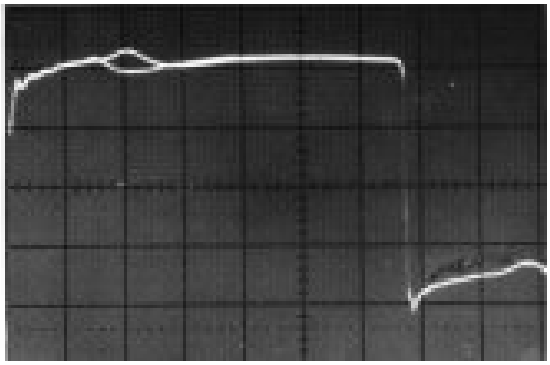


Figure 2. Waveforms for a shorted turn

Historical RSO waveforms as viewed on an analogue oscilloscope

Grant used very simple equipment in his original experiments and it was necessary to use Polaroid photography to record and compare the RSO waveforms. Subsequently, digital oscilloscopes have been used, but the relatively limited resolution of these devices made waveform interpretations difficult.

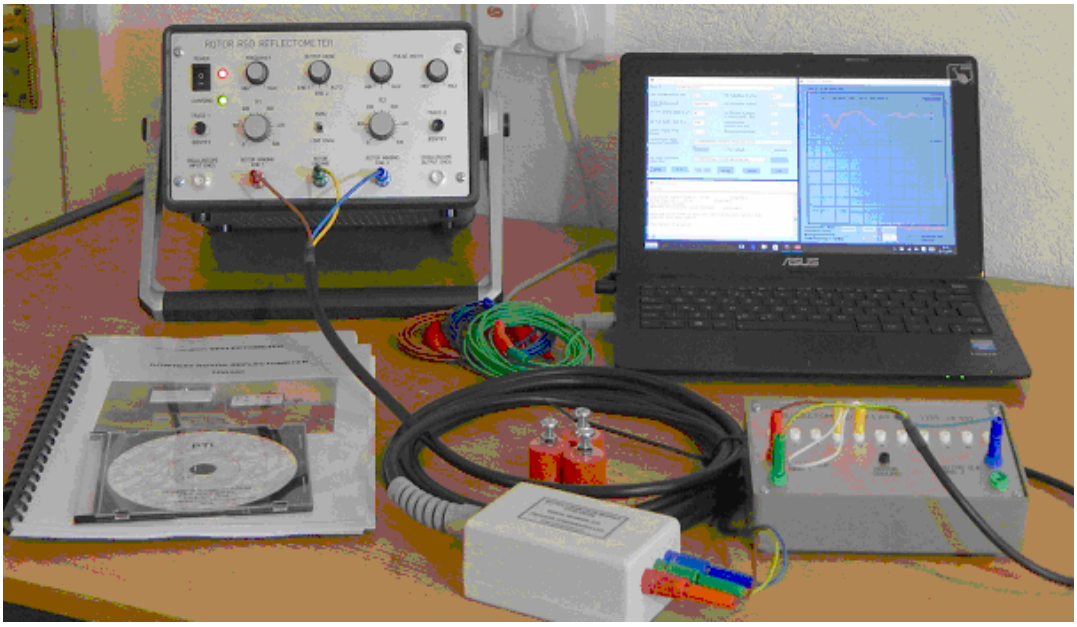
The Rowtest **TDR200** RSO test equipment is a modern implementation of Grant's original method. It is controlled by and displays the rotor waveforms directly on the screen of a **notebook PC**. Its **digital interface** contains a **16-bit ADC converter**, which gives a much higher measurement resolution than is achievable with most conventional digital oscilloscopes. Moreover, there is no need to adjust triggering or gain controls, as the on-screen waveforms are displayed under PC control in an optimised format in all cases.

The waveforms at each end of the rotor winding are displayed continuously and simultaneously in real-time and can be saved directly as digital data files on the PC. Consequently, a portable oscilloscope and/or camera are no longer required to carry out the test.

In its normal digital mode, The **TDR200** is controlled by custom **TDRPlot** software running on the **notebook PC** via a USB link. This software displays the RSO waveforms at either the input or output ends of the rotor winding on the PC screen, together with the difference between them. The **pulse transit times** can be measured using **on-screen cursors** and the displayed waveforms can be saved to bit-map files and also text files which can be read by other software (eg MS Excel).

The **TDR200** can be also be used in Grant's original analogue mode with an oscilloscope if preferred. In this case, its specifications and operation are identical to that of the original **CDL TDR100** instrument, which has now been discontinued.

ROWTEST TDR200 MEASUREMENT SYSTEM DETAILS



TDR200 Rotor winding RSO measurement system

The **TDR200** Reflectometers are supplied as complete **Rotor winding RSO measurement systems,** including a **Notebook PC** (in a **laptop case** with pre-loaded **TDRPlot** software), a **demonstration delay line**, **set of connecting leads and magnets** for attaching the test leads to the rotor slip rings and a set of **instruction manuals** (in English), all contained within a **custom padded transit bag.**

The **TDR200 equipment** has many advantages over conventional RSO test systems, including the following operational features:

The **2 RSO waveforms** at each end of the rotor winding are automatically displayed together in real-time on the PC screen and under PC control, with screen update rates up to 10 per second. This eliminates the problems which can occur when attempting to trigger digital oscilloscopes. The use of internal **rechargable batteries** withtin the **TDR200** unit, together with a **notebook PC**, means that **no external power supply** is needed to carry out RSO tests with this equipment.

It is **impossible to obtain two different RSO waveform traces for a fault-free rotor winding**, even if the controls on the test equipment are incorrectly adjusted. Moreover, the difference between the 2 RSO waveforms can be plotted and displayed automatically and an **on-screen cursor** displays the **percentage difference** between these traces.

Trace ID buttons allow the **RSO traces** at each end of the winding to be identified and a **calibrated delay line** (supplied) allows the test system to be checked and calibrated without the need for access to a real rotor winding

The **TDR200** operates in both **on-line** and **off-line** modes. In **on-line mode**, the software controls the equipment using the supplied custom **TDRPlot software** to display and capture RSO data. In **off-line mode**, the same software reads and displays data from files captured during operation in on-line mode. This allows **saved RSO data** to be re-plotted and analysed. Custom setup files can be saved for individual rotors and this information is included within in each data file.

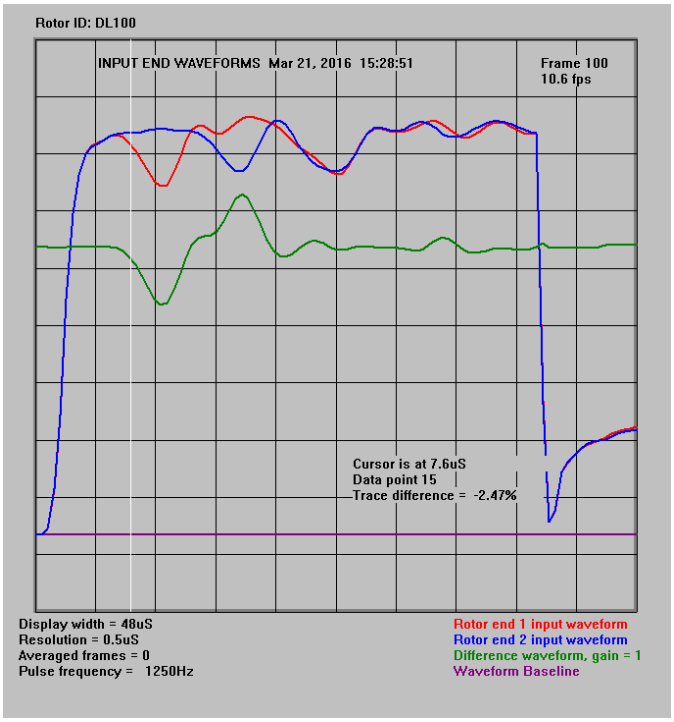
An on-screen cursor provides accurate time measurements and percentage differences between the 2 RSO traces at each cursor location and a built-in algorithm gives an estimate of the location of any winding faults.

Averaging can be used to reduce the effects of noise due to brush contact problems.

Test results are saved automatically to both **text and bit-map image files** on program exit. They can also be saved to unique file names at any time during the test. These data files can be subsequently read and displayed in both the **TDRPlot** and other suitable software (eg MS Excel).

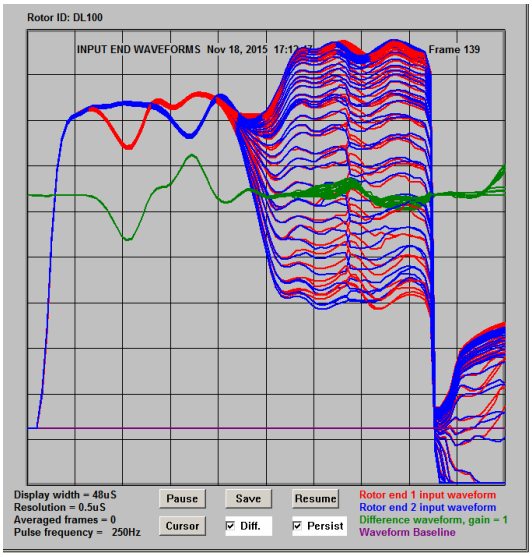
The equipment can also be used in analogue mode with an oscilloscope if required and this option allows non-alternating pulse-excitation modes to be used.

The following figure shows the waveforms displayed using the **TDRPlot software** and the **demonstration delay line** containing a **simulated inter-coil fault**.



Typical TDRPlot display on notebook PC for simulated inter-coil fault

An optional **persistence mode** allows waveforms to be compared directly, as shown below and an averaging option allows any waveform noise to be reduced.



Example of use of persistence mode

SPECIFICATION TDR200

POWER OPTIONS	110-240V AC, 50-60Hz, or from an internal maintenance free rechargeablebattery pack with an integral charger, giving over 8 hours continuous use under average operating conditions.
IMPEDANCE MATCHING RANGE	5 ohms to 500 ohms or 500 ohms to 1000 ohms.
PULSE RATE	40Hz to 200Hz continuously variable (analogue mode) or as set on the **Control PC** (digital mode).
PULSE WIDTH	20µS to 400µS in three switched ranges.
PULSE AMPLITUDE	12V nominal
ENCLOSURE	Two-tone grey metal case with adjustable carrying handle.
DIMENSIONS:	
Reflectometer only:	W: 320mm H: 155mm D: 360mm inc. handle.
Padded bag:(approx.)	W: 460mm H: 360mm D: 220mm
Total system Weight:	Approximately 15kg
ACCESSORIES	Supplied in padded transit bag with manuals, leads, contact magnets and Delay Line (DL100).
***Laptop PC:**	Standard Windows laptop PC in case.

* NB. The laptop PC is optimised for use with the TDR200 system and is not suitable for use as a general-purpose PC.

Please note that the original CDL TDR100 Reflectometer has now been discontinued, as the TDR200 system retains all the functionality of the original TDR100 equipment.

For further information, please contact us **at enquiries@rowtest.com.**

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