Van Welleman Villas

WhitePaper
Outbound Time-Domain Reflectometry ver 1.0

"also detecting the hidden faults"

Ensuring the highest possible electrical safety requires much more than the traditional acceptance-test of the electrical installation. Therefore Van Welleman Villas performs three additional laboratory-grade measurements. The first two measurements cover the residual current as well as path- and source-impedances. The third (and by far the most complex) measurement is an outbound time-domain reflectometry measurement. The goal of this measurement is to detect hidden defects in the electrical cabling.

In our high-tech world, electrical power is perceived as an obvious, simple, and a safe good that requires little or no attention. Although electrical systems are quite simple and straightforward, they are far from safe when treated without the required safety precautions. It is mandatory that all used materials are of high quality and installed according to the highest safety standards in order to avoid life-threatening situations afterwards. That is why Van Welleman Villas® uses complex time-domain reflectometry measurements to ensure the highest possible safety for our electrical systems.

Time-domain reflectometry measurements are based upon the analysis of the reflections of a Dirac pulse on a conducting media. A Dirac pulse is an electrical pulse with an extremely short pulse width. Typically we use test signals with a pulse width of approximately 0,000.000.050s (i.e. 0,05us). The reflected signals are then analyzed with a resolution of 0,000.000.000.500s (i.e. 2 Gigasamples/s), enabling to detect the smallest defaults in the electrical cabling.

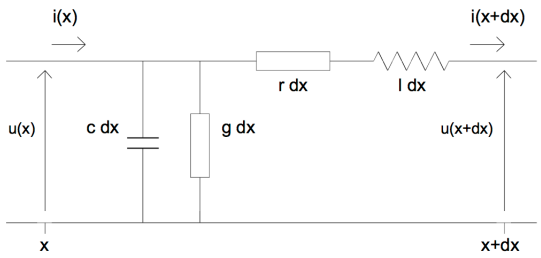
Under ideal circumstances (i.e. all impedances perfectly matched) little or no reflections will be measured. In a reality however, reflections will be measured as soon the Dirac pulse enters the cable. The reason for these reflections are a multitude of variations in the cable impedance due to mechanical manufacturing tolerances, variations in material composition and altering electrical characteristics (R, L, C).

The analysis of these "reflections" provide a thorough insight on the quality of the path between the fuse and the outlet.

The following are some advantages of this acceptance test :
- Overall view on the quality of the electrical system.
- Provides insight on the continuity of the cable segment.
- Ensures a unique end-to-end measurement.
- Provides useful data for statistical analysis.
- Enables a comparative check upon future modifications.
- The use of professional Rohde & Schwarz high resolution laboratory equipments ensures reliable measurements.
- TDR measurements enable to detect errors that are impossible to detect with traditional equipments (e.g. DMM).

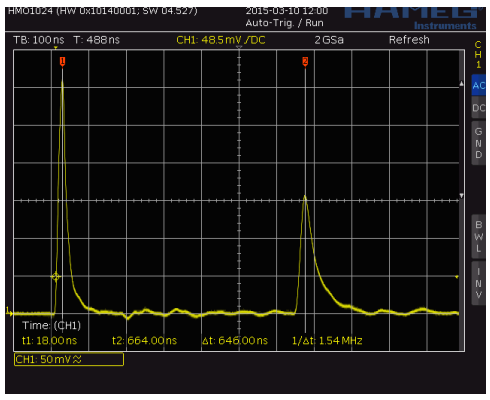
All of the above is done with one purpose only … ensuring the very best and safest electrical systems for our customers.

Line impedance
All electrical wires consist out of an infinite amount of small networks (Z_0) connected in series. They vary throughout their path and together they define the line-impedance of the cable.

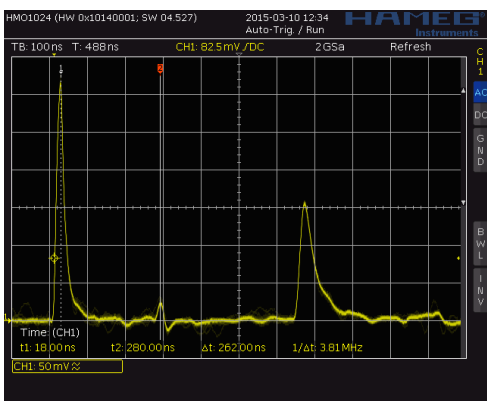


$$Z_0 = \sqrt{\frac{r + j\omega l}{g + j\omega c}}$$

Open-loop measurement
The Time-Domain Reflectometry (TDR) measurement below is performed on a mains segment of 62m consisting out of a single piece of XVB-F2 3G2,5 cable.



TDR acceptance measurement
The TDR measurement below is performed on the same mains segment, although repaired with cage clamps at a distance of 25m from the technical rack (see 2nd marker at 284ns).



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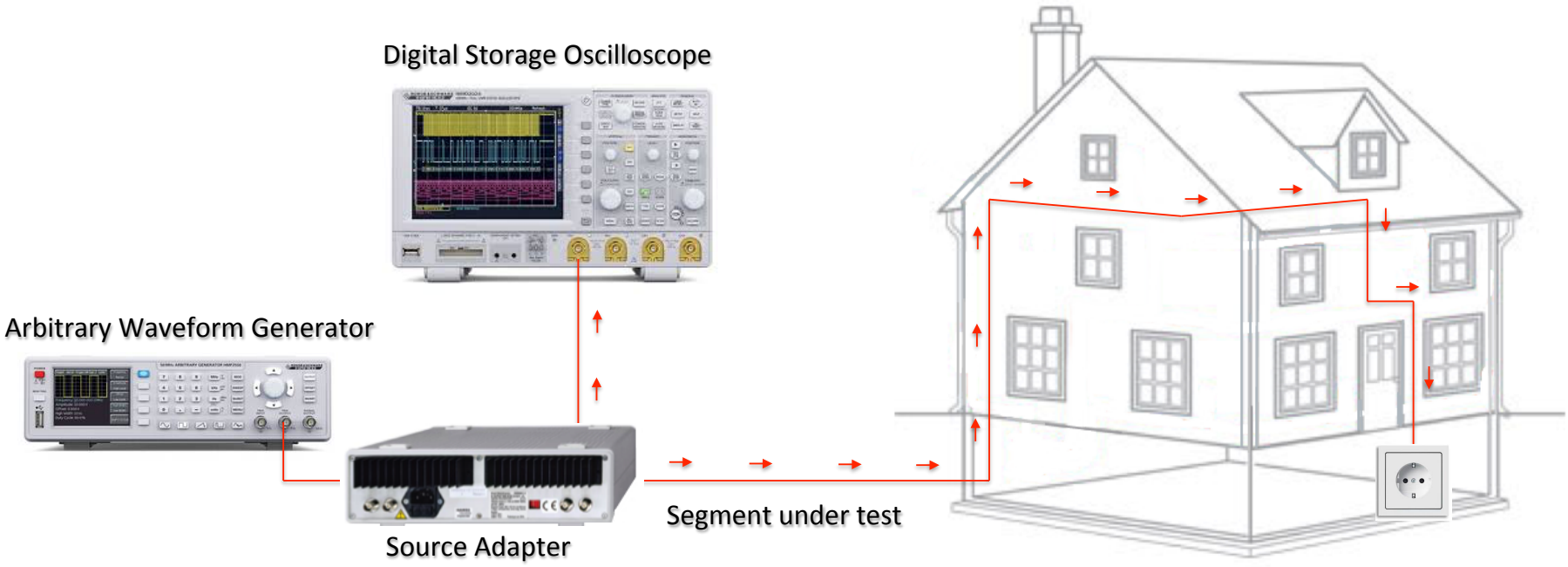

fig 1. Time-domain reflectometry measurement of a power segment.
(e.g. connection between fuse and outlet)

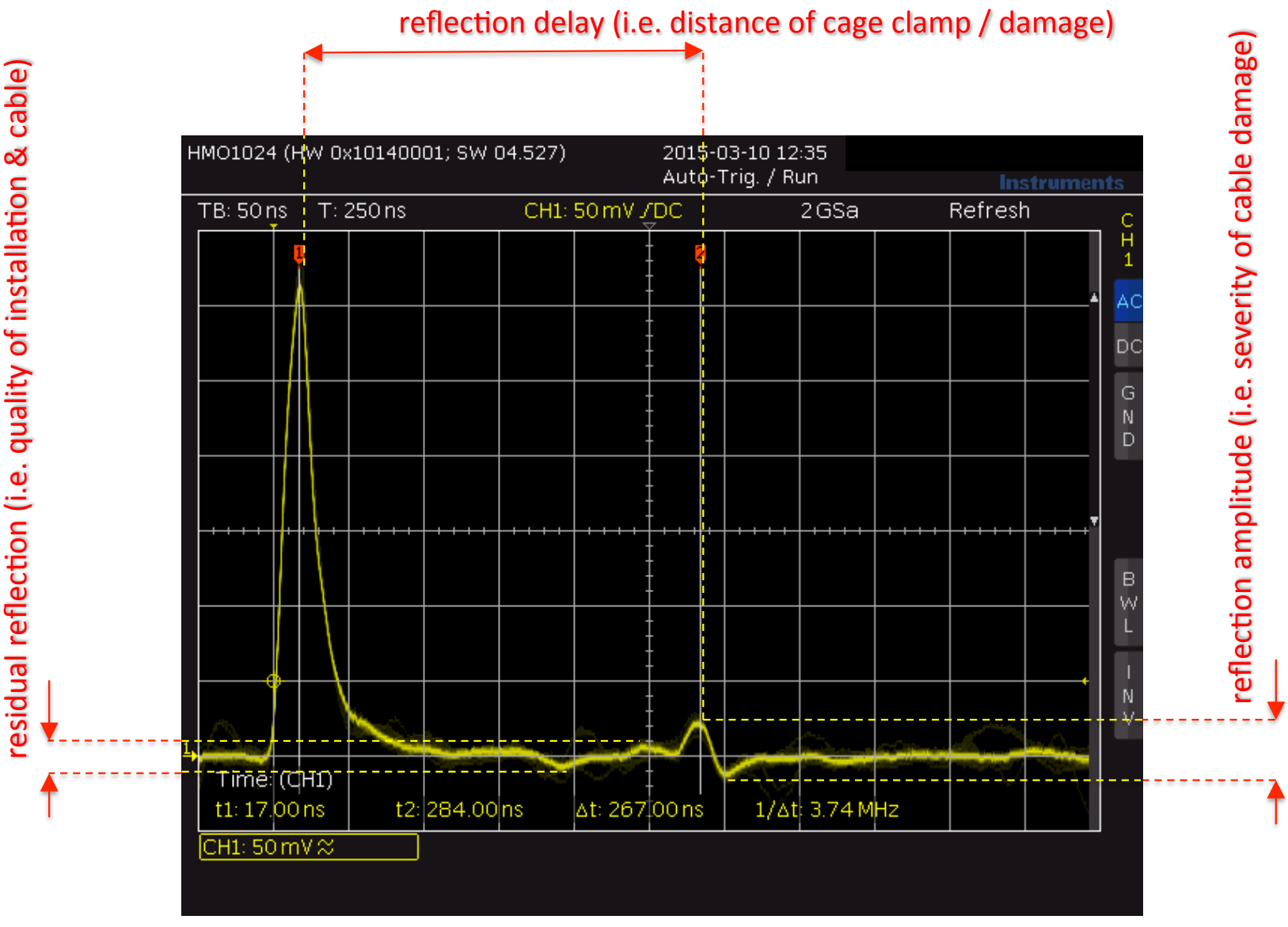

fig 2. Anatomy of a reflected signal.
(DSO settings: 50ns/DIV, 50mV/DIV, 2GSamples/sec.)

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