DTDR-800

Differential Time-Domain Reflectometer

The unique combination of bandwidth, time base stability & form factor

Main features:

- **10%-90% rise/fall-time below 800ps**
- **True differential technology**
- **Ultra stable time base (RMS-jitter < 3.0ps)**
- **Analog sampling bandwidth ≈1GHz**
- **All specifications valid for 0°C ≤ T ≤ 40°C**
- **High stability w/o recurring calibrations**
- **Laboratory & industrial applications**
- **Full metal housing: high immunity to EMI**
- **Hi-Speed USB-interface**

Step rise/fall-time

The DTDR-800 is equipped with two fast internal step generators providing step-signals with a 10% - 90% rise/fall-time below 800ps (typ. 650ps), corresponding to a 20% - 80% rise-time below 550ps (typ. 450ps). The use of two generators enables true differential technology, which makes differential probing easy, since ground contacts are not required. Of course, ground contacts are still needed in case the fully integrated single-ended functionality is used. The voltage step of each channel amounts to 550mV under matched conditions.

Ultra low random Jitter

The DTDR-800 exhibits the best RMS-jitter performance in its class: lower than 3.0ps over the full temperature range.

Superior Stability over Temperature

All Sequid products undergo a temperature check from 0°C to 40°C to verify the functionality over the full range. The DTDR-800's excellent jitter performance is minimally influenced by temperature. Amplitude variations are around only 1%. This performance is achieved without application of time consuming and recurring error compensations.

Laboratory & Industrial

Due to its time base and temperature stability the DTDR-800 is the ideal choice not only for laboratory but also for outdoor applications. In addition, its full metal housing offers a high level of immunity to EMI and makes it well suited for industrial applications. The casing exhibits a small form factor and weighs below 3kg.

Software Applications

A wide range of accessories & applications are implemented or optionally available (see section 5), e.g. probes, TDR functionality and S_{11}-parameters. The DTDR-800 comes along with a user-software (SEUNIS = Sequid Universal Measurement Software), combining all different applications and calibrations. Software libraries (SAIL = Sequid Automation Interface Library) are available for controlling the device in ATE applications from many programming languages (e.g. C/C^{++}, C$^{\#}$, Python, LabVIEW, MATLAB). Modules for exporting the data from the Sequid software are included.

1. Time Base Stability

Sequid TDRs are optimized for time base stability over a wide temperature range from 0°C to 40°C. The typical time bases of the DTDR-800 are based on a fixed equivalent sampling frequency of 10GHz corresponding to a sampling time of 100ps (except #5, 200ps/5GHz).

In this document the time base is referred to the combination of the repetition frequency f_{rep} and the sampling interval T_s.

f_{rep} determines the maximum measurement range $r_m = \frac{c_0}{4 \cdot f_{rep} \cdot \sqrt{\varepsilon_r}}$, with c_0 being the velocity of light and ε_r the environmental permittivity. Please note that the maximum range is valid for $\varepsilon_r = 1$ and under matched conditions at the far end of the device under test.

The sampling interval T_s should be at least 4 times smaller than the rise time, i.e. the latter sets the minimum spatial resolution to approx. 10cm. Please note that spatial resolution increases linearly with the rise time of the reflected signal, which may increase, e.g. due to the low-pass nature of attached cables.

Typical time bases are listed in Table 1.

Table 1: Available Time Bases

#	T_s [ps]	f_{rep} [kHz]	Max. Range [m]	Min. Acquisition Time [s]
1	100	400	185	0.064
2	100	200	375	0.256
3	100	100	750	1.000
4	100	50	1500	4.000
5	200	50	1500	2.000

More time bases (e.g. for extended measurement ranges up to 4000m) are available upon request.

The jitter performance is summarized in Table 2. Due to the DTDR-800's unique time base generation technique the maximum RMS-jitter remains below 3.0ps for all temperatures. The jitter performance shows very little deterioration with temperature, making the DTDR-800 to the device with the best time base stability in its class. This advantage comes along with a high degree of comfort, since it is achieved without the need for any time-consuming and recurring calibration procedures.

Table 2: Jitter performance vs. temperature

Temperature [°C]	RMS-Jitter [ps]	
	Typ.	Max.
0	2.2	3.0
10	2.3	
20	2.4	
30	2.5	
40	2.6	

Additional drifts between the two channels originating from changes in the signal path's permittivity and from temperature variations are reduced by the consequent usage of identical signal paths to 3ps.

2. Signal Generator

The DTDR-800 is equipped with two synchronized high performance single ended step generators featuring rise/fall-times below 800ps and a skew below 20ps. The differential output voltage amounts under matched conditions to 1.1V. The generators exhibit a duty cycles of 50% with variations of less than 0.5%. The preset repetition rate is 400kHz.

2.1 Rise/fall-Time

The rise/fall-time is the key feature not only for spatial resolution in cable fault detection but also for high bandwidth measurements when using TDR e.g. as a time-domain-network-analyzer (TDNA).

The rise-time is the duration the signal requires for the transition from 10% to 90% of its steady state value (Figure 1). The minimum, typical, and maximum values are given in Table 3 for the entire temperature range.

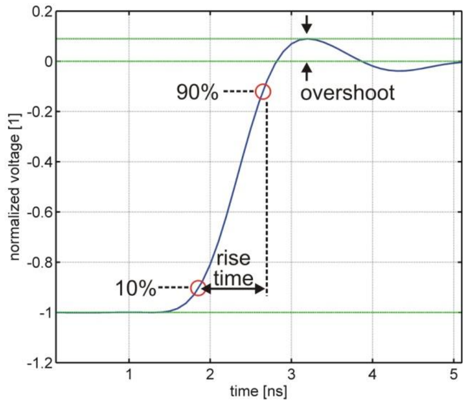

Figure 1: Example of rise-time and overshoot.

The typical rise/fall-time slightly increases with temperature and does typically not exceed 650ps under normal conditions, enabling TDNA-measurements up to 1GHz.

Table 3: 10%-90% rise/fall-time vs. temperature

Temperature [°C]	Rise/fall-time [ps]		
	Min.	Typ.	Max.
0	620	640	800
10	625	645	800
20	630	650	800
30	635	655	800
40	640	660	800

Less usual but also found in literature is the 20% - 80% rise/fall-time. For better comparability with this specification the 20%-80% rise/all-time is given in Table 4. It is about 35% shorter than the 10%-90% rise/fall-time and shows in general the equivalent increase with temperature.

Table 4: 20%-80% rise/fall-time vs. temperature

Temperature [°C]	Rise/fall-time [ps]		
	Min.	Typ.	Max.
0	420	440	550
10	425	445	550
20	430	450	550
30	435	455	550
40	440	460	550

2.2 Overshoot

The overshoot is defined as the percentage by which the maximum exceeds the steady state value (see Fig. 1).

The overshoot vs. temperature of the DTDR-800 is correlated linearly with rise/fall-time, levels typically between 11% and 15%, and does not exceed 20%. For details see Table 5.

If a calibration is active – which is the normal case – the overshot reduces to the ideal value of 0.

Table 5: Overshoot vs. temperature

Temperature [°C]	Overshoot [%]		
	Min.	Typ.	Max.
0	5	15	20
10	5	14	20
20	5	13	20
30	5	12	20
40	5	11	20

3. Acquisition Unit

Analog Bandwidth
The acquisition units consist of two high bandwidth (≈ 1GHz) sampling modules followed by 12-bit Analog-Digital-Converters.

Noise
The characteristic single channel RMS-noise typically amounts to 800µV and does not exceed 1200µV. This holds for temperature conditions within the range of $0°C \leq T \leq 40°C$. Considering the entire temperature range, the maximum drift of the amplitude is below 0.5% of the nominal amplitude.

Memory Depth
The maximum number of acquisition points is 50,000. This value ensures the capturing of more than half a period for the time bases 1-4 and 6 listed in Table 1. The number of acquisition points can be changed by the user software.

4. General Specifications

4.1 Wave Impedance

The system's wave impedance is 50Ω ± 1Ω.

4.2 Dimensions

Without connectors: 220 × 210 × 82.5mm^3
With connectors: 242 × 210 × 82.5mm^3
SMA-connector spacing: 28mm

4.3 Weight

The device weighs 2.6kg.

4.4 Temperature

Condition	Temperature [°C]
Operation	0 – 40
Storage	-20 – 80

4.5 Power

AC-Power
100-240 VAC, 50-60Hz, 1.5A via external power adapter

DC-Power
24 V, 350mA typ., 1100mA max. (during charging), low voltage jack, 6.3/2.1mm

Power Indicator
During operation, the red LED (incorporated in the ON/OFF button) is on, otherwise off.

5. Accessories

5.1 Standard (delivered with device)

- Seunis user software featuring
    - Typical TDR-functionality
    - Calibration wizard (OSL)
    - De-embedding
    - Saving, reloading & exporting data
- Software module for single-ended impedance measurement (*SMM-Ωplus*)
- Software module for differential impedance measurement (*SMM-DΩplus*)
- Power supply (for indoor use only)
- Operator's manual & quick start guide
- 2m USB-cable for connection with PC
- 24-months standard limited warranty
- Test certificate

5.2 Optional (*order code*)

- Integrated ESD-Protection Module (SESD-PCS-D800)
- Metallic Storage and Travel suitcase for safe transport and storage (*SSTC*)
- Software module for Differential Time-Domain-Network-Analyzer functionality (*SMM-DS11* with *SMM-S11* included)
- RPC-3.5mm calibration kit OSL (S03K30R-OSL3), OSLT (S03K30R-OSLT)
- SMA economy calibration kit OSL (*SCKE-SF-R*), OSLT (SCKE-SF-RT)
- Phase matched pair of SMA cables (75cm, 50Ω, skew < 1ps) with SMA (*SPMC-P*)
- Phase matched pair of RPC-3.5 cables (50cm, 50Ω, skew < 1ps) with (*SPMC-P-3.5mm*)
- Precision 50Ω single-ended SMA cable with rotational adapter (*SCC-P*)
- Precision 50Ω single-ended SMA cable (*SCC-P-S*)
- Economy single-ended probe with fixed 2.5 or 5.mm pitch (*SSTP-E*)
- Precision single-ended probe with variable pitch from 0.5 to 1.5mm (*SSTP-P*)
- Economy differential probe with fixed 1.0 or 2.5mm pitch (*SDTP-E*)
- Precision differential probe with variable pitch from 0.5 to 5.0mm (*SDTP-P*)
- USB foot switch (*SUSB-FS2*)

6. Sales Contact

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