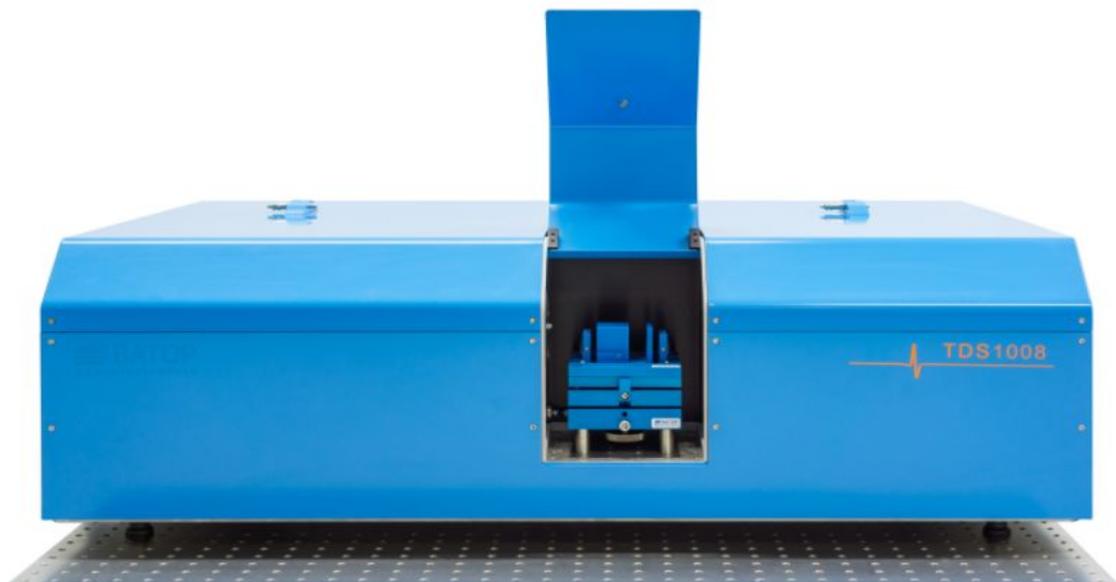


## Data Sheet TDS10XX System

### Benchtop Terahertz Time-Domain Spectrometer



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## Index of Abbreviations

DAQ	<b>D</b> ata <b>A</b> cquisition (System)
FSU	<b>F</b> ast <b>S</b> can <b>U</b> nit
PCA	<b>P</b> hotoconductive <b>A</b> ntenna
IU	<b>I</b> maging <b>U</b> nit
SHA	<b>S</b> ample <b>H</b> older <b>A</b> ttenuated Total Reflection
SHB	<b>S</b> ample <b>H</b> older <b>B</b> ase
SHR	<b>S</b> ample <b>H</b> older <b>R</b> eflection
SHT	<b>S</b> ample <b>H</b> older <b>T</b> ransmission
TDS	<b>T</b> ime- <b>D</b> omain <b>S</b> pectrometer
T2T	<b>T</b> heta- <b>2</b> - <b>T</b> heta
THz	<b>T</b> erahertz

## 1 Overview

Our Terahertz (THz) Time-Domain Spectrometer (TDS) system has been developed for contact-free material characterization measurements in the THz region<sup>1</sup>. The TDS system is based on two photoconductive antennas (PCA), used as emitter and detector of the THz radiation, which are driven by a femtosecond laser.

The TDS system comes in different versions, depending on the laser (780 nm / 1560 nm) and choice of antennas (Internal / External).

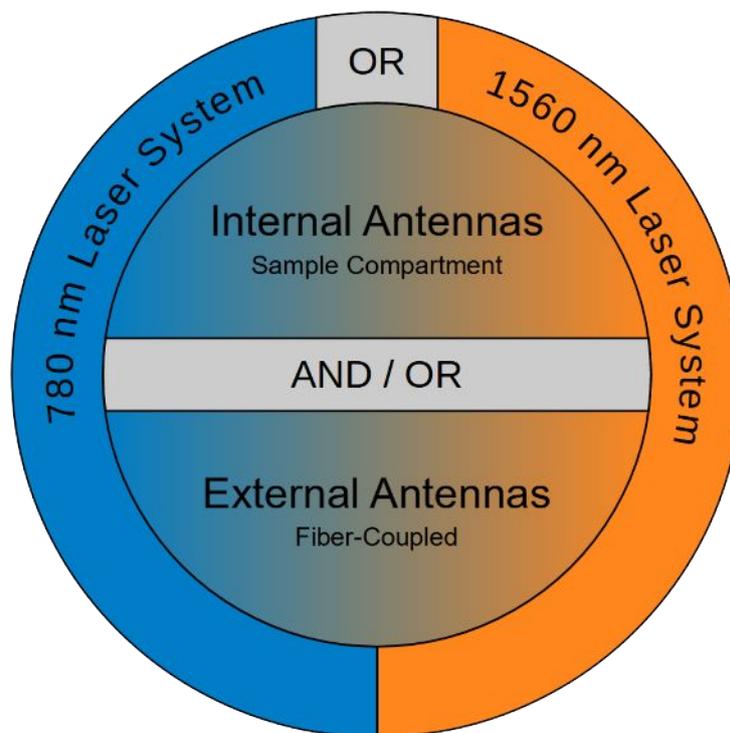


Figure 1: Versions of the TDS system

<sup>1</sup> Frequency range from 0.3 to 3.0 THz

## 2 TDS10XX System

### 2.1 Laser Wavelength

The TDS10XX system is available with the two laser wavelengths down below:

#### 2.1.1 780 Nanometer

Our **TDS1008** contains a femtosecond laser with a wavelength of 780 nm and pulse width shorter than 100 fs. In combination with our high performance PCAs the **TDS1008** achieves a large spectral bandwidth and high dynamic range.

#### 2.1.2 1560 Nanometer

Our more affordable **TDS1015** contains a femtosecond laser with a wavelength of 1560 nm and pulse width shorter than 80 fs. Due to the reduced electrical resistance and increased relaxation time of the PCAs suitable for this wavelength, the spectral bandwidth and dynamic range is lower compared to the **TDS1008**.



Figure 2: Both TDS systems share the same housing

## 2.2 Antenna Setup

Both available laser wavelengths can be configured with one of the three antenna setups down below:

### 2.2.1 Internal Antennas

Our benchtop THz spectrometer with internal antennas is called [TDS10XX](#) and has a sample compartment for transmission and reflection measurements, which can be purged with nitrogen. The sample holder for transmission measurements is already included and additional sample holders can be purchased separately (⇒ Point 3.1).

The femtosecond laser system, beam guiding optics, delay line and data acquisition system (DAQ)<sup>2</sup> is placed inside the housing. The operation of the THz spectrometer and data management is done on a Laptop via our pre-installed [T3DS](#) and [T3DS Calculator](#) software.

### 2.2.2 External Antennas

Our benchtop THz spectrometer with external antennas is called [TDS10XX-fo](#) and has fiber coupled PCAs, which can be positioned freely in order to perform transmission or reflection measurements on larger objects. Specialized sample holders can be purchased separately (⇒ Point 3.2).

The femtosecond laser system, beam guiding optics, dispersion compensation, delay line and data acquisition system (DAQ)<sup>2</sup> is placed inside the housing. The operation of the THz spectrometer and data management is done on a Laptop via our pre-installed [T3DS](#) and [T3DS Calculator](#) software.

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<sup>2</sup> Unifying the pulse generator, signal amplifier and lock-in detector

## 2.2.3 Internal and External Antennas

Our benchtop THz spectrometer with internal and external antennas is called [TDS10XX+f](#) and has a sample compartment, which can be purged with nitrogen, as well as fiber coupled PCAs. Both can be used for transmission and reflection measurements.

The sample holder for transmission measurements is already included and additional sample holders can be purchased separately (⇒ Point 3.1).

The fiber coupled PCAs can be positioned freely in order to perform measurements on larger objects. Specialized sample holders can be purchased separately (⇒ Point 3.2).

The femtosecond laser system, beam guiding optics, dispersion compensation, delay line and data acquisition system (DAQ)<sup>3</sup> is placed inside the housing. The operation of the THz spectrometer and data management is done on a Laptop via our pre-installed [T3DS](#) and [T3DS Calculator](#) software.

## 2.3 Fast Scan Unit

The Fast Scan Unit ([FSU](#)) can be purchased separately. The system is also placed inside the housing and can be used independently from the antenna setup (⇒ Point 2.2). It generates a live representation of the THz signal and spectrum, which simplifies the optimization. Due to the limited scan range and resolution it can not collect data in the same quality as a full slow scan measurement.

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<sup>3</sup> Unifying the pulse generator, signal amplifier and lock-in detector

## 2.4 Specification

The available configurations of our TDS10XX system have the following typical specification:

Table 1: TDS10XX specification

		TDS1008	TDS1015
Internal Antennas	Spectral Range <sup>a</sup>	0.05 – 4.50 THz	0.05 – 1.50 THz
	Dynamic Range <sup>a</sup>	> 85 dB	> 65 dB
External Antennas	Spectral Range <sup>a</sup>	0.05 – 3.50 THz	0.05 – 1.00 THz
	Dynamic Range <sup>a</sup>	> 70 dB	> 55 dB
Max. Scan Range <sup>b</sup>		500 ps	
Spectral Resolution		≥ 2 GHz	
Collimated Beam	Beam Diameter <sup>c</sup>	22 mm	
	Sample Size <sup>c</sup>	≥ 30 x 30 mm	
Focused Beam	Beam Diameter <sup>c</sup>	0.5 mm	
	Sample Size <sup>c</sup>	≥ 10 x 10 mm	
Dimensions (WxDxH)		90 x 60 x 30 cm	
Weight		90 kg	
Supply Voltage		110 – 230 V / 50 – 60 Hz	
Power Consumption <sup>d</sup>		< 50 W	< 50 W
Power Plug		CEE 7/4 / IEC Type F	

<sup>a</sup> Spectral and dynamic range for transmission measurements with a collimated beam using a 100 ps scan interval and integration time of 0.5 s

<sup>b</sup> Longer scan ranges/higher spectral resolutions are available upon request

<sup>c</sup> Beam diameter and sample size for the SHT

<sup>d</sup> Power consumption does not include the laser

## 3 Sample Holder

### 3.1 Internal Sample Holder

The internal sample holders are designed for the sample compartment of our TDS100XX system. Nonetheless way can also easily integrated into setups with fiber coupled PCAs.

#### 3.1.1 Sample Holder Base

The Sample Holder Base (**SHB**) is required for the utilization of the ...

- Sample Holder Transmission (**SHT**) > Point 3.1.2
- Sample Holder Reflection (**SHR**) > Point 3.1.3
- Sample holder Attenuated Total Reflection (**SHA**) > Point 3.1.4

The **SHB** comes with every TDS) system and ensures the correct position of the sample holder in the THz beam path. It allows you to change the sample holder in two axes (horizontal & vertical), together with the rotation and slope in relation to the THz beam.



Figure 3: Sample Holder Base

## 3.1.2 Sample Holder Transmission

The Sample Holder Transmission (SHT) comes with every TDS system and consists of a plate, two sleds with focusing THz lenses, one adapter for small samples (at least 10 x 10 mm) and one adapter for large samples (at least 25 x 25 mm).

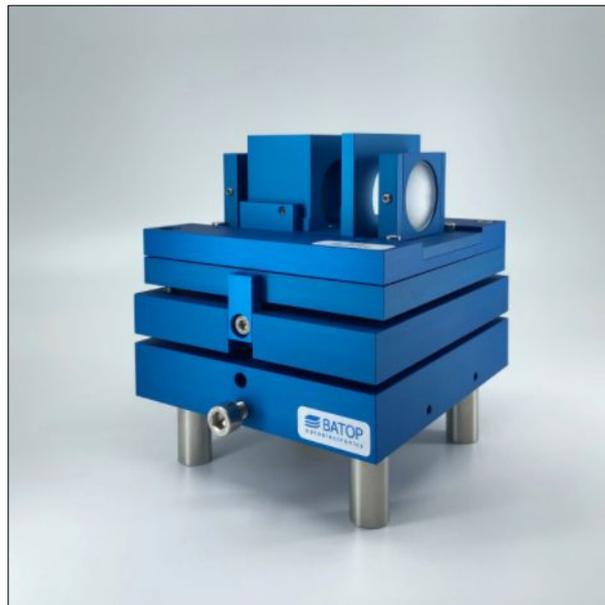


Figure 4: Sample Holder Transmission on the mandatory Sample Holder Base

### 3.1.3 Sample Holder Reflection

The Sample Holder Reflection (SHR) can be purchased separately and consists of a plate, two sleds with focusing THz lenses, one adapter for small samples (at least 15 x 15 mm) and one adapter for large samples (at least 30 x 30 mm).

**It is meant as an extension of the measurement capabilities of your THz spectrometer, enabling measurements of highly reflecting/absorbing samples.**



Figure 5: Sample Holder Reflection on the mandatory Sample Holder Base

## 3.1.4 Sample Holder Attenuated Total Reflection

The Sample Holder Attenuated Total Reflection (SHA) can be purchased separately and consists of a plate with a repository for liquids.

**It is meant as an extension of the measurement capabilities of your THz spectrometer, enabling measurements of fluids with a high absorption coefficient and a refractive index lower than 2.5.**

The THz beam is redirected by the silicon ATR prism towards its top surface, where an attenuated total reflection occurs. The THz signal will be altered by the properties of the fluid. However, the penetration depth of the evanescent wave strongly depends on the wavelength. Therefore a quantitative analysis is much more complicated compared to the transmission (SHT) or reflection (SHR) measurements.



Figure 6: Sample Holder Attenuated Total Reflection on the mandatory Sample Holder Base

## 3.2 External Sample Holder

The external sample holders can be only used with fiber coupled antennas!

### 3.2.1 Imaging Unit

The Imaging Unit (IU) for x-y scans can be purchased separately. It can be used for transmission or reflection measurements. The standard scan range is 150 x 150 mm (IU150)<sup>4</sup>.

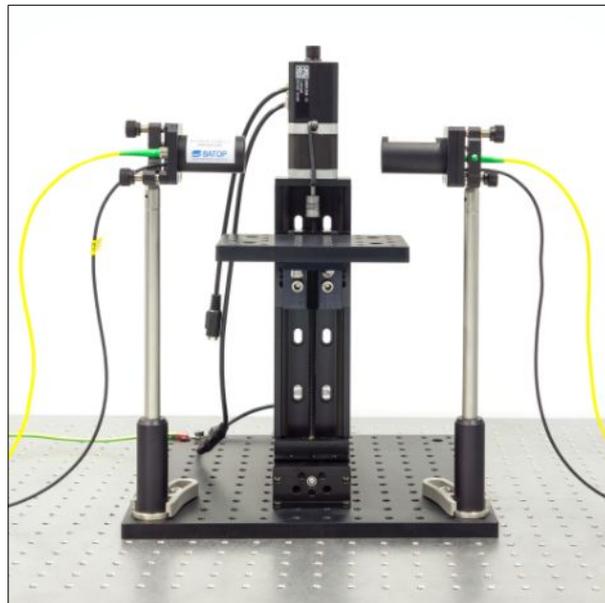


Figure 7: Imaging Unit

<sup>4</sup> Longer scan ranges (300 mm & 450 mm) are available

## 3.2.2 Theta-2-Theta

The Theta-2-Theta (**T2T**) unit for angular resolved measurements can be purchased separately. There is a manually and automatically operated version. Both can be also used for simple transmission or reflection (with an angle of incidence down to  $15^\circ$ ) measurements.

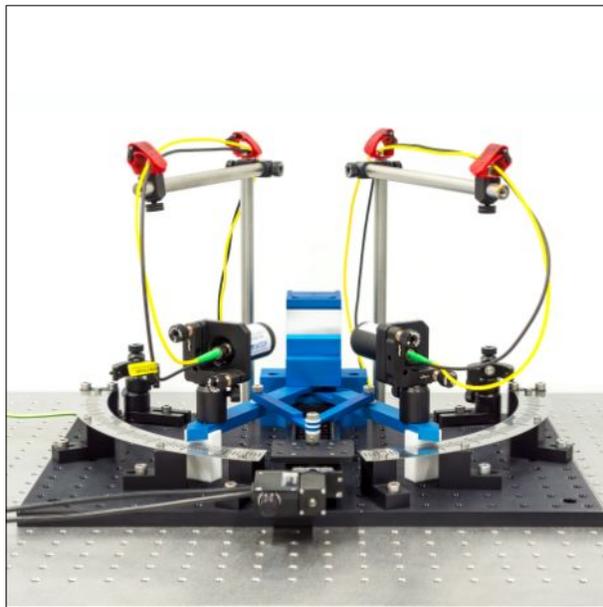


Figure 8: Theta-2-Theta Unit

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