A NEW WAY TO SEE

protemics
Your laser-based THz system can do much more than just spectroscopy – discover the fascinating world of high-resolution THz applications!

TeraSpike
LT-GaAs photoconductive field detector

With the new device series TeraSpike we proudly introduce the next generation of microprobes for the photoconductive detection of electric fields in the THz frequency range. Based on our customers’ feedback and growing application-driven demands a thorough re-design of our previous near-field probe-tip series has been developed. The result is a versatile detector for radiated and surface-near electric fields in the THz-range with unprecedented performance, robustness and applicability. It seamlessly fits into THz time-domain systems with optical excitation wavelengths below 860 nm and is the most cost-efficient solution to turn your system into a powerful high-resolution near-field THz system.

Key features
- Smallest active THz probe-tip on the market with only 1 µm cantilever thickness based on a patented design (DE 10 2009 000 823.3)
- Spatial resolution up to 3 µm
- Frequency range 0 – 4 THz
- Adaptable to all laser-based THz-Systems with λ < 860 nm
- Mounting compatible with standard opto-mechanical components
- Required optical excitation power < 1 mW

Applications
- Terahertz research: Metamaterials, plasmonics, graphene, waveguides, ...
- High-resolution Terahertz near-field imaging
- Contact-free sheet resistance imaging of semiconductors
- MMIC device characterization
- Non-destructive chip inspection
- Time-domain reflectometry (TDR)
Transversal field microprobes

**TeraSpike TD-800-X**

### Technical data

<table>
<thead>
<tr>
<th>TeraSpike TD-800-X-</th>
<th>HR</th>
<th>HRS</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. spatial resolution</td>
<td>3 µm</td>
<td>20 µm</td>
<td>100 µm</td>
</tr>
<tr>
<td>PC gap size</td>
<td>1.5 µm</td>
<td>2 µm</td>
<td>3 µm</td>
</tr>
<tr>
<td>Dark current @ 1 V Bias</td>
<td>&lt; 0.5 nA</td>
<td>&lt; 0.5 nA</td>
<td>&lt; 0.4 nA</td>
</tr>
<tr>
<td>Photocurrent (*)</td>
<td>&gt; 1 µA</td>
<td>&gt; 0.6 µA</td>
<td>&gt; 0.6 µA</td>
</tr>
<tr>
<td>Excitation wavelength</td>
<td>700 .. 860 nm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. excitation power</td>
<td>0.1 .. 4 mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection type</td>
<td>SMP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Product details
- Photoconductive probe-tip with integrated overvoltage protection optimized for pulsed excitation
- Mount for variable probe orientation
- Simple & safe probe removal from the set-up
- Robust probe storage box
- Test certificate & manual

### Accessories
- SMP to SMA/BNC cable connection
- Photo-current amplifier
- Probe-tip dummy structure
- Mounting & focusing units
- Starter Kit

### Set-up (exemplary for near-field transmission measurements)

To photo-current amplifier

- Optical probe beam
- Sample (xy-scanned)
- THz emitter
- Optical pump beam
- λ < 860 nm

**HR**

- **Without resonant antenna**
- **With resonant antenna**

**HRS**

**HS**

All TD-800-X probes are sensitive to x-oriented field components
**Time-domain measurement data**

![Time-domain measurement data](image)

**Frequency-domain measurement data**

![Frequency-domain measurement data](image)

**Key feature:**
- Highest sensitivity for $f < 0.5$ THz

**Key feature:**
- Highest sensitivity for $0.5$ THz < $f$ < 1.3 THz

**Key feature:**
- Highest spatial resolution
- Highest bandwidth
**Technical data**

<table>
<thead>
<tr>
<th>TeraSpike TD-800-Z-</th>
<th>A-500G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. spatial resolution</td>
<td>8 µm</td>
</tr>
<tr>
<td>PC gap size</td>
<td>5 µm</td>
</tr>
<tr>
<td>Dark current @ 1 V Bias</td>
<td>&lt; 0.4 nA</td>
</tr>
<tr>
<td>Photocurrent(*)</td>
<td>&gt; 0.5 µA</td>
</tr>
<tr>
<td>Excitation wavelength</td>
<td>700 .. 860 nm</td>
</tr>
<tr>
<td>Avg. excitation power</td>
<td>0.1 .. 4 mW</td>
</tr>
<tr>
<td>Connection type</td>
<td>SMP</td>
</tr>
</tbody>
</table>

(*) For a focus diameter of circa 20 µm, bias voltage 1 V, average optical excitation power 4 mW.

**Time-domain (FFT) data**

![FFT graph]

**Spatial resolution**

![Spatial resolution graph]

**Set-up (exemplary for near-field transmission measurements)**

To photo-current amplifier

- Optical probe beam
- TeraSpike
- Sample (xy-scanned)
- THz emitter
- Optical pump beam
- LT-GaAs
- Au electrodes

All TD-800-Z probes are sensitive to z-oriented field components.
Measurement example:

3D vector field mapping

**THz field data**

Measured with TD-800-Z-A-500G

**Device under test: Radial-mode emitter pair**

Device cross-section:

Field lines

Zoom to center regions:

Device top-view:

Pair of radial-mode THz emitters based on planar bi-metal gratings
**Technical data**

<table>
<thead>
<tr>
<th>TeraSpike TD-1550-Y</th>
<th>-BF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse rise time</td>
<td>&lt;1 ps (down to 0.4 ps)</td>
</tr>
<tr>
<td>Bandwidth*</td>
<td>0.01 .. 2.5 THz</td>
</tr>
<tr>
<td>Excitation wavelength</td>
<td>700 .. 1600 nm (&lt;860 nm recommended)</td>
</tr>
<tr>
<td>Avg. excitation power</td>
<td>0.1 .. 4 mW</td>
</tr>
<tr>
<td>Cantilever material</td>
<td>InGaAs (n-type)</td>
</tr>
<tr>
<td>Lateral tip radius</td>
<td>8 .. 12 µm</td>
</tr>
<tr>
<td>Cantilever length</td>
<td>570 .. 600 µm</td>
</tr>
</tbody>
</table>

*For excitation with optical pulses of 90 fs duration.
*Other designs possible on request.

**Product details**

- Probe-tip for surface-near bias-free optical generation of pulsed THz signals
- Mount for variable probe orientation and simple removal from the set-up
- Robust probe storage box
- Test certificate & manual
- Patent pending DE 10 2013 020 216.7

**Accessories**

- Probe-tip dummy structure
- Mounting & focusing units

**Tip design (standard)**

- R = 10 µm

**Emitter scheme**

- Emitter TD-1500-Y-BF
- Optical pump beam
- To photo-current amplifier
- Optical probe beam
- λ < 860 nm
- InGaAs cantilever
- Optical pump beam
- Generated THz field pulse
- Metal stripline

**Set-up (example for TDR)**

- Optical pump beam
- To photo-current amplifier
- Optical probe beam
- E<sub>THz</sub>
- Metal stripline
Measurement example:

**THz TDR measurement**

**Time-domain measurement data**

- Input pulse
- Open-end reflection

**Frequency-domain measurement data**

**Sample data:**

- Thin-film microstrip line
  - $Z_0 = 110 \, \Omega$
  - $w = 35 \, \mu m$
  - $h = 57 \, \mu m$

**Cross-section:**

- $\varepsilon_r = 2.3$

**Set-up:**

**Applied Laser:**
- Wavelength: 780 nm
- Pulse length: 90 fs
- Repetition rate: 100 MHz

**Emitter:**
- TeraSpike TD-1500-Y-BF
- Optical power: 4 mW

**Detector:**
- TeraSpike TD-800-X-HRS
- Amplification: $10^8$ V/A
- Optical power: 3 mW
Background

The new bias-free Terahertz emitter series TeraBlast from Protemics are optically pumped THz sources which can be used with a wide range of femtosecond laser sources (such as low power oscillators or amplified lasers with wavelengths in the range of 700..1600 nm).

They are ideally suited and tested for near-field imaging applications including TeraSpike micro-probe operation. The TeraBlast is also a great emitter for classic far-field spectroscopy and other THz applications.

Technical data

<table>
<thead>
<tr>
<th>TeraBlast TD-1550-L-165</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation wavelength range</td>
<td>700 .. 1600 nm</td>
</tr>
<tr>
<td>Typ. average excitation power range</td>
<td>5 mW .. 1000 mW</td>
</tr>
<tr>
<td>Average THz emission power</td>
<td>&gt; 2.5 µW&lt;sup&gt;(a)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Active area diameter</td>
<td>ca. 11 mm&lt;sup&gt;(b)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Adapter dimension (Outer diameter)</td>
<td>1/2 inch</td>
</tr>
</tbody>
</table>

<sup>(a)</sup> Measured with pyroelectric detector (Spectrum Detector Inc. SPI-D-62-THz) for 370 mW optical pump power
<sup>(b)</sup> Larger active areas possible. Please request!

Key benefits

- Recommended THz source for TeraSpike microprobe operation
- High emission power
- Patent pending design (DE102012010926 A1)
- Unmatched simple handling
- Virtually no alignment or focusing effort
- Can be used as a point source or array emitter
- Linearly polarized emission
- Extremely robust due to bias-free operation
- No device failure on local short-cut defects
- No dark current
- No parasitic off-set signal generation in lock-in detection schemes
**Terahertz emitter**

**TeraBlast**

**Emitter scheme**

Terahertz pulse emission

Semiconductor

Metal 2

Optical pulse excitation beam

**Dimensions**

**Exemplary measurement data**

THz emission measured in 15 mm distance (without back-surface aperture)

(a) Measured with TeraSpike TD-800-X-HRS, (b) Measured with SPI-D-62-THz from Spectrum Detector Inc. (c) & (d) Far-field transient measured with THz receiver TM5-R-DP10_25M from Fraunhofer HHI.
Sub-system D-B1

**Description**

Mini-board set-up with pre-aligned opto-mechanical components for the system integration of TeraSpike microprobes.

**Functions:**
- Microprobe mount
- Manual beam-to-microprobe focusing
- Manual beam-to-microprobe alignment
- Manual microprobe height variation

Sub-system D-B2

**Description**

Multi-board set-up with pre-aligned opto-mechanical components.

**Functions:**
- Motherboard including sub-system D-B1 in customized height
- Assembly brackets
- 2 alignment apertures
- 2 tilt mirrors
- Extendable with CCD camera and distance sensor
THz microprobe series

TeraSpike

Post holder and post included in starter kit

Plug area

Photoconductive cantilever tip

Glass interposer

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### Order information

<table>
<thead>
<tr>
<th>Terahertz microprobes detectors</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>TeraSpike</strong></td>
<td>THz photoconductive probe-tip with SMP plug</td>
</tr>
<tr>
<td><strong>Series: TD-800-X</strong> (Type: HR, HS or HRS)</td>
<td></td>
</tr>
<tr>
<td><strong>Series: TD-800-Z</strong> (Type: A-500G)</td>
<td></td>
</tr>
<tr>
<td><strong>TeraSpike Starter Kit</strong></td>
<td>Includes: TeraSpike TD-800 microprobe, TS Phantom, TS Cable, mounting post and holder</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Terahertz microprobe emitters</th>
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<tbody>
<tr>
<td><strong>TeraSpike</strong></td>
<td>InGaAs cantilever microprobe</td>
</tr>
<tr>
<td><strong>Series: TD-1550-Y-BF</strong></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Large-area bias-free Terahertz emitters</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>TeraBlast</strong></td>
<td>TD-1550-L-165</td>
</tr>
<tr>
<td><strong>Option (-HPF): Back-surface high-pass filter</strong></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Sub-system modules</th>
<th></th>
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<tbody>
<tr>
<td><strong>D-B1</strong></td>
<td>Axial positioning, focusing, alignment unit</td>
</tr>
<tr>
<td><strong>D-B2</strong></td>
<td>Vertical board base unit including D-B1</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Current amplifiers</th>
<th></th>
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<tbody>
<tr>
<td><strong>DLP-CA-200</strong></td>
<td>Variable gain current amplifier with 50 kHz Bandwidth @ 10^7 V/A amplification</td>
</tr>
<tr>
<td><strong>DHPCA-100</strong></td>
<td>Variable gain current amplifier with 220 kHz Bandwidth @ 10^7 V/A amplification</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessory</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TeraSpike Phantom</strong></td>
<td>Dummy probe-tip device</td>
</tr>
<tr>
<td><strong>TS Cable</strong></td>
<td>SMP to SMA/BNC probe connection cable</td>
</tr>
</tbody>
</table>

### Service offer

- Not sure how to integrate TeraSpike into your system or do you have other questions? We are happy to advise you!
- Custom microprobe designs are possible on request.
- We offer measurement services including detailed data analysis reports for your samples in our laboratories.
- On-site installation support
- Training courses
- Component repair and maintenance services
Terahertz microprobing Solutions

Applications

- Non-destructive testing
- Terahertz technology
- Terahertz research & development
- Near-field analytics
- Transparent conductors
- Flexible electronics
- Graphene
- Wafer inspection
- Thin-film analysis
- Metamaterials
- Solar cell inspection
- Terahertz device analysis
- Fault location
- Time-domain reflectometry
- Terahertz waveguide analysis
- Marker-free biosensing
- Optoelectronics
- Plasmonics
TERAHERTZ MICROPROBING SOLUTIONS