A NEW WAY TO SEE
A NEW WAY TO SEE
**Terahertz microprobing technology:**
Taking advantage of Terahertz range benefits without being compromised by wavelength-based resolution limitations.

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<tr>
<th>Terahertz Research</th>
<th>Thin-film Inspection</th>
<th>Chip-package Testing</th>
<th>Volume Screening</th>
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<tr>
<td>• Metamaterials</td>
<td>• Solar cells</td>
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<td>• Emitters</td>
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<td>• Sensor surfaces</td>
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<td></td>
</tr>
<tr>
<td>• Graphene</td>
<td></td>
<td></td>
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<table>
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<tr>
<th><strong>Benefits:</strong></th>
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</tr>
</thead>
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<tr>
<td>• Near-field access</td>
<td>• Sheet resistance imaging</td>
<td>• Market leading TDR resolution</td>
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<td>• Cost-efficient system extension</td>
<td>• Contactless</td>
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<td>• High-sensitivity</td>
<td>• Micron-scale resolution</td>
<td>• Contactless</td>
<td>• Screening of Vis/IR opaque plastics</td>
</tr>
<tr>
<td>• Low-invasiveness</td>
<td>• Large-area scanning</td>
<td>• Non-destructive</td>
<td>• Detection of micron-scale structures</td>
</tr>
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<td>• Polarisation sensitive</td>
<td>• High-speed scanning</td>
<td>• Cost advantage over all-electronic systems</td>
<td></td>
</tr>
</tbody>
</table>
Femtosecond-laser-based THz systems

Photoconductive TeraSpike microprobes are the key enabling components for high-resolution Terahertz imaging offering unprecedented sensitivity, resolution and non-invasiveness.

We offer

- **Systems**: Near-field imaging systems, sub-systems, modules & custom solutions
- **Components**: THz microprobes, THz emitters, accessories,...
- **Measurement services**

Please contact us for further information or inquiries.
Application areas

Thin-film inspection

Contact-free, high-resolution and high-speed sheet resistance & mobility imaging

Semiconductor wafer scanners with TeraSpike microprobes yield more information in a shorter time – compared to the prior art*.

Application areas:

- Solar cells
- Graphene/2D-Mat.
- Displays
- Flexible electronics
- Semiconductors
- Transparent conductors

Benefits:

- Sheet resistance imaging
- Contactless
- Micron-scale resolution
- Large-area scanning
- High-speed scanning

a) Results from a Terahertz near-field transmission measurement at a four-inch diameter graphene layer on silicon.
b) High-resolution measurement within the marked area with visible defects from the graphene transfer process.
c) Charge carrier mobility histogram for the marked region of the graphene layer.

* Such as Eddy-Current probe, or four point probe tools.
Thin-film inspection

Sheet resistance imaging

**THz transmission working principle**

![Diagram showing THz transmission through a thin-film conductor layer and substrate.]

Tinkham formula:

\[ T = \frac{T_{SL}}{T_S} = \frac{1}{1 + \frac{Z_0}{R_{sh} \cdot (n + 1)}} \]


**Accessible measurement ranges and sample conditions**

<table>
<thead>
<tr>
<th></th>
<th>Optimal</th>
<th>Acceptable</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Graphene</strong> $R_{sh}$</td>
<td>$5 - 500 , \Omega/\square$</td>
<td>$0.5 - 5000 , \Omega/\square$</td>
<td>$&lt; 0.1 , \Omega/\square$</td>
</tr>
<tr>
<td><strong>Substrate Material</strong></td>
<td>Sapphire $Al_2O_3$, Crystalline Quartz $SiO_2$, Highly resistive ($\rho &gt; 100 , \Omega cm$) semiconductors</td>
<td>Flexible Dielectrics, Lightly doped Semiconductors</td>
<td>Paper, Strongly Doped or metalized Substrates</td>
</tr>
<tr>
<td><strong>Substrate and stiffness</strong></td>
<td>Flat and rigid</td>
<td>Flexible and slightly bended</td>
<td>Strongly curved or 3-dimensional</td>
</tr>
<tr>
<td><strong>Substrate variation</strong></td>
<td>$&lt; 1 , \mu m$</td>
<td>$&lt; 20 , \mu m$</td>
<td>$&gt; 100 , \mu m$</td>
</tr>
<tr>
<td><strong>Spatial Resolution</strong></td>
<td>$25 - 250 , \mu m$</td>
<td>$10 - 10000 , \mu m$</td>
<td>$&lt; 5 , \mu m$</td>
</tr>
<tr>
<td><strong>Sample Size</strong> (longer edge)</td>
<td>$20 - 100 , mm$</td>
<td>$5 - 150 , mm$</td>
<td>$&lt; 1 , mm$</td>
</tr>
<tr>
<td><strong>Measurement Points</strong></td>
<td>$100 , Pz - 100 , kPz$</td>
<td>$&lt; 1 , MPz$</td>
<td>$&gt; 1 , MPz$</td>
</tr>
</tbody>
</table>
**THz near-field scanning system**

**TeraCube Scientific**

**Key features**

- High-speed continuous move scanning & data acquisition
- Optical sample topography detection for scanning at constant microprobe/surface-distance
- Synchronized motion-control and real-time position detection
- Linear polarized and rotatable THz emitter for polarization-dependent measurements
- High performance THz emitter/detector component
- High dynamic range Lock-in detection
- Integrated CCD camera module for monitoring of microprobe tip and sample position
- System control and measurement automation software on integrated PC unit
- Software-implemented alignment monitoring function and system health check electronics
- Software assisted microprobe-tip to sample surface approximation
- Time-domain signal preview mode for fast optical alignment
- Data-export as plain-text or Matlab-compatible format
- System housing for laser beam and dust protection
- Open extendable lab-type system platform

---

**The new standard for micron-scale resolution THz imaging on large areas**

**THE** TeraCube Scientific is a fully automated THz near-field scanning system. The system provides a high-efficient source for the optical generation of broadband THz pulses which can be transmitted through planar samples. Spatially and temporally resolved detection of the transmitted pulses in the near-field of sample surfaces is enabled by Protemics TeraSpike microprobes integrated near-field detectors. The system enables measurements on arbitrary surface topographies through active control of the detector/surface distance. It can be driven by an existing or new fs-laser source with suitable specifications.

**Application areas**

- THz Metamaterial research and sensing application
- Semiconductor wafer inspection
- Sheet resistance imaging
- Graphene analysis
- THz device characterization
- Microstructure analysis
- Non-destructive testing
**Technical data**

<table>
<thead>
<tr>
<th>Type</th>
<th>TeraCube Scientific</th>
<th>TeraCube Scientific M2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical system construction</td>
<td>Free-space beam</td>
<td>Fiber-coupled</td>
</tr>
<tr>
<td>Spectral range</td>
<td>0.05 – 3 THz</td>
<td>0.05 – 4 THz</td>
</tr>
<tr>
<td>Maximum sample size (x, y, z)</td>
<td>20 cm, 20 cm, 1 cm</td>
<td></td>
</tr>
<tr>
<td>Maximum scanning speed (x, y)</td>
<td>200 mm/s</td>
<td></td>
</tr>
<tr>
<td>Min. scanning time per pixel</td>
<td>10 ms / <strong>Single TD position</strong></td>
<td>10 ms / <strong>Full TD Transient (5ps)</strong></td>
</tr>
<tr>
<td>Maximum scanning range (x, y, z)</td>
<td>18 cm, 18 cm, 3 mm</td>
<td></td>
</tr>
<tr>
<td>Time-domain scanning range</td>
<td>1000 ps</td>
<td>5 .. 200 ps</td>
</tr>
<tr>
<td>Time-domain step resolution (dt)</td>
<td>6.6 fs</td>
<td>50 fs</td>
</tr>
<tr>
<td>Bi-directional repeatability (x, y, z)</td>
<td>+-0.1 µm, +-0.1 µm, +-0.15 µm</td>
<td></td>
</tr>
</tbody>
</table>

**Measurement example**

Example plots of the THz near-field distribution measured at a metamaterial surface for sensing applications which is locally loaded with sample material. Left: Peak excitation state, right: 2 ps after excitation.

**Installation requirements**

- Vibration-damped optical table with 1.5m x 1m x 1.5m of space for system placement
- Laser laboratory specification of class 3b or higher
Next generation Terahertz microprobe series

TeraSpike
LT-GaAs photoconductive field detector

The microprobe device series TeraSpike has been introduced in 2013. Since then through our customers’ feedback and application-driven demands the functional range of the microprobes has been continuously extended. The TeraSpike microprobe is a versatile detector for radiated and surface-near electric fields in the THz frequency-range offering unprecedented performance, robustness and applicability. It is the key component of the TeraCube Scientific near-field scanning system. Furthermore, it seamlessly fits into most other THz time-domain systems with optical excitation wavelengths below 860 nm. It 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)

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

Measured near-field image of a pulse-excited THz metamaterial surface.

Measured sheet conductivity image of a laser-doped multicrystalline silicon wafer.
Transversal field microprobes
TeraSpike TD-800-X

Technical data

<table>
<thead>
<tr>
<th>TeraSpike TD-800-X-</th>
<th>HR</th>
<th>HRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. spatial resolution</td>
<td>3 µm</td>
<td>20 µm</td>
</tr>
<tr>
<td>PC gap size</td>
<td>1.5 µm</td>
<td>2 µm</td>
</tr>
<tr>
<td>Dark current @ 1 V Bias</td>
<td>&lt; 0.5 nA</td>
<td>&lt; 0.5 nA</td>
</tr>
<tr>
<td>Photocurrent (*)</td>
<td>&gt; 0.2 µA</td>
<td>&gt; 0.2 µA</td>
</tr>
<tr>
<td>Excitation wavelength</td>
<td>700 .. 860 nm</td>
<td></td>
</tr>
<tr>
<td>Avg. excitation power</td>
<td>0.1 .. 4 mW</td>
<td></td>
</tr>
<tr>
<td>Connection type</td>
<td>SMP</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

100 µm

Photo-switch

LT-GaAs

100 µm

Au electrodes

HR

Without resonant antenna

HRS

With resonant antenna

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

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

- **Field amplitude (a.u.)**
- **Time (ps)**

Key feature:
- Highest sensitivity for $0.5 \text{ THz} < f < 1.3 \text{ THz}$

Frequency-domain measurement data

- **Power (dB)**
- **Frequency (THz)**

Key feature:
- Highest spatial resolution
- Highest bandwidth
# Longitudinal field microprobes

## TeraSpike TD-800-Z

### Technical data

<table>
<thead>
<tr>
<th>TeraSpike TD-800-Z</th>
<th>A-500G</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. spatial resolution</td>
<td>8 µm</td>
<td>8 µm</td>
</tr>
<tr>
<td>PC gap size</td>
<td>5 µm</td>
<td>2 µm</td>
</tr>
<tr>
<td>Dark current @ 1 V Bias</td>
<td>&lt; 0.4 nA</td>
<td>&lt; 0.4 nA</td>
</tr>
<tr>
<td>Photocurrent (*)</td>
<td>&gt; 0.5 µA</td>
<td>&gt; 0.1 µA</td>
</tr>
<tr>
<td>Excitation wavelength</td>
<td>700 .. 860 nm</td>
<td>700 .. 860 nm</td>
</tr>
<tr>
<td>Avg. excitation power</td>
<td>0.1 .. 4 mW</td>
<td>0.1 .. 4 mW</td>
</tr>
<tr>
<td>Connection type</td>
<td>SMP</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

![Time-domain (FFT) data graph]

### Spatial resolution

THz z-field scan across test structure

![Spatial resolution graph]

### Tip design options

- **LT-GaAs**
- **Au electrodes**
- **Photo-switch**

All TD-800-Z probes are sensitive to z-oriented field components.
Measurement example:  
3D vector field mapping

THz field data

Device under test: Radial-mode emitter pair

Device cross-section:

Zoom to center regions:

Device top-view:

Pair of radial-mode THz emitters based on planar bi-metal gratings
TeraSpike TD-800-TR.5

The new TeraSpike model TR.5 comes with a pair of closely spaced photoconductive THz antennas offering new means for high-performance near-field measurements in reflection-mode. While one antenna is used as a THz pulse generator, the other antenna is used as the detector. The slim transceiver probe is taking advantage of Proteomics’ proprietary “wave-trap” design for the suppression of probe-internal reflection signals as well as the XR-type flexible PET cantilever design for increased mechanical robustness. In contrast to standard reflection-mode approaches based on far-field emitter/detector components the new near-field transceiver probe provides access to sub-wavelength-resolution and shortest THz transmissions paths.
Terahertz sensor head solution for Non-destructive Testing

Reflection imaging examples

Conduction layers: Solar cells

Buried plastic welds

Air bubbles

Key benefits

- Includes THz emitter and detector
- Reflection-mode measurements
- Ideal for opaque or bulky samples not measurable in transmission-mode
- Ideal for large scanning areas using moving probe instead of moving sample set-ups

Product details

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

Technical data

<table>
<thead>
<tr>
<th>TeraSpike TD-800-TR.5</th>
<th>TR.5</th>
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<tr>
<td>Dark current @ 1 V Bias</td>
<td>&lt; 1.5 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>2x SMP</td>
</tr>
</tbody>
</table>

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

Accessories

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

**TeraSpike XR-option**

The standard design of the TeraSpike probe is optimized for highest spatial resolution, lowest field invasiveness and highest sensitivity. This is achieved through the free-standing semiconductor-based cantilever microstructure containing the active field sensor elements. The mechanical robustness of this standard design matches the requirements of long-term application in well controlled and automated systems such as the TeraCube Scientific allowing also pointed sample contact.

For application in rougher environments or where the sample distance is more difficult to control the new XR-design is an excellent choice with drastically further increased mechanical robustness with only low loss of spatial resolution and sensitivity.

### Comparison of cross-section designs: Standard vs. –XR option

#### Standard

- **Electrodes**
- LT-GaAs

- **Probe beam**
- Glass

- **Sample**

#### XR

- **Electrodes**
- LT-GaAs

- **Probe beam**
- PET (flexible)

- **Sample**
  - < 20 µm

### Time- and frequency-domain response: Standard vs. -XR

![Graphs showing time and frequency domain response]
Integrated absorber design ("wavetrap")

**TeraSpike WT-option**

**TeraSpike** near-field probes are used under different excitation conditions. Some might generate THz modes which are able to propagate along the internal electrodes of the probe. So far, these modes were observed in terms of reflection signals in the recorded time-domain transients.

Protemics has developed a new patent pending design* called "wavetrap" which is effectively slowing down and absorbing such probe-internal THz signal transmission.

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*German patent application DE 10 2014 015 516.1

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**Tip design**

**WT**

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**Standard**

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**Availability**

The WT/XR-options are currently available for the following probes:
- TeraSpike TD-800-X-HR-WT
- TeraSpike TD-800-X-HR-WT-XR
- TeraSpike TD-800-Z-N-WT
- TeraSpike TD-800-Z-N-WT-XR
### Technical data

<table>
<thead>
<tr>
<th>TeraSpike TD-1550-Y</th>
<th>-BF</th>
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<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</td>
</tr>
<tr>
<td></td>
<td>(&lt;860nm 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 scheme diagram]

**Set-up example: Time-domain reflectometry (TDR)**

Optical pump beam

To photo-current amplifier

Optical probe beam

λ < 860 nm

Detector

Transmission line

Emitter TD-1500-Y-BF

InGaAs cantilever

Optical pump beam

Generated THz field pulse

Metal stripline
Measurement example:

**THz TDR measurement**

**Time-domain measurement data**

- Input pulse
- Open-end reflection

**Frequency-domain measurement data**

- Graph showing power vs. frequency [THz]

**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
THz microprobe series
TeraSpike

Schematic

Post holder and post included in starter kit

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Germany

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info@protemics.com
Phone: +49 241 8867 140
Fax: +49 241 8867 560
**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>Standard</th>
<th>-AR(^{(a)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation wavelength range</td>
<td>700 .. 1600 nm</td>
<td></td>
</tr>
<tr>
<td>Typ. average excitation power range</td>
<td>5 mW .. 1000 mW</td>
<td></td>
</tr>
<tr>
<td>Average THz emission power</td>
<td>&gt; 2.5 µW (^{(b)})</td>
<td></td>
</tr>
<tr>
<td>Active area diameter</td>
<td>ca. 11 mm (^{(c)})</td>
<td></td>
</tr>
<tr>
<td>Adapter dimension (Outer diameter)</td>
<td>1/2 inch</td>
<td></td>
</tr>
</tbody>
</table>

\(^{(a)}\) With THz anti-reflection coating on out-put surface.

\(^{(b)}\) Measured with pyroelectric detector (Spectrum Detector Inc. SPI-D-62-THz) for 370 mW optical pump power.

\(^{(c)}\) Larger active areas possible. Please request!

**Key benefits**

- Recommended THz source for TeraSpike microprobe operation
- High emission power
- Patent pending design (DE102012010926 A1)
- 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
Bias-free Terahertz emitter

TeraBlast

Emitter scheme

Terahertz pulse emission

Semiconductor

Metal 2

Metal 1

Optical pulse excitation beam

Dimensions

Exemplary measurement data

(a) Measured with TeraSpike TD-800-X-HRS, (b) Measured with SPI-D-62-THz from Spectrum Detector Inc. (c) & (d) Far-field transmission through atmosphere measured with a femtosecond laser from Laser Quantum (‘taccor’) and electrooptic detection in a 400-µm-thick GaP crystal using ASOPS based time-domain spectroscopy.
**IR-to-NIR light conversion modul**

**SHG-Unit**

**THE** new SHG-Unit from Protemics is an easy to operate and very efficient solution to convert IR light from cost-efficient femtosecond fiber-lasers into NIR light for the high-efficiency excitation of our LT-GaAs-based TeraSpike microprobes and TeraBlast emitters.

**Technical data**

<table>
<thead>
<tr>
<th>SHG-Unit TD-1550-NLO (-FS/-FC)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input wavelength range</td>
<td>1500 .. 1600 nm</td>
</tr>
<tr>
<td>Typ. average input power range</td>
<td>30 mW .. 200 mW</td>
</tr>
<tr>
<td>Typ. power conversion efficiency (a)</td>
<td>10 .. 50 % (a)</td>
</tr>
<tr>
<td>Min. aperture diameter</td>
<td>ca. 10 mm</td>
</tr>
<tr>
<td>Dimensions (l x d)</td>
<td>120 mm x 45 mm</td>
</tr>
</tbody>
</table>

**Key benefits**

- Recommended for TeraSpike microprobe operation with IR femtosecond lasers
- High power conversion efficiency
- Passive and robust design
- Short warm-up time: (10-15 min)
- Can be configured for free-space (-FS) or fiber-coupled input beams (-FC)
- Easy to use and integrate

**Configuration example**

**Sub D-B1**

For an input pulse length of 90 fs and pulse repetition rates of 80 MHz.

Protemics GmbH
Otto-Blumenthal-Str. 25
52074 Aachen
Germany

Phone: +49 241 8867 140
Fax: +49 241 8867 560

www.protemics.com
info@protemics.com
The test target P-TTT-2-1200 has been specially developed for the characterization of Terahertz imaging systems. Featuring structures and areas from 2 µm up to 8 mm of lateral size it is suited for standard diffraction-limited systems as well as near-field imaging systems with sub-wavelength resolution.

**Technical data**

<table>
<thead>
<tr>
<th>P-TTT-2-1200</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substrate material</strong></td>
<td>High-resistivity FZ silicon, 2-side polished</td>
</tr>
<tr>
<td><strong>Substrate Resistivity</strong></td>
<td>&gt; 10 kOhm cm</td>
</tr>
<tr>
<td><strong>Target overall size</strong></td>
<td>2&quot; x 2&quot; (50 mm x 50 mm)</td>
</tr>
<tr>
<td><strong>Substrate thickness</strong></td>
<td>525 µm</td>
</tr>
<tr>
<td><strong>Coating material</strong></td>
<td>Cr, Au</td>
</tr>
<tr>
<td><strong>Coating thickness</strong></td>
<td>Cr: 10 nm, 65 nm and 75 nm Au: 50 nm</td>
</tr>
<tr>
<td><strong>Orthogonal pairs of triple stripes</strong></td>
<td>2 – 1200 µm wide lines &amp; spaces, 45° rotated for 2 - 460 µm wide line &amp; spaces</td>
</tr>
<tr>
<td><strong>Siemens star</strong></td>
<td>6 mm diameter, 18 elements</td>
</tr>
<tr>
<td><strong>Inverted Newton rings</strong></td>
<td>5.6 mm max. diameter, 10–500 µm ring widths</td>
</tr>
<tr>
<td><strong>Continuous $R_{th}$ Reference areas</strong></td>
<td>6.7 mm x 8.3 mm</td>
</tr>
<tr>
<td><strong>Tilted metal grating areas</strong></td>
<td>2 mm x 6.7 mm, 0°, 18°, 36°, 54°, 72°, 90°</td>
</tr>
<tr>
<td><strong>Bow-tie array metamaterial</strong></td>
<td>300 µm length, 5µm gap</td>
</tr>
<tr>
<td><strong>Double slit array metamaterial</strong></td>
<td>3 µm and 6 µm slit width and spaces</td>
</tr>
</tbody>
</table>

**Key benefits**

- Optimized for THz far- and near-field imaging system evaluation with semitransparent thin-film conductor structures
- Applicable for sub-wavelength and standard diffraction-limited resolution (2 µm – 1.2 mm)
- Includes metamaterial structures with local field enhancement specially useful for near-field system evaluation
- Also applicable for contrast evaluation and referencing of sheet resistance imaging systems
Integration components

Sub-system modules

Sub-system D-B1-TR

Description

Mini-board set-up with prealigned opto-mechanical components for the transceiver probe TeraSpike TD-800-TR.5.

Functions:

- Supports two optical beams for emitter and detector switch excitation
- Probe-tip mounts
- Manual beam-to-tip focusing
- Manual beam-to-tip alignment
- Manual probe-tip height variation

Diagram:

- z-Translation stage
- Iris 1
- Focus stage
- Iris 2
- Lens
- Tilt mirror
Integration components
Sub-system modules

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

Option (-CAM):
- Integrated CCD microscope camera system with variable illumination for monitoring of probe-tip to sample surface approximation and sample positioning

Exemplary CCD camera image of a TeraSpike microprobe tip above sample microstructure.
Terahertz microprobing
Solutions

Applications
- Non-destructive testing
- Terahertz research
- 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
- Plasmonics

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## Order information

<table>
<thead>
<tr>
<th>Sub-system modules</th>
<th>Terahertz microprobes detectors</th>
<th>Terahertz microprobe transceivers</th>
<th>Products &amp; Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D-B1</strong></td>
<td><strong>TeraSpike</strong></td>
<td><strong>TeraSpike</strong></td>
<td><strong>Starter Kit</strong></td>
</tr>
<tr>
<td></td>
<td>Axial positioning, focusing,</td>
<td>THz PC probe-tip with SMP plug</td>
<td>Includes: TeraSpike</td>
</tr>
<tr>
<td></td>
<td>alignment unit</td>
<td><strong>Series: TD-800-X</strong> (Type: HR</td>
<td>microprobe, TS</td>
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<td></td>
<td></td>
<td>or HRS)</td>
<td>Phantom, TS</td>
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<tr>
<td></td>
<td></td>
<td><strong>Series: TD-800-Z</strong> (Type: A-500G</td>
<td>Cable, mount</td>
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<td></td>
<td>or N)</td>
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<tr>
<td><strong>D-B2</strong></td>
<td></td>
<td><strong>Series: TD-1550-Y-BF</strong></td>
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<td></td>
<td>Vertical board base unit</td>
<td><strong>Series: TD-800-TR.5</strong></td>
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<td></td>
<td>including D-B1</td>
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<td><strong>Current amplifiers</strong></td>
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<td><strong>DLPCA-200</strong></td>
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<td></td>
<td>Variable gain current amplifier</td>
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<td></td>
<td>with 50 kHz Bandwidth @ 10^7 V/A</td>
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<td></td>
<td><strong>DHPCA-100</strong></td>
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<td>Variable gain current amplifier</td>
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<tr>
<td></td>
<td></td>
<td>with 220 kHz Bandwidth @ 10^7 V/A</td>
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<tr>
<td><strong>Accessory</strong></td>
<td><strong>TeraSpike Phantom</strong></td>
<td>Dummy probe-tip device</td>
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<tr>
<td></td>
<td><strong>TS Cable</strong></td>
<td>SMP to SMA/BNC probe connection</td>
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<tr>
<td></td>
<td></td>
<td>cable</td>
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</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