Instruction manual and data sheet cPCA-1000-05-05-800-x

Photoconductive THz antenna for laser excitation wavelength $\lambda \sim 800$ nm

cPCA – cross dipole Photo Conductive Antenna

For polarization sensitive THz measurements

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1. Antenna performance

Emitter: cPCA-1000-05-05-800-h  
Detector: PCA-100-05-10-800-h

![Graph showing THz voltage vs. time delay](image1)

- $\lambda = 780$ nm  
- $t_{\text{pulse}} = 100$ fs  
- $P_{\text{opt}} = 10$ mW  
- $V_{\text{emitter}} = 20$ V  
- $f = 10$ kHz  
- $t_{\text{delay}} = 50$ ps  
- $\Delta t = 20$ fs  
- $t_{\text{ex}} = 0.5$ s

![Graph showing spectral amplitude vs. frequency](image2)

- $\lambda = 780$ nm  
- $t_{\text{pulse}} = 100$ fs  
- $P_{\text{opt}} = 10$ mW  
- $V_{\text{emitter}} = 20$ V  
- $f = 10$ kHz  
- $t_{\text{delay}} = 50$ ps  
- $\Delta t = 20$ fs  
- $t_{\text{ex}} = 0.5$ s

Wafer 928
2. Antenna design

Antenna chip dimensions

Central part with antenna gap

3. Antenna parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>minimum ratings</th>
<th>standard</th>
<th>maximum ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark resistance</td>
<td>1.5 MΩ</td>
<td>2.5 MΩ</td>
<td>3.5 MΩ</td>
</tr>
<tr>
<td>Voltage (2xVx, 2xVy), symmetrically</td>
<td></td>
<td>20 V</td>
<td>25 V</td>
</tr>
<tr>
<td>Optical mean power @ 50 – 100 MHz repetition rate</td>
<td>10 mW</td>
<td>15 mW</td>
<td></td>
</tr>
<tr>
<td>Optical pulse fluence</td>
<td>250 µJ/cm²</td>
<td>500 µJ/cm²</td>
<td></td>
</tr>
</tbody>
</table>

Attention: The F-number of the optical lens focusing the laser beam onto the antenna gap must be larger than a certain value to avoid too high pulse fluency. This means, that the minimum diameter of the focused beam waist must be about 120 % of the gap distance \( g \). For a Gaussian beam the minimum focus length \( f_{\text{min}} \) of the optical lens can be estimated as

\[
f_{\text{min}} = \frac{0.3 \cdot \pi \cdot g \cdot D}{\lambda}
\]

with
\( g \) – gap distance of the antenna
\( \lambda \) - laser wavelength
\( D \) – diameter of the laser beam hitting the focusing lens.

For \( \lambda = 0.8 \mu \text{m} \) and \( g = 5 \mu \text{m} \) the minimum possible F-number of the lens is \( f_{\text{min}}/D = 1.9 \pi \approx 6 \).
4. Antenna applications

Possible applications of crossed dipole antennas are:

- **Emission of THz waves with electronically controlled polarization direction**
  By using the crossed dipole antenna as emitter the polarization of the emitted THz waves is determined by the bias voltage ratio on the crossed dipoles. This allows polarization dependent reflection or transmission measurements on a sample without mechanical rotation of the antennas or the sample.

- **Detection of the polarization direction of incoming THz waves**
  The induced signal voltage ratio on both arms of the crossed dipole receiver antenna can be used to determine the polarization direction of incoming THz waves.

- **Functional principle of the crossed dipole antenna**
  By using the antenna as emitter the two dipoles x and y are driven by separate supply voltages $V_X$ and $V_Y$. The emitted electric field amplitudes $E_X$ and $E_Y$ add up to the resulting THz electric field amplitude $E_{THz}$ according to the superposition principle. The tilt angle $\phi$ between the THz field direction and the x-dipole is determined by the supply voltage ratio $V_Y/V_X$ according to

$$\phi = \arctan \left( \frac{V_Y}{V_X} \right)$$

(1)

Crossed dipole antenna with separate supply voltages $V_X$ and $V_Y$ on the single dipoles x and y. The resulting THz electric field $E_{THz}$ is the superposition of the filed components $E_X$ and $E_Y$ from both dipoles. The tilt angle $\phi$ between the THz field and the x-dipole direction is determined by the voltage ratio $V_Y/V_X$ according to equation (1).

**Important:** The supply voltages are symmetrical with respect to the ground potential located at the illuminated crossed dipole center.

The graph below shows the connection between the voltage ratio $V_Y/V_X$ and the tilt angle $\phi$ according to equation (1). If the same voltage is applied on both dipoles then the tilt angle is $\phi = 45^{\circ}$.
• **Receiver antenna**

If the antenna is used as polarization sensitive detector the incoming THz field $E_{\text{THz}}$ induces the detector voltages $V_Y$ and $V_X$ in the two dipoles. These voltages are also symmetrically with respect to the illuminated antenna gap ground point. Therefore two amplifier circuits with a symmetric input must be used for signal voltage detection.

The tilt angle $\phi$ of the THz field against the x-dipole direction can be calculated also with equation (1).
5. **Order information**

cPCA-1000-5-15-800-x Photoconductive antenna

- **Length** \( l = 1000 \mu m \)
- **Gap** \( g = 5 \mu m \)
- **Width** \( w = 5 \mu m \)
- **Laser wavelength** \( \lambda = 800 \, \text{nm} \)

\( x \) denotes the type of mounting as follows:

- **x = 0** unmounted chip 4 mm x 4 mm with 4 bond contact pads
- **x = h** mounted on an Al disc with 25.4 mm \( \varnothing \) and hyperhemispherical silicon substrate lens, 1m four wire cable
- **x = a** mounted on an Al disc with 25.4 mm \( \varnothing \) and aspheric focusing silicon substrate lens, 1m four wire cable
- **x = c** mounted on an Al disc with 25.4 mm \( \varnothing \) and aspheric collimating silicon substrate lens CL-20 for 20 mm THz beam diameter, 1m four wire cable
- **x = c-f** fiber coupled antenna with collimating silicon substrate lens
- **x = l** with aspheric focusing optical lens for free space laser excitation

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