Pyroelectric Linear Arrays

PYROSENS

For Measurement Applications
Linear Arrays in Volume Production
The LTx family of pyroelectric linear arrays is specifically designed for non-contact temperature measurement and infrared spectrometry. The arrays include a lithium tantalate chip with 128, 256 or 510 elements. The signals produced by the elements are processed in a CMOS circuit. Signal processing is carried out by the analogue circuitry, including an adapted low-noise preamplifier for each pixel, a multiplexer, an output amplifier. The pyroelectric chip and CMOS readout circuit are located on a thick film substrate, which is mounted inside a hermetic metal housing. The incident radiation passes through a window or filter, is transparent to infrared wavelengths, and reaches the sensitive elements.

The preamplifiers transform the signal charges of each pixel into a signal voltage, include bandwidth limiting and pass the amplified signal to the sample & hold for the read-out process. The digital inputs are CMOS compatible.

For measurement of the detector temperature a sensor (type AD 590) is integrated into the package. It provides an output current which is proportional to the temperature.

In common with all pyroelectric detectors, the incoming infrared radiation needs to be modulated for a measurement to be made.

Ion-beam milled pyroelectric detector chips with a thickness of approximately 5 µm enable a high responsivity and a low noise equivalent power NEP. An additional metal black coating („M“ in type designation) realizes a high and homogeneous spectral absorption. Detector chips with ion-beam etched thermal isolation trenches („SL“ in type designation) allow low modulation frequencies up to 10 Hz with excellent signal/noise-ratio.

What does the name of the array say?

<table>
<thead>
<tr>
<th>PYROSENS</th>
<th>256</th>
<th>LT</th>
<th>M</th>
<th>I</th>
<th>SL</th>
<th>SP</th>
<th>0.5</th>
<th>V3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pixel number (128, 256 or 510)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithium tantalate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal black coating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ion beam etched (higher responsivity)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal isolation trenches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Array optimized for spectroscopic application</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pixel length in mm (0.5 mm or 1.0 mm, without indication 0.1 mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optional internal gain factor (3, 5, 8 or 16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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</table>
## Pyroelectrical Linear Arrays – Types and Features

### Pyroelectric Linear Arrays – Types and Features

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensitive Element</th>
<th>Sensor Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Width [µm]</td>
</tr>
<tr>
<td>128LT</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>256LTI</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>256LTI MI</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>256LTI MI SL</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>510LTI</td>
<td>128</td>
<td>90</td>
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</table>

### Element length 0.1 mm

<table>
<thead>
<tr>
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<th>Sensitive Element</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>128LT</td>
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<td>90</td>
</tr>
<tr>
<td>128LT MI</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>128LT MI SL</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>256LTI</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI SL</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>510LTI</td>
<td>128</td>
<td>90</td>
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</table>

### Element length 0.5 mm

<table>
<thead>
<tr>
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<th>Sensor Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Width [µm]</td>
</tr>
<tr>
<td>128LT</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>128LT MI</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>128LT MI SL</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>256LTI</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI SL</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V3</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V5</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V8</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V16</td>
<td>256</td>
<td>42</td>
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</tbody>
</table>

### Element length 1.0 mm

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensitive Element</th>
<th>Sensor Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Width [µm]</td>
</tr>
<tr>
<td>128LT</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>128LT MI</td>
<td>128</td>
<td>90</td>
</tr>
<tr>
<td>128LT MI V3</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>128LT MI V5</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>128LT MI V8</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V3</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V5</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>256LTI MI V8</td>
<td>256</td>
<td>42</td>
</tr>
<tr>
<td>510LTI</td>
<td>128</td>
<td>90</td>
</tr>
</tbody>
</table>

1 Typical values, rectangular chopping with $f_C$, array temperature 25 °C, black body source temperature 400 °C, filter transmission 100 %.

<table>
<thead>
<tr>
<th>$f_C$</th>
<th>Chopper frequency for rectangular modulation</th>
<th>$S_0$</th>
<th>Sensitivity</th>
<th>$u_n$</th>
<th>Noise voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_C$</td>
<td></td>
<td>$S_0$</td>
<td>$u_n$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_0$</td>
<td></td>
<td>$u_n$</td>
<td>NEP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEP</td>
<td></td>
<td>NEP</td>
<td>MTF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MTF</td>
<td></td>
<td>MTF</td>
<td>Uniformity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- $f_C$... Chopper frequency for rectangular modulation
- $S_0$... Sensitivity
- $u_n$... Noise voltage
- NEP... Noise equivalent power
- MTF... Modulation transfer function
- Uniformity of $S_0$... Uniformity of sensitivity
**PYROSENS**

**Pyroelectric Linear Arrays – Technical Data**

### Technical Data

<table>
<thead>
<tr>
<th>Features</th>
<th>Maximum/minimum Conditions¹</th>
<th>Typical Responsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>– 128, 256 or 510 pixel arranged in one line</td>
<td>– VDD, VD2: –0.3 V to 7 V</td>
<td></td>
</tr>
<tr>
<td>– NEP (128 Hz) down to 1.1 nW (128LTx, 256LTx), 1.3 nW (510LTx)</td>
<td>– Digital inputs CLK, RES, VVR, VDR, VSH: –0.3 V to VDD + 0.3 V</td>
<td></td>
</tr>
<tr>
<td>– Dynamic range &gt; 75 dB</td>
<td>– Chopping frequency ( f_{ch} ): 10 Hz to 512 Hz</td>
<td></td>
</tr>
<tr>
<td>– Modulation frequency up to 512 Hz</td>
<td>– AD590+ to AD590–: –20 V to 44 V</td>
<td></td>
</tr>
<tr>
<td>– Output voltage 2.5 V ± 2 V</td>
<td>– Analog output²: ± 5 mA</td>
<td></td>
</tr>
<tr>
<td>– Integrated CMOS multiplexer</td>
<td>– Maximum irradiance: 50 mW/mm²</td>
<td></td>
</tr>
<tr>
<td>– High long-term stability</td>
<td>– Soldering temperature: 300 °C</td>
<td></td>
</tr>
<tr>
<td>– Simple mode of operation</td>
<td>– Storage temperature: –20 °C to 80 °C</td>
<td></td>
</tr>
<tr>
<td>– Operation at ambient temperature</td>
<td>– Operation temperature: –15 °C to 70 °C</td>
<td></td>
</tr>
<tr>
<td>– Small package</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Coated silicon or germanium as infrared window</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Broad band windows (&gt; 1.3 µm) or special filters on request</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Customized arrays with up to 510 elements with special sizes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ All voltages refer to ground (pin 10, 15).

² Not short resistant.

### Electrical Parameters³

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum value</th>
<th>Typical value</th>
<th>Maximum value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>4.75</td>
<td>5.0</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>VD2</td>
<td>2.4</td>
<td>2.5</td>
<td>2.6</td>
<td>V</td>
</tr>
<tr>
<td>Digital inputs, low voltage</td>
<td>0</td>
<td>0.3 VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Digital inputs, high voltage</td>
<td>0.7 VDD</td>
<td>VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Digital inputs, switching threshold</td>
<td>0.5 VDD</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital inputs, leakage current</td>
<td>± 1</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current consumption</td>
<td>8</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AD590 operating voltage⁴</td>
<td>4.75</td>
<td>30</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

³ All values for VDD = 5 V, VD2 = 2.5 V. ⁴ See data sheet of Analog Devices. ⁵ Valid for 510LTx.

### Pins – 128LTx, 256LTx and 510LTx

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Function</th>
<th>Pin</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CLK</td>
<td>Input clock CLK (trigger on rising edge)</td>
<td>9</td>
<td>OUT, OUT¹</td>
<td>Analog signal output, analog signal output (odd pixels)⁶</td>
</tr>
<tr>
<td>2</td>
<td>RES</td>
<td>Input clock RES (active low)</td>
<td>10</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>VVR</td>
<td>Input clock VVR (active high)</td>
<td>11</td>
<td>n.c., OUT²</td>
<td>Not connected, analog signal output (even pixels)⁶</td>
</tr>
<tr>
<td>4</td>
<td>VDR</td>
<td>Input clock VDR (active high)</td>
<td>12</td>
<td>AD590+</td>
<td>Temperature sensor</td>
</tr>
<tr>
<td>5</td>
<td>VSH</td>
<td>Input clock VSH (active high)</td>
<td>13</td>
<td>AD590–</td>
<td>Temperature sensor</td>
</tr>
<tr>
<td>6</td>
<td>VD2</td>
<td>Operating voltage (+2.5 V)</td>
<td>14</td>
<td>case</td>
<td>Case</td>
</tr>
<tr>
<td>7</td>
<td>VDD</td>
<td>Operating voltage (+5 V)</td>
<td>15</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>8</td>
<td>VD2</td>
<td>Operating voltage (+2.5 V)</td>
<td>16</td>
<td>VDD</td>
<td>Operating voltage (+5 V)</td>
</tr>
</tbody>
</table>

⁶ Only available for 510LTx.
Internal Read-out Circuit

Clock parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Relative value</th>
<th>Minimum value</th>
<th>Typical value</th>
<th>Maximum value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chopping frequency ( f_{Ch} )</td>
<td>10</td>
<td>128</td>
<td>512</td>
<td></td>
<td>Hz</td>
</tr>
<tr>
<td>Readout CLK ( f_{CLK} )</td>
<td>( 2 \cdot f_{Ch} \cdot 268 )</td>
<td>0</td>
<td>69</td>
<td>300</td>
<td>kHz</td>
</tr>
<tr>
<td>Reset clock low-impulse duration ( t_{RES} )</td>
<td>( 1/2 t_{CLK} )</td>
<td>1.8</td>
<td>7.5</td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>Clock VVR high-impulse duration ( t_{VVR} )</td>
<td>2 ( t_{CLK} )</td>
<td>7.5</td>
<td>30</td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>Clock VDR high-impulse duration ( t_{VDR} )</td>
<td>28 ( t_{CLK} )</td>
<td>200</td>
<td>400</td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>Clock VSH high-impulse duration ( t_{VSH} )</td>
<td>( t_{CLK} )</td>
<td>3.5</td>
<td>15</td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>Setting time at the output ( t_{out} )</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>µs</td>
</tr>
</tbody>
</table>

1 All values for \( VDD = 5 \) V, \( VD2 = 2.5 \) V. 1 \( t_{Ch, \text{low}} = t_{Ch, \text{high}} \). 1 For \( f_{Ch} = 512 \) Hz must be \( t_{VDR} = 56 \cdot t_{CLK} = 200 \) µs.

Clock diagram
Connect pin 6 to pin 8 (VD2), pin 7 to pin 16 (VDD), pin 10 to pin 15 (GND).

Readout direction (S101Tx only):
OUT1 (odd pixel): 1, 3, ..., 509
OUT2 (even pixel): 510, 508, ..., 2
The Evaluation Kit allows easy operation of the PYROSENS arrays. It consists of a small circuit board with complete electronics and software by which the electronics is controlled via USB connection from a Windows PC. The power can be provided by the USB port or a separate power supply (9 V). For synchronisation with further external components, such as for radiation modulation, a trigger pulse is provided. The read-out cycle can be adjusted between 1 and 30 lines/s.

A DLL interface for the integration of the evaluation kit in custom software solutions and common laboratory software is available. Thus, commissioning and integration of PYROSENS arrays in their own software and system solutions become even easier. The interface permits access to all array parameters via API functions and reading out the pixel values.

The evaluation kit can be integrated into a variety of software environments, e.g.

– NATIONAL INSTRUMENTS LabVIEW
– MathWorks MATLAB
– Microsoft Visual Studio
– Embarcadero RAD Studio

For the development of software in C / C++ corresponding header and lib files are included.