Test Data Sheet

EO-T1055M3-TXC
S/N:

Resonant electro-optic phase modulator

- thermal crystal mount
- temperature sensor (NTC)
- tunable resonance frequency

<table>
<thead>
<tr>
<th>RF properties</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resonance frequency: $f_0$</td>
<td>984 - 1099</td>
<td>MHz</td>
</tr>
<tr>
<td>Preset frequency: $f_{set}$</td>
<td>1055</td>
<td>MHz</td>
</tr>
<tr>
<td>Bandwidth: $\Delta v$</td>
<td>4.3</td>
<td>MHz</td>
</tr>
<tr>
<td>Quality factor: $Q$</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Required RF power for 1rad @ 739nm</td>
<td>25.5</td>
<td>dBm</td>
</tr>
<tr>
<td>max. RF power: $RF_{max}$</td>
<td>4</td>
<td>W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optical properties</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EO crystal</td>
<td>MLN</td>
<td></td>
</tr>
<tr>
<td>Aperture</td>
<td>3x2.6</td>
<td>mm$^2$</td>
</tr>
<tr>
<td>Wavefront distortion (633nm)</td>
<td>$\lambda/4$</td>
<td>nm</td>
</tr>
<tr>
<td>recommended max. optical intensity (739nm)</td>
<td>&lt;10</td>
<td>W/mm$^2$</td>
</tr>
<tr>
<td>AR coating (R&lt;0.5%)</td>
<td>500 - 900</td>
<td>nm</td>
</tr>
</tbody>
</table>

1) at 24.3°C  2) with 50Ω termination  3) no damage with $RF_{max} < 10$W
Fig. 1: Oscilloscope trace

![Oscilloscope trace graph](image)

- Measured modulation frequency: $f_0 = 1055$ MHz
- Modulation depth: $\beta = 1.0\, \text{rad}$
- Wavelength: $\lambda_{\text{test}} = 671\, \text{nm}$
- RF output: $24.6\, \text{dBm}$

**Table 1: Expected modulation**

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>unit</th>
<th>$\lambda_1$</th>
<th>$\lambda_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 rad</td>
<td>nm</td>
<td>671</td>
<td>739</td>
</tr>
<tr>
<td>P</td>
<td>dBm</td>
<td>24.6</td>
<td>25.5</td>
</tr>
<tr>
<td>P</td>
<td>mW</td>
<td>286</td>
<td>359</td>
</tr>
<tr>
<td>U</td>
<td>$V_p$</td>
<td>5.4</td>
<td>6.0</td>
</tr>
<tr>
<td>$U_T$</td>
<td>$V_p$</td>
<td>16.8</td>
<td>18.8</td>
</tr>
<tr>
<td>$\beta/\lambda$</td>
<td>rad / V</td>
<td>0.19</td>
<td>0.17</td>
</tr>
</tbody>
</table>

**Fig. 2: Carrier/sideband ratio**

![Bessel functions graph](image)

- Bessel functions $J_0^2$, $J_1^2$, and $J_2^2$

**Fig. 3: RF–signal amplitude vs. modulation depth**

![RF signal amplitude vs. modulation depth graph](image)

**Test setup**

- Laser
- EOM
- Spectrum analyzer
- PD
- Oscilloscope

**Note:** Experimentally recorded modulation depth displayed in Fig.1 might vary from the respective values ($\beta=1\, \text{rad}$) provided in the table.
**Resonance characteristics**

**Test setup**

- **Laser**
- **+45° Glan-Thompson Polarizer**
- **EOM**
- **-45° Glan-Thompson Polarizer**
- **PD**
- **Vector Network Analyzer**
- **RF sweep**
- **Transmission**

**Tuning performance**

<table>
<thead>
<tr>
<th>MAX resonance frequency</th>
<th>( f_{0\text{ max}} )</th>
<th>1099 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN resonance frequency</td>
<td>( f_{0\text{ min}} )</td>
<td>984 MHz</td>
</tr>
<tr>
<td>number of turns</td>
<td>( N_{\text{max}} )</td>
<td>6</td>
</tr>
<tr>
<td>counter clock-wise turns</td>
<td>( \uparrow )</td>
<td>higher ( f_0 )</td>
</tr>
<tr>
<td>clock-wise turns</td>
<td>( \downarrow )</td>
<td>lower ( f_0 )</td>
</tr>
</tbody>
</table>

**Attention:**

No upper stop!!

---

Max resonance frequency: \( 1.055000 \) GHz

MIN resonance frequency: \( 0.984 \) GHz

Number of turns: 6

Counter clock-wise turns: Higher \( f_0 \)

Clock-wise turns: Lower \( f_0 \)
Handling instructions

- Housing is hermetically sealed. There are no user serviceable parts inside. None of the screws must not be loosened at any time! Crystal will be damaged otherwise.
- Input laser polarisation must be orthogonally aligned with respect to the cooling fins.
- Please handle device carefully. Avoid shock. Don't drop.
- After turn on the resonance frequency might drift slightly with applied rf power. Please compensate by tuning the rf drive frequency until steady-state (~min).

Package drawing

Note 1: mounting screws (M4x0.7) must not exceed 5mm length.

Note 2: crystal aperture is 3x3mm.

Attention!!!

Housing is hermetically sealed. No use serviceable parts inside. Screws must not be loosened! Crystal will be damaged otherwise.
Mounting hardware:

- SMD capacitor: 1x 47μF - C1210C476M4PACTU
- TEC: 2xUwe Elektronik UEPT-42168
- Thermal pads: 2x, double sided adhesive (40x40mm²)
- Thermally insulating screw (PEEK): 2x M4, socket head

Temperature Controller Settings:
(tested with modified T-controller: Wavelength Electronics PTC2.5-CH)

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-Gain</td>
<td>12</td>
</tr>
<tr>
<td>Enable Jumper</td>
<td>internal enable (IEN)</td>
</tr>
<tr>
<td>Voltage Setpoint Jumper</td>
<td>external voltage stepping (EVS)</td>
</tr>
<tr>
<td>Sensor Bias Select</td>
<td>100μA</td>
</tr>
<tr>
<td>Sensor Type Select</td>
<td>Other</td>
</tr>
<tr>
<td>Current Limit</td>
<td>2.5A</td>
</tr>
<tr>
<td>Integrator Time Constant</td>
<td>47μF</td>
</tr>
<tr>
<td>Time Constant</td>
<td>~60s</td>
</tr>
</tbody>
</table>

Temperature Controller Measurement:

actual temperature in R(T) = V(T)/100μA vs. time (1 sample = 1s)
Temperature sensor characteristics:

<table>
<thead>
<tr>
<th>NTC part number</th>
<th>Resistance (25°C) (ohm)</th>
<th>B-Constant (25-50°C) (K)</th>
<th>Operating Current for Sensor (25°C) (mA)</th>
<th>Rated Electric Power (25°C) (mW)</th>
<th>Typical Dissipation Constant (25°C) (mW/°C)</th>
<th>Thermal Time Constant (25°C) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NXFT15XH103FA2B050</td>
<td>10k +/- 1%</td>
<td>3380 +/- 1%</td>
<td>0.12</td>
<td>7.5</td>
<td>1.5</td>
<td>4</td>
</tr>
</tbody>
</table>

- Operating Current for Sensor raises Thermistor’s temperature by 0.1°C
- Rated Electric Power shows the required electric power that causes Thermistor’s temperature to rise to 30°C by self heating, at ambient temperature of 25°C.

Temperature vs Resistance Chart:

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Resistance (kΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>297.388</td>
</tr>
<tr>
<td>-35</td>
<td>343.295</td>
</tr>
<tr>
<td>-30</td>
<td>393.345</td>
</tr>
<tr>
<td>-25</td>
<td>438.381</td>
</tr>
<tr>
<td>-20</td>
<td>488.915</td>
</tr>
<tr>
<td>-15</td>
<td>54.166</td>
</tr>
<tr>
<td>-10</td>
<td>42.889</td>
</tr>
<tr>
<td>-5</td>
<td>34.196</td>
</tr>
<tr>
<td>0</td>
<td>27.445</td>
</tr>
<tr>
<td>5</td>
<td>22.165</td>
</tr>
<tr>
<td>10</td>
<td>18.010</td>
</tr>
<tr>
<td>15</td>
<td>14.720</td>
</tr>
<tr>
<td>20</td>
<td>12.099</td>
</tr>
<tr>
<td>25</td>
<td>10.000</td>
</tr>
<tr>
<td>30</td>
<td>8.309</td>
</tr>
<tr>
<td>35</td>
<td>6.939</td>
</tr>
<tr>
<td>40</td>
<td>5.824</td>
</tr>
<tr>
<td>45</td>
<td>4.911</td>
</tr>
<tr>
<td>50</td>
<td>4.160</td>
</tr>
<tr>
<td>55</td>
<td>3.539</td>
</tr>
<tr>
<td>60</td>
<td>3.024</td>
</tr>
<tr>
<td>65</td>
<td>2.593</td>
</tr>
<tr>
<td>70</td>
<td>2.233</td>
</tr>
<tr>
<td>75</td>
<td>1.929</td>
</tr>
<tr>
<td>80</td>
<td>1.673</td>
</tr>
<tr>
<td>85</td>
<td>1.495</td>
</tr>
<tr>
<td>90</td>
<td>1.270</td>
</tr>
<tr>
<td>95</td>
<td>1.112</td>
</tr>
<tr>
<td>100</td>
<td>0.976</td>
</tr>
<tr>
<td>105</td>
<td>0.860</td>
</tr>
<tr>
<td>110</td>
<td>0.759</td>
</tr>
<tr>
<td>115</td>
<td>0.673</td>
</tr>
<tr>
<td>120</td>
<td>0.598</td>
</tr>
<tr>
<td>125</td>
<td>0.532</td>
</tr>
</tbody>
</table>

TEC characteristics:

<table>
<thead>
<tr>
<th>TEC part number</th>
<th>Imax (A)</th>
<th>Umax (V)</th>
<th>Qmax (W)</th>
<th>ΔTmax (K)</th>
<th>Tmax (°C)</th>
<th>A (mm)</th>
<th>B (mm)</th>
<th>H (mm)</th>
<th>ID (mm)</th>
<th>Sealing</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEPT422561</td>
<td>4.0</td>
<td>15.2</td>
<td>40.1</td>
<td>67.0</td>
<td>125.0</td>
<td>40.0</td>
<td>40.0</td>
<td>4.6</td>
<td>4.5</td>
<td>Silicon</td>
</tr>
</tbody>
</table>

Characteristic Line

- ID
- Hot side
- Cold side
- Wire (+)
- Wire (-)