

High Luminous Efficacy
Warm White LED Emitter

LZ4-00WW00



Key Features

- High Luminous Efficacy 10W Warm White LED
- Ultra-small foot print – 7.0mm x 7.0mm
- Surface mount ceramic package with integrated glass lens
- Very low Thermal Resistance (1.1°C/W)
- Individually addressable die
- Very high Luminous Flux density
- Spatial color uniformity across radiation pattern
- JEDEC Level 1 for Moisture Sensitivity Level
- Autoclave complaint (JEDEC JESD22-A102-C)
- Lead (Pb) free and RoHS compliant
- Reflow solderable (up to 6 cycles)
- Emitter available on Standard MCPCB (optional)

Typical Applications

- General Lighting
- Museum Lighting
- Retail & Display Lighting
- Hospitality Lighting
- Accent & Task Lighting
- Architectural Detail Lighting

Description

The LZ4-00WW00 Warm White LED emitter provides 10W power in an extremely small package. With a 7.0mm x 7.0mm ultra-small footprint, this package provides exceptional luminous flux density. LED Engin's patent-pending thermally insulated phosphor layers provide spatial color uniformity across the radiation pattern and a consistent CCT over time and temperature. LED Engin's LZ4-00WW00 LED offers ultimate design flexibility with individually addressable die. The high quality materials used in the package are chosen to optimize light output and minimize stresses which results in monumental reliability and lumen maintenance. The robust product design thrives in outdoor applications with high ambient temperatures and high humidity.

Part number options

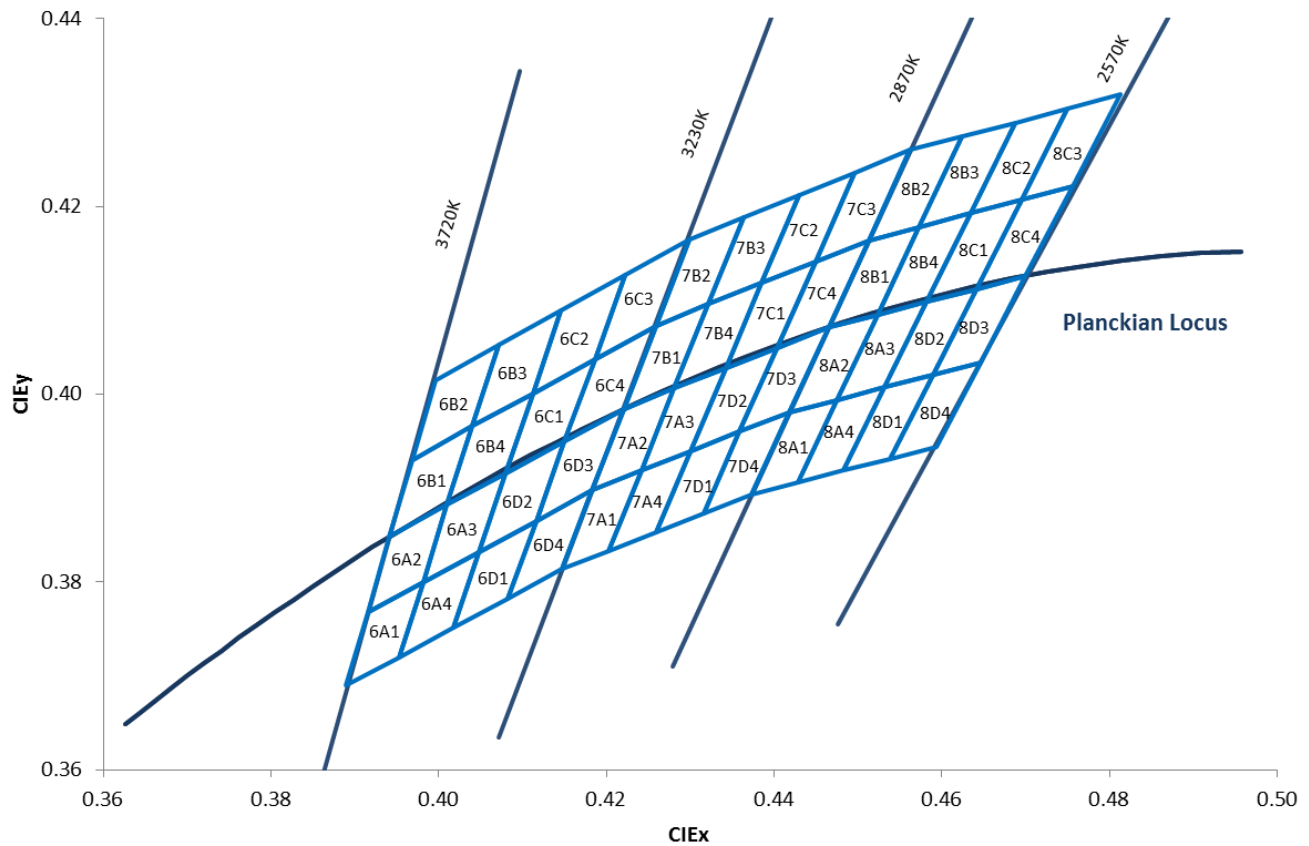
Base part number

| Part number | Description |
|-----------------|--|
| LZ4-00WW00-xxxx | LZ4 emitter |
| LZ4-40WW00-xxxx | LZ4 emitter on Standard Star 1 channel MCPCB |

Bin kit option codes

| WW, Warm-White (2700K – 3500K) | | | |
|--------------------------------|--------------|--|--|
| Kit number suffix | Min flux Bin | Color Bin Ranges | Description |
| 0027 | T | 8A1, 8A2, 8B1, 8B2, 8A4, 8A3, 8B4, 8B3, 8D1, 8D2, 8C1, 8C2, 8D4, 8D3, 8C4, 8C3 | full distribution flux; 2700K ANSI CCT bin |
| 0227 | T | 8A2, 8B1, 8A3, 8B4, 8D2, 8C1, 8D3, 8C4 | full distribution flux; 2700K ANSI CCT half bin |
| 0427 | T | 8A3, 8B4, 8D2, 8C1 | full distribution flux; 2700K ANSI CCT quarter bin |
| 0030 | T | 7A1, 7A2, 7B1, 7B2, 7A4, 7A3, 7B4, 7B3, 7D1, 7D2, 7C1, 7C2, 7D4, 7D3, 7C4, 7C3 | full distribution flux; 3000K ANSI CCT bin |
| 0230 | T | 7A2, 7B1, 7A3, 7B4, 7D2, 7C1, 7D3, 7C4 | full distribution flux; 3000K ANSI CCT half bin |
| 0430 | T | 7A3, 7B4, 7D2, 7C1 | full distribution flux; 3000K ANSI CCT quarter bin |
| 0035 | T | 6A1, 6A2, 6B1, 6B2, 6A4, 6A3, 6B4, 6B3, 6D1, 6D2, 6C1, 6C2, 6D4, 6D3, 6C4, 6C3 | full distribution flux; 3500K ANSI CCT bin |
| 0235 | T | 6A2, 6B1, 6A3, 6B4, 6D2, 6C1, 6D3, 6C4 | full distribution flux; 3500K ANSI CCT half bin |
| 0435 | T | 6A3, 6B4, 6D2, 6C1 | full distribution flux; 3500K ANSI CCT quarter bin |

Warm White Chromaticity Groups



Standard Chromaticity Groups plotted on excerpt from the CIE 1931 (2°) x-y Chromaticity Diagram.
Coordinates are listed below in the table.

Warm White Bin Coordinates

| Bin code | CIEx | CIEy | Bin code | CIEx | CIEy | Bin code | CIEx | CIEy | Bin code | CIEx | CIEy |
|----------|--------|--------|----------|--------|--------|----------|--------|--------|----------|--------|--------|
| 6A1 | 0.3889 | 0.369 | 6A2 | 0.3915 | 0.3768 | 6B1 | 0.3941 | 0.3848 | 6B2 | 0.3968 | 0.393 |
| | 0.3915 | 0.3768 | | 0.3941 | 0.3848 | | 0.3968 | 0.393 | | 0.3996 | 0.4015 |
| | 0.3981 | 0.38 | | 0.401 | 0.3882 | | 0.404 | 0.3966 | | 0.4071 | 0.4052 |
| | 0.3953 | 0.372 | | 0.3981 | 0.38 | | 0.401 | 0.3882 | | 0.404 | 0.3966 |
| 6A4 | 0.3889 | 0.369 | 6A3 | 0.3915 | 0.3768 | 6B4 | 0.3941 | 0.3848 | 6B3 | 0.3968 | 0.393 |
| | 0.3953 | 0.372 | | 0.3981 | 0.38 | | 0.401 | 0.3882 | | 0.404 | 0.3966 |
| | 0.3981 | 0.38 | | 0.401 | 0.3882 | | 0.404 | 0.3966 | | 0.4071 | 0.4052 |
| | 0.4048 | 0.3832 | | 0.408 | 0.3916 | | 0.4113 | 0.4001 | | 0.4146 | 0.4089 |
| 6D1 | 0.4017 | 0.3751 | 6D2 | 0.4048 | 0.3832 | 6C1 | 0.408 | 0.3916 | 6C2 | 0.4113 | 0.4001 |
| | 0.4048 | 0.3832 | | 0.408 | 0.3916 | | 0.4113 | 0.4001 | | 0.4146 | 0.4089 |
| | 0.4116 | 0.3865 | | 0.415 | 0.395 | | 0.4186 | 0.4037 | | 0.4222 | 0.4127 |
| | 0.4082 | 0.3782 | | 0.4116 | 0.3865 | | 0.415 | 0.395 | | 0.4186 | 0.4037 |
| 6D4 | 0.4017 | 0.3751 | 6D3 | 0.4048 | 0.3832 | 6C4 | 0.408 | 0.3916 | 6C3 | 0.4113 | 0.4001 |
| | 0.4082 | 0.3782 | | 0.4116 | 0.3865 | | 0.415 | 0.395 | | 0.4186 | 0.4037 |
| | 0.4116 | 0.3865 | | 0.415 | 0.395 | | 0.4186 | 0.4037 | | 0.4222 | 0.4127 |
| | 0.4183 | 0.3898 | | 0.4221 | 0.3984 | | 0.4259 | 0.4073 | | 0.4299 | 0.4165 |
| 7A1 | 0.4147 | 0.3814 | 7A2 | 0.4183 | 0.3898 | 7B1 | 0.4221 | 0.3984 | 7B2 | 0.4259 | 0.4073 |
| | 0.4183 | 0.3898 | | 0.4221 | 0.3984 | | 0.4259 | 0.4073 | | 0.4299 | 0.4165 |
| | 0.4242 | 0.3919 | | 0.4281 | 0.4006 | | 0.4322 | 0.4096 | | 0.4364 | 0.4188 |
| | 0.4203 | 0.3833 | | 0.4242 | 0.3919 | | 0.4281 | 0.4006 | | 0.4322 | 0.4096 |
| 7A4 | 0.4147 | 0.3814 | 7A3 | 0.4183 | 0.3898 | 7B4 | 0.4221 | 0.3984 | 7B3 | 0.4259 | 0.4073 |
| | 0.4183 | 0.3898 | | 0.4221 | 0.3984 | | 0.4259 | 0.4073 | | 0.4299 | 0.4165 |
| | 0.4242 | 0.3919 | | 0.4281 | 0.4006 | | 0.4322 | 0.4096 | | 0.4364 | 0.4188 |
| | 0.4203 | 0.3833 | | 0.4242 | 0.3919 | | 0.4281 | 0.4006 | | 0.4322 | 0.4096 |
| 7D1 | 0.4259 | 0.3853 | 7D2 | 0.43 | 0.3939 | 7C1 | 0.4342 | 0.4028 | 7C2 | 0.4385 | 0.4119 |
| | 0.43 | 0.3939 | | 0.4342 | 0.4028 | | 0.4385 | 0.4119 | | 0.443 | 0.4212 |
| | 0.4359 | 0.396 | | 0.4403 | 0.4049 | | 0.4449 | 0.4141 | | 0.4496 | 0.4236 |
| | 0.4316 | 0.3873 | | 0.4359 | 0.396 | | 0.4403 | 0.4049 | | 0.4449 | 0.4141 |
| 7D4 | 0.4259 | 0.3853 | 7D3 | 0.43 | 0.3939 | 7C4 | 0.4342 | 0.4028 | 7C3 | 0.4385 | 0.4119 |
| | 0.4316 | 0.3873 | | 0.4359 | 0.396 | | 0.4403 | 0.4049 | | 0.4449 | 0.4141 |
| | 0.4359 | 0.396 | | 0.4403 | 0.4049 | | 0.4449 | 0.4141 | | 0.4496 | 0.4236 |
| | 0.4418 | 0.3981 | | 0.4465 | 0.4071 | | 0.4513 | 0.4164 | | 0.4562 | 0.426 |
| 8A1 | 0.4373 | 0.3893 | 8A2 | 0.4418 | 0.3981 | 8B1 | 0.4465 | 0.4071 | 8B2 | 0.4513 | 0.4164 |
| | 0.4418 | 0.3981 | | 0.4465 | 0.4071 | | 0.4513 | 0.4164 | | 0.4562 | 0.426 |
| | 0.4475 | 0.3994 | | 0.4523 | 0.4085 | | 0.4573 | 0.4178 | | 0.4624 | 0.4274 |
| | 0.4428 | 0.3906 | | 0.4475 | 0.3994 | | 0.4523 | 0.4085 | | 0.4573 | 0.4178 |
| 8A4 | 0.4373 | 0.3893 | 8A3 | 0.4418 | 0.3981 | 8B4 | 0.4465 | 0.4071 | 8B3 | 0.4513 | 0.4164 |
| | 0.4428 | 0.3906 | | 0.4475 | 0.3994 | | 0.4523 | 0.4085 | | 0.4573 | 0.4178 |
| | 0.4475 | 0.3994 | | 0.4523 | 0.4085 | | 0.4573 | 0.4178 | | 0.4624 | 0.4274 |
| | 0.4532 | 0.4008 | | 0.4582 | 0.4099 | | 0.4634 | 0.4193 | | 0.4687 | 0.4289 |
| 8D1 | 0.4483 | 0.3919 | 8D2 | 0.4532 | 0.4008 | 8C1 | 0.4582 | 0.4099 | 8C2 | 0.4634 | 0.4193 |
| | 0.4448 | 0.3906 | | 0.4475 | 0.3994 | | 0.4523 | 0.4085 | | 0.4573 | 0.4178 |
| | 0.4532 | 0.4008 | | 0.4582 | 0.4099 | | 0.4634 | 0.4193 | | 0.4687 | 0.4289 |
| | 0.4483 | 0.3919 | | 0.4532 | 0.4008 | | 0.4582 | 0.4099 | | 0.4634 | 0.4193 |
| 8D4 | 0.4538 | 0.3931 | 8D3 | 0.4589 | 0.4021 | 8C4 | 0.4641 | 0.4112 | 8C3 | 0.4695 | 0.4207 |
| | 0.4589 | 0.4021 | | 0.4641 | 0.4112 | | 0.4695 | 0.4207 | | 0.475 | 0.4304 |
| | 0.4646 | 0.4034 | | 0.47 | 0.4126 | | 0.4756 | 0.4221 | | 0.4813 | 0.4319 |
| | 0.4593 | 0.3944 | | 0.4646 | 0.4034 | | 0.47 | 0.4126 | | 0.4756 | 0.4221 |
| | 0.4538 | 0.3931 | | 0.4589 | 0.4021 | | 0.4641 | 0.4112 | | 0.4695 | 0.4207 |

Luminous Flux Bins

Table 1:

| Bin Code | Minimum Luminous Flux (Φ_V) @ $I_F = 700\text{mA}$ ^[1,2] (lm) | Maximum Luminous Flux (Φ_V) @ $I_F = 700\text{mA}$ ^[1,2] (lm) |
|----------|--|--|
| T | 445 | 556 |
| U | 556 | 695 |

Notes for Table 1:

1. Luminous flux performance guaranteed within published operating conditions. LED Engin maintains a tolerance of $\pm 10\%$ on flux measurements.
2. Future products will have even higher levels of luminous flux performance. Contact LED Engin Sales for updated information.

Forward Voltage Bins

Table 2:

| Bin Code | Minimum Forward Voltage (V_F) @ $I_F = 700\text{mA}$ ^[1,2] (V) | Maximum Forward Voltage (V_F) @ $I_F = 700\text{mA}$ ^[1,2] (V) |
|----------|--|--|
| 0 | 12.80 | 16.64 |

Notes for Table 2:

1. LED Engin maintains a tolerance of $\pm 0.04\text{V}$ for forward voltage measurements.
2. Forward Voltage is binned with all four LED dice connected in series.

Absolute Maximum Ratings

Table 3:

| Parameter | Symbol | Value | Unit |
|--|-----------|---|--------------------|
| DC Forward Current at $T_{jmax}=135^{\circ}\text{C}^{[1]}$ | I_F | 1200 | mA |
| DC Forward Current at $T_{jmax}=150^{\circ}\text{C}^{[1]}$ | I_F | 1000 | mA |
| Peak Pulsed Forward Current ^[2] | I_{FP} | 1500 | mA |
| Reverse Voltage | V_R | See Note 3 | V |
| Storage Temperature | T_{stg} | -40 ~ +150 | $^{\circ}\text{C}$ |
| Junction Temperature | T_J | 150 | $^{\circ}\text{C}$ |
| Soldering Temperature ^[4] | T_{sol} | 260 | $^{\circ}\text{C}$ |
| Allowable Reflow Cycles | | 6 | |
| Autoclave Conditions ^[5] | | 121 $^{\circ}\text{C}$ at 2 ATM, 100% RH for 168 hours | |
| ESD Sensitivity ^[6] | | > 8,000 V HBM Class 3B JESD22-A114-D | |

Notes for Table 3:

- Maximum DC forward current (per die) is determined by the overall thermal resistance and ambient temperature. Follow the curves in Figure 10 for current derating.
- Pulse forward current conditions: Pulse Width $\leq 10\text{msec}$ and Duty cycle $\leq 10\%$.
- LEDs are not designed to be reverse biased.
- Solder conditions per JEDEC 020D. See Reflow Soldering Profile Figure 5.
- Autoclave Conditions per JEDEC JESD22-A102-C.
- LED Engin recommends taking reasonable precautions towards possible ESD damages and handling the LZ4-00WW00 in an electrostatic protected area (EPA). An EPA may be adequately protected by ESD controls as outlined in ANSI/ESD S6.1.

Optical Characteristics @ $T_c = 25^{\circ}\text{C}$

Table 4:

| Parameter | Symbol | Typical | Unit |
|---|-----------------|---------|---------|
| Luminous Flux (@ $I_F = 700\text{mA}$) ^[1] | Φ_V | 550 | lm |
| Luminous Flux (@ $I_F = 1000\text{mA}$) ^[1] | Φ_V | 700 | lm |
| Luminous Efficacy (@ $I_F = 350\text{mA}$) | | 72 | lm/W |
| Correlated Color Temperature ^[2] | CCT | 3000 | K |
| Color Rendering Index (CRI / R9) | Ra | 85 | |
| Viewing Angle ^[3] | $2\theta_{1/2}$ | 105 | Degrees |
| Total Included Angle ^[4] | $\theta_{0.9V}$ | 135 | Degrees |

Notes for Table 4:

- Luminous flux typical value is for all four LED dice operating concurrently at rated current.
- Typical Color Rendering Index (CRI) is 80.
- Viewing Angle is the off axis angle from emitter centerline where the luminous intensity is $\frac{1}{2}$ of the peak value.
- Total Included Angle is the total angle that includes 90% of the total luminous flux.

Electrical Characteristics @ $T_c = 25^{\circ}\text{C}$

Table 5:

| Parameter | Symbol | Typical | Unit |
|---|---------------------------|---------|-----------------------------|
| Forward Voltage (@ $I_F = 700\text{mA}$) ^[1] | V_F | 14.0 | V |
| Forward Voltage (@ $I_F = 1000\text{mA}$) ^[1] | V_F | 14.6 | V |
| Temperature Coefficient of Forward Voltage ^[1] | $\Delta V_F / \Delta T_J$ | -11.9 | mV/ $^{\circ}\text{C}$ |
| Thermal Resistance (Junction to Case) | $R\theta_{J-C}$ | 1.1 | $^{\circ}\text{C}/\text{W}$ |

Notes for Table 5:

- Forward Voltage typical value is for all four LED dice connected in series.

IPC/JEDEC Moisture Sensitivity Level

Table 6 - IPC/JEDEC J-STD-20 MSL Classification:

| Level | Floor Life | | Soak Requirements | | | |
|-------|------------|--------------------------------------|-------------------|---------------------------------|-------------|------------|
| | Time | Conditions | Standard | Conditions | Accelerated | Conditions |
| 1 | Unlimited | $\leq 30^{\circ}\text{C}/$ 85% RH | 168 +5/-0 | $85^{\circ}\text{C}/$ 85% RH | n/a | n/a |

Notes for Table 6:

1. The standard soak time is the sum of the default value of 24 hours for the semiconductor manufacturer's exposure time (MET) between bake and bag and the floor life of maximum time allowed out of the bag at the end user of distributor's facility.

Average Lumen Maintenance Projections

Lumen maintenance generally describes the ability of a lamp to retain its output over time. The useful lifetime for solid state lighting devices (Power LEDs) is also defined as Lumen Maintenance, with the percentage of the original light output remaining at a defined time period.

Based on long-term WHTOL testing, LED Engin projects that the LZ Series will deliver, on average, 70% Lumen Maintenance at 65,000 hours of operation at a forward current of 700 mA per die. This projection is based on constant current operation with junction temperature maintained at or below 125°C.

Mechanical Dimensions (mm)

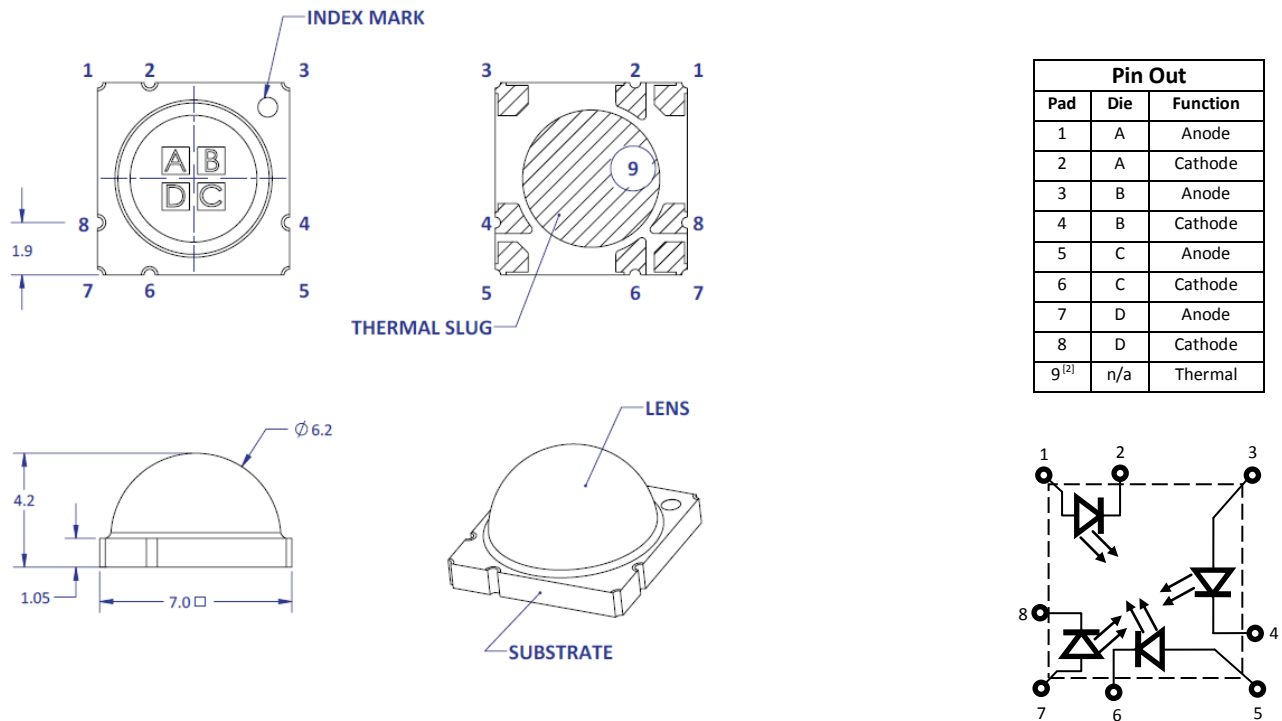


Figure 1: Package outline drawing.

Notes for Figure 1:

1. Unless otherwise noted, the tolerance = ± 0.20 mm.
2. Thermal contact, Pad 9, is electrically neutral.

Recommended Solder Pad Layout (mm)

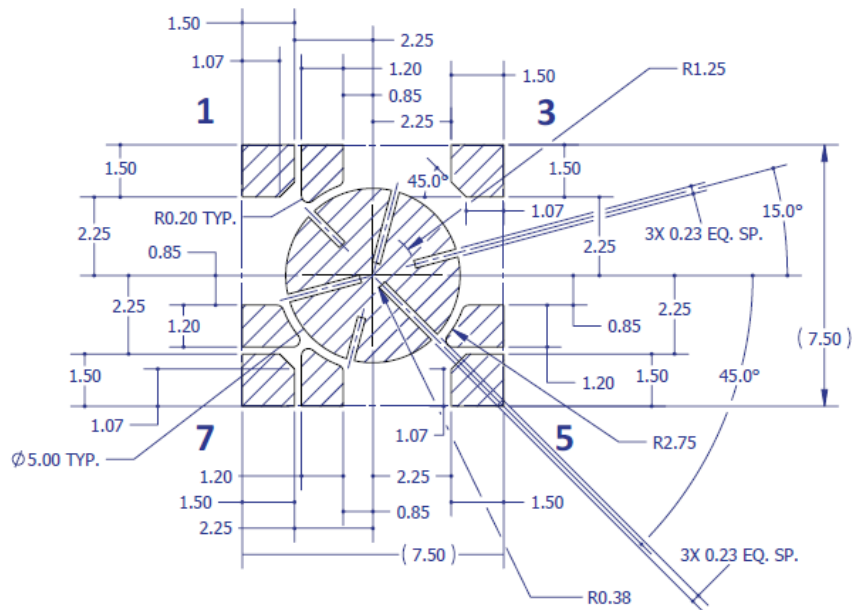


Figure 2a: Recommended solder pad layout for anode, cathode, and thermal pad.

Note for Figure 2a:

1. Unless otherwise noted, the tolerance = ± 0.20 mm.
2. This pad layout is "patent pending".

Recommended Solder Mask Layout (mm)

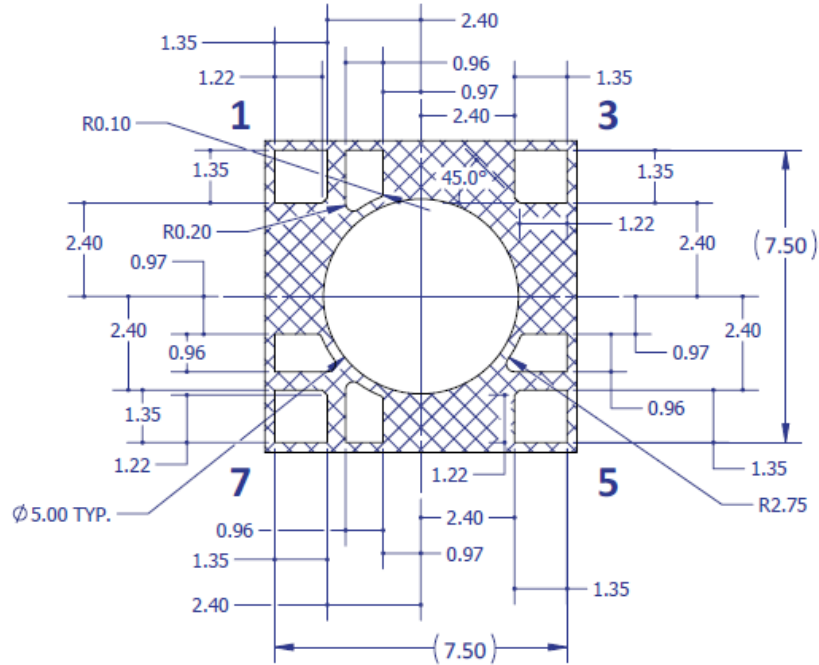


Figure 2b: Recommended solder mask opening (hatched area) for anode, cathode, and thermal pad.

Note for Figure 2b:

1. Unless otherwise noted, the tolerance = ± 0.20 mm.

Reflow Soldering Profile

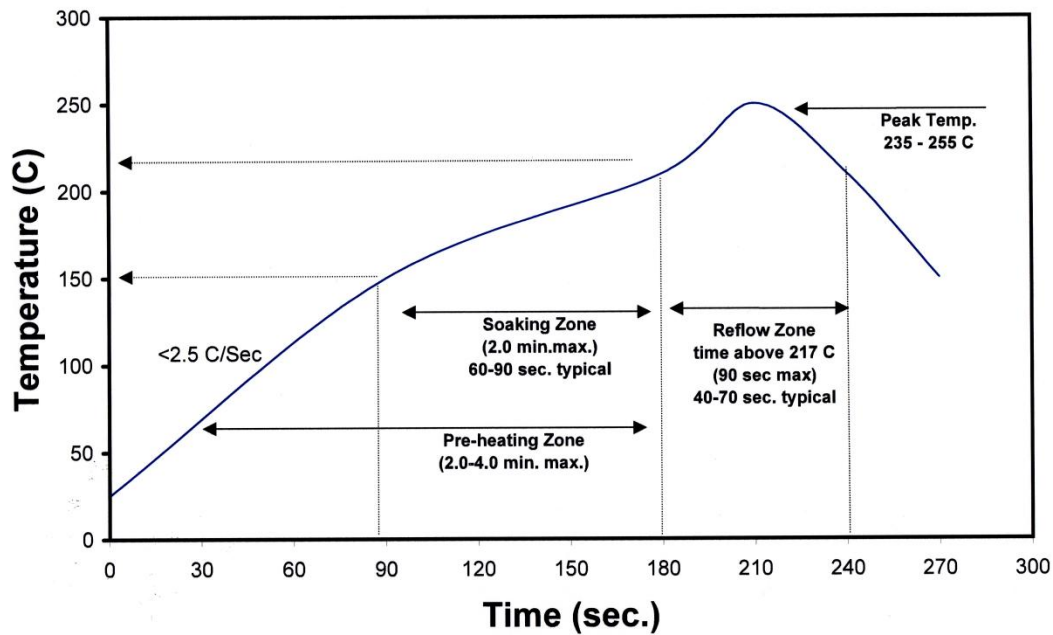


Figure 3: Reflow soldering profile for lead free soldering.

Typical Radiation Pattern

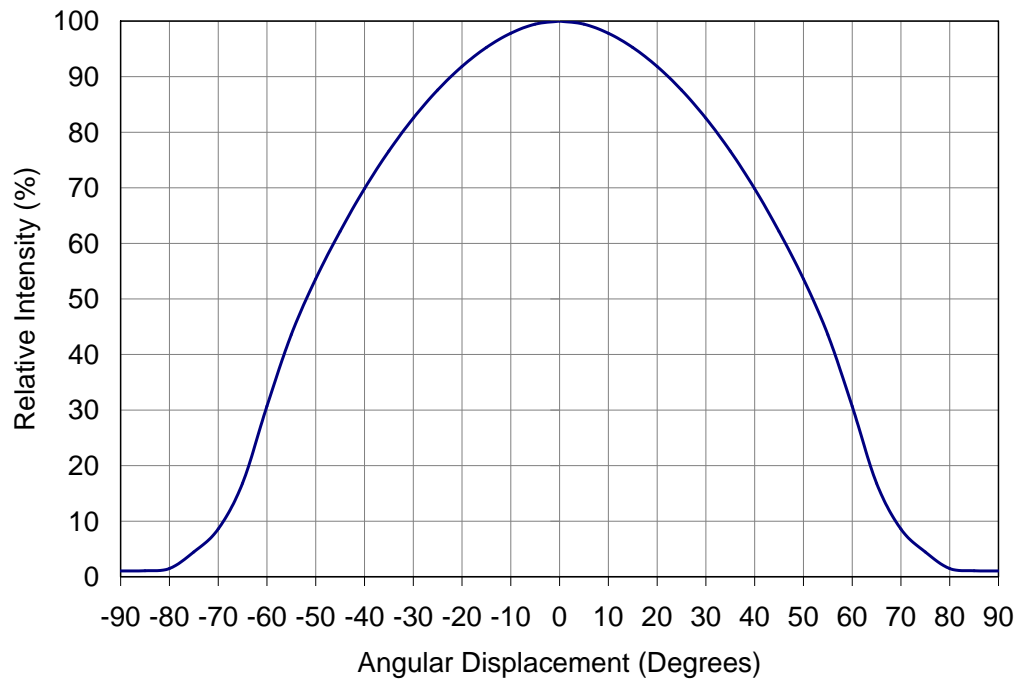


Figure 4: Typical representative spatial radiation pattern.

Typical Relative Spectral Power Distribution

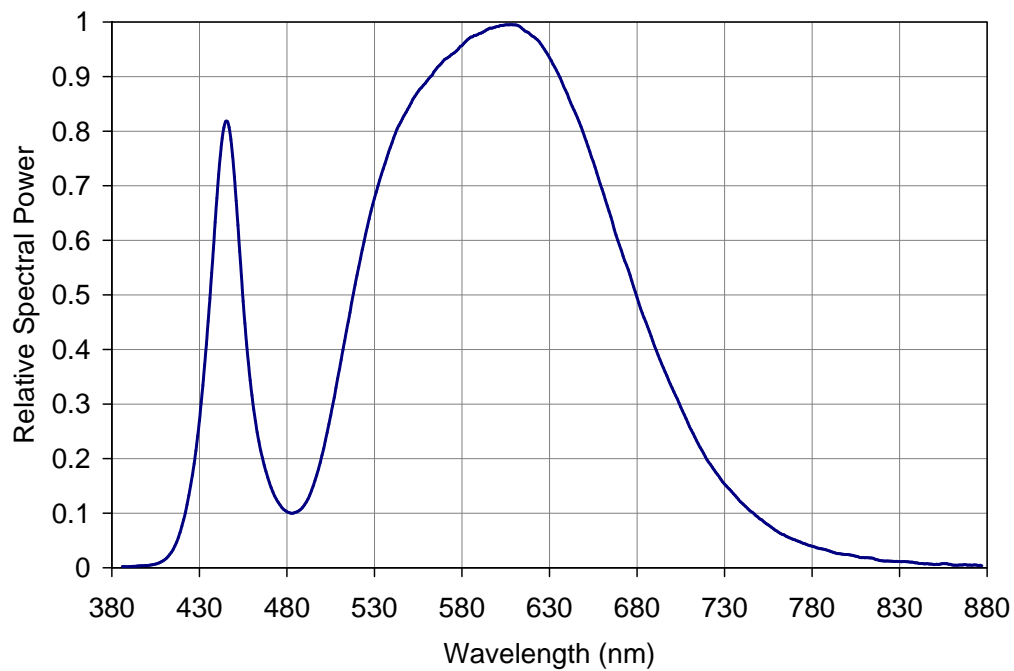


Figure 5: Typical relative spectral power vs. wavelength @ $T_c = 25^\circ\text{C}$.

Typical Relative Light Output

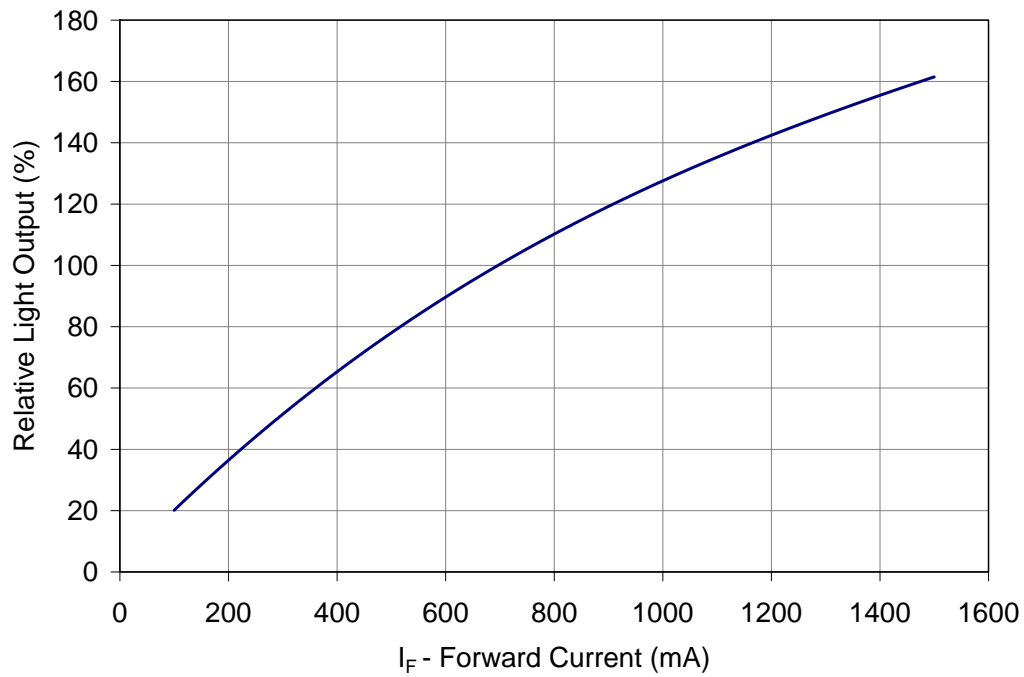


Figure 6: Typical relative light output vs. forward current @ T_c = 25°C.

Typical Relative Light Output over Temperature

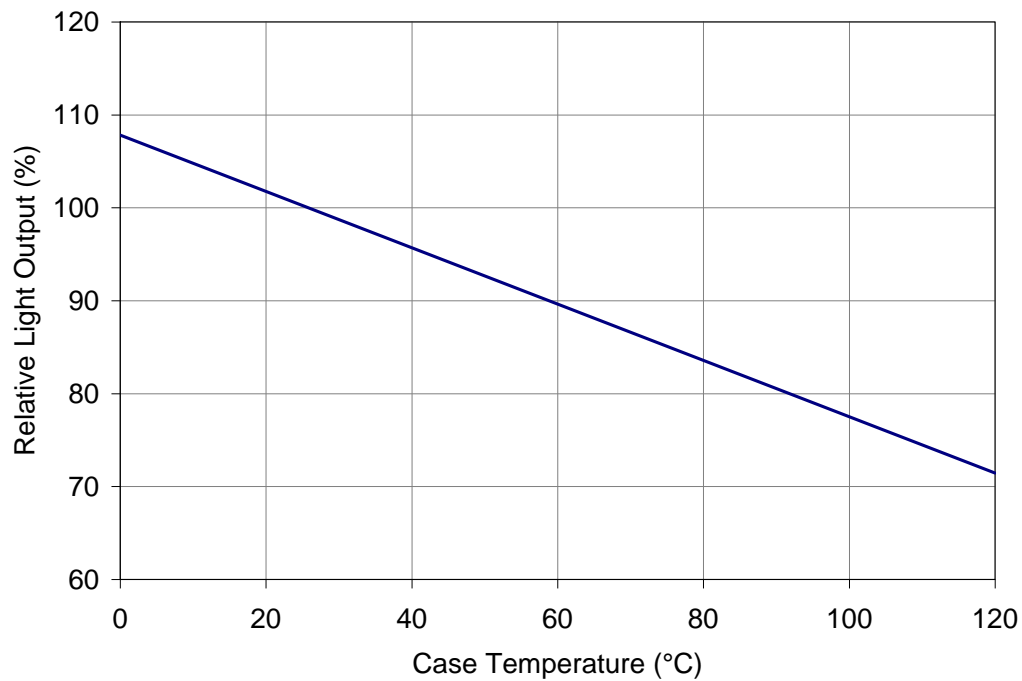


Figure 7: Typical relative light output vs. case temperature.

Typical Forward Current Characteristics

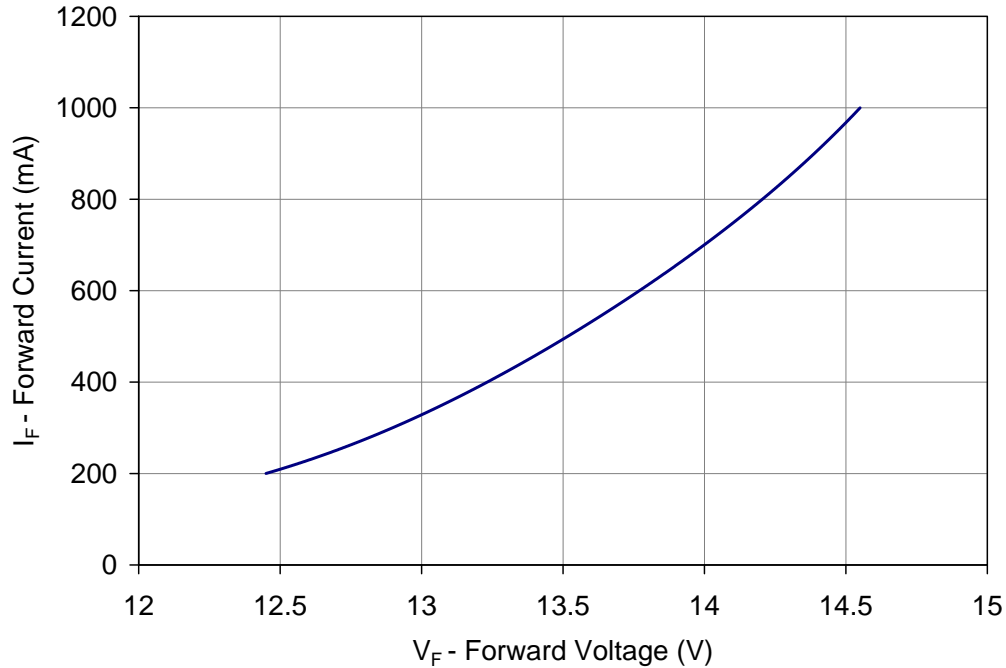


Figure 8: Typical forward current vs. forward voltage @ $T_C = 25^\circ\text{C}$.

Note for Figure 8:

1. Forward Voltage curve assumes that all four LED dice are connected in series.

Current De-rating

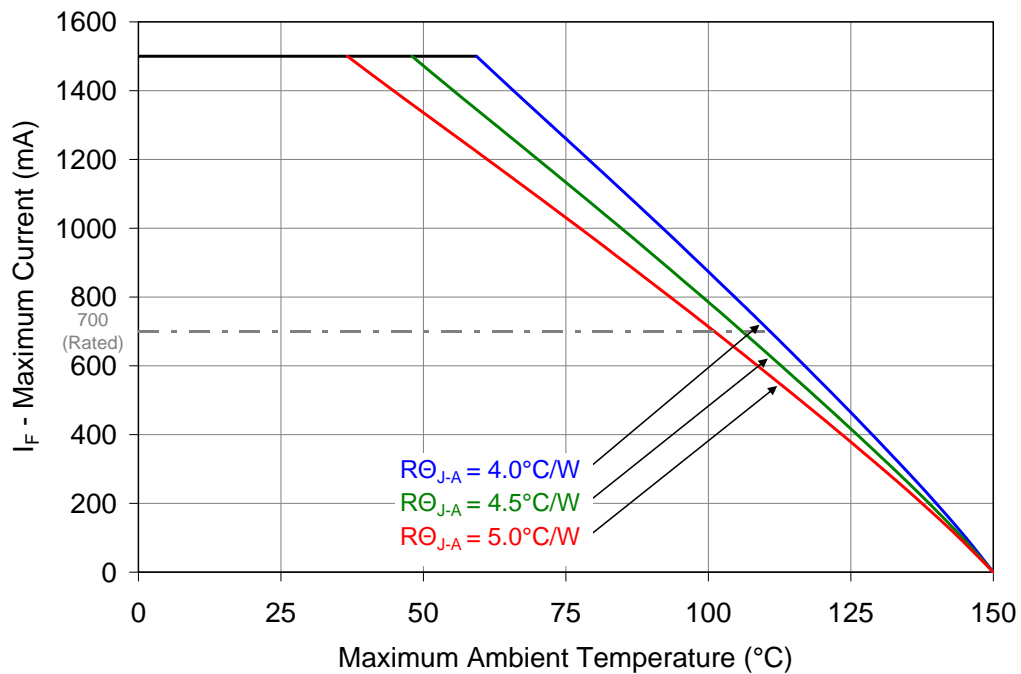


Figure 9: Maximum forward current vs. ambient temperature based on $T_{J(\text{MAX})} = 150^\circ\text{C}$.

Notes for Figure 9:

1. Maximum current assumes that all four LED dice are operating concurrently at the same current.
2. $R\theta_{JC}$ [Junction to Case Thermal Resistance] for the LZ4-00CW10 is typically 1.1°C/W .
3. $R\theta_{JA}$ [Junction to Ambient Thermal Resistance] = $R\theta_{JC} + R\theta_{CA}$ [Case to Ambient Thermal Resistance].

Emitter Tape and Reel Specifications (mm)

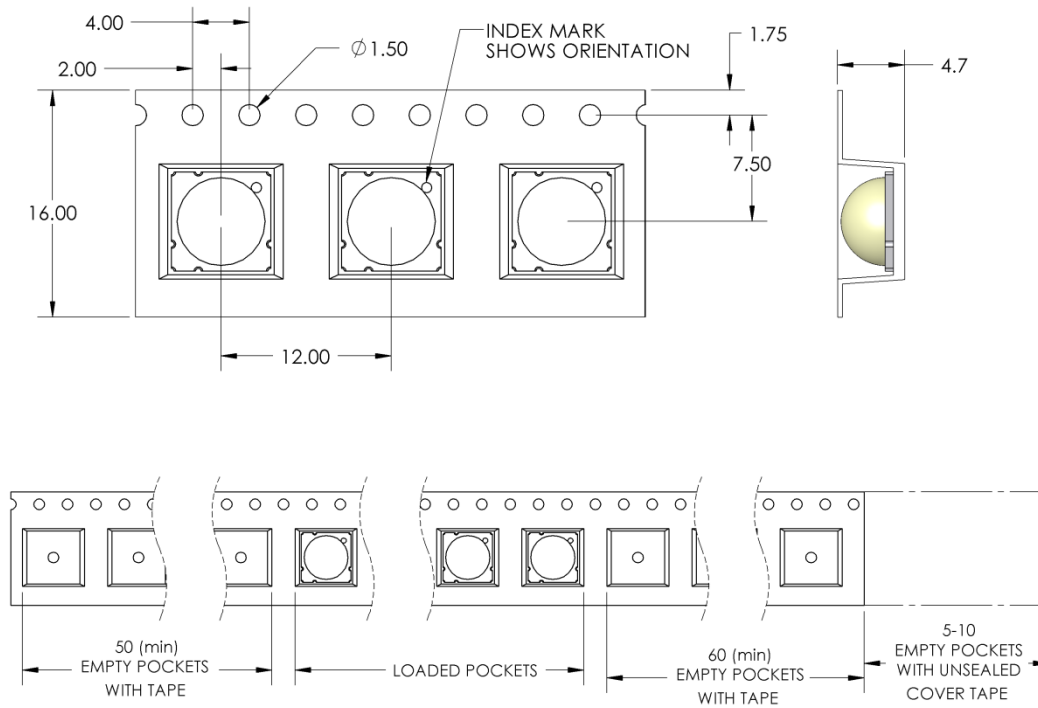


Figure 10: Emitter carrier tape specifications (mm).

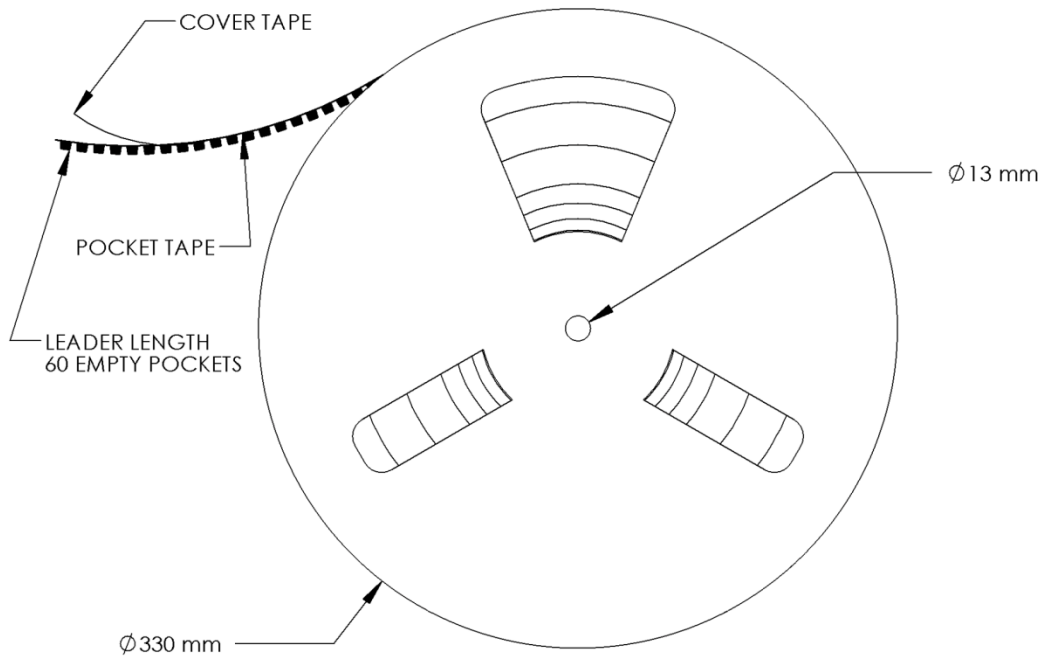


Figure 11: Emitter Reel specifications (mm).

LZ4 MCPCB Family

| Part number | Type of MCPCB | Diameter (mm) | Emitter + MCPCB Thermal Resistance (°C/W) | Typical V_f (V) | Typical I_f (mA) |
|-------------|---------------|---------------|---|-------------------|--------------------|
| LZ4-4xxxxxx | 1-channel | 19.9 | $1.1 + 1.1 = 2.2$ | 14.0 | 700 |

Mechanical Mounting of MCPCB

- MCPCB bending should be avoided as it will cause mechanical stress on the emitter, which could lead to substrate cracking and subsequently LED dies cracking.
- To avoid MCPCB bending:
 - Special attention needs to be paid to the flatness of the heat sink surface and the torque on the screws.
 - Care must be taken when securing the board to the heat sink. This can be done by tightening three M3 screws (or #4-40) in steps and not all the way through at once. Using fewer than three screws will increase the likelihood of board bending.
 - It is recommended to always use plastics washers in combinations with the three screws.
 - If non-taped holes are used with self-tapping screws, it is advised to back out the screws slightly after tightening (with controlled torque) and then re-tighten the screws again.

Thermal interface material

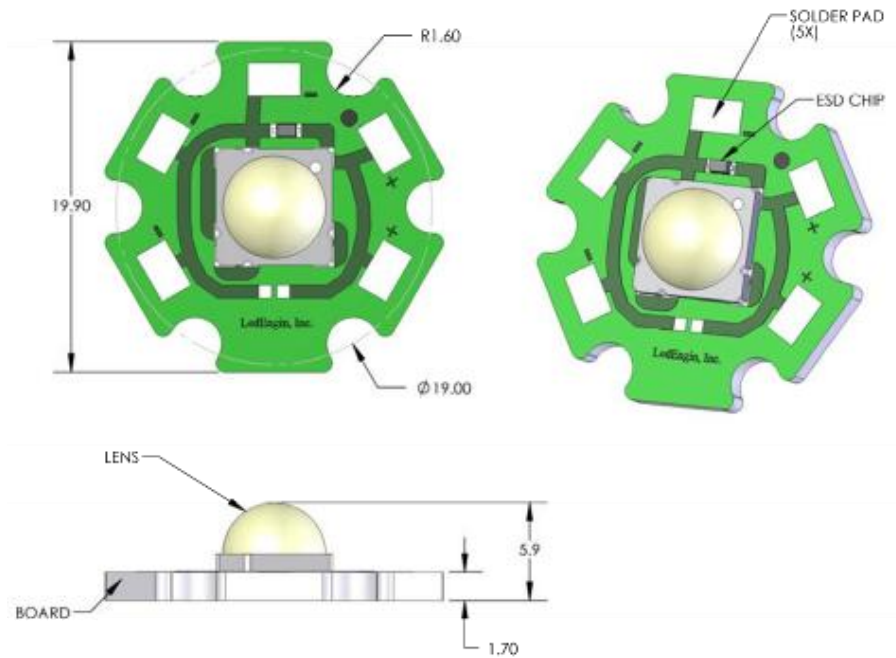
- To properly transfer heat from LED emitter to heat sink, a thermally conductive material is required when mounting the MCPCB on to the heat sink.
- There are several varieties of such material: thermal paste, thermal pads, phase change materials and thermal epoxies. An example of such material is Electrolube EHTC.
- It is critical to verify the material's thermal resistance to be sufficient for the selected emitter and its operating conditions.

Wire soldering

- To ease soldering wire to MCPCB process, it is advised to preheat the MCPCB on a hot plate of 125-150°C. Subsequently, apply the solder and additional heat from the solder iron will initiate a good solder reflow. It is recommended to use a solder iron of more than 60W.
- It is advised to use lead-free, no-clean solder. For example: SN-96.5 AG-3.0 CU 0.5 #58/275 from Kester (pn: 24-7068-7601)

LZ4-4xxxxx

1 channel, Standard Star MCPCB (1x4) Dimensions (mm)



Notes:

- Unless otherwise noted, the tolerance = ± 0.2 mm.
- Slots in MCPCB are for M3 or #4-40 mounting screws.
- LED Engin recommends plastic washers to electrically insulate screws from solder pads and electrical traces.
- Electrical connection pads on MCPCB are labeled "+" for Anode and "-" for Cathode
- LED Engin recommends thermal interface material when attaching the MCPCB to a heatsink
- The thermal resistance of the MCPCB is: R0C-B 1.1°C/W

Components used

MCPCB: HT04503 (Bergquist)
ESD chips: BZX585-C30 (NXP, for 4 LED dies in series)

| Pad layout | | | |
|------------|-----------|------------|-----------|
| Ch. | MCPCB Pad | String/die | Function |
| 1 | - | 1/ABCD | Cathode - |
| | + | | Anode + |

Company Information

LED Engin, based in California's Silicon Valley, develops, manufactures, and sells advanced LED emitters, optics and light engines to create uncompromised lighting experiences for a wide range of entertainment, architectural, general lighting and specialty applications. LuxiGen™ multi-die emitter and secondary lens combinations reliably deliver industry-leading flux density, upwards of 5000 quality lumens to a target, in a wide spectrum of colors including whites, tunable whites, multi-color and UV LEDs in a unique patented compact ceramic package. Our LuxiTune™ series of tunable white lighting modules leverage our LuxiGen emitters and lenses to deliver quality, control, freedom and high density tunable white light solutions for a broad range of new recessed and downlighting applications. The small size, yet remarkably powerful beam output and superior in-source color mixing, allows for a previously unobtainable freedom of design wherever high-flux density, directional light is required.

LED Engin is committed to providing products that conserve natural resources and reduce greenhouse emissions.

LED Engin reserves the right to make changes to improve performance without notice.

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