

## AREQ-9x20-xx000

### 3528 PLCC-4 Surface Mount Infrared LED

#### Overview

The Broadcom<sup>®</sup> AREQ-9x20-xx000 is a double junction 940-nm infrared emitter packaged in an industrial-standard PLCC-4. This high-efficiency infrared emitter is suitable to be used in industrial sensing and infrared illumination for cameras.

The package is compatible with reflow soldering process. To facilitate easy pick and place assembly, the products are packed in tape and reel form.

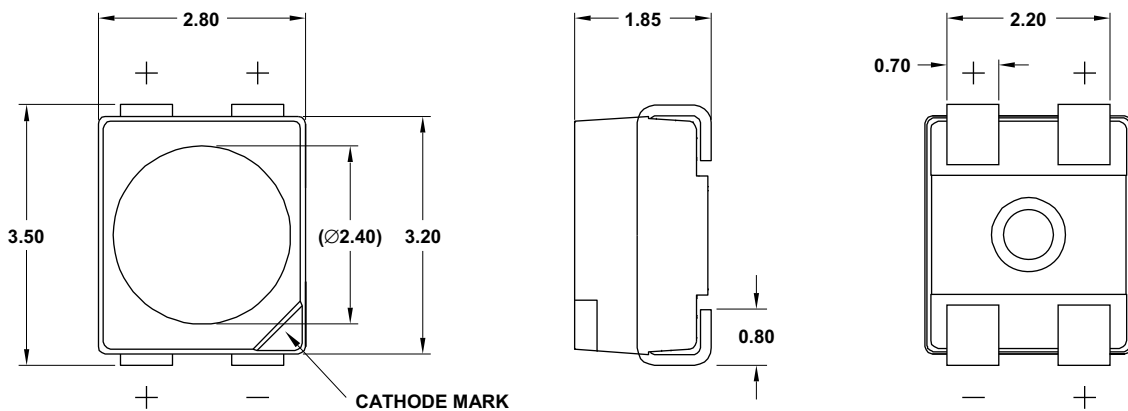
#### Features

- Available in peak wavelength 940 nm
- Available In 30°, 50°, and 120° viewing angle
- JEDEC MSL 3

#### Applications

- Infrared illumination for cameras
- Industrial sensing

Figure 1: Package Drawing for AREQ-9020-xx000



**CAUTION!** This LED is ESD sensitive. Observe appropriate precautions during handling and processing. Refer to application note AN-1142 for additional detail.

Figure 2: Package Drawing for AREQ-9320-xx000

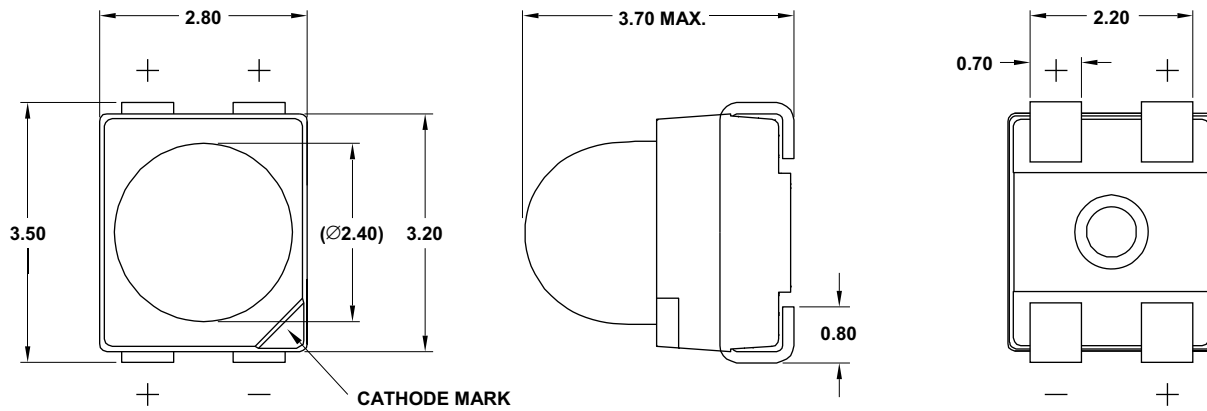
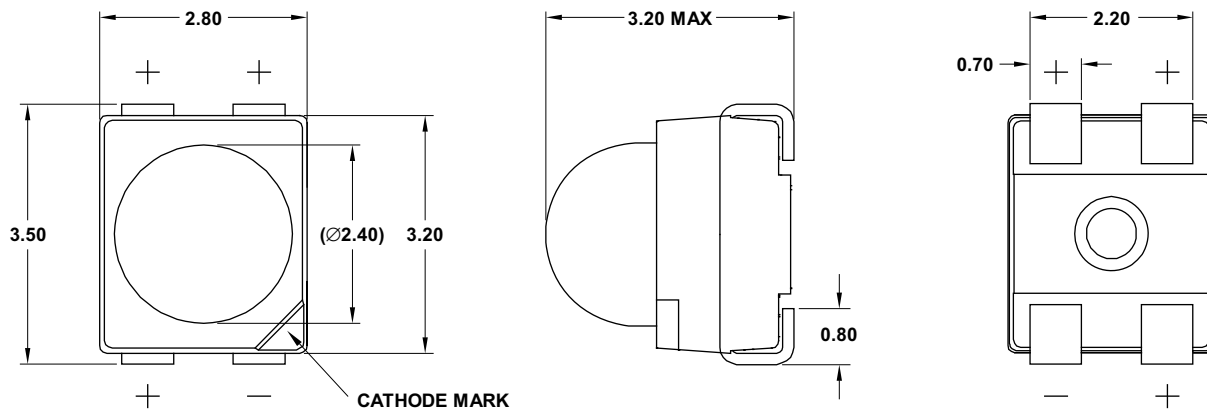


Figure 3: Package Drawing for AREQ-9520-xx000

**NOTE:**

1. All dimensions in millimeters (mm).
2. Tolerance is  $\pm 0.20$  mm unless otherwise specified.
3. Terminal finish = silver plating.
4. Dimensions in bracket are for reference only.

## Device Selection Guide ( $T_J = 25^\circ\text{C}$ , $I_F = 100\text{ mA}$ , $t_p = 20\text{ ms}$ )

Part Number	Viewing Angle, $2\theta_{1/2}$ ( $^\circ$ )	Peak Wavelength, $\lambda_p$ (nm)	Radiant Intensity, $I_e$ (mW/sr) <sup>a, b</sup>		
	Typ.	Typ.	Min.	Typ.	Max.
AREQ-9020-MP000	120	940	18.0	30.0	71.5
AREQ-9520-PR000	50	940	45.0	80.0	180.0
AREQ-9320-RT000	30	940	112.5	200.0	450.0

a. The radiant intensity,  $I_e$ , is measured at the mechanical axis of the package, and it is tested with a single current pulse condition. The actual peak of the spatial radiation pattern might not be aligned with the axis.

b. Tolerance is  $\pm 12\%$ .

## Absolute Maximum Ratings

Parameters	AREQ-9x20-xx000	Unit
DC Forward Current <sup>a</sup>	100	mA
Peak Forward Current <sup>b</sup>	1000	mA
Power Dissipation	360	mW
Reverse Voltage	Not designed for reverse bias operation	
LED Junction Temperature	125	$^\circ\text{C}$
Operating Temperature Range	-40 to +100	$^\circ\text{C}$
Storage Temperature Range	-40 to +100	$^\circ\text{C}$

a. Derate linearly as shown in [Figure 10](#) and [Figure 11](#).

b. Duty factor = 1%, frequency = 100 Hz,  $T_S = 25^\circ\text{C}$ .

## Optical and Electrical Characteristics ( $T_J = 25^\circ\text{C}$ )

Parameters	Min.	Typ.	Max.	Unit	Test Conditions
Viewing Angle, $2\theta_{1/2}$ <sup>a</sup>	—	120	—	$^\circ$	$I_F = 100\text{ mA}$
AREQ-9020-MP000	—	120	—		
AREQ-9520-QR000	—	50	—		
AREQ-9320-RT000	—	30	—		
Spectral Half-Width, $\Delta\lambda_{1/2}$	—	41	—	nm	$I_F = 100\text{ mA}$ , $t_p = 20\text{ ms}$
Forward Voltage, $V_F$ <sup>b</sup>	—	3.1	3.6	V	$I_F = 100\text{ mA}$ , $t_p = 20\text{ ms}$
Forward Voltage, $V_F$ <sup>b</sup>	—	4.1	—	V	$I_F = 1\text{ A}$ , $t_p = 100\text{ }\mu\text{s}$
Rise Time, $t_r$ , $t_f$ <sup>c</sup>	—	15	—	ns	$I_F = 100\text{ mA}$
Rise and Fall Time, $t_r$ , $t_f$ <sup>c</sup>	—	25	—	ns	$I_F = 100\text{ mA}$
Thermal Resistance, $R_{\theta J-S}$ <sup>d</sup>	—	140	—	$^\circ\text{C/W}$	—
Temperature Coefficient of Radiant Intensity, $TC_{I_e}$	—	-0.15	—	$\%/^\circ\text{C}$	$I_F = 100\text{ mA}$ , $25^\circ\text{C} \leq T \leq 85^\circ\text{C}$
Temperature Coefficient of Forward Voltage, $TC_{V_F}$	—	-2.40	—	$\text{mV}/^\circ\text{C}$	$I_F = 100\text{ mA}$ , $25^\circ\text{C} \leq T \leq 85^\circ\text{C}$
Temperature Coefficient of Peak Wavelength, $TC_{\lambda_p}$	—	0.31	—	$\text{nm}/^\circ\text{C}$	$I_F = 100\text{ mA}$ , $25^\circ\text{C} \leq T \leq 85^\circ\text{C}$

a.  $\theta_{1/2}$  is the off-axis angle where the radiant intensity is half of the peak intensity.

b. Forward voltage tolerance is  $\pm 0.1\text{ V}$ .

c. 10% and 90% of  $I_{e\text{ max}}$ .

d. Thermal resistance from LED junction to solder point.

## Part Numbering System

A R E Q - 

x <sub>1</sub>	x <sub>2</sub>	x <sub>3</sub>
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 0 - 

x <sub>4</sub>	x <sub>5</sub>
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 0 0 0

Code	Description	Option	
x <sub>1</sub>	Peak Wavelength	9	940 nm
x <sub>2</sub>	Viewing Angle	0	120°
		5	50°
		3	30°
x <sub>3</sub>	Junction Type	2	Double Junction
x <sub>4</sub>	Minimum Intensity Bin	Refer to the <a href="#">Radiant Intensity Bin Limits (CAT)</a> table.	
x <sub>5</sub>	Maximum Intensity Bin		

## Part Number Example

AREQ-9020-MP000

- x<sub>1</sub> : 9      – Peak wavelength 940 nm
- x<sub>2</sub> : 0      – 120° viewing angle
- x<sub>3</sub> : 2      – Double junction type
- x<sub>4</sub> : M      – Minimum intensity bin M
- x<sub>5</sub> : P      – Maximum intensity bin P

## Bin Information

### Radiant Intensity Bin Limits (CAT)

Bin ID	Radiant Intensity, I <sub>e</sub> (mW/sr)	
	Min.	Max.
M	18.0	28.5
N	28.5	45.0
P	45.0	71.5
Q	71.5	112.5
R	112.5	180.0
S	180.0	285.0
T	285.0	450.0

Tolerance = ±12%.

Figure 4: Spectral Power Distribution

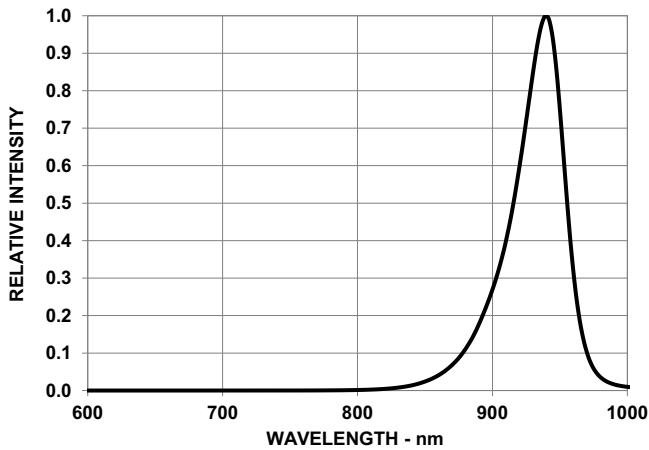


Figure 5: Forward Current vs. Forward Voltage

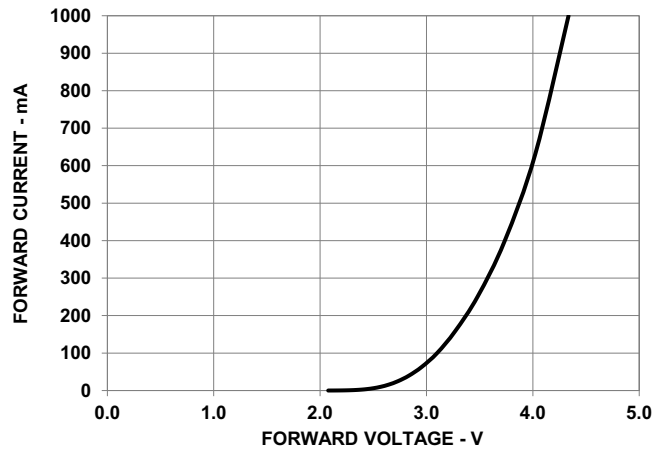


Figure 6: Relative Radiant Intensity vs. Mono Pulse Current

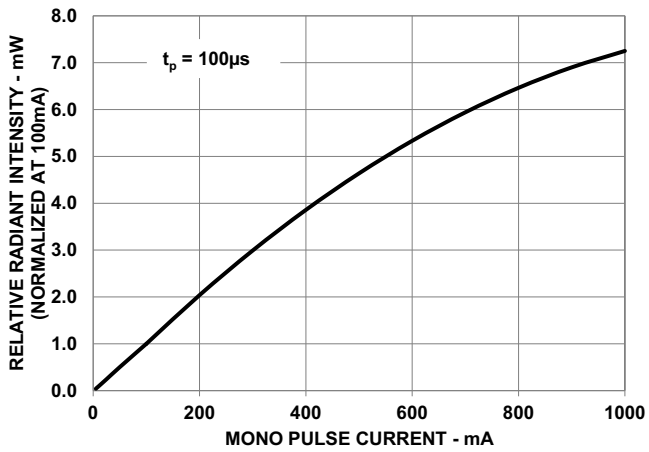


Figure 7: Radiation Pattern for AREQ-9020-xx000

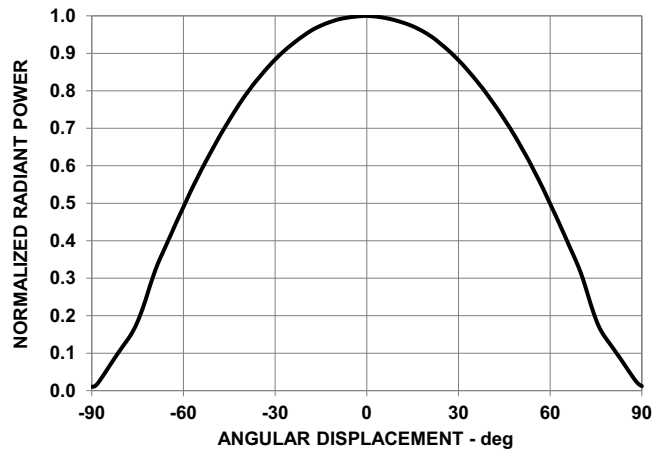


Figure 8: Radiation Pattern for AREQ-9520-xx000

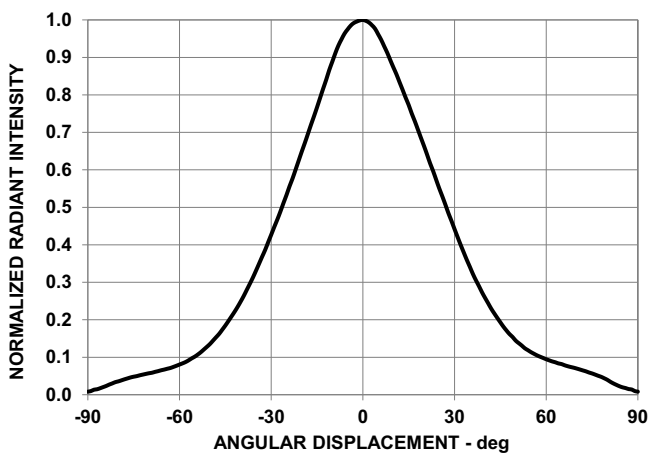


Figure 9: Radiation Pattern for AREQ-9320-xx000

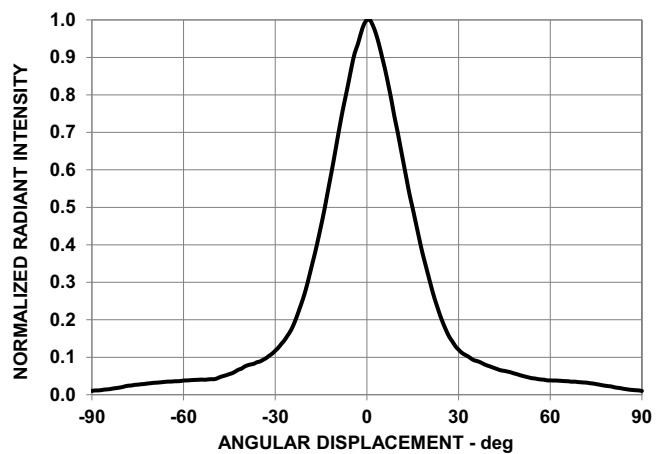


Figure 10: Maximum Forward Current vs. Ambient Temperature

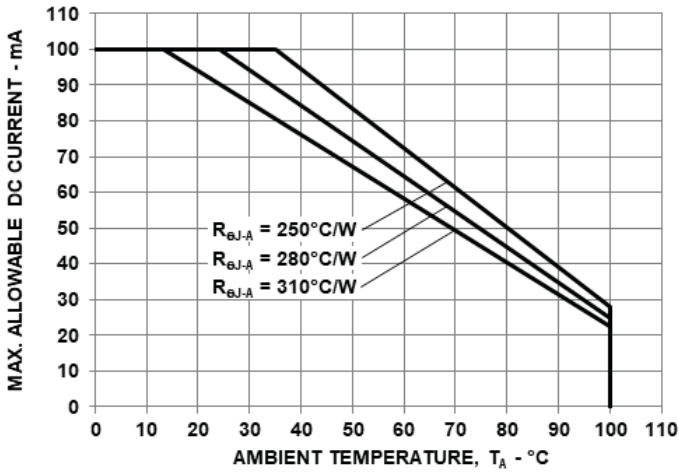


Figure 11: Maximum Forward Current vs. Solder Point Temperature

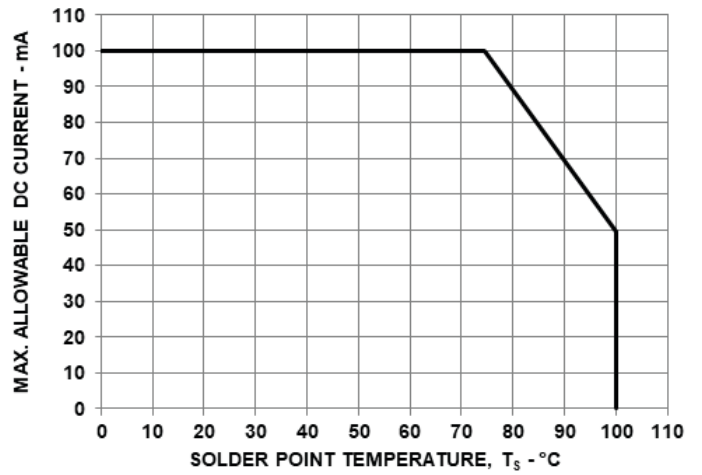


Figure 12: Maximum Pulse Current vs. Ambient Temperature at  $T_S \leq 83^\circ\text{C}$

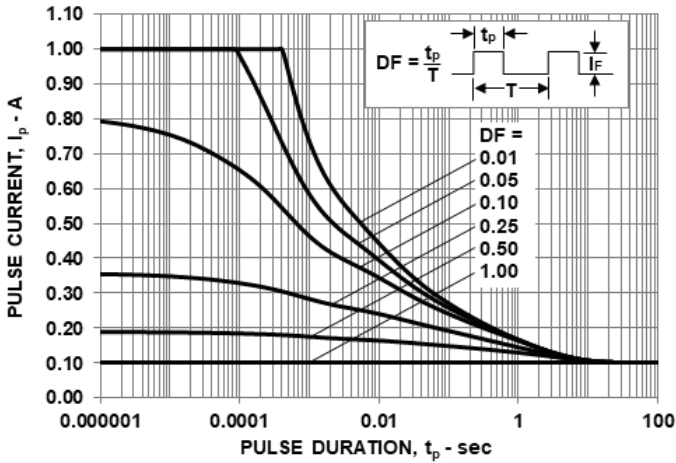
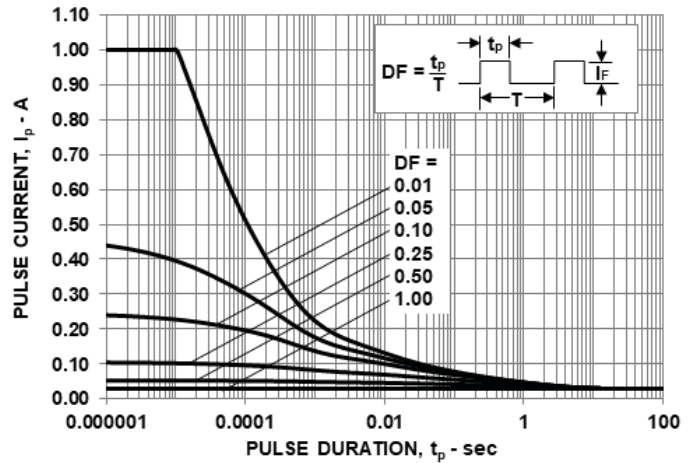
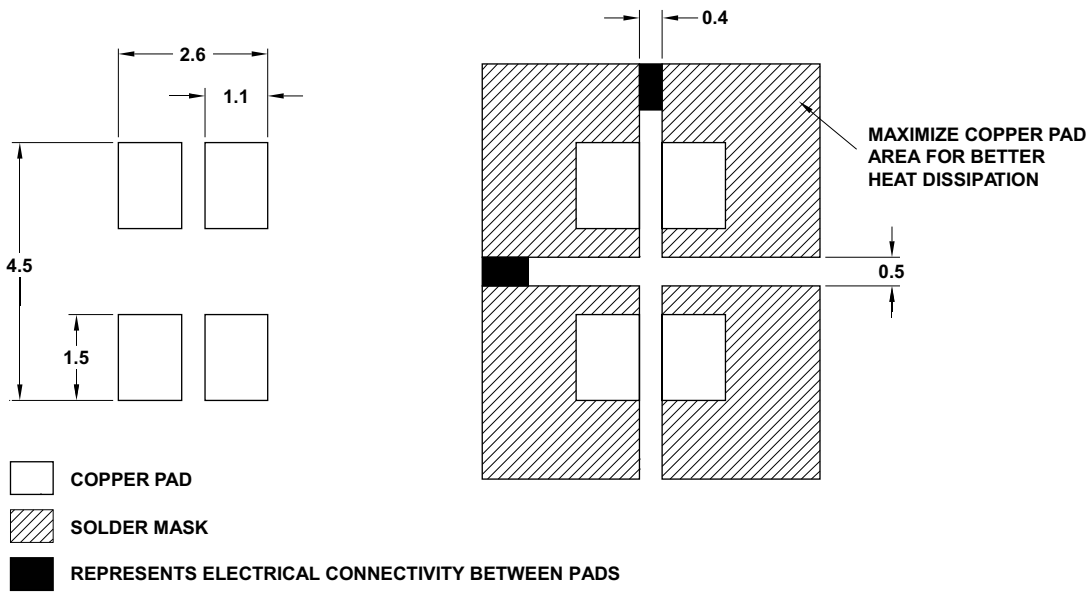


Figure 13: Maximum Pulse Current vs. Ambient Temperature at  $T_S = 100^\circ\text{C}$

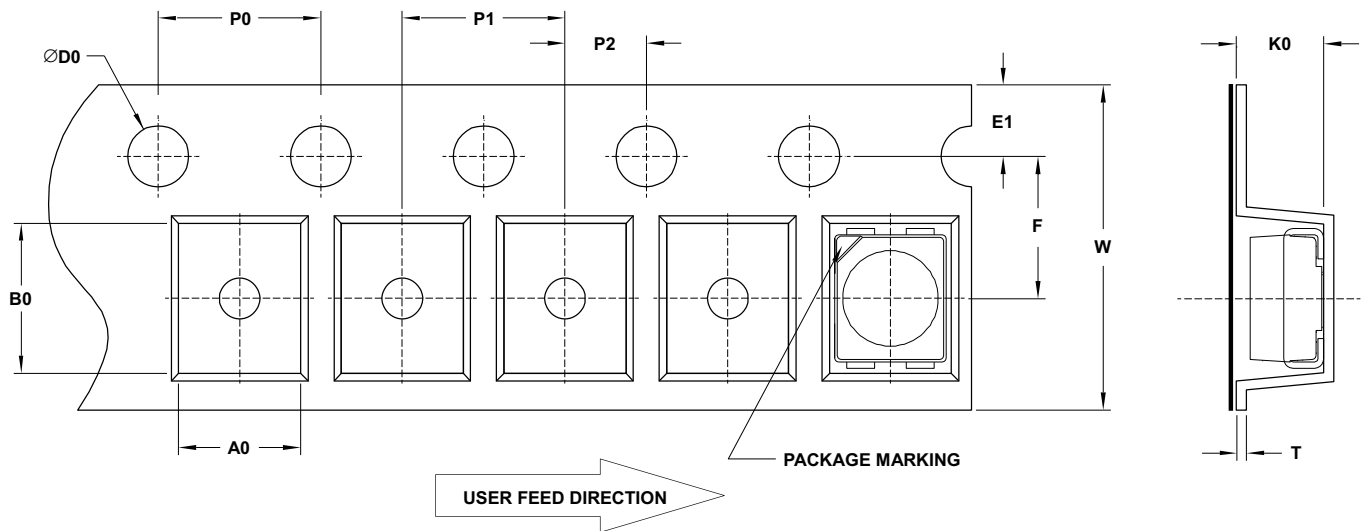


**Figure 14: Recommended Soldering Land Pattern**



**NOTE:** All dimensions are in millimeters (mm).

**Figure 15: Carrier Tape Dimensions for AREQ-9020-xx000**

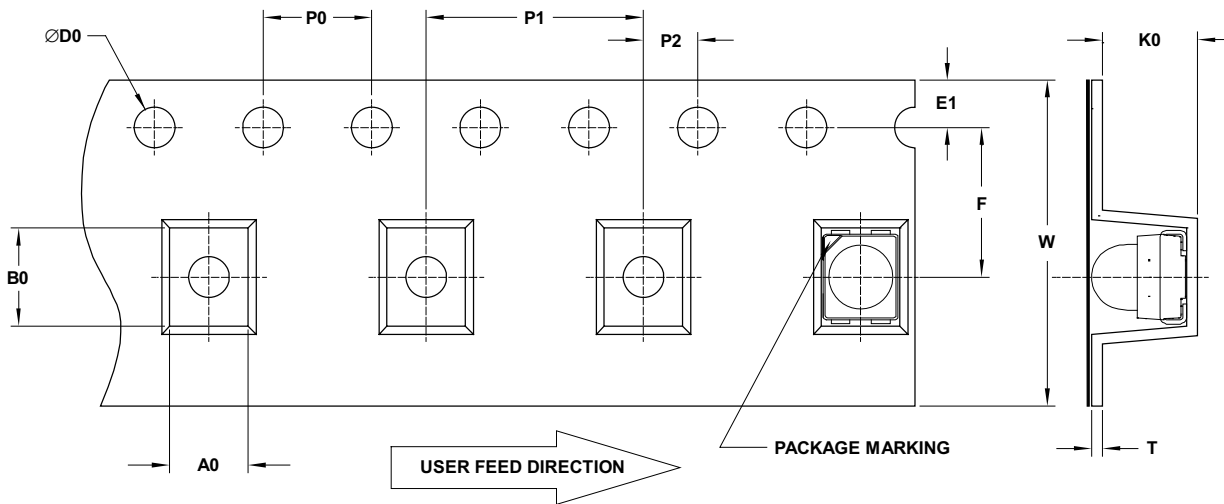


F	P0	P1	P2	D0	E1	W
3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	1.5 +0.1/-0	1.75 ±0.1	8.0 +0.3/-0.1

T	B0	K0	A0
0.25 ±0.05	3.7 ±0.1	2.15 ±0.1	3.0 ±0.1

**NOTE:** All dimensions are in millimeters (mm).

Figure 16: Carrier Tape Dimensions for AREQ-9320-xx000 and AREQ-9520-xx000



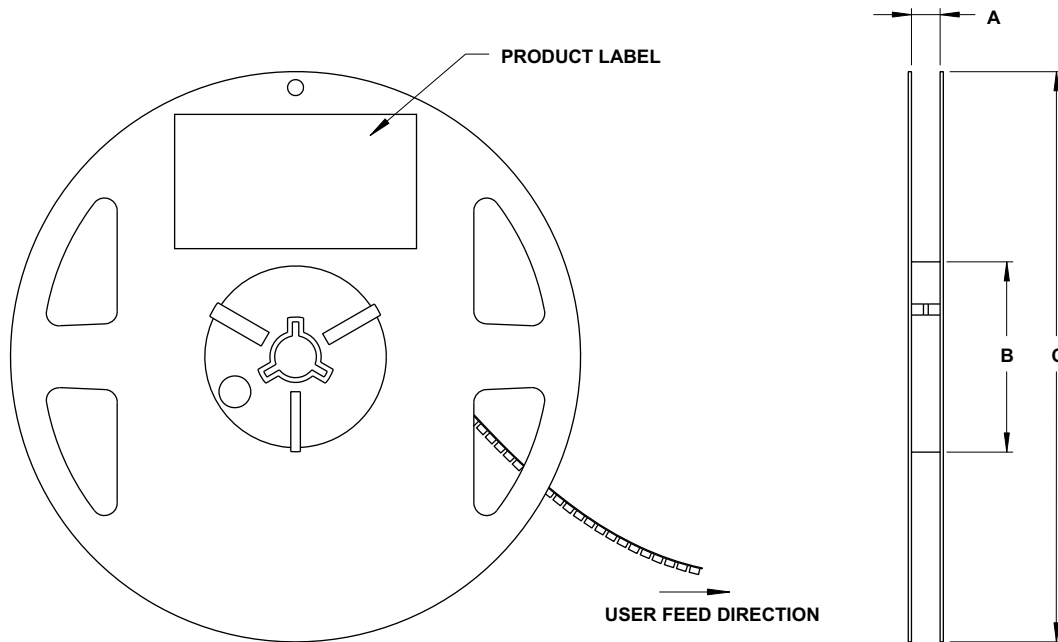
F	P0	P1	P2	D0	E1	W
5.5 ±0.05	4.0 ±0.1	8.0 ±0.1	2.0 ±0.05	1.5 +0.1/-0	1.75 ±0.1	12.0 ±0.3

Part Number	T	B0	K0	A0
AREQ-9520	0.4 ±0.05	3.6 ±0.1	3.17 ±0.1	2.9 ±0.1
AREQ-9320	0.4 ±0.05	3.6 ±0.1	3.50 ±0.1	2.9 ±0.1

**NOTE:** All dimensions are in millimeters (mm).



Figure 17: Reel Dimensions



Part Number	A	B	C
AREQ-9020	9.0	60.0	178.5
AREQ-9520	12.5	100.0	330.0
AREQ-9320	12.5	100.0	330.0

**NOTE:** All dimensions are in millimeters (mm).

# Precautionary Notes

## Soldering

- Do not perform reflow soldering more than twice. Observe necessary precautions of handling moisture-sensitive device as stated in the following section.
- Do not apply any pressure or force on the LED during reflow and after reflow when the LED is still hot.
- Use reflow soldering to solder the LED. Use hand soldering only for rework if unavoidable, but it must be strictly controlled to following conditions:
  - Soldering iron tip temperature = 315°C max.
  - Soldering duration = 3 seconds max.
  - Number of cycles = 1 only
  - Power of soldering iron = 50W max.
- Do not touch the LED package body with the soldering iron except for the soldering terminals because it may cause damage to the LED.
- Confirm beforehand whether the functionality and performance of the LED is affected by soldering with hand soldering.

Figure 18: Recommended Lead-Free Reflow Soldering Profile

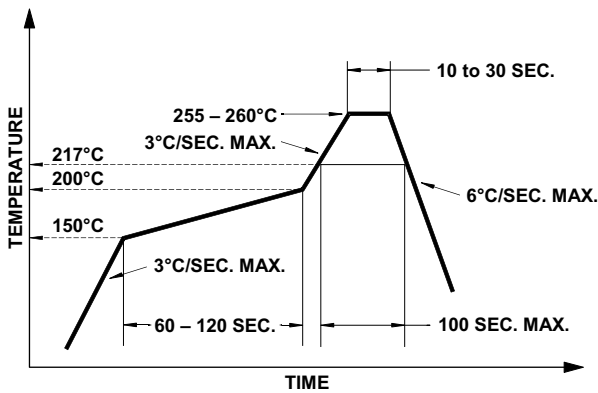
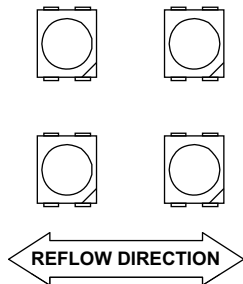


Figure 19: Recommended Board Reflow Direction



# Handling of Moisture-Sensitive Devices

This product has a Moisture Sensitive Level 3 rating per JEDEC J-STD-020. Refer to Broadcom Application Note AN5305, *Handling of Moisture Sensitive Surface Mount Devices*, for additional details and a review of proper handling procedures.

## Before use:

- An unopened moisture barrier bag (MBB) can be stored at <40°C/90% RH for 12 months. If the actual shelf life has exceeded 12 months and the Humidity Indicator Card (HIC) indicates that baking is not required, then it is safe to reflow the LEDs per the original MSL rating.
- Do not open the MBB prior to assembly (for example, for IQC). If unavoidable, MBB must be properly resealed with fresh desiccant and HIC. The exposed duration must be taken in as floor life.

## Control after opening the MBB:

- Read the HIC immediately upon opening of MBB.
- Keep the LEDs at <30°/60%RH at all times, and complete all high temperature-related processes, including soldering, curing or rework within 168 hours.

## Control for unfinished reel:

Store unused LEDs in a sealed MBB with desiccant or a desiccator at <5% RH.

## Control of assembled boards:

If the PCB soldered with the LEDs is to be subjected to other high-temperature processes, store the PCB in a sealed MBB with desiccant or desiccator at <5% RH to ensure that all LEDs have not exceeded their floor life of 168 hours.

## Baking is required if the following conditions exist:

- The HIC indicator indicates a change in color for 10% and 5%, as stated on the HIC.
- The LEDs are exposed to conditions of >30°C/60% RH at any time.
- The LED's floor life exceeded 168 hours.

The recommended baking condition is: 60 ± 5°C for 20 hours.

Baking can only be done once.

**Storage:**

The soldering terminals of these Broadcom LEDs are silver plated. If the LEDs are exposed in ambient environment for too long, the silver plating might be oxidized, thus affecting its solderability performance. As such, keep unused LEDs in a sealed MBB with desiccant or in a desiccator at <5% RH.

**Application Precautions**

- The drive current of the LED must not exceed the maximum allowable limit across temperature as stated in the data sheet. Constant current driving is recommended to ensure consistent performance.
- Circuit design must cater to the whole range of forward voltage ( $V_F$ ) of the LEDs to ensure the intended drive current can always be achieved.
- The LED exhibits slightly different characteristics at different drive currents, which may result in a larger variation of performance (meaning: intensity, wavelength, and forward voltage). Set the application current as close as possible to the test current to minimize these variations.
- Do not use the LED in the vicinity of material with sulfur content or in environments of high gaseous sulfur compounds and corrosive elements. Examples of material that might contain sulfur are rubber gaskets, room-temperature vulcanizing (RTV) silicone rubber, rubber gloves, and so on. Prolonged exposure to such environments may affect the optical characteristics and product life.
- Avoid rapid change in ambient temperature, especially in high-humidity environments, because they cause condensation on the LED.
- If the LED is intended to be used in harsh or outdoor environment, protect the LED against damages caused by rain water, water, dust, oil, corrosive gases, external mechanical stresses, and so on.

**Thermal Management**

The optical, electrical, and reliability characteristics of the LED are affected by temperature. Keep the junction temperature ( $T_J$ ) of the LED below the allowable limit at all times.  $T_J$  can be calculated as follows:

$$T_J = T_A + R_{\theta J-A} \times I_F \times V_{Fmax}$$

where:

$T_A$  = Ambient temperature ( $^{\circ}\text{C}$ )

$R_{\theta J-A}$  = Thermal resistance from LED junction to ambient ( $^{\circ}\text{C}/\text{W}$ )

$I_F$  = Forward current (A)

$V_{Fmax}$  = Maximum forward voltage (V)

The complication of using this formula lies in  $T_A$  and  $R_{\theta J-A}$ . Actual  $T_A$  is sometimes subjective and hard to determine.  $R_{\theta J-A}$  varies from system to system depending on design and is usually not known.

Another way of calculating  $T_J$  is by using the solder point temperature,  $T_S$ , as follows:

$$T_J = T_S + R_{\theta J-S} \times I_F \times V_{Fmax}$$

where:

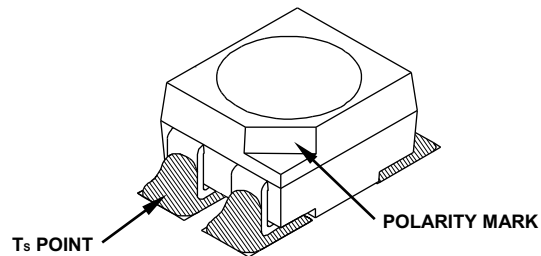
$T_S$  = LED solder point temperature as shown in the following figure ( $^{\circ}\text{C}$ )

$R_{\theta J-S}$  = thermal resistance from junction to solder point ( $^{\circ}\text{C}/\text{W}$ )

$I_F$  = forward current (A)

$V_{Fmax}$  = maximum forward voltage (V)

**Figure 20: Solder Point Temperature on PCB**



$T_S$  can be easily measured by mounting a thermocouple on the soldering joint as shown in preceding figure, while  $R_{\theta J-S}$  is provided in the data sheet. Verify the  $T_S$  of the LED in the final product to ensure that the LEDs are operating within all maximum ratings stated in the data sheet.

**Eye Safety Precautions**

LEDs can pose optical hazards when in operation. Do not look directly at operating LEDs because it might be harmful to the eyes. For safety reasons, use appropriate shielding or personal protective equipment.

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