BROADCOM®

Data Sheet

ASM6-SWx1-NxxxH

3W 3535 Surface Mount LED

Description

The Broadcom® ASM6 LED series, a proliferation from the earlier ASM3 series, are the latest development edition of these high-power LEDs. While maintaining a similar 3535 footprint, the ASM6 series exhibits higher lumen output and displays better cost-per-lumen ratio. This new ASM6 family is energy efficient and adapts good heat sink properties. It is also superior in package robustness and better product longevity with its silicone encapsulation.

Features

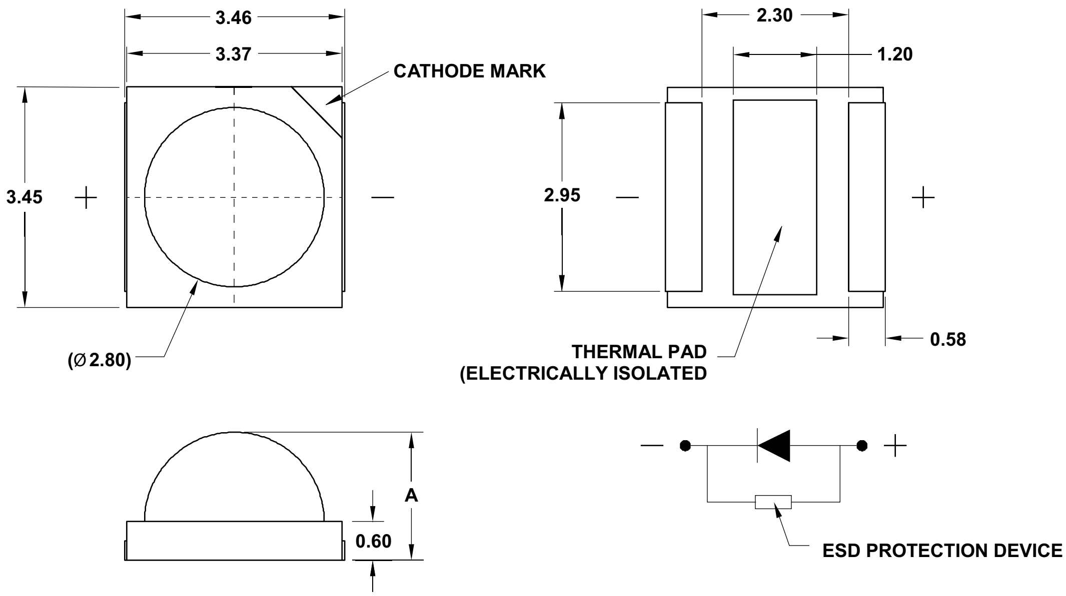
- High reliability package with enhanced silicone resin encapsulation
- Available in 3000K, 3500K, 4000K, 5000K, 5700K, 6500K, and 8000K CCT
- Available in 90° and 130° viewing angles
- Compatible with reflow soldering processes
- JEDEC MSL 1

Applications

- Horticulture lighting
- Commercial lighting
- Architecture lighting
- Specialty lighting

CAUTION! This LED is ESD sensitive. Please observe appropriate precautions during handling and processing. Refer to the *Premium InGaN LEDs: Safety Handling Fundamentals ESD*, Application Note AN-1142, for additional details.

Figure 1: Package Drawing



Part Number	Dimension A (mm)
ASM6-SWD1-NxxxH	1.90
ASM6-SW91-NxxxH	2.50

NOTE:

1. All dimensions are in millimeters (mm).
2. Tolerance is ± 0.20 mm unless otherwise specified.
3. Encapsulation = silicone.
4. Terminal finish = silver plating.
5. Dimensions in parentheses are for reference only.

Device Selection Guide (T_J = 25°C, I_F = 350 mA)

Part Number	Correlated Color Temperature, CCT (Kelvin)	Viewing Angle, $2\theta_{½}$ (°)[a]	Luminous Flux, Φ_V (lm)[b, c]			PPF, Φ_P (µmol/s)[d, e]	PPF/W (µmol/J)	Dice Technology
	Typ.	Typ.	Min.	Typ.	Max.	Typ.	Typ.	
ASM6-SW91-NMQBH	3000	90	90.5	110.0	140.0	1.58	1.50	InGaN
ASM6-SW91-NMQCH	3500	90	90.5	115.0	140.0	1.65	1.57	InGaN
ASM6-SW91-NNRDH	4000	90	105.0	120.0	154.0	1.70	1.62	InGaN
ASM6-SW91-NPREH	5000	90	115.0	125.0	154.0	1.74	1.66	InGaN
ASM6-SW91-NPRFH	5700	90	115.0	125.0	154.0	1.74	1.66	InGaN
ASM6-SW91-NPRHH	6500	90	115.0	125.0	154.0	1.74	1.66	InGaN
ASM6-SW91-NNRKH	8000	90	105.0	120.0	154.0	1.67	1.59	InGaN
ASM6-SWD1-NPSBH	3000	130	115.0	130.0	169.0	1.86	1.77	InGaN
ASM6-SWD1-NPSCH	3500	130	115.0	135.0	169.0	1.94	1.85	InGaN
ASM6-SWD1-NQTDH	4000	130	127.0	140.0	186.0	1.98	1.89	InGaN
ASM6-SWD1-NQTEH	5000	130	127.0	145.0	186.0	2.02	1.92	InGaN
ASM6-SWD1-NQTFH	5700	130	127.0	145.0	186.0	2.02	1.92	InGaN
ASM6-SWD1-NQTHH	6500	130	127.0	145.0	186.0	2.02	1.92	InGaN
ASM6-SWD1-NQTKH	8000	130	127.0	140.0	186.0	1.95	1.86	InGaN

a. $\theta_{½}$ is the off-axis angle where the luminous intensity is half of the peak intensity.

b. Luminous flux, Φ_V, is the total output measured with an integrating sphere at a single current pulse condition.

c. Luminous flux, Φ_V tolerance is ±10%.

d. Photosynthetic Photon Flux (PPF), Φ_P, is the measurement of Photosynthetically Active Radiation (PAR) ranging from 400 nm to 700 nm.

e. Values are calculated and for reference only.

Absolute Maximum Ratings

Parameters	ASM6-SWx1-NxxxH	Units
DC Forward Current[a]	1000	mA
Peak Forward Current[b]	2000	mA
Power Dissipation	3400	mW
Reverse Voltage	Not designed for reverse bias operation	
LED Junction Temperature	125	°C
Operating Temperature Range	–40 to +120	°C
Storage Temperature Range	–40 to +120	°C

a. Derate linearly as shown in Figure 19 and Figure 20.

b. Duty factor = 10%, frequency = 1 kHz.

Optical and Electrical Characteristics (T_J = 25°C, I_F = 350 mA)

Parameters	Min.	Typ.	Max.	Units
Forward Voltage, V_F[a]	2.6	3.0	3.4	V
Color Rendering Index, CRI	—	80	—	—
Thermal Resistance, $R_{\theta J\text{-}S}$[b]	—	4	—	°C/W

a. Forward voltage, V_F, tolerance is ± 0.1V.

b. Thermal resistance from LED junction to solder point.

Performance Characteristics (T_J = 25°C, I_F = 700 mA)

Part Number	Correlated Color Temperature, CCT (Kelvin)	Viewing Angle, $2\theta_{½}$ (°)	Luminous Flux, Φ_V (lm)	PPF, Φ_P (µmol/s)	Forward Voltage, V_F (V)
		Typ.	Typ.	Typ.	Typ.
ASM6-SW91-NMQBH	3000	90	200.4	2.88	3.3
ASM6-SW91-NMQCH	3500	90	209.5	3.01	3.3
ASM6-SW91-NNRDH	4000	90	218.6	3.10	3.3
ASM6-SW91-NPREH	5000	90	227.8	3.17	3.3
ASM6-SW91-NPRFH	5700	90	227.8	3.17	3.3
ASM6-SW91-NPRHH	6500	90	227.8	3.17	3.3
ASM6-SW91-NNRKH	8000	90	218.6	3.04	3.3
ASM6-SWD1-NPSBH	3000	130	236.9	3.39	3.3
ASM6-SWD1-NPSCH	3500	130	246.0	3.53	3.3
ASM6-SWD1-NQTDH	4000	130	255.1	3.61	3.3
ASM6-SWD1-NQTEH	5000	130	264.2	3.68	3.3
ASM6-SWD1-NQTFH	5700	130	264.2	3.68	3.3
ASM6-SWD1-NQTHH	6500	130	264.2	3.68	3.3
ASM6-SWD1-NQTKH	8000	130	255.1	3.55	3.3

Part Numbering System

A	S	M	6	-	S	W	x_1	x_2	-	N	x_3	x_4	x_5	x_6

Code	Description	Option	
x_1	Viewing Angle	9	90°
		D	130°
x_2	Internal Code		
x_3	Minimum Flux Bin	Refer to Luminous Flux Bin Limits (CAT) table	
x_4	Maximum Flux Bin		
x_5	Color Correlated Temperature	B	3000K
		C	3500K
		D	4000K
		E	5000K
		F	5700K
		H	6500K
		K	8000K
x_6	Test Option	H	Test Current = 350 mA

Part Number Example

ASM6-SWD1-NPSBH

x_1: D – 130° viewing angle

x_3: P – Minimum radiant flux bin P

x_4: S – Maximum radiant flux bin S

x_5: B – CCT 3000K

x_6: H – Test current = 350 mA

Bin Information

Luminous Flux Bin Limits (CAT)

Bin ID	Luminous Flux, Φ_V (lm)	
	Min.	Max.
M	90.5	105.0
N	105.0	115.0
P	115.0	127.0
Q	127.0	140.0
R	140.0	154.0
S	154.0	169.0
T	169.0	186.0

Tolerance = ± 10%.

Forward Voltage Limits (VF)

Bin ID	Forward Voltage, V_F (V)	
	Min.	Max.
5	2.6	2.8
6	2.8	3.0
7	3.0	3.2
8	3.2	3.4

Tolerance = ± 0.1V.

Color Bin Limits (BIN)

Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates	
	x	y		x	y		x	y		x	y
8000K			**6500K**			**5700K**			**5000K**		
1A	0.2895	0.3135	2A	0.3048	0.3207	3A	0.3215	0.3350	4A	0.3371	0.3490
	0.2870	0.3210		0.3130	0.3290		0.3290	0.3417		0.3451	0.3554
	0.2937	0.3312		0.3144	0.3186		0.3290	0.3300		0.3440	0.3427
	0.2962	0.3220		0.3068	0.3113		0.3222	0.3243		0.3366	0.3369
1B	0.2920	0.3060	2B	0.3028	0.3304	3B	0.3207	0.3462	4B	0.3376	0.3616
	0.2895	0.3135		0.3115	0.3391		0.3290	0.3538		0.3463	0.3687
	0.2962	0.3220		0.3130	0.3290		0.3290	0.3417		0.3451	0.3554
	0.2984	0.3133		0.3048	0.3207		0.3215	0.3350		0.3371	0.3490
1C	0.2984	0.3133	2C	0.3115	0.3391	3C	0.3290	0.3538	4C	0.3463	0.3687
	0.2962	0.3220		0.3205	0.3481		0.3376	0.3616		0.3551	0.3460
	0.3028	0.3304		0.3213	0.3373		0.3371	0.3490		0.3533	0.3760
	0.3048	0.3207		0.3130	0.3290		0.3290	0.3417		0.3451	0.3620
1D	0.2984	0.3133	2D	0.3130	0.3290	3D	0.3290	0.3417	4D	0.3451	0.3554
	0.3048	0.3207		0.3213	0.3373		0.3371	0.3490		0.3533	0.3620
	0.3068	0.3113		0.3221	0.3261		0.3366	0.3369		0.3515	0.3487
	0.3009	0.3042		0.3144	0.3186		0.3290	0.3300		0.3440	0.3427

Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates	
	x	y		x	y		x	y		x	y
4000K						**3500K**					
6A1	0.3670	0.3578	6A3	0.3744	0.3685	7A1	0.3889	0.3690	7A3	0.3981	0.3800
	0.3686	0.3649		0.3763	0.3760		0.3915	0.3768		0.4010	0.3882
	0.3744	0.3685		0.3825	0.3798		0.3981	0.3800		0.4080	0.3916
	0.3726	0.3612		0.3804	0.3721		0.3953	0.3720		0.4048	0.3832
6B1	0.3702	0.3722	6B3	0.3782	0.3837	7B1	0.3941	0.3848	7B3	0.4040	0.3966
	0.3719	0.3797		0.3802	0.3916		0.3968	0.3930		0.4071	0.4052
	0.3782	0.3837		0.3869	0.3958		0.4040	0.3966		0.4146	0.4089
	0.3763	0.3760		0.3847	0.3877		0.4010	0.3882		0.4113	0.4001
6C1	0.3825	0.3798	6C3	0.3912	0.3917	7C1	0.4080	0.3916	7C3	0.4186	0.4037
	0.3847	0.3877		0.3937	0.4001		0.4113	0.4001		0.4222	0.4127
	0.3912	0.3917		0.4006	0.4044		0.4186	0.4037		0.4299	0.4165
	0.3887	0.3836		0.3978	0.3958		0.4150	0.3950		0.4259	0.4073
6D1	0.3783	0.3646	6D3	0.3863	0.3758	7D1	0.4017	0.3751	7D3	0.4116	0.3865
	0.3804	0.3721		0.3887	0.3836		0.4048	0.3832		0.4150	0.3950
	0.3863	0.3758		0.3950	0.3875		0.4116	0.3865		0.4221	0.3984
	0.3840	0.3681		0.3924	0.3794		0.4082	0.3782		0.4183	0.3898
6A2	0.3686	0.3649	6A4	0.3726	0.3612	7A2	0.3915	0.3768	7A4	0.3953	0.3720
	0.3702	0.3722		0.3744	0.3685		0.3941	0.3848		0.3981	0.3800
	0.3763	0.3760		0.3804	0.3721		0.4010	0.3882		0.4048	0.3832
	0.3744	0.3685		0.3783	0.3646		0.3981	0.3800		0.4017	0.3751
6B2	0.3719	0.3797	6B4	0.3763	0.3760	7B2	0.3968	0.3930	7B4	0.4010	0.3882
	0.3736	0.3874		0.3782	0.3837		0.3996	0.4015		0.4040	0.3966
	0.3802	0.3916		0.3847	0.3877		0.4071	0.4052		0.4113	0.4001
	0.3782	0.3837		0.3825	0.3798		0.4040	0.3966		0.4080	0.3916
6C2	0.3847	0.3877	6C4	0.3887	0.3836	7C2	0.4113	0.4001	7C4	0.4150	0.3950
	0.3869	0.3958		0.3912	0.3917		0.4146	0.4089		0.4186	0.4037
	0.3937	0.4001		0.3978	0.3958		0.4222	0.4127		0.4259	0.4073
	0.3912	0.3917		0.3950	0.3875		0.4186	0.4037		0.4221	0.3984
6D2	0.3804	0.3721	6D4	0.3840	0.3681	7D2	0.4048	0.3832	7D4	0.4082	0.3782
	0.3825	0.3798		0.3863	0.3758		0.4080	0.3916		0.4116	0.3865
	0.3887	0.3836		0.3924	0.3794		0.4150	0.3950		0.4183	0.3898
	0.3863	0.3758		0.3898	0.3716		0.4116	0.3865		0.4147	0.3814

Bin ID	Chromaticity Coordinates		Bin ID	Chromaticity Coordinates	
	x	y		x	y
3000K					
8A1	0.4147	0.3814	8A3	0.4242	0.3919
	0.4183	0.3898		0.4281	0.4006
	0.4242	0.3919		0.4342	0.4028
	0.4203	0.3833		0.4300	0.3939
8B1	0.4221	0.3984	8B3	0.4322	0.4096
	0.4259	0.4073		0.4364	0.4188
	0.4322	0.4096		0.4430	0.4212
	0.4281	0.4006		0.4385	0.4119
8C1	0.4342	0.4028	8C3	0.4449	0.4141
	0.4385	0.4119		0.4496	0.4236
	0.4449	0.4141		0.4562	0.4260
	0.4403	0.4049		0.4513	0.4164
8D1	0.4259	0.3853	8D3	0.4359	0.3960
	0.4300	0.3939		0.4403	0.4049
	0.4359	0.3960		0.4465	0.4071
	0.4316	0.3873		0.4418	0.3981
8A2	0.4183	0.3898	8A4	0.4203	0.3833
	0.4221	0.3984		0.4242	0.3919
	0.4281	0.4006		0.4300	0.3939
	0.4242	0.3919		0.4259	0.3853
8B2	0.4259	0.4073	8B4	0.4281	0.4006
	0.4299	0.4165		0.4322	0.4096
	0.4364	0.4188		0.4385	0.4119
	0.4322	0.4096		0.4342	0.4028
8C2	0.4385	0.4119	8C4	0.4403	0.4049
	0.4430	0.4212		0.4449	0.4141
	0.4496	0.4236		0.4513	0.4164
	0.4449	0.4141		0.4465	0.4071
8D2	0.4300	0.3939	8D4	0.4316	0.3873
	0.4342	0.4028		0.4359	0.3960
	0.4403	0.4049		0.4418	0.3981
	0.4359	0.3960		0.4373	0.3893

Tolerance = ± 0.01.

Example of bin information on reel and packaging label:

CAT: N	–	Luminous Flux bin N
BIN: 1E	–	Color bin 1E
VF: 5	–	Forward Voltage bin 5

Figure 2: Chromaticity Diagram (5000K to 8000K)

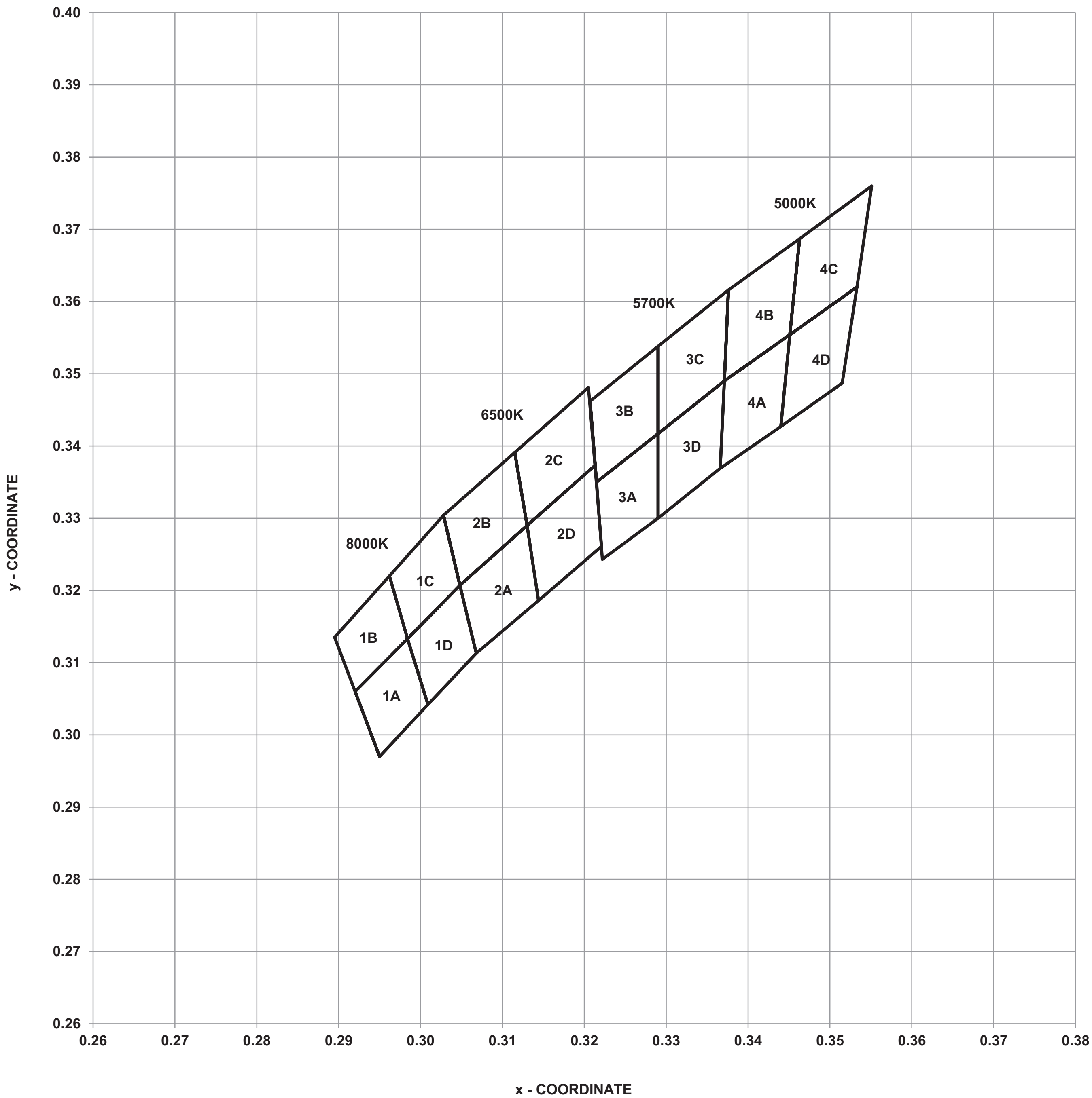


Figure 3: Chromaticity Diagram (3000K to 4000K)

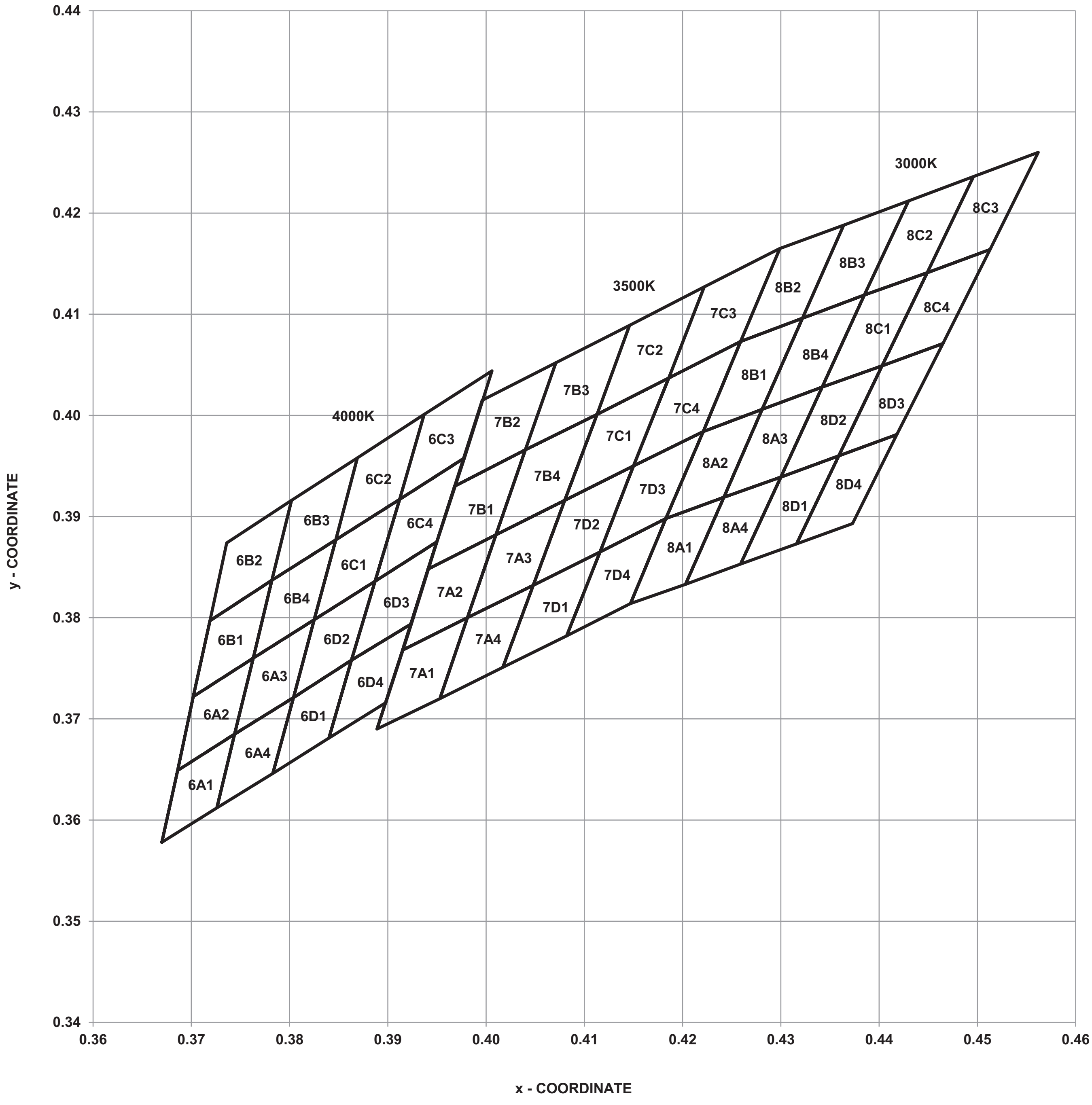


Figure 4: Spectral Power Distribution

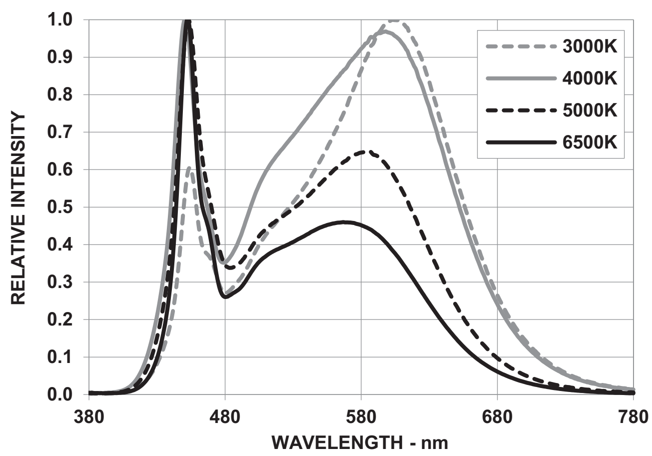


Figure 5: Forward Current vs. Forward Voltage

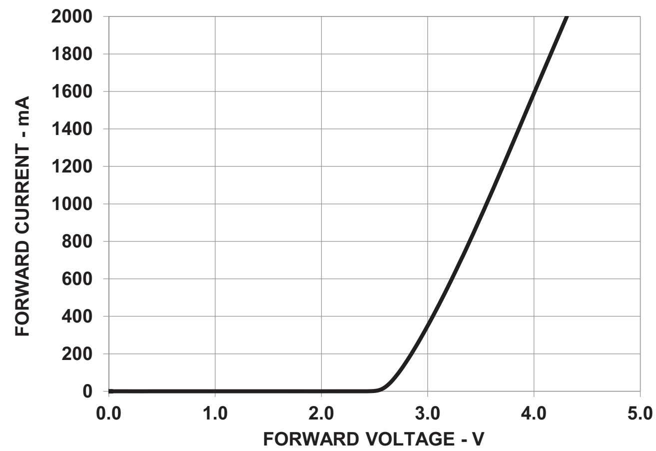


Figure 6: Relative Luminous Flux vs. Mono Pulse Current

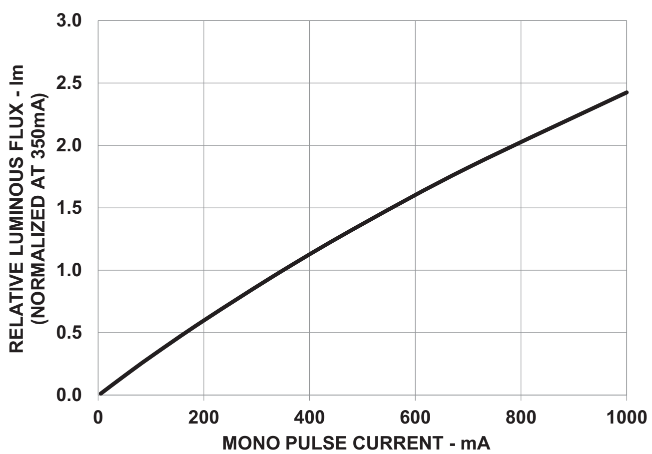


Figure 7: Radiation Pattern – 90°

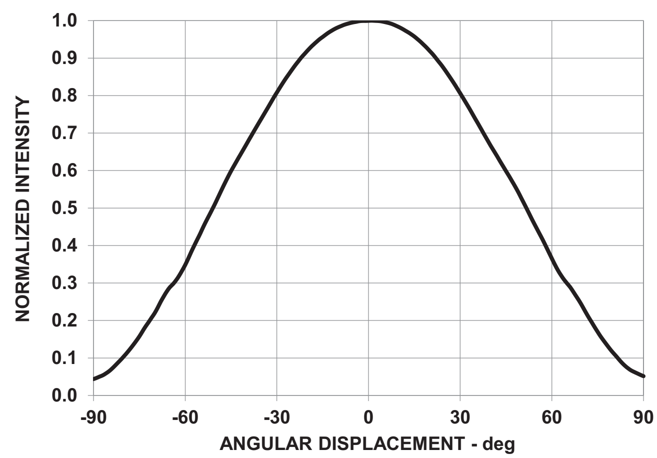


Figure 8: Radiation Pattern – 130°

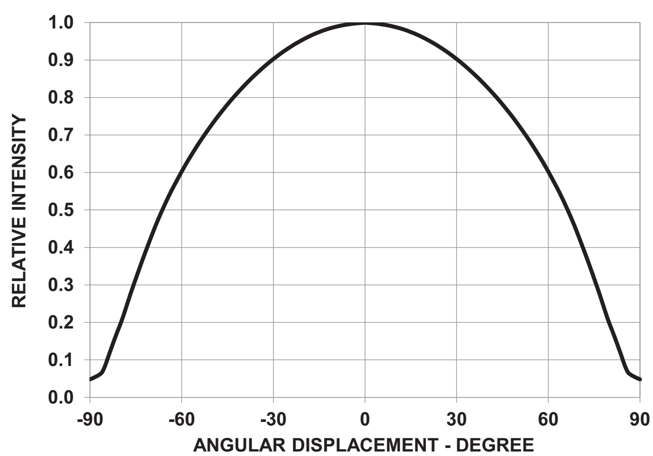


Figure 9: Chromaticity Coordinate Shift vs. Mono Pulse Current – 3000K

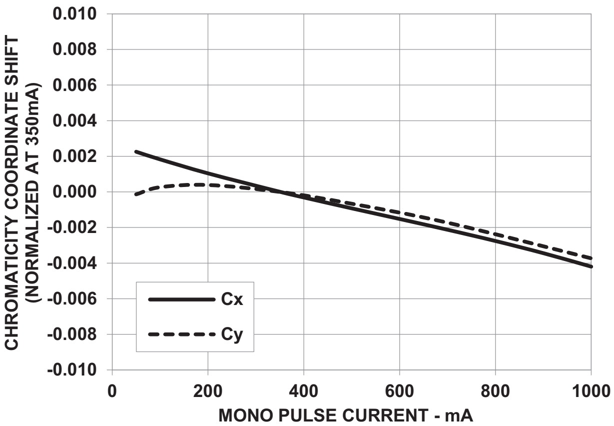


Figure 10: Chromaticity Coordinate Shift vs. Mono Pulse Current – 4000K

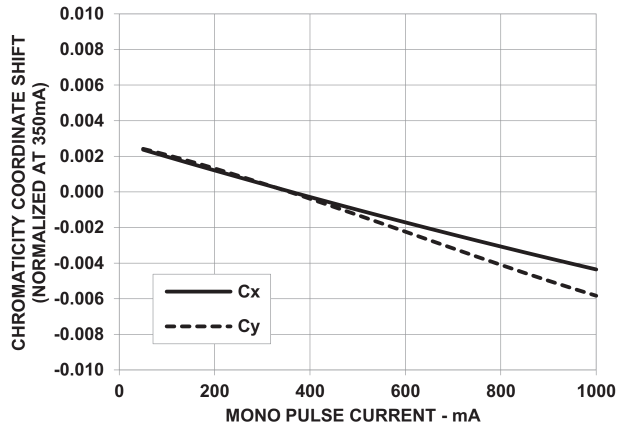


Figure 11: Chromaticity Coordinate Shift vs. Mono Pulse Current – 5000K

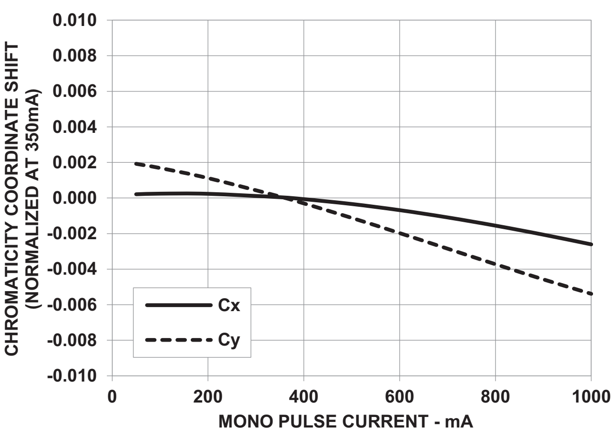


Figure 12: Chromaticity Coordinate Shift vs. Mono Pulse Current – 6500K

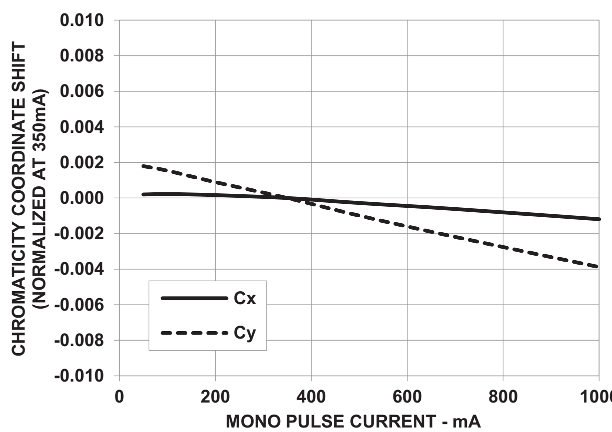


Figure 13: Relative Light Output vs. Junction Temperature

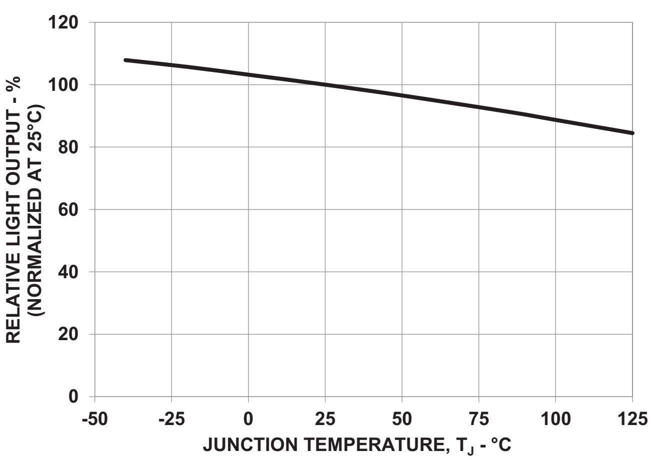


Figure 14: Forward Voltage Shift vs. Junction Temperature

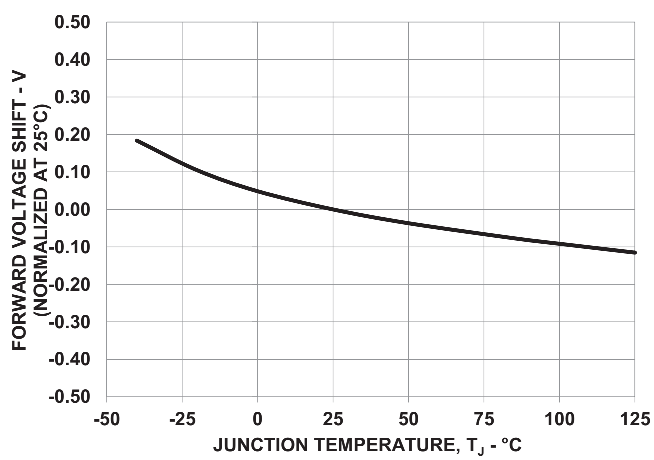


Figure 15: Chromaticity Coordinate Shift vs. Junction Temperature – 3000K

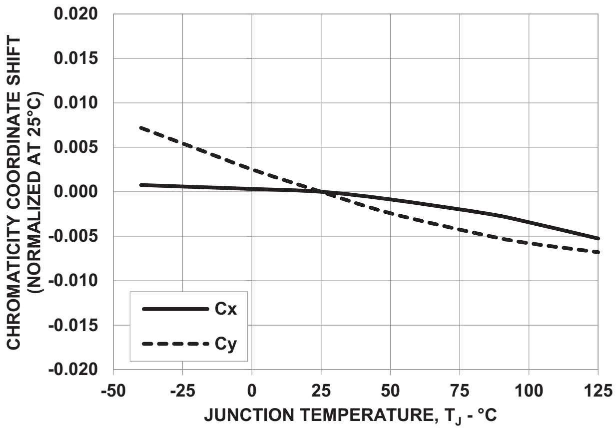


Figure 16: Chromaticity Coordinate Shift vs. Junction Temperature – 4000K

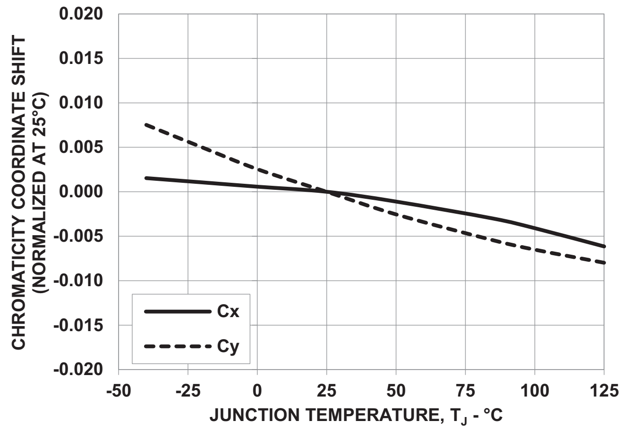


Figure 17: Chromaticity Coordinate Shift vs. Junction Temperature – 5000K

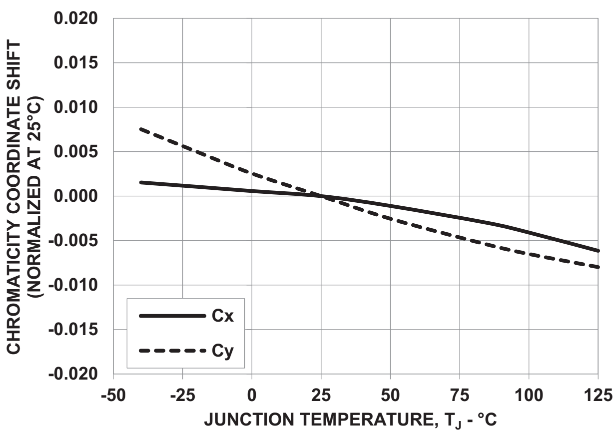


Figure 18: Chromaticity Coordinate Shift vs. Junction Temperature – 6500K

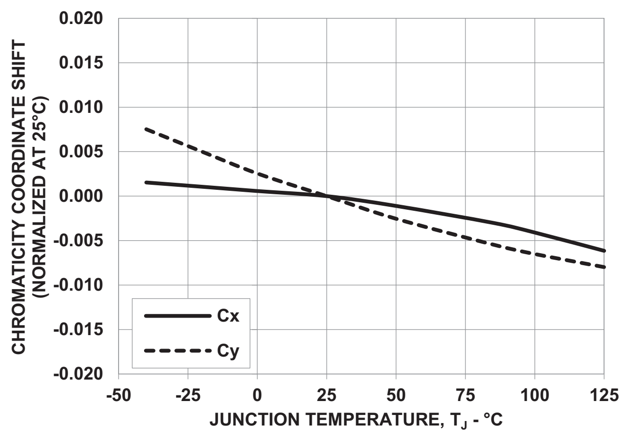


Figure 19: Maximum Forward Current vs. Ambient Temperature

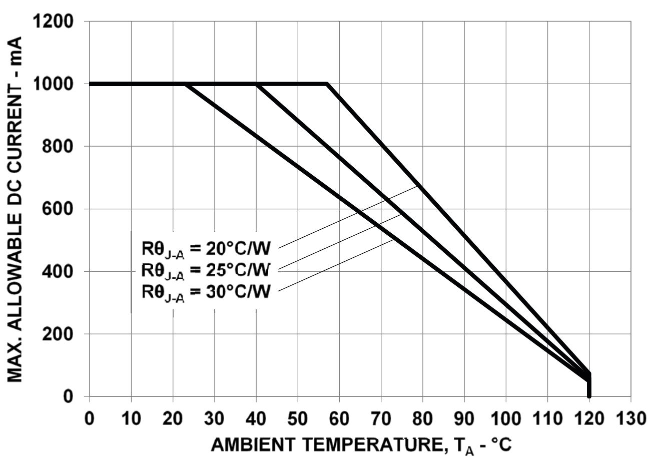


Figure 20: Maximum Forward Current vs. Solder Point Temperature

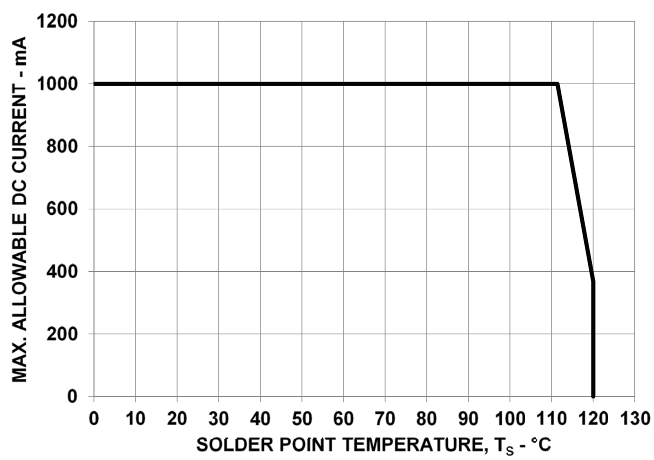


Figure 21: Recommended Soldering Land Pattern

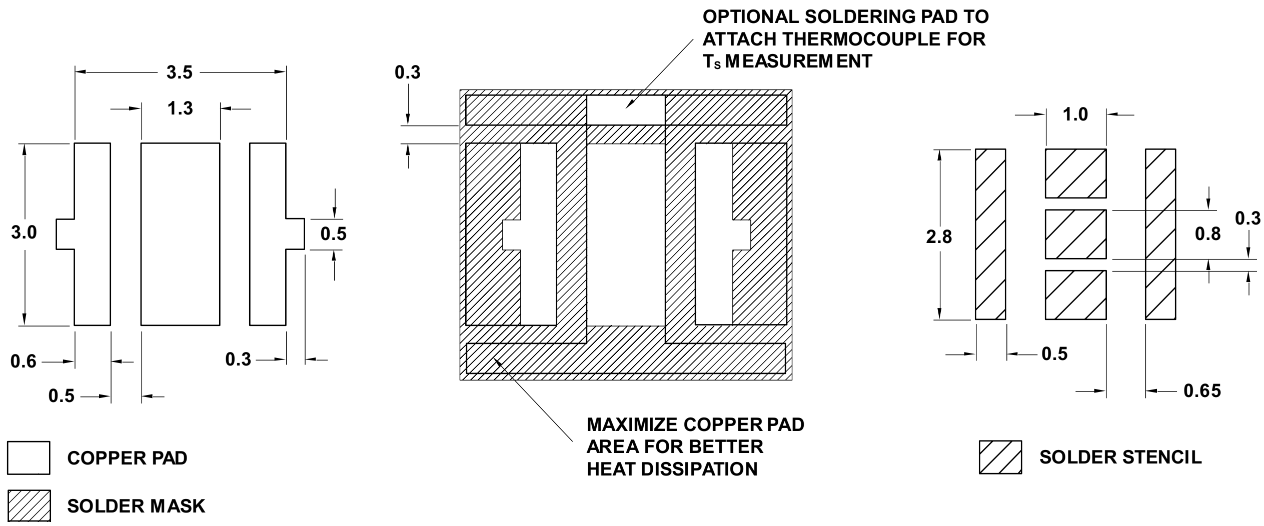
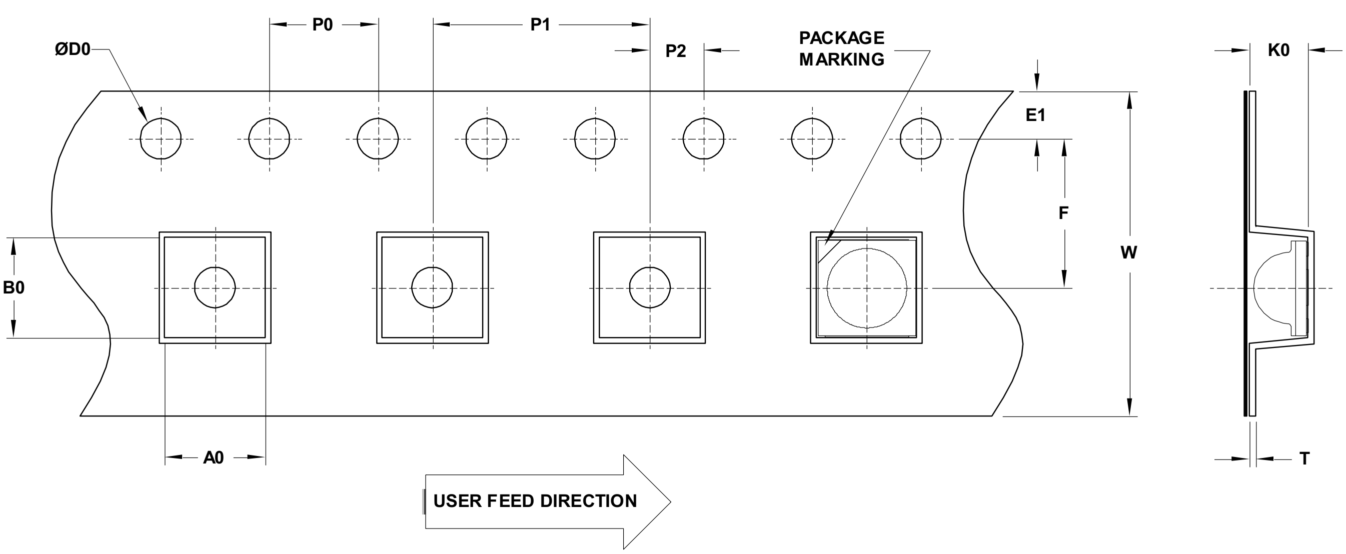


Figure 22: Carrier Tape Dimensions

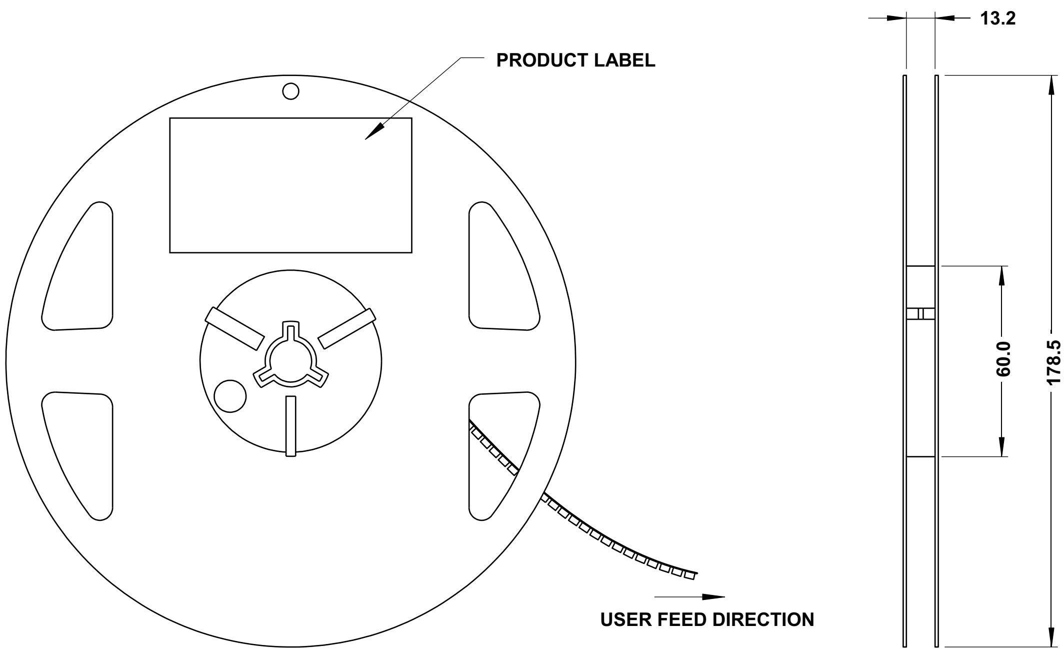


F	P0	P1	P2	D0	E1	W
5.50 ± 0.05	4.00 ± 0.10	8.00 ± 0.10	2.00 ± 0.05	1.50 ± 0.1	1.75 ± 0.10	12.00 ± 0.20

Part Number	T	A0	B0	K0
ASM6-SWD1	0.28 ± 0.05	3.75 ± 0.10	3.75 ± 0.10	2.20 ± 0.10
ASM6-SW91	0.28 ± 0.05	3.75 ± 0.10	3.75 ± 0.10	2.65 ± 0.10

NOTE: All dimensions are in millimeters (mm).

Figure 23: Reel Dimensions



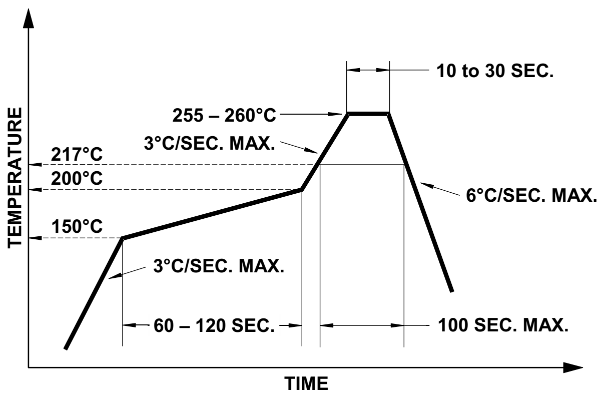
NOTE: All dimensions are in millimeters (mm).

Precautionary Notes

Reflow Soldering

- Do not perform reflow soldering more than twice. Observe necessary precautions of handling moisture-sensitive devices 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.

Figure 24: Recommended Lead-Free Reflow Soldering Profile



Handling Precautions

The encapsulation material of the LED is made of silicone for better product reliability. Compared to epoxy encapsulant, which is hard and brittle, silicone is softer and flexible. Observe special handling precautions during assembly of silicone encapsulated LED products. Failure to comply might lead to damage and premature failure of the LED. Refer to Broadcom Application Note AN5288, *Silicone Encapsulation for LED: Advantages and Handling Precautions*, for additional information.

- Do not poke sharp objects into the silicone encapsulant. Sharp objects, such as tweezers or syringes, might apply excessive force or even pierce through the silicone and induce failures to the LED die or wire bond.
- Do not touch the silicone encapsulant. Uncontrolled force acting on the silicone encapsulant might result in excessive stress on the wire bond. Hold the LED only by the body.
- Do not stack assembled PCBs together. Use an appropriate rack to hold the PCBs.
- The surface of silicone material attracts dust and dirt easier than epoxy due to its surface tackiness. To remove foreign particles on the surface of silicone, use a cotton bud with isopropyl alcohol (IPA). During cleaning, rub the surface gently without putting too much pressure on the silicone. Ultrasonic cleaning is not recommended.
- For automated pick-and-place, Broadcom has tested a nozzle size with OD 3.7 mm and ID 3.0 mm to work with this LED. However, due to the possibility of variations in other parameters, such as pick-and-place machine maker/model, and other settings of the machine, verify that the selected nozzle will not cause damage to the LED.

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 entire 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 can result in a larger variation of performance (such as 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 can affect the optical characteristics and product life.
- White LEDs must not be exposed to acidic environments and must not be used in the vicinity of any compound that can have acidic outgas, such as, but not limited to, acrylate adhesive. These environments have an adverse effect on LED performance.
- Avoid rapid changes in ambient temperature, especially in high-humidity environments, because they cause condensation on the LED.

- If the LED is intended to be used in a harsh or an 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:

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

where:

T_A = Ambient temperature (°C)

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

I_F = Forward current (A)

V_{Fmax} = Maximum forward voltage (V)

The complication of using this formula lies in T_A and $R_{\theta J\text{-}A}$. Actual T_A is sometimes subjective and hard to determine. $R_{\theta J\text{-}A}$ 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:

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

where:

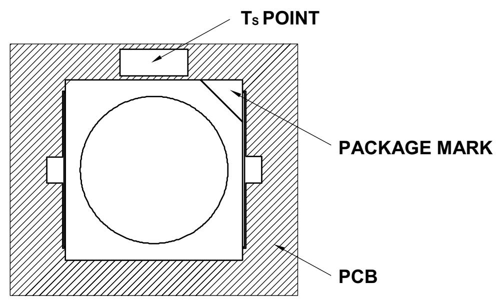
T_S = LED solder point temperature as shown in the following figure (°C)

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

I_F = Forward current (A)

V_{Fmax} = Maximum forward voltage (V)

Figure 25: Solder Point Temperature on PCB



TS can be easily measured by mounting a thermocouple on the soldering joint as shown in preceding figure, while R J-S is provided in the data sheet. Verify the TS 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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