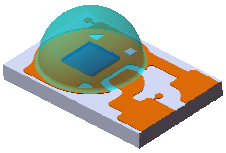
Federal Series



Federal is a surface mount, compact, high brightness LED that is built for various illumination needs. A single Cool White Federal can deliver typical luminous flux of 80 lm while driving at 350mA suitable for any kind of lighting sources, including general illumination, flashlights, streetlights, spotlights, signal lights, industrial and commercial lightings. The small physical dimension can free customers from any constrains or limitations in these fields of applications. Furthermore, the reflow-solderable nature of Federal provides an easy path towards the optimum thermal management to achieve a promising reliability. In conclusion, Federal offers you an extraordinary LED experience.

Features

- High lumen performancel
- Promising lumen maintenance characteristics
- High efficiency package
- Level 1 on JEDEC moisture sensitivity analysis
- 350mA – 700mA drive current
- RoHS compliant

Typical Applications

- Reading lights
- Up-lights and Down-lights
- General lighting
- Ceiling lights
- Decoration lights
- Beacon lights
- Portable flashlight
- LCD Backlights
- Contour lights
- Garden lighting
- Architectural lighting

Table of Contents

Federal Nomenclature

E F E W - 1 A E 1

X1 X2 X3 X4 X5 X6 X7

Table 1.

X1 LED Item		X2 Module		X3 Emitting Color		X4 Power		X5 Substrate Type	
Code	Type	Code	Type	Code	Type	Code	Type	Code	Type
EF	Federal	E	Emitter	W	White	1	350mA	A	4.5mm x 3mm
		S	Star	H	Neutral White	3	700mA		
				X	Warm White				
				R	Red				
				A	Amber				
				T	Green				
				B	Blue				
				D	Dental Blue				
				C	Royal Blue				
				J	Cyan				
				E	Deep Red				
				F	Cherry Red				
				V	Ultraviolet				

X6 Emitter Type		X7 Internal Usage	
Code	Type	Code	Type
E	E-type	1	

Environmental Compliance

Federal is compliant to the Restriction of Hazardous Substances Directive or RoHS. The restricted materials including lead, mercury cadmium hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ether (PBDE) are not used in Federal to provide an environmentally friendly product to the customers.

E-Type Package Dimensions

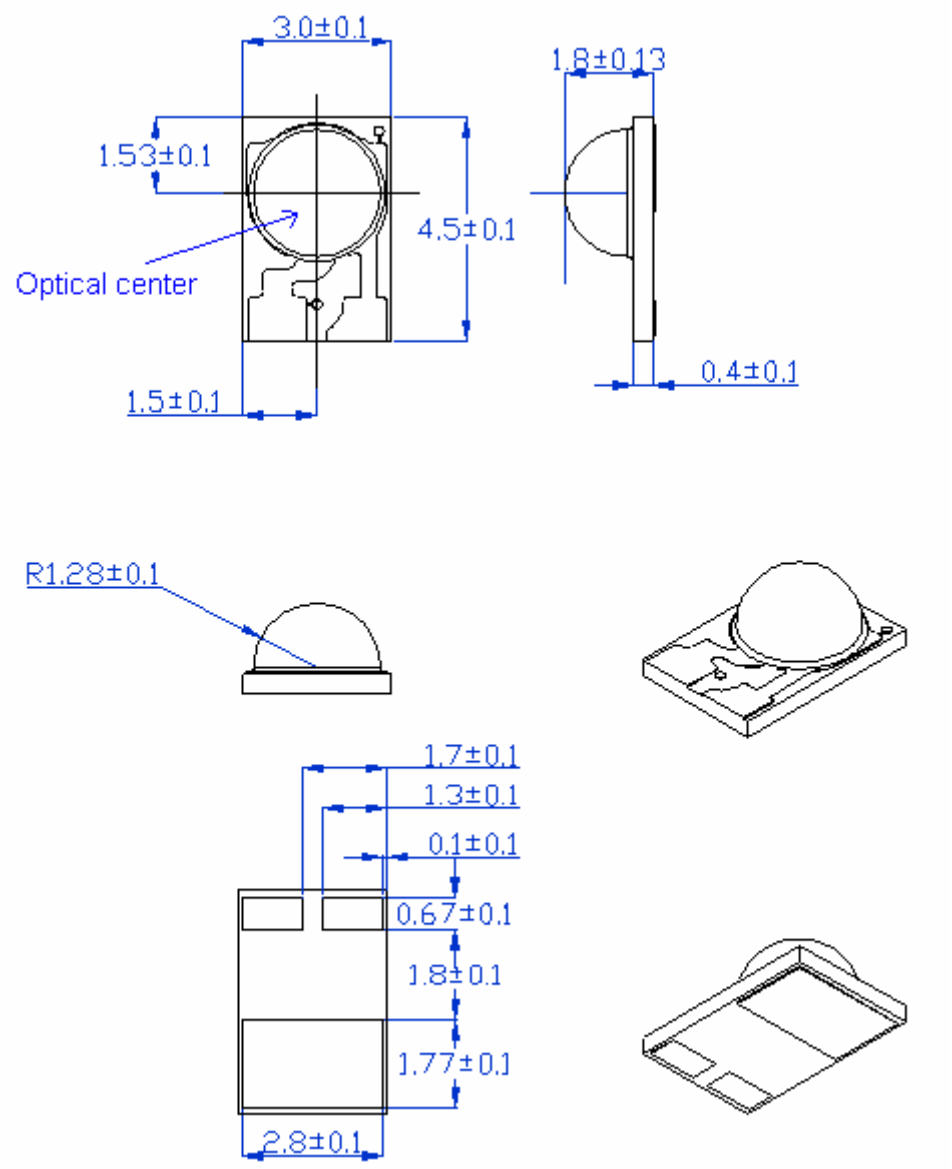
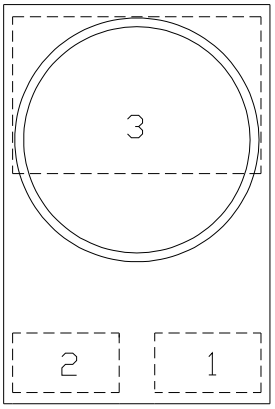


Figure 1: E-Type Package Drawings

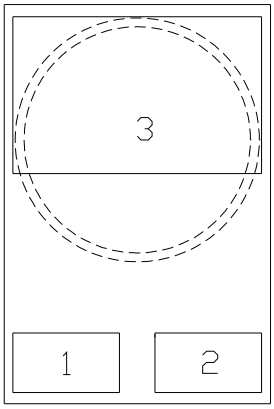
Notes:

1. **All dimensions are in millimeters.**
2. **Drawings are not to scale.**

E-Type Package Polarity



TOP



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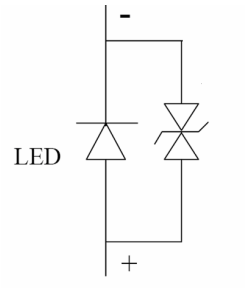


PAD	FUNCTION
1	ANODE
2	CATHODE
3	THERMAL

Figure 2: E-Type Pad Configuration

Note:

The thermal pad is electrically isolated from anode and cathode.

Absolute Maximum Ratings

Table 2.

Parameter	Symbol	Rating	Units
DC Forward Current[1]	I_F	350 / 700	mA
Peak Pulsed Current; (tp≦100μs, Duty cycle=0.25)	I_{pulse}	1000	mA
Transient Surge Voltage	V_{TS}	8	V
Reverse Voltage[2]	V_r	Note 2	V
LED Junction Temperature[3]	T_j	150 / 125[4]	°C
Operating Temperature	T_{opr}	-40 ~ +80	°C
Storage Temperature	T_{stg}	-40 ~ +120	°C
ESD Sensitivity	V_B	2,000	V
Allowable Reflow Cycles	n/a	3	cycles
Soldering Temperature	T_{sol}	260	°C

Notes:

1. **Maximum forward current for 1W and 3W are 350mA and 700mA respectively.**
2. **LEDs are not designed to drive in reverse bias.**
3. **Proper current derating must be observed to maintain junction temperature below the maximum.**
4. **The maximum junction temperature for Red, Amber, Deep Red and Cherry Red is 125°C.**

Luminous Flux Characteristics, IF=350mA and Thermal Pad=25℃

Table 3.

Power Consumption	Part Name	Color	Flux			Units
			Min.	Typ.	Max.	
1W	**EFEW-1AE1**	Cool White	--	***90***	--	lm
	EFEH-1AE1	Neutral White	--	***80***	--	lm
	EFEX-1AE1	Warm White	--	***65***	--	lm
	EFER-1AE1	Red	--	***50***	--	lm
	EFEA-1AE1	Amber	--	***45***	--	lm
	EFET-1AE1	True Green	--	***70***	--	lm
	EFEB-1AE1	Blue	--	***20***	--	lm
	EFED-1AE1	Dental Blue	--	***300***	--	mW
	EFEC-1AE1	Royal Blue	--	***320***	--	mW
	EFEJ-1AE1	Cyan	--	***30***	--	lm
	EFEE-1AE1	Deep Red	--	***135***	--	mW
	EFEF-1AE1	Cherry Red	--	***110***	--	mW
	EFEV-1AE1	Ultraviolet	--	***210***	--	mW

Luminous Flux Characteristics, I_F=700mA and Thermal Pad=25℃

Table 4.

Lens Item	Part Name	Color	Flux			Units
			Min.	Typ.	Max.	
3W	**EFEW-3AE1**	Cool White	--	***160***	--	lm
	EFEH-3AE1	Neutral White	--	***130***	--	lm
	EFEX-3AE1	Warm White	--	***120***	--	lm
	EFER-3AE1	Red	--	***85***	--	lm
	EFET-3AE1	True Green	--	***130***	--	lm
	EFEB-3AE1	Blue	--	***27***	--	lm

Note:

The luminous flux performance is guaranteed within published operating conditions. Edison maintains a tolerance of ±10% on flux measurements.

Color Temperature or Dominant/Peak Wavelength Characteristics, T_J=25°C at 350mA

Table 5.

Power Consumption	Part Name	Color	CCT/Wavelength			Units
			Min.	Typ.	Max.	
1W	EFEW-1AE1	Cool White	***5,000***	--	***10,000***	K
	EFEH-1AE1	Neutral White	***3,800***	--	***50,00***	K
	EFEX-1AE1	Warm White	***2,670***	--	***3,800***	K
	EFER-1AE1	Red	***620***	--	***630***	nm
	EFEA-1AE1	Amber	***585***	--	***595***	nm
	EFET-1AE1	True Green	***515***	--	***535***	nm
	EFEB-1AE1	Blue	***455***	--	***475***	nm
	EFED-1AE1	Dental Blue[1]	***450***	--	***470***	nm
	EFEC-1AE1	Royal Blue[1]	***440***	--	***460***	nm
	EFEJ-1AE1	Cyan	***490***	--	***510***	nm
	EFEE-1AE1	Deep Red[1]	***650***	--	***670***	nm
	EFEF-1AE1	Cherry Red[1]	***730***	--	***750***	nm
	EFEV-1AE1	Ultraviolet[1]	***395***	--	***410***	nm

Notes:

1. **Wavelengths are stated as peak wavelength.**
2. **Edison maintains a tolerance of ±0.5nm for dominant wavelength, ±2nm for peak wavelength and ±5% on CCT measurement.**

Forward Voltage Characteristics, T_J=25°C

Table 6.

Power Consumption	Part Name	Color	Forward Current (mA)	V_F			Units
				Min.	Typ.	Max.	
1W	**EFEW-1AE1**	White	350	***3.0***	**--**	***4.0***	V
	EFEH-1AE1	Neutral White	350	***3.0***	**--**	***4.0***	
	EFEX-1AE1	Warm White	350	***3.0***	**--**	***4.0***	
	EFER-1AE1	Red	350	***2.0***	**--**	***3.0***	
	EFEA-1AE1	Amber	350	***2.0***	**--**	***3.0***	
	EFET-1AE1	True Green	350	***2.8***	**--**	***4.0***	
	EFEB-1AE1	Blue	350	***3.0***	**--**	***4.0***	
	EFED-1AE1	Dental Blue	350	***3.0***	**--**	***4.0***	
	EFEC-1AE1	Royal Blue	350	***3.0***	**--**	***4.0***	
	EFEJ-1AE1	Cyan	350	***2.8***	**--**	***4.0***	
	EFEE-1AE1	Deep Red	350	***2.0***	**--**	***3.0***	
	EFEF-1AE1	Cherry Red	350	***2.0***	**--**	***3.0***	
	EFEV-1AE1	Ultraviolet	350	***3.0***	**--**	***4.0***	
3W	**EFEW-3AE1**	White	700	***3.0***	**--**	***4.0***	V
	EFEH-3AE1	Neutral White	700	***3.0***	**--**	***4.0***	
	EFEX-3AE1	Warm White	700	***3.0***	**--**	***4.0***	
	EFER-3AE1	Red	700	***2.0***	**--**	***3.0***	
	EFET-3AE1	True Green	700	***2.8***	**--**	***4.0***	
	EFEB-3AE1	Blue	700	***3.0***	**--**	***4.0***	

Note:

Edison maintains a tolerance of 0.06V on forward voltage measurement.

Emission Angle Characteristics

Table 7.

2Θ½(Typ.) Lambertian	Units
120	Degrees

JEDEC Moisture Sensitivity

Table 8.

Level	Floor Life		Soak Requirements	
	Time	Conditions	Standard Time (hours)	Conditions
1	unlimited	≦30℃ / 85% RH	168 +5/-0	85°C / 85% RH

Thermal Resistance – Junction to Thermal Pad

Table 9.

Thermal Resistance from Junction to Thermal Pad	Units
10	°C / W

Operating Life, Mechanical and Environmental Tests on Federal

Table 10.

Stress Test	Stress Conditions	Stress Duration	Failure Criteria
Room Temperature Operating Life	55 °C, I_F =DC max[1]	1000 hours	Note 2
High Temperature High Humidity Operating Life	85 °C / 85%RH, I_F =DC max[1]	1000 hours	Note 2
High Temperature Operating Life	85 °C, I_F =DC max[1]	1000 hours	Note 2
Low Temperature Operating Life	-40 °C, I_F =DC max[1]	1000 hours	Note 2
High Temperature Storage Life	150 °C	1000 hours	Note 2
Low Temperature Storage Life	-40 °C	1000 hours	Note 2
Non-Operating Thermal Shock	-40 / 125℃, 20 min dwell ＜10 sec transfer	500 cycles	No catastrophic
Mechanical Shock	1500 G, 0.5 msec pulse, 5 shocks each 6 axis	N/A	No catastrophic
Free Drop	On concrete from 1.2 m, 3X	N/A	No catastrophic
Variable Vibration Frequency	10-2000-10 Hz, log or linear sweep rate, 20 G about 1 min, 1.5 mm, 3X/axis	N/A	No catastrophic
Solder Heat Resistance (SHR)	Three JEDEC Pb-free reflow profile	N/A	No catastrophic

Note:

1.DC max is defined to be 350mA and 700mA for 1W and 3W Federal respectively.

2. Failure Criteria:

- Electrical failures: V_F shifts >= 10%

- Light Output Degradation: Percentage level shift >= 50% at 1,000hrs or 500cycle

- Visual failures: Broken or damaged package on lens or substrate

White Edixeon® Federal Color Spectrum, T_J = 25°C

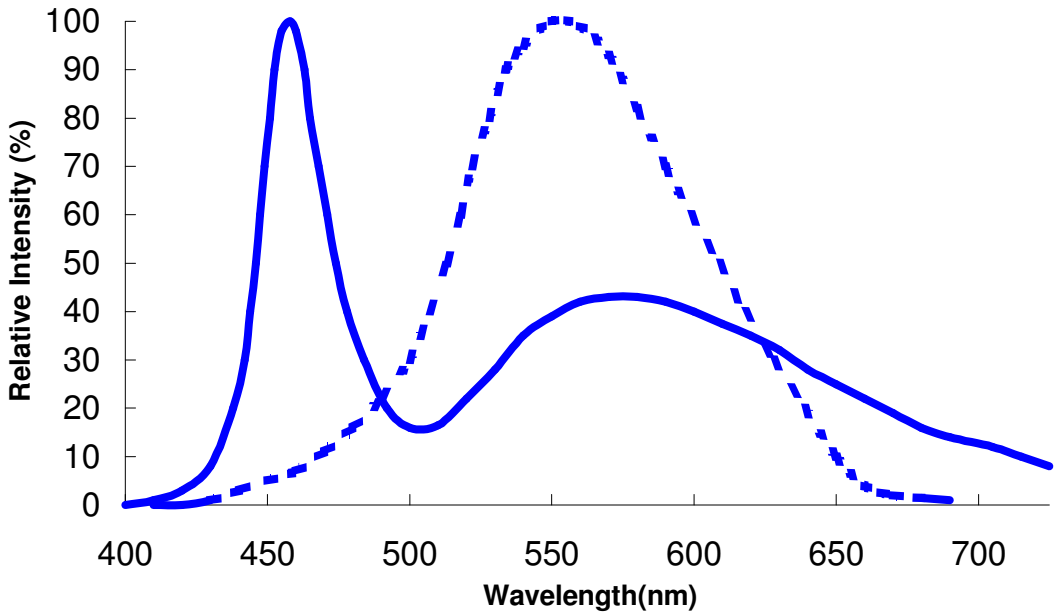


Figure 3: Color Spectrum for Cool White at a typical CCT. Dotted curve represents the standard eye response, T_J=25°C.

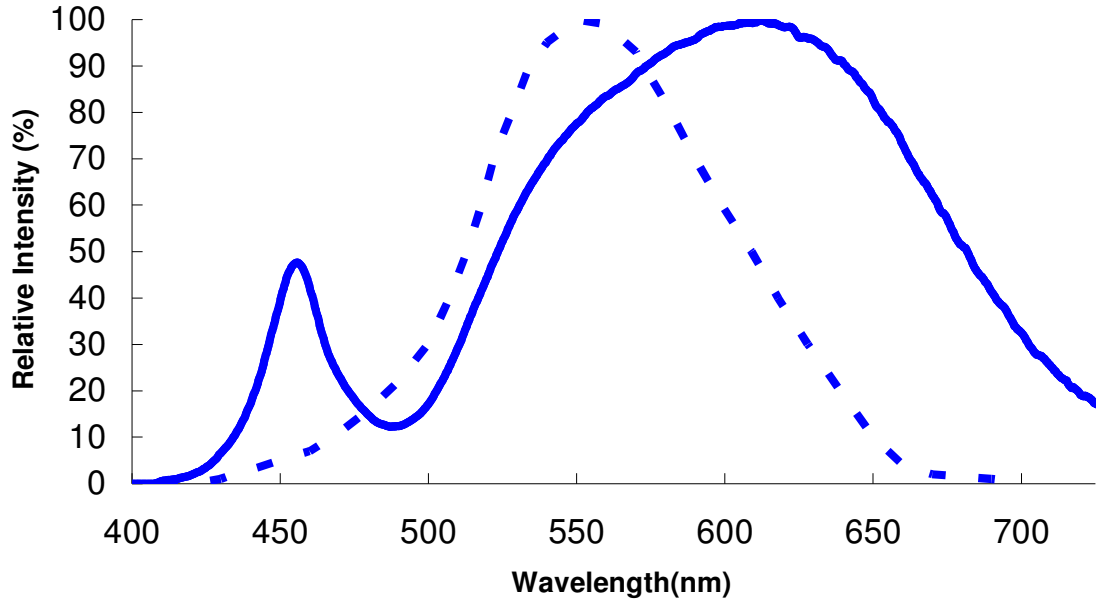


Figure 4: Color Spectrum for Neutral White and Warm White at a typical CCT. Dotted curve represents the standard eye response, T_J=25°C.

Typical Radiation Pattern, T_J = 25°C

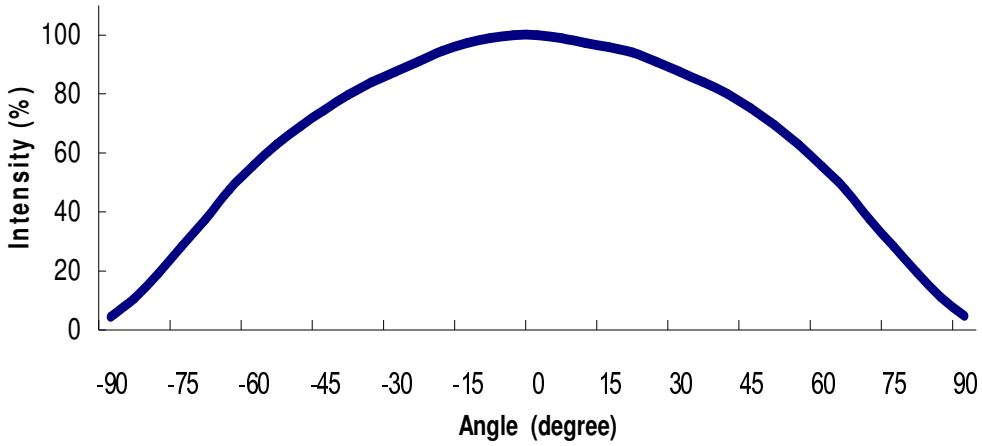


Figure 5: Lambertain Pattern for all colors at T_J=25°C..

Optical & Electric Curves

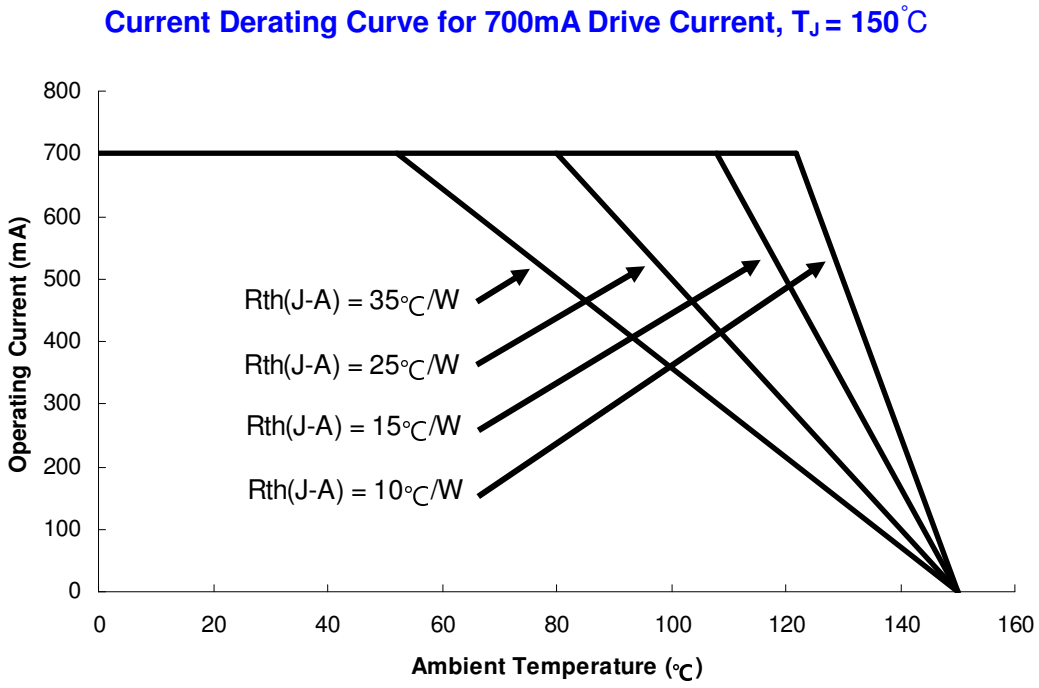


Figure 6: Maximum Operating Current vs Ambient Temperature for White, Blue, Green, Cyan, Royal Blue, Dental Blue and Ultraviolet.

Current Derating Curve for 700mA Drive Current, T_J= 125℃

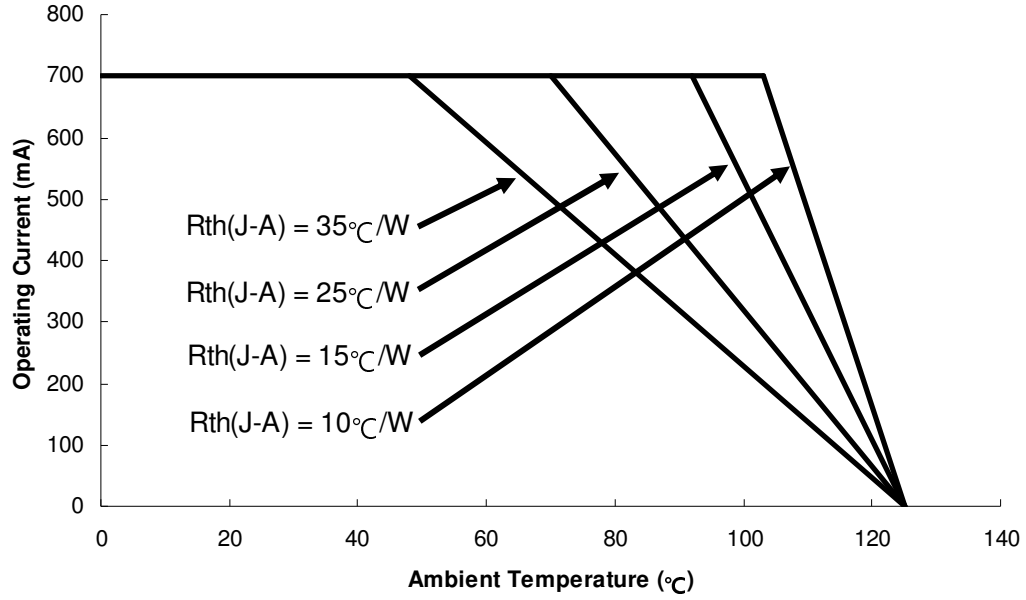


Figure 7: Maximum Operating Current vs Ambient Temperature for Red, Amber, Deep Red, Cherry Red.

Typical Forward Voltage Characteristics for White, Blue, Dental Blue and Royal Blue Federal, T_J = 25℃

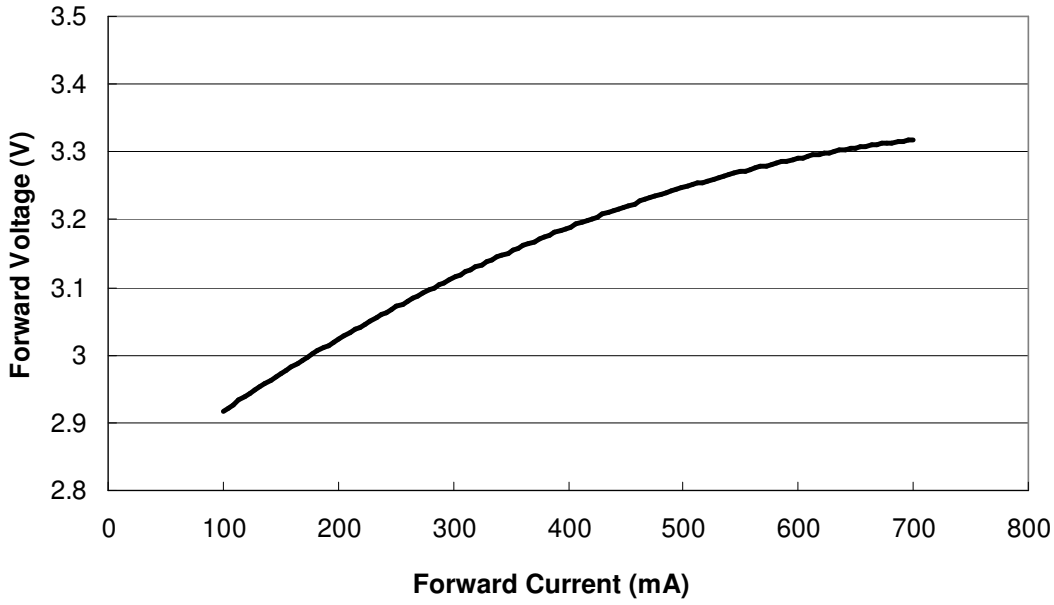


Figure 8: Forward voltage vs. forward current for White, Blue, Dental Blue and Royal Blue.

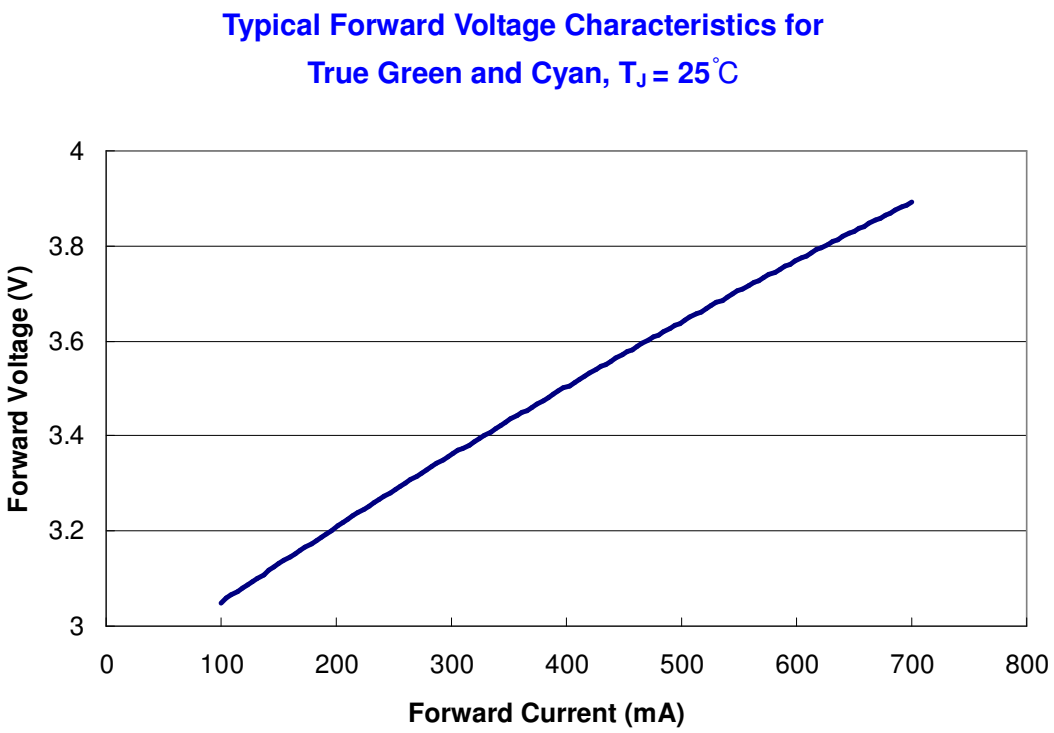


Figure 9: Forward voltage vs. forward current for True Green and Cyan.

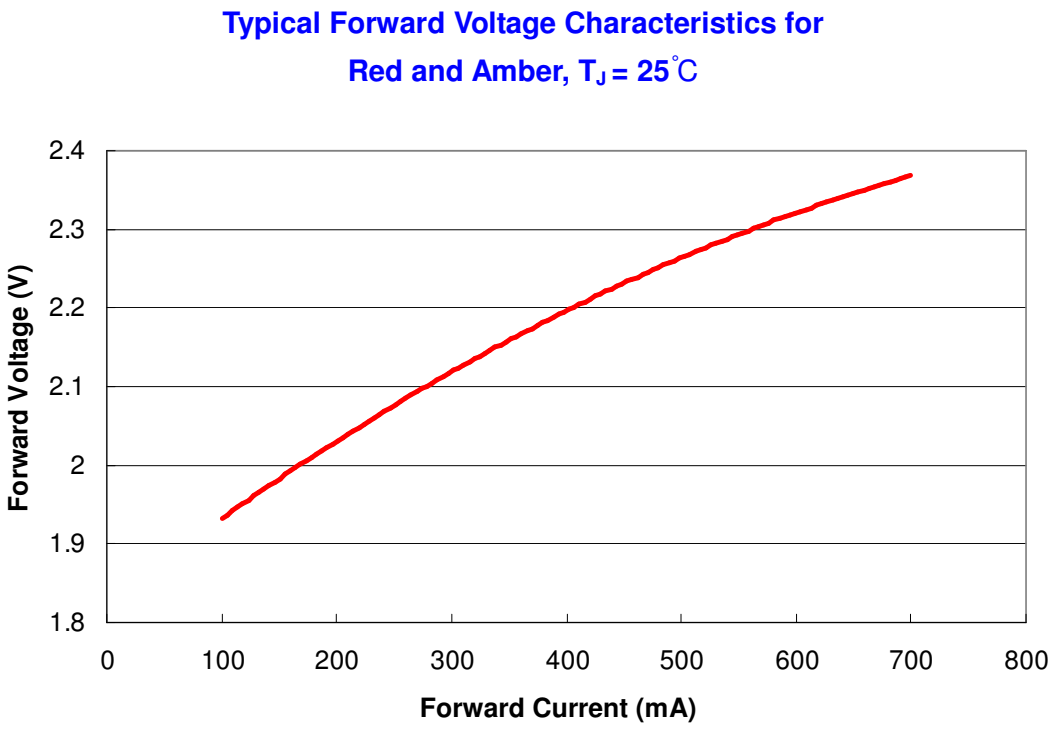


Figure 10: Forward voltage vs. forward current for Red and Amber.

Typical Relative Luminous Flux for Cool White, True Green, Blue, Cyan, Dental Blue, and Royal Blue, T_J = 25℃

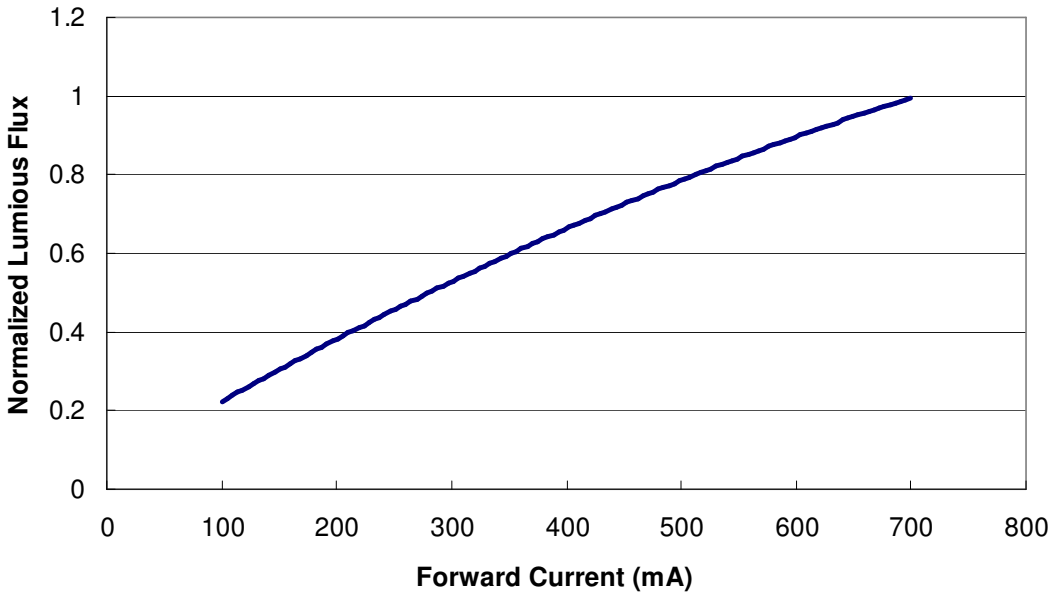


Figure 11: Relative luminous flux vs. forward current for Cool White, True Green, Blue, Cyan, Dental Blue and Royal Blue.

Typical Relative Luminous Flux for Red and Amber, T_J = 25℃

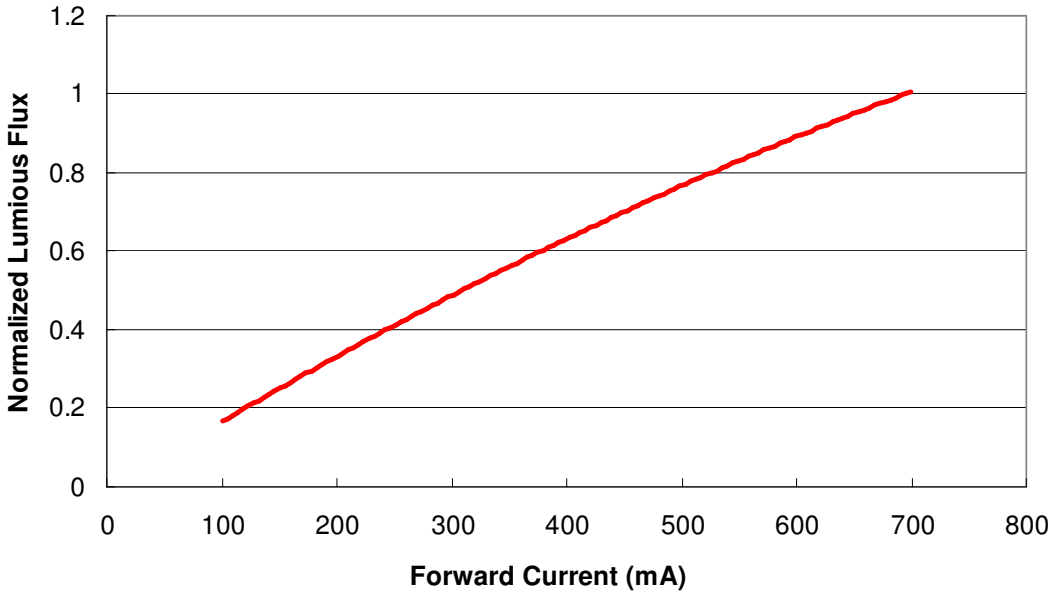


Figure 12: Relative luminous flux vs. forward current for Red and Amber.

Typical Wavelength Shift Characteristic for True Green and Blue, T_J = 25℃

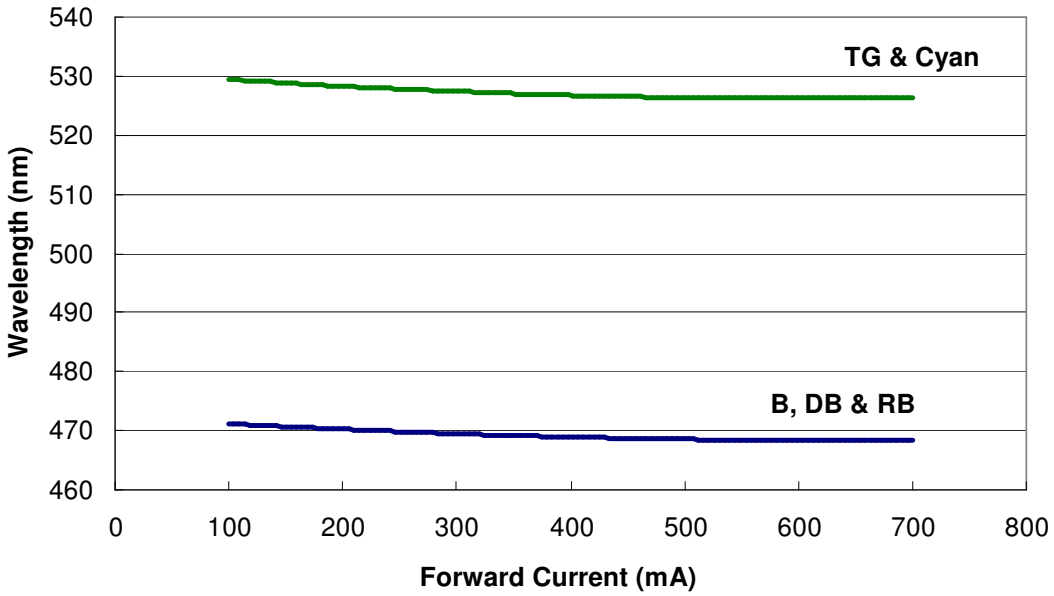


Figure 13: Wavelength length vs. forward current for True Green, Blue, Cyan, Royal Blue and Dental Blue.

Typical Wavelength Shift Characteristic for Red and Amber, T_J = 25℃

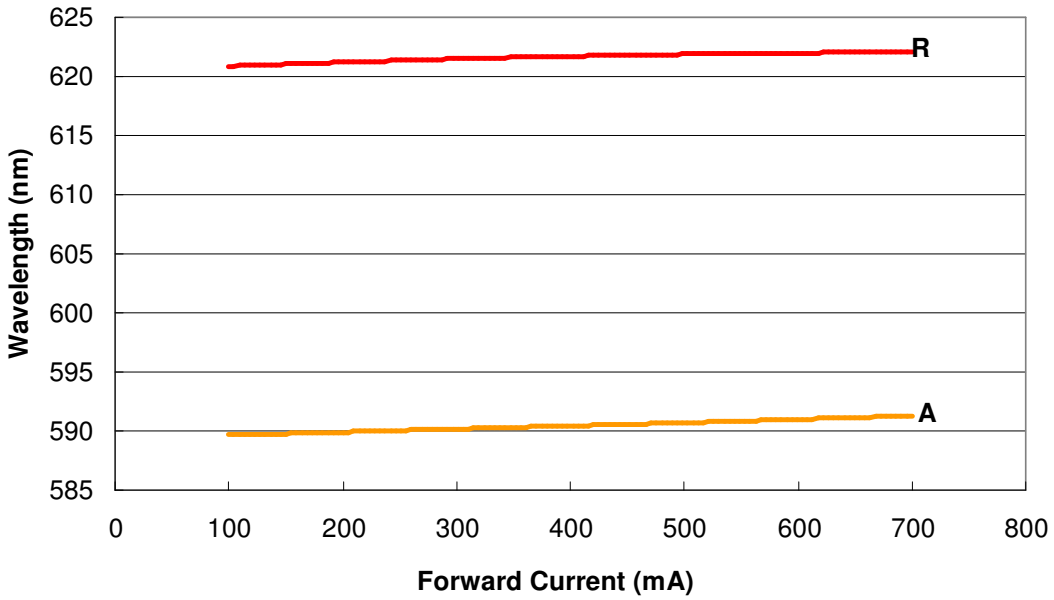


Figure 14: Wavelength length vs. forward current for Red and Amber.

Typical CCT Shift Characteristic for Cool White $T_J = 25^{\circ}C$

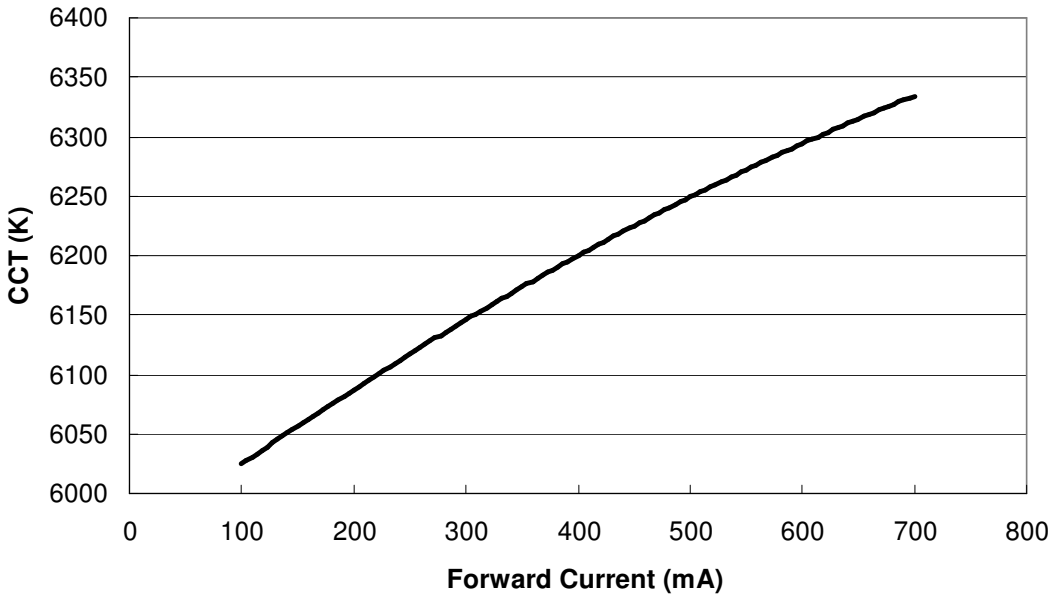


Figure 15: CCT vs. forward current for Cool White.

Typical CCT Shift Characteristic for Cool White

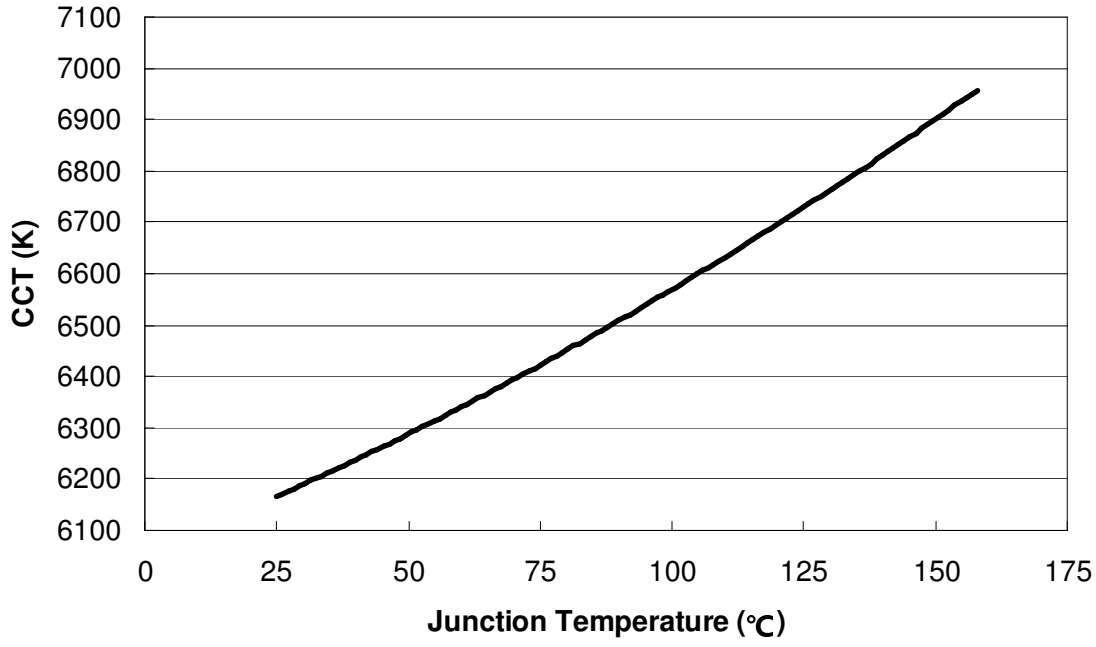


Figure 16: Typical CCT vs. junction temperature for Cool White.

Typical Light Output Characteristics over Thermal Pad Temperature for Cool White

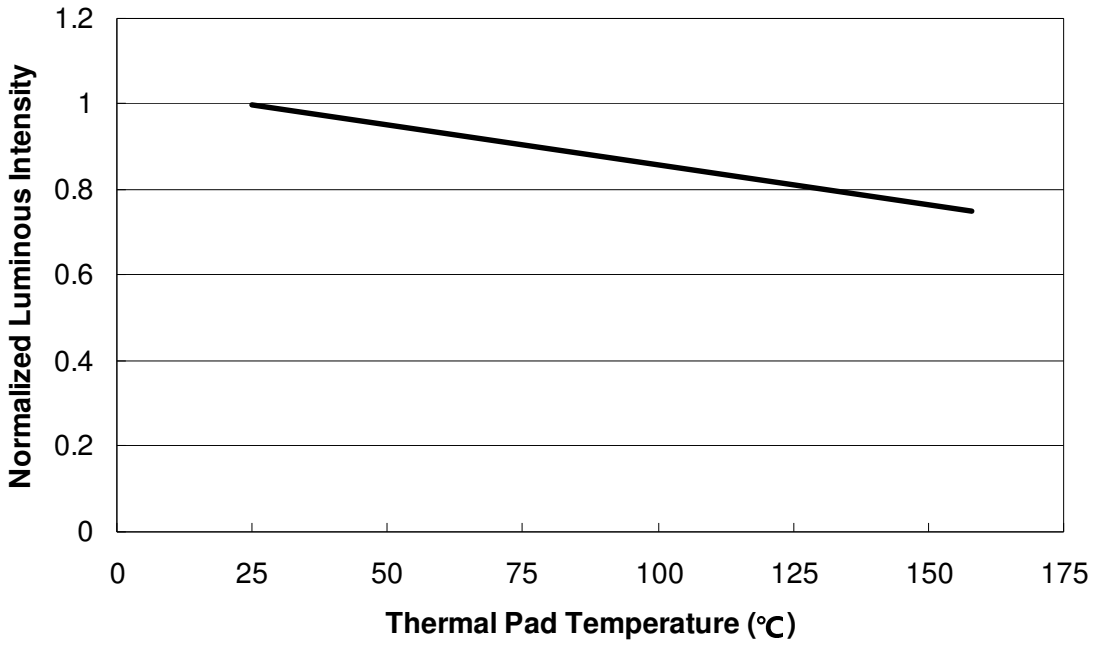


Figure 17: Relative luminous flux vs. thermal pad temperature for Cool White.

Typical Light Output Characteristics over Thermal Pad Temperature for True Green, Blue, Red and Amber

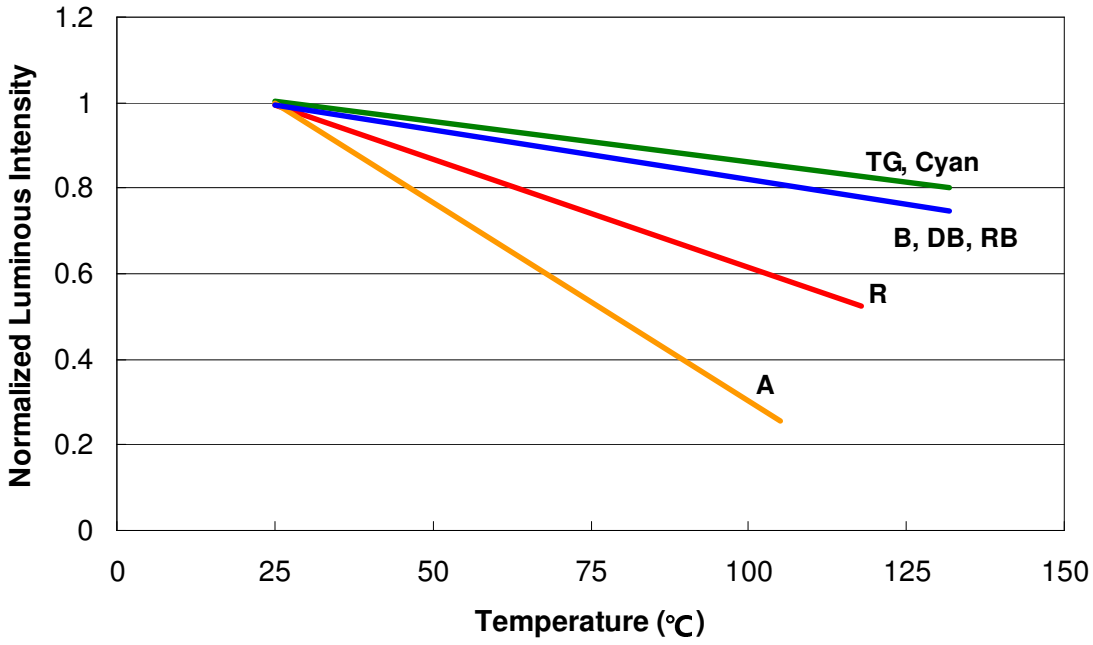


Figure 18: Relative luminous flux vs. thermal pad temperature for True Green, Blue, Red and Amber.

Reflow Profile

The following reflow profile is from IPC/JEDEC J-STD-020D which provided here for reference.

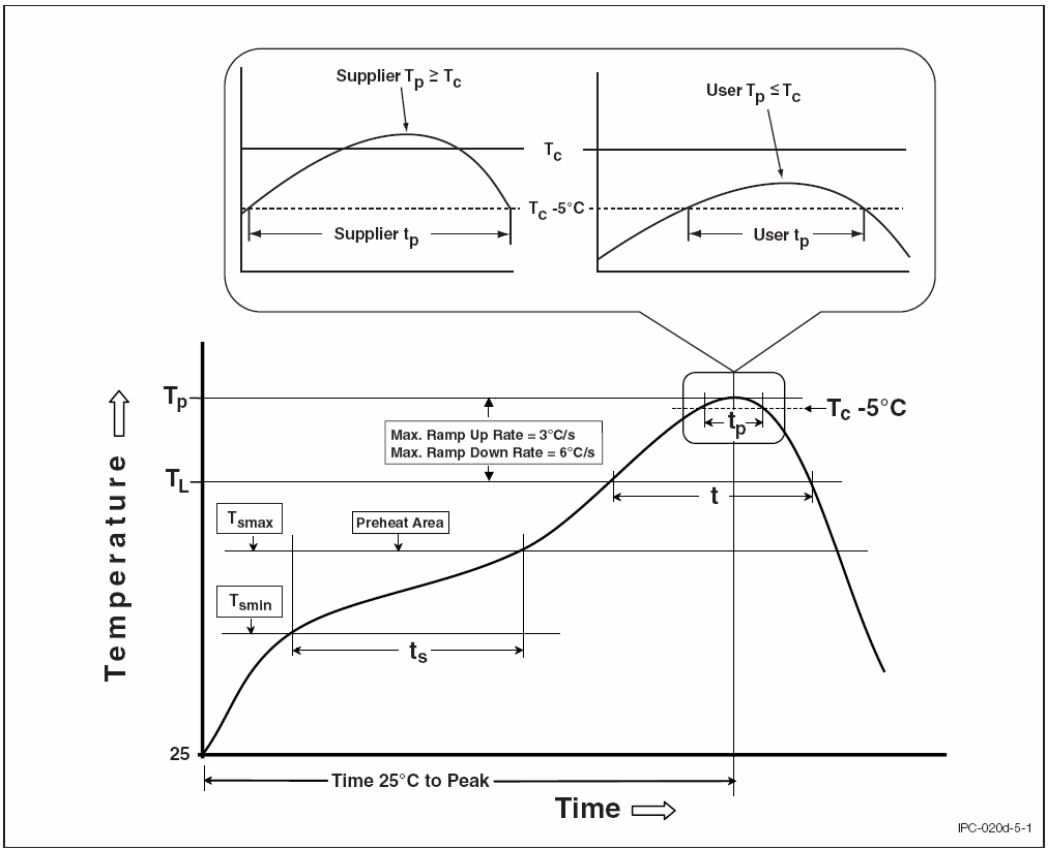
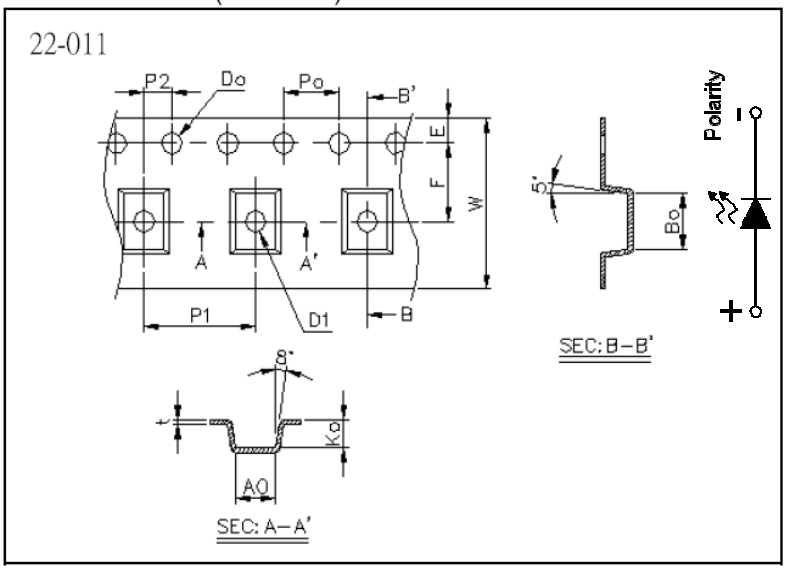


Table 11.

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	 100 ℃ 150 ℃ 60-120 seconds	 150 ℃ 200 ℃ 60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 ℃/second max.	3 ℃/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 ℃ 60-150 seconds	217 ℃ 60-150 seconds
Peak package body temperature (T_p)*	230 ℃ ~235 ℃ *	255 ℃ ~260 ℃ *
Classification temperature (T_c)	235 ℃	260 ℃
Time (t_p)** within 5 ℃ of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 ℃/second max.	6 ℃/second max.
Time 25 ℃ to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Tape & Reel Packaging

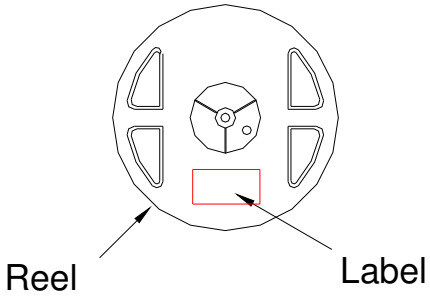
Dimensions. (Unit: mm)



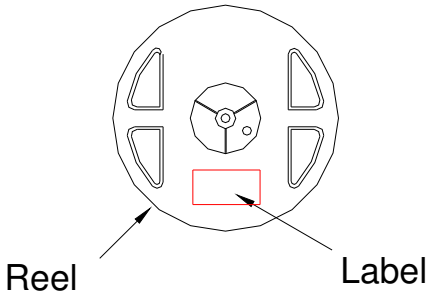
Item	Specification	Tol. (+/-)
W	**12.00**	± 0.20
E	**1.75**	± 0.10
F	**5.50**	± 0.05
D0	**1.50**	+0.10, -0
D1	**1.50**	± 0.10
P0	**4.00**	± 0.05
P1	**8.00**	± 0.10
P2	**2.00**	± 0.05
P0 x 10	**40.00**	± 0.20

t	**0.25**	± 0.05
A0	**3.32**	± 0.10
B0	**4.87**	± 0.10
K0	**2.27**	± 0.10
A1		
B1		
K1		

Figure 19: Federal Reel Dimensions.



Item	Quantity	Total	Dimensions(mm)
Reel	250pcs	250pcs	Diameter=178
Inner box	4 reels	1,000pcs	240*235*67
Outer box	5 inner boxes	5,000pcs	353*254*256



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Inner box	5 reels	5,000pcs	240*235*67
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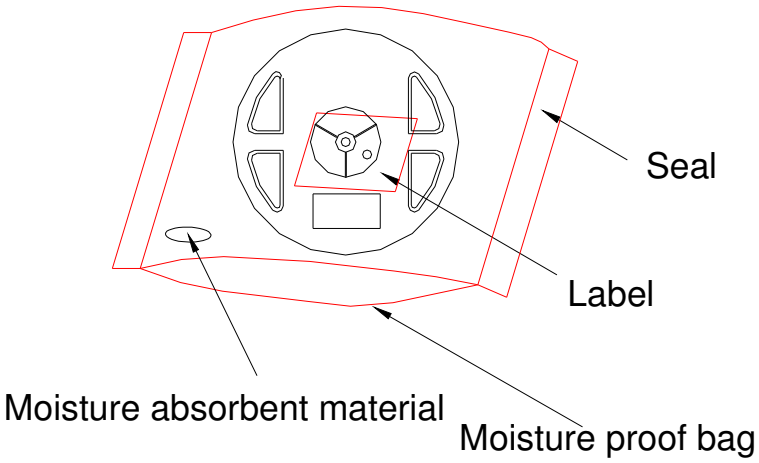

Package Label

Federal Bin Groups

Photometric Luminous Flux Bins for Cool White, Neutral White and Warm White

Table 12.

Group	Min. (lm)	Max. (lm)	Group	Min. (lm)	Max. (lm)
A	0.1	1.0	T1	66.5	70.0
B	1.0	1.3	T2	70.0	80.0
C	1.3	1.7	T3	80.0	86.5
D	1.7	2.2	U1	86.5	90
E	2.2	2.9	U2	90	100
F	2.9	3.7	U3	100	112.5
G	3.7	4.8	V1	112.5	129.4
H	4.8	6.3	V2	129.4	146.2
J	6.3	8.2	W1	146.2	168.1
K	8.2	10.6	W2	168.1	190.0
L	10.6	13.8	X1	190.0	218.6
M	13.8	17.9	X2	218.6	247.1
N	17.9	23.3	Y1	247.1	284.2
P	23.3	30.3	Y2	284.2	321.2
Q	30.3	39.4	Z1	321.2	369.4
R	39.4	51.2	Z2	369.4	417.5
S1	51.2	58.8			
S2	58.8	66.5			

Photometric Luminous Flux Bins for Single Colors

Table 13.

Group	Min. (lm)	Max. (lm)	Group	Min. (lm)	Max. (lm)
A	0.1	1.0	N	17.9	23.3
B	1.0	1.3	P	23.3	30.3
C	1.3	1.7	Q	30.3	39.4
D	1.7	2.2	R	39.4	51.2
E	2.2	2.9	S	51.2	66.5
F	2.9	3.7	T	66.5	86.5
G	3.7	4.8	U	86.5	112.5
H	4.8	6.3	V	112.5	146.2
J	6.3	8.2	W	146.2	190.0
K	8.2	10.6	X	190.0	247.1
L	10.6	13.8	Y	247.1	321.2
M	13.8	17.9	Z	321.2	417.5

Radiometric Power Bins (mW)

Table 14.

Group	Min.	Max.	Group	Min.	Max.
A	*10.0*	*15.0*	K	*384.4*	*576.7*
B	*15.0*	*22.5*	L	*576.7*	*865.0*
C	*22.5*	*33.8*	M	*865.0*	*1,298*
D	*33.8*	*50.6*	N	*1,298*	*1,946*
E	*50.6*	*75.9*	P	*1,946*	*2,919*
F	*75.9*	*113.9*	Q	*2,919*	*4,379*
G	*113.9*	*170.9*	R	*4,379*	*6,659*
H	*170.9*	*256.3*	S	*6,659*	*9,853*
J	*256.3*	*384.4*	T	*9,853*	*14,779*

Cool White X,Y Groups

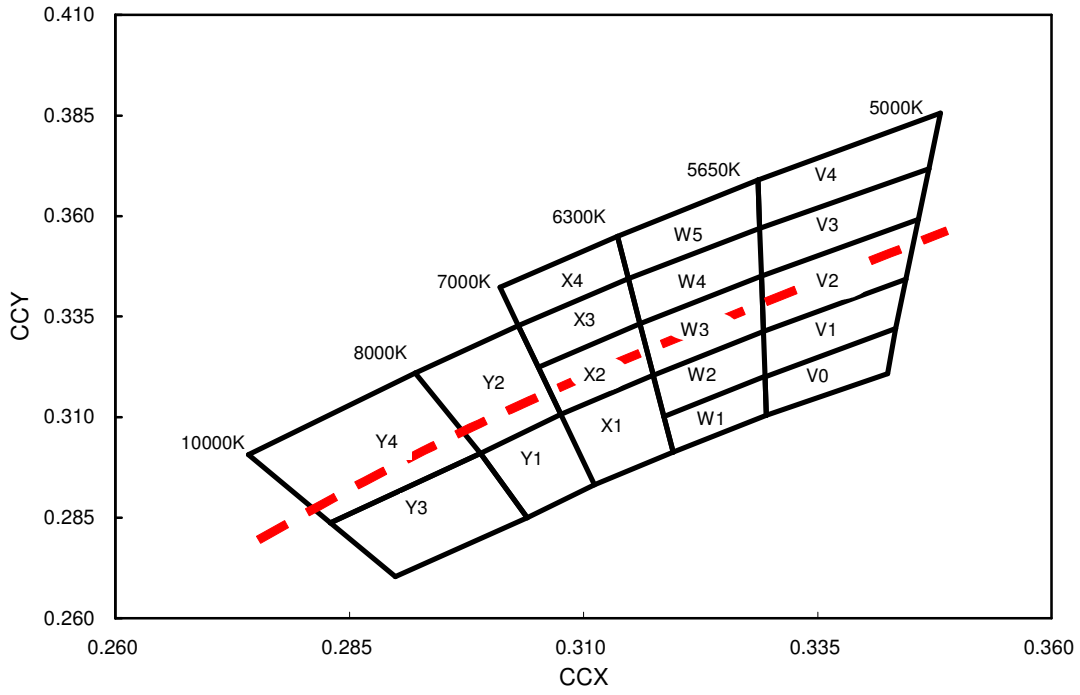

Figure 20: Cool White bin structure. The red line represents the blackbody locus on CIE 1931 graph.

Note:

Edison maintains a tolerance of ±0.005 on x, y color coordinates.

Cool White Edixeon® Federal X, Y Coordinates

Table 15.

Group/ CCT(Typ)	X	Y
V0	0.34335	0.33203
	0.34250	0.32080
	0.32954	0.31050
5300K	0.32939	0.32002

Group/ CCT(Typ)	X	Y
W1	0.32920	0.32021
	0.32954	0.31050
	0.31960	0.30130
6000K	0.31861	0.31020

Group/ CCT(Typ)	X	Y
X1	0.30755	0.31078
	0.31745	0.32044
	0.31960	0.30130
6650K	0.31116	0.29319

Group/ CCT(Typ)	X	Y
Y1	0.30400	0.28500
	0.29900	0.30100
	0.30755	0.31078
7500K	0.31116	0.29319

V1	0.32922	0.33133
	0.34444	0.34423
	0.34335	0.33203
5300K	0.32939	0.32002

W2	0.32922	0.33133
	0.32939	0.32021
	0.31861	0.31020
6000K	0.31747	0.32044

X2	0.30755	0.31078
	0.30517	0.32239
	0.31604	0.33322
6650K	0.31747	0.32044

Y2	0.29900	0.30100
	0.29200	0.32100
	0.30305	0.33271
7500K	0.30755	0.31078

V2	0.32922	0.33133
	0.32901	0.34509
	0.34578	0.35919
5300K	0.34444	0.34423

W3	0.32901	0.34509
	0.32922	0.33133
	0.31747	0.32044
6000K	0.31604	0.33322

X3	0.30517	0.32239
	0.30305	0.33271
	0.31479	0.34444
6650K	0.31604	0.33322

Y3	0.30400	0.28500
	0.28992	0.27032
	0.28297	0.28377
9000K	0.29900	0.30100

V3	0.32901	0.34509
	0.32882	0.35692
	0.34690	0.37174
5300K	0.34578	0.35919

W4	0.32901	0.34509
	0.31604	0.33322
	0.31479	0.34444
6000K	0.32882	0.35692

X4	0.30305	0.33271
	0.30109	0.34224
	0.31362	0.35499
6650K	0.31479	0.34444

Y4	0.29200	0.32100
	0.27424	0.30067
	0.28297	0.28377
9000K	0.29900	0.30100

V4	0.32882	0.35692
	0.32864	0.36895
	0.34815	0.38563
5300K	0.34690	0.37174

W5	0.31479	0.34444
	0.31362	0.35499
	0.31864	0.36895
6000K	0.32882	0.35692

Neutral White X,Y Groups

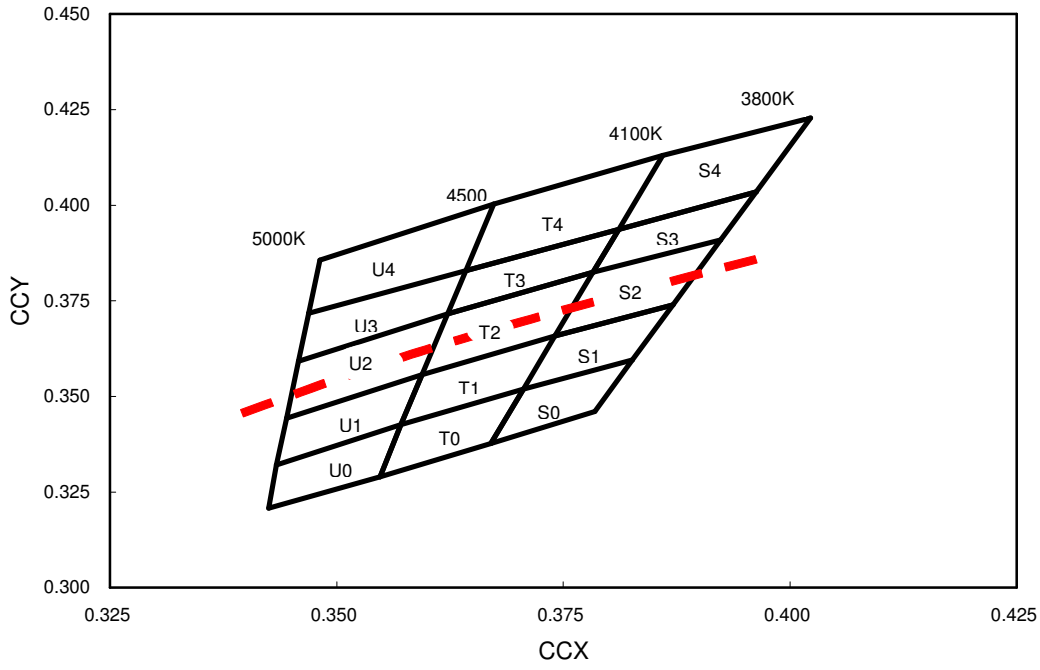

Figure 21: Neutral White bin structure. The red line represents the blackbody locus on CIE 1931 graph.

Note:

Edison maintains a tolerance of ±0.005 on x, y color coordinates.

Neutral White Federal X, Y Coordinates

Table 16.

Group/ CCT(Typ)	X	Y
S0	0.382598	0.359515
	0.378500	0.346000
3900K	0.367000	0.337700
	0.370582	0.351953
S1	0.374075	0.365822
	0.387071	0.373899
3900K	0.382598	0.359515
	0.370582	0.351953
S2	0.378264	0.382458
	0.392368	0.390932
3900K	0.387071	0.373899
	0.374075	0.365822
S3	0.378264	0.382458
	0.381106	0.393747
3900K	0.396279	0.403508
	0.392368	0.390932
S4	0.385953	0.412995
	0.402270	0.422776
3900K	0.396279	0.403508
	0.381106	0.393747

Group/ CCT(Typ)	X	Y
T0	0.370582	0.351953
	0.367000	0.337700
4300K	0.354800	0.329000
	0.357079	0.342581
T1	0.359401	0.355699
	0.357079	0.342581
4300K	0.370582	0.351953
	0.374075	0.365822
T2	0.362219	0.371616
	0.378264	0.382458
4300K	0.374075	0.365822
	0.359401	0.355699
T3	0.364212	0.382878
	0.381106	0.393747
4300K	0.378264	0.382458
	0.362219	0.371616
T4	0.367294	0.400290
	0.385953	0.412995
4300K	0.381106	0.393747
	0.364212	0.382878

Group/ CCT(Typ)	X	Y
U0	0.357079	0.342581
	0.354800	0.329000
4750K	0.342500	0.320800
	0.343352	0.332034
U1	0.344443	0.344232
	0.343352	0.332034
4750K	0.357079	0.342581
	0.359401	0.355699
U2	0.362219	0.371616
	0.359401	0.355699
4750K	0.344443	0.344232
	0.345781	0.359190
U3	0.364212	0.382878
	0.362219	0.371616
4750K	0.345781	0.359190
	0.346904	0.371742
U4	0.364212	0.382878
	0.367294	0.400290
4750K	0.348147	0.385629
	0.346904	0.371742

Warm White X,Y Groups

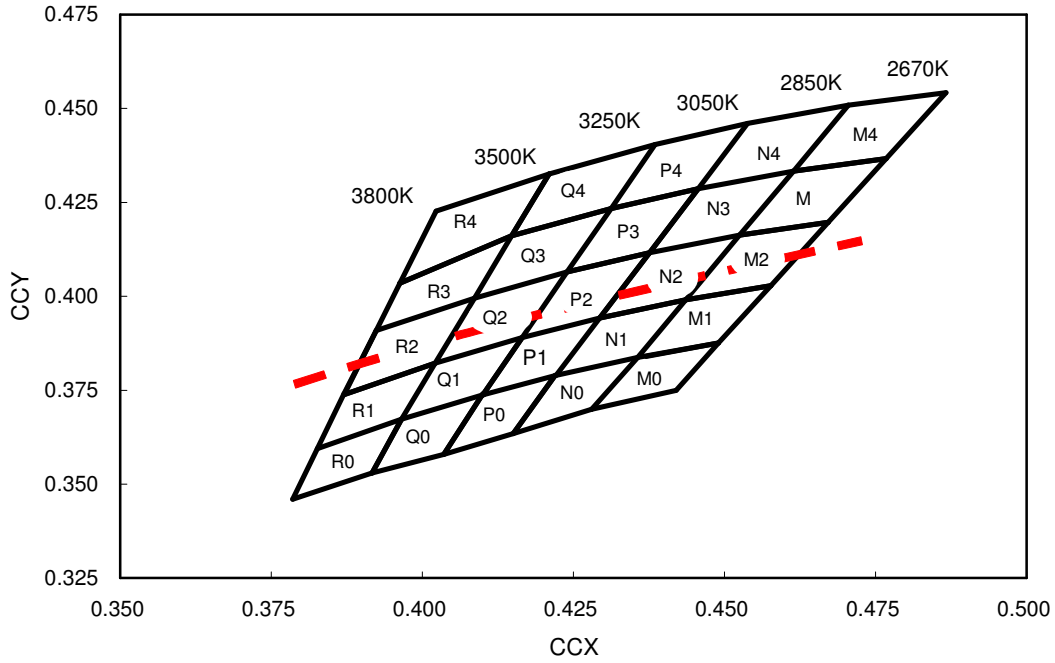

Figure 22: Warm White bin structure. The red line represents the blackbody locus on CIE 1931 graph.

Note:

Edison maintains a tolerance of ±0.005 on x, y color coordinates.

Warm White Federal X, Y Coordinates

Table 17.

Group/ CCT(Typ)	X	Y
M0	0.43700	0.38400
	0.44899	0.38752
2700K	0.44200	0.37500
	0.42800	0.37000

Group/ CCT(Typ)	X	Y
N0	0.43559	0.38371
	0.42800	0.37000
2900K	0.41500	0.36350
	0.42200	0.37900

Group/ CCT(Typ)	X	Y
P0	0.42200	0.37900
	0.41500	0.36350
3150K	0.40350	0.35800
	0.41000	0.37400

M1	0.44360	0.39911
	0.45766	0.40287
2700K	0.44899	0.38752
	0.43559	0.38371

N1	0.42937	0.39428
	0.44360	0.39911
2900K	0.43559	0.38371
	0.42212	0.37895

P1	0.42937	0.39428
	0.42212	0.37895
3150K	0.41000	0.37381
	0.41649	0.38900

M2	0.45251	0.41624
	0.46713	0.41963
2700K	0.45766	0.40287
	0.44360	0.39911

N2	0.43758	0.41163
	0.42937	0.39428
2900K	0.44360	0.39911
	0.45251	0.41624

P2	0.42396	0.40647
	0.43758	0.41163
3150K	0.42937	0.39428
	0.41649	0.38900

M3	0.46140	0.43333
	0.47673	0.43663
2700K	0.46713	0.41963
	0.45251	0.41624

N3	0.46140	0.43333
	0.45251	0.41624
2900K	0.43758	0.41163
	0.44564	0.42868

P3	0.43119	0.42339
	0.44564	0.42868
3150K	0.43758	0.41163
	0.42396	0.40647

M4	0.47051	0.45083
	0.48665	0.45419
2700K	0.47673	0.43663
	0.46140	0.43333

N4	0.45382	0.44598
	0.47051	0.45083
2900K	0.46140	0.43333
	0.44564	0.42868

P4	0.43846	0.44040
	0.45382	0.44598
3150K	0.44564	0.42868
	0.43119	0.42339

Forward Voltage Bins for White, True Green, Blue, Dental Blue, Royal Blue, Cyan and Ultraviolet

Table 18.

V_F (V)	
V 0 1	2.8 — 3.1
V 0 2	3.1 — 3.4
V 0 3	3.4 — 3.7
V 0 4	3.7 — 4.0
V 0 5	4.0 — 4.3
V 0 6	4.3 — 4.6
V 0 7	4.6 — 4.9
V 0 8	4.9 — 5.2

Forward Voltage Bins for Red, Amber, Deep Red and Cherry Red

Table 19.

V_F (V)	
V 0 1	2.0 — 2.25
V 0 2	2.25 — 2.5
V 0 3	2.5 — 2.75
V 0 4	2.75 — 3.0
V 0 5	3.0 — 3.25

Dominant/Peak Wavelength Bin Structure

Group	λ_d(nm), λ_p(nm)
Ultraviolet[1]	***395 — 410***
W	*395 — 400*
X	*400 — 405*
Y	*405 — 410*
Royal Blue[1]	***440 — 460***
V	*440 — 445*
W	*445 — 450*
X	*450 — 455*
Y	*455 — 460*
Dental Blue[1]	***450 — 470***
W	*450 — 455*
X	*455 — 460*
Y	*460 — 465*
Z	*465 — 470*
Blue	***455 — 475***
V	*455 — 460*
W	*460 — 465*
X	*465 — 470*
Y	*470 — 475*
True Green	***515 — 535***
V	*515 — 520*
W	*520 — 525*
X	*525 — 530*
Y	*530 — 535*
Amber	***585 — 595***
X	*585 — 588*
Y	*588 — 591*
Z	*591 — 595*
Red	***620 — 630***
X	*620 — 630*
Deep Red	*650 — 670*
Cherry Red	*730 — 750*

Notes:

1. **Wavelengths are stated as peak wavelength.**

Dominant Wavelength and CIE Coordinate

Table 20.

Royal Blue	Wavelength/nm @ 350 mA			CIE color coordinates		
	Min. λ_p	Max. λ_p	Avg. λ_p	saturation	average x	average y
Royal Blue V	440	445	442.5	99.6%	0.1645	0.0114
Royal Blue W	445	450	447.5	99.6%	0.1597	0.0169
Royal Blue X	450	455	452.5	99.2%	0.1554	0.0226
Royal Blue Y	455	460	457.5	98.7%	0.1500	0.0299

Blue	Wavelength/nm @ 350 mA			CIE color coordinates		
	Min. λ_d	Max. λ_d	Avg. λ_d	saturation	average x	average y
Blue W	460	465	462.5	98.2%	0.1434	0.0396
Blue X	465	470	467.5	96.8%	0.1367	0.0568
Blue Y	470	475	472.5	95.8%	0.1263	0.0817

True Green	Wavelength/nm @ 350 mA			CIE color coordinates		
	Min. λ_d	Max. λ_d	Avg. λ_d	saturation	average x	average y
Green V	515	520	517.5	73.0%	0.1307	0.6939
Green W	520	525	522.5	75.0%	0.1538	0.7077
Green X	525	530	527.5	80.0%	0.1744	0.7201
Green Y	530	535	532.5	83.5%	0.2003	0.7181

Amber	Wavelength/nm @ 350 mA			CIE color coordinates		
	Min. λ_d	Max. λ_d	Avg. λ_d	saturation	average x	average y
Amber X	585	588	586.5	99.3%	0.5480	0.4490
Amber Y	588	591	589.5	99.3%	0.5631	0.4339
Amber Z	591	595	593.0	99.6%	0.5785	0.4195

Red & Red Orange	Wavelength/nm @ 350 mA			CIE color coordinates		
	Min. λ_d	Max. λ_d	Avg. λ_d	saturation	average x	average y
Red Orange	610	620	615	99.7%	0.6839	0.3149
Red	620	630	625	99.8%	0.7011	0.2982