บรรณานุกรม

[1] http://www.eppo.co.th

[2] http://www.9engineer.com

[3] http://www.future-mag.com/0706/0706270.asp

[4] http://electronicdesign.com/Content/UserStorage/15001/61314-table-1.jpg

[5] http://www.sizes.com/units/CRI.htm

[6] http://www.bloggang.com/viewdiary.php?id=sugarandbananaleaf&month=08-2010&date=20&group=14&gblog=1

[7] http://en.wikipedia.org/wiki/CIE_1931_color_space

[8] http://www.futurelightingsolutions.com/en/Pages/index.aspx

[9] http://www.future-mag.com/0801/080119.asp

[10] Datasheet of Nichia รุ่น NS6W083BT และ NS3W183

[11] ชำนาญ ห่อเกียรติ, "เทคนิคการส่องสว่าง," กรุงเทพมหานคร, มหาวิทยาลัยเกษตรศาสตร์, 2540

[12] ศุลี บรรจลจิตร, "หลักการ และเทคนิค การออกแบบระบบไฟฟ้ากำลัง," บริษัท ซีเอ็ดยูเคชั่น จำกัด (มหาชน), 2537

[13] Jianwen Shao, "Single Stage Offline LED Driver," in IEEE APEC'09, 2009, pp. 582 – 586.

[14] Liu YU and Jinming YANG, "The Topologies of White LED Lamps' Power Drivers," in *Proc. IEEE PESA'09*, 2009, pp. 1 – 6.

[15] Tzuen-Lih Chern, Li-Hsiang Liu, Ping-Lung Pan, and Yi-Jie Lee, "Single-Stage Flyback Converter for Constant Current Output LED Driver with Power Factor Correction," in *Proc. IEEE ICIEA'09*, 2009, pp. 2891 – 2896.

[16] M. Rico-Secades, A. J. Calleja, J. Cardesin, J. Ribas, E. L. Corominas, J. M. Alonso, and J. Garcia, "Driver for high efficiency LED based on flyback stage with current mode control for emergency lighting system," in *Proc. IEEE IAS'04*, 2004, vol. 3, pp. 1655 – 1659.

ภาคผนวก ก

หน่วยมาตราฐาน International System of Units (SI) ของแสง

ปริมาณ	หน่วย SI	ตัวย่อ	หมายเหตุ
พลังงานการส่องสว่าง	จูล (joule)	J	
ฟลักซ์ส่องสว่าง (Luminous flux)	ลูเมน (lumen)	lm	อาจเรียกว่า กำลังของความสว่าง (Luminous power)
ความเข้มของการส่องสว่าง (Luminous intensity)	แคนเดลา (candela)	cd	
ความเข้มของความสว่าง (Luminance)	แคนเดลา/ตารางเมตร (candela per meter^2)	cd/m^2	ปริมาณแสงที่สะท้อนออกมาจากวัตถุต่อพื้นที่ ปริมาณแสงที่เท่ากันเมื่อตกกระทบลงมาบนวัตถุที่มีสีต่างกันจะมีปริมาณแสงสะท้อนกลับต่างกัน นั่นคือ ลูมิแนนซ์ ต่างกัน สาเหตุที่ต่างกันก็เนื่องมาจากสัมประสิทธิ์การสะท้อนแสงของวัสดุต่างกัน หรืออาจเรียกว่า ความหนาแน่นของความเข้มการส่องสว่าง
ความสว่าง (Illuminance)	ลักซ์ (lux) หรือ ลูเมน/ตารางเมตร	lx	หมายถึงปริมาณแสงที่กระทบลงบนวัตถุต่อพื้นที่
ประสิทธิภาพการส่องสว่าง (Luminous efficiency)	ลูเมน/วัตต์ (lumens per watt)	lm/W	
หน่วยการวัดกระแสไฟฟ้า	แอมป์แปร์ (Ampère)	A	
หน่วยการวัดแรงดันไฟฟ้า	โวลต์ (Volt)	V	
หน่วยการวัดกำลังไฟฟ้า	วัตต์ (Watt)	W	มีค่าเท่ากับผลคูณของกระแสและแรงดัน

ภาคผนวก ข
อภิธานศัพท์เทคนิค

องศาเคลวิน (Kelvin)	หมายถึง การบอกสีทางด้านการส่องสว่างมักด้วยอุณหภูมิสี ซึ่งหมายถึงสีที่เกิดจากการเผาไหม้วัสดุสีดำซึ่งมีการดูดซับความร้อนได้สมบูรณ์ด้วยอุณหภูมิที่กำหนด เช่น หลอดฟลูออเรสเซนต์คูลไวท์มีอุณหภูมิสี 6500 องศาเคลวิน หมายถึง เมื่อเผาวัตถุสีดำให้ร้อนถึงอุณหภูมิ 6500 เคลวิน วัตถุนั้นจะเปล่งแสงออกมาเป็นสีคูลไวท์หรือขาวปนน้ำเงิน เป็นต้น
ความเข้มของความสว่าง (Luminance)	หมายถึง ปริมาณแสงที่สะท้อนออกมาจากวัตถุต่อพื้นที่ มีหน่วยเป็น แคนเดลาต่อตารางเมตร ในระบบ SI หรือเป็น foot - lambert (fl.) ในระบบอังกฤษ ปริมาณแสงที่เท่ากันเมื่อตกกระทบลงมาบนวัตถุที่มีสีต่างกัน จะมีปริมาณแสงสะท้อนกลับต่างกัน นั่นคือ ลูมิแนนซ์ ต่างกัน สาเหตุที่ต่างกันก็เนื่องมาจาก สัมประสิทธิ์การสะท้อนแสงของวัสดุ ต่างกัน
อุณหภูมิสี (color temperature)	ในการกล่าวถึงอุณหภูมิสีมักพาดพิงถึงการแผ่รังสีของวัตถุดำ (black body radiation) เสมอ วัตถุดำหมายถึงวัตถุที่มีคุณสมบัติในการดูดกลืนพลังงานที่จ่ายให้แก่ตัวมันไว้ได้ทั้งหมด ไม่มีพลังงานส่วนใด พุ่งผ่านหรือสะท้อนกลับออกมาได้เลย และเมื่อคิดในแง่ของการจ่าย พลังงานวัตถุดำจึงเป็นตัวที่สามารถให้พลังงานออกมา ที่ทุกความยาวคลื่นมากกว่าแหล่งกำเนิดแสงชนิดอื่นๆ คุณลักษณะในการแผ่รังสีของวัตถุดำของ unknown area จะแสดงในรูปปริมาณ 2 ตัวคือ ค่า magnetude ของการแผ่รังสีที่ความยาวคลื่นใดๆ และค่า absolute temperature ซึ่งใช้อธิบายได้อย่างแม่นยำใน visible region ของสเปกตรัมสำหรับหลอดไส้ทังสเตน โดยวัตถุดำจะเปลี่ยนสีไปตามอุณหภูมิ ที่เพิ่มขึ้นจากแดงเป็น ส้ม เหลือง ฟ้า และขาวตามลำดับ ดังนั้นอุณหภูมิสีจึงถูกนำมาใช้ในการอธิบายสีของแหล่งกำเนิดแสง โดยเทียบกับสีของวัตถุดำเช่น สีที่ปรากฏให้เห็นของหลอดอินแคนเดสเซนต์คล้ายกับสีของวัตถุดำ เมื่อถูกเผา ที่อุณหภูมิประมาณ 3000 องศาเคลวิน (kelvin , K) เราจึงบอกว่าหลอดอินแคนเดสเซนต์มีอุณหภูมิสี 3000 องศาเคลวินเป็นต้น

ดัชนีค่าความเพี้ยนของสี (Color Rendering Index: CRI)	เป็นดัชนีแสดงค่าความเพี้ยนของสีสำหรับแหล่งกำเนิดแสงแต่ละตัวซึ่งเราสามารถเปรียบเทียบ คุณลักษณะทางแสงสีของแหล่งกำเนิดแสงต่างๆ ได้จากการนำแหล่งกำเนิดแสงแต่ละตัวมาทดสอบเทียบกับแหล่งกำเนิด แสงมาตรฐาน โดยฉายแสงของแหล่งกำเนิดที่ต้องการทดสอบและแสงมาตรฐานสลับกันลงไปแผ่นตัวอย่างสี 8 ตัวตามที่ CIE กำหนดไว้ในระบบมุนเซลคือ P, RP, R, Y, GY, G, BG, PB ทำการวิเคราะห์หาค่าความยาวคลื่นเด่น (dominant wavelength) ความบริสุทธิ์ของการกระตุ้น (excitation purity) นำค่าทั้งหมดมาเฉลี่ยและเทียบกับแหล่งกำเนิดแสง มาตรฐาน หากตำแหน่งสีของแผ่นตัวอย่างสีเมื่อถูกส่องสว่างด้วยแหล่งกำเนิดทั้งสองไม่ต่างกันเลย แสดงว่าไม่มีความเพี้ยนของสี เกิดขึ้นและค่า color rendering index ของแหล่งกำเนิดนั้นจะมีค่าสูงสุดเท่ากับ 100 ถ้าแหล่งกำเนิดที่ถูกทดสอบใดทำให้ตำแหน่งสีเปลี่ยนไปจะทำให้เกิดความเพี้ยนของสีขึ้น ตำแหน่งสียิ่งเปลี่ยนไปมากยิ่งทำให้ค่า color rendering index ลดลงซึ่งค่านี้ขึ้นอยู่กับ ❖ คุณลักษณะการสะท้อนแสงทางสเปกตรัมของแผ่นตัวอย่างสี ❖ การกระจายพลังงานทางสเปกตรัมของแหล่งกำเนิดแสงที่ถูกทดสอบ ❖ การกระจายพลังงานทางสเปกตรัมของแหล่งกำเนิดแสงมาตรฐาน การปรับตัวของตา

ภาคผนวก ค

เอกสารด้านเทคนิค Datasheet

(Nichia รุ่น NS6W083BT และ NS3W183T)

SPECIFICATIONS

(1) Absolute Maximum Ratings

Item	Symbol	Absolute Maximum Rating	Unit
Forward Current	I_F	350	mA
Pulse Forward Current	I_{FP}	600	mA
Allowable Reverse Current	I_R	85	mA
Power Dissipation	P_D	1.40	W
Operating Temperature	T_{opr}	-30~85	°C
Storage Temperature	T_{stg}	-40~100	°C
Junction Temperature	T_J	120	°C

* Absolute Maximum Ratings at T_A=25°C.
* I_{FP} conditions with pulse width ≤10ms and duty cycle ≤10%.

(2) Initial Electrical/Optical Characteristics

Item		Symbol	Condition	Typ	Unit
Forward Voltage		V_F	I_F=300mA	3.3	V
Luminous Flux		Φ_v	I_F=300mA	100	lm
Luminous Intensity		I_v	I_F=300mA	31	cd
Chromaticity Coordinate	x	-	I_F=300mA	0.344	-
	y	-	I_F=300mA	0.355	-

* Characteristics at T_A=25°C.
* Luminous Flux value is traceable to the CIE 127:2007-compliant national standards.
* The Chromaticity Coordinates are derived from the CIE 1931 Chromaticity Diagram.

NICHIA CORPORATION

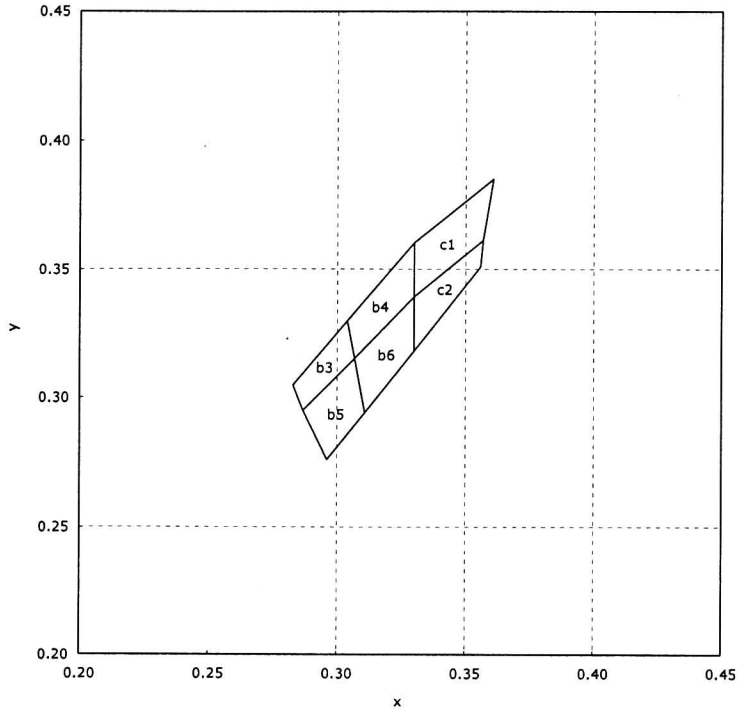
SPECIFICATIONS FOR WHITE LED

NS6W083BT

- Pb-free Reflow Soldering Application
- Built-in ESD Protection Device
- RoHS Compliant

NICHIA

CHROMATICITY DIAGRAM



RANKS

Item	Rank	Min	Max	Unit
Forward Voltage	M	3.6	4.0	V
	L	3.2	3.6	
	K	2.8	3.2	
Luminous Flux	B10	100	110	lm
	B09	90	100	
	B08	80	90	

Color Ranks

	Rank b3			
x	0.287	0.283	0.304	0.307
y	0.295	0.305	0.330	0.315

	Rank b4			
x	0.307	0.304	0.330	0.330
y	0.315	0.330	0.360	0.339

	Rank b5			
x	0.296	0.287	0.307	0.311
y	0.276	0.295	0.315	0.294

	Rank b6			
x	0.311	0.307	0.330	0.330
y	0.294	0.315	0.339	0.318

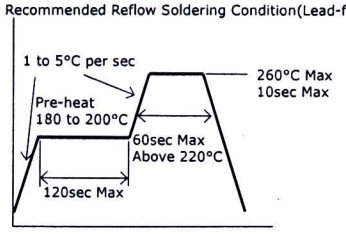
	Rank c1			
x	0.330	0.330	0.361	0.357
y	0.339	0.360	0.385	0.361

	Rank c2			
x	0.330	0.330	0.357	0.356
y	0.318	0.339	0.361	0.351

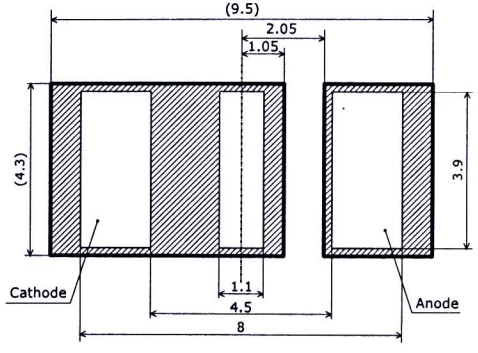
* Ranking at T_A=25°C.
* Tolerance of measurements of the Forward Voltage is ±3%.
* Tolerance of measurements of the Luminous Flux is ±10%.
* Tolerance of measurements of the Chromaticity Coordinate is ±0.01.
* Basically, a shipment shall consist of the LEDs of a combination of the above ranks. The percentage of each rank in the shipment shall be determined by Nichia.

SOLDERING

• Recommended Reflow Soldering Condition(Lead-free Solder)



• Recommended Soldering Pad Pattern



(単位 Unit: mm)

Blank boxes: Solder resist opening , Shaded areas: Footprint
Die Heat Sink and the cathode should be soldered to a PCB.

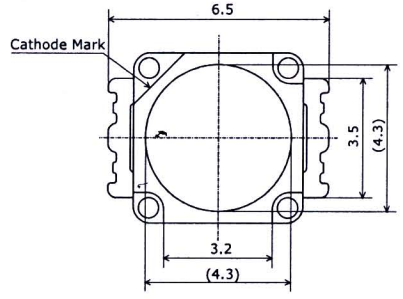
* The product is designed to be reflow soldered to a PCB. If you use dip soldering or manual soldering for the products, Nichia cannot guarantee its reliability.
* Reflow soldering must not be performed more than twice.
* Care should be taken to avoid cooling at a rapid rate and ensure the peak temperature ramps down slowly.
* Customer is advised to use nitrogen reflow soldering as air flow process can cause optical degradation due to the heat and atmosphere of reflow soldering.
* Since silicone used as encapsulating resin in this product is a soft material, do not press on the encapsulant. Failure to comply might lead to nicks, chip-outs, delamination and deformation of the encapsulant, wire breakage and an adverse effect on product reliability.
* Repairing should not be done after the LEDs have been soldered. When repairing is unavoidable, a hot plate should be used.
  It should be confirmed beforehand whether the characteristics of the LEDs will or will not be damaged by repairing.
* The Die Heat Sink should be soldered to customer PCB.
  If it is difficult or impossible, use high heat-dissipating adhesive.
* When soldering, avoid applying any stress to the LED package while heated.

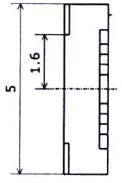
OUTLINE DIMENSIONS

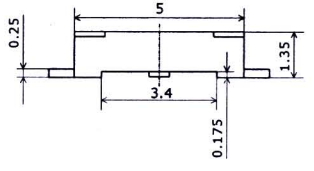
* 本製品はRoHS指令に適合しております。
  This product complies with RoHS Directive.

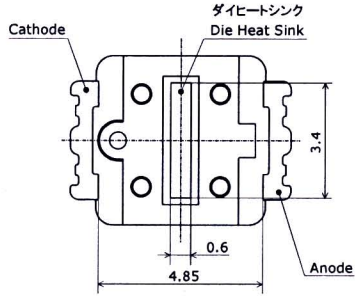
NS6x083x
管理番号 No. STS-DA7-0404

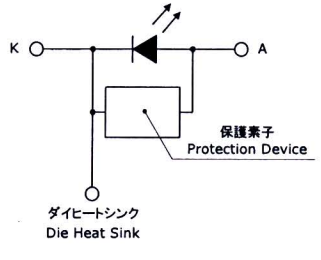
(単位 Unit: mm, 公差 Tolerance: ±0.2)









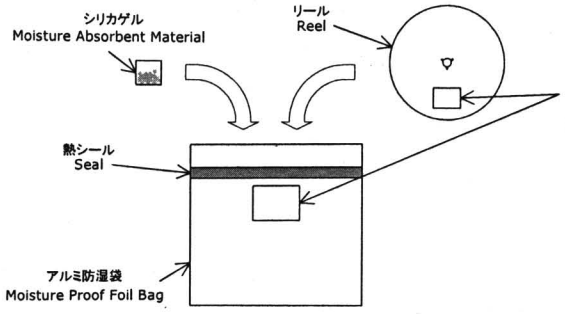


項目 Item	内容 Description
パッケージ材質 Package Materials	耐熱性ポリマー Heat-Resistant Polymer
封止樹脂材質 Encapsulating Resin Materials	シリコーン樹脂(蛍光体入り) Silicone Resin(with phosphor)
電極材質 Electrodes Materials	銅合金+銀メッキ Ag-plated Copper Alloy
ダイヒートシンク材質 Die Heat Sink Materials	銅合金+銀メッキ Ag-plated Copper Alloy
質量 Weight	0.093g(TYP)

PACKAGING - TAPE & REEL

シリカゲルとともにリールをアルミ防湿袋に入れ、熱シールにより封をします。
The reel is placed in the moisture proof bag with a moisture absorbent material. The bag is heat sealed.

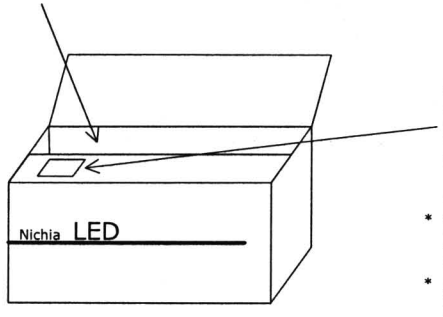
Nxxxxxxx
管理番号 No. STS-DA7-0006A



ラベル Label

NICHIA
XXXX LED
TYPE Nxxxxxxx
****
LOT YMxxxx-RRR
QTY. PCS
RoHS
NICHIA CORPORATION 491 OKA, KAMINAKA, ANAN, TOKUSHIMA, JAPAN

アルミ防湿袋を並べて入れ、ダンボールで仕切ります。
The moisture proof foil bags are packed in a cardboard box with corrugated partition.



ラベル Label

NICHIA
XXXX LED
TYPE Nxxxxxxx
****
RANK RRR
QTY. PCS
RoHS
NICHIA CORPORATION
491 OKA, KAMINAKA, ANAN, TOKUSHIMA, JAPAN

* 客先型名を*******で示します。
客先型名が設定されていない場合は空白です。
******* is the customer part number.
If not provided, it is not indicated on the label.

* ロット表記方法についてはロット番号の項を参照して下さい。
For details, see "LOT NUMBERING SCHEME" in this document.

* ランク分けがない場合はランク表記はありません。
The label does not have the RANK field for un-ranked products.

* 本製品はテーピングしたのち、輸送の衝撃から保護するためダンボールで梱包します。
The products are taped and reeled, and then packed in moisture-proof bags.
The moisture-proof bags are packed in cardboard boxes to prevent damage during shipment.

* 取り扱いに際して、落下させたり、強い衝撃を与えたりしますと、製品を損傷させる原因になりますので注意して下さい。
Do not drop the cardboard box or expose it to shock. If the box falls, the products could be damaged.

* ダンボールには防水加工がされておりませんので、梱包箱が水に濡れないよう注意して下さい。
The cardboard box is not water-resistant. Do not expose to water.

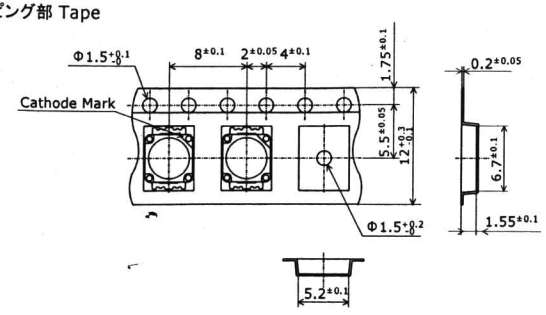
* 輸送、運搬に際して弊社よりの梱包状態あるいは同等の梱包を行って下さい。
Customer is advised to pack the products in the original packaging or equivalent in transit.

TAPE AND REEL DIMENSIONS

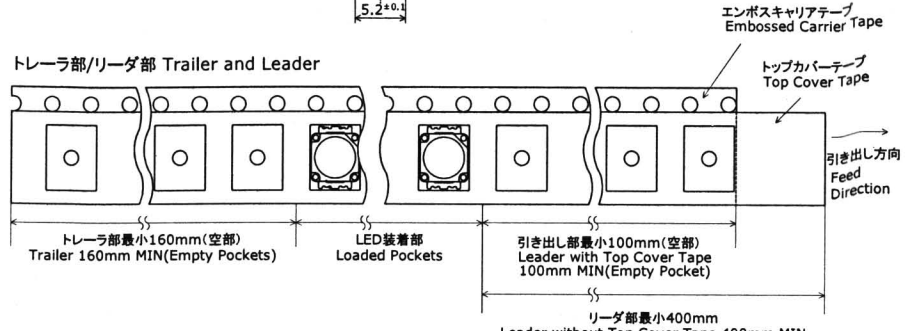
テーピング部 Tape

Nxxx083x
管理番号 No. STS-DA7-0151

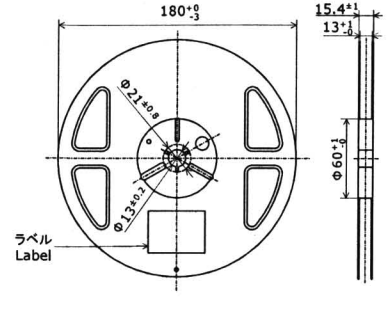
(単位 Unit: mm)



トレーラ部/リーダ部 Trailer and Leader



リール部 Reel



* 数量は1リールにつき 1400個入りです。
Quantity per reel=1400pcs

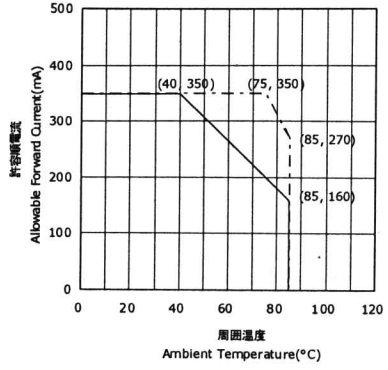
* JIS C 0806電子部品テーピングに準拠しています。
The tape packing method complies with JIS C 0806 (Packaging of Electronic Components on Continuous Tapes).

DERATING CHARACTERISTICS

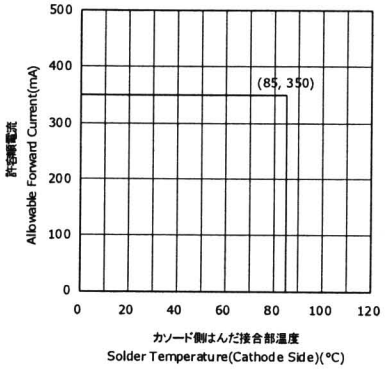
NS6x083x
管理番号 No. STS-DA7-0606A

周囲温度-許容順電流特性
Ambient Temperature vs
Allowable Forward Current

$R_{\theta JA}$ =35°C/W
$R_{\theta JA}$ =65°C/W

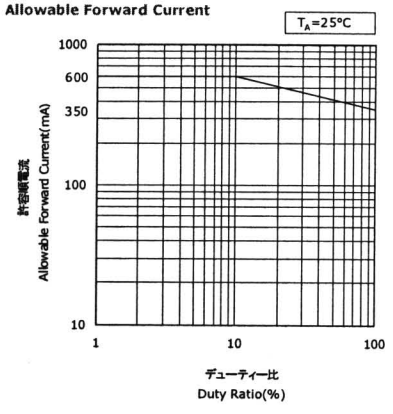


カソード側はんだ接合部温度-許容順電流特性
Solder Temperature(Cathode Side) vs
Allowable Forward Current



デューティー比-許容順電流特性
Duty Ratio vs
Allowable Forward Current

T_A=25°C



LOT NUMBERING SCHEME

Lot Number is presented by using the following alphanumeric code.

YMxxxx - RRR

Y - Year

Year	Y
2009	9
2010	A
2011	B
2012	C
2013	D
2014	E

M - Month

Month	M	Month	M
1	1	7	7
2	2	8	8
3	3	9	9
4	4	10	A
5	5	11	B
6	6	12	C

xxxx-Nichia's Product Number

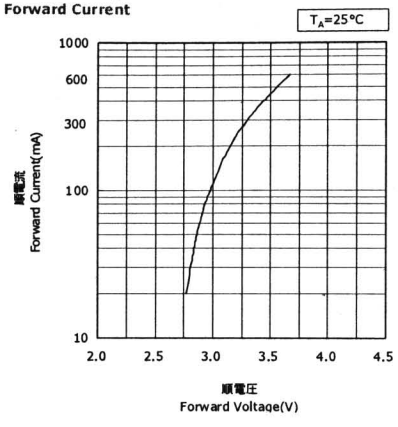
RRR-Ranking by Color Coordinates, Ranking by Luminous Flux, Ranking by Forward Voltage

FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

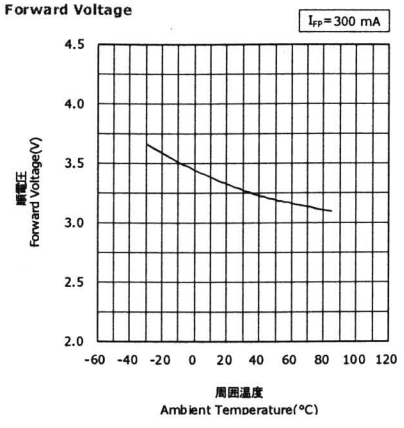
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NS6W083B
管理番号 No. STS-DA7-0618

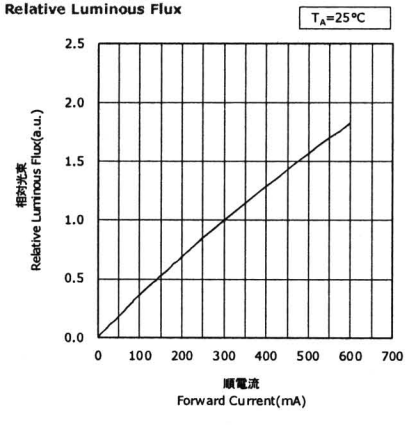
順電圧-順電流特性
Forward Voltage vs Forward Current



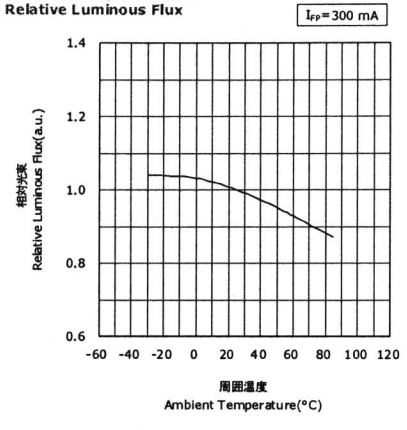
周囲温度-順電圧特性
Ambient Temperature vs Forward Voltage



順電流-相対光束特性
Forward Current vs Relative Luminous Flux



周囲温度-相対光束特性
Ambient Temperature vs Relative Luminous Flux

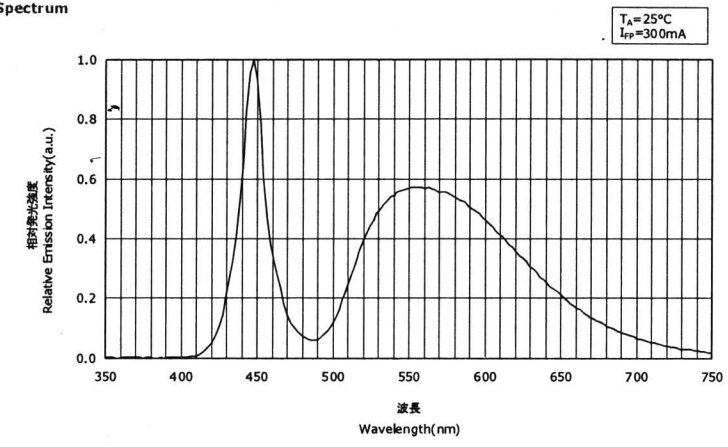


OPTICAL CHARACTERISTICS

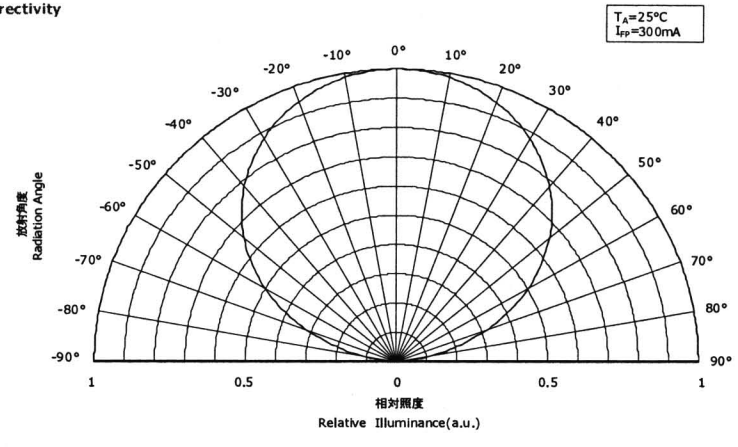
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NS6W083B
管理番号 No. STS-DA7-0617

発光スペクトル
Spectrum



指向特性
Directivity



RELIABILITY

(1) Tests and Results

Test	Reference Standard	Test Conditions	Test Duration	Failure Criteria #	Units Failed/Tested
Resistance to Soldering Heat (Reflow Soldering)	JEITA ED-4701 300 301	T_{sld}=260°C, 10sec, 2reflows, Precondition: 30°C, 70%RH, 168hr		#1	0/22
Solderability (Reflow Soldering)	JEITA ED-4701 303 303A	T_{sld}=245±5°C, 5sec, Lead-free Solder(Sn-3.0Ag-0.5Cu)		#2	0/22
Temperature Cycle	JEITA ED-4701 100 105	-40°C(30min)~25°C(5min)~ 100°C(30min)~25°C(5min)	100cycles	#1	0/50
Moisture Resistance (Cyclic)	JEITA ED-4701 200 203	25°C~65°C~-10°C, 90%RH, 24hr per cycle	10cycles	#1	0/22
High Temperature Storage	JEITA ED-4701 200 201	T_A=100°C	1000hours	#1	0/22
Temperature Humidity Storage	JEITA ED-4701 100 103	T_A=60°C, RH=90%	1000hours	#1	0/22
Low Temperature Storage	JEITA ED-4701 200 202	T_A=-40°C	1000hours	#1	0/22
Room Temperature Operating Life		T_A=25°C, I_F=350mA Test board: See NOTES below	1000hours	#1	0/22
High Temperature Operating Life		T_A=85°C, I_F=160mA Test board: See NOTES below	1000hours	#1	0/22
Temperature Humidity Operating Life		60°C, RH=90%, I_F=250mA Test board: See NOTES below	500hours	#1	0/22
Low Temperature Operating Life		T_A=-30°C, I_F=300mA Test board: See NOTES below	1000hours	#1	0/22
Vibration	JEITA ED-4701 400 403	200m/s², 100~2000~100Hz, 4cycles, 4min, each X, Y, Z	48minutes	#1	0/22
Electrostatic Discharges	JEITA ED-4701 300 304	HBM, 2kV, 1.5kΩ, 100pF, 3pulses, alternately positive or negative		#1	0/22
Board Bending	JEITA ED-4702B 003	1bend to a deflection of 3mm for 5±1sec		#1	0/22
Soldering Joint Shear Strength	JEITA ED-4702B 002 3	5N, 10±1sec		#1	0/22

NOTES:

1) Test board: FR4 board thickness=1.6mm, copper layer thickness=0.07mm, $R_{\theta JA}$≈65°C/W

2) Measurements are performed after allowing the LEDs to return to room temperature.

(2) Failure Criteria

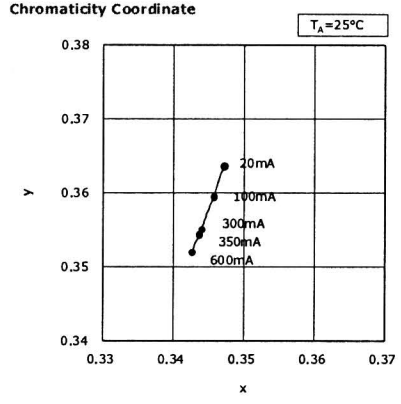
Criteria #	Items	Conditions	Failure Criteria
#1	Forward Voltage(V_F)	I_F=300mA	>Initial value×1.1
	Luminous Flux(Φ_V)	I_F=300mA	<Initial value×0.7
#2	Solderability	-	Less than 95% solder coverage

FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

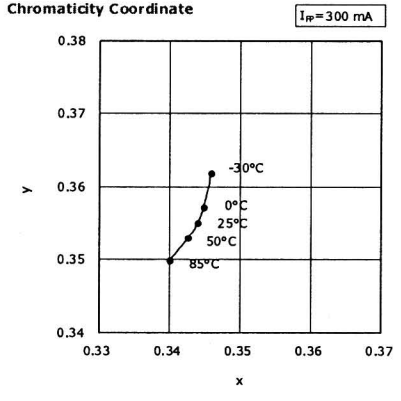
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NS6W083B
管理番号 No. STS-DA7-0619

順電流-色度特性
Forward Current vs Chromaticity Coordinate



周囲温度-色度特性
Ambient Temperature vs Chromaticity Coordinate



CAUTIONS

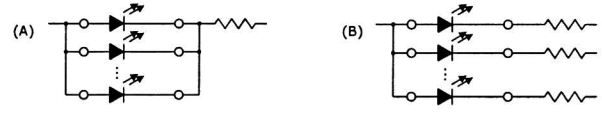
(1) Storage

Conditions		Temperature	Humidity	Time
Storage	Before Opening Aluminum Bag	≤30°C	≤90%RH	Within 1 Year from Delivery Date
	After Opening Aluminum Bag	≤30°C	≤70%RH	≤168hours
Baking		65±5°C	-	≥24hours

- This product is compliant to JEDEC MSL 3 or equivalent. See IPC/JEDEC STD-020 for the details of the moisture sensitivity levels.
- Interface delamination can occur due to vaporization and expansion of absorbed moisture in the LED packages caused by soldering heat, which may result in degradation in optical performance. To minimize moisture absorption into the products during the transportation and storage, the products are packed in a moisture-proof aluminum bag. Desiccants (silica gel) inside the packing turn from blue to red as it absorbs moisture.
- After opening the moisture-proof aluminum bag, the products should be completed soldering process within the range of the conditions above. If unused LEDs remain, they should be stored with desiccants (silica gel) in hermetically sealed container. Nichia recommends using the original moisture-proof bag for storage.
- After the "Period After Opening" specified above, or if the desiccants (silica gel) are no longer blue, the products need to be baked. Note that baking must only be done once.
- Customer is advised to keep the LEDs in an airtight container when not in use as exposure to a corrosive environment might cause the plated metal parts of the product to tarnish, which might lead to difficulties in soldering and/or adverse effects on optical characteristics. It is also recommended to return the LEDs to the original moisture proof bag and seal the moisture proof bag again.
- After assembly and during use, silver plating can be affected by the corrosive gases emitted by components and materials in close proximity of the LEDs within an end product, and the gases entering into the product from the external atmosphere. The above should be taken into consideration when designing. After assembly and during use, silver plating can be affected by the corrosive gases emitted by components and materials in close proximity of the LEDs within an end product, and the gases entering into the product from the external atmosphere. The above should be taken into consideration when designing. Resin materials, in particular, may contain substances which affects on silver plating, such as halogen.
- To avoid condensation, the products must not be stored in the areas where temperature and humidity fluctuate greatly.

(2) Directions for Use

- In designing a circuit, the current through each LED must not exceed the Absolute Maximum Rating specified for each LED. It is recommended to use Circuit B which regulates the current flowing through each LED. In the meanwhile, when driving LEDs with a constant voltage in Circuit A, the current through the LEDs may vary due to the variation in Forward Voltage characteristics of the LEDs.



- This product should be operated in forward bias. A driving circuit must be designed so that the product is not subjected to either forward or reverse voltage while it is off. In particular, if a reverse voltage is continuously applied to the product, such operation can cause migration resulting in LED damage.
- For stabilizing the LED characteristics, it is recommended to operate at 10% of the rated current or higher.
- For outdoor use, necessary measures should be taken to prevent water, moisture and salt air damage.

(3) Handling Precautions

- When handling the product, do not touch it directly with bare hands as it may contaminate the surface and affect on optical characteristics. In the worst cases, excessive force to the product might result in catastrophic failure due to package damage and/or wire breakage.
- When handling the product with tweezers, make sure that excessive force is not applied to the resin portion of the product. Failure to comply can cause the resin portion of the product to be cut, chipped, delaminated and/or deformed, and wire to be broken, and thus resulting in catastrophic failure.
- If the product is dropped, it might be damaged.
- Do not stack assembled PCBs together. Failure to comply can cause the resin portion of the product to be cut, chipped, delaminated and/or deformed, and wire to be broken, and thus resulting in catastrophic failure.

(4) Design Consideration

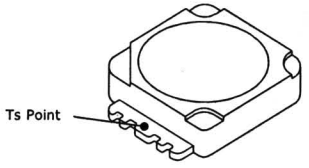
- PCB warpage after mounting the products onto a PCB can cause the package to break. The LEDs should be placed so as to minimize the stress on the LEDs due to PCB bow and twist.
- The position and orientation of the LEDs affect how much mechanical stress is exerted on the LEDs placed near the score lines. The LEDs should be placed so as to minimize the stress on the LEDs due to board flexing.
- Board separation must be performed using special jigs, not with hands.

(5) Electrostatic Discharge (ESD)

- The products are sensitive to static electricity or surge voltage. An ESD event may damage its die or reduce its reliability performance. When handling the products, measures against electro static discharge, including the followings, are strongly recommended.
  - Eliminating the charge;
  - Wrist strap, ESD footwear and garments, ESD floors
  - Grounding the equipment and tools at workstation
  - ESD table/shelf mat (conductive materials)
- Proper grounding techniques are required for all devices, equipment and machinery used in the assembly of the products. Also note that surge protection should be considered in the design of customer products.
- If tools or equipment contain insulating materials, such as glass or plastic, proper measures against electro static discharge, including the followings, are strongly recommended.
  - Dissipating the charge with conductive materials
  - Preventing the charge generation with moisture
  - Neutralizing the charge with ionizers
- When performing the characteristics inspection of the LEDs in your application, customer is advised to check on the LEDs whether or not they are damaged by ESD. Such damage can be detected during forward voltage measurement at low current. (the recommended current is 6mA or lower)
- ESD-damaged LEDs may have a current flow at low voltage.
  Failure Criteria: V_F<2.0V at I_F=3.0mA

(6) Thermal Management

- Thermal management is an important factor when designing your product by using the LEDs.
  The rise in LED die temperature can be affected by PCB thermal resistance or/and LED spacing as mounted on the board.
  Customer is advised to design the product to ensure that the LED die temperature
  does not exceed the required maximum Junction Temperature (T_J).
- Drive current should be determined for the surrounding ambient temperature (T_A) to dissipate the heat from the product.
- The following equations can be used to calculate the junction temperature of the products.
  1) $T_J=T_A+R_{\theta JA}\cdot W$ 2) $T_J=T_S+R_{\theta JS}\cdot W$
  *T_J=LED junction temperature: °C
  T_A=Ambient temperature: °C
  T_S=Soldering temperature (cathode side): °C
  $R_{\theta JA}$=Thermal resistance from junction to ambient: °C/W
  $R_{\theta JS}$=Thermal resistance from junction to T_S measuring point≈10°C/W
  W=Input power($I_F\times V_F$): W



(7) Cleaning

- If required, isopropyl alcohol (IPA) should be used. Other solvents may cause premature failure to the LEDs
  due to the damage to the resin portion. The effects of such solvents should be verified prior to use.
  In addition, the use of CFCs such as Freon is heavily regulated.
- Ultrasonic cleaning is not recommended for the LEDs since it may adversely effect on the LEDs
  by the ultrasonic power and LED assembled condition.
  If it is unavoidable, customer is advised to check prior to use that the cleaning will not damage the LEDs.

(8) Eye Safety

- The International Electrical Commission (IEC) published in 2006, IEC 62471:2006 Photobiological safety of lamps
  and lamp systems which includes LEDs within its scope. Meanwhile LEDs were removed from the scope
  of the IEC 60825-1:2007 laser safety standard, the 2001 edition of which included LED sources within its scope.
  However, keep it mind that some countries and regions have adopted standards based on the IEC laser safety standard
  IEC 60825-1:2001 which includes LEDs within its scope. Following IEC 62471:2006, most of Nichia LEDs can be classified
  as belonging to either Exempt Group or Risk Group 1. Especially a high-power LED, that emits light containing blue wavelengths,
  may be in Risk Group 2. Great care should be taken when viewing directly the LED driven at high current or the LED
  with optical instruments, which greatly increase the hazard to your eyes.
- Viewing a flashing light may cause eye discomfort. When incorporating the LED into your product,
  precaution should be taken to avoid adverse effect on human body caused by the light stimulus.

(9) Others

- The LEDs described in this brochure are intended to be used for ordinary electronic equipment (such as office equipment,
  communications equipment, measurement instruments and household appliances).
  Consult Nichia's sales staff in advance for information on the applications in which exceptional quality
  and reliability are required, particularly when the failure or malfunction of the LEDs may directly jeopardize life or
  health (such as for airplanes, aerospace, submersible repeaters, nuclear reactor control system, automobiles,
  traffic control equipment, life support systems and safety devices).
- The customer shall not reverse engineer by disassembling or analysis of the LEDs without having prior written consent
  from Nichia. When defective LEDs are found, the customer shall inform Nichia directly before disassembling or analysis.
- Customer and Nichia shall agree the official specification of supplied products prior to the start of a customer's volume production.
- The appearance and specifications of the product may be modified for improvement without notice.

SPECIFICATIONS

(1) Absolute Maximum Ratings

Item	Symbol	Absolute Maximum Rating	Unit
Forward Current	I_F	400	mA
Pulse Forward Current	I_{FP}	600	mA
Allowable Reverse Current	I_R	85	mA
Power Dissipation	P_D	1.60	W
Operating Temperature	T_{opr}	-40~100	°C
Storage Temperature	T_{stg}	-40~100	°C
Junction Temperature	T_J	135	°C

* Absolute Maximum Ratings at T_A=25°C.
* I_{FP} conditions with pulse width ≤10ms and duty cycle ≤10%.

(2) Initial Electrical/Optical Characteristics

Item		Symbol	Condition	Typ	Unit
Forward Voltage		V_F	I_F=350mA	3.5	V
Luminous Flux		Φ_v	I_F=350mA	120	lm
Luminous Intensity		I_v	I_F=350mA	40	cd
Chromaticity Coordinate	x	-	I_F=350mA	0.344	-
	y	-	I_F=350mA	0.355	-

* Characteristics at T_A=25°C.
* Luminous Flux value is traceable to the CIE 127:2007-compliant national standards.
* The Chromaticity Coordinates are derived from the CIE 1931 Chromaticity Diagram.

NICHIA STS-DA1-1449A <Cat.No.110310>

NICHIA CORPORATION

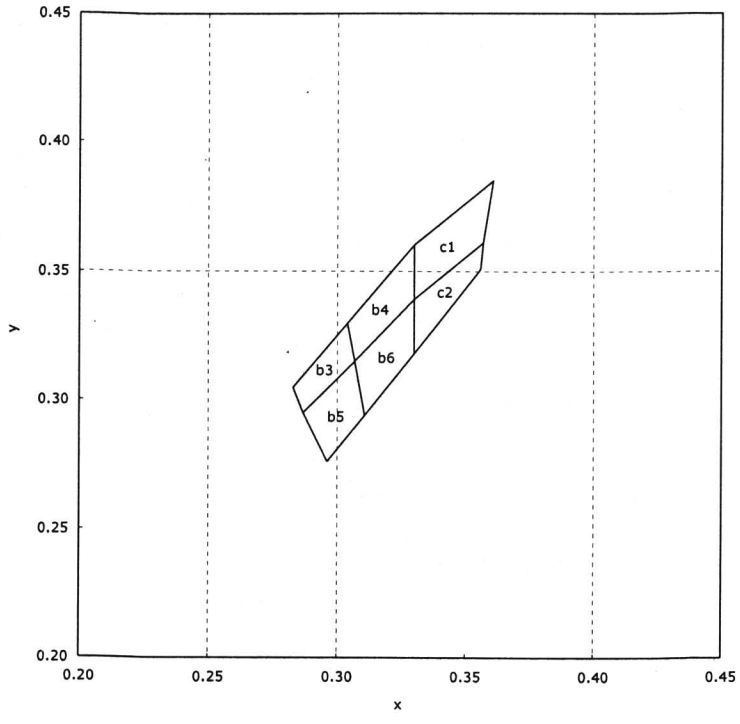
SPECIFICATIONS FOR WHITE LED

NS3W183T

- Pb-free Reflow Soldering Application
- Built-in ESD Protection Device
- RoHS Compliant

NICHIA

CHROMATICITY DIAGRAM



RANKS

Item	Rank	Min	Max	Unit
Forward Voltage	M	3.6	4.0	V
	L	3.2	3.6	
	K	2.8	3.2	
Luminous Flux	B12	120	130	lm
	B11	110	120	
	B10	100	110	

Color Ranks

	Rank b3			
x	0.287	0.283	0.304	0.307
y	0.295	0.305	0.330	0.315

	Rank b4			
x	0.307	0.304	0.330	0.330
y	0.315	0.330	0.360	0.339

	Rank b5			
x	0.296	0.287	0.307	0.311
y	0.276	0.295	0.315	0.294

	Rank b6			
x	0.311	0.307	0.330	0.330
y	0.294	0.315	0.339	0.318

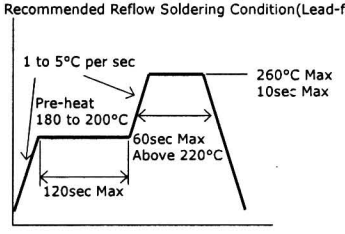
	Rank c1			
x	0.330	0.330	0.361	0.357
y	0.339	0.360	0.385	0.361

	Rank c2			
x	0.330	0.330	0.357	0.356
y	0.318	0.339	0.361	0.351

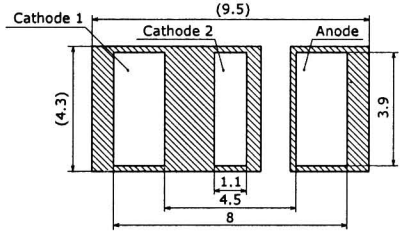
* Ranking at T_A=25°C.
* Tolerance of measurements of the Forward Voltage is ±3%.
* Tolerance of measurements of the Luminous Flux is ±7%.
* Tolerance of measurements of the Chromaticity Coordinate is ±0.01.
* Basically, a shipment shall consist of the LEDs of a combination of the above ranks. The percentage of each rank in the shipment shall be determined by Nichia.

SOLDERING

• Recommended Reflow Soldering Condition(Lead-free Solder)



• Recommended Soldering Pad Pattern



(単位 Unit: mm)

Blank boxes: Solder resist opening , Shaded areas: Footprint
Cathode 1 and Cathode 2 should be soldered to a PCB.

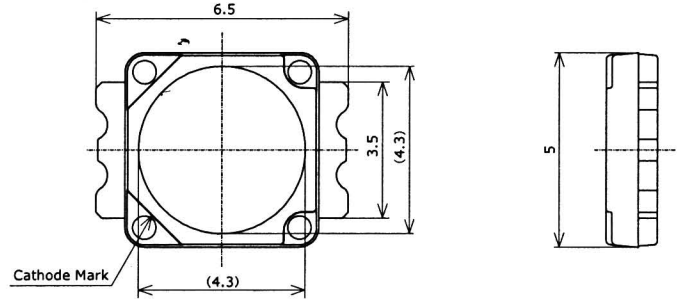
* The product is designed to be reflow soldered to a PCB. If you use dip soldering or manual soldering for the products, Nichia cannot guarantee its reliability.
* Reflow soldering must not be performed more than twice.
* Care should be taken to avoid cooling at a rapid rate and ensure the peak temperature ramps down slowly.
* Customer is advised to use nitrogen reflow soldering as air flow process can cause optical degradation due to the heat and atmosphere of reflow soldering.
* Since silicone used as encapsulating resin in this product is a soft material, do not press on the encapsulant. Failure to comply might lead to nicks, chip-outs, delamination and deformation of the encapsulant, wire breakage and an adverse effect on product reliability.
* Repairing should not be done after the LEDs have been soldered. When repairing is unavoidable, a hot plate should be used.
It should be confirmed beforehand whether the characteristics of the LEDs will or will not be damaged by repairing.
* The Cathode 2 should be soldered to customer PCB.
If it is difficult or impossible, use high heat-dissipating adhesive.
* When soldering, avoid applying any stress to the LED package while heated.

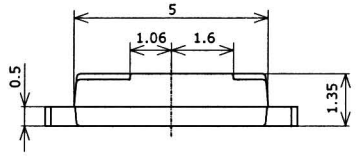
OUTLINE DIMENSIONS

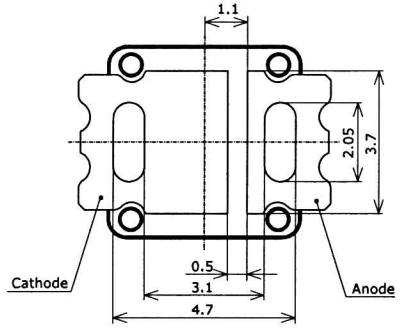
* 本製品はRoHS指令に適合しております。
This product complies with RoHS Directive.

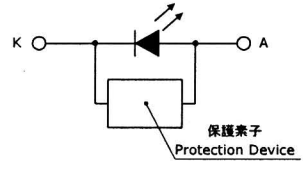
NSxW183x
管理番号 No. STS-DA7-0379A

(単位 Unit: mm, 公差 Tolerance: ±0.2)







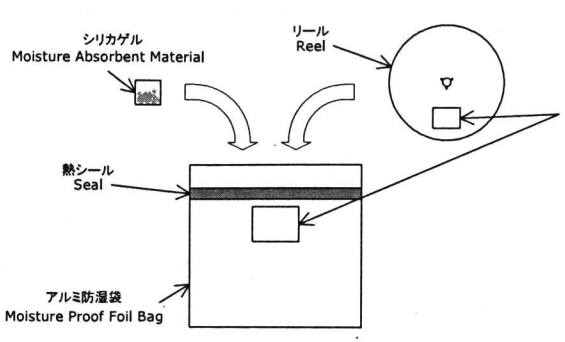


項目 Item	内容 Description
パッケージ材質 Package Materials	耐熱性ポリマー Heat-Resistant Polymer
封止樹脂材質 Encapsulating Resin Materials	シリコーン樹脂 (拡散剤+蛍光体入り) Silicone Resin (with diffuser and phosphor)
電極材質 Electrodes Materials	銅合金+銀メッキ Ag-plated Copper Alloy
質量 Weight	0.13g(TYP)

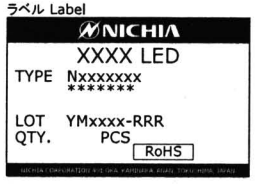
PACKAGING - TAPE & REEL

シリカゲルとともにリールをアルミ防湿袋に入れ、熱シールにより封をします。
The reel is placed in the moisture proof bag with a moisture absorbent material. The bag is heat sealed.

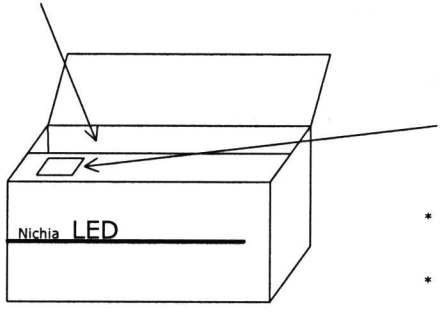
Nxxxxxxx
管理番号 No. STS-DA7-0006A



ラベル Label



アルミ防湿袋を並べて入れ、ダンボールで仕切ります。
The moisture proof foil bags are packed in a cardboard box with corrugated partition.



ラベル Label

* 客先型名を*******で示します。
客先型名が設定されていない場合は空白です。
******* is the customer part number.
If not provided, it is not indicated on the label.

* ロット表記方法についてはロット番号の項を参照して下さい。
For details, see "LOT NUMBERING SCHEME" in this document.

* ランク分けがない場合はランク表記はありません。
The label does not have the RANK field for un-ranked products.

* 本製品はテーピングしたのち、輸送の衝撃から保護するためダンボールで梱包します。
The products are taped and reeled, and then packed in moisture-proof bags.
The moisture-proof bags are packed in cardboard boxes to prevent damage during shipment.

* 取り扱いに際して、落下させたり、強い衝撃を与えたりしますと、製品を損傷させる原因になりますので注意して下さい。
Do not drop the cardboard box or expose it to shock. If the box falls, the products could be damaged.

* ダンボールには防水加工がされておりませんので、梱包箱が水に濡れないよう注意して下さい。
The cardboard box is not water-resistant. Do not expose to water.

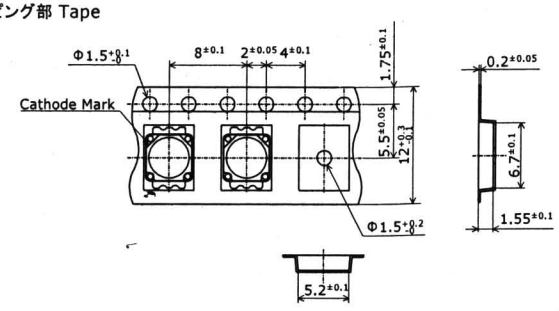
* 輸送、運搬に際して弊社よりの梱包状態あるいは同等の梱包を行って下さい。
Customer is advised to pack the products in the original packaging or equivalent in transit.

TAPE AND REEL DIMENSIONS

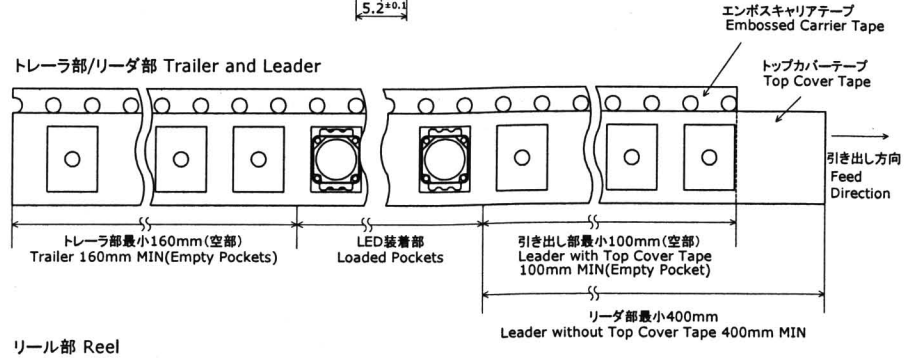
テーピング部 Tape

Nxxx183x
管理番号 No. STS-DA7-0152A

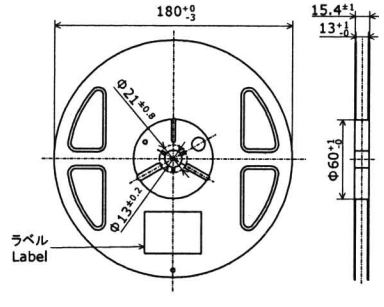
(単位 Unit: mm)



トレーラ部/リーダ部 Trailer and Leader



リール部 Reel



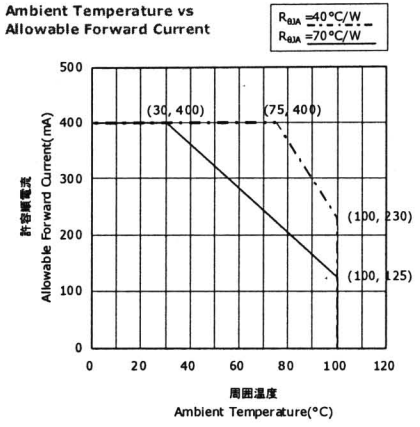
* 数量は1リールにつき 1400個入りです。
Quantity per reel=1400pcs

* JIS C 0806電子部品テーピングに準拠しています。
The tape packing method complies with JIS C 0806 (Packaging of Electronic Components on Continuous Tapes).

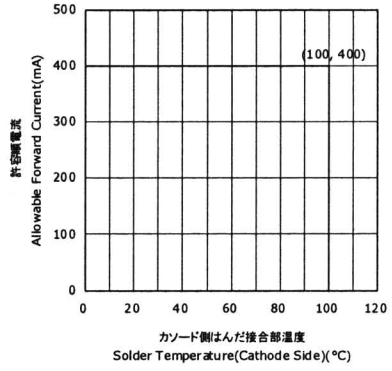
DERATING CHARACTERISTICS

NS3W183
管理番号 No. STS-DA7-0683

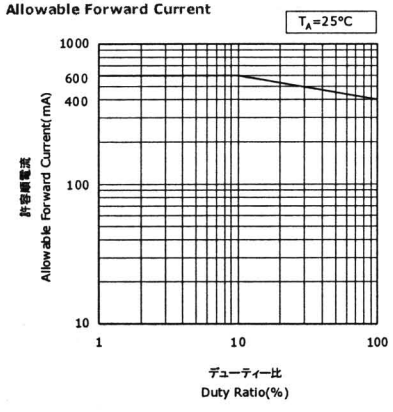
周囲温度-許容順電流特性
Ambient Temperature vs
Allowable Forward Current



カソード側はんだ接合部温度-許容順電流特性
Solder Temperature(Cathode Side) vs
Allowable Forward Current



デューティー比-許容順電流特性
Duty Ratio vs
Allowable Forward Current



LOT NUMBERING SCHEME

Lot Number is presented by using the following alphanumeric code.

YMxxxx - RRR

Y - Year

Year	Y
2009	9
2010	A
2011	B
2012	C
2013	D
2014	E

M - Month

Month	M	Month	M
1	1	7	7
2	2	8	8
3	3	9	9
4	4	10	A
5	5	11	B
6	6	12	C

xxxx-Nichia's Product Number

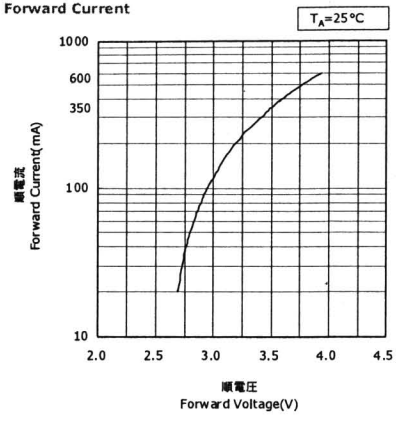
RRR-Ranking by Color Coordinates, Ranking by Luminous Flux, Ranking by Forward Voltage

FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

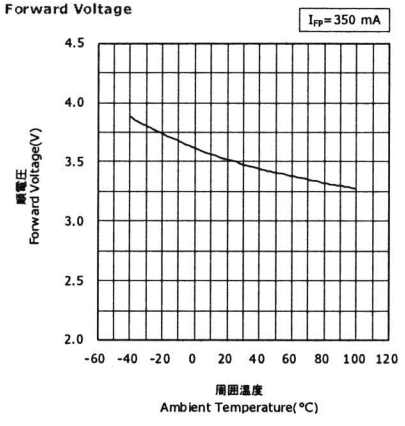
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NS3W183
管理番号 No. STS-DA7-0685

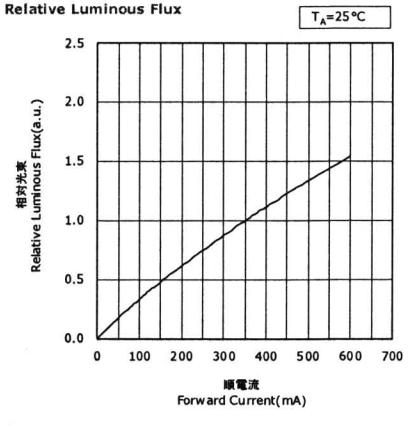
順電圧-順電流特性
Forward Voltage vs
Forward Current



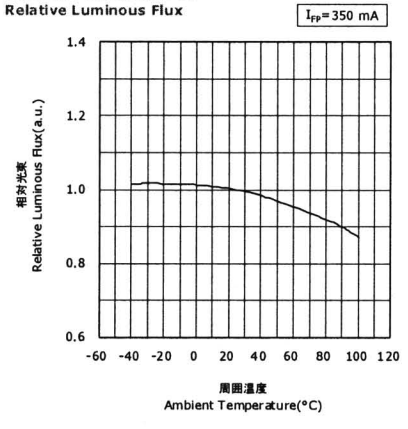
周囲温度-順電圧特性
Ambient Temperature vs
Forward Voltage



順電流-相対光束特性
Forward Current vs
Relative Luminous Flux



周囲温度-相対光束特性
Ambient Temperature vs
Relative Luminous Flux

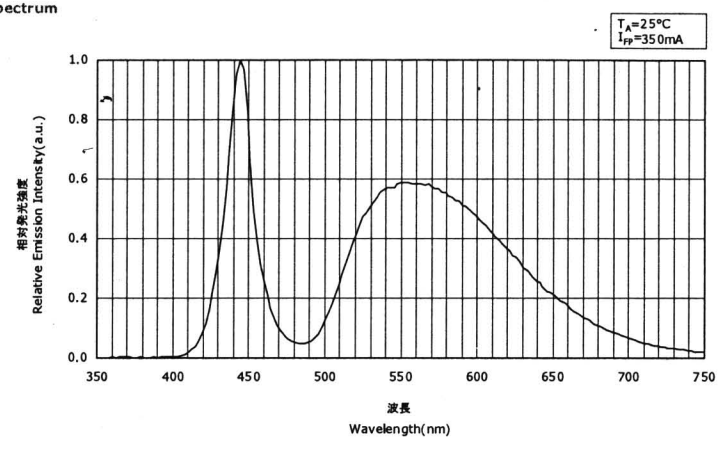


OPTICAL CHARACTERISTICS

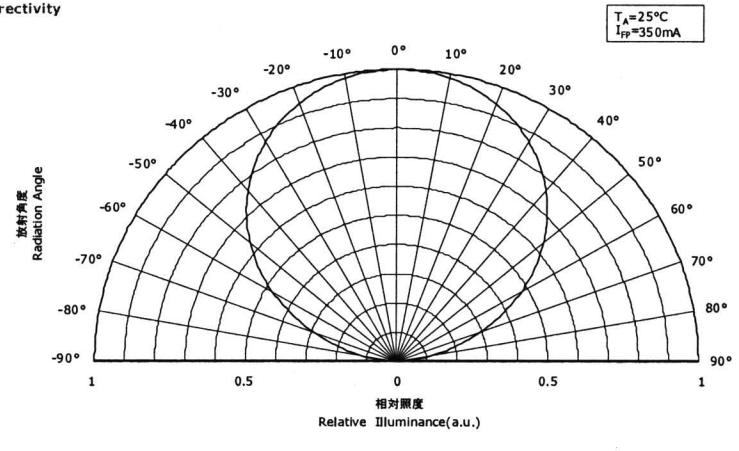
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NS3W183
管理番号 No. STS-DA7-0684

発光スペクトル
Spectrum



指向特性
Directivity



RELIABILITY

(1) Tests and Results

Test	Reference Standard	Test Conditions	Test Duration	Failure Criteria #	Units Failed/Tested
Resistance to Soldering Heat (Reflow Soldering)	JEITA ED-4701 300 301	T_{sld}=260°C, 10sec, 2reflows, Precondition: 30°C, 70%RH, 168hr		#1	0/22
Solderability (Reflow Soldering)	JEITA ED-4701 303 303A	T_{sld}=245±5°C, 5sec, Lead-free Solder(Sn-3.0Ag-0.5Cu)		#2	0/22
Temperature Cycle	JEITA ED-4701 100 105	-40°C(30min)~25°C(5min)~ 100°C(30min)~25°C(5min)	100cycles	#1	0/50
Moisture Resistance (Cyclic)	JEITA ED-4701 200 203	25°C~65°C~-10°C, 90%RH, 24hr per cycle	10cycles	#1	0/22
High Temperature Storage	JEITA ED-4701 200 201	T_A=100°C	1000hours	#1	0/22
Temperature Humidity Storage	JEITA ED-4701 100 103	T_A=60°C, RH=90%	1000hours	#1	0/22
Low Temperature Storage	JEITA ED-4701 200 202	T_A=-40°C	1000hours	#1	0/22
Room Temperature Operating Life		T_A=25°C, I_F=400mA Test board: See NOTES below	1000hours	#1	0/22
High Temperature Operating Life		T_A=100°C, I_F=125mA Test board: See NOTES below	1000hours	#1	0/22
Temperature Humidity Operating Life		60°C, RH=90%, I_F=250mA Test board: See NOTES below	500hours	#1	0/22
Low Temperature Operating Life		T_A=-40°C, I_F=350mA Test board: See NOTES below	1000hours	#1	0/22
Vibration	JEITA ED-4701 400 403	200m/s^2, 100~2000~100Hz, 4cycles, 4min, each X, Y, Z	48minutes	#1	0/22
Electrostatic Discharges	JEITA ED-4701 300 304	HBM, 2kV, 1.5kΩ, 100pF, 3pulses, alternately positive or negative		#1	0/22
Soldering Joint Shear Strength	JEITA ED-4702B 002 3	5N, 10±1sec		#1	0/22

NOTES:

1) Test board: FR4 board thickness=1.6mm, copper layer thickness=0.07mm, $R_{\theta JA}$≈70°C/W

2) Measurements are performed after allowing the LEDs to return to room temperature.

(2) Failure Criteria

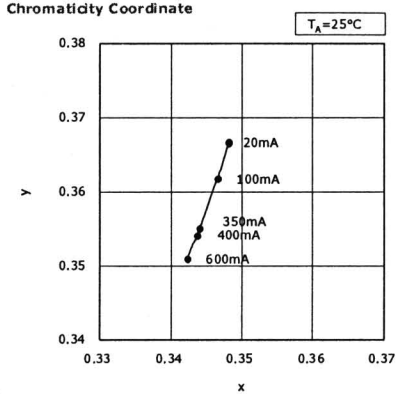
Criteria #	Items	Conditions	Failure Criteria
#1	Forward Voltage(V_F)	I_F=350mA	>Initial value×1.1
	Luminous Flux(Φ_V)	I_F=350mA	<Initial value×0.7
#2	Solderability	-	Less than 95% solder coverage

FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

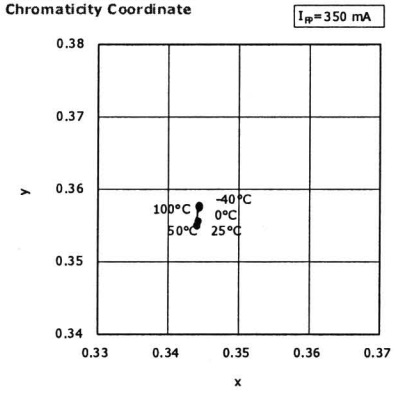
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NS3W183
管理番号 No. STS-DA7-0686

順電流-色度特性
Forward Current vs Chromaticity Coordinate



周囲温度-色度特性
Ambient Temperature vs Chromaticity Coordinate



CAUTIONS

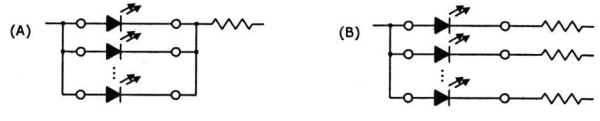
(1) Storage

	Conditions	Temperature	Humidity	Time
Storage	Before Opening Aluminum Bag	≤30°C	≤90%RH	Within 1 Year from Delivery Date
	After Opening Aluminum Bag	≤30°C	≤70%RH	≤168hours
Baking		65±5°C	-	≥24hours

- This product is compliant to JEDEC MSL 3 or equivalent. See IPC/JEDEC STD-020 for the details of the moisture sensitivity levels.
- Interface delamination can occur due to vaporization and expansion of absorbed moisture in the LED packages caused by soldering heat, which may result in degradation in optical performance. To minimize moisture absorption into the products during the transportation and storage, the products are packed in a moisture-proof aluminum bag. Desiccants (silica gel) inside the packing turn from blue to red as it absorbs moisture.
- After opening the moisture-proof aluminum bag, the products should be completed soldering process within the range of the conditions above. If unused LEDs remain, they should be stored with desiccants (silica gel) in hermetically sealed container. Nichia recommends using the original moisture-proof bag for storage.
- After the "Period After Opening" specified above, or if the desiccants (silica gel) are no longer blue, the products need to be baked. Note that baking must only be done once.
- Customer is advised to keep the LEDs in an airtight container when not in use as exposure to a corrosive environment might cause the plated metal parts of the product to tarnish, which might lead to difficulties in soldering and/or adverse effects on optical characteristics. It is also recommended to return the LEDs to the original moisture proof bag and seal the moisture proof bag again.
- After assembly and during use, silver plating can be affected by the corrosive gases emitted by components and materials in close proximity of the LEDs within an end product, and the gases entering into the product from the external atmosphere. The above should be taken into consideration when designing. After assembly and during use, silver plating can be affected by the corrosive gases emitted by components and materials in close proximity of the LEDs within an end product, and the gases entering into the product from the external atmosphere. The above should be taken into consideration when designing. Resin materials, in particular, may contain substances which affects on silver plating, such as halogen.
- To avoid condensation, the products must not be stored in the areas where temperature and humidity fluctuate greatly.

(2) Directions for Use

- In designing a circuit, the current through each LED must not exceed the Absolute Maximum Rating specified for each LED. It is recommended to use Circuit B which regulates the current flowing through each LED. In the meanwhile, when driving LEDs with a constant voltage in Circuit A, the current through the LEDs may vary due to the variation in Forward Voltage characteristics of the LEDs.



- This product should be operated in forward bias. A driving circuit must be designed so that the product is not subjected to either forward or reverse voltage while it is off. In particular, if a reverse voltage is continuously applied to the product, such operation can cause migration resulting in LED damage.
- For stabilizing the LED characteristics, it is recommended to operate at 10% of the rated current or higher.
- For outdoor use, necessary measures should be taken to prevent water, moisture and salt air damage.

(3) Handling Precautions

- When handling the product, do not touch it directly with bare hands as it may contaminate the surface and affect on optical characteristics. In the worst cases, excessive force to the product might result in catastrophic failure due to package damage and/or wire breakage.
- When handling the product with tweezers, make sure that excessive force is not applied to the resin portion of the product. Failure to comply can cause the resin portion of the product to be cut, chipped, delaminated and/or deformed, and wire to be broken, and thus resulting in catastrophic failure.
- If the product is dropped, it might be damaged.
- Do not stack assembled PCBs together. Failure to comply can cause the resin portion of the product to be cut, chipped, delaminated and/or deformed, and wire to be broken, and thus resulting in catastrophic failure.

(4) Design Consideration

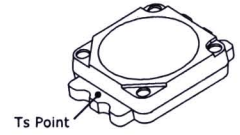
- PCB warpage after mounting the products onto a PCB can cause the package to brake. The LEDs should be placed so as to minimize the stress on the LEDs due to PCB bow and twist.
- The position and orientation of the LEDs affect how much mechanical stress is exerted on the LEDs placed near the score lines. The LEDs should be placed so as to minimize the stress on the LEDs due to board flexing.
- Board separation must be performed using special jigs, not with hands.

(5) Electrostatic Discharge (ESD)

- The products are sensitive to static electricity or surge voltage. An ESD event may damage its die or reduce its reliability performance. When handling the products, measures against electro static discharge, including the followings, are strongly recommended.
  - Eliminating the charge;
  - Wrist strap, ESD footwear and garments, ESD floors
  - Grounding the equipment and tools at workstation
  - ESD table/shelf mat (conductive materials)
- Proper grounding techniques are required for all devices, equipment and machinery used in the assembly of the products. Also note that surge protection should be considered in the design of customer products.
- If tools or equipment contain insulating materials, such as glass or plastic, proper measures against electro static discharge, including the followings, are strongly recommended.
  - Dissipating the charge with conductive materials
  - Preventing the charge generation with moisture
  - Neutralizing the charge with ionizers
- When performing the characteristics inspection of the LEDs in your application, customer is advised to check on the LEDs whether or not they are damaged by ESD. Such damage can be detected during forward voltage measurement at low current. (the recommended current is 3mA or lower)
- ESD-damaged LEDs may have a current flow at low voltage.
  - Failure Criteria: V_F<2.0V at I_F=1.5mA

(6) Thermal Management

- Thermal management is an important factor when designing your product by using the LEDs.
  The rise in LED die temperature can be affected by PCB thermal resistance or/and LED spacing as mounted on the board.
  Customer is advised to design the product to ensure that the LED die temperature
  does not exceed the required maximum Junction Temperature (T_J).
- Drive current should be determined for the surrounding ambient temperature (T_A) to dissipate the heat from the product.
- The following equations can be used to calculate the junction temperature of the products.
  1) $T_J=T_A+R_{\theta JA}\cdot W$ 2) $T_J=T_S+R_{\theta JS}\cdot W$
  *T_J=LED junction temperature: °C
  T_A=Ambient temperature: °C
  T_S=Soldering temperature (cathode side): °C
  $R_{\theta JA}$=Thermal resistance from junction to ambient: °C/W
  $R_{\theta JS}$=Thermal resistance from junction to T_S measuring point≈15°C/W
  W=Input power($I_F\times V_F$): W



(7) Cleaning

- If required, isopropyl alcohol (IPA) should be used. Other solvents may cause premature failure to the LEDs
  due to the damage to the resin portion. The effects of such solvents should be verified prior to use.
  In addition, the use of CFCs such as Freon is heavily regulated.
- Ultrasonic cleaning is not recommended for the LEDs since it may adversely effect on the LEDs
  by the ultrasonic power and LED assembled condition.
  If it is unavoidable, customer is advised to check prior to use that the cleaning will not damage the LEDs.

(8) Eye Safety

- The International Electrical Commission (IEC) published in 2006, IEC 62471:2006 Photobiological safety of lamps
  and lamp systems which includes LEDs within its scope. Meanwhile LEDs were removed from the scope
  of the IEC 60825-1:2007 laser safety standard, the 2001 edition of which included LED sources within its scope.
  However, keep it mind that some countries and regions have adopted standards based on the IEC laser safety standard
  IEC 60825-1:2001 which includes LEDs within its scope. Following IEC 62471:2006, most of Nichia LEDs can be classified
  as belonging to either Exempt Group or Risk Group 1. Especially a high-power LED, that emits light containing blue wavelengths,
  may be in Risk Group 2. Great care should be taken when viewing directly the LED driven at high current or the LED
  with optical instruments, which greatly increase the hazard to your eyes.
- Viewing a flashing light may cause eye discomfort. When incorporating the LED into your product,
  precaution should be taken to avoid adverse effect on human body caused by the light stimulus.

(9) Others

- The LEDs described in this brochure are intended to be used for ordinary electronic equipment (such as office equipment,
  communications equipment, measurement instruments and household appliances).
  Consult Nichia's sales staff in advance for information on the applications in which exceptional quality
  and reliability are required, particularly when the failure or malfunction of the LEDs may directly jeopardize life or
  health (such as for airplanes, aerospace, submersible repeaters, nuclear reactor control system, automobiles,
  traffic control equipment, life support systems and safety devices).
- The customer shall not reverse engineer by disassembling or analysis of the LEDs without having prior written consent
  from Nichia. When defective LEDs are found, the customer shall inform Nichia directly before disassembling or analysis.
- Customer and Nichia shall agree the official specification of supplied products prior to the start of a customer's volume production.
- The appearance and specifications of the product may be modified for improvement without notice.