

Report No.: SLED-19-031-R02



Test Report

IES LM-80-15 Approved Method for Measuring Lumen Maintenance of LED Light Sources

Report no.: SLED-19-031-R02
Testing start date: 2017.07.28
Testing completion date: 2019.08.27
Report issued date: 2019.05.31
Report revised date: 2020.05.21

Client	Testing performed by
SAMSUNG ELECTRONICS LED BUSINESS Lighting Marketing Group	SAMSUNG ELECTRONICS LED BUSINESS 1, Samsung-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17113, Korea e-mail) kwon.sc@samsung.com
Tested By	Technical Manager
KyungYeup Kwak	DooSung Park
Test Personal Name & Signatory	Approval Name & Signatory

The above test report is the accredited test result by Korea Laboratory Accreditation Scheme, which signed the ILAC-MRA.

* If you need confirmation about the authenticity of the test report, please contact the above contact information.

SAMSUNG ELECTRONICS LED BUSINESS

Accredited by KOLAS, Republic of KOREA



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■ Test Report Information

- 1. This test report complies with KS Q ISO/IEC 17025 and KOLAS accreditation regulations.
- 2.
 ☐ This test report does not comply with KS Q ISO/IEC 17025 and KOLAS accreditation regulations.
- 3. The test results are limited to samples provided by the client and cannot be partially replicated without the approval of this authority, except as a whole.
- 4. If a statement of conformity is provided in this report, the applied decision rule does not apply the measurement uncertainty except for the case where the measurement uncertainty is mentioned in the above test method.
- 5. The test results marked @ are not accredited by KOLAS.
- 6. The test results received from external providers for the test results marked ①.

Revision History

		Approved
ev.0 : New Version K.Y.	KWAK	D.S.PARK
		D.S.PAKK
1 : Typos Correction K.Y.	KWAK	D.S.PARK
Extended Test Duration K.Y.	KWAK	D.S.PARK



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■ Test Summary

	Life test	condition		Summary of result	
Test condition	Current (mA)	Case temperature (°C)	Test duration (h)	Average lumen maintenance (%)	Maximum chromaticity shift (△u'v')
1	1 000	55.2	17 000	98.1	0.000 8
2	1 000	85.1	17 000	97.9	0.001 4
3	1 000	105.1	17 000	96.5	0.0023

Number of the sample

- 20 Packages tested at actual case temperature 55.2 °C
- 20 Packages tested at actual case temperature 85.1 °C
- 20 Packages tested at actual case temperature 105.1 °C
- Sampling method: Minimum three manufacturing lots with each manufacturing lot built from different wafer lots built on non-consecutive days.

2. Description of LED light sources

- Tested model code: SPHWHTL3D50CE4W***

- Product series: LH351C (SPHWHTL3D50C******)

- Sample manufacturer : Samsung Electronics

Sample Type : LED Package

Package dimension: (3.5 x 3.5) mm

- Minimum die spacing : -

- CCT / CRI (Nominal): 2 700 K / 70

3. Location of Test

■ Permanent Testing Lab ☐ On Site Testing

(Address: 1, Samsung-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17113, Korea)

4. Description of auxiliary equipment and Operating time

- 1) Instrument Integrating sphere ISP1000-100
- 2) Instrument CAS140-CT
- 3) Keithley 2425 Sourcemeter
- 4) Electrical condition

- Drive current: 1 000 mA

- Typical voltage: 3.06 V

- Total input power : 3.06 W

- Average current density per LED die : 499 mA/mm²

- Average power density per LED die: 1.52 W/mm²
- * LED packages are driven with a constant direct current.
- 5) Test duration: 17 000 h

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5. Ambient conditions including airflow, temperature and relative humidity

The minimal airflow is maintained in chamber.

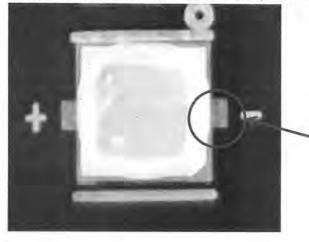
The ambient temperature around the LED packages inside chamber is controlled by air flowing and the thermocouple readings are monitored.

- Case temperature : Contorlled to -2 °C

- Surrounding air temperature : Contorlled to -5 °C

- Relative humidity : < 65 % R.H.

6. Case temperature (Test point temperature)



Case Temperature Measurement Point

7. Drive current of the LED light source during lifetime test

See Sub-clause 9.1, 9.2 and 9.3

8. Initial luminous flux and forward voltage

See the table

9. Lumen maintenance data for each individual LED light source

See the table





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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

N.	Flux (lm) Vf (V)		Lumen Maintenance (%)							
No.		h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h	
1	335.1	3.104	99.1	99.3	98.6	98.5	98.4	98.6	98.5	
2	337.7	3.053	99.1	98.8	98.6	98.4	98.4	98.4	98.1	
3	341.5	3.071	99.6	98.9	98.8	98.6	98.4	98.3	98.0	
4	332.0	3.070	99.1	98.7	98.6	98.6	98.4	98.6	98.3	
5	335.5	3.028	99.9	98.9	98.4	98.3	98.1	98.2	98.2	
6	337.9	3.098	99.4	98.8	98.3	98.4	98.4	98.6	98.6	
7	339.3	3.060	99.6	99.0	98.9	98.9	98.6	98.8	99.0	
8	341.6	3.037	99.2	98.7	98.5	98.4	98.3	98.4	98.2	
9	335.9	3.043	99.7	99.3	98.6	98.9	98.4	98.5	98.1	
10	341.9	3.020	99.6	99.1	98.8	98.6	98.5	98.4	98.2	
11	338.7	- 3.081	99.4	99.1	99.0	98.9	98.8	98.8	98.9	
12	338.3	3.050	99.0	98.9	98.6	98.3	98.3	98.2	98.1	
13	345.7	3.052	99.4	98.8	98.8	98.7	98.5	98.7	98.7	
14	343.8	3.100	100.0	98.9	98.5	98.4	98.7	98.5	98.5	
15	333.9	3.019	99.9	99.2	98.9	98.9	98.6	98.4	98.3	
16	338.1	3.053	99.2	98.8	98.7	98.6	98.6	98.4	98.4	
17	341.0	3.046	99.2	98.8	98.7	98.6	98.5	98.5	98.5	
18	342.2	3.033	99.8	99.4	98.7	98.5	98.6	98.5	98.3	
19	334.6	3.037	100.0	99.2	99.0	98.7	98.6	98.5	98.4	
20	332.0	3.104	99.8	99.5	98.8	98.9	98.8	98.8	98.6	
						30.5		33.0		
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		-							***************************************	
1.0	220.2	2.00	00.5	00.0	00.7	00.6	00.5	00.5	00.4	
Mean	338.3	3.06	99.5	99.0	98.7	98.6	98.5	98.5	98.4	
Median	338.2	3.05	99.5	98.9	98.7	98.6	98.5	98.5	98.4	
std.dev	3.8	0.03	0.3	0.2	0.2	0.2	0.2	0.2	0.3	
Max	345.7	3.10	100.0	99.5	99.0	98.9	98.8	98.8	99.0	
Min	332.0	3.02	99.0	98.7	98.3	98.3	98.1	98.2	98.0	





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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

No	Lumen Maintenance (%)											
No.	7 000 h	8 000 h	9 000 h	10 000 h			13 000 h	14 000 h	15 000			
1	98.3	98.4	98.4	98.4	98.3	98.4	98.3	98.5	98.6			
2	97.8	97.8	97.7	97.8	97.6	97.7	97.6	97.6	97.7			
3	98.1	98.1	98.1	98.2	97.9	97.9	97.8	97.9	98.0			
4	98.3	98.4	98.4	98.4	98.3	98.4	98.3	98.4	98.6			
5	98.0	98.1	97.9	97.9	97.9	97.9	97.8	97.9	97.9			
6	98.3	98.5	98.4	98.7	98.6	98.7	98.6	98.6	98.7			
7	98.7	98.7	98.6	98.6	98.6	98.5	98.5	98.6	98.6			
8	98.1	98.3	98.1	98.2	98.1	98.2	98.1	98.2	98.3			
9	97.9	98.1	98.0	97.9	97.8	97.9	97.6	97.7	97.8			
10	97.8	- 97.9	97.8	97.8	97.7	97.8	97.6	97.7	97.8			
11	98.5	98.4	98.4	98.4	98.3	98.3	98.1	98.2	98.2			
12	98.1	98.3	98.2	98.2	98.1	98.3	98.1	98.3	98.4			
13	98.5	98.7	98.6	98.5	98.5	98.5	98.4	98.4	98.4			
14	98.1	98.3	98.2	98.1	98.1	98.1	98.0	98.1	98.2			
15	98.2	98.3	98.2	98.2	98.0	98.1	97.8	98.0	98.1			
16	98.3	98.5	98.2	98.2	98.2	98.2	98.1	98.1	98.2			
17	98.4	98.6	98.4	98.4	98.3	98.4	98.3	98.4	98.5			
18	98.2	98.3	98.1	98.2	98.0	98.1	97.9	98.0	98.0			
19	98.2	98.4	98.2	98.1	98.0	98.0	97.8	97.8	97.9			
20	98.2	98.2	98.1	98.1	97.9	97.8	97.7	97.7	97.6			
	***************************************	***************************************										

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								***************************************	***************************************			
Mean	98.2	98.3	98.2	98.2	98.1	98.2	98.0	98.1	98.2			
Median	98.2	98.3	98.2	98.2	98.1	98.2	98.0	98.1	98.2			
std.dev	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3			
Max	98.7	98.7	98.6	98.7	98.6	98.7	98.6	98.6	98.7			
Min	97.8	97.8	97.7	97.8	97.6	97.7	97.6	97.6	97.6			



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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

16	Lumen Maintenance (%) 16 000 h 17 000 h 18 000 h 19 000 h 20 000 h 21 000 h 22 000 h 23 000 h 24 000 h											
No.	16 000 h	17 000 h	18 000 h					22 000 h	23 000 h	24 000 1		
1	98.5	98.6		3,0 0,0			000 11	22 000 11	25 000 11	24 000 1		
2 .	97.7	97.7										
3	97.9	97.9								***************************************		
4	98.5	98.5										
5	97.8	97.8										
6	98.7	98.6										
7	98.6	98.6					***************************************			************************		
8	98.2	98.2		***************************************	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		***************************************			••••••		
9	97.7	97.7										
10	97.5	97.6	·	***************************************								
11	98.1	98.1							:			
12	98.3	98.4										
13	98.5	98.4		***************************************								
14	98.1	98.0										
15	97.9	97.8	•••••									
16	98.1	98.2	***************************************									
17	98.4	98.5						***************************************		***************************************		
18	98.0	97.9										
19	97.8	97.7								••••••		
20	97.6	97.5		· · · · · · · · · · · · · · · · · · ·					***************************************			

	***************************************	***************************************										
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1						,,,,,,,,,,,						
					•••••				***************************************	***************************************		
										••••••		
					***************************************					***************************************		
Mean	98.1	98.1										
Median	98.1	98.1										
std.dev	0.4	0.4										
Max	98.7	98.6										
Min	97.5	97.5										





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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

Meas	urement (Current	1 000 mA								
No.	u'	V'			Chroma	aticity Shift	(∆u'v')				
140.	0	h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h		
1	0.261 1	0.526 2	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7		
2	0.262 0	0.527 4	0.000 2	0.000 4	0.000 4	0.000 5	0.000 6.	0.000 6	0.000 6		
3	0.263 4	0.529 1	0.000 1	0.000 2	0.000 3	0.000 3	0.000 4	0.000 4	0.000 4		
4	0.262 5	0.527 1	0.000 2	0.000 4	0.000 5	0.000 5	0.000 5	0.000 6	0.000 6		
5	0.263 2	0.530 0	0.000 2	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 6		
6	0.262 4	0.527 4	0.000 1	0.000 4	0.000 4	0.000 5	0.000 5	0.000 6	0.000 5		
7	0.262 3	0.527 0	0.000 5	0.000 6	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8		
8	0.262 2	0.528 5	0.000 1	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 6		
9	0.262 4	0.527 9	0.000 4	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7	0.000 8		
10	0.262 7	0.529 9	0.000 3	0.000 5	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7		
11	0.262 0	0.527 2	0.000 3	0.000 3	0.000 5	0.000 6	0.000 6	0.000 5	0.000 5		
12	0.263 4	0.528 2	0.000 3	0.000 3	0.000 5	0.000 5	0.000 5	0.000 6	0.000 6		
13	0.263 0	0.526 6	0.000 0	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6	0.000 6		
14	0.262 1	0.526 8	0.000 3	0.000 4	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6		
15	0.262 3	0.527 8	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7	0.000 8		
16	0.262 5	0.526 9	0.000 4	0.000 4	0.000 6	0.000 5	0.000 6	0.000 6	0.000 6		
17	0.262 1	0.526 8	0.000 3	0.000 5	0.000 6	0.000 6	0.000 6	0.000 7	0.000 7		
18	0.260 9	0.526 6	0.000 1	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6		
19	0.263-3	0.528 2	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 7		
20	0.262 3	0.528 0	0.000 2	0.000 4	0.000 6	0.000 5	0.000 5	0.000 6	0.000 6		
		-									
		-					/				
Mean	0.262 4	0.527 7	0.000 3	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 6		
Median	0.262 3	0.527 4	0.000 3	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6	0.000 6		
std.dev	0.000 7	0.001 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1		
Max	0.263 4	0.530 0	0.000 5	0.000 6	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8		
Min	0.260 9	0.526 2	0.000 0	0.000 2	0.000 3	0.000 3	0.000 4	0.000 4	0.000 4		



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9.1 Test condition 1

55 ℃

Drive Current

1 000 mA

Measurement Current

Meas	urement (Current	1 000 mA						
No.				Chroma	ticity Shift	: (△u'v′)			
110.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	0.000 7	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
2	0.000.6	0.000 6	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6
3	0.000 5	0.000 5	0.000 5	0.000 4	0.000 5	0.000 5	0.000 5	0.000 5	0.000 5
4	0.000 6	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
5	0.000 6	0.000 6	0.000 7	0.000 6	0.000 7	0.000 6	0.000 7	0.000 7	0.000 6
6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6
7	0.000 8	0.000 9	0.000 9	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7
9	0.000 8	0.000 8	0.000 9	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
10	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
11	0.000 6	0.000 6	0.000 6	0.000 5	0.000 6	0.000 5	0.000 6	0.000 5	0.000 5
12	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6
13	0.000 6	0.000 6	0.000 7	0.000 6	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7
14	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6
15	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 6	0.000 6
16	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 8	0.000 7	0.000 7
17	0.000 7	0.000 7	0.000 8	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 7
18	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6
19	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
20	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7
		-						***************************************	***************************************
								i.	
						1			
Mean	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
Median	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
std.dev	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1
Max	0.000 8	0.000 9	0.000 9	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
Min	0.000 5	0.000 5	0.000 5	0.000 4	0.000 5	0.000 5	0.000 5	0.000 5	0.000 5



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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

No	Chromaticity Shift (△u'v') 16 000 h 17 000 h 18 000 h 19 000 h 20 000 h 21 000 h 22 000 h 23 000 h 24 000 h											
No.	16 000 h	17 000 h	18 000 h				22 000 h	23 000 h	24 000 1			
1	0.000 8	0.000 8					774 .83.0 74.0					
2	0.000 6	0.000 6										
3	0.000 5	0.000 5		***************************************	***************************************							
4	0.000 7	0.000 8			1							
5	0.000 6	0.000 6			1		***************************************		***************************************			
6	0.000 6	0.000 6			***************************************	***************************************						
7	0.000 8	0.000 7						***************************************				
8	0.000 7	0.000 7			•••••							
9	0.000 8	0.000 8					***************************************					
10	0.000 8	0.000 8										
11	0.000 5	0.000 5							***************************************			
12	0.000 6	0.000 6										
13	0.000 7	0.000 7							•••••			
14	0.000 5	0.000 5										
15	0.000 6	0.000 6					i i					
16	0.000 7	0.000 7										
17	0.000 8	0.000 8										
18	0.000 6	0.000 6		1								
19	0.000 7	0.000 7										
20	0.000 6	0.000 6										
		- 0							7			
								-				
				,								
Mean	0.000 7	0.000 7										
Median	0.000 7	0.000 7										
std.dev	0.000 1	0.000 1										
Max	0.000 8	0.000 8	Θ									
Min	0.000 5	0.000 5										



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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

Measure	ement Current	1 000 mA						
No.				CCT (K)				
140.	0 h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	2 730	2 737	2 740	2 741	2 743	2 743	2 743	2 743
2	2 705	2 710	2 713	2 713	2 715	2 715	2 716	2 716
3	2 668	2 670	2 672	2 674	2 673	2 676	2 675	2 675
4	2 696	2 698	2 702	2 705	2 704	2 705	2 707	2 707
5	2 671	2 674	2 678	2 680	2 681	2 681	2 682	2 682
6	2 697	2 698	2 704	2 704	2 706	2 706	2 707	2 707
7	2 701	2 711	2 712	2 714	2 716	2 716	2 715	2 715
8	2 698	2 699	2 705	2 707	2 707	2 708	2 709	2 709
9	2 694	2 701	2 704	2 705	2 707	2 707	2 708	2 708
10	2 681	2 687	2 690	2 691	2 692	2 692	2 693	2 693
11	2 707	2 712	2 713	2 716	2 717	2 717	2 716	2 716
12.	2 672	2 676	2 678	2 680	2 680	2 681	2 682	2 681
13	2 688	2 688	2 695	2 697	2 696	2 698	2 699	2 699
14	2 707	2 712	2.714	2 714	2 716	2 716	2 717	2 717
15	2 697	2 705	2 706	2 708	2 709	2 710	2 709	2 711
16	2 696	2 703	2 704	2 706	2 705	2 706	2 707	2 707
17	2 706	2 711	2 714	2 717	2 717	2 717	2 718	2 718
18	2 73-2	2 733	2 740	2 740	2 742	2 743	2 744	2 744
19	2 674	2 680	2 6.81	2 683	2 684	2 685	2 684	2 685
20	2 697	2 700	2 704	2 707	2 706	2 707	2 707	2 707
						••••••		
				•••••				
			,					
Mean	2 696	2 700	2 703	2 705	2 706	2 706	2 707	2 707
Mean	2 697	2 700	2 703	2 706	2 706	2 707	2 708	2 707
Median	17	18	18	18	18	18	18	18
std.dev							2 744	
Max	2 732	2 737	2 740	2 741	2 743	2 743		2 744
Min	2 668	2 670	2 672	2 674	2 673	2 676	2 675	2 675



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9.1 Test condition 1

55 °C

Drive Current

Meas	urement (Current	1 000 mA							
No.			CCT (K)							
140.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 H	
1	2 743	2 743	2 744	2 743	2 744	2 742	2 743	2 742	2 742	
2	2 716	2.716	2 715	2 716	2 716	2 715	2 715	2 715	2 714	
3	2 676	2 676	2 676	2 675	2 676	2 675	2 675	2 675	2 674	
4	2 706	2 708	2 707	2 707	2 708	2 707	2 707	2 707	2 707	
5	2 682	2 682	2 683	2 682	2 682	2 681	2 682	2 681	2 681	
6	2 707	2 707	2 707	2 707	2 707	2 706	2 707	2 706	2 706	
7	2 716	2 716	2 716	2 715	2 716	2 714	2 715	2 714	2 713	
8	2 710	2 710	2 710	2 709	2 710	2 709	2 709	2 708	2 708	
9	2 707	2 708	2 709	2 707	2 708	2 707	2 708	2 707	2 707	
10	2 693	2 694	2 693	2 694	2 694	2 693	2 693	2 693	2 693	
11	2 717	2 717	2 717	2 716	2 716	2 715	2 715	2 714	2 714	
12	2 683	2 682	2 682	2,681	2 683	2 681	2 682	2 681	2 681	
13	2 698	2 698	2 699	2 699	2 699	2 698	2 699	2 698	2 698	
14	2 716	2 716	2 716	2 716	2 716	2 715	2 715	2 715	2 714	
15	2 709	2 710	2 710	2 709	2 709	2 708	2 708	2 707	2 706	
16	2 708	_2 708	2 709	2 707	2 709	2 707	2 708	2 707	2 707	
17	2 717	2 718	2 719	2 718	2 719	2 717	2 718	2 717	2 717	
18	2 743	2 743	2 743	2 743	2 744	2 742	2 742	2 742	2 741	
19	2 685	2 685	2 685	2 685	2 685	2 684	2 684	2 684	2 683	
20	2 708	2 708	2 708	2 707	2 708	2 707	2 707	2 706	2 706	

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	••••••••						***************************************	***************************************	***************************************	
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	***************************************	***************************************								

Mean	2 707	2 707	2 707	2 707	2 708	2 706	2 707	2 706	2 706	
Median	2 708	-2 708	2 709	2 707	2 709	2 707	2 708	2 707	2 707	
std.dev	18	18	18	1.8	18	18	18	18	18	
Max	2 743	2 743	2 744	2 743	2 744	2 742	2 743	2 742	2 742	
Min	2 676	2 676	2 676	2 675	2 676	2 675	2 675	2 675	2 674	



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9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

Meas	urement C	urrent	1 000 mA	4					
No.	, , ,				CCT (K)				
140.	16 000 h	17 000 h	18 000 h	19 000 h	20 000 h	21 000 h	22 000 h	23 000 h	24 000 h
1	2 742	2 741							
2	2 714	2 714							***************************************
3	2 674	2 674							
4	2 707	2 707							
5	2 680	2 680	Ĭ.						***************************************
6	2 705	2 705							***************************************
7	2 713	2 712							
8	2 708	2 708							,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
9.	2 706	2 706						••••••	••••••
10	2 693	2 693							***************************************
11	2 713	2 713						***************************************	***************************************
12	2 680	2 680			***************************************		***************************************		••••••
13	2 698	2 698					***************************************		***************************************
14	2 714	2 714							
15	2 706	- 2 705							***************************************
16	2 707	2 707							
17	2 717	2 716	-						
18	2 741	2 741							
19	2 683	2 683							
20	2 706	2 706					,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
•••••••••••				***************************************					
								· · · · · · · · · · · · · · · · · · ·	

Mean	2 705	⁻ 2 705							
Median	2 707	2 707			T				
std.dev	18	18	(
Max	2 742	2 741						.,,	
Min	2 674	2 674	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,						
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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

NI-	Flux (lm)	Vf (V)	Lumen Maintenance (%)								
No.	0		500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h		
1	339.4	3.084	98.9	98.9	98.8	98.7	98.2	98.3	98.1		
2	335.6	3.055	99.3	98.7	98.4	98.2	97.9	97.9	98.1		
3	344.1	3.029	99.7	99.2	99.3	99.0	98.5	98.7	98.6		
4	332.5	3.037	99.9	99.5	99.0	98.9	98.6	98.8	98.5		
5	339.4	3.043	99.3	99.4	99.2	99.0	98.7	98.6	98.4		
6	343.6	3.104	99.7	99.4	98.6	98.6	98.5	98.5	98.4		
7	334.1	3.093	99.6	98.9	98.5	98.4	98.1	98.3	98.2		
8	336.1	3.073	99.1	99.0	98.6	98.2	98.0	98.1	98.1		
9	333.9	3.058	98.9	98.7	98.5	98.4	97.9	98.0	97.9		
10	333.8	3.033	99.5	99.4	99.1	98.9	98.6	98.7	98.5		
11	342.9	3.082	99.6	98.9	98.6	98.5	98.5	98.5	98.3		
12	338.3	3.056	99.6	98.8	98.3	98.2	97.7	98.0	97.9		
13	336.8	3.041	99.3	99.0	98.7	98.1	97.8	98.0	97.9		
14	337.9	3.033	99.6	99.3	98.7	98.6	98.3	98.4	98.2		
15	335.2	3.028	99.8	99.0	98.6	98.3	98.1	98.2	98.0		
16	332.7	3.074	99.1	98.7	98.4	98.3	98.0	. 98.1	98.1		
17	331.6	3.085	99.0	98.7	98.3	98.2	97.8	97.9	97.8		
18	346.2	3.063	99.0	98.8	98.5	98.4	98.2	98.4	98.2		
19	336.9	3.105	99.3	98.9	98.7	98.4	98.2	98.4	98.3		
20	337.2	3.016	99.8	99.2	99.0	98.6	98.2	98.2	98.1		
							,				
		-			yuuuuuuu						
Mean	337.4	3.06	99.4	99.0	98.7	98.5	98.2	98.3	98.2		
Median	336.8	3.06	99.4	99.0	98.6	98.4	98.2	98.3	98.2		
std.dev	4.1	0.03	0.3	0.3	0.3	0.3	0.3	0.3	0.2		
Max	346.2	3.10	99.9	99.5	99.3	99.0	98.7	98.8	98.6		
Min	331.6	3.02	98.9	98.7	98.3	98.1	97.7	97.9	97.8		



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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

No	Lumen Maintenance (%)												
No.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000				
1	98.0	98.0	97.9	97.9	97.7	97.7	97.6	97.7	97.7				
2	98.2	98.0	98.0	98.2	98.0	97.9	98.0	98.1	98.3				
3	98.5	98.4	98.4	98.3	98.2	98.2	98.3	98.2	98.4				
4	98.6	98.3	98.3	98.2	98.1	98.0	98.0	98.1	98.1				
5	98.5	98.5	98.2	98.4	98.1	98.1	98.2	98.3	98.2				
6	98.4	98.3	98.2	98.4	98.1	98.2	98.2	98.1	98.3				
7	98.2	98.2	98.1	98.1	98.0	98.1	98.1	98.2	98.3				
8	98.1	98.1	98.0	98.1	98.0	98.1	98.2	98.2	98.4				
9	98.0	97.8	97.8	97.8	97.6	97.7	97.7	97.8	97.8				
10	98.5	98.4	98.4	98.3	98.1	98.1	98.2	98.3	98.3				
11	98.4	98.2	98.0	98.0	97.8	97.8	97.8	97.9	97.9				
12	98.3	- 98.3	98.2	98.1	98.2	98.0	98.2	98.1	98.1				
13	98.1	97.9	97.9	97,8	97.8	97.9	97.9	98.0	98.1				
14	98.1	98.0	97.9	98.0	97.8	97.7	97.5	97.5	97.7				
15	98.1	98.0	97.9	97.9	97.7	97.6	97.7	97.7	97.9				
16	97.9	97.8	97.7	97.7	97.6	97.5	97.5	97.5	97.6				
17	97.8	97.6	97.5	97.5	97.5	97.4	97.4	97.4	97.5				
18	98.3	98.2	98.1	97.9	97.9	97.9	97.9	98.0	98.1				
19	98.1	97.8	97.7	97.6	97.4	97.3	97.3	97.3	97.4				
20	97.9	97.8	97.7	97.6	97.4	97.3	97.3	97.4	97.3				

		-											
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			ē										
Mean	98.2	98.1	98.0	98.0	97.9	97.8	97.9	97.9	98.0				
Median	98.1	98.1	98.0	98.0	97.9	97.9	97.9	98.0	98.1				
std.dev	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3				
Max	98.6	98.5	98.4	98.4	98.2	98.2	98.3	98.3	98.4				
Min	97.8	97.6	97.5	97.5	97.4	97.3	97.3	97.3	97.3				



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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

NI	Lumen Maintenance (%)											
No.	16 000 h	17 000 h	18 000 h				22 000 h	23 000 h	24 000 h			
1	97.6	97.7							7 7 7 7 7 2 5 3 5 5			
2	98.1	98.3										
3	98.2	98.2			-							
4	98.0	98.0										
5	98.1	98.2						***************************************	***************************************			
6	98.1	98.2										
7	98.1	98.3						• • • • • • • • • • • • • • • • • • • •	***************************************			
8	98.3	98.2							***************************************			
9	97.7	97.8						••••••	***************************************			
10	98.3	_ 98.3							•••••••			
11	97.9	97.9							***************************************			
12	98.2	98.2							***************************************			
13	98.0	98.1										
14	97.5	97.4										
15	97.8	97.9										
16	97.6	97.5							***************************************			
17	97.4	97.4										
18	98.0	98.0							***************************************			
19	97.2	97.2										
20	97.2	97.2										

				1								
	- 1											
		*										
				_								
Mean	97.9	97.9										
Median	98.0	98.0		•>>-	•••••				••••••••			
td.dev	0.3	0.4							•			
Max	98.3	98.3										
Min	97.2	97.2										



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9.2 Test condition 2 85 ℃

Drive Current 1 000 mA
Measurement Current 1 000 mA

Meas	urement (Current	1 000 mA						
No.	u'	V			Chroma	aticity Shift	: (△u'v')		
110.	0	h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	0.262 3	0.527 9	0.000 3	0.000 4	0.000 6	0.000 6	0.000 6	0.000 7	0.000 7
2	0.263 3	0.529 2	0.000 1	0.000 4	0.000 4	0.000 5	0.000 6	0.000 7	0.000 6
3	0.262 4	0.528 2	0.000 1	0.000 4	0.000 4	0.000 6	0.000 6	0.000 7	0.000 6
4	0.263 5	0.527 6	0.000 4	0.000 5	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7
5	0.261 9	0.528 6	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 7	0.000 7
6	0.261 7	0.527 2	0.000 1	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7
7	0.261 3	0.527 6	0.000 2	0.000 4	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6
8	0.262 4	0.529 1	0.000 3	0.000 5	0.000 7	0.000 6	0.000 8	0.000 7	0.000 7
9	0.262 9	0.528 4	0.000 3	0.000 4	0.000 6	0.000 5	0.000 6	0.000 7	0.000 6
10	0.261 5	0.527 8	0.000 3	0.000 5	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7
11	0.263 7	0.529 0	0.000 2	0.000 4	0.000 5	0.000 6	0.000 7	0.000 6	0.000 7
12	0.262 3	0.527 8	0.000 4	0.000 5	0.000 6	0.000 7	0.000 9	0.000 9	0.000 9
13	0.261 3	0.527 0	0.000 4	0.000 5	0.000 7	0.000 9	0.000 8	0.000 9	0.000 9
14	0.263 5	0.528 7	0.000 4	0.000 4	0.000 5	0.000 5	0.000 7	0.000 8	0.000 6
15	0.262 1	0.527 7	0.000 3	0.000 6	0.000 8	0.000 8	0.000 9	0.000 8	0.000 8
16	0.261 4	0.527 1	0.000 2	0.000 5	0.000 6	0.000 7	0.000 9	0.000 8	0.000 8
17	0.262 5	0.527 3	0.000 3	0.000 3	0.000 5	0.000 6	0.000 6	0.000 7	0.000 7
18	0.261 9	0.527 0	0.000 3	0.000 4	0.000 6	0.000 6	0.000 7	0.000 8	0.000 7
19	0.263 2	0.528 1	0.000 2	0.000 3	0.000 5	0.000 5	0.000 6	0.000 5	0.000 6
20	0.264 0	0.529 6	0.000 2	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 7
Mean Median	0.262 4 0.262 3	0.528 0 0.527 8	0.000 3	0.000 4	0.000 6 0.000 6	0.000 6 0.000 6	0.000 7	0.000 7	0.000 7
std.dev	0.000 8	0.000 8	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1
Max	0.264 0	0.529 6	0.000 4	0.000 6	0.000 8	0.000 9	0.000 9	0.000 9	0.000 9
Min	0.261 3	0.527 0	0.000 1	0.000 3	0.000 4	0.000 5	0.000 5	0.000 5	0.000 6



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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

Meas	urement	Current	1 000 mA								
No.				Chroma	aticity Shift	: (△u'v')					
140.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h		
1	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7		
2	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7		
3	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6		
4	0.000 8	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7		
5	0.000 6	0.000 8	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7		
6	0.000 7	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8		
7	0.000 6	0.000 6	0.000 5	0.000 6	0.000 5	0.000 5	0.000 5	0.000 5	0.000 6		
8	0.000 8	0.000 8	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7		
9	0.000 6	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7		
10	0.000 7	0.000 7	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 8	0.000 8		
11	0.000 9	0.000 9	0.001 0	0.001 0	0.001 0	0.001 0	0.001 0	0.001 1	0.001 1		
12	0.000 9	0.001 0	0.001 1	0.001 1	0.001 2	0.001 2	0.001 2	0.001 3	0.001 3		
13	0.001 0	0.001 0	0.001 1	0.001 2	0.001 2	0.001 2	0.001 2	0.001 2	0.001 3		
14	0.000 8	0.000 8	0.001 0	0.001 0	0.001 1	0.001 1	0.001 2	0.001 2	0.001 2		
15	0.001 0	0.001 0	0.001 0	0.001 0	0.001 0	0.001 1	0.001 1	0.001 1	0.001 2		
16	0.001 0	0.001 0	0.001 1	0.001 0	0.001 1	0.001 1	0.001 1	0.001 1	0.001 1		
17	0.000 8	0.000 9	0.000 9	0.000 9	0.001 0	0.001 1	0.001 1	0.001 1	0.001 1		
18	0.000 9	0.000 9	0.001 0	0.001 1	0.001 1	0.001 1	0.001 1	0.001 2	0.001 2		
19	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9	0.001 0	0.001 0		
20	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9	0.000 9	0.000 9		

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						***************************************			***************************************		

Mean	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9	0.000 9	0.000 9		
Median	0.000 8	0.000 8	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9		
std.dev	0.000 1	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2		
Max	0.001 0	0.001 0	0.001 1	0.001 2	0.001 2	0.001 2	0.001 2	0.001 3	0.001 3		
Min	0.000 6	0.000 6	0.000 5	0.000 6	0.000 5	0.000 5	0.000 5	0.000 5	0.000 6		



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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

	urement Current 1 000 mA Chromaticity Shift (△u'v')											
No.	16 000 h	17 000 h	10 000 6				22 000 1	22,000 !	24.000 !			
1	0.000 7	0.000 8	16 000 11	19 000 h	20 000 h	21 000 h	22 000 h	23 000 h	24 000 r			
2	0.000 7	0.000 7										
3	0.000 7	0.000 7										
4	0.000 7	0.000 7		••••••								
5	0.000 7	0.000 8		·····								
6	0.000 9	0.000 9										
7	0.000 6	0.000 6							***************************************			
8	0.000 7	0.000 7										
9	0.000 7	0.000 8										
10	0.000 8	0.000 8		• • • • • • • • • • • • • • • • • • • •								
11	0.001 1	0.001 1					***************************************					
12	0.001 3	0.001 4							,			
13	0.001 3	0.001 3		***************************************	***************************************		***************************************					
14	0.001 2	0.001 2										
15	0.001 2	0.001 2					***************************************		***************************************			
16	0.001 2	0.001 2							***************************************			
17	0.001 2	0.001 2		,					•			
18	0.001 2	0.001 2							••••••			
19	0.001 0	0.001 1							***************************************			
20	0.001 0	0.001 0										
		-										
					-							
,												

) y									
				V.								
					74)					
Mean	0.000 9	0.001 0										
Median	0.000 9	0.000 9										
std.dev	0.000 2	0.000 2										
Max	0.001 3	0.001 4										
Min	0.000 6	0.000 6										





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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

Measure	ement Current	1 000 mA						
No.				CCT (K)				
140.	0 h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 H
1	2 698	2 702	2 704	2 708	2 707	2 707	2 708	2 707
2	2 672	2 673	2 677	2 678	2 680	2 681	2 681	2 680
3	2 694	2 695	2 700	2 700	2 703	2 703	2 704	2 703
4	2 673	2 678	2 680	2 682	2 682	2 683	2 683	2 683
5	2 703	2 709	2 710	2 712	2 711	2 712	2 713	2 712
6	2 712	2 713	2 718	2 719	2 721	2 722	2 722	2 721
7	2 720	2 723	2 726	2 727	2 728	2 728	2 729	2 728
8	2 691	2 695	2 699	2 701	2 700	2 703	2 701	2 700
9	2 683	2 687	2 688	2 691	2 690	2 691	2 692	2 691
10	2 715	2 720	2 722	2 724	2 725	2 725	2 726	2 724
11	2 663	2 665	2 668	2 669	2 671	2 672	2 672	2 672
12	2 698	2 703	2 705	2 706	2 709	2 711	2 711	2 711
13	2 722	2 728	2 729	2 732	2 735	2 734	2 736	2 735
14	2 669	2 674	2 674	2 676	2 676	2 679	2 680	2 677
15	2 702	2 707	2 711	2 714	2 713	2 715	2 715	2 714
16	2 719	2 721	2.726	2 727	2 729	2 732	2 730	2 730
17	2 696	2 700	2 700	2 704	2 705	2 705	2 706	2 705
18	2 709	2 714	2 715	2 719	2 718	2 720	2 722	2 719
19	2 678	2 680	2 682	2 685	2 683 -	2 685	2 685	2 684
20	2 654	2 657	2 659	2 660	2 661	2 663	2 663	2 663
Mean	2 694	2 697	2 700	2 702	2 702	2 704	2 704	2 703
Median	2 697	2 701	2.702	2 705	2 706	2 706	2 707	2 706
std.dev	20	21	21	21	21	21	21	21
Max	2 722	2 728	2 729	2 732	2 735	2 734	2 736	2 735
Min	2 654	2 657	2 659	2 660	2 661	2 663	2 663	2 663



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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

Meas	urement (urrent	1 000 mA										
No.	CCT (K)												
140.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000				
1	2 707	2 706	2 707	2 705	2 706	2 705	2 705	2 705	2 704				
2	2 680	2 679	2 680	2 678	2 678	2 678	2 677	2 677	2 677				
3	2 702	- 2 701	2 700	2 701	2 700	2 699	2 699	2 699	2 698				
4	2 684	2 683	2 682	2 680	2 680	2 680	2 679	2 679	2 679				
5	2 711	2 713	2 711	2 710	2 710	2 710	2 709	2 709	2 709				
6	2 721	2 720	2 722	2 720	2 721	2 720	2 720	2 720	2 720				
7	2 728	2 727	2 725	2 726	2 725	2 724	2 724	2 724	2 723				
8	2 702	2 701	2.701	2 698	2 698	2 698	2 698	2 697	2 697				
9	2 691	2 692	2 691	2 689	2 690	2 689	2 689	2 689	2 689				
10	2 725	2 723	2 725	2 723	2 723	2 723	2 723	2 722	2 722				
11	2 675	2 675	2 675	2 675	2 676	2 676	2 675	2 676	2 675				
12	2 711	2 712	2 713	2 713	2 714	2 714	2 714	2 714	2 715				
13	2 736	2 736	2 738	2 738	2 739	2 738	2 737	2 737	2 738				
14	2 680	2 679	2 682	2 682	2 683	2 683	2 684	2 683	2 684				
15	2 716	2 716	2 716	2 715	2 715	2 716	2 716	2 716	2 716				
16	2 733	2 733	2 733	2 733	2 733	2 733	2 733	2 732	2 732				
17	2 706	2 708	2 708	2 708	2 709	2 709	2 709	2 709	2 709				
18	2 7.22	2 721	2 723	2 723	2 723	2 724	2 723	2 724	2 724				
19	2 687	2 687	2 686	2 686	.2 687	2 687	2 688	2 688	2 688				
20	2 665	2 664	2 665	2 664	2 665	2 665	2 664	2 665	2 665				
	***************************************	***************************************	••••••••••					*********************					
	••••••				<u> </u>			.,					
		*************************	***************************************										

					/								
***************************************		***************************************											
***************************************		***************************************	***************************************										
				20									
Mean	2 704	2 704	2 704	2 703	2 704	2 704	2 703	2 703	2 703				
Median	2 706	2 707	2 707	2 707	2 707	2 707	2 707	2 707	2 707				
std.dev	21	21	21	21	21	21	21	21	21				
Max	2 736	2 736	2 738	2 738	2 739	2 738	2 737	2 737	2 738				
Min	2 665	2 664	2 665	2 664	2 665	2 665	2 664	2 665	2 665				



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9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

No					CCT (K)				
No.	16 000 h	17 000 h	18 000 h	19 000 h		21 000 h	22 000 h	23 000 h	24 000 F
1	2 7.04	2 704							2,000,
2	2 677	2 676	•••••						
3	2 698	2 698	•••••		•••••••		***************************************		
4	2 679	2 679							
5	2 709	2 709			***************************************		******************************	,	
6	2 720	2 720							
7	2 723	2 723	13					••••••	***************************************
8	2 697	2 696							
9	2 689	2 689			•••••			A	***************************************
10	2 722	2 722	recommendation of	***************************************	,				••••••
11	2 675	2 674						***************************************	***************************************
12	2 715	2 715							
13	2 736	2 736							
14	2 684	2 684						***************************************	
15	2 717	2 717						***************************************	
1.6	2 732	2 732		-2					
17	2 710	2 709							
18	2 724	2 723			+				
19	2 689	2 689							
20	2 666	2 665							••••••
								***************************************	••••••
***************************************									***************************************
									••••••

									••••••
							-		
Mean	2 703	2 703							
Median	2 706	2 706	1	=					
std.dev	21	- 21							
Max	2 736	2 736							
Min	2 666	2 665		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

Meas	urement (1 000 mA	A .					
No.	Flux (lm)	Vf (V)			Lumen	Maintena	nce (%)		
		h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	339.7	3.071	99.6	99.0	98.8	98.6	98.2	97.8	97.7
2	336.4	3.049	99.0	98.1	98.0	97.7	97.1	97.0	97.0
3	343.8	3.042	99.9	99.6	98.5	98.3	97.9	97.7	97.4
4	334.9	3.017	99.5	98.7	98.2	98.1	97.5	97.5	97.4
5	341.0	3.025	98.7	98.2	97.9	98.0	97.6	97.7	97.4
6	343.3	3.089	98.6	98.4	98.1	97.9	97.5	97.7	97.2
7	330.7	3.083	99.4	99.1	98.3	97.9	97.6	97.3	97.0
8	342.4	3.028	99.3	98.5	98.3	97.8	97.8	97.3	96.9
9	344.2	3.039	99.6	98.2	98.5	98.3	97.8	97.5	97.3
10	340.9	3.030	99.5	98.8	98.7	98.3	98.2	97.6	97.6
11	337.5	3.059	98.5	98.1	97.7	97.4	97.1	97.2	97.1
12	339.9	3.039	99.0	98.4	98.2	97.8	97.6	97.3	97.0
13	339.8	3.061	99.3	98.7	98.4	98.2	97.7	97.4	97.0
14	341.9	3.042	98.8	98.5	98.4	98.2	97.9	97.6	97.6
15	330.5	3.056	100.1	99.8	99.4	98.5	98.1	98.1	98.0
16	336.6	3.096	98.7	98.3	. 98.3	97.9	97.4	97.5	97.4
17	334.9	3.095	99.0	98.6	98.3	98.2	97.4	97.3	97.2
18	341.1	3.087	98.7	98.5	98.3	98.0	97.7	97.4	97.0
19	340.5	3.059	99.2	99.1	98.8	98.5	98.0	97.5	97.5
20	334.3	3.018	99.7	99.2	98.8	98.5	98.0	97.5	97.3
						***************************************		***************************************	***************************************
Mean	338.7	3.05	99.2	98.7	98.4	98.1	97.7	97.5	97.3
Median	339.8	3.05	99.3	98.5	98.3	98.1	97.7	97.5	97.3
std.dev	4.1	0.03	0.5	0.5	0.4	0.3	0.3	0.2	0.3
Max	344.2	3.10	100.1	99.8	99.4	98.6	98.2	98.1	98.0
Min	330.5	3.02	98.5	98.1	97.7	97.4	97.1	97.0	96.9



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

NI-		•	Lumen Maintenance (%)								
No.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000		
1	97.4	97.4	97.5	97.4	97.3	97.2	97.2	97.1	97.2		
2	96.9	96.8	97.0	97.0	96.9	97.0	97.0	97.0	97.1		
3	97.4	97.1	97.3	97.3	97.2	97.2	97.1	97.1	97.2		
4	97.2	97.2	97.4	97.1	97.1	97.0	97.0	96.9	97.0		
5	97.1	96.9	97.0	97.0	96.7	96.7	96.6	96.5	96.6		
6	97.0	97.0	97.2	97.0	96.8	96.8	96.8	96.7	96.8		
7	96.7	96.7	96.8	96.8	96.6	96.5	96.5	96.4	96.4		
8	96.6	96.6	96.5	96.4	96.4	96.3	96.2	96.0	96.1		
9	97.1	97.0	97.2	97.1	97.0	97.0	97.0	96.9	97.0		
10	97.5	97.3	97.5	97.4	97.3	97.1	97.0	96.9	96.9		
11	97.0	96.9	97.1	97.1	97.0	97.0	97.1	97.0	97.1		
12	96.9	97.0	96.9	96.9	96.8	96.8	96.9	96.7	96.9		
13	97.2	97.0	97.1	96.9	96.7	96.7	96.6	96.6	96.7		
14	97.2	96.9	96.8	96.6	96.3	96.1	96.1	96.0	96.0		
15	97.7	97.2	97.2	97.2	96.9	96.7	96.5	96.3	96.3		
16	97.3	97.2	97.1	97.0	96.9	96.8	96.7	96.6	96.6		
17	97.0	97.0	97.1	97.1	97.0	97.0	97.0	96.8	96.9		
18	97.0	97.0	97.1	97.0	96.9	96.9	96.9	96.9	96.9		
19	97.2	97.1	97.3	97.1	97.1	97.0	97.1	97.0	97.1		
20	96.9	96.6	96.9	96.6	96.5	96.4	96.4	96.2	96.3		
Mean	97.1	97.0	97.1	97.0	96.9	96.8	96.8	96.7	96.8		
Median	97.1	97.0	97,1	97.0	96.9	96.9	96.9	96.8	96.9		
std.dev	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4		
Max	97.7	97.4	97.5	97.4	97.3	97.2	97.2	97.1	97.2		
Min	96.6	96.6	96.5	96.4	96.3	96.1	96.1	96.0	96.0		





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9.3 Test condition 3

105 °C

Drive Current -

1 000 mA

Measurement Current

NI-	Lumen Maintenance (%)											
No.	16 000 h	17 000 h	18 000 h			21 000 h	22 000 h	23 000 h	24 000 1			
1	97.1	97.0					-	20 000 11	2.0001			
2	97.0	96.9			••••••		•••••					
3	97.0	97.0		••••••								
4	96.9	96.8		••••••••••			***************************************					
5	96.4	96.3		***************************************								
6	96.6	96.6	***************************************									
7	96.3	96.2					***************************************					
8	96.0	95.9	•••••••••••									
9	96.9	96.9					************************					
10	96.7	96.5										
11	96.9	96.8		***************************************	***************************************				*******************************			
12	96.8	96.6										
13	96.5	96.5			********************			i	***************************************			
14	95.8	95.8							***************************************			
15	96.0	95.9	·····		***************************************							
16	96.5	96.3										
17	96.8	96.8			***************************************			***************************************				
18	96.9	96.7										
19	96.9	96.8							••••••••			
20	96.1	96.1										
									••••••			
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					***************************************				***************************************			

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					a .							
		,		•	······································				/			
Mean	96.6	96.5										
Median	96.7	96.6										
std.dev	0.4	0.4			•••••							
Max	97.1	97.0										
Min	95.8	95.8										



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

Meas	urement	Current	1 000 mA						
No.	u'	V'			Chroma	aticity Shift	: (△u'v')		
INO.	0	h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	0.260 9	0.526 2	0.000 9	0.001 3	0.001 4	0.001 6	0.001 6	0.001 6	0.001 6
2	0.264 2	0.528 9	0.000 6	0.000 7	0.001 0	0.000 8	0.001 0	0.001 1	0.001 1
3	0.261 9	0.527 2	0.000 9	0.001 3	0.001 7	0.001 5	0.001 6	0.001 5	0.001 5
4	0.261 4	0.527 2	0.001 0	0.001 3	0.001 4	0.001 5	0.001 6	0.001 5	0.001 4
5	0.263 3	0.528 5	0.000 6	0.000 9	0.001 1	0.001 2	0.001 2	0.001 5	0.001 4
6	0.263 0	0.527 7	0.000 6	0.000 5	0.000 8	0.000 9	0.000 8	0.000 9	0.001 0
7	0.263 7	0.528 6	0.000 9	0.000 8	0.001 3	0.001 1	0.001 3	0.001 1	0.001 2
8	0.262 3	0.529 6	0.000 9	0.001 2	0.001 4	0.001 5	0.001 6	0.001 5	0.001 4
9	0.263 0	0.528 7	0.000 8	0.001 2	0.001 4	0.001 5	0.001 4	0.001 5	0.001 4
10	0.261 2	0.528 7	0.000 4	0.001 0	0.001 4	0.001 3	0.001 3	0.001 4	0.001 5
11	0.263 1	0.527 1	0.001 1	0.001 2	0.001 4	0.001 2	0.001 5	0.001 3	0.001 3
12	0.261 9	0.528 0	0.001 0	0.001 3	0.001 3	0.001 4	0.001 6	0.001 5	0.001 4
13	0.262 0	0.526 3	0.000 9	0.001 2	0.001 3	0.001 4	0.001 4	0.001 5	0.001 4
14	0.262 1	0.527 3	0.001 0	0.001 1	0.001 3	0.001 5	0.001 4	0.001 5	0.001 5
15	0.262 2	0.527 9	0.000 7	0.001 1	0.001 3	0.001 1	0.001 3	0.001 2	0.001 2
16	0.261 8	0.525 8	0.001 0	0.001 3	0.001 6	0.001 5	0.001 7	0.001 5	0.001 4
17	0.261 1	0.527 0	0.000 5	0.000 7	0.001 0	0.001 1	0.001 3	0.001 1	0.001 1
18	0.261 3	0.527 0	0.000 7	0.000 6	0.001 0	0.001 3	0.001 2	0.001 3	0.001 3
19	0.263 5	0.528 3	0.001 0	0.001 0	0.001 3	0.001 1	0.001 3	0.001 5	0.001 1
20	0.261 8	0.527 0	0.001 1	0.001 3	0.001 6	0.001 5	0.001 7	0.001 6	0.001 5
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Mean	0.262 3	0.527 6	0.000 8	0.001 1	0.001 3	0.001 3	0.001 4	0.001 4	0.001 3
Median	0.262 0	0.527 5	0.000 9	0.001 1	0.001 3	0.001 4	0.001 4	0.001 5	0.001 4
std.dev	0.001 0	0.001 0	0.000 2	0.000 3	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2
Max	0.264 2	0.529 6	0.001 1	0.001 3	0.001 7	0.001 6	0.001 7	0.001 6	0.001 6
Min	0.260 9	0.525 8	0.000 4	0.000 5	0.000 8	0.000 8	0.000.8	0.000 9	0.001 0



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Meas	urement	Current	1 000 mA								
No.			Chromaticity Shift (△u'v')								
INO.	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h		
1	0.001 8	0.002 0	0.002 0	0.002 0	0.002 0	0.002 1	0.002 1	0.002 1	0.002 2		
2	0.001 1	0.001 0	0.001 2	0.001 1	0.001 2	0.001 3	0.001 3	0.001 3	0.001 3		
3	0.001 7	0.001 6	0.001 6	0.001 5	0.001 6	0.001 6	0.001 6	0.001 6	0.001 6		
4	0.001 7	0.001 6	0.001 6	0.001 5	0.001 6	0.001 6	0.001 6	0.001 6	0.001 7		
5	0.001 4	0.001 7	0.001 6	0.001 5	0.001 7	0.001 8	0.001 8	0.001 8	0.001 9		
6	0.001 0	0.000 9	0.001 1	0.001 2	0.001 2	0.001 3	0.001 3	0.001 3	0.001 4		
7	0.001 3	0.001 3	0.001 2	0.001 2	0.001 3	0.001 3	0.001 3	0.001 3	0.001 4		
8	0.001 6	0.001 6	0.001 5	0.001 4	0.001 6	0.001 6	0.001 5	0.001 5	0.001 6		
9	0.001 4	0.001 6	0.001 6	0.001 4	0.001 6	0.001 6	0.001 6	0.001 6	0.001 7		
10	0.001 3	0.001 2	0.001 4	0.001 3	0.001 4	0.001 4	0.001 4	0.001 4	0.001 5		
11	0.001 5	0.001 5	0.001 5	0.001 6	0.001 6	0.001 7	0.001 7	0.001 7	0.001 8		
12	0.001 5	0.001 6	0.001 5	0.001 5	0.001 6	0.001 6	0.001 6	0.001 5	0.001 6		
13	0.001 5	0.001 7	0.001 7	0.001 7	0.001 8	0.001 9	0.001 9	0.001 9	0.002 0		
14	0.001 5	0.001 5	0.001 7	0.001 6	0.001 7	0.001 8	0.001 7	0.001 7	0.001 8		
15	0.001 3	0.001 2	0.001 5	0.001 3	0.001 4	0.001 5	0.001 4	0.001 4	0.001 5		
16	0.001 8	0.001 9	0.001 9	0.001 8	0.001 9	0.002 0	0.002 0	0.002 0	0.002 1		
17	0.001 2	0.001 4	0.001 3	0.001 3	0.001 4	0.001 5	0.001 5	0.001 5	0.001 5		
18	0.001 2	0.001 2	0.001 4	0.001 3	0.001 3	0.001 4	0.001 4	0.001 4	0.001 5		
19	0.001 3	0.001 3	0.001 6	0.001 5	0.001 6	0.001 6	0.001 7	0.001 6	0.001 7		
20	0.001 6	0.001 6	0.001 5	0.001 5	0.001 6	0.001 6	0.001 5	0.001 5	0.001 6		
			•		***************************************						
					***************************************		***************************************				
				- 1							
	×===										
Mean	0.001 4	0.001 5	0.001 5	0.001 5	0.001 6	0.001 6	0.001 6	0.001 6	0.001 7		
Median	0.001 5	0.001 5	0.001 5	0.001 5	0.001 6	0.001 6	0.001 6	0.001 5	0.001 6		
std.dev	0.000 2	0.000 3	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2		
Max	0.001 8	0.002 0	0.002 0	0.002 0	0.002 0	0.002 1	0.002 1	0.002 1	0.002 2		
Min	0.001 0	0.000 9	0.001 1	0.001 1	0.001 2	0.001 3	0.001 3	0.001 3	0.001 3		



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

No	Chromaticity Shift (△u'v')										
No.	16 000 h	17 000 h	18 000 h	19 000 h	20 000 h	21 000 h	22 000 h	23 000 h	24 000 h		
1	0.002 3	0.002 3							0.3.2.3.3.		
2	0.001 4	0.001 5									
3	0.001 7	0.001 7			• • • • • • • • • • • • • • • • • • • •		***************************************				
4	0.001 7	0.001 8		;	•••••						
5	0.002 0	0.002 1	•	***************************************	•••••			•			
6	0.001 5	0.001 6	•	***************************************							
7	0.001 4	0.001 5		-				•••••			
. 8	0.001 6	0.001 7						,			
9	0.001 7	0.001 8			(2)						
10	0.001 5	0.001 6									
11	0.001 8	0.001 9									
12	0.001 7	0.001 7									
13	0.002 1	0.002 2									
14	0.001 9	0.001 9									
15	0.001 6	0.001 7									
16	0.002 2	0.002 3									
17	0.001 6	0.001 7			-1						
18	0.001 5	0.001 6									
19	0.001 8	0.001 9									
20	0.001 6	0.001 7									
		-									
					18						
								in .			
								-			
Mean	0.001 7	0.001 8									
Median	0.001 7	0.001 7									
std.dev	0.000 3	0.000 3									
Max	0.002 3	0.002 3									
Min	0.001 4	0.001 5									



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

Measure	ement Current	1 000 mA								
No.		CCT (K)								
140.	0 h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h		
1	2 735	2 751	2 758	2 761	2 762	2 762	2 762	2 759		
2	2 652	2 664	2 664	2 669	2 664	2 667	2 669	2 666		
3	2 709	2 727	2.734	2 740	2 735	2 738	2 735	2 733		
4	2 718	2 737	2 744	2 745	2 746	2 747	2 744	2 741		
5	2 674	2 685	2 690	2 694	2 694	2 693	2 698	2 695		
6	2 682	2 692	2 690	2 695	2 695	2 693	2 693	2 693		
7	2 665	2 680	2 680	2 689	2 683	2 686	2 682	2 682		
8	2 691	2 709	2 714	2 717	2 717	2 719	2 716	2 713		
9	2 680	2 696	2 701	2 705	2 706	2 705	2 706	2 702		
10	2 717	2 723	2 735	2 742	2 740	2 738	2 739	2 740		
11	2 683	2 702	2 704	2 709	2 704	2 707	2 703	2 701		
12	2 705	2 724	2 730	2 730	2 730	2 732	2 730	2 727		
13	2 710	2 728	2 734	2 735	2 735	2 734	2 735	2 732		
14	2 704	2 723	2 723	2 728	2 729	2 727	2 728	2 728		
15	2 699	2 710	2 718	2 721	2 717	2 720	2 716	2 715		
16	2 717	2 733	2 739	2 746	2 742	2 744	2 741	2 735		
17.	2 726	2 734	2 738	2 742	2 744	2 747	2 742	2 740		
18	2 722	2 734	. 2 733	2 740	2 744	2 742	2 743	2 740		
19	2 669	2 688	2 688	2 693	2 686	2 691	2 693	2 684		
20	2 712	2 733	2 738	2 740	2 739	2 742	2 739	2 736		
						***************************************		***************************************		
-								***************************************		
	-							***************************************		
		***************************************						,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		

***************************************				***************************************				***************************************		
		1								
Mean	2 698	2 714	2 718	2 722	2 721	2 722	2 721	2 718		
Median	2 704	2 723	2 727	2 729	2 730	2 730	2 729	2 727		
std.dev	23	23	25	24	26	26	25	25		
Max	2 735	2 751	2 758	2 761	2 762	2 762	2 762	2 759		
Min	2 652	2 664	2 664	2 669	2 664	2 667	2 669	2 666		
(VIII)	2 032	2 004	2 004	2 003	2 004	2 007	2 003	2 000		



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Meas	urement (Current	1 000 mA								
No.			CCT (K)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 1		
1	2 763	2 765	2 763	2 760	2 761	2 761	2 760	2 760	2 760		
2	2 664	2 662	2 661	2 657	2 658	2 658	2 656	2 656	2 655		
3	2 733	2 732	2 727	2 723	2 724	2 722	2 719	2 717	2 717		
4	2 744	2 741	2 737	2 733	2 734	2 732	2 730	2 728	2 728		
5	2 695	2 698	2 695	2 690	2 694	2 694	2 692	2 692	2 693		
6	2 691	2 689	2 689	2 686	2 686	2 685	2 683	2 682	2 681		
7	2 682	2 679	2 674	2 672	2 672	2 670	2 667	2 665	2 665		
8	2 714	2 713	2 708	2 705	2 706	2 704	2 701	2 700	2 699		
9	2 700	2 703	2 699	2 694	2 696	2 694	2 692	2 691	2 691		
10	2 734	2 732	2 732	2 727	2 727	2 725	2 722	2 721	2 721		
11	2 704	2 702	2 699	2 700	2 698	2 698	2 696	2 694	2 694		
12	2 728	2 727	2 723	2 720	2 720	2 719	2 716	2 715	2 714		
13	2 734	2 736	2 734	2 730	2 732	2 732	2 730	2 730	2 730		
14	2 726	2 726	2 728	2 724	2 725	2 725	2 723	2 722	2 722		
15	2 715	2 712	2 714	2 707	2 708	2 707	2 705	2 703	2 703		
16	2 741	2 744	2 740	2 734	2 737	2 736	2 734	2 733	2 734		
17	2 739	2 743	2 738	2.735	2 736	2 734	2 732	2 731	2 732		
18	2 736	2 735	2 734	2 727	2 728	2 726	2 723	2 722	2 722		
19	2 686	2 685	2 687	2 684	2 684	2 683	2 682	2 680	2 680		
20	2 737	2 735	2 731	2 727	2 727	2 725	2 723	2 721	2 721		
		-									
					-						
			(
Mean	2 718	2 718	2 716	2 712	2 713	2 712	2 709	2 708	2 708		
Median	2 727	2 726	2 725	2 721	2 722	2 720	2 718	2 716	2 716		
std.dev	25	26	26	-25	25	25	26	26	26		
Max	2 763	2 765	2 763	2 760	2 761	2 761	2 760	2 760	2 760		
Min	2 664	2 662	2 661	2 657	2 658	2 658	2 656	2 656	2 655		



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9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

NI	CCT (K)											
No.	16 000 h	17 000 h	18 000 h	19 000 h		21 000 h	22 000 h	23 000 h	24 000			
1	2 762	2 762				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						
2	2 654	2 654	•••••									
3	2 718	2 717			***************************************		d	••••••				
4	2 729	2 728							***************************************			
5	2 694	2 695			8				***************************************			
6	2 682	2 681			***************************************	•			***************************************			
7	2 665	2 666	••••••••••						***************************************			
8	2 700	2 699							***************************************			
9	2 692	2 692	••••••		***************************************							
10	2 722	2 721							***************************************			
11	2 695	2 695			***************************************				***************************************			
12	2 715	2 714										
13	2 732	2 732							***************************************			
14	2 724	2 724							•			
15	2 704	2 703							••••••••			
16	2 735	2 735										
17	2 732	2 731							***************************************			
18	2 722	2 721										
19	2 681	2 680	13						***************************************			
20	2 722	- 2 721										
									•••••			

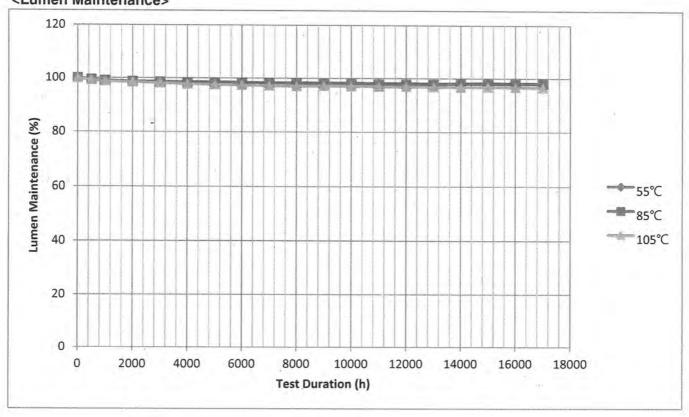
								0	••••••			
.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,							·······		***************************************			
Mean	2 709	2 709										
Median	2 716	2 716										
std.dev	26	26		.,					***************************************			
Max	2 762	2 762				·		.,,,,	•••••			
Min	2 654	2 654										

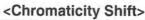


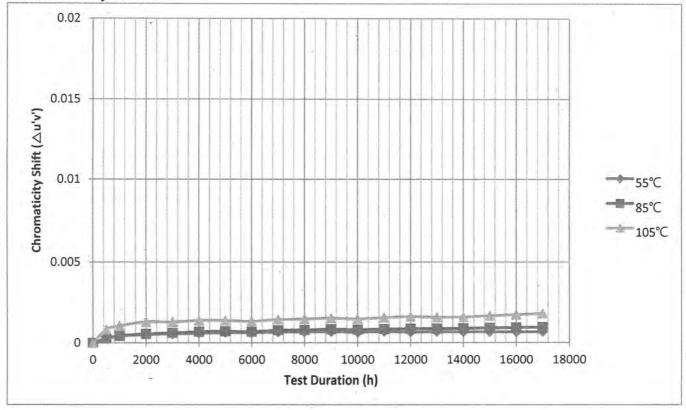
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9.4 Chart

<Lumen Maintenance>



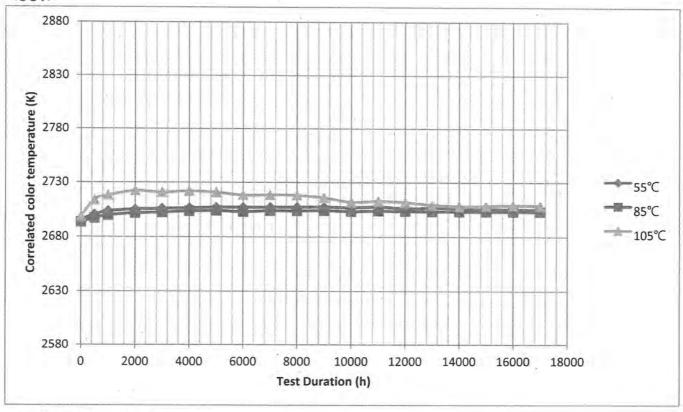






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10. Observation of failures

No optical, Electrical or mechanical failure of any LED Package was seen during the lifetime testing.

11. LED light source monitoring interval

0 500 1 000 2 000 3 000 4 000 5 000 6 000 7 000 8 000 9 000 10 000 12 000 11 000 13 000 14 000 15 000 16 000 17 000

12. Photometric measurement uncertainty

3.5%

13. TM-21-11 Report: Projecting Long Term Lumen Maintenance of LED Light Source

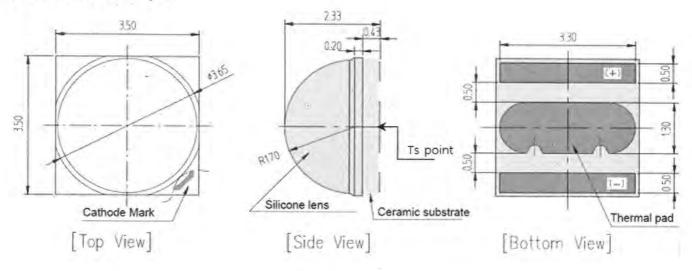
		Table 1: Report at each LM-	80 Test Condition	n_		
Description of LED Ligh (manufacturer, catalog num	model,					
Test Condition 1 - 55°C	Case Temp	Test Condition 2 - 85°C	Case Temp	Test Condition 3 - 105°C Case Temp		
Sample size	20	Sample size	20	Sample size	20	
Number of failures	0	Number of failures	0	Number of failures	0	
DUT drive current used in the test (mA)	1 000	DUT drive current used in the test (mA)	1 000	DUT drive current used in the test (mA)	1 000	
Test duration (hours)	17,000	Test duration (hours)	17,000	Test duration (hours)	17,000	
Test duration used for projection (hour to hour)	8,000 - 17,000	Test duration used for projection (hour to hour)	8,000 - 17,000	Test duration used for projection (hour to hour)	8,000 - 17,000	
Tested case temperature (°C)	55	Tested case temperature (°C)	85	Tested case temperature (°C)	105	
α	1.667E-07	α	1.484E-07	α	6.010E-07	
В	0.984	В	0.981	В	0.975	
Reported L90(17k) (hours)	>102000	Reported L90(17k) (hours)	>102000	Reported L90(17k) (hours)	>102000	

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14. Dimension of samples



15. Cover models