



ENERGY STAR® TM-21 Calculator

Note: Users should download a new copy of this calculator for each use, to ensure use of the most up-to-date version of the calculator. Users are encouraged to bookmark the hyperlink to this calculator. Project-specific copies complete with calculations may be saved on a local drive.

This calculator is based on the Illuminating Engineering Society's TM-21-11: *Projecting Long Term Lumen Maintenance of LED Light Sources* and *Addendum B for TM-21-11: Projecting Long Term Lumen Maintenance of LED Packages*. Calculator results have been reviewed by the U.S. National Institute of Standards and Technology (NIST). Calculations are locked; only data entry cells may be modified.

Calculator inputs are entered on the second tab, with instructions. The calculator may be used with one, two or three case temperatures. Inputting values on the second tab generates a complete TM-21 report on the Report tab.

For calculating data with different test period lengths, use data from the time period equal to the shortest time period for all temperatures.

Questions may be directed to lighting@energystar.gov.



TM-21 Inputs

Instructions

Yellow fields are completed by the user. Fields not used should be left blank. Cyan fields are calculated based on user entries.

First, enter a description of the LED light source tested. Then complete the fields labeled "LM-80 Testing Details". Test duration must be at least 6,000 hours. If only one case temperature data set is to be used (no interpolation), complete only "Tested case temperature 1". For only two case temperature data sets, complete 1 and 2.

Next, further to the right, in the corresponding box(es) for each tested case temperature, enter the test data along with the time (in hours) at which each measurement was taken. Data entered must be normalized then averaged measured data (per TM-21 sections 5.2.1 and 5.2.2). If case temperatures have different test durations, enter data up to the lowest of the test durations for all of the case temperatures.

Enter drive current, *in-situ* temperature data and the percentage of initial lumens to project to in the fields labeled "*In-Situ* Inputs".

Results can be tailored to estimate lumen maintenance at a specific time by entering a value (t) in the yellow field. A complete TM-21 report will appear on the next tab labeled "Report".

Description of LED Light Source Tested (manufacturer, model, catalog number)

Samsung Electronics Co., LTD. SPMWH1228xxxxxxxxxx

LM-80 Testing Details

Total number of units tested per case temperature:	25
Number of failures:	0
Number of units measured:	25
Test duration (hours):	9000
Tested drive current (mA):	120
Tested case temperature 1 (T_c , °C):	55
Tested case temperature 2 (T_c , °C):	85
Tested case temperature 3 (T_c , °C):	105

***In-Situ* Inputs**

Drive current for each LED package/array/module (mA):	100.5
<i>In-situ</i> case temperature (T_c , °C):	65
Percentage of initial lumens to project to (e.g. for L_{70} , enter 70):	70

Results

Time (t) at which to estimate lumen maintenance (hours):	50,000
Lumen maintenance at time (t) (%):	91.88%
Reported L70 (hours):	>54000

LM-80 Test Inputs

Test Data for 55°C Case
Temperature

Time (hours)	Lumen Maintenance (%)
1000	100.08%
2000	99.88%
3000	99.75%
4000	99.59%
5000	99.42%
6000	99.28%
7000	99.16%
8000	99.00%
9000	98.82%

Test Data for 85°C Case
Temperature

Time (hours)	Lumen Maintenance (%)
1000	99.80%
2000	99.65%
3000	99.44%
4000	99.27%
5000	99.10%
6000	98.85%
7000	98.66%
8000	98.42%
9000	98.17%

Test Data for 105°C Case Temperature

Time (hours)	Lumen Maintenance (%)
1000	99.55%
2000	99.32%
3000	99.12%
4000	98.87%
5000	98.68%
6000	98.49%
7000	98.24%
8000	97.95%
9000	97.66%

Calculations:

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Minimum Case Temperature ($T_{s,1}$) for Extrapolation (K):	328.15
α_1	0.0000
B_1	1.0019
Maximum Case Temperature ($T_{s,2}$) for Extrapolation (K):	358.15
α_2	0.0000
B_2	1.0019
E_a/k_b	1549.41
k_b (eV/K)	8.6173E-05
E_a (eV)	1.3352E-01
A	0.0002
B_0	1.0019
In Situ Case Temperature ($T_{s,i}$) (K):	338.15
α_i	0.0000
Reported L70 (hrs):	>54000

Table 1: Report at each LM-80 Test Condition					
Case Temperature 1		Case Temperature 2		Case Temperature 3	
Temperature (°C):	55	Temperature (°C):	85	Temperature (°C):	105
Temperature (°K):	328.15	Temperature (°K):	358.15	Temperature (°K):	378.15
α :	1.51E-06	α :	2.24E-06	α :	2.47E-06
B:	1.00	B:	1.00	B:	1.00
Reported L70 (hrs):	>54000	Reported L70 (hrs):	>54000	Reported L70 (hrs):	>54000

Table 2: Report for Interpolation (based on in-situ temperature)

$T_{s,1}$ (°C)	55.00
$T_{s,1}$ (K)	328.15
α_1	1.5062E-06
B_1	1.0019
$T_{s,2}$ (°C)	85.00
$T_{s,2}$ (K)	358.15
α_2	2.2370E-06
B_2	1.0019
E_a/k_b	1.55E+03
A	0.0002
B_0	1.0019
$T_{s,i}$ (°C)	65
$T_{s,i}$ (K)	338.15
α_i	1.7320E-06



TM-21 Report

Table 1: Report at each LM-80 Test Condition

Description of LED Light Source Tested (manufacturer, model, catalog number)		Samsung Electronics Co., LTD. SPMWH1228xxxxxxxxxx					
Test Condition 1 - 55°C Case Temp		Test Condition 2 - 85°C Case Temp		Test Condition 3 - 105°C Case Temp			
Sample size	25	Sample size	25	Sample size	25		
Number of failures	0	Number of failures	0	Number of failures	0		
DUT drive current used in the test (mA)	120	DUT drive current used in the test (mA)	120	DUT drive current used in the test (mA)	120		
Test duration (hours)	9,000	Test duration (hours)	9,000	Test duration (hours)	9,000		
Test duration used for projection (hour to hour)	4,000 - 9,000	Test duration used for projection (hour to hour)	4,000 - 9,000	Test duration used for projection (hour to hour)	4,000 - 9,000		
Tested case temperature (°C)	55	Tested case temperature (°C)	85	Tested case temperature (°C)	105		
α	1.506E-06	α	2.237E-06	α	2.468E-06		
B	1.002	B	1.002	B	0.999		
Reported L70(9k) (hours)	>54000	Reported L70(9k) (hours)	>54000	Reported L70(9k) (hours)	>54000		

Table 2: Interpolation Report
(projection based on *in-situ* temperature entered)

$T_{s,1}$ (°C)	55.00
$T_{s,1}$ (K)	328.15
α_1	1.506E-06
B_1	1.002
$T_{s,2}$ (°C)	85.00
$T_{s,2}$ (K)	358.15
α_2	2.237E-06
B_2	1.002
E_a/k_b	1.55E+03
A	1.692E-04
B_0	1.002
$T_{s,i}$ (°C)	65.00
$T_{s,i}$ (K)	338.15
α_i	1.732E-06
Reported L70(9k) at 65°C (hours)	>54000

Report Generated By:	Notes:
Company:	
Date:	