Fraunhofer
ISE

Evaluation of the Sundaya Ulitium Solar Light

Final Test Report

June 2010

Fraunhofer ISE

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Date: 25.06.2010

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Heidenhofstraße 2
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Overview of the Measurement and Test Results

Manufacturer: Sundaya Device under Test: Ulitium Light_Kit_1		ISE labelling 040-LSSDY-1002 - 060-LSSDY-1002						End of test 16.06.2010
		Sample #						
Test criteria		1 (040)	2 (050)	3 (060)	4 [mod][8]	5	6	Comments:
Nominal Battery capacity:	meas. [mAh]	2073	2145	2121	1993	--	--	
2250 mAh	dev. [%]	-8	-5	-6	-9	--	--	
Nominal PV power:	meas. [Wp]	3.8	3.6	3.8	3.5	3.5	3.5	
3.6 W	dev. [%]	+5.4	+0.9	+4.7	-3.1	-3.3	-1.4	
"Run time"[1]:	meas. [min]	--	--	--	490	--	--	
Average luminous flux[2]:	meas. [lm]	--	--	--	222	--	--	
Solar charging: charge to discharge ratio[3]	meas. [%]	--	--	--	210	--	--	
Mechanical charging: "run time after cranking"[4]	meas. [min]	--	--	--	--	--	--	
Grid charging: state of charge[5]	meas. [%]	--	--	--	--	--	--	
Task light: "Useable" working surface[6]	meas. [m²]	1	1	1	--	--	--	
Illuminance on working surface	meas. [lx]	67	67	64	--	--	--	
Ambient light: Useable angle of radiation[7]	meas. [°]	250	230	220	--	--	--	
Illuminance over "useable" angle	meas. [lx]	42	42	43	--	--	--	
LED degradation @2000 h	meas. [%]	--	--	--	2.5	--	--	@2,232 hours. Assuming a linear degradation this leads to a L70 lifetime of 26,784 hours!

Summary

- The light shows a very good overall quality
- The LED depreciation is very small, that reflects a very high L_{70} lifetime of the LEDs
- The total light output is very high, the LED as well as the overall efficiency is extremely high
- We found the PV modules of very high quality; three out of six modules showed a higher output than stated, the output of the other modules was not significantly below the nominal values
- The run time (autonomous time) is very high
- There is a charge controller built in to prevent the battery from over- and deep-discharging
- There are indicators for "battery is being charged" and "full battery"

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[1] Measured with a fully charged battery; if the light output reaches 70 percent of the initial luminous flux measured after 20 min, the end of the "run time" is reached
[2] The luminous flux is averaged over the runtime; the luminous flux can be determined if an Integrating Sphere is available in the lab
[3] The daily charge to discharge ratio is determined with the measured values of the PV power, P_{MPP} and battery capacity using the provided Excel tool
[4] The „run time after cranking" is determined after 5 min cranking. If the light output reaches 70 percent of the initial luminous flux, the end of the luminous period is reached
[5] State of charge after 8 h of charging
[6] The „useable" working surface is the area, which is illuminated with ≥ 20 lx
[7] The „useable" angle of radiation is the angle within an illuminance level of ≥ 4 lx can be achieved
[8] Sample with modified software to eliminate the autodimming (modification by Sundaya)

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Record Form for General Data

Name: **Sundaya Ulitium Light_Kit_1**				**End of test: 19.06.2010**	
1230-LSSU-1001		☒ retail	☐ wholesale		
External screening	Housing	Plastic housing			
	Cable	Cable with bayonet plugs			
	Connectors	1 "Hub4"-Connector			
	Handles	--			
		Light distribution: ☒ 180° horizontal ☐ 360° horizontal ☐ Other		Other:	
	Size (w·h·d)	10·10·18 cm³		Weight: 265 grams	
	Indicators	Green Indicator: charging Red Indicator: Light is charged; Light is discharged			
Internal screening	Wiring	Cold joints: Yes ☐ No ☒ Workmanship O.K. ☒ Not O.K ☐			
		Comment:			
	Fixture of Parts	Parts Screwed ☒ Clamped ☐ Others ☐ Glued ☐ Taped ☐			
	Deficiencies	Soldering of the LEDs: sufficient workmanship			
Function test	Switches	Manual test: O.K. ☒ Not O.K. ☐			
		-			
	Sockets	Manual test: O.K. ☒ Not O.K. ☐			
		-			
Electronic components	Electronic Ballast	☐ Resistor ☒ Others / not evident ☐ Constant voltage source ☐ Constant current source ☐ Pulse Width Modulation			
	Battery (Specifications Label)	Technology: ☐ Lead-acid ☐ NiCd ☐ NiMH ☒ Li-Ion ☐ Not evident			
		Capacity:	2250 mAh		
	Light Source	☐ High power LED ☒ Low power LED Number of LEDs: 12			
Mechanical charge	Robustness	--			
	Miscellaneous	--			
Solar module	Size (w·h)	Total: 28·16.5 cm²		Cell area: 295 cm²	
	Module ext./int.	External ☒		Integrated ☐	
	Specifications (Specifications Label)	Module type: Poly-Si		P_{MPP}: 3.6 W	
		V_{OC}: 21.3 V	V_{MPP}: 17.0 V	I_{SC}: 0.26 A	I_{MPP}: 0.21 A
	Miscellaneous	36 single cells			
	Robustness	Satisfactory			
	Cable length	5 m			

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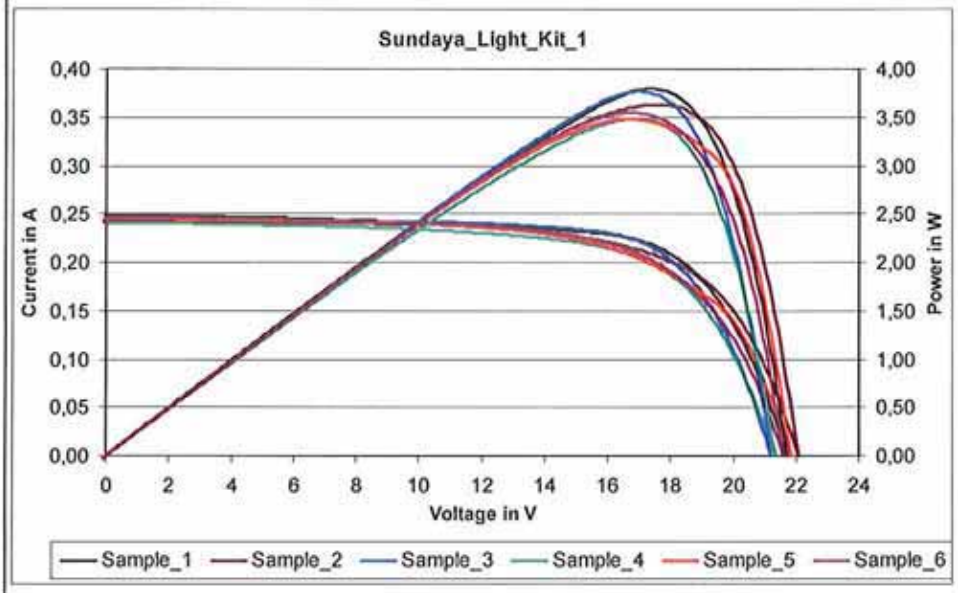
Test Protocol

Documentation available [FISE Method 4.1.14]	Operation manual: ☒ Yes ☐ No	Charge controller info: ☐ Yes ⇒ ☐ Type ☒ No ☐ Controller limits
	Battery info: ☒ Yes ⇒ ☒ Type ☐ No ☒ Capacity	PV module info: ☒ Yes ⇒ ☒ P_{MPP} ☐ No ☒ I_{MPP} / V_{MPP} or I_{SC} / V_{OC}
Additional information due to data sheet [FISE Method 4.1.14]	Run time [h]	6 h with 200 lumen
		12 h with 100 lumen
		60 h with 20 lumen
Charge indication	Yes	
Grid charging	No	
Cable length	5m	
Estimated IP class	IP 44	
Comment visual screening [FISE Method 4.1.2]	• Circuit board: very good workmanship • Soldering of the LEDs: sufficient workmanship • Mounting of the PV-module is glued to the Module	
Picture of the light		

Test Protocol (continued)

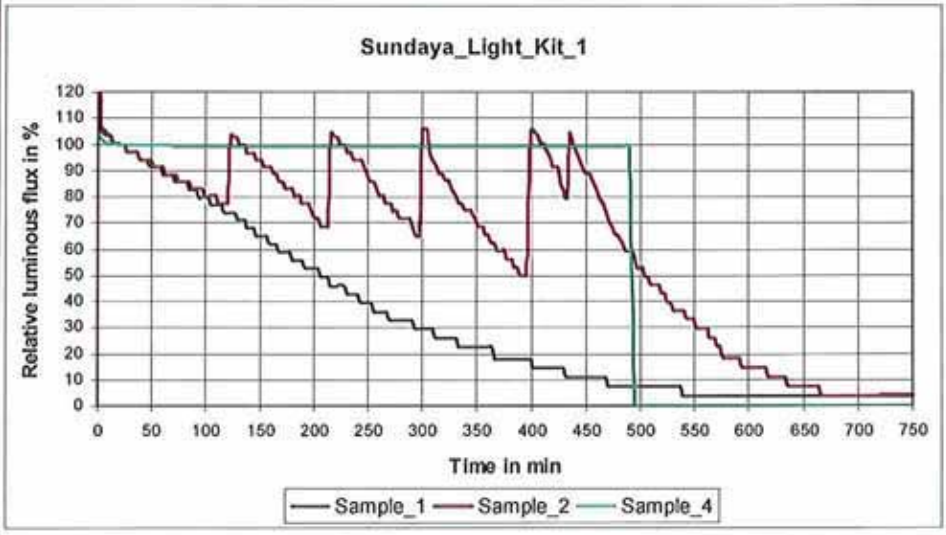
#	Test Procedure	Measurement Parameter	Results (Sample #)					
			1	2	3	4 [mod]	5	6
1	Battery [FISE Method 4.1.4]	Capacity (measured) [mAh]	2073	2145	2121	1993	--	--
		Deviation from nom. capac. (2250 mAh) [%]	-8	-5	-6	-9	--	--
2	PV Module [FISE Method 4.1.3]	Module power (measured) [Wp]	3.8	3.6	3.8	3.5	3.5	3.5
		Deviation from nom. power (P_{MPP}: 3.6 W) [%]	+5.4	+0.9	+4.7	-3.1	-3.3	-1.4
		Short circuit current (measured) [A]	0.25	0.24	0.25	0.24	0.25	0.25
		Open circuit voltage (fitted) [V]	21.7	22.1	21.2	21.3	21.8	21.6

Module characteristics curve (@ STC)



			Sample #					
			1	2	3	4 [mod]	5	6
3	"Run Time" [Autonomous time] [FISE Method 4.1.6]	"Run time" @ 70 % [min]	--	--	--	490	--	--
		Average luminous flux [lm] (over "run time")	--	--	--	222	--	--

Relative luminous flux
Sample 1: auto-dimming ; Sample 2 : manually resetting to maximum brightness level
Sample 4: auto-dimming switched off (modified software)



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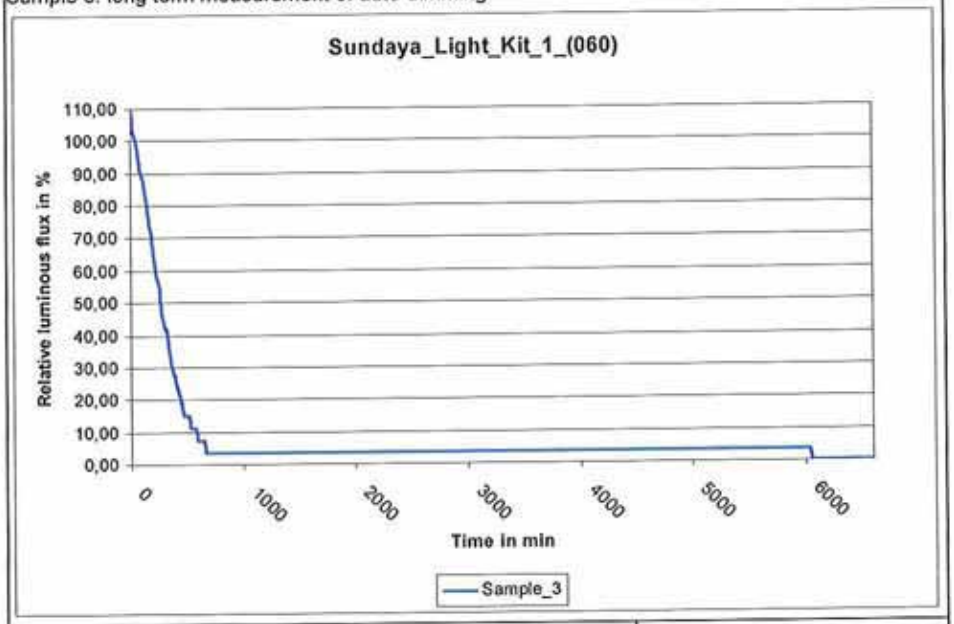
Test Protocol (continued)

<table>
<tr><th>#</th><th>Test Procedure</th><th>Measurement Parameter</th><th colspan="6">Results</th></tr>
<tr><td>3</td><td>"Run Time"
[Autonomous time]
[FISE Method 4.1.6]</td><td colspan="6">Relative luminous flux
Sample 3: long term measurement of auto-dimming
 
</td></tr>
<tr><td rowspan="8">4</td><td rowspan="8">Test charge controller
– NiMH battery –
[FISE Method 4.1.5]</td><td rowspan="7">Active charge controller</td><td></td><td colspan="2">Deep discharge</td><td colspan="2">Overcharge</td></tr>
<tr><td></td><td>V / cell</td><td>≥ 1.00 ± 0.05</td><td>< 0.95</td><td>≤ 1.40 ± 0.05</td><td>> 1.45</td></tr>
<tr><td rowspan="6">Sample #</td><td>1</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>2</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>4</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>5</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>6</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td rowspan="8">Passive charge controller</td><td></td><td colspan="2">Voltage per cell @ 24 h</td><td colspan="2">Continuous charging current</td></tr>
<tr><td></td><td>V / cell</td><td>≥ 0.80</td><td>< 0.80</td><td>< $2I_{10}$</td><td>≥ $2I_{10}$</td></tr>
<tr><td rowspan="6">Sample #</td><td>1</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>2</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>4</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>5</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>6</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>7</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td rowspan="8">4a</td><td rowspan="8">Test charge controller
– Li-Ion battery –
[FISE Method 4.1.5]</td><td rowspan="8">Active charge controller</td><td></td><td colspan="2">Deep discharge</td><td colspan="2">Overcharge</td></tr>
<tr><td></td><td>V / cell</td><td>≥ 3.00 ± 0.05</td><td>< 2.95</td><td>≤ 4.10 ± 0.05</td><td>> 4.15</td></tr>
<tr><td rowspan="6">Sample #</td><td>1</td><td>3.64</td><td>--</td><td>--</td><td>4.19</td></tr>
<tr><td>2</td><td>3.65</td><td>--</td><td>--</td><td>4.19</td></tr>
<tr><td>3</td><td>3.67</td><td>--</td><td>--</td><td>4.19</td></tr>
<tr><td>4</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>5</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>6</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td rowspan="8">4b</td><td rowspan="8">Test charge controller
– Lead-Acid batt. –
[FISE Method 4.1.5]</td><td rowspan="8">Active charge controller</td><td></td><td colspan="2">Deep discharge</td><td colspan="2">Overcharge</td></tr>
<tr><td></td><td>V / cell</td><td>≥ 1.87 ± 0.05</td><td>< 1.82</td><td>≤ 2.42 ± 0.05</td><td>> 2.47 V</td></tr>
<tr><td rowspan="6">Sample #</td><td>1</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>2</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>4</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>5</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>6</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

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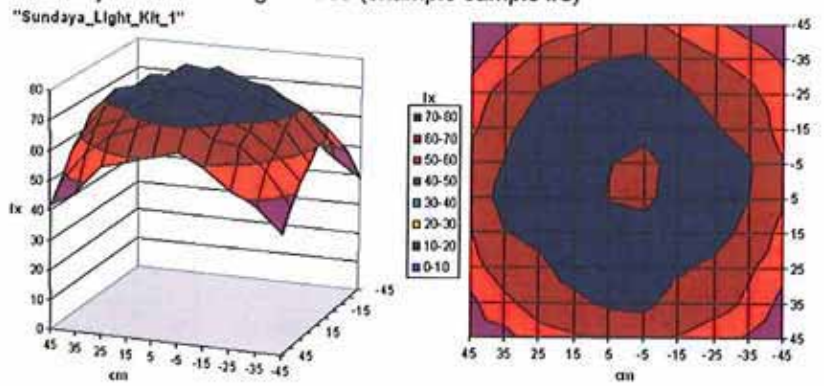
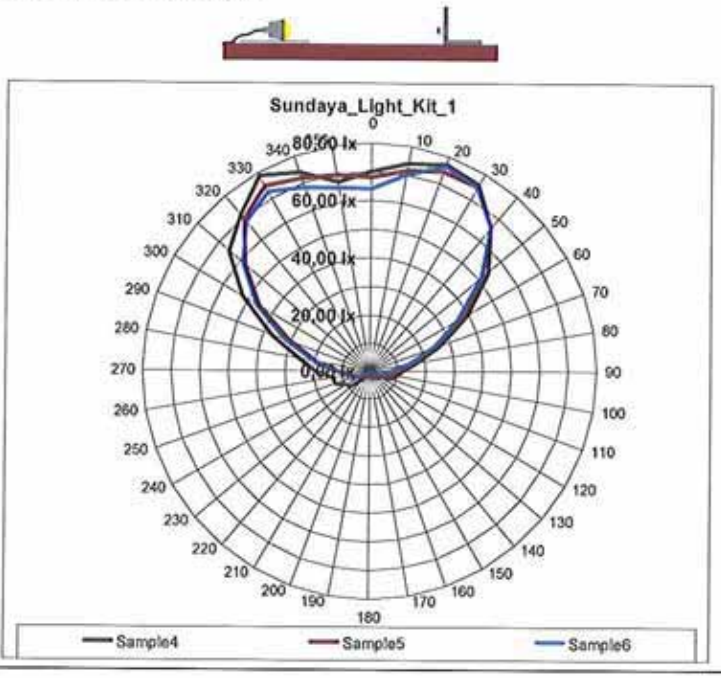
#	Test Procedure	Measurement Parameter	Results					
5	Solar charging	Sample #	1	2	3	4 [mod]	5	6
		Daily charge to discharge ratio; [%]	--	--	--	210	--	--
5a	Mechanical charging [FISE Method 4.1.9]	Run time after 5 min of cranking [min]	--	--	--	--	--	--
5b	Grid charging [FISE Method 4.1.9]	State of charge after 8 h of charging [%]	--	--	--	--	--	--
6a	Lighting service task light [FISE Method 4.1.8]	Sample #	1	2	3	4	5	6
		"Useable" working surface (≥ 20 lx) [m²]	1	1	1	--	--	--
		Average illuminance on working surface [lx]	67	67	64	--	--	--
		Light uniformity on the working surface (example sample #3)  Comment: Illuminance measured with a fully charged battery after 20 min "burn in time" at the interception points of the lines						
6b	Lighting service ambient light [FISE Method 4.1.8]	Sample #	1	2	3	4	5	6
		Useable angle of radiation @ 1m and ≥ 4 lx [°]	250	230	220	--	--	--
		Average illuminance over useable angle [lx]	42	42	43	--	--	--
		Light distribution in horizontal plane 						

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#	Test Procedure	Results

7 — Switches, connectors [FISE Method 4.1.11] — Stability of switches and connectors (1000 cycles)

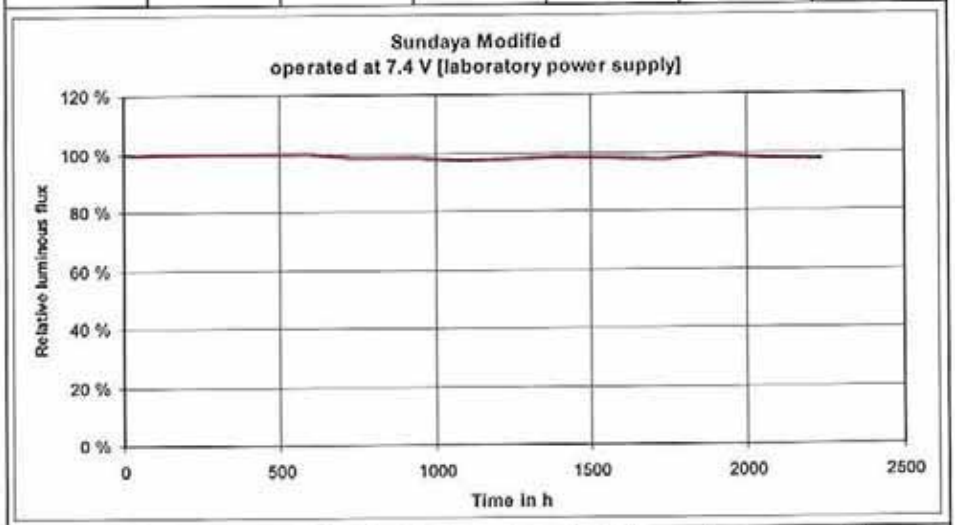
Sample #	Cycles achieved: switches	Cycles achieved: connectors	Slight damages: yes	Slight damages: no
1	1000	--	☐	☒
2	1000	--	☐	☒
3	1000	--	☐	☒
4	--	--	☐	☐
5	--	--	☐	☐
6	--	--	☐	☐

8 — Mechanical durability (drop test) [FISE Method 4.1.10] — Mechanical resistance

Sample #	Light still functional?: yes	Light still functional?: no	Slight damages: yes	Slight damages: no
1	☒	☐	☐	☒
2	☒	☐	☐	☒
3	☒	☐	☐	☒
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐

9 — Long-Term lumen degradation [FISE Method 4.1.13]

Degradation @2000 h [%]	--	--	--	2.5 @ 2232 h	--	--



Comments

- LEDs: (I_{LEDmax} = 50 mA). The long-term test showed a very small degradation.
- Charge Control:
  Self-Consumption: 14 - 25 µA
- DC-DC Converter
  LEDs driven by: 11.6 V; 50 mA (it seems likely that 3 LEDs are operated in series connection with a resistor. Four of such 3 LEDs branches are connected in parallel and operated with 11.6 V)
- Light efficiency:
  at nominal voltage 7.4 V; current 265 mA → 1.96 W input power
  220 Lumen -> ca. 112 Lumen/Watt for the complete system (!)
- LED_driver_efficiency:
  86.4 % @ nominal voltage
  „DC Input" 7.40 V; 265 mA -> 1.961 W
  „DC Output" 11.61 V; 146 mA -> 1.695 W

DAP Deutsches Akkreditierungssystem Prüfwesen GmbH

Unterzeichner der Multilateralen Abkommen von
EA und ILAC zur gegenseitigen Anerkennung

vertreten im

Deutschen AkkreditierungsRat

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Die DAP Deutsches Akkreditierungssystem Prüfwesen GmbH bestätigt hiermit, dass das

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für sein

Kalibrierlabor Photovoltaik Module

die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt,

Prüfung einschließlich Kalibrierung und Charakterisierung von Photovoltaikmodulen

gemäß den in der Anlage aufgeführten Prüfverfahren auszuführen.
Die Akkreditierung ist gültig vom 2006-11-06 bis 2011-11-05.
DAR-Registriernummer: **DAP-PL-3996.82**
Berlin, 2006-11-06

i. V. Valbuena

Univ.-Prof. Dr.-Ing. habil. K. Ziegler
Geschäftsführer
DAP Deutsches Akkreditierungssystem
Prüfwesen GmbH

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Als Leitende Begutachterin wurde Frau Ing.- Päd. U. Hagen von der Bundesanstalt für Materialforschung und -prüfung (BAM) beauftragt

Anlage zur Akkreditierungsurkunde DAP-PL-3996.82 nach DIN EN ISO/IEC 17025:2005

Gültigkeitsdauer: 2006-11-06 bis 2011-11-05

Urkundeninhaber: **Fraunhofer-Institut für Solare Energiesysteme (ISE)**

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für sein

Kalibrierlabor Photovoltaik Module

Prüfung im Bereich: **Prüfung einschließlich Kalibrierung und Charakterisierung von Photovoltaikmodulen**

IEC 60904-1 1987-12	Measurement of Photovoltaic current-voltage characteristics
IEC 60904-3 1989-03	Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance

verwendete Abkürzung:

IEC	International Electrotechnical Commission

Certificate DE07/3874

The management system of

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Heidenhofstraße 2
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has been assessed and certified as meeting the requirements of

ISO 9001:2008

For the following activities

Research, development and service in the fields of thermal and electrical solar energy application, building services and hydrogen technology

Further clarifications regarding the scope of this certificate and the applicability of ISO 9001:2008 requirements may be obtained by consulting the organization

This certificate is valid from 30/04/2010 until 29/04/2013
Issue 4. Certified since March 2001

Authorised by

Deutscher Akkreditierungs Rat
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TGA-ZM-17-93-00

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