

# Indoor Low Light Energy Harvesting Photovoltaic Cells for Connected Devices

Ambient's endless power technology eliminates the hassle, expense and environmental cost of battery replacement by harvesting low indoor light, making Ambient cells ideal for powering the next generation of smart home, consumer electronics and IoT devices.

## High Power Density

Ambient indoor low light photovoltaic cells deliver the highest performance available on the market. Compared to conventional amorphous silicon solar cells, Ambient photovoltaic cells produce 300% more energy at typical indoor light levels and up to 400% more energy at very low indoor light levels.

## Optimized for All Indoor Light Sources

Ambient's thin and lightweight dye sensitized PV cells deliver consistent power across all types of indoor illumination sources including LED, fluorescent, incandescent and diffuse natural light.

## Industry's Only Monolithic Single Cell Architecture

High open circuit voltage of ~900 mV at 200 lux allows efficient use of a wide range of energy harvesting solutions while retaining a single cell architecture. This single-cell approach delivers pleasing aesthetics and easy scalability -- unlike conventional amorphous silicon cells or nascent organic PV cells. Conventional indoor PV technology uses multi-cell modules which cut power output to zero if just one of the cells is shaded. Ambient's single-cell designs are exceptionally shade tolerant, maximizing energy delivery under real-world conditions.

The single cell approach also enables Ambient to deliver a flexible form factor, with cells that can be made in arbitrary rectangular sizes to fit any device and satisfy virtually any power requirement. Ambient cells range from 5 cm<sup>2</sup> to 225 cm<sup>2</sup> and anywhere in between.

## Superior Sustainability

Recognizing the need to lessen environmental hazards and lower carbon footprints, many manufacturers have focused on device lifetime extension and power requirement reductions. These strategies serve to cut down the number of batteries consumers will require to maintain desired functionality. Ambient's low light PV cells do more to help manufacturers achieve electronic device sustainability goals than any other technology on the market. In addition, in keeping with our green chemistry DNA, Ambient's manufacturing processes and proprietary chemistry avoid toxics and waste.

## Market-Ready Reference Designs

We offer a turnkey solution with custom-sized cells, application expertise, and energy harvesting reference designs from a wide range of leading PMIC providers.

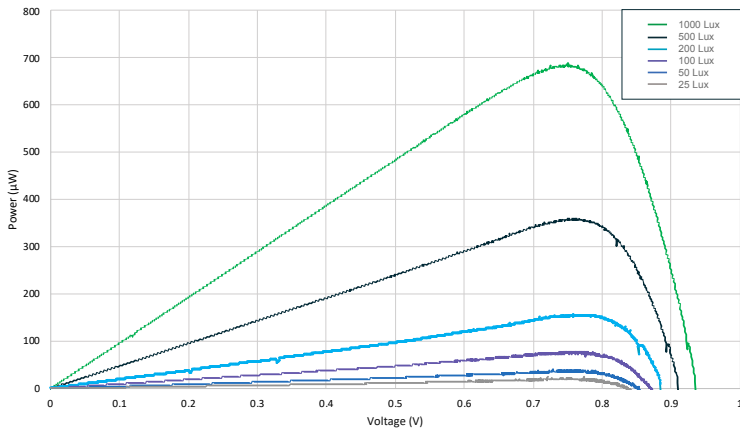
**POWER IS THE META-RESOURCE**

More power, more functionality, greater value

- More powerful edge computing
- Enhance IoT security
- Extend communications range
- Increase sensing capabilities

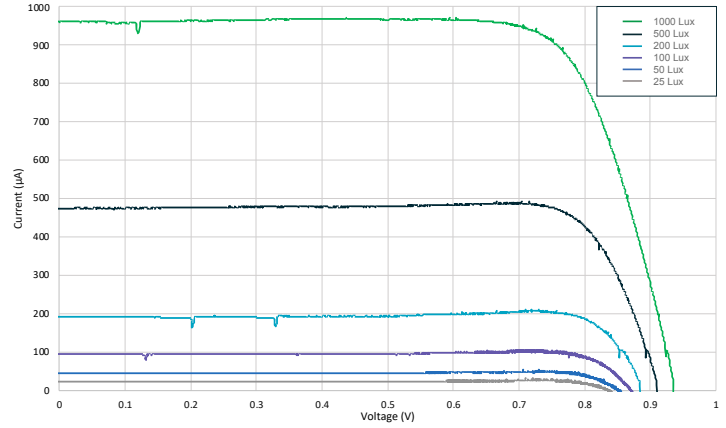
## Nearly Constant Maximum Power Point

Power-Voltage curves of 10 cm<sup>2</sup> Ambient LLI PV cells at various light levels



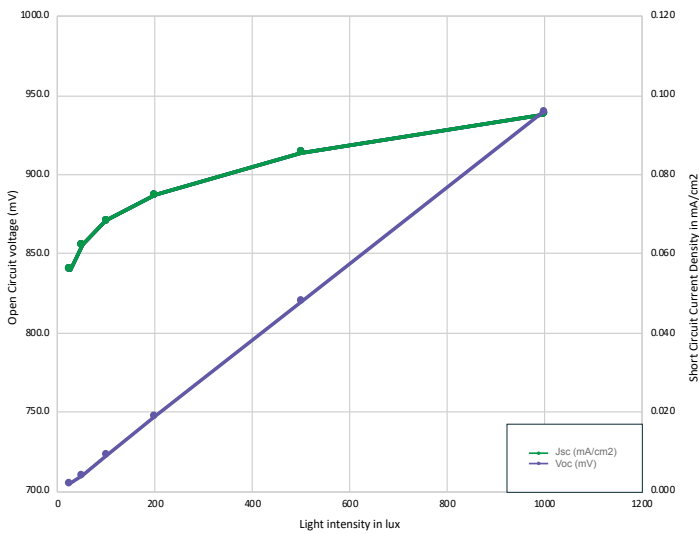
## I-V Curve

Current-Voltage curves of 10 cm<sup>2</sup> Ambient LLI cell at various light levels

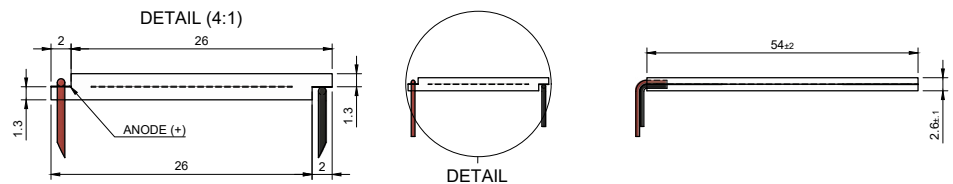
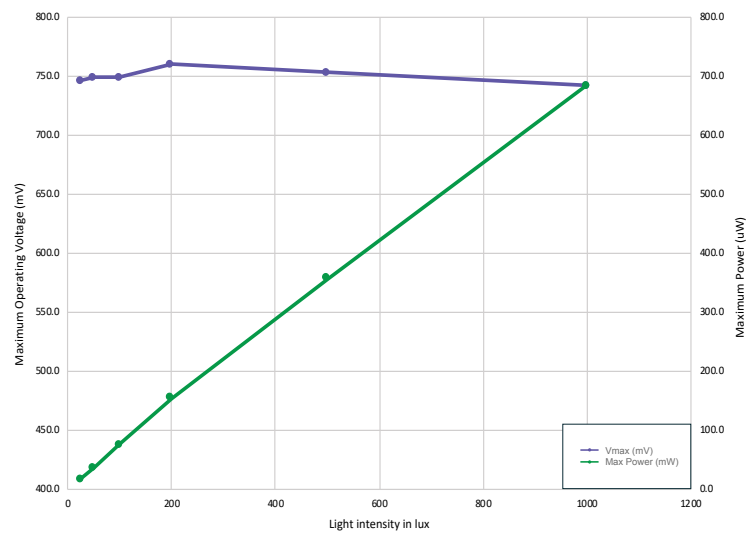


Unlike conventional silicon solar cells, Ambient cells have nearly fixed maximum power point resulting in easier integration with energy harvesting circuits.

## Voc and Jsc vs. Light Intensity

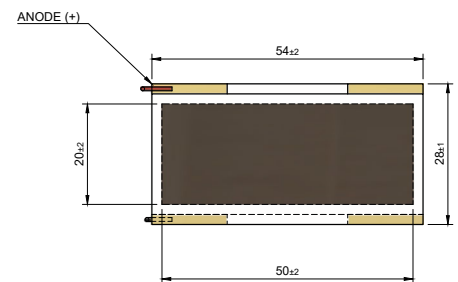
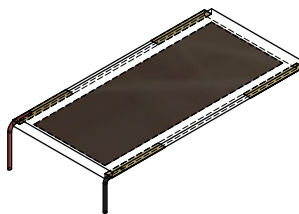


## Power and Operating Voltage at Various Light Levels



## Indicative Dimensions

Ambient cells can be manufactured in a range of aspect ratios and sizes from 5 cm<sup>2</sup> to 225 cm<sup>2</sup>. The diagram below depicts indicative dimensions for a 2 x 5 cm<sup>2</sup> cell.



- NOTE**
1. Overall PV volume is: 54 +/- 2 mm x 28 +/- 1mm x 2.6 +/- 0.1 mm
  2. Dimensions without tolerance are indicative only
  3. Wire attachments and regions are indicative only
  4. Drawing scale is 2:1 unless otherwise noted
  5. Drawing units are millimeters unless otherwise noted

## Electrical Specifications (10 cm<sup>2</sup> cell) at 200 lux

Item	Unit	Minimum	Typical	Maximum
Operating Voltage ( $V_{ope}$ )	mV	700	750	780
Operating Current ( $I_{ope}$ )	$\mu$ A	150	170-180	190
Maximum Power ( $P_{max}$ )	$\mu$ W	115	135-150	160
Open Circuit Voltage ( $V_{oc}$ )	mV	840	860-880	900
Short Circuit Current ( $I_{sc}$ )	$\mu$ A	160	200	200

All above specifications at 200 lux with white LED at 25° C.

## Operating Conditions

Item	Unit	Minimum	Maximum
Surface Temperature	°C	-30	40
Ambient Humidity	%RH	non-condensing	

## Storage Conditions

Item	Unit	Minimum	Maximum
Surface Temperature	°C	-30	65
Ambient Humidity	%RH	0	90

## Precautions

Do not apply a current or voltage exceeding the maximum rating from the outside the external interface (lead wire).

Item	Unit	Maximum Rating
Forward Voltage	mV	Maximum $V_{oc}$ +10%
Reverse bias maximum	mV	-100

## Effective Service Life

The following Highly Accelerated Life Tests (HALT) have been designed to demonstrate an effective service life of ten years provided that the device is used in accordance with applicable specifications. Devices which pass the test demonstrate less than 20% degradation in electrical performance following the HALT procedure.

Test Condition	Test Parameters
Light soaking (Open circuit and load)	2,000 hours at 20,000 lux
Thermal Aging (dark)	1,000 hours at 50° C 200 hours at 65° C
Damp heat	1,000 hours at 42° C/93% RH
Temperature cycling	50 cycles -20 to 65° C

Pre-production samples are provided AS-IS. Ambient does not make and hereby disclaims all warranties and conditions including without limitation the implied warranties of merchantability, fitness for a particular purpose, title, or non-infringement of third-party rights.

Pre-production samples are intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and are not considered to be finished end-products fit for general consumer use. Persons handling the product should have electronics training and observe good engineering practice standards. Ambient makes no assurances that any prototypes produced in connection with the Services fall within the scope of the European Union directives regarding electromagnetic compatibility, FCC, CE or UL and therefore may not meet the technical requirements of these directives or other related documents.

Rev. 20210618