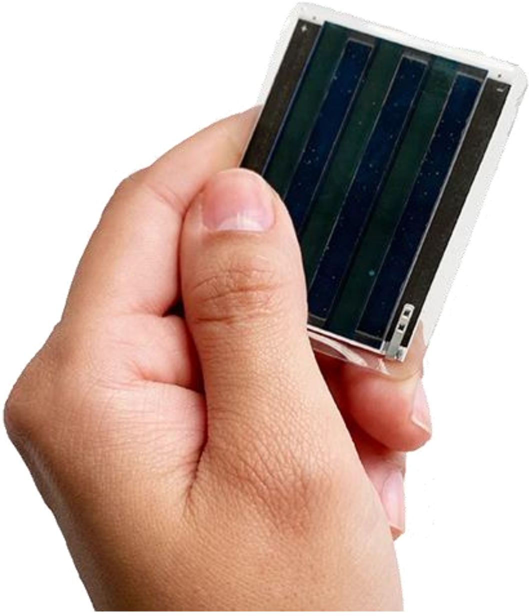
Batteryless MiroCard

Deploy-and-Forget Sensing Devices using BLE®



Description

The MiroCard is our first generation of batteryless sensors. Using the latest solar harvesting technology, these devices operate without batteries even in low indoor lighting conditions, thus eliminating the need for battery maintenance. Their small size and width, less than a credit card, enables them to be used as either deploy-and-forget sensors for smart infrastructure, or as a replacement for contactless smartcards. These light-harvesting devices are privacy conscious, as they only work when there is enough light present (>200 lux). They are more secure than Near Field Communication because they are inherently immune against RFID skimming. Since obscured solar cells cannot be remotely energized by third parties, MiroCard are only active when users *decide* to expose the it to light.

Onboard sensors include light, temperature, humidity, magnetic field and acceleration. This device is currently available using Bluetooth Low Energy technology.

Key benefits

- No battery maintenance
- Fast wake up (~3 seconds)
- Small form factor
- Immunity against RFID skimming
- Bluetooth and 802.15.4 protocols

Applications

- Environmental sensing
- Smart buildings
- Wireless sensing
- Asset Tracking
- Electronic Point of Sale
- Secure authentication
- Industrial and home automation

About this Document	
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We reserve the right to make technical changes, which serve to improve the product, without prior notification.

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Functional Description

Batteryless IoT Sensors are a new line of energy-harvesting sensors with virtually infinite lifetimes. These devices are powered entirely from the environment, using a high efficiency solar cell. Our advanced power management enables fast wake-up times of several seconds, depending on light availability. Once the device is in operation, it can read different sensors including light, temperature, humidity and acceleration. The MiroCard operates in the 2.4GHz frequency band and can broadcast sensor data in Bluetooth Low Energy (BLE) beacon format, as well as proprietary 802.15.4-based protocols.

Electrical Specifications

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
RF_{OUT}	RF Output Power	V_{CC} > 2.4 V	-	-	+5	dBm
RX_{SEN}	Receiver Sensitivity	BLE Mode	-	-97	-	dBm
		802.15.4 PHY	-	-100	-	dBm
P_{RX}	Link Budget	BLE Mode	-	102	-	dB
		802.15.4 PHY	-	105	-	dB
T_{OP}	Operating Temperature	-	-20	-	+40	°C
Power Conversion						
$P_{SRC,COLD\text{-}START}$	Input power required for cold start	During cold-start	3	-	-	µW
V_{SRC}	Input voltage of solar cell	During cold-start	0.38	-	5	V
		After cold-start	0.05	-	5	
IDD_{MAX}	Maximum supplied current	-	-	-	80	mA
$V_{CAP,ACTIVE}$	Capacitor voltage during activation	-	2.8	-	4.25	V
Current Consumption						
IDD_{SL}	Supply current in sleep mode	-	-	2.5		µA
IDD_{rx}	Supply current in RX mode	-	-	5.9	-	mA
IDD_{tx}	Supply current in TX mode	TX power @ 5 dBm	-	9.1	-	mA

Packet Transmission Rate

Condition	Luminosity	Startup Time	Average Input Power	Average Comm. Rate[1]
Natural + indoor light	2600 lx	2.9 s	977 µW	16.25 pkt/s
High indoor light	1000 lx	7.2 s	372 µW	6.17 pkt/s
Medium indoor light	500 lx	13.6 s	181 µW	2.92 pkt/s
Low indoor light	250 lx	33.5 s	85 µW	1.9 pkt/s

[1]Average packet transmission measured using a packet size of 42 bytes, containing 25 bytes of advertisement data.

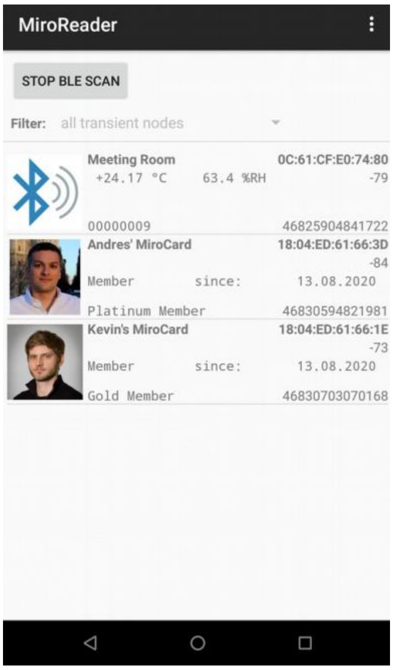
Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Unit
V_{SRC}	Input voltage of solar cell	0	5.5	V
T_{OP}	Operating Temperature	-20	+40	°C
RH_{OP}	Operating Relative Humidity (non-condensing)	0	85	%

WARNING!
Stressing the device beyond the “Absolute Maximum Ratings” may cause permanent damage. These are stress ratings only. The product is not protected against over voltage or reversed voltages.

Companion App

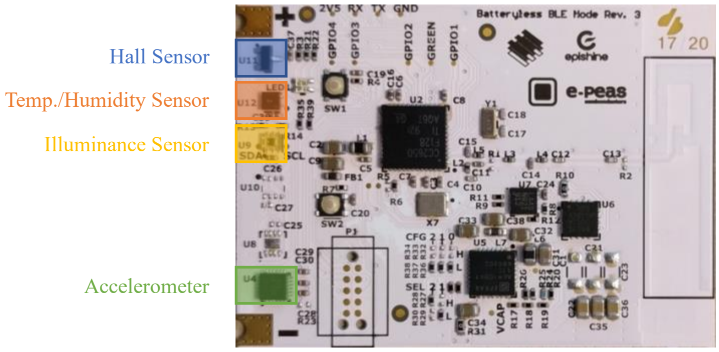
The MiroReader companion App for Android devices can be used to visualize the sensor data from the MiroCard. Depending on the specific configuration, this can mean either sensor data, or user data. In the following figure, two different MiroCard types are visualized. The first is a temperature and humidity sensor. Depending on the MiroCard configuration, not all sensor readings might be enabled. This directly correlates with the periodicity with which sensor values can be transmitted.



Device Layout

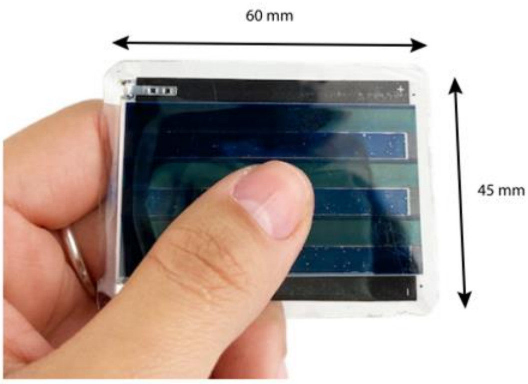
MiroCard hosts four different sensors. Two are environmental sensors: a light sensor and a high-accuracy temperature/humidity sensor. In addition, a Hall sensor can detect the presence of a magnetic field. This can be used to determine the proximity of objects with magnets. An accelerometer can detect the orientation of the MiroCard. These sensors can be used in conjunction with internal cryptographic keys to establish a secure communication protocol with smartphones and base stations.

Bottom view:

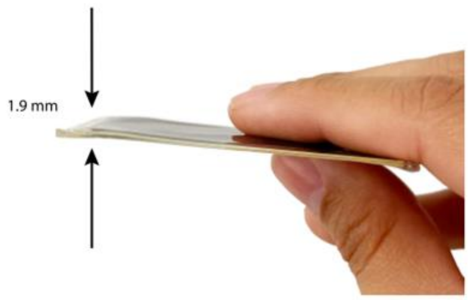


Mechanical Dimensions

Top View



Side View



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The MiroCard and MiroReader app are designed by Andres Gomez, inspired by the Transient BLE Node project developed at ETH Zurich. The MiroCard and MiroReader app will be released as open-source projects under an MIT License. The Transient BLE Node project is an open-source project released under the Creative Commons Attribution 4.0 International License.