

European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs and MC Meeting at LINKOPING, 3 - 5 June 2015

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

LOW COST CO2 SENSOR FOR BATTERY POWERED APPLICATIONS



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WG Member

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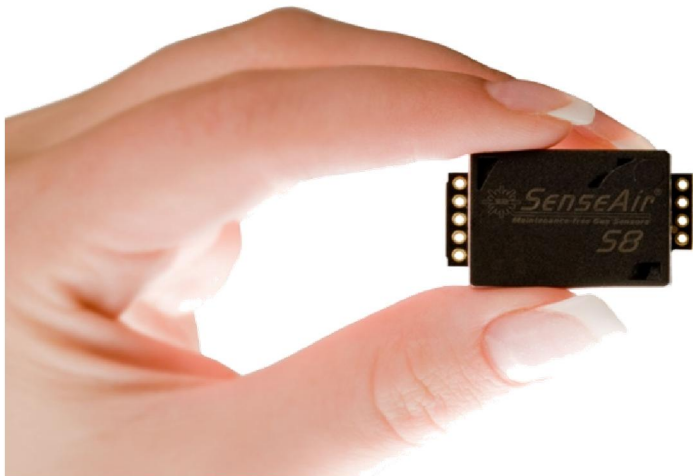
 **cost**
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



SenseAir

World leading within research, development and production of NDIR gas sensors and gas analyzers

Large volumes of various gas sensors,
> 300 000 per year



IR Components for Low Power CO2 NDIR sensor

Optimal Effective Noise Bandwidth per measurement in NDIR sensor is 2,5-4 Hz

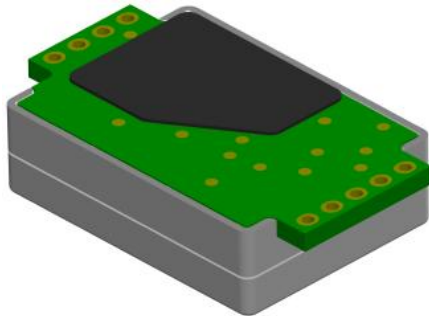
IR detectors

Class	Type	Model	D*, cm $\times\sqrt{\text{Hz/W}}$	Price
Thermal	Thermopile	Heimann HMS J21	1,4 $\times 10^8$	Low
	Pyroelectric	InfraTec LME-335 DIAS LTSI Q2PC	6 $\times 10^8$ 6.2 $\times 10^8$	High
Photon	Photoconductive PbS, PbSe (uncooled)	CalSensor, Teledyne, Hamamatsu, ES, Nanolight	1 $\times 10^8$ - 1 $\times 10^{10}$	Moderate / High
	Photovoltaic InAs, InSb, InAsSb	Lms43PD-05	(6-10) $\times 10^8$	Moderate
		Used in LP8 sensor	8,7 $\times 10^8$	Moderate

IR sources

Class	Type	Model	Optimal voltage, V	Opt. peak current, mA	Charge per meas., mC	Relative signal @5Hz	Price
Thermal	Filament lamp	5V 115mA CC-6	4,5	250	14,6	1	Low
		SenseAir specs.	2,5	125	2,4	0,2	Low
	MEMS	Leister EMIRS50	2,7	64	3,7	0,05	High
Photon	LED		0,3-1,5	20 - 2000	0,5 - 10	0,01 – 0,3	High

LP8 miniature low-power sensor



Charge per measurement:

Total	3,6 mC
IR source	2,5 mC
Electronics	1,1 mC

Achieving RMS noise in CO₂ measurements:

@400ppm	4 ppm
@1000ppm	7 ppm

STANDARD SPECIFICATION

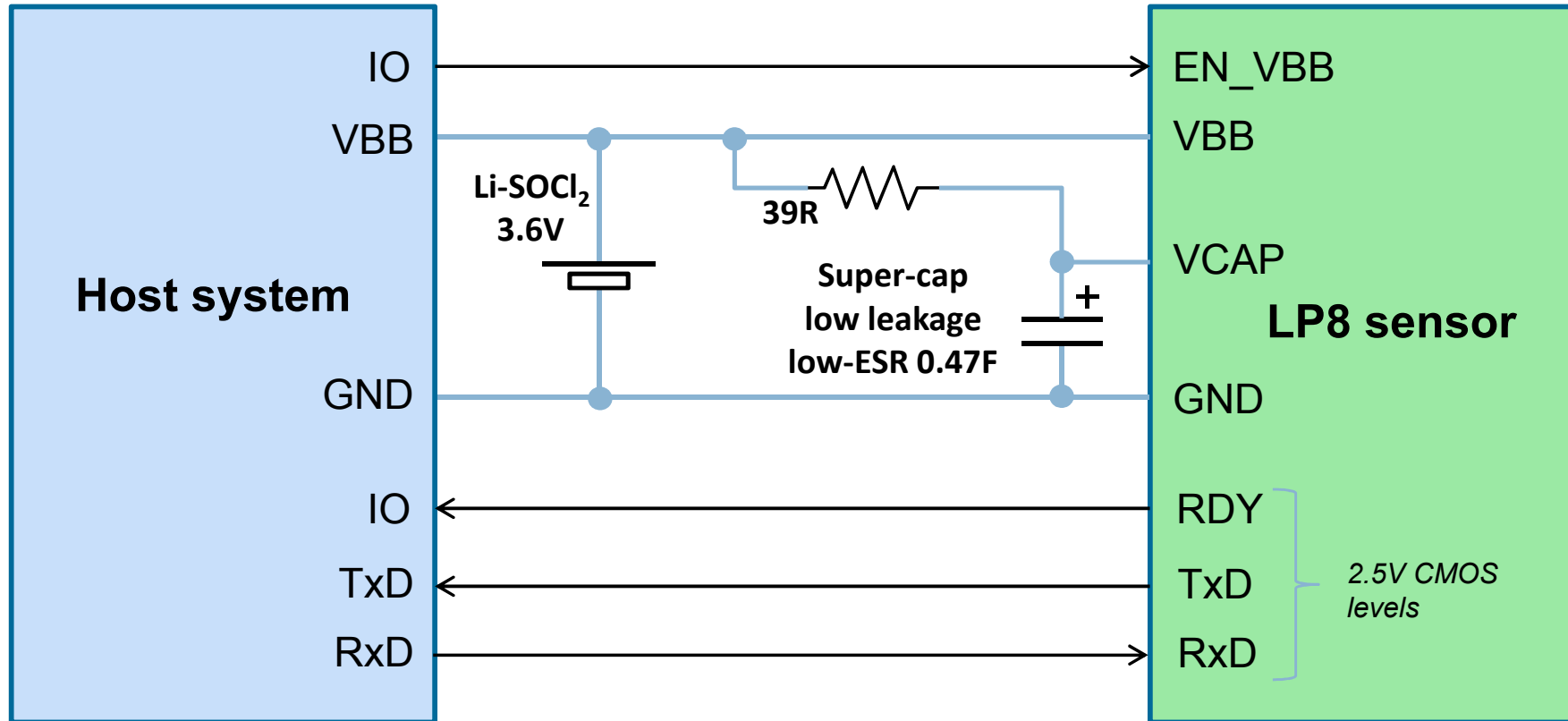
Measured gas	Carbon dioxide (CO ₂)
Operating principle	Non-dispersive infrared (NDIR)
Measurement range	0 - 10000ppm
Accuracy CO ₂	±35ppm ±3% of reading ¹
RMS noise CO₂	4 ppm @ 400 ppm 7 ppm @ 1000 ppm
Accuracy Temperature	±0.7°C
Power supply	2.9 – 5.5V
Peak current	125 mA
Shutdown current	1 µA ^{2,3}
Charge per measurement	3.6 mC
Energy per measurement	11.9 mJ @ 3.3V
Average current having	
16 s meas. period	225 µA ^{2,3}
60 s meas. period	61 µA ^{2,3}
120 s mes. period	31 µA ^{2,3}
Measurement period	≥16 s
Dimensions	8 mm x 33mm x 20mm
Life expectancy	>15 years
Operation temperature range	0 - 50°C
Communication	UART (host-slave protocol)

Note 1: 10 – 40°C, 20 – 60 % RH

Note 2: Option of measuring battery voltage adds 12 uA

Note 3: External super-capacitor leakage is not considered

Typical connection to host

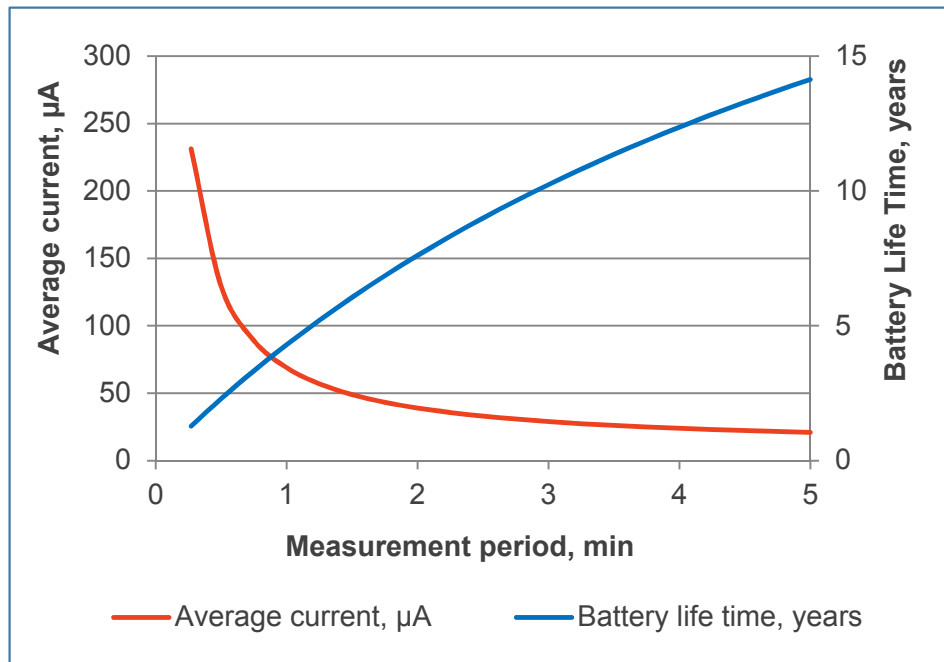


To limit sensor peak current to 2 mA use a super-capacitor.

Recommended super-capacitor Eaton Bussman PM-5R0H474-R (0.47F 5V). It is specified for 8 μ A leakage current @5V, 20 $^{\circ}$ C and 500m Ω ESR.

Flexibility in interaction with a host

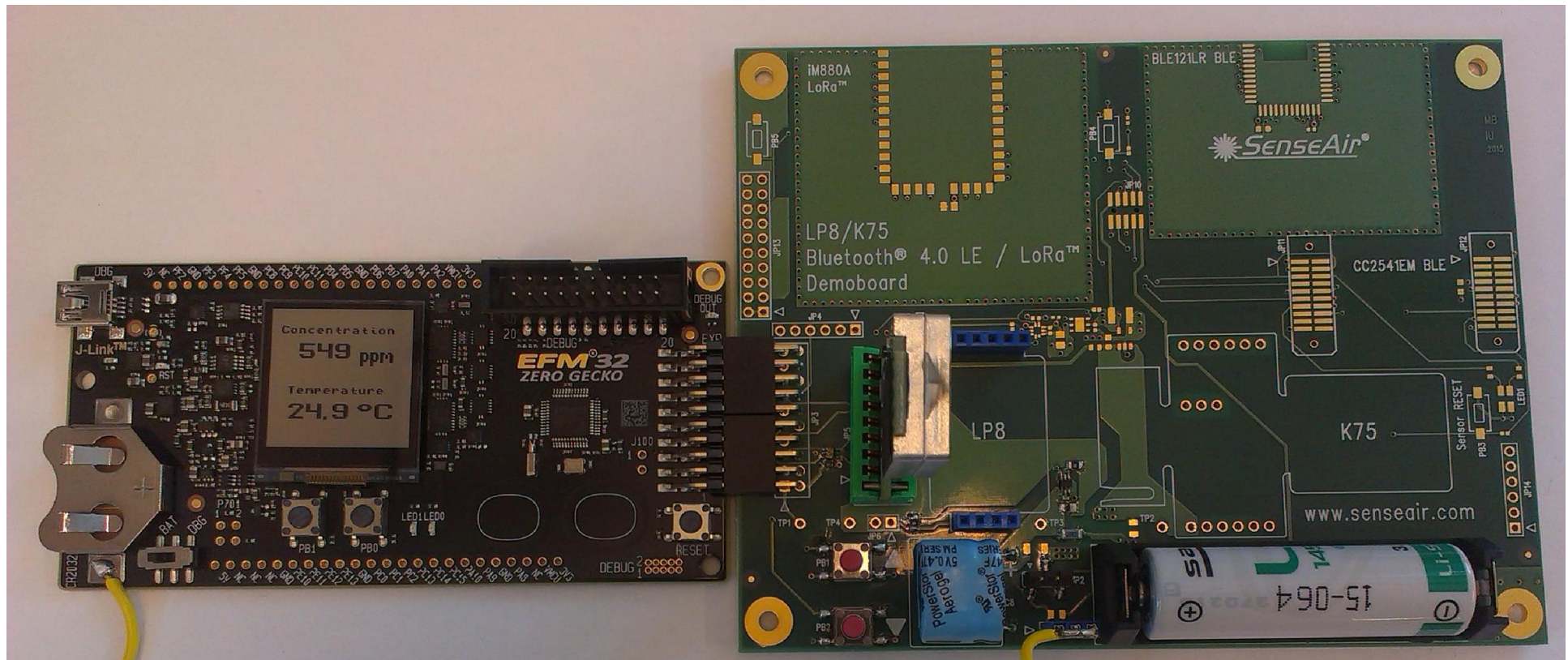
Minimum measurement period is 16 seconds.
A host system can vary measurement period dynamically adjusting consumed power.



Automatic Background Calibration (ABC)
Host System count ABC period and when it expires simple sends a command to the sensor which invokes recalibration.

To insure low sleep current below 1µA sensor voltage regulator is switched off between measurements. Host maintains sensor state.

A graphical display application

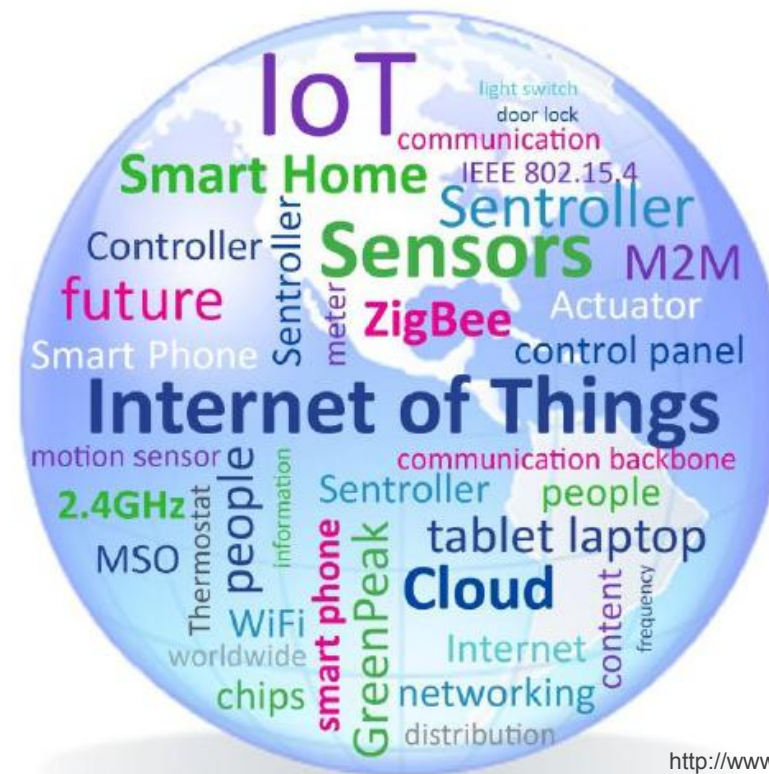


Display part:
EFM Zero Gecko MCU starter kit with static
Toshiba graphical display.
Display is updated with measurement
period.

Charge per measurement:
Display Host part 8,2 mC
LP8 sensor 3,6 mC

Wireless battery powered applications

Standards / Alliances / WGs

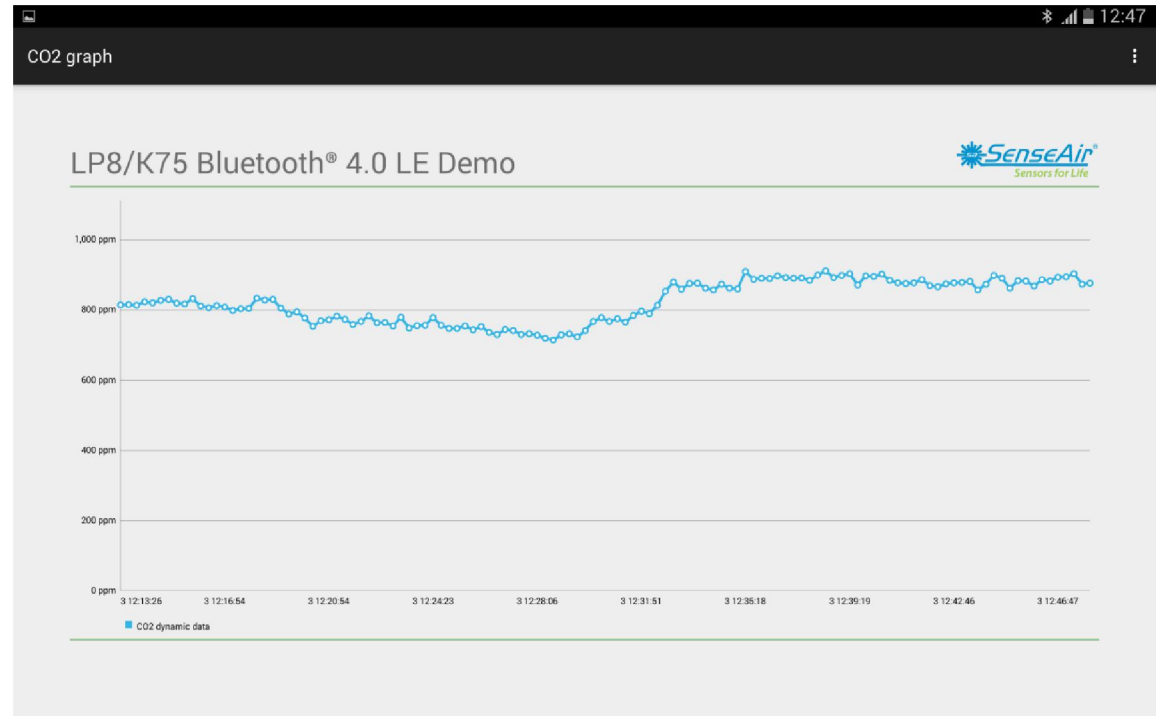


EE Times IoT Analysis: In the future, cellular networks may take about 10% of the whole IoT traffic; short-range RF solutions such as Bluetooth, WiFi, or ZigBee may support about 35% of the traffic; and long-range IoT-dedicated networks may grab 55% of the data load.

Bluetooth® Low Energy on Smartphones and Tablets

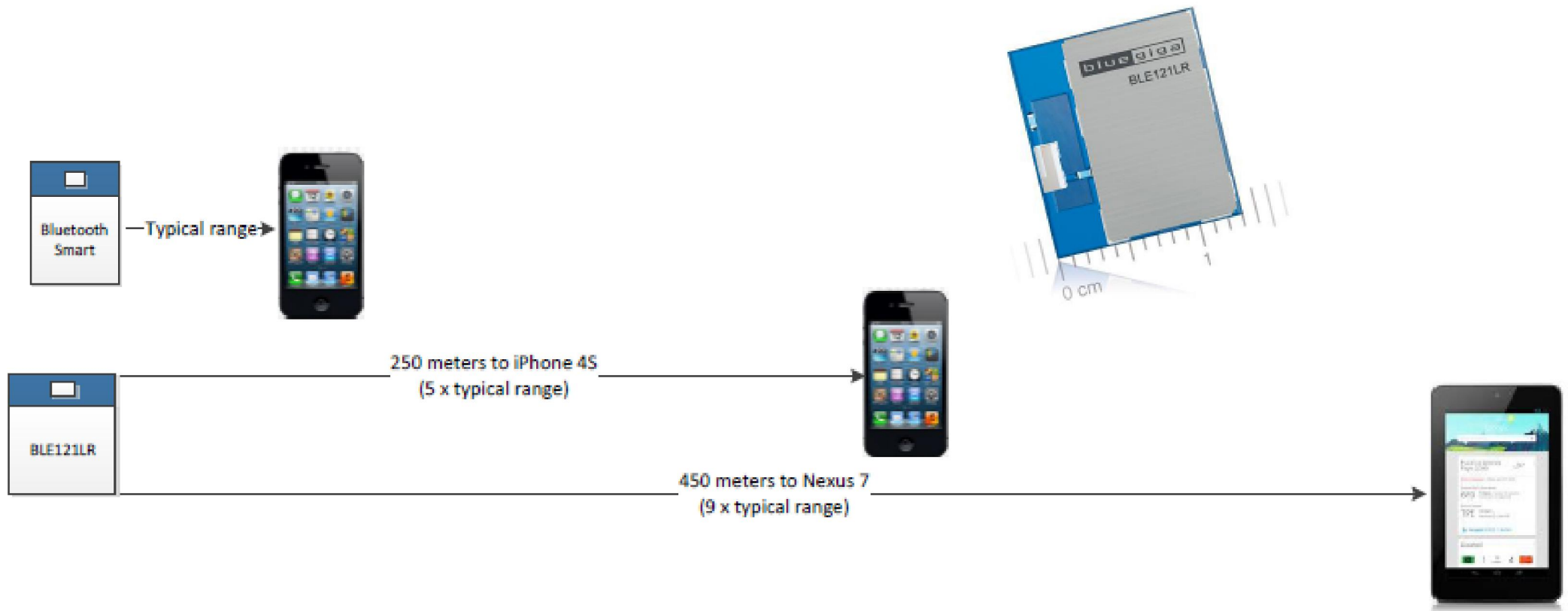


SenseAir Demoboard is ready for evaluation of LP8 sensor with a BLE module.



BlueGIGA BLE121LR module

BLE121LR *Bluetooth*® Smart Long Range Module is a good example of Bluetooth Low Energy range capabilities.



LoRa[®] Application

www.lora-alliance.com



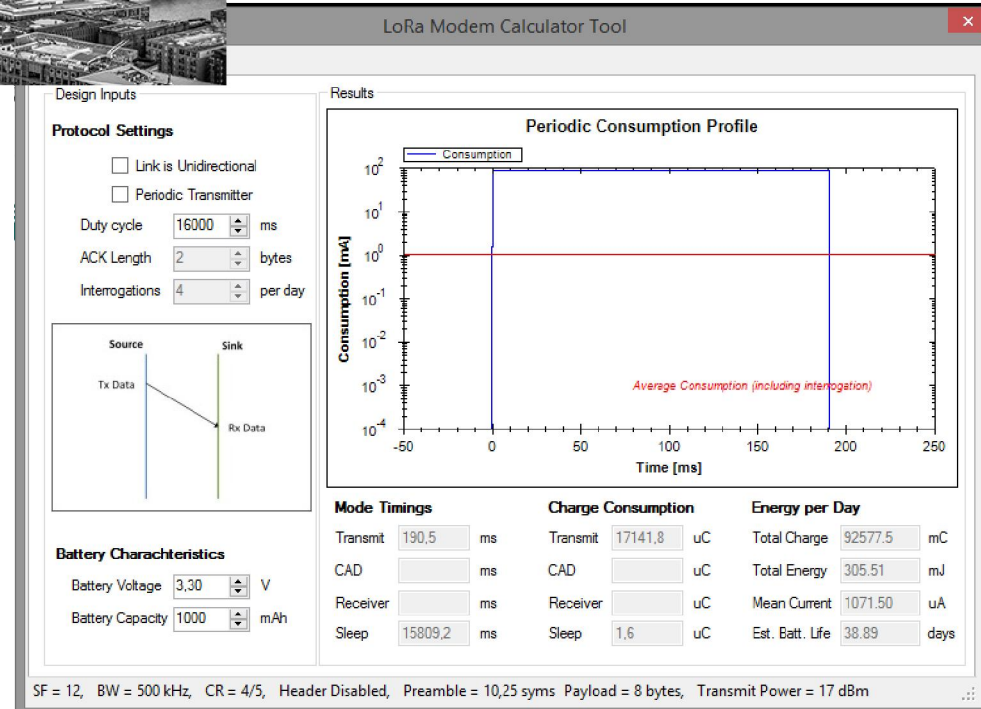
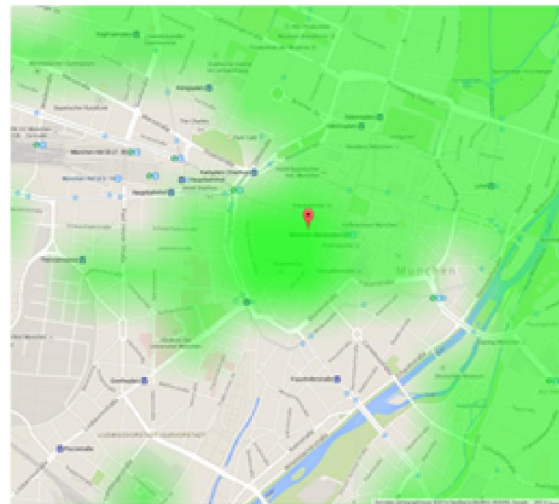
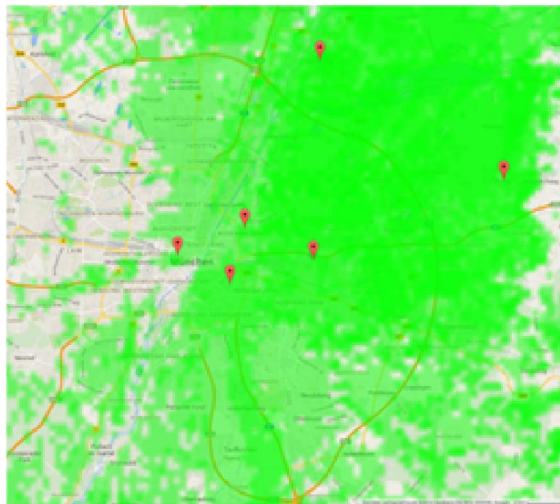
LoRaWAN (Long Range Wide-Area Network) is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated Things in regional, national or global network. LoRaWAN target key requirements of internet of things such as secure bi-directional communication, mobility and localization services.

- ✓ Star topology.
- ✓ Bi-directional. 0,3-50 kbps.
- ✓ Long Range up to 18 km
- ✓ Secure

SemTech LoRa charge calculator.
15-21 mC if configured as periodic transceiver.



Real world example: Deployment of 7 LoRa Technology gateways creates IoT network coverage for most of Munich





Thank You for Your Attention!!!