Wireless Solar Temperature Sensor

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Client: Dan Stiler of Powerfilm Inc.

Introduction:

Problem: We are required to measure the low power consumption of a circuit system. The system should be remote sensing device, and be solar powered.

Statement: This solar powered system needs to measure the temperature and humidity as well as translate the data through wireless transmission to mobile devices. The purpose is to provide power consumption data in different builds of Wireless solar temperature and humidity sensor circuit. The view of design and analysis is on how little power the system can consume and be useable.

Solution: Try different ways of data transmission and test different sensor technologies for lowest power consumption. We also need to choose the solar panel and battery to work continuously in low light conditions.

Design Requirements:

Functional requirements: Keep the system operable under 400 lux light level, keep power consumption low, precisely measure and record the temperature and humidity changes from the sensor.

Non-Function requirements: The scale of the system should be small.

Operating environments: The system should work effectively within 20 meters indoors and outdoors.

Intended client and support: This design project has been proposed by PowerFilm Inc. Most of the components are provided by the client Dan Stiler of Powerfilm Inc.

Design Approach:

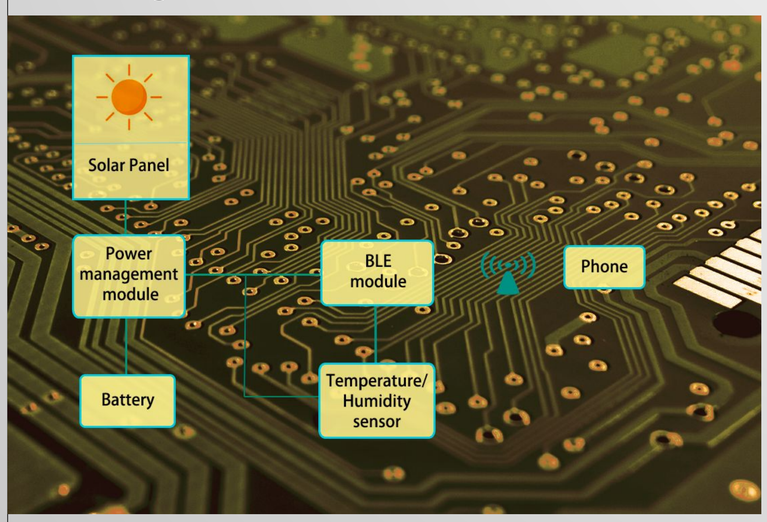
Concept sketch
To meet the requirements we need to have

- Wireless communication module with a programmable microcontroller
- Low power consumption temperature and humidity sensor
- Solar panel and power management module
- Suitable battery

After doing researches we find the **Bluetooth Low Energy** is the best wireless protocol which can provide good transmission in our requirement range and keep the power consumption as low as possible. Ref 1

In the design, we tested different sensor to find the HDC1080 is the best one for our system. The HDC1080 uses the lowest power while offering the best sensor range and accuracy.

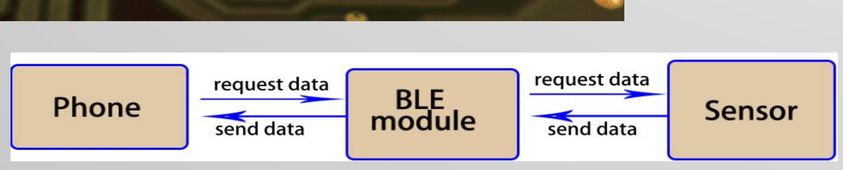
Block Diagram



In the system we design to reuse **solar panel** to get solar power.

The energy through **power management module** will be used to charge the **battery.**

The voltage regulated by **power management module** supply the **BLE module** and **sensor.**



The **BLE module** will generate data from **temperature and humidity sensor** and send it to **mobile devices.**

Programming the BLE MCU is essential as it communicate with the sensor and user terminals.

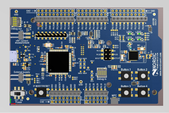
Hardware Function Module Detail:

Humidity & Temperature Sensor

- HDC1080
  - Humidity range:0 %~ 100%
  - Temperature range: -40C~25C
  - Minimum voltage supply:2.7V

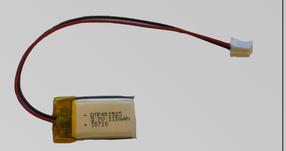
BLE Module

- NRF52
  - Data rate : 1Mbps
  - TX power: -20 to +4 dBm in 4dB step
  - Supply voltage: 1.7V~3.6V



Battery

- Lithium polymer battery 401525
  - 100mah Capacity
  - 3.7v

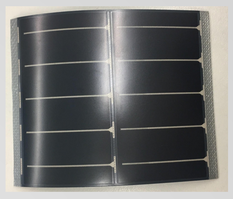


Power Management Module

- BQ25570 Battery charger Evaluation Module
  - Output efficiency: up to 93%

Solar Panel

- Operating Voltage: 2V
- Provided by PowerFilm Inc.



Development Tool:

Arduino IDE

Libraries

- SPI.h - SPI.h allows to communicate with Serial Peripheral Interface devices.
- Wire.h - Wire.h allows to communicate with I2C and TWI devices.
- Adafruit_BLE_UART.h - BLE_UART.h provides connection between bluetooth and UART phone application
- ClosedCube_HDC1080.h - HDC1080 library provides all associated function to get temperature and humidity data.

uVision 5 Software

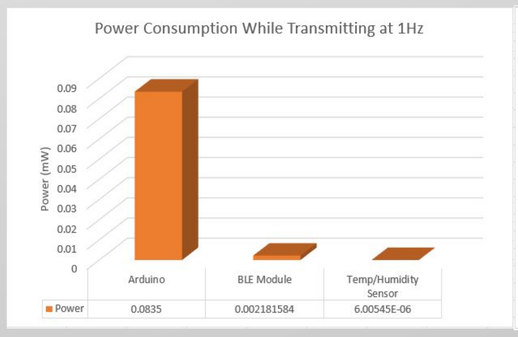
Example Pack

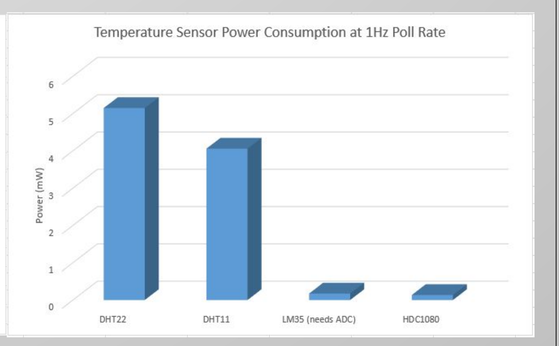
- Ble_app_uart
  - Ble_app_uart example provides communication functions for bluetooth device.
- Twi_sensor
  - Twi sensor example enables to communicate with hdc1080 sensor.
  - This provides several functions to read temperature and humidity data from the sensor.

System Power Consumption:

- Hardware prototype included Arduino
- Final version eliminates the Arduino in favor of programming the BLE MCU directly
- As a result power consumption has decreased tenfold

	LM35	HDC1080	DHT22	DHT11
Minimum Tested Voltage Supply (V)	4	2.7	3	3
Temp Range (°C)	-55 ~ 150	-40 ~ 125	-40 ~ 125	0 ~ 50
Temp Accuracy (°C)	0.5	0.2	0.5	2
Humidity Range (%)	NA	0 ~100	0 ~ 100	20 ~ 90
Humidity Accuracy (%)	NA	2	2	5
Idle Current	0.0529mA	0.100uA	40uA	150uA
Average Current During 1Hz Polling	0.0529mA	0.041mA	1.56mA	1.23mA





References

1. Phil Smith. Comparing Low-Power Wireless Technologies. Contributed By Convergence Promotions LLC. Aug.08.2011. https://www.digikey.com/en/articles/techzone/2011/aug/comparing-low-power-wireless-technologies